Introduction to Information Visualization

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Things we visualize ...

- Static visualization on on a printed paper
  - Postcards
  - Calendars
  - Book-Cover
  -
  -
  -

A Beautiful Visualization

- Novel

  A fresh look at the data or a format that gives readers a spark of excitement and results in a

  new level of understanding

A Beautiful Visualization

- Novel
- Informative

Providing access to information so that the user may gain knowledge.

A Beautiful Visualization

- Novel
- Informative
- Efficient

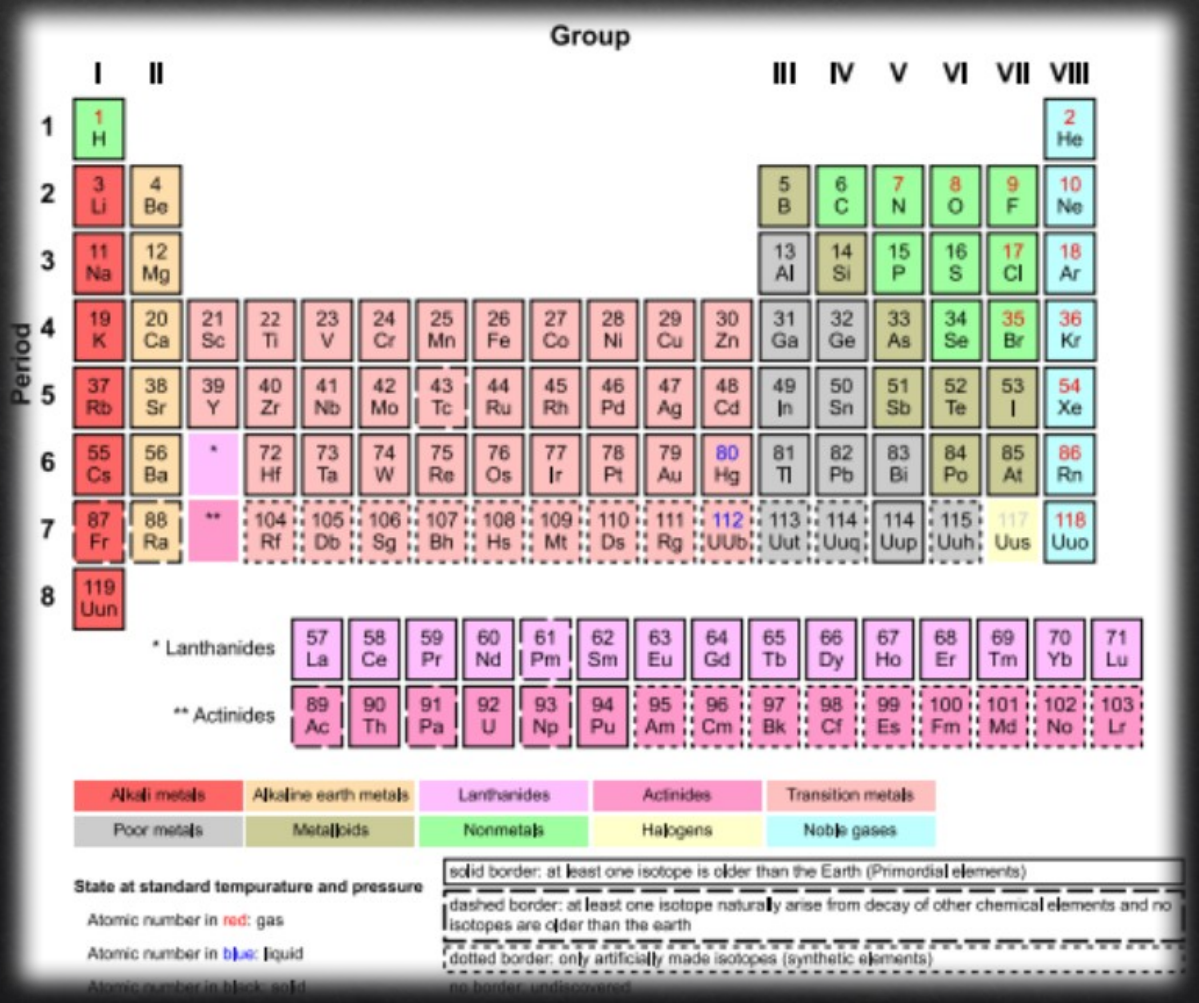
Access to this information should be as straightforward as possible, without sacrificing any necessary, relevant complexity

A Beautiful Visualization

- Novel
- Informative
- Efficient
- Aesthetic

Appropriate usage of graphical elements for presentation of information is essential for guiding the reader, as well as for visual appeal.

Mendeleev’s Periodic Table



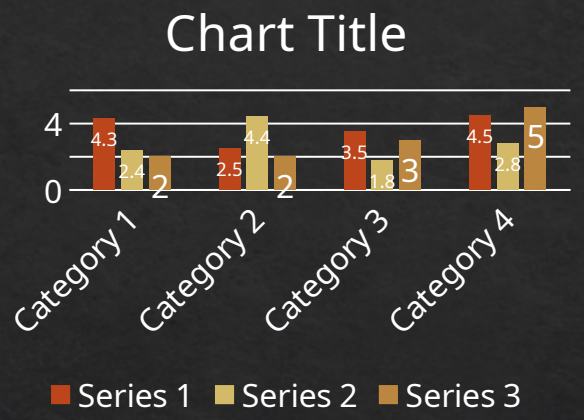
A completely new approach to a problem that previously hadn’t had a successful visual solution.

