

Exploring the Future of Digital Twins

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Digital Twins

I. Motivators

II. Open challenges

III. Our work & engaging with us

Digital Twins Now and Tomorrow

The SIRIUS Centre

Eight years' financing from RCN

13 Industrial Partners (11 in 2017)

3 Leading Academic Institutions:
Oslo, NTNU Trondheim, Oxford

Centre for Research-Based Innovation

Funding for 20 Ph.D. students

Innovation through prototypes and pilots

45 affiliated researchers

Equinor

DNV GL
Schlumberger
TechnipFMC

IBM
SAP

Computas
Evry

Dolphin Interconnect
Numascale

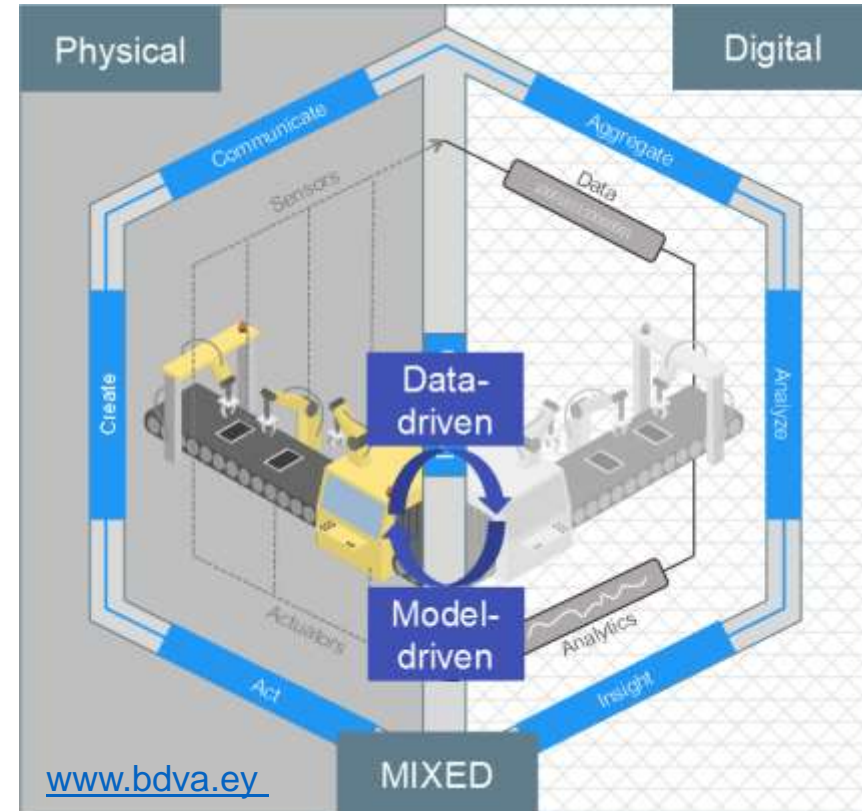
Fluid Operations
Kadme
OSIsoft

What is a Digital Twin?

An integrated

- multi-physics, multi-scale, probabilistic
- simulation of an as-built system, ... that uses the best available
- models,
- sensor information, and
- input data to
- mirror and predict activities/performance over the life of its corresponding physical twin

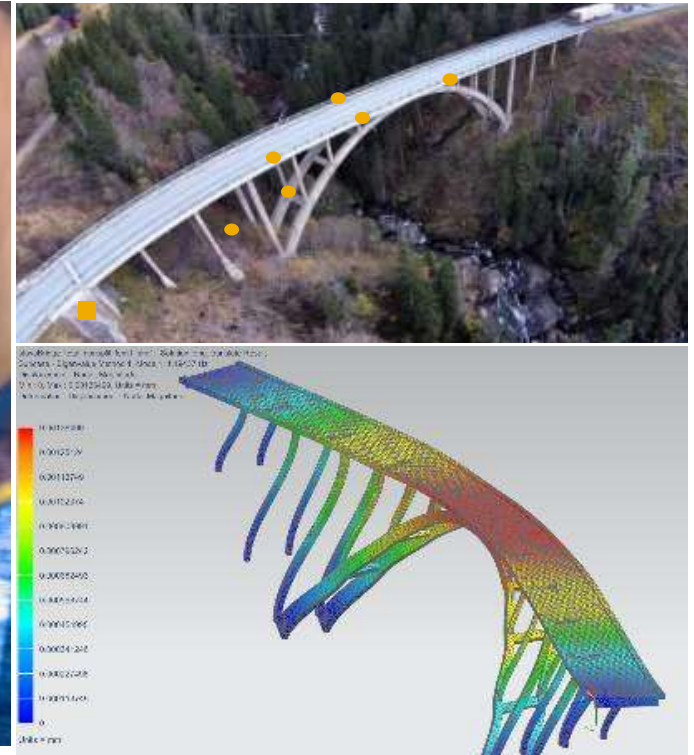
USDOD Procurement Dictionary



Digital Twins – Dream....



licensed from Shutterstock



Norwegian Public Roads Administration

... or reality



licensed from iStockPhoto/Getty Images

The pains of the digital twin

- Hype and oversell: The top of the Gartner hype curve
- “Everybody” is offering digital twin.
- Concepts driven by aerospace and automotive.
- Fragmented systems, siloed perspectives and overload of data.
- Systems are difficult to configure, maintain and scale.
- Challenges in work practices, security and alignment to business.

