Part 3: Relational Data, Preparing Data and Linear Models

(c) Linear Model - Energy Example

Transmission System (2017)

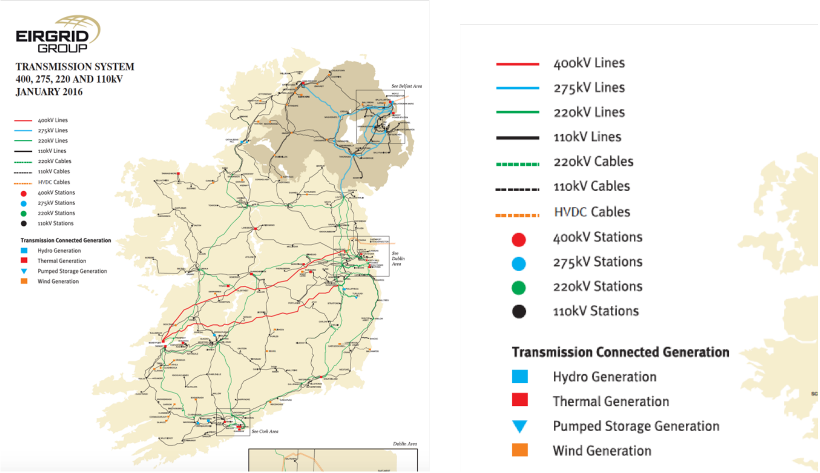


Figure 1: Electricity Transmission System

Generation Information

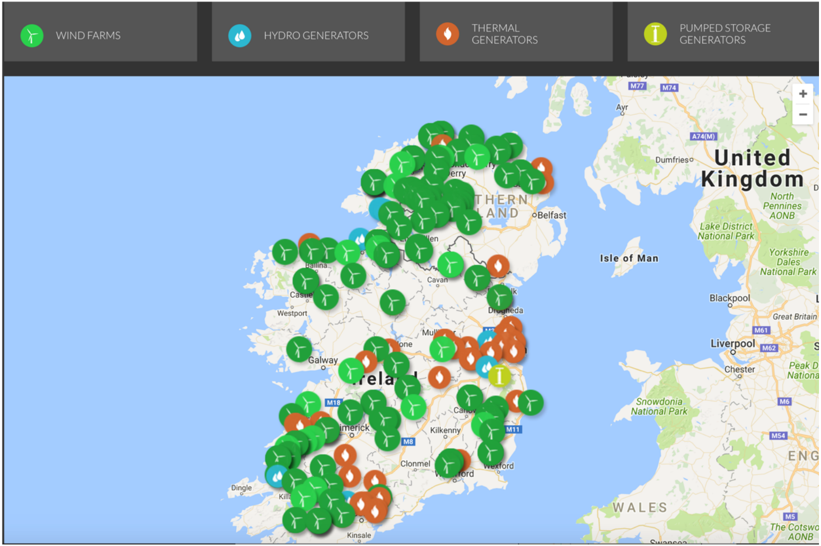
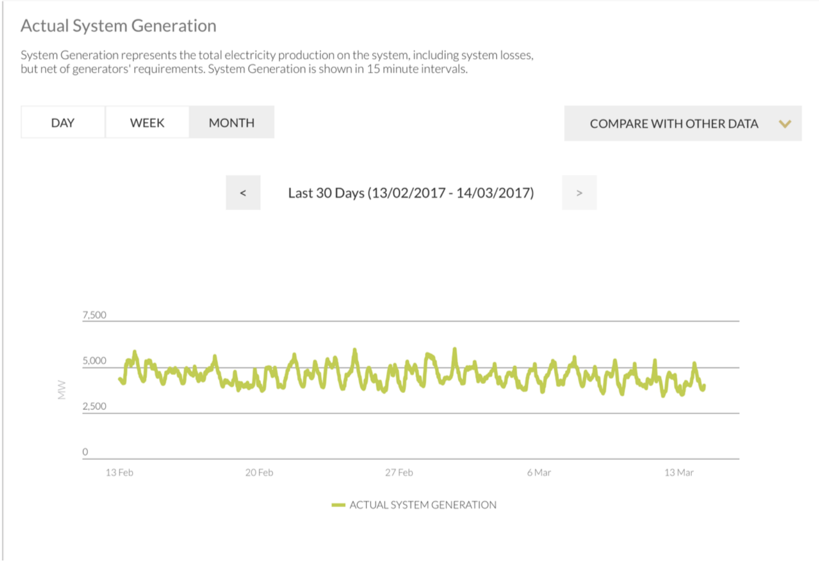


Figure 2: Generation Information

Sample Data



Actual System Generation

System Generation represents the total electricity production on the system, including system losses, but net of generators' requirements. System Generation is shown in 15 minute intervals.

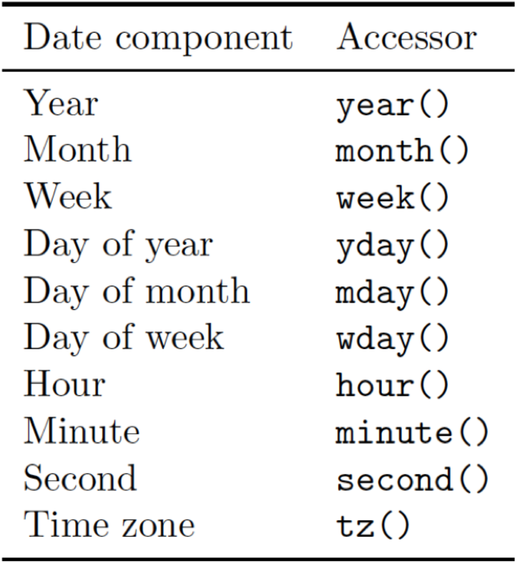
Figure 3: Generation Information

Accessing Data

```
ener <- read_excel("../../datasets/energy/IrelandData Janua
glimpse(ener)
```

```
## Observations: 2,784
## Variables: 8
## $ DateTime   <dttm> 2017-01-29 00:00:00, 2017-01-29 00:1
## $ Demand     <dbl> 3834, 3785, 3708, 3634, 3581, 3552, 3
## $ Generation <dbl> 4041, 4041, 4130, 4181, 4211, 4278, 4
## $ Wind       <dbl> 449, 505, 521, 492, 538, 561, 484, 47
## $ CO2        <dbl> 552, 548, 544, 543, 555, 531, 545, 55
## $ NetImports <dbl> -145, -200, -294, -419, -503, -598, -
## $ EWIC       <dbl> -33, -108, -183, -258, -333, -379, -3
## $ Moyle      <dbl> -112, -92, -111, -161, -170, -219, -1
```

Processing Dates - lubridate



Date component	Accessor
Year	`year()`
Month	`month()`
Week	`week()`
Day of year	`yday()`
Day of month	`mday()`
Day of week	`wday()`
Hour	`hour()`
Minute	`minute()`
Second	`second()`
Time zone	`tz()`

Extracting information

```
ener$DateTime[1]
```

```
## [1] "2017-01-29 UTC"
```

```
year(ener$DateTime[1])
```

```
## [1] 2017
```

```
wday(ener$DateTime[1])
```

```
## [1] 1
```

Adding New Columns

```
ener <- ener %>% mutate(Date=ymd(DateTime),
                        HourOfDay=hour(DateTime),
                        MinuteOfDay=minute(DateTime),
                        DayOfWeek=wday(DateTime,label=T))
```

```
## Warning: All formats failed to parse. No formats found.
```

```
glimpse(ener)
```

```
## Observations: 2,784
## Variables: 12
## $ DateTime    <dttm> 2017-01-29 00:00:00, 2017-01-29 00:
## $ Demand      <dbl> 3834, 3785, 3708, 3634, 3581, 3552,
## $ Generation  <dbl> 4041, 4041, 4130, 4181, 4211, 4278,
## $ Wind        <dbl> 449, 505, 521, 492, 538, 561, 484, 4
## $ CO2         <dbl> 552, 548, 544, 543, 555, 531, 545, 5
## $ NetImports  <dbl> -145, -200, -294, -419, -503, -598,
## $ EWIC        <dbl> -33, -108, -183, -258, -333, -379, -
## $ Moyle       <dbl> -112, -92, -111, -161, -170, -219, -
```

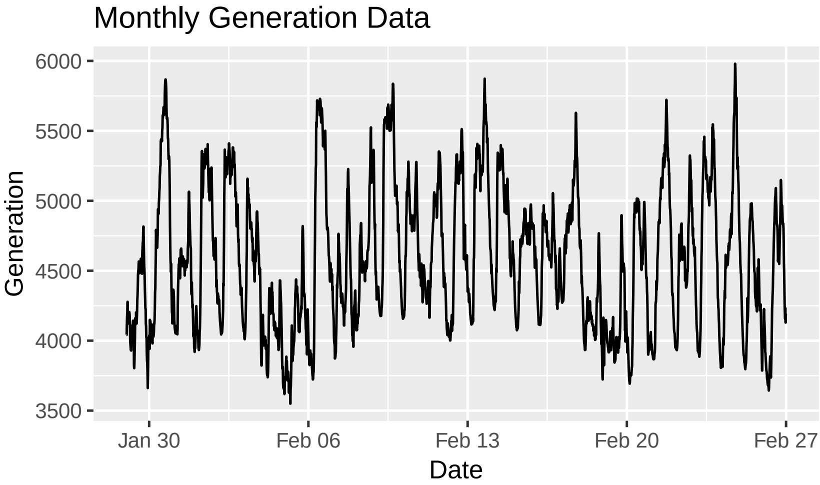
Split out date and time (need for join later)

```
ener <- ener %>% separate(DateTime,c("Date","Time"),
                          sep=" ", remove=F) %>%
        mutate(Date=ymd(Date))
glimpse(ener)
```

```
## Observations: 2,784
## Variables: 13
## $ DateTime    <dttm> 2017-01-29 00:00:00, 2017-01-29 00:
## $ Date        <date> 2017-01-29, 2017-01-29, 2017-01-29,
## $ Time        <chr> "00:00:00", "00:15:00", "00:30:00",
## $ Demand      <dbl> 3834, 3785, 3708, 3634, 3581, 3552,
## $ Generation  <dbl> 4041, 4041, 4130, 4181, 4211, 4278,
## $ Wind        <dbl> 449, 505, 521, 492, 538, 561, 484, 4
## $ CO2         <dbl> 552, 548, 544, 543, 555, 531, 545, 5
## $ NetImports  <dbl> -145, -200, -294, -419, -503, -598,
## $ EWIC        <dbl> -33, -108, -183, -258, -333, -379, -
## $ Moyle       <dbl> -112, -92, -111, -161, -170, -219, -
## $ HourOfDay   <int> 0, 0, 0, 0, 1, 1, 1, 1, 2, 2, 2, 2,
## $ MinuteOfDay <int> 0, 15, 30, 45, 0, 15, 30, 45, 0, 15
```

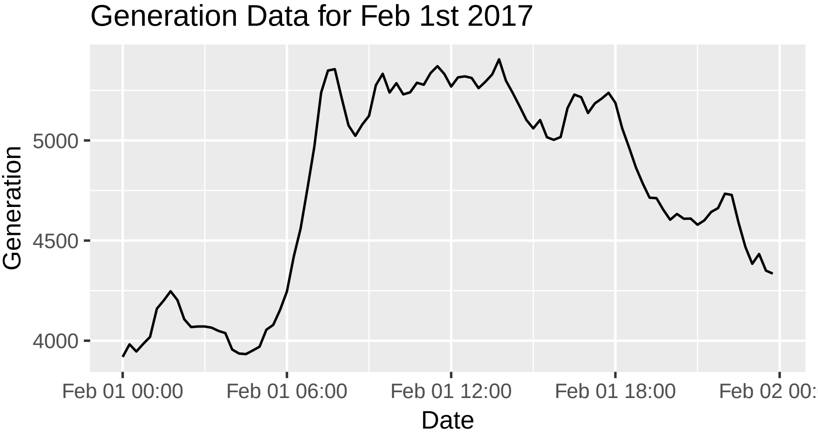
Plot time series

```
ggplot(data = ener,aes(x=DateTime, y=Generation)) +
  geom_line() + xlab("Date") + ylab("Generation") +
  ggtitle("Monthly Generation Data")
```



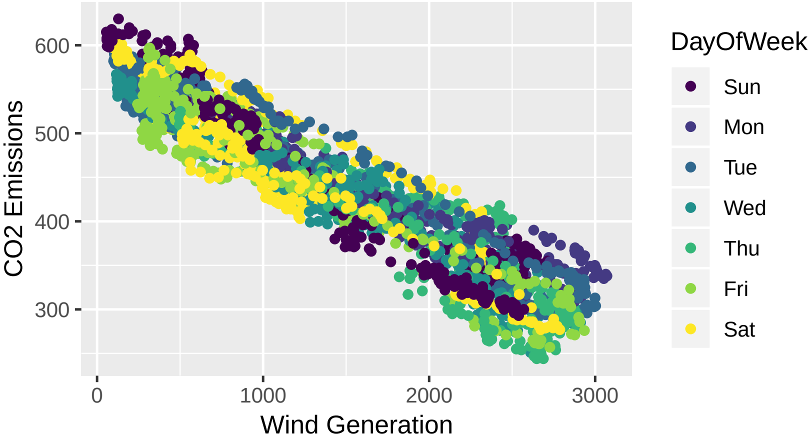
Value for 1/2/2017

```
ggplot(data = filter(ener,Date=="2017-02-01"),
       aes(x=DateTime, y=Generation)) +
  geom_line() + xlab("Date") + ylab("Generation") +
  ggtitle("Generation Data for Feb 1st 2017")
```

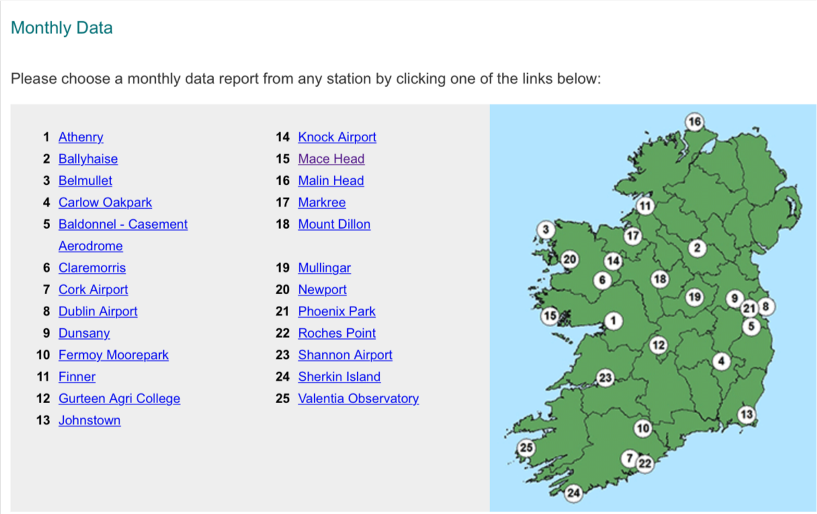


Wind Generation v CO2 Emissions

```
ggplot(data = ener) +
  geom_point(aes(x=Wind,y=CO2,colour=DayOfWeek))+
  xlab("Wind Generation") + ylab("CO2 Emissions")
```



Linking weather to wind generation

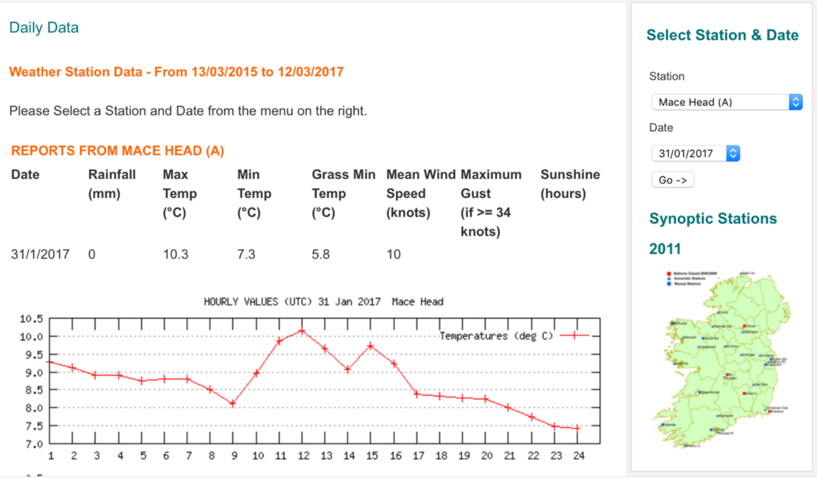


Monthly Data

Please choose a monthly data report from any station by clicking one of the links below:

1 Athenry
2 Ballyhaise
3 Belmullet
4 Carlow Oakpark
5 Baldonnel - Casement Aerodrome
6 Claremorris
7 Cork Airport
8 Dublin Airport
9 Dunsany
10 Fermoy Moorepark
11 Finner
12 Gurteen Agri College
13 Johnstown
14 Knock Airport
15 Mace Head
16 Malin Head
17 Markree
18 Mount Dillon
19 Mullingar
20 Newport
21 Phoenix Park
22 Roches Point
23 Shannon Airport
24 Sherkin Island
25 Valentia Observatory

Sample Data



Daily Data

Weather Station Data - From 13/03/2015 to 12/03/2017

Please Select a Station and Date from the menu on the right.

