

# APP4 – Section Mill

Translator:



Industrial  
Partner:



# Business Case

In terms of the business case, the following factors were highlighted as the most important:

- well-controlled and optimised production process
- even a small improvement could lead to a huge change in a large-scale production
- optimising the steel production process is a key to tackle raising energy, materials or CO<sub>2</sub> tariff costs
- digital tools for production process optimisation / analysis reduces costly experimental tests



1) Good understanding of the business case

2) Good understanding of the industrial case

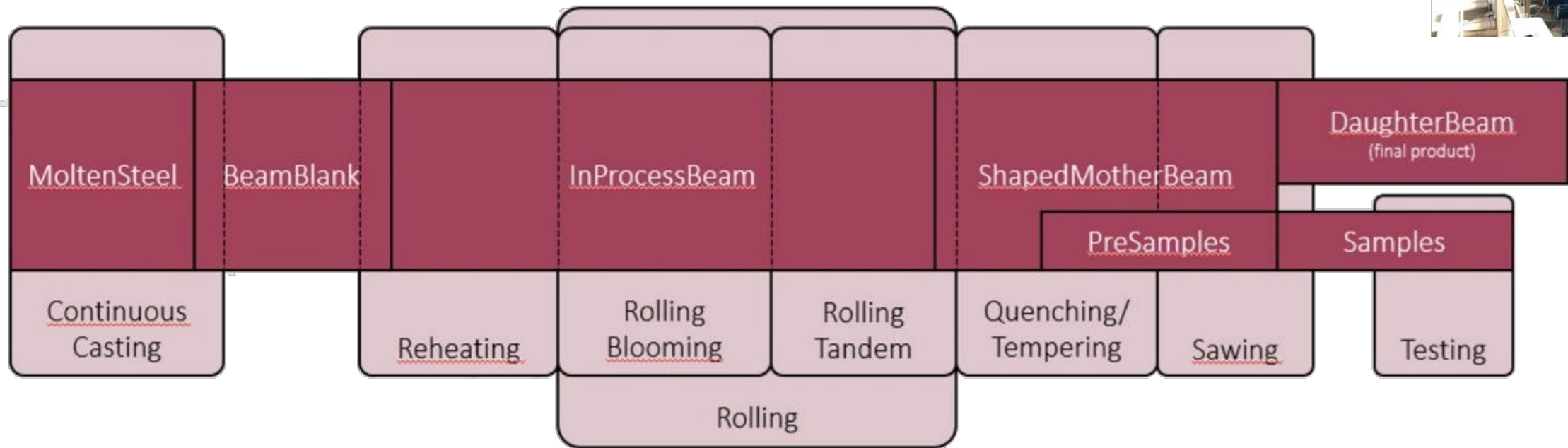
3) Analysis of the experimental (and modelling) data available within the client

4) Translation to (preferably more than one) workflow(s)

5) Propose to the client modelling executor(s) and strategy for model validation

6) Translation of the modelling results to information that is understandable and usable by the client

# Industrial Case



1) Good understanding of the business case

2) Good understanding of the industrial case

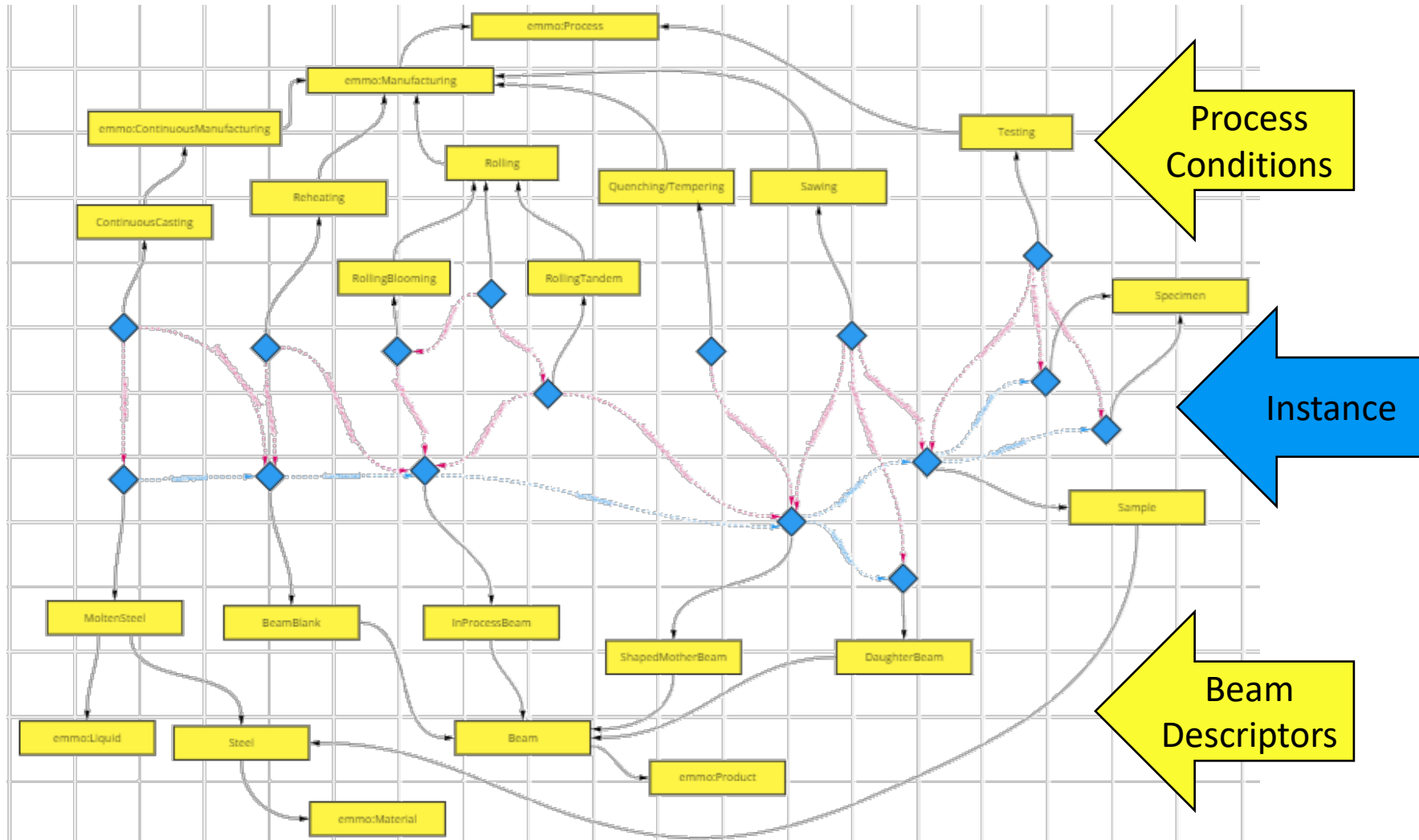
3) Analysis of the experimental (and modelling) data available within the client

4) Translation to (preferably more than one) workflow(s)

5) Propose to the client modelling executor(s) and strategy for model validation

6) Translation of the modelling results to information that is understandable and usable by the client

# EMMO Compliant Application Ontology

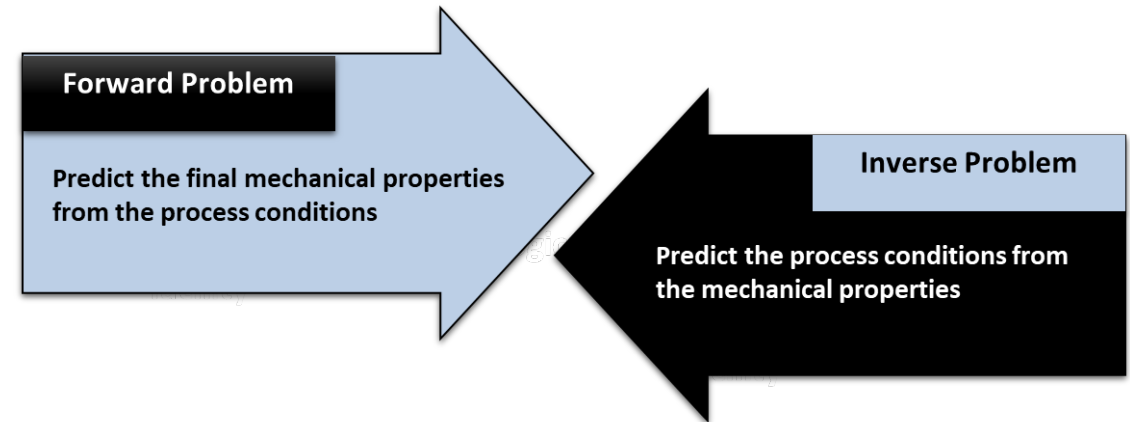


# Full EMMO description of industrial process

# The Challenge

APP4 interface designed to take into account both following problems:

- Predict the final mechanical properties of steel beams from the process conditions – Forward Problem
- Predict the process conditions from the mechanical properties – Inverse Problem



1) Good understanding of the business case

2) Good understanding of the industrial case

3) Analysis of the experimental (and modelling) data available within the client

4) Translation to (preferably more than one) workflow(s)

5) Propose to the client modelling executor(s) and strategy for model validation

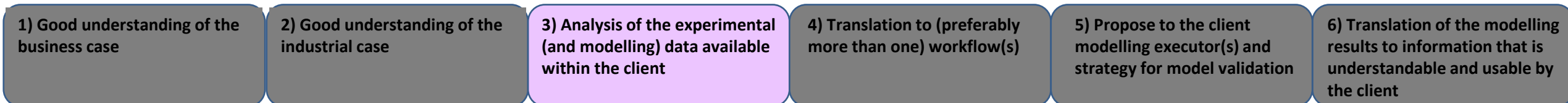
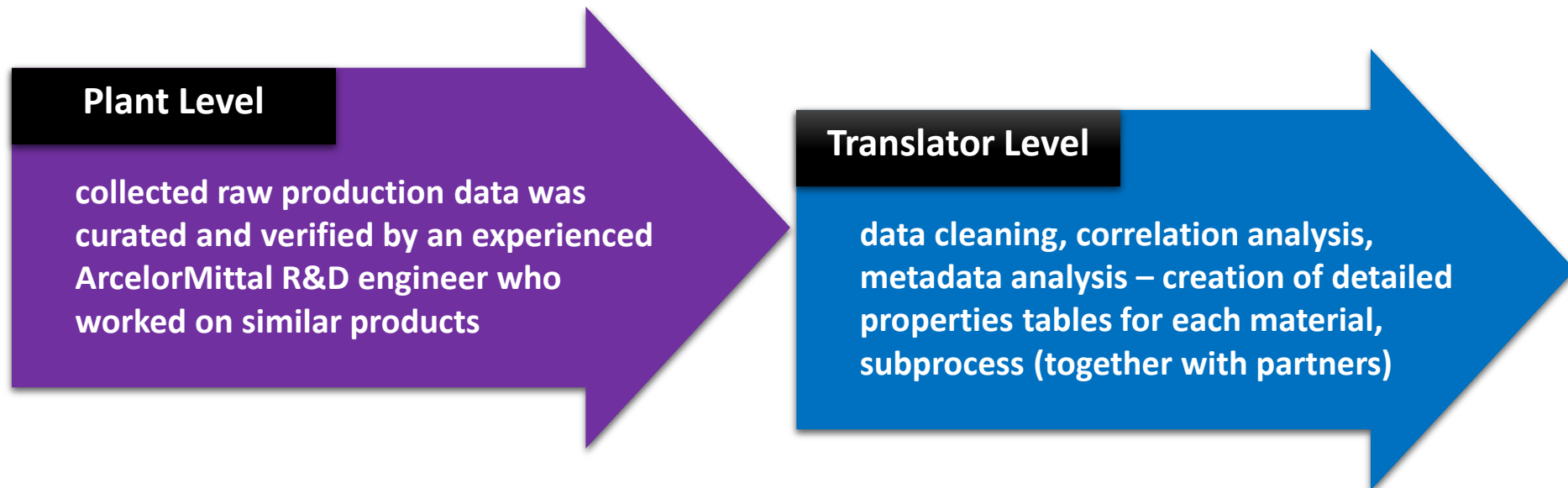
6) Translation of the modelling results to information that is understandable and usable by the client



# Data and Metadata Curation



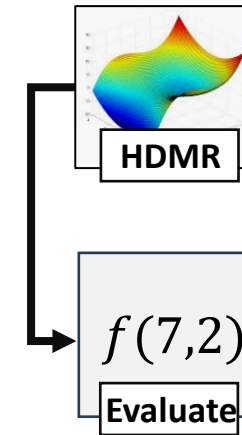
- Two-step curation process : Plant and Translator Level



# Forward Problem

Based on the previous steps, CMCL, the translator for this use case offers:

- The experimental data is used to generate a surrogate model where a fast-response surface is directly fitted based on the use case experimental data using the HDMR algorithm
- The used specifies a set of process conditions and the surrogate model is evaluated



1) Good understanding of the business case

2) Good understanding of the industrial case

3) Analysis of the experimental (and modelling) data available within the client

4) Translation to (preferably more than one) workflow(s)

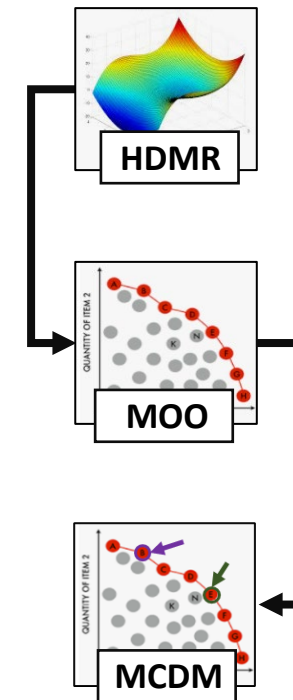
5) Propose to the client modelling executor(s) and strategy for model validation

6) Translation of the modelling results to information that is understandable and usable by the client

# Backward Problem

Based on the previous steps, CMCL, the translator for this use case offers:

- a Surrogate Model workflow where a fast-response surface is directly fitted based on the use case experimental data using the HDMR algorithm
- a Multi-Objective Optimisation workflow (MOO) to optimise the use case KPIs, taking as an input the fitted surrogate model from the previous step
- a Multi-Criteria Decision-Making workflow (MCDM), taking as an input the Pareto front points from the previous MOO step



1) Good understanding of the business case

2) Good understanding of the industrial case

3) Analysis of the experimental (and modelling) data available within the client

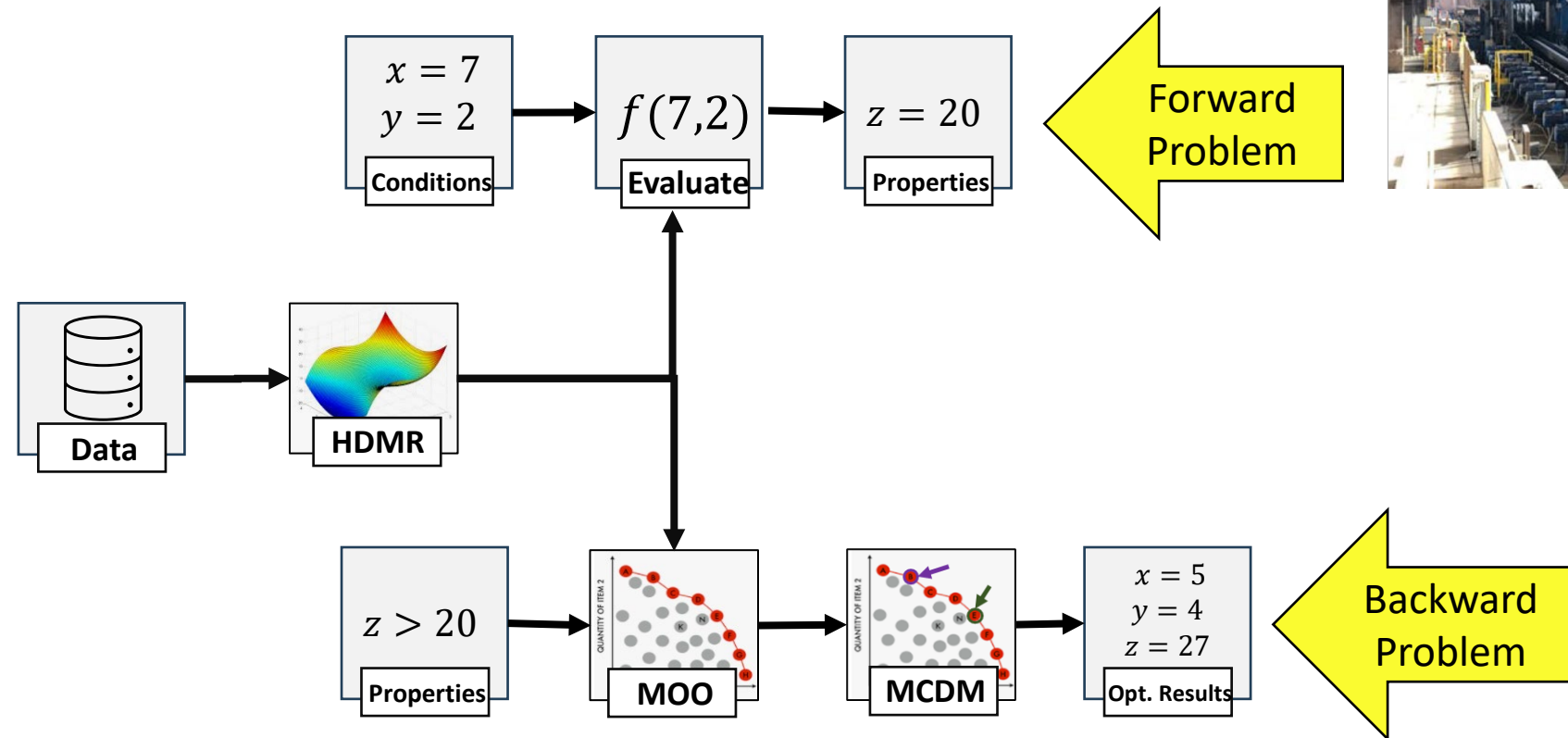
4) Translation to (preferably more than one) workflow(s)

5) Propose to the client modelling executor(s) and strategy for model validation

6) Translation of the modelling results to information that is understandable and usable by the client



# Process Model



1) Good understanding of the business case

2) Good understanding of the industrial case

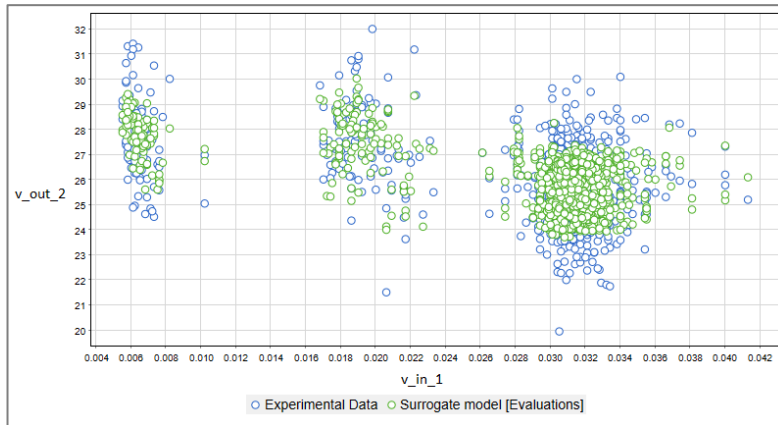
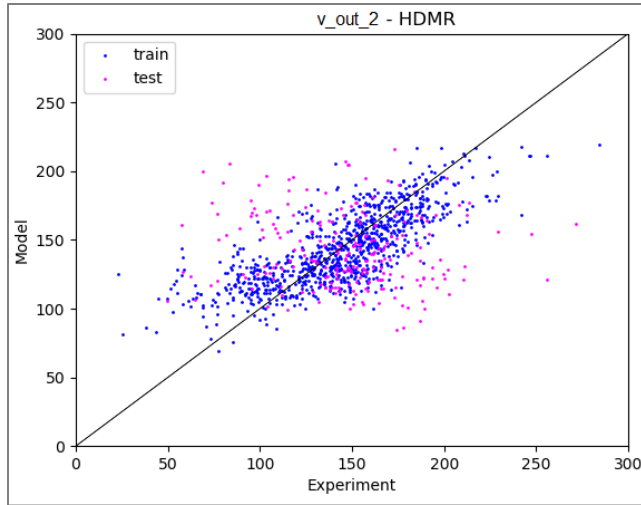
3) Analysis of the experimental (and modelling) data available within the client

4) Translation to (preferably more than one) workflow(s)

5) Propose to the client modelling executor(s) and strategy for model validation

6) Translation of the modelling results to information that is understandable and usable by the client

# Model Validation & Communication



- Theoretical: Cross-validation of results over a test set of experimental data which have not been used in the modelling phase
- Industrial: Perform experiments (in factory/lab) using the new information arising from modeling and optimization procedures

1) Good understanding of the business case

2) Good understanding of the industrial case

3) Analysis of the experimental (and modelling) data available within the client

4) Translation to (preferably more than one) workflow(s)

5) Propose to the client modelling executor(s) and strategy for model validation

6) Translation of the modelling results to information that is understandable and usable by the client

# MoDS Agent

- Model Development Suite from CMCL
- MoDS Agent is a REST API for the Model Development Suite.
- Different functionality being developed for both projects.



Name	Last commit message	Last commit date
..		
.m2	dev-simple-mods-agent: Created the beginnings of a basic templates ba...	last year
.vscode	711-modssimpleagent	
credentials	dev-simple-mods-age	
examples	711-modssimpleagent	
mods-simple-agent	711-modssimpleagent	
savesurrogates/example-surrogate/GenSurrogateAlg	711-modssimpleagent	
secrets	Configure for debuggi	
.dockerignore	Configure for debuggi	
.gitignore	711-modssimpleagent	
Dockerfile	711-modssimpleagent	
README.md	711-modssimpleagent	
docker-compose.debug.yml	711-modssimpleagent	
docker-compose.yml	711-modssimpleagent	
entrypoint.sh	Configure for debuggi	

This agent is able to access a limited amount of the functionality of the Model Development Suite (MoDS).

### Deployment

This agent is currently deployed at <https://kg.cmcinnovations.com/mods-agent>, however if you require local deployment you can follow the following instructions.

Login to the CMCL Docker registry using the following command.

```
docker login docker.cmcinnovations.com
```

To deploy the MoDS Simple Agent a `.lic` licence file is required to be placed in the `secrets` directory. Running the following command will spin up the MoDS Simple Agent at port `58085`.

```
docker compose up -d
```

### Usage

Example input files can be found in the `examples` directory. To submit a job via curl or a web browser use <https://kg.cmcinnovations.com/mods-agent/request> (remote on KG server) or <http://localhost:58085/request> (local), with a "query" parameter with a value (URL encoded if working through a browser) similar to these input files. For example click [here](#) to run a the job specified in the multi-objective optimisation with pregenerated surrogate example.

Some `SimulationType`'s will be returned the results of the simulation immediately in a JSON object.

- Multi-Criteria Decision Making (MCDM)
- Sensitivity Analysis (Sensitivity)

Others will return only return a the "jobID" and the "SimulationType" in a JSON object and run asynchronously.

- High-Dimensional Model Representation Surrogate Generation (HDMR)
- Surrogate Generation and Multi-Objective Optimisation (SGMO)
- Multi-Objective Optimisation with a pregenerated saved surrogate (MOOwily)
- Evaluation of a pregenerated saved surrogate (EvaluatE). The JSON object returned by this query (URL encoded if working through a browser) can then be passed as the "query" parameter to this URL <https://kg.cmcinnovations.com/mods-agent/output/request> (remote on KG server) or <http://localhost:58085/output/request> (local) to retrieve the results when the simulation is complete.

The MoDS Simple Agent supports the loading and saving of surrogates generated. In the examples an "example-surrogate" is loaded using "surrogateIsLoad": "example-surrogate". This field can be replaced with the "jobID" of a previous job where "savesurrogate": true.

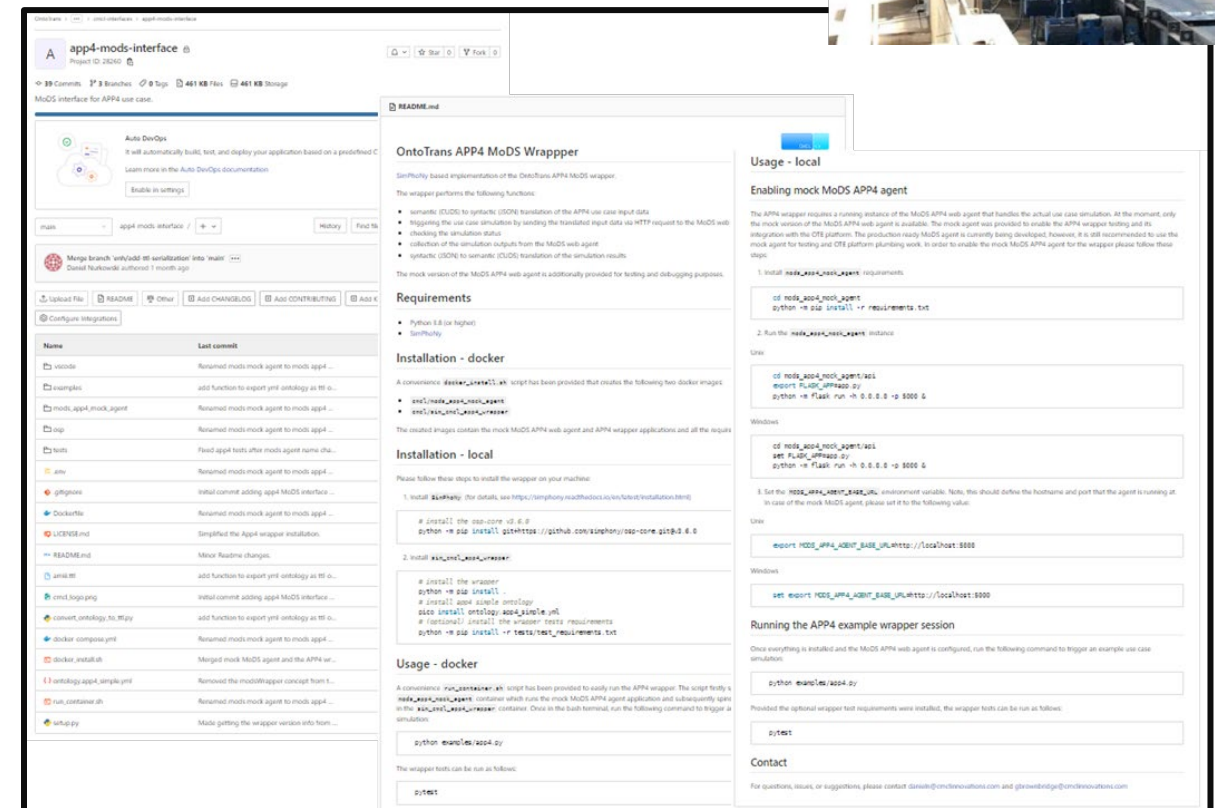
### Development

Add the following files to the `credentials` directory.

- `cmcl_repo_username.txt`: username for logging into container repo ([docker.cmcinnovations.com](https://kg.cmcinnovations.com))
- `cmcl_repo_password.txt`: password (or preferably token) for container repo ([docker.cmcinnovations.com](https://kg.cmcinnovations.com))
- `tw_repo_username.txt`: username for into TWA repo
- `tw_repo_password.txt`: password (or preferably token) for TWA repo

# APP4 Interface

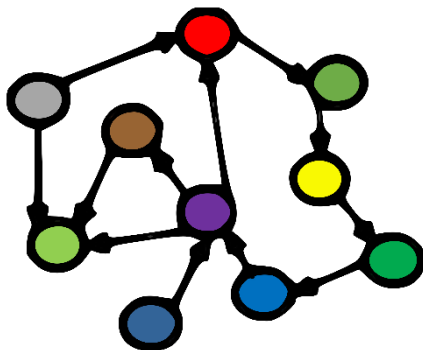
- The APP4 Interface beta version released on GitLab
- The interface built using the SimPhoNy-OSP
- Now supports forward and backward problem.
- The APP4 interface relies on the MoDS Agent to perform the necessary simulations.



