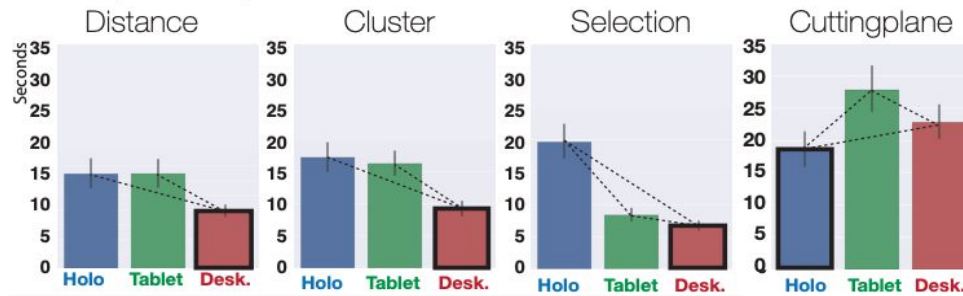
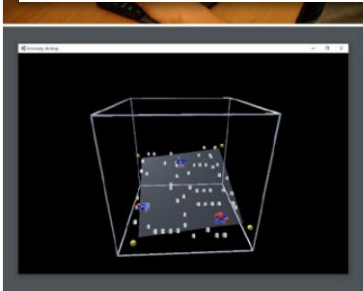


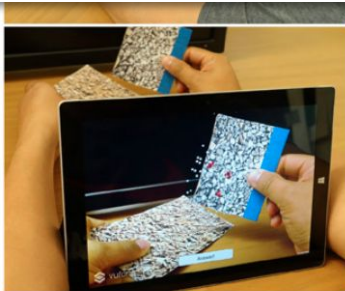
Time (seconds):



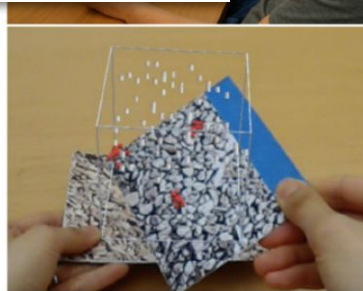
Evaluating Visualizations



Desktop



Tablet AR



Immersive AR



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Questionnaire - Experiment on Dynamic Graph Transitions

Thank you for participating in our experiment. Please answer this questionnaire in order to give us valuable feedback. You have the opportunity to add comments at the end of the questionnaire. We are happy to cite your comments, which happens anonymously. Feel free to give us any feedback you like.

Please enter the ID you got at the experiment. *

Short-answer text

Personal questions

Description (optional)

Your age

Short-answer text

Gender

☐ Female

☐ Male

Do you or have you worked with graphs visualizations before?

Not at all ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Almost Daily

Benjamin Bach

June 2020

<http://benjbach.me>

<https://datavis-online.github.io>

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**How do we know if
a visualization is successful?**

Guidance on Evaluation

- Evaluation means to assure that your design will be **successful**.
- Do not evaluate for the sake of it. **Evaluation is not the end**. It should help you **improve** your design, not just "validating".
- Thus, take the critique, and move on.
- It is not a critique of your personal work— it's to assure you're doing the right thing at the right means.

Guidance on Evaluation

- Yes, you can **over-evaluate**:
- i.e., trying to fit your visualization to any specific need
 - This can make your visualization **boring**.
 - Keep some of the energy and creativity and optimize what you want to optimize for — no visualization is ever perfect.

Why is evaluation hard?

- **Visualizations** are different
- **Humans** are different
- **Tasks** vary
- **Pre-knowledge** varies
- Visualizations are hardly **quantifiable**
- When is a visualization **successful**?

Evaluation techniques

Applicability

High



Low

Difficulty

Low



High

Strength

Low



High

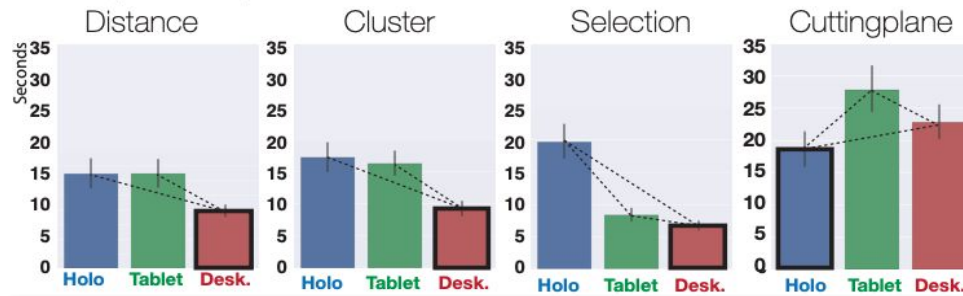
Heuristics & Guidelines

Case studies

Subjective Feedback

Objective Measurements

Time (seconds):

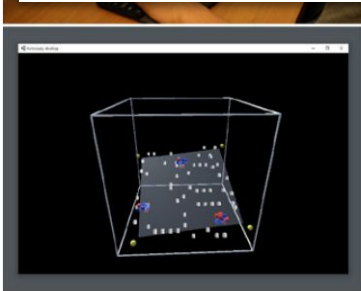


Questionnaire - Experiment on Dynamic Graph Transitions

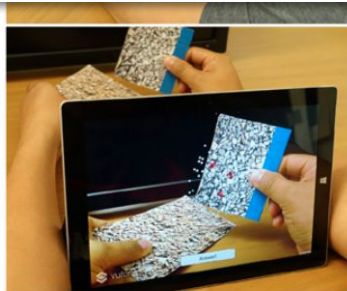
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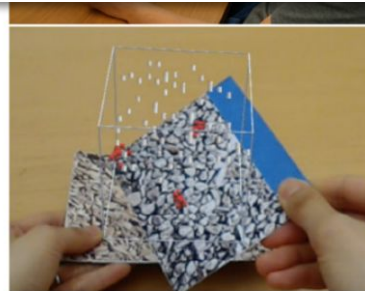
Evaluating Visualizations Heuristics and Guidelines



Desktop



Tablet AR



Immersive AR

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☐ Female

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June 2020

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Guidelines & Heuristics

- Heuristic: **self-discovery**
- **Guidelines:** *"general rule, principle, or piece of advice"*
 - *"Don't use the rainbow colormap"*
 - *"Optimize data-ink ratio"*
 - *"Overview first, zoom and filter, details on demand"*
 - ...
- Guidelines are limited.
- Apply on case-to-case basis.

Heuristics for visualization

- **Perception:** Avoid the rainbow color map, Do not use more than 7 colors, Data-ink ratio, ...
- **Cognition:** Provide organization of material, facilitate overview, use legends, do not deceive, use familiar visualizations, ...
- **Usability:** maximize effectiveness (i.e., task support), positive satisfaction, ...
- **Interaction:** Orientation & help, navigation & querying...

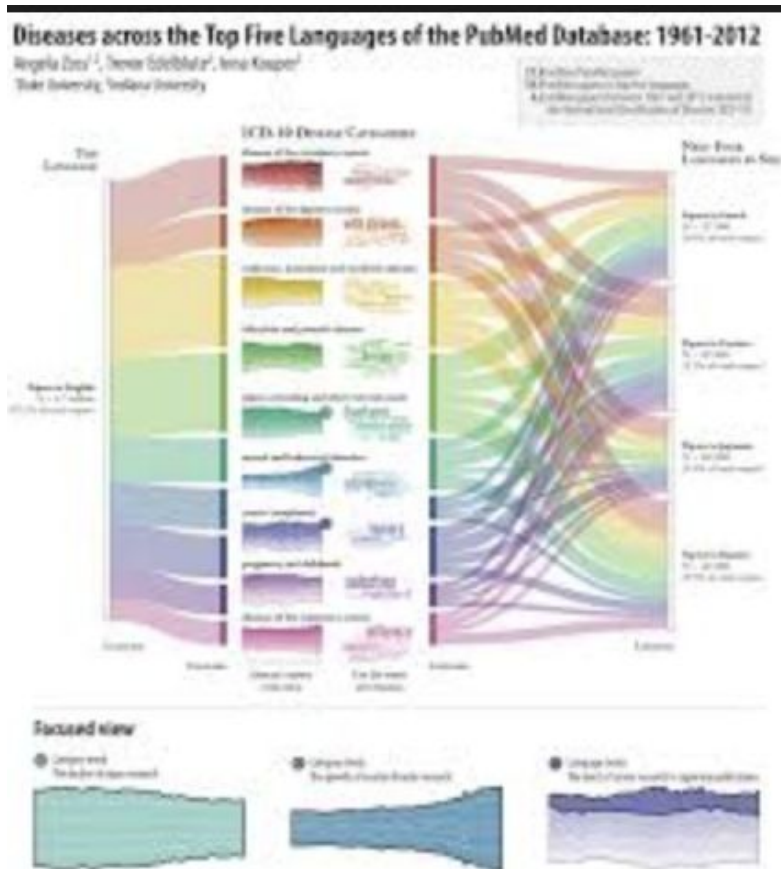
The
RUSTIC
principle

An efficient figure / visualization is ...

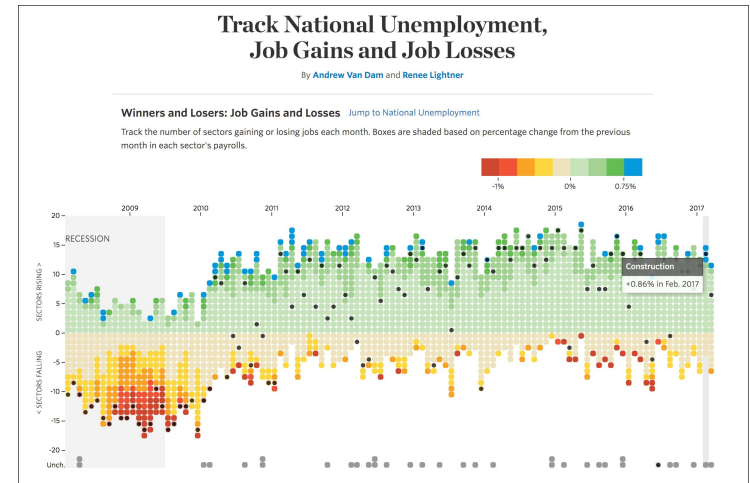
- **Readable:** does it allow for correct perception of information and provides access to all information I need to understand the data?
- **Understandable:** does it allow reasoning about the phenomena?
- **Supportive:** does it allow solving tasks?
- **Truthful:** is it showing data correctly?
- **Insightful:** does it provide meaningful *insights* for the viewer to solve their problem?
- **Communicative:** does it support clear communication?

