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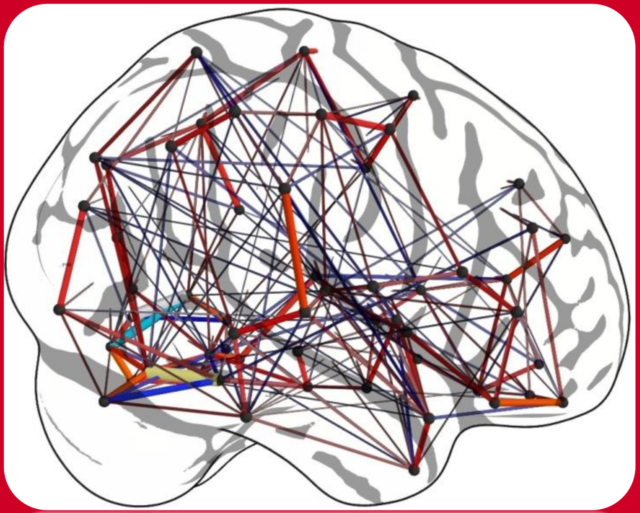

Brain Connectivity using Graph Theory

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Problem Statement

- During certain activity different regions of brain get activated.
- The active regions (or) regions of interest (ROIs) can be represented as nodes (or) vertices in a graph.
- Functional connectivity between the ROIs are the edges.
- Using this information, shortest path between the ROIs can be computed.
- Why Shortest Path?
  - The length of the shortest path is indicative of the potential strength of functional interactions.
  - Another factor determining this strength may be how many different short paths exist.
  - We have chosen Floyd's, Dijkstra and BFS algorithm to measure the shortest path.

Data Structure - Adjacency Matrix

- fMRI data is an image set where structural information is a 3D data set, 4^{th} D is the time series information of the activation of the brain when the person was being scanned.

- Processing steps involved in fMRI Image:
  - Brain is extracted from the whole head.
  - Functional/activation information is superimposed on the structural information.
  - The ROIs/nodes which are active over the duration of activity is extracted along with the time series information.
  - Using the ROIs and time series information, the connectivity between the ROIs are extracted as a graph with nodes and edges (adjacency matrix).

Experiment

	LG	MTGPD	LLV	LOCID	AG
LG	0	0	1	1	0
MTGPD	1	0	0	1	1
LLV	0	1	0	0	1
LOCID	1	0	1	0	1
AG	1	0	0	1	0

Space & Time Complexity for Adjacency matrix:

- Adjacency matrix has a space complexity of O(V^2)
- Add vertex – O(V^2)
- Add Edge – O(1)
- Query – O(1)

- While running the experiment we varied the source and the target nodes and observed how the time varies.
- Finally we took the average value of different trials

