Practice Exam
Semester: Fall 2019

Show work when needed, it can be used for partial credit! Also note that these questions are a rough estimate and are compiled by TA's who have not seen the exam. Topics covered in class are fair game even if they are not on this exam.

Name:
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Unit 1

1. Identify if there is an error in the following statements. If there is, identify the type of error.

   a)
   ```
   print("2 + 2 = 5")
   ```

   Logic Error

   b)
   ```
   for i in range(6):
       print(5 / i)
   ```

   Division by 0 (Runtime Error)

   c)
   ```
   a = [1, 2, 3]
   a.append([4])
   ```

   No error

   d)
   ```
   while x < len(L):
       if x = 2:
           return False
       return True
   ```

   Syntax Error (using = not ==)

2. You are processing the responses to a survey, and would like to store them in the **least** number of bits possible. One of the questions allows the respondent to select any multiple of 10 between 0 and 100 (inclusive on both sides). Your colleague claims that you need to allocate at least 7 bits, since 7 bits are required to represent 100 in binary. Is your colleague correct? If not, how many bits would you allocate, and why?

   Hint: Do you need to represent numbers like 2,3,4,5? How many numbers do you need to represent?

   No. Only 4 bits are required, because there are only 11 options (0, 10, …, 100), and 11 can be represented in 4 bits in binary.

3. Given the following function, will this function return a value of 200 at the very end? Why or why not?

```
def loops():
    for i in range(10):
        counter = 0
        for j in range(20):
            counter += 1
    return counter
```

   The function will return the value 20 instead of 200. This is because the variable counter is defined within the scope of the first for loop, meaning that every time the first for loop iterates, the counter will be reset. If counter were defined outside the loop, it would return 199.

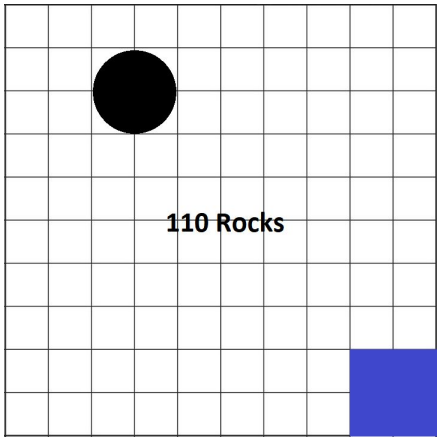
4. Code Tracing: Write the expected output in the box under the code

```
def ct1(s):
    n = 0
    w = 'AEIOU'
    i = 0
    while i < len(s):
        if not s[i].isalpha():
            n += 1
            s = s[:i] + s[(i+1):]
        else:
            if s[i].isupper() and s[i] in w:
                return s[:i]
            i += 1
    return s
print(ct1('1L1keT034tapplE5!!x'))
```

```
'LkeTtappl'
```

Unit 2

5. We have the following 10x10 grid with a black circle, blue rectangle, and a text that says “110 Rocks” in the center of the canvas. Write the code that will reproduce this. You may assume that the canvas has already been created and passed to your function in the variable 'canvas', and that the window is 400px x 400px.




```
data[“cellSize”] = 40

canvas.create_oval(data["cellSize"] * 2, data["cellSize"],
data["cellSize"] * 4, data["cellSize"] * 3, fill = "black")

canvas.create_rectangle(data["cellSize"] * 8, data["cellSize"] *
8, data["cellSize"] * 10, data["cellSize"] * 10, fill = "blue")

canvas.create_text(data["width"]//2, data["height"]//2, fill =
"black"
```

6. Write a function removeMultiples(L, e) that takes in a list L of integers and removes all of the elements in L that are a multiple of e.

```
def removeMultiples(L, e):
    newL = []
    for elem in L:
        if elem % e != 0:
            newL.append(elem)
    return newL
```

7. Write the expected output of the following code in the box below the code.

```
def ct1():
    x = [1, 2, 3]
    y = [4, 5, 6]
    z = y
    y = x
    x.append(4)
    y.extend([5])
    x = x + [6]
    print(x)
    print(y)
    print(z)
ct1()
```

```
[1,2,3,4,5,6]

[1,2,3,4,5]

[4,5,6]
```

8. Write the recursive function numLength(num) that recursively finds how many digits a positive integer contains.

   Input: `num = 15110`

   Output: `5`

```
def numLength(n):
 if n<10:
   return 1
 else:
   return 1+numLength(n//10)
```

9. Give the reduced big-O runtime of the following functions:

`def f(s):`
`  for i in range(len(s)):`
`  for j in range(i, len(s)):`
`  print(s)`
	O(n**2):
	
	nested for-loops

`def f(n):`
`  for i in range(10**10):`
`  print("hello")`
	O(1):
	
	complexity does not depend on n

`def f(L):`
`  for n in L:`
`  if n % 2 == 0:`
`  return`
	O(n):
	
	worst case iterates through every item in l

`def f(L):`
`  for i in range(len(L)):`
`  if i % 2 == 0:`
`  return`
	O(1):
	
	complexity does not depend on the length of l since it always returns during first iteration

10. What is the worst-case complexity of linear search, and when does it occur?

O(N). When the element you want to search for is at the end of the array

11. What does the following code do? Do we have a special name for this algorithm?

```
def mystery(M, val):
    if len(M) == 0:
        return False
    n = len(M)//2
    if M[n] == val:
        return True
    elif M[n] > val:
        return mystery(M[:n], val)
    elif M[n] < val:
        return mystery(M[n+1:], val)
```

Binary Search

12. In less than 3 sentences, define hash collision and describe a way that we can handle it.

Collision is when a hash function assigns the same hash index to 2 different values, we can simply put the 2 values in a list at the same index

13. Given a dictionary mapping a professor to a list of their students, write a function numProfs(d) that returns a dictionary mapping each student to the number of professors they have.

Example Input:

```
d = { "Prof A" :
["Gayatri","Tina","Alice","Brittney","William"],
      "Prof B" : ["Enock","Tina","Marie","Brittney"],
      "Prof C" : ["Gayatri","Tina","Alice"] }
```

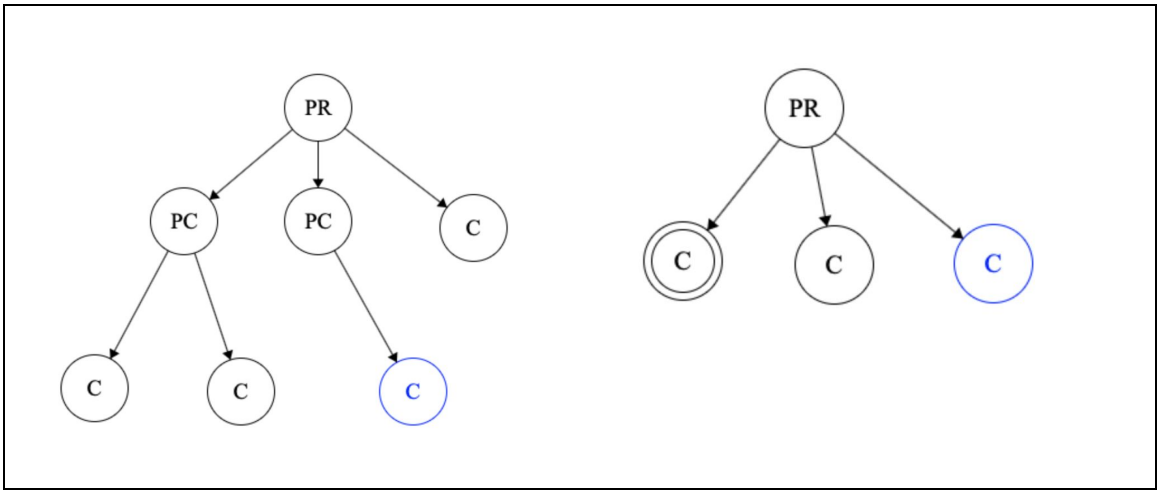
Example Output:

```
{ 'Gayatri': 2, 'Tina': 3, 'Alice': 2, 'Brittney': 2,
  'William': 1, 'Enock': 1, 'Marie': 1}
```

```
def studentToClasses(d):
     res={}
     for teacher in d:
          for elem in d[teacher]:
               if elem not in res:
                    res[elem]=0
               res[elem]+=1
```

```
    return res
```

14. A 3-tree is a tree where each parent node has **at most three** children. Draw 2 distinct 3-trees and label parents with P, children with C, and the root with R. Note that some nodes might be labeled with more than one of P, C, R. **(Ignore double circles on the first solution)**



15. **True** or **False** - if we are able to find a solution to a problem in NP-Complete in polynomial time, then we can solve all NP-Complete problems in polynomial time.

16. **True** or **False** - An algorithm that runs in O(n!) is tractable.

Unit 3

17. A cafe has three stations: cashiering, food, and beverages. Three employees are on staff, each at one station. Give one example of pipelining in this situation. In contrast, what would happen if there was no pipelining?

    Hint: Does the person behind you in line have to wait for your order to be served before they make their order?

    Multiple cashiering jobs can be pipelined one after another with no need to wait on related food or beverage jobs.
    No Pipelining: The person behind you in line would have to wait for your order to be served and paid for before they can take their turn

18. What's one thing an IP address can tell you and one thing it cannot?

    Can:

    Identify a particular machine at a particular time

    A vague geographic based on the ISP

    Can't:

    Who is using the machine

    What kind of machine it is

19. Give the name of each of the following security attacks:

a. You're doing your homework at a Starbucks connected to the public wifi and are messaging your friends. Someone also connected to the same wifi is reading all of your messages.

Man in the Middle

b. You find a USB stick in one of the Gates clusters and decide to plug it into your laptop to try and figure out who to return it to. After you do this, you cannot access any of the data on your laptop unless you pay someone.

Malware

c. Everyone goes to check their final grades at the same time. SIO's servers can't handle that many people trying to login, so no one can access SIO.

DDOS

20. Describe 2 characteristics of cloud computing.

Remotely hosted: Services and data are hosted on remote resources.

Ubiquitous: Services and data are available from anywhere.

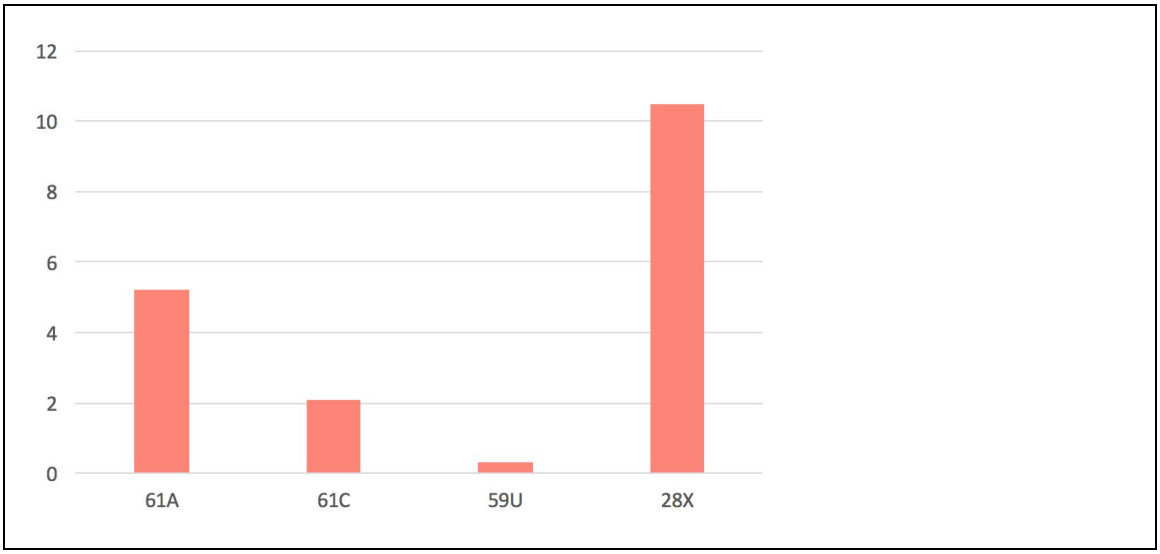
Commodified: The result is a utility computing model similar to traditional utilities such as electricity and water. You pay for what you use!

Unit 4

21. You are given a CSV file of Pittsburgh bus lines (e.g., 59U, 61C, 28X) and how late they were in minutes on average to arrive at the Morewood Ave stop.

```
61A, 5.2\n
61C, 2.1\n
59U, 0.3\n
28X, 10.5\n
```

First: draw an appropriate plot to visualize the data.



Suppose you are given the code so that the variable line equals one line of text from the CSV. For example line = "61A, 5.2\n" Write code that would get the lateness from line and convert it to a float.

```
float(line[5:len(line)])
```

22. Read the simulation code below, then answer the following questions.

```
def makeModel(data):
    data["x"] = 0
    y = 0

def makeView(data, canvas):
    y = 0
    canvas.create_text(200, 100, text="X: " + str(data["x"]))
    canvas.create_text(200, 300, text="Y: " + str(y))

def runRules(data, call):
    data["x"] = data["x"] + 1

def keyPressed(data, event):
    y = 0
    if event.keysym == "Space":
        y = y + 1
```

What will make the value printed next to X change?

Time passing

What will make the value printed next to Y change?

Nothing, as y is not stored in data

23. Write a short function that takes no input and runs a single trial of a Monte Carlo simulation. The trial should simulate flipping two coins, and should return True if the two coins show the same result, and False otherwise. Once you finish writing the code, answer the questions below.

```
import random
def runTrial():
      coin1 = random.randint(0,1)
      coin2 = random.randint(0,1)
      return coin1 == coin2
```

Assume you run your function many times using the Monte Carlo method.

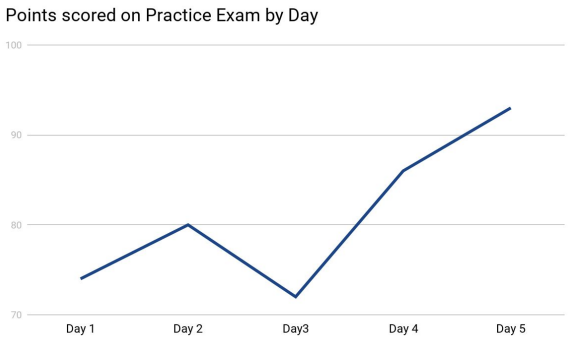
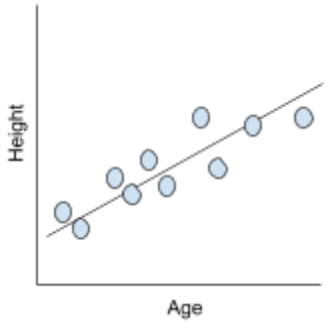
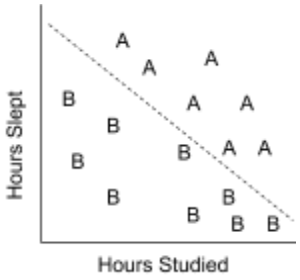
What will happen to the accuracy of your result as the number of trials goes up?

The accuracy will increase.

What will happen to the time that the function takes as the number of trials goes up?

The time it takes will not change because the function is O(1).

24. For each of the graphs below, is it depicting a classification, a regression, or a time-series algorithm?

	❑ Classification ❑ Regression ❑ Time-series
Predict Height of a Person by their Age 	❑ Classification ❑ Regression ❑ Time-series
Predict Final Exam Grade (A or B) based on Hours Slept and Hours Studied 	❑ Classification ❑ Regression ❑ Time-series

25. What algorithm do we use to search an AI graph of nodes as states and edges as actions?

BFS

Unit 5

26. Name the three hardware components that helped transition computers from large devices that only corporations and governments could use to smaller, personal devices.

Transistor; Integrated Circuit; Microprocessor.

27. Describe an example of bias in machine learning that we discussed in class. Where did the bias come from in this example?

See slides, sample answer: algorithms that try to recommend bail based on recidivism have exhibited racial bias. The bias comes from the data that was fed into the algorithm: the AI can only use the data it's provided, so if the data is originally biased the AI will recommend biased rules.

28. Define the term 'deepfake' and briefly explain the potential ramifications of the technology.

Deepfake is where a video of one person talking is doctored to look like someone else speaking, using machine learning methods. With deepfakes, it gets more and more difficult to trust that a video of someone speaking means that that person actually said those things.