Explainable Tinyml: creating distributed knowledge in industry 5.0

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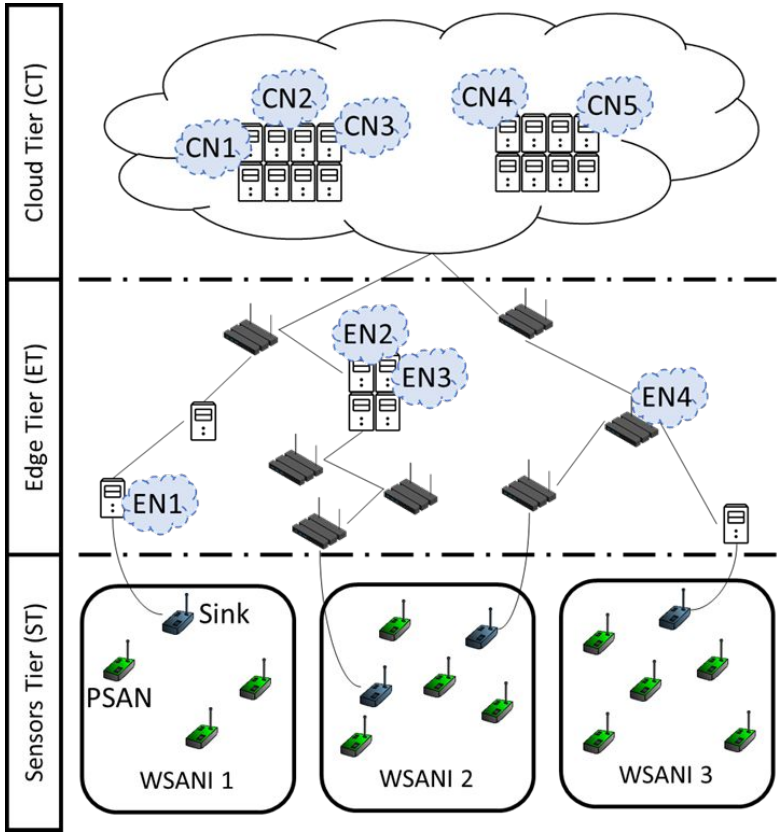
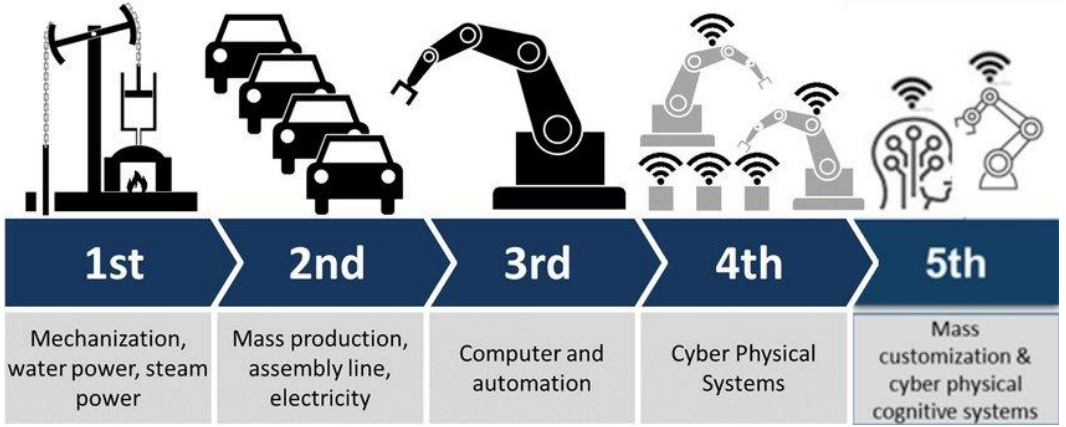
Internet Of Things