Harry Beck’s map of the London Underground (Tube map)

Highlighted the most relevant information and stripped away much of the irrelevant information

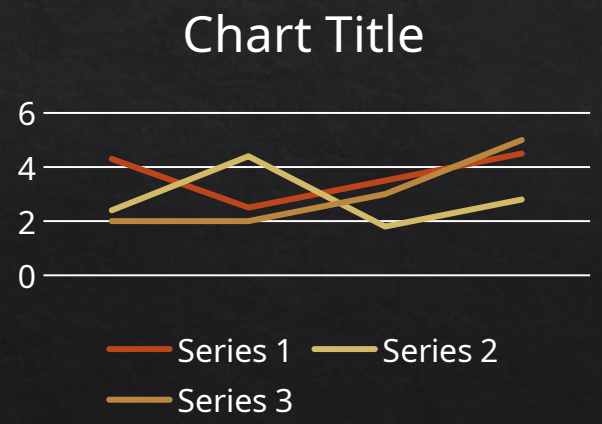
Standard formats and conventions

Bar graphs



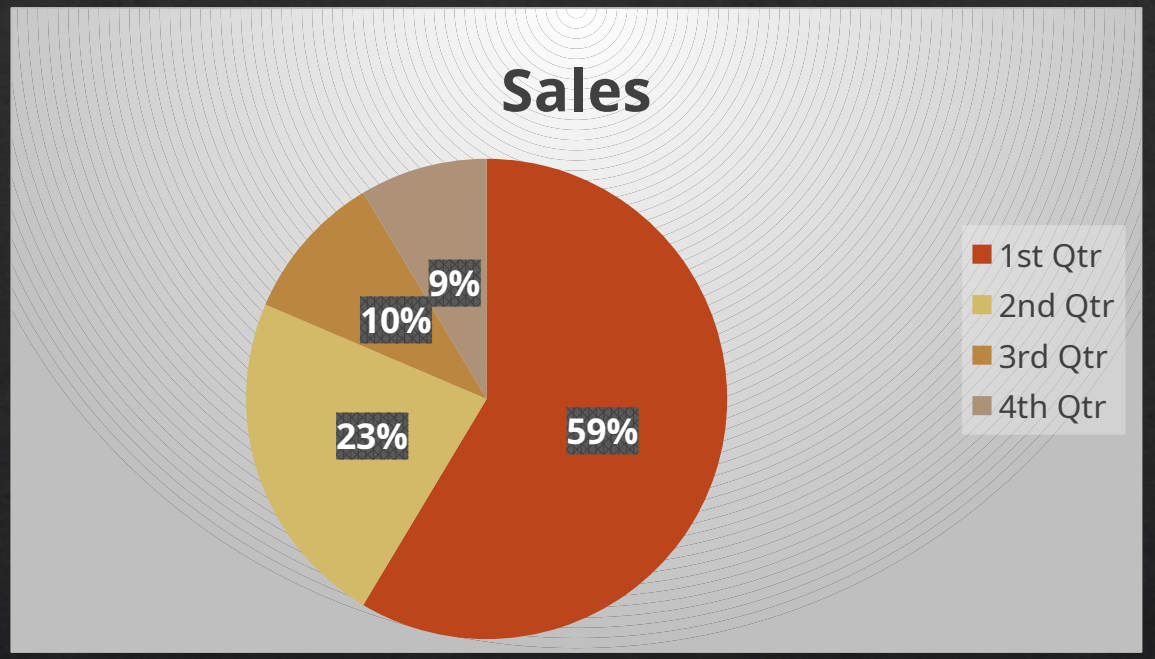
Discrete data

Line graphs



Continuous/ Discrete data

Standard formats and conventions



Pretty picture but waste of space

Common Questions

What question you’re trying to answer, or what story you’re trying to tell?

How is the visualization going to be used?

Is it to reveal what is already known?

Is it to facilitate discovery?

A bit of Advice

Make it efficient!

Visually emphasize what matters (not for sensitive data)

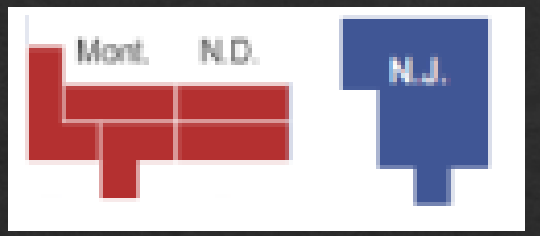
Use axes to convey meaning and give free information

