R graphics with ggplot2

Ghana Data Science Workshop TADs

EPIDEMIOLOGY, ECONOMICS AND RISK ASSESSMENT (EERA)

Graphics in R

- Vizualising data is extremely important
  - data checking and understanding
  - very powerful way of describing results in presentations/publications etc
- R can produce journal quality graphs! (superior to Excel, Minitab etc.)
- BUT!!! There is a bit of R code to learn; the grammar of graphics (ggplot2 package)

NB: There are simpler ways to plot things with R, but are much uglier so this is worth the pain!

Install package and import dataset

- Install the **ggplot2** package.
- Run the library function to start using the ggplot2 functions.
- **ggplot2** is actually part of **tidyverse** so you can just load tidyverse.

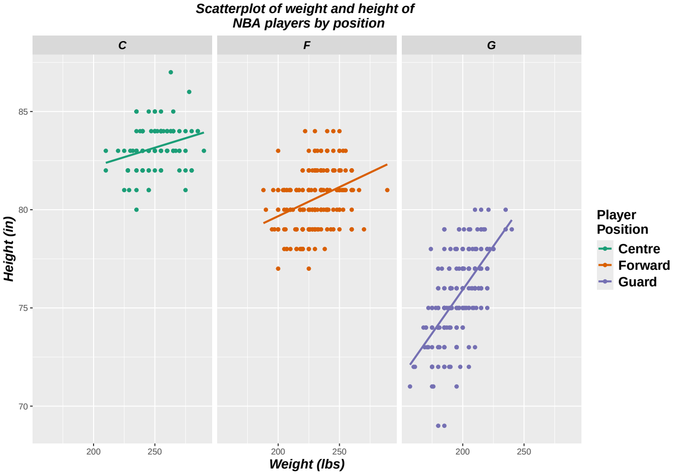
```r
#install.packages("ggplot2")
library(here)
library(ggplot2)
#OR
library(tidyverse)
```

- Import a dataset and see what we can do with it in **ggplot2**.
- The **"NBA.csv"** dataset contains the **height**, **weight**, **age** and **positions** of NBA players.

```r
nba <- read_csv(here("data","NBA.csv"))
```

An example of a plot by ggplot2

Now lets visualize the relationship between the **Weight** and **Height** of NBA players according to their **position**.



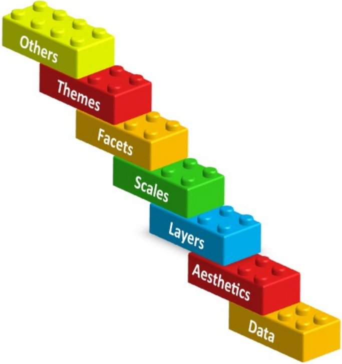
The code for this plot is the following!!

```
ggplot(nba, aes(x = Weight, y = Height, colour = Pos)) +
geom_point() +
stat_smooth(method = "lm", se = FALSE) +
scale_colour_brewer(palette="Dark2",
                    name  ="Player \nPosition",
                    breaks=c("C", "F", "G"),
                    labels=c("Centre", "Forward", "Guard")) +
facet_grid(. ~ Pos) +
labs(x = "Weight (lbs)",
     y = "Height (in)",
     title = "Scatterplot of weight and height of \n NBA players by position")
theme(axis.title = element_text(colour = "black", size = 14, face = "bold.itali
strip.text = element_text(colour = "black", face = "bold.italic", size = 12),
plot.title = element_text(colour = "black", size = 14, face = "bold.italic", hj
legend.title = element_text(colour="black", size=14, face="bold"),
legend.text = element_text(colour="black", size = 14, face = "bold") )
```

The ggplot grammar

- We just need to go through the ggplot grammar step by step.
- ggplots are composed of **building blocks** that are added to the plot one after the other using the + sign.

Here are the most important building blocks. We start building a plot from the bottom!



