CS Scholars Programming Hw5 - Written
Due Date: Wednesday 08/11 EOD

Name:

AndrewID:

For full credit on the assignment, complete all Core problems (#1-#4), plus either the Tetris project or a self-designed project. Bonus problems are related to the Advanced Track content, and are optional.

The assignment is not due until Wednesday 08/11, but we recommend that you complete and submit the Core written and programming problems (minus the project) by Friday 08/06 anyway. We will do an initial grading run that weekend for early submissions to the core written and programming problems.

Note that submissions for Hw5 are complicated. You'll need to submit files to:

- **Hw5 - Written** [written PDF]
- **Hw5 - Programming** [guessingGame and bonus, if attempted]
- **Hw5 - Tetris** [IF attempting the Tetris project]
- **Hw5 - Self-designed Project** [IF attempting the self-designed project]

Core Problems - Written [20pts]

#1 - Components vs. Rules - 5pts

Can attempt after Simulation lecture

Let's say we want to design a simulation that determines how many students will sign up for a course during registration week. The simulation's time loop will loop over each sign-up time slot in order.

We need to design the model for this simulation. For each of the following values, would this value work better as a **component** of the model, or as a **rule** of the model?

Current length of the course's waitlist

- ☐ Component
- ☐ Rule

Students are more likely to sign up if a class is required for their major

- ☐ Component
- ☐ Rule

Number of students who are required to take this class, and haven't taken it yet, organized by sign-up timeslot

- ☐ Component
- ☐ Rule

Students are less likely to sign up for a class if the waitlist is long

- ☐ Component
- ☐ Rule

Information on whether or not the course will be offered again in the following semester

- ☐ Component
- ☐ Rule

#2 - Simulation Code - 5pts

Can attempt after Simulation lecture

We want to write code for a simulation that moves a circle from the left side of the screen to the right side of the screen in a 400px x 400px window. When the user clicks on the circle or presses 'Enter', the circle moves back to the left side of the screen.

For each part of the simulation (the Model, the View, the Time Rules, and the Event Rules), select the line of code that needs to be included in that part.

Hint: if you're not sure, try implementing this using the simulation starter code!

Which line of code should be included in the **model**, in `init(data)`?

☐ `cx = 5`

☐ `data.cx = 5`

☐ `canvas.create_oval(cx - 20, cy - 20, cx + 20, cy + 20)`

Which line of code should be included in the **view**, in `redrawAll(canvas, data)`?

☐ `data.cx = data.cx + 5`

☐ `canvas.create_oval(200 - 20, 200 - 20, 200 + 20, 200 + 20)`

☐ `canvas.create_oval(data.cx - 20, 200 - 20, data.cx + 20, 200 + 20)`

Which line of code should be included in the **time rules**, in `timerFired(data)`?

☐ `data.cx = 5`

☐ `data.cx = data.cx + 5`

☐ `cx = data.cx + 5`

How would you check if the user clicked in the circle in `mousePressed(event, data)`?

☐ `((data.cx - data.x)**2 + (200 - data.y)**2)**0.5 <= 20`

☐ `((data.cx - event.x)**2 + (200 - event.y)**2)**0.5 <= 20`

☐ `(data.x**2 + data.y**2)**0.5 <= 20`

☐ `(event.x**2 + event.y**2)**0.5 <= 20`

How would you check if the user pressed "Enter" in `keyPressed(event, data)`?

☐ `if (data.char == "Return"):`

☐ `if (data.keysym == "Return"):`

☐ `if (event.char == "Return"):`

☐ `if (event.keysym == "Return"):`

#3 - Monte Carlo Methods - 10pts

Can attempt after Experimentation lecture

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 and how the result is used 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()`

Core Problems - Programming [10pts]

#4 - Guessing Game - 10pts

Can attempt after Large Projects lecture

In the function `guessingGame()`, implement an interactive guessing game that the computer plays with the user. The computer should generate a random number between 1-10 and repeatedly ask the user to guess what it is until the user gets it right.

You can design your guessing game however you like, but it must meet the following constraints:

- The computer must actually pick a random number in the range [1, 10] each time the function is called (don't hardcode it!)
- If the user guesses right, the computer tells the user how many total guesses they made and ends the function
- If the user guesses wrong, the computer tells them whether the number they guessed was too high or too low and makes them guess again
- The program **must not crash** if the user enters an illegal input (a number outside of 1-10, or something that isn't an integer)

For example, here's a possible run of `guessingGame`, with user inputs bolded:

```
Welcome to the guessing game!
I'm thinking of a random number between 1 and 10
Make a guess: five
That's not an integer number! Try again.
Make a guess: 5
Not quite, it's larger than that.
Make a guess: 100
Not quite, it's smaller than that.
Make a guess: 8
You got it! Well done.
You made 4 total guesses.
```

Hw5 Project [70pts]

For the majority of the Hw5 assignment (your final assignment!), you get to create a project to make something cool in Python. You can either complete a guided project (Tetris), or you can design and code a project of your own choice (with approval from Prof. Kelly). Instructions for the two options are included below.

