



Cartography M.Sc.

Navigating Pictorial Maps with attention guiding and narrative techniques

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Outline

- Terminology
- Motivation & Problem Statement
- Research Objectives
- Methodology
- Answering Research Questions
- Results
- Conclusion and Future Recommendations

Terminology

Pictorial Maps

- “A map or map-like presentation, representing a theme, containing illustrations of actual or imaginary geographical features that are subject to scaling.”



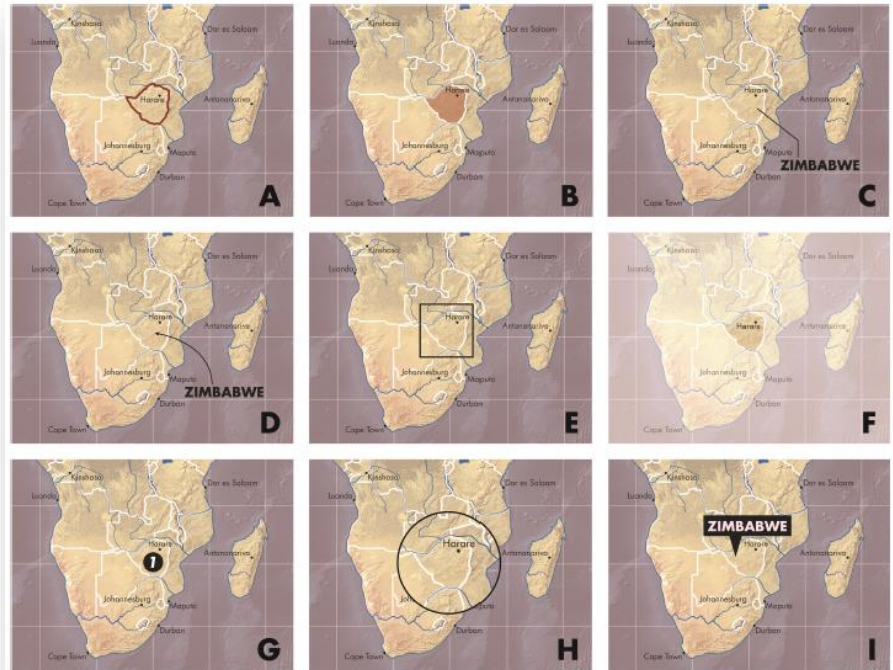
An Interactive Map of Sochi for Olympics (2014)

Attention Guiding Techniques

Guides attention

Robert Roth devised two main categories for attention guiding (tropes):

- a) visual hierarchy (figure-ground)
- b) visual accenting



Visual accenting techniques by Roth (2020)

Narrate information

Cortes (2018) classified some of the Visual Narrative Techniques as “Communication of Narrative & Information”:

- a) media,
- b) textual,
- c) graphic.

Motivation and Problem Statement

While there has been research on narrative visualization of data for storytelling. *There has not been much research on the use of existing genres and techniques for the case of pictorial maps.*

The motivation is *to find narrative and attention guiding techniques that work well for pictorial maps in terms of perceptions and navigation.*

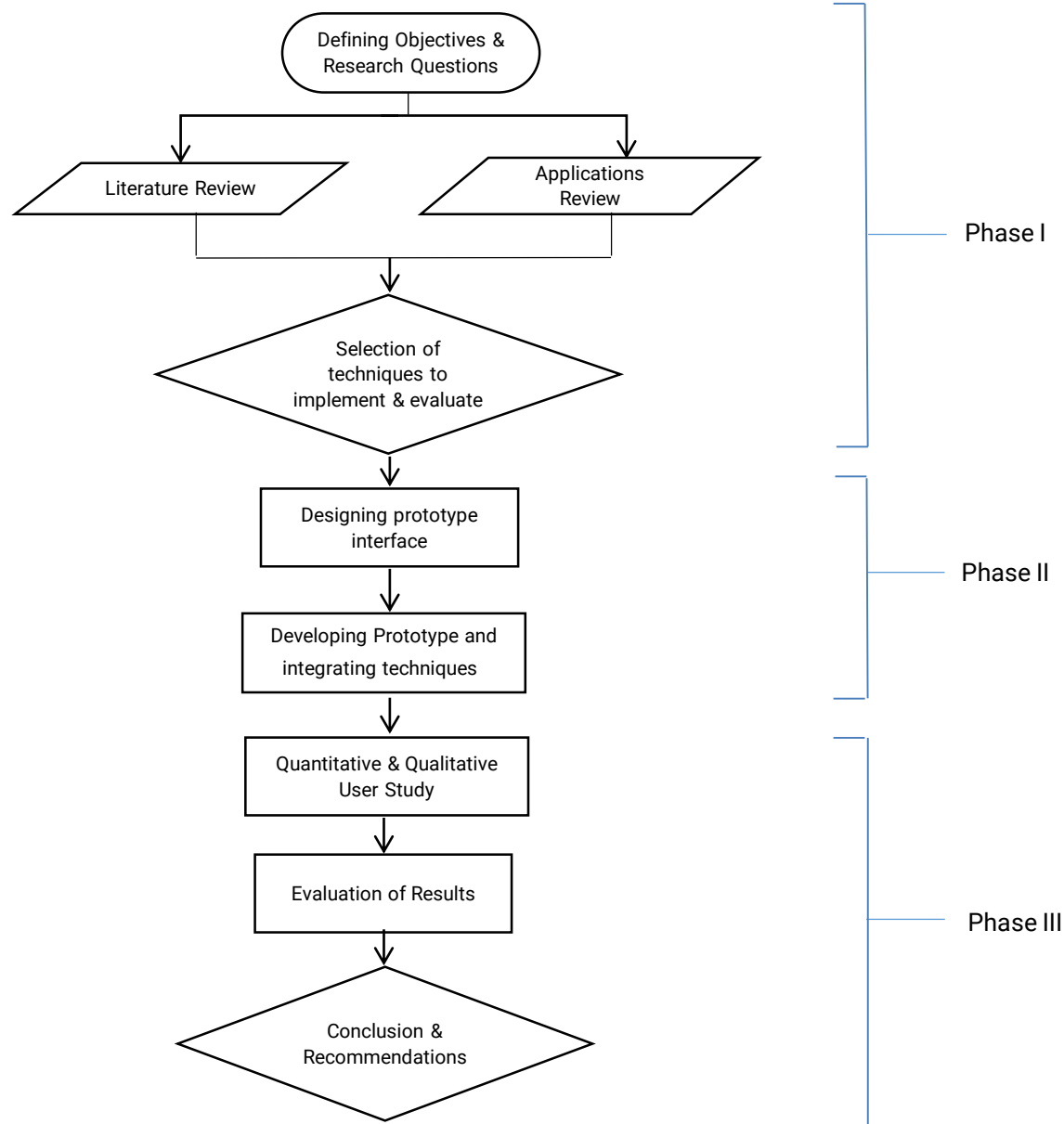
Target Audience

- Students and cartographers,
- Tourists,
- Oil and Gas Exploration Workers,
- Indoor Evacuation Planners,
- Storytellers,
- Specialists in heritage digitalization: for preservation and conveyance of the heritage site and belongings through a digital medium,
- Museum specialists: for virtual navigation of the museum chambers and treasures.

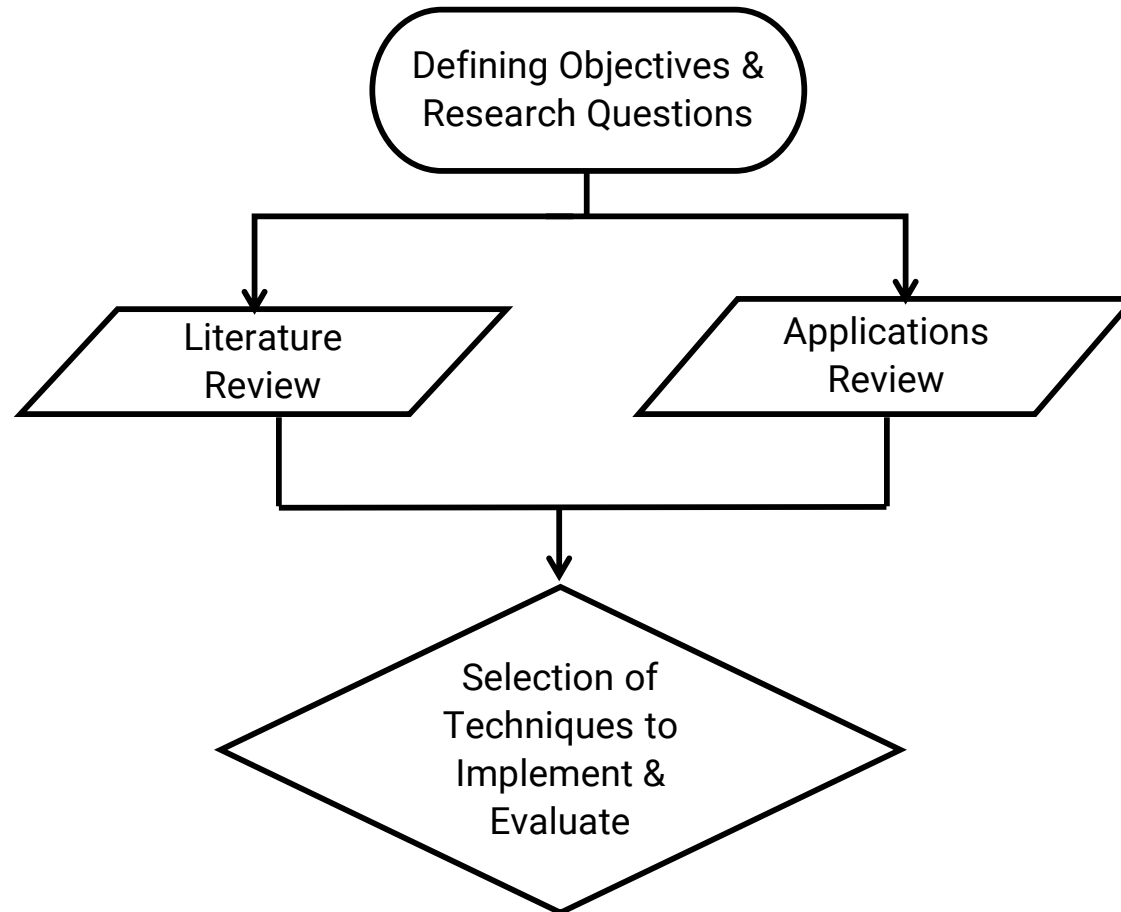
Research Objectives

- Creation of a taxonomy of attention guiding techniques based on the existing literature and web-based applications review.
- Selection and implementation of chosen techniques in a web-based prototype.
- Evaluation of the applied techniques through a user study and results analysis.

