

# Human Factored AI

(Predicting grad school admission AI program)

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# Empathize

While mentoring students who are interested in applying to US graduate school, I have got so many questions whether they can get accepted to this school with their score.



Can I get an admission from this school?



## Point of View (POV) (User, Need, Insight)

Of course, the graduate school admission is not solely decided by their GRE scores or GPA, but I got interested **what if I could help students to predict and give them some sense of which school they can try to apply or not from their test results?**

# Ideate / Prototype

## Data collection

1. I decided to focus on applying to **US school physics department application** at this time since I am a physics student, and I wanted to try out my test result that I used for my grad school application to check if the code makes sense.
2. I collected all students information gender, race, domestic/international, GRE test scores (Verbal, Quantitative, Writing, Physics), gpa from the physics graduate school application community (<https://physicsgre.com/viewtopic.php?f=3&t=145205>)
3. Based on their application results, I made an excel sheet with their test results and their application results(Admitted : 1, No-admission : 0) for each school that they applied.
4. I classified the rank of the schools from 1 to 5 based on the physics ranking from US news report. (<https://www.usnews.com/best-graduate-schools/top-science-schools/physics-rankings>) if the school is ranked between 1 - 20, I marked as “1” in the rank section, if 21-40, I marked as “2”.

After the data collection, I made a plan to use **keras tool in the tensorflow library** in python since I can make deep learning model easily with keras.

# Ideate / Prototype

## **Process to get to the final version**

1. Worked with pandas data frame by removing gender, race, international/domestic information so that I can only use columns GRE quantitative, GRE verbal, GRE writing, GRE physics, gpa, school rank ("xdata") as training data to train using deep learning model.
2. Created a deep learning model after making multiple nodes with Keras in the tensorflow.
3. Compiled the model
4. Trained the model 10000 times
5. Tested the model with my actual scores that I used for my application to verify if the result makes sense, and also tried some random scores to see the possibility of getting in to the school with a certain rank.

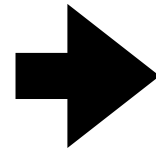
# Test

1. Worked with pandas data frame by removing gender, race, international/domestic information so that I can only use columns GRE quantitative, GRE verbal, GRE writing, GRE physics, gpa, school rank (“xdata”) as training data to train using deep learning model.

```
1 import pandas as pd #import pandas library to use excel file data
2 import matplotlib.pyplot as plt #import matplotlib to create a plot at the final.
3
4 df = pd.read_csv('physicsgrescore2019_rev.csv') #read student information and score information
5 df1 = df[['admit','gre_q','gre_v','gre_w','gre_phys','gpa','rank']]
6 #only extract information about 'admit','gre_q','gre_w','gre_phys','gpa','rank'
7 df1 = df1.dropna() #preprocessing just make sure to remove any row with null values.
8
9 print(df) #print df
10 print(df1) #print df1
```

df

	admit	gender	race	Domestic	gre_q	gre_v	gre_w	gre_phys	gpa	rank
0	0	M	Hispanic	Y	158	156	4.0	530.0	3.39	1
1	0	M	Hispanic	Y	158	156	4.0	530.0	3.39	2
2	1	M	Hispanic	Y	158	156	4.0	530.0	3.39	4
3	1	M	White	Y	165	155	4.0	680.0	3.92	2
4	0	M	White	Y	165	155	4.0	680.0	3.92	1
5	0	F	White	Y	166	162	4.5	610.0	3.44	1
6	1	F	White	Y	166	162	4.5	610.0	3.44	3
7	0	F	White	Y	167	163	5.0	640.0	3.30	1
8	1	F	White	Y	167	163	5.0	640.0	3.30	2
9	1	F	White	Y	167	163	5.0	640.0	3.30	2
10	1	M	Asian	N	167	157	3.0	880.0	3.70	3
11	0	M	Asian	N	167	157	3.0	880.0	3.70	2
12	0	M	Asian	N	167	157	3.0	880.0	3.70	1
13	1	F	Hispanic	Y	160	159	3.5	850.0	3.50	1
14	1	F	Hispanic	Y	160	159	3.5	850.0	3.50	2
15	0	M	Asian	N	170	159	4.5	990.0	3.30	1
16	1	M	Asian	N	170	159	4.5	990.0	3.30	2
17	0	M	White	Y	160	152	4.5	620.0	3.20	2



df1

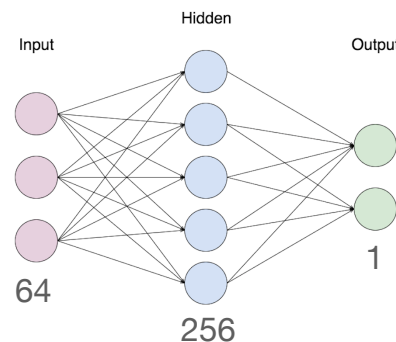
	admit	gre_q	gre_v	gre_w	gre_phys	gpa	rank
0	0	158	156	4.0	530.0	3.39	1
1	0	158	156	4.0	530.0	3.39	2
2	1	158	156	4.0	530.0	3.39	4
3	1	165	155	4.0	680.0	3.92	2
4	0	165	155	4.0	680.0	3.92	1
5	0	166	162	4.5	610.0	3.44	1
6	1	166	162	4.5	610.0	3.44	3
7	0	167	163	5.0	640.0	3.30	1
8	1	167	163	5.0	640.0	3.30	2
9	1	167	163	5.0	640.0	3.30	2
10	1	167	157	3.0	880.0	3.70	3
11	0	167	157	3.0	880.0	3.70	2
12	0	167	157	3.0	880.0	3.70	1
13	1	160	159	3.5	850.0	3.50	1
14	1	160	159	3.5	850.0	3.50	2
15	0	170	159	4.5	990.0	3.30	1
16	1	170	159	4.5	990.0	3.30	2
17	0	160	152	4.5	620.0	3.20	2

# Test

2. Created a deep learning model after making multiple nodes with Keras in the tensorflow,

```
1 ydata = df1['admit'].values #These are the answers for the training set.
2 xdata = [] #make blank list to append x_list later from the following for loop.
3
4 for i, rows in df1.iterrows(): #This is to make list in each row.
5     xdata.append([rows['gre_q'], rows['gre_v'], rows['gre_w'], rows['gre_phys'], rows['gpa'], rows['rank']])
6 #append each row information in xdata list
7 import numpy as np #import numpy library
8 import tensorflow as tf #import tensorflow library
9
10 model = tf.keras.models.Sequential([ Sequential provides training features
11     tf.keras.layers.Dense(64, activation='tanh'), #deep learning hidden layer with multiple node, first layer
12     # second parameter in Dense is activation, tanh is used.
13     tf.keras.layers.Dense(256, activation = 'tanh'), #number inside shows number of nodes.
14     tf.keras.layers.Dense(1, activation = 'sigmoid'), #Last node number should be 1, since we are predicting the
15     #sigmoid is a activation function that gives you probability value between 0 and 1
16 ]) #To create deep learning model
17 #keras is a tool in tensorflow, and we can easily make deep learning model.
```

Hyperbolic model: tanh  
(It is known that “tanh” is normally preferred and gives better result than sigmoid)



3. Compiled the model

```
1 model.compile(optimizer='adam', loss='binary_crossentropy', metrics = ['accuracy'])
2 #model will be completed after compiling. Therefore we need compile process.
3 #Adam optimization gets adaptive estimation of first-order and second-order moments.
4 #If you want to get the probability, the binary_crossentropy is the best option because it is from 0 to 1
```

# Test

## 4. Trained the model 10000 times

```
In [4]: 1 model.fit(np.array(xdata), np.array(ydata), epochs=10000)
        2 #This will process the deep learning process.
        3 #to train the model, xdata is training data, ydata is an answer. epoch is how many times you will train
        4 #to convert list to array, I used numpy .np, since this function only accepts numpy array
```

```
Epoch 9992/10000
2/2 [=====] - 0s 3ms/step - loss: 0.5992 - accuracy: 0.7018
Epoch 9993/10000
2/2 [=====] - 0s 5ms/step - loss: 0.6018 - accuracy: 0.6842
Epoch 9994/10000
2/2 [=====] - 0s 4ms/step - loss: 0.5945 - accuracy: 0.7018
Epoch 9995/10000
2/2 [=====] - 0s 3ms/step - loss: 0.5996 - accuracy: 0.7018
Epoch 9996/10000
2/2 [=====] - 0s 7ms/step - loss: 0.6091 - accuracy: 0.7018
Epoch 9997/10000
2/2 [=====] - 0s 5ms/step - loss: 0.5979 - accuracy: 0.7018
Epoch 9998/10000
2/2 [=====] - 0s 3ms/step - loss: 0.6075 - accuracy: 0.7018
Epoch 9999/10000
2/2 [=====] - 0s 3ms/step - loss: 0.6015 - accuracy: 0.7018
Epoch 10000/10000
2/2 [=====] - 0s 4ms/step - loss: 0.5986 - accuracy: 0.7018
```

```
Out[4]: <keras.callbacks.History at 0x7fde4e7adf40>
```

