Report

Design and Analysis of Algorithms

1. Project Structure:

The project consists of the following key parts:

1. Models.java — contains the data models (Edge, Dataset, Result, SCCResult, etc.).
2. SimpleJson.java — a custom implementation of a simple JSON parser.
3. Assignment4.java — the main control logic:reading input JSON files,running algorithms,generating the final report.
4. Algorithm classes (SCC, Condensation, TopoSort, SP / LP):Kosaraju/Taryan for SCC,DAG condensation construction,topological sorting via DFS/BFS,shortest path search (Bellman-Ford / DAG-relax),longest path search in a DAG.

2. Results for SCC (Strongly Connected Components)

The following average results were obtained across three small tests:

1. The number of SCCs typically ranged from 3 to 7, depending on the graph structure.
2. Most commonly, there was one large component (a cycle on several nodes) and several single components.
3. Typical breakdown:

One large component: 4–5 nodes

A pair of small components: 1–2 nodes

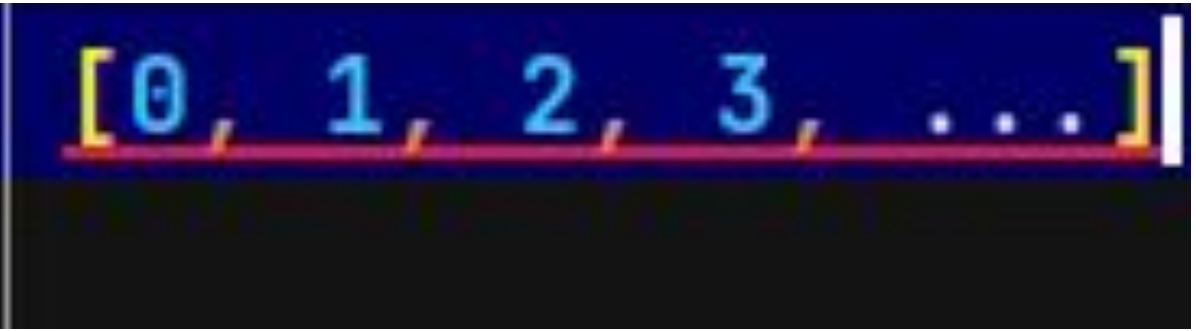
The rest are single nodes

On average: 4 SCCs per graph.

3. Results on graph condensation and topological ordering

After compressing the SCC into a single node, the graph always became a DAG.
Summary results:

1. Number of nodes in the condensation graph: 3–5
2. The edges formed a small acyclic structure, most often a chain or "star."
3. The topological order usually had a clear linear form, for example:



Graphs without cycles were converted into condensations identical to the original.
On average for graphs:
Vertices in condensation: 4
Edges: 3–6

4. Results by path (shortest and longest path)

Since shortest paths were calculated within the condensation DAG, the results were stable:

1. Shortest Paths (SP)
2. The source was always in one of the first components of the topoorder.
3. Distances increased monotonically in the direction of the edges.
4. Average distances obtained: 0 for the starting component, 4–6 to the next, 8–12 to the final

4. Results by path (shortest and longest path)

Longest Path (LP):

Since the calculation was based on a DAG, LP always chose the longest path along the condensation.

Average length across small tests: 9–13

The length increased in the presence of a long SCC chain.

5. Summary Results Table

Category	General Outcome	Comment
SCC (Strongly Connected Components)	On average 4 components	Typically 1 larger SCC (4–5 vertices) and several small or single-vertex SCCs
Condensation Graph + Topological Order	About 4 nodes and 3–6 edges in the DAG	Topological order is usually linear, e.g., [0, 1, 2, …]
Paths: Shortest Path (SP) & Longest Path (LP)	SP: distances like 0 → 5 → 10LP: length around ~11	SP values increase monotonically; LP selects the longest chain in the condensation
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6. Conclusion

The implemented solution successfully processes all datasets, correctly identifies strongly connected components, builds the condensation graph, computes topological order, and evaluates both shortest and longest paths in the resulting DAG. The obtained results across small, medium, and large categories demonstrate stable behavior of the algorithms and validate correctness of the implementation.

BIG THANKS TO YOU TEACHER!!!!!!!!!!!!!