Value of Modeling

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Focus of the presentation

The current presentation is not about numbers but rather about inspiration

and I hope,

it provides information for a deeper understanding of the topic,

rises new discussions

and

become the starting point for developing new approaches and ideas

Value is relative

A father, before he died, said to his son: “This is the watch your grandfather gave me and this is more than 200 years old. Before I give it to you go to the first watch shop you find, and ask how much they offer”

The son came back and said, "The watchmaker offers to pay $5 because it's old and has a lot of scratches..”

He then asked him to go to the coffee shop. The son went and after an hour, he came back and said: “The coffee shop owner offers $5, father.”

“Go to the museum and show that watch”. He went ahead and then came back happily. “They offered me a million for this piece.”

Moral of the story?

~~the modelling belongs in the museum~~

Understand the origins of the value

Understand who are the right stakeholders

What we will talk about

- The subject of interest - modeling
- Its value
- Analysis and Synthesis
- Discussing and verifying concepts – evolution of concepts
- Proving access to information and knowledge
- Code Generation

Let’s start with the Model – What is it?

Model is a system, which is studied to obtain information about another system

MODEL

Model is a representation of reality (mathematical, graphical, descriptive, …) designed to represent its certain aspects and allows us to answer the questions of study

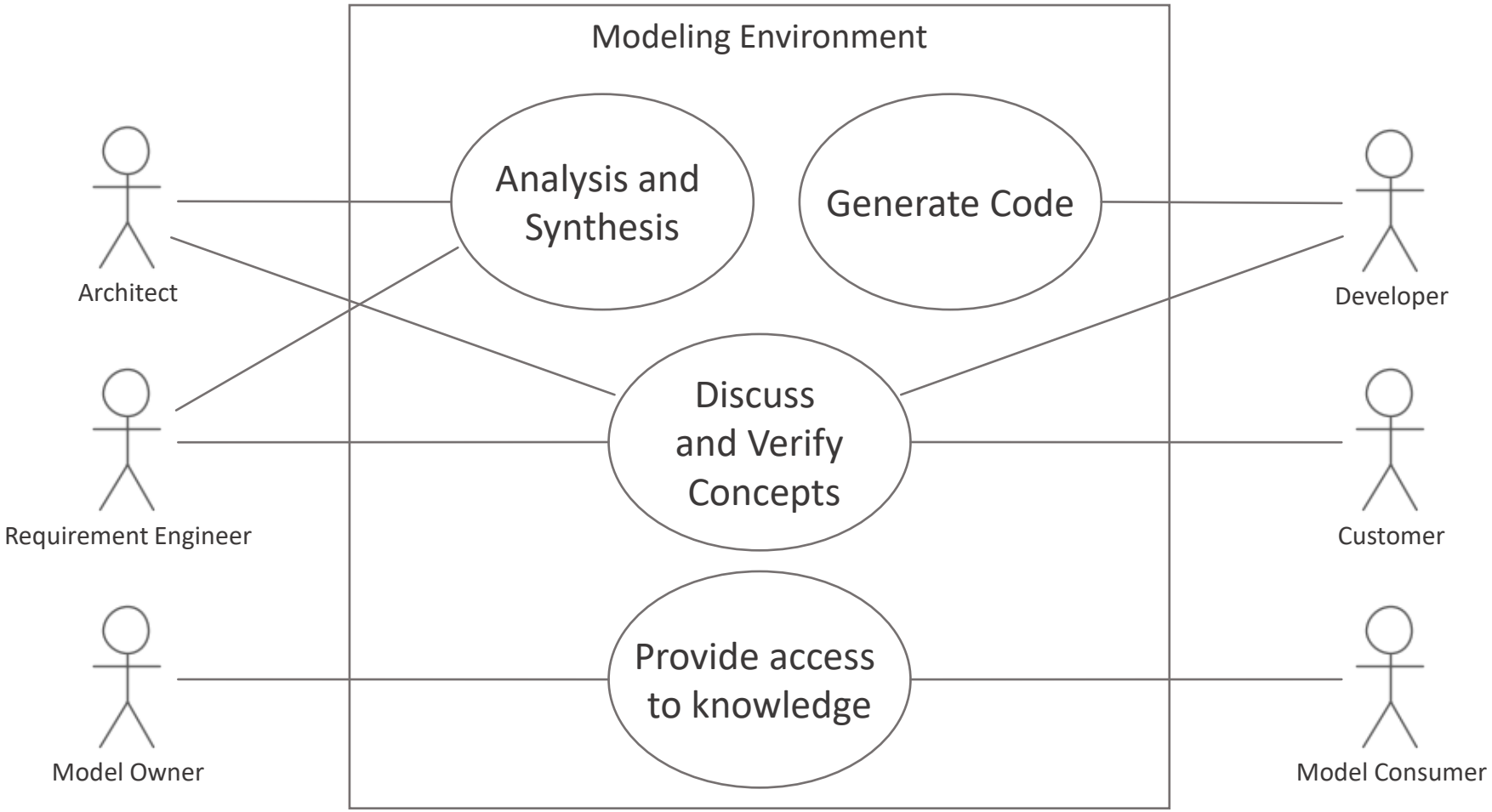
https://ru.wikipedia.org/wiki/%D0%9C%D0%BE%D0%B4%D0%B5%D0%BB%D1%8C
А. И. Уёмов Логические основы метода моделирования, М.: Мысль, 1971. — 311 с, с.48
Когаловский М. Р. и др. Глоссарий по информационному обществу / Под общ. ред. Ю. Е. Хохлова. — М., 2009. — 160 с.