Industry 5.0

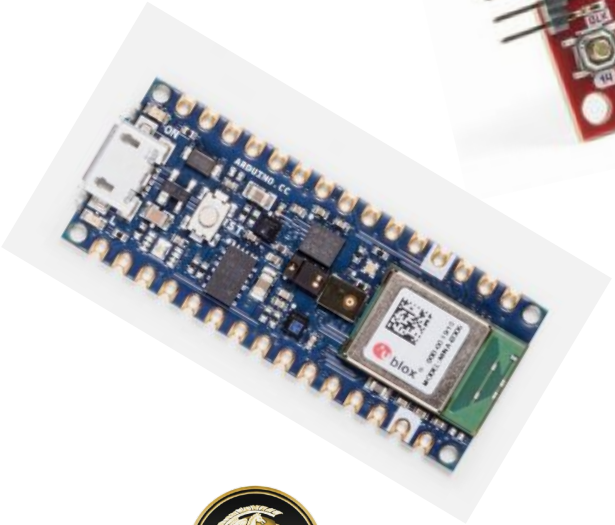

Human-centric
Industry 5.0
Resilient
Sustainable

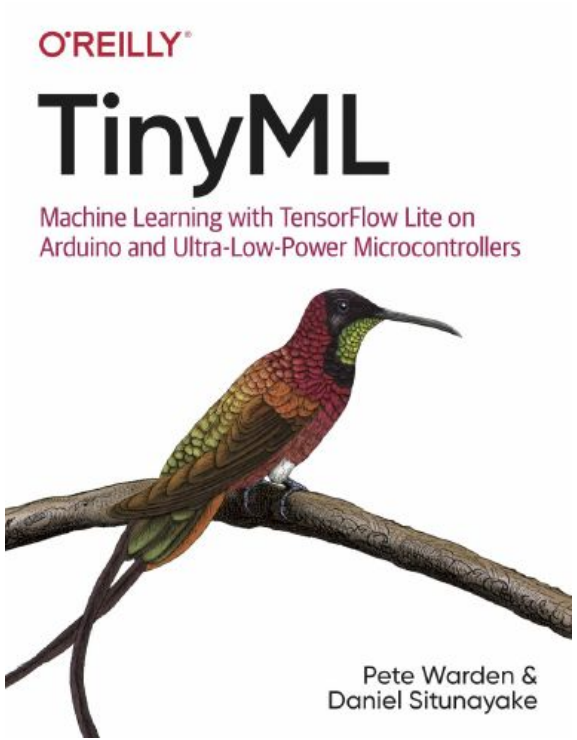

1st
2nd
3rd
4th
5th
Mechanization, water power, steam power
Mass production, assembly line, electricity
Computer and automation
Cyber Physical Systems
Mass customization & cyber physical cognitive systems


