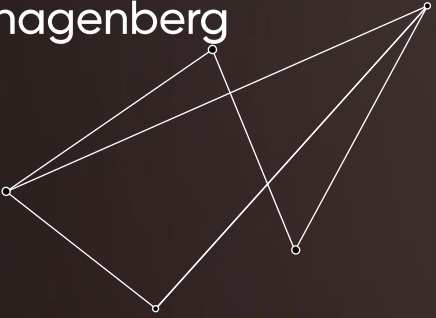


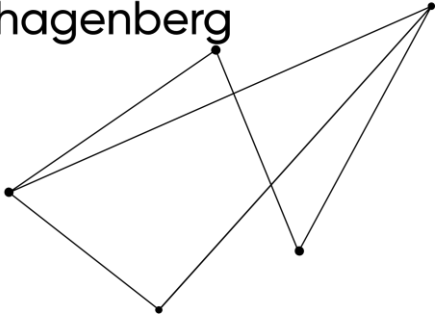
scch {  
software  
competence  
center  
hagenberg  
}



# Big-Data-Management, Predictive Modeling, and Reactive Optimization for Industrial Processes

DI (FH) Michael Roßbory

```
scch {  
  software  
  competence  
  center  
  hagenberg  
}
```



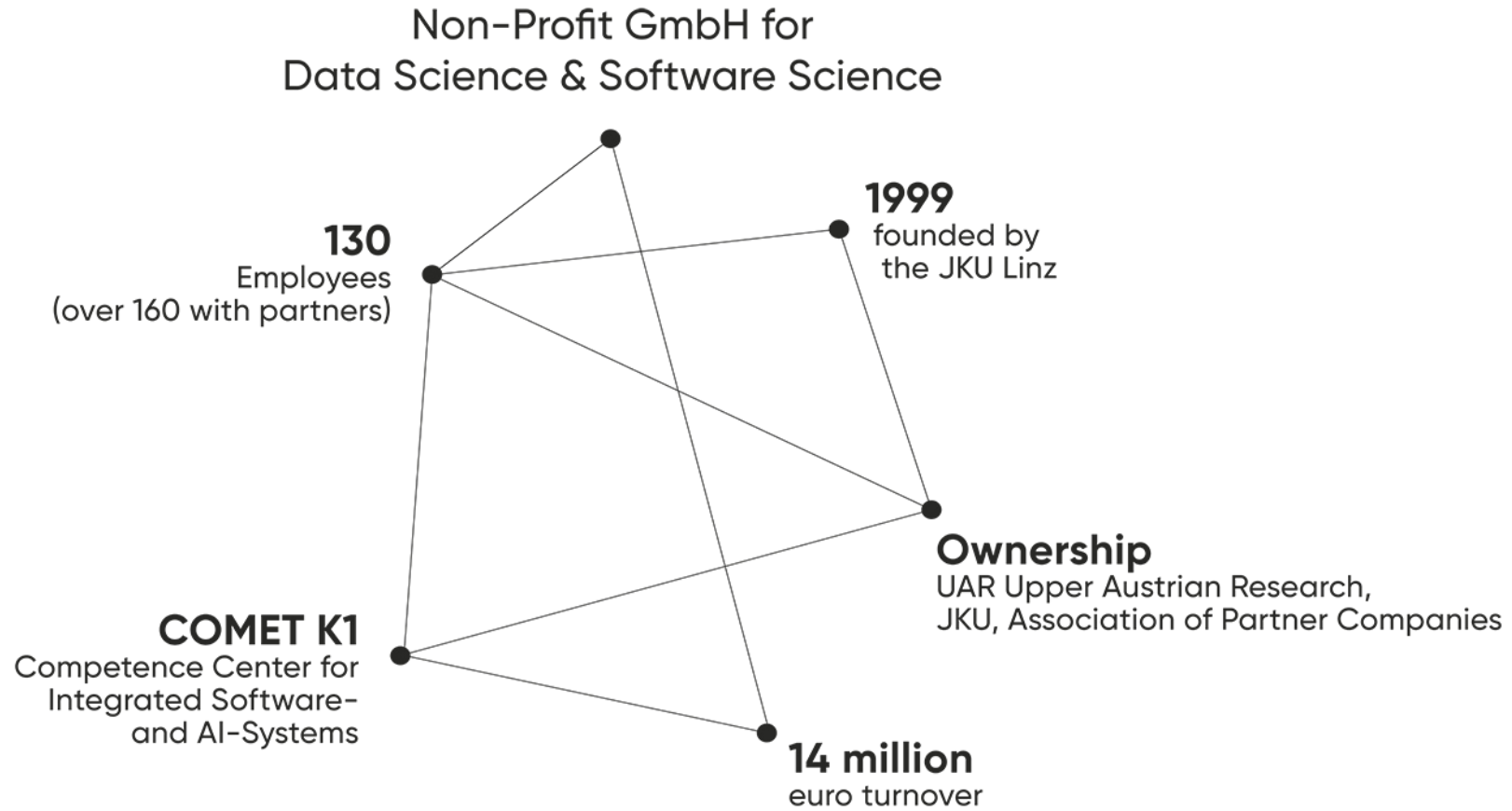
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scch {}
```

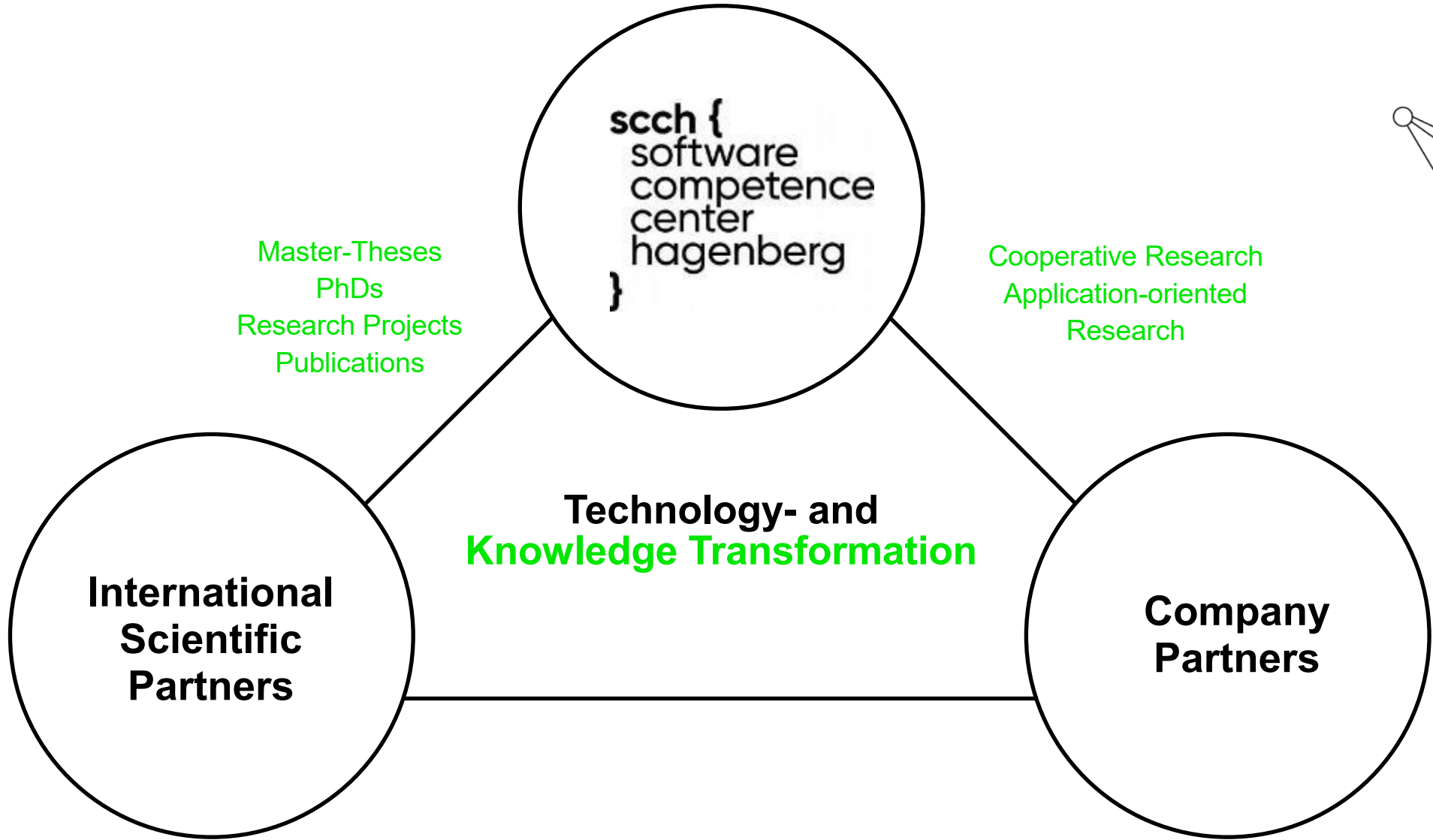
# Software Competence Center Hagenberg

Application-Oriented Research in  
Data Science & Software Science

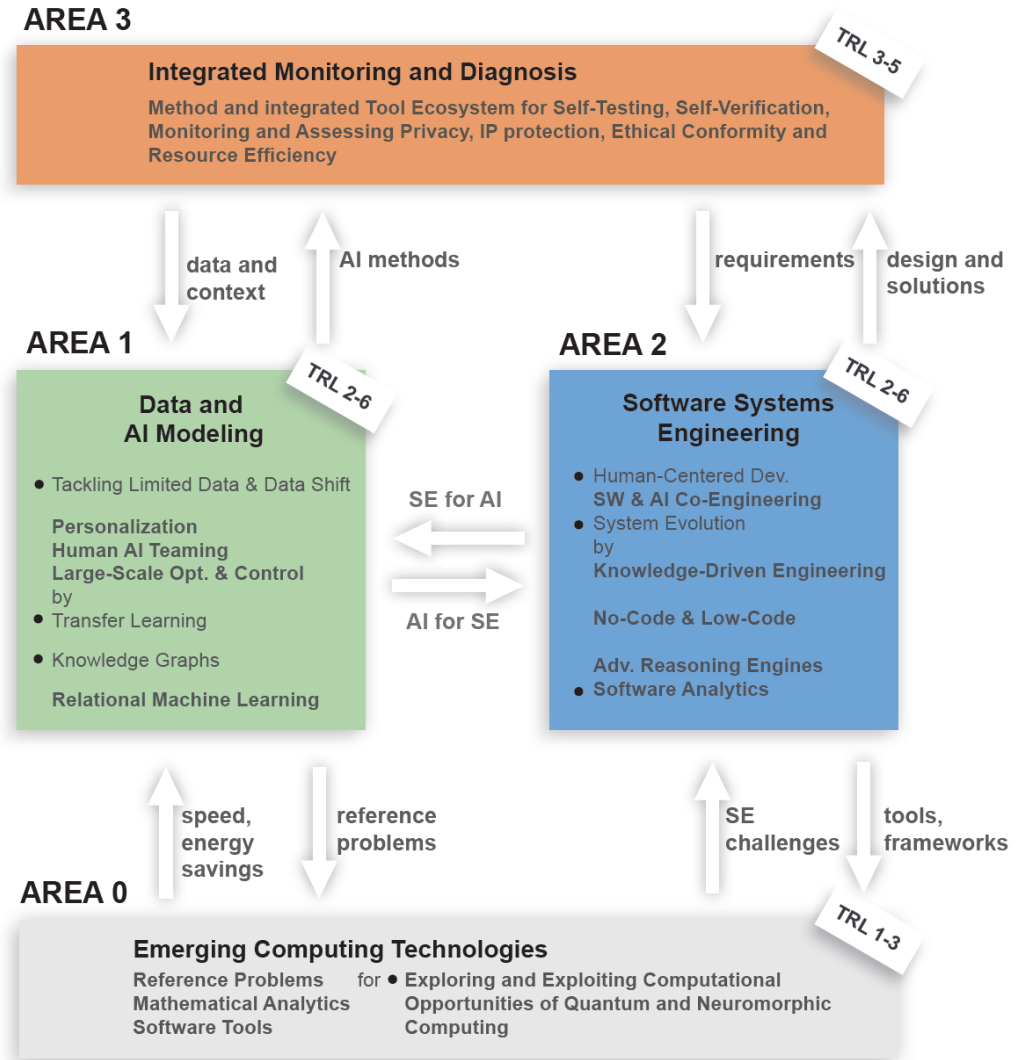
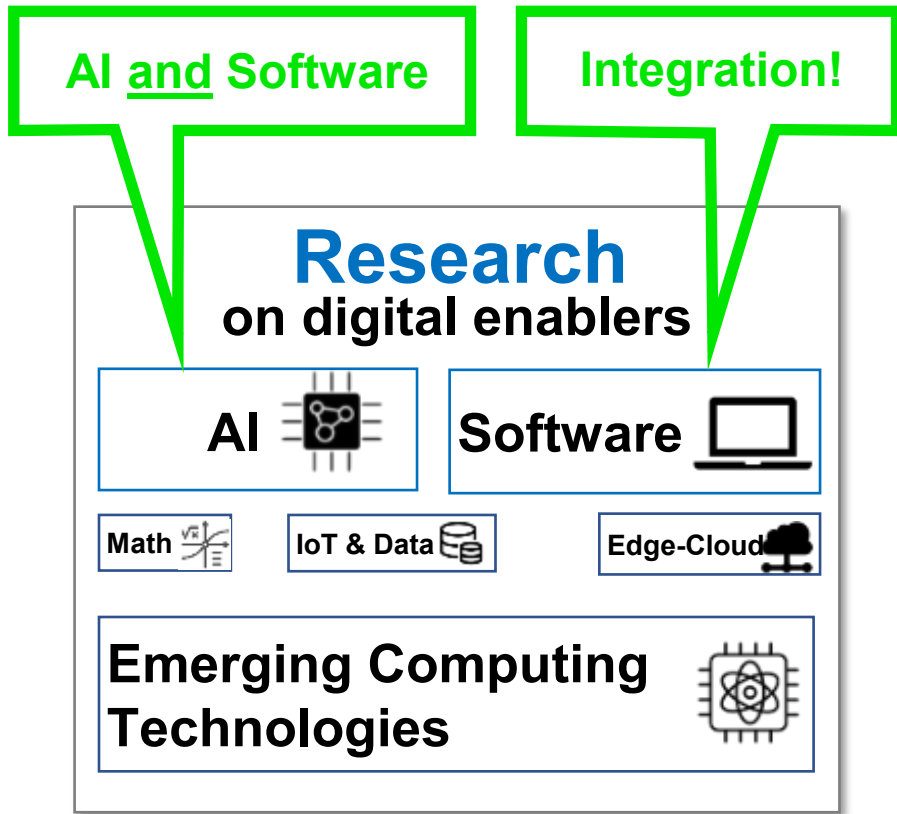
# Software Competence Center Hagenberg

scch { }

