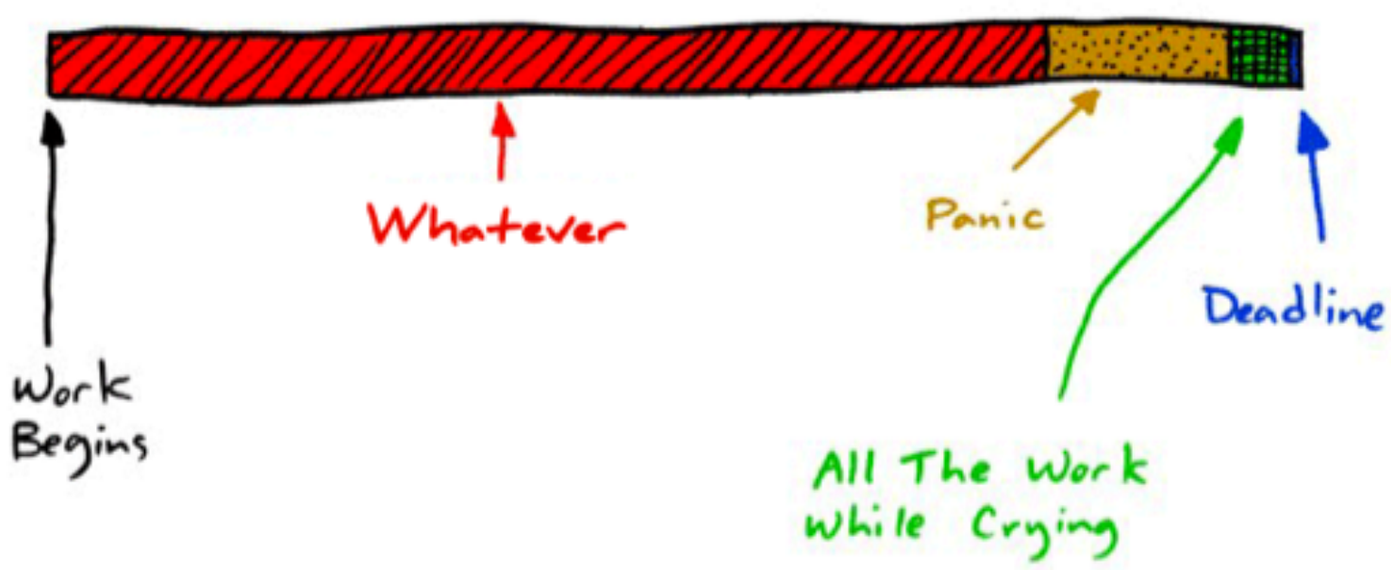
CS 171

Visualization Process

Hendrik Strobelt

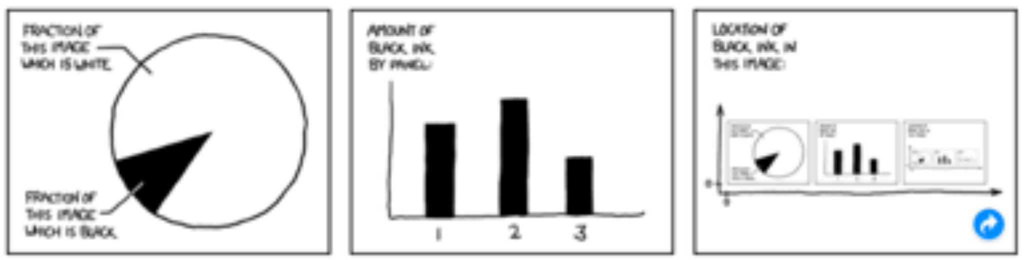


https://twitter.com/trickybrit/status/532643158572548096

CS 171

Design Principles

Hanspeter Pfister
pfister@seas.harvard.edu



CS 171

Perception

Hanspeter Pfister (pfister@g.harvard.edu)

CS 171

Cognition

Hendrik Strobelt

CS 171

Interaction for Visualization

Hanspeter Pfister

http://schedule.sxsw.com/2015/events/event_IAP43345

CS 171

Design Principles

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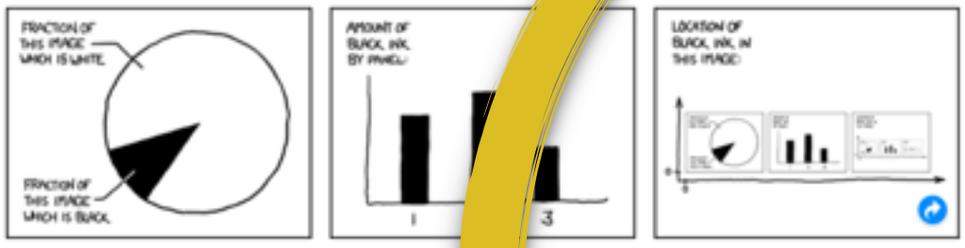


CS 171

Perception

Hanspeter Pfister (pfister@g.harvard.edu)

CS 171

Cognition

Hendrik Strobelt

CS 171

Interaction for Visualization

Hanspeter Pfister

Feedback

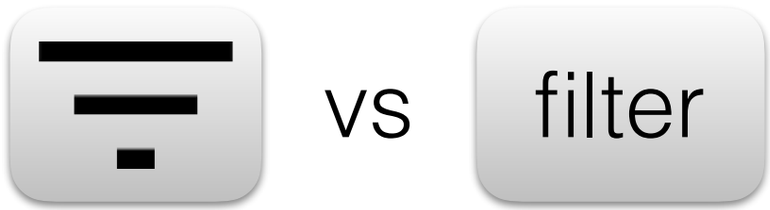
- Is there a ranking on interaction methods similar to visual rankings?
- Should we always use a storyboard?
- What makes a good storyboard?
- How can I realize the ideas in D3?
- How does everything play together?

Is there a ranking on interaction methods similar to visual rankings?

- Interactions are learned
- Good interactions reduce amount of learning
- Rules of thumb:
    - use standards from digital world
    - use standards from the real world (direct manipulation)
    - rank interactions w.r.t. likelihood of use and importance (reduce ‘click count’ for high ranks)
    - use known alphabets as labels
    - golden goal: be intuitive

Is there a ranking on interaction methods similar to visual rankings?

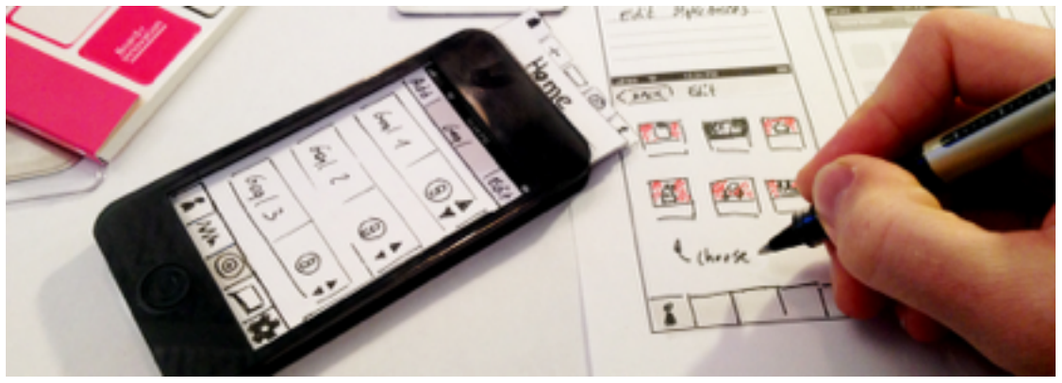
intuition



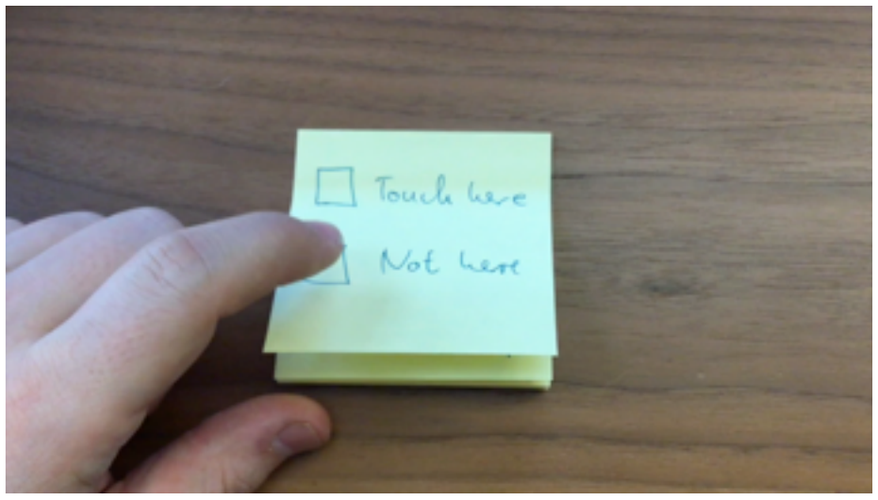
alphabet

Should we always use a storyboard?

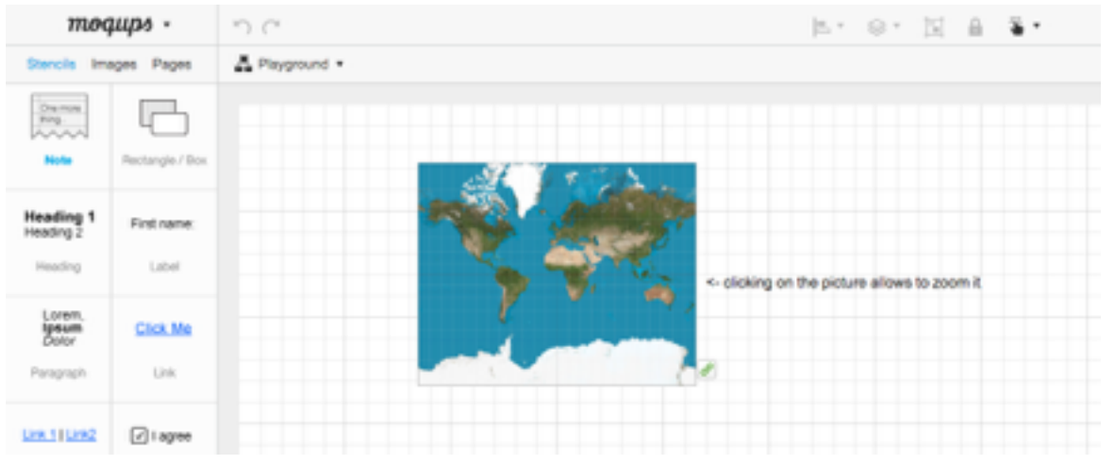
No, BUT always use **low-fidelity** prototypes



Paper Prototyping



Video Prototyping



Use Mockup Tools

Rapid Code Prototype

Feedback

- ✓ Is there a ranking on interaction methods similar to visual rankings?
- ✓ Should we always use a storyboard?

- How can I realize the ideas in D3?
- What makes a good storyboard?
- How does everything play together?

Today

- Get an **Overview** of the Visualization Process

- Learn to **Abstract** Tasks

- Use your Visualization to **Tell a Story**

Overview of the Visualization Process

CS 171

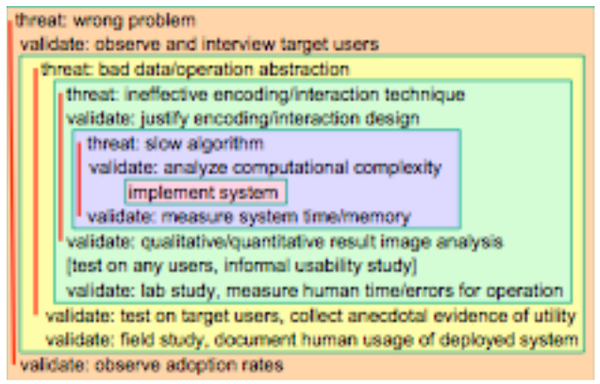
Several Models

A Nested Model for Visualization Design and Validation

Tamara Munzner, *Member, IEEE*

Abstract—We present a nested model for the visualization design and validation with four layers: characterize the task and data in the vocabulary of the problem domain, abstract into operations and data types, design visual encoding and interaction techniques, and create algorithms to execute techniques efficiently. The output from a level above is input to the level below, bringing attention to the design challenge that an upstream error inevitably cascades to all downstream levels. This model provides prescriptive guidance for determining appropriate evaluation approaches by identifying threats to validity unique to each level. We also provide three recommendations motivated by this model: authors should distinguish between these levels when claiming contributions at more than one of them, authors should explicitly state upstream assumptions at levels above the focus of a paper, and visualization venues should accept more papers on domain characterization.

Index Terms—Models, frameworks, design, evaluation.



Visualization Pipeline

http://www.infovis-wiki.net/index.php/Visualization_Pipeline

Visual Analytics: Definition, Process, and Challenges

Daniel Keim[1], Gennady Andrienko[2], Jean-Daniel Fekete[3], Carsten Görg[4], Jörn Kohlhammer[5], and Guy Melançon[6]

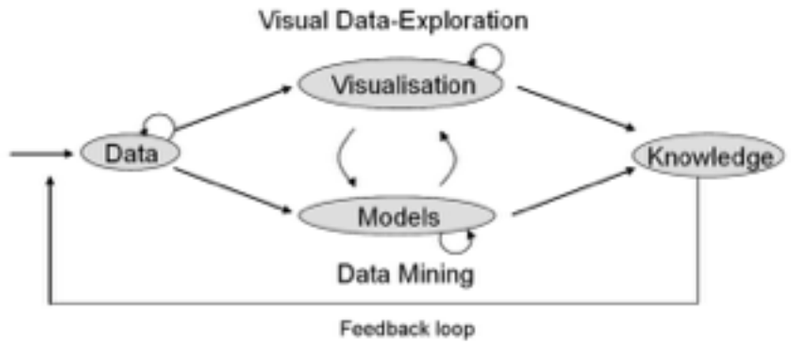


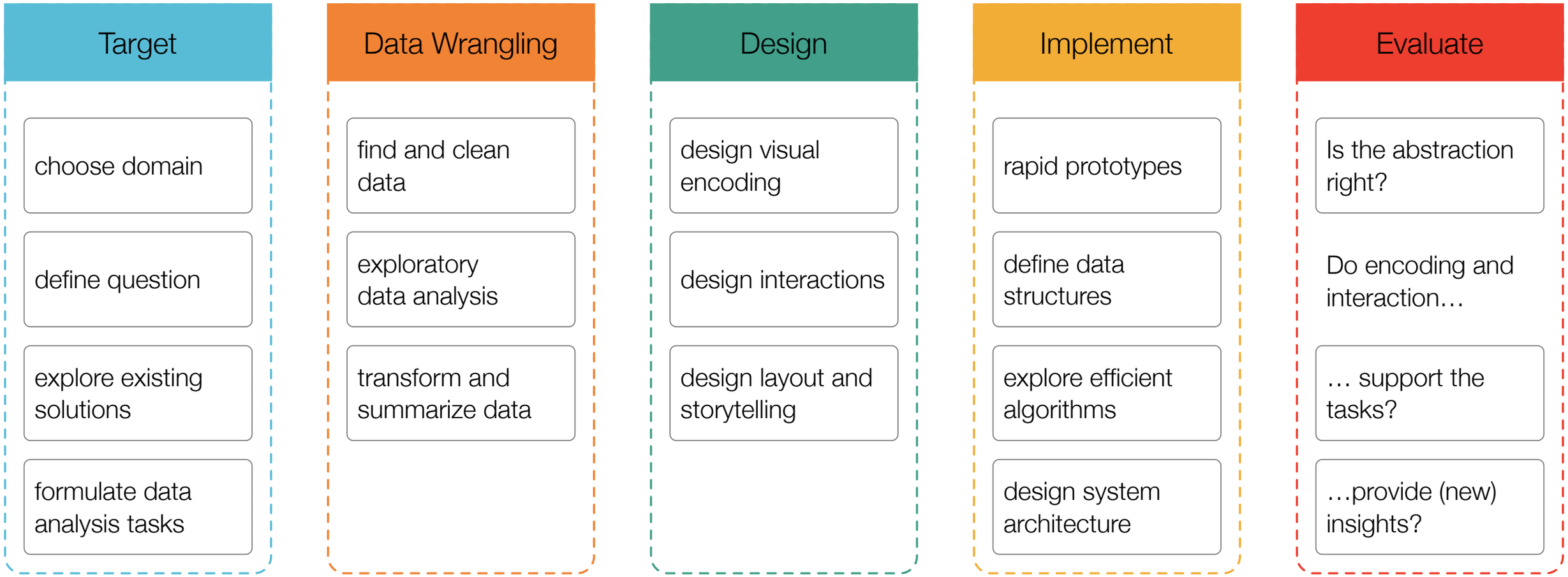
Fig. 1. Tight integration of visual and automatic data analysis methods with database technology for a scalable interactive decision support.

Our Model

Target | Data Wrangling | Design | Implement | Evaluate

based on work from Mariah Meyer

Our Model



based on work from Mariah Meyer

Target	Data Wrangling	Design	Implement	Evaluate
choose domain	find and clean data	design visual encoding	rapid prototypes	Is the abstraction right?
define question	exploratory data analysis	design interactions	define data structures	Do encoding and interaction…
explore existing solutions	transform and summarize data	design layout and storytelling	explore efficient algorithms	… support the tasks?
formulate data analysis tasks			design system architecture	…provide (new) insights?

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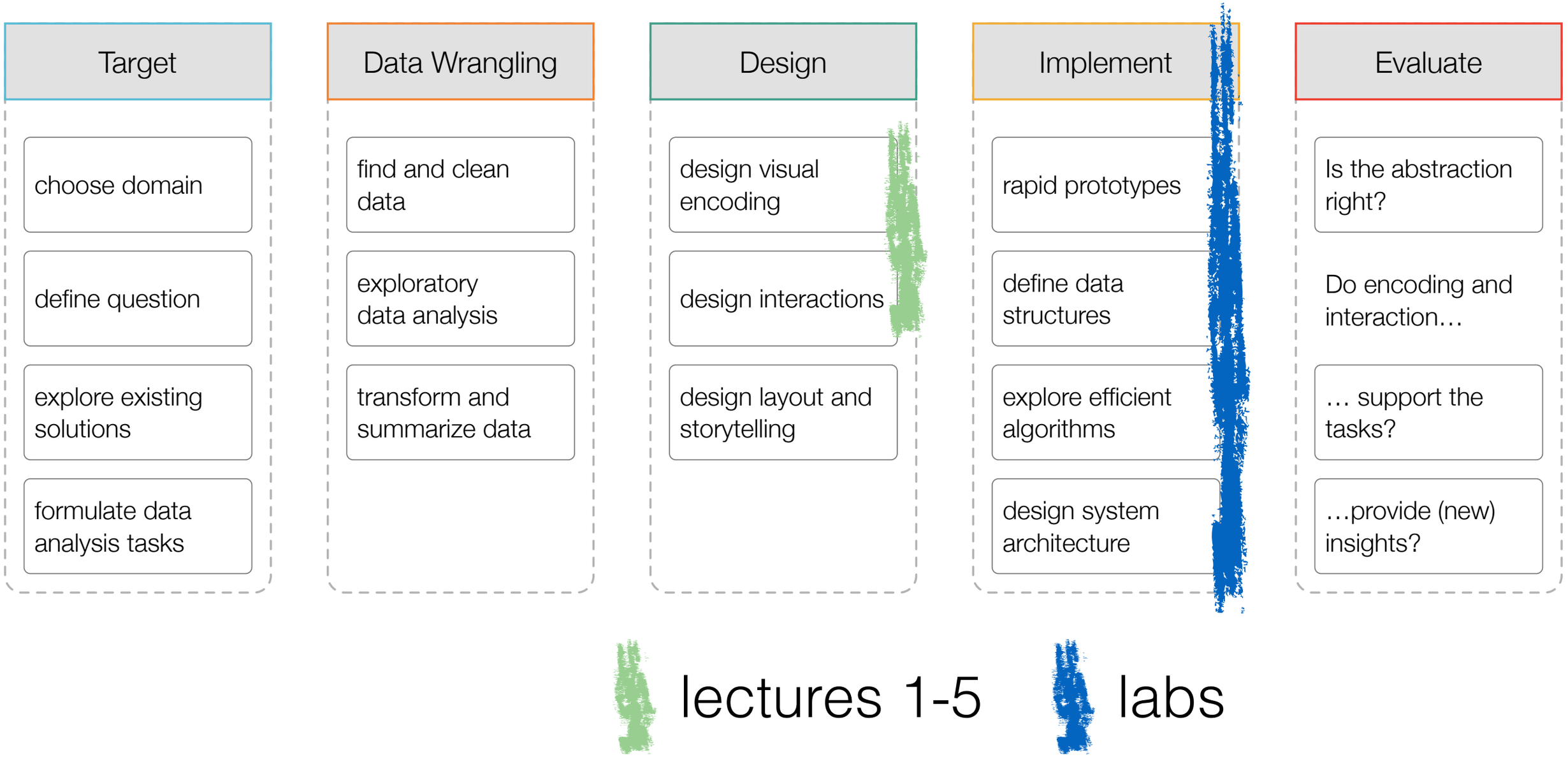
lectures 1-5


Target
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Do encoding and interaction…
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lectures 1-5
labs

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- define question
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Data Wrangling

- find and clean data
- exploratory data analysis
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- rapid prototypes
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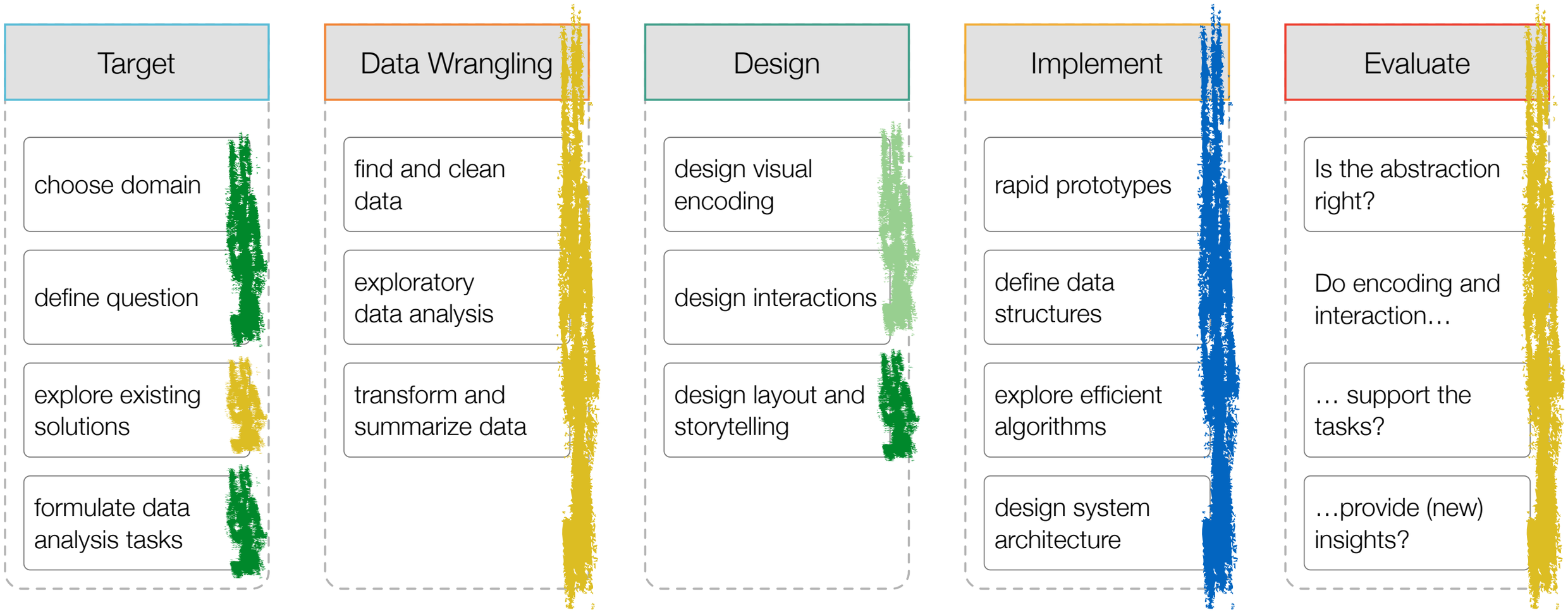
today lectures 1-5 labs

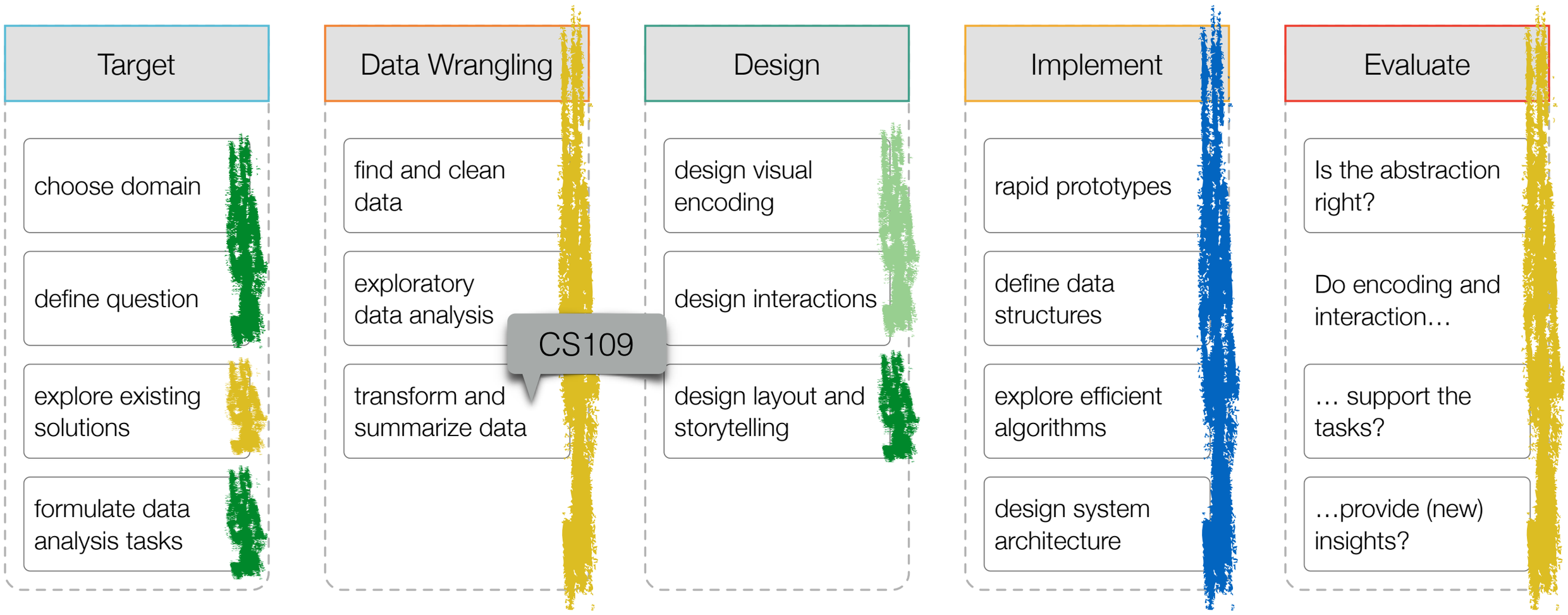


today

lectures 1-5

labs

after spring break & project



today

lectures 1-5

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based on work from Mariah Meyer

not necessarily !

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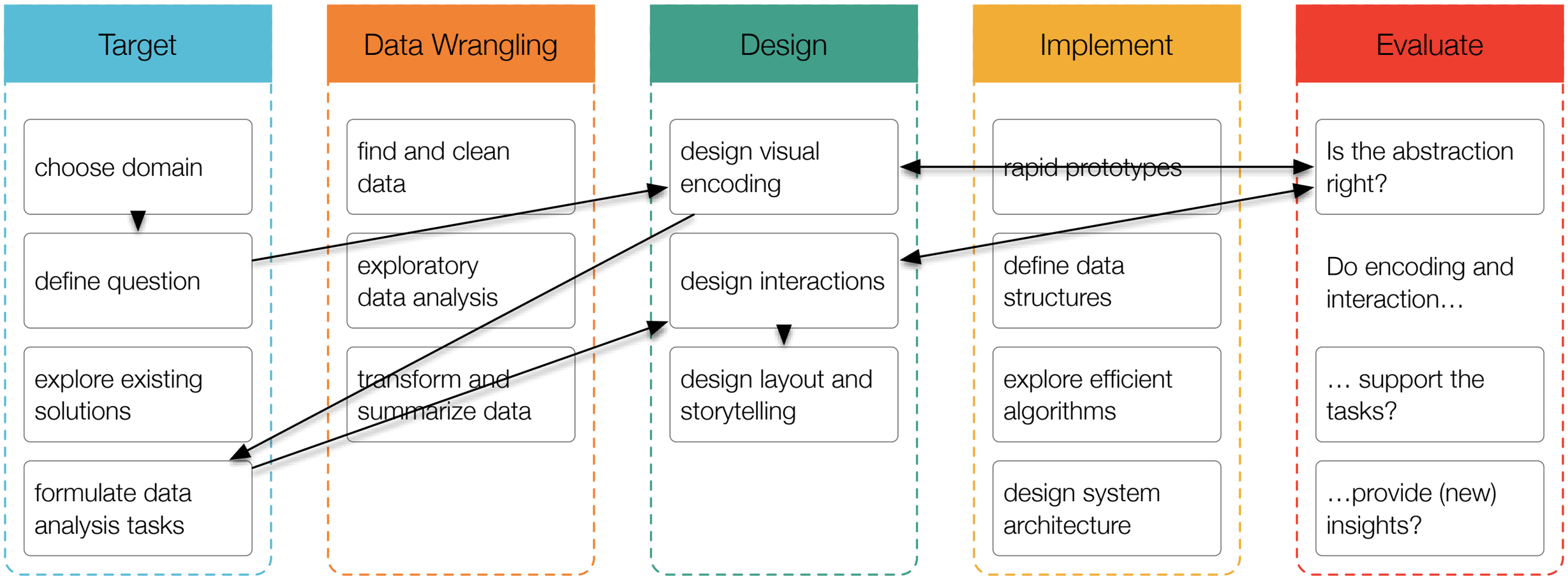
based on work from Mariah Meyer

Today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Today

choose domain

define question

design visual encoding

formulate data analysis tasks

design interactions

design layout and storytelling

Is the abstraction right?

Is the abstraction right?

Today

choose domain

define question

design visual encoding

formulate data analysis tasks

X design interactions

design layout and storytelling

Is the abstraction right? X

Is the abstraction right? X

Activity

CS 171

Read the handout material and become a pancake expert. Formulate questions that a user might want to answer.
(3+2 min)

hs8.de/cs171/

Pancake Recipes

hs8.de/cs171/

Ingredients

1 1/2 cups all-purpose flour
3 1/2 teaspoons baking powder
1 teaspoon salt
1 tablespoon white sugar
1 1/4 cups milk
1 egg
3 tablespoons butter, melted

allrecipes.com

Ingredients:

- 2 cups all-purpose flour, stirred or sifted before measuring
- 2 1/2 teaspoons baking powder
- 3 tablespoons granulated sugar
- 1/2 teaspoon salt
- 2 large eggs
- 1 1/2 to 1 3/4 cups milk
- 2 tablespoons melted butter

about.com

Combine the dry ingredients in a bowl, whisk, set aside:

2 cups flour
2 tbsp sugar
4 tsp baking powder
1 tsp baking soda
1 tsp fine salt

Combine the wet ingredients in a second bowl, whisk:

2 cups buttermilk
4 tbsp melted butter
1 tsp vanilla extract
2 beaten eggs

kottke.org

Ingredients:

1 ½ cups sifted flour

2 ½ tsp. baking powder

¾ tsp. salt

1 beaten egg

1 cup milk

3 tablespoons vegetable oil

makepancakes.com

Questions

- Given some ingredients, which pancake recipe can I make?
- Which is the most diet friendly recipe?
- How will pancakes turn out for the difference recipes? Taste? Texture?
- What recipe will require the least amount of money?
- To what extent do quantities vary? How much deviation is there?
- What would be a good story to tell around Pancake recipes ?

Questions

!!

Given some ingredients, which pancake recipe can I make?

Which is the most diet friendly recipe?

How will pancakes turn out for the difference recipes? Taste? Texture?

What recipe will require the least amount of money?

- To what extent do quantities vary? How much deviation is there?
- What would be a good story to tell around Pancake recipes ?

Activity

Sketch one visualization design. Think about what are the most important dimensions of the data you want to show and how you encode them. (4 min)

!!

Given some ingredients, which pancake recipe can I make?

Which is the most diet friendly recipe?

How will pancakes turn out for the difference recipes? Taste? Texture?

What recipe will require the least amount of money?

Your Ideas

Activity

CS 171

For the goals/questions you identified think of two interactions that would help the user to answer the questions (2 min).

Select
Sort
Filter
Navigate
Coordinate

Abstract Tasks

CS
171

Data Task Abstraction

Abstract questions into data types and operations

- Retrieve Value
- Filter
- Compute Derived Value
- Find Extremum
- Sort
- Determine Range
- Characterize Distribution
- Find Anomalies
- Cluster
- Correlate
- Compare X vs. Y
- Identify Containments

based on [Amar, Eagan, & Stasko, 2005]

Goal - Task relationship

- Goal A:
    - Task 1
    - Task 2
- Goal B:
    - Task 3
    - Task 4

Goal - Task relationship

- Goal A:
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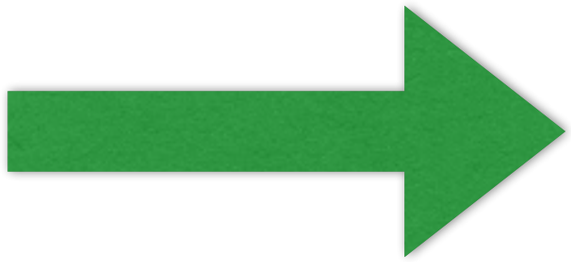
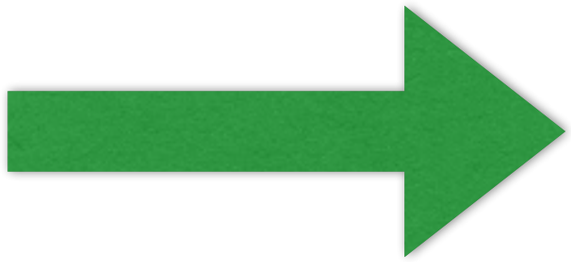


more realistic

Goal - Task relationship

- Goal A:
  - Task 1
  - Task 2
- Goal B:
  - Task 3
  - Task 4

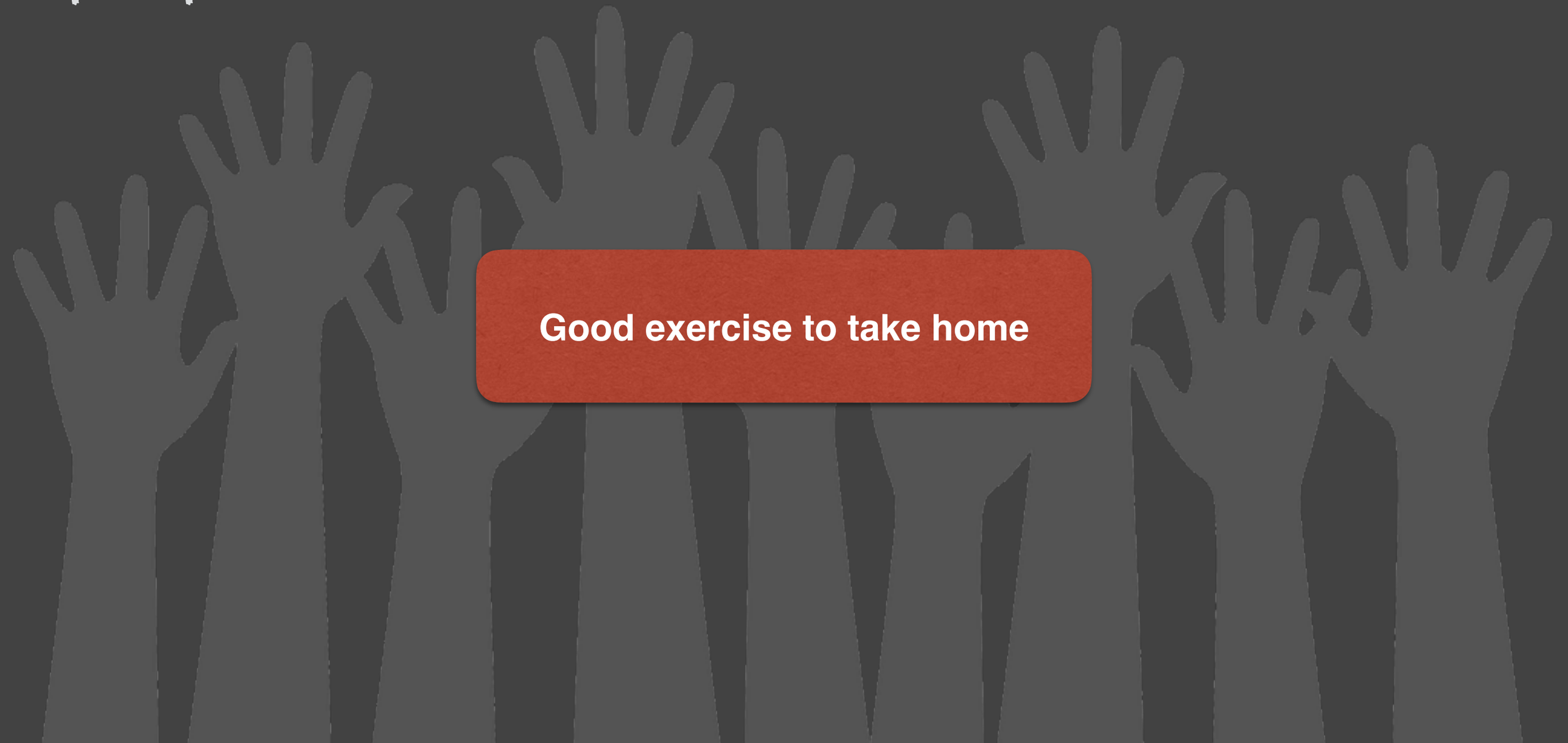


more realistic

- Task 1:
  - Goal A
- Task 2:
  - Goal A
  - Goal B
- Task 3:
  - Goal B
- Task 4:
  - Goal A

Activity

Create a branching storyboard to explain two of the interactions you proposed. (7min)



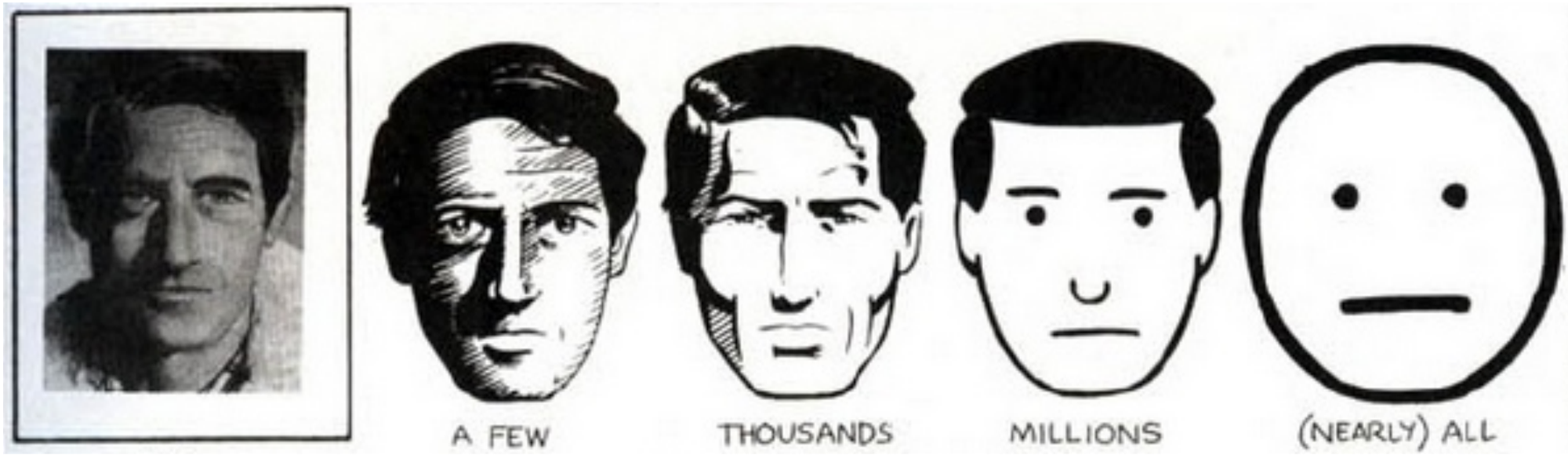
Good exercise to take home

Visual Abstraction

—> Useful for Storyboards

Scott McCloud: “Understanding Comics”

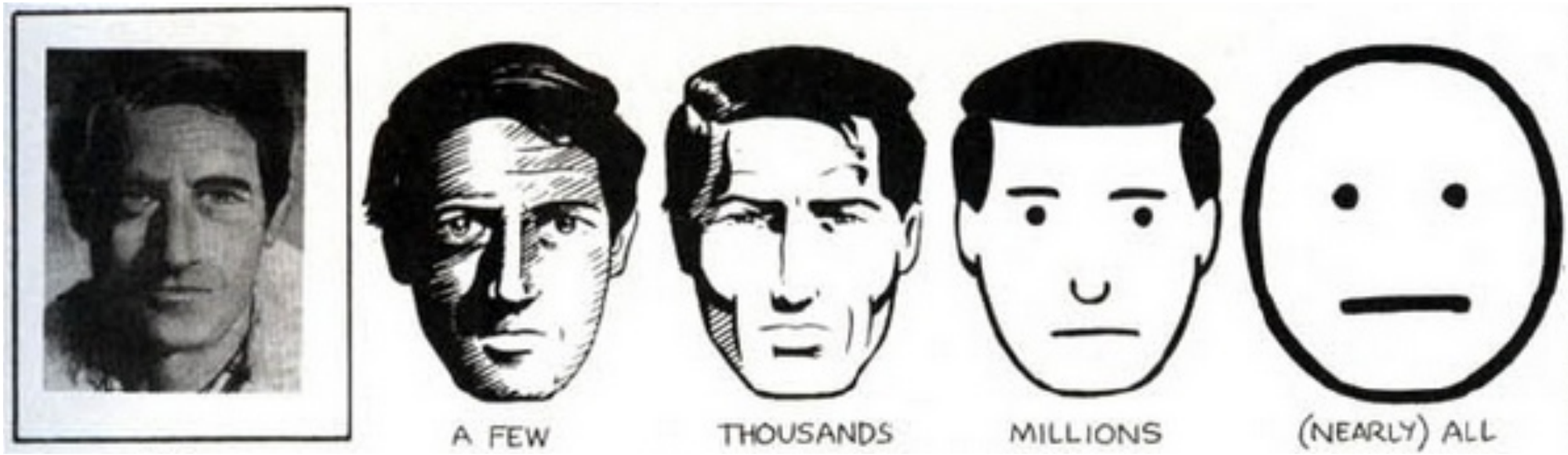
Visual Abstraction



—> Useful for Storyboards

Scott McCloud: “Understanding Comics”

Visual Abstraction

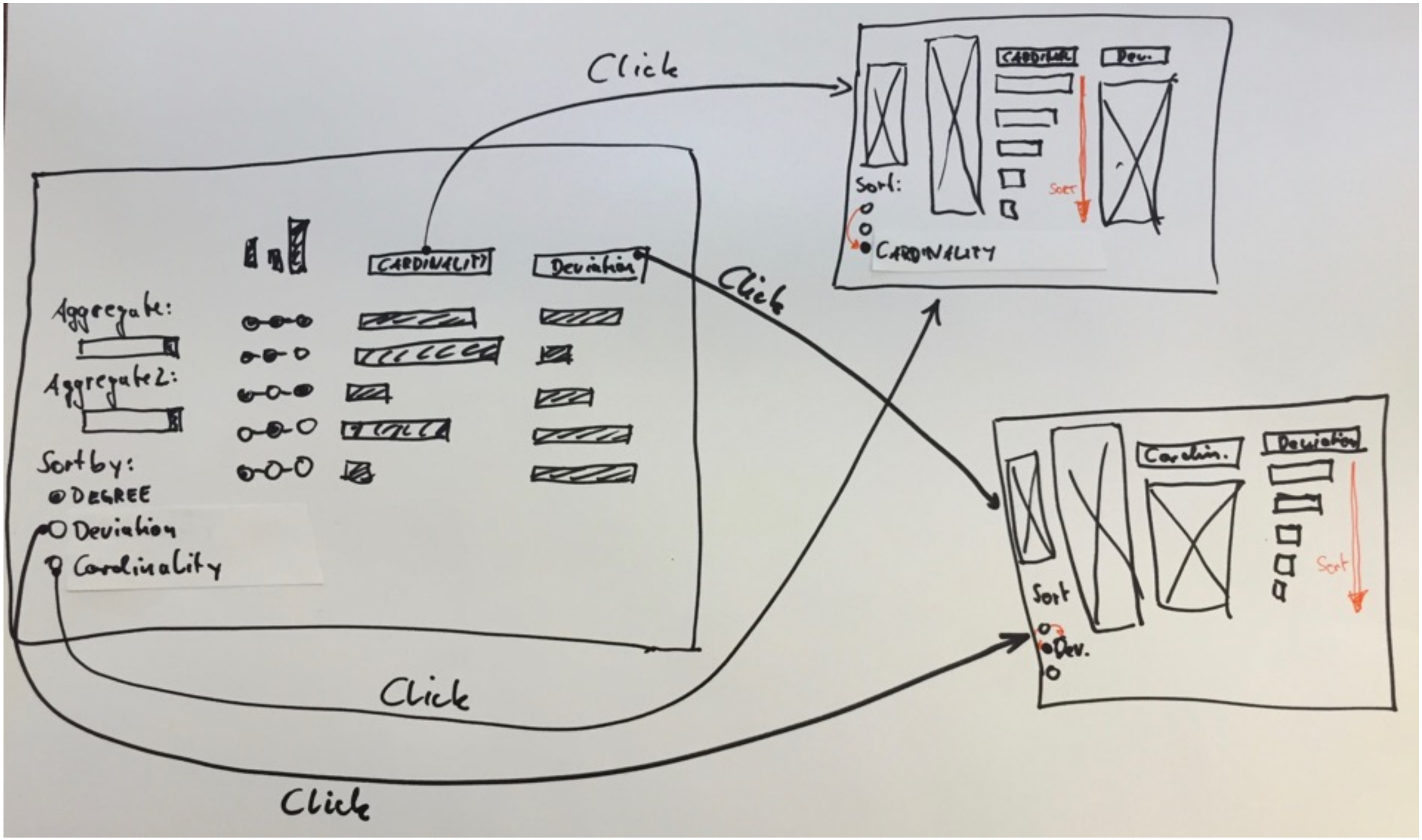


Face

—> Useful for Storyboards

Scott McCloud: “Understanding Comics”

Where and **how** an action is triggered and **what** does change



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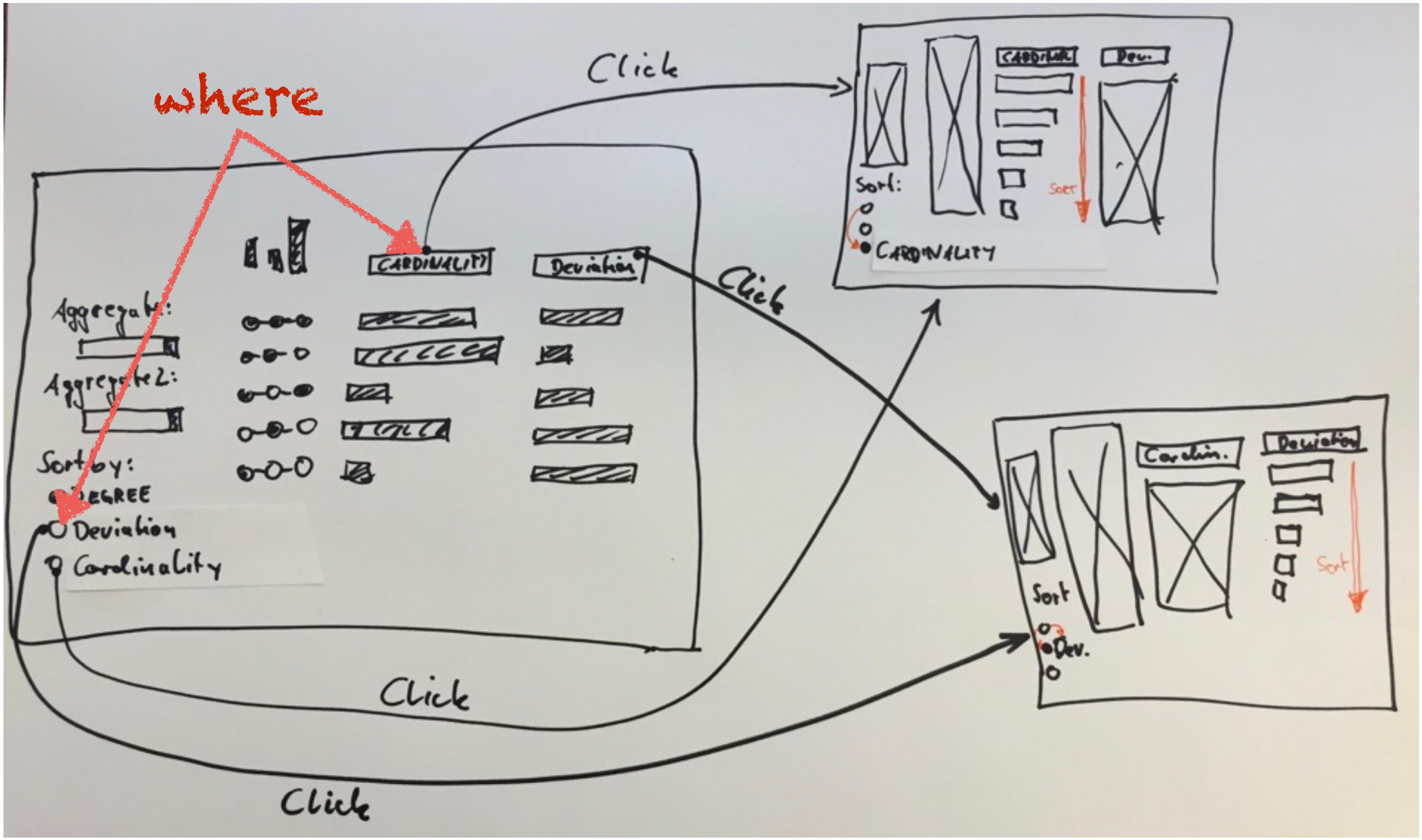

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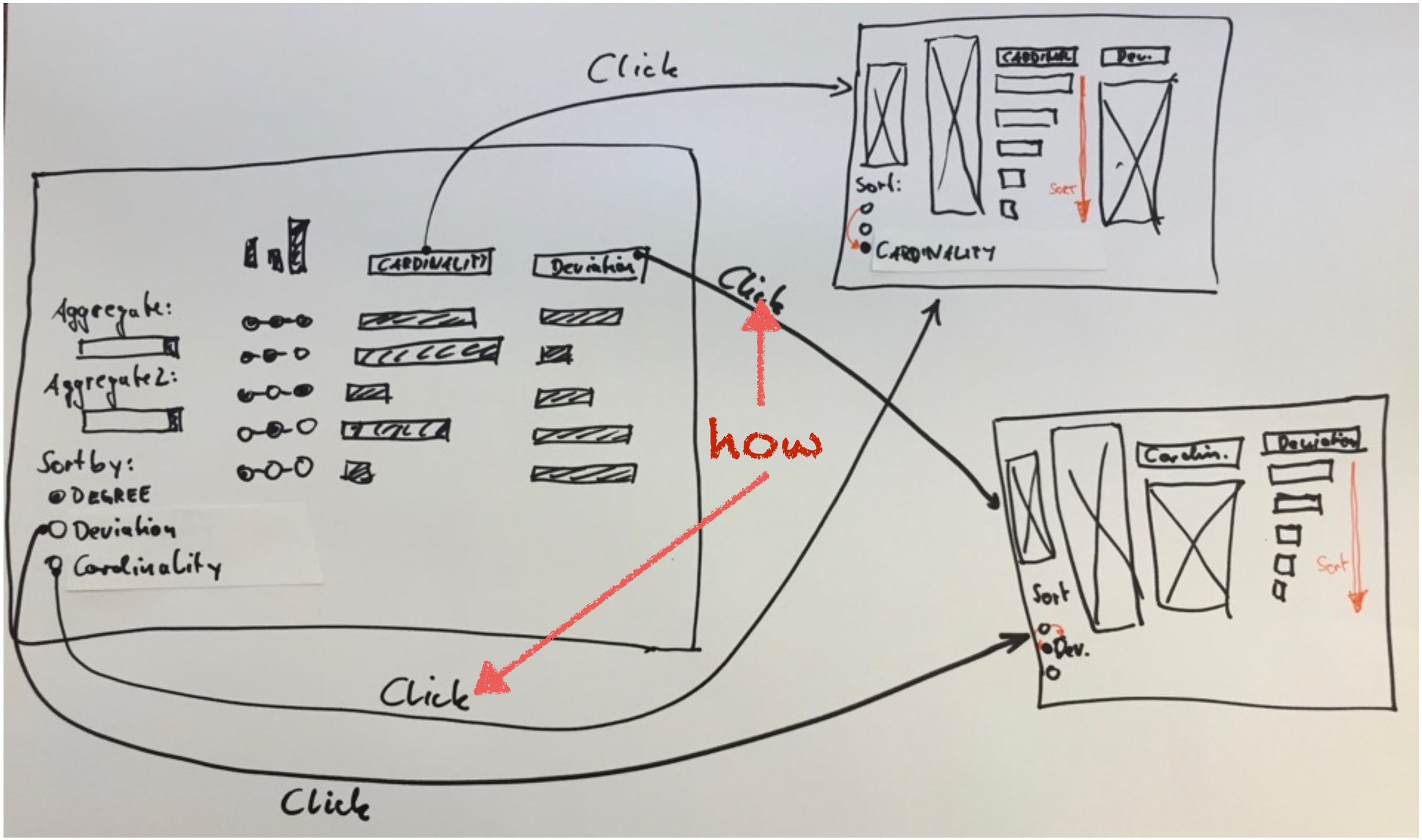

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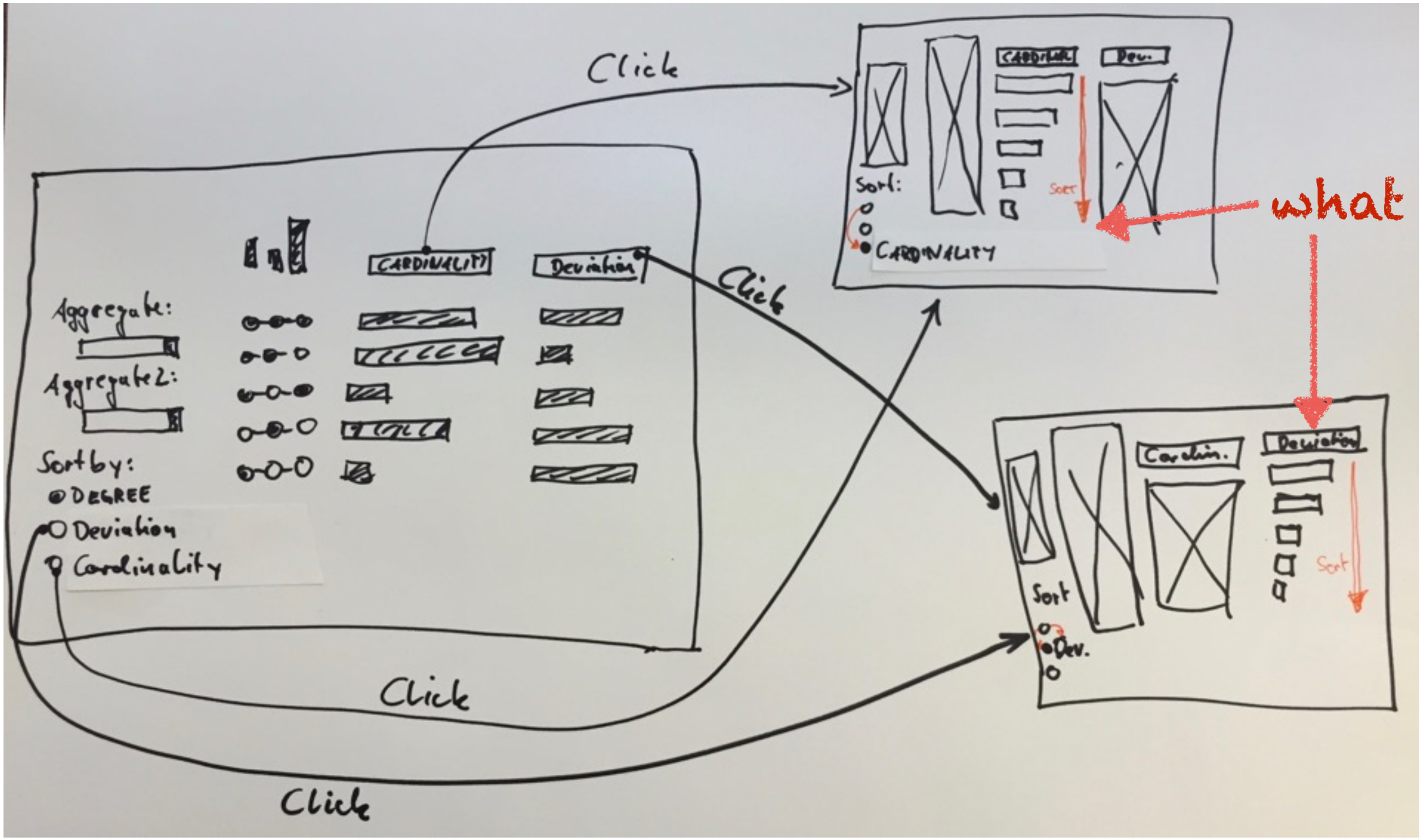

"Do your viewers want to see the data presented as-is, or do they want you to cut to the chase and interpret the data?"

–Ann K. Emery

Use your Visualization to **Tell a Story**

CS 171

Questions

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- Which is the most diet friendly recipe?
- How will pancakes turn out for the difference recipes? Taste? Texture?
- What recipe will require the least amount of money?
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- What would be a good story to tell around Pancake recipes ?

Activity

Your visualization will be part of an online article in the Gotham Times. Create a sketch of a page layout. You can think of text snippets like (7 min):

- All pancake are (not) equal...
- The pancake in your diet...
- The pancake for small budgets...

Here are four design strategies you can use to **tell a story** in your graph:

Descriptive titles

Descriptive subtitles

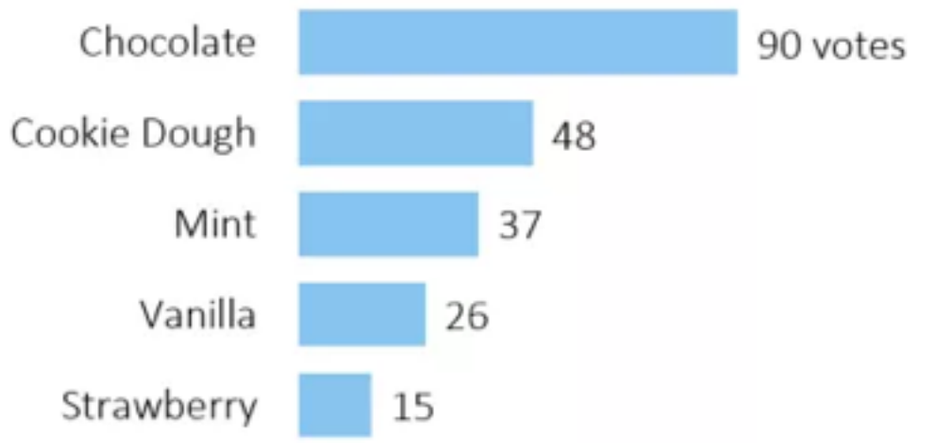
Annotations

Saturation

Ann K. Emery: http://annkemery.com/four-storytelling-strategies/

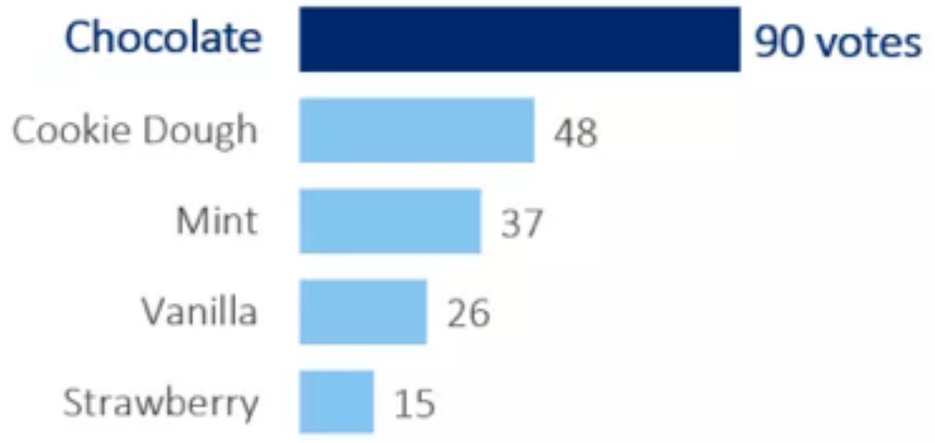
Descriptive title and **saturation** to show how chocolate is the preferred ice cream flavor.

Ice cream flavor preferences based on 2014 survey of elementary school students (n=216)



or

Chocolate was most popular flavor among elementary students surveyed

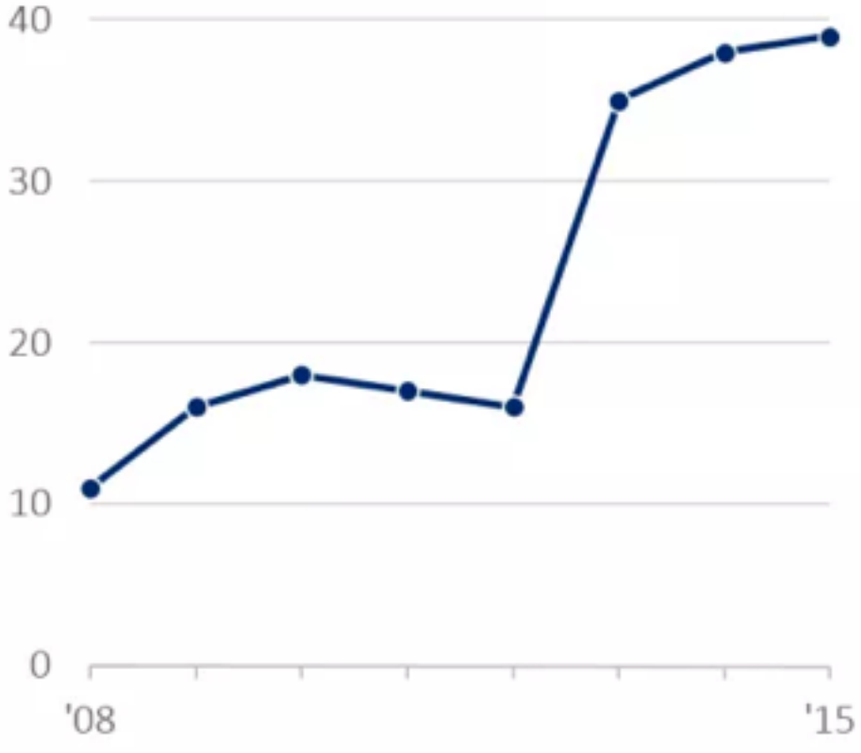


Source: 2014 survey of elementary school students (n=216)

Ann K. Emery: http://annkemery.com/four-storytelling-strategies/

Descriptive title, descriptive subtitle and **annotation**

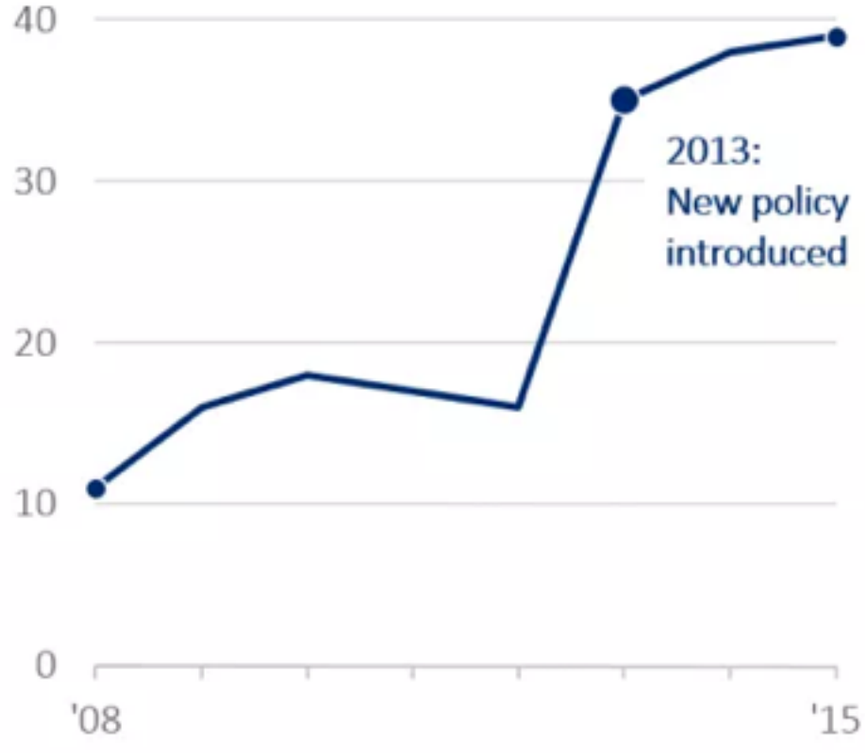
Number of studies funded each year



or

We're funding more studies each year

Beginning in 2013, we set aside new funding to measure the effectiveness of our initiatives – and we evaluated 39 of our programs in 2015 alone.



Ann K. Emery: http://annkemery.com/four-storytelling-strategies/

Contrast

Making elements different increases understanding.

Repetition

Repeat visual elements to create strong unity.

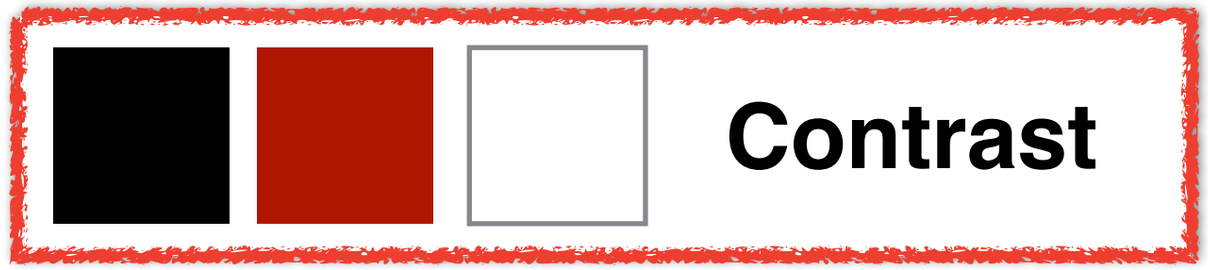
Alignment

Nothing should be placed arbitrarily. Placement illustrates relationships between elements.

Proximity

Related items should be placed together.

http://howtwosondesign.blogspot.com/2012/03/crap-theory.html



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C.R.A.P. Design

- **Contrast** helps to highlight and focus attention.

- **Repetition** helps to unite a document so that it looks like a coherent whole.

- **Alignment** helps to organize information to make it clearer.

- **Proximity** helps to establish relationships between items.

http://2012books.lardbucket.org/books/designing-business-information-systems-apps-websites-and-more/s07-01-c-r-a-p-principles-of-graphic-.html

C.R.A.P. Design

- **Contrast** helps to highlight and focus attention.

Perception lecture

- **Repetition** helps to unite a document so that it looks like a coherent whole.

GP: “Similarity”

- **Alignment** helps to organize information to make it clearer.

Hierarchical design, Similarity using Position

- **Proximity** helps to establish relationships between items.

GP: “Proximity”

http://2012books.lardbucket.org/books/designing-business-information-systems-apps-websites-and-more/s07-01-c-r-a-p-principles-of-graphic-.html

Text should be readable and legible for your users

Es schlug mein Herz, geschwind zu Pferde!
Es war getan fast eh gedacht.
Der Abend wiegte schon
die Erde,
Und an den Bergen hing die Nacht;
Schon stand im Nebelkleid die Eiche,
Ein aufgetürmter Riese,
da,
Wo Finsternis aus dem Gesträuche
Mit hundert schwarzen Augen sah.

vs

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Alignment

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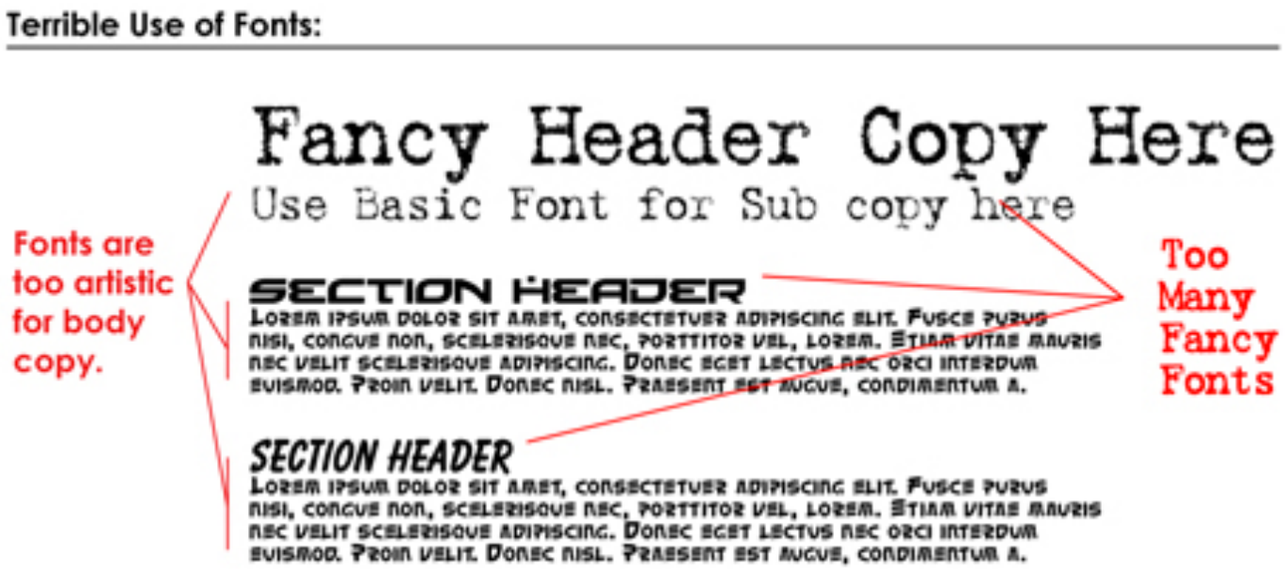
Size

To horse! my pounding heart kept crying,
No sooner was it thought than done.
In evening's lap the earth was lying,
And on the peaks the night was spun;
Already clad in mist, the giant,
The oak, stood towering eerily,
Where darkness from the copse defiant
Turned many somber eyes on me.

Audience

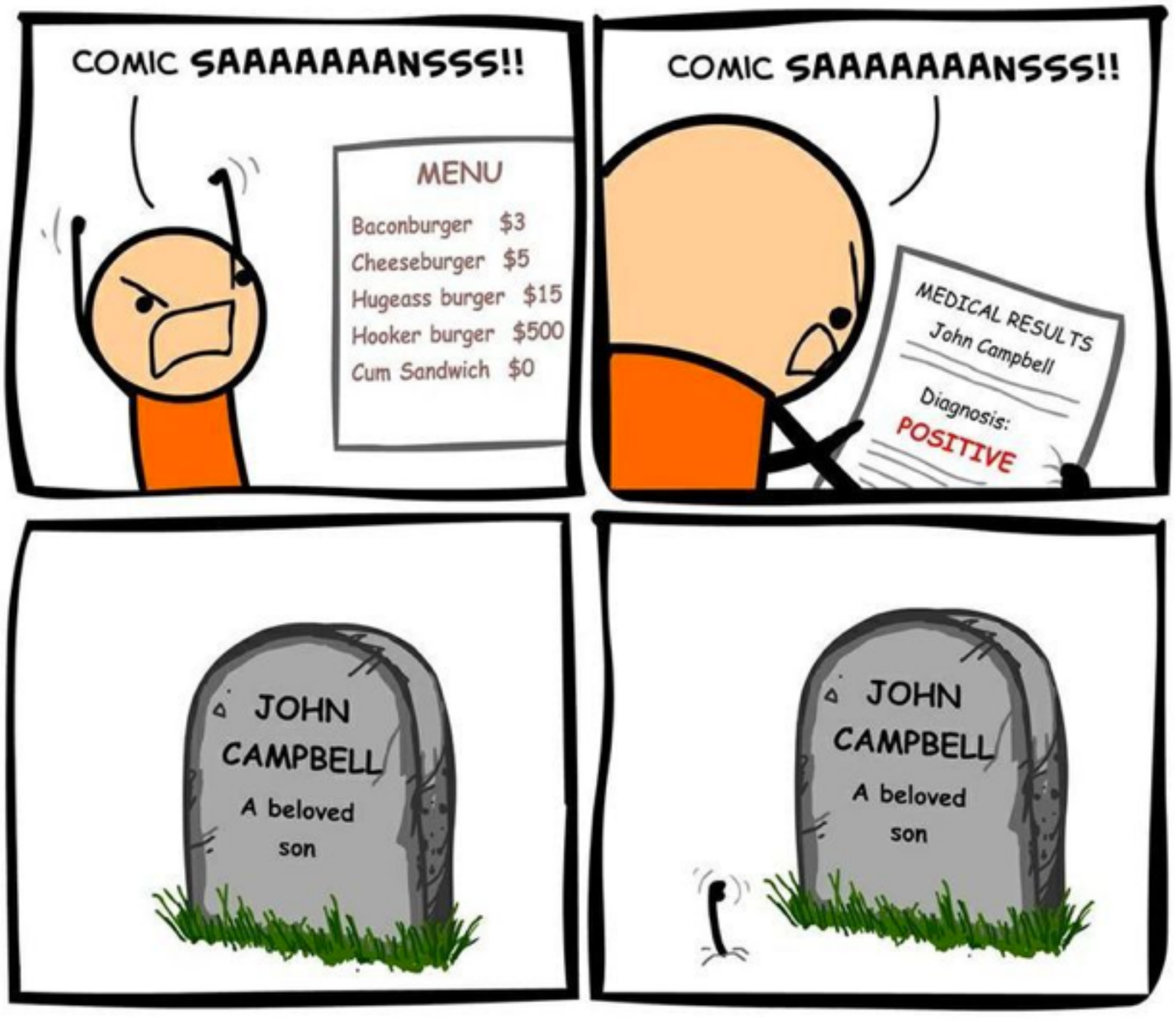
Reduce the number of font variations whenever you can.



http://gomedia.com/zine/tutorials/rule-one-limit-your-fonts/

THE COMIC SANS GAME! TRY IT!

Keep an eye out for everyone's favorite stylistically-awkward font in everyday life!
You'll notice it more often than you think!
If you see it, just raise your fist and shout "COMIC SAAAAAAAAAANNS!!!"



choose fonts wisely

less fancy as fallback

Activity

Critique your neighbor's design w.r.t. use of the C.R.A.P. principles. (1+1min)

Contrast

Making elements different increases understanding.

Repetition

Repeat visual elements to create strong unity.

Alignment

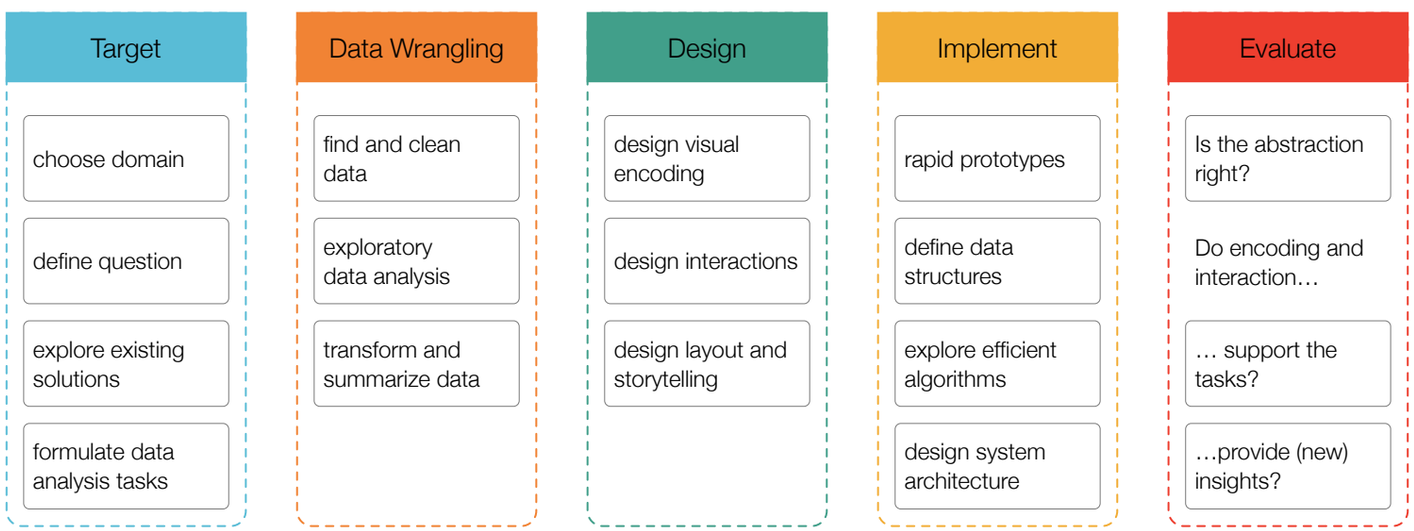
Nothing should be placed arbitrarily. Placement illustrates relationships between elements.

Proximity

Related items should be placed together.

Potential Pitfalls

- Wrong problem - they don't do that
- Wrong abstraction - you're showing them the wrong thing
- Wrong encoding / interaction - the way you show it does not work
- Wrong algorithm - your code is too slow



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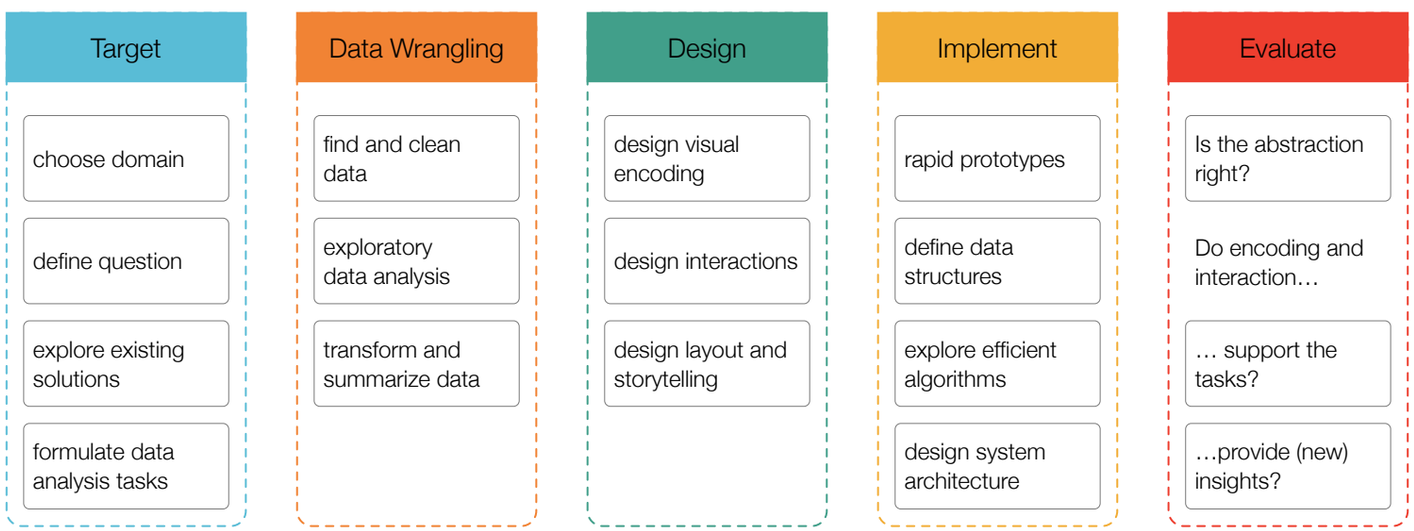

The Big Unknown

Target	Data Wrangling	Design	Implement	Evaluate
choose domain	find and clean data	design visual encoding	rapid prototypes	Is the abstraction right?
define question	exploratory data analysis	design interactions	define data structures	Do encoding and interaction…
explore existing solutions	transform and summarize data	design layout and storytelling	explore efficient algorithms	… support the tasks?
formulate data analysis tasks			design system architecture	…provide (new) insights?

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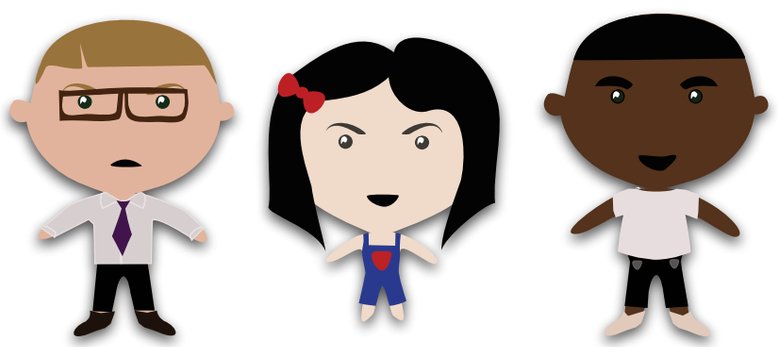

the user / the expert

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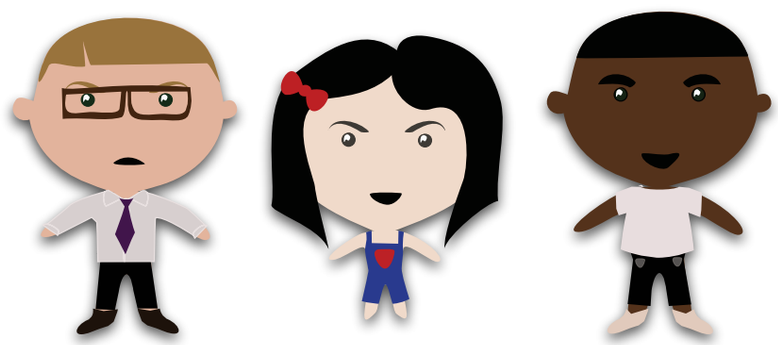

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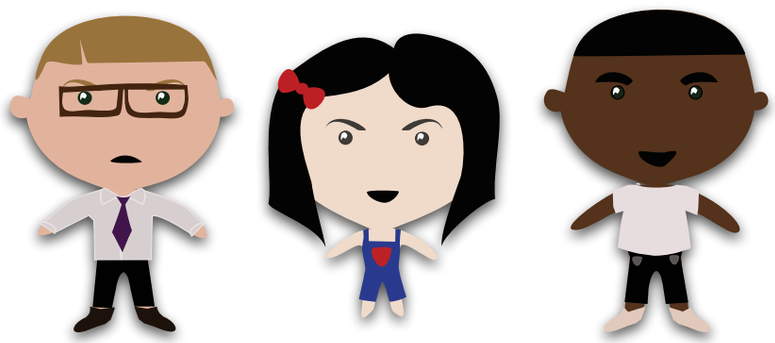

the user / the expert

“What does the user want to see?
What does the data want to be?”

–Jarke van Wijk

Dealing with experts

- Use a user centered approach!

Jarke van Wijk: https://vimeo.com/80334651

Dealing with experts

- Use a user centered approach!

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Your CS171 Project

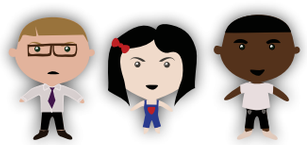
- groups of three students
- assignment in **studios this week**
    - If you have already a project idea, please prepare a 1-min pitch
- project proposal:
    - Have the data at hand !
    - Come up with interesting questions:
        - Why is it interesting?
        - What do you want to see/communicate?
    - Have the data at hand :)

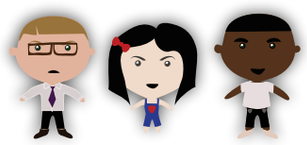
Today

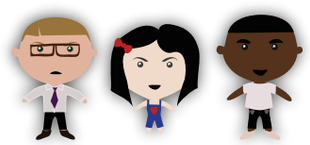
1 min paper

- Get an **Overview** of the Visualization Process

Target | Data Wrangling | Design | Implement | Evaluate



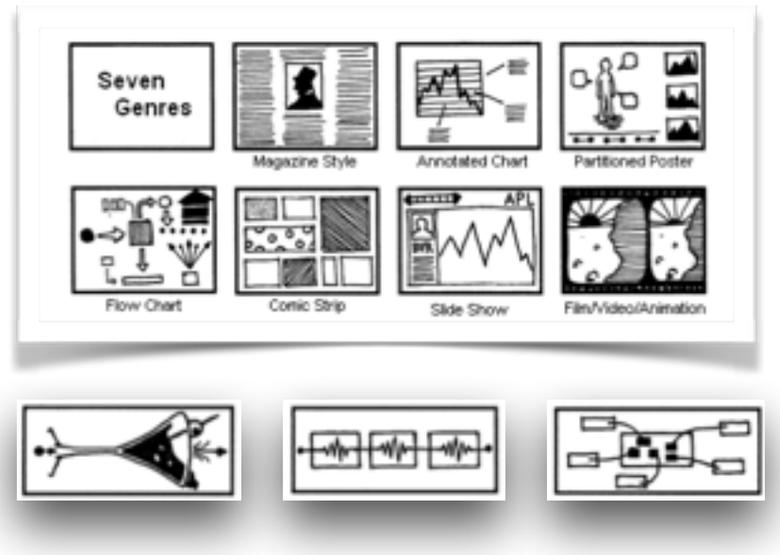




- Learn to **Abstract** Goals and Tasks

Analytic Task Taxonomy, Task-Goal Relationship

- Use your Visualization to **Tell a Story**

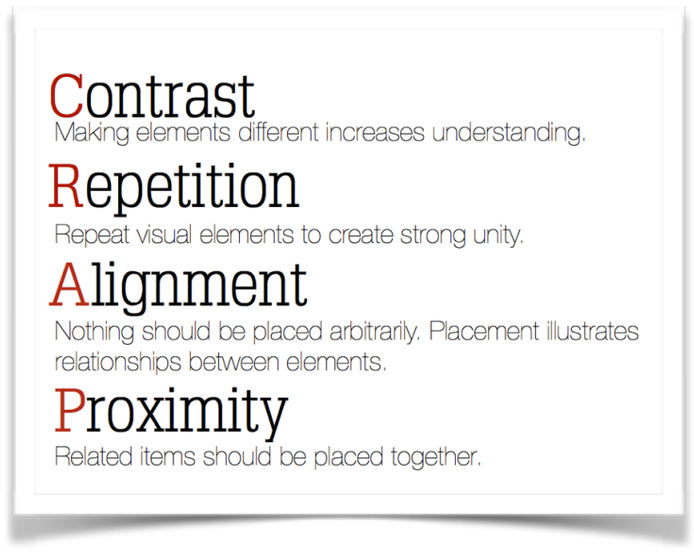


Descriptive titles

Descriptive subtitles

Annotations

Saturation



This Thursday…

- D3 layouts (graphs, trees,..), GeoVis, Multiple Data Files
- Reading: D3 book, Ch. 11 (p. 201-214) & Ch. 12 (p. 217-229)

!! important to attend !!

Next Tuesday…

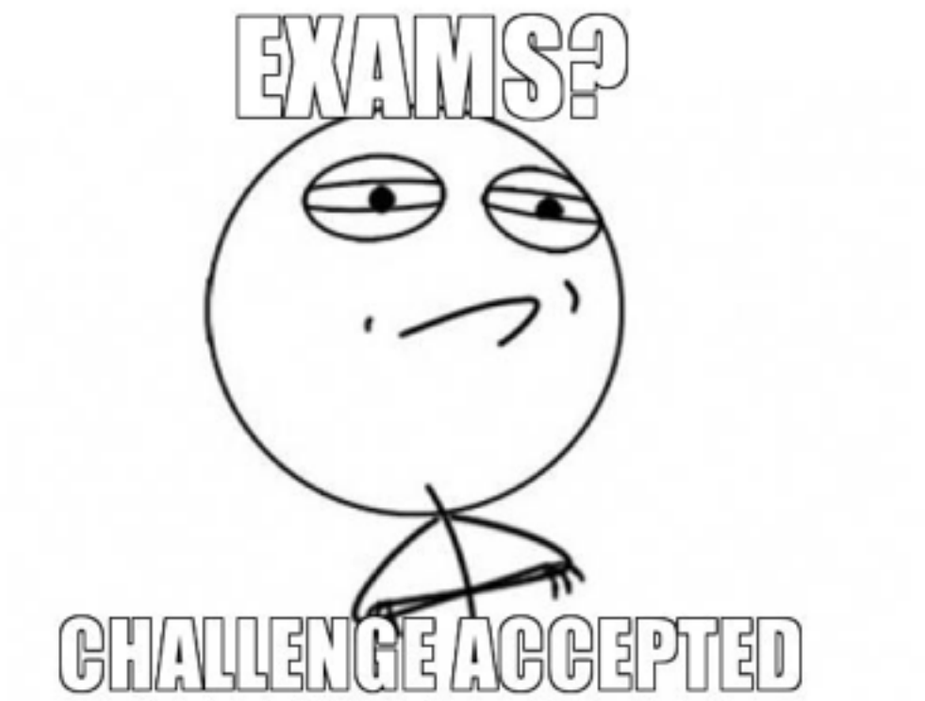
- Midterm
- Reading: labs and lecture notes

Homework (due Monday)…

- No HW - Please prepare for Midterm

Midterm

- two parts:
  - exam (50 points)
  - project (50 points)
- please be in time
- do not worry



Midterm - Exam

- please be in time - March 8, 2:30pm ET

Allowed:

✓ Interactive Data Visualization for the Web, Scott Murray
✓ Visual Thinking for Design, Colin Ware
✓ Your personal laptop or tablet (including google)
✓ Your own notes and materials from lecture, labs and homeworks
✓ Camera to scan your designs after the end of the midterm exam

Not allowed:

✗ Collaboration with your neighbors
✗ Smartphones
✗ Facebook, email or other messaging systems
✗ Piazza

Midterm - Exam (DCE)

- due on Wednesday, March 9th 2016 at 11:59 pm EST on Canvas)

Allowed:

✓ Interactive Data Visualization for the Web, Scott Murray
✓ Visual Thinking for Design, Colin Ware
✓ Your personal laptop or tablet (including google)
✓ Your own notes and materials from lecture, labs and homeworks
✓ Camera to scan your designs after the end of the midterm exam

Not allowed:

✗ Collaboration with your neighbors
✗ Smartphones
✗ Facebook, email or other messaging systems
✗ Piazza

Midterm - Project

- due on Sunday, March 13th 2016
  at 11:59 pm EST on Vocareum

- similar to a homework assignment

- no studios in midterm week

- no lab (Thu) in midterm week

- no office hours in midterm week

- **no piazza**