01 Learning and finding congestion-free routes

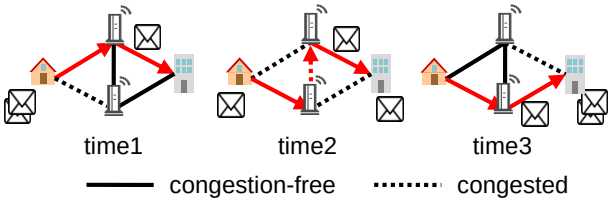
- Online shortest path algorithm with binary decision diagrams -

Abstract

We consider adaptively finding congestion-free routes connecting specified two locations on a network. In many practical scenarios, congestion on a network, or transmission time taken to send messages, changes dynamically. Therefore, we need to effectively learn congestion using past congestion data and efficiently find a congestion-free route each time we send a message. While there exist learning algorithms that can be used for predicting congestion, they incur too much computation cost due to the presence of a huge number of possible routes. We overcome this difficulty by using the zero-suppressed binary decision diagram (ZDD), which is a compact representation of all possible routes. We develop a learning algorithm that can work on ZDDs without examining all possible routes explicitly, which enbles us to find congestion-free routes far more efficiently than the existing algorithms.

Problem Setting

We choose a route every time we send a message, where congestion on the network changes dynamically.



We aim to find a congestion-free route at each time.

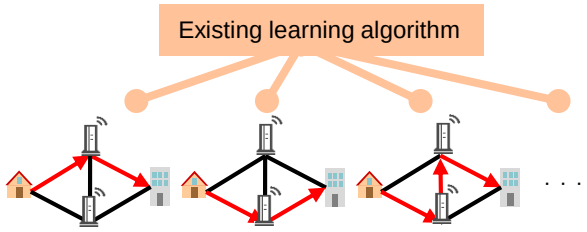
Difficulties of the Problem

First, we cannot see how congested each edge is when sending a message.

For example, cyberattacks may cause sudden congestion, which is sometimes hard to observe without sending a message and getting a feedback.

Second, since there are a huge number of possible routes, predicting congestion for each route is too costly.

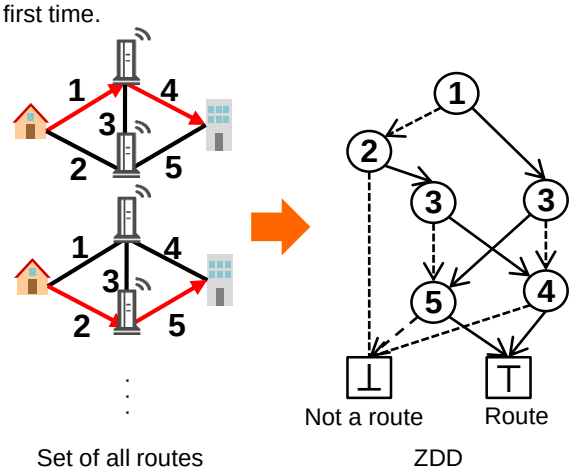
Existing methods (e.g., [2]) learns and predicts congestion by examining all possible routes, which takes too long time.



Efficient Algorithm with ZDDs

Our algorithm first compactly represents the set of all possible routes using the zero-suppressed binary decision diagram (ZDD), and then performs learning algorithm [2] on the ZDD without examining all routes.

We have achieved to find congestion-free routes adaptively on a network with dozens of nodes for the first time.



Point 1. Can learn congestion-free routes efficiently.

All operations are performed on compact ZDDs, and thus our algorithm can run faster than existing algorithms.

Point 2. Need not reconstruct ZDDs at each time.

Once a ZDD is constructed, we can reuse it at each time. This makes our algorithm so efficient as to deal with sudden congestion.

References

[1] S. Sakaue, M. Ishihata, S. Minato, "Efficient bandit combinatorial optimization algorithm with zero-suppressed binary decision diagrams," in *Proc. 21st International Conference on Artificial Intelligence and Statistics (AISTATS)*, 2018.

[2] N. Cesa-Bianchi, G. Lugosi, "Combinatorial bandits," *Journal of Computer and System Sciences*, Vol. 78, No. 5, pp. 1404—1422, 2012.

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