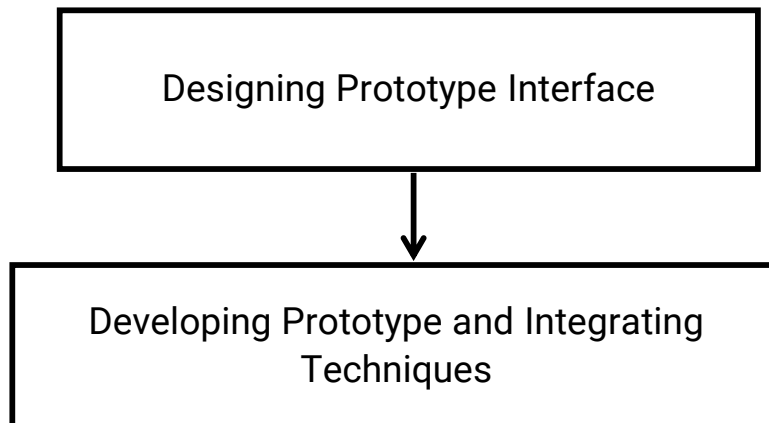
Methodology

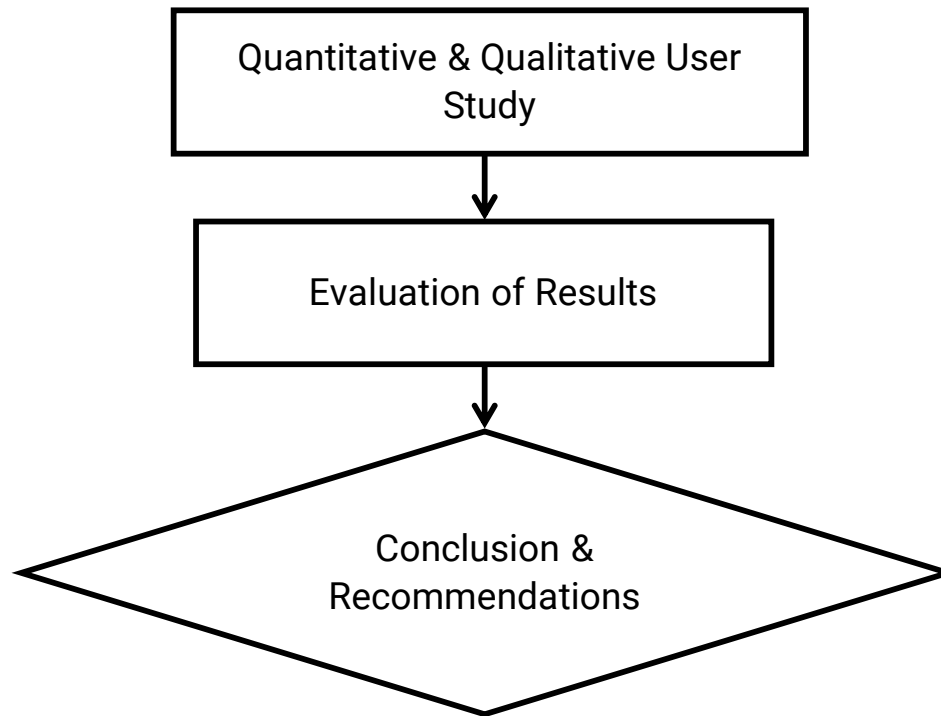


Phase I



Phase II





Objective 1

Creation of a taxonomy of attention guiding techniques based on the existing literature and web- based applications review.

Literature research

RQ1: What are the group of attention guiding and narrative techniques available in the literature?

RQ2: Have any of these techniques been tested/researched for cartography?

Application-based research

RQ3: What are the main groups of attention guiding techniques and narrative techniques available online?

RQ4: Do these techniques exist in combinations or in isolation?

RQ5: What attention guiding and narrative technique did I choose for study and why?

RQ1: What are the group of attention guiding and narrative techniques available in the literature?

	Narrative	Genres	Attention Guiding Tropes
Segel and Heer (2010)		Magazine Style Annotated Chart Partitioned Poster Flow Chart Comic Strip Slide Show Film/Video/Animation	Close-Ups Feature Distinction Character Direction Motion Audio Zooming
Song (2017)	Three-act narrative structure	Longform Infographics Vs. Dynamic Slideshows	Leader lines Vs. Color highlighting
Cortes (2018)	Textual: Intro text, labels, narrative text, annotations, captions, articles Media: video, images, sound, audio narration Graphics: Maps, animation, ribbons, arrows, static & interactive visualization	Static News Maps Longform Infographics Dynamic Slideshows Narrated Animations Personalized Story Maps Multimedia Visual Experiences	Emphasis <ul style="list-style-type: none"> • Highlighting • Call-outs • Annotation • Masking • Dynamic Panning • Dynamic Zooming • Animations...
Roth (2020)	Three-act Narrative	Static Visual Stories Longform Infographics Dynamic Slideshows Narrated Animations Multimedia Visual Experiences Personalized Story Maps	Visual Hierarchy Visual accenting: <ul style="list-style-type: none"> • Highlighting & visual variables • Annotation: leader lines, flow arrows, appended geometric frames, opacity masks, numbering, changes in map scale, variable levels of detail, call-outs, labelling clarifications • Dynamic: blinking/flickering, dynamic panning/zooming, focus + context visualization

RQ2: Have any of these techniques been tested/researched for cartography?

Song (2017) conducted a research evaluating the genres & tropes proposed by Roth. She evaluated on Visual accenting techniques:

- black leader lines(left image)
- black color highlighting (right image)



Song (2017)

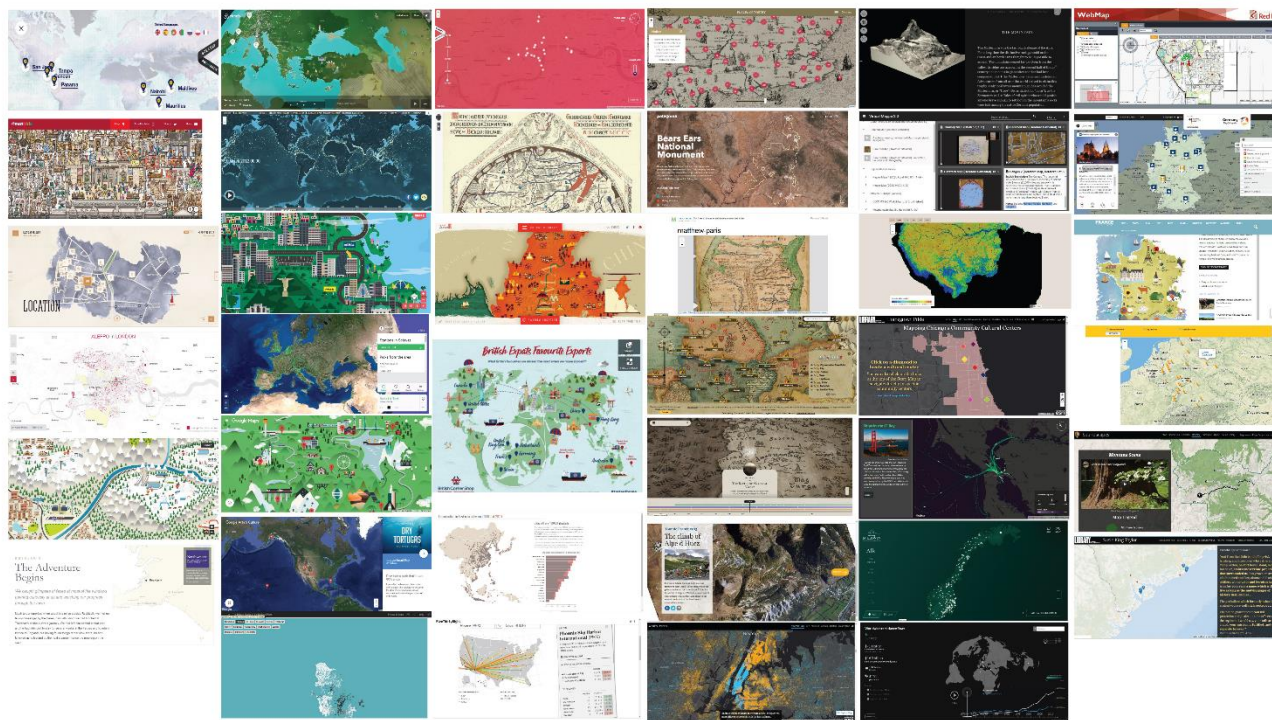
RQ3: What are the main groups of attention guiding techniques and narrative techniques available online?

a) collection of map-based applications, identification of techniques in them.

	URL	X	Y	Focus Attention Technique Used	Narrative Technique	Image
#5OLDN - Webatvantage	http://london.webatvantage.be	1	3	Highlighting, call outs	Images, Captions	Y
#MetKids Map	https://www.metmuseum.org/	3	3	Opacity mask, markers	Images, Video, Text, Accompanying	Y
Chasing the Matterhorn	https://storytelling.nzz.ch/2015	-2	-2	Dynamic panning/zooming, call-outs, labelling	Images, Text Narration, Animations	Y
City of Red Deer WebMap	http://webmap.reddeer.ca/web	0	3	Visual variables, Color Highlighting, flickering	labels, map	Y
Costing Nature	https://costingnature.infoamazi	0	3	none	legend, text narration	Y
DM	https://sims2.digitalmappa.org/	2	3	Highlighting, call outs	text narration	Y
Dreamscapes	https://www.lufthansa-dreams	0	2	Markers	labels, images, video, text	Y
Explore The Hidden Worlds of our Nations	https://artsandculture.google.c	-2	-3	Dynamic panning/zooming, call-outs, labelling	text, images, videos	Y
Google Maps: Miniatur Wunderland Street	https://www.google.com/maps	2	2	markers	images, text, animations	Y
House at Khlebný	https://hleby-dom.ru/en/location	3	2	Highlighting, call outs	text, images	Y
Interactive Map of France French Cities,	https://www.francetoday.com/	3	2	Dynamic flickering	labels, text, accompanying articles	Y
Interactive Map of Germany - Search Land	http://www.orangesmile.com/t	0	3	markers, shadows	labels, images, text	Y
Interactive Storytelling Codrops	https://tympanus.net/Develop	0	-3	visual heirarchy	text narration, animation, images	Y
John Mandeville and the Hereford Map - C	http://historiacartarum.org/om	2	3	highlighting	text	Y
Map of Germany	https://www.germany.travel/en	-1	3	visual heirarchy	text, images	Y
Map of the Northern Kingdoms :: Witcher	http://vitaln.com/ehalos/witch	3	3	visual heirarchy change on hover	labels	Y
matthew-paris	https://bl.ocks.org/mapsmania/	2	3	none	text	Y
Netflix The Witcher Karte des Kontinen	https://www.witchernetflix.co	3	2	highlighting, dynamic zooming, animation	text, headlines, images	Y
Places of Poetry	https://www.placesofpoetry.or	2	2	labels	text	Y
Radio Garden	http://radio.garden/	-1	3	highlighting	text	Y
Reprojected Destruction	http://hanshack.com/aleppo/	0	3	highlighting on polygon fill	text, labels, pop-ups	Y
Rio 2016 Interactive Map	https://rio2016interactivemap.c	3	2	animation, call-outs on hover	text, sound	Y
Shipmap.org	https://www.shipmap.org/	-1	0	highlighting, animation	audio narration, animation	Y
Ships in the San Francisco Bay	https://labs.mapbox.com/bites	0	0	color highlighting, visual variable: size	image, text, animation	Y
Sochi 2014 Interactive Map	http://www.sochi2014interactiv	3	2	animation, call-outs on hover	text, map	Y
Sounderance	https://nnc.manc.arts.cornell	-2	-3	Dynamic panning/zooming, visual variables	audio, sound, images, videos, text	Y

RQ3: What are the main groups of attention guiding techniques and narrative techniques available online?

b) Creation of Visual Taxonomy



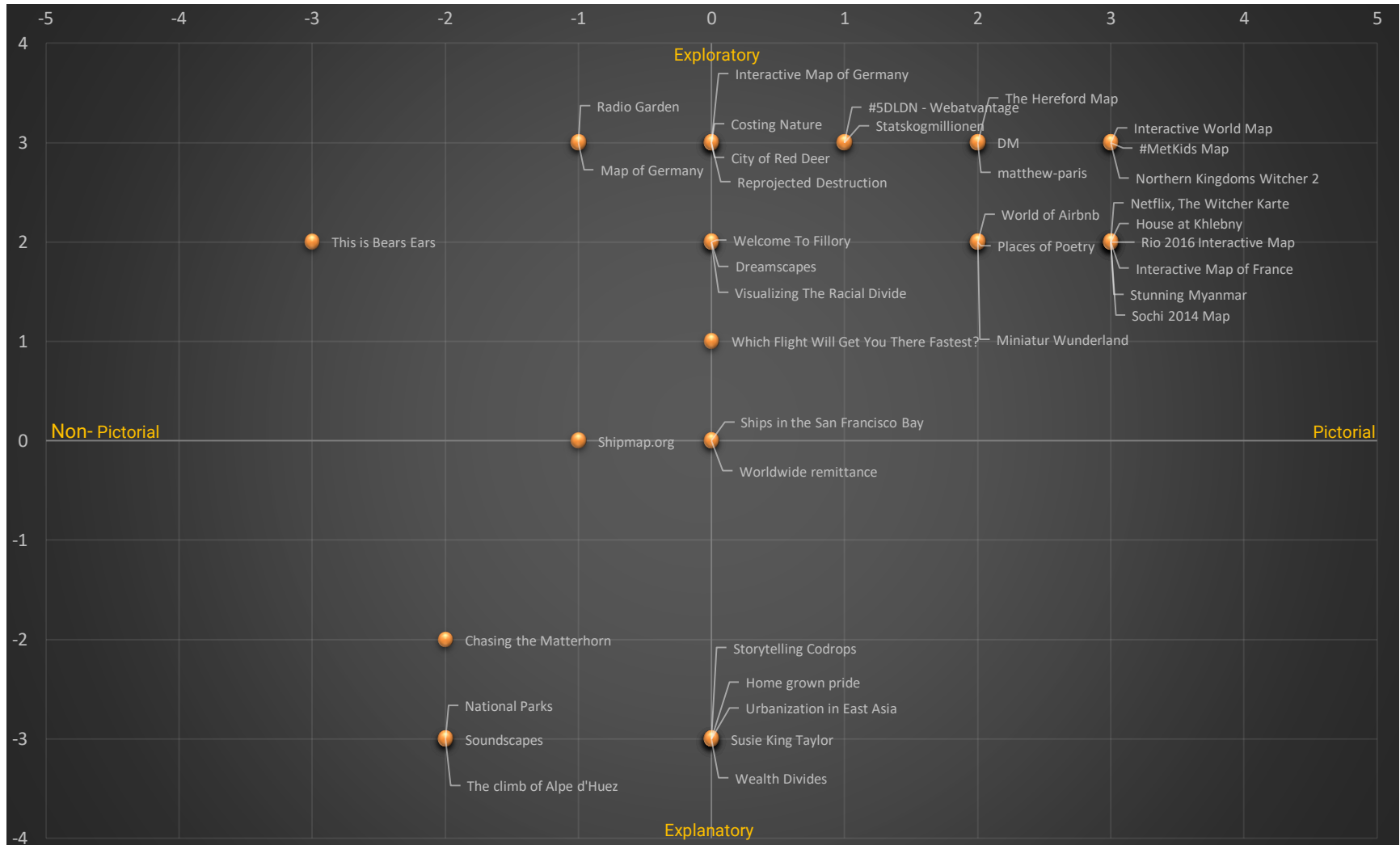
RQ3: What are the main groups of attention guiding techniques and narrative techniques available online?

c) coding and categorization of collected map applications

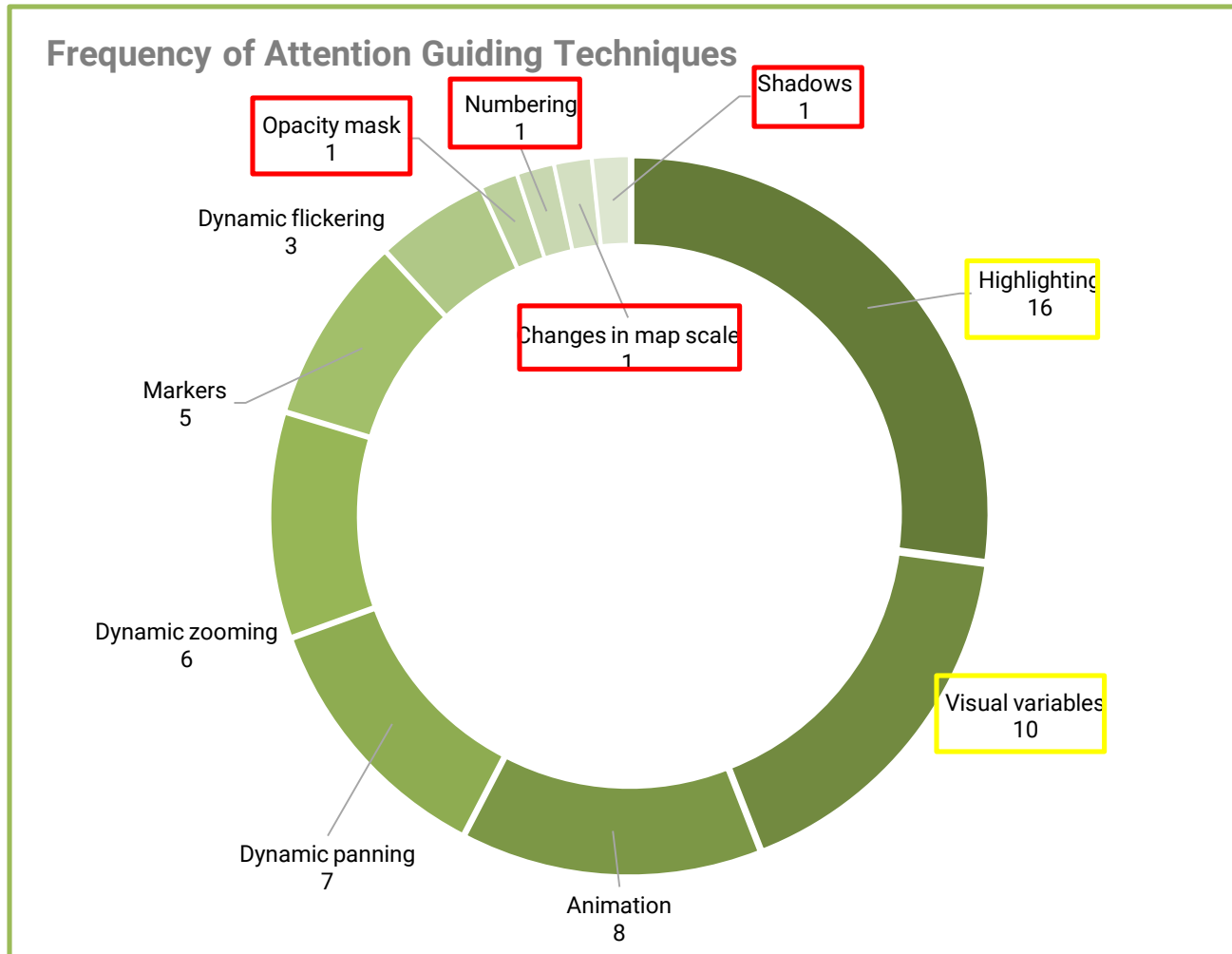
X-Axis - Illustration						
Non-Pictorial						Pictorial
-3	-2	-1	0	1	2	3
Remote sensing imagery as background, supported with real images and videos of the landscape or area	Image background with one more element supporting realism	Vector map with images	Vector map with no pictorial elements	One of the three map elements (text, icon, background) is pictorial	Two of the three map elements (text, icons, background) are pictorial	All three elements (text, icon, background) are pictorial

Y-Axis – Freedom of Exploration		
Exploratory	3	User is free to explore a map without any explanations imposed
	2	An initial introduction or pop up
	1	A full guide as an initial display before the map
	0	Choice given to either explore or follow the instructions/explanations
	-1	Sequence/structure to follow in the map
	-2	Narration through any media
Explanatory	-3	Fully guided story with narration and animation

RQ3: What are the main groups of attention guiding techniques and narrative techniques available online?



RQ3: What are the main groups of attention guiding techniques and narrative techniques available online?