1. DATA

Anything you try to plot with ggplot needs to belong to a dataframe. The variables we want to visualize belong to the **NBA** dataset.

```
head(nba)
```

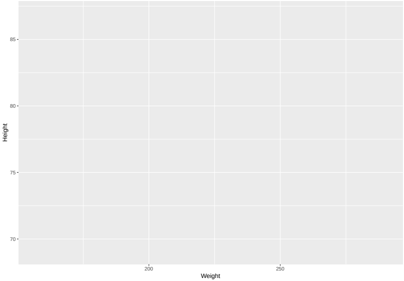
```
## # A tibble: 6 x 7
##        X Player              Pos   Height Weight   Age Age21
##    <dbl> <chr>               <chr>  <dbl>  <dbl> <dbl> <chr>
## 1      1 "Nate\xcaRobinson"  G         69    180    29 >21
## 2      2 "Isaiah\xcaThomas"  G         69    185    24 >21
## 3      3 "Phil\xcaPressey"   G         71    175    22 >21
## 4      4 "Shane\xcaLarkin"   G         71    176    20 <=21
## 5      5 "Ty\xcaLawson"      G         71    195    25 >21
## 6      6 "John\xcaLucas III" G         71    157    30 >21
```

2. Aesthetics mapping

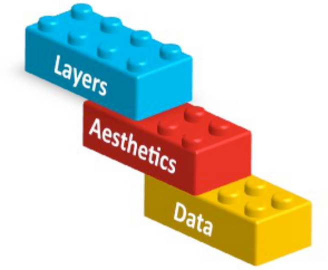
Aesthetics refer to the variables we want to see. In this case **Weight** and **Height**! So let's start building our plot using the **ggplot** function.

2. Aesthetics mapping

```
ggplot(data = nba, aes(x = Weight, y = Height))
```



3. Layers

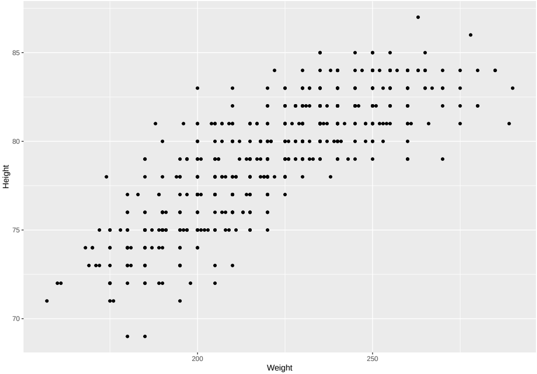


In order to see something on our plot we need to add layers. Layers include geometric elements (**geoms**) and statistical transformations (**stats**).

3. Layers

Since we want to build a scatterplot our first layer will be a layer of points (geom_point):

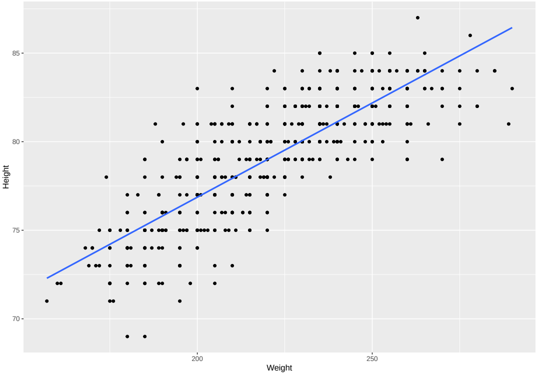
```
ggplot(data = nba, aes(x = Weight, y = Height)) +
  geom_point() # Layer 1
```



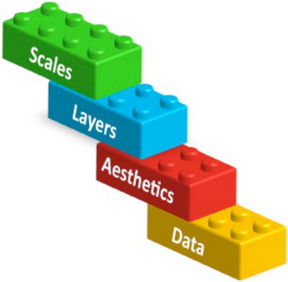
3. Layers

We also want to see the statistical relationship between weight and height so we will add a regression line as our second layer.

```r
ggplot(data = nba, aes(x = Weight, y = Height)) +
  geom_point() + # Layer 1
stat_smooth(method = "lm", se = FALSE) # Layer 2
```