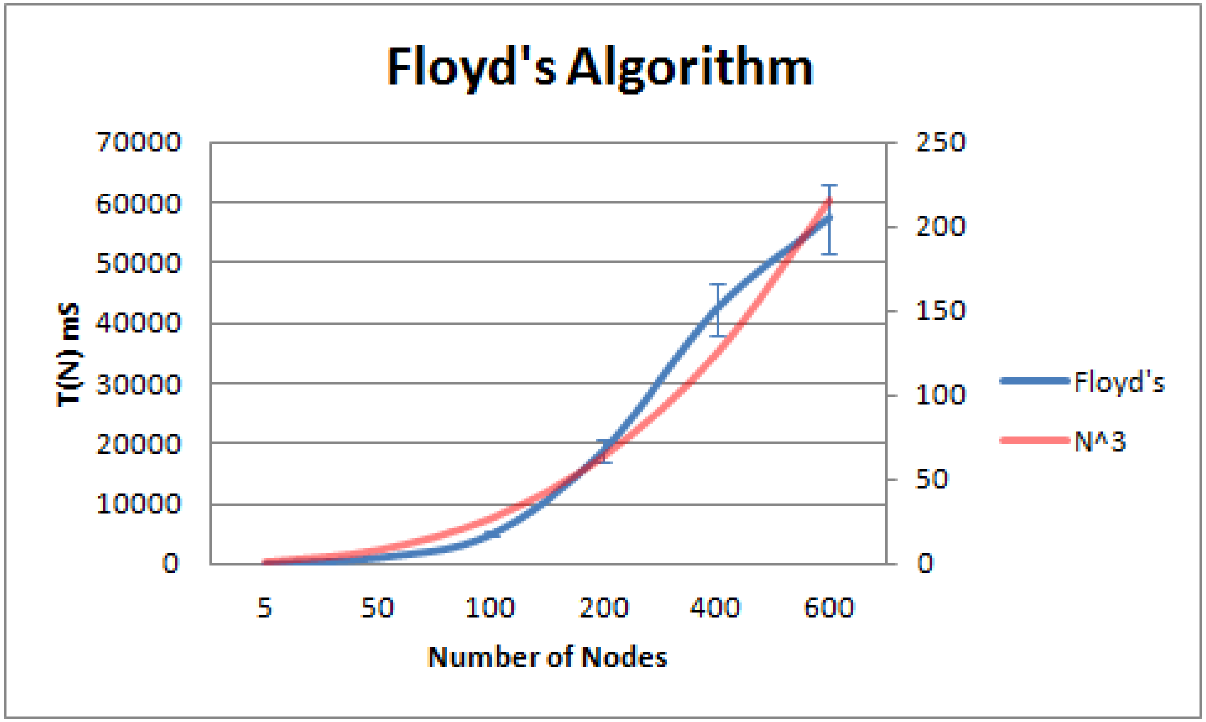
Floyd-Warshall Algorithm

- Floyd–Warshall algorithm compares all possible paths through the graph between each pair of vertices
- It finds the shortest path as a function shortestPath(i,j,k) defined as

if dist[i][k] + dist[k][j] < dist[i][j]
then dist[i][j] ← dist[i][k] + dist[k][j]
next[i][j] ← k

- It finds the shortest path from i->j using k=1, then 2 and so on until k=n.

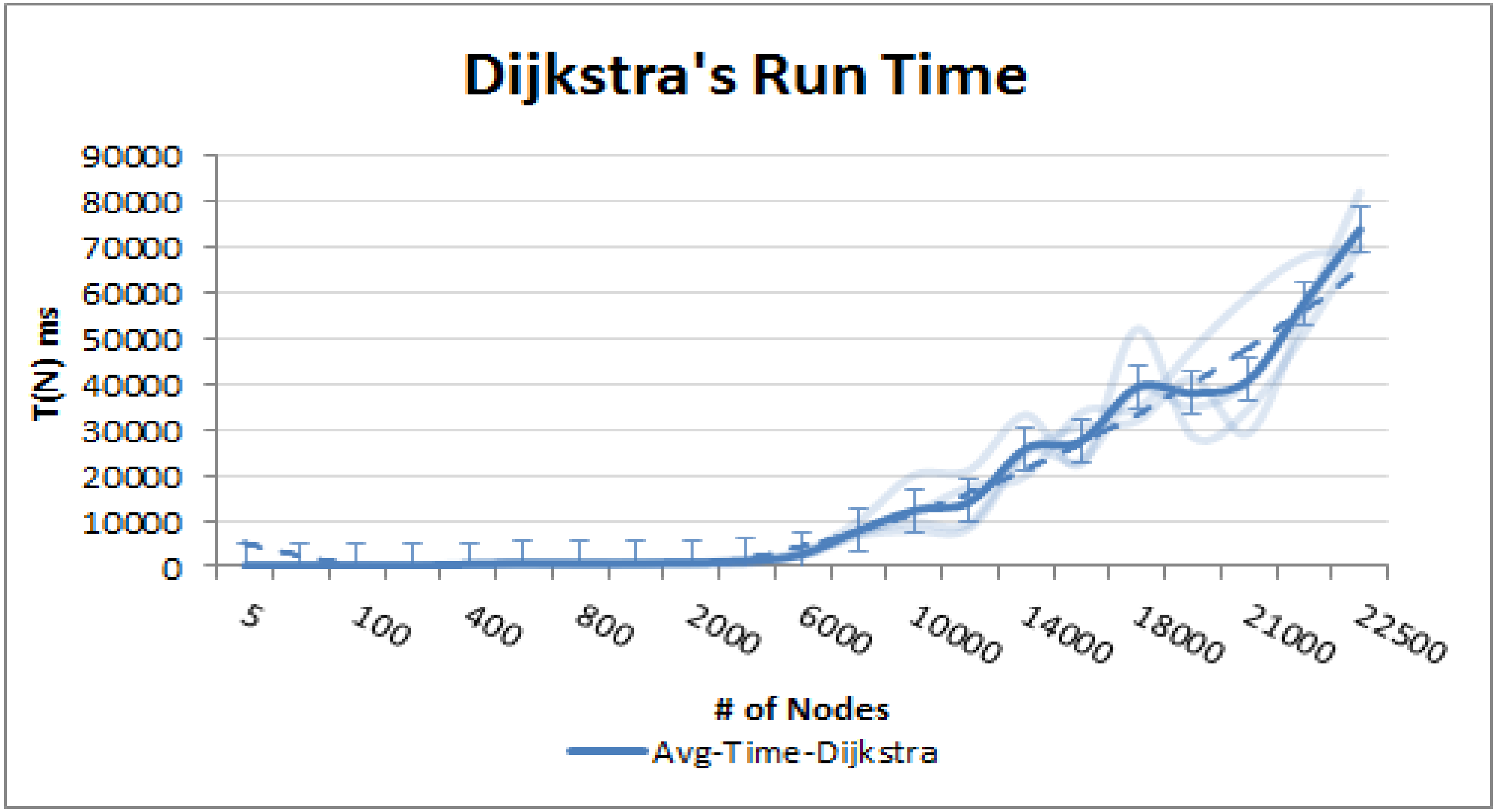
Time Analysis for Floyd's Warshall Algorithm



