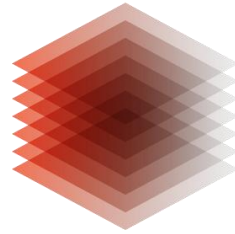


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# Open Research Knowledge Graph

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TechLib Summit Zurich

# The Idea of a Knowledge Graph

Expressing knowledge through  
semantically enriched, interlinked knowledge graphs

- From Text to structured Knowledge
- Examples from Industry
- Knowledge Graph for Encyclopedic Knowledge
- Knowledge Graph for Science

# From Text to Structured Knowledge

## Processes Modelling in Civil Engineering based on Hierarchical Petri Nets

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**ABSTRACT:** Process modeling is a central aspect for the support of the network-based coordination of planning processes in civil engineering. Hereby, the planning processes are characterized by some significant aspects, especially the great complexity and the dynamical behavior. To master both, the complexity and the refinement of planning processes, appropriate hierarchical structured process models are necessary. This contribution provides a Petri Net based approach for hierarchical process modelling. The focus is on the formalism to ensure the structural and behavioural correctness of the hierarchical process models and a prototype software implementation for hierarchical process modelling in civil engineering.

### 1 INTRODUCTION

In building engineering every state of design, planning, construction and usage is characterized by specific processes. These processes can be organized very efficiently with the support of modern information and communication technology. Within the research projects "Coordination of Planning Processes in Geotechnical Engineering" (Darmstadt) and "Relational Process Modelling in Co-operative Building Planning" (Hannover), that are both part of the priority program "Network-based Co-operative Planning Processes in Structural Engineering" from the German Research Foundation (DFG), relational process models based on hierarchical Petri Nets have been defined and implemented.

### 2 PROCESS MODELLING WITH PETRI NETS

Petri Nets provide a mathematical formalism and a graphical representation based on the graph theory in order to model the concurrent and asynchronous behavior of a discrete system. The Petri Net theory originates from the PhD thesis of Carl Adam Petri (1962). Since then, various researches, extensions and improvements have been applied to the original Petri Net theory. The application of Petri Nets to process modeling and workflow management has

main reasons for modeling Civil Engineering processes with Petri Nets are:

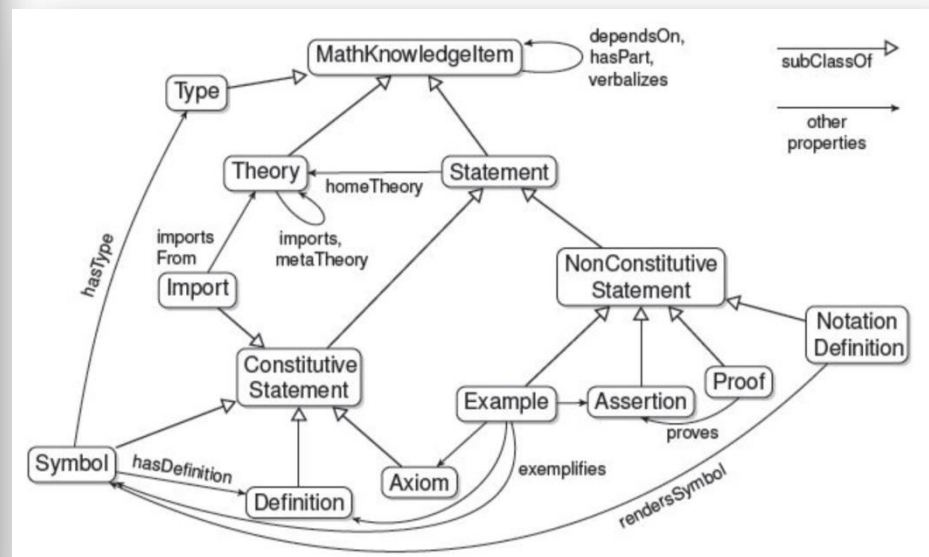
- the graphical representation of the structure and marking
- the bipartite structure with places and transitions for modeling both planning states and planning activities,
- the token concept for modeling logical firing conditions and the flow of planning information within an engineering workflow
- the mathematical formalism for structural, behavioral and simulation analysis of engineering process models.

For a short introduction to Petri Nets see, e.g., (Aalst 1998), for a comprehensive introduction, e.g., (Reisig 1985) or (Baumgarten 1990) are recommend. As illustrated in Figure 1 Petri Net consists of places, transitions and arcs, with each arc connecting either a transition and a place or a place and a transition. The tokens reside on the places. Based on well defined rules the transitions can "fire" and thus let the tokens "flow" through the net.

### 3 HIERARCHICAL PROCESS MODELING

#### 3.1 Basic Idea of hierarchical process modeling

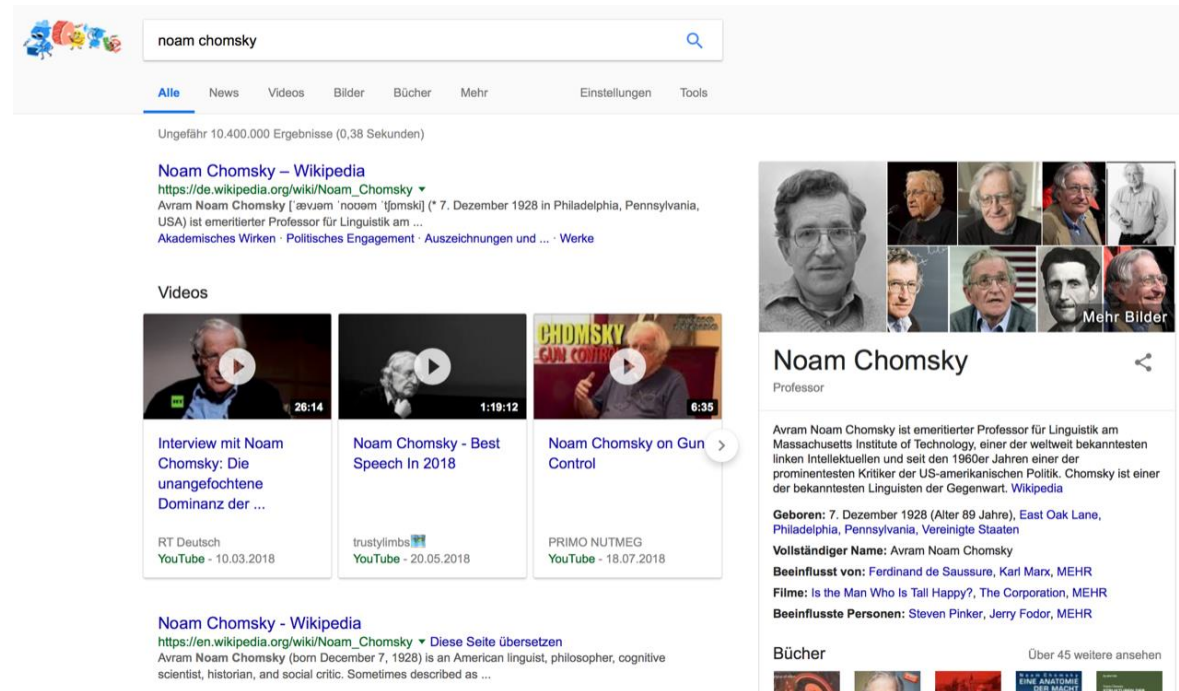
The process structure covers all planning activities.



Christoph Lange: Ontologies and languages  
[http://www.semantic-web-journal.net/sites/default/files/swj122\\_3.pdf](http://www.semantic-web-journal.net/sites/default/files/swj122_3.pdf)

# Knowledge Graphs in Industry

- Google Knowledge Graph
- Amazon Product Graph
- Facebook Graph API
- IBM Watson



The screenshot shows a Google search for "noam chomsky". The search bar at the top contains the text "noam chomsky". Below the search bar, there are tabs for "Alle", "News", "Videos", "Bilder", "Bücher", "Mehr", "Einstellungen", and "Tools". The "Alle" tab is selected. Below the tabs, it says "Ungefähr 10.400.000 Ergebnisse (0,38 Sekunden)".

