

HW1

Due on Friday 02/13/25, 11:59 PM

This is an individual/group homework assignment. Groups of **up to three** students can submit joint solutions. For group submissions, please follow the following rules:

- 1) **Form a Group:** First, self-enroll in a group with your partner(s) by navigating to People → Groups → Assignment1 Group.
- 2) **Submit as a Group:** When submitting the assignment, select the "Group Submission" option. This allows one team member to submit the work on behalf of the entire group, ensuring everyone in the group sees the grade and feedback. Important: ALL GROUP PARTNER NAMES should appear on ALL submitted documents.

You may use the Canvas Discussion Board to look for groupmates and create your group.

Individual submission is accepted too.

As it appears in the course syllabus, for the homework assignments, students are encouraged to discuss the problems with others, but you are expected to turn in the results of your own effort (not the results of a friend's efforts)". Even when not explicitly asked, you are supposed to justify your answers concisely.

Question 1)

- a) Define an algorithm. Explain its properties.
- b) Consider a problem in people's daily life that has been solved by an algorithm. Explain the problem and the algorithm used to solve the problem. Do you have any better idea to solve the same problem? Explain why?

Question 2)

- a) Define an **instance** of a problem in general.
- b) Consider the following **Summation** problem: Given an integer list (an array) of size n , we want to calculate the summation of all numbers in the list and display the result.
 - (1) Specify two different instances of the Summation problem defined above.
 - (2) What is the solution for each instance in part (1). How did you come up with that solution?

Question 3)

- a) Write an algorithm for sorting a list of integer numbers using the bubble sort algorithm (you have studied this sorting algorithm in CS413 prerequisites like Data Structures and Algorithms courses. Study this algorithm, and after you recall that completely, write what you understood from the algorithm USING your own **ENGLISH DESCRIPTION. No point for a code here**). Ensure you provide enough detail and follow the definition of an algorithm as we studied in video lectures.

- b) Assume you are given the numbers 4, 2, 3, 1. Show step by step how your described algorithm in part (a) works on the given list of numbers and moves them through the list until the algorithm terminates and the list is sorted in increasing order.
- c) Now analyze the time complexity of the bubble sort algorithm STEP BY STEP as what we did for the **linear search**. Show all your work. Then specify the worst-case time complexity of bubble sort in Big-O notation.

Question 4)

Write a **complete program** in **C++/Java** for the bubble sort algorithm in Question 3. Paste your complete **code** here as the solution. Also, share 3 screenshots of the output you get from your program once you run your code for the following inputs:

Input #1: 11, 23, 2, 4, 6, 22, 8, 9, -1

(we expect these numbers to appear in ascending order as the output of your code, i.e., -1, 2, 4, 6, 8, 9, 11, 22, 23)

Input #2: 15, -1, 56, 34, 22, 8, 48, 1

Input #3: 6, -9, -15, 12, 38, 4, 11