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Interactive Visualisations: Joining Interaction Design and Software Engineering

Jens Gulden

Information Systems and
Enterprise Modeling

ICB Institute for Computer Science
and Business Information Systems

Institut für Informatik und
Wirtschaftsinformatik (ICB)

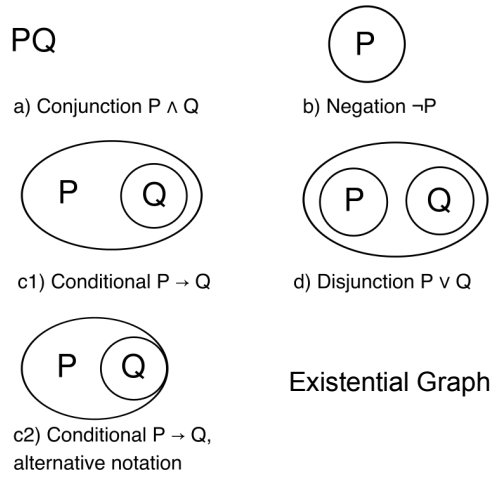
UNIVERSITÄT
DUISBURG
ESSEN

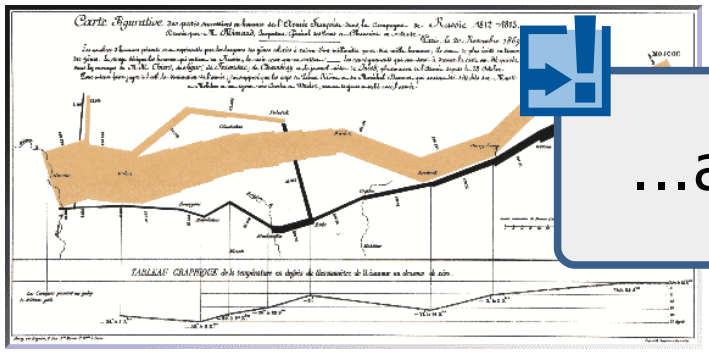
Agenda

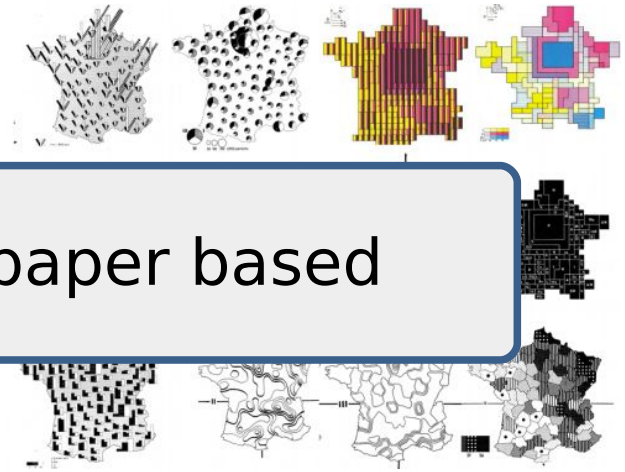
1. Interactive Visualisations
2. Interactive Visualisation Development as Software Development
3. First own Publications on the Topic

Traditional Information Visualisation

- Principles of presenting information visually are examined since the end of the 19th century.
- Connection between diagrams and human thinking reflected since C. S. Peirce 1902 (“diagrammatic reasoning”)
- Bertin 1967, Tufte 1983: empirical collections of diagram types



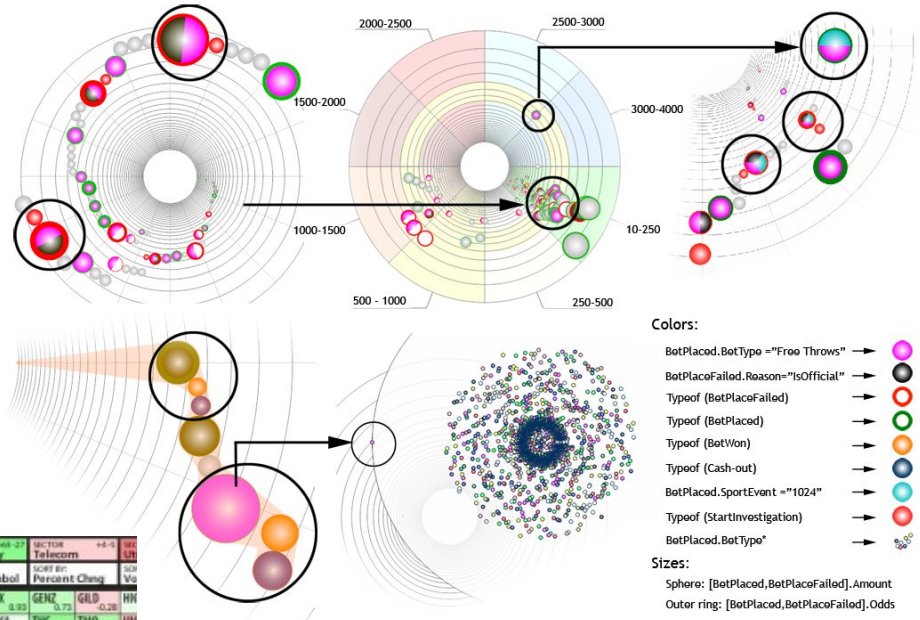




...all paper based

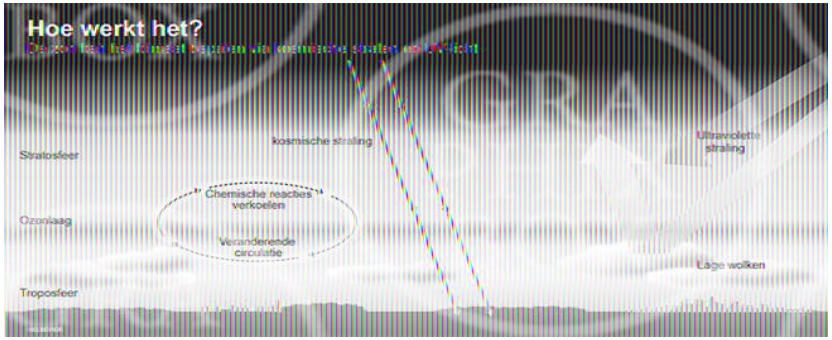
Interactive Visualisations

- Reports, Charts
- Clickable Maps
- Infographics
- etc.



