Machine Learning Final Project

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Topic: Regression with Energy Efficiency.

Import all library used in the file.

In [1]:

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import BaggingClassifier
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import Ridge
from sklearn.linear_model import Lasso
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import mean_squared_error
from sklearn.metrics import r2_score
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score
from sklearn.metrics import f1_score
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from sklearn.metrics import classification_report
from sklearn.metrics import plot_roc_curve
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import MinMaxScaler
from sklearn.preprocessing import RobustScaler
from sklearn.preprocessing import Normalizer
from sklearn.tree import DecisionTreeClassifier
from imblearn.under_sampling import RandomUnderSampler
from imblearn.over_sampling import RandomOverSampler
from imblearn.over_sampling import SMOTE
from sklearn.model_selection import GridSearchCV
from math import sqrt
```

Regression Dataset

Exploration and Preprocessing

Load in the dataset from excel.

In [2]:
```
dataset = pd.read_excel('ENB2012_data.xlsx')
dataset = dataset[dataset.columns[:-2]]
dataset
```

Out[2]:

	X1	X2	X3	X4	X5	X6	X7	X8	Y1	Y2
0	0.98	514.5	294.0	110.25	7.0	2	0.0	0	15.55	21.33
1	0.98	514.5	294.0	110.25	7.0	3	0.0	0	15.55	21.33
2	0.98	514.5	294.0	110.25	7.0	4	0.0	0	15.55	21.33
3	0.98	514.5	294.0	110.25	7.0	5	0.0	0	15.55	21.33
4	0.90	563.5	318.5	122.50	7.0	2	0.0	0	20.84	28.28
...	...	...	...	...	...	...	...	...	...	...
763	0.64	784.0	343.0	220.50	3.5	5	0.4	5	17.88	21.40
764	0.62	808.5	367.5	220.50	3.5	2	0.4	5	16.54	16.88
765	0.62	808.5	367.5	220.50	3.5	3	0.4	5	16.44	17.11
766	0.62	808.5	367.5	220.50	3.5	4	0.4	5	16.48	16.61
767	0.62	808.5	367.5	220.50	3.5	5	0.4	5	16.64	16.03

768 rows × 10 columns

Change the column headers to their original names.

In [3]:
```
dataset.columns = ['Relative  Compactness', 'Surface  Area', 'Wall  Area',
        , 'Orientation', 'Glazing  Area', 'Glazing Area  Distributi
dataset.head()
```

Out[3]:

	Relative Compactness	Surface Area	Wall Area	Roof Area	Overall Height	Orientation	Glazing Area	Glazing Area Distribution	Heating Load	C
0	0.98	514.5	294.0	110.25	7.0	2	0.0	0	15.55	
1	0.98	514.5	294.0	110.25	7.0	3	0.0	0	15.55	
2	0.98	514.5	294.0	110.25	7.0	4	0.0	0	15.55	
3	0.98	514.5	294.0	110.25	7.0	5	0.0	0	15.55	
4	0.90	563.5	318.5	122.50	7.0	2	0.0	0	20.84	

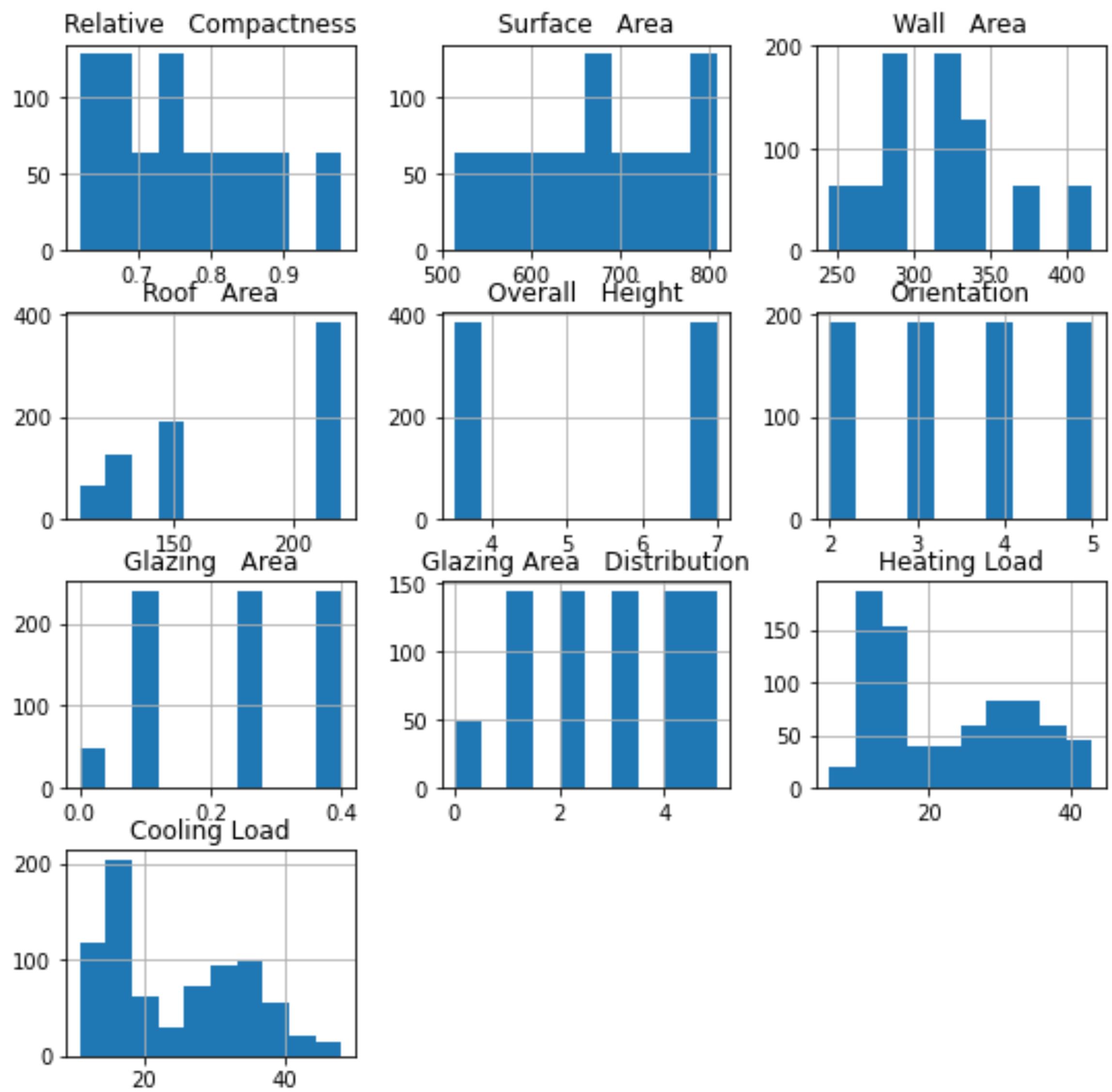
Check for null values in the dataset.

In [4]:
```
dataset.isnull().sum()
```

```
Out[4]: Relative   Compactness          0
        Surface   Area                  0
        Wall   Area                     0
        Roof   Area                     0
        Overall   Height                0
        Orientation                     0
        Glazing   Area                  0
        Glazing Area   Distribution     0
        Heating Load                    0
        Cooling Load                    0
        dtype: int64
```

Visualize the data through histograms.

```
In [5]: dataset.hist(figsize=(9,9))
        plt.show()
```



Assign columns to their respective X and y. Heating and Cooling loads should be the y variable.

In [6]:
```
X = dataset.drop(['Heating Load','Cooling Load'], axis=1)
y = dataset[['Heating Load','Cooling Load']]
X
```

Out[6]:

	Relative Compactness	Surface Area	Wall Area	Roof Area	Overall Height	Orientation	Glazing Area	Glazing Area Distribution
0	0.98	514.5	294.0	110.25	7.0	2	0.0	0
1	0.98	514.5	294.0	110.25	7.0	3	0.0	0
2	0.98	514.5	294.0	110.25	7.0	4	0.0	0
3	0.98	514.5	294.0	110.25	7.0	5	0.0	0
4	0.90	563.5	318.5	122.50	7.0	2	0.0	0
...	...	...	...	...	...	...	...	...
763	0.64	784.0	343.0	220.50	3.5	5	0.4	5
764	0.62	808.5	367.5	220.50	3.5	2	0.4	5
765	0.62	808.5	367.5	220.50	3.5	3	0.4	5
766	0.62	808.5	367.5	220.50	3.5	4	0.4	5
767	0.62	808.5	367.5	220.50	3.5	5	0.4	5

768 rows × 8 columns

Split up the training and testing set with a test size of 0.33.

In [7]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.33, r
```

Normalize the training and testing data.

