A Reinforcement Learning Approach to the Constrained Resource Allocation Problem

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***Abstract*—This paper proposes a generalized framework to solve constrained resource allocation problem using a modified reinforcement learning algorithm.**

I. Introduction

Resource allocation is an old and widely-solved problem in many fields, including electrical engineering, computer science, economics, management science and many more. It typically involves a fixed number of resource units to be distributed to a set of tasks over a period of time, such as landing aircraft scheduling, wireless communication routing, social security welfare and shared resources in parallel computer architectures. The problems of resource allocating are ubiquitous, but they all essentially boil down to one simple notion–based on a set of criteria, how many resource units should be allocated to which task first, and for how long.

To name a few remarkable research examples to solve this type of problems, Dresner and Stone proposed s reservation system for autonomous intersection management [1] to allocate right of road for crossing traffic, Perkins and Royer presented a novel routing algorithm for ad-hoc on-demand mobile nodes management [2], and Foster et al. came up with a reservation and allocation architecture for heterogeneous resource management in computer network. While they all addressed an elegant solution to a specific domain, most of the techniques cannot be easily transferred to similar decision problems in other domains. In this paper, we focus on addressing exactly this issue and forming a general resource allocation framework that is suitable to be solved by a reinforcement learning method.

The first contribution of this paper is to form the Constrained Resource Allocation Framework (CRAF), in which we designed a generalized architecture to capture most of the resource allocation problems. In addition to the conventional first-come, first-served basis, we introduced the notion of constraints and queue propagation to reflect a more realistic setting and to relax more complicated systems into a single-frontier problem.

Secondly, we defined a collection of analysis criteria and evaluation methods to both qualitatively and quantitatively study how a reinforcement learning algorithm perform on our framework. Lastly, we proposed three benchmark problems to empirically demonstrate how CRAF applies to different resource allocation problems consistently and effectively.

II. Background

K-armed bandit

Adaptive K-Meteorologist

Met-Rmax SCRAM-Rmax

III. The Constrained Resource Allocation Framework

Instance -¿ observables Constraints -¿ rewards Prototype Capacity -¿ resources available (treat each token as a multi-agent unit) Queue propagation (only solve the frontier instances at each round)

failure handling

properties: fairness progression safety liveness

measurements: latency throughput rewards

IV. Experiment Results

taxi sharing autonomous intersection management household welfare

V. Discussion and Related Work

VI. Conclusion

VII. Future Work

VIII. Acknowledgements

References

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