Short Course: Day 2

Data analysis, modeling and reporting using R, RStudio and RMarkdown

International symposium on current trends in modeling and software development in data science and Statistics

Cape Town, South Africa

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vl(ru)os
SHARING MINDS, CHANGING LIVES

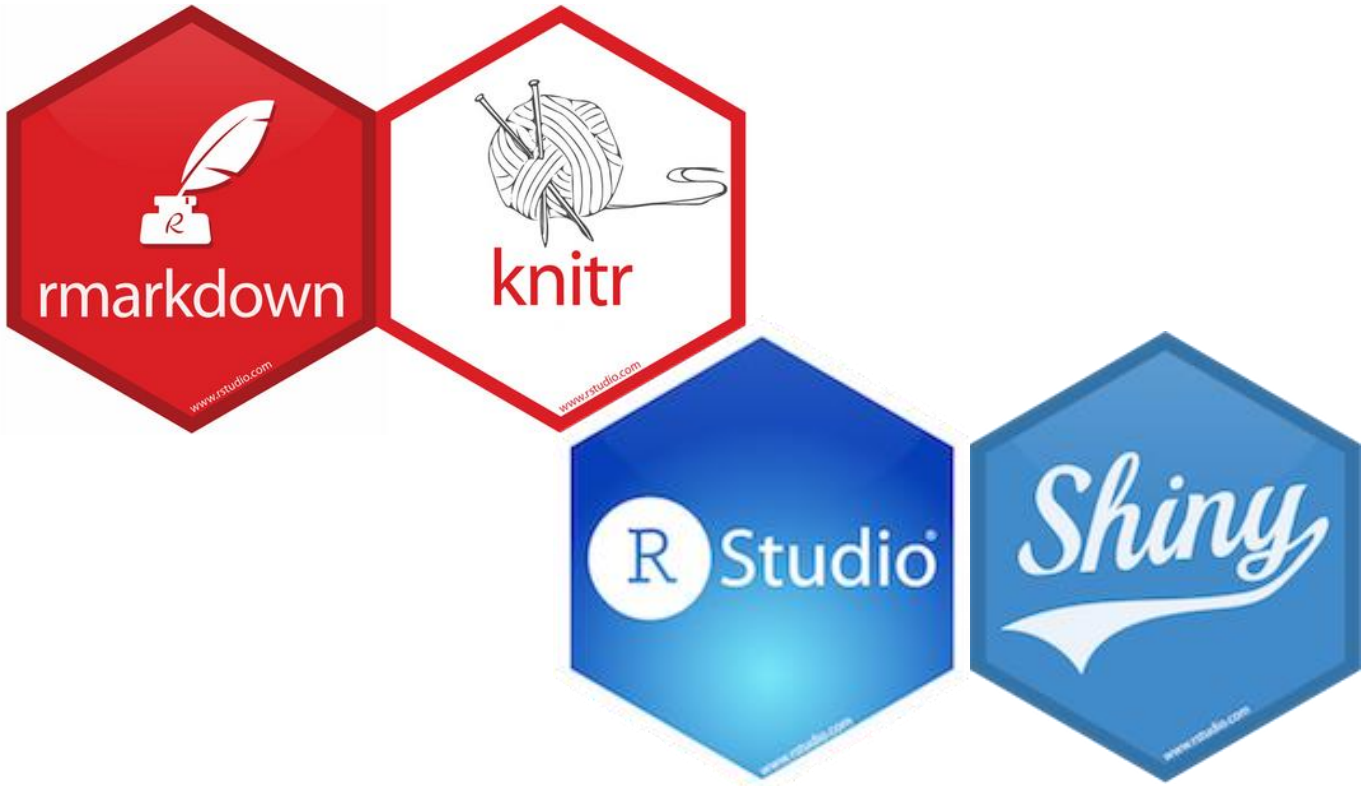
Overview

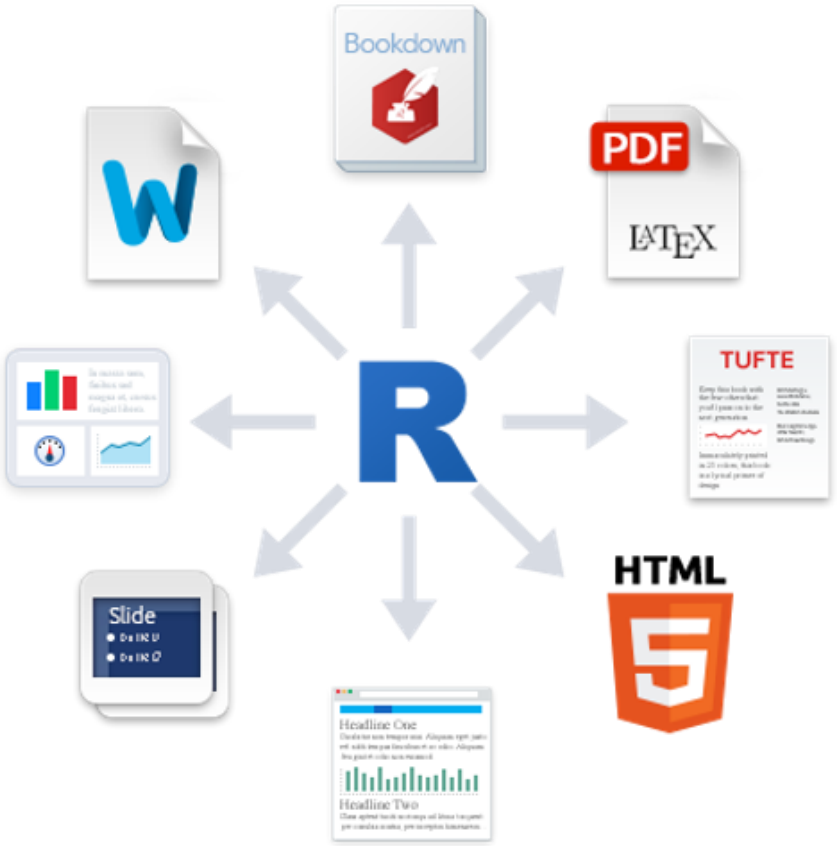
1. Introduction & Motivation
2. R Software: Basic Introduction
3. R Studio Interface
4. Installing and Loading R Packages
5. Projects in R and developing R packages
6. Case Study and analysis with R
7. RMarkdown
8. **Advanced RMarkdown**
9. Dashboard for Covid-19 using RMarkdown

RMarkdown Refresher

Reporting in R

R Markdown & Shiny





- Automated, reproducible and dynamic reporting!
- How to share/publish your visualisations?

https://rmarkdown.rstudio.com/gallery.html

Reporting in R

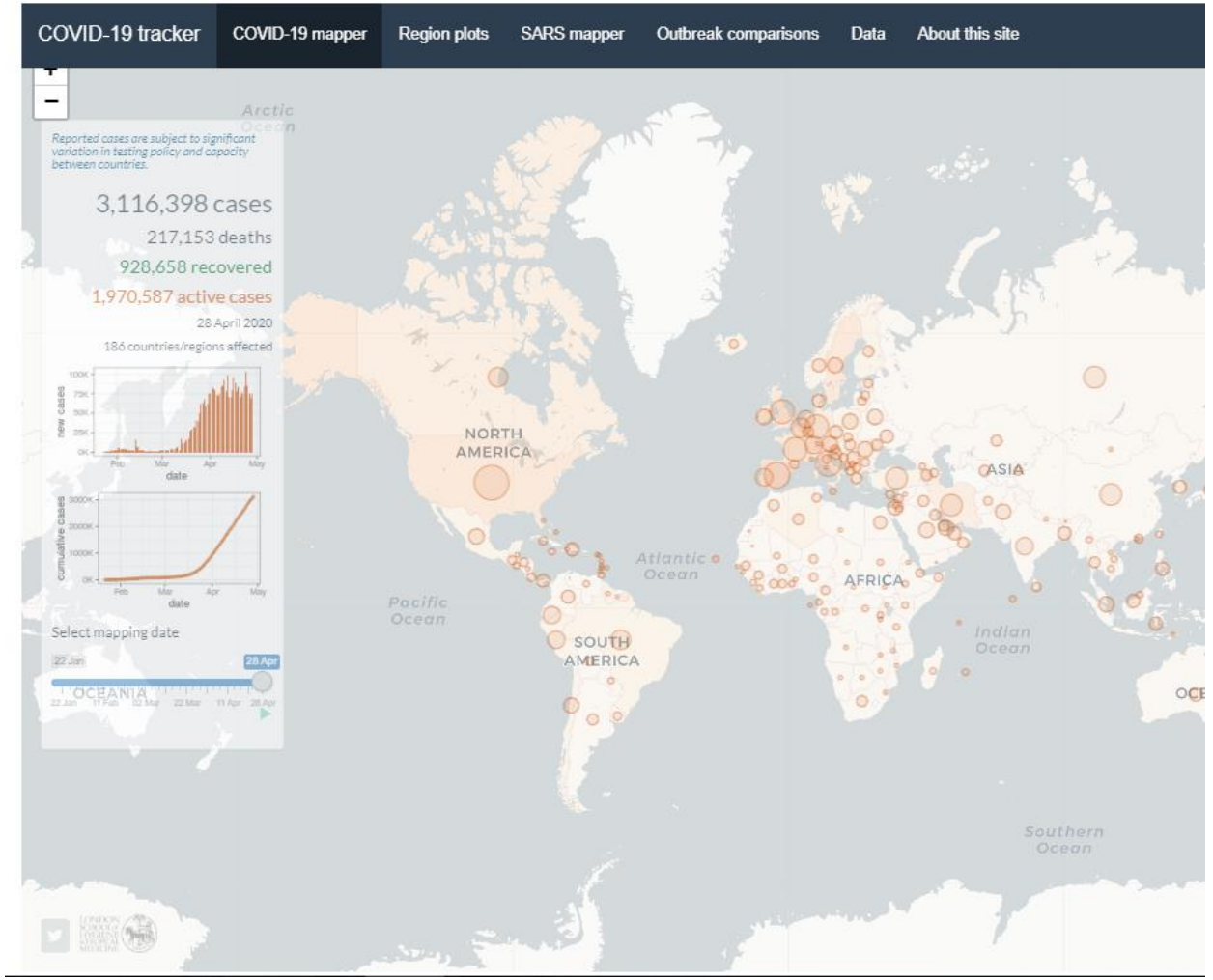
- Text + Statistical Code
- Flexdashboards, Reports, Presentations, Books, Websites, Journal Templates...
- same report, different data / same report, different analysis parameters
- Static/dynamic/interactive
- Allow full analysis workflow:

  Upload -> Analyse -> Visualise -> Report/Download

Reporting in R

Shiny

Fully interactive and on-the-fly computations!



Example: RMarkdown

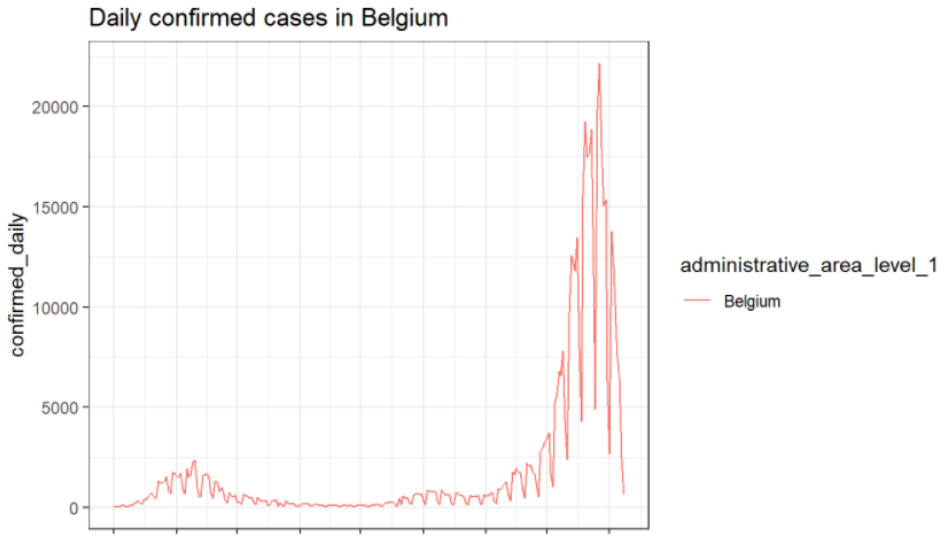
Exercise 1

Use `data1` to visualize the daily confirmed cases in Belgium over time with a *colored* line. Also make sure all months (with year) appear on the x-axis and give the graph a title.

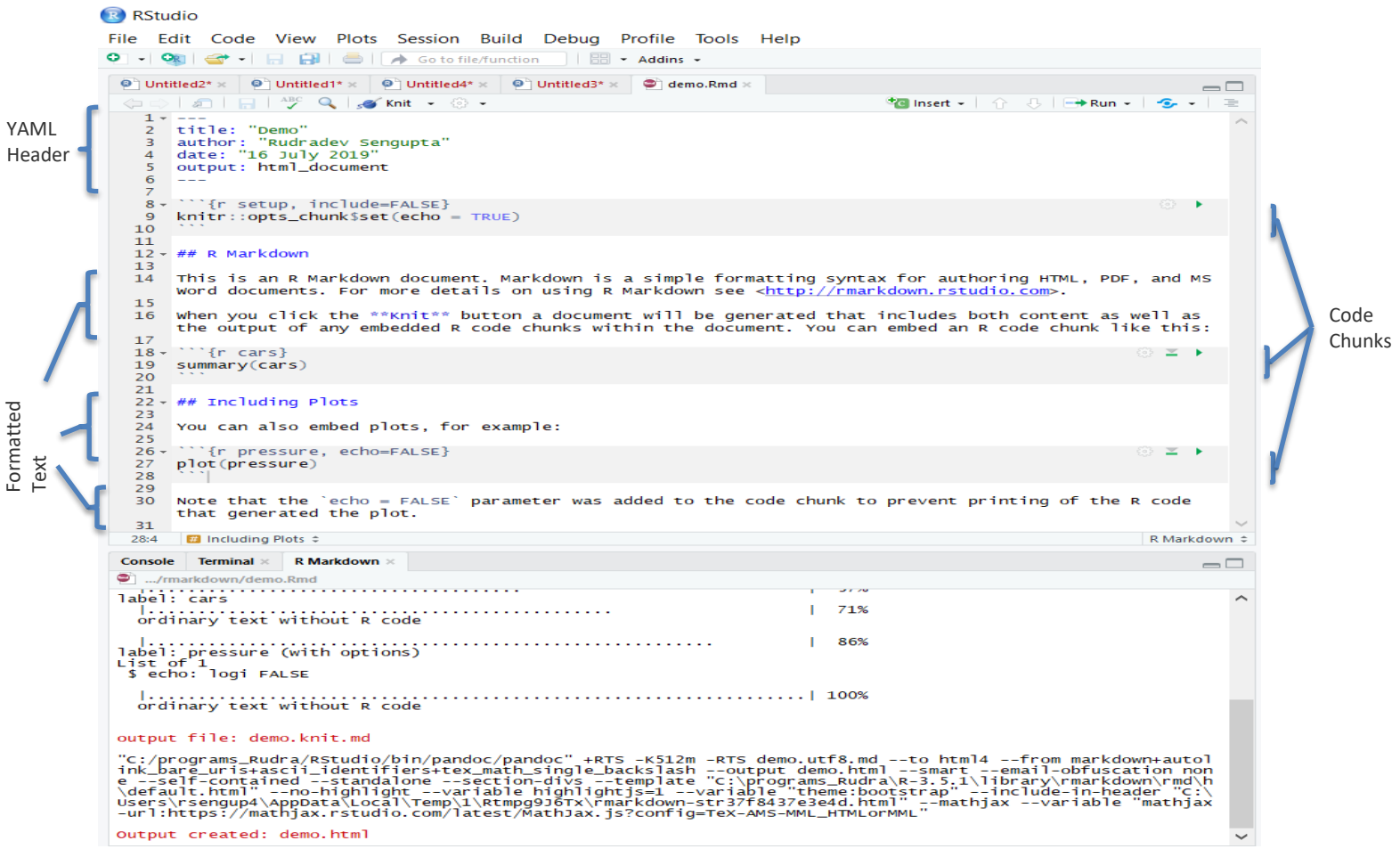
- **Data:** `data1`
- **Variables of interest:** `date`, `confirmed_daily`, `administrative_area_level_1`
- **Functions/tips:** `geom_line`, `scale_x_date`, `geom_smooth`

```
# Enter your solution here

ggplot(data1,aes(x=date,y=confirmed_daily,col=administrative_area_level_1)) +
  geom_line() +
  scale_x_date(date_breaks="1 month", date_labels = format("%B %Y"))+
  theme_bw() + labs(title="Daily confirmed cases in Belgium") +
  theme(axis.text.x = element_text(angle=60,hjust=1))
```



RMarkdown: Refresher



- There are principally three sections to an RMarkdown document:
- YAML header surrounded by `---`
- Code chunks surrounded by ```
- Free text mixed with simple text formatting like `#heading` and `_italics_`
- Also possible to include inline code to make it more dynamic:
  - `` `r pressure$temperature[5] * pressure$pressure[5]` ``