In [8]:
```
nr = Normalizer(copy=False)
X_train_norm = nr.fit_transform(X_train)
X_test_norm = nr.fit_transform(X_test)
```

Linear Regression

Perform Linear Regression on the dataset.

In [9]:
```
lr = LinearRegression(normalize=True)
lr.fit(X_train_norm,y_train)
```

Out[9]:
```
LinearRegression(normalize=True)
```

Using the Linear Regression model predict values based off the test data.

In [10]:

```python
y_pred = lr.predict(X_test_norm)
y_pred
```

Out[10]:

```
array([[18.37424611, 19.66773346],
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[32.59299611, 34.29273346],
[34.21799611, 35.01148346]])
```

Output the error scores and scores of the Linear Regression predicition.

In [11]:

```
print('Mean Absolute Error', str(mean_absolute_error(y_test, y_pred)).rjust(3
print('Root Mean Squared Error', str(sqrt(mean_squared_error(y_test, y_pred))
print('Mean Squared Absolute Error',str(mean_squared_error(y_test, y_pred)).r
print('R2 Score', str(r2_score(y_test, y_pred)).rjust(41))
```

```
Mean Absolute Error                2.1419015824626975
Root Mean Squared Error            3.064763987733124
Mean Squared Absolute Error        9.39277830050584
R2 Score                           0.9036148603886349
```

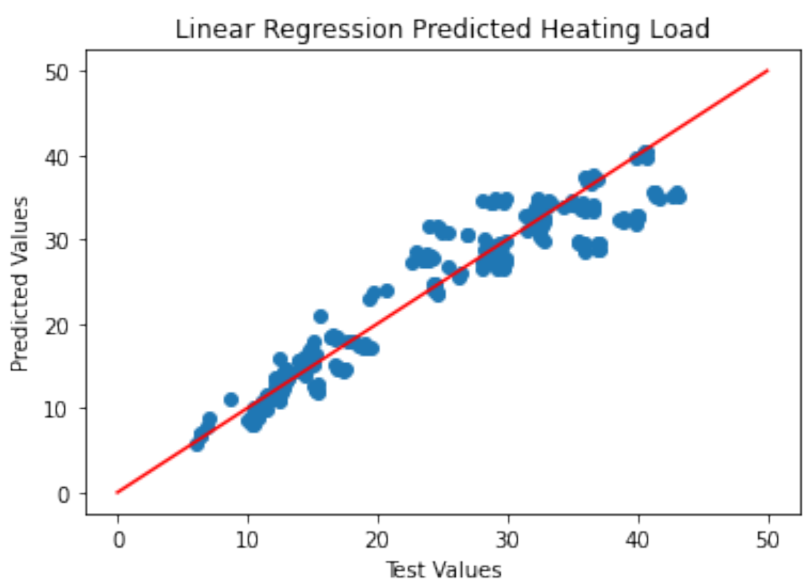
Plot a graph of the predicted Linear Regression data for Heating Load vs the real test data.

