

D666 | EGU2020-19332

UNDERSTANDING DISTRIBUTED DATA – A SEMANTIC WEB APPROACH FOR DATA BASED ANALYSIS OF NDT DATA IN CIVIL ENGINEERING

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further
explanations
are available
in the slide
notes

Many practical tasks can be solved



NDT in Civil Engineering

Structure

Grain structure

Micro structure

Material characterisation

Moisture

Migration monitoring

Determination

Ions

Chlorides

Sulphates

Alkaline

Rebar

Tendons

Anchors

Pipes

Localization of built-in components

Structural exploration

Interfaces

Layer

Geometry

Sulphate attack

Corrosion

ASR

Chemical reaction

Damage analysis

Honeycombing

Grouting defect

Homogeneity

Fatigue

Cracking Delamination

Poor construction

Is it possible to create value from existing data? BAM

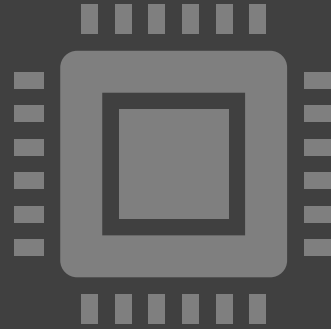
The fourth paradigm of science*



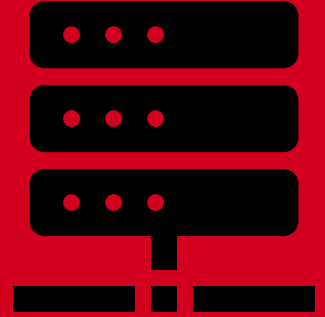
**Empirical
Science**



**Theory
Driven
Science**



**Computational
Science**



**Data
Driven
Science**

*Hey, T. et al. (2009) ISBN: 978-0-9825442-0-4

Creating value from data in NDTCE

What questions can we answer with data?

Querying (distributed) data (*NDT-Google*)

Which NDT method has the best performance for the detection of cracks in 20 cm depth?

Knowledge extraction (analysis of hidden correlations)

Which factor influences the quality of a specific testing task the most?

Improvement of engineering and physical models

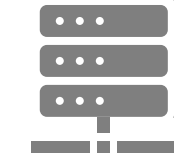
Based on similar cases, when is the next production step feasible?

Research data management status quo in the dpt. for NDTCE

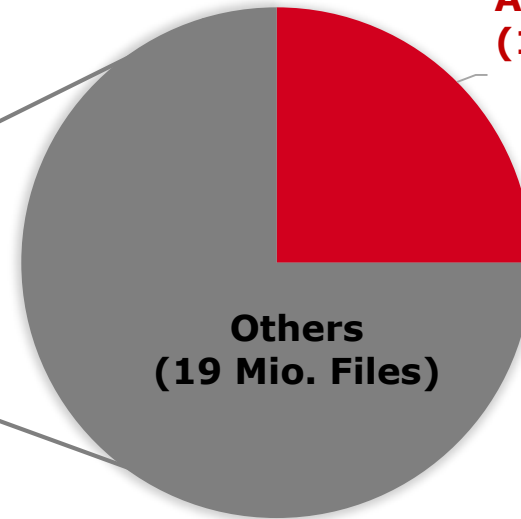
- Large amounts of data
available at BAM



>20 Years



~15 TB
~30 Mio.



**Advanced NDT
(11 Mio. Files)**

GPR

830 GB, 285 k Files

Ultrasonic

420 GB, 10 Mio. Files

Reconstruction

860 GB, 10 k Files

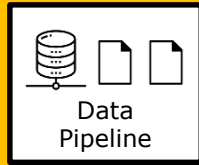
Problem: Data stored in Windows file system

-> reuse not practically

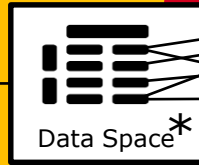
Ontology based data management



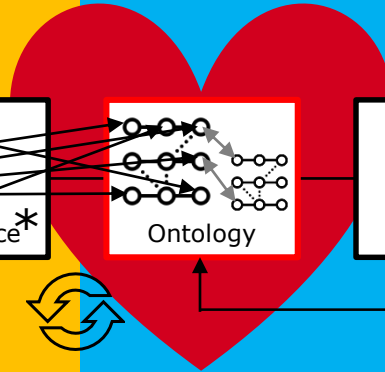
Automated data source management



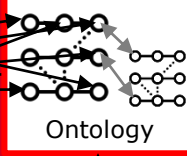
Data Pipeline



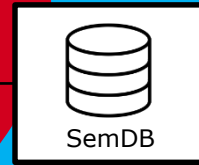
Data Space*



Semantic-Web

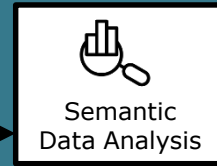


Ontology



SemDB

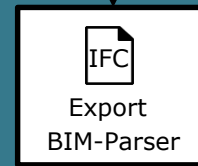
Platform based Data Analysis



Semantic Data Analysis



Data Analyst



IFC
Export
BIM-Parser



Engineer



NDT-Expert

*e.g. as in: Adnan, K. et al. 2019;
<https://doi.org/10.1186/s40537-019-0254-8>

Enabling seamless communication between stakeholders

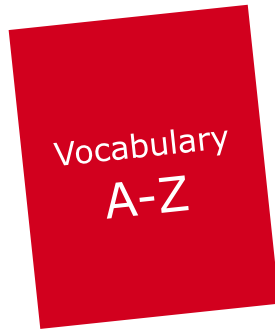
Ontologies

Overview

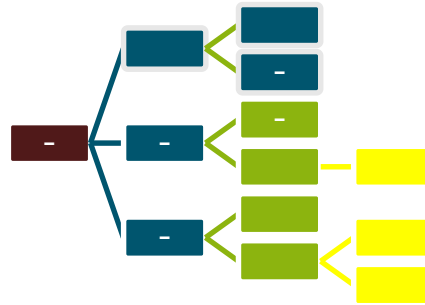
- Ontologies are the “core” of the semantic web.
- *"The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation."**
- Ontologies are knowledge graphs that provide a machine readable data-description-framework which can be highly expressive.

*Berners-Lee et al. (2001) "The Semantic Web"

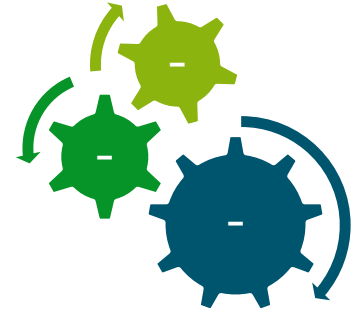
Ontologies describe data on three levels:



Specifying a controlled vocabulary for relevant entities & phenomena



Defining relationships between entities



Defining rules for the interpretation of relationships (reasoning)

Ontologies

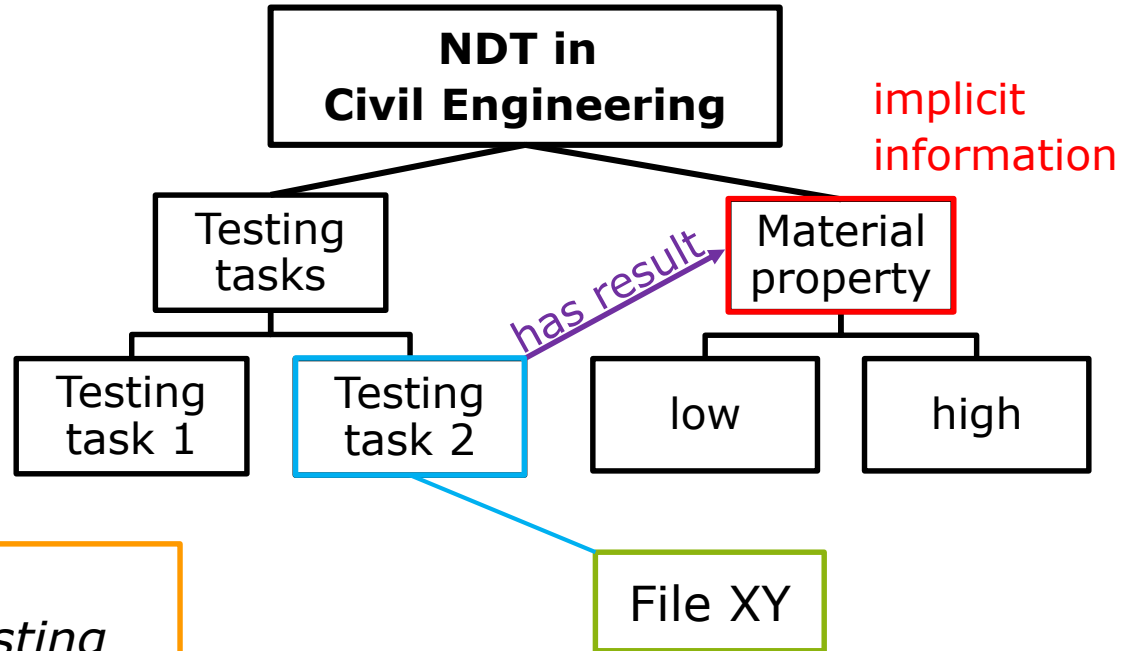
Enhanced expressivity

1) map **data** on ontology (**explicit information**)

2) infer additional (**implicit**) information through **axioms**.

3) store information in **database**:

File XY:
-performs „*Testing task 2*“
-relates to „*Material property*“

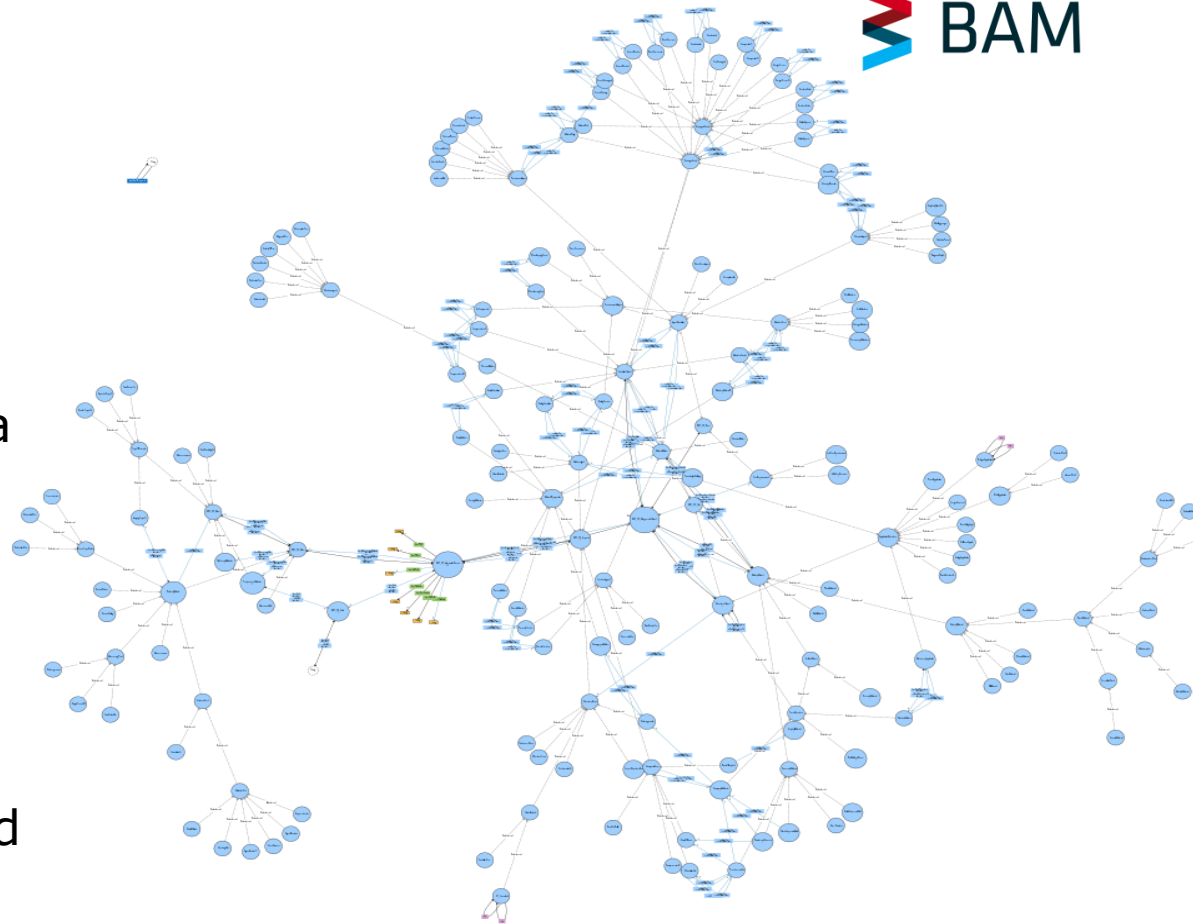


Ontologies

Practical example

Ontology describing GPR in NDT-CE*

- Created to describe 50 randomly selected data sets (~1500 axioms)
- **415** explicit data properties specified
- **471** additional implicit properties were derived



- Many research questions related to distributed information cannot be answered to date
- Answering these questions requires powerful meta data frameworks
- Diverse domains (such as NDT-CE) benefit from semantic data description
- Ontologies enable seamless information exchange between stakeholders (e.g. via data platforms)

Thank you very much for your interest.

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