Introduction to Data Science (11372 & G 11516)

Semester 1 2021

UNIVERSITY OF CANBERRA

INTRODUCTION TO DATA SCIENCE

Lecture 10

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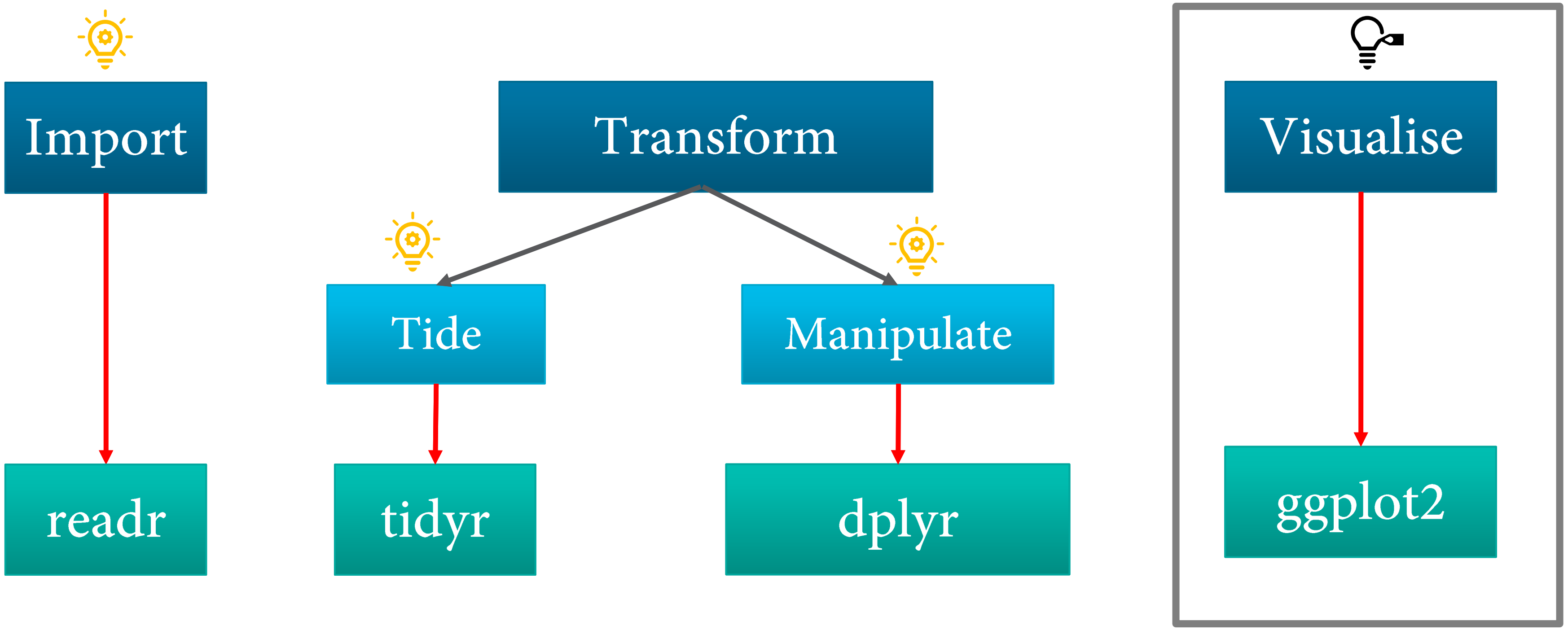
DISTINCTIVE BY DESIGN

OUTLINE

- Data Wrangling, a recap
- Exploratory Data Analysis, a recap
- EDA; Univariate Analysis
- EDA; Bivariate Analysis
  - Continuous
  - Continuous + discrete
  - Discrete

DATA WRANGLING

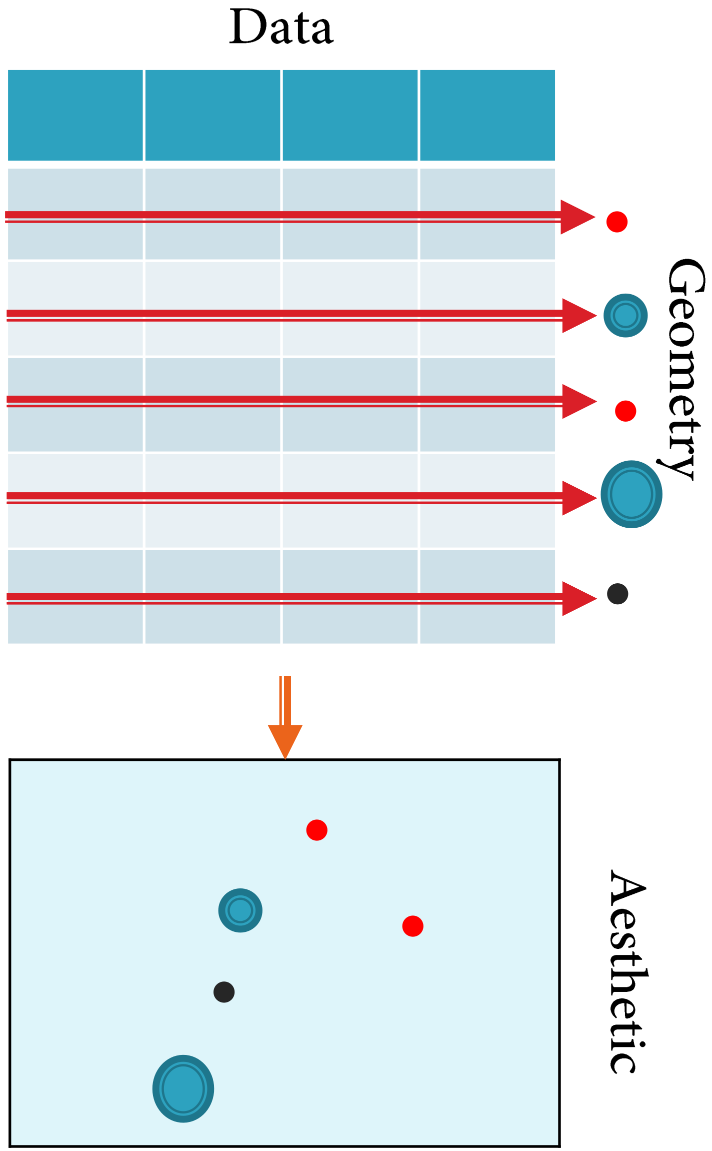
- Practically, we have three main processes to wrangle the data



GRAPH COMPONENTS

- To build a graph in R , you will need to specify three components:

  1. **Data:** the set of records/variables that we need to represent with a graph
  2. **Geometry:** the type of the plot, which will be generated, usually it is a function such as (scatterplot, boxplot, barplot, histogram, smooth density, etc.)
  3. **Aesthetic mapping**: the coordinate map and the other visual cues, such as size, scale and color.



