



# Cartography M.Sc.

## Visualisation of Collective Spatial Keyword Queries and their Usability

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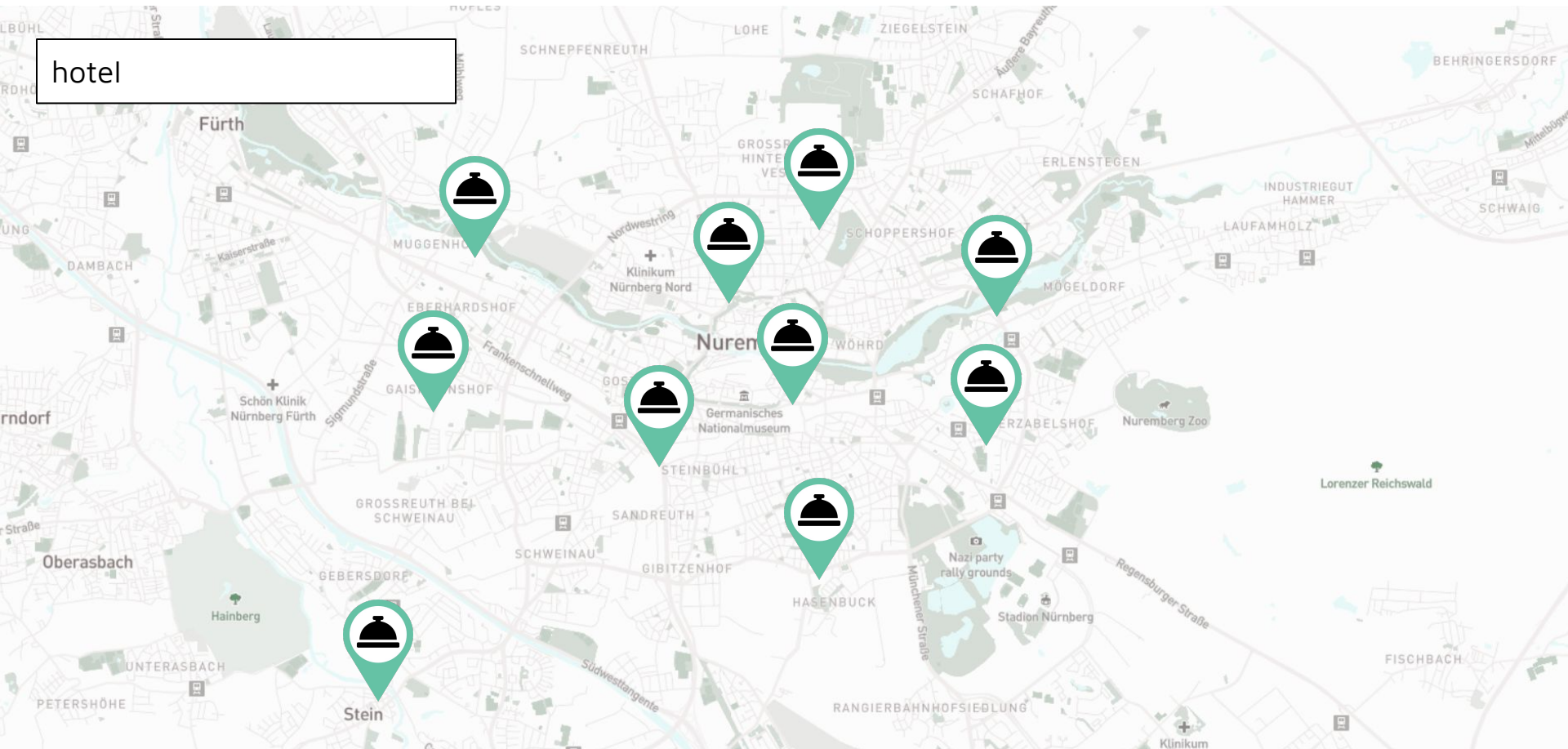
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# Background

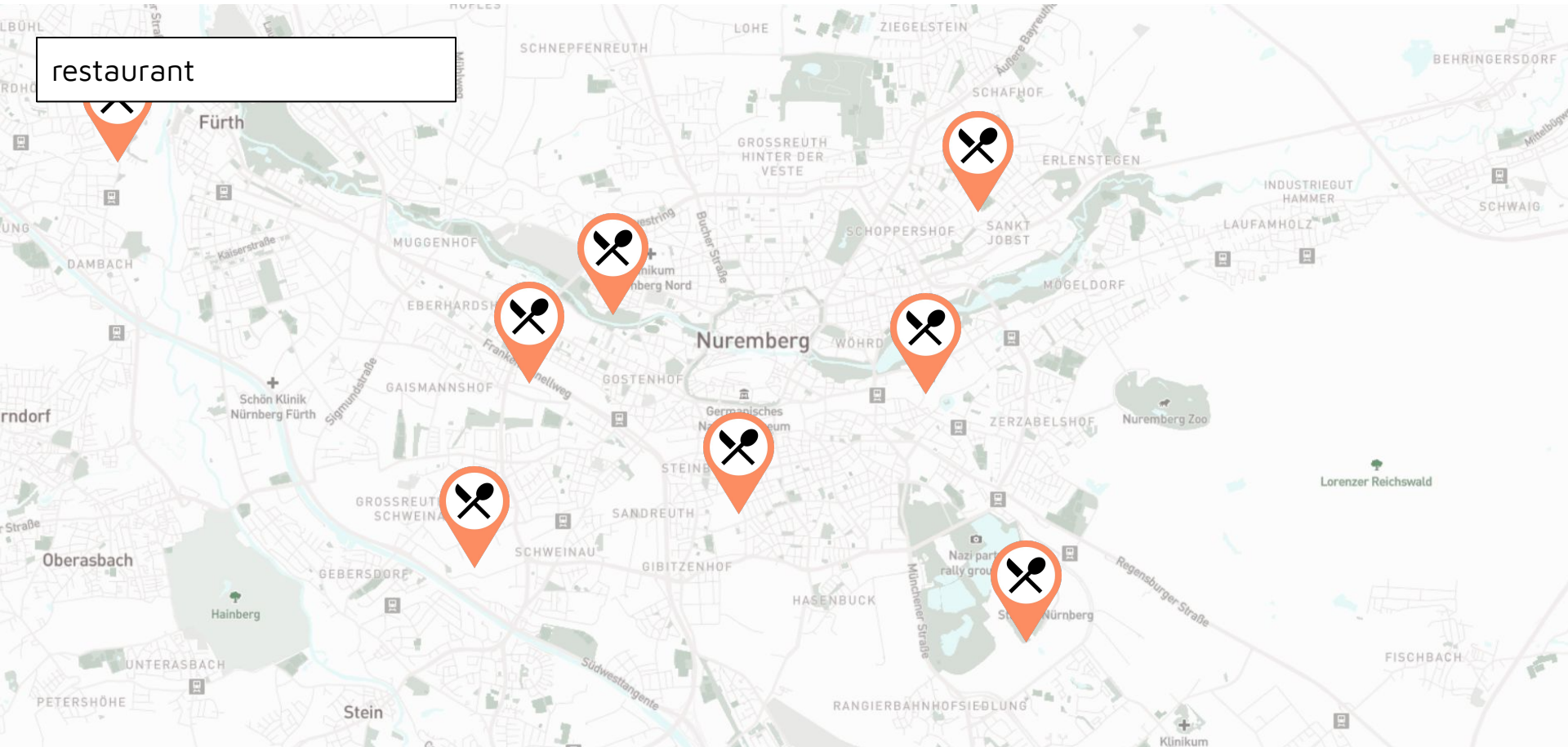
# What is a **collective spatial keyword query**?



