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M16 Practice Exam Problems

- Enter your ID (the wisc email ID without @wisc.edu) here: and click (or hit enter key)
- The same ID should generate the same set of questions. Your answers are not saved when you close the browser. You could print the page: , solve the problems, then enter all your answers at the end.
- Please do not refresh the page: your answers will not be saved.

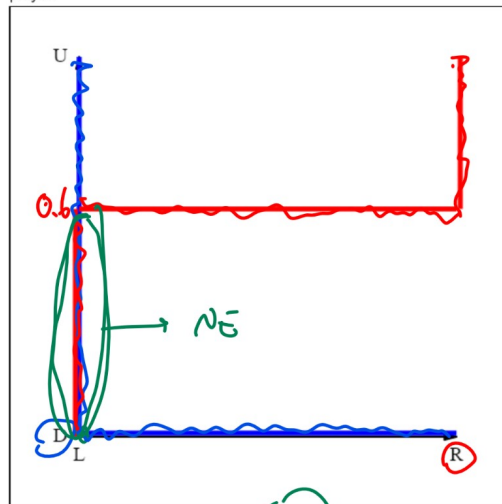
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Question 1

• [4 points] Given the following game payoff table, suppose the the row player uses a mixed strategy playing U with probability p , and column player uses a pure strategy. What is the smallest and largest value of p in a mixed strategy Nash equilibrium?

Row \ Col	L q	R $1-q$
U p	7,0	0,4
D $1-p$	7,6	7,0

Note: the following is a diagram of the best responses (make sure you understand what they are and how to draw them). The red curve is the best response for the column player and the blue curve is the best response for the row player.



Handwritten notes and equations:

- $U > D$
- $7q > 7$
- $br_{row}(q) = \begin{cases} [0,1] & q=1 \\ D & q < 1 \end{cases}$
- $L > R$
- $6(1-p) > 4p \Rightarrow p < 0.6$
- $br_{col}(p) = \begin{cases} L & p < 0.6 \\ [0,1] & p = 0.6 \\ R & p > 0.6 \end{cases}$

• Answer (comma separated vector):

Question 2

- [4 points] You will receive 4 points for this question and you can choose to donate x points (a number between 0 and 4). Your final grade for this question is the points you keep plus twice the average donation (sum of the donations from everyone in your section divided by the number of people in your section, combining both versions). Enter the points you want to donate (an integer between 0 and 4).
- Answer: (The grade for this question will be updated later).

Question 3

• [3 points] 16 firms sharing the use of a river decide whether to filter (F) or release (R) pollutants (poisonous substance) into the river. If n firms choose to pollute the river (R), each of these n firms incurs a cost of $15n$ dollars, and each of the remaining firms that chooses to install filters (F) incurs a cost of $3n + 90$ (cost due to pollution plus the cost of the filter). Every firm wants to minimize cost. What is the number of firms that choose to install filters (F) in a pure strategy Nash equilibrium? Note: remember to enter an integer.

• Answer:

Handwritten notes and equations:

- $L \leq n \leq U$
- $\begin{cases} R \rightarrow F \\ F \rightarrow R \end{cases}$ (me)
- Case $R \leq \text{cost}_F$
- Case $\text{cost}_F \leq \text{cost}_R$
- for n firms R: $15n \leq 3(n-1) + 90$
- for n firms F: $3n + 90 \leq 15(n-1)$

Question 4

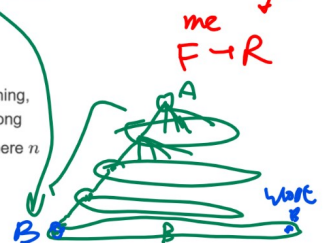
• [4 points] Imagine a world where each person has 5 friends. Alice and Bob are $d = 4$ "friendship links" away (i.e. if $d = 1$, Alice and Bob are friends; if $d = 2$, there is a third person X such that Alice and X are friends, and Bob and X are friends; and so on). Imagine a breadth first search (BFS) algorithm that has access to the friendship links. The algorithm starts at Alice and the goal is to find Bob. In the best (luckiest) case, how many people the algorithm needs to visit (including Alice and Bob)?

• Answer:

Handwritten equation: $1 + 5 + 5^2 + 5^3 + 1$

Question 5

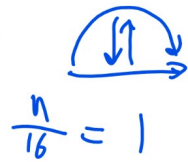
• [4 points] There are 240 people living in the suburbs and all of them commute to work in the city. Every morning, each individual decides which way to drive to the city simultaneously: the Direct Way or the Long Way. The Long Way takes 1 hour of driving. The time spent on the Direct Way depends on the traffic is equal to $\frac{n}{c}$ hours, where n



is the total number of cars taking the Direct Way, and $c = 16$ is the capacity. Each individual wants to minimize the driving time, break tie by choosing the Direct Way. What is the number of people taking the Long Way in the Nash equilibrium?

• Answer: Calculate

$$n = 16$$



Question 6

• [4 points] Given the following BoS game, what is the row (Romeo) player's (expected) value (i.e. payoff) in the mixed strategy Nash equilibrium?

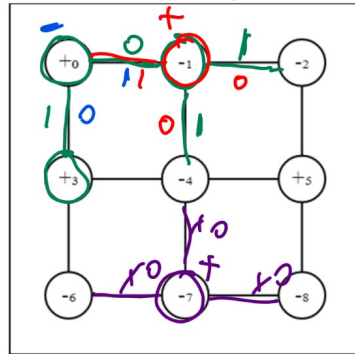
Romeo \ Juliet	Bach q	Stravinsky $1-q$
Bach	4, 3	0, 0
Stravinsky	0, 0	3, 4

• Answer: Calculate

$B = S = \text{value of row in NE}$
 $4q = 3(1-q)$
 $q = \frac{3}{7}$
 $\frac{12}{7} = \frac{12}{7}$

Question 7

• [3 points] In the following graph coloring problem, each node is either labeled as + or -. The score of the graph is the number of edges connecting two nodes with the same label (color). We are minimizing the score. If the successor function is to change the label of a single node, in hill climbing (here, valley finding), which node should we change in the following graph? Enter the index of the node (subscript in the diagram) or -1 if we are at a local minimum. Break ties by entering the node with the smaller index.



score unchanged if flip 0
 score ↓ by 1 — 1
 score ↓ by 3 — 7

In case the diagram is not clear: the labels are (1 is +, 0 is -) $\begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$ and the indices are $\begin{bmatrix} 0 & 1 & 2 \\ 3 & 4 & 5 \\ 6 & 7 & 8 \end{bmatrix}$.

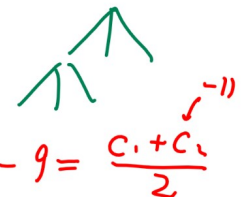
• Answer: Calculate

Question 8

• [2 points] A search tree has 4 levels (the root is at level 0, a tree with only the root has 0 levels), and every internal node has 3 children. Suppose there is no goal node. How many goal checks (we perform a goal check every time we expand a node) will depth first search perform? Include the initial node (the root).

• Answer: Calculate

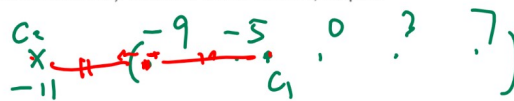
$$1 + 3 + 3^2 + 3^3 + 3^4$$



Question 9

• [4 points] Given the dataset [3 0 -5 -9 7], the cluster centers are computed by k-means clustering algorithm with $k = 2$. The first cluster center is x and the second cluster center is -11 . What is the maximum value of x such that the second cluster is empty (contains 0 instances). In case of a tie in distance, the point belongs to cluster 1.

• Answer: Calculate



$$-9 = \frac{c_1 + c_2}{2}$$

Question 10

• [4 points] Suppose 8 witnesses heard a gunshot near 221B Baker Street. The benefit from at least one witness calling the police is 5 and the cost of calling the police is 1. If no witness calls the police, everyone gets 0. In a Nash equilibrium in which every witness uses the same mixed strategy, what is the probability that no one calls the police?

• Hint: see Volunteer's Dilemma example near the end of Lecture 20.
 • Answer: Calculate

value $C = \frac{\text{value}}{1-P}$
 $5-1 = 5(1-(1-P)^8)$

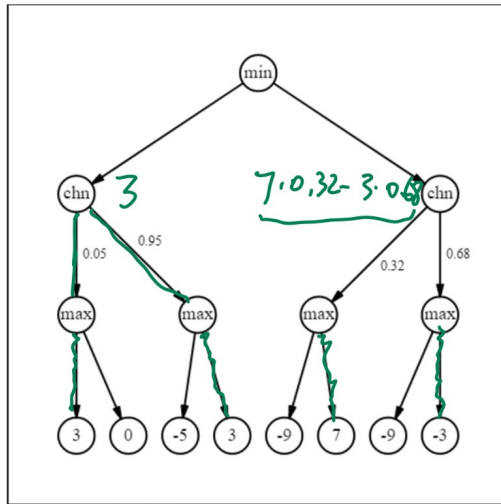
Question 11

• [4 points] Consider a zero-sum sequential move game with Chance. Min player moves first, then Chance, then Max. The values of the terminal states are shown in the diagram. What is the (expected) value of the game (for the Max player)?

