AI Applications in Manufacturing

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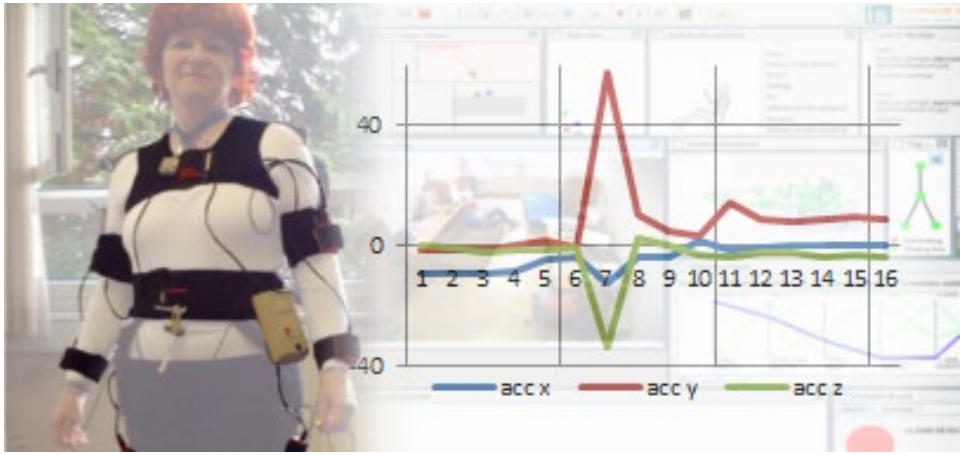
Ljubljana, 12 February 2020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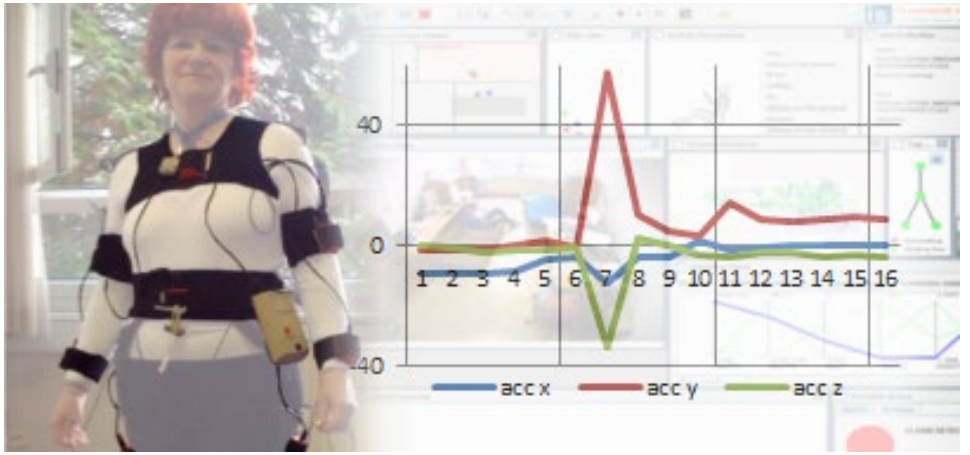
0
-40
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
acc x
acc y
acc z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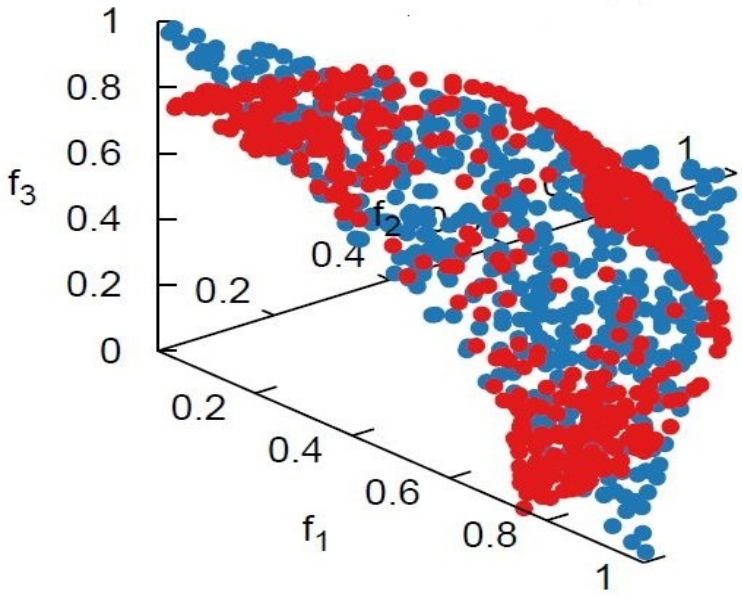
1
0.8
0.6
0.4
0.2
0
f3
0.2
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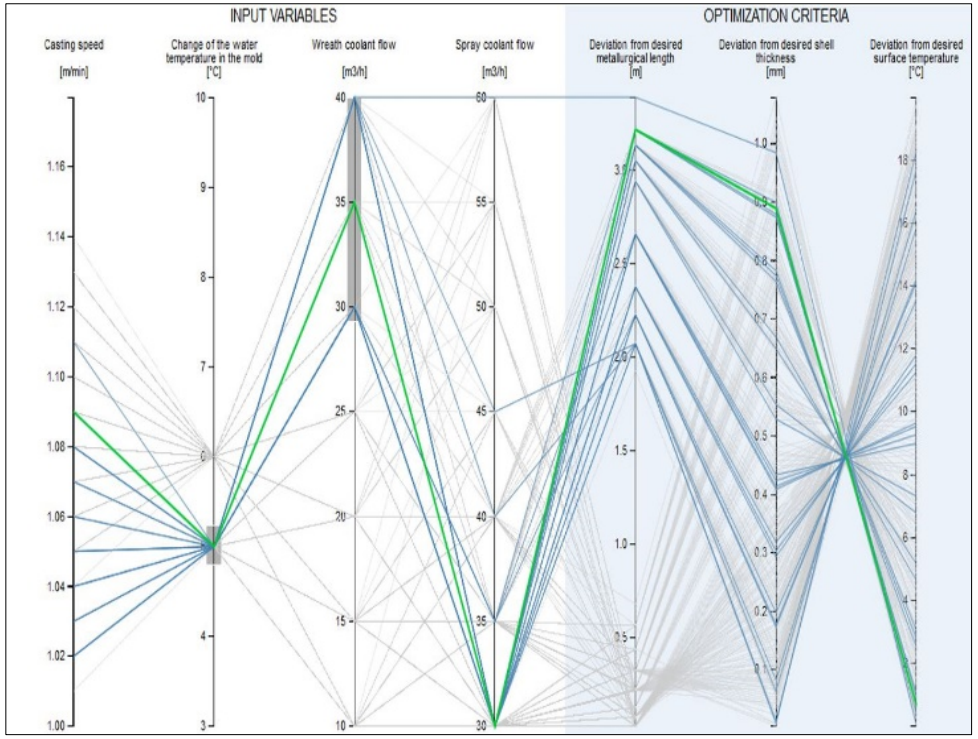
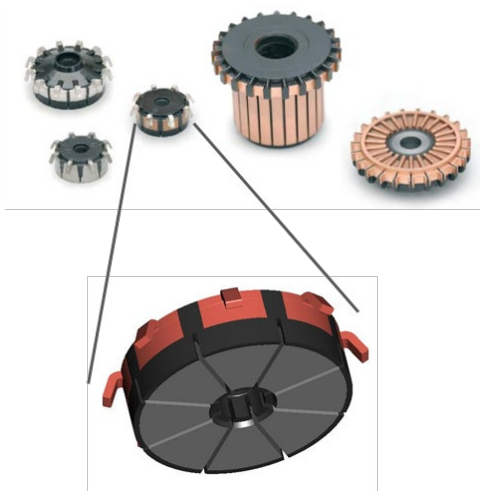
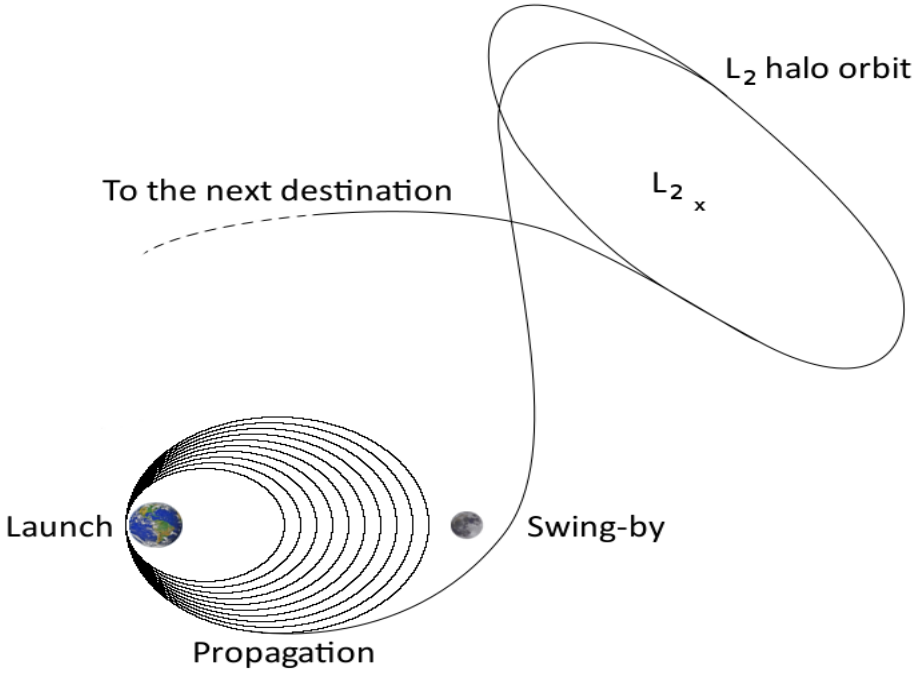
f2
1
0.2
0.4
0.6
0.8
1
f1


