DATA SOCIETY®

Interactive visualization with R - Part 1

One should look for what is and not what he thinks should be.
-Albert Einstein.

Rising Data Science Interest

- With the rise of COVID-19, the need for fast visualizations to put data into perspective has also risen
- Have a look at this ***Visualization article*** while we wait to start class to get a peek at what's ahead.

Recap

- In the last module, we:
  - Transformed data using `tidyverse`
  - Plotted the transformed and tidy data to produce complex visualizations
- In this module, we will create plots using the `highcharter` package

Module completion checklist

Objective	Complete
Introduce using the highcharter package to build interactive visualizations	
Use highcharter with tidy data to create a scatterplot	
Visualize a correlation plot with hchart	
Build a column plot with hchart	
Create a boxplot with hchart	
Save interactive plots with htmlwidgets	

Directory settings

- In order to maximize the efficiency of your workflow, you may want to encode your directory structure into `variables`
- Let the `main_dir` be the variable corresponding to your `skillsoft` folder

```
# Set `main_dir` to the location of your `skillsoft` folder (for Mac/Linux).
main_dir = "~/Desktop/skillsoft"
# Set `main_dir` to the location of your `skillsoft` folder (for Windows).
main_dir = "C:/Users/[username]/Desktop/skillsoft"
# Make `data_dir` from the `main_dir` and remainder of the path to data directory.
data_dir = paste0(main_dir, "/data")
# Make `plots_dir` from the `main_dir` and remainder of the path to plots directory.
plot_dir = paste0(main_dir, "/plots")
# Set directory to data_dir.
setwd(data_dir)
```

Interactive visualizations with highcharter

- Similar to `ggplot2` and other plotting libraries (including base R itself), `highcharter` allows us to build complex, customized, and meaningful visualizations with the help of **layers** of graphical elements
- `Highcharter` is an R wrapper that allows R users to tap into one of the most comprehensive data visualization JavaScript-based libraries: ***Highcharts***
- `Highcharts` is free for individual research and non-profit purposes, but there are cases and restrictions to its use and you may need to obtain a license if you decide to integrate it into software or company-wide products

```
> library(highcharter)
Highcharts (www.highcharts.com) is a Highsoft software product which is
not free for commercial and Governmental use
>
```

Interactive visualizations: highcharter

Let's install the package and check its documentation

```
# Install `highcharter` package.
install.packages("highcharter")

# Load the library.
library(highcharter)

# View documentation.
library(help = "highcharter")
```

Documentation for package 'high...

```
                Information on package 'highcharter'

Description:

Package:            highcharter
Type:               Package
Version:            0.5.0
Title:              A Wrapper for the 'Highcharts' Library
Description:        A wrapper for the 'Highcharts' library including shortcut functions t
                    <http://www.highcharts.com/> is a charting library offering numerous
                    configuration syntax.
Authors@R:          c( person("Joshua", "Kunst", role = c("aut", "cre"), email = "jbkunst
                    "Agostinho", role = c("ctb"), comment = "hchart.survfit, densities an
                    person("Eduardo", "Flores", role = c("ctb"), comment = "First version
                    person("Dean", "Kilfoyle", role = c("ctb"), comment = "First version
                    person("Adline", "Dsilva", role = c("ctb"), comment = "First version
Date:               2016-09-05
URL:                http://jkunst.com/highcharter
BugReports:         https://github.com/jbkunst/highcharter/issues
Maintainer:         Joshua Kunst <jbkunst@gmail.com>
License:            MIT + file LICENSE
RoxygenNote:        5.0.1
Depends:            R (>= 2.10)
Imports:            htmlwidgets, magrittr, purrr, rlist, assertthat, zoo, dplyr, tibble (
                    quantmod, tidyr, htmltools, jsonlite, igraph, lubridate
Suggests:           knitr, rmarkdown, survival, ggplot2, httr, viridisLite
VignetteBuilder:    knitr
```

Highcharter main function: highchart

```
?highchart
```

- Similar to `ggplot2`, in order to create a plot, we need to call the main plotting function `ggplot()`
- In `highcharter` it is `highchart()`
- The function doesn't need any required arguments, and all of the graphic parameters and plotting options can be specified within layers themselves

Files | Plots | Packages | Help | Viewer

R: Create a Highcharts chart widget Find in Topic

highchart {highcharter} R Documentation

Create a Highcharts chart widget

Description

This function creates a Highchart chart using **htmlwidgets**. The widget can be rendered on HTML pages generated from R Markdown, Shiny, or other applications.

Usage

```
highchart(hc_opts = list(), theme = getOption("highcharter.theme"),
  type = "chart", width = NULL, height = NULL, elementId = NULL)
```

Arguments

hc_opts	A list object containing options defined as http://api.highcharts.com/highcharts.
theme	A hc_theme class object
type	A character value to set if use Highchart, Highstock or Highmap. Options are "chart", "stock" and "map".
width	A numeric input in pixels.
height	A numeric input in pixels.
elementId	Use an explicit element ID for the widget.

[Package *highcharter* version 0.5.0 Index]

