

# R for Data Science (I): Visualization

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Recerca

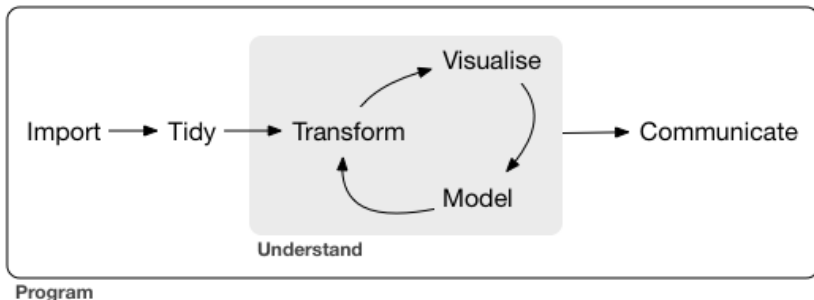
# Readme

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# Outline: Data Exploration

- The Data Science Approach in R
- Data Visualization
- Data Transformation
- Exploratory Data Analysis

## Recall: The Data Science Approach in R



# Data Visualization

## Graphics in the tidyverse

- Traditionally graphics in R are relatively complicated because they are based in functions with many parameters.
- Improving a graphic or overimposing distinct plots is also a non-trivial task.
- The `tidyverse` approach provides a distinct way to draw plots which is, at the same time, **intuitive, flexible and powerful**.
- This is made possible because it implements the so-called *grammar of graphics* which was introduced by Hadley Wickam in his paper A layered grammar of graphics.

# The grammar of graphics

- Graphics are treated as a set of elements which can be combined to produce the final plot.
- The idea consists of *working with distinct layers* starting with a first one that sets the data to be plotted.
- Successive layers are added, for instance to change colors, add annotations, overimpose other plots, etc.

## The ggplot2 package

- This package implements the grammar of graphics within the tidyverse.
- The package does not belong to the standard R distribution, so it has to be installed.
  - This can be done when installing the tidyverse or separately (only for this package).
- Option 1:

```
install.packages('tidyverse')
```

- Option 2:

```
install.packages('ggplot2')
```



## Creating a plot with ggplot2

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  - 5 facets and scales allow to visualize different subsets of the data and control the representation in space.

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  - 5 facets and scales allow to visualize different subsets of the data and control the representation in space.
  - 6 Different elements can be included in the graph with the operator +.

## Creating a plot in practice

The basic steps to create a plot are:

- 1 Create a `ggplot` object providing the data and some aesthetics
- 2 Add one or more geoms using the `+` operator to define and shape the plot type.

## Example 1. The data

- First we need the data

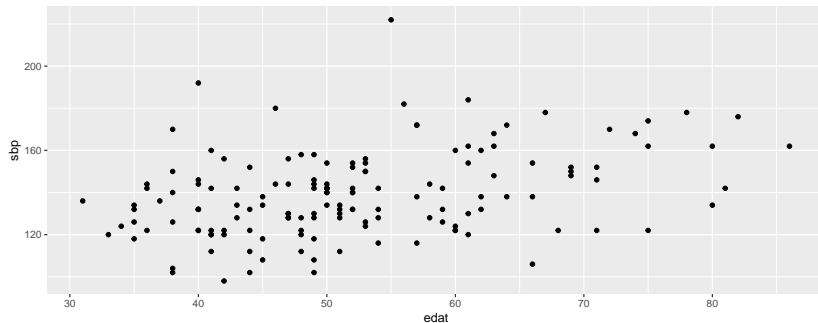
```
library(readxl)
diabetes <- read_excel("datasets/diabetes.xls")
head(diabetes)
```

```
## # A tibble: 6 x 11
##   numpacie mort   tempsviu   edat   bmi edatdiag tabac  s
##   <dbl> <chr>     <dbl> <dbl> <dbl>   <dbl> <chr> <dbl>
## 1       1 Vivo      12.4   44  34.2     41 No f~ 1
## 2       2 Vivo      12.4   49  32.6     48 Fuma~ 1
## 3       3 Vivo       9.6   49  22      35 Fuma~ 1
## 4       4 Vivo       7.2   47  37.9     45 No f~ 1
## 5       5 Vivo      14.1   43  42.2     42 Fuma~ 1
## 6       6 Vivo      14.1   47  33.1     44 No f~ 1
```



## Example 1. Build the plot

```
library(ggplot2)  
ggplot(diabetes)+  
  geom_point(aes(x=edat,y=sbp))
```



## Variations on the theme

- Calls to ggplot can be combined differently

```
ggplot(data=diabetes,aes(x=edat,y=sbp))+  
  geom_point()
```

or

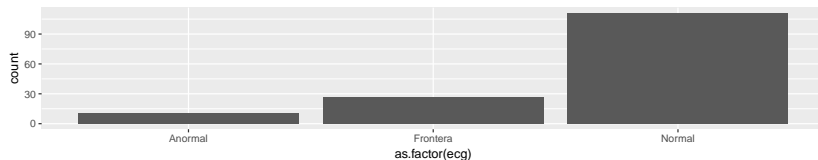
```
ggplot()+  
  geom_point(data=diabetes,aes(x=edat,y=sbp))
```

# Aesthetics

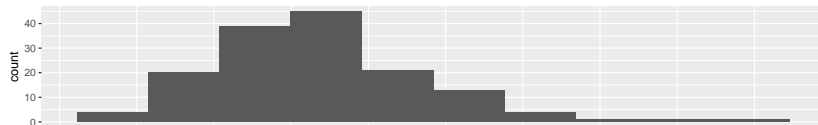
- In a ggplot aesthetic `aes ()` refers to *what we can see*, that is, visual properties of an object.
  - `x`, `y`: what goes on the axes
  - `color`: exterior color
  - `fill`: color of the interior
  - `shape`: shape of the points
  - `linetype`: type of line
  - `size`: size
  - `alpha`: transparency (1: opaque; 0: transparent)
- Each type of geometry accepts a subset of the possible options.
- One of the most used functions is to define groups through various aesthetics variables or directly with the option on “group”.

## Example 2: Aesthetics

```
ggplot(diabetes)+  
  geom_bar(aes(x=as.factor(ecg)))
```

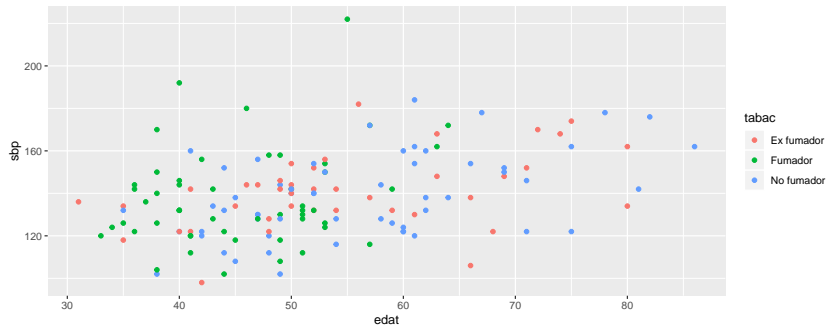


```
ggplot(diabetes)+  
  geom_histogram(aes(x=bmi), bins=10)
```



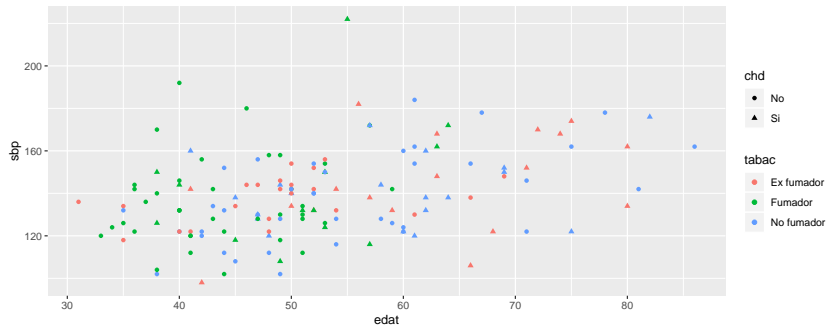
## Distinguishing between groups using aes() (1)

```
ggplot(diabetes)+  
  geom_point(aes(x=edat,y=sbp, col=tabac))
```



## Distinguishing between groups using aes() (2)

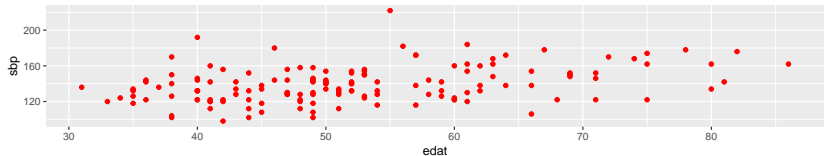
```
ggplot(diabetes)+  
  geom_point(aes(x=edat,y=sbp, col=tabac, shape=chd))
```



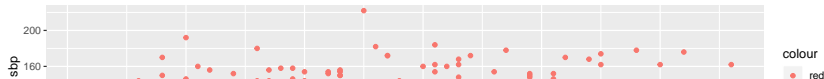
## aes properties that do not depend on variables

Notice the difference between these plots.

```
ggplot(diabetes)+  
  geom_point(aes(x=edat, y=sbp), col='red')
```



```
ggplot(diabetes)+  
  geom_point(aes(x=edat, y=sbp, col='red'))
```



# Geometric Objects



## Modifying plots by adding geoms

- Geometric objects are the actual marks we put on a plot.  
Examples include:
  - points (`geom_point`, for scatter plots, dot plots, etc)
  - lines (`geom_line`, for time series, trend lines, etc)
  - boxplot (`geom_boxplot`, for, well, boxplots!)
- A plot **must have at least one geom**; there is no upper limit.
  - You can add a geom to a plot using the `+` operator
- You can get a list of available geometric objects using the code below: `help.search("geom_", package = "ggplot2")`

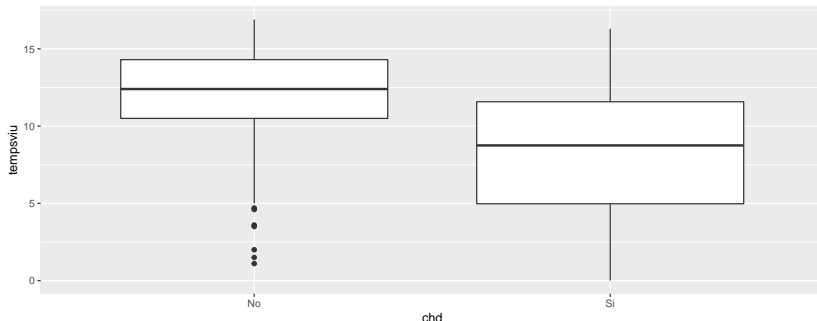
## Drawing plots incrementally

- In the console run the follow instructions one after the other

```
(p <- ggplot(diabetesF, aes(x=edat, y=sbp)))  
(p<- p + geom_point())  
(p<- p + geom_smooth(method='lm'))
```

## Do not forget boxplots!

```
(p<- ggplot(diabetes, aes(x=chd, y=tempsviu)) +  
  geom_boxplot())
```

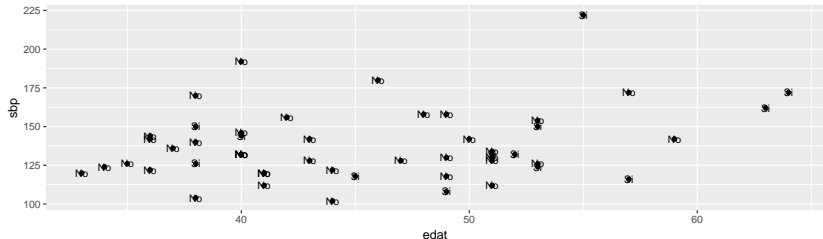


```
(p<- p+  
  ggtitle("Relation between temps viu and chardiac diseas
```

## Adding labels to your plot

- It is straightforward with the `geom_text()` which accepts a labels mapping.
- An alternative is using `geom_label`

```
ggplot(diabetesF, aes(x=edat, y=sbp)) +  
  geom_point() +  
  geom_text(aes(label=chd), size = 3)
```