INPUT VARIABLES
OPTIMIZATION CRITERIA
Casting speed
[m/min]
Change of the water temperature in the mold
[°C]
Wreath coolant flow
[m3/h]
Spray coolant flow
[m3/h]
Deviation from desired metallurgical length
[m]
Deviation from desired shell thickness
[mm]
Deviation from desired surface temperature
[°C]




L_2 halo orbit
To the next destination
$L_{2\,x}$
Launch
Swing-by
Propagation

Concepts

Industry 4.0

Smart factory

Autonomous systems

Predictive maintenance

Automated quality control

Cyber-physical systems

Digitalization

Collaborative robots

Digital twins

Factory of the future

etc.

Concepts

Industry 4.0
Smart factory
Autonomous systems
Predictive maintenance
Automated quality control
Cyber-physical systems
Digitalization
Collaborative robots
Digital twins
Factory of the future
etc.

Techniques

IoT
3D printing
Artificial intelligence
Machine learning
Deep learning
Computer vision
Big data
Cloud computing
Data analytics
Decision making
Optimization
etc.

Benefits

Create rapid, data determined decisions

Facilitate enhanced production outcomes

Advance process effectiveness

Minimize operational costs

Facilitate superior scalability

Facilitate product development

(The Future of AI in Manufacturing Industries)

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Predictions

Market size for AI in manufacturing is anticipated to grow more than 40% from 2019 to 2025

(Global Market Insights)

Industry 4.0 market worth $156.6 billion by 2024

(MarketsandMarkets)

By 2025 smart factories will generate $37 trillion

(McKinsey)

Warnings

While AI is growing and by all resources will continue to, maturity, confidence, ROI, scaling, and connectivity might be slowing mass adoption

(MachineDesign.com)

AI will make manufacturing operations smarter –
but a learning curve comes first

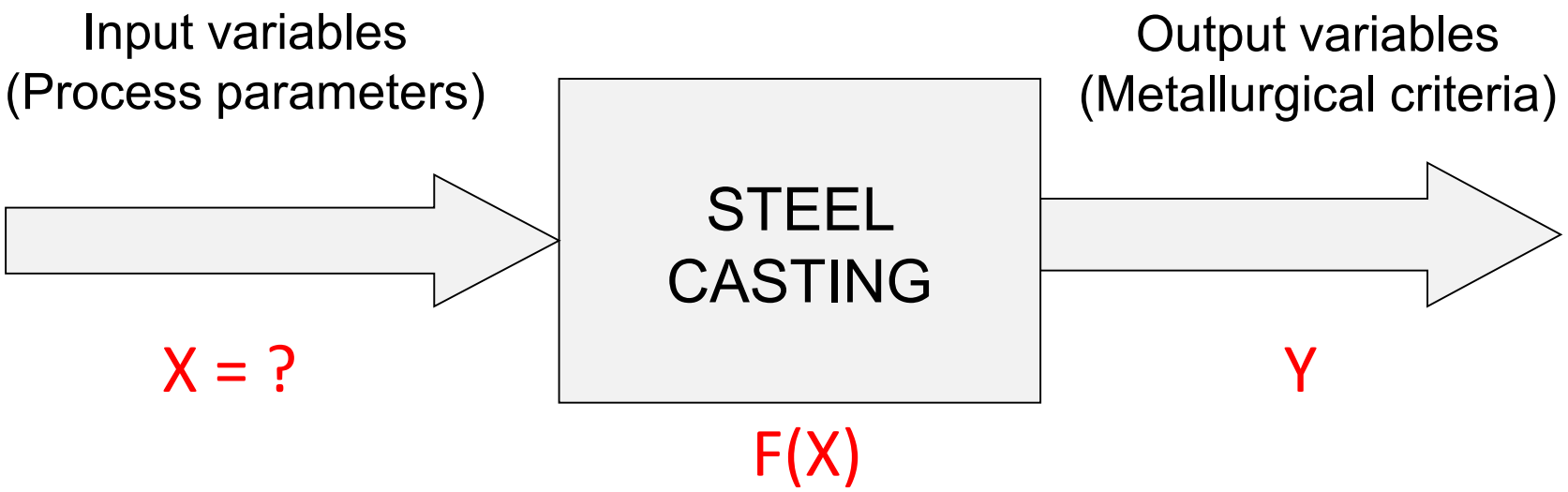
(Gartner)

The increasing scale of adoption of AI in manufacturing seems more like an evolution, rather than an industry disruption