VS
5.0
4.0

TinyML - Computer Vision

- Tensor flow lite micro





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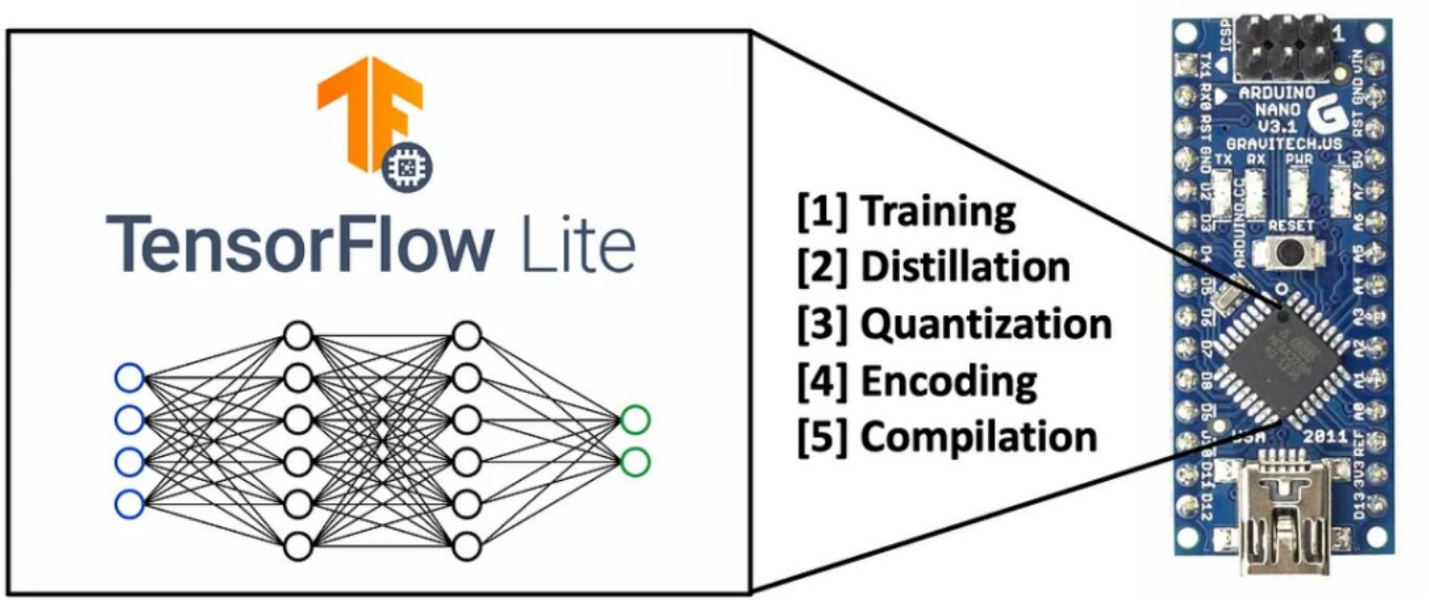
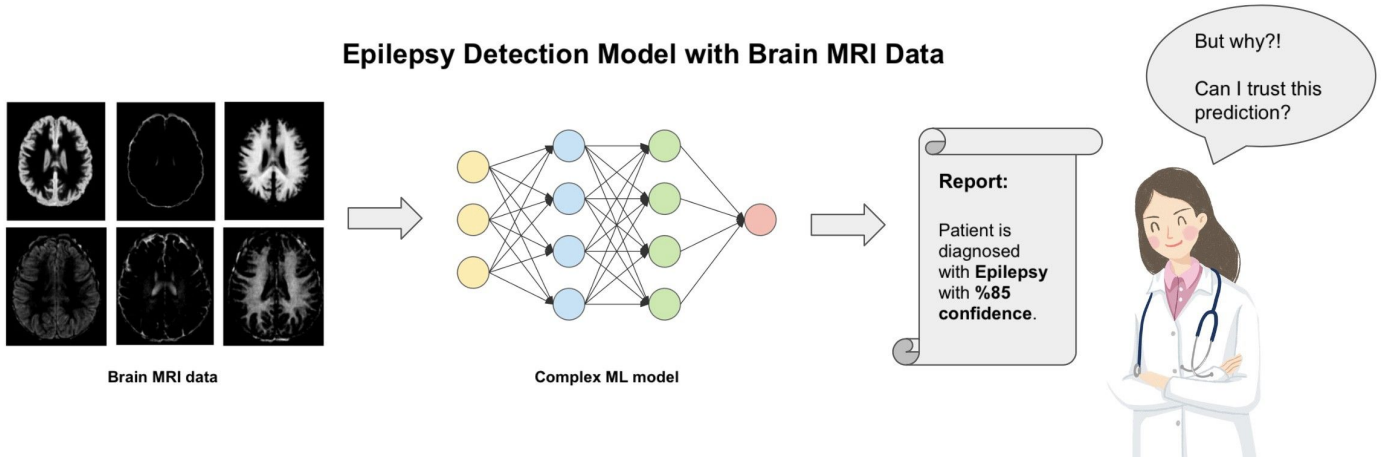

TensorFlow Lite
[1] Training
[2] Distillation
[3] Quantization
[4] Encoding
[5] Compilation
ARDUINO
NANO
V3.1
GRAVITECH.US
RESET

