15-110: Principles of Computing, Spring 2018

Problem Set 9 (PS9)

Due: Friday, April 6 by 2:30PM via Gradescope Hand-in

HANDIN INSTRUCTIONS

Download a copy of this PDF file. You have two ways to fill in your answers:

1. **Just edit (preferred) - Use any PDF editor (e.g., Preview on Mac, iAnnotate on mobile, Acrobat Pro on pretty much anything) to typeset your answers in the given spaces. You can even draw pictures or take a picture of a drawing and import it in the correct place in the document. That's it. (Acrobat Pro is available on all cluster machines.)**

2. **Print and Scan - Alternatively, print this file, write your answers neatly by hand, and then scan it into a PDF file. This is labor-intensive and must be done by the deadline.**

Once you have prepared your submission, submit it on Gradescope. A link to Gradescope is provided in our Canvas course portal.

Fill in your answers ONLY in the spaces provided. Any answers entered outside of the spaces provided may not be graded. Do not add additional pages. We will only score answers in the given answer spaces provided. If we cannot read your answer or it contains ambiguous information, you will not receive credit for that answer.

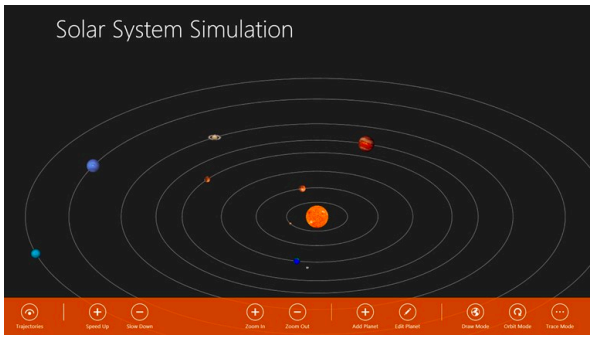
Be sure to enter your full name below along with your section letter (A, B, C, etc.) and your Andrew ID. Submit your work on Gradescope by 2:30PM on the Friday given above.

REMINDER: Sharing your answers with another student who is completing the assignment, even in another semester, is a violation of the academic integrity policies of this course. Please keep these answers to yourself.

Name (First Last) _____

Section _____ Andrew ID _____

1. (2 pts) A simulation of planetary motion is to be designed. A snapshot of the simulation is shown to the right. In the simulation, planets rotate around the sun smoothly. For each of the following simulation tradeoffs, pick which most accurately describes this simulation and write one sentence explaining why you chose that option.



Agent-based or Equation-based?

Abstract or Accurate?

Static or Dynamic?

Deterministic or Stochastic?

2. (2.5 pts) In our flu virus simulation discussed in class, suppose that our canvas is 600 pixels wide and 400 pixels high, but we still want to display the same 400 people as rectangles in 20 rows with 20 columns.

(a) What is the size of each rectangle in pixels?

```
___________ pixels wide    by    ___________ pixels high
```

(b) Write the drawing command in the simulation so that it draws each rectangle in its correct place on the canvas. Remember that this code is in a set of nested loops with loop variables `row` and `col` respectively and a variable `color` that is set to the desired color for that rectangle given the person's health state in the `matrix` at the given `row` and `col`.

```
c.create_rectangle(____________________, ____________________,
                   ____________________, ____________________,
                   fill = color, outline = "black")
```

3. (1 pt) In the simulation for the spread of the flu virus demonstrated in class, there were some subtle issues that we overlooked. Review the code and answer the following statements.

a. TRUE OR FALSE: When a person contacts four people, they are not guaranteed to be different people.

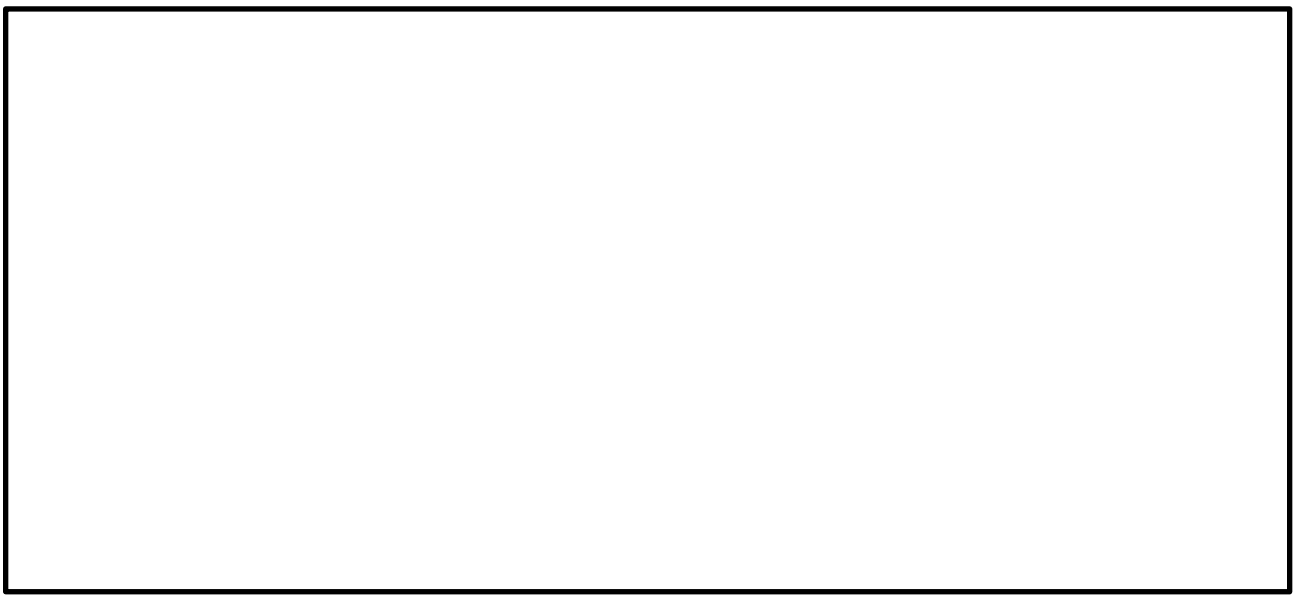
b. TRUE OR FALSE: When a person contacts four random people, at most one of them can be contagious.

c. TRUE OR FALSE: When a person contacts four random people to see if any are contagious, the person could contact himself/herself.

d. TRUE OR FALSE: A person can get infected by contacting himself/herself.

4. (1 pt) In our flu virus simulation, the `update` function takes the current `matrix` representing the health states of the population and computes and returns a new matrix of the health states of the population for the next day. Note that we created an entirely new matrix; we didn't reuse the current matrix. What subtle logical error occurs if we were to reuse the current matrix instead, as shown below (changes in red)? Answer this question by considering the case where the last person in the population is healthy and contacts four people that were healthy in the original matrix that is passed into the function.

```
def update(matrix):
    # create next day
    for i in range(0,20):
        for j in range(0,20):
            if immune(matrix, i, j):
                matrix[i][j] = IMMUNE
            elif infected(matrix, i, j) or contagious(matrix, i, j):
                matrix[i][j] = matrix[i][j] + 1
            elif healthy(matrix, i, j):
                for k in range(0,4):  # repeat 4 times
                    # pick a random person at position random x and y
                    random_x = randint(0,19)
                    random_y = randint(0,19)
                    if contagious(matrix, random_x, random_y):
                        matrix[i][j] = INFECTED
    return matrix
```



5. (1 pt) Suppose in our flu virus simulation, we want to implement the following rule:

> If a person is immune, there is a 10% chance that this person may become infected again without contacting any other person (i.e. the virus re-emerges).

Show how to revise the following part of the `update` function to handle this new rule. **Hint:** you'll need to use a random number generator.

```
if immune(matrix, i, j):
    newmatrix[i][j] = IMMUNE
```

```
if immune(matrix, i, j):
    if _____________________________________________:
        newmatrix[i][j] = INFECTED
    else:
        newmatrix[i][j] = IMMUNE
```

6. (1.5 pts) Suppose we want to change our flu virus simulation in the following manner. When a person *i, j* is healthy, instead of contacting 4 random people, that person contacts the person(s) to its immediate left and right. If either is contagious, then the person gets infected. Show how to change the relevant part of the code to implement this updated rule. **NOTE:** Remember that for some people, they might not have a left or right neighbor, so you need to check for this situation first.

```
elif healthy(matrix, i, j):
    # check left neighbor
    if ___________________ and ___________________________________:
        newmatrix[i][j] = INFECTED
    # check right neighbor
    if ___________________ and ___________________________________:
        newmatrix[i][j] = INFECTED
```

7. (1 pt) Read chapter 4 of the book *Blown To Bits*, pages 109-137. (Feel free to read the whole chapter if the material interests you.) This reading discusses how a search engine works. Answer the following questions based on the reading.

(a) You often hear that once you put something on the web, it's on the web forever, even if you erase it from your website later. Briefly explain why this statement is true in the context of search engines as explained in the chapter. (**HINT:** Think about how search engines catalog the web so they can present search results to you quickly.)

(b) When you do a web search, the results of your search are ranked, with the most relevant results shown first. How search engines rank results vary by the engine. Google became successful with an algorithm called PageRank. Based on PageRank, a graph is created of webpages that point to other webpages. What condition(s) must be true in order for a webpage to be ranked higher (i.e. more important) using the PageRank principle?