How to create applications using Shiny

ISGlobal

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Bloque III: Logic of Shiny

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Outline

Part III: Logic of Shiny

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How Shiny works

UI & Server sections

UI

- Where the elements and form structure is specified.
- The commands to create elements must be separated by commas.
- Do not write `input$elem`.
  You can only refer to input elements values thru `conditionalPanel`.

```
fluidPage(
  textInput(...),
  conditionalPanel("input.help",
        ...
  ),
  tabsetPanel(
    tabPanel(...),
    tabPanel(...)
  ),
  plotOutput(...)
)
```

Server

Where the computations are performed (tables, plots, etc). It can contain

- UI code using **`renderUI`**:

```
function(input, output){
  output$elementoUI <- renderUI(
    sliderInput("alias","label", 0, input$n, 0)
  )
}
```

- objects that are re-computed when necessary and used by other functions inside server (**`reactive`**):

```
function(input, output){
  dat <- reactive(...)
  output$plot <- renderPlot(
    hist(dat())
  )
  output$summ <- renderPrint(
    summary(dat())
  )
}
```

- nothing.

```
function(input, output){}
```

Files structure

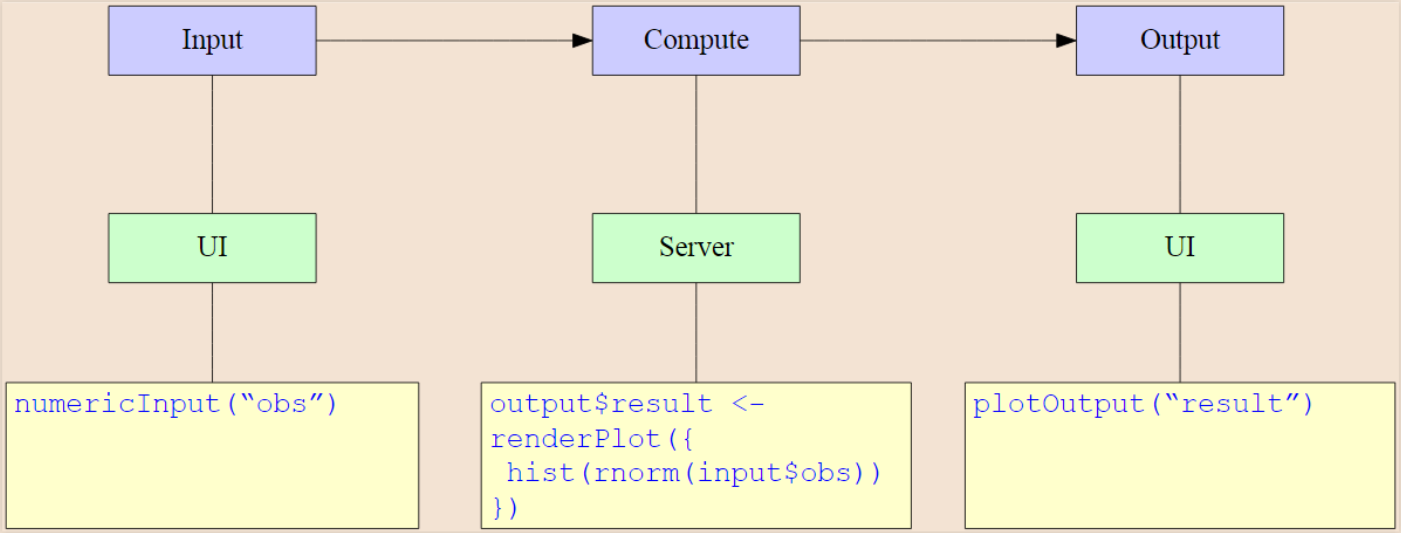
Separated files

- Mandatory files
  - `ui.R`: file with UI section code.
  - `server.R`: file with Server section code.
- Optional files
  - `global.R`: file where required packages are loaded, data read, objects and functions created, etc. Its code is executed once the app is iniciated.
  - `www`: folder with images, CSS code files, …

Single file

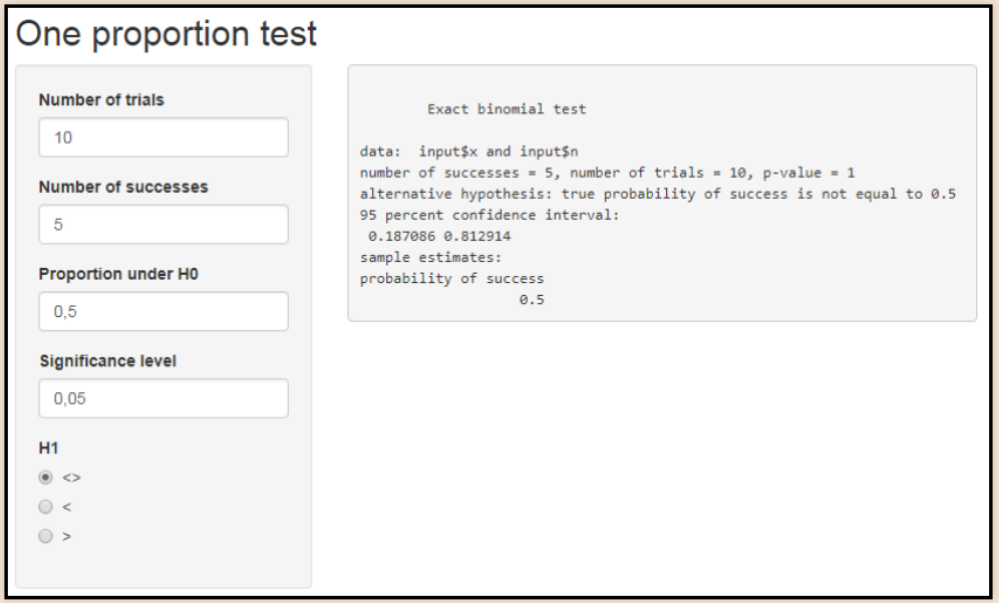
- Mandatory files
  - `app.R`: with UI and Server code, and other code that would be placed in "global.R" file.
- Optional files
  - `www`: folder with images, CSS code files, …

Pipeline



- **Reactivity**: creating and upating elements in **input** and **output** lists.
- **input** and **output** lists are the arguments in the function defined in **Server** section.

Translation of an R function to a Shiny app



Inputs:

- number of trials,
- number of successes,
- proportion under H0,
- significance level,
- H1 direction (one-sided, two-sided).

Outputs:

- binomial test result.

```
ui <- fluidPage(

  titlePanel("One proportion test"),

  sidebarLayout(
    sidebarPanel(
      numericInput("n", "Number of trials", 10),
      numericInput("x", "Number of successes", 5),
      numericInput("p0", "Proportion under H0", 0.5),
      numericInput("alpha", "Significance level", value = 0.05),
      radioButtons("side", "H1", c("<>"=1, "<"=2, ">"=3), 1)
    ),
    mainPanel(
      verbatimTextOutput("result")
    )
  )
)

server <- function(input, output) {

  output$result <- renderPrint({
    binom.test(input$x,
               input$n,
               p = input$p0,
               alt = switch(input$side, '1'="two.sided", '2'="less",'3'="greater"),
               conf.level = 1-input$alpha)
 })

}

shinyApp(ui = ui, server = server)
```

Isolate

Reactivity control: Isolate

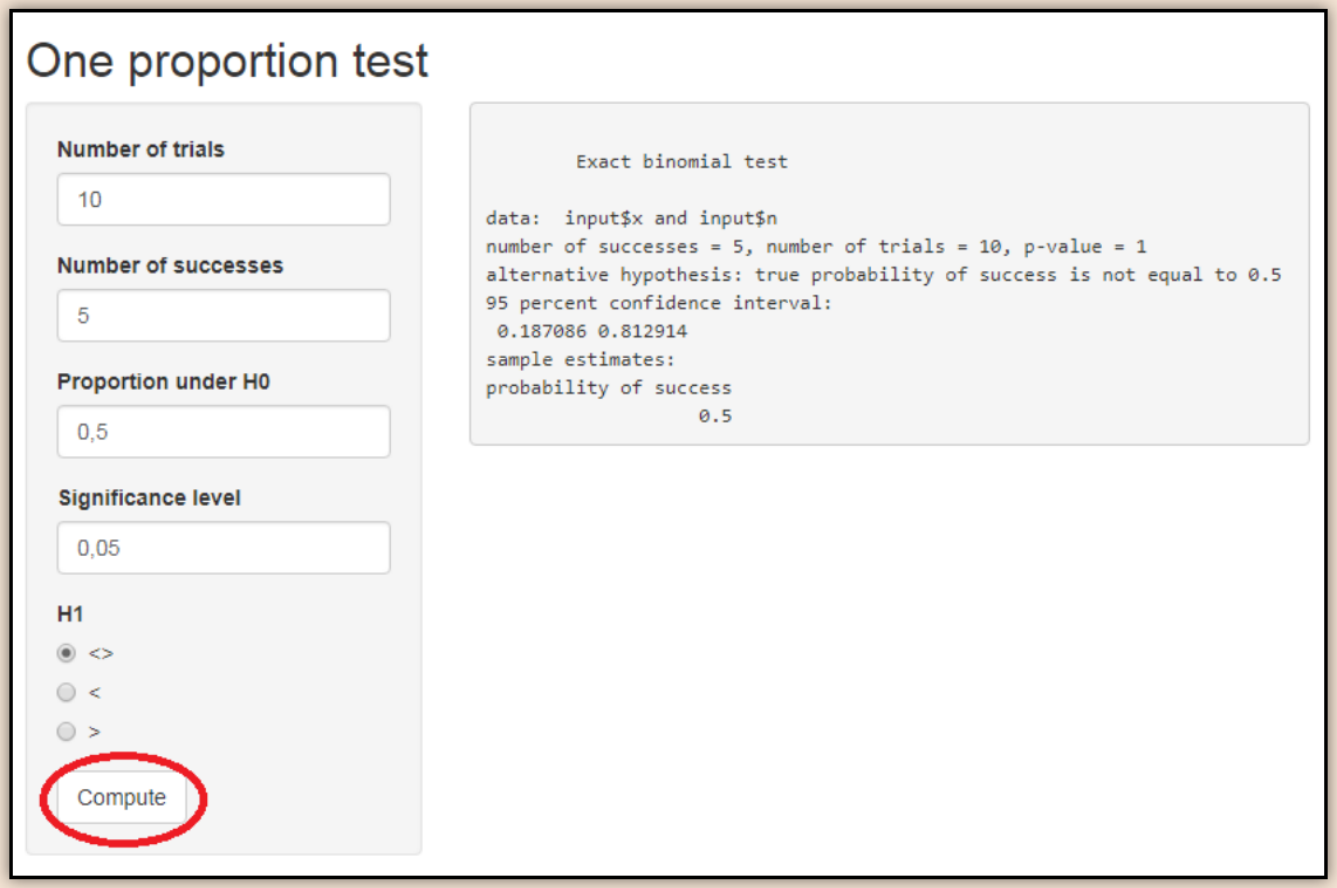
- By default, every time an input element is changed or updated, all instruction inside a "block" or "blocks" in Server section where this or these elements are called (`renderPrint`, `renderTable`, `reactive`, ...) are executed.

