individuals' activity sets; the weight for a unique link is obtained from the total occurrences of this link in the combination.

2.2 Network Embedding

We apply Node2Vec [2] to the networks of activity places and learn a mapping of places to a low-dimensional space of features that maximizes the likelihood of preserving the network structure of nodes. We then discover the communities of human activity places based on the learned embedding presentations.

2.3 Community Discovery

In this study, communities are groups of highly interactive and densely connected places that are frequently visited by individual trajectories. These places will be mapped as points close to each other in the embedding space. In order to determine the similarity between places, we calculate cosine similarity between the embeddings. Formally, *similarity* between embedding A and B could be defined as:

$$similarity = \cos(\theta) = \frac{\mathbf{A}\cdot\mathbf{B}}{\|\mathbf{A}\|\|\mathbf{B}\|} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\sum_{i=1}^{n} B_i^2}} \quad (4)$$

For a given place, a rank of other places can be found based on the calculated cosine similarity (4). A community can be delineated by choosing the top-k ranked places surrounding the target place. Alternatively, community detection can be done with clustering techniques [1].

3 EXPERIMENTAL RESULTS

The set of collected observations in a weekday in Guangzhou is composed of 48,178 points for 2,575 volunteers in the Guangzhou city. We compute the network of 1,852 nodes and 21,742 edges and learn continuous feature representations for the nodes. Figure 2 shows the visualization of our network.

Figure 2: Visualization of the Trajectory Network

Ranking of Similarity	Xinfeng Residential District	Hualin International Plaza	Shisanhang Apparel Market	Qingping Medicine Market
1	Liwanhu Park	Hualin Temple	Hengbao Shopping Center	Sun-Yat-San Memorial Hospital
2	Xinglong District	7 Days Inn	Xinya Commercial Center	Guangzhou Hospital of Chinese Medicine
3	Duobao Market	Minghui Plaza	Yutian Center	Xinfeng District

Table 1: Selected Training Results

Each point is associated with a POI where user stays to perform some activities. In order to discover places having high interactions, we choose four target POIs with a relatively high frequency of visits in the dataset and find the top 3 most similar POIs of each target POI based on the embeddings and the cosine similarity measure. Table 1 shows the above selected results. To validate our network embedding approach, we complete a field investigation. Specifically, we interviewed 50 people in those four different places and requested them to label two common destinations in their daily activities. We then aggregated the results and found the top 3 most visited POIs for each place. It shows that over 50 percent of their choices are assigned into the same POIs with high similarity in Table 1.

4 DISCUSSION AND FUTURE WORKS

We proposed an exploratory study on human activity community based on POI data and a network embedding approach. The novelty of this work is two-fold. First, we presented an algorithm to build a complex network that synthesizes trajectories of places that people visit to conduct daily activities. Second, we employ a network embedding technique to learn a representation for activity places as nodes connected by movement links to preserve the structural human activities. Some potential future works include discovering socioeconomic groups from individual trajectories and simulation of human travel patterns to assist urban-transport planning.

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