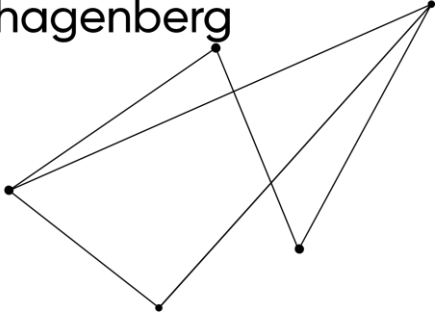




# Research Areas



```
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  software  
  competence  
  center  
  hagenberg  
}
```



```
scch {}
```



# COGNIPLANT

Cognitive Platform to enhance  
Performance and Sustainability of the  
European Process Industry

# Project Overview

scch { }

## Horizon 2020 SPIRE Project (#869931)

- 14 Partners from 8 different European Countries
  - 4 Industrial Use-Case Partner
- Oct. 2019 – Sep. 2023
- Goal: **Creation of a Cognitive Platform to Enhance Performance and Sustainability of the European Process Industry**



# Cogniplant – General Overview

scch {}

## Co-Digitise Layer

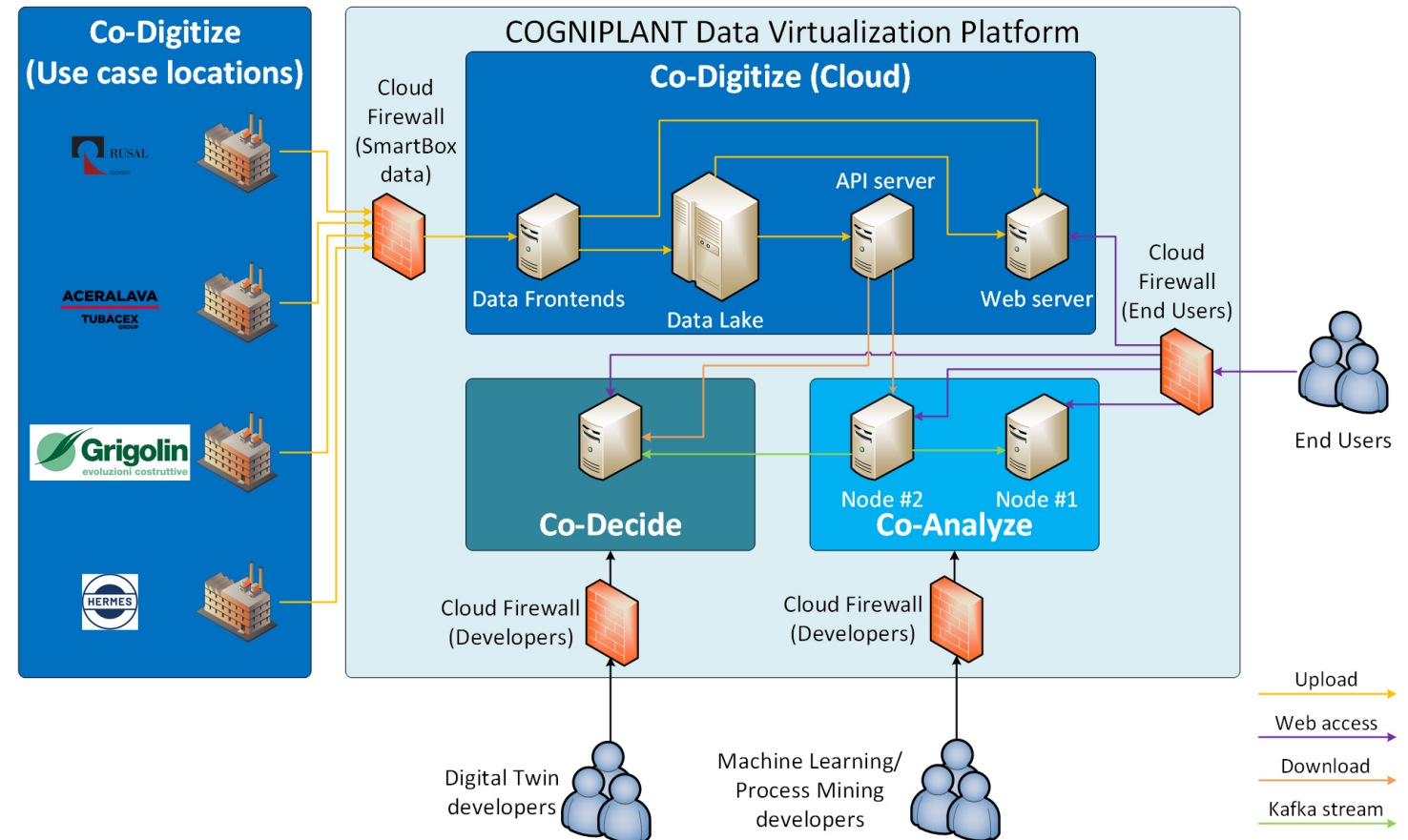