Challenges from Industry

Wisdom

Knowledge

Information

Data

How

Why

What

A person wearing a VR headset is shown from the side, interacting with a large, complex 3D mechanical model of a machine. The model is composed of many gears, shafts, and components, rendered in a metallic, semi-transparent style. The person's hands are positioned as if they are manipulating or examining the model. In the background, another person is visible at a desk with multiple computer monitors. The scene is set in a modern office with large windows and glass partitions. A semi-transparent pyramid is overlaid on the image, divided into four horizontal sections, each containing a word. The pyramid is colored with a gradient from blue at the top to green at the bottom.

Wisdom

Knowledge

Information

Data

Partners in understanding



How to learn valuable new things about our world

- Seeing realistic representations of things and systems
- Answering open-ended or what-if questions
- Receiving predictions or warnings

Cooperative knowledge



How to multiply our knowledge continuously

- Knowing “who to ask” for required knowledge
- Ability to “drop in” new applications onto a Twin
- Not needing to do much integration work

Information exchange



How to communicate meaning

- Breaking down boundaries and silos
- Seeing “your” world-view of the information

Data readiness



How to know what our data streams represent

- Data being semantically well-described
- Everyone contributing to this effort
- Not requiring an ivory tower

Challenges to Technology

Data readiness



How to crowd-source semantic context:

- Accelerating the data-mapping process
- Rewarding contribution
- Addressing the complexity-power balance in ontologies

Information exchange



How to form semantic context into purposeful views

- Meta-understanding the assets and data
- Targeting world-views to consumers

Cooperative knowledge



How to get applications collaborating

- Minimizing required integration work
- Forming “teams” around an asset or fleet



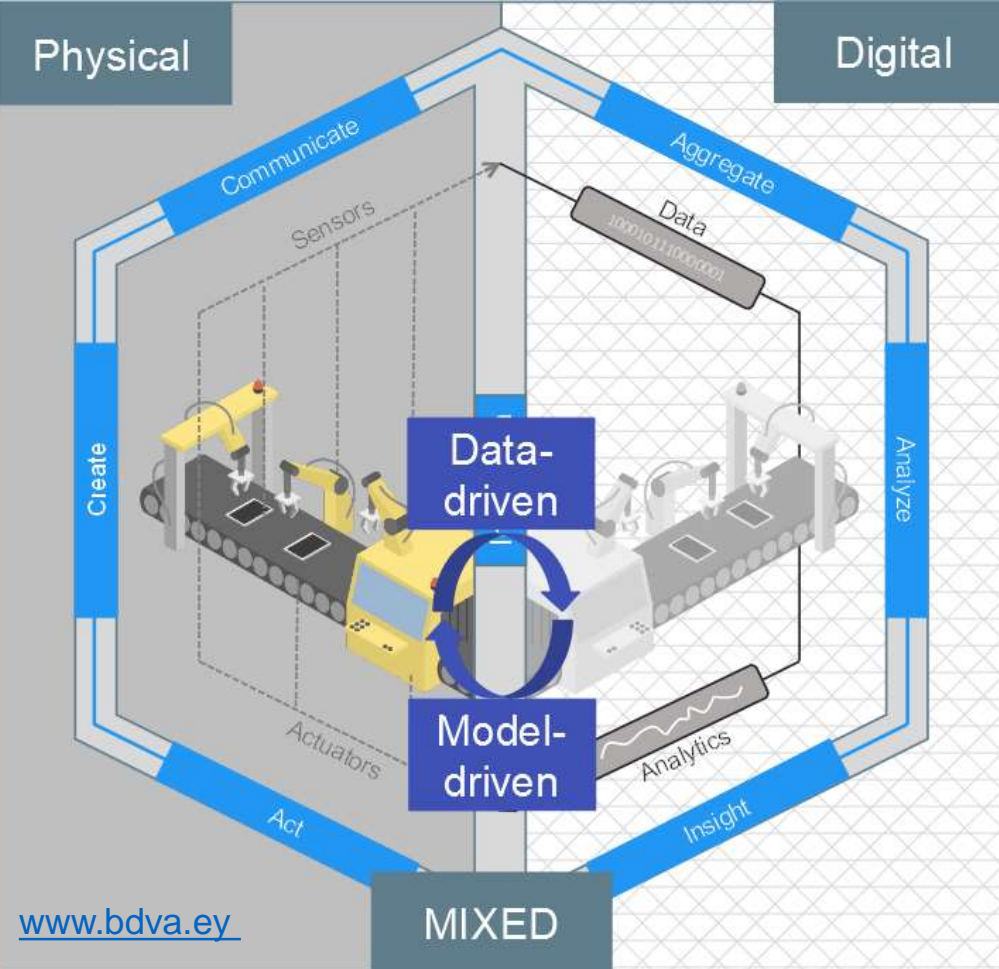
Partners in understanding

How to augment the physical world

- Mimicking a physical asset (Turing test?)
- Democratizing deep learning and AI
- Blurring the lines between physical and digital

