Optimization of Advertisement Budget

Beula Joslyn Jose (CWID: 10473421)
Priyank Thakur (CWID: 20009546)
Simrat Kaur Anand (CWID: 20008654)

Problem Statement

Building an optimization model for advertising dataset:

- A budget constraint restricting the total amount of money to be allocated among three different sources, i.e., TV, Radio, Newspaper
- The total expenditure for each of the above mentioned sources should be less than or equal to the allotted budget
- Finding an objective function to maximize sales

Why is it important?

- Advertising delivers messages to consumers, drawing them through a company's product distribution sources
- Hence forecasting of sales is accomplished by the impact of advertisement through various sources such as TV, radio, and newspaper
- It is equally important to channel proper expenditure to each of these sources to have high sales
- Surveying and analysis would help in determining the source that should be concentrated more to achieve maximum sales

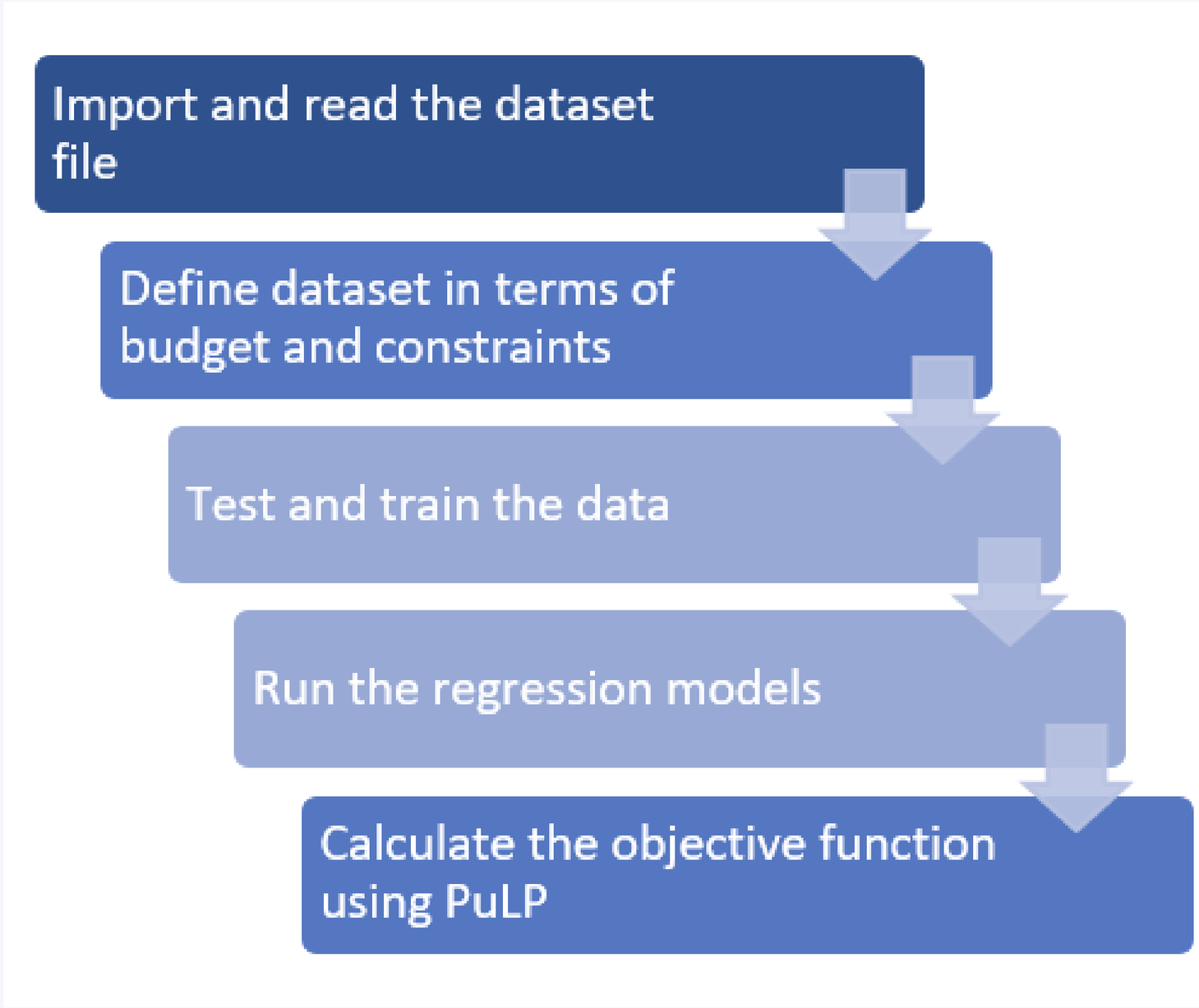