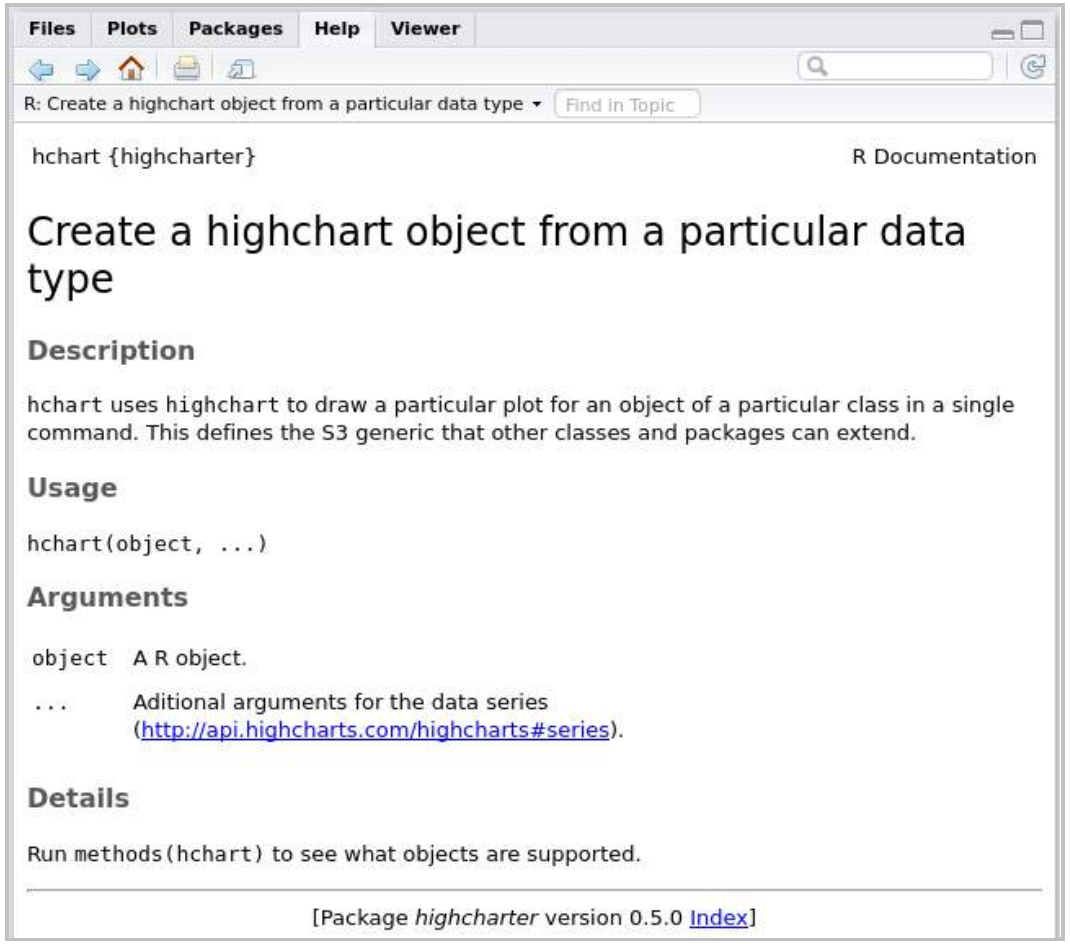
Highcharter: `hchart` vs `highchart`

```
?hchart

hchart(Some_data,        #<- dataset to use
       "plot_type",      #<- plot type to use
       hcaes(x = variable1, #<- x-axis mapping
             y = variable2, #<- y-axis mapping
             group = variable3, #<- group by
             ...))
```

`hchart` is a shorthand version of the `highchart` function, which takes a few key arguments to plot:

1. Data to use
2. Type of plot to create (e.g., `scatter`, `bar`, `column`, `line`, etc.)
3. `hcaes` (i.e., highcharts aesthetics) mapping of variables (works exactly the same way as with `ggplot2`!)



Files | Plots | Packages | Help | Viewer

R: Create a highchart object from a particular data type Find in Topic

hchart {highcharter} R Documentation

Create a highchart object from a particular data type

Description

hchart uses highchart to draw a particular plot for an object of a particular class in a single command. This defines the S3 generic that other classes and packages can extend.

Usage

```
hchart(object, ...)
```

Arguments

object	A R object.
...	Aditional arguments for the data series (http://api.highcharts.com/highcharts#series).

Details

Run methods(hchart) to see what objects are supported.

[Package *highcharter* version 0.5.0 Index]

Layers in Highcharts: series

- Just like `ggplot2`, the `highcharter` library has its own vocabulary
- Each new data / graphic layer in `highcharter` is called a **series**
- Each series can be of different `type`. Here are some widely used ones:

Highcharter series type	Plot type
scatter	scatterplot
line	line graph
boxplot	boxplot
column	bar plot
bar	horizontal bar plot
histogram	histogram
area	density

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Set up: load & prepare data

- Let's load the `CMP_subset` dataset from our `data_dir` into R's environment

```
# Set working directory to where we store
data.
setwd(data_dir)

library(tidyverse)

# Read CSV file
CMP_subset = read.csv("CMP_subset.csv",
            header = TRUE)
```

Now, tidy the data as before and transform it from wide to long for easy visualization

```
# Prep data for univariate plots
CMP_subset_long = CMP_subset %>%
  gather(key = "variable",
         value = "value")

# Make names of processes and materials more user
friendly and readable.
CMP_subset_long = CMP_subset_long %>%
     mutate(variable =
            str_replace(variable,
                        "Biological", "Bio ")) %>%
     mutate(variable =
            str_replace(variable,
                        "Manufacturing", "Man. "))
%>%
     mutate(variable =
            str_replace(variable,
                        "0", " ")) %>%
    group_by(variable) %>%              #<- normalize
    mutate(norm_value =
           value/max(value, na.rm = TRUE))
```

Set up: prepare data

```
# Prep data for scatterplot
CMP_subset_long2 = CMP_subset %>%
  gather(BiologicalMaterial01:ManufacturingProcess03,
         key = "variable",
         value = "value") %>%
  # All other transformations we've done before.
  mutate(variable = str_replace(variable, "Biological", "Bio ")) %>%
  mutate(variable = str_replace(variable, "Manufacturing", "Man. ")) %>%
  mutate(variable = str_replace(variable, "0", " ")) %>%
  group_by(variable) %>%
  mutate(norm_value = value/max(value, na.rm = TRUE))

head(CMP_subset_long2,3)
```

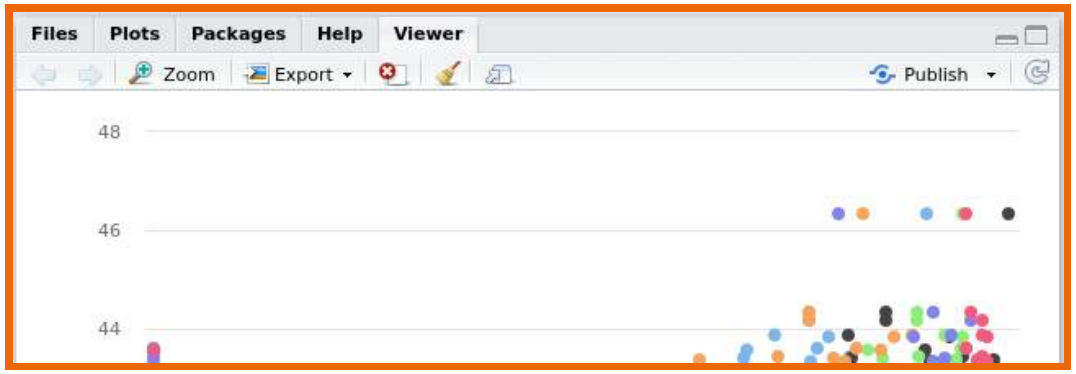
```
# A tibble: 3 x 4
# Groups:   variable [1]
  Yield variable       value norm_value
  <dbl> <chr>          <dbl>      <dbl>
1  38   Bio Material 1  6.25      0.709
2  42.4 Bio Material 1  8.01      0.909
3  42.0 Bio Material 1  8.01      0.909
```

hchart: scatterplot

To construct a scatterplot with `highcharter`, we use the `hchart()` function and pass the **data**, **plot type** (`scatter`), and **aesthetics** to it as arguments

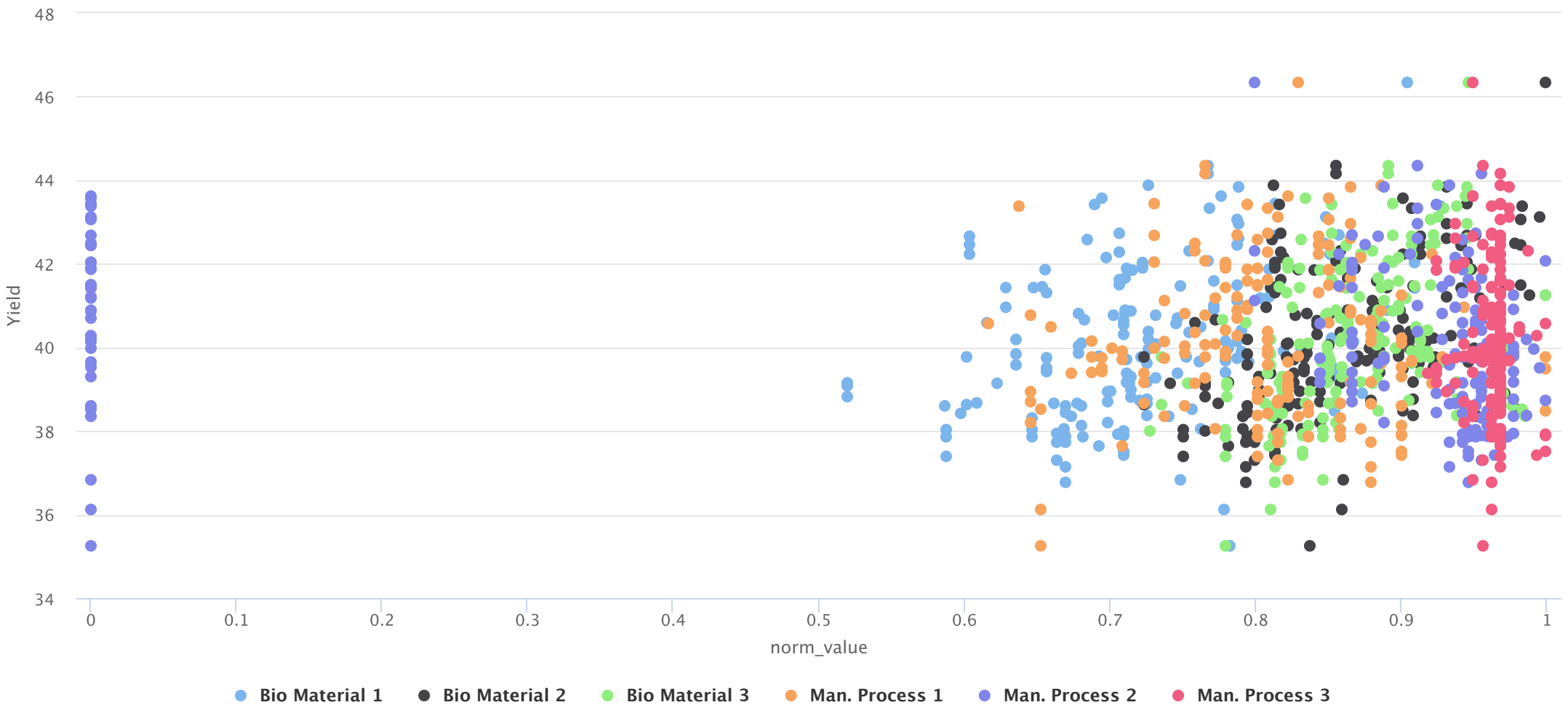
```
# Construct an interactive scatterplot.
scatter_interactive =                #<- name the
plot
  hchart(CMP_subset_long2,           #<- set data
         "scatter",                  #<- plot type
"scatter"
          hcaes(x = norm_value,      #<- set
aesthetics to map x-axis
                y = Yield,           #<- set
aesthetics to map y-axis
                group = variable)) #<- group by
```

- In R, interactive charts appear in the `Viewer` pane, right next to the `Help` tab



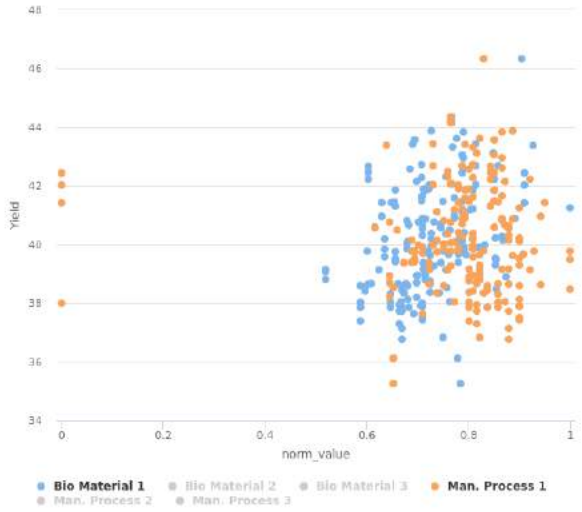
hchart: scatterplot (cont'd)

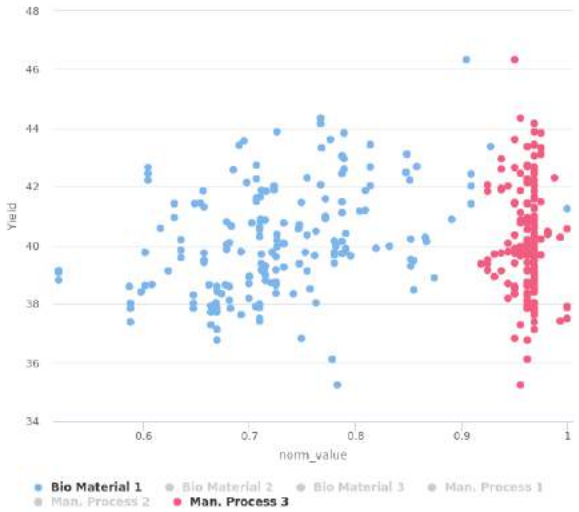
```
scatter_interactive
```



Scatterplot: selecting categories

- In `highcharts` every plotted category seen in the legend is called a `series`
- Highcharts auto-colors series when it detects more than 1 category
- We can interactively select and de-select which series to display by clicking on the series names in the legend