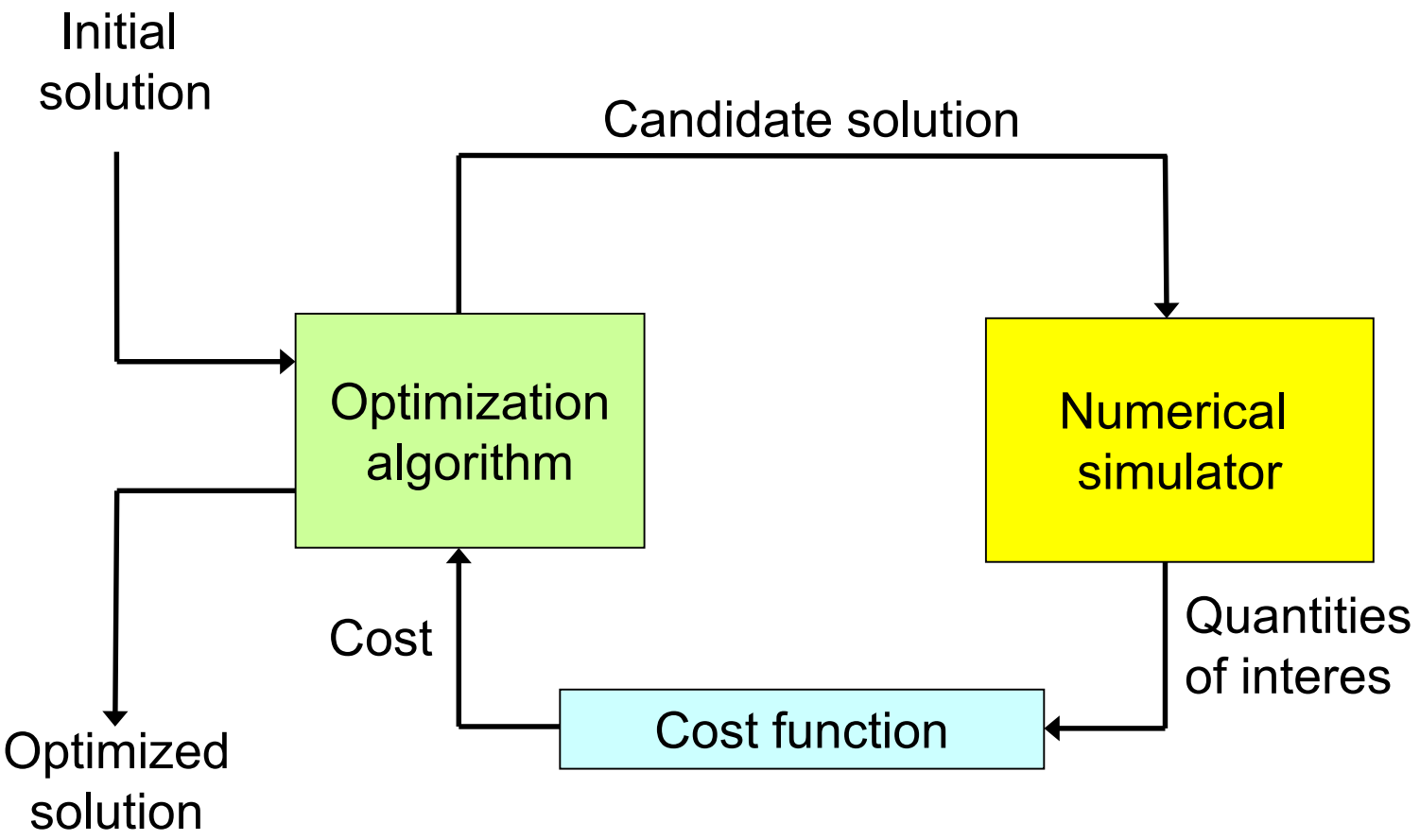
(R. Chuprina)

