論 文 の 内 容 の 要 旨

論文題目

Development of optimal decision-making system for road-reconstruction considering human mobility by applying reinforcement learning

(深層強化学習に基く人の移動性を考慮した道路ネットワーク復旧戦略の最適化)

氏名 朱　秀賢

Western Japan experienced record-breaking heavy rain from June 28 to July 8, 2018. Approximately 600 road sections were closed due to flooding in Hiroshima and Okayama Prefecture. The government develops road-recovery plans to return human mobility to a specific level as soon as possible, however, restoring neighborhood roads was delayed for a week after this flooding. This means that their own plan might not be effective to achieve their own objective. There three limitations government has: 1) lack of prior knowledge, 2) absence of evaluation indicators and 3) the difficulty of estimating human mobility.

With the demand for increased efficiency, we suggested the road reconstruction plan for rapid human mobility recovery with Deep RL. In addition, we utilized origin-destination pairs from mobile phone GPS data, and digital road map to estimate and evaluate human movement under recovery operation at each time step.

The agent in our model is one operation crew. Input layers and reward consist of

the information related to each damage road's recovery, inter-road connectivity with the results of traffic allocation, the travel time. With single agent RL and multi agent RL, the agents could establish the optimal policy for at least 15 roads and up to 45 roads. Multi agent RL might consider a recovery plan for almost damage roads in Hiroshima Prefecture. The agent in our model could identify the recovery effect and the importance of each disrupted roads. It selected disrupted roads with high effect of human mobility recover preferentially after learning progress. Moreover, the operation crews in multi-agent systems could learn the concept of cooperation through information about road usage in O-D. In this study, approximately 1000 kinds of O-Ds' route choice models could identify the change of traffic volume with the sequence reconstruction operation process, and the visualization data would allow the government officials to response further to abnormal traffic phenomena.

The final human mobility recovery rate with their optimal policy is 25% better on average than the lowest recovery rate when working randomly. Furthermore, the system in this paper could solve the optimization problem for the number of cases in $6.13 * 10^{34}$ in less than three hours. With the comparison of previous studies, this model could examine the number of cases greater than 10^{7}times for the computation time similar to them.