Exacting Eccentricity for Small-World Networks

Wentao Li[1], Miao Qiao[2], Lu Qin[1], Ying Zhang[1],

Lijun Chang[3], and Xuemin Lin[4]

[1]CAI, FEIT, University of Technology Sydney, Australia

[2]Massey University, New Zealand

[3]The University of Sydney, Australia

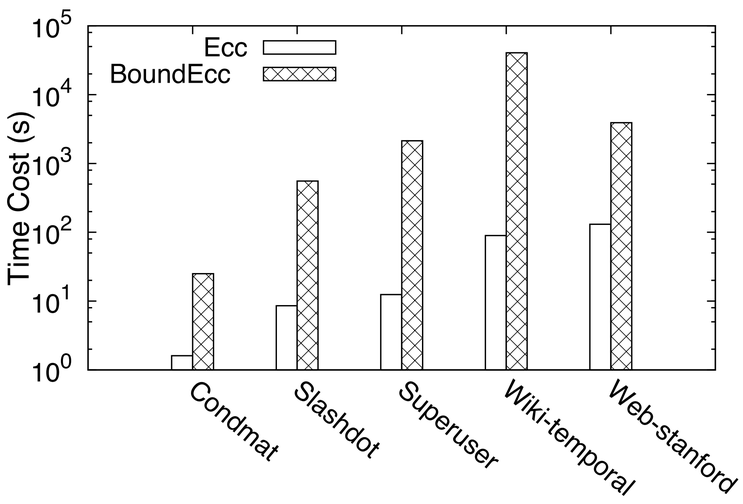
[4]The University of New South Wales, Australia

CONTRIBUTIONS

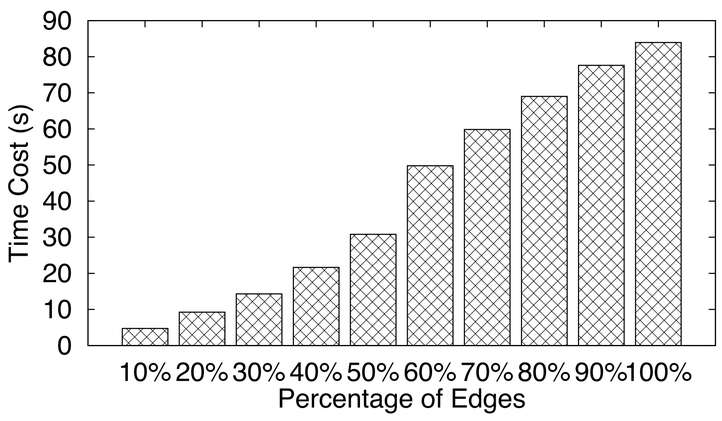
- We study the efficiency issue on computing the exact eccentricity-distribution for a small-world network.
- We propose an algorithm to determine the eccentricity at an early-stage rather than traveling the whole graph.
- We conduct extensive experiments using real small-world networks to demonstrate the efficiency of our algorithm.

PERFORMANCE STUDIES

Comparison with the State-of-the-art:



Scalability Testing on the Wiki-temporal Graph:

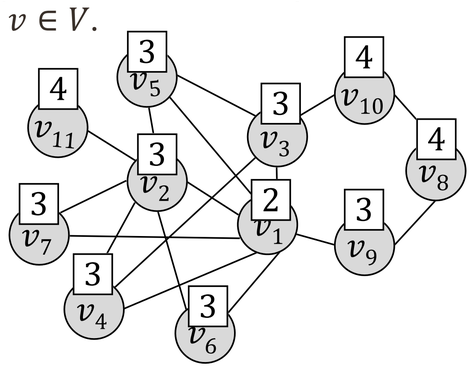


ACKNOWLEDGMENT

Lu Qin is supported by ARC DP160101513. Ying Zhang is supported by ARC FT170100128 and DP180103096. Lijun Chang is supported by ARC DP160101513 and DE150100563. Xuemin Lin is supported by NSFC 61672235, DP170101628 and DP180103096.

PROBLEM DEFINITION

- The term **small-world networks** describes a group of graphs that feature a highly clustered topology and short path-length.
- Define **eccentricity**: The eccentricity $ecc(v)$ is the longest shortest distance from one node v to all the other nodes of the graph.
- **Problem Statement**: Given a graph $G(V, E)$, compute the eccentricity-distribution, namely, the eccentricity $ecc(v)$ for all the nodes $v \in V$.



CHALLENGES

- Approximation algorithms may lead to undesirable errors for networks with a small diameter.
- Naïve Algorithms that apply the all-pairs shortest path (APSP) algorithm to find the eccentricity of all nodes cause an efficiency issue.
- The state-of-the-art method incurs exhaustive Breadth-First-Search (BFS).

PROPERTIES OF SMALL-WORLD NETWORKS

- There exist some reference nodes that are near to all the nodes in a small-world network.
- If a node v is near a reference node, then the farthest nodes of the reference node will not be too close to v.
- Therefore, the node v visits first from nodes that are distant to the reference node, which are likely to be the farthest nodes of v.
- 2-hop distance labeling methods make this reversing visiting possible.

EXACTING ECCENTRICITY FOR A NODE

- The distance between v and the visited nodes provides the lower bound $\underline{ecc}(v)$.
- The distance upper bound between v and the unvisited nodes, together with the distance between v and the visited nodes, provides the upper bound $\overline{ecc}(v)$.
- If the upper bound meets the lower bound, we find the eccentricity of v.