15장. 다중 회귀 분석 과제

In [1]:

```
!pip install seaborn
```

```
Requirement already satisfied: seaborn in c:₩users₩이준용₩.conda₩envs₩data_mining
₩lib₩site-packages (0.11.0)
Requirement already satisfied: matplotlib>=2.2 in c:₩users₩이준용₩.conda₩envs₩dat
a_mining₩lib₩site-packages (from seaborn) (3.3.2)
Requirement already satisfied: scipy>=1.0 in c:₩users₩이준용₩.conda₩envs₩data_min
ing₩lib₩site-packages (from seaborn) (1.5.2)
Requirement already satisfied: pandas>=0.23 in c:₩users₩이준용₩.conda₩envs₩data_m
ining₩lib₩site-packages (from seaborn) (1.1.3)
Requirement already satisfied: numpy>=1.15 in c:₩users₩이준용₩.conda₩envs₩data_mi
ning₩lib₩site-packages (from seaborn) (1.19.2)
Requirement already satisfied: kiwisolver>=1.0.1 in c:₩users₩이준용₩.conda₩envs₩d
ata_mining₩lib₩site-packages (from matplotlib>=2.2->seaborn) (1.3.0)
Requirement already satisfied: certifi>=2020.06.20 in c:₩users₩이준용₩.conda₩envs
₩data_mining₩lib₩site-packages (from matplotlib>=2.2->seaborn) (2020.6.20)
Requirement already satisfied: python-dateutil>=2.1 in c:₩users₩이준용₩.conda₩env
s₩data_mining₩lib₩site-packages (from matplotlib>=2.2->seaborn) (2.8.1)
Requirement already satisfied: cycler>=0.10 in c:₩users₩이준용₩.conda₩envs₩data_m
ining₩lib₩site-packages (from matplotlib>=2.2->seaborn) (0.10.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.3 in c:₩use
```

1. 데이터셋

1.1 데이터셋 읽기 (Graduate Admission)

- 특징 : GRE Scores, TOEFL, CGPA, SOP Rating, LOR Rating, Research Papers, University Ratings
- 타겟 : Chance of Admit (대학원 입학 허가 확률)
- https://www.kaggle.com/mohansacharya/graduate-admissions (https://www.kaggle.com/mohansacharya/graduate-admissions)

In [2]:

```
import os
import pandas as pd

path1 = os.path.join('data', 'Admission_Predict_Ver1.1.csv')
path2 = os.path.join('data', 'Admission_Predict.csv')

data1 = pd.read_csv(path1)
data2 = pd.read_csv(path2)

dataset = pd.concat([data1, data2])

dataset.sample(5)
```

Out[2]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
217	218	321	109	4	4.0	4.0	9.13	1	0.85
215	216	330	116	5	5.0	4.5	9.36	1	0.93
362	363	338	115	5	4.5	5.0	9.23	1	0.91
122	123	310	106	4	1.5	2.5	8.36	0	0.57
211	212	328	110	4	5.0	4.0	9.14	1	0.82

1.2 Series No 컬럼 삭제 (Q1)

샘플마다 유일하게 존재하는 ID 역할을 하는 컬럼은 학습에 방해가 되므로 삭제하시오.

In [3]:

```
dataset = dataset.drop('Serial No.', axis=1)
dataset.sample(5)  # 과제 제출시 지우기
```

Out[3]:

	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
27	298	98	2	1.5	2.5	7.50	1	0.44
439	312	105	2	1.5	3.0	8.46	0	0.66
370	310	103	2	2.5	2.5	8.24	0	0.72
259	331	119	4	5.0	4.5	9.34	1	0.90
196	306	105	2	3.0	2.5	8.26	0	0.73

2. 데이터 탐색

2.1 요약 통계량

In [4]:

```
dataset.describe()
```

Out[4]:

