A sneak peek:

Online high-dimensional modelling of industrial crane data

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Problem

High
dimensionality

Real-time
analysis

Scalability

→ **Need for efficient modelling/visualization methods**

Proposed solution: Multivariate fuzzy time-series-data model
1. Can fuzzy methods be used for modelling/visualizing n-dimensional industrial machine data?
2. Does fuzzy based modelling provide useful information for machine users?

Modelling method

Fuzzy logic (multivalued logic)

- E.g., 2500kg load can be *heavy* with a weight of **0.6** and *very heavy* with a weight of **0.4**
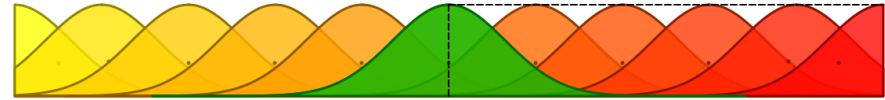
Benefits:

1. Data compression

2. Processing efficiency

3. Interpretability of the model

4. In-built aggregation
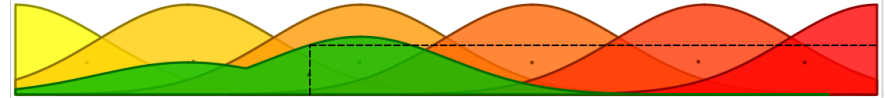
A few example fuzzy data rows

BridgePosition	TrolleyPosition	LoadTare	Weight
5	2	4	0.9
5	1	5	0.5

Bridge Position

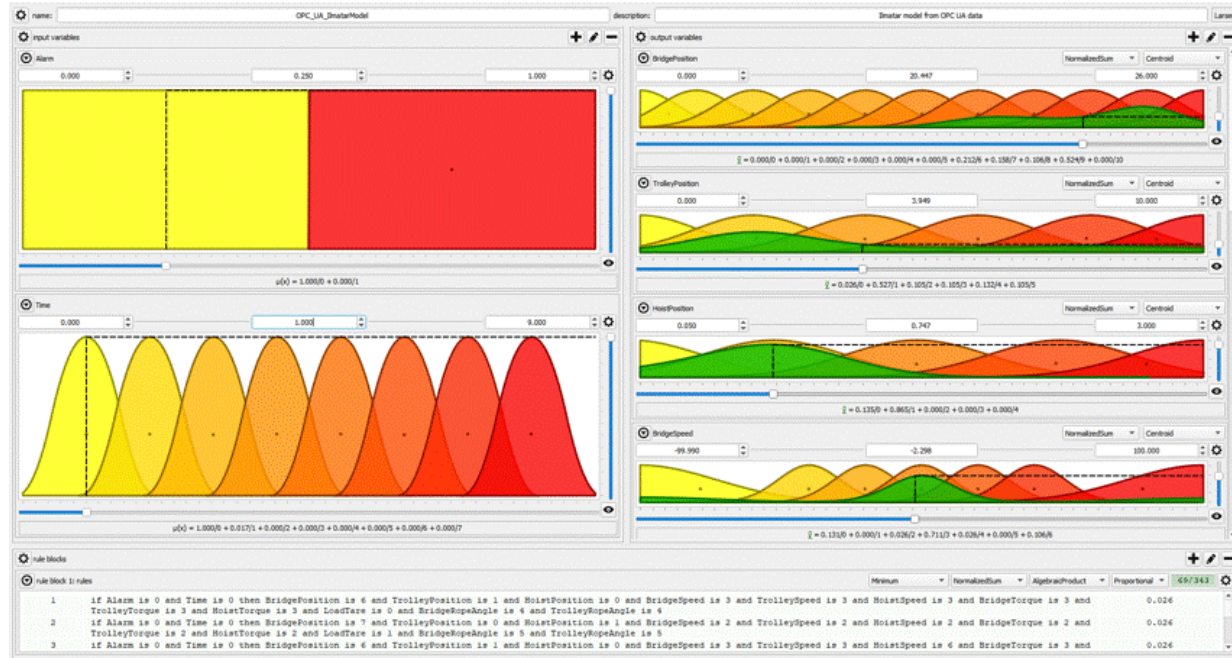Trolley Position

Load Tare

Time-series modelling

By introducing time or other defining variables

→ We can view the model in any state

A few example data rows

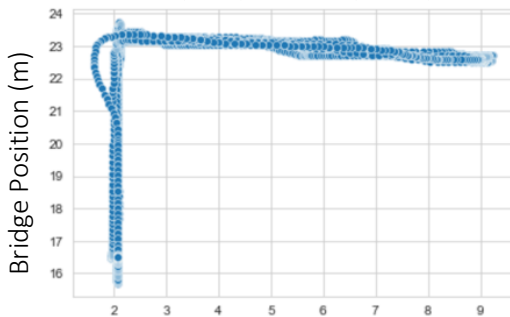| Time	Alarm	BridgePosition	TrolleyPosition	LoadTare	Weight
1	0	5	2	4	0.9
1	0	5	1	5	0.5
2	1	4	0	5	0.8

