

# Knowledge Based Schematization of Route Directions

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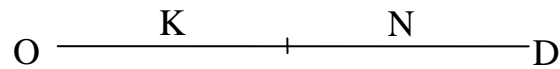
Over the past several decades, there has been a considerable amount of research conducted on the nature and quality of route directions, including those in mixed environments (Fontaine & Denis, 1999; Lovelace *et al.*, 1999). We extend this work to situations where wayfinding tasks take place in an environment that is composed of a familiar part and an unfamiliar part, which we refer to as a partially familiar route. We introduce a formalization that models routes of this nature, conduct an empirical study to investigate whether partially schematized directions are preferred over complete directions for such routes, and conclude with observations about the usefulness of the formal approach for future implementation in a wayfinding system.

## CONCEPTS FOR CODING FAMILIARITY

We use a graph theoretic approach to model the heterogeneity of route knowledge. The terminology we use to represent routes is derived from work on wayfinding choremes (Klippel, 2003a, 2003b; Klippel *et al.*, 2005).

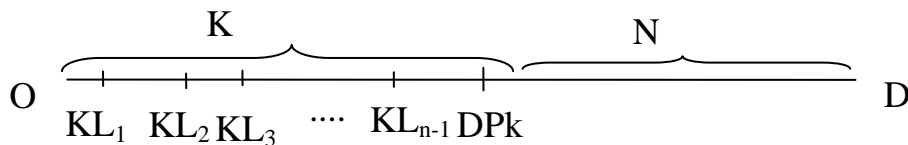
To Klippel's original framework, we introduce the concept of a partially familiar route, or knowledge route (<kroute>). A partially familiar route is one which incorporates a familiar region (<K>) and an unfamiliar region (<N>) along the same route (Figure 1). This gives the most basic form of a partially familiar route. The braces indicate that the order of <K> and <N> can be interchanged.

$$\langle \text{kroute} \rangle ::= \langle \text{O} \rangle \{ \langle \text{K} \rangle \langle \text{N} \rangle \} \langle \text{D} \rangle$$



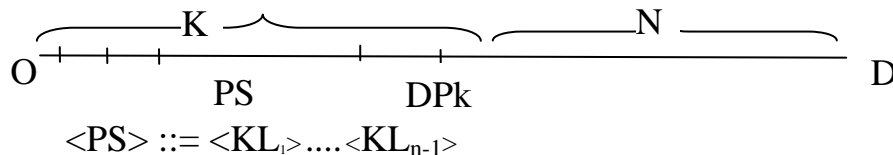
**Fig. 1:** The most basic form of a partially familiar route

Points along the familiar portion of the route will consist of one or more points called known locations (KLs). A KL is a point along a route that a person is confident of being able to navigate to. We list three broad categories of KLs, one is a decision point (e.g. “Bates Street entrance ramp to I-376”), the second is a local landmark (e.g. “The Capitol”) and the third is a building or address that an individual may frequent (e.g. “Hillman Library”). The third concept we introduce is a special case of a KL which is the KL that is closest to or at the intersection of a K and N region of a route, called a known decision point and is denoted as (DP<sub>k</sub>) (Figure 2).



**Fig. 2:** The basic partially familiar route with the ‘n’ KLs including the DP<sub>k</sub>

The final concept we introduce is the concept of a ‘knowledge chunk’. Knowledge chunking is similar to landmark chunking, presented by Klippel (2003b). In our model, knowledge chunking is carried out after the DP<sub>k</sub> has been determined and involves grouping all the segments in the region of K into one ‘knowledge chunk’ that we term as the ‘proceed to statement’ <PS>. In the case of the basic <kroute> presented in Figure 2, directions describing the route along the ‘n’ segments in the region of K can be chunked into one <PS> statement (figure 3).



**Fig. 3:** The <PS> statement used to represent the n segments preceding the DP<sub>k</sub>

The primitives identified above along with slight variations to the <PS> statements are suitable for characterizing three distinct cases of partially familiar routes that we have identified as

- KN-NK routes: Routes of this kind consist of one K region followed by an N region or vice versa
- KNK-NKN routes: Routes of this kind consist of a N or a K region sandwiched between two K or N regions
- KNKN<sup>+</sup>-NKNK<sup>+</sup> routes: This case is presented in the interest of completeness

Knowledge chunks allow for the schematization of directions so that routes in familiar regions <K> can be treated differently than routes in unfamiliar regions <N>. In the next section, empirical evidence is presented for the simplest case of KN routes.

### **EXPERIMENTAL SUPPORT**

To establish whether schematized directions are preferred over complete directions given that the subject has prior knowledge of an area, a study was conducted on two different scales. The first experiment looked at walking directions and is denoted a medium scale space. The second experiment looked at driving directions and is denoted a large scale space. In both experiments, subjects' knowledge of a section of the route was established and schematized directions along with complete directions were presented. We hypothesized that significantly more schematized directions would be preferred by subjects. Overall, across all destinations and both the experiments, the results supported the hypothesis ( $p$ 's < 0.01). Questionnaires confirmed subjects' preferences for schematization but emphasized the role of knowledge in determining this preference.

### **CONCLUDING REMARKS**

The formalization discussed can be implemented in a future wayfinding system which can access a user's knowledge of a route and model the route as a <kroute>. The system can then apply the knowledge chunking rules and present a schematized route to the user. Another natural extension is the schematization of maps based on a user's prior knowledge of the area. For instance, a map gesture (Hirtle, 2000) can be used to direct a user from the DPK to the destination in the NK model. These issues will have to be confirmed with further empirical studies.

## REFERENCES

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