TENFORCE elisa company × AI·PROFICIENT

Artificial intelligence for improved production efficiency, quality and maintenance

JUNE 8TH, 2023

# FUTURE

## THE FUTURE IS WOW 2023

BRINGING AI TECHNOLOGY TO THE PRODUCTION LINE

AI·PROFICIENT

Artificial intelligence
for improved production efficiency,
quality and maintenance

# Short-term Post-hock Anomaly Analysis

Industry: Continental,

AI-PROFICIENT (H2020 funding) Operation environment

This product is part of a project that has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 957391.

# SPAA concept

**Context**

- AI-PROFICIENT Use Cases, CONTI-10

**Environment**

- Continental Combiline system for rubber preparation, Sarreguemines, France
- Deployed alongside SDDM and GHO (developed by IMP)

**The problem**

- Perform Anomaly Detection on machine-level parameters, based on product characteristics. When monitored parameters of the product deviate from the desired values, the user needs to know which machine parameter(s) malfunctioned and lead to product problems. SPAA software undertakes action to provide insights on malfunctioning system components

# Short-term Post-hock Anomaly Analysis

- Service overview
  - Anomaly Detection
  - Root-cause Analysis
  - User Interface and Feedback mechanism
  - Reinforcement Learning

# SPAA Business perspective

**Services**

- **Anomaly Detection algorithms** enable the operators to early detect deficiencies in product characteristics and malfunctions in the production line machines.
- A **Root-Cause Analysis operation** running complementary to **Anomaly Detection** assists the operator to determine the cause of the detected anomalies.
- An interface visualizing the results of **Anomaly Detection** and **Root-Cause Analysis modules** and also used to collect the operator's feedback (reject/verify/modify/enhance the results suggested by the modules).
- A **reinforcement learning algorithm** using operator's feedback from the interface and initial **Anomaly Detection** and **Root Cause Analysis** results for improving the algorithm and providing better results in future cases where a problem is detected.

# Anomaly Detection

Real-time operations:

- Monitoring process related signals/parameters
- Real-time measurements on Product characteristics:
  - Weight
  - Width
  - Length
  - Thickness

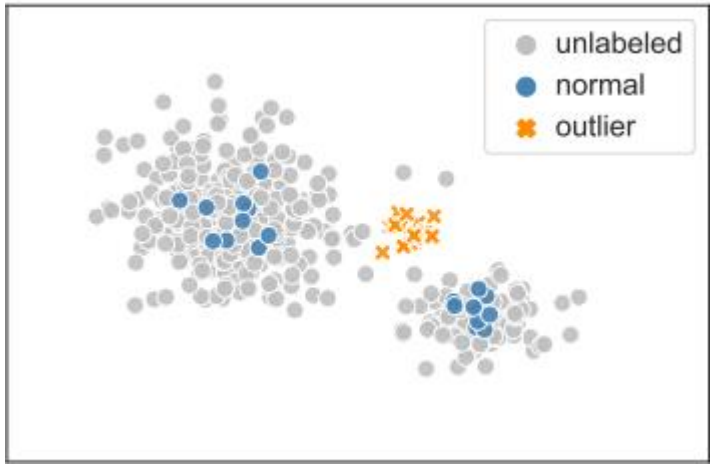
```
------------------------------------------------
CHECK STATUS
No deviation found at piece_weight
No deviation found at meter_weight
No deviation found at width
No deviation found at length
No deviation found at thickness_left_plate
No deviation found at thickness_right_plate
------------------------------------------------
```

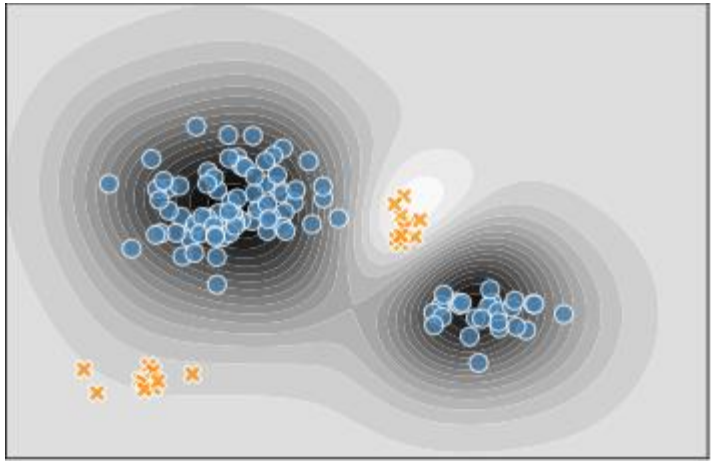
- Compares values against thresholds
- Detects anomalies
- User alerts generated by UI

```
------------------------------------------------
CHECK STATUS
No deviation found at piece_weight
Deviation found at meter_weight
```