#5a - Tetris - 70pts

Can attempt after Large Projects lecture

Using the simulation starter code, write the classic arcade game **Tetris**, where you arrange blocks that fall from the top of the screen to clear rows and keep the game going for as long as possible.

Tetris is much more complicated than the homeworks you've solved so far. You'll need to implement 15 helper functions to completely implement the game. But you don't have to do it alone- we've written guidelines that include algorithmic guidance to help you through the process!

Please visit this website to view the step-by-step instructions for the project:
http://www.krivers.net/CSS-m21/tetris/index.html

All students attempting Tetris will complete the same project. If you want to break down the project into review/core/spicy components, the breakdown might look like this:

- **Review:** Creating and drawing the board & falling piece; moving the falling piece
- **Core:** Placing pieces on the board; handling game over; removing full rows; rotating pieces
- **Spicy:** Full game plus bonus features like music, piece preview, piece editor, etc

Start with the Tetris starter file on the course website. When you're ready, submit your work to **Hw5 - Tetris** for manual grading.

Note: if you add bonus features to your Tetris game, add a comment at the top of your file explaining what they are so we know to look for them.

#5b - Self-designed Project - 70pts

Can attempt after Large Projects lecture

Alternatively, if you have a cool idea for a project that you want to attempt, you can complete that project instead of coding Tetris. However, your project must follow a few guidelines to ensure that it is at least as complex as Tetris:

- Your project must use simulation in some meaningful way
- Your project must use top-down design with helper functions to break the program down into its different components. Tetris has ~15 helper functions; your project should have around the same number (or more)
- Your project should be reasonably complex in the types of code used. Tetris contains ~150 lines of code and uses functions, conditionals, loops, and lists (one- and two-dimensional); your project should cover a similar range of complexity (or add more complexity)

If you want to design your own project, send Prof. Kelly an email or Slack message by **Friday 08/06 6pm EST at the latest** (preferably earlier) to propose a project idea. Your proposal should include a short description (1-2 paragraphs) of what the project will involve and what the final product will be. Prof. Kelly will respond within 1-2 days to approve or deny your project proposal.

When you're ready, submit your work to **Hw5 - Self-designed Project** for manual grading. Include the description of your project that you submitted to Prof. Kelly in a comment at the top of your file.

Bonus Problems [10pts]

Advanced Programming - User Interfaces - 5pts

Create a tkinter application in `hw5.py` under the `### Bonus Problems ###` comment that uses at least two different kinds of widgets (not counting `Canvas` or the root `Tk` window). At least one of the widgets must modify the state of the application based on user input through use of an event handler.

The widgets you use don't have to be the three shown in the examples- feel free to explore all the options in the documentation!

Advanced CS - Machine Learning 1 - 2.5pts

For each of the following prompts, fill in the blanks with the type of **learning algorithm** that should be used and/or the type of **reasoning algorithm** that should be used.

You have a dataset that consists of student grades from past semesters of 15-110, including final grades. Use _____ learning to predict a student's **numerical** final grade based on their **numerical** quiz scores with a _____ algorithm.

You have a dataset of weather patterns in different major cities around the world. Use _____ learning to propose **new groupings** of cities based on the **categorical** weather patterns with a _____ algorithm.

You have a dataset of athletes' descriptions (age, height, weight, etc) and the sport that they play. Use _____ learning to predict an athlete's **categorical** sport based on their **numerical** age, height, weight, etc. with a _____ algorithm.

To train a robot how to throw a basketball through a hoop through repeated practice and feedback, you'd want to use _____ learning.

To identify previously-unknown market trends based on stocks that go up and down together at similar times, you'd want to use _____ learning.

Advanced CS - Machine Learning 2 - 2.5pts

Imagine a scenario where Bill wants to train a machine learning algorithm to identify which pictures on the internet have cats in them. He downloads 1,000 pictures of cats and other animals from the internet, decides to use a basic image recognition algorithm which will identify important features, trains on all 1,000 pictures, then tests his on a quarter of that dataset (250 pictures). He finds that his algorithm has a 97% success rate, which he publishes on his blog.

Bill made a few mistakes in this process. **What was his <u>biggest</u> mistake?**