The University of Texas at Dallas
CS 6364
Artificial Intelligence
Fall 2021
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Teaching Assistant: Maxwell Weinzierl

Homework 1: 100 points (70 points extra-credit)
Issued September 2, 2021
Due September 22, 2021, before midnight

INSTRUCTIONS FOR HOMEWORK SUBMISSION

Homework 1 has some programming assignments. The code of the programming assignments NEEDS to compile and run on csgrads1.utdallas.edu
It is your responsibility that the code can run not only in your account, but that it can also run in the TA's account on csgrads1.utdallas.edu
You will receive ZERO credit for the programming assignments if your code does not compile or run.
When submitting your Homework 1 in eLearning, you MUST provide a README.txt file which contains the following:
1. A list of commands which will compile your code (if compilation is necessary) on csgrads1.utdallas.edu
2. A list of commands which will run your code on csgrads1.utdallas.edu
We will **NOT** run pre-compiled code such as .jar or .class files.

You must submit your code in a .zip file on eLearning, which must contain:
1. A pdf file with your solutions to the problems from the homework, clearly marking down the problem and question for which you provide an answer, e.g. Solution for Problem 1, Question 1: ….
1. All source code files for programming assignments in the homework (.java, .py, etc.)
3. Your README.txt file, which describes how the programming assignment can be compiled, run, etc
4. Any additional files used by your source code to run, such as datasets.
5. Follow the software engineering requests listed at the end of the homework.
IMPORTANT: Failure to submit the homework in the required format will lead to a grading of ZERO.

PROBLEM 1: Intelligent Agents (**15 points**)

Enhance the Kitty robot discussed in class to a model-based agent in which the state has 3 components: [position happiness, battery]; where the battery has a value of 100 for FULL initially and 0 when it is discharged. Also add an admissible new action: TURN-AROUND. The possible positions of Kitty are:

| 1 | 2 | 3 | 4 | 5 | 6 |
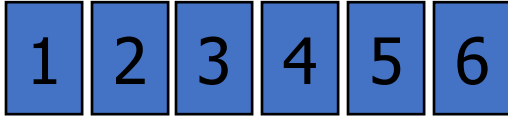
You are asked to:
1. Describe the entire state space (**2 points**)
2. Write a new State-Update function that changes the value of the battery by -1 for every new change of position by walking; by -4 when it turns around; by -5 when it bumps against the wall; by -3 every time Kitty purrs and by -2 every time it meows You should consider that when the battery is discharged, no more actions are possible. (**10 points**)
3. Write a utility function that combines the happiness with the state of the battery. (**3 points**)

PROBLEM 2: Problem Formulation for Search (**55 points**)
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The Missionaries and Cannibals Problem is stated as follows. Three missionaries and three cannibals are on one side of the river, along with a boat that can hold one or two people. Find a way to get everyone to the other side without ever leaving a group of missionaries outnumbered by cannibals in that place.

   a. Formulate the search problem formally. State clearly how you represent states, (including the initial state and the goal state(s)), what actions are available in each state, including the cost of each action. (**15 points**)
   b. Sketch a solution of the problem. Show the path and its cost. Describe the search strategy that you have used and <u>motivate it.</u> (**15 points** for the manual solution; **5 points** for its motivation). **TOTAL 20 points**

Programming Assignment for Problem 2:
1. Use the implementations of the search strategies available in the aima code; available at:
 https://github.com/aimacode/
to write the program that will search for the solution to Missionaries and Cannibals Problem. (**10 points**)

2. Provide the path to the solution generated by your code, indicating each state it has visited when using: (a) uniform-cost search; (b) iterative deepening search; (c) greedy best-first search; (d) A* search and (e) recursive best-first search (**1 point/strategy**). Describe <u>clearly</u> how you have implemented each state in the search space. (**5 points**)
TOTAL: 10 points

Extra-credit: Have your program list the content of the frontier and the list of explored nodes for the first 5 steps of each of the strategies used in 2. (**2 points/step/strategy**)
TOTAL: 50 points <u>ONLY if it is possible to comprehend (1) the current node; (2) the content of the frontier; (3) the content of the list of explored/expanded nodes; (4) the children of the current node for each step</u>.

PROBLEM 3: Searching for Road Trips in the U.S.A. (**30 points**)
Considering the following table:
Table of direct/flight distances to Dallas (in miles).

```
_____
Austin            182
Charlotte         929
San Francisco    1230
Los Angeles      1100
New York         1368
Chicago           800
Seattle          1670
Santa Fe          560
Bakersville      1282
Boston           1551
_____
```

You contemplate to search for a trip back to Dallas from Seattle, having access to a road map which should be implemented as a graph.
1/ Programming Assignment for Problem 3 – Part A:
Use the implementations in the AIMA code available at:
https://github.com/aimacode
to find the solution and return a simulation of the RBFS strategy by generating automatically the following five values: (1) *f_limit*; (2) *best*; (3) *alternative*; (4) *current-city*; and (5) *next-city* for each node visited. (**10 points**)

2/ Find the same solution manually and specify how you have computed the following five values: (1) *f_limit*; (2) *best*; (3) *alternative*; (4) *current-city*; and (5) *next-city* for each node visited. Specify at each step the current node and the next node. (**5 points**)

```
The road graph is (in miles):
_____
Los Angeles --- San Francisco ::: 383
Los Angeles --- Austin        ::: 1377
Los Angeles --- Bakersville   ::: 153
San Francisco --- Bakersville ::: 283
San Francisco --- Seattle  ::: 807
Seattle  --- Santa Fe  ::: 1463
Seattle --- Chicago  :::  2064
Bakersville -- Santa Fe ::: 864
Austin --- Dallas ::: 195
Santa Fe --- Dallas ::: 640
Boston --- Austin  ::: 1963
Dallas --- New York  ::: 1548
Austin --- Charlotte  ::: 1200
Charlotte -- New York ::: 634
New York --- Boston ::: 225
Boston --- Chicago ::: 983
Chicago -- Santa Fe ::: 1272
Boston --- San Francisco ::: 3095
```

3/ Perform the same search for your optimal road trip from Seattle to Dallas when using A*. Find the solution manually, specifying:

(a) the current node; If it is not a goal node then also:
(b) the children of the current node and the value of their evaluated function (detailing how you have computed it)
(c) The current path from Seattle to the current city + the cost
(d) The Contents of the Explored Cities list
(e) The Contents of the Frontier
(f) Next node.

(5 points)

4/ *Programming Assignment for Problem 3 – Part B:*
Use the implementations in the AIMA code available at:
https://github.com/aimacode
to find the solution to the same search which implements the A* algorithm. Make sure that the program lists the contents of the frontier and explored list for each node that you visit during search, in the format:
[Current node: X; Evaluation function (current node)=???;
Explored Cities: [….]; Frontier: [(City_X, f(City_X)), ….];] (**10 points**)

Extra-credit Write a program that will check if the heuristic provided in this problem is consistent, given the road graph   **TOTAL: 20 points**
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Software Engineering (includes documentation for your programming assignments)

Your README file must include the following:

- Your name and email address.
- *Homework number* for this class (AI CS6364), and the *number of the problem* it solves.
- A description of every file for your solution, the programming language used, supporting files from the aima code used, etc.
- How your code operates, in detail.
- A description of special features (or limitations) of your code.

Within Code Documentation:

- Methods/functions/procedures should be documented in a meaningful way. This can mean expressive function/variable names as well as explicit documentation.
- Informative method/procedure/function/variable names.
- Efficient implementation
- Don't hardcode variable values, etc