TinyML

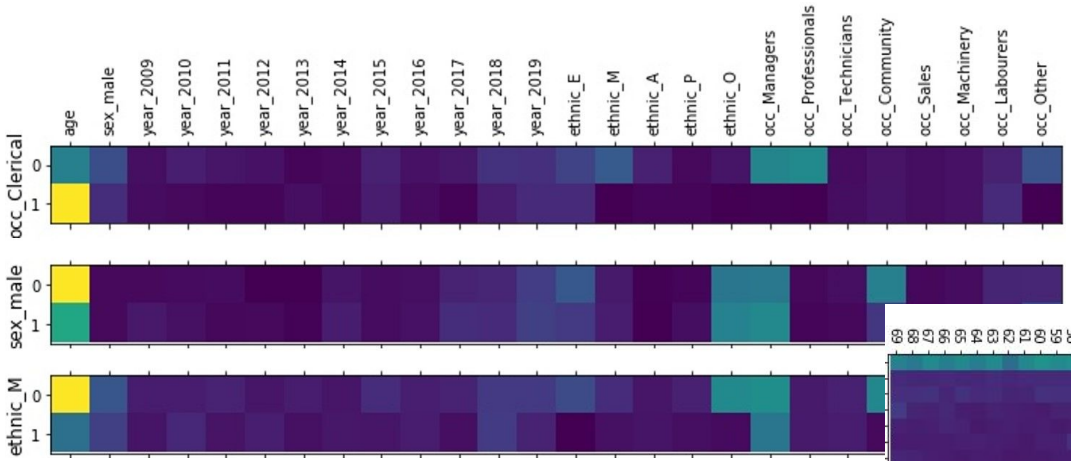
Problem - not a new one

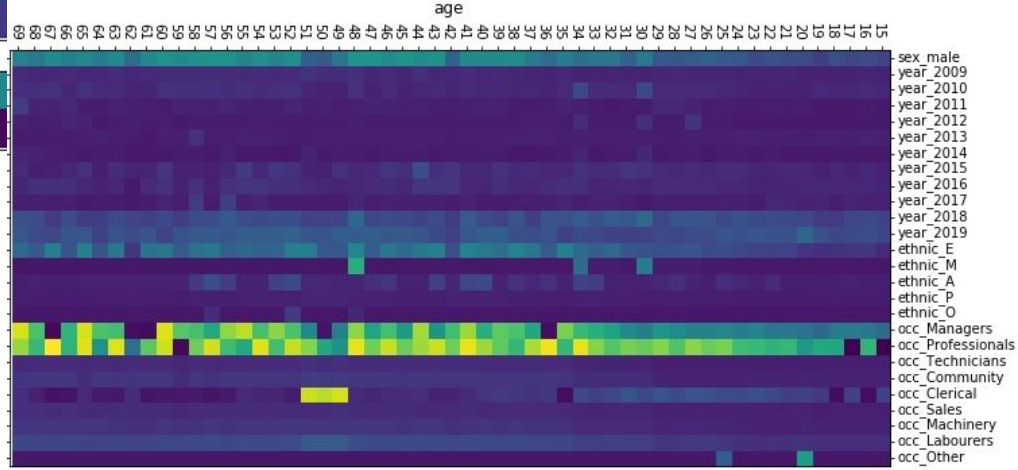
- Resource constrained environment
- Decision making
- CNN is the traditional way

Explainable AI



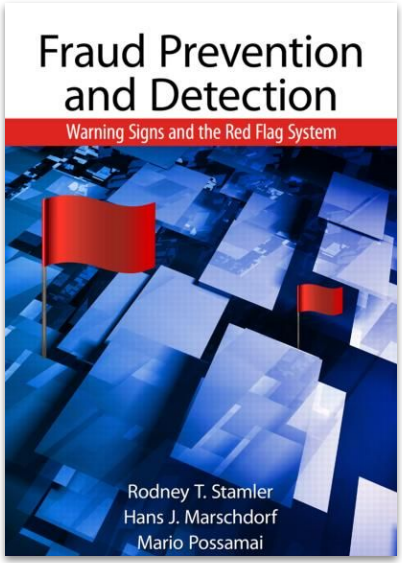
Training Data Attacks





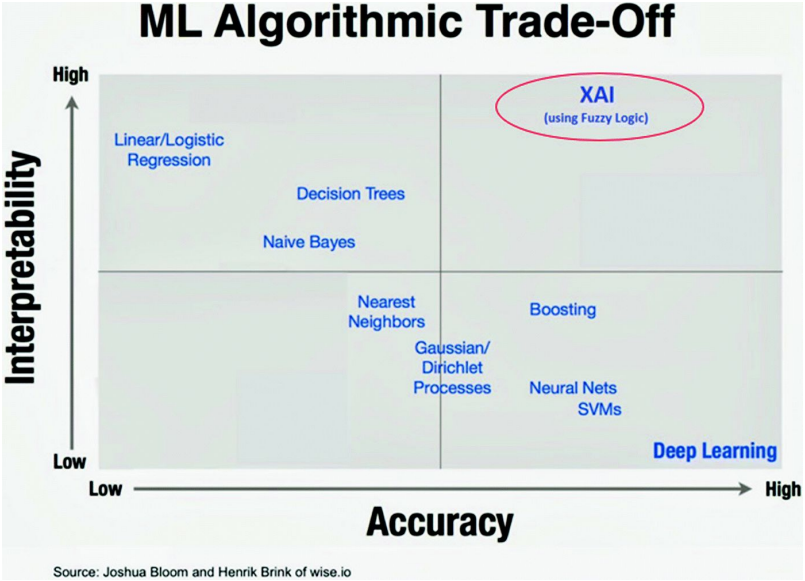
Context matters!