	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Ch
count	900.000000	900.000000	900.000000	900.000000	900.00000	900.000000	900.000000	900
mean	316.621111	107.288889	3.102222	3.385556	3.47000	8.586433	0.554444	0
std	11.369700	6.073968	1.143048	0.997612	0.91319	0.600822	0.497303	0
min	290.000000	92.000000	1.000000	1.000000	1.00000	6.800000	0.000000	0
25%	308.000000	103.000000	2.000000	2.500000	3.00000	8.140000	0.000000	0
50%	317.000000	107.000000	3.000000	3.500000	3.50000	8.570000	1.000000	0
75%	325.000000	112.000000	4.000000	4.000000	4.00000	9.052500	1.000000	0
max	340.000000	120.000000	5.000000	5.000000	5.00000	9.920000	1.000000	0

2.2 누락 데이터 확인

In [5]:

```
dataset.isnull().sum()
```

Out[5]:

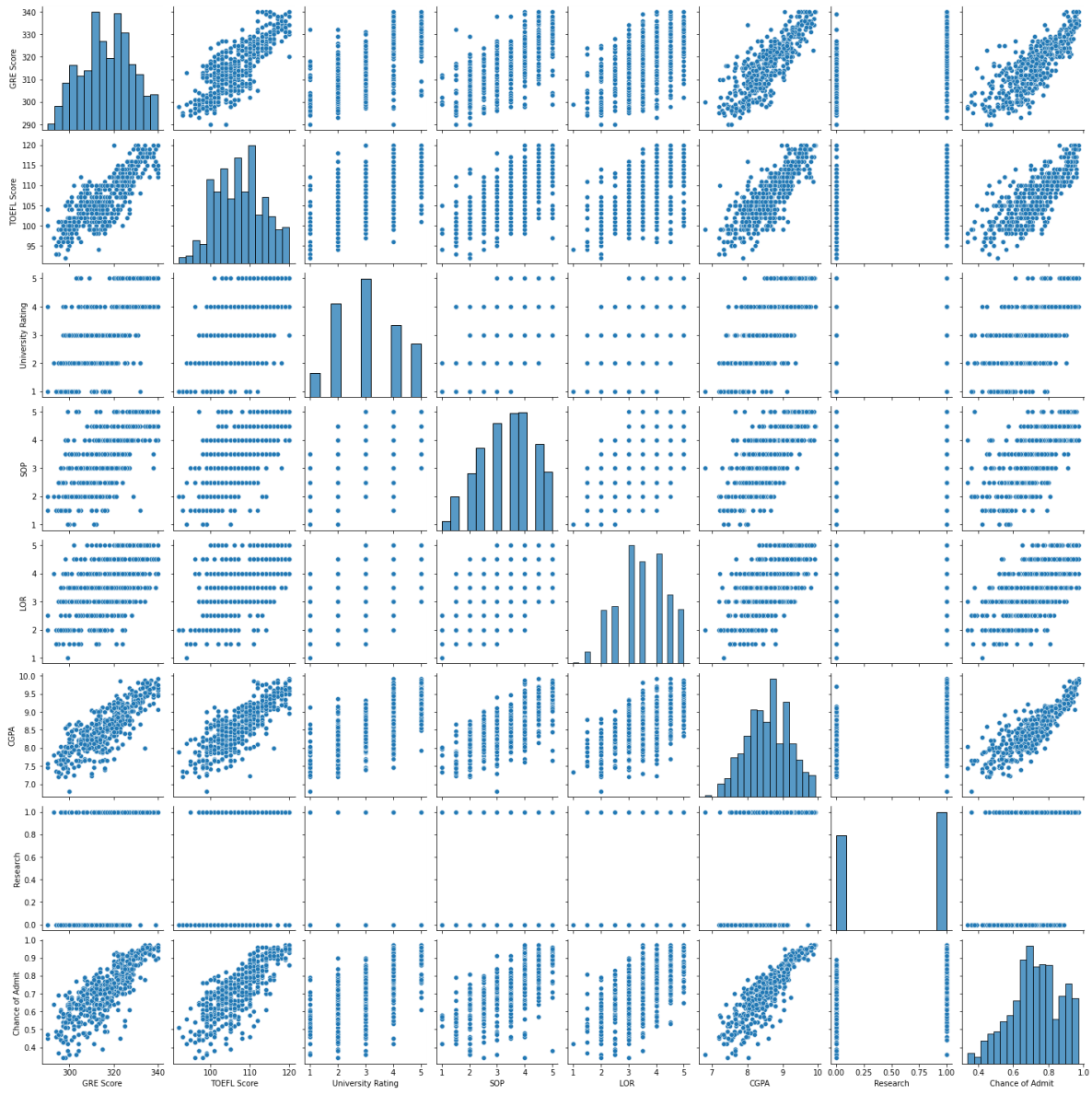
```
GRE Score            0
TOEFL Score          0
University Rating    0
SOP                  0
LOR                  0
CGPA                 0
Research             0
Chance of Admit      0
dtype: int64
```

