Data Visualization with R
Ggplot2 tutorial (part 1)

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What is ggplot2?

Ggplot2 is the graphics package from the tidyverse, a collection of R packages designed for data science.

There is a base graphics package in R, which is present in the default version of R.

However, ggplot2 gives users a lot more flexibility and control over their visualizations.

Main concepts of ggplot2

Ggplot2 is based on layers:

- A first layer to describe the dataset.
- Layers describing the objects representing the data (dots, lines, bars, etc.).
- Additional objects describing the graphic itself (coordinates, scales, fonts, etc.).

Example: Histograms

Built-in R graphics package:

```
hist(airquality$Temp)
```

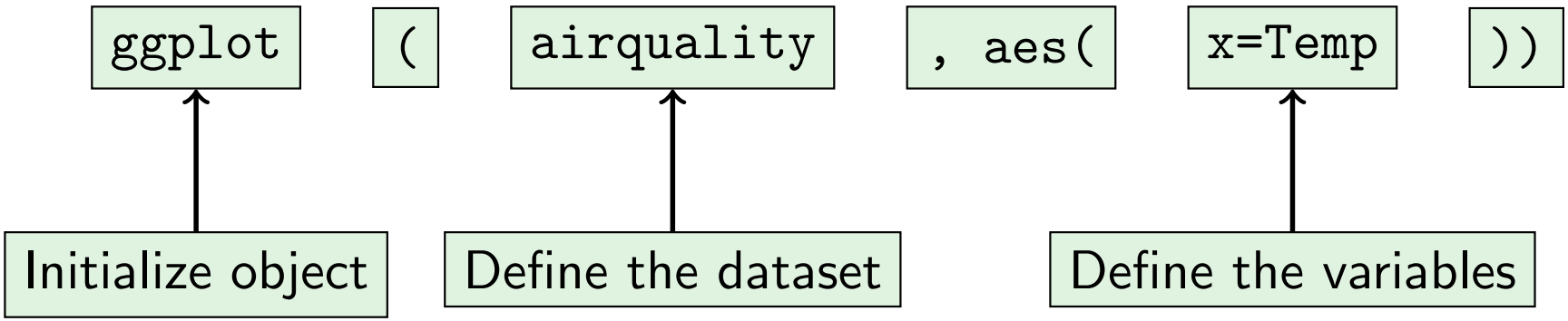
Quick plot using ggplot2:

```
qplot(airquality$Temp)
```

Ggplot2 command structure

```
ggplot(airquality, aes(x=Temp))
```

This command does not plot anything.



Ggplot2 command structure

We need to add a command to explain the kind of object that we want to plot:

```
ggplot(airquality, aes(x=Temp)) +
geom_histogram()
```

Bar plots

We can use bar plots to visualize one categorical variable:

```
ggplot(df_desc, aes(x=Vancouver)) +
geom_bar()
```

The height of the bar is proportional to the number of cases in each group.

Bar plots

Or a combination of a categorical variable and a continuous variable:

```
ggplot(RetailSales, aes(x=Month, y=Sales)) +
geom_bar(stat="identity")
```

Using `stat = "identity"` tells ggplot2 to sum the values for each group (Month) and plot bars proportional to the sums.

Box plots

For each layer that we want to add on our plot, we add the corresponding object:

```
ggplot(df_hum, aes(x=month, y=Vancouver)) +
geom_boxplot()
```

Scatter plots and line plots

The relationship between two continuous variables can be visualize with a scatter plot or a line plot:

```
ggplot(df, aes(x=time, y=distance)) +
geom_point()
```

```
ggplot(df, aes(x=time, y=distance)) +
geom_line()
```

Changing histogram defaults

Modify the number of bins:

```
ggplot(df_hum, aes(x=Vancouver)) +
geom_histogram(bins=15)
```

Modify the filling and the color:

```
ggplot(df_hum, aes(x=Vancouver)) +
geom_histogram(bins=15, fill="white", color=1)
```

Adding aesthetics to the plot

Add title and axis labels to the histogram:

```
ggplot(df_hum, aes(x=Vancouver)) +
geom_histogram(bins=15, fill="white", color=1) +
ggtitle("Humidity for Vancouver city") +
xlab("Humidity") +
theme(axis.text.x=element_text(size=12),
axis.text.y=element_text(size=12))
```

Adding aesthetics to the boxplot

Add labels to the box plot:

```
ggplot(df_hum, aes(x=month, y=Vancouver)) +
geom_boxplot(color=1, fill=3) +
ylab("Humidity") +
theme(axis.text.x=element_text(size=15),
axis.text.y=element_text(size=15),
axis.title.x=element_text(size=15, color=2),
axis.title.y=element_text(size=15, color=2))
```

Layers

Each plot can be thought as a separate variable, and the sum of the variables will make the final plot. You can define:

```
p1 <- ggplot(df,
      aes(x=Electricity_consumption_per_capita))
p2 <- p1 + geom_histogram()
p3 <- p1 + geom_histogram(bins=15)
p4 <- p3 + xlab("Electricity consumption per capita")
```

and you can choose to plot p2, p3, or p4.

Scales

Scales `scale_x_continuous` or `scale_x_discrete` can be used to specify the axes. `name`, `limits`, `breaks`, and `labels` are the main parameters that can be adjusted.

```
p1 <- ggplot(df, aes(x=gdp_per_capita))
p2 <- p1 + geom_histogram()
p3 <- p2 + scale_x_continuous(
           name="GDP per capita"),
           limits=c(0, 50000),
           breaks=seq(0, 40000, 4000),
           labels=c("0K", "4K", "8K", "12K", "16K",
           "20K",  "24K", "28K", "32K", "36K", "40K"))
```

Polar coordinates

You can define the coordinates with `coord_cartesian` or `coord_polar`:

```
t <- seq(0, 360, by=15)
r <- 2
qplot(r, t) +
coord_polar(theta="y") +
scale_y_continuous(breaks=seq(0, 360, 30))
```

Facets

A Trellis display allows creating a plot for each group of a categorical variable:

```
p <- ggplot(df,
     aes(x=gdp_per_capita,
         y=Electricity_consumption_per_capita)) +
     geom_point()
p + facet_grid(Country ~ .)
p + facet_grid(. ~ Country)
p + facet_wrap(~Country)
```

You can group subplots horizontally, vertically or wrapped together.

Shapes and colors

You can change shape and color for the entire plot:

```
ggplot(df, aes_string(x=var1, y=var2)) +
geom_point(color=2, shape=2)
```

Or assign a different shape and color for each group of a categorical variable:

```
ggplot(df, aes_string(x=var1, y=var2)) +
geom_point(aes(color=Country, shape=Country))
```