CSE 412: Design and Analysis of Algorithms, Fall 2025

Programming Homework 2. Due: Friday, December 5, 2025 on LMS

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1. This assignment focuses on computing all-pairs shortest paths (APSP) on directed graphs using three classic algorithms and comparing their performance across graph densities and weight regimes.

   Implementation

   - Breadth-First Search from every source for unweighted graphs
   - Dijkstra from every source for non-negative weighted graphs
   - Floyd-Warshall for general weights (including negative edges; detect negative cycles)

   Requirements

   - All graphs should be directed graphs: $G = (V, E, w : E \to \mathbb{Z})$
   - Sparse regime: $|E| = \Theta(|V|)$
   - Dense regime: $|E| = \Theta(|V|^2)$
   - Weight regimes:
     - Unweighted: $\forall e \in E, w(e) = 1$
     - Non-negative weights: $\forall a \in E, w(w) \geq 0$
     - General integer weights: $\forall e \in E, w(e) \in \mathbb{Z}$
   - Required experiment combinations:
     - Unweighted graphs (sparse and dense): BFS, Dijkstra, and Floyd-Warshall
     - Non-negative weighted graphs (sparse and dense): Dijkstra and Floyd-Warshall
     - General integer-weighted graphs (sparse and dense, may include negative edges): Floyd-Warshall with negative-cycle detection
   - For each run, record the wall-clock running time; the primary reported metric is running time.

   Outcomes

   - Behavior of different pathfinding algorithms on sparse vs dense graphs
   - Impact of weight regimes (unweighted, non-negative, general)
   - Where each algorithm performs best, and why