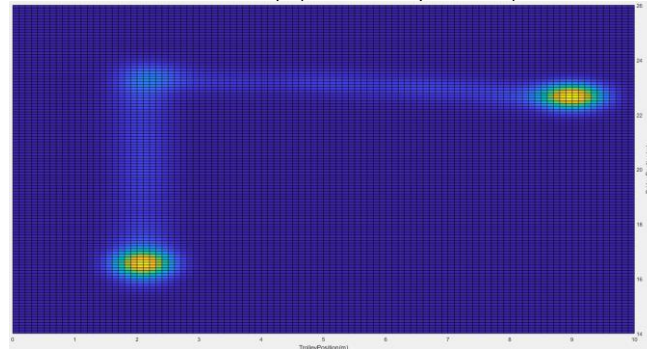Graphical interface example animation (QtFuzzyLite):

Software available from fuzzylite.com

Model visualization examples
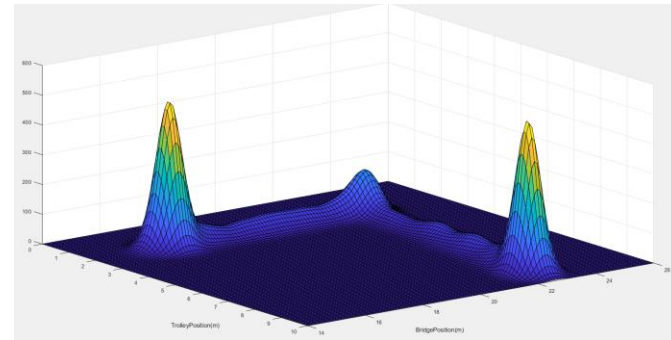
Scatter plot (raw data points)

2D heatmap (from fuzzy model)

Surface plot (from fuzzy model)

Bridge Position (m)

Trolley Position (m)

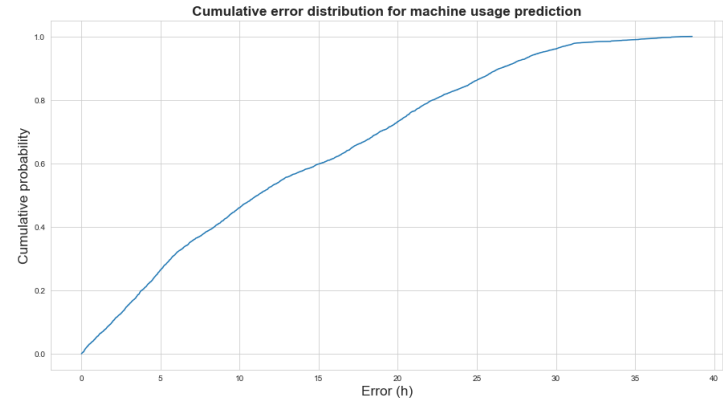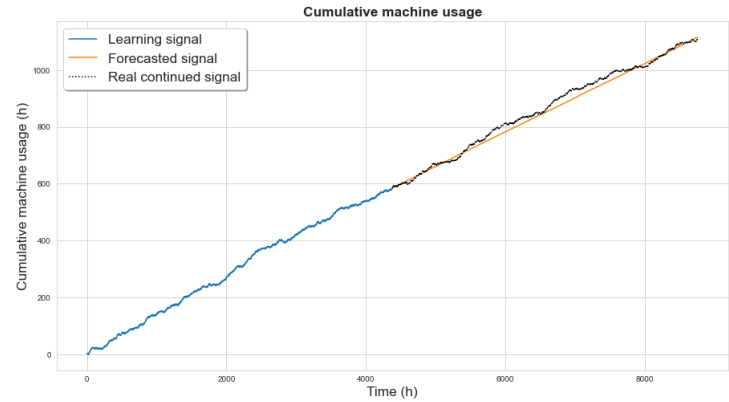|	Signals (pcs)	Rows (pcs)	File size in .csv format (kB)
Raw data	15	3214	352
Fuzzy model	16	1633	**68**
Raw data visualization	2	3214	44
Fuzzy visualization	3	83	**2**

With fuzzy methods:

80.6% smaller file size

95.5% smaller file size

Prediction examples

➢ We can create a prediction model to look forward a certain time step (1 hour, 1 week…)

➢ We can recursively predict N steps forward

➢ Goal is to predict multiple signal systems

➢ Anomaly detection:

1. Predict current state

2. Compare to actual values

3. Quantify (absolute or % difference)

Cumulative machine usage

Cumulative error distribution for machine usage prediction

A few example prediction data rows

Variable (T)	Variable (T+1 step)	Weight
4	4	0.2
4	5	0.4

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Findings

➢ Promising preliminary results – accurate results efficiently

➢ Model usage: Viewing state of model, visualizations, predictions and anomaly detection

Future work:

➢ Model development

➢ Predictions for more complex N-signal systems

➢ Implement anomaly detection

➢ Identification of practical use cases

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REMION