TU WIEN BI
Business Informatics Group

The enduring value of conceptual modelling

Hend*erik* A. Proper

30.06.2026

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The enduring value of conceptual modelling –

Fundamentally understanding what we are reasoning, explaining, and coding about

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Conceptual modelling

Conceptual modelling

An often hidden

Conceptual modelling

An often hidden,
and yet frequently critical

Conceptual modelling

An often hidden,
and yet frequently critical,
natural human activity ...

Agenda

1. Some use cases for conceptual modelling
2. Conceptual models
3. The roots of conceptual modelling
4. ViA RoME
5. Some thoughts on value in creation
6. Wrap up

Agreeing on concepts

Agreeing on concepts – Facing variety

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What is a customer?

Agreeing on concepts – Facing variety

What is a customer?

A definition; taken from WikiPedia:

> *In sales, commerce, and economics, a customer (sometimes known as a client, buyer, or purchaser) is the recipient of a good, service, product, or an idea, obtained from a seller, vendor, or supplier via a financial transaction or an exchange for money or some other valuable consideration*

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Your own definition?

Agreeing on concepts – Facing variety

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Your own definition?

How many definitions used in a real world organisation?

Agreeing on concepts

Agreeing on concepts – How to count?

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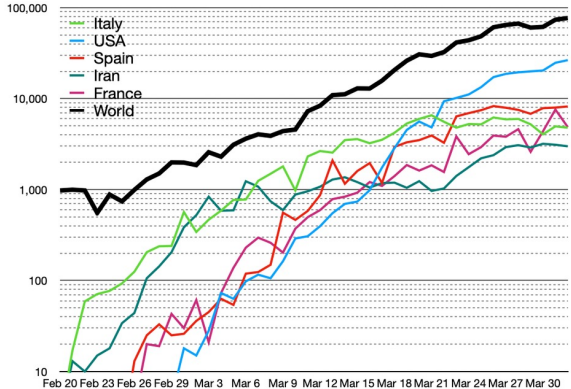
Covid-19; *definition of the number of Covid cases?*

Agreeing on concepts – How to count?

Covid-19; *definition of the number of Covid cases?*



Source: `https://theconversation.com/coronavirus-country-comparisons-are-pointless-unless-we-account-for-these-biases-in-testing-135464`

Defining concepts

Defining concepts – What is an event?

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Actually a billion € question

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9/11 attacks; *one event, or multiple events?*

Defining concepts – What is an event?

Actually a billion € question

9/11 attacks; *one event, or multiple events?*

> Swiss Re said on Wednesday that a New York appeals court had ruled in its favour in a compensation dispute with the leaseholder of the World Trade Center (WTC).
>
> October 19, 2006 - 00:05
>
> It said the court had confirmed that the destruction of the WTC in the September 11, 2001 terrorist attacks was a single event and not a double one as the leaseholder claimed. The ruling ends a long legal battle.

Source: https://www.swissinfo.ch/eng/demographics/swiss-re-wins-world-trade-center-case/5510012

Understanding concepts

Understanding concepts – What's a train?

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Source: https://www.railadvent.co.uk/2023/07/35-more-double-decker-trains-to-be-produced-for-austria.html

Understanding concepts – What's a train?

Source: https://www.railadvent.co.uk/2023/07/35-more-double-decker-trains-to-be-produced-for-austria.html

A train-set with a locomotive and carriages?

A planned slot in the train schedule?

A specific train-set travelling from Innsbruck to Vienna on a specific day, and at a specific time?

Understanding concepts – Car colour?

Understanding concepts – Car colour?

Source: http://www.fixation.ca/painting.html

Understanding concepts – Car colour?

Source: http://www.fixation.ca/painting.html

Car repair shop:

- What is the colour of a car?
- What layers of coating?

Understanding concepts – Dining out?

Understanding concepts – Dining out?

Source: https://www.gloriafood.com/restaurant-seating-strategy

Understanding concepts – Dining out?

Source: https://www.gloriafood.com/restaurant-seating-strategy

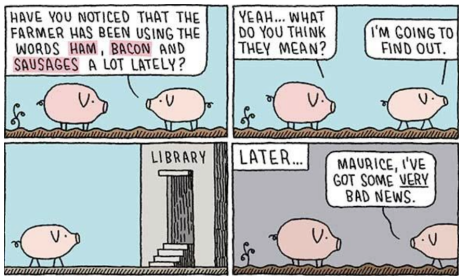
Table management:

- Group of people consuming food and beverages
- Possibly moving between bar and table(s)
- Possibly with allergies
- Possibly paying separately

Explaining concepts

Explaining concepts – Your bacon, or mine?

