Goals:

This is a double-weight assignment. It counts as two short assignments in your grade and you are being given two full weeks to complete this assignment.

This assignment has two objectives:

- First, to help you understand the A-Star algorithm, which is a classic AI search algorithm from 1968. [This connects to Learning Objective (1) on Search-based algorithms in AI]

- Second, to help you understand the strengths and weaknesses of modern AI tools that assist programmers in developing code. [This connects to Learning Objective (5) on the broader impact of AI]

Task:

For this assignment, you should use an AI tool to help you implement the A-Star algorithm.

You will document your process of using the AI tool and at the end you will evaluate how helpful the AI tool was in developing code for this task. I expect that the AI tool will be more useful for some aspects of the software development task than for others.

In particular, your software development task has three components:

1) Read data from a text file that defines a graph. (Details of the input file format are included below)

2) Run the A-Star algorithm to find the shortest path from the start vertex to the finish vertex.

3) Print out both the shortest path, as well as the order in which the A-Star algorithm explored the vertices in the graph.

Every vertex in the graph is a city with coordinates in a two-dimensional plane. (E.g., Latitude/Longitude)

When an edge exists between two vertices, that means there is a direct road between the cities. The length/cost for the edge is the (Euclidean) distance between the two cities in the plane.

For example, if City A is at (1,1) and City B is at (3,3) then the edge between City A and City B would have length/cost equal to the square root of 8.

The Heuristic that you should use for A-Star is the Euclidean distance from the current city to the destination. (That is, use as a heuristic the length of a hypothetical edge between the current city and the destination, even though that edge might not exist.)

Input File Format:

The input text file has the following components:

- The first line of the file has a single integer that represents the number of cities (i.e., the vertices in the graph. Call this number N.

- The next N lines will each have a label and a pair of numbers. The label will be a string of letters (with no spaces or non-alphabetic characters). The two integers should be interpreted as the X and Y coordinates (respectively) of a city. The three components (label, x-coordinate, y-coordinate) will be separated by commas.

NOTE: The label that is provided first in this section is the starting city for the A* search, and the city that is listed last in this section is the target destination for the A* search.

- The remaining lines should have pairs of labels (separated by commas) that represent the edges of the graph. The graph is symmetric and so edges can be traveled in both directions. This is to say that the following two lines are equivalent

  A,B
  B,A

  Either of these lines in the file would indicate the existence of an edge between A and B.

Here is a simple example:

```
5
A,1,1
B,2,2
C,1,0
D,0,1
E,3,3
A,B
A,C
A,D
B,E
C,E
D,E
```

This above file describes a symmetric graph with 5 vertices and 6 edges. (The shortest path in this simple example, goes from A to B to E)

What to Submit

You will submit three items:

1) A zip file containing your code. Please include a README file in the code indicating how to run the code. (E.g., Does the input file need to have a particular name? Do I give it a command line parameter? …)

2) A document explaining how you got the code. That is, you should provide:
    - Provide the important/useful prompts that you gave to the AI tool.
    - What code were you able to use directly from the AI tool with little-to-no modification?
    - What code (if any) required substantial modification using your human expertise?
    - Was there code that you needed to completely write yourself?

3) A brief write-up connecting your experiences with this project to the state of AI tools for software development. What types of tasks are the AI tools good at? What types of tasks require significant human expertise? What implications might this have for the job market in software development in the near future?

Collaboration

If you wish, you are welcome to work with one or two colleagues on this assignment. For deliverables (1) and (2) in the previous section, you are allowed to submit exactly the same code and process documentation as your teammates. However, every group member MUST write their own version of deliverable (3) capturing your own personal thoughts and conclusions on the broader impact of these AI tools on software development.

Evaluation

You will be evaluated based on the following Rubric:

	A	B	C	F
A-Star Correctness	Correctly implements A-Star with the specified heuristic.	General structure of the algorithm is correct, but there is a minor logical issue. (E.g., incorrect heuristic, or off-by-one error)	Substantial correctness issues with the algorithm. (i.e., issues that could not be resolved by changing a few lines of code)	No serious effort was made to implement A-Star correctly.
Input/Output Correctness	File input is correctly implemented. Output to the screen is correct and clear to understand. All test input files work.	Minor implementation issues with either input or output – but not both – which lead to either unclear/ambiguous output or some number of failed test cases.	Substantial implementation issues with input and/or output. (i.e., issues that could not be resolved by changing a few lines of code.)	No serious effort was made to implement input and output correctly
Use of AI Tool	A serious effort was made to use an AI tool to assist the developer. The documentation makes it clear how this AI tool was used to help produce the submitted code.	A serious effort was made to use an AI tool to assist the developer. However, several aspects of the documentation were unclear as to how the AI was used.	At least a limited effort was made to use the AI tool. However, the documentation on the use of the AI tool has serious deficiencies. (E.g., parts of the explanation seem to be completely missing)	No serious effort was made to document the use of an AI tool to help the developer. It is unclear if an AI tool was used at all or, if so, how it was used.

Broader Impact	Thoughtful discussion of the broader impact of AI tools. Clearly connects the student's experience on this assignment with the student's conclusions regarding impacts on software development.	Effort was made to connect the student's experience in this assignment with an argument about the broader impact of these tools. However, how this assignment reinforces the student's conclusions is unclear (or illogical) in some places.	Write-up contains interesting claims/conclusions about the impact of AI tools on software development. However, there is little to no connection to the student's specific experience on this assignment.	No serious effort was made to produce a thoughtful write-up on the broader impact of AI tools on software development.

Your assignment grade is obtained by averaging the grades for each component of the rubric. (An "A" in three categories is an "A" on the assignment. An "A" in two categories is an "AB" on the assignment)