Static Reporting vs Shiny

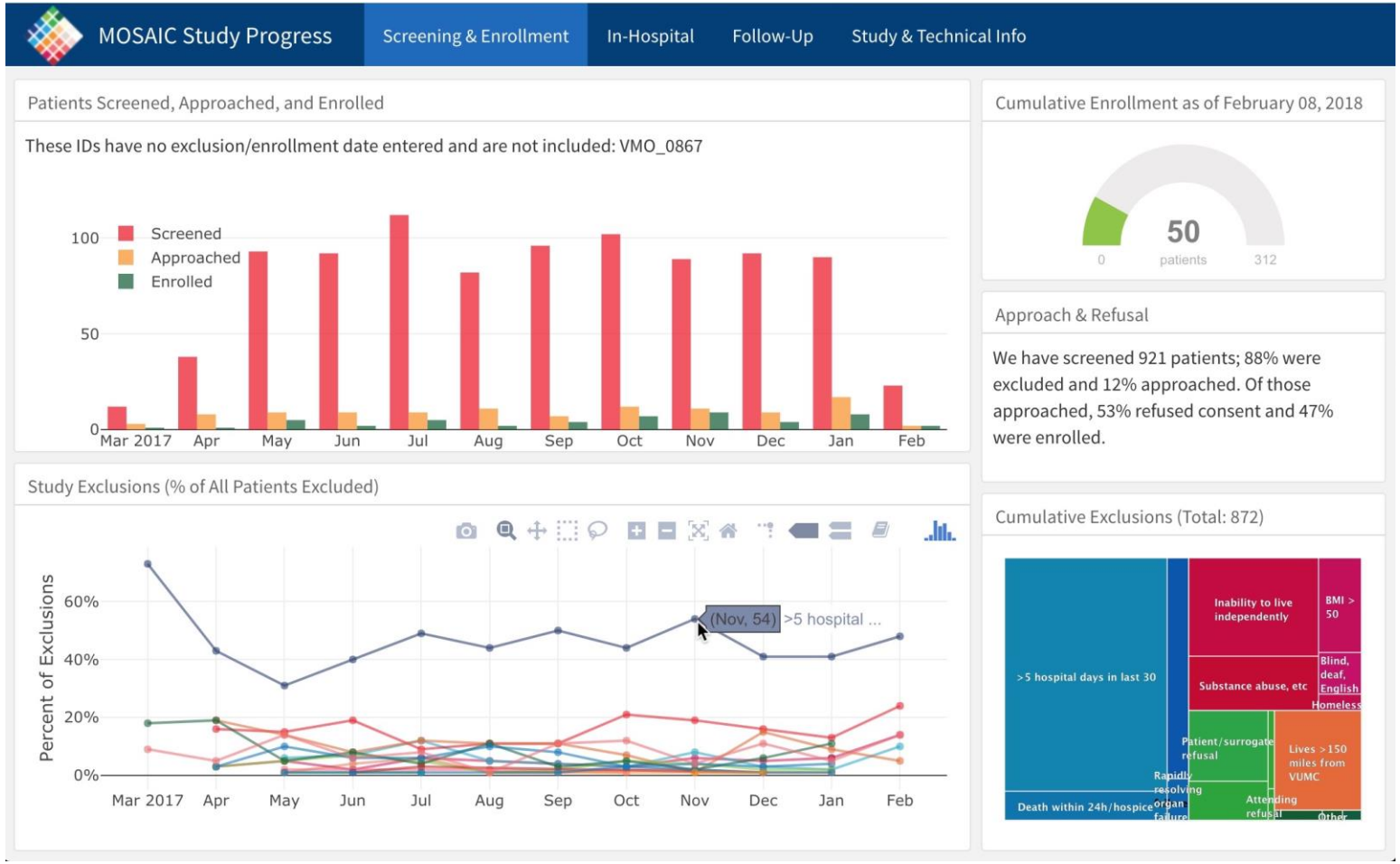
Static File

- `rmarkdown`, `bookdown`, `flexdashboard`,...
- Reporting
  - Html, pdf,...
- Htmlwidgets
  - Interactive Plots, Tables,...

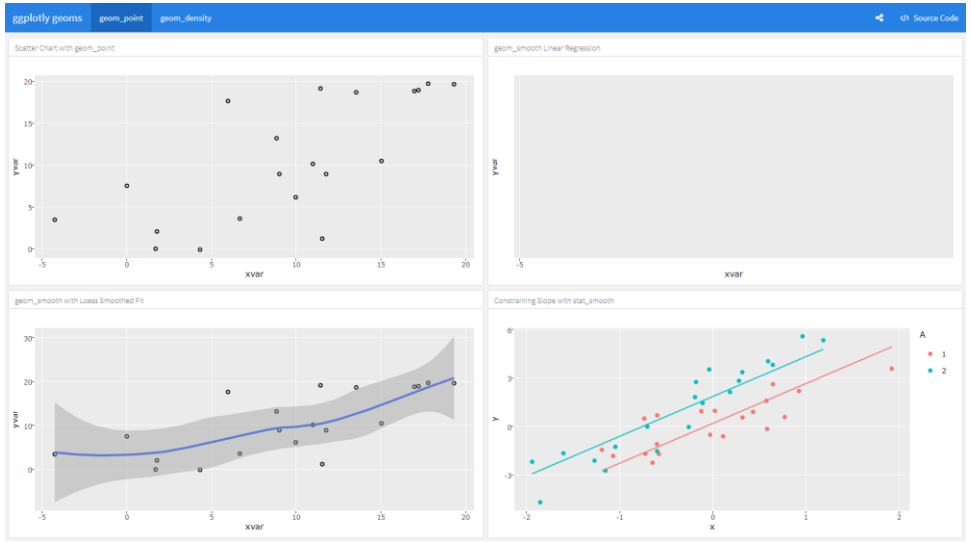
Server-Hosted

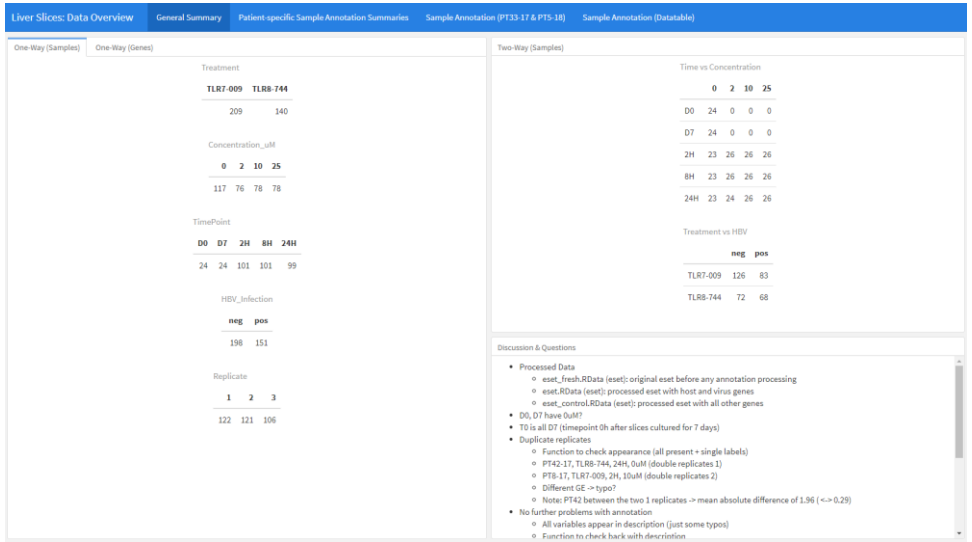
- `shiny`, `shinydashboard`
- Upload/Download
- Full Pipeline/Analysis
- Generate Reports
- Fully Interactive Visualisation

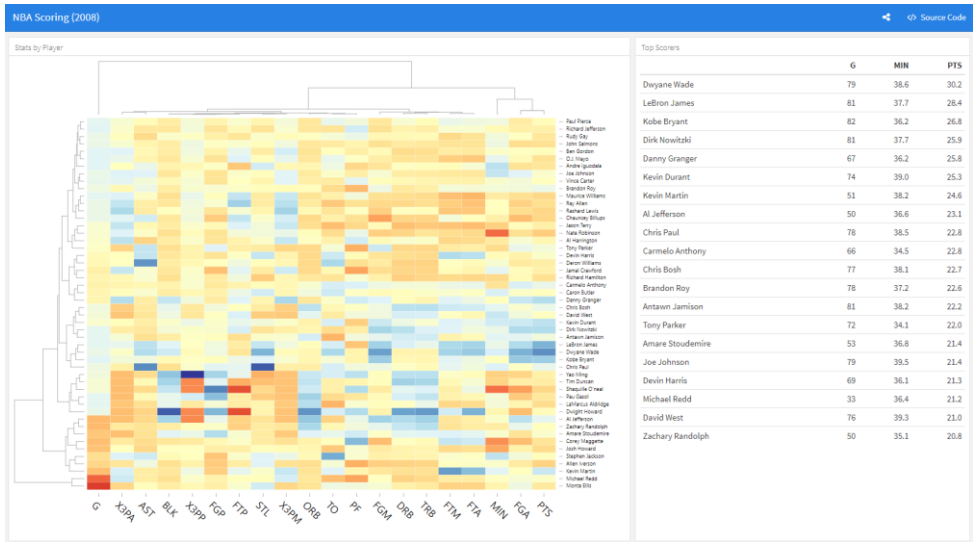
Example: Flexdashboard



Example: Flexdashboard







Note:
For all examples, you can click the *source code* button on the top right to see the .Rmd file.

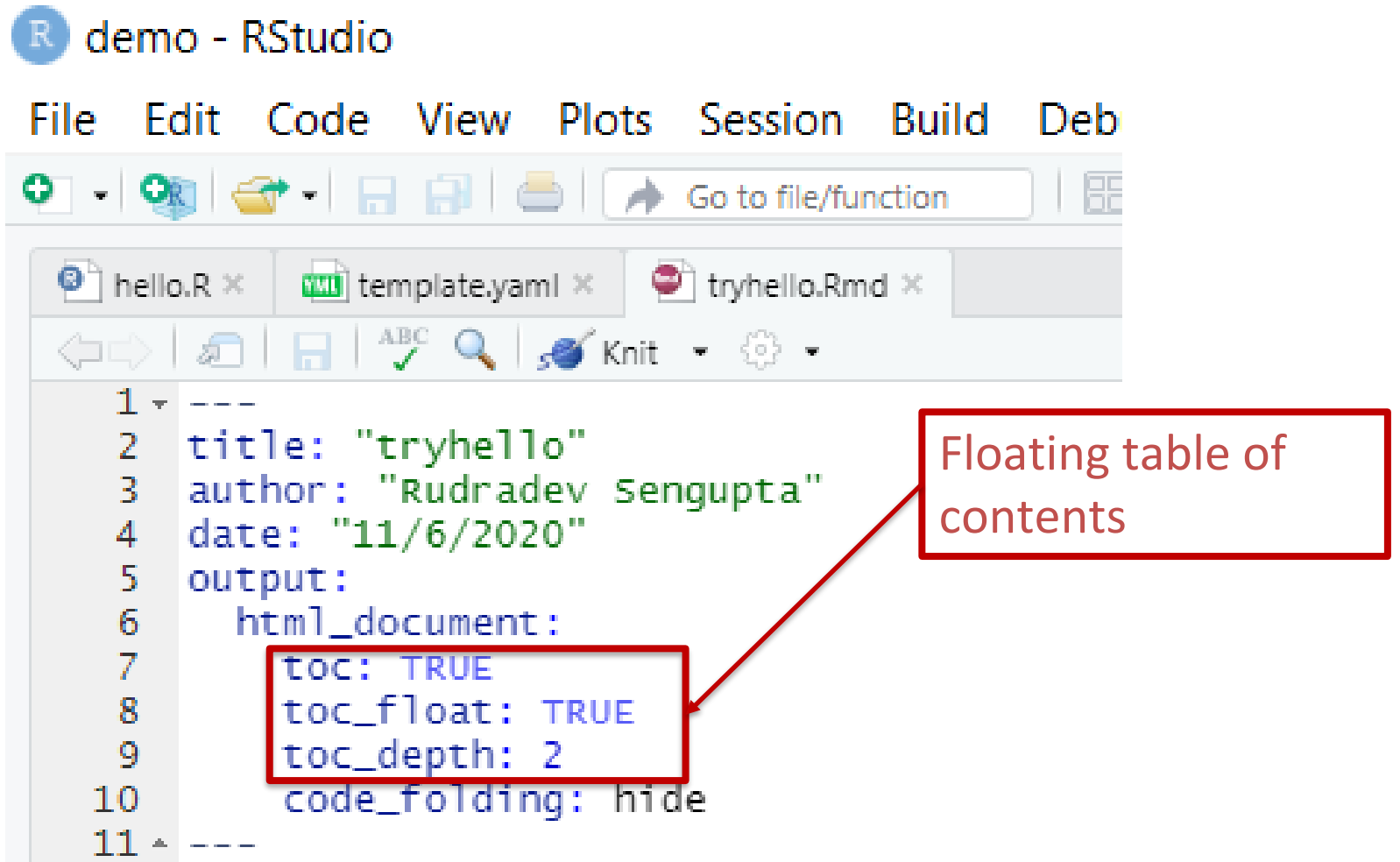
Advanced RMarkdown

Customize YAML Header

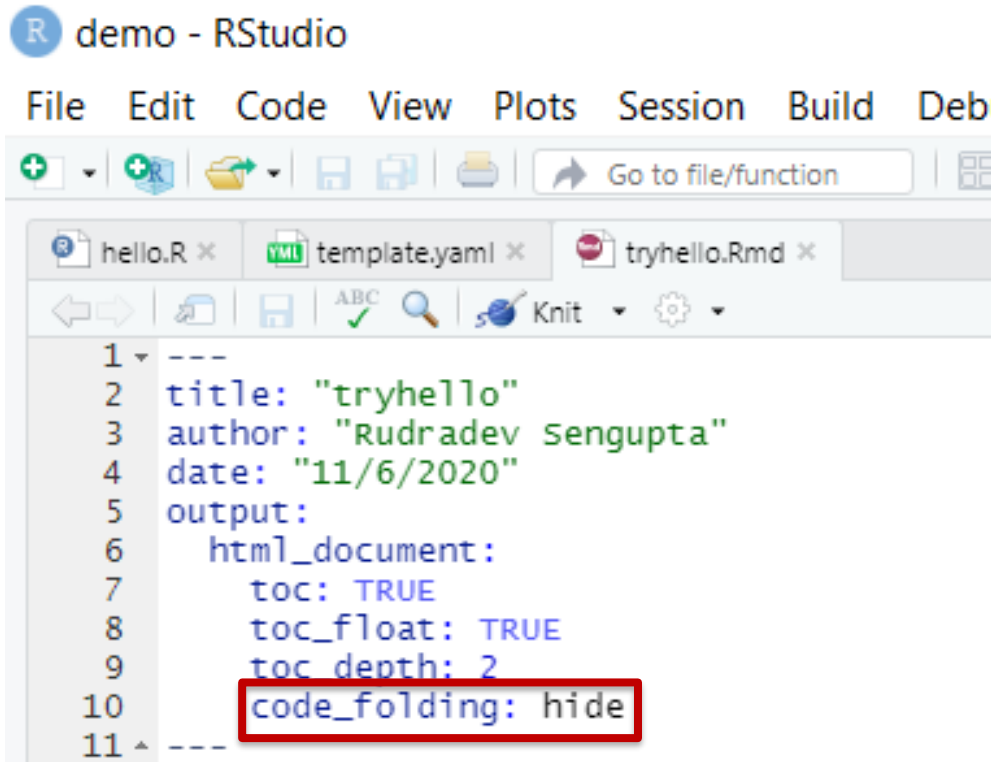
```yaml
---
title: "Analysis"
author: "Rudradev Sengupta"
date: "November 2020"
output:
  html_document:
    theme: cerulean
    code_folding: hide
    toc: true
    toc_depth: 2
    toc_float: true
    collapsed: true
    number_sections: true
params:
  # Filter region by upper/lower-bound.
  region:
    label: "Region to be Analyzed"
    value: [25,200]
    input: slider
    min: 0
    max: 500
    step: 1
    round: 1
    sep: ''
  thresh:
    label: "Quantile Threshold"
    value: 0.05
    input: numeric
    step: 0.05
  spiralpointSize:
    label: "Dot Size for the Spiral Plot"
    value: 3
    input: numeric
    step: 1
  data_location:
    label: "Input Data Location"
    value: "default path"
  ref_location:
    label: "Reference Data Location"
    value: "default path"
knit: (function(input, ...) {
    rmarkdown::render(
      input,
      output_dir = "output path")
  })
---
```

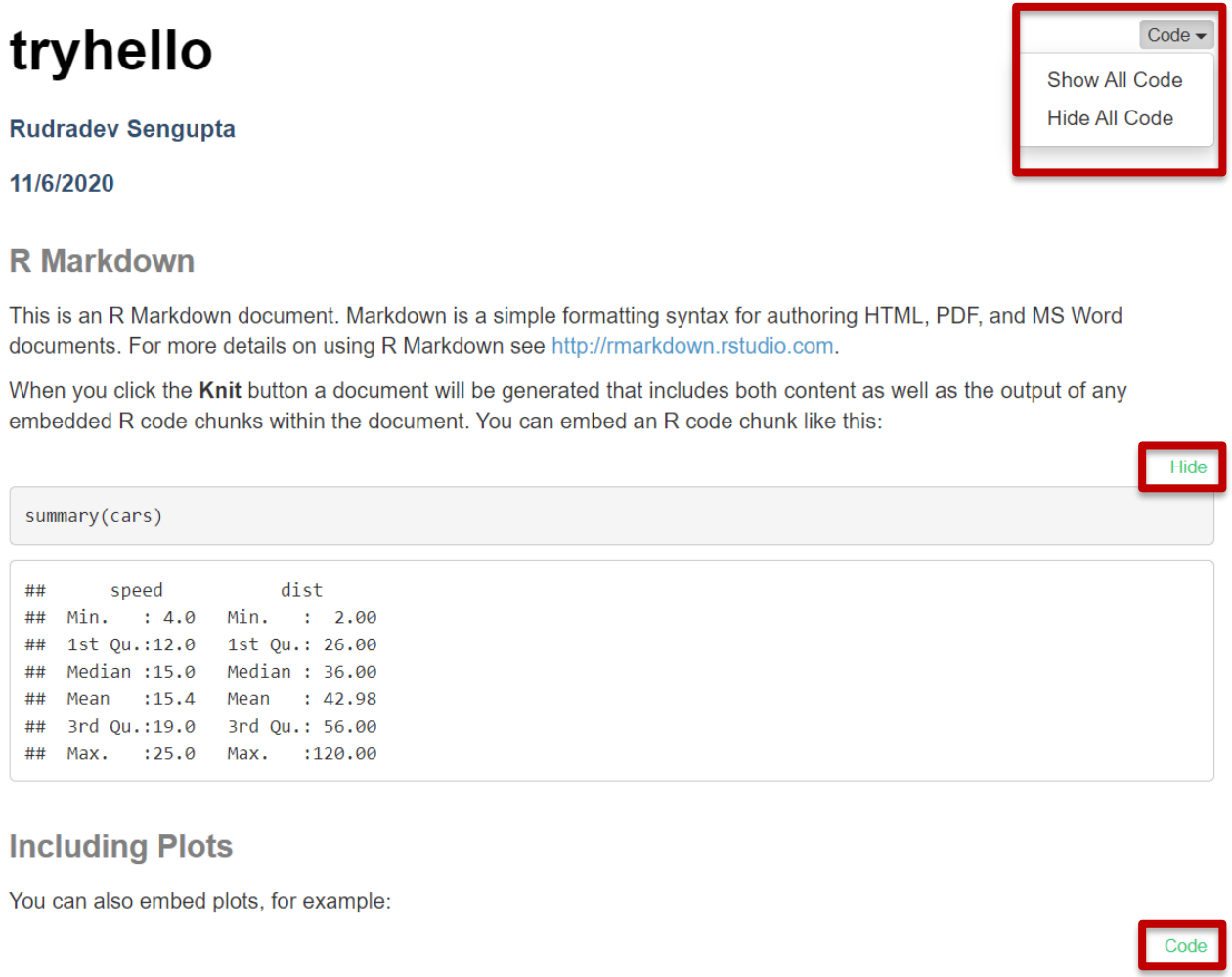
- Code folding option
- Specify parameters to be used in the code later
  - Loation of input files, output files