$$P = 1 - \left(1 - \frac{5-1}{5}\right)^7$$

$$\left(\frac{1-P}{5}\right)^8 = \left(1 - \frac{5-1}{5}\right)^8$$

prob at least one of other 7 players called police
 $1 - \text{prob no one called}$



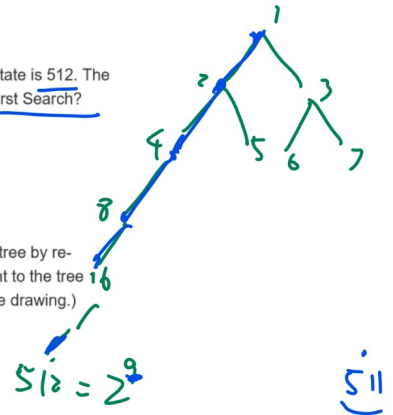
• Answer: Calculate

Question 12

• [4 points] Suppose the states are integers between 1 and 512. The initial state is 1, and the goal state is 512. The successors of a state i are $2i$ and $2i + 1$, if exist. How many states are expanded using a Depth First Search? Include both the initial and goal states.

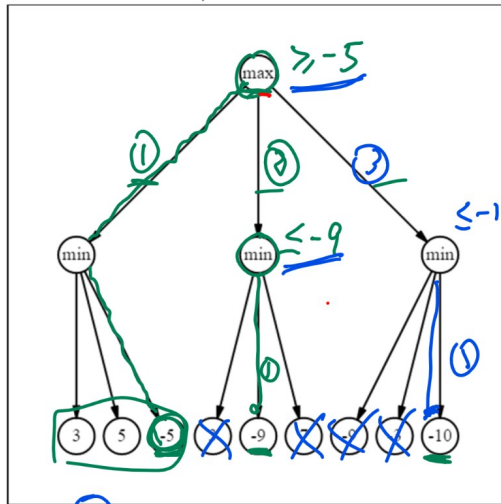
• Note: use the convention used in the lectures, push the states with larger index into the stack first.

• Answer: Calculate



Question 13

• [4 points] Consider the following zero-sum game tree. MAX player moves first. Draw a new game tree by re-ordering the children of each internal node (including the root), such that the new game is equivalent to the tree above, but alpha-beta pruning will prune as many nodes as possible. (You do not have to submit the drawing.) Enter the number of nodes pruned.



• Answer:

Question 14

• [4 points] Perform iterated elimination of strictly dominated strategies. Player A's strategies are the rows. The two numbers are (A, B)'s payoffs, respectively. Recall each player wants to maximize their own payoff. Enter the payoff pair that survives the process. If there are more than one rationalizable action, enter the pair that leads to the largest payoff for player A.

A \ B	I	II	III	IV
I	0, 3	3, 0	3, -1	0, -2
II	3, 0	-1, 3	-2, -5	0, -4
III	-3, 2	2, 0	2, 0	-2, 2
IV	-2, 2	-2, 1	-1, 5	-1, -2

dom by I
dom by I

• Answer (comma separated vector)

Question 15

• [1 points] Please enter any comments including possible mistakes and bugs with the questions or your answers. If you have no comments, please enter "None": do not leave it blank.

• Answer:

Grade

ID: yw

Question 1 is correct. (4/4)

Question 2 is correct. (4/4)

Question 3 is correct. (3/3)

Question 4 is correct. (4/4)

Question 5 is correct. (4/4)

Question 6 is correct. (4/4)

Question 7 is correct. (3/3)

Question 8 is correct. (2/2)

Question 9 is correct. (4/4)

Question 10 is correct. (4/4)

Question 11 is correct. (4/4)

Question 12 is correct. (4/4)

Question 13 is correct. (4/4)

Question 14 is correct. (4/4)

Question 15 is correct. (1/1)

Grade: 53 out of 53.

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```
##m: 16
##id: yw
##1: 0,0.6
##2: 0
```

- You could save the text in the above text box to a file using the button or copy and paste it into a file yourself .
- You could load your answers from the text (or txt file) in the text box below using the button . The first two lines should be "##m: 16" and "##id: your id", and the format of the remaining lines should be "##1: your answer to question 1" newline "##2: your answer to question 2", etc. Please make sure that your answers are loaded correctly before submitting them.

M16Y.txt
##m: 16
##id: yw

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