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Dynamic user-centric multi-dimensional resource allocation for a wide-area coverage signaling cell based on DQN

Key words: 6G; Wide-area coverage signaling cell; Multi-dimensional resource allocation; Deep Q-network (DQN)

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Motivation

1. While ensuring the performance requirements, such as high data rate and low latency, the problem of high energy consumption in the fifth-generation wireless communication system (5G) network has become one of the problems to be solved in sixth-generation wireless communication system (6G).

2. The wide-area coverage signaling cell technology conforms to the future development trend of radio access networks.

3. In wide-area coverage signaling cells, on-demand multi-dimensional resource allocation is an important technical means to ensure the ultimate performance requirements of users, and its effect will directly affect the efficiency of network resource utilization.

Main idea

1. The network side uses intelligent capabilities to summarize user characteristics.

2. Deep Q-network (DQN) can transform the update of Q-table into a function fitting problem when the state space and action space are high-dimensional and continuous.

3. A user admission control scheme is formulated to enable the on-demand on/off of data base stations (BSs).

Method

1. A user-centric dynamic allocation model is constructed for multi-dimensional wireless resources, in which more differentiated requirements of users in the future are considered.

2. The optimization problem in this study is formulated as a constrained Markov decision process (CMDP) problem.

3. A DQN-based dynamic allocation algorithm for wireless resources is proposed to realize user admission control and the dynamic and flexible allocation of physical resource blocks (PRBs) and power.

Method (Cont'd)

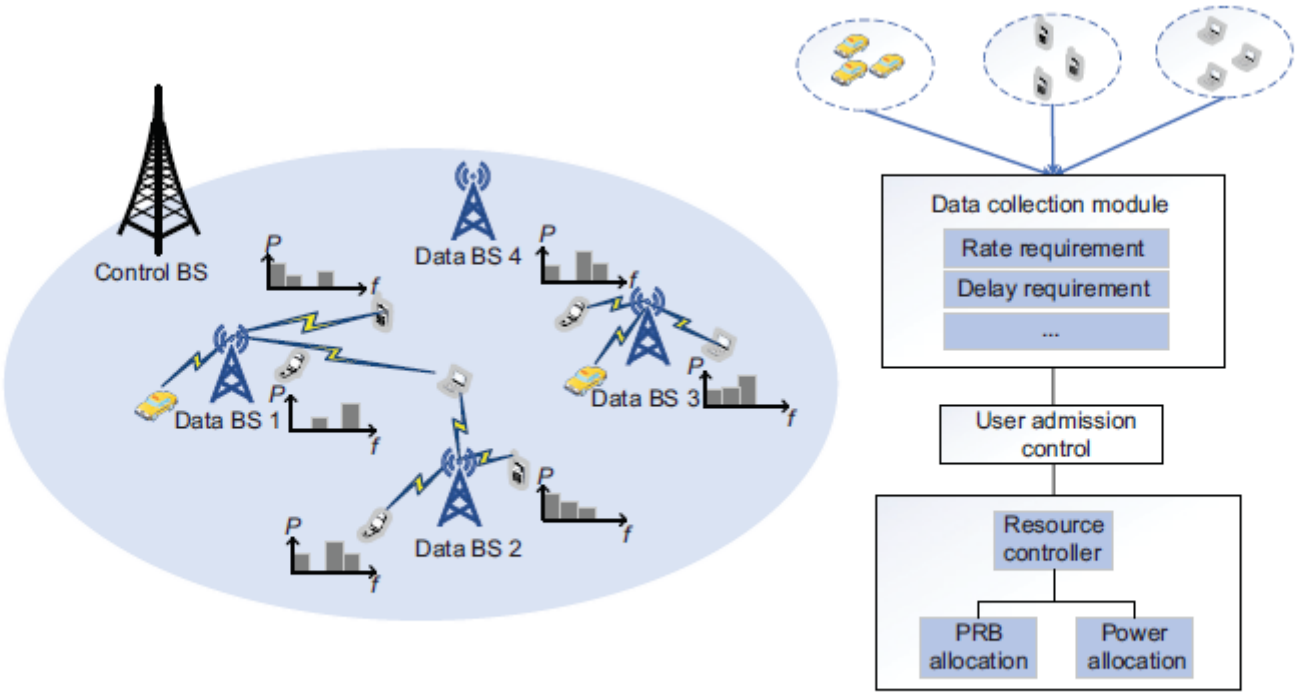


Fig. 2 Dynamic user-centric resource allocation model in a wide-area coverage signaling cell (BS: base station; PRB: physical resource block)

Method (Cont'd)

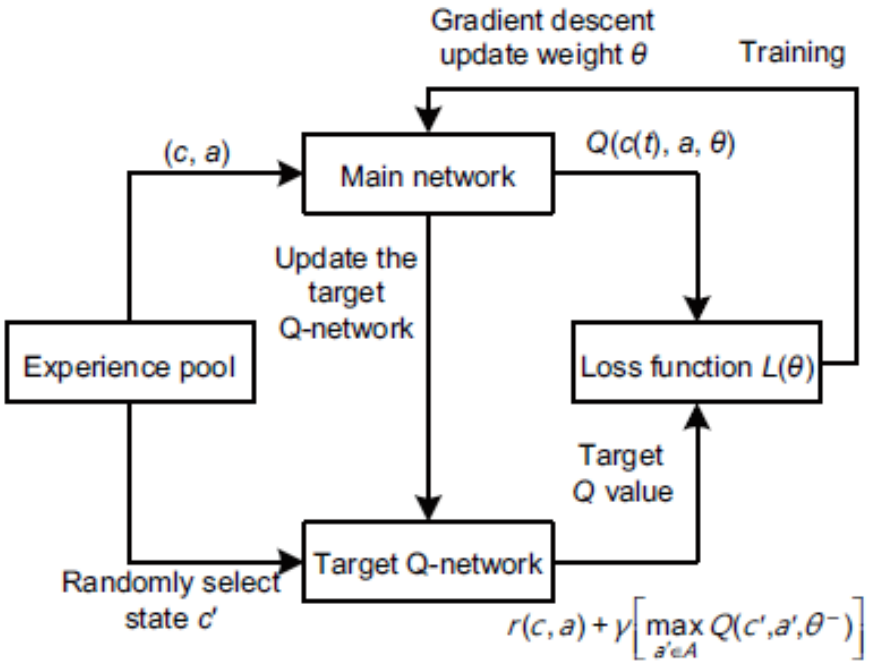


Fig. 3 Deep Q-learning network training model

Major results

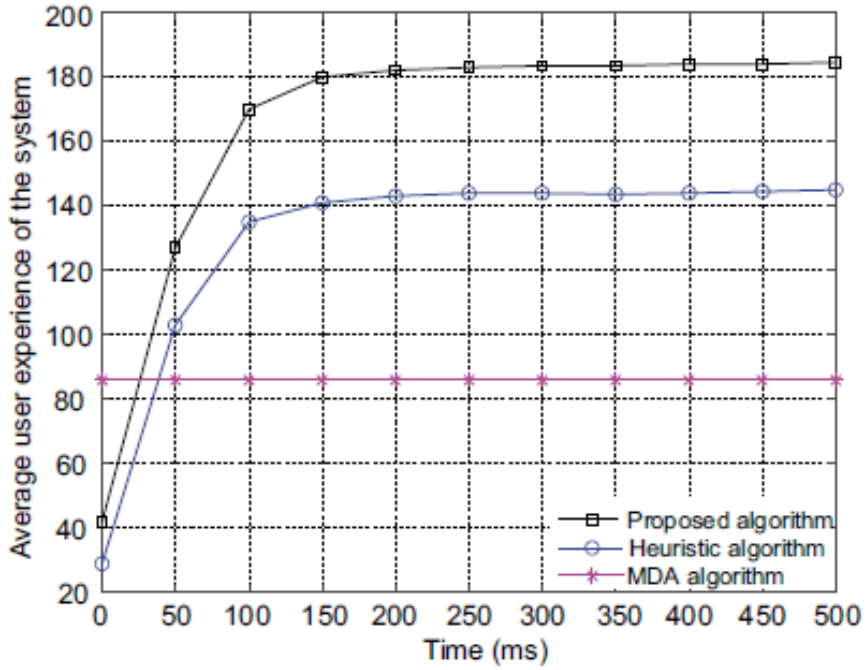


Fig. 4 Changes of the user experience of the system over time when the number of users is 30 and the maximum transmission power of the base station is 39 dBm

Major results (Cont'd)

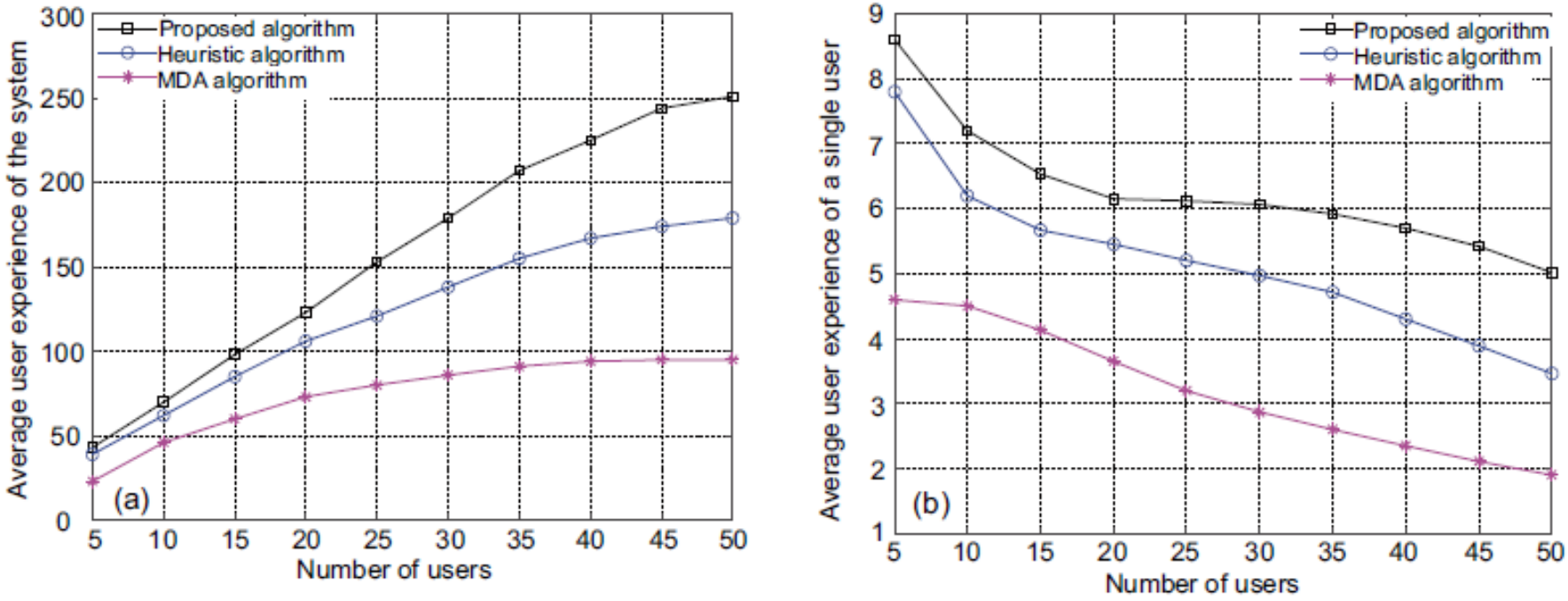


Fig. 5 Average user experience varying with the number of users when the maximum transmission power of the base station is 39 dBm: (a) average user experience of the system; (b) average user experience of a single user

Major results (Cont'd)

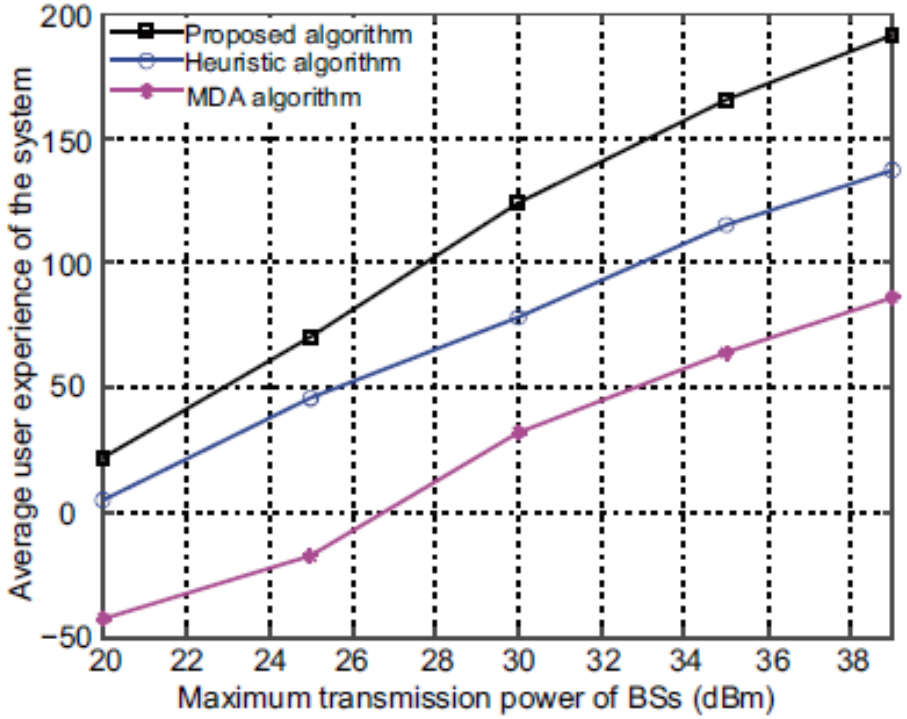


Fig. 6 Average user experience of the system varying with the maximum transmission power of the base stations (BSs) when the number of users is 30

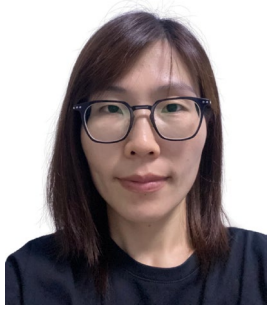
Conclusions

1. A DQN-based dynamic allocation algorithm for wireless resources has been proposed to maximize the overall user experience.

2. The proposed algorithm realized on-demand user admission control and dynamic resource allocation according to the requirements of rate and latency reported by users.

3. The proposed algorithm can effectively improve the average user experience on a long time scale, and ensure network users a high data rate and low energy consumption.

Zhou TONG received her MS degree from Beijing University of Posts and Telecommunications in 2021. She is currently with the China Mobile Research Institute. Now, she is working on the architecture and protocol functions of the next-generation RAN.



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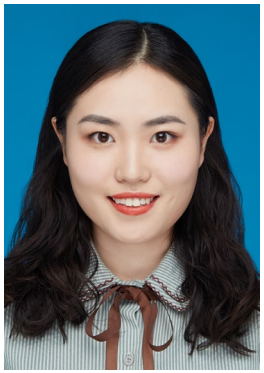

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