- If you don't want all these instructions be executed, or results be updated, untill modify all desired inputs, you must specify it. -> **`isolate`** function.

```
server <- funcion(input, ouput){

  output$foo <- renderXXX({

    input$elem1

    isolate({
      ....
    })

  })
}
```

Example: One proportion test

Let's recover the previous example. Now it is desired that results don't be updated until the **compute** button is pressed.



```
ui <- fluidPage(
  titlePanel("One proportion test"),
  sidebarLayout(
    sidebarPanel(
      numericInput("n", "Number of trials", 10),
      numericInput("x", "Number of successes", 5),
      numericInput("p0", "Proportion under H0", 0.5),
      numericInput("alpha", "Significance level", value = 0.05),
      radioButtons("side", "H1", c("<>"=1, "<"=2, ">"=3), 1),
      actionButton("compute", "Compute")
    ),
    mainPanel(
      verbatimTextOutput("result")
    )
  )
)

server <- function(input, output) {

  output$result <- renderPrint({
    if (input$compute==0) return(invisible(NULL))
    isolate({
      binom.test(input$x,
                 input$n,
                 p = input$p0,
                 alt = switch(input$side, '1'="two.sided", '2'="less",'3'="greater"),
                 conf.level = 1-input$alpha)
    })
 })

}

shinyApp(ui = ui, server = server)
```

Reactive objects

Reactive objects

- In Shiny, objects are recomputed when some input values are changed by the user.
- At the same time, these input elements may be involved in the computation of several elements of **output** list.
- Recomputing them every time may be inefficient. For example, when reading a huge data base or solving complex algorithms.
- The reactive object is created by the `reactive` function.

Example: iris data to perform a summary and a plot.

```
function(input, output) {

  dat <- reactive({
    if (input$specie == 'All')
      return(iris)
    else
      return(subset(iris, Species == input$specie))
  })

  output$summary <- renderPrint(summary(dat()))

  output$plot <- renderPlot(pairs(dat()[,-5]))

}
```

Note: The object `dat` is **not** a data.frame but a function, `dat()`. It is only updated when needed.

