R-Bootcamp: Series 2

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*** Solutions ***
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1 Exercise: Graphics I

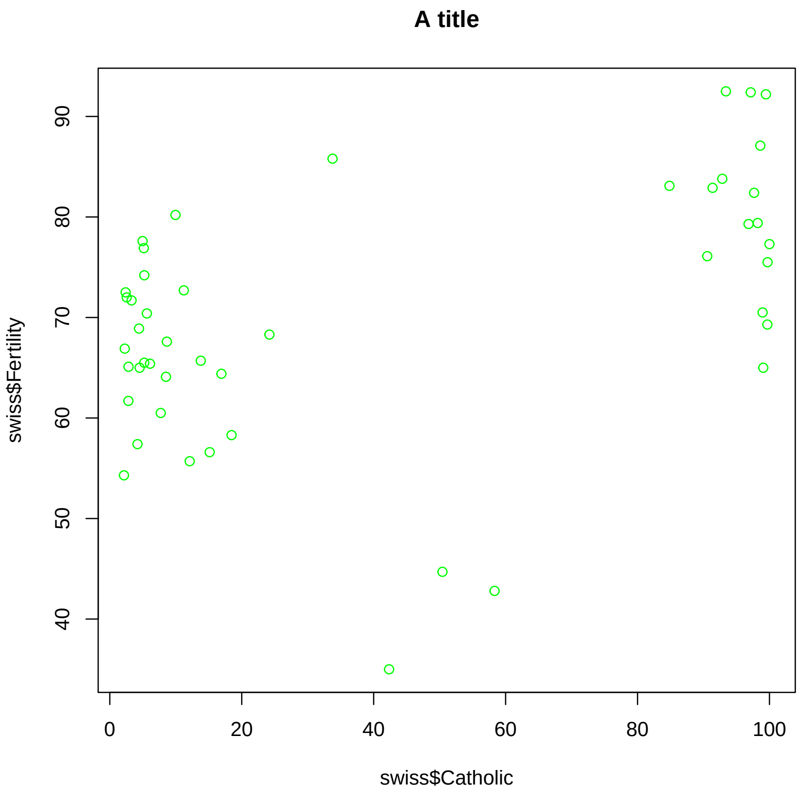
1.1 Question:

Using the `plot()` *function and built-in dataset* `swiss` *create a graph with the following properties*

- do not use the formula interface
- plot ”Fertility” on the y-axis
- plot ”Catholic” on the x-axis
- set the colour of the observations to green
- add a title to the graph

Answers

```
plot(y = swiss$Fertility,
     x = swiss$Catholic,
     col = "green",
     main = "A title")
```



1.2 Question:

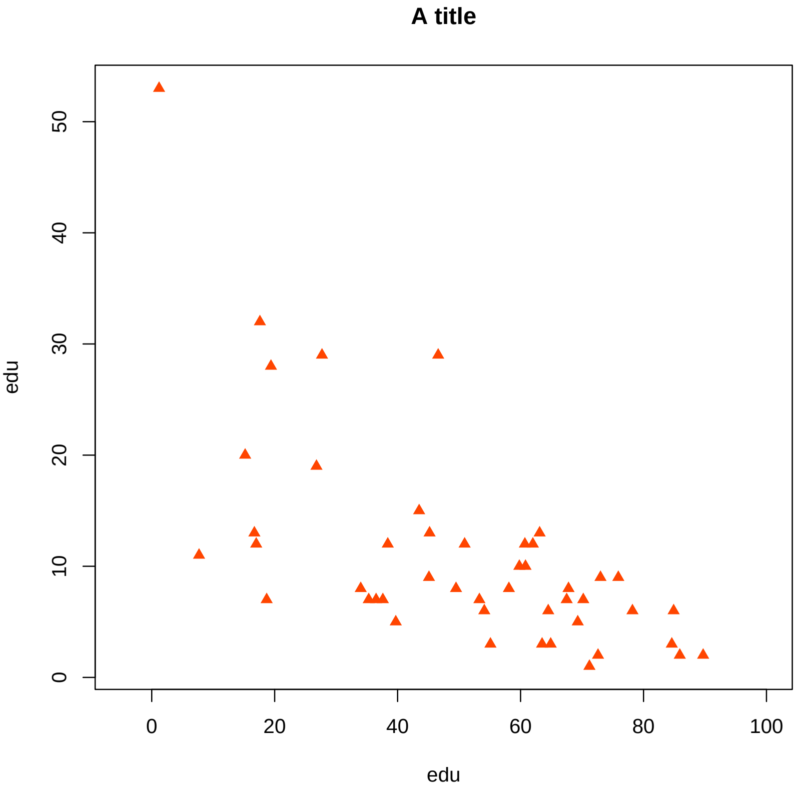
Using the ***plot()*** *function and built-in dataset* ***swiss*** *create a graph with the following properties*