Problem formulation

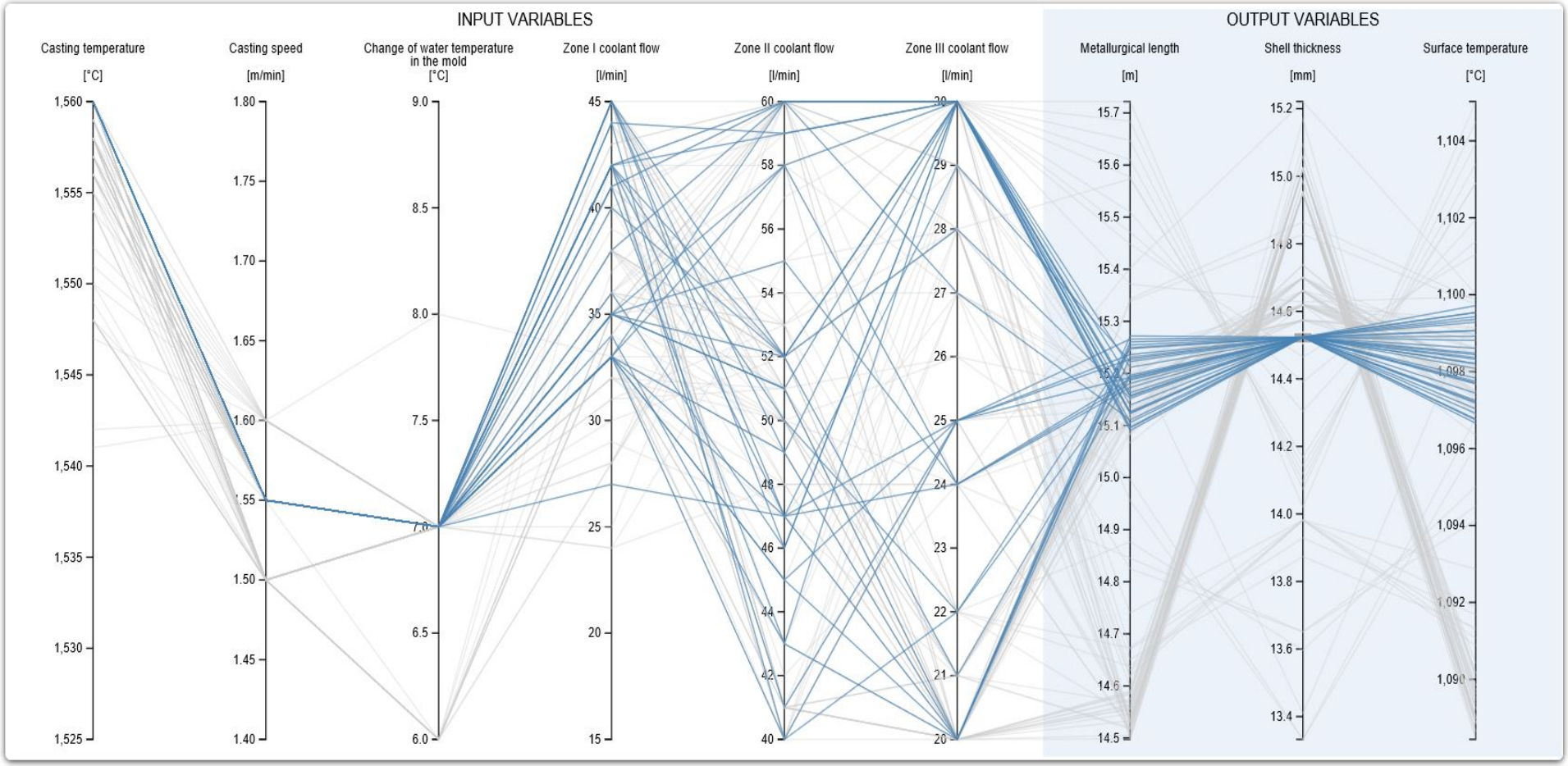
Problem formulation



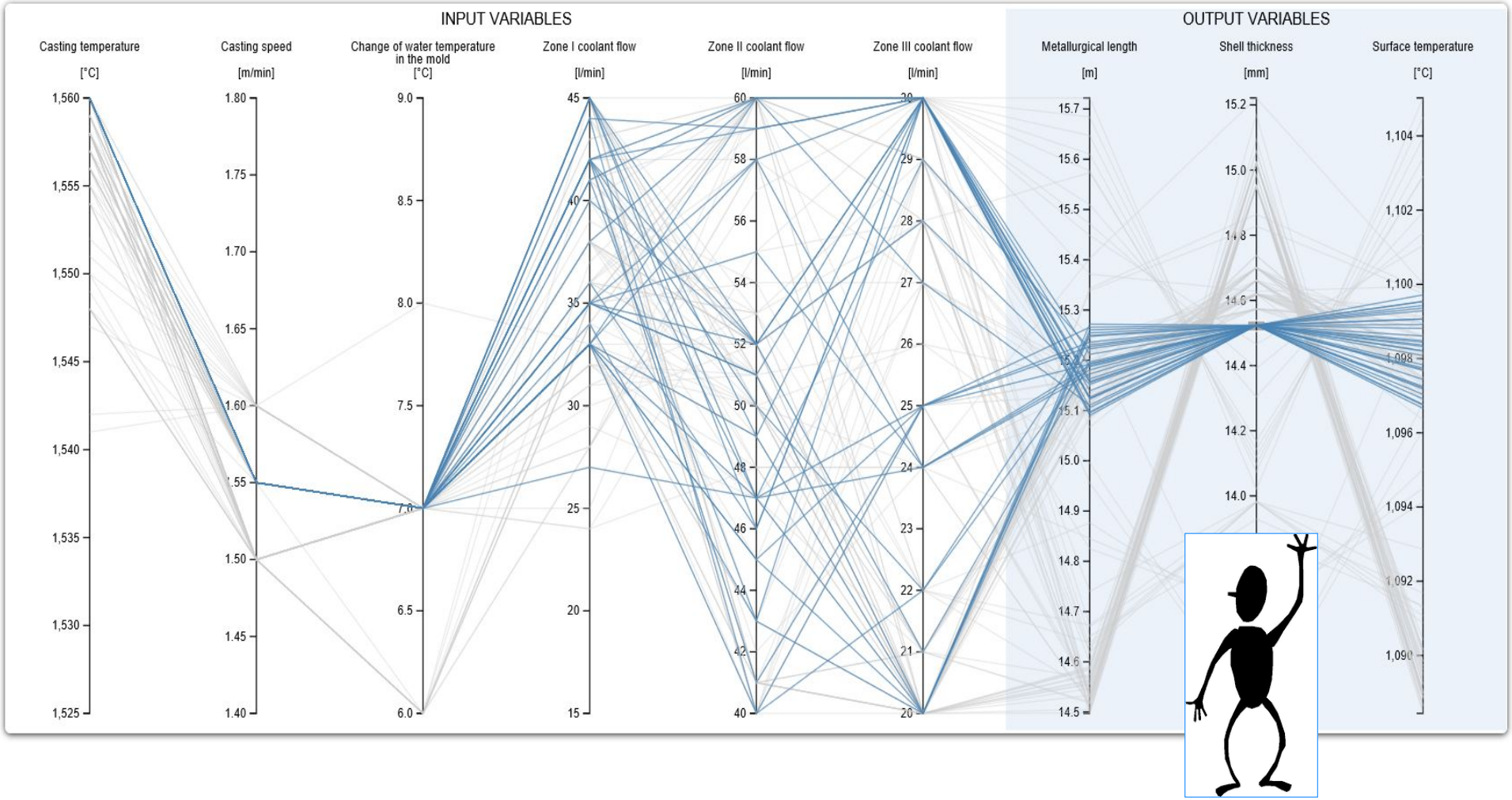
Simulation-based optimization

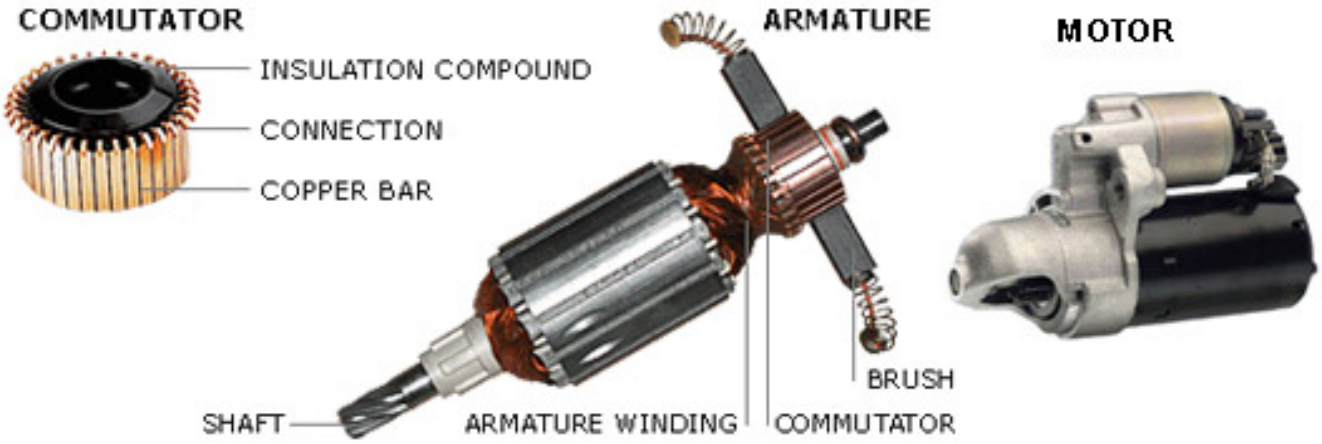


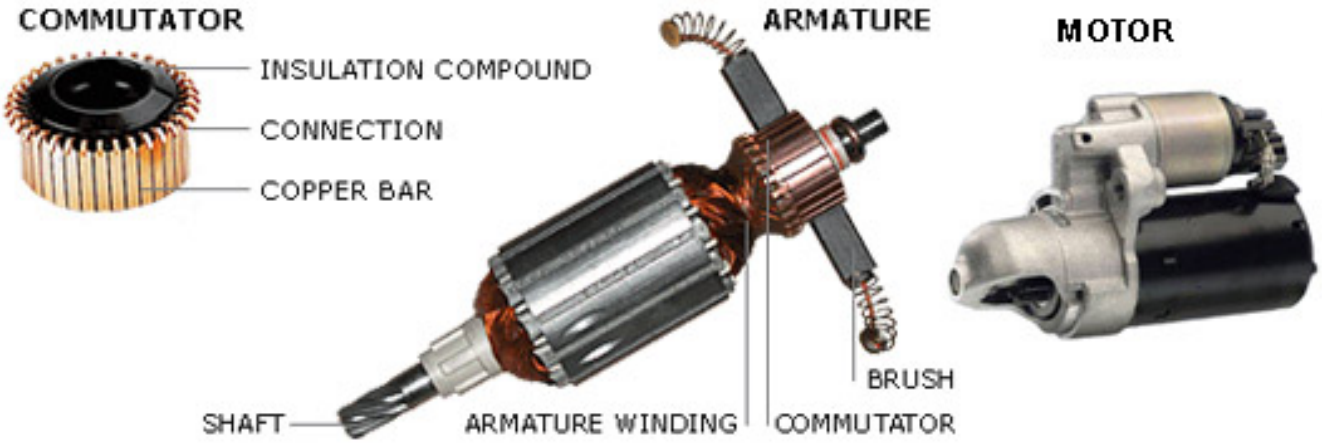
Solution visualization for decision support



