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Human Mobility with Agent-based Modeling and Particle Filter Following Mobile Spatial Statistics

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Background

Understanding the moving patterns of human beings on the citywide level is essential for urban planning. However, it is difficult to construct an accurate model for all cities at once. Meanwhile, finding the optimized parameter set for one specific city often costs much effort. Thus, approaches that can get potentially optimized parameters effectively seem to be of great significance.

In this study, we propose a novel approach that combines the particle filter method with the agent-based model to find the optimized solution. Our motivation is to use low-cost and accessible data to simulate the citywide human movement.

Methodology

Agent-based Model

The agent-based model is an effective method to simulate complex systems such as the urban area. By generating agents, representing one or more people, we can simulate personal behaviors and elaborate the trajectories. For the destination, agents will choose from their choice set considering their types,

Particle Filter Method

Particle filter enables the improvement of system states jointly using prior knowledge and experimental data. The next state is predicted by the past and current state, suitable for the non-linear, non-Gaussian, and multi-modal system, which meets the requirement of simulating trajectories of human beings.

Result

The performance is evaluated by the Pearson correlation coefficient between the prediction result and the observation data. The Root Mean Square Error and Absolute Error Ratio are also evaluated in the analysis. Figure 1 shows that the particle can predict the accurate result in the most target area.

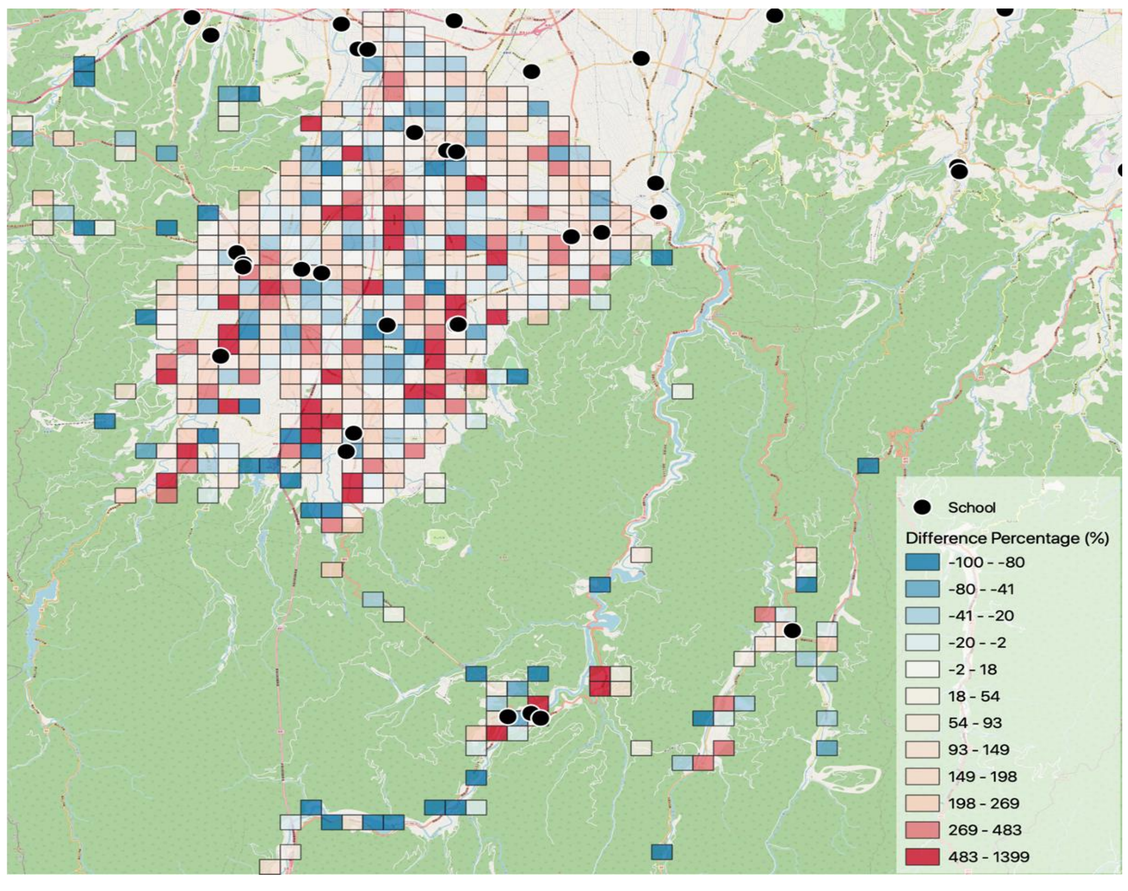

Fig.1. Visualization of Absolute Error Ratio on the Map.

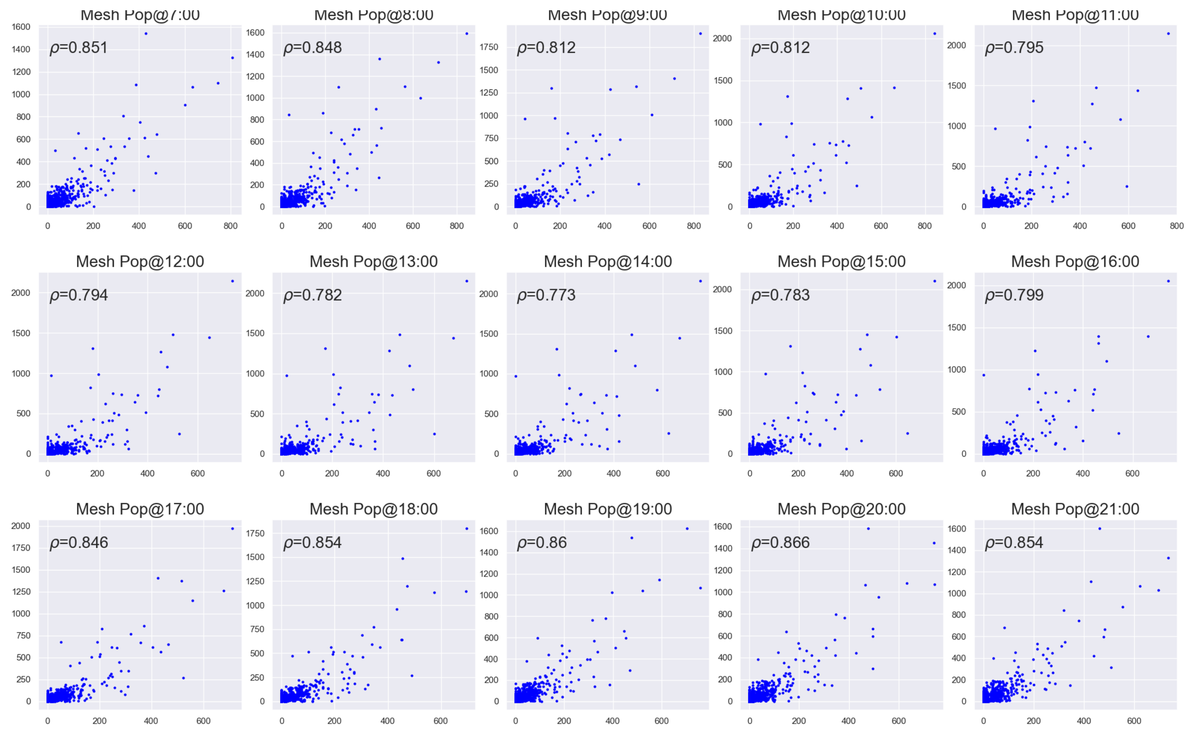

Fig. 2. Pearson Correlation Coefficient Between the Observation and Simulation, each pot represents population of a 500 x 500 m grid in the target area, x-axis is the observation, y-axis is the simulation.

The result has a good correlation coefficient with the observation data for the whole day. Meanwhile, the particle filter can generate diversified particles with very different performance and does not encounter degeneration problem, which is one of the most important metric of evaluation of this approach.