Communicating with Navigation Systems about Places

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Abstract. The aim of this research is to investigate the initial phase of route communication with a navigation system: the specification of a route by an origin and a destination. Comparing inputting of a place description to the ways that people communicate about places with each other, we observe gaps impacting the usability and efficiency of navigation systems. From these gaps we identify future research questions. This research only looks at the communication about places, and leaves other phases of the route communication such as the provision of route directions phase and confirmation and closing phase for future work.

1 Problem and motivation

In daily life, people frequently communicate to each other about place. Although they have varying and incomplete descriptive knowledge about their spatial environment, their communication regularly succeeds. Similarly, navigation systems provide interfaces for inputting place descriptions specifying an origin and a destination. A *place description* in the context of this research is an answer to a *where* question [1]. Current navigation systems reveal mismatches between their approaches and their users' cognitive reasoning and verbalization of place descriptions. Firstly, systems use gazetteers for toponym resolution [2]. To ease the burden of natural language processing, system interfaces come with structured input formats. Users have to be adaptive enough to describe their intended places in systems' format, e.g., postal addresses. In this given example, users cannot use the system if they do not know the addresses or their desired places have no formatted postal address. For example, a hospital occupying a block would not have an address with one street number and one street name. Additionally, gazetteers consist of a set of geographic placenames, each georeferenced with a pair of coordinates. This way of georeferencing is not a realistic representation of our world: geographic features have a spatial extent and should be represented by regions rather than a point at the centre position. Also, gazetteers do not store relations between places. Secondly, systems have no awareness that their gazetteers are incomplete and outdated, and the structure and extent of gazetteers are implicit to users. When users look for places names that do not exist in the gazetteers, the systems might offer a close match but would never locate the desired places precisely no matter how users amend input.

Contrary to formatted input in systems, humans describe places in a flexible manner. Winter and Wu [3] studied the route communication with a state-of-the-art navigation system, Metlink's Journey Planner, and observed several gaps in communicating with the system. This research looks at state of the art navigation systems, and identifies fundamental questions relating to the cognitive base of communicating with systems about place in general for future research.

The communication between users and route planning systems consists of three phases: the initial phase where users ask information for directions, the second phase where the systems offer information, and the last phase of confirmation and closing [4]. This research focuses on the initial phase, and proposes a system that allows users' input in a flexible manner as they use in daily life. The hypothesis of this research is that current systems have fundamental gaps in their understanding people's descriptions of place.

2 Experiments

Many navigation systems firstly provide users with an interface to input place descriptions: their current location (or another start place) and their desired destination. To understand how flexibly users can get into contact with systems, the input interface of six state-of-the-art navigation systems are tested (Table 1). The results show that systems have explicit or implicit formats for input, which users have to adapt to. Explicit input format is inefficient for users. For example with Metlink's Journey Planner, it is not clear for users that "The University of Melbourne" is in the category of landmark, stop/station or address. To find out whether systems with implicit input format work better than explicit format, we design the second experiment.

A typical scenario, finding tourist places, is tested. Three of selected state-of-the-art navigation systems serving Melbourne, Australia are further examined on their behavior of matching places. The results are categorized by the following legend: (a) exact match; (b) matched with a list of options where the correct result is found at i/n (i is the index of the correct option; n is the total number of options); (c) failed to deal with input or to match any of the options. The chosen place descriptions are picked up from a widely used tourist guide book [5].

The results (Table 2) show that none of the three systems succeeds in matching all seven places uniquely. In particular, WhereIs only works with addresses, although some places without addresses are labeled on its maps. Google Maps performs best: it identifies all seven places with the most relevant at the top of the result list. Both Google Maps and WhereIs are capable of searching for business services in the vicinity.

Having the best performance, Google Maps is further investigated to determine how adaptable it is to users' input. The spatial reference with the second and seventh places, *cnr Flinders & Swanston Sts*, is tested by varying input in different formats that users would use. The results show that when *Melbourne* is not included in key words, Google Maps frequently locates the place at the

Table 1. Comparison of state-of-the-art navigation systems (T for text; M for click on map; P for public transport, pedestrians or cyclists; C for cars).

	Input types	Input manner	Businesses nearby?	Services	Region
Metlink[1]	station/stop; landmark; address	T, M	no	P	Melbourne (Australia)
WhereIs[2]	address	T	yes	C	Australia
Tomtom Car Navigation	address; landmark; crossing	T	yes	C	Melbourne (Australia)
German Railway[3]	station/stop; landmark; address	T	limited	P	Germany
Sogou[4]	any	T, M	limited	P, C	China
Google Maps[5]	any	T, M	yes	C	Global

intersection of Swanston Street and Flinders Street, Yokine WA 6060. Although it also indicates other relevant options with *Flinders* and *Swanston* within Australia domain, these options are in an arbitrary order with the one in Yokine WA at the top. Additionally, Google Maps does have format constraints: it locates *cnr Flinders & Swanston Sts, Melbourne* at the intersection of Flinders **Lane**, instead of Flinders **Street**, and Swanston Street. It is obvious that Google Maps does not interpret *Sts* as an abbreviation in natural language. In further tests, it is found that some abbreviations can be interpreted properly, e.g., *cnr* and *st*. If searching for *Flinders / Swanston* without specific street types, Google Maps offers 79 options "for **Flinders /** near **Swanston TAS**" as result. The spatial relationship "near" is not appearing in key words but inferred by Google Maps. It also identifies other spatial relationships, e.g., *in*. However there is no reference explaining what and how spatial relationships are defined in Google Maps.

3 Discussion

This research examines the initial phase of the route communication with state-of-the-art navigation systems. Experiments are designed to test whether these systems have constraints and to benchmark the performance of dealing with flexible input. The results show that current navigation systems are inefficient in the specification of a route by an origin and a destination. There are cognitive

[1] www.metlinkmelbourne.com.au
[2] www.whereis.com
[3] www.bahn.de
[4] map.sogou.com
[5] maps.google.com.au

Table 2. Results of searching tourist places in Melbourne, Australia.

	Test input	Metlink[6]	Google Maps[7]	WhereIs[8]
1	Melbourne Museum (Carlton Gardens)	(b)3/3	(b)1/153	(c)
2	Federation Square (cnr Flinders & Swanston Sts)	(a)	(b)1/666	(c)
3	Royal Botanic Gardens	(a)	(b)1/1666	(c)
4	Immigration Museum (400 Flinders St)	(a)	(b)1/121	(a)
5	Queen Victoria Market (513 Elizabeth St)	(a)	(b)1/714	(a)
6	Rialto Towers observation deck (525 Collins St)	(a)	(b)1/29	(b)2/2
7	St Paul's Cathedral (cnr Flinders & Swanston Sts)	(c)	(b)1/68	(c)

gaps between users and systems. In particular, with more format constraints users have to adapt to the systems and have difficulties to express themselves in the process, while with less format constraints the systems have challenges to interpret users' input. Therefore the hypothesis is proved.

From the experiment, unsolved fundamental research questions raise as follows: what is the most natural and effective input model for navigation systems, and how can systems interpret users' input properly and efficiently? As natural language of spatial concepts express everything as place descriptions in principle, further questions are how to locate a place given by a place description, and what is the status of having place descriptions. Additionally, the semantic base in the place description also requires further investigation, such as understanding spatial relations, vernacular names, and context-dependent expressions.

References

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[6] All inputs are tested by using Landmark input type in Metlink's Journey Planner.
[7] All place descriptions are attached with *Melbourne* in input.
[8] If available, the address is tested instead of place name. All addresses are affixed with *Melbourne, VIC* in input.