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Intercity Human Mobility Simulation at Mega Metropolitan Area via Reinforcement Learning

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Background

Agent-based simulations, combined with large scale mobility data, have been an effective method for understanding urban scale human dynamics. However, collecting such large scale human mobility datasets are especially difficult during rare events (e.g., natural disasters), reducing the performance of agent-based simulations. To tackle this problem, it is essential to develop an agent-based model that can simulate urban dynamics during rare events by learning from other cities using inverse reinforcement learning.

Reinforcement Learning

In this study, we use reinforcement learning (RL) as the mathematical skeleton to model the decision-makings. The agent behaviors are motivated and reinforced by the feedback from environment as "Reward" to achieve a set of goals.

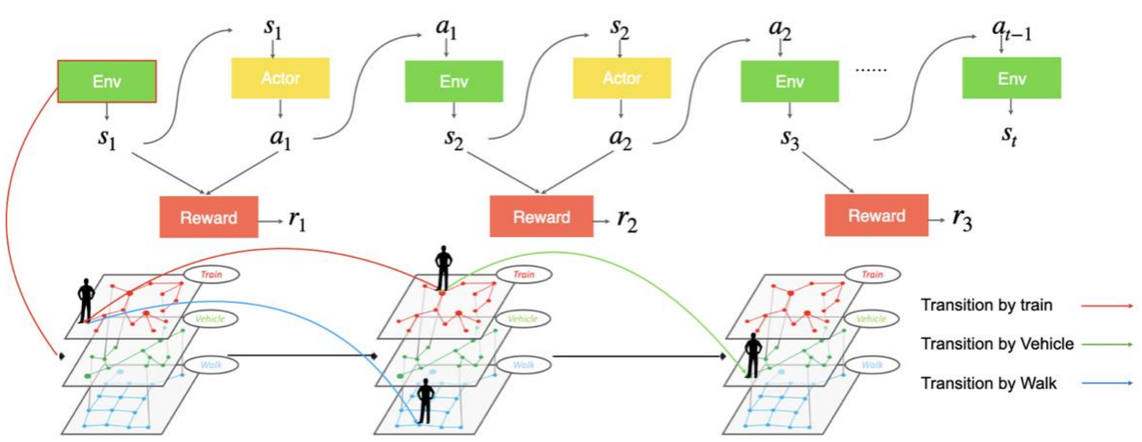

Fig.1 RL-based Agent Model

Framework

An intercity mobility simulation framework is developed in which agents imitate real human-beings' travel behavior from areas where rare events have occurred in the past (source area), and reproduce synthetic daily people movement in different cities and various situations where mobility data are hard to be observed or collected (target area).

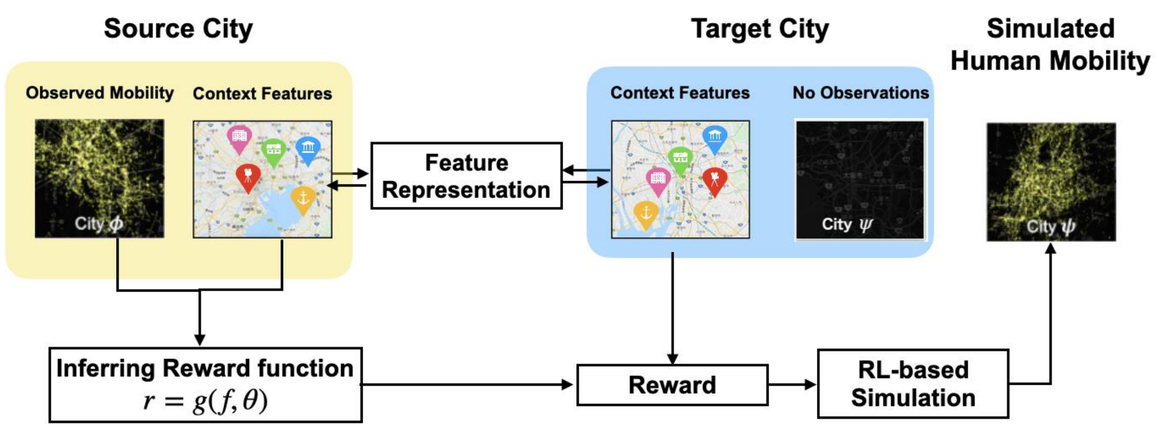

Fig.2 Framework of this study

Experiment Results

In the experiment, we tried to simulate irregular human mobility between two cities, Aomori and Kyoto, both of them held a large traditional summer festival events, as Nobuta matsuri and Gion matsuri.

1. Simulated Population Distribution

The dynamic simulated population distribution compared with ground truth data in the two areas are 0.913 in Aomori(blue) and 0.879 in Kyoto (red) area.