Readability

Resolution



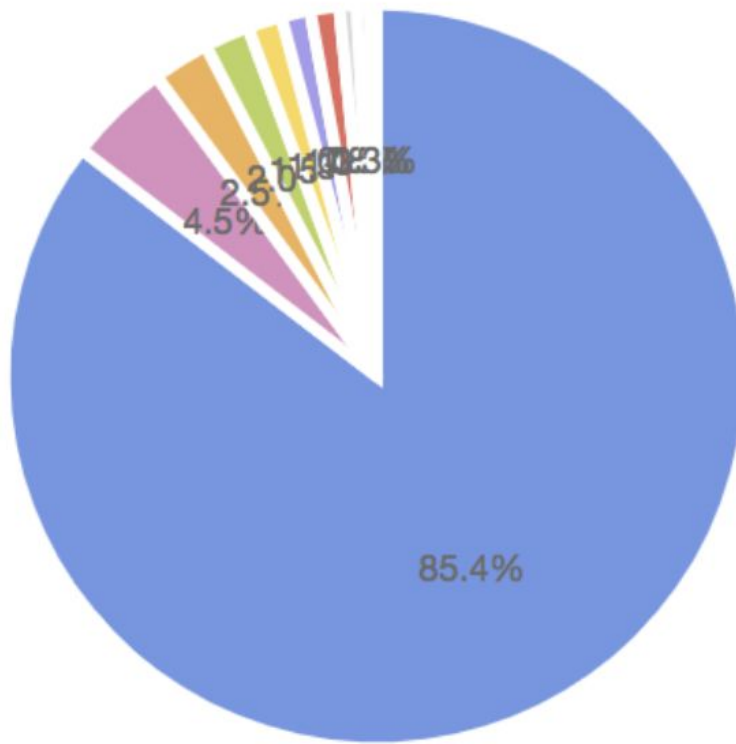
Size



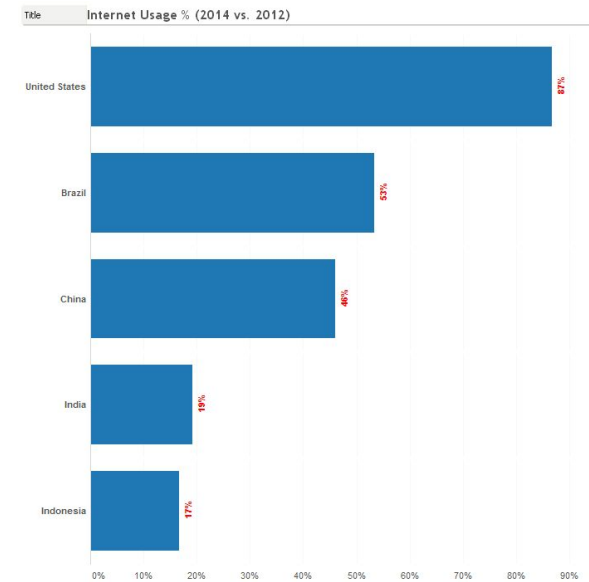
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque sollicitudin ipsum elit, et vestibulum nisl dictum et. Sed lobortis molestie felis. Praesent et ligula commodo magna fringilla egestas. Nam nec risus in magna facilisis sollicitudin nec et metus. Sed tincidunt dapibus lacus in viverra. Donec gravida finibus metus eget semper. In nec mauris

