Understanding User Spatial Behaviors and Human-Place Interaction

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ABSTRACT
In this position paper, we firstly discuss our opinions on the questions related to the GeoHCI workshop. Then we describe our work of understanding user spatial behaviors and human-place interactions.

Author Keywords
Spatial behavior, human-place interaction, trade area analysis

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors; Measurement

POSITION STATEMENT FOR GEO-HCI

One of the most important aspects that mobile computing brings to HCI research is location. Several fields of research center around this new perspective, including but not limited to location based recommendations, mobile mapping and navigation, crisis informatics, and augmented reality. Coming from the traditional HCI field (specifically information seeking, social network dynamics, and data science), our research specifically focuses on studying people's spatial behaviors and human-place interactions captured in mobile devices.

The fundamental principles in our area is user spatial behaviors models, such as gravity model, entropy maximizing model, or spatial choice-behavior model. To study human-places interactions, we borrowed concepts from trip modeling, network theory, and information seeking and foraging theories. There are many open questions related to Geo-HCI in this area. The important ones include but not limited to:

- What are the characteristics and limitations of using mobile data to study user spatial behaviors and human-place interactions?
- What are key factors and rules governing human spatial behaviors, trip sequences, and places visiting choices?
- How should we handle location related privacy issues in research and development?

The methodology we adopted includes exploratory spatial data analysis and spatial statistics (on general understanding of spatial data collected), spatial behavior analysis (on individual user behavior). We are also developing new methods based on previous work, such as trajectory network analysis for studying trip sequence, extended trade area analysis for studying human-store interaction), and spatial patch analysis for studying user spatial behavior. The datasets we use include public collectible data such as geo-tagged tweets, Foursquare check-ins, and business partner data such as Call Detail Records (CDR) from mobile carriers. The tools we use include open source tools such as spatial related packages in R as well as our commercial software and datasets such as spatial visualization and analysis tools (i.e. MapInfo Professional [4]) and Geocoding/reverse geocoding/routing services, and property datasets like business location points, residential locations, demographic information, and traffic information of given locations. Making all of these data easily accessible is a daunting task, but combining it together adds weight to our analytics that could not be achieved by individual datasets.

The area of our research is interdisciplinary, our methods and literature comes from many fields, including but not limited to HCI, GIS, Social Science, Urban Planning, Retail Business, and Marketing. We found that a good grasp of spatial analytics concepts and techniques are the key to processing and analyzing the data collected, related spatial behavior models in social and retail science are the key to developing a solid theoretical foundation, and related theories in HCI and information science guide our research direction and the design of new location related services. This area needs stronger collaborations from different disciplines as well as between academia and industry due to rapidly emerging needs, available datasets, analytics tools/services, and a lack of cross-discipline expertise. As a research group from industry, we are eagerly looking for collaboration opportunities.

OUR RESEARCH

Our research follows two lines of inquiry: making sense of user spatial behavior and understanding human-place interactions.

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Understanding User Spatial Behaviors

Our research has focused on spatial behavior analysis on the patch-level [1]. The analytic unit of previous research was limited to geographic point level (i.e. a store or a place). We propose a new unit of analysis that was originally used in animal foraging theories. Patch-level analysis extends the findings of existing research by taking into account spatial segmentations in geographical environment (e.g. change of landscape, retail agglomeration, administrative district), in daily activities (e.g. home area vs. office area), and in human's cognitive map (e.g. a safety residential area, or a shopping area with luxury stores). This new perspective reveal behavior patterns that point-level analysis fail to detect, agglomeration and segmentation being two examples.

Figure 1. Several regularly visited patches (denoted with different colors) in a foursquare user's location histories

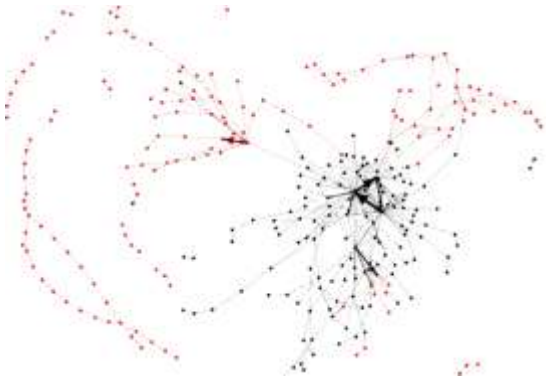

Figure 2. A person's location history has a network structure and reveals many hidden patterns of the person's spatial behaviors

We are also working on applying social network analysis into trip trajectory analysis [3]. The general idea is that if we link all locations a person has visited by their time sequence, the network structure will reveal hidden patterns of behavior such as the location hubs (frequently visited places like a coffee shop), trip triads (daily routines), and long paths (multiple purposes trips).

Human-place interactions --- Trade Area Analysis

Another focus of our research is human-place interaction, specifically how the user generated mobile location data can be used in Trade Area Analysis (TAA) [2]. We have created a new framework and series of analytic methods to identify the activity center of a mobile user, profile users based on their location histories, and model user preferences by probability. Extensions to traditional TAA are introduced like customer-centric distance decay analysis and check-in sequence analysis. Analyzing visits to a retail store in the context of a customer's daily life has significant academic and commercial implications.

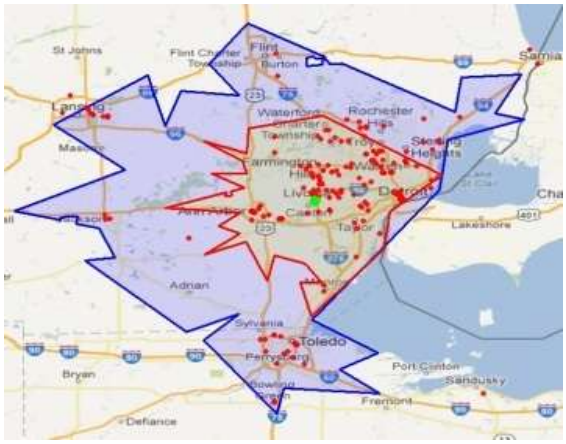

Figure 3. Analyzing trade area of a MI IKEA store by applying drive-time analysis and distance decay analysis on the foursquare check-in data of this store

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