# Standard Query



# Standard Query

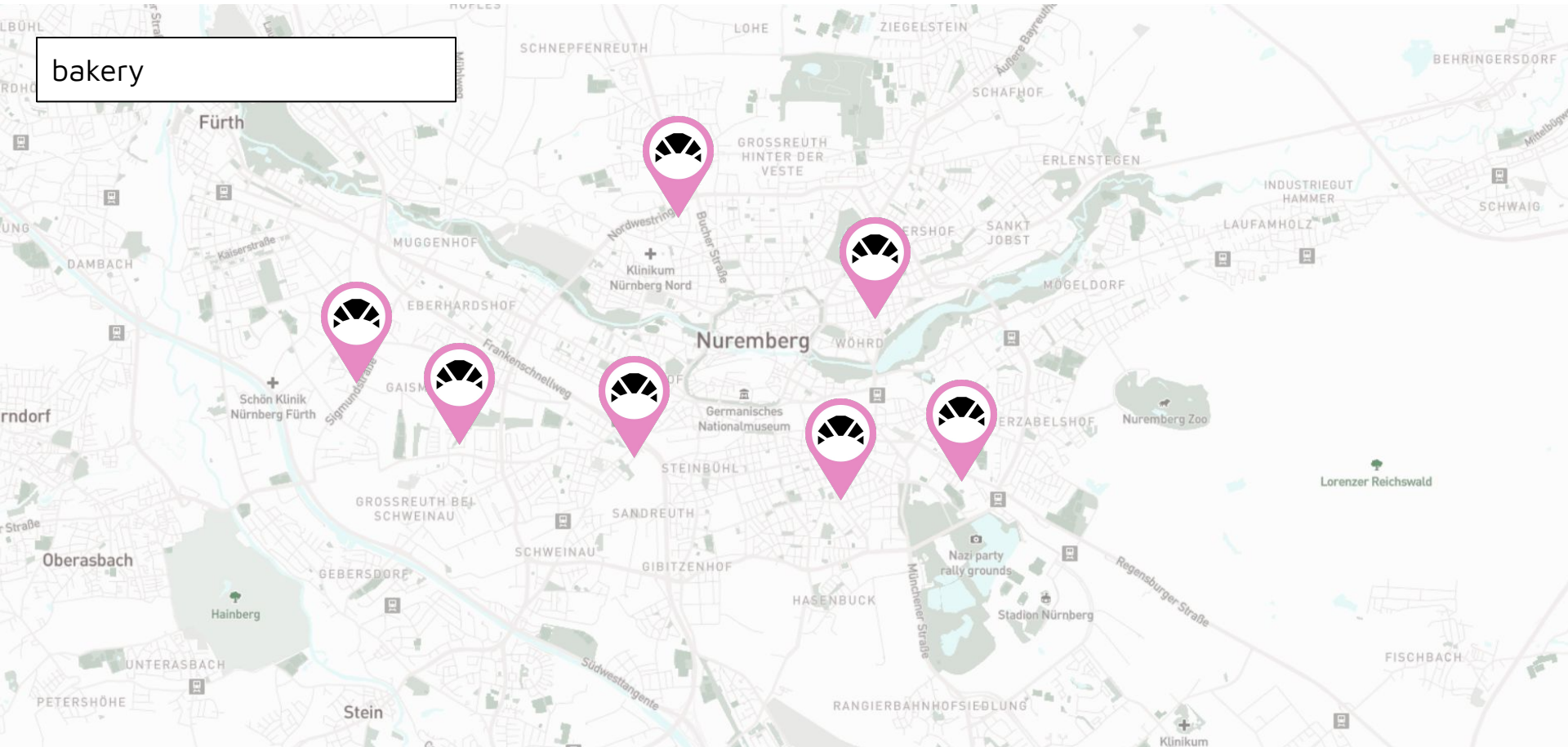




# Standard Query



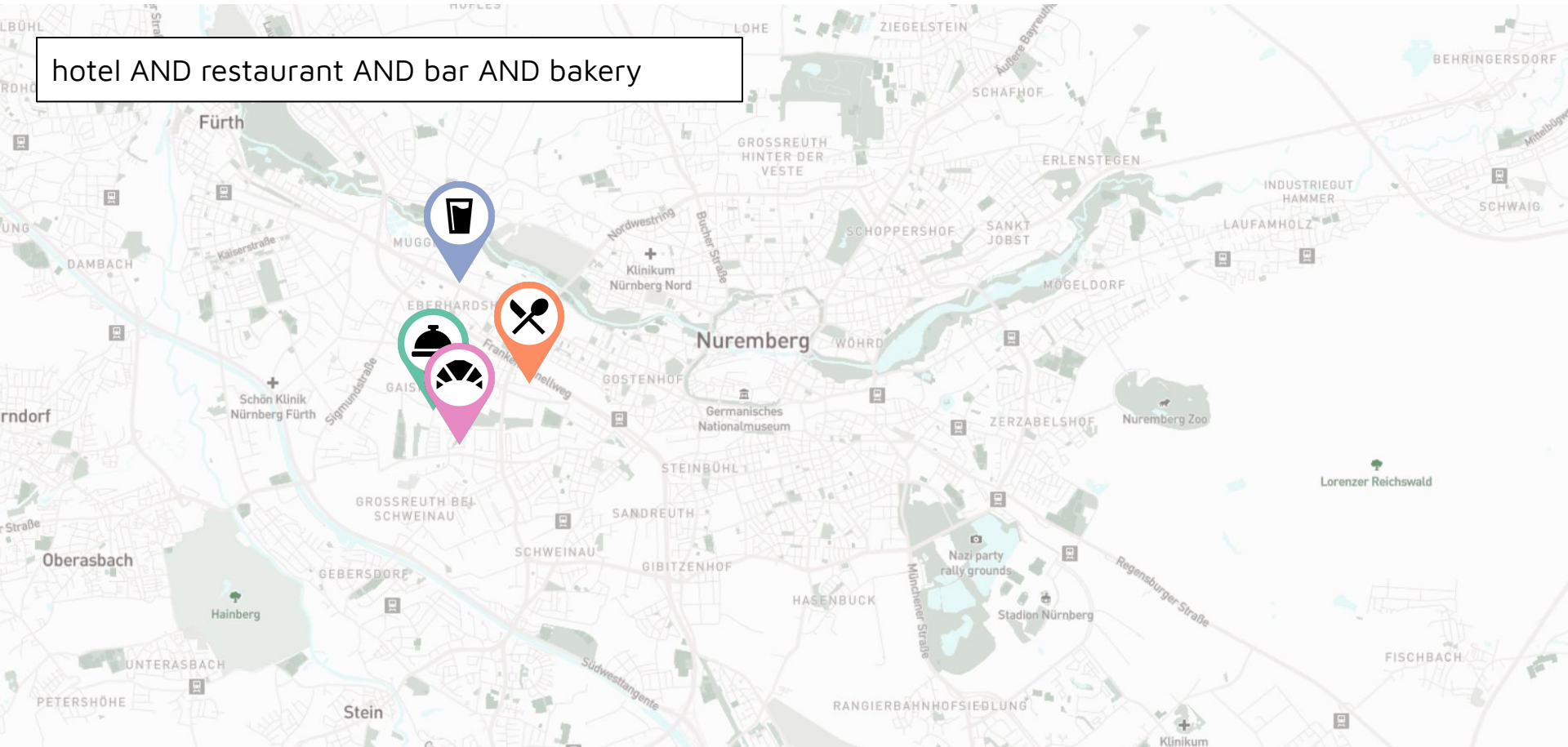
# Standard Query



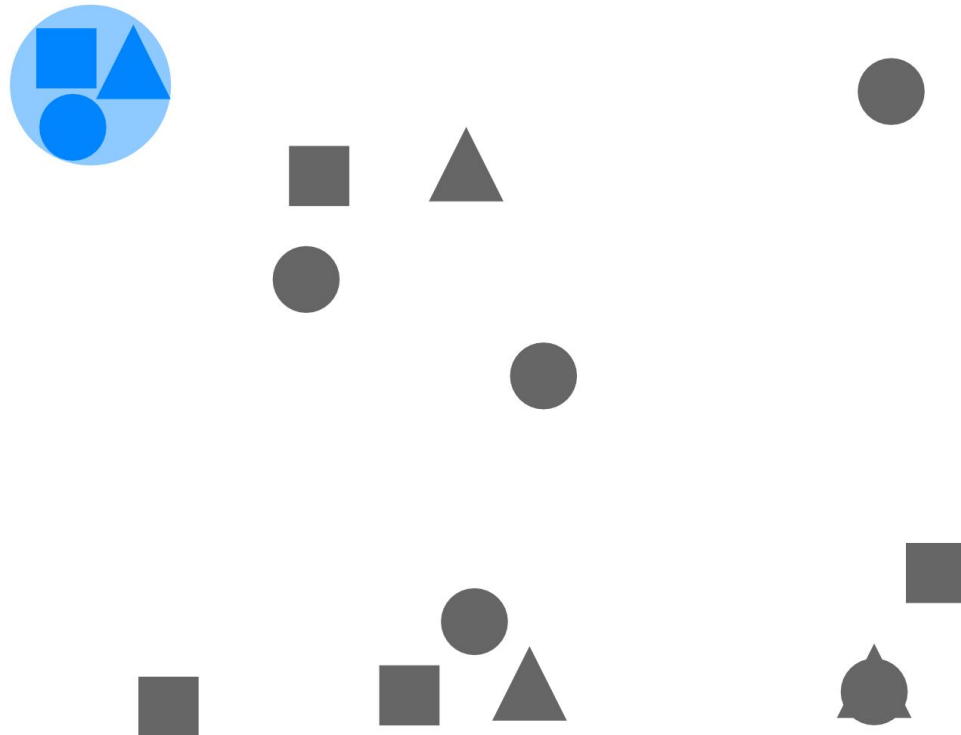


# Collective Query

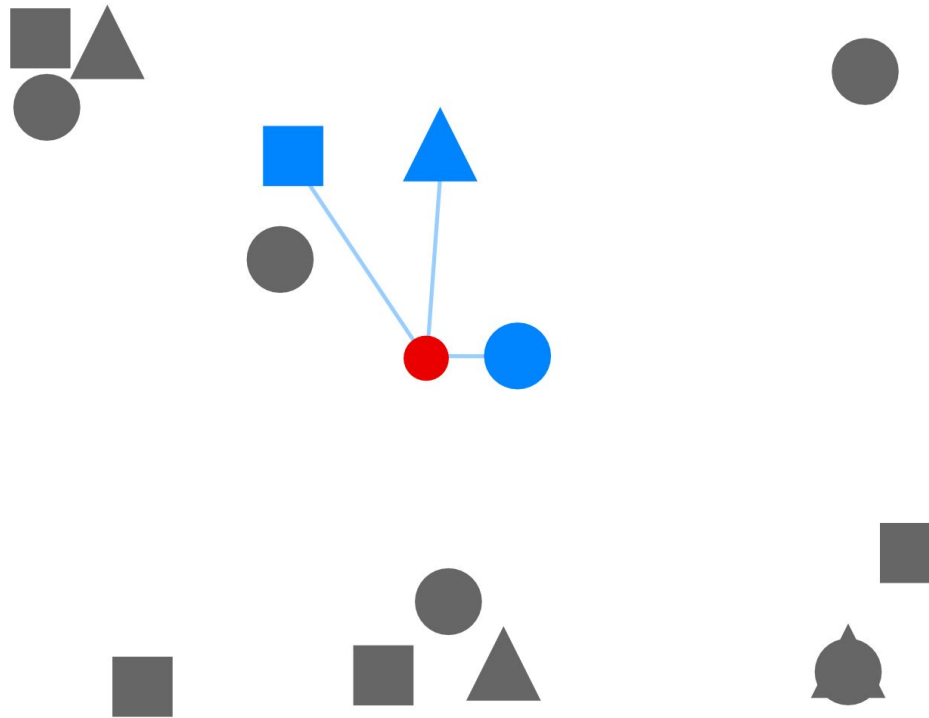
hotel AND restaurant AND bar AND bakery



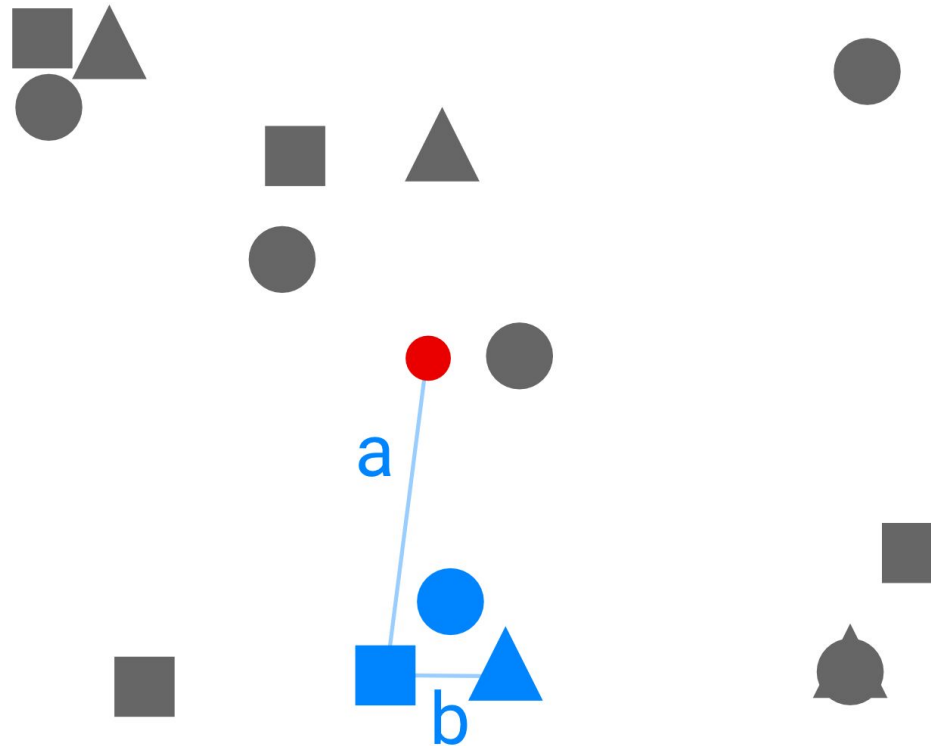
# mSKQ



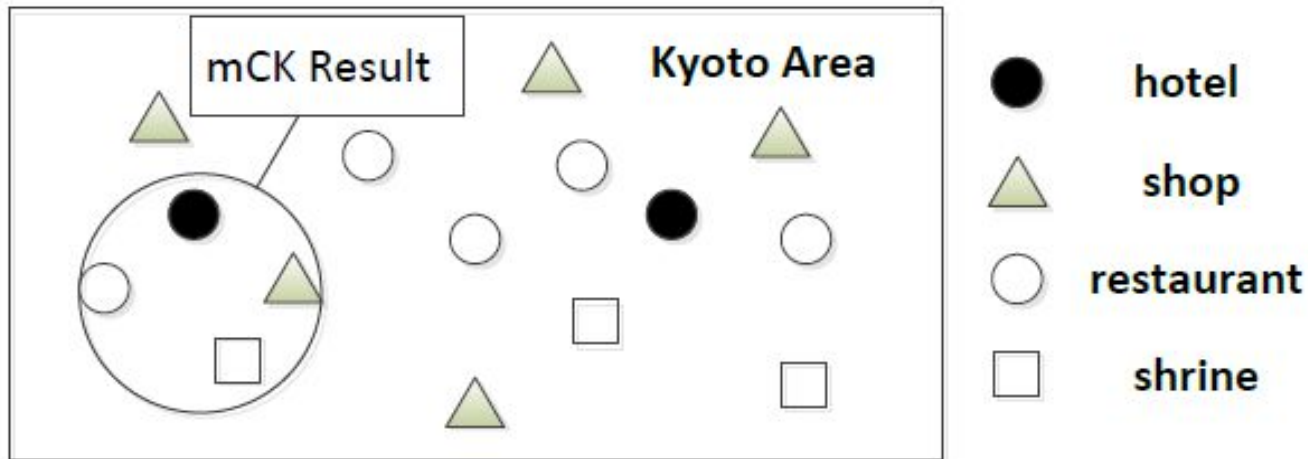
# Type 1 SGK Query



# Type 2 SGK Query



# Visualisation of Collective Queries



T. Guo, X. Cao, and G. Cong, 'Efficient Algorithms for Answering the m-Closest Keywords Query', in *Proceedings of the 2015 ACM SIGMOD International Conference on Management of Data - SIGMOD '15*, Melbourne, Victoria, Australia, 2015, pp. 405–418, doi: [10.1145/2723372.2723723](https://doi.org/10.1145/2723372.2723723)



# Research Objectives

**Objective 1:** Creation of a visual concept for simultaneously searching Pols of different categories

**Objective 2:** Creation of a visual concept for displaying the results of collective spatial keyword queries on a map

**Objective 3:** Evaluation of the concepts

**RQ1:** How can a visual concept for searching multiple Pols simultaneously look and behave?

- how does ordering of keywords affect a query result?