- use the formula interface
- plot "Education" on the y-axis
- plot "Agriculture" on the x-axis
- set the colour of the points to any colour of your preference[1]
- plot the observations as filled triangles
- set the axes labels as "edu" and "agri"
- set the limits of the x-axis to (-5, 100)
- add a title

Answers

```
plot(Education ~ Agriculture,
     data = swiss,
     col = "orangered",
     pch = 17,
     ylab = "edu", xlab = "edu",
     xlim = c(-5, 100),
     main = "A title")
```

[1] You may want to type `colours()` or google "R + colours" to find all the available options.



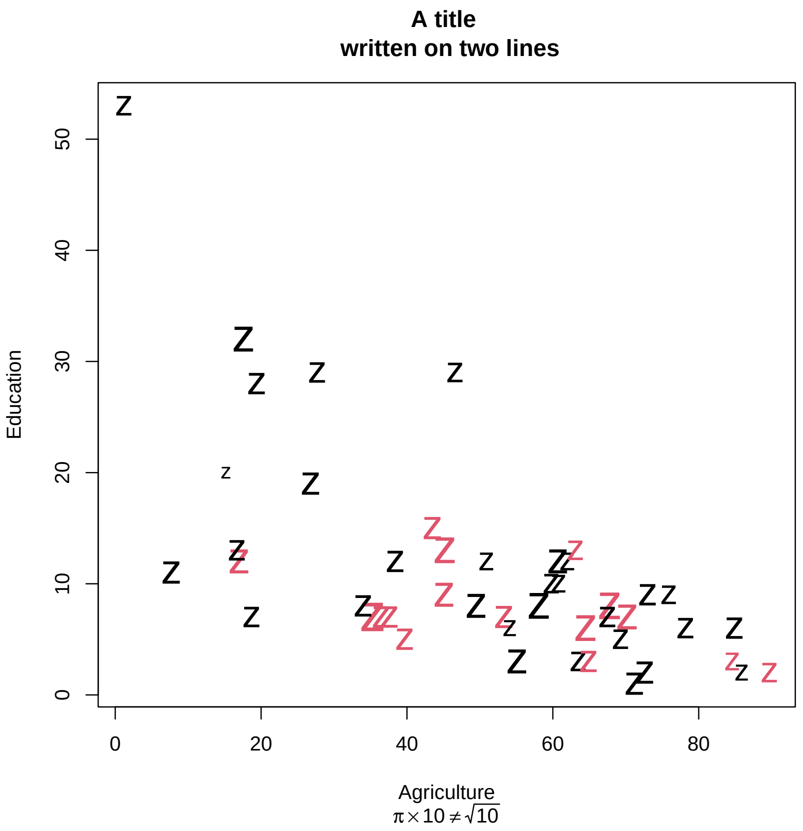
Going further (*)

Using the `plot()` *function and built-in dataset* `swiss` *create a graph with the following properties*

- use the formula interface
- plot "Education" on the y-axis
- plot "Agriculture" on the x-axis
- plot the observations with "Fertility" equal or greater than 76 with a different colour to all the others
- use the letter "z" as plotting character
- set the expansion factor to be proportional to the variable "Infant.Mortality"
- add a title written on two lines
- add a subtitle that contains the expression $\pi * 10 \neq \sqrt(10)$

Answers

```
v.colour <- (swiss$Fertility >= 76) + 1
plot(Education ~ Agriculture,
     data = swiss,
     col = v.colour,
     pch = "z",
     cex = Infant.Mortality / 10,
     main = "A title \n written on two lines",
     sub = expression(pi %*% 10 != sqrt(10)))
```



1.3 Question:

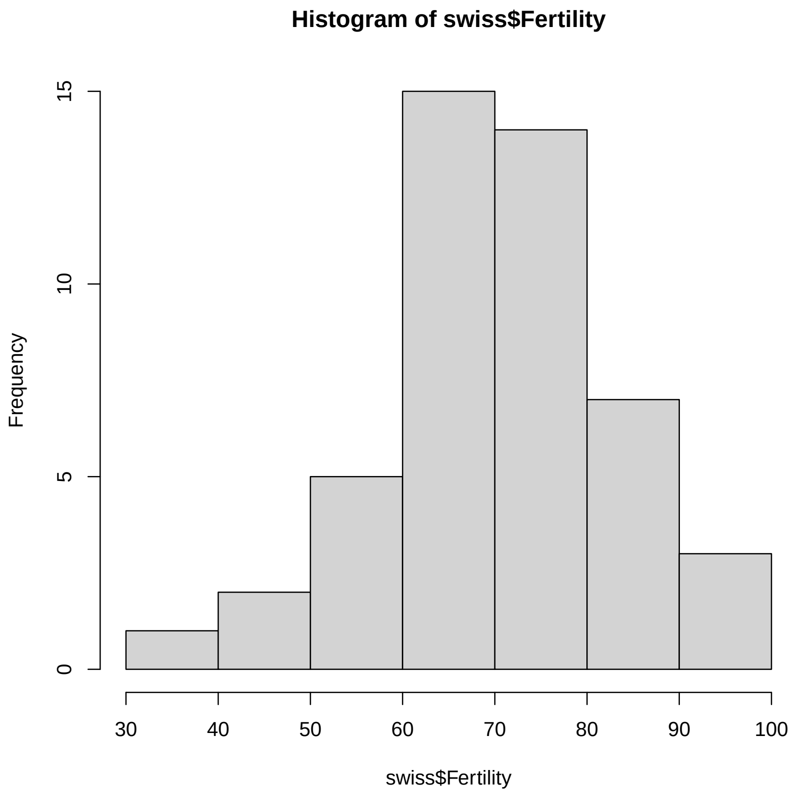
We now want you to familiarise with other basic graphical functions. Create the following graphs.

1. an histogram of the ”Fertility” variable found in `swiss` (hint: use `hist()`)
2. a boxplot of where the ”Sepal.Length” variable found in `iris` is plotted against ”Species” (hint: use `boxplot()`)
3. a graph where all variable of the `swiss` dataset are plotted against each other (hint: use `pairs()`)

Answers

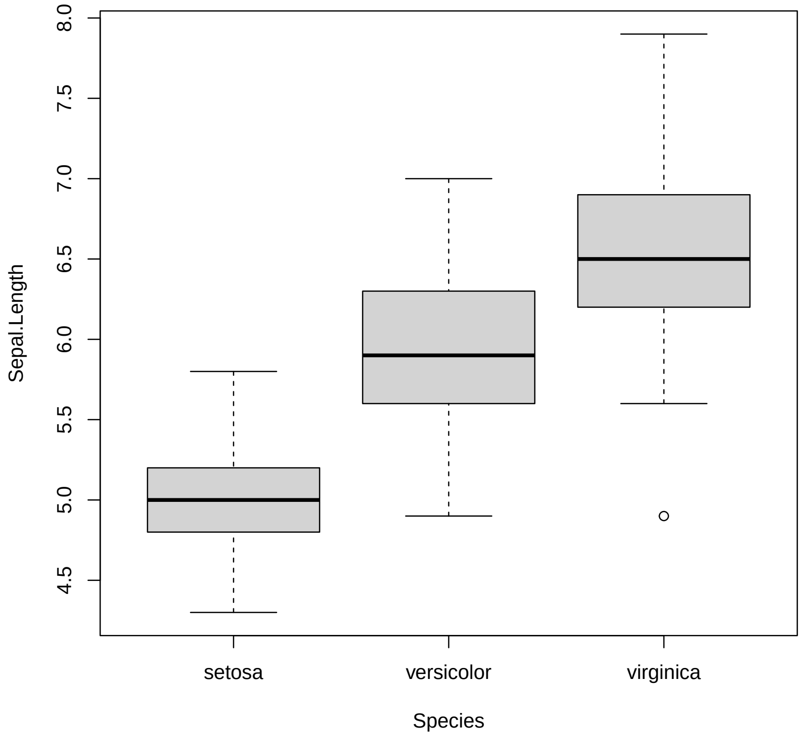
1.

```
hist(x = swiss$Fertility)
```



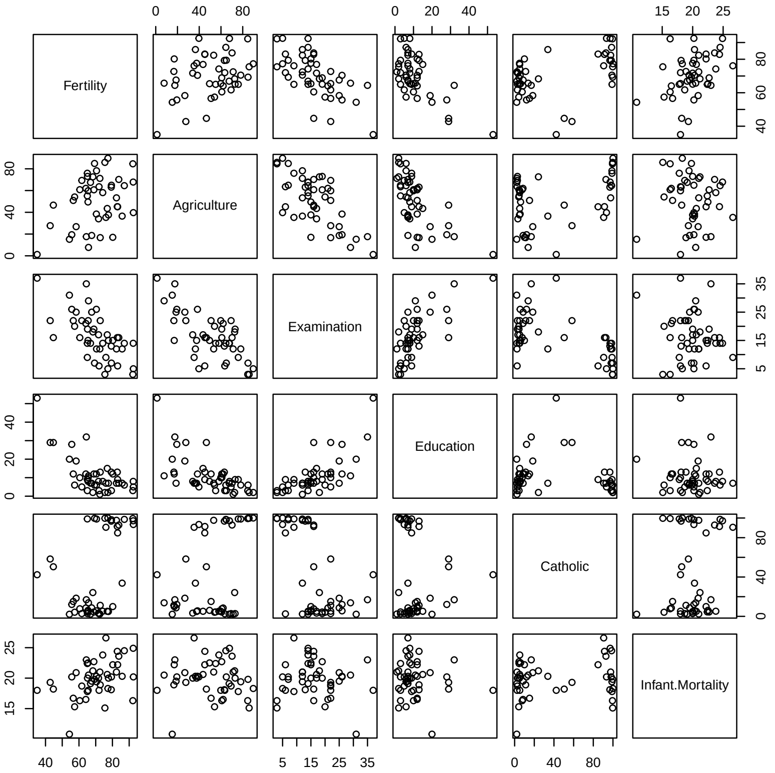
2.

```r
boxplot(Sepal.Length ~ Species, data = iris)
```



3.

```
pairs(swiss)
```



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2 Exercise: Graphics II

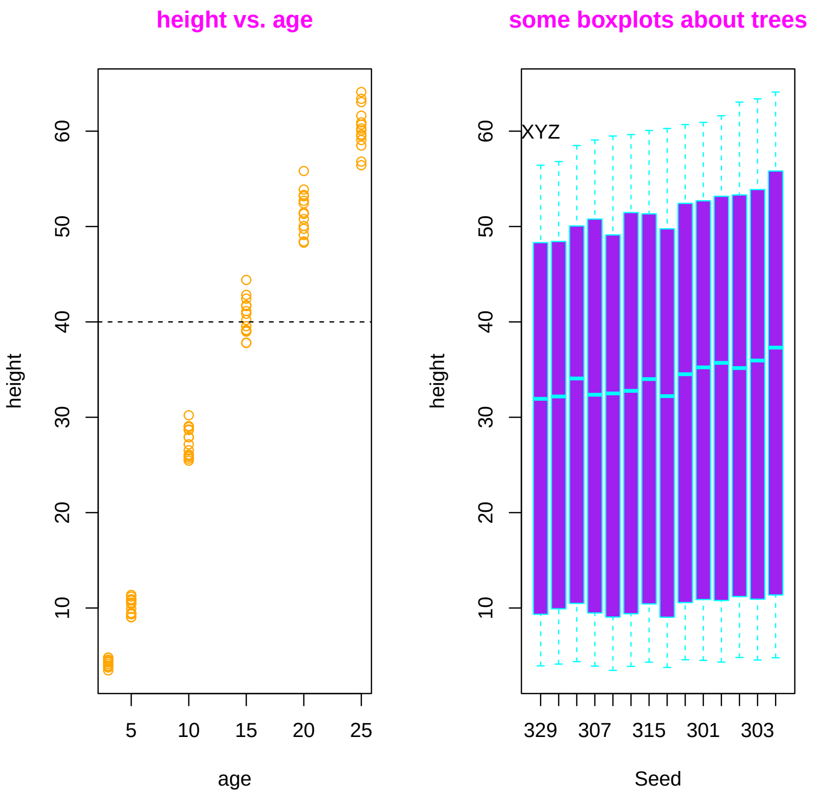
2.1 Question:

Consider the built-in dataset `Loblolly` (type `?Loblolly` to get more information). Using the `plot()`, `abline()` and `par()` functions create a graph with the following properties.

- the device region is divided in two part such that a graph can be accommodated on the left and one on the right-hand side
- the first plot on the left is a scatterplot of "height" against "age" (i.e. "height" is on the y-axis)
- the plot on the rights is a boxplot where the "height" of the trees is plotted against the variable "Seed"
- dots in the scatterplot must be rendered with the colour orange
- the inner area of the boxplots must be rendered with the colour purple
- the border of the boxplots and the whiskers must be rendered with the colour "cyan"
- both graphs must have a title
- on the scatterplot there is an horizontal dashed line flat on 40
- on the boxplot graph write some text above the very first boxplot on the left
- all graph titles must be written with the colour magenta. Use the function `par()` function to do that

Answers

```
par(mfrow = c(1, 2),
    col.main = "magenta")
plot(height ~ age, data = Loblolly,
     col = "orange",
     main = "height vs. age")
abline(h = 40, lty = "dashed")
boxplot(height ~ Seed, data = Loblolly,
        col = "purple", border = "cyan",
        main = "some boxplots about trees")
text(1, 60, "XYZ")
```



2.2 Question:

Use the Rstudio interface to export this graph as a pdf file. Save the pdf on your Desktop.

Answers

Create your graph and then simply click on ”Export” → ”Same as PDF”. Set the directory where to save the file by clicking on ”Directory” button.

3 Exercise: Graphics III

3.1 Question:

The dataset used in this exercise is `Orthodont`, which is about the growth of 29 children. Load the add-on package {`nlme`} such that the dataset is available (Then type `?Orthodont` if you wish more information about the dataset).

*To better understand the way multipanel conditioning and grouping work, run the following **R**-commands. You may try to guess what the resulting plot will be before running the command.*

```
library(lattice)
library(nlme) ## for the dataset
# ? Orthodont

## 1. No multipanel conditioning, points only
xyplot(distance ~ age, data = Orthodont)
##
## 2. No conditioning, points and a regression line
xyplot(distance ~ age, data = Orthodont,
       type = c("p", "r"))
##
## 3. No conditioning, grouping (Sex), points and a regression line
xyplot(distance ~ age, data = Orthodont, groups = Sex,
       type = c("p", "r"))
##
## 4. multipanel conditining for Sex, points and a regression line
xyplot(distance ~ age | Sex, data = Orthodont,
       type = c("p", "r"))
```

Answers

For the sake of brevity the plots are not reported here. Simply run the code yourself. If you have any questions, do not hesitate to ask the course instructors.

3.2 Question:

We now do the same with the {ggplot2} package.

```
library(ggplot2)

## 1. No multipanel conditioning, points only
ggplot(data = Orthodont,
       mapping = aes(y = distance,
                     x = age)) +
  geom_point()
##
## 2. No conditioning, points and a regression line
ggplot(data = Orthodont,
       mapping = aes(y = distance,
                     x = age)) +
  geom_point() +
  geom_smooth(method = "lm")
```

```
`geom_smooth()` using formula 'y ~ x'
```

```
##
## 3. No conditioning, grouping (Sex), points and a regression line
ggplot(data = Orthodont,
       mapping = aes(y = distance,
                     x = age,
                     group = Sex,
                     colour = Sex)) +
  geom_point() +
  geom_smooth(method = "lm")
```

```
`geom_smooth()` using formula 'y ~ x'
```

```
##
## 4. multipanel conditining for Sex, points and a regression line
ggplot(data = Orthodont,
       mapping = aes(y = distance,
                     x = age)) +
  geom_point() +
  geom_smooth(method = "lm") +
  facet_wrap(. ~ Sex)
```

```
‘geom_smooth()‘ using formula ’y ~ x’
```

Answers

For the sake of brevity the plots are not reported here. Simply run the code yourself. If you have any questions, do not hesitate to ask the course instructors.

3.3 Question:

For the next exercise you can choose whether to work with {`lattice`}, {`ggplot2`} or even try with both.

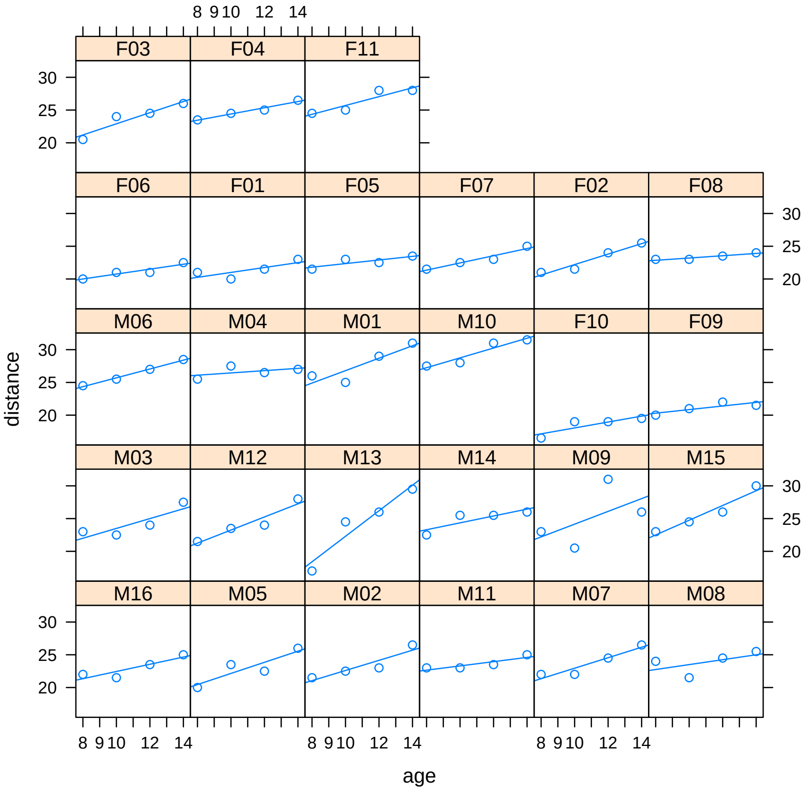
1. Now try to produce a plot where each person is plotted in a different panel, use points and a regression line in each panel. If you use `ggplot()` make sure that the confidence interval around the regression line is turned off (makes little sense with 4 observations to estimate a CI).
2. than replace points and regression lines with lines connecting points for each Subject. In addition you should add a grid in the background. This comes as a default with `ggplot()` but not with `xyplot()` (you may want to type `?xyplot` for help).
3. finally, modify the previous plot and use different points and lines colours for the two genders.

Answers

`xyplot()` solutions:

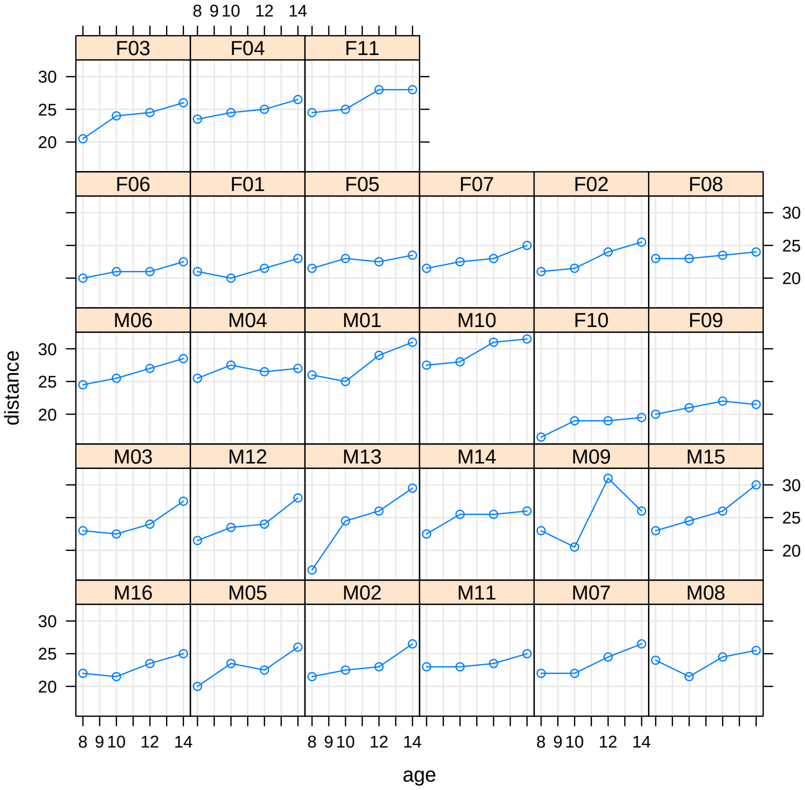
1.

```
xyplot(distance ~ age | Subject, data = Orthodont,
       type = c("p", "r"))
```



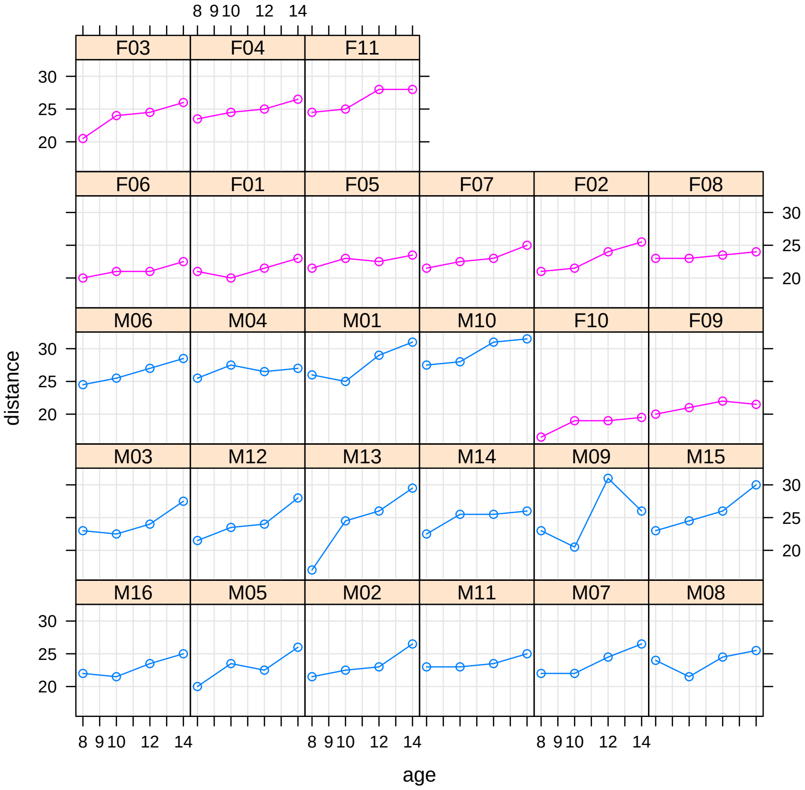
2.

```
xyplot(distance ~ age | Subject, data = Orthodont,
     type = c("b", "g"))
```



3.

```
xyplot(distance ~ age | Subject, data = Orthodont,
       groups = Sex,
       type = c("b", "g"))
```

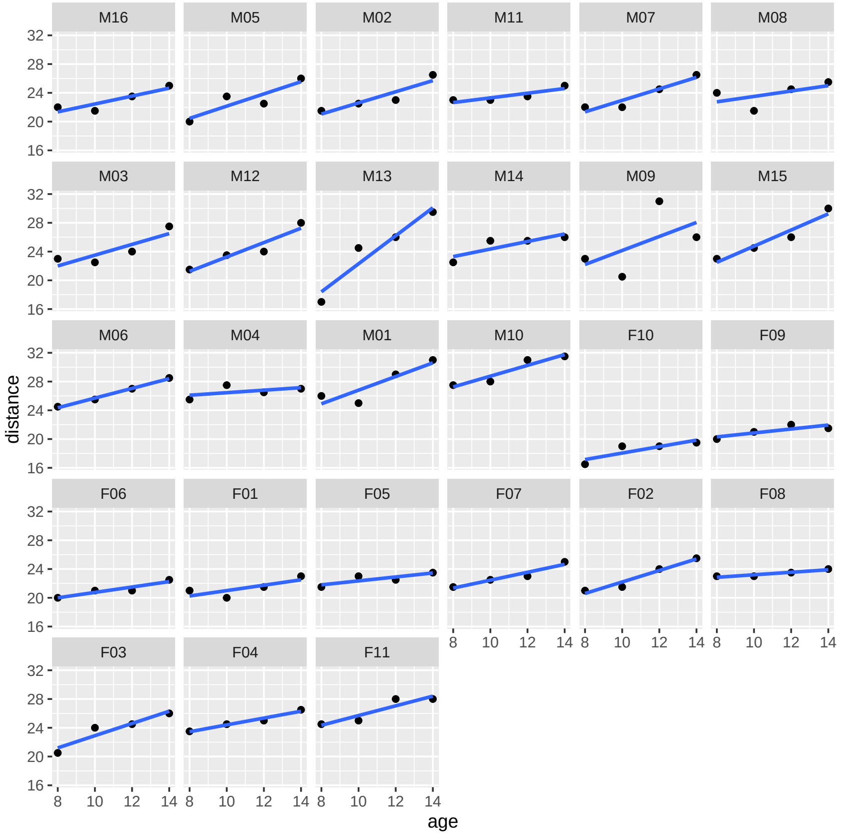


`ggplot()` solutions:

1.

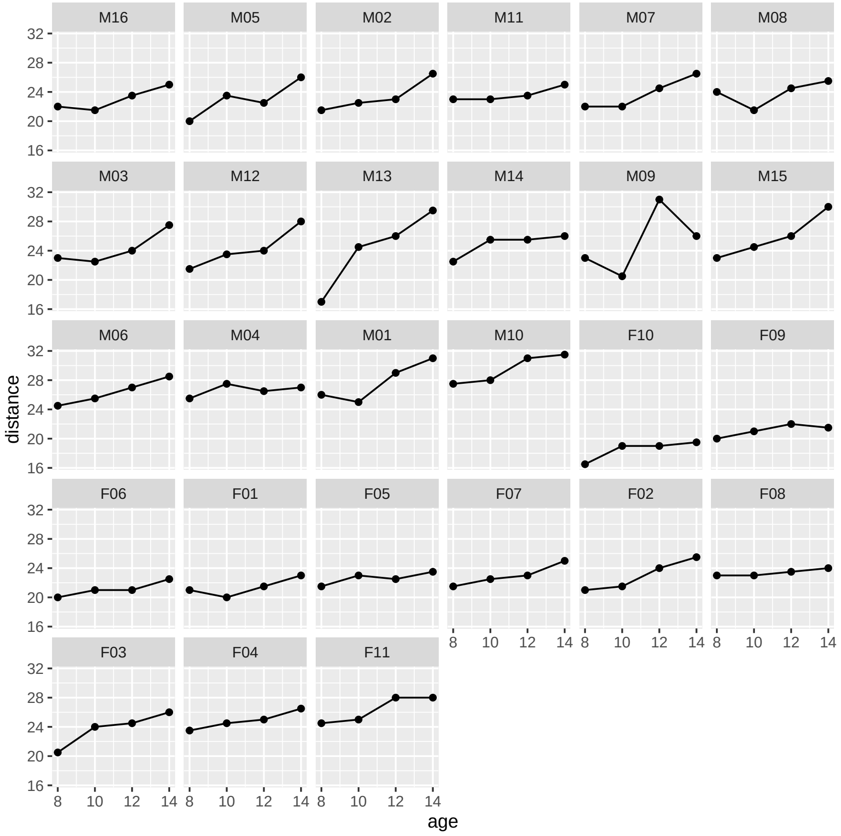
```
ggplot(data = Orthodont,
       mapping = aes(y = distance,
                     x = age)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE) +
  facet_wrap(. ~ Subject)
```

```
`geom_smooth()` using formula 'y ~ x'
```



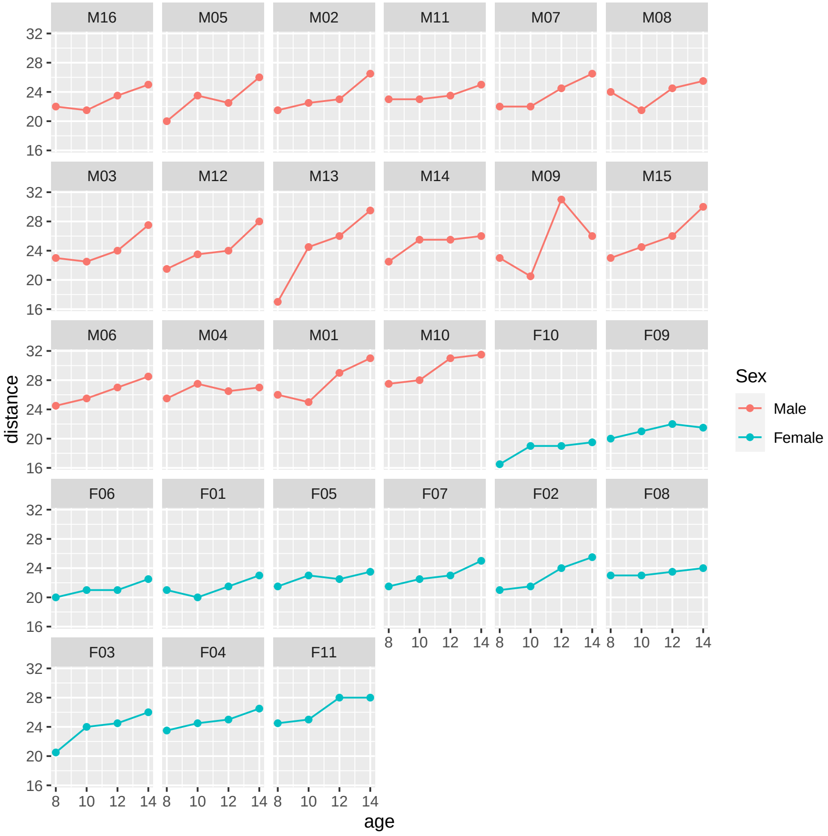
2.

```
ggplot(data = Orthodont,
       mapping = aes(y = distance,
                     x = age)) +
  geom_point() +
  geom_line() +
  facet_wrap(. ~ Subject)
```



3.

```
ggplot(data = Orthodont,
       mapping = aes(y = distance,
                     x = age,
                     colour = Sex)) +
  geom_point() +
  geom_line() +
  facet_wrap(. ~ Subject)
```



3.4 Question:

NB: before starting to work on this exercise, read the whole assignment here. Indeed, this exercise involves some collaborative work.

*Using any of the built-in datasets (type `data()` for the whole list) produce a graph with the base **R** functions (i.e. `plot()`, `boxplot()`,...). Then save it as a jpeg file.*

Using the same dataset produce a graph with either `xyplot()` or `ggplot()`.

Exchange the two graphs with another participant in the room and without looking at his/her code try to reproduce the exact same graph.

Finally, discuss with the other participant your solution. Again, you may want to involve in this discussion the course instructors.