Parallelization of Pathfinding Graph Algorithms

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Outline

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2. Planned Algorithms
3. Parallel Approaches
4. Code Overview
5. Datasets
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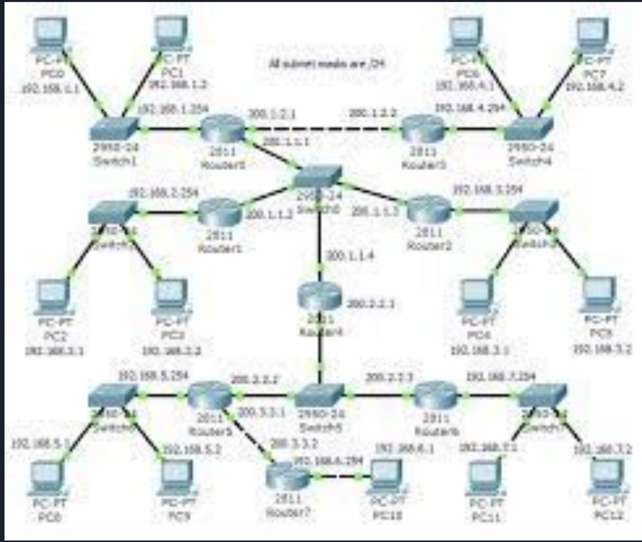
Network Routing



- Routers maintain a routing table in order to send packets in efficient paths.
- Network graphs are useful as they allow for straightforward graph algorithms to perform the routing.

