An Interpretable Linear Regression Demo

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We set the **working directory**.

```
setwd("/home/hbunyamin/Projects/interpretable-ml-book/R/")
```

Let's load the dataset (Molnar 2019).

```
load("../data/bike.RData")
```

We view the first five rows.

```
head(bike)
```

```
##   season   yr mnth    holiday weekday     workingday weathersit     temp
## 1 SPRING 2011  JAN NO HOLIDAY     SAT NO WORKING DAY      MISTY 8.175849
## 2 SPRING 2011  JAN NO HOLIDAY     SUN NO WORKING DAY      MISTY 9.083466
## 3 SPRING 2011  JAN NO HOLIDAY     MON    WORKING DAY       GOOD 1.229108
## 4 SPRING 2011  JAN NO HOLIDAY     TUE    WORKING DAY       GOOD 1.400000
## 5 SPRING 2011  JAN NO HOLIDAY     WED    WORKING DAY       GOOD 2.666979
## 6 SPRING 2011  JAN NO HOLIDAY     THU    WORKING DAY       GOOD 1.604356
##       hum windspeed  cnt days_since_2011
## 1 80.5833 10.749882  985               0
## 2 69.6087 16.652113  801               1
## 3 43.7273 16.636703 1349               2
## 4 59.0435 10.739832 1562               3
## 5 43.6957 12.522300 1600               4
## 6 51.8261  6.000868 1606               5
```

We summarize the `bike` dataset as follows:

```
summary(bike)
```

```
##     season       yr           mnth           holiday    weekday
##  SPRING:181   2011:365   JAN    : 62   NO HOLIDAY:710   SUN:105
##  SUMMER:184   2012:366   MAR    : 62   HOLIDAY   : 21   MON:105
##  FALL  :188              MAY    : 62                     TUE:104
##  WINTER:178              JUL    : 62                     WED:104
##                          AUG    : 62                     THU:104
##                          OKT    : 62                     FRI:104
##                          (Other):359                     SAT:105
##           workingday            weathersit       temp             hum
##  NO WORKING DAY:231   GOOD           :463   Min.   :-5.221   Min.   : 0.00
##  WORKING DAY   :500   MISTY          :247   1st Qu.: 7.843   1st Qu.:52.00
##                       RAIN/SNOW/STORM: 21   Median :15.422   Median :62.67
##                                             Mean   :15.283   Mean   :62.79
##                                             3rd Qu.:22.805   3rd Qu.:73.02
##                                             Max.   :32.498   Max.   :97.25
```

```
##
##    windspeed           cnt       days_since_2011
##  Min.   : 1.500   Min.   :  22   Min.   :  0.0
##  1st Qu.: 9.042   1st Qu.:3152   1st Qu.:182.5
##  Median :12.125   Median :4548   Median :365.0
##  Mean   :12.763   Mean   :4504   Mean   :365.0
##  3rd Qu.:15.625   3rd Qu.:5956   3rd Qu.:547.5
##  Max.   :34.000   Max.   :8714   Max.   :730.0
##
```

We extract the features columns just like in the slides as follows:

```
bike_to_interpreted <- bike[c("cnt", "season", "holiday", "days_since_2011",
                          "workingday", "weathersit", "temp", "hum", "windspeed")]
```

We summarize the `bike_to_interpreted` dataset.

```
summary(bike_to_interpreted)
```

```
##       cnt          season          holiday    days_since_2011
##  Min.   :  22   SPRING:181   NO HOLIDAY:710   Min.   :  0.0
##  1st Qu.:3152   SUMMER:184   HOLIDAY   : 21   1st Qu.:182.5
##  Median :4548   FALL  :188                    Median :365.0
##  Mean   :4504   WINTER:178                    Mean   :365.0
##  3rd Qu.:5956                                 3rd Qu.:547.5
##  Max.   :8714                                 Max.   :730.0
##           workingday            weathersit       temp             hum
##  NO WORKING DAY:231   GOOD           :463   Min.   :-5.221   Min.   : 0.00
##  WORKING DAY   :500   MISTY          :247   1st Qu.: 7.843   1st Qu.:52.00
##                       RAIN/SNOW/STORM: 21   Median :15.422   Median :62.67
##                                             Mean   :15.283   Mean   :62.79
##                                             3rd Qu.:22.805   3rd Qu.:73.02
##                                             Max.   :32.498   Max.   :97.25
##    windspeed
##  Min.   : 1.500
##  1st Qu.: 9.042
##  Median :12.125
##  Mean   :12.763
##  3rd Qu.:15.625
##  Max.   :34.000
```

At last, we create the *interpretable linear model* that is **linear regression** as follows:

```
lm_bike <- lm(cnt ~ ., data=bike_to_interpreted)
```

We show the details of the linear models as follows:

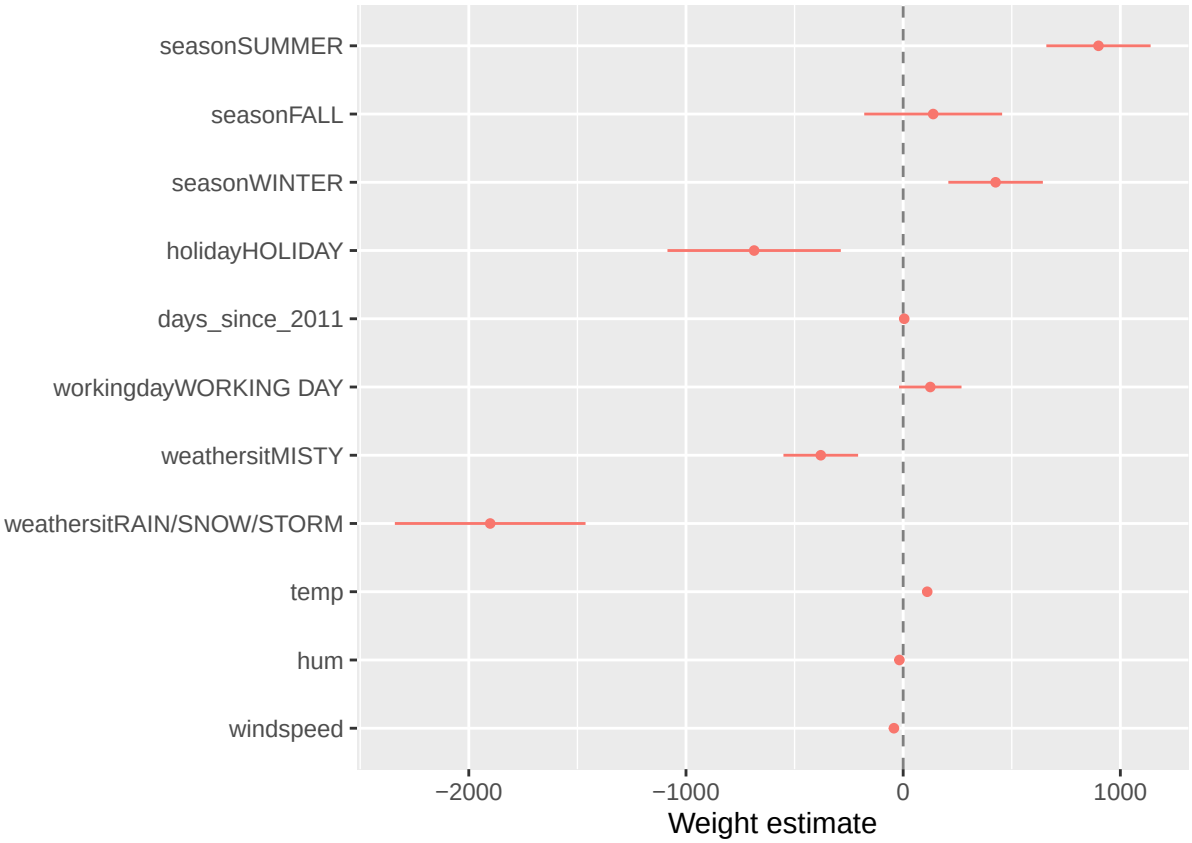
```
summary(lm_bike)
```

```
##
## Call:
## lm(formula = cnt ~ ., data = bike_to_interpreted)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3509.6  -397.9    78.7   534.1  3482.4
##
## Coefficients:
```

```
##                              Estimate Std. Error t value Pr(>|t|)
## (Intercept)                2399.4422   238.3066  10.069  < 2e-16 ***
## seasonSUMMER                899.3182   122.2833   7.354 5.24e-13 ***
## seasonFALL                  138.2154   161.7037   0.855 0.392977
## seasonWINTER                425.6029   110.8199   3.840 0.000134 ***
## holidayHOLIDAY             -686.1154   203.3015  -3.375 0.000778 ***
## days_since_2011               4.9264     0.1728  28.507  < 2e-16 ***
## workingdayWORKING DAY       124.9209    73.2666   1.705 0.088623 .
## weathersitMISTY            -379.3985    87.5532  -4.333 1.68e-05 ***
## weathersitRAIN/SNOW/STORM -1901.5399   223.6400  -8.503  < 2e-16 ***
## temp                        110.7096     7.0433  15.718  < 2e-16 ***
## hum                         -17.3772     3.1694  -5.483 5.80e-08 ***
## windspeed                   -42.5135     6.8917  -6.169 1.15e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 886.9 on 719 degrees of freedom
## Multiple R-squared:  0.7936, Adjusted R-squared:  0.7904
## F-statistic: 251.2 on 11 and 719 DF,  p-value: < 2.2e-16
```

We probably need to install the `dotwhisker` and `dply` packages. Specifically, with `dotwhisker` we can view the weights of our linear model. Alternatively, we can call `coef-plot.R` function.

```
library(dotwhisker)
library(dplyr)
dwplot(lm_bike,
       vline = geom_vline(xintercept = 0, colour = "grey50", linetype = 2)) + xlab("Weight estimate")
```

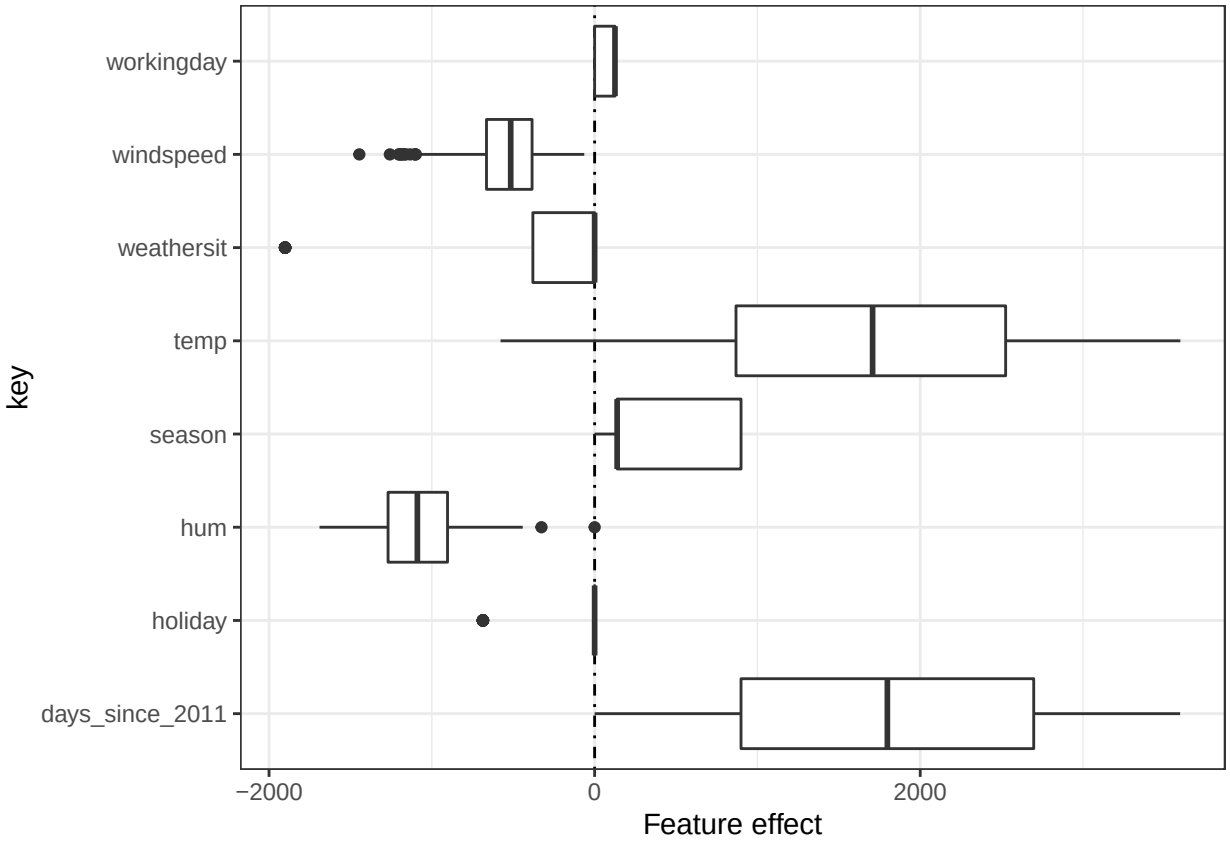


We can load the following R codes consisting several functions for showing the *interpretability of our linear regression* model.

```
source("/home/hbunyamin/Projects/interpretable-ml-book/R/utils.R", encoding = "UTF-8")
source("/home/hbunyamin/Projects/interpretable-ml-book/R/ggplot-theme.R", encoding = "UTF-8")
source("/home/hbunyamin/Projects/interpretable-ml-book/R/effect-plot.R", encoding = "UTF-8")
source("/home/hbunyamin/Projects/interpretable-ml-book/R/coef-plot.R", encoding = "UTF-8")
```

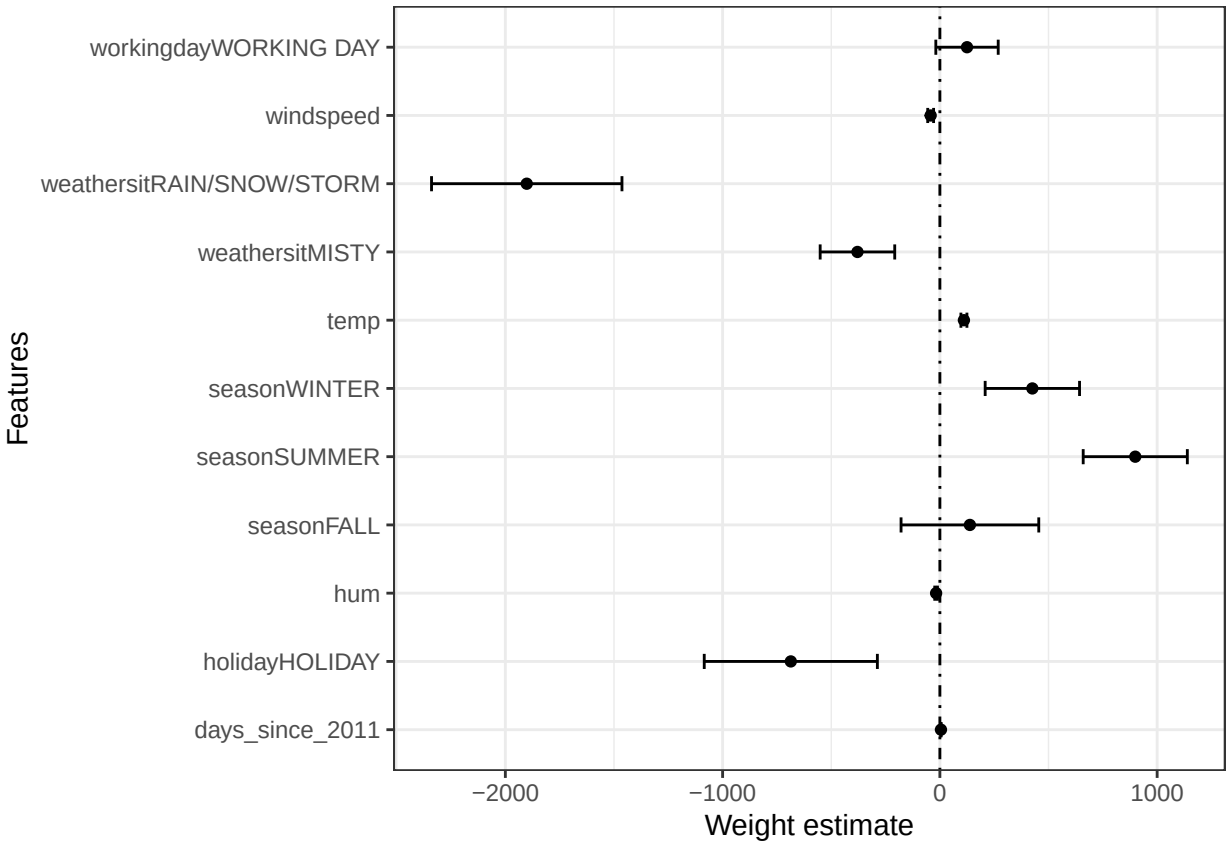
Let's display the **effect plot** of our model.

```
effect_plot(lm_bike, bike_to_interpreted)
```



Let's display the **coefficient plot** of our model.

```
coef_plot(lm_bike)
```



References

Molnar, Christoph. 2019. *Interpretable Machine Learning: A Guide for Making Black Box Models Explainable.*