iStar'21 - The 14th International i* Workshop

October 18, 2021

Conceptual Modeling Languages: Origin, Utilization and Impact

Dimitris Karagiannis

dk@dke.univie.ac.at

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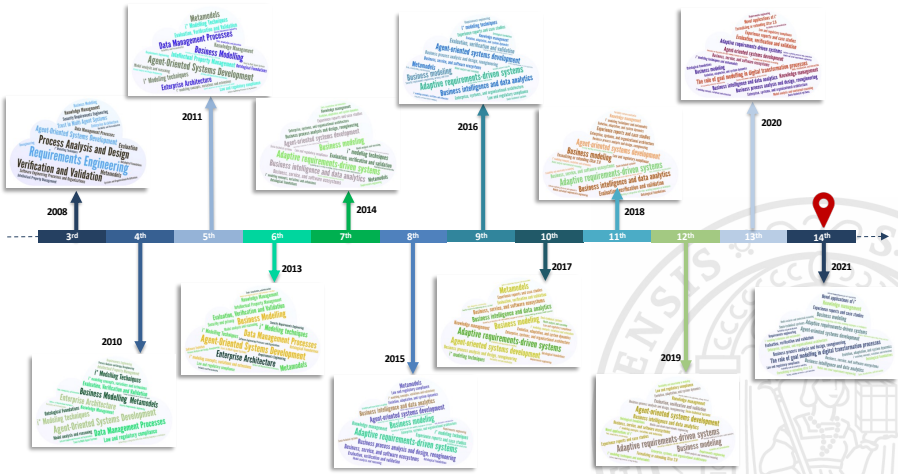
Topics of Interest – A Look Over the Years



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Source: Call for Papers 3rd to 14th iStar Workshops from 2008 – 2021 (no Workshop in 2009, no CfP available for 1st and 2nd edition)

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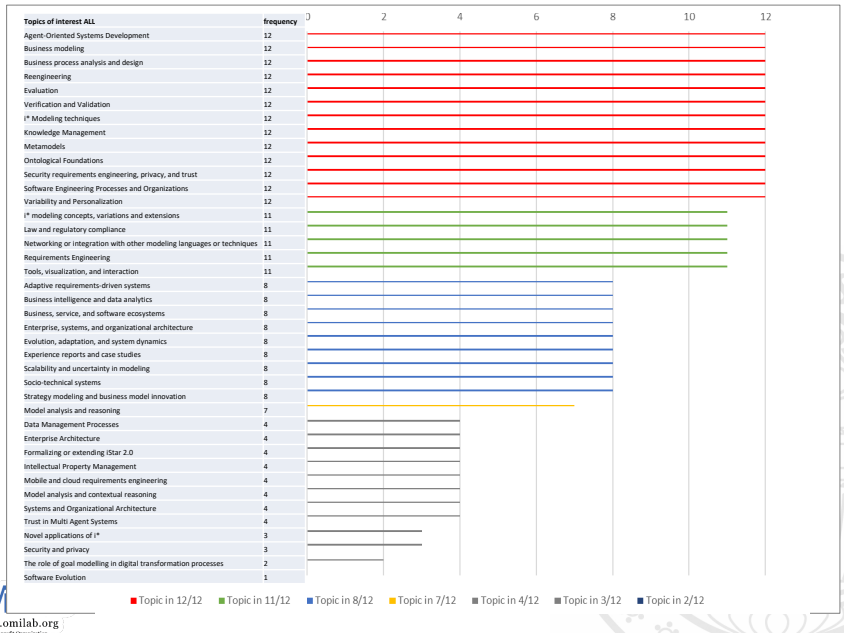
Analysis: Topics of Interest Frequency

Topics of interest ALL	frequency
Agent-Oriented Systems Development	12
Business modeling	12
Business process analysis and design	12
Reengineering	12
Evaluation	12
Verification and Validation	12
i* Modeling techniques	12
Knowledge Management	12
Metamodels	12
Ontological Foundations	12
Security requirements engineering, privacy, and trust	12
Software Engineering Processes and Organizations	12
Variability and Personalization	12
i* modeling concepts, variations and extensions	11
Law and regulatory compliance	11
Networking or integration with other modeling languages or techniques	11
Requirements Engineering	11
Tools, visualization, and interaction	11
Adaptive requirements-driven systems	8
Business intelligence and data analytics	8
Business, service, and software ecosystems	8
Enterprise, systems, and organizational architecture	8
Evolution, adaptation, and system dynamics	8
Experience reports and case studies	8
Scalability and uncertainty in modeling	8
Socio-technical systems	8
Strategy modeling and business model innovation	8
Model analysis and reasoning	7
Data Management Processes	4
Enterprise Architecture	4
Formalizing or extending iStar 2.0	4
Intellectual Property Management	4
Mobile and cloud requirements engineering	4
Model analysis and contextual reasoning	4
Systems and Organizational Architecture	4
Trust in Multi Agent Systems	4
Novel applications of i*	3
Security and privacy	3
The role of goal modelling in digital transformation processes	2
Software Evolution	1