2.3 산포도 행렬

- 행렬의 대각 방향 : 히스토그램
- 행렬의 나머지 셀 : 두 변수 간의 상관성 분석을 위한 산포도

In [6]:

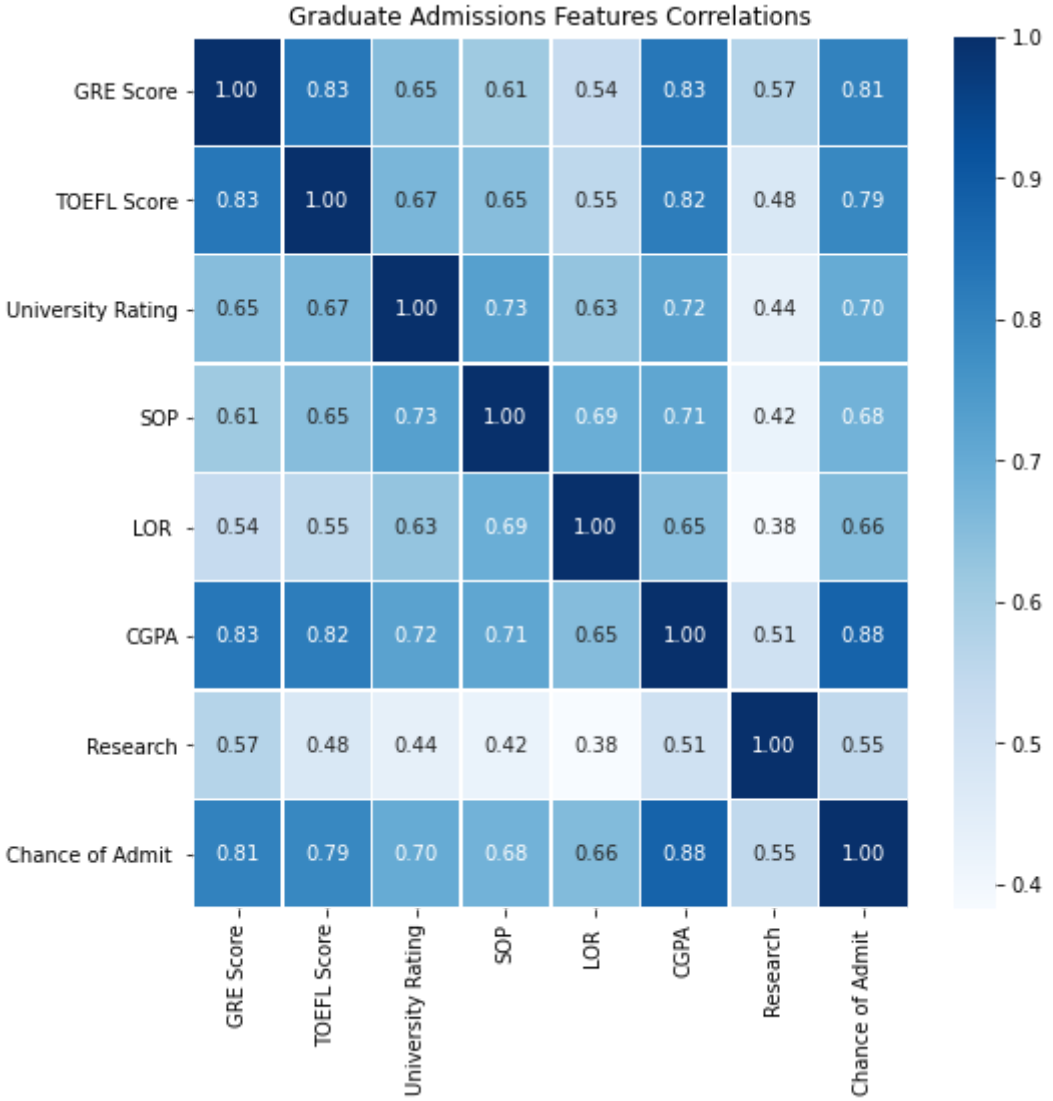
```
import seaborn as sns
import matplotlib.pyplot as plt
sns.pairplot(dataset)
plt.show()
```



