

# Homework #1

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**Due** Feb 5 by 6pm    **Points** 100    **Submitting** a file upload    **File Types** pdf, txt, rtf, py, lsp, and zip  
**Available** until Feb 17 at 6pm

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This assignment was locked Feb 17 at 6pm.

This homework will be graded out of 100 points. It will count 6% of the grade. The homework has to be done individually, no collaboration with other student and no copying answers from anyone/anywhere.

Submit the assignment electronically using canvas. The written part has to be uploaded as a .pdf file. Please do not submit word files!

## Written Part (80 points)

1. [15 points] A robot has to deliver three identical packages A, B, and C to locations in an office environment. The robot starts in location 4 holding two packages, A and B. Package C is at location 8. Each package has a location where it needs to be dropped. The environment is a line of 10 squares, numbered from 1 to 10. The robot can move along the line of squares in either direction, one square at each step, and can pick up or drop packages in the square where the robot is. Specify the state space representation of the problem (not its solution) by specifying what is in a state, the initial state, the goal test, and the actions. Be precise and consistent.
2. [20 points] This question is on properties of search algorithms. Consider the following uninformed search algorithms: depth-first, breadth-first, uniform cost, depth-limited depth first, iterative deepening depth first, and bidirectional. Answer the following questions. You need to explain the reasons for your answers, not simply write the algorithm name:
  1. if you want to limit the memory requirements which algorithm(s) would you choose? why?
  2. if you want to limit the time required to find a solution, which algorithm(s) would you choose? why?
  3. if you want to find the minimum cost solution, which algorithm(s) would you choose? why?
  4. if you want to find a solution with the minimum number of steps, which algorithm(s) would you choose? why?
  5. if you want to find a solution with the minimum number of steps and you do not want to use a lot of memory, which algorithm(s) would you choose? why?
3. [20 points]
  1. If you are given a problem described using a state space representation and you add 20 to the cost of each action, will the optimal solution be the same as the one with the original costs? Show an example on a state space of your choice and explain what happens in general.
  2. If instead of adding 20 to the costs of each action you double the costs, will the optimal solution be the same as the one with the original costs? Show an example on a state space of your choice and explain what happens in general.
4. [10 points] In the game of chess, assume a rook can move on the chessboard any number of squares in a straight line, vertically or horizontally, but cannot jump over other pieces. Is the Manhattan distance an admissible heuristic for the problem of moving the rook from square A to square B in the smallest number of moves? If yes, explain why, if not why not.
5. [15 points] Suppose you have two admissible heuristics,  $h_1$  and  $h_2$ . You decide to create the following new heuristic functions defined as follows:

$$h_3(n) = \max(h_1(n), h_2(n))$$

$$h_4(n) = \max(h_1(n), 1.1 * h_2(n))$$

$$h_5(n) = \min(h_1(n), 3 * h_2(n))$$

$$h_6(n) = h_1(n) + h_2(n)$$

$$h_7(n) = (h_1(n) + h_2(n)) / 2$$

For each of the new heuristics specify if it is admissible or not. Justify your answer. For the new heuristics  $h_2(n)$  to  $h_7(n)$ , if

they are admissible, would you use them instead of using h1 or h2? hy (or why not)?

## Programming Part (20 points)

Here are the instructions to use the python code from the textbook. If you want to use Lisp, let me know and I'll send you the instructions. We will be using colab notebooks later in the semester for neural networks, so it is good to get started with them now.

This is the link to the colab notebook: <https://colab.research.google.com/drive/1JhcVvfTGY0F1OdBVXMdTIN7u0IDKJoWk?usp=sharing> [. \(https://colab.research.google.com/drive/1JhcVvfTGY0F1OdBVXMdTIN7u0IDKJoWk?usp=sharing\)](https://colab.research.google.com/drive/1JhcVvfTGY0F1OdBVXMdTIN7u0IDKJoWk?usp=sharing)

Make a copy of the notebook, using the link under the File menu. Run the code in the notebook to create the folder, download the aimia software, and install it. After this is done, write code to answer these questions:

1. [10 points] Use the code to run for 20 steps the reflex vacuum agent. Use the TraceAgent function to print the perceptions and actions. If you run the program a second time, do you get the same results?
2. [10 points] Use the code to run for 10 steps the model based vacuum agent and use TraceAgent to print.
3. Submit a text file (using cut and paste) with the output you get in colab from:
  1. Part 1: installation of the aimia code, to show the code was installed;
  2. Part 2: Complete HW1 questions, to show the code you wrote and its output.

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hw1

Criteria	Ratings								Pts
Question 1 (Graded by Fei)	<b>15 pts</b> <b>Full Marks</b>	<b>10 pts</b> <b>Mirror mistakes</b>			<b>5 pts</b> <b>Major mistakes</b>		<b>0 pts</b> <b>No Marks</b>		15 pts
Question 5 (Graded by Fei)	<b>15 pts</b> <b>Full Marks</b>	<b>14 pts</b> <b>mistakes in the second question</b> using $h_7(n)$ does not make sense because its value is always smaller than the largest of the heuristics you have	<b>14 pts</b> <b>mistakes in the second question</b> only $h_3(n)$ can be used to replace $h_1$ or $h_2$	<b>13 pts</b> <b>mistakes</b>	<b>13 pts</b> <b>mistakes in the second question</b>	<b>10 pts</b> <b>mistakes</b> lack answer to the second question	<b>10 pts</b> <b>mistakes</b>	<b>0 pts</b> <b>No Marks</b>	15 pts
Question 2 (Graded by Trevor)	<b>20 pts</b> <b>Full Marks</b>	<b>17 pts</b> <b>Major issue with 1 question</b>	<b>14 pts</b> <b>Issues with 2 questions</b>	<b>11 pts</b> <b>Issues with 3 questions</b>	<b>8 pts</b> <b>Issue with 4 questions</b>	<b>5 pts</b> <b>Issues with 5 questions</b>	<b>0 pts</b> <b>No Marks</b>		20 pts
Question 4 (Graded by Trevor)	<b>10 pts</b> <b>Full Marks</b>	<b>7 pts</b> <b>Lacking explanation</b> Correct answer, explanation was lacking	<b>5 pts</b> <b>mistakes</b> incorrect answer but gave a thorough explanation			<b>3 pts</b> <b>Incorrect answer</b> Incorrect and lacking substantial explanation		<b>0 pts</b> <b>No Marks</b>	10 pts
Question 3 (Graded by Ioanna) Approximately for a, b (10 points each): answer: 2 points state space example: 4	<b>20 to &gt;18.0 pts</b> <b>Full Marks</b>	<b>18 to &gt;16.0 pts</b> <b>correct answer, minor mistakes in a/ b</b>	<b>16 to &gt;14.0 pts</b> <b>correct, incomplete/ minor mistakes in a+b</b>	<b>14 to &gt;10.0 pts</b> <b>mistakes</b>	<b>10 to &gt;5.0 pts</b> <b>Major mistakes both 4a and 4b</b> incorrect answer and explanation has major mistakes/	<b>5 to &gt;0.0 pts</b> <b>incorrect, very incomplete &amp; incorrect explanation</b>	<b>0 pts</b> <b>No Marks</b>		20 pts

Criteria	Ratings							Pts
points explanation: 4 points					incomplete explanation or only a or b is answered and is correct			
Programming (Graded by Robert)	20 pts Full Marks	15 pts Either Reflex of Model Vacuum Not Working		10 pts Missing or Incorrect Vacuum Programs Software successfully installed but missing or incorrect problems.			0 pts No Marks	20 pts
Total Points: 100								