# CUDS and DLite

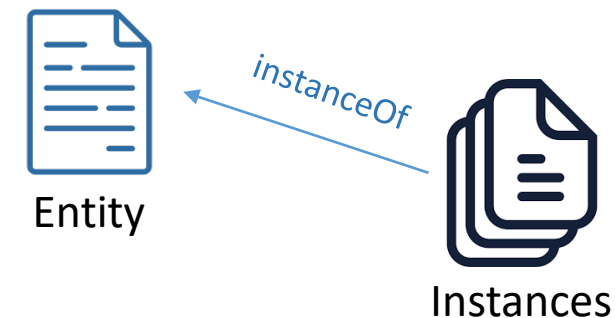
- CUDS

- data structure based on ontology
- CUDS is an ontology individual
- each CUDS object can be seen as a node in a graph
- a certain instance can be seen as a container of other instances



- DLite

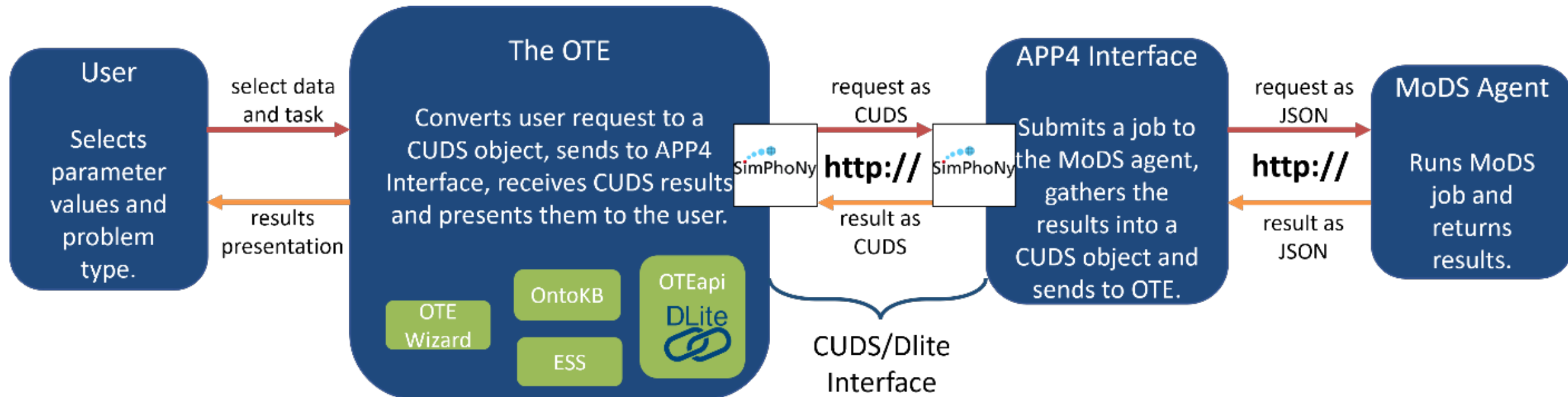
- data-centric framework for interoperability
- Separation between data and metadata
- DLite instances are described by data models
- Metadata schema: identity, description, dimensions, properties
- Semantics via mappings to ontologies





# Technical Workflow

- App Interface
- Ontology development
- UI design



# Advantage Brought by OntoTrans



- Complete ontological description of workflow:
  - Enhances understanding of industrial case.
  - Allows interoperability.
- Will allow users to explore the data themselves in a standardised way without needing any prior knowledge of any software or modelling techniques.
- Gives access to tools to post process and analyse data.
- Gives ability to expand on use case.