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Secretariat: ANSI

Information technology — Artificial Intelligence (AI) — Use cases

WD/CD/DIS/FDIS stage

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Foreword

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This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 42, *Artificial Intelligence*.

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Introduction

[Editor's Note: Extract from WG4 N7, SG3 study report, 1.1 BACKGROUND]

During its 32nd Plenary meeting, ISO/IEC JTC 1 passed a resolution to establish SC 42 on Artificial Intelligence, subject to ratification by the IEC Standards Management Board (SMB) and the ISO Technical Management Board (TMB). The SC 42 Chair has developed the proposed structure of SC 42. During the Inaugural JTC 1/SC 42 Plenary meeting, delegates approved the establishment of JTC 1/SC 42/SG 3 Use cases and applications.

[SOURCE: SC42 N078, Resolution 9]

As per JTC 1 Standing Document 10, SC 42 can create Study Groups with defined membership to carry out certain responsibilities. Study Groups are chartered to investigate the need and feasibility of additional standardization and/or guidance in a technical area. The main objective of a Study Group is to understand the current activities in this area and make recommendations to SC 42, which may include development of New Work Item Proposals for SC 42 ballot.

In SG3, we collect and analyze AI-related industry applications and use cases. By investigating use case, it is possible to find the new technical requirements (standardized demand) from the market, accelerating the transformation of Science and Technology achievements. We consider that the use cases can be a useful tool for:

— Shaping the work programme of SC 42

— Extracting technical requirements which can lead to new work item proposals

— Scoping discussions outside of the standards community

To properly address the above bullets, it is recommended that use cases are captured in a document that is publicly and freely available. A Technical Report is a suitable document type.

[SOURCE: SC42/SG3 N011, contribution from UK NB)

[Editor's Note: Extract from SG3 1st F2F discussion at Sunnyvale, refers to SC42 N204]

Rationale for the proposed TR on use cases:

— Illustrating the applicability of the SC 42 program of work across a variety of application domains

— Input to and reference by SC 42 program of work

— Sharing the collected use cases in support of the SC 42 program of work with external organizations and internal entities to foster collaboration

— Reach out to new stakeholders interested in AI applicability

— Establishment of category C Liaisons to collect requirements for AI via use cases

Title Information technology — Artificial Intelligence (AI) — Use cases

1 Scope *(mandatory)*

This document provides a collection of representative use cases of AI applications in a variety of domains.

2 Normative references *(mandatory)*

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC AWI 22989, *Artificial intelligence -- Concepts and terminology*

3 Terms and definitions *(mandatory)*

For the purposes of this document, the terms and definitions given in ISO/IEC AWI 22989 and the following apply.

3.1 Terms defined elsewhere

None

3.2 Terms defined in this document

[Editor's Note: Extract from WG4 N7, SG3 study report, 5 TERMINOLOGY AND CONCEPTS.]

[Editor's proposal: To collect and define terms used in use cases.]

We are developing a word analysis tool for matching the terms and concepts in use cases and applications against those defined in ISO/IEC AWI 22989 and ISO/IEC AWI 23053. This section lists some frequent candidates of terminology that are extracted from use cases. We will collect and study more candidates to create a terminology and concepts list of SG3.

3.2.1 AI component

3.2.2 AI solution

3.2.3 bounding box

3.2.4 computer vision

3.2.5 cyber-physical system

3.2.6 deep reinforcement learning

3.2.7 ensemble classifier

3.2.8 explainable AI

3.2.9 feature extraction

3.2.10 heuristic

3.2.11 image recognition

3.2.12 inference logic

3.2.13 knowledge graph

3.2.14 quality assurance process

3.2.15 topological data analysis

3.2.16 trained model

3.2.17 training sample

3.3 Abbreviated terms

[Editor's Note and Editor's proposal: The abbreviated terms will be collected and be defined from use cases.]

[TBD]

4 Applications

[Editor's Note: Extract from WG4 N7, SG3 study report, 3 APPLICATIONS]

While we started a bottom-up approach from collecting use cases, we take a top-down approach as well in parallel in order to fully address the first item of the current ToR, "identification of applications from the perspectives of their domains and context of their use". It should be noted that the definition of "Deployment Models" in this report corresponds to "AI application domains", and the definition of "Application domains" corresponds to "context" in current ToR(Ch 1). The inconstancy of information elements in the collected use cases will be addressed in future work based on the collection and documentation of use cases.

4.1 Application domains

[Editor's Note: Based on SG3 study report and refer to SG3 N26 to modify the items.]

[Editor's proposal: To add definition and description to all domains]

Agriculture, Construction, Defence, Digital marketing, Education, Energy, Fintech, Healthcare, Home/Service Robotics, ICT, Knowledge management, Legal, Logistics, Low-resource Communities, Maintenance & support, Manufacturing, Media and Entertainment, Mobility, Public sector, Retail, Security, Social infrastructure, Transportation, Work & life

4.2 Deployment models

[Editor's Note: Similar to SG3 study report.]

[Editor's proposal: To add definition and description to all models.]

Cloud services, On-premise systems, Embedded systems, Cyber-physical systems, Social networks, Hybrid

4.3 Applications

[Editor's Note: Extract from WG4 N7, SG3 study report, 3.3 APPLICATIONS.]

[Editor's proposal: To study more about the AI applications, and to add descriptions to all items.]

This section lists applications of AI as follows. This list is collected from SC42/SG3 N061 and these applications were derived from "Artificial Intelligence White Paper":

Development Design, Production process, Video Surveillance & Crime risk prediction,

Surgical automation, Stock exchange and trading, Smart personal agent,

Smart home appliances, Security assurance against cyber-attacks, Scoring,

Sales logistics, Robot Taxi, Robot construction,

Register less store, Public service matching, Product quality inspection,

Procurement logistics, Power demand forecasting, Personal Information Management,

Online service support, Online campaign performance optimization, New drug development,

Medical Platform, Logistics in the base, Loan screening,

Landslide, flood prediction, Judicial recommendation,

Improving operational efficiency, Fraud identification, Equipment operation,

Electronic warfare, Early case assessment, Dynamic map for autonomous cruise control,

Diagnosis support, Cyber Security, Cultivation management, Craftsmanship skill transfer, Construction planning, City-wide traffic control,

Autonomous driving store, Autonomous driving, Automatic cruise control,

Asset management, Agricultural automation, Adaptive learning,

Abnormality or malfunction prediction,

[SOURCE: SC42/SG3 N079]

5 Use cases

[Editor's Note: Extract from WG4 N7, SG3 study report, 4 USE CASES with updating information of use case collection.]

We collected 61 use cases. In this chapter, we describe our template that is used for collecting use cases and show a blank template. Then we give some basic statistics of collected 61 use cases.

5.1 Properties

[Editor's Note: The descriptions of use case and template correspond to WG4 N44, use case template]

5.1.1 General

General information of the use case

— Use case name: Use case name provided by the use case contributor

— Application domain: Refers to 4.1 application domain

— Deployment models: Refers to 4.2 deployment models

— Status: The status of the use case, includes Prototype, PoC (Proof of Concept), or in-operation

— Scope: The scope defines the intended area of applicability, limits, and audience.

— Objective(s) : The intention of the system; what is to be accomplished?; who/what will benefit?.

— Narrative: Descriptions(short and complete) of the use case

— Stakeholders: Stakeholder are those that can affect or be affected by the AI system in the scenario; e.g., organizations, customers, 3rd parties, end users, community, environment, negative influencers, bad actors, etc.

— Stakeholders' assets, values: Stakeholders' assets and values that are at stake with potential risk of being compromised by the AI system deployment – e.g., competitiveness, reputation, trustworthiness, fair treatment, safety, privacy, stability, etc.

— System's threats and vulnerabilities: Threats and vulnerabilities can compromise the assets and values above - e.g., different sources of bias, incorrect AI system use, new security threats, challenges to accountability, new privacy threats (hidden patterns), etc.

— Key performance indicators (KPIs) : Descriptions of KPIs for evaluating the performance or useness of use cases. Descriptions include KPI's name, description of the KPI and reference to mentioned use case objectives

— AI features: Descriptions of features of use case in AI consideration. Descriptions include:

1) Task(s): The main task in use case. A pull-down list includes the following terms: Recognition, Natural language processing, Knowledge processing & discovery, Inference, Planning, Prediction, Optimization, Interactivity, Recommendation or Other

2) Method(s): AI method(s)/framework(s) used in development.

3) Hardware: Hardware system used in development and deployment.

4) Topology: opology of the deployment network architecture.

5) Terms and concepts used: Terms and concepts used here should be consistent with those defined by Working Group 1 (AWI 22989 and AWI 23053) or to be recommended for inclusion.

— Standardization opportunities/requirements: Descriptions of Standardization opportunities/ requirements that are derived from the use case.

— Challenges and issues: Descriptions of challenges and issues in the use case

— Societal concerns: Refers to the proposed ToR update

1) Description: Description of societal concerns that are derived from the use case.

2) SDGs to be achieved: The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a collection of 17 global goals set by the United Nations General Assembly. SDGs are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

5.1.2 References

— References related to the use case

— Type: Document type of the reference (e.q. standards, paper, patent, press release)

— Reference: Title of the reference

— Status: The status of the referenced document.

— Impact on use case: Where does the document influence the use case?

— Originator/organization: Who published the document?

— Link: If available, a public link can be provided.

5.2 Template

The below blank use case templates were used for collecting use cases. The terms used in these blank templates were defined in 5.1.

The template is based on:

— ISO/IEC 20547-2: Big data reference architecture – Part2

— IEC 62559: Use case methodology

— IEEE P7003: Use case template

It was intended to be augmented by "process" part, training, evaluation, execution, and refraining.

NOTE The terms used in this template may or may not match with ISO/IEC AWI 22989 and ISO/IEC AWI 23053.

5.2.1 General

Table 1 — General part of use case template

<table>
<tr><td>ID</td><td colspan="4"></td></tr>
<tr><td>Use case name</td><td colspan="4"></td></tr>
<tr><td>Application domain</td><td colspan="4"></td></tr>
<tr><td>Deployment Model</td><td colspan="4"></td></tr>
<tr><td>Status</td><td colspan="4"></td></tr>
<tr><td>Scope</td><td colspan="4"></td></tr>
<tr><td>Objective(s)</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td colspan="3"></td></tr>
<tr><td>Complete description</td><td colspan="3"></td></tr>
<tr><td>Stakeholders</td><td colspan="4"></td></tr>
<tr><td>Stakeholders' assets, values</td><td colspan="4"></td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">AI features</td><td>Task(s)</td><td colspan="3"></td></tr>
<tr><td>Method(s)</td><td colspan="3"></td></tr>
<tr><td>Hardware</td><td colspan="3"></td></tr>
<tr><td>Topology</td><td colspan="3"></td></tr>
<tr><td>Terms and concepts used</td><td colspan="3"></td></tr>
<tr><td>Standardization opportunities/ requirements</td><td colspan="4"></td></tr>
<tr><td>Challenges and issues</td><td colspan="4"></td></tr>
<tr><td>Societal</td><td>Description</td><td colspan="3"></td></tr>
</table>

concerns		
	SDGs to be achieved	

5.2.2 References

Table 2 — Reference part of use case template

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link

5.3 Acceptable Sources of Use Case

[Editor's Note and proposal: Extract from WG4 N37, use case template instead of the description in study report. The sub-clause title is modified for clarifying the intention of this description.]

For improving the quality of use case description, acceptable sources are:

— Peer-reviewed scientific/technical publications on AI applications (e.g. [1]).

— Patent documents describing AI solutions (e.g. [2], [3]).

— Technical reports or presentations by renowned AI experts (e.g. [4])

— High quality company whitepapers and presentations

— Publicly accessible sources in sufficient detail

This list is not exhaustive. Other credible sources may be acceptable as well.

[SOURCE: Based on SC 42/SG 3 N026 and subsequent discussion at SG 3 and WG 4 meetings]

5.4 Use Case Selection Guidance

[Editor's Note and proposal: Extract from WG4 N37, use case template instead of the description in study report. The sub-clause title is modified for clarifying the intention of this description.]

For preparing use cases that cover both the most important application areas and the most relevant AI technologies, use case contributors can consider the following AI characteristics as useful selection guidance:

— Data Focus & Learning: Use Cases for AI system which utilizes Machine Learning, and those who use a fixed a-priory knowledge base.

— Level of Autonomy: Use cases demonstrating several degrees (dependent, autonomous, human/critic in the loop, etc.) of AI system autonomy.

— Verifiability & Transparency: Use cases demonstrating several types and levels of verifiability and transparency, including approaches for explainable AI, accountability, etc.

— Impact: Use cases demonstrating the impact of AI systems to society, environment, etc.

— Architecture: Use cases demonstrating several architectural paradigms for AI systems (cloud, distributed AI, Crowdsourcing, Swarm Intelligence)

[SOURCE: Based on SC 42/SG 3 N026 and subsequent discussion at SG 3 and WG 4 meetings]

5.5 Basic statistics

[Editor's Note: Extract from WG4 N7, SG3 study report, 4.3 BASIC STATISTICS.]

5.5.1 Basic information of use cases

We collected 61 use cases which were contributed from the following NB's experts: Canada, China, German, India, Ireland and Japan. The below table includes basic information of use cases, which includes use case name, application domain, deployment mode and status.

Table 3 — List of use cases

ID	Use case name	Application domain	Deployment model	Status
1	Explainable artificial intelligence for Genomic Medicine	Healthcare	Cloud services	Prototype
2	Revolutionizing clinical decision-making using artificial intelligence	Healthcare	On-premise systems	PoC
3	AI solution to calculate amount of contained material from mass spectrometry measurement data	Manufacturing	Embedded systems	PoC
4	AI solution to quickly identify defects during quality assurance process on wind turbine blades	Manufacturing	On-premise systems	In operation
5	Solution to detect signs of failures in wind power generation system	Manufacturing	On-premise systems	PoC
6	Computer-aided diagnosis in medical imaging based on machine learning	Healthcare	On-premise systems	PoC
7	AI Ideally Matches Children to Daycare Centers	Public sector	On-premise systems	In operation
8	Deep Learning Technology Combined with Topological Data Analysis Successfully Estimates Degree of Internal Damage to Bridge Infrastructure	Social infrastructure	Cloud services	PoC
9	AI Components for Vehicle Platooning on Public Roads	Transportation	Self-driving vehicles	Prototype
10	Self-Driving Aircraft Towing Vehicle	Transportation	Self-driving vehicles	Prototype
11	Unmanned Protective Vehicle for Road Works on Motorways	Transportation	Self-driving vehicles	Prototype
12	autonomous apron truck	Mobility	Embedded systems	PoC
13	AI solution to identify automatically false positives from a specific check for	Other (please specify) This will be relevant	Cloud services	PoC

	" untranslated target segments " from an automated quality assurance tool	for content from across any domains		
14	Behavioural and sentiment analytics	Security	On-premise systems	PoC
15	Generative design of mechanical parts	Manufacturing	On-premise systems	In operation
16	Robotic prehension of objects	Other (please specify) Robotics	Embedded systems	PoC
17	Robotic vision - scene awareness	Work & life	Embedded systems	PoC
18	AI solution for Car Damage Classification	Other (Insurance)	Cloud services	PoC
19	AI to understand adulteration in commonly used food items	Agriculture	Cloud services	PoC
20	Detection of frauds based on collusions	Fintech	On-premise systems	In operation
21	Information Extraction from Hand-marked Industrial Inspection Sheets	Manufacturing	Cloud services	PoC
22	AI (Swarm Intelligence) solution for Attack Detection in IoT Environment	Security	Hybrid or other (Agent Based Hub-Spoke)	Prototype
23	VTrain recommendation engine	Education	On-premise systems	In operation
24	AI solution to predict Post-Operative Visual Acuity for LASIK Surgeries	Healthcare	Cloud services	In operation
25	Use of robotic solution for traffic policing and control	Security	On-premise systems	PoC
26	Robotic solution for replacing human labour in Hazardous condition	Security	On-premise systems	PoC
27	Credit scoring using KYC data	Fintech	On-premise systems	PoC
28	Recommendation algorithm for improving member experience and discoverability of resorts in the booking portal of a hotel chain	Healthcare	Cloud services	In operation
29	Enhancing traffic management efficiency and infraction detection accuracy with AI technologies	Transportation	Hybrid or other (please specify) Cloud services and on-premise systems	In operation
30	Autonomous network and automation level definition	ICT	Cyber-physical systems	PoC
31	Autonomous network scenarios	ICT	Cyber-physical systems	PoC
32	AI solution to help mobile phone to have better picture effect	Mobility	Hybrid or other (please specify)	In operation
33	Automated defect classification on product surfaces	Manufacturing	On premise system	PoC
34	Robotic task automation: Insertion	Manufacturing	Embedded systems – Cloud service	PoC
35	Causality-based Thermal Prediction for Data Center	Other (data center)	On-premise systems	Prototype
36	Powering Remote Drilling Command Centre	Manufacturing	Cloud services	In operation
37	Leveraging AI to enhance adhesive quality	Manufacturing	On-premise systems	In operation

38	Machine learning driven approach to identify the weak spots in the manufacturing of the circuit breakers.	Manufacturing	Prototype	On-premise system
39	Machine Learning Driven Analysis of Batch Process Operation Data to Identify Causes for Poor Batch Performance	Manufacturing	On-premise systems	Prototype
40	Empowering Autonomous Flow meter control- Reducing time taken to "proving of meters"	Manufacturing	Cloud services	In operation
41	Improving Productivity for Warehouse Operation	Logistics	On-premise systems	PoC
42	Emotion-sensitive AI Customer Service	Retail	On-premise systems	In operation
43	Deep Learning Based User Intent Recognition	Retail	On-premise systems	In operation
44	Chromosome Segmentation and Deep Classification	Healthcare	Hybrid or other (please specify)	PoC
45	Anomaly Detection in Sensor Data Using Deep Learning techniques	Maintenance & support	Hybrid or other (Cloud or on premise deployment)	PoC
46	Adaptable Factory	Manufacturing	Cyber-physical System, Embedded System	PoC
47	Order-Controlled Production	Manufacturing	Cloud Services	Prototype
48	Value-based Service	Manufacturing	Hybrid or other (Cloud or on premise deployment)	PoC
49	AI solution for traffic signal Optimization based on multi-source data fusion	Transportation	Cloud services	In operation
50	AI solution to quality control of Electronic Medical Record(EMR) in real time	Healthcare	Cloud services	In operation
51	Machine Learning Tools in Support of Transformer Diagnostics	Performance evaluation and diagnostics	Prototype	Prototype
52	Automated Travel Pattern Recognition using Mobile Network Data for Applications to Mobility as a Service	Transportation	Activity- based Modelling for New mobility Services	PoC
53	Improving conversion rates and RoI (Return on Investment) with AI technologies	Digital marketing	On-premise	In operation
54	bioBotGuard	Agriculture	Hybrid or other (Cloud or on premise deployment)	PoC
55	RAVE	Education	Hybrid or other (Cloud or on premise deployment)	PoC
56	Logo and Trademark Detection	Digital Marketing	Hybrid or other (Cloud or on premise deployment)	PoC
57	Virtual Bank Assistant	Fintech	Cloud services	In operation

58	Video on Demand Publishing Intelligence Platform	TMT Industry, Technology Department	On premise	In operation
59	Predictive Testing	TMT Industry – Application development	On premise	PoC
60	Predictive Data Quality	Other (please specify) Data Management	Hybrid or other (Cloud or on premise deployment)	PoC
61	Robot consciousness	Home/Service Robotics	Embedded systems	PoC

5.5.2 Application domain

The below graph describes the percentage of use cases by application domain. This figure did not include the following application domains because these did not have any use cases:

— Construction, Defence, Energy, Knowledge management, Legal, Low-resource Communities, Media and Entertainment

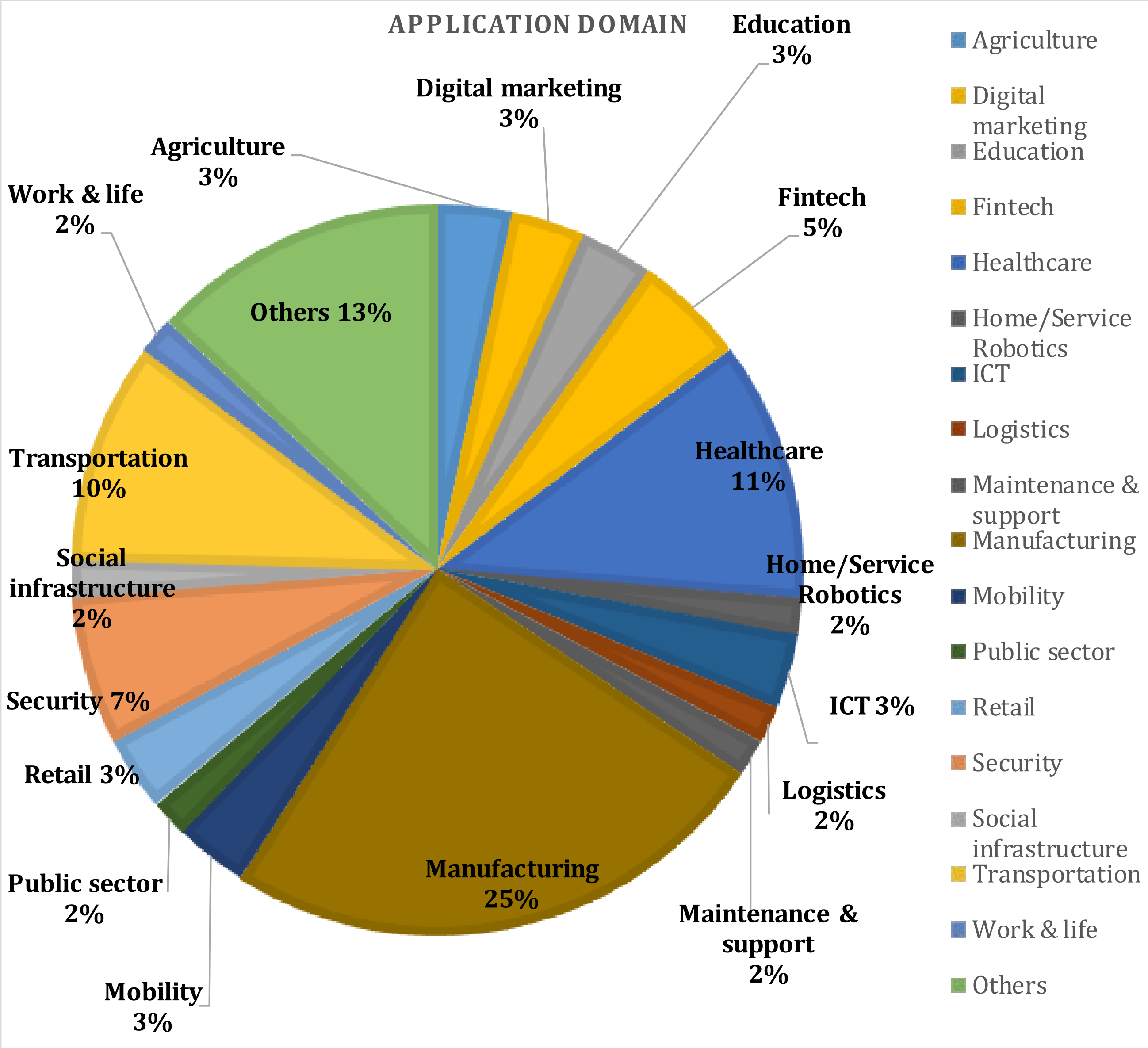

Figure 1 — Distribution of use cases by application domains

5.5.3 Status

The below graph describes the percentage of use cases by status.

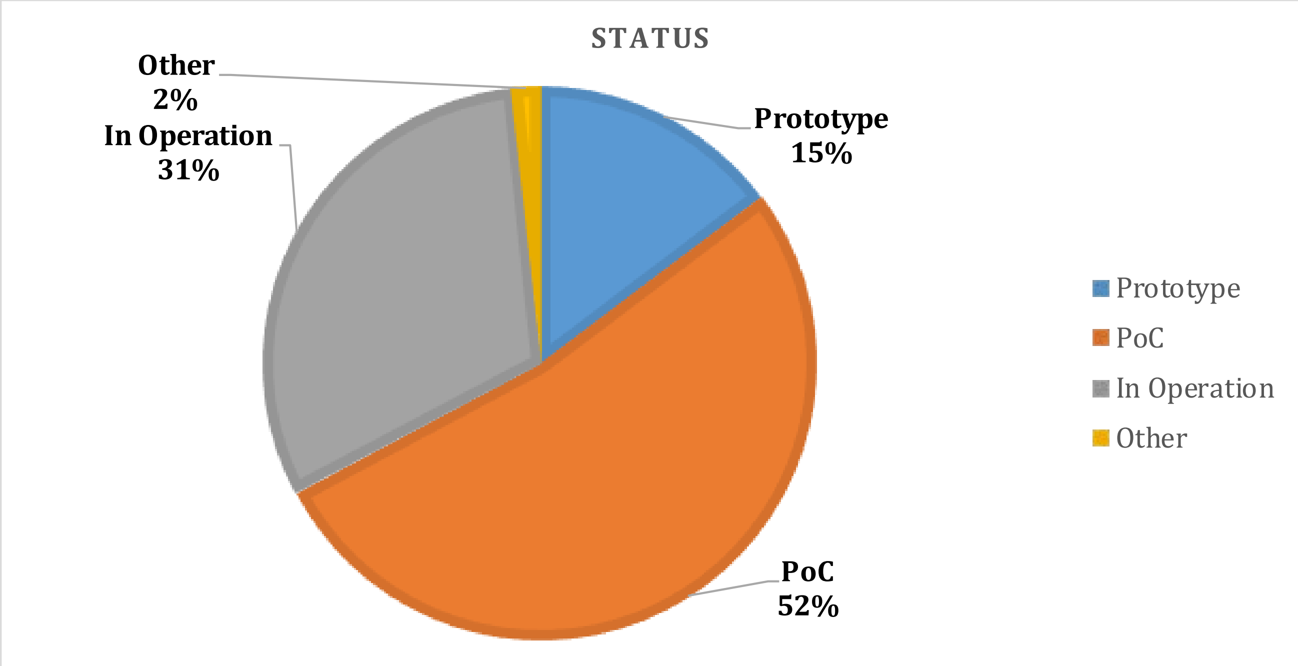

Figure 2 — Distribution of use cases by status

5.5.4 AI features (Task)

The below graph describes the percentage of use cases by AI features (Task).

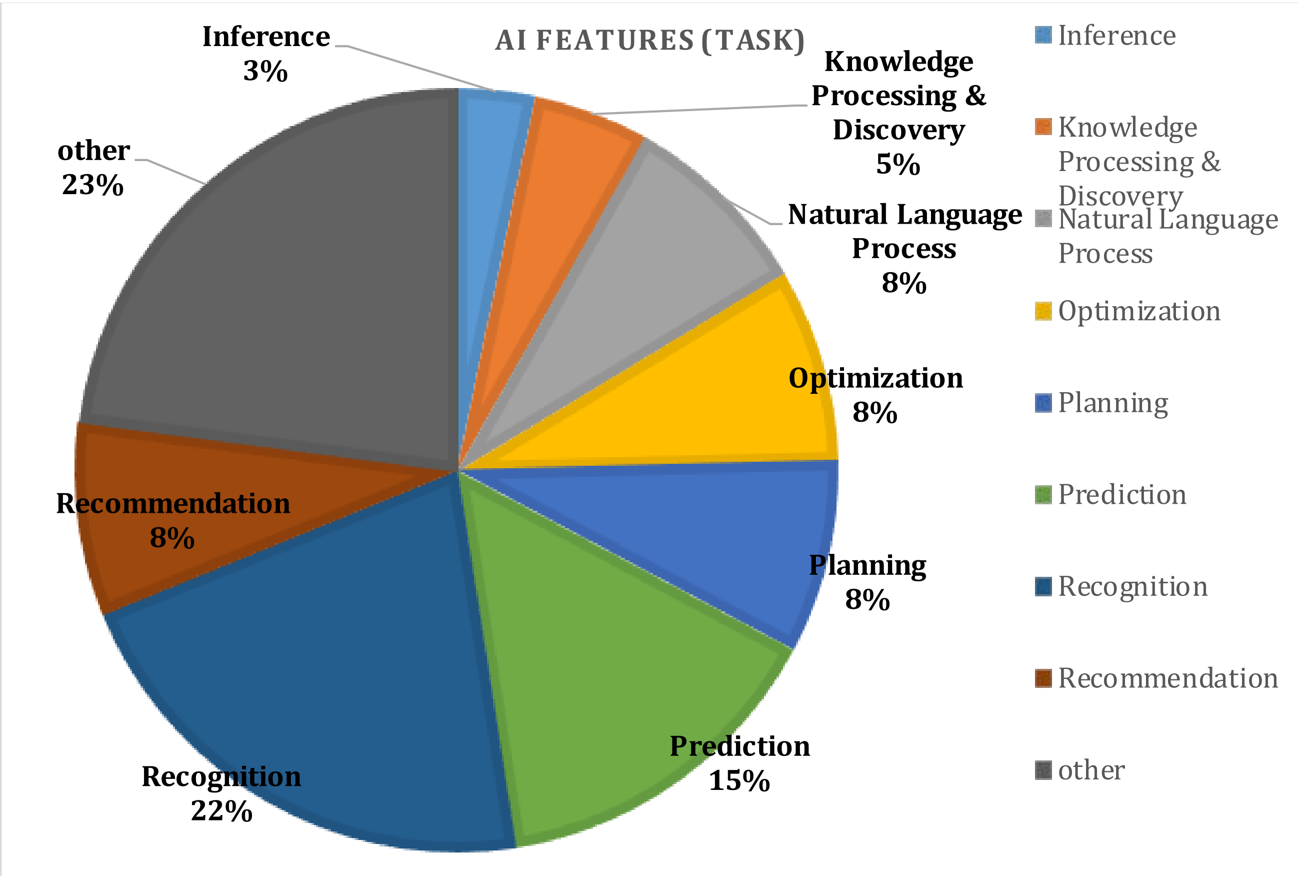

Figure 3 — Distribution of use cases by AI task

5.6 Societal concerns

[Editor's Note: Extract from WG4 N7, SG3 study report, 4.4 SOCIETAL CONCERNS.]

[Editor's proposal: To analyse societal concerns of use cases and to identify features of societal concerns.]

It will be studied fully once SC42/SG3 is reaffirmed with updated ToR. However, we have some consideration about societal concerns of use cases. One consideration is to add a description of reported societal concerns that have been brought forward in the media or by experts, and a description of the technical and organizational measures related to that use case available to mitigate these societal concerns. For instance, a use case on face recognition to identify customers in super markets for automatic payment would refer to measures and techniques to ensure the protection of personally identifiable data.

[SOURCE: SC42/SG3 N026, contribution from German NB]

5.7 Findings

[Editor's Note and proposal: To study and to analyse use cases more. New findings such as standardization opportunities will be summarized here.]

[TBD]

6 Use cases summaries

[Editor's Note and proposal: This section summarizes use cases and classifies use cases by application domains. Use case summary includes general information and easy for understanding the use case. Details of use case are in annex. Subsection title refers to correspond use case in annex.]

6.1 Agriculture

6.1.1 AI to Understand Adulteration in Commonly Used Food Items (A.19)

6.1.1.1 Scope

Understand the patterns in hyperspectral / NIR or visual imaging specifically for adulteration in milk, banana and mangoes.

6.1.1.2 Objective

To device a simple, cost effective tool to identify the adulteration in food items at point of purchase.

6.1.1.3 Narrative (Short description)

Food adulteration is one of the big evil of modern society. Adulterated milk is hazard for children, many aliments including cancer / kidney failures due to consumption of adulterated food. Hyperspectral technology was evaluated to find out adulteration in food items.

6.1.1.4 Challenges and issues

Large scale data collection, Miniaturization of frugal NIR / Hyperspectral sensor.

6.1.1.5 Societal concerns

If the AI system is rolled out and taken as reliable then it should be able to perform in all cases and scenarios. Incorrect classification can lead to false accusations.

SDGs to be achieved: Good health and well-being for people

6.1.2 bioBotGuard (A.54)

6.1.2.1 Scope

Use visual recognition to identify and help fight parasites attacking organic farms.

6.1.2.2 Objective

The use case shows how AI contributing to modernize Agriculture industry.

6.1.2.3 Narrative (Short description)

BioBotGuard defines itself as an initiative of Precision Farming as a Service. From an IT perspective it uses drones with GPS and highresolution cameras to monitor the crops; the images are then processed by computer vision API in order to spot diseases and harmful insect attacks, building a georeferenced risk map of the crop. This can be used to send operational drones to put the treatment (or antagonist insects) only when and where it is needed.

6.1.2.4 Challenges and issues

Acquire filed as well as crop images at different distances and normalize image recognition and pattern detection.

6.1.2.5 Societal concerns

None.

SDGs to be achieved: [TBD]

6.2 Construction

[TBD]

6.3 Defence

[TBD]

6.4 Digital marketing

6.4.1 Improving conversion rates and RoI (Return on Investment) with AI technologies (A.53)

6.4.1.1 Scope

Utilizing AI technologies in digital marketing.

6.4.1.2 Objective

1) Help the operation team identify new business scenarios and seize more market opportunities,

2) Increase conversion rate and marketing effectiveness,

3) Improve user experience by providing individually customized services

6.4.1.3 Narrative (Short description)

Personalized digital marketing has become increasingly important in response to the needs of providing different services to different consumers. The combination of big data and AI algorithms is the core of personalized digital marketing. By modeling user preferences, we can predict the services that users may be interested in, improve marketing effectiveness and enhance user experience.

6.4.1.4 Challenges and issues

How to collect, utilize and protect user information within the scope of what is permitted by relevant national and regional legislation and regulations.

How to let the system evolve and improve continuously with applying new AI models and algorithms.

6.4.1.5 Societal concerns

For Users: enjoy better service at a lower cost

For Merchants: Increase profits and decrease costs

For Cities and communities: Promote economic prosperity and develop green economy

SDGs to be achieved: Sustainable cities and communities

6.4.2 Logo and Trademark Detection (A.56)

6.4.2.1 Scope

Identification of logos / trademarks in pictures, optionally performing sentiment analysis associated to the product.

6.4.2.2 Objective

Understand usage of retail or fashion products and optionally sentiment associated to it, according to pictures posted on the internet or social networks by customers.

6.4.2.3 Narrative (Short description)

The case is about being able to identify logos and trademarks in pictures provided to the AI systems, and optionally derive a positive or negative sentiment for the product based on the written context that was provided with the picture.

6.4.2.4 Challenges and issues

The primary challenge is to be able to correctly identify trademarks in all situations (with bad lighting, image distortions, dirt, etc.) and interpret the sentiment and tone in different countries and languages, as people might use slang and irony.

6.4.2.5 Societal concerns

Automated analysis of public posts on social networks might be seen unethical in certain cultures.

SDGs to be achieved: [TBD]

6.5 Education

6.5.1 VTrain Recommendation Engine (A.23)

6.5.1.1 Scope

Based on an employee's career objectives find skill requirements and its training.

6.5.1.2 Objective

Recommend a personalised list of "best" training courses to an employee, which will help him/her meet his/her career objectives.

6.5.1.3 Narrative (Short description)

The vTrain system helps employees improve their skills by recommending appropriate training courses from a given list and historical data.

6.5.1.4 Challenges and issues

Need large amounts of training data; predicting human behaviour is tricky.

6.5.1.5 Societal concerns

Employees may feel challenged or demoralized.

SDGs to be achieved: Decent work and economic growth

6.5.2 RAVE (A.55)

6.5.2.1 Scope

Use of advanced an multimodal sensing ability to facilitate a complex task

6.5.2.2 Objective

Avatar and social robot interact with deaf babies for facilitating language learning.

6.5.2.3 Narrative (Short description)

RAVE system is an integrated multi-agent system involving a robot and virtual human designed to augment language exposure for 6-12 month old infants. The system is an engineered robot and avatar to provide visual language to effect socially contingent human conversational exchange. The team demonstrated the successful engagement of our technology through case studies of deaf and hearing infants.

6.5.2.4 Challenges and issues

Ability to decode a learner cognitive status and his attention level

6.5.2.5 Societal concerns

None

SDGs to be achieved: [TBD]

6.6 Energy

[TBD]

6.7 Fintech

6.7.1 Detection of Frauds based on Collusions (A.20)

6.7.1.1 Scope

Validating the predicted collusion set is effort-intensive and needs investigative and legal expertise.

6.7.1.2 Objective

Automatic unsupervised detection of frauds based on collusions.

6.7.1.3 Narrative (Short description)

A set of unsupervised machine learning algorithms to detect collusion-based frauds, particularly, circular trading and price manipulation in stock market trading.

6.7.1.4 Challenges and issues

Actual examples of collusion-based frauds may not be available easily, even for evaluation and testing.

6.7.1.5 Societal concerns

Incorrect detection of Collusions and frauds may cause unnecessary stress in stock traders.

SDGs to be achieved: Decent work and economic growth

6.7.2 Credit Scoring using KYC Data (A.27)

6.7.2.1 Scope

Building a risk scorecard for loan applicants using KYC data for better risk management and high population coverage.

6.7.2.2 Objective

Assigning a risk score to every loan applicant in real time, using just KYC data, which will ensure both new-to-credit and mature customers can be assessed for their creditworthiness, and offered loans on appropriate terms.

6.7.2.3 Narrative (Short description)

It can be often difficult to build a risk scorecard using only KYC data, which often has noisiness and incompleteness issues. However if realized, it can be used to provide an objective score to all loan applicants, even the new-to-credit ones. Non-linear classification algorithms are suitable for this purpose.

Several variables are collected from the customer during the KYC process such as Age of customer, Self-reported income, Type of Occupation, Purpose of loan, etc. All these features can be added to a non-linear risk model and their complex interactions allowed to take place.

6.7.2.4 Challenges and issues

— KYC data obtained from extreme rural areas can be noisy, may have several missing values, and needs appropriate preprocessing and treatment before feeding to the model algorithm.

— Non-linear models like Random Forest and XGBoost need significant computational power during the training phase.

6.7.2.5 Societal concerns

We don’t see any societal concerns if it is used.

SDGs to be achieved: [TBD]

6.7.3 Virtual Bank Assistant (A.57)

6.7.3.1 Scope

Use of advanced chatbots and dialogue systems to automatize part of the call center activities

6.7.3.2 Objective

Provide better quality help desk support to employees

6.7.3.3 Narrative (Short description)

The Virtual Assistant of the Bank is the first point of contact for branch operators, who receive immediate answers at any time - it allows to optimize the time of the "human operators" of the Service Desk, which they are dedicated to activities of greater value.

6.7.3.4 Challenges and issues

Provide a natural and consistent interaction with users from different levels of experience (and thus terminology) and background.

6.7.3.5 Societal concerns

None

SDGs to be achieved: [TBD]

6.8 Healthcare

6.8.1 Explainable Artificial Intelligence for Genomic Medicine (A.1)

6.8.1.1 Scope

To explain reason and basis behind AI-generated findings in genomic medicine.

6.8.1.2 Objective

To improve the efficiency of investigatory work for experts in genomic medicine.

6.8.1.3 Narrative (Short description)

This technology was deployed to improve the efficiency of investigatory work for experts in genomic medicine, utilizing training data and a knowledge graph that made use of public databases and medical literature databases in the field of bioinformatics. It was then evaluated to validate that it was possible to find and link the basis supporting findings with regard to phenomena whose interrelationships are only partially understood.

6.8.1.4 Challenges and issues

Challenges: To reduce experts' workloads, shortening determination periods in genomic medicine.

6.8.1.5 Societal concerns

— Accountability for using AI in medical examination.

— Incorrect explanation will cause the determination periods increasing.

SDGs to be achieved: Good health and well-being for people

6.8.2 Revolutionizing Clinical Decision-making using Artificial Intelligence (A.2)

6.8.2.1 Scope

To improve clinical decision-making and the accurate assessment of risks for individual patients of mental healthcare.

6.8.2.2 Objective

Halving the time to pre-screen patient records and giving more time for patient consultations.

6.8.2.3 Narrative (Short description)

The solution has halved the time for the preliminary assessment of patient records, increasing the time available for consultations.

6.8.2.4 Challenges and issues

The incorporation of many different types of data is revolutionizing the healthcare sector. The ability to apply semantic and analytic technologies to this heterogeneous mass of data, as well as traditional healthcare data, to discover hidden correlations, identify care patterns and support clinical decision-making is paving the way for a new generation of improved healthcare services.

6.8.2.5 Societal concerns

Incorrect decision and unexplainable result.

SDGs to be achieved: Good health and well-being for people

6.8.3 Computer-aided Diagnosis in Medical Imaging based on Machine Learning (A.6)

6.8.3.1 Scope

Detecting image anomality.

6.8.3.2 Objective

Provide AI method to alleviate growing burden of histopathological diagnosis by human.

6.8.3.3 Narrative (Short description)

The advances in image recognition technology enable the machine learning system to support diagnosis in medical imaging. This technology is expected to contribute the great reduction of the burden on doctors and the improvement of diagnostic accuracy when it is used for screening and double checking. Specifically, a support system is currently under development that analyzes histopathological images to automatically detect suspected lesion.

6.8.3.4 Challenges and issues

[TBD]

6.8.3.5 Societal concerns

[TBD]

SDGs to be achieved: [TBD]

6.8.4 AI Solution to Predict Post-Operative Visual Acuity for LASIK Surgeries (A.24)

6.8.4.1 Scope

Predicting Post-Operative Visual Acuity for LASIK Surgeries from retrospective LASIK surgery data with patient follow-ups.

6.8.4.2 Objective

Given: Pre-operative examination results and demography information about a patient. Predict: Post-operative UCVA after one day, one week and one month of the surgery.

6.8.4.3 Narrative (Short description)

LASIK (Laser-Assisted in SItu Keratomileusis) surgeries have been quite popular for treatment of myopia, hyperopia and astigmatism over the past two decades. In the past decade, over 10 million LASIK procedures had been performed in the United States alone with an average cost of approximately $2000 USD per surgery. While 99% of such surgeries are successful, the commonest side effect is a residual refractive error and poor uncorrected visual acuity (UCVA). In this work, we aim at predicting the UCVA post LASIK surgery. We model the task as a regression problem and use the patient demography and pre-operative examination details as features. To the best of our knowledge, this is the first work to systematically explore this critical problem using machine learning methods. Further, LASIK surgery settings are often determined by practitioners using manually designed rules. We explore the possibility of determining such settings automatically to optimize for the best post-operative UCVA by including such settings as features in our regression model. Our experiments on a dataset of 791 surgeries provides an RMSE (root mean square error) of 0.102, 0.094 and 0.074 for the predicted post-operative UCVA after one day, one week and one month of the surgery respectively.

6.8.4.4 Challenges and issues

The problem is challenging because: (1) large amount of data about such surgeries is not easily available; (2) there are a lot of pre-operative measurements that can be used as signals; and (3) data is sparse, i.e., there are a lot of missing values.

6.8.4.5 Societal concerns

[TBD]

SDGs to be achieved: Good health and well-being for people

6.8.5 Chromosome Segmentation and Deep Classification (A.44)

6.8.5.1 Scope

Karyotyping of the chromosomes is restricted to healthy patients.

6.8.5.2 Objective

— Automating Karyotyping of the chromosomes in cell spread images.

— Segmentation of chromosomes in the images using non expert crowd.

6.8.5.3 Narrative (Short description)

Karyotyping of the chromosomes micro-photographed under metaphase is done by characterizing the individual chromosomes in cell spread images. Currently, considerable effort and time is spent to manually segment out chromosomes from cell images, and classifying the segmented chromosomes. We proposed a method to segment out and classify chromosomes for healthy patients using a combination of crowdsourcing, preprocessing and deep learning, wherein the non-expert crowd from external crowdsourcing platform is utilized to segment out the chromosomes, which are then classified using deep neural network. Results are encouraging and promise to significantly reduce the cognitive burden of segmenting and karyotyping chromosomes.

6.8.5.4 Challenges and issues

— Crowd's job satisfaction.

— Spamming in annotated data.

6.8.5.5 Societal concerns

Inaccurate classification of chromosomes can lead to stress in patients in case the classification is not reviewed by expert doctors.

SDGs: Good health and well-being for people

6.8.6 AI Solution to Quality Control of Electronic Medical Record(EMR) in Real Time (A.50)

6.8.6.1 Scope

Detecting defects in EMR by inspecting unstructured data based on Natural Language Processing (NLP) ability.

6.8.6.2 Objective

To insure the completeness, consistency, punctuality and medical-compliance of EMR written by physicians.

6.8.6.3 Narrative (Short description)

This AI solution in ET Medical Brain Medical service support system was developed that could simultaneously detect mistakes while physicians wrote EMR（Electronic Medical Record）.

Using NLP（Natural Language Processing） ability, it can process a large amount of unstructured text and judge the accuracy according to recognized medical reference.

It achieved 80% coverage of all the EMR quality control requirements issued by Chinese government, and human labour of EMR QC （Quality Control） was reduced 60%, which translated into cost savings, and enhanced physician education.

6.8.6.4 Challenges and issues

Challenges: Achieve all EMR QC requirements in different disease areas.

Issues: 1) Lack of medical reference data 2) Lack of medical knowledge graph

6.8.6.5 Societal concerns

Achieved 80% coverage of all the EMR quality control requirements issued by Chinese government, and human labour of EMR QC （Quality Control） was reduced 60%, which translated into cost savings, and enhanced physician education.

SDGs to be achieved: Good health and well-being for people

6.9 Home/Service Robotics

6.9.1 Robot consciousness (A.61)

6.9.1.1 Scope

A robot for museum tours equipped with the main capabilities of functional consciousness, accepted and transparent to untrained users.

6.9.1.2 Objective

The robot “CiceRobot” offering guided tours in indoor and outdoor museum and equipped with capabilities of functional consciousness, with no concern on the robot qualitative experience. The objective of case study is the acceptance and transparency of the autonomous behavior of the robot in an environment populated with untrained users as the museum visitors.

6.9.1.3 Narrative (Short description)

The “CiceRobot” is a robot with capabilities associated with functional aspects of consciousness. CiceRobot offered indoors guided tours and outdoors guided tours. The outcome of the project is the acceptance and transparency of the autonomous behavior of the robot towards untrained visitors.

6.9.1.4 Challenges and issues

The primary challenge of robot consciousness is the transparency and acceptance of robot operations, important in environments populated by untrained people as tourists in an archaeological museum.

6.9.1.5 Societal concerns

The main concern may be the capability of the robot to act in a way which may is considered unethical to humans.

SDGs to be achieved: [TBD]

6.10 ICT

6.10.1 Autonomous Network and Automation Level Definition (A.30)

6.10.1.1 Scope

Communications network

6.10.1.2 Objective

To define autonomous network concept and automation level for the common understanding and consensus.

6.10.1.3 Narrative (Short description)

With the goal of providing common understanding and consensus for autonomous self-driving network, this use case delivers a harmonized classification system and supporting definitions that:

— Define the concept of autonomous network.

— Identify six levels of network automation from “no automation” to “full automation”.

— Base definitions and levels on functional aspects of technology.

— Describe categorical distinctions for a step-wise progression through the levels.

— Educate a wider community by clarifying for each level what role (if any) operators have in performing the dynamic network operations task while a network automation system is engaged.

6.10.1.4 Challenges and issues

Data usage and sharing, human expertise & competence

6.10.1.5 Societal concerns

None.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.10.2 Autonomous network scenarios (A.31)

6.10.2.1 Scope

Communications network.

6.10.2.2 Objective

Clarification and showcases of autonomous network usage.

6.10.2.3 Narrative (Short description)

Multiple scenarios of autonomous network enabled by AI is addressed for improving operational efficiency, customer experience and service innovation, including wireless network performance improvement, optical network failure prediction, data center energy saving etc.

6.10.2.4 Challenges and issues

Data usage and sharing, human expertise & competence.

6.10.2.5 Societal concerns

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.11 Knowledge management

[TBD]

6.12 Legal

[TBD]

6.13 Logistics

6.13.1 Improving Productivity for Warehouse Operation (A.41)

6.13.1.1 Scope

Big data analysis for enhancing productivity.

6.13.1.2 Objective

To improve productivity of warehouse operation by detecting and changing controllable factors.

6.13.1.3 Narrative (Short description)

AI-driven operating system that uses big data from work performance information to issue appropriate work instructions has been developed. In PoC, picking operation improvement was conducted in a distribution warehouse. As the result, 8% work reduction was performed.

6.13.1.4 Challenges and issues

Understanding of workers' human factors (privacy, additional work etc.)

6.13.1.5 Societal concerns

Solving labor shortage problem and improving labor related issues with aiming improving productivity.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.14 Low-resource Communities

[TBD]

6.15 Maintenance & support

6.15.1 Anomaly Detection in Sensor Data Using Deep Learning Techniques (A.45)

6.15.1.1 Scope

Temporal Data captured from sensors.

6.15.1.2 Objective

Identify Anomalies and Events by learning the temporal patterns of sensor data, based on Deep Learning techniques.

6.15.1.3 Narrative (Short description)

Mechanical devices such as engines, vehicles, aircrafts, etc., are typically instrumented with numerous sensors to capture the behaviour and health of the machine. The sensors temporal data has several complex patterns that are very hard to identify with traditional methods. We have proposed the use of

Deep Learning algorithms for analysing such temporal patterns for anomaly/event detection, diagnosis, root cause analysis.

Algorithms proposed so far are LSTM-AD, EncDec-AD, online RNN-AD. We used industrial datasets wherever possible and publically available datasets in other scenarios. In most of the cases, our algorithms were significantly better than other methods.

6.15.1.4 Challenges and issues

— Noisy Data

— Data with missing temporal features

— Rarity of Anomalous Data

6.15.1.5 Societal concerns

None

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16 Manufacturing

6.16.1 AI Solution to Calculate Amount of Contained Material from Mass Spectrometry Measurement Data (A.3)

6.16.1.1 Scope

Calculating amount of contained material from mass spectrometry measurement data using chromatography.

6.16.1.2 Objective

To find an accurate and efficient solution to calculating amount of contained material without dependence on individuals.

6.16.1.3 Narrative (Short description)

An AI solution was developed that could automatically pick the peak related to the contained material from measurement data through deep learning. Compared with manual results by an experienced operator, the automated peak picking results using AI had a false detection rate of 7% and an undetected rate of 9%. The peak picking operation time using AI was estimated to be about one fifth.

6.16.1.4 Challenges and issues

— Challenges: Achieve the same level as experienced operators for peak picking.

— Issues: 1) Lack of training data per contained material, 2) how to create good images for deep learning from mass spectrometry measurement data.

6.16.1.5 Societal concerns

[TBD]

SDGs to be achieved: [TBD]

6.16.2 AI solution to quickly identify defects during quality assurance process on wind turbine blades (A.4)

6.16.2.1 Scope

Detecting defects in products by inspecting nondestructive testing scanning data.

6.16.2.2 Objective

To find an accurate and efficient solution to detect defects without compromising the detection of in-material damage and risking a loss in reputation.

6.16.2.3 Narrative (Short description)

An AI solution was developed that could automatically detect defects through deep learning together with what is called "imagification"; it achieved high coverage of various defects and evaluation of each nondestructive testing scanning was reduced by 80%, which translated into cost savings, reduced production lead times, and increased productivity.

6.16.2.4 Challenges and issues

Challenges: Achieve the same level as ultrasonic accredited engineers for detecting critical defects.

Issues: 1) Lack of defect data per defect type, 2) how to create good images for deep learning from UT raw data, and 3) back wall detection

6.16.2.5 Societal concerns

[TBD]

SDGs to be achieved: Affordable and clean energy

6.16.3 Solution to Detect Signs of Failures in Wind Power Generation System (A.5)

6.16.3.1 Scope

Detect signs of malfunction (failure) in wind power generators.

6.16.3.2 Objective

Detect signs of failure in wind power generation, earlier than human specialists.

6.16.3.3 Narrative (Short description)

A system is currently in development that uses machne learning to detect signs of equipment failure that would be difficult to detect from visual inspection. Currently, sensor data is being collected from 43 actual domestic large wind turbines, and large-scale verification testing is being conducted. The goal is for a paradigm shift from responding after the fact to maintenance that prevents problems and maintenans safety

6.16.3.4 Challenges and issues

[TBD]

6.16.3.5 Societal concerns

[TBD]

SDGs to be achieved: [TBD]

6.16.4 Generative Design of Mechanical Parts (A.15)

6.16.4.1 Scope

Help mechanical engineers design lighter, strong, better parts.

6.16.4.2 Objective

Create optimized parts following precise mechanical constraint while permitting cost savings by reducing the amount of material necessary to achieve goals.

6.16.4.3 Narrative (Short description)

From Wikipedia: Generative design is an iterative design process that involves a program that will generate a certain number of outputs that meet certain constraints, and a designer that will fine tune the feasible region by changing minimal and maximal values of an interval in which a variable of the program meets the set of constraints, in order to reduce or augment the number of outputs to choose from.

6.16.4.4 Challenges and issues

Challenges: Environment may be cluttered, occlusions of target might occur, objects may move around. Issues: For safety reasons, speed and force of robot need to be limited in assistive environment to avoid harm. Human intervention can happen at any time.

6.16.4.5 Societal concerns

[TBD]

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.5 Information Extraction from Hand-marked Industrial Inspection Sheets (A.21)

6.16.5.1 Scope

Localization and Mapping of machine zones, arrows and text, to extract information from manually tagged inspection sheets.

6.16.5.2 Objective

To create a pipeline to build an information extraction system for machine inspection sheets, by mapping the machine zones to the handwritten code using state-of-the-art deep learning and computer vision techniques.

6.16.5.3 Narrative (Short description)

Inspection Sheets are filled regularly to detect defects and maintain heavy machines. Sheets contains a lot of unstructured information and requires domain experts' intervention to read and digitize. We have proposed a novel pipeline to build an information extraction system for such machine inspection sheets, utilizing state-of-the-art deep learning and computer vision techniques.

6.16.5.4 Challenges and issues

Challenges:

- Quality of Images
- Structural deformities of individual components(arrows, handwritten code)
- Quantity of data
- Cascading effect of error at each stage of the pipeline

6.16.5.5 Societal concerns

Inspection engineers may have to develop other skills.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.6 Automated Defect Classification on Product Surfaces (A.33)

6.16.6.1 Scope

Image Analytics for water taps in sanitary industries.

6.16.6.2 Objective

Image analytics using a combination of feature extraction and classification of defects on shining surfaces in sanitary industries.

6.16.6.3 Narrative (Short description)

A vision system that inspects and identifies the defects on water taps in sanitary industries. The system uses a combination of features for an automatic defect classification on product surfaces. All defects (15 types are identified) are classified into two major categories, real-defects and pseudo-defects. The pseudo-defects cause no quality problem; while the real-defects are critical as they might malfunction the final products.

The AI system uses Support Vector Machine (SVM) classifier along with the combined features to identify the defect types. With the vision system in place, the quality control process is fully automated without any human intervention.

6.16.6.4 Challenges and issues

Real time implementation, accurately identify the nature of defects.

6.16.6.5 Societal concerns

Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.7 Robotic Task Automation: Insertion (A.34)

6.16.7.1 Scope

Robotic assembly.

6.16.7.2 Objective

— Simple programing/instruction and flexibility in usage

— Automation of tasks lacking analytic description

— Reliability and efficiency

6.16.7.3 Narrative (Short description)

Assembly process often includes steps where two parts need to be matched and connected to each other through force exertion. In an ideal case, perfectly formed parts can be matched and be assembled together with predefined amount of force. Due to imperfection of production steps, surface imperfection and other factors such as flexibility of parts, this procedure can become complex and unpredictable. In such cases, human operator can be instructed with simple terms and demonstrations and perform the task easily, while a robotic system will need very detailed and extensive program instructions to be able to perform the task including required adaptation to the physical world. The need for such a complex program instruction will make use of automation cumbersome or uneconomical. Control algorithm that are based on machine learning, especially those including reinforcement learning can become alternative solutions increasing and extending the level of automation in manufacturing.

6.16.7.4 Challenges and issues

— Complex and unpredictable assembly process due to imperfection of production steps, surface imperfection and other factors such as flexibility of parts.

— Accuracy of sensing

— Coworking with humans

6.16.7.5 Societal concerns

Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.8 Powering Remote Drilling Command Centre (A.36)

6.16.8.1 Scope

Oil and Gas Upstream (Deployed in 150 Oil Rigs and 2.5 Billion+ Data Points each).

6.16.8.2 Objective

Automatic generation of Daily Performance Report, reduction in overall drilling time, cut down Invisible Loss Time and improve rig asset management.

6.16.8.3 Narrative (Short description)

It is important for a drilling contractor to have real time monitoring of rig parameters to optimize operations. The customer lacked granular insights during drilling, could not ascertain the root cause of non-productive time, and manual interpretation of signals led to missing of anomalies further degrading performance.

6.16.8.4 Challenges and issues

Compliance of organizations.

6.16.8.5 Societal concerns

Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.9 Leveraging AI to Enhance Adhesive Quality (A.37)

6.16.9.1 Scope

Batch/Continuous/Discrete Manufacturing (Deployed in 75+ manufacturing lines in 10+ countries; Specifically identified the contributors to quality; predict potential quality failures).

6.16.9.2 Objective

Enhance Adhesive Quality, Performance Benchmarking.

6.16.9.3 Narrative (Short description)

Cerebra IOT signal intelligence platform provides the ability to have a holistic perspective and understanding of the sensitivity of the key parameters affecting output quality and ability to monitor and control the process in real-time. This will avoid variations in yields, build-up of inventories and missed customer deadlines.

6.16.9.4 Challenges and issues

Patented process if any, security restrictions.

6.16.9.5 Societal concerns

Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.10 Machine Learning Driven Approach to Identify the Weak Spots in the Manufacturing of the Circuit Breakers (A.38)

6.16.10.1 Scope

Detecting the issues in manufacturing process that leads to early failures of the circuit breakers through the data mining of the manufacturing process.

6.16.10.2 Objective

To generate actionable intelligence to improve the manufacturing process of circuit breakers through mining of manufacturing related data.

6.16.10.3 Narrative (Short description)

An approach was developed that can mine the manufacturing data of circuit breakers through multiple machine learning algorithms. The approach could successfully identify the weak spots in the manufacturing where failure rate jumped from 0.2% to 7% (35 fold more probability of failure) and hence candidates for improvement in the manufacturing process.

6.16.10.4 Challenges and issues

Discovering actionable insight with partial data set and managing bias in ML models due to limited number of failed cases.

6.16.10.5 Societal concerns

Safe and reliable power delivery.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.11 Machine Learning Driven Analysis of Batch Process Operation Data to Identify Causes for Poor Batch Performance (A.39)

6.16.11.1 Scope

Detecting the issues in batch manufacturing process that leads to bad quality products or longer cycle times of batch processing.

6.16.11.2 Objective

Provide insight to the operation team to improve the productivity of batch manufacturing through machine learning on historical operation data.

6.16.11.3 Narrative (Short description)

An approach was developed that can use machine learning models to identify issues in batch manufacturing.

6.16.11.4 Challenges and issues

Discovering actionable insight with limited industrial data set, handling dynamics in the process variables.

6.16.11.5 Societal concerns

Consistent batch operation lead to enhanced productivity.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.12 Empowering Autonomous Flow Meter Control- Reducing Time Taken to “Proving of Meters” (A.40)

6.16.12.1 Scope

Calibration of control devices.

6.16.12.2 Objective

Reduce the time taken for trial & error methods to set the VFD and FCV setpoints.

6.16.12.3 Narrative (Short description)

The customer had to set VFD and FCV % manually to achieve desired flowrate using trial & error methods, which could take about 3-4 hours. Efficiency for the proving of the meters was very less & improvement was needed to remove any aberration in reading as it was time consuming.

6.16.12.4 Challenges and issues

[TBD]

6.16.12.5 Societal concerns

Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.13 Adaptable Factory (A.46)

6.16.13.1 Scope

(Semi-)Automatic change of a production system’s capacities and capabilities from a behavioral and physical point of view.

6.16.13.2 Objective

The objective is to enable flexible production resources which enable fast reconfiguration and adaptation to changing situations, context, and requirements which facilitate optimized resource usage under uncertainty.

6.16.13.3 Narrative (Short description)

Rapid, and in some cases completely automated, conversion of a manufacturing facility, by changing both production capacities and production capabilities. This use case describes the adaptability of an individual factory by (physical) conversion and/or adaption of a factory's and its machines behavior in order to adjust to changing situations like disruptions, material quality variation, production of new products, etc.

A prerequisite is a modular and thereby adaptable design for manufacturing within the factory. The result is a need for intelligent and interoperable modules that basically adapted to an altered configuration on their own, and standardized interfaces between these modules.

6.16.13.4 Challenges and issues

[TBD]

6.16.13.5 Societal concerns

Enabling flexible and autonomously reconfigurable production systems ease human-machine configuration, facilitate optimized machine use, reduce failures through autonomous compensation, optimized product quality through prediction techniques.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.14 Order-Controlled Production (A.47)

6.16.14.1 Scope

Automatic distribution of production jobs across dynamic supplier networks.

6.16.14.2 Objective

The objective is to enable automatic supplier contracting for optimized utilization of manufacturing capabilities at suppliers, novel degrees of flexibility in contract manufacturing, and enable (mass) customized customer ordering.

6.16.14.3 Narrative (Short description)

A network of production capabilities and capacities that extend beyond factory and company boundaries allows for a quick order-controlled adaption to changing market and order conditions. The result is a largely fragmented and dynamic value chain network that change as required by the individual order, and thereby make the best use of capabilities and capacities of existing production facilities. The goal is to allow for automated order planning, allocation and execution, thereby considering all production steps and facilities required to facilitate linking external factories into a company's production process, as automated as possible.

6.16.14.4 Challenges and issues

[TBD]

6.16.14.5 Societal concerns

Enabling mass-customized production in global dynamic supply chains, and by that, ease production of small lot sizes for customized products.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.16.15 Value-based Service (A.48)

6.16.15.1 Scope

Process and status data from production and product use sources are the raw materials for future business models and services.

6.16.15.2 Objective

The objective of this use case is the provision of remote services for product and production based on (generic) service platforms. This use case can be seen as a fundament for the deployment of arbitrary AI remote services.

6.16.15.3 Narrative (Short description)

Service platforms collects data from product use – for example machines or plants – and analyses and processes this data to provide tailor-made individualized services, e.g. optimized maintenance at the proper time, or the timely provision of the correct process parameters for a production task currently being requested. Companies offering these services (service providers) occupy the interface between the product provider and the user.

6.16.15.4 Challenges and issues

[TBD]

6.16.15.5 Societal concerns

Increasing complexity of modern cyber-physical production systems cannot be managed by humans. AI technologies provide one solution in this context for more reliable, fault-tolerant, safe and secure production systems.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.17 Media and Entertainment

[TBD]

6.18 Mobility

6.18.1 Autonomous Apron Truck (A.12)

6.18.1.1 Scope

Automated transportation of luggage (carts) to requested destinations on an airport apron while following local traffic rules and resolve unplanned conflicts.

6.18.1.2 Objective

Automate transport to increase reliability, precision, efficiency and safety.

6.18.1.3 Narrative (Short description)

An AI solution was planned that could operate a luggage truck on an airport apron where it interacts with aircrafts, other machines and humans. It prevents accidents with humans at all times and follows local traffic rules.

6.18.1.4 Challenges and issues

Challenges: Achieve at least the same level as human truck operators.

Issues: 1) detect other apron traffic participants (especially aircraft) including intentions 2) Multiplicity of various outside conditions (e.g. signs painted on road but ice and snow covering it), and 3) prediction of human behaviour (e.g. workers in reverse walk).

6.18.1.5 Societal concerns

Changed work environment for workers during loading/unloading with less interactions with co-workers but more non-social interactions (machines).

SDGs to be achieved: [TBD]

6.18.2 AI Solution to Help Mobile Phone to have Better Picture Effect (A.32)

6.18.2.1 Scope

Better understanding the image and improving image effect on smartphone by using DL model which is trained in the cloud or offline.

6.18.2.2 Objective

To find an efficient solution to Increase camera image quality on smartphone without Increasing too much operation and power burden for mobile phone.

6.18.2.3 Narrative (Short description)

An AI solution was developed that could increase smartphone camera image quality. Using deep learning, smartphone can identify more scenarios and objects than before. Based on the identified scenarios and objects, smartphone can better understand the image and improve image effect.

6.18.2.4 Challenges and issues

Challenges: Achieve the same level as professional SLR camera for pictures.

Issues:

— Lack of data for certain scene;

— Lack of computing ability on terminal side ;

— Users can feel the improvement of image quality, but may not know that it is brought by AI.

6.18.2.5 Societal concerns

For the wrong object detection, it may lead to racial prejudice or privacy protection problems.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.19 Public sector

6.19.1 AI Ideally Matches Children to Daycare Centers (A.7)

6.19.1.1 Scope

Assignment pattern that satisfies complex applicants' requirements.

6.19.1.2 Objective

To determine the assignment pattern that will fulfill the preferences of as many applicants as possible automatically.

6.19.1.3 Narrative (Short description)

This AI technology automatically determines the assignment pattern while fulfilling as many applicants' preferences as possible by priority ranking by using game theory.

6.19.1.4 Challenges and issues

Challenges: Determine an optimal assignment pattern instantly and fairly depending on unique and complex rules in each local government.

Issues: Long calculation time is required in the case of a large number of children and siblings

6.19.1.5 Societal concerns

— Supporting working women

— Resolving the problem of children waiting for day care

SDGs to be achieved: Decent work and economic growth

6.20 Retail

6.20.1 Emotion-sensitive AI Customer Service (A.42)

6.20.1.1 Scope

Extracting sentiment and its intensity from customers' input, and responding with appropriate attitude in order to improve the quality of customers' inquiry.

6.20.1.2 Objective

To design an efficient solution for customers' sentiment and intensity detection, especially in the situation of limited training dataset.

6.20.1.3 Narrative (Short description)

The emotion-sensitive AI customer service of JD.com Int., is supported by AI technology and deep learning method. It is developed for ameliorating accuracy of customer sentiment and intensity. In sentiment classification, it has achieved 74% accuracy and 90% recall score while in intensity detection, it has accomplished 85% accuracy and 85% recall. During the special sale of "618", it has increased customer satisfaction by 57%.

6.20.1.4 Challenges and issues

Challenge: the system's performance should be as good as the human customer server.

Issues: 1) limited training data; 2) sentiment classification among seven categories.

6.20.1.5 Societal concerns

Improving the corresponding efficiency of customer service, improving customer service experience ;

Reducing labor costs, and reducing operating costs.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.20.2 Deep Learning Based User Intent Recognition (A.43)

6.20.2.1 Scope

Recognizing users' intent to solve their problems in e-commerce fields.

6.20.2.2 Objective

To recognize and understand users' intent by AI and deep learning technologies and apply such technologies to build chat bot systems to further reduce labor cost and to be applied in various fields.

6.20.2.3 Narrative (Short description)

Intelligent customer service chat bot is mainly used to categorize users' questions, recognize users' intents and answer users' questions intelligently for different business jobs. Currently, this chat bot has been used to handle 90% of online customer service and has enabled JD.com to save over 100 million labor costs every year.

6.20.2.4 Challenges and issues

Current challenges of deep leaning and intent recognition:

— High semantic ambiguity, similar sentences can deliver different meanings.

— Unclear classification rules caused by complicated business logics

— Hard to answer reasoning questions

6.20.2.5 Societal concerns

— Solve problems intelligently to increase efficiency

— Free labors from repetitive work to save large amount of resources for the society

SDGs to be achieved: Decent work and economic growth

6.21 Security

6.21.1 Behavioural and Sentiment Analytics (A.14)

6.21.1.1 Scope

Derive emotional state and goal of person from their gestures, face, actions.

6.21.1.2 Objective

Determine if the movements, actions and general behaviour of a person is sign of malevolent intentions. Detect stealing of objects and other criminal behaviours. Prevent undesired behaviour (suicide), adapt narrative to state of person, provide dynamic content according to emotional responses.

6.21.1.3 Narrative (Short description)

[TBD]

6.21.1.4 Challenges and issues

Challenges: Surveillance cameras often have low resolution, can be in poorly lit environment with bad top-down view angle. A lot of suspicious behaviour can be hidden by passer-by or large crowds. Issues: Unwanted behaviours is MUCH LESS frequent than normal behaviour and can take on various forms.

6.21.1.5 Societal concerns

Right to privacy.

SDGs to be achieved: Peace, justice and strong institutions

6.21.2 AI (Swarm Intelligence) Solution for Attack Detection in IoT Environment (A.22)

6.21.2.1 Scope

Anomaly Based Attack Detection in IoT environment using Swarm Intelligence.

6.21.2.2 Objective

Given: AMI (Advanced Metering Infrastructure – Smart Meters in Smart Buildings in Smart Cities.

Detect: Detect energy theft / meter tampering by consumer in AMI (Advanced Metering Infrastructure) or hacking attack by an external agent (man in the middle) for edge computing security scenarios with intermitted disconnection, near real-time response without using server or cloud-based analytics.

6.21.2.3 Narrative (Short description)

This is a unique approach to detect attacks in IoT environment using Anomaly Based Attack Detection using Swarm Intelligence methods. This is a key solution to detect energy theft scenario in Smart Metering. Energy Theft problem varies from 2% in developed countries to 35% in developing countries. This is complimentary to traditional AI or other static rule-based analysis which is heavily dependent on analysis of huge amounts of data on centralized cloud infrastructure. This solution is simple, nimble and can be run on low powered edge (IoT Nodes) for near real-time, low latency, low power, small compute, small storage Mist / Edge Computing Scenarios.

6.21.2.4 Challenges and issues

The problem is challenging because

— 1. Varied data set for different scenarios - large amount of data needs to be pre-processed to arrive at operation threshold parameters to be used for detection in real-time.

— 2. IoT (Edge) Nodes Configuration to suite specific environments The Swarm Intelligence System (SIS) involves a swarm of devices. It should be possible to easily configure the entire swarm for different network environments and locations.

— Solution: Many reusable modules for Logging, Debugging and configuration through XML has been developed which has enabled binary re-use without having to change any code to suit a new network environment.

— 3. Flexible to reuse / customize solution for different use-cases / scenarios and scalability

— The platform needs to be able to provide facilities for different algorithms for anomaly detection to be plugged in with minimum modification, recoding, recompilation.

— Solution: Completely dynamically pluggable Algorithm binaries can be developed that conforms to defined interface Specifications, which gives flexibility to try out new algorithms, without needing to change existing code or re-compile. Use of Swarm Intelligence ensures very less localized communication that is required. Furthermore, the Swarm Intelligence System communication capability also addresses throttling of network traffic because of multi-threading / queuing capability built in.

6.21.2.5 Societal concerns

Accuracy of Solution. Fraud (Anomaly Detection) usually incurs a false positive alarm issue.

SDGs to be achieved: Responsible consumption and production

6.21.3 Use of robotic solution for traffic policing and control (A.25)

6.21.3.1 Scope

Robotics based traffic policing system.

6.21.3.2 Objective

Efficient traffic control through use of Humanoid robots for traffic control.

6.21.3.3 Narrative (Short description)

Creation of a humanoid robot which can be deployed for traffic monitoring and control on roads. The solution will use computer vision and will be enabled with IOT for centralized control and data collection. This will relieve the human police from working in polluted environment.

6.21.3.4 Challenges and issues

The problem is challenging because accurate control instructions is crucial for proper traffic control.

6.21.3.5 Societal concerns

Addresses the pressing concern of effective traffic control.

SDGs to be achieved: Sustainable cities and communities

6.21.4 Robotic Solution for Replacing Human Labour in Hazardous Condition (A.26)

6.21.4.1 Scope

Building an AI based robotics solution for replacing Human Labour in Hazardous condition.

6.21.4.2 Objective

Building an AI based robotics solution for replacing Human Labour in Hazardous condition.

6.21.4.3 Narrative (Short description)

Building an AI based robotic solution enabled with computer vision and equipped with various sensors such as temperature, pressure, smoke detector etc which can effectively replace human labour in risky work environment.

6.21.4.4 Challenges and issues

The problem is challenging because

— Solution should be customizable for different work environments.

6.21.4.5 Societal concerns

Addresses the issue of accidents in Hazardous work environment.

SDGs to be achieved: Decent work and economic growth

6.22 Social infrastructure

6.22.1 Deep Learning Technology Combined with Topological Data Analysis Successfully Estimates Degree of Internal Damage to Bridge Infrastructure (A.8)

6.22.1.1 Scope

Estimate and detect the risk of the catastrophic collapses of old bridges.

6.22.1.2 Objective

Enables estimation of failure, state of degradation with surface-mounted sensors.

6.22.1.3 Narrative (Short description)

Development of sensor data analysis technology that can aggregate vibration data from sensors attached to the surface of a bridge, and then estimate the degree of the bridge's internal damage.

6.22.1.4 Challenges and issues

Challenges: Detecting the occurrence of internal stress using this technology allows for the estimation of damage in its earliest stages, and can contribute to early countermeasures.

Issues: Conduct trials using vibration data from actual bridges, with the goal of real-world usage.

6.22.1.5 Societal concerns

[TBD]

SDGs to be achieved: [TBD]

6.23 Transportation

6.23.1 AI Components for Vehicle Platooning on Public Roads (A.9)

6.23.1.1 Scope

Trains of vehicles that drive very close to each other at nearly equal speed (platoons) on public roads, in particular platooning trucks on motorways.

6.23.1.2 Objective

The objectives of truck automation are energy saving and enhanced transportation capacity by platooning, and eventually possible reduction of personnel cost by unmanned operation of following vehicles. In a variant of this concept, platoons of passenger cars follow a truck autonomously.

6.23.1.3 Narrative (Short description)

The overall concept of automated platooning is that the lead vehicle will be driven as normal by a trained (professional) driver, and the following vehicles will be driven fully automatically by the system, allowing the drivers to perform tasks other than driving their vehicles. The EU roadmap for truck platooning (EU project ENSEMBLE) envisions market introduction of multi-brand platooning by 2025. Several pilot projects have been carried out since about the year 2000. While a few AI components are already used in the pilot projects (e.g. lane keeping), future products are likely to incorporate AI solutions on several functional levels.

6.23.1.4 Challenges and issues

Highly unpredictable traffic environment, legislative situation, standardisation, stress and comfort of human drivers involved

6.23.1.5 Societal concerns

Stress or boredom for the drivers, Big Brother and constant monitoring, Safety, system security, and reliability, Risk of hacking and hijacking a long-haul freight truck poses great danger, Trust over system reliability when driving next to a computer-controlled platoon.

SDGs to be achieved: [TBD]

6.23.2 Self-Driving Aircraft Towing Vehicle (A.10)

6.23.2.1 Scope

Self-Driving towing vehicle for aircrafts, operating on an airfield autonomously.

6.23.2.2 Objective

A towing vehicle that will, on command, autonomously navigate to an assigned aircraft, attach itself, tow the aircraft to an assigned location (a runway for departures, a gate for arrivals), autonomously detach itself, and navigate to an assigned location, either a staging area or to service another aircraft.

6.23.2.3 Narrative (Short description)

Self-driving vehicle technology is applied to the problem of towing aircraft at busy airports from gate to runway and runway to gate. Autonomous aircraft towing can be supervised by human ramp controllers, by air traffic controllers (ATC), by pilots, or by ground crew. The controllers provide route information to the tugs, assisted by an automated route planning system. The planning system and tower and ground controllers work in conjunction with the tugs to make tactical decisions during operations to ensure safe and effective taxiing in a highly dynamic environment.

6.23.2.4 Challenges and issues

Safe operations in the airfield environment, minimal changes to the airport infrastructure, minimal impact of their incorporation into normal operations

6.23.2.5 Societal concerns

If labor replacements are involved, then the use of autonomy must provide an equivalent or greater benefit to some portion of the labor pool to offset the potential job loss; furthermore, they must operate in a way that feels common and familiar to humans, and must be perceived as completely safe, simple and non-intimidating.

SDGs to be achieved: [TBD]

6.23.3 Unmanned Protective Vehicle for Road Works on Motorways (A.11)

6.23.3.1 Scope

Unmanned operation of a protective vehicle in order to reduce the risk for road workers in short-time and mobile road works carried out in moving traffic.

6.23.3.2 Objective

A vehicle that is able to follow mobile road works automatically on the hard shoulder of a German motorway.

6.23.3.3 Narrative (Short description)

Mobile road works on the hard shoulder of German highways bear an increased accident risk for the crew of the protective vehicle safeguarding road works against moving traffic. The "Automated Unmanned Protective Vehicle for Highway Hard Shoulder Road Works" aims at the unmanned operation of the protective vehicle in order to reduce this risk. The vehicle has first been tested in a real operation on the German autobahn A3 in June 2018 [4]. It is actually the very first unmanned operation of a vehicle on German roads in public traffic. The scientific challenges of the project are strongly related to the general challenges in the field of automated driving.

6.23.3.4 Challenges and issues

Safe operations in public traffic, compliance with ISO 26262.

6.23.3.5 Societal concerns

[TBD]

SDGs to be achieved: [TBD]

6.23.4 Enhancing traffic management efficiency and infraction detection accuracy with AI technologies (A.29)

6.23.4.1 Scope

Utilizing AI technologies in traffic monitoring and management.

6.23.4.2 Objective

To increase the accuracy and efficiency of infraction detection, traffic monitoring and flow analysis, while minimizing the human effort and the overall solution cost.

6.23.4.3 Narrative (Short description)

Big data enabled AI technologies are applied to monitoring and managing the traffic in a large municipality in China. Multi-sourced data (traffic flow, vehicle data, pedestrian movement, etc.) is monitored, from which illegal operation of vehicles, unexpected incidents, surge of traffic etc. are detected and analysed with machine learning (ML) methods. ML tasks (including training and deployment) are carried out on a platform supporting the integration of various ML frameworks, models and algorithms. The platform is based on heterogeneous computing resources. The efficiency and accuracy of infraction detection, and the effectiveness of traffic management are significantly improved, with much reduced human effort and overall solution cost.

6.23.4.4 Challenges and issues

- Constant improvement in hardware architecture to increase the performance and efficiency of running ML/DL tasks.
- Consistent interfaces between applications, ML engines and heterogeneous resource pools.
- Support of new models and emerging algorithms for growing functionalities.

6.23.4.5 Societal concerns

AI's application in urban transportation significantly improves the quality of life for urban citizens, reduces the time wasted in heavy traffic and the air pollution from vehicles.

SDGs to be achieved: Sustainable cities and communities

6.23.5 AI Solution for Traffic Signal Optimization based on Multi-source Data Fusion (A.49)

6.23.5.1 Scope

Generate traffic signal timing plans by analyzing traffic flow status and patterns based on fusing internet data, induction coils data and video data, and control the traffic signal with the generated timing plans in a real-time, self-adaptive and cooperative way.

6.23.5.2 Objective

To find an effective and efficient solution to improve the road utilization efficiency by increasing traffic flow speed and reducing traffic flow waiting time.

6.23.5.3 Narrative (Short description)

An AI solution was developed that could recognize real-time traffic flow status and abstract traffic flow patterns by fusing internet data, induction coils data and video data, and could generate optimized traffic signal timing plan by self-adaptively responding to real-time traffic flow fluctuation and with regards to traffic flow coordination among multiple intersections within a given region.

6.23.5.4 Challenges and issues

Challenges: Traffic signal self-adaptive and coordinated control for a large number of intersections. Issues: 1. Not all intersections are equipped with detectors such as induction coil or video. 2. The detectors may output abnormal values which need data clean processing.

6.23.5.5 Societal concerns

Relieve urban road congestion.

SDGs to be achieved: Sustainable cities and communities

6.23.6 Automated Travel Pattern Recognition using Mobile Network Data for Applications to Mobility as a Service (A.52)

6.23.6.1 Scope

Detect automatically travel pattern recognition from anonymized and aggregated Mobile phone Network Data.

6.23.6.2 Objective

Phase 1: Attribute trip purpose and mode of transport to multimodal door-to-door journeys from Mobile phone Network Dataset using AI and machine learning techniques (Activity based model)

Phase 2: Generate daily activities for static agents in the Agent Based Model

Phase 3: Optimisation of New Mobility services in integration with mass transit

6.23.6.3 Narrative (Short description)

Activity- based modelling has the capability to exploit big data source generated by smart cities to create a digital twin of urban environments to test Mobility as a Service schemes. MND data have been used to create activities for an Agent Based Model.

AI is used to automatically detect purpose and mode of transport in multimodal round trips, obtained by anonymized and aggregated MND trip-chains dataset. Data fusion techniques and SQL queries were also used to consider land use and facilities in the urban area of interest.

6.23.6.4 Challenges and issues

The use of Mobile Phone Network data is still not precise for shorter trips and internal trips which might be not detected. However, with the introduction of 5G, MND will be even more reliable and available to use in transport modelling.

6.23.6.5 Societal concerns

The use of anonymization techniques minimise the risk of disclosing personal information when analyzing location based data and Mobile phone Network Data.

SDGs to be achieved: [TBD]

6.24 Work & life

6.24.1 Robotic Prehension of Objects (A.16)

6.24.1.1 Scope

Outputting end effector velocity & rotation vector in response to view from RGB-D camera located on robot wrist.

6.24.1.2 Objective

Use reinforcement learning to train the robot to grasp misc. objects in simulation and transfer this learning to real-life robots.

6.24.1.3 Narrative (Short description)

It may be difficult and time-consuming for clients of assistive robotic arms to control them with the fine degree required for grasping household objects (such as in the context of having a meal). In order to improve their quality of life, we propose a method by which users can select the bounding box around the object they wish grasped, and the robot performs the grasping action. We use methods from reinforcement learning to train first in simulation, in order to reduce total training time and potential robot breakage, and then transfer this learning to real-life.

6.24.1.4 Challenges and issues

Challenges: The camera cannot have a bird's eye view and will instead move with the robot. Sparse rewards may complicate learning. Environment may be cluttered, occlusions of target might occur, objects may move around Issues: For safety reasons, speed and force of robot need to be limited in assistive environment to avoid harm. Human intervention can happen at any time.

6.24.1.5 Societal concerns

Prevent arm to people and animals near robot when it is performing a grasping task

SDGs to be achieved: Good health and well-being for people

6.24.2 Robotic Vision – Scene Awareness (A.17)

6.24.2.1 Scope

Determining in which environment the robot is and which actions are available to it.

6.24.2.2 Objective

Robustly identify the scene from video and depth sensors. From the scene and the seen objects, propose the actions to make to human collaborator .

6.24.2.3 Narrative (Short description)

Household robots need to navigate a very diverse set of environments and be able to accomplish different tasks depending on their position and action set. To meet these goals, the robots need to quickly and accurately identify the visual context in which they operate and derive the set of possible actions from this context. They can then propose relevant actions to the end user so that he does not have to define context himself and then sift through a long list of irrelevant actions.

6.24.2.4 Challenges and issues

Challenges: Environment can be poorly lit leading to difficult context recognition. Issue: Sensors degradation can occur.

6.24.2.5 Societal concerns

Privacy concerns (what data from sensors is kept, reviewed and used to improve models).

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.25 Others

[Editor's Note and Proposal: This subclause includes use cases with other application domains that are out of the pull-down list.]

6.25.1 AI Solution to Identify Automatically False Positives from a Specific Check for "Untranslated Target Segments" from an Automated Quality Assurance Tool (A.13)

6.25.1.1 Scope

The scope of this use case is limited to automated linguistic quality assurance tools, but the outcome of this use case could be applicable to other areas, such as for example: Machine Translation, automated post-editing, Computer Aided Translation Analysis and pre-translation, etc.

6.25.1.2 Objective

To reduce the number of false positive issues for check for untranslated target segment for bilingual content with in-house automated quality assurance tool.

6.25.1.3 Narrative (Short description)

In the future, we aim to build an AI solution that could automatically identify likely false positives issues from the results of the "check for untranslated target segments" following an approach where we could use machine learning based on already identified false positives by our users.

The expected outcome would be to increase end user's productivity when reviewing automated quality assurance findings and to change user behaviour to pay more attention to this type of issues by reducing the number of false positives in 80%. In addition, we would like to reduce the amount of time, we spent on a yearly basis on refining this check manually based on users' feedback.

6.25.1.4 Challenges and issues

Challenges: Try to achieve eventually 80% of the accuracy of linguists when identifying false positives for untranslated target segments, preventing as much as possible false negatives.

Issues: segmentation of false positive data by Customer and Product profile could be challenging.

6.25.1.5 Societal concerns

Not applicable

SDGs to be achieved: [TBD]

6.25.2 AI Solution for Car Damage Classification (A.18)

6.25.2.1 Scope

Car damage classification for common damage types such as bumper dent, door dent, glass shatter, head lamp broken, tail lamp broken, scratch and smash.

6.25.2.2 Objective

— To create an automated system for car damage classification using CNNs.

— Experiment using transfer and ensemble learning to find which is better for training a CNN for car damage classification.

6.25.2.3 Narrative (Short description)

Image based vehicle insurance processing is an important area with large scope for automation. We have considered the problem of Car damage classification. We explore deep learning based techniques for this purpose. Initially, we try directly training a CNN. However, due to small set of labeled data, it does not work well. Then, we explore the effect of domain-specific pre-training followed by fine-tuning. Finally, we experiment with transfer learning and ensemble learning. Experimental results show that transfer learning works better than domain specific fine-tuning. We achieve accuracy of 89.5% with combination of transfer and ensemble learning. We hosted the trained model on cloud that can be plugged into applications using API and can be used for automated first level assessment of the damage, in car insurance sector.

6.25.2.4 Challenges and issues

— Small size of the damages

— Less Quantity of data

— Ambiguity in damaged and non-damaged images

6.25.2.5 Societal concerns

Insurance agents may need to be re-skilled

SDGs to be achieved: Decent work and economic growth

6.25.3 Recommendation Algorithm for Improving Member Experience and Discoverability of Resorts in the Booking Portal of a Hotel Chain (A.28)

6.25.3.1 Scope

Building a personalized recommendation algorithm to help members of the hotel chain to find their desirable hotel for the family holiday.

6.25.3.2 Objective

Offering personalized recommendations by understanding the member preferences from past holiday patterns and searches in the booking portal. Various member and hotel features were also considered for the model.

6.25.3.3 Narrative (Short description)

Refining existing system and implement a new model that can give personalized recommendations to members and improve bookings at the undiscoverable or not-so-popular hotels. The algorithm would help in reshaping the demand and increase the visibility of the hotels which are at the lower spectrum of demand.

We would include member and resort features along with interaction data like members visiting a hotel, and giving a rating to a resort visit etc.

6.25.3.4 Challenges and issues

— Cold Start Problem: Since the member has only visited certain hotels in the past, the interaction matrix is very sparse.

— The matrix computation at times is computational resource intensive causing system failures.

6.25.3.5 Societal concerns

We don't see any societal concerns if it is used.

6.25.4 Causality-based Thermal Prediction for Data Center (A.35)

6.25.4.1 Scope

Data center cooling control involving use of air cooling to control hot spots in data center.

6.25.4.2 Objective

Minimize energy usage in managing data center.

6.25.4.3 Narrative (Short description)

Data centers tend to be overcooled to prevent computing machines from failing due to heat. A reliable fine-grained control that could regulate air control unit (ACU) supply air temperature or flow is needed to avoid overcooling. Methods that are based on correlation-based techniques do not generalize well. Hence, we seek to uncover the causal relationship between ACUs supplying cool air and temperature at the cabinets to prioritize which ACUs should be regulated to control a hot-spot near a cabinet.

6.25.4.4 Challenges and issues

Data sufficiency.

6.25.4.5 Societal concerns

Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.25.5 Machine Learning Tools in Support of Transformer Diagnostics (A.51)

6.25.5.1 Scope

Power Transformers operation and maintenance

6.25.5.2 Objective

Use of Machine Learning (ML) algorithms as supporting tools for the automatic classification of power transformers operating condition

6.25.5.3 Narrative (Short description)

The successful use of ML tools may find multiple applications in the industry such as providing fast ways of analysing new data streaming from online sensors, evaluating the importance of individual variables in the context of transformer condition assessment and also the need or adequacy of data imputation in the so widely common problem of missing data

6.25.5.4 Challenges and issues

Data availability, missing data, imbalanced classes

6.25.5.5 Societal concerns

Safe and reliable power delivery

SDGs to be achieved: Industry, Innovation, and Infrastructure

6.25.6 Video on Demand Publishing Intelligence Platform (A.58)

6.25.6.1 Scope

Video on Demand Content Preparation Process Error detection & recommendation system.

6.25.6.2 Objective

System errors comprehension, errors prediction, recommendation engine implementation.

Proactive approach to system maintenance problems management.

6.25.6.3 Narrative (Short description)

E2D solution design and development for error detection system based on Machine Learning models and a recommendation engine supported by a reinforcement learning framework.

6.25.6.4 Challenges and issues

Machine Learning Engines processing time had to be very short

6.25.6.5 Societal concerns

[TBD]

SDGs to be achieved: [TBD]

6.25.7 Predictive Testing (A.59)

6.25.7.1 Scope

Predictive testing of application development.

6.25.7.2 Objective

Improving the level of automation and the activity throughput of test verifiers by reducing the number of failure notices that are wrongly generated and suggesting mitigation actions according to past experience.

6.25.7.3 Narrative (Short description)

The solution adopt machine learning to analyze data coming from test results to identify correlation and patterns in order to reduce false positives and suggest recommendation actions.

6.25.7.4 Challenges and issues

Being able to manage and handle different type of data, normalize and use different type of data (including contextual information), integrate the solution in the processes and procedure of the company.

6.25.7.5 Societal concerns

[TBD]

SDGs to be achieved: [TBD]

6.25.8 Predictive Data Quality (A.60)

6.25.8.1 Scope

A solution for assessing Data Quality in data collection systems.

6.25.8.2 Objective

Using machine learning techniques for identifying complex or unknown correlation among data in order to score its quality and enhance the confidence for data consumer in using data for the decision making processes.

6.25.8.3 Narrative (Short description)

The solution adopt machine learning methods to analyze data collected in order to identify complex correlation on data (unknown at priori) and predict data quality issues.

6.25.8.4 Challenges and issues

Being able to manage and handle different type of data, link data to reference knowledge model, change management in the organization.

6.25.8.5 Societal concerns

[TBD]

SDGs to be achieved: [TBD]

Annex A
(informative)

Collected use cases

[Editor's Note and Proposal: The collected use cases will be added in this annex with full information. Each use case will be in an individual section.]