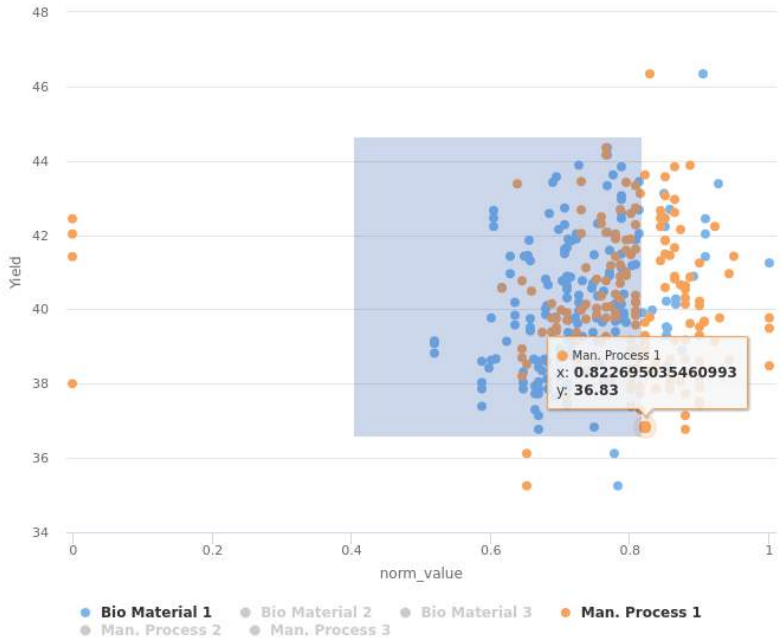


Scatterplot: `pipe` and customize

- In `highcharts` every new option or layer can be added using the already familiar `pipe` operator (as opposed to the + operator in `ggplot2`)
- The `hc_chart` function is responsible for global chart options like zoom, size, and theme
- Let's set a zoom for our plot by passing the `zoomType` argument to `hc_chart`
- `xy` zoom allows to zoom across both `x` and `y` axes

```
# Pipe chart options to original chart.
scatter_interactive = scatter_interactive %>%
  # Use chart options to specify zoom.
  hc_chart(zoomType = "xy")

scatter_interactive
```



Scatterplot: add title

A title can be added to `highcharter` plots using the `hc_title()` function

```
# Pipe chart options to original chart.
scatter_interactive = scatter_interactive %>%
 # Add title to the plot.
 hc_title(text = "CMP data: Yield vs. other variables")

scatter_interactive
```

Module completion checklist

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Introduce using the highcharter package to build interactive visualizations	✔
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hchart: correlation matrix

- `hchart` recognizes the type of data being given to it
- If we pass a correlation matrix, it will create a correlation plot
- No other arguments are necessary to create a basic plot!

```
# Compute a correlation matrix for the first
# 4 variables in our data.
cor_matrix = cor(CMP_subset[, 1:4])

# Construct a correlation plot by
# simply giving the plotting function
# a correlation matrix.
correlation_interactive = hchart(cor_matrix) %>%
 # Add title to the plot.
 hc_title(text = "CMP data: correlation")
```

hchart: correlation matrix (cont'd)

```
correlation_interactive
```

Knowledge check 1

Exercise 1

Module completion checklist

Objective	Complete
Introduce using the highcharter package to build interactive visualizations	✔
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hchart: column plot

Let's now create an interactive plot to visualize the summary of our data

- To do that, we first need to get the summary statistics and save them as a dataframe

```
# Create data summary.
CMP_summary = summary(CMP_subset)

# Save it as a data frame.
CMP_summary = as.data.frame(CMP_summary)

# Inspect the data.
head(CMP_summary)
```

```
  Var1      Var2            Freq
1          Yield Min.   :35.25
2          Yield 1st Qu.:38.75
3          Yield Median :39.97
4          Yield Mean   :40.18
5          Yield 3rd Qu.:41.48
6          Yield Max.   :46.34
```

```
# Remove an empty variable.
CMP_summary$Var1 = NULL

# Rename remaining columns.
colnames(CMP_summary) = c("Variable",
                          "Summary")
# Inspect updated data.
head(CMP_summary)
```

```
   Variable         Summary
1     Yield Min.   :35.25
2     Yield 1st Qu.:38.75
3     Yield Median :39.97
4     Yield Mean   :40.18
5     Yield 3rd Qu.:41.48
6     Yield Max.   :46.34
```

Column plot: prepare data

- Let's separate the summary values from the summary statistics
- We can utilize the `separate` function in `tidyr`

```
# Separate `Summary` column into 2 columns.
CMP_summary = CMP_summary %>%                #<- set original data
  separate(Summary,                          #<- separate `Summary` variable
           into = c("Statistic", "Value"),   #<- into 2 columns: `Statistic`, `Value`
           sep = ":",                        #<- set separating character
           convert = TRUE)                   #<- where applicable convert data (to numeric)

# Inspect the first few entries in data.
head(CMP_summary)
```

```
   Variable Statistic Value
1     Yield   Min.    35.25
2     Yield   1st Qu. 38.75
3     Yield   Median  39.97
4     Yield   Mean    40.18
5     Yield   3rd Qu. 41.48
6     Yield   Max.    46.34
```

```
# Inspect total number of rows in data including NAs.
nrow(CMP_summary)
```

```
[1] 49
```

Column plot: create plot

```
# Inspect `Value` column for `NAs`.
which(is.na(CMP_summary$Value) == TRUE)
```

```
[1]  7 14 21 28
```

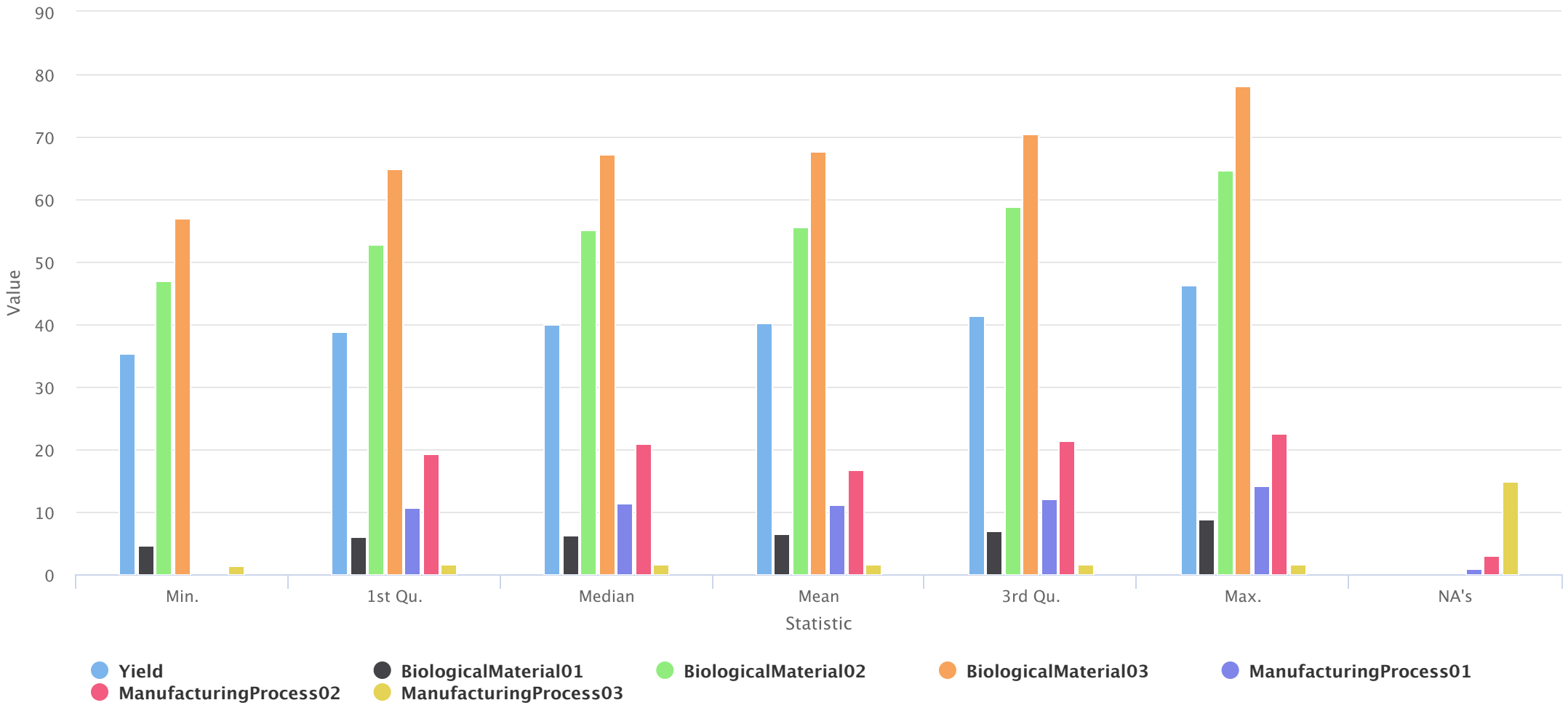
```
# Subset only rows where `Value` is not NAs.
CMP_summary = subset(CMP_summary, !is.na(Value))

# Now the number of rows should be 4 less.
nrow(CMP_summary)
```

```
[1] 45
```

```
# Construct the summary chart.
CMP_summary_interactive =
  hchart(CMP_summary,              #<- set data
         "column",                 #<- set type (`column` in highcharts)
         hcaes(x = Statistic,      #<- arrange `Statistics` across x-axis
               y = Value,          #<- map `Value` of each `Statistic` to y-axis
               group = Variable)) #<- group columns by `Variable`
```

Column plot: display plot

```
CMP_summary_interactive
```



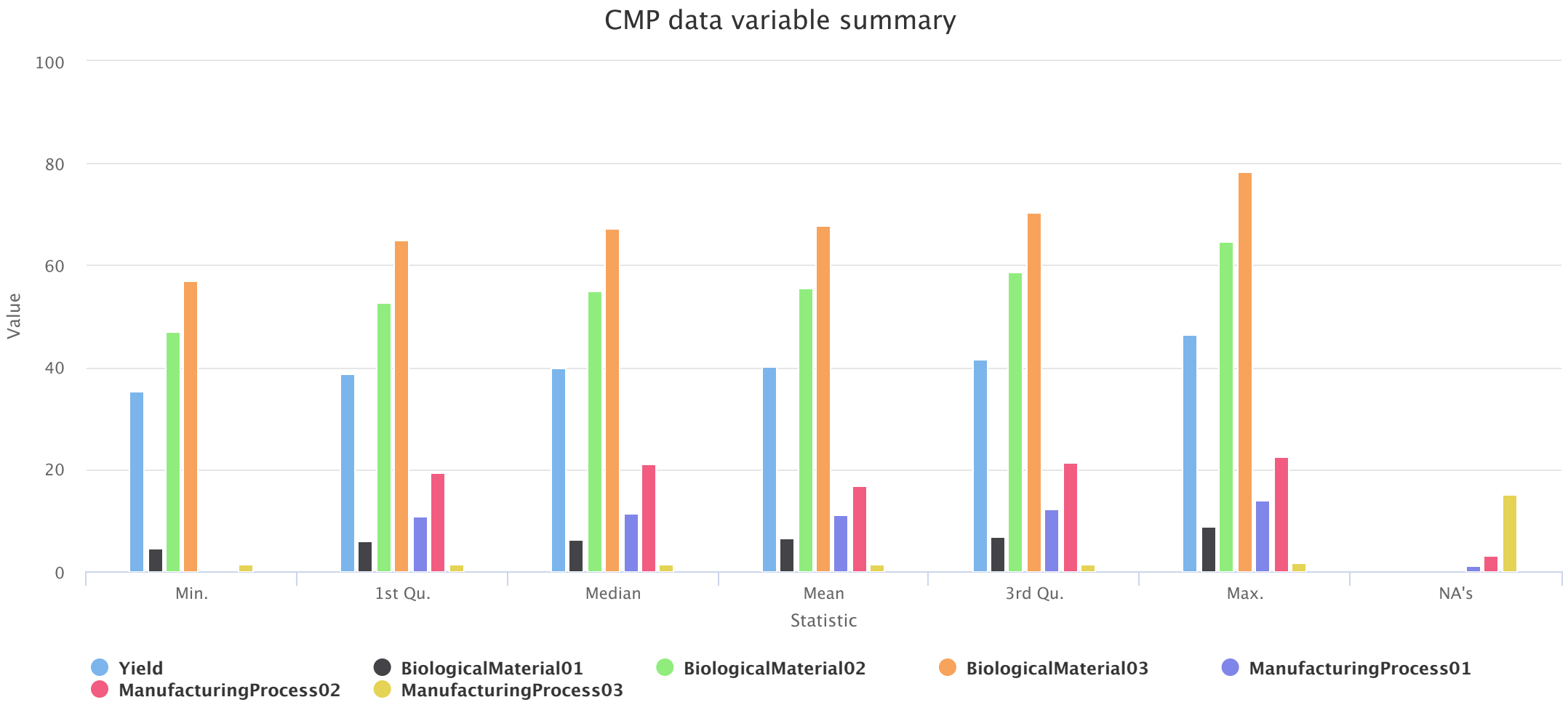
Column plot: customize tooltip

- Since we are comparing variables' summary `statistics`, it would be convenient for the `tooltip` to contain information about the `group` rather than the individual columns within the `group`
- We can control different `tooltip` options of the chart using the `hc_tooltip` option
- The `shared` option is often used to share a tooltip between members of a `group`

```
# Adjust tooltip options by piping `hc_tooltip` to base plot.
CMP_summary_interactive = CMP_summary_interactive %>%
  hc_tooltip(shared = TRUE)  %>%                #<- `shared` needs to be set to `TRUE`
  hc_title(text = "CMP data variable summary") #<- add title to your plot
```

Column plot: customize tooltip (cont'd)

```
CMP_summary_interactive
```



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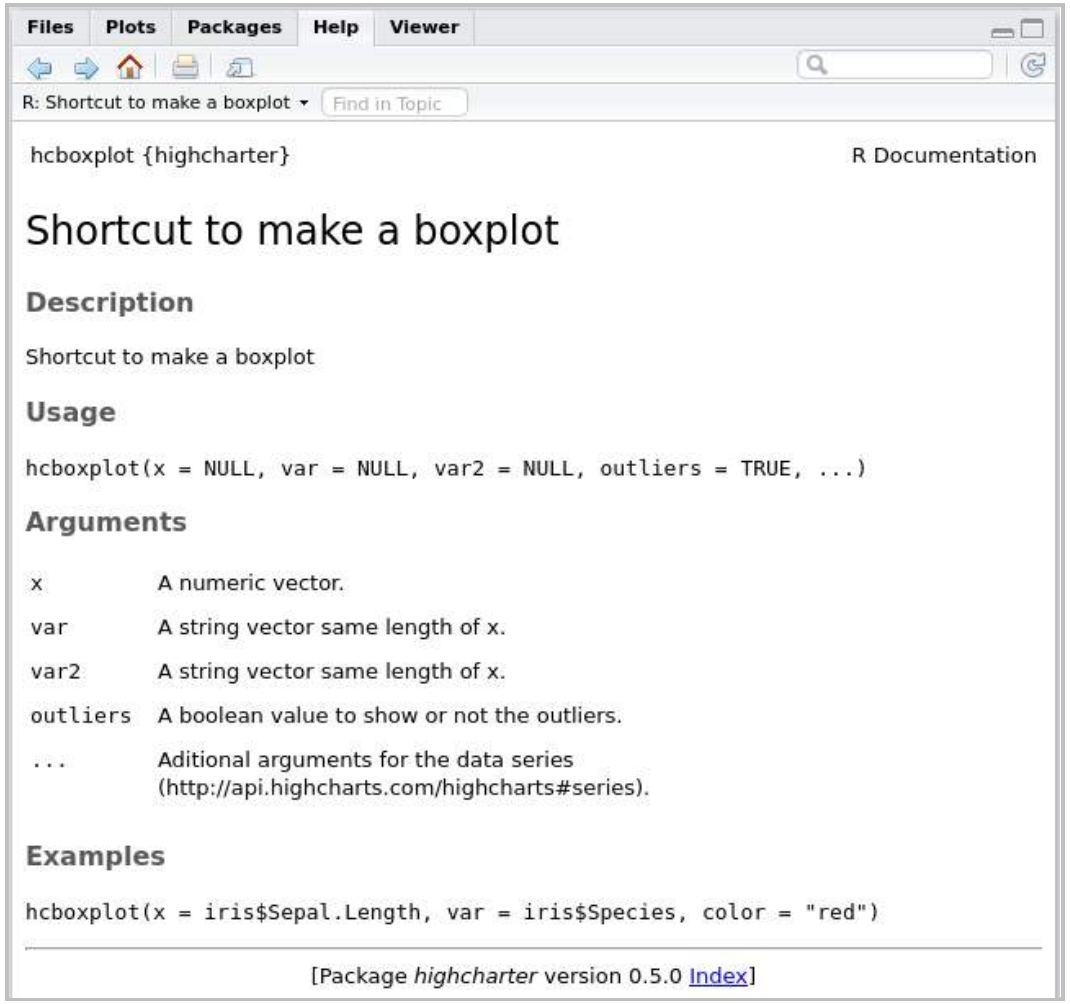
Highcharts boxplot: hcboxplot

`hcboxplot` allows us to create an interactive boxplot. It needs two arguments:

- `x` requires the numeric data to be plotted along the x-axis (`boxplot` in `highcharts` is horizontal by default)
- `var` requires categorical data to be plotted along the y-axis

```
?hcboxplot

hcboxplot(x = Numeric_data_vector,
          var = Categorical_data_vector,
          ...)
```



Files | Plots | Packages | Help | Viewer

R: Shortcut to make a boxplot | Find in Topic

hcboxplot {highcharter} R Documentation

Shortcut to make a boxplot

Description

Shortcut to make a boxplot

Usage

```
hcboxplot(x = NULL, var = NULL, var2 = NULL, outliers = TRUE, ...)
```

Arguments

x	A numeric vector.
var	A string vector same length of x.
var2	A string vector same length of x.
outliers	A boolean value to show or not the outliers.
...	Aditional arguments for the data series (http://api.highcharts.com/highcharts#series).