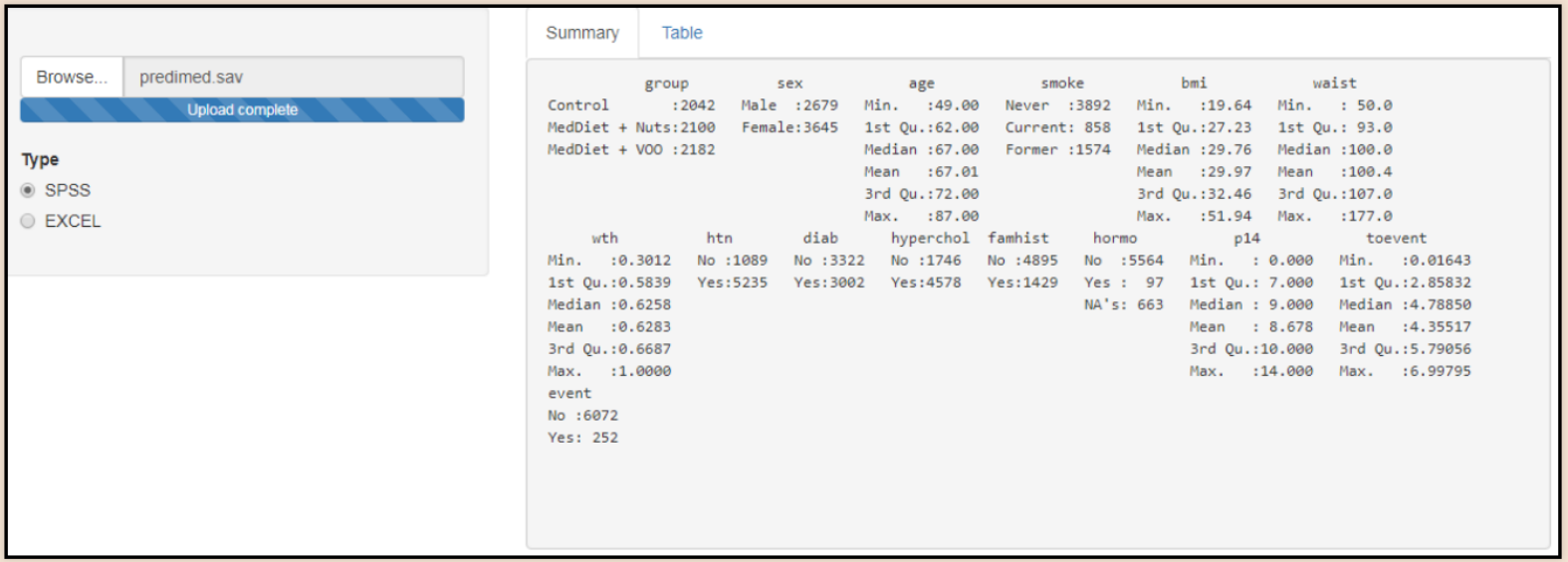
Exercise: write the UI section with the minimum required input elements

Upload data

Upload data

- Use `fileInput` function in UI section.
- The input element defined with `fileInput` contains the file name, among other file properties.
- The proper R function will be used to read the file in Server section: `spss.get`, `read.table`, `read.xls`, `xlsx`, etc.
- It is suggested to read the data set as a reactive object with the `reactive` function.

```
library(Hmisc) # read SPSS
library(xlsx) # read Excel

ui <- fluidPage(
  sidebarLayout(
    sidebarPanel(
      fileInput("files", ""),
      radioButtons("datatype", "Type", c("SPSS","EXCEL"))
    ),
    mainPanel(
      tabsetPanel(
        tabPanel("Summary", verbatimTextOutput("sum")),
        tabPanel("Table", tableOutput("tab"))
      )
    )
  )
)

server <- function(input, output) {
  dd<-reactive({
    inFile<-input$files
    if (is.null(inFile)) return(invisible(NULL))
    if (input$datatype=='EXCEL')
      return(read.xlsx(inFile$datapath,1))
    if (input$datatype=='SPSS')
      return(spss.get(inFile$datapath))
  })
  output$sum <- renderPrint(summary(dd()))
  output$tab <- renderTable(head(dd()))
}

shinyApp(ui = ui, server = server)
```


Browse...
predimed.sav
Upload complete
Type
SPSS
EXCEL
Summary
Table
group sex age smoke bmi waist
Control :2042 Male :2679 Min. :49.00 Never :3892 Min. :19.64 Min. : 50.0
MedDiet + Nuts:2100 Female:3645 1st Qu.:62.00 Current: 858 1st Qu.:27.23 1st Qu.: 93.0
MedDiet + VOO :2182 Median :67.00 Former :1574 Median :29.76 Median :100.0
Mean :67.01 Mean :29.97 Mean :100.4
3rd Qu.:72.00 3rd Qu.:32.46 3rd Qu.:107.0
Max. :87.00 Max. :51.94 Max. :177.0
wth htn diab hyperchol famhist hormo p14 toevent
Min. :0.3012 No :1089 No :3322 No :1746 No :4895 No :5564 Min. : 0.000 Min. :0.01643
1st Qu.:0.5839 Yes:5235 Yes:3002 Yes:4578 Yes:1429 Yes : 97 1st Qu.: 7.000 1st Qu.:2.85832
Median :0.6258 NA's: 663 Median : 9.000 Median :4.78850
Mean :0.6283 Mean : 8.678 Mean :4.35517
3rd Qu.:0.6687 3rd Qu.:10.000 3rd Qu.:5.79056
Max. :1.0000 Max. :14.000 Max. :6.99795
event
No :6072
Yes: 252

Download files

Download files

From the Server section

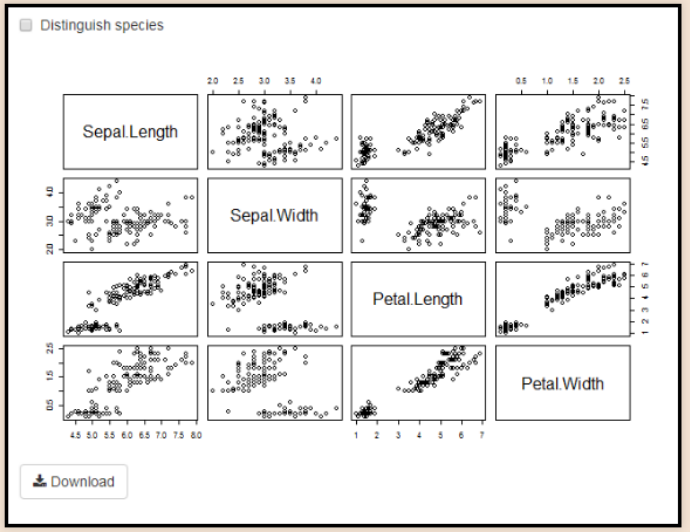
- Use the `downloadHandler` function to create the element of the output list.
- `downloadHandler` has two arguments:
  - `filename`: function without any argument that returns the filename.
  - `content`: function that creats and save the plot (or the file in general) as the file name defined in its input.

From the UI section

- In the UI section use the `downloadButton` widget.

Example 1: download a plot

```
ui <- fluidPage(
  checkboxInput("group", "Distinguish species"),
  plotOutput("result"),
  downloadButton('down', 'Download')
)

server <- function(input, output) {
  output$result <- renderPlot(
    if (input$group)
      pairs(iris[,-5],col=iris[,5])
    else
      pairs(iris[,-5])
  )
  output$down <- downloadHandler(
    filename = function() "figure.pdf",
    content = function(ff) {
      pdf(ff)
      if (input$group)
        pairs(iris[,-5],col=iris[,5])
      else
        pairs(iris[,-5])
      dev.off()
    }
  )
}

shinyApp(ui = ui, server = server)
```



Example 2: download a data table

```
ui <- fluidPage(
  downloadButton('down', 'Download'),
  hr(),
  dataTableOutput("result")
)

server <- function(input, output) {
  output$result <- renderDataTable(iris)
  output$down <- downloadHandler(
    filename = function(){
      "iris.csv"
    },
    content = function(ff){
      write.table(iris, file=ff,
                  sep=";", row.names=FALSE)
    }
  )
}

shinyApp(ui = ui, server = server)
```

Note: The app must be launched from a navigator (Chome, Firefox, ...). From RStudio viewer only pdf file can be downloaded.

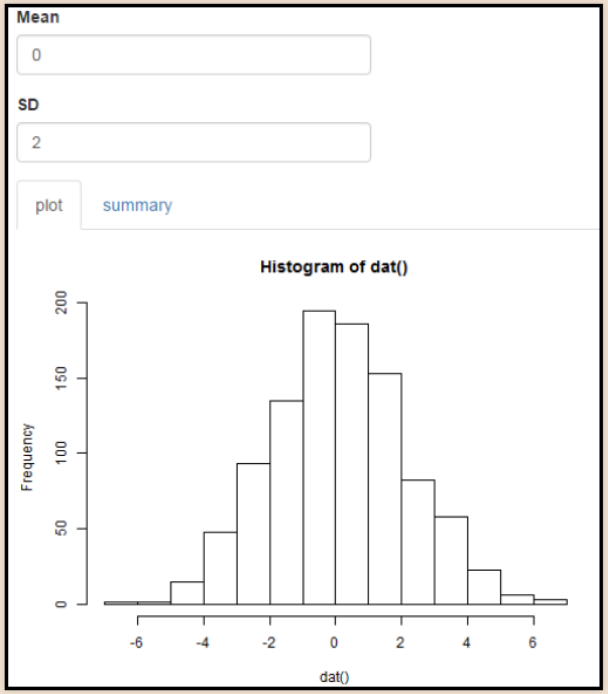
Validate inputs

Validate inputs

- Sometimes the output (plot, table or text) need of some valid input values.
- Under the user point of view it is useful to recieve a message to know what happens if he or she has introduced wrong parameters.
- Use `validate` in conjuntion to `need` function
- This text is printed even when a plot or table is expected.
- First argument of `need` is an expression the input element to be checked.
- If the expression is FALSE, NULL, empty or return an error, a message placed as the second argument is displayed in the output.

Validate inputs

```
ui <- fluidPage(
  numericInput("mu","Mean",0),
  numericInput("sd","SD",1),
  tabsetPanel(
    tabPanel("plot", plotOutput("plot")),
    tabPanel("summary", verbatimTextOutput("summ"))
  )
)

server <- function(input, output){

  dat <- reactive({

    validate(
      need(input$sd>0,"sd must be >0")
    )

    rnorm(1000, input$mu, input$sd)
  })

  output$plot <- renderPlot(hist(dat()))
  output$summ <- renderPrint(summary(dat()))

}

shinyApp(ui, server)
```



