Candidate Name:

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Thesis title:

Distributed Algorithm for Solving Large Resource Allocation Problems

Abstract:

Resource allocation problems happen everywhere in our daily lives. Some quick examples like the power scheduling problems, the traffic management problems, the time-slot arrangement problems, the communication server allocation problems and the cloud computing scheduling problems are all resource allocation problems. Resources in these problems could be continuous, e.g., the gas, water, electrical power, or discrete, e.g., the manpower, the equipment. The objectives could be to maximize the performance indices, to minimize the cost or to meet some user oriented performance requirements, e.g., the Quality of Service (QoS) involved in communication systems.

Several major technical obstacles appear when moving toward solving resource allocation problems efficiently. Firstly, the constraints involved in resource allocation problems are complex, which are hard to be modeled. Secondly, the numbers of decision variables and constraints are huge, which may lead to extremely high computational complexity for solving these large-scale optimization problems. Thirdly, the nature of resources involved in these problems could be either continuous or discrete and the computational benefits from the convexity may not be able to achieve.

To overcome these difficulties, this report proposes (1) a general model of resource allocation problems; (2) a distributed computation structure to reduce the computational complexity; (3) algorithms for solving large resource allocation problems; and (4) examples on various systems with large resource allocation problems. Simulation results in both power systems and traffic systems show that the proposed distributed computational architecture with heuristic algorithms can achieve good performance whilst reduce the computation complexity.

In this thesis, we first give a brief introduction about the resource allocation problems, including the concepts, the constraint sets, decision variables and objectives. Then, a review on the methodologies for solving large resource allocation problems is presented and both centralized and distributed methodologies are included in this review. Then, a distributed computation structure is proposed and some algorithms for solving the large resource allocation problems are described based on this structure. Some case studies from the resource allocation problems involved in electrical power systems, microgrids and transportation systems are analyzed in this thesis and the simulation results show the effectiveness and efficiency of the proposed computation structure and algorithms on solving these problems. The conclusions are drawn in the last chapter and some possible further works are listed.

Publication list:

Journal Papers

1. Y. Zhang, R. Su, Q. Li, C. G. Cassandras and L. Xie. Distributed flight routing and scheduling in air traffic flow management. IEEE Transactions on Intelligent Transportation Systems, 18(10), 2681-2692, 2017.
2. Y. Zhang, R. Su, G. G. N. Sandamali and C. G. Cassandras. A Hierarchical Approach for Air Traffic Routing and Scheduling. IEEE Transactions on Intelligent Transportation Systems. Under review.
3. Y. Zhang, R. Su, Y. Zhang and C. Sun. Modelling and Traffic Signal Control of Heterogeneous Traffic Systems. IEEE Transactions on Intelligent Transportation Systems. Under review.

Peer Reviewed Conference Papers

1. Y. Zhang, R. Su, N. Sandamali, Y. Zhang and C. G. Cassandras. A Hierarchical Approach for Air Traffic Routing and Scheduling. 56th IEEE Conference on Decision and Control (CDC'17), 2017.
2. Y. Zhang, R. Su, C. Sun and Y. Zhang. Modelling and Traffic Signal Control of a Heterogeneous Traffic Network with Signalized and Non-Signalized Intersections. 1st IEEE Conference on Control Technology and Applications (CCTA'17), 2017.
3. Y. Zhang, R. Su, Q. Li, C. G. Cassandras and L. Xie. Distributed Flight Routing and Scheduling in Air Traffic Flow Management. 55th IEEE Conference on Decision and Control (CDC'16), 2016.
4. Y. Zhang, R. Su, C. Wen, M. Y. Lee and C. Gajanayake. Distributed Power Allocation and Scheduling for Electrical Power System in More Electric Aircraft. 42nd Annual Conference of IEEE Industrial Electronics Society (IECON), 2016.
5. Y. Zhang, Q. Li and R. Su. Sector-based Distributed Scheduling Strategy in Air Traffic Flow Management. 14-th IFAC Symposium on Control in Transportation Systems (CTS'16), 2016.
6. Y. Zhang, R. Su and K. Gao. Urban Road Traffic Light Real-Time Scheduling. The 54th IEEE Conference on Decision and Control (CDC'15), 2015.
7. Y. Zhang, Y. Su and R. Su. Real-Time Scheduling in Urban Road Traffic Light Control. 14th Asian Pacific Intelligent Transportation System Conference, 2015.