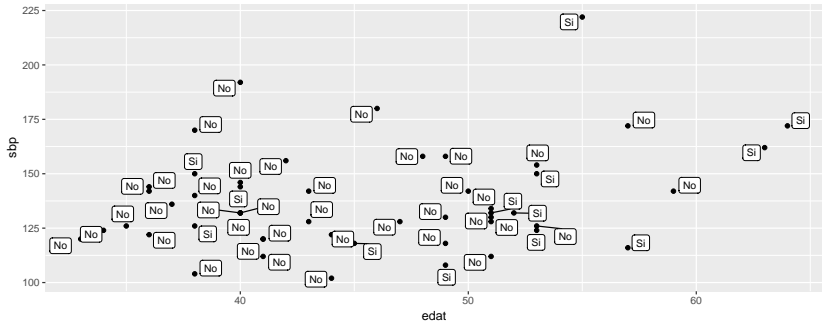
## ggplot extensions: the ggrepel package

Use this package to avoid overlapping of labels and points

```
install.packages("ggrepel")
```

```
require(ggrepel)  
ggplot(diabetesF, aes(x=edat, y=sbp))+ geom_point() +  
  geom_label_repel(aes(label=chd), size = 3)
```

## ggplot extensions: the ggrepel package



## Exercise I

- The data for this exercise, stored in the file `EconomistData.csv`.
  - They consist of Human Development Index and Corruption Perception Index scores for several countries.
- 1 Create a scatter plot with CPI on the x axis and HDI on the y axis.
  - 2 Color the points blue.
  - 3 Map the color of the the points to Region.
  - 4 Make the points bigger by setting size to 2
  - 5 Map the size of the points to HDI.Rank

# Facets



# Facets

- Faceting is ggplot2 parlance for small multiples
- The idea is to create separate graphs for subsets of data
- ggplot2 offers two functions for creating small multiples:
  - `facet_wrap()`: define subsets as the levels of a single grouping variable
  - `facet_grid()`: define subsets as the crossing of two grouping variables
- Faceting facilitates comparison among plots, not just of geoms within a plot

## The housings dataset

For the following examples we will use a database on housing prices.

```
require(readr)  
housing <- read_csv("datasets/landdata-states.csv")
```

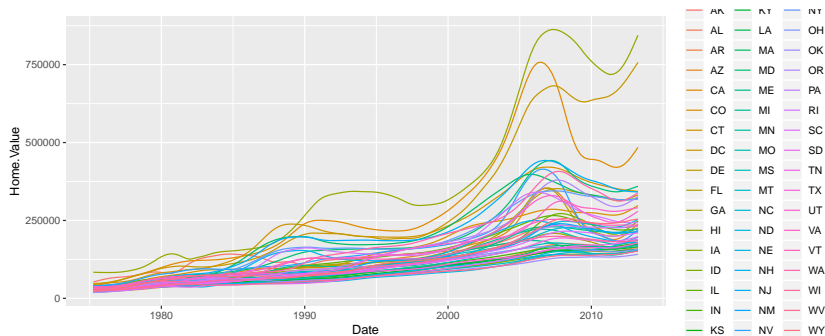
## What is the trend in housing prices in each state?

We can start with what we know how to do: map State to color.

```
p5 <- ggplot(housing, aes(x = Date, y = Home.Value))  
p5 + geom_line(aes(color = State))
```

## Housing prices trends by states (1)

```
p5 <- ggplot(housing, aes(x = Date, y = Home.Value))  
p5 + geom_line(aes(color = State))
```

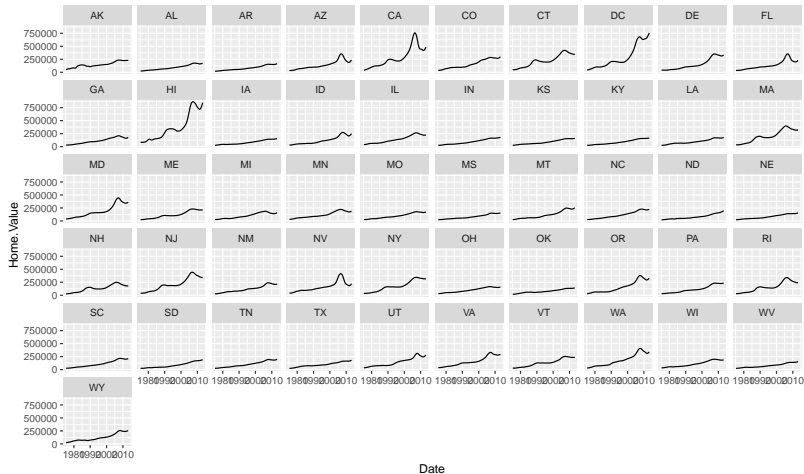


## Housing prices by states (2)

- Visibility of distinct trends depending on state can be improved if we plot each state in a separate graphic.

```
p5 <- ggplot(housing, aes(x = Date, y = Home.Value))  
(p5 <- p5 + geom_line() +  
  facet_wrap(~State, ncol = 10))
```

## Housing prices by states (2)



## Exercise

- Interpret the result of the following instructions:

```
ggplot(mtcars, aes(x=wt, y=mpg)) + geom_point() +  
+ geom_smooth() +  
+ facet_grid(as.factor(am) ~ as.factor(gear))
```

- What happens if we try to separate based on a continuous variable?
- How can this be solved?

# Statistical transforms



# Statistics

- Some plot types (such as scatterplots) do not require transformations—each point is plotted at  $x$  and  $y$  coordinates equal to the original value.
- Other plots, such as boxplots, histograms, prediction lines etc. require statistical transformations:
  - for a boxplot the  $y$  values must be transformed to the median and  $1.5(IQR)$
  - for a smoother the  $y$  values must be transformed into predicted values

## One stat per each geom

- Each geom has a default statistic, but these can be changed.

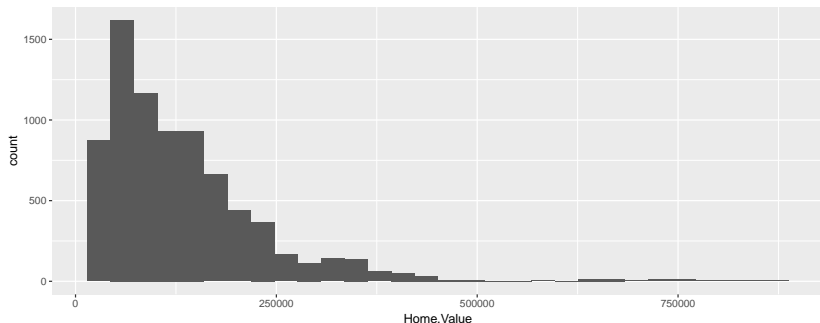
geom	stat
geom_bar()	stat_count()
geom_col()	stat_identity()
geom_pol()	stat_identity()
geom_smooth()	stat_smooth()

- The “stat” is an argument of the “geom” and the “geom” is an argument from the “stat”.
- Compare the outputs from:

```
args(geom_histogram)
args(stat_bin)
```

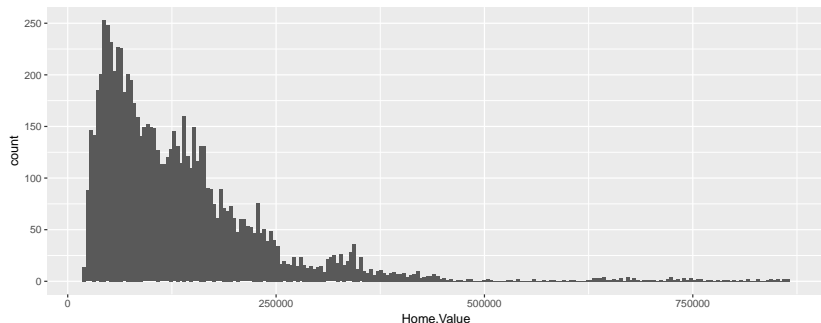
## Seeing the effect of stats (1: default)

```
p <- ggplot(housing, aes(x = Home.Value))  
(p <- p + geom_histogram())
```



## Seeing the effect of stats (2: change values)

```
p<- ggplot(housing, aes(x = Home.Value))  
(p<-p+geom_histogram(stat= 'bin', binwidth=4000))
```



## That's (not) all

- There are many other things you can do with your plots.
- An easy way to learn is adapting other people's plots.
  - You can go to R graphs gallery which has a
  - specific section on ggplot2

and start adapting some of their plots to your needs.

- And do not forget the cheatsheet!:
  - [ggplot2-cheatsheet-2.1-Spanish.pdf](#)

## Your turn

Use the dataset from "The Economist" available from the course page to draw the plot from the figure below:

