
# Data Science with R

Statistics – ITS

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# Meet 1 : Introduction R

**Outline**

- Introduction R and R Studio
  - Basic Calculation
  - If Statement
  - Looping Statement
  - Type of data
  - Read data and write data
- Visualization Data and Summary Data
  - Pie Chart, Bar Chart
  - Histogram, Box Plot
  - Scatterplot, Matrix Scatterplot
  - Summary data/Descriptive statistics (Mean, Median, Q1, Q3, St. Dev)
  - Make a simple analysis
- Let's Practice!

# Introduction R and R Studio

R is a language and environment for statistical computing and graphics. Available at https://cran.r-project.org/

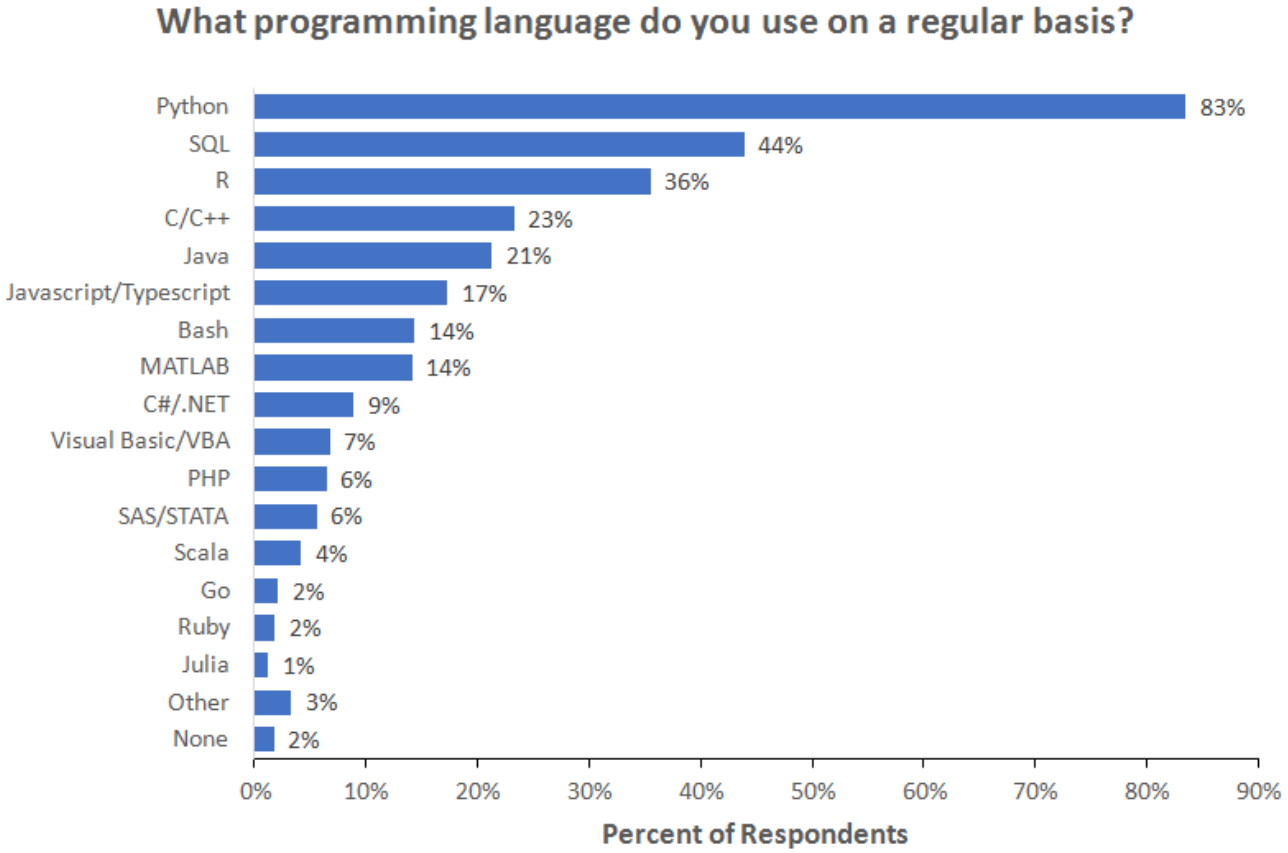
RStudio allows the user to run R in a more user friendly environment. It is open source (i.e. free) and available at http://www.rstudio.com/

# Introduction R and R Studio

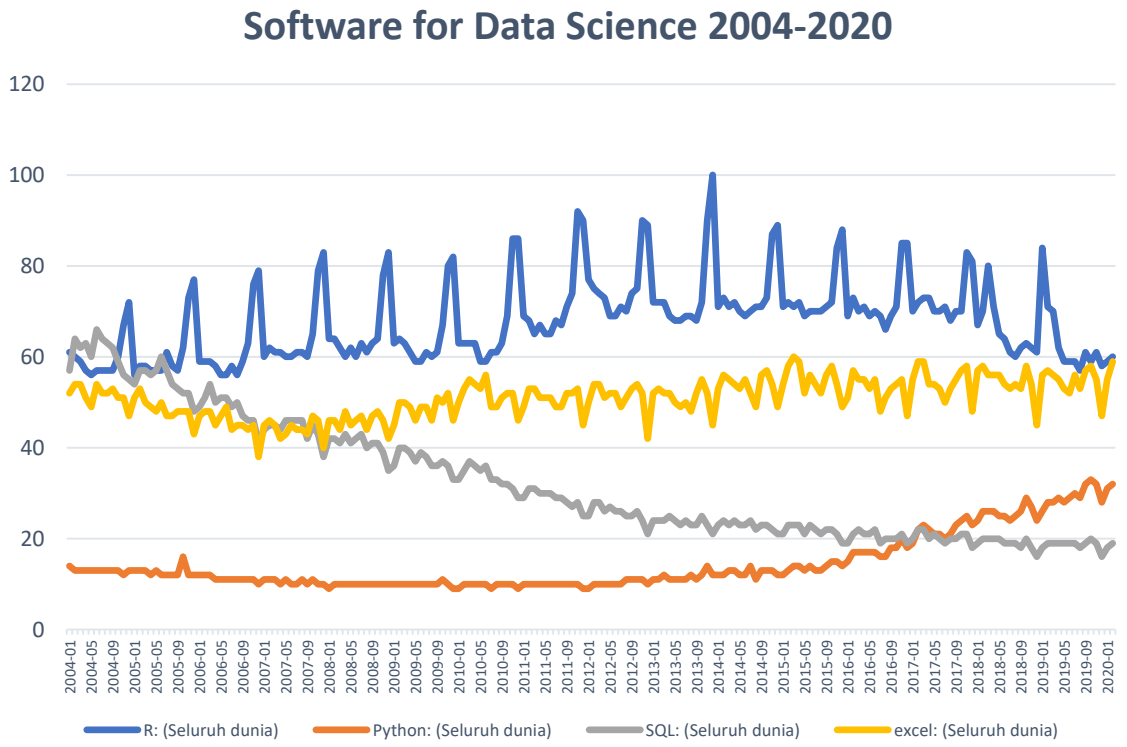
Why use R (R Studio)?

- **Data analysis software:** R is s data analysis software. It is used by data scientists for statistical analysis, predictive modeling and visualization.
- **Statistical analysis environment:** R provides a complete environment for statistical analysis. It is easy to implement statistical methods in R. Most of the new research in statistical analysis and modeling is done using R. So, the new techniques are first available only in R.
- **Open source:** R is open source technology, so it is very easy to integrate with other applications.
- **Community support:** R has the community support of leading statisticians, data scientists from different parts of the world and is growing rapidly.
- **It's free:** R use free package to analysis data

# Introduction to R




Note: Data are from the 2018 Kaggle Machine Learning and Data Science Survey. You can learn more about the study here: http://www.kaggle.com/kaggle/kaggle-survey-2018. A total of 18827 respondents answered the question.



# Introduction to R

## Aritmathic function in R/R Studio and Variable Assignment

In its most basic form, R can be used as a simple calculator. Consider the following arithmetic operators:

- Addition: +
- Subtraction: -
- Multiplication: *
- Division: /
- Exponentiation: ^
- Modulo: %%

```
> 4+3-2
[1] 5
(6+18)/6
[1] 4
> 2**3
[1] 8
2^3
[1] 8
> 2^(2*3)
[1] 64
```

```
x=3; x
[1] 3
> y=4 ; y
[1] 4
> z=x+y;z
[1] 7
```

**names are case sensitive**

- pi is a constant, but still can be used as variable name.
- print(x) prints content of x

# Introduction R and R Studio

## If Statement

```
# simple if
x<-1
if (x==2){ print ("x=2") }
x
[1] 1
# if - else
x<-1
if (x>=0){x="A"} else {x="B"}
x
[1] "A"
```

| Logical Function | Meaning |
|---|---|
| < | smaller |
| <= | smaller or equal |
| > | bigger |
| >= | bigger or equal |
| != | unequal |
| == | logical equal |
| ! | logical NOT ( unary ) |
| & | logical AND ( vector ) |
| \| | logical OR ( vector ) |
| && | logical AND (no vector ) |
| \|\| | logical OR (no vector ) |

# Introduction R and R Studio

## Looping Statement (for)

```
for (i in 1:4) { print (i) }
[1] 1
[1] 2
[1] 3
[1] 4

for (i in letters [1:4]) { print (i) }
[1] "a"
[1] "b"
[1] "c"
[1] "d"

a<-numeric (20) # generate empty a of length 20
for (i in 1:20) { a[i]=i } # fill a with 1:20
a
[1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
```

# Introduction to R

## Mathematical Function

| Function | Meaning |
|---|---|
| log(x) | log to base e of x |
| exp(x) | antilog of x (=2.7818x) |
| log(x,n) | log to base n of x |
| log10(x) | log to base 10 of x |
| sqrt(x) | square root of x |
| factorial(x) | x! |
| choose(n,x) | binomial coefficients n!/(x! (n – x)!) |
| gamma(x) | Γ.x.(x – 1)! for integer x |
| lgamma(x) | natural log of gamma(x) |
| floor(x) | greatest integer < x |

# Introduction to R

## Mathematical Function

| Function | Meaning |
|---|---|
| ceiling(x) | smallest integer > x |
| trunc(x) | closest integer to x between x and 0: trunc(1.5) =1, trunc(-1.5) = -1 |
| trunc | is like floor for positive values and like |
| ceiling | for negative values |
| round(x, digits=0) | round the value of x to an integer |
| signif(x, digits=6) | give x to six digits in scientific notation |
| runif(n) | generates n random numbers between 0 and 1 from a uniform distribution |
| cos(x) | cosine of x in radians |
| sin(x) | sine of x in radians |
| tan(x) | tangent of x in radians |
| acos(x), asin(x), atan(x) | inverse trigonometric transformations of real or complex numbers. |
| acosh(x), asinh(x), atanh(x) | inverse hyperbolic trigonometric transformations on real or complex numbers |
| abs(x) | the absolute value of x, ignoring the minus sign if there is one |

# Introduction to R

## Basic data type in R

### Main Structures

Vector array with 1 dimension in size m (1 data type)
Matrix array with 2 dimension in size m × n (1 data type)
Dataframe like matrix, but it contain more than 1 data type

### Data Type

character vector of strings
numeric vector of real numbers
integer vector of signed integer
logical vector of boolean (TRUE or FALSE)
complex vector of complex numbers
list vector of R objects
factor sets of labelled observations, pre-defined set of labels
NA not available, missing value

# Introduction to R

## Vector in R

```
a=1:3
> b=2:4
> c(a,b)
[1] 1 2 3 2 3 4
> c(1,a) [1] 1 1 2 3
> array(1,3) [1] 1 1 1
> seq(1,5) [1] 1 2 3 4 5
> seq(from=1,to=3,length.out = 4) #desired length of the sequence
[1] 1.000000 1.666667 2.333333 3.000000
> AA <- letters [1:3] ;AA
[1] "a" "b" "c" > K <- c(3,2,1,3,2)
> length(K)
[1] 5
> K[2]
[1] 2
> K[1:3]
[1] 3 2 1
> K[-1]
[1] 2 1 3 2
```

# Introduction to R

## Type of data

Vector Function

| Operation | Meaning |
|---|---|
| max(x) | maximum value in x |
| min(x) | minimum value in x |
| sum(x) | total of all the values in x |
| mean(x) | arithmetic average of the values in x |
| median(x) | median value in x |
| range(x) | vector of min(x) and max(x) |
| var(x) | sample variance of x, with degrees of freedom=length(x) -1 |
| cor(x,y) | correlation between vectors x and y |
| sort(x) | a sorted version of x |
| rank(x) | vector of the ranks of the values in x |

# Introduction R and R Studio


## Vector Function

| Operation | Meaning |
|---|---|
| order(x) | an integer vector containing the permutation to sort x into ascending order |
| quantile(x) | vector containing the minimum, lower quartile, median, upper quartile, and maximum of x |
| cumsum(x) | vector containing the sum of all of the elements up to that point |
| cumprod(x) | vector containing the product of all of the elements up to that point |
| cummax(x) | vector of non-decreasing numbers which are the cumulative maxima of the values in x up to that point. |
| cummin(x) | vector of non-increasing numbers which are the cumulative minima of the values in x up to that point. |
| pmax(x,y,z) | vector, of length equal to the longest of x, y, or z containing the maximum of x, y or z for the ith position in each |
| pmin(x,y,z) | vector, of length equal to the longest of x, y, or z containing the minimum of x, y or z for the ith position in each |

# Introduction to R

## Matrix in R

```
> matriks.1 = matrix(c(1,2,3,4,5,6),nrow=2,ncol=3);matriks.1
     [,1] [,2] [,3]
[1,]    1    3    5
[2,]    2    4    6
> matriks.2 = matrix(1:6,nrow=2,ncol=3) ; matriks.2
     [,1] [,2] [,3]
[1,]    1    3    5
[2,]    2    4    6
> data=c(6.4,8.8,7.5,5.3,7.6,9.5) ; data
[1] 6.4 8.8 7.5 5.3 7.6 9.5
> matriks.a=matrix(data,nrow=3,ncol=2) ; matriks.a
     [,1] [,2]
[1,]  6.4  5.3
[2,]  8.8  7.6
[3,]  7.5  9.5
> dim(matriks.1)
[1] 2 3
```

# Introduction to R

## Operator Matrix in R

| Operator | Note |
|---|---|
| * | Multiplication by element of matrix |
| %*% | Matrix multiplication |
| Solve | Inverse matrix |
| t | Transpose |
| crossprod | Crossproduct matrix t(x) %*% x |

```
a=1:5
> a
[1] 1 2 3 4 5
> a*a [1] 1 4 9 16 25
> crossprod(a)
     [,1]
[1,] 55
> b=matrix(c(1:4),2)
> b
     [,1] [,2]
[1,] 1    3
[2,] 2    4
> b*b [,1] [,2]
[1,] 1 9
[2,] 4 16
> b%*%b
   [,1] [,2]
[1,] 7 15
[2,] 10 22
```

```
> solve(b)
     [,1] [,2]
[1,] -2  1.5
[2,]  1 -0.5
> c=c(3,5)
> d=cbind(b,c)
> d=cbind(b,c); d
c [1,] 1 3 3
[2,] 2 4 5
> e=rbind(b,c);e
[,1] [,2]
   1 3
   2 4
c  3 5
```

# Introduction to R

**Example of vector and data frame**

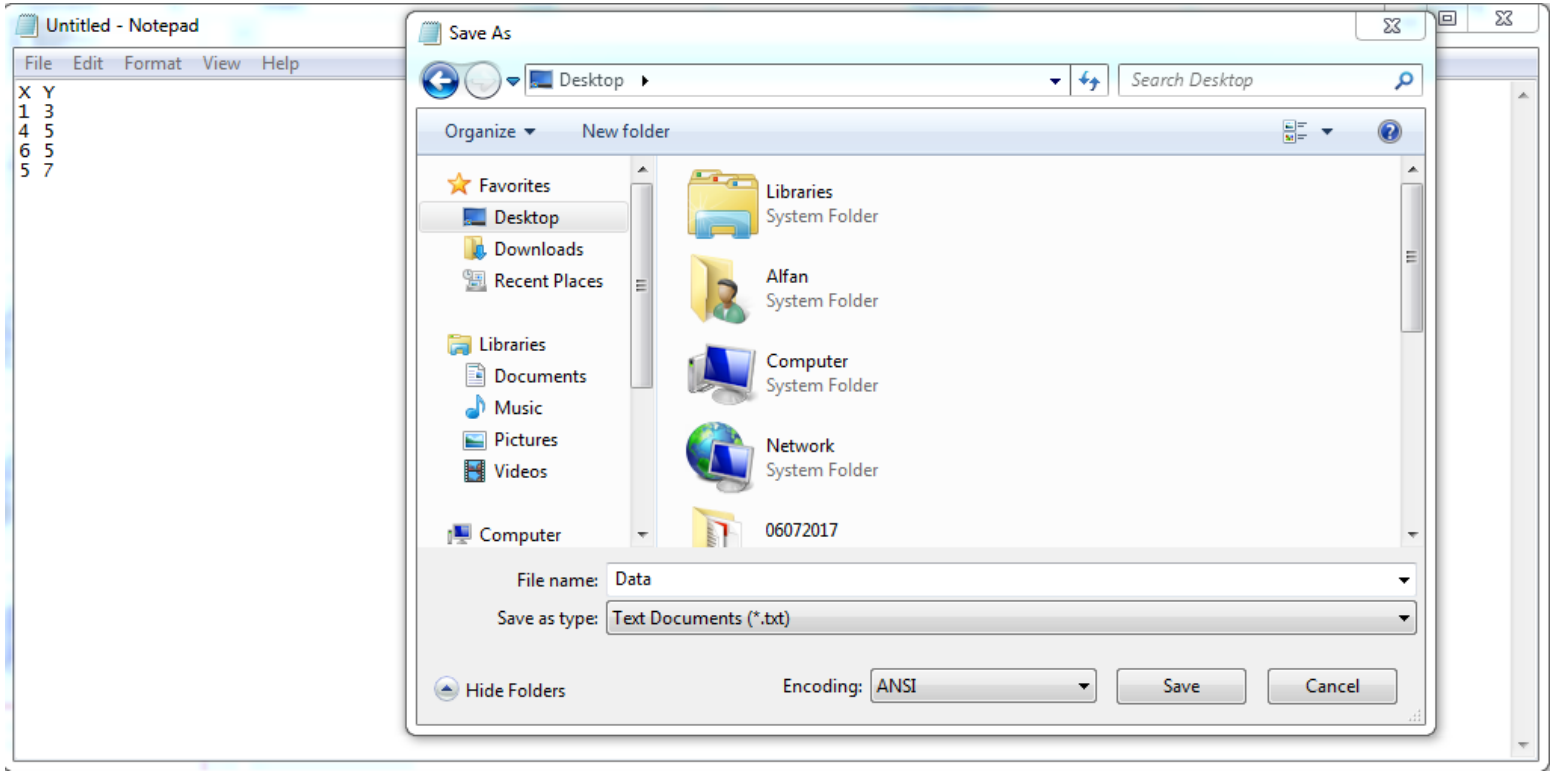
```
land=factor(c("Belgium","Denmark","France","GB","Ireland","Italy","Luxemburg",
                  "Holland","Portugal","Spain","USA","Japan","Deutschland"))
x=c(2.8,1.2,2.1,1.6,1.5,4.6,3.6,2.1,6.5,4.6,3,1.3,4.2);
y=c(9.4,10.4,10.8,10.5,18.4,11.1,2.6,8.8,5,21.5,6.7,2.5,5.6);
data1=data.frame(land,x,y)
colnames(data1)= c("countries","index","unemp")
income= c(12,10,13,9,8,10,11,12,13.5,14,10,11,13);
datanew = cbind(data1,income); datanew
subset(datanew,income<13)
subset(datanew$index,datanew$unemp>10) #mengambil data index sesuai ketentuan unemp>10
```

```
     countries index unemp
1      Belgium   2.8   9.4
2      Denmark   1.2  10.4
3       France   2.1  10.8
4           GB   1.6  10.5
5      Ireland   1.5  18.4
6        Italy   4.6  11.1
7    Luxemburg   3.6   2.6
8      Holland   2.1   8.8
9     Portugal   6.5   5.0
10       Spain   4.6  21.5
11         USA   3.0   6.7
12       Japan   1.3   2.5
13 Deutschland   4.2   5.6
```

```
> datanew
     countries index unemp income
1      Belgium   2.8   9.4   12.0
2      Denmark   1.2  10.4   10.0
3       France   2.1  10.8   13.0
4           GB   1.6  10.5    9.0
5      Ireland   1.5  18.4    8.0
6        Italy   4.6  11.1   10.0
7    Luxemburg   3.6   2.6   11.0
8      Holland   2.1   8.8   12.0
9     Portugal   6.5   5.0   13.5
10       Spain   4.6  21.5   14.0
11         USA   3.0   6.7   10.0
12       Japan   1.3   2.5   11.0
13 Deutschland   4.2   5.6   13.0
```

# Introduction to R

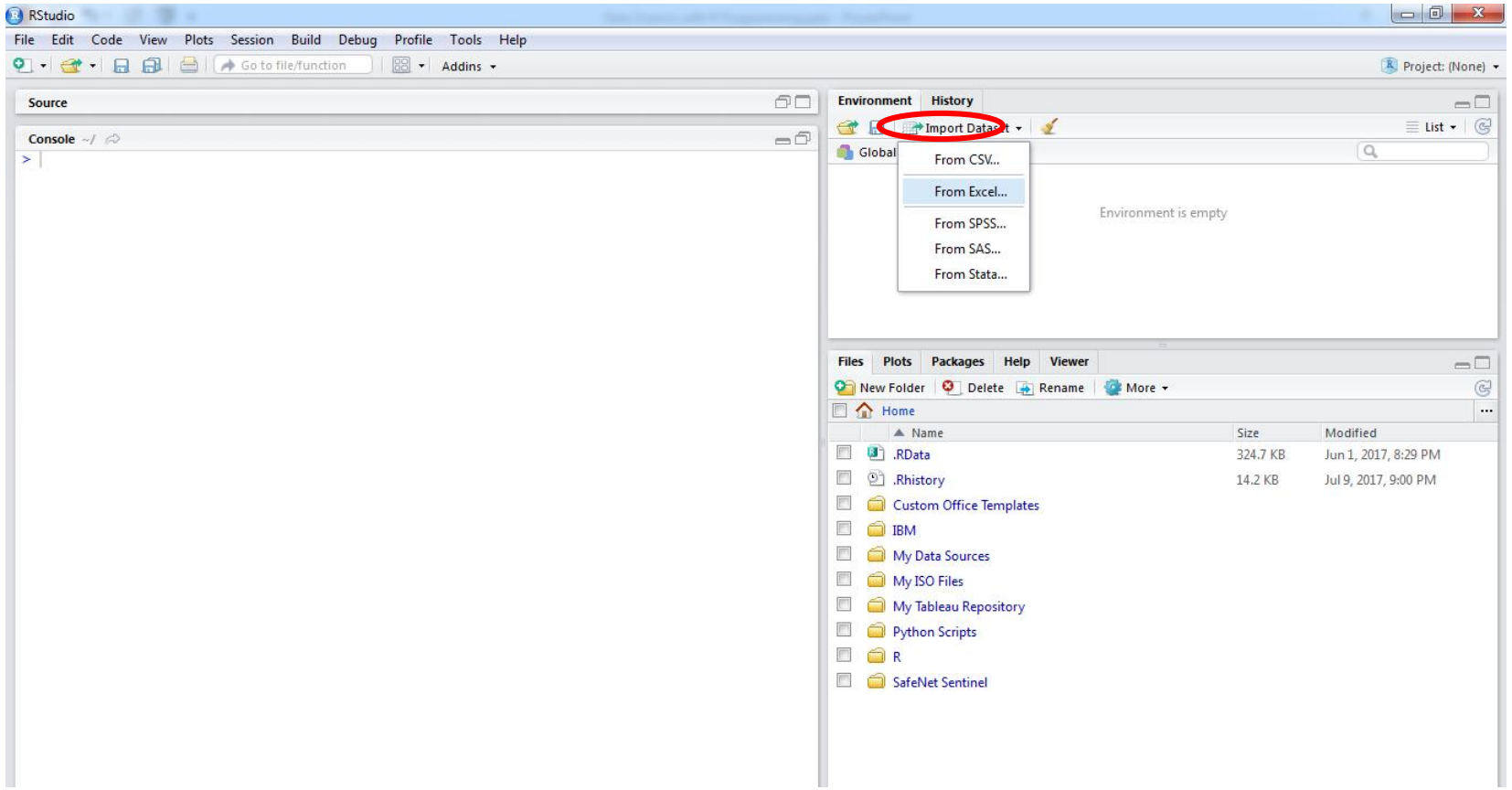
## Read data and write data




For example we create data in notepad

# Introduction to R

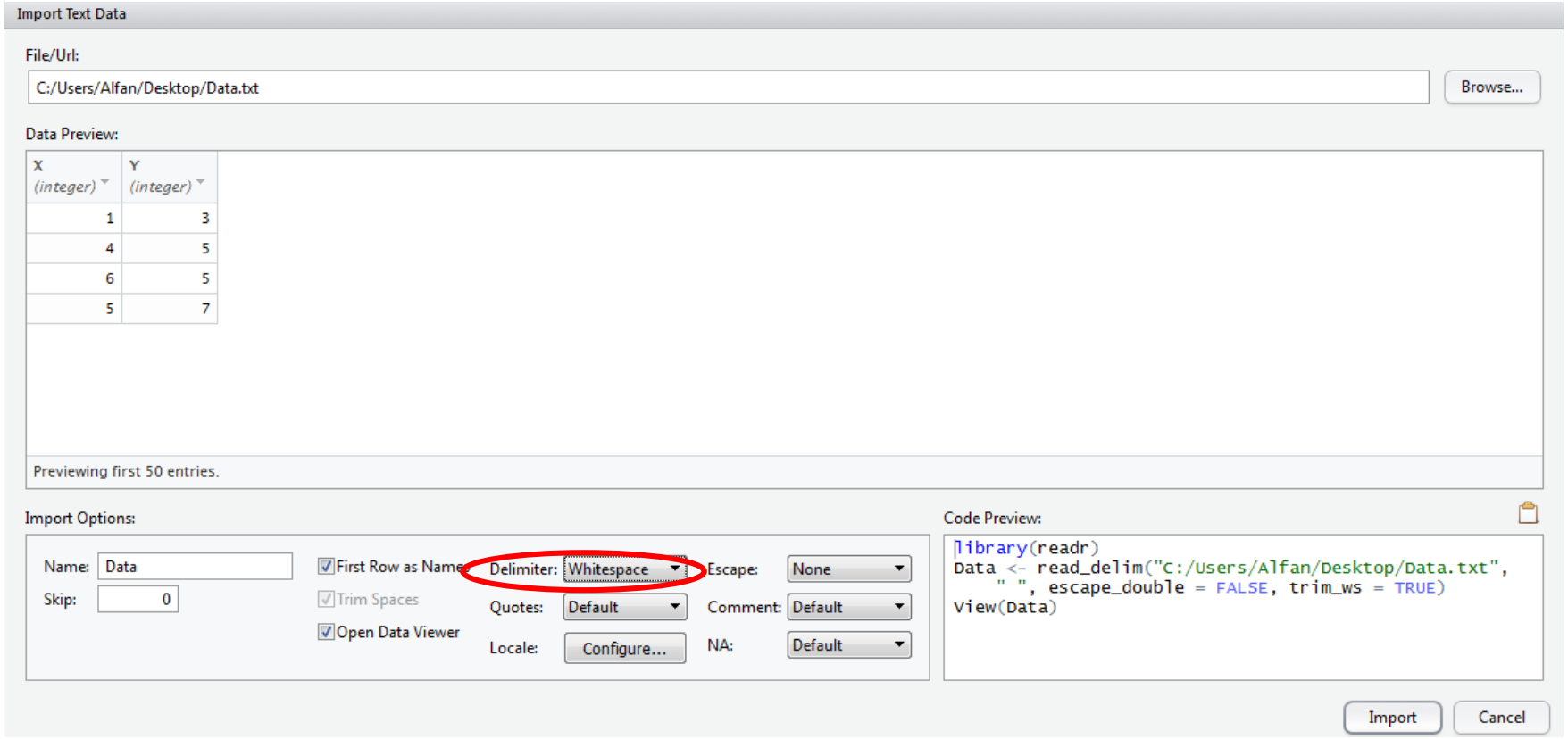
## Read data and write data




Click import dataset at R Studio, choose from CSV

# Introduction to R

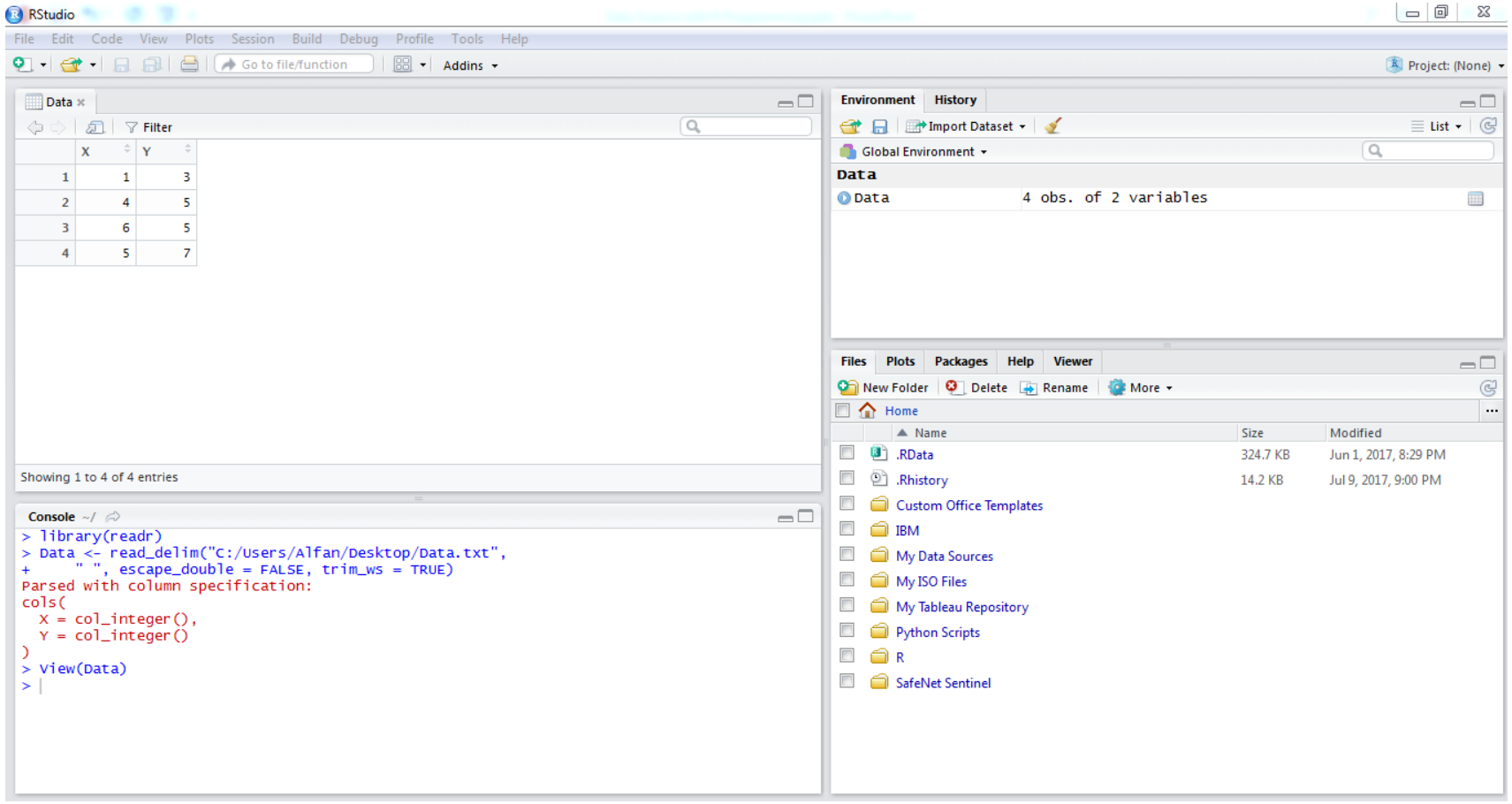
## Read data and write data




Change delimiter with whitespace, and click import

# Introduction to R

## Read data and write data



# Introduction to R


Read data and write data

# Introduction to R


Read data and write data

# Introduction to R

## Read data and write data

```
#Function write.table
write.table(x, file = "", , quote = TRUE, sep = " ", na = "NA", dec = ".",
row.names = TRUE, col.names = TRUE)
```

| | |
|---|---|
| `x` | the object to be written, preferably a matrix or data frame. If not, it is attempted to coerce `x` to a data frame. |
| `file` | either a character string naming a file or a connection open for writing. `""`indicates output to the console. |
| `quote` | a logical value (`TRUE` or `FALSE`) or a numeric vector. If `TRUE`, any character or factor columns will be surrounded by double quotes. If a numeric vector, its elements are taken as the indices of columns to quote. In both cases, row and column names are quoted if they are written. If `FALSE`, nothing is quoted. |
| `sep` | the field separator string. Values within each row of `x` are separated by this string. |
| `na` | the string to use for missing values in the data. |
| `dec` | the string to use for decimal points in numeric or complex columns: must be a single character. |
| `row.names` | either a logical value indicating whether the row names of `x` are to be written along with `x`, or a character vector of row names to be written. |
| `col.names` | either a logical value indicating whether the column names of `x` are to be written along with `x`, or a character vector of column names to be written. See the section on 'CSV files' for the meaning of `col.names = NA`. |

# Introduction to R

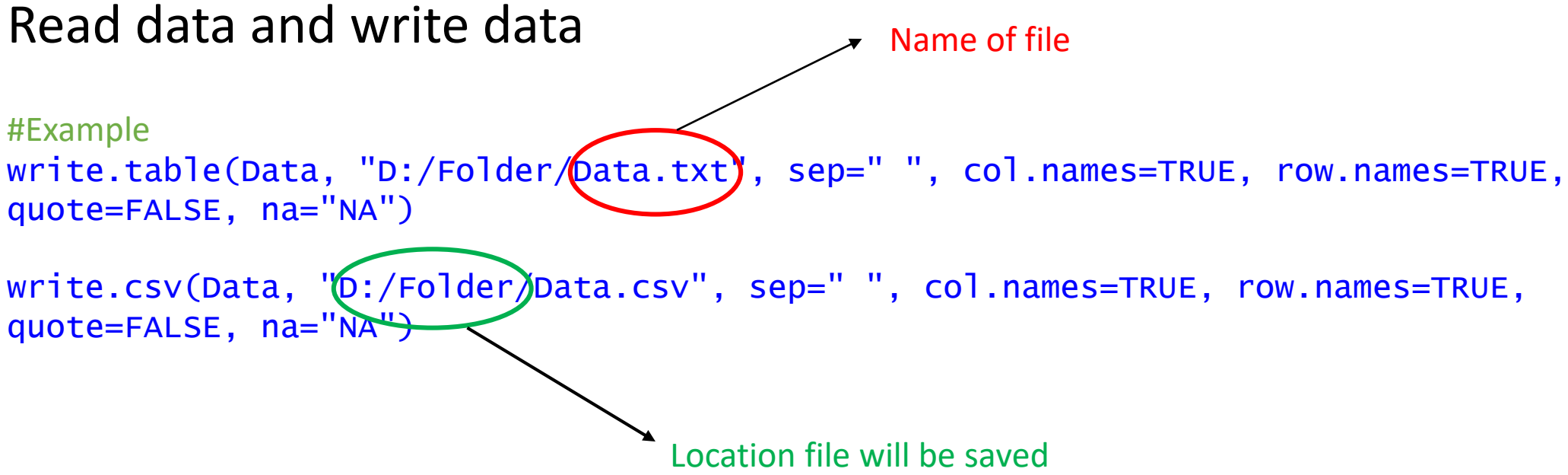
## Read data and write data

```
#Function write.csv
write.csv(x, file = "", , quote = TRUE, sep = " ", na = "NA", dec = ".",
row.names = TRUE, col.names = TRUE)
```

| | |
|---|---|
| `x` | the object to be written, preferably a matrix or data frame. If not, it is attempted to coerce `x` to a data frame. |
| `file` | either a character string naming a file or a connection open for writing. ""indicates output to the console. |
| `quote` | a logical value (`TRUE` or `FALSE`) or a numeric vector. If `TRUE`, any character or factor columns will be surrounded by double quotes. If a numeric vector, its elements are taken as the indices of columns to quote. In both cases, row and column names are quoted if they are written. If `FALSE`, nothing is quoted. |
| `sep` | the field separator string. Values within each row of `x` are separated by this string. |
| `na` | the string to use for missing values in the data. |
| `dec` | the string to use for decimal points in numeric or complex columns: must be a single character. |
| `row.names` | either a logical value indicating whether the row names of `x` are to be written along with `x`, or a character vector of row names to be written. |
| `col.names` | either a logical value indicating whether the column names of `x` are to be written along with `x`, or a character vector of column names to be written. See the section on 'CSV files' for the meaning of `col.names = NA`. |

# Introduction to R

## Read data and write data

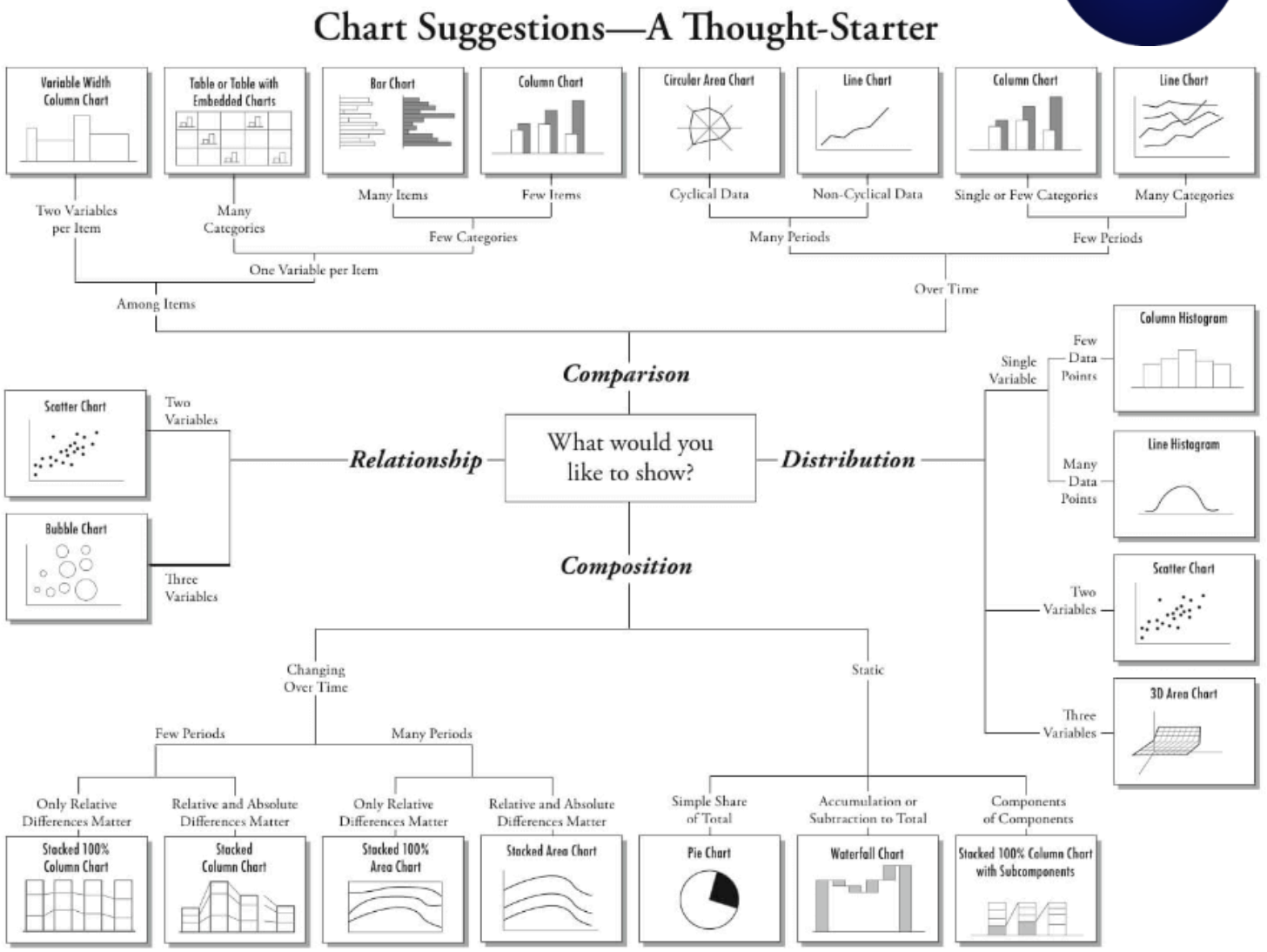


# Visualization and Summary Data

# Visualization and Summary Data

**There are four basic presentation types:**

- Comparison
- Composition
- Distribution
- Relationship



# Visualization and Summary Data

## Titanic data set

| PassengerId | Survived | Pclass | Name | Sex | Age | SibSp | Pa |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 3 | Braund, Mr. Owen Harris | male | 22.00000 | 1 | 0 |
| 2 | 1 | 1 | Cumings, Mrs. John Bradley (Florence Briggs Thayer) | female | 38.00000 | 1 | 0 |
| 3 | 1 | 3 | Heikkinen, Miss. Laina | female | 26.00000 | 0 | 0 |
| 4 | 1 | 1 | Futrelle, Mrs. Jacques Heath (Lily May Peel) | female | 35.00000 | 1 | 0 |
| 5 | 0 | 3 | Allen, Mr. William Henry | male | 35.00000 | 0 | 0 |
| 6 | 0 | 3 | Moran, Mr. James | male | 29.69912 | 0 | 0 |
| 7 | 0 | 1 | McCarthy, Mr. Timothy J | male | 54.00000 | 0 | 0 |
| 8 | 0 | 3 | Palsson, Master. Gosta Leonard | male | 2.00000 | 3 | 1 |
| 9 | 1 | 3 | Johnson, Mrs. Oscar W (Elisabeth Vilhelmina Berg) | female | 27.00000 | 0 | 2 |
| 10 | 1 | 2 | Nasser, Mrs. Nicholas (Adele Achem) | female | 14.00000 | 1 | 0 |
| 11 | 1 | 3 | Sandstrom, Miss. Marguerite Rut | female | 4.00000 | 1 | 1 |
| 12 | 1 | 1 | Bonnell, Miss. Elizabeth | female | 58.00000 | 0 | 0 |
| 13 | 0 | 3 | Saundercock, Mr. William Henry | male | 20.00000 | 0 | 0 |

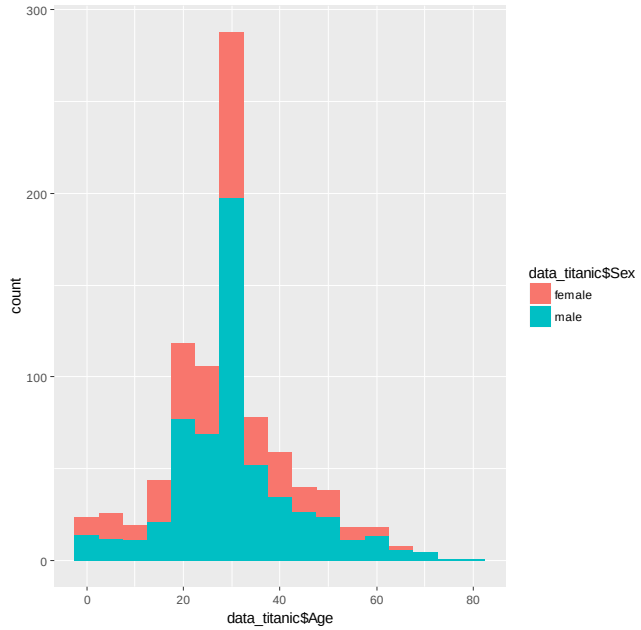
```
'data.frame':   891 obs. of  12 variables:
 $ PassengerId: int  1 2 3 4 5 6 7 8 9 10 ...
 $ Survived   : int  0 1 1 1 0 0 0 0 1 1 ...
 $ Pclass     : int  3 1 3 1 3 3 1 3 3 2 ...
 $ Name       : Factor w/ 891 levels "Abbing, Mr. Anthony",..: 109 191 358 277 16 559 520 629 417
81 ...
 $ Sex        : Factor w/ 2 levels "female","male": 2 1 1 1 2 2 2 2 1 1 ...
 $ Age        : num  22 38 26 35 35 ...
 $ SibSp      : int  1 1 0 1 0 0 0 3 0 1 ...
 $ Parch      : int  0 0 0 0 0 0 0 1 2 0 ...
 $ Ticket     : Factor w/ 681 levels "110152","110413",..: 524 597 670 50 473 276 86 396 345 133
 ...
 $ Fare       : Factor w/ 247 levels "0","1,108,833",..: 174 183 172 142 210 225 139 71 14 106 ..
 $ Cabin      : Factor w/ 148 levels "","A10","A14",..: 1 83 1 57 1 1 131 1 1 1 ...
 $ Embarked   : Factor w/ 4 levels "","C","Q","S": 4 2 4 4 4 3 4 4 4 2 ...
```

**survival** - Survival (0 = No; 1 = Yes)
**class** - Passenger Class (1 = 1st; 2 = 2nd; 3 = 3rd)
**name** - Name
**sex** - Sex
**age** - Age
**sibsp** - Number of Siblings/Spouses Aboard
**parch** - Number of Parents/Children Aboard
**ticket** - Ticket Number
**fare** - Passenger Fare
**cabin** - Cabin
embarked - Port of Embarkation (C = Cherbourg; Q = Queenstown; S = Southampton)
boat - Lifeboat (if survived)
body - Body number (if did not survive and body was recovered)

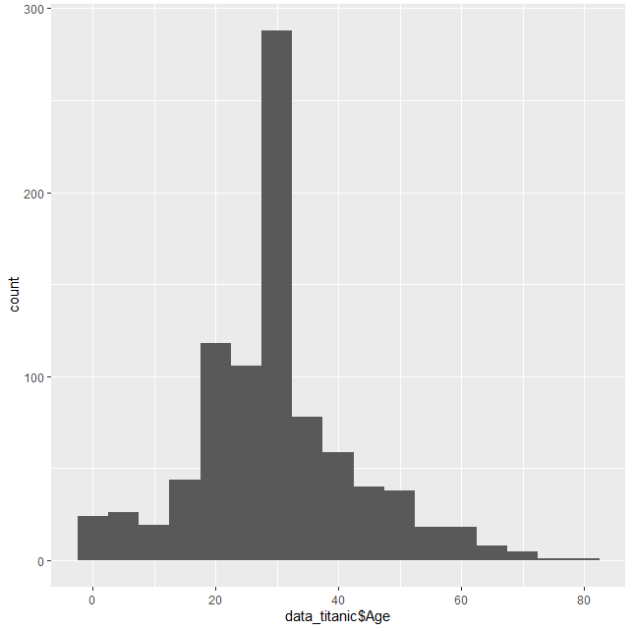
# Visualization and Summary Data

## Histogram

```
#using Titanic Dataset in R

library(ggpubr)

ggplot(data = data_titanic, mapping = aes(x
=data_titanic$Age, fill = data_titanic$Sex),

palette = c("#00AFBB", "#E7B800")) +
geom_histogram(binwidth = 5)
```



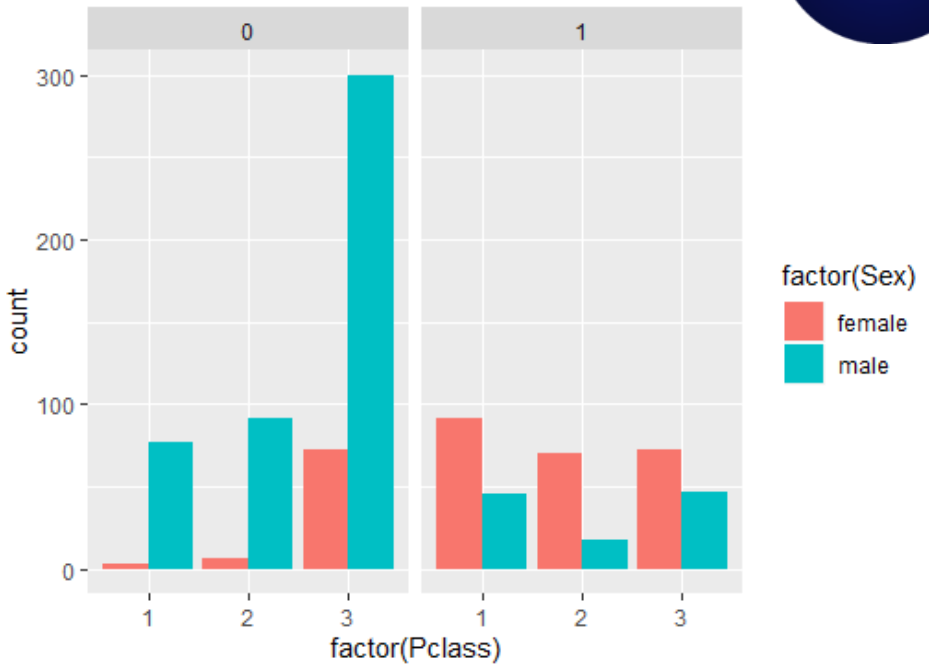

```
ggplot(data = data_titanic, mapping = aes(x
=data_titanic$Age),palette = c("#00AFBB",
"#E7B800")) + geom_histogram(binwidth = 5)
```

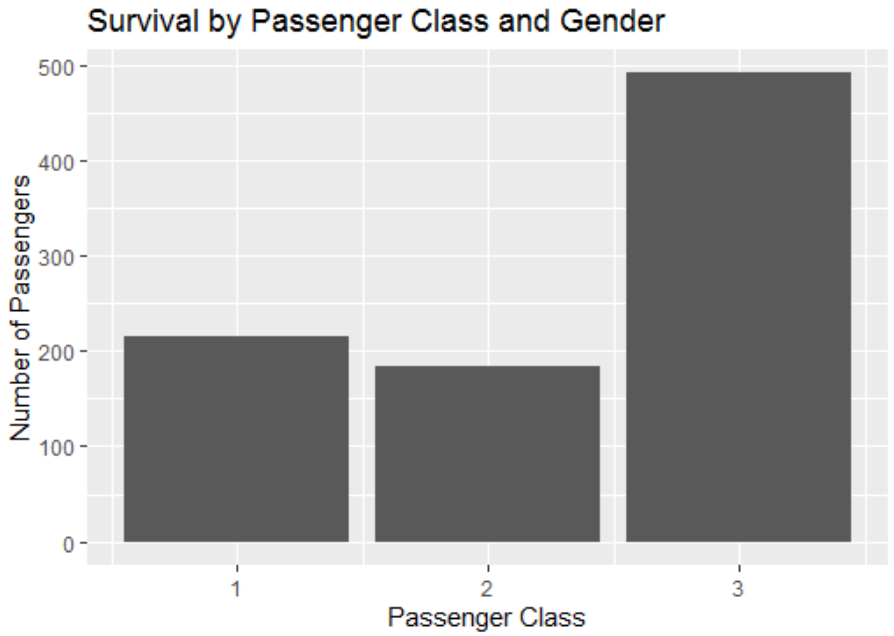


# Visualization and Summary Data

## Bar Chart

```
ggplot(data_titanic,aes(x=factor(Pclass),fill=
factor(Sex)))+ geom_bar(position="dodge")+
  facet_grid(". ~ Survived")
```

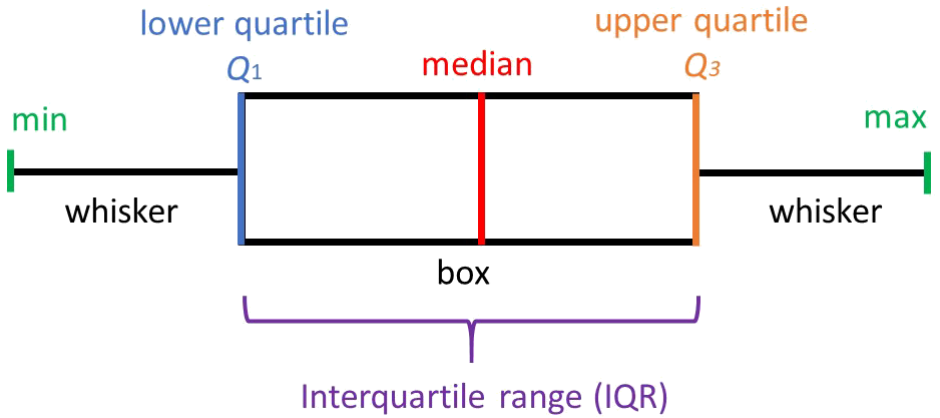


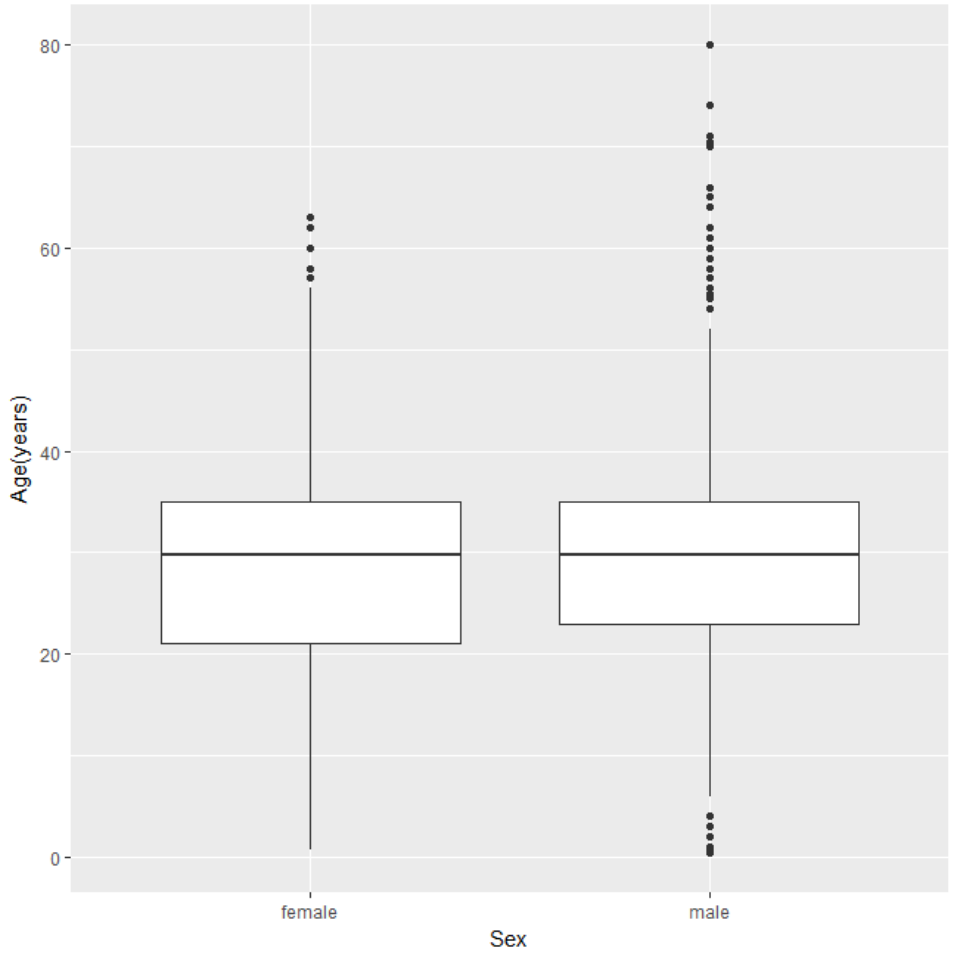

```
barchart <- ggplot(data_titanic, aes(Pclass,
fill=Survived))+geom_bar()
barchart+xlab("Passenger Class")+ylab("Number of
Passengers")+
  ggtitle("Survival by Passenger Class and Gender")+
  scale_fill_discrete(name = "", labels = c("Died",
"Survived"))
```

# Visualization and Summary Data

## Boxplot




```
ggplot(data = data_titanic, mapping = aes(x =
data_titanic$Sex, y = data_titanic$Age)) +
  geom_boxplot() +
  xlab("Sex") + ylab("Age(years)")
```

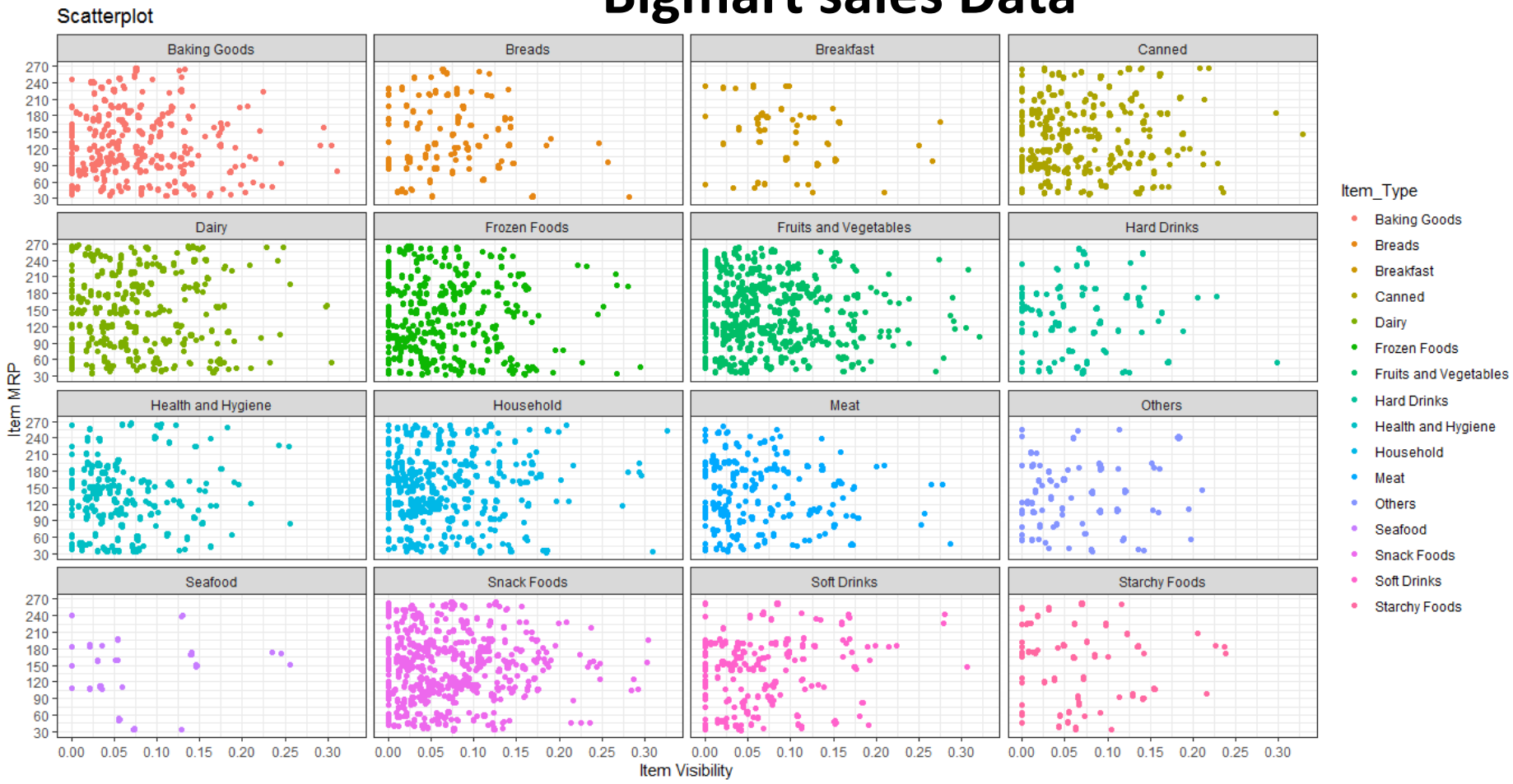


# Visualization and Summary Data

## Scatter Plot

```
ggplot(train,
aes(Item_Visibility,
Item_MRP)) +
geom_point(aes(color =
Item_Type)) +

scale_x_continuous("It
em Visibility", breaks
= seq(0,0.35,0.05))+

scale_y_continuous("It
em MRP", breaks =
seq(0,270,by = 30))+
  theme_bw() +
labs(title="Scatterplo
t") + facet_wrap( ~
Item_Type)
```

**Bigmart sales Data**



# Visualization Data and Summary Data

Let’s make a simple story

# Visualization Data and Summary Data

## Iris Dataset

About the Iris Data Set

* The Iris Data Set is a multivariate data set used by R. A Fisher in his 1936 paper "The use of multiple measurements in taxonomic problems" as an example of linear discriminate analysis.
* The data was collected by Edgar Andersen in 1935 to quantify the morphologic variation of Iris flowers of three related species.
* Two of the species were collected in the Gaspé Peninsula, Canada, in one pasture, picked the same day, measured at the same time by the same person using the same equipment
* The Iris data set contains 150 random observations and 5 variables (one categorical and 4 numeric) from three iris species, setosa, versicolor, and virginica.
* There are 50 observations from each of the three iris species, measuring sepal length, sepal width, petal length and petal width, all numeric values in centimeters.
* There is no missing data.

# Visualization Data and Summary Data

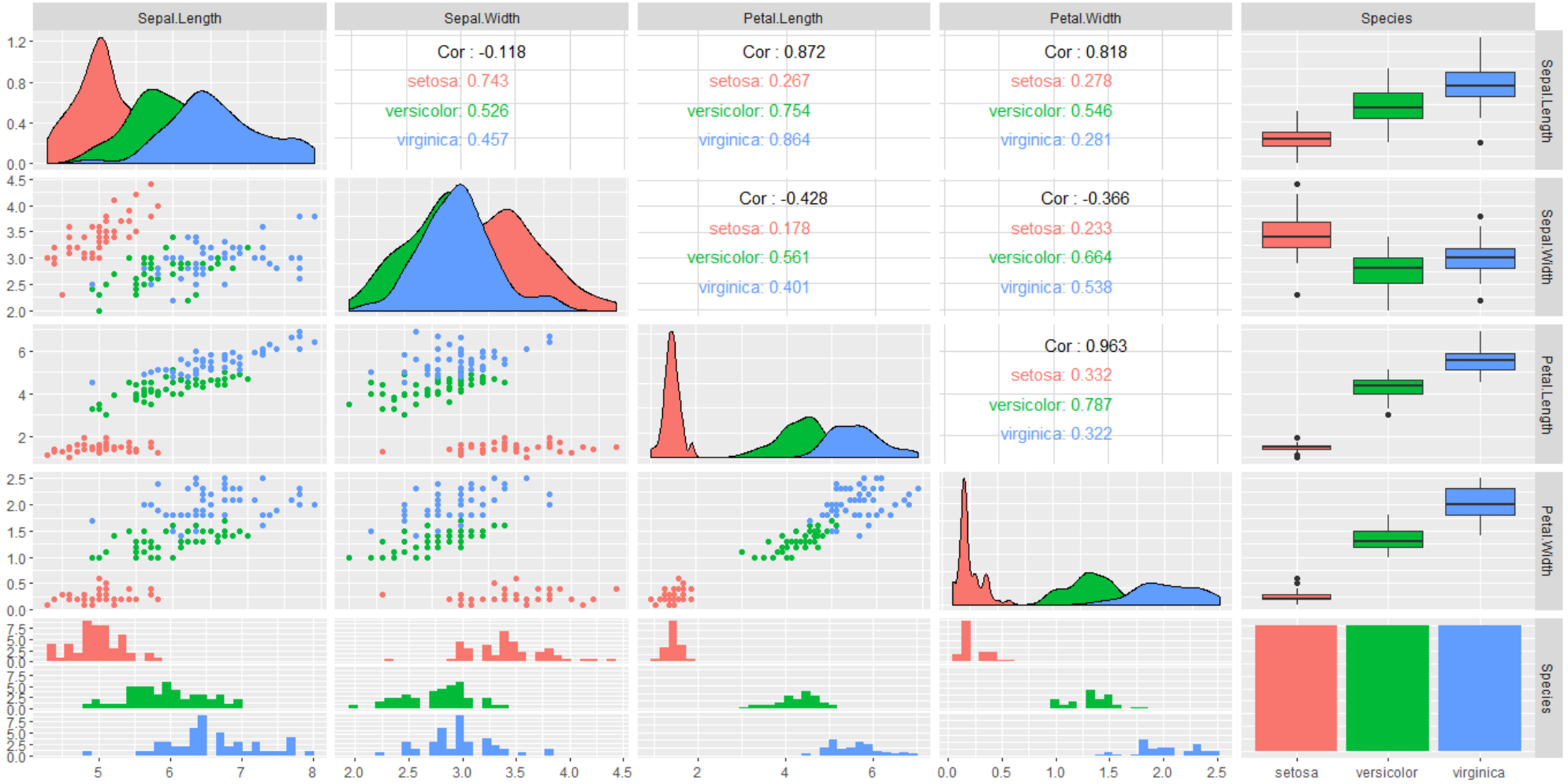
```
View(iris)
```

iris

Filter

| | Sepal.Length | Sepal.Width | Petal.Length | Petal.Width | Species |
|---|---|---|---|---|---|
| 1 | 5.1 | 3.5 | 1.4 | 0.2 | setosa |
| 2 | 4.9 | 3.0 | 1.4 | 0.2 | setosa |
| 3 | 4.7 | 3.2 | 1.3 | 0.2 | setosa |
| 4 | 4.6 | 3.1 | 1.5 | 0.2 | setosa |
| 5 | 5.0 | 3.6 | 1.4 | 0.2 | setosa |
| 6 | 5.4 | 3.9 | 1.7 | 0.4 | setosa |
| 7 | 4.6 | 3.4 | 1.4 | 0.3 | setosa |
| 8 | 5.0 | 3.4 | 1.5 | 0.2 | setosa |
| 9 | 4.4 | 2.9 | 1.4 | 0.2 | setosa |
| 10 | 4.9 | 3.1 | 1.5 | 0.1 | setosa |

# Visualization Data and Summary Data




```
ggpairs(iris[,c(1:5)],ggplot2::aes(colour=Species))
```

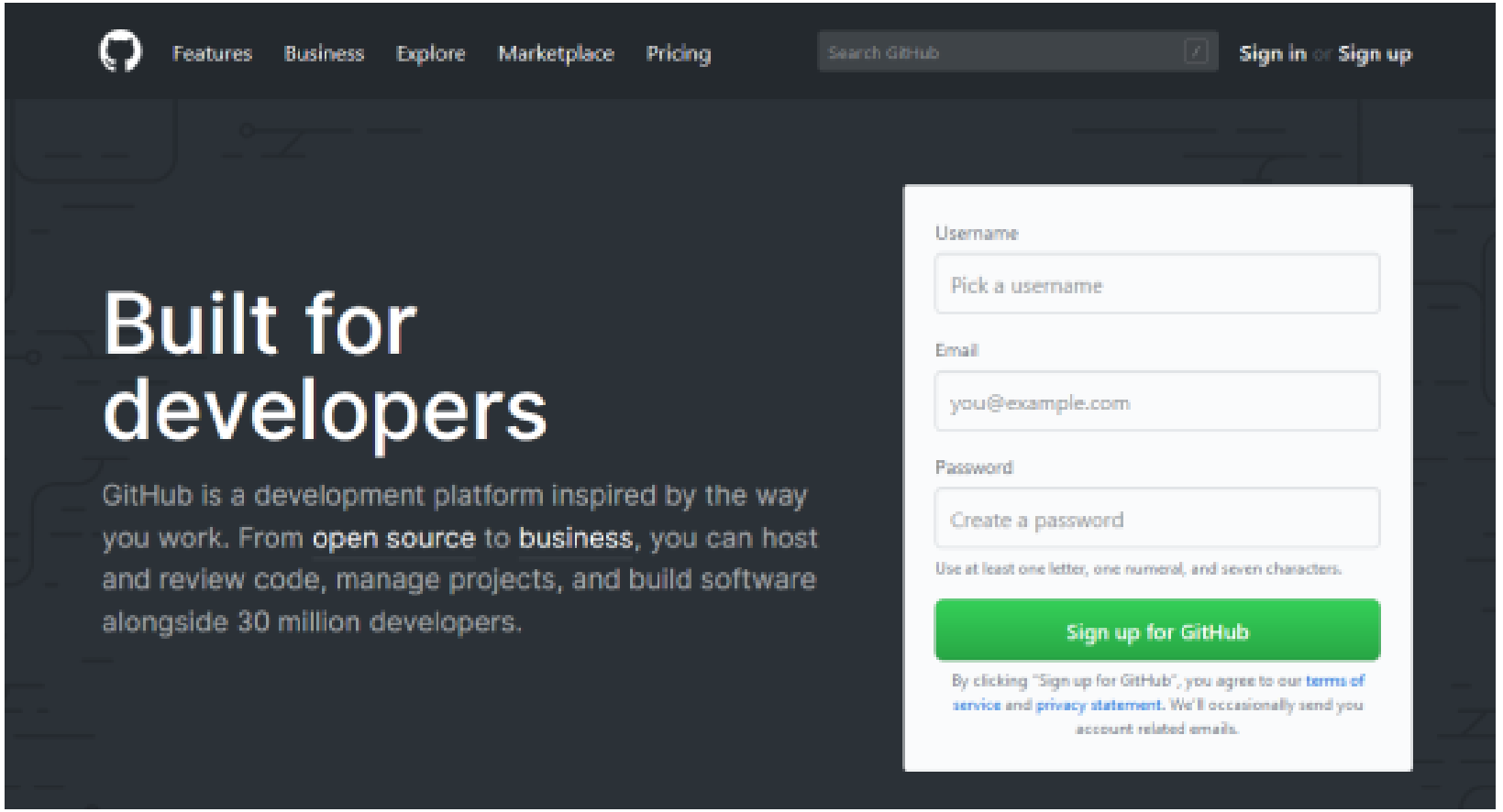
# Visualization Data and Summary Data


```
Setosa=subset(iris,Species=="setosa")
summary(Setosa[,-5])
Versicolor=subset(iris,Species=="versicolor")
summary(Versicolor[,-5])
Virginica=subset(iris,Species=="virginica")
summary(Virginica[,-5])
```

# GitHub

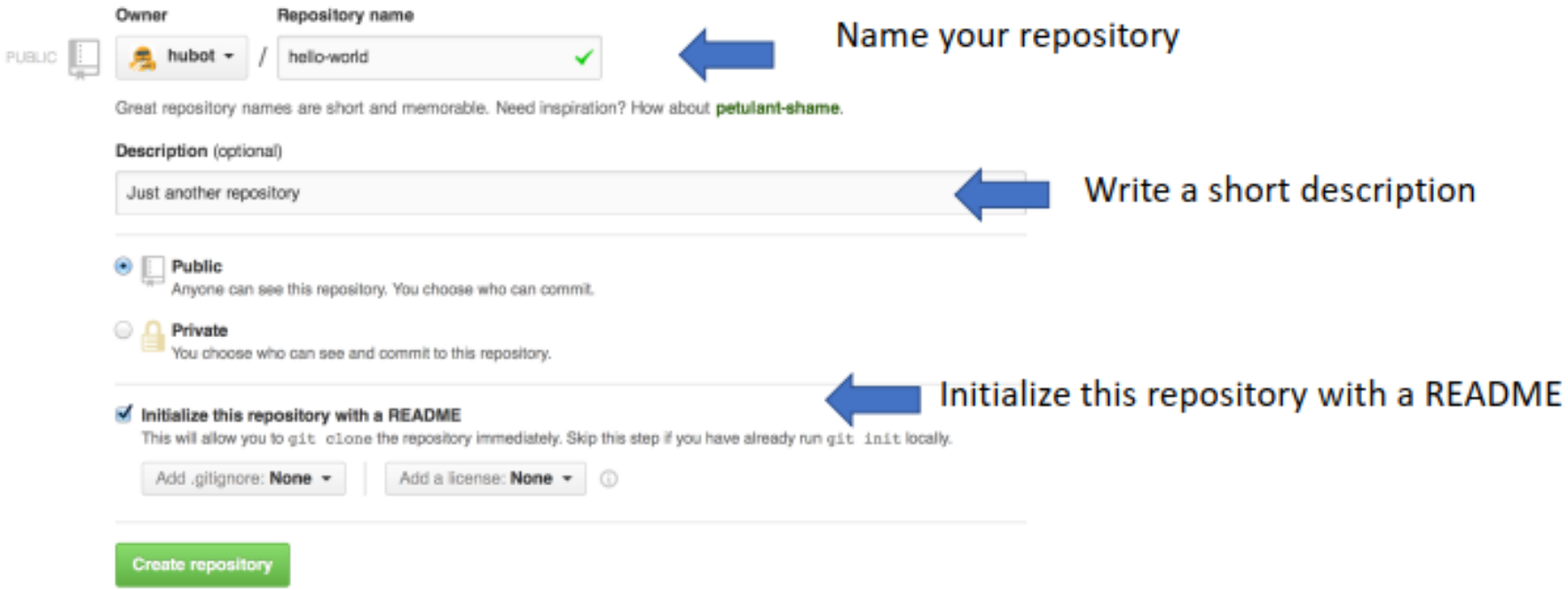
## What is GitHub?

code hosting platform for version control and collaboration. It lets you and others work together on projects from anywhere.



# Repository

A **repository** is usually used to organize a single project. Repositories can contain folders and files, images, videos, spreadsheets, and data sets – anything your project needs.



# Branch

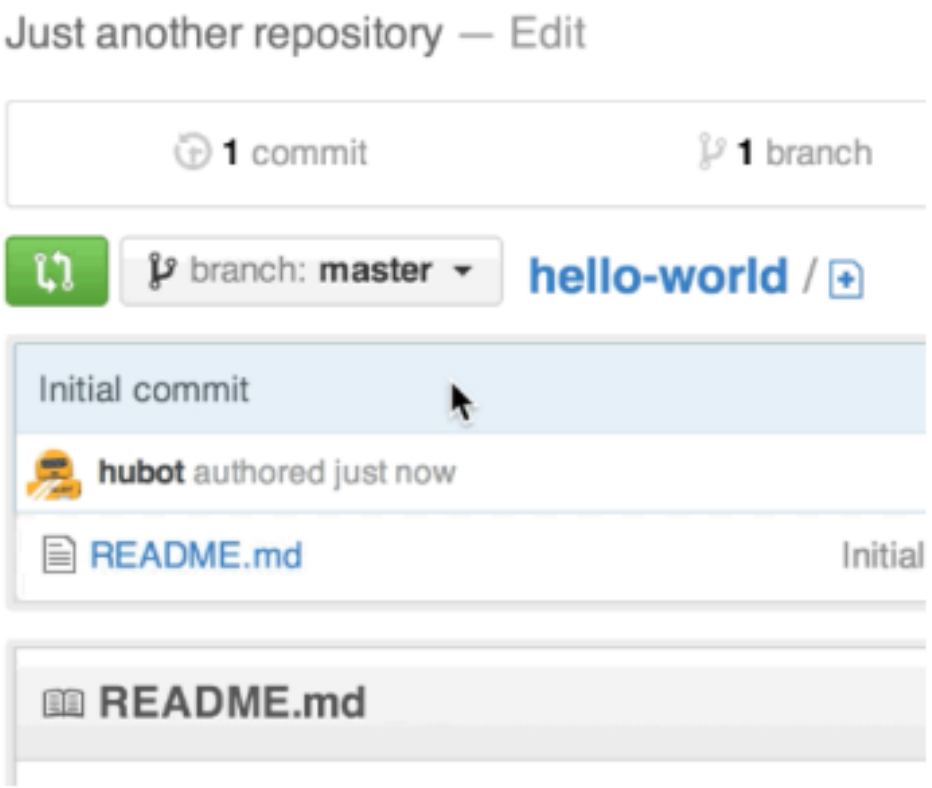
**Branching** is the way to work on different versions of a repository at one time.

Have you ever saved different versions of a file? Something like:

- `Laporan.docx`
- `Laporan-revisi-1.docx`
- `Laporan-final.docx`

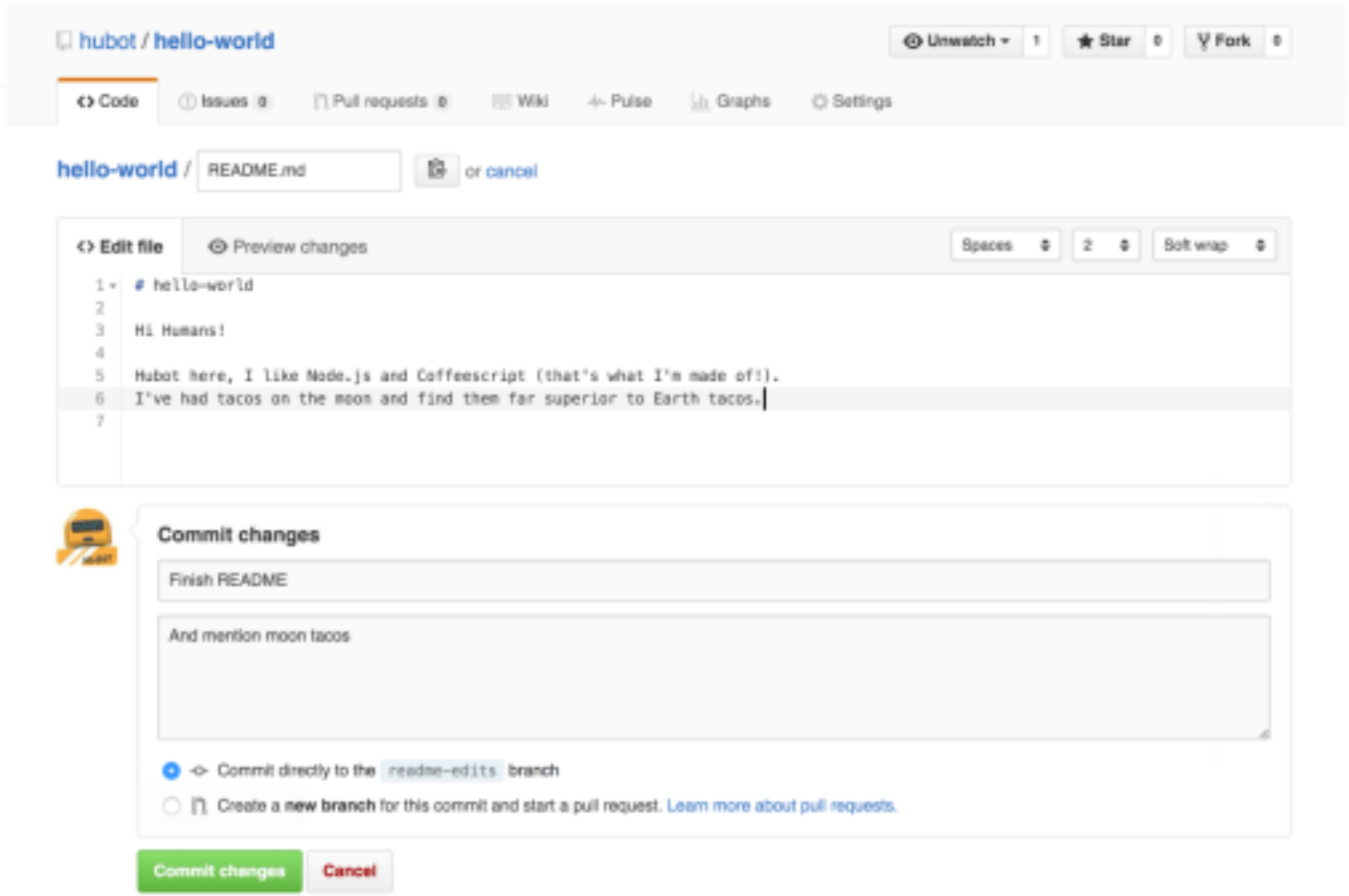
Branches accomplish similar goals in GitHub repositories.

# Branch


Just another repository — Edit
1 commit
1 branch
branch: master
hello-world /
Initial commit
hubot authored just now
README.md
Initial
README.md

# Make and commit changes

## On GitHub, saved changes are called *commits*.




These changes will be made to just the README file on your branch, so now this branch contains content that's different from master.