Floating Table of Contents



Code Folding



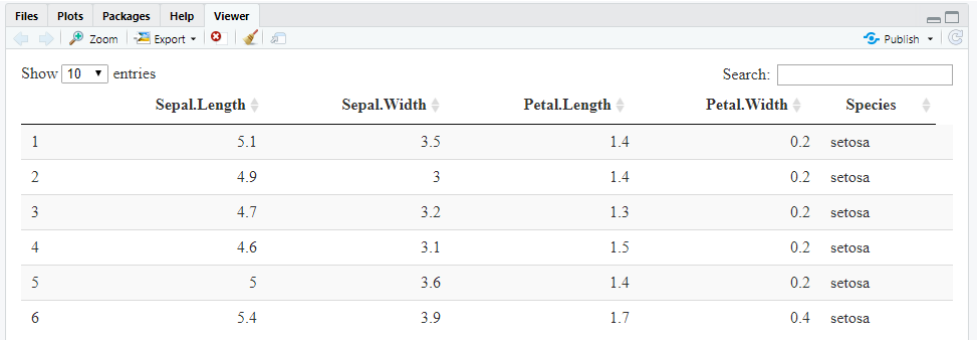


Include Tables in RMarkdown

knitr::kable(head(iris))

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3.0	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5.0	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa

DT::datatable(head(iris))



- kable takes a data.frame as input, and outputs the table into a markdown table, which will get rendered into the appropriate output format
- datatable adds interactivity (in html) – options to search, sort, …

Tables in RMarkdown

- Adding captions to tables:
  - knitr::kable(head(iris), caption = “A subset of the IRIS dataset.“)
  - DT::datatable(head(iris), caption = “A subset of the IRIS dataset.“)

- Check the functions for other available options

- Refer to a table within Rmarkdown:
  - Table \@ref(tab:tab1) …….

```
```{r tab1, echo = TRUE}

knitr::kable(
  head(mtcars[, 1:8], 10), booktabs = TRUE,
  caption = 'A table of the first 10 rows of the mtcars data.')
```
```

- More details: https://bookdown.org/yihui/bookdown/tables.html#tables

Include Plots/Images in RMarkdown

- ggplot(iris, aes(x = Sepal.Length, y = Petal.Length)) + geom_point(aes(color = Species)) or include_graphics(img_path)
- Add captions
- Use plotly to make it interactive (in html)

````
```{r fig1, echo = TRUE, fig.cap = "Scatterplot of Sepal.Length vs Petal.Length"}

data("iris")
ggplot(iris, aes(x = Sepal.Length, y = Petal.Length)) + geom_point(aes(color = Species))

```
````

Control Figure Dimensions

- ```{r fig1, echo = TRUE, fig.cap = "Scatterplot of Sepal.Length vs Petal.Length", fig.height=2}
  data("iris")
  ggplot(iris, aes(x = Sepal.Length, y = Petal.Length)) + geom_point(aes(color = Species))
```

- ```{r fig2, echo = TRUE, fig.cap = "Scatterplot of Sepal.Length vs Petal.Length", fig.width=2}
  data("iris")
  ggplot(iris, aes(x = Sepal.Length, y = Petal.Length)) + geom_point(aes(color = Species))
```

- ```{r fig3, echo = TRUE, fig.cap = "Scatterplot of Sepal.Length vs Petal.Length", fig.dim=c(2,2)}
  data("iris")
  ggplot(iris, aes(x = Sepal.Length, y = Petal.Length)) + geom_point(aes(color = Species))
```

- Refer to a figure within Rmarkdown:
  - Figure \@ref(fig:fig1) …….
```

Creating Tabs

```
## Sales Report {.tabset}

### By Product

(tab content)

### By Region

(tab content)
```

Creating Tabs

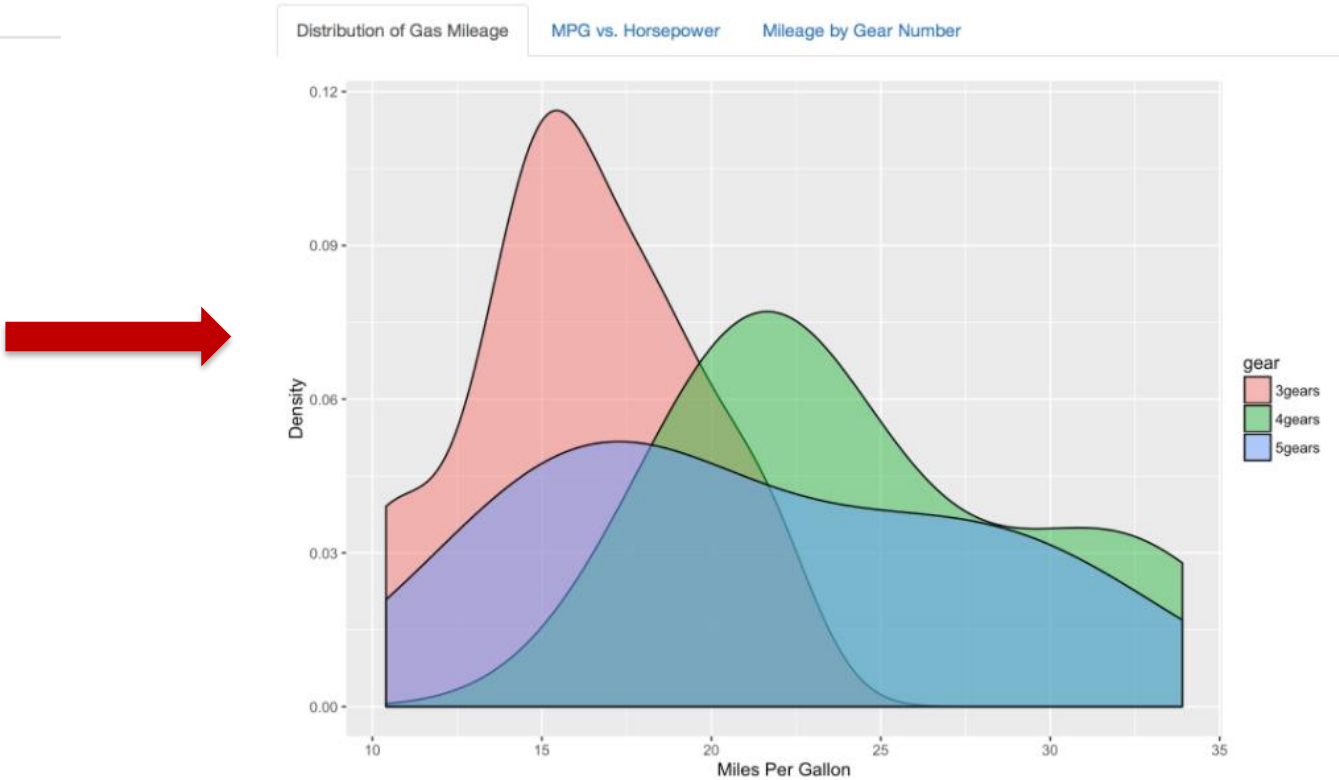
```
## Sales Report {.tabset}

### By Product

(tab content)

### By Region

(tab content)
```



Overview

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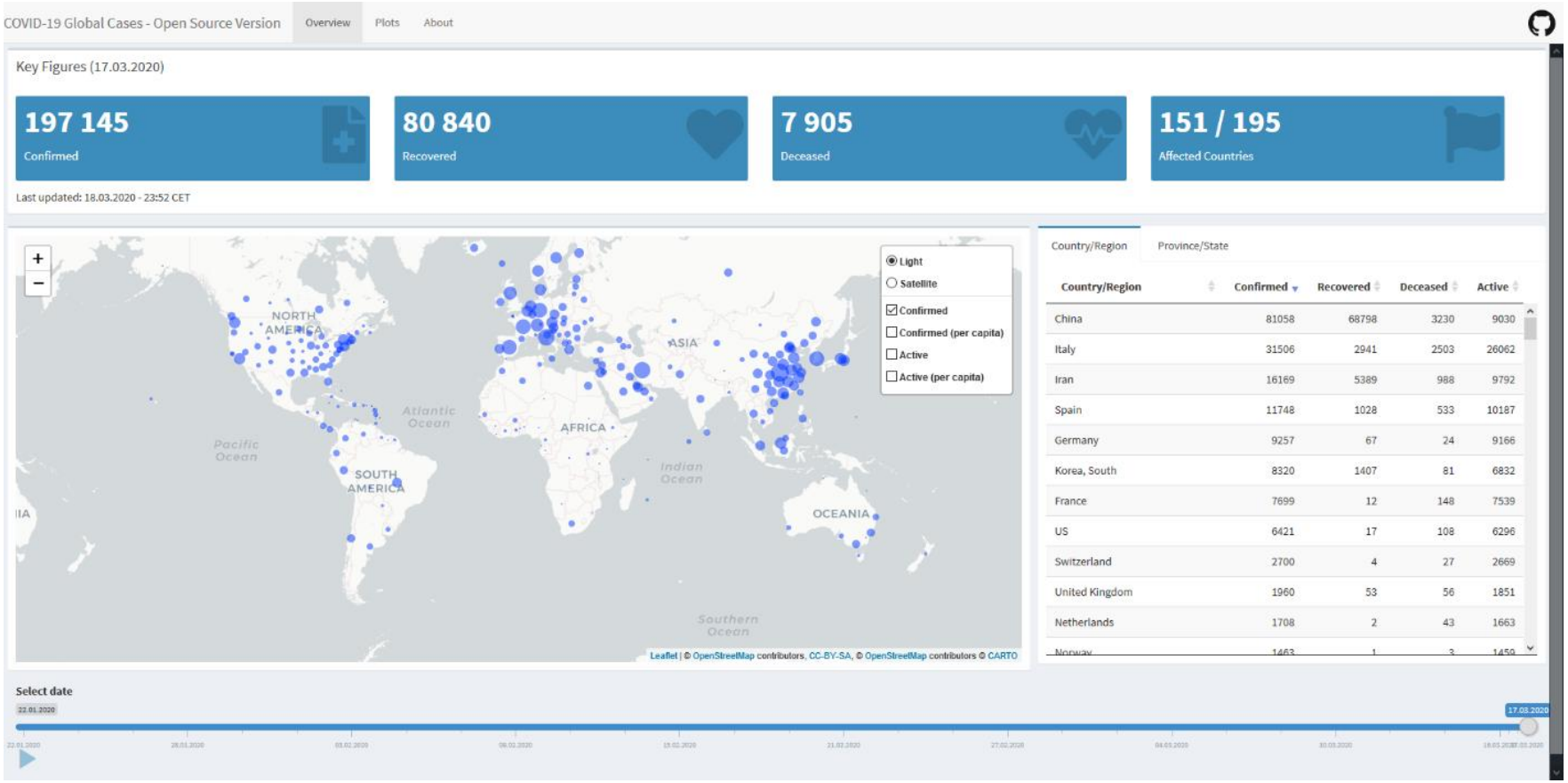
9. **Dashboard for Covid-19 using RMarkdown**

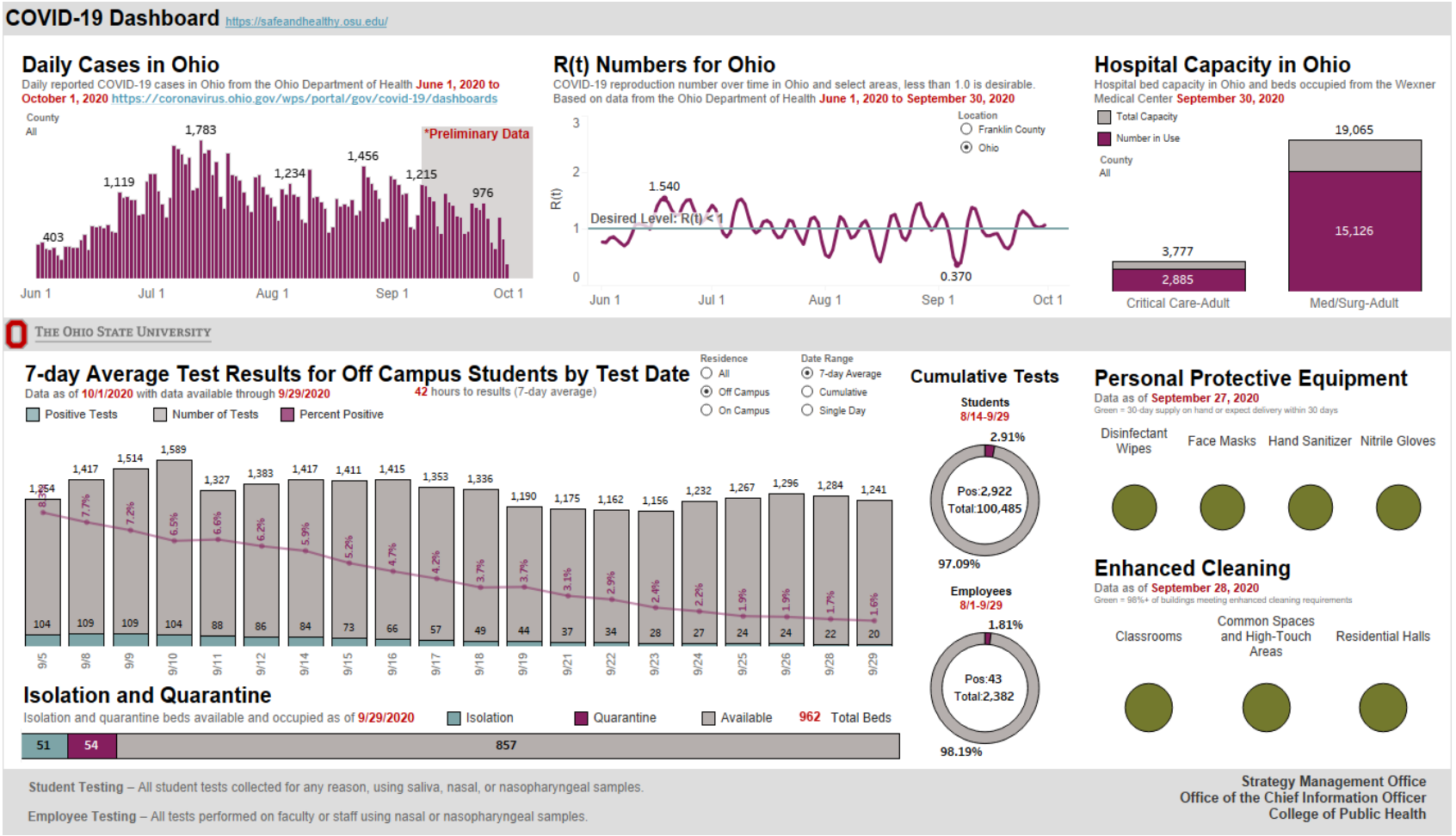
Flexdashboard

What is a Dashboard ?

What is a Dashboard ?



What is a Dashboard ?



What is a Dashboard ?

Why a Dashboard ?

- Easier online communication of the modelling results and current outbreak situation for:
  - the general public.
  - policy makers.

- Very useful:
  - for understanding the real picture.
  - against fake news.

Why a Dashboard using R ?

- Free software to do statistical analysis.
- Results can be reproduced and validated by anybody.
- Publicly available datasources
  - Governments can sometimes manipulate the data.
  - Delay in official data publication.

What is Flexdashboard?

- Publish data report/visualisations as a **dashboard**
- Combine:
  - Text Annotation, R code, R graphics (base, ggplot2,...), Tables (knitr::kable()), Value Boxes, Gauges...
  - Storyboard: Design, Methodology, Exploration, Results, Discussion,...

Flexdashboard	Shiny

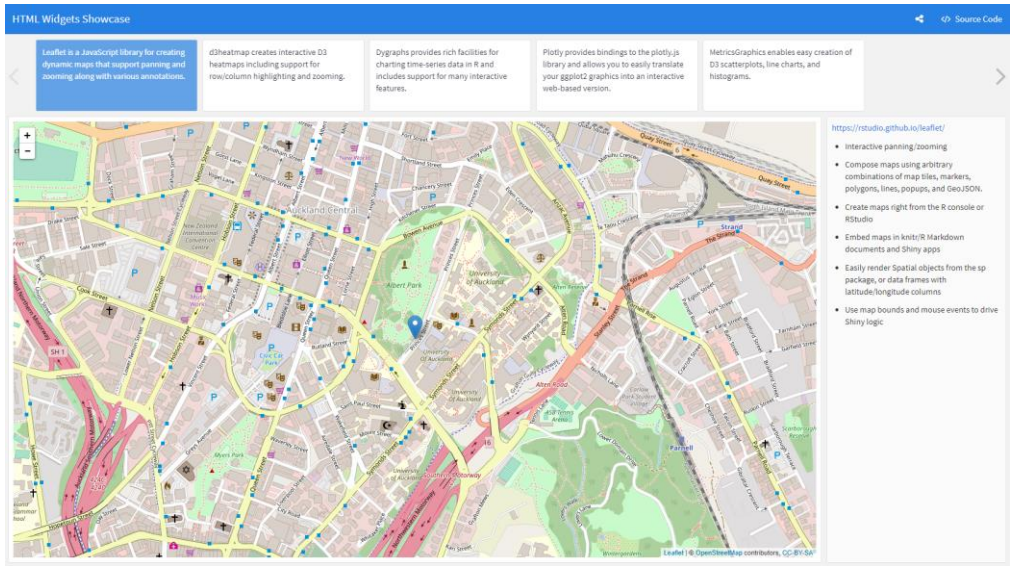
- **Static**
  - No on-the-fly calculations
  - Interactivity: htmlwidgets
 	
- *Deployment*
  - Html file
- **R Markdown Syntax**
- Optional: include Shiny
- Change size: window, mobile,...
	- **Fully Interactive**
	  - On-the-fly calculations
	  - Interactivity: widgets, htmlwidgets,...
	
	- *Deployment*
	  - Server
	- Shiny Syntax

Why Flexdashboard?

- Visually appealing alternative to standard Rmarkdown
- Quick learning curve due if you are familiar to Rmarkdown
- Can provide a better format to visually tell a story and/or explore results
- Extremely flexible layout system
- Static html file
- Shiny (server-hosted) integration also possible

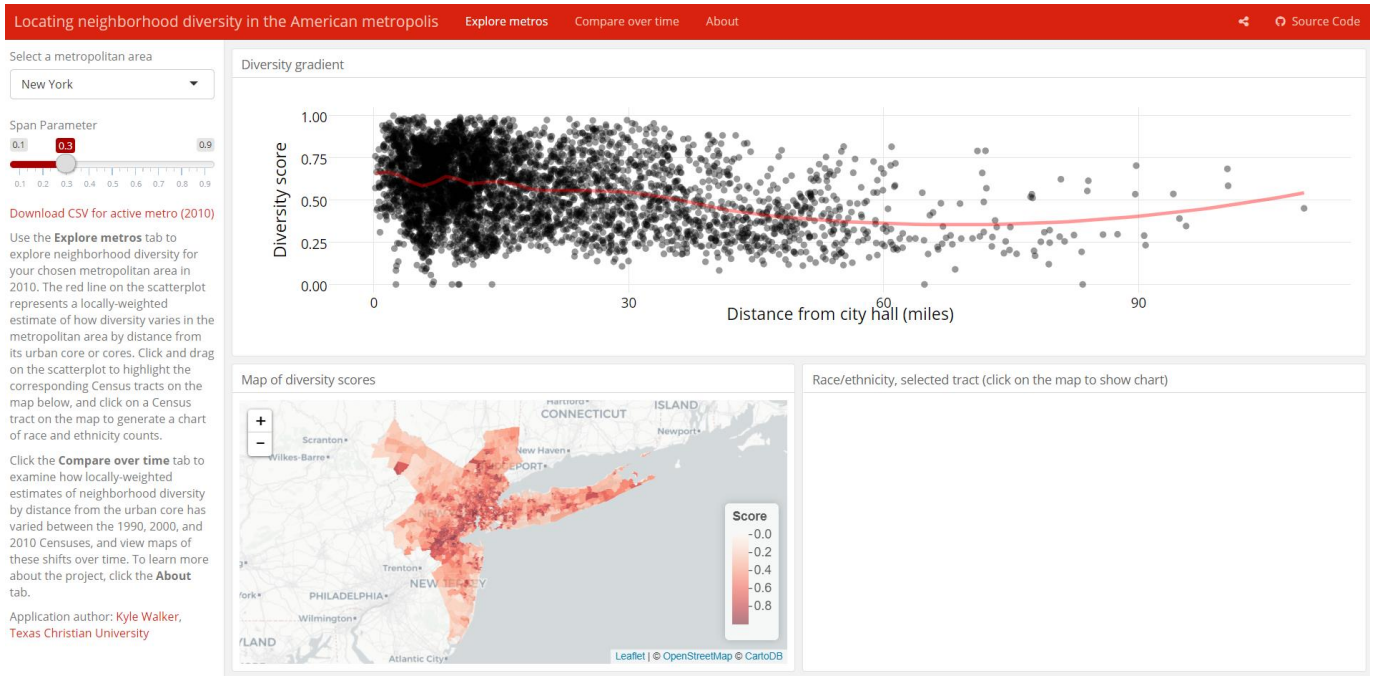
Flexdashboard: htmlwidgets

- **htmlwidgets for R**
  - Employ JavaScript visualisation libraries in R
  - Can be used in **Static HTML**
    - => Can be used in *flexdashboard, R Markdown,...*
  - Leaflet, Plotly, d3heatmap, DataTables, d3scatter, dygraphs,...



Flexdashboard: Shiny

- **Integrate Shiny in a flexdashboard**
  - Interactive
  - Run on a server/cloud

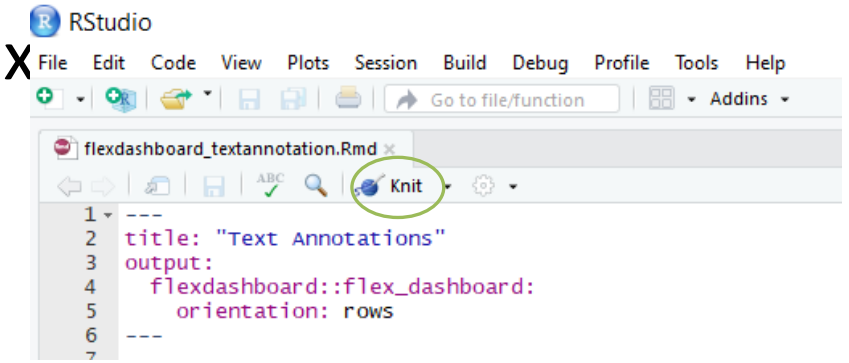


Flexdashboard

- Installation

```
install.packages("flexdashboard")
```

- Syntax
  - Rmarkdown = Flexdashboard
    (i.e. Text, Plots, Tables, R chunks, Htmlwidgets,...)
  - Simple layout syntax

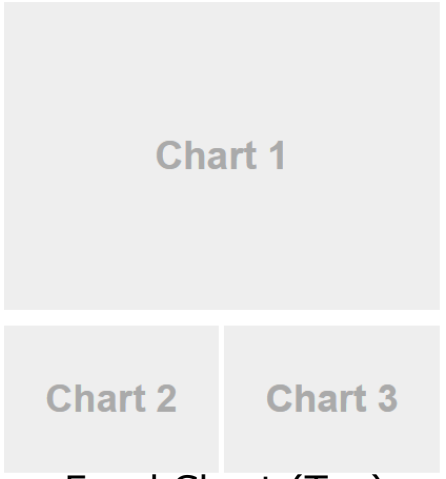


- Compile to html

```
rmarkdown::draft("dashboard.Rmd", template = "flex_dashboard", package = "flexdashboard")
```

Flexdashboard: Layout Overview

Chart Stack



Focal Chart (Top)

Focal Chart (Left)

Chart Grid

Tabset Column

Tabset Row

Input Sidebar

And more...

- Multiple Pages
- Storyboard
- Mobile Specific
- Scrolling Layout
- ...

Flexdashboard: Starting Point

```
---
title: "Arranging Data for Clear Communication"
output:
  flexdashboard::flex_dashboard:
    storyboard: true
    orientation: columns
    vertical_layout: fill
    source_code: embed
---
```

Flexdashboard: Layout with Fill/Scroll

```
---
title: "Single Column (Fill)"
output:
  flexdashboard::flex_dashboard:
    vertical_layout: fill
---

### Chart 1

```{r}

```

Chart 2

```{r}

```
```

Allow scrolling of the full page when more height is needed for multiple charts

```
---
title: "Single Column (Scrolling)"
output:
  flexdashboard::flex_dashboard:
    vertical_layout: scroll
---

### Chart 1

```{r}

```

Chart 2

```{r}

```

Chart 3

```{r}

```
```

Flexdashboard: Layout by Row/Column

```
---
title: "Column Orientation"
output: flexdashboard::flex_dashboard
---

Column
-------------------------------------

### Chart 1

```{r}
```

Column

Chart 2

```{r}
```

Chart 3

```{r}
```
```


```
---
title: "Row Orientation"
output:
  flexdashboard::flex_dashboard:
    orientation: rows
---

Row
-------------------------------------

### Chart 1

```{r}
```

Row

Chart 2

```{r}
```

Chart 3

```{r}
```
```

Flexdashboard: Layout by Row/Column

```
---
title: "Column Orientation"
output: flexdashboard::flex_dashboard
---

Column
-----------------------------------

### Chart 1

```{r}
```

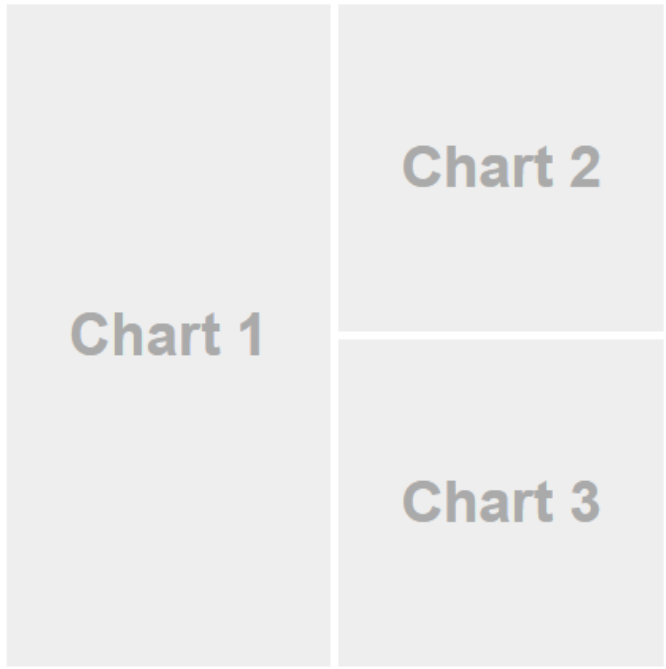
Column

Chart 2

```{r}
```

Chart 3

```{r}
```
```




```
---
title: "Row Orientation"
output:
  flexdashboard::flex_dashboard:
    orientation: rows
---

Row
-----------------------------------

### Chart 1

```{r}
```

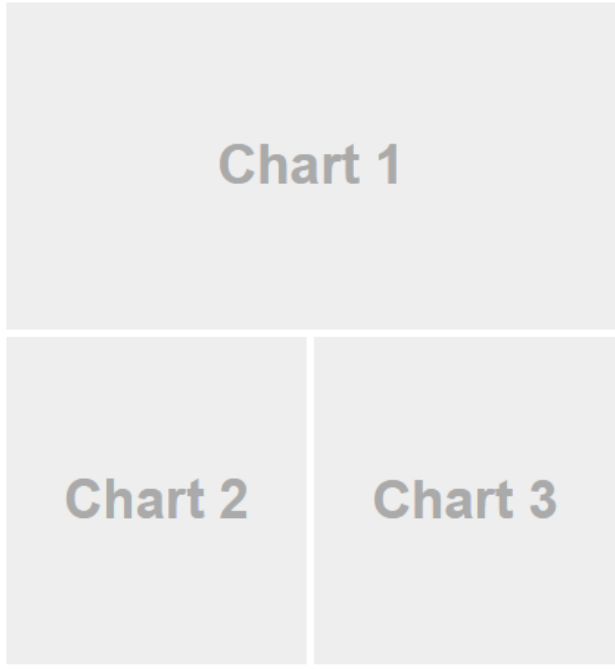
Row

Chart 2

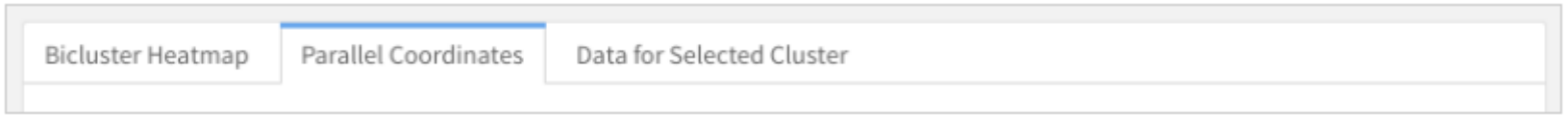
```{r}
```

Chart 3

```{r}
```
```



Flexdashboard: Layout Tabsets




```
---
title: "Tabset Column"
output: flexdashboard::flex_dashboard
---

Column
-------------------------------------

### Chart 1

```{r}
```

Column {.tabset}

Chart 2

```{r}
```

Chart 3

```{r}
```
```


```
---
title: "Tabset Row"
output:
  flexdashboard::flex_dashboard:
    orientation: rows
---

Row
-------------------------------------

### Chart 1

```{r}
```

Row {.tabset .tabset-fade}

Chart 2

```{r}
```

Chart 3

```{r}
```
```

Fade: fade-in/fade-out effect when switching tabs

Flexdashboard: Layout Sizing

```
---
title: "Chart Sizing"
output:
  flexdashboard::flex_dashboard:
    orientation: rows
---

Row {data-height=650}
-------------------------------------

### Chart 1

```{r}
```

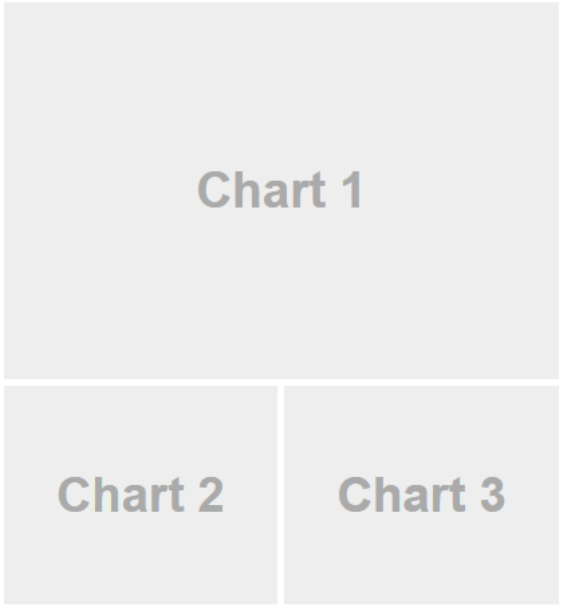
Row {data-height=350}

Chart 2

```{r}
```

Chart 3

```{r}
```
```




```
---
title: "Custom Chart Height"
output: flexdashboard::flex_dashboard
---

### Chart 1 {data-height=600}

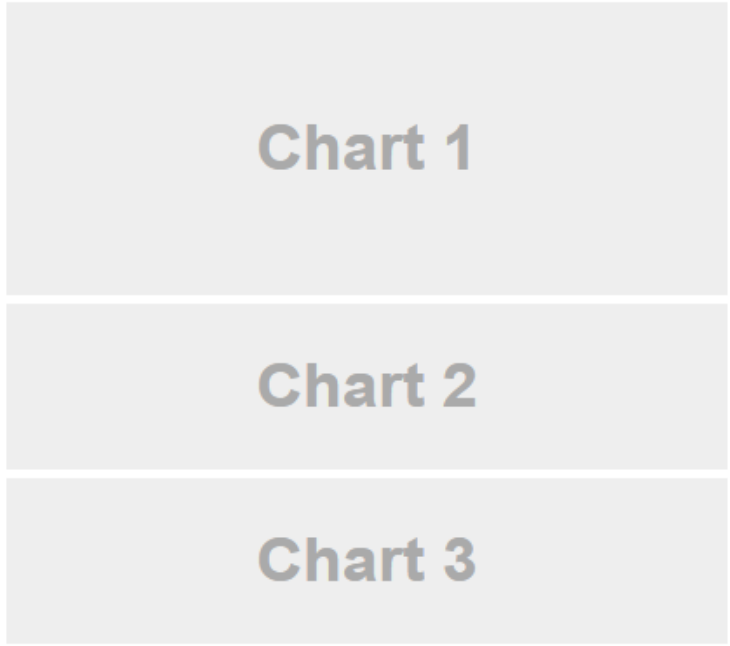
```{r}
```

Chart 2 {data-height=200}

```{r}
```

Chart 3 {data-height=200}

```{r}
```
```



Width of charts determined by browser
(unless overwritten by `data-width`)

Chart Padding (default 8 pixels)

```
### Chart 1 {.no-padding}

```{r}
```

Chart 2 {data-padding=10}

```{r}
```
```

Flexdashboard: Layout Multiple Pages

```
---
title: "Multiple Pages"
output: flexdashboard::flex_dashboard
---

Page 1
=====================================

### Chart 1

```{r}
```

Chart 2

```{r}
```

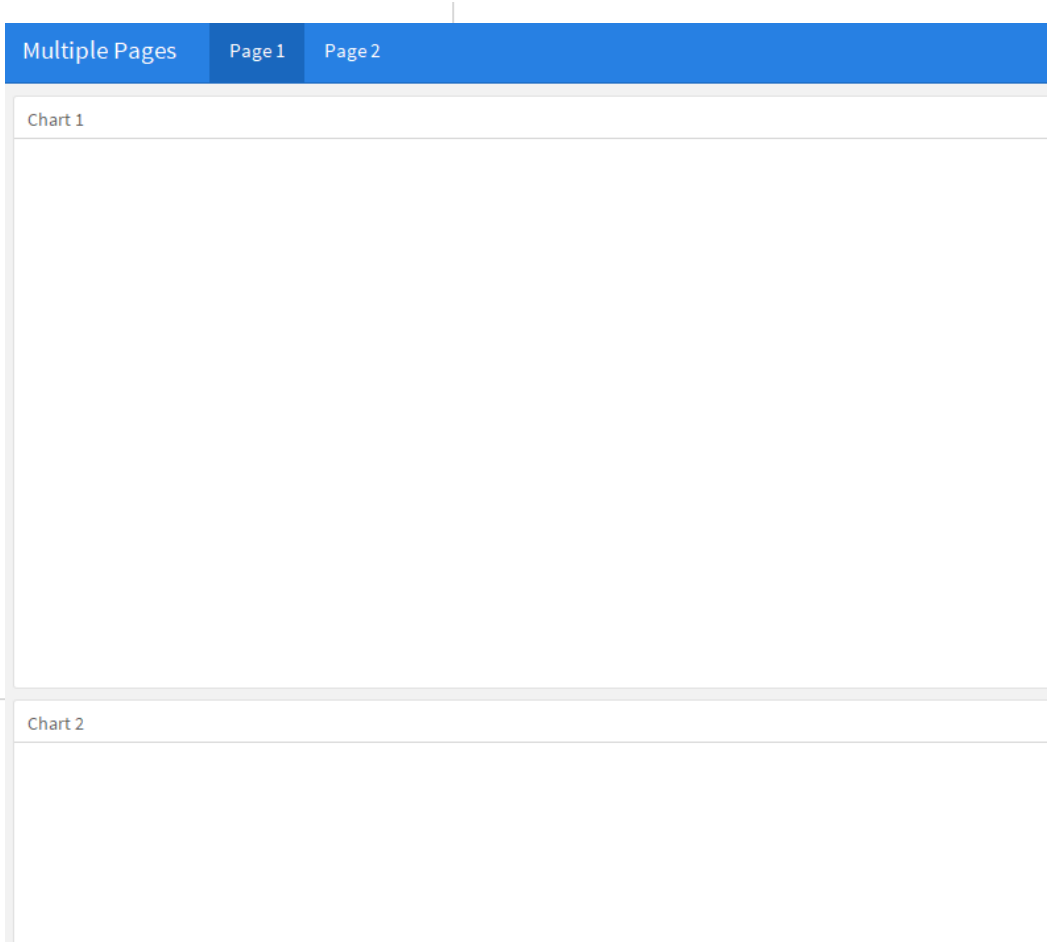
Page 2
=====================================

Chart 1

```{r}
```

Chart 2

```{r}
```
```




```
---
title: "Page Orientation"
output: flexdashboard::flex_dashboard
---

Page 1
=====================================


Page 2 {data-orientation=rows}
=====================================

```

Flexdashboard: Layout Multiple Pages

```
---
title: "Page Navigation Menus"
output: flexdashboard::flex_dashboard
---

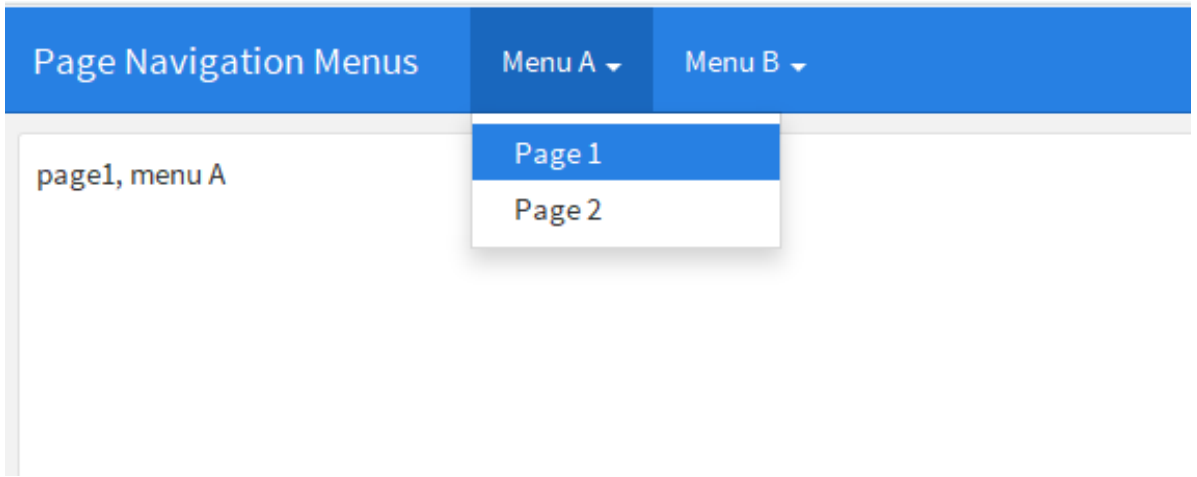
Page 1 {data-navmenu="Menu A"}
=====================================


Page 2 {data-navmenu="Menu A"}
=====================================


Page 3 {data-navmenu="Menu B"}
=====================================


Page 4 {data-navmenu="Menu B"}
=====================================

```



Extra for Multiple Pages

- Page Links
  - Links to specific pages
- Hiding Pages
  - Using page links instead
- Page Icons

Flexdashboard: Layout Storyboards

```
---
title: "Storyboard"
output:
  flexdashboard::flex_dashboard:
    storyboard: true
---

### Frame 1

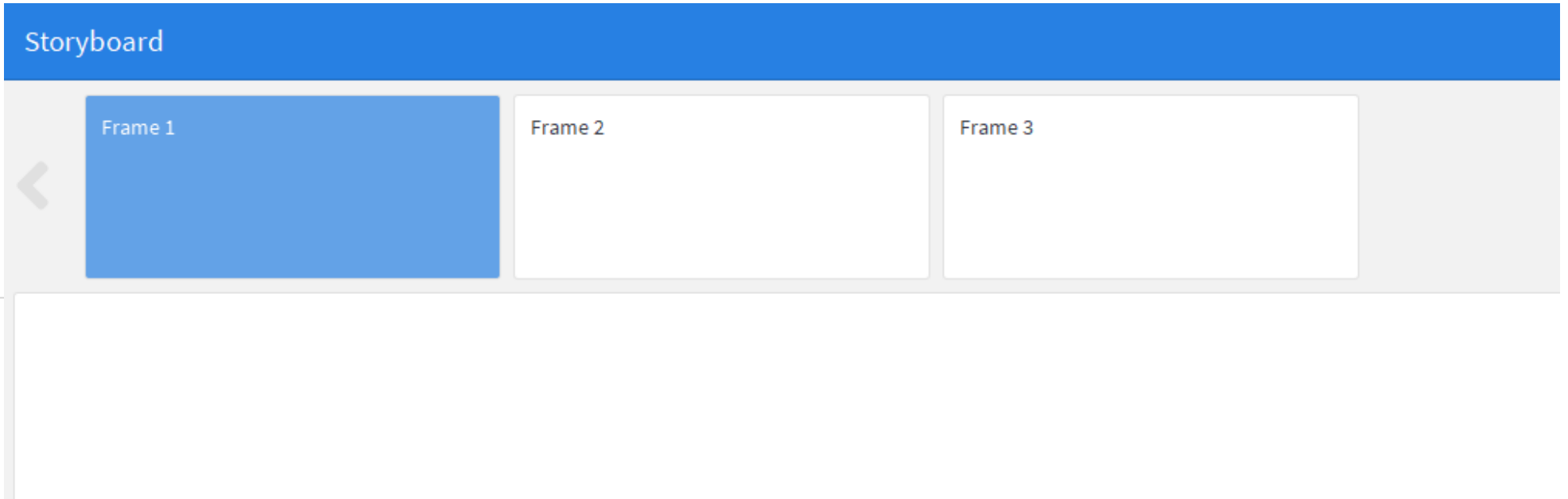
```{r}
```

Frame 2

```{r}
```

Frame 3

```{r}
```
```



Flexdashboard: Layout Storyboards

```
---
title: "Storyboard Page"
output: flexdashboard::flex_dashboard
---

Analysis {.storyboard}
=====================================

### Frame 1

```{r}
```

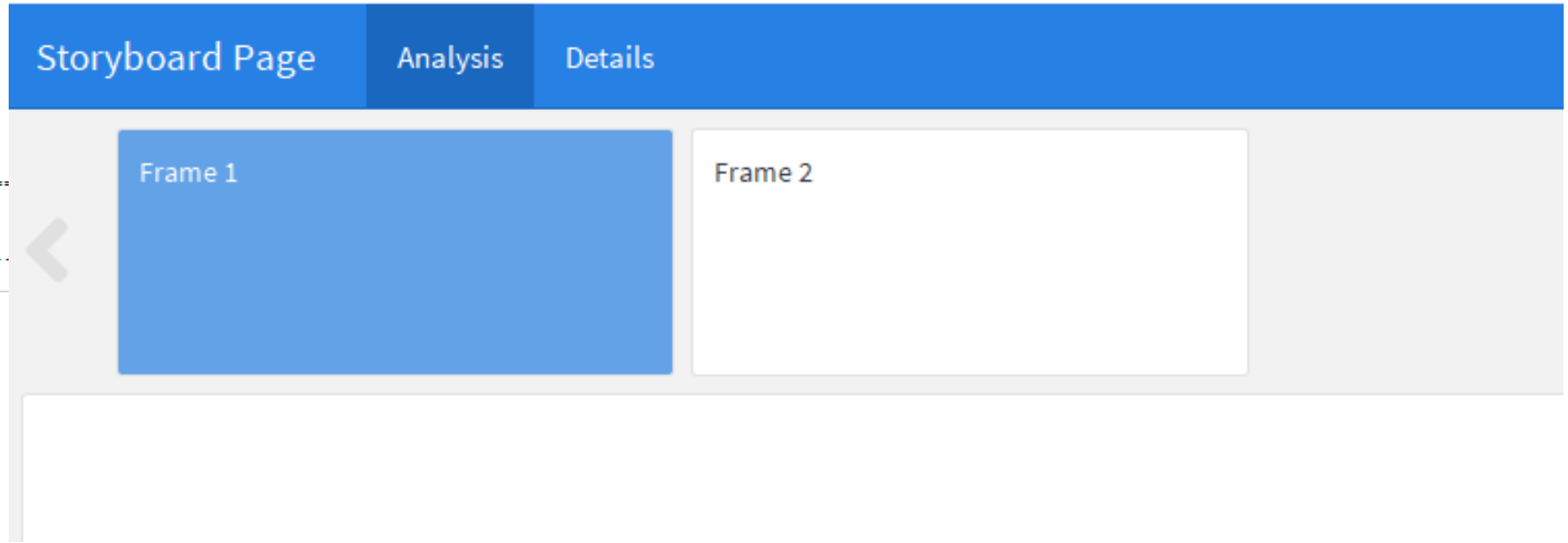
Frame 2

```{r}
```

Details
=====================================

Column

```



Flexdashboard: Layout Storyboards

```
---
title: "Storyboard Commentary"
output:
  flexdashboard::flex_dashboard:
    storyboard: true
---

### Frame 1

```{r}
```

***

Some commentary about Frame 1.

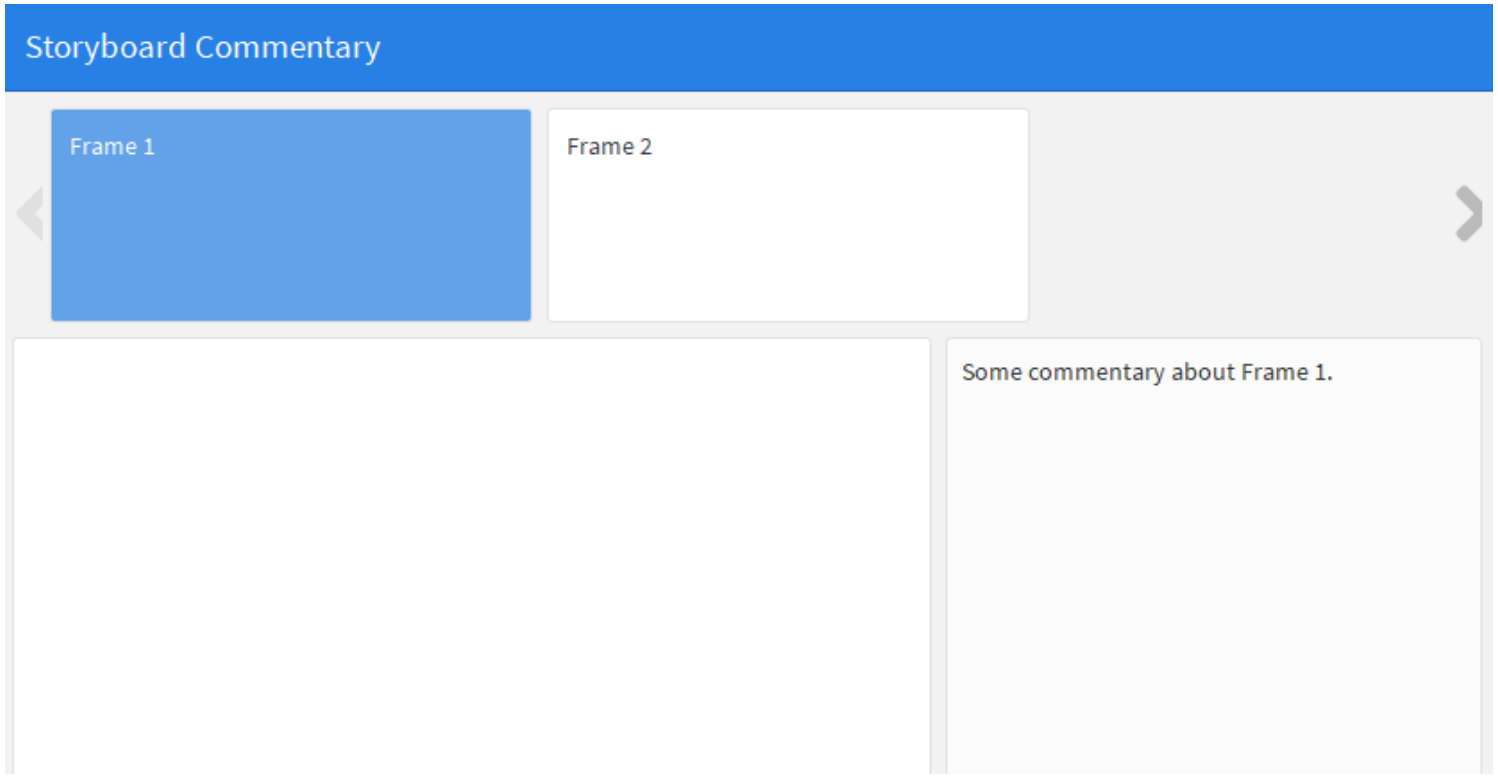
Frame 2 {data-commentary-width=400}

```{r}
```

***

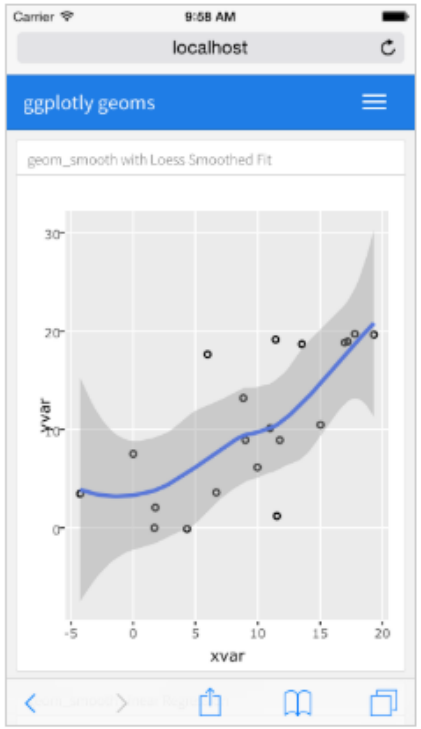
Some commentary about Frame 2.

```



# Flexdashboard: Mobile Layout

- R graphics rendered twice, natural and mobile-optimized size
- Portrait is used (control with `fig_mobile` )




*Exclude components*

```
---
title: "Exclude on Mobile"
output: flexdashboard::flex_dashboard

Chart 1

```{r}
plot(cars)
```

Chart 2 {.no-mobile}

```{r}
plot(summary)
```
```

Mobile-specific

```
---
title: "Mobile Specific Component"
output: flexdashboard::flex_dashboard
---

### Chart 1

```{r}
plot(cars)
```

Chart 1 {.mobile}

```{r}
plot(cars)
```
```

Flexdashboard: Layout Components

Value Boxes

```
Row
-----------------------------------------------------------------------

### Articles per Day

```{r}
articles <- computeArticles()
valueBox(articles, icon = "fa-pencil")
```

Comments per Day

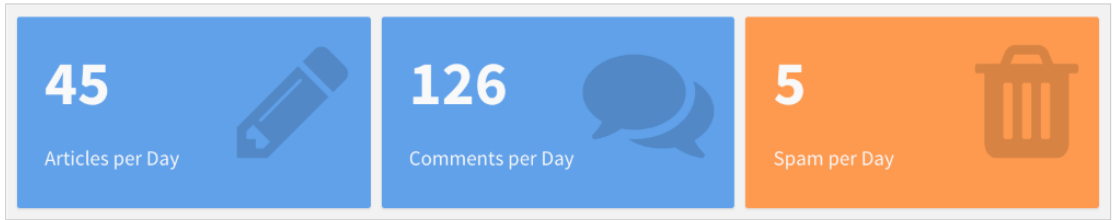
```{r}
comments <- computeComments()
valueBox(comments, icon = "fa-comments")
```

Spam per Day

```{r}
spam <- computeSpam()
valueBox(spam,
         icon = "fa-trash",
         color = ifelse(spam > 10, "warning", "primary"))
```
```

```
### Linked Value Box

```{r}
valueBox(42, icon = "fa-pencil", href="#details")
```
```



Gauges

```
Row
-----------------------------------------------------------------------

### Contact Rate

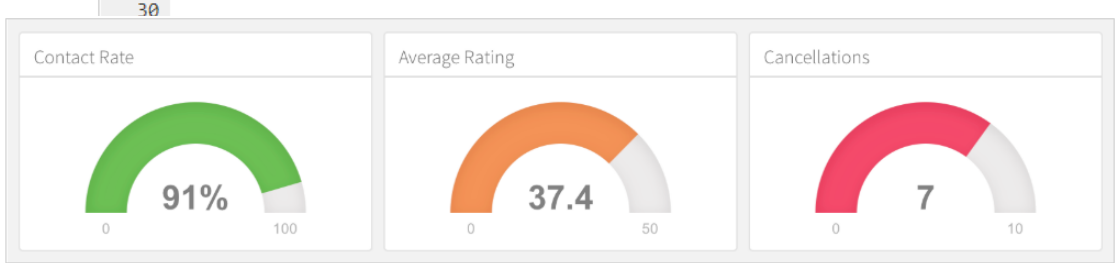
```{r}
rate <- computeContactRate()
gauge(rate, min = 0, max = 100, symbol = '%', gaugeSectors(
  success = c(80, 100), warning = c(40, 79), danger = c(0, 39)
))
```

Average Rating

```{r}
rating <- computeAverageRating()
gauge(rating, min = 0, max = 50, gaugeSectors(
  success = c(41, 50), warning = c(21, 40), danger = c(0, 20)
))
```

Cancellations

```{r}
cancellations <- computeCancellations()
gauge(cancellations, min = 0, max = 10, gaugeSectors(
  success = c(0, 2), warning = c(3, 6), danger = c(7, 10)
))
```
```



Flexdashboard: Layout Text Annotation

```
---
title: "Text Annotations"
output:
  flexdashboard::flex_dashboard:
    orientation: rows
---

Monthly deaths from bronchitis, emphysema and asthma in the
UK, 1974-1979 (Source: P. J. Diggle, 1990, Time Series: A
Biostatistical Introduction. Oxford, table A.3)

```{r setup, include=FALSE}
library(dygraphs)
```

Row {data-height=600}

All Lung Deaths {.no-title}

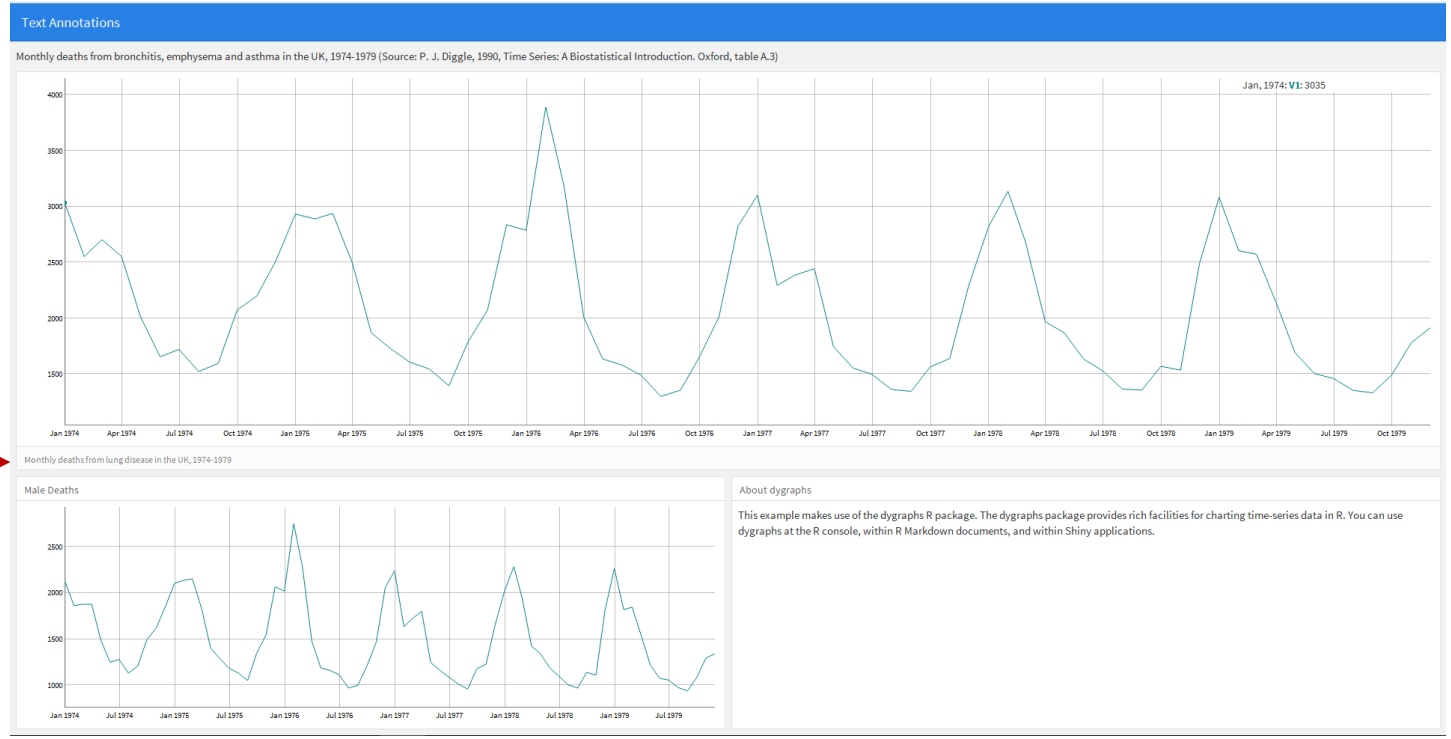
```{r}
dygraph(ldeaths)
```
> Monthly deaths from lung disease in the UK, 1974-1979
Row {data-height=400}

Male Deaths

```{r}
dygraph(mdeaths)
```

About dygraphs

This example makes use of the dygraphs R package. The dygraphs
package provides rich facilities for charting time-series data
in R. You can use dygraphs at the R console, within R Markdown
documents, and within Shiny applications.
```

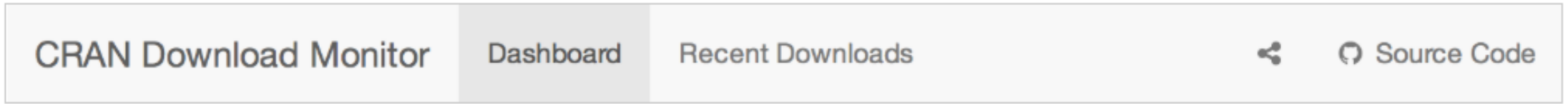


Flexdashboard: Layout Themes

- Themes:
  - default, cosmo, bootstrap, cerulean, journal, flatly, readable, spacelab, united, lumen, paper, sandstone, simplex, yeti
  - https://bootswatch.com/

```
1  ---
2  title: "Themes"
3  output:
4    flexdashboard::flex_dashboard:
5      theme: bootstrap
6  ---
7
```

- Extra:
  - Navigation Bar
  - Source Code (Embed/Link)
  - Social links

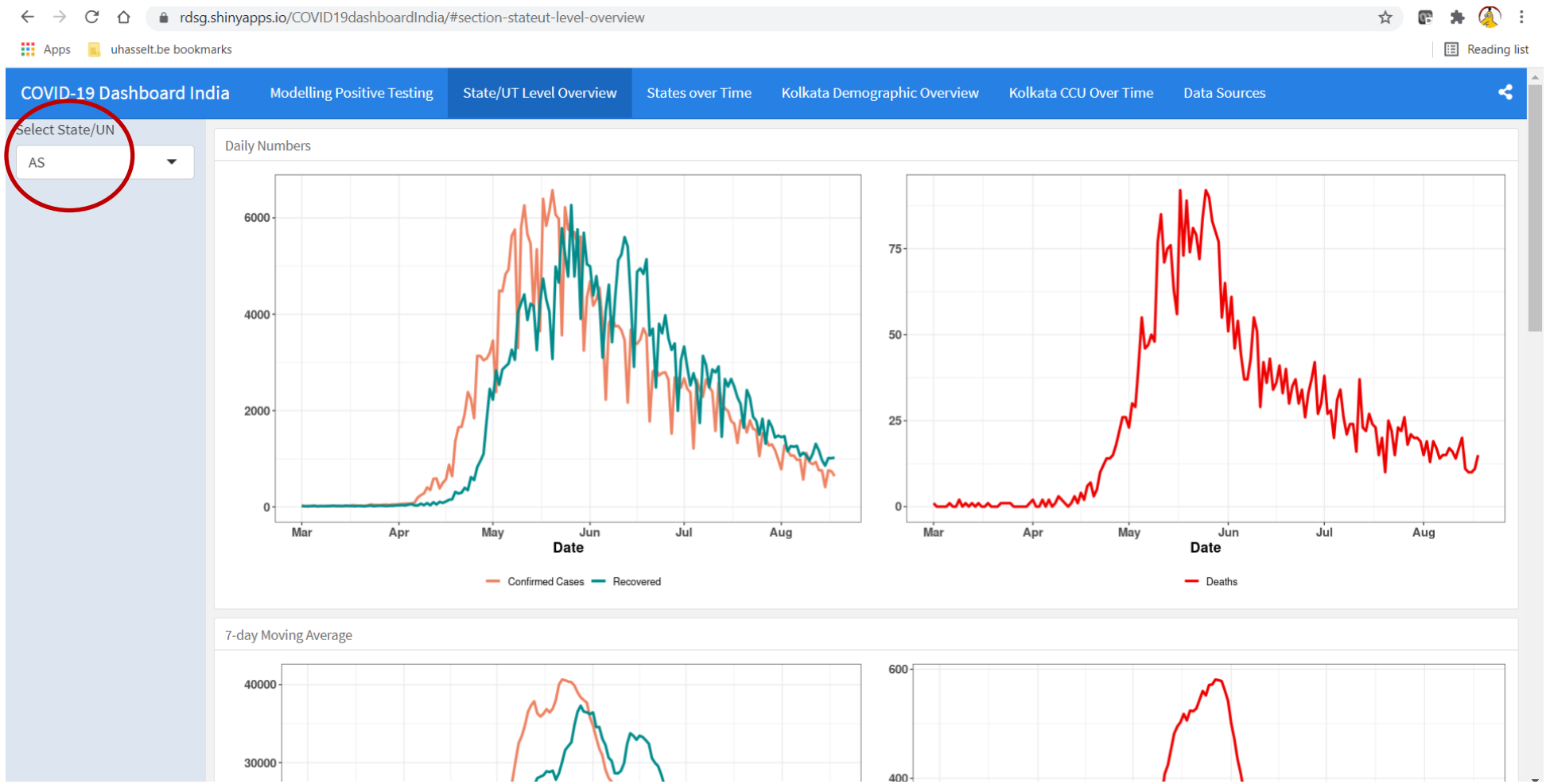


COVID-19 Dashboard: India

- Interactive and automated dashboard entirely made in R
- Information communicated in the dashboard:
  - Number of daily cases (overall and by state): local transmission.
  - Positive testing rate.
  - Number of cases by state over time.
  - Availability of CCU beds.
  - Availability of hospitals without CCU beds.
- All information from online datasets.

COVID-19 Dashboard: India

COVID-19 Dashboard: India

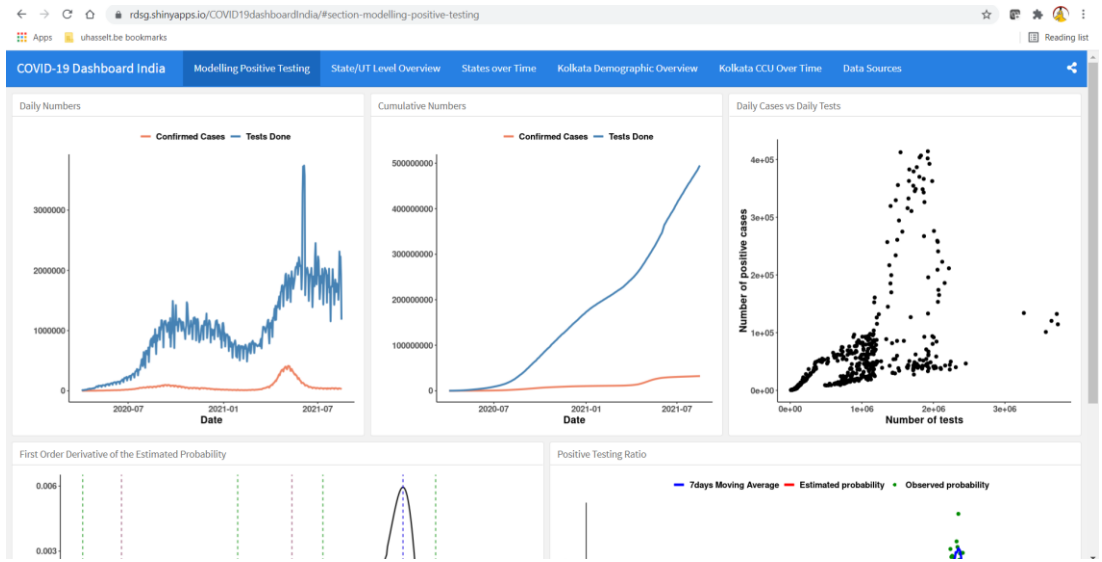


How to Create the Dashboard in R ?

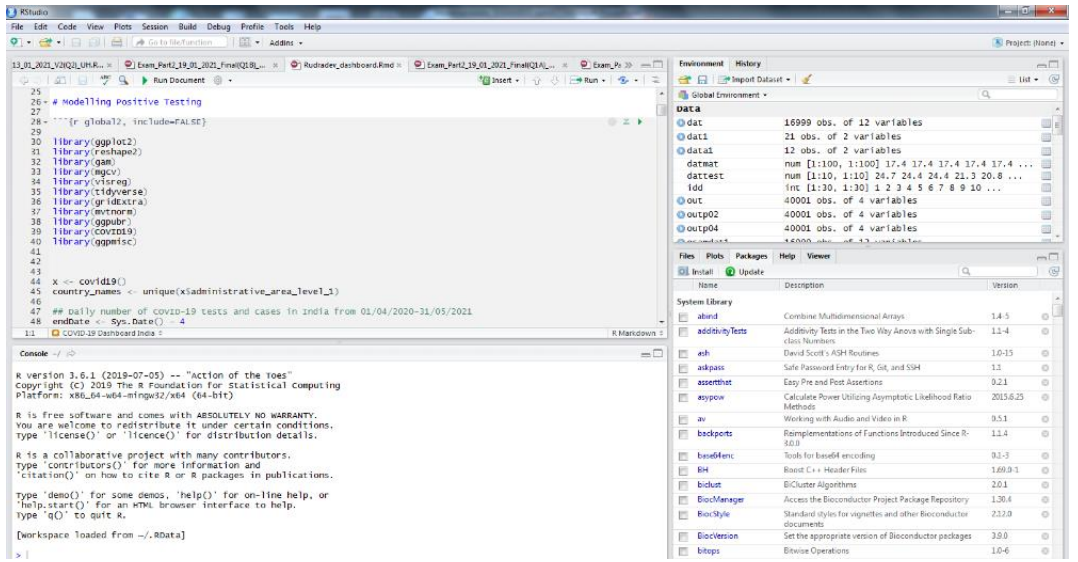
- R studio.
- R markdown.
- flexdashboard/shinydashboard.
- Graphical displays: ggplot2, plotly, ….
- Tables: DT, data.table

RMarkdown and Dashboard

Dashboard

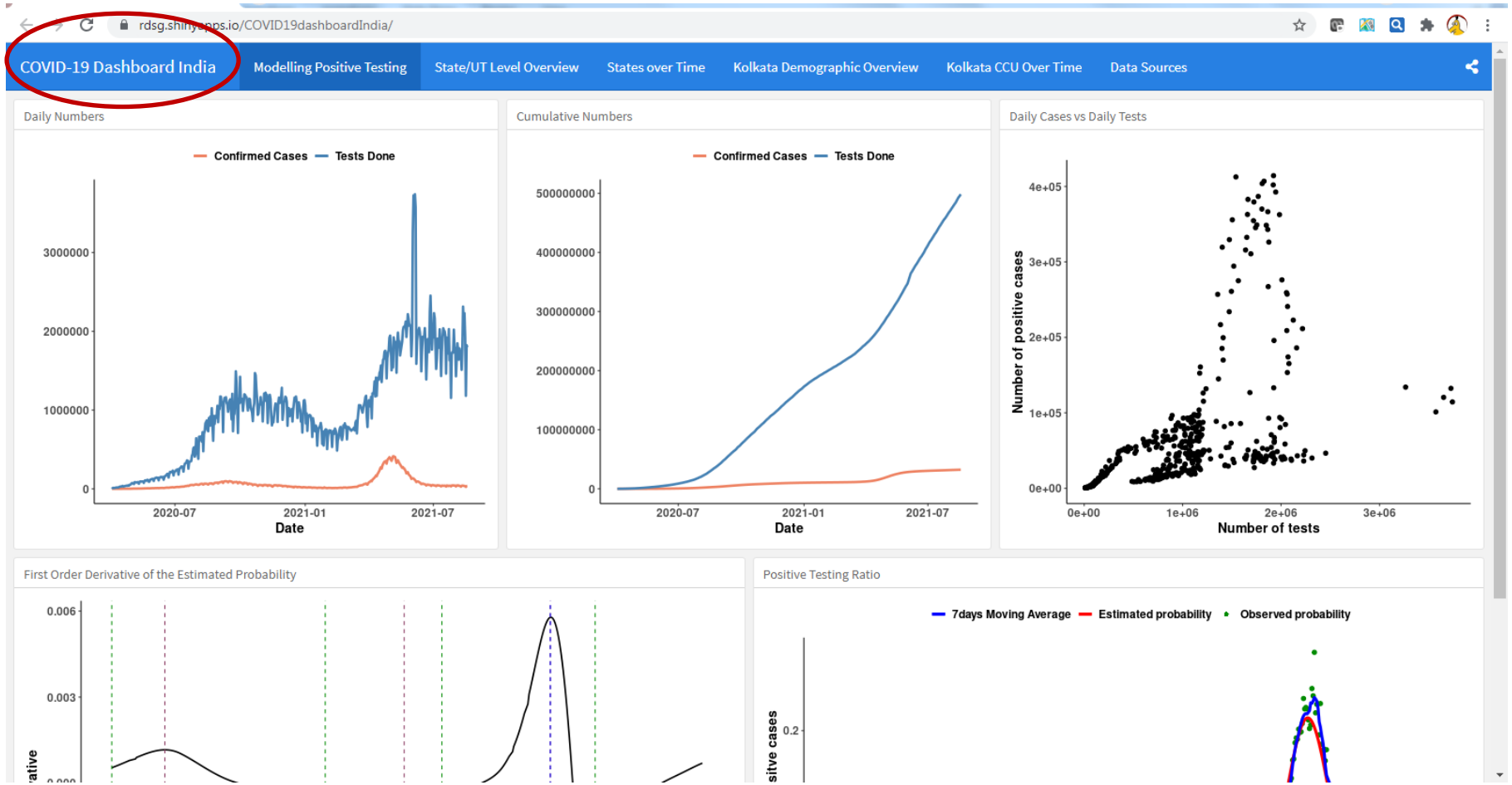


Rmd file

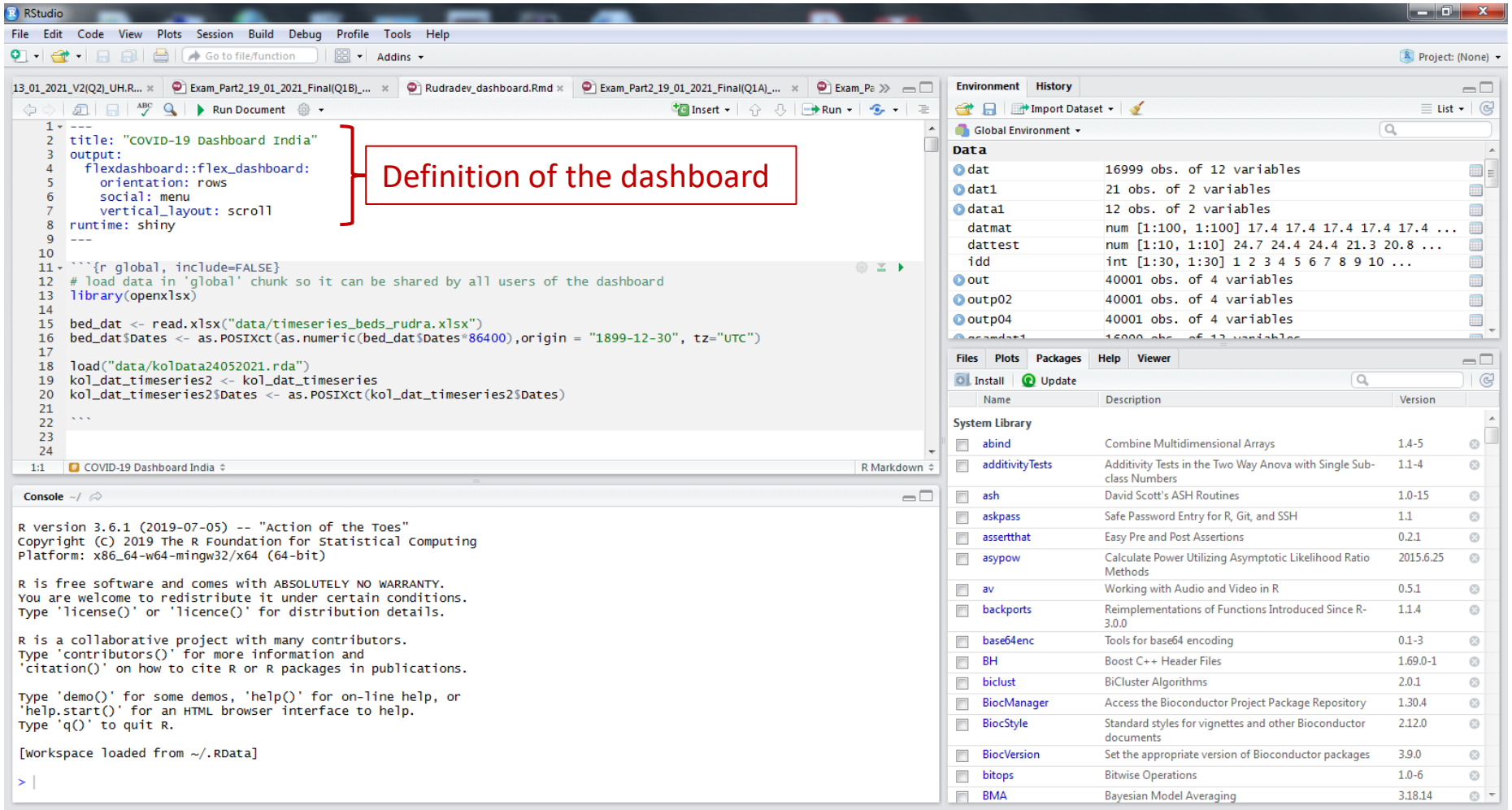


- We focus on:
  - Dashboard in R.
  - How to produce the dashboard for India in R.

COVID-19 Dashboard for India: Main Page



Rmd File


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
Exam_Part2_19_01_2021_Final(Q1B)_...
Rudradev_dashboard.Rmd
Exam_Part2_19_01_2021_Final(Q1A)_...
Run Document
Insert
Run
---
title: "COVID-19 Dashboard India"
output:
flexdashboard::flex_dashboard:
orientation: rows
social: menu
vertical_layout: scroll
runtime: shiny

Definition of the dashboard
```{r global, include=FALSE}
# load data in 'global' chunk so it can be shared by all users of the dashboard
library(openxlsx)
bed_dat <- read.xlsx("data/timeseries_beds_rudra.xlsx")
bed_dat$Dates <- as.POSIXct(as.numeric(bed_dat$Dates*86400),origin = "1899-12-30", tz="UTC")
load("data/kolData24052021.rda")
kol_dat_timeseries2 <- kol_dat_timeseries
kol_dat_timeseries2$Dates <- as.POSIXct(kol_dat_timeseries2$Dates)
```
1:1
COVID-19 Dashboard India
R Markdown
Console ~/
R version 3.6.1 (2019-07-05) -- "Action of the Toes"
Copyright (C) 2019 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)
R is free software and comes with ABSOLUTELY NO WARRANTY.
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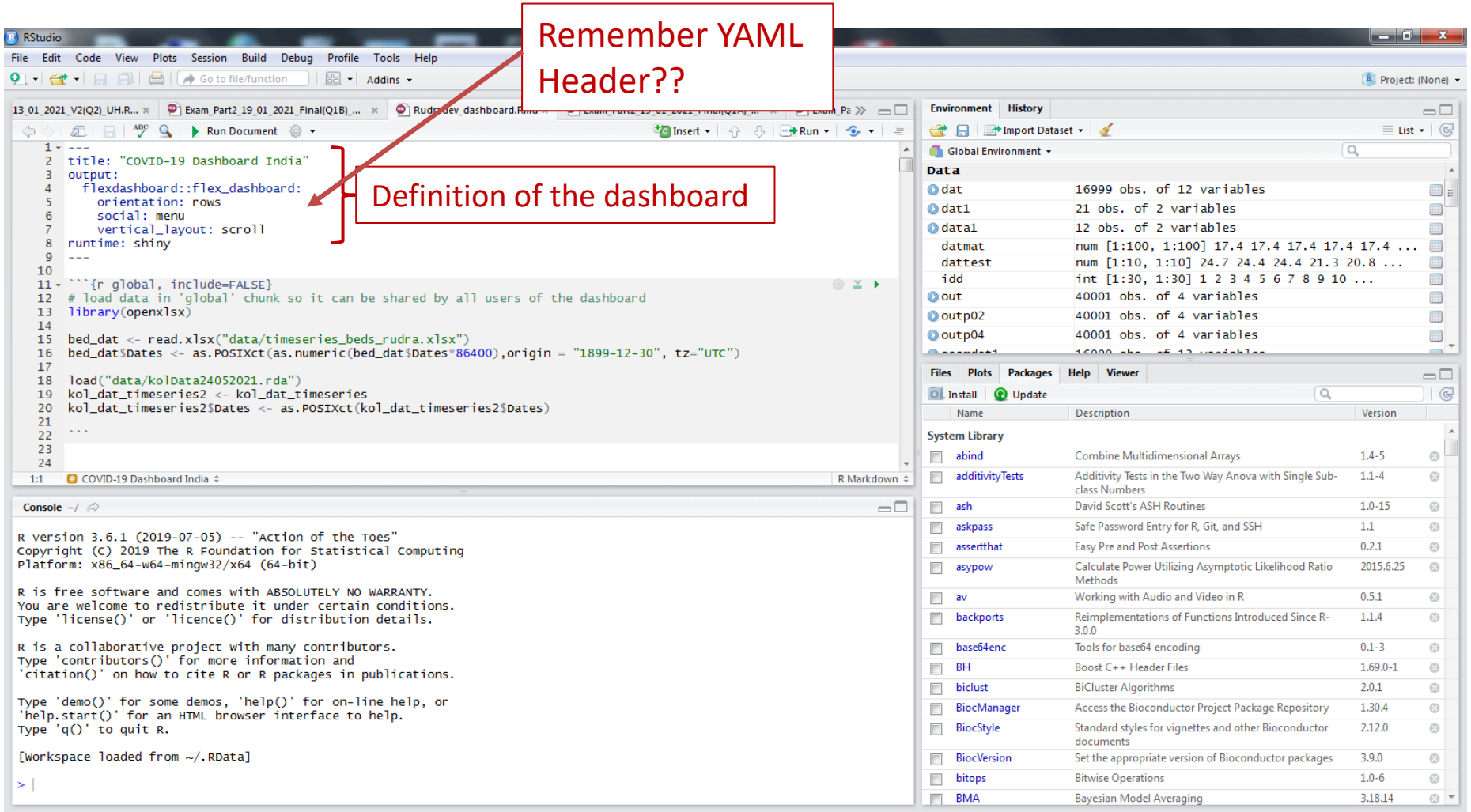
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
[Workspace loaded from ~/.RData]
>
Environment History
Import Dataset
List
Global Environment
Data
dat 16999 obs. of 12 variables
dat1 21 obs. of 2 variables
data1 12 obs. of 2 variables
datmat num [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ...
dattest num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
idd int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...
out 40001 obs. of 4 variables
outp02 40001 obs. of 4 variables
outp04 40001 obs. of 4 variables
Files Plots Packages Help Viewer
Install Update
Name Description Version
System Library
abind Combine Multidimensional Arrays 1.4-5
additivityTests Additivity Tests in the Two Way Anova with Single Sub-class Numbers 1.1-4
ash David Scott's ASH Routines 1.0-15
askpass Safe Password Entry for R, Git, and SSH 1.1
assertthat Easy Pre and Post Assertions 0.2.1
asypow Calculate Power Utilizing Asymptotic Likelihood Ratio Methods 2015.6.25
av Working with Audio and Video in R 0.5.1
backports Reimplementations of Functions Introduced Since R-3.0.0 1.1.4
base64enc Tools for base64 encoding 0.1-3
BH Boost C++ Header Files 1.69.0-1
biclust BiCluster Algorithms 2.0.1
BiocManager Access the Bioconductor Project Package Repository 1.30.4
BiocStyle Standard styles for vignettes and other Bioconductor documents 2.12.0
BiocVersion Set the appropriate version of Bioconductor packages 3.9.0
bitops Bitwise Operations 1.0-6
BMA Bayesian Model Averaging 3.18.14

Rmd File


Remember YAML Header??
Definition of the dashboard
RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Run Document
---
title: "COVID-19 Dashboard India"
output:
flexdashboard::flex_dashboard:
orientation: rows
social: menu
vertical_layout: scroll
runtime: shiny