The first result is "Noam Chomsky – Wikipedia" with the URL [https://de.wikipedia.org/wiki/Noam\\_Chomsky](https://de.wikipedia.org/wiki/Noam_Chomsky). The snippet reads: "Avram Noam Chomsky [ˈævjəm ˈnoəm ˈtʃɒmski] (\* 7. Dezember 1928 in Philadelphia, Pennsylvania, USA) ist emeritierter Professor für Linguistik am ...". Below the snippet are links for "Akademisches Wirken", "Politisches Engagement", "Auszeichnungen und ...", and "Werke".

Below the Wikipedia result is a "Videos" section with three video thumbnails. The first video is titled "Interview mit Noam Chomsky: Die unangefochtene Dominanz der ..." and has a duration of 26:14. The second video is titled "Noam Chomsky - Best Speech In 2018" and has a duration of 1:19:12. The third video is titled "Noam Chomsky on Gun Control" and has a duration of 6:35.

Below the videos is another "Noam Chomsky - Wikipedia" result with the URL [https://en.wikipedia.org/wiki/Noam\\_Chomsky](https://en.wikipedia.org/wiki/Noam_Chomsky). The snippet reads: "Avram Noam Chomsky (born December 7, 1928) is an American linguist, philosopher, cognitive scientist, historian, and social critic. Sometimes described as ...".

