In [ ]:
```
#Define Machine Learning
#1. The Broader Notion of Building Statistical Artifacts That Become M
ore Accurate Over Time Based on Experience
#2. Linear Algebra + Statistical Analysis, Written In Code
#3. Cost = Sumation(answer - guess)**2
```

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np

%matplotlib inline
plt.style.use('seaborn-poster')
```

In [2]:
```
df = pd.read_csv('/Users/swllms/DAT-10-14-SW/class material/Unit3/Data
/housing.csv')
```

In [3]:
```
df.head() #housing prices from the boston area that includes 13 charac
teristic of the house to predict price
#Target variable = price , guess = prediction
```

Out[3]:

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LST
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296	15.3	396.90	4
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242	17.8	396.90	9
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242	17.8	392.83	4
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222	18.7	394.63	2
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222	18.7	396.90	5

In [4]:
```
#See additonal notebook on machine learning terms:
#Regression, classification, supervised, unsupervised, structured, uns
tructered
```

In [ ]:
```
#Machine Learning: Linear Models - Most common algorithm used for Mach
ine Learning
#Based on the old equation y = mx + b
#Can extend this intuition to multiple variables
```

In [ ]:
```
#LSTAT = Lower economic status
#Linear regression is the second best model for everything, similar to python, taking the linear combination and creating a prediidiction
#Linear Models: Very well understood, Performant, Results are interpretable: easy to understand what causes what
#not great with subtile relations or outliers, requires more data preperation than other techniques, not as accurate
```

In [ ]:
```
#Scikit Learn: The main library used to implement ML methods; runs on CPU and not GPU (grpahic cards); used most
```

In [6]:
```
from sklearn.linear_model import LinearRegression
```

In [ ]:
```
Big Three Methods
#fit() - apply the algorithm to your data
#score() - evaluate your algorithm
#predict() - estimate answer based on new info

#get_params() - access parameters of your algorithm
#set_params() - change parameters of your algorithm
```

In [7]:
```
lreg = LinearRegression() #Must initialize the algorithm before you can use.
#(creating an instance of algo to be used later on)
```

In [8]:
```
X = df[['LSTAT']] #X is upercase and generally multi colms (sklearn requres the dimensions of your data to do predictions)
y = df['PRICE']
```

In [10]:
```
X.shape #The 1 indicates the diminsion of the table needed for predictions
```

Out[10]:
```
(506, 1)
```

In [11]:
```
type(X) #second [] make a dataframe
```

Out[11]:
```
pandas.core.frame.DataFrame
```

In [12]:
```
type(y) #this is a series
```

Out[12]:
```
pandas.core.series.Series
```

In [13]:
```
lreg.fit(X,y) #this allows Sklearn to learn your dataset and open up more information to be discovered () contains the different parameters/arguments
```

Out[13]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

In [14]:
```
lreg.coef_ #Basically the slope of the line or M in the equation y=mx=b
```

Out[14]:
```
array([-0.95004935])
```

In [15]:
```
lreg.intercept_ #eqauals b in the equation #note the trailing _ is only available after you call fit.
```

Out[15]:
```
34.55384087938311
```

In [17]:
```
X[:1]*lreg.coef_[0] + lreg.intercept_ #manually calculating the predicition
```

Out[17]:

	LSTAT
0	29.822595

In [19]:
```
lreg.predict(X[:1])
```

Out[19]:
```
array([29.8225951])
```

In [26]:
```
Z = df[['LSTAT', 'RM']]
y = df['PRICE']
```

In [27]:
```
lreg.fit(Z,y)
```

Out[27]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

In [37]:
```
Z[:1]
```

Out[37]:

	LSTAT	RM
0	4.98	6.575

In [ ]:
```
#W= (-0.64*LSTAT) + (5.094*RM) + -1.35 # Linear combination of your va
riables
#W= (-.64*4.98) + (5.094*6.575) + -1.35
#W= -3.198 + 33.498 + -1.35
#w=28.94
```

In [35]:
```
lreg.coef_
```

Out[35]:
```
array([-0.64235833,  5.09478798])
```

In [38]:
```
Z[:1]*lreg.coef_
```

Out[38]:

	LSTAT	RM
0	-3.198945	33.498231

In [29]:
```
lreg.intercept_
```

Out[29]:
```
-1.3582728118744605
```

In [32]:
```
(Z[:1]*lreg.coef_).sum(axis=1) + lreg.intercept_
```

Out[32]:
```
0    28.941014
dtype: float64
```

In [33]:
```
lreg.predict(Z[:1])
```

Out[33]:
```
array([28.94101368])
```

In [39]:
```
lreg.predict(Z)
```

Out[39]:
```
array([28.94101368, 25.48420566, 32.65907477, 32.40652   , 31.630406
99,
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```

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63,
        20.14301944, 26.02005928, 23.98921598, 30.56006716, 29.093234
75,
        24.30151506])
```

In [40]:

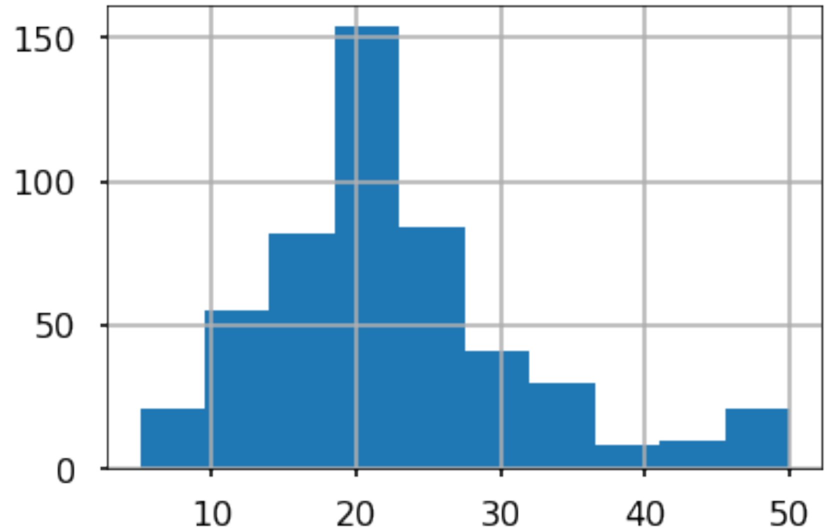
```
lreg.score(Z, y) #this the R Squared Value = how much of that number i
s acutally explained in our model.
#63% of observations are included in this model. How much of the chang
e in y can be explained in this model
```

Out[40]:

```
0.6385616062603403
```

In [41]:
```
y.hist() df
```

Out[41]: <matplotlib.axes._subplots.AxesSubplot at 0x1a1bcb58d0>



In [44]:
```
df['PREDICTIONS'] = lreg.predict(X)
df.head()
```

Out[44]:

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LST
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296	15.3	396.90	4
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242	17.8	396.90	9
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242	17.8	392.83	4
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222	18.7	394.63	2
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222	18.7	396.90	5

In [43]:
```
lreg.predict(X)
```

Out[43]:
```
array([28.94101368, 25.48420566, 32.65907477, 32.40652   , 31.630406
99,
       28.05452701, 21.28707846, 17.78559653,  8.10469338, 18.246506
73,
       17.99496223, 20.73221309, 18.5534842 , 23.64474107, 23.108958
23,
       22.9239452 , 24.65257604, 19.73611045, 18.9297215 , 20.573775
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36,
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       13.23095259, 21.20092715, 11.15596625, 15.89983805, 16.633986
```

```
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37,
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         20.38222834, 23.73891662, 28.42223975, 23.78518476, 19.132935
49,
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        24.30151506])
```

In [50]:
```
naive_model_cost = np.sum((y - y.mean())**2)
```

In [54]:
```
model_cost = np.sum((y - df['PREDICTIONS'])**2)
```

In [55]:
```
model_cost, naive_model_cost
```

Out[55]:
```
(15439.309201313532, 42716.29541501976)
```

In [57]:

```
1 - (model_cost/naive_model_cost)
#Man. calculate the R squared value; highest R value is 1 and technica
lly no minimum; 0 means you are predicting as well as the average.
# The informational gain it has above and beyond the target value in t
his case it is y.
```

Out[57]:

```
0.6385616062603403
```

In [ ]: