What is Orientation?

Jakub Krukar and Angela Schwering

Institute for Geoinformatics, University of Muenster,
Heisenbergstr. 2, 48149 Muenster, Germany;
krukar@uni-muenster.de

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The dominant approach for computer-assisted navigation is realised by a turn-by-turn set of instructions communicated briefly before the decision point of the navigator. This technology has been shown to have no positive impact on users' survey knowledge [5], even after prolonged periods of active usage. One suggested reason for such an effect is its incompatibility with natural means of structuring and communicating spatial knowledge exhibited by human navigators [6]. While expressing wayfinding instructions, people use a wide variety of landmark types, simplified qualitative relations between route elements, refer to distant but salient spatial features as well as to a broad range of other 'auxiliary' information. These additional units of information are often not required to give the 'minimal correct' route description, and yet, navigators show consistency in the selection of elements deserving such a mention.

The recently commenced project 'WayTO: Wayfinding Through Orientation' aims to prototype and test a navigational support system whichadditionally to enabling an effective travelwill positively contribute to spatial orientation of its user in their broader urban environment. This will be realised by enriching navigational information with elements consistently used by human navigators for structuring and communicating spatial knowledge.

Traditionally, researchers have considered 'orientation' as synonymous to 'human performance in tasks' measuring concepts as diverse as spatial knowledge, spatial abilities and wayfinding performance. As a result, the existing literature uses the term 'orientation' inconsistently, sometime meaning a vague mixture of the above components contributing to one's understanding of their own location, and other times as a synonym of very narrowly defined notions such as 'survey knowledge'.

While we believe that survey knowledge (or spatial knowledge in general) is an important component of 'orientation', the terms are here distinguished. This is guided by the fact that complete spatial knowledge does not guarantee a perfect and continuously correct understanding of one's own location in the broader urban context. Conversely, a 'good enough' orientation is possible (and often exhibited) by individuals having a very limited knowledge of the environment. In the narrowest existing definitions, considering 'orientation' synonymous to 'survey knowledge' would indicate that a large proportion of population is as bad in remaining oriented as is their survey knowledge of the considered environment (and consequently their performance in survey knowledge-centred tasks employed in wayfinding studies). This seems to be untrue - as both research evidence and practical observations suggest, human navigators can flexibly adopt a broad range of strategies, combine unstructured, biased, hierarchical spatial knowledge of uneven quality or certainty and infer unknown spatial properties in order to reach their destinations.

This is possible as an imperfect spatial knowledge of one's own surrounding is not a 'mental map with blacked-out regions' but a mixture of graph-based representation of relations between regions and features, partial and intuitive knowledge of qualitative spatial relations, knowledge of hierarchical structure of objects in regions, and metric information at the finer level of detail [3, 4, 7]. And yet, despite a significant advancement in our understanding of the structure of spatial mental representations, wayfinding studies and technological evaluations remain dominated by measures relying on route- or survey-knowledge: the implication often being, that a more complete 'cognitive map' is a sign of better orientation. Such an approach does not consider human ability to infer some spatial properties and remains ignorant of the non-uniform importance of the precision and correctness of those properties for the success of natural navigation.

We therefore propose to consider orientation as a dynamic process of deriving one's position in space with regard to known environmental information at a scale (or subset of scales) relevant to the current goal. This implies that such a representation can be correct at some levels of conceptualising space while remaining imprecise (or even incorrect) at others. For instance, a navigator might know that they are located at position A, south from the city centre, and that the destination point B is somewhere inside a region located north-west of the centre. They might be aware of the fact that arriving there from the current position would require following a path along a park and crossing a river. These are all correct informational units sufficient for a high degree of orientation - probably sufficient to complete a navigational task and to update one's location along the route. And yet, externalisation of this representation can result in a broad range of possible results due to the need to infer unknown spatial information (e.g. the angular direction from A to B or the exact location of B inside its region). Figure 1 demonstrates some sample possibilities.

