

KEEN - Künstliche Intelligenz INkubator Labore in der Prozessindustrie (AI Incubator Labs in the Process Industry)

Supported by:



Federal Ministry
for Economic Affairs
and Energy

on the basis of a decision
by the German Bundestag

17.12.2020



KEEN

AI opens potentials for the process industry

Potential of Deep Learning

Breakdown of use cases by applicable techniques, %

Full value can be captured using non-AI techniques

AI necessary to capture value ("greenfield")

AI can improve performance over that provided by other analytics techniques

Potential incremental value from AI over other analytics techniques, %



The KEEN platform addresses attractive targets that respect the severe constraints of the process industries

Shorter Development Durations and Time 2 Market

- Application: new products and processes,
- Shorten large projects at least for about 1-3 years

Know-how transfer from planning over production to marketing

- Faster Commissioning
- More efficient operation

Energy- and resource optimized processes with shorter start-up/shutdown times

- Up to 10% better efficiency (energy, resources)
- Less disturbances due to operator interventions

Chui, M. et al. (2018) *Notes from the AI Frontier Insights from Hundreds of Use Cases*.
Edited by McKinsey Global Institute.

17.12.2020

Approved for the PUBLIC use by the KEEN partners

2



Specific AI challenges in the Process Industry

Availability of data

- Bare bone instrumentation and measurements for conventional process operation
- Data retention policies

Algorithms are executed at the process interfaces, not in the cloud

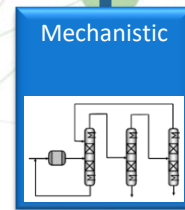
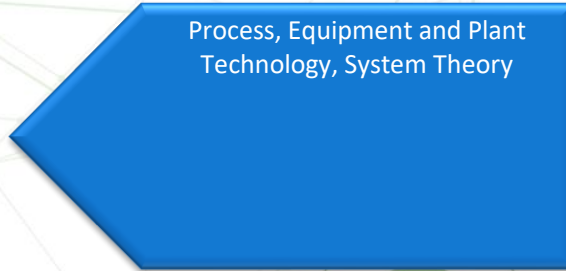
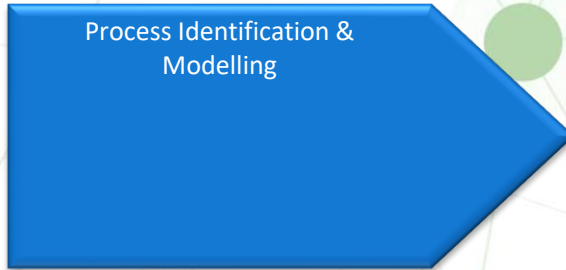
- Reliability, latency and real time needs
- Raw data filtering and preprocessing

