

CSC2421: Online and Other Myopic Algorithms

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Lecture 6

Announcements

As stated in a Quercus announcement, please send me your initial thoughts on what Open Problems you are thinking of pursuing for your individual and your group projects. I will try to suggest some possible collaborations for the group project. You can email these to bor@cs.toronto.edu or abborodin@gmail.com

Today's agenda

We will continue with my commenting on some open problems. My co-author Denis Pankratov suggests that we call these problems "Clopen Problems" in analogy to clopen sets in topology (i.e., sets that are both open and closed). By the time Volumes 1 and 2 are available, it is quite possible that most (if not all) these Clopen Problems will have been solved.

Open problems: Chapter 8

Open problem 1 probably has not received that much attention.

I haven't followed the literature on File Migration and File Replication problems but I would think the gaps in the competitive ratios are still open as suggested in the second open problem. This is an area that directly relates to applications.

Multidimensional bin packing and vector bin packing are well studied problems which still have open problems and would be of much interest.

The hard k -taxi problem remains one of the more prominent questions in competitive analysis. Ali has “collaborated” with ChatGPT to provide a potential function based analysis of the double coverage algorithm for the hard k -taxi problem on HSTs and for rooted trees of depth d . This was an open problem in Buchbinder, Coester and Naor [2021] which provided these results using a less conventional primal-dual analysis.

The Weighted and Generalized k -server problems are perhaps a little less studied but still important problems in competitive analysis.

Open problems: Chapter 9

Online algorithms in social choice (eg fairness and voting) and mechanism design are relatively new areas of research. So I suspect all the problems here and many others in these areas are still open problems.

I think Open problem 4 concerning the Parking problem is an interesting question. How can we better reflect real parking problems? Perhaps extend the line metric to a cycle. In addition, people usually only park cars for a given duration. The k -taxi problem can also be extended to reflect the time duration involved in responding to a request.

The Parking problem is an instance of studying online mechanism design algorithms where the decisions are being made by self-interested agents. Many online problems can be formulated so that self-interested agents are making decisions and the online *mechanism* must incentivize agents so that the overall “social welfare” is approximately optimized. Uber and Lyft requests are also being decided by self-interested drivers.

Open problems: Chapter 10

Open problem 1 concerns what can be achieved when the total weight of clauses is not known.

Ali got ChatGPT to work on Open questions 2 and 3. With a little help from Ali, ChatGPT wrote a paper that claims to prove that $3/4$ is the optimal randomized competitive bound by showing the negative result (matching known algorithms) for Exact-Max-2-Sat which implies the same negative result for Max-2-Sat and Max-Sat. The proof looks reasonably substantial. .

Comment It might be good to initially assume that ChatGPT can make mistakes thinking it has a solution without providing all the “details”.

I believe Open problem 4 (regarding the Directed MaxCut problem) is still open if for no other reason that it is not precisely formulated. What do we mean by “simple online”?

Some open problems in Volume 2

As mentioned Volume 2 is far from complete and we have very few stated open problems so far in Volume 2. In fact, we have not stated any open problems in Chapters 3 4,7 and 9.

Chapter 1 concerns the primal dual method. We apply the method to a number of problems including the maximum edge-weighted one-sided bipartite matching problem.

Open problem 1 concerns the display ads problem which was introduced in Chapter 7 of Volume 1. The display ads problem is one of the two prominent problems corresponding to online advertising. The current best competitive ratio is achieved using a relatively new method called *online correlated selection (OCS)*. There is still a substantial gap in our understanding of this problem. Here I am looking at the small capacities and free disposal.

Volume 2, Chapter 1 open problems continued

Open problem 2 concerns the AdWords problem, which is the other prominent problem relating to online advertising. Here we are interested in large bids (compared to the budget) and again the most recent progress uses OCS.

The last stated open problem concerns two special cases for both Display Ads and AdWords. Namely, the first special case is when the edge weight is the weight on the online vertex. The second case is when the weight of an edge $(u, v) = w(u) \cdot w(v)$.

A good starting point for online matching and applications is the 2024 EC survey by Huang, Tang and Wajc.

We ended the sixth class here and will finish up our tour of research questions next Monday.