OWFgraph

A graph database for the off-shore wind farm domain

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EUROS Programme – Wind Farm Design Optimization – Uncertainty Model of Wind Farms

WESC 2017
27 June 2017

2.1 Wake description

The wake behind a turbine is assumed to have a start diameter equal to the turbine diameter, and to spread linearly as a function of downwind distance. This simplification means that the wake velocity cannot be found very accurately at all downwind positions, but by adjusting the spread angle to fit data at distances larger than about four diameters, only the calculation of the near-wake zone will involve large errors. As wind turbines are seldom put closer together than this distance, it is not necessary to make accurate calculations here.

Inside the wake the velocity is considered constant, instead of using the commonly seen Gaussian distribution. This simplification is made because the aim of the model is to give an estimate of the energy content in the wind field seen by the downwind turbines, rather than to describe the velocity field accurately.

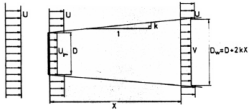

Fig. 2. Schematic view of wake description

With symbols defined in Fig. 2, a balance of momentum gives:

$$D^2U_r + (D_w^2 - D^2)U = D_w^2 V$$

The wake velocity is found by the expression

$$V/U = 1 - 2a/(1 + 2kX/D)^2 \quad ,$$

a is defined as the initial velocity deficit $1-U_r/U$ but can also be expressed as

$$a = (1 - \sqrt{1 - C_t})/2$$

where Ct is the thrust coefficient of the turbine. Hence, the velocity deficit of the wake at a given position X is:

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The problem of interacting wakes is solved by assuming the kinetic energy deficit of a mixed wake to be equal to the sum of the energy deficits for each wake at the calculated downwind position.

TUDelft

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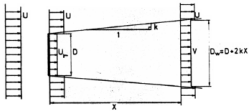

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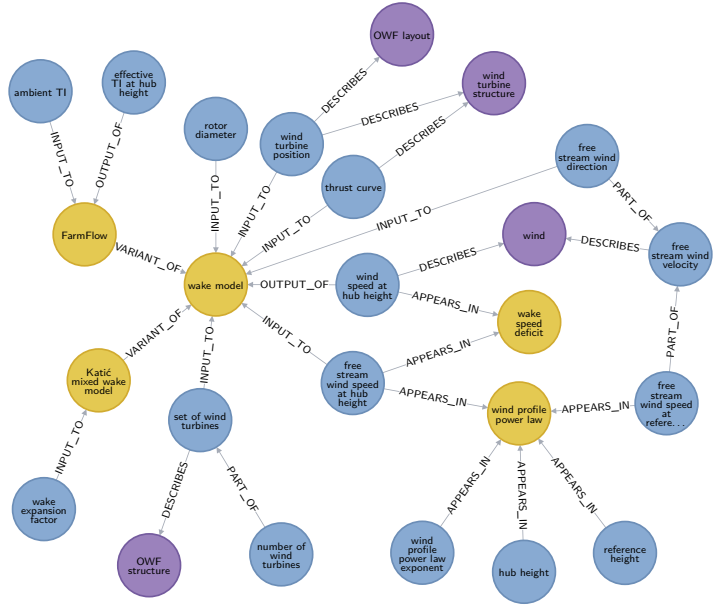

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Querying	How do we add and extract data?
Conclusions	What is different from what we expected? What are our plans for the future?

Goal – EUROS programme context

Project 3 Wind Farm Design Optimization

Work Package 3.2 Uncertainty Model of Wind Farms

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Challenge Develop a model for the accumulation of uncertainty from multiple sources in performance and cost of an entire OWF.

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⇒ Conclusion Create a structured description of the domain

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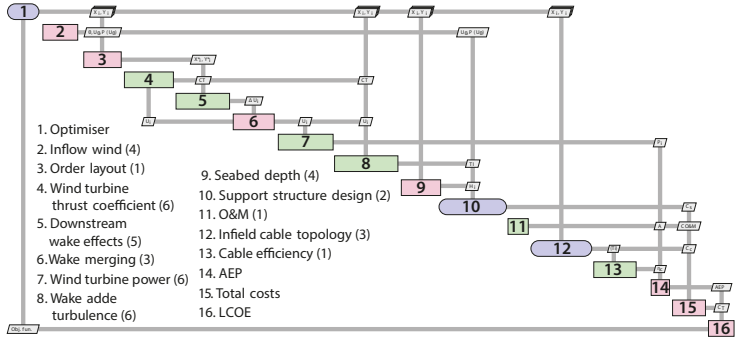
- Evaluation of multidisciplinary design analysis and optimization workflows (Sebastian's project)