Solution visualization for decision support




COMMUTATOR
INSULATION COMPOUND
CONNECTION
COPPER BAR
ARMATURE
MOTOR
BRUSH
SHAFT
ARMATURE WINDING
COMMUTATOR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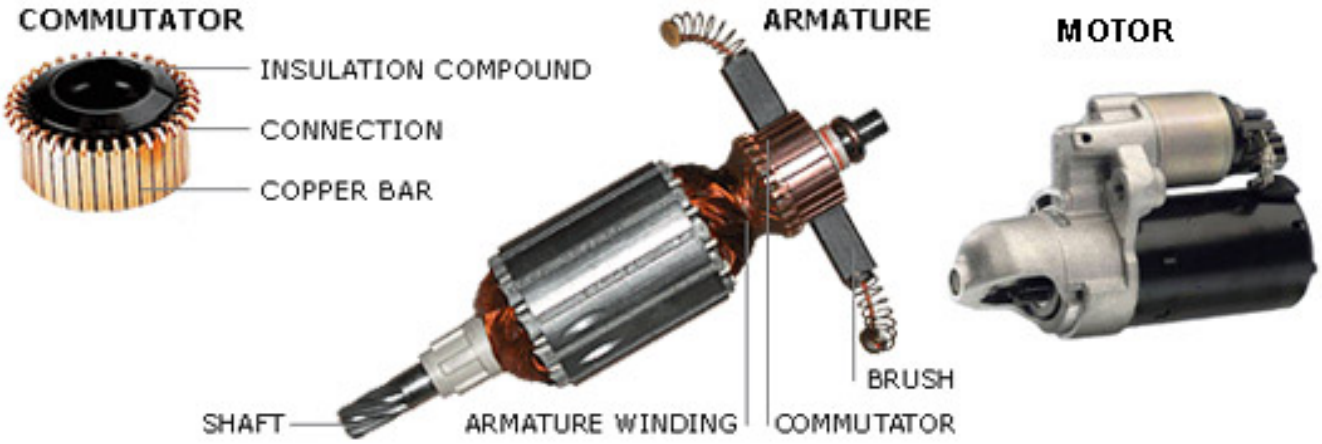
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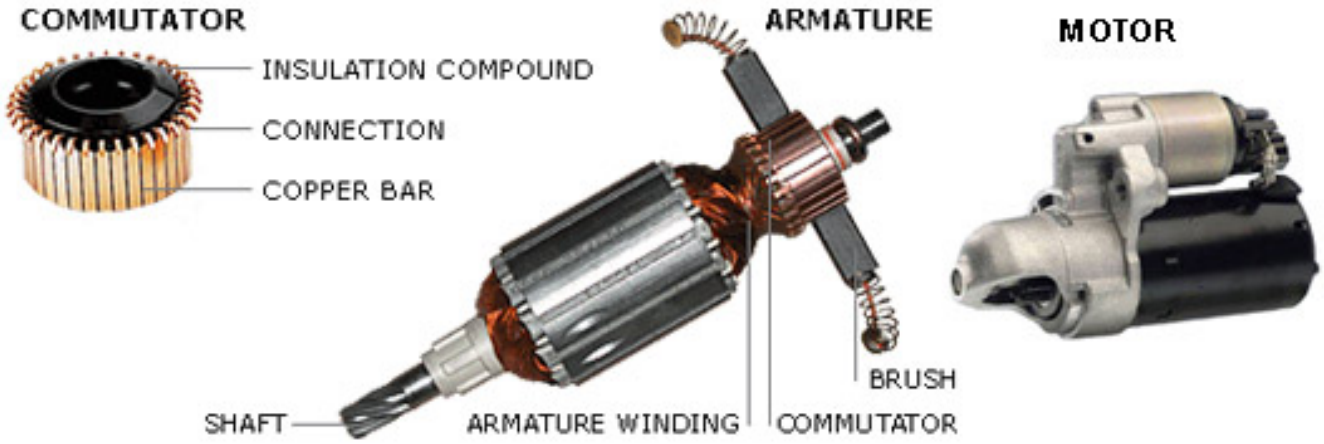
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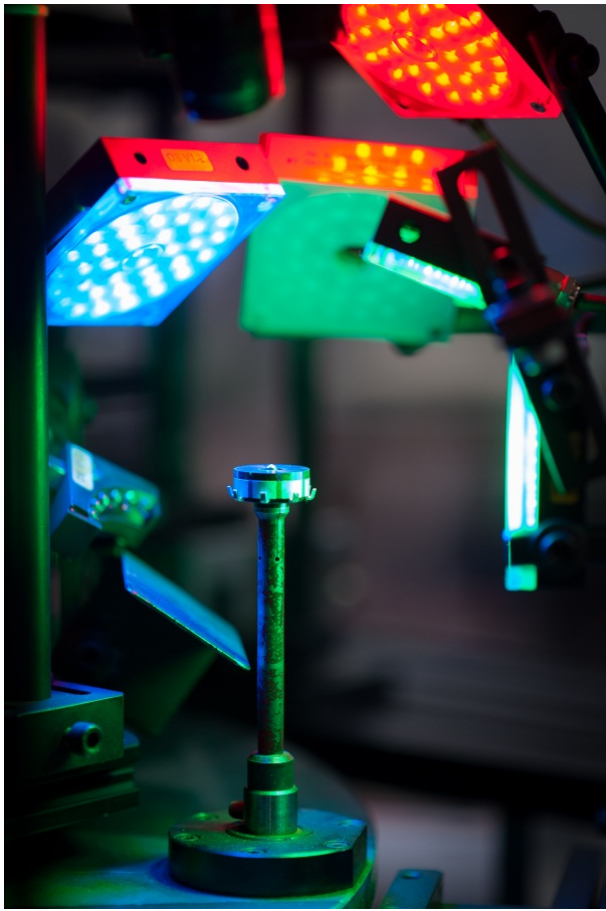
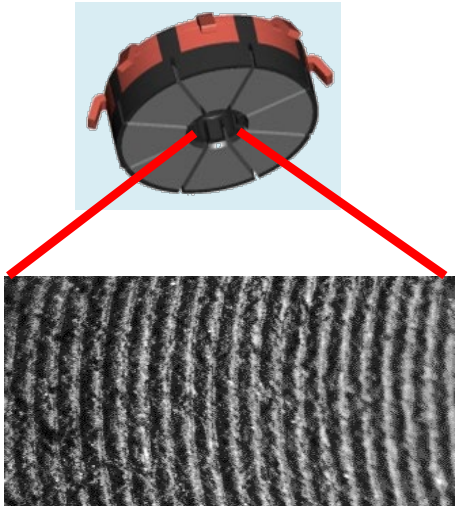
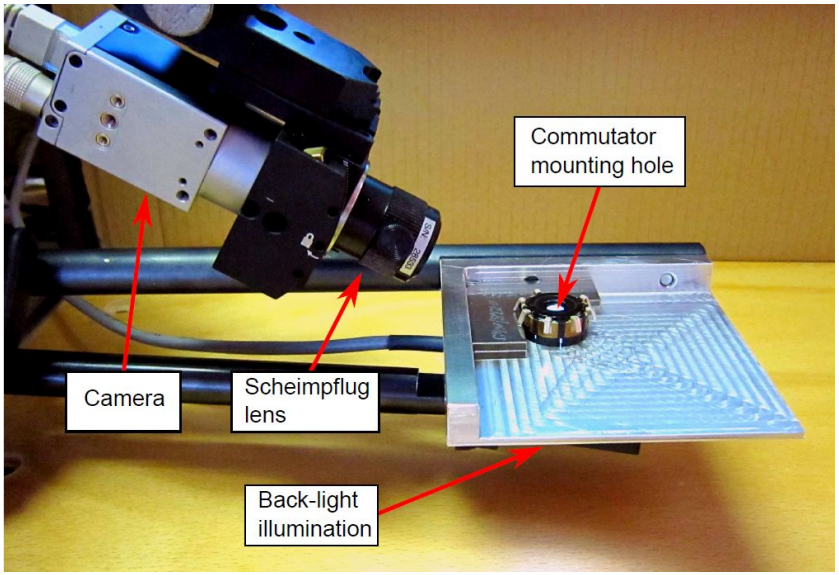
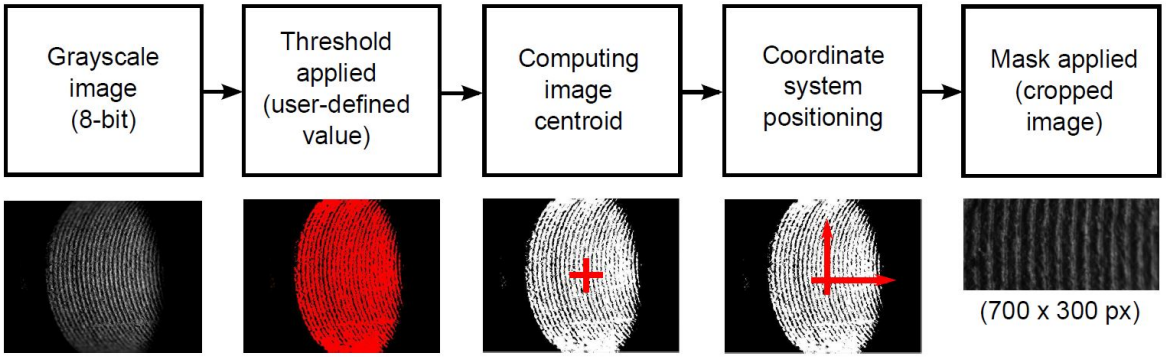