2.4 히트맵

In [7]:

```
fig, ax = plt.subplots(figsize=(8, 8))
sns.heatmap(dataset.corr(), linewidths=.5, annot=True, fmt=".2f", cmap='Blues')
plt.title('Graduate Admissions Features Correlations')
plt.show()
```



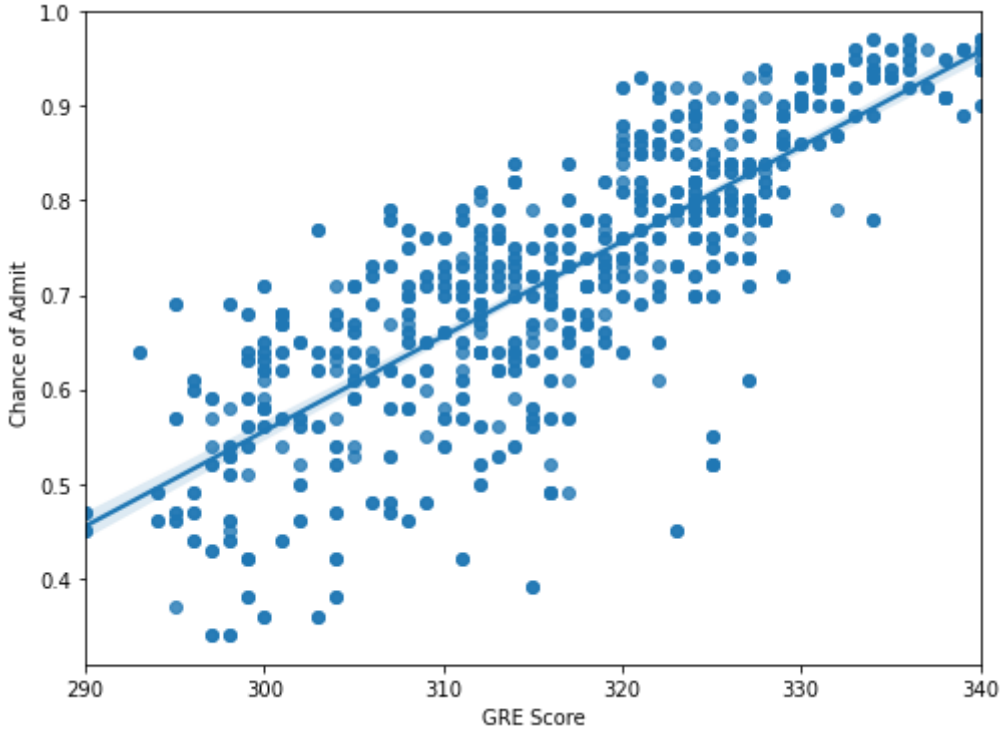
2.5 산포도와 단순 회귀선

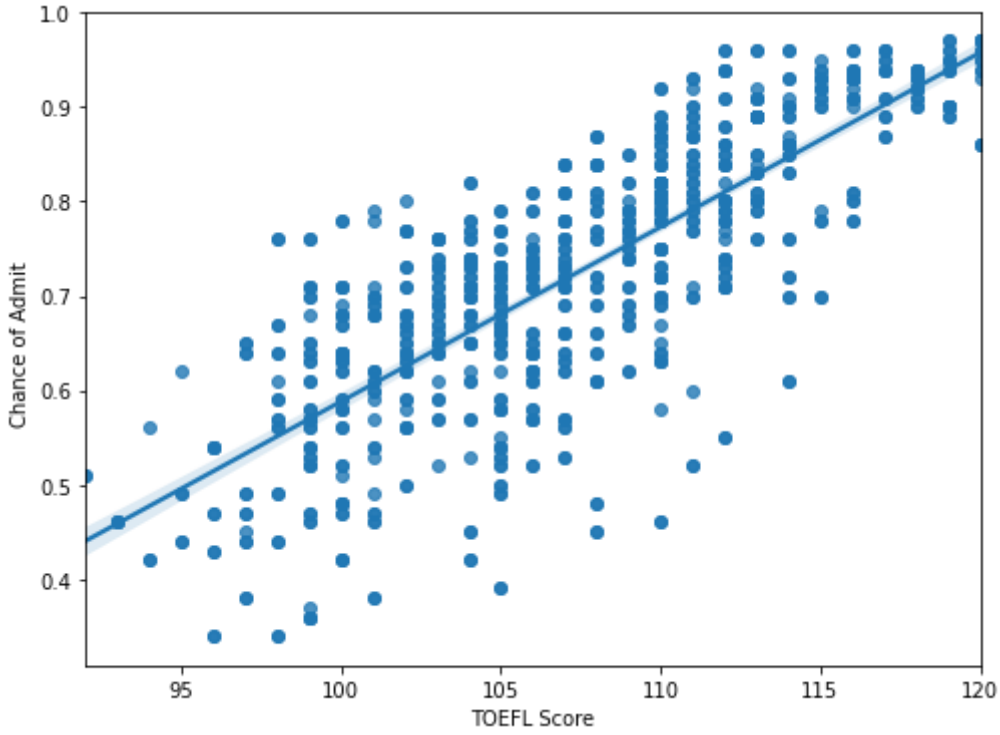
In [8]:

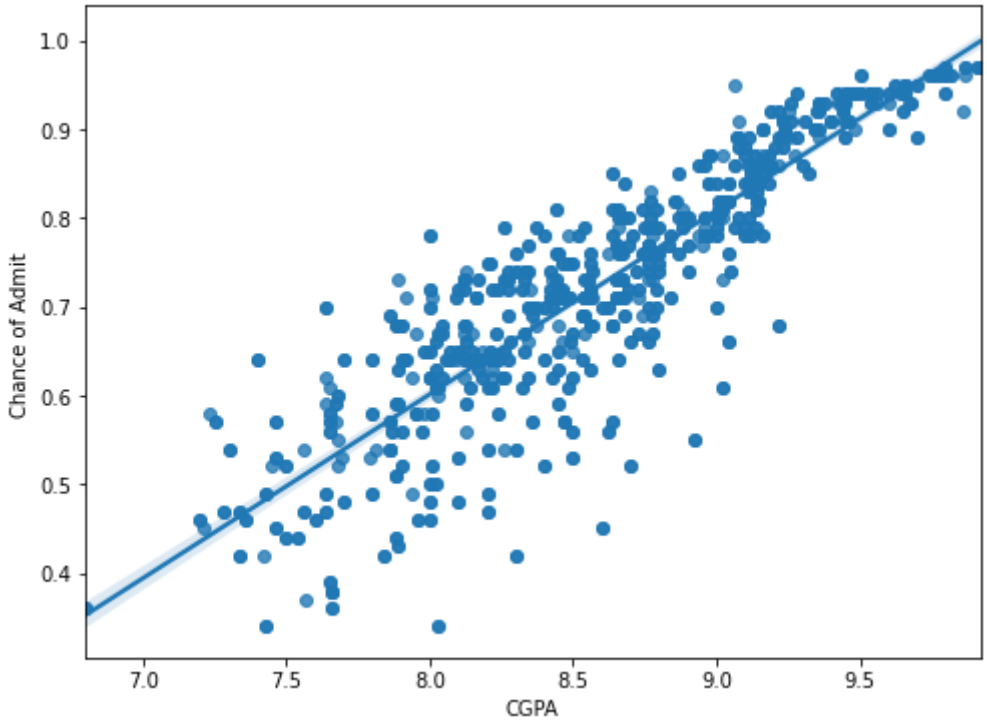
```
plt.subplots(figsize=(8,6))
sns.regplot(x="GRE Score", y="Chance of Admit ", data=dataset)
plt.subplots(figsize=(8,6))
sns.regplot(x="TOEFL Score", y="Chance of Admit ", data=dataset)
plt.subplots(figsize=(8,6))
sns.regplot(x="CGPA", y="Chance of Admit ", data=dataset)
```

