CSE 4309 - Assignments - Assignment 1

List of assignment due dates.

The assignment should be submitted via Canvas. Submit a file called assignment1.zip, containing the following files:

- answers.pdf, for your answers to the written tasks. Only PDF files will be accepted. All text should be typed, and if any figures are present they should be computer-generated. Scans of handwriten answers will NOT be accepted.
- file_stats.py, containing your code for Task 9.
- nth_smallest.py, containing your code for Task 10.

The above naming conventions are mandatory, non-adherence to these specifications can incur a penalty of up to 20 points.

Your name and UTA ID number should appear on the top line of your answers.pdf document.

Task 1 (5 points)

```
def factorial(n):
    result = 1
    for i in range(2, (n+1)):
        result = result * i;

    return result
```

Consider the `factorial` function above, implemented in Python. What is the time complexity of this function, in Θ notation, with respect to n?

Task 2 (10 points)

Re-implement, in Python, the factorial function of Task 1 so that it uses a recursive function call instead of using any loops (like while loops and for loops). Do not call any built-in or library functions for computing the factorial. You do NOT need to do any error-checking (like checking if the input argument is negative). For this task, please include your code in the answers.pdf file, do NOT submit a separate code file.

Task 3 (10 points)

```
def foo(n):
    result = 0
    for i in range(1, n+1):
        for j in range(1, i+1):
            result = result + 1
    return result
```

Consider the `foo` function above, implemented in Python. What is the time complexity of this function, in Θ notation?

Task 4 (5 points)

Consider matrices A and B defined as:

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}, \quad B = \begin{bmatrix} e \\ f \end{bmatrix}$$

What is the result of matrix multiplication A*B? Specify the values at all positions of the result matrix.

Task 5 (10 points)

Consider function $f(x) = 3x^2 + 5x - 7$.

Part a: What is the first derivative f'(x)? Provide a specific formula as a function of x.

Part b: What is f'(5)? Your answer should be a real number.

Part c: What is the second derivative f''(x)? Provide a specific formula as a function of x.

Part d: What is f''(5)? Your answer should be a real number.

Task 6 (15 points)

In this task, we denote by P(x) the probability of event x. A and B are two events that are independent of each other. P(A) = 0.3 and P(B) = 0.6.

Compute the following quantities:

- P(A and B).
- P(A or B).
- P(not(A)).
- P(A | B) (i.e., the conditional probability of A given B).

Task 7 (15 points)

Color	Price $20 to $40	Price $50 to $70	Price $80 to $100
red	40	70	35
green	15	50	30
blue	60	20	80

The above table shows, for a certain hat store, the number of hats in their inventory, for each combination of color and price. For example, the inventory contains 40 red hats at a price between $20 and $40. Using that table:

Part a: Determine P(price < $75), i.e., the probability that a hat costs less than $75.

Part b: Determine P(price < $75 | color=green), i.e., the conditional probability that the price of a hat is under $75, given that the color of that hat is green.

Part c: Determine P(price < 75, color=green), i.e., the joint probability that the price of a hat is under 75 and the color of that hat is green.

Task 8 (10 points)

Two hens lay a combined total of two eggs in two days. If this rate of egg production per hen per day continues, how many eggs do ten hens lay in ten days?

Task 9 (10 points)

Write a python function `(avg, stdev) = file_stats(pathname)` that:

- Takes as input argument the pathname of a file stored locally on the computer. Your function can assume that the file is a text file, that contains exactly one floating point number in each line. An example of such a file is numbers1.txt.
- Returns the average and standard deviation of the numbers contained in the file. For standard deviation, please use the formula that divides by n-1 (when we have n numbers in our dataset). You can assume that the dataset will contain at least two numbers.

Please place your python code in a file called file_stats.py, and include that file in your assignment1.zip package.

Task 10 (10 points)

Write a python function `result = nth_smallest(data, top, bottom, left, right, n)` with these specs:

- The first argument, `data`, is a two-dimensional numpy array.
- The function returns the n-th smallest value in the subarray of `data` that goes from row `top` up to (and including) row `bottom`, and from column `left` up to (and including) column `right`.

For example, consider this code:

```
import numpy as np


def nth_smallest(data, top, bottom, left, right, n):
# your code goes here


a = np.array([[0.8147, 0.0975, 0.1576, 0.1419, 0.6557, 0.7577],
       [0.9058, 0.2785, 0.9706, 0.4212, 0.4212, 0.7431],
       [0.127 , 0.5469, 0.9572, 0.9157, 0.8491, 0.3922],
       [0.9134, 0.9575, 0.4854, 0.7922, 0.934 , 0.6555],
       [0.6324, 0.9649, 0.8003, 0.9595, 0.6787, 0.1712]])

print(nth_smallest(a, 1, 2, 3, 4, 1))
print(nth_smallest(a, 1, 2, 3, 4, 2))
print(nth_smallest(a, 1, 2, 3, 4, 3))
print(nth_smallest(a, 1, 2, 3, 4, 4))
```

If you implement the `nth_smallest` function correctly, the above code should print:

```
0.4212
0.4212
0.8491
0.9157
```

Please place your python code in a file called nth_smallest.py, and include that file in your assignment1.zip package.

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