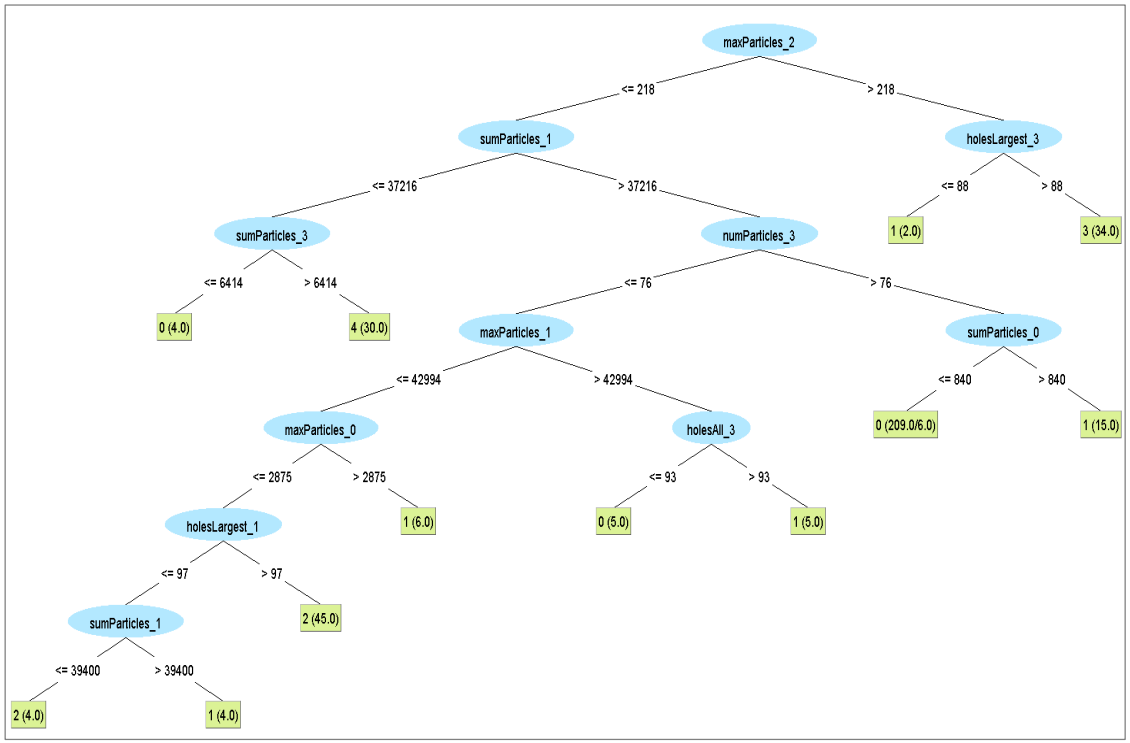
Computer vision approach …



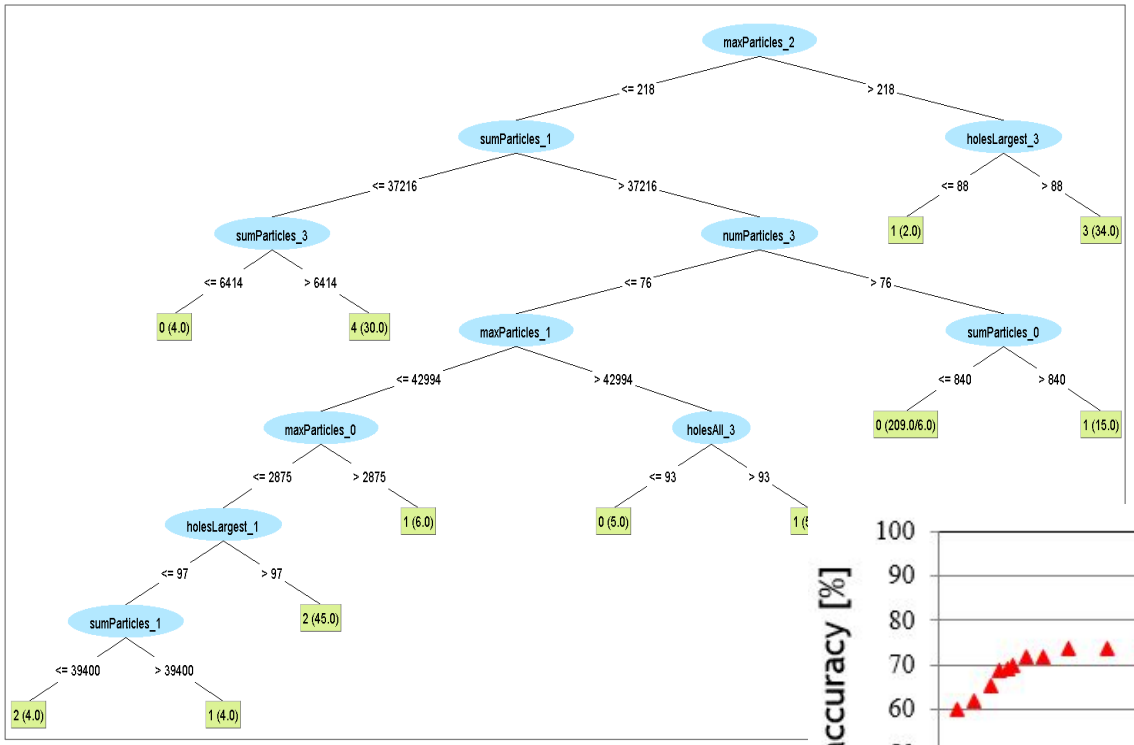


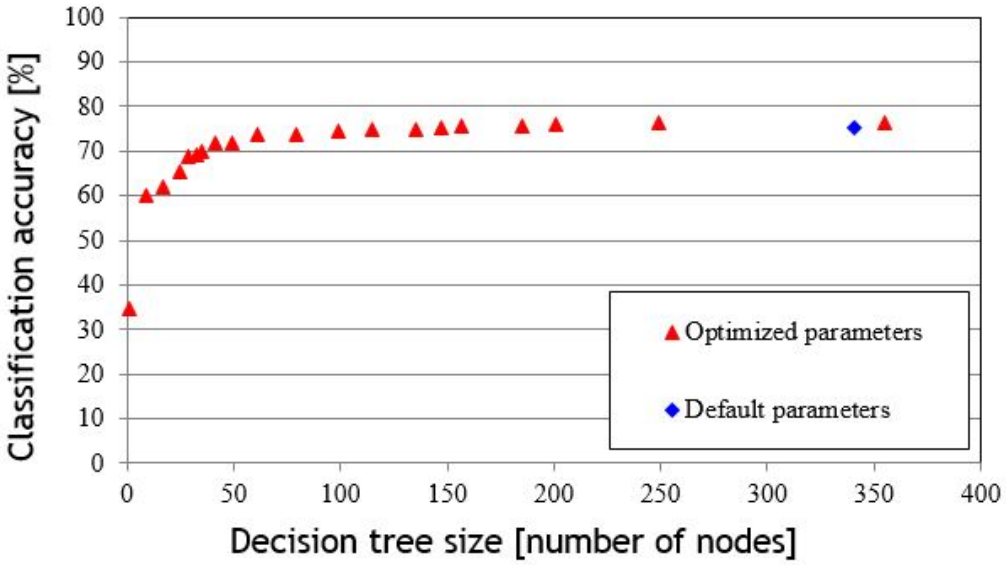


… combined with machine learning

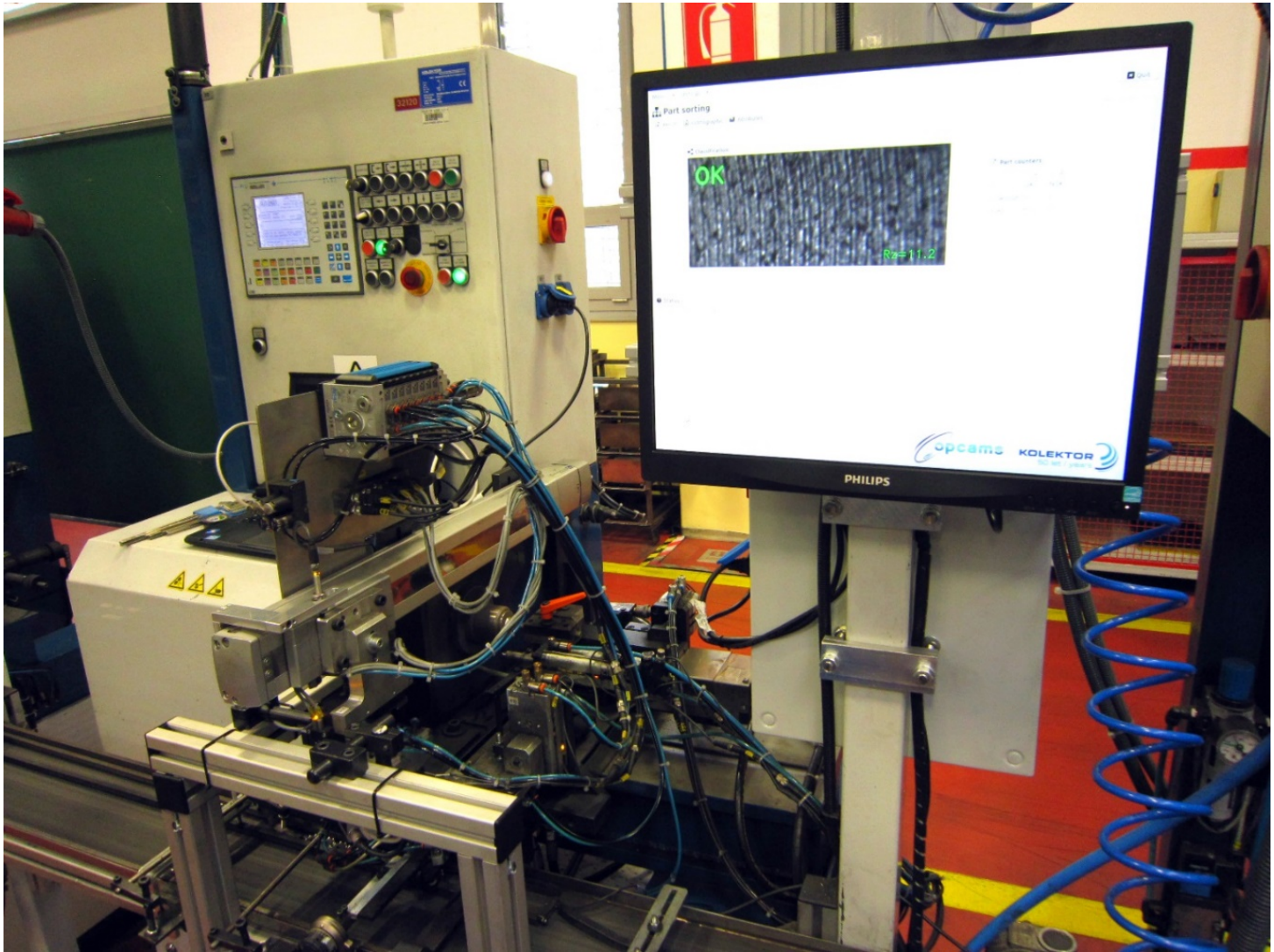


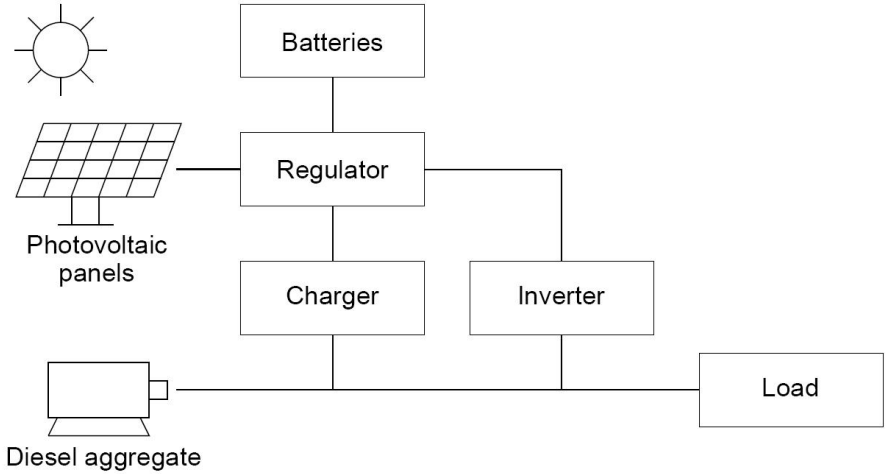
… combined with machine learning

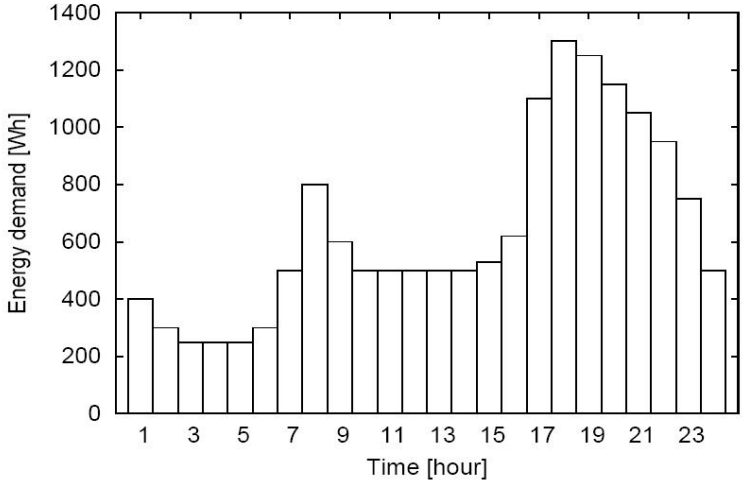


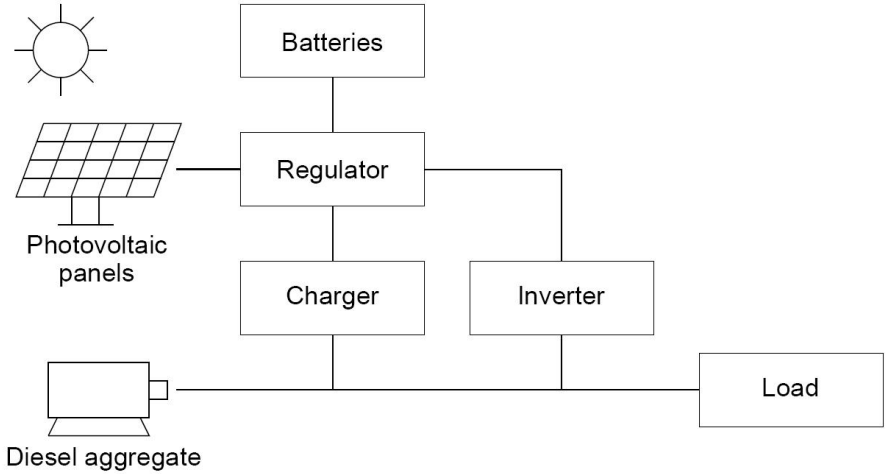


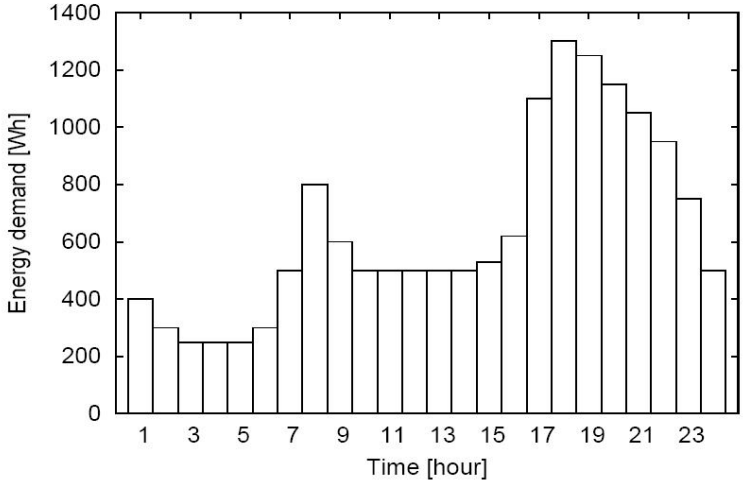
Implementation on a production line




Batteries
Regulator
Photovoltaic panels
Charger
Inverter
Load
Diesel aggregate

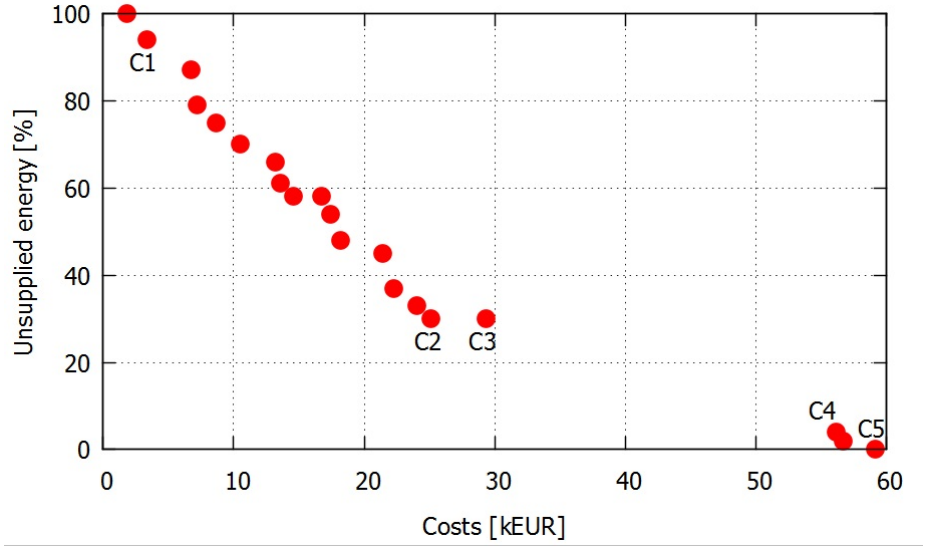