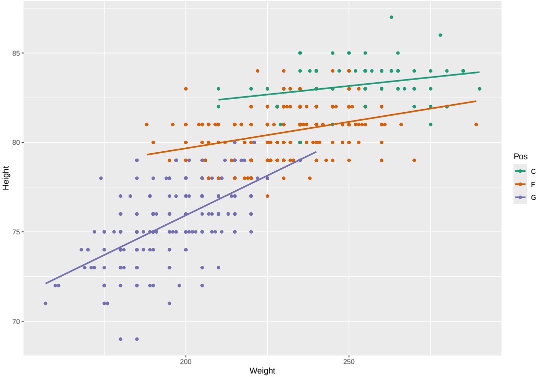
4. Scales



- Scales map values in the data space to values in an aesthetic space. This can be colour, size or shape.
- Let's colour each point by the player's position using scales.
- This will also automatically create a legend to explain the colours on the plot.

4. Scales

```
ggplot(data = nba, aes(x = Weight, y = Height, colour = Pos)) +
  geom_point() +
stat_smooth(method = "lm", se = FALSE) +
scale_colour_brewer(palette="Dark2")
```

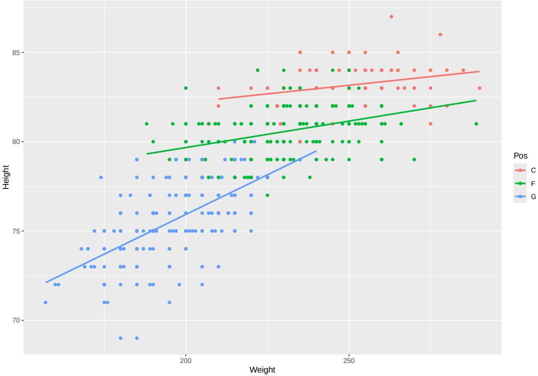


NB: You can obtain a similar plot just by adding a colour variable in the aesthetics. Scales give you the ability to have control over the colours chosen.

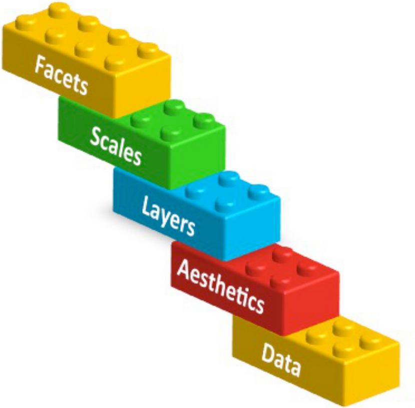
4. Scales

You can plot the same thing without using scales!

```
ggplot(data = nba, aes(x = Weight, y = Height, colour = Pos)) +
  geom_point() +
stat_smooth(method = "lm", se = FALSE)
```



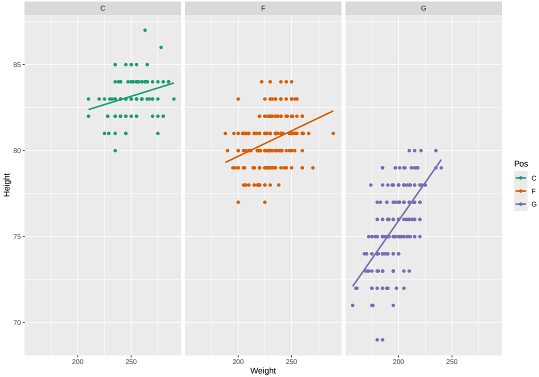
5. Facets



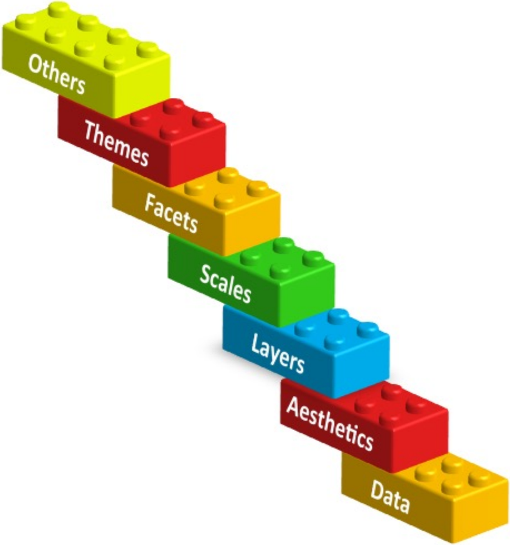
- What if we want to see a separate plot for each player position?
- Using facets we can display our data split by the chosen variable, in this case position.

