Graphic Deep Reinforcement Learning for Dynamic Resource Allocation in SAGIN

Yue Cai, Peng Cheng, Zhuo Chen, Wei Xiang, Branka Vucetic, Yonghui Li

Introduction

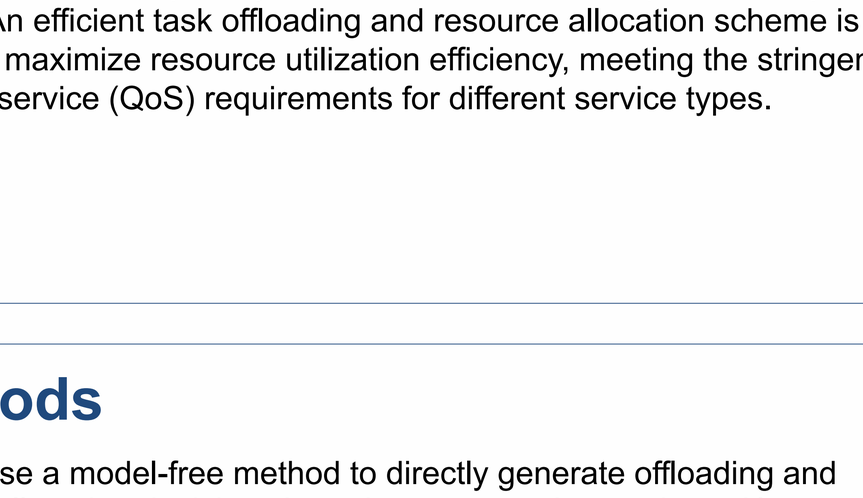
We formulate a problem of sequential decision-making task offloading and resource allocation. Our proposed solution is an innovative online approach referred to as graphic DRL (GDRL). This approach utilizes a graph neural network (GNN)-based feature extraction network to identify the inherent dependencies within the graphical structure of the states. We design an action mapping network with an encoding scheme for end-to-end generation of task offloading and resource allocation decisions. Additionally, we incorporate meta-learning into GDRL to swiftly adapt to rapid changes in key parameters of the SAGIN environment, significantly reducing online deployment complexity.

Aims

Space-air-integrated network (SAGIN) is a crucial component of the 6G, enabling global and seamless communication coverage. This multi-layered communication system integrates space, air, and terrestrial segments, each with computational capability, and also serves as a ubiquitous computing platform.An efficient task offloading and resource allocation scheme is key in SAGIN to maximize resource utilization efficiency, meeting the stringent quality of service (QoS) requirements for different service types.

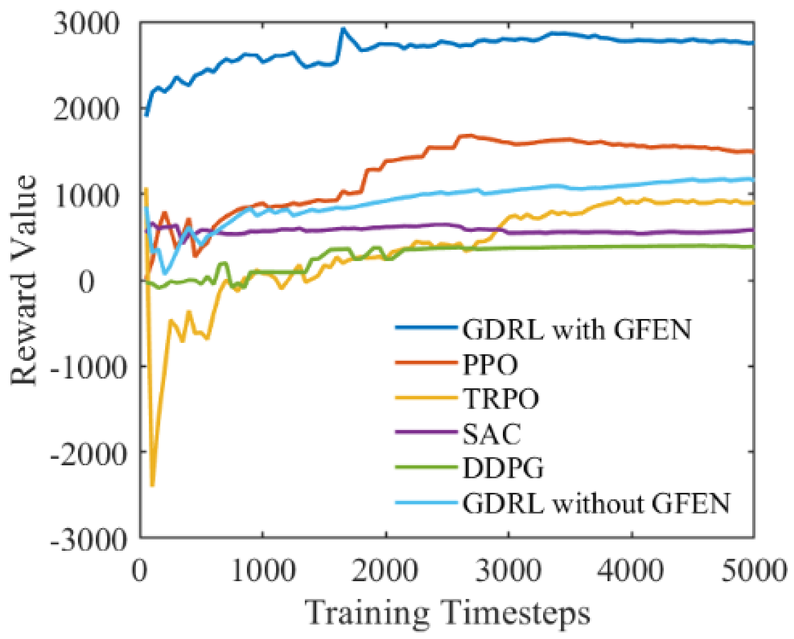
Methods

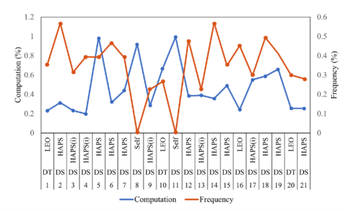
We propose a model-free method to directly generate offloading and resource allocation decisions based on current observations. Also, we separate the environmental states into static (graph-structured) and dynamic ones (non-graph-structured); the latter is influenced by the solution set at the previous timestep, while the former does not. Each state is processed by a uniquely tailored neural network.



Results

We first validate that our proposed GDRL has the best latency performance compared with other baseline methods to solve the SAGIN task offloading and resource allocation problem. Then, we verify that the proposed GDRL, with its built-in MAML, is robust against network parameter variation.





The task offloading and resource allocation actions for different service types.

References

[1] P. Mach and Z. Becvar, "Mobile Edge Computing: A Survey on Architecture and Computation Offloading," in IEEE Communications Surveys & Tutorials, vol. 19, no. 3, pp. 1628-1656.

[2] D. K. Hammond, P. Vandergheynst, and R. Gribonval, “Wavelets on graphs via spectral graph theory,” Applied and Computational Harmonic Analysis, vol. 30, no. 2, pp. 129–150, 2011

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program