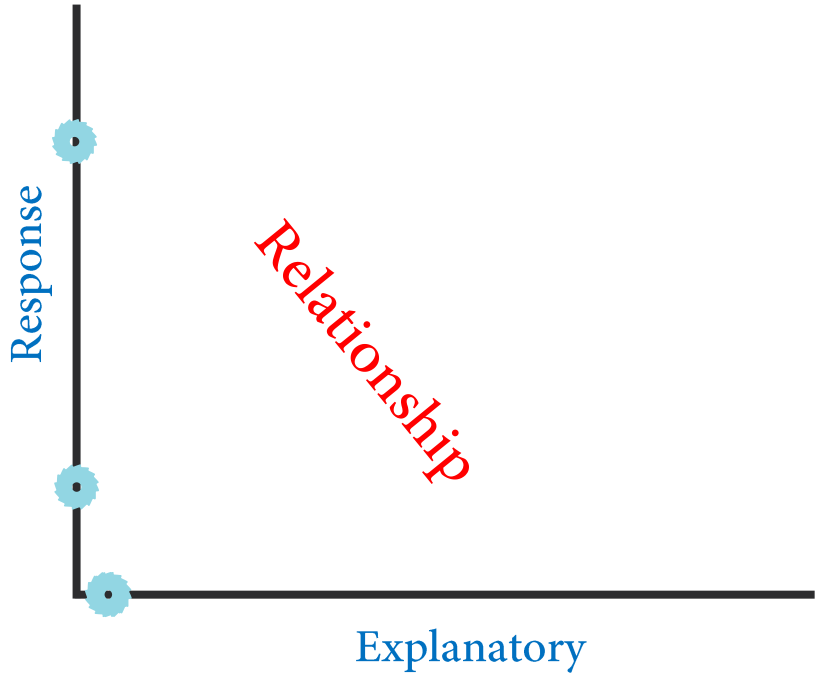
EXPLORATORY DATA ANALYSIS (EDA)

- To extract the relationships between variables or to discover the patterns/distributions of the variables, we need to check on the types of these variables.
- To conduct the data analysis on variables for sake of understanding their relationships, this analysis can be either:
  - Uni-variate analysis
    - Discover the variations of the data into **one** variable
  - Multi-variate analysis
    - Discover the co-variation of **multiple** variables
    - Bi-variate analysis is a special type of this analysis with only **two** variables.

EDA – UNIVARIATE (RECAP)

- There are two types of visualization-based univariate analysis:
  - Variation of a continuous variable
  - Variation of a discrete variable
- Examples of univariate continuous :
  - Histograms, etc.
- Examples of univariate discrete:
  - bar plots, etc.

EDA – BI-VARIATE ANALYSIS



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EDA – BI-VARIATE ANALYSIS (2)

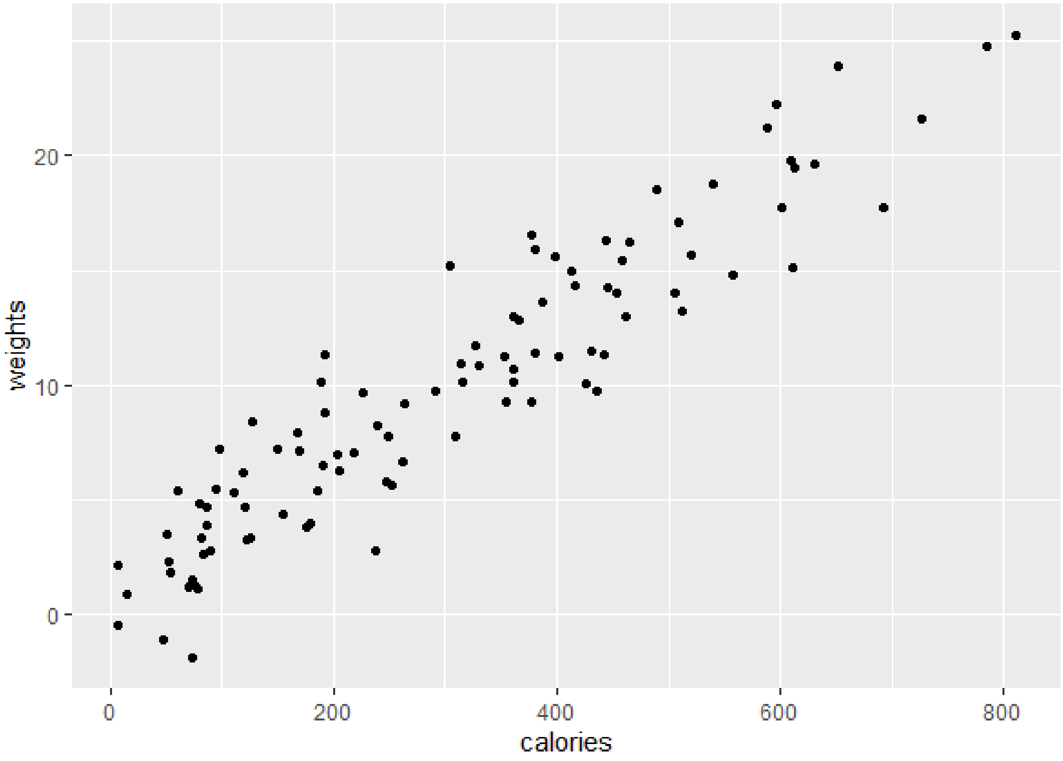
- The bivariate analysis will be done for each of the following pairs:
  - Bivariate analysis of a continuous variable with respect to another continuous variable
  - Bivariate analysis of a continuous variable with respect to a discrete variable
  - Bivariate analysis of a discrete variable with respect to another discrete variable

EDA – BIVARIATE, CONTINUOUS

- The analysis is done to inspect the relationship between two variables, where both of them are 'numerical', continuous variables.
- ggplot2 provides many functions to plot the variation between these two variables such as:
    - *geom_point()*, for a scatter plot
    - *geom_jitter(),* for scatter plot with displacing the overlapped points a bit away from each other
    - Etc.

SCATTER PLOTS

- Summarise the relationship between two variables as scatter dots in the cartesian plane.
- A scatter plot can be used to check properties, such as:
  - Correlation between variables;
  - Presence of outliers



BUILDING A SCATTERPLOT

1- a) First layer contains the data specification
   b) Also specifies the two variables

2- a) Second layer specifies the type of plot; the geometric function

3- a) Third and following layers specify axis labels and further visual cues

```
ggplot(data,aes(x= explanatory, y= response))+
  geom_point() +
  xlab(“x axis label”) +
  ylab(“y axis label”)+
  ggtitle(“plot title”)
```

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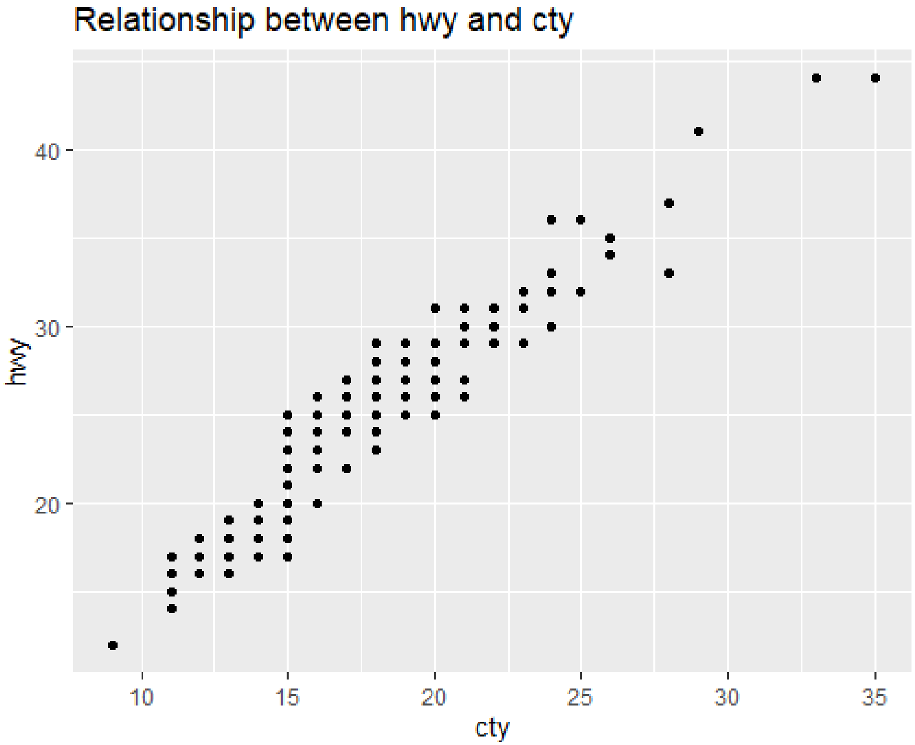
EXAMPLE

Basic scatterplot visualization

```
ggplot(data= mpg, aes(x= cty, y= hwy)) +
  geom_point() +
  theme_minimal() +
  ggtitle("Relationship between hwy and cty")
```



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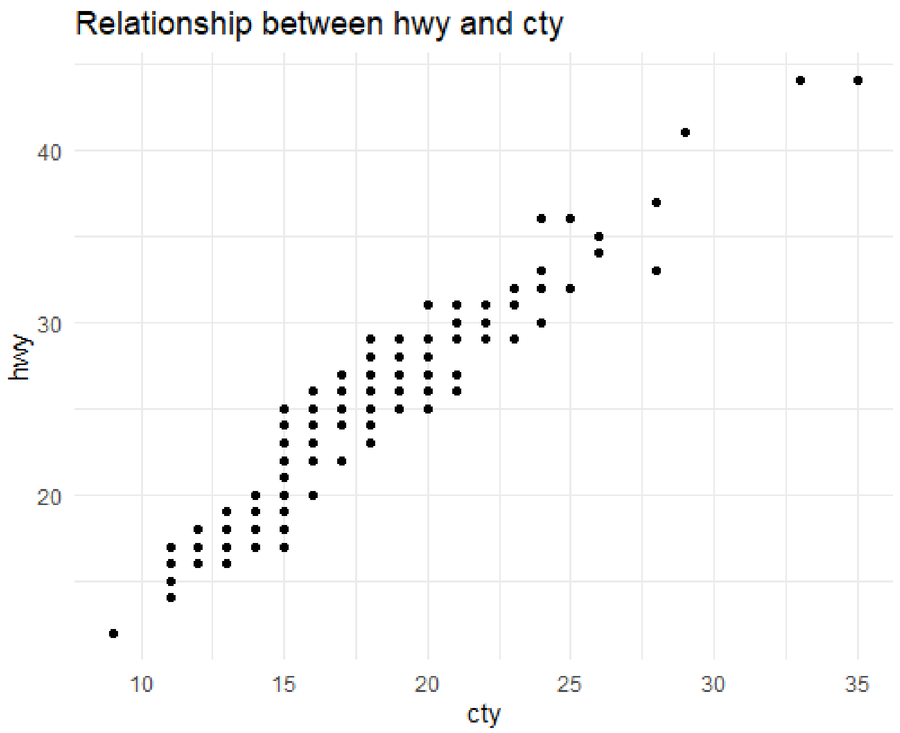
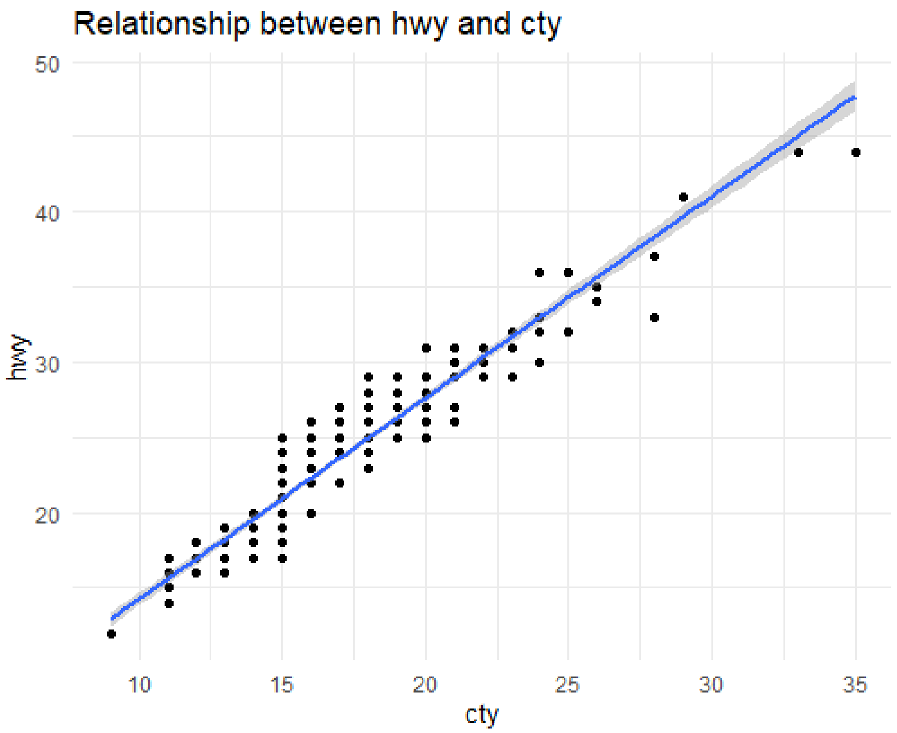
EXAMPLE (2)