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Global Trends Impact on the i* Workshop

- **12 Call For Papers Analysed** (3rd-14th iStar Workshop)
- **41 Unique Topics of Interest**
- **13 Topics throughout all WSs**

n=41 unique topics of interest

Red … 12/12: 13 topics

Green … 11/12: 5 topics

Blue … 8/12: 9 topics

Orange … 7/12: 1 topic

Grey <=4/12: 12 topics

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Abstract

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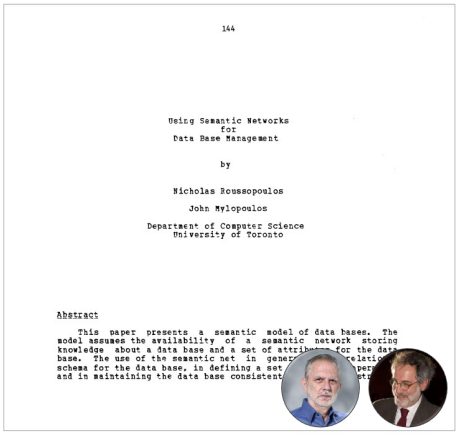
VLDB '75: Proceedings of the
1st International Conference on Very Large Data BasesSeptember 1975



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Using Semantic Networks
for
Data Base Management

by

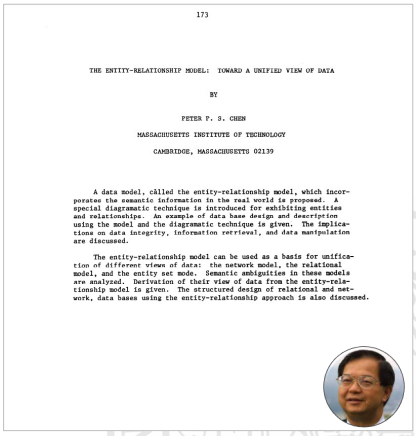
Nicholas Roussopoulos

John Mylopoulos

Department of Computer Science
University of Toronto

Abstract

This paper presents a semantic model of data bases. The model assumes the availability of a semantic network storing knowledge about a data base and a set of attrib for the da base. The use of the semantic net in gener relati schema for the data base, in defining a set per and in maintaining the data base consistent



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THE ENTITY-RELATIONSHIP MODEL: TOWARD A UNIFIED VIEW OF DATA

BY

PETER P. S. CHEN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASSACHUSETTS 02139

A data model, called the entity-relationship model, which incorporates the semantic information in the real world is proposed. A special diagramatic technique is introduced for exhibiting entities and relationships. An example of data base design and description using the model and the diagramatic technique is given. The implications on data integrity, information retrieval, and data manipulation are discussed.

The entity-relationship model can be used as a basis for unification of different views of data: the network model, the relational model, and the entity set mode. Semantic ambiguities in these models are analyzed. Derivation of their view of data from the entity-relationship model is given. The structured design of relational and network, data bases using the entity-relationship approach is also discussed.

Method: An adaptable methodology for database design
Tooling: Semantic Database Design (SDBD)

Language: Entity Relationship
Tooling: (Multiple implementations)

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Roussopoulos, Nicholas, and John Mylopoulos. "Using semantic networks for data base management." In Proceedings of the 1st International Conference on Very Large Data Bases, pp. 144-172. 1975.
Peter P. S. Chen. "The entity-relationship model: toward a unified view of data." In Proceedings of the 1st International Conference on Very Large Data Bases, pp. 173. 1975.
Roussopoulos, N., & Utz, W. (2016). Design semantics on accessibility in unstructured data environments. In Domain-Specific Conceptual Modeling: Concepts, Methods and Tools. https://doi.org/10.1007/978-3-319-39417-6_4

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Conceptual Modeling: Definitions

J. Mylopoulos (1992): Conceptual modeling is the activity of formally describing ***some aspects*** of the physical and social world around us for the purpose of **understanding and communication**.

E. Yu (2009): Conceptual modeling frameworks aim to offer succinct representations of ***certain aspects*** of complex realities through a small number of modeling constructs, with the intent that they can support some **kinds of analysis.**

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Mylopoulos J. (1992): Conceptual Modeling and Telos. In: Loucopoulos P. and Zicari R. (eds.). Conceptual modeling, databases, and case: an integrated view of information systems development. Wiley Publishers, New York
Yu E. (2009): Social Modeling and i*. In: Borgida A., Chaudhri V., Giorgini P., Yu E. (eds.). Conceptual Modeling: Foundations and Applications – Esseys in Honor of Jphn Mylopoulos. LNCS vol. 5600, Springer

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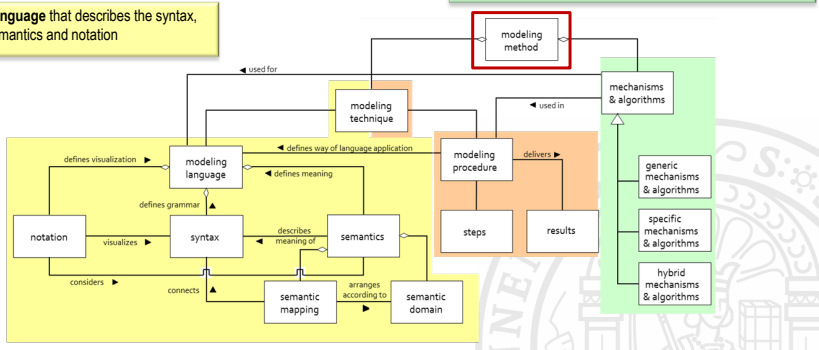
Generic Modeling Method Framework
from LANGUAGE to METHOD

Algorithms and mechanisms that provide functionality to use and evaluate models described by a modeling language

The **modeling language** that describes the syntax, semantics and notation



The **modeling procedures** that apply the methodology

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Karagiannis D., Kühn H. (2002) Metamodeling Platforms. In: Bauknecht K., Tjoa A.M., Quirchmayr G. (eds) E-Commerce and Web Technologies. EC-Web 2002. Lecture Notes in Computer Science, vol 2455. Springer, Berlin, Heidelberg. https://doi.org/10.1007/3-540-45705-4_19

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Abstract

In this talk, the **origin of conceptual modeling languages** as the adequate vocabulary for **knowledge representation** and **processing** is introduced.

The **conceptualization process** is required to **enable machine interpretation** of these languages. For that it is necessary to understand how these are conceptually structured.

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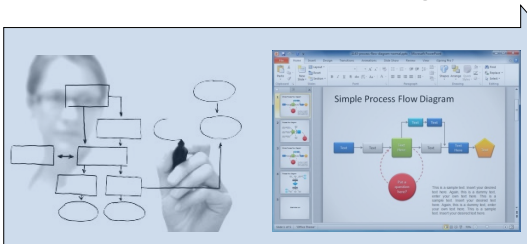
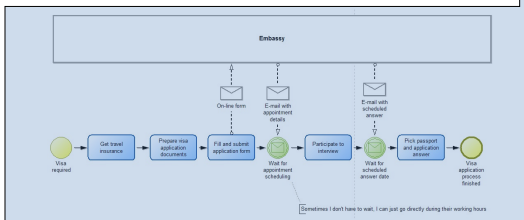
Conceptual Models = **Knowledge Structures**



Free drawing

Diagramming

Visual representations created to convey some **meaning** (focus on visualization)



Conceptual modeling

Knowledge structure that may have some **visual manifestation** (focus on structured encoding of knowledge)

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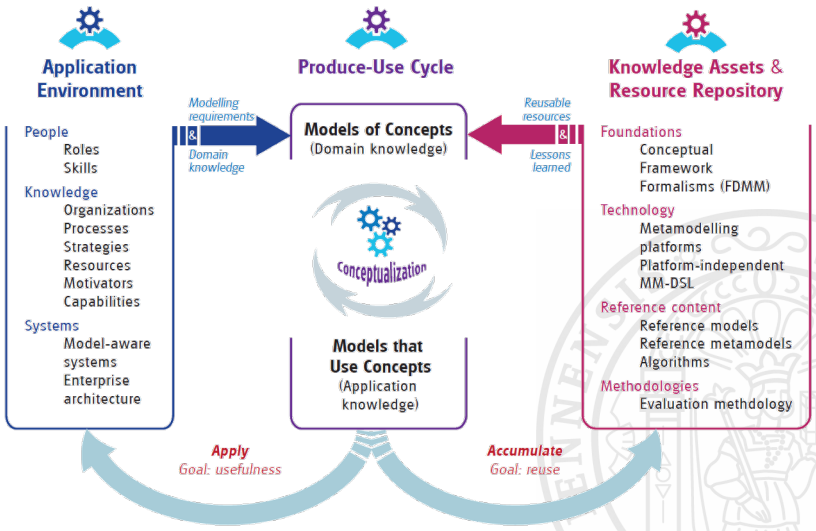
Agile Modeling Method Engineering (AMME): The Conceptualization Framework



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Dimitris Karagiannis. 2015. Agile modeling method engineering. In Proceedings of the 19th Panhellenic Conference on Informatics (PCI '15). Association for Computing Machinery, New York, NY, USA, 5–10. DOI:https://doi.org/10.1145/2801948.2802040

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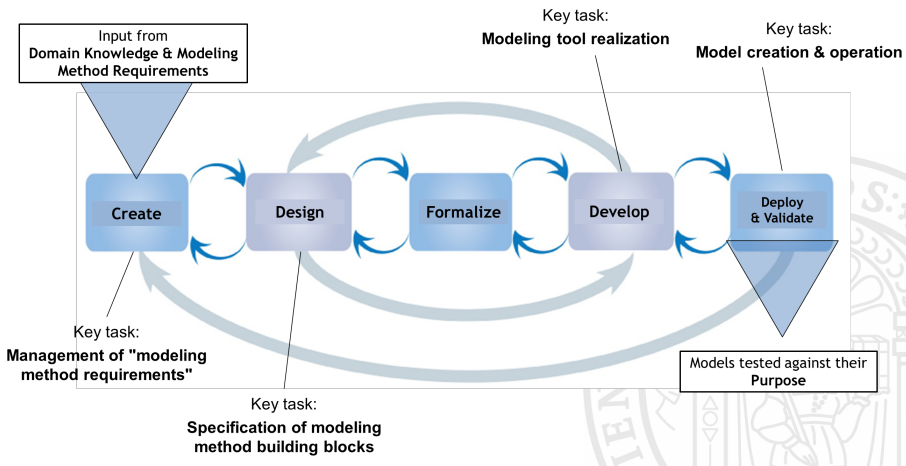
Agile Modeling Method Engineering (AMME): The Metamodeling Lifecycle



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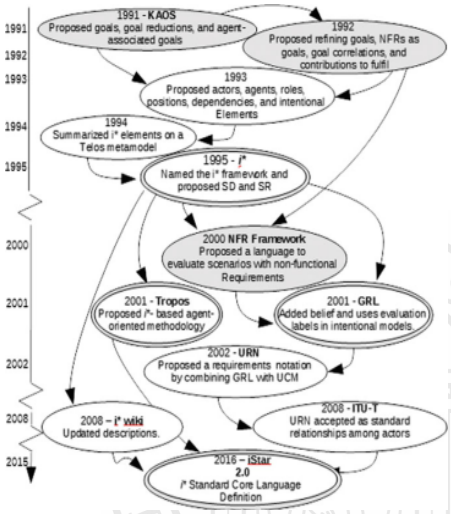
How is this relevant for i* ?

All modeling languages evolve, including i*

AMME enables this evolution in iterations that are:

- *more granular*
- *more productive*
- *more responsive*

… generally, more "agile"



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See Franch, X., Lopez, L., Cares, C., Colomer, D., *The i* Framework for Goal-Oriented Modeling*, in Domain-specific Conceptual Modeling, Springer, 2016, p. 485

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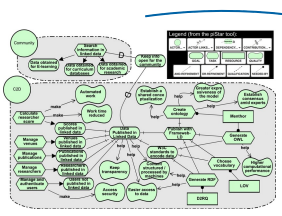
How is this relevant for i* ?



i*

A class of agile i* methods

The AMME realization approach

i*
value co-creation

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Levels of agility

1. **Graphical agility** (notation-level)
   Custom graphical shapes, dynamic and interactive symbols
2. **Syntactic agility**
   New restrictions on how graphical symbols are allowed to be combined in a specific type of model
3. **Conceptual agility**:
   New concepts/meaning added to the language
4. **Semantic agility**:
   Existing concepts enriched with properties and hyperlinks
5. **Functional agility**:
   New functionality in the modeling tool

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Possible Triggers for "Agile i* methods"

Conceptualizations of new i-star methods can be initiated by:

- **Shortcomings**
  e.g. criticism of i* notation, see the "physics of notation" in
  Moody, D. L., Heymans, P., Matulevicius, R., *Visual syntax does matter: improving the cognitive effectiveness of the i* visual notation*, Requirements Engineering 15(2):141-175
- **Explicit Requirements**
  e.g. see forward evaluation algorithm implemented in ADOxx in
  Franch, X., Lopez, L., Cares, C., Colomer, D., *The i* Framework for Goal-Oriented Modeling*, in Domain-specific Conceptual Modeling, Springer, 2016, p. 485
- **Domain-specific adaptations**
  e.g. see Secure Tropos (incorporating security concepts) in ADOxx in
  Mouratidis, H., Argyropoulos, N., Shei, Sh., *Security requirements engineering for cloud computing: the Secure Tropos approach*, in Domain-specific Conceptual Modeling, Springer, 2016, p. 357