Physical

Digital



www.bdva.ey

Our Work: Digital Twins via PI

Specific audience and goals

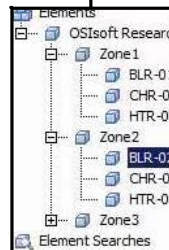
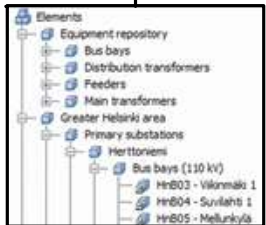
Grid health



Turbine performance



Power use



...

analytical data



Historian

PI Asset Framework of today

to support process industries, asset models:

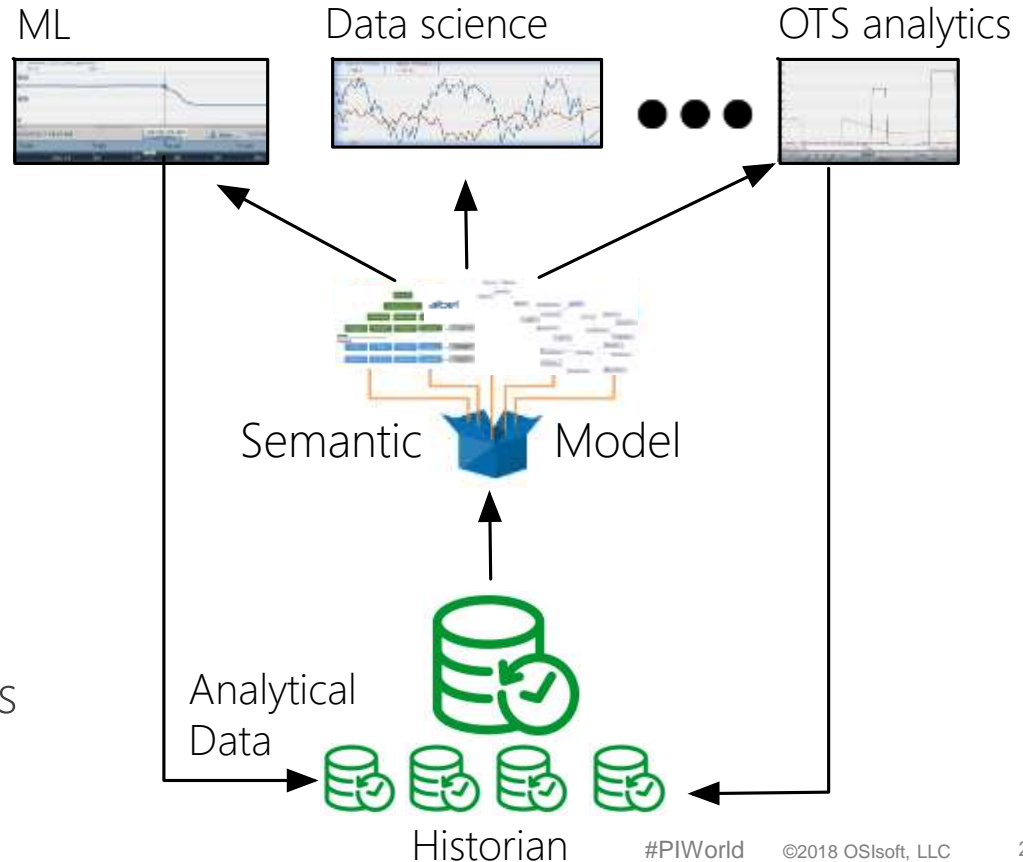
- target audiences and goals
- reduce the cost of curiosity
- build bridges across sites

PI Asset Framework of tomorrow?

to support Digital Twins,
semantic models:

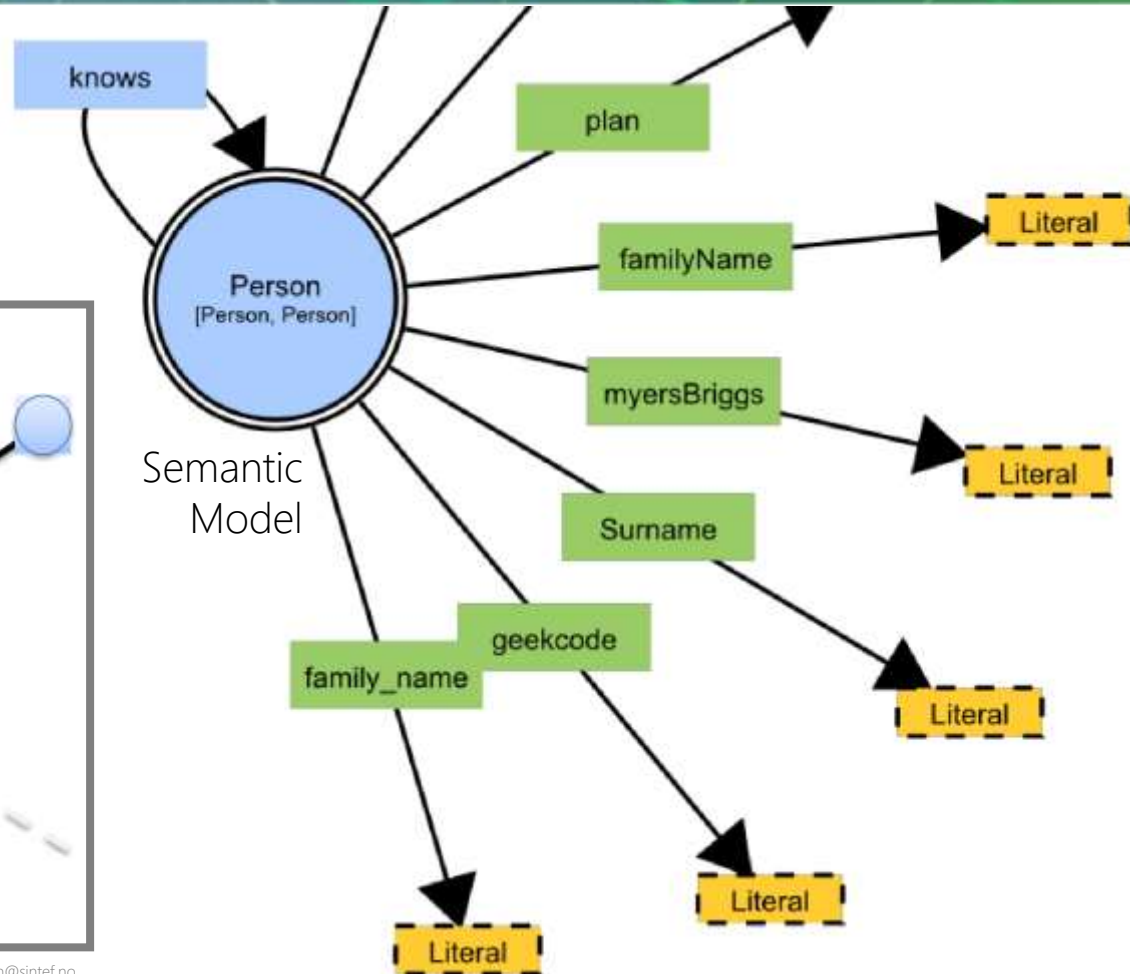
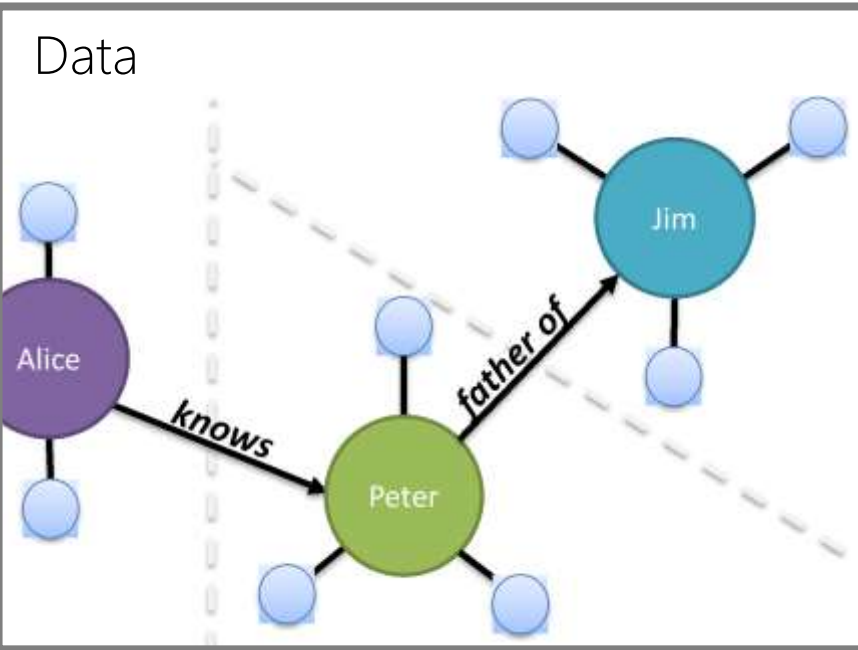
- span audiences and goals
- reduce the cost of integrating new applications
- build bridges across organizations and supply chains

Wide audiences, open-ended use

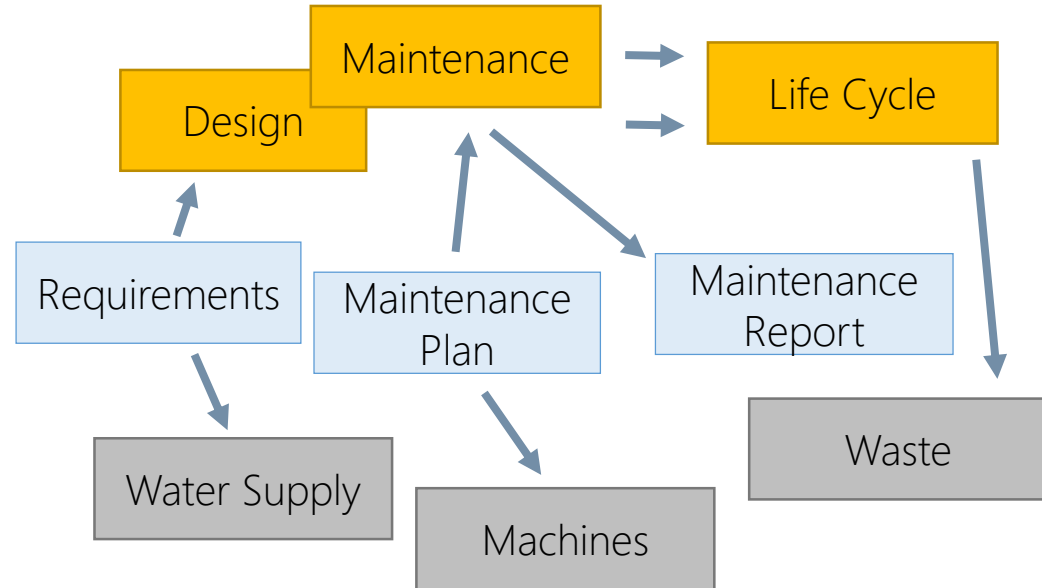
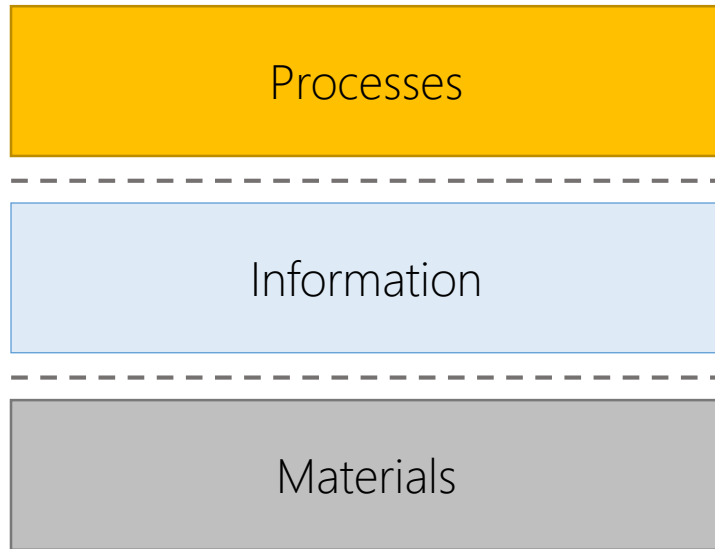


Semantic Models

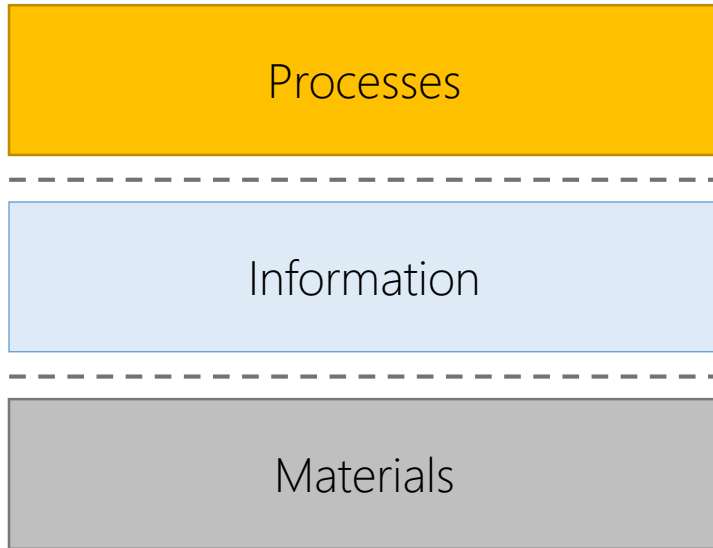
Data



Semantic Models

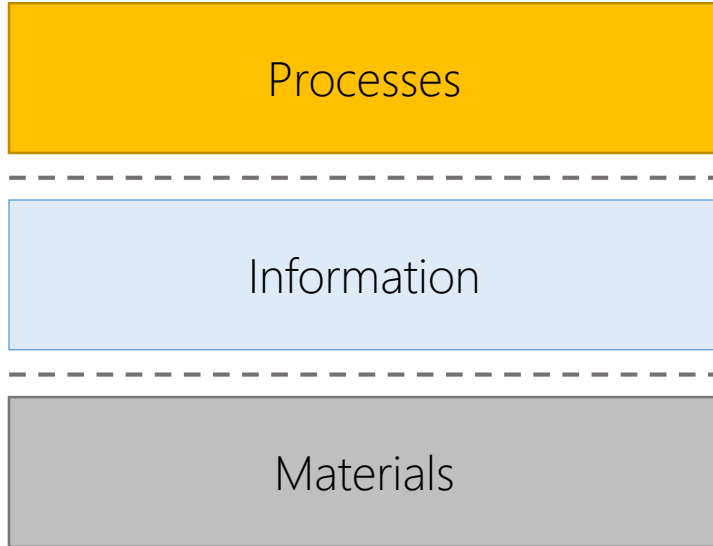


Semantic Model Features - 1



- Object oriented
- Bring together multiple worlds
 - Physical (Real)
 - Cyber (Digital)
 - Biological (Human/Cognitive)
 - ...

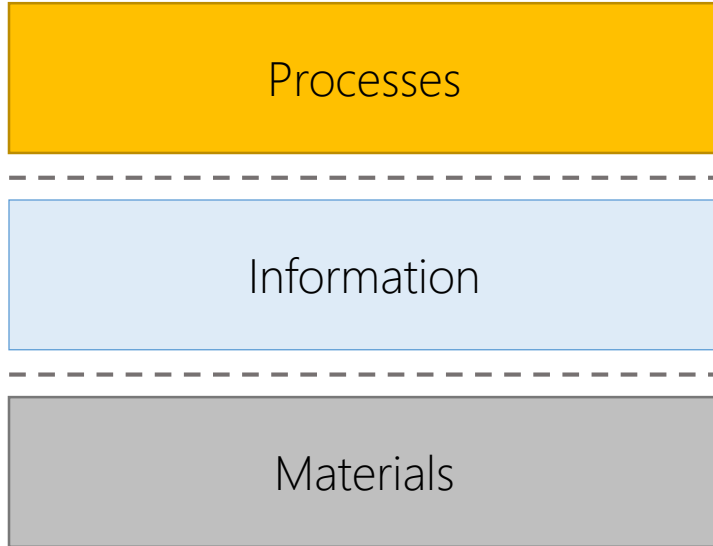
Semantic Model Features - 2



- Multi-faceted
- Different models for different user groups, e.g.:
 - Engineers
 - Finance
 - Risk Management
 - ...



Semantic Model Features - 3



- Formal languages
 - Machine processible
- Wide range of management tools
 - Editing
 - Debugging
 - Integration
 - Querying
 - Browsing
- International standards

