ML0101EN-Reg-Polynomial-Regression-Co2-py-v1

August 7, 2019

Polynomial Regression

About this Notebook

In this notebook, we learn how to use scikit-learn for Polynomial regression. We download a dataset that is related to fuel consumption and Carbon dioxide emission of cars. Then, we split our data into training and test sets, create a model using training set, evaluate our model using test set, and finally use model to predict unknown value.

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0.0.1 Importing Needed packages

[4]:
```
import matplotlib.pyplot as plt
import pandas as pd
import pylab as pl
import numpy as np
%matplotlib inline
```

Downloading Data

To download the data, we will use !wget to download it from IBM Object Storage.

[5]:
```
!wget -O FuelConsumption.csv https://s3-api.us-geo.objectstorage.softlayer.net/cf-courses-data/
↪CognitiveClass/ML0101ENv3/labs/FuelConsumptionCo2.csv
```

```
--2019-08-07 05:07:24--  https://s3-api.us-geo.objectstorage.softlayer.net/cf-
courses-data/CognitiveClass/ML0101ENv3/labs/FuelConsumptionCo2.csv
Resolving s3-api.us-geo.objectstorage.softlayer.net (s3-api.us-
geo.objectstorage.softlayer.net)... 67.228.254.193
Connecting to s3-api.us-geo.objectstorage.softlayer.net (s3-api.us-
geo.objectstorage.softlayer.net)|67.228.254.193|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 72629 (71K) [text/csv]
Saving to: FuelConsumption.csv
```

FuelConsumption.csv 100%[==========>] 70.93K --.-KB/s in 0.04s

2019-08-07 05:07:24 (1.62 MB/s) - FuelConsumption.csv saved [72629/72629]

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0.1 Understanding the Data

0.1.1 FuelConsumption.csv:

We have downloaded a fuel consumption dataset, FuelConsumption.csv, which contains model-specific fuel consumption ratings and estimated carbon dioxide emissions for new light-duty vehicles for retail sale in Canada. Dataset source

- **MODELYEAR** e.g. 2014
- **MAKE** e.g. Acura
- **MODEL** e.g. ILX
- **VEHICLE CLASS** e.g. SUV
- **ENGINE SIZE** e.g. 4.7
- **CYLINDERS** e.g 6
- **TRANSMISSION** e.g. A6
- **FUEL CONSUMPTION in CITY(L/100 km)** e.g. 9.9
- **FUEL CONSUMPTION in HWY (L/100 km)** e.g. 8.9
- **FUEL CONSUMPTION COMB (L/100 km)** e.g. 9.2
- **CO2 EMISSIONS (g/km)** e.g. 182 –> low –> 0

0.2 Reading the data in

[6]:
```
df = pd.read_csv("FuelConsumption.csv")

# take a look at the dataset
df.head()
```

[6]:

	MODELYEAR	MAKE	MODEL	VEHICLECLASS	ENGINESIZE	CYLINDERS
0	2014	ACURA	ILX	COMPACT	2.0	4
1	2014	ACURA	ILX	COMPACT	2.4	4
2	2014	ACURA	ILX HYBRID	COMPACT	1.5	4
3	2014	ACURA	MDX 4WD	SUV - SMALL	3.5	6
4	2014	ACURA	RDX AWD	SUV - SMALL	3.5	6

	TRANSMISSION	FUELTYPE	FUELCONSUMPTION_CITY	FUELCONSUMPTION_HWY
0	AS5	Z	9.9	6.7
1	M6	Z	11.2	7.7
2	AV7	Z	6.0	5.8

3	AS6	Z	12.7	9.1
4	AS6	Z	12.1	8.7

	FUELCONSUMPTION_COMB	FUELCONSUMPTION_COMB_MPG	CO2EMISSIONS
0	8.5	33	196
1	9.6	29	221
2	5.9	48	136
3	11.1	25	255
4	10.6	27	244

Lets select some features that we want to use for regression.

