Information Visualization

Uncertainty Visualization

Dr. David Koop





Time Curves for Wikipedia



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Visual Piling





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Other Examples of Piles

[F. Lekschas et al., 2020]





Visual Piling Goals/Tasks

- **T1** Grouping: manually or automatically sort items into piles.
- **T2** Arrangement: position items and piles relative to each other in an orderly, randomized, gridded, or unconstrained layout.
- **T3** Previewing: identify and locate items on a pile using *in-place*, gallery, foreshortened, combining, and indicating previews.
- **T4 Browsing:** search, explore, and navigate within and between piles through *in-place*, *dispersive*, *layered*, and *hierarchical* browsing.
- **T5** Aggregation: summarize a pile into a synthesized, representative, or abstract representation.









StreamStory at Different Scales



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[L. Stopar et al., 2019]











Survey Paper

- Due Tuesday, October 19
- Categorize references
- Tables to organize references
- Not all references will fit nicely into one categorization!
- Find themes in existing research
- Uncover unanswered research questions









Next Paper: Critique Due Tuesday

When (ish) is My Bus? User-centered Visualizations of **Uncertainty in Everyday, Mobile Predictive Systems**

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Bus Timeline



Route Timeline



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Uncertainty

- Uncertainty shows up in science all the time
 - Measuring
 - Modeling
 - Forecasting
- People know there is uncertainty in data analysis, but don't actually understand most ways of communicating the amount of uncertainty







Graphical Annotations of Distributional Properties

Intervals and Ratios



error bars

Distributions



violin plot



hypothetical outcome plot

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box plot







quantile dot plot



ensemble plot







Visual Encodings of Uncertainty









Hybrid Approaches



contour boxplot

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probability density and interval plot







Uncertainty Visualization Theories

Theory	Summary	Visualization Techniques
Frequency Framing [30] (Section 1.2)	Uncertainty is more intuitively understood in a frequency framing (1 out of 10) than in a probabilistic framing (10%)	icon array [13], quantile dotplot [11], hypothetical outcome plots [10]
Attribute Substitution [31] - Deterministic Construal Error [32] (Section 1.2)	If given the opportunity, viewers will mentally substitute uncertainty information for data that are easier to understand	hypothetical outcome plots [10]
Visual Boundaries = Cognitive Categories [21] (Section 1.2)	Ranges that are represented by boundaries lead people to believe that data inside and outside the boundary are categorically different	ensemble display [12], error bar alternatives [7, 9]
Visual Semiotics [14] (Section 1.2)	Some encoding techniques naturally map onto uncertainty	fuzziness, transparency, location, etc. [14], value-suppressing color pallet [25]





A biased tour of the uncertainty visualization zoo

Matthew Kay





Spaghetti Plot vs. HOP









Spaghetti Plot vs. HOP









Watch how the measles outbreak spreads when kids get vaccinated - and when they don't



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58.5[%] vax rate, similar to Okanagan County, WA

68.9% vax rate, similar to **Thurston County, WA**





90.0[%] vax rate, similar to **Orange County, CA**

99.7[%] vax rate, similar to Gadsden County, FL





Northern Illinois University







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Northern Illinois University







Follow the lives of 79 boys who grew up in rich families ...



Most white boys raised in wealthy families will stay rich or upper middle class as adults, but black boys raised in similarly rich households will not.

Adult outcomes reflect household incomes in 2014 and 2015.







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Response to HOPs

- Distributions have:
 - Spread: the range across which the values are distributed)
 - Central Tendency: a measure of the distribution's center)
 - Shape: the pattern that is formed by the set of values when arranged from lowest to highest)
- These don't rely on counting during animation
- Would a sentence suffice instead?











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New Experiments

(95% Cls)



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[Kale et al., 2018]





New Experiments



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[Kale et al., 2018]





Study Queries



Q: Given the data on the chart, which headline would you assign?

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How confident are you in your answer? 50% 100%













Stimuli



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[Kale et al., 2018]







Conclusions

- Designers need to make sure people perceive uncertainty accurately
- HOPs help provide more interpretable reading
- Tension between showing all outcomes (ensembles) and dealing with occlusion/density vs. attention blindness











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