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Matching Complementary Spatio-Temporal Needs of People

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Abstract

We outline a system that is able to publish and match complementary spatio-temporal needs of people, e.g., the need for carpooling. Key points discussed are the modeling and publishing of needs, their specification by the user, and the efficient processing of match queries.

Extended Abstract

A multitude of specialized search platforms on the Web use spatio-temporal information as a core component to match complementary needs of people. Imagine Alice, who looks for carpooling from Zurich to Munich. Most likely, she would use a general purpose search engine to find one of the many platforms that provide assistance in matching carpooling needs, e.g., by allowing her to pose a query or post an ad.

In our currently ongoing research, we are exploring ways to generalize and improve location based searches having a *matching intent* (See also Raubal et al. 2007). A key aspect is the duality of the matching need. For example, a user posing a query with the intention of finding someone to carpool with is not just providing a *query*, but a potential *result* as well. This is in stark contrast to purely informational, navigational or transactional needs known in Web search (cf. Broder 2002): Someone searching for information about Zurich is usually not interested in any interaction with the creators of the respective content. Alice, on the other hand, looking for carpooling, is interested in getting in touch with or evaluating all potential ride sharers.

Another aspect is the interdependency of needs: Alice's need for carpooling is ultimately caused by a need of her being present in Munich at a certain time, which could also be fulfilled by matching her with a public transport provider, or, if it happens frequently, with someone renting out an apartment there.

Research in this field will allow us to integrate specialized search platforms and build systems that are able to match arbitrary needs. Assessing systems that recommend matches actively and in real-time will ensure the earliest matches possible.

Modeling and Publishing Needs

Current systems often build custom data schemas in order to model query and result individually. Instead, we argue that a single model should capture both sides of needs in the same system, and thus provide a better generalization, which allows building services that span a large range of needs that could possibly be matched. With current systems, one-to-one mappings between many data schemas would have to be defined in order to create such a service mashup.

Linked Data, a principle used in the Semantic Web (cf. Berners-Lee et al. 2000) offers possibilities for providing abstractions over the variety of models currently found. In addition, it allows publishing matching needs into the already existing Web of data, where other applications are free to provide matches.

Figure 1 shows the adaption of the schema.org[1] vocabulary to carpooling needs. Previous research on building applications with Linked Data mostly focuses on creating mashups using various data sources (cf. Hausenblas 2009), e.g., the ones listed by the Linking Open Data project (Bizer 2009).

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[1] schema.org is an initiative by the largest web search providers, to create, maintain and promote schema for structured data on the Internet.

```
Thing > Intangible > Need > CarpoolingNeed
from: Place («Zurich»)
to: Place («Munich»)
leavingTime: DateTime («2015-05-12T16:00:00»)
arrivalTime: DateTime («2015-05-12T20:00:00»)
byWhom: Person («Alice»)
hasCar: Boolean («false»)
carType: Car («Minivan, Station Wagon»)
...
```

Figure 1. A need for carpooling, extended from the schema.org schema.

Recommendation of Needs

For the actual matching step, it is often not sufficient to run queries against a database (though query expansion can help integrating more complex results), as the relevance of a match is determined by how well its two needs complement each other, which is closely related to similarity analysis. Janowicz et al. (2014) built a framework to specify the semantics of similarity, which can be used to choose appropriate measures also for matching linked data.

It is important for users to specify their needs in adequate detail. As needs can take any form, the user interface has to guide and assist a user in specifying the right properties. We are exploring adaptive user interfaces that generate the most appropriate property specifications, given a "full text" input, as known from general purpose search engines (cf. Hearst (2009) for an overview). Using methods from recommender systems research, most likely input fields and properties can be determined. Figure 2 shows a possible user interface for someone looking for carpooling. Note, the need for carpooling could also be inferred automatically, e.g., from Alice's calendar application (cf. Abdalla et al. 2013).

Figure 2. Inferring fields for carpooling.

By specifying a need graph as in Figure 3 (using the same Linked Data principle), we can go even further and recommend needs unknown to the user before. This allows taking into account diverse needs on various abstraction levels.

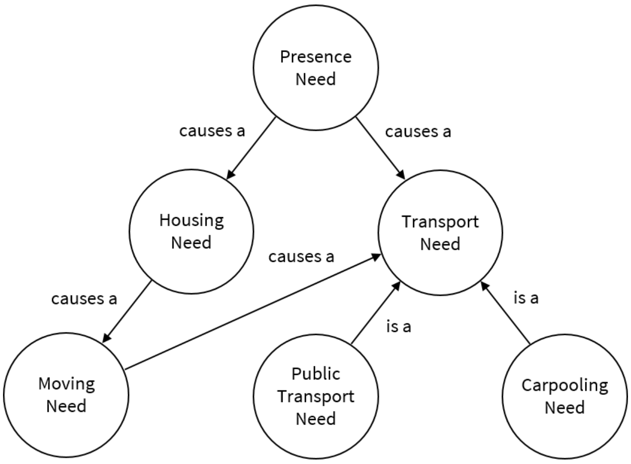

Figure 3. An exemplary need graph.

Efficiently Process Match Queries

Without restrictions on the type of needs, systems quickly become complex, and similarity analysis and recommendations become costly operations. In addition, the matching needs of users are rather fast-changing, and users expect to be notified about the earliest possible match. Thus, needs should ideally be processed in real time. We envision a distributed, scalable architecture, which processes input in a streaming manner (e.g., using a streaming engine as in (Abadi 2005)). A way to achieve distribution is via the spatio-temporal component of matching needs (i.e., using the fact that most matches will be in the vicinity of the users' places of living, and running matching algorithms on only this subset of data).

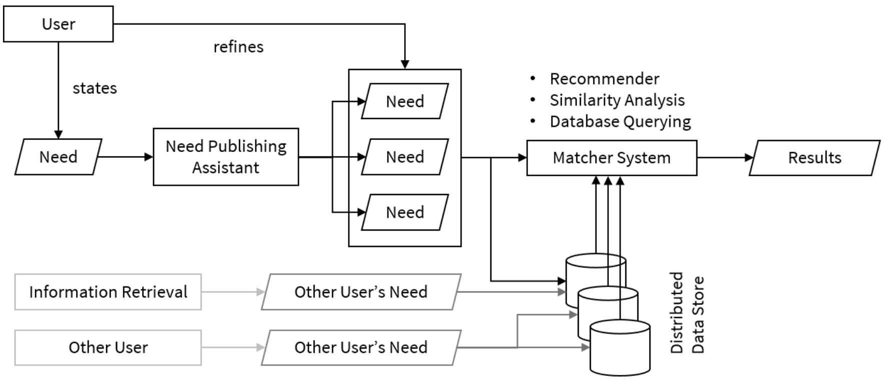

Figure 4. The processing of matching needs.

Figure 4 shows a system design where a publishing assistant is used to propose refinements of needs to users, which are then matched with other users' needs. Since many user needs are available from specialized web platforms, information retrieval can be employed to extract and integrate them into the matching process. However, this will require a careful consideration of privacy-related issues (cf. Weiser and Scheider 2014).

Conclusion and Outlook

In order to provide matching for complementary needs of people, we identified three areas of particular importance: (1) modeling and publishing of *matching needs*, (2) specification by recommendation and user refinement and (3) processing and calculation of the matches in real-time. We propose a distributed system that calculates similarities and recommendations in a streaming fashion, using Linked Data for modeling purposes and adaptive user interfaces to help users specify their needs in adequate detail. Future work will concern the definition of an optimal match, in addition to more in-depth work in above three areas.

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