In [12]:

```
plt.scatter(y_test.iloc[:,0], y_pred[:,0])
plt.plot([0,50], [0, 50],"r-")
plt.title('Linear Regression Predicted Heating Load')
plt.xlabel('Test Values')
plt.ylabel('Predicted Values')
```

Out[12]:

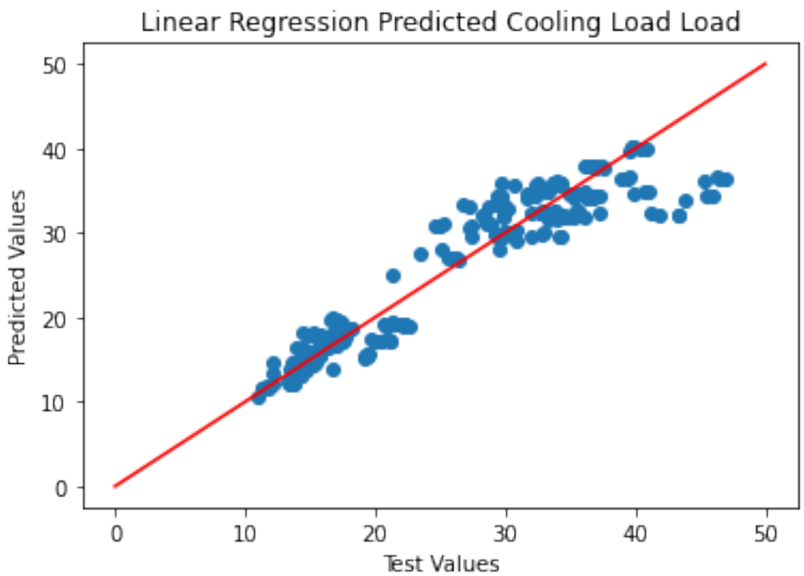
```
Text(0, 0.5, 'Predicted Values')
```



Plot a graph of the predicted Linear Regression data for Cooling Load vs the real test data.

In [13]:
```
plt.scatter(y_test.iloc[:,1], y_pred[:,1])
plt.plot([0,50], [0, 50],"r-")
plt.title('Linear Regression Predicted Cooling Load Load')
plt.xlabel('Test Values')
plt.ylabel('Predicted Values')
```

Out[13]: `Text(0, 0.5, 'Predicted Values')`



Ridge Regression

Perform Ridge Regression on the normalized data.

In [14]:
```
ridge_reg = Ridge(alpha=0.2)
ridge_reg.fit(X_train, y_train)
```

Out[14]: `Ridge(alpha=0.2)`

Predict the target elements basae on the testing data.

In [15]:
```
y_pred_ridge = ridge_reg.predict(X_test)
y_pred_ridge
```

Out[15]:
```
array([[19.5807136 , 20.50538015],
       [13.82020669, 16.47584962],
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```

Output the error scores and scores of the Ridge Regression predicition.

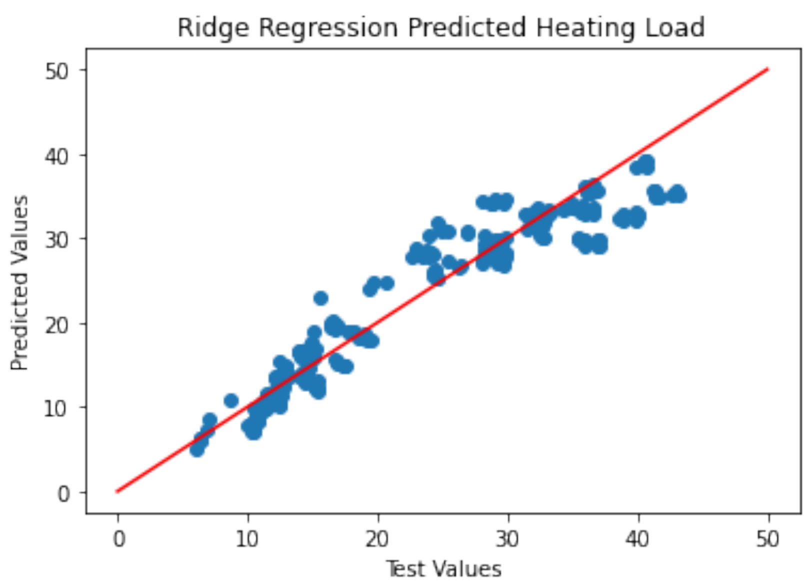
In [16]:
```
print('Mean Absolute Error', str(mean_absolute_error(y_test, y_pred_ridge)).r
print('Root Mean Squared Error', str(sqrt(mean_squared_error(y_test, y_pred_r
print('Mean Squared Absolute Error',str(mean_squared_error(y_test, y_pred_rid
print('R2 Score', str(r2_score(y_test, y_pred_ridge)).rjust(41))
```

