User-Centered Evaluation of Visualization

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Video from MD SHAHRIAR ISLAM / Pixabay

Chart Suggestions—A Thought-Starter

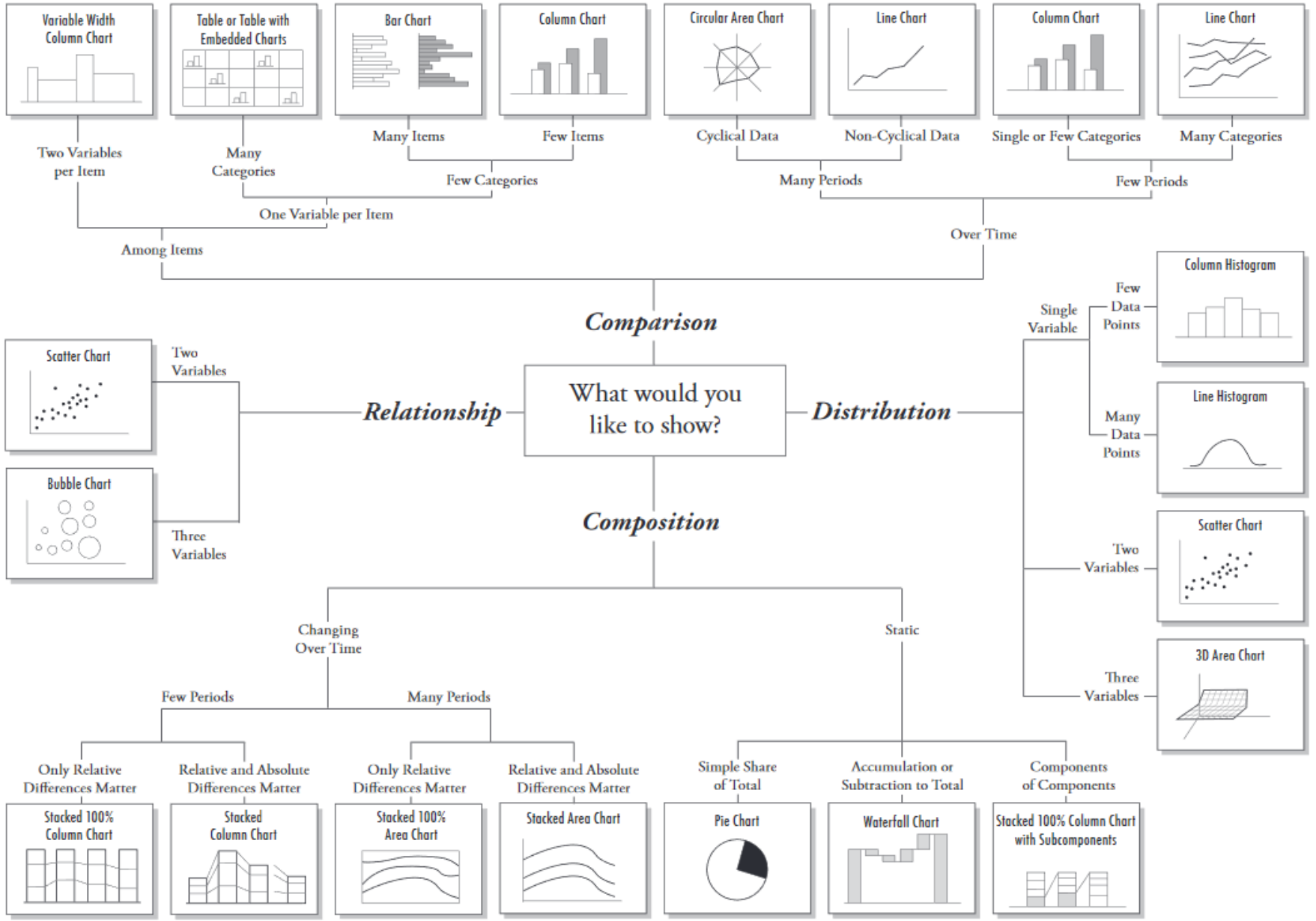


Image from https://extremepresentation.typepad.com/files/choosing-a-good-chart-09.pdf

Photo by fotografierende from Pexels

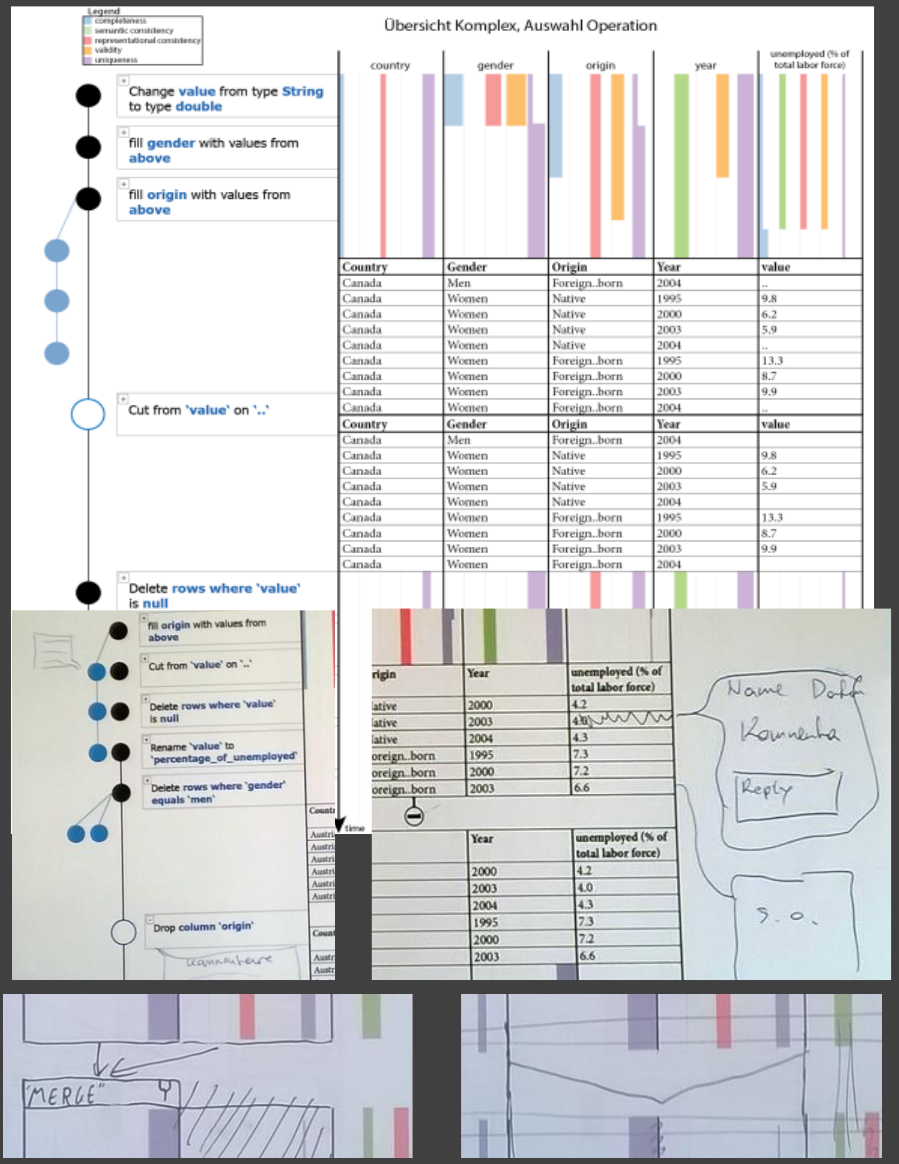
Success of a visualization depends strongly on the target users

- their expectations and needs
- how well they can interpret the data with the visualization

- understandable/ correct interpretation
- which visualization approach is better?
- why does the approach not work?
- what can we change?
- how can we improve it?
- …

What will be evaluated?

Understanding the impact of operations on the data's quality and structural changes



Bors, C., Gschwandtner, T., & Miksch, S. (2014). Qualityflow: Provenance generation from data quality. In *Poster Proceedings of the EuroGraphics Conference on Visualization*.

Prototyping

There exist many types of prototypes of varying degrees of fidelity, e.g.:

- single page vs. multipage such that the user can complete a task
- realistic and detailed vs. hand-sketched
- interactive (clickable) vs. static (a person simulates the system)

Level of fidelity -> the level of detail and functionality

- Low-fidelity
- High-fidelity

Fidelity of a prototype can vary:

- Visual design
- Content
- Interactivity

Source: https://www.nngroup.com/articles/ux-prototype-hi-lo-fidelity/ https://blog.adobe.com/en/publish/2017/11/29/prototyping-difference-low-fidelity-high-fidelity-prototypes-use.html#gs.qcml9j

Who will be evaluated?

Photo by Sora Shimazaki from Pexels

Expert evaluation

Review of the visualization approach

Good if you

- have limited access to users
- need to conduct an extremely fast review -> do not have time to recruit participants

But experts are often not the user!!!

Recommended before a user study to find large number of basic problems

Ideally, experts in HCI and the domain (no or little involvement in the project)

- rarely covered by one person -> 2-3 experts with different backgrounds

Wilson, C. (2009). *User experience re-mastered: your guide to getting the right design*. Morgan Kaufmann.
Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons.

Photo by Sora Shimazaki from Pexels

User Study

"Real" Target user

Goal

- Feedback on strengths and weaknesses of the design
- Identify usability problems
- Identify improvement possibilities
- Comparison between different approaches

Two approaches:

- Attitudinal – you listen to users' words (e.g., in interviews)
- Behavioral – you watch their actions through observational studies

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons.
Source: https://www.interaction-design.org/literature/topics/user-research

Where will be evaluated?

Photo by Sora Shimazaki from Pexels

User Study

Testing Environment

- Lab
- User’s place (field study)

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons.

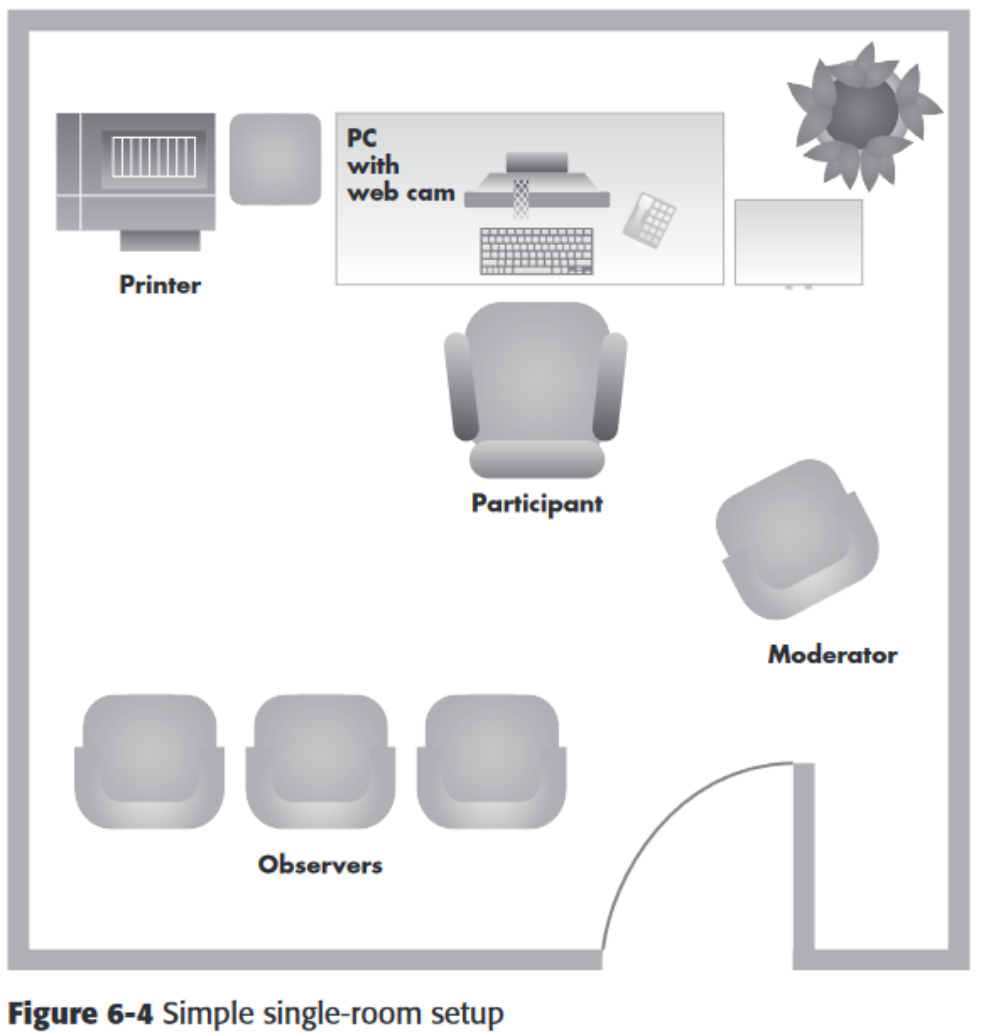


Figure 6-4 Simple single-room setup

Image from: Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons. (page 102)

User Study

Testing Environment

- Lab
  - Simulate different testing setups/environments (e.g., office setting)
  - Same conditions -> better to compare
  - Controllable
  - Leaves the user and moderator alone
  - Observers are in a separate room
  - If you don't have a lab -> portable lab equipment and a quiet room
    - Laptop for the user
    - Laptop for the moderator (e.g., to take notes)
    - Webcam to record the user
    - Input device

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons.
Source: https://www.nngroup.com/articles/traveling-usability-lab/

Photo by Sora Shimazaki from Pexels

User Study

Testing Environment

- User's site (field study)
  - Test in real context and location

    -> important if the environment can influence the design
  - Need special planning -> logistics are not trivial -> portable lab equipment
  - Decide where to best observe people in action
  - Be sensitive and considerate -> person's personal space (workplace or home)

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons.
Source: https://www.nngroup.com/articles/field-studies/

How will be evaluated?

Photo by Sora Shimazaki from Pexels

User Study

Test Preparation

1. Identify and specify the purpose and goals of the test
   - Specify the questions what you would like to answer with this test
2. Identify and define participant characteristics (e.g., background, expertise, domain,…) -> Personas can help
3. Recruit test persons -> needs time!!
4. Method(s) (test design)
5. Specify which data has to be collected
6. Specify the test environment and equipment (e.g., audio and/or video recorder, check batteries!!)
7. Specify the tasks for the test
8. Prepare materials (e.g., pen, notepad,…)
9. Prepare the test procedure/test plan
10. Letter of agreement (permission of the participants)

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons.

Photo by Sora Shimazaki from Pexels

User Study

Tasks

Representative of typical user activities

But: do not focus too much on a specific feature -> see how users will use the visualization

Tasks should have the following characteristics:

- Typical kind of things that people will do
- Describe tasks as scenarios -> not too long and easy to understand
- Tasks should have a specific end goal -> fulfilled/not fulfilled
- Avoid giving clues -> Step descriptions often contain hidden clues

Wilson, C. (2009). *User experience re-mastered: your guide to getting the right design*. Morgan Kaufmann.
Source: https://www.nngroup.com/articles/task-scenarios-usability-testing/

Photo by Sora Shimazaki from Pexels

User Study

Qualitative data/methods

- for answering questions about **why** or **how to fix** a problem
- to get an in-depth understanding of the experiences and everyday lives of individual users or user groups
- e.g.: observation notes, user explanations and opinions, non-numeric terms, anecdotes, transcripts,...

Quantitative data/methods

- for answering **how many** and **how much**
- to measure user behavior in a way that can be quantified and used for statistical analysis
- e.g.: logging of user actions, speed, error rate, counts of activities

Purpose and goals of the test

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons.
Source: https://www.interaction-design.org/literature/article/user-research-what-it-is-and-why-you-should-do-it
https://www.nngroup.com/articles/which-ux-research-methods/

Photo by Sora Shimazaki from Pexels

User Study

Examples of methods:

- Observation
- Thinking Aloud
- Interviews and questionnaires
- Log file

Use Cases

Video von Oleg Gamulinskiy / Pixabay

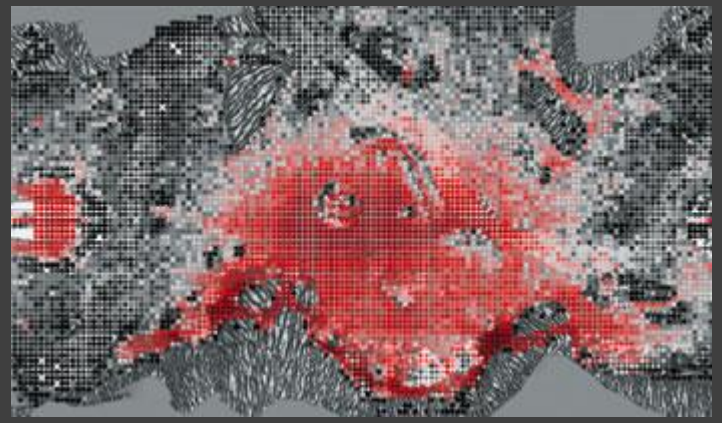
Gameplay Visualizations

Heatmaps are **very popular** since they

- are easy to create
- indicate the **frequency of occurrence** of a variable (e.g., death locations of players) at a particular location

Examples: Colors show where players died most often in each map

Halo 3

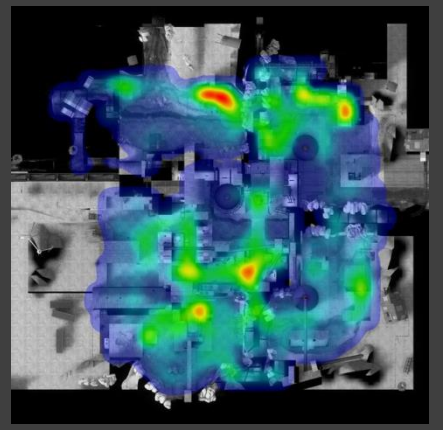


http://www.wired.com/images/article/magazine/1509/ff_halo5_350.jpg

Call of Duty

http://www.polygon.com/2012/11/27/3682896/how-call-of-duty-elite-evolved

Team Fortress 2

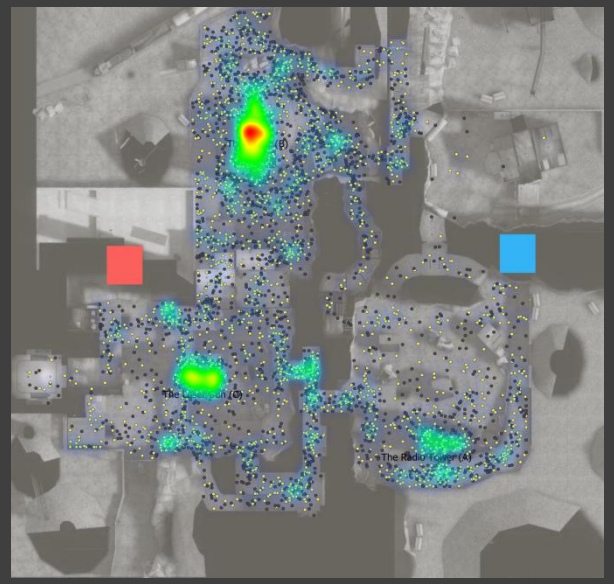


http://tf2wiki.net/wiki/File:Valve_stats_cp_dustbowl_deaths.jpg

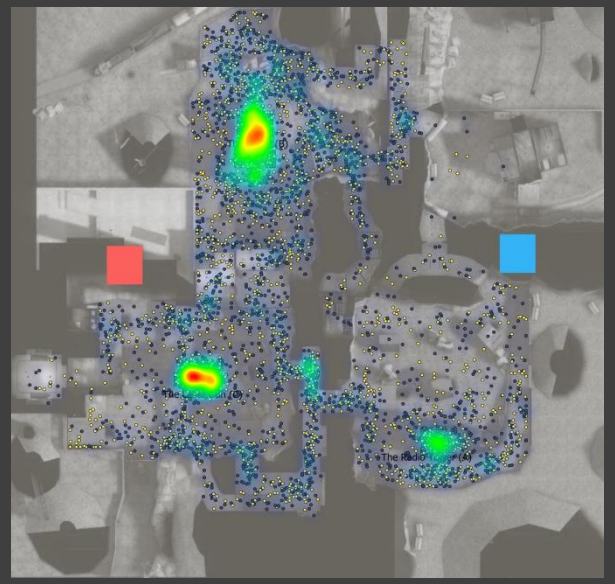
Gameplay Visualizations

Analysis of **multiple variables** (e.g., attackers versus victims) is **difficult** with heatmaps

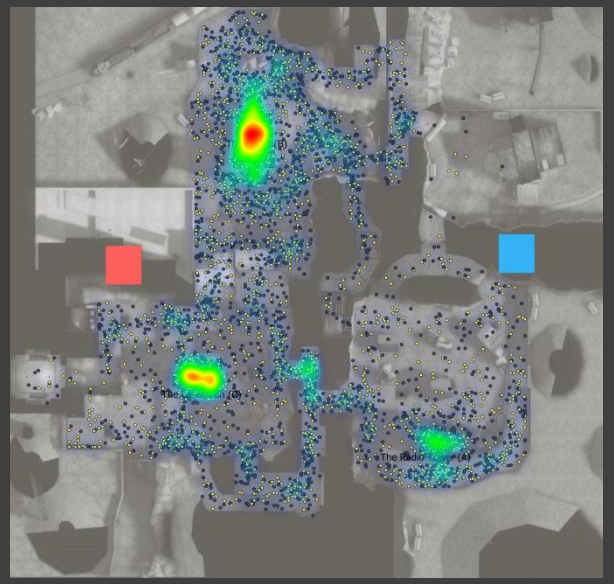
Attackers



Victims



Attackers + Victims

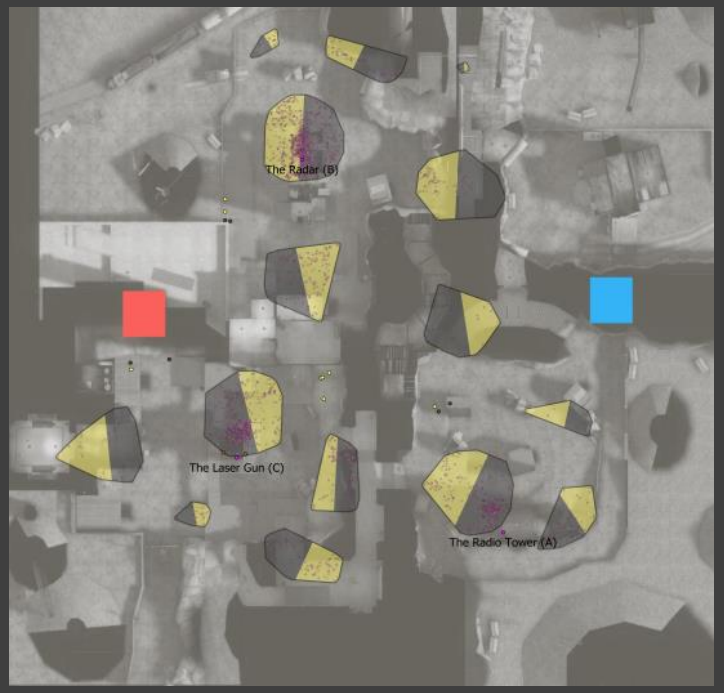


Gameplay Visualizations

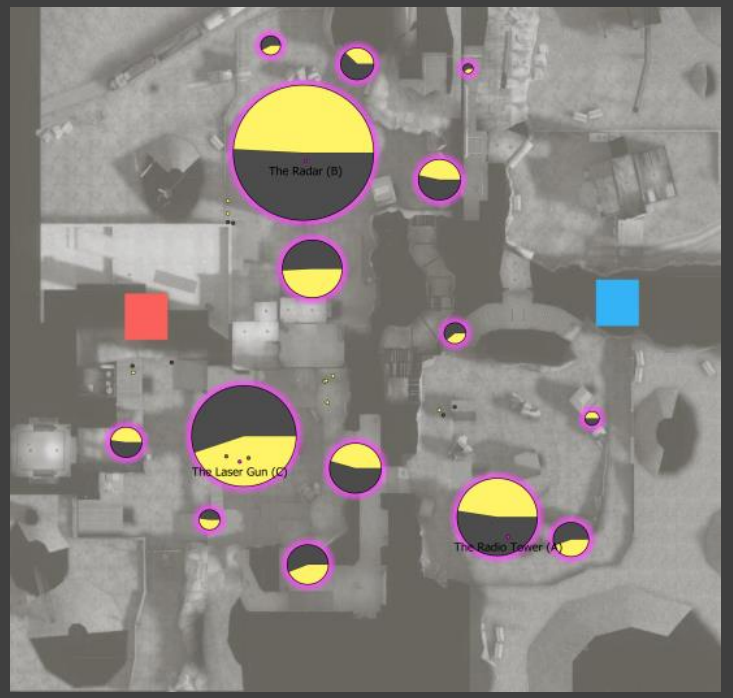
Two visualization techniques were developed as suitable **alternatives** to classic heatmaps that

- use clustering to group nearby data points

Enclosure



Circle



Test Case

A (team-based) first-person shooter

- Heatmaps are **commonly used in this genre** to communicate data about gameplay back to the player

Team Fortress 2

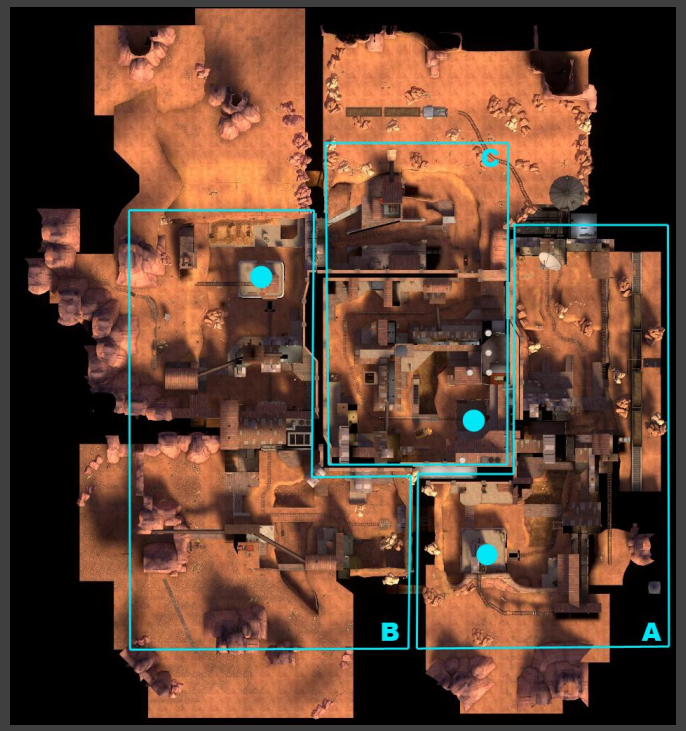
- Popularity
- Log-files contain information about the spatial **coordinates of players** for specific events

Image from http://www.hlportal.de/images/images/original/13682.jpg

Test Case

For the evaluation, we used data from the following two maps:

Gravel Pit (GP)



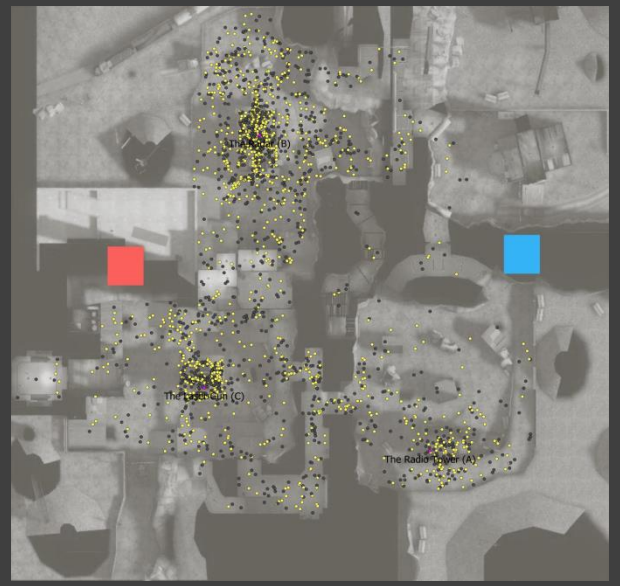
Gold Rush(GR)

Test Case

We extracted

- players' **death locations** and **weapons** which have been used
- locations where players were located when **killing another player**

The positions (attacker, victim) were represented as small colored circular nodes



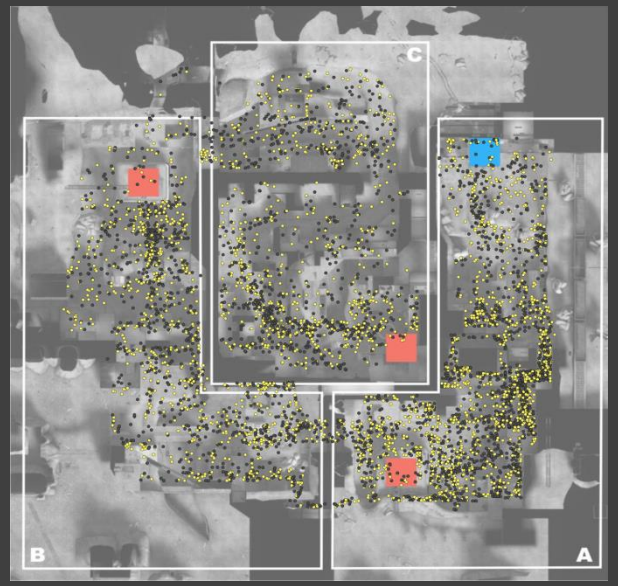



Photo by Sora Shimazaki from Pexels

Sample

We selected participants with

- varying gaming experience
- different knowledge of Team Fortress 2

29 participants

- 23 males and 6 females between 22 and 34 years
- played digital games
- were familiar with FPS

Photo by fotografierende from Pexels

Tasks

Participants were asked to use the different visualizations to analyze the provided data and to report their observations

Participants had to find the area on the map where a **single variable** occurred most frequently

Participants had to find the areas on the map where one variable occurred more frequently **in relation to other variables**

Photo by fotografierende from Pexels

Methods

Thinking aloud

Observation

Questionnaire

- if the representation was suitable to solve the task after each round
- which of the three representations they preferred
- for which tasks the different visualizations are more suitable
- which representation caused greater confidence with his/her solutions
- advantages as well as disadvantages

Photo by Sora Shimazaki from Pexels

Sample & Procedure

5 Experts from the game industry

Duration: 2-hour sessions

Introduction about the purpose of the study

They were asked to sign a consent form informing them about which data is collected and how it will be used

They played the game for ten minutes to allow them to familiarize themselves with the game

After that, the visualization system was introduced to explain the functionality and navigation

Solved tasks with focus on movement, gaze, emotion, and their combination

Kepplinger, D. Wallner, G., Kriglstein, S., and Lankes, M.: See, Feel, Move - Player Behaviour Analysis through Combined Visualization of Gaze, Emotions, and Movement. Proc. of the SIGCHI Conference on Human Factors in Computing Systems, ACM, 2020

Photo by Sora Shimazaki from Pexels

Sample & Procedure

Participants were asked to rate the helpfulness of the tool for the given task on a 5-point Likert-like scale anchored by not helpful (1) and very helpful (5)

After they finished they were asked, e.g.,

- how helpful the tool was for analyzing gameplay data
- which features they liked the most
- which aspects of the tool they think need further refinement

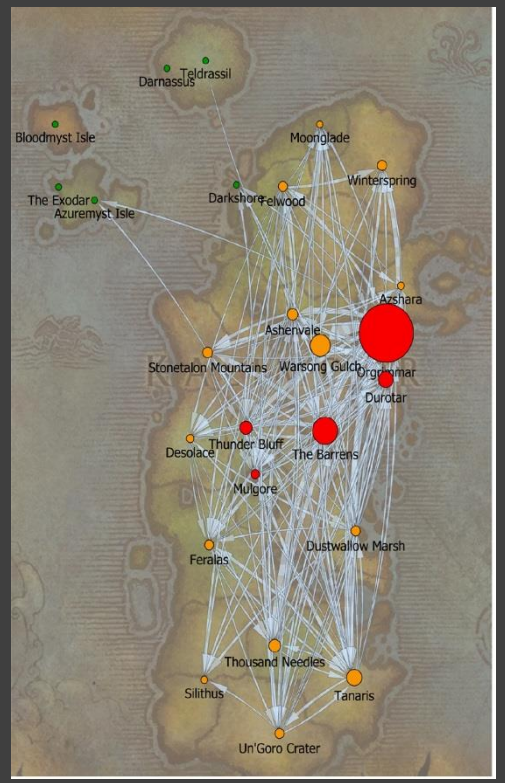
Kepplinger, D. Wallner, G., Kriglstein, S., and Lankes, M.: See, Feel, Move - Player Behaviour Analysis through Combined Visualization of Gaze, Emotions, and Movement. Proc. of the SIGCHI Conference on Human Factors in Computing Systems, ACM, 2020

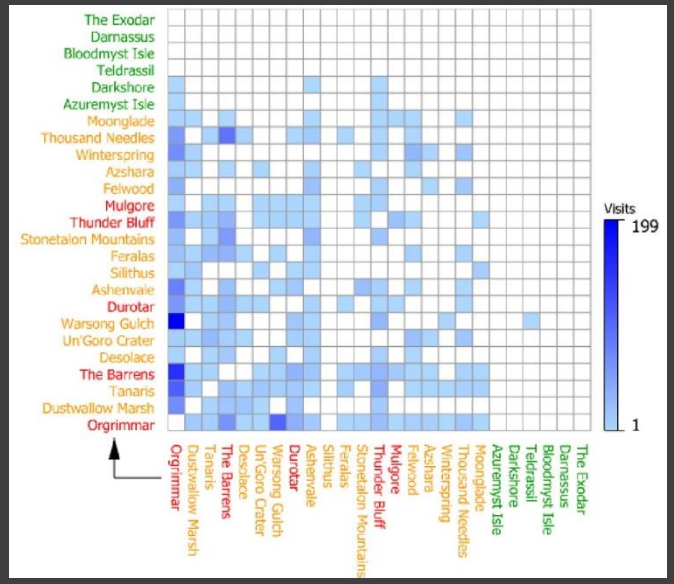
Motivation

- Node-link diagrams and matrix representations are two popular ways to visualize graphs

Node-link diagrams …

- allow users to directly see the connections between the nodes as lines
- can easily lead to clutter





Images from *Wallner, G., & Kriglstein, S. (2014). PLATO: A visual analytics system for gameplay data. Computers & Graphics, 38, 341-356.*

Matrix representations …

- use space more efficiently and do not lead to clutter
- detection of relationships is not as intuitive

Photo by fotografierende from Pexels

Often hybrid visualizations are used to combine the strengths of both representations

Analyzing and interpreting the same data **from different viewpoints** can be **challenging** in order to see the connections between them

Goal is …

- to get more **detailed understanding** of the **conceptual problems** which may occur when people have to **convert node-link diagrams to matrices and vice versa**

Photo by fotografierende from Pexels

Research Questions

Correctness and Efficiency

- Do participants convert node-link diagrams to matrix or vice versa more correctly?

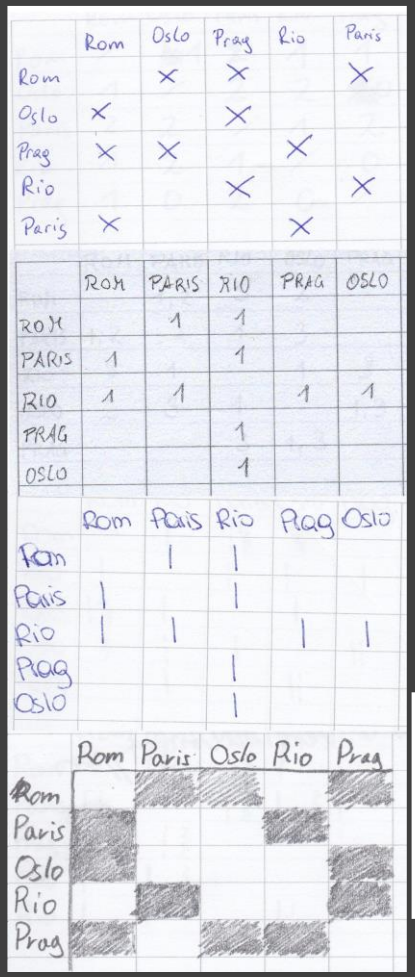
Interpretation

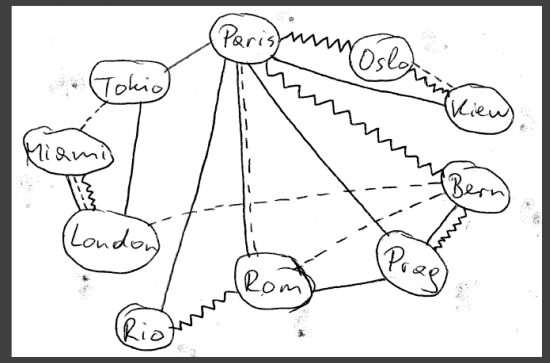
- How do participants convert node-link diagrams to matrices and vice versa?
- How do they transform the connections between those two representations?
- How do they transform the nodes from a node-link diagram to a matrix and vice versa?

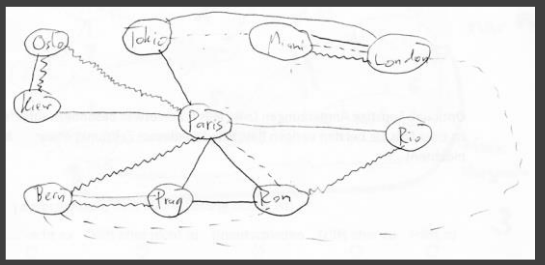
Method

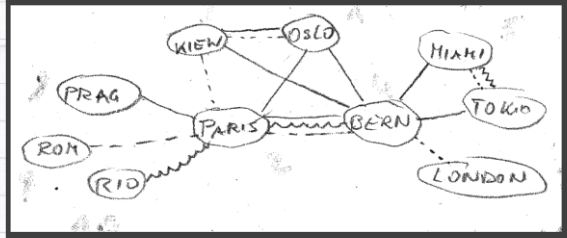
Hand drawn sketches are an effective method

- offer creative freedom
- help to express, develop, and communicate concepts with a low entry
- avoid any restrictions or influences resulting from any software



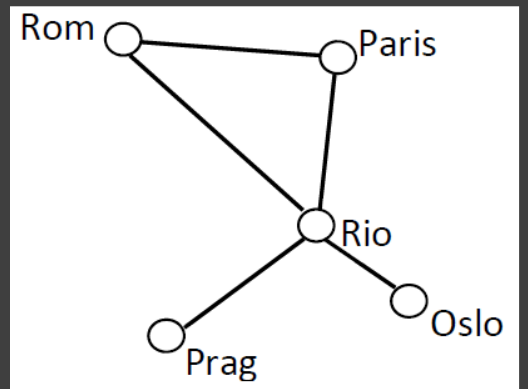






Materials

2 test cases with the following 4 types of examples were generated



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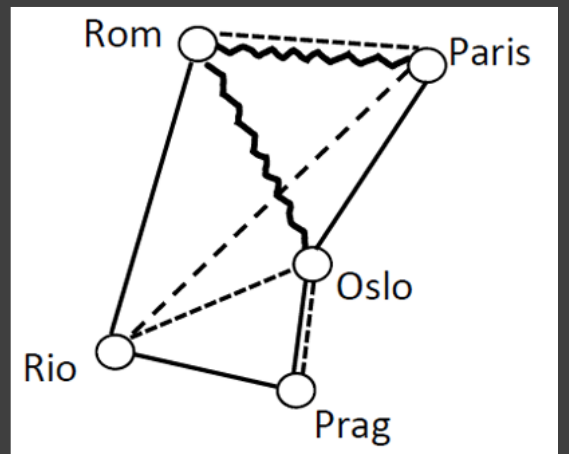
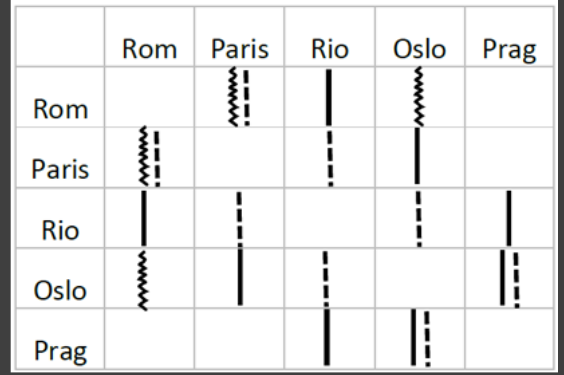
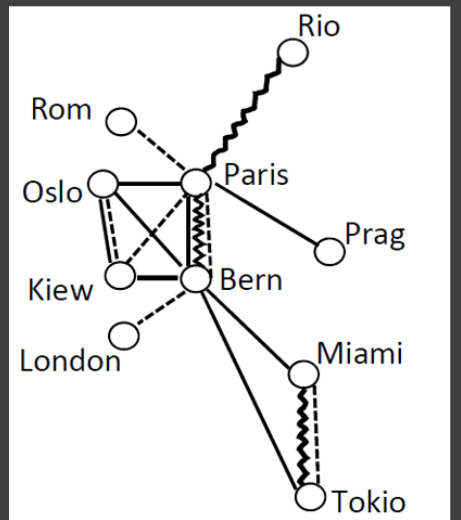
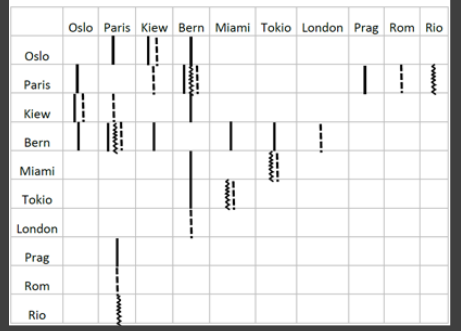
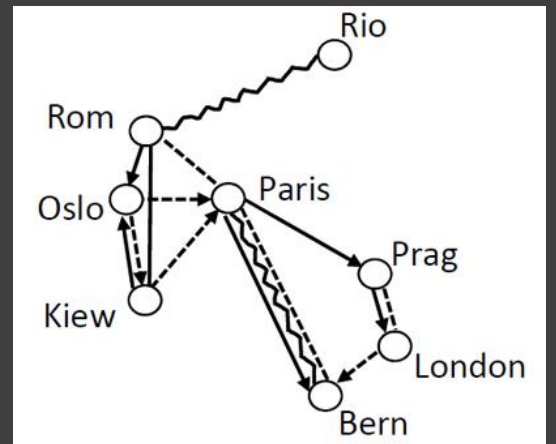
Paris	×		×		
Rio	×	×		×	×
Oslo			×		
Prag			×		











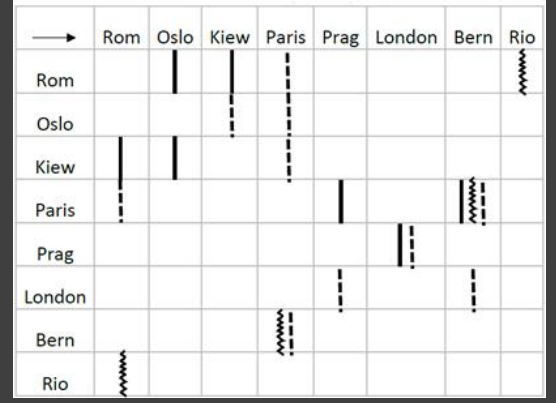


Photo by Sora Shimazaki from Pexels

Sample & Procedure

The experimental session was conducted in a quiet seminar room

The average duration was about 47 minutes

12 participants (average age of 25.16) with at least basic knowledge with matrix and node-link visualizations

Kriglstein, S., Pohl, M., & Haider, J. D. (2018, June). How Users Transform Node-Link Diagrams to Matrices and Vice Versa. In *International Conference on Theory and Application of Diagrams* (pp. 526-534). Springer, Cham.

Photo by Sora Shimazaki from Pexels

Sample & Procedure

A short introduction and participants had the possibility to ask questions to clarify any issues with the study

To counteract learning effects the participants were divided into two groups

- One group got the four matrices from one test case and had to draw the corresponding node-link diagrams
- After they finished they got the four node-link diagrams from the other test case and had to draw the corresponding matrices
- For the other group, the order was reversed

Participants were asked if they found it difficult to convert matrices into the corresponding node-link diagram and vice versa

Kriglstein, S., Pohl, M., & Haider, J. D. (2018, June). How Users Transform Node-Link Diagrams to Matrices and Vice Versa. In *International Conference on Theory and Application of Diagrams* (pp. 526-534). Springer, Cham.

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