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Visualization concepts for representing spatiotemporal vagueness in colonial collection research using the example of historical ship journeys

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Abstract:

In provenance research, one of the main goals is to trace the different stages of object acquisition, for example in relation to colonial collection activities. Historical sources such as logbooks or travel reports can provide useful information to reconstruct the itineraries of ships from the colonial era, while important insights such as ship encounters or preferred travel routes may only be gained through cartographic representation and by overlaying the itineraries of different ship journeys. Within the DiViAS (Digitization, Visualization and Analysis of Collection Items) research network, different historical processes and objects from colonial contexts are analyzed, which have in common that they all include a space-time component. An example of such a process is the analysis of historical ship journeys, which is primarily based on two specific historical sources, namely the Prize Papers collection (https://www.prizepapers.de/) of the National Archives in London, UK, including logbooks and journals, and the provenance and collector biographies from collections of the State Museum Nature and Human in Oldenburg, Germany, covering the Southwestern Pacific area. To reconstruct historical ship routes, logbooks and travel reports are first transcribed, then validated and corrected by hand if necessary. Afterwards, information such as place names, coordinates, dates and times, persons, and objects are automatically extracted from the transcripts using named entity recognition and large language model-based workflows. This information is then stored in a geo database and serves as the basis for visualizing the paths of ships, persons or museum objects.

When reconstructing and visualizing historical ship routes, a particular challenge is posed by the often vague data basis, especially with regard to spatial and temporal information, which can result from measurement errors, gaps in the data or imprecise descriptions. To visually communicate spatial and temporal vagueness, the concept of *possibility spaces* is introduced. A possibility space comprises the entire space where an event may have taken place, which could relate to the geographic space, but also to a time range. The level of vagueness inherent to a described location can range from very precise (e.g. a single object) to very imprecise (e.g. a very large area). Hence, depending on the wording of a description from the historical source, the possibility space to be defined can, for example, encompass the area of a harbor, a bay or in extreme cases of an entire ocean. The spatial extent of objects in place descriptions can have the format of a point, line or an area geometry. A point geometry is for example used in case of a precise location name or if coordinates are provided in the source. A line geometry can result from descriptions like “anchoring 300 meters off Kabotteron Island” (Figure 1.A), which can be represented as a parallel line at a constant distance from the coastline, while an area geometry can result from descriptions like “anchoring at Mankai Bay” (Figure 1.B) or “passing through Steffen Strait” (Figure 2.A). The possibility space to be created then can also include a buffer in order to represent the uncertainty. Importantly, the definition in this work currently focuses on possibility spaces for locations on water, while the definition can be extended to locations on land – for example in the case of shore leaves of the crew. Similar as for spatial vagueness, it is also possible to define different levels of temporal vagueness. Here, the vagueness can range from a very precise time indication to very imprecise temporal information. In addition to defining possibility spaces for locations, it is also possible to define such a space for a route segment between two locations on water. In this case, a different approach is followed. Since the historical sources do not provide exact information about the itinerary of the journeys, the path

between two described locations of the journey is often vague. This requires reconstructing the travel paths by calculating possible route options based on the geographic space that is crossed, as well as further information such as weather, time or direction information. The resulting route options, which not necessarily only include the shortest or fastest options, can then be used to define the extent of the possibility space, in such a way that the boundaries of the possibility space are defined by those route options that take the longest detour, but are still considered plausible (Figure 2.B).

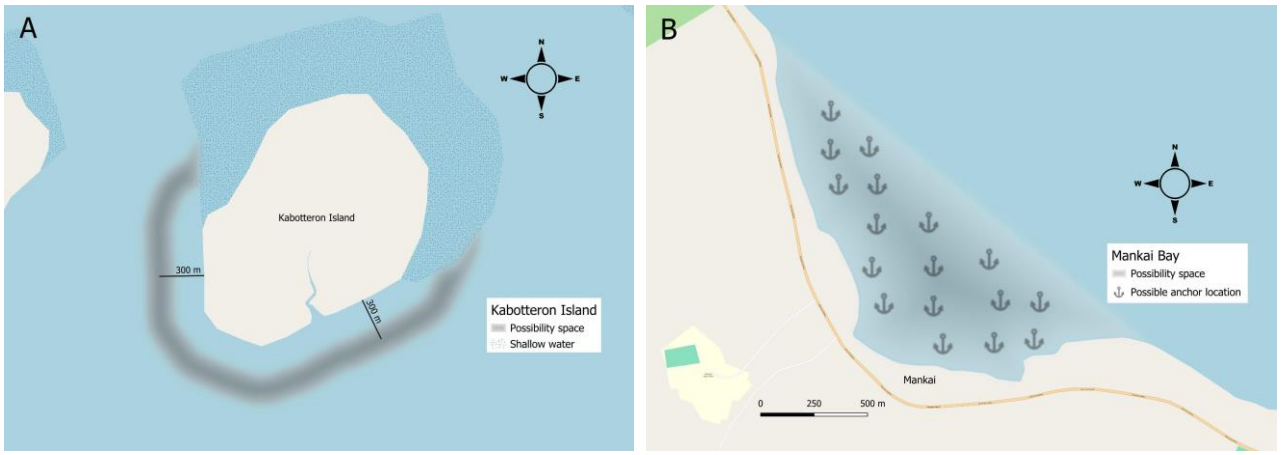

Figure 1. Visualization examples for events with static location information. A: Example for the event “anchoring 300 meters off Kabotteron Island” showing an uncertainty buffer around the offset coastline. B: Map example showing the possibility space of the event “anchoring at Mankai Bay”.

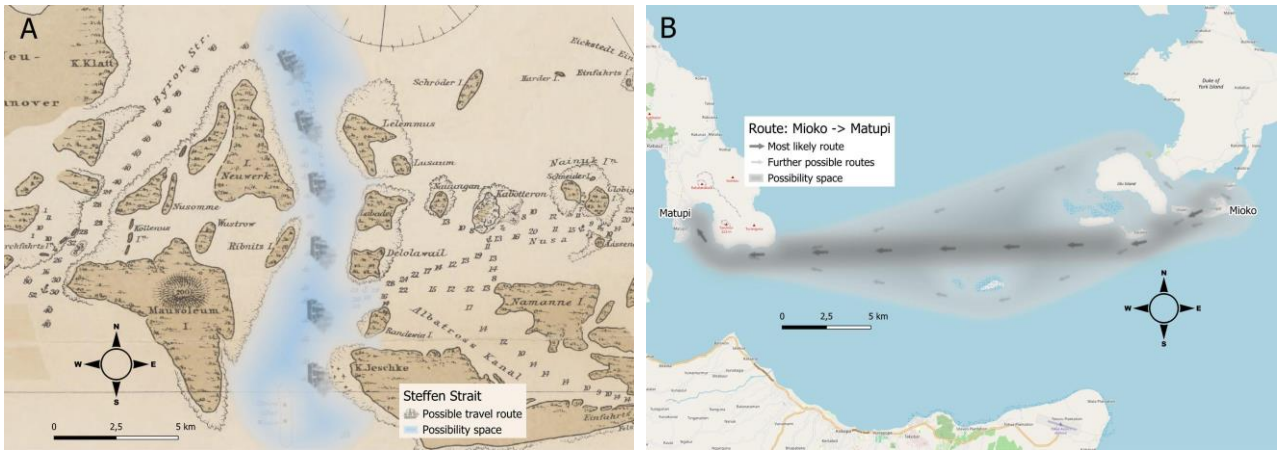

Figure 2. Visualization examples for events with dynamic location information. A: Example using a historical base map for the event “passing through Steffen Strait”. Base map: Der Nord-Westl. Theil von Neu-Mecklenburg; Bundesarchiv R 1001-KART/11007; Berlin, Germany. B: Map showing the possibility space including a selection of path options for the route between Mioko and Matupi.

In some cases, the available data sources may allow to further distinguish vagueness variations within a possibility space or other geometries such as route segments, which can be visually communicated using map symbols. Starting from the most probable location within a geometry (e.g. in the center), the symbolization is varied towards the least probable part within the geometry. To visually distinguish different vagueness levels for route segments and possibility spaces, different visual variables are used that have been found effective for encoding uncertainty information in previous works, including the use of transparency, blurring and dashing, but also the use of further experimental visualization methods such as using scribbles or jagged lines (Carroll et al., 2020; Kinkeldey et al., 2014; MacEachren et al., 2005; Schiewe, 2016). Furthermore, a possible application of dynamic effects such as animations, which may depict movement data more intuitively, is explored.

In the future, the resulting visualizations of the project will be integrated into a digital platform that is made available to the interested public. Since different user groups are expected to be interested in different aspects of the colonial collection activities, the visual presentation of the information needs to be adapted to different target groups. A museum visitor, for instance, might be interested in getting an overview of all ship routes and objects and explore the available content in an illustrative way. A researcher, on the other hand, might want to analyze the data by querying specific relations between

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ship movements, objects and persons, while a member of the societies of origin might want to find out more about the provenance chain, the acquisition context and the current whereabouts of objects that once belonged to their society. In all cases, providing additional vagueness information intends to raise the user's awareness of the fact that the visualized events did not necessarily happen at a precisely determined place or time, but rather represent the totality of possibilities in space and time. To address the diverse needs of different user groups, multiple variants of a web map representation are implemented that show the same information, while the way of presenting them, as well as the options for interaction differ from each other. The default representation involves displaying the entire journey in the initial view and allows different types of interaction such as zooming, filtering and searching for locations, objects or persons. Furthermore, a timeline is used to show the sequence of events over time. A variant representation for example uses a story map design that shows a sequential representation of the events that happened during the journey, with events (locations or route segments) being presented separately by zooming in on the relevant map areas. The user can interact with the map, for example by scrolling to the next event. A story map representation could be particularly interesting in a museum context, because visitors might be interested in being virtually guided along historical ship journeys by means of storytelling.

In the long term, the usability of the proposed visualization concepts for representing vagueness, as well as the different types of presentation within the digital platform, will be tested by potential users, with a focus on evaluating the user preferences regarding clarity and visual attractiveness based on different user groups. While the concepts have been described exemplarily for application to historical ship journeys, they are intended to serve as a blueprint for application to other use cases, problems and applications in the context of collection research.

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