https://www.cg.tuwien.ac.at/research/publications/2007/TR-186-2-07-07/

http://www.vizworld.com/2010/04/stockmapper-interactive-stock-market-visualization



https://www.graphix-box.nl/en

Creating Interactive Visualisations

Interactive visualisation development involves...

Research / Journalism

motivation and knowledge

Visual Conceptualization

what to show and how to interact with it

Graphic Design

showing things recognizable and beautiful

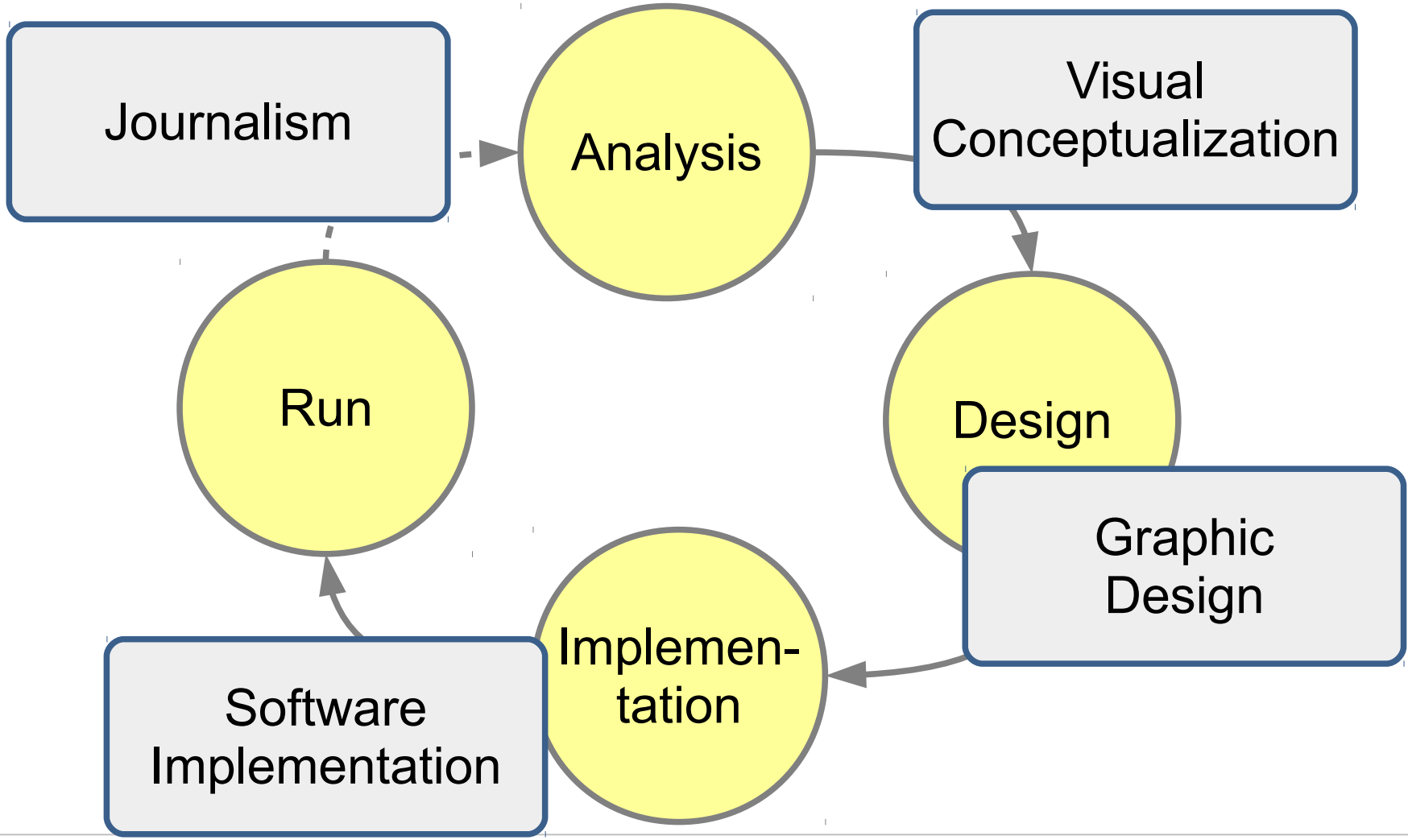
Software Development

technical realization

[Cairo12]

...through the Eyes of a Software Developer

- Software development method

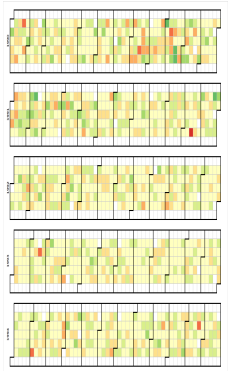


Interactive Visualisations as Software Products

- Fundamental: interactive visualisations **require software** to provide interactivity

→ Strong **link** to software development

- Typical technologies for implementation:
  - Action Script in Flash / Dynamic HTML with JavaScript
  - Libraries: D3, Infoviz, Prefuse, ...
  - Technological components, but not “thinking” in terms of knowledge-presentation, information needs, etc.