Optimization Models

Predict sales through different linear optimization methods:

- Linear Regression
- Lasso Regression
- Ridge Regression
- Elastic Regression

Tools used: Scikit-Learn Linear model and PuLP library

Proposed Solution

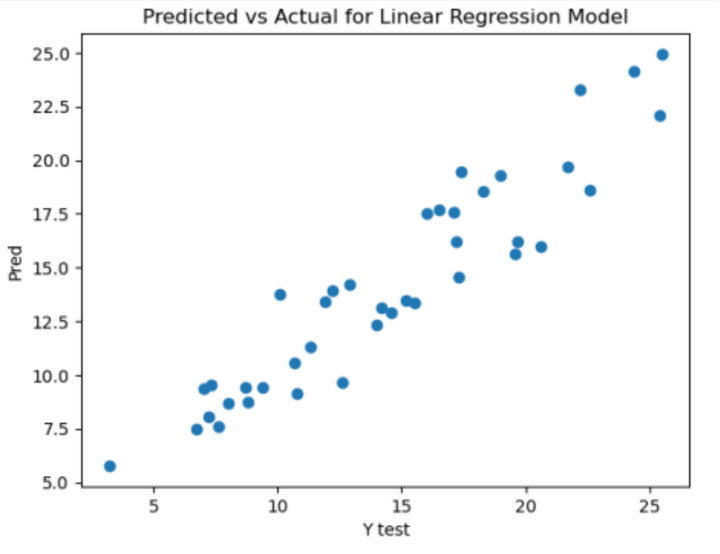


Linear Regression

- Linear regression model is used to predict the relationship between variables and factor
- There are two variables in linear regression, dependent variable (the predicted value) and the independent variable(s) (the factors used to predict)
- Linear regression is given by:

$$y = c + m_1 x_1 + m_2 x_2 + \cdots + m_n x_n$$

- Where 'y' is the predicted output, 'x' values are the independent factors, and 'm' are the slopes respectively.



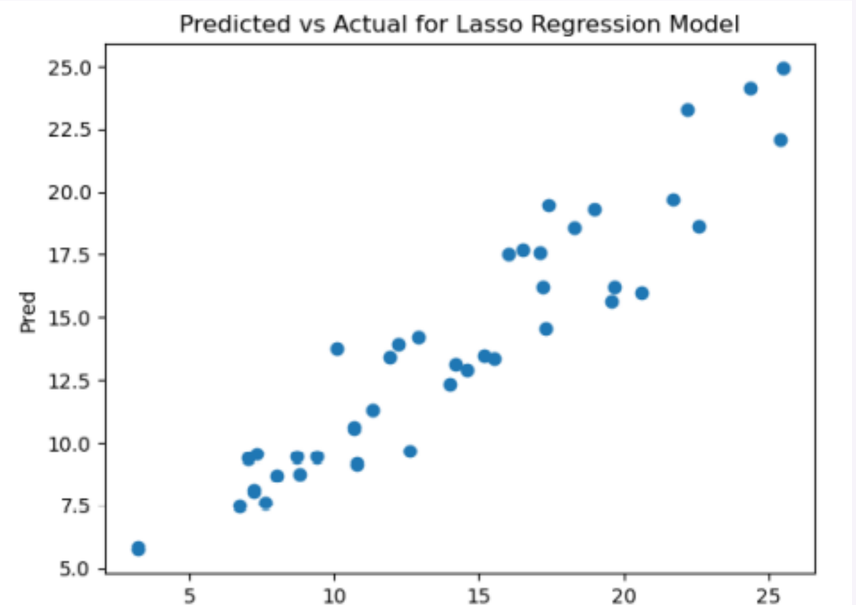

```
Metrics for Linear Regression are as follows:
----------------------------------------
Score:    0.8723010124704045
Error:    2.026016654732277
Coef:     0.15518937421349988
Intercept:        4.671512412906933
```