REPORTS FROM MACE HEAD (A)

Date	Rainfall (mm)	Max Temp (°C)	Min Temp (°C)	Grass Min Temp (°C)	Mean Wind Speed (knots)	Maximum Gust (if >= 34 knots)	Sunshine (hours)
31/1/2017	0	10.3	7.3	5.8	10		

Select Station & Date

Station

Mace Head (A)

Date

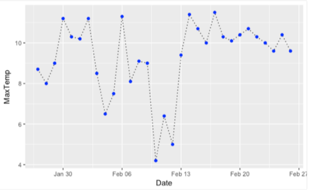
31/01/2017

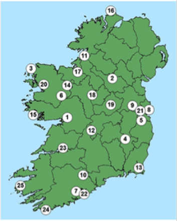
Synoptic Stations

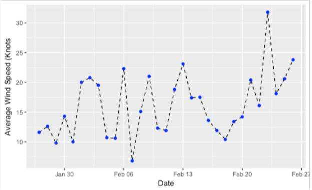
2011

http://www.met.ie

Mace Head Daily Data







Date	Rainfall	MaxTemp	MinTemp	GrassMinTemp	AVRWind	MaxWindGust
27/01/17	7.9	8.7	4.3	-0.7	11.6	
28/01/17	3.5	8	4.5	2.9	12.6	
29/01/17	4.7	9	4.9	3.7	9.8	
30/01/17	7.8	11.2	7.1	5.8	14.3	
31/01/17	0	10.3	7.3	5.8	10	
01/02/17	0.6	10.2	6.1	5.2	20	38
02/02/17	4.9	11.2	7.4	6.4	20.8	45
03/02/17	2.2	8.5	3.6	2.1	19.5	46
04/02/17	5.3	6.5	1.8	-1.3	10.7	

Weather Data

```
wd <- read_excel("../../datasets/energy/Mac Head Wind Data
wd <- mutate(wd,Date=ymd(Date))
slice(wd,1:7)
```

```
## # A tibble: 7 x 7
##   Date       Rainfall MaxTemp MinTemp GrassMinTemp AVRWi
##   <date>        <dbl>   <dbl>   <dbl>        <dbl>   <db
## 1 2017-01-27      7.9     8.7     4.3         -0.7    11
## 2 2017-01-28      3.5     8       4.5          2.9    12
## 3 2017-01-29      4.7     9       4.9          3.7     9
## 4 2017-01-30      7.8    11.2     7.1          5.8    14
## 5 2017-01-31      0      10.3     7.3          5.8    10
## 6 2017-02-01      0.6    10.2     6.1          5.2    20
## 7 2017-02-02      4.9    11.2     7.4          6.4    20
```

Select Required Columns - Generation

```r
gd <- select(ener,DateTime,Date,Wind) %>%
      arrange(DateTime)
slice(gd,1:7)
```

```
## # A tibble: 7 x 3
##   DateTime            Date        Wind
##   <dttm>              <date>     <dbl>
## 1 2017-01-29 00:00:00 2017-01-29   449
## 2 2017-01-29 00:15:00 2017-01-29   505
## 3 2017-01-29 00:30:00 2017-01-29   521
## 4 2017-01-29 00:45:00 2017-01-29   492
## 5 2017-01-29 01:00:00 2017-01-29   538
## 6 2017-01-29 01:15:00 2017-01-29   561
## 7 2017-01-29 01:30:00 2017-01-29   484
```

Select Required Columns - Weather

```r
wd1 <- select(wd,Date,AVRWind) %>%
      arrange(Date)
slice(wd1,1:7)
```

```
## # A tibble: 7 x 2
##   Date       AVRWind
##   <date>       <dbl>
## 1 2017-01-27    11.6
## 2 2017-01-28    12.6
## 3 2017-01-29     9.8
## 4 2017-01-30    14.3
## 5 2017-01-31    10
## 6 2017-02-01    20
## 7 2017-02-02    20.8
```

