Mining Simple Cycles in Temporal Network

Rohit Kumar[1,2], Toon Calders[1,3]

[1]Department of Computer and Decision Engineering
Université Libre de Bruxelles, Belgium

[2]Department of Service and Information System Engineering
Universitat Polit´ ecnica de Catalunya (BarcelonaTech), Spain

[3]Department of Mathematics and Computer Science
Universiteit Antwerpen, Belgium

1. Temporal Networks?

A temporal network is a sequence of timestamped interactions ϵ over edges of a dynamic graph G = (V,E).

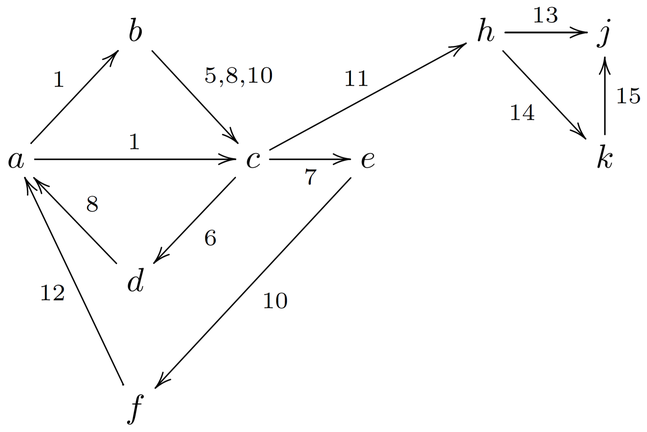
For example:

- Social interactions in a social network.
- Email/ Message or call interaction in a communication network.
- Data exchange in a computer network.
- People contact network.
- Financial transaction data with time stamp of transactions.

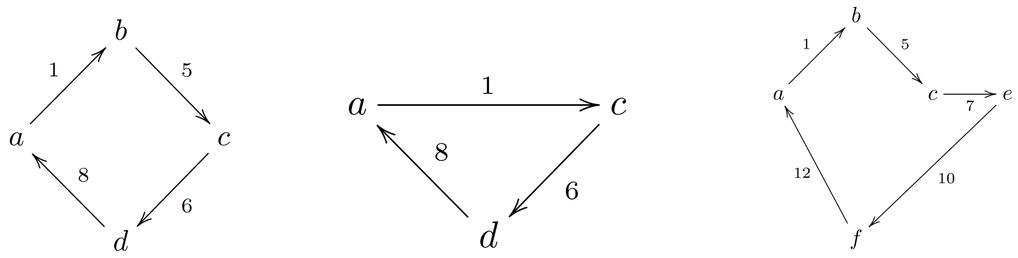
2. What we want to study?

The main focus of this study is, given an temporal network and a time window **(w)** :

- Find all simple cycles in the time window
- Find root nodes which appear most frequently in the cycles.
- Using simple cycle frequency to categories the type of network.

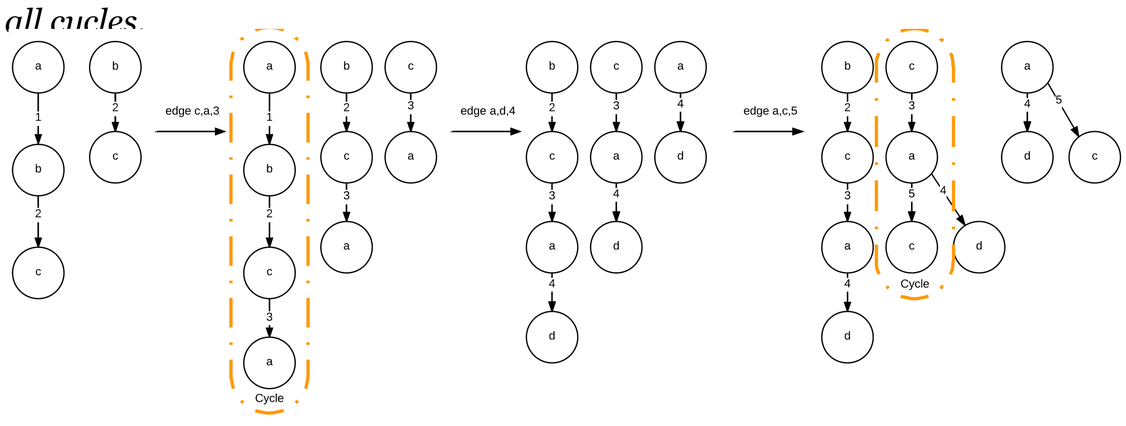


3 simple cycles with *a* as root node and same start time



3. Approach 1

*Using temporal variation of **DFS** with window limit on the length of the path we can detect all cycles.*



***Pros**: single pass algorithm every edge will be processed only once.*

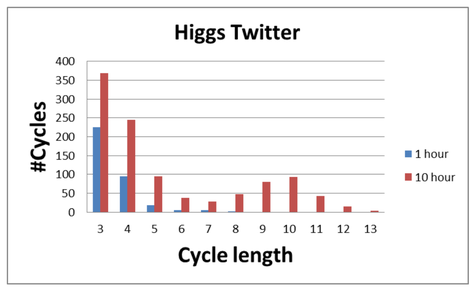
***Cons**: too many candidate path to evaluate and maintain for each edge!!*

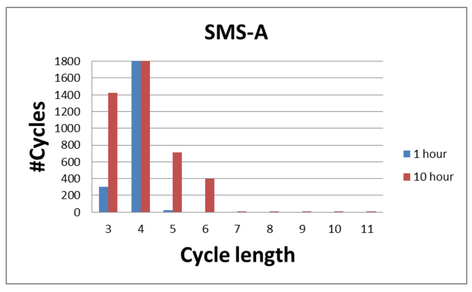
4. Results

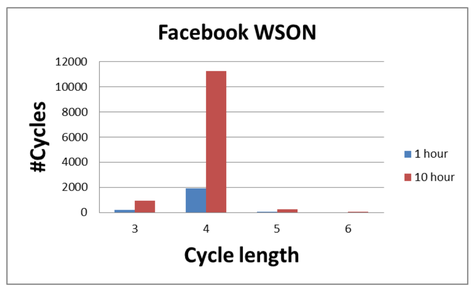
Algorithm run time and memory

Dataset	#Nodes	Edges	Processing time (min)		Memory (MB)	
			w=1 hr	w=10 hr	w=1 hr	w=10 hr
Facebook WSON	46,952	876,993	6.4	7.0	14	19
Higgs Twitter	304,691	526,167	35.2	187.3	156	1815
SMS-A	44,100	545,000	11.3	50.9	29	777

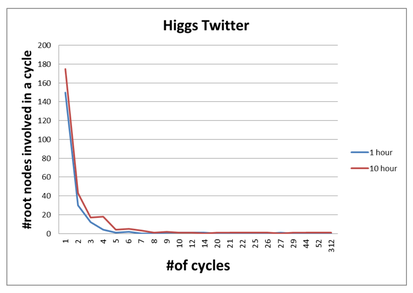
Cycle length Frequency Distribution

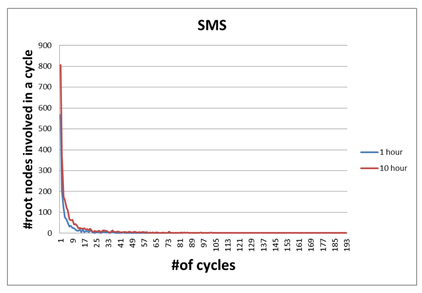


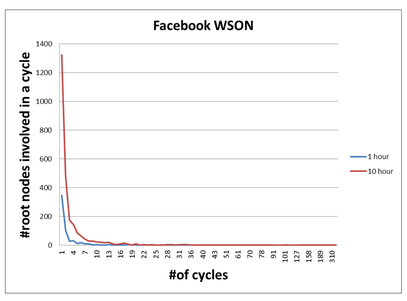




Cycle count Frequency Distribution







5. Work in Progress: Multi Phase approach

Phase 1:

1) Run strongly connected component algorithm and throw away nodes and edges which are not in a strongly connected component.
2) Run IRS algorithm* to find root nodes and candidates set for cycles from root node.

Phase 2:

1) Running DFS for root node found in phase 1 only for subgraph of root node and candidate set.

* Information Propagation in Interaction Networks. EDBT 2017 , Rohit Kumar and Toon Calders