# Deep Semi-supervised Anomaly Detection (Deep SAD)

- **Machine Learning Technique**
  - Labelled/Unlabeled data → Identify Anomalous Patterns
  - Based on unsupervised Deep Support Vector Data Description (Deep SVDD)

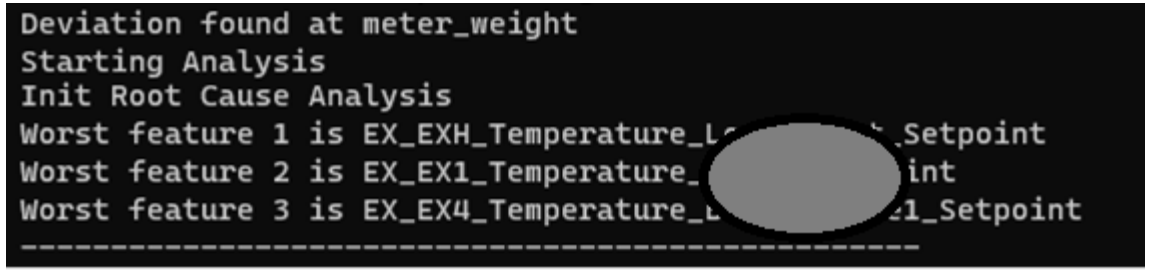


# Root-cause Analysis

Real-time operations:

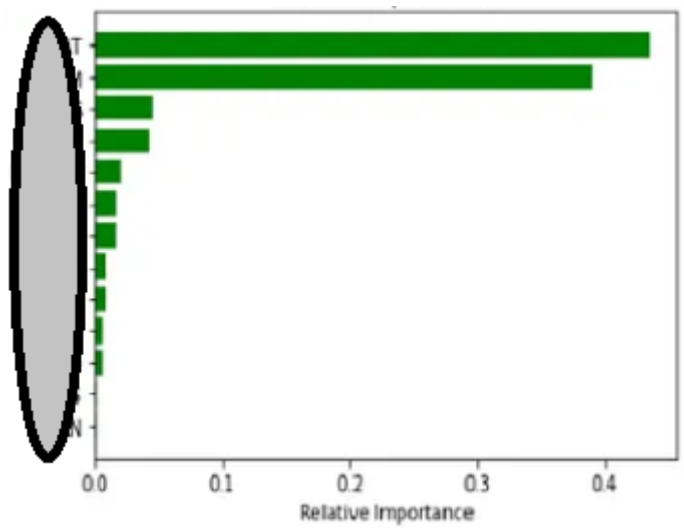
- Triggered upon Anomaly Detection
- Analysis of latest 60 seconds of data
- Provides possible causes to the user
- Possible causes
  - Mix Temperature
  - Storage times of Base/Final Mix
  - Machine/Screw/Conveyor speed
  - Feeding pressure

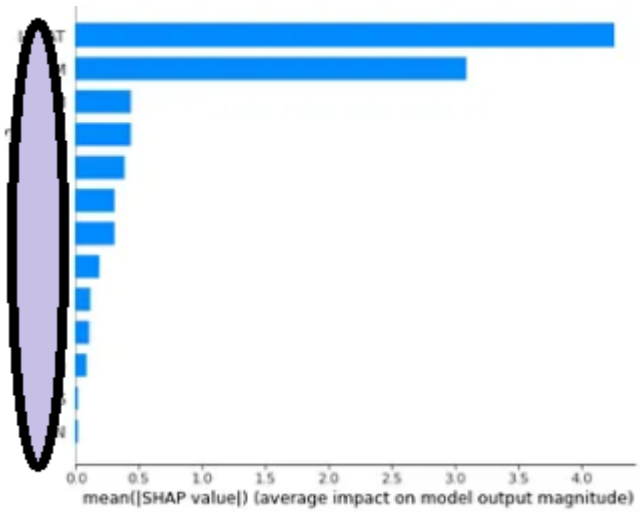


# Shapley Additive Explanations (SHAP)

**Main focus:**

- Model explainability
- SHAP method → explain individual predictions
- Feature values of data instances → act as players in a coalition
- Shapley value: the average marginal contribution of a feature value across all possible coalitions



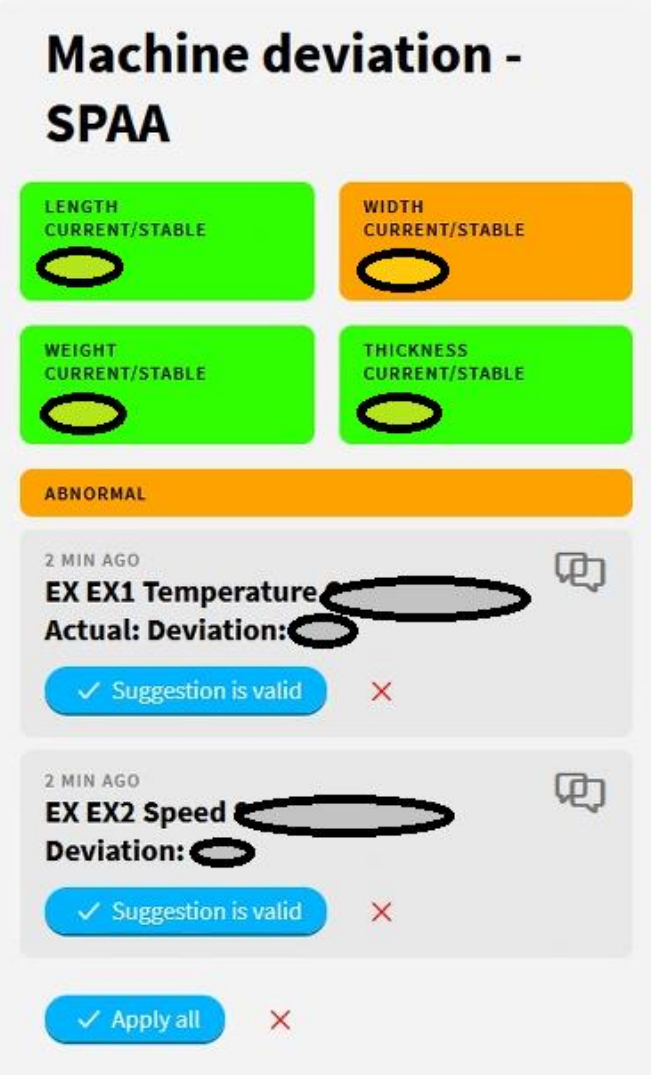



# Reinforcement learning by human feedback

**Short-term Post-hock Anomaly Analysis feedback collection system**

Real-time Operations:

- Real time monitoring of feedback database
- Erroneous outcome → reported by user
- Feedback is Collected
- When predefined amount of observations is reached → Improvement system activated



