COMS BC3159: Problem Set 0

Due Friday, September 13, 2024 11:59 PM

Hello and welcome to COMS BC3159!

"Ugh, why do I have to do PS0? We haven't even learned anything yet!?"

Take this opportunity to **practice** completing and turning in assignments for our class. After PS0, we will expect you to know the infrastructure for submissions.

PS0 should **not** feel arduous nor time consuming—if you are struggling with this assignment, please do reach out to teaching staff or other classmates!

Please show your work for all solutions to receive partial/full credit. Feel free to use Ed for clarification of any given question. Always turn in *only* your own, independent work. Scan, upload, and **submit via Gradescope** (assign each question to a page in your submission). For our late policy, refer to the syllabus. All other administrative questions can be posted on Slack.

Collaborators:

AI Tool Disclosure:

The following exercises will review some math and (re)introduce the type-setting tool LaTeX. In addition to these written problems, you will also complete the coding part of the assignment, found in the GitHub repo.

1 Algebra, the linear kind. (2 points)

Solve the following system of linear equations for $x, y,$ and z. Show your work and use matrix algebra.

$$\begin{aligned} x + 2y + 3z &= 1 \\ 2x + 2y + 3z &= 2. \\ x + 3y + 4z &= 2 \end{aligned}$$

Hint: the inverse of $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 2 & 3 \\ 1 & 3 & 4 \end{bmatrix}$ is $\begin{bmatrix} -1 & 1 & 0 \\ -5 & 1 & 3 \\ 4 & -1 & -2 \end{bmatrix}$

2 Calculus, the multivariable kind. (4 points)

2.1 Minimize! (2 points)

Suppose that we wish to minimize some loss function $\mathcal{L}$ with respect to a variable x where:

$$\mathcal{L}(x) = 3x^2 + 2x - 1$$

Given this loss function, what value of x minimizes the loss? In other words, for what value of x is this function minimal?

2.2 Differentiate! Partially. (2 points)

Find the partial derivative $\frac{\partial f}{\partial x}$ of the following function:

$$f(x, y) = 3x^2 + 2xy - 5y^2$$

Now evaluate that derivative at $(x, y) = (2, 3)$.

3 Asymptotically! (2 points)

In this class, we will loosely use Big-O asymptotic notation. This notation provides a common vocabulary to discuss run-times of algorithms.

- For a simple beginner's guide, see here.
- Recall that the insertion sort algorithm takes $O(n^2)$ time—where n is the length of the list to sort.
- Merge sort takes $O(n \log n)$ time.

Consider the following code excerpts:

```
def sum_list(lst):
    """
    Function that returns the sum of elements in lst
    :param lst: input list
    :type  lst: [int]
    :return: sum of the list
    :rtype : int
    """
    rtn = 0
    for elt in lst:
        rtn += elt
    return rtn


def foo(lst):
    """
    Foo Algorithm
    :param lst: input list of length n
    :type  lst: [int]
    :return: ???
    :rtype : int
    """
    for elt in lst:
        if elt < 0:
            return -1
    return sum_list(lst)
```

What is the runtime of the `foo` algorithm in Big-O notation?

What does the `foo` function do?

4 The Old Man and the C (2 Points)

Consider the following C code:

```c
#include <stdio.h>

int main() {
    int arr[5] = {1, 2, 3, 4, 5};
    int* ptr = &arr[2];
    *ptr = 7;
    printf("%d\n", *ptr + 2);
    return 0;
}
```

What values are in the final array? (**Note:** if you don't remember much about pointers and C/C++, try the coding part of PS0 first, then return to this problem and/or copy and run this code!)

What is printed out by the function?