

Orion: A Graph Coordinate System for Shortest Path Estimation

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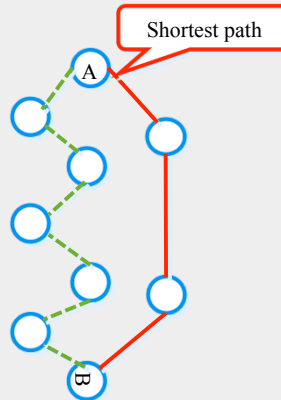
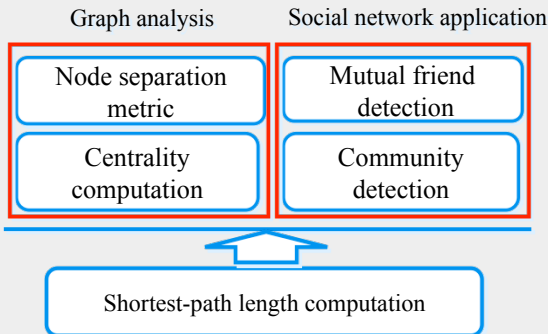
CURRENT LAB

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Motivation

- Shortest-path computation is a critical primitive in large social graph.



- Scalability limitation on large scale graphs.

Method	Time complexity for all node pair
BFS	$O(mn)$
Dijkstra	$O(n^2 \log(n) + m)$
Floyd-Warshall	$O(n^3)$

- ❖ Current methods are **not tolerable** in large scale graphs.
- ❖ Scalable and efficient algorithm for shortest-path length computation is needed.

Designing Orion

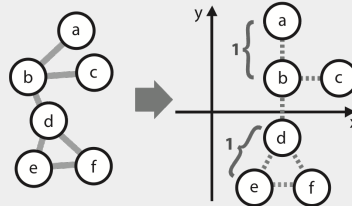
- **Basic idea:**

❖ Mapping nodes into a **low dimension Euclidean space**;

❖ **Computing Euclidean distances** in **constant** time

- **Our goals:**

❖ Scalability, accuracy and fast convergence



- **Landmark-based approach**

❖ Divided landmarks for scalability

➢ Initial group: rely on each other

➢ Secondary group: based on Initial group

❖ Separated landmark selection for accuracy

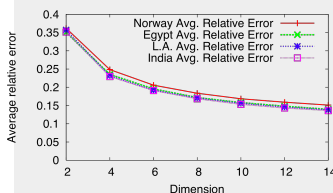
➢ Highest degree nodes

➢ 2-hop away from each other

Experimental Results

Accuracy and Efficiency of Orion

Average relative error of different coordinate dimensions



- ❖ Increase of dimension increase accuracy.
- ❖ When dimension is larger than 6, average relative error is **smaller than 0.2**
- ❖ Orion can estimate shortest-path accurately

❖ Orion is **7 orders of magnitude faster** than BFS.

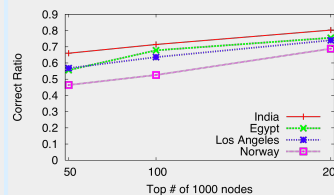
❖ Orion is efficient to compute shortest path compared to BFS

Response times for Orion and BFS

Time	India	Egypt	L.A.	Norway
Orion	0.2 μ s	0.2 μ s	0.18 μ s	0.19 μ s
BFS	1.028s	0.75s	1.027s	1.44s

Application-level benchmarks

Centrality Computation



❖ Centrality is that the average shortest path length from a node a to every other nodes in the graph.

❖ The overlap between Orion and BFS' results increase with k

❖ The correct estimates are **more than 50%** when selecting top 5% nodes

❖ Orion produces errors **less than 0.3** compared to BFS.

❖ Orion is accurate to estimate average path length of graphs.

Ave. Path Length Computation

