PGT: Measuring Mobility Relationship Using Personal, Global and Temporal Factors

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Mobility Relationship

• Measuring the mobility relationship between two mobile users based on their interaction in real world
  o Given trajectories of two users, measure their relationship strength
• How often two persons meet and where and when
• Application: crime investigation, transportation scheduling, advertisement targeting, urban planning etc.
Problem Formulation

• Given a spatio-temporal dataset of $n$ users and two input users $i$ & $j$, determine the relationship between $i$ & $j$, denoted by $F_{ij}$

• The relationship $F_{ij}$ is a function of all the meeting events between users $i$ & $j$, expressed as $F_{ij} = G(E_{ij})$

• $E_{ij} = \{ e_1, e_2, \ldots \}$ denote the sequence of meeting events between $i$ & $j$, where each event $e_k$ contains a location and time stamp

• A meeting event is formed when a pair of location records $(loc_p^i, t_p^i)$ & $(loc_q^j, t_q^j)$ corresponding to users $i$ & $j$ satisfy the following constraints, $\text{dist}(loc_p^i, loc_q^j) < \delta$ & $|t_p^i, t_q^j| < \tau$
• **Personal Factor:** The same location carries different meaning for different persons
  o Times square as a travel destination vs office neighborhood

• **Global Factor:** The popularity of a location to general public
  o Downtown in a city, football stadium are popular locations

• **Temporal Factor:** This factor considers the time gaps between consecutive meeting events
  o With increasing time window meetups become less coincidental
Personal Background Modeling

- Personal mobility background models the probability that a user visits a location
- Probability of user $i$ to visit location $\text{loc}$ can be expressed as

$$p(i, \text{loc}) = \frac{|\{(\text{loc}_k, t_k) \in S_i : \text{loc}_k \sim \text{loc}\}|}{|S_i|}$$

Hard constraints on equivalence test

To overcome hard constraints, PGT uses a density function
Global Background Modeling

• Global background captures location popularity inferred from all mobile users

• Probability of user $i$ to visit location $loc_k$ can be expressed as

$$p(i, loc_k) = |S_i(loc_k)| / \Sigma_i |S_i(loc_k)|$$
Mining Mobility Relationship

- Continuous meeting event -> a trip
- Sporadic meeting event -> strong rel.
Experiment: Compare with State of the Art
Experiment: Compare Various Factors
Thank You!