Notes on the timely presentation of route related information

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Notes on the timely presentation of route related information

Sabine Timpf, Zürich

Abstract

Modeling inter-modal navigation for location-based services requires answers to the questions 'what', 'when' and 'how' to present information to the traveler. In this short paper, we propose to derive the information needed (the what) from the information collage and the time of presentation from the action plan. The presentation of the information is dependent on the answers to the 'what' and 'when'. This paper presents work in progress.

1 Introduction

Information needed for navigating in a dynamic environment needs to be presented in a timely fashion in order to be useful to the traveler. This observation is especially true within the context of location-based services. We understand inter-modal navigation as wayfinding (Golledge 1999) with several modes of transportation, i.e., a combination of different means to get from one place to another. This type of navigation can usually be found in urban areas where changing from walking to riding the bus to taking the subway is the normal way of using the transportation system. In inter-modal navigation the traveler uses diverse and maybe even contradictory information to find her way to the goal.

Humans collect information about routes and represent this spatial and non-spatial information mentally. Tversky has suggested that a collage is a fitting metaphor for the mental representation of wayfinding information (Tversky 1993). Our work uses the structure of a collage to represent assorted wayfinding information about a specific route at a specific time. This work is part of the effort of naïve geography, which aims at incorporating human mental models into formal models about space and spatial behavior (Egenhofer and Mark 1995).

The metaphor collage provides a good structure for (at least partial) integration or ordering of heterogeneous information based on the task of the traveler (Kuhn 1993). The information can be spatial (route), temporal (duration of trip), financial (ticketing), or social (dangerous at night). The integration has to be primarily spatio-temporal for wayfinding, but the other information may serve as constraints or additional decision criteria for alternative routes.

The optimal presentation time for navigation information can be deduced in a first approximation from an action plan. This plan depends on the complexity of the route (Heye, Rüetschi and Timpf 2003), the aims and abilities of the traveler, and her familiarity with the environment. An action plan details the spatio-temporal actions that a traveler needs to carry out in order to find a way from a start to a goal. The action plan corresponds in most cases to the route instructions derived in the route planning (Timpf et al. 1992). However, depending on the user's requirements, the instruction can be more or less coarse. Therefore we propose a hierarchical graph containing action plans for a specific route at different levels of granularity.

The paper is structured as follows: section 2 presents the information collage and the notion of cognitive collage from which it is derived. Section 3 explains our notion of an action plan and the corresponding hierarchical wayfinding graph. This graph is needed to derive the time when information should be presented to the traveler. Section 4 presents conclusions and future work.

2 Information Collage

The term information collage (Fig. 1) is derived from the term cognitive collage coined by Tversky (1993). Tversky argues that some spatial information is not pictorial and thus cannot be represented in a cognitive map. She prefers to use the term *spatial mental model* to account for all types of spatial information representations, pictorial and non-pictorial. In the same work, she proposed the notion of a *cognitive collage* to account for the fact that spatial information collected and accumulated over the years is very diverse, has different formats, different levels of detail, shows different aspects or point of views and even allows for erroneous, contradictory, and incomplete information. She also stated the very personal nature of a cognitive collage that included recollections of places and memories, even overlapping (temporally or otherwise) information. In addition the metaphor is most appropriate for knowledge about environments that are not well known.

This metaphor has inspired work by Claramunt (1996) who built a model describing a cognitive map, which represents navigation knowledge. The model includes the notions of spatial view and of *spatial collage*. Each coherent description of the navigation

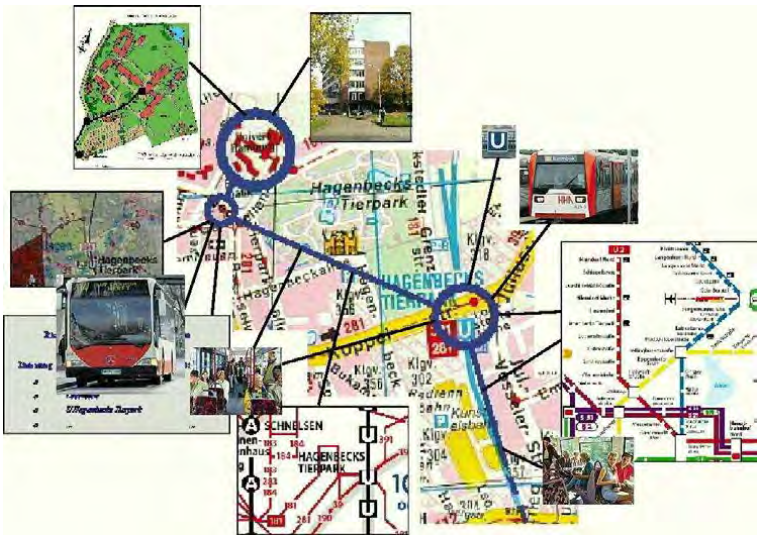

Fig.1: Part of an information collage

process is termed a spatial view on a collection of database objects. A spatial collage is defined as a connection between spatial views. So, for example, the description of a navigation process would use three different spatial views and thus require two collages to connect them.

A cognitive collage for a navigation process is a collection of disparate pieces of knowledge about decision points along a route and the route itself: recollections of journeys through this decision point or along the route, memories of maps, recall of verbal (aural or written) instructions, facts about the decision point or the route, different spatial (might also be historical) views of points along the route and more (olfactory information, associations (meeting with friends, seeing something strange)). The structure of the cognitive collage is unordered, the only combining effect for each of these pieces of information is that they belong to a route and can be 'triggered' through knowledge in the world.

A cognitive collage is highly personal and subjective. However there are pieces of information in a collage that could be termed objective: information on timetables, alternatives of routes, views of buildings, means of transportation, knowledge about decision points, etc. The structure of a collage can be used to associate many different pieces of 'objective' information with a given route.

We are interested in providing a user with a collection of information pieces or fragments associated with a route the user has to travel. An *information collage* is the collection of all the pieces of information that an information system could retrieve at a certain point in time as they pertain to the route, including information on the route itself. Each piece of information is called an information fragment. Instead of trying to integrate all the information fragments and make them consistent, we associate each fragment with the point of the route it corresponds to. These points may be places, locations or time points during an action or operation. Information fragments may be graphical or textual.

3 Action Plan

An action plan details the spatio-temporal actions that a traveler needs to carry out in order to find a way from a start to a goal. The action plan corresponds in most cases to the route instructions derived from the route planning process. However, depending on the user's requirements, the instruction can be more or less coarse. For example, a traveler who knows the urban area might just need a reminder where to go (cf. essential actions in Table 1), whereas a person in a wheelchair might prefer the details presented at the level of the operations (cf. in Table 1).

Our model uses a hierarchical action plan to represent the route action information at different levels of activity. Each level of actions represents in fact a progressive abstraction of more detailed actions (Stell 1999). Actions start at a certain time and place in the navigation process and end again at a specific time and place. Those places are called decision points. They correspond to places where the correctness of the route may be reaffirmed or an alternate solution might be chosen.

Activity	**Wayfinding from Informatikum to Hamburg main station**					
Essential Action			Take bus 181 to Hagenbecks Tierpark		Take U2 to Hauptbahnhof	
Action		1	2	3	4	5
		Walk from Informatikum to bus stop 181	Take Bus 181 to station Hagenbecks Tierpark	Walk from bus stop to platform of subway	Take U2 from Hagenbecks Tierpark to Haupbahnhof	Walk from subway station U2 Hauptbahnhof Nord to Hauptbahnhof front entrance
Operation	A	Walk out of building	Get into bus 181	Walk towards U2 station	Get into subway	Take stairs at front of subway train
	B	Leave the campus	Buy ticket	Take stairs down to the platforms		Turn right at top
	C	Walk straight along Vogt-Koelln Strasse	Ride (4 stops) until bus stop Hagenbecks Tierpark	Walk on right platform with trains in direction Wandsbek-Gartenstadt or Barmbek	Ride (9 stations or 20 min) until subway station Hauptbahnhof Nord	Take next stairs to top
	D	Cross the next street	Get off bus		Get off subway	Turn right and walk 10 meters
	E	Turn left				
	F	Walk to bus stop				

Tab.1. Action plans in wayfinding at different levels of granularity (case study Hamburg)

The hierarchical wayfinding graph (Fig. 2) encodes the knowledge about activity, actions, and operations at the same time as it stores knowledge about the routes at different levels. Each level shows the route at a different granularity, i.e. at a different activity level (cf. Timpf 2002).

Nodes are places (e.g., Informatikum, Hagenbecks Tierpark) and depending on the granularity level also locations (e.g., bus stop at Hagenbecks Tierpark, top of stairs). Edges connect nodes and thus carry information on the action or operation to be performed. Each edge corresponds to exactly one action or operation. In addition, temporal and spatial information can be added to the edges.

The optimal presentation time for navigation information can be deduced in a first approximation from the action plan. It is important to note, that the information presentation should take place just *before* a new action is to be taken by the traveler. The absolute time interval, which denotes *before* is dependent on several factors (this is an open list): speed of travel, complexity of the route, number of potential interactions (may be dependent on the time of day, e.g., rush hour), number of alternatives, complexity of the choice, and potential disability of the person.

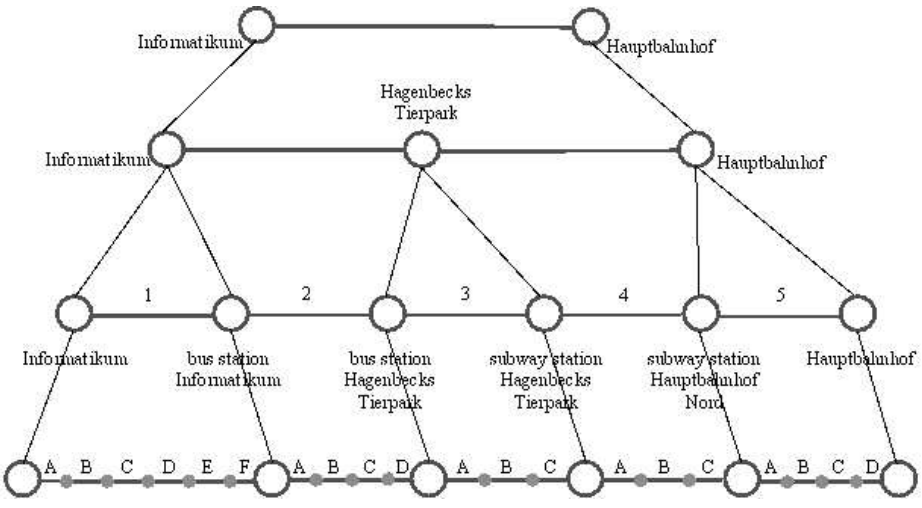

Fig.2: Hierarchical wayfinding graph including action plan

4 Conclusions

In this short paper we present work in progress in the area of modeling inter-modal navigation for location-based services. The focus of the paper is *when* to present *what* information to the traveler. We propose to derive the time of presentation from the action plan (derived from the route plan) and the information needed (the what) from the information collage.

We provide a model for navigation that is very similar to humans' mental representation of wayfinding information. The model takes into account that route information can be given at several levels of granularity and that different levels might be necessary in the course of one trip due to missing knowledge in the world (Norman 1988). The action plan at the appropriate level is chosen and the information presented to the user just before a new action is started.

In addition to the hierarchical wayfinding graph, we use the structure of an information collage to encode contextual information about the route and the navigation process. Information fragments are views on data in distributed information systems, e.g., bus timetables or subway connection information. Within the information collage fragments are associated with route sections, i.e., places or actions. The information collage has many advantages: it uses the same structure and mental model as the human traveler. It can include uncertain and contradictory information without becoming unusable. Through the different levels of activity the model is more adaptable to user needs, can solve the contradiction by providing more detailed information and through the same way makes the information less uncertain. The model also includes redundant information, which provides the user with greater security and flexibility. Redundant information might also solve the uncertainty of one fragment by providing a second one.

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