Online Caching through Optimistic Online Mirror Descent

Introduction

· Effective caching policies are important in edge networks[1], figure 6.

· Online Convex Optimization (OCO) used to tackle the caching problem[2].

· A no-regret policy is introduced through optimism[3].

· **How does optimistic online mirror descent as a caching policy measure against previous OCO caching policies?**

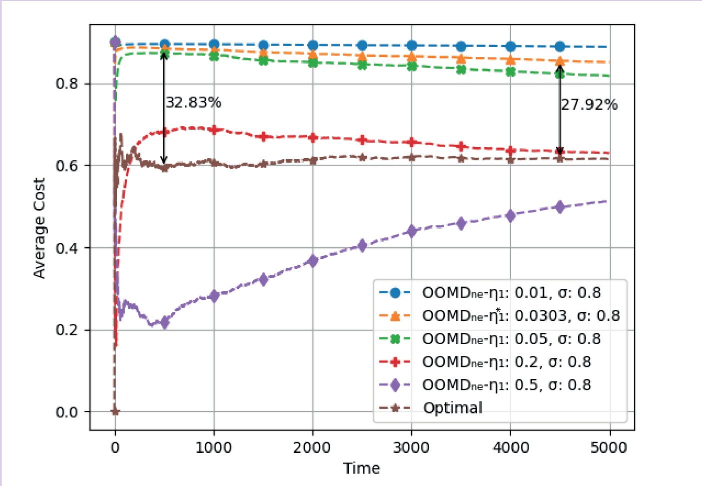

figure 2, effects of different learning rates over stationary trace.

Conclusion

· The optimal learning rate η* ensures the optimallity over any request trace, it perfoms well even under a stationary trace, as seen in figure 2.

· Over a non-stationary trace outperforms $OOMD_{ne}$ its non-optimistic counterpart slightly, as seen in figure 3.

· $OOMD_{ne}$ with a high quality of recommendations has sub-zero regret over an adversarial trace, as seen in figure 4.

· A slight increase in perfomance between different quality of recommendations can be seen over a stationary trace, as seen in figure 5.

· **Over all traces does $OOMD_{ne}$ have a sub-linear regret regardless of the quality of recommendation**

Methodology

· Online Gradient Descent (OGD)

· Online Mirror Descent (OMD_{ne}), used with a negative entropy mirror map.

· Optimisitic OMD_{ne} ($OOMD_{ne}$), uses predictions for future request.

· A visual representation of the $OOMD_{ne}$ policy is given in figure 1.

· Policies perfomance measured through cost function and regret.

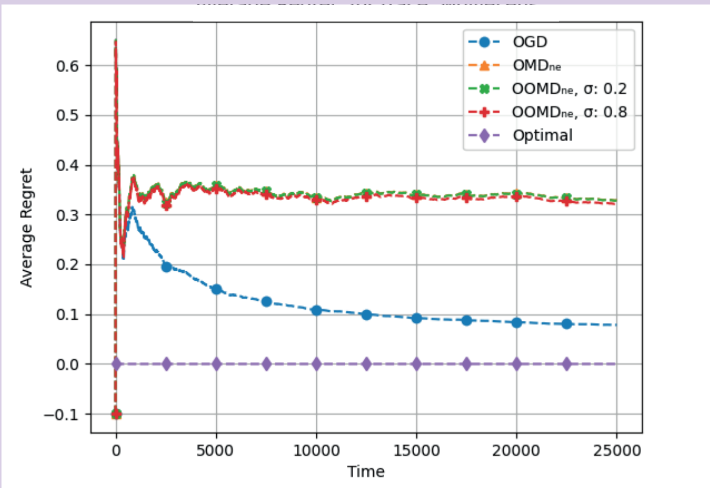

figure 3, average regret over MovieLens trace.

