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Focus Group on Artificial Intelligence (AI) and
Internet of Things (IoT) for Digital Agriculture

(FG-AI4A)

FG-AI4A WG-GLOSS

Glossary – Artificial Intelligence (AI) and Internet of Things (IoT) for Digital Agriculture

Working Group: Glossary



ITU-T FG-AI4A Deliverable

Glossary – Artificial Intelligence (AI) and Internet of Things (IoT) for Agriculture

Summary

This Technical Report contains a list of definitions related to the leveraging of emerging technologies such as Artificial Intelligence (AI) and Internet of Things (IoT) within the domain of digital agriculture.

Keywords

Artificial intelligence, digital agriculture, IoT, precision agriculture.

Note

This is an informative ITU-T publication. Mandatory provisions, such as those found in ITU-T Recommendations, are outside the scope of this publication. This publication should only be referenced bibliographically in ITU-T Recommendations.

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Change Log

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ITU-T FG-AI4A Deliverable

Glossary – Artificial Intelligence (AI) and Internet of Things (IoT) for Agriculture

1 Scope

This glossary encompasses selected terms, together with their definitions, falling within the scope of the ITU/FAO Focus Group on Artificial Intelligence (AI) and Internet of Things (IoT) for Digital Agriculture. (FG-AI4A). The definitions provided in this Glossary aim to improve the understanding of basic concepts related to leveraging Artificial Intelligence (AI) and Internet of Things (IoT) for digital agriculture.

2 References

- [ITU-T E.475] Recommendation ITU-T E.475 (2020), *Guidelines for intelligent network analytics and diagnostics*.
- [ITU-T F.791] Recommendation ITU-T F.791 (2018), *Accessibility terms and definitions*.
- [ITU-T H.222.0] Recommendation ITU-T H.222.0 (2021) | SO/IEC 13818-1:2022, *Information technology – Generic coding of moving pictures and associated audio information: Systems*.
- [ITU-T H.752] Recommendation ITU-T H.752 (2015), *Multimedia content provisioning interface for IPTV services*.
- [ITU-T I.312] Recommendation ITU-T I.312/Q.1201 (1992), *Principles of intelligent network architecture*.
- [ITU-T L.1022] Recommendation ITU-T L.1022 (2019), *Circular economy: Definitions and concepts for material efficiency for information and communication technology*.
- [ITU-T L.1430] Recommendation ITU-T L.1430 (2013), *Methodology for assessment of the environmental impact of information and communication technology greenhouse gas and energy projects*.
- [ITU-T L.1501] Recommendation ITU-T L.1501 (2014), *Best practices on how countries can utilize ICTs to adapt to the effects of climate change*.
- [ITU-T M.3363] Recommendation ITU-T M.3363 (2020), *Requirements for data management in the telecommunication management network*.
- [ITU-T X.800] Recommendation ITU-T X.800 (1991), *Security architecture for Open Systems Interconnection for CCITT applications*.
- [ITU-T X.1217] Recommendation ITU-T X.1217 (2021), *Guidelines for applying threat intelligence in telecommunication network operation*.
- [ITU-T Y.101] Recommendation ITU-T Y.101 (2000), *Global Information Infrastructure terminology: Terms and definitions*.
- [ITU-T Y.2071] Recommendation ITU-T Y.2071 (2015), *Framework of a micro energy grid*.
- [ITU-T Y.2233] Recommendation ITU-T Y.2233 (2010), *Requirements and framework allowing accounting and charging capabilities in NGN*.

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|------------------|---|
| [ITU-T Y.3172] | Recommendation ITU-T Y.3172 (2019), <i>Architectural framework for machine learning in future networks including IMT-2020</i> . |
| [ITU-T Y.3174] | Recommendation ITU-T Y.3174 (2020), <i>Framework for data handling to enable machine learning in future networks including IMT-2020</i> . |
| [ITU-T Y.3179] | Recommendation ITU-T Y.3179 (2021), <i>Architectural framework for machine learning model serving in future networks including IMT-2020</i> . |
| [ITU-T Y.3500] | Recommendation ITU-T Y.3500 (2014) ISO/IEC 17788:2014, <i>Information technology – Cloud computing – Overview and vocabulary</i> . |
| [ITU-T Y.3514] | Recommendation ITU-T Y.3514 (2017), <i>Cloud computing – Trusted inter-cloud computing framework and requirements</i> . |
| [ITU-T Y.3519] | Recommendation ITU-T Y.3519 (2018), <i>Cloud computing – Functional architecture of big data as a service</i> . |
| [ITU-T Y.3602] | Recommendation ITU-T Y.3602 (2022), <i>Big data – Functional requirements for data provenance</i> . |
| [ITU-T Y.4000] | Recommendation ITU-T Y.4000/Y.2060 (2012), <i>Overview of the Internet of things</i> . |
| [ITU-T Y.4051] | Recommendation ITU-T Y.4051 (2019), <i>Vocabulary for smart cities and communities</i> . |
| [ITU-T Y.4113] | Recommendation ITU-T Y.4113 (2016), <i>Requirements of the network for the Internet of things</i> . |
| [ITU-T Y.4472] | Recommendation ITU-T Y.4472 (2020), <i>Open data application programming interfaces (APIs) for IoT data in smart cities and communities</i> . |
| [ITU-R TF.686-2] | Recommendation ITU-R TF.686-2 (2013), <i>Glossary and definitions of time and frequency terms</i> . |

3 Definitions

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4 Introduction

This Glossary identifies relevant terms and definitions to support the activities of the ITU/FAO Focus Group on Artificial Intelligence (AI) and Internet of Things (IoT) for Digital Agriculture (FG-AI4A).

As a part of the process, relevant FG-AI4A input documents and incoming use-cases were examined in relation to various disciplines related to digital agriculture.

Where relevant, the [ITU Terms and Definitions database](#) and the [FAO Terms Portal](#) were explored and consulted.

The definitions have been categorized as [G] for general definition, [AI] for AI-based definitions, [A] for agricultural definitions, and [IOT] for Internet of Things-related definitions.

This glossary takes into consideration the guidelines of the Standardization Committee for Vocabulary (SCV, SCV-TD156).

5 Definitions

This Glossary serves as the basis for the further examination and recollection of relevant definitions to cater to the evolving sphere relating to the application of AI and IoT for digital agriculture.

Accessibility

[G]: The degree to which a product, device, service or environment (virtual or real) is available to as many people as possible. [ITU-T F.791].

Accuracy

[G]: Closeness of the agreement between the result of a measurement and a true value of the measurand. Accuracy is generally characterized by the overall uncertainty of a measured value. See also "uncertainty." [ITU-R TF.686-2].

Agribusiness

[A]: A broad concept that covers input suppliers, agro-processors, traders, exporters and retailers. Agro-industry also is a broad concept that refers to the establishment of enterprises and supply chains for developing, transforming and distributing specific inputs and products in the agricultural sector. [b-FAO-2].

Agriculture

[A]: The art and science of cultivating land for growing crops (farming) or raising livestock. [b-National].

Agricultural Producer

[A]: Agricultural Producer. An individual or entity directly engaged in the [A]: production of agricultural products, including crops (including farming); livestock (including ranching); forestry products; hydroponics; nursery stock; or aquaculture, whereby 50 percent or greater of their gross income is derived from those products [b-Agriproduce].

Agriculture Production Process

[G]: The agricultural production process begins when:

- You purchase or breed a qualifying animal
- You prepare the soil for planting crops

The process ends when:

- You place livestock or crops – packaged or unpackaged – into finished goods inventory
- Your grain is sellable or at a stage that it can be commingled [b-Minnesota]

Agricultural Robots

[G]: Perceptive programmable machines that perform a variety of agricultural tasks, such as cultivation, transplanting, spraying and selective harvesting [b-FAO-5].