Readability

Overlapping labels

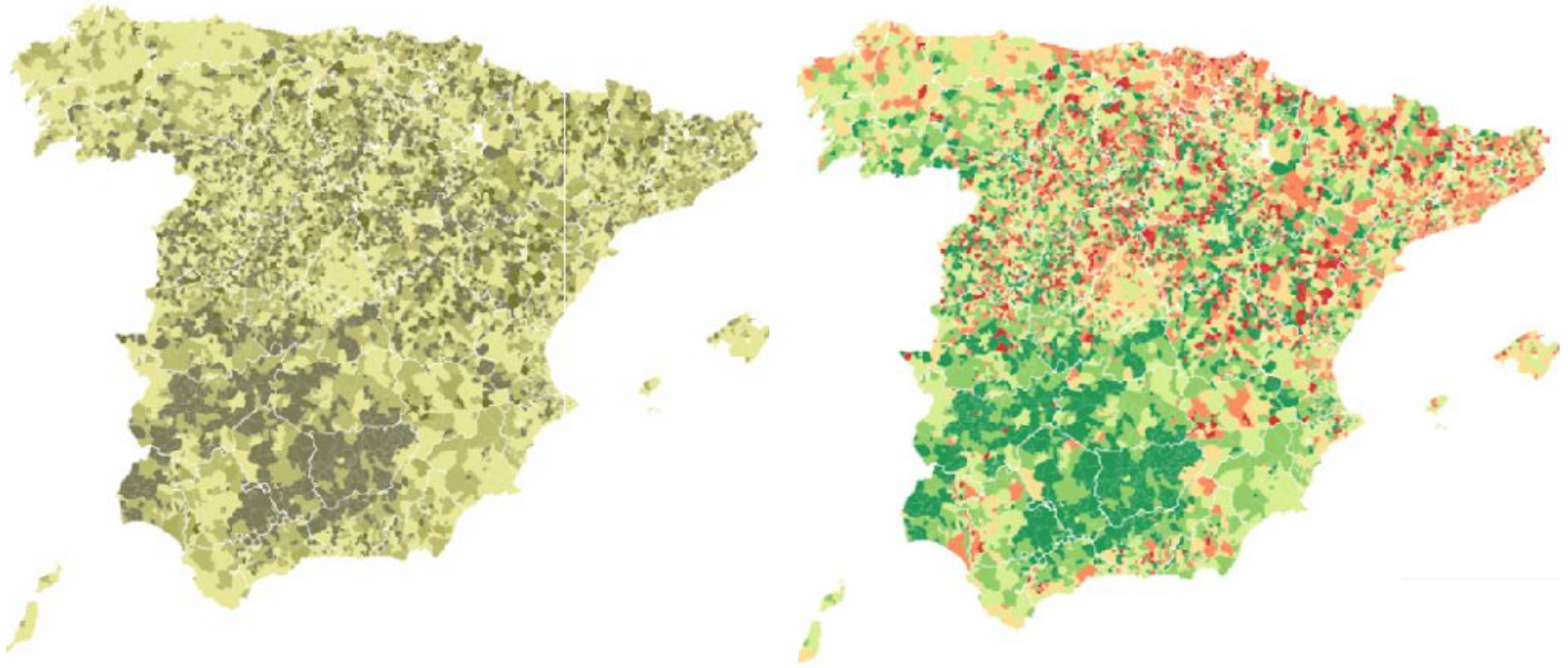


Small labels

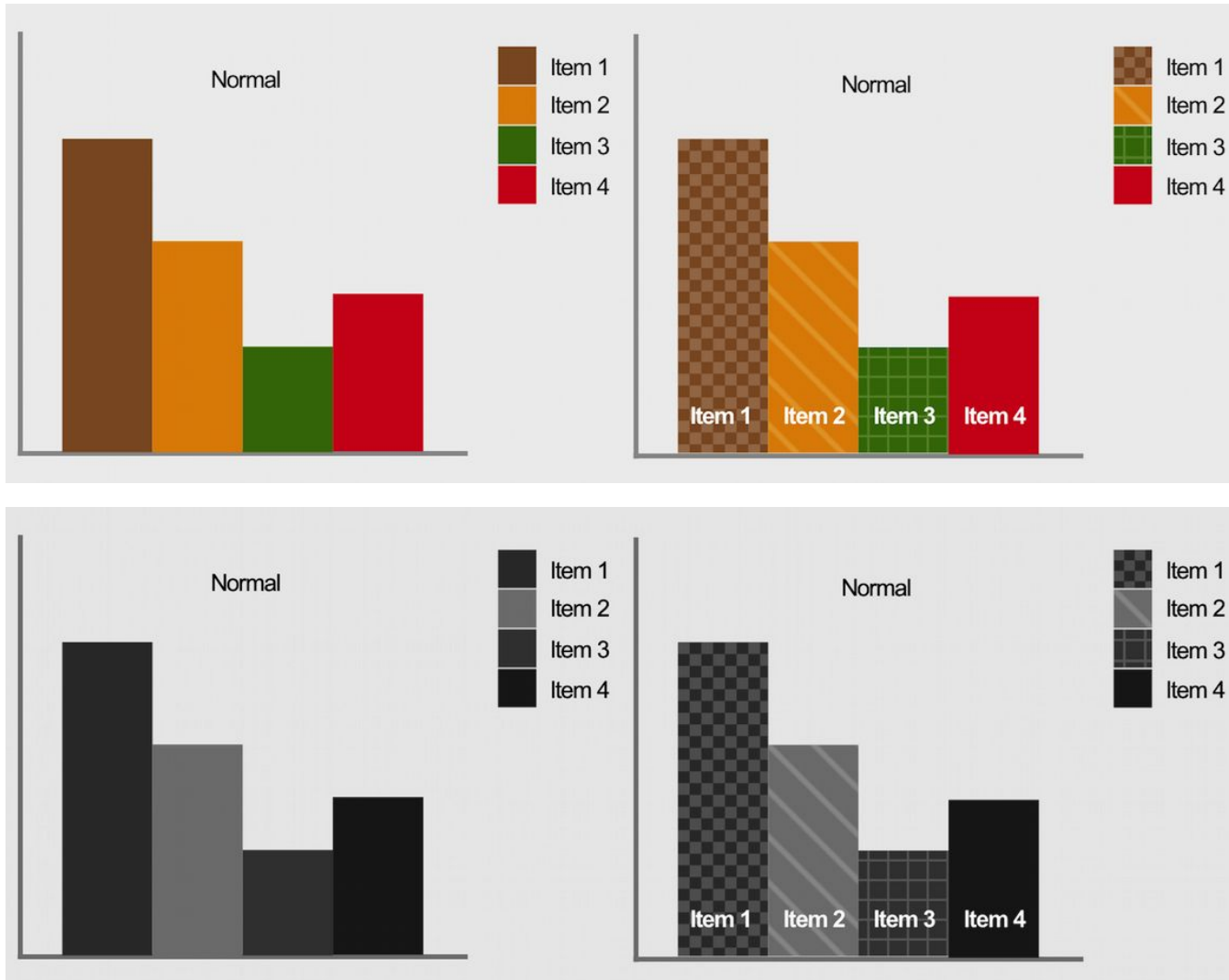


Readability: Colorblindness

www.color-blindness.com

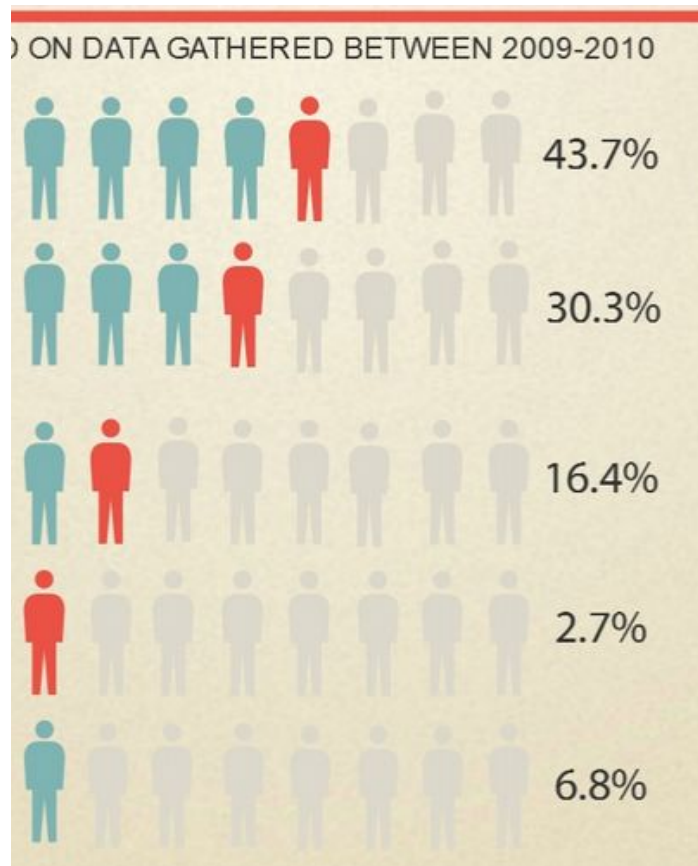


Readability: Redundant encoding

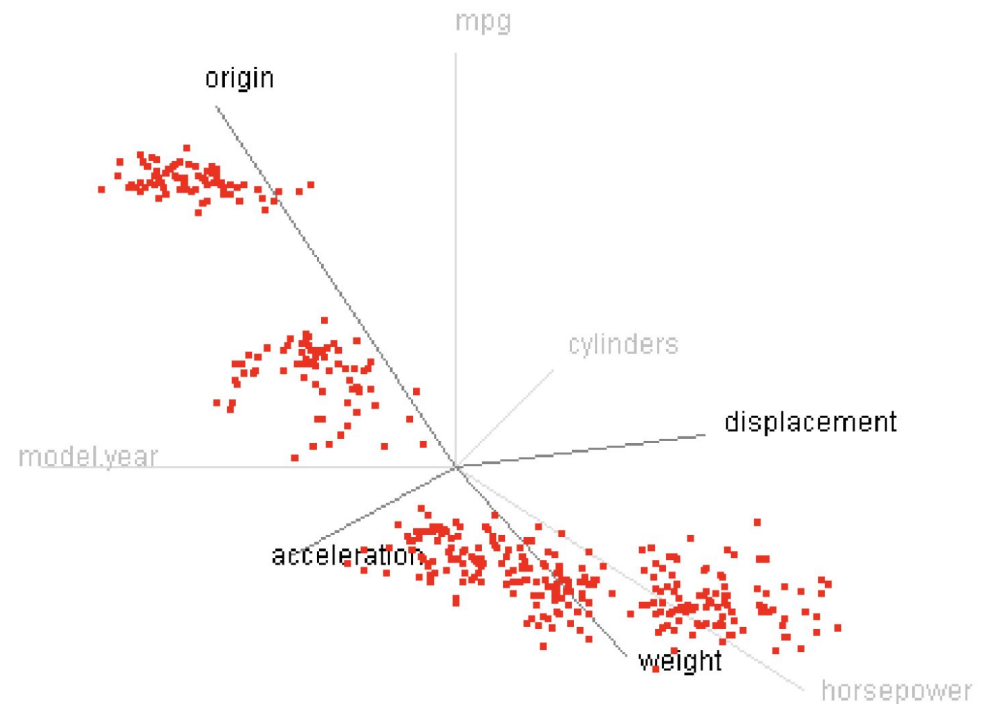


Understandability

Missing legends



Unknown visualizations



Supportive: is it supporting my tasks?

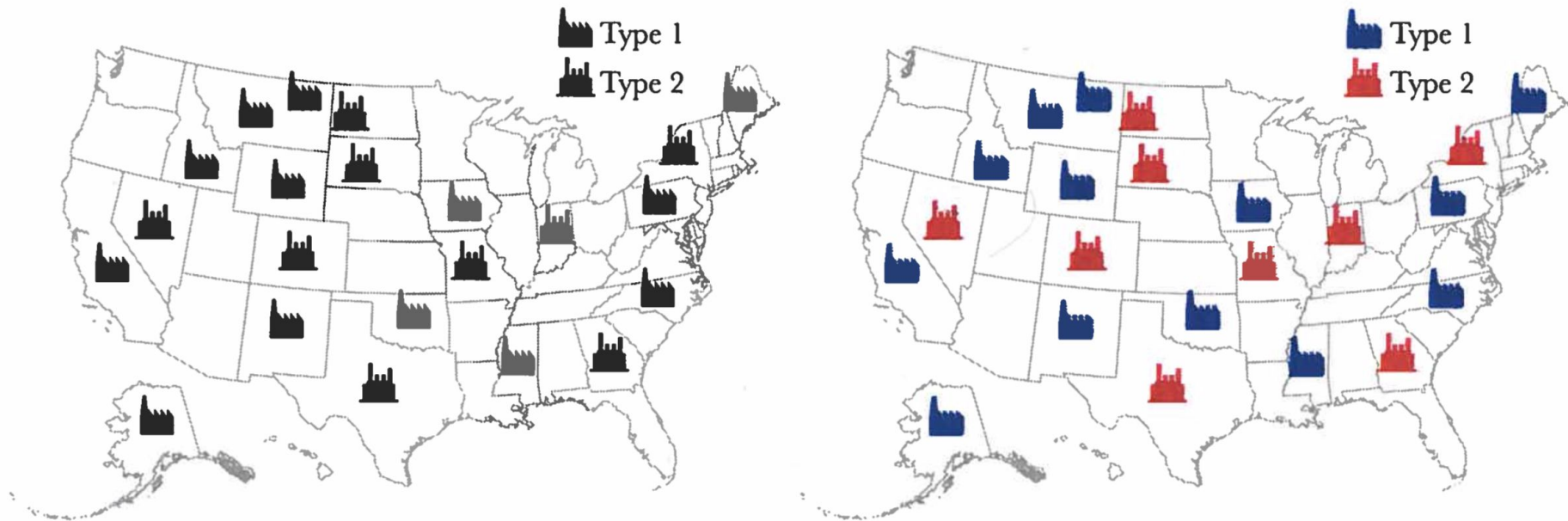
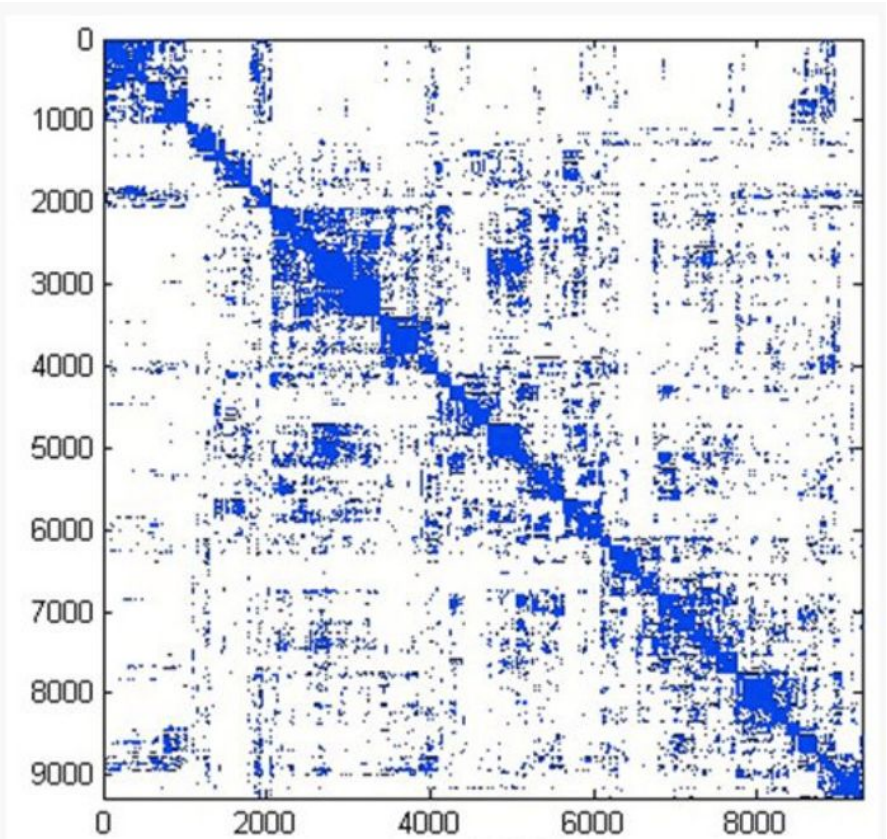
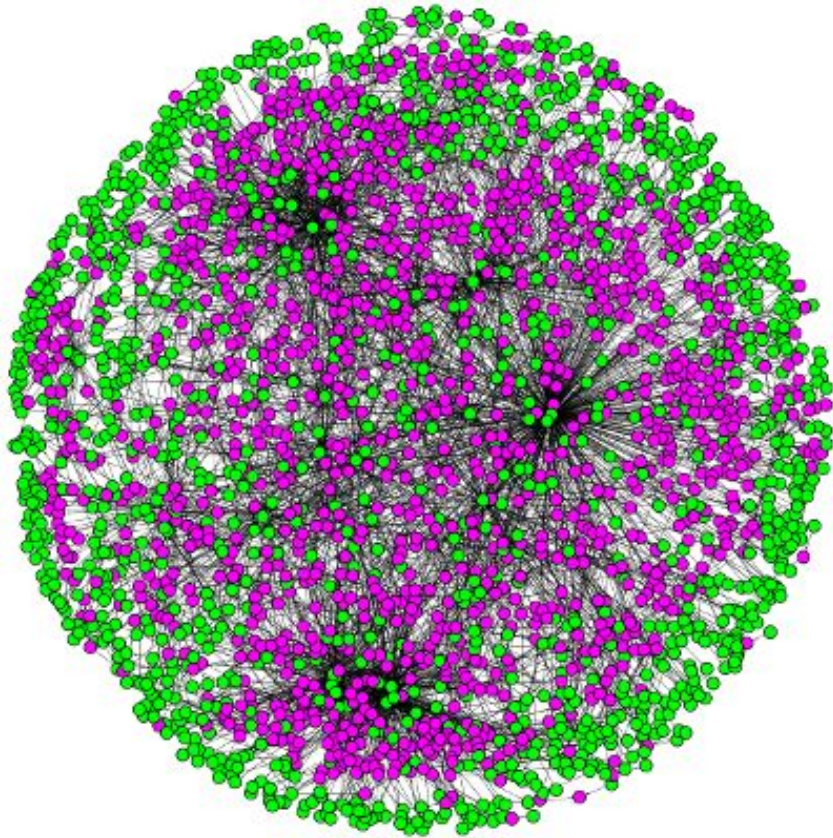