Analysis:

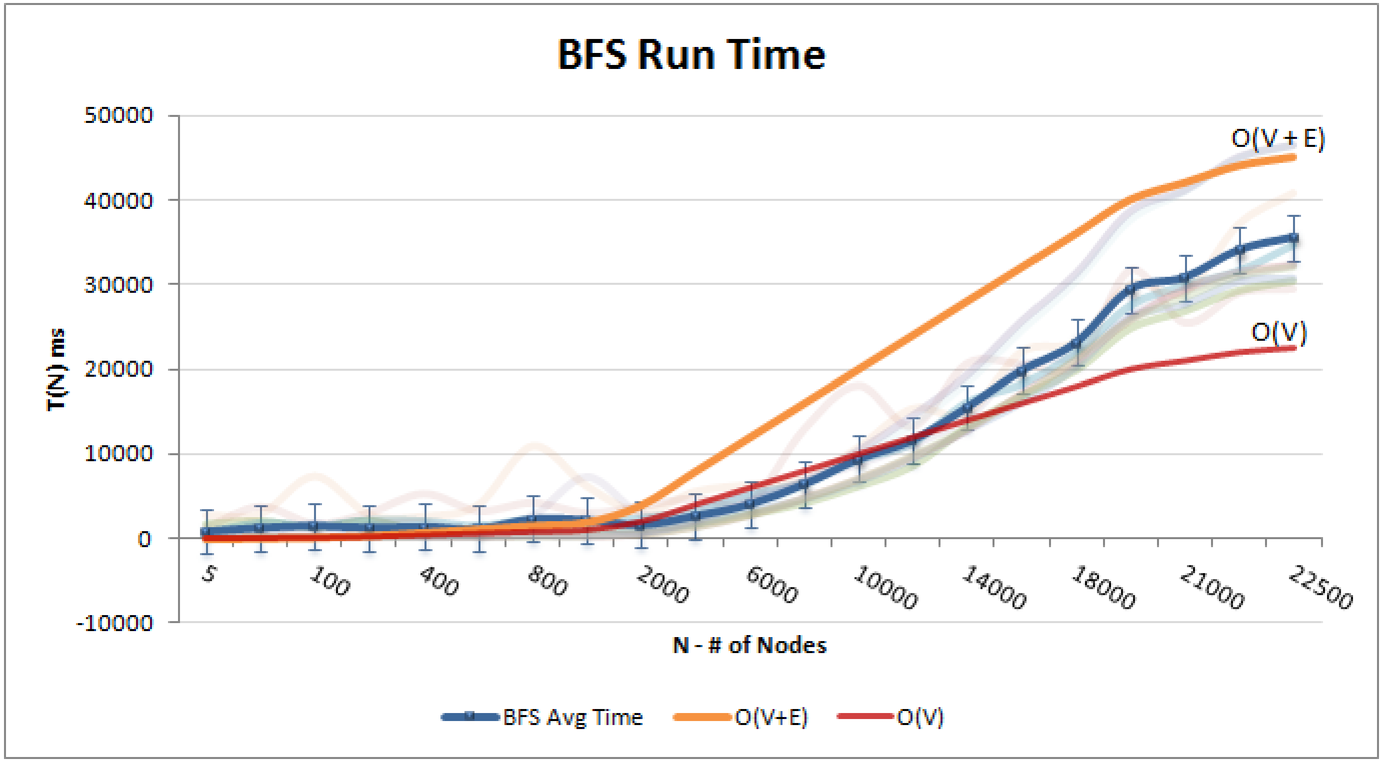
➢ As we ran for different number of nodes, we found that the time complexity for Floyd's is followed as O(N^3)

Dijsktra's Algorithm



- Complexity: O(V^2)
- Since the data structure used is an array it is a greedy approach and hence the above said complexity.

BFS Execution Time

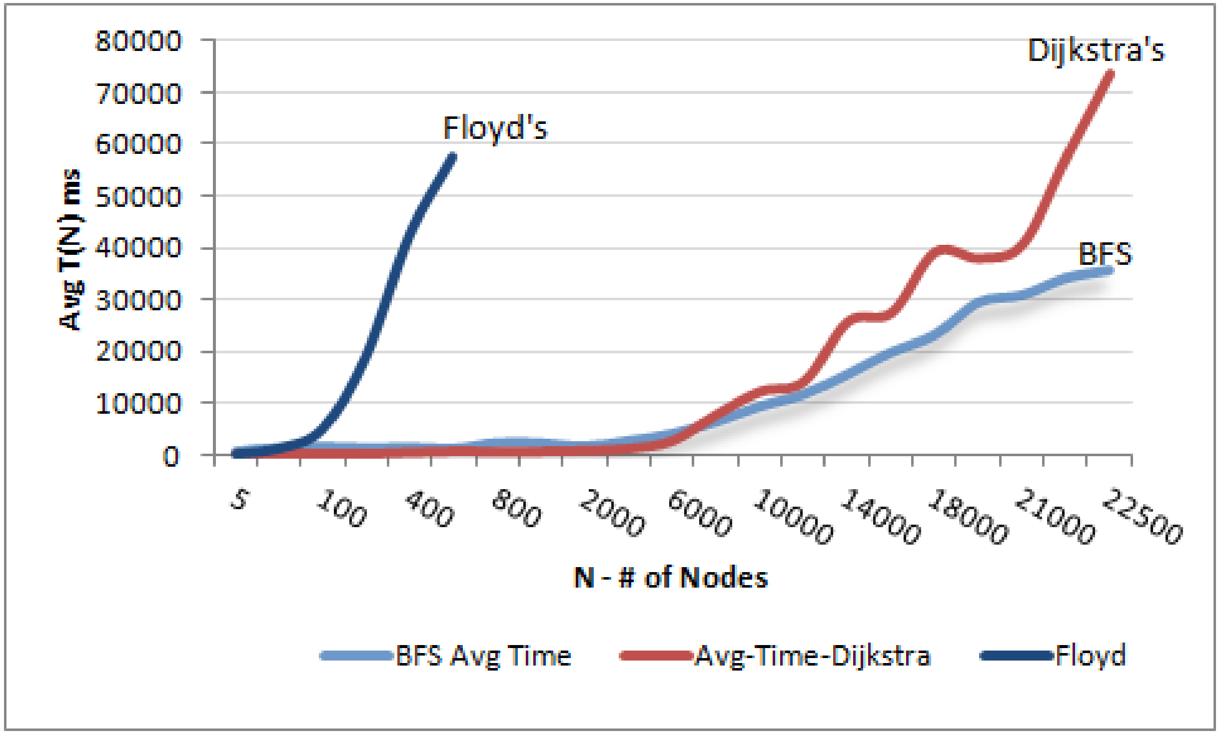


Analysis:

➢ As the number of nodes increases, the time complexity increases in the order of O(V+E)

➢ The number of edges are varying between 0 – V-1, which give the characteristics to the observed run time complexity.

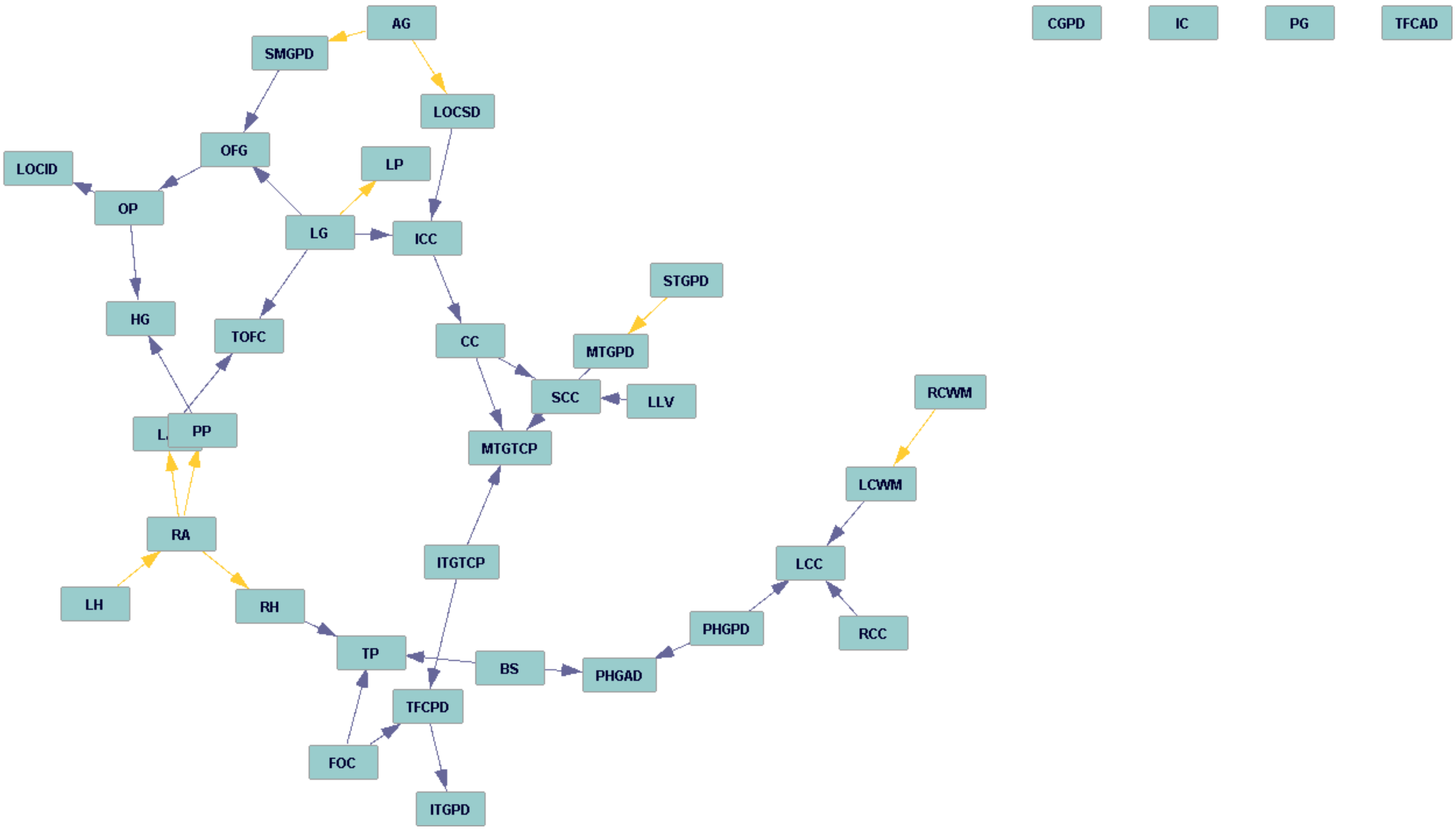
Comparison of Floyd, Dijkstra & BFS



Analysis:

- Floyd's Algorithm has a run time of O(V^3)
- Dijkstra's Algorithm has a run time of O(V^2)
- BFS has a run time of O(V+E), which implies that BFS takes least time complexity to calculate shortest path

A View of connectivity of ROIs of Brain



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THANK YOU

Questions?