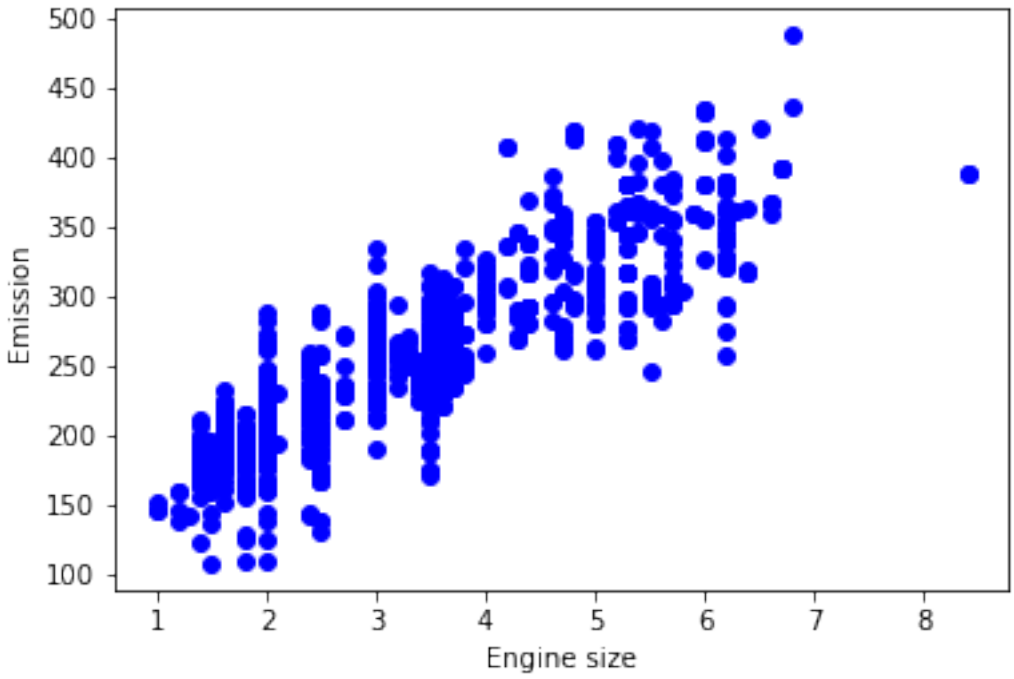
[7]:
```
cdf = df[['ENGINESIZE','CYLINDERS','FUELCONSUMPTION_COMB','CO2EMISSIONS']]
cdf.head(9)
```

[7]:

	ENGINESIZE	CYLINDERS	FUELCONSUMPTION_COMB	CO2EMISSIONS
0	2.0	4	8.5	196
1	2.4	4	9.6	221
2	1.5	4	5.9	136
3	3.5	6	11.1	255
4	3.5	6	10.6	244
5	3.5	6	10.0	230
6	3.5	6	10.1	232
7	3.7	6	11.1	255
8	3.7	6	11.6	267

Lets plot Emission values with respect to Engine size:

[8]:
```
plt.scatter(cdf.ENGINESIZE, cdf.CO2EMISSIONS,  color='blue')
plt.xlabel("Engine size")
plt.ylabel("Emission")
plt.show()
```



Creating train and test dataset Train/Test Split involves splitting the dataset into training and testing sets respectively, which are mutually exclusive. After which, you train with the training set and test with the testing set.

[9]:
```
msk = np.random.rand(len(df)) < 0.8
train = cdf[msk]
test = cdf[~msk]
```

Polynomial regression

Sometimes, the trend of data is not really linear, and looks curvy. In this case we can use Polynomial regression methods. In fact, many different regressions exist that can be used to fit whatever the dataset looks like, such as quadratic, cubic, and so on, and it can go on and on to infinite degrees.

In essence, we can call all of these, polynomial regression, where the relationship between the independent variable x and the dependent variable y is modeled as an nth degree polynomial in x. Lets say you want to have a polynomial regression (let's make 2 degree polynomial):

$y = b + \theta_1 x + \theta_2 x^2$

Now, the question is: how we can fit our data on this equation while we have only x values, such as **Engine Size**? Well, we can create a few additional features: 1, x, and x^2.

PloynomialFeatures() function in Scikit-learn library, drives a new feature sets from the original feature set. That is, a matrix will be generated consisting of all polynomial combinations of the features with degree less than or equal to the specified degree. For example, lets say the original feature set has only one feature, *ENGINESIZE*. Now, if we select the degree of the polynomial to be 2, then it generates 3 features, degree=0, degree=1 and degree=2: