A Task-based Taxonomy of Cognitive Biases for Information Visualization

Eudoxia Dimara, Steven Franconeri, Catherine Flanagan, Anastasia Bearerianos, and Pierre Dragone:

Three kinds of limitations

The Computer

The Display

Three kinds of limitations

The Computer

The Display

Three kinds of limitations: humans

Human vision

Human reasoning

Perceptual bias

Magnitude estimation

Color perception

Cognitive bias

Behaviors when humans consistently behave irrationally

Pohl's criteria distilled:
• Are predictable and consistent
• People are unaware they're doing them
• Are not misunderstandings

How they built their taxonomy

Three kinds of limitations

Human vision

Human reasoning

This Paper's Goals

• Provide a broad review of cognitive biases, for visualization researchers
• Layout the problem space to guide future studies that help designers anticipate limitations of human judgment

Taxonomies of Cognitive Biases

Essentially, the related work section

Taxonomies of Cognitive Biases

• Explanatory taxonomies
  • A. Tversky and D. Kahneman, "Judgement Under Uncertainty: Heuristics and Biases"
  • J. Baron, Thinking and Deciding
  • J. Evans, Hypothetical thinking: Dual processes in Reasoning and Judgement
  • K. Stanovich, Rationality and the Reflective Mind

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How they built their taxonomy

The methodology section

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  • K. Stanovich, Rationality and the Reflective Mind

• Taxonomies from decision-support
  • W. E. Concus and J. C. Knight, "Toward Intelligent Decision Support Systems: An Artificially Intelligent Statistician."
  • D. Arnett, "Cognitive Biases and Decision Support Systems Development: a Design Science Approach"
How they built their taxonomy

**Step 1:** Cross reference the biases with information visualization literature.

If visualization literature exists

**Step 2.a:** Find the experiment study the vis paper cites for this bias.

If no visualization literature exists

**Step 2.b:** Look for any literature on the bias.

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Their Task-Based Taxonomy

Their "Results" section

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Cognitive Biases by Task

Base rate fallacy
We overestimate the likelihood of an event.

Conjunction fallacy
We believe that specific events are more probable than general ones.

Optimism bias
We make more optimistic predictions about ourselves than other people.

Decision tasks biases: a sample

Attraction effect
Our decision between two alternatives is influenced by the presence of inferior alternatives.

Ambiguity effect
We avoid decisions associated with ambiguous outcomes.

IKEA effect
We like things we invest self-effort into more

Hypothesis assessment tasks: a sample

Confirmation Bias
We favor evidence that confirm our initial hypotheses with ignoring disconfirming evidence.

Illusory Truth Effect
We think propositions are true if repeatedly exposed to it.

Illusory Correlation Bias
We consider relationships between variables that do not exist.

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Biases in estimation tasks: a sample

Base rate fallacy:
We overestimate the likelihood of an event.

Conjunction fallacy:
We believe that specific events are more probable than general ones.

Optimism bias:
We make more optimistic predictions about ourselves than other people.

Decision tasks biases: attraction effect

The Gym Experiment
The Bet Experiment

Dimara, et al. The Attraction Effect in Information Visualization

Decision tasks biases: Attraction effect

Wall, E et al. Warning, Bias May Occur: A Proposed Approach to Detecting Cognitive Bias in Interactive Visual Analytics.

Hypothesis assessment tasks: Confirmation Bias

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Cognitive Biases by Flavor

Cognitive Biases by Task

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Decision tasks biases: Attraction effect

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Hypothesis assessment tasks: Confirmation Bias

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Biases in estimation tasks: in vis

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Discussion

My opinion
👍 Survey of cognitive biases that are relevant to visualization research
👌 Their taxonomy good but not great.

Acknowledged Limitations
• Each bias was assigned a single category
• One bias could exist in more than one task category.
• Only one person did the initial coding and sorting
• But all authors reviewed the process
• “Deviations from reality” is a complex and controversial notion.
• We haven’t proved that cognitive biases actually reflect irrationality.

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What’s the point of flavors?

It’s another task taxonomy

Cognitive Biases by Flavor

A Multi-Level Typology of Abstract Visualization Tasks

Questions