```
Mean Absolute Error              2.2628656618312797
Root Mean Squared Error          3.130251468619064
Mean Squared Absolute Error      9.798474256791806
R2 Score                         0.8995346011629067
```

Plot a graph of the predicted Ridge Regression data for Heating Load vs the real test data.

In [17]:
```
plt.scatter(y_test.iloc[:,0], y_pred_ridge[:,0])
plt.plot([0,50], [0, 50],"r-")
plt.title('Ridge Regression Predicted Heating Load')
plt.xlabel('Test Values')
plt.ylabel('Predicted Values')
```

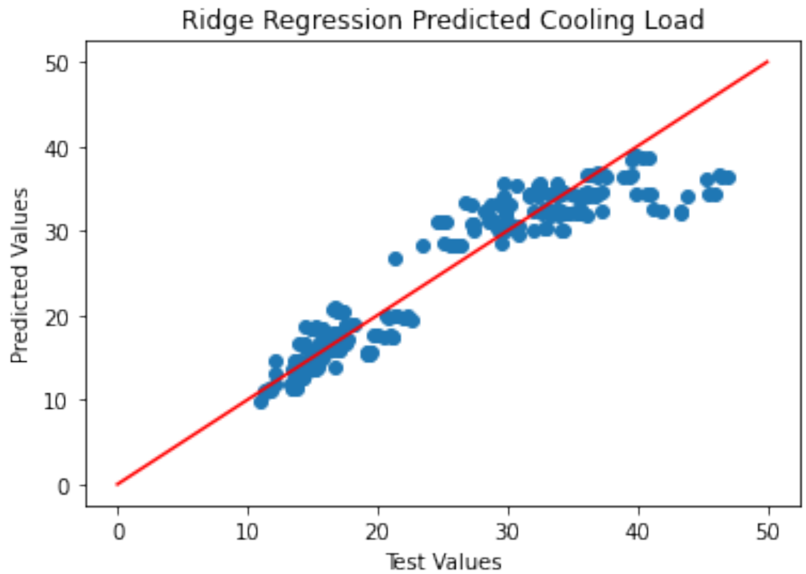
Out[17]:
```
Text(0, 0.5, 'Predicted Values')
```



Plot a graph of the predicted Rdige Regression data for Cooling Load vs the real test data.

In [18]:
```
plt.scatter(y_test.iloc[:,1], y_pred_ridge[:,1])
plt.plot([0,50], [0, 50],"r-")
plt.title('Ridge Regression Predicted Cooling Load')
plt.xlabel('Test Values')
plt.ylabel('Predicted Values')
```

Out[18]: Text(0, 0.5, 'Predicted Values')



Lasso Regression

Perform Lasso Regression on the normalized data.

In [19]:
```
lasso_reg = Lasso(alpha=0.2)
lasso_reg.fit(X_train, y_train)
```

Out[19]: Lasso(alpha=0.2)

Predict the target elements based on the testing data.

In [20]:
```
y_pred_lasso = lasso_reg.predict(X_test)
y_pred_lasso
```

Out[20]:
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In [21]:

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print('Mean Absolute Error', str(mean_absolute_error(y_test, y_pred_lasso)).r
print('Root Mean Squared Error', str(sqrt(mean_squared_error(y_test, y_pred_l
print('Mean Squared Absolute Error',str(mean_squared_error(y_test, y_pred_las
print('R2 Score', str(r2_score(y_test, y_pred_lasso)).rjust(41))
```