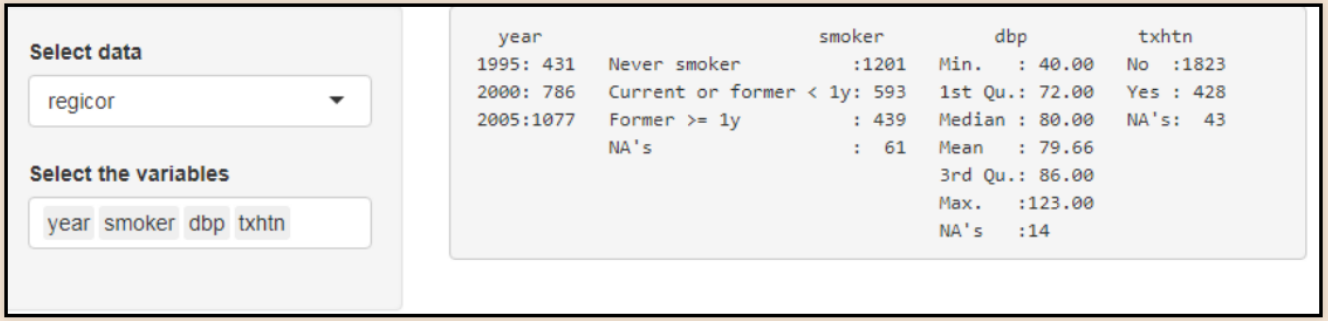
Rendering input elements
`uiOutput` / `renderUI`

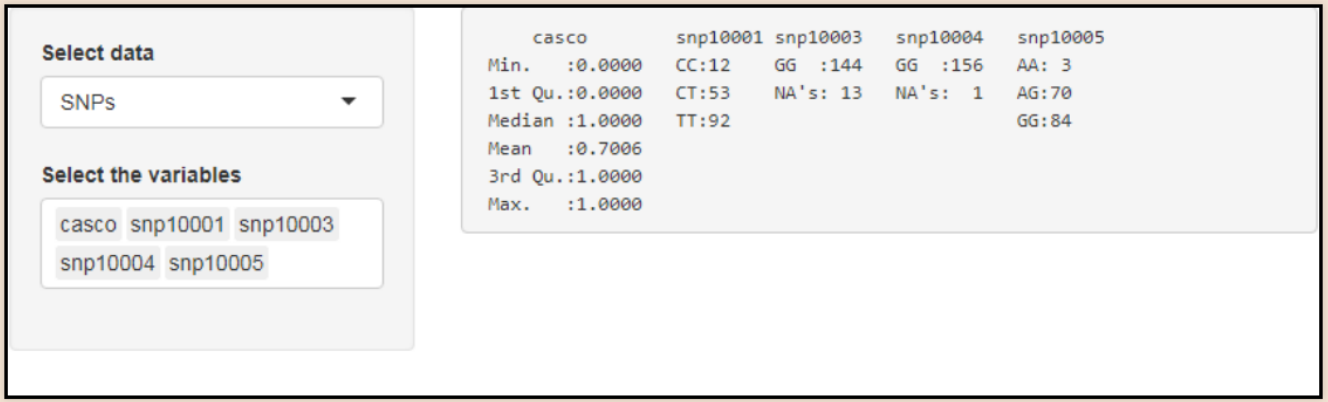
Rendering elements

- Up to this point, we have seen how to hide or show input elements in the form depending on the value of other input elements by using `conditionalPanel` function.
- But often we want to modify some apects or properties of input elements according to other input element value.
- To do so, there exists **`renderUI`**, **`uiOutput`** functions to render input elements in a very powerful and flexible way.

Example. Selecting variables from a data base

- Firstly, the user must choose the data base from (regicor, predimed or SNPs) available from `compareGroups` package.
- Once the data set is chosen, a list containing the variables must appaer.
- The user, then choose which variables are summarized.
- Note that the **items** (`choices` argument) of `selectInput` varies according on the chosen data base.


Select data
regicor
Select the variables
year smoker dbp txhtn
year smoker dbp txhtn
1995: 431 Never smoker :1201 Min. : 40.00 No :1823
2000: 786 Current or former < 1y: 593 1st Qu.: 72.00 Yes : 428
2005:1077 Former >= 1y : 439 Median : 80.00 NA's: 43
NA's : 61 Mean : 79.66
3rd Qu.: 86.00
Max. :123.00
NA's :14


Select data
SNPs
Select the variables
casco snp10001 snp10003
snp10004 snp10005
casco snp10001 snp10003 snp10004 snp10005
Min. :0.0000 CC:12 GG :144 GG :156 AA: 3
1st Qu.:0.0000 CT:53 NA's: 13 NA's: 1 AG:70
Median :1.0000 TT:92 GG:84
Mean :0.7006
3rd Qu.:1.0000
Max. :1.0000

```
library(compareGroups); data(regicor);data(predimed);data(SNPs)

ui <- fluidPage(
  sidebarLayout(
    sidebarPanel(
      selectInput("data", "Select data", c("regicor", "predimed", "SNPs")),
      uiOutput("listvars")
    ),
    mainPanel(verbatimTextOutput("result"))
  )
)

server <- function(input, output) {

  dat <- reactive(get(input$data))

  output$result <- renderPrint({
    summary(dat()[input$vars])
  })

  output$listvars <- renderUI({
    vars <- names(dat())
    selectInput("vars", "Select the variables", names(dat()), multiple=TRUE)
  })

}

shinyApp(ui = ui, server = server)
```

Exercise: Modify the code using `conditionalPanel` function

Example 2: Password

The app must be visible only if the password is correct.

