

Route Planning in Hierarchically Structured Environments: From Places to Regions

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Introduction

The structure of human spatial memory has been studied using a wide variety of experimental paradigms. In regionalized environments distance- and directional-judgments, spatial priming- and recall-procedures produce systematic distortions (Hirtle & Jonides, 1985; McNamara, 1986; Stevens & Coupe, 1978). These results led to the hierarchical theories of spatial representations that propose that spatial memory is structured, depending on physical properties and subjective evaluation of space. This structure can be expressed in a graph like representation of space in which places are grouped together to regions that form super ordinate nodes. Here we present three experiments that reveal an influence of environmental regions on human route planning behaviour. Furthermore we propose a route planning heuristic that could account for the observed effects.

Methods & Findings

Subjects navigated through virtual environments that were divided into different regions. Places within these environments could be identified by associated landmarks. After learning the environments subjects were asked to either find the shortest route to a single target-place or to find the shortest route for visiting three places in the environment. We find (i.) that subjects minimize the number of region boundaries they have to pass by during a trip, (ii.) that subjects preferred paths that allowed for fastest access to the region containing the target, and (iii.) that in routes with multiple target regions, subjects chose to visit the closest target region first.

Discussion

These findings show that environmental regions do influence human route planning behaviour and suggest that regions are explicitly represented in human spatial memory. Human route planning takes into account region-connectivity and is not based on place-connectivity alone.

Planning Heuristic

Motivated by the empirical findings we propose a planning heuristic that uses both, coarse space information (region-connectivity) for the distant locations and fine space information (place-connectivity) for the close

locations. In routes with multiple goals, the planning algorithm will start by selecting the next goal region, i.e. the closest region containing a goal. The next step is to plan a route for fastest access to that region, irrespective of where exactly the goal is located within that region. This strategy would lead to results like the ones presented.

By using spatial information at different levels of detail for current location and target location, the proposed planning mechanism is less computationally expensive than planning mechanisms that use detailed information solely.

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References

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