Data analytics in process industry

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High Performance Computing
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Data

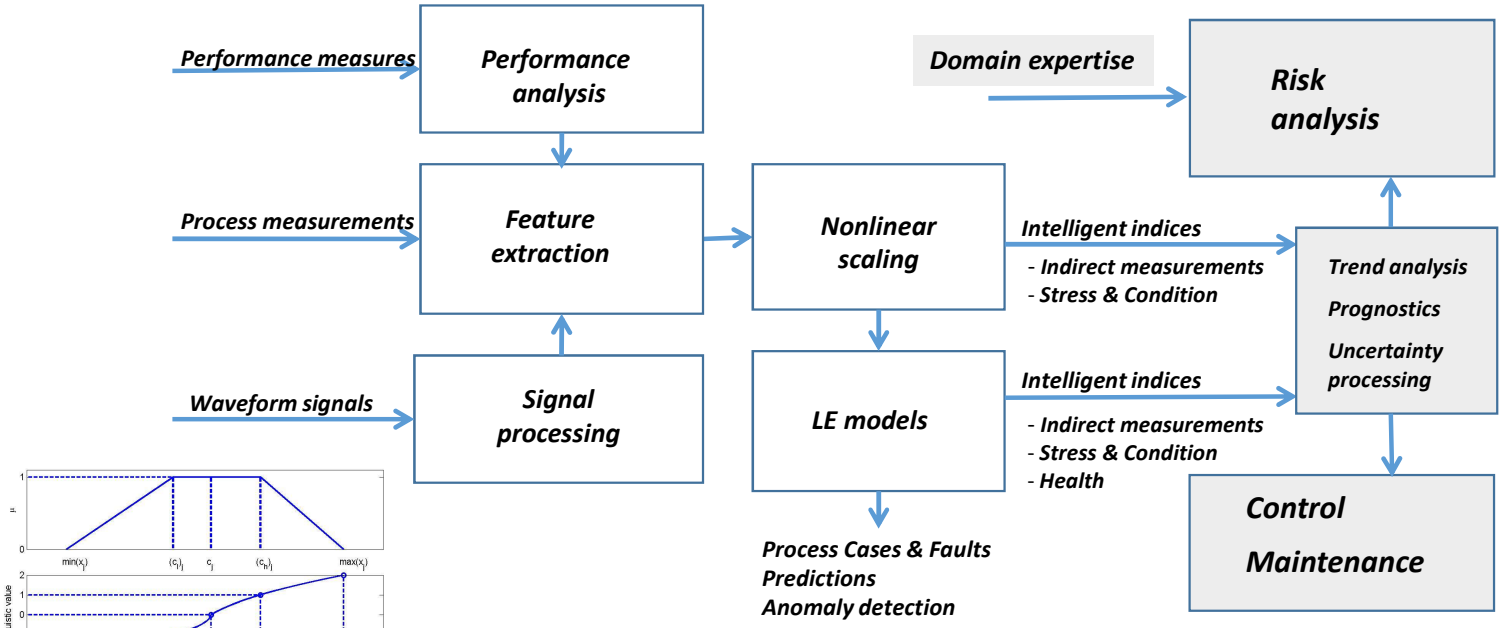
Parallel processing
of large datasets
(variable specific)

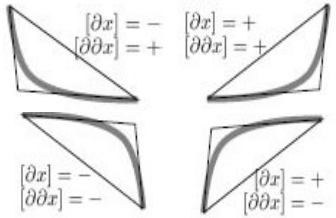
Analysis

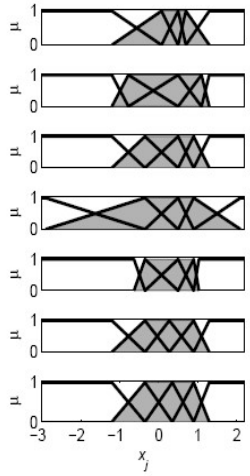
Interactions of
scaled variables

Applications

Detection
of changes







Machine learning

- Interactions
- Recursive analysis

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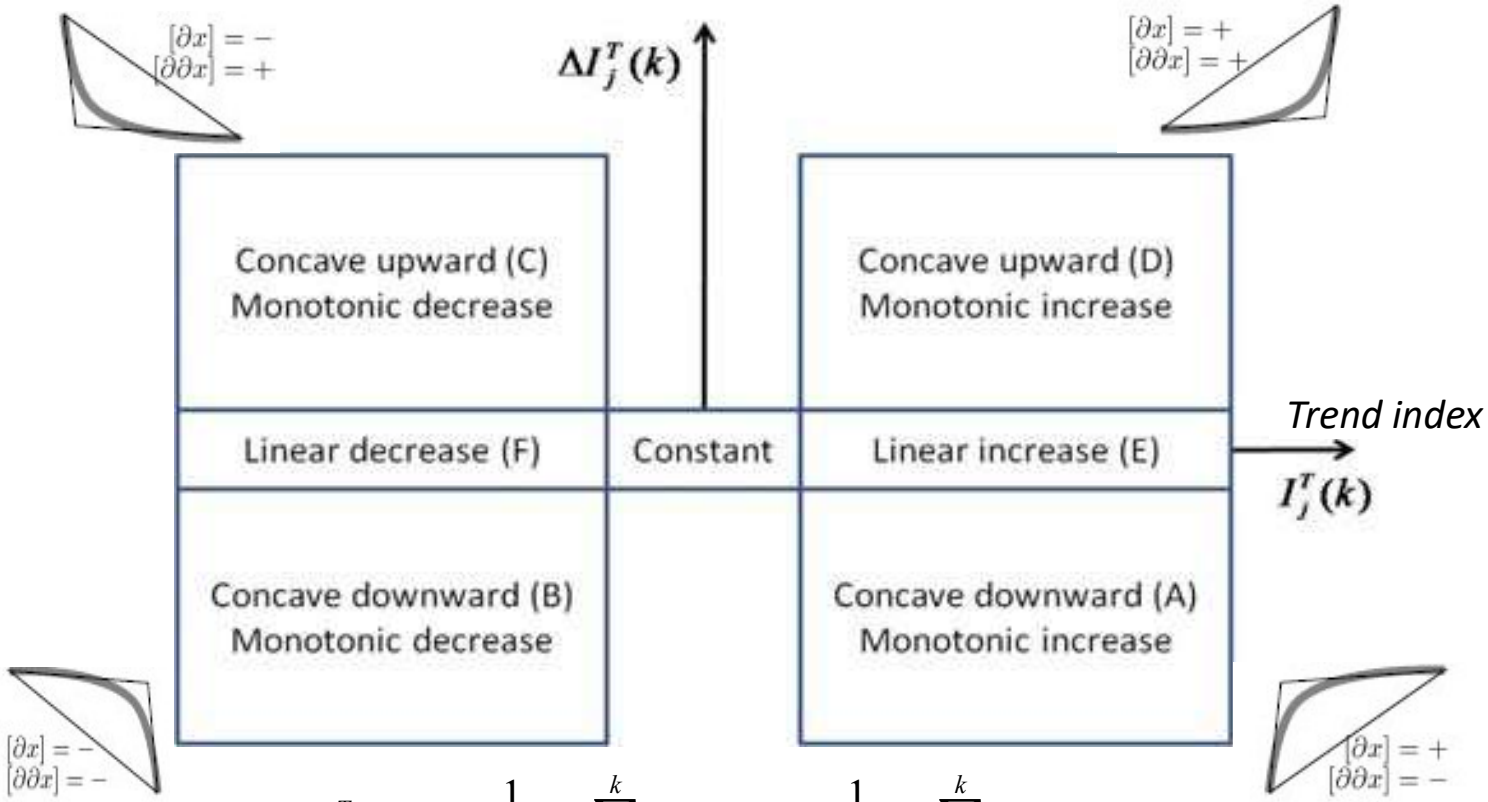
Trend analysis: Parallel calculation of trends



$$I_j^T(k) = \frac{1}{n_S + 1} \sum_{i=k-n_S}^{k} X_j(k) - \frac{1}{n_L + 1} \sum_{i=k-n_L}^{k} X_j(k)$$

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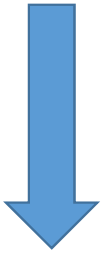
Monitoring interface

- Data analysis (Parallel processing → Data efficiency)
- Functionalities (Understanding and interactions)

	Scaled value	Variation/ Fluctuation	Trend index	Derivative of trend index
Level	x			
Uncertainty		x		
Trend			x	
Trend episodes			x	x
Trend severity	x		x	x

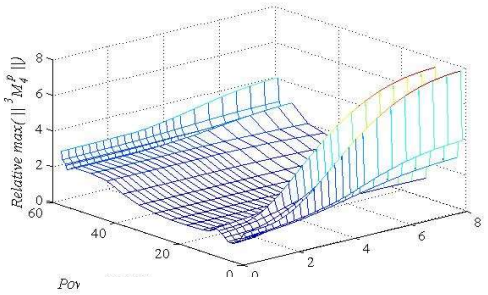


Gradually refined

- All in [-2, 2] → Natural language → Decisions ***Human interaction***

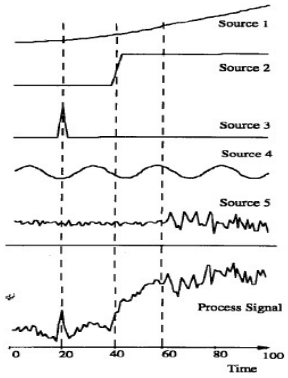
Data Analysis → Features → Indices

	OEE	Scaled OEE	Limits
Excellent	95.0%	2	≥ 1.5
Very good	86.6%	1	[0.5, 1.5)
Good	76.4%	0	[-0.5, 0.5)
Acceptable	62.6%	-1	[-1.5, -0.5)
Poor	48.0%	-2	< -1.5



Performance measures

Performance analysis
- *Interpolation*
- *Uncertainty handling*

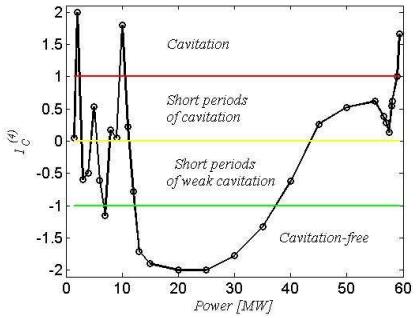


Process measurements

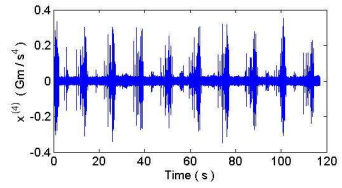
Feature extraction
- *Generalised norms*
- *Histograms*
- *Variable selection*
- *Grouping*

Nonlinear scaling
- *Normalisation*
- *Asymmetry*
- *Scaling functions*

Intelligent indices
- *Indirect measurements*
- *Stress & Condition*



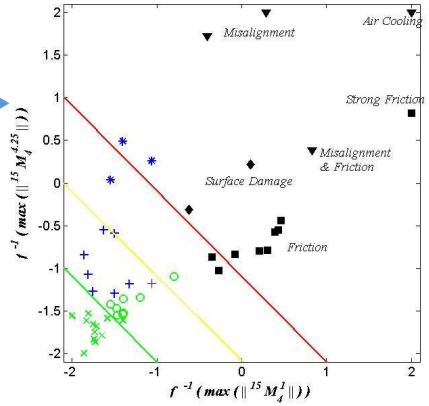
Waveform signals



Signal processing
- *Derivation & Integration*
- *Filters*
- *Blind source separation*

LE models
- *Steady-state*
- *Dynamic*
- *Multimodel*

Intelligent indices
- *Indirect measurements*
- *Stress & Condition*
- *Health*



Process Cases & Faults
Predictions
Anomaly detection

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Conclusions

Methodology

- Norms: a good order α, and proper p and τ
- ***Nonlinear scaling → Intelligent indicators***
  - Fuzzy logic
  - Trend analysis
  - Performance measures

Applications

- Consistent understanding of the ***performance***
- Awareness of the ***risks*** in varying operating conditions
- ***Operation & Maintenance***
- ***Big Data*** analysis as a tool

All in [-2, 2]

Natural language

Domain expertis

Automatic analysis

Domain expertise

Huge number of equipment and processes to monitor &
Extensive linguistic information

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