Complexity of models and their predictions

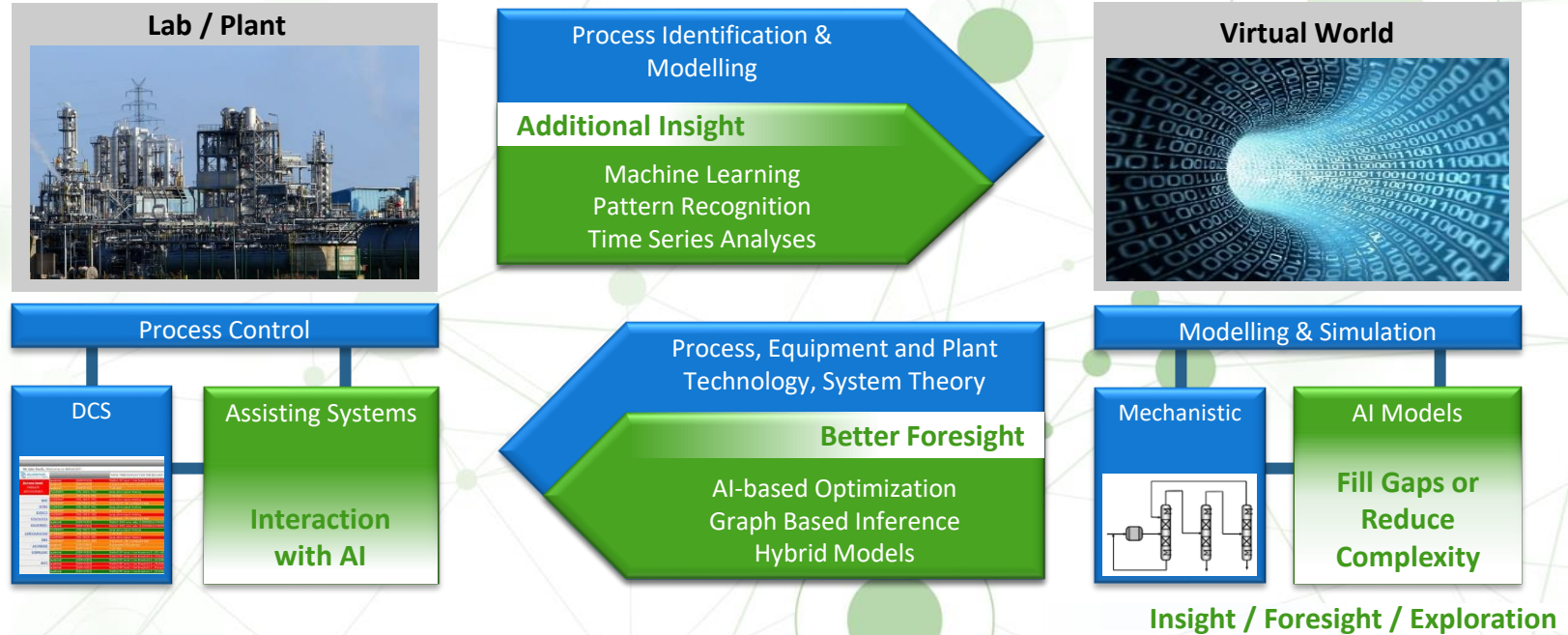
- Vulnerability to certain data / algorithm biases
- Human centered design of order reduction strategies and result presentation
- Regulatory demands: explainable, comprehensible, verifiable

Conventional general purpose data driven and AI methods and technologies will fail!

A toolbox for the process industry ...



... that may be expanded with AI as „Cognitive Amplifier“



BMW Digital Technologies - Innovation Competition „AI as a driver for economically relevant ecosystems“

Challenge: Successful AI needs sector specific approaches

Highly competitive evaluation & selection process

- > 150 Proposals
- 35 Competitive Preparation Projects (< 1 year)
- 16 Platform Projects (Total Budget: 160 Mio EUR)

KEEN: single process industry platform

- Total Budget: 17,5 Mio EUR (10 Mio funding)
- Competitive Advantage
 - Strong partner structure connected by **DECHEMA**, NAMUR, VCI
 - Strong preliminary work (Tutzing, ENPRO, FEE, etc.)



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KEEN provides a collaboration platform to develop AI tools, implement and communicate AI solutions

AI-based Modelling

- Explainable AI
- Hybrid Modelling on Steroids

AI-based Engineering

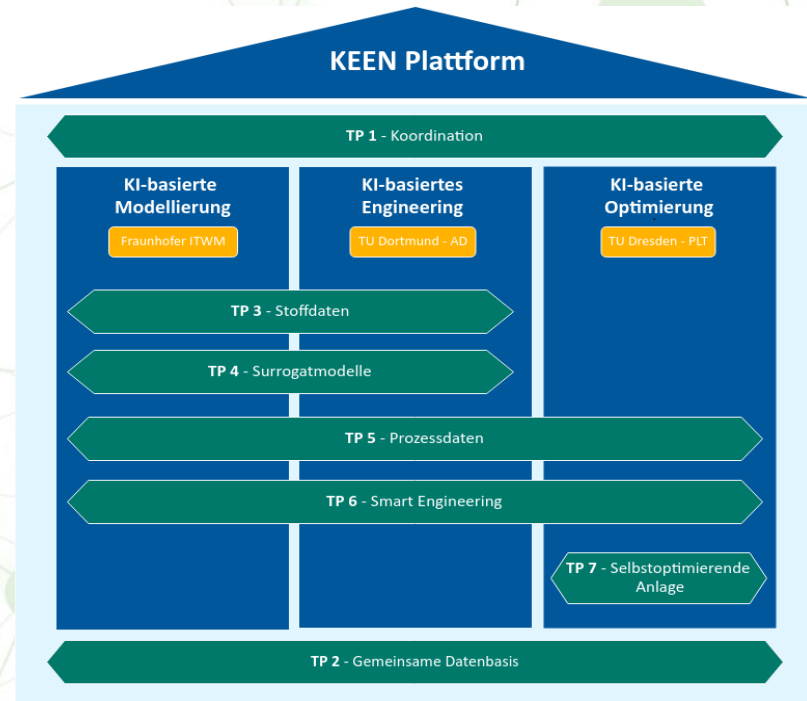
- Support of complex processes
- Safety & HAZOP-Analysis

AI-based Optimization

- Optimization utilizing AI-Methods
- AI-supported process operation

Cross Cutting Concerns

- Common Models, Data and Interfaces



KEEN Applications Landscape

7 Work Packages / ~40 Use Cases

(I4.0 Maturity Model)