A.1 Explainable Artificial Intelligence for Genomic Medicine

[SOURCE: SC42/WG4 N050 uc_1]

A.1.1 General

ID	1	
Use case name	Explainable artificial intelligence for Genomic Medicine	
Application domain	Healthcare	
Deployment Model	Cloud services	
Status	Prototype	
Scope	To explain reason and basis behind AI-generated findings in genomic medicine	
Objective(s)	To improve the efficiency of investigatory work for experts in genomic medicine.	
Narrative	Short description (not more than 150 words)	This technology was deployed to improve the efficiency of investigatory work for experts in genomic medicine, utilizing training data and a knowledge graph that made use of public databases and medical literature databases in the field of bioinformatics. It was then evaluated to validate that it was possible to find and link the basis supporting findings with regard to phenomena whose interrelationships are only partially understood.
	Complete description	Deep Learning is one of the most representative technologies in recent AI and shows high performance in pattern recognition and analysis. However, as it cannot explain the reasons for its judgment, it is called "black box AI." There is a graph-structured data based machine learning technology called "Deep Tensor" that can directly analyze the relations among numerous pieces of real-world data ranging from intercompany transactions to material structures. Additionally, there is also a technology for building a large-scale knowledge base, which is called a "knowledge graph" and consists of vast knowledge existing around the world such as academic papers, by using our unique technology. This technology identifies the factors (partial graphs) that had a significant influence on an inference and coordinates these with partial graphs from a knowledge graph, building a series of pieces of information

		in the form of connections in the knowledge graph as the basis for the findings. People can combine these two technologies and develop a system that enables AI to explain the reasons and basis (evidence) for its judgment. A use case of applying this explainable AI is genomic medicine (for cancer treatment). The latest genomic medicine helps detect patients' genetic defects that have caused disease (cancer) and uses therapeutic drugs that affect cancer cells produced by such genetic defects. In genomic medicine today, a patient's normal and cancerous cells are analyzed with a next-generation sequencer; then, a medical team uses the obtained genetic data to identify a causal gene and determines the recommended treatment. It takes at least two weeks for the medical team to conduct an examination after completing genetic analysis. Unless the cost and time problems are solved, spreading this advantageous genomic medicine far and wide will be difficult. In this use case, the explainable AI trained Deep Tensor using 180,000 pieces of disease mutation data, successfully embedding more than 10 billion pieces of knowledge from 17 million medical articles and other materials into Knowledge Graph. Inputting genetic mutation data into this system enables Deep Tensor to infer disease-causing factors and enables Knowledge Graph to find medical evidence to justify the obtained results. Medical specialists then simply need to review the flow of obtained inference logic, thereby reducing the period between analysis and report submission significantly— from two weeks to a single day.		
Stakeholders	Doctors of genomic medicine, researchers of genomic medicine, patients			
Stakeholders' assets, values	Reducing the determination periods, maintaining the accuracy of predication as well as manual predication			
System's threats and vulnerabilities	Update knowledge graph lately, huge size of knowledge graph			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Accuracy of predication	Proportion of the true positives and true negatives combined in the disease predication by AI	Improve accuracy
	2	Appropriateness of explanation	Proportion of the appropriate flow of obtained inference logic	Improve efficiency
	3	Determination periods	The periods that a medical team uses	Improve efficiency

			the obtained genetic data to identify a causal gene and determines the recommended treatment.	
AI features	Task(s)	Knowledge processing & discovery, Natural Language Processing, Inference, Prediction		
	Method(s)	Knowledge Graph, Deep Learning (Deep Tensor), Natural Language Processing		
	Hardware			
	Topology			
	Terms and concepts used	Knowledge Graph, Deep Learning, Natural Language Processing, Explainable AI		
Standardization opportunities/ requirements				
Challenges and issues	Challenges: To reduce experts' workloads, shortening determination periods in genomic medicine. Issues: The inability to explain the reason behind inferences from the learning algorithm of black-box AI.			
Societal concerns	Description	1, Accountability for using AI in medical examination 2, Incorrect explanation will cause the determination periods increasing.		
	SDGs to be achieved	Good health and well-being for people		

A.1.2 Data (optional)

Data characteristics	
Description	Knowledge Graph
Source	Disease mutation data, medical articles and other materials
Type	Graph-structured data in RDF format
Volume (size)	180,000 pieces of disease mutation data, more than 10 billion pieces of knowledge from 17 million medical articles
Velocity (e.g. real time)	Batch
Variety (multiple datasets)	multiple datasets
Variability (rate of change)	Static
Quality	High

A.1.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Training	Train a model (deep tensor) with	Disease mutation data for training is ready	To extract disease mutation data from	

		training data set		knowledge graph	
2	Evaluation	Evaluate whether the trained model(dee p tensor) can be deployed	Completion of training		Meeting accuracy requirement of predication (e.g. accuracy of predication is 90% or more) is the "success" condition
3	Execution	1, Enables Deep Tensor to infer disease-causing factors 2, Enables Knowledge Graph to find medical evidence to justify the obtained results.	The genetic mutation data is ready	To extract mutation data from knowledge graph	

A.1.4 Training (optional)

Scenario name	Training				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Disease mutation data for training is ready	Extract training diseases mutation data	Doctors or researchers pf genomic medicine	Extract mutation data from knowledge graph	The software for processing RDF data base has to be provided by the AI solution provider
2	Completion of Step 1	Model training	AI solution provider	Train a model (deep tensor) with the training data set created by Step 1	

Specification of training data	

A.1.5 Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Completion of training	Extract evaluating diseases mutation data	Doctors or researchers pf genomic medicine	Extract diseases mutation data from	The software for processing RDF data base has to be

				knowledge graph	provided by the AI solution provider
2	Completion of Step 1	Predication	AI solution provider	Given the mutation data from Step 1, predicate disease / non-disease using deep tensor models that were trained in the scenario of training	
3	Completion of Step 2	Evaluation	Doctors or researchers pf genomic medicine	Compare the result of Step 2 with that of human inspection	

Input of evaluation	
Output of evaluation	

A.1.6 Execution (optional)

Scenario name	Execution				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	The genetic mutation data is ready	Extract genetic mutation data	Doctors or researchers pf genomic medicine	Extract the target of genetic mutation data from knowledge graph	The software for processing RDF data base has to be provided by the AI solution provider
2	Completion of Step 1	Predication	AI solution provider	Given the mutation data from Step 1, predicate disease / non-disease using deep tensor models that were trained in the scenario of training	
3	Completion of Step 2	Inference	AI solution provider	Enables Deep Tensor to infer disease-causing factors	
4	Completion of Step 3	Explanation	AI solution provider and Doctors or	Enables Knowledge Graph to find medical	

			researchers pf genomic medicine	evidence to justify the obtained results	

Input of Execution	
Output of Execution	

A.1.7 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Brochure				Fujitsu	http://journal.jp.fujitsu.com/en/2018/01/23/02/
2	Brochure				Fujitsu	http://www.fujitsu.com/jp/group/labs/en/business/artificial-intelligence/
3	Press Release				Fujitsu	http://www.fujitsu.com/global/about/resources/news/press-releases/2017/0920-02.html
4	Journal				Nature	http://s3-service-broker-live-19ea8b98-4d41-4cb4-be4c-d68f4963b7dd.s3.amazonaws.com/uploads/ckeditor/attachments/8429/04_UK_Fujistu_AI.PDF

A.2 Revolutionizing Clinical Decision-making using Artificial Intelligence

[SOURCE: SC42/WG4 N050 uc_2]

A.2.1 General

ID	2
Use case name	Revolutionizing clinical decision-making using artificial intelligence
Application domain	Healthcare
Deployment Model	On-premise systems
Status	PoC
Scope	To improve clinical decision-making and the accurate assessment of risks for individual patients of mental healthcare.

Objective(s)	Halving the time to pre-screen patient records and giving more time for patient consultations	
Narrative	Short description (not more than 150 words)	The solution has halved the time for the preliminary assessment of patient records, increasing the time available for consultations
	Complete description	Traditional healthcare institutions have extensive paper archives built up over many years, representing a body of data that is often difficult to systematize, locate and interpret. The implementation of the electronic clinical history represents significant progress, facilitating analysis by providing information in an accessible and legible format with centralized access. However, in a "post-digitization" era, the information generated on a daily basis remains underused. "We have access to a vast quantity of data but it's hard to extract meaningful information that helps us improve the quality of the care we provide," explains Dr. Julio Mayol Martínez, Medical Director and Director of Innovation at the San Carlos Clinical Hospital. The solution has been developed on the back of the company's in-depth research into applying advanced data analytics for healthcare applications. It has involved working in close collaboration with San Carlos Clinical Hospital's expert clinicians, applying Fujitsu's principles of co-creation to deliver tangible value in the field of mental healthcare. It deploys Fujitsu Laboratories' state of the art anonymization technologies and Fujitsu's data analytics technologies, tailored to meet the specific needs of the local Spanish healthcare sector. The technology will form the basis of a new Health Application Programming Interface (API), to be deployed in the Fujitsu cloud or delivered locally in a private cluster or cloud. The field trial took place over a 6-month period, involving senior mental health clinicians from San Carlos Clinical Hospital and a core database of over 36,000 anonymized patient records. Fujitsu leveraged this database to develop its Advanced Clinical Research Information System, based on its advanced artificial intelligence expertise including data analytics and semantic modelling. In the field trial, each of the clinicians looked at issues associated with the main diagnosis, any co-morbidities, potential risks from suicide, substance or alcohol abuse, and the patient history of using the healthcare system. Fujitsu's system demonstrated a very high degree of risk assessment accuracy, with the system accelerating and systemizing the verification of key clinical data and identification of existing clinical problems. It achieved results of over 85 percent to identify suicide, alcohol and drug abuse risk.
Stakeholders		
Stakeholders' assets, values		

System's threats and vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
AI features	Task(s)	Natural language processing		
	Method(s)	Knowledge Graph		
	Hardware			
	Topology			
	Terms and concepts used			
Standardization opportunities/ requirements				
Challenges and issues	The incorporation of many different types of data is revolutionizing the healthcare sector. The ability to apply semantic and analytic technologies to this heterogeneous mass of data, as well as traditional healthcare data, to discover hidden correlations, identify care patterns and support clinical decision-making is paving the way for a new generation of improved healthcare services			
Societal concerns	Description	Incorrect decision Unexplainable result		
	SDGs to be achieved	Good health and well-being for people		

A.2.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Brochure				Fujitsu	http://www.fujitsu.com/global/Images/CS_2017Apr_IdISSC_San-Carlos-Hospital_Eng_v.1.pdf
2	Brochure				Fujitsu	http://www.fujitsu.com/global/microsite/vision/customerstories/hospital-clinico-san-carlos/
3	Press Release				Fujitsu	http://www.fujitsu.com/uk/about/resources/news/press-releases/2015/pr-fle20161110.html

A.3 AI Solution to Calculate Amount of Contained Material from Mass Spectrometry Measurement Data

[SOURCE: SC42/WG4 N050 uc_3]

A.3.1 General

ID	3	
Use case name	AI solution to calculate amount of contained material from mass spectrometry measurement data	
Application domain	Manufacturing	
Deployment model	Embedded systems	
Status	PoC	
Scope	Calculating amount of contained material from mass spectrometry measurement data using chromatography	
Objective(s)	To find an accurate and efficient solution to calculating amount of contained material without dependence on individuals	
Narrative	Short description (not more than 150 words)	An AI solution was developed that could automatically pick the peak related to the contained material from measurement data through deep learning. Compared with manual results by an experienced operator, the automated peak picking results using AI had a false detection rate of 7% and an undetected rate of 9%. The peak picking operation time using AI was estimated to be about one fifth.
	Complete description	The technology was developed that utilizes AI (artificial intelligence) to process the vast amounts of data used in analyzing the measurement results, which are essential to analytical processes, acquired from mass spectrometers. Mass spectrometers are used for research and quality control in various areas such as the establishment of early detection techniques for diseases and the measurement of residual pesticides in foods, and because of improvements in sensitivity and speed, the amount of data acquired is enormous. As a result, the data analysis step called "peak picking" has become the bottleneck in the workflow. Complete automation is difficult and to some extent manual adjustments are required. Therefore, there are differences in analysis accuracy depending on each operator and there is a possibility that analytical results might be affected by each operator's practices and data alterations. In recent years, automated data analysis with high accuracy that eliminates this kind of dependence on individuals is now demanded in the fields of healthcare and new drug development. To solve this issue using AI, the three companies investigated the application of deep learning, a neural network technology that imitates brain neurons. Arising to confront this process were two problems: 1) insufficient

		training data; and 2) learning could not proceed when analytical equipment output data was input, as is, into the deep learning network. The technologies to produce extra data to compensate for the lack of training data and to convert the analysis equipment output features into images were developed. Moreover, the companies developed the feature extraction technology to learn the analytical skills of experienced analysts. By doing this, the deep learning network was able to learn from the over 30,000 items of generated training data. Compared with manual peak picking results by an experienced operator, the automated peak picking results using AI had a false detection rate of 7% and an undetected rate of 9%. These results indicate that an automated peak picking can compare favorably with a peak picking by an experienced operator.		
Stakeholders				
Stakeholders' assets, values				
System's threats and vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Recall	Proportion of the true positive to positive results by an experienced operator	Improve accuracy
	2	Precision	Proportion of the true positive to positive results by AI	Improve accuracy
	3	Operation time	Ratio of operation time using AI to the conventional one	Improve efficiency
AI features	Task(s)	Recognition		
	Method(s)	Deep Learning		
	Hardware			
	Topology			
	Terms and concepts used	Deep Learning, Data Augmentation		
Standardization opportunities/ requirements				
Challenges and issues	Challenges: Achieve the same level as experienced operators for peak picking. Issues: 1) Lack of training data per contained material, 2) how to create good images for deep learning from mass spectrometry measurement data			
Societal concerns	Description			

	SDGs to be achieved	

A.3.2 Data (optional)

Data characteristics	
Description	Mass spectrometry measurement data
Source	Mass spectrometry
Type	Numerical data
Volume (size)	
Velocity (e.g. real time)	Batch
Variety (multiple datasets)	Single
Variability (rate of change)	Static
Quality	High

A.3.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Training	Train a model (deep neural network) with training samples			
2	Evaluation	Evaluate whether the trained model can be deployed			
3	Execution	Pick peaks using the trained model and calculate the amount of contained material			
4	Retraining	Retrain a model with training samples			

A.3.4 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link

1	Brochure				Fujitsu	http://www.fujitsu.com/global/vision/customerstories/shimadzu-corporation/index.html
2	Press Release				Fujitsu	http://www.fujitsu.com/global/about/resources/news/press-releases/2017/1113-01.html

A.4 AI Solution to Quickly Identify Defects during Quality Assurance Process on Wind Turbine Blades

[SOURCE: SC42/WG4 N050 uc_4]

A.4.1 General

ID	4	
Use case name	AI solution to quickly identify defects during quality assurance process on wind turbine blades	
Application domain	Manufacturing	
Deployment Model	On-premise systems	
Status	In operation	
Scope	Detecting defects in products by inspecting nondestructive testing scanning data	
Objective(s)	To find an accurate and efficient solution to detect defects without compromising the detection of in-material damage and risking a loss in reputation.	
Narrative	Short description (not more than 150 words)	An AI solution was developed that could automatically detect defects through deep learning together with what is called "imagification"; it achieved high coverage of various defects and evaluation of each nondestructive testing scanning was reduced by 80%, which translated into cost savings, reduced production lead times, and increased productivity.
	Complete description	The manufacturer produces over 5,000 wind turbine blades every year for use in on/offshore wind farms. Each blade can be up to 75 meters in length and takes a highly skilled professional quality controller up to 6 hours to evaluate the Ultrasonic Testing (UT) scanning in the quality assurance process. This is because the structure can contain multiple defect types, including how fiberglass can wrinkle during the production process. This has the potential to be catastrophic if this makes the blade crash during operation. The manufacturer must put each wind turbine blade through a stringent quality assurance process. Any defects when a blade is in operation could not only prove catastrophic but also inflict major damage to the company's

		reputation. Working with the AI solution provider together they co-created an AI solution that could automatically detect defects through deep learning capabilities; it achieved high coverage (more than 95%) of various defects and evaluation of each nondestructive testing scanning reduced by 80%. Another method featured in the AI solution is "imagification," which transforms raw data into image data based on RGB where deep learning-based image recognition can be applied effectively. Quality controllers can focus their efforts on suspicious areas and disregard all clean data; humans only need to examine the blades that are flagged by the AI system. With 5,000 blades produced every year, that adds up to a saving of almost 32,000 man-hours, which translates into significant cost savings, reduced production lead times, and increased productivity. Today, there is a shortage of ultrasonic engineers/inspectors. This solution means the same inspector can do 4 to 5 blades per day instead of 1 previously.		
Stakeholders	Manufacturer			
Stakeholders' assets, values	Reputation			
System's threats and vulnerabilities	Changes in defects of in-material damage over time			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Coverage	Ratio of defects included/found in the regions of product which are "of interest" for manual inspection. Ideal target is 95%.	Improve accuracy
	2	Split	Proportion of the regions of product which are "of interest" for manual inspection. The less split, the more efficient the total quality assurance process becomes.	Improve efficiency
AI features	Task(s)	Recognition		
	Method(s)	Deep learning		
	Hardware			
	Topology			

	Terms and concepts used	Deep learning, "imagification", neural network, training, training data set
Standardization opportunities/ requirements		
Challenges and issues	Challenges: Achieve the same level as ultrasonic accredited engineers for detecting critical defects. Issues: 1) Lack of defect data per defect type, 2) how to create good images for deep learning from UT raw data, and 3) back wall detection	
Societal concerns	Description	
	SDGs to be achieved	Affordable and clean energy

A.4.2 Data (optional)

Data characteristics	
Description	UT scanning data
Source	UT scanning instrument
Type	Ultrasonic data from scanner vendor
Volume (size)	
Velocity (e.g. real time)	Batch
Variety (multiple datasets)	Single source
Variability (rate of change)	Static
Quality	High (depending on UT equipment)

A.4.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Training	Train a model (deep neural network) with training data set	Sample raw data set is ready		
2	Evaluation	Evaluate whether the trained model can be deployed	Completion of training/re training		Meeting KPI requirements (e.g. coverage is 95% or more, split is 20% or less) is the "success" condition
3	Execution	Detect defects (regions including defects) using the trained	Completion of UT scanning of a blade	The trained model has been evaluated as deployable	

		model			
4	Retraining	Retrain a model with training data set	Certain period of time has passed since the last training/re training		

A.4.4 Training (optional)

Scenario name	Training				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Sample raw data set is ready	Imagification	Manufacture r	Transform sample raw data from UT scanning to image data based on RGB	The software for imagification has to be provided by the AI solution provider.
2	Completion of Step 1	Training data set creation	Manufacture r	Create training data set by labelling the output of Step 1 with "defective"/"non -defective"	
3	Completion of Step 2	Model training	AI solution provider	Train a model (deep neural network) with the training data set created by Step 2	

Specification of training data	

A.4.5 Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Completion of training/retraining	Imagification	Manufacturer	Transform raw data from UT scanning for blind test to image data based on RGB	
2	Completion of Step 1	Detection	AI solution provider	Given the image data from Step 1, detect defects (regions	

				including defects) using the deep neural network trained in the scenario of training	
3	Completion of Step 2	Evaluation	Manufacturer	Compare the result of Step 2 with that of human inspection	

Input of evaluation	
Output of evaluation	

A.4.6 Execution (optional)

Scenario name	Execution				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Completion of UT scanning of a blade	Imagification	Manufacture r	Transform raw data from UT scanning to image data based on RGB	
2	Completion of Step 1	Detection	Manufacture r	Given the image data from Step 1, detect defects (regions including defects) using the trained deep neural network with the output of Step 1 as input	The trained deep neural network has to be handed over to the manufacture r.

Input of Execution	
Output of Execution	

A.4.7 Retraining (optional)

Scenari o name	Retraining				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Certain period of time has passed since the last training/retraining	Imagification	Manufact urer	Transform sample raw data from UT scanning to image data based on RGB	
2	Completion of Step 1	Training data set creation	Manufact urer	Create training data set by labelling the output of Step 1 with "defective"/"non-defective"	

3	Completion of Step 2	Model training	AI solution provider	Train a model (deep neural network) with the training data set created by Step 2	

Specification of retraining data	Retraining data set has to include recent data

A.4.8 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Brochure				Fujitsu	http://www.fujitsu.com/global/vision/customerstories/siemens-gamesa/index.html
2	Press release				Fujitsu	http://www.fujitsu.com/fts/about/resources/news/press-releases/2017/emeai-20171107-artificial-intelligence-solution-from.html
3	Press release				Fujitsu	http://www.fujitsu.com/fts/about/resources/news/press-releases/2017/emeai-20171002-fujitsu-develops-state-of-the-art-ai.html

A.5 Solution to Detect Signs of Failures in Wind Power Generation System

[SOURCE: SC42/WG4 N050 uc_5]

A.5.1 General

ID	5
Use case name	Solution to detect signs of failures in wind power generation system
Application domain	Manufacturing
Deployment Model	On-premise systems

<table>
<tr><td>Status</td><td colspan="4">PoC</td></tr>
<tr><td>Scope</td><td colspan="4">Detect signs of malfunction (failure) in wind power generators</td></tr>
<tr><td>Objective(s)</td><td colspan="4">Detect signs of failure in wind power generation, earlier than human specialists</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td colspan="3">A system is currently in development that uses machine learning to detect signs of equipment failure that would be difficult to detect from visual inspection. Currently, sensor data is being collected from 43 actual domestic large wind turbines, and large-scale verification testing is being conducted. The goal is for a paradigm shift from responding after the fact to maintenance that prevents problems and maintenance safety</td></tr>
<tr><td>Complete description</td><td colspan="3">"We present a method for detecting anomalies in vibration signals of wind turbine components.
The predominant characteristics of wind turbine vibration signals are extracted by applying a time-frequency feature extraction method based on Fourier local autocorrelation (FLAC) features. For anomaly detection, one-class classification based on an unsupervised clustering approach is applied in consideration of the wind turbine’s dynamic operating conditions and environment. To validate the proposed system, we conducted experiments using the vibration data of actual 2 MW wind turbines. The results showed the effectiveness of using the FLAC features, particularly in the case of the low-speed main bearing where the conventional method with traditional features cannot detect the anomalies. "</td></tr>
<tr><td>Stakeholders</td><td colspan="4"></td></tr>
<tr><td>Stakeholders’ assets, values</td><td colspan="4"></td></tr>
<tr><td>System’s threats and vulnerabilities</td><td colspan="4"></td></tr>
<tr><td rowspan="4">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>Time from alert to failure</td><td></td><td></td></tr>
<tr><td>2</td><td>Precision</td><td></td><td></td></tr>
<tr><td>3</td><td>Recall</td><td></td><td></td></tr>
<tr><td rowspan="5">AI features</td><td>Task(s)</td><td colspan="3">Recognition</td></tr>
<tr><td>Method(s)</td><td colspan="3">Anomaly detection based on machine learning techniques,
Accurate feature extraction from vibration signals</td></tr>
<tr><td>Hardware</td><td colspan="3"></td></tr>
<tr><td>Topology</td><td colspan="3"></td></tr>
<tr><td>Terms and concepts used</td><td colspan="3">Fourier Local AutoCorrelation (FLAC) features,
Unsupervised learning</td></tr>
<tr><td>Standardization opportunities/ requirements</td><td colspan="4"></td></tr>
<tr><td>Challenges and issues</td><td colspan="4"></td></tr>
<tr><td>Societal</td><td>Description</td><td colspan="3"></td></tr>
</table>

concerns		
	SDGs to be achieved	

A.6 Computer-aided Diagnosis in Medical Imaging based on Machine Learning

[SOURCE: SC42/WG4 N050 uc_6]

A.6.1 General

ID	6	
Use case name	Computer-aided diagnosis in medical imaging based on machine learning	
Application domain	Healthcare	
Deployment Model	Hybrid or other (please specify)	
Status	PoC	
Scope	Detecting image anomality	
Objective(s)	Provide AI method to alleviate growing burden of histopathological diagnosis by human	
Narrative	Short description (not more than 150 words)	The advances in image recognition technology enable the machine learning system to support diagnosis in medical imaging. This technology is expected to contribute the great reduction of the burden on doctors and the improvement of diagnostic accuracy when it is used for screening and double checking. Specifically, a support system is currently under development that analyzes histopathological images to automatically detects suspected lesion.
	Complete description	In histopathological diagnosis, a clinical pathologist discriminates between normal tissues and cancerous tissues. However, recently, the shortage of clinical pathologists is posing increasing burdens on meeting the demands for such diagnoses, and this is becoming a serious social problem. Currently, it is necessary to develop new medical technologies to help reduce their burdens. Therefore, as a diagnostic support technology, an extended method of HLAC (Higher-order Local AutoCorrelation) feature extraction for classification of histopathological images into normal and anomaly. The proposed method can automatically classify cancerous images as anomaly by using an extended geometric invariant HLAC features with rotation- and reflection-invariant properties from three-level histopathological images, which are segmented into nucleus, cytoplasm and background. In conducted experiments, we demonstrate a reduction in the rate of not only false-negative errors but also of false-positive errors, where a normal image is falsely classified as an image with an anomaly that is suspected as being cancerous.
Stakeholders		
Stakeholders' assets, values		

System's threats and vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Precision		
	2	Recall		
AI features	Task(s)	Recognition		
	Method(s)	Higher-order Local Auto-Correlation		
	Hardware			
	Topology	Higher-order Local Auto-Correlation		
	Terms and concepts used	Higher-order Local Auto-Correlation		
Standardization opportunities/ requirements				
Challenges and issues				
Societal concerns	Description			
	SDGs to be achieved			

A.7 AI Ideally Matches Children to Daycare Centers

[SOURCE: SC42/WG4 N050 uc_7]

A.7.1 General

ID	7	
Use case name	AI Ideally Matches Children to Daycare Centers	
Application domain	Public sector	
Deployment model	On-premise systems	
Status	In operation	
Scope	Assignment pattern that satisfies complex applicants' requirements	
Objective(s)	To determine the assignment pattern that will fulfill the preferences of as many applicants as possible automatically.	
Narrative	Short description (not more than 150 words)	This AI technology automatically determines the assignment pattern while fulfilling as many applicants' preferences as possible by priority ranking by using game theory.
	Complete description	The number of children on daycare center waiting lists has become a social issue. Matching children to daycare centers while accommodating each family's preferences is time- and labor-intensive for local governments.

		The basic goal of daycare admissions screening is to satisfy the preferences of applicants according to the priority ranking of children in consideration of the number of places in each daycare center. In addition, each local government can incorporate more complex requirements, such as applicants who want their siblings assigned to the same daycare center and who want siblings assigned in the same period, in order to increase the satisfaction of applicants. Saitama city government has eight requirements concerning sibling admissions as well as the timing of the siblings' admissions. The screening rule thus became more complex, and consequently there are cases where multiple assignment patterns can fulfill the rule or no patterns fulfill the rule. This means the city officials are required to take a long time to carefully determine the assignment of applicants to be absolutely sure that the relevant rules have been correctly fulfilled. This AI technology has made it possible to match children to daycare centers, meeting as many preferences as possible, following a priority ranking. This is done by modeling the dependency relationships of complex requirements, including parents who prioritize siblings going to the same daycare center, or parents who do not mind if their children go to different daycare centers as long as both children get a seat, using a mathematical model based on game theory, which rationally resolves the relationships between people having differing values. When this technology was evaluated using anonymized data from about 8,000 children in the city of Saitama, it successfully calculated an optimal assignment result in just a few seconds.		
Stakeholders	City officials, Daycare centers, Applicants			
Stakeholders' assets, values	Maintaining fairness of matching results, Reducing the burden of seat assignment tasks, Leading to return women to the workplace smoothly.			
System's threats and vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Accuracy	The matching rate of assignment	Automatic assignment
	2	Time	The computation time to find an optimal assignment	Time reduction
AI features	Task(s)	Optimization		
	Method(s)	Game theory		
	Hardware			
	Topology			
	Terms and concepts used	Game theory, Matching theory		

Standardization opportunities/ requirements	Need to consider unique requirements for assignment rules in each local government.	
Challenges and issues	Challenges: Determine an optimal assignment pattern instantly and fairly depending on unique and complex rules in each local government. Issues: Long calculation time is required in the case of a large number of children and siblings	
Societal concerns	Description	Supporting working women Resolving the problem of children waiting for day care
	SDGs to be achieved	Decent work and economic growth

A.8 Deep Learning Technology Combined with Topological Data Analysis Successfully Estimates Degree of Internal Damage to Bridge Infrastructure

[SOURCE: SC42/WG4 N050 uc_8]

A.8.1 General

ID	8	
Use case name	Deep Learning Technology Combined with Topological Data Analysis Successfully Estimates Degree of Internal Damage to Bridge Infrastructure	
Application domain	Social infrastructure	
Deployment Model	Cloud services	
Status	PoC	
Scope	Estimate and detect the risk of the catastrophic collapses of old bridges	
Objective(s)	Enables estimation of failure, state of degradation with surface-mounted sensors	
Narrative	Short description (not more than 150 words)	Development of sensor data analysis technology that can aggregate vibration data from sensors attached to the surface of a bridge, and then estimate the degree of the bridge's internal damage
	Complete description	Inspection tasks for bridges are usually performed visually to check the structure for damage. The issue with relying only on information gathered visually, however, is that inspectors can only identify abnormalities or anomalies appearing on the structure's surface, and are consequently unable to grasp information regarding the degree of internal damage. There have been many trials in which sensors were attached to the surface of the bridge deck, using vibration data to evaluate the level of damage. With the methods used until now, accurately understanding the degree of damage within the interior of the deck was an issue. Deep learning AI technology for time-series data can discover anomalies and express in numerical terms degrees of change that demonstrate drastic changes in the status of objects such as structures or machinery, and detect the occurrence of abnormalities or distinctive changes. The technology learns from the geometric characteristics extracted from complex, constantly changing time-series

		vibration data collected by sensors equipped on IoT devices, thus enabling users to estimate and validate the state of degradation or failure in a variety of social infrastructure or machinery. This technology has now been confirmed through the application of verification test data from RAIMS (Research Association for Infrastructure Monitoring System).		
Stakeholders				
Stakeholders' assets, values				
System's threats and vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Anomaly detection	The geometric characteristics extracted from the vibration data by this technology would appear as a single cluster when the bridge was intact, but the shape changes when the bridge had developed internal damage.	Enabling to detect anomalous feature
	2	Change detection	The degree of abnormality and the degree of change that can be calculated by converting the geometric characteristics to numerical values correspond with the results measured by strain sensors embedded within the bridge deck.	Precise measure of anomaly
AI features	Task(s)	Recognition		
	Method(s)	Topological Data Analysis		
	Hardware			
	Topology			
	Terms and concepts used	Topological Data Analysis, Anomaly Detection, Time Series Classification, Convolutional Neural Network		
Standardization				

opportunities/ requirements		
Challenges and issues	Challenges: Detecting the occurrence of internal stress using this technology allows for the estimation of damage in its earliest stages, and can contribute to early countermeasures. Issues: Conduct trials using vibration data from actual bridges, with the goal of real-world usage.	
Societal concerns	Description	
	SDGs to be achieved	

A.8.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Press Release				Fujitsu	http://www.fujitsu.com/global/about/resources/news/press-releases/2017/0828-01.html
2	Press Release				Fujitsu	http://www.fujitsu.com/global/about/resources/news/press-releases/2016/0216-01.html
3	Technical Paper	Time Series Classification via Topological Data Analysis			Transactions of the Japanese Society for Artificial Intelligence	https://www.jstage.jst.go.jp/article/tjsai/32/3/32_D-G72/_article
4	Technical Paper	Topological Data Analysis and its Application to Chronological Data Analysis			FUJITSU Journal (in Japanese)	http://www.fujitsu.com/jp/documents/about/resources/publications/magazine/backnumber/vol69-4/paper15.pdf

A.9 AI Components for Vehicle Platooning on Public Roads

[SOURCE: SC42/WG4 N050 uc_9]

A.9.1 General

ID		
Use case name	AI Components for Vehicle Platooning on Public Roads	
Application domain	Transportation	
Deployment model	Self-driving vehicles	
Status	Prototype	
Scope	Trains of vehicles that drive very close to each other at nearly equal speed (platoons) on public roads, in particular platooning trucks on motorways.	
Objective(s)	The objectives of truck automation are energy saving and enhanced transportation capacity by platooning, and eventually possible reduction of personnel cost by unmanned operation of following vehicles. In a variant of this concept, platoons of passenger cars follow a truck autonomously.	
Narrative	Short description (not more than 150 words)	The overall concept of automated platooning is that the lead vehicle will be driven as normal by a trained (professional) driver, and the following vehicles will be driven fully automatically by the system, allowing the drivers to perform tasks other than driving their vehicles. The EU roadmap for truck platooning (EU project ENSEMBLE) envisions market introduction of multi-brand platooning by 2025 [12]. Several pilot projects have been carried out since about the year 2000 [8,9,10,13,14]. While a few AI components are already used in the pilot projects (e.g. lane keeping), future products are likely to incorporate AI solutions on several functional levels.
	Complete description	A major development in research on Intelligent Transportation Systems (ITS) is Cooperative Adaptive Cruise Control (CACC). It takes Adaptive Cruise Control (ACC) to the next level by adding direct communication between vehicles. Directly communicating accurate state information allows vehicles to drive much closer to each other without compromising safety. This is the basis of platooning: trains of vehicles that drive very close to each other at nearly equal speed. By CACC, platoons become string stable: changes in the acceleration or deceleration are reduced by the following vehicles instead, of getting amplified. This property is expected to greatly improve the throughput of vehicles on highways, because it is exactly the amplification of acceleration and deceleration that causes many traffic jams. R&D on truck platooning is driven partially by the potential fuel savings and the expectation of an attractive return on investment. Implementations of platooning are complex cyber-physical systems [3]. In freight transportation, for example, a typical system architecture consists of the fleet layer, the cooperation layer, and the vehicle layer. AI components are already used on the vehicle layer (e.g. lane keeping), future products are likely to incorporate AI solutions on several functional levels and all system layers. Lane keeping is an established AI technology in the automotive industry [6]. Some examples for other potential AI components in platooning systems are: • Prediction of behavior of surrounding traffic [4]

		• Controllers for platooning strategies [1,3] • Road surface recognition [2] • Driver state assessment [7,11] Safe control and safety regions [5]		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Efficiency, environmental and economic benefits	• improved on-road safety • greater fuel efficiency and reduced emissions • ease of driving • increased operational efficiency • additional road capacity • reduced labor costs	see above
	2	Societal Acceptance	Safety testing, reporting, benefits analyses, and demonstrations of automated platooning are needed and should be available to the public	see above
	3	Safety	The system must be safe, secure, and reliable	
AI features	Task(s)	Lane keeping, environment perception, prediction, driver monitoring, planning and optimization		
	Method(s)	machine learning, computer vision, logical decision making, pattern recognition, multimodal event detection, multi-agent planning and scheduling, probabilistic predictive modeling, evolutionary algorithm		
	Hardware	commercial road vehicles, positioning sensors, environment sensors (radar, LIDAR, electro-optical cameras, infrared cameras), GPS, V2V communication (UMTS,4/5G, 802.11 networks)		

	Topology	
	Terms and concepts used	autonomous vehicle guidance, environment perception, self perception, planning and scheduling, optimization, human-machine interaction, cyber-physical system
Standardization opportunities/ requirements		
Challenges and issues	highly unpredictable traffic environment, legislative situation, standardisation, stress and comfort of human drivers involved	
Societal Concerns	Description	Stress or boredom for the drivers, Big Brother and constant monitoring, Safety, system security, and reliability, Risk of hacking and hijacking a long-haul freight truck poses great danger, Trust over system reliability when driving next to a computer-controlled platoon.
	SDGs to be achieved	

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A.10 Self-Driving Aircraft Towing Vehicle

[SOURCE: SC42/WG4 N050 uc_10]

A.10.1 General

ID	10	
Use case name	Self-Driving Aircraft Towing Vehicle	
Application domain	Transportation	
Deployment model	Self-driving vehicles	
Status	Prototype	
Scope	Self-Driving towing vehicle for aircrafts, operating on an airfield autonomously.	
Objective(s)	A towing vehicle that will, on command, autonomously navigate to an assigned aircraft, attach itself, tow the aircraft to an assigned location (a runway for departures, a gate for arrivals), autonomously detach itself, and navigate to an assigned location, either a staging area or to service another aircraft.	
Narrative	Short description (not more than 150 words)	Self-driving vehicle technology is applied to the problem of towing aircraft at busy airports from gate to runway and runway to gate. Autonomous aircraft towing can be supervised by human ramp controllers, by air traffic controllers (ATC), by pilots, or by ground crew. The controllers provide route information to the tugs, assisted by an automated route planning system. The planning

		system and tower and ground controllers work in conjunction with the tugs to make tactical decisions during operations to ensure safe and effective taxiing in a highly dynamic environment.
	Complete description	Advances in self-driving automobiles make it technologically feasible to apply this technology for the purpose of taxiing planes to the runway from the terminal gate and vice-versa. Deploying self-driving vehicles for this purpose offers fewer technical challenges than deploying them on roadways and highways. Routes between gates to runways and runways to gates are typically pre-determined, with little or no possibility for alternatives. In addition, to ensure safety, constraints on taxiing operations are rigid and unambiguous. Rules such as separation constraints between taxiing aircraft and those governing right-of-way at intersection points are clearly documented and enforced by ramp and ATC controllers. These rules and procedures reduce the overall uncertainty in the operational environment and therefore potentially simplify the models that need to be employed by self-driving vehicles. Nominal autonomous operation of the towing vehicle (tug) is captured as the following sequence (for the case of departures): a tug sits at a tug depot, a designated area of the airport surface where tugs recharge and return when not in service. When the tug receives a message, describing time, route, and gate, it travels to the specified gate following the provided route. As the tug approaches the specified gate, it navigates to a designated ready position. Once the ground marshal attending the gate signals readiness for attachment, the tug assesses the environment to verify the surroundings are obstacle-free before moving to dock with the aircraft. Once a taxi navigation plan is received from the centralized route planner and the aircraft crew and ground marshal both signal ready to push back, the tug pushes the aircraft away from the gate and begins navigation through its assigned route. When reaching a designated location in the takeoff queue near the runway, the tug autonomously detaches from the aircraft, moves to a safe position away from the aircraft, signals to the aircraft's crew through a cockpit display that it is detached, and navigates back to the depot along the route provided by the planner.

Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives

	1	Efficiency, environmental and economic benefits	Amount of delay in taxi time and maximizing throughput, reduced fuel emissions, reduced maintenance costs	Advantage of self-driving towing vehicle on busy airports
	2	Complexity of logistics	Complexity of logistics, primarily in the form of workload for flight crew, tower personnel or ground crew	Advantage of self-driving towing vehicle as to reduced workload for personnel
	3	Safety	Safety in the form of things like maintaining separation constraints and avoiding potentially dangerous events such as runway incursions	No compromises on safety by the autonomous operation
AI features	Task(s)	Environment Perception, Path Planning, Obstacle Avoidance, Navigation, Fault Detection, Situational Awareness		
	Method(s)	computer vision , logical decision making, pattern recognition, multimodal event detection, multi-agent planning and scheduling, probabilistic predictive modeling		
	Hardware	host platform: AeroTech Expediter 600; positioning sensors, environment sensors (LIDAR, electro-optical cameras, infrared cameras)		
	Topology	autonomous vehicle guidance, environment perception, self perception, planning and scheduling		
	Terms and concepts used			
Standardization opportunities/ requirements				
Challenges and issues	Safe operations in the airfield environment, minimal changes to the airport infrastructure, minimal impact of their incorporation into normal operations			
Societal Concerns	Description	If labor replacements are involved, then the use of autonomy must provide an equivalent or greater benefit to some portion of the labor pool to offset the potential job loss; furthermore, they must operate in a way that feels common and familiar to humans, and must be perceived as completely safe, simple and non-intimidating.		
	SDGs to be achieved			

A.10.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
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2					NASA Johnson Space Center	www.nasa.gov
3					Lockheed Martin Advanced Technology Laboratories	www.lmco.com
4					University of California-Santa Cruz Affiliated Research Center	www.ucsc.edu
5					Carnegie Mellon University	www.cmu.edu

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A.11 Unmanned Protective Vehicle for Road Works on Motorways

[SOURCE: SC42/WG4 N050 uc_11]

A.11.1 General

ID	11	
Use case name	Unmanned Protective Vehicle for Road Works on Motorways	
Application domain	Transportation	
Deployment model	Self-driving vehicles	
Status	Prototype	
Scope	Unmanned operation of a protective vehicle in order to reduce the risk for road workers in short-time and mobile road works carried out in moving traffic	
Objective(s)	A vehicle that is able to follow mobile road works automatically on the hard shoulder of a German motorway.	
Narrative	Short description (not more than 150 words)	Mobile road works on the hard shoulder of German highways bear an increased accident risk for the crew of the protective vehicle safeguarding road works against moving traffic. The "Automated Unmanned Protective Vehicle for Highway Hard Shoulder Road Works" aims at the

		unmanned operation of the protective vehicle in order to reduce this risk. The vehicle has first been tested in a real operation on the German autobahn A3 in June 2018 [4]. It is actually the very first unmanned operation of a vehicle on German roads in public traffic. The scientific challenges of the project are strongly related to the general challenges in the field of automated driving.		
	Complete description	A typical operational scenario for the automated unmanned protective vehicle looks as follows: In the beginning of the operation, an employee of the road maintenance service manually drives the protective vehicle from the depot to the location of the road works. There the employee stops the protective vehicle and switches to the road maintenance vehicle in front. The employee can activate the automated operation of the protective vehicle via a user interface. The vehicle guidance system then takes over the longitudinal and lateral control of the protective vehicle and follows the road maintenance vehicle in a defined distance at low speeds of about 10 km/h. In unmanned operation the vehicle guidance system operates in one of the three automated modes: Follow Mode, Coupled Mode, and Safe Halt. In Follow Mode, the vehicle guidance system performs the longitudinal and lateral control based on environmental information. The environment perception extracts the lane boundaries, e.g. lane markings, of the highway hard shoulder, the road maintenance vehicle and other obstacles in front of the protective vehicle. If an obstacle is detected, for example an emergency halting car, the system automatically transitions into Safe Halt. The system also performs this transition in case it detects that it is not capable of maintaining unmanned operation. In Coupled Mode, the protective vehicle is controlled by the vehicle guidance system, too. The longitudinal and lateral control is purely based on control commands and state information of the road maintenance vehicle. While lane boundaries are ignored in this mode of operation, obstacles in front of the protective vehicle are still detected. As in Follow Mode, the protective vehicle is able to detect functional system boundaries and to transfer itself to Safe Halt.		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
AI features	Task(s)	obstacle detection, lane following, scene perception and representation, self perception		

	Method(s)	computer vision , logical decision making, pattern recognition, multimodal event detection
	Hardware	truck vehicle equipped with cameras, radar system, motion and acceleration sensors, rain sensor
	Topology	
	Terms and concepts used	autonomous vehicle guidance, environment perception, self perception
Standardization opportunities/ requirements		
Challenges and issues	Safe operations in public traffic, compliance with ISO 26262	
Societal Concerns	Description	
	SDGs to be achieved	

A.11.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
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3					WABCO Development GmbH	www.wabco-auto.com
4					Hochschule Karlsruhe	www.hs-karlsruhe.de
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A.12 Autonomous Apron Truck

[SOURCE: SC42/WG4 N050 uc_12]

A.12.1 General

ID	12	
Use case name	autonomous apron truck	
Application domain	Mobility	
Deployment model	Embedded systems	
Status	PoC	
Scope	Automated transportation of luggage (carts) to requested destinations on an airport apron while following local traffic rules and resolve unplanned conflicts.	
Objective(s)	Automate transport to increase reliability, precision, efficiency and safety.	
Narrative	Short description (not more than 150 words)	An AI solution was planned that could operate a luggage truck on an airport apron where it interacts with aircrafts, other machines and humans. It prevents accidents with humans at all times and follows local traffic rules.
	Complete description	While the number of airplanes visiting German airports steadily increased over the last decades and recently reached a new all-time high the logistics to enable a smooth processing also increased correspondingly in complexity. To further manage even higher number of airplanes a fully automated luggage truck is developed. The truck shall receive tasks from a machine or human coordinator and automatically execute these. For specific tasks as loading and unloading or maintenance further interaction with human workers is needed. Therefore the truck is able to communicate its status and intents to surrounding workers. While operating on the apron the truck shall always obey local traffic rules. The only occasion to violate these rules if an accident is thereby avoided. Human safety is always the truck's first priority. For achieving all these functions an AI system consisting of multiple individual elements which all have to operate collaboratively is designed. The three main modules are a perception module, a behavior generator and an execution module. The truck perceives its environment is by its perception module which consists of multiple submodules, as object detection, recognition, tracking and data fusion blocks for multiple sensor types. The perceived information and their respective uncertainties are further processed to localize, re-project and detect the objects' intend in the trucks coordinate system. The perception unit outputs a context model which the behavior generator receives to decide on what actions to

		take next. This behavior generator consists of a deep reinforcement learning agent and is supervised by a symbolic rule checker to reassure the agent operates fault free. If a taken action violates a rule either the agent has to determine a new action or, in safety critical situations the rule checker determines safe actions by symbolic reasoning. The execution module executes the behavior determined by the behavior generator. It consists of motion planning, control and communication submodules which execute the intended task while reporting back to the behavior generator to react on unexpected situations. Additionally, the trucks status and intends are constantly reported over communication systems to its surrounding to enable uncomplicated interaction with the truck.		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Safety	Number of accidents weighted by the level of severity.	Reduce accidents
	2	Efficiency	The sum of idle time and covered distance.	Improve efficiency
AI features	Task(s)	Other (please specify) Sense&Plan&Act		
	Method(s)	Symbolic reasoning & sub-symbolic machine learning & Image Processing, Data Fusion		
	Hardware			
	Topology			
	Terms and concepts used	Computer Vision, Symbolic Reasoning, Deep Reinforcement Learning		
Standardization opportunities/ requirements				
Challenges and issues	Challenges: Achieve at least the same level as human truck operators. Issues: 1) detect other apron traffic participants (especially aircraft) including intentions 2) Multiplicity of various outside conditions (e.g. signs painted on road but ice and snow covering it), and 3) prediction of human behaviour (e.g. workers in reverse walk)			
Societal Concerns	Description	Changed work environment for workers during loading/unloading with less interactions with co-workers but more non-social interactions (machines).		
	SDGs to be achieved			

A.12.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Publication	IEEE ITSC 2018: @inproceedings{DBLP:conf/itsc/, author = {Martin Buechel, Alois Knoll}, title = {Deep Reinforcement Learning for Predictive Longitudinal Control of Automated Vehicles}, booktitle = {21th {IEEE} International Conference on Intelligent Transportation Systems, {ITSC} 2018, Hawaii, November 4-7, 2018}, pages = {}, year = {2018}, crossref = {DBLP:conf/itsc/2018}, } (to appear)		Predictive control of the vehicle	fortiss	
2	Publication	IEEE ITSC 2018: @inproceedings{DBLP:conf/itsc/, author = {Michael Truong Le, Frederik Diehl, Thomas Brunner, Alois Knoll}, title = {Uncertainty Estimation for Deep Neural Object Detectors in Safety-Critical Applications}, booktitle = {21th {IEEE} International Conference on Intelligent Transportation Systems, {ITSC} 2018, Hawaii, November 4-7, 2018}, pages = {}, year = {2018}, crossref = {DBLP:conf/itsc/2018}, } (to appear)		Estimating the uncertainties of the vehicles sensor processing	fortiss	
3	Publication	IEEE ITSC 2018: @inproceedings{DBLP:conf/itsc/, author = {Klemens Esterle, Patrick Christopher Hart, Alois Knoll}, title = {Spatiotemporal Motion Planning with Combinatorial Reasoning for Autonomous Urban Driving}, booktitle = {21th {IEEE} International Conference on Intelligent Transportation Systems, {ITSC} 2018, Hawaii, November 4-7, 2018}, pages = {}, year = {2018}, crossref = {DBLP:conf/itsc/2018}, } (to appear)		The vehicles motion planning with combinatorial reasoning	fortiss	

4	Public ation	IEEE ITSC 2018: @inproceedings{DBLP:conf/itsc/, author = {Tobias Kessler, Pascal Minnerup, Klemens Esterle, Christian Feist, Florian Mickler, Erwin Roth, Alois Knoll}, title = {Roadgraph Generation and Free-Space Estimation in Unknown Structured Environments for Autonomous Vehicle Motion Planning}, booktitle = {21th {IEEE} International Conference on Intelligent Transportation Systems, {ITSC} 2018, Hawaii, November 4-7, 2018}, pages = {}, year = {2018}, crossref = {DBLP:conf/itsc/2018}, } (to appear)		The vehicles' ability to plan in unknown environme nts	fortiss	
5	Public ation	IEEE ITSC 2018: @inproceedings{DBLP:conf/itsc/, author = {Julian Bernhard and Robert Gieselmann and Alois Knoll}, title = {Experience Based Heuristic Search: Robust Motion Planning with Deep Q-Learning}, booktitle = {21th {IEEE} International Conference on Intelligent Transportation Systems, {ITSC} 2018, Hawaii, November 4-7, 2018}, pages = {}, year = {2018}, crossref = {DBLP:conf/itsc/2018}, } (to appear)		Robust motion planning	fortiss	

A.13 AI Solution to Identify Automatically False Positives from a Specific Check for "Untranslated Target Segments" from an Automated Quality Assurance Tool

[SOURCE: SC42/WG4 N050 uc_13]

A.13.1 General

ID	13
Use case name	AI solution to identify automatically false positives from a specific check for "untranslated target segments" from an automated quality assurance tool
Application domain	Other (please specify) This will be relevant for content from across any domains
Deployment model	Cloud services
Status	PoC

<table>
<tr><td>Scope</td><td colspan="2">The scope of this use case is limited to automated linguistic quality assurance tools, but the outcome of this use case could be applicable to other areas, such as for example: Machine Translation, automated post-editing, Computer Aided Translation Analysis and pre-translation, etc.</td></tr>
<tr><td>Objective(s)</td><td colspan="2">To reduce the number of false positive issues for check for untranslated target segment for bilingual content with in-house automated quality assurance tool.</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td>In the future, we aim to build an AI solution that could automatically identify likely false positives issues from the results of the "check for untranslated target segments" following an approach where we could use machine learning based on already identified false positives by our users.