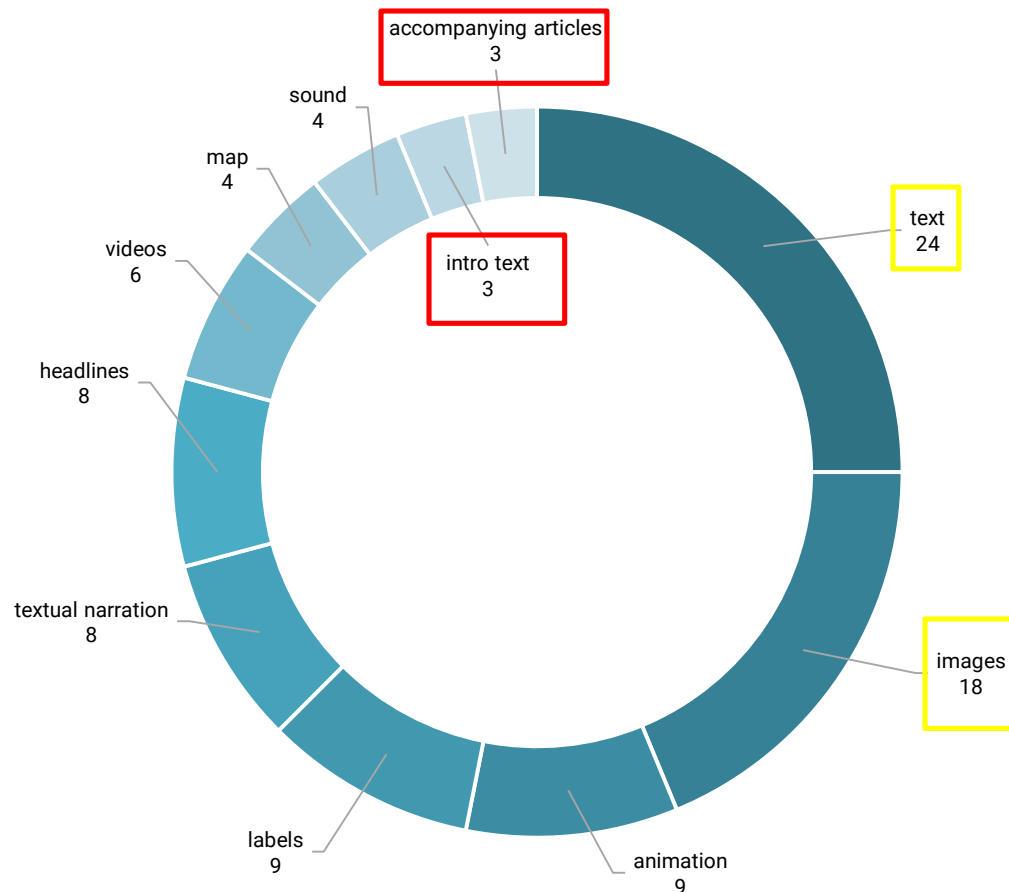
Groups of attention guiding techniques (from map apps)

Dominant:
Highlighting, visual variables

Least used:
Numbering,
Opacity mask,
Changes in map scale, shadows

RQ3: What are the main groups of attention guiding techniques and narrative techniques available online?

Frequency of Narrative Techniques

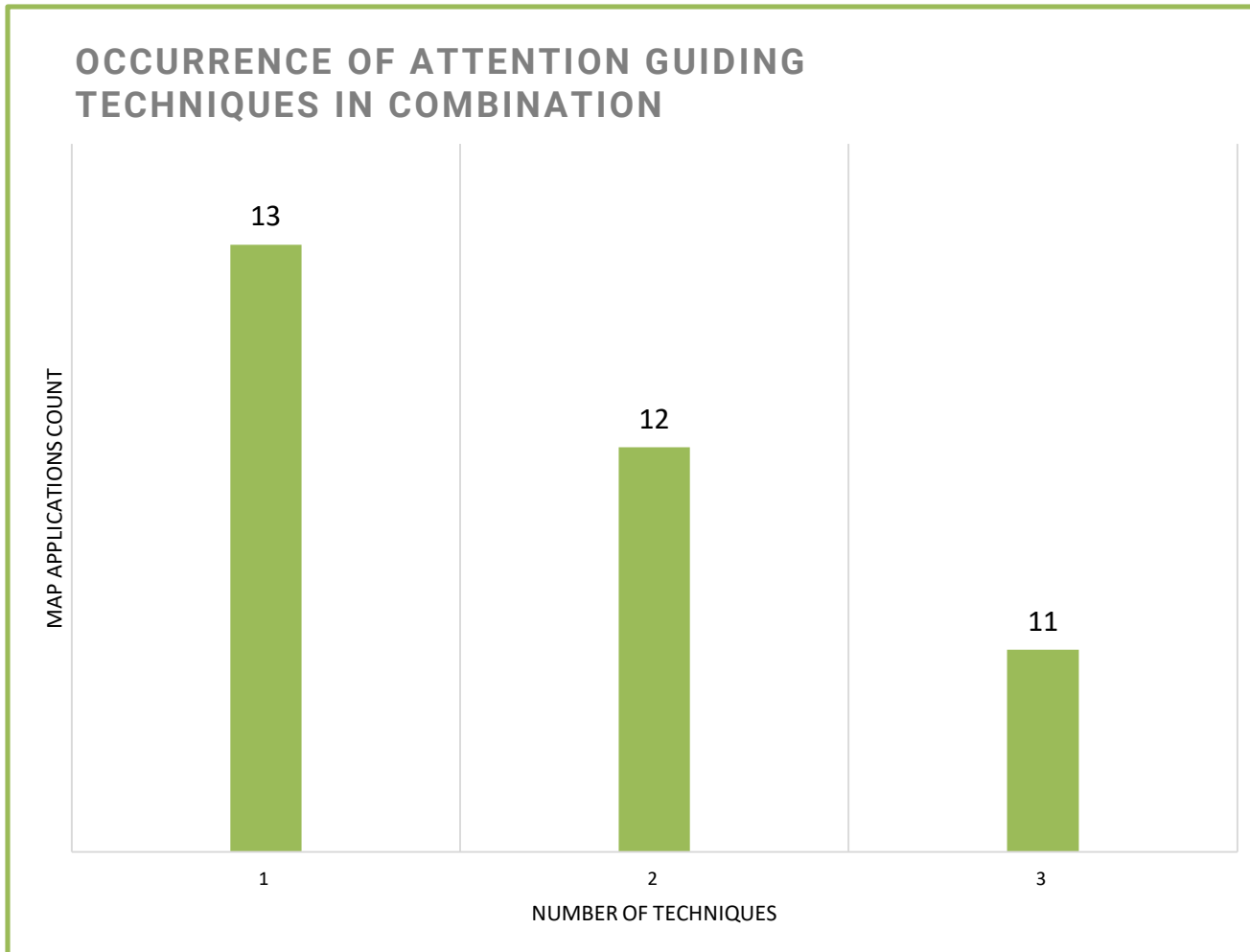


Groups of Narrative Techniques (from map apps)

Dominant: Images, text

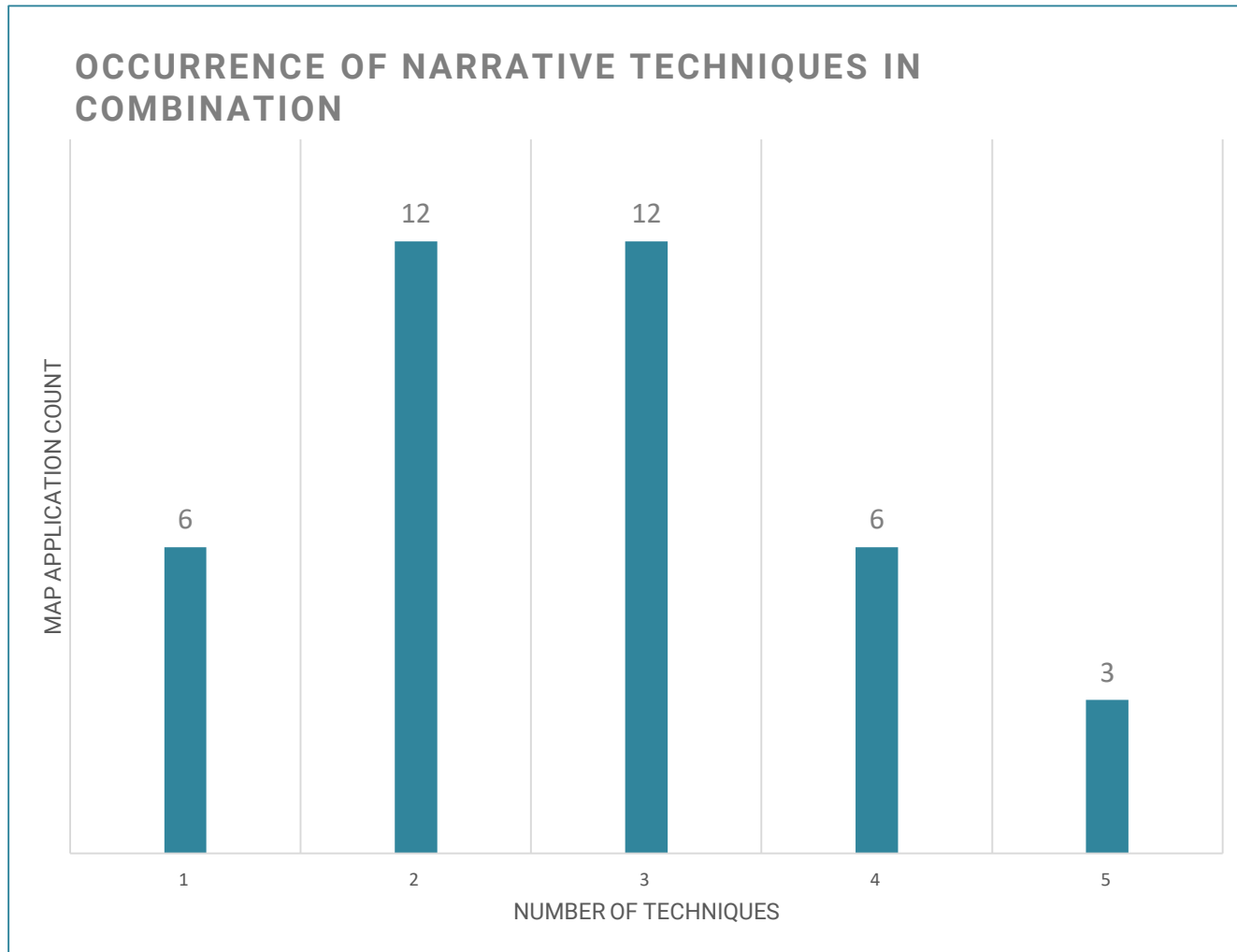
Least used: Introductory text, accompanying articles

RQ4: Do these techniques exist in combinations or isolation?



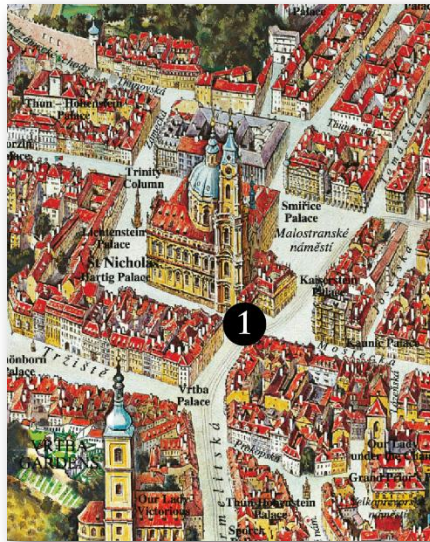
Attention guiding techniques: Both alone & in combination

RQ4: Do these techniques exist in combinations or in isolation?