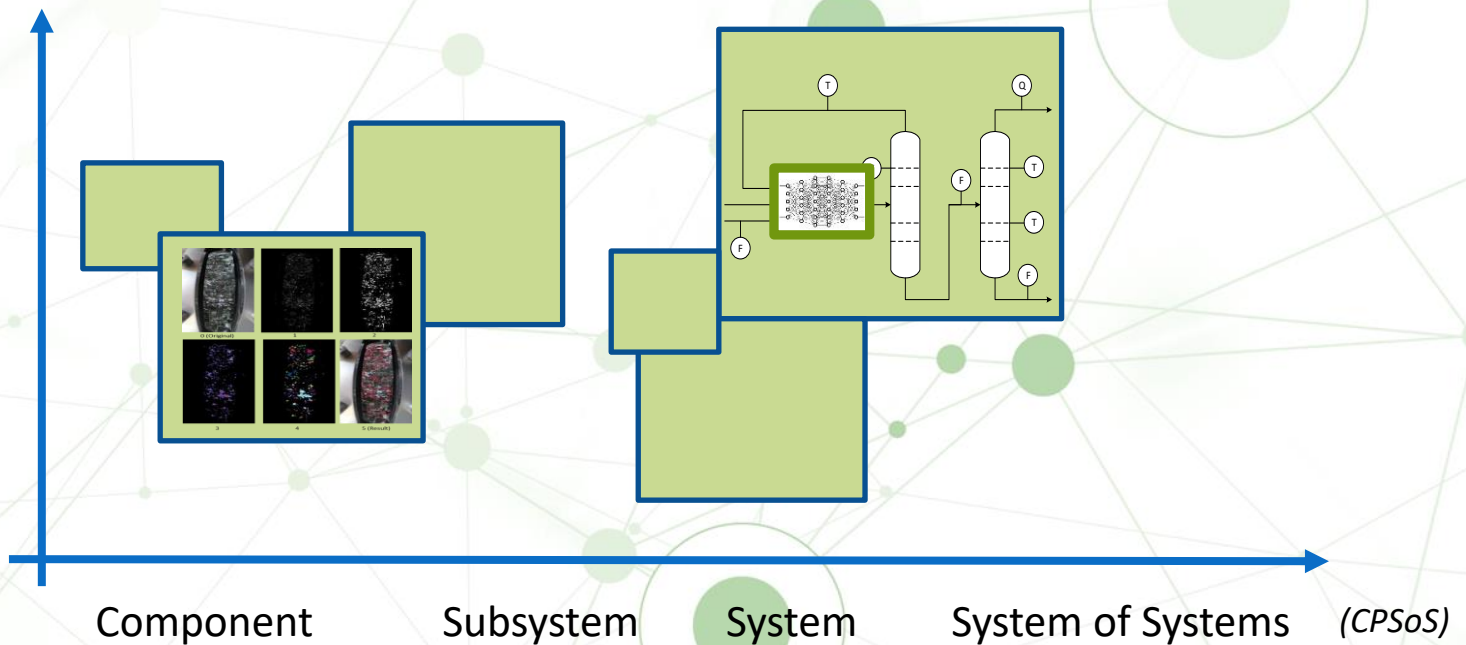
Self
optimizing

Self
assessing

Self
describing

Connected

Manual



Component Level / Self Assessing / Optimizing AI-complemented Process Systems Simulation

Use Case

- Energy intensive complex processes

AI in Action

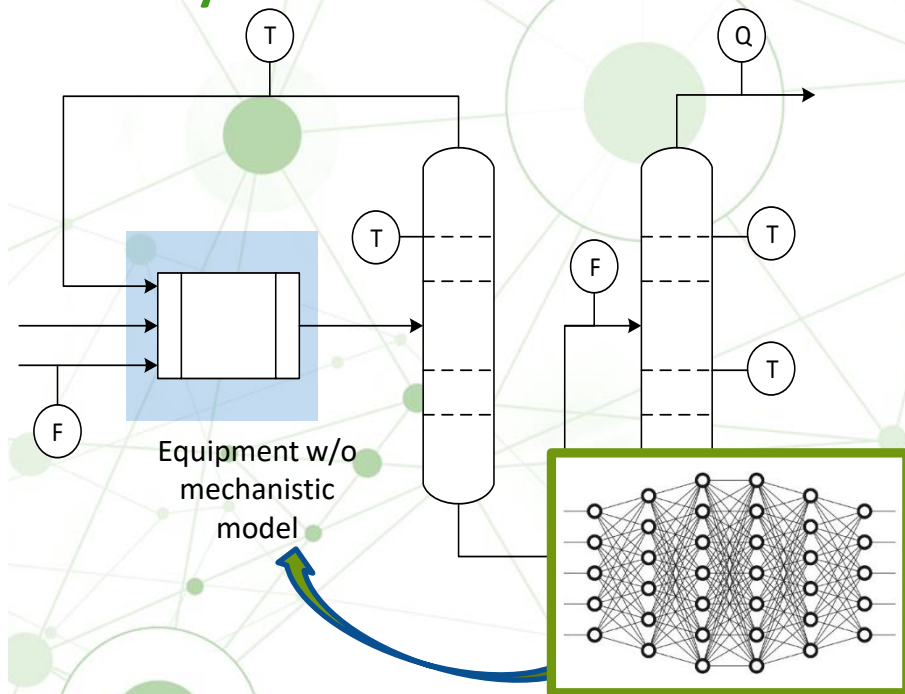
- Mixed-Model Simulation

Results

- AI can be used to simulate full system
- 5 % less energy consumption

KEEN Research Areas

- Reduce extreme high efforts for data preparation and implementation
- Transferability & Generalization



