Project 00 Latex Sheet

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1 Python Code to show System Requirements

```
#Cameron Brenner
#HW00
#Import statements and version

import sys
import numpy
import scipy
import sklearn
import matplotlib
import pandas

print (sys.version)
print (numpy.__version__)
print (scipy.__version__)
print (sklearn.__version__)
print (matplotlib.__version__)
print (pandas.__version__)
```

And here are the results..

```
C:\Users\Cameron\Python\Python37-32>python importstatements.py
3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)]
1.16.0
1.2.0
0.20.2
3.0.2
0.23.4
```

Figure 1: The results of the import statements and checking their versions

2 Github Deliverables

Here is the link to my Github repository for this class, with my username included in the URL: `https://github.com/cameron-brenner/data440`

Here is proof I have added Dr. Pablo Rivas as a collaborator

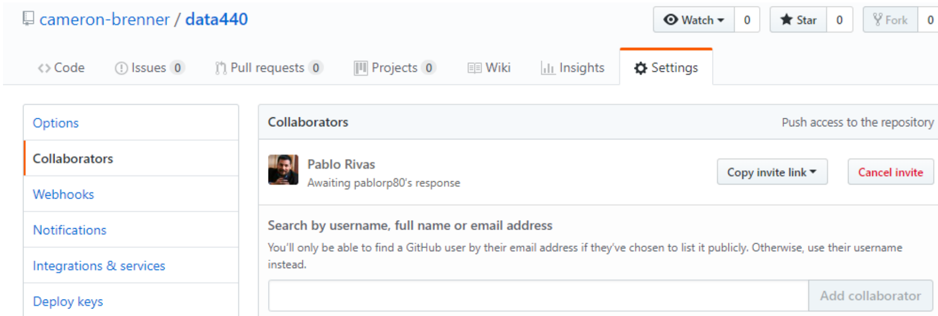
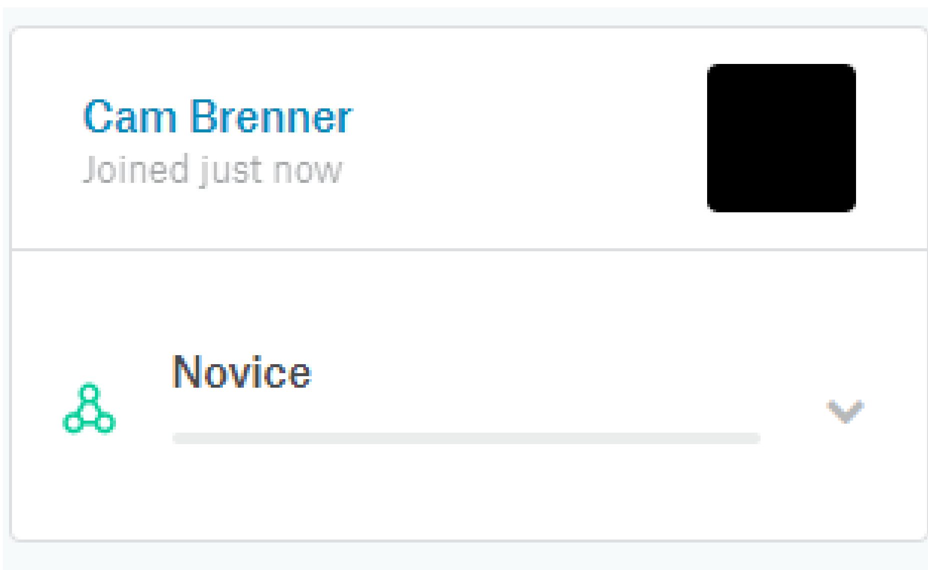


Figure 2: This is Dr. Rivas

3 Kaggle account and username

Here is the link to my Kaggle account: `https://www.kaggle.com/cameronbrenner`

Here is proof I have created my account:



4 Solution to Problem 1

We are asked to find the value for x that maximizes $g(x)$ given the equation $g(x) = -3x^2 + 24x - 30$. To do this we must first find where the derivative is equal to zero, as that is where the minimums and maximums of the function are.