5. Facets

```
ggplot(data = nba, aes(x = Weight, y = Height, colour = Pos)) +
  geom_point() +
stat_smooth(method = "lm", se = FALSE) +
scale_colour_brewer(palette="Dark2") +
facet_grid(. ~ Pos) # split grid by the variable Pos
```



6+7. Themes and other useful tricks!



6+7. Themes and other useful tricks!

ggplot is very flexible and you can adjust pretty much every aspect of the plot to your preference. In our original plot we had added a plot title using the **labs** function and the **title**, **x** and **y** arguments respectively as shown in the code below.

We also changed the title and labels of our legend by adding information to **scale** and the facet labels by adding information to **facet**.

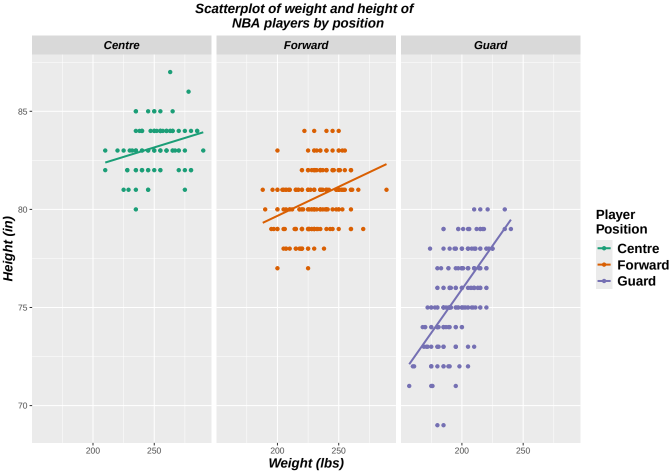
Lastly, we used **theme** to change font size, colour and style of many elements of the plot. You can use theme to change pretty much everything you like on your plot.

6+7. Themes and other useful tricks!

- Here is the whole code again!
- Check handout for some useful websites to understand each building block better!

```
ggplot(nba, aes(x = Weight, y = Height, colour = Pos)) +
geom_point() +
stat_smooth(method = "lm", se = FALSE) +
scale_colour_brewer(palette="Dark2",
                    name  ="Player \nPosition",
                    breaks=c("C", "F", "G"),
                    labels=c("Centre", "Forward", "Guard")) +
facet_grid(. ~ Pos, labeller=labeller(Pos = c("C"="Centre", "F"="Forward", "G"="
labs(x = "Weight (lbs)",
     y = "Height (in)",
     title = "Scatterplot of weight and height of \n NBA players by position")
theme(axis.title = element_text(colour = "black", size = 14, face = "bold.itali
strip.text = element_text(colour = "black", face = "bold.italic", size = 12),
plot.title = element_text(colour = "black", size = 14, face = "bold.italic", hj
legend.title = element_text(colour="black", size=14, face="bold"),
legend.text = element_text(colour="black", size = 14, face = "bold") )
```

Final plot!


Scatterplot of weight and height of
NBA players by position
Centre
Forward
Guard
Height (in)
85
80
75
70
200
250
200
250
200
250
Weight (lbs)
Player
Position
Centre
Forward
Guard

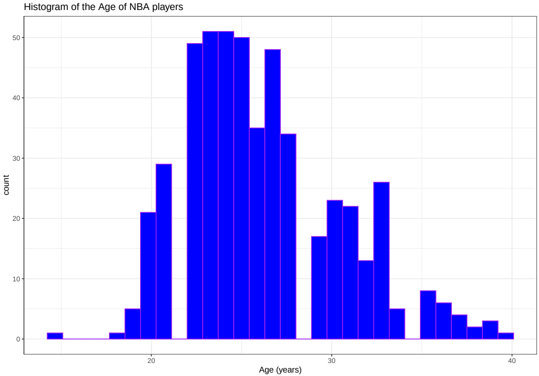
Other plot types

- You can plot pretty much any type of plot you like and you can change that by changing the **geom** type used.
- Some of the common ones are below and also in the cheat sheet provided.

geom	description
geom_point	Points, eg. a scatterplot
geom_line	lines
geom_ribbon	Ribbons, y range with continuous x
geom_polygon	Polygon, a filled path
geom_pointrange	vertical line with point in the middle
geom_path	connect observations in original order
geom_histogram	Histograms
geom_text	Textural annotations
geom_violin	Violin plots
geom_map	Polygons from map

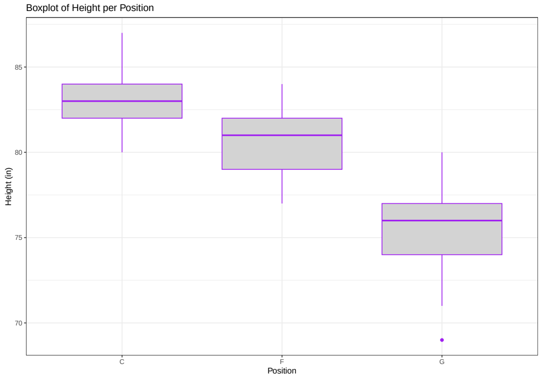
Histograms

```r
p <- ggplot(data=nba, aes(x=Age)) +
      geom_histogram( fill="blue", colour="purple") +
      labs(title="Histogram of the Age of NBA players",
           x="Age (years)") +
      theme_bw()
p
```



Boxplots

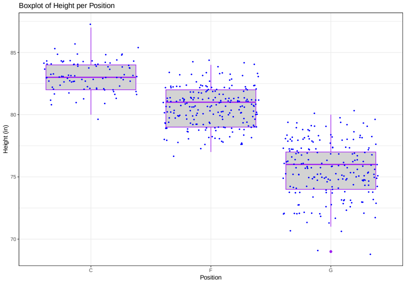
```
ggplot(data=nba) +
      geom_boxplot(aes(x=Pos, y=Height), fill="lightgrey",
                   colour="purple") +
      labs(x="Position",
           y="Height (in)",
           title="Boxplot of Height per Position") +
      theme_bw()
```



Boxplots

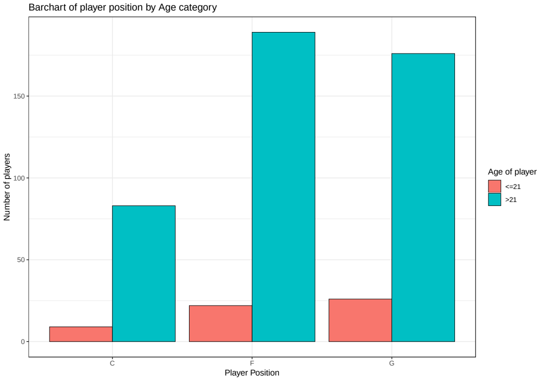
- Overlay the raw data as well
- Jitter to avoid overlap

```
ggplot(data=nba) +
geom_boxplot(aes(x=Pos, y=Height), fill="lightgrey", colour="purple") +
geom_jitter(aes(x=Pos, y=Height), colour="blue", size=0.5) +
labs(x="Position",
     y="Height (in)",
     title="Boxplot of Height per Position") +
theme_bw()
```



Barcharts

```r
ggplot(data=nba, aes(x=Pos, fill=Age21)) +
    geom_bar(colour="black", stat="count",
             position=position_dodge(),
             size=.3) +
    scale_fill_discrete(name="Age of player") +
    labs(x = "Player Position", y = "Number of players",
         title = "Barchart of player position by Age category") +
    theme_bw() # Set theme
```



More info

- R Cookbook Graphs
- Line plots tutorial
- Bar plots tutorials
- Scatter plots tutorials
- Histograms tutorial
- Boxplots tutorial

Exercises

- Ex1. Using dataset *mtcars* plot a box-plot of Gross horse power (*hp*) against number of cylinders (*cyl*). Give the plot the title *Boxplot by (Your Name)*. Add the real horse power values using dots coloured by Number of carburetors (*carb*) faceted by Number of forward gears (*gear*). Change the labels of gear to "3 Gears", "4 Gears", "5 Gears".

