Übung zur Vorlesung

Informationsvisualisierung

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Visualizing Multivariate Data

Multivariate Data?

⟹ Data based on more than one variable per sampling unit.

Example: Weather data (Munich)

	Temperatur °C max. Ø	Temperatur °C min. Ø	Niederschlag mm	Niederschlag Tage	relative Feuchte	Sonne h/Tag
Jan	1,6	-5,1	53	16	83	2
Feb	3,6	-4	52	15	83	2,7
Mär	8,1	-0,8	56	13	77	4,1
Apr	12,6	2,6	75	14	72	5,1
Mai	17,4	6,8	107	15	73	6,4
Jun	20,5	10,2	131	16	73	6,8
Jul	22,8	12,1	116	16	73	7,6
Aug	22,3	11,8	116	15	75	6,9
Sep	19,1	8,9	79	13	78	5,6
Okt	13,6	4,4	57	12	82	4,2
Nov	6,9	-0,1	64	14	86	2,2
Dez	2,6	-3,7	60	14	86	1,6

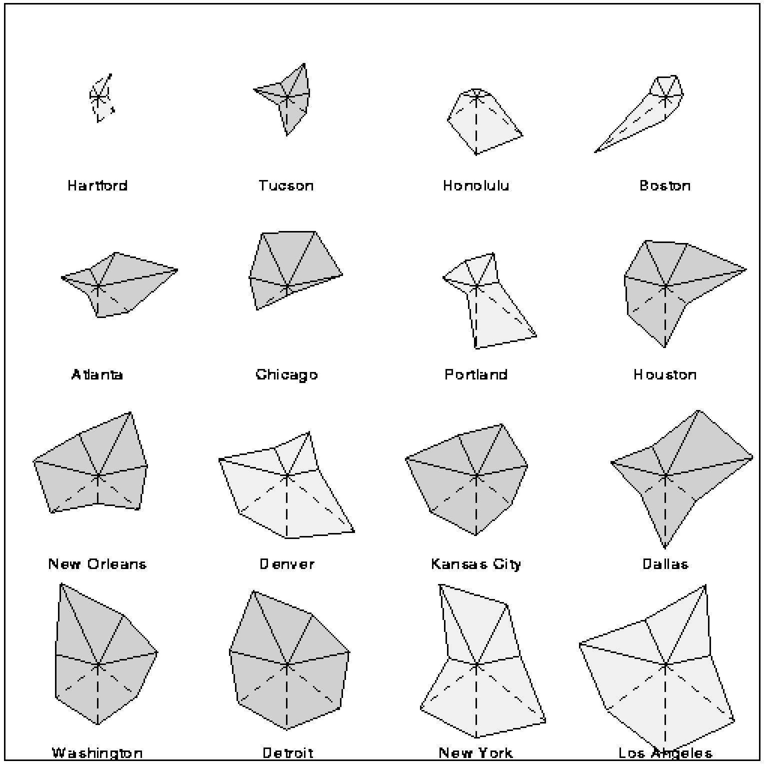
Glyphs

- Small-sized visual symbols
- Variables are encoded as properties of glyph
- Each case is represented by a single glyph

- **Main Limitation**: Have to be learned
- Not suitable for large data sets.

Star Glyphs

- aka web diagram, spider chart, star diagram …
- Radial axes representing the variables
- Allows for comparison based on the shape of the resulting object

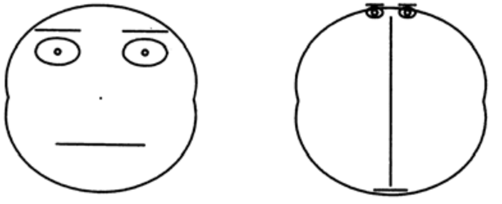


[4]

- Limitations:
  - Works for small data sets only [5]
  - Hard to compare fine differences in spoke lengths
  - Thus better suited for identifying outliers

Chernoff Faces

- Theory
  - Humans are able to recognize small changes in facial characteristics
  - Data is encoded by stylized faces using up to 18 characteristics



[1]

- Limitations
  - Extreme values negatively influence the impression of a face and the recognition of other values [1]
  - Experiments [2] reveal that recognition of Chernoff faces is a serial process and thus there is no significant advantage over other iconic visualization

Your Turn

Student	Course	Relationship	MMI 1	Infovis	DBS	Theor.	DS
1	MI	yes	2	1	2	4	2
2	Inf	no	2	2	1	2	1
3	KuM	yes	2	1	4	5	4
4	KuM	no	1	2	3	3	2
5	MI	no	1	1	2	2	2
6	Inf	yes	2	1	2	4	3
7	Inf	no	3	2	1	2	2
8	MI	yes	2	1	2	3	3
9	KuM	yes	1	2	3	4	5

Nominal

Ordinal

Some Background on Data Types & Evaluation

Types of Data

Qualitative vs. Quantitative Data

- deals with descriptions
- data can be observed but not measured
- colors, textures, smells, tastes, etc.
- Qualitative -> Quality

- deals with numbers
- data which can be measured
- length, height, area, volume, speed, costs etc.
- Quantitative -> Quantity

Oil Painting

Qualitative data:

- blue/green color, gold frame
- smells old and musty
- texture shows brush strokes of oil paint
- peaceful scene of the country

Oil Painting

Quantitative data:

- picture is 40 cm by 60 cm
- with frame 45 cm by 65 cm
- weighs 4 kilogramm
- costs 300€

Types of Data

From [3]

- Nominal
- Ordinal

non-parametric

- Interval
- Ratio

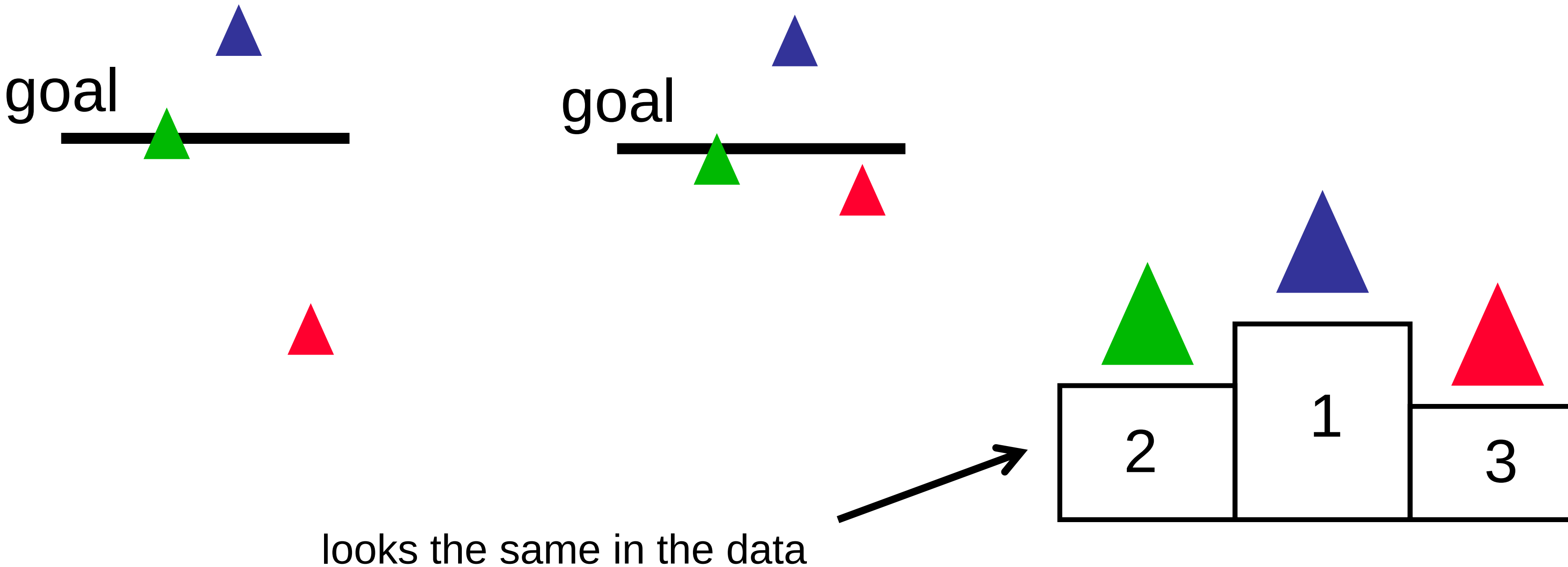
parametric

↓ more information

Ordinal vs. Interval

- ordinal provides an order
- doesn‘t tell anything about the differences

- example: triangle race



Evaluating InfoVis

Cause and Effect

Goal: Find causal links between variables

Precondition: Cause has to precede effect

How to infer causality:

- Two controlled conditions
  - Cause is present (experimental condition)
  - Cause is absent (control condition)

Hypotheses

- Prediction of the result:
  - „how will the *indepent variables* effect the *dependent variables*?“

- Hypotheses must be formulated before running the study
  - By doing the experiment, the hypotheses is either proved or disaproved

Variables

- Independent variables: *„What do I change?“*

  - Manipulated by the experimenter
  - Conditions under which the tasks are performed
  - The number of different values is called **level**, e.g.
    - Traffic light can be *red*, *yellow* or *green* (3 levels)

- Dependent variables: *„What do I observe?“*

  - Affected by the independent variables
  - Measured in the user study
  - Dependent variables should only depend on the indepent variables

Study Designs

Basic approaches

- Observational: „observe what naturally happens“
- Experimental: „manipulate some aspects“

Design types

•Within subject („repeated measures“)

- Each subject is exposed to all conditions
- The order of conditions must be randomized to avoid ordering effects

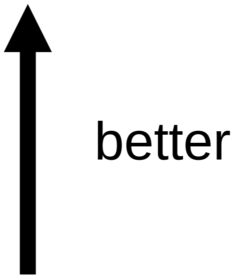
•Between groups („independent measures“)

- Separate groups (participants) for each condition
- Careful selection of groups is essential

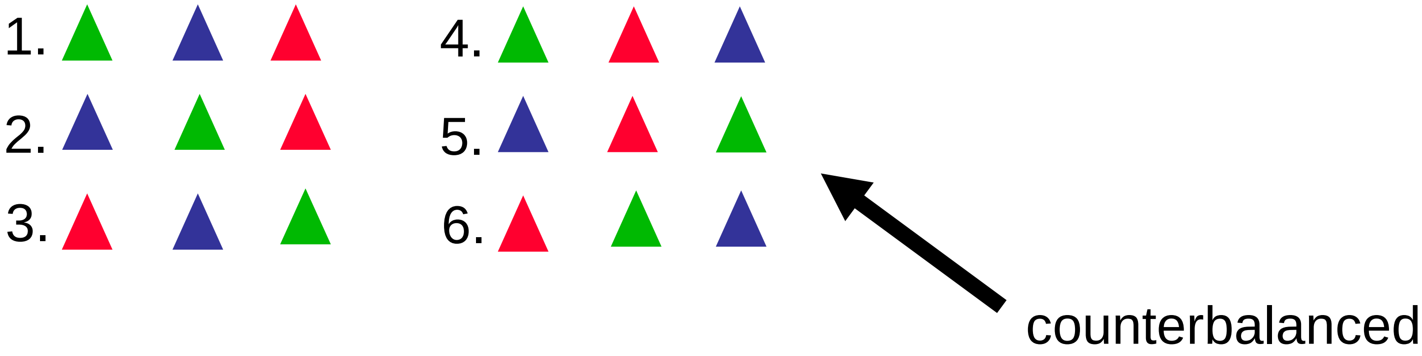
•Hybrid („mixed“) designs

Learning Effect

- people get better over time
- to avoid influences on the experiment:
  - use perfect counterbalancing if possible
  - Latin square designs
  - randomization
  - other designs



Example: One variable with 3 levels. 3! = 6 arrangements.



Participants

- Should be representative for the target group
- Avoid bias (e.g. not only men, students)
- Choose the right sample size

- Choose domain experts [4] if possible (especially in infovis)
  - More realistic results and tasks
  - Busy people with few time
  - Hard to get a big enough sample size

Principles

- The results of the experiment should be

1. **Valid**
   - Measurements are accurate and due to manipulations (**internal validity**)
   - Findings are representative and not only valid in the experiment setting (**external validity**)
2. **Reliable**
   - Consistency of measurement
   - A persons score doing the same test under the same conditions twice must be similar
3. **Generalizable**
   - Results should be valid for all people
   - Test users must be representative

Infovis Specifics [4]

- Find out:
  - If the visualization supports the user in the information task
  - How to improve the visualization to better support them
- Participants:
  - Domain experts if possible
- Data sets
  - Usually extremely large sets
  - Don’t just choose a subset
- Time:
  - It is not unusual for a task to take weeks or months
  - Hard to reproduce this in an experiment
- Tool status:
  - Hard to provide a fully functional tool rather than a prototype

Likert Scales

- used to „measure“ opinions
- participants give ratings
- Attention: there is a huge discussion going on whether likert scale data is ordinal (non-parametric) or interval (parametric)*

centered

1. fully agree
2. agree
3. neutral
4. disagree
5. totally disagree

uncentered

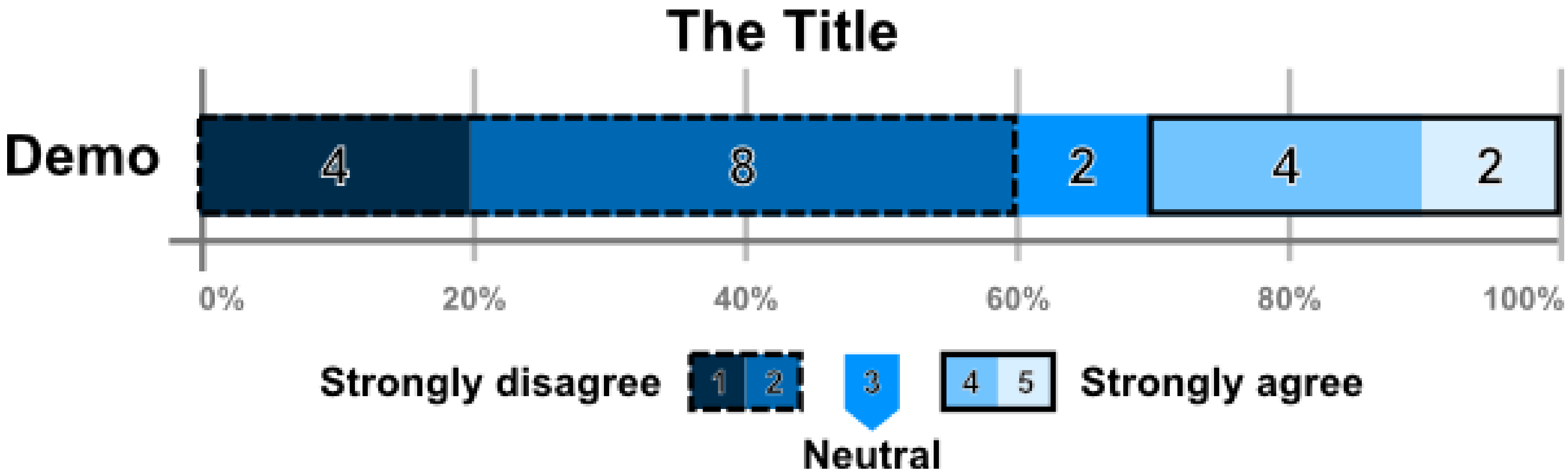
1. fully agree
2. agree
3. disagree
4. totally disagree

* Computer scientists believe it is ordinal. Please read the following blog entry for information and implications: http://cacm.acm.org/blogs/blog-cacm/107125-stats-were-doing-it-wrong/fulltext

Likert Scales?

- Don‘t report the mean
- If possible, report and visualize frequencies

- For example:

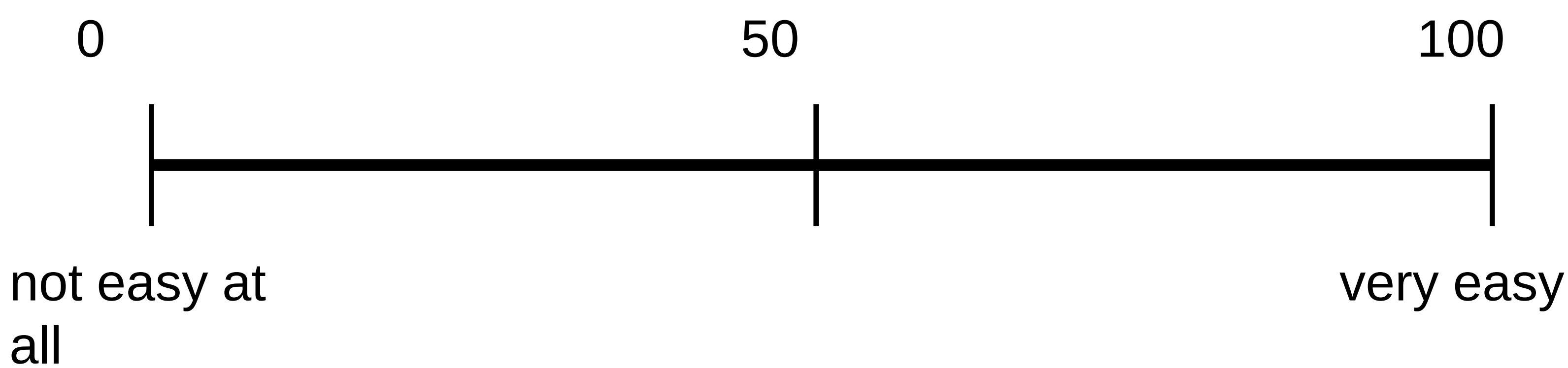


Visualization by Max Maurer. Script available here http://www.paje-systems.de/likert/

Visual-Analog Rating Scales

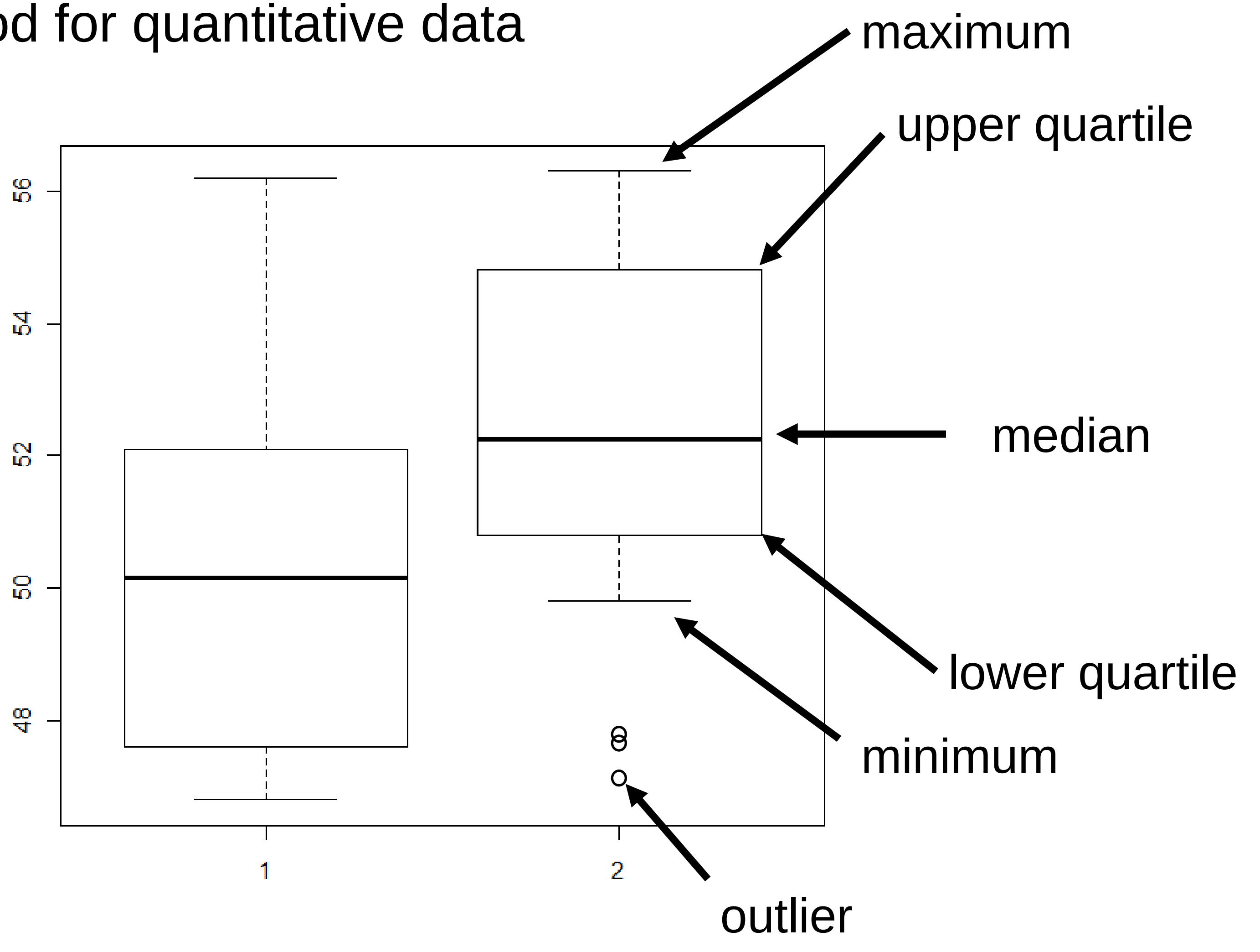
- no categories
- advantage: users cannot remember their response

How easy to use was the prototype?



Boxplot

- good for quantitative data



Analysis

- Choose the right statistical tests
  - Heavily influenced by the choice of measurement tools
  - … and the types of data used
  - Parametric tests (e.g. ANOVA, T-Test) vs. non-parametric tests (e.g. Wilcoxon, Kruskal-Wallis)

- Choose the right visualization (yes, you have to visualize the results of your visualization study ;-)

References

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5. NIST/SEMATECH (2003). Star Plot in: e-Handbook of Statistical Methods.
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