N. Asprion et al , *Chem. Ing. Tech.* 91 (2018)

N. Asprion et al , *Comp. Chem. Eng.* 40 (2017) 97-102

System Level / Self Assessing / Predicting AI supported process state estimation

Use Case

- Estimation, optimization and prediction of batch processes

AI in Action

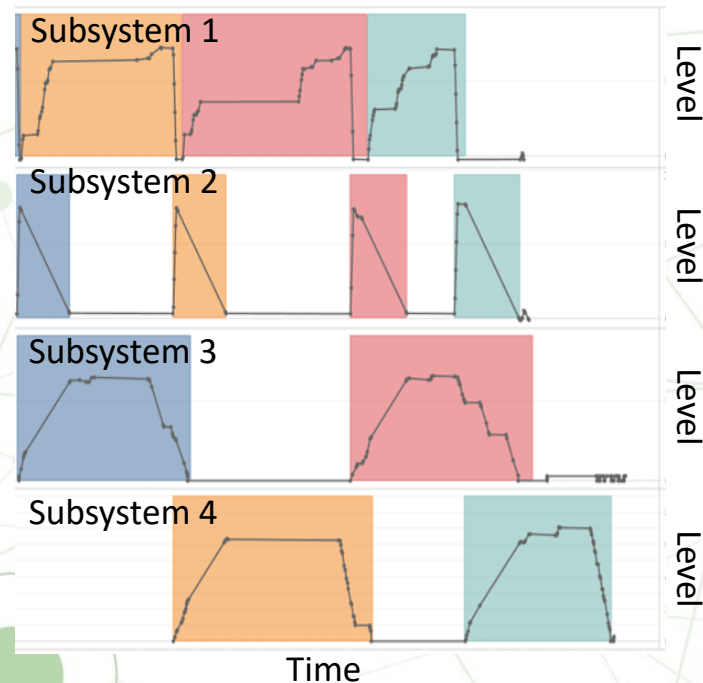
- Classification and prediction based on time series data

Results

- Better understanding of complex batch processes
- Cost savings through well-timed catalyst exchange

KEEN Research Areas

- Use different process information for modelling smartly
- Find a balance between accuracy and explainability
- Increase acceptance of AI models for the industrial use



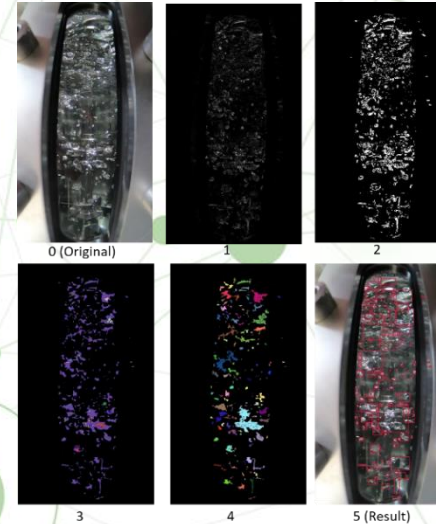
Bayer/TU Dresden

Component Level / Self Describing AI Based Analysis of Process Image Data

- Use Case: Utilize AI on Images and Video Data to measure process & product properties

- DL with Convolutional NN
 - Segmentation & Classification
 - YOLOv3-tiny Framework

ID ¹		
Use case name	Process information extraction from video data	
Application domain	Aerated stirred tanks with transparent liquids, bioreactor module	
Deployment model	Hybrid deployment: Cloud for model training and edge for model execution	
Status	Research to prove feasibility (TRL 3)	
Scope ²	This feasibility study is focused on the investigation which information about the process can be extracted from the video data by means of the AI-methods in order to identify the flow regime and evaluate the mixing time. In addition, other possible approaches will be analysed which can further reduce uncertainties by means of results of the additional CFD-simulation and process values.	
Objective(s)	The objective of this use case is the development, verification and validation of the soft-sensor for the flow regime identification and mixing time evaluation.	
	Short description (not more than 150 words)	This feasibility study is focused on the investigation which information about the process can be extracted from the video data by means of the AI-methods in order to identify the flow regime and evaluate the mixing time. In addition, other possible approaches will be analysed which can further reduce uncertainties by means of results of the additional CFD-simulation and process values.