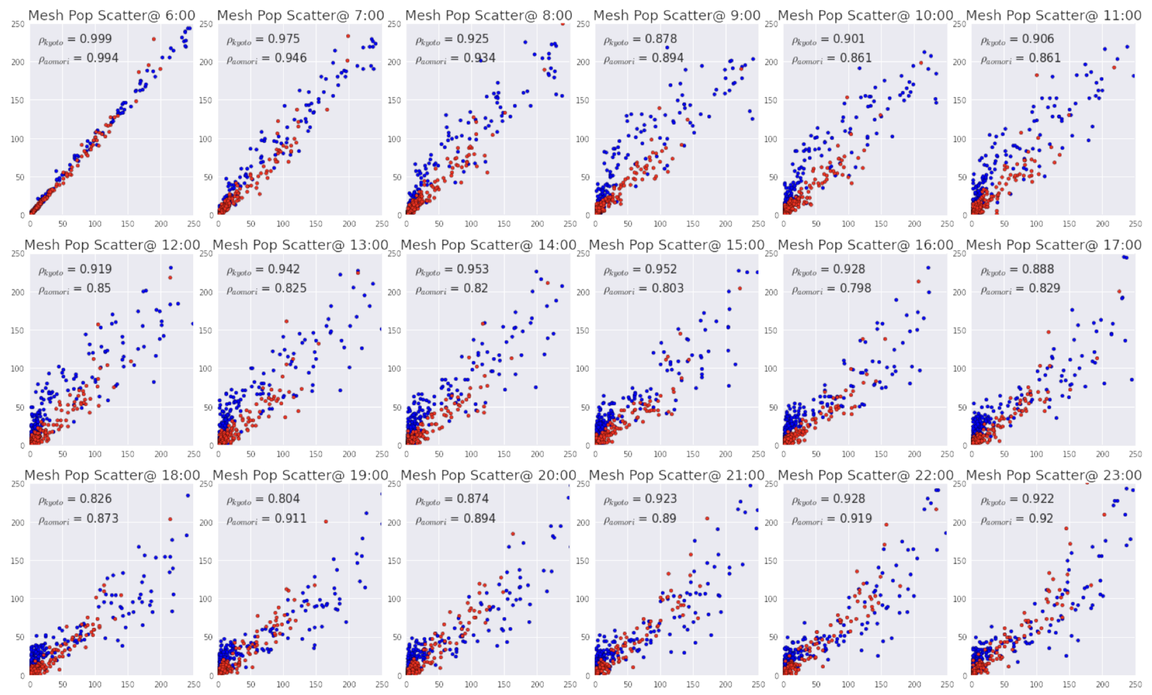

Fig.3 Population distribution between simulation and observation

2. Case study in Kyoto

The simulated people movement at Kyoto during the festival period. The crowded people flow along festival parade is correctly reproduced.

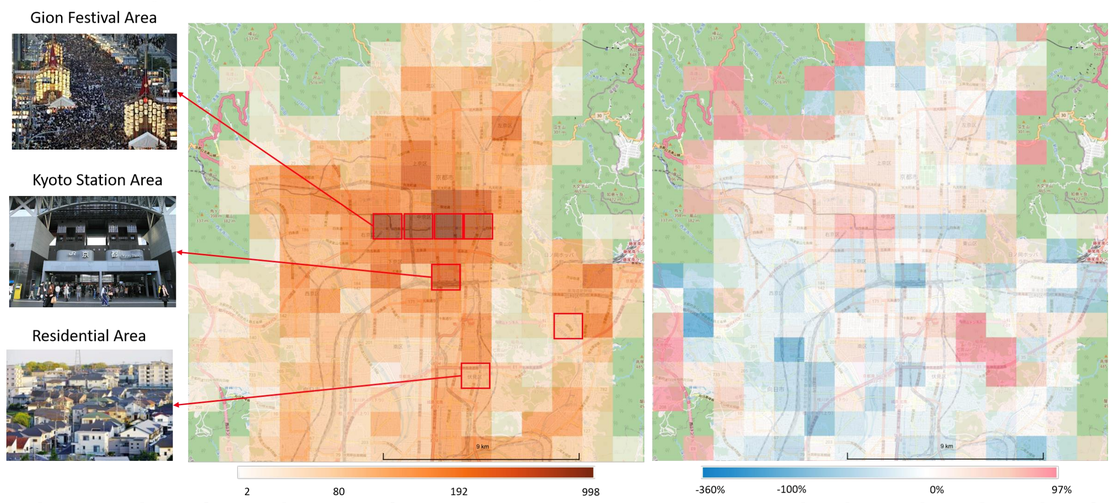

Fig.4 Simulated people movement at Kyoto during the festival period