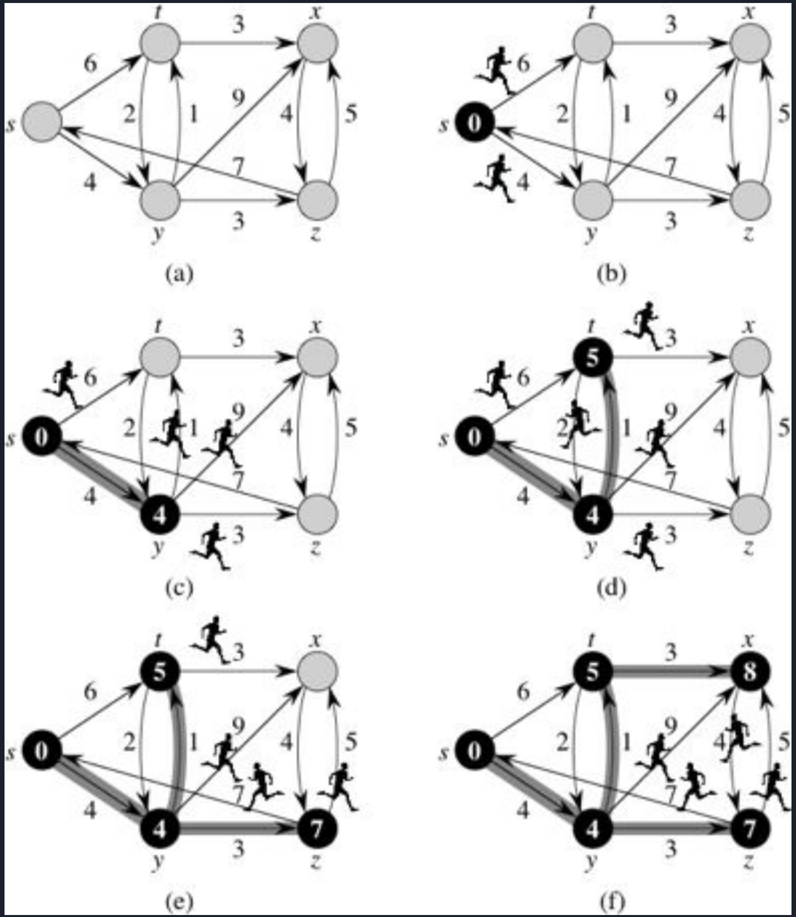
Our Goals

1. Implement an efficient parallelized version of Dijkstra’s and Bellman-Ford with OpenMP.

2. Evaluate the speedup and scalability of the algorithms relative to each other and their serial versions.

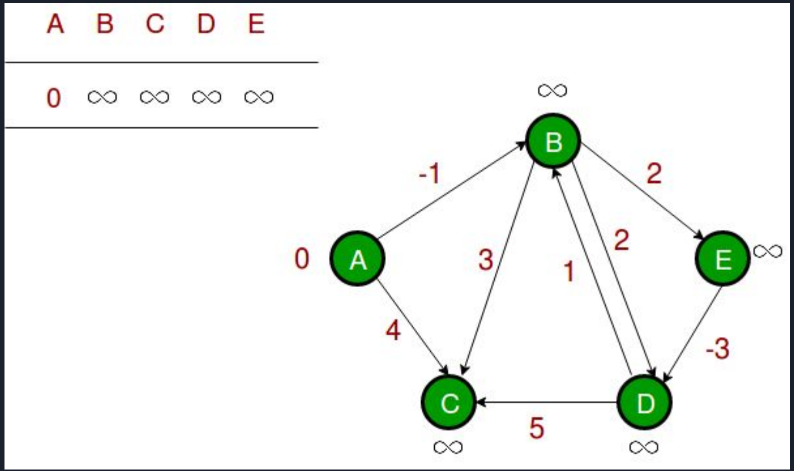
Dijkstra’s

- Main Idea: Very similar to BFS but uses a priority queue vs. a standard queue
- Allows for termination upon visiting the destination
- O((m+n)log(n)) for n nodes, m vertices



Bellman-Ford

- Main Idea: Use dynamic programming to build the shortest path in a bottom up manner
- May terminate early after no distances change
- O(nm) for n nodes, m edges



Parallel Approach: Dijkstra's

Simple Approach: Relies on previous results, but could parallelize the loops within each iteration.