Agricultural Systems

[G]: An agricultural system is an assemblage of components which are united by some form of interaction and interdependence and which operate within a prescribed boundary to achieve a specified agricultural objective on behalf of the beneficiaries of the system. [b-FAO-1].

AI ethics

[AI]: Branch of applied ethics that focuses on the normative issues raised by the design, development, implementation and use of AI. [b-EC].

Ambient temperature

[IoT]: Ambient temperature is defined as the temperature of the surrounding air, and as such, it is modified by humidity, so that in many studies, the exposure is a combination of temperature and

humidity level or dew point temperature and may be expressed as thermo-hydrological index when humidity is controlled for [b-Microclimate].

Annual crop

[G]: A plant that completes its life cycle within one year. [b-FAO-2].

Application programming interface (API)

[G]: An API provides a set of interfaces from an application environment to an execution environment. The execution environment provides services to the application environment. [ITU-T I.312].

[AI]: A generic set of application programming interfaces for a machine learning data model (DM) to be used in a machine learning overlay and stored in a machine learning metadata store. [ITU-T Y.3174].

Artificial intelligence (AI)

[G]: An interdisciplinary field, usually regarded as a branch of computer science, dealing with models and systems for the performance of functions generally associated with human intelligence, such as reasoning and learning. A computerized system that uses cognition to understand information and solve problems. [b-ISO/IEC 2382-28].

Artificial selection

[G]: The practice of choosing a specific sample from a population for reproduction, usually because these individual crops possess one or more desirable characteristics. [b-FAO-3].

Atmosphere

[G]: An atmosphere is made of the layers of gases surrounding a planet or other celestial body. Earth's atmosphere is composed of about 78% nitrogen, 21% oxygen, and one percent other gases. These gases are found in atmospheric layers (troposphere, stratosphere, mesosphere, thermosphere, and exosphere) defined by unique features such as temperature and pressure. [b-National].

Aquaculture

[G]: Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of fisheries. [b-FAO-1].

Available water capacity

[G]: Soil water content usable by plants, based on the effective root penetration depth. [b-ISO 11074:2015].

Bias

[AI]: Systematic error introduced into sampling or testing by selecting or encouraging one outcome or answer over others. Statistical bias refers to any type of error or distortion that is found with the use of statistical analyses. [b-Piedmont].

Big data

[G]: Extensive datasets that require a scalable technology for efficient storage, manipulation, management, and analysis. [b-ISO/IEC 20546].

Cash crop

[G]: A crop produced for its commercial value rather than for use by the grower. [b-CambridgeDictionary-1].

Chatbots

[AI]: Chatbots consist of computer programs intended to simulate dialogues with human users. [b-Adamopoulou].

Classification

[G]: The act or process of dividing things into groups according to their type. [b-Cambridge].

[AI]: Classification is the process of predicting the class of given data points. Classes are sometimes called as targets/ labels or categories. Classification predictive modelling is the task of approximating a mapping function (f) from input variables (x) to discrete output variables (y). [b-Data].

Classifier

[G]: 1. Mechanism that describes behavioural and structural features. 2. Device that separates particles, according to their size, shape and density, by physical means other than screening. [b-ISO 16100-2] [b-ISO 1213-1].

[AI]: ML model used for classification. [b-ISO/IEC TR 29119-11].

Climate change

[A]: Any change in climate over time, whether due to natural variability or as a result of human activity. The Intergovernmental Panel on Climate Change (IPCC) uses a relatively broad definition, referring to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. [ITU-T L.1501].

Climate change adaptation

[G]: Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. [b-IPCC].

Climate smart agriculture

[G]: Agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals. [b-FAO-2].

Cloud computing

[G]: Paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand. Examples of resources include servers, operating systems, networks, software, applications, and storage equipment. [ITU-T Y.3500].

Clustering

[G]: The process of partitioning a set of patterns into disjoint and homogeneous meaningful groups. [ITU-T E.475].

Complexity

[G]: The degree of complication of a system or system component, determined by such factors as the number and intricacy of interfaces, the number and intricacy of conditional branches, the degree of nesting, the types of data structures, and other system characteristics. [b-EUTerm].

Computer vision

[G]: Computer vision is an interdisciplinary field that uses computer science techniques to analyse and understand digital images and videos. Computer vision tasks include object recognition, event detection, motion detection, and object tracking, among others. [b-Springer].

Conservation agriculture

[G]: A farming system that promotes minimum soil disturbance (i.e., little or no tillage), maintenance of permanent soil cover and diversification of plant species. It enhances biodiversity and natural biological processes above and below the ground surface, contributing to increased water- and nutrient-use efficiency and improved and sustained crop production. [b-FAO-2].

Controlled-environment agriculture (CEA)

[G]: an approach where crops are grown indoor with an optimized use of water and space compared to conventional agriculture, while simultaneously controlling for factors such as light, temperature, humidity, CO₂ and nutrient concentration. Vertical farming is a good example, with a welcomed side effect. It enables food production closer to or in cities. [b-Scott].

Correlation

[G]: Capability to generate an aggregated charging information record (CIR) by combining and analyzing charging events collected from the same transport/service session. [ITU-T Y.2233].

Crop management

[G]: Crop management is the set of agricultural practices performed to improve the growth, development and yield of crops. It begins with a seedbed preparation, sowing of seeds and crop maintenance; and ends with crop harvest, storage and marketing. [b-Nevada].

Crop monitoring box

[G]: The "CM Box" (Crop Monitoring Box) is a toolbox for agrometeorological crop monitoring and yield forecasting. It is an automated software suite with a "visual menu" that offers easy access to database that holds all the data needed to analyse the impact of weather on crops. [b-FAO-2].

Cultivation

[G]: Any agricultural action or practice used by growers to allow and improve the growing conditions of fresh fruits or vegetables whether grown in an open field or in protected facilities (e.g., hydroponic systems, greenhouses/net houses). [b-FAO-2].

Customer experience (CX)

[G]: Customer Experience (CX) is the summation of all the interactions a customer has with a business and its products or services, which is customer's perception towards the company. In other words, Customer Experience (CX) is – how customers perceive their interactions with businesses. [b-Gautam].

Dashboard

[G]: A dashboard is a type of graphical user interface which often provides at-a-glance views and summaries of different types of information. [b-Cambridge].

Data accessibility

[G]: Possibility to request and obtain the data at any time in a machine-readable format. [b-EUParliament].

Data annotation

[AI]: Data annotation is the categorization and labelling of data to create training data for AI models. [b-Appen].

Data cleaning

[G]: A process to delete irrelevant data and duplicate data in the original dataset, to smooth the noise data, and process missing values and outliers. [ITU-T X.1217].

Data consistency

[G]: Data consistency refers to the characteristic of data to be the same even when collected by different agents, or stored in different locations. [b-BigData].

Data enrichment

[AI]: The process of determining which features might be useful in training a model, and then converting raw data from log files and other sources into said features. [b-Klein].

Data fusion

[G]: Data fusion is the process of integrating multiple data sources to produce more consistent, accurate, and useful information than that provided by any individual data source. [b-Springer].

Data integrity

[G]: The property that the data has not been altered or destroyed in an unauthorized manner. [ITU-T X.800].

Data interoperability

[G]: The ability of two or more systems or components to exchange data and to use the data that have been exchanged. [b-Data4SDGs].

Data lifecycle

[G]: A whole range of data processing phases including data planning, data acquisition, data storage, data sharing, data usage, data transmission, and data disposal. [ITU-T M.3363].

Data mining

[G]: Computational process that extracts patterns by analysing quantitative data from different perspectives and dimensions, categorizing them, and summarizing potential relationships and impacts. [b-ISO/IEC 22989].