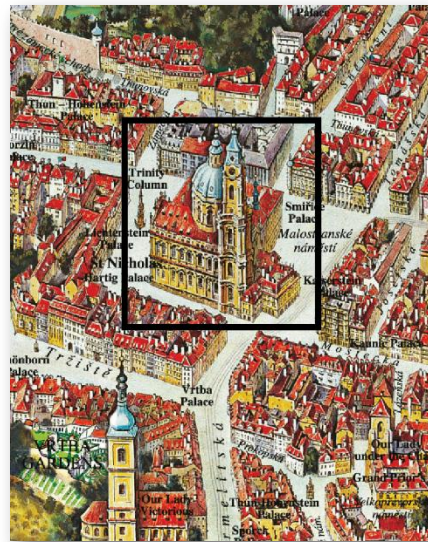


Narrative techniques:
Mostly in combination

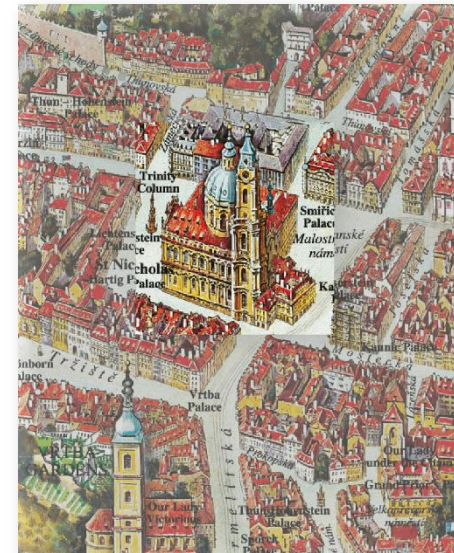
RQ5: What attention guiding and narrative technique is chosen for this study and why?



Numbering



Geometric Boundary



Opacity Mask

RQ5: What attention guiding and narrative technique did I choose for study and why?

Visual Accenting Technique as shown in Figure by Roth (2020)	Considered Techniques (Roth, 2020)	Decision if chosen	Reason
A	Boundary Highlighting	No	Song (2017) already researched it.
B	Color Highlighting (polygon fill)	No	Well suited for vector maps but not pictorial maps because of rich pictorial objects instead of empty polygons.
C	Leader Lines with Label	No	Song (2017) already researched it.
D	Flow Arrows with Label	No	Additional labels are too cluttered for a pictorial map.
E	Geometric Boundaries	Yes	Highlights the important objects while keeping the surrounding objects in view.
F	Opacity Mask	Yes	Brings out the object in consideration by dimming down the other information. Less present in the observed map applications.
G	Numbering	Yes	Helps to find important objects quickly and follows a sequence. Appeared less in the observed map applications.
H	Change in Scale	No	The variable scale might be confusing while zooming in and out of the map.
I	Call-outs	No	Contains labels which might make the map busier.

RQ5: What attention guiding and narrative technique did I choose for study and why?

Genres

- Static Map
- Personalized Story Map

Rest of the Storytelling Genres can't be applied to this specific case of Pictorial Map.

Narrative Techniques

- Image
- Textual Narration

We want to keep a simple narrative technique as most evaluation is focused on the attention guiding techniques

Objective 2

Selection of the techniques and their implementation in prototype development.

RQ6: What technologies are used in the development of the prototype?

RQ7: How to design and deploy attention guiding techniques using visual encoding and interactions?

RQ6: What technologies are used in the development of the prototype?

- Framework: AngularJS, NodeJS
- Languages: JavaScript, Typescript, HTML, CSS
- Tools: Visual Studio Code, Notepad++
- Sharing and Hosting: GitHub and Netlify



RQ7: How to design and deploy attention guiding techniques using visual encoding and interactions?

Case study map



RQ7: How to design and deploy attention guiding techniques using visual encoding and interactions?

PRAGUE

On this map, the city of Prague is shown in a way that highlights its historical significance. The map is divided into several sections, each representing a different part of the city. The top section shows the Old Town, the middle section shows the New Town, and the bottom section shows the Lesser Town. The map is color-coded to show different historical periods: red for the 15th century, blue for the 16th century, green for the 17th century, and yellow for the 18th century. The map also includes a legend and a scale bar.

St. Vitus Cathedral
The most important religious building in Prague, it was built in the 14th century. It is a masterpiece of Gothic architecture, with its main tower reaching a height of 95 meters. The cathedral is located in the Old Town Square, one of the most important squares in Prague.

Charles Bridge
The most important bridge in Prague, it was built in the 14th century. It is a masterpiece of Gothic architecture, with its main tower reaching a height of 95 meters. The bridge is located in the Old Town Square, one of the most important squares in Prague.

Old Town Square
One of the most important squares in Prague, it was built in the 14th century. It is a masterpiece of Gothic architecture, with its main tower reaching a height of 95 meters. The square is located in the Old Town, one of the most important parts of Prague.

St. Nicholas Church
A masterpiece of Gothic architecture, it was built in the 14th century. The church is located in the Old Town, one of the most important parts of Prague.

St. Martin's Church
A masterpiece of Gothic architecture, it was built in the 14th century. The church is located in the Old Town, one of the most important parts of Prague.

St. James's Church
A masterpiece of Gothic architecture, it was built in the 14th century. The church is located in the Old Town, one of the most important parts of Prague.

St. John's Church
A masterpiece of Gothic architecture, it was built in the 14th century. The church is located in the Old Town, one of the most important parts of Prague.

St. Elizabeth's Church
A masterpiece of Gothic architecture, it was built in the 14th century. The church is located in the Old Town, one of the most important parts of Prague.

St. Francis's Church
A masterpiece of Gothic architecture, it was built in the 14th century. The church is located in the Old Town, one of the most important parts of Prague.

St. Clare's Church
A masterpiece of Gothic architecture, it was built in the 14th century. The church is located in the Old Town, one of the most important parts of Prague.

St. Anne's Church
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St. Mary's Church
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St. Peter's Church
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St. Paul's Church
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St. George's Church
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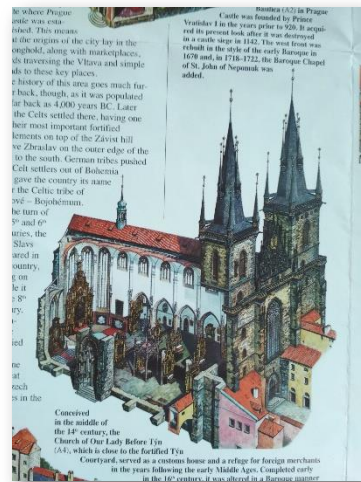
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A masterpiece of Gothic architecture, it was built in the 14th century. The church is located in the Old Town, one of the most important parts of Prague.

POIs and Narrative Information

RQ7: How to design and deploy attention guiding techniques using visual encoding and interactions?



Masking



	A	B	C	D	E
1	1	Prague Castle	A2	Prague Castle, the residence for Bohemian sovereigns and presidents for the past thousand years, is unique thanks to the various structures of which it is composed.	
2	2	St. George's Basilica	A2	St. George's Basilica in Prague Castle was founded by Prince Vratislav I in the years prior to 920. It acquired its present look after it was destroyed in a castle siege.	
3	3	Church of Our Lady Before Tyn	A4	Conceived in the middle of the 14th century, the Church of Our Lady Before Tyn, which is close to the fortified Tyn Courtyard, served as a customs house and a refuge for foreign merchants in the years following the early Middle Ages. Completed early in the 16th century, it was altered in a Baroque manner.	
4	4	The town hall complex	A4	The town hall complex in Old Town was begun in 1338, when the town hall was founded and was added to until the middle of the 19th century. This involved the construction of the Old Town Hall and the Old Town Hall Tower.	
5	4.5	The Astronomical clock	A4	The astronomical clock in Old Town town hall was crafted by the clockmaker Mikulas from Kadan with the assistance of Jan Sindel, a professor at Charles University.	
6	5	Old-new Synagogue	A3	The people responsible for building the Convent of St. Agnes probably also built the Old-New Synagogue, which is the oldest of its kind in central Europe and one of the best-preserved in the world.	
7	6	Old Jewish Cemetery	A3	Approximately 100,000 people are buried in the world's oldest Jewish cemetery. Within its one hectare are about 12,000 gravestones from across the centuries.	
8	7	Royal Summer Palace	A2	The Royal Summer Palace in the eastern part of the Royal Garden represents the purist Renaissance construction north of the Alps. Emperor Ferdinand I had done it.	
9	8	Charles Bridge	A2,3	Charles Bridge, which Charles IV had constructed in 1357 to replace the Romanesque Judith's Bridge that had been swept away by floods. One element remains from the original structure.	
10	9	Vrtba Garden	A2	The Baroque Vrtba Garden, supposedly conceived by Frantisek Matous Kanka in 1712-1720, is accounted the most beautiful terrace garden in Prague. Its site was chosen by the architect.	
11	10	St. Nicholas Church	A2	The Church of St. Nicholas in Little Quarter is the greatest high Baroque structure in Prague. In 1702-1737, Kystof Dientzenhofer constructed its nave, replacing the earlier structure.	
12	11	National Theatre	B3	The neo-Renaissance National Theatre on the bank of the River Vltava was built to encourage a Czech theatrical tradition. The construction dates back to 1881.	
13	12	Municipal House	A5	The ostentatious Municipal House, the most important construction of the Prague Art Nouveau, which was built in 1903-1912 to the design of A. Balsemek and F. L. Ryskind.	
14	13	Dancing House	B3	The building known as the Dancing House was built on a site between other structures on Rasín embankment to the plans of architects Vlado Milunic and Frantisek Chaloupka.	
15					
16					
17					
18					
19					
20					
21					


POIs and Narrative Information

RQ7: How to design and deploy attention guiding techniques using visual encoding and interactions?

Narrative Information in Prototype


PICTORIAL MAP OF PRAGUE

● None ● Opacity Mask ● Numbering ● Geometric Boundaries



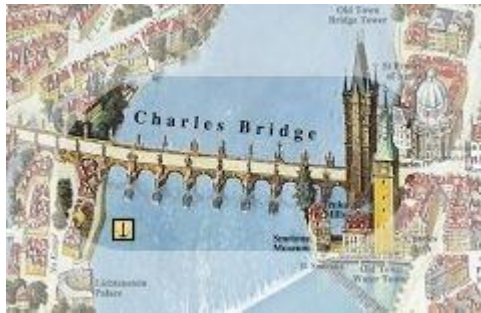
Word 2013 (2)

Church of Our Lady Before Tyn



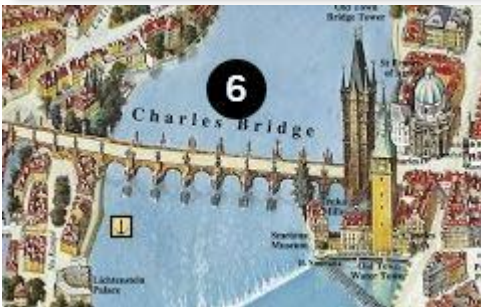
Conceived in the middle of the 14th century, the Church of our Lady Before Tyn, which is close to the fortified Tyn Courtyard, served as a customs house and a refuge for foreign merchants in the years following the early Middle Ages. Completed early in the 16th century, it was altered in a Baroque manner after 1679. It is the last resting place of Tycho de Brahe, an astronomer of Rudolph II.