```{r global, include=FALSE}
# load data in 'global' chunk so it can be shared by all users of the dashboard
library(openxlsx)
bed_dat <- read.xlsx("data/timeseries_beds_rudra.xlsx")
bed_dat$Dates <- as.POSIXct(as.numeric(bed_dat$Dates*86400),origin = "1899-12-30", tz="UTC")
load("data/kolData24052021.rda")
kol_dat_timeseries2 <- kol_dat_timeseries
kol_dat_timeseries2$Dates <- as.POSIXct(kol_dat_timeseries2$Dates)
```
COVID-19 Dashboard India
R Markdown
Console
R version 3.6.1 (2019-07-05) -- "Action of the Toes"
Copyright (C) 2019 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)
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Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
[Workspace loaded from ~/.RData]
Environment History
Import Dataset
Global Environment
Data
dat 16999 obs. of 12 variables
dat1 21 obs. of 2 variables
data1 12 obs. of 2 variables
datmat num [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ...
dattest num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
idd int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...
out 40001 obs. of 4 variables
outp02 40001 obs. of 4 variables
outp04 40001 obs. of 4 variables
Files Plots Packages Help Viewer
Install Update
Name Description Version
System Library
abind Combine Multidimensional Arrays 1.4-5
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askpass Safe Password Entry for R, Git, and SSH 1.1
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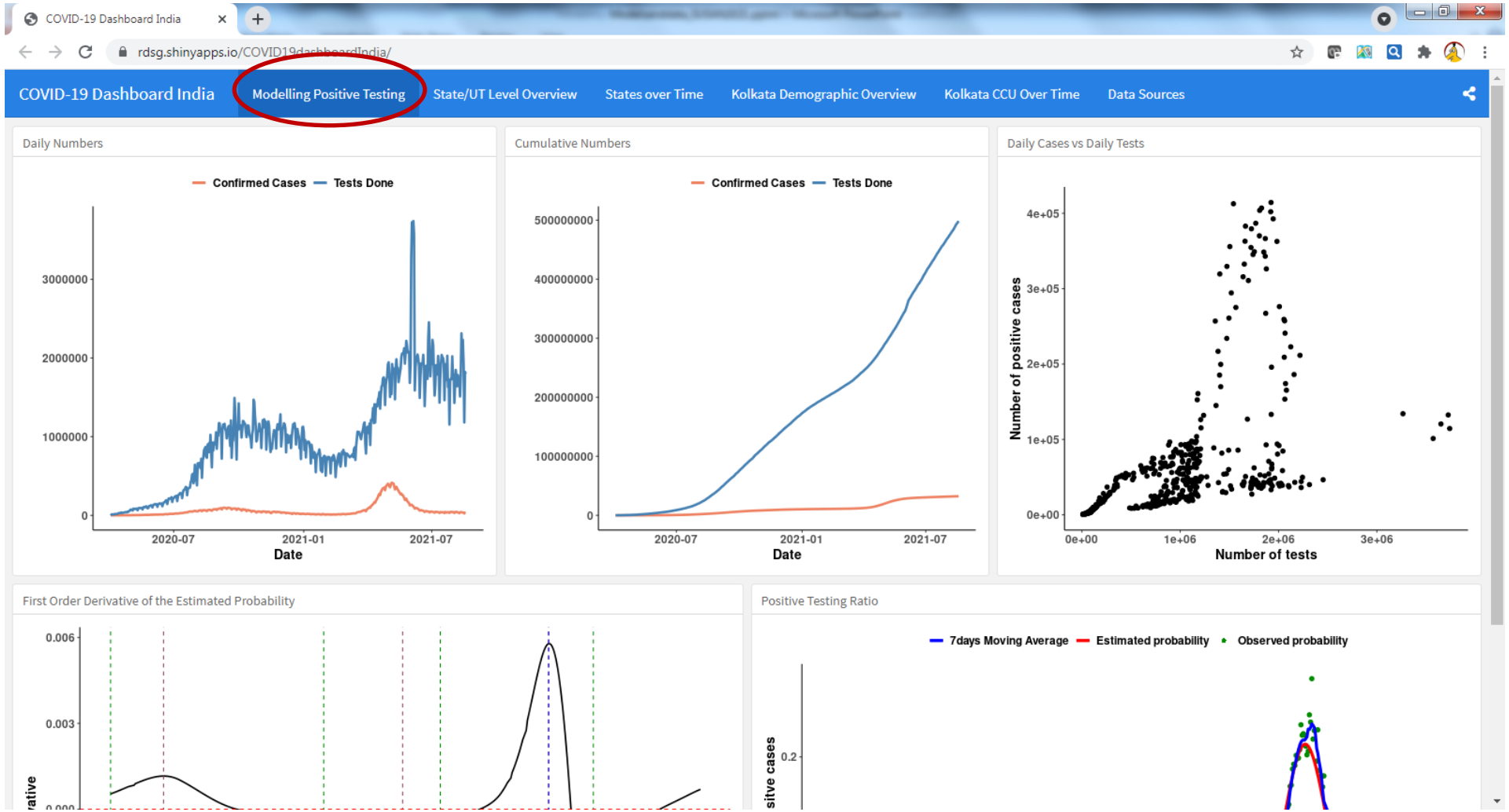
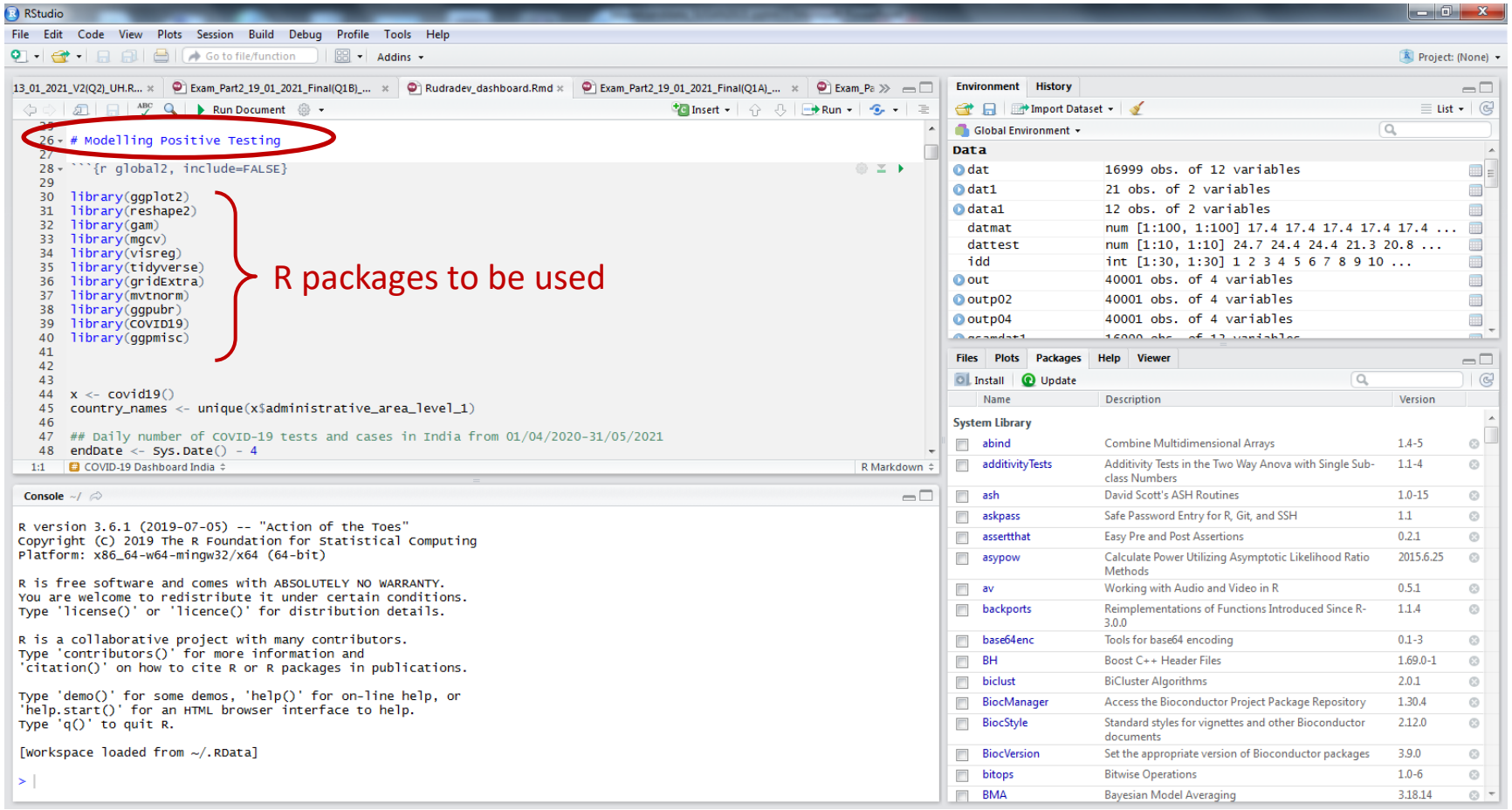
BiocVersion Set the appropriate version of Bioconductor packages 3.9.0
bitops Bitwise Operations 1.0-6
BMA Bayesian Model Averaging 3.18.14

First Tab: Modelling Positive Testing



Rmd File


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Addins
Project: (None)
Run Document
Insert
Run
26 # Modelling Positive Testing
28 ```{r global2, include=FALSE}
30 library(ggplot2)
31 library(reshape2)
32 library(gam)
33 library(mgcv)
34 library(visreg)
35 library(tidyverse)
36 library(gridExtra)
37 library(mvtnorm)
38 library(ggpubr)
39 library(COVID19)
40 library(ggpmisc)
R packages to be used
44 x <- covid19()
45 country_names <- unique(x$administrative_area_level_1)
47 ## Daily number of COVID-19 tests and cases in India from 01/04/2020-31/05/2021
48 endDate <- Sys.Date() - 4
COVID-19 Dashboard India
R Markdown
Console
R version 3.6.1 (2019-07-05) -- "Action of the Toes"
Copyright (C) 2019 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)
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dattest num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
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outp02 40001 obs. of 4 variables
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assertthat Easy Pre and Post Assertions 0.2.1
asypow Calculate Power Utilizing Asymptotic Likelihood Ratio Methods 2015.6.25
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backports Reimplementations of Functions Introduced Since R-3.0.0 1.1.4
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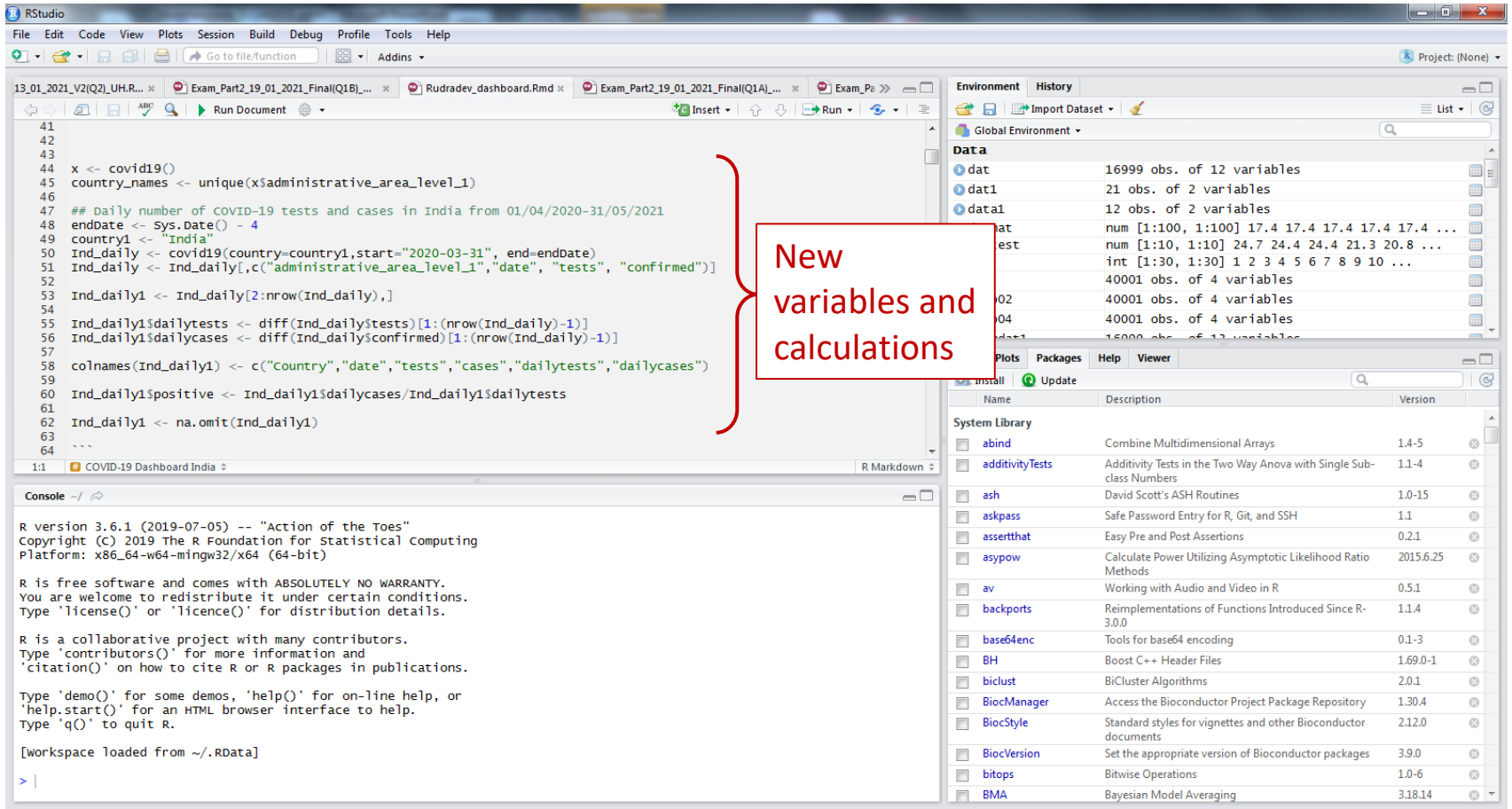
BiocVersion Set the appropriate version of Bioconductor packages 3.9.0
bitops Bitwise Operations 1.0-6
BMA Bayesian Model Averaging 3.18.14

Rmd File


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Run Document
Insert
Run
x <- covid19()
country_names <- unique(x$administrative_area_level_1)
Daily number of COVID-19 tests and cases in India from 01/04/2020-31/05/2021
endDate <- Sys.Date() - 4
country1 <- "India"
Ind_daily <- covid19(country=country1,start="2020-03-31", end=endDate)
Ind_daily <- Ind_daily[,c("administrative_area_level_1","date", "tests", "confirmed")]
Ind_daily1 <- Ind_daily[2:nrow(Ind_daily),]
Ind_daily1$dailytests <- diff(Ind_daily$tests)[1:(nrow(Ind_daily)-1)]
Ind_daily1$dailycases <- diff(Ind_daily$confirmed)[1:(nrow(Ind_daily)-1)]
colnames(Ind_daily1) <- c("Country","date","tests","cases","dailytests","dailycases")
Ind_daily1$positive <- Ind_daily1$dailycases/Ind_daily1$dailytests
Ind_daily1 <- na.omit(Ind_daily1)
COVID-19 Dashboard India
R Markdown
New variables and calculations
Console
R version 3.6.1 (2019-07-05) -- "Action of the Toes"
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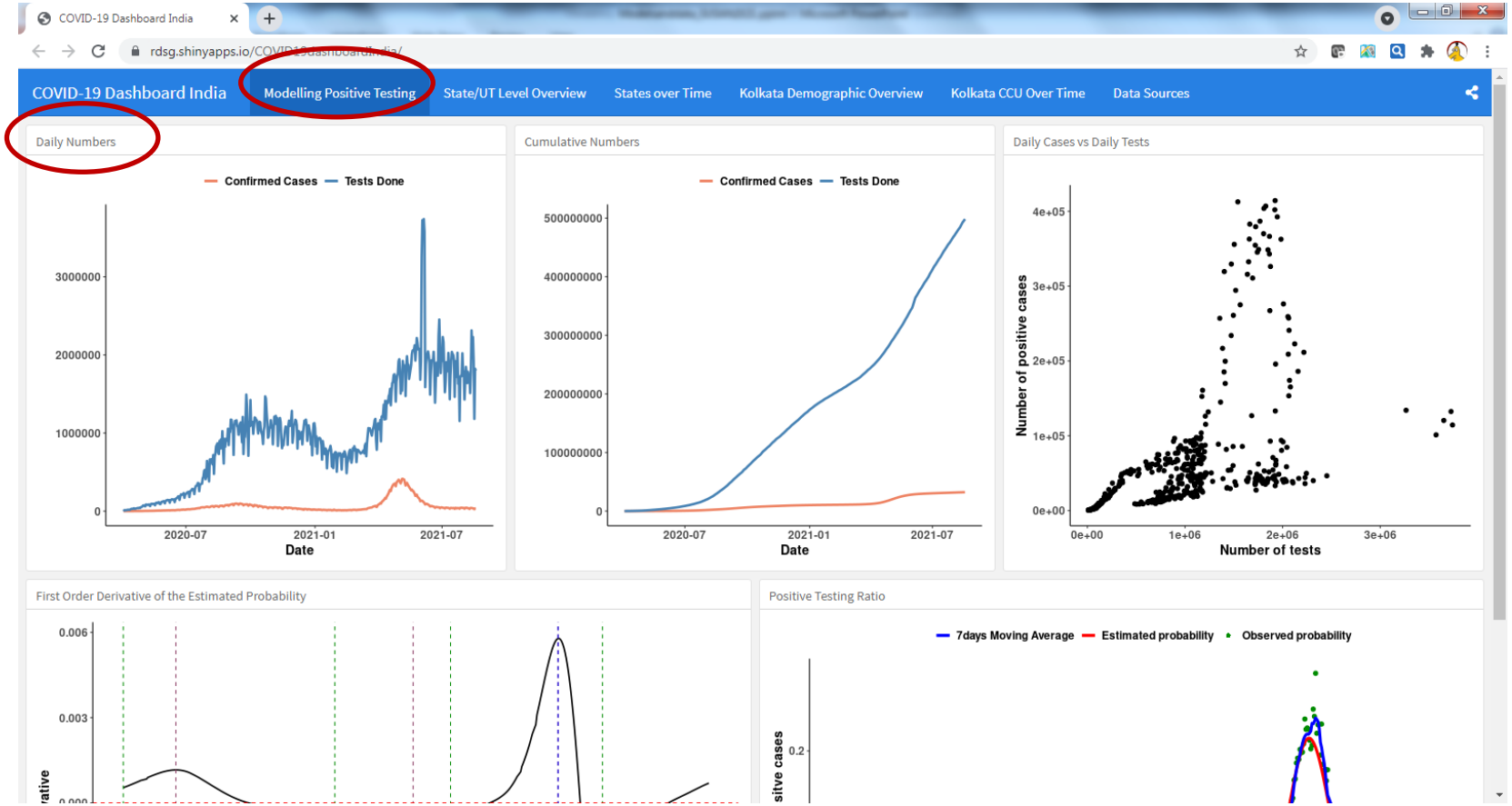
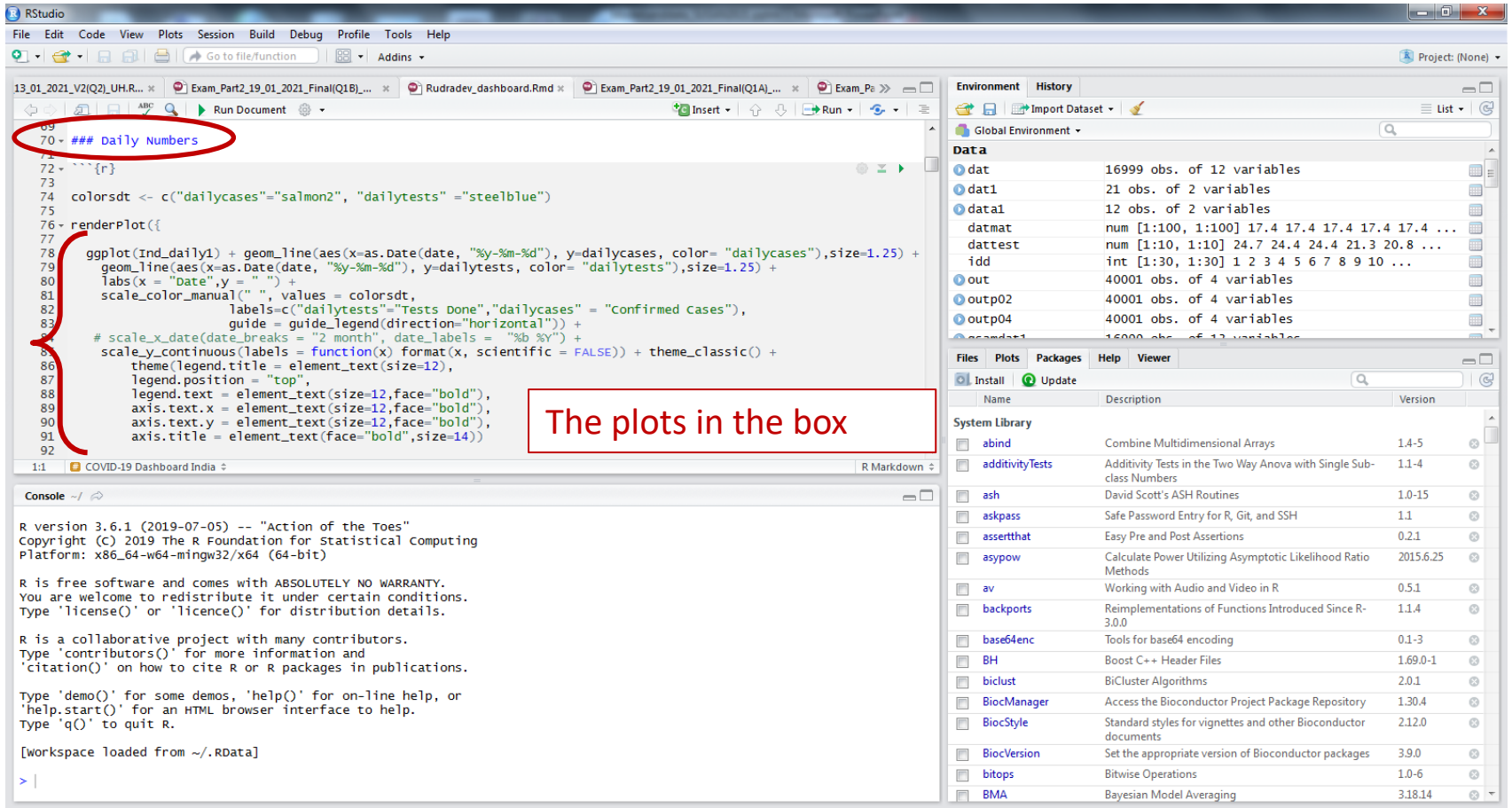
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
[Workspace loaded from ~/.RData]
Environment History
Import Dataset
Global Environment
Data
dat 16999 obs. of 12 variables
dat1 21 obs. of 2 variables
data1 12 obs. of 2 variables
40001 obs. of 4 variables
Packages Help Viewer
Install Update
Name Description Version
System Library
abind Combine Multidimensional Arrays 1.4-5
additivityTests Additivity Tests in the Two Way Anova with Single Sub-class Numbers 1.1-4
ash David Scott's ASH Routines 1.0-15
askpass Safe Password Entry for R, Git, and SSH 1.1
assertthat Easy Pre and Post Assertions 0.2.1
asypow Calculate Power Utilizing Asymptotic Likelihood Ratio Methods 2015.6.25
av Working with Audio and Video in R 0.5.1
backports Reimplementations of Functions Introduced Since R-3.0.0 1.1.4
base64enc Tools for base64 encoding 0.1-3
BH Boost C++ Header Files 1.69.0-1
biclust BiCluster Algorithms 2.0.1
BiocManager Access the