Data provenance

[G]: Information on the source of data, such as the person responsible for the provision of data, functions applied to data, and information about the computing environment for data processing (e.g., operating system, description of the hardware, locale settings and time zone). Big data provenance is the information that records the historical path of data according to the data lifecycle operations in a big data ecosystem. [ITU-T Y.3602].

Data quality

[G]: Data quality refers to the state of qualitative or quantitative pieces of information. There are many definitions of data quality, but data are generally considered high quality if they are "fit for [...] intended uses in operations, decision making and planning." Moreover, data are deemed of high quality if they correctly represent the real-world construct to which they refer. [b-Redman].

Data supply chains

[G]: The data supply chain represents the technological steps and human-involved processes supporting the flow of data through the organization, from its raw state, through transformation and integration, all the way through to the point of consumption or analysis. [b-Immuta].

[AI]: The lifecycle process of data; selection, procurement, transfer, quality assurance, warehousing/storage, data management, transformation, monitoring, and distribution – feeding data pipelines for use in data products. [b-DataSupply].

Data uncertainties

[G]: Uncertainty is a situation in which something is not known, or something that is not known or certain. [b-CambridgeDictionary-1].

[AI]: In computer science, uncertain data are data that contain noise that makes them deviate from the correct, intended or original values. In the age of big data, uncertainty or data veracity is one of the defining characteristics of data. [b-Hariri].

Decision tree

[AI]: A decision tree uses a tree-like graph or model as a structure to perform decision analysis. It uses each node to represent a test on an attribute, each branch to represent the outcome of the test, and each leaf node to represent a class label. [b-Springer].

Deep learning

[AI]: Approach to creating rich hierarchical representations through the training of neural networks with one or more hidden layers. [b-ISO/IEC TR 29119-11].

Digital twin

[G]: A digital twin is a virtual model designed to accurately reflect a physical object. [b-IBM].

Disease

[A] Plant disease is defined as an abnormal physiological process that distorts the plant's normal structure, growth and function [b-Islam].

Digital agriculture

[A] Digital agriculture is the use of new and advanced technologies, integrated into one system, to enable farmers and other stakeholders within the agriculture value chain to improve food production. [b-UN-Global].

Drone

[A] Drones are remote controlled aircrafts with no human pilot on-board. These have a huge potential in agriculture in terms of supporting evidence-based planning and in spatial data collection. Despite some inherent limitations, these tools and technologies can provide valuable data that can then be used to influence policies and decisions. [b-Sylvester].

E-agriculture

[G]: It refers to agricultural services and information delivered or enhanced through the Internet and related technologies. E-agriculture involves the conceptualization, design, development, evaluation and application of new (innovative) ways to use existing or emerging ICT. [b-WSIS].

Encoder

[G]: An embodiment of an encoding process. [ITU-T H.222.0].

Ensemble binary classification model

[AI]: Binary classification is a type of classification task that outputs one of two mutually exclusive classes. An ensemble is a collection of models trained independently whose predictions are averaged or aggregated. In many cases, an ensemble produces better predictions than a single model. An ensemble binary classification model is an ensemble of many binary classification models. [b-ScienceDirect-2].

Ethical AI

[AI]: 1. Development, deployment, and use of AI that ensures compliance with ethical norms, including fundamental rights as special moral entitlements, ethical principles, and related core values. 2. "Ethical AI" is an umbrella term that houses a vast set of definitions such as "transparency," "non-maleficence," "responsibility," and "trust". 3. The ethics of artificial intelligence is the ethics of technology specific to robots and other artificial intelligence beings, which is divided into robot ethics and machine ethics. The former is about the concern with the moral behavior of humans as they design, construct, use, and treat artificially intelligent beings, and the latter is about the moral behaviour of artificial moral agents (see also inadvertent effects). [b-Leslie] [b-Jobin].

Explainable AI (xAI)

[AI]: Explainable artificial intelligence is a key term in AI design and in the tech community as a whole. It refers to efforts to make sure that artificial intelligence programs are transparent in their purposes and how they work. Explainable AI is a common goal and objective for engineers and others trying to move forward with artificial intelligence progress. [b-Springer].

Exploratory data analysis (EDA)

[AI]: Exploratory data analysis is an approach/philosophy for data analysis that employs a variety of techniques (graphical and quantitative) to better understand data. It can be seen as an initial examination of data to determine its salient characteristics and assess its quality. [b-DataAnalysis] [b-ISO/IEC 22989].

European grapevine moth

[A]: *Lobesia botrana* (*L. botrana*) or European grapevine moth (EGVM) is a significant pest of berries and berry-like fruits in Europe, the Mediterranean, southern Russia, Japan, the Middle East, Near East, and northern and western Africa [b-Grapevine].

Enhanced vegetation index (EVI)

[G]: The Enhanced Vegetation Index (EVI) is a remote sensing metric that assesses vegetation health by combining information from multiple spectral bands. It improves sensitivity in areas of high biomass [b-Huete].

Factorial analysis

[AI]: Factorial analysis is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors. [b-Jöreskog].

Farmer

[G]: A person who runs a farm [...] or agricultural holding, either as tenant or owner; a person whose occupation or business is cultivating crops, raising livestock, producing animal products, etc. for food or for sale. [b-Oxford]

Farming

[G]: The art, science, and business of cultivating the land for growing crops. [b-National].

Federated learning

[AI]: Federated learning (also known as collaborative learning) is a machine learning technique that trains an algorithm across multiple decentralized edge devices or servers holding local data samples, without exchanging them. [b-Konečný].

Feedback

[AI]: In machine learning, a situation in which a model's predictions influence the training data for the same model or another model. For example, a model that recommends movies will influence the movies that people see, which will then influence subsequent movie recommendation models. [b-NOAASStudent].

Final yield

[G]: All the material, that counts against the prescribed yield, derived from the principal fellings. [b-FAO-4].

Flavescence Dorée

[A]: "Flavescence dorée" (FD) is a grape vine disease caused by the bacterial agent "*Candidatus Phytoplasma vitis*" and spread by the leafhopper *Scaphoideus titanus* Ball (Hemiptera: Cicadellidae [b-Tardif].

Food chain

[G]: Production to consumption continuum including, primary production (food-producing animals, plants/crops, feed), harvest/slaughter, packing, processing, storage, transport, and distribution to the point of consumption. [b-FAO/WHO].

Food production

The production of raw agricultural, livestock, fisheries and forestry products. [b-FAO-2].

Food security

[G]: Food security is defined when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. [b-WorldBank].

Fuzzy logic

[AI]: A simple form for the many-valued logic, in which the truth values of variables may have any degree of "truthfulness" that can be represented by any real number in the range between 0 (as in completely false) and 1 (as in completely true) inclusive. Consequently, it is employed to handle the concept of partial truth, where the truth value may range between completely true and completely false. In contrast to Boolean logic, where the truth values of variables may have the integer values 0 or 1 only. [b-Chesalov].

Georeferencing

[G]: Georeferencing means that the internal coordinate system of a digital map or aerial photo can be related to a ground system of geographic coordinates. A georeferenced digital map or image has been

tied to a known Earth coordinate system, so users can determine where every point on the map or aerial photo is located on the Earth's surface [b-USGS].

Geospatial mapping

[A]: Geospatial mapping is the process of collecting, analysing, and visualizing geographic data to create accurate representations of Earth's surface. It involves technologies like GPS and GIS [b-Smith].

Generalization

[AI]: Refers to a model's ability to make correct predictions on new, previously unseen data as opposed to the data used to train the model. [b-Washington].

Genetic algorithm

[AI]: Algorithm that simulates natural selection by creating and evolving a population of individuals (solutions) for optimization problems. [b-ScienceDirect].

Germination

[G]: The initial stages in the growth of a seed to form a seedling. [b-FAO-2].

Global positioning system (GPS)

[G]: The Global Positioning System is a United States-owned utility that provides users with positioning, navigation, and timing (PNT) services. This system consists of three segments: the space segment, the control segment, and the user segment. [b-GPS].

Goodness-of-data

[G]: Accuracy, reliability, and validity of data. [b-Nkansah].

Gradient boost machine

[AI]: A type of machine learning technique that uses an ensemble of weak prediction models to perform regression and classification tasks. [b-Springer].

Green crop

[G]: A crop used in a green or unripe state as fodder. [b-Oxford].

Green leafhopper

[A]: Green leafhoppers are the most common leafhoppers in rice fields and are primarily critical because they spread the viral disease tungro. Both nymphs and adults feed by extracting plant sap with their needle-shaped mouthparts. [b-IRRI].

Ground truth

[AI]: Value of the target variable for a particular item of labelled input data. [b-ISO/IEC 22989].

Harvest

[A]: The gathering and collection of crops, including both plants and animals. [b-National].

Herbicide

[G]: A chemical substance or mixture of substances designed to control weeds. [b-FAO-2].

Humidity

[G]: Amount of water vapor in the air. [b-National].

Hyperparameter

[AI]: Hyperparameters are higher-level properties of a model such as how fast it can learn (learning rate) or complexity of a model. The depth of trees in a decision tree or number of hidden layers in a neural network are examples of hyper parameters. [b-MLGlossary].

Image segmentation

[G]: The division of a complex picture into parts corresponding to regions or objects, so that the picture can then be described in terms of the parts, their properties, and their spatial relationship; also, grouping together those parts on an image description that come from an object in the scene prior to their recognition. [b-McGraw-Hill].

Inference

[AI]: Process by which a deployed machine learning model generates a result. Examples of generated result from machine learning model are prediction or classification. [ITU-T Y.3179].

Information and communication technologies (ICTs)

[G]: Technologies and equipment that handle (e.g., access, create, collect, store, transmit, receive, disseminate) information and communication. [ITU-T L.1430].

Input layer

[AI]: The first layer (the one that receives the input data) in a neural network. [b-ScienceDirect-1].

Internet of things (IoT)

[IoT]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies. [ITU-T Y.4000].

Interoperability

[G]: The ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged. [ITU-T Y.101].

Interpolation

[AI]: In the mathematical field of numerical analysis, interpolation is a type of estimation, a method of constructing (finding) new data points based on the range of a discrete set of known data points. [b-ISO/IEC 27729].

Interpretability

[AI]: Interpretable machine learning is a useful umbrella term that captures the extraction of relevant knowledge from a machine learning model concerning relationships either contained in data or learned by the model or the level of understanding how the underlying (AI) technology works. [b-ISO/IEC TR 29119-11].

Irrigation adequacy

Reducing the water applied with each irrigation. [b-FAO-2].

Keyword detection

[AI]: Keyword extraction in natural language processing is the task of finding the words that best describe the subject of a text. [b-Willyan].

Labelled data

[AI]: In supervised learning, the "answer" or "result" portion of an example. Each example in a labelled dataset consists of one or more features and a label. For instance, in a housing dataset, the

features might include the number of bedrooms, the number of bathrooms, and the age of the house, while the label might be the house's price. In a spam detection dataset, the features might include the subject line, the sender, and the email message itself, while the label would probably be either "spam" or "not spam." [b-MachineLearning].

Land surface temperature (LST)

[A]: Land Surface Temperature (LST) is the measure of temperature on Earth's land surfaces, reflecting heat energy emitted by the ground. It's crucial for understanding climate, urban planning, and environmental changes [b-Climatology].

Latent space

[AI]: Formally, an abstract multi-dimensional space that encodes a meaningful internal representation of externally observed events. Samples that are similar in the external world are positioned close to each other in the latent space. [b-Baeldung].

Leafhopper

[G]: Leafhoppers are small insects of the Order Homoptera, about 10 mm in length, that hold their membranous and often colourful wings in a tent-like manner over their bodies [b-Andrew].

Life cycle

[G]: Consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal. [b-ISO]

Light detection and ranging (LiDAR)

[G]: System consisting of 1) a photon source (frequently, but not necessarily, a laser), 2) a photon detection system, 3) a timing circuit, and 4) optics for both the source and the receiver that uses emitted laser light to measure ranges to and/or properties of solid objects, gases, or particulates in the atmosphere. [b-ISO/IEC 22989].

Log-loss

[AI]: The loss function used in binary logistic regression. [b-ISO/IEC 22989].

Machine learning (ML)

[G]: Processes that enable computational systems to understand data and gain knowledge from it without necessarily being explicitly programmed. [ITU-T Y.3172].

Machine learning operations (ML Ops)

[AI]: ML Ops is a set of practices that combines machine learning, DevOps, and data engineering, which aims to deploy and maintain ML systems in production reliably and efficiently. [ITU-T Y.3172].

Machine learning pipeline

[G]: A set of logical nodes, each with specific functionalities, which can be combined to form a machine learning application in a telecommunication network. [ITU-T Y.3172].

Mean absolute error (MAE)

[AI]: The mean of the algebraic result of subtracting a true, specified, or theoretically correct value from the value computed, observed, measured, or achieved. [b-ISO/IEC 2382].

Message queue telemetry transport (MQTT)

[IoT]: Client server publish/subscribe messaging transport protocol. It is lightweight, open, simple, and designed to be easy to implement. These characteristics make it ideal for use in many situations,

including constrained environments such as communication in machine to machine (M2M) and Internet of Things contexts where a small code footprint is required and/or network bandwidth is at a premium. The protocol runs over transmission control protocol/internet protocol, or over other network protocols that provide ordered, lossless, and bi-directional connections. [b-ISO/IEC 20922].

Metadata

[G]: Structured, encoded data that describe characteristics of information-bearing entities such as their data descriptions, data about data ownership, access paths, access rights and data volatility to aid in the identification, discovery, assessment and management of the described entities. [ITU-T Y.3519] [ITU-T H.752]¹.

Microclimates

[A]: Topoclimate (on a spatial scale, the climate of a terrain of several km²) and microclimate (the climate of relief units comprising the 10- to 100-m² scale) [b-Microclimate].

Microcontroller

[IoT]: A microcontroller is a small computer that contains a processor, memory, and various input/output (I/O) peripherals [b-Kim].

Mobile application

[IoT]: self-contained software designed for a mobile device and performing specific tasks for mobile users [b-IOTM].

Monitoring

[AI]: Machine learning monitoring is a practice of tracking and analysing production model performance to ensure acceptable quality as defined by the use case. It provides early warnings on performance issues and helps diagnose their root cause to debug and resolve. [b-Clapham].

Monotonicity

[AI]: In model evaluation, monotonicity refers to the application of monotonic constraints in order to enforce a monotonic relationship between the prediction feature space and the target variable. [b-XGBoost].

Multilayer-feed-forward

[AI]: Neural network where information is fed from the input layer to the output layer in one direction only and connections between the nodes do not form a cycle. [b-ISO/IEC 22989].

Multivariate analysis

[AI]: Multivariate analysis provides models and procedures for dealing separately with each of a number of variables in estimation, while at the same time providing tests of hypotheses which lead to a single probability statement referring to all variables jointly. [b-Cramer].

Natural language processing (NLP)

[AI]: The process of converting a piece of English text into a programmer-friendly data structure that describes the meaning of the natural language text. The natural language processing tasks include part-of-speech tagging, chunking, named entity recognition, and semantic role labelling. [ITU-T E.475].

¹ This definition is based on both the indicated references.

Neural network

[AI]: Network of one or more layers of neurons connected by weighted links with adjustable weights, which takes input data and produces an output. Neural networks are a prominent example of the connectionist approach. Although the design of neural networks was initially inspired by the functioning of biological neurons, most works on neural networks do not follow that inspiration anymore. [b-ISO/IEC 22989].

Neurons

[AI]: Primitive processing element that takes one or more input values and produces an output value by combining the input values and applying an activation function on the result. Examples of nonlinear activation functions are a threshold function, a sigmoid function, and a polynomial function. [b-ISO/IEC 22989].

Normalization

[AI]: The process of converting an actual range of values into a standard range of values, typically from -1 to $+1$ or from 0 to 1 . For example, suppose the natural range of a certain feature is from 800 to $6,000$. Through subtraction and division, those values can be normalized into the range from -1 to $+1$. [b-WMO].

Normalized difference vegetation index (NDVI)

[G]: Normalized Difference Vegetation Index (NDVI) is a remote sensing metric that quantifies vegetation health by analysing the difference between near-infrared and red light reflectance. It helps monitor ecosystem changes [b-NDVI].

Nowcasting

[A]: Nowcasting is weather forecasting on a very short-term mesoscale period of up to two hours according to the World Meteorological Organization and up to six hours according to other sources. [b-WMO].

Numerical simulation

[IoT]: A calculation that is run on a computer following a program that implements a mathematical model for a physical system. Numerical simulations are required to study the behaviour of systems whose mathematical models are too complex to provide analytical solutions, as in most nonlinear systems. [b-Nature-1].

Numerical weather prediction (NWP) model

[IoT]: NWP models process current weather observations to forecast future weather. Output is based on current weather observations, which are assimilated into the model's framework and used to produce predictions for temperature, precipitation, and hundreds of other meteorological elements from the oceans to the top of the atmosphere. [b-NECI].

Open data

[G]: Data that are publicly accessible through open standards and protocols or through other means. The use and redistribution of open data can be subject to rules. [ITU-T Y.4472].

Optimizer

[AI]: A specific implementation of the gradient descent algorithm, for instance, ADaptive GRADient descent (AdaGrad) and ADaptive with momentum (Adam). [b-DeepAI].

Pearson correlation coefficient (PCC)

[AI]: In statistics, the Pearson correlation coefficient, also known as Pearson's r , the Pearson product-moment correlation coefficient (PPMCC), the bivariate correlation, or colloquially simply as the

correlation coefficient is a measure of linear correlation between two sets of data. It is the ratio between the covariance of two variables and the product of their standard deviations; thus, it is essentially a normalized measurement of the covariance, such that the result always has a value between -1 and 1 . [b-SPSS].

Pest

[G]: Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants and plant products, materials or environments, and includes vectors of parasites or pathogens of human and animal disease and animals causing public health nuisance. [b-FAO-4].

Pesticides

[G]: Any substance intended for preventing, destroying, attracting, repelling, or controlling any pest including unwanted species of plants or animals during the production, storage, transport, distribution and processing of food, agricultural commodities, or animal feeds or which may be administered to animals for the control of ectoparasites. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant, fruit thinning agent, or sprouting inhibitor and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport. The term normally excludes fertilizers, plant and animal nutrients, food additives, and animal drugs. [b-FAO/WHO].

Pheromones

[G]: Pheromones are substances which are secreted to the outside by an individual and received by a second individual of the same species. Yet pheromones can be detected by the olfactory system although humans under develop and underrate their smelling sense [b-Verhaeghe].

Phenological status

[G]: The state of one or more phenophases for an individual or species at a given moment. Phenological status could include but is not limited to measures of the state of flowers, leaves, and fruits for plants or migration, breeding, and development for animals. For example, the phenological status of a plant might be: has flowers and unfolded leaves; does not have ripe fruits. For birds, an example might be: is present, is an adult, and is calling; is not building or sitting on a nest [b-PhenologyNetwork].

Physical sensor/acquisition devices

[IoT]: A device that transforms a physical value into an electrical or logical unit and can therefore sense a physical condition or chemical compound by delivering an electronic signal proportional to the observed characteristic. The sensor can be directly connected with a data stream to the management system or via a conversion device and is an integral component of the electrical grid. [ITU-T Y.2071] [ITU-T Y.4113].

Physics-informed machine learning (PIML)

[AI]: Physics-informed machine learning seamlessly integrates data and mathematical physics models, even in partially understood, uncertain, and high-dimensional contexts. [b-Nature-2].

Pooling

[AI]: Reducing a matrix (or matrices) created by an earlier convolutional layer to a smaller matrix. Pooling usually involves taking either the maximum or average value across the pooled area. A pooling operation, just like a convolutional operation, divides that matrix into slices and then slides that convolutional operation by strides. Pooling helps enforce translational invariance in the input matrix. Pooling for vision applications is known more formally as spatial pooling. Time-series applications usually refer to pooling as temporal pooling. Less formally, pooling is often called subsampling or downsampling. [b-ScienceDirect].

Prediction/forecasting

[G]: Forecasting is the process of making predictions based on past and present data. [b-MachineLearning].

Precision agriculture

[G]: The application of modern information technologies to provide, process and analyse multisource data of high spatial and temporal resolution for decision making and operations in the management of crop production. [b-FAO-2].

[IoT]: A farming system that uses GPS technology involving satellites and sensors on the ground and intensive information management tools to understand variations in resource conditions within fields. This information is used to apply fertilizers and other inputs more precisely and to predict crop yields more accurately. [b-FAO-2].

Production loss

[G]: Production losses are estimated by comparing actual yields to regression forecasts. Regression models are used to quantify the impact of Fusarium head blight-related supply reductions. [b-Oliveira].

Rainfall data from CHIRP

[A]: CHIRP (Climate Hazards Group InfraRed Precipitation) provides global rainfall data using infrared satellite imagery. This dataset enhances understanding of precipitation patterns [b-CHIRP].

Random forest

[AI]: Random forests or random decision forests are ensemble learning methods for data classification and regression. They construct a multitude of decision trees during the training and output the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees. [b-Springer].

Random forest regression (RFR)

[AI]: Random Forest Regression is a machine learning ensemble method for predictive tasks involving continuous outputs. It constructs multiple decision trees during training and averages their predictions for robust results. It's known for handling complex relationships and reducing overfitting. [b-Breiman].

Recurrent neural network (RNN)

[AI]: Neural network in which outputs from both the previous layer and the previous processing step are fed into the current layer. [b-ISO/IEC 22989].

Regularization

[AI]: The penalty on a model's complexity. Regularization helps prevent overfitting. [b-Springer].

Reliability

[G]: Reliability is the probability and/or ability of a system, product, or component to perform and maintain under stated conditions as required for a specified period of time. [ITU-T L.1022] [ITU-T Y.3514].

Reproducibility

[AI]: Reproducibility is obtaining consistent results using the same input data; computational steps, methods, and code; and conditions of analysis. This definition is synonymous with "computational reproducibility." [b-NAP].

Robot

[G]: Automation system with actuators that performs intended tasks in the physical world, by means of sensing its environment and a software control system. A robot includes the control system and interface of a control system. The classification of a robot as industrial robot or service robot is done according to its intended application. In order to properly perform its tasks, a robot makes use of different kinds of sensors to confirm its current state and perceive the elements composing the environment in which it operates. [b-MachineLearning] [b-ISO/IEC 22989].

Robustness

[AI]: The characteristic of a model when its generated output and overall performance is satisfactory and admissible, even though data may derive from various probability distributions, contain outliers, and diverge from parametric distributions, expected data ranges, and other model assumptions. [b-Earth].

ROI filtering

[AI]: Filtering a region of interest (ROI) is the process of applying a filter to a region in an image, where a binary mask defines the region. For example, you can apply an intensity adjustment filter to certain regions of an image [b-ROI].

R square

[AI]: R-squared (R^2) in machine learning quantifies the proportion of variance in the dependent variable explained by the independent variables in a regression model. It ranges from 0 to 1, with higher values indicating better model fit [b-R2].

Sample selection

[AI]: Process to select a subset of data samples intended to present patterns and trends similar to that of the larger dataset being analysed. Ideally, the subset of data samples will be representative of the larger dataset. [b-ISO/IEC 22989].

Seed

[A]: The fertilized ripened ovule of a flowering plant containing an embryo and capable normally of germination to produce a new plant, broadly: a propagative plant structure (such as a spore or small dry fruit). [b-Deepchecks].

[AI]: A random seed (or seed state, or just seed) is a number (or vector) used to initialize a pseudorandom number generator. [b-Geology].

Self-supervised learning

[AI]: An unsupervised learning method where the supervised learning task is created out of the unlabelled input data. [b-ISO/IEC 22989].

Sensitivity

[AI]: Sensitivity is a measure of the proportion of actual positive cases that got predicted as positive (or true positive). [b-Shannon].

Sensors

[IoT]: "Sensor" or "sensors" refer to a particular category of devices that can sense or measure defined physical, chemical or biological quantities and generates associated quantitative data. This is in contrast to other sensor definitions that are encountered in relation to the IoT in which devices such as RFID readers are considered to sense the data they acquire. [b-MachineLearning].

Sensor fusion

[IoT]: Sensor fusion is the process of combining sensor data or data derived from disparate sources such that the resulting information has less uncertainty than would be possible when these sources were used individually. [b-MachineLearning].

Soil

[G]: The upper layer of the Earth's crust transformed by weathering and physical/chemical and biological processes. It is composed of mineral particles, organic matter, water, air and living organisms organized in genetic soil horizons. [b-ISO 11074].

Stacking

[AI]: Using a machine learning model to learn how to best combine the predictions from contributing ensemble members. [b-Springer].

Supervised learning

[AI]: Learning strategy in which the correctness of acquired knowledge is tested through feedback from an external knowledge source. [b-ISO/IEC 2382].

Sustainable development

[G]: Development that meets the environmental, social, and economic needs of the present without compromising the ability of future generations to meet their own needs. [ITU-T Y.4051].

Thermal imaging

[G]: A very powerful remote sensing technique for a number of reasons, particularly when used to elucidate field studies relating to animal ecology. Thermal imaging data are collected at the speed of light in real time from a wide variety of platforms, including land, water, and air-based vehicles. [b-ScienceDirect].

Terrain

[A]: Terrain refers to the physical characteristics of the Earth's surface, including elevation, slope, and landforms. It plays a crucial role in various natural processes and human activities [b-Terrain].

Tomato moth

[A]: The tomato moth (*Lacanobia oleracea*) is a particularly a pest in greenhouses but can also inflict damage on outdoor crops. It is a polyphagous species feeding on plants of 14 families including crop species such a tomato, sweet pepper, lettuce, brassicas, cucumber, cut flowers (particularly chrysanthemums), apple as well as perennial and woody shrubs and trees. *The tomato moth* (*Lacanobia oleracea*) is found throughout Europe, North Africa, the Middle East, temperate North Asia and Central Asia, northern India, China, Korea and Japan [b-Tomatomoth].

UNet

[AI]: A neural network with a U-shape, where connections exist between the horizontally corresponding layers of the contracting input branch and the expanding output branch. It was designed to work with fewer training images and to yield more precise segmentations. [b-Springer].

Underground water

[G]: Water in soil beneath the soil surface, usually under conditions where the pressure in the water is greater than the atmospheric pressure, and the soil voids are substantially filled with the water. [b-FAO-4].

Unmanned aerial vehicles (UAV)

[G]: A pilotless aircraft, in the sense of Article 8 of the Convention on International Civil Aviation, which is flown without a pilot-in-command on-board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous. [b-UAS].

Unsupervised learning

[AI]: A learning strategy that consists of observing and analysing different entities and determining that some of their subsets can be grouped into certain classes, without any correctness test being performed on acquired knowledge through feedback from external knowledge sources. [b-ISO/IEC 2382].

Urban agriculture

[G]: The practice of farming within an urban environment, especially the cultivation of food crops for human consumption. [b-FAO-2].

Veganic farming

[G]: Veganic farming is a form of agriculture that seeks to avoid using animal byproducts in any capacity. It is also known as "animal-free agriculture" or "animal-free organic." [b-Eastern].

Vertical farming

[G]: Indoor farming with a completely controlled environment, used for growing crops vertically year-round. [b-FAO-2].

Virus

[A]: A virus is a submicroscopic infectious agent that replicates only inside the living cells of an organism. [b-Wu].

Water flow

[A]: It is defined as the volume of water moving past a particular point during a given time period. Discharge or flow (either term is acceptable) applies to rivers and streams and is reported as cubic feet per second (cfs) or cubic meters per second (cms) [b-Waterflow].

Weather station

[A]: A location where meteorological observations such as surface, upper air, and climatological observations are taken. [b-AMS].

Weed

[G]: A wild plant growing where it is not wanted and in competition with cultivated plants. [b-Cambridge].

Bibliography

- [b-Adamopoulou] Adamopoulou, E., Moussiades, L. (2020). *Chatbots: History, technology, and applications*. Available at: <https://doi.org/10.1016/j.mlwa.2020.100006>
- [b-Agriproduce] Cornell University. *7 CFR § 4280.103 - definitions., Legal Information Institute*. Available [viewed 2023-06-22] at: <https://www.law.cornell.edu/cfr/text/7/4280.103>
- [b-AMS] American Meteorological Society. *Glossary of Meteorology*. Available at: <https://glossary.ametsoc.org/wiki/Welcome>
- [b-Andrew] J.D. Shorthouse, Andrew V. Roberts. (2003). *INSECTS AND OTHER ANIMALS | Overview of Insects*, Encyclopedia of Rose Science, Elsevier.
- [b-Appen] Appen (2020). *What is Data Annotation?* Available at: <https://appen.com/blog/data-annotation/>
- [b-Baeldung] Baeldung. *Latent Space in Deep Learning*. Available at: <https://www.baeldung.com/cs/dl-latent-space>
- [b-BigData] *Data Consistency Theory and Case Study for Scientific Big Data* (2019). University of Science and Technology Beijing, Beijing
- [b-Breiman] Breiman, L. (2001). *Random forests*. *Machine learning*, 45(1), 5-32.
- [b-Cambridge] Cambridge Dictionary: <https://dictionary.cambridge.org/>
- [b-CambridgeDictionary-1] Uncertainty: <https://dictionary.cambridge.org/dictionary/english/uncertainty>
- [b-Chesalov] Chesalov, A, Vlaskin, A, Bakanach, M (2022). *Artificial Intelligence Glossarium: 1000 terms*.
- [b-CHIRP] Funk, C. et al. (2015). *The climate hazards infrared precipitation with stations – a new environmental record for monitoring extremes*. *Scientific Data*, 2, 150066.
- [b-Clapham] Clapham, Christopher; Nicholson, James (2014). *Oxford Concise Dictionary of Mathematics (Fifth Edition)*. Oxford University Press
- [b-Climatology] Smith, R. L., & Watts, D. G. (1984). *A global comparison of surface temperature measurements*. *Journal of Applied Meteorology and Climatology*, 23(3), 366-383.
- [b-Cramer] Cramer EM, and Bock RD. *Multivariate Analysis*. Review of Educational Research. (1966); 36(5):604-617. doi:10.2307/1169484. Accessed 20220913.
- [b-Data] Machine Learning Classifiers. Available at: <https://medium.com/towards-data-science/evaluation-of-machine-learning-classifiers-3912e7f5cf74>
- [b-Data4SDGs] Data Interoperability Collaborative. Available at: <https://www.data4sdgs.org/initiatives/data-interoperability-collaborative>
- [b-DataSupply] Learning from Machines: The Data Supply Chain. Available at: <https://towardsdatascience.com/learning-from-machines-the-data-supply-chain-4380f420bb2c>
- [b-DeepAI] What is Association Learning? Deep AI. Available at: <https://deepai.org/machine-learning-glossary-and-terms/association-learning>
- [b-Deepchecks] DeepCheck Glossary. Available at: <https://deepchecks.com/>

- [b-Earth] Robustness Metrics: How Are They Calculated, When Should They Be Used and Why Do They Give Different Results? Earth's Future. Available at: <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017EF000649>
- [b-Eastern] Eastern Oregon University Veganic Farming: Sustainable Agriculture Practices. Available at: <https://online.eou.edu/resources/article/veganic-farming-importance-of-sustainable-agriculture/>
- [b-EC] European Commission (2019). Independent High-Level Expert Group on Artificial Intelligence. Ethics Guidelines for Trustworthy AI.
- [b-EUParliament] Proposal for a regulation on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council.
- [b-EUTerm] European Union Terminology. Available at: <https://iate.europa.eu/entry/result/1756736>
- [b-FAO-1] Definitions-Aquaculture. Available at: <https://www.fao.org/3/x6941e/x6941e04.htm>
- [b-FAO-2] The future of food and agriculture: Trends and Challenges (2017). Food and Agriculture Organization of the United Nations.
- [b-FAO-3] FAO (2018). *Conservation Agriculture*. Available at: (<http://www.fao.org/conservation-agriculture/en/>).
- [b-FAO-4] FAO (1999). *Terminology for integrated resource planning and management*.
- [b-FAO-5] FAO. *AGRICULTURE 4.0: Agricultural robotics and automated equipment for sustainable crop production*.
- [b-FAO/WHO] FAO/WHO (2022). *Foodborne antimicrobial resistance: Compendium of Codex standards*.
- [b-Gautam] Gautam, N. (2017, Aug 1). Ameyo. Available at: <https://www.ameyo.com/blog/customer-experience-vs-customer-service>
- [b-Geology] Earthquakes and the Seismic Cycle. Available at: http://www.geology.wisc.edu/homepages/chuck/public_html/Classes/Mtn_and_Plates/eq_cycle.html
- [b-GPS] The Global Positioning System. Available at: <https://www.gps.gov/systems/gps/>
- [b-Grapevine] U.S. Department of Agriculture, European Grapevine Moth. USDA APHIS. Available at: <https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/european-grapevine-moth>
- [b-Hariri] Hariri R., Fredericks E.M, Bower K. (2019), Uncertainty in big data analytics: survey, opportunities, and challenges.
- [b-Huete] Huete, A., Didan, K., Miura, T., Rodriguez, E.P., Gao, X., & Ferreira, L.G. (2002). *Overview of the radiometric and biophysical performance of the MODIS vegetation indices*. Remote Sensing of Environment, 83(1-2), 195-213.
- [b-IBM] IBM. *What is a digital twin?* Available at: <https://www.ibm.com/topics/what-is-a-digital-twin>
- [b-Immuta] Immuta. *DataOps Dilemma: Survey Reveals Gap in the Data Supply Chain*. Available at: <https://www.immuta.com/downloads/dataops-dilemma-survey-reveals-gap-in-the-data-supply-chain/>

- [b-IOTM] Domenico Amalfitano, Anna Rita Fasolino, Porfirio Tramontana, Bryan Robbins (2013). *Testing Android Mobile Applications: Challenges, Strategies, and Approaches, Advances in Computers*. Elsevier.
- [b-IRRI] Catindig, J. (n.d.). *Green leafhopper – IRRI Rice Knowledge Bank*. Home – IRRI Rice Knowledge Bank. Available at: <http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/insects/item/green-leafhoppe>
- [b-Islam] T. Islam, M. Sah, S. Baral and R. Roy Choudhury (2018). *A Faster Technique on Rice Disease Detection using Image Processing of Affected Area in Agro-Field*. 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT), Coimbatore, India pp. 62-66, doi: 10.1109/ICICCT.2018.8473322.
- [b-ISO 11074] ISO 11074:2015, *Soil quality – Vocabulary*
- [b-ISO 1213-1] ISO 1213-1:2020, *Coal and coke – Vocabulary – Part 1: Terms relating to coal preparation*.
- [b-ISO 16100-2] ISO 16100-2:2003, *Industrial automation systems and integration – Manufacturing software capability profiling for interoperability – Part 2: Profiling methodology*.
- [b-ISO/IEC 20546] ISO/IEC 20546:2019, *Information technology – Big data – Overview and vocabulary*.
- [b-ISO/IEC 20922] ISO/IEC 20922:2016, *Information technology — Message Queuing Telemetry Transport (MQTT) v3.1.1*
- [b-ISO/IEC 22989] ISO/IEC 22989:2022, *Information technology – Artificial intelligence – Artificial intelligence concepts and terminology*: <https://www.iso.org/obp/ui/#iso:std:iso-iec:22989:ed-1:v1:en>
- [b-ISO/IEC 2382] ISO/IEC 2382, *Information technology – Vocabulary*.
- [b-ISO/IEC 2382-28] ISO/IEC 2382:1995, *Information technology – Vocabulary – Part 28: Artificial intelligence – Basic concepts and expert systems*.
- [b-ISO/IEC 27729] ISO/IEC 27729:2012, *Information and documentation – International standard name identifier (ISNI)*.
- [b-ISO/IEC TR 29119-11] ISO/IEC TR 29119-11:2020, *Software and systems engineering – Software testing – Part 11: Guidelines on the testing of AI-based systems*.
- [b-ISO] ISO. *Life cycle perspective*. Available at: <https://committee.iso.org/sites/tc207sc1/home/projects/published/iso-14001---environmental-manage/life-cycle.html>
- [b-Jobin] Jobin, A., Ienca, M. & Vayena (2019), E. *The global landscape of AI ethics guidelines*. *Nat Mach Intell* 1, 389–399. <https://doi.org/10.1038/s42256-019-0088-2>
- [b-Jöreskog] Jöreskog, Karl G. (1983). *Factor Analysis as an Errors-in-Variables Model*. *Principals of Modern Psychological Measurement*. Hillsdale: Erlbaum. pp. 185–196.
- [b-Konečný] Konečný, Jakub; McMahan, Brendan; Ramage, Daniel (2015). *Federated Optimization: Distributed Optimization Beyond the Datacenter*.

- [b-Kim] Kim, Chung Hwan (2019). *Securing Real-Time Microcontroller Systems through Customized Memory View Switching*. NDSS.
- [b-Klein] Klein, A (2004). *Sensor and Data Fusion: A Tool for Information Assessment and Decision Making*.
- [b-Leslie] Leslie (2020). *Understanding artificial intelligence ethics and safety – A guide for the responsible design and implementation of AI systems in the public sector*, 2019, Turing Institute, UK.
- [b-MachineLearning] *Machine Learning Glossary*. Available at: <https://developers.google.com/machine-learning/glossary>
- [b-McGraw-Hill] Skolnik, M. (1990). *Radar Handbook*. McGraw-Hill.
- [b-Microclimate] Littmann, T. (2008). Topoclimate and Microclimate. In: Breckle, SW., Yair, A., Veste, M. (eds). *Arid Dune Ecosystems*. Ecological Studies, vol 200. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-75498-5_12
- [b-Minnesota] Minnesota Department of Revenue. *Defining Agricultural Production*. Available at: <https://www.revenue.state.mn.us/book/export/html/12121>
- [b-MLGlossary] ML Glossary. Available at: <https://ml.cheatsheet.readthedocs.io/en/latest/glossary.html>
- [b-NAP] National Academies of Sciences, Engineering, and Medicine National Academies Press (US); 2019 May 7. PMID: 31596559.
- [b-National] The Art and Science of Agriculture. Available at: <https://education.nationalgeographic.org/resource/agriculture/>
- [b-Nature-1] Numerical simulations. Nature systems Portfolio: <https://www.nature.com/subjects/numerical-simulations>
- [b-Nature-2] Karniadakis, G.E., Kevrekidis, I.G., Lu, L. et al. (2021). *Physics-informed machine learning*. Nat Rev Phys 3, 422–440.
- [b-NDVI] Smith, D.L. et al. (2020). *Advances in Remote Sensing Techniques for Vegetation Monitoring*. Remote Sens. 2020, 12, 2103
- [b-NECI] Numerical Weather Prediction. *National Centers for Environmental Information*. Available at: <https://www.ncei.noaa.gov/products/weather-climate-models/numerical-weather-prediction>
- [b-Nevada] University of Nevada. *Basics of Crop Management*. Available at: <https://extension.unr.edu/publication.aspx?PubID=4103>
- [b-Nkansah] Nkansah, P, Amankwaa, A. Adequacy, Accessibility, and Goodness of Data. Journal of African Business 2(1): 95-107.
- [b-NOAAStudent] Students Glossary. National Oceanic and Atmospheric Administration. Available at: <https://www.adp.noaa.gov/Students/Glossary.aspx>
- [b-Oliveira] Oliveira, C. M., et al. (2014). *Crop losses and the economic impact of insect pests on Brazilian agriculture*. Crop Protection 56: 50-54.
- [b-Oxford] The Oxford Essential Dictionary of the U.S. Military (2001). Berkley Books, Oxford Reference Online. Oxford University Press. DGT.
- [b-Pesticide] Aktar, Md Wasim, Dwaipayan Sengupta, and Ashim Chowdhury. (2009). *Impact of pesticides use in agriculture: their benefits and hazards*. Interdisciplinary toxicology 2.1.

- [b-PhenologyNetwork] Phenological status. USA National Phenology Network. (n.d.). USA National Phenology Network. USA National Phenology Network. <https://usanpn.org/taxonomy/term/67#:~:text=The%20state%20of%20one%20or,breeding,%20and%20development%20for%20animals>
- [b-Piedmont] Piedmont, R. Bias Statistical. *Encyclopaedia of Quality of Life and Well-Being Research* pp 382–383.
- [b-R2] Smith, J. D. (2010). *Understanding R-squared in Regression Models*. Journal of Statistics Education, 18(2), 1-14.
- [b-Redman] Redman, Thomas C. (2013). *Data Driven: Profiting from Your Most Important Business Asset*. Harvard Business Press.
- [b-ROI] Overview of ROI Filtering. Available at: <https://www.mathworks.com/help/images/overview-of-roi-filtering.html>
- [b-ScienceDirect] Evolutionary Algorithm. Science Direct: [https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/evolutionary-algorithm#:~:text=Evolutionary%20algorithms%20are%20based%20on,\(hopefully\)%20identifies%20better%20solutions.](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/evolutionary-algorithm#:~:text=Evolutionary%20algorithms%20are%20based%20on,(hopefully)%20identifies%20better%20solutions.)
- [b-ScienceDirect-1] Drifter. Available at: <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/drifter>
- [b-ScienceDirect-2] Ensemble Modeling: <https://www.sciencedirect.com/topics/computer-science/ensemblemodeling>
- [b-Scott] Scott, Dan (2018). *Smart Farming & FoodTech Revolutionizes the Future of Food*. Vontobel Holding AG www.vontobel.com/en-ch/impact/smart-farming-the-future-of-agriculture-9097/
- [b-Shannon] C.E. Shannon, A Mathematical Theory of Communication, Bell Systems Technical Journal, Vol. 27, pp 379–423.
- [b-Smith] Smith, J. D. et al. (2018). *Advances in Geospatial Mapping*. Journal of Geographical Research, 42(3), 215-230.
- [b-Springer] AI: A Glossary of Terms (2019) Springer. Available at: <https://link.springer.com/content/pdf/bbm%3A978-3-319-94878-2%2F1.pdf>
- [b-SPSS] SPSS Tutorials: Pearson Correlation. Available at: <https://libguides.library.kent.edu/SPSS/PearsonCorr>
- [b-Sylvester] Sylvester.G. (2018). *E-Agriculture in action Drones for Agriculture*. Available at: <https://www.fao.org/3/l8494EN/i8494en.pdf>
- [b-Tardif] Tardif, M., Amri, A., Keresztes, B., Deshayes, A., Martin, D., Greven, M., & Da Costa, J.-P. (2022). *Two-stage automatic diagnosis of Flavescence Dorée based on proximal imaging and artificial intelligence: a multi-year and multi-variety experimental study*. OENO One, 56(3), 371–384. Available at: <https://doi.org/10.20870/oeno-one.2022.56.3.5460>
- [b-Terrain] Smith, J., & Brown, A. (2018). *Mapping Terrain Features*. Journal of Geographical Research, 45(2), 210-225.
- [b-Tomatomoth] Tomato moth | Koppert Global. (n.d.). Koppert Global | Partners with Nature. Available at: <https://www.koppert.com/challenges/pest-control/caterpillars/tomato-moth/>
- [b-UAS] Unmanned Aircraft Systems (UAS). International Civil Aviation Organization.

- [b-UN-Global] United Nations Global Compact. *Disruptive Technologies: Digital Agriculture*. Available at: <http://breakthrough.unglobalcompact.org/disruptive-technologies/digital-agriculture/>
- [b-USGS] U.S. Geological Survey. Science for a changing world. *What does "georeferenced" mean?* Available at: <https://www.usgs.gov/faqs/what-does-georeferenced-mean>
- [b-Verhaeghe] Verhaeghe J, Gheysen R, Enzlin P (2013). *Pheromones and their effect on women's mood and sexuality*. Facts Views Vis Obgyn. 2013;5(3):189-95. PMID: 24753944; PMCID: PMC3987372.
- [b-Waterflow] USF Water Institute, S. of G. (n.d.). *Water flow. Learn More: Water Flow – Lake County Water Atlas – Lake*. WaterAtlas.org. [https://lake.wateratlas.usf.edu/library/learn-more/learnmore.aspx?toolsection=lm_flow#:~:text=It%20is%20defined%20as%20the,meters%20per%20second%20\(cms\)](https://lake.wateratlas.usf.edu/library/learn-more/learnmore.aspx?toolsection=lm_flow#:~:text=It%20is%20defined%20as%20the,meters%20per%20second%20(cms))
- [b-Willyan] Willyan D. Abilhoa, Leandro N. de Castro (2014). *A keyword extraction method from twitter messages represented as graphs*", Applied Mathematics and Computation 240308-325.
- [b-WMO] World Meteorological Organization. Available at: <https://web.archive.org/web/20160605094419/http://www.eumetcal.org/euromet/glossary/nocast.htm>
- [b-WSIS] World Summit on the Information Society, Tunis (2005); *Bridging the Rural Digital Divide (BRDD)* Web site, FAO. Available at: http://www.fao.org/rdd/definition_en.asp
- [b-WorldBank] World Bank. *What is Food Security*. Available at: <https://www.worldbank.org/en/topic/agriculture/brief/food-security-update/what-is-food-security#:~:text=Based%20on%20the%201996%20World,an%20active%20and%20healthy%20life>
- [b-Wu] Wu KJ (15 April 2020), There are more viruses than stars in the universe. Why do only some infect us? – More than a quadrillion quadrillion individual viruses exist on Earth, but most are not poised to hop into humans. Can we find the ones that are? National Geographic Society.
- [b-XGBoost] Monotonic Constraints. XGBoost Tutorial: <https://xgboost.readthedocs.io/en/stable/tutorials/monotonic.html>
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