Reasonable Model Qualities

- **Adequacy** – the conformity of the model to the real system, first of all under consideration its most important qualities, connections and characteristics. It is very difficult to estimate adequacy of a model at an initial stage in case of development of a new system. In such a situation - try to base on your previous modeling experience.
- **Accuracy** - the degree of matching the obtained modeling results process with the predetermined, desired system qualities. The important task here is to evaluate the required accuracy of the results and the available accuracy of desired qualities, aligning them among themselves and with the accuracy of the used model
- **Universality** – the applicability of the model to the analysis of several similar systems in one or more modes of operation.
- **Cost-effectiveness** - the accuracy of the results and the generality of the solution of the problem should be related to the cost of modeling. And the successful choice of the model, as practice shows, is the result of a compromise between the invested resources and the model capabilities.

https://ru.wikipedia.org/wiki/%D0%9C%D0%BE%D0%B4%D0%B5%D0%BB%D1%8C

My thesis – there are only 4 use cases of modeling



The Trick – I used modeling method to understand the value of modeling :-)

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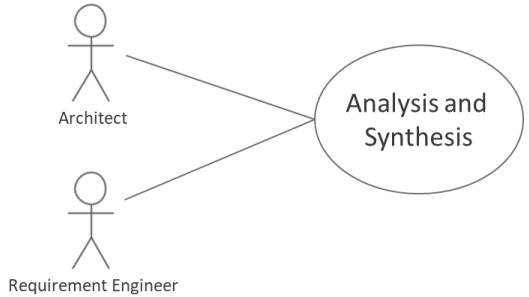
What about Model Simulation?

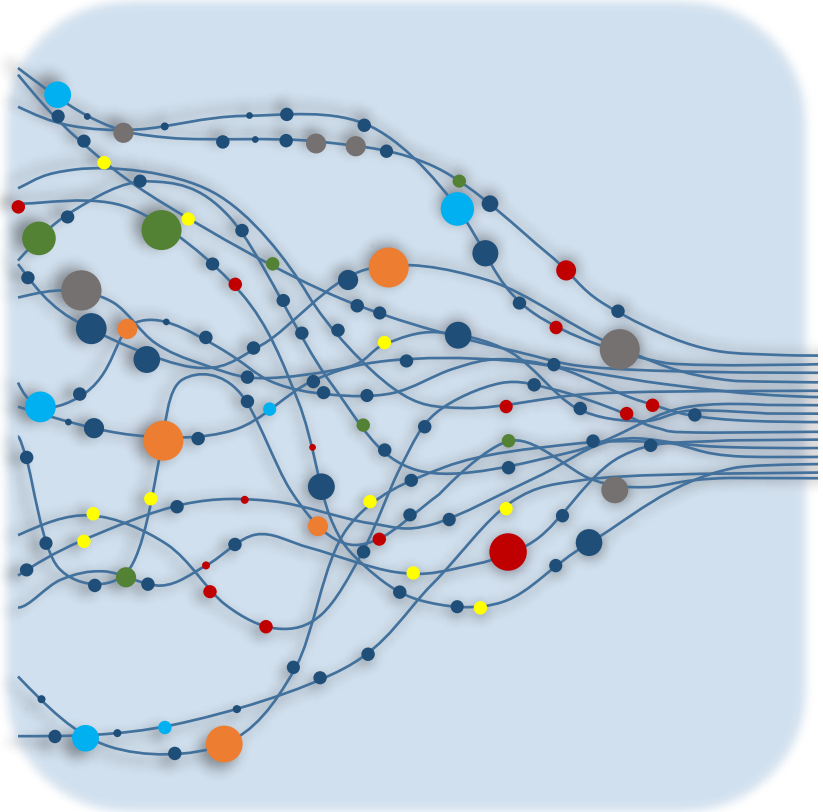
- Is not a separate use case, but rather it provides added value for other use cases
- Simulation shorts the feedback loop while modeling or model studying and thus improves the learning effect

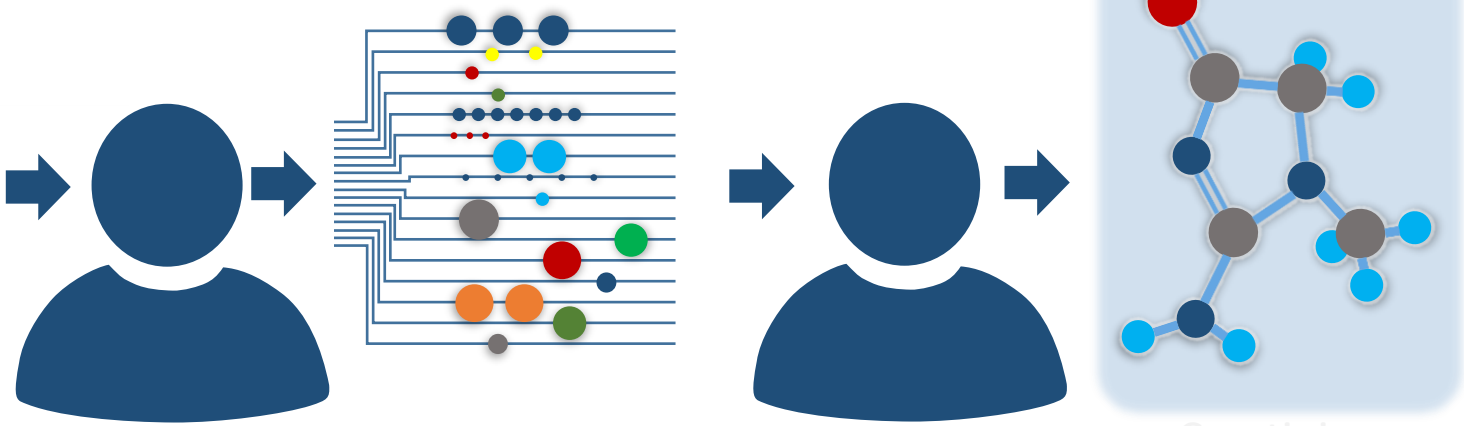
Analysis and Synthesis



Analysis

1. Decompose the object of interest into mostly elementary parts
2. Study the elementary parts – their properties and functions in isolation
3. Describe the object as the sum of properties and functions of its parts





Synthesis

1. Compose the parts (its qualities, properties, relations) identified during the analysis into a concrete system
2. Recreate the general properties of the object of interest

Analysis and Synthesis should be a part of every well developed model

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Examples of Analysis and Synthesis

- Requirements analysis
  - Derive system requirements from the customer requirements
  - Split system requirements into sub-system requirements
  - Split until lowest level has been reached
- System decomposition
  - Decompose the system into sub-systems, components, services, etc.
  - Define their properties/qualities, interfaces, etc.
- Process and activity analysis
- Many activities of an architect are about synthesis
  - E.g. using IBD SysML diagrams

Limitation of Using Analysis only

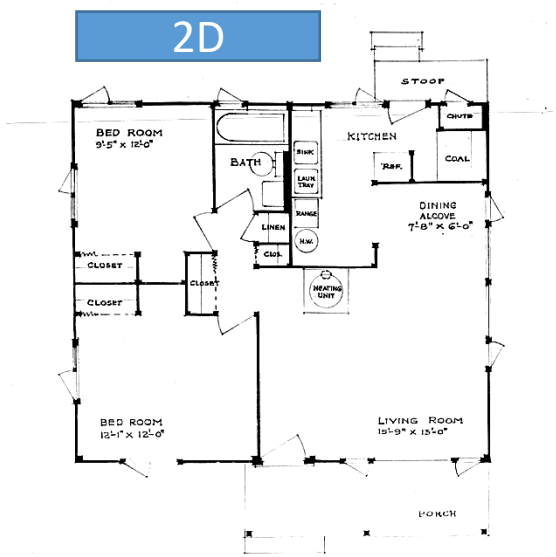
- Problem – the context and the relationships between parts are get lost
- Works well in case of low interconnectivity and interdependency between the elements within the system's context
- Examples with high interconnectivity and interdependency
  - complex technical systems, eco systems, complex networks, social systems
- They are described primarily by the relations between the elements and not by the properties of elements
- Safety is global property and cannot be reached by just combination of safe components

➢ The context for the object-of-interest is required - Analysis-by-Synthesis is required

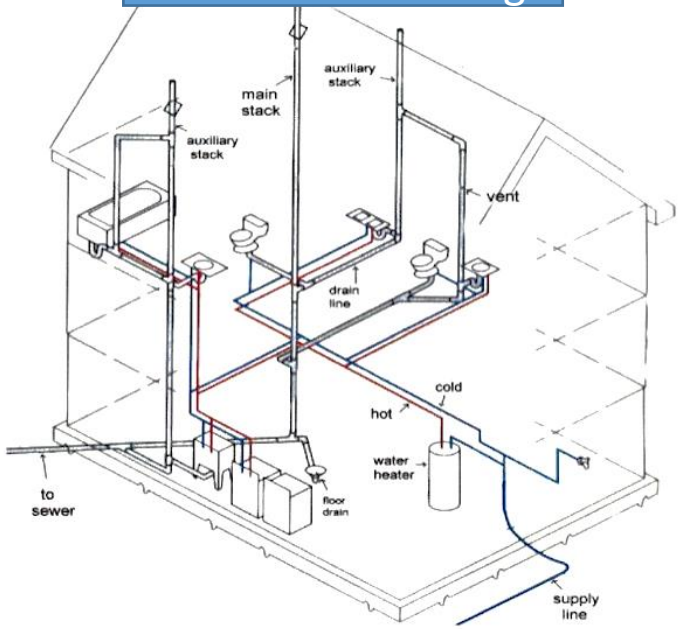
Limitation of Analysis only

3D

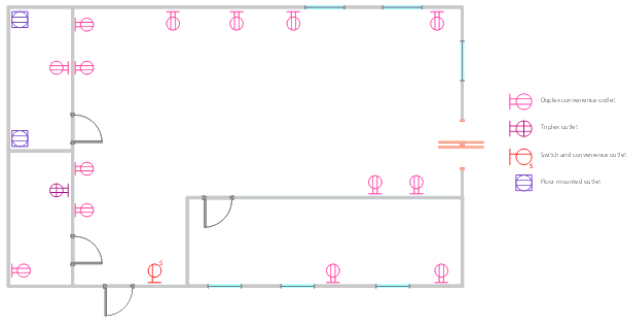
2D



Water and Heating



Electrical



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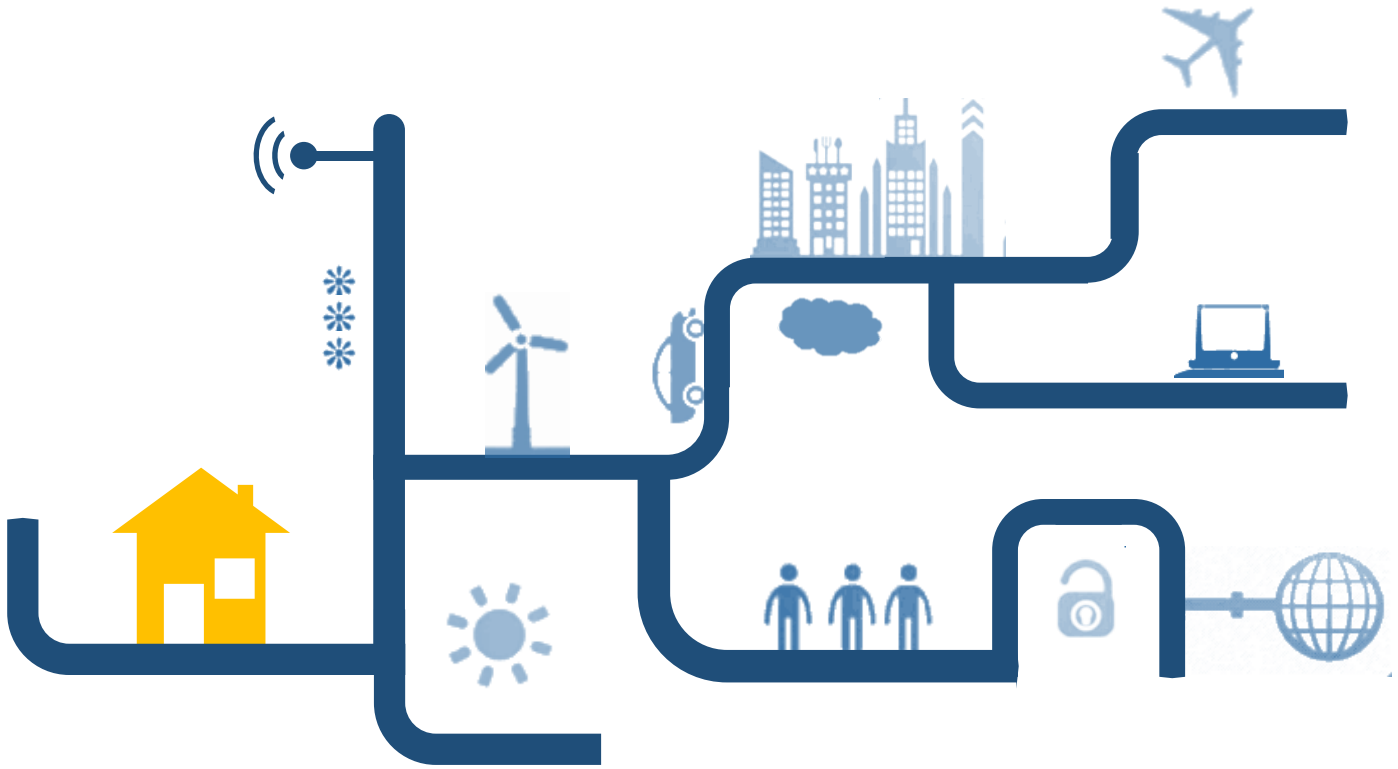
Analysis-by-Synthesis

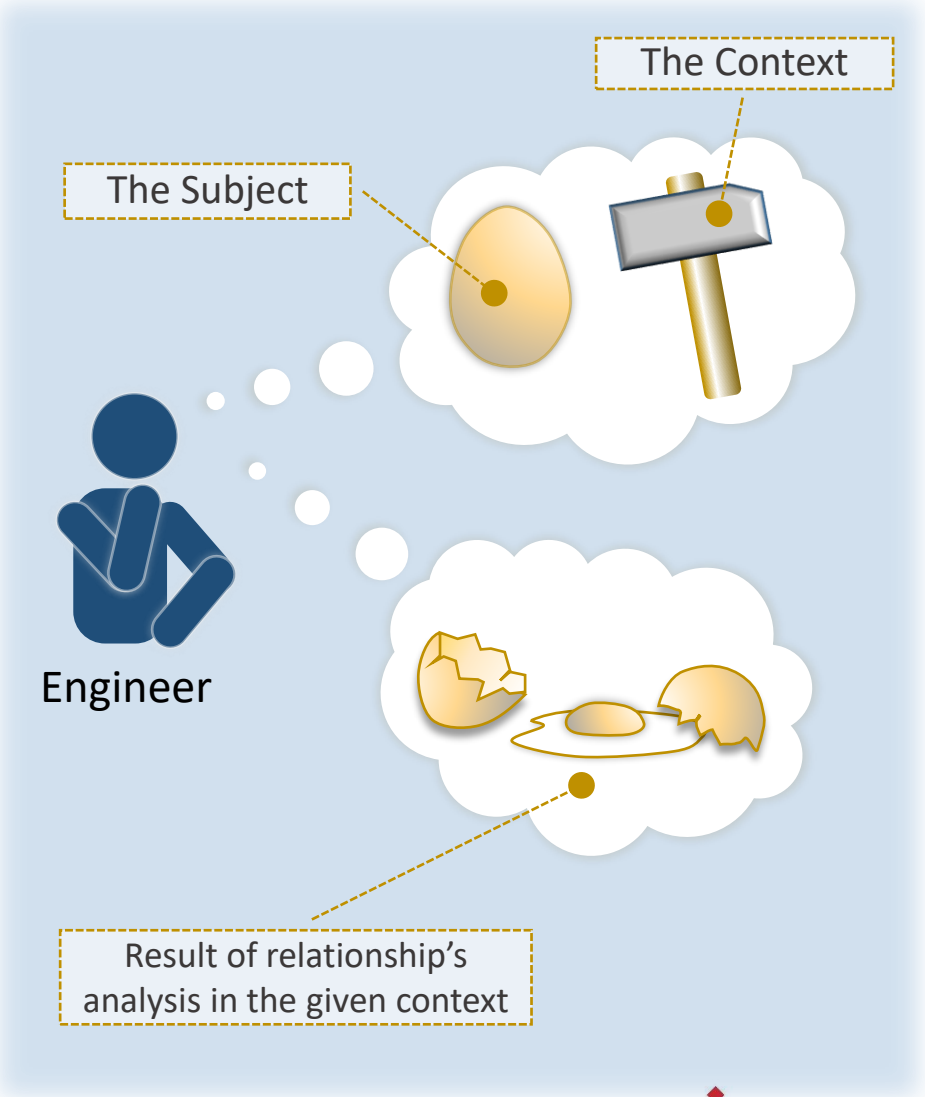
- Put your object of interest in its context
- If we don’t understand the context, we’ll walk in cycles and simply react on existing solutions.



Analysis-by-Synthesis – most native way for an engineer?

Analysis-by-Synthesis plays an important role in the engineering process. We discover new generalized properties of an object (i.e. performs its analysis) by synthesis-act – putting the **object of interest** in a specific context, followed by the analysis of the relationships in the context.

For example, in order to determine whether a material is fragile, a person must mentally or really perform its interaction with other materials.



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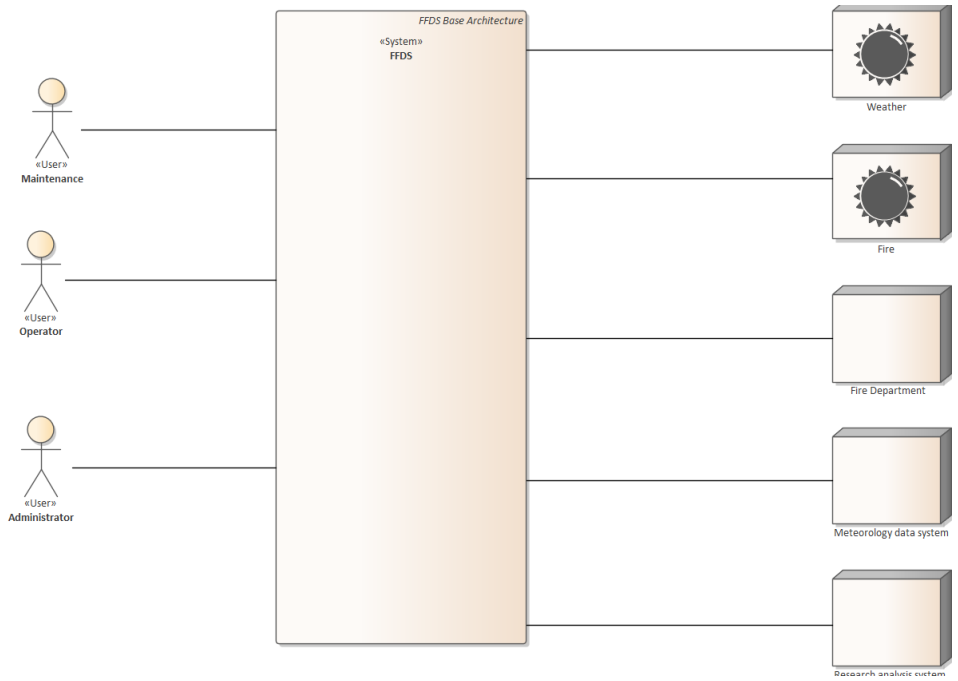
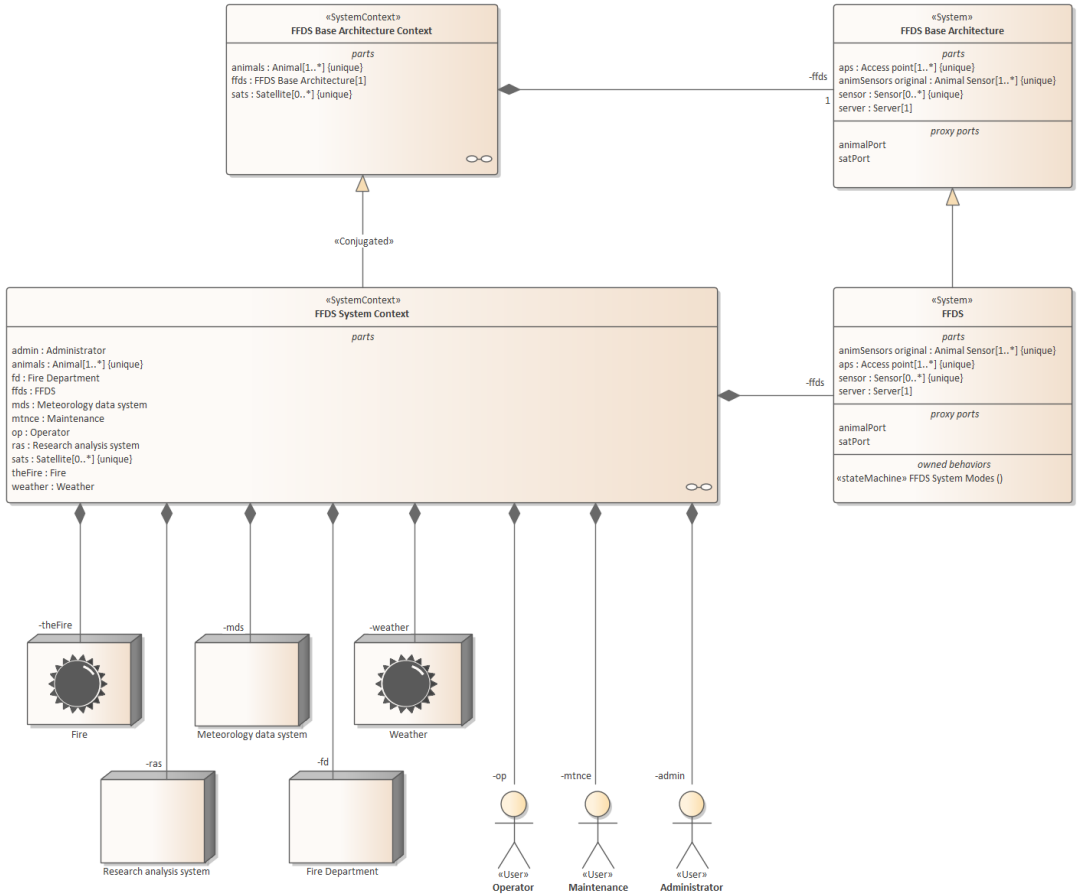
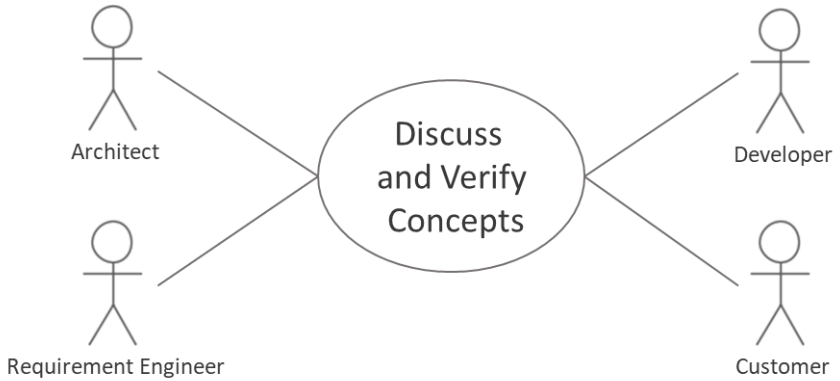
SYSMOD Example of a Context Diagram





Discussing and Verifying Concepts

- If you want to share, discuss and verify your ideas, you need a language
- In particular – a modeling language
- What was the reason for developing human language from evolution point of view?
- What was the advantage over other species humans got?
- What is the value?
- This is not a trivial question
- Just for communication?



Evolution is the key

- Evolution on the hardware level
- Evolution on the software level - We call it learning
- Evolution in the ~~cloud~~ crowd - better 5 people work on a concept 1 day than one person for 5 days
- Science as the driver of evolution of ideas

Evolution of hardware and software

Evolution of a concept

1776	1856	1868	1870	1920	1924	1952	1965	1971
Only white land-owning men	All white men at least 21 years old	Citizenship possible for black Americans, but not right to vote	Preventing denying right to vote based on race	Right to vote for women. Citizenship for many minorities is still denied	Citizenship for Native Americans, but not in all states right to vote	Citizenship and right to vote for Asian Americans	Removing discrimination kept many people of color from voting	Voting age is lowered from 21 to 18

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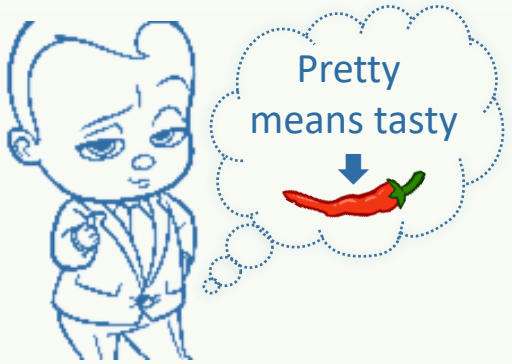
Every baby knows the SCIENTIFIC METHOD – EVOLUTION OF IDEAS

1 *Make an observation*

2 *Form a hypothesis*



3 Perform the experiment

4 Analyze the data

5 Report your findings

6 Invite others to reproduce the results

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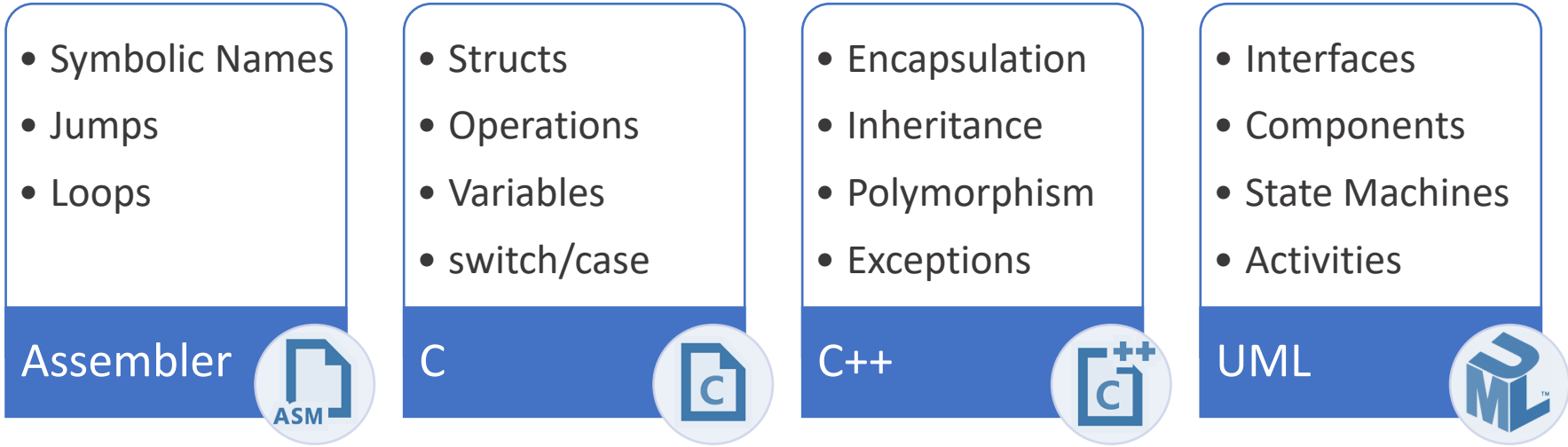
Modeling Language brings a higher Level of Abstraction

- Where is the Abstraction Level coming from?
- From concepts realized by the language!



- First, we need to introduce a word for a concept, before we can start talk about it
- As soon as the word is introduced, other people can participate in concept development

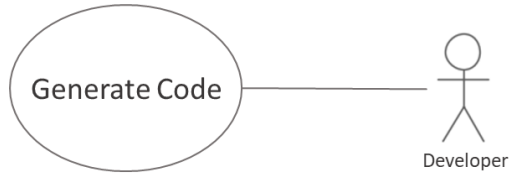
Extendable Modeling Language

- DSL is very powerful tool in developing new concepts and for communication
- My Thesis - UML is still alive, because it supports profiles and can be adapted for a specific domain / problem

Agile Development, etc.

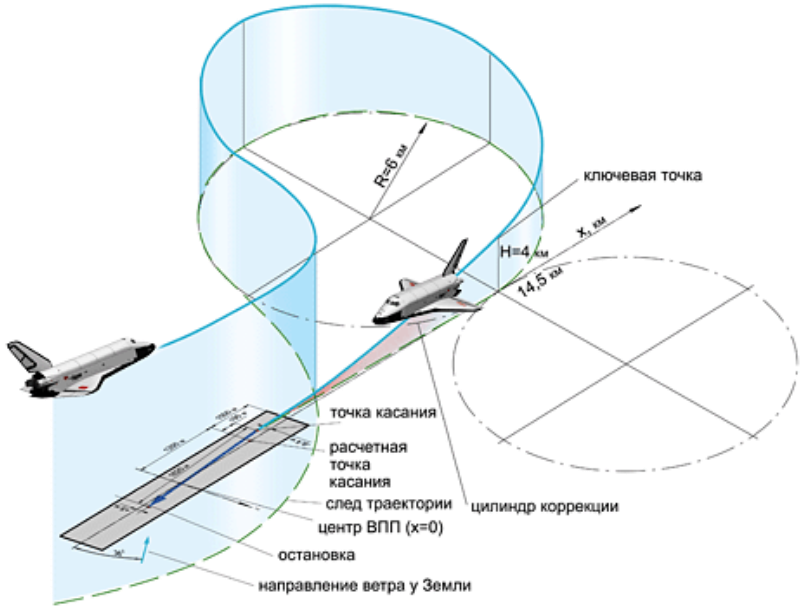
- Why agile methods are so popular?
- My thesis: because they are focusing on shorten of learning loop and improving learning in a group
- If your development process / methodology is not improving that – it's not effective from evolutionary point of view

Code Generation



- Due to lack of programming resources Soviet Union developed graphical programming languages (e.g DRAKON, SIPROL) to encrease productivity
- Result – autonomous operating spacecraft like Buran or **Sea Launch** (multinational spacecraft launch service)

