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Destination Choice Model Utilizing Urban Knowledge Graph to Improve Accuracy of Behavior Prediction

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Introduction

Destination choice model is indispensable for understanding and predicting human mobility patterns. However, traditional models are highly dependent on limited survey samples with static demographic features, thus limiting accuracy and generalization ability in high-resolution scenarios.
Therefore, we construct Urban Knowledge Graph (UrbanKG) to provide rich contextual information, and train the attribute-aware embedding to create an interpretable and intervenable 500m mesh-level destination choice recommendation system.

Data

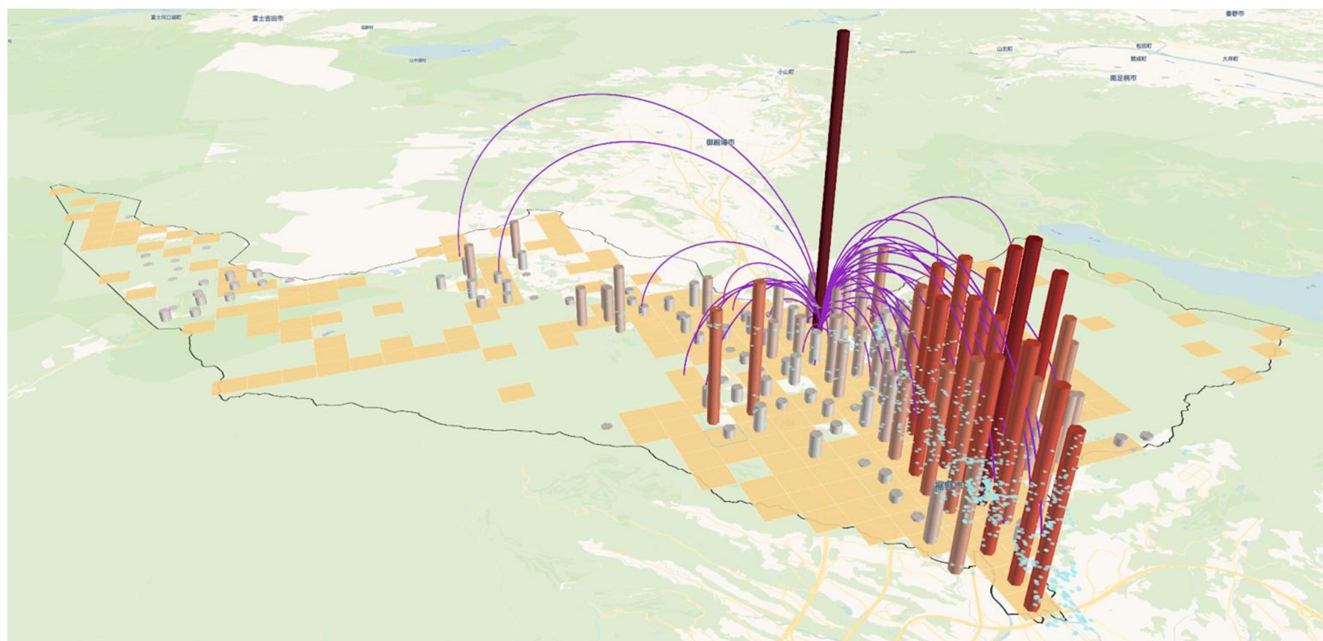

*Figure 1: Urban data in **Susono** City, Shizuoka Prefecture. The bar graph represents the population density of the 500m grid area, the purple arcs represent the OD connections (only some samples), the blue dots are the POI distributions.*

Methodology

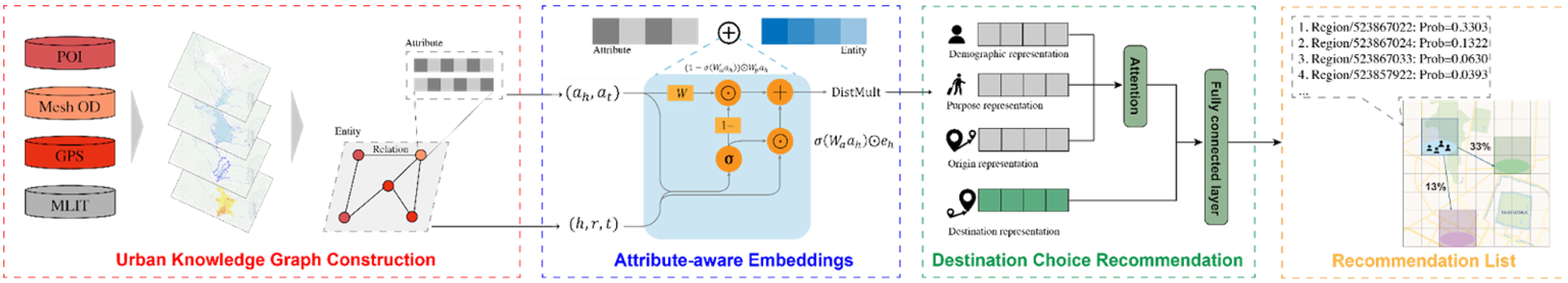

Figure 2: The proposed two-stage approach for knowledge graph embedding-based destination choice recommendation.

1. Geographic features, trip features and demographic features are extracted by integrating multi-source data and organized into a structured UrbanKG. At the same time, attribute such as population density are applied to geographic unit entities.
2. An attribute-aware embedding model is constructed to augment the attributes of Region with different roles using a Gate-based algorithm to specialize the features of Origin and Destination, while learning the holistic structural information.
3. Integrate the embedding results into context and then learn the relationship between and Destination embedding through Attention, and calculate the similarity to get the final recommendation list.

Results & Conclusion

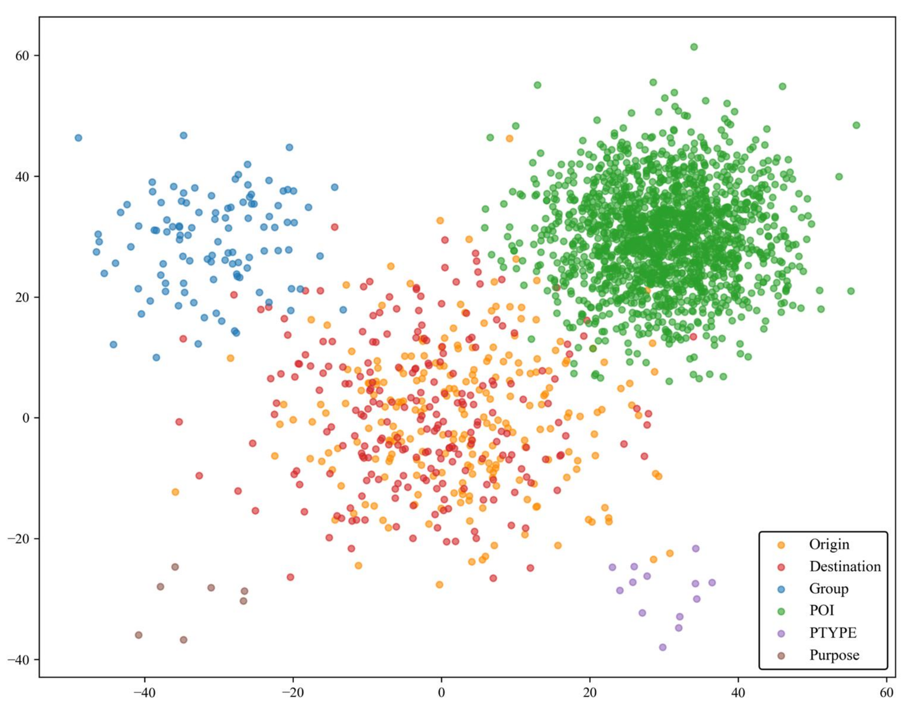

Figure 3: Embedding visualization.

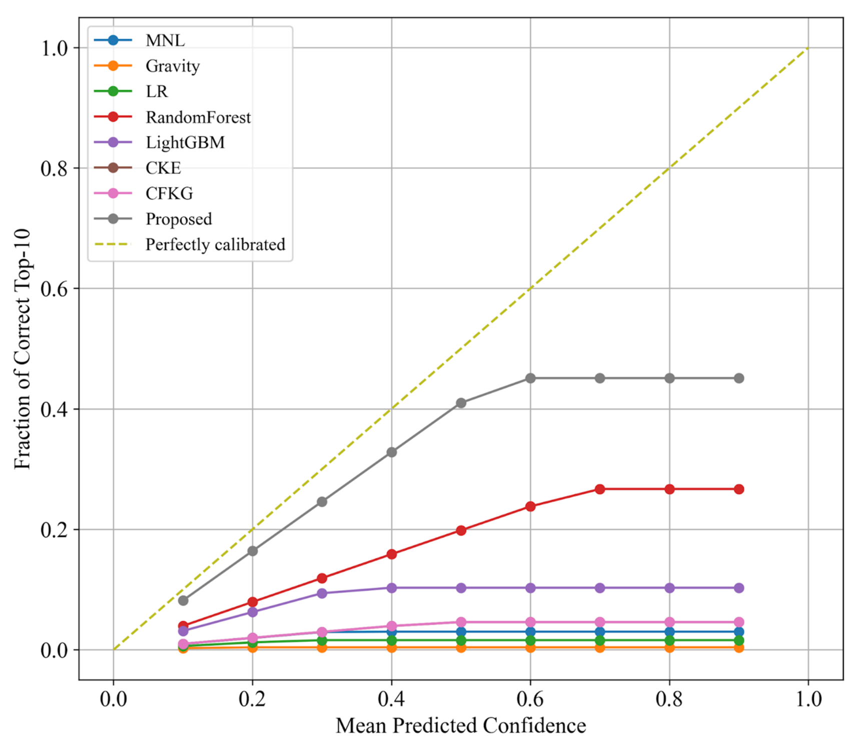

Figure 4: Reliability diagram of Top-10.

- ❑ Our attribute-aware embedding model learns embeddings that retain the semantics of the entity, and in particular Region enhances the attributes according to the different roles, distilling the knowledge in the urban data.
- ❑ The performance of recommendation is higher for RF from the Table 1, but considering the confidence (Fig.4), the confidence and correctness of our method match the most, while there is a possibility of overconfidence for RF.

Table 1: Results of baseline models and proposed approach.

Model	MRR	Recall@10	Precision@10	NDCG@10
MNL	0.144	0.306	0.030	0.299
Gravity model	0.034	0.146	0.004	0.169
LR	0.138	0.261	0.016	0.159
Random Forest	**0.417**	**0.673**	0.267	**0.526**
LightGBM	0.221	0.329	0.103	0.253
CKE	0.299	0.466	0.046	0.356
CFKG	0.306	0.465	0.046	0.362
Proposed	0.392	0.550	**0.451**	0.416

➢ This study demonstrates that Urban Knowledge Graphs can bridge the gap between spatial semantics and behavioral modeling in destination prediction. By embedding both structural and attribute information, our framework enables accurate, interpretable, and privacy-preserving destination recommendations. The approach offers a new perspective for integrating urban computing and recommender systems in mobility research.

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