Examples

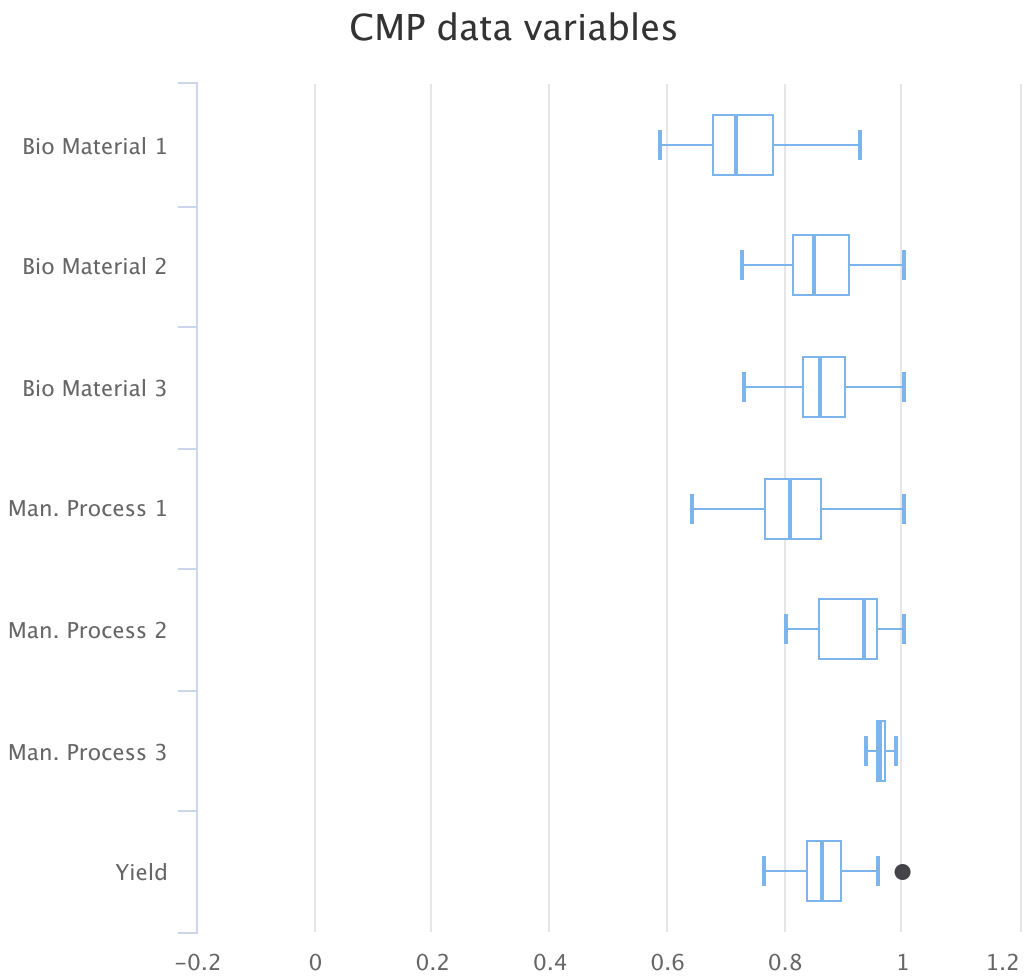
```
hcboxplot(x = iris$Sepal.Length, var = iris$Species, color = "red")
```

[Package *highcharter* version 0.5.0 Index]

Highcharts boxplot: hcboxplot (cont'd)

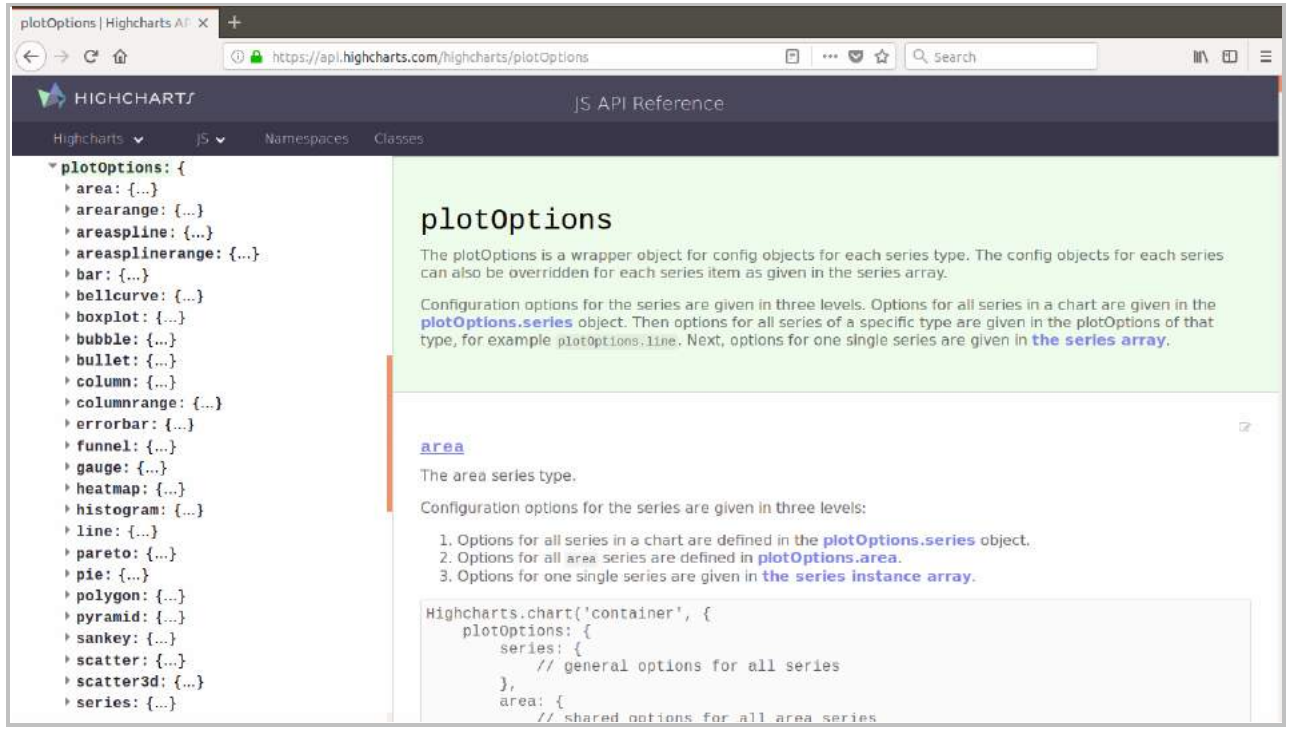
```
# Construct an interactive boxplot.
boxplot_interactive =
  hcboxplot(x = CMP_subset_long$norm_value,
            var = CMP_subset_long$variable,
            name = "Normalized value") %>%
  hc_title(text = "CMP data variables")
```

```
boxplot_interactive
```



Highcharts plotOptions

- To control individual layer/`series` options for various plot types, we use the `hc_plotOptions` function
- It can be **piped** to the original chart to enhance our base plot
- **Each series type** represented in the chart **can be given a unique set of options**
- **Every set of options is a list** of micro-level adjustments