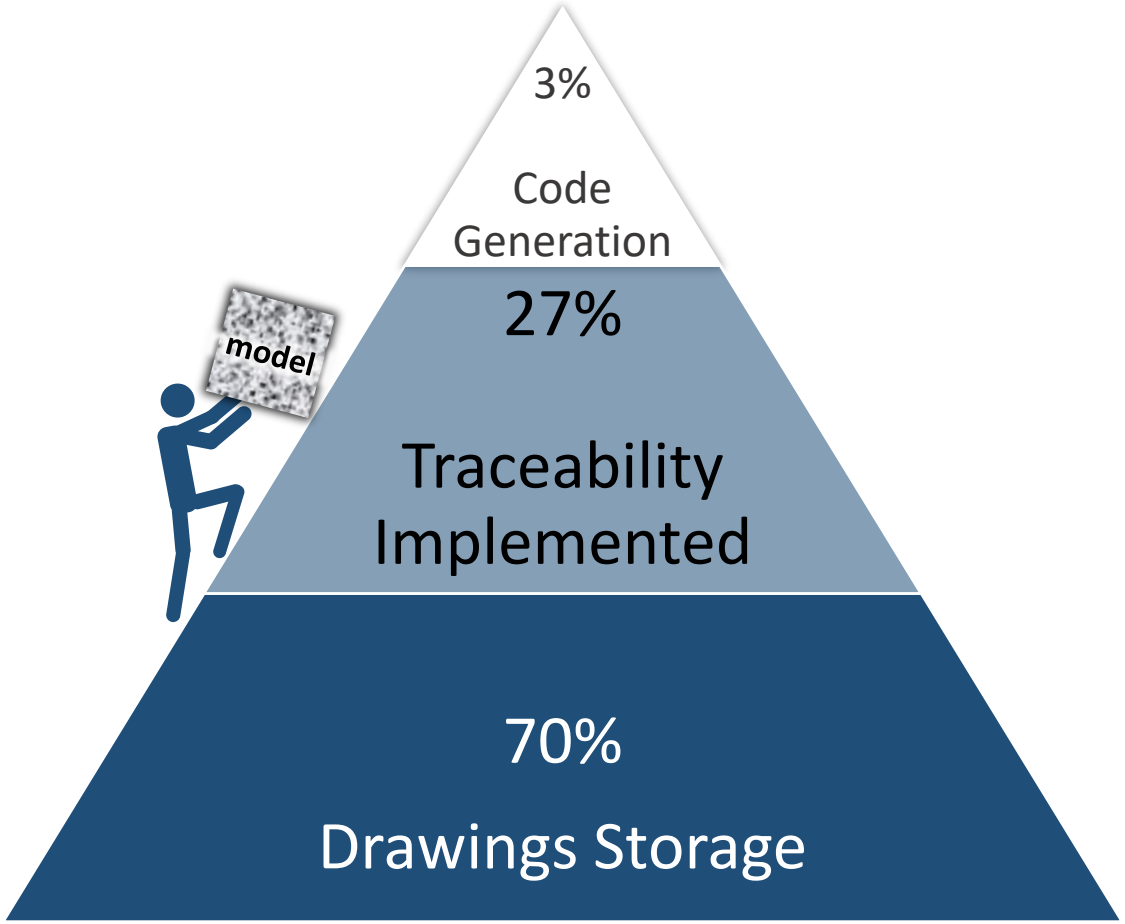
Sea Launch - launch platform Ocean Odyssey

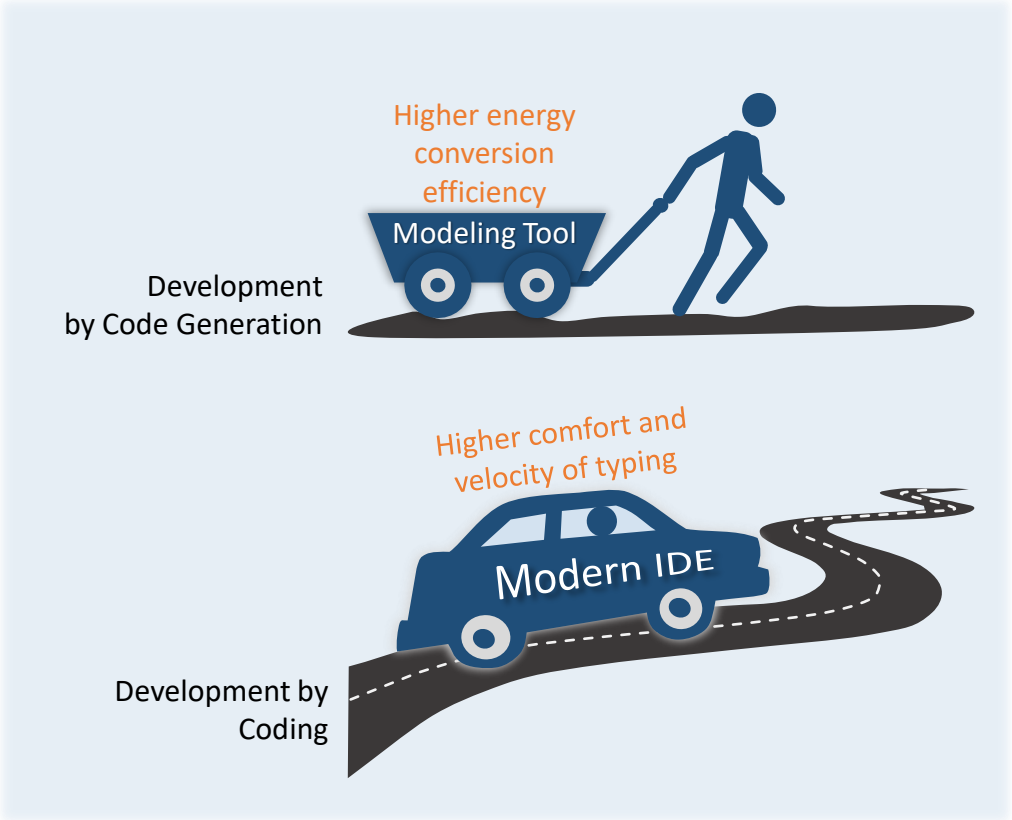


Buran space shuttle - 15 November 1988 completely automatic calculated and performed landing. Under the given conditions it was the most correct decision of the ship's on-board computers.

https://en.wikipedia.org/wiki/DRAKON ; https://m.habr.com/ru/post/86876/ ; https://en.wikipedia.org/wiki/Sea_Launch

Pyramidal World of Models





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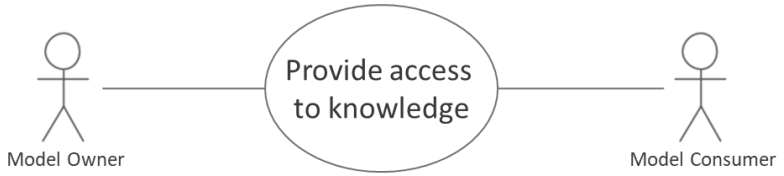
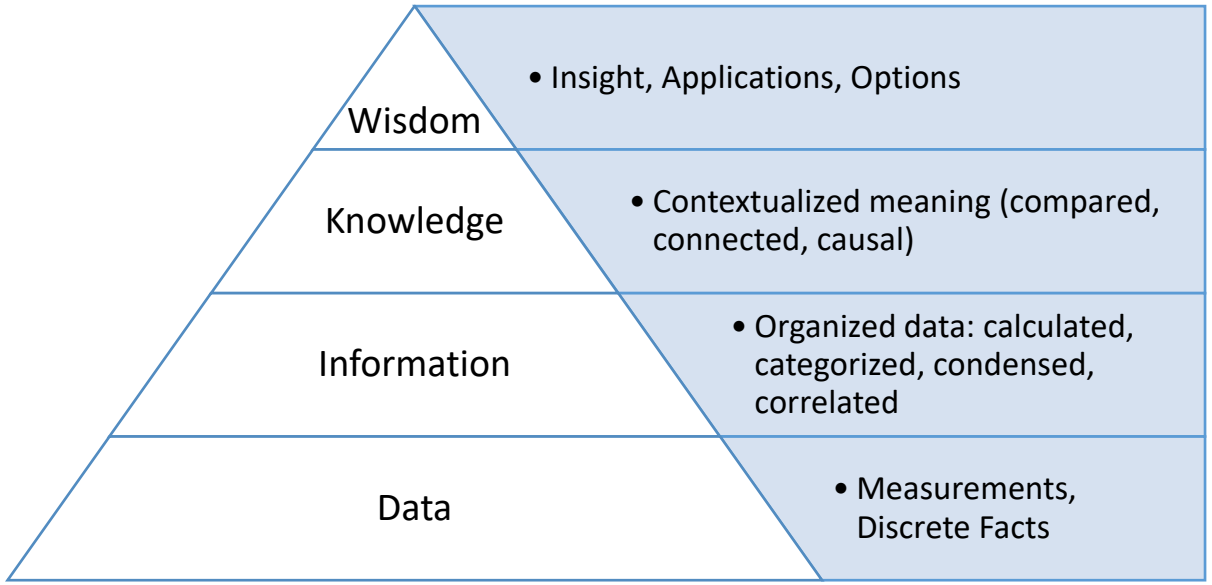
Provide Access to Knowledge



What is knowledge?

Vision of Google
Organize the world's information and make it universally accessible and useful

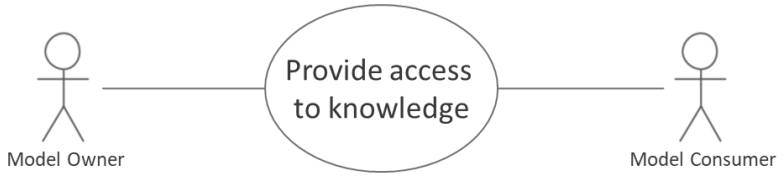
DIKW Pyramid



Knowledge without context is nothing

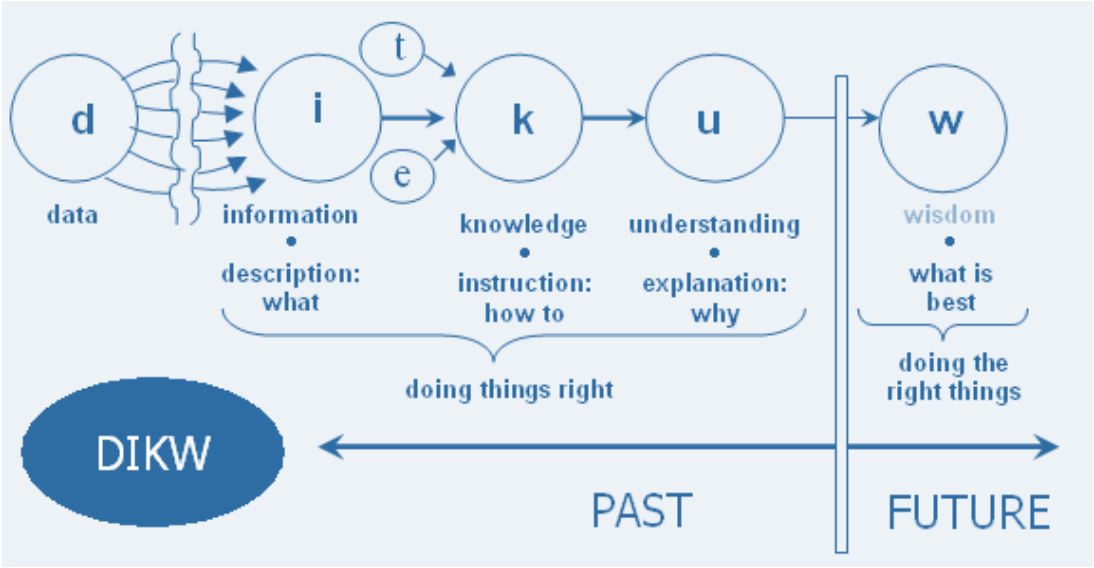
https://en.wikipedia.org/wiki/DIKW_pyramid

Provide Access to Knowledge



How to provide access

Doing the right things vs doing things right



- Information is not useful (it's garbage) if it's not true.
- It is not true if it's not up-to-date or if it is not consistent.
- Model repositories make it possible to ensure the consistency.
- Model repositories make it possible to avoid (at least decrease) the redundancy.
- The model repository increase the chance it's not just data, but information and may be knowledge, because everything is interconnected and set into context.

https://en.wikipedia.org/wiki/DIKW_pyramid

Thank you for your attention!