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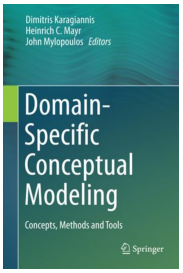
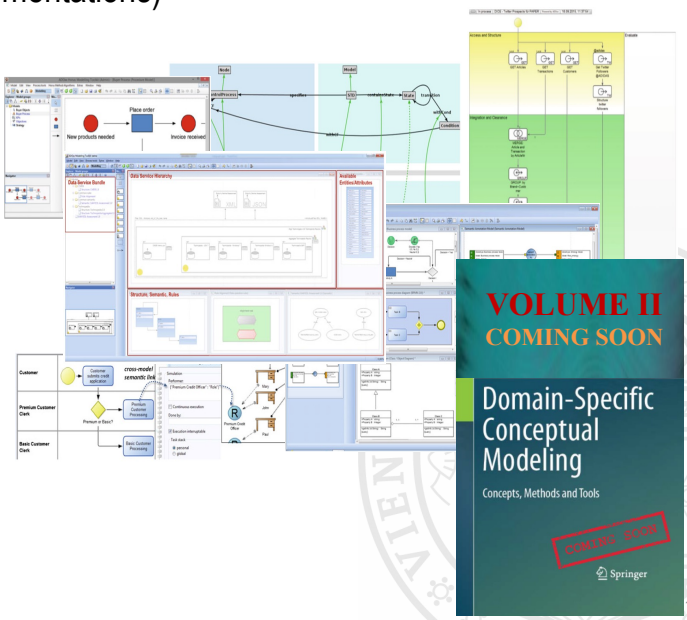
Conceptualization with ADOxx
(includes i* implementations)



Modeling tools developed on ADOxx



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The **conceptualization process** is required to **enable machine interpretation** of these languages. For that it is necessary to understand how these are conceptually structured.

The **"Purpose-Specificity Framework"** is discussed as an instrument to classify the **utilization**, considering propagation techniques of domain semantics and model-value functionalities.

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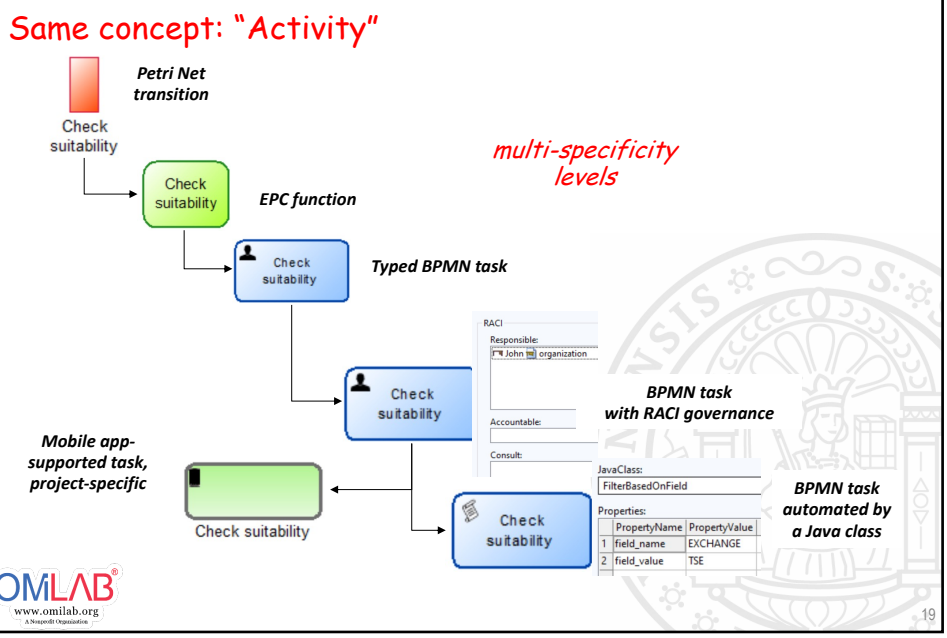
Domain + Changing Requirements => **Specificity Levels**



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We formulate 4 Classes of Specificity

Formalism-specific: highly-abstract concepts pertaining to a formalism (e.g. set theory, elementary nets)

Field-specific: concepts pertaining to a business sector, a field of activity

Technology-specific: concepts pertaining to a technology (e.g. SQL, RDF)

System-specific: concepts tightly-coupled with a system instance, not reusable anywhere else (e.g. an in-house ETL pipeline, custom system interfaces)

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We formulate 3 Classes of Purposes

Basic purpose: communication, understanding, documentation

Design-time purposes: purpose is fulfilled within the modeling environment (e.g. model analysis, simulation, report generation)

Run-time purposes: purpose is fulfilled at run-time based on interoperable model contents (e.g. code generation, process-aware systems, RPA)

