Wayfinding in Scene Space

Modelling Transfers in Public Transport

Urs-Jakob Rüetschi

The thesis presented here attempts to create a cognitively plausible simulation of human wayfinding in semi-structured environments such as train stations. The goals are to characterise such environments, to formally represent them along with the wayfinding process in a computational model, and to use this model to analyse which environmental structures help making human wayfinding so reliable.

1 The Environment

Wayfinding is a daily activity for all of us: purposeful movement in an environment, such as the public transport system. Wayfinding in public transport takes place on traffic networks. These consist of lines that are interconnected at nodes, ranging in size from small stops to large stations. The network is essential to wayfinding because it is the basis for routing decisions (such routing is much simplified by the presence of network maps and electronical timetables). To the traveller, however, the stops and stations are equally important, for they are the places where the complexity of the system is most intensely experienced. Moreover, there are usually no maps or guidance systems to help the traveller, and there is no obvious network that helps with routing. Rather, stations consist of open 'scenes' in a hierarchical structure. I refer to such places as *scene space* to contrast them from *network space*. Wayfinding in public transport inevitably takes place in both types of space, but transfers are in scene space. Scene space is directly experienced, whereas network space is mediated through maps and schedules [1].

Scene space comprises the halls, squares, and platforms at train stations. It also includes stairs, elevators, gateways, etc. All these elements are assumed to be in an obvious hierarchical structure, whereas the topological structure is hard to grasp, at least to the novice user of a train station. Besides train stations, there are other examples of scene spaces, such as shopping malls, university campuses, and public greens. They are all the result of architectural and urban design (rather than engineering, which is the driving force behind the structure of network spaces). Navigating railway stations is a specific but representative instance of wayfinding in scene space.

2 Hypothesis and Method

This thesis investigates the hypothesis that *structural information* provided by the architectural layout is enough to guide travellers through railway stations. Computational modelling is used to test the hypothesis. This method allows to make structural changes to a railway station, which is hardly feasible with other methods such as surveys. Performing experiments, that is, running simulations, is also cheap and easy. The price to be paid is a considerable development endeavour and, in this specific case, the conceptual difficulty of finding an adequate representation for the vague notion of scene space (as opposed to network space, for which graph models are an obvious and well-established representation).

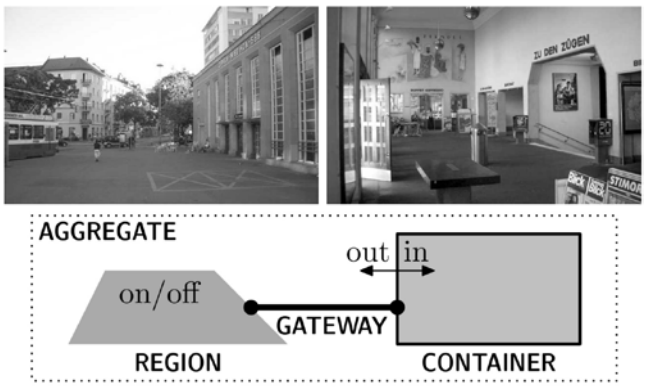

Figure 1: Using image schemata to represent a train station. The square (region) is linked with the hall (container) by way of the doors (gateway); all together belongs to the station (aggregate).

3 Schematic Geometry

The model of scene space, called *schematic geometry*, builds on image schemata [2] as its primitives. Image schemata are cognitive patterns that structure our perceptions and actions; many of them are inherently spatial. The theory of image schemata suggests that structural information is immediately usable for wayfinding decisions.

An image schemata driven analysis of railway stations resulted in a set of six frequently occurring schemata: region, container, aggregate, link, unconscious link, and object (Figure 1). Instances of these schemata, as created by a real railway station, always form a partonomy (part-of structure) or, mathematically speaking, a partial order. This observation reduces scene space to a well-known (but computationally unwieldy) structure, while maintaining spatial semantics by reference to the instantiated image schemata.

Schematic geometry allows for a formal definition of the notion of a *scene* (that part of the surrounding environment which can be seen and reached without conscious effort)