http://d3js.org/

Interactive Visualisation Development from the Software Development Perspective

- Methods and principles from software development
- Esp. **Domain Specific Software Development**
  - Interactive Visualisations form their **own class of software products**
  - To be examined: what is the **language spoken** when creating interactive visualisations
  - Potential of re-use → capture common abstractions via domain specific **models**
  - Maybe combine with visual **prototype editors**
  - Finally model-driven code-generation to create interactive visualisation (semi-)automatically

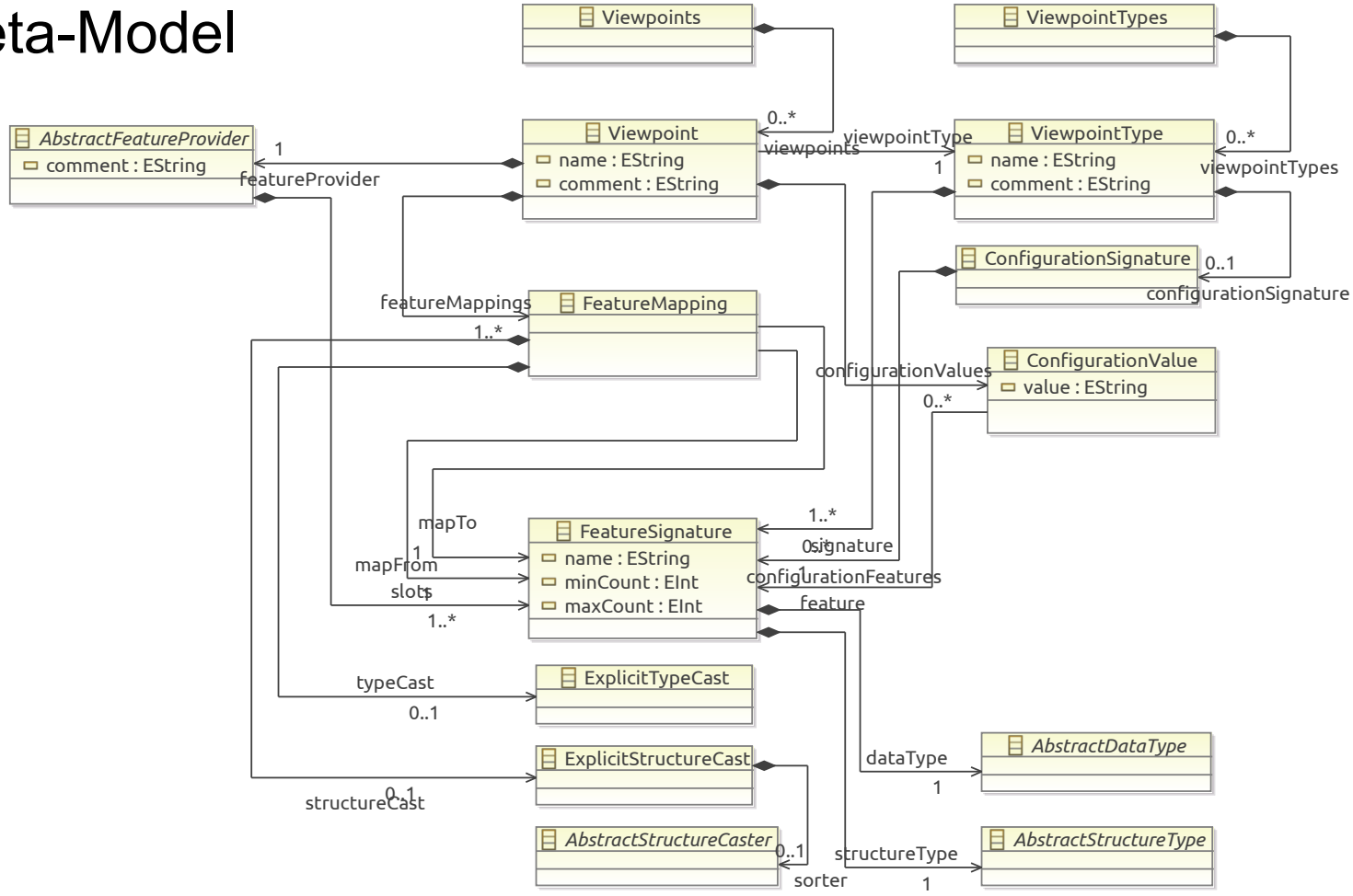
Research Question

- The software development that is part of creating interactive visualisations can be seen as a **software development project**

Research question: How can software development techniques be applied to interactive visualisation development, in a way that interactive visualisation software can be developed faster, cheaper, and less error-prone?