Out[8]:

```
<AxesSubplot:xlabel='CGPA', ylabel='Chance of Admit '>
```




Chance of Admit
TOEFL Score
1.0
0.9
0.8
0.7
0.6
0.5
0.4
95
100
105
110
115
120


Chance of Admit
CGPA
1.0
0.9
0.8
0.7
0.6
0.5
0.4
7.0
7.5
8.0
8.5
9.0
9.5

3. 데이터 전처리

3.1 입력 및 타겟 데이터 추출

In [9]:

```
X = dataset.iloc[:,:-1].values
y = dataset.iloc[:,-1].values # Chance of Admit
```

입력 데이터에 상수 항에 대한 입력 1 추가

In [10]:

```
X = [[1.0] + list(row[:]) for row in X]
```

3.2 데이터셋 분리

In [11]:

```
import random
from scratch.machine_learning import train_test_split

random.seed(12)
X_train, X_test, y_train, y_test = train_test_split(X, y, 0.25)
print('train dataset :', len(X_train))
print('test dataset :', len(X_test))
```

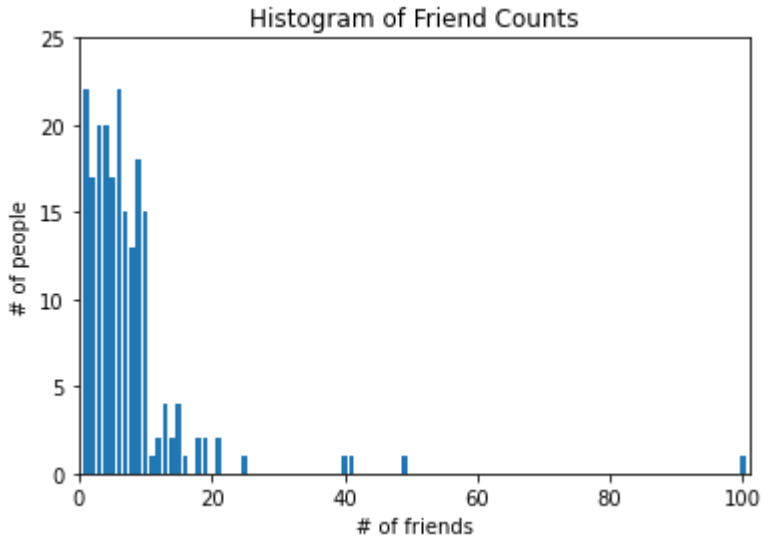
```
train dataset : 675
test dataset : 225
```

3.3 데이터 표준화 (Q2)

훈련 데이터의 평균과 표준 편차로 테스트 데이터를 표준화 하도록 normalization() 함수를 작성해 보시오.