RQ7: How to design and deploy attention guiding techniques using visual encoding and interactions?



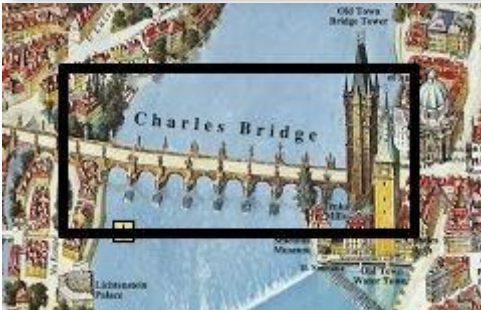
Opacity Mask

- Oblique, skew angle: 350°
- Transparency: 80%



Numbering

- Black circle: 30x30 pixels
- White text, font-size: 18px



Geometric Boundary

- Black color
- Width: 5px

RQ7: How to design and deploy attention guiding techniques using visual encoding and interactions?

Interactions and micro-interactions

- Change of cursor on hover
- Zoom-in upon click
- Side-pane with Narrative Information upon click

Functions

- Switching between Techniques
- Zoom-in, Zoom-out, Refresh to original extent
- Scroll & Pan
- <https://ppmshahtaj.netlify.app/>

Objective 3

Evaluation of the applied techniques through user study and results analysis

RQ8: Which method is employed for the evaluation of techniques?

RQ9: Which technique performed better in the user study and on what grounds?

RQ10: What are the differences observed between the baseline pictorial map and the attention guiding technique applied to it?

RQ8: Which method is employed for the evaluation of techniques?

A user study with quantitative and qualitative questions regarding the user's experience of the prototype and its functions.

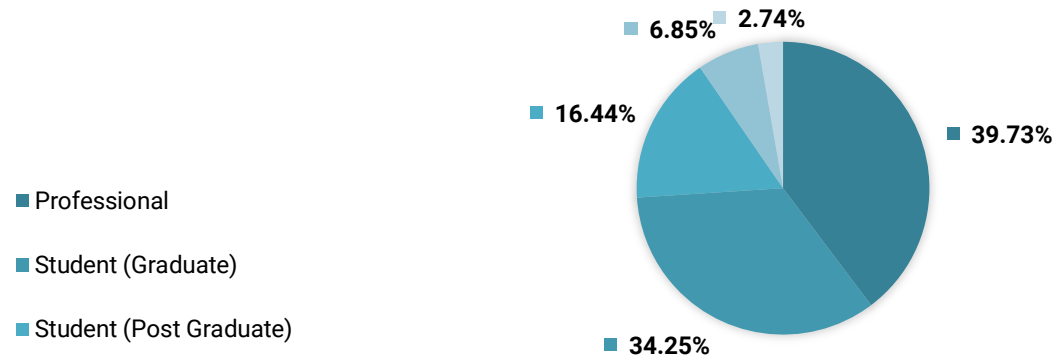
- *Sampling*: Dependent
- *Platform*: SoSci Survey
- *What it measures?*
 - Understanding,
 - Experience,
 - Ability to Navigate,
 - Preference.



Results

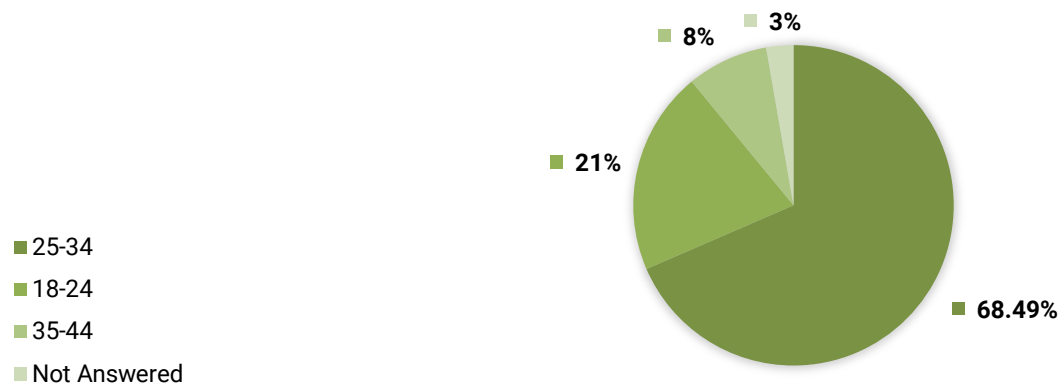
Demographics

STUDY STATUS OF PARTICIPANTS



Out of the total 73 participants, 81% had knowledge of GIS or Cartography

AGE GROUP DIVISION



Familiarity

- 64% had visited Prague
- 84% have seen a Pictorial map before
- Participants understanding of a Pictorial Map (qualitative)

	A	B	C	D	E	F
1	A107_01 - What is a pictorial map?	Coding		73-7=66 responses		
2	a map with little pictures in it	Contains		How it represents?		
3	A map containing illustrations	Contains		What it contains?		
4				What it preserves/distorts		
5	A map that does not follow standard mathematical projections and cartographic principles and relies more on artistic visuals instead.	contains, preserves		What is the viewing perspective?		
6	Map with pictures or maps with more details in them in the form of pictures or art	contains		What is the function/purpose?		
7	A map that contains pictures?					
8	Pictorial maps are more artistic rather than technical	represents, preserves				
9						
10						
11	Map in which illustrations and pictures are used to display information	contains, function				
12	An image/picture with a spatial/map component	represents, contains				
13	map with illustrations/pictures e.g a tourist map with sights not just "technical" information like a road map					
14	A map telling a story.					
15	A map which is more artistic as opposed to practical, eg. a panorama map, a 3D illustration of a scene					
16						
17	Map with pictures					
18	A more artistic map meant to bring a city alive, but not as helpful for navigation or practical use.					
19	Its a map which looks like a picture					
20	its a picture like map					
21	A map that uses pictures as symbology, i.e. to represent geographic features.					
22	Images used to create a map					
23	An image acting as a map. You can navigate, pan, view etc					
24	Artistic map highlighting a theme					
25						
26	A map that relies on visual information, for instance images or illustrations.					
27	Pictures cater to the geographical information					
28	more artistic map rather than street/topographic map. Spatial features may be depicted by 3d perspective or 2d models/pictures, that what I understood about pictorial maps					
29	The emphasis of pictorial maps is less on showing a specific territory to scale and more on the choice of particular landscape features so as to delineate a place and at times to emphasize a specific feature.					
30	artistic maps					
31	A map which would show certain landmarks in an area with pictures resembling its appearance.					
32	Type of map displayed in an illustrated way.					
33	A map which gives more detailed and clear view of the sight.					
34	A map with pictures of landmarks					
35						
36	Map of artists and graphics designers I guess					
37	a pictorial map is advanced version of simple maps containing more details of the objects					
38	A map that is very similar to a image, having a lot of artistic or natural detail, but with limited amounts of map symbology and abstraction overlaid.					
39	An informal kind of a geographic map which presents the features in a given area.					
40	A map that depicts an area with symbols and pictures rather than through technical elements					
41	Pictorial maps depict a given territory with a more artistic rather than technical style.					
42	A map which makes use of illustrative elements of concrete things, rather than only abstract shapes (like charts etc.)					
43	A map with pictures at locations with specific buildings					
44	map w pictures					
45	A map using illustrations to depict real world phenomenon/features. Focuses on certain areas/parts and geography is somewhat distorted.					
46	The depiction of a specific area with a more artistic rather than technical style.					
47	Map complimented with pictures					
48	They are a representation of our perception of the use of camera					

Emerged themes

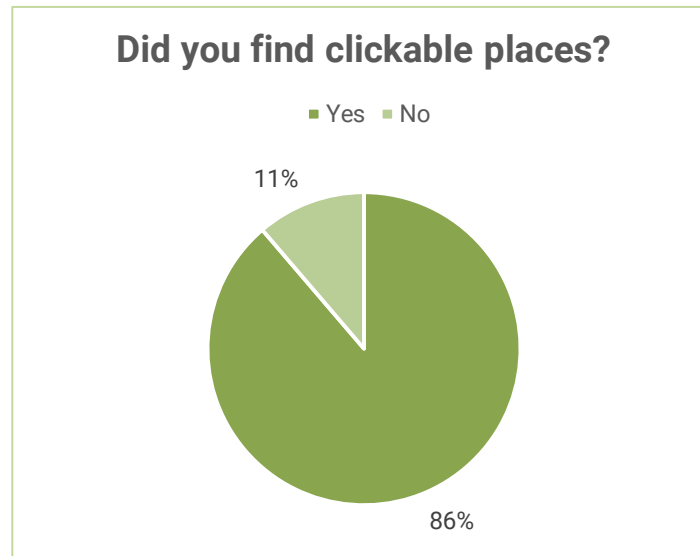
- **What it contains?** *the elements presented on the map,*
- **How it represents?** *thematic or artistic look of the map,*
- **What it preserves or distorts?** *geographical and factual adjustments,*
- **What is the viewing perspective?** *e.g. top-down, panoramic, 3D,*
- **What is the function or purpose?** *e.g. storytelling or tourist guide.*

Definition of a Pictorial Map

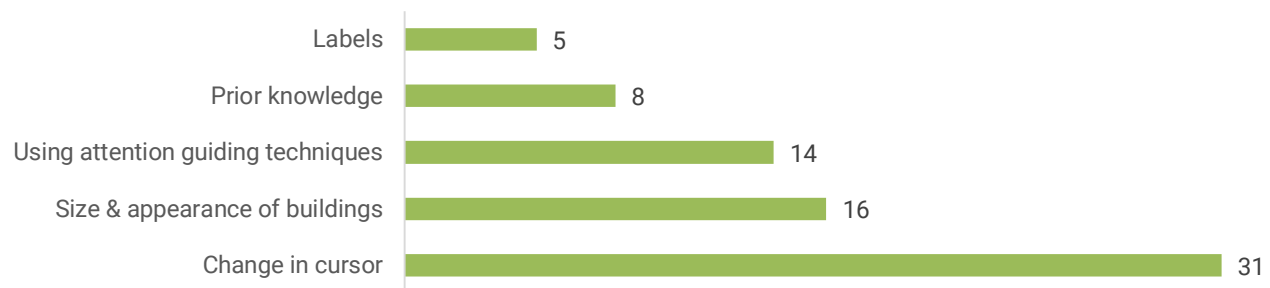
“A map or map-like presentation, representing a theme, containing illustrations of actual or imaginary geographical features that are subject to scaling.”

Exploration

Exploring the map on 'None' layer

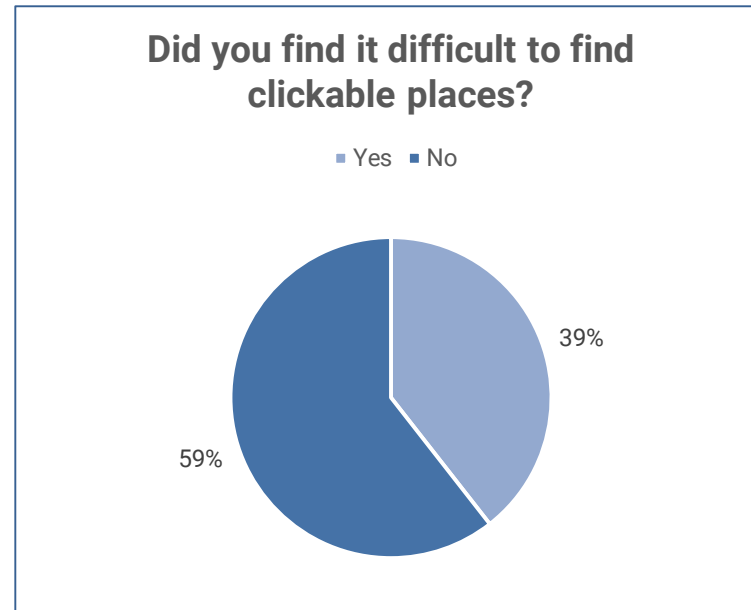


What helped in finding clickable places?

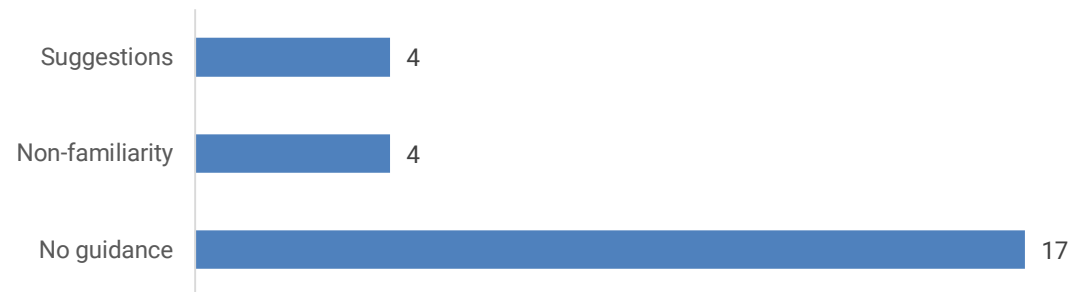


Exploration

Exploring the map on 'None' layer

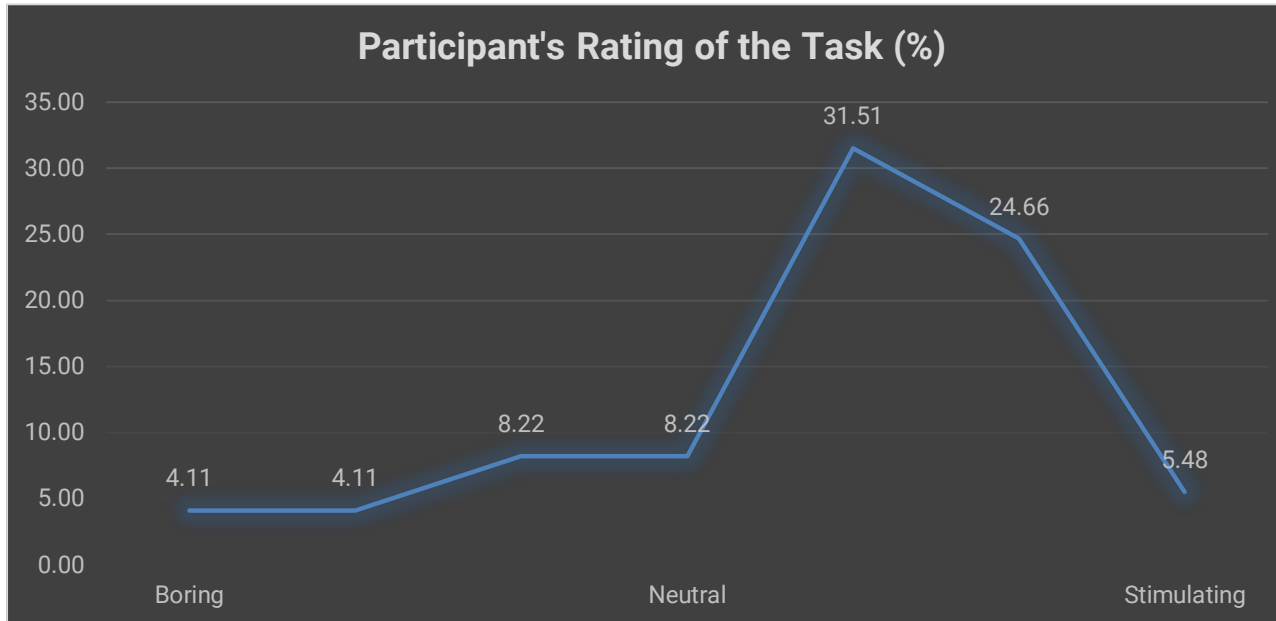


Why was it difficult to find clickable places?



