Optional Lab: Linear Regression using Scikit-Learn

There is an open-source, commercially usable machine learning toolkit called [scikit-learn (https://scikit-learn.org/stable/index.html)](https://scikit-learn.org/stable/index.html). This toolkit contains implementations of many of the algorithms that you will work with in this course.

Goals

In this lab you will:

- Utilize scikit-learn to implement linear regression using Gradient Descent

Tools

You will utilize functions from scikit-learn as well as matplotlib and NumPy.

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
from sklearn.linear_model import SGDRegressor
from sklearn.preprocessing import StandardScaler
from lab_utils_multi import  load_house_data
from lab_utils_common import dlc
np.set_printoptions(precision=2)
plt.style.use('./deeplearning.mplstyle')
```

Gradient Descent

Scikit-learn has a gradient descent regression model [sklearn.linear_model.SGDRegressor (https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.SGDRegressor.html#examples-using-sklearn-linear-model-sgdregressor)](https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.SGDRegressor.html#examples-using-sklearn-linear-model-sgdregressor). Like your previous implementation of gradient descent, this model performs best with normalized inputs. [sklearn.preprocessing.StandardScaler (https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html#sklearn.preprocessing.Standa](https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html#sklearn.preprocessing.StandardScaler) will perform z-score normalization as in a previous lab. Here it is referred to as 'standard score'.

Load the data set

In [2]:
```
X_train, y_train = load_house_data()
X_features = ['size(sqft)','bedrooms','floors','age']
```

Scale/normalize the training data

In [3]:
```
scaler = StandardScaler()
X_norm = scaler.fit_transform(X_train)
print(f"Peak to Peak range by column in Raw        X:{np.ptp(X_train,axis=0)}")
print(f"Peak to Peak range by column in Normalized X:{np.ptp(X_norm,axis=0)}")
```

```
Peak to Peak range by column in Raw        X:[2.41e+03 4.00e+00 1.00e+00 9.50e+01]
Peak to Peak range by column in Normalized X:[5.85 6.14 2.06 3.69]
```

Create and fit the regression model

In [4]:
```
sgdr = SGDRegressor(max_iter=1000)
sgdr.fit(X_norm, y_train)
print(sgdr)
print(f"number of iterations completed: {sgdr.n_iter_}, number of weight updates: {sgdr.t_}")
```

```
SGDRegressor(alpha=0.0001, average=False, early_stopping=False, epsilon=0.1,
             eta0=0.01, fit_intercept=True, l1_ratio=0.15,
             learning_rate='invscaling', loss='squared_loss', max_iter=1000,
             n_iter_no_change=5, penalty='l2', power_t=0.25, random_state=None,
             shuffle=True, tol=0.001, validation_fraction=0.1, verbose=0,
             warm_start=False)
number of iterations completed: 118, number of weight updates: 11683.0
```

View parameters

Note, the parameters are associated with the *normalized* input data. The fit parameters are very close to those found in the previous lab with this data.

In [ ]:
```
b_norm = sgdr.intercept_
w_norm = sgdr.coef_
print(f"model parameters:                   w: {w_norm}, b:{b_norm}")
print( "model parameters from previous lab: w: [110.56 -21.27 -32.71 -37.97], b: 363.16")
```

Make predictions

Predict the targets of the training data. Use both the `predict` routine and compute using w and b.

In [ ]:
```
# make a prediction using sgdr.predict()
y_pred_sgd = sgdr.predict(X_norm)
# make a prediction using w,b.
y_pred = np.dot(X_norm, w_norm) + b_norm
print(f"prediction using np.dot() and sgdr.predict match: {(y_pred
== y_pred_sgd).all()}")

print(f"Prediction on training set:\n{y_pred[:4]}" )
print(f"Target values \n{y_train[:4]}")
```

Plot Results

Let's plot the predictions versus the target values.

In [ ]:
```
# plot predictions and targets vs original features
fig,ax=plt.subplots(1,4,figsize=(12,3),sharey=True)
for i in range(len(ax)):
    ax[i].scatter(X_train[:,i],y_train, label = 'target')
    ax[i].set_xlabel(X_features[i])
    ax[i].scatter(X_train[:,i],y_pred,color=dlc["dlorange"], label
= 'predict')
ax[0].set_ylabel("Price"); ax[0].legend();
fig.suptitle("target versus prediction using z-score normalized mod
el")
plt.show()
```

Congratulations!

In this lab you:

- utilized an open-source machine learning toolkit, scikit-learn
- implemented linear regression using gradient descent and feature normalization from that toolkit

In [ ]:
```
```