Online Linear Optimization with Inventory Management Constraints

Lin Yang*
The Chinese University of Hong Kong, China
Hong Kong
linyang@cs.umass.edu

Mohammad H. Hajiesmaili*
University of Massachusetts Amherst, USA
Amherst, MA
hajiesmaili@cs.umass.edu

Ramesh Sitaraman
University of Massachusetts Amherst, USA
Amherst, MA
ramesh@cs.umass.edu

Adam Wierman
California Institute of Technology, USA
Pasadena, CA
adamw@caltech.edu

Enrique Mallada
Johns Hopkins University, USA
Baltimore, MD
mallada@jhu.edu

Wing S. Wong
The Chinese University of Hong Kong, China
Hong Kong
wswong@ie.cuhk.edu.hk

ABSTRACT

This paper considers the problem of online linear optimization with inventory management constraints. Specifically, we consider an online scenario where a decision maker needs to satisfy her time-varying demand for some units of an asset, either from a market with a time-varying price or from her own inventory. In each time slot, the decision maker is presented a (linear) price and must immediately decide the amount to purchase for covering the demand and/or for storing in the inventory for future use. The inventory has a limited capacity and can be used to buy and store assets at low price and cover the demand when the price is high. The ultimate goal of the decision maker is to cover the demand at each time slot while minimizing the cost of buying assets from the market. We propose ARP, an online algorithm for linear programming with inventory constraints, and ARPRate, an extended version that handles rate constraints to/from the inventory. Both ARP and ARPRate achieve optimal competitive ratios, meaning that no other online algorithm can achieve a better theoretical guarantee. To illustrate the results, we use the proposed algorithms in a case study focused on energy procurement and storage management strategies for data centers.

CCS CONCEPTS

• **Theory of computation** → **Online algorithms**; **Linear programming**; • **Hardware** → *Energy generation and storage*; *Power estimation and optimization.*

KEYWORDS

Online linear optimization; inventory management; competitive online algorithms; energy procurement; data center

*Both authors contributed equally to this research.

SIGMETRICS '20 Abstracts, June 8–12, 2020, Boston, MA, USA

ACM ISBN 978-1-4503-7985-4/20/06.
https://doi.org/10.1145/3393691.3394207

ACM Reference Format:
Lin Yang, Mohammad H. Hajiesmaili, Ramesh Sitaraman, Adam Wierman, Enrique Mallada, and Wing S. Wong. 2020. Online Linear Optimization with Inventory Management Constraints. In *ACM SIGMETRICS / International Conference on Measurement and Modeling of Computer Systems (SIGMETRICS '20 Abstracts), June 8–12, 2020, Boston, MA, USA.* ACM, New York, NY, USA, 1 page. https://doi.org/10.1145/3393691.3394207

The full version of this abstract is available in [1].

1 ACKNOWLEDGMENTS

This work was funded by the National Science Foundation through the CNS-1908298, CNS-1763617, AitF-1637598, CNS-1518941, CPS-1544771, EPCN-1711188, CAREER-1752362, AMPS-1736448, TRIPODS-1934979 grants, and ARO: W911NF-17-1-0092, DoE: ENERGISE-DE-EE0008006 grants, and a Google Faculty Research Award. Lin Yang wants to acknowledge the support from Schneider Electric, Lenovo Group (China) Limited and the Hong Kong Innovation and Technology Fund (ITS/066/17FP) under the HKUST-MIT Research Alliance Consortium.

REFERENCES

[1] L. Yang, M. H. Hajiesmaili, R. Sitaraman, A. Wierman, E. Mallada, and W. S. Wong. Onlinelinearoptimizationwithinventorymanagementconstraints. *Proc. ACM Meas. Anal. Comput. Syst.*, 4(1):Article16, 2020.