Energy demand [Wh]
0
200
400
600
800
1000
1200
1400
1
3
5
7
9
11
13
15
17
19
21
23
Time [hour]





Variable	Minimum value	Maximum value
Number of photovoltaic modules	0	20
Type of photovoltaic modules	1	9
Number of batteries	0	10
Type of batteries	1	12
Diesel aggregate power [kW]	0	11

Techno-economical optimization



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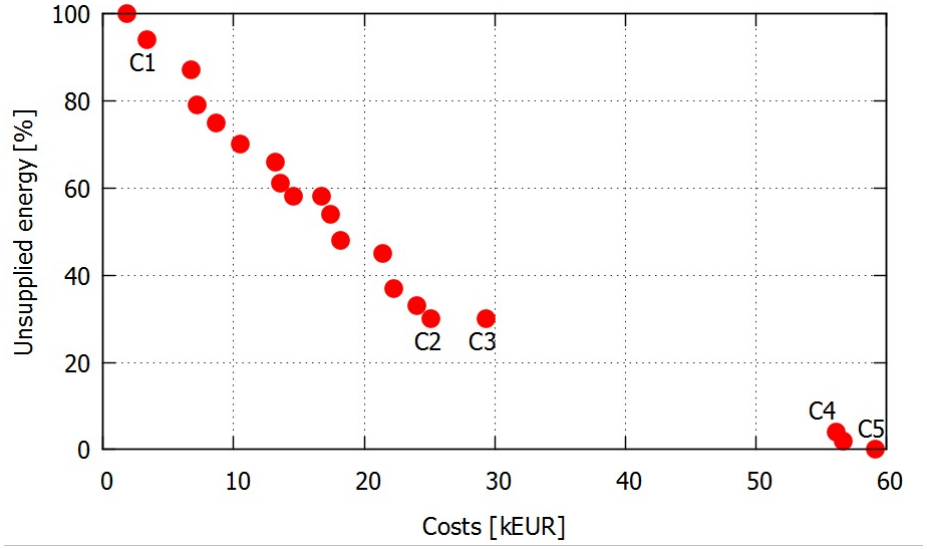
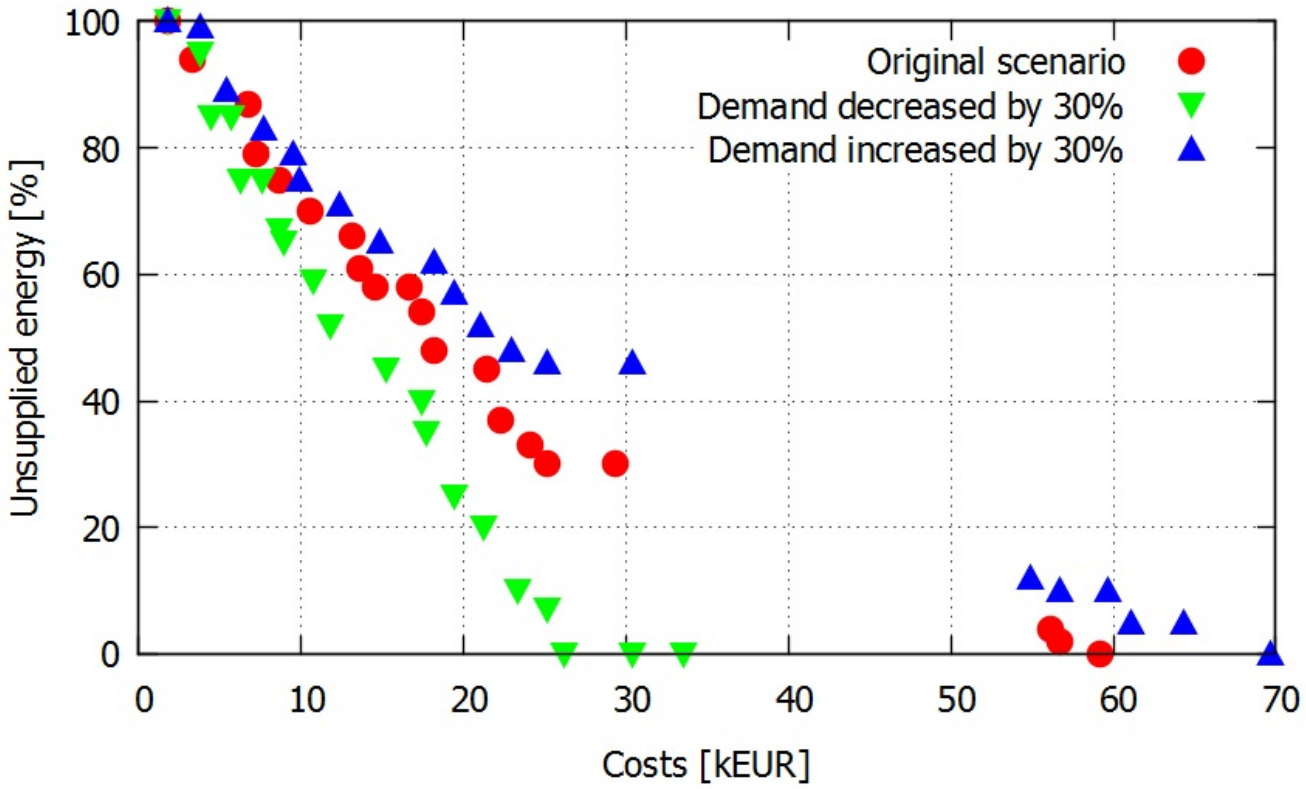


Variable / Criterion	C1	C2	C3	C4	C5
Number of photovoltaic modules	2	20	20	12	20
Type of photovoltaic modules	7	9	9	6	9
Number of batteries	0	5	9	3	4
Type of batteries	0	12	12	5	12
Type of diesel aggregate	0	0	0	1	1
Costs [kEUR]	3,3	25,1	29,3	56,1	59,1
Unsupplied energy [%]	94,5	30,5	30,4	4,3	0

Sensitivity analysis



Summary

- AI certainly has great potential in manufacturing
- However, do not expect unmanned factories too soon, rather count on the interaction between humans and technology
- Most successful applications have been in the form of testbeds, not full-scale projects
- We are contributing to these as shown in this presentation

Acknowledgements

Acknowledgements