**CSCI 4525/5525: Written Assignment for Unit 1: Search**

**Assignment**

Complete the following exercises from *Artificial Intelligence: A Modern Approach*. They are reprinted here for your convenience (and because the digital “global edition” has different problems than the physical copy, so this should clarify things—do the problems here!) The numbers I use here are from the physical edition of the book.

**Question 1** *(3.10 from AI: A Modern Approach)* – **8 points total, 1 point each**

Define in your own words the following terms:

1. State
2. State space
3. Search tree
4. Search node
5. Goal
6. Action
7. Transition model
8. Branching factor.

**Question 2** *(3.6 from AI: A Modern Approach) –* ***12 points total, 4 points each***

Give a ***complete problem formulation*** for each of the following three problems. That is to say, for each of the three presented problems, specify the following six things:

1.) What a representation of a ‘state’ is.

2.) What a reasonable initial state is.

3.) The actions you can take.

4.) The transition model.

5.) The cost function.

6.) The goal test.

*The problems:*

1. Using only four colors, you have to color a map of all of the countries in the world in such a way that no two adjacent countries have the same color.
2. A 3-foot-tall monkey is in a room where some bananas are suspended from the 8-foot ceiling. He would like to get the bananas. The room contains two stackable, movable, climbable 3-foot-high crates.
3. You have three jugs, measuring 12 gallons, 8 gallons, and 3 gallons, and a water faucet. You can fill jugs up to their maximum capacity from the faucet, or empty jugs completely by pouring their contents to the ground. You can also empty water from one jug into another until the ‘receiving’ jug is at maximum capacity, at which point the water transfer needs to stop. You need to measure exactly one gallon.

**Question 3** (*3.15 from AI: A Modern Approach*) – **8 points total, 2 points each, 2 points bonus.**

Consider a state space where the start state is number 1 and each state k has two successors: numbers 2k and 2k+1

1. Draw the portion of the state space for states 1 to 15
2. Suppose the goal state is 11. List the order in which nodes will be visited for breadth-first search, depth-limited search with limit 3, and iterative deepening search.
3. How well would bidirectional search work on this problem? What is the branching factor in each direction of bidirectional search?
4. Does the answer to **c** suggest a reformulation of the problem that would allow you to solve the problem of getting from state 1 to a given goal state with almost no search?
5. **BONUS**: Call the action of going from *k* to *2k* **Left**, and the action going from *k* to *(2k+1*) **Right**. Can you find an algorithm that outputs the solution to this problem without any search at all? If so, describe it in English and include pictures demonstrating how it works.

**Students enrolled in CSCI 5525 must also complete the following (undergrads may do this for extra credit):**

**Question 4** (*3.23 from AI: A Modern Approach*) – **8 points total**

Trace the operation of A\* search applied to the problem of getting to Bucharest from Lugoj using the straight-line distance heuristic. That is, for each “step” of the algorithm, show the sequence of nodes on the frontier that the algorithm will consider and the f, g, and h score for each of those nodes. For this problem, assume that you \*can\* revisit nodes. That is, even if a node has already been moved from the frontier to the closed list, it can be added to the frontier again. In other words: **when you visit a node, always add all of its neighbors to the frontier no matter what.**

See the following page for both the actual travel costs from city to city (figure 3.2) and the straight-line distance heuristic from any given city and Bucharest (Figure 3.22).

**Chart, diagram, radar chart

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**Table

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**Submission**

Please observe these requirements in your submission:

* Submission must include your name and which section of the class you are enrolled in (i.e. 4525 or 5525).
* Submissions must be typed.
* Submissions must be submitted as PDF files.
* Submissions must be uploaded to Moodle on time

**Grading**

Problems will be graded using the following simple grading procedure, applied to each part (e.g. part a, part b, etc.) of the problem:

* Problem not attempted or does not demonstrate significant effort: no credit.
* Problem thoroughly attempted, but answer is incorrect or incomplete: half credit.
* Problem thoroughly attempted, and answer is correct and complete: full credit.

**You must show your work on all problems to receive credit**. Simply giving the answer (correct or incorrect) will earn no credit for that problem.