The expected outcome would be to increase end user's productivity when reviewing automated quality assurance findings and to change user behaviour to pay more attention to this type of issues by reducing the number of false positives in 80%. In addition, we would like to reduce the amount of time, we spent on a yearly basis on refining this check manually based on users' feedback.</td></tr>
<tr><td>Complete description</td><td>Untranslated target segments contain characters, symbols, and words that remain the same in source and target language. These segments can contain, numbers, alphanumeric content, numbers, code, e-mail addresses, prices, proper nouns, etc. or any combination of those. On a yearly basis, this check produces over 1 Million potential issues across over 50 different languages.

Refining this check manually based on annotated false positive data for each specific customer and product and for specific language pairs is very costly, and the coverage is never sufficient, as new content is constantly produced and there are always new opportunities for refining this check via code. In addition, because of the high proportion of false positives over (95.5%) our translators tend to ignore the output from this valuable check and in many cases, we suspect that valid relevant issues for situations when there are real forgotten translations are missed.

There are typically three types of false positives for this type of check:

1) Language specific false positives, for example for situations where source and target segment need to be the same as the words from these segments are "cognates" with the same meaning. For example:
<table><tr><th>Source Language</th><th>Target Language</th><th>Source Segment</th><th>Target Segment</th><th>Checker Message</th><th>Fa</th></tr><tr><td>en-us</td><td>es-es</td><td>beta</td><td>beta</td><td>1445 - Untranslated target segment.</td><td>FF</td></tr><tr><td>en-us</td><td>fr-fr</td><td>beta</td><td>beta</td><td>1445 - Untranslated target segment.</td><td>FF</td></tr><tr><td>en-us</td><td>es-es</td><td>Monitor</td><td>Monitor</td><td>1445 - Untranslated target segment.</td><td>FF</td></tr></table>2) Customer profile specific false positives, for example situations where certain segments are to be left untranslated based on specific guidelines from the customer, for example for segments that jut consist of Company names, Product</td></tr>
</table>

Names or specific words and segments that have been determined as not to be translated by our customer:

Source Language	Target Language	Source Segment	Target Segment	Checker Mes
en-us	es-es	Microsoft	Microsoft	1445 - Untran
en-us	es-es	Microsoft Azure	Microsoft Azure	1445 - Untran
en-us	es-es	- Outlook	- Outlook	1445 - Untran

3) Segments that remain the same in source and target, because they act as special type of entities with some special meaning, for example:
alphanumeric segments, for example part numbers, placeholders, code.

Source Language	Target Language	Source Segment	Target Segment	Checker Message
en-us	es-es	public inline virtual const std::string & GetErrorName	public inline virtual const std::string & GetErrorName	1445 - Untranslated target segment.
en-us	es-es	public int64_t Write	public int64_t Write	1445 - Untranslated target segment.
en-us	es-es	SELECT * FROM c	SELECT * FROM c	1445 - Untranslated target segment.

The idea is to create an AI solution that can automatically identify results from the "check for untranslated target segment" that are likely to be a False Positive. With this solution, we expect to reduce the number of potential issues presented by this check to our end users in 80%. This way our end users can focus their efforts on those potential issues that are more likely to be valid corrections because there could have been a forgotten translation. In addition, we will be able to increase the productivity of our end users when reviewing automated quality assurance potential issues from their bilingual content evaluation, and we will be able to save costs internally as we won't have to manually implement code changes in this check based on manual analysis of our data based on user's annotation.

<table>
<tr><td>Stakeholders</td><td colspan="4">Customers, Translation partners, end users of the translated content.</td></tr>
<tr><td>Stakeholders' assets, values</td><td colspan="4">Customer's content</td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4">Bias from changes in requirements on the customer's end or inappropriate training data.</td></tr>
<tr><td rowspan="3">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>Coverage</td><td>Ratio of potential issues which are "of interest" for human evaluation. Ideal target is to reduce the current volume by 80%.</td><td>Improve accuracy</td></tr>
<tr><td>2</td><td>Split</td><td>Proportion of the potential issues which are "more likely to be a valid issue" for our end users.</td><td>Improve efficiency</td></tr>
<tr><td>AI features</td><td>Task(s)</td><td colspan="3">Recognition</td></tr>
</table>

	Method(s)	Machine Learning
	Hardware	
	Topology	
	Terms and concepts used	Machine Learning
Standardization opportunities/ requirements		
Challenges and issues	**Challenges:** Try to achieve eventually 80% of the accuracy of linguists when identifying false positives for untranslated target segments, preventing as much as possible false negatives. **Issues:** segmentation of false positive data by Customer and Product profile could be challenging.	
Societal Concerns	Description	Not applicable
	SDGs to be achieved	

A.13.2 Data (optional)

Data characteristics	
Description	Data from end user identification of false positives and valid corrections for the "untranslated target segment check" results of Moravia QA Tools.
Source	RWS Moravia Analytics Portal (https://analytics.moravia.com/Dashboard/459)
Type	Structured content in a table with additional metadata fields (source segment, target segment, source language, target language, valid correction, false positive, customer and product profile, frequency)
Volume (size)	(Data for last 18 months)
Velocity	Every hour
Variety	Data types will be the same but there would be different variables to be considered (source language, target language, customer and product profile)
Variability (rate of change)	No changes
Quality	End-user dependent

A.14 Behavioural and Sentiment Analytics

[SOURCE: SC42/WG4 N050 uc_14]

A.14.1 General

ID	14
Use case name	Behavioural and sentiment analytics
Application domain	Security
Deployment model	On-premise systems
Status	PoC
Scope	Derive emotional state and goal of person from their gestures, face, actions

Objective(s)	Determine if the movements, actions and general behaviour of a person is sign of malevolent intentions. Detect stealing of objects and other criminal behaviours. Prevent undesired behaviour (suicide), adapt narrative to state of person, provide dynamic content according to emotional responses.				
Narrative	Short description (not more than 150 words)				
	Complete description				
Stakeholders	Organizations, end users, community				
Stakeholders' assets, values	Reputation, trustworthiness, fair treatment, privacy				
System's threats & vulnerabilities	Bias, security threats, privacy threats				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives	
AI features	Task(s)	Recognition			
	Method(s)	Decision trees, deep learning			
	Hardware	Video camera, microphone, network, cpu, gpu			
	Topology				
	Terms and concepts used	Behavioural analytics, action, visual cues, sentiment, emotion, goal, social media, security, surveillance			
Standardization opportunities/ requirements					
Challenges and issues	Challenges: Surveillance cameras often have low resolution, can be in poorly lit environment with bad top-down view angle. A lot of suspicious behaviour can be hidden by passer-by or large crowds. Issues: Unwanted behaviours is MUCH LESS frequent than normal behaviour and can take on various forms				
Societal Concerns	Description	Right to privacy			
	SDGs to be achieved	Peace, justice and strong institutions			

A.15 Generative Design of Mechanical Parts

[SOURCE: SC42/WG4 N050 uc_15]

A.15.1 General

ID	15

<table>
<tr><td>Use case name</td><td colspan="4">Generative design of mechanical parts</td></tr>
<tr><td>Application domain</td><td colspan="4">Manufacturing</td></tr>
<tr><td>Deployment model</td><td colspan="4">On-premise systems</td></tr>
<tr><td>Status</td><td colspan="4">In operation</td></tr>
<tr><td>Scope</td><td colspan="4">Help mechanical engineers design lighter, strong, better parts</td></tr>
<tr><td>Objective(s)</td><td colspan="4">Create optimized parts following precise mechanical constraint while permitting cost savings by reducing the amount of material necessary to achieve goals.</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td colspan="3">From Wikipedia: Generative design is an iterative design process that involves a program that will generate a certain number of outputs that meet certain constraints, and a designer that will fine tune the feasible region by changing minimal and maximal values of an interval in which a variable of the program meets the set of constraints, in order to reduce or augment the number of outputs to choose from.</td></tr>
<tr><td>Complete description</td><td colspan="3">https://en.wikipedia.org/wiki/Generative_design

https://www.autodesk.com/solutions/generative-design

http://www.newequipment.com/research-and-development/what-generative-design-and-why-its-future-manufacturing</td></tr>
<tr><td>Stakeholders</td><td colspan="4">Organizations, Designers, Customers, End users</td></tr>
<tr><td>Stakeholders' assets, values</td><td colspan="4">Competitiveness, safety, stability</td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4">Highly dependent on engineer input for constraints and requirements</td></tr>
<tr><td rowspan="3">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>Weight reduction</td><td>Is the resulting part lighter than original version</td><td>Use less material</td></tr>
<tr><td>2</td><td>Mechanical constraints metrics</td><td>Various mechanical metrics</td><td>Obtain strong, better parts</td></tr>
<tr><td rowspan="5">AI features</td><td>Task(s)</td><td colspan="3">Optimization</td></tr>
<tr><td>Method(s)</td><td colspan="3">Genetic algorithms, optimisation algorithms, generative adversarial networks</td></tr>
<tr><td>Hardware</td><td colspan="3">CPU, GPU</td></tr>
<tr><td>Topology</td><td colspan="3"></td></tr>
<tr><td>Terms and concepts used</td><td colspan="3">Design, generative adversarial network, genetic algorithm, mimicry</td></tr>
<tr><td>Standardization opportunities/ requirements</td><td colspan="4"></td></tr>
</table>

Challenges and issues	Challenges: The engineers using this technology still need to know how to define the constraints, start and end points for the piece. Issues: Pieces generated to satisfy a set of constraint may still have design flaws overlooked because of misunderstanding by the user.	
Societal Concerns	Description	
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.15.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Public	Wikipedia Generative Design webpage			Contributions	https://en.wikipedia.org/wiki/Generative_design
2	Public	Generative design solutions from autodesk			Autodesk	https://www.autodesk.com/solutions/generative-design
3	Public	R&D article on the future of manufacturing			New equipment digest	https://www.newequipment.com/research-and-development/what-generative-design-and-why-its-future-manufacturing

A.16 Robotic Prehension of Objects

[SOURCE: SC42/WG4 N050 uc_16]

A.16.1 General

ID	16
Use case name	Robotic prehension of objects
Application domain	Other (please specify) Robotics
Deployment model	Embedded systems
Status	PoC
Scope	Outputting end effector velocity & rotation vector in response to view from RGB-D camera located on robot wrist

Objective(s)	Use reinforcement learning to train the robot to grasp misc. objects in simulation and transfer this learning to real-life robots.	
Narrative	Short description (not more than 150 words)	It may be difficult and time-consuming for clients of assistive robotic arms to control them with the fine degree required for grasping household objects (such as in the context of having a meal). In order to improve their quality of life, we propose a method by which users can select the bounding box around the object they wish grasped, and the robot performs the grasping action. We use methods from reinforcement learning to train first in simulation, in order to reduce total training time and potential robot breakage, and then transfer this learning to real-life.
	Complete description	It can be very difficult and time-consuming for users to perform fine movements with a robot arm, like grasping various household objects. To mitigate this problem, attempts are made to grant users the ability to control the arm at a higher level of abstraction; thus, rather than specifying each translation and rotation of the arm, we would like them to be able to select an object to grasp, and have the arm grasp it automatically. This requires some degree of computer vision, to be able to detect objects in the robot's field of view (a camera will be affixed to its wrist). With that achieved, we will be able to focus on grasping an object selected from the detections. Current literature on robotic grasping One might be tempted to start from a heuristic, geometric approach. That is, to use a set of pre-established rules for picking up objects -- for example, executing pincer grasps from the top along the thinnest dimension of the object that is not too narrow to be grasped. Such approaches work reasonably well in conditions that match the restrictive assumptions on which the rules are built, but fail when encountering even small deviations from those conditions (for example, they do not adapt well to clutter). Attempting to list and plan a proper response to all such failure cases heuristically would be an exercise in futility. In contrast, approaches based on machine learning can generalize to unforeseen or novel situations, and, as in the case of object detection, generally perform better than heuristic solutions. Machine learning-based approaches to grasping and object manipulation vary widely. At the simplest level, we can predict the likelihood of grasp success based on an image patch of an object and a given angle of approach. Robot control, in such cases, is beyond the scope of the machine learning model. However, methods can scale up to end-to-end systems which learn to control the robot at the level of its joint actuators in response to a visual stimulus consisting of a bird's eye view of the arm and several objects placed in a bin.
Stakeholders	Customers, 3rd parties, end users, community	
Stakeholders' assets, values	Trustworthiness, safety, privacy, stability	

System's threats & vulnerabilities	Object or gripper bias, security threats, privacy threats			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Success rate in simulation	Grasp success rates on both objects seen during training, and new objects, in simulation.	Improve accuracy and generalization.
	2	Success rate in real life	Grasp success rates on both objects seen during training, and new objects, in real life.	Improve accuracy and generalization.
AI features	Task(s)	Planning		
	Method(s)	Reinforcement learning, deep learning		
	Hardware	Depth camera, RGB camera, GPU, actuators, gripper		
	Topology			
	Terms and concepts used	Reinforcement learning, Deep learning, point cloud, depth, scene completion, grasping, transfer learning		
Standardization opportunities/ requirements				
Challenges and issues	Challenges: The camera cannot have a bird's eye view and will instead move with the robot. Sparse rewards may complicate learning. Environment may be cluttered, occlusions of target might occur, objects may move around Issues: For safety reasons, speed and force of robot need to be limited in assistive environment to avoid harm. Human intervention can happen at any time.			
Societal Concerns	Description	Prevent arm to people and animals near robot when it is performing a grasping task		
	SDGs to be achieved	Good health and well-being for people		

A.16.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Technical publication	Pinto L, Gupta A. Supersizing Self-supervision: Learning to Grasp from 50K Tries and 700 Robot Hours [Internet]. arXiv [cs.LG]. 2015.				http://arxiv.org/abs/1509.06825
2	Technical publication	Bousmalis K, Irpan A, Wohlhart P, Bai Y, Kelcey M, Kalakrishnan M, et al. Using Simulation and Domain Adaptation to Improve Efficiency of Deep Robotic Grasping [Internet].arXiv [cs.LG]. 2017				http://arxiv.org/abs/1709.07857

3		Gu S, Holly E, Lillicrap T, Levine S. Deep Reinforcement Learning for Robotic Manipulation with Asynchronous Off-Policy Updates [Internet]. arXiv [cs.RO]. 2016				http://arxiv.org/abs/1610.00633

A.17 Robotic Vision – Scene Awareness

[SOURCE: SC42/WG4 N050 uc_17]

A.17.1 General

ID	17			
Use case name	Robotic vision – scene awareness			
Application domain	Other (please specify) Robotics			
Deployment model	Embedded systems			
Status	PoC			
Scope	Determining in which environment the robot is and which actions are available to it			
Objective(s)	Robustly identify the scene from video and depth sensors. From the scene and the seen objects, propose the actions to make to human collaborator			
Narrative	Short description (not more than 150 words)	Household robots need to navigate a very diverse set of environments and be able to accomplish different tasks depending on their position and action set. To meet these goals, the robots need to quickly and accurately identify the visual context in which they operate and derive the set of possible actions from this context. They can then propose relevant actions to the end user so that he does not have to define context himself and then sift through a long list of irrelevant actions.		
	Complete description	http://places2.csail.mit.edu/challenge.html		
Stakeholders	Customers, 3rd parties, end users, community			
Stakeholders' assets, values	Trustworthiness, safety, privacy, stability			
System's threats & vulnerabilities	Dynamic environment, security threats, privacy threats			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Classification error	Min distance between 5 labels and ground truth	Improve context confidence
AI features	Task(s)	Recognition		
	Method(s)	Deep learning, decision trees		
	Hardware	Sensors, processors		

	Topology	
	Terms and concepts used	Context awareness, scene recognition, deep learning, action proposal
Standardization opportunities/ requirements		
Challenges and issues	Challenges: Environment can be poorly lit leading to difficult context recognition. Issue: Sensors degradation can occur	
Societal Concerns	Description	Privacy concerns (what data from sensors is kept, reviewed and used to improve models).
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.17.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Public	Places challenge			Bolei Zhou, Aditya Khosla, Antonio Torralba, Aude Oliva	http://places2.csail.mit.edu/challenge.html
2	Peer-Reviewed	B. Zhou, A. Lapedriza, J. Xiao, A. Torralba, and A. Oliva, "Learning deep features for scene recognition using places database," in In Advances in Neural Information Processing Systems, 2014.			MIT	http://places.csail.mit.edu/places_NIPS14.pdf
3	Peer-Reviewed	L. Herranz, S. Jiang, X. Li, "Scene recognition with CNNs: objects, scales and dataset bias", Proc. International Conference on Computer Vision and Pattern Recognition (CVPR16), Las Vegas, Nevada			Key Laboratory of Intelligent Information Processing of Chinese Academy of Sciences	https://arxiv.org/pdf/1801.06867.pdf

A.18 AI Solution for Car Damage Classification

[SOURCE: SC42/WG4 N050 uc_18]

A.18.1 General

ID	18
Use case name	AI solution for Car Damage Classification
Application domain	Other (Insurance)
Deployment model	Cloud services

Status	PoC	
Scope	Car damage classification for common damage types such as bumper dent, door dent, glass shatter, head lamp broken, tail lamp broken, scratch and smash.	
Objective(s)	1. To create an automated system for car damage classification using CNNs. 2. Experiment using transfer and ensemble learning to find which is better for training a CNN for car damage classification.	
Narrative	Short description (not more than 150 words)	Image based vehicle insurance processing is an important area with large scope for automation. We have considered the problem of Car damage classification. We explore deep learning based techniques for this purpose. Initially, we try directly training a CNN. However, due to small set of labeled data, it does not work well. Then, we explore the effect of domain-specific pre-training followed by fine-tuning. Finally, we experiment with transfer learning and ensemble learning. Experimental results show that transfer learning works better than domain specific fine-tuning. We achieve accuracy of 89.5% with combination of transfer and ensemble learning. We hosted the trained model on cloud that can be plugged into applications using API and can be used for automated first level assessment of the damage, in car insurance sector.
	Complete description	Today, in the car insurance industry, a lot of money is wasted due to claims leakage [1] [2]. Claims leakage / Underwriting leakage is defined as the difference between the actual claim payment made and the amount that should have been paid if all industry leading practices were applied. Visual inspection and validation have been used to reduce such effects. However, they introduce delays in the claim processing. There have been efforts by a few start-ups to mitigate claim processing time [3] [4]. An automated system for the car insurance claim processing is a need of the hour. We employ Convolutional Neural Network (CNN) based methods for classification of car damage types. Specifically, we consider common damage types such as bumper dent, door dent, glass shatter, head lamp broken, tail lamp broken, scratch and smash. To the best of our knowledge, there is no publicly available dataset for car damage classification. Therefore, we created our own dataset by collecting images from web and manually annotating them. The classification task is challenging due to factors such as large inter-class similarity and barely visible damages. We experimented with many techniques such as directly training a CNN, pre-training a CNN using auto-encoder followed by fine-tuning, using transfer learning from large CNNs trained on ImageNet and building an ensemble classifier on top of the set of pretrained classifiers. We observe that transfer learning combined with ensemble learning works the best. We also devise a method to localize a particular damage type. We achieve accuracy of 89.5% with combination of transfer and ensemble learning. The same technique can be used for localization of damages. Further, only car specific features may not be effective for damage classification. It thus underlines the superiority of feature representation learned from the large training sets.

		We hosted the trained model on cloud that can be plugged into applications using API and can be used for automated first level assessment of damages, in car insurance sector.		
Stakeholders	Insurance companies, Car owner/user			
Stakeholders' assets, values	competitiveness, reputation, trustworthiness, fair treatment			
System's threats & vulnerabilities	Misclassification of car damage and insurance claims			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Accuracy	We performed experiment with transfer learning and ensemble learning. Experimental results show that transfer learning works better than domain specific fine-tuning. We achieve accuracy of 89.5% with combination of transfer and ensemble learning.	Objective 2
AI features	Task(s)	Recognition		
	Method(s)	Deep learning		
	Hardware	c4.2xlarge Amazon AWS EC2 instance which has 8 core Intel Xeon E5-2666 v3 (Haswell) CPUs and 15GB RAM		
	Topology	GPU enabled servers		
	Terms and concepts used	Deep learning, transfer learning, supervised learning, convolutional neural networks		
Standardization opportunities/ requirements	ensemble learning, transfer learning, Localization, manual annotation through crowd sourced efforts			
Challenges and issues	1. Small size of the damages 2. Less Quantity of data 3. Ambiguity in damaged and non-damaged images			
Societal Concerns	Description	Insurance agents may need to be re-skilled		
	SDGs to be achieved	Decent work and economic growth		

A.18.2 Data (optional)

Data characteristics	
Description	We created a dataset consisting of images belonging to different types of car damage. We consider seven commonly observed types of damage such as bumper dent, door dent, glass shatter, head lamp broken, tail lamp broken, scratch and smash. In addition, we also collected images which belong to a no damage class
Source	The images were collected from web and were manually annotated
Type	
Volume (size)	
Velocity	
Variety	multiple web sources
Variability (rate of change)	
Quality	Medium

A.18.3 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Conference Paper	International Conference on Machine Learning and applications	Published		Tata Consultancy Services Limited	https://ieeexplore.ieee.org/abstract/document/8260613/

A.19 AI to Understand Adulteration in Commonly Used Food Items

[SOURCE: SC42/WG4 N050 uc_19]

A.19.1 General

ID	19
Use case name	AI to understand adulteration in commonly used food items
Application domain	Agriculture
Deployment model	Cloud services
Status	PoC
Scope	Understand the patterns in hyperspectral / NIR or visual imaging specifically for adulteration in milk, banana and mangoes
Objective(s)	To device a simple , cost effective tool to identify the adulteration in food items at point of purchase

Narrative	Short description (not more than 150 words)	Food adulteration is one of the big evil of modern society. Adulterated milk is hazard for children, many aliments including cancer / kidney failures due to consumption of adulterated food. Hyperspectral technology was evaluated to find out adulteration in food items			
	Complete description	Food adulteration is becoming menace especially with adulterants that are either carcinogenic or harmful to body parts like kidney. To give few examples, Milk is adulterated with Soda, Urea and detergents. Whereas mangoes and bananas are quickly ripened by calcium carbide and so on. Common man cannot live without these items. There is no frugal way to identify these type of adulterations. Experiment of controlled adulteration was done and hyperspectral reflectance reading were taken. AI helped to find the patterns in hyperspectral signature and was able to reliably classify (90% ++) samples that were unadulterated and adulterated.			
Stakeholders	Consumers, Farmers, Health monitoring agencies				
Stakeholders' assets, values	Health, reputation, trust, fair treatment				
System's threats & vulnerabilities	different sources of bias, incorrect AI system use, improperly trained model, incorrect classification				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives	
	1	Features related to adulterants in radio spectrum	Intensities around NIR range	Health	
AI features	Task(s)	Recognition			
	Method(s)	Machine learning			
	Hardware	Hyperspectral camera, GPS servers			
	Topology	GPU servers			
	Terms and concepts used	Deep learning, supervised learning, classification			
Standardization opportunities/ requirements	Image classification of hyper-spectral camera images				
Challenges and issues	Large scale data collection, Miniaturization of frugal NIR / Hyperspectral sensor				
Societal Concerns	Description	If the AI system is rolled out and taken as reliable then it should be able to perform in all cases and scenarios. Incorrect classification can lead to false accusations			
	SDGs to be achieved	Good health and well-being for people			

A.19.2 Data (optional)

Data characteristics	
Description	Hyperspectral signatures (300 nm to 1300 nm @ 30 nm band)

Source	Hyperspectral camera
Type	
Volume (size)	~ 500 samples
Velocity	
Variety	
Variability (rate of change)	
Quality	

A.19.3 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Conference	Published in SPIE Proceedings Vol.9860: Hyperspectral Imaging Sensors: Innovative Applications and Sensor Standards 2016 David P. Bannon, Editor(s)			Tata Consultancy Services Limited	http://spie.org/Publications/Proceedings/Paper/10.1117/12.2223439?origin_id=x4323&start_year=1963

A.20 Detection of Frauds based on Collusions

[SOURCE: SC42/WG4 N050 uc_20]

A.20.1 General

ID	20	
Use case name	Detection of frauds based on collusions	
Application domain	Fintech	
Deployment model	On-premise systems	
Status	In operation	
Scope	Validating the predicted collusion set is effort-intensive and needs investigative and legal expertise	
Objective(s)	Automatic unsupervised detection of frauds based on collusions	
Narrative	Short description (not more than 150 words)	A set of unsupervised machine learning algorithms to detect collusion-based frauds, particularly, circular trading and price manipulation in stock market trading

	Complete description	Frauds are prevalent across all industries; and they are particularly severe in today's computerized, web-connected, mobile-accessible, and cloud-enabled business environments. An FBI report states that the insurance industry in the US, which consists of over 7000 companies and collects over $1 trillion in premiums, loses about $40 billion annually in frauds in the non-health insurance sector alone. The aggregate size of the 52 regulated stock exchanges across the world (total market capitalization) was $55 trillion as on Dec. 2012. Given the money involved, it is not surprising that the stock market is a target of frauds. Many malpractices in stock market trading, e.g. circular trading and price manipulation—use the modus operandi of collusion. Informally, a set of traders is a candidate collusion set when they have "heavy trading" among themselves, as compared to their trading with others. We formalize the problem of detection of collusion sets, if any, in a given trading database. We show that naïve approaches are inefficient for real-life situations. We adapt and apply two well-known graph clustering algorithms for this problem. We also propose a new graph clustering algorithm, specifically tailored for detecting collusion Sets; further, we establish a combined collusion set. Treating individual experiments as evidence, this approach allows us to quantify the confidence (or belief) in the candidate collusion sets. We have carried out detailed simulation experiments to demonstrate effectiveness of the proposed algorithms. The system is also operational in a government organization. Note that all our collusion detection algorithms are completely unsupervised and do not need any training data.		
Stakeholders	Stock market regulator, stock traders, stock investors			
Stakeholders' assets, values	Fair price, Prevention of Collusions and frauds			
System's threats & vulnerabilities	Incorrect fraud detection may lead to unnecessary alerts			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Prediction accuracy	How many predicted collusion sets were actually involved in frauds	Improve accuracy
AI features	Task(s)	Knowledge processing & discovery		
	Method(s)	Machine learning		
	Hardware	GPU enabled servers		
	Topology	GPU enabled servers		

	Terms and concepts used	Deep learning, unsupervised learning, clustering
Standardization opportunities/ requirements	Graph based clustering	
Challenges and issues	Actual examples of collusion-based frauds may not be available easily, even for evaluation and testing	
Societal Concerns	Description	Incorrect detection of Collusions and frauds may cause unnecessary stress in stock traders
	SDGs to be achieved	Decent work and economic growth

A.20.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Conference				Tata Consultancy Services Limited	D. K. Luna, G. K. Palshikar, M. Apte, A. Bhattacharya, *Finding Shell Company Accounts using Anomaly Detection*, **ACM India Joint International Conference on Data Science and Management (CoDS-COMAD 2018),** Goa, India, Jan 11-13, 2018
2	Journal				Tata Consultancy Services Limited	G. K. Palshikar, M. Apte, *Collusion Set Detection Using Graph Clustering*, vol. 16, no. 2, April 2008, **Data Mining and Knowledge Discovery** journal (Springer-Verlag), pp. 135 – 164
3	Book chapter				Tata Consultancy Services Limited	M. Apte, G.K. Palshikar, S. Baskaran, *Frauds in Online Social Networks: A Review*, accepted as a Book Chapter, in **Social Network and Surveillance for Society**, T.

						Ozyer and S. Bakshi (ed.s), to be published by Springer in 2018
4	Book chapter				Tata Consultancy Services Limited	G.K. Palshikar, M. Apte, *Financial Security against Money Laundering: A Survey*, Chapter 36 in B. Akhgar, H.R. Arabnia (Ed.s), **Emerging Trends in Information and Communication Technologies Security**, pp. 577 – 590, Elsevier (Morgan Kaufman), 2013

A.21 Information Extraction from Hand-marked Industrial Inspection Sheets

[SOURCE: SC42/WG4 N050 uc_22]

A.21.1 General

ID	21	
Use case name	Information Extraction from Hand-marked Industrial Inspection Sheets	
Application domain	Manufacturing	
Deployment model	Cloud services	
Status	PoC	
Scope	Localization and Mapping of machine zones, arrows and text, to extract information from manually tagged inspection sheets.	
Objective(s)	To create a pipeline to build an information extraction system for machine inspection sheets, by mapping the machine zones to the handwritten code using state-of-the-art deep learning and computer vision techniques.	
Narrative	Short description (not more than 150 words)	Inspection Sheets are filled regularly to detect defects and maintain heavy machines. Sheets contains a lot of unstructured information and requires domain experts' intervention to read and digitize. We have proposed a novel pipeline to build an information extraction system for such machine inspection sheets, utilizing state-of-the-art deep learning and computer vision techniques.
	Complete description	In order to effectively detect faults and maintain heavy machines, a standard practice in several organizations is to conduct regular manual inspections. The procedure for conducting such inspections requires marking of the damaged components on a standardized inspection sheet

		which is then camera scanned. These sheets are marked for different faults in corresponding machine zones using hand-drawn arrows and text. As a result, the reading environment is highly unstructured and requires a domain expert while extracting the manually marked information We have proposed a novel pipeline to build an information extraction system for such machine inspection sheets, utilizing state-of-the-art deep learning and computer vision techniques. The pipeline proceeds in the following stages: (1) localization of different zones of the machine, arrows and text using a combination of template matching, deep learning and connected components, and (2) mapping the machine zone to the corresponding arrow head and the text segment to the arrow tail, followed by pairing them to get the correct damage code for each zone. The proposed method yields an accuracy of 83.2% at the end of the pipeline. The organization has 2 million such sheets which are manually processed. This project will enable considerable savings in terms of time and manpower as it takes roughly 5 minutes per sheet for the manual process. The AI system will process a sheet in 20 seconds and can be parallelized for further speed up.		
Stakeholders	Manufacturing companies, Machine Inspectors, Engineers			
Stakeholders' assets, values	Reduced dependence on Expert Engineer time, Possibility of pointing out errors in inspection			
System's threats & vulnerabilities	Trained on one set of inspection sheets can lead to inaccurate classification of another inspector's inspection sheet			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Accuracy	Accuracy of system to read the code and map it to the right Machine zone	
AI features	Task(s)	Recognition		
	Method(s)	Deep learning		
	Hardware	GPU enabled desktop / server		
	Topology	GPU enabled servers		
	Terms and concepts used	Deep learning, Feature engineering, Recurrent neural networks (RNN), Convolutional neural network (CNN)		
Standardization opportunities/ requirements	pipeline for information extraction from industrial inspection sheets			
Challenges and issues	Challenges: 1. Quality of Images 2. Structural deformities of individual components(arrows, handwritten code) 3. Quantity of data 4. Cascading effect of error at each stage of the pipeline			

Societal Concerns	Description	Inspection engineers may have to develop other skills
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.21.2 Data (optional)

Data characteristics	
Description	a dataset of anonymized inspection sheets provided by a company
Source	a company employing heavy machines in manufacturing
Type	Camera scanned images with resolution of 3210 *2200
Volume (size)	330 scans
Velocity	daily
Variety	Scanned inspection sheets; single source
Variability (rate of change)	Well scanned sheets, poorly scanned sheets, soiled sheets, poorly marked sheets
Quality	Can have missing text, missing arrows etc.

A.21.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Industrial Inspection	Physical inspection of heavy machinery	Scan of machine inspection sheet	Human inspected marked sheets	Digitized information from inspection sheets
2	Training Arrow Detection Model	Train a deep model to recognize arrows in an image	Arrow images	Synthetically generated arrow images	Trained detector with high > 90% accuracy
3	Training Regression model for arrow head and tail	Train a deep model for regressing to head and tail of arrows	Detected Arrow images	Arrow Images	Head and Tail Localization
4	Text Detection	Detect Text via deep model	Detected handwritten text	Handmarked image	Localized handwritten text
5	Reading Handwritten Text	Read text via deep model	Read handwritten text	Isolated handwritten text	Digitized text
6	Mapping of Zones	Zone Mapping	Map each text to a machine zone using arrow	Machine Zone to fault mapping	Final Mapping to database

A.21.4 Training (optional)

Scenario name	Training				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Synthetic Arrow Dataset is ready	Train arrow detector	AI Solution Provider	Train a model to isolate arrows in an image	Needed for mapping text to zones
2	Handwritten text recognition	Train handwritten text recognizer	AI Solution Provider	Train a model to recognize handwritten text	Needed for fault identification
3	Text Detection	Isolate Handwritten text	AI Solution Provider	Train a model to isolate handwritten text	Needed for Text detection

Specification of training data	

A.21.5 Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement

Input of evaluation	Manually annotated sheets, AI System
Output of evaluation	Accuracy

A.21.6 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Conference Pape	International Conference on Document Analysis and Recognition	Published		Tata Consultancy Services Limited	https://ieeexplore.ieee.org/abstract/document/8270293/

A.22 AI (Swarm Intelligence) Solution for Attack Detection in IoT Environment

[SOURCE: SC42/WG4 N050 uc_22]

A.22.1 General

<table>
<tr><td>ID</td><td colspan="2">22</td></tr>
<tr><td>Use case name</td><td colspan="2">AI (Swarm Intelligence) solution for Attack Detection in IoT Environment</td></tr>
<tr><td>Application domain</td><td colspan="2">Security</td></tr>
<tr><td>Deployment model</td><td colspan="2">Hybrid or other (Agent Based Hub-Spoke)</td></tr>
<tr><td>Status</td><td colspan="2">Prototype</td></tr>
<tr><td>Scope</td><td colspan="2">Anomaly Based Attack Detection in IoT environment using Swarm Intelligence</td></tr>
<tr><td>Objective(s)</td><td colspan="2">Given: AMI (Advanced Metering Infrastructure – Smart Meters in Smart Buildings in Smart Cities.

Detect: Detect energy theft / meter tampering by consumer in AMI (Advanced Metering Infrastructure) or hacking attack by an external agent (man in the middle) for edge computing security scenarios with intermitted disconnection, near real-time response without using server or cloud-based analytics.</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td>This is a unique approach to detect attacks in IoT environment using Anomaly Based Attack Detection using Swarm Intelligence methods. This is a key solution to detect energy theft scenario in Smart Metering. Energy Theft problem varies from 2% in developed countries to 35% in developing countries. This is complimentary to traditional AI or other static rule-based analysis which is heavily dependent on analysis of huge amounts of data on centralized cloud infrastructure. This solution is simple, nimble and can be run on low powered edge (IoT Nodes) for near real-time, low latency, low power, small compute, small storage Mist / Edge Computing Scenarios.</td></tr>
<tr><td>Complete description</td><td>Introduction to Anomaly Based Attack Detection using Swarm Intelligence

Motivation
World-wide statistics shows there will be IoT install based of 12.86 billion units in the consumer segment by 2020.
In Smart city industry, smart security is expected to account for 13.5 percent of global smart city market. There will be more than 1 billion devices installed in smart homes.
India is planning 100 Smart cities to be developed in next 5 years, and security is of paramount importance. Securing Advanced metering Infrastructure (AMI) will be key component for securing smart city infrastructure.
Important aspect of securing AMI is securing the Smart Energy meters and detecting attacks on these smart meters.
While there are many traditional solutions for anomaly and intrusion-based detection based on static preset rules / policies, these solutions are not effective in detecting future attacks that are already not known. A more robust and more secure security solution to detect attacks in edge network is</td></tr>
</table>

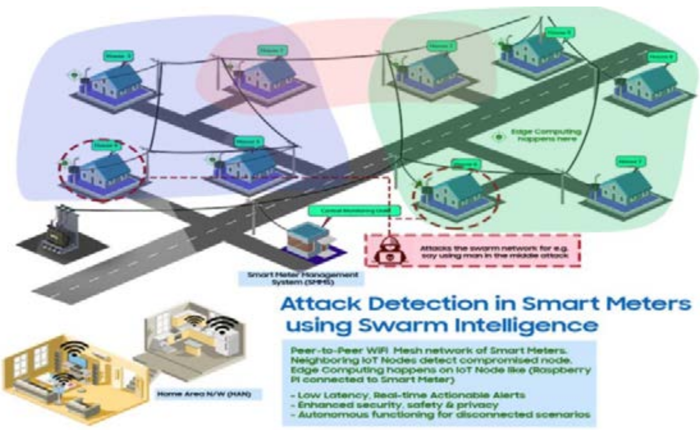
essential. Hence a new innovative approach of using Swarm Intelligence along with Anomaly based Detection has been a technology choice to solve this problem in a unique way.

Problem Statement
Detect energy theft / meter tampering by consumer in AMI (Advanced Metering Infrastructure) or hacking attack by an external agent (man in the middle) for edge computing security scenarios with intermitted disconnection, near real-time response without using server or cloud-based analytics.

Current situation
There are many cloud based centralized solutions available using static rules / policies configured which can detect existing known attack only. Processing in centralized cloud involves transferring data from sensors / actuator to cloud which in itself is a concern in terms of privacy, security, regulations & compliance for some key industry verticals.

Solution Approach
Swarm Intelligence is a specific branch of AI. A new innovative approach using swarm intelligence (AI) based solution for attack detection. Used collective behavior of decentralized self-organizing swarm of nodes with simple computational rules, interacting locally.

Result: Simple collective algorithms for detection of man in the middle attacks on data / network.
The following Anomaly based attack detection algorithms were used
1. Moving average based
2. Mahalanobis distance based
3. Entropy based



Use-Case: Attack detection of attacks AMI – Smart Metering network.

1. Energy Theft by consumer.

		2. Attack launched by external entity (hacker) using say man in-the-middle attack. **Technology:** Swarm Intelligence & Anomaly Based attack detection using energy consumption data from Smart Meter to detect attacks using consensus-based anomaly detection algorithms. **Solution Steps:** ▪ Each Smart meter node reads its Energy Consumption data ▪ Node shares Energy Consumption data with its neighboring nodes ▪ Node computes anomaly index based on Anomaly Detection algorithm ▪ Neighboring nodes detect anomalous node(s) based on Anomaly index by consensus ▪ Neighboring nodes raise alarm indicating attacked / compromised node ▪ Notify alarm to back end host. Display monitoring status on host UI.		
Stakeholders	End users of Smart Metering, Utility Companies			
Stakeholders' assets, values	Competitiveness, trustworthiness, safety, privacy			
System's threats & vulnerabilities	Challenges to accountability			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Recommendation	System can be used to detect even unknown attacks in IoT Environment especially for real-time or near real-time scenarios	use-case for AMI – Smart Metering with innovative approach
	2	Improve accuracy	We found the accuracy of the model to be reasonably good	Improve accuracy
AI features	Task(s)	Inference		
	Method(s)	Machine Learning, Statistics, Heuristics, Anomaly Detection (Distance / Density based).		
	Hardware	IoT Nodes (like Raspberry PI, Micro-Controllers, Edge Devices, Cloud etc.		
	Topology	Agent based hub-spoke model. Anomaly Detection in peer-to-peer mesh network.		
	Terms and concepts used	Swarm Intelligence, Anomaly Detection, AMI (Advanced Metering Infrastructure).		

Standardization opportunities/ requirements	Standardization of use of Swarm Intelligence for specific use case scenarios	
Challenges and issues	The problem is challenging because 1. **Varied data set for different scenarios** - large amount of data needs to be pre-processed to arrive at operation threshold parameters to be used for detection in real-time. 2. **IoT (Edge) Nodes Configuration to suite specific environments** The Swarm Intelligence System (SIS) involves a swarm of devices. It should be possible to easily configure the entire swarm for different network environments and locations. **Solution:** Many reusable modules for Logging, Debugging and configuration through XML has been developed which has enabled binary re-use without having to change any code to suit a new network environment. 3. **Flexible to reuse / customize solution for different use-cases / scenarios and scalability** The platform needs to be able to provide facilities for different algorithms for anomaly detection to be plugged in with minimum modification, recoding, recompilation. **Solution:** Completely dynamically pluggable Algorithm binaries can be developed that conforms to defined interface Specifications, which gives flexibility to try out new algorithms, without needing to change existing code or re-compile. Use of Swarm Intelligence ensures very less localized communication that is required. Furthermore, the Swarm Intelligence System communication capability also addresses throttling of network traffic because of multi-threading / queuing capability built in.	
Societal Concerns	Description	Accuracy of Solution. Fraud (Anomaly Detection) usually incurs a false positive alarm issue.
	SDGs to be achieved	Responsible consumption and production

A.22.2 Data (optional)

Data characteristics	
Description	Energy consumption data collected from smart meters.
Source	1. 3 years of dataset from smart meters downloaded from publicly available data source. 2. Meter Data Sets received from IIT-Delhi. 3. Sample data collected from Smart Meter setup in the Creative Lab (C-Lab) in Samsung. 4. Analysis & Recommendations on AMI (Advanced metering infrastructure) and Smart Metering scenarios from many research papers.

	Various online sources on application of Swarm Intelligence as a technology for solving complex problems using simple steps.
Type	Structured Data
Volume (size)	Multi-year Energy Consumption data from smart meters collected at the rate of 2 entries per hour 48 entries in a day; 17520 entries in a year.
Velocity	Batch, near-real time.
Variety	Single source. Similar data from multiple sources of smart meters.
Variability (rate of change)	Static. Datasets vary based on geography, season etc. as energy consumption varies based on these factors.
Quality	Contains some noise. Better quality after pre-processing.

A.22.3 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Paper	Energy Theft Detection-AMI	published	High	TSINGHUA SCIENCE AND TECHNOLOGY	https://ieeexplore.ieee.org/document/6787363/
2	Paper	Intrusion Detection - AMI	published	High	IEEE University of Illinois	https://ieeexplore.ieee.org/document/5622068/
3	Paper	EPPA	published	High	IEEE University of Waterloo, Waterloo	https://ieeexplore.ieee.org/document/6165271/
4	Report	Quantifying the Extent of Energy Theft	published	Medium	City of Cape Town, SARPA	https://www.smartenergy.com/wpcontent/uploads/Deon%20Louw_0.pdf
5	website	About Swarm Intelligence	Available Online	High	TechFerry	http://www.techferry.com/articles/swarm-intelligence.html

A.23 VTrain Recommendation Engine

[SOURCE: SC42/WG4 N050 uc_23]

A.23.1 General

ID	23
Use case name	VTrain recommendation engine
Application domain	Education
Deployment	On-premise systems

<table>
<tr><td>model</td><td colspan="4"></td></tr>
<tr><td>Status</td><td colspan="4">In operation</td></tr>
<tr><td>Scope</td><td colspan="4">Based on an employee’s career objectives find skill requirements and its training</td></tr>
<tr><td>Objective(s)</td><td colspan="4">Recommend a personalised list of “best” training courses to an employee, which will help him/her meet his/her career objectives.</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td colspan="3">The vTrain system helps employees improve their skills by recommending appropriate training courses from a given list and historical data.</td></tr>
<tr><td>Complete description</td><td colspan="3">Continuous training is crucial for creating and maintaining the right skill-profile for the industrial organization’s workforce. There is a tremendous variety in the available trainings within an organization: technical, project management, quality, leadership, domain-specific, soft-skills etc. Hence it is important to assist the employee in choosing the best trainings, which perfectly suits him/her background, project needs and career goals. In this work, we focus on algorithms for training recommendation in an industrial setting. We formalize the problem of next training recommendation, taking into account the employee’s training and work history. We have developed several new unsupervised sequence mining algorithms to mine the past trainings data from the organization for arriving at personalized next training recommendation. Using the real-life data about trainings of 118587 employees over 5019 distinct trainings from a large multi-national IT organization, we show that these algorithms outperform several standard recommendation engine algorithms as well as those based on standard sequence mining algorithms.</td></tr>
<tr><td>Stakeholders</td><td colspan="4">Employees, Job requirements, Training requirements</td></tr>
<tr><td>Stakeholders’ assets, values</td><td colspan="4">Skill profile, Job description requirements</td></tr>
<tr><td>System’s threats & vulnerabilities</td><td colspan="4">Different sources of bias can come based on model training, incorrect AI system use can cause stress in employees</td></tr>
<tr><td rowspan="3">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>Prediction accuracy</td><td>Number of employees undertaking courses from the recommended list</td><td>Improve accuracy</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">AI features</td><td>Task(s)</td><td colspan="3">Recommendation</td></tr>
<tr><td>Method(s)</td><td colspan="3">Deep learning</td></tr>
<tr><td>Hardware</td><td colspan="3">GPU enabled servers</td></tr>
<tr><td>Topology</td><td colspan="3">GPU enabled servers</td></tr>
<tr><td>Terms and concepts used</td><td colspan="3">Deep learning, Unsupervised learning, Recommendation</td></tr>
<tr><td>Standardization opportunities/ requirements</td><td colspan="4">unsupervised sequence mining algorithms to mine the past data</td></tr>
</table>

Challenges and issues	Need large amounts of training data; predicting human behaviour is tricky	
Societal Concerns	Description	Employees may feel challenged or demoralized
	SDGs to be achieved	Decent work and economic growth

A.23.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Journal				Tata Consultancy Services Limited	R. Srivastava, G.K. Palshikar, S. Chaurasia, A. Dixit, What's Next? A Recommendation System for Industrial Training, accepted in Data Science and Engineering journal (Springer).
2	Conference				Tata Consultancy Services Limited	R. Srivastava, G.K.Palshikar, S.Chaurasia, What's Next? A Recommendation System for Industrial Training, Proc. of Workshop on Human Capital Management, held as part of International Conference on Data Management (ICDM 2017), New Orleans, USA, 18?21 November, 2017.
3	Conference				Tata Consultancy Services Limited	R. Srivastava, S. Hingmire, G. K. Palshikar, S. Chaurasia, A. Dixit, CSRS: A Context and Sequence Aware Recommendation System, 8th Meeting of the Forum for Information Retrieval Evaluation (FIRE 2016), 7 – 10 December 2016, Kolkata, India.