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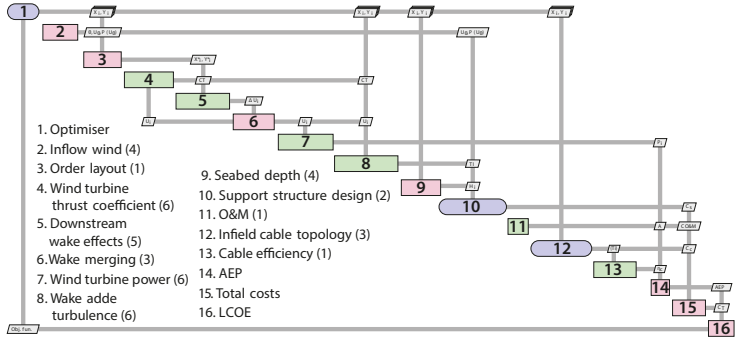

- Teaching:
  - domain exploration;
  - analysis of how different disciplines are coupled.
- . . .

Content

Content as node labels

support structure,
active yaw system,
rotor bearing,...

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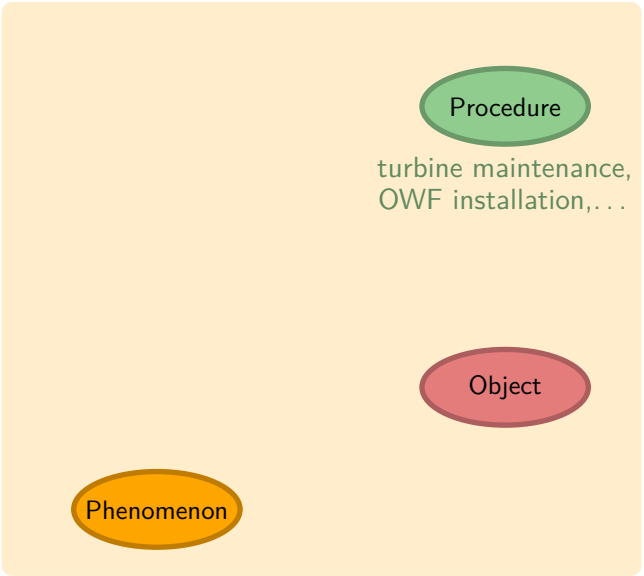
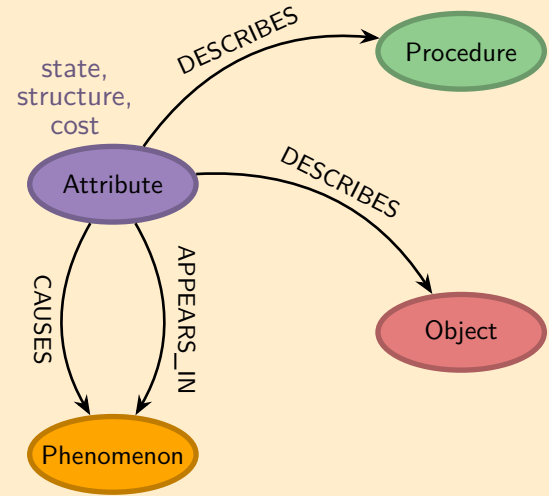


Content & its structure as edges and their type



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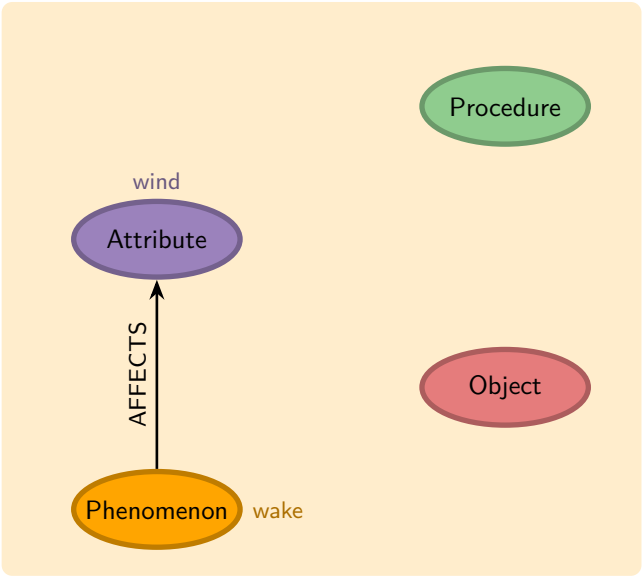

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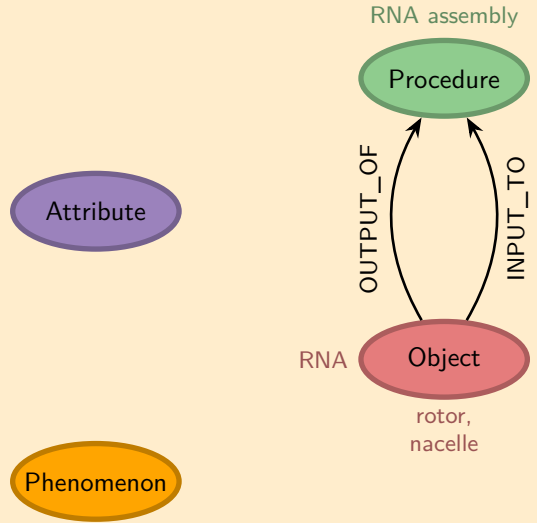

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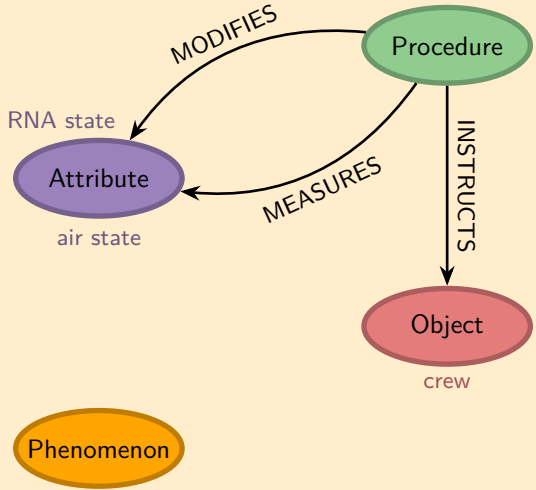

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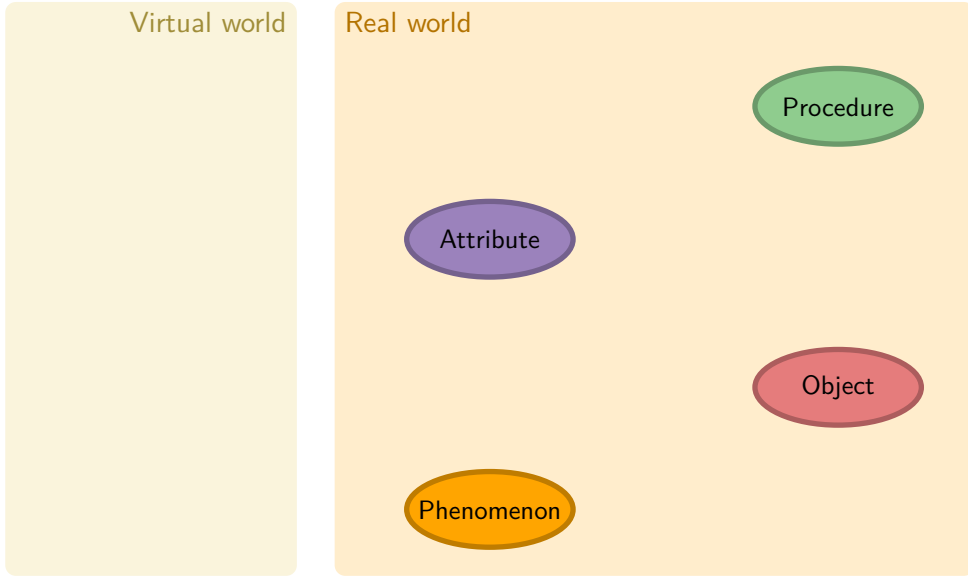

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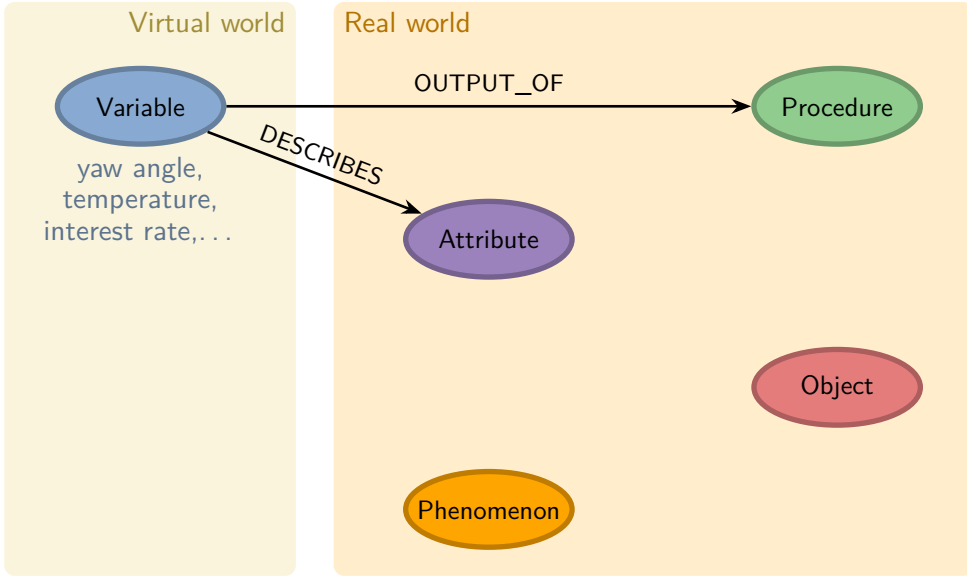

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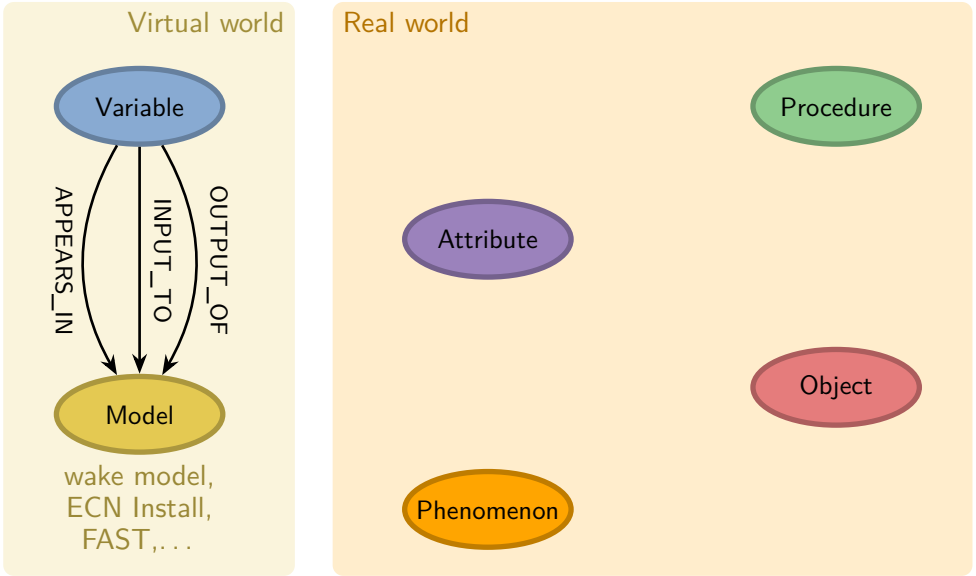

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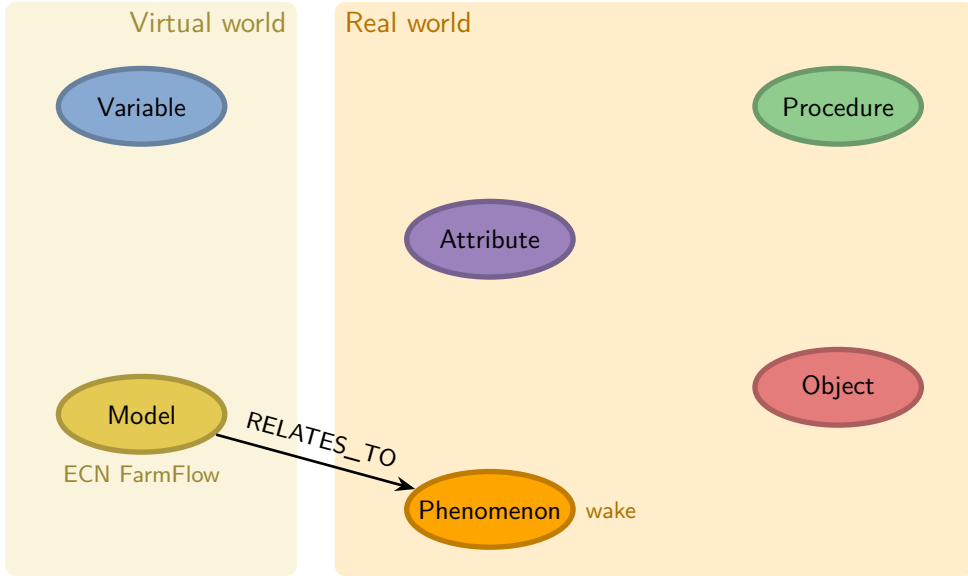

