regression

November 8, 2022

Aim: Program to implement linear and multiple regression techniques using any standard dataset available in the public domain and evaluate its performance.

Short notes:

Linear regression assumes a linear relationship between the input variable (X) and a single output variable (Y). When there is a single input variable, the method is referred to as a simple linear regression.

In a simple linear regression, we can estimate the coefficients required by the model to make predictions on new data analytically. That is, the line for a simple linear regression model can be written as:

y = B0 + B1 * x +

where B0 and B1 are the coefficients we must estimate from the training data and is an error term. Once the coefficients are estimated, we can use this equation to predict output values for y conditional on new input examples of x. We use LinearRegression() from sklearn.linear_model.

Multiple Linear Regression: When one variable/column in a dataset is not sufficient to create a good model and make more accurate predictions, we'll use a multiple linear regression model instead of a simple linear regression model. The line equation for the multiple linear regression model is:

y = 0 + 1X1 + 2X2 + 3X3 + …. + pXp + e

We use datasets.load_diabetes dataset for this program.

About the dataset.

The diabetes dataset consists of 10 physiological variables (such as age, sex, weight, blood pressure) measure on 442 patients, and an indication of disease progression after one year. Note that the input variables have all been standardised to each have mean 0 and squared length = 1.

[316]:

```
import matplotlib.pyplot as plt
import numpy as np
from sklearn import datasets, linear_model
from sklearn.metrics import mean_squared_error, r2_score
```

[317]:

```
df = datasets.load_diabetes()
df['feature_names']
```

[317]:

```
['age', 'sex', 'bmi', 'bp', 's1', 's2', 's3', 's4', 's5', 's6']
```

[318]:
```python
# Load the diabetes dataset
diabetes_X, diabetes_y = datasets.load_diabetes(return_X_y=True)
diabetes_X.shape
```

[318]: (442, 10)

[319]:
```python
diabetes_y.shape
```

[319]: (442,)

[320]:
```python
# Use only one feature
diabetes_X = diabetes_X[:, np.newaxis, 2]
diabetes_X.shape
```

[320]: (442, 1)

[321]:
```python
# Split the data into training/testing sets
diabetes_X_train = diabetes_X[:-20]
diabetes_X_test = diabetes_X[-20:]

# Split the targets into training/testing sets
diabetes_y_train = diabetes_y[:-20]
diabetes_y_test = diabetes_y[-20:]
```

[322]:
```python
# Create linear regression object
regr = linear_model.LinearRegression()

# Train the model using the training sets
regr.fit(diabetes_X_train, diabetes_y_train)
```

[322]: LinearRegression()

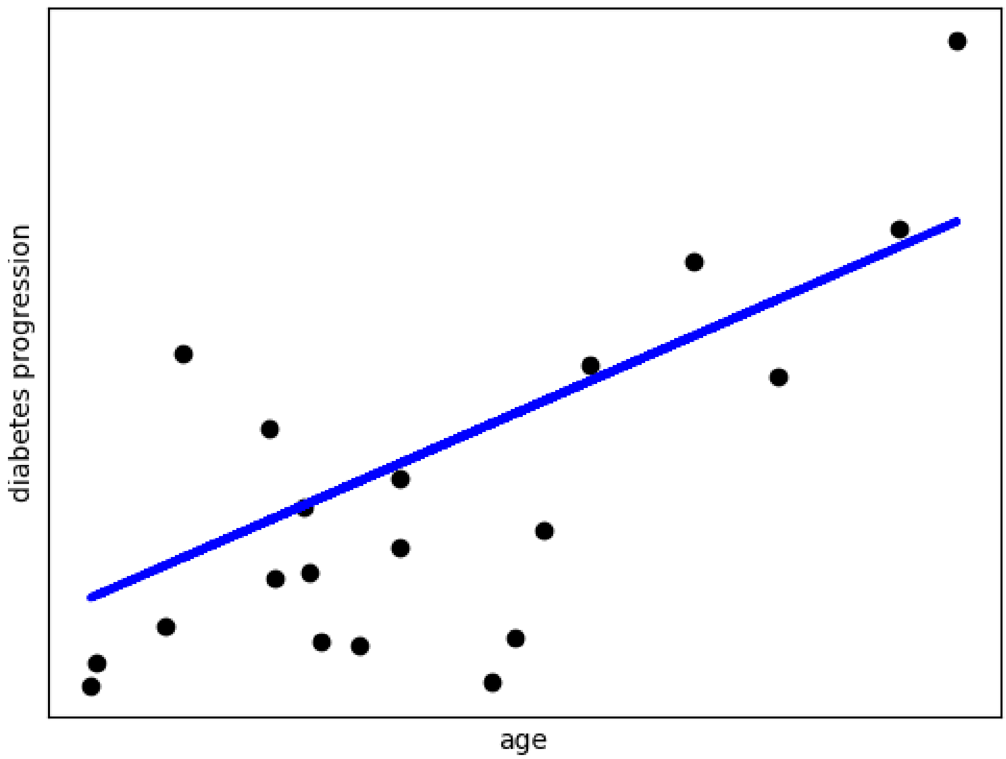
[323]:
```python
# Make predictions using the testing set
diabetes_y_pred = regr.predict(diabetes_X_test)
```

[324]:
```python
# The coefficients
print("Coefficients: \n", regr.coef_)
# The mean squared error
print("Mean squared error: %.2f" % mean_squared_error(diabetes_y_test,␣
 ↪diabetes_y_pred))
# The coefficient of determination: 1 is perfect prediction
print("Coefficient of determination: %.2f" % r2_score(diabetes_y_test,␣
 ↪diabetes_y_pred))
```

```
Coefficients:
 [938.23786125]
Mean squared error: 2548.07
Coefficient of determination: 0.47
```

[325]:
```
# Plot outputs
plt.scatter(diabetes_X_test, diabetes_y_test, color="black")
plt.plot(diabetes_X_test, diabetes_y_pred, color="blue", linewidth=3)
plt.xlabel("age")
plt.ylabel("diabetes progression")
plt.xticks(())
plt.yticks(())

plt.show()
```



Multiple Regression

[326]:
```
diabetes_X, diabetes_y = datasets.load_diabetes(return_X_y=True)
diabetes_X.shape
diabetes_X = diabetes_X[:,[0,2]]
diabetes_X.shape
```

[326]: (442, 2)

[327]:
```
# Split the data into training/testing sets
diabetes_X_train = diabetes_X[:-20]
diabetes_X_test = diabetes_X[-20:]
```

```
# Split the targets into training/testing sets
diabetes_y_train = diabetes_y[:-20]
diabetes_y_test = diabetes_y[-20:]
```

[328]:
```
# Create linear regression object
regr = linear_model.LinearRegression()

# Train the model using the training sets
regr.fit(diabetes_X_train, diabetes_y_train)
```

[328]: LinearRegression()

[329]:
```
# Make predictions using the testing set
diabetes_y_pred = regr.predict(diabetes_X_test)
```

[330]:
```
# The coefficients
print("Coefficients: \n", regr.coef_)
print("Intercept: \n", regr.intercept_)
# The mean squared error
print("Mean squared error: %.2f" % mean_squared_error(diabetes_y_test,␣
 ↪diabetes_y_pred))
# The coefficient of determination: 1 is perfect prediction
print("Coefficient of determination: %.2f" % r2_score(diabetes_y_test,␣
 ↪diabetes_y_pred))
```

```
Coefficients:
 [139.20420118 912.45355549]
Intercept:
 152.8767000140564
Mean squared error: 2596.60
Coefficient of determination: 0.46
```

[331]:
```
x = diabetes_X_test[:, 0]
y = diabetes_X_test[:, 1]
#z = diabetes_X_test[:, 2]
```

The following plots the values in three different angles.

[333]:
```
plt.style.use('default')

fig = plt.figure(figsize=(12, 4))

ax1 = fig.add_subplot(131, projection='3d')
ax2 = fig.add_subplot(132, projection='3d')
ax3 = fig.add_subplot(133, projection='3d')

axes = [ax1, ax2, ax3]
```

```python
for ax in axes:
    ax.plot(x, y, diabetes_y_pred, color='k', zorder=15, linestyle='none', marker='o', alpha=0.5)
    ax.scatter(x.flatten(), y.flatten(), diabetes_y_pred, facecolor=(0,0,0,0), s=20, edgecolor='#70b3f0')
    ax.set_xlabel('Age', fontsize=12)
    ax.set_ylabel('BMI', fontsize=12)
    ax.set_zlabel('diabetes', fontsize=12)
    ax.locator_params(nbins=4, axis='x')
    ax.locator_params(nbins=5, axis='x')

ax1.view_init(elev=28, azim=120)
ax2.view_init(elev=4, azim=114)
ax3.view_init(elev=60, azim=165)

fig.suptitle('$R^2 = %.2f$' % r2_score(diabetes_y_test, diabetes_y_pred), fontsize=20)

fig.tight_layout()
```