Cartography M.Sc.

# Animated Transitions in Statistical Maps

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# Outline

- **Introduction**
- **Related work**
- **Design of transitions between maps and charts**
- **Research Methodology**
- **Interpretation of results**
- **Conclusions and outlook**

# Introduction

What kind of animated transitions are possible between maps and charts and how do they affect user perception?

## Research Objectives and Questions

How animated transitions from statistical maps to charts and vice versa change user perception?

- To describe possible animated transitions between statistical maps and charts;
- To develop working examples of the suggested transition types;
- To test and analyze if and how the animated transitions affect user perception.

**Q1** What are the possible ways to transition between statistical maps and charts?

**Q2** How do animated transitions affect the map reader's perception?

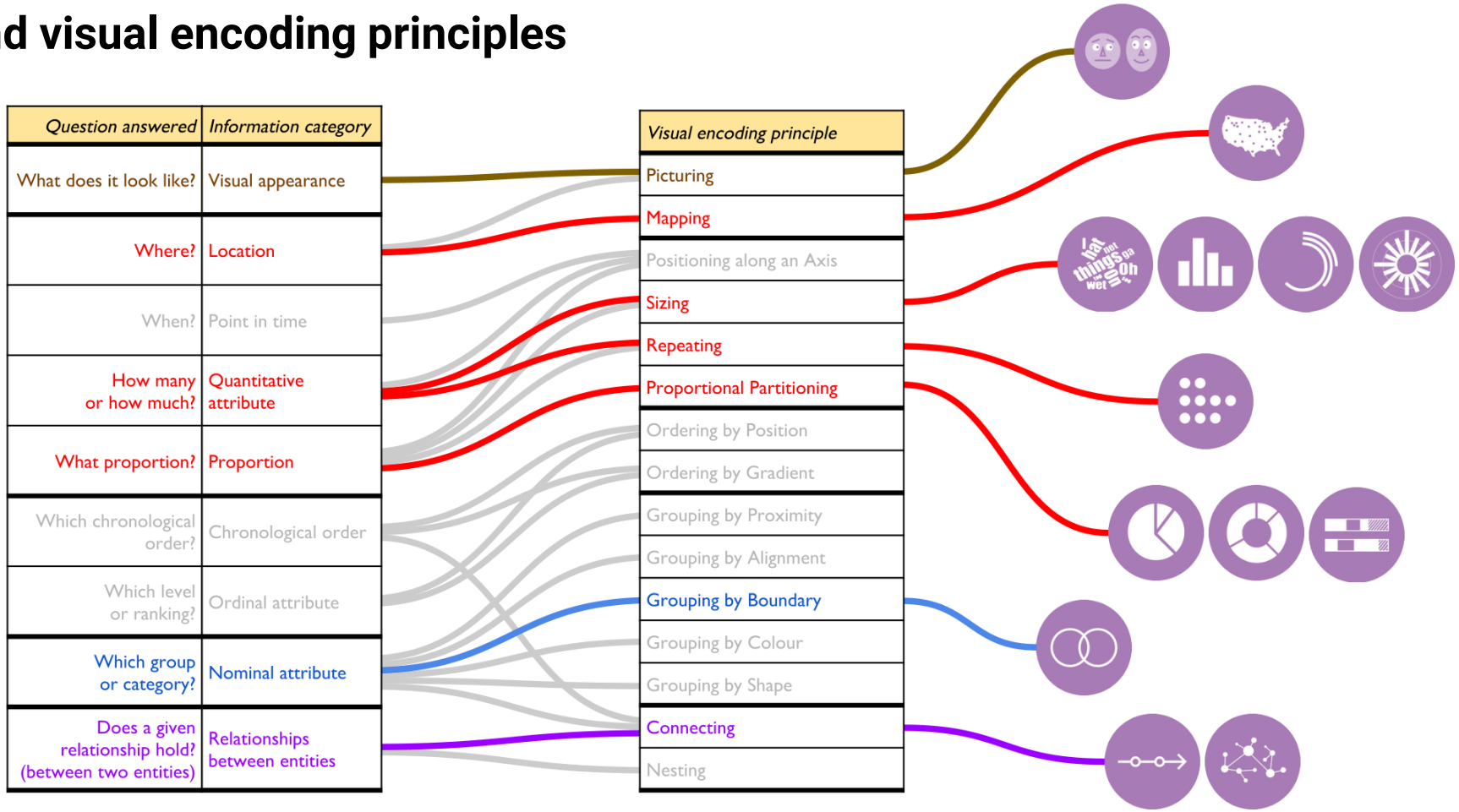
**Q3** Does the change in perception improve the understanding of patterns, trends or relationships in statistical data?

# Related Work

## Graphic components and visual encoding principles

**Components:**

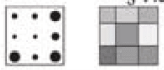
- Bands;
- Bars;
- Partitions;
- Surface locators;
- Symbols.




(Engelhardt & Richards, 2018)

# Related Work

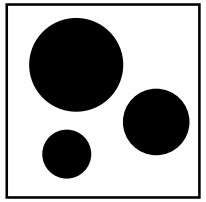
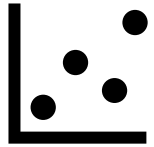
## Statistical maps

| | | qualitative | quantitative | | |
|---|---|---|---|---|---|
| | | nominal | ordinal/interval/ratio | | composite |
| graphic variables | | variation of hue, orientation, form | repetition | variation of grain, size, grey value | variation of size, segmentation |
| discreta | point data | nominal point symbol maps § 7.5.4  | dot maps § 7.5.7  | proportional symbol maps § 7.5.5  | point diagram maps § 7.5.6  |
| | linear data a) lines | nominal line symbol maps  | — | flowline maps § 7.5.8  | line diagram maps § 7.5.6  |
| | b) vectors | — | standard vector maps  | graduated vector maps  | vector diagram maps  |
| | areal data regular distribution | R.S. landuse maps  | regular grid symbol maps  | proportional symbol grid maps § 7.5.5 grid choropleth § 7.5.2  | areal diagram grid maps § 7.5.6  |
| | irregular boundaries | chorochromatic mosaic maps § 7.5.1  | — | choropleth § 7.5.2  | areal diagram § 7.5.6  |
| | volume data | — | — | stepped statistical surface § 7.5.9  | — |
| continua | surface data | — | isoline map § 7.5.3  | filled-in isoline map § 7.5.3  | — |
| | volume data | — | — | smooth statistical surface § 7.5.9  | — |

(Kraak & Ormeling, 2013)

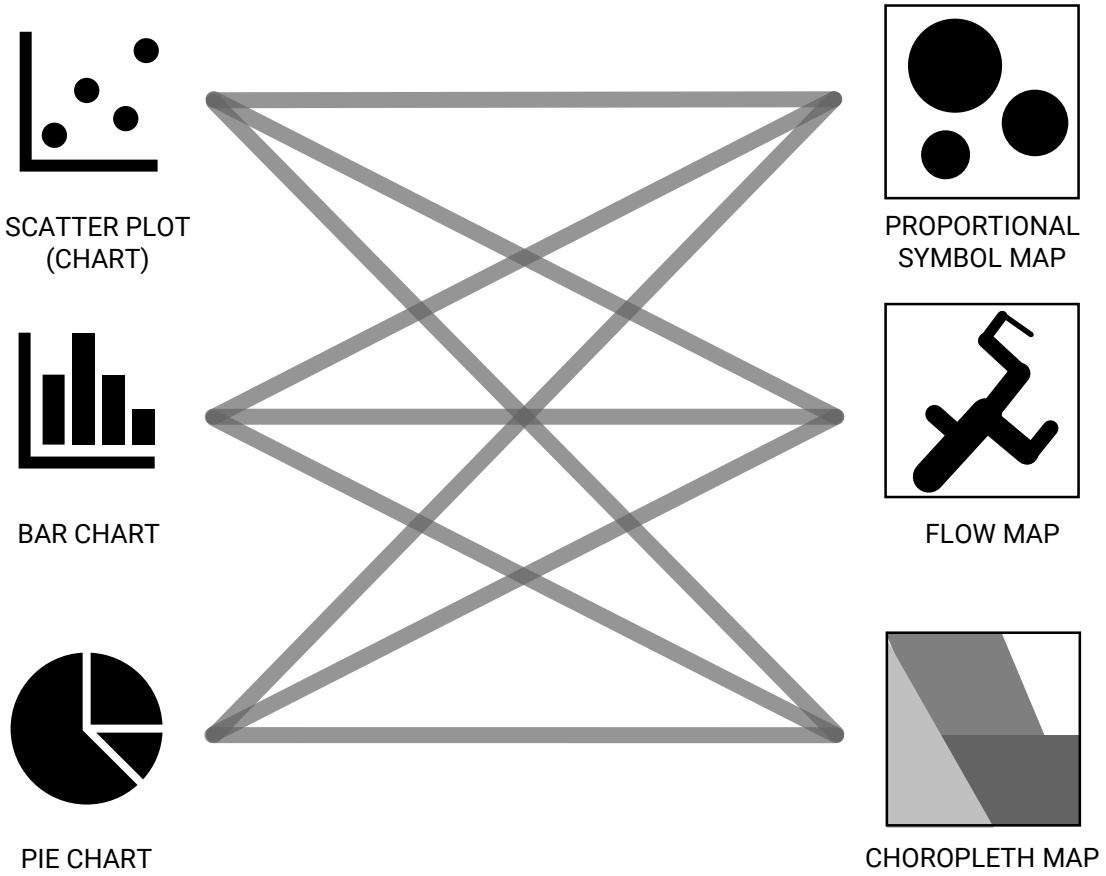
# Design of transitions between maps and charts

## Selection of maps and charts

| | PROPORTIONAL SYMBOL MAP | FLOW MAP | CHOROPLETH MAP | SCATTER PLOT | BAR CHART | PIE CHART |
|---|---|---|---|---|---|---|
| |  |  |  |  |  |  |
| *VISUAL ENCODING PRINCIPLES:* | MAPPING + SIZING | MAPPING + SIZING + CONNECTING | MAPPING + ORDERING BY GRADIENT / GROUPING BY COLOR | POSITIONING ALONG AN AXIS | SIZING | PROPORTIONAL PARTITIONING |
| *GRAPHIC COMPONENTS:* | PROPORTIONAL DOT/CIRCLE SYMBOLS | BANDS | SURFACE LOCATORS | DOT/CIRCLE SYMBOLS | BARS | PARTITIONS |
| *BASIC SPATIAL ELEMENTS:* | POINT | LINE | AREA | | | |

# Design of transitions between maps and charts

## Design of transitions




Shape tweening [3]

# Research Methodology

**Experiments**

**Experiment 1 – Object Tracking**

Tests *the effects (effectiveness) of animated transitions*
at the syntactic level of analysis

Tests 3 transition types among each other

**Experiment 2 – Determining Trends and Objects with the highest/lowest value**

Tests if *animation facilitates graphical perception of determining trends and evaluating values*
at the semantic level of analysis

Tests animated and static graphics between each other
Animated tasks contain 3 transition types

The evaluation of results is based on answers' accuracy, time spent on completing each task, and subjective preferences.

# Research Methodology

## Workflow

**1.** Selection of several designed animations and data preparation;

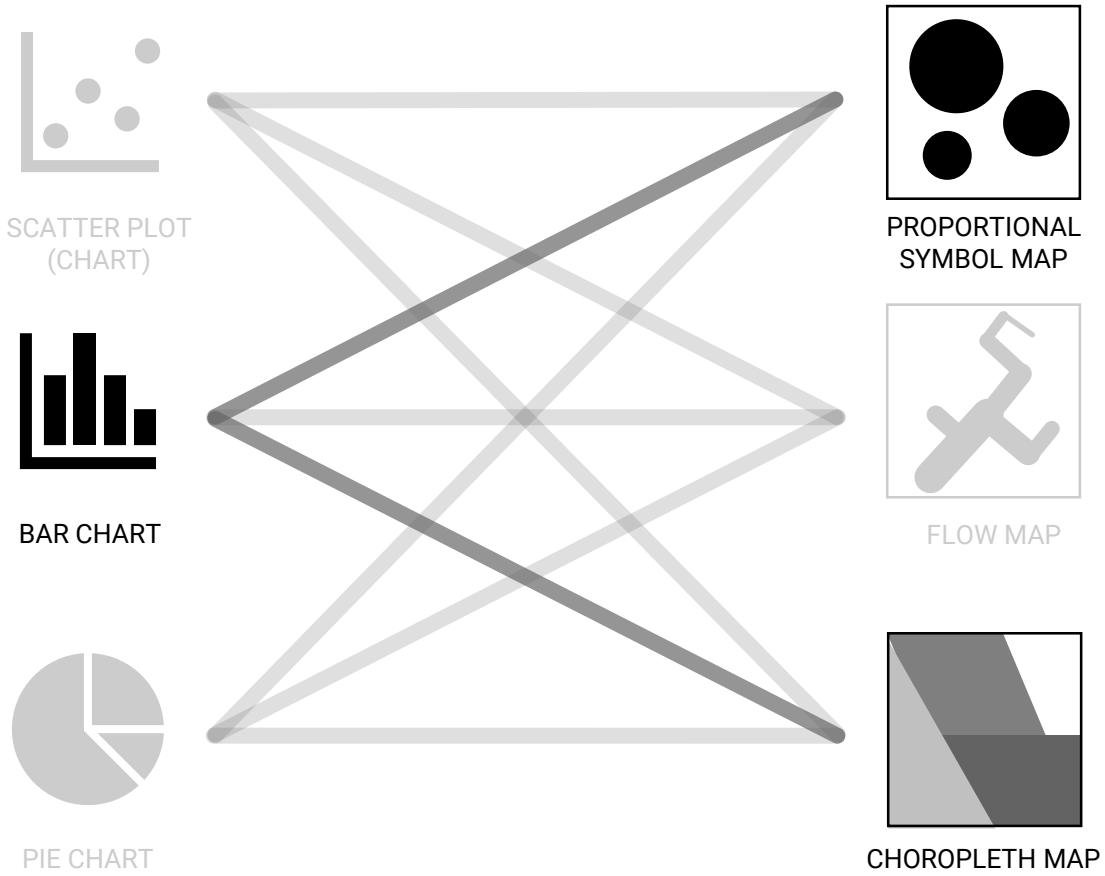
**2.** Animated transitions and experiment tasks development;

**3.** Survey implementation and results based on the:
- Correctness of the answers;
- Time of completing each task.

**4.** The analysis and interpretation of the results considering:
- The participants' qualitative responses.

# Research Methodology

## Selection of transitions for development



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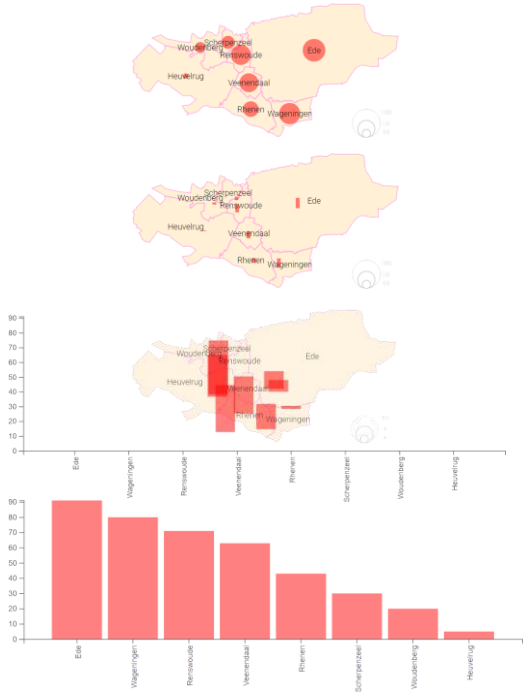
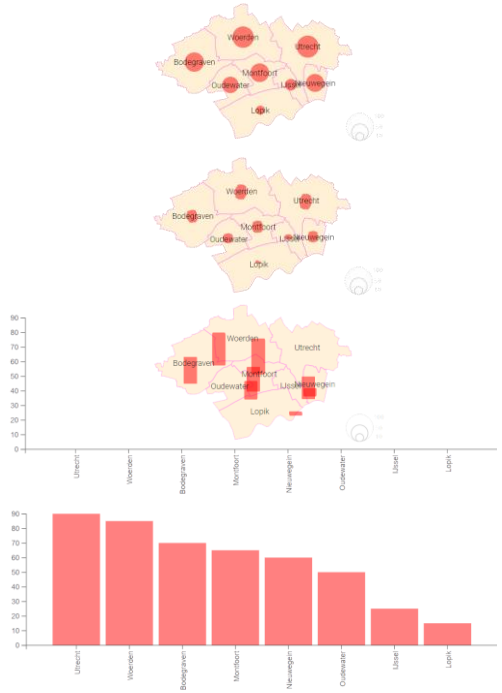
# Research Methodology

## Transitions Development

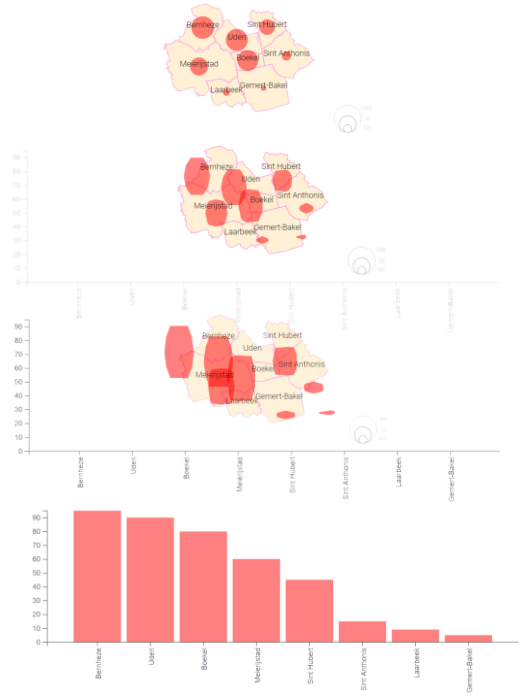
**I** Graphic components *sharply* change their shape, then smoothly interpolate their size and position (**staged**);



**II** Graphic components *smoothly* change their shape, then smoothly interpolate their size and position (**staged**);



**III** Graphic components simultaneously **tween** their shape, size, and position.



# Research Methodology

## Experiment Tasks Development

### Experiment 1 – Object Tracking

24 animated tasks:
- 3 transitions;
- 2 types of maps;
- 2 transitions orders;
- 2 levels of complexity.

Subjects were asked to follow two objects across a transition and identify the locations of the objects in the final graphic

### Experiment 2 – Determining Trends and Objects with the highest/lowest value

6 animated tasks:
- 3 transitions;
- 2 types of maps.

2 tasks with static graphics:
- 2 types of maps.

Subjects were asked to look at animated or static graphics and determine the trend or objects with the highest/lowest value. They could use animation if needed in animated tasks.

# Research Methodology

## Workflow

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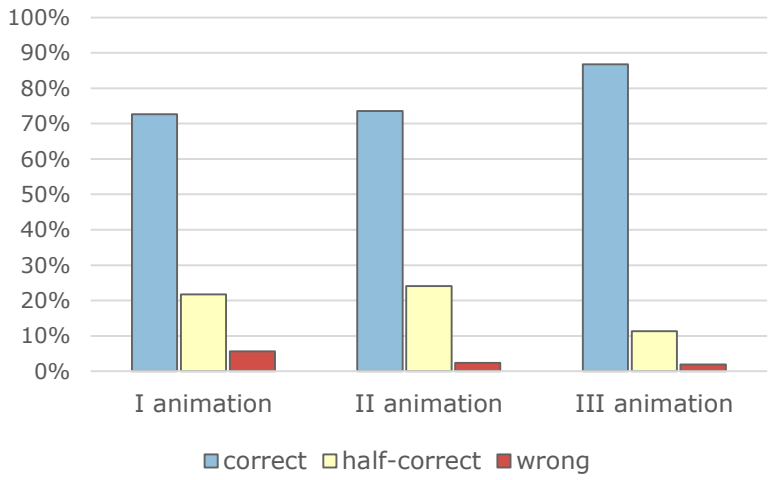
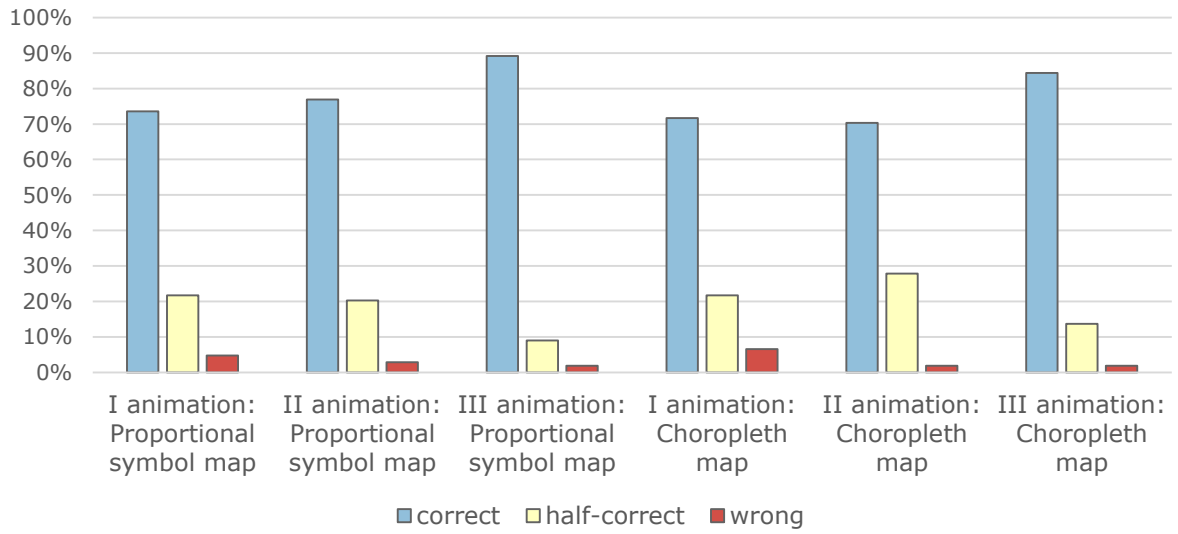
# Research Methodology

## Survey Implementation and Results – Experiment 1 (Object Tracking)

53 participants (22 female, 31 male), from 22 to 65 (M=33.5, SD=10.9)



# Research Methodology

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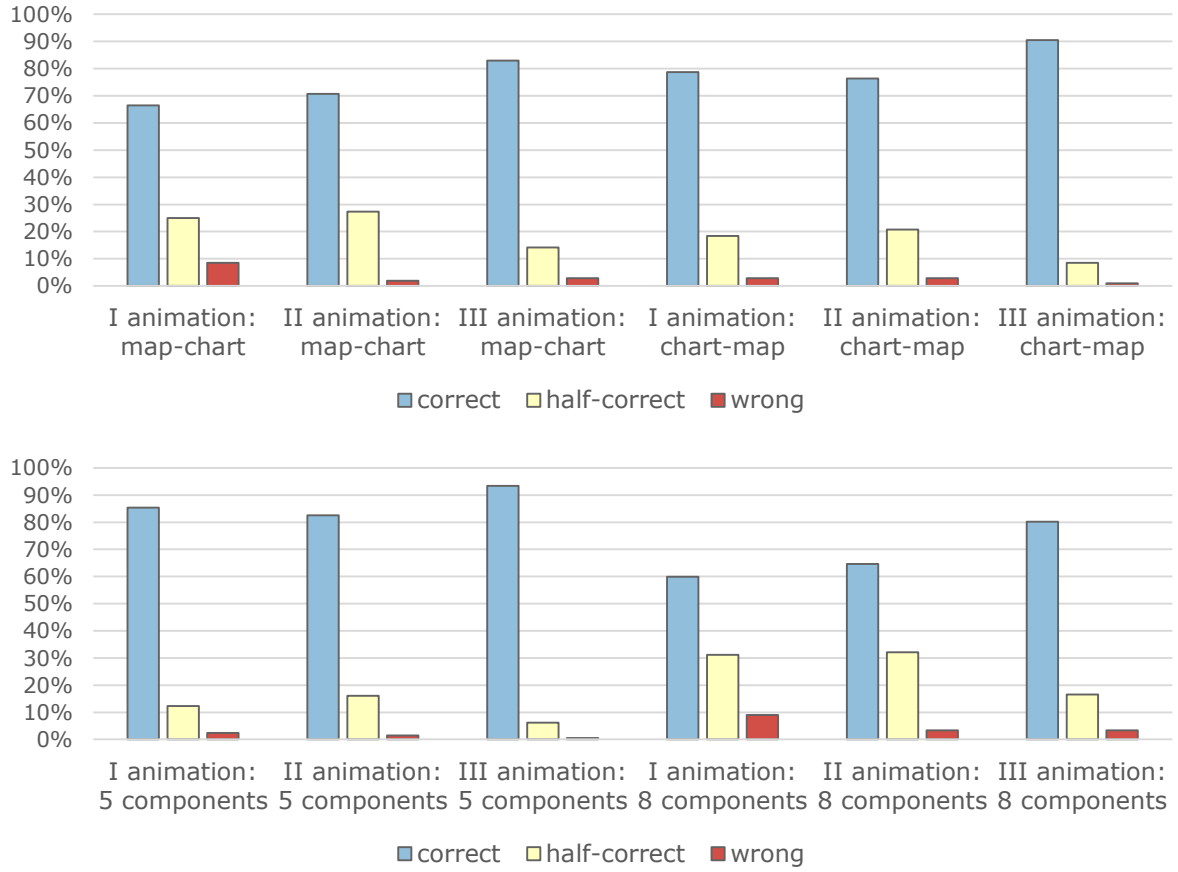
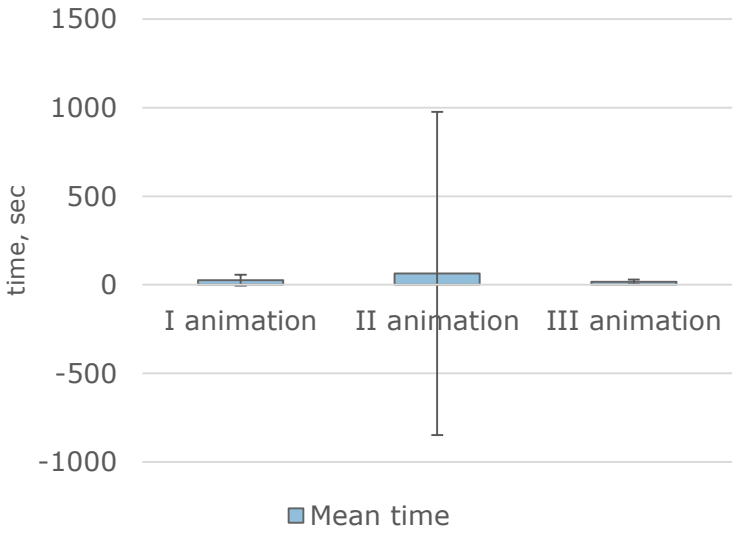
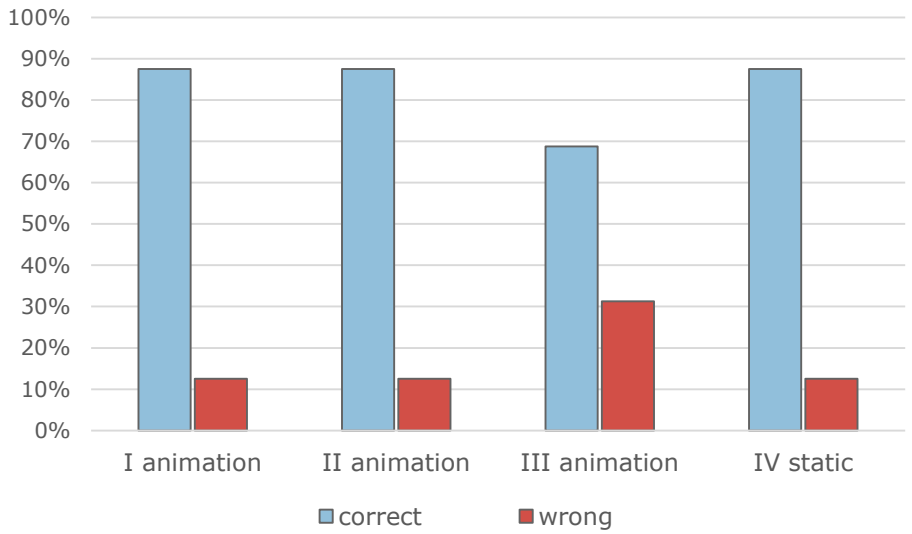


