Homework 0

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1/30/19

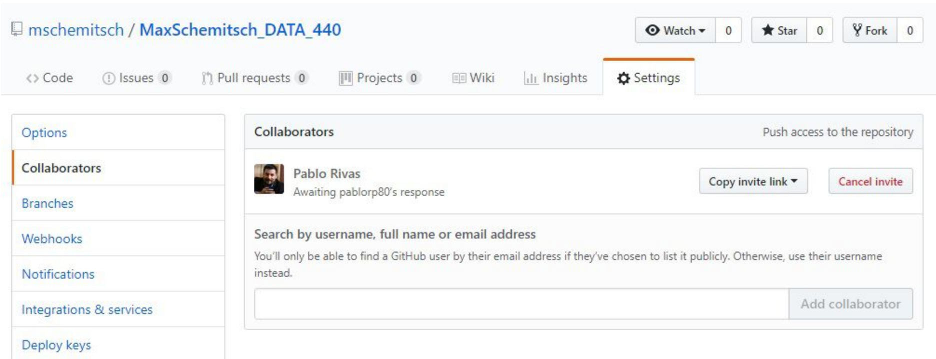
1 Python Requirements (2.1)

```
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__)
```

```
3.7.2
1.16.0
1.2.0
0.20.2
3.0.2
0.24.0
```

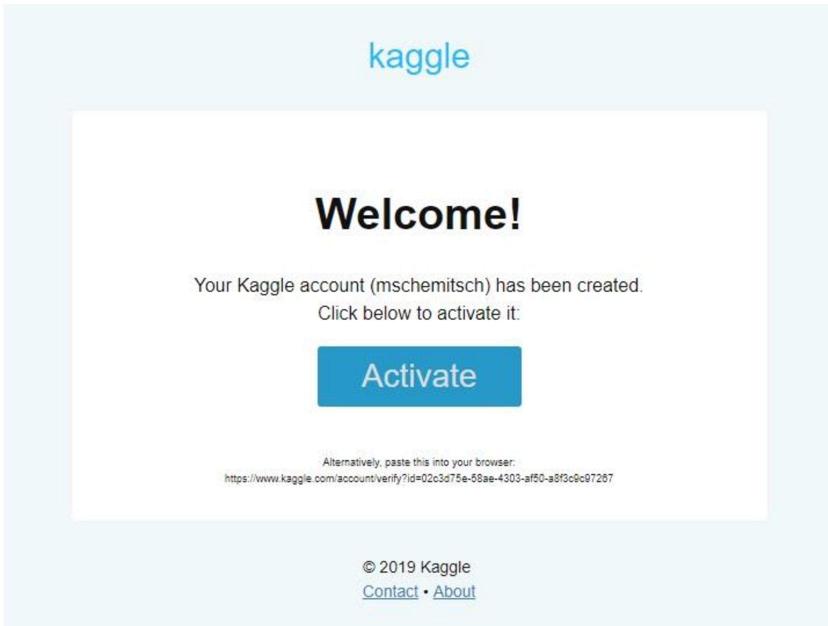
2 GitHub Class Repository (2.2)

My GitHub username is mschemitsch. Here's the link to my class repository:
`https://github.com/mschemitsch/MaxSchemitsch_DATA_440`



3 Kaggle Account (2.3)

My Kaggle username is mschemitsch.



4 Problems

4.1 Question 1

In order to find the value of x that maximizes $g(x) = -3x^2 + 24x - 30$, we must first take its derivative. We have that $g'(x) = -6x + 24$. Then we evaluate the first derivative at 0. This gives us $x = 4$. Thus $x = 4$ maximizes $g(x) = -3x^2 + 24x - 30$.

4.2 Question 2

In order to take the partial derivative of a function, we derive that parts we are respecting and treat the other parts as constants. The partial derivative of $f(x) = 3x_0^3 - 2x_0x_1^2 + 4x_1 - 8$ with respect to x_0 is $9x_0^2 - 2x_1^2$. The partial derivative with respect to x_1 is $-4x_0x_1 + 4$.

4.3 Question 3

a)

```python
import numpy
A = numpy.array([[1, 4, -3], [2, -1, 3]])
B = numpy.array([[-2, 0, 5], [0, -1, 4]])
A.dot(B)
```

```
Traceback (most recent call last):
  File    <stdin>   , line 1, in <module>
ValueError: shapes (2,3) and (2,3) not aligned: 3 (dim 1) != 2 (dim 0)
```

This error means that the two matrices are unable to be multiplied. This is because the dimensions dont match for there to be a dot product. 2 by 3 matrices, like both A and B, can only be multiplied with a matrix of at least 3 rows.

b)

```
A.T.dot(B)
numpy.linalg.matrix_rank(A.T.dot(B))
```

```
array([[-2,  -2,  13],
       [-8,  1,  16],
       [6,  -3,  -3]])
```

c)

```
C=numpy.array([[1,0], [0,2]])
A.dot(B.T)+numpy.linalg.inv(C)
```

```
array([[-16.  , -16.  ],
       [ 11.  , 13.5]])
```

4.4 Question 4

A simple Gaussian, or normal distribution, has a probability density function of $\frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{(x-\mu)^2}{2\sigma^2}}$ with $E[X]=\mu$ and $Var[X]=\sigma^2$.

A multivariate Gaussian distribution is similar to a simple Gaussian distribution, but utilizes more than one variable. Instead of being a 2 dimensional bell curve, it is instead a 3 dimensional curve.

A Bernoulli distribution, $X \sim Bernoulli(p)$ utilizes a single probability p. Its probability mass function is p if $k=1$ or $q=1-p$ if $k=0$. Its expected value is p and variance is pq.

A binomial distribution utilizes a similar p probability and also number of trials n. Its probability mass function is $\binom{n}{k}p^k(1-p)^{n-k}$. It has an expected value of np and variance of $np(1-p)$.

An exponential distribution a rate of λ. Its probability density function is $\lambda e^{-\lambda x}$ and its cumulative distribution function is $1-e^{-\lambda x}$. It has an expected value of $\frac{1}{\lambda}$ and variance of $\frac{1}{\lambda^2}$.

4.5 Question 5

The binomial distribution is a representation of how many successes occur in n independent Bernoulli distribution experiments or trials.

4.6 Question 6

The expected value for $X \sim N(2,3)$, a normal distribution with $\mu=2$ and $\sigma=3$, is equal to its μ or 2.

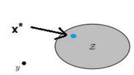
4.7 Question 7

a)

$$x^* = arg_x min||x-y||_2^2 \tag{1}$$

This equation represents that x^* equals the x value that minimizes the squared vector 2-norm of $x-y$. If $y=1.1$ and $Z=N$, x^* is equal to the value that minimizes $||x-1.1||_2^2$

b)



4.8 Question 8

a) $\int_{-\infty}^{\infty} e^{-y} dy = -e^{-y}|_0^\infty = 1$

b) $E[Y] = \int_0^\infty ye^{-y} dy = e^{-y}(-y-1)|_0^\infty = 1$

c) $Var[Y] = \int_0^\infty (y-1)^2 dy = \frac{y^3}{3} - y^2 + y|_0^\infty =???$

d)
Sorry, I couldn't quite figure out question D or the end of question C.