

### Pondering the Concept of Abstraction in (Illustrative) Visualization

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- Omnipresent in visualization and visual arts
- Somewhat intuitively understood, formal definition not available
- Contribution to visualization theory kernel
- Abstract; Latin *abstrahere* = drawn away





#### **Related Work**

Aggregate

Subsample

Project

Filter



Distribution

Correlation

[Sarikaya et al. 2018]

Frequency

Trends

Clusters

Outliers

- Summary visualization
- Data and task abstraction
- Map Generalization
- Topology
- Semiotics











#### Abstraction is a transformation which preserves one or more key concepts and removes detail that can be attributed to natural variation, noise, or other aspects that one intentionally wants to disregard from consideration.







# **Visual representation** *is any* **graphical form** *that* **refers to something** *and can be* **perceived** *as a* **stimulus of the visual system** *and that is further processed by means of perceptual and cognitive machinery.*









# **Visualization** *is a multi-stage* **transformation** *of* **digital data** *into* **visual representations** *which are cognitively consumable by humans. The outcome of such transformation is also termed as visualization.*









# **Visual abstraction** *is a* **concept-preserving transformation** *used in visual arts and* **data visualization***, which transforms (digital)* **information** *into* **visual representations** *by removing details attributed to natural variation, noise, etc.*



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#### **Aspects of Visual Abstraction**





#### Axes of Abstraction



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#### Inspiration: abstraction in visual arts



Mondrian: Trees to Abstraction

#### Abstraction axes: abstraction could/should be ordered, measurable



#### Axes of Abstraction and Abstraction Spaces



Proposition: Data gets abstracted in various ways in visualization, controlled by users or intent.

The results are points in a multi-dimensional *abstraction space*. The control of a single attribute of visual abstraction forms an *axis of abstraction*.



from: McCloud, 1993





#### Groups of Abstraction Axes plus Scale











- change or removal of geometric elements of the visualization
- e.g., simplification (GIS), geometry relocation, topology, different representations (structural biology), dimensional projections, etc.





#### **Photometric Abstraction**



#### change of illumination and/or shading of depicted elements



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portrayal of dynamic/procedural phenomena as direct animation, explicit story graph, or implicit rule-based state machine.







- Proposition: Visual abstraction as removal of details naturally connects one scale of representation with another.
- but vast ranges of scale as in biology, astronomy, etc.
  - each scale/scale transition to use unique axes & their instantiations
  - ideally, scales are connected seamlessly, visual integration of scales



[Hsu et al., 2011]







**Proposition:** Axes are *orthogonal* to each other if the changes they cause in the visual representation are independent of each other and unique to the axis.

result: abstraction spaces



[v. d. Zwan et al., 2011]



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#### **Abstraction Spaces**







#### **Abstraction Spaces**







#### **Fundamental Questions**



#### Discrete vs. continuous (global) abstraction along an axis?











- Discrete vs. continuous (global) abstraction along an axis?
- Global vs. spatially local abstraction along an axis?



[Lueks et al., 2011]



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- Discrete vs. continuous (global) abstraction along an axis?
- Global vs. spatially local abstraction along an axis?
- Independence/systematics of several axes of the same type?



[Born et al., 2010]



[Theisel et al., 2003]









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- Independence of axes between abstraction types?







- Discrete vs. continuous (global) abstraction along an axis?
- Global vs. spatially local abstraction along an axis?
- Independence/systematics of several axes of the same type?
- Independence of axes between abstraction types?
- Forking of axes?





### Practical Opportunities for a Visual Abstraction Theory







- Selection of visual representations requires certain structuring
- Which visual representations are in principle at hand?
- What is the appropriate level of visual abstraction having a certain intent and audience in mind?
- Visual abstraction theory can provide a scaffold for such process







- Uncertainty in statistics: box plot
- In visual crafts: visual abstraction
- Understanding visual abstraction gives us a new way to encode uncertainty in an intuitive manner



https://pxhere.com/en/photo/1059702



#### Discussion

- Visual abstraction may serve a many purposes: describe, simplify, reveal, summarize, generalize, guide, categorize, interpret, explain...
- Is visual mapping equivalent to visual abstraction?
- What is a visual metaphor?
- Abstraction of visual data
- Abstraction by visual means





#### Conclusions



- Without well-defined terminology we cannot build a theory
- Visual abstraction is at the heart of any visualization scenario
- To lay foundations of visualization science community effort is needed











#### https://doi.org/10.1109/TVCG.2017.2747545