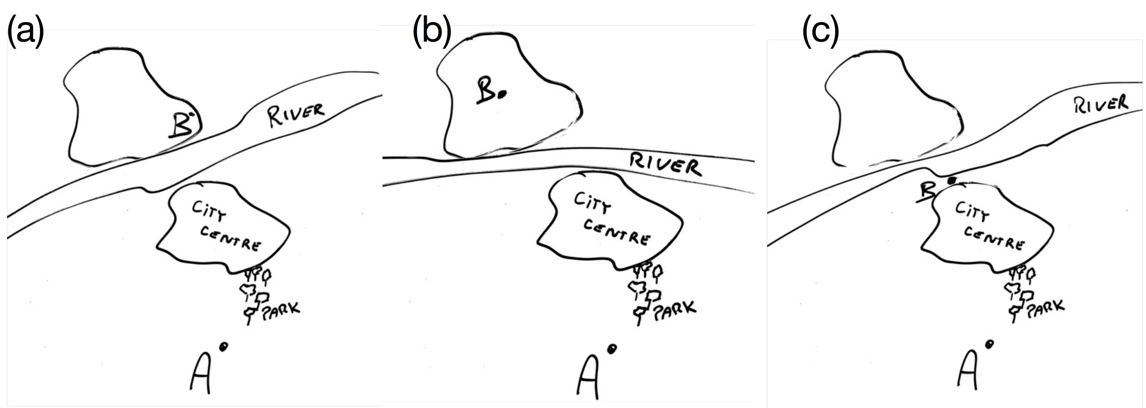

Fig. 1. (a) Correct survey representation of the environment. (b) Potential externalisation variant based on participant's imperfect knowledge assuming the navigator only knows that they are located at position A, south from the city centre, and that the destination point B is 'somewhere inside' a region located north-west of the centre, as well as that arriving there would require following a path along a park and crossing a river. Estimated position of point B in (b) might be biased towards the centre of the region and river might be adjusted to the orthogonal axis. This externalisation would yield relatively large errors in a Pointing Task and Bidimensional Regression Analysis of sketch maps. Despite being incorrect (or imprecise), it should suffice to orient in the environment. (c) A small metric, but large qualitative error, inconsistent with participant's knowledge. This would yield good survey-knowledge results if measured traditionally.

Note that as traditional measures used for establishing wayfinding performance are dominated by the ‘map in the head’ metaphor, they could yield drastically different results. For instance, poor pointing performance or a low bidimensional regression score of a drawn sketch map can be observed even when the actual knowledge of the required spatial relations is matching the factual environmental configuration at a degree sufficient for a navigational task. The opposite is also possible: a high bidimensional regression score or pointing performance can be observed, while participant has an incorrect representation of key spatial relations between important structural elements of the environment; for instance, believing that the destination is at the incorrect side of the river would correspond to a small metric/angular error in traditional tasks but jeopardise one’s navigational possibilities in the region.

Despite the vagueness resulting from imperfect and uneven knowledge of different spatial properties, humans are relatively efficient at using such sparse and unevenly distributed knowledge to navigate. One strategy demonstrating that being the on-line correction of wrong assumptions based on the newly gained visuo-spatial information during walking [2].

Considering orientation as a dynamic process and not as a stable, constantly updated representation on a metric ‘map in the head’, implies that orientation can vary on a goal-by-goal (or rather ‘extraction-by-extraction’) basis. Asking a participant to point to an element X can prompt different orientation than pointing to element Y as element Y might be strongly associated with previously unneeded features or relations (e.g. at a larger scale). The process of inferring unknown spatial properties can be thus seen as not less important than the process of externalising known spatial elements and relations [1].

In this view, an orientation-supportive navigational assistance system can contribute to its user’s orientation by:

a) correcting incorrect (biased) assumptions about a subset of those spatial properties which might be most broadly applied to other potential cases of deriving orientation (e.g. global and regional landmarks, large structural features);

b) linking unknown spatial knowledge to known spatial features;

c) highlighting information about yet-unknown structural regularities and hierarchies assisting to organise the newly acquired knowledge in a manner in-line with the ways such knowledge is organised naturally (for instance in a hierarchical way dominated by salient features, and alignments to regular geometrical shapes).

In the talk we will present the goal of the recently commenced ‘Wayfinding Through Orientation’ project, preliminary results supporting some of the above claims, as well as theoretical and methodological considerations for the way forward.

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