In [12]:

```
# from __future__ import annotations  # 질의 응답에서 '과제5 질문'이라는 제목의
# 게시물에서 똑같은 오류 발생하여
# 아래와 같이 대입하였으나
# NameError: name 'Vector' is not defined
# 발생하여 python 3.10 부터  Postponed evaluation of annotations 가능하기때문에
# 위와같이 대입함
from __future__ import annotations
from typing import List
from scratch.working_with_data import scale
from scratch.linear_algebra import vector_mean
from scratch.statistics import standard_deviation
def normalization(data: List[Vector],
                  means : Vector = None,
                  stdevs : Vector = None) -> List[Vector]:

    dim = len(data[0])
#     means = vector_mean(data)
#     stdevs = [standard_deviation([vector[i] for vector in data])
#                     for i in range(dim)]

    means, stdevs = scale(data)

    rescaled = [v[:] for v in data]

    for v in rescaled:
        for i in range(dim):
            if stdevs[i] > 0:
                v[i] = (v[i] - means[i]) / stdevs[i]


    return rescaled, means, stdevs
# 결과에 추가되는 Histogram of Friend Counts는 왜 나오는지 모르겠습니다,..
```



In [13]:

```
X_train_normed, X_train_means, X_train_stdevs = normalization(X_train)
X_test_normed, _, _  = normalization(X_test, X_train_means, X_train_stdevs)
```

4. 선형 회귀 분석 (Linear Regression)

4.1 예측 (Q3)

모델 예측 코드를 작성해 보시오.

In [14]:

```
from scratch.linear_algebra import dot, Vector
def predict(x: Vector, beta: Vector) -> float:

    return dot(x, beta)
```

4.2 손실 함수 (Q4)

손실 함수와 그래디언트를 작성해 보시오.

In [15]:

```
from typing import List
def error(x: Vector, y: float, beta: Vector) -> float:
    return predict(x, beta) - y

def squared_error(x: Vector, y: float, beta: Vector) -> float:
    return error(x, y, beta) ** 2

def sqerror_gradient(x: Vector, y: float, beta: Vector) -> Vector:
    err = error(x, y, beta)
    return [2 * err * x_i for x_i in x]
```

4.3 모델 훈련 (Q5)

최소 자승법

선형 회귀의 최소 자승법을 경사 하강법으로 구현하시오.

In [16]:

```
import random
import tqdm
from scratch.linear_algebra import vector_mean
from scratch.gradient_descent import gradient_step
def least_squares_fit(xs: List[Vector],
                      ys: List[float],
                      learning_rate: float = 0.001,
                      num_steps: int = 1000,
                      batch_size: int = 1) -> Vector:


    guess = [random.random() for _ in xs[0]]

    for _ in tqdm.trange(num_steps, desc="least squares fit"):
        for start in range(0, len(xs), batch_size):
            batch_xs = xs[start:start+batch_size]
            batch_ys = ys[start:start+batch_size]
            gradient = vector_mean([sqerror_gradient(x, y, guess)
                                    for x, y in zip(batch_xs, batch_ys)])

            guess = gradient_step(guess, gradient, -learning_rate)
    return guess
```

In [17]:

```
learning_rate = 0.001

beta = least_squares_fit(X_train_normed, y_train, learning_rate, 5000, 50)
```

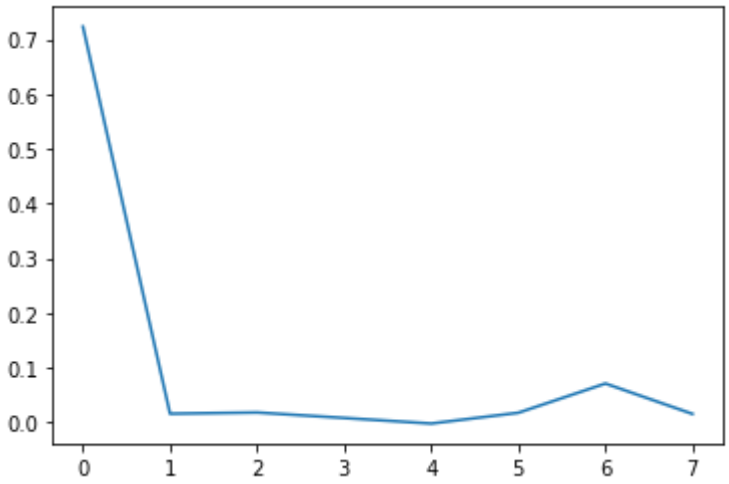
```
least squares fit: 100%|████████████████████████████████████████████████████████████|
5000/5000 [00:36<00:00, 135.36it/s]
```