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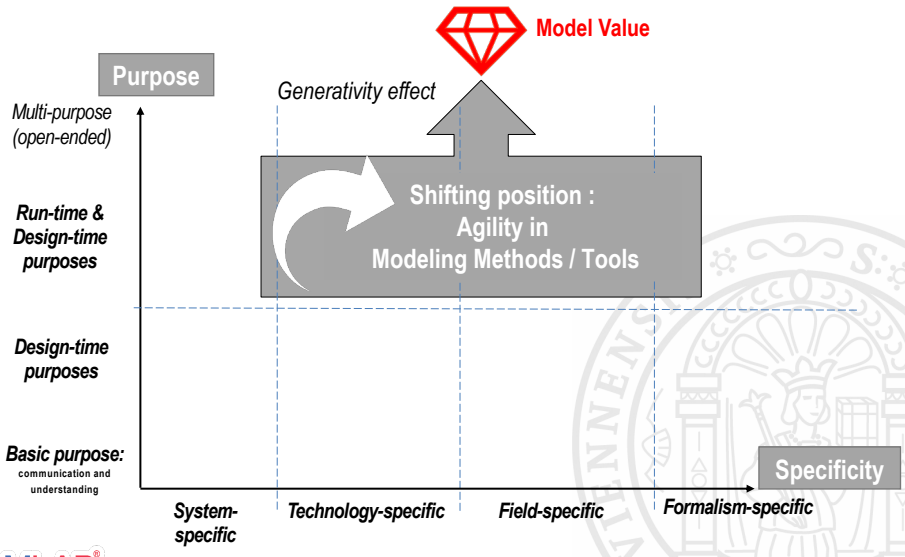
THE PURPOSE-SPECIFICITY FRAMEWORK



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See Buchmann R A, The Purpose-Specificity Framework for Domain-specific Conceptual Modeling, in Karagiannis et al. (eds.), Domain-specific Conceptual Modeling vol. 2, Springer, 2021, in press.

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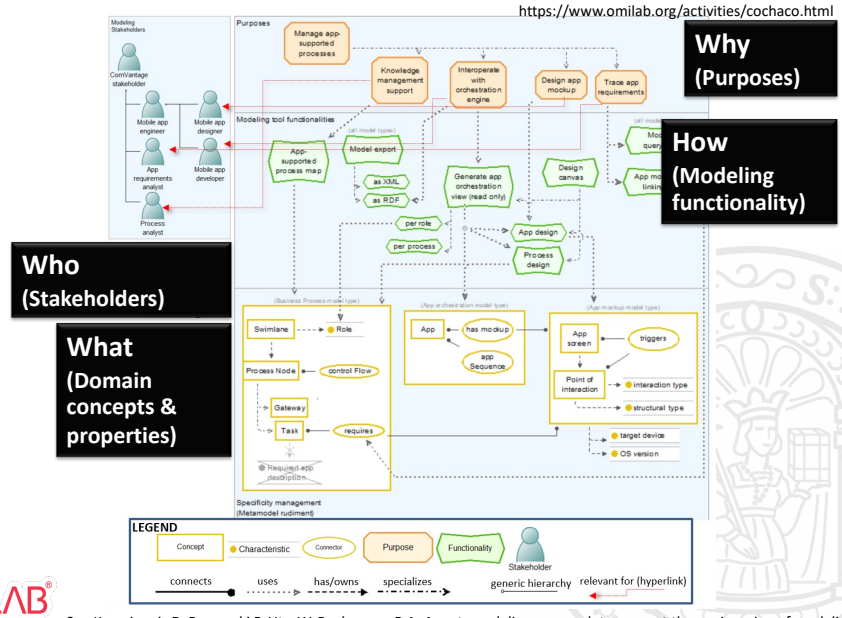
Managing **Requirements for Purpose-Specificity: CoChaCo**

https://www.omilab.org/activities/cochaco.html



See Karagiannis D, Burzynski P, Utz, W, Buchmann, R A, A metamodeling approach to support the engineering of modeling method requirements, in RE 2019, IEEE, DOI 10.1109/RE.2019.00030

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The **conceptualization process** is required to **enable machine interpretation** of these languages. For that it is necessary to understand how these are conceptually structured.

The **"Purpose-Specificity Framework"** is discussed as an instrument to classify the utilization, considering propagation techniques of domain semantics and model-value functionalities.

Impact in the sense of scientific/commercial uptake is closely related to the purpose of the language, linked to the application needs. Cases from the OMiLAB Community of Practice (www.omilab.org) are presented to explain the applicability of the framework and to discuss further research directions.

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IMPACT

Impact „supported by“ **technology**

-> TOOLING <-

Impact „supported by“ **content**

-> DOMAIN KNOWLEDGE <-

Impact „supported by“ **concepts**

-> APPLICABILITY VALUE <-

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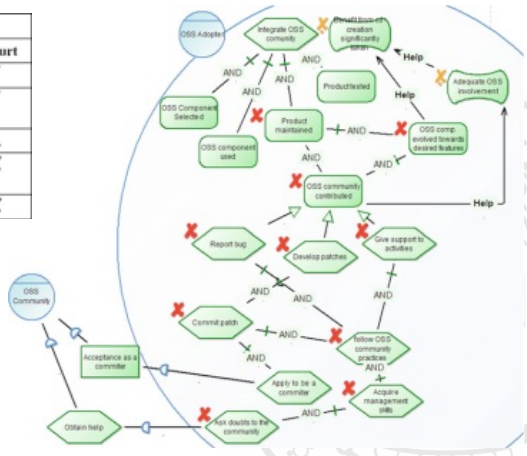
TOOLING: Functional requirements for i*

Forward evaluation algorithm with graphical markings
See Franch, X., Lopez, L., Cares, C., Colomer, D., *The i* Framework for Goal-Oriented Modeling*, in Domain-specific Conceptual Modeling, Springer, 2016, p. 485

Source Label		*Contribution* Link Type			
	Name	Make	Help	Break	Hurt
✓	Satisfied	✓	✓.	✗	✗.
✓.	Partially Satisfied	✓.	✓.	✗.	✗.
✗	Conflict	✗	✗	✗	✗
✗.	Partially Denied	✗.	✗.	✓.	✓.
✗	Denied	✗	✗.	✓.	✓.

Propagation rules



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DOMAIN: Domain-specific extensions of i*

Secure Tropos implementation
Mouratidis, H., Argyropoulos, N., Shei, Sh., *Security requirements engineering for cloud computing: the Secure Tropos approach*, in Domain-specific Conceptual Modeling, Springer, 2016, p. 357

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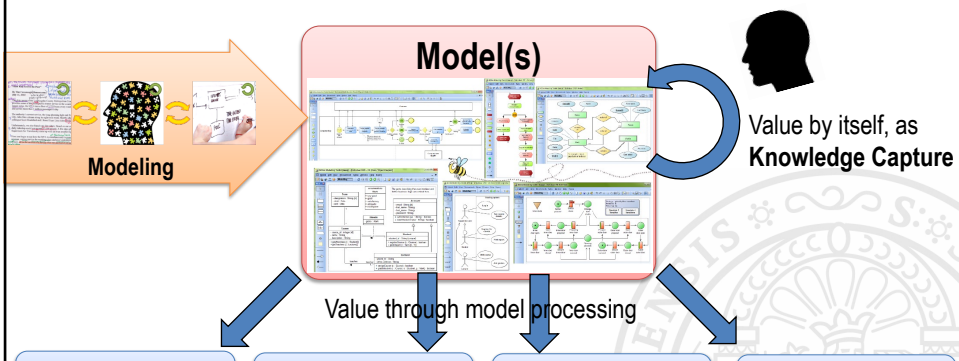
APPLICABILITY Impact through Model VALUE based on Metamodeling



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VALUE through Model Processing based on Metamodeling

BASIC MODEL PROCESSING:

- ✓ **Models can be Queried** (=machine-readable)
- ✓ **Models can be Semantically Connected** (=in a hypergraph)

ADVANCED MODEL PROCESSING:

=> Models can be **translated into code** (e.g. Low-code programming)

=> Models can **drive running code** (e.g. Process Automation)

=> Models can be **semantically rich virtualizations** (e.g. Digital Twins)

=> Models can be **generated out of Data** (e.g. Process Mining)

=> Models can be **analyzed** (e.g. Simulation)

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Topics of Interest – A Look Over the Years

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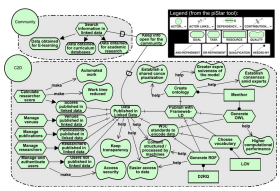
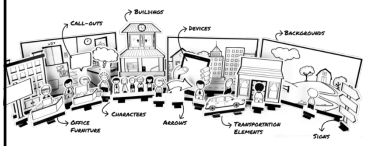
Further Potentials using Metamodeling within ADOxx



i*

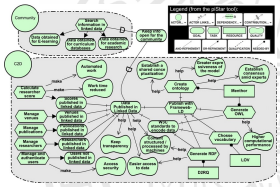
i*-empowered Digital Twins?

Cyber-physical systems



Design Thinking Scenes

Bridging Design Thinking and i*?



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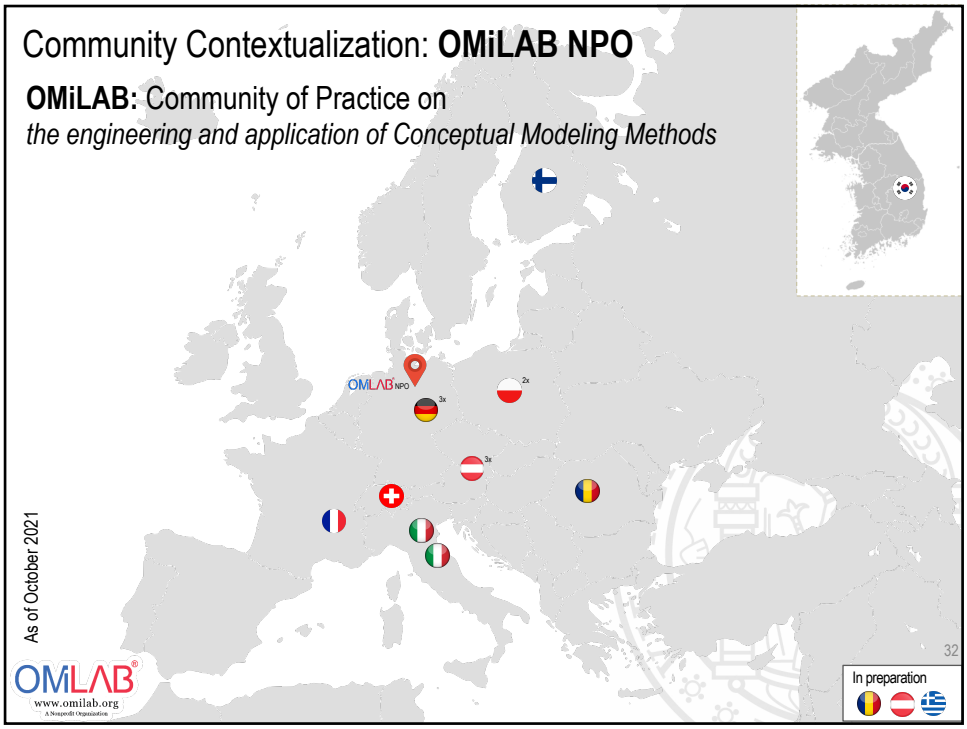
Community Contextualization: **OMiLAB NPO**

OMiLAB: Community of Practice on
the engineering and application of Conceptual Modeling Methods



As of October 2021

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In preparation

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Key Value Proposition of OMiLAB "Nodes"

The Digital Innovation Environment (DIEn):

Academic
OMiLAB Innovation Corner

Industrial
OMiLAB Innovation Corner

A layered installation having Conceptual Models as a semantic core

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OMiLAB's DIEn Instantiation of AMME

Modeling Method Requirements derived through Digital Design Thinking

Input from **Digital Design Thinking storyboards**

Key task: **Digitization of SAP Scenes** (Scene2Model)

Key task: **Modeling tool adaptation** (ADOxx)

Key task: **Model interoperability** (OLIVE integration platform & connectors)

Create → Design → Formalize → Develop → Deploy & Validate

Key task: **Management of "modeling method requirements"** (CoChaCo)

Key task: **Specification of modeling method building blocks** (CoChaCo)

Key task: **Prototyping** (Cyber-physical development platforms)

Models interoperable with **Physical Twins & Digitized Services**

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Modeling Tool deployment for Cyber-Physical Integration

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COMMUNITY RESULTS: TOOLING

https://www.omilab.org/activities/projects/

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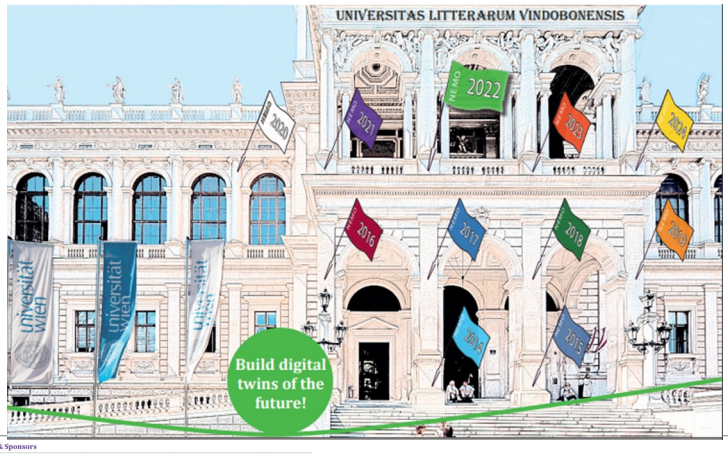
NEMO: BECOME A DIGITAL LEADER



Contributing Institutions & Sponsors

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- Focuses on the conceptualization, design, and implementation of Next Generation Enterprise Modelling Methods.
- Modelling tools and platforms which support domain specific methods need to provide user interaction functionalities and enable management capabilities for the execution environment in addition to the modelling method design and implementation.

The 8th Edition takes place between the 11th and 22nd of July 2022

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CONCLUSION

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Conceptual modeling: An "Engineering" Approach

We use abstraction
to reduce complexity in a domain
for a specific purpose

D. Karagiannis (2016): When employed in the context of an Agile Enterprise, an underlying requirement for Conceptual modeling ***agility*** emerges - manifested not only *on* ***model content level***, but also *on* ***modeling method level***.

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Thank you!
For follow-up questions:

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