Use conventions thoughtfully

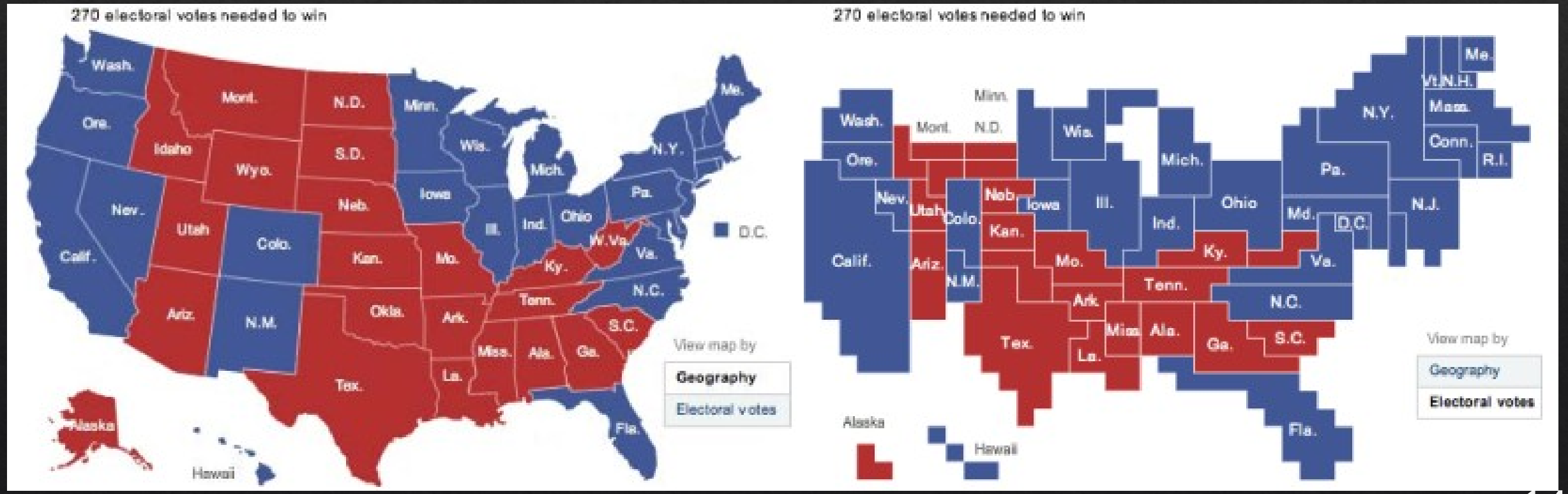
Trade-offs

2008 presidential election results

Trade-offs



2008 presidential election results



Computer Based Info-Vis

Computer-based **visualization** systems provide visual representations of datasets designed to help people carry out tasks more effectively.

- Augment human capabilities – but does not replace human
  - How to create?
  - How to interact?
- NOT a precise science!
  - Trade-offs: computers, users, displays
  - Data Aspects & Vis Aspects

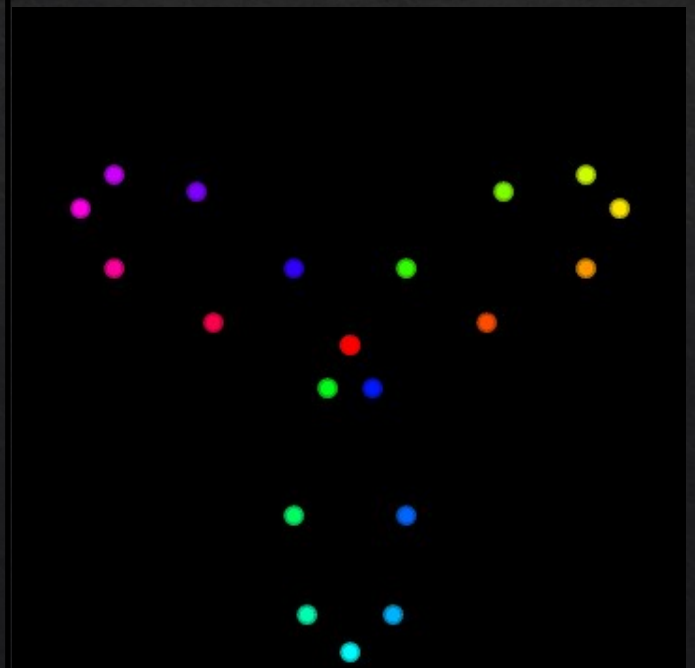
Are you feeling Lost?

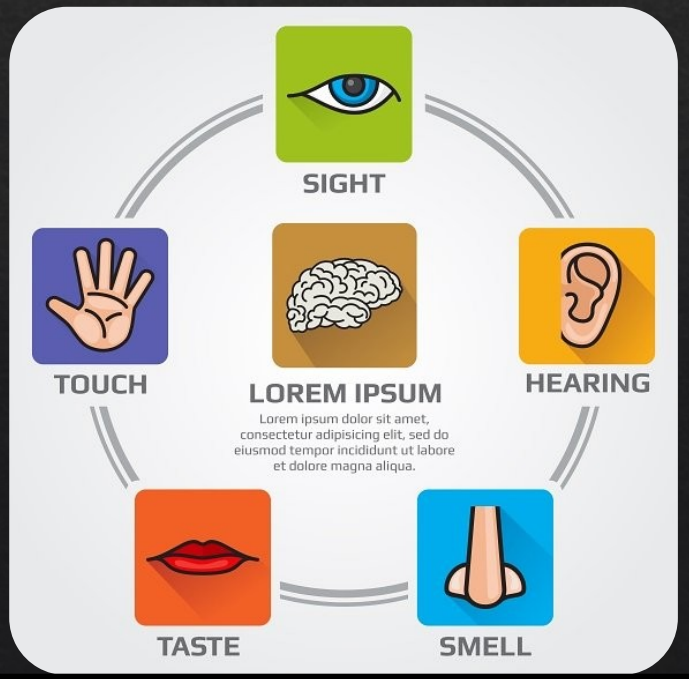
- Vis allows people to analyze data when they don’t know exactly what questions they need to ask in advance.

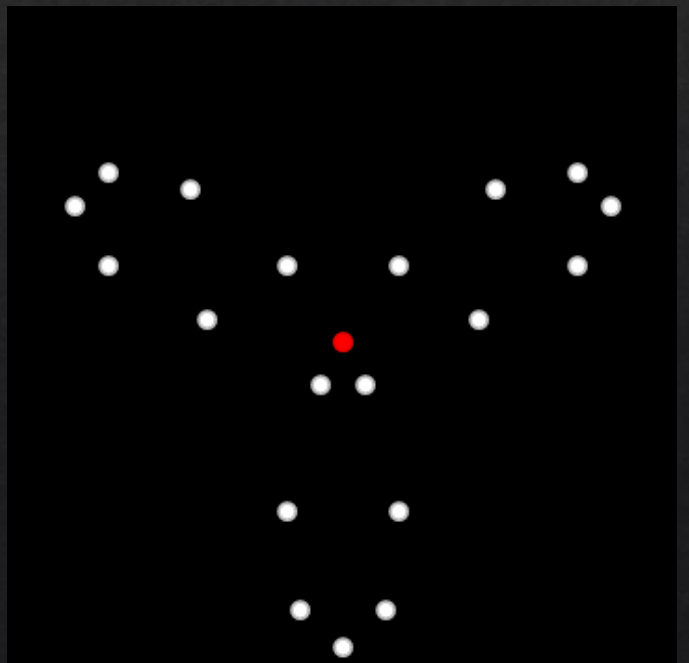
- Computational Techniques:
  - Statistics
  - Machine Learning
  - Specific Algorithms
  - Heuristics & Exhaustive Search

Challenges?

- Sometimes a visualization may be misinterpreted – is the red dot moving on a line?







What a Vis Tool Can Do?

- Help understand the user's task
- Help algorithm developers to choose the parameters
- Help exploration and discovery
- Help whether a system is working correctly
- In telling a story
  - https://www.nytimes.com/interactive/2016/08/15/sports/olympics/usain-bolt-mens-100-meters-final.html
  - https://www.nytimes.com/interactive/2016/12/09/science/mapping-three-decades-of-global-water-change.html

What a Vis Tool Can Do?

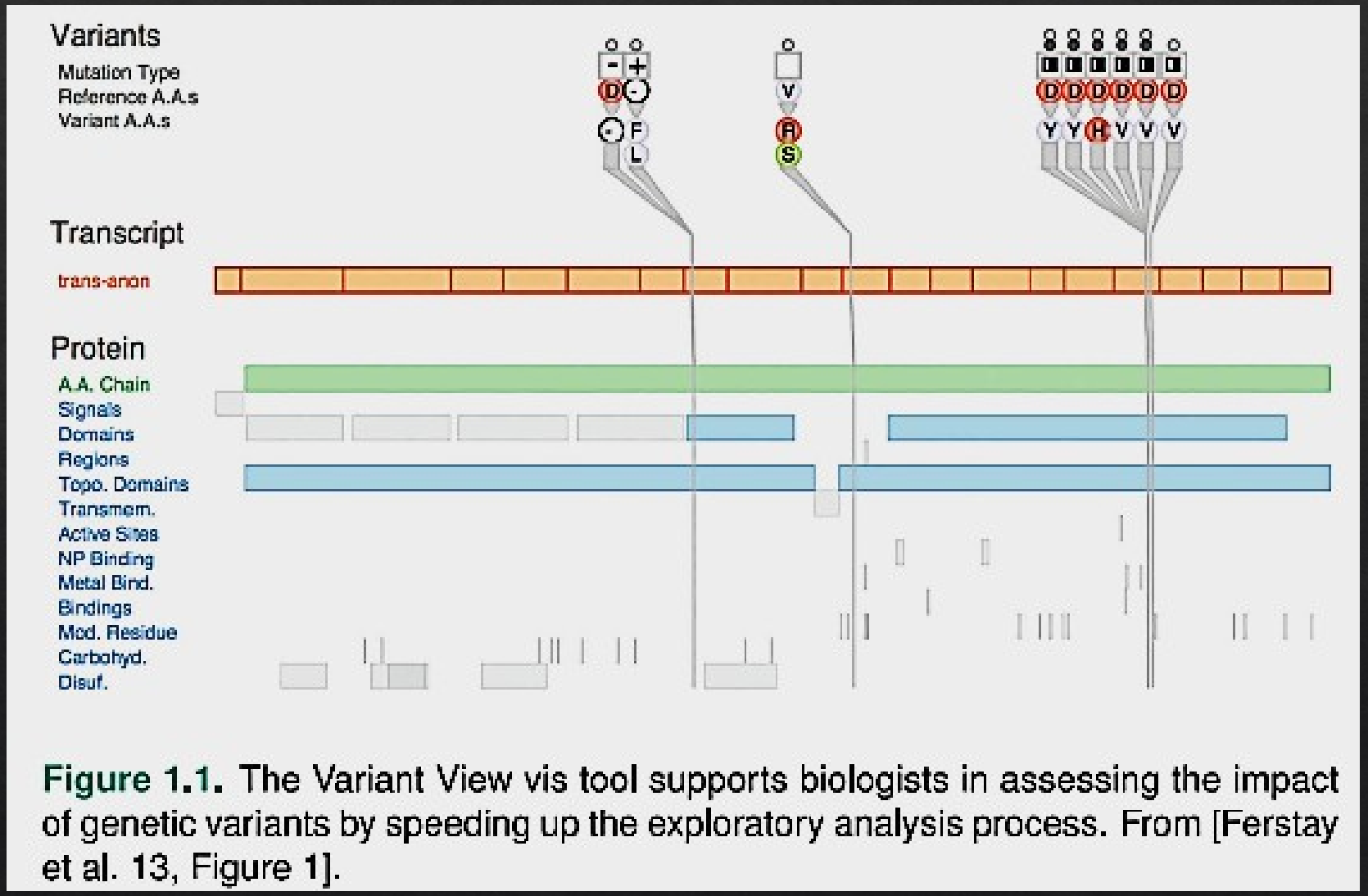


Figure 1.1. The Variant View vis tool supports biologists in assessing the impact of genetic variants by speeding up the exploratory analysis process. From [Ferstay et al. 13, Figure 1].

What a Vis Tool Can Do?

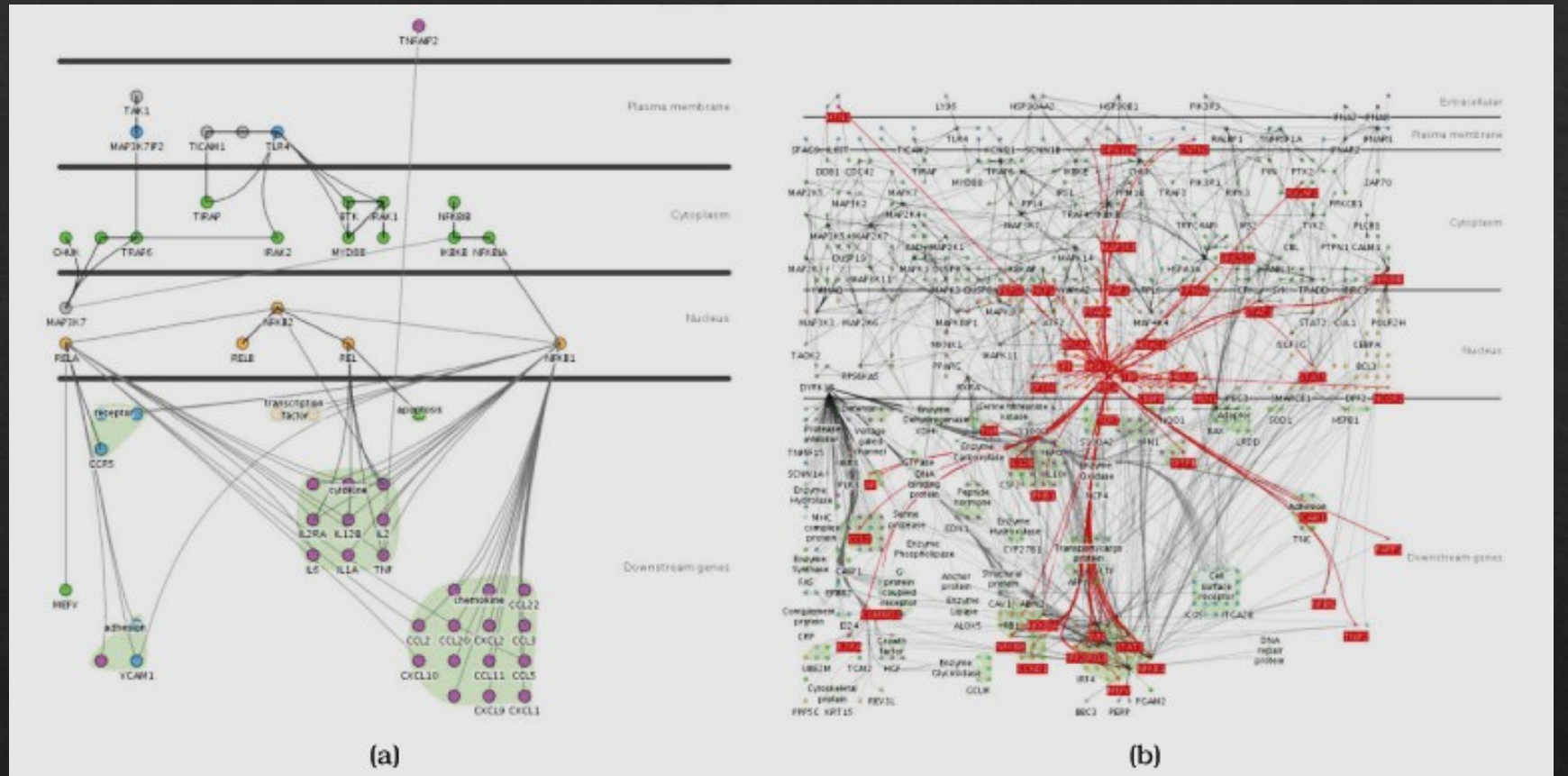
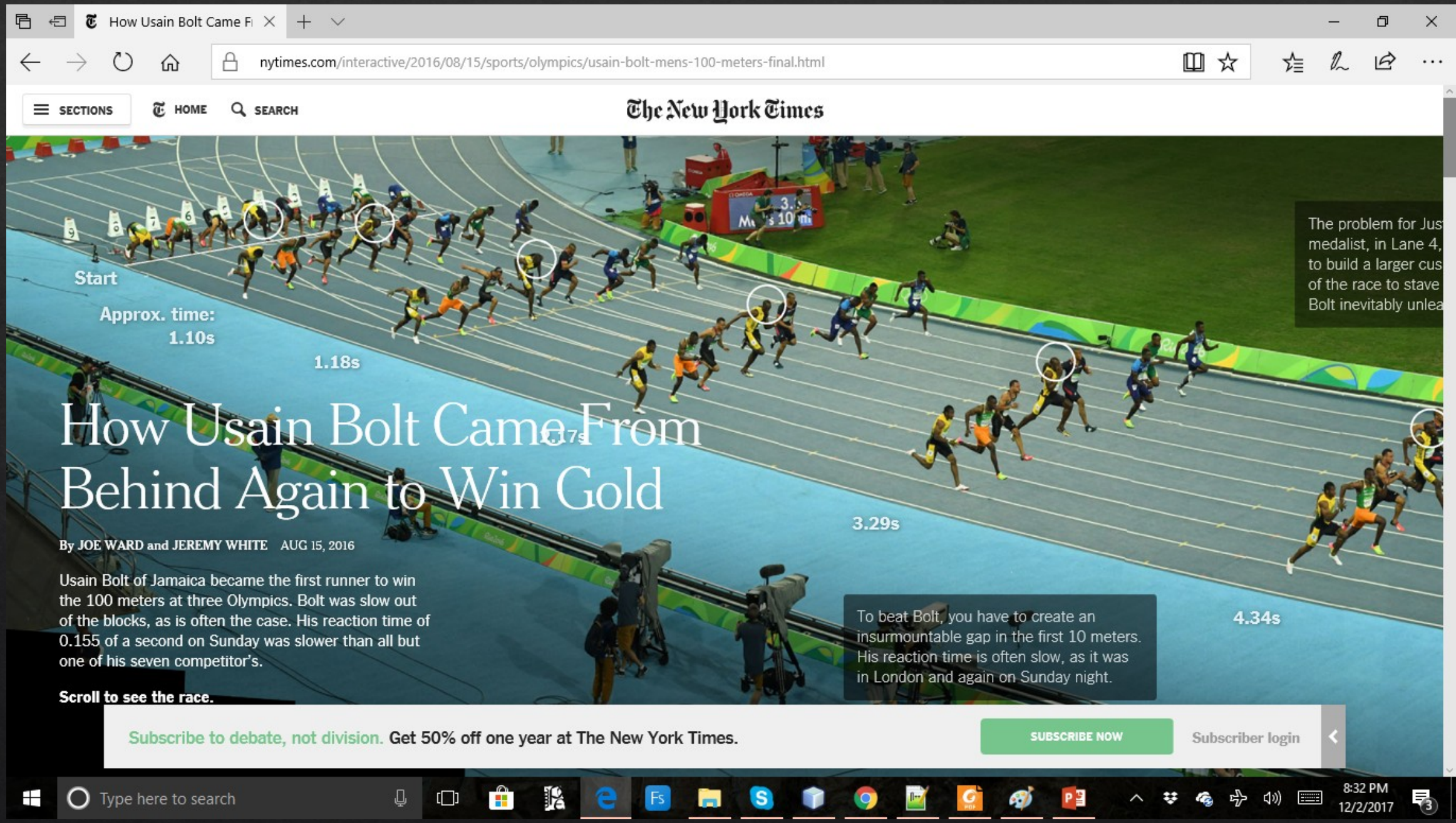


Figure 1.2. The Cerebral vis tool captures the style of hand-drawn diagrams in biology textbooks with vertical layers that correspond to places within a cell where interactions between genes occur. (a) A small network of 57 nodes and 74 edges might be possible to lay out by hand with enough patience. (b) Automatic layout handles this large network of 760 nodes and 1269 edges and provides a substrate for interactive exploration: the user has moved the mouse over the MSK1 gene, so all of its immmediate neighbors in the network are highlighted in red. From [Barsky et al. 07, Figures 1 and 2].


How Usain Bolt Came Fi
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How Usain Bolt Came From Behind Again to Win Gold
By JOE WARD and JEREMY WHITE AUG 15, 2016
Usain Bolt of Jamaica became the first runner to win the 100 meters at three Olympics. Bolt was slow out of the blocks, as is often the case. His reaction time of 0.155 of a second on Sunday was slower than all but one of his seven competitor's.
Scroll to see the race.
To beat Bolt, you have to create an insurmountable gap in the first 10 meters. His reaction time is often slow, as it was in London and again on Sunday night.
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Summary or Details?

Mean	9.0	7.5	9.0	7.5	9.0	7.5	9.0	7.5
Variance	10.0	3.75	10.0	3.75	10.0	3.75	10.0	3.75
Correlation	0.816		0.816		0.816		0.816	

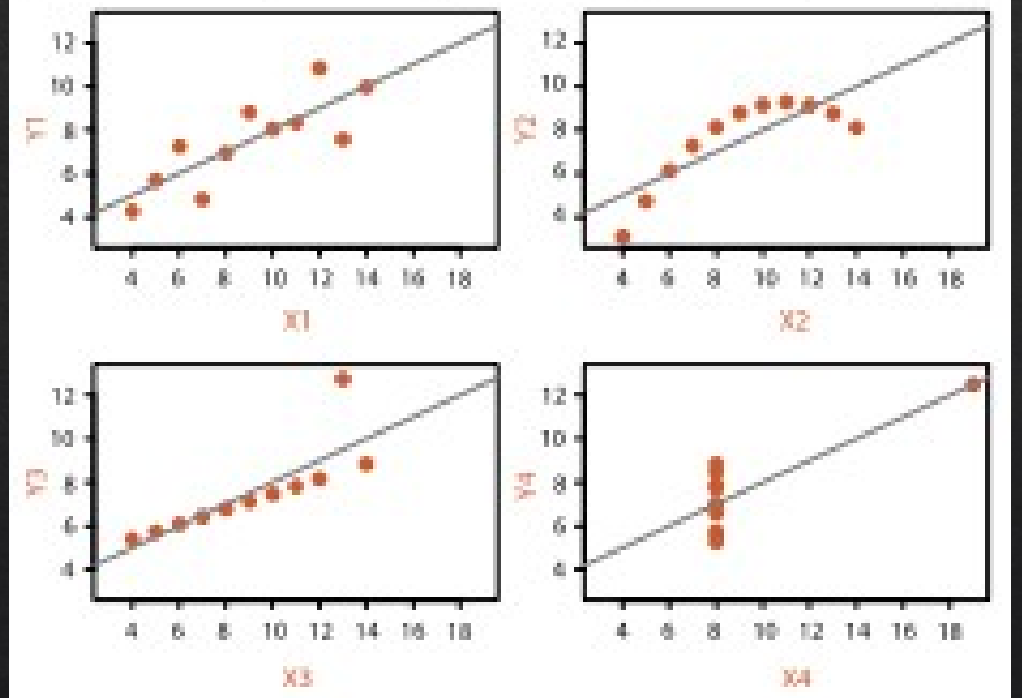
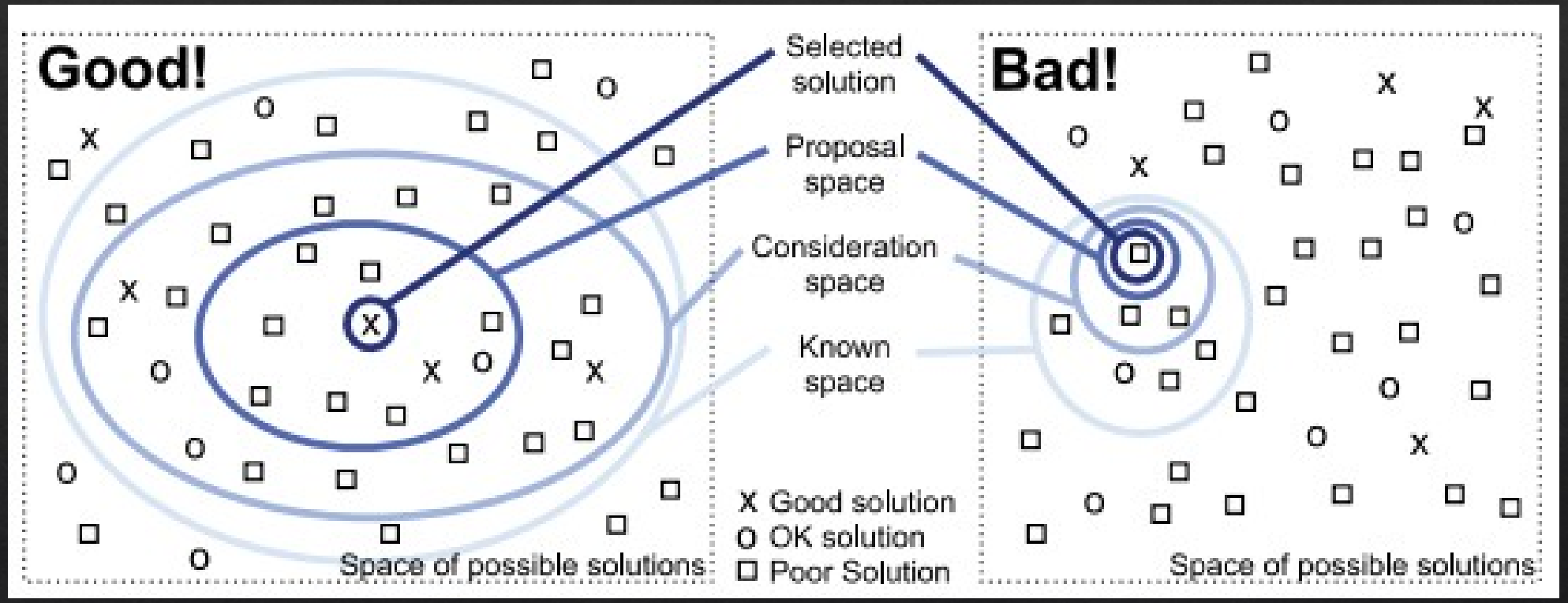


Figure 1.3. Anscombe's Quartet is four datasets with identical simple statistical properties: mean, variance, correlation, and linear regression line. However, visual inspection immediately shows how their structures are quite different. After [Anscombe 73, Figures 1–4].

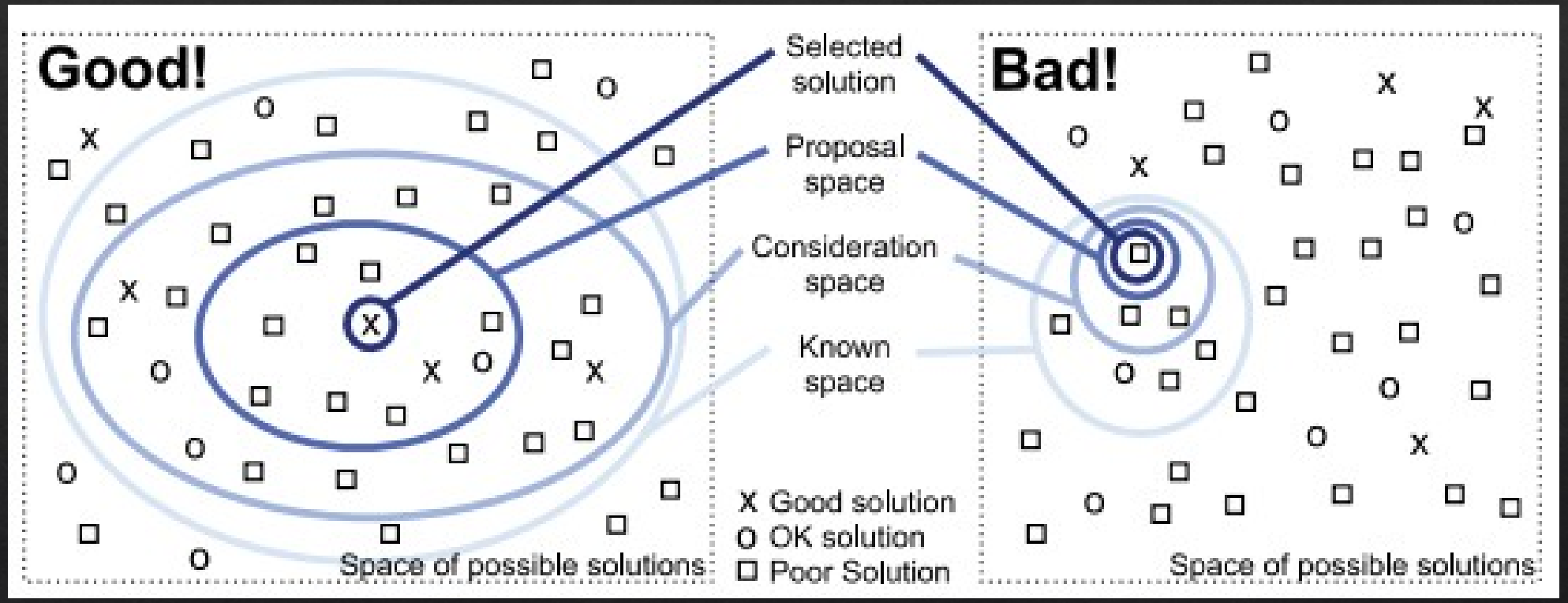
Statistics may lose information (e.g., about patterns)!

How to Design a Vis?



- We will see design guidelines, but there is no absolute truth!

How to Design a Vis?



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How do you know if it works?

- Validation is hard
  - “Users perceive/use a visualization effectively” - what is user efficiency?
  - What is benchmark data?
  - How to measure quality of a vis tool?
  - Is there a trade-off among algorithms, display, memory usage …
  - Scalable? Can it deal with big data?

Learning Goal

- Understand the difference between traditional and computer-aided visualization
- Learn the basic properties of a good visualization
- Able to distinguish between visualization and statistical computations
- Describe the challenges and trade-offs in creating a good visualization
- Get familiar with conventional visualizations.