# Initiation to R Software

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## Problem Set III

### 1) Import and export data

a) Create an ASCII file (a text file with tabulation separator) with 4 columns (3 `numeric`, 1 `character`) and 5 observations. Give the columns names in the first row. Save this file in the working directory.
b) Import this file in R, in an object of type `data.frame`. Print the content of the object, check rows/columns names (`name()`, `dimnames()`, `colnames()`, `rownames()`).
c) Choose rows names.
d) Add a column whose values indicate if values in the third columns are greater than 10 (1 if $> 10$, 0 elsewhere).
e) Export the new `data.frame` to the working directory in a text file, with space separator, without rows/columns names.

### 2) Probability distributions

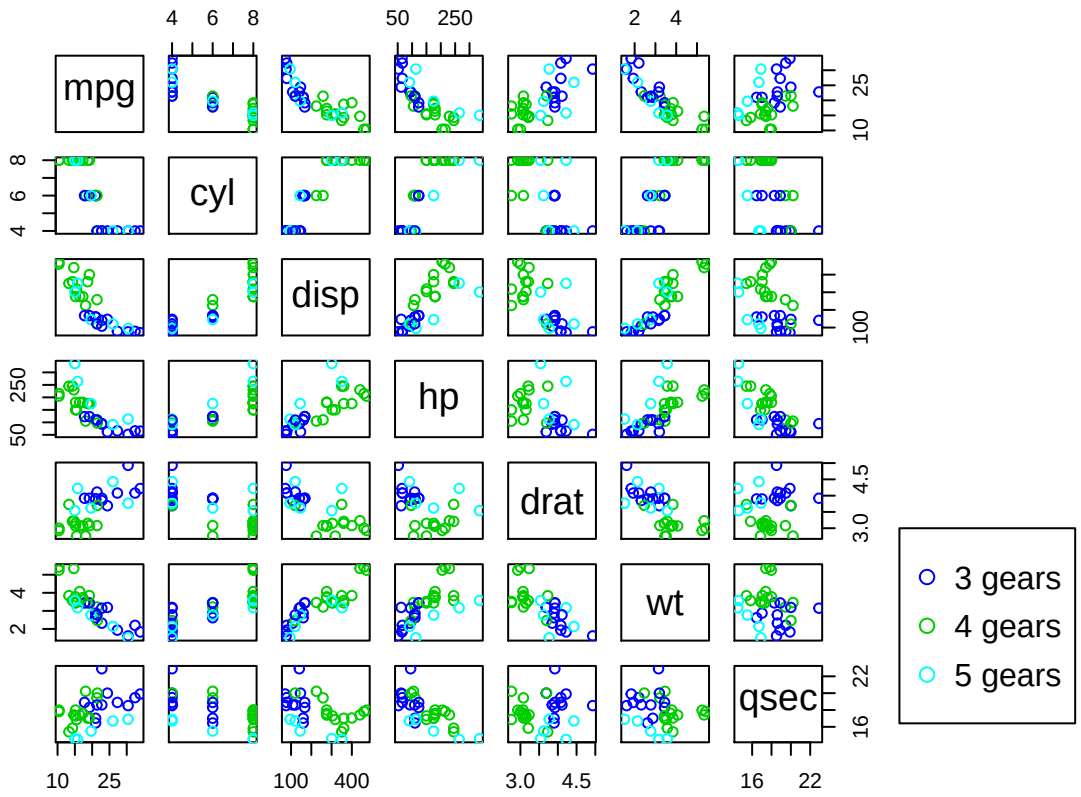
a) Compute the probability that a random variable $X$ following a binomial distribution $\mathcal{B}(10, \frac{1}{3})$ takes the value $0, 1, 2, ..., 10$, i.e $P(X = k)$.

b) Compute the probability that a random variable $X$ following a binomial distribution $\mathcal{B}(10, \frac{1}{3})$ takes values less than or equal to 10 and greater than 5, i.e $P(5 < X \leq 10)$.
c) Compute the value x for which $P(X <= x) = 0.97$, where $X$ follows a normal distribution $\mathcal{N}(0, 1)$.
d) Compute the quantile of order 2% of a Student's distribution with 5 degrees of freedom ($\sqcup(5)$.

### 3) Descriptive statistics

Load the *mtcars* dataset from the package `base`, and print its content. Below is a statistica summary of the dataset and a plot of pairs of continuous variables.

```
##       mpg             cyl             disp             hp       
##  Min.   :10.40   Min.   :4.000   Min.   : 71.1   Min.   : 52.0  
##  1st Qu.:15.43   1st Qu.:4.000   1st Qu.:120.8   1st Qu.: 96.5  
##  Median :19.20   Median :6.000   Median :196.3   Median :123.0  
##  Mean   :20.09   Mean   :6.188   Mean   :230.7   Mean   :146.7  
##  3rd Qu.:22.80   3rd Qu.:8.000   3rd Qu.:326.0   3rd Qu.:180.0  
##  Max.   :33.90   Max.   :8.000   Max.   :472.0   Max.   :335.0  
##       drat             wt             qsec             vs        
##  Min.   :2.760   Min.   :1.513   Min.   :14.50   Min.   :0.0000  
##  1st Qu.:3.080   1st Qu.:2.581   1st Qu.:16.89   1st Qu.:0.0000  
##  Median :3.695   Median :3.325   Median :17.71   Median :0.0000  
##  Mean   :3.597   Mean   :3.217   Mean   :17.85   Mean   :0.4375  
##  3rd Qu.:3.920   3rd Qu.:3.610   3rd Qu.:18.90   3rd Qu.:1.0000  
##  Max.   :4.930   Max.   :5.424   Max.   :22.90   Max.   :1.0000  
##        am              gear            carb      
##  Min.   :0.0000   Min.   :3.000   Min.   :1.000  
##  1st Qu.:0.0000   1st Qu.:3.000   1st Qu.:2.000  
##  Median :0.0000   Median :4.000   Median :2.000  
##  Mean   :0.4062   Mean   :3.688   Mean   :2.812  
##  3rd Qu.:1.0000   3rd Qu.:4.000   3rd Qu.:4.000  
##  Max.   :1.0000   Max.   :5.000   Max.   :8.000
```




a) For continuous variables you can have a statistical summary computing standard empirical estimations: mean, variance, first and third quartiles and median. Compute these estimators on *mtcars* columns that correspond to continuous variables (use `summary()`). Plot the corresponding histograms/boxplots (use `hist()` and `boxplot()`). Comment.
b) Identify the variables for which the assumption of normality is plausible (use `qqnorm()` and `qqline()`).
c) Evaluate the possible correlations between these variables (use `cor()`).
d) For discrete variables, provide a table of counts (use `table()`) and a graphical representation of this table (`barplot(table()`). Comment.

## 4) Generate random samples, empirical mean and variance

a) Generate 100 samples of size 100 from a normal distribution $\mathcal{N}(3, 1)$. For each sample, compute the mean and the empirical variance (use `apply()`, `replicate()`).
b) Compute the mean and variance of the two series.
c) Plot on the same figure the histogram of relative counts with a kernel estimation of the means series.
d) Re-run for 100, 500, 1000 samples. What do you observe ?
e) Comment the results.

## 5) Random sampling

a) Simulate 25 draws of a coin.
b) Test the following commands:

- `urn = c(rep("red"", 8), rep("blue", 4), rep("yellow", 3)); sample(urn, 6, replace = F)`
- `plot(0:10, dbinom(0:10, size = 10, prob = .25), type="h", lwd = 30, col = "gray", main="Binomial distribution; n=10; p=0.25")`

- `curve(dnorm(x), from = -3, to = 3)`
- `curve(pnorm(x, mean = 10, sd = 2),from = 4,to = 16)`