KEEN connects all the necessary players to speed up AI development

Innovative Owner/Operators



Established Technology Providers



Experienced Scientists



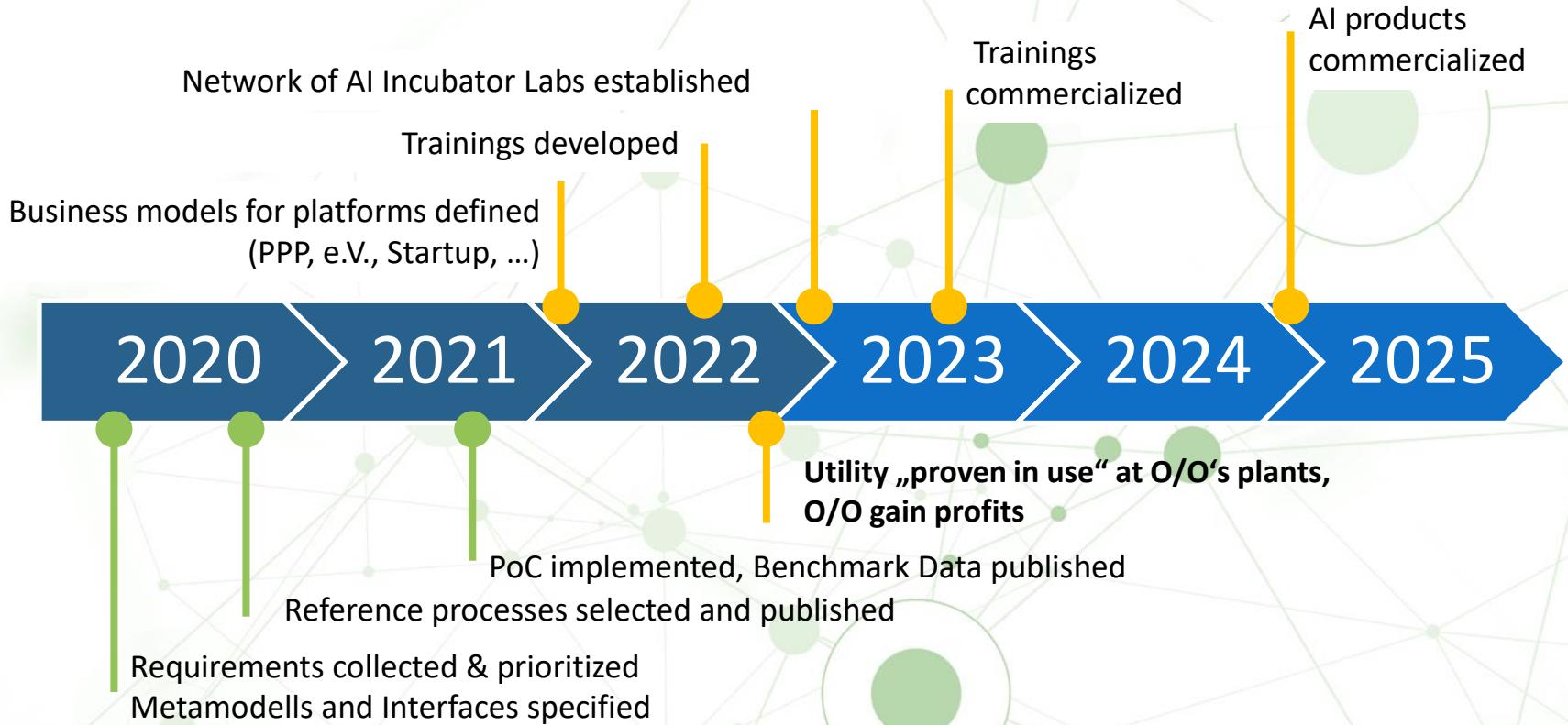
Agile SMC / Startups



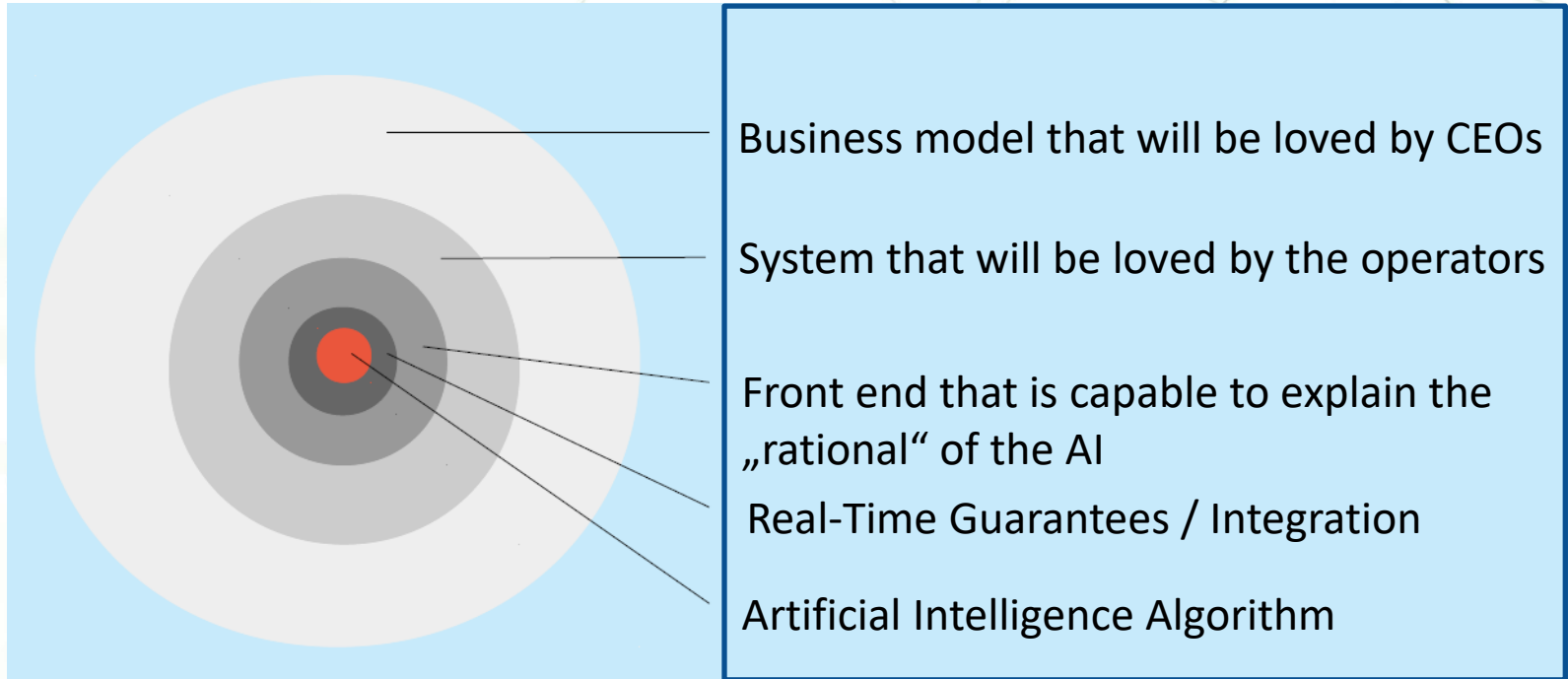
Associated Partners



KEEN Roadmap



Instead of a summary some first lessons learned



(inspired by Leo Spenner's talk at the 2nd KEEN workshop 2019)

KEEN Summary

AI in the Process Industry

- AI extends our elaborated toolbox as cognitive amplifier
- The capability to handle and manage complex data flows is key
- Explainable AI call for a tight cooperation of domain experts and data scientists

[keen-platform.de](https://www.keen-platform.de)

- News, Events
- Use Cases, Benchmark Data

