Exercise 3 - Short- and Long-run Paid Search Advertising Response

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## Overview

[TODO: Overview of the analysis.]

# Clear All Variables & Clear the Screen  
rm(list=ls())  
cat("\014")

# Read in the Data  
data.adv = read.csv("Ex3\_Data\_R.csv")  
  
# Explore the data  
str(data.adv)

## 'data.frame': 66 obs. of 3 variables:  
## $ Day : Factor w/ 66 levels "5/1/2019","5/10/2019",..: 1 12 23 26 27 28 29 30 31 2 ...  
## $ Visitors : int 530 530 530 511 511 511 514 514 514 545 ...  
## $ Total.Spent: int 365 365 365 435 435 435 303 303 303 188 ...

summary(data.adv)

## Day Visitors Total.Spent   
## 5/1/2019 : 1 Min. : 511.0 Min. : 188.0   
## 5/10/2019: 1 1st Qu.: 615.0 1st Qu.: 430.0   
## 5/11/2019: 1 Median : 918.5 Median : 786.5   
## 5/12/2019: 1 Mean : 862.1 Mean : 714.1   
## 5/13/2019: 1 3rd Qu.:1044.0 3rd Qu.: 884.0   
## 5/14/2019: 1 Max. :1197.0 Max. :1400.0   
## (Other) :60

# Prepare the data  
data.adv$logVisitors <- log(data.adv$Visitors)  
data.adv$logTotal.Spent <- log(data.adv$Total.Spent)  
data.adv$sqVisitors <- (data.adv$Visitors)^2  
summary(data.adv)

## Day Visitors Total.Spent logVisitors   
## 5/1/2019 : 1 Min. : 511.0 Min. : 188.0 Min. :6.236   
## 5/10/2019: 1 1st Qu.: 615.0 1st Qu.: 430.0 1st Qu.:6.422   
## 5/11/2019: 1 Median : 918.5 Median : 786.5 Median :6.821   
## 5/12/2019: 1 Mean : 862.1 Mean : 714.1 Mean :6.721   
## 5/13/2019: 1 3rd Qu.:1044.0 3rd Qu.: 884.0 3rd Qu.:6.951   
## 5/14/2019: 1 Max. :1197.0 Max. :1400.0 Max. :7.088   
## (Other) :60   
## logTotal.Spent sqVisitors   
## Min. :5.236 Min. : 261121   
## 1st Qu.:6.064 1st Qu.: 378225   
## Median :6.667 Median : 845805   
## Mean :6.453 Mean : 793317   
## 3rd Qu.:6.784 3rd Qu.:1089936   
## Max. :7.244 Max. :1432809   
##

## Short-run Response

This section shows the analysis of short-run response of clicks to advertising.

1. Simple linear

lm.modelSL <- lm(Total.Spent ~ Visitors,data = data.adv)  
summary(lm.modelSL)

##   
## Call:  
## lm(formula = Total.Spent ~ Visitors, data = data.adv)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -542.09 -90.25 -18.24 78.78 541.28   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -80.5126 119.4382 -0.674 0.503   
## Visitors 0.9217 0.1341 6.873 3.1e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 243.9 on 64 degrees of freedom  
## Multiple R-squared: 0.4247, Adjusted R-squared: 0.4157   
## F-statistic: 47.24 on 1 and 64 DF, p-value: 3.1e-09

betaSL = lm.modelSL$coefficients[2]  
meanA = mean(data.adv$Visitors)  
meanS = mean(data.adv$Total.Spent)  
aeSL = betaSL\*meanA/meanS  
aeSL

## Visitors   
## 1.112748

ii Concave logarithmic

lm.modelCL <- lm(Total.Spent ~ logVisitors, data = data.adv)  
summary(lm.modelCL)

##   
## Call:  
## lm(formula = Total.Spent ~ logVisitors, data = data.adv)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -523.76 -51.70 -9.88 84.69 531.75   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -4329.5 687.6 -6.296 3.14e-08 \*\*\*  
## logVisitors 750.4 102.2 7.341 4.67e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 236.9 on 64 degrees of freedom  
## Multiple R-squared: 0.4571, Adjusted R-squared: 0.4487   
## F-statistic: 53.89 on 1 and 64 DF, p-value: 4.674e-10

1. Concave quadratic

lm.modelCQ <- lm(Total.Spent ~ Visitors + sqVisitors, data = data.adv )  
summary(lm.modelCQ)

##   
## Call:  
## lm(formula = Total.Spent ~ Visitors + sqVisitors, data = data.adv)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -522.62 -84.11 -12.23 98.88 510.10   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -1.615e+03 4.908e+02 -3.291 0.001638 \*\*   
## Visitors 4.971e+00 1.267e+00 3.923 0.000219 \*\*\*  
## sqVisitors -2.466e-03 7.678e-04 -3.211 0.002082 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 227.9 on 63 degrees of freedom  
## Multiple R-squared: 0.5056, Adjusted R-squared: 0.4899   
## F-statistic: 32.22 on 2 and 63 DF, p-value: 2.307e-10