Semantic Model Features - 3

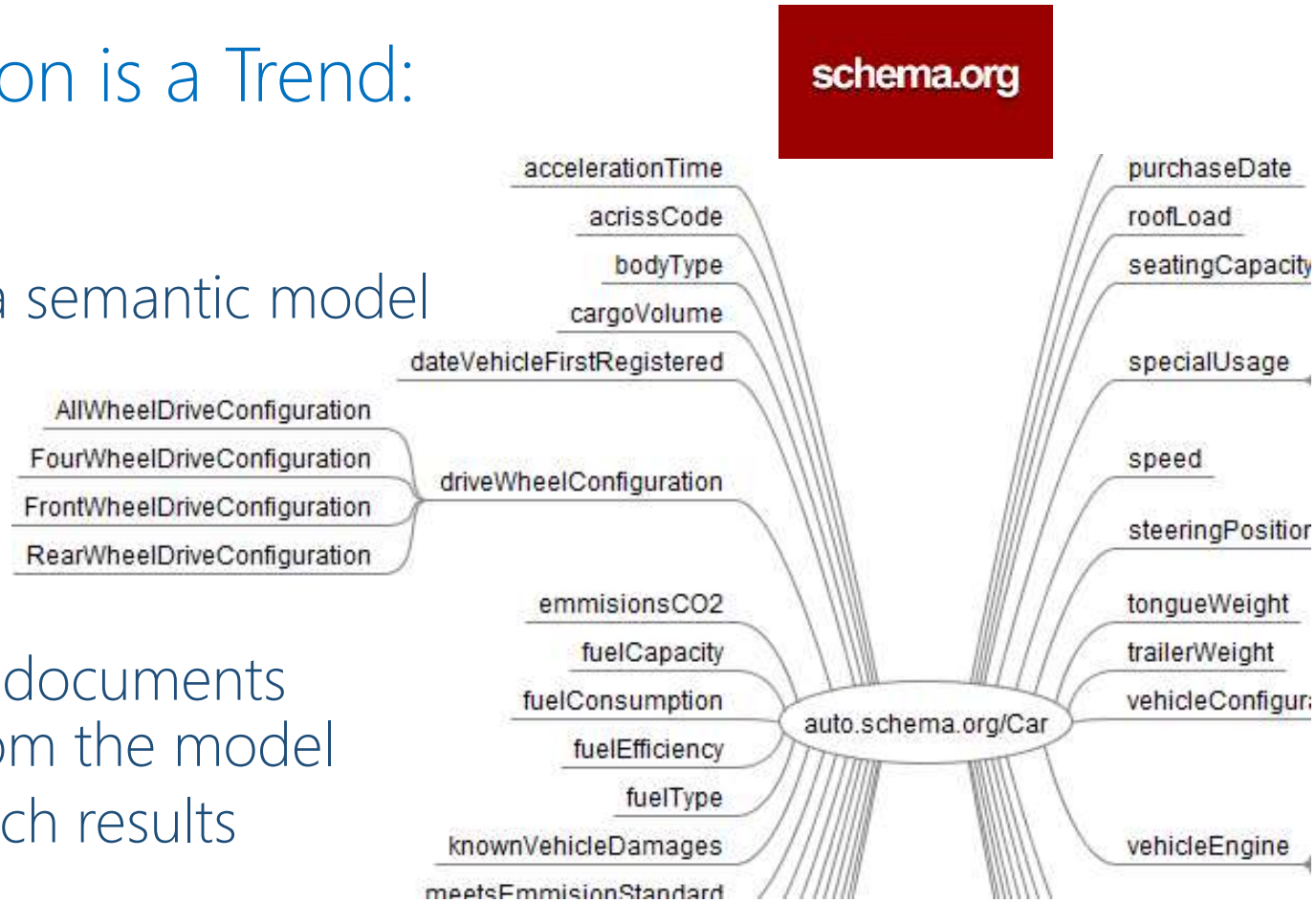


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Semantification is a Trend: Examples

Schema.org: is a semantic model

- annotate your documents with classes from the model
- get better search results





borsch



All

Images

Maps

Videos

News

More

Settings

Tools

About 2,260,000 results (0.53 seconds)

Classic Ukrainian Borsch Recipe - Красный Борщ - Natasha's Kitchen



<https://natashaskitchen.com/classic-russian-borscht-recipe/> ▼

★★★★★ Rating: 4.8 - 115 votes - 2 hr

Sep 26, 2010 - After several requests for my borscht recipe, here it is. Ukrainian Borscht... everyone knows what it is and many people enjoy it; Ukrainian or not. ... If you are pressed for time, shave off 1 hour by using canned beets with their juice.

How to Cook Borsch - Russian Recipe for Borshch - Master Russian



masterrussian.com/russianrecipes/borsch.htm ▼

Borsch is the famous soup in many Russian families, as well as many Eastern and Central European countries. The recipes of **borsch** vary, but vegetables ...

Semantification is a Trend: Examples

Google Knowledge Graph

knows Thomas Jefferson

- that he is a person
- it knows information about him
- it knows relevant people



Thomas Jefferson
3rd U.S. President

Thomas Jefferson was an American Founding Father, the principal author of the Declaration of Independence, and the third President of the United States. [Wikipedia](#)

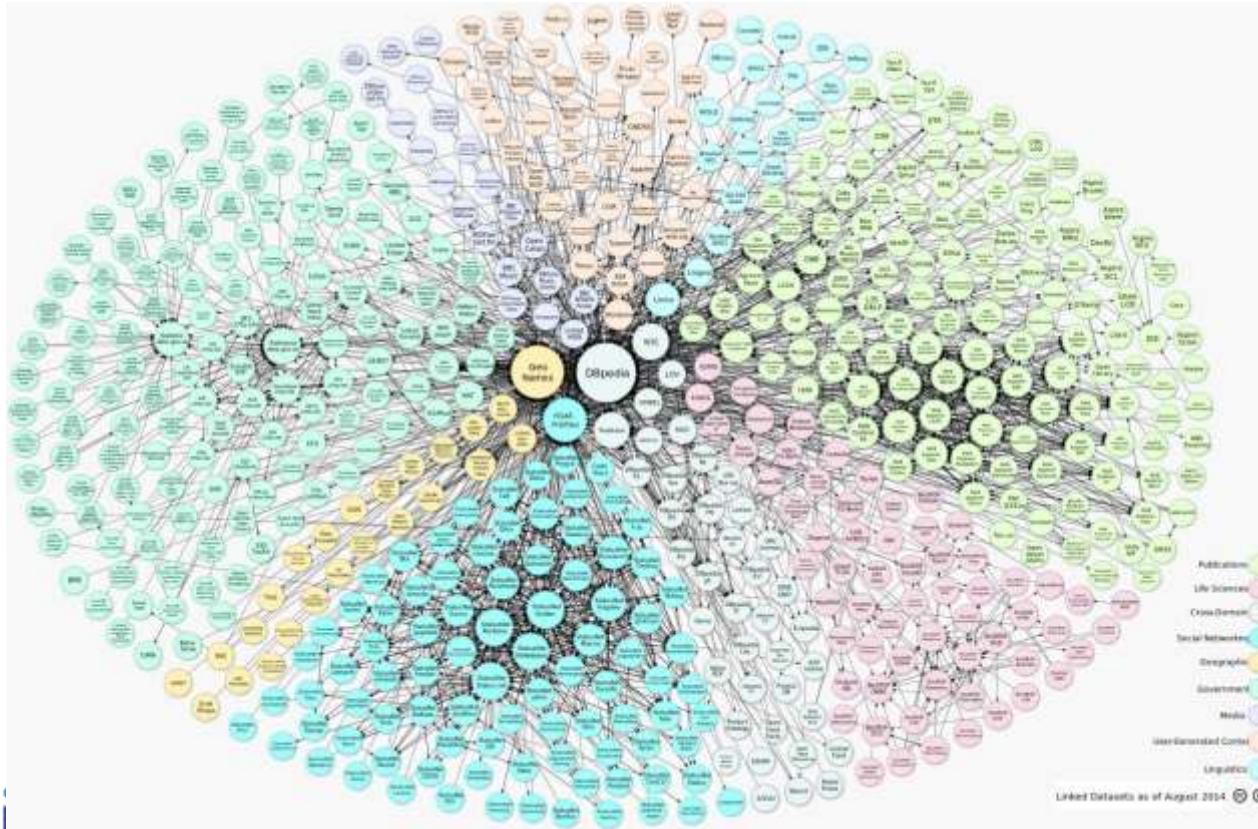
Born: April 13, 1743, Shadwell, VA
Died: July 4, 1826, Charlottesville, VA
Presidential term: March 4, 1801 – March 4, 1809
Spouse: Martha Jefferson (m. 1773–1782)
Party: Democratic-Republican Party
Awards: AIA Gold Medal

Get updates about Thomas Jefferson ☐ Keep me updated

People also search for [View 15+ more](#)

John Adams George Washington Benjamin Franklin James Madison Alexander Hamilton

Semantification is a Trend



Linked
Open
(Semantic)
Data
Cloud

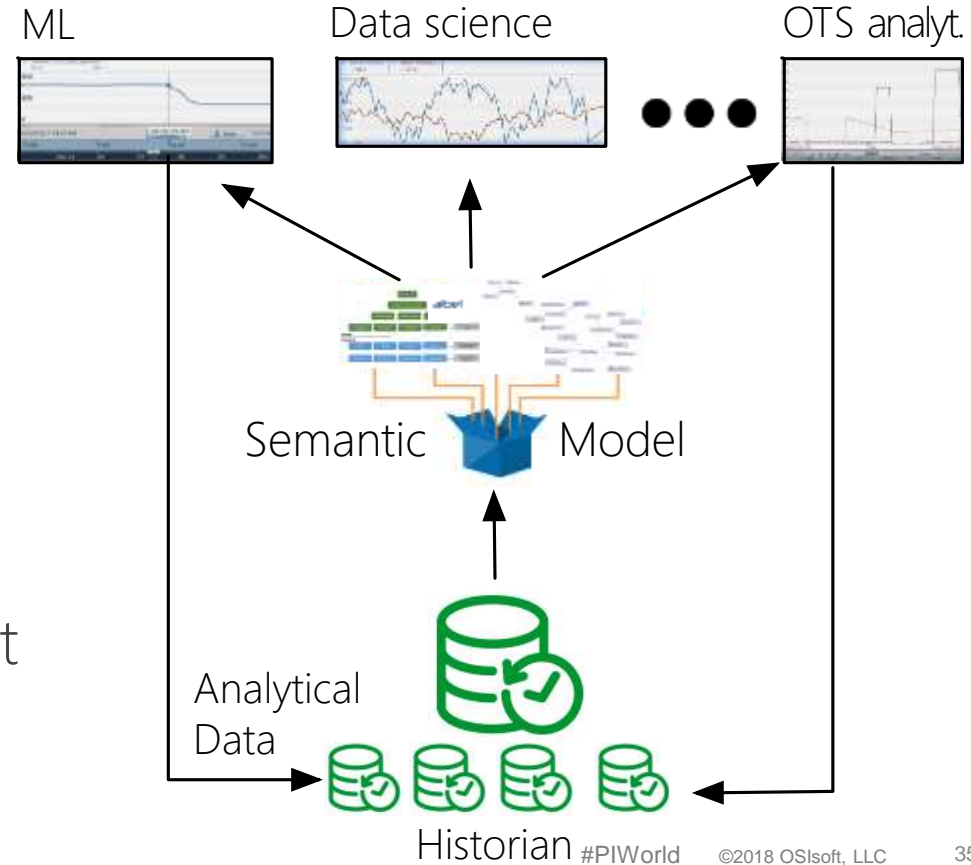


Semantic Digital Twins

Semantic models

- mediate data and applications
- are universal across users and applications
- already exist and can be offered via market places

Wide audience, open-ended use



Our Mid Term (Research) Goals

- Extend the PI System with semantic models
- Develop example ML tasks over semantic models
- Provide solid theoretical foundation for extensions
- Develop industrial use-cases and requirements
- Provide a demonstration with dashboards

Engaging With Us

SIRIUS' Digital Twin Strategy

Your
Logo
Here!

Pilot projects with Oil Companies, EPC and Vendors

Gaps and
needs

Research
solutions

Research and Prototyping Projects

Semantic backbone

Simulation of cloud
deployment

Use of
unstructured data

Support for data
science workflows

Faceted user
interfaces

Standardization of
semantics & interfaces

Use of streaming data
from sensors

Hybrid analytics

Contact Information



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Questions?

Please wait for
the **microphone**

State your
name & company



Please rate this session in the mobile app!