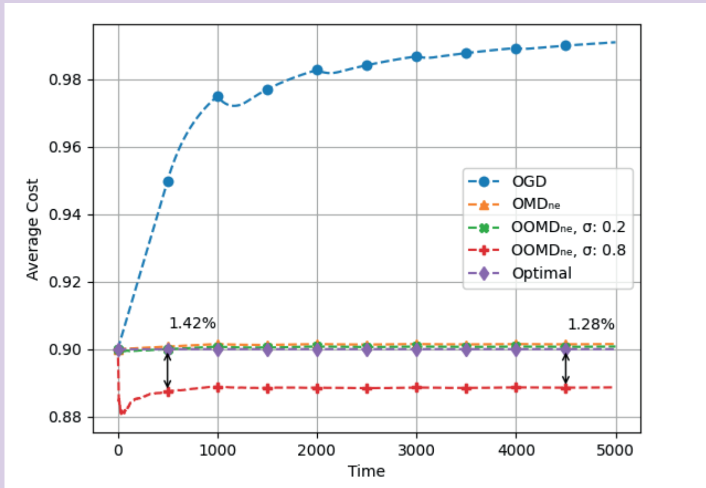

figure 4, average cost over an adversarial trace.

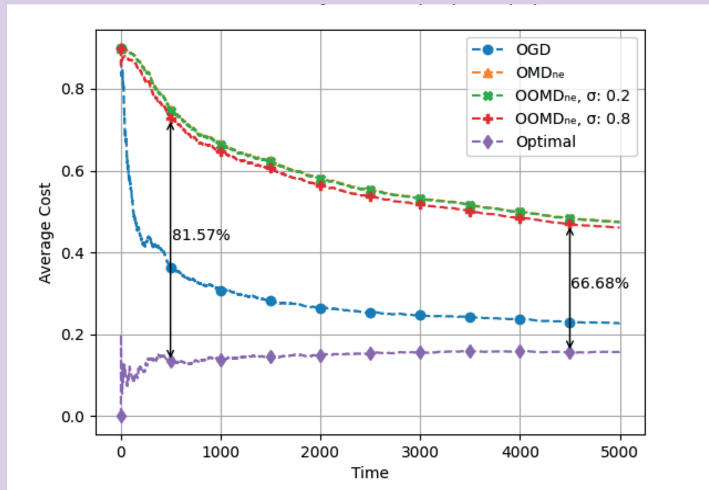

figure 5, average cache cost over stationary trace.

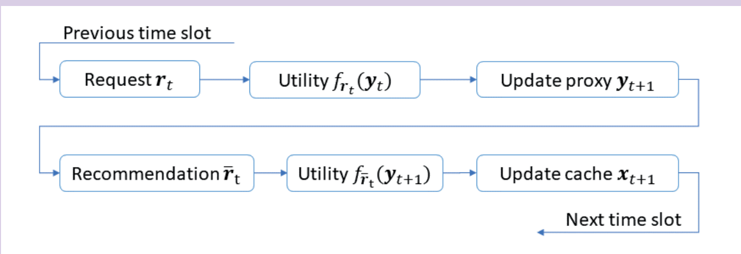

figure 1, system model of the $OOMD_{ne}$ policy

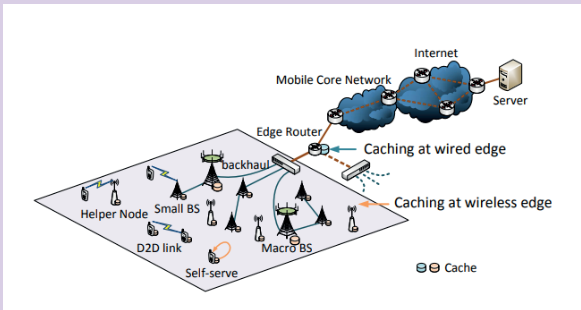

figure 6, a model of an edge cache network[4]

Future Works

· Batch requests instead of single file request

· From single cache to a cache networks

· Integration with a recommender system on real data sets

· Theoretical regret bounds for learning rates of $OOMD_{ne}$

[1] S.E. Elayoubi and J. Roberts. Performance and Cost Effectiveness of Caching in Mobile Access Networks. In *ICN 2015*, Proceedings of ICN 2015, San Francisco, United States, September 2015.
[2] G. S. Paschos, A. Destounis, L. Vigneri, and G. Iosifidis. Learning to cache with no regrets. In *IEEE INFOCOM 2019 - IEEE Conference on Computer Communications*, pages 235–243, 2019.
[3] A. Rakhlin and K. Sridharan. Online learning with predictable sequences. *Journal of Machine Learning Research*, 30, 08 2012.
[4] Modified Figure 1 from D. Liu, B. Chen, C. Y and A.F. Molisch, "Caching at the wireless edge: design aspects, challenges, and future directions," in *IEEE Communications Magazine*, vol. 54, no. 9, pp. 22-28, September 2016

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