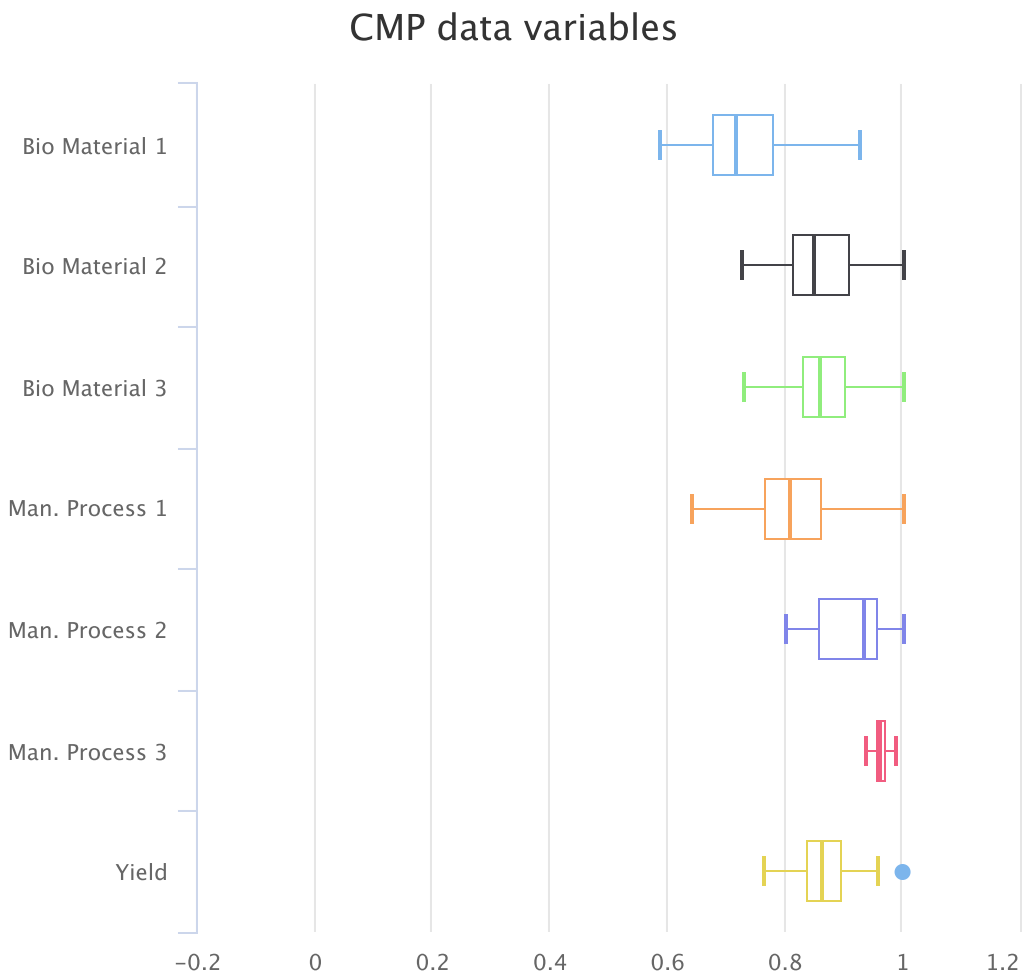
- The full list of plot options can be found in `Highcharts API` documentation ***https://api.highcharts.com/highcharts/plotOptions***

hcboxplot: customize with `hc_plotOptions`

Now we will use the `hc_plotOptions()` function to customize color for our boxplot

```
# Enhance original boxplot with color options.
boxplot_interactive = boxplot_interactive %>%
  hc_plotOptions(   #<- plot options
    boxplot = list(     #<- for boxplot
      colorByPoint = TRUE)) #<- color each box
```

```
boxplot_interactive
```



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Save interactive plots: htmlwidgets

- The `htmlwidgets` package lets us use JavaScript visualization libraries in R console
- We can embed widgets in R markdown and Shiny web applications
- Explore `htmlwidgets` ***here***

```
# Install `htmlwidgets` package.
install.packages("htmlwidgets")

# Load the library.
library(htmlwidgets)

# View documentation.
library(help = "htmlwidgets")
```

Documentation for package 'html...

```
                Information on package 'htmlwidgets'

Description:

Package:            htmlwidgets
Type:               Package
Title:              HTML Widgets for R
Version:            0.9
Date:               2017-07-10
Authors@R:          c( person("Ramnath", "Vaidyanathan", role = c("aut", "cph")), person("Yihui
                    c("aut")), person("JJ", "Allaire", role = c("aut", "cre"), email = "jj@rstu
                    person("Joe", "Cheng", role = c("aut")), person("Kenton", "Russell", role =
                    person(family = "RStudio", role = "cph") )
Description:        A framework for creating HTML widgets that render in various contexts inclu
                    Markdown' documents, and 'Shiny' web applications.
License:            MIT + file LICENSE
VignetteBuilder:    knitr
Imports:            htmltools (>= 0.3), jsonlite (>= 0.9.16), yaml
Suggests:           knitr (>= 1.8)
Enhances:           shiny (>= 0.12)
URL:                https://github.com/ramnathv/htmlwidgets
BugReports:         https://github.com/ramnathv/htmlwidgets/issues
RoxygenNote:        6.0.1
NeedsCompilation:   no
Packaged:           2017-07-10 10:49:02 UTC; jjallaire
Author:             Ramnath Vaidyanathan [aut, cph], Yihui Xie [aut], JJ Allaire [aut, cre], Jo
                    Russell [aut, cph], RStudio [cph]
```

Save interactive plots: htmlwidgets (cont'd)

```
# Set working directory to where you save plots.
setwd(plot_dir)

# Save desired interactive plot to an HTML file.
saveWidget(scatter_interactive,        #<- plot object to save
           "interactive_scatterplot.html", #<- name of file to where the plot is to be saved
           selfcontained = TRUE)              #<- set `selfcontained` to TRUE, so that
                                              #   all necessary files and scripts are embedded
                                              #   into the HTML file itself
```

Knowledge check 2

Exercise 2

Module completion checklist

Objective	Complete
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Build a column plot with hchart	✔
Create a boxplot with hchart	✔
Save interactive plots with htmlwidgets	✔

Summary

In this module, we:

- Outlined the `highcharter` package for creating interactive visualizations
- Built an interactive scatterplot, column plot, and boxplot using the `hchart()` function of `highcharter`
- Customized plots using various `highchart` options and parameters
- Learned to save interactive plots using `htmlwidgets` so that they can be embedded in R markdown and R shiny applications

In the next module, we will:

- Introduce how to build an interactive map with a json file
- Discuss best practices for highcharter

This completes our module

Congratulations!