- Con: Creates a high overhead with little benefit on sparse graphs

Advanced Approach: Each processor handles a subset S of graph G to find eventually map the path through each cluster

Parallel Approach: Bellman-Ford

Algorithm 1: BELLMAN-FORD

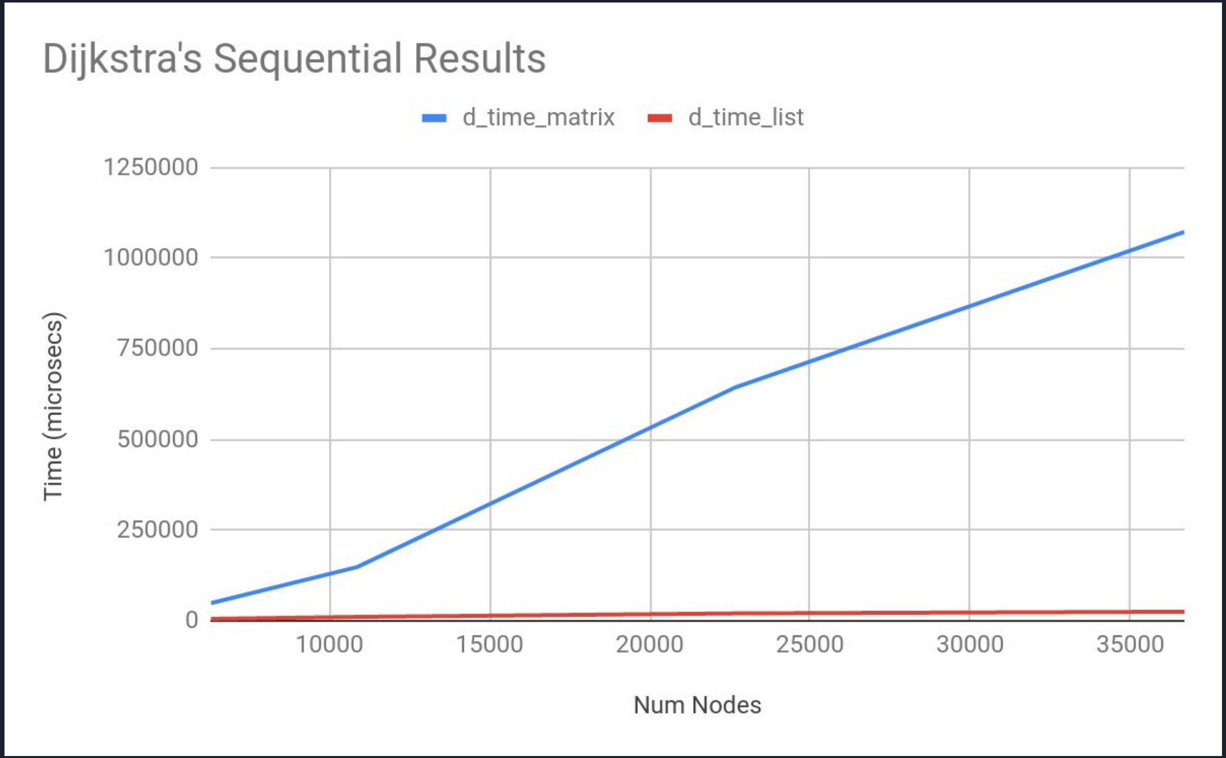
Input : Graph G =(V,E), source vertex
Output : shortest distance & predecessor arrays

```
Initialize distance array to ∞
Initialize predecessor array to −1
distance[source] := 0
predecessor[source] := -1
for i ← 1 to |V-1| do
    for each edge (u, v) with weight w in E do
        if distance[u] + w < distance[v] then
            distance[v] := distance[u] + w
            predecessor[v] := u
        end
    end
end
return distance, predecessor
```

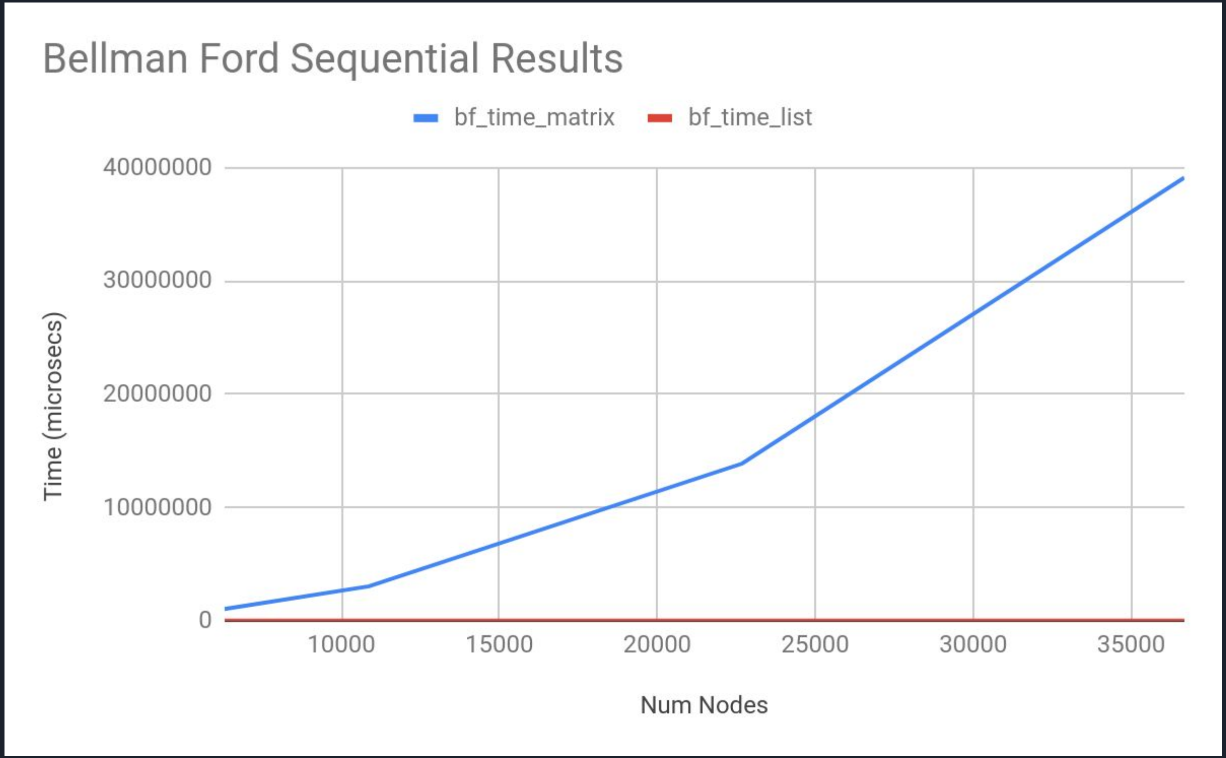
Dataset's

- Using the Stanford Large Network Dataset
- Consists of various sized peer-to-peer network models
    - Undirected and unweighted
    - Very sparse graphs
- In order to create weighted edges, edges are assigned a random weight between 0-255 during the initial parse of the graph

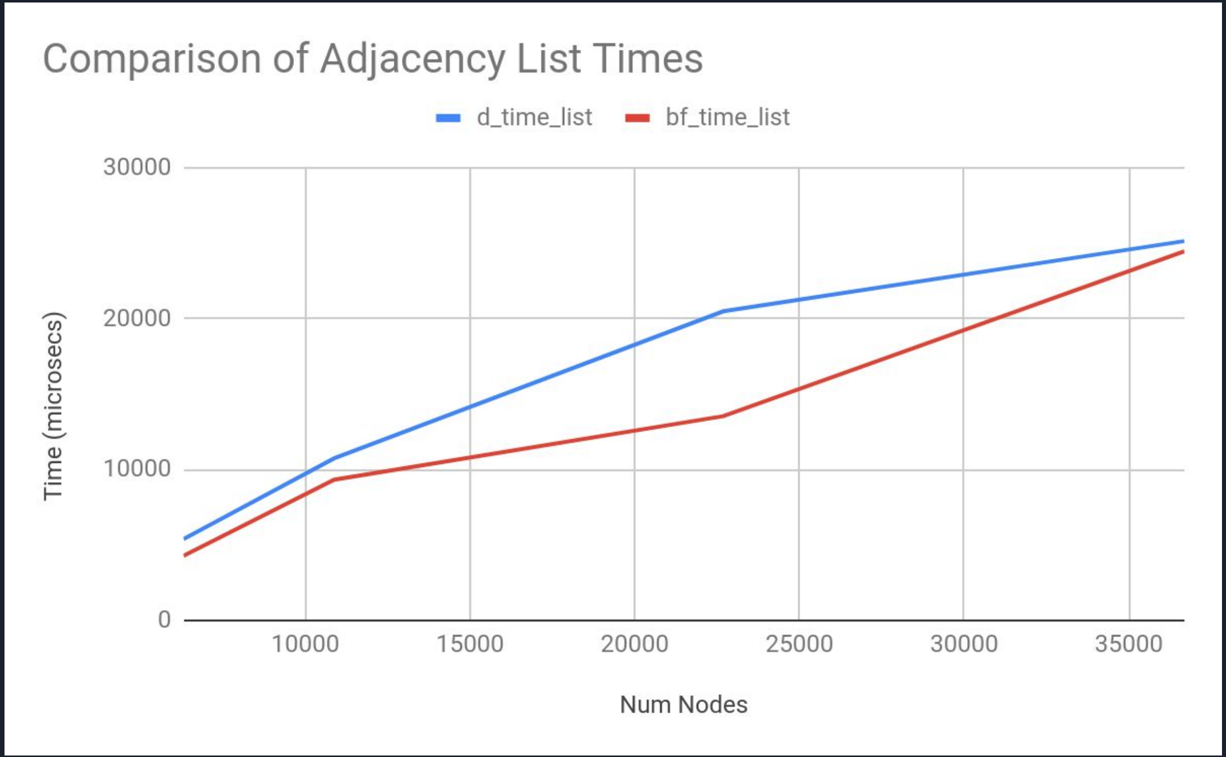
Sequential Results



Sequential Results



Sequential Results



Parallel Results

- Still working on ironing out the parallel versions of Dijkstra’s and Bellman-Ford for the report
- Currently Bellman-Ford has proven much easier to implement
    - Dijkstra’s is a lot less straightforward
- Final step before the final paper

Thank you!