Applying Situation-Person-Driven Semantic Similarity On Location-Specific Cognitive Frames For Improving Location Prediction

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In recent years, there has been an increase in demand for personalization, user-tailored solutions and context awareness. When one thinks of personalization, it becomes apparent how important it is to understand the users' individual point of view, how users perceive and understand the world. Minsky introduced in the 1970s' so called (cognitive) *Frames* to capture and represent the personal, experience- and situation-gained knowledge of individuals [1]. Today, however most applications rely solely on a user's predefined or learned set of preferences. This makes them incapable of reflecting the aforementioned personal dynamics and thus they are in need of improvement. In this paper, within the scope of optimizing location prediction systems and in line with the Ontology Design Pattern technique, we propose a way to encapsulate the user's transient perception of locations and define our own *Location-Specific Cognitive Frames*. Furthermore, we apply semantic similarity analysis methods in order to build dynamic and user-centered location-specific constructs instead of using a rigid location taxonomy as a basis for all the users. We use the resulting constructs to improve the location prediction accuracy.

Location prediction has come to represent a broad research field. Most of the work done today applies probabilistic or diverse machine learning based modelling methods on plain GPS data, like Ashbrook et al. did in [2]. However, in the last years, many researchers have been using semantic knowledge to describe context information at a higher level aiming at improving the prediction with promising results. The described context comprises locations, activities or even the users themselves. By doing so, they dissociate themselves from the usual GPS trajectories and they build their models upon so called *semantic trajectories*. Semantic trajectories describe movement as a sequence of meaningful and human understandable annotated locations (e.g. home, office, gym, mall, ..). Ying et al. introduces as one of the first semantic trajectories as a basis for a location prediction algorithm [3]. Karatzoglou et al. investigate the use of artificial neural networks to model semantic trajectories in different semantic layers [4]. Some use ontologies in their attempt to create more solid and reusable location and trajectory representations. Wannous et al.'s research [5] for example focuses

on modeling movement by combining ontologies with rules. However, the aforementioned work rarely goes beyond clusters and hierarchical structures when it comes to modeling semantic locations and trajectories.

Our goal is to cover the full semantic spectrum of locations and how these are actually being perceived by the user. For this purpose, we need to bring locations together with the temporary situation and user's experience. The location entities are linked to the corresponding entities, which capture and mirror the whole experience of a person visiting a place, such as the purpose of visit, the time, the activity, her companion, but also even more personal concepts like her personality, mood and her overall mental state at that time. By taking a closer look at our goal and the requirements mentioned above, we can easily identify so called *Poly-hierarchies* and complex *N-ary relations* in them. We consider this as our conditional framework. In this paper, we adopt the workaround method for solving the N-ary issue, and we propose the creation and use of an extra class in order to be able to embrace locations and their special meaning to the user in its whole. In tangible terms, we propose to model the set of relationships of a location entity to each of the aforementioned corresponding entities, like time, purpose of visit, mood, etc., as a single resource, which we call *Location-Specific Cognitive Frames (LSCFs)*. Each instance of this class captures a personal and temporary view on a location. An office for instance becomes a place of pleasure during the annual Christmas party, where the employee links it with a different time(evening), different mood(unstressed), and different activities(eat, drink, dance). We hypothesize that the use of such LSCFs in trajectories can significantly support location prediction by enabling higher accuracy. Due to the expectation of a great number of instances that differ only slightly to each other, we propose furthermore the appliance of semantic similarity analysis metrics (for instance Tversky's Similarity equation) in order to cluster them appropriately and overcome human fuzziness or noise in our conclusions.

Some first preliminary results based on a 5-week long real trajectory data set of 4 users substantiate our hypothesis with our approach achieving an up to 32% higher f-score in comparison to Ying's first approach.

References

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