TU WIEN BI
Business Informatics Group

What are we reasoning, learning, and talking about?

Hend*erik* A. Proper

24.09.2024

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My interests

Understanding, and improving, domain modeling practices

In particular in the context of enterprises

Agenda

1. Meaning and explanation
2. Conceptual models
3. Information systems revisited

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The meaning of things

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What is a customer?

The meaning of things

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?

The meaning of things

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Your own definition?

How many definitions used in your organization?

The meaning of things

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

The meaning of things

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.

The meaning of things

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

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

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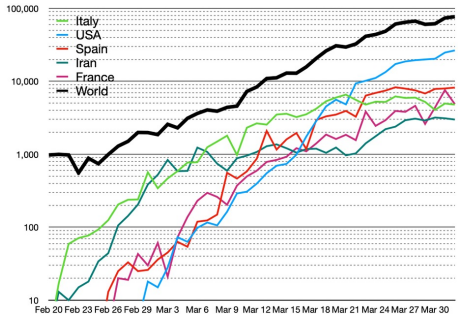

Source: `https://theconversation.com/coronavirus-country-comparisons-are-pointless-unless-we-account-for-these-biases-in-testing-135464`

The meaning of things

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

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

... .. .

The meaning of things

Mealy, 1967:

> *Data are fragments of a theory of the real world, and data processing juggles representations of these fragments of theory ...*
>
> *The issue is one of ontology, or the question of what exists.*

Explaining things

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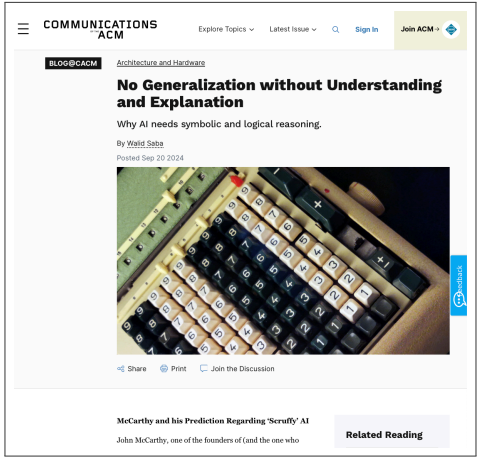
Explainable (& transparent) AI

Explaining things

Explainable (& transparent) AI



Explaining things

Explainable (& transparent) AI

Just explainable AI?

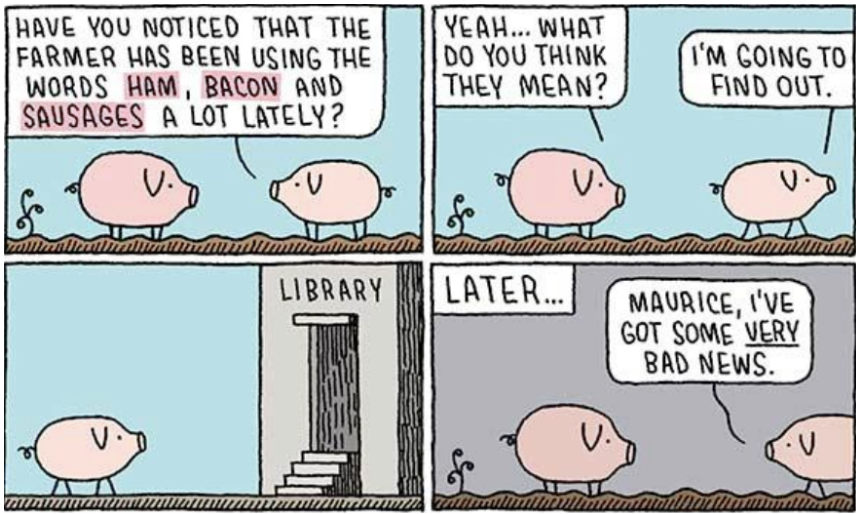
Explaining things

Explainable (& transparent) AI

Just explainable AI?

How about decisions made by complex (rule-based) systems!?

Explaining things



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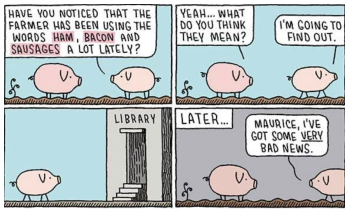
Explaining things

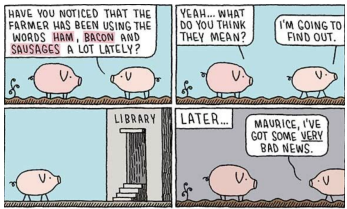


©Tom Gauld

Guizzardi and Guarino, 2024:

> *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.*

Explaining things



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Guizzardi and Guarino, 2024:

> *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. Obviously, for the same reason, it would not explain what kind of reasoning steps we take to understand the implicit joke.*

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Domain models

Domain model

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

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

Not just boxes-and-lines:

> *Henderik A. Proper and Giancarlo Guizzardi (2024). "Understanding the Variety of Domain Models: Views, Programs, Animations, and Other Models". In: SN Computer Science 5.* URL: *https://doi.org/10.1007/s42979-024-03163-y*

Conceptual models

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 conceptualization of the domain by the collective agent, while
2. there is an explicit mapping from the elements in the model to the latter conceptualization.

Conceptual models

Examples of traditional conceptual modeling languages:

- ER
- Fact-based Modeling (Halpin and Morgan, 2008):
  NIAM, ORM, FCOIM, ...
- UML class diagrams

Conceptual models

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but also:

- BPMN for business processes
- ArchiMate for enterprise architectures
- e3Value for value networks
- OntoUML for ontologies
- ...

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, 2020, 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 . . . they allow us to understand 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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Could pertain to an existing situation, as well as a desired, or imaginary, situation

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Discipline via ...

Beyond information systems engineering

For example, by following the steps:

- Verbalization of elementary propositions (good old NIAM/ORM)
- Identification of how we refer to things
- 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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Conceptual models in a world of data and AI

Defining semantics; *what's this data about?*

Conceptual models in a world of data and AI

Defining semantics; *what's this data about?*

Enabling explanations; *what are the actual relations and causalities?*

Conceptual models in a world of data and AI

Defining semantics; *what's this data about?*

Enabling explanations; *what are the actual relations and causalities?*

Which also takes us back to information systems engineering

Information systems

Position statements ...

Information systems

Position statements:

- where there is data (with value) there is an information system,

Information systems

Position statements:

- where there is data (with value) there is an information system,
- where there is AI (in use) there is an information system, and

Information systems

Position statements:

- where there is data (with value) there is an information system,
- where there is AI (in use) there is an information system, and
- a Digital Twin, as a functioning system, is an information system

Domain awareness

Is the information system able to ‘reason’ explicitly about the domain they are concerned with?

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For instance, to:

- provide advice to its users,
- trigger actions, or even
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Examples:

- *Business process aware information systems*
- *Business transaction aware information systems*
- *Information systems involving explainable (AI) functionality*

The role of conceptual modeling

The role of conceptual modeling

Where conceptual modeling has a broader role to play then information systems engineering alone, its role in data-fueled and AI-driven, information systems becomes even more crucial

The role of conceptual modeling

Suggested approach:

The role of conceptual modeling

Suggested approach:

1. *Conceptual ontology model*

   Start from a thorough understanding, in terms of its *ontology*, of the domain of interest of the information system, abstracting from the way in which the domain of interest will be represented, as well as associated technology choices

The role of conceptual modeling

Suggested approach:

1. *Conceptual ontology model*
2. *Conceptual data model*

   Using the conceptual ontology model as a base, we then define a conceptual data model which identifies those elements of the domain of interest that are to be represented (as data) by the computerized information system, as well as possible explanations
   Example: *All people have a gender, but will we actually require the recording of the gender of all people?*

The role of conceptual modeling

Suggested approach:

1. *Conceptual ontology model*
2. *Conceptual data model*
3. *Logical data model*

   Using the conceptual data model as a base, as well as insights regarding e.g. the potential number of instances, as well as the kinds/frequency of queries to be put the information system, we can already make some optimizations, while still remaining agnostic with regards to the underlying database platform

The role of conceptual modeling

Suggested approach:

1. *Conceptual ontology model*
2. *Conceptual data model*
3. *Logical data model*
4. *Physical data model*

   Given an actual database platform of choice, we can make a model of how the data will actually be stored/managed in terms of the underlying database platform
   Example: *SQL table structures, RDF triplets, knowledge graphs, ...*

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