Benefits of and questions to a theory of visualization

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1. Benefits of a Theory*) of Data Visualization

*) Probably we will have no single, universal theory but a bundle of theories & conceptual models
Benefits of a Theory of (Data) Visualization

Practical benefits

• Qualitative models would
  • help us to describe, understand and reason about visualization processes
  • provide hints, which visual representations, analysis actions, work flows are more efficient than others

• Quantitative models would
  • help us to make predictions about quantitative dependencies in visualization processes
  • help us to optimize mathematically parts of visualization processes
Benefits of a Theory of (Data) Visualization

Strategic benefits

A clearly identifiable core of knowledge, methods and techniques

- on which we all can build,
- which we expand together,
- and which is clearly assigned to (and only to) data vis
could

- be an effective countermeasure to the danger of fragmentation of VIS
- increase the survival capability of VIS in the landscape of competing disciplines
- prevent VIS from being overtaken and then made disappear
  by competing neighboring disciplines
Side remark: Fragmentation of Data Vis

1. Subdivision in InfoVis, SciVis, VA (contentwise unjustifiable)

2. Need of specialization: VIS experts for specific application fields
   - good solutions ➔ require to understand the users’ problems in detail
   - we are forced to acquire detailed application knowledge
   - this leads to specialists for specific application fields
   - VIS becomes more and more particularized
   - VIS could lose
     - common communication platforms
     - common language
     - and even common views
   - Is synergies between different VIS branches could be lost
   - VIS as a whole might come into danger
Conclusion 1

Establishing a unique, clearly identified core, including

- taxonomies & ontologies
- conceptual models
- theoretic frameworks
- principles and guidelines

is (in my opinion) the most urgent task of data vis research
2. Questions to be Answered by a Theory* of Data Visualization

*) Probably we will have no single, universal theory but a bundle of theories & conceptual models
## Questions to be answered

<table>
<thead>
<tr>
<th>What is visualization and what is it for?</th>
<th>Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Many definitions exist</td>
<td>No consensus achieved</td>
</tr>
<tr>
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<td>Vague terms are used: “gaining insight“, „amplifying cognition“, „unveiling structure“</td>
</tr>
</tbody>
</table>

| What is information?                    | |
|-----------------------------------------| No consensus achieved |
| Distinction of structural and symbolic information missing | Question for the *information value* is unsettled |
Questions to be answered

What is the solution of the *data – information - knowledge* conundrum?

Problems

Several explanations exist

Consensus achieved?

New developments regarding *value of information* not considered
## Questions to be answered

<table>
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<th>Question</th>
<th>Problems</th>
</tr>
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<tbody>
<tr>
<td>What are the elementary knowledge units?</td>
<td>Answers largely unknown</td>
</tr>
<tr>
<td>How can prior knowledge be characterized in detail?</td>
<td>Answers largely unknown</td>
</tr>
<tr>
<td>What are the elementary acts of reasoning with new external information (data)?</td>
<td>Answers largely unknown</td>
</tr>
<tr>
<td>What are the elementary acts in which humans increase their knowledge using external information (nonvisual/visual)?</td>
<td>Answers largely unknown</td>
</tr>
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</table>
Questions to be answered

What leads to the emergent phenomenon of eureka moments?

What is the role of mental images in reasoning? And how are external and mental images related?

If we have (better) answers to such questions: How can these be practically utilized?

What are the limits of visualization?

Problems

Answers largely unknown

Answers largely unknown

...
Conclusion 2

• Particularly fundamental questions are not yet satisfactorily answered.

• We have to put a lot of work into the taxonomy.

• Almost all the fundamental questions can be answered only in collaboration with other sciences, especially cognitive sciences. That will not happen if it is not initiated by us.