Figure 6.3 On which of these maps is it easier to identify the number of factories of each kind?

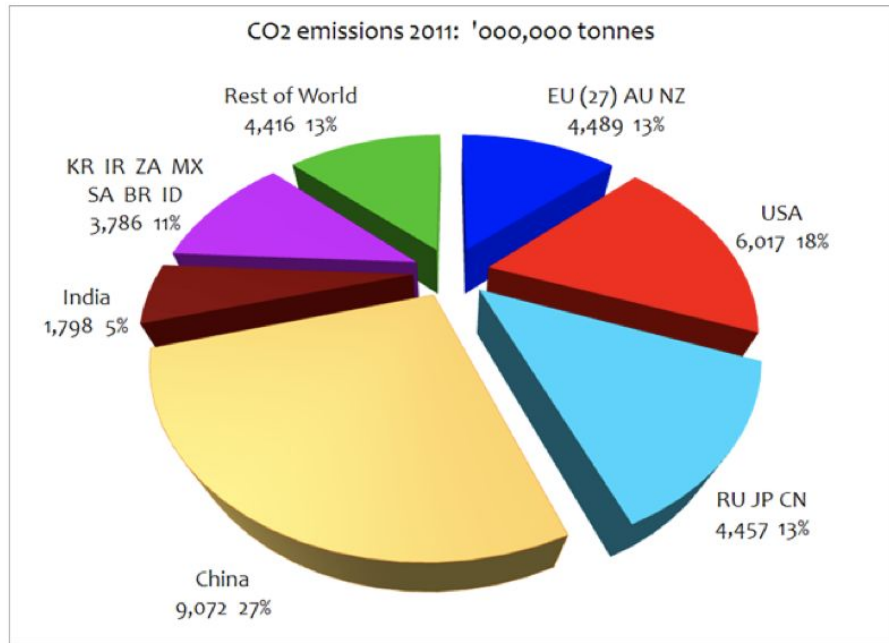
Supportive: is it supporting my task?

Appropriate for data

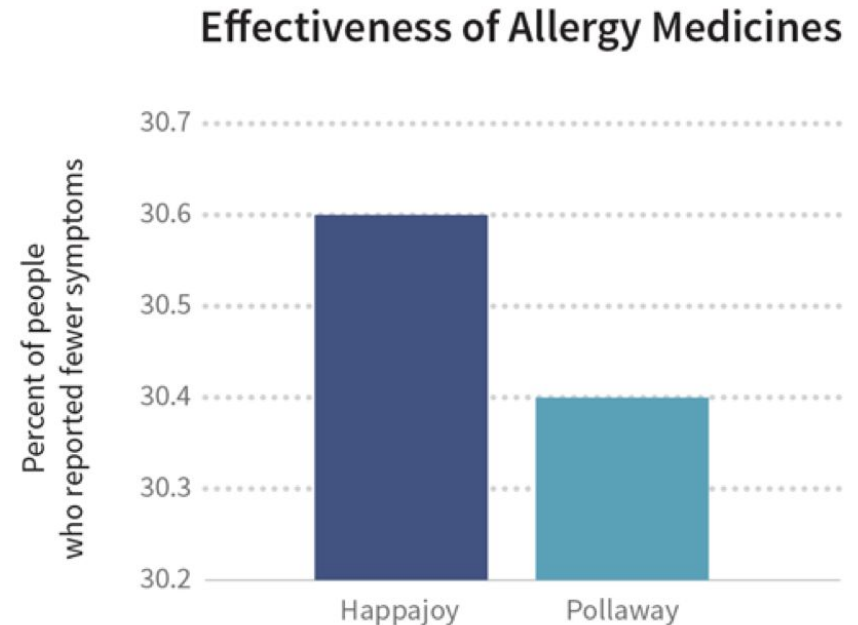


Truthful: is it showing data correctly?

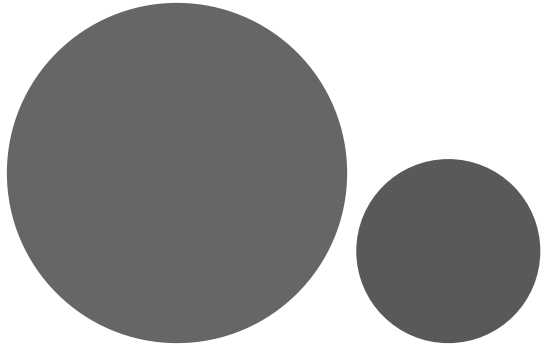
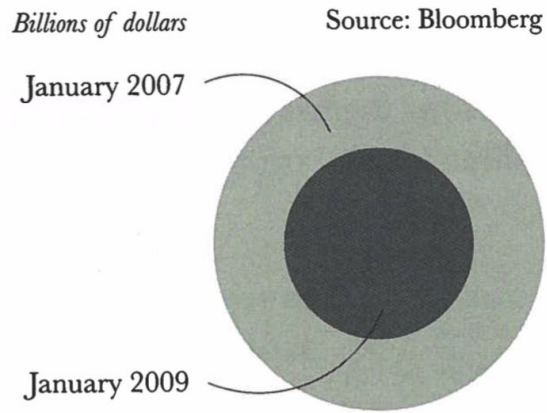
Deceptive



Deceptive



Truthful



a)



b)

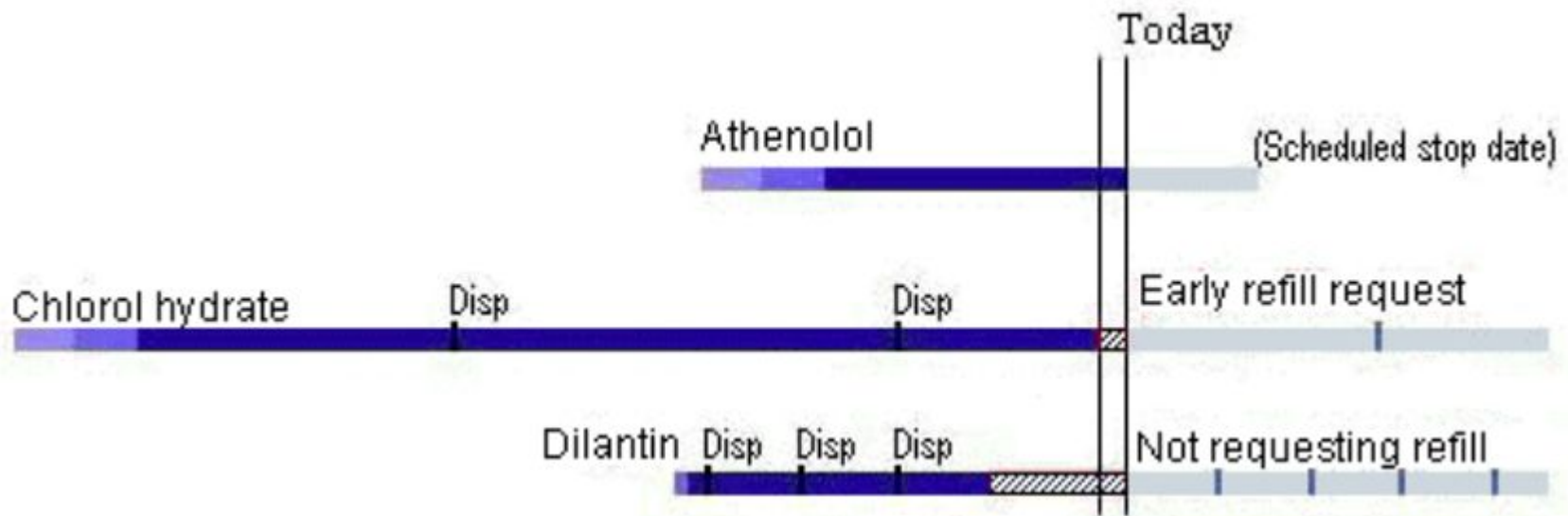


c)



Insightful: does it provide meaningful *insights* for the viewer to solve their problem?

- Does it support new information?
- Does it surprise?
- Does it help making decisions?
- Is it showing the right things?

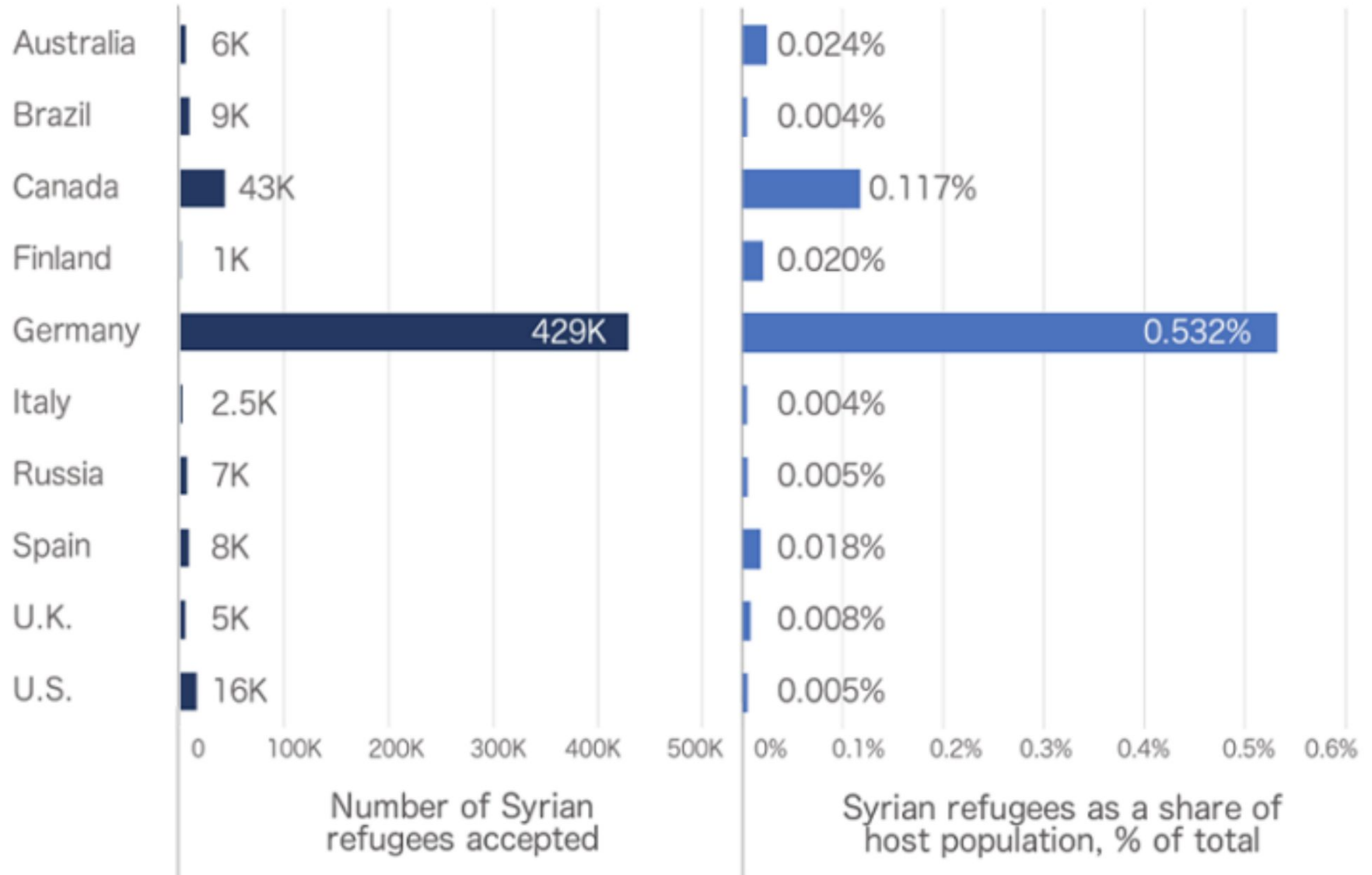


Communicative: does it support clear communication?

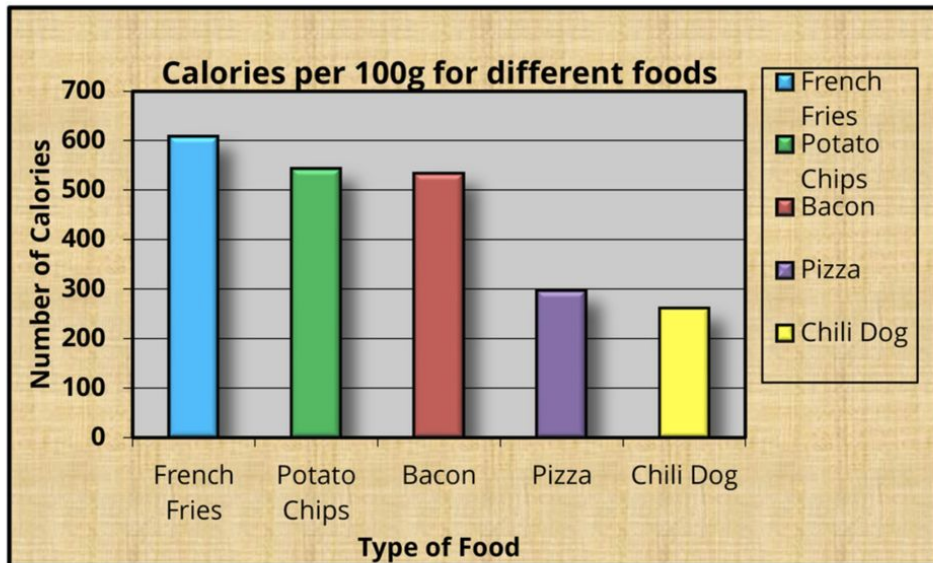
- Is the visualization ready for "first contact"?
- Are visualizations and visual encodings explained?
- Are key messages highlighted?
- Is the visualization "attractive", e.g., does it invite to observation?
- Is the visualization clearly structured?
- Is context and take-home message clear?

Communicative: Titles & Explanations

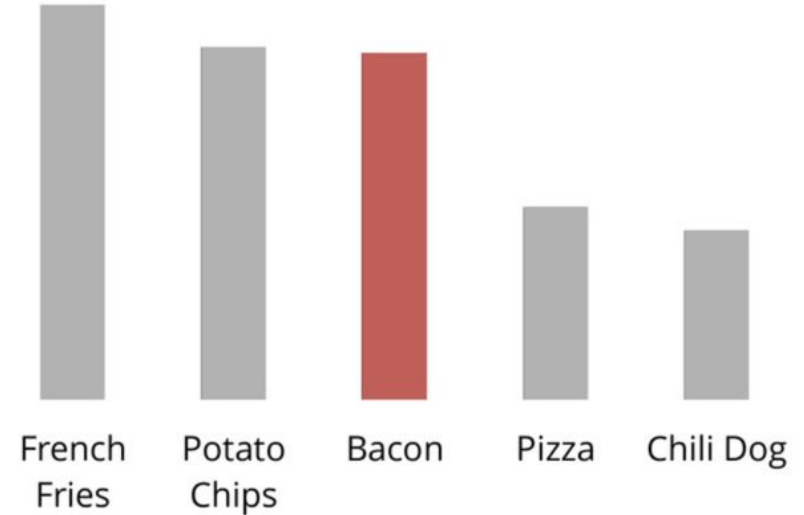
Non-neighboring
countries



Communicative: Data ink ratio

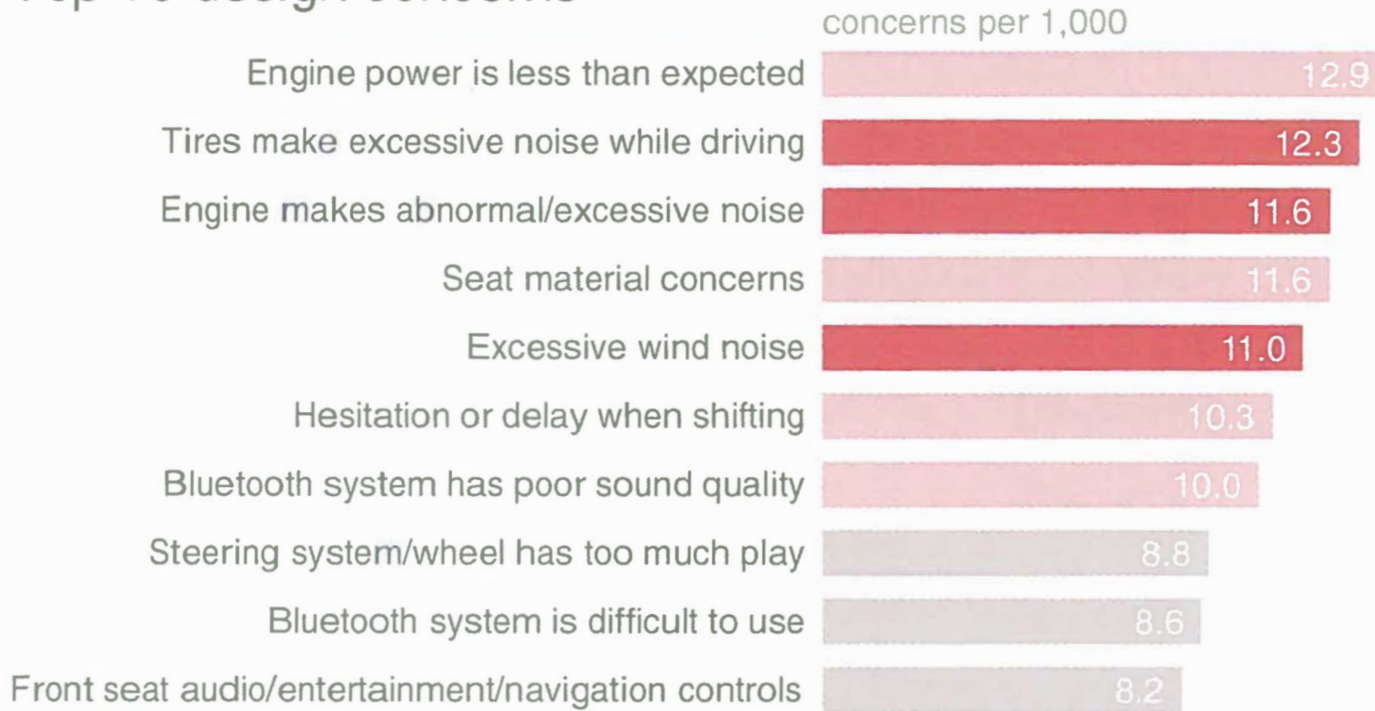


Calories per 100g



Communicative: Highlight

Top 10 design concerns



Comments indicate that **noisy tire issues** are most apparent **in the rain**.

Complaints about **engine noise** commonly cited **after the car had not been driven for a while**.

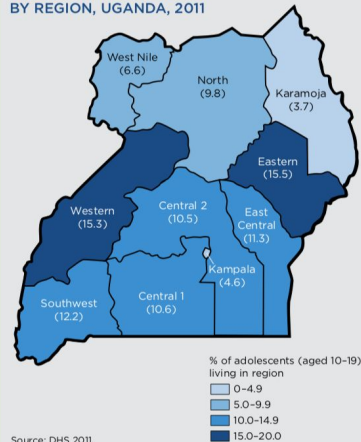
Excessive **wind noise** is noted primarily in **freeway driving at high speeds**.

FIGURE 4.9 Create a visual hierarchy of information

Communicative: Text + Picture

physical, social, political, and economic structures of a region can place residents at varying risks for vulnerability. Areas susceptible to violence or natural disaster pose clear threats to individuals. An individual's environment also affects his or her development and behavioral choices. Resources available in the physical and social environments create the contexts within which decisions are made about health, education, and employment. Political and social environments also dictate whether resources are accessible to all adolescents. An examination of the residential distribution of adolescents provides a baseline for comparing geographical patterns of vulnerability. Within Uganda, by type of residence, the majority of adolescents (87 percent) live in rural versus urban areas. Figure 6 shows the distribution of adolescents aged 10 to 19 living in Uganda. Regional distributions show Karamoja contains only four percent of the adolescent population. Kampala with a much denser population contains 4.6 percent of the population. The Eastern and Western regions contain the largest proportions of the adolescent population.

FIGURE 6
PROPORTION OF ADOLESCENTS AGED 10-19 BY REGION, UGANDA, 2011



Household factors influencing vulnerability

Household-level factors have direct impacts on the well-being of adolescents. Households are the primary setting where adolescents live and engage in activities. For this reason, the household environment and the people who live there have significant impacts on the lives of adolescents. Physical conditions of the home influence the health of residents. Family structures and demographic characteristics of household members affect the knowledge, decisions, behaviors and interactions in the environment of the adolescent.

Access to improved water sources and sanitation

Unsafe water, inadequate sanitation, and poor hygiene are among the five leading risk factors responsible for one quarter of all deaths in the world (WHO 2009). Unsafe water supplies and inadequate sanitation in homes increase exposure to water-borne diseases and can cause diarrhea. Ensuring access to clean water sources and sanitation is key to maintaining hygiene and health. Improved water sources are those that either naturally protect water from contamination or are constructed to do so. These include piped water, public taps, standpipes, boreholes, tube wells, protected wells and springs, and rainwater collection. Improved sanitation includes constructs and systems that prevent fecal contamination. These include flush or pour toilets, ventilated pit latrines, pit latrines with slabs, and composting toilets (UNICEF 2013b).

Housing conditions across East and Southern Africa are largely in need of improvement, and lack of improved sanitation varies by country. In nearly all of East and Southern Africa, over half of adolescents either do not have improved sanitation or share facilities with other households. Conditions are worst in Madagascar and Mozambique where fewer than four percent of adolescents live in households with improved sanitation that is not shared (Figure 7). Rwanda has the lowest proportion of adolescents affected—35 percent—which is still unacceptably high. Lack of access to improved water sources affects lower proportions but is still a problem in the region. In five countries, fewer than half of adolescents have access to improved water sources (Figure 8). Water conditions are best in Namibia, where only 15 percent of adolescents have no access to improved water.

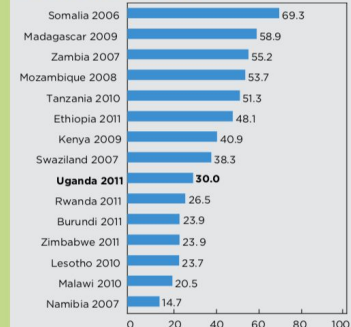
In Uganda, overall access to improved water and sanitation increased by a small but significant percentage between 2006 and 2011 (Figure 9). In 2006, 33 percent of adolescents had no access to improved water; in 2011, it is 30 percent. The proportion of adolescents without access to improved

FIGURE 7
PERCENT OF ADOLESCENTS AGED 10-19 LIVING IN HOUSEHOLDS WITH NO IMPROVED OR WITH SHARED SANITATION, EAST AND SOUTHERN AFRICA



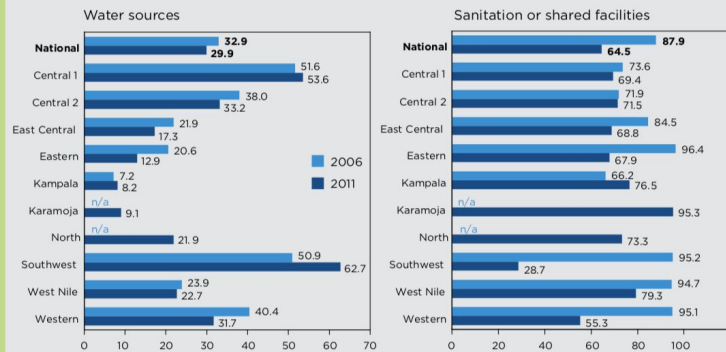
Source: DHS 2007-2011; MICS 2006-2008.

FIGURE 8
PERCENT OF ADOLESCENTS AGED 10-19 LIVING IN HOUSEHOLDS WITH NO IMPROVED WATER SOURCE, EAST AND SOUTHERN AFRICA



Source: DHS 2007-2011; MICS 2006-2008.

FIGURE 9
PERCENT OF ADOLESCENTS AGED 10-19 LIVING IN HOUSEHOLDS WITHOUT ACCESS TO IMPROVED WATER AND WITHOUT ACCESS TO IMPROVED OR WITH SHARED SANITATION, IN UGANDA, BY REGION, 2006 AND 2011



Source: DHS 2006 and 2011.

Note: Changes to the geographic boundaries were made to the North region in the 2011 DHS. The 2006 DHS North region is now divided into the North and Karamoja. For this reason, rates for 2006 are not shown for the North since it is not comparable and Karamoja was not identified in the previous survey.

An efficient figure / visualization is ...

- **Readable:** does it allow for correct perception of information and provides access to all information I need to understand the data?
- **Understandable:** does it allow reasoning about the phenomena?
- **Supportive:** does it allow solving tasks?
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Time (seconds):

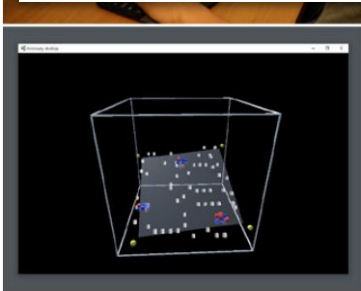


Questionnaire - Experiment on Dynamic Graph Transitions

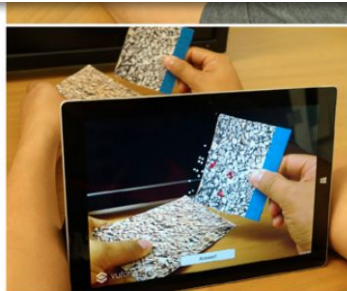
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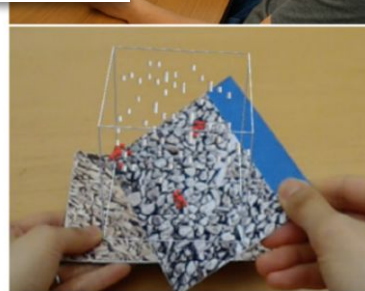
Evaluating Visualizations Case Studies



Desktop



Tablet AR



Immersive AR

Your age

Short-answer text

Gender

☐ Female

☐ Male

Do you or have you worked with graphs visualizations before?

Not at all ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Almost Daily



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June 2020

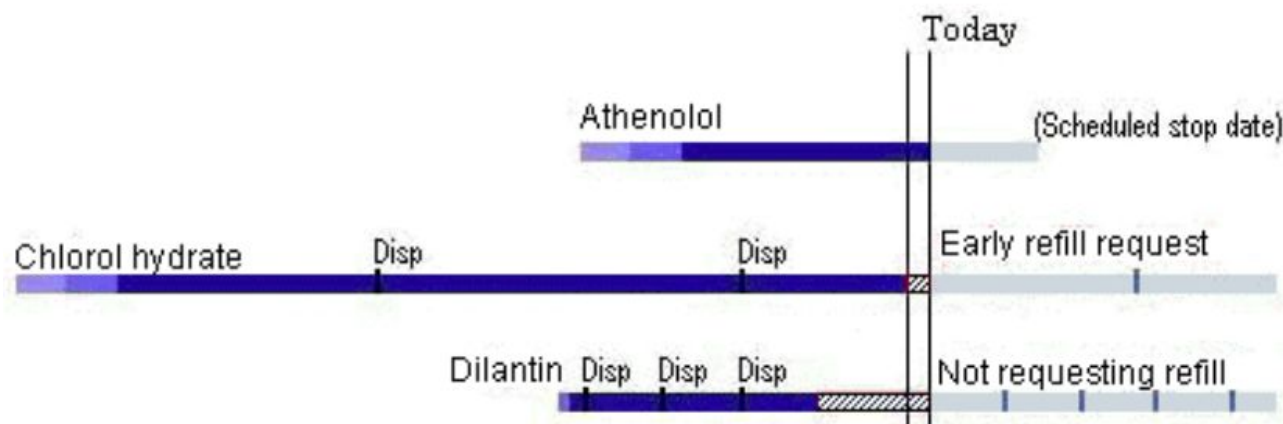
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Case studies

- Can my visualization solve a given **problem**?
- Define **tasks** that an analyst/audience wants to solve
- Find a good data **example**
- Show how to solve these tasks:
 - screenshots + **explanations**
- **Convince** yourself, your reader, and your skeptics



Time (seconds):

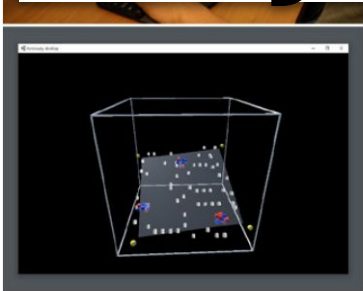


Questionnaire - Experiment on Dynamic Graph Transitions

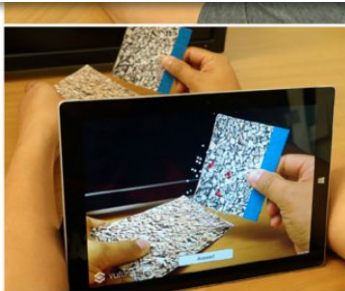
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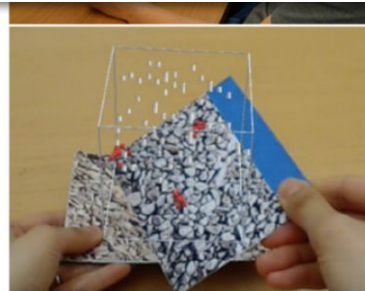
Evaluating Visualizations Subjective Feedback



Desktop



Tablet AR



Immersive AR

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Observations

- Provide users with precise **tasks**
- **Explain** your study
- **Explain** your visualization
- Let your participants **solve** the tasks
- **Record** responses
 - Think aloud (+video)
 - Notes
 - Questionnaires
- **Collect:**
 - Demographics
 - Rankings / ratings
 - Specific feedback to questions
 - Open feedback

- Demographics
- Preferences
- Rankings

- Demographics
- Preferences
- Rankings

Techniques can have the same ratings

	Very useless to ...				Very useful me
Flip Book	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Video Animation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Staged Animation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Thank you for participating in our experiment. Please answer this questionnaire in order to give us valuable feedback. You have the opportunity to add comments at the end of the questionnaire. We are happy to cite your comments, which happens anonymously. Feel free to give us any feedback you like.

Short-answer text

Description (optional)

Short-answer text

☐ Female

☐ Male

	1	2	3	4	5
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Almost Daily

Questionnaires:

Google forms

- Ask for **background** and **expertise**
- **Demographics** if necessary
- Pose very **specific questions**:
 - *"how hard was it to understand X."*
 - *How confident were you doing X?*
 - *Did X help solving Y?*
- **Likert scales** 1-5 points
- Ask for positive and negative feedback
- Leave space for **open comments**

Time (seconds):

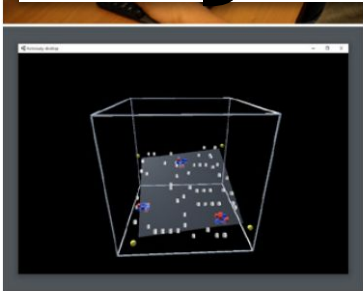


Questionnaire - Experiment on Dynamic Graph Transitions

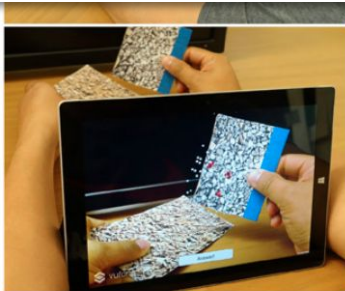
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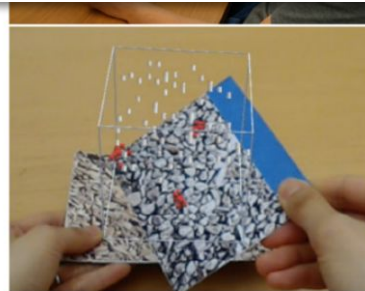
Evaluating Visualizations Objective Measurements



Desktop



Tablet AR



Immersive AR

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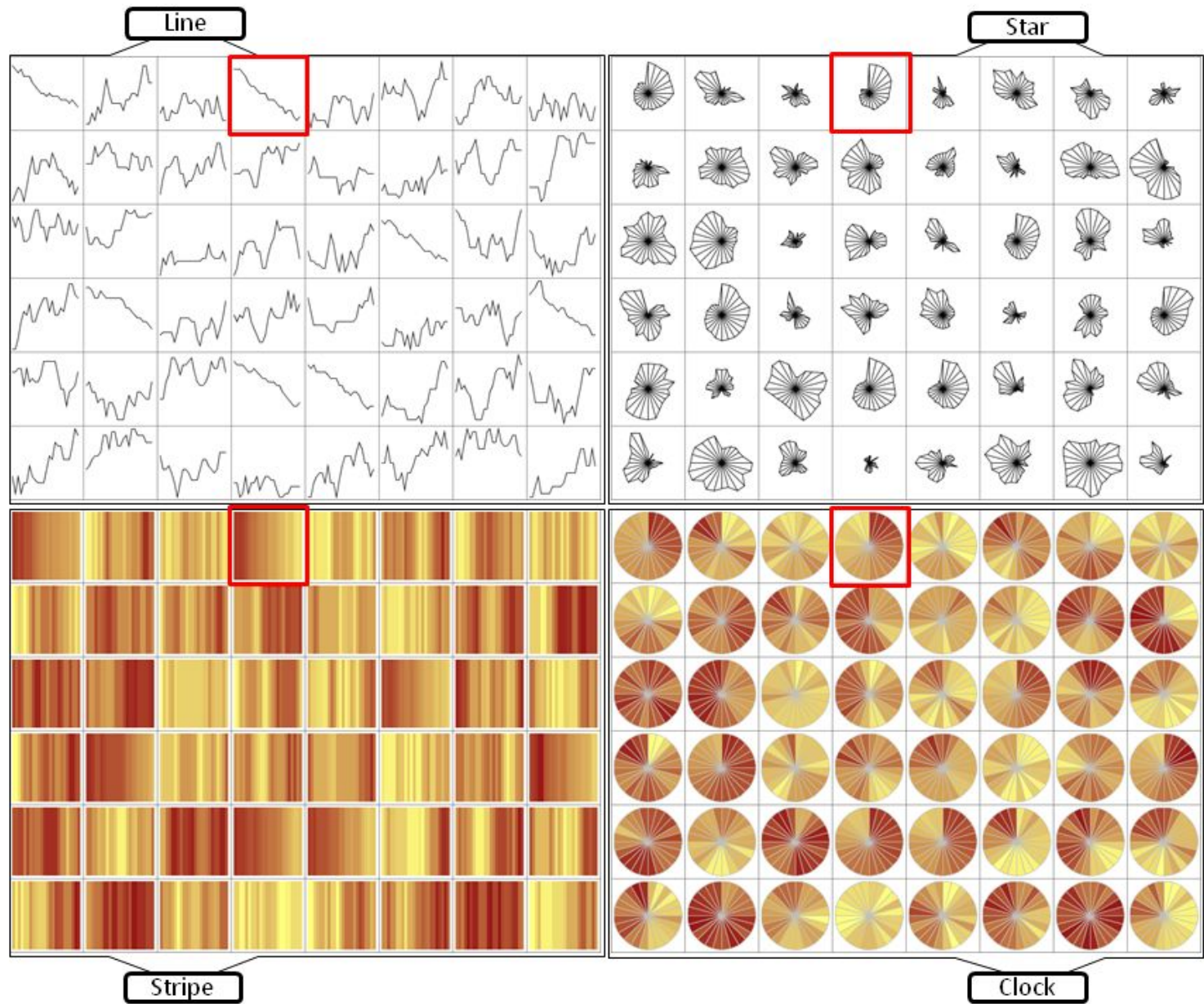
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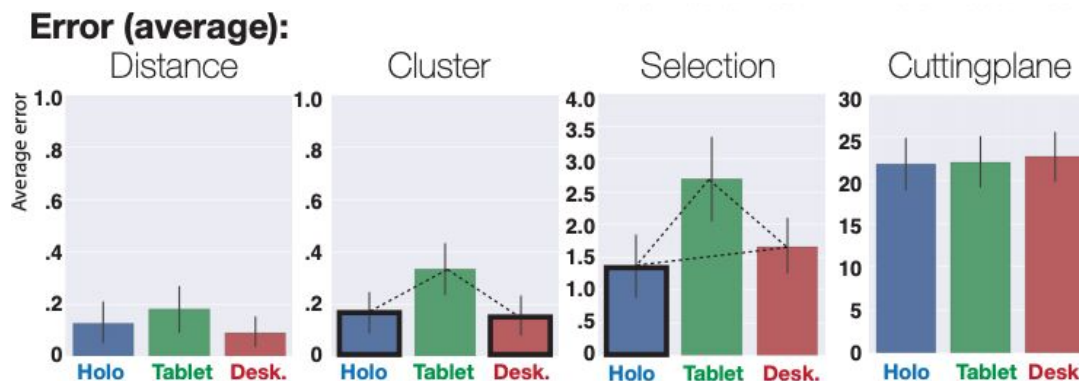
<https://datavis-online.github.io>

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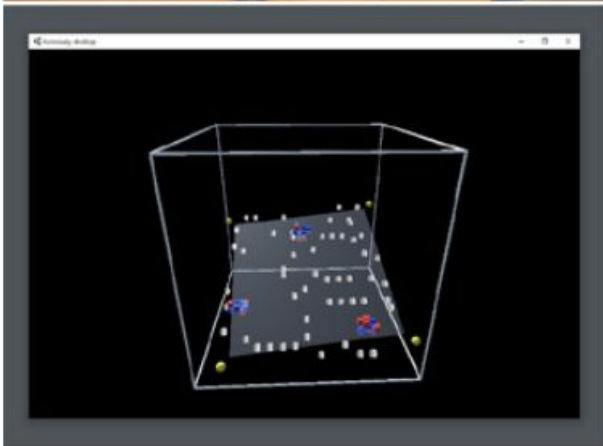


Controlled user studies:

- Collect quantitative data about **performance**
- Define **hypotheses**
- Define **conditions** under which to test
- Define precise **tasks**
- **Control** for data, context, task, ...
- **Record**, e.g.,
 - Time users take
 - Errors they make
- **Analyze** results: Means, medians, pair-wise comparison..



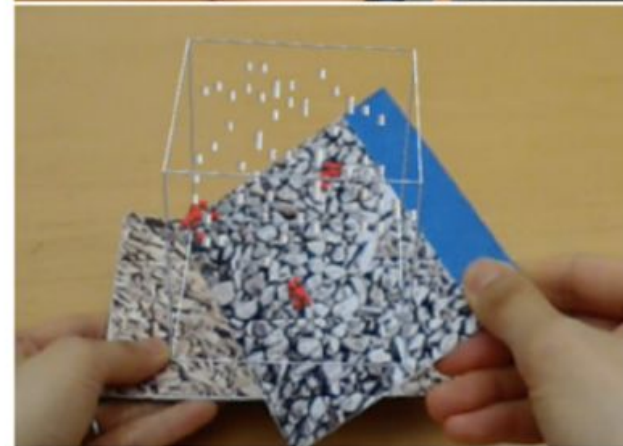
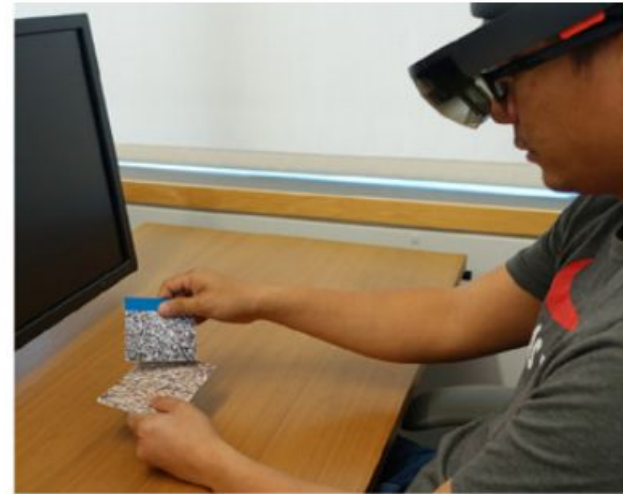
Controlled user studies:



Desktop



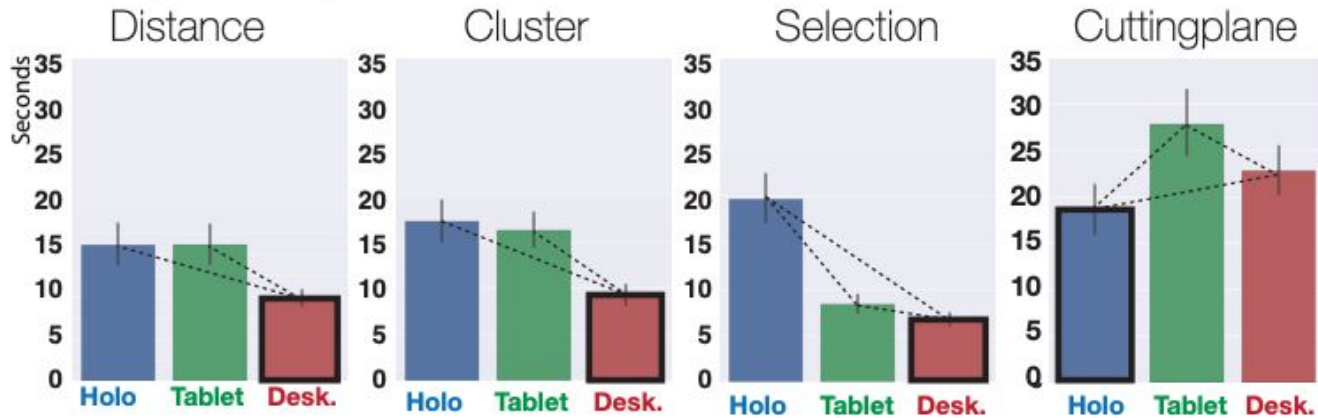
Tablet AR



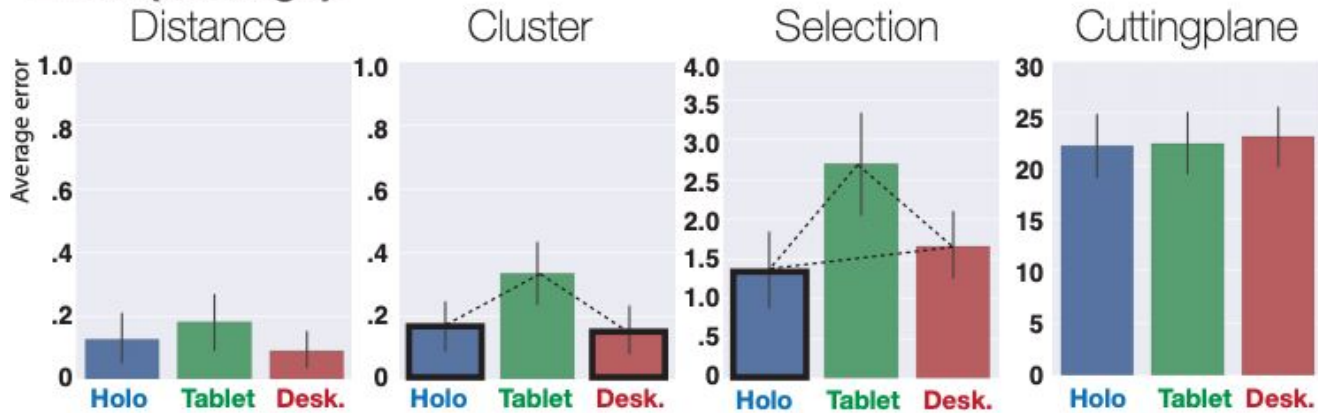
Immersive AR

Controlled user studies:

Time (seconds):



Error (average):



Evaluation techniques

Applicability

High



Low

Difficulty

Low



High

Strength

Low



High

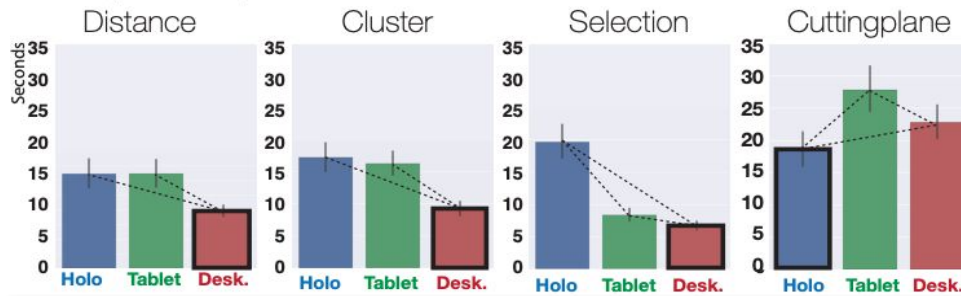
Heuristics & Guidelines

Case studies

Subjective Feedback

Objective Measurements

Time (seconds):

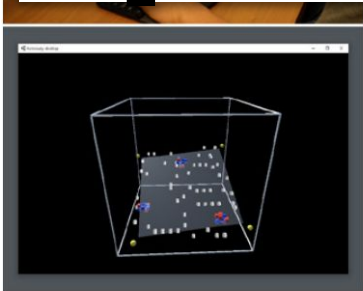


Questionnaire - Experiment on Dynamic Graph Transitions

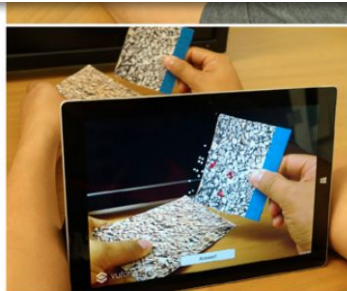
Thank you for participating in our experiment. Please answer this questionnaire in order to give us valuable feedback. You have the opportunity to add comments at the end of the questionnaire. We are happy to cite your comments, which happens anonymously. Feel free to give us any feedback you like.

Please enter the ID you got at the experiment. *

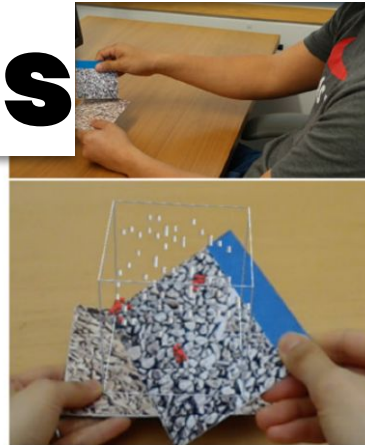
Evaluating Visualizations Open Issues



Desktop



Tablet AR



Immersive AR

Your age

Short-answer text

Gender

☐ Female

☐ Male

Do you or have you worked with graphs visualizations before?

Not at all ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Almost Daily



Online Course
**Data Visualization
for Professionals**



THE UNIVERSITY
of EDINBURGH

Benjamin Bach

June 2020

<http://benjbach.me>

<https://datavis-online.github.io>

-- Not for external use --

Open Issues in Evaluation

- Measuring task difficulty & task **taxonomies**
- **Train** participants
- Defining when a visualization is '**successful**'
- Find examples of true **insights**
- Measure visualizations **in-the-wild**.
- Measuring user **experience**
- ..

Further readings

- Elmqvist, Niklas, and Ji Soo Yi. "Patterns for visualization evaluation." *Information Visualization* 14.3 (2015): 250–269.
- Lam, Heidi, et al. "Empirical studies in information visualization: Seven scenarios." *IEEE transactions on visualization and computer graphics* 18.9 (2011): 1520–1536.
- Lam, Heidi, et al. "Seven guiding scenarios for information visualization evaluation." (2011).
- Isenberg, Tobias, et al. "A systematic review on the practice of evaluating visualization." *IEEE Transactions on Visualization and Computer Graphics* 19.12 (2013): 2818–2827.
- Borgo, Rita, et al. "Information visualization evaluation using crowdsourcing." *Computer Graphics Forum*. Vol. 37. No. 3. 2018.
- Kang, Youn-ah, and John Stasko. "Examining the use of a visual analytics system for sensemaking tasks: Case studies with domain experts." *IEEE Transactions on Visualization and Computer Graphics* 18.12 (2012): 2869–2878.