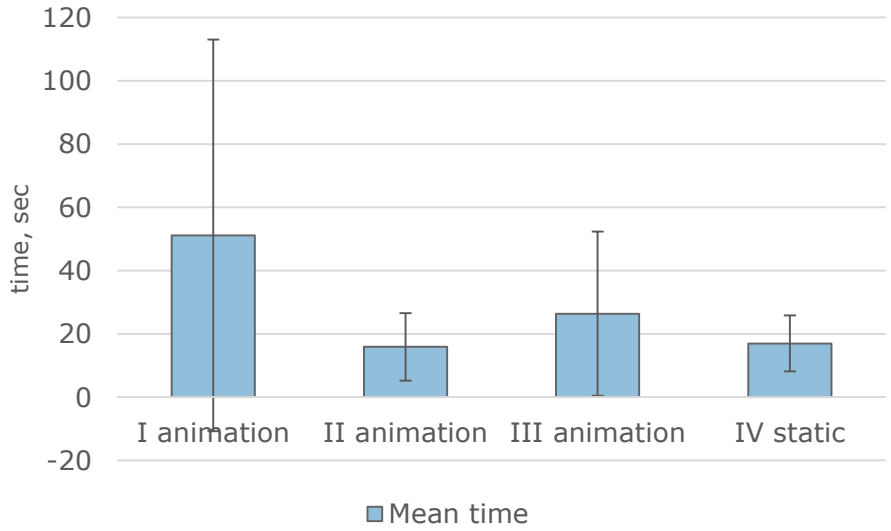



# Research Methodology

## Survey Implementation and Results – Experiment 2 (Determination of trends)

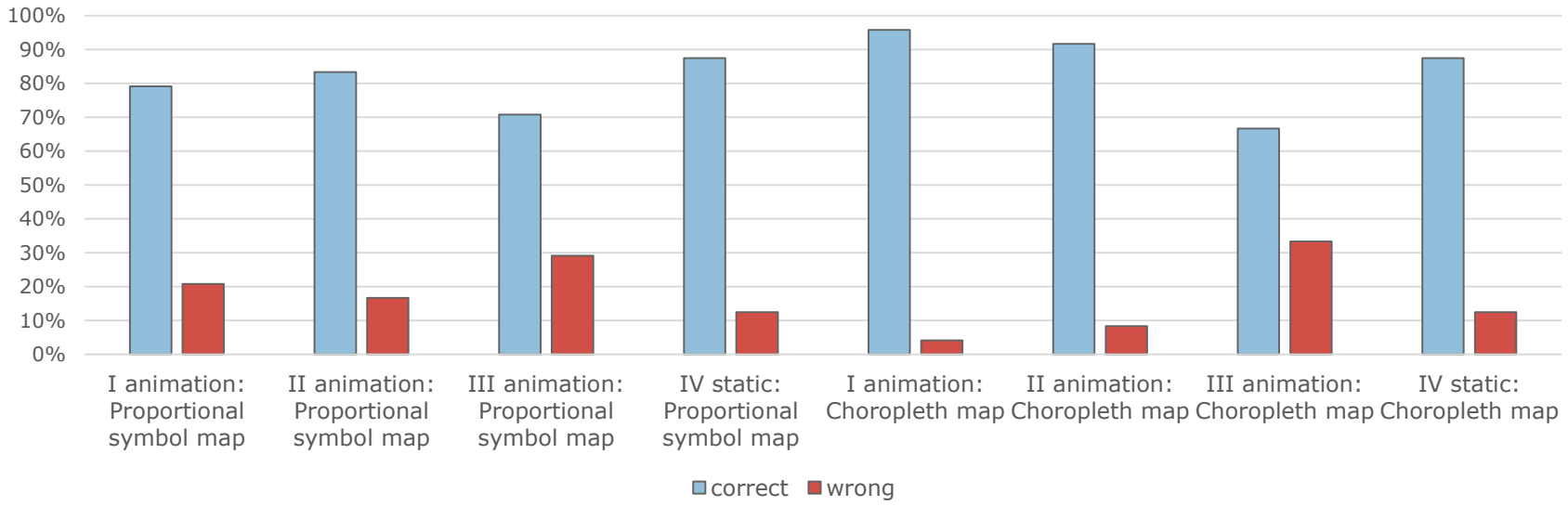
24 participants (15 female, 9 male), from 22 to 65 (M=33.5, SD=10.9)



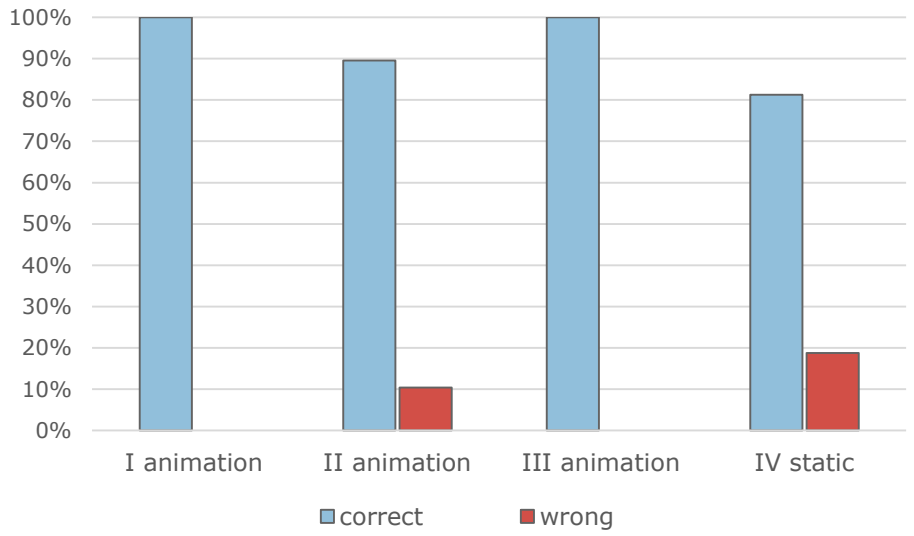
# Research Methodology

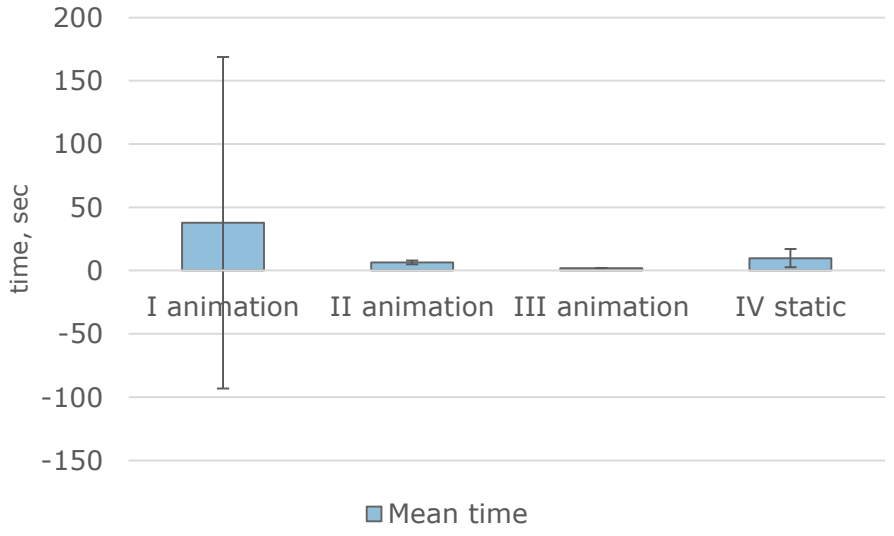
## Survey Implementation and Results – Experiment 2 (Determination of trends)



# Research Methodology

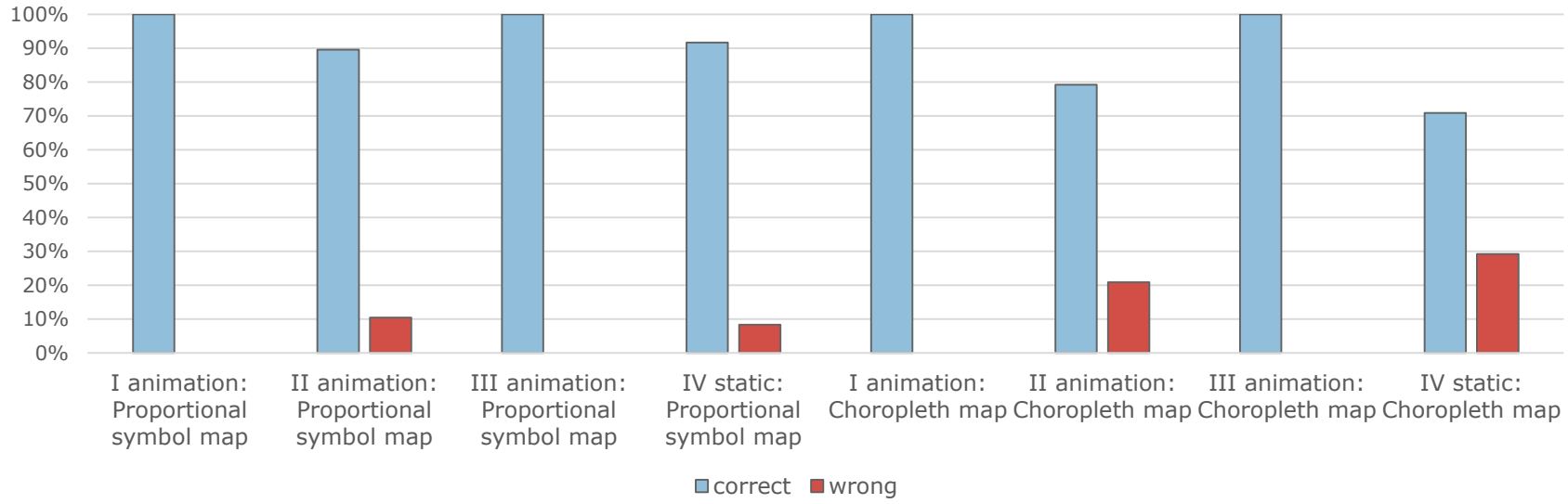
## Survey Implementation and Results – Experiment 2 (Determination of an object with the highest/lowest value)



# Research Methodology

## Survey Implementation and Results – Experiment 2 (Determination of an object with the highest/lowest value)



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# Interpretation of results

**The effects of transitions on the underlying data understanding**

- The advantages of animated graphics when identifying objects with the highest/lowest value. Possible reasons:
    1) Transitions;
    2) A single-view bar chart;
- No influence of animation when determining trends;

# Interpretation of results

**The effects of transitions on a map reader's perception**

- Tweening technique is more effective than staging for object tracking (syntactic level of analysis);
- Participants preferred tweening to staging techniques;
- Tasks with proportional symbol maps performed better than choropleth;
- Charts to Maps transitions generally had a higher rate of correct answers, but were less preferred by participants;
- The less number of animated objects, the better results.

# Conclusions

**Q1** What are the possible ways to transition between statistical maps and charts?

There are 9 possible animated transitions between 3 types of maps and 3 types of charts.

**Q2** How do animated transitions affect the map reader's perception?

**Q3** Does the change in perception improve the understanding of patterns, trends or relationships in statistical data?

*Objects tracking:* tweening outperforms staging;

*Determining trends:* no animation effects;

*Identifying objects' values:* animation improves understanding of statistical data.

# Outlook

- Develop and test the other 7 designed transitions;
- Analyze animation effects on understanding of patterns and relationships;
- See whether there is a difference between identifying the object with the highest/lowest value and determining the object value;
- Refine transitions in tasks determining trends;
- Implement other animation techniques and parameters;
- Design possible transitions with other graphics;
- Study whether transitions between spatial and non-spatial statistical graphics should be designed differently compared to those designed only between non-spatial representations

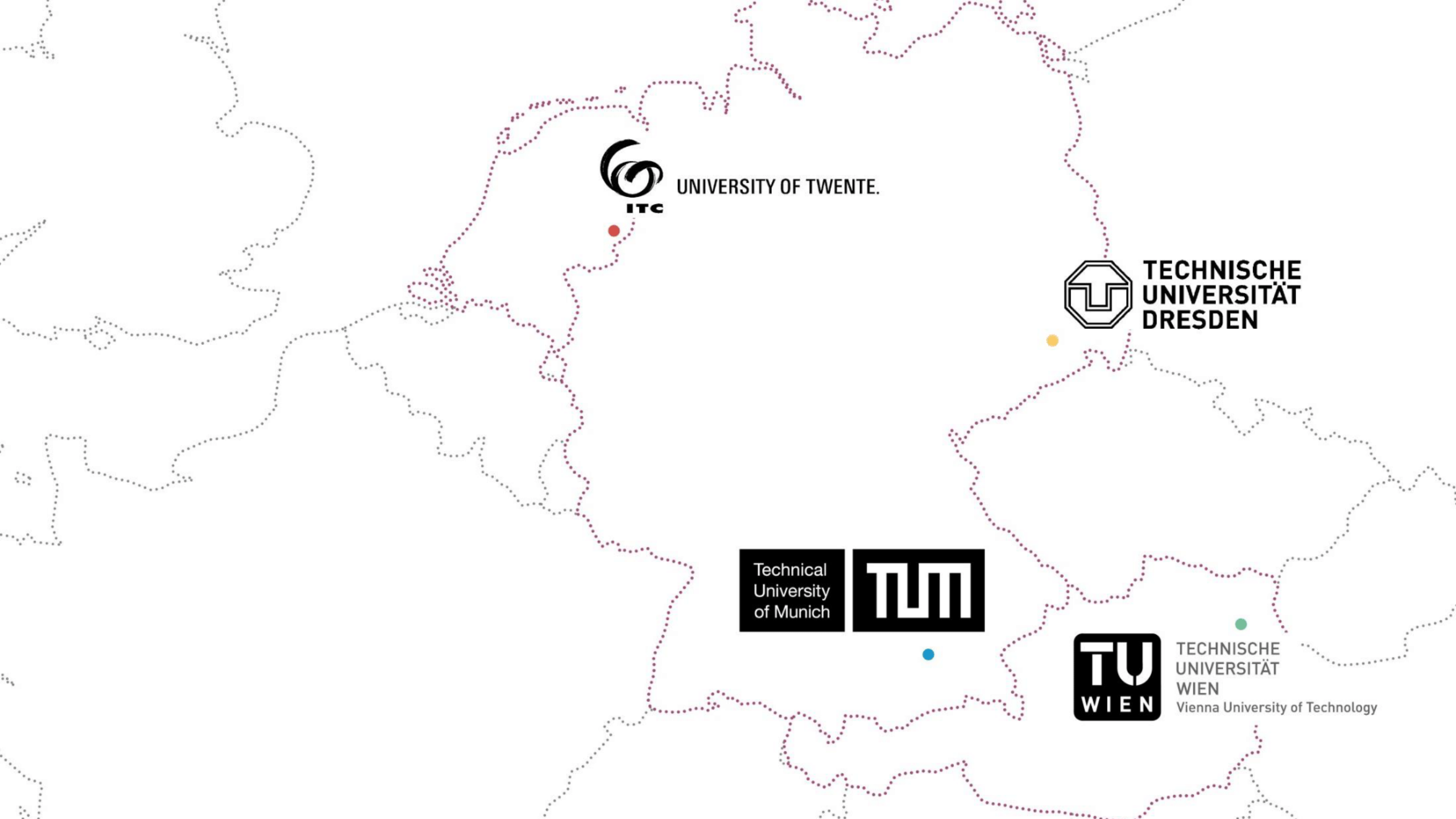
Thank you for your attention!

# References

[1] Engelhardt, Y., & Richards, C. (2018). A framework for analyzing and designing diagrams and graphics. In P. Chapman, G. Stapleton, A. Moktefi, S. Perez-Kriz, & F. Bellucci (Eds.), *Diagrammatic representation and inference* (pp. 201–209). Cham: Springer International Publishing.

[2] Kraak, M.-J, & Ormeling, F. (2013). *Cartography: Visualization of spatial data* (3rd ed.). USA: CRC Press.

[3] Bostock, M. (2019). *Shape Tweening*. https://bl.ocks.org/mbostock/3081153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