Using `conditionalPanel`

```
ui <- fluidPage(
  passwordInput("pass","pass"),
  conditionalPanel(
    condition = "input.pass=='123'",
    numericInput("age", "Age", 30),
    textInput("name", "Name", "")
  )
)

server <- function(input, output) {}

shinyApp(ui = ui, server = server)
```

Problem: Launch the app from a web browser and click the right side mouse button to see the "source code" and you will see the password.

Password as an object/variable

```
pass<-'123'

ui <- fluidPage(
  passwordInput("pass","pass"),
  conditionalPanel(
    condition = "input.pass==pass",
    numericInput("age", "Age", 30),
    textInput("name", "Name", "")
  )
)

server <- function(input, output) {}

shinyApp(ui = ui, server = server)
```

Problem: It doesn't work because no objects or variables can be passed thru `conditionalPanel` condition.

Using renderUI y uiOutput

```
pass<-'123'

ui <- fluidPage(
  passwordInput("pass","pass"),
  uiOutput("result")
)

server <- function(input, output) {
  output$result <- renderUI({
    if (input$pass != pass) return(invisible(NULL))
    tagList(
    numericInput("age", "Age", 30),
    textInput("name", "Name", "")
    )
  })
}

shinyApp(ui = ui, server = server)
```

It works!!!

Source code (browser)

Using conditionalPanel

```
<!DOCTYPE html>
<html>
<head>

  <meta http-equiv="Content-Type" content="text/html; charset=utf-8"/>
  <script type="application/shiny-singletons"></script>
  <script type="application/html-dependencies">json2[2014.02.04];jquery[1.12.4];shiny[1.0.5];bootstrap[3.3.7]</script>
<script src="shared/json2-min.js"></script>
<script src="shared/jquery.min.js"></script>
<link href="shared/shiny.css" rel="stylesheet" />
<script src="shared/shiny.min.js"></script>
<meta name="viewport" content="width=device-width, initial-scale=1" />
<link href="shared/bootstrap/css/bootstrap.min.css" rel="stylesheet" />
<script src="shared/bootstrap/js/bootstrap.min.js"></script>
<script src="shared/bootstrap/shim/html5shiv.min.js"></script>
<script src="shared/bootstrap/shim/respond.min.js"></script>

</head>

<body>
  <div class="container-fluid">
    <div class="form-group shiny-input-container">
      <label for="pass">pass</label>
      <input id="pass" type="password" class="form-control" value=""/>
    </div>
    <div data-display-if="input.pass==&#39;123&#39;" data-ns-prefix="">
      <div class="form-group shiny-input-container">
        <label for="age">Age</label>
        <input id="age" type="number" class="form-control" value="30"/>
      </div>
      <div class="form-group shiny-input-container">
        <label for="name">Name</label>
        <input id="name" type="text" class="form-control" value=""/>
      </div>
    </div>
  </div>
</body>

</html>
```

Using `renderUI` y `uiOutput`

```
<!DOCTYPE html>
<html>
<head>

  <meta http-equiv="Content-Type" content="text/html; charset=utf-8"/>
  <script type="application/shiny-singletons"></script>
  <script type="application/html-dependencies">json2[2014.02.04];jquery[1.12.4];shiny[1.0.5];bootstrap[3.3.7]</script>
<script src="shared/json2-min.js"></script>
<script src="shared/jquery.min.js"></script>
<link href="shared/shiny.css" rel="stylesheet" />
<script src="shared/shiny.min.js"></script>
<meta name="viewport" content="width=device-width, initial-scale=1" />
<link href="shared/bootstrap/css/bootstrap.min.css" rel="stylesheet" />
<script src="shared/bootstrap/js/bootstrap.min.js"></script>
<script src="shared/bootstrap/shim/html5shiv.min.js"></script>
<script src="shared/bootstrap/shim/respond.min.js"></script>

</head>

<body>
  <div class="container-fluid">
    <div class="form-group shiny-input-container">
      <label for="pass">pass</label>
      <input id="pass" type="password" class="form-control" value=""/>
    </div>
    <div id="result" class="shiny-html-output"></div>
  </div>
</body>

</html>
```

Exercise

Create an app that:

1. loads a data base in SPSS.
2. the user choose the variables (one or more).
3. displays a summary of chosen variables.
4. download all variables of the data base in semicolon separated variables csv format.

The app must be visible only when the user enter the correct password (e.g. “123”), which is verified after pressing a button.

Advanced: Load an excel file

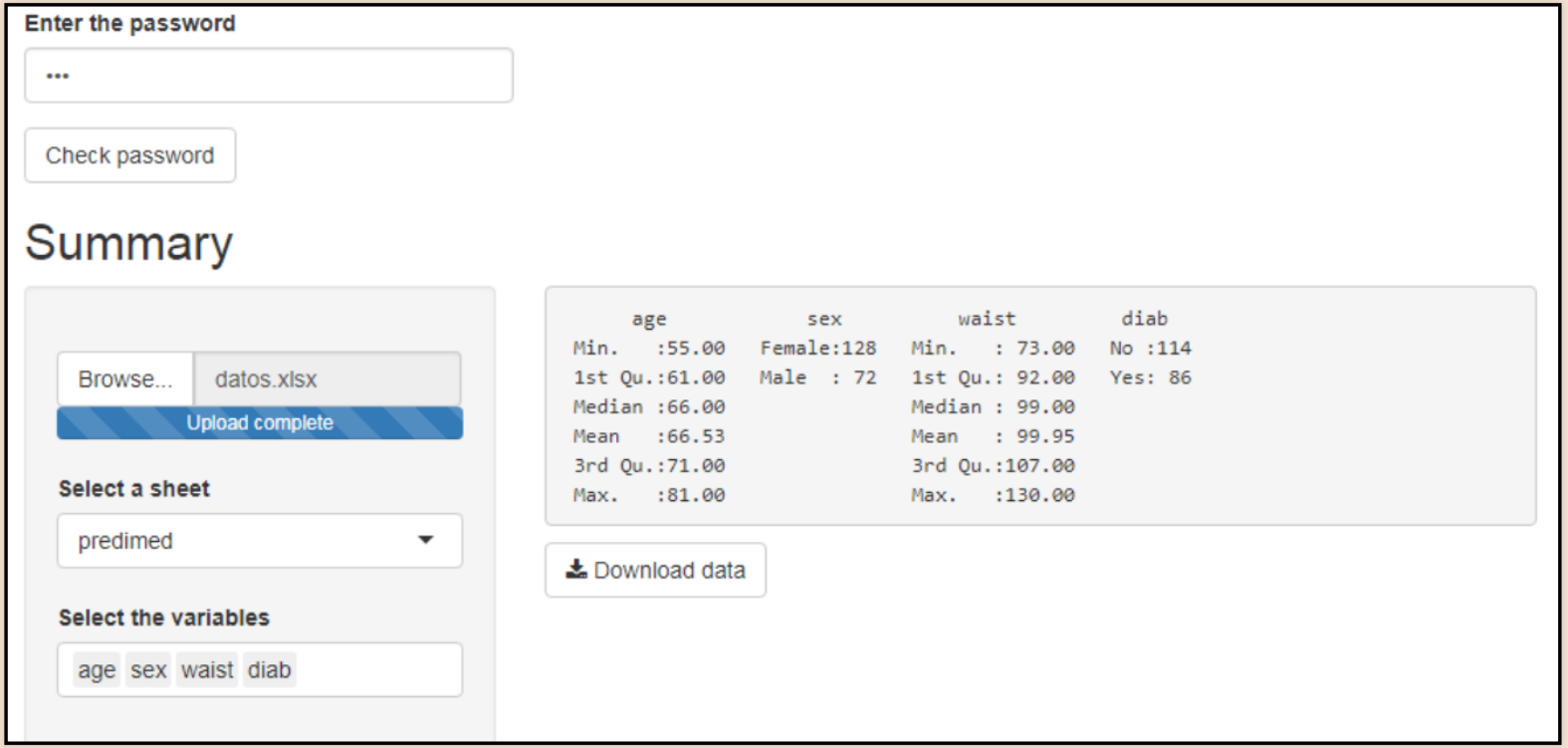
- The user must have the chance of selecting the sheet
- list of available sheets

```
names(getSheets(loadWorkbook(input$file$datapath)))
```

SPSS


Enter the password
...
Check password
Summary
Browse...
regicor.sav
Upload complete
Select the variables
year
smoker
sex
year
Min. :1995
1st Qu.:2000
Median :2000
Mean :2001
3rd Qu.:2005
Max. :2005
smoker
: 61
Current or former < 1y: 593
Former >= 1y : 439
Never smoker :1201
sex
Female:1193
Male :1101
Download data

Excel


Enter the password
...
Check password
Summary
Browse...
datos.xlsx
Upload complete
Select a sheet
predimed
Select the variables
age sex waist diab
age sex waist diab
Min. :55.00 Female:128 Min. : 73.00 No :114
1st Qu.:61.00 Male : 72 1st Qu.: 92.00 Yes: 86
Median :66.00 Median : 99.00
Mean :66.53 Mean : 99.95
3rd Qu.:71.00 3rd Qu.:107.00
Max. :81.00 Max. :130.00
Download data