Visualization & Visual Analytics 1

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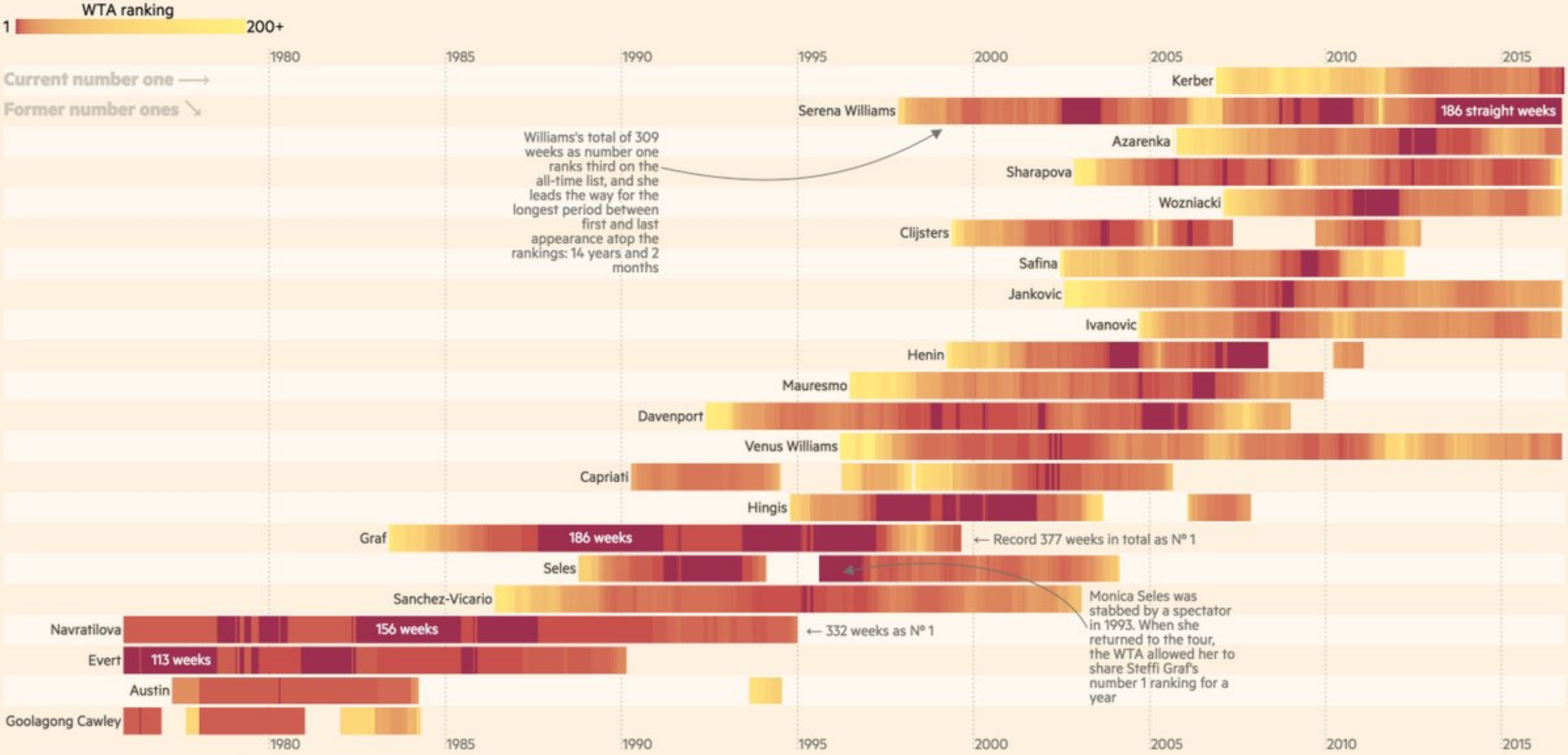
creativecoding.evl.uic.edu/courses/cs424

A visual history of women's tennis

Serena Williams was toppled from the number one spot following the US Open, just as she matched Steffi Graf's all-time record of 186 consecutive weeks atop the WTA rankings. Shown below is every player ever to have appeared at number one at least once since the rankings were created in November 1975



Williams's total of 309 weeks as number one ranks third on the all-time list, and she leads the way for the longest period between first and last appearance atop the rankings: 14 years and 2 months

