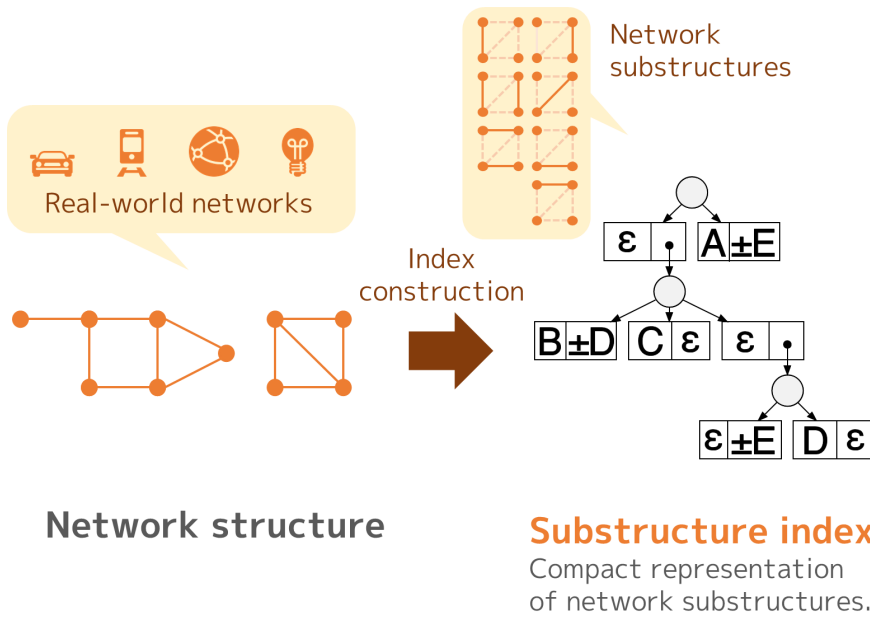


Abstract

We developed a new **substructure index** called the **zero-suppressed sentential decision diagram (ZSDD)** and efficient algorithms with which to construct it. A substructure index is a compact representation of **network substructures**. With it, we can count and find exponentially many substructures in time **linear to the index size**. Since ZSDD is generally smaller than similar data structures, we can solve network-related problems much faster. For example, we can count more than 100 million network routes within a second using ZSDD. Our algorithm can solve a wide range of problems on real-world networks like communication networks, traffic networks, and power grids. Therefore, it will make society more efficient by **finding better solutions to network-related problems**.

Substructure index for solving network problems



We can efficiently find and count network substructures with the substructure index.

Applications

- Find best travel route
- Show multiple delivery routes
- Evaluate reliability of communication networks

This is a result of a joint research with Kyoto University.

Key technologies

1. Zero-suppressed sentential decision diagram (ZSDD)

compact index that supports many useful operations

2. ZSDD construction algorithm

Faster than baseline construction algorithm

Network	Index size		Construction time (ms)	
	ZSDD (Proposed)	ZDD (baseline)	ZSDD (Proposed)	ZDD (Baseline)
att48	279,613	387,715	3,494	3,005
berlin52	937,746	3,194,017	11,826	62,706
eil51	838,254	7,178,190	25,828	94,272
ulysses22	3,036	16,762	39	65
grafo10106	1,756	4,057	28	53
grafo10183	224,373	16,414,697	2,866	538,878
grafo10223	1,009,299	7,313,087	48,563	128,097
grafo10248	16,524	47,605	301	672

References

- [1] M. Nishino, N. Yasuda, S. Minato, M. Nagata, "Zero-suppressed Sentential Decision Diagrams," in *Proc. 30th AAAI Conference on Artificial Intelligence (AAAI 16)*, 2016.
- [2] M. Nishino, N. Yasuda, S. Minato, M. Nagata, "Compiling Graph Substructures into Sentential Decision Diagrams," in *Proc. 31st AAAI Conference on Artificial Intelligence (AAAI 17)*, 2017.
- [3] Y. Nakahata, M. Nishino, J. Kawahara, S. Minato, "Enumerating All Subgraphs Under Given Constraints using Zero-suppressed Sentential Decision Diagrams," in *Proc. 18th Symposium on Experimental Algorithms (SEA 2020)*, 2020.

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