## CSCE 580/581: Intr AI/ Trusted AI Prof. Biplav Srivastava, Fall 2023

## Quiz 2 / October 3, 2023/ Instructions

* Upload a .pdf with your answer to Blackboard before the end of day on Tuesday (Oct 10, 2023)
* For coding part (Q3), implement a python notebook or in Collab. Call it – “<Yourname>-Quiz2-Response”.
* Send email confirming submission made to both Instructor and TA

Total points = (10 + 60 + 30): 100 points, Obtained =

Student Name: Deep Patel

**The quiz is to test your understanding of concepts of search.**

**Q1: Search and Heuristics** [2 + 2 + 2 + 4 = 10 points]

**Instructions**: Give your answers in bullet points.

a) What is an admissible heuristics ? [2 points]

* Admissible heuristics is when the estimated cost is lower than or equal to the actual cost of reaching the goal state from n (initial state). It never overestimates true cost to reach goal.

b) Suppose you are given “h = 0” as the heuristics for a problem. Is it admissible ? [2 points]

* With 0 being the best-case scenario for cost, it is admissible.

c) Suppose you are given “h = k” as the heuristics for a problem, where k is any number e.g., k=1? Can you say it is admissible ? [2 points]

* You cannot say it is admissible because if the value for k is higher than the total cost, then it will not be admissible.

d) You are given 3 heuristics: h1, h2 and h3 of which you are sure that one is admissible. Will   
h = min (h1, h2, h3) be admissible ? What can we say about h = max (h1, h2, h3) as admissible ?

[2 + 2 = 4 points]

* Yes taking the minimum of the heuristics will ensure that a certain heuristic will be admissible because if one is admissible, then the heuristic with the least cost will be admissible. Taking the maximum of the heuristics does not guarantee that it will be admissible. The value for this heuristic could overestimate the true cost, therefore preventing it from being admissible.

**Q2: Using search for a practical problem** [30 + 30 = 60 points]

Consider the missionaries and cannibals problem. Three missionaries and three cannibals are on one side of a 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 in one place

outnumbered by the cannibals in that place.

* States: a state consists of an ordered sequence of three numbers representing the number of missionaries, cannibals, and boats on the bank of the river from which they started. Thus, the start state is (3,3,1).
* Operators: from each state the possible operators are to take either one missionary, one cannibal, two missionaries, two cannibals, or one of each across in the boat. Thus, there are at most five operators,
* Goal test: reached state (0,0,0).
* Path cost: number of crossings.

a) Use any uninformed search method and solve this problem? Show code, solution and time. [30 points]

* See DeepPatel-Quiz2-Q2A.ipynb

b) Use any informed search method and solve this problem ? (Example: choose A\* and any admissible heuristic). Show code, solution and time. [30 points]

* See DeepPatel-Quiz2-Q2B.ipynb

**Q3: Formulating CSPs**  [30 points]

a) Consider the cryptanalyst problem:

T W 0

+ T W 0

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F O U R

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Where each character stands for a unique number in the range (0-9). Formulate it as a CSP.

What are the variables, their domains and constraints? [15 points[30 points]]

* The variables are {T,W,O,F,U,R}
  + Since there are multiple digits, there place must be accounted for.
  + TWO is T\*100 + W\*10 + O
  + FOUR is F\*1000 + O\*100 + U\*10 + R
* The domain for each variable is {0,1,2,3,4,5,6,7,8,9}
  + However, T!=0 and F!=0 since they are the leading variables
* Constraints: T!=W, T!=O, T!=F, T!=U, T!=R

W!=O, W!=F, W!=U, W!= R

F!=O, F!=U, F!=R

O!=U, O!=R

U!=R

b) Can we try to solve it using node, arc and path consistency? Show the closest you can come to a solution? [15 points]

* See DeepPatel-Quiz2-Response. This solution was produced using Prolog not Python.
* Node Consistency
  + T,W,O, F,U,R = {0,1,2,3,4,5,6,7,8,9}
* Arc Consistency
  + T,W,O,U = {0,1,2,3,4,5,6,7,8,9}
  + R = {0,2,4,6,8}
  + F = {0,1}
* Path Consistency
  + T,W,O,U and R = {0,2,4,6,8}
  + T,W,O,U and F = {0,1}