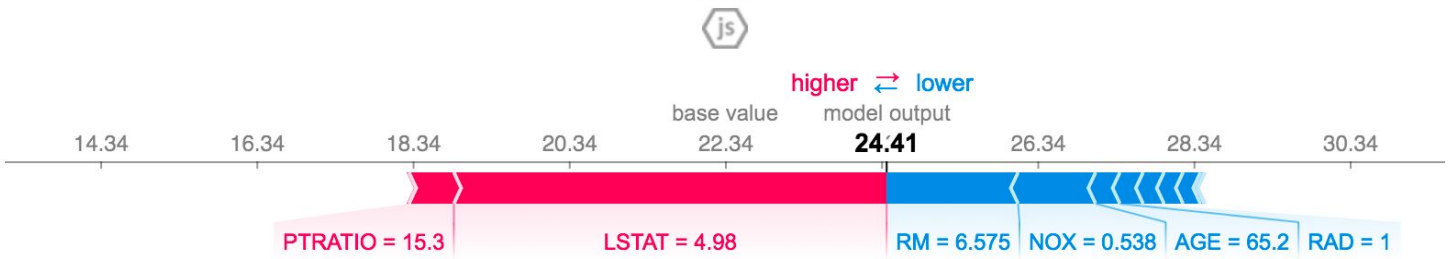
Red Flags & Compliance



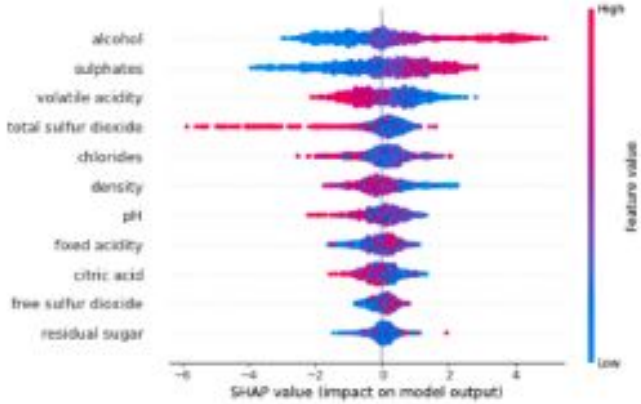
Explainable AI

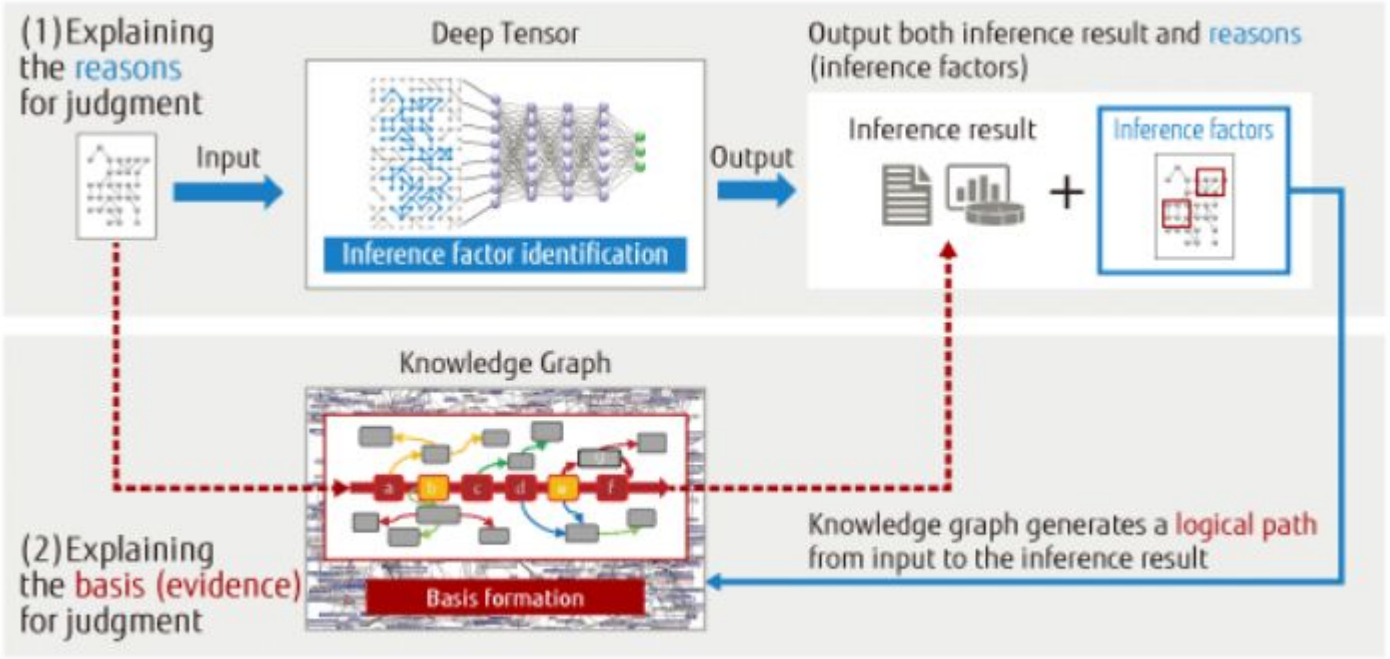
- Prediction x Causality (?)
  - Fairness: job salaries
- Explainability x Prediction Accuracy
- SHAP, LIME, etc



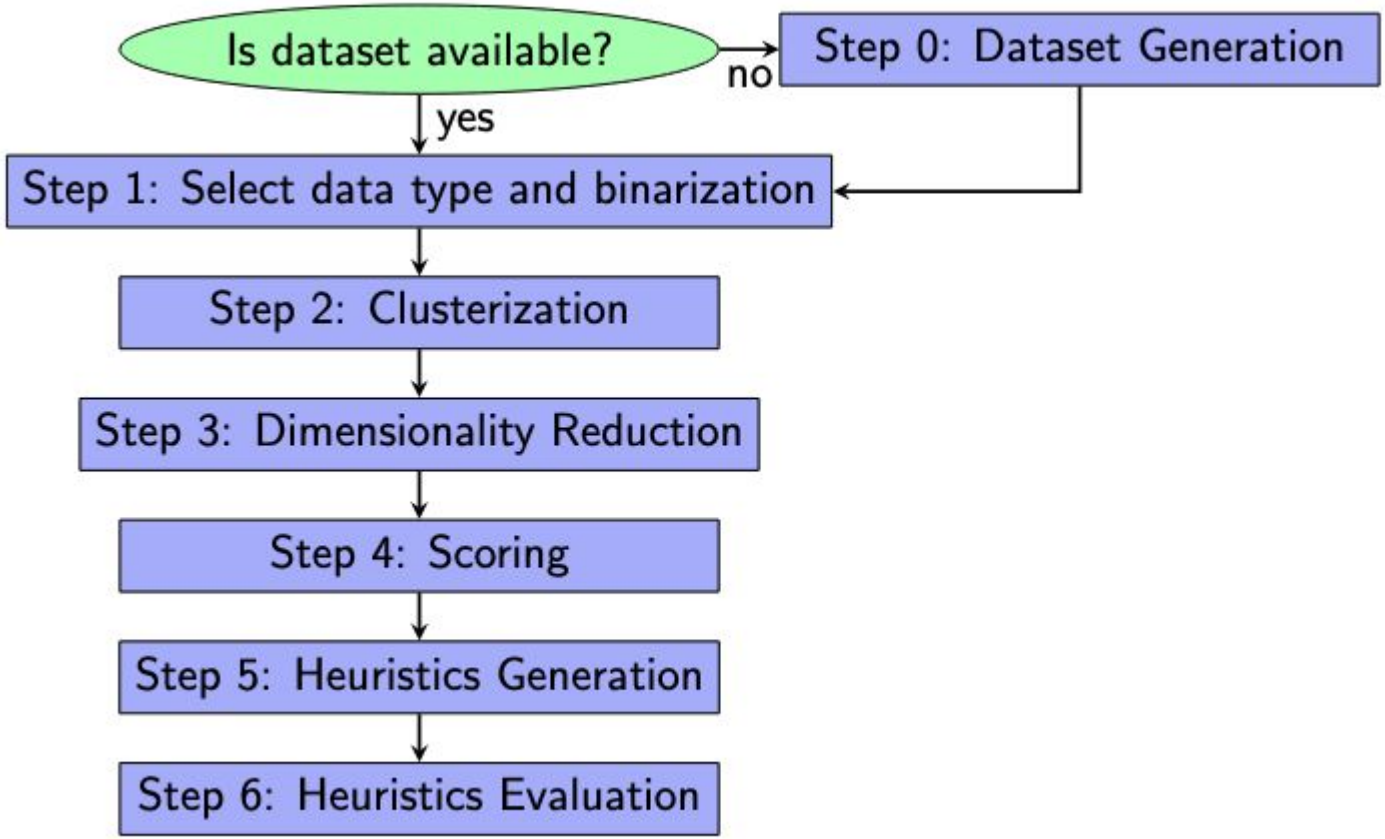


- Existing interpretability methods, like LIME and SHAP, are computationally intensive.
- These methods may lack robustness and struggle with scalability, especially when dealing with complex models and large datasets.