Adding extra visual cues and more options


Relationship between hwy and cty


Relationship between hwy and cty

The full code is shared under week 10 on Canvas

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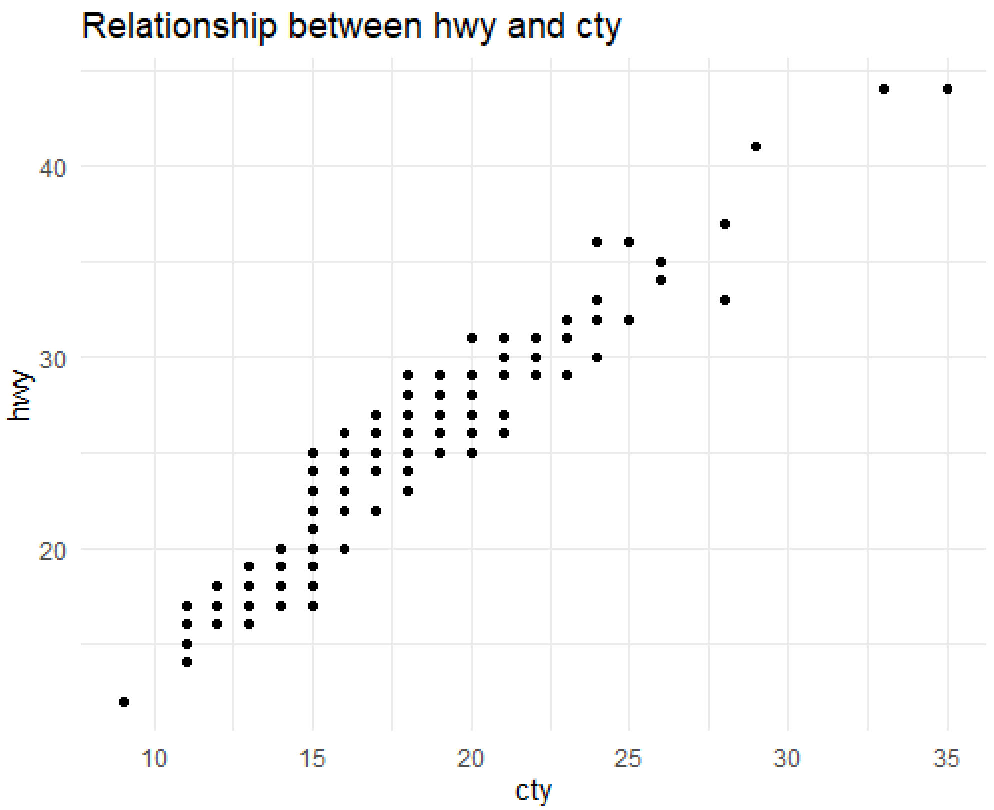
SCATTER PLOT INTERPRETATION



Scatter plot can be used to answer these questions:

- Are the variables related? [**Form**]
- Are they positively or negatively related? [**Direction**]
- What is the strength of the correlation?[**Strength**]
- Are there outliers?

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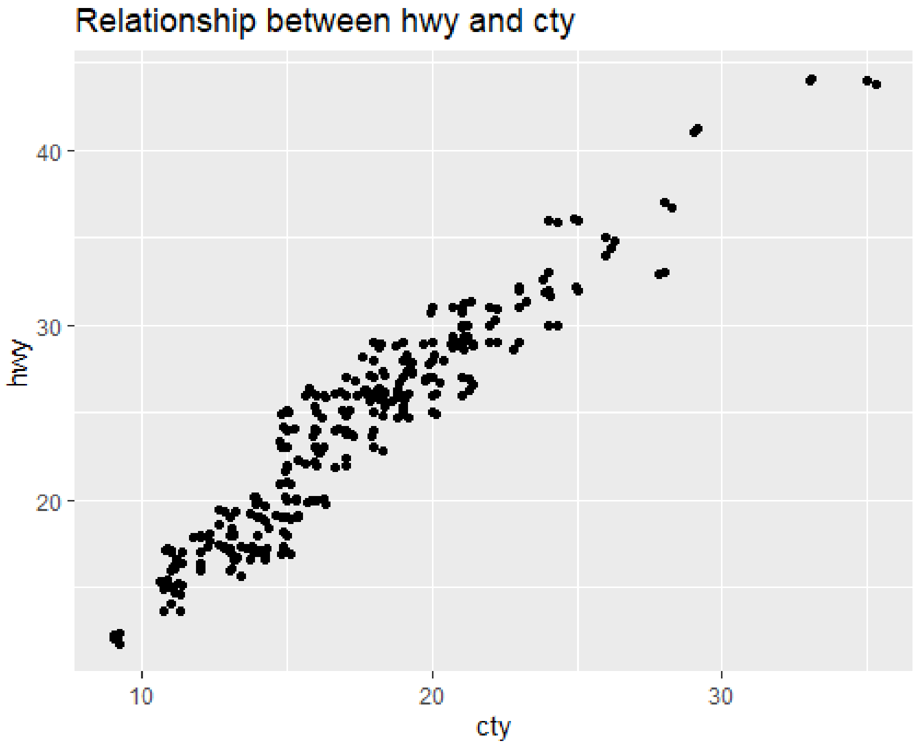
EXAMPLE OF JITTER PLOT

Basic jitterplot visualization

```
ggplot(data= mpg, aes(x= cty, y= hwy)) +
  geom_jitter() +
  theme_minimal() +
  ggtitle("Relationship between hwy and cty")
```



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EXAMPLE OF JITTER PLOT (2)

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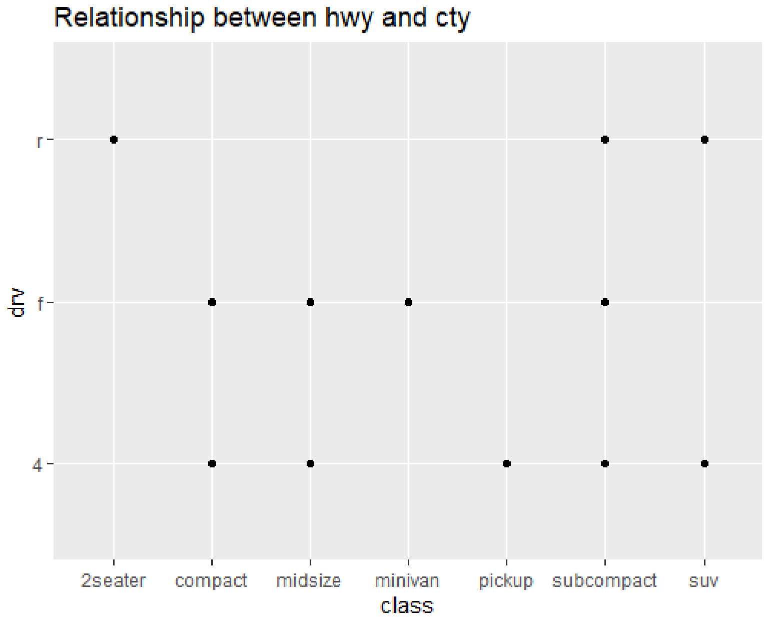
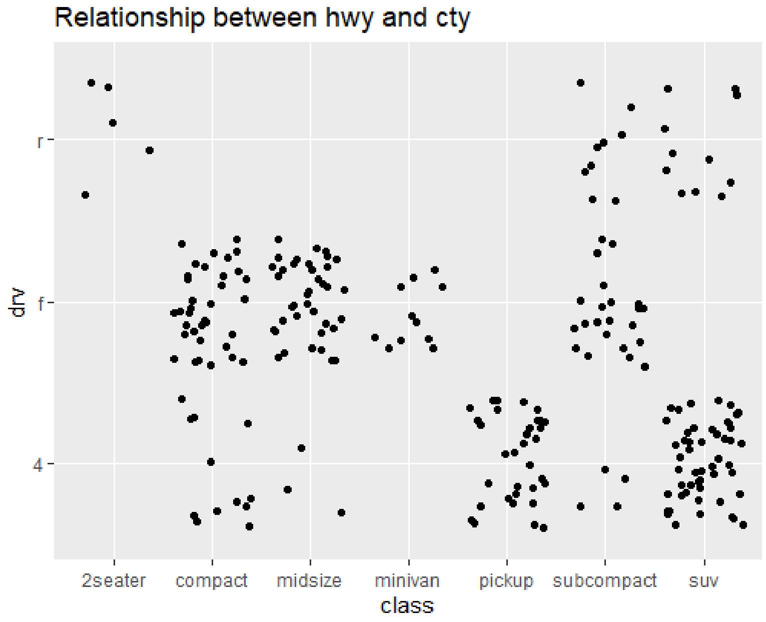
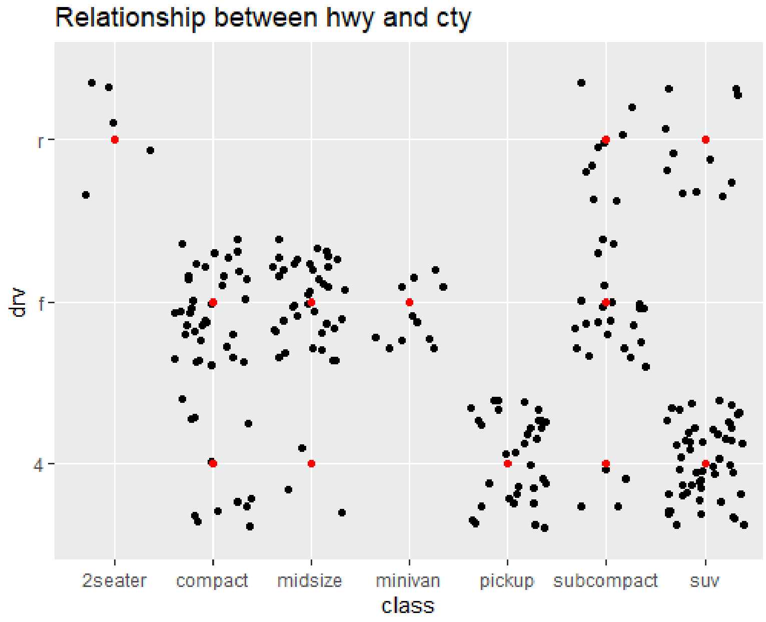
Adding extra visual cues and more options



```
mpg %>%
  ggplot(aes(class, drv)) +
  geom_point() +
  labs(title = "Relationship between class and drv")
```



```
mpg %>%
  ggplot(aes(class, drv)) +
  geom_jitter() +
  labs(title = "Relationship between class and drv")
```



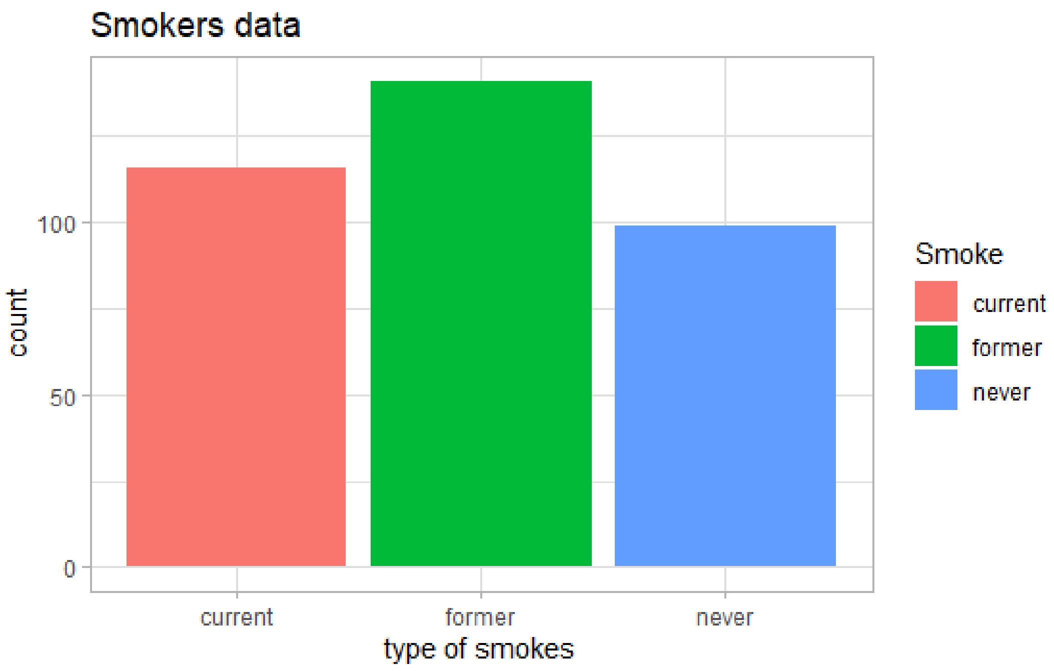
```
mpg %>%
  ggplot(aes(class, drv)) +
 geom_point(colour=“red”)+
  geom_jitter() +
  labs(title = "Relationship between class and drv")
```

BIVARIATE, CONTINUOUS & DISCRETE

- The analysis is done to inspect the relationship between two variables, where the explanatory variable is discrete and the response variable is continuous.
- ggplot2 provides some functions to plot this variation such as:
  - *geom_bar()*, for a bar plot
  - *geom_boxplot(),* for visualising the quantiles of response variable
  - Etc.

BAR PLOTS

- Bar plot is usually used to visualize the counts or the frequencies of the categories of the explanatory variable
- In this case, the visualisation is represented by bars
- The response variable is the counts or the frequencies



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BOXPLOTS

- Boxplot usually allows us to compare the distribution of a continuous variable across categories of a discrete variable
- It shows the distributions by marking the following values:
  - Minimum
  - Maximum
  - Median
  - IQR: inter Quantile Range
  - 25% percentile
  - 27% percentile

BUILDING A BOXPLOT

1- a) First layer contains the data specification
b) Also specifies the two variables

2- a) Second layer specifies the type of plot; the geometric function

3- a) Third and following layers specify axis labels and further visual cues

```
ggplot(data,aes(x= explanatory, y= response))+
  geom_boxplot(colour=classification) +
  xlab(“x axis label”) +
  ylab(“y axis label”)+
  ggtitle(“plot title”)
```

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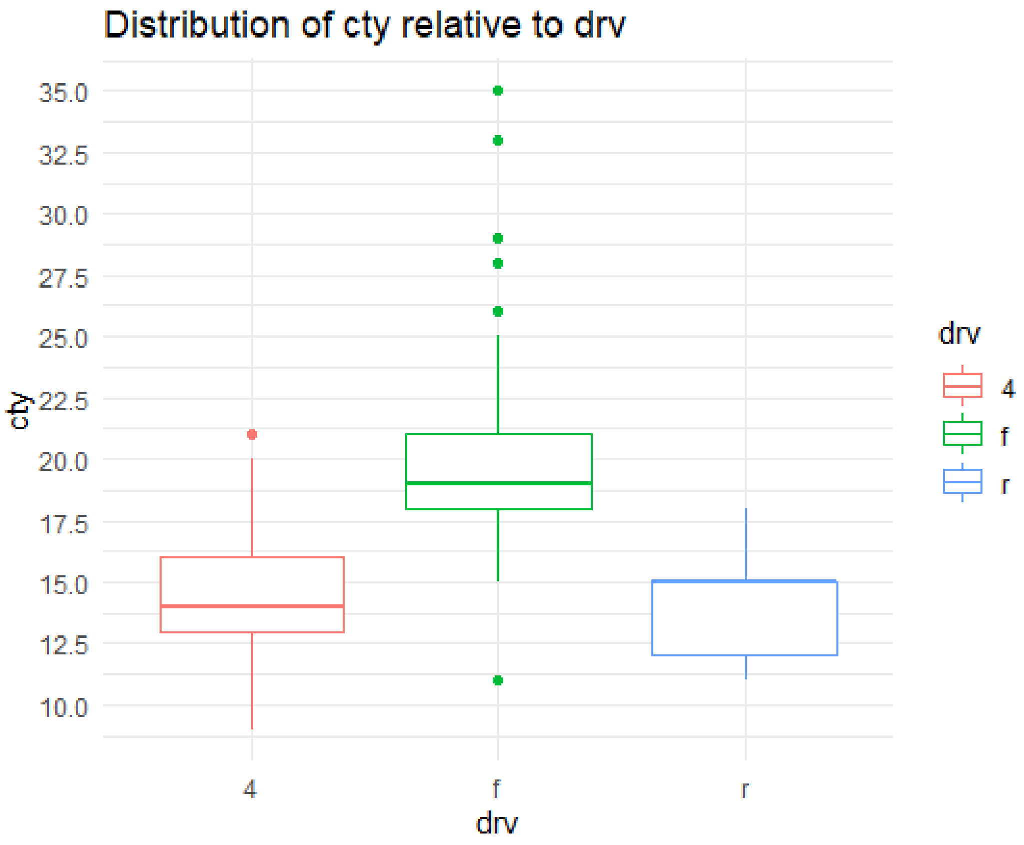
EXAMPLE

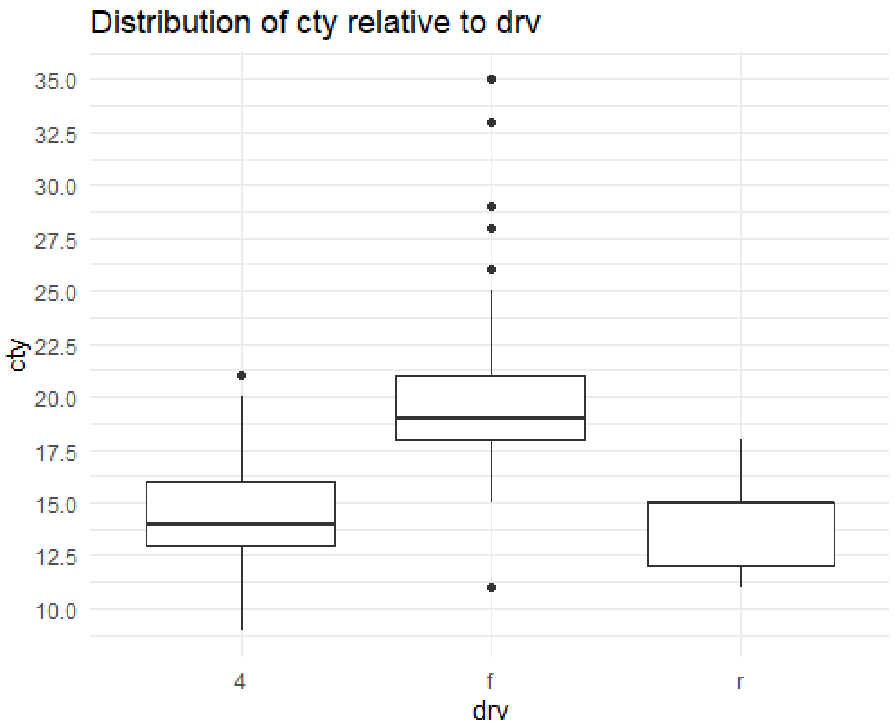
Basic boxplot visualization

```
ggplot(data= mpg, aes(x= drv, y= cty)) +
  geom_boxplot(colour=) +
  theme_minimal() +
  ggtitle("Relationship between drv and cty")
```

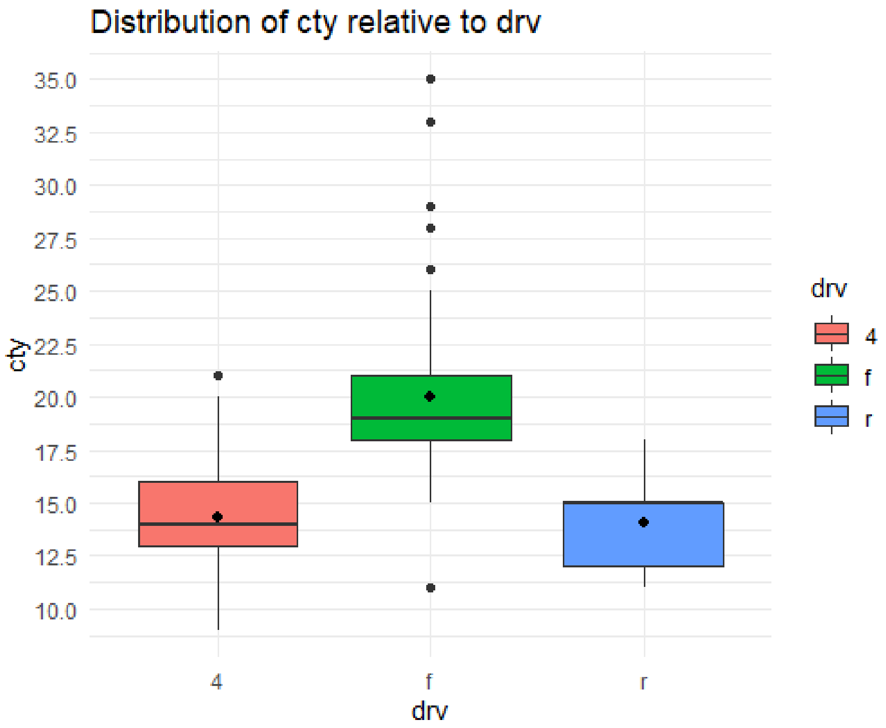


EXAMPLE (2)

Adding extra visual cues and more options



Basic plot



Combined with stat_summary

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BOXPLOTS INTERPRETATION

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- Bivariate box plots combined with stat_summary() can help to understand the distribution of the variables.
- They can also show the distribution of several levels, allowing you to efficiently identify outliers, find patterns and spread of the observations
- Excellent for conveying the variation and particularly detecting and illustrating the variation changes between different levels of data
- Boxplots can help answer the following questions:
  - Is a category significant over the others?
  - Does the center differ between categories?
  - Does the variation differ between categories?
  - Are there any outliers?

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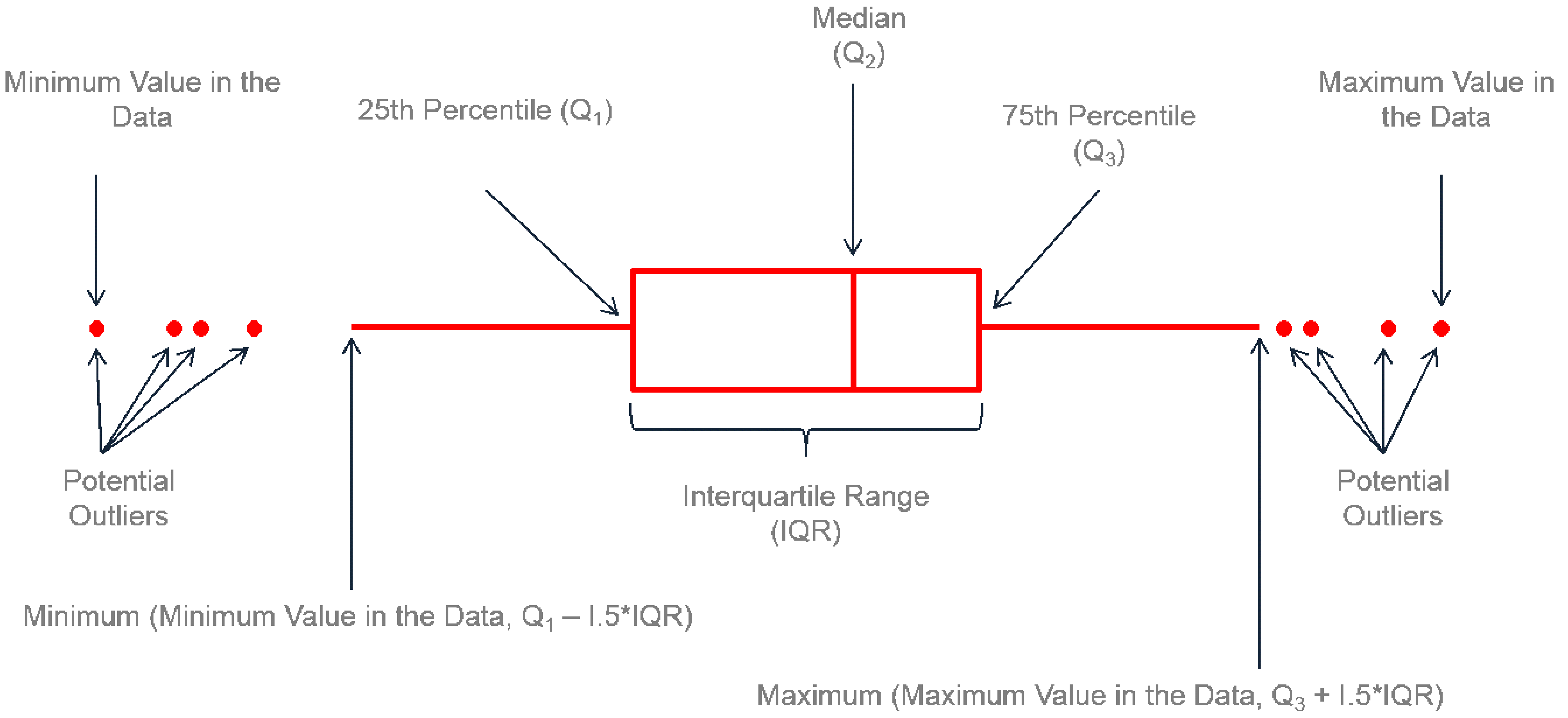
BOXPLOTS INTERPRETATION (2)


Median
(Q_2)
Minimum Value in the Data
25th Percentile (Q_1)
75th Percentile (Q_3)
Maximum Value in the Data
Potential Outliers
Interquartile Range (IQR)
Potential Outliers
Minimum (Minimum Value in the Data, Q_1 – 1.5*IQR)
Maximum (Maximum Value in the Data, Q_3 + 1.5*IQR)

Credit: https://www.leansigmacorporation.com/box-plot-with-minitab

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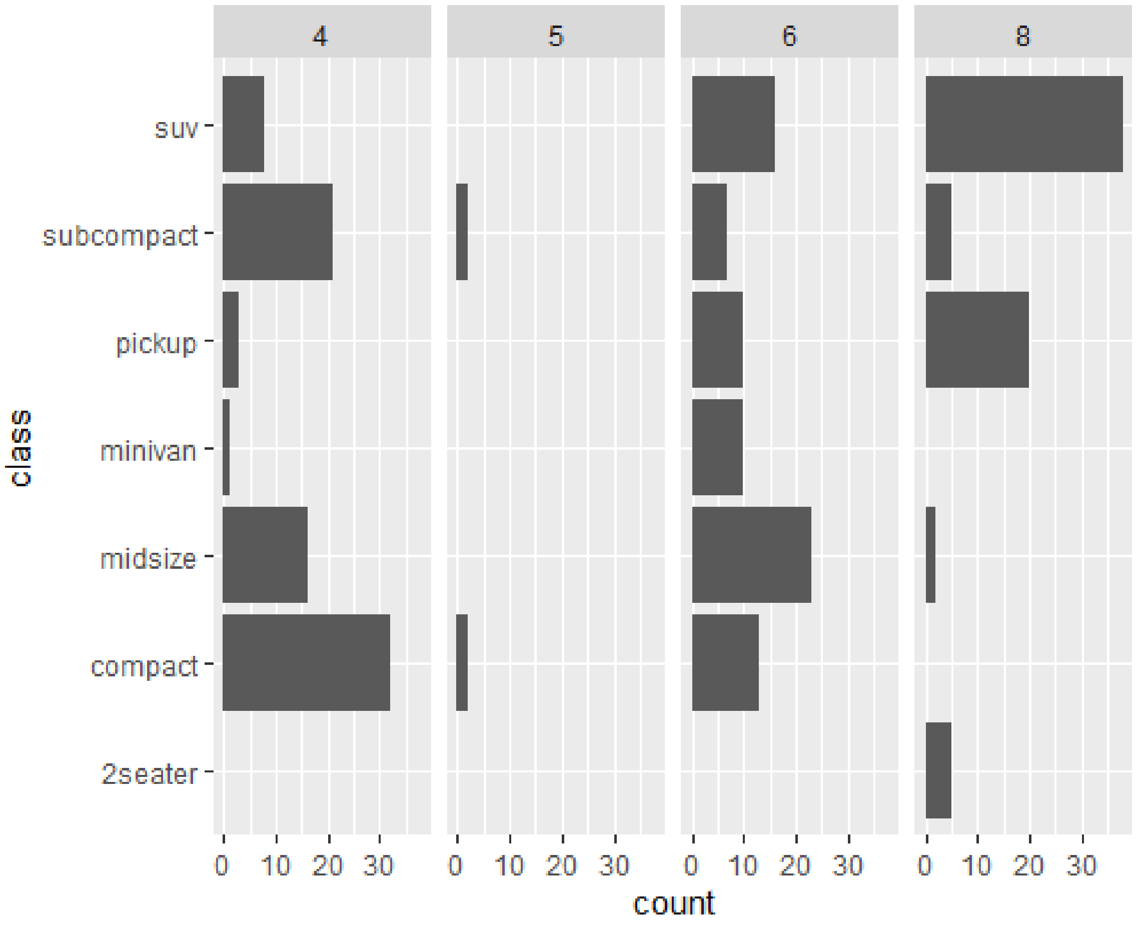
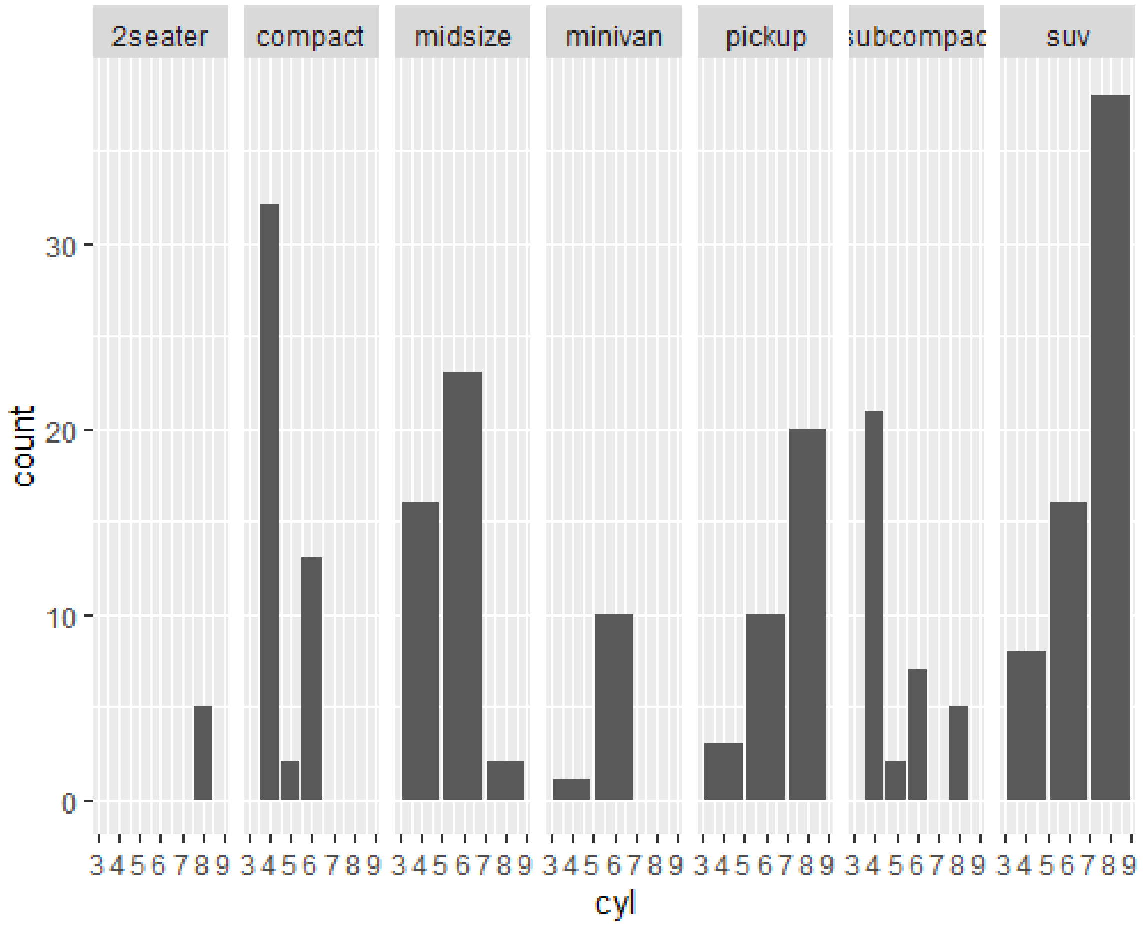
BIVARIATE, DISCRETE

- The analysis is done to inspect the relationship between two variables, where both of them are discrete.
- ggplot2 provides some functions to plot this variation such as:
  - *facet + geom_bar()*, for a bar chart for different categories as subplots
  - *geom_bin2d()*

EXAMPLE OF DISCRETE BIVARIATE

Facet + barplot





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RECOMMENDED READING

- You are recommended to read chapters 7 from the *“R for Data Science”* book:
  - https://r4ds.had.co.nz/exploratory-data-analysis.html
  - https://beta.rstudioconnect.com/content/3350/dplyr_tutorial.html