Explaining concepts – Your bacon, or mine?



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Giancarlo Guizzardi and Nicola Guarino (2024). "Explanation, Semantics, and Ontology". In: *Data & Knowledge Engineering* 153, p. 102325. ISSN: 0169-023X:

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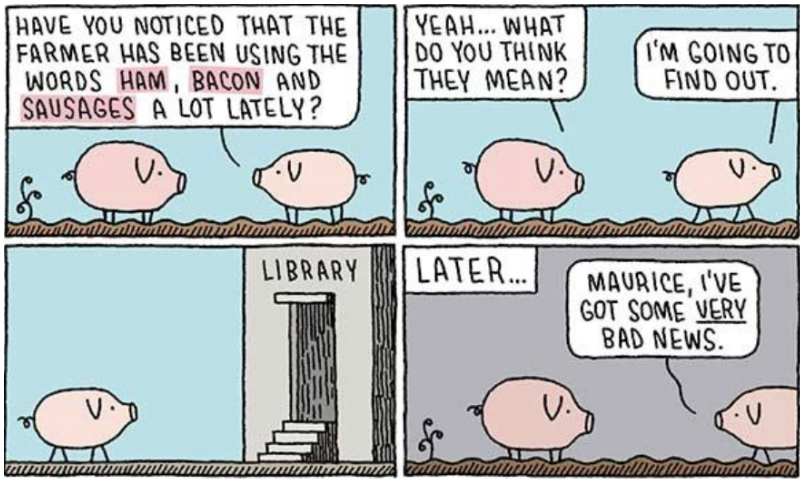

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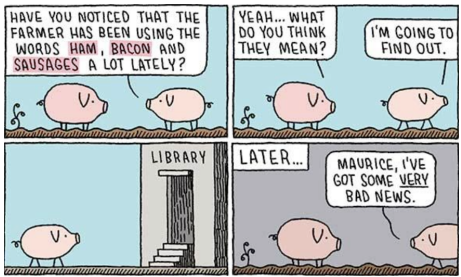

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> *Mapping the words 'ham', 'bacon' and 'sausages' to subsets of a semantic domain would not do Maurice here any good, and would not explain why having these words frequently mentioned by the farmer would be very bad news for the pigs.*

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Definitions ...

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Henderik A. Proper and Giancarlo Guizzardi (Oct. 2024). "Understanding the Variety of Domain Models: Views, Programs, Animations, and Other Models". In: *SN Computer Science* 5.7, p. 861

Domain model

A social artefact that is understood, and acknowledged, by a (collective) human agent to represent an abstraction of some domain for a particular cognitive purpose.

Definitions ...

Henderik A. Proper and Giancarlo Guizzardi (Oct. 2024). "Understanding the Variety of Domain Models: Views, Programs, Animations, and Other Models". In: *SN Computer Science* 5.7, p. 861

Conceptual model

A domain model, where (1) the purpose of the model is dominated by the ambition to remain as-true-as-possible to the conceptualisation of the domain by the collective agent, while (2) there is an explicit mapping from the elements in the model to the latter conceptualisation.

Expressing conceptual models

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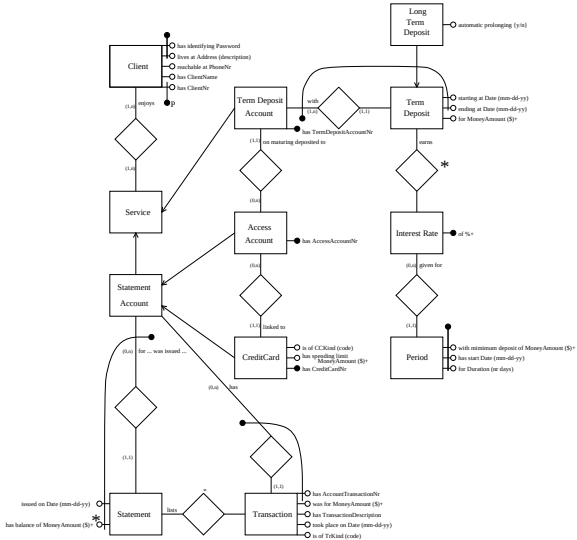