- While they offer explanations for model predictions, they may not always provide comprehensive insights into the underlying decision-making processes.

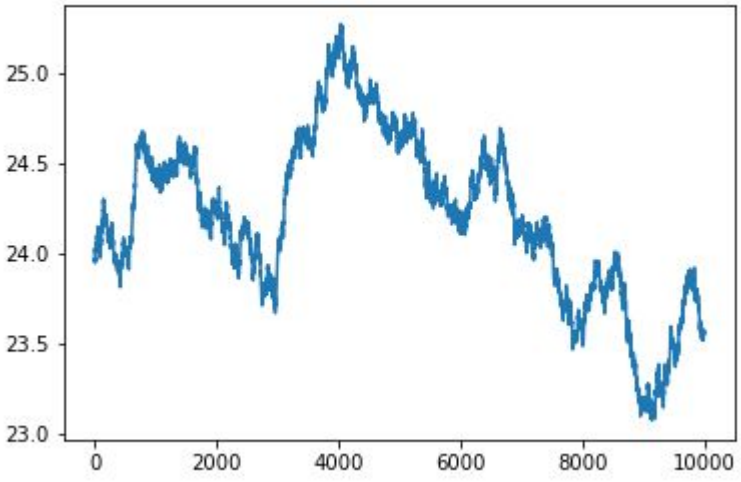


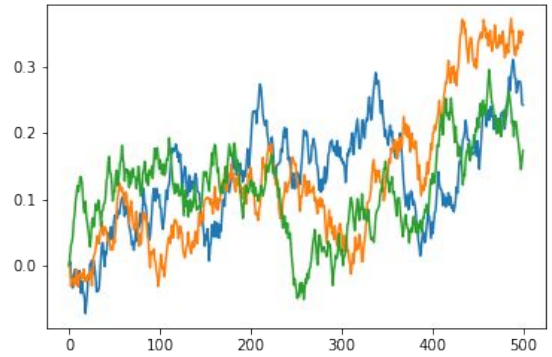


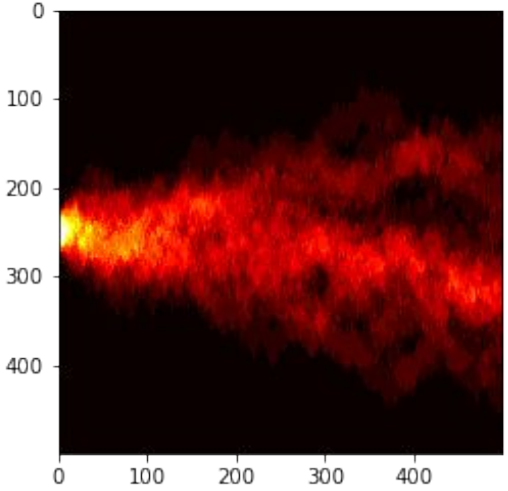
Explainable AI with Deep Tensor and Knowledge Graph