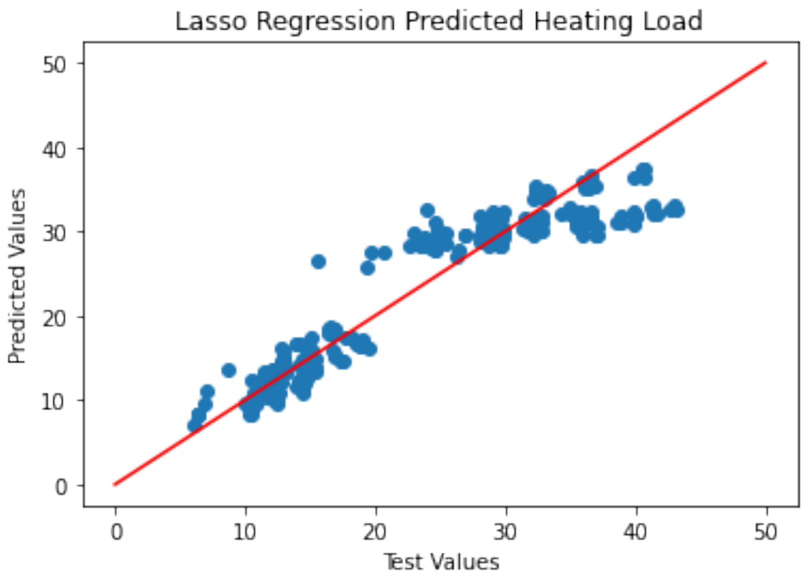
```
Mean Absolute Error              2.6244742250819693
Root Mean Squared Error            3.55975563075367
Mean Squared Absolute Error      12.671860150682459
R2 Score                         0.8700113674552772
```

Plot a graph of the predicted Lasso Regression data for Heating Load vs the real test data.

In [22]:

```
plt.scatter(y_test.iloc[:,0], y_pred_lasso[:,0])
plt.plot([0,50], [0, 50],"r-")
plt.title('Lasso Regression Predicted Heating Load')
plt.xlabel('Test Values')
plt.ylabel('Predicted Values')
```

Out[22]: Text(0, 0.5, 'Predicted Values')

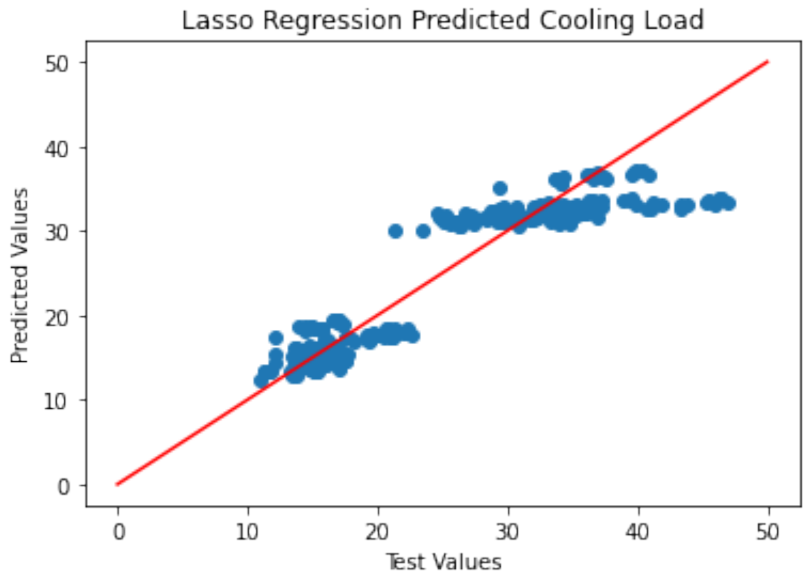


Plot a graph of the predicted Lasso Regression data for Cooling Load vs the real test data.

In [23]:

```
plt.scatter(y_test.iloc[:,1], y_pred_lasso[:,1])
plt.plot([0,50], [0, 50],"r-")
plt.title('Lasso Regression Predicted Cooling Load')
plt.xlabel('Test Values')
plt.ylabel('Predicted Values')
```

Out[23]: Text(0, 0.5, 'Predicted Values')



In [24]:
```
r2_linear=r2_score(y_test, y_pred)
r2_ridge=r2_score(y_test, y_pred_ridge)
r2_lasso=r2_score(y_test, y_pred_lasso)
r2=[r2_linear,r2_linear,r2_linear]
plt.bar(['Linear Regression','Ridge Regression', 'Lasso Regression'], r2,colo
plt.title('Regression R2 Scores')
plt.ylabel('R2 Score')
```

Out[24]: Text(0, 0.5, 'R2 Score')