17th May 2022



CAIN 2022

UDAVA: An Unsupervised Learning Pipeline for Sensor Data Validation in Manufacturing

Erik Johannes Husom Simeon Tverdal Arda Goknil Sagar Sen



- Context
- Approach
- Deployment
- Evaluation
- Future work



- Manufacturing
 - Machining (milling, broaching, drilling etc)
 - Repetitive production cycles



- Manufacturing
 - Machining (milling, broaching, drilling etc)
 - Repetitive production cycles
 - How can shifts and changes in production be automatically detected?





- Manufacturing
 - Machining (milling, broaching, drilling etc)
 - Repetitive production cycles
 - How can faults and changes in production be automatically detected?
- Sensor data validation
 - Identifying behavioral modes
 - Verifying a "normal" production pattern
 - Detecting anomalies and deviations





• Challenges: Few or no labels





- Challenges: Few or no labels
- Unsupervised learning





Clustering



- Challenges: Few or no labels
- Unsupervised learning
- Al engineering





Clustering



- Background
- Approach
- Deployment
- Evaluation
- Future work











- Features:
 - Mean
 - Median
 - Standard deviation
 - Variance
 - Range
 - Frequency
- Scaling to give features equal weight





































- Background
- Approach
- Deployment
- Evaluation
- Future work









1	{"param": {"modeluid": "618b9b95-7805"},
2	"scalar": {
3	"headers": ["date","SpindleTorque"],
4	"data": [
5	["2017-08-23 17:57:00", 101.2],
6	["2017-08-23 17:57:05", 101.3],
7	["2017-08-23 17:57:10", 101.2],
8	["2017-08-23 17:57:15", 101.3],
9	["2017-08-23 17:57:20", 101.4],
10	<pre>["2017-08-23 17:57:25", 101.5],] } </pre>

Listing 1: Example JSON request to UDAVA API.

```
1 {"param": {"modeluid": "618b9b95-7805"},
2 "scalar": {
3 "headers": ["date","cluster","metric"],
4 "data": [
5 ["2017-08-23 17:57:05", 0, 16.77],
6 ["2017-08-23 17:57:20", 1, 38.74], ] } }
```

Listing 2: Example JSON response from UDAVA API.



- Background
- Approach
- Deployment
- Evaluation
- Future work



- Can UDAVA discover process behavior patterns?
- Can we use UDAVA to detect shifts/drifts in production cycles?
- How can UDAVA be deployed, tested and maintained in industrial production environments?
- Use cases:
 - Aerospace domain
 - Automotive domain



• Broaching of turbine discs for airplane jet engines























- DVC (Data Version Control) for data/model versioning and tracking/caching input and output of pipeline stages
- Improving greenness of pipelines
- Reducing pipeline debt
- Federated learning for data security
- Continual learning and domain adaption







- Background
- Approach
- Deployment
- Evaluation
- Future work



- Al-driven control of manufacturing processes
- Multi-sensor data synchronization
- User involvement in ML-infused systems



Technology for a better society





Major cluster events (above a certain size) in time series A : a0, a1, a2, a3, a4

Major cluster events in time series B: b0, b1, b2, b3, b4

Segmentation of accelerometer and power data



- Al-driven control of manufacturing processes
- Multi-sensor data synchronization
- User involvement in ML-infused systems













Technology for a better society