Multivariate regression Closed form

In [ ]:

```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
main_df = pd.read_csv("insurance.csv")




#Use scikit learn
# column_to_label_encode = normalized_df["sex"]
# column_to_label_encode.head()

# label_encoder = LabelEncoder()
# label_encoded_column = label_encoder.fit_transform(column_to_label_encode)
# label_encoded_column
```

Data Description

In [ ]:

```python
main_df.head()
```

Out[ ]:

	age	sex	bmi	children	smoker	region	charges
0	19	female	27.900	0	yes	southwest	16884.92400
1	18	male	33.770	1	no	southeast	1725.55230
2	28	male	33.000	3	no	southeast	4449.46200
3	33	male	22.705	0	no	northwest	21984.47061
4	32	male	28.880	0	no	northwest	3866.85520

In [ ]:

```python
main_df.describe()
```

Out[ ]:

	age	bmi	children	charges
count	1338.000000	1338.000000	1338.000000	1338.000000
mean	39.207025	30.663397	1.094918	13270.422265
std	14.049960	6.098187	1.205493	12110.011237
min	18.000000	15.960000	0.000000	1121.873900
25%	27.000000	26.296250	0.000000	4740.287150
50%	39.000000	30.400000	1.000000	9382.033000
75%	51.000000	34.693750	2.000000	16639.912515
max	64.000000	53.130000	5.000000	63770.428010

Checking for missing values

In [ ]:
```
main_df.isna().sum()
```

Out[ ]:
```
age         0
sex         0
bmi         0
children    0
smoker      0
region      0
charges     0
dtype: int64
```

One hot encoding

In [ ]:
```
column_names_to_one_hot = ["sex", "smoker", "region"]
```

In [ ]:
```
main_df = pd.get_dummies(main_df, columns=column_names_to_one_hot)
```

In [ ]:
```
main_df.loc[:20,:]
```

Out[ ]:

	age	bmi	children	charges	sex_female	sex_male	smoker_no	smoker_yes	re
0	19	27.900	0	16884.92400	1	0	0	1	
1	18	33.770	1	1725.55230	0	1	1	0	
2	28	33.000	3	4449.46200	0	1	1	0	
3	33	22.705	0	21984.47061	0	1	1	0	
4	32	28.880	0	3866.85520	0	1	1	0	
5	31	25.740	0	3756.62160	1	0	1	0	
6	46	33.440	1	8240.58960	1	0	1	0	
7	37	27.740	3	7281.50560	1	0	1	0	
8	37	29.830	2	6406.41070	0	1	1	0	
9	60	25.840	0	28923.13692	1	0	1	0	
10	25	26.220	0	2721.32080	0	1	1	0	
11	62	26.290	0	27808.72510	1	0	0	1	
12	23	34.400	0	1826.84300	0	1	1	0	
13	56	39.820	0	11090.71780	1	0	1	0	
14	27	42.130	0	39611.75770	0	1	0	1	
15	19	24.600	1	1837.23700	0	1	1	0	
16	52	30.780	1	10797.33620	1	0	1	0	
17	23	23.845	0	2395.17155	0	1	1	0	
18	56	40.300	0	10602.38500	0	1	1	0	
19	30	35.300	0	36837.46700	0	1	0	1	
20	60	36.005	0	13228.84695	1	0	1	0	

In [ ]:
```
main_df.columns
```

```
Out[ ]: Index(['age', 'bmi', 'children', 'charges', 'sex_female', 'sex_male',
               'smoker_no', 'smoker_yes', 'region_northeast', 'region_northwest',
               'region_southeast', 'region_southwest'],
              dtype='object')
```

Checking for duplicate rows

```
In [ ]: main_df.index[main_df.duplicated()]
        main_df.duplicated().sum()
```

```
Out[ ]: 1
```

```
In [ ]: main_df.drop(axis="rows", labels=main_df.index[main_df.duplicated()], inplac
```

```
In [ ]: main_df.duplicated().sum()
```

```
Out[ ]: 0
```

Normalization

```
In [ ]: normalized_df=(main_df-main_df.min())/(main_df.max()-main_df.min())
```

```
In [ ]: normalized_df =  (main_df-main_df.min())/(main_df.max()-main_df.min())
        np.random.shuffle(normalized_df.values)
```

```
In [ ]: X = normalized_df.drop(axis="columns", labels="charges").to_numpy().astype(n
        y = normalized_df["charges"].to_numpy().astype(np.float64)
        ones = np.ones([X.shape[0],1])
        X = np.concatenate((ones,X),axis=1)
```

```
In [ ]: len(X)
```

```
Out[ ]: 1337
```

```
In [ ]: len(y)
```

```
Out[ ]: 1337
```

Train test split

```
In [ ]: train_num = int(1337*.8)
```

```
In [ ]: train_X,test_X = X[train_num:], X[:train_num]
        train_y, test_y = y[train_num:], y[:train_num]
```

```
In [ ]: train_X
```

Out[ ]:

```
array([[1.        , 0.45652174, 0.44498251, ..., 0.        , 0.        ,
        1.        ],
       [1.        , 0.60869565, 0.3992467 , ..., 0.        , 0.        ,
        1.        ],
       [1.        , 0.82608696, 0.43960183, ..., 0.        , 0.        ,
        0.        ],
       ...,
       [1.        , 0.36956522, 0.34813021, ..., 0.        , 0.        ,
        1.        ],
       [1.        , 0.76086957, 0.4881625 , ..., 0.        , 0.        ,
        0.        ],
       [1.        , 0.82608696, 0.26836158, ..., 0.        , 0.        ,
        0.        ]])
```

In [ ]:

In [ ]:

```
# train_X, test_X, train_y, test_y = train_test_split(X, y, train_size=0.6)
```

In [ ]:

```
train_X
```

Out[ ]:

```
array([[1.        , 0.45652174, 0.44498251, ..., 0.        , 0.        ,
        1.        ],
       [1.        , 0.60869565, 0.3992467 , ..., 0.        , 0.        ,
        1.        ],
       [1.        , 0.82608696, 0.43960183, ..., 0.        , 0.        ,
        0.        ],
       ...,
       [1.        , 0.36956522, 0.34813021, ..., 0.        , 0.        ,
        1.        ],
       [1.        , 0.76086957, 0.4881625 , ..., 0.        , 0.        ,
        0.        ],
       [1.        , 0.82608696, 0.26836158, ..., 0.        , 0.        ,
        0.        ]])
```

Closed form solution

In [ ]:

```
coeffs = np.linalg.pinv(train_X.transpose().dot(train_X)).dot(train_X.transp
```

In [ ]:

```
def predict(X):
    preds = np.dot(X, coeffs)

    return preds
```

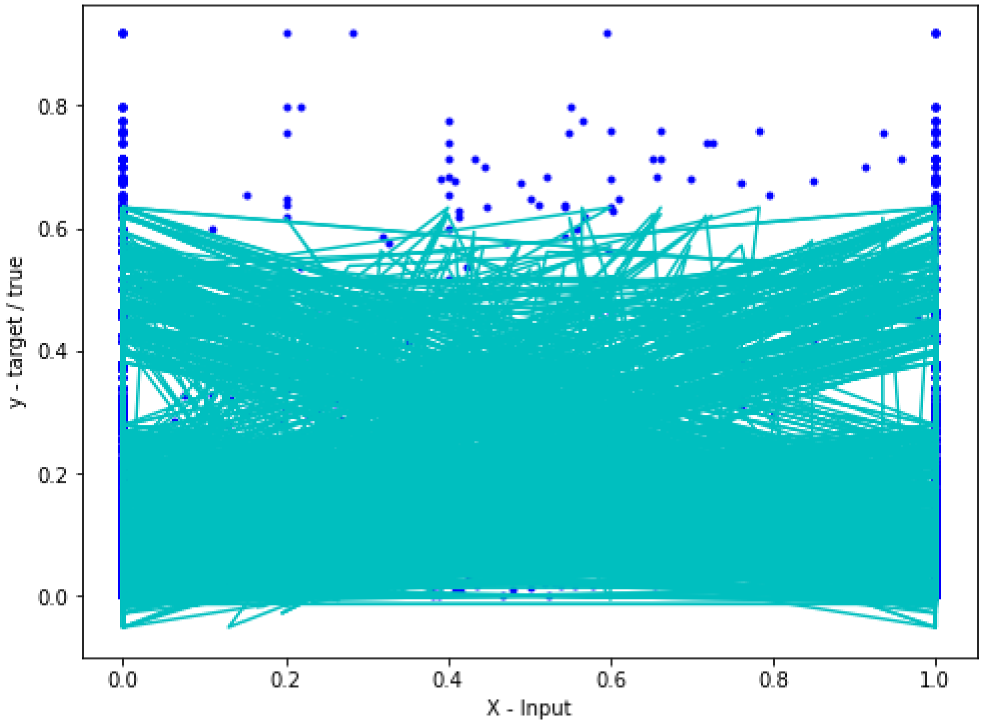
Graph

In [ ]:

```
preds = predict(train_X)
# Plotting the predictions.
fig = plt.figure(figsize=(8,6))
plt.plot(train_X, train_y, 'b.')
plt.plot(train_X, preds, 'c-')
plt.xlabel('X - Input')
plt.ylabel('y - target / true')
```

Out[ ]:

```
Text(0, 0.5, 'y - target / true')
```



MSE

In [ ]:

```
((test_y-(test_X).dot(coeffs)).transpose()).dot(test_y-(test_X).dot(coeffs))
```

Out[ ]:

```
0.00987537630438524
```