DATA VISUALIZATION

Bùi Tiến Lên

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Contents

Data Visualization

What is Visualization

Concept 1

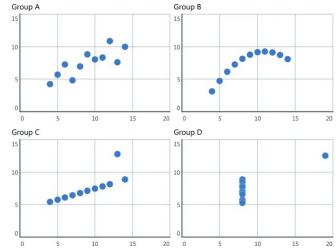
Visualization is a computational process that generates visual representations of data.

- It offers a method to see the unseen.

Why Do We Visualize Data?

- Table with four groups of numbers: What do they tell you?

Group A		Group B		Group C		Group D	
x	y	x	y	x	y	x	y
10.00	8.04	10.00	9.14	10.00	7.46	8.00	6.58
8.00	6.95	8.00	8.14	8.00	6.77	8.00	5.76
13.00	7.58	13.00	8.74	13.00	12.74	8.00	7.71
9.00	8.81	9.00	8.77	9.00	7.11	8.00	8.84
11.00	8.33	11.00	9.26	11.00	7.81	8.00	8.47
14.00	9.96	14.00	8.10	14.00	8.84	8.00	7.04
6.00	7.24	6.00	6.13	6.00	6.08	8.00	5.25
4.00	4.26	4.00	3.10	4.00	5.39	19.00	12.50
12.00	10.84	12.00	9.13	12.00	8.15	8.00	5.56
7.00	4.82	7.00	7.26	7.00	6.42	8.00	7.91
5.00	5.68	5.00	4.74	5.00	5.73	8.00	6.89



Why Do We Visualize Data? (cont.)

Consider the following table, which shows sales numbers for three categories, by quarter, over a four-year period. What trends can you see?

Category	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2014 Q2	2014 Q3	2014 Q4
Furniture	$463,988	$352,779	$338,169	$317,735	$320,875	$287,934	$319,537	$324,319
Office Supplies	$232,558	$290,055	$265,083	$246,946	$219,514	$202,412	$198,268	$279,679
Technology	$563,866	$244,045	$432,299	$461,616	$285,527	$353,237	$338,360	$420,018

Category	2015 Q1	2015 Q2	2015 Q3	2015 Q4	2016 Q1	2016 Q2	2016 Q3	2016 Q4
Furniture	$307,028	$273,836	$290,886	$397,912	$337,299	$245,445	$286,972	$313,878
Office Supplies	$207,363	$183,631	$191,405	$217,950	$241,281	$286,548	$217,198	$272,870
Technology	$333,002	$291,116	$356,243	$386,445	$386,387	$397,201	$359,656	$375,229

Visualization Systems

Concept 2

Visualization systems (**vis**) provide visual representations of datasets designed to **help** people **carry out** tasks more effectively.

- Computer-based visualization systems

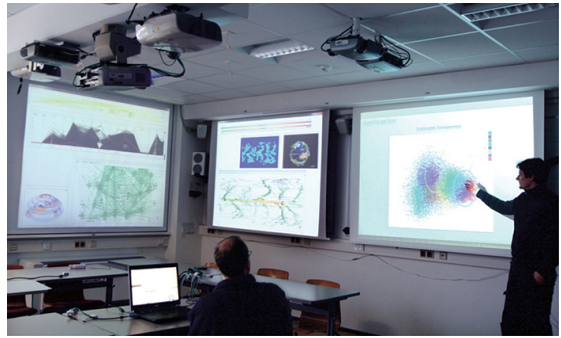
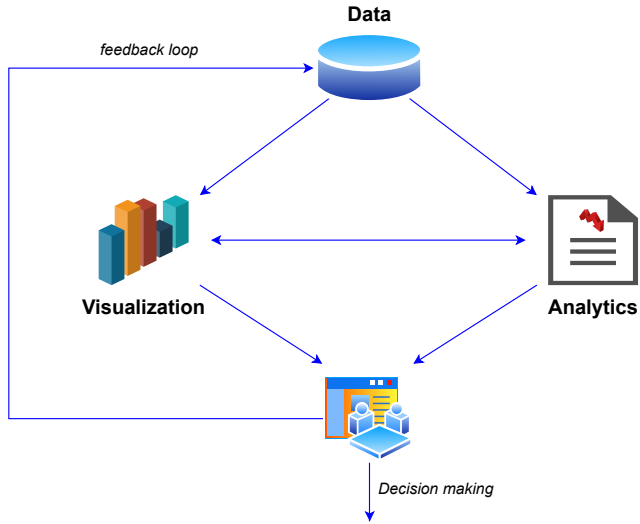


Diagram of Components

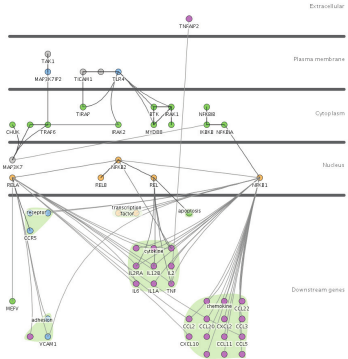


Why have a human in the loop?

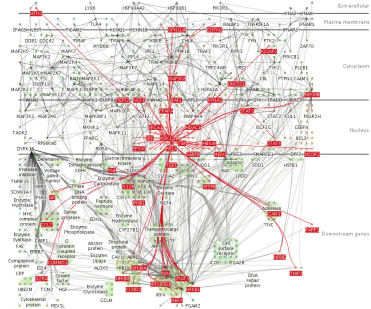
- Visualization is suitable when there is a need to augment human capabilities rather than replace people with computational decision-making methods
- Vis allows people to analyze data when they don't know exactly what questions they need to ask in advance
- **Don't need** vis when fully automatic solution exists and is trusted

Why have a computer in the loop?

- By using computers, we can build tools that allow people to explore or present large datasets that would be completely infeasible to draw by hand, thus opening up the possibility of seeing how datasets change over time.



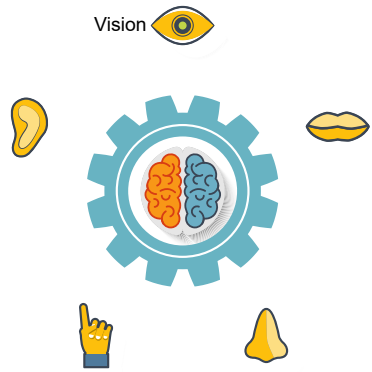
(a)



(b)

Why depend on vision?

- **Human visual system** is high-bandwidth channel to brain, overview possible due to background processing
- **Sound**: lower bandwidth and different semantics, overview not supported
- **Touch**: impoverished record/replay capacity, only very low-bandwidth communication thus far
- **Taste**
- **Smell**



Why Use Interactivity?

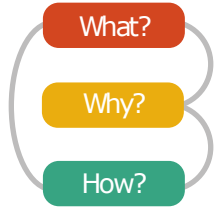
- **Interactivity** is crucial for building vis tools that handle complexity.
- It allows us to actively take part in the visual data analysis.

Visual Data Analyze

Why analyze?

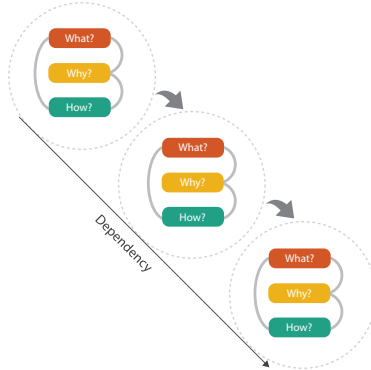
Three-part analysis framework for a vis instance:

- **why** is the task being performed
- **what** data is shown in the views
- **how** is the vis idiom constructed in terms of design choices.



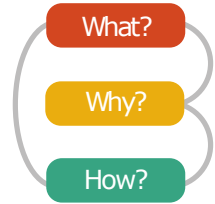
Why analyze? (cont.)

- Analyzing vis usage as chained sequences of instances, where the output of one instance is the input to another.



Four levels, three questions

- **Domain situation**
  - who are the target users?
- **Abstraction**
  - translate from specifics of domain to vocabulary of vis
  - **what** is shown? **data abstraction**, often don't just draw what you're given: transform to new form
  - **why** is the user looking at it? **task abstraction**
- **Idiom (figure, chart, diagram)**
  - **how** is it shown?
    - visual encoding idiom: how to draw
    - interaction idiom: how to manipulate
- **Algorithm**
  - efficient computation



Validation

- Different ways to get it wrong at each level

Validation (cont.)

- Use methods from different fields at each level

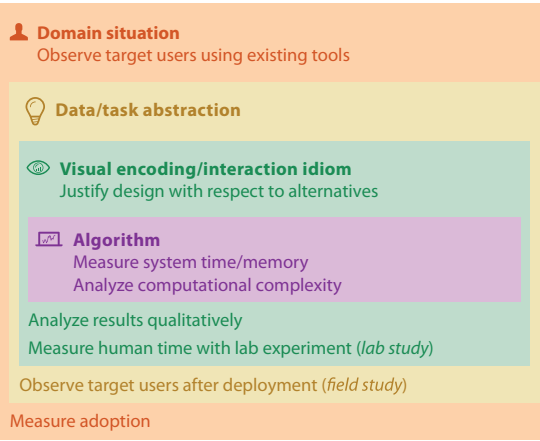
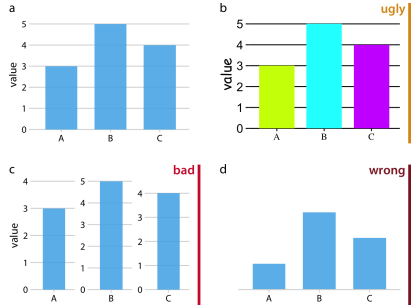


Figure Validation

- **Ugly**: A figure that has aesthetic problems but otherwise is clear and informative
- **Bad**: A figure that has problems related to perception; it may be unclear, confusing, overly complicated, or deceiving
- **Wrong**: A figure that has problems related to mathematics; it is objectively incorrect



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