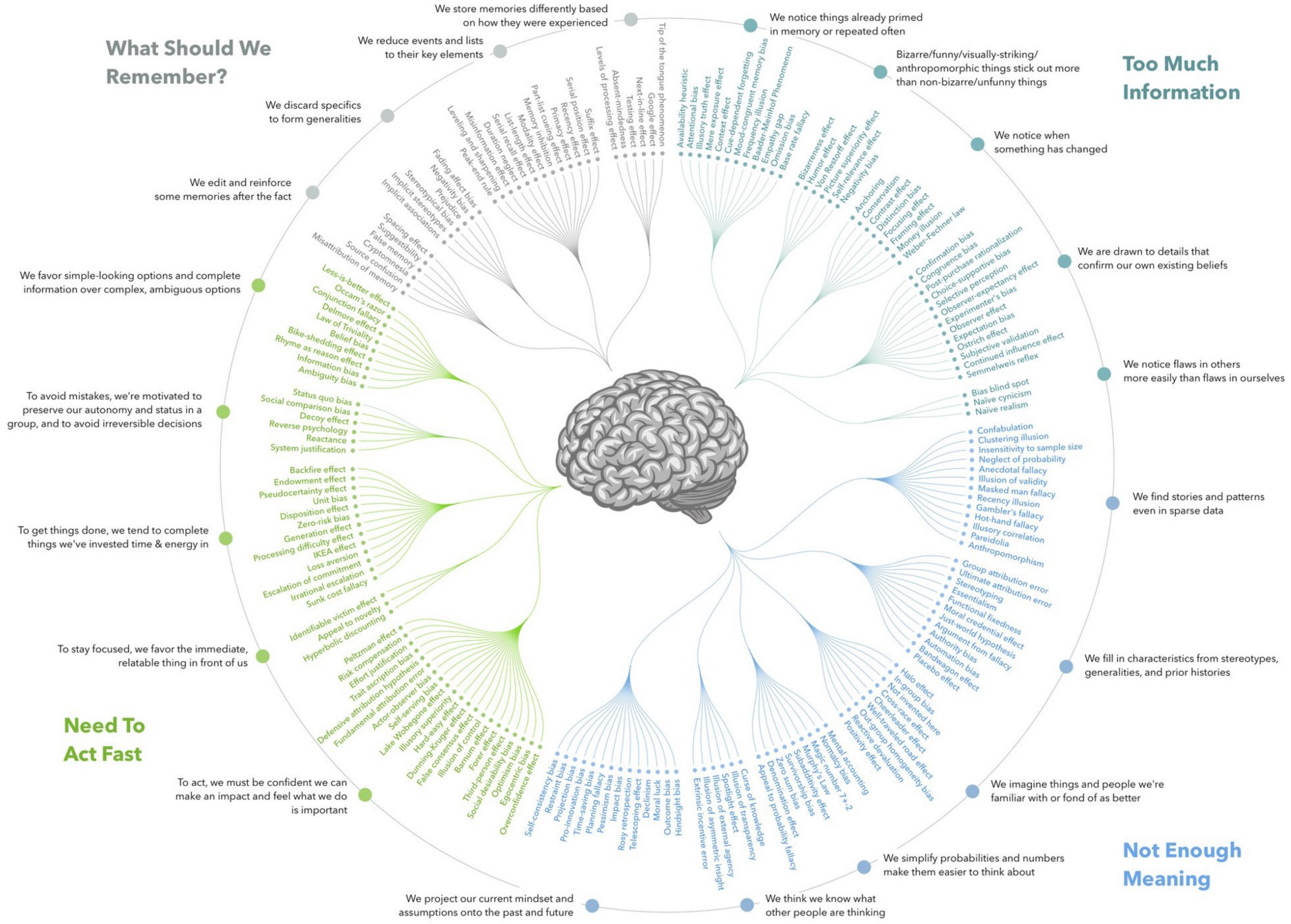
← Record 377 weeks in total as N° 1

← 332 weeks as N° 1

Monica Seles was stabbed by a spectator in 1993. When she returned to the tour, the WTA allowed her to share Steffi Graf's number 1 ranking for a year

For players ranked below number one before 1983, rankings are based on year-end standings
Sources: WTA, FT research
Graphic by John Burn-Murdoch / @jburnmurdoch

COGNITIVE BIAS CODEX, 2016



What Should We Remember?

We store memories differently based on how they were experienced

- Tip of the tongue phenomenon
- Google effect
- Next-in-line effect
- Testing effect
- Absent-mindedness
- Levels of processing effect

We reduce events and lists to their key elements

- Suffix effect
- Serial position effect
- Recency effect
- Primacy effect
- Memory inhibition
- Part-list cueing effect
- Modality effect
- List-length effect
- Serial recall effect
- Duration neglect
- Misinformation effect
- Leveling and sharpening
- Peak-end rule

We discard specifics to form generalities

- Fading affect bias
- Negativity bias
- Prejudice
- Stereotypical bias
- Implicit stereotypes
- Implicit associations

We edit and reinforce some memories after the fact

- Spacing effect
- Suggestibility
- False memory
- Cryptomnesia
- Source confusion
- Misattribution of memory

Too Much Information

We notice things already primed in memory or repeated often

- Availability heuristic
- Attentional bias
- Illusory truth effect
- Mere exposure effect
- Context effect
- Cue-dependent forgetting
- Mood-congruent memory bias
- Frequency illusion
- Baader-Meinhof Phenomenon
- Empathy gap
- Omission bias
- Base rate fallacy

Bizarre/funny/visually-striking/anthropomorphic things stick out more than non-bizarre/unfunny things

- Bizarreness effect
- Humor effect
- Von Restorff effect
- Picture superiority effect
- Self-relevance effect
- Negativity bias

We notice when something has changed

- Anchoring
- Conservatism
- Contrast effect
- Distinction bias
- Focusing effect
- Framing effect
- Money illusion
- Weber-Fechner law

We are drawn to details that confirm our own existing beliefs

- Confirmation bias
- Congruence bias
- Post-purchase rationalization
- Choice-supportive bias
- Selective perception
- Observer-expectancy effect
- Experimenter's bias
- Observer effect
- Expectation bias
- Ostrich effect
- Subjective validation
- Continued influence effect
- Semmelweis reflex

We notice flaws in others more easily than flaws in ourselves

- Bias blind spot
- Naïve cynicism
- Naïve realism

Not Enough Meaning

We find stories and patterns even in sparse data

- Confabulation
- Clustering illusion
- Insensitivity to sample size
- Neglect of probability
- Anecdotal fallacy
- Illusion of validity
- Masked man fallacy
- Recency illusion
- Gambler's fallacy
- Hot-hand fallacy
- Illusory correlation
- Pareidolia
- Anthropomorphism

We fill in characteristics from stereotypes, generalities, and prior histories

- Group attribution error
- Ultimate attribution error
- Stereotyping
- Essentialism
- Functional fixedness
- Moral credential effect
- Just-world hypothesis
- Argument from fallacy
- Authority bias
- Automation bias
- Bandwagon effect
- Placebo effect

We imagine things and people we're familiar with or fond of as better

- Halo effect
- In-group bias
- Not invented here
- Cross-race effect
- Cheerleader effect
- Well-traveled road effect
- Out-group homogeneity bias
- Reactive devaluation
- Positivity effect

We simplify probabilities and numbers make them easier to think about

- Mental accounting
- Normalcy bias
- Magic number 7+-2
- Murphy's Law
- Subadditivity effect
- Survivorship bias
- Zero sum bias
- Denomination effect
- Appeal to probability fallacy

We think we know what other people are thinking

- Curse of knowledge
- Illusion of transparency
- Spotlight effect
- Illusion of external agency
- Illusion of asymmetric insight
- Extrinsic incentive error

We project our current mindset and assumptions onto the past and future

- Hindsight bias
- Outcome bias
- Moral luck
- Declinism
- Telescoping effect
- Rosy retrospection
- Impact bias
- Pessimism bias
- Planning fallacy
- Time-saving bias
- Pro-innovation bias
- Projection bias
- Restraint bias
- Self-consistency bias

Need To Act Fast

To act, we must be confident we can make an impact and feel what we do is important

- Overconfidence effect
- Egocentric bias
- Optimism bias
- Social desirability bias
- Third-person effect
- Forer effect
- Barnum effect
- Illusion of control
- False consensus effect
- Dunning-Kruger effect
- Hard-easy effect
- Illusory superiority
- Lake Wobegone effect
- Self-serving bias
- Actor-observer bias
- Fundamental attribution error
- Defensive attribution hypothesis
- Trait ascription bias
- Effort justification
- Risk compensation
- Peltzman effect

To stay focused, we favor the immediate, relatable thing in front of us

- Hyperbolic discounting
- Appeal to novelty
- Identifiable victim effect

To get things done, we tend to complete things we've invested time & energy in

- Sunk cost fallacy
- Irrational escalation
- Escalation of commitment
- Loss aversion
- IKEA effect
- Processing difficulty effect
- Generation effect
- Zero-risk bias
- Disposition effect
- Unit bias
- Pseudocertainty effect
- Endowment effect
- Backfire effect

To avoid mistakes, we're motivated to preserve our autonomy and status in a group, and to avoid irreversible decisions

- System justification
- Reactance
- Reverse psychology
- Decoy effect
- Social comparison bias
- Status quo bias

We favor simple-looking options and complete information over complex, ambiguous options

- Ambiguity bias
- Information bias
- Rhyme as reason effect
- Bike-shedding effect
- Belief bias
- Law of Triviality
- Delmore effect
- Conjunction fallacy
- Occam's razor
- Less-is-better effect

ALGORITHMIC LAYOUT + DESIGN BY JM3 · JOHN MANOOGIAN III // CONCEPT + METICULOUS CATEGORIZATION BY BUSTER BENSON // DEEP RESEARCH BY WIKIPEDIANS FAR + WIDE

Quiz

Average score: **72**

Lowest score: **23**

Highest score: **111**

3 people got full points for the extra credit question.

Project 1

9 people got an A

21 people got a B

9 people got a C

1 person got a D

3 people got an F

Shiwangi will send you grades and very brief comments via Piazza by tomorrow

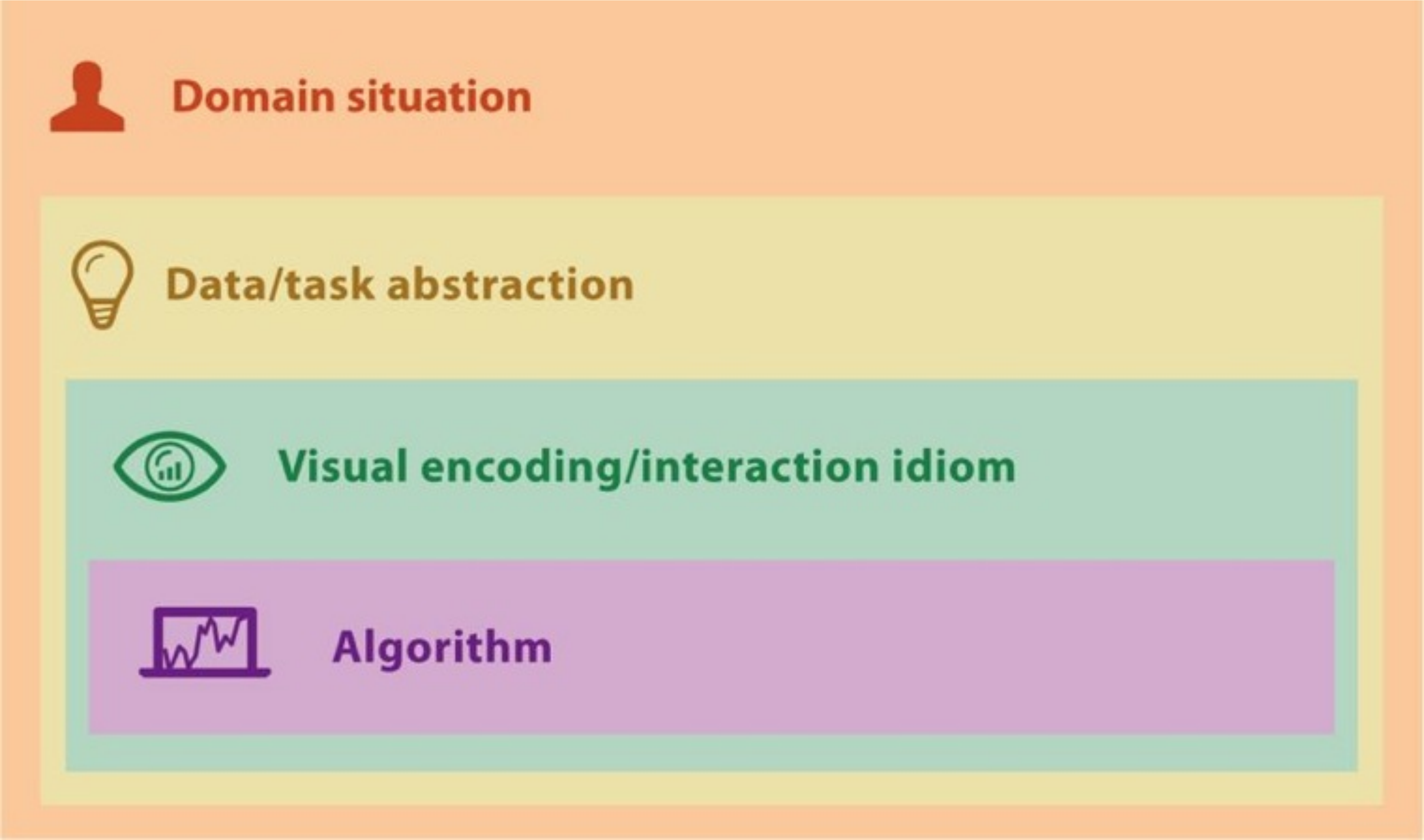
Validation

For this first project, Shiwangi and I served as the experts who evaluated your project.