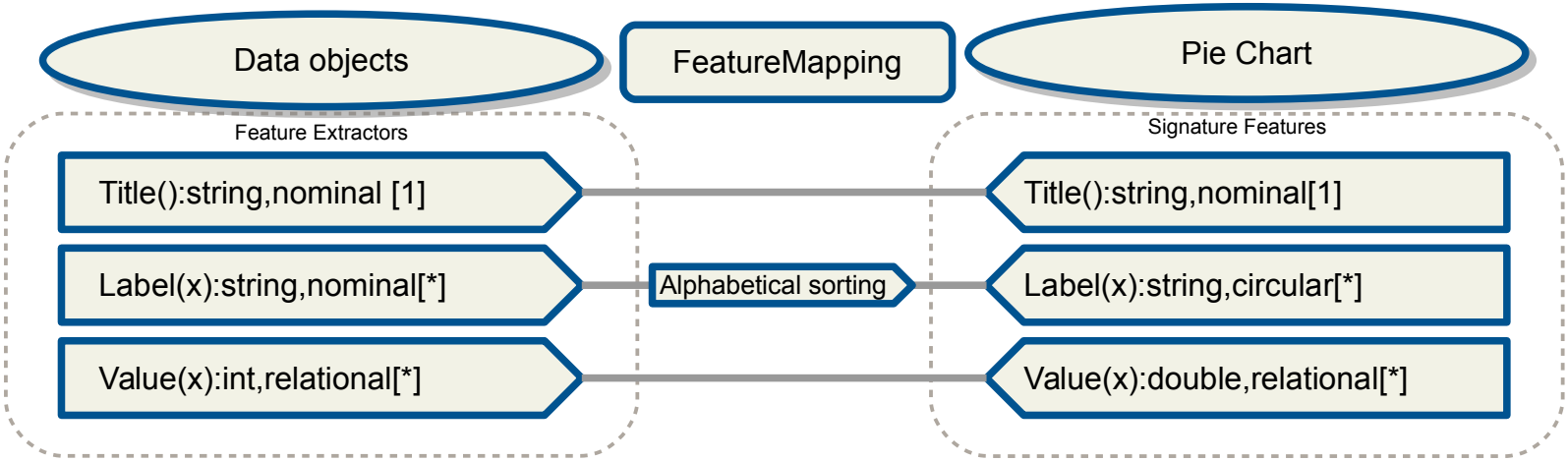
[Gulden15a] Unifying Data and Visualisations

- Suggestion for a unified description of data characteristics and visualisation characteristics
- Meta-Model

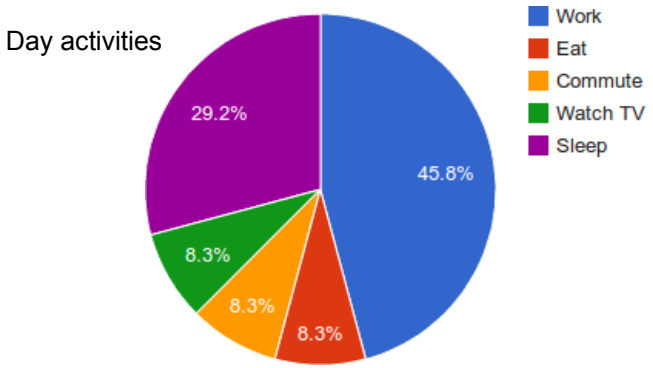


[Gulden15a] Example Feature Mapping Model

- Visual notation example

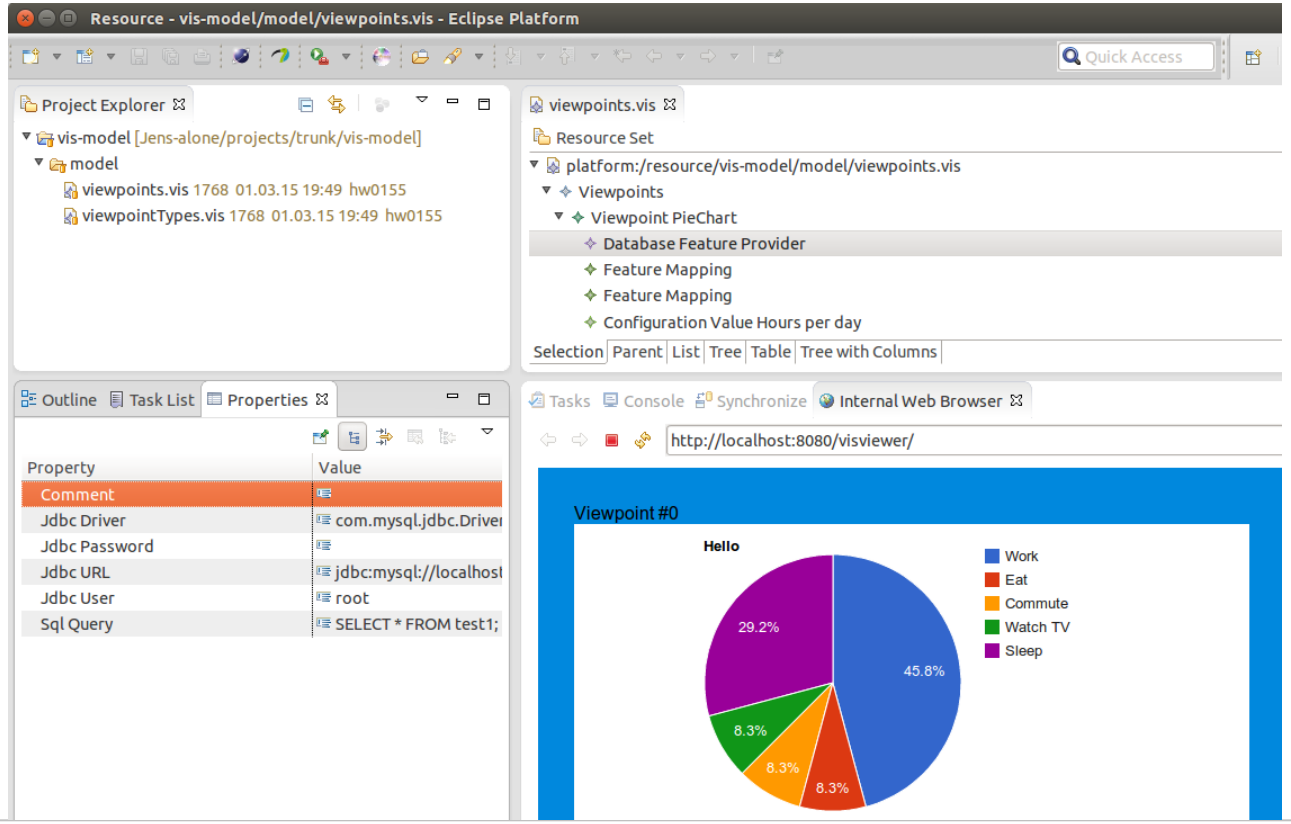


	A	B	C
1	*Title*	*Label*	*Value*
2	Day activities	Work	11
3	Day activities	Eat	2
4	Day activities	Commute	2
5	Day activities	Watch TV	2
6	Day activities	Sleep	7



