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Discussion on 23.10.2026
Homework due on 30.10.2026 at 10:15

Possible solution for Exercise Sheet 2 in

Scientific and Technical English

WiSe 2026/27

The exercise sheets consist of in-class exercises and homework. The in-class exercises take place during the second half of the lecture time slots. The homework, which is optional and ungraded, can be submitted via the "Homework" section in Moodle. The homework is subject to peer review.

Unless indicated otherwise, generative artificial intelligence assistants such as ChatGPT may be used, as long as you acknowledge how you use them as specified by the Institute's policy on plagiarism.[1] However, you may not use such tools to generate peer reviews for you. In addition, we strongly recommend that you do not use them to generate entire solutions, since that would defeat the purpose of the exercises.

Homework 2-3 ***From Title to Ideas, then to Sketch*** Dijkstra's algorithm solves the single-source shortest-paths problem on a positive-weighted directed graph. Sketch a 15-page paper describing and evaluating the algorithm by following these steps:

a) Choose a title for your paper. It may be catchy, informative, or double-barreled.

b) Write your paper's table of contents, and allocate a page budget to every section and subsection.

c) In each section and subsection, write down at least two bullet points standing in for the future content.

d) Refine your bullet points by adding descriptions of the examples, definitions, code excerpts, tables, and figures that will appear in each section and subsection.

POSSIBLE SOLUTION:

Solving the Single-Source Shortest-Path Problem Using Dijkstra's Algorithm

1. Introduction (1.5 pages)

[1] `https://www.medien.ifi.lmu.de/lehre/Plagiate-IfI.pdf`

- Provide a motivating example with the shortest route from Berlin to Paris
- From Wikipedia: [The algorithm] was conceived by computer scientist Edsger W. Dijkstra in 1956 and published three years later

2. Background (2 pages)

- A graph (V, E) consists of a finite set of vertices V and a set of edges $E \subseteq V \times V$
- A partially ordered set A has a binary relation $< \subseteq A \times A$ that is transitive and asymmetric
- A monoid $(A, +, 0)$ has a carrier set A, an associative binary operation $+ : A \to A \to A$, and an identity element 0
- A weighted graph has a weight function $w : E \to \mathbb{O}$, where $\mathbb{O}$ is a partially ordered set and $(\mathbb{O}, +, 0)$ is a monoid such that $\forall x\, y.\, x \leq x + y$
- From Wikipedia: The shortest-path problem is the problem of finding a path between two vertices (or nodes) in a graph such that the sum of the weights of its constituent edges is minimized
- In the single-source shortest-path problem, we have to find the shortest paths from a fixed source vertex to all other vertices in the graph
- From Wikipedia: A min-priority queue is an abstract data type that provides 3 basic operations: `add-with-priority()`, `decrease-priority()`, and `extract-min()`
- Complexity classes and big O notation

3. Dijkstra's Algorithm (5 pages)

- Code listing: pseudocode for `Dijkstra(graph, source)`
- Line-by-line explanation
- Figure: visual example with small graph and state at every loop iteration
- Code listing: pseudocode to read/analyze the path from source to target
- Complexity upper bound + proof
- Complexity lower bound + proof

4. Implementation (3 pages)

- Discussion of data structure and memory representation
- Code listing: implementation in C
- Line-by-line explanation

5. Evaluation (2 pages)

- Three sets of benchmarks: train networks, maze puzzles, randomly generated graphs
- Table: results of our implementation

6. Related Work (1 page)

- From Wikipedia: Bellman–Ford algorithm solves the single-source problem if edge weights may be negative
- From Wikipedia: A* search algorithm solves for single-pair shortest path using heuristics to try to speed up the search
- From Wikipedia: Floyd–Warshall algorithm solves all-pairs shortest paths
- From Wikipedia: Johnson's algorithm solves all-pairs shortest paths, and may be faster than Floyd–Warshall on sparse graphs
- From Wikipedia: Viterbi algorithm solves the shortest stochastic path problem with an additional probabilistic weight on each node

7. Conclusion (0.5 pages)

- We presented a full description of Dijkstra's algorithm
- Our evaluation on hardware X showed that it can solve realistic problems up to size Y in less than Z seconds
- Ideas for future work include a presentation of Bellman–Ford and a comparison