- which UI elements are necessary to enable collective search?

**RQ2:** How can a visual concept for displaying results of collective queries look and behave?

- what information needs to be represented visually in a result?
- how can a collective query with multiple results be visualised on a map?
- how can routing information be integrated into the visualisation?

**RQ3:** Is a system that supports collective queries superior in terms of usability to current commercial systems?

- is the visual representation an improvement in terms of usability?
- are there misunderstandings in the semantics of the system?
- is the system actually useful?



# Hypothesis

The technique of collective querying has advantages in terms of usability and usefulness over the current commercial state of the art in certain scenarios.

# Methodology

## TYPE2a SGK Query

- separates the first keyword and treats it as a “center point”
- all other keywords are searched in the vicinity of the found center points
- every center point around the query location yields a result
- keyword order matters!



# Visual Concept

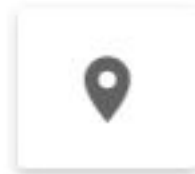
- three UI elements:
  - search bar with autocomplete feature





# Visual Concept

- three UI elements:
  - search bar with autocomplete feature
  - query location button



# Visual Concept

- three UI elements:
  - search bar with autocomplete feature
  - query location button
  - map component



# Visual Concept

- three UI elements:
  - search bar with autocomplete feature
  - query location button
  - map component

**⇒ Research Objective 1**

# Map Markers for Collective Queries

- Problem: Clutter in lower zoom levels
- Generalisation as anti-clutter mechanism
- Typification as generalisation method

# Combined Markers

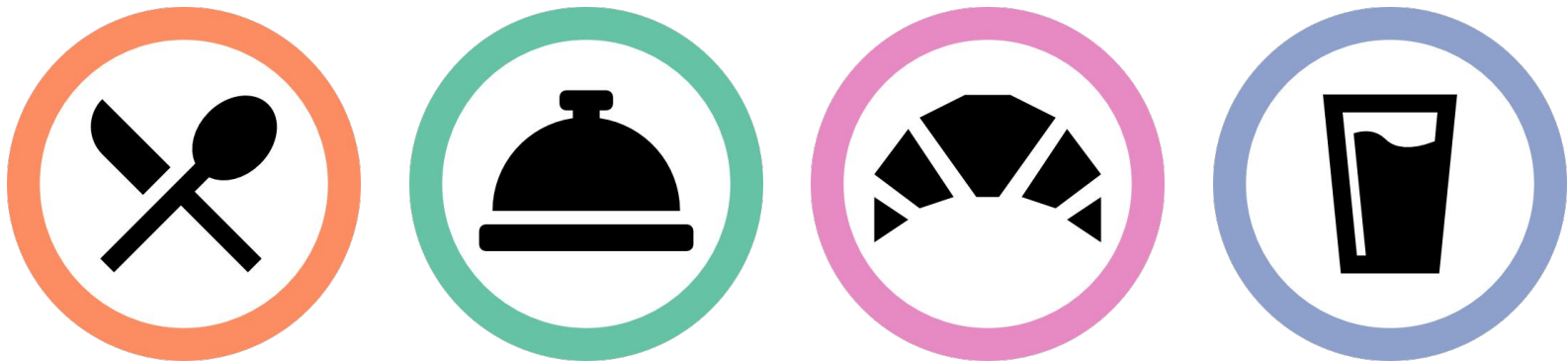
- center point semantic
- visual variables (colour, size, orientation) for higher level information





# Visual Variables for Combined Markers

- colour (and icon) for categorical membership, corresponding with search bar



# Visual Variables for Combined Markers

- colour (and icon) for categorical membership, corresponding with search bar
- size for fitness of the result



# Visual Variables for Combined Markers

- colour
- size
- orientation for direction in the map plane

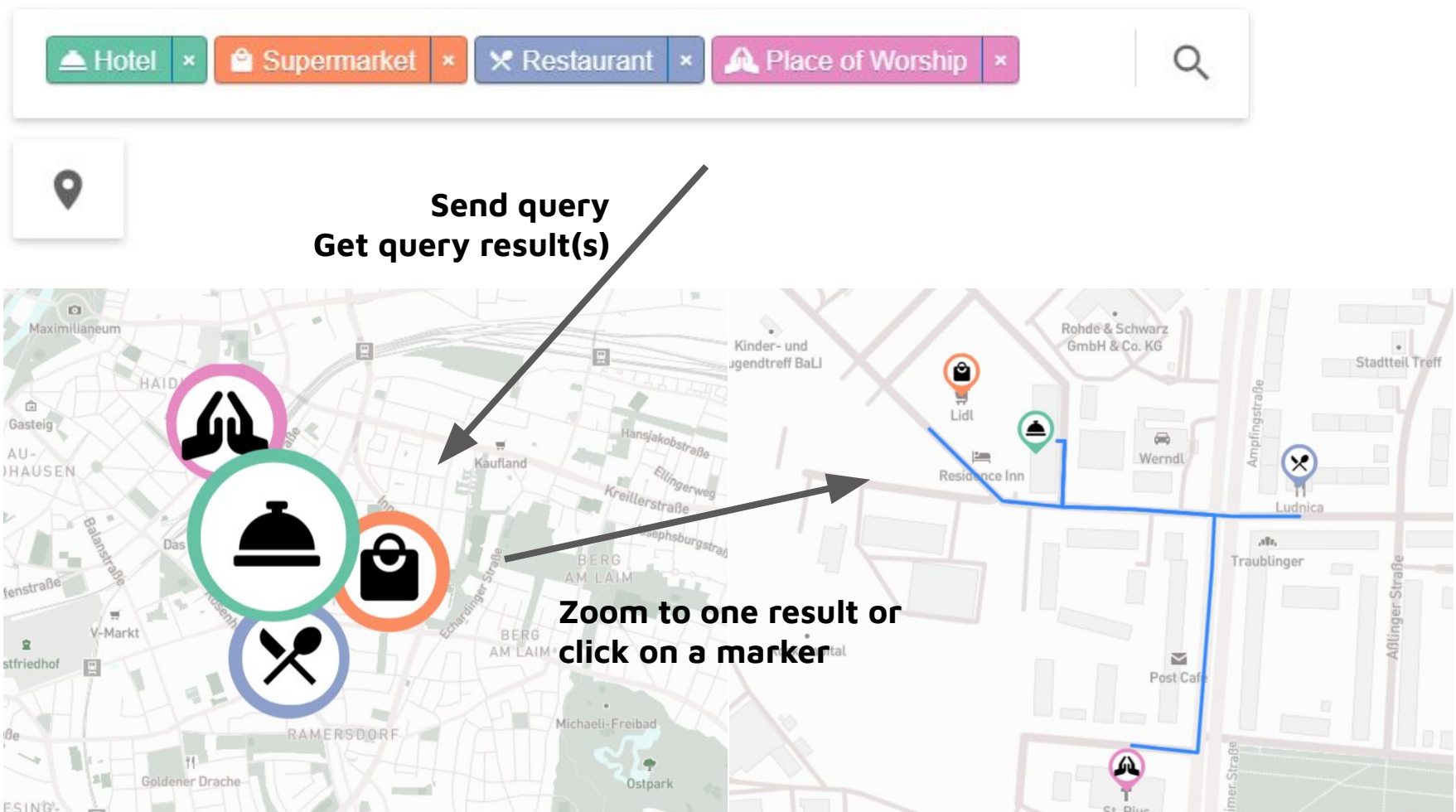


# Individual Markers

- for higher zoom levels
- no clutter reduction
- routing



# Workflow



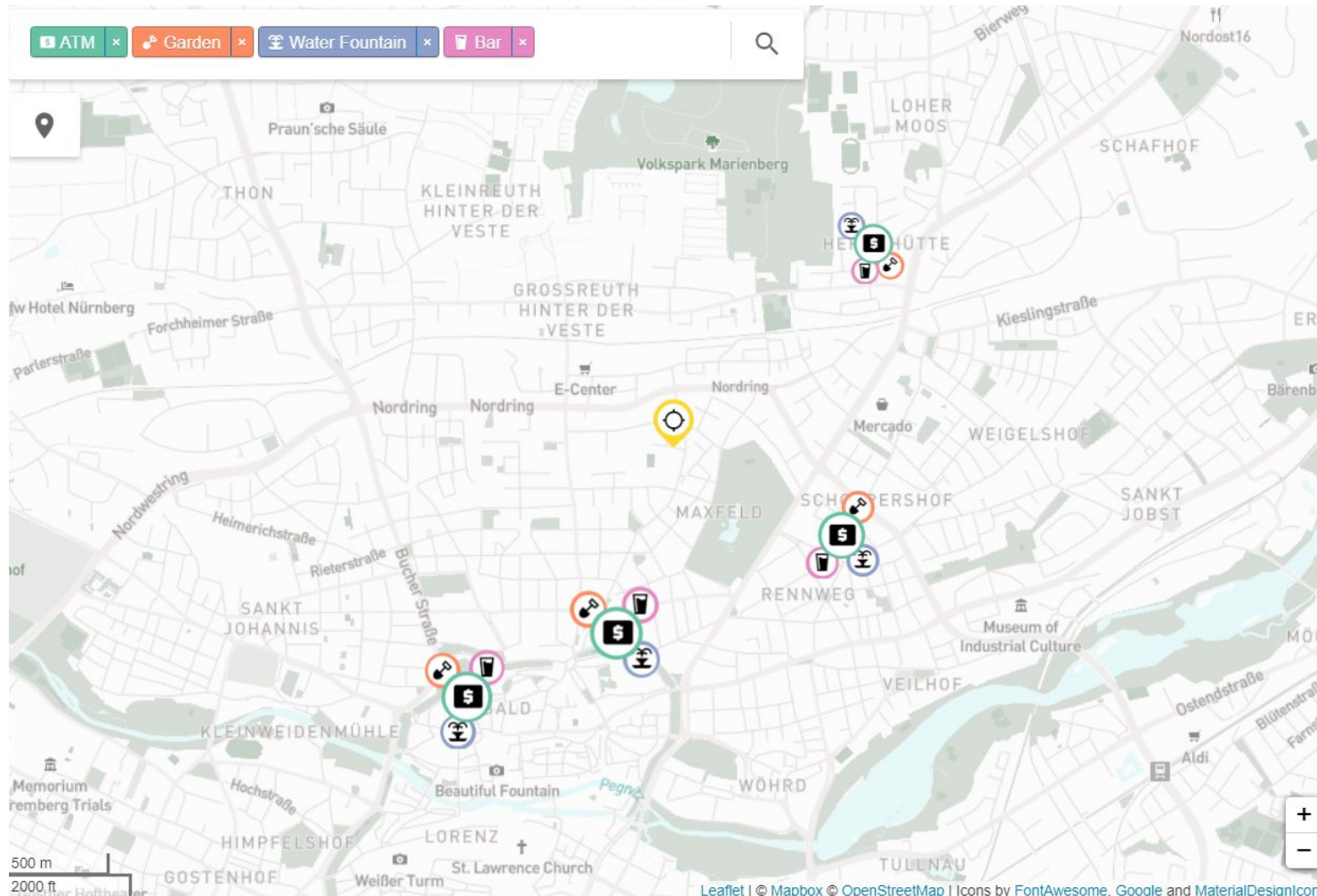
⇒ Research Objective 2

# Case Study

# Prototype

- CoSKQVis (Collective Spatial Keyword Query Visualisation)
- web-based browser application
- geodatabase with small API
- about 300 000 Pols in over 100 categories
- OpenStreetMap data
- routing with OSRM

# Prototype





# User Test

- comparative user study with Google Maps
- participants had to solve a task where they needed to find a result consisting of five Pols (hotel, bank, playground, cinema, zoo)
- user group: advanced web map / navigation users

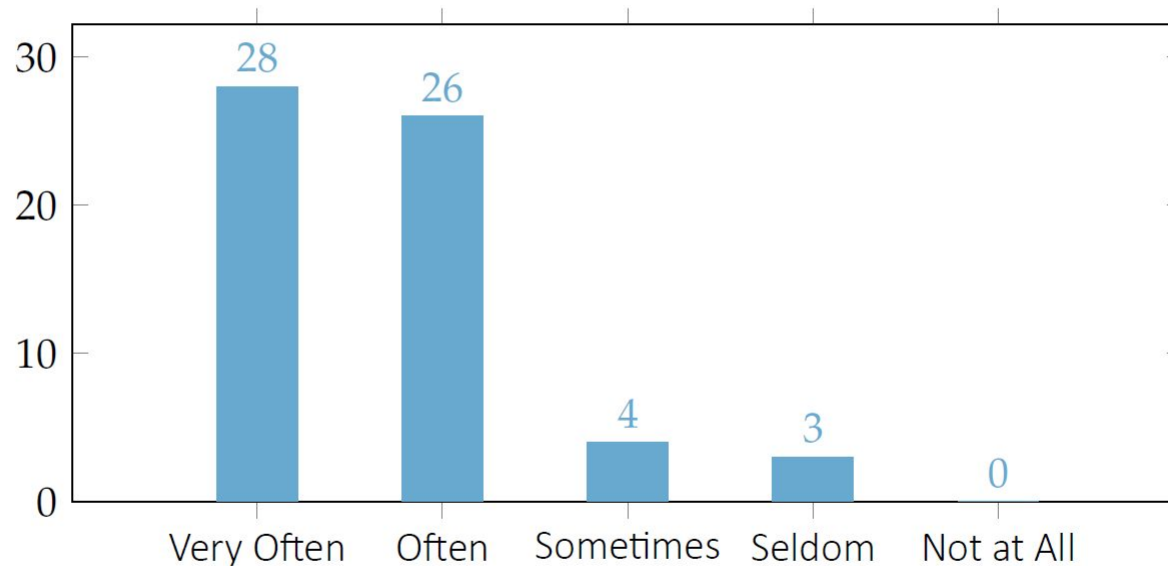
# User Test

- testing for efficiency, learnability, accuracy, subjective satisfaction, ease of usage
- usefulness of the technique
- usage of visual variables

# Results

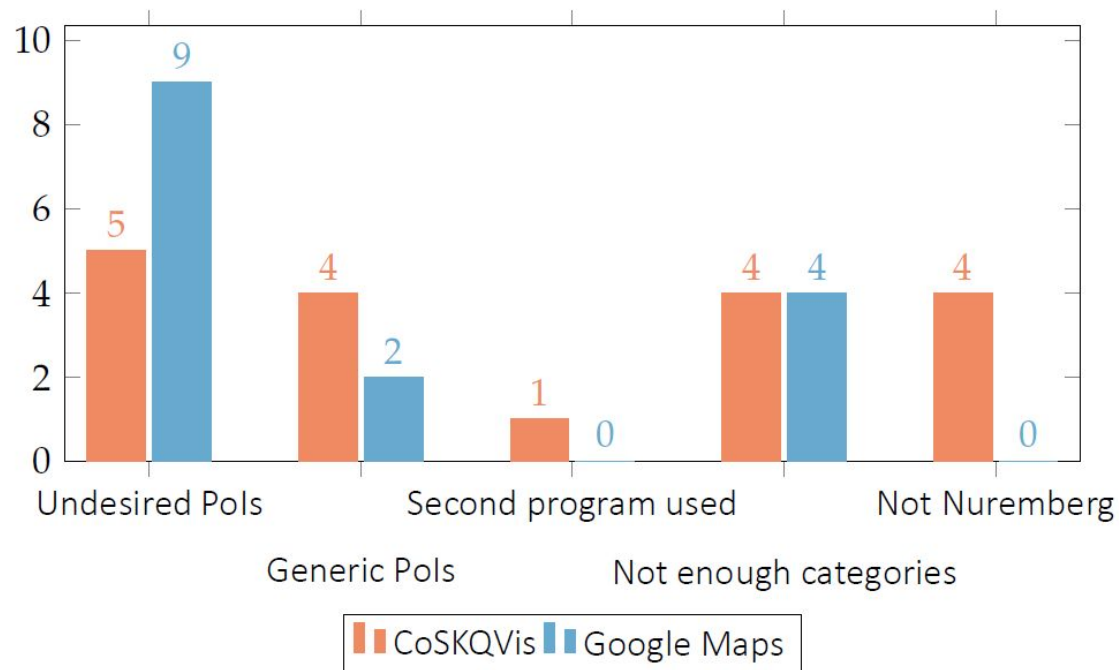
# Participation

- 61 participants  
(32 for CoSKQVis, 29 for Google Maps)
- Heavy users of web mapping products

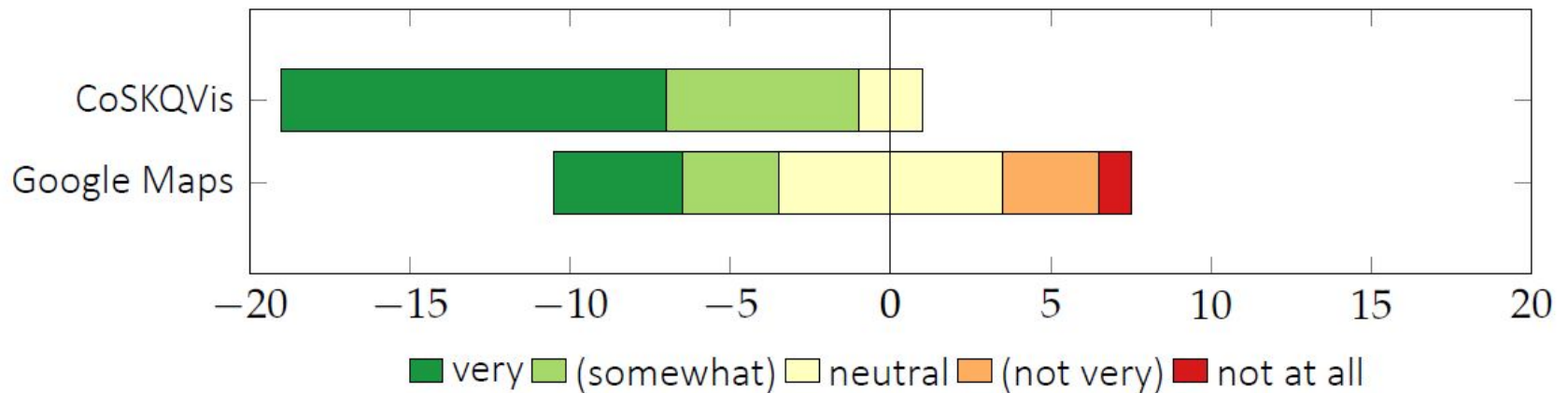


# Task Completion

- only 38 usable results
- different types of errors



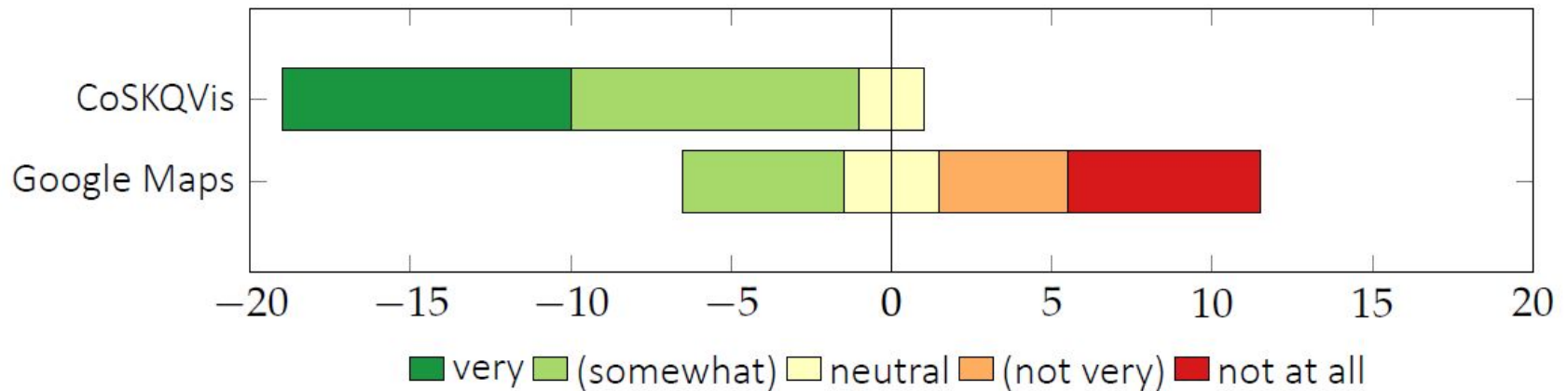
# Ease of Use



Distribution of answers for Q10:

**How easy was the process to find a set of Pols?**

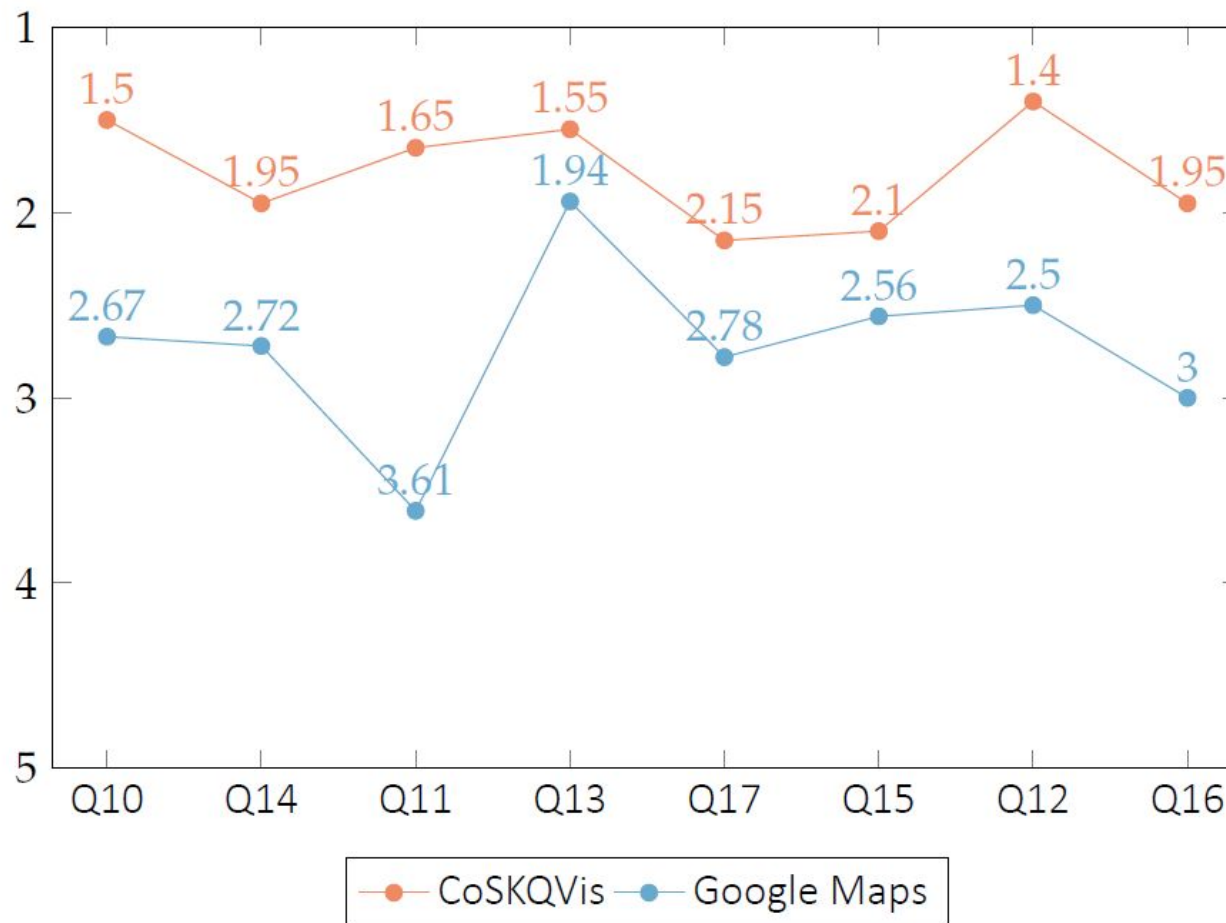
# Efficiency



Distribution of answers for Q11:

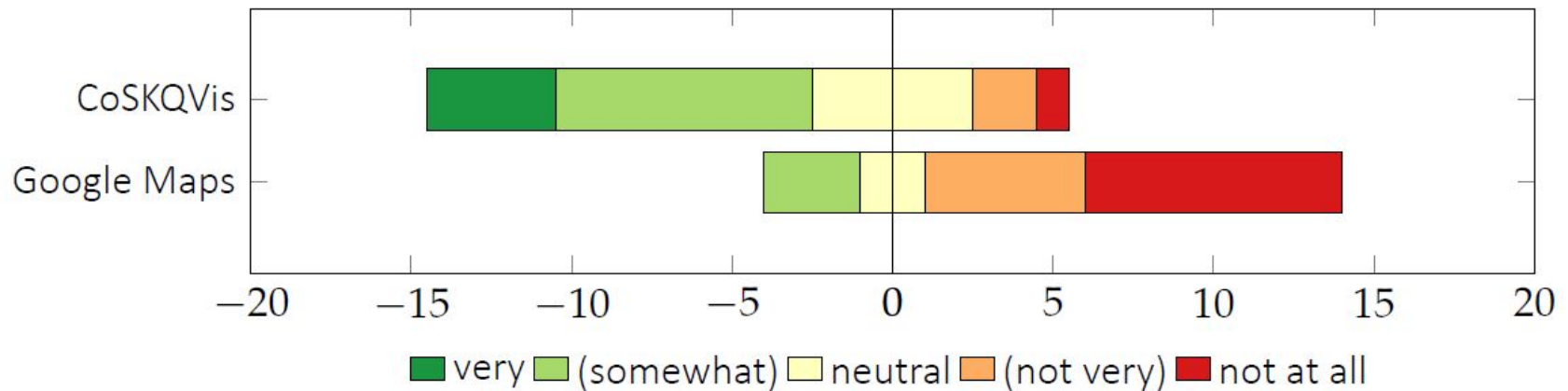
**How efficient was the process to find a set of Pols?**

# Overall results





# Confidence in Found Set



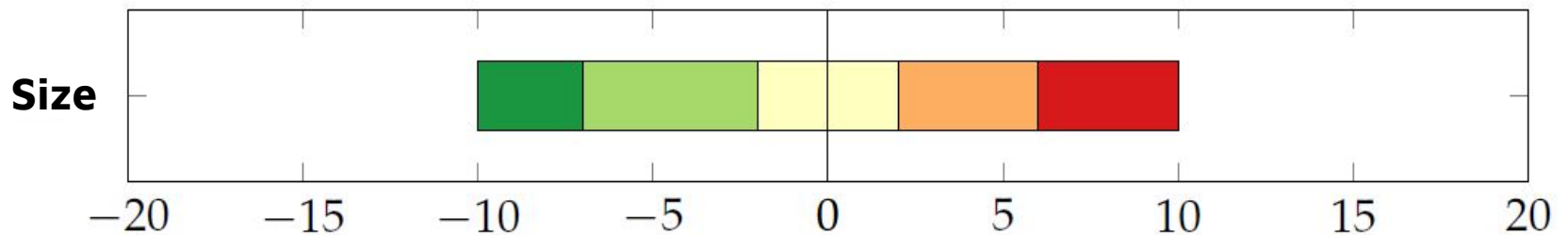
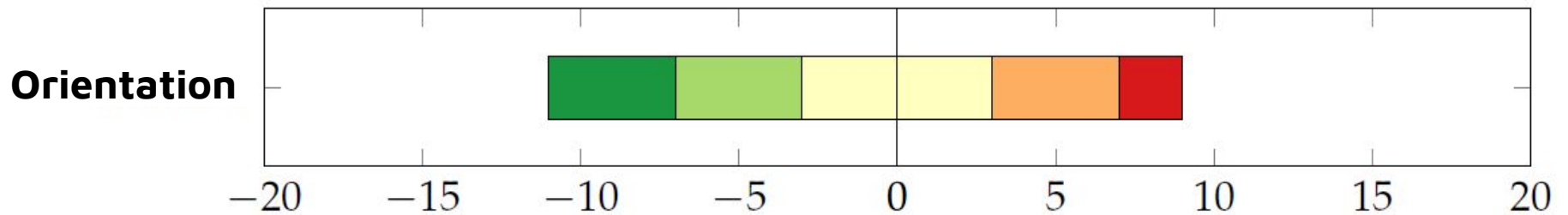
Distribution of answers for Q18:

**How confident are you that you found the selection of Pols that has the smallest distances between each other?**

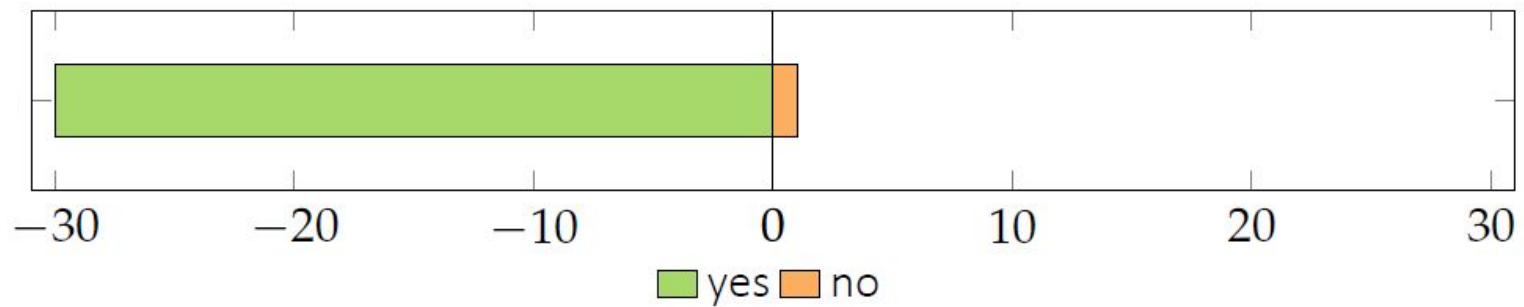
## Accuracy / Errors

- more guidance wished
- no location search
- number of results sometimes too low
- significance of keyword ordering unclear
- query location marker confusing

# Visual Variables



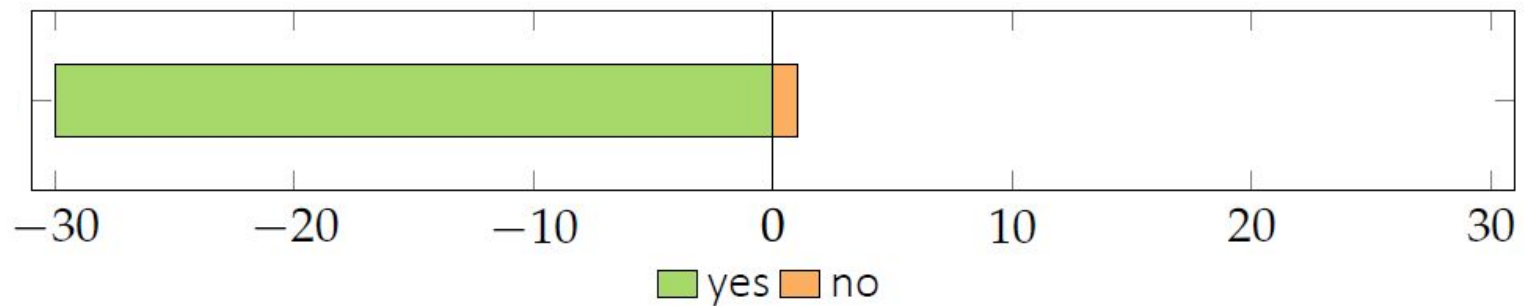
# Usefulness



Distribution of answers for Q24:

**Do you think that this kind of search may be useful for certain tasks?**

# Usefulness



Distribution of answers for Q24:

**Do you think that this kind of search may be useful for certain tasks?**

**⇒ Research Objective 3**

# Conclusion

Usefulness of the concept is given for certain scenarios. Usability of the prototype is significantly higher for some attributes than for the tested alternative.

However, the high number of errors and comments given show that the approach is not easily understood by everyone and there is room for further research.

# Outlook

- integration of a location search (“NEAR”)
- investigation of visual variables, icons
- decrease error rate: different wording, help texts

# Contribution to Research

- novel type of Collective Spatial Keyword Query
- visualisation proposal for searching multiple keywords simultaneously
- visualisation proposal for displaying multiple search results
- evaluation of these concepts in terms of usability and usefulness



## Quote

*"The option of searching for combinations of Pols in a cluster has unlimited possibilities and now that I have used it I have realized what we were missing on."*

**Thank you for your attention!**