# Reinforcement learning by human feedback

**Short-term Post-hock Anomaly Analysis Improvement System**

Improvement outcomes

- Optimizes anomaly detection model
- Optimizes root-cause analysis accuracy
- Non-intrusive process

```
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Checking Feedback Store
Number of feedback observations:
101
Starting optimization: 1685367207.154425
Optimization Complete: 0:00:00.819040
Create back up of old anomaly detection model
Saving new anomaly detection model
Prepare Data for SHAP model optimization
Using 202 background data samples could cause slower run times. Consider using shap.sample(data, K) or shap.kmeans(data, K) to summarize the background as K samples.
Create back up of old SHAP model
Soft Reset SPAA
-------------------------
```
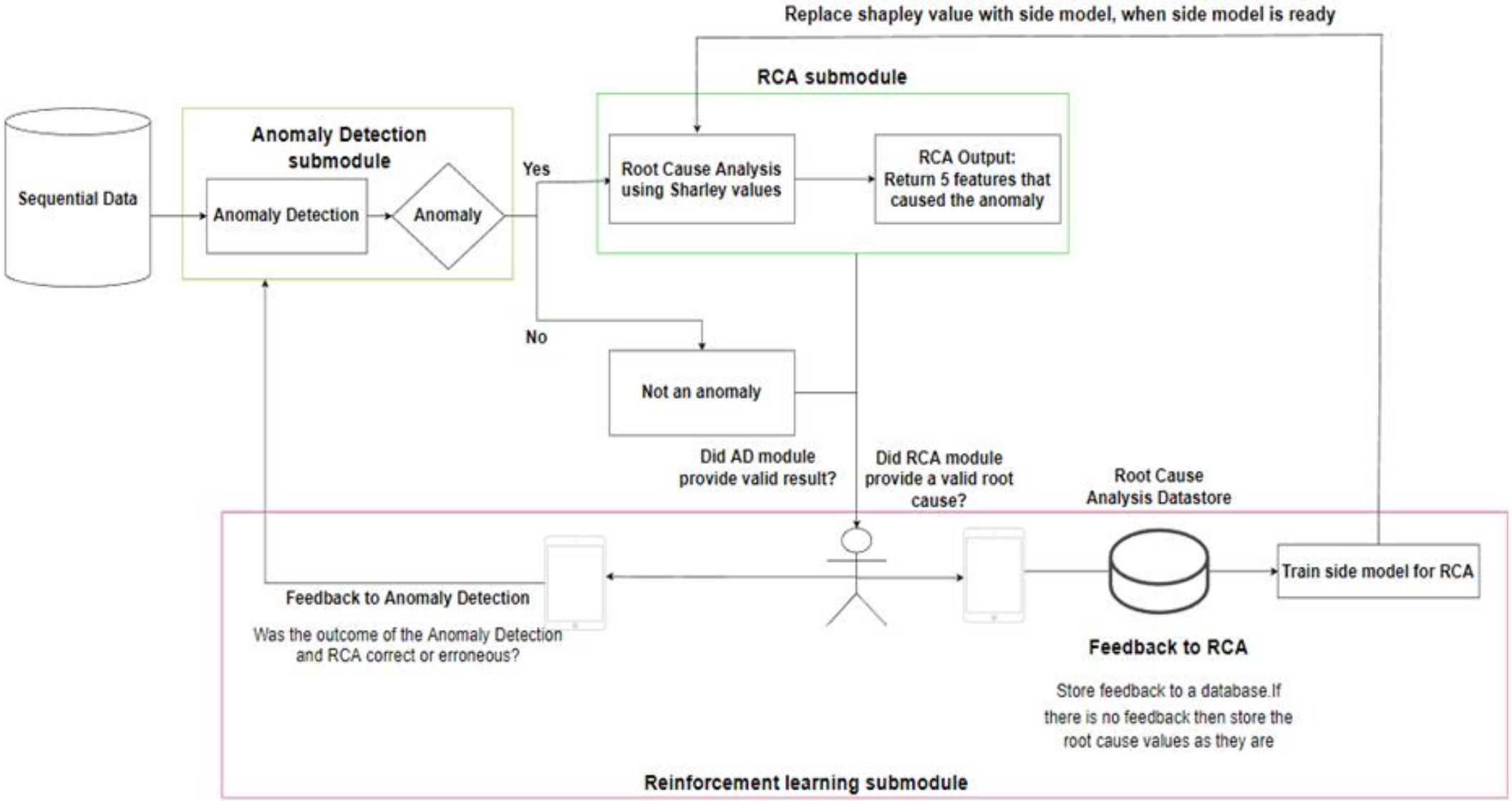

# SPAA Architecture characteristics

- **Deployment characteristics**
  - Containerized
  - Deployed in Docker compose, Kubernetes, etc
  - Deployed alongside SQL databases and/or other services
  - Integrated with
    - Continental’s Influx DB
    - SQL instance → insert results (detected anomalies)
  - Communication mechanism to
    - Fetch metrics per second (Influx DB)
    - Compare with thresholds
    - Generate entry in SQL
  - Persistent Volumes to store
    - Trained models of SPAA
    - SQL DB

# SPAA Workflow



**Thank you for your attention,**

**George Triantafyllou**
**g.triantafyllou@atc.gr**
**Athens Technology Center**

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