A.24 AI Solution to Predict Post-Operative Visual Acuity for LASIK Surgeries

[SOURCE: SC42/WG4 N050 uc_24]

A.24.1 General

ID	24	
Use case name	AI solution to predict Post-Operative Visual Acuity for LASIK Surgeries	
Application domain	Healthcare	
Deployment model	Cloud services	
Status	In operation	
Scope	Predicting Post-Operative Visual Acuity for LASIK Surgeries from retrospective LASIK surgery data with patient follow-ups.	
Objective(s)	Given: Pre-operative examination results and demography information about a patient. Predict: Post-operative UCVA after one day, one week and one month of the surgery.	
Narrative	Short description (not more than 150 words)	LASIK (Laser-Assisted in SItu Keratomileusis) surgeries have been quite popular for treatment of myopia, hyperopia and astigmatism over the past two decades. In the past decade, over 10 million LASIK procedures had been

		performed in the United States alone with an average cost of approximately $2000 USD per surgery. While 99% of such surgeries are successful, the commonest side effect is a residual refractive error and poor uncorrected visual acuity (UCVA). In this work, we aim at predicting the UCVA post LASIK surgery. We model the task as a regression problem and use the patient demography and pre-operative examination details as features. To the best of our knowledge, this is the first work to systematically explore this critical problem using machine learning methods. Further, LASIK surgery settings are often determined by practitioners using manually designed rules. We explore the possibility of determining such settings automatically to optimize for the best post-operative UCVA by including such settings as features in our regression model. Our experiments on a dataset of 791 surgeries provides an RMSE (root mean square error) of 0.102, 0.094 and 0.074 for the predicted post-operative UCVA after one day, one week and one month of the surgery respectively.
	Complete description	**Introduction to LASIK surgeries** Refractive surgeries for eye are performed to correct (normalize) the refractive state of the eye, to decrease or eliminate dependency on glasses or contact lenses. This can include various methods of surgical remodeling of the cornea or cataract surgery. LASIK is a refractive eye surgery that uses a laser to correct nearsightedness, farsightedness, and/or astigmatism. In LASIK, a thin flap in the cornea is created using either a microkeratome blade or a femto-second laser. The surgeon folds back the flap, then removes some corneal tissue underneath using a laser. The flap is then laid back in place, covering the area where the corneal tissue was removed. With nearsighted people, the goal of LASIK is to flatten the steep cornea; with farsighted people, a steeper cornea is desired. LASIK can also correct astigmatism by smoothing an irregular cornea into a more normal shape. LASIK surgeries are highly popular; over 10 million LASIK procedures have been performed in the United States alone in the past decade. **Motivation** While overall patient satisfaction rates after primary LASIK surgery have been around 95%, it may not be recommended for everybody for two reasons: (1) high cost with potentially no significant improvement for certain types of patients, and (2) possible eye complications after the surgery. LASIK surgeries cost approximately $2000 USD per surgery. An ability to predict post-operative UCVA can help patients make an informed decision about investing their money in undergoing a LASIK surgery or not. It can

		also help surgeons recommend the most promising type of laser surgery to the patients. How can we perform this prediction? Further, while performing such surgeries, surgeons need to set multiple parameters like suction time, flap and hinge details, etc. These are often set using manually designed rules. Can we design a data driven automated method to suggest the best settings for a patient undergoing a laser surgery of a certain type? **Problem Definition** In this paper, we address the following problem. Given: Pre-operative examination results and demography information about a patient Predict: Post-operative UCVA after one day, one week and one month of the surgery. Challenges The problem is challenging because (1) large amount of data about such surgeries is not easily available; (2) there are a lot of pre-operative measurements that can be used as signals; and (3) data is sparse, i.e., there are a lot of missing values. **Brief Overview of our Approach** We model the task as a regression problem. We use domain knowledge to preprocess data by transforming a few categorical features into binary features.We also use average values to impute missing values for numeric features. For categorical features, we impute missing values using the most frequent value for the feature. We evaluate multiple regression approaches. Our experiments on a dataset of 791 surgeries provides an RMSE of 0.102, 0.094 and 0.074 for the predicted post-operative UCVA after one day, one week and one month of the surgery respectively. **Summary** – We described a critical problem of predicting post-operative UCVA for patients undergoing LASIK surgeries. – We modeled the task as a regression problem. We explored the effectiveness of demographic, pre-operative features and surgery settings for the prediction task. – Using a dataset of 791 LASIK surgeries performed on 404 patients from 2013 and 2014, we tested the effectiveness of the machine learning methods.
Stakeholders	Hospitals, Patients undergoing LASIK surgeries.	
Stakeholders' assets, values		
System's threats & vulnerabilities	different sources of bias; incorrect AI system use	

Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Recommendation	The system can be used to automatically recommend the right LASIK surgery to the patient.	New use-case in healthcare
	2	Improve accuracy	We found the accuracy of the model to be reasonably good to be practically useful.	Improve accuracy
AI features	Task(s)	Prediction		
	Method(s)	Machine Learning, Gradient Boosted Decision Trees Based Regression		
	Hardware	Machine with 1 CPU and 2 GB RAM. Any Operating system.		
	Topology	LASIK surgeries, UCVA, Uncorrected visual acuity, Regression		
	Terms and concepts used			
Standardization opportunities/ requirements				
Challenges and issues	The problem is challenging because (1) large amount of data about such surgeries is not easily available; (2) there are a lot of pre-operative measurements that can be used as signals; and (3) data is sparse, i.e., there are a lot of missing values.			
Societal Concerns	Description			
	SDGs to be achieved	Good health and well-being for people		

A.24.2 Data (optional)

Data characteristics	
Description	The dataset contains information for 404 patients in the age range of 18 to 47 years. 215 of these patients are females, and the rest are males. The 791 LASIK surgeries were done in 2013 and 2014. 397 of the surgeries were performed on the left eye and remaining ones on the right eye. Most of the surgeries are either of the Wavefrontguided-LASIK type or of the Plano-scan-LASIK type. Orbscan is the most popular topography machine used; Oculyzer being the second most popular one. Pre-operative UCVA values vary between 0.15 and 2. Post-operative UCVA values vary between - 0.2 and 1 for day 1, -0.3 and 1 for week 1 and -0.2 and 0.95 for month 1 after the operation. Although

	usually large datasets improve accuracy of the learned machine learning models, it is difficult to obtain large datasets in this domain.
Source	Measured using various medical machines at the LVPEI Eye Institute, Hyderabad, India.
Type	Structured Data
Volume (size)	791 instances from 404 patients.
Velocity	Batch.
Variety	Single source. Data from multiple centers of the hospital.
Variability (rate of change)	Static.
Quality	Contains some noise. High quality after pre-processing.

A.24.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Pre-processing	Remove unnecessary, noisy, redundant columns. Impute missing values. Remove outliers.	As soon as raw dataset arrives		Pre-processed clean data is ready.
2	Training	Train a model with training samples	Pre-processed clean data is ready.	Pre-processing	Trained regression model
3	Evaluation	Evaluate whether the trained model is of good accuracy	Completion of training/re-training	Training/re-training	Accuracy values
4	Prediction/Deployment	Test new instances using the trained model	When a new patient visits the hospital for LASIK surgery	Training/re-training	Prediction of post-LASIK surgery outcomes
5	Retraining	Retrain model with more training samples.	Certain period of time has passed since last training/re training and more training	Pre-processing	Retrained regression model.

			samples are available		

A.24.4 Training (optional)

Scenario name	Training				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Sample Raw data is ready	Pre-processing	AI Cloud Service Provider	Outlier detection, feature selection, missing value imputation	API to perform pre-processsing
2	Completion of step 1	Training sample creation	AI Cloud Service Provider	Create training samples by clearly recognizing relevant features and training label for data from step 1	
3	Completion of step 2	Model training	AI Cloud Service Provider	Train a gradient boosted trees based regression model using training samples from step 2.	

Specification of training data	

A.24.5 Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	New patient visits hospital for LASIK surgery	Pre-processing	AI Cloud Service Provider	Get relevant data from various machines based on patient registration form, and do pre-processing.	
2	Completion of Step 1	Prediction	AI Cloud Service Provider	Given pre-processed instances from step 1 and the trained model, compute predictions for	

				the current patient.	
3	Completion of Step 2	Evaluation	AI Cloud Service Provider	Compare the result of Step 2 with that of the results after surgery.	

Input of evaluation	
Output of evaluation	

A.24.6 Execution (optional)

Scenario name	Execution				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	New patient comes in	Pre-processing	Hospital	Pre-process input data from patient	
2	Completion of step 1	Prediction	AI Cloud Service Provider	Hospital uses the model hosted on the cloud to predict post-surgery results for the patient based on input from step 1	
3	Completion of step 2	Consultation and surgery recommendation	Hospital	Based on results for various types of LASIK surgeries from step 2, suggest the best suitable surgery to patient.	

Input of Execution	
Output of Execution	

A.24.7 Retraining (optional)

Scenario name	Retraining				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement

1	Certain period of time has passed since the last training/retraining	Pre-processing	AI Cloud Service Provider	Outlier detection, feature selection, missing value imputation	API/software to perform pre-processsing
2	Completion of step 1	Training sample creation	AI Cloud Service Provider	Create training samples by clearly recognizing relevant features and training label for data from step 1	
3	Completion of step 2	Model training	AI Cloud Service Provider	Train a gradient boosted trees based regression model using training samples from step 2.	

Specification of retraining data	

A.24.8 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Research Paper	LASIK surgery prediction	Published	High	Microsoft, LVPEI	https://link.springer.com/chapter/10.1007/978-3-319-31753-3_39
2	Keynote video snip	LASIK surgery prediction	Available Online	High	Microsoft	https://www.youtube.com/watch?v=mmDz7cwC7CE&t=128s
3	Related Paper	Visual Acuity Prediction	Published	Medium	Visx Inc, Sunnyvale, Calif.	https://www.ncbi.nlm.nih.gov/pubmed/1450116
4		Visual Acuity Predict	Published	Medium	Department of Ophthalmology, University of	https://www.ncbi.nlm.nih.gov/pubmed/8965225

	Relate d Paper	ion for Childre n			Minnesota, Minneapolis, USA.	

A.25 Use of robotic solution for traffic policing and control

[SOURCE: SC42/WG4 N050 uc_25]

A.25.1 General

ID	25			
Use case name	Use of robotic solution for traffic policing and control			
Application domain	Security			
Deployment model	On-premise systems			
Status	PoC			
Scope	Robotics based traffic policing system			
Objective(s)	Efficient traffic control through use of Humanoid robots for traffic control.			
Narrative	Short description (not more than 150 words)	Creation of a humanoid robot which can be deployed for traffic monitoring and control on roads. The solution will use computer vision and will be enabled with IOT for centralized control and data collection. This will relieve the human police from working in polluted environment.		
	Complete description	Traffic police needs to stand for long hours in polluted environment which creates stress, other health related issues and may reduce his performance. A humanoid robot equipped with computer vision and IOT can be effectively deployed for effective traffic control. A robotic system can work continuously without any fatigue. This system will be centrally controlled and real time data collected can be used to bring efficiency in traffic control.		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Accuracy of Instructions	The instructions provided by the robot for controlling traffic on various roads.	The controlling instructions should be accurate as per specific traffic conditions.

	2	Response Time	The response required to react to changing traffic condition.	Response time should be minimal (real time) for effective traffic control.
	3	Data collection & control	The robotic system should accurately collect various traffic conditions such as number of vehicles, speed etc. for effective control	The traffic data collected should be accurate for generation of effective control instructions.
AI features	Task(s)	Recommendation		
	Method(s)	Machine Learning, Statistics, Heuristics, Anomaly Detection (Distance / Density based). Artificial Intelligence, Machine Learning, Statistics, Heuristics,Anomaly Detection, Pattern recognition, Computer Vision		
	Hardware	IoT enabled and AI powered Humanoid robots.		
	Topology			
	Terms and concepts used	Automation, Machine Learning, Computer Vision		
Standardization opportunities/ requirements				
Challenges and issues	The problem is challenging because accurate control instructions is crucial for proper traffic control.			
Societal Concerns	Description	Addresses the pressing concern of effective traffic control.		
	SDGs to be achieved	Sustainable cities and communities		

A.25.2 References

[1] J. Zhang, T. Gao, Z. G. Liu, Traffic Video Based Cross Road Violation Detection, In Proc, 2009, International Conference on Measuring Technology and Mechatronics Automation (ICMTMA), Vol.3, pages 645-648, April 2009.

[2] D. W. Lim, S. H. Choi, J. S. Jun, Automated detection of all kinds of violations at a street intersection using real time individual vehicle tracking, Image Analysis and Interpretation, 2002. Proceedings. 5th IEEE Southwest Symposium, pages 126-129, 2002.

[3] Y. Chen, C. Yang, Vehicle red-light violation detection base on region, Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference, Vol. 9, pages 700-703, July 2010.

[4] P. KaewTraKulPong and R. Bowden, An improved adaptive background mixture model for real time tracking with shadow detection, In Proc. 2nd European Workshop on Advanced Video Based Surveillance Systems, AVBS01, Sept 2001.

A.26 Robotic Solution for Replacing Human Labour in Hazardous Condition

[SOURCE: SC42/WG4 N050 uc_26]

A.26.1 General

ID	26			
Use case name	Robotic solution for replacing human labour in Hazardous condition			
Application domain	Security			
Deployment model	On-premise systems			
Status	PoC			
Scope	Building an AI based robotics solution for replacing Human Labour in Hazardous condition			
Objective(s)	Building an AI based robotics solution for replacing Human Labour in Hazardous condition			
Narrative	Short description (not more than 150 words)	Building an AI based robotic solution enabled with computer vision and equipped with various sensors such as temperature, pressure, smoke detector etc which can effectively replace human labour in risky work environment.		
	Complete description	Human labour in Hazardous work environment causes many accidents and loss of life, recent example being NTPC incident that occurred in November 2017 in Unchahar power plant. Working under hazardous conditions also create other serious health related problems including cancer, Asthama etc An AI based robotic system in line with Industry 4.0 fusing technology based automation in manufacturing can replace human labour in hazardous condition and can work efficiently. This also has the potential to reduce incidents caused by human mistakes.		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Response Time	Response time required to react to work environment	Response time should be minimal (real time), so that the robotic system can intelligently react in changing

				work environment.
	2	Minimum Overshoot	The movement of robotic physical system beyond the intended position should be minimum, ideally zero.	This will enable the robotic system to work accurately in the work environment.
	3	Reliability	The robotic system should be extremely reliable to avoid any catastrophic failure in the industry. The system should continuously monitor the fitness of its software and hardware component and must have adequate redundancy. It should be able to generate alarm before failure.	Industrial grade robotic solution should be extremely reliable.
AI features	Task(s)	Automation		
	Method(s)	Artificial Intelligence, Machine Learning, Statistics, Anomaly Detection, Computer Vision		
	Hardware	Robotic Hands, Centralized monitoring and control,		
	Topology			
	Terms and concepts used	Automation, Computer Vision, Reinforced Learning		
Standardization opportunities/ requirements				
Challenges and issues	The problem is challenging because 1. **Solution should be customizable for different work environments**			
Societal Concerns	Description	Addresses the issue of accidents in Hazardous work environment.		
	SDGs to be achieved	Decent work and economic growth		

A.26.2 References

[1]J. Zhang, T. Gao, Z. G. Liu, Traffic Video Based Cross Road Violation Detection, In Proc, 2009, International Conference on Measuring Technology and Mechatronics Automation (ICMTMA), Vol.3, pages 645-648, April 2009.

[2] D. W. Lim, S. H. Choi, J. S. Jun, Automated detection of all kinds of violations at a street intersection using real time individual vehicle tracking, Image Analysis and Interpretation, 2002. Proceedings. 5th IEEE Southwest Symposium, pages 126-129, 2002.

[3] Y. Chen, C. Yang, Vehicle red-light violation detection base on region, Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference, Vol. 9, pages 700-703, July 2010.

[4] P. KaewTraKulPong and R. Bowden, An improved adaptive background mixture model for real time tracking with shadow detection, In Proc. 2nd European Workshop on Advanced Video Based Surveillance Systems, AVBS01, Sept 2001.

A.27 Credit Scoring using KYC Data

[SOURCE: SC42/WG4 N050 uc_27]

A.27.1 General

ID	27	
Use case name	Credit scoring using KYC data	
Application domain	Banking and Financial Services	
Deployment model	On-premise systems	
Status	PoC	
Scope	Building a risk scorecard for loan applicants using KYC data for better risk management and high population coverage	
Objective(s)	Assigning a risk score to every loan applicant in real time, using just KYC data, which will ensure both new-to-credit and mature customers can be assessed for their creditworthiness, and offered loans on appropriate terms	
Narrative	Short description (not more than 150 words)	It can be often difficult to build a risk scorecard using only KYC data, which often has noisiness and incompleteness issues. However if realized, it can be used to provide a objective score to all loan applicants, even the new-to-credit ones. Non-linear classification algorithms are suitable for this purpose. Several variables are collected from the customer during the KYC process such as Age of customer, Self-reported income, Type of Occupation, Purpose of loan, etc. All these features can be added to a non-linear risk model and their complex interactions allowed to take place.
	Complete description	Financial institutions find it much easier to assess customers with an existing credit history, or those living in urban areas. There are also several credit bureaus who assist them in this endeavor. However, these frameworks don't work as well for new-to-credit customers, especially in rural areas. If only industry wide models or simple heuristics are used to score such customers, many deserving loan applicants will end up not getting a loan or not getting it at deserving terms. Instead, if a good risk scorecard is built using KYC data,

		which is collected from every loan applicant as a routine and regulated process, it will ensure every applicant receives an objective score. To tackle this problem, non-linear models such as Random Forest and XGBoost are being used which can accommodate many parameters, including categorical ones, and are reasonably resistant to noise in the data.		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Delinquency Rate	Percentage of loan defaulters in first X months from loan disbursal vs score bins	Large monotonous decrease in delinquency rate as creditworthiness score increases is desirable, and indicates a good scorecard
	2	Approval rate	Ratio of loan disbursals to loan applicants	Larger approval rate at a predetermined risk level is desirable and indicates a good scorecard
AI features	Task(s)	Credit Scoring		
	Method(s)	Random Forest, XGBoost and Ensemble models		
	Hardware	64 GB RAM, Intel Core i5		
	Topology			
	Terms and concepts used	Classification, Bagging, Boosting, Ensembles		
Standardization opportunities/ requirements				
Challenges and issues	1. KYC data obtained from extreme rural areas can be noisy, may have several missing values, and needs appropriate preprocessing and treatment before feeding to the model algorithm 2. Non-linear models like Random Forest and XGBoost need significant computational power during the training phase			
Societal	Description	We don't see any societal concerns if it is used		

Concerns	SDGs to be achieved	

A.27.2 Data (optional)

Data characteristics	
Description	Historical KYC data available in internal systems
Source	EDW (Enterprise Data Warehouses)
Type	Structured Data
Volume (size)	10 GB
Velocity	One-time data dump during training phase, real time in production phase
Variety	Mostly Structured
Variability (rate of change)	Moderate
Quality	Moderate

A.27.3 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Paper	[Breiman 01] Leo Breiman. “Random Forests”. Machine Learning, Volume 45, Issue 1, Pages 5-32. 2001.	Published	High	University of California, Berkeley	https://dl.acm.org/ citation.cfm?id=570182
2	Paper	[Chen 16]. Tianqi Chen. “XGBoost: A Scalable Tree Boosting System”. Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining Pages 785- 794. 2016.	Published	High	University OF Washington, Seattle	https://dl.acm.org/citation.cfm?id=2939785
3	Paper	[Opitz 99]. David Opitz. “Popular ensemble methods: an empirical study”. Journal of Artificial Intelligence Research. Volume 11 Issue 1, Pages 169-198.1999.	Published	High	University Of Montana, Missoula, MT	https://dl.acm.org/citation.cfm?id=3013549

A.28 Recommendation Algorithm for Improving Member Experience and Discoverability of Resorts in the Booking Portal of a Hotel Chain

[SOURCE: SC42/WG4 N050 uc_28]

A.28.1 General

ID	28	
Use case name	Recommendation algorithm for improving member experience and discoverability of resorts in the booking portal of a hotel chain	
Application domain	Leisure and Hospitality	
Deployment model	Cloud services	
Status	In operation	
Scope	Building a personalized recommendation algorithm to help members of the hotel chain to find their desirable hotel for the family holiday	
Objective(s)	Offering personalized recommendations by understanding the member preferences from past holiday patterns and searches in the booking portal. Various member and hotel features were also considered for the model	
Narrative	Short description (not more than 150 words)	Refining existing system and implement a new model that can give personalized recommendations to members and improve bookings at the undiscoverable or not-so-popular hotels. The algorithm would help in reshaping the demand and increase the visibility of the hotels which are at the lower spectrum of demand. We would include member and resort features along with interaction data like members visiting a hotel, and giving a rating to a resort visit etc
	Complete description	The traditional search engine in member portal for booking a hotel is mainly based on the members limited visibility and knowledge of popular holiday destinations. In contrast, a hotel chain might offer a variety of options to members. Each option brings a different holiday experience and possibly include a lot of activities for family members to choose from. In the absence of an intelligent algorithm, many good hotels will be invisible in the large number of hotel lists. This will in turn also increase the burden on some popular hotels which might get disproportionally high bookings, and sometimes run in overcapacity and depriving other hotels of their share of bookings. To solve for this problem, the hybrid recommendation algorithm will help shape the demand and bring up the hotels which are similar to the ones a member has already visited but yet provide a different experience, thus encouraging the member to consider an alternative to their usual preferences.
Stakeholders		

Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Occupancy %	Percentage of room nights occupied in a hotel	Occupancy in low demand hotels will improve
	2	First time Refusal Rate	Bookings denied because of overdemand in a particular resort	First time refusals will go down
AI features	Task(s)	Recommendation		
	Method(s)	Matrix Factorization and Hybrid Approach		
	Hardware	16 GB RAM, Intel Core i5		
	Topology			
	Terms and concepts used	Matrix Factorization, LightFM, Item and User Features, Latent Features		
Standardization opportunities/ requirements				
Challenges and issues	1. Cold Start Problem: Since the member has only visited certain hotels in the past, the interaction matrix is very sparse 2. The matrix computation at times is computational resource intensive causing system failures			
Societal Concerns	Description	We don't see any societal concerns if it is used		
	SDGs to be achieved			

A.28.2 Data (optional)

Data characteristics	
Description	Member Visit Data from booking portals
Source	EDW (Enterprise Data Warehouses)
Type	Structured Data
Volume (size)	1 GB
Velocity	Weekly
Variety	Mostly Structured
Variability (rate of change)	Moderate
Quality	Moderate

A.28.3 References

References

No.	Type	Reference	Status	Impact on use case	Originator/ organization	Link
1	Paper	[Kula 15] "Metadata embeddings for user and item cold-start recommendations". In Proceedings of the 2nd Workshop on New Trends on Content-Based Recommender Systems co- located with 9th ACM Conference on Recommender Systems (RecSys 2015), Vienna, Austria, September 16--20, 2015., pages 14--21, 2015.	Published	High	ACM	https://arxiv.org/abs/1507.08439
2	Paper	[Adomavicius et. al 05]. "Toward the next generation of recommender systems: A survey of the state-of-the- art and possible extensions". Knowledge and Data Engineering, IEEE Transactions on. 17. 734-749.10.1109/TKDE.2005.99.	Published	Medium	IEEE	https://dl.acm.org/citation.cfm?id=2959160
3	Paper	Yehuda et. al 09], "Matrix Factorization Techniques for Recommender Systems", Computer, v.42 n.8, p.30- 37, August 2009 [doi>10.1109/MC.2009.263]	Published	Medium	IEEE	https://dl.acm.org/citation.cfm?id=1608614

A.29 Enhancing traffic management efficiency and infraction detection accuracy with AI technologies

[SOURCE: SC42/WG4 N050 uc_29]

A.29.1 General

ID	29
Use case name	Enhancing traffic management efficiency and infraction detection accuracy with AI technologies
Application domain	Transportation
Deployment	Hybrid or other (please specify) Cloud services and on-premise systems

model		
Status	In operation	
Scope	Utilizing AI technologies in traffic monitoring and management	
Objective(s)	To increase the accuracy and efficiency of infraction detection, traffic monitoring and flow analysis, while minimizing the human effort and the overall solution cost.	
Narrative	Short description (not more than 150 words)	Big data enabled AI technologies are applied to monitoring and managing the traffic in a large municipality in China. Multi-sourced data (traffic flow, vehicle data, pedestrian movement, etc.) is monitored, from which illegal operation of vehicles, unexpected incidents, surge of traffic etc. are detected and analysed with machine learning (ML) methods. ML tasks (including training and deployment) are carried out on a platform supporting the integration of various ML frameworks, models and algorithms. The platform is based on heterogeneous computing resources. The efficiency and accuracy of infraction detection, and the effectiveness of traffic management are significantly improved, with much reduced human effort and overall solution cost.
	Complete description	With the population and the number of vehicles growing in large cities, managing the heavy traffic in urban areas has become a challenging yet essential task for the municipality. Addressing this issue has become particularly urgent for big cities in China, where millions of people live and commute every day. In this use case, big data based AI technologies are applied to monitoring and managing the heavy traffic in a metropolitan in south China. Previously, significant human resources were involved in the vehicle and road monitoring, and large investment was made to the computing infrastructure specific to certain functionalities. To increase the efficiency of urban transportation, reduce the traffic jam and air pollution, as well as minimize the human effort, machine learning techniques (e.g. deep learning) are applied to image and video analysis, such as traffic flow analysis, infraction detection and incident detection. Example applications include but not limited to 1) detection of traffic rule violation, e.g. over-speeding, wrong driving lanes or parking. AI-enabled detection produces much faster and more accurate result, and helps in enforcing the traffic regulation. 2) traffic light optimization. Based on the modelling and analysis of multi-sourced traffic information (both real-time and historical data), traffic lights are dynamically configured to divert the flow, increase the passing speed of cars and reduce the traffic jam in major junctions. The use of AI has obtained remarkable results: The infraction detection efficiency gets 10X increase, and the detection accuracy is greater than 95%. The urban area traffic jam is much alleviated, with vehicles' passing speed through major junctions increases by 9%-25%.

Stakeholders	Urban citizens (drivers and pedestrians), government, car companies, traffic administrative bureaus, logistics companies, etc.			
Stakeholders' assets, values	Transportation efficiency, controlability and predictability of commute time, pedestrian and vehicle safety, air quality, etc.			
System's threats & vulnerabilities	Low quality pictures, insufficient processing capability			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	accuracy	The accuracy of infraction and incident detection from traffic pictures/videos	To increase the accuracy of traffic monitoring and inspection
	2	split	Proportion of images requiring human inspection. The less the split, the higher the efficiency.	To minimize the human effort in inspection
	3	resource utilization ratio	Achievable resource utilization ratio in the hardware infrastructure (the higher the utilization ratio, the lower amount the required resource)	To reduce the infrastructure investment and overall solution cost
AI features	Task(s)	Recognition		
	Method(s)	Machine learning, Deep learning		
	Hardware	Heterogeneous computing platform (CPU plus heterogeneous accelerators such as GPU, FPGA etc.)		
	Topology			
	Terms and concepts used	Heterogeneous resource pooling, on-demand resource scheduling		
Standardization opportunities/ requirements	• Requirement of computing infrastructure to empower AI applications in the transportation domain, e.g. the integration of acceleration units (GPU, FPGA, etc.), dynamic scheduling and on-demand allocation of heterogeneous resources • Support of mainstream ML frameworks, and the algorithms and models from different vendors, to prevent vendor lock-in			
Challenges and issues	• Constant improvement in hardware architecture to increase the performance and efficiency of running ML/DL tasks • Consistent interfaces between applications, ML engines and heterogeneous resource pools Support of new models and emerging algorithms for growing functionalities			
Societal Concerns	Description	AI's application in urban transportation significantly improves the quality of life for urban citizens, reduces the		

		time wasted in heavy traffic and the air pollution from vehicles.
	SDGs to be achieved	Sustainable cities and communities

A.29.2 Data (optional)

Data characteristics	
Description	Traffic data (vehicle, road, and pedestrian data)
Source	Traffic camera
Type	Image, video
Volume (size)	~100TB/day
Velocity	Stream and batch
Variety	Traffic flows, vehicle information, pedestrian information, etc.
Variability (rate of change)	Subject to random surge (rush hour, accident, etc.)
Quality	Vary (depending on the weather condition, environment etc.)

A.29.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Training	Train a model (e.g. neural network) with training samples	Sample raw dataset is ready		
2	Evaluation	Evaluate whether the model is properly trained for the detection	Completion of training/re training		Meeting KPI requirements (e.g. accuracy, split) of the particular case
3	Execution	Deploy the model for infraction detection and traffic analysis	Traffic image/vide o data is applied.	The model has been evaluated as properly trained.	
4	Retraining	Retrain a model with training samples	Changes in dataset pattern is expected, or new requiremen t on detection.		

A.29.4 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Journal		Published online		Huawei Technologies Co.,Ltd.	https://www.huaweicloud.com/journal/detail_09.html

A.30 Autonomous Network and Automation Level Definition

[SOURCE: SC42/WG4 N050 uc_30]

A.30.1 General

ID	30	
Use case name	Autonomous network and automation level definition	
Application domain	ICT	
Deployment model	Cyber-physical systems	
Status	PoC	
Scope	Communications network	
Objective(s)	To define autonomous network concept and automation level for the common understanding and consensus	
Narrative	Short description (not more than 150 words)	With the goal of providing common understanding and consensus for autonomous self-driving network, this use case delivers a harmonized classification system and supporting definitions that: • Define the concept of autonomous network • Identify six levels of network automation from “no automation” to “full automation”. • Base definitions and levels on functional aspects of technology. • Describe categorical distinctions for a step-wise progression through the levels. • Educate a wider community by clarifying for each level what role (if any) operators have in performing the dynamic network operations task while a network automation system is engaged.
	Complete description	The telecom CSPs have a dual challenge – to increase agility while reducing network operating cost. 1) The exponential growth of network complexity e.g. 5G will make the traditional network O&M model unsustainable; 2) Digital transformation accelerates service innovation but requires automation capabilities. As CSPs start to evaluate their digital transformation strategies, automation is a central concern. Some operators

are already introducing automation to some of their network processes, most commonly O&M, planning and optimization. According to Analysys Mason, in 2018, 56% of CSPs globally have little or no automation in their networks. But by 2025, according to their own predictions, almost 80% expect to have automated 40% or more of their network operations, and one-third will have automated over 80%. The introduction of AI/ML (artificial intelligence/machine learning) will be an important part of that process for many CSPs, helping to make the network more intelligent, agile and predictive.

The autonomous self-driving network has two essential elements in common with the autonomous self-driving car:

- There are different levels of automation, relating to different timescales and scenarios
- Intensive use of artificial intelligence (AI) is essential

With the goal of providing common understanding and consensus for autonomous self driving network, this use case delivers a harmonized classification system and supporting definitions that set out six levels of automation for the network.

Level	Name	Definition	Execution (Hands)	Awareness (Eyes)	Decision (Minds)	Experienc (Hearts)
0	**Manual Operation & Maintenance**	Even with auxiliary tools, O&M personnel perform all dynamic tasks.	P	P	P	P
1	**Assisted Operation & Maintenance**	Under the applicable design scope, the system can execute a sub-task repeatedly based on rules.	P/S	P	P	P
2	**Partial Autonomous**	Under the applicable design scope, the	S	P	P	P

	Network	system continuously completes the control task of a unit based on the model.						
3	**Conditional Autonomous Network**	Under the applicable design scope, the system can implement complete closed-loop automation of single-domain scenarios. Users can respond to the requests in a timely manner when the system fails.	S	**S**	P	P		**Domain level**
4	**Highly Autonomous Network**	Under the applicable design scope, the system can automatically analyze and execute cross-domain and service close-loop automation.	S	S	**P**	P		**Service level**
5	**Full Autonomous Network**	The system can perform complete dynamic tasks and exception handling in all network environments. O&M personnel do not need	S	S	S	**P/S**		**All Modes**

		to intervene. P=Personnel (Manual), S=System (Automated) **-Level 0 - manual O&M:** The system delivers assisted monitoring capabilities, which means all dynamic tasks have to be executed manually. **-Level 1 - assisted O&M:** The system executes a certain sub-task based on existing rules to increase execution efficiency. **-Level 2 - partial autonomous network:** The system enables closed-loop O&M for certain units under certain external environments, lowering the bar for personnel experience and skills. **-Level 3 - conditional autonomous network:** Building on L2 capabilities, the system can sense real-time environmental changes, and in certain domains, optimize and adjust itself to the external environment to enable intent-based closed-loop management. **-Level 4 - highly autonomous network:** Building on L3 capabilities, the system enables, in a more complicated cross-domain environment, predictive or active closed-loop management of service and customer experience-driven networks. This allows operators to resolve network faults prior to customer complaints, reduce service outages and customer complaints, and ultimately, improve customer satisfaction. **-Level 5 - full autonomous network:** This level is the ultimate goal for telecom network evolution. The system possesses closed-loop automation capabilities across multiple services, multiple domains, and the entire lifecycle, achieving autonomous driving networks. The lower levels can be applied now and deliver immediate cost and agility benefits in certain scenarios. An operator can then evolve to the higher levels, gaining additional benefits and addressing a wider range of scenarios. Network automation is a long run objective with step-to-step process, from providing an alternative to repetitive execution actions, to performing perception and monitoring of network environment and network device status, making decisions based on multiple factors and policies, and providing effective perception of end user experience. The system capability also starts from some service scenarios and covers all service scenarios.

Stakeholders	Communications Service Providers, Suppliers, Industrial and consumer users			
Stakeholders' assets, values	Efficiency; productivity; competitiveness; safety; privacy; availability; experience			
System's threats & vulnerabilities	incorrect AI system use			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Automation level	See the definition in the table	
	2	Accuracy	Predictive & prescriptive decision making&reasoning	
	3	Real-time	The relative response time meets the requirements of operations	
AI features	Task(s)	Other (please specify): All		
	Method(s)	Machine learning, deep learning, Knowledge graph, decision making&reasoning, analytics		
	Hardware	AI training and inference system, and network management system		
	Topology	End-to-end		
	Terms and concepts used	Autonomous network, self-driving network		
Standardization opportunities/ requirements	To standardize autonomous network and automation level			
Challenges and issues	Data usage and sharing, human expertise & competence			
Societal Concerns	Description	None		
	SDGs to be achieved	Industry, Innovation, and Infrastructure		

A.31 Autonomous network scenarios

[SOURCE: SC42/WG4 N050 uc_31]

A.31.1 General

ID	31
Use case name	Autonomous network scenarios

Application domain	ICT	
Deployment model	Cyber-physical systems	
Status	PoC	
Scope	Communications network	
Objective(s)	Clarification and showcases of autonomous network usage	
Narrative	Short description (not more than 150 words)	Multiple scenarios of autonomous network enabled by AI is addressed for improving operational efficiency, customer experience and service innovation, including wireless network performance improvement, optical network failure prediction, data center energy saving etc.
	Complete description	The leading reason to adopt AI-assisted network automation is to reduce the cost – almost 80% operators placed this in their top three drivers, followed by: ● improvement to customers' network quality of experience ● efficient planning and management of dense networks ● part of an end-to-end automation strategy spanning the network and IT operations While OPEX reduction is the most important cost-related driver, others include better alignment of network costs to the revenue that is generated; and the ability to defer some capital expenditure (CAPEX) by using existing assets more efficiently. Obviously, the autonomous self-driving network needs to move from an O&M approach that is focused on network elements, to one based on usage scenarios. This means that process changes relate directly to a particular result, defined by the operator, and with a business value. Progress will be accelerated if a core set of scenarios is defined, which will be of value to all operators. Development of the related autonomous self driving network solutions can then be prioritized accordingly. The criteria for the selection of scenarios as follows: ● Extent of digitalization: Reflects the technical readiness of the scenarios. Digitalization is the foundation of automation, and the extent to which it is supported determines the extent to which automation can be achieved immediately; ● TCO contribution: Reflects OPEX savings and the improvement to CAPEX efficiency in the given scenario; ● O&M life cycle: Reflects the ability to build differentiation in each phase of the life cycle in order to achieve full autonomous driving across many scenarios. The O&M life cycle spans planning, deployment, maintenance, optimization and provisioning of the network and scenarios have been identified for each one.

Based on those three criteria, we selected six typical key scenarios for the purpose of illustration and clarification.

Scenario 1: Base Station Deployment

1) Definition and Description of Scenario
The base station deployment scenario refers to the entire process after site survey, including network planning and design, site design, configuration data preparation, site installation, site commissioning and site acceptance.

2) Automation Classification
Level 1: The O&M tool helps some elements of the process to be automated, but configuration and site acceptance have to be done manually.

Level 2: Some hardware can be detected and configured automatically, and configuration data is simplified based on rules.

Level 3: E2E automation: radio parameter self-planning, hardware self-detection and self-configuration, self-acceptance without dialing test.

Initial outcomes: Upon the usage of AI, some initial results are achieved as follows:

-Site Deployment Time Shortened by 30%

-Feature Deployment Time Shortened by 60%

-Performance Converging Shortened by 85%

Scenario 2: Network Performance Monitoring

1) Definition and Description of Scenario
The mobile network has entered the stage of very precise planning sites and resources: on the one hand, to identify and forecast high traffic areas, and allocate resources precisely to support business goals; on the other hand, to identify and forecast high-frequency temporary traffic, scheduling resources to meet business objectives.

2) Automation Classification
Level 1: Network quality is consistent, and network anomalies can be discovered by tools;

Level 2: 3D presentation of network quality and anomalies, and network planning is self-generated;

Level 3: E2E closed-loop monitoring and planning: predicting network development according to historical network information, finding value areas and hidden

		problems, recommending the best network planning and estimating the gain automatically. **Scenario 3: Fault Analysis and Handling** 1) Definition and Description of Scenario The security and reliability is the most important mission of the network, so quick alarm detection and quick fault healing are important. The fault analysis and handling scenario comprises several steps, including alarm monitoring, root cause analysis, and fault remediation. Monitoring: Real-time monitoring of network alarm, performance, configuration, user experience, and other information. Analysis: By analyzing the correlation between alarms and other dimensions data, root cause of fault and fault repairing can be achieved quickly. Healing: Repair fault remotely or by site visiting based on the repairing suggestions. 2) Automation Classification Level 1: Some tools are used to simplify alarm processing, but thresholds and alarm correlation rules are set manually based on expert experience. Level 2: Automatic alarm correlation and root cause analysis. Level 3: Closed-loop of alarms analysis and handling process: Based on the intelligent correlation analysis of multi-dimensional data, accurate location of alarm root cause, precise fault ticket dispatching, and fault self-healing could be reached successfully. Level 4: Proactive troubleshooting: Based on the trend analysis of alarms, performance, and network data, alarms and faults could be predicted and rectified in advance. Initial outcomes: Upon the usage of AI, some initial results are achieved as follows: -Reduction of alarms: 90% **Scenario 4: Network Performance Improvement** 1) Definition and Description of Scenario Wireless networks are geographically very distributed, and activity varies significantly in different places and at different times of day. This makes the network very dynamic and complex. That complexity is further increased by the

		diversity of services and of terminal performance, and by the mobility of users. If the network cannot achieve the benchmark KPIs or SLAs (service level agreements), or enable good user experience, it must be adjusted to meet or exceed those requirements. This is the function of network performance improvementor optimization. The complete process of network performance improvement or optimization includes several stages: ● network monitoring and evaluation ● root cause analysis of performance problems ● optimization analysis and optimization decision-making ● optimization implementation ● post- evaluation and verification 2) Automation Classification Level 2: Drive test evaluation is not required for coverage optimization. Adjustment suggestions are provided automatically. Level 3: Closed-loop of network performance improvement: Automatic identification of network coverage and quality problems, automatic configuration of performance parameters, and automatic evaluation. Level 4: Dynamic adjustment is implemented based on the scenario awareness and prediction to achieve the optimal network performance. Network prediction capability is available: scenario change trends could be perceived, and network configuration could adjusted real-time to achieve optimal performance. Initial outcomes: Upon the usage of AI, some initial results are achieved as follows: -Capacity increase: 30%, -Delivery duration: 2 weeks, non-manual **Scenario 5: Site Power Saving** 1) Definition and Description of Scenario T Site power consumption cost accounts for more than 20% of network OPEX. Although network traffic declines greatly during idle hours, equipment continues to operate, and power consumption does not dynamically adjust to the traffic level, resulting in waste. It is necessary to build the "Zero Bit, Zero Watt" capability. 2) Automation Classification Level 2: Tool aided execution;

		Level 3: Power-saving closed-loop: Based on the analysis of traffic trends, self-adaptive generation of power-saving strategies, effect and closed-loop KPI feedback; Level 4: Real-time adjustment of power-saving strategies based on traffic prediction. Through integration with third-party space-time platforms, the operator can also add predictive perception of traffic changes, smooth out the user experience, and maximize power-saving. Initial outcomes: Upon the usage of AI, some initial results are achieved as follows: -Power saving: 10~15% **Scenario 6: Wireless Broadband Service Provisioning** 1) Definition and Description of Scenario WTTx has become a foundational service for mobile operators because of its convenient installation and low cost of single bit. Rapid launch of WTTx service, accurate evaluation after launch, and network development planning have become important supports for new business development. 2) Automation Classification Level 1: Blind launch; Level 2: Automation tools to assist the launch, check the coverage and capacity of the user's location before the business hall, and experience evaluation; Level 3: Closed-loop for business launch: Integrated with BOSS system to achieve one-step precise launch, remote account launching, CPE installation, fault self-diagnosis and complaint analysis; Level 4: Auto-balancing of multi-service, automatic value areas identification and network planning recommendation.		
Stakeholders	Communications Service Providers, Suppliers, Industrial and consumer users			
Stakeholders' assets, values	Efficiency; productivity; competitiveness; safety; privacy; availability; experience			
System's threats & vulnerabilities	incorrect AI system use			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
AI features	Task(s)	Other (please specify) All		
	Method(s)	Machine learning, deep learning, Knowledge graph, decision making&reasoning, analytics		
	Hardware	AI training and inference system, and network management system		

	Topology	End-to-end
	Terms and concepts used	Autonomous network, self-driving network
Standardization opportunities/ requirements		
Challenges and issues		
Societal Concerns	Description	
	SDGs to be achieved	

A.32 AI Solution to Help Mobile Phone to have Better Picture Effect

[SOURCE: SC42/WG4 N050 uc_32]

A.32.1 General

ID	32	
Use case name	AI solution to help mobile phone to have better picture effect	
Application domain	Mobility	
Deployment model	Hybrid or other (please specify)	
Status	In operation	
Scope	Better understanding the image and improving image effect on smartphone by using DL model which is trained in the cloud or offline.	
Objective(s)	To find an efficient solution to Increase camera image quality on smartphone without Increasing too much operation and power burden for mobile phone.	
Narrative	Short description (not more than 150 words)	An AI solution was developed that could increase smartphone camera image quality. Using deep learning, smartphone can Identify more scenarios and objects than before. Based on the identified scenarios and objects, smartphone can better understand the image and improve image effect.
	Complete description	At present, there are 1.4 billion smart phone shipments in the world every year. Photography is one of the most important functions of smart phones. The industry has been trying to improve the picture quality of mobile phone photography. It hopes to reach even the quality of the professional SLR camera. The traditional image processing algorithm is currently facing the ceiling, many scenes traditional algorithms can not be used, just because the effect is very poor. Deep learning algorithm provides a turning point for solving the above problems. By using the AI solution, smartphones can better "understand" the pictures they take. Based on the deep learning algorithm, the smart phone can analyze the shooting scene in real time and intelligently identify various scenes in the shooting process, such as blue sky, flowers,

<table>
<tr><td></td><td></td><td colspan="3">green plants, night view, snow scene, etc. And the smart phone can also intelligently detect the shooting objects in the scene. Base on scene recognition and object detection ,the smartphone can automatically adjust and set parameters for different pictures, so as to get better photo effects.