$g(x) = -3x^2 + 24x - 30$
$g(x)' = -6x + 24$
$g(0)' = -6x + 24$
$-24 = -6x$
$4 = x$

This means, that when x=4, there is a maximum, and we know it is a maximum because the value for x is positive.

5 Solution to Problem 2

We are given the function $f(x) = 3x_0^3 - 2x_0x_1^2 + 4x_1 - 8$ and told to take the partial derivatives with respect to x_0 and x_1

When we take the derivative with respect to x_0, we treat x_1 like a constant.
$f(x) = 3x_0^3 - 2x_0x_1^2 + 4x_1 - 8$
$f(x)'_{x_0} = 9x_0^2 - 2x_1^2$
When we take the derivative with respect to x_1, we treat x_0 like a constant.
$f(x) = 3x_0^3 - 2x_0x_1^2 + 4x_1 - 8$
$f(x)'_{x_1} = -4x_0x_1 + 4$

6 Solution to Problem 3

We are given the matrices

A= $\begin{matrix} [1 & 4 & -3] \\ [2 & -1 & 3] \end{matrix}$ **and** B = $\begin{matrix} [-2 & 0 & 5] \\ [\ 0 & -1 & 4] \end{matrix}$

Part A. asks if we are able to multiply the matrices. When considering matrix multiplication, we must consider the dimensions of A(m x n) and B(n x m). If we are to multiply A x B, then the number of rows in A should equal the number of columns in B. A is a 3 x 2 matrix, and B is a 3 x 2 matrix. The rows and columns do not match so it is not possible to do matrix multiplication on these two matrices. We check it in Python with the code:

```
#Cameron Brenner
#Project 00 - Problem 3

import numpy
import scipy

A = [[1, 4, -3],
     [2, -1, 3]]

B = [[-2, 0, 5],
     [0, -1, 4]]

numpy.dot(A, B)
```

And we get the results

```
C:\Users\Cameron\Python\Python37-32>python hw00prob3.py
Traceback (most recent call last):
  File "hw00prob3.py", line 13, in <module>
    numpy.dot(A, B)
ValueError: shapes (2,3) and (2,3) not aligned: 3 (dim 1) != 2 (dim 0)
```

Part B. asks us to multiply A^T with B. A^T is A transposed so that the columns and rows are switched. We are also asked to give it's rank. Here is the code showing such:

```
#Cameron Brenner
#Project 00 - Problem 3 part b

import numpy
import scipy

```

```
AT = [[1,  2],
      [4, -1],
      [3, -3]]

B = [[-2,  0, 5],
     [0,  -1, 4]]


print(numpy.dot(AT, B))

print(numpy.linalg.matrix_rank(numpy.dot(AT, B)))
```

And here are the results:

```
C:\Users\Cameron\Python\Python37-32>python hw00prob3partb.py
[[-2 -2 13]
 [-8  1 16]
 [-6  3  3]]
2
```

7 Solutions to Part 4

The simple Gaussian distribution, also known as the normal distribution, is mathematically defined as:

$$f(x|\mu,\sigma^2) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \tag{1}$$

The multivariate Gaussian distribution is defined as

$$f(x|\mu,\Sigma) = \frac{1}{(2\pi)^{n/2}|\Sigma|^{1/2}} e^{(\frac{-1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu))} \tag{2}$$

The Bernoulli Distribution is defined as

$$f(k;p) = \begin{cases} p & if k = 1, \\ q = 1-p & if k = 0. \end{cases} \tag{3}$$

The Binomial Distribution can be described as

$$\binom{n}{k} = \frac{n!}{k!(n-k)!} \tag{4}$$

The Exponential Distribution can be described as

$$f(x;\lambda) = \begin{cases} \lambda e^{-\lambda x} & x \geq 0 \\ 0 & x < 0 \end{cases} \tag{5}$$

8 Solution to question 6

The given equation is

$$X \sim N(2,3) \tag{6}$$

We are given the normal distribution and asked to find the expected value. The value 2 is the mean of the distribution and 3 is the standard deviation, so 2 is the expected value.