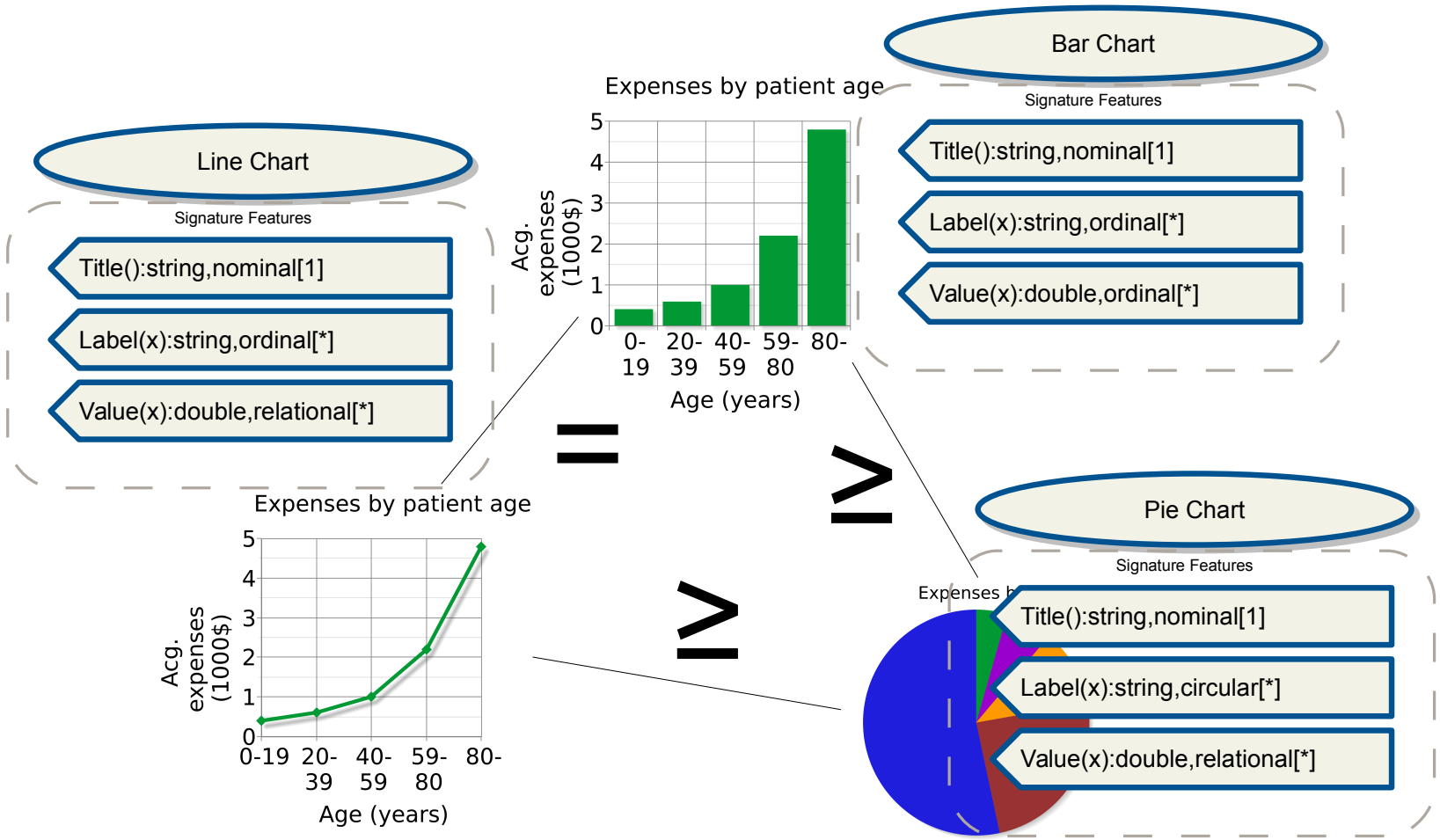
[Gulden15a] Prototype

- Eclipse EMF meta-modeling environment and Google Visualisation API
- Dynamic web pages with generated JavaScript

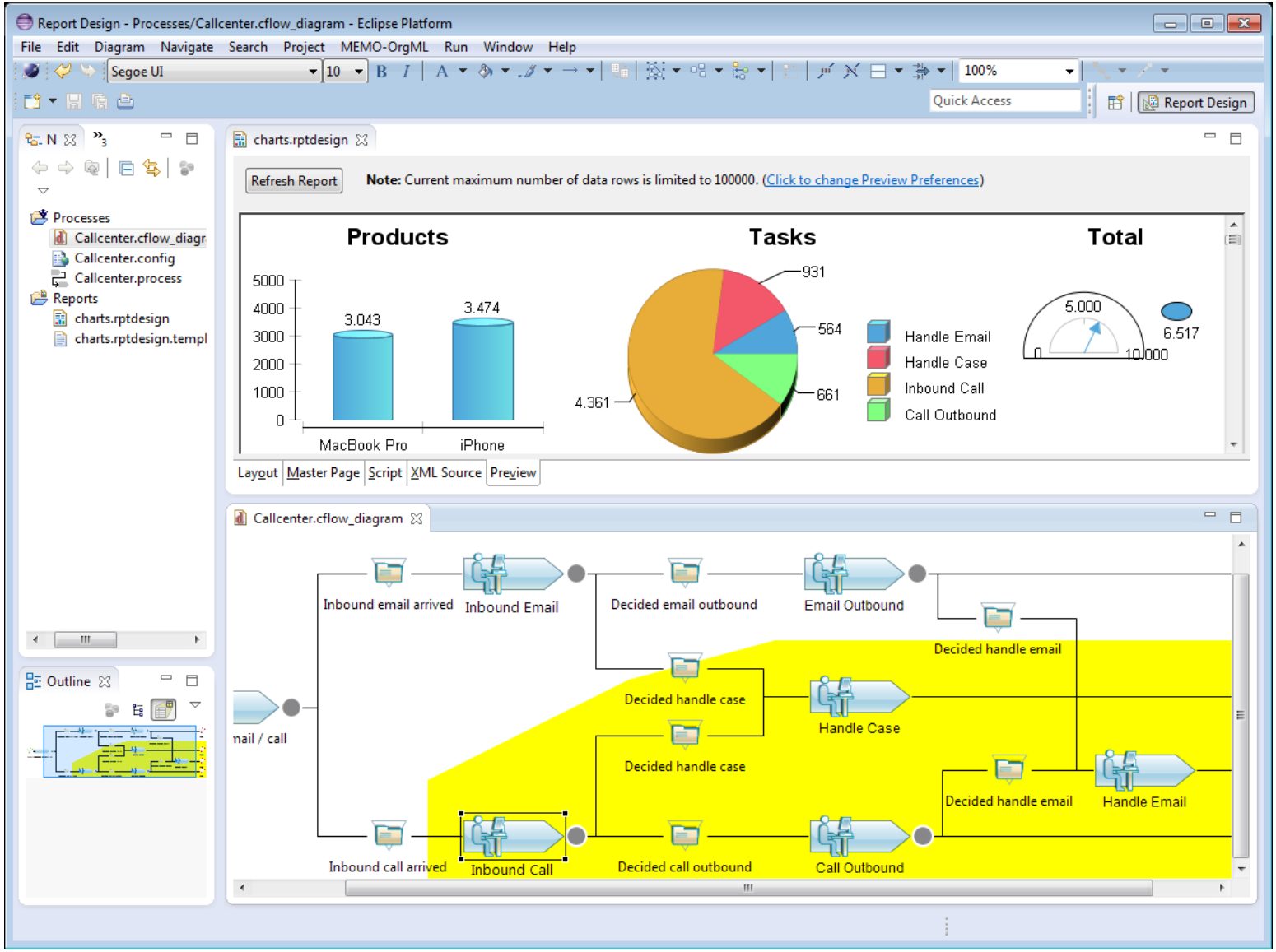


[Gulden15a] Comparing Visualisation Types

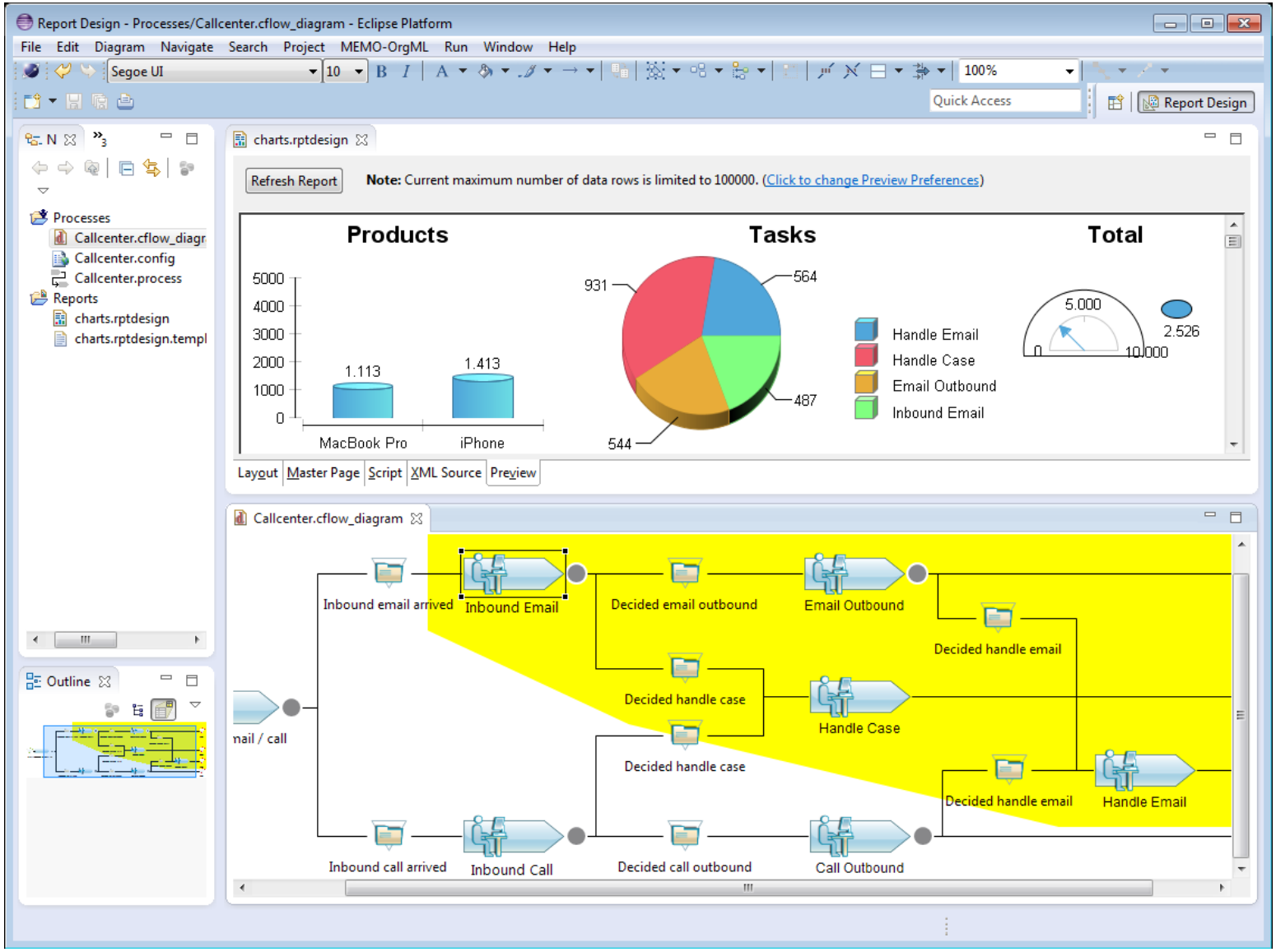
- Substitutability relationship



[GuldenAttfield15] Processes for Navigating (1/2)

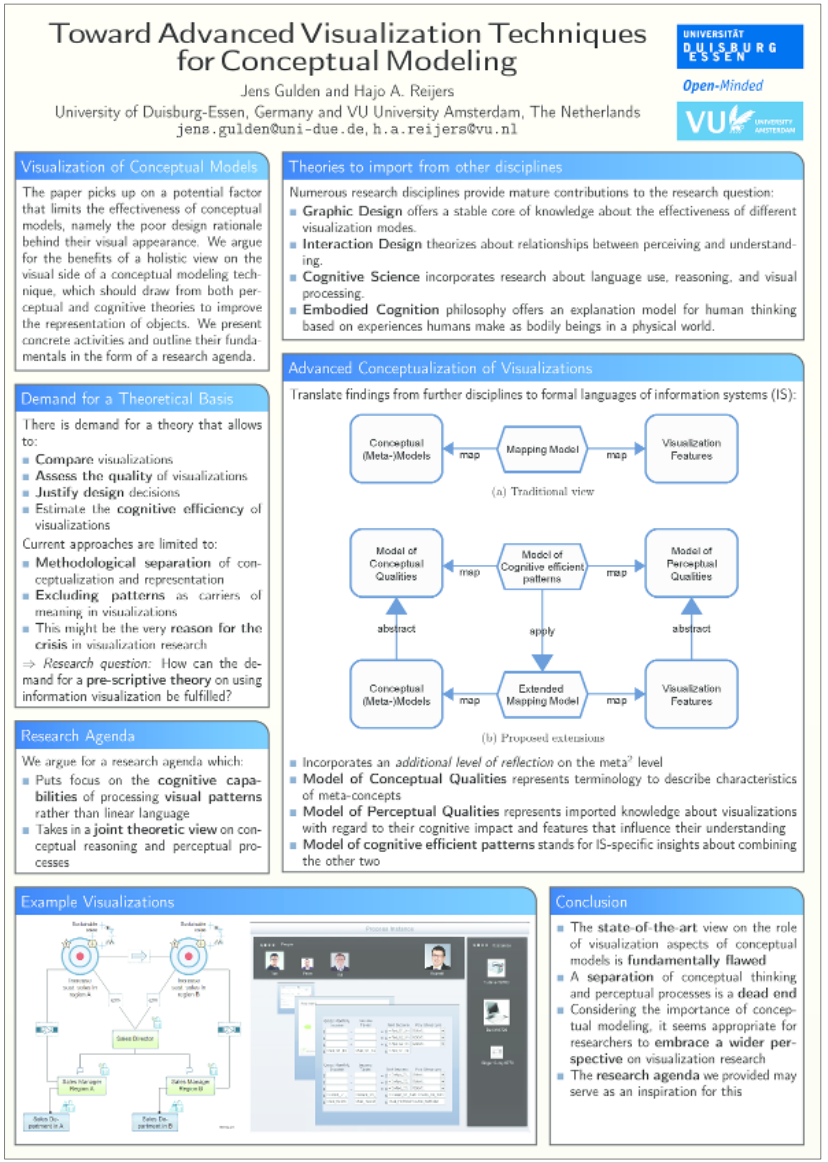


[GuldenAttfield15] Processes for Navigating (2/2)



[GuldenReijers15] Research Agenda (1/2)

- Basic research for Information Systems
- Identify demand for a theory that allows to:
  - Compare visualisations
  - Assess the quality of visualisations
  - Justify design decisions
  - Estimate the efficiency of visualisations
- Current approaches are limited to separation of concepts and representation



Toward Advanced Visualization Techniques for Conceptual Modeling

Jens Gulden and Hajo A. Reijers

University of Duisburg-Essen, Germany and VU University Amsterdam, The Netherlands

jens.gulden@uni-due.de, h.a.reijers@vu.nl

Visualization of Conceptual Models

The paper picks up on a potential factor that limits the effectiveness of conceptual models, namely the poor design rationale behind their visual appearance. We argue for the benefits of a holistic view on the visual side of a conceptual modeling technique, which should draw from both perceptual and cognitive theories to improve the representation of objects. We present concrete activities and outline their fundamentals in the form of a research agenda.

Theories to import from other disciplines

Numerous research disciplines provide mature contributions to the research question:

- **Graphic Design** offers a stable core of knowledge about the effectiveness of different visualization modes.
- **Interaction Design** theorizes about relationships between perceiving and understanding.
- **Cognitive Science** incorporates research about language use, reasoning, and visual processing.
- **Embodied Cognition** philosophy offers an explanation model for human thinking based on experiences humans make as bodily beings in a physical world.

Demand for a Theoretical Basis

There is demand for a theory that allows to:

- **Compare** visualizations
- **Assess the quality** of visualizations
- **Justify design** decisions
- Estimate the **cognitive efficiency** of visualizations

Current approaches are limited to:

- **Methodological separation** of conceptualization and representation
- **Excluding patterns** as carriers of meaning in visualizations
- This might be the very **reason for the crisis** in visualization research

⇒ *Research question:* How can the demand for a **pre-scriptive theory** on using information visualization be fulfilled?

Advanced Conceptualization of Visualizations

Translate findings from further disciplines to formal languages of information systems (IS):

- Incorporates an *additional level of reflection* on the meta² level
- **Model of Conceptual Qualities** represents terminology to describe characteristics of meta-concepts
- **Model of Perceptual Qualities** represents imported knowledge about visualizations with regard to their cognitive impact and features that influence their understanding
- **Model of cognitive efficient patterns** stands for IS-specific insights about combining the other two

Research Agenda

We argue for a research agenda which:

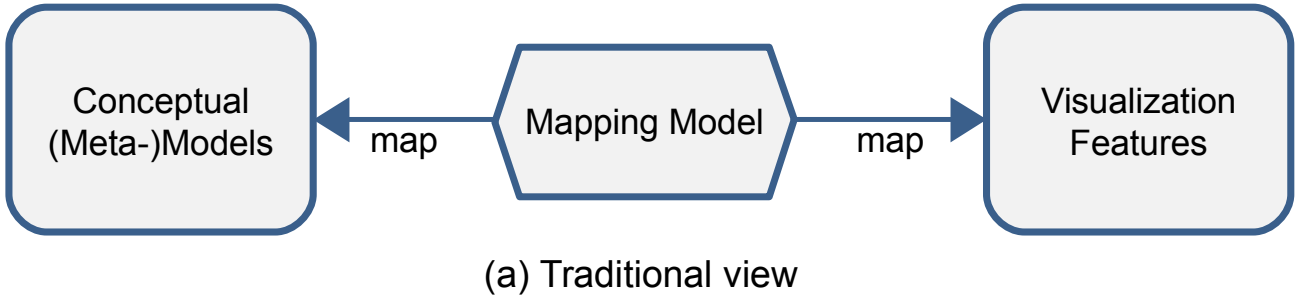
- Puts focus on the **cognitive capabilities** of processing **visual patterns** rather than linear language
- Takes in a **joint theoretic view** on conceptual reasoning and perceptual processes

Example Visualizations

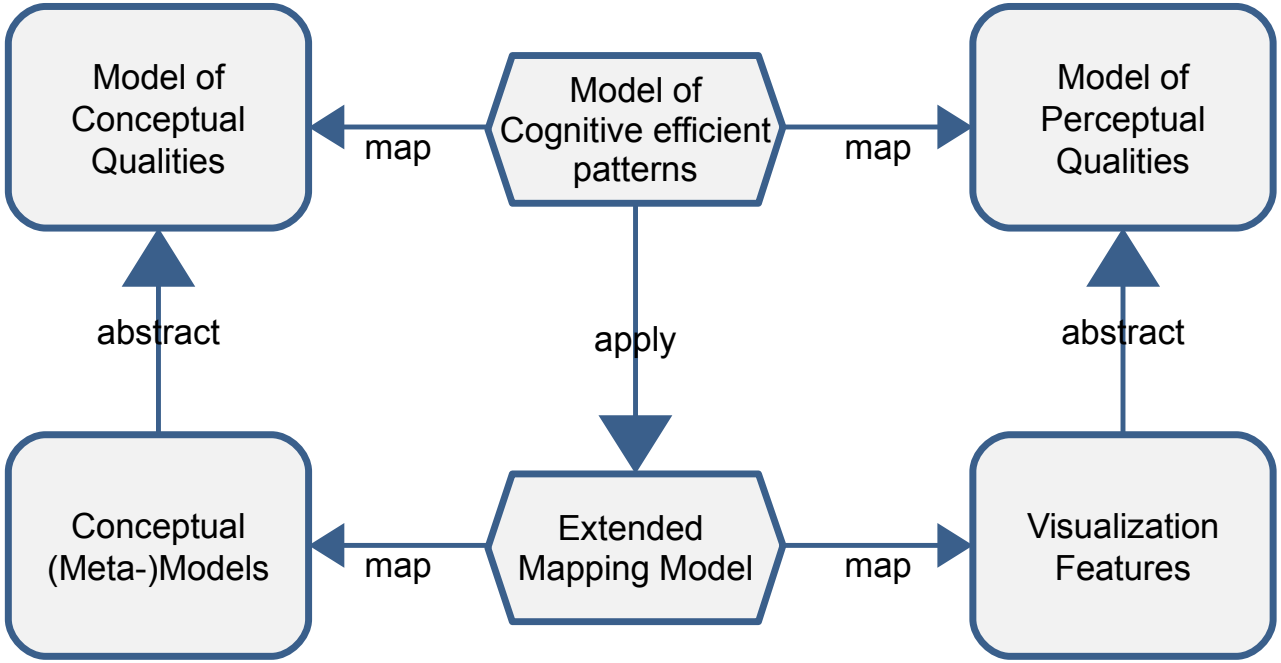
Conclusion

- The **state-of-the-art** view on the role of visualization aspects of conceptual models is **fundamentally flawed**
- A **separation** of conceptual thinking and perceptual processes is a **dead end**
- Considering the importance of conceptual modeling, it seems appropriate for researchers to **embrace a wider perspective** on visualization research
- The **research agenda** we provided may serve as an inspiration for this

[GuldenReijers15] Research Agenda (2/2)



(a) Traditional view



(b) Proposed extensions

End of the Presentation

Thank you for your attention

Jens Gulden
jens.gulden@uni-due.de