β 확인

In [18]:

```
print("beta = ", beta)
plt.plot(beta)
plt.show()
```

```
beta =  [0.7230369263767936, 0.01589118373524194, 0.018101419703239086, 0.0081133607
37764688, -0.002073350176785202, 0.017606264994132734, 0.0710238708099809, 0.0155116
99194081541]
```



4.4 모델 테스트 (Q6)

테스트 데이터를 이용해서 예측을 해보고 SSE를 계산해 보시오.

In [19]:

```
import numpy as np
from scratch.working_with_data import rescale
from scratch.multiple_regression import predict
def test(xs: List[Vector], ys: List[float], beta : Vector) -> float:


    rescaled_xs = rescale(xs)
    pred_y = [predict(x_i, beta) for x_i in rescaled_xs]
    SSE = np.mean(np.sqrt(pred_y))

    return pred_y, SSE
```

In [20]:

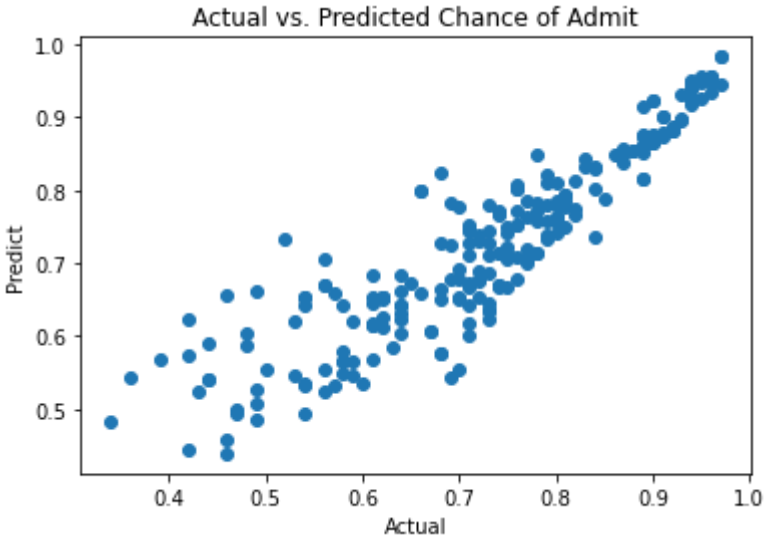
```
pred_y, SSE = test(X_test_normed, y_test, beta)
print("SSE = ", SSE)
```

```
SSE =  0.8470073638769235
```

실제 값과 예측 값의 상관 관계

In [21]:

```
plt.scatter(y_test, pred_y)
plt.title("Actual vs. Predicted Chance of Admit")
plt.xlabel("Actual")
plt.ylabel("Predict")
plt.show()
```



4.5 모델 적합도 (goodness-of-fit)

결정계수

In [22]:

```
from scratch.simple_linear_regression import total_sum_of_squares

def multiple_r_squared(xs: List[Vector], ys: Vector, beta: Vector) -> float:
    sum_of_squared_errors = sum(error(x, y, beta) ** 2
                                for x, y in zip(xs, ys))

    return 1.0 - sum_of_squared_errors / total_sum_of_squares(ys)
```

In [23]:

```
r_squared = multiple_r_squared(X_test_normed, y_test, beta)
print(r_squared)
```

0.8165357651185116

In [ ]:

```

```