Now the mobile phone can recognize 100 kinds of scenes and can reach hundreds in the future. By using the depth learning algorithm, the mobile phone can now detect the 20 types of subjects, and the future can be detected by hundreds of subjects. Object detection can be used for SmartZoom (auto focus on targets), and portrait segmentation can be used for background blur or light efficiency.</td></tr>
<tr><td>Stakeholders</td><td colspan="4">mobile phone manufacturer、end users、third party testing and evaluation agency</td></tr>
<tr><td>Stakeholders' assets, values</td><td colspan="4">Competitiveness</td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4">new privacy threats (hidden patterns).</td></tr>
<tr><td rowspan="3">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>MIoU(Mean Intersection over Union)</td><td>The intersection of prediction area and actual area divided by the union of the predicted area and the actual area. Ideal target is 100%.</td><td>Improve accuracy</td></tr>
<tr><td>2</td><td>FAR(false acceptance rate)</td><td>Negative samples are identified as positive samples / Total number of negative samples.The low FAR, the more smartphone will get correct scenes and objects</td><td>Improve accuracy</td></tr>
<tr><td rowspan="5">AI features</td><td>Task(s)</td><td colspan="3">Recognition</td></tr>
<tr><td>Method(s)</td><td colspan="3">Deep learning</td></tr>
<tr><td>Hardware</td><td colspan="3">NPU、GPU、CPU etc.</td></tr>
<tr><td>Topology</td><td colspan="3">No Need</td></tr>
<tr><td>Terms and concepts used</td><td colspan="3">Deep learning, "Understand"</td></tr>
<tr><td>Standardization opportunities/ requirements</td><td colspan="4">The standardized content includes:
1) the format of training picture data;
2) the format of deep learning model generated offline or cloud, which will be transplanted to smart phones;</td></tr>
</table>

	3) the platform to support the transplanted model in the smart phone; 4) API which can be used by others applications, such as: picture classification, security.	
Challenges and issues	Challenges: Achieve the same level as professional SLR camera for pictures. Issues: 1) Lack of data for certain scene; 2) Lack of computing ability on terminal side ; 3) Users can feel the improvement of image quality, but may not know that it is brought by AI.	
Societal Concerns	Description	For the wrong object detection, it may lead to racial prejudice or privacy protection problems.
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.32.2 Data (optional)

Data characteristics	
Description	Annotated pictures
Source	Public picture library /Self collection picture library /Web crawling pictures /Automatic synthesis of pictures
Type	Picture format supported by a training platform and smart phone
Volume (size)	
Velocity	
Variety	Single source
Variability (rate of change)	
Quality	

A.33 Automated Defect Classification on Product Surfaces

[SOURCE: SC42/WG4 N050 uc_33]

A.33.1 General

ID	33	
Use case name	Automated defect classification on product surfaces	
Application domain	Manufacturing processes	
Deployment model	On premise system	
Status	PoC	
Scope	Image Analytics for water taps in sanitary industries.	
Objective(s)	Image analytics using a combination of feature extraction and classification of defects on shining surfaces in sanitary industries.	
Narrative	Short description (not more than 150 words)	A vision system that inspects and identifies the defects on water taps in sanitary industries. The system uses a combination of features for an automatic defect classification on product surfaces. All defects (15 types are identified) are classified into two major categories, real-

		defects and pseudo-defects. The pseudo-defects cause no quality problem; while the real-defects are critical as they might malfunction the final products. The AI system uses Support Vector Machine (SVM) classifier along with the combined features to identify the defect types. With the vision system in place, the quality control process is fully automated without any human intervention.		
	Complete description	The proposed vision system has two parts: the hardware part and the software part. The hardware captures the images of product surfaces under a constant illuminating condition. The software is developed to perform image processing tasks and identify defects on product surfaces. The steps of proposed system include image acquisition, preprocessing, segmentation, feature extraction, classification and post-processing. The system presents two software components: Feature Extraction and Classifier Design. These two modules are implemented independently which can be developed in offline platform and can be integrated into vision system and work online. As a first step, the feature extraction is critical and guides the extent to which a classifier can distinguish the defects from one class to another. A combination of features is used like geometry (shape, texture), and statistical features of the segmented images. In the second step, a support vector machine classification model is trained to identify the defect types. The classification results obtained by combining Gabor features, Statistical features, and grayscale features showed comparable performances with human evaluations. Overall, the vision system is modularized with capabilities to self-learn and future extensions.		
Stakeholders	Sanitary Industries			
Stakeholders' assets, values	Competitiveness; Quality Check;			
System's threats & vulnerabilities	Incorrect AI System use (AI system affecting quality control); New Security Threats.			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Classification Ratio	Real to Pseudo wrong classification	Establishes the quality of identification
AI features	Task(s)	Recognition		
	Method(s)	Classification; Feature Extraction		
	Hardware	IP Camera and Work Station		
	Topology			

	Terms and concepts used	Classification, Feature Extraction, Defect Identification
Standardization opportunities/ requirements	1) Quality acceptance criterion from AI systems: What is the acceptable standard for AI output related to quality? How that can be independently validated? 2) Standards for dealing with AI failures: How/Can standards facilitate dealing with AI failures, w.r.t., quality, productivity criteria?	
Challenges and issues	Real time implementation, accurately identify the nature of defects.	
Societal Concerns	Description	Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.33.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Publication	B. Kuhlenkötter, X. Zhang, C. Krewet, Quality Control in Automated Manufacturing Processes – Combined Features for Image Processing Acta Polytechnica Vol. 46 No. 5/2006.	Published	Use case taken from this reference	Czech Technical University	https://ojs.cvut.cz/ojs/index.php/ap/article/view/868

A.34 Robotic Task Automation: Insertion

[SOURCE: SC42/WG4 N050 uc_34]

A.34.1 General

ID	34	
Use case name	Robotic task automation: Insertion	
Application domain	Manufacturing	
Deployment model	Embedded systems – Cloud service	
Status	PoC	
Scope	Robotic assembly	
Objective(s)	1. Simple programing/instruction and flexibility in usage 2. Automation of tasks lacking analytic description 3. Reliability and efficiency	
Narrative	Short description (not more than 150 words)	Assembly process often includes steps where two parts need to be matched and connected to each other through force exertion. In an ideal case, perfectly formed parts can be matched and be assembled together with predefined amount of force. Due to imperfection of production steps, surface imperfection and other factors such as flexibility of parts, this procedure can become complex and unpredictable. In such cases, human operator can be instructed with simple terms and demonstrations and perform the task easily, while a robotic system will need very detailed and extensive program instructions to be able to perform the task including required adaptation to the physical world. The need for such a complex program instruction will make use of automation cumbersome or uneconomical. Control algorithm that are based on machine learning, especially those including reinforcement learning can become alternative solutions increasing and extending the level of automation in manufacturing.
	Complete description	The case described here is a common step in assembly processes in manufacturing industry and includes matching and properly connecting two parts when one needs to be inserted into another. Successful and efficient insertion usually needs action by feeling. It is difficult to describe in terms of mathematical algorithms and therefore is difficult to program. Complexities in programming, or high degree of operational failure make usage of robots, or automation unattractive. Use of machine learning and artificial intelligence is one of promising methods to overcome such difficulties. As will be described below, there are several different phases in the process, where different methodologies can and should be used. To make the methodology usable in a practical case, it should be utilizable by operators without deep technical knowledge with an effort that can be accepted on a production line. Ultimately, such methods must remove the need for programing completely. The assumption here is that the parts to be assembled are properly localized, such that they can be manipulated by a

robot in the desired way. The problem concerns the following steps:

1. Identification and picking the first part (A).
2. Moving A to the vicinity of the second part (B).
3. Alignment of the two parts.
4. Exertion of force with simultaneous movement for smooth insertion.
5. Termination of the task when complete insertion is complete.

The above task, with all possible challenges, can easily be performed by a human operator. An operator in majority of cases needs very limited amount of information. Using prior knowledge and experiences and the sensory system the task can be completed and all possible exceptions can be handled. With time, a human operator becomes constantly more efficient and performs the task faster and more reliably.

The topics to be handled in this use case are how a machine can be instructed, trained, perform and improve to a high level of reliability and efficiency. The process can be divided into following steps:

1. Localization of parts: Image processing, object identification, classification and localization.
2. Alignment of parts: Control and optimization with (mainly) vision inputs.
3. Insertion through exertion of forces: Control and optimization with (at least) vision and force sensor feedback
4. Sensing the termination of the process: Pattern recognition in time series.
5. Continuous improvement: Reinforcement learning.

Vision and force sensors are most commonly used sensors in such processes. The objects and environment need to be observed at moderate as well as in very close distances. Force sensors are needed but have the weakness of not being active before a complete contact. Therefore, use of other sensors could be helpful.

The method is used for assembly tasks with the target of reducing the programming effort and increasing flexibility. For that to be achieved, the effort necessary to teach, train and use the system should be minimum and the reliability should come high at short time. This implicitly means that the system should become useful with limited amount of data and at limited amount of time. After an initial relatively stable state is reached, reinforcement can be used to improve the efficiency of the system.

The solution will become more attractive if transfer learning is utilized to further reduce the initial training time.

		For benchmarking purpose a specific set of objects to be assembled together should be defined and performance of the methods can be measured by necessary training time, need for computing power and memory as well as time for completion of the task. The objects in the tests can be geometrically relatively simple. Special features such as rough surfaces, tight fitting or flexibility of the objects can be considered for different classes of problems.		
Stakeholders	Discrete manufacturing industries; Operators			
Stakeholders' assets, values	Competitiveness; Productivity			
System's threats & vulnerabilities	Incorrect AI system use; New security threats			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Ease of use		Simplicity and efficiency during initial learning. Teaching process should be easy.
	2	Training efficiency		Amount of necessary data for training might lead to practical obstacles in application.
	3	Initial success rate		After initial training, the success rate needs to be acceptable such that the system can be put in the production line.
	4	Speed of improvement		Higher convergence speed of the reinforcement algorithm is making the solution more attractive.
	5	Operational efficiency		Cycle time is the primary measure in manufacturing industry.
	6	Success rate		Very high success rate is required for the solution to be accepted.
AI features	Task(s)	Recognition, classification, control, optimization		
	Method(s)	Deep learning, image processing, control, Optimization		

	Hardware	PC equipped with GPU accelerators
	Topology	NA
	Terms and concepts used	Reinforcement learning
Standardization opportunities/ requirements	• Standardization of definition of KPIs; • Standardization of fail-safe options w.r.t. safety and quality; • Standardization towards "Human-Co-working" • Minimum acceptable standards for commercialization; • Standard data set to independently validate the claims;	
Challenges and issues	• Complex and unpredictable assembly process due to imperfection of production steps, surface imperfection and other factors such as flexibility of parts. • Accuracy of sensing • Coworking with humans	
Societal Concerns	Description	Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.34.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Conference	Fan Dai, Arne Wahrburg, Björn Matthias, Hao Ding: Robot Assembly Skills Based on Compliant Motion Proceedings of 47th International Symposium on Robotics (ISR 2016), At Munich, Germany	Published	Cited to support the detailed description	ABB	https://www.researchgate.net/publication/310951674_Robot_Assembly_Skills_Based_on_Compliant_Motion
2	Conference	Te Tang, Hsien-Chun Lin, Masayoshi Tomizuka, A learning-based framework for robot peg-hole-insertion, Proceedings of the ASME 2015 Dynamic Systems and Control Conference, October 28-30, 2015, Columbus, Ohio, USA	Published	Cited to support the detailed description	University of California	https://www.researchgate.net/publication/314634124_A_Learning-Based_Framework_for_Robot_Peg-Hole-Insertion
3	Publication	Fares J. Abu-Dakka, Bojan Nemec, Aljaž Kramberger, Anders Glent Buch, Norbert Krüger and Aleš Ude, Solving peg-in-hole tasks by human	Published	Cited to support the detailed description	Jožef Stefan Institute , Dept. of Automatics, Biocybernetics,	https://www.researchgate.net/publication/273170116_So

		demonstration and exception strategies, Industrial Robot: An International Journal 41/6 (2014) 575–584			and Robotics, Slovania Maersk Mc-Kinney Moller Institute, University of Southern Denmark	lving_peg-in-hole_tasks_by_human_demonstration_and_exception_strategies
4	Publication	Mel Vecerik, Todd Hester, Jonathan Scholz, Fumin Wang, Olivier Pietquin, Bilal Piot, Nicolas Heess, Thomas Rothörl, Thomas Lampe, Martin Riedmiller, Leveraging Demonstrations for Deep Reinforcement, Learning on Robotics Problems with Sparse Rewards, arXiv:1707.08817v2 [cs.AI] 8 Oct 2018	Published	Cited to support the detailed description	Deepmind	https://arxiv.org/pdf/1707.08817.pdf
5	Publication	Mel Vecerik, Oleg Sushkov, David Barker, Thomas Roth¨orl, Todd Hester, Jon Scholz, A Practical Approach to Insertion with Variable Socket Position Using Deep Reinforcement Learning, arXiv:1810.01531v2 [cs.RO] 8 Oct 2018	Published	Cited to support the detailed description	Deepmind	https://arxiv.org/pdf/1810.01531.pdf

A.35 Causality-based Thermal Prediction for Data Center

[SOURCE: SC42/WG4 N050 uc_35]

A.35.1 General

ID	35	
Use case name	Causality-based Thermal Prediction for Data Center	
Application domain	Other (data center) Cooling control is data center. This is mainly intended towards reducing energy requirements towards cooling of data centers.	
Deployment model	On-premise systems	
Status	Prototype	
Scope	Data center cooling control involving use of air cooling to control hot spots in data center.	
Objective(s)	Minimize energy usage in managing data center	
Narrative	Short description (not more than 150 words)	Data centers tend to be overcooled to prevent computing machines from failing due to heat. A reliable fine-grained control that could regulate air control unit (ACU) supply air

		temperature or flow is needed to avoid overcooling. Methods that are based on correlation-based techniques do not generalize well. Hence, we seek to uncover the causal relationship between ACUs supplying cool air and temperature at the cabinets to prioritize which ACUs should be regulated to control a hot-spot near a cabinet.		
	Complete description	First, we perform experiments in 6SigmaRoom for the layout of the data center being studied. We collect time-series data for supply air temperature and flow per ACU, and for inlet temperature at the cabinets. Next, we test the recorded time series for checking if Granger-causality (G-causality) can be established between the supply air temperature from an ACU to a cabinet. G-causality establishes the unidirectional temporal precedence for data center control actions from ACUs that leads to changes in specific cabinet temperatures. A variable X is said to Granger-Cause Y if, including data about past terms from X, leads to a better prediction of the future value of Y (i.e., Yt+1) than predicting Yt+1 based solely on past terms from Y. We show by way of simulation that the ACU flows that Granger-Cause reduction in temperature at a cabinet provide a larger share of influence (based on Zone of Influence/Thermal Correlation Index from the simulation) on the cabinet. This could allow an operator to come up with a better control strategy to control hotspots in a data center by regulating ACU supply air temperature/flows.		
Stakeholders	Data center owner; Data center users; Environment			
Stakeholders' assets, values	Competitiveness; Reputation; Stability			
System's threats & vulnerabilities	Incorrect AI system use; Security threats			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Zone of Influence/ Thermal Correlation Index	Extent of influence of ACUs on data center racks.	Helps in improved control.
AI features	Task(s)	Prediction		
	Method(s)	Regression		
	Hardware	64 GB RAM Windows server		
	Topology	NA		
	Terms and concepts used	Granger Causality		
Standardization opportunities/ requirements	• Standardization towards testing robustness • Standardization of input data format and application side information model • Benchmark datasets			

	• Failsafe mode of operation	
Challenges and issues	Data sufficiency	
Societal Concerns	Description	Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.35.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Conference	Causality-based Thermal Prediction for Data Center. 2018 IEEE 23rd International Conference on Emerging Technologies and Factory Automation (ETFA). Turin, Italy. 4-7 Sept. 2018.	Published	Use case taken from this reference	ABB	https://www.researchgate.net/publication/328995714_Causality-Based_Thermal_Prediction_for_Data_Center

A.36 Powering Remote Drilling Command Centre

[SOURCE: SC42/WG4 N050 uc_36]

A.36.1 General

ID	36	
Use case name	Powering Remote Drilling Command Centre	
Application domain	Manufacturing	
Deployment model	Cloud services	
Status	In operation	
Scope	Oil and Gas Upstream (Deployed in 150 Oil Rigs and 2.5 Billion+ Data Points each)	
Objective(s)	Automatic generation of Daily Performance Report, reduction in overall drilling time, cut down Invisible Loss Time and improve rig asset management	
Narrative	Short description (not more than 150 words)	It is important for a drilling contractor to have real time monitoring of rig parameters to optimize operations. The customer lacked granular insights during drilling, could not ascertain the root cause of non-productive time, and manual interpretation of signals led to missing of anomalies further degrading performance.
	Complete description	Cerebra product extracted and ingested different types of signals from surface and downhole sensors to perform near real-time processing. More than **170 vital signals every second** from each oil rig were processed by Cerebra to

		provide near real time insights into drilling operations. This was achieved by handling **Data Format and Data Extraction standards** and Cerebra's **Visualization Studio** provides the flexibility of generating customized asset utilization reports, thus helping the oilfield engineers to understand the root causes of non-productive time and better utilize the assets on field. Rig specific utilization reports, and weekly and monthly utilization reports helped to plan drilling operations improving drilling efficiency.		
Stakeholders	Oil and Gas Upstream sector; Environment, Humans			
Stakeholders' assets, values	Competitiveness (operational excellence); Safety and Environment			
System's threats & vulnerabilities	Challenges to accountability, security threats			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Invisible Loss Time	Indicates the lost time of the asset in being idle or off or unplanned downtime	Asset Utilization Reports indicate the effectively utilized time there indicating the lost time and their causes
	2	Overall drilling time	The time spent on one drilling job inclusive of the all downtimes	Real Time visibility into operations gives the operations early warnings to take actions immediately.
AI features	Task(s)	Knowledge processing & discovery		
	Method(s)	Utilization and Performance Evaluation		
	Hardware	Application Server: 64 GB RAM/ 16 Core / 500 GB HDD Data Server: 128 GB RAM/ 16 Core, 3 TB HDD		
	Topology			
	Terms and concepts used	**ISO 14224:** • Equipment classification and application • Equipment boundary, taxonomy and time definitions **ISO 13379:** • Condition monitoring set-up and diagnostics requirements • Failure mode symptoms analysis • Elements used for diagnostics • Diagnostic approaches **ISO 13381-1:** • Prognosis Concepts • Failure and deterioration models used for Prognosis • Prognosis Process o ***Existing*** failure mode prognosis process o ***Future*** failure mode prognosis process		

		ISO 17359:
		• Equipment audit
		  o Identification of equipment
		  o Identification of equipment function
		• Reliability and criticality audit
		  o Reliability block diagram
		  o Equipment criticality
		  o Failure modes, effects and criticality analysis
		  o Alternative maintenance tasks
		• Monitoring method
		  o Measurement technique
		  o Accuracy of monitored parameters
		  o Feasibility of monitoring
		  o Operating conditions during monitoring
		  o Monitoring interval
		  o Data acquisition rate
		  o Record of monitored parameters
		  o Measurement locations
		  o Initial alert/alarm criteria
		  o Baseline data
		• Data acquisition and analysis
		  o Measurement and trending
		  o Quality of measurements
		  o Measurement comparison to alert/alarm criteria
		  o Diagnosis and prognosis
		  o Improving diagnosis and/or prognosis confidence
		Determine maintenance action

Standardization opportunities/ requirements	• **Mandate of the key sensors based on the type of equipment** Based on the type of equipment, the makers need to have the basic set on sensors imbibed onto the system. E.g. for a pump – it is important to measure the input flow and output flow rates, vibrations, rotation speed, lube oil temperature and pressure. This will guide the equipment manufactures to provide their customers and their data products to capture the minimum required data and understand the equipment performance. • **Mandate for the organizations to expose the minimum and key parameters** The equipment owners need to enable the basic set of sensors for the equipment health and performance which are required for monitoring the asset from any failures. • **Standards for data formats** Each organization has a different way of capturing data and storing them in different formats. Due to which the solutions are not scalable across organizations though the product behind them is same. It takes customised efforts each time. • **Guidelines for deciding the sampling frequency based on the type of data** We see a need to have a specific set of guidelines to capture data at a minimum required sampling frequency. For e.g. a vibration sensor should capture data at least at 1 ms. • **Guidelines for feature engineering**	

	There must be guidelines as to how the features need to be engineered for AI models. Lack of this would lead to more black box models not explaining how the models behave the way they do. • **Guidelines for standardization of event types and codes** There are multiple events which occur for an asset or in a manufacturing plant. Guidelines would help people capture the data in a similar fashion helping the industry to benchmark against one another and at industry level we can understand, which events are the most critical. • **Guidelines for standardization of fault and error codes for an equipment or process** Similar to events, it is also useful to capture fault, failure and error codes in a standard way. • **Process guidelines for event related data (maintenance and work orders)** Guidelines would help people capture the data in a similar fashion helping the industry to benchmark against one another and at industry level we can understand, which events are the most critical.	
Challenges and issues	Compliance of organizations	
Societal Concerns	Description	Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.36.2 Data (optional)

Data characteristics	
Description	Data from an Oil & Gas Rig
Source	Drilling Equipment
Type	Time-Series Sensor Data
Volume (size)	
Velocity	2.5 Billion+ Data Points each day
Variety	Machine Data
Variability (rate of change)	
Quality	

A.36.3 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Web Page	Upstream Sensor Data + Big Data Analytics = Game Changer in	Published	Use case take from this case study	Flutura Business Solutions Pvt. Ltd.	https://www.flutura.com/blog/Upstream-Sensor-Data--Big-Data-Analytics-=-Game-

		Oil n Gas industry				Changer-in-Oil-n-Gas-industry
2	Web Page	Cerebra creating game changing impact on upstream outcomes	Published	Use case take from this case study	Flutura Business Solutions Pvt. Ltd.	https://flutura.com/case-study-oil-and-gas

A.37 Leveraging AI to Enhance Adhesive Quality

[SOURCE: SC42/WG4 N050 uc_37]

A.37.1 General

ID	37	
Use case name	Leveraging AI to enhance adhesive quality	
Application domain	Manufacturing	
Deployment model	On-premise systems	
Status	In operation	
Scope	Batch/Continuous/Discrete Manufacturing (Deployed in 75+ manufacturing lines in 10+ countries; Specifically identified the contributors to quality; predict potential quality failures).	
Objective(s)	Enhance Adhesive Quality, Performance Benchmarking	
Narrative	Short description (not more than 150 words)	Cerebra IOT signal intelligence platform provides the ability to have a holistic perspective and understanding of the sensitivity of the key parameters affecting output quality and ability to monitor and control the process in real-time. This will avoid variations in yields, build-up of inventories and missed customer deadlines.
	Complete description	Cerebra IOT signal intelligence platform ingested 3+ years of process data and sensor data regarding plant operations from temperature, rpm, torque and pressure sensors which were strapped on to industrial mixers. These are the mandatory sensors for the operations. Cerebra used its episode detection algorithms (deep learning) to filter signal from noise and specifically identify the contributors to quality (anomaly signatures) that can then be used as signals to predict quality. It used its proprietary N-dimensional Euclidian distance-based scoring algorithms to normalize and present a unified score to the business team. This unified health score provided the process team a different lens to benchmark, specifically target and radically improve process efficiencies. Cerebra then leveraged its sophisticated ensemble models to predict potential quality failures allowing the operations team to take real-time actions to control process deviations. The signals identified

		in the earlier steps provide Model Explainability to the end-user for reasons behind Quality deviation.		
Stakeholders	Manufacturing industries; Suppliers and Buyers; Environment			
Stakeholders' assets, values	Competitiveness (Respond to and exceed customers' and consumers' expectations by providing the best value, quality, service and winning innovations, brands and technologies to create sustainable value).			
System's threats & vulnerabilities	Challenges to accountability, New Security Threats.			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Prediction Accuracy	To what extent has the model been able to predict correctly	Provided ability as to % of times the quality complied
AI features	Task(s)	Prediction		
	Method(s)	N-dimensional Euclidian distance-based scoring algorithms		
	Hardware	Application Server: 64 GB RAM/ 16 Core / 500 GB HDD Data Server: 128 GB RAM/ 16 Core, 3 TB HDD		
	Topology			
	Terms and concepts used	ISO 13381-1: ● Prognosis Concepts ● Failure and deterioration models used for Prognosis ● Prognosis Process ➢ ***Existing*** failure mode prognosis process ➢ ***Future*** failure mode prognosis process ISO 17359: ● Monitoring method ➢ Measurement technique ➢ Accuracy of monitored parameters ➢ Feasibility of monitoring ➢ Operating conditions during monitoring ➢ Monitoring interval ➢ Data acquisition rate ➢ Record of monitored parameters ➢ Measurement locations ➢ Initial alert/alarm criteria ➢ Baseline data ● Data acquisition and analysis ➢ Measurement and trending ➢ Quality of measurements ➢ Measurement comparison to alert/alarm criteria ➢ Diagnosis and prognosis ➢ Improving diagnosis and/or prognosis confidence ISA 95: ● Identify and work on the boundaries between the enterprise systems and the control systems		
Standardization opportunities/ requirements	• **Mandate of the key sensors based on the type of equipment.** Based on the type of equipment, the makers need to have the basic set on sensors imbibed onto the system. e.g. for a pump – it is important to measure the input flow and output flow rates, vibrations, rotation			

speed, lube oil temperature and pressure. This will guide the equipment manufactures to provide their customers and their data products to capture the minimum required data and understand the equipment performance.

- **Mandate for the organizations to expose the minimum and key parameters.**
  The equipment owners need to enable the basic set of sensors for the equipment health and performance which are required for monitoring the asset from any failures.
- **Standards for Data Formats**
  Each organization has a different way of capturing data and storing them in different formats. Due to this, the solutions are not scalable across organizations though the product behind them is same. It takes customised efforts each time.
- **Guidelines for deciding the sampling frequency based on the type of data.**
  We see a need to have a specific set of guidelines to capture data at a minimum required sampling frequency, e.g. a vibration sensor should capture data at least at 1 ms or less.
- **Guidelines for Feature Engineering.**
  There must be guidelines as to how the features need to be engineered for AI models. Lack of this would lead to more black box models not explaining how the models behave the way they do.
- **Guidelines for Standardization of event types and codes.**
  There are multiple events which occur for an asset or in a manufacturing plant. Guidelines would help people capture the data in a similar fashion helping the industry to benchmark against one another and at industry level we can understand, which events are the most critical.
- **Guidelines for standardization of Fault and Error Codes for an equipment or process.**
  Similar to events, it is also useful to capture fault, failure and error codes in a standard way.
- **Process Guidelines for event related data (Maintenance and Work Orders):**
  Guidelines would help people capture the data in a similar fashion helping the industry to benchmark against one another and at industry level we can understand, which events are the most critical.
- **Guidelines for Training AI models:**
  A defined set of guidelines for AI models would be useful for the data scientists to follow. It will also aid the consumers of AI models to understand how the outcome has been deduced.
- **Guidelines around AI model explainability:**
  With so many black-box models floating around in the industry, it is difficult for consumers of AI models to understand these models and their output. And with engineers and domain experts coming into the picture, it is very much required to make these models more explainable.
- **Process Guidelines and methods for model evaluation (retraining)**
  Before deployment and post deployment, it is very critical to have standard methods for models. And also post deployment, we must set guidelines for retaining the model on a periodic basis or based on data volatility. This is increasingly becoming important as AI models are being involved in more strategic and operational decision making.

	• **Guidelines for disaster recovery n autonomous operations:** With the aid of AI models, the operations of an equipment or manufacturing plant are becoming more and more autonomous and self-sufficient. But the human monitoring is also important as any kind of inaccurate prediction can lead to a disaster and it is must to have some standard to recover from this situation and to assess the conditions to go for autonomous operations.	
Challenges and issues	Patented process if any, security restrictions	
Societal Concerns	Description	Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.37.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Web link	Leveraging Cerebra's AI to enhance quality – from Quality Inspection to Quality Assurance	Published as case study	Use case take from this case study	Flutura Business Solutions Pvt. Ltd.	https://flutura.com/case-study-specialty-chemicals

A.38 Machine Learning Driven Approach to Identify the Weak Spots in the Manufacturing of the Circuit Breakers

[SOURCE: SC42/WG4 N050 uc_38]

A.38.1 General

ID	38
Use case name	Machine learning driven approach to identify the weak spots in the manufacturing of the circuit breakers.
Application domain	Manufacturing
Deployment model	Prototype
Status	On-premise system
Scope	Detecting the issues in manufacturing process that leads to early failures of the circuit breakers through the data mining of the manufacturing process.

<table>
<tr><td>Objective(s)</td><td colspan="4">To generate actionable intelligence to improve the manufacturing process of circuit breakers through mining of manufacturing related data.</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td colspan="3">An approach was developed that can mine the manufacturing data of circuit breakers through multiple machine learning algorithms. The approach could successfully identify the weak spots in the manufacturing where failure rate jumped from 0.2% to 7% (35 fold more probability of failure) and hence candidates for improvement in the manufacturing process.</td></tr>
<tr><td>Complete description</td><td colspan="3">High voltage circuit breakers are critical component of an electric circuit and it has a normal lifespan of 30-40 years. However, due to various reasons few circuit breakers fail within 0-5 years of operation. As a manufacturer of these circuit breakers, lots of data related to manufacturing aspects are present with the manufacturer. Such data has information about production lot size, material of production, design voltages for sub-components, heater voltages, date of failure etc. In general data related to 49 variables are captured for close to 56000 circuit breakers over a lifespan of several years. The manufacturer is interested to know if there are any weak spots in the manufacturing process which leads to higher failure rates.

Circuit breakers can fail not only due to manufacturing defects but also due to wrong operation of the circuit breaker in the field e.g. applying voltages higher than design values. However, operational data of the circuit breakers was not available with the manufacturer.

Therefore, the key challenge of this project was knowledge discovery with partial data set using machine learning algorithms.

The data scientists applied various machine learning algorithms such as decision tree, random forest, support vector machine, Naïve Bayes classifier, logistic regression and neural network and compared the results of one algorithm verses the other algorithm. Through multiple numerical experimentations on data selection and algorithm hyper parameter tuning, the data scientist team selected the best algorithms and deduced the key weak spots in the manufacturing that are generally associated with high failure rates. In conclusion, the work provided a set of 5 actionable rules, where the failure rates jumped drastically from 0.2% to 7% leading to 35-fold higher chance of failure.</td></tr>
<tr><td>Stakeholders</td><td colspan="4">Manufacturer of HV circuit breakers</td></tr>
<tr><td>Stakeholders' assets, values</td><td colspan="4">Reliable and safe power supply to customers</td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4">Incorrect use of AI/ML</td></tr>
<tr><td rowspan="2">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>Ratio of ML discovered failure</td><td>What combination of manufacturing processes/decisio</td><td>Actionable intelligence to improve the</td></tr>
</table>

		rate to nominal failure rate	ns leads to higher failure rates compared to nominal failure rate	manufacturing process of HV circuit breakers
AI features	Task(s)	Classification		
	Method(s)	Decision trees, SVM, ANN, Logistic Regression, Random Forest and Naïve Bayes		
	Hardware	64 GB RAM Windows server		
	Topology	NA		
	Terms and concepts used	Classification, Actionable Rules, HV Circuit breakers		
Standardization opportunities/ requirements	Standardization of data representation models comprising of both manufacturing related data and end-use related data.			
Challenges and issues	Discovering actionable insight with partial data set and managing bias in ML models due to limited number of failed cases			
Societal Concerns	Description	Safe and reliable power delivery		
	SDGs to be achieved	Industry, Innovation, and Infrastructure		

A.38.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originato r/organiz ation	Link
1	Confer ence	Kumar, S., K., Jamkhandi, A., G., and Gugaliya, J., K., Achieving Manufacturing Excellence through Data Driven Decisions, IEEE International Conference on Industrial Technology, Melbourne Australia PP 1267-1273	Presented in Feb 2019	Use case taken from this reference	ABB	Yet to be published

A.39 Machine Learning Driven Analysis of Batch Process Operation Data to Identify Causes for Poor Batch Performance

[SOURCE: SC42/WG4 N050 uc_39]

A.39.1 General

ID	39
Use case name	Machine Learning Driven Analysis of Batch Process Operation Data to Identify Causes for Poor Batch Performance

<table>
<tr><td>Application domain</td><td colspan="4">Batch Manufacturing</td></tr>
<tr><td>Deployment model</td><td colspan="4">On-premise systems</td></tr>
<tr><td>Status</td><td colspan="4">Prototype</td></tr>
<tr><td>Scope</td><td colspan="4">Detecting the issues in batch manufacturing process that leads to bad quality products or longer cycle times of batch processing</td></tr>
<tr><td>Objective(s)</td><td colspan="4">Provide insight to the operation team to improve the productivity of batch manufacturing through machine learning on historical operation data</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td colspan="3">An approach was developed that can use machine learning models to identify issues in batch manufacturing.</td></tr>
<tr><td>Complete description</td><td colspan="3">Batch operation is generally quite complex involving dynamics in the operation and interplay of various process variables. Due to this, sometimes, few batches end up running slower than nominal batch time and few batches also yield bad quality end products resulting in significant production loss. Additionally, often in the industrial context, data size and variety are limited and to develop a robust machine learning model from limited available data sets is a challenging task.

Due to transient nature of batch operation data, the traditional PCA algorithm fails in analyzing the batch data and hence MPCA was applied as logical extension of PCA algorithm. As MPCA naturally considers the dynamics in the data and inter-correlations among the process variables, it provides a valuable insight on the batch data.

The approach was successfully demonstrated on milk pasteurization process data where only 4 batches were provided for modelling. Using such 4 seed batches, the algorithm synthetically creates 50 batches of data and introduction of anomalies in some batches. Concept of design of experiments and stochastic perturbations are used in synthetic generation of the data set.
The work was able to successfully build a robust MPCA model with such data and isolate the bad batches of data from good batches of the data. Additionally, through contribution plots, the algorithm identifies when a certain batch drifted from nominal operation and which variables are the root causes for the bad batch operation.</td></tr>
<tr><td>Stakeholders</td><td colspan="4">Batch manufacturer such as milk pasteurization, pharmaceutical, paint manufacturing, etc.</td></tr>
<tr><td>Stakeholders' assets, values</td><td colspan="4">Improve the productivity and avoid the re-work</td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4">Incorrect use of AI/ML; New Security Threats</td></tr>
<tr><td rowspan="2">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>Closeness to Golden Batch</td><td>How close a process is to the</td><td>Helps in isolation of bad batches</td></tr>
</table>

			best possible batch	from good batches by identifying combination of process variable trajectories that lead to good or bad batch operation.
AI features	Task(s)	Classification		
	Method(s)	Multiway Principal Component Analysis		
	Hardware	64 GB RAM Windows server		
	Topology	NA		
	Terms and concepts used	Classification, MPCA, Anomalies		
Standardization opportunities/ requirements	• Standard data representation models for AI relevant batch data handling • Standard GUI for AI relevant result presentation.			
Challenges and issues	Discovering actionable insight with limited industrial data set, handling dynamics in the process variables			
Societal Concerns	Description	Consistent batch operation lead to enhanced productivity		
	SDGs to be achieved	Industry, Innovation, and Infrastructure		

A.39.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Conference	Jeffy, F., J., Gugaliya, J., K., and Kariwala, V. Application of Multi-Way Principal Component Analysis on Batch Data, 2018 UKACC 12th International Conference on Control	Published	Use case taken from this source	ABB	https://www.researchgate.net/publication/328989762_Application_of_Multi-Way_Principal_Component_Analysis_on_Batch_Data

A.40 Empowering Autonomous Flow Meter Control- Reducing Time Taken to "Proving of Meters"

[SOURCE: SC42/WG4 N050 uc_40]

A.40.1 General

ID	40

<table>
<tr><td>Use case name</td><td colspan="4">Empowering Autonomous Flow meter control- Reducing time taken to “proving of meters”</td></tr>
<tr><td>Application domain</td><td colspan="4">Manufacturing</td></tr>
<tr><td>Deployment model</td><td colspan="4">Cloud services</td></tr>
<tr><td>Status</td><td colspan="4">In operation</td></tr>
<tr><td>Scope</td><td colspan="4">Calibration of control devices</td></tr>
<tr><td>Objective(s)</td><td colspan="4">Reduce the time taken for trial & error methods to set the VFD and FCV setpoints</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td colspan="3">The customer had to set VFD and FCV % manually to achieve desired flowrate using trial & error methods, which could take about 3-4 hours. Efficiency for the proving of the meters was very less & improvement was needed to remove any aberration in reading as it was time consuming.</td></tr>
<tr><td>Complete description</td><td colspan="3">Cerebra was integrated with the system considering the flow of the fluid. The customer can choose between the available options of high flow rate, low flow rate or multi viscous flow. Then, with the master meter in the loop of testing, the meter from the field was introduced to analyse how much of aberration is there and then proving it more efficiently. Since it took more time for them to get the exact values of VFD & FCV % to achieve the desired flow rate, Cerebra’s Prognostics Engine was introduced. Purely based upon machine learning algorithms, the data models for the VFD & FCV % was used to predict the values to be chosen with an accuracy of about 98%. Since there was a presence of a closed-loop system, this predicted value was automatically registered on the valves’ monitors which only required small tweaking in the end, thus reduced human efforts.</td></tr>
<tr><td>Stakeholders</td><td colspan="4">Process Industries; Humans</td></tr>
<tr><td>Stakeholders’ assets, values</td><td colspan="4">Competitiveness; Stability.</td></tr>
<tr><td>System’s threats & vulnerabilities</td><td colspan="4">Challenges to accountability, security threats</td></tr>
<tr><td rowspan="3">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>Model Accuracy</td><td>Accuracy of the prediction model</td><td>The extent to which the setpoints have correctly predicted</td></tr>
<tr><td>2</td><td>% Reduction in Calibration Time</td><td>The amount of time saved from manually setting the calibration</td><td></td></tr>
<tr><td rowspan="3">AI features</td><td>Task(s)</td><td colspan="3">Prediction</td></tr>
<tr><td>Method(s)</td><td colspan="3">Random Forest prediction, one hot encoding, cross validation, normalization</td></tr>
<tr><td>Hardware</td><td colspan="3">Application Server: 64 GB RAM/ 16 Core / 500 GB HDD; Data Server: 128 GB RAM/ 16 Core, 3 TB HDD</td></tr>
</table>

	Topology	
	Terms and concepts used	**ISO 14224:** • Equipment classification and application • Equipment boundary, taxonomy and time definitions **ISO 13379:** • Condition monitoring set-up and diagnostics requirements • Failure mode symptoms analysis • Elements used for diagnostics • Diagnostic approaches **ISO 13381-1:** • Prognosis Concepts • Failure and deterioration models used for Prognosis • Prognosis Process o ***Existing*** failure mode prognosis process o ***Future*** failure mode prognosis process **ISO 17359:** • Equipment audit o Identification of equipment o Identification of equipment function • Reliability and criticality audit o Reliability block diagram o Equipment criticality o Failure modes, effects and criticality analysis o Alternative maintenance tasks • Monitoring method o Measurement technique o Accuracy of monitored parameters o Feasibility of monitoring o Operating conditions during monitoring o Monitoring interval o Data acquisition rate o Record of monitored parameters o Measurement locations o Initial alert/alarm criteria o Baseline data • Data acquisition and analysis o Measurement and trending o Quality of measurements o Measurement comparison to alert/alarm criteria o Diagnosis and prognosis o Improving diagnosis and/or prognosis confidence • Determine maintenance action **ISA 95:** Identify and work on the boundaries between the enterprise systems and the control systems
Standardization opportunities/ requirements	• **Mandate of the key sensors based on the type of equipment** Based on the type of equipment, the makers need to have the basic set on sensors imbibed onto the system. E.g. for a pump – it is important to	

	measure the input flow and output flow rates, vibrations, rotation speed, lube oil temperature and pressure. This will guide the equipment manufactures to provide their customers and their data products to capture the minimum required data and understand the equipment performance • **Mandate for the organizations to expose the minimum and key parameters** The equipment owners need to enable the basic set of sensors for the equipment health and performance which are required for monitoring the asset from any failures • **Standards for Data Formats** Each organization has a different way of capturing data and storing them in different formats. Due to which the solutions are not scalable across organizations though the product behind them is same. It takes customised efforts each time. • **Guidelines for deciding the sampling frequency based on the type of data** We see a need to have a specific set of guidelines to capture data at a minimum required sampling frequency. For e.g. a vibration sensor should capture data at least at 1 ms or less. • **Guidelines for Feature Engineering** There must be guidelines as to how the features need to be engineered for AI models. Lack of this would lead to more black box models not explaining how the models behave the way they do. • **Guidelines for Standardization of event types and codes** There are multiple events which occur for an asset or in a manufacturing plant. Guidelines would help people capture the data in a similar fashion helping the industry to benchmark against one another and at industry level we can understand, which events are the most critical. • **Guidelines for standardization of Fault and Error Codes for an equipment or process** Similar to events, it is also useful to capture fault, failure and error codes in a standard way. • **Process Guidelines for event related data (Maintenance and Work Orders)** Guidelines would help people capture the data in a similar fashion helping the industry to benchmark against one another and at industry level we can understand, which events are the most critical • **Guidelines for Training AI models** A defined set of guidelines for AI models would be useful for the data scientists to follow. It will also aid the consumers of AI models to understand how the outcome has been deduced • **Guidelines around AI model explainability** With so many black box models floating around in the industry, it is difficult for consumers of AI models to understand then and their output. And with engineers and domain experts, coming into the picture, it is very much required to make these models more explainable. • **Process Guidelines and methods for model evaluation (retraining)** Before deployment and post deployment, it is very critical to have standard methods for models. And also post deployment, we must set guidelines for retaining the model on a periodic basis or based on data volatility. This is increasingly becoming important as AI models are being involved in more strategic and operational decision making. • **Guidelines for disaster recovery and autonomous operations**

	With the aid of AI models, the operations of an equipment or manufacturing plant are becoming more and more autonomous and self- sufficient. But the human monitoring is also important as any kind of inaccurate prediction can lead to a disaster and it is must to have some standard to recover from this situation and to assess the conditions to go for autonomous operations.	
Challenges and issues		
Societal Concerns	Description	Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.40.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Web Page	Accelerating shale production through digital technology integration	Published	Use case taken from this source	Flutura Business Solutions Pvt. Ltd. TechnipFMC	https://www.technipfmc.com/en/media/features/accelerating-shale-production-through-digital-technology-integration?type=features
2	Web Page	Fundamentals of meter provers and proving methods	Published	Fundamental definition of Meter Provers	Flow Management Devices	https://asgmt.com/wp-content/uploads/2016/02/011_.pdf

A.41 Improving Productivity for Warehouse Operation

[SOURCE: SC42/WG4 N050 uc_41]

A.41.1 General

ID	41
Use case name	Improving Productivity for Warehouse Operation
Application domain	Logistics
Deployment model	On-premise systems
Status	PoC
Scope	Big data analysis for enhancing productivity

Objective(s)	To improve productivity of warehouse operation by detecting and changing controllable factors			
Narrative	Short description (not more than 150 words)	AI-driven operating system that uses big data from work performance information to issue appropriate work instructions has been developed. In PoC, picking operation improvement was conducted in a distribution warehouse. As the result, 8% work reduction was performed.		
	Complete description	Attempts are being made to increase the efficiency of work improvements through more widespread application of IT to work systems. However, as each new improvement is added or improvements are made with respect to environmental changes, it requires manual changes to the system, leading to increases in work improvement costs. This case has developed an AI system that uses big data such as work performance information, to understand worksite improvements and environmental changes and issue appropriate work instructions. It has conducted a demonstration test, which confirmed the effectiveness of this system for improving distribution warehouse work. In the future, we will continue to work on expanding the AI system to a wide range areas such as manufacturing and distribution.		
Stakeholders	warehouse manager			
Stakeholders' assets, values	reducing cost, reducing labor related problems (e.g. minimizing labors complaint), speed up of operation.			
System's threats & vulnerabilities	possibility of back action			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Number of labors	reduced % of labors	improvement of productivity
	2	Number of complaints	reduced % of labor's complaint	improvement of productivity
	3	Lead time	time from order to shipment	improvement of productivity
AI features	Task(s)	Optimization		
	Method(s)	modeling of relationship between explaining variables and outcome, and optimization		
	Hardware	PC, wearable sensor		
	Topology			
	Terms and concepts used	Human big data analysis, regression analysis		
Standardization opportunities/ requirements	standardization of data format, sensors to be used, and API of IT and mechanical systems			
Challenges and issues	understanding of workers' human factors (privacy, additional work etc.)			
Societal Concerns	Description	solving labor shortage problem and improving labor related issues with aiming improving productivity.		

	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.41.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	company's technical journal		Published		Hitachi, Ltd.,	http://www.hitachi.com/rev/archive/2016/r2016_06/106/index.html

[1] F. Kudo T. Akitomi and N. Moriwaki, "An Artificial Intelligence Computer System for Analysis of Social Infrastructure Data," IEEE conf. Business Infomatics (CBI), 2015.

[2] J. Kimura et al., "Framework for Collaborative Creation with Customers to Improve Warehouse Logistics," Hitachi Review, 65, pp. 873-877, 2016.

[3] Hitachi News Release, "Development of Artificial Intelligence issuing work orders based on understanding of on-site Kaizen activity and demand fluctuation," 2015. http://www.hitachi.com/New/cnews/month/2015/09/150904.html

A.42 Emotion-sensitive AI Customer Service

[SOURCE: SC42/WG4 N050 uc_42]

A.42.1 General

ID	42	
Use case name	Emotion-sensitive AI Customer Service	
Application domain	Retail	
Deployment model	On-premise systems	
Status	In operation	
Scope	Extracting sentiment and its intensity from customers' input, and responding with appropriate attitude in order to improve the quality of customers' inquiry.	
Objective(s)	To design an efficient solution for customers' sentiment and intensity detection, especially in the situation of limited training dataset.	
Narrative	Short description (not more than 150 words)	The emotion-sensitive AI customer service of JD.com Int., is supported by AI technology and deep learning method. It is developed for ameliorating accuracy of customer sentiment and intensity. In sentiment classification, it has achieved 74% accuracy and 90% recall score while in intensity detection, it has accomplished 85% accuracy and 85% recall. During the special sale of "618", it has increased customer satisfaction by 57%.
	Complete description	JD's customer service representatives need to handle millions of requests on a daily basis. Regular AI customer

		service systems, 24/7 online, are capable of offering instant assistance, which alleviates the labor resources to a large extent. However, it is quite challenging, if not impossible, for those systems to interpret emotions from customer input and respond as friendly as human. Under this background, based on huge data set of customer comments and rich experience of Natural Language Processing, our system can automatically detect sentiments like happy, angry, anxious, etc. Moreover, this system can also detect the intensity of customer sentiment. Furthermore, we adapt Convolutional Neural Networks, a widely used techniques in visual computing, to interpret the semantic meaning of customer's expression. It can improve the system's performance for sentiment classification and intensity detection. Moreover, with the adoption of transfer learning, the system can also be applied into various types of data. To overcome the difficulty of limited training data, we also use data augmentation method such as reverse translation and data noise to increase the variability of training data. Up to now, the system has reached 90% recall and 74% accuracy rate for sentiment classification over 7 categories. The overall recall and accuracy for sentiment intensity are also around 85%, it has increased customer satisfaction by 57%.		
Stakeholders	Customers targeted for the Customer Service system			
Stakeholders' assets, values	Customer experience may be in influnced by the use of AI custemer service			
System's threats & vulnerabilities	The low degree of humanization, and lack of semantic diversity for response; Reducing the number of human customer service.			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Customer Satisfaction	The ratio of customer satisfaction when using this system for requests. The expectation is 100%	Increasing its ratio as high as possible
	2	Accuracy	Among all the predicted customer sentiment classification, the ratio of accurate prediction, current value is 76.4%	Increasing to 90%

	3	Recall	Among all the customer sentiment intensity, the ratio of accurate prediction, current overall value is 90%	Increasing to 90%
	4	Accuracy	Among all the predicted customer sentiment intensity, the ratio of accurate prediction, current overall value is 85%	Increasing to 90%
	5	Recall	Among all the customer sentiment intensity, the ratio of accurate prediction, current overall value is 85%	Increasing to 90%
AI features	Task(s)	Natural language processing		
	Method(s)	Deep learning, transfer learning, data augmentation		
	Hardware			
	Topology			
	Terms and concepts used	Deep learning: a class of machine learning algorithms use a cascade of multiple layers of nonlinear processing units for feature extraction and transformation. Transfer learning: we adopt multi-task learning method in this system. Jointly training different annotated data in same domain, this method improves the model performance for classification problems. Data augmentation: we apply reverse translation to firstly translation Chinese into English and then translate it backward. We also use data noise to improve the data diversity.		
Standardization opportunities/ requirements	The system can be promoted to as many customer cervices companies as possible once provide with enough training data for the specific Application scenario			
Challenges and issues	Challenge: the system's performance should be as good as the human customer server. Issues: 1) limited training data; 2) sentiment classification among seven categories.			
Societal Concerns	Description	Improving the corresponding efficiency of customer service, improving customer service experience； Reducing labor costs, and reducing operating costs.		

	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.42.2 Data (optional)

Data characteristics	
Description	For sentiment classification: conversation data from after-sales customer services. It's annotated by professional annotators into 7 categories of sentiments. For sentiment intensity: Only including sentiment data with "anger" and "anxious"; it's annotated into 3 degrees of intensity: "low, medium, high".
Source	Conversation data from JD.com real-time customer services.
Type	Text
Volume (size)	Around 60,000 sentences for sentiment classification and 20,000 for sentiment intensity.
Velocity	Batch Processing
Variety	Real-time data from JD.com, including various categories of products.
Variability (rate of change)	Static
Quality	High

A.42.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Data Augmentation	Using reverse translation and noise processing to increase the size and diversity of data.	Annotated raw data is ready.		Increase the performance of model training.
2	Model Training	Based on the large training data, with deep learning method, to develop model for sentiment classification (7 categories) or	Augmented data is ready		

		sentiment intensity (3 categories).			
3	Evaluation	Evaluate data performance on open dataset and specific data.	Pretrained model is ready		
4	Execution	Apply the trained model on real-time AI customer service.		The trained model has been evaluated as deployable	
5	Retraining	Retraining model with new annotated data and new requirement from industry.			

A.42.4 Training (optional)

Scenario name	Training				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Complete data augmentation	Design model for training	AI algorithm engineers	Using CNN for sentiment classification and intensity.	
2	Complete model designing	Transfer learning	AI algorithm engineers	Multi-task learning with different data in same domain.	

Specification of training data	

A.42.5 Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Complete model training	Evaluation on open dataset	AI algorithm engineers	Evaluate different models'	Their performance shall be as

				performance on open dataset	good as state-of-art.
2	Complete model training	Evaluation on own dataset	AI algorithm engineers	Evaluate different models' performance on own dataset	Their performance shall meet certain standard.

Input of evaluation	Independent testing data
Output of evaluation	Accuracy and Recall

A.42.6 Execution (optional)

Scenario name	Execution				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Finish model training	Application	AI engineers	Making trained model into application of AI Customer Service system.	
2	Given customer's input	Data processing	AI algorithm engineers	Processing data into required format for model.	
3	Finish data processing	Model prediction	AI algorithm engineers	Predicting sentiment or sentiment intensity.	
4	Completion of Step3	Making response	AI algorithm engineers	Making response according to the preidiction from previous step.	

Input of Execution	
Output of Execution	

A.42.7 Retraining (optional)

Scenario name	Retraining				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activit y	Requirement
1	Certain period of time has passed since the last	Improve architecture of model	AI algorith m engineer s	Collecting new requirements for model designing.	

	training/retrainig				
2	Certain period of time has passed since the last training/retrainig	Collecting new data	AI algorithm engineers	Collecting new data based on the further requirements.	
3	Completing Step1&Step2	Model retraining	AI algorithm engineers	Training new model on additional data.	

Specification of retraining data	

A.42.8 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	IT company	XiaoIce	In operation		Microsoft Asia	

A.43 Deep Learning Based User Intent Recognition

[SOURCE: SC42/WG4 N050 uc_43]

A.43.1 General

ID	43	
Use case name	Deep Learning Based User Intent Recognition	
Application domain	Retail	
Deployment model	On-premise systems	
Status	In operation	
Scope	Recognizing users' intent to solve their problems in e-commerce fields	
Objective(s)	To recognize and understand users' intent by AI and deep learning technologies and apply such technologies to build chat bot systems to further reduce labor cost and to be applied in various fields.	
Narrative	Short description (not more than 150 words)	Intelligent customer service chat bot is mainly used to categorize users' questions, recognize users' intents and answer users' questions intelligently for different business jobs. Currently, this chat bot has been used to handle 90%

		of online customer service and has enabled JD.com to save over 100 million labor costs every year.		
	Complete description	JD.com has been committed to using technology to drive business growth and improve user experience in all customer service fields. Based on the improvement of customer consulting experience and the developing trend of artificial intelligence technology, as early as 2012, JD had decided to develop intelligent chat bots to fulfill the needs of continuous expansion of business, to save customer service costs and increase service capability. Intent recognition is a key and core technology to build such an intelligent customer service chat bot. By applying natural language processing technologies, deep learning technologies, traditional machine learning algorithms, intent recognition accuracy has reached to 95%. Based on accurate intents, and a series of solution finding algorithms, our chat bot can solve the user's problems to a great extent and give the user a high quality consulting experience. Finally, in order to provide diversified and personalized customer services, we are continuously improving the accuracy of intent recognition, personalized solution generation, sentiment recognition, and image recognition. So far, intelligent customer service has revolutionized the traditional customer service consulting business.		
Stakeholders	users			
Stakeholders' assets, values	Users' experience			
System's threats & vulnerabilities	high semantic ambiguity, Multiple language expressions in one sentence			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Accuracy	The number of correctly recognized users' intent over total number of users. Currently, accuracy reaches 95%.	Improve accuracy of recognizing users' intent
	2	Resolution	The number of answers solved over total number of questions asked	Improve the resolution of questions from users
	3	Satisfaction	The number of users who are satisfied with customer service over total number of users	Improve user experience
AI features	Task(s)	Natural language processing		
	Method(s)	Machine learning and deep learning		

	Hardware	GPU and CPU
	Topology	TensorFlow
	Terms and concepts used	Natural language processing, deep learning, CNN, HAN, logistic regression
Standardization opportunities/ requirements	Process Standardization will Improve Quality and Productivity	
Challenges and issues	Current challenges of deep leaning and intent recognition: 1. high semantic ambiguity, similar sentences can deliver different meanings. 2. Unclear classification rules caused by complicated business logics 3. Hard to answer reasoning questions	
Societal Concerns	Description	1. Solve problems intelligently to increase efficiency 2. Free labors from repetitive work to save large amount of resources for the society
	SDGs to be achieved	Decent work and economic growth

A.43.2 Data (optional)

Data characteristics	
Description	Question answering data from the JD.com online dialogue log
Source	Customer's dialogue log at JD.com
Type	Text
Volume (size)	Millions
Velocity	Real time
Variety	various scenarios, various business, various categories of products
Variability (rate of change)	Non-linear
Quality	good

A.43.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Training	Based on millions of labeled streaming data, train a model using diversified algorithms, such as a deep learning neural network or a	The training sample is ready		

		traditional machine learning algorithm			
2	Evaluation	Evaluate the performance of the model on online dialogue data	The training procedure has been finished		Each requirement must be satisfied or exceeded to reach the condition of 'success' (e.g. the accuracy should be more than 95%)
3	Execution	Apply the trained model to predict user's intent	Require user's query		
4	Retraining	Take a training sample from online dialogue to retrain the model and compare it with the old one by AB test	bad cases are feed back to update the training dataset		The requirement is that the new model must be better than the old one

A.43.4 Training (optional)

Scenario name	Training				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Raw data stored in the database	Data extraction	Database engineer	Extract related data from the database to generate the raw dataset	
2	Completion of Step 1	Generating training samples	Data labeling team	Label the raw dataset of step one with 300 categories	
3	Completion of Step 2	Pre-process	AI engineer	Segment the sentence into words and convert those words into vectors	
4	Completion of Step 3	Model training	AI engineer	Based on vectors generated on step 3 to train a model using diversified	

				algorithms, such as a deep learning neural network or a traditional machine learning algorithm	

Specification of training data	After manual verifying, the accuracy of labelling should be more than 95%

A.43.5 Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Certain period of time has passed since the last training/retraining	Data Extraction	Database engineer	Randomly take a sample from streaming data to form a test sample	
2	Completion of Step 1	Prediction	AI engineer	Predict the test sample in step 1 by the trained model	
3	Completion of Step 2	Evaluation	Data labeling team	Compare the result of predicted with the result of labeling	

Input of evaluation	the result of labeling and the result of prediction
Output of evaluation	The accuracy and recall rate

A.43.6 Execution (optional)

Scenario name	Execution				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Acquire the user's query	pre-process	AI engineer	Segment the sentence into words and convert those words into vectors	The trained model has been in operation
2	Completion of Step 1	Text classification	AI engineer	Predict the label of user's query	
3	Completion of Step 2	Response	AI trainer	Answer the query based on the	

				result of intent classification	

Input of Execution	
Output of Execution	

A.43.7 Retraining (optional)

Scenario name	Retraining				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Certain period of time has passed since the last training/retraining	Data extraction	Database engineer	Randomly take a sample from streaming data to from a training sample	
2	Completion of Step 1	Labeling the sample	Data labeling team	Manually label the sample data	
3	Completion of Step 2	Model training	AI engineer	Combine the new training sample with the old and train a model (deep learning and machine learning)	
4	Completion of Step 3	AB Test	AI engineer	Compare the predicted results of the new model with the results of the old one	The performance of the new model is better than results of the old one
5	Completion of Step 4	Online active of new model	AI engineer	The new model is been active online at JD.com	

Specification of retraining data	After the calibration, the accuracy of labelling should be more than 95%

A.43.8 References

References

No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Paper	Convolutional Neural Networks for Sentence Classification			New York University	https://arxiv.org/abs/1408.5882
2	Paper	Hierarchical Attention Networks for Document Classification			Carnegie Mellon University, Microsoft Research, Redmond	http://www.aclweb.org/anthology/N16-1174
3	Paper	LIBLINEAR: A library for large linear classification Journal of Machine Learning Research			National Taiwan University	http://www.jmlr.org/papers/volume9/fan08a/fan08a.pdf

A.44 Chromosome Segmentation and Deep Classification

[SOURCE: SC42/WG4 N050 uc_44]

A.44.1 General

ID	44	
Use case name	Chromosome Segmentation and Deep Classification	
Application domain	Healthcare	
Deployment model	Hybrid or other (please specify)	
Status	PoC	
Scope	Karyotyping of the chromosomes is restricted to healthy patients	
Objective(s)	Automating Karyotyping of the chromosomes in cell spread images. Segmentation of chromosomes in the images using non expert crowd.	
Narrative	Short description (not more than 150 words)	Karyotyping of the chromosomes micro-photographed under metaphase is done by characterizing the individual chromosomes in cell spread images. Currently, considerable effort and time is spent to manually segment out chromosomes from cell images, and classifying the segmented chromosomes. We proposed a method to

		segment out and classify chromosomes for healthy patients using a combination of crowdsourcing, preprocessing and deep learning, wherein the non-expert crowd from external crowdsourcing platform is utilized to segment out the chromosomes, which are then classified using deep neural network. Results are encouraging and promise to significantly reduce the cognitive burden of segmenting and karyotyping chromosomes.
	Complete description	Metaphase chromosome analysis is one of the primary techniques utilized in cytogenetics. Observations of chromosomal segments or translocations during metaphase can indicate structural changes in the cell genome, and is often used for diagnostic purposes. Karyotyping of the chromosomes micro-photographed under metaphase is done by characterizing the individual chromosomes in cell spread images. Currently, considerable effort and time is spent to manually segment out chromosomes from cell images, and classifying the segmented chromosomes into one of the 24 types, or for diseased cells to one of the known translocated types. Segmenting out the chromosomes in such images can be especially laborious and is often done manually, if there are overlapping chromosomes in the image which are not easily separable by image processing techniques. Many techniques have been proposed to automate the segmentation and classification of chromosomes from spread images with reasonable accuracy, but given the criticality of the domain, a human in the loop is often still required. In this paper, we present a method to segment out and classify chromosomes for healthy patients using a combination of crowdsourcing, preprocessing and deep learning, wherein the non-expert crowd from CrowdFlower is utilized to segment out the chromosomes from the cell image, which are then straightened and fed into a (hierarchical) deep neural network for classification. Experiments are performed on 400 real healthy patient images obtained from a hospital. Results are encouraging and promise to significantly reduce the cognitive burden of segmenting and karyotyping chromosomes.
Stakeholders	Hospitals, Doctors, Cytogeneticists, Patients	
Stakeholders' assets, values	Health, Diagnosis, Privacy	
System's threats & vulnerabilities	Incorrect classification and segmentation, Inadequate training samples for karyotyping of chromosomes, incorrect straightening of bent chromosomes; bias in annotation by crowd-sourcing	

Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Classifier Accuracy	Without straightening and pre-processing, the average	

			classification accuracy obtained was 68.5%. However, with preprocessing, the classification accuracy improved to 86.7%. These results are very likely to improve with more annotated training data for classification.	
	2	Annotation Completeness	35.9 chromosomes segmented out after crowd annotation, for 50 images having 46 chromosomes	
AI features	Task(s)	Recognition		
	Method(s)	Crowdsourcing and Deep learning		
	Hardware	GPU enabled desktops		
	Topology	Deep models used for training and testing		
	Terms and concepts used	Deep learning, crowd sourcing, non-expert crowd, segmentation, karyotyping		
Standardization opportunities/ requirements	When images are of poor resolution apply super-resolution techniques before feeding the images to any classifier network.			
Challenges and issues	Crowd's job satisfaction Spamming in annotated data			
Societal Concerns	Description	Inaccurate classification of chromosomes can lead to stress in patients in case the classification is not reviewed by expert doctors		
	SDGs to be achieved	Good health and well-being for people		

A.44.2 Data (optional)

Data characteristics	
Description	The dataset comprised of 400 stained images with varying degrees of overlap between chromosomes, out of which 200 were kept for testing and the remaining for training and validation
Source	Partner hospital
Type	Images
Volume (size)	400
Velocity	
Variety	

Variability (rate of change)	
Quality	

A.44.3 References

[1] Sharma, Monika & Saha, Oindrila & Sriraman, Anand & Hebbalaguppe, Ramya & Vig, Lovekesh & Karande, Shirish. (2017). Crowdsourcing for Chromosome Segmentation and Deep Classification. 786-793. 10.1109/CVPRW.2017.109.

A.45 Anomaly Detection in Sensor Data Using Deep Learning Techniques

[SOURCE: SC42/WG4 N050 uc_45]

A.45.1 General

ID	45	
Use case name	Anomaly Detection in Sensor Data Using Deep Learning techniques	
Application domain	Maintenance & support	
Deployment model	Hybrid or other (Cloud or on premise deployment)	
Status	PoC	
Scope	Temporal Data captured from sensors	
Objective(s)	Identify Anomalies and Events by learning the temporal patterns of sensor data, based on Deep Learning techniques.	
Narrative	Short description (not more than 150 words)	Mechanical devices such as engines, vehicles, aircrafts, etc., are typically instrumented with numerous sensors to capture the behaviour and health of the machine. The sensors temporal data has several complex patterns that are very hard to identify with traditional methods. We have proposed the use of Deep Learning algorithms for analysing such temporal patterns for anomaly/event detection, diagnosis, root cause analysis. Algorithms proposed so far are LSTM-AD, EncDec-AD, online RNN-AD. We used industrial datasets wherever possible and publically available datasets in other scenarios. In most of the cases, our algorithms were significantly better than other methods.
	Complete description	Mechanical devices such as engines, vehicles, aircrafts, etc., are typically instrumented with numerous sensors to capture the behaviour and health of the machine. However, there are often external factors or variables which are not captured by sensors leading to time-series which are inherently unpredictable. For instance, manual controls and/or unmonitored environmental conditions or load may lead to inherently unpredictable time-series. Detecting anomalies/events in such scenarios becomes challenging using standard approaches based on mathematical models

		that rely on stationarity, or prediction models that utilize prediction errors to detect anomalies. LSTM-AD Our Work started with Stacked LSTM network which is trained on non-anomalous data and used as a predictor over a number of time steps. The resulting prediction errors are modeled as a multivariate Gaussian distribution, which is used to assess the likelihood of anomalous behavior. The efficacy of this approach was demonstrated on four datasets: ECG, space shuttle, power demand, and multi-sensor engine dataset. EncDec-AD As an extension to the prior work we proposed a Long Short Term Memory Networks based Encoder-Decoder scheme for Anomaly Detection (EncDec-AD) that learns to reconstruct normal time-series behavior, and thereafter uses reconstruction error to detect anomalies. We experimented with three publicly available quasi predictable time-series datasets: power demand, space shuttle, and ECG, and two real-world engine datasets with both predictive and unpredictable behavior. We had shown that EncDec-AD is robust and can detect anomalies from predictable, unpredictable, periodic, aperiodic, and quasi-periodic time-series. Further, we showed that EncDec-AD is able to detect anomalies from short time-series (length as small as 30) as well as long time-series (length as large as 500). Online-AD The common approach of training one model in an offline manner using historical data is likely to fail under dynamically changing and non-stationary environments where the definition of normal behavior changes over time making the model irrelevant and ineffective. We described a temporal model based on Recurrent Neural Networks (RNNs) for time series anomaly detection to address challenges posed by sudden or regular changes in normal behaviour. The model is trained incrementally as new data becomes available, and is capable of adapting to the changes in the data distribution. RNN is used to make multi-step predictions of the time series, and the prediction errors are used to update the RNN model as well as detect anomalies and change points. Large prediction error is used to indicate anomalous behaviour or a change (drift) in normal behaviour. Further, the prediction errors are also used to update the RNN model in such a way that short term anomalies or outliers do not lead to a drastic change in the model parameters whereas high prediction errors over a period of time lead to significant updates in the model parameters such that the model rapidly adapts to the new norm. We demonstrate the efficacy of the proposed approach on a diverse set of synthetic, publicly available and proprietary real-world datasets.

Stakeholders	Maintenance and support functions, Monitoring, Procurement			
Stakeholders' assets, values	Anomaly/event detection, Diagnosis, Root cause analysis			
System's threats & vulnerabilities	Data biases could result in high number of false negatives and false positives that could result in heavy losses. Accuracy cannot be 100%.			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Precision	Correctly Predicted Anomalous scenarios/ Total Anomalous scenarios predicted	
	2	Recall	Correctly Predicted Anomalous scenarios /Total Anomalous Scenarios	
AI features	Task(s)	Prediction		
	Method(s)	Deep Learning		
	Hardware	GPU enabled desktops and servers		
	Topology	Deep models used for training and testing		
	Terms and concepts used	Deep Learning, Recurrent Neural Networks, feature engineering		
Standardization opportunities/ requirements	Sensor data collection			
Challenges and issues	Noisy Data Data with missing temporal features Rarity of Anomalous Data			
Societal Concerns	Description	None		
	SDGs to be achieved	Industry, Innovation, and Infrastructure		

A.45.2 Data (optional)

Data characteristics	
Description	Multiple datasets(publically available, real industrial) were used
Source	
Type	Temporal data
Volume (size)	
Velocity	
Variety	Space shuttle, ECG, Engine, Power demand
Variability (rate of change)	
Quality	

A.45.3 References

[1] Pankaj Malhotra, Anusha Ramakrishnan, Gaurangi Anand, Lovekesh Vig, Puneet Agarwal, Gautam Shroff, LSTM-based Encoder-Decoder for Multi-sensor Anomaly Detection, https://arxiv.org/abs/1607.00148

[2] Sakti Saurav, Pankaj Malhotra, Vishnu TV, Narendhar Gugulothu, Lovekesh Vig, Puneet Agarwal, Gautam Shroff, Online anomaly detection with concept drift adaptation using recurrent neural networks, CoDS-COMAD '18, Proceedings of the ACM India Joint International Conference on Data Science and Management of Data, Goa, India — January 11 - 13, 2018

A.46 Adaptable Factory

[SOURCE: SC42/WG4 N050 uc_46]

A.46.1 General

ID	46	
Use case name	Adaptable Factory	
Application domain	Manufacturing	
Deployment model	Cyber-physical System, Embedded System	
Status	PoC	
Scope	(Semi-)Automatic change of a production system’s capacities and capabilities from a behavioral and physical point of view	
Objective(s)	The objective is to enable flexible production resources which enable fast reconfiguration and adaptation to changing situations, context, and requirements which facilitate optimized resource usage under uncertainty.	
Narrative	Short description (not more than 150 words)	Rapid, and in some cases completely automated, conversion of a manufacturing facility, by changing both production capacities and production capabilities. This use case describes the adaptability of an individual factory by (physical) conversion and/or adaption of a factory’s and its machines behavior in order to adjust to changing situations like disruptions, material quality variation, production of new products, etc. A prerequisite is a modular and thereby adaptable design for manufacturing within the factory. The result is a need for intelligent and interoperable modules that basically adapted to an altered configuration on their own, and standardized interfaces between these modules.
	Complete description	Use Case description taken from [1,2,3]. Plug & Play – using a home computer and a USB cable, it is easy to connect new devices and use them almost immediately without any additional effort. The flexibility that has been available for quite a while on desktop computers is now gaining importance for industrial production. Demands on adaptability of production infrastructure are already rapidly increasing. Shorter and shorter product and innovation cycles require investment decisions for new production facilities that reflect future demand for production and

		process changes, where possible. In addition, the growing volatility of orders is hindering the optimal utilization of manufacturing lines with increasing frequency. Flexibility and adaptability will become increasingly important criteria in decisions regarding construction and operation of new production facilities. One example is product labeling. Various printing technologies are available, for example tampon printers (transferring ink from the printing form to the product using an elastic tampon), inkjet printers and/or laser printers. In an adaptable factory this type of operating equipment can be connected directly to the automated production process. Simply put, the material to be printed says: "Print me", and the tampon printer will ask: "Is the material to be printed greaseless?" The ink jet printer will then ask about the material characteristics, because it uses heat for the drying process, for example. A laser printer will ask about the material receiving the label to ensure sufficient contrast. **Key aspects** The application scenario for adaptable factories describes the rapid, and in some cases completely automated conversion of a manufacturing facility, by changing both production capacities and production capabilities. The key concept for implementation is a modular and thereby adaptable design for manufacturing within the factory. Intelligent and interoperable modules that basically adapted to an altered configuration on their own, and standardized interfaces between these modules allow for quick and simple conversion to adapt to changes in the market and customer demands. Whereas the application scenario Order-Controlled Production emphasizes flexible use of existing manufacturing facilities by means of intelligent connectivity, this scenario describes the adaptability of an individual factory by (physical) conversion. Today, when creating a production line, the focus is usually not only on quality, but also maximization of productivity and profitability of a pre-conceived product range. Individual components are connected statically and are capable of producing the pre-conceived functionalities and projected volumes. Frequently, a system integrator takes care of coordinating the individual components and developing a control system for the entire facility. However, if the order level is driven by strong product individuality or high fluctuation in demand, companies can no longer rely on the advantage of particular production lines. In this case, modular, order-oriented and adaptable manufacturing configurations become more attractive: For example, they increase overall utilisation or ability to deliver products. At the same time, however, the demands on individual machines or manufacturing modules increase. Even more important than high variance of specific manufacturing steps will be the ability to combine individual modules with ease

		and in any situation. In order to achieve this, the modules must contain a self-description regarding their ability to be combined or converted into a machine or plant very rapidly and robustly. The following examples illustrate these requirements: • A new network-enabled field device, for example a drive with a new version of firmware, is hooked up to the production line. The new device must be provided automatically with network connectivity and be made known to all online subsystems. The participating systems must correspondingly be updated. • An unconfigured field device is introduced to production, for example to quickly replace another defective device. The field device now must be individualized and parameterized due to the information located in the software components. • A production facility is converted or modified because a new product variation is planned. The control and software related changes must be detected and automatically transmitted to all participating systems. • After conversion of a plant, it should be possible to move software components for process management around the decentralized control units, while observing certain criteria, such as output or availability. • A (new) function of the Manufacturing Execution System (MES) is inserted or altered, for example the visualization of a situation not previously required. The visualization should be done automatically and access to the necessary information from the field level should also be automatic. This requires the mechanical engineer to design the internal development processes accordingly. Modular machines require “modular” engineering, based on libraries of re-usable modules (“platform development”). Machine architecture must be designed such that combinable mechatronic modules are created, including the Plug & Produce capability of production modules using interoperable interfaces and adaptive automation technology. This requires development of concepts for “services” across manufacturer boundaries, such as archiving, alerting or visualising, as well as a low-cost integration of MES functions. **Effect on value chains** Value added is shifted from the system integrator to the machine provider or its supplier, because the machines or components are enhanced so that they are easier to integrate. The type and quality of system integration change. The present focus on (production) technology shifts to a stronger focus on organization and business processes

<table>
<tr><td></td><td></td><td colspan="3">related to production processes. In extreme cases, the system integrator could become obsolete if intelligent, self-configuring and interoperable manufacturing modules can be created at the level of the machine suppliers.

Value added for participants
For manufacturing companies, a quick, inexpensive and reliable conversion of manufacturing becomes possible, so that they can react quickly to changes in customer and market demands. Increasing standardization and modularization also expand the possibilities for combining manufacturing entities of various providers and therefore realizing the most economic solution for each individual module.

Machine modularization opens up new areas with scale effects for machinery manufacturers.</td></tr>
<tr><td>Stakeholders</td><td colspan="4">Component suppliers (sensors, actuators), Machine builders, system integrators, plant operators (manufacturer)</td></tr>
<tr><td>Stakeholders' assets, values</td><td colspan="4"></td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">AI features</td><td>Task(s)</td><td colspan="3">Automatic reasoning (e.g. [7,8]), AI (task) planning (e.g. [4,6]), distributed coordination and negotiation (e.g. [5])</td></tr>
<tr><td>Method(s)</td><td colspan="3"></td></tr>
<tr><td>Hardware</td><td colspan="3"></td></tr>
<tr><td>Topology</td><td colspan="3"></td></tr>
<tr><td>Terms and concepts used</td><td colspan="3"></td></tr>
<tr><td>Standardization opportunities/ requirements</td><td colspan="4">Standardization needs for setting up this use case is currently under further investigation. Some initial intentions on standardization needs are the following: a vocabulary with formal semantic for symbolic reasoning about production capabilities across different vendors, standardized negotiation mechanisms, standardized autonomy classes of components, machines, etc. Quality model for trustful learned models and automatic behavior resulting from it.</td></tr>
<tr><td>Challenges and issues</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Societal Concerns</td><td>Description</td><td colspan="3">Enabling flexible and autonomously reconfigurable production systems ease human-machine configuration, facilitate optimized machine use, reduce failures through autonomous compensation, optimized product quality through prediction techniques.</td></tr>
<tr><td>SDGs to be achieved</td><td colspan="3">Industry, Innovation, and Infrastructure</td></tr>
</table>

A.46.2 References

[1] Working Group on Research and Innovation of the Plattform Industrie 4.0. Aspects of the Research Roadmap in Application Scenarios, Working Paper, German Federal Ministry for Economic Affairs and Energy, url: https://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/aspects-of-the-research-roadmap.html , 2016.

[2] Working Group on Research and Innovation of the Plattfom Industrie 4.0 and Alliance Industrie du Futur: Plattform Industrie 4.0 & Alliance Industrie du Futur : Common List of Scenarios. url: https://www.plattform-i40.de/I40/Redaktion/DE/Downloads/Publikation/plattform-i40-und-industrie-du-futur-scenarios.html, 2018

[3] Communication Promoters Group of the Industry-Science Research Alliance and German National Academy of Science and Engineering. Recommendations for implementing the strategic initiative INDUSTRIE 4.0, Final report of the Industrie 4.0 Working Group, url: https://www.acatech.de/Publikation/recommendations-for-implementing-the-strategic-initiative-industrie-4-0-final-report-of-the-industrie-4-0-working-group, April 2013

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A.47 Order-Controlled Production

[SOURCE: SC42/WG4 N050 uc_47]

A.47.1 General

ID	47
Use case name	Order-Controlled Production
Application domain	Manufacturing
Deployment model	Cloud Services
Status	Prototype
Scope	Automatic distribution of production jobs across dynamic supplier networks

Objective(s)	The objective is to enable automatic supplier contracting for optimized utilization of manufacturing capabilities at suppliers, novel degrees of flexibility in contract manufacturing, and enable (mass) customized customer ordering	
Narrative	Short description (not more than 150 words)	A network of production capabilities and capacities that extend beyond factory and company boundaries allows for a quick order-controlled adaption to changing market and order conditions. The result is a largely fragmented and dynamic value chain network that change as required by the individual order, and thereby make the best use of capabilities and capacities of existing production facilities. The goal is to allow for automated order planning, allocation and execution, thereby considering all production steps and facilities required to facilitate linking external factories into a company's production process, as automated as possible.
	Complete description	Use Case description taken from [1,2,3]. Many contemporary products are changing at an ever-in-creasing rate. Whereas up until just recently, smartphone displays were flat, the first curved displays are already on the market. The array of materials used in the automotive sector is also continually expanding – from aluminum, to high-strength steels and even fiber-reinforced plastics, today many types of materials are used. Innovation and product cycles are getting shorter all the time, and new production technologies are putting pressure on manufacturing companies to react more and more rapidly and make quick investment decisions regarding both consumer goods and investment goods. In order to confront this trend and avoid lengthy investment decisions, companies are starting to increase the network of their production capabilities beyond their own company boundaries. **Key aspects** The Order-Controlled Production application scenario describes a flexible manufacturing configuration. Owing a network of production capabilities and capacities that extend beyond factory and company boundaries, this company can quickly adapt to a changing market and order conditions, and thereby make the best use of capabilities and capacities of existing production facilities. In this way the potential provided by a network to other factories out-side of the company's own facilities is used to align the company's own portfolio – and especially its production – to quickly changing customer and market demands. Specifically, manufacturing chains are optimized for various parameters, such as cost and time. At its core, order-controlled production is based on standardization of the individual process steps on the one hand and the self-description of production facility capabilities on the other hand. This standardization allows for auto-mated order planning, allocation and execution, thereby considering all production steps and facilities

<table>
<tr><td></td><td></td><td colspan="3">required. This helps to combine individual process modules much more flexibly and earlier than previously possible, and to make use of their specific capabilities.

In this respect, companies offer their available production capacities to other companies and thereby increase the utilization of their own machinery. Other companies may access these capacities as needed, thereby temporarily expanding their own production spectrum. In so doing, available production capacities are utilized better and order fluctuations can be smoothed out. The goal is to facilitate linking external factories into a company's production process, as automated as possible. In particular, the order placement process required for this should be executed automatically.

Effect on value chains
Today's relatively rigid and separately negotiated relationships between companies along the value chain will be transformed into a largely fragmented and dynamic value chain network that changes as required by the individual order. This applies both horizontally over the entire manufacturing process as well as vertically, with regard to production depth. Manufacturing companies focus on value-added steps that distinguish them significantly from other competitors. The possibility of creating fast and global client-manufacturer relationships can lead to unexpected competitive situations, because companies may change their role from order to order. Dynamically integrating production capacities will lead to better machine utilization and, as a result, diminishing demand for machinery suppliers.

Value added for participants
On the one hand, manufacturing companies will be able to automatically expand their production capabilities and capacities ad hoc in line with demand, by utilizing external production modules. No investment is required. This enables companies to react very flexibly to changing market and customer demands. On the other hand, companies offering their machines on the market can optimize their utilization rates.</td></tr>
<tr><td>Stakeholders</td><td colspan="4">Customer, Producing companies, Broker</td></tr>
<tr><td>Stakeholders' assets, values</td><td colspan="4">Customer orders a good via the broker (separate stakeholder), Producing companies operate factories and machine parks.</td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>AI features</td><td>Task(s)</td><td colspan="3">Automatic reasoning, AI (task) planning, distributed coordination and negotiation (cf. [5-8] for details and overview)</td></tr>
</table>

	Method(s)	
	Hardware	
	Topology	
	Terms and concepts used	
Standardization opportunities/ requirements	Standardization needs for setting up this use case is currently under further investigation. Some initial intentions on standardization needs are the following: Standardization of data formats and semantic for exchanged data is enabler for this use case where multiple companies and institutions are involved (formal semantics for reasoning about 3d models, task decomposition and planning), standardization of interaction protocols between participants (esp. coordination and negotiation) enables automatic cross-company contracting.	
Challenges and issues		
Societal Concerns	Description	Enabling mass-customized production in global dynamic supply chains, and by that, ease production of small lot sizes for customized products.
	SDGs to be achieved	Industry, Innovation, and Infrastructure

A.47.2 References

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[5] Birgit Vogel-Heuser, Jay Lee, and Paolo Leitao. Agents enabling cyber-physical production systems. at – automatisierungstechnik 63(10). DOI: 10.1515/auto-2014-1153, 2015.

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A.48 Value-based Service

[SOURCE: SC42/WG4 N050 uc_48]

A.48.1 General

<table>
<tr><td>ID</td><td colspan="2">48</td></tr>
<tr><td>Use case name</td><td colspan="2">Value-based Service</td></tr>
<tr><td>Application domain</td><td colspan="2">Manufacturing</td></tr>
<tr><td>Deployment model</td><td colspan="2">Hybrid deployment: Cloud and on-premise deployment in the production field</td></tr>
<tr><td>Status</td><td colspan="2">PoC</td></tr>
<tr><td>Scope</td><td colspan="2">Process and status data from production and product use sources are the raw materials for future business models and services.</td></tr>
<tr><td>Objective(s)</td><td colspan="2">The objective of this use case is the provision of remote services for product and production based on (generic) service platforms. This use case can be seen as a fundament for the deployment of arbitrary AI remote services.</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td>Service platforms collects data from product use – for example machines or plants – and analyses and processes this data to provide tailor-made individualized services, e.g. optimized maintenance at the proper time, or the timely provision of the correct process parameters for a production task currently being requested. Companies offering these services (service providers) occupy the interface between the product provider and the user.</td></tr>
<tr><td>Complete description</td><td>Use Case description taken from [1,2,3]. In the consumer area, the increased interconnectivity of users which has made it possible to collect user data has made a whole new range of services possible. For example, navigation systems in our cars not only determine the shortest route, but also the quickest, as the traffic situation is assessed in real time based on movement data from other users. Entertainment media is no longer purchased rather made available as needed using streaming services. The services offered extend beyond simply making the products available. The individual customer receives optimized offers, based on user data: the quickest route during rush hour, or music tailored to that customer's taste.

Similar developments are occurring in an increasingly interconnected industrial environment. Services that go significantly beyond simply providing a production unit – a contemporary example is leasing – are gaining in importance and are changing the classic value-added processes and business models.

Key aspects
At the heart of this application scenario are IT platforms that collect data from product use – for example machines or plants for production purposes – and analyze and process this data to provide tailor-made individualized services. This could include for example optimized maintenance at the proper time, or the timely provision of the correct process</td></tr>
</table>

		parameters for a production task currently being requested. The collected data could be product parameters, for example the machines and plants required for manufacture, the product status information, or data from the production process or the upstream supply process. Even the characteristics of the processed raw materials or the parts of the product could be included. The goal is to use this data as a raw material for optimizing products and production processes and for new services. This can help to not only improve existing value chains but also perhaps create new value-added elements. **Effect on value chains** The industrial environment today is influenced in principle by two actors – the product provider (i.e. manufacturers of production facilities and service providers) and the customer (product users, i.e. production facility operators), who work together with varying degrees of intensity. With the introduction of Value-Based Services an additional actor enters the scene, operating IT platforms that it uses to provide new services to both classic partners. This platform operator could be a new element of the value chain, that is, an autonomous company. However, this role could be taken on by product providers by increasing their value added compared with the current situation. Product providers make their product data and parameters available. On the basis of all of this user data, new services can now be developed, such as individual optimized maintenance or specific operating and process parameters that optimize or even expand production capabilities of the existing infrastructure. The companies offering these services (service providers) occupy the interface between the product provider and the user. The result is that the share in the value chain spanning from the product provider to the user can be shifted significantly, compared with the situation today. The user can then distinguish between the products by considering the accompanying services or the possibility of expanding those services even after purchasing the product, and no longer primarily by the (physical) specifications mandated by the product provider. This makes it very attractive for the product provider to use such platforms and to offer new services on them. **Value added for participants** In this application scenario the value added for the product provider stems from the availability of a multitude of process data from various application scenarios, which the user can apply to further development of its product port-folio. As an operator of related IT platforms, the product provider can offer new services. In this way, it strengthens customer loyalty and increases its portion of value added.

		Value added for the user, on the other hand, can come from better utilization of the product, enhanced product availability from improved maintenance, for example, or optimized product use as a result of optimally adapted product parameters.		
Stakeholders	Customer (product user), platform provider, service provider, product provider			
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
AI features	Task(s)	Reasoning and autonomous problem solving in the platform, services based on the platform use AI features, e.g. for predictive maintenance, data semantics (cf. [5,6] for an overview)		
	Method(s)			
	Hardware			
	Topology			
	Terms and concepts used			
Standardization opportunities/ requirements	Standardization needs for setting up this use case is currently under further investigation. Some initial intentions on standardization needs are the following: For this use case, standardization can be seen as enabler because an agreement on a (small set of) communication protocols would facilitate to connect to the platform and use this protocol also for device2device communication. Since services running on a platform are not aware of an implicit sematic of data sources (machines, sensors, actuators, …), an explicit semantic or a common vocabulary is need describing data and enable reasoning about machine states on premise (on the machine/edge) as well as on the cloud. For cloud2cloud communication and cloud federation, further interoperability standards are required on communication level as well as on data semantics level.			
Challenges and issues				
Societal Concerns	Description	Increasing complexity of modern cyber-physical production systems cannot be managed by humans. AI technologies provide one solution in this context for more reliable, fault-tolerant, safe and secure production systems.		
	SDGs to be achieved	Industry, Innovation, and Infrastructure		

A.48.2 References

[1] Working Group on Research and Innovation of the Plattform Industrie 4.0. Aspects of the Research Roadmap in Application Scenarios, Working Paper, German Federal Ministry for Economic Affairs and Energy, url: https://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/aspects-of-the-research-roadmap.html , 2016.

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A.49 AI Solution for Traffic Signal Optimization based on Multi-source Data Fusion

[SOURCE: SC42/WG4 N050 uc_49]

A.49.1 General

ID	49	
Use case name	AI solution for traffic signal Optimization based on multi-source data fusion	
Application domain	Transportation	
Deployment model	Cloud services	
Status	In operation	
Scope	Generate traffic signal timing plans by analyzing traffic flow status and patterns based on fusing internet data, induction coils data and video data, and control the traffic signal with the generated timing plans in a real-time, self-adaptive and cooperative way	
Objective(s)	To find an effective and efficient solution to improve the road utilization efficiency by increasing traffic flow speed and reducing traffic flow waiting time.	
Narrative	Short description (not more than 150 words)	An AI solution was developed that could recognize real-time traffic flow status and abstract traffic flow patterns by fusing internet data, induction coils data and video data, and could generate optimized traffic signal timing plan by self-adaptively responding to real-time traffic flow fluctuation and with regards to traffic flow coordination among multiple intersections within a given region.
	Complete description	By far, traffic administrator produces traffic signal timing plans by observing traffic flow situation on-site at intersections or through videos, and relies on her/his personal experience. Then, the timing plans are input into and executed by the traffic signal control system. The disadvantages of this manual traffic signal timing plan generation approach are as follows: 1. Low computing

		efficiency, it consumes very long time for traffic administrator to observe and analyze traffic patterns. 2. Low computing precision, traffic administrator only cares about the macro traffic flow tendency at intersections without computing detailed traffic parameters such as speed, queue length in each lane, etc. 3. Slow response to traffic flow fluctuation, it is hard for traffic administrator to produce adaptive timing plan in time with respect to real-time traffic flow fluctuation, due to her/his limited computing ability, not mention to coordinate traffic flows among multiple intersections by controlling the traffic signal in real-time. 4. Experienced traffic administrators are severely in short for cities with the scale of thousands intersections. For solving the above problems, the AI provider applies a multi-source data fusion approach to recognize the traffic flow status and generalize the traffic flow pattern by analyzing the internet data (i.e., vehicle driving trajectory data provided by internet service supplier), detector data collected by induction coils, and structured data recognized from videos. Furthermore, the AI provider develops an optimization method to figure out optimized traffic signal timing plan by self-adaptively responding to real-time traffic flow fluctuation and with regards to traffic flow coordination among multiple intersections. The developed methods have been applied in practice within a given region from a large city. It generates traffic signal timing plans for all the intersections in the region according to their real-time traffic flow fluctuation with an updating frequency of 5 minutes per time. Compared with the manual traffic signal timing plans form the traffic administrators, the plans generated by the new method have increased the average vehicle driving speed by 9%, and reduced the average vehicle waiting time by 15%.		
Stakeholders	DOT DOP			
Stakeholders' assets, values	Safety,stability,trustworthiness			
System's threats & vulnerabilities	new privacy threats,new security threats			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives

	1	Average vehicle driving speed	Average vehicle driving speed on all the road sections in a given region	Improve the road utilization efficiency
	2	Average vehicle waiting time	Average vehicle waiting time at all the intersections in a given region	Improve the road utilization efficiency
AI features	Task(s)	Optimization		
	Method(s)	Deep learning, Bayesian network, Time series analysis, Operational research optimization method (i.e., Mixed integer linear programming, etc.)		
	Hardware	ECS		
	Topology	Cloud Service		
	Terms and concepts used	Traffic signal self-adaptive and coordinative control for a large number of intersections. Issues: 1. Not all intersections are equipped with detectors such as induction coil or video. 2. The detectors may output abnormal values which need data clean processings.		
Standardization opportunities/ requirements				
Challenges and issues	Challenges: Traffic signal self-adaptive and coordinated control for a large number of intersections. Issues: 1. Not all intersections are equipped with detectors such as induction coil or video. 2. The detectors may output abnormal values which need data clean processing.			
Societal Concerns	Description	Relieve urban road congestion		
	SDGs to be achieved	Sustainable cities and communities		

A.49.2 Data (optional)

Data characteristics	
Description	Internet data, Induction coil data, Video data
Source	Internet, Detector, Detector
Type	Structured text and number, Structured text and number, Unstructured video
Volume (size)	
Velocity	Internet data updated daily, Induction coil data updated every 5 minutes, Video data updated in real-time
Variety	From multiple domains
Variability (rate of change)	Dynamic
Quality	Exists missing values or abnormal values

A.49.3 Process scenario (optional)

Scenario conditions

No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Training	Train multiple models (deep learning, Bayesian network, Time series analysis) for recognizing traffic flow volume and abnormal values in the input data	Dataset is ready		
2	Optimization	Based on the data processed by the trained models, optimize the period length, split, and key phase offsets among multiple intersections for traffic signal timing plans	Completion of training/retraining	Completion of missing values or abnormal values processings	
3	Evaluation	Pre-evaluate the execution effects of the optimized traffic signal timing plans, which include the period lengths, splits, and	Completion of optimization	Input prediction of traffic flow situation in the next period	The pre-evaluated execution effects of the optimized traffic signal timing plan is superior to the current one

		key phase offsets among multiple intersections			
4	Execution	Execute the optimized traffic signal timing plan	Completion of evaluation	The pre-evaluated execution effects of the optimized traffic signal timing plan is superior to the current one	

A.49.4 Training (optional)

Scenario name	Training				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Dataset is ready	Transform video data into structured data	AI provider	Transform video data into structured data by deep learning	
2	Completion of Step 1	Data clustering	AI provider	Recognize abnormal value patterns and label them in internet data, induction coil data, and structures video data by data clustering	
3	Completion of Step 2	Processing of missing value and abnormal value	AI provider	Recognize abnormal value and process them, and fill missing values by data clustering, time series analysis and Bayesian network	
4	Completion of Step 3	Data fusion	AI provider	Compute traffic status parameters such as traffic volume, vehicle driving speed, etc. by fusing internet	

				data, induction coil data and structured video data	

Specification of training data	

A.49.5 Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Completion of optimization	Construct the evaluation model of the traffic signal timing plan	AI provider	Construct the evaluation model of the traffic signal timing plan based on traffic engineering theory	
2	Completion of Step 1	Evaluate the effect of the computed traffic signal timing plan	Traffic administrator	Pre-evaluate the effect of the computed traffic signal timing plan with the evaluation model	

Input of evaluation	
Output of evaluation	

A.49.6 Execution (optional)

Scenario name	Execution				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Completion of evaluation	Execute the computed traffic signal timing plan	Traffic administrato r	Input the computed traffic signal timing plan into the traffic signal control system and execute it	The pre-evaluated execution effects of the optimized traffic signal timing plan is superior to

					the current one

Input of Execution	
Output of Execution	

A.49.7 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	patent	ZHANG MAOLEI;WEI LIXIA;CHEN XIAOMING;LI JIN.，”Crossing traffic jam judging and control method and system based on sensing detectors ”.CN201310395431.2013			QINGDAO HISENSE TRANS TECH CO	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml
2	patent	ZHANG MAOLEI;WEI LIXIA;CHEN XIAOMING;LIU XIN;LIU HONGMEI;LI JIN.“Multi-strategy and multi-object self-adaptation traffic control method”. CN201310548921.2013			QINGDAO HISENSE TRANS TECH CO	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml
3	patent	WANGMENGJIA;MINWANLI.” Road traffic optimization method and device and electronic equipment ”. CN201710081075.2017			ALIBABA GROUP HOLDING LTD;	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml
4	patent	HUA XIANSHENG” Assessment method and device of traffic condition ”. CN201610645412.2016			ALIBABA GROUP HOLDING LTD;	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml
5	patent	HUA XIANSHENG,REN PEIRAN,SHEN CHEN,CHU WENQING,LIU YAO.” Road intersection traffic flow control method and device”. CN201610644132.2016			ALIBABA GROUP HOLDING LTD;	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml

6	paper	Liang Yu,Jingqiang Yu,Maolei Zhang, Xin Zhang, Yuehu Liu."Large Scale Traffic Signal Network Optimization-a Paradigm Shift Driven by Big Data". ICDE2019			Alibaba Cloud Computing Hangzhou, China	
7		M. Papageorgiou, C. Diakaki, V. Dinopoulou, A. Kotsialos, and Y.Wang, "Review of road traffic control strategies," Proceedings of the IEEE, vol. 91, no. 12, pp. 2043–2067, 2003.				
8	paper	P. Lowrie, "Scats, sydney co-ordinated adaptive traffic system: A traffic responsive method of controlling urban traffic," 1990.				
9	paper	F. Corman, A. D'Ariano, D. Pacciarelli, and M. Pranzo, "Evaluation of green wave policy in real-time railway traffic management," Transportation Research Part C: Emerging Technologies, vol. 17, no. 6, pp. 607–616, 2009.				
10	paper	L. Singh, S. Tripathi, and H. Arora, "Time optimization for traffic signal control using genetic algorithm," International Journal of Recent Trends in Engineering, vol. 2, no. 2, p. 4, 2009.				

A.50 AI Solution to Quality Control of Electronic Medical Record(EMR) in Real Time

[SOURCE: SC42/WG4 N050 uc_50]

A.50.1 General

ID	50
Use case name	AI solution to quality control of Electronic Medical Record(EMR) in real time
Application domain	Healthcare
Deployment model	Cloud services
Status	In operation

<table>
<tr><td>Scope</td><td colspan="2">Detecting defects in EMR by inspecting unstructured data based on Natural Language Processing(NLP) ability</td></tr>
<tr><td>Objective(s)</td><td colspan="2">To insure the completeness, consistency, punctuality and medical-compliance of EMR written by physicians</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td>This AI solution in ET Medical Brain Medical service support system was developed that could simultaneously detect mistakes while physicians wrote EMR（Electronic Medical Record）.

Using NLP（Natural Language Processing） ability, it can process a large amount of unstructured text and judge the accuracy according to recognized medical reference.
It achieved 80% coverage of all the EMR quality control requirements issued by Chinese government, and human labour of EMR QC （Quality Control） was reduced 60%, which translated into cost savings, and enhanced physician education.</td></tr>
<tr><td>Complete description</td><td>Medical records are the records of the occurrence, development and prognosis of patients' diseases, as well as the medical activities such as examination, diagnosis and treatment.

A high-quality medical record has great value at medical and legal level.

When medical records are converted from handwritten to electronic input, delayed, uncompleted writing and copying are endangering the quality of medical records.

Once the medical record data does not meet the requirements, it will greatly affect the health of patients, the development of medicine and the judgment of responsibility in medical accidents.

Nowadays, hospital has a Medical Records Department to control medical records quality manually. However, as the number of medical records increases, the inspection requirements become more complex, and the medical professional knowledge requirements are improved, so the medical records quality inspection becomes harder.

The intelligent electronic medical record quality control system is based on NLP. When a doctor writes medical records, it can analyze unstructured medical record text, and control the quality based on government requirements, ensure the integrity, consistency, timeliness and compliance of medical records.

ET（Evolutionary Technology） Medical Brain Medical service support system has learning ability to learn more medical knowledge including clinical pathway, drug compatibility taboo etc. it can learn the habits and rules of doctor’s manual review to inspects records profoundly.</td></tr>
</table>

		The current system has covered 189 medical records quality inspection requirements, saved 60% review time for medical record department, which greatly saved the cost of the hospital, reduced the inspection time and repeated work, and will help doctors put more energy into the education and training.		
Stakeholders	Doctor, Hospital, Patient			
Stakeholders' assets, values	Safety, privacy, fair treatment, trustworthiness			
System's threats & vulnerabilities	New privacy threats, new security threats			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Coverage	Ratio of EMR QC requirements done in the solution/all issued EMR QC requirements in China. Ideal target is 100%.	Improve accuracy
AI features	Task(s)	Natural language processing		
	Method(s)	SimHash		
	Hardware	ECS		
	Topology	Cloud Service		
	Terms and concepts used	Jaccard index		
Standardization opportunities/ requirements				
Challenges and issues	Challenges: Achieve all EMR QC requirements in different disease areas Issues: 1) Lack of medical reference data 2) Lack of medical knowledge graph			
Societal Concerns	Description	Achieved 80% coverage of all the EMR quality control requirements issued by Chinese government, and human labour of EMR QC （Quality Control） was reduced 60%, which translated into cost savings, and enhanced physician education.		
	SDGs to be achieved	Good health and well-being for people		

A.50.2 Data (optional)

Data characteristics	
Description	EMR text data
Source	EMR system
Type	Text data from EMR system vendor
Volume (size)	
Velocity	Real time
Variety	Multiple datasets

Variability (rate of change)	Static
Quality	High (depending on EMR system)

A.50.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Training	Train a model (deep neural network) with training samples	Sample raw dataset is ready		
2	Evaluation	Evaluate whether the trained model can be deployed	Completion of training/re training		
3	Execution	Detect defects (regions including defects) using the trained model	Completion of deploymen t in EMR system	The trained model has been evaluated as deployable	
4	Retraining	Retrain a model with training samples	Certain period of time has passed since the last training/re trainig		

A.50.4 Training (optional)

Scenario name	Training				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Raw data preparation	Raw data to cloud	AI solution provider	Transform sample raw data from EMR system to server on cloud	The software for data transform has to be provided by the AI solution provider.
2	Completion of Step 1	Training sample creation	AI solution provider	Create training samples by	

				labelling the output of Step 1 with "defective"/"non-defective"	
3	Completion of Step 2	Model training	AI solution provider	Train a model (deep neural network) with the training samples created by Step 2	

Specification of training data	

A.50.5 Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event	Name of process/Activity	Primary actor	Description of process/activity	Requirement
1	Completion of training/retraining	Preparation	AI solution provider	Transform sample raw data from EMR system to server on cloud	
2	Completion of Step 1	Detection	AI solution provider	Given the image data from Step 1, detect defects (regions including defects) using the deep neural network trained in the scenario of training	
3	Completion of Step 2	Evaluation	Manufacturer	Compare the result of Step 2 with that of human inspection	

Input of evaluation	
Output of evaluation	

A.50.6 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1						https://et.aliyun.com/brain/healthcare?spm=a2c17.92424.1146454.87.254f1a43dCNCpb
2	Patent	A medical symptom knowledge base classification system construction algorithm and device based on lexical cluster similarity	In application			Patent number: 100424310
3	Patent	Electronic medical record named entity recognition method and device combining Section feature information	In application			Patent number: 100557465
4	Patent	Algorithm and device for recognizing nested medical named entities based on two-layer recurrent neural network	In application			Patent number: 100609063
5	Patent	Algorithm and device for unsupervised keyword-based medical image report key information extraction	In application			Patent number: 100619640
6	Patent	Medical record text structure analysis algorithm and device based on pseudo corpus generation	In application			Patent number: 100558223
7	Patent	Algorithm and device for improving accuracy of medical record quality assurance system by using doctor behavior log	In application			Patent number: 100558228
8	Patent	Medical record text structure analysis algorithm and device based on context-free grammar parsing technology	In application			Patent number: 100549098
9	Patent	Algorithm and device for structural analysis of medical records combined with visual features	In application			Patent number: 100605377
10	Patent	Method and device for Chinese medical record named entity recognition by using Iterated Dilated	In application			Patent number: 100554136

		CNN with condition random field model based on Chinese character structure				
11	Patent	Method and device for Chinese medical field relationship extraction by using residual convolution attention network model	In applicatio n			Patent number: 100558469
12	Patent	Method and device to detect similar electronic medical records	In applicatio n			

A.51 Machine Learning Tools in Support of Transformer Diagnostics

[SOURCE: SC42/WG4 N050 uc_51]

A.51.1 General

ID	51	
Use case name	Machine Learning Tools in Support of Transformer Diagnostics	
Application domain	Performance evaluation and diagnostics	
Deployment model	Prototype	
Status	Under development	
Scope	Power Transformers operation and maintenance	
Objective(s)	Use of Machine Learning (ML) algorithms as supporting tools for the automatic classification of power transformers operating condition	
Narrative	Short description (not more than 150 words)	The successful use of ML tools may find multiple applications in the industry such as providing fast ways of analysing new data streaming from online sensors, evaluating the importance of individual variables in the context of transformer condition assessment and also the need or adequacy of data imputation in the so widely common problem of missing data
	Complete description	The work consists of training 12 ML algorithms with real data from 1,000 (one thousand) transformers that were individually analyzed by human experts. Each transformer in the database is scored with a 'green', 'yellow' or 'red' card depending on the data, the interpretation of human experts, or even after some calculations carried out by the company's internal algorithms frequently utilized by the experts to identify units with technical operational issues. The ML algorithms, however, do not utilize or are given any of the engineering tools employed by the human experts. The algorithms only employed the raw data in a supervised learning process in which a column named 'Class' was added to the transformer information with the classification red, yellow or green provided by the human expert.
Stakeholders	Transformers end users	

<table>
<tr><td>Stakeholders' assets, values</td><td colspan="4">Enhanced diagnostic of transformer fleet with consequent improvement on predictive maintenance and therefore electrical grid reliability</td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4">Lack of enough data to perform the analysis</td></tr>
<tr><td rowspan="4">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>Algorithm accuracy</td><td>Output when compared to the human expert analysis of the same data</td><td>See reference</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">AI features</td><td>Task(s)</td><td colspan="3">Statistical learning</td></tr>
<tr><td>Method(s)</td><td colspan="3">12 ML methods used for the comparison exercise:
Linear Algorithms
1. General linear regression (logistic regression) - GLM
2. Linear discriminant analysis - LDA
Non-linear Algorithms
1. Classification and regression trees (CART and C5.0)
2. Naïve Bayes algorithm (NB)
3. K-Nearest Neighbor (KNN)
4. Support Vector Machine (SVM)
Ensemble Algorithms
1. Random Forest (stochastic assembly of a large number of CART algorithms)
2. Tree Bagging (Tree Bagging)
3. Extreme Gradient Boosting Machine (xGBM1 and xGBM2)
4. Artificial Neural Networks (ANN)</td></tr>
<tr><td>Hardware</td><td colspan="3">Standard laptop</td></tr>
<tr><td>Topology</td><td colspan="3">NA</td></tr>
<tr><td>Terms and concepts used</td><td colspan="3">Machine Learning Algorithms, Transformer Diagnostics, Condition Assessment, Automated Tool</td></tr>
<tr><td>Standardization opportunities/ requirements</td><td colspan="4">Standardization of asset performance data format and analysis</td></tr>
<tr><td>Challenges and issues</td><td colspan="4">Data availability, missing data, imbalanced classes</td></tr>
<tr><td rowspan="2">Societal Concerns</td><td>Description</td><td colspan="3">Safe and reliable power delivery</td></tr>
<tr><td>SDGs to be achieved</td><td colspan="3">Industry, Innovation, and Infrastructure</td></tr>
</table>

A.51.2 References

<table>
<tr><td colspan="7">References</td></tr>
<tr><td>No.</td><td>Type</td><td>Reference</td><td>Status</td><td>Impact on use case</td><td>Originato r/organi zation</td><td>Link</td></tr>
</table>

1	Conference	Cheim, Luiz V. Machine Learning Tools in Support of Transformer Diagnostics Cigre General Session Paris 2018, paper reference A2-206	Presented in Aug 2018	Use case taken from this reference	ABB	Cigre web page

A.52 Automated Travel Pattern Recognition using Mobile Network Data for Applications to Mobility as a Service

[SOURCE: SC42/WG4 N050 uc_52]

A.52.1 General

ID	52	
Use case name	Automated Travel Pattern Recognition using Mobile Network Data for Applications to Mobility as a Service	
Application domain	Other (please specify) Transport	
Deployment model	Activity- based Modelling for New mobility Services	
Status	PoC	
Scope	Detect automatically travel pattern recognition from anonymized and aggregated Mobile phone Network Data	
Objective(s)	Phase 1: Attribute trip purpose and mode of transport to multimodal door-to-door journeys from Mobile phone Network Dataset using AI and machine learning techniques (Activity based model) Phase 2: Generate daily activities for static agents in the Agent Based Model Phase 3: Optimisation of New Mobility services in integration with mass transit	
Narrative	Short description (not more than 150 words)	Activity- based modelling has the capability to exploit big data source generated by smart cities to create a digital twin of urban environments to test Mobility as a Service schemes. MND data have been used to create activities for an Agent Based Model. AI is used to automatically detect purpose and mode of transport in multimodal round trips, obtained by anonymized and aggregated MND trip-chains dataset. Data fusion techniques and SQL queries were also used to consider land use and facilities in the urban area of interest.
	Complete description	Activity- based modelling has the capability to exploit big data source generated by smart cities to create a digital twin of urban environments to test Mobility as a Service schemes. Given the rise of location- based data and Mobile phone Network Data (MND) for transport modelling purpose, Agent based modelling has become a viable tool to explore a sustainable introduction of mobility services, exploring the integration with mass transit. AI is used in detecting purpose and mode of transport in multimodal round trips and assign purpose and mode of

		transport to trip- chains dataset coming from MND. The methodology has been developed for the Innovate UK funded Mobility on Demand Laboratory Environment (MODLE) project and will undergo a validation process during the Demand Modelling and Assessment through a Network Demonstrator (DeMAND) project for the Department for Transport (UK)		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Generation of Activities (land use information and time of travel)	Purpose of activities is assigned based on land use information and time of travel. Cnesus data and national/ local travel surveys will provide validation for the process	Phase 1
	2	Generation of agents (travel times, speed on links)	Agents generated will build up in the network creating realistic conditions of congestion. Speed on links	Phase 2
		Operation of service (number of users for the service)	Optimisation of route and operation time in the day. Validation provided using data collected by Mobility service operators during the operation of service	Phase 3
AI features	Task(s)	Assign purpose of each trip in the chain, assign model of transport for each trip in the chain, generate daily activity plans, generate static agents (users), generate dynamic agents (service)		
	Method(s)	Agent Based Models with Activity based approach		
	Hardware	NA		
	Topology			
	Terms and concepts used	Data fusion, machine learning techniques		
Standardization opportunities/ requirements				
Challenges and issues	The use of Mobile Phone Network data is still not precise for shorter trips and internal trips which might be not detected. However, with the introduction of 5G, MND will be even more reliable and available to use in transport modelling.			

Societal Concerns	Description	The use of anonymization techniques minimise the risk of disclosing personal information when analyzing location based data and Mobile phone Network Data
	SDGs to be achieved	

A.52.2 References

[1] Franco P, Johnston R, McCormick (2019) Demand Responsive transport: generation of activity patterns from mobile phone network data to support the operation of flexible mobility services. - Special issue of Transportation Research Part A (TRA) on developments in Mobility as a Service (MaaS) and intelligent mobility (forthcoming) https://www.sciencedirect.com/journal/transportation-research-part-a-policy-and-practice/vol/121/suppl/C

[2] Franco P, Johnston R, McCormick E (2018) Role of Intelligent Transport Systems applications in the uptake of mobility on demand services, United Nation "Transport and Communications Bulletin for Asia and the Pacific, 2018, No. 88 - Intelligent Transport Systems", https://www.unescap.org/sites/default/files/Ch02-Role%20of%20Intelligent%20Transport%20Systems%20%28ITS%29%20applications%20in%20the%20uptake%20of%20mobility%20on%20demand%20services_0.pdf

[3] Franco P, McCormick E, Johnston R (2018) Multimodal activity Modelling for supporting mobility service operations, ITS World Congress Copenhagen, 17-21 September 2018

[4] Franco P, McCormick E, Van Leeuwen K, Ryan Johnston, Gregor Engelmann (2017) Multi-Modal Activity-Based Models to support Flexible Demand Mobility Services. ITS World Congress 2017, Montreal 29 October- 2 November 2017. Awarded Best Paper

[5] Franco P, McCormick E, Van Leeuwen K (2017) Framework for modelling MaaS using ABM and real-time data from ride-sharing services. 12ve ITS Europe Congress 2017, Strasbourg, 19-22 June 2017. Proceedings

A.53 Improving conversion rates and RoI (Return on Investment) with AI technologies

[SOURCE: SC42/WG4 N050 uc_53]

A.53.1 General

ID	53
Use case name	Improving conversion rates and RoI (Return on Investment) with AI technologies
Application domain	Digital marketing
Deployment model	On-premise systems
Status	In operation
Scope	Utilizing AI technologies in digital marketing
Objective(s)	1) help the operation team identify new business scenarios and seize more market opportunities, 2) increase conversion rate and marketing effectiveness, 3) improve user experience by providing individually customized services

Narrative	Short description (not more than 150 words)	Personalized digital marketing has become increasingly important in response to the needs of providing different services to different consumers. The combination of big data and AI algorithms is the core of personalized digital marketing. By modeling user preferences, we can predict the services that users may be interested in, improve marketing effectiveness and enhance user experience.		
	Complete description	With the economic development, consumers are more emphatic about self-personality. Digital Marketing has also begun to focus more on the consumer's personality instead of the commonality. Personalized digital marketing has become increasingly important in response to the needs of providing different services to different consumers. The combination of big data and AI algorithms is the core of personalized digital marketing. By modeling user preferences, we can predict the services that users may be interested in, improve marketing effectiveness and enhance user experience. There are three main parts of personalized marketing technology: 1) Audience Targeting: Forecasting people who may be interested in the marketing activities, focusing on high-conversion probability populations to increase conversion rates; 2) Smart subsidy: Different marketing subsidies for different users to achieve higher conversion rates at lower cost ; 3. Personalized Recommendation : Predict user preferences for services or items, and recommend to users what they are most likely to be interested in, to increase conversion rates. Through the application of AI technology, personalized digital marketing has achieved very significant results: the predicted population's conversion rates has achieved more than 30% improvement; in subsidy scenario it has achieved a cost reduction of more than 10% while the 2% increase in conversion rate; in the coupon recommendation scenario, the conversion rate has been improved by more than 70%.		
Stakeholders	Third-party payment companies, end users, merchants			
Stakeholders' assets, values	User experience, digital marketing RoI, conversion rate, marketing cost			
System's threats & vulnerabilities	Abuse of personal information, Falsified or dirty data			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
		Conversion rate	the percentage of users who accept the marketing (e.g., clicks) out of the total number of visitors	To increase the conversion rate
		RoI	RoI=conversion_rate*(1-k*cost) k is the cost impact factor and	To increase the marketing effectiveness

			it can be adjusted to get higher conversion rate or lower cost	

AI features	Task(s)	Audience Targeting, Smart Pricing, Personalized Recommendation
	Method(s)	Machine learning, Deep learning
	Hardware	
	Topology	
	Terms and concepts used	Attribution Analysis, Fatigue control, Smart Pricing, Off-line Batch Computation, OLAP Analysis
Standardization opportunities/ requirements	• Technical framework of AI-enabled digital marketing system • Guidelines for collecting, storing and handling of digital marketing data • Guidelines for applying AI technology to digital marketing	
Challenges and issues	• How to collect, utilize and protect user information within the scope of what is permitted by relevant national and regional legislation and regulations • How to let the system evolve and improve continuously with applying new AI models and algorithms ……	
Societal Concerns	Description	For Users: enjoy better service at a lower cost For Merchants: Increase profits and decrease costs For Cities and communities: Promote economic prosperity and develop green economy
	SDGs to be achieved	Sustainable cities and communities

A.53.2 Data (optional)

Data characteristics	
Description	sample and feature data of marketing campaign
Source	Customers
Type	Log Text
Volume (size)	~500GB/day
Velocity	Stream and batch
Variety	Device information, location information, conversion information (clicks, transactions), active level
Variability (rate of change)	Subject to digital marketing effort (Festival, on sale)
Quality	Vary (depending on position of data collection and data reflow mechanism)

A.53.3 Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
1	Training				
2	Evaluation				
3	Execution				

4	Retraining				

A.53.4 References

References						
No.	Type	Reference	Status	Impact on use case	Originato r/organi zation	Link
1	Journa l		Published online	implement ation	Ant Financial Services Group	https://martech.al ipay.com

A.54 bioBotGuard

[SOURCE: SC42/WG4 N050 uc_54]

A.54.1 General

ID	54	
Use case name	bioBotGuard	
Application domain	Agriculture	
Deployment model	Cloud Services or On-prem systems	
Status	PoC	
Scope	Use visual recognition to identify and help fight parasites attacking organic farms.	
Objective(s)	The use case shows how AI contributing to modernize Agriculture industry.	
Narrative	Short description (not more than 150 words)	BioBotGuard defines itself as an initiative of Precision Farming as a Service. From an IT perspective it uses drones with GPS and highresolution cameras to monitor the crops; the images are then processed by computer vision API in order to spot diseases and harmful insect attacks, building a georeferenced risk map of the crop. This can be used to send operational drones to put the treatment (or antagonist insects) only when and where it is needed.
	Complete description	BioBotGuard main goals are to cut the use of Phyto-sanitary treatments to contain the environmental health risk by estimating the probability of incubation and development of plant diseases or harmful insects attacks and anticipate treatments. BioBotGuard monitors microclimatic conditions with high accuracy measurement and prediction models to optimize irrigations. From the technology point of view, it employs: AgroDrones to patrol and map the culture filed that are equipped with 20Mx high-resolutions cameras to capture in real-time images. On the backend the drone send data to computer vision API for image classifications and pattern detections. Among others, the system is able to detect harmful insects and build a georeferenced risk map of the crop. As a result, bioBotGuard can help AgriFood producers to change the cost structure of the industry, by requiring less

		water and less treatment, as well as a significant reduction in labor costs.		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Optimize Phytosanitary treatments	The objective is to contain the environmental health risk by estimating the probability of incubation and development of plant diseases or harmful insects attacks and anticipate treatments.	Improve healthy
	2	Reduced field mapping time	The objective is to reduce the time as well as achieve a more frequent monitoring time of the crop and the field microclimate.	Reduce Time
	3	Reduced Labor Costs	Reduction of the labor costs due to autonomous monitoring systems	Reduce Costs
AI features	Task(s)	Image Classification and Analysis		
	Method(s)	Deep Learning, Pattern Recognition		
	Hardware	Drones		
	Topology			
	Terms and concepts used	Drones, Agriculture, Image Recognition, Computer Vi		
Standardization opportunities/ requirements				
Challenges and issues	Acquire filed as well as crop images at different distances and normalize image recognition and pattern detection			
Societal Concerns	Description	None.		
	SDGs to be achieved			

A.54.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originato r/organi zation	Link

1		bioBotGuard project Web site and presentation				https://www.blueit.it/biobotguard/ https://vimeo.com/238174241

A.55 RAVE

[SOURCE: SC42/WG4 N050 uc_55]

A.55.1 General

ID	55	
Use case name	RAVE	
Application domain	Learning	
Deployment model	Hybrid Cloud or other	
Status	PoC	
Scope	Use of advanced an multimodal sensing ability to facilitate a complex task	
Objective(s)	Avatar and social robot interact with deaf babies for facilitating language learning.	
Narrative	Short description (not more than 150 words)	RAVE system is an integrated multi-agent system involving a robot and virtual human designed to augment language exposure for 6-12 month old infants. The system is an engineered robot and avatar to provide visual language to effect socially contingent human conversational exchange. The team demonstrated the successful engagement of our technology through case studies of deaf and hearing infants
	Complete description	The RAVE system is designed as a dual-agent that uses a physical robot and a virtual human to engage 6-12month old deaf infants in linguistic interactions. The system was bolstered by a perception system capable of estimating infant attention and engagement through thermal imaging and eye tracking. RAVE has been designed and experienced for a unique population (deaf infants) during a three period of observation and developing three case studies. This system has been successful at soliciting infant attention, directing attention to the linguistic content, and keeping the infant engaged for developmentally appropriate lengths of time. It has been also observed instances of infants copying robot behavior, of infants producing signs displayed by the avatar, and of infants producing signs to the non-signing robot agent that they had observed the virtual human perform. These initial experiences give the hope that longer-term exposure to a system based on this work may be able to impact long-term learning in this unique population.
Stakeholders		
Stakeholders' assets, values		
System's threats & vulnerabilities		

Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Soliciting infant attention	The objective is to have a system able to capture the infant attention status and decode his "ready to learn" moment to provide content	Improve learner attention
	2	Keeping Infant engaged	The objective is to keep the learning engaged during the learning process	Improve learner engagement
AI features	Task(s)	Virtual Humans and 3D model reconstruction, Robot, Biometric status by using thermal cameras, eye tracking, Motion Capture		
	Method(s)	Deep Learning, Pattern Recognition		
	Hardware	Robot, Thermal Camera, Screen		
	Topology			
	Terms and concepts used	Learning, thermal camera, eye tracking, Image Recognition, Computer Vision		
Standardization opportunities/ requirements				
Challenges and issues	Ability to decode a learner cognitive status and his attention level			
Societal Concerns	Description	None		
	SDGs to be achieved			

A.55.2 References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
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[2] Brian Scassellati, Jake Brawer, Katherine Tsui, Setareh Nasihati Gilani,Melissa Malzkuhn, Barbara Manini, Adam Stone,Geo Kartheiser,Arcangelo Merla, Ari Shapiro, David Traum, Laura-Ann Petitto3. Teaching Language to Deaf Infants with a Robot and a Virtual Human, http://petitto.net/wp-content/uploads/2014/04/Petitto_CHI18.pdf

A.56 Logo and Trademark Detection

[SOURCE: SC42/WG4 N050 uc_56]

A.56.1 General

ID	56			
Use case name	Logo and Trademark Detection			
Application domain	Digital Marketing, Retail and Other (e.g. Fashion)			
Deployment model	Cloud services or on-premises systems			
Status	PoC			
Scope	Identification of logos / trademarks in pictures, optionally performing sentiment analysis associated to the product			
Objective(s)	Understand usage of retail or fashion products and optionally sentiment associated to it, according to pictures posted on the internet or social networks by customers			
Narrative	Short description (not more than 150 words)	The case is about being able to identify logos and trademarks in pictures provided to the AI systems, and optionally derive a positive or negative sentiment for the product based on the written context that was provided with the picture.		
	Complete description	In order to provide business and marketing with a better understanding of how/in what context products are used, AI can be leveraged to help determine customer segments, anticipate changes in brand perception and customer preferences and help generate ideas for designers. The use case involves several steps: - Confirm scope (including countries, targets, logos/trademarks) and business metrics - Select and gather a suitable data set for training and testing the visual recognition algorithm. - Optionally determine the rules that identify a proper context to be analysed with NLP techniques, to understand the sentiment associated to the logo/trademark contained in the picture when posted online. Pictures can be crawled from social networks, forums, and other websites, from which textual context (comments, etc) is obtained as well. - Deploy to production and manage the lifecycle of AI, while providing business with the outcomes of the AI analysis.		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
		Number of logos/trademarks identified correctly	This is a technical precision/recall/accuracy measurement of how the visual	Refers to the main objective

			recognition classifier is performing	
		Sentiment of Logo / trademark	This is a business measurement, that allows to understand the sentiment associated to a certain logo/trademark. The KPI is usually segmented by picture source, or other variables from the context	Refers to the main objective
AI features	Task(s)	Object detection and localization in pictures, Classification, Sentiment and Tone Analysis		
	Method(s)	Convolutional Neural Networks, Natural Language Processing		
	Hardware	None		
	Topology			
	Terms and concepts used	Visual Recognition, Sentiment Analysis, Tone Analysis		
Standardization opportunities/ requirements				
Challenges and issues	The primary challenge is to be able to correctly identify trademarks in all situations (with bad lighting, image distortions, dirt, etc.) and interpret the sentiment and tone in different countries and languages, as people might use slang and irony.			
Societal Concerns	Description	Automated analysis of public posts on social networks might be seen unethical in certain cultures.		
	SDGs to be achieved			

A.57 Virtual Bank Assistant

[SOURCE: SC42/WG4 N050 uc_57]

A.57.1 General

ID	57
Use case name	Virtual Bank Assistant
Application domain	Banking
Deployment model	Cloud services
Status	In operation

<table>
<tr><td>Scope</td><td colspan="4">Use of advanced chatbots and dialogue systems to automatize part of the call center activities</td></tr>
<tr><td>Objective(s)</td><td colspan="4">Provide better quality help desk support to employees</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td colspan="3">The Virtual Assistant of the Bank is the first point of contact for branch operators, who receive immediate answers at any time - it allows to optimize the time of the "human operators" of the Service Desk, which they are dedicated to activities of greater value</td></tr>
<tr><td>Complete description</td><td colspan="3">A bank in Italy has created a virtual consultant to support internal staff in their operations and interaction with customers.
The solution enabled a significant change in the service model of the bank, allowing to achieve important results in terms of greater contact volumes, extension of service hours and reduction of low-value humancentric activities.
The Virtual Assistant has been conceived as the first (and only) access point for assistance, it is easy to use and responds with a high level of reliability to the questions of branch colleagues. The virtual assistant has been not designed as a simple "chatbot" trained on a specific topic, but the virtual "colleague" to turn to for any question, completely integrated into the bank knowledge chain. To date, Virtual Bank Assistant manages all fourteen knowledge domains of the bank receiving thousands of answers.
From the beginning of its use (January 2018), the Virtual Assistant manages 100% of the requests, partly independently and partly in collaboration with the human operators of Service Desk.
The effectiveness of the solution is evidenced by the very high level of satisfaction, with positive feedback from users exceeding 90% and the reduction in the time spent by Service Desk operators in providing support to the branches, which today can be quantified in a reduction of 25 %.</td></tr>
<tr><td>Stakeholders</td><td colspan="4"></td></tr>
<tr><td>Stakeholders' assets, values</td><td colspan="4"></td></tr>
<tr><td>System's threats & vulnerabilities</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
<tr><td>1</td><td>Greater contact volumes with the bank</td><td>The objective is to expand the quantity of internal support activities provided by the bank its employees.</td><td>Improve productivity of service desk operators (already measured an improvement of 25%)</td></tr>
<tr><td>2</td><td>Extension of service hours</td><td>Expand the internal support activities 24/7</td><td>Always on</td></tr>
</table>

	3	Reduction of low-value human-centric activities	Reduction of the low level labor activities and let employees concentrate on more added value activities.	Improve the quality of work
AI features	Task(s)	Natural Language Dialogue systems		
	Method(s)	NLP		
	Hardware	Web based solution		
	Topology			
	Terms and concepts used	Natural Language Processing, Chat Bot, Dialogues Systems		
Standardization opportunities/ requirements				
Challenges and issues	Provide a natural and consistent interaction with users from different levels of experience (and thus terminology) and background			
Societal Concerns	Description	None		
	SDGs to be achieved			

A.58 Video on Demand Publishing Intelligence Platform

[SOURCE: SC42/WG4 N050 uc_58]

A.58.1 General

ID	58	
Use case name	Video on Demand Publishing Intelligence Platform	
Application domain	TMT Industry, Technology Department	
Deployment model	On premise	
Status	Delivered Project	
Scope	Video on Demand Content Preparation Process Error detection & recommendation system	
Objective(s)	System errors comprehension, errors prediction, recommendation engine implementation. Proactive approach to system maintenance problems management.	
Narrative	Short description (not more than 150 words)	E2D solution design and development for error detection system based on Machine Learning models and a recommendation engine supported by a reinforcement learning framework.
	Complete description	The Errors' detection allows to simulate a workflow and to analyze the process in relation with the current state of the systems, in order to estimate the task error probability and specifying the error type basing on the evidences detected on the systems in the last 20 minutes. The Machine Learning engine exploits the evidences collected in the last

		20 minutes on Main Application and on Monitoring system (e.g. each IT system involved in the process). The most significant variables can directly be the error reason or can be factors indirectly related to an error occurrence. The ML models identify the key metrics values most related to a high error probability level. Model and user defined actions challenge each other in order to provide the best action prioritization for that specific environmental machines state of art (last 20 minutes history) and the specific simulation test launched.		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Error frequency	Error frequency to be reduced	
	2	Lateness	Processing time not aligned with the standards to be reduced	
	3	Environmental Log errors	Environmental Log errors	
AI features	Task(s)	The system produce main errors probability of occurrence, then the next best actions are suggested from an automatic recommendation engine. A reinforcement-learning engine takes final users suggestions if he does not agree with the system suggested action, and at the next simulation, users driven and ML driven actions challenge each other.		
	Method(s)	Random Forest, Variable Importance evaluation, Sigmoid function for reinforcement learning engine		
	Hardware	Virtual Machines		
	Topology			
	Terms and concepts used	Machine Learning, Reinforcement Learning, Recommendation Engine, Environmental logs, Application log, Next Best Action,		
Standardization opportunities/ requirements				
Challenges and issues	Machine Learning Engines processing time had to be very short			
Societal Concerns	Description			
	SDGs to be achieved			

A.59 Predictive Testing

[SOURCE: SC42/WG4 N050 uc_59]

A.59.1 General

ID	59			
Use case name	Predictive Testing			
Application domain	Other (please specify) TMT Industry – Application development			
Deployment model	On premise			
Status	PoC			
Scope	Predictive testing of application development			
Objective(s)	Improving the level of automation and the activity throughput of test verifiers by reducing the number of failure notices that are wrongly generated and suggesting mitigation actions according to past experience.			
Narrative	Short description (not more than 150 words)	The solution adopt machine learning to analyze data coming from test results to identify correlation and patterns in order to reduce false positives and suggest recommendation actions		
	Complete description	The testing phase represents a critical point for many companies with a strong technological impact: the execution of the tests is often not very automated, thus requiring a significant effort in terms of people and times, and there is a lack of analysis of the results obtained which generates false positives, or the understanding of where the error occurred and the correct evaluation of the outcome of the general test. The solution consists of adopting Machine Learning methodologies to analyze the available data (coming from different applications and sources involved in the tests), identify correlations and patterns with objectives to identify: false positives, automate testing phases and recommend mitigation actions		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	False positive	Reduce false positives	
	2	Test efficiency	Shorten testing phase	
AI features	Task(s)	Data analysis, Anomaly Detection, Complex event correlations		
	Method(s)	Autoencoders, Restricted Boltzman Machine, Convolutional Neural Network, Long-Short Term Memory		
	Hardware	ND		

	Topology	
	Terms and concepts used	Data integration, compress and denoise, probability distribution of events, complex patterns
Standardization opportunities/ requirements		
Challenges and issues	Being able to manage and handle different type of data, normalize and use different type of data (including contextual information), integrate the solution in the processes and procedure of the company	
Societal Concerns	Description	
	SDGs to be achieved	

A.60 Predictive Data Quality

[SOURCE: SC42/WG4 N050 uc_60]

A.60.1 General

ID	60	
Use case name	Predictive Data Quality	
Application domain	Other (please specify) Data Management	
Deployment model	On premise / cloud	
Status	PoC	
Scope	A solution for assessing Data Quality in data collection systems	
Objective(s)	Using machine learning techniques for identifying complex or unknown correlation among data in order to score its quality and enhance the confidence for data consumer in using data for the decision making processes	
Narrative	Short description (not more than 150 words)	The solution adopt machine learning methods to analyze data collected in order to identify complex correlation on data (unknown at priori) and predict data quality issues
	Complete description	The solution relies on four elements: - Sources: the data sources represent the subject of the assessment. This sources can be heterogeneous (structured and semi-structured) - Model: the representation of the ontology used as a reference for identifying the non-conformity on data - Processes: the set of processes that produce and consume data, whose execution could be affected by the quality of data - Organization and governance: the set of policies, procedures for governing data and handling the advanced data quality techniques
Stakeholders		
Stakeholders' assets, values		
System's threats & vulnerabilities		

Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Conformity Indicator	An indicator of the intrinsic data quality	
	2	Robustness Indicator	An indicator of the completeness of the set of data quality controls	
AI features	Task(s)	Data analysis, Anomaly Detection, Complex event correlations		
	Method(s)	Bayesian network, Support Vector Machine, CNN		
	Hardware	ND		
	Topology			
	Terms and concepts used	Data integration, data linkage, correlation analysis		
Standardization opportunities/ requirements				
Challenges and issues	Being able to manage and handle different type of data, link data to reference knowledge model, change management in the organization			
Societal Concerns	Description			
	SDGs to be achieved			

A.61 Robot consciousness

[SOURCE: SC42/WG4 N050 uc_61]

A.61.1 General

ID	61	
Use case name	Robot consciousness	
Application domain	Other (please specify) Robotics	
Deployment model	Embedded systems	
Status	PoC	
Scope	A robot for museum tours equipped with the main capabilities of functional consciousness, accepted and transparent to untrained users.	
Objective(s)	The robot "CiceRobot" offering guided tours in indoor and outdoor museum and equipped with capabilities of functional consciousness, with no concern on the robot qualitative experience. The objective of case study is the acceptance and transparency of the autonomous behavior of the robot in an environment populated with untrained users as the museum visitors.	
Narrative	Short description (not more than 150 words)	The "CiceRobot" is a robot with capabilities associated with functional aspects of consciousness. CiceRobot offered indoors guided tours and outdoors guided tours. The

		outcome of the project is the acceptance and transparency of the autonomous behavior of the robot towards untrained visitors.		
	Complete description	The "CiceRobot" is a robot with the capabilities associated with the functional aspects of consciousness. The architecture was instantiated on a wheeled robot for indoor use, on a wheeled robot for outdoor use and currently is instantiated on a humanoid robot. The robot has capabilities associated with the functional aspects of consciousness: - to build and to maintain an internal model of the environment and itself; - to pay attention to the relevant entities in the environment; - to integrate information from different sources and different parts of the same source; - to generate expectations about the possible events in the environment; - to self-monitor; - to simulate emotional states; - to process information by making it globally available to the robot. The primary outcome of the case study is the acceptancy and transparency of the autonomous behavior of the robot in an environment populated by untrained users as museum tourists.		
Stakeholders				
Stakeholders' assets, values				
System's threats & vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Robot transparency	The capability of the robot to act in a transparent way to tourists. The transparency of robot behavior is measured by questionnaires, M.O.S. on scale 1 – 5. The transparency of personal data handling and mitigation of cyberattack is pursued by local use of data (what happens to the robot remains on the robot and it is part of its	

			personal history) and measured by questionnaires, M.O.S. on scale 1 – 5.	
	2	Robot acceptance	The capability of the robot to be accepted by tourists as a museum guide is measured by user satisfaction questionnaires, M.O.S. on scale 1-5.	
AI features	Task(s)	Internal model generation, attention, self-modeling, global workspace, expectation generation, information integration		
	Method(s)	Neural networks, symbolic representation systems, hybrid symbolic-subsymbolic systems, global representations.		
	Hardware	Wheeled indoor robot; wheeled outdoor robot; humanoid robot.		
	Topology			
	Terms and concepts used	Consciousness, attention, information integration, self-monitoring, expectation generation, internal modeling, global workspace.		
Standardization opportunities/ requirements				
Challenges and issues	The primary challenge of robot consciousness is the transparency and acceptance of robot operations, important in environments populated by untrained people as tourists in an archaeological museum.			
Societal Concerns	Description	The main concern may be the capability of the robot to act in a way which may is considered unethical to humans.		
	SDGs to be achieved			

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Annex B
(informative)

Collected Applications

[Editor's Note: Extract from WG4 N7, SG3 study report, APPENDIX: COLLECTED APPLICATIONS]

This appendix lists collected applications. More detail will be included in the reference.

The abbreviations used in the table are defined as follows:

— CL:Cloud, ES:Embedded System, OP:On-premise, CP:Cyber-phyusical, SN:Social Net, HY:Hybrid or other

[SOURCE: SC42/SG3 N061, contribution from Japan NB]

Application domain	Deployment mode	Application	Short description
Manufacturing	CL, OP, HY	Development Design	CL: Accumulate Design Patterns to help Designer OP: Check design pattern with real constraints on premise
Manufacturing	CL, OP, HY	Production process	CL: Accumulate production quality actuation pattern and estimate the performance of quality OP: Accumulate production through put related parameters and estimate the output throughput
Manufacturing	On-premise systems	Product quality inspection	Inspect products by image recognition
Mobility	CL, ES, OP,	Autonomous driving	Mainly realized cars. CL: Update cruising control software dynamically ES: Enablize autonomous driving without any help from connected devices. CL: Accumulate road condition and disseminate them to autonomous agents
Mobility	CL, ES, OP,	Automatic cruise control	Mainly enablized at wheel chairs, ships, and autonomous robots CL: Update cruising control software dynamically ES: Enablize autonomous driving without any help from connected devices. CL: Accumulate road condition and disseminate them to autonomous agents

Mobility	CL, ES, OP,	Robot Taxi	CL: Pick-up arrangement system controls robot taxis effectively EM: Autonomously drive through the road with dynamic control of steering and acceleration and breaking. OP: Autonomously drive through the road with road map
Mobility	CL, OP, HY	Dynamic map for autonomous cruise control	CL: Create, maintain, and disseminate map information with semantic tags with real-time communication with mobile agents such as cars, wheelchairs, robots, and human beings. OP: Accumulate the real road situation and recognize the objects which is not involved in the map to be shared.
Mobility	Cyber-physical systems	City-wide traffic control	Optimize city-wide traffic by inspecting real-time traffic image and controlling traffic signals
Social infrastructure	CL, OP, HY	Abnormality or malfunction prediction	CL: Accumulate normal signal patterns to learn normal signals OP: Find out abnormal signal patterns on premise
Social infrastructure	CL, OP	Equipment operation	CL: Accumulate operational parameters and learn normal operations OP: Monitor operation and find out abnormal operation patterns
Agriculture	CL, OP	Agricultural automation	CL: Monitor the field condition and manage the field condition OP, ES: Accumulate weeds or insects pattern and eliminate them
Agriculture	CL, OP	Craftsmanship skill transfer	CL: Learn about best practices by craftsmen, and feed back them to others
Agriculture	OP	Cultivation management	OP: Monitor the field condition and manage irrigation condition
Healthcare	CL, OP	Diagnosis support	CL: Learn about normal condition OP: Find out abnormal condition compared with normal condition
Healthcare	CL	New drug development	Curation: CL: Find out the co-relation among submitted papers Molecular pattern: CL: Find out the effective coordination of target molecular

Healthcare	CL, OP, ES	Surgical automation	CL: Accumulate disease patterns and healthy patterns OP: Support identification of disease patterns on premise
Healthcare	CL, OP, ES, HY	Medical Platform	Accumulate and disseminate the learning patterns and assistants as an integrated medical support system.
Security	CL	Cyber Security	Monitoring transactions in cyber space and find out attacks through finding abnormal transaction patterns
Security	CL	Personal Information Management	Monitoring operations for GDPR conformance assurance
Security	CL	Video Surveillance & Crime risk prediction	Monitor the behavioral patterns in town and predict crime risk and find out criminal patterns.
Defense	CL	Cyber Security	Monitoring cyber transactions against important defense assets and find out attack patterns and prevent their intrusion.
Defense	CL, OP, ES	Electronic warfare	Autonomous pilot with cloud support to enablise the electronic warfare
Disaster Prevention	CL, OP	Landslide, flood prediction	Monitoring weather and ground condition in realtime and predict the disaster such as landslide, flood etc.
Social infrastructure	Cloud services	Power demand forecasting	Learn about demand patterns with other significant parameters and forecast the future demand
Social infrastructure	Cloud services	Improving operational efficiency	Learn about the co-relation among significant parameters and manage to realize the most efficient operations. Traffic control, Electricity supply control, etc.
Education	On-premise systems	Adaptive learning	Through using learning model, provide personalized learning materials to achieve the efficient learning results.
Education	On-premise systems	Scoring	Through using the cognitive learning model, make the most effective feed back to the learners to achieve the most effective learning results.
Fintech	Cloud services	Stock exchange and trading	Accumulate the best practices and enablize the 7week 24 hours trading

Fintech	Cloud services	Asset management	Accumulate and learn about the best practices and apply them to realize the customer satisfaction
Fintech	Cloud services	Loan screening	Learn about the normal backgrounds of customers to find out the abnormal loan patterns
Fintech	Cloud services	Fraud identification	Identify fraud transactions and make warning to the managers
Fintech	Cloud services	Security assurance against cyber attacks	
Logistics	CL OP	Procurement logistics	Analyze the procurement context and propose the best procurement actions.
Logistics	CL OP	Logistics in the base	Coordinate the best logistic move in the local procurement base warehouse
Logistics	CL OP	Sales logistics	Analyze and learn about the best practices of sales logistics and provide the most effective routs to sales move.
Construction	Cloud services	Construction planning	Learn about the best practices and apply them to coming planning
Construction	CL OP	Robot construction	Provide autonomous construction robot to the construction sites
Retail	On-premise systems	Autonomous driving store	Provide autonomous driving sales robot
Retail	On-premise systems	Register less store	Monitor all the moves of each customers to realize cash register less retail shops.
Digital marketing	Cloud services	Online campaign performance optimization	As we have in GAFA
Legal	Cloud services	Early case assessment	AI support the work preps had been doing
Legal	Cloud services	Judical recommendation	Judge support by using the previous judical judgement cases
Public sector	CL OP	Public service matching	Optimize matching between residents and public services
Public sector	CL SN	Online service support	Provide residents with support for online services

Work & life	Embedded systems	Smart home appliances	Include robot vacuums and refrigerators and air conditioners with sophisticated control
Work & life	Social networks	Smart personal agent	Smart agents assist individual users

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