Evacuation simulation by approximating flow function on partial areas

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Abstract

The current evacuation simulations are mainly based on a multi agent (MA) model. However, it requires computational complexity and it is difficult to examine various evacuation situations. On the other hand, there is a flow rate model expressing evacuation movement between coarse-grained areas by a constant called a crowd flow. Although it has a small amount of calculation, it is difficult to set a detailed setting. Although the amount of calculation required for the flow model is small, it is difficult to make detailed settings.

In this research, MA simulation (MAS) is performed in a limited size region (partial region). Various regional models are described by function approximation of evacuation outflow amount and inflow amount (inflow/outflow amount) from the obtained partial region. In the actual simulation, various regional models obtained by the MAS are applied to each mesh-divided target area. And by calculating the evacuation inflow/outflow amount, we realize a large-scale evacuation simulation.

In this study, firstly, MAS in a partial area is performed using an agent model that acts stochastically, and the inflow/outflow amount in a partial area is examined by fixing the agent density.

It is divided into the presence or absence of inflow. The outflow amount without inflow increased monotonously with an increase in agent density. The amount of runoff will increase up to a certain agent density with the inflowing outflow amount. However, after that it decreased and stabilized at a certain value. They approximated and abstracted "maximum approximation" of the first order approximation and "maximum decreasing approximation" of the complex function.

We created a medium-sized area of approximate model and inflow tolerance of 600 meters square, and compared it with MAS. Both approximate models agreed with the evacuation trend of MAS when the agent density was large. However, when the agent density was small, they did not match. "Maximum decreasing approximation" is. It showed evacuation tendency similar to MAS than "Maximum approximation".

Finally. Hyogo prefecture Amagasaki City modeled around the coastal area as a model and created a 2 kilometer square evacuation area, MAS. The number of agents was set to $30,000$, and the approximate model of the outflow amount was compared with the MAS. When comparing the execution time until 80% of agents to evacuate, we were able to realize 550 times faster than MAS. Next, we compare evacuation tendency with MAS. In the approximate model, it was confirmed that the agent flowed out in a partial area and flowed out in the next step, and the evacuation tendency of the approximate model appeared greatly. As a result, the number of agents decreased faster than MAS, and it was not possible to match the evacuation trend of MAS.