- Collection of data
- Virtualization of data
- Structure definition of data

## Co-Analyse Layer

- Advanced data analysis methods for process data
- Predictions for defined Use-Case KPIs

## Co-Decide Layer

- Decision support for KPI optimization





# AVUBDI – A Versatile Usable Big Data Infrastructure

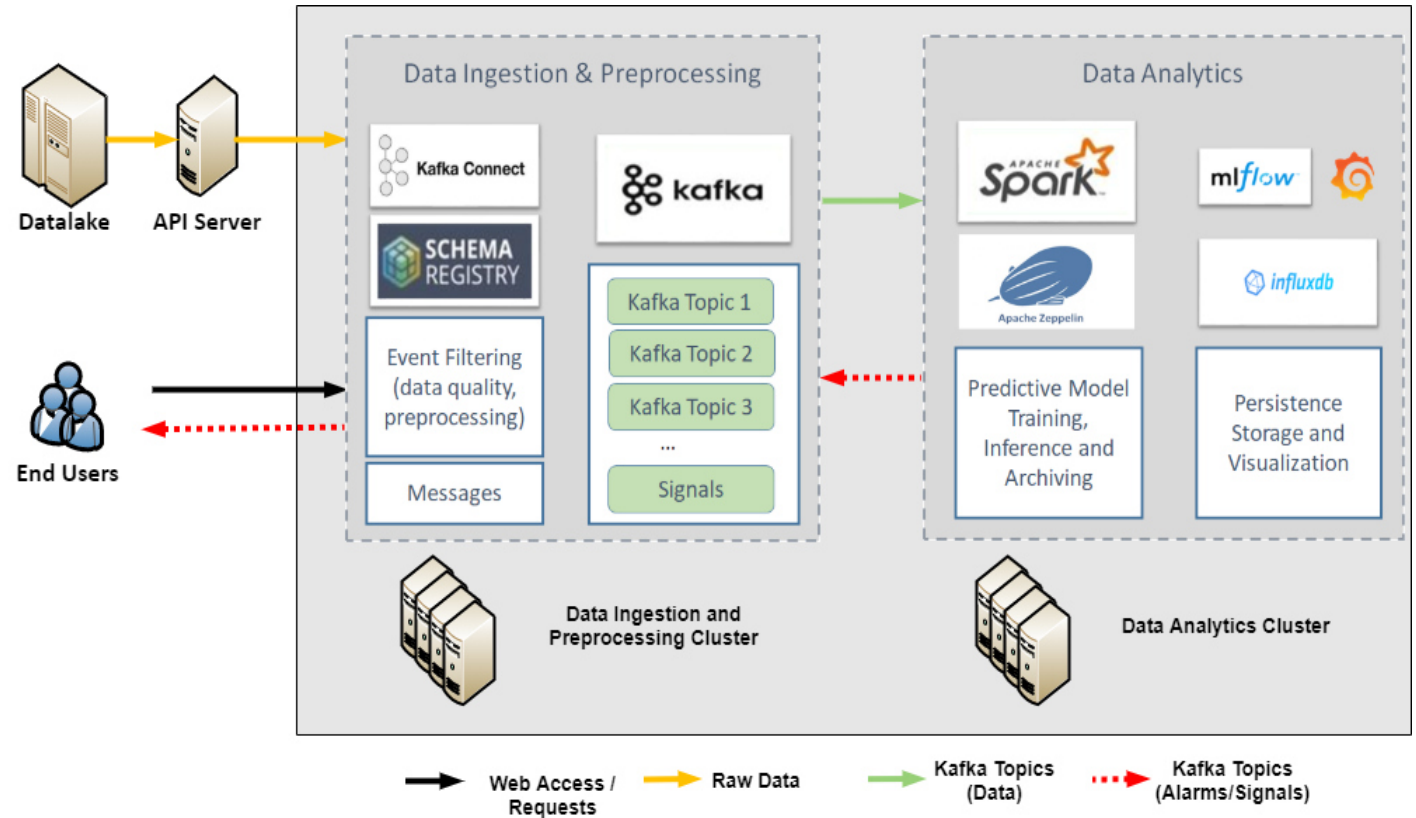
scch { }

## Data Ingestion & Preprocessing

- Basis of overall Big Data infrastructure
- Central Data Management Components
- Data retrieval as batch / stream and transformation
- Streams via topics

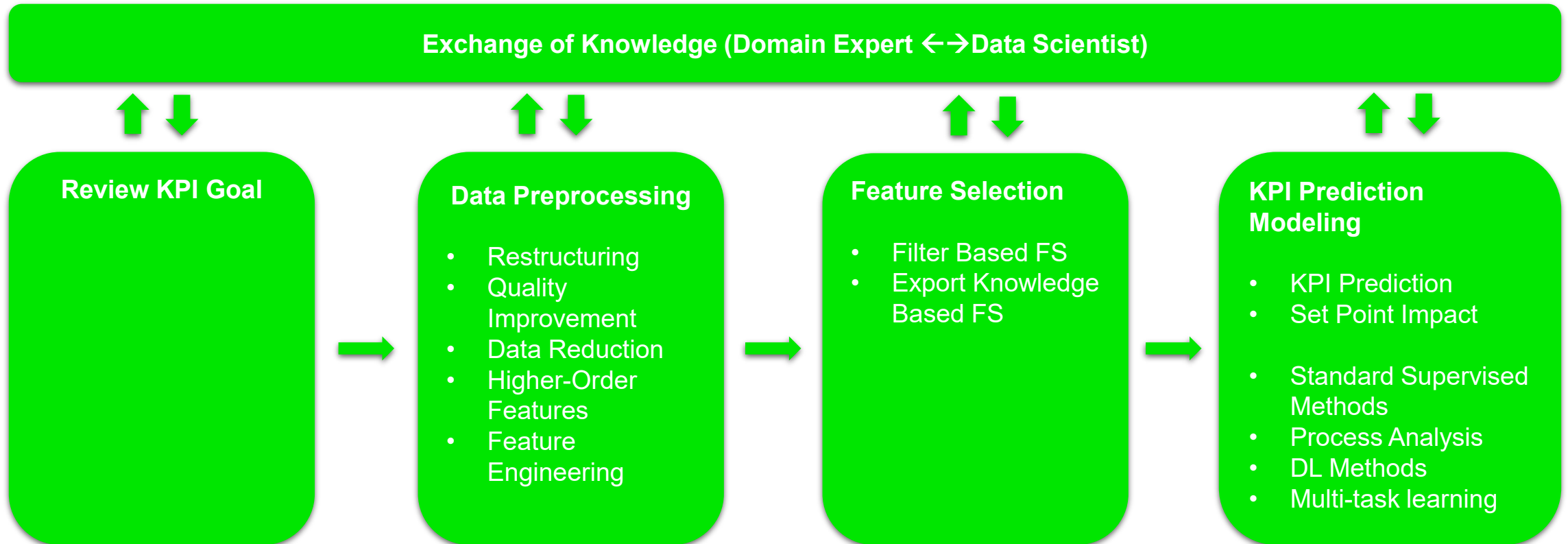
## Data Analytics

- Processing streaming data in spark jobs
- Preprocessing / Prediction
- Model Management
- Visualization



# Data Analytics Pipeline

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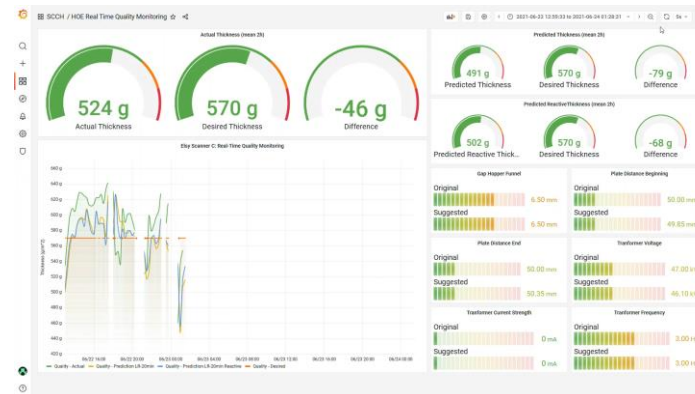
# Monitoring Dashboards

- Improved understanding
  - **Process details** & influence of setpoints on KPIs
- Faster response to critical conditions
  - **Predictions** provide better responses
- Learning better configurations
  - Prediction-based **optimization**
- Better use of human resources
  - Pro-active **responses**

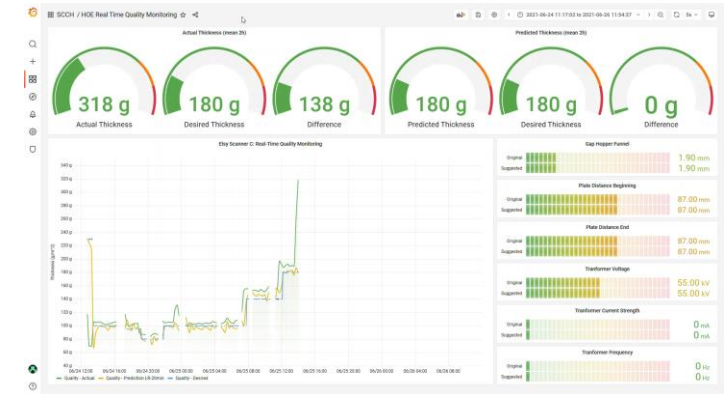
## Analytics Monitoring



## Optimization Monitoring



## KPI Real-time Monitoring



# Use-Case I - Lime Production

scch { }

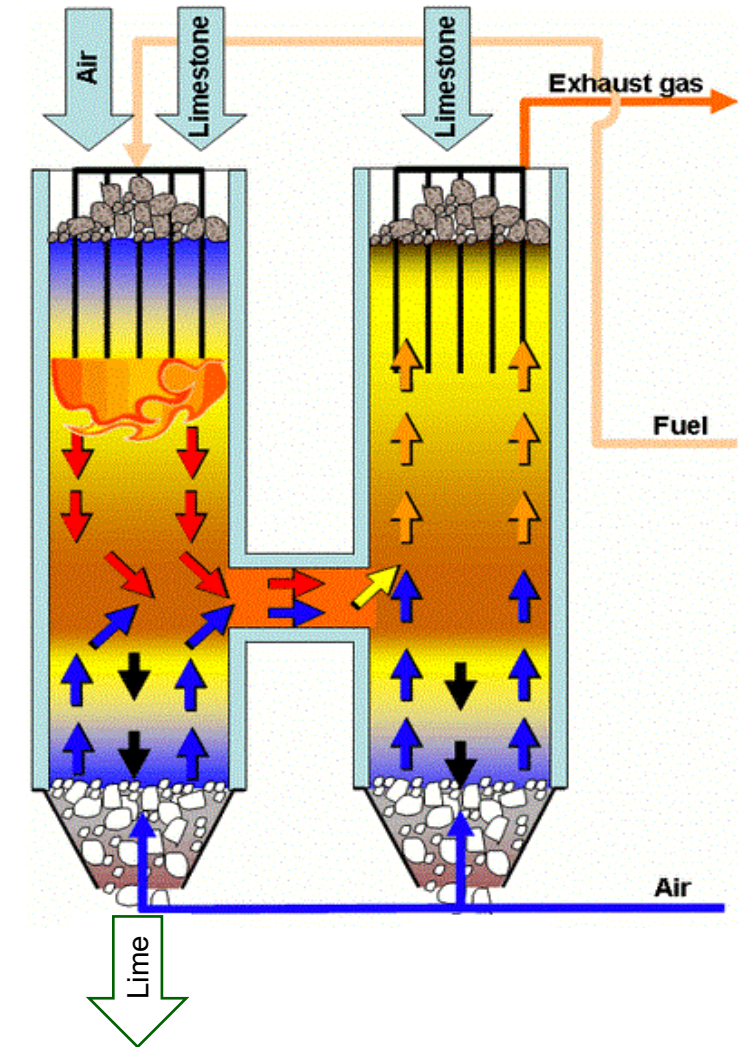
Production of Lime using the Grigolin Calcination Process

Measurement of lime quality (reactivity & CO<sub>2</sub>)

- Samples every 1-2 hours

High influence of fuel and limestone size on quality of lime

- Adjusting of temperatures within the process as adjustable parameters for optimization



# Use-Case I - Lime Production

## Goal & Challenges

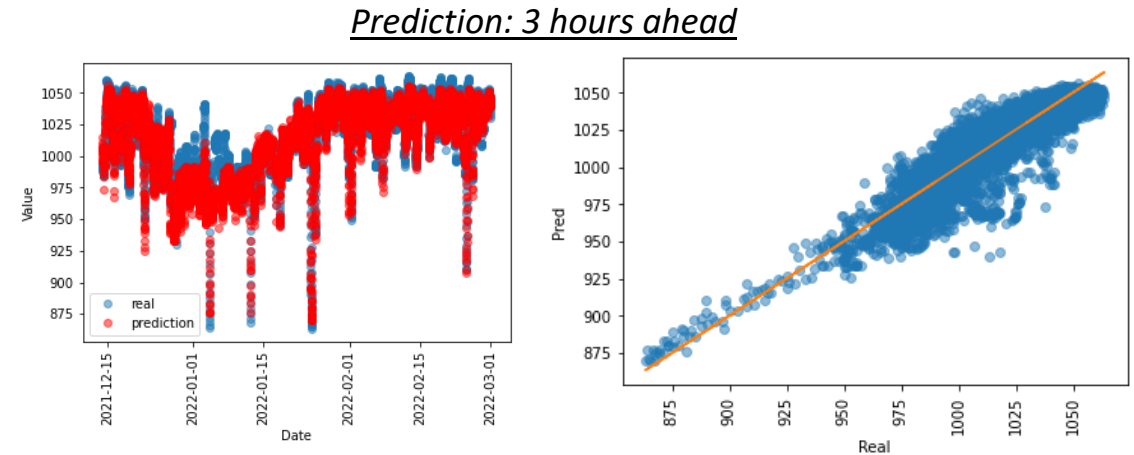
- Maintain temperature within limits
- Slow moving process, high inertia (multiple hours)
- Slow response times to setpoint changes

## Impact

- Accurate prediction can reduce volatility
- Influences kiln stops, (product) quality standards

## Analysis

- Preprocessing data quality improvements
- Correlation analysis to capture dependencies
- Advanced preprocessing is required



	Naive Model	Cogniplant Model	Improvement (%)
nRMSE (3h-ahead average prediction)	0.0102	0.0083	18.63%
nRMSE (3h-ahead point prediction)	0.0370	0.0137	39.73%

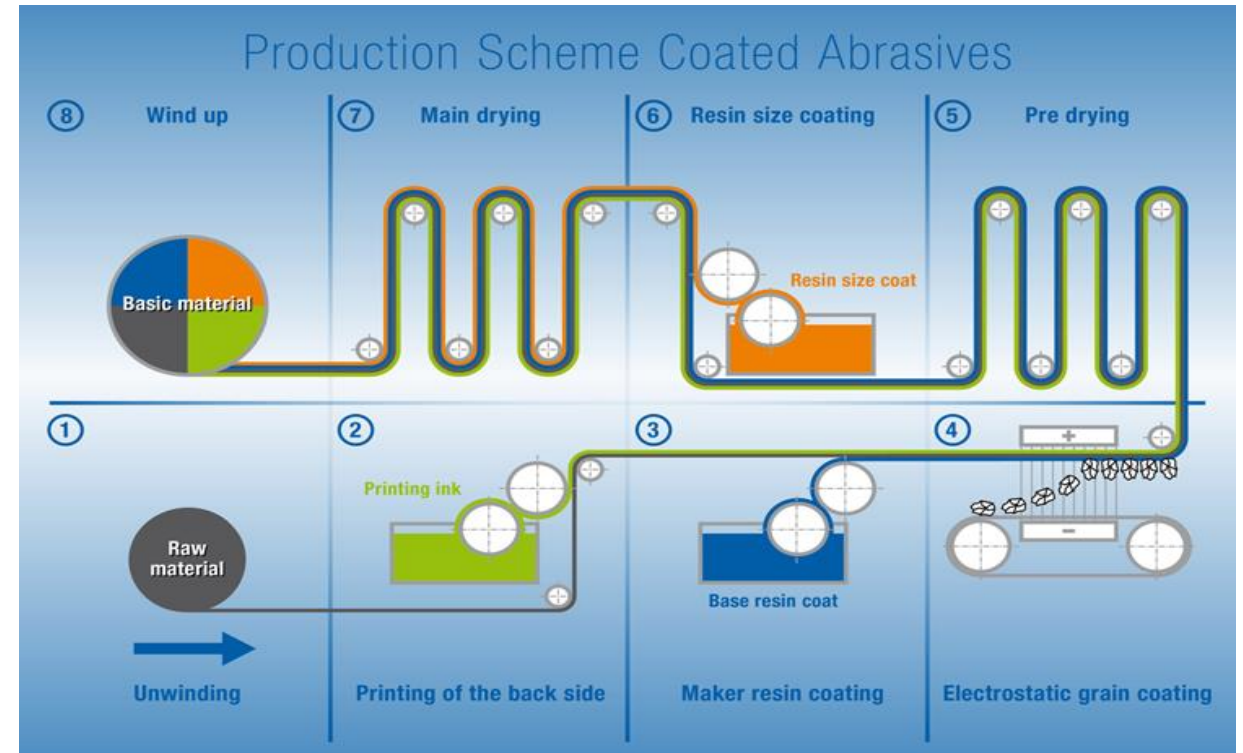
**19% improvement** in prediction accuracy of 3h-average Channel Temp.  
**40% improvement** in prediction accuracy of 3h-point Channel Temp.

# Use-Case II - Abrasives

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## Production of abrasives

- 8 Processing steps, whereat the 4<sup>th</sup> has the most influence on quality
- Selected, manually configurable, control parameters are adjustable for a higher quality (→ optimization)
- Faults cause scrap material & unplanned production stops



# Use-Case II - Abrasives

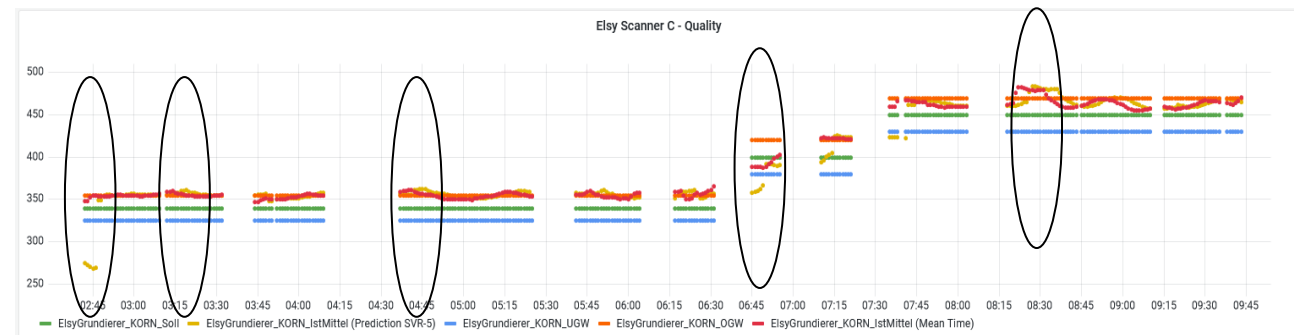
## Analysis based on higher-order temporal Features

- Data preprocessing and restructuring
- Different product types with varying amount of produced abrasives
- Application of various machine learning approaches
  - Linear Regression, Deep Neural Networks, Multi-Task Learning ,...

**55% improvement in prediction accuracy of 5min-ahead Quality using the COGNIPLANT platform for development.**

## Reactive Optimization

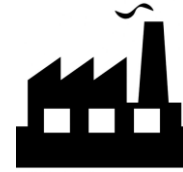
- Detecting abnormal “expected” operating conditions
- Utilize stochastic search optimization
- Compute alternative configuration inputs
- Near real-time response



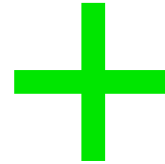
Highlighting of undesired quality profiles

# Call-to-Action

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Process  
Industry



Reduce CO2  
emissions



Reduce energy  
use



Improve  
product quality

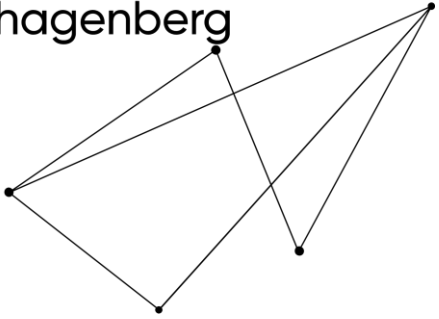


Improve  
process control

**Contact us and benefit from the high-end development and the know-how in customization at SCCH.**



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Senior Research Project Manager Data Science and Business Development  
Research Team Lead AI-Assisted Prescriptive Analytics

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[www.scch.at](http://www.scch.at)