Hint: To find more info about a R dataset try *?mtcars*.

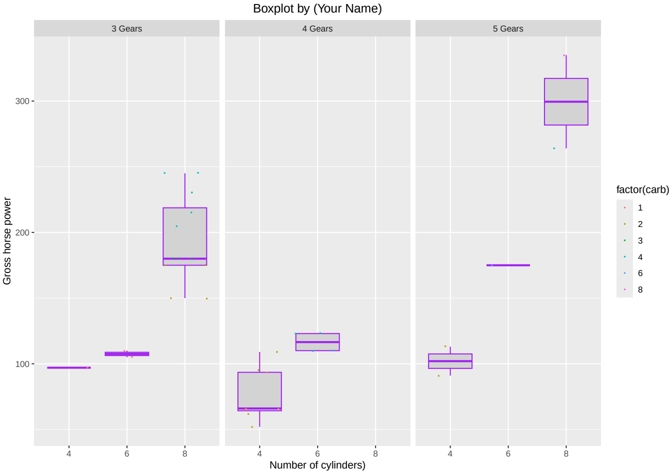
- Ex2. Using the same dataset plot a stacked bar chart of number of cylinders (*cyl*) by Transmission (*am*). Change colours corresponding to *am* manually to blue for 0 and red for 1. Change the legend labels to Autumatic and Manual and the legend title to Transmission.

Hint: Check the bar plots tutorial websites above for help or GOOGLE!! Which scale would allow us to manually change colours?

Answers - Ex1.

```
ggplot(data=mtcars) +
geom_boxplot(aes(x=factor(cyl), y=hp),
             fill="lightgrey", colour="purple") +
geom_jitter(aes(x=factor(cyl), y=hp,
                colour=factor(carb)), size=0.2) +
facet_grid(.~gear,
           labeller=labeller(gear = c("3"="3 Gears", "4"="4 Gears",
                                      "5"="5 Gears"))) +
labs(x = "Number of cylinders)",
     y = "Gross horse power",
     title = "Boxplot by (Your Name)") +
theme(plot.title = element_text(hjust = 0.5))
```

Answers - Ex1.

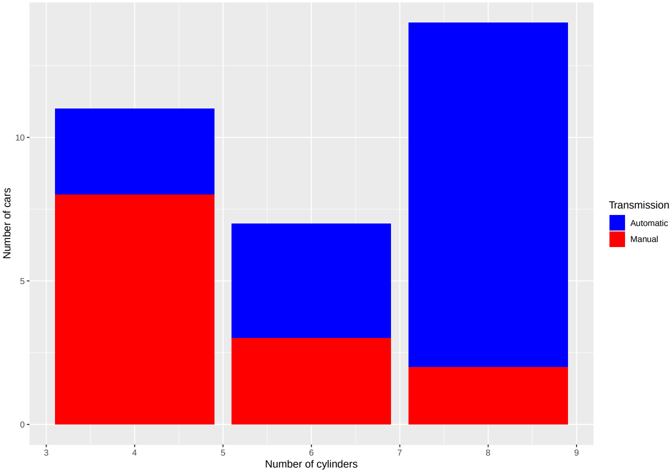


Boxplot by (Your Name)
3 Gears
4 Gears
5 Gears
Gross horse power
300
200
100
4
6
8
Number of cylinders)
factor(carb)
1
2
3
4
6
8

Answers - Ex2.

```
ggplot(data=mtcars) +
geom_bar(aes(x = cyl, fill = factor(am)),
                           stat= "count") +
scale_fill_manual(values = c("0" = "blue","1" = "red"),
                         name  ="Transmission",
                         breaks=c("0", "1"),
                         labels=c("Automatic", "Manual")) +
labs(x = "Number of cylinders",
     y = "Number of cars")
```

Answers - Ex2.



10
5
0
Number of cars
3
4
5
6
7
8
9
Number of cylinders
Transmission
Automatic
Manual