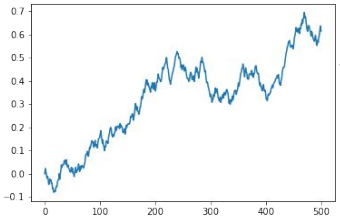

Is dataset available?
no
Step 0: Dataset Generation
yes
Step 1: Select data type and binarization
Step 2: Clusterization
Step 3: Dimensionality Reduction
Step 4: Scoring
Step 5: Heuristics Generation
Step 6: Heuristics Evaluation

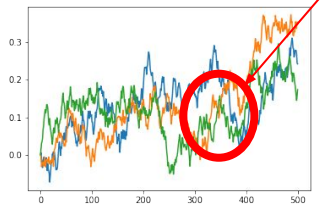
Working Paper

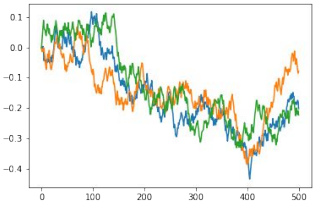




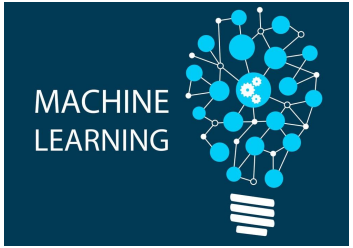




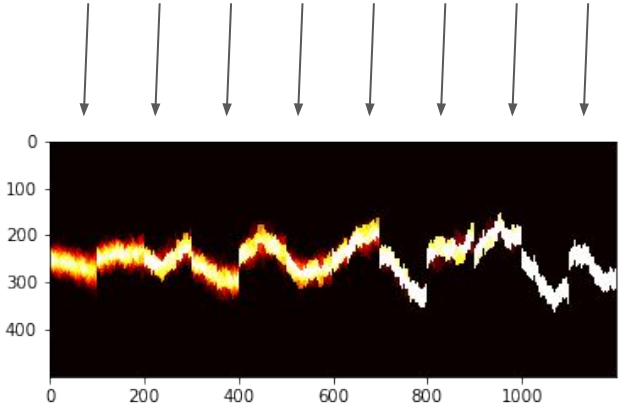


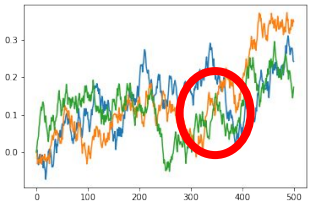


XAI

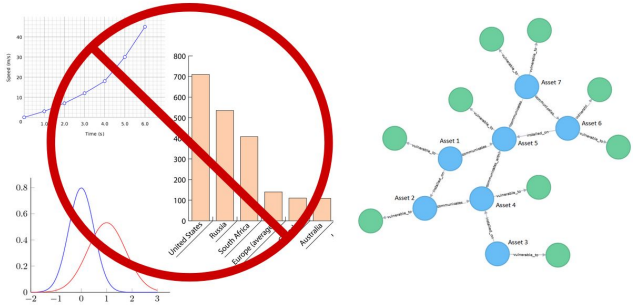


y1 y2 y3 .... yn





red flags



Knowledge Graphs

“Turn on the HVAC system. The room is empty but class will start in 15 minutes and not working full load will save energy.”

“If students do not arrive on time, there is a chance the next class will not occur.”

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Publications

- A multisensor prediction-based heuristic for the internet of things
  - Journal Computing (2021)
  - We proposed an heuristic for adapting data prediction and data fusion techniques to preprocess data to avoid unnecessary communication between sensor devices and sink node. We also compared (i) linear estimation; (ii) Weightless Neural Networks; and (iii) Moving Average Convergence Divergence in the aforementioned context.
- A Prediction-Based Multisensor Heuristic for the Internet of Things
  - 15th ACM Symposium on QoS and Security for Wireless and Mobile Networks - Q2SWinet 2019
  - We applied an heuristic for increasing efficiency with many IoT devices in the same environment.
- Sensor Data Prediction Techniques for Nodes in IoT
  - 22nd International Conference on Information Fusion - FUSION 2019
  - We proposed a method for saving energy on IoT devices by reducing the data transmission frequency using machine learning.
- Modeling Sparse Data as Input for Weightless Neural Network
  - 27th European Symposium on Artificial Neural Networks, Computational Intelligence and MachineLearning - ESANN 2019
  - We proposed a technique to reduce input size from a bag-of-words matrix and obtained faster and more accurate classification results.