After training the model for 10000 times, the accuracy became 0.7018 for the prediction

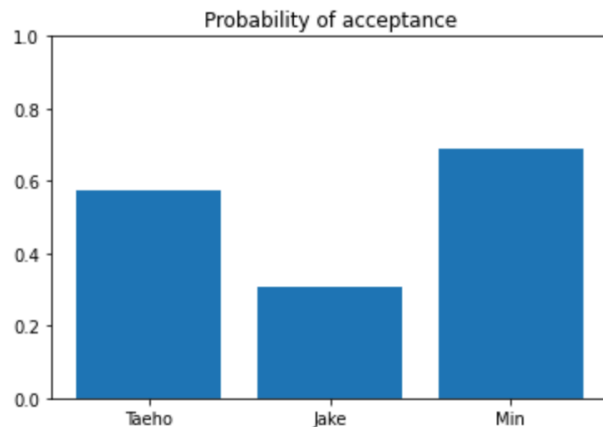
# Test

5. Tested the model with my actual scores that I used for my application to verify if the result makes sense, and also tried some random scores to see the possibility of getting in to the school with a certain rank.

```
In [7]: 1 #prediction
2
3 y = model.predict([[164, 149, 4.0, 830, 3.7, 3],[167, 143, 4.5, 700, 3.7, 1],[170, 167, 5.0, 990, 3.8, 1]])
4 print(y)
5
6 y_list = y.tolist()
7 y_list_new = [i[0] for i in y_list]
8 print(y_list_new)
9
10 students = ['Taeho', 'Jake', 'Min']
11 plt.ylim(bottom = 0, top=1)
12 plt.bar(students, y_list_new)
13 plt.title("Probability of acceptance")

[[0.5725241 ]
 [0.3054558 ]
 [0.68979716]]
[0.5725240707397461, 0.3054558038711548, 0.6897971630096436]
```

Out[7]: Text(0.5, 1.0, 'Probability of acceptance')



(Taeho)  
GRE Q : 164  
GRE V : 149  
GRE W: 4.0  
GRE Phy: 830  
GPA: 3.7  
Rank : 3  
Probability of  
getting accepted:  
57.2 %

(Jake)  
GRE Q : 167  
GRE V : 143  
GRE W: 4.5  
GRE Phy: 700  
GPA: 3.7  
Rank : 1  
Probability of  
getting accepted:  
30.5 %

(Min)  
GRE Q : 170  
GRE V : 167  
GRE W: 5.0  
GRE Phy: 990  
GPA: 3.8  
Rank : 1  
Probability of  
getting accepted:  
68.9 %

# Difficulties

Getting a right value for the number of nodes was challenging to get the most reasonable result. I tried several values by actually changing the number of nodes and the number of training (number of epoch)

# Conclusions

- By following the human-centered design principles, I was able to **design and develop an AI model to predict the probability of getting accepted to the school** within the certain rank with my current GRE test scores and GPA using deep learning technique with Keras in the tensorflow library.
- Even though graduate school application is not only determined by the test scores, I expect that this will help students who are trying to apply for us physics graduate school. This code will give students some sense of whether they can get admission from the school.
- Accuracy will be improved if I could increase the number of the data sets by collecting more data from the website.
- I learned that a lot of different factors affect to the result (the number of nodes, the number of training (epoch), the model for compiling), and we are the one who has to decide which one to use to optimize the result.

# Privacy / Ethical considerations

- To get rid of bias issues, I did not include gender or nationality data into the AI system.
- I explained what type of data were collected, and how those are used using the quotation mark to make it clear for the privacy issues.