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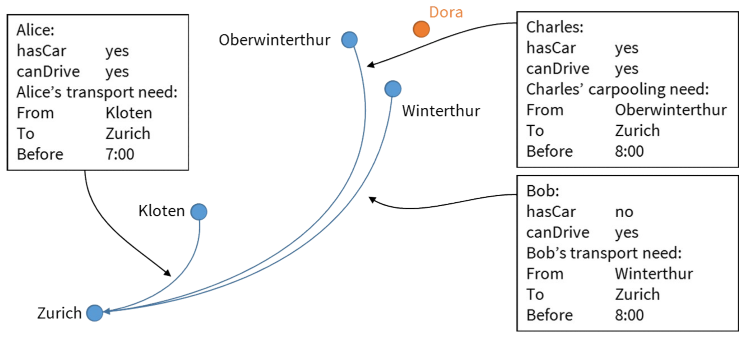
Matching Complementary Transport Needs

Dominik Bucher, Paul Weiser, Simon Scheider, Martin Raubal
Institute of Cartography and Geoinformation, Chair of Geoinformation-Engineering
Stefano-Franscini-Platz 5, Zürich, Switzerland

1. Introduction

Alice, Bob and Charles are looking for carpooling partners for their daily commutes. While Alice posts a classified ad on Craigslist, Bob uses a specialized Web portal to publish his need. Charles browses through offers of others to see if he can find a partner.



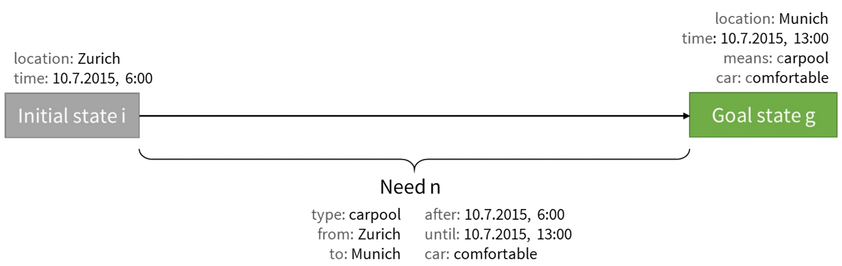
It is unlikely that they find optimal matches, because current technology (cf. Weiser et al. 2015):

- Lacks support for the **duality of query and result**: Every search query is a result for an agent with a complementary need. E.g, Charles should not have to explicitly post another ad. His search provides enough data to infer the base need, and make it available to others (cf. Brimicombe & Li, 2006, p.13).
- Keeps **data in «silos»**: A large amount of data is kept within proprietary applications with their own data structures and user interfaces, making automatic and manual interaction with them difficult (McKenzie, 2015).

«How can we improve the process of finding people with complementary needs?»

2. Needs as Linked Data

A need n is the discrepancy between a desired goal state g and an initial state i (Burton & Merrill, 1991). We propose to specify needs by assigning it a type t and linking initial and goal conditions to this need.

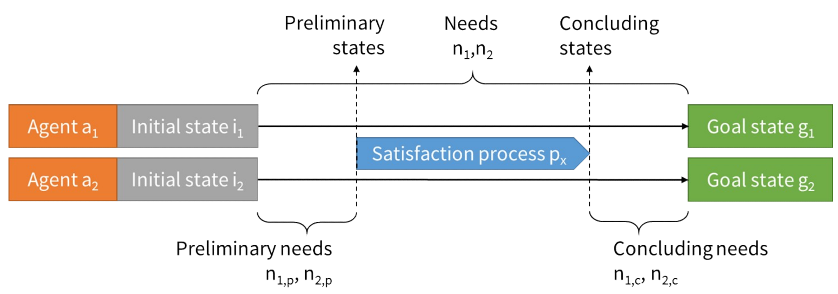


Why *Linked Data*?

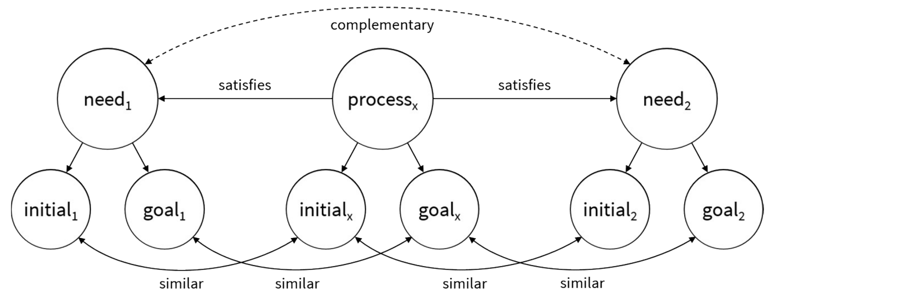
- Needs have real-world reference (e.g., to existing persons and places).
- User can choose the amount of details in their need specification.
- Needs can easily be integrated into the existing Web of Linked Data.

3. *Complementary Needs*

Needs are *complementary* (i.e., they *match*) when there is a (collaborative) satisfaction process p_x that satisfies them. Optimally, simulating this process transforms initial states into goal states (cf. agent planning (Russel & Norvig, 2010; Raubal & Winter, 2010)). In cases where only an approximation is possible, one can leave initial or goal states unsatisfied and create new *preliminary* needs $n_{k,p}$ or *concluding* needs $n_{k,c}$.

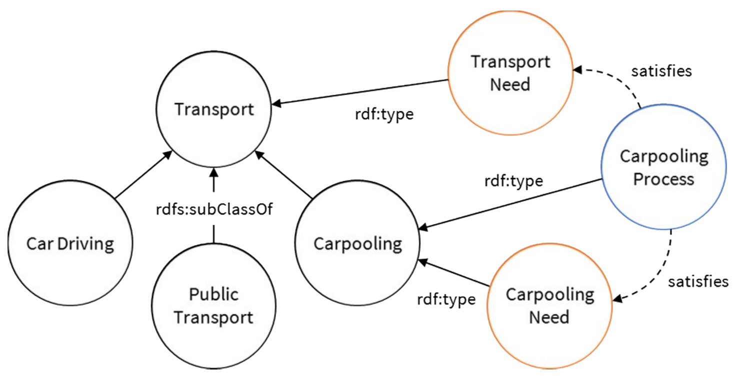


The degree of satisfaction is defined in terms of similarity of initial and goal states (Janowicz, Raubal, & Kuhn, 2011). The outcome of the process simulation yields the following graph (initial and goal nodes are *named graphs* which represent the world in its respective state):



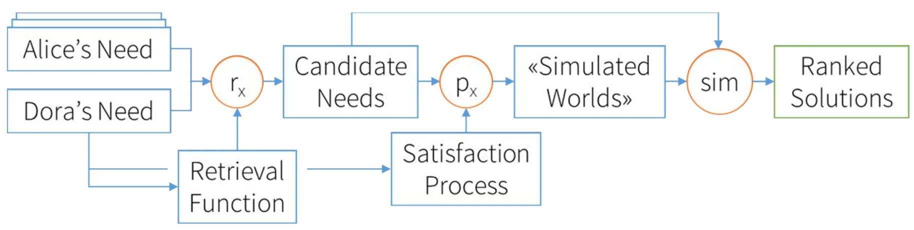
4. Efficient Processing

Because the number of needs is potentially unbounded, we use a need's spatio-temporal characteristics and its type t to select a subset of matching candidates. For example in the case of carpooling, other carpooling needs in close proximity are analyzed first, followed by more general transport needs. The assessment order can be represented by a need graph:



5. Workflow

1. Based on the need to match, a retrieval function and a satisfaction process are chosen (e.g., $r_{carpool}$ and $p_{carpool}$).
2. The retrieval function r_x is used to select a set of candidate needs (e.g., using time geography (Raubal et al., 2007)).
3. The satisfaction process p_x is used to simulate a best-possible match and assess how well which combination of needs can be matched.
4. These «simulated worlds» are compared to the original needs, and ranked according to how well they approximate the needs of users.
5. In case no good matches are found, the process is repeated using different processes, by trying to match preliminary and concluding needs or by relaxing goal states.



References

Brimicombe, A., & Li, Y. (2006). Mobile space-time envelopes for location-based services. *Transactions in GIS*, 10(1), 5–23.

Bucher, D., Weiser, P., Scheider, S., Raubal, M. (2015). A Model for Matching Complementary Spatio-Temporal Needs. In *Spatial Cognition & Computation*. Under Review.

Bucher, D., Weiser, P., Scheider, S., Raubal, M. (2015). Matching complementary spatiotemporal needs of people. In *Web proceedings of the 12th international symposium on location-based services.*

Burton, J. K., & Merrill, P. F. (1991). Needs assessment: Goals, needs, and priorities. *Instructional design: Principles and applications*, 17–43.

Janowicz, K., Raubal, M., & Kuhn, W. (2011). The semantics of similarity in geographic information retrieval. *Journal of Spatial Information Science* (2), 29–57.

Mckenzie, G. D. (2015). A temporal approach to defining place types based on user-contributed geosocial content *(Unpublished doctoral dissertation)*.

Raubal, M., & Winter, S. (2010). A spatio-temporal model towards ad-hoc collaborative decision-making. In *Geospatial Thinking. Lecture Notes in Geoinformation and Cartography* (pp. 279–297). Springer, Berlin, Heidelberg

Raubal, M., Winter, S., Tessmann, S., Gaisbauer, C. (2007). Time geography for ad-hoc shared-ride trip planning in mobile geosensor networks. *ISPRS Journal of Photogrammetry and Remote Sensing*, 62, 366–381.

Russell, S., & Norvig, P. (2010). *Artificial intelligence: A modern approach*. Prentice Hall.

Weiser, P., Scheider, S., Bucher, D., Kiefer, P., & Raubal, M. (2015; under review). Towards sustainable mobility behavior: Research challenges for location-aware information and communication technology. *Geoinformatica*.