

## 15-110 Check6-2 - Written Portion

Name:

AndrewID:

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### #1 - Visualizations - 8pts

Given the description of the data below, what visualization(s) would be **most** appropriate to use? If multiple visualizations are equally valid, select all that apply.

Compare **numerical** quiz averages to **numerical** final grades.

- |  |  |
|--|--|
| <input type="checkbox"/> Bar Chart             | <input type="checkbox"/> Histogram           |
| <input type="checkbox"/> Box and Whiskers Plot | <input type="checkbox"/> Pie Chart           |
| <input type="checkbox"/> Bubble Plot           | <input type="checkbox"/> Scatter Plot        |
| <input type="checkbox"/> Colored Scatter Plot  | <input type="checkbox"/> Scatter Plot Matrix |

Investigate the number of **ordinal** letter grades (A, B, C, etc) in a class

- |  |  |
|--|--|
| <input type="checkbox"/> Bar Chart             | <input type="checkbox"/> Histogram           |
| <input type="checkbox"/> Box and Whiskers Plot | <input type="checkbox"/> Pie Chart           |
| <input type="checkbox"/> Bubble Plot           | <input type="checkbox"/> Scatter Plot        |
| <input type="checkbox"/> Colored Scatter Plot  | <input type="checkbox"/> Scatter Plot Matrix |

Compare **categorical** sports to **numerical** athlete heights.

- |  |  |
|--|--|
| <input type="checkbox"/> Bar Chart             | <input type="checkbox"/> Histogram           |
| <input type="checkbox"/> Box and Whiskers Plot | <input type="checkbox"/> Pie Chart           |
| <input type="checkbox"/> Bubble Plot           | <input type="checkbox"/> Scatter Plot        |
| <input type="checkbox"/> Colored Scatter Plot  | <input type="checkbox"/> Scatter Plot Matrix |

Compare **numerical** athlete heights to **numerical** ages based on **categorical** sports.

- |  |  |
|--|--|
| <input type="checkbox"/> Bar Chart             | <input type="checkbox"/> Histogram           |
| <input type="checkbox"/> Box and Whiskers Plot | <input type="checkbox"/> Pie Chart           |
| <input type="checkbox"/> Bubble Plot           | <input type="checkbox"/> Scatter Plot        |
| <input type="checkbox"/> Colored Scatter Plot  | <input type="checkbox"/> Scatter Plot Matrix |

## #2 - Matplotlib - 7pts

Assume you have a dictionary that maps the andrewID of every student at CMU to the number of miles they walked in the last week. Use the matplotlib API, examples, and documentation to design a **histogram** that will chart the distribution of miles walked.

**Note:** for this problem (and only this problem!), you may search external resources as much as you like (in fact, you're encouraged to). However, you still should not directly copy answers from the internet or other students; write the answers in your own words.

**Hint:** start at the pyplot documentation:

[https://matplotlib.org/stable/api/\\_as\\_gen/matplotlib.pyplot.html](https://matplotlib.org/stable/api/_as_gen/matplotlib.pyplot.html)

Which **method** looks like a great option to create a histogram?

What are the **required argument(s)** for that method? Do you need to **reformat** the data dictionary to use it as an argument? If yes, how should you change it?

You want to customize the histogram to break up the data into exactly 10 groups. You also want to change the histogram's color to be red. Which **keyword arguments** should you set to change these properties? Do you need to **reformat** the data to add these properties? If yes, how should you change it?

### #3 - Monte Carlo Methods - 9pts

For each of the following questions, use **Monte Carlo methods** to find the answer to the given question. You can use the `monteCarlo(trials)` function from the notes to average results over 100,000 trials; you just need to update the `runTrial()` function for each question.

Please submit your answer as a decimal probability (like 0.45; 100% = 1, 50% = 0.5), and round your answer for each question to have only 2 digits after the decimal point.

What is the probability that, if you roll a die twice, the second roll will be either 2 larger or 2 smaller than the first?

For example, you could roll a 4 and then a 6, or a 4 and then a 2.

Pick a random odd number between 1 and 99. What is the probability that that number is a multiple of 7?

Hint: make a list of all odd numbers between 1 and 99, then use `random.choice()`

Make a list with six values (two "red", two "green", two "blue") and shuffle it. What is the probability that the first two values in the list are both "red"?

Hint: use the destructive function `random.shuffle()`

## #4 - Advanced Simulation - 6pts

Recall the zombie outbreak simulation we wrote in class. The following questions test your understanding of how all the code works together.

Which of the following segments of code set up the original number of zombies?

- `for zombie in range(5): data["creatures"].append(...`
- `move = random.choice([[-1, 0], [1, 0], [0, -1], [0, 1]])`
- `creature["species"] = "zombie"`

Which of the following segments of code made a zombie move in a random direction?

- `row = creature["row"] ; col = creature["col"]`
- `creature["row"] += move[0] ; creature["col"] += move[1]`
- `zombies.append(creature)`

Which of the following segments of code determined whether or not a specific human was infected?

- `data["rate"] = 0.5`
- `if creature["species"] == "human": color = "green" ;  
else: color = "purple"`
- `odds = random.random() ; if odds < data["rate"]: ...`

## #5 - Game Trees - 9pts

Nim (<https://en.wikipedia.org/wiki/Nim>) is a simple game for two players. The game starts with a pot containing some number of marbles on the table. Players take turns removing marbles from the pot. Each player must choose to remove 1, 2, or 3 marbles on their turn. Whoever removes the last marble loses.

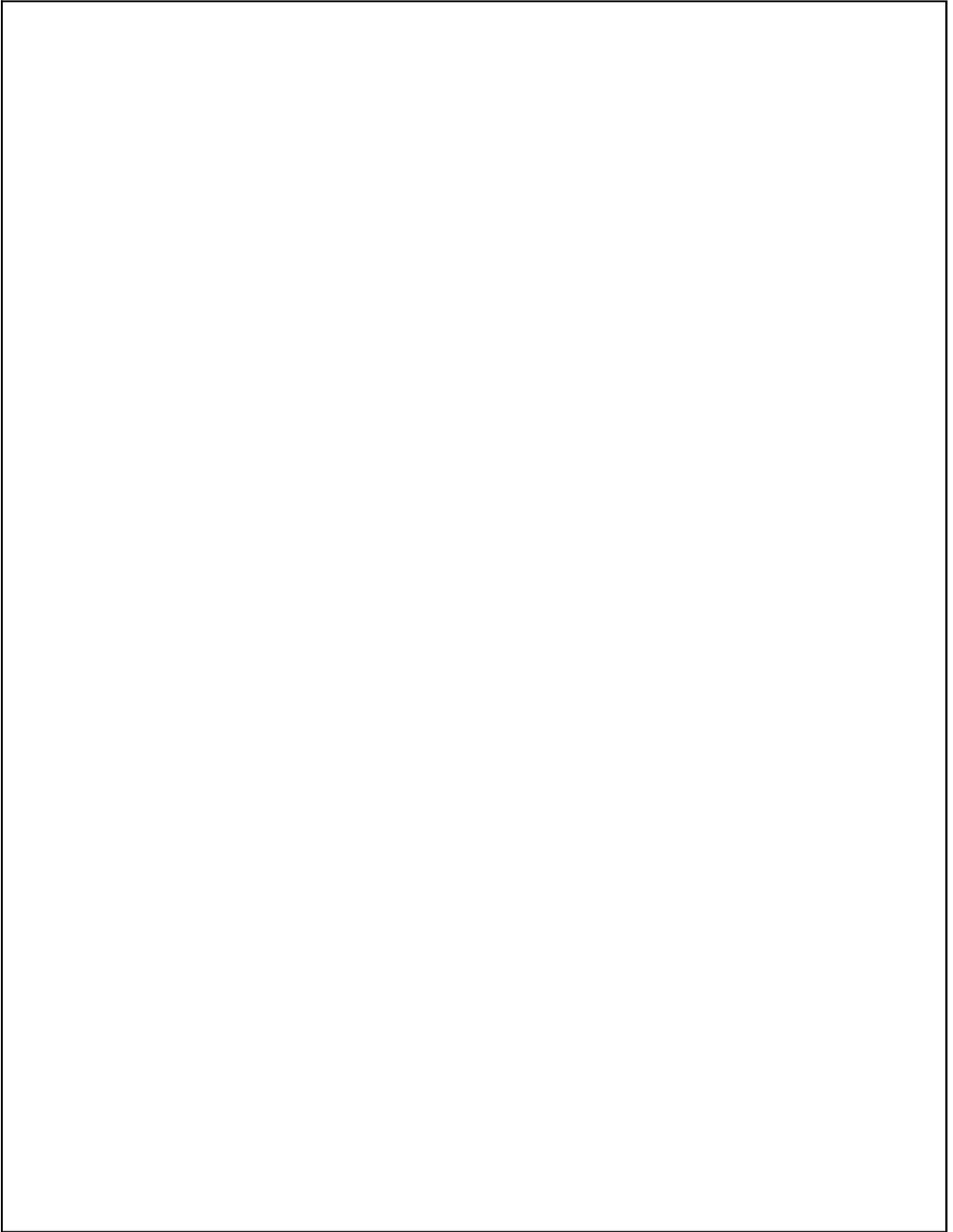
Assume you want to build a basic AI agent that can play Nim using a game tree. In this game, the pot will start with 16 marbles, and the **state** of the game is the number of marbles in the pot. On the next page, draw the root node and the first two levels of the game tree (you do not have to draw any levels past that), with the game state (number of marbles) as the value of each node. Annotate your game tree to show which actions are taken by the AI agent vs. the opponent, assuming the agent gets the first turn.

You can do this with a picture of a physical drawing or an online image editing tool (like Google Drawings). To upload the image, use the same approach you used on Hw5.

What is the maximum **depth** of the game tree if it was built out fully? (A node with only the root has depth 1).

Assume that the AI uses minimax to find the best action to take on its turn. When comparing the results on the level right below the root, should the AI pass the **maximum** or **minimum** result to the top level with the root?

- Maximum
- Minimum



## #6 - Heuristics - 6pts

Consider the two-player game **Draughts**, or **Checkers**

(<https://en.wikipedia.org/wiki/Draughts>). This game is too complex for an AI to build a full game tree; it would need to use **heuristics** instead, to support fast search for the next move to make.

Which of the following factors could be included to build a well-designed heuristic for a Draughts game state? **Select all that apply.**

- How many pieces each player has on the board
- How many 'king' pieces each player has on the board
- Whether the players are calling the game 'draughts' or 'checkers'
- Where pieces are located (closer to the opponent's side = better)

Which of the following **best** describes how an AI could choose its next move, using that heuristic? **Select only one answer.**

- Apply the heuristic to the current board, and use the resulting score to choose which move to take
- Build a game tree to some set depth, score the leaves with the heuristic algorithm, and then apply minimax to get the result
- Build the next level of the game tree, then apply the heuristic to find the best-scoring child. Then generate all of that child's next moves, and apply the heuristic again. Continue until an end state is reached to get the next move
- Choose one of the possible moves randomly