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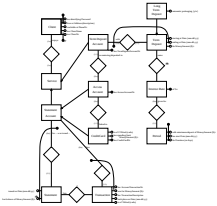

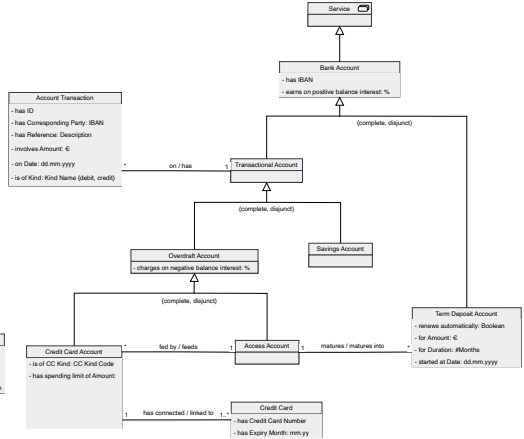

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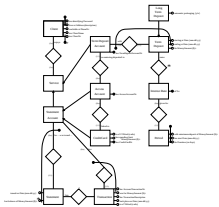

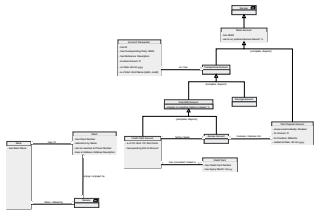

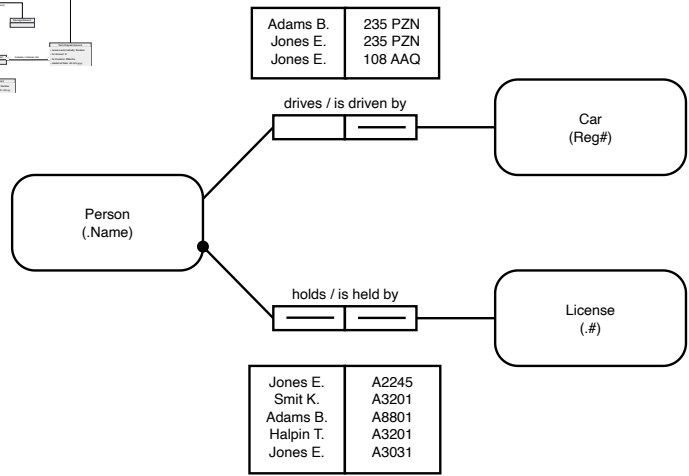

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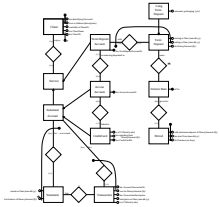

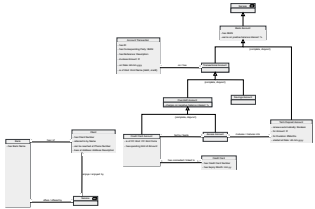

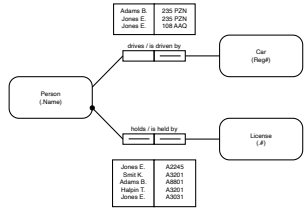

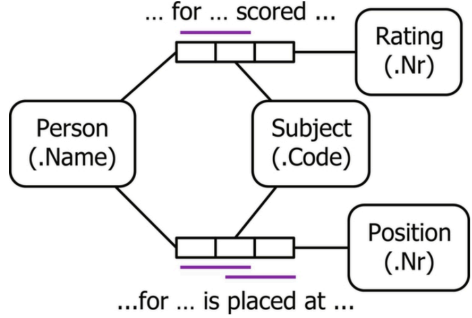

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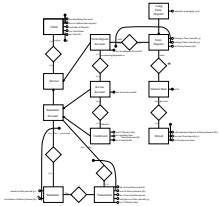
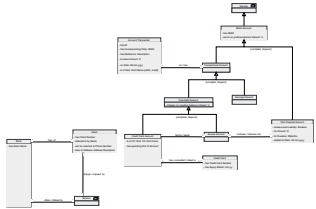
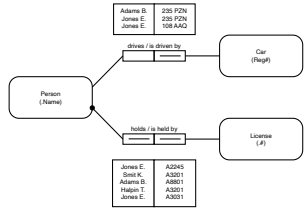
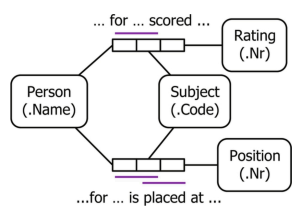