But in actuality, you should be able to evaluate your own projects.

Chapter 4 provides an overview of ways to validate different aspects of your project.

Aspects of the Project



Domain situation

Data/task abstraction

Visual encoding/interaction idiom

Algorithm

Domain Situation

- community of users / experts
- specific vocabulary
- specific questions that are important
- particular types of data
- particular methodologies
- specific workflows that evolved for historical reasons to address important problems in that area
- often times experts are used to a particular way of doing things, but open to something that makes it easier

Task and Data Abstraction

- What visualization tasks would support the communities questions and would: make their lives easier, or help them to ask deeper questions about their data?
- What are the important aspects of the data?
- Could their data be simplified, transformed into another format?
- What are they hoping **to see** in their data? If they saw it, what would that **let them do**? What **decisions** could they make?
- Comparing? Filtering? Searching? Analyzing?

Encoding and Idiom

- How can you present their data – or some subset of or transformation of their data – so that the visualization supports their tasks?
- Can you make it easy to show all of the important data, while hiding all of the unimportant data?
- Can you make it is easy to find and analyze interesting patterns in the data?

Algorithm

- Is your software fast enough to support complex analysis tasks using your visualization encodings and interaction idioms?

“A Nested Model”

The success of each aspect depends on the how well it fulfills the expectations of the outer level, and inspires expectations of the inner level.

Answers to questions asked at one level are **inputs** to the next, inner level.

Domain -> Task

Domain – What questions are being asked, or should be being asked, by experts working with a particular types of datasets? What problems are they trying to solve?

Accurately determining these questions will lead to appropriate definitions of specific *visualization tasks.*

Task – "Your goal is to determine which data type supports a visual representation that addresses the user's problem."

Tasks -> Encodings / idioms

Task – What information is useful, is salient, is necessary to help user's think about and/or answer their questions. What visualization tasks will help them do this.

Visual Encoding / Interaction Idiom – What's a good way to present this information so that the visualization tasks can be effectively carried out?

Encodings / idioms

Visual Encoding / Interaction Idiom

Choose effective marks and channels for your dataset type.

- "*Intuitive*" – but what exactly does this mean?
- nothing "gets in the way"
- "*affordance*" – it's obvious what to do
- no visual clutter to confuse the user or obscure the data itself or the execution of the task
- easy to perceive the meaning of the data and to find patterns in the data

Problematic encodings I noticed

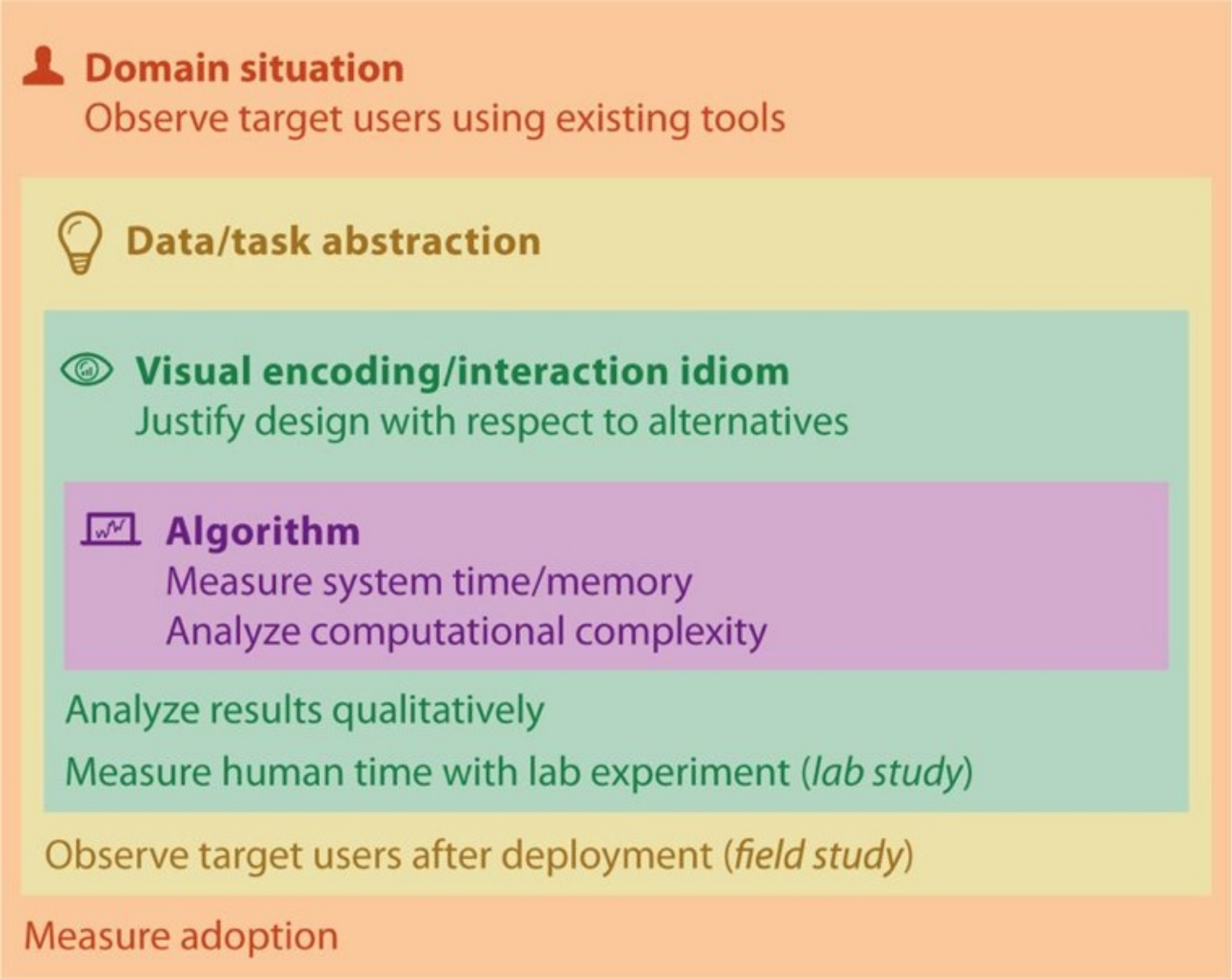
- blinking
- abrupt changes or too much motion
- surprises / unexpected visualizations
- lack of legend or instructions
- “chart junk”
- mouseovers caused overlapping tooltips
- mouseouts caused information to vanish
- upside-down text
- distracting colors, shapes

Encodings / idioms -> Algorithms

Make sure that you can quickly visualize and effectively enable the encodings and idioms you’ve designed.

- If your visual encoding and interaction idiom involves letting the user click on a hierarchy of circles and then zoom into more information in each successful circle, then make sure you can program that interaction.

- If your visualization involves 3D volume rendering, then make sure it’s computationally efficient enough to render on a desktop, etc



Domain situation

Observe target users using existing tools

Data/task abstraction

Visual encoding/interaction idiom

Justify design with respect to alternatives

Algorithm

Measure system time/memory

Analyze computational complexity

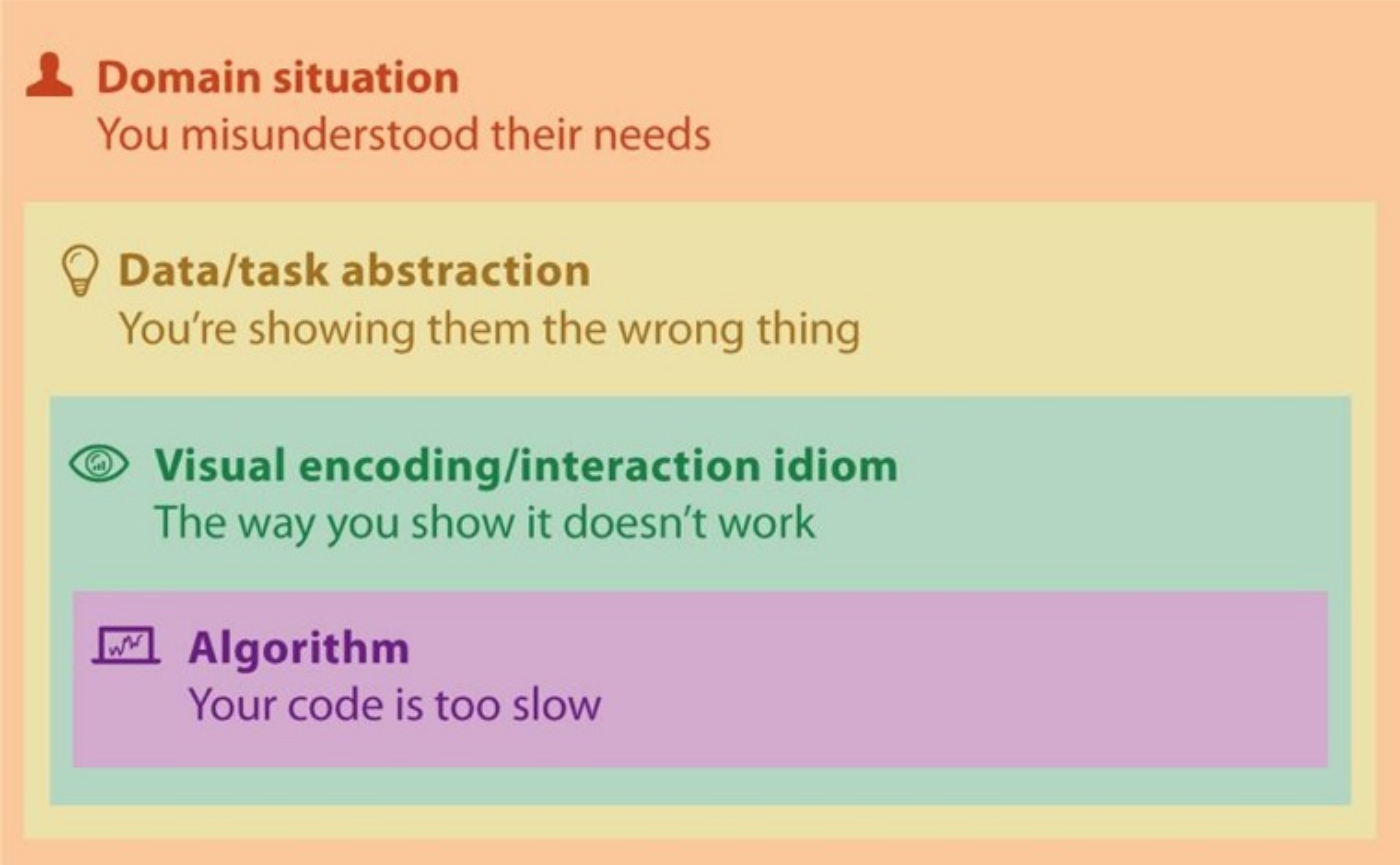
Analyze results qualitatively

Measure human time with lab experiment (*lab study*)

Observe target users after deployment (*field study*)

Measure adoption

Why does it go wrong?



Domain situation

You misunderstood their needs

Data/task abstraction

You're showing them the wrong thing

Visual encoding/interaction idiom

The way you show it doesn't work

Algorithm

Your code is too slow

Threats and Validations

If it *does* go wrong…

Maybe need to re-think your design…

- Maybe have a great idea for some complex interaction idiom, but it is too computationally difficult to develop in time for a release data…
- Maybe have a nifty way to define the user's data, but they are used to thinking of it in a certain way and so reject your task definitions.

Threats and Validations

We're mostly going to look at levels 2 and 3 in this class: defining the visualization task and choosing the visual encoding and interaction idiom.

Threats and Validations

TASK

threat: You've chosen the wrong task or data abstraction. That is, solving a problem that doesn't need to be solved.

validation: ask an expert (or teacher) for feedback; conduct a field study to see if this task is indeed being attempted or is important

(evaluation can be done *before* or *after* your work)

Threats and Validations

ENCODING / IDIOM

threat: You've designed a visualization that doesn't make sense or isn't effective.

validation:

Justify the design – why this way and not some other way?

Conduct a usability study – do people understand the visualization?

Conduct a quantitative study – prove its effectiveness…

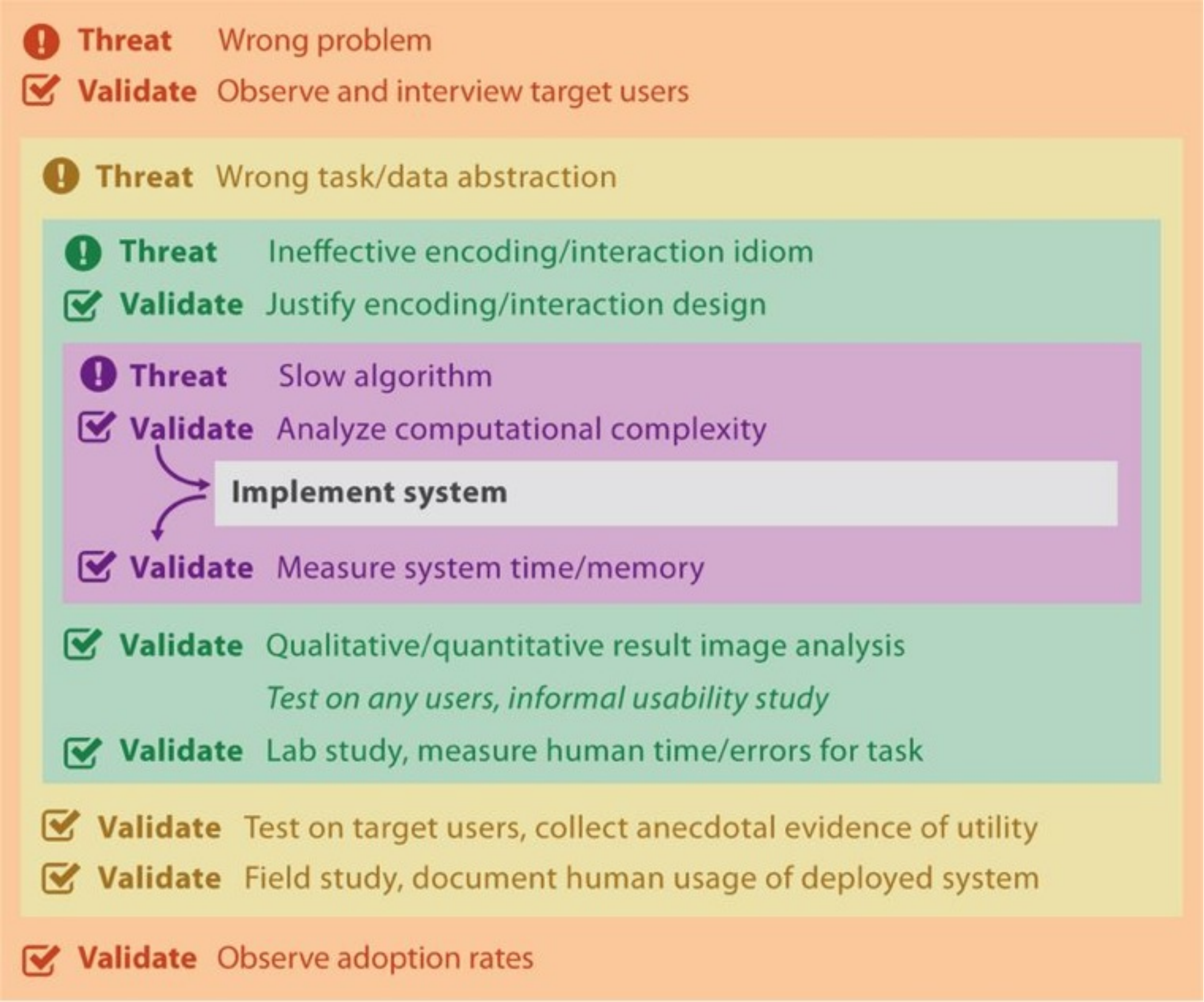
"Effectiveness"

- Accuracy
- Speed
- Enjoyment

Can a user perform data manipulation tasks quickly and accurately? *low level...*

- Supports task

Can a user use visualization to help answer a domain specific question? *high level...*



- ❗ **Threat** Wrong problem
- ☑ **Validate** Observe and interview target users
  - ❗ **Threat** Wrong task/data abstraction
    - ❗ **Threat** Ineffective encoding/interaction idiom
    - ☑ **Validate** Justify encoding/interaction design
      - ❗ **Threat** Slow algorithm
      - ☑ **Validate** Analyze computational complexity
      - **Implement system**
      - ☑ **Validate** Measure system time/memory
    - ☑ **Validate** Qualitative/quantitative result image analysis
      Test on any users, informal usability study
    - ☑ **Validate** Lab study, measure human time/errors for task
  - ☑ **Validate** Test on target users, collect anecdotal evidence of utility
  - ☑ **Validate** Field study, document human usage of deployed system
- ☑ **Validate** Observe adoption rates

For Thursday

Continue to practice D3.js

Will introduce Project 2 in class on Thursday

Shiwangi will lead programming lab in class on Tuesday