Lasso Regression

- Lasso regression model has the ability to perform variable selection as well as regularization to improve the prediction accuracy of the model
- This model allows to shrink or regularize the coefficients to avoid overfitting and make them work better
- Lasso regression is given by:

D= least- squares + lambda * summation (absolute values of the magnitude of the coefficients)

- Where 'least-square' is the sum of the squares of the distance between the points from the plotted curve



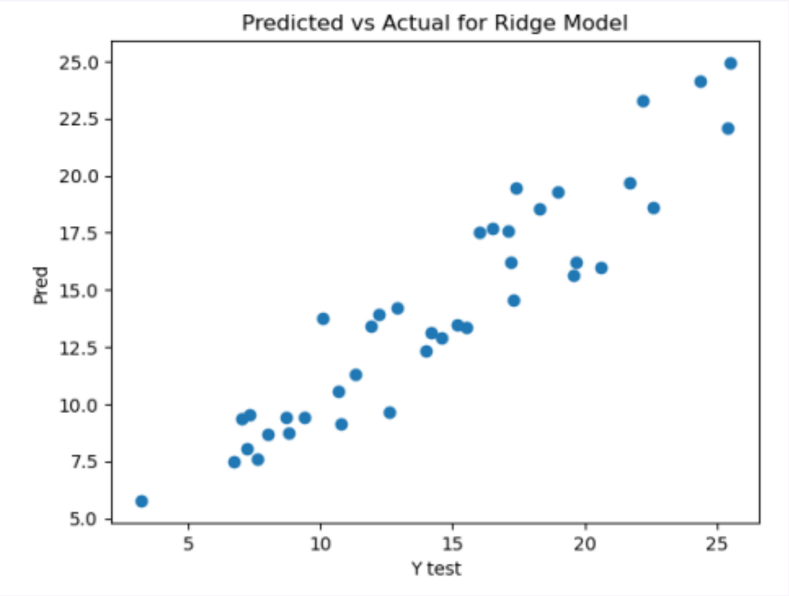

```
Metrics for Lasso Model are as follows:
----------------------------------------
Score:    0.8722934450614519
Error:    2.0260766844542673
Coef:     0.15517870012065144
Intercept:        4.672242463039764
```

Ridge Regression

- Ridge regression is a model tuning method that is used to analyze any data that suffers from multicollinearity
- The first step is to standardize the variables (both dependent and independent) by subtracting their means and dividing by their standard deviations
- Ridge regression is given by:

$$Y = XB + e$$

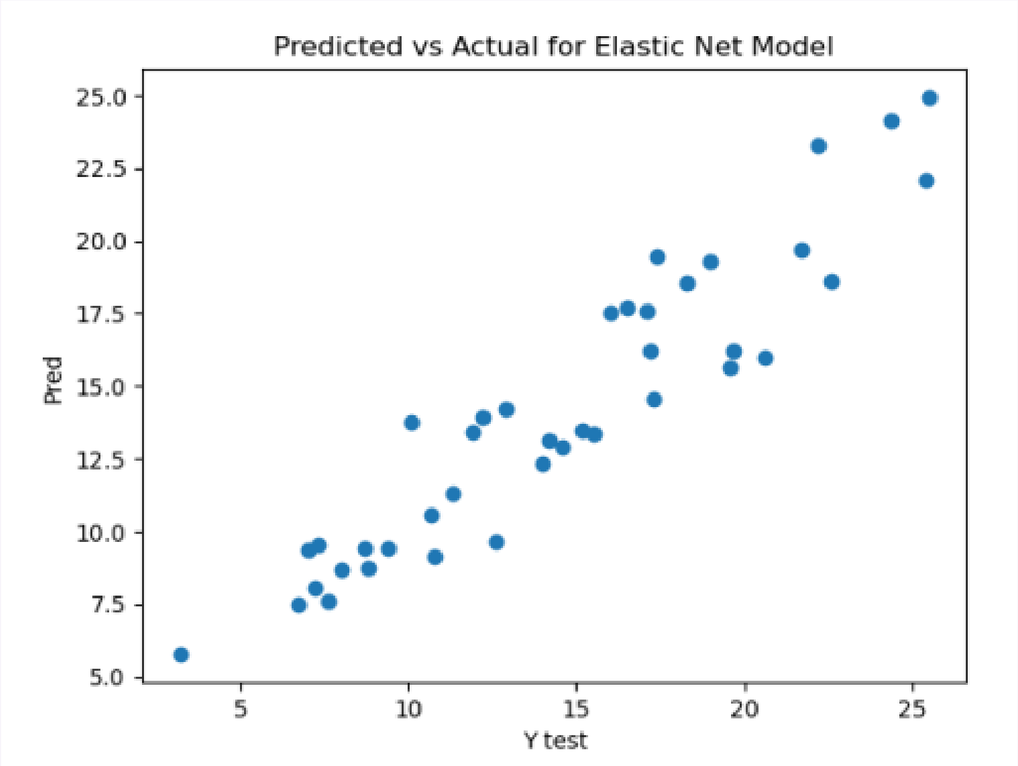
- Where Y is the dependent variable, X represents the independent variables, B is the regression coefficients to be estimated, and e represents the errors are residuals




```
Metrics for Ridge Model are as follows:
---------------------------------------
Score:    0.8723010051341012
Error:    2.0260167129295756
Coef:     0.15518936386033 94
Intercept:        4.671513121007029
```

Elastic Net

- Elastic net linear regression uses the penalties from both the lasso and ridge techniques to regularize regression models
- The elastic net method performs variable selection and regularization simultaneously
- Groupings and variables selection are the key roles of the elastic net technique




```
Metrics for Elastic Net are as follows:
--------------------------------------
Score:    0.8722966425000338
Error:    2.026051320461346
Coef:     0.1551832089470853
Intercept:        4.671934083734499
```

Final Results

Let the maximum set budget 'B' = 1000

T = funds alloted to TV

R = funds alloted to Radio

N = funds alloted to Newspaper

Using PuLP:

```
AdvsSalesOpt:
MAXIMIZE
-0.0034977*Newspaper + 0.11150177*Radio + 0.05367932*TV + 4.773466912078015
SUBJECT TO
_C1: Newspaper + Radio + TV <= 1000

VARIABLES
Newspaper <= 500 Continuous
Radio <= 500 Continuous
TV <= 200 Continuous

Newspaper = 0.0
Radio = 500.0
TV = 200.0
```

```
Objective Value = 71.260216
Optimized Budget Sales:  71.27233720326984
```

Conclusion

- Set the values to constraints using Linear regression of advertisement sales variables includes the three sources, i.e., T.V - T, Radio - R, Newspaper - N
- Calculate objective function to maximize the sales based on advertisement variables
- Use Linear Regression model to maximize using python's PuLP library

Future Works

- Add more media constraints in advertisement to get better results to maximize sales
- Having a better understanding on customer needs or analyzing data to target an ideal customer results in maximizing sales
- Scale across various industries and more complex problems in marketing and advertisement to achieve maximum sales