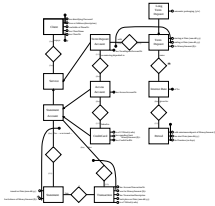


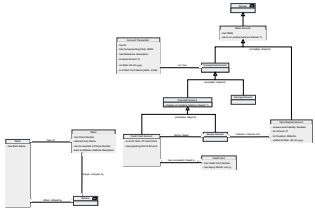
Person with Person Name 'Adams, B.' drives the Car with Reg# '235 PZN'

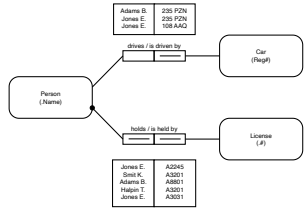
Person with Person Name 'Jones, E.' drives the Car with Reg# '235 PZN'

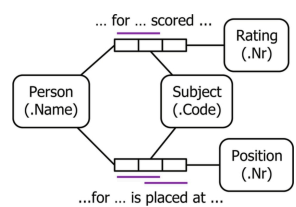
Person with Person Name 'Jones, E.' drives the Car with Reg# '108 AAQ'

Expressing conceptual models









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if some Athlete engages in the Sport 'Cycling' then
that Athlete does not consume a Weekly serving of
some Milk based drink serving
which contains a Cholesterol mass which is $>$ 36 miligram

Expressing conceptual models

Examples of traditional conceptual modeling languages:

- (Structured) natural language
- Graph-like languages
- ER(s)
- Fact-based Modeling: NIAM, ORM, FCOIM, ...
- UML class diagrams

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but also:

- BPMN for business processes
- ArchiMate for enterprise architectures
- OntoUML for ontologies
- ...

Expressing conceptual models

Abstract syntax:

- a graph labelled with meaningful names,
- possibly with (non-cyclic) (stereo) typing relations,
- possibly with associated rules, and
- definitions of the involved concepts

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The graph should match the concepts (including types and instances) as observed (conceptualised) in the modelled domain as *truly* as 'possible'

Expressing conceptual models

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Concrete syntax:

- represented by a visual and/or textual notation

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Understandable to the modeller and/or domain expert

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Daniel L. Moody (May 2010). "The "Physics" of Notations: A Scientific Approach to Designing Visual Notations in Software Engineering". In: *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering – ICSE 2010, Cape Town, South Africa, 1-8 May 2010*. Ed. by Jeff Kramer et al. Vol. 2. New York City, New York, USA: ACM, pp. 485–486. ISBN: 978-1-60558-719-6

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Paul J. M. Frederiks and Theo P. van der Weide (July 2006). "Information Modeling: The Process and the Required Competencies of Its Participants". In: *Data & Knowledge Engineering* 58.1, pp. 4–20. ISSN: 0169-023X

Elephants in the room?

Source: https://www.milwaukeeindependent.com/reggie-jackson

Elephants in the room?

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Agile: *Do we need modelling? Modelling by coding?*

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AI: *Can't we use LLM's to do the modelling? Are models needed at al?*

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Agile: *Do we need modelling? Modelling by coding?*

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AI: *Can't we use LLM's to do the modelling? Are models needed at al?*

But how about: *defining*, *agreeing*, *understanding*, *explaining*, ...

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The roots of conceptual modeling

Conceptual schema in information systems engineering:

> *ISO/IEC JTC 1/SC 32 Technical Committee on Data management and interchange (1987). Information Processing Systems – Concepts and Terminology for the Conceptual Schema and the Information Base. Tech. rep. ISO/TR 9007:1987. ISO*

The roots of conceptual modeling

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But, as discussed in Guarino, Guizzardi, and Mylopoulos, 2019, there are older roots:

> *M. R. Quillian (1968). "Semantic Memory, Semantic Information Processing". PhD thesis. Boston, Massachusetts, USA: MIT*

Beyond information systems engineering

Conceptual models have a much broader role to play in society than conceptual database design

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They allow us to define, agree on, understand, and explain, the concepts, and their relations, in any domain

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Where *logic* has brought us discipline for the way we reason, conceptual modeling can bring discipline to the way we *define* what we reason, learn, explain, and talk, *about*

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Discipline via ...

Beyond information systems engineering

For example, by following the steps:

- Verbalisation of elementary propositions (analogous to e.g. ORM)
- Identification of truth-bearers and truth-makers; leading to facts
- Identification of relators (e.g. marriage, membership, ...)
- Grounding of the conceptual model on a foundational ontology

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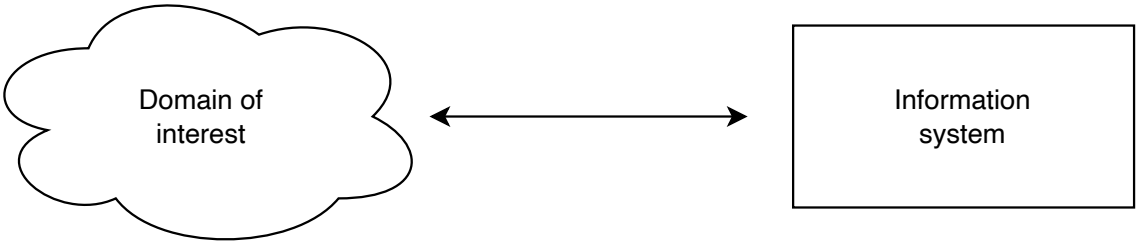
Where the actual modelling language used may also depend on the (relevant) properties of the domain being modelled

For instance: *static structures* versus *processual dynamics*

Applied in an ISE context



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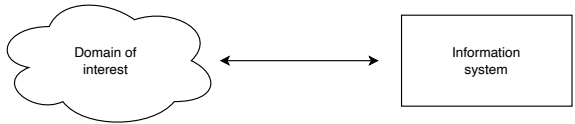
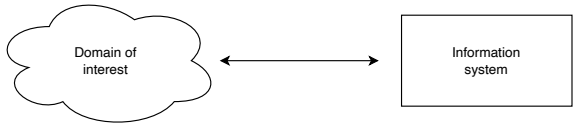


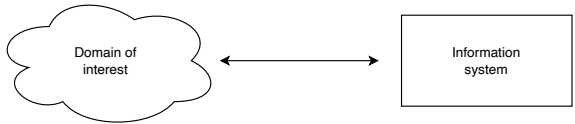
- Create a conceptual (ontology) model of the domain the information system will be ‘about’

Applied in an ISE context



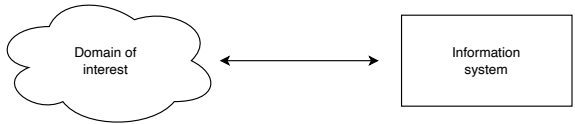
- Create a conceptual (ontology) model of the domain the information system will be 'about'
- Determine what the information system should know about this domain, and the needed (possibly bi-directional) *fidelity*

Applied in an ISE context



- Create a conceptual (ontology) model of the domain the information system will be 'about'
- Determine what the information system should know about this domain, and the needed (possibly bi-directional) *fidelity* and *rate*

Applied in an ISE context



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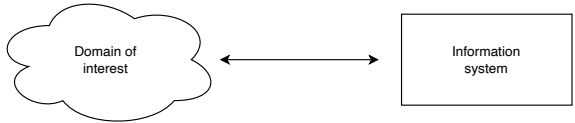

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- Capture this in a conceptual (data) model, and ensure we can identify all 'things' the information system needs to refer to
- Use the resulting conceptual (data) model as a base to implement the information system

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Return on Modelling Effort – RoME

Henderik A. Proper and Giancarlo Guizzardi (2023). "Modeling for Enterprises; Let's go to RoME ViA RiME". In: *Proceedings of the Forum at Practice of Enterprise Modeling 2022 (PoEM-Forum 2022) co-located with PoEM 2022, London, UK, November 23-25, 2022*. Ed. by Tony Clark et al. Vol. 3327. CEUR Workshop Proceedings. Aachen, Germany: CEUR-WS.org, pp. 4–15. URL: https://ceur-ws.org/Vol-3327/paper02.pdf

Return on Modelling Effort – RoME

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Return on Modelling Effort – RoME

Modelling involves different (potential) efforts

Return on Modelling Effort – RoME

Modelling involves different (potential) efforts

Beforehand:

- Learn a language/conventions
- Acquire needed tools and infrastructures

Return on Modelling Effort – RoME

Modelling involves different (potential) efforts

During model creation:

- Gather relevant sources
- Creation of the model

Return on Modelling Effort – RoME

Modelling involves different (potential) efforts

After model creation:

- Management of the model
- Utilisation of the model
- Interpreting the model

Return on Modelling Effort – RoME

Modelling is done for a reason ... its purpose

Return on Modelling Effort – RoME

Modelling is done for a reason ... its purpose

Value-in-Action (ViA):

- Value-in-Use of a model
- Value-in-Creation of a model

Return on Modelling Effort – RoME

Modelling is done for a reason ... its purpose

Value-in-Action (ViA):

- Value-in-Use of a model
- Value-in-Creation of a model

Isadora Valle Sousa et al. (2026). "Modeling Value Canvas – A Tool to Rationalize the Value of Domain Modeling". In: *Advanced Information Systems Engineering – 38th International Conference, CAiSE 2026, Verona, Italy, June 8-12, 2026, Proceedings, Part I*. ed. by Lidia Fuentes et al. Vol. 16558. Lecture Notes in Computer Science. Berlin, Germany: Springer, pp. 119–136. ISBN: 978-3-032-28110-4

Agenda

1. Some use cases for conceptual modelling
2. Conceptual models
3. The roots of conceptual modelling
4. ViA RoME
5. Some thoughts on value in creation
6. Wrap up

Conceptual modelling is best done slowly

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Giancarlo Guizzardi, Oscar Pastor, and Veda C. Storey (Nov. 2023). "Thinking Fast and Slow in Software Engineering". In: *IEEE Software* 40.6, pp. 139–142. ISSN: 0740-7459

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Conceptual modelling primarily involves a system 2 type of thinking activity

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Conceptual modelling primarily involves a system 2 type of thinking activity

A disciplined way of (self!) creating conceptual models can aid in engaging system 2 type thinking processes

Enable ownership by engagement

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Initial results from interviews with modellers from practice confirms that going through the process of creat*ing* a model together with domain experts, increases their understanding ownership of the result

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Use the language of the domain experts in the modelling process!

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Engage domain experts by asking them to (help) verbalise/formulate examples

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Use the language of the domain experts in the modelling process!

Engage domain experts by asking them to (help) verbalise/formulate examples

Also relates to the notion of *self explanation*

Michelene T. H. Chi et al. (1989). "Self-Explanations: How Students Study and Use Examples in Learning to Solve Problems". In: *Cognitive Science* 13.2, pp. 145–182

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Elephants in the room?

Source: https://www.milwaukeeindependent.com/reggie-jackson

Agile: *Do we need modelling? Modelling by coding?*

Low code: *Or even 'no-code'*

AI: *Can't we use LLM's to do the modelling? Are models needed at al?*

Elephants in the room?

Source: https://www.milwaukeeindependent.com/reggie-jackson

Agile: *RoME based tradeoffs on why/what/how to model!*

Low code: *Or even 'no-code'*

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Elephants in the room?

Source: https://www.milwaukeeindependent.com/reggie-jackson

Agile: *RoME based tradeoffs on why/what/how to model! Ownership?*

Low code: *Or even 'no-code'*

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Source: https://www.milwaukeeindependent.com/reggie-jackson

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Elephants in the room?

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Agile: *RoME based tradeoffs on why/what/how to model! Ownership?*

Low code: *Specification burden remains; low on code → high on models*

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Elephants in the room?

Source: https://www.milwaukeeindependent.com/reggie-jackson

Agile: *RoME based tradeoffs on why/what/how to model! Ownership?*

Low code: *Specification burden remains; low on code → high on models*

AI: *Explain, understand, & take ownership of, what AI is reasoning about*

A role for AI in conceptual modelling

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Mixing three kinds of intelligence:

1. Human intelligence
2. Symbolic AI
3. Sub-symbolic AI

A role for AI in conceptual modelling

Mixing three kinds of intelligence:

1. Human intelligence
2. Symbolic AI
3. Sub-symbolic AI

Christophe Feltus et al. (2021). "Towards AI Assisted Domain Modeling". In: *Advances in Conceptual Modeling – ER 2021 Workshops CoMoNoS, EmpER, CMLS, St. John's, NL, Canada, October 18-21, 2021, Proceedings*. Ed. by Iris Reinhartz-Berger and Shazia W. Sadiq. Vol. 13012. Lecture Notes in Computer Science. Berlin, Germany: Springer, pp. 75–89. ISBN: 978-3-030-88358-4

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