```
###  HW2  #####
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### September 20th 2022 ####

library(ggplot2)
```

```
## Warning: replacing previous import 'lifecycle::last_warnings' by
## 'rlang::last_warnings' when loading 'pillar'
```

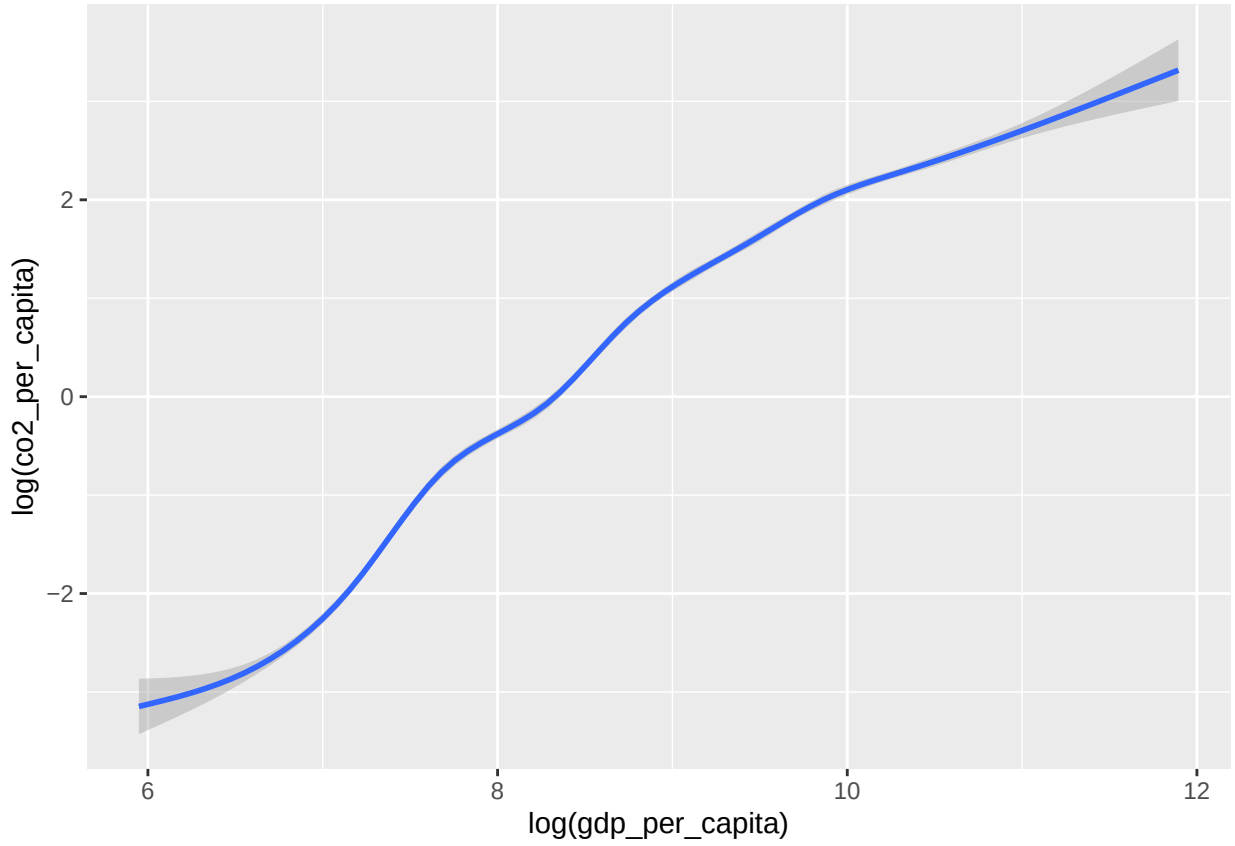
```
#Step 1
#Read and load carbon emmisions data sets
Carbon_Emissions_data= read.csv("carbon_emissions.csv")


#Step 2
#Fiting a Bivariate Model
#The outcome is emissions per capita and the predictor is GDP per capita
#Our data was not linear so we transformed the log data

carbonEmissionLM<-lm(log(co2_per_capita)~ log(gdp_per_capita) ,data = Carbon_Emissions_data)
summary(carbonEmissionLM)
```

```
##
## Call:
## lm(formula = log(co2_per_capita) ~ log(gdp_per_capita), data = Carbon_Emissions_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.19079 -0.49833 -0.09689  0.40296  2.77028
##
## Coefficients:
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)         -10.953202   0.071300  -153.6   <2e-16 ***
## log(gdp_per_capita)   1.305839   0.008013   163.0   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7511 on 6346 degrees of freedom
##   (2612 observations deleted due to missingness)
## Multiple R-squared:  0.8071, Adjusted R-squared:  0.8071
## F-statistic: 2.656e+04 on 1 and 6346 DF,  p-value: < 2.2e-16
```

```
ggplot(Carbon_Emissions_data,aes(x=log(gdp_per_capita),y=log(co2_per_capita)))+
  geom_smooth()
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

```
## Warning: Removed 2612 rows containing non-finite values (stat_smooth).
```



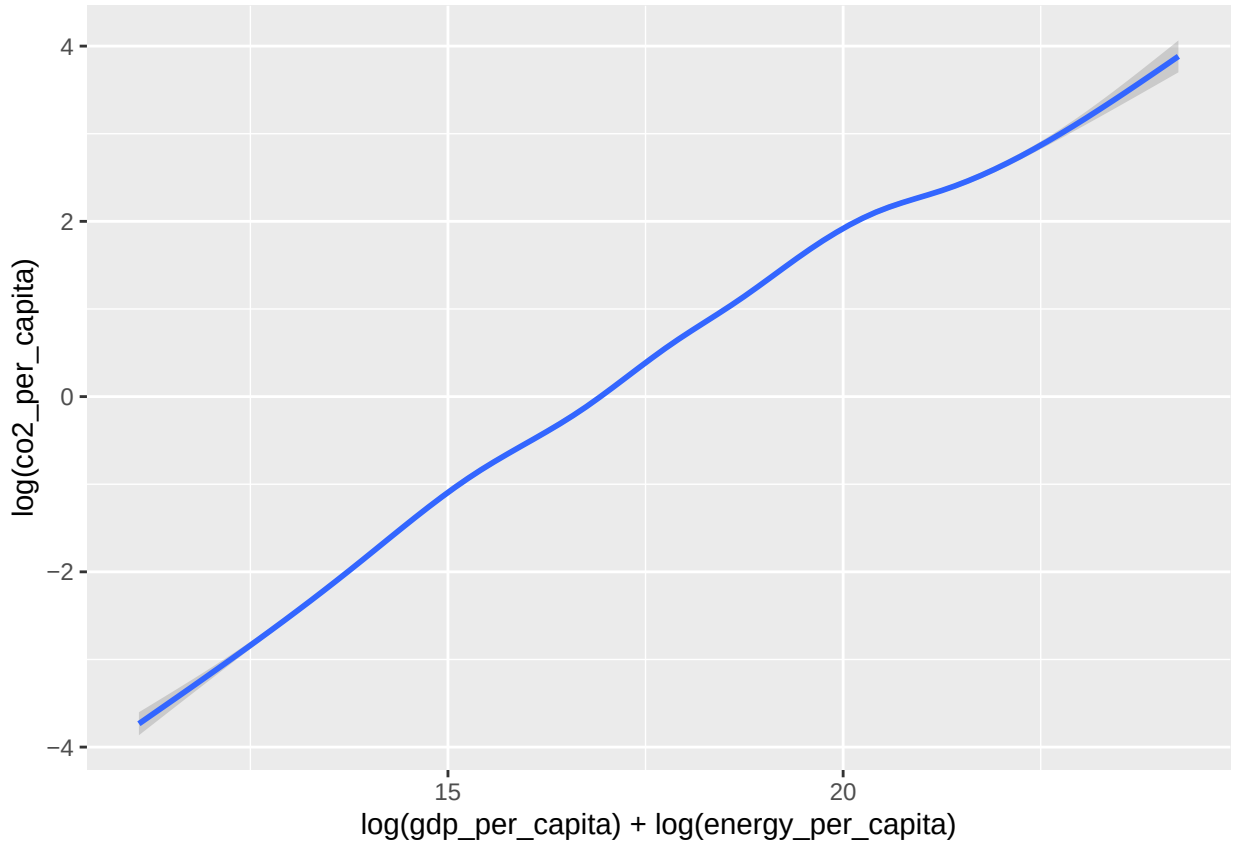

```
#Step 4
#Fitting a Multivariate Model

carbonEmissionLM2<-lm(log(co2_per_capita)~ log(gdp_per_capita)+log(energy_per_capita),data = Carbon_Emis
summary(carbonEmissionLM2)
```

```
##
## Call:
## lm(formula = log(co2_per_capita) ~ log(gdp_per_capita) + log(energy_per_capita),
##     data = Carbon_Emissions_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.82684 -0.19243  0.06398  0.23619  2.15388
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)            -8.807637   0.043809 -201.04   <2e-16 ***
## log(gdp_per_capita)     0.142966   0.011010   12.98   <2e-16 ***
## log(energy_per_capita)  0.890428   0.007725  115.26   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4168 on 6134 degrees of freedom
##   (2823 observations deleted due to missingness)
## Multiple R-squared:  0.9415, Adjusted R-squared:  0.9415
```

```
## F-statistic: 4.937e+04 on 2 and 6134 DF,  p-value: < 2.2e-16
```

```
ggplot(Carbon_Emissions_data,aes(x=log(gdp_per_capita)+log(energy_per_capita),y=log(co2_per_capita)))+
  geom_smooth()
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'

## Warning: Removed 2823 rows containing non-finite values (stat_smooth).
```




```
#Step 6
#Out of sample Predictions
#Create a new data set for the predictions


Prediction_Co2<-data.frame(co2_per_capita=mean(Carbon_Emissions_data$co2_per_capita,na.rm = T),
                           energy_per_capita=mean(Carbon_Emissions_data$energy_per_capita,na.rm = T),
                          gdp_per_capita= c(gdp_per_capitaMin=min(Carbon_Emissions_data$gdp_per_capita,
                           gdp_per_capitaMax=max(Carbon_Emissions_data$gdp_per_capita,na.rm = T),
                           gdp_per_capitaMean=mean(Carbon_Emissions_data$gdp_per_capita,na.rm = T))
                         )

CO2_Predictins =predict(carbonEmissionLM2,Prediction_Co2)
print(CO2_Predictins)
```

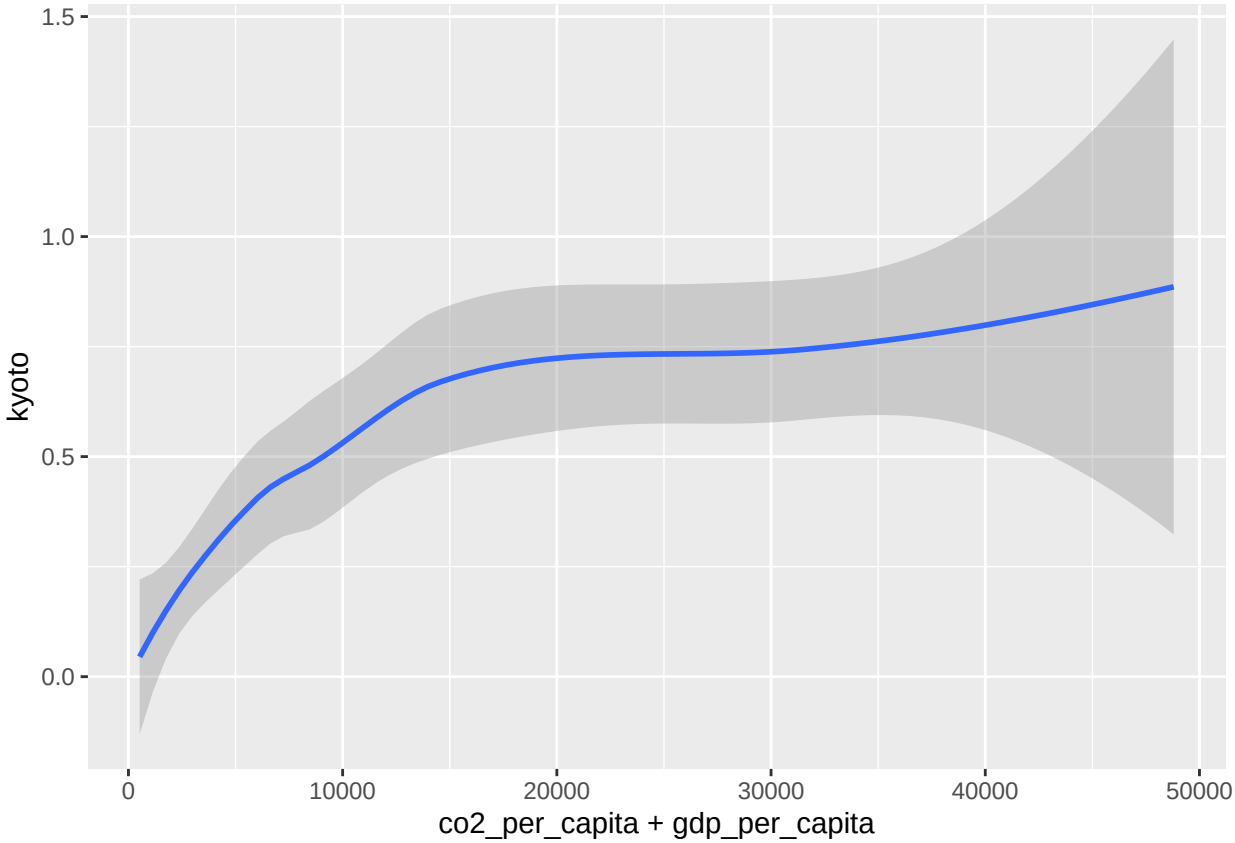
```
##  gdp_per_capitaMin  gdp_per_capitaMax gdp_per_capitaMean
##           1.024454           1.874476           1.523278
```

```
#Step 7
#Subset the Data


 Kyoto_Protocol<-subset(Carbon_Emissions_data,Carbon_Emissions_data$year=="1998")


#Step 8
#Modeling the Decision to Sign the Kyoto Protocol

Kyto_logit<- glm(kyoto~co2_per_capita+gdp_per_capita,data = Kyoto_Protocol,family = "binomial")
summary(Kyto_logit)
```

```
##
## Call:
## glm(formula = kyoto ~ co2_per_capita + gdp_per_capita, family = "binomial",
##     data = Kyoto_Protocol)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.1017  -0.8271  -0.7433   1.0518   1.8216
##
## Coefficients:
##                  Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -1.258e+00  2.505e-01  -5.023 5.09e-07 ***
## co2_per_capita -7.566e-02  4.180e-02  -1.810   0.0703 .
## gdp_per_capita  1.225e-04  2.777e-05   4.412 1.03e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 223.21  on 163  degrees of freedom
## Residual deviance: 188.47  on 161  degrees of freedom
##   (56 observations deleted due to missingness)
## AIC: 194.47
##
## Number of Fisher Scoring iterations: 4
```

```
ggplot(Kyoto_Protocol,aes(x=co2_per_capita+gdp_per_capita,y=kyoto))+geom_smooth()
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'

## Warning: Removed 56 rows containing non-finite values (stat_smooth).
```




```
#Step 9
#Out-Of-Sample Predictions for the Kyoto Protocol

Kyto_Pred <- data.frame(kyto=mean(Kyoto_Protocol$kyoto,na.rm = T),
                        gdp_per_capita=mean(Kyoto_Protocol$gdp_per_capita,na.rm = T),
                        co2_per_capita=c(co2_per_capitaMin=min(Kyoto_Protocol$co2_per_capita,na.rm = T)
                        co2_per_capitaMax=max(Kyoto_Protocol$co2_per_capita,na.rm = T),
                        co2_per_capitaMean=mean(Kyoto_Protocol$co2_per_capita,na.rm = T))
                        )

PredictonsKytoTreaty=predict.glm(Kyto_logit,Kyto_Pred)
print(PredictonsKytoTreaty)
```

```
##  co2_per_capitaMin  co2_per_capitaMax co2_per_capitaMean
##         0.08361975        -4.26515426        -0.25838635
```