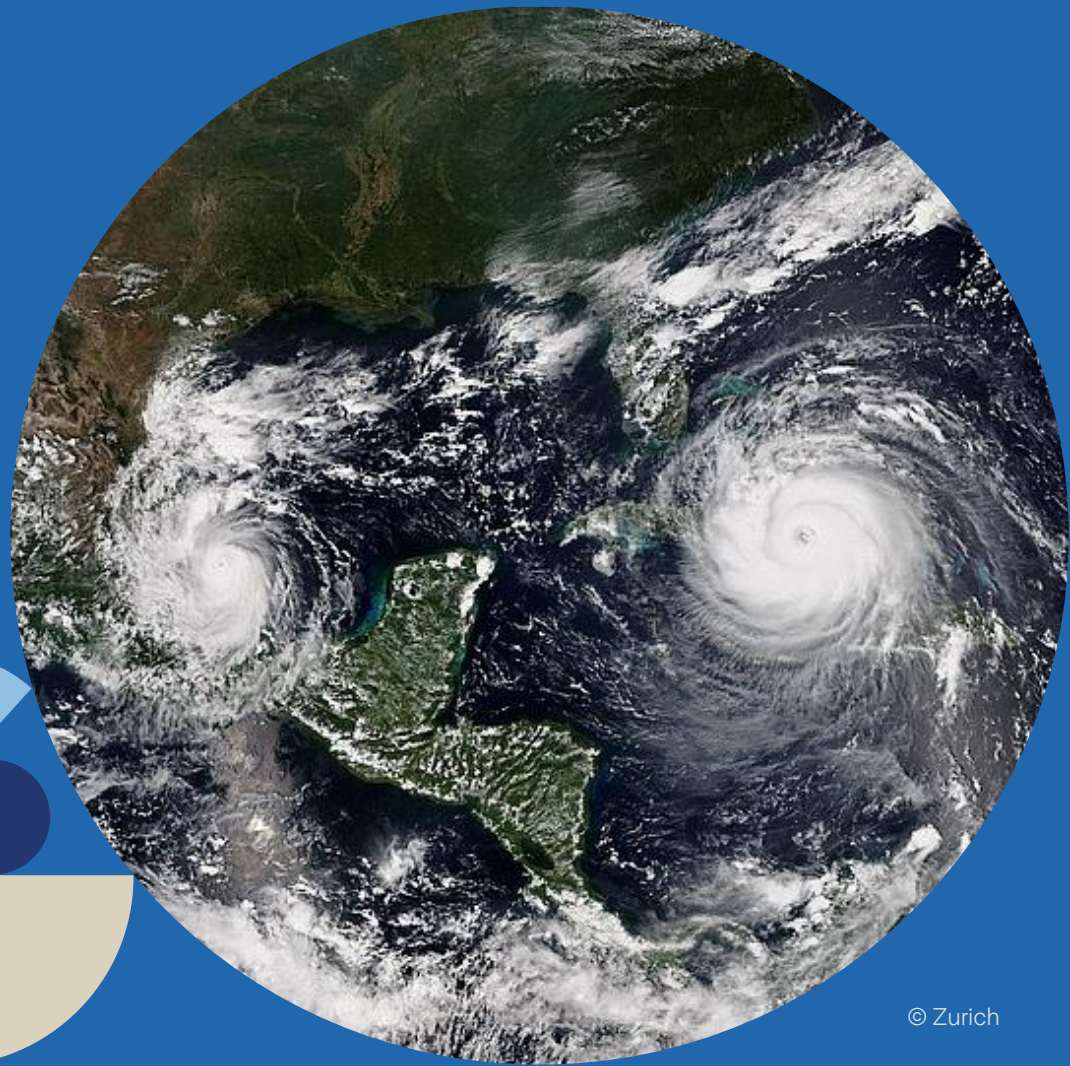
ZURICH

AI applications in natural and man-made catastrophe modelling

3rd ITU/WMO/UNEP Workshop on AI for Natural Disaster Management



30.8.2021
Roland Schöbi
Catastrophe R&D

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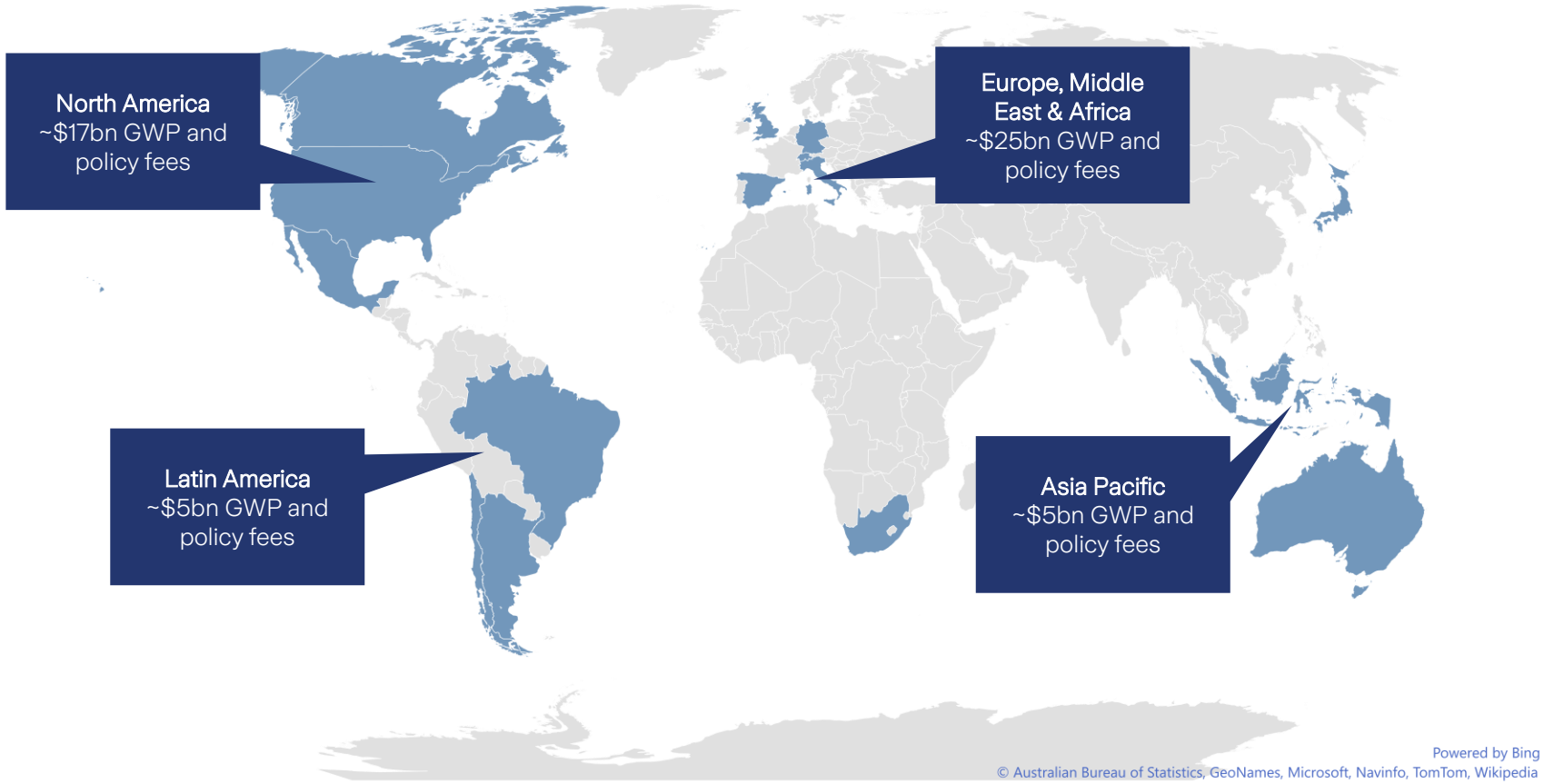
Zurich Insurance – a Global Company



- 215 countries and territories, 55'000 employees, ~**60 million people insured**
- Property & casualty insurances (36bn USD gross written premium) and Life insurance (28bn USD gross written premium)
- (numbers as of Dec 31st, 2020)

Hurricanes, Typhoons
Windstorms
Tornados
Hail

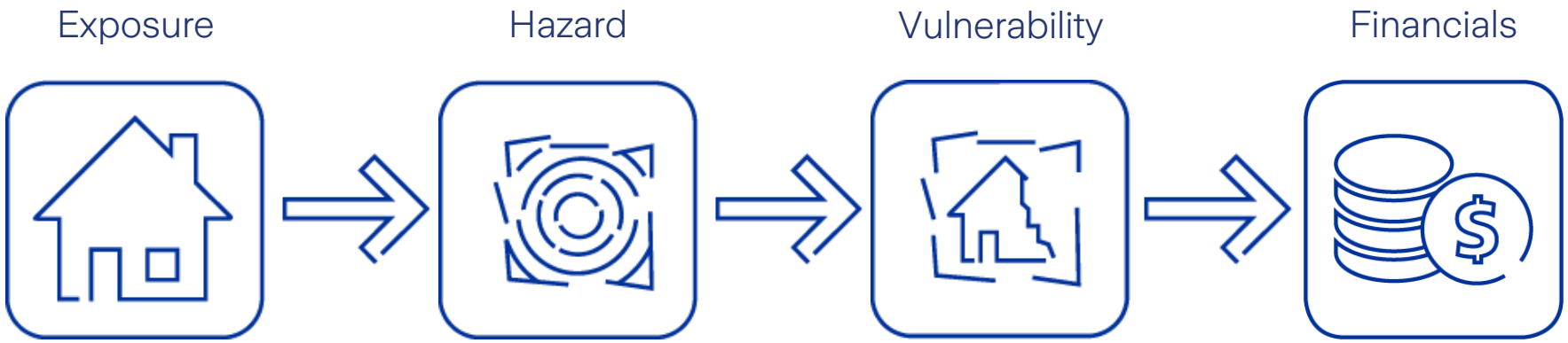
Inland floods
Storm surge

Earthquake

Cyber

Terrorism

Catastrophe Modelling



Portfolio of insurance contracts, spread around the world

Likelihood of potential events and their intensity

Physical consequences of intensity on asset

Financial consequences / losses associated to physical damage

Relevant use cases **prior** to an event
- Appropriate ***pricing*** of the risk
- ***Accumulation control*** for the portfolio of all policies as a measure of risk management
- Risk ***consulting*** through the inhouse risk engineers

Relevant use cases **during**/shortly after an event
- On portfolio level, cost estimation of a single event when the event occurs (***liquidity risk***)
- ***Damage/claim prediction*** of a single event to accurately estimate the payout to the individual customers

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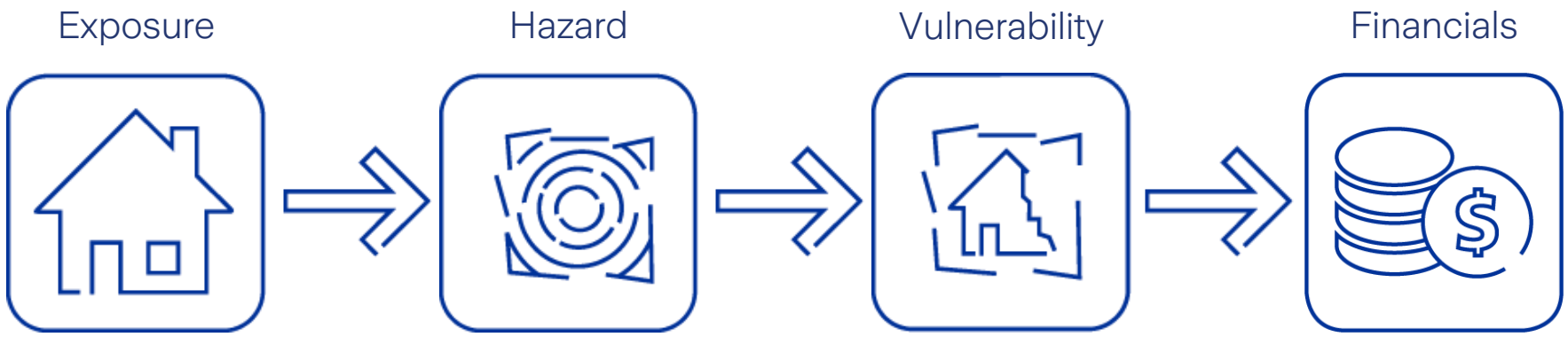
Application Areas of AI in Catastrophe Modelling

Typical examples highlighted



Portfolio of insurance contracts, spread around the world

Likelihood of potential events and their intensity

Physical consequences of intensity on asset

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Exposure data enrichment
- Location (address, lat/lon)
- Type of business (retail, personal, educational,…)
- Type of coverage (building, content, business interruption)
- Building features (height, construction year, number of floors,…)
- Surrounding (soil features, trees, lifelines,…)
- Contractual terms (hour clause, litigation, deductibles,…)

Event description and likelihood
- Frequency of occurrence
- Severity of occurrence
- Stochastic event sets / event footprints
- Transition model (e.g. GMPE for earthquakes)

Damage assessment
- Vulnerability functions / damage ratios
- (Fragility functions / damage states)
- Cascading events (e.g. fire following an earthquake)

Financial payout
- Application and interpretation of financial terms
- Human element
- From client loss to insured loss
- Reinsurance terms

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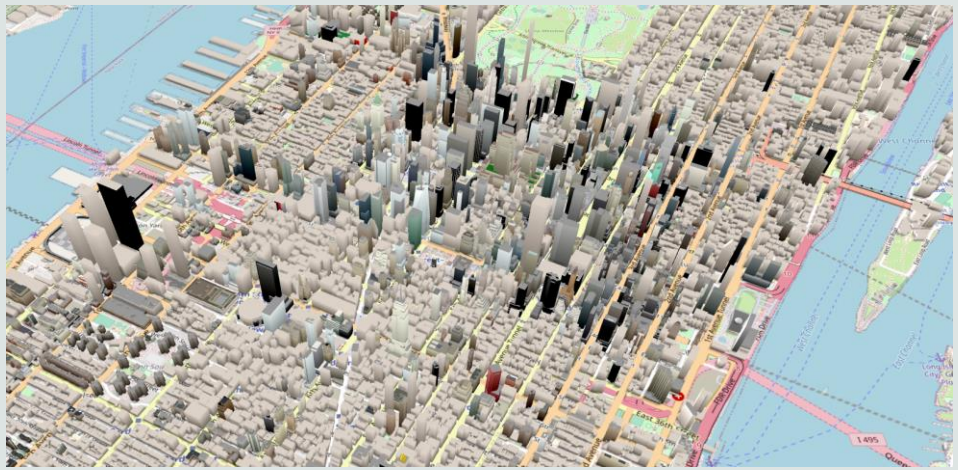
Benchmark Application – Terrorism modelling

Overview

Goal: assess the terrorism risk for a truck bomb in an(y) urban area

Building database

- *Zurich Global Exposure Database*
  - Database of all Zurich contracts, including building details
  - Including any building in the world
- *Open Street Maps*
  - Freely available, global map database containing any object from roads to buildings (>8.7 billion GPS points, >464 million buildings)
  - Very active project with continuous contributions
  - Accessible with API calls for specific regions or complete downloads
  - Good completeness (in terms of roads and building footprints) in the areas where Zurich has large exposure

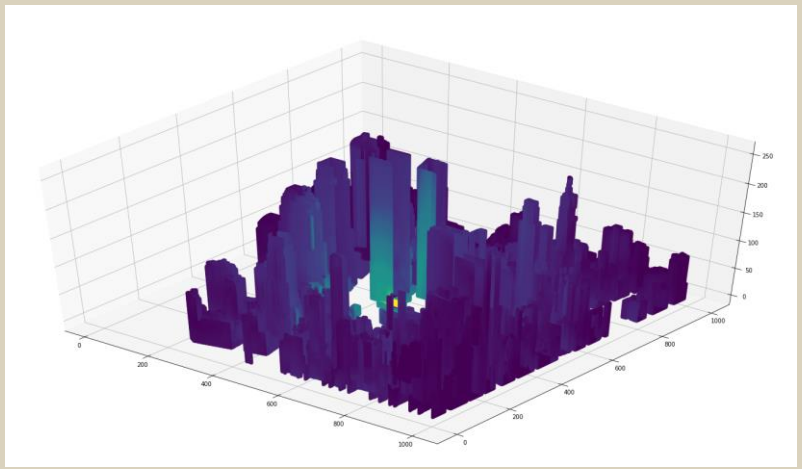


https://osmbuildings.org/

Bomb blast behavior

- *Computational Fluid Dynamics simulation*
  - Realistic 3D blast simulations using proprietary software resulting in façade level blast impacts
  - ~6000 blasts of truck bombs in New York City
  - Damage estimation for the surrounding buildings
  - Amount of people injured by the blast wave (grouped in 6 categories from medical treatment to death)

  → Computationally intense simulation prevents scaling globally



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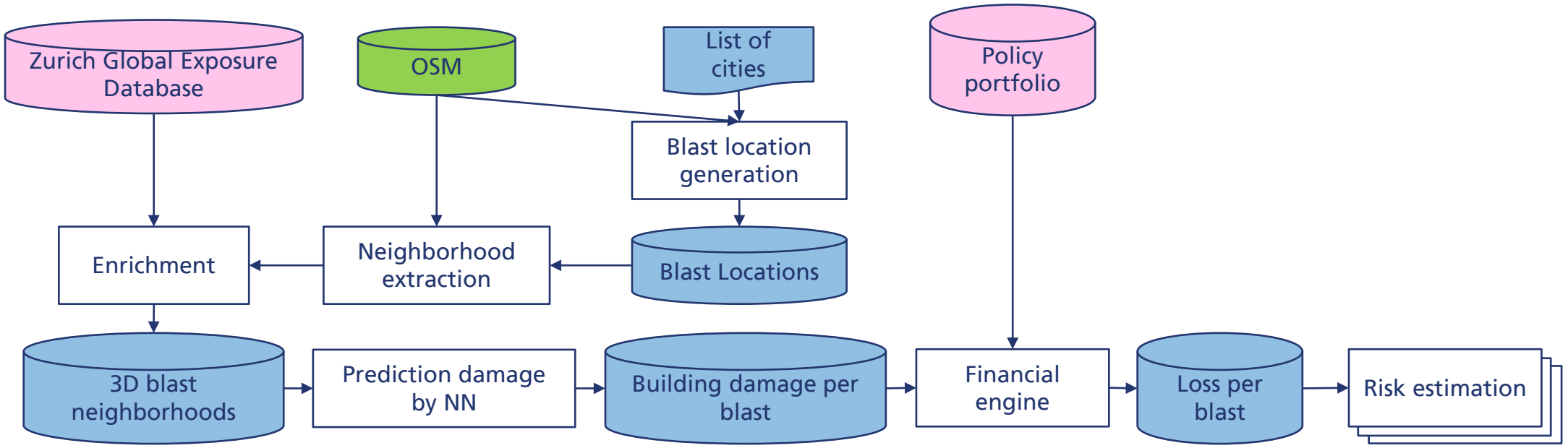
Benchmark application – Terrorism modelling

Modelling chain



- *Zurich Global Exposure Database* is built with machine learning methods on different proprietary, paid, and public data sources
- *Prediction* of damage by neural network (NN) consists of a chain of a pix2pix-like and a feedforward neural network model
- *Vulnerability function* fitted by statistical regression models

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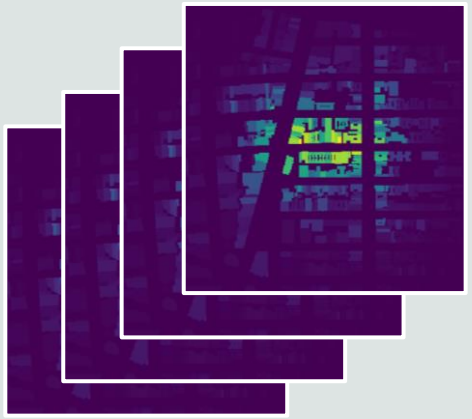
Benchmark application – Terrorism modelling

Use cases

Accumulation management

- Estimate the risk for our group portfolio
- Find the target that would produce the largest loss
- Find most likely events
- Find most risky events (product of probability and loss)
- Diversify the portfolio to reduce the accumulation risk



Pricing / underwriting

- Estimate the risk neutral price for each insurance contract that we are underwriting
- By considering any event that produces losses at the location of interest
- By considering the building properties and general usage

Event assessment

- Estimate the damage that a blast creates shortly after the event
- To inform the management about the financial impact
- To inform the claims department to anticipate the impacted clients

E.g. Alfred Murrah building in Oklahoma City (1995)

https://en.wikipedia.org/wiki/Oklahoma_City_bombing#/media/File:Murrah_Building_-_Aerial.jpg

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Conclusions and Outlook

Conclusions

- Variety of business relevant use cases that can be informed by AI
- Availability of data encourages the use of machine learning methods
- Terrorism application shows machine learning for extrapolation to unseen/hypothetical events

Outlook

- Extension of the terrorism model to any location of interest
- ML for estimating the impact of climate change (e.g. evolution of local risk to flooding)
- ML for satellite image recognition (e.g. remote damage classification)
- ML for cyber risk modelling (e.g. dynamic threat modelling)

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Thank you

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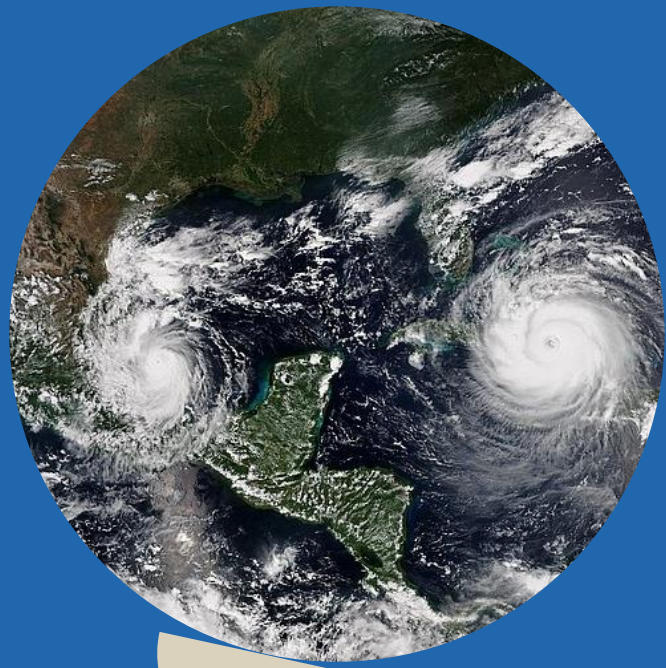

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