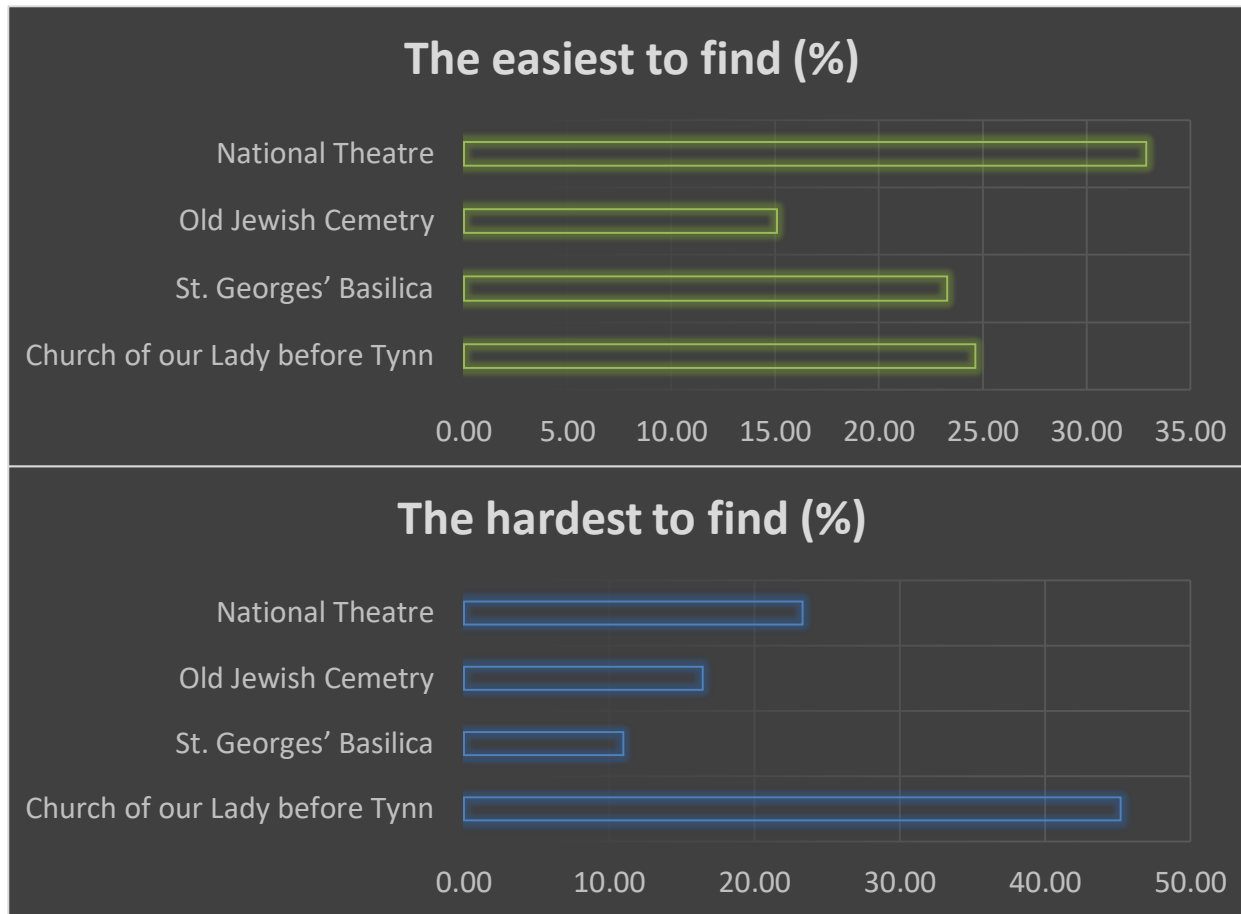
Task

Finding different places using different attention guiding techniques



Task

Finding different places using different attention guiding techniques



Layers used to find each POI

National Theatre:
Numbering

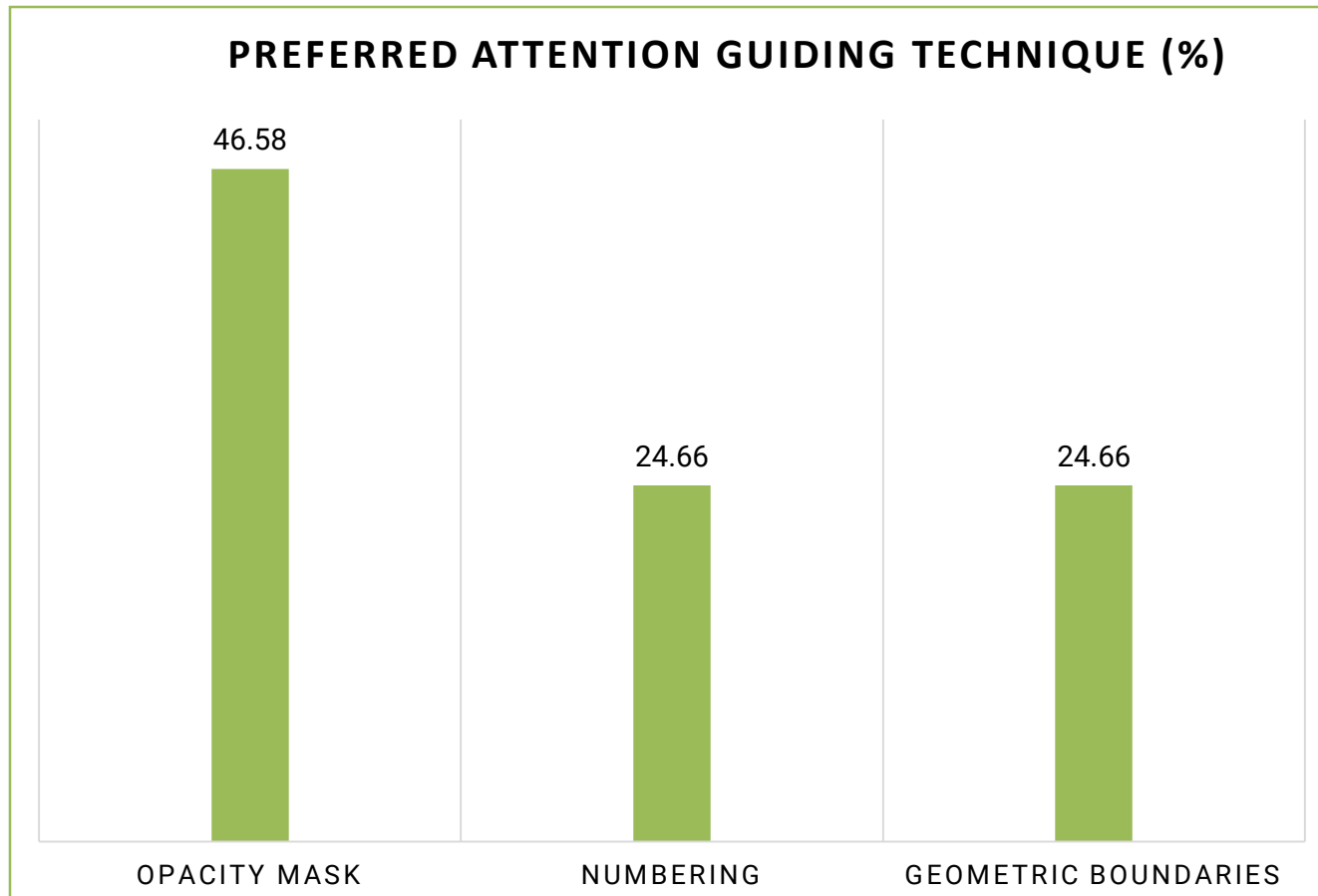
Old Jewish Cemetery:
Geometric Boundaries

St. George's Basilica:
Opacity Mask

Church of our Lady before Tynn: None

RQ9: Which technique performed better in the user study and on what grounds?

Preference



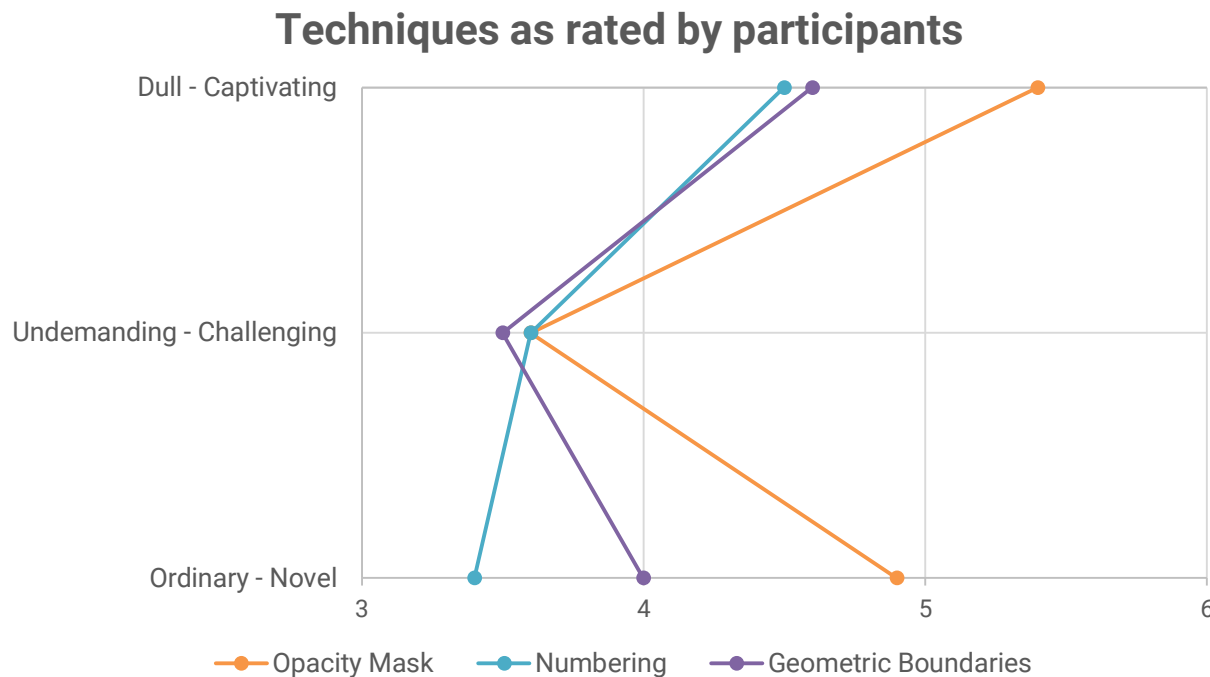
RQ9: Which technique performed better in the user study and on what grounds?

Technique	Positive Inclination	Negative Inclination
Opacity Mask	Does not obstruct the view	Did not work well in areas of white or bright colors
		Should have highlighted the exact shape of boundary
	Improves readability	Hides the beautiful map
		Low transparency
	Nice contrast	Ignored details
	Gives immense attention	
	Narrows focus, fades the rest	
	User Experience	
	Most visually pleasing	
	Took the shortest time	
Numbering	Does not affect aesthetics	
	Links number to buildings	
	Easy to follow	Does not make sense
	Looks good	
	Interfered least with the map	
	Easy navigation	Does not explain order
	Gives a total count	What object the number points to
	Distinctive boundary	Intrusive
Geometric Boundaries	Highlights	Not aesthetic
	Easily visible	Made map visually turbulent
	Makes task easy	Area not well defined
		Overlap of boundaries
	Leaves beauty of map intact	Hides structure with borders
	Guides attention	



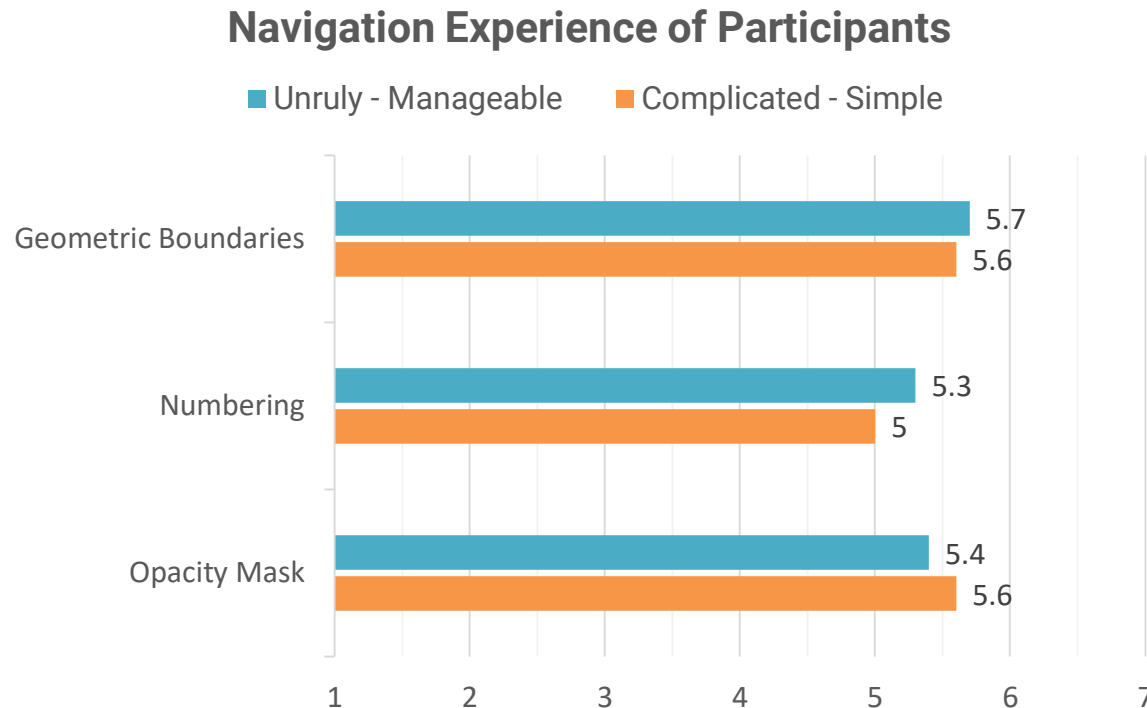
RQ9: Which technique performed better in the user study and on what grounds?

Experience



RQ9: Which technique performed better in the user study and on what grounds?

Navigation Experience



RQ10: What are the differences observed between the baseline pictorial map and the attention guiding technique applied to it?

- The baseline pictorial map fails to guide the reader to the POIs,
- The map with attention guiding technique applied to it highlights the POIs so they are quickly found.
- The baseline map keeps the beauty and aesthetics of the original map intact.
- Attention guiding techniques hinder some elements of the map to bring attention to the important ones.

Slide 44 & 46 have explanation graphs

Conclusion and Future Recommendations

- *A pictorial map with some attention guiding technique applied to it* is preferred.
It is found to be more helpful in exploring the places within the map.
- *Opacity Mask* is most liked by people.
It is also found to be more captivating and novel than the other two.

Applications

- Tourist maps, with *pictorial map* on the base and the *attention guiding techniques*.
- Maps for games, scavenger hunts can use *pictorial maps* as well as *attention guiding techniques*.
- Storytelling maps can adapt *Opacity Mask* to narrow focus.
- Navigation maps can use *Numbering* to guide readers.
- *Geometric Boundaries* are a great way to highlight exits and assembly points in health and safety maps.
- The plant and site maps of Oil and Gas exploration can make use of *attention guiding techniques* along with *narrative information* of the facilities available.

Future Recommendations

Design Guidelines

- Explore levels of transparency with Opacity Mask.
- Add a numbered list of POIs in map, using Numbering.
- Experiment with narrower widths and softer colors for Geometric Boundaries.
- When adding own labels, keep them legible in terms using color, font and size.
- Add pop-ups on hover.
- Smooth transitions between clicked elements.
- Keep the map extent adaptive, such that it need not be scrolled both vertically and horizontally.
- Consider learning effect of readers.



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