Approach

Need to find the average generation by wind from grid data

```
avr_wd1 <- gd %>% group_by(Date) %>%
  summarise(AvrWindGeneration=mean(Wind))
slice(avr_wd1,1:7)
```

```
## # A tibble: 7 x 2
##   Date       AvrWindGeneration
##   <date>                 <dbl>
## 1 2017-01-29              431.
## 2 2017-01-30             1726.
## 3 2017-01-31              330.
## 4 2017-02-01             2047.
## 5 2017-02-02             2647
## 6 2017-02-03             1050.
## 7 2017-02-04              591.
```

Join the tables

```r
join_t <- left_join(avr_wd1,wd1)
```

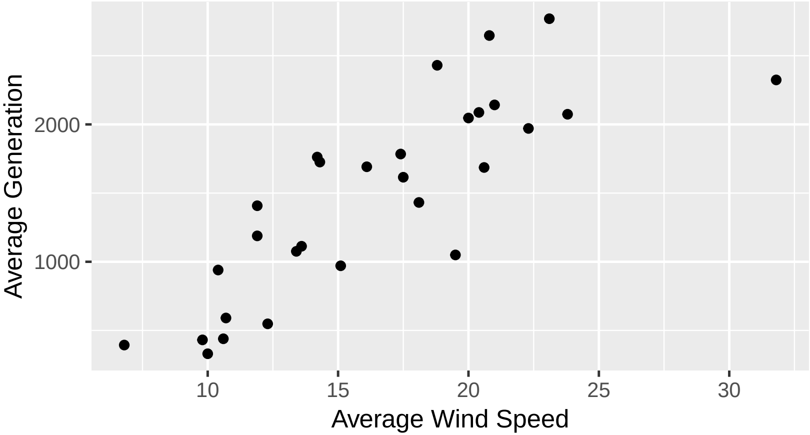
```
## Joining, by = "Date"
```

```r
slice(join_t,1:7)
```

```
## # A tibble: 7 x 3
##   Date       AvrWindGeneration AVRWind
##   <date>                 <dbl>   <dbl>
## 1 2017-01-29              431.     9.8
## 2 2017-01-30             1726.    14.3
## 3 2017-01-31              330.    10  
## 4 2017-02-01             2047.    20  
## 5 2017-02-02             2647     20.8
## 6 2017-02-03             1050.    19.5
## 7 2017-02-04              591.    10.7
```

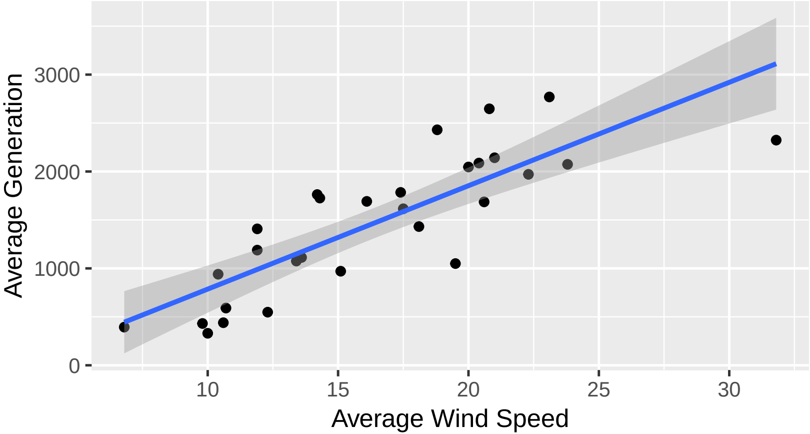
Plot Avr Wind Speed v Avr Wind Generation

```
ggplot(data = join_t) +
  geom_point(aes(x=AVRWind,y=AvrWindGeneration))+
  xlab("Average Wind Speed") + ylab("Average Generation")
```



Visualise Linear Model

```
ggplot(data = join_t,
       aes(x=AVRWind,y=AvrWindGeneration)) +
  geom_point()+xlab("Average Wind Speed") + ylab("Average G
  geom_smooth(method="lm")
```



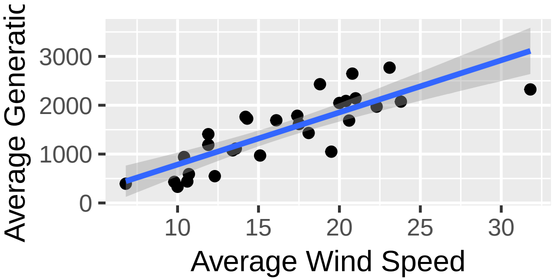
Generate Model

```r
mod <- lm(data=join_t,AvrWindGeneration~AVRWind)
mod
```

```
## 
## Call:
## lm(formula = AvrWindGeneration ~ AVRWind, data = join_t)
## 
## Coefficients:
## (Intercept)      AVRWind
##      -280.8        106.7
```

Predicting Values

```
ggplot(data = join_t,
       aes(x=AVRWind,y=AvrWindGeneration)) +
  geom_point()+xlab("Average Wind Speed") + ylab("Average 
  geom_smooth(method="lm")
```



```
predict(mod, newdata = data.frame(AVRWind=25))
```

```
##        1
## 2386.727
```

Challenge

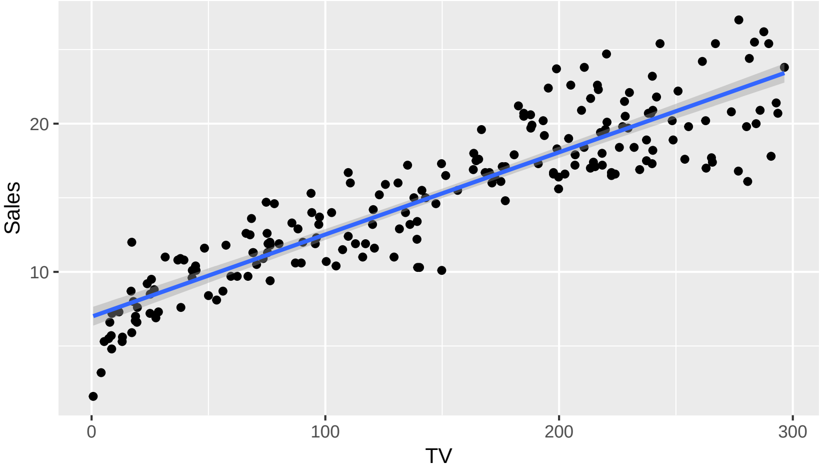
Generate linear models with the advertising data

```
adv <- read_excel("../../datasets/Advertising/AdvertisingDa
slice(adv,1:8)
```

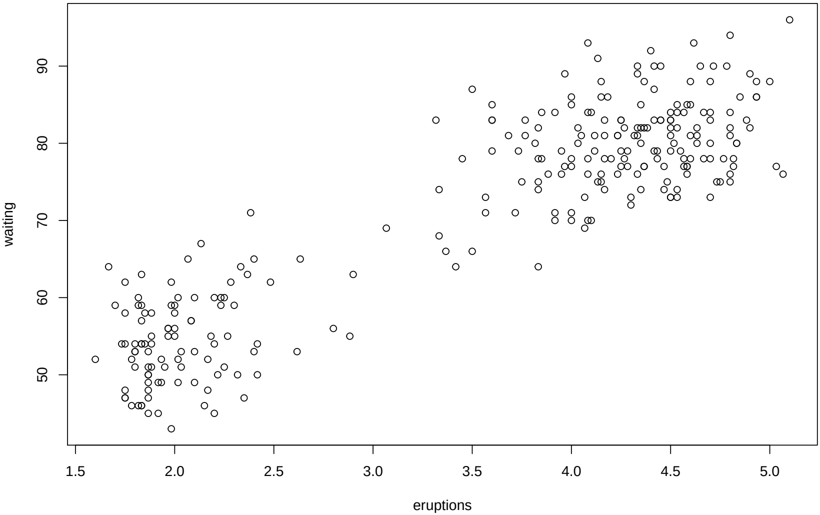
```
## # A tibble: 8 x 4
##       TV Radio Newspaper Sales
##    <dbl> <dbl>     <dbl> <dbl>
## 1 230.    37.8      69.2  22.1
## 2  44.5   39.3      45.1  10.4
## 3  17.2   45.9      69.3  12
## 4 152.    41.3      58.5  16.5
## 5 181.    10.8      58.4  17.9
## 6   8.7   48.9      75     7.2
## 7  57.5   32.8      23.5  11.8
## 8 120.    19.6      11.6  13.2
```

Visualise Relationship

```
ggplot(data = adv,
       aes(x=TV,y=Sales)) +
  geom_point()+geom_smooth(method="lm")
```



Test Slide with Plot


waiting
eruptions