Exploring the Experience of Path Networks

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1 Motivation and hypothesis

Despite individual distortions in the mental representations, people familiar with the environment can successfully communicate spatial knowledge in route directions. The hierarchical organization of this knowledge in mental representations is reflected in hierarchical route directions and place descriptions [1, 2]. Wayfinders—hearers are able to adapt the information received from direction givers—speakers, and match it to their own mental representation, grounded in a different hierarchy. This may be possible because the two hierarchies are created through similar processes, and thus have similar structure.

It seems that a part of the environmental knowledge is shared, at least at coarser levels of granularity, by the majority of locals. This shared knowledge is assumed by the speaker in a communication situation. As Schelling showed in his work on strategies in communication [3], prominent objects or locations are used as references in tacit communication. In order to create route directions with a variable level of granularity [2], prominent parts of the street network must be identified.

Our hypothesis is that we can quantify this prominence and hierarchically rank streets, reflecting the likelihood of the shared experience, through measures of network connectivity. Our goal is the identification of connectivity measures that will reflect the experience of space of the wayfinders, and thus will provide a plausible quantification of network elements' prominence.

2 Method

We use *named paths* [4, 5] as basic analytic elements of the street network, referred to in route directions. Degree, closeness and betweenness centrality were analyzed, starting from simple regular graphs, consecutively modified by the introduction of shortcuts and distortions. Global and local properties of the measures, as well as the change of their values after the introduction of irregular elements, were analyzed. The emergence of the hierarchy through experience driven by likelihood of usage was considered to assess the plausibility of the results.

Betweenness centrality was identified as a good candidate for explaining the experiential hierarchy of urban networks. It quantifies the proportion of shortest paths a graph element lies on. With the increasing number of trips performed by a wayfinder

in city, the likelihood that betweenness approximates well the agent's experience of the urban environment increases. As the size and layout of the network influences the values of betweenness, it is the relative difference between the values within a network that reflects the variation of prominence.

3 Experiment

The analysis of the city of Melbourne, Australia was performed to test the path hierarchy revealed by betweenness centrality on a larger scale. Melbourne has a distinct regular grid pattern in its center and a system of streets which reach radially beyond the center. The paths identified by the analysis correspond to the most prominent streets of Melbourne, well known to virtually all inhabitants of Melbourne. Highest ranking Victoria Street is the major east-west street, and has a similar role as the second King Street, channeling most of the north-south traffic. Due to scale-free distribution, the few paths with high betweenness values are prominent and are likely to be experienced by any local or visitor of Melbourne.

4 Conclusion

This result illustrates the plausibility with which betweenness centrality reveals the experiential hierarchy in an urban network, and also points to the importance of named paths as a conceptual building block of the urban network. Urban datasets structured to match the experience of locals, instead of administrative hierarchies, are an important input for improved communication of spatial information in context aware applications, such as route direction generation for locals.

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