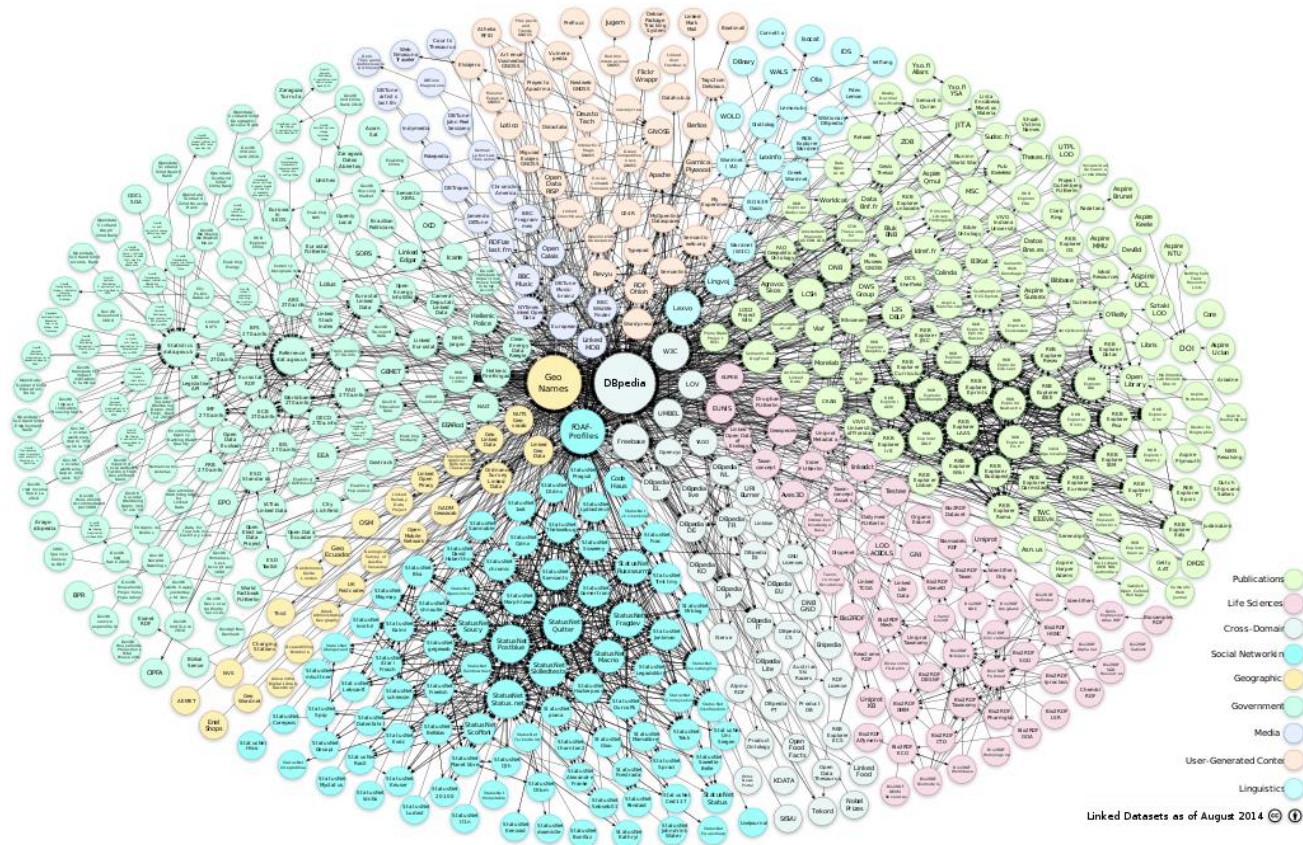
On the right side of the search results is a "Knowledge Panel" for "Noam Chomsky". It features a large portrait of Noam Chomsky and a grid of smaller portraits of other people. Below the portraits, it says "Noam Chomsky" and "Professor". The panel also contains a biographical text: "Avram Noam Chomsky ist emeritierter Professor für Linguistik am Massachusetts Institute of Technology, einer der weltweit bekanntesten linken Intellektuellen und seit den 1960er Jahren einer der prominentesten Kritiker der US-amerikanischen Politik. Chomsky ist einer der bekanntesten Linguisten der Gegenwart. Wikipedia". Below this text are fields for "Geboren: 7. Dezember 1928 (Alter 89 Jahre), East Oak Lane, Philadelphia, Pennsylvania, Vereinigte Staaten", "Vollständiger Name: Avram Noam Chomsky", "Beeinflusst von: Ferdinand de Saussure, Karl Marx, MEHR", "Filme: Is the Man Who Is Tall Happy?, The Corporation, MEHR", and "Beeinflusste Personen: Steven Pinker, Jerry Fodor, MEHR". At the bottom of the panel is a "Bücher" section with a grid of book covers and the text "Über 45 weitere ansehen".

<https://www.google.com/search?q=noam+chomsky>



# Knowledge Graphs for Wikidata

- DBpedia
- Yago
- FreeBase



<https://de.wikipedia.org/wiki/DBpedia>

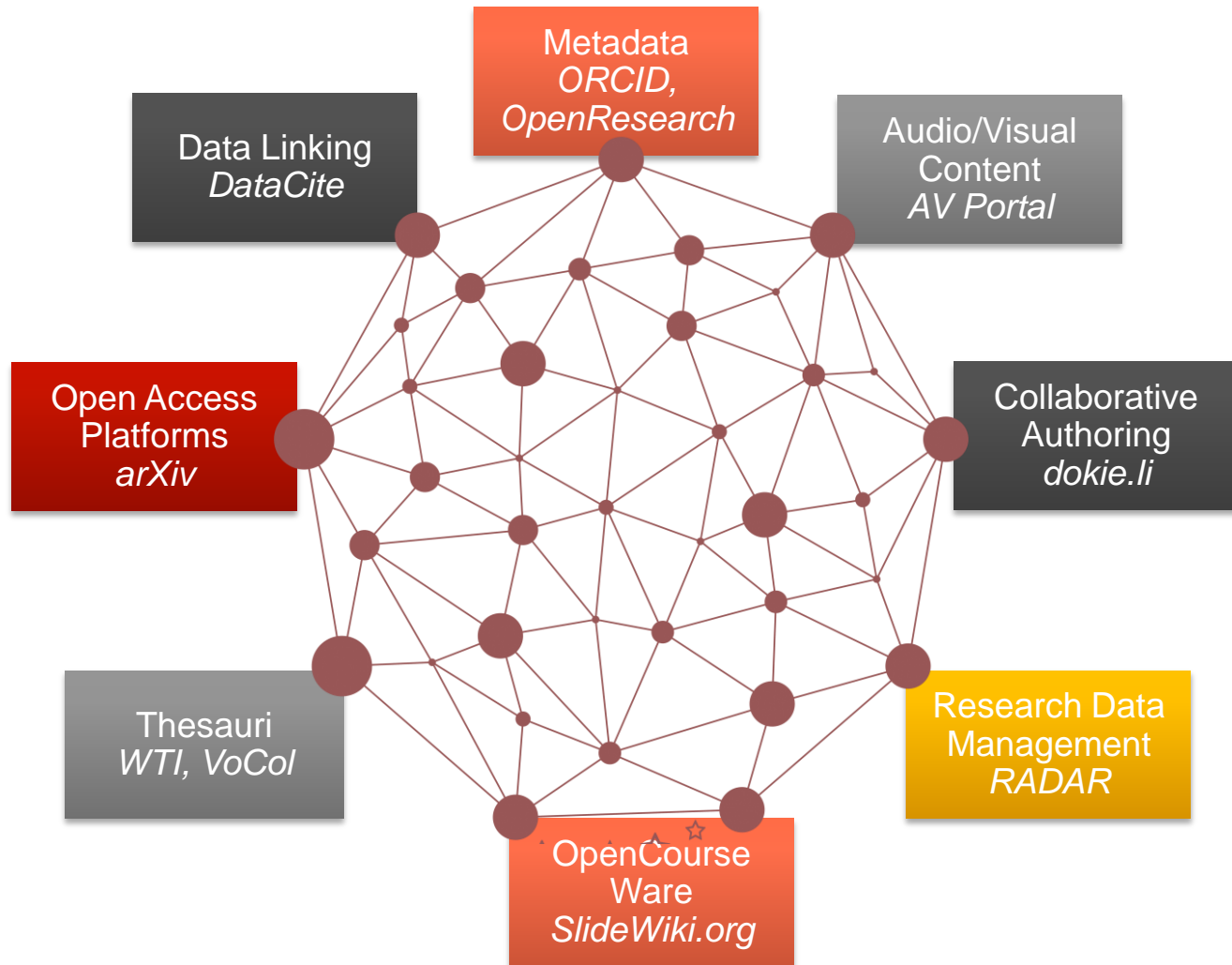
# Knowledge Graph for Science



## Advantages

- Clear **identification** of all relevant artifacts, concepts, attributes, relationships, etc.
- More terminological and conceptual **precision** and sharpness, less ambiguity
- Better and explicit networking of all relevant artefacts and information sources -> **Traceability**
- **Machine readability** of the ORKG enables new search, retrieval, mining, assistance applications
- Avoidance of media breaks in the various phases of scientific work  
-> Increased **efficiency**
- Use of concepts and relationships across disciplinary boundaries  
-> **Interdisciplinarity**
- **Confine information overload** of scientific publications

# Structure





# Elements

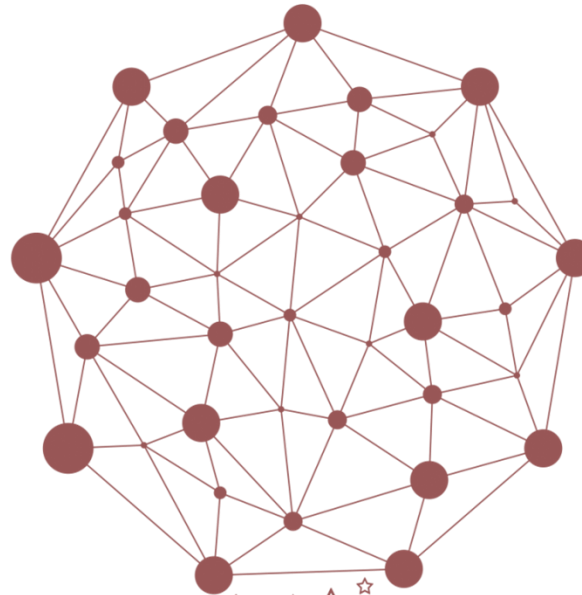
## Overall concepts:

- Research problems
- Definitions
- Approaches
- Methods

## Artifacts:

- Publications
- Data
- Software
- Image/Audio/Video
- Knowledge Graps/  
Ontologies

## Domain specific concepts:



The Research Knowledge Graph makes comprehensive and subject-specific concepts clearly identifiable and links them semantically (with clearly described relations) with each other and with other relevant artifacts

Math	Physics	Chemistry	Informatics	Technology	Architecture
<ul style="list-style-type: none"> <li>• Definitions</li> <li>• Theorems</li> <li>• Evidence</li> <li>• Methods</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• Experiments</li> <li>• Data</li> <li>• Models</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• Substances</li> <li>• Structures</li> <li>• Reactions</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• Concepts</li> <li>• Structures</li> <li>• Algorithms</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• Norms / Standards</li> <li>• Components</li> <li>• Units, Sensor data</li> </ul>	<ul style="list-style-type: none"> <li>• Norms / Formalities</li> <li>• Components</li> <li>• Models</li> <li>• ...</li> </ul>

# Populating the Graph

Combination of automated and manual procedures

- Existing metadata, data, taxonomies, ontologies and information models
- Contributions from scientists with descriptions of their own work supported by intelligent interfaces
- Automated methods for knowledge extraction and networking
- Curating and quality assurance by librarians and information scientists

# Semantic Representation

## 1. Original Publication



## 2. Graph Curation Form

Author	Robert Reed
Research Problem	Genome editing in Lepidoptera
Methods	CRISPR/cas9
related Concepts	Lepidoptera;Genome editing;CRSIPR
Experimental Data	<a href="https://doi.org/10.5281/zenodo.896916">https://doi.org/10.5281/zenodo.896916</a>

## 3. Graph representation



## Minimum Viable ORKG Infrastructure

- Data model for semantically representing scholarly communication, use RDF and Linked Data as scaffold
- Scalable graph-storage backend infrastructure for storing original ORKG content
- Exposing a comprehensive API for interacting with the ORKG
- User interface widgets and components for collaborative authoring and curation of the graph and integration into third-party services
- Semi-automated semantic integration, search, extraction and recommendation services to support the curation of the knowledge graph

## More Information on Project Website

<https://projects.tib.eu/orkg/>



[HOME](#) [PROJECT](#) [USE CASES](#) [PUBLICATIONS](#) [WORKSHOPS](#) [OUTREACH](#) [STUDENTS](#)

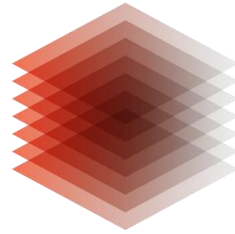
We build the next generation digital libraries for *semantic* scientific knowledge communicated in scholarly literature. We focus on the communicated content rather than the context e.g., people and institutions in which scientific knowledge is communicated, and the content is semantic i.e., machine interpretable.

Scientific knowledge continues to be confined to the document, seemingly inseparable from the medium as hieroglyphs carved in stone. The global scientific knowledge base is little more than a collection of documents. It is written by humans for humans, and we have done so for a long time. This makes perfect sense, after all it is people that make up the audience, and researchers in particular.

Yet, with the monumental progress in information technologies over the more recent decades, one may wonder why it is that the scientific knowledge communicated in scholarly literature remains largely inaccessible to machines. Surely it would be useful if some of that knowledge is more available to automated processing.

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**Thanks for your attention!**

**[www.tib.eu](http://www.tib.eu)**

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