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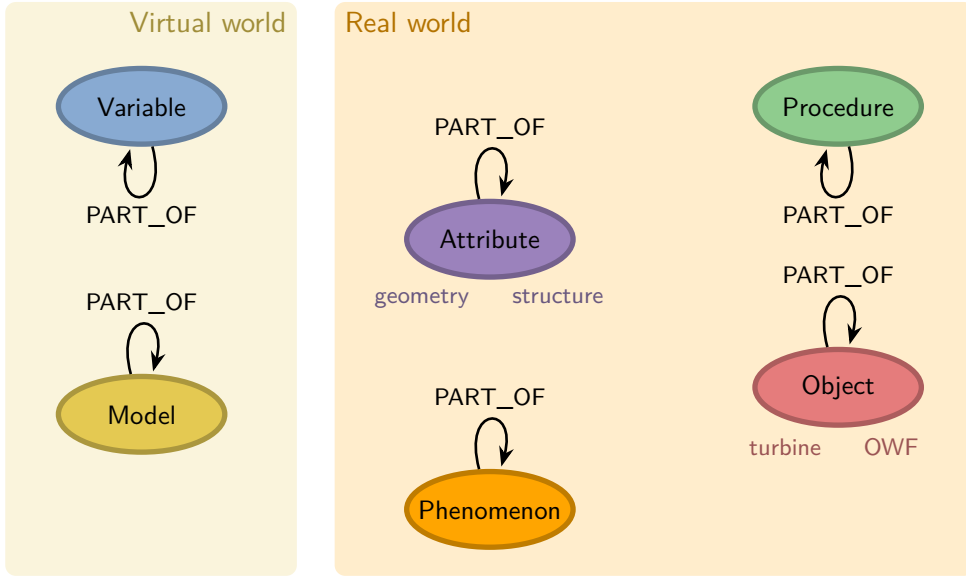

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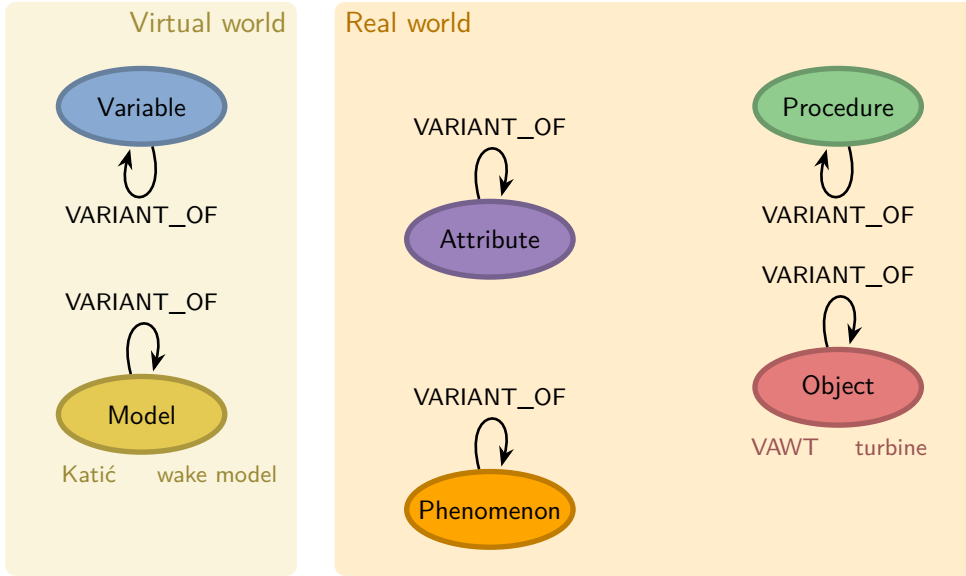
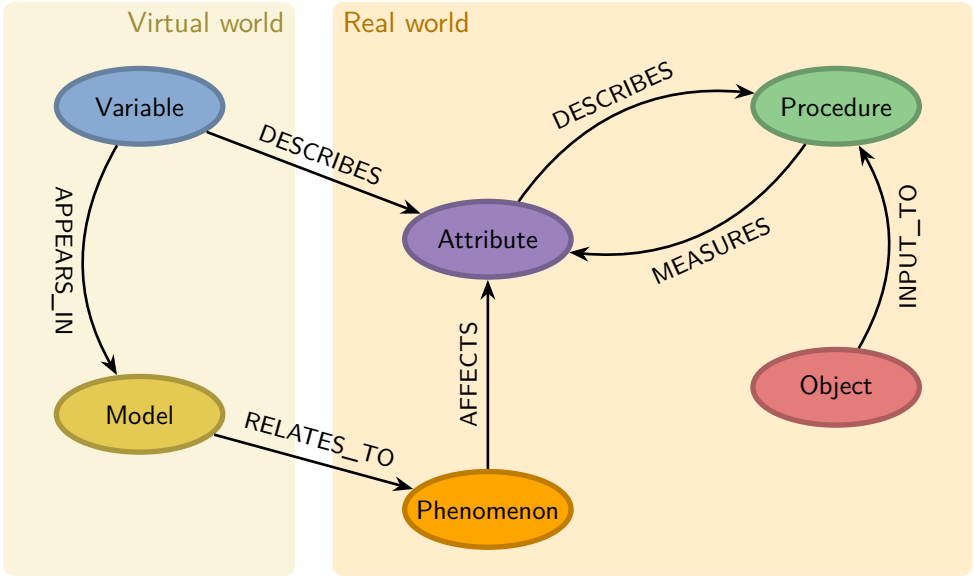
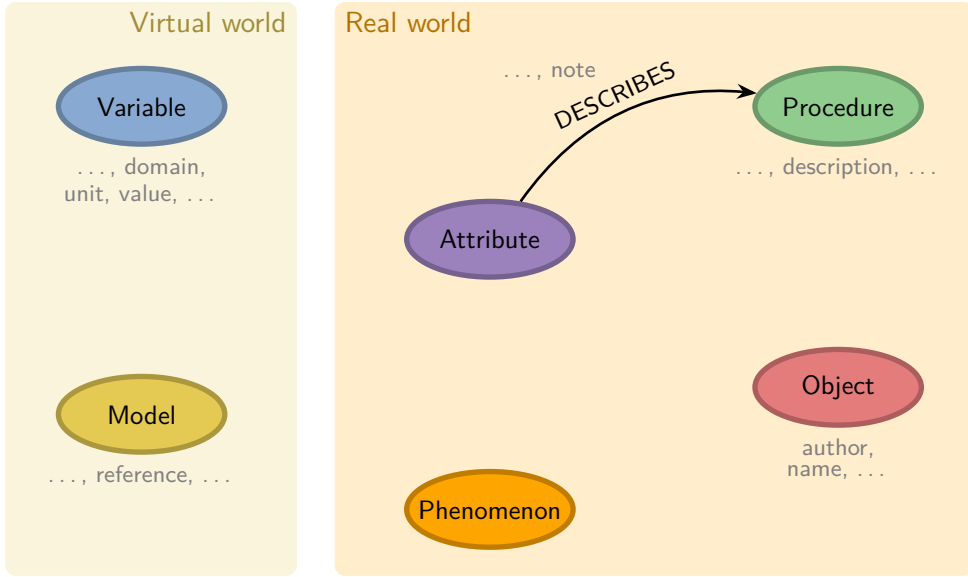


Content constrained by the foundational ontology



Content as node and edge properties



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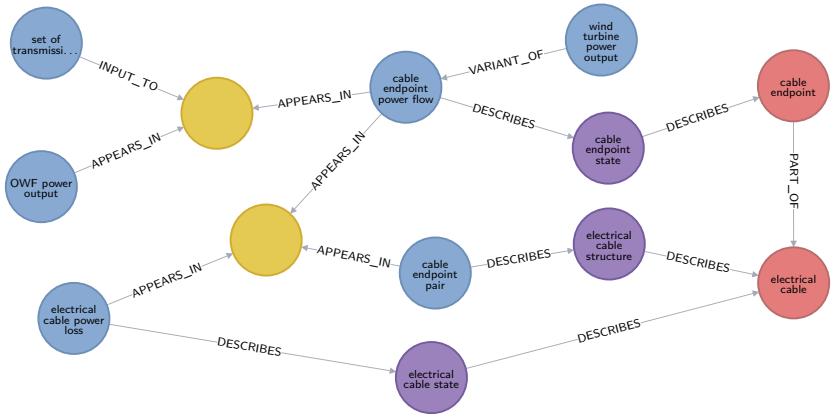

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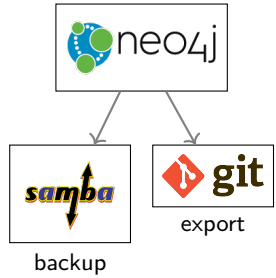

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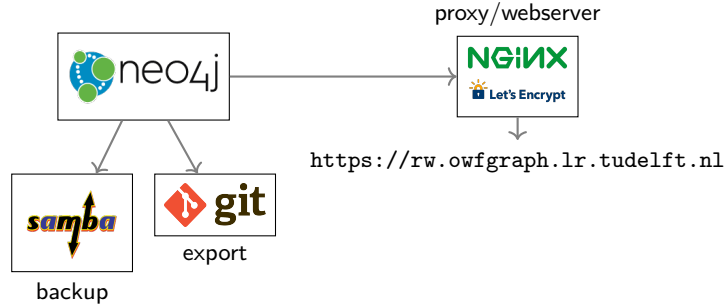

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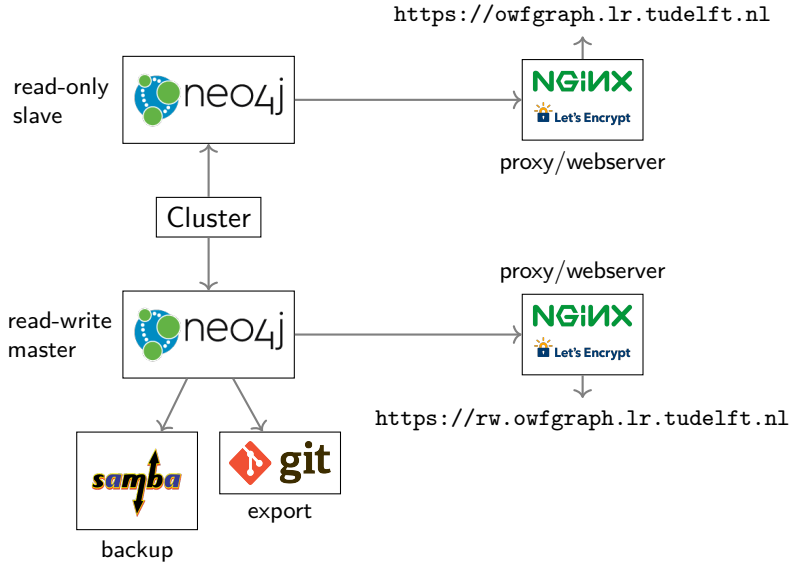

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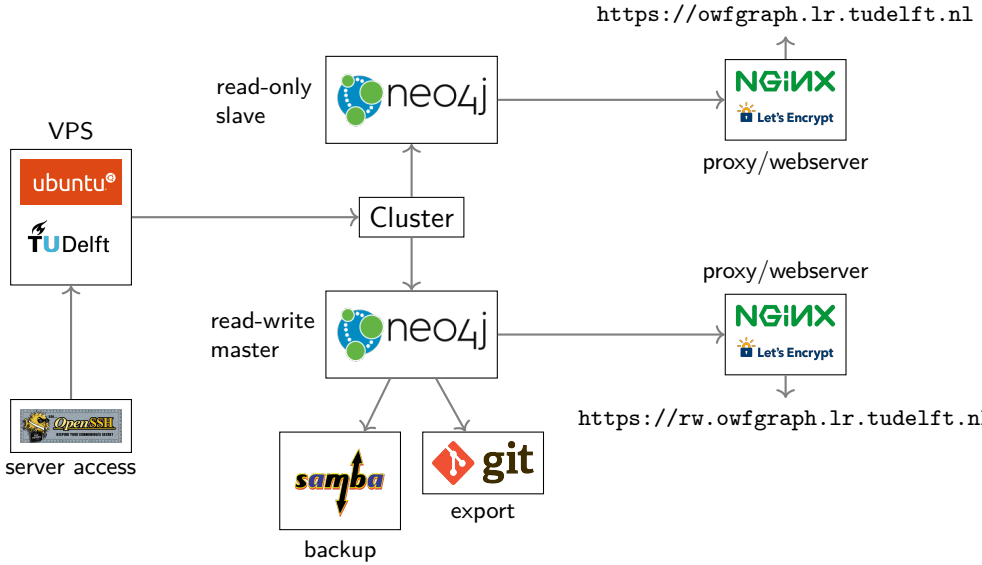

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match p = shortestPath((w:Variable)-[*0..6]-(f:Variable))
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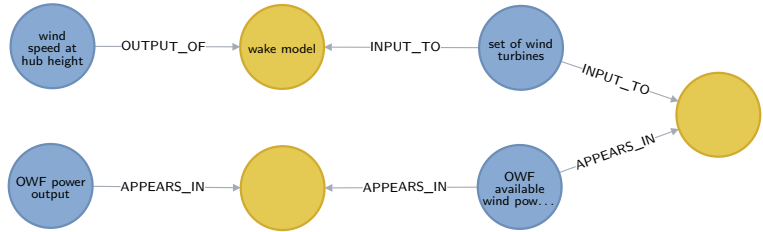

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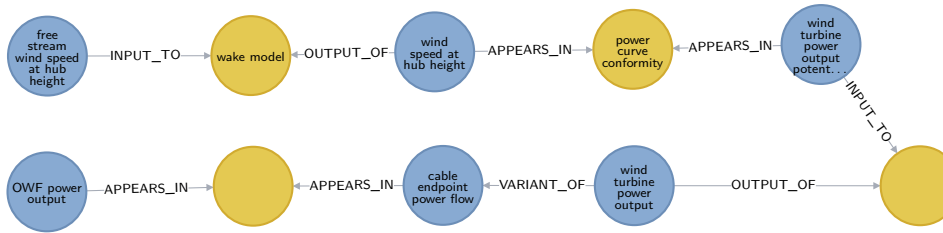

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But those are growing pains:
the knowledge base idea is feasible and our implementation works!

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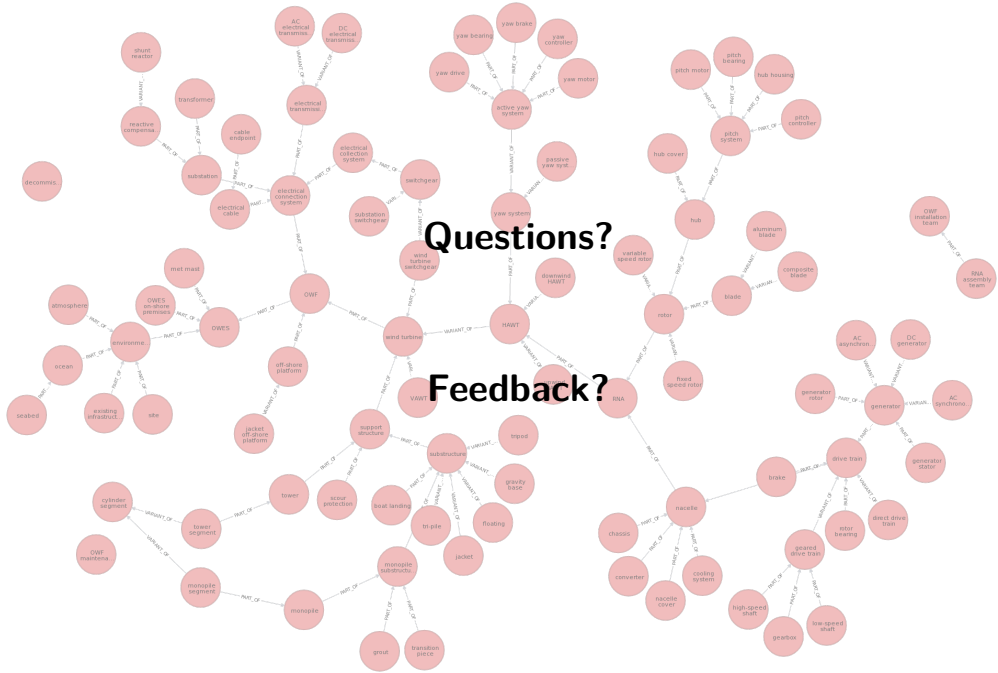
- Opening up the database.
  - Now: Read-only version semi-publicly available.
  - Next: get others involved in using and adding content.
    (Learning curve!)
  - Future: build a community to maintain and improve the database.



TUDelft

Live demo – Read-Only

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- Interface: command line at the top, output canvas below,
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- Table output:

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match (n:Object) with n limit 5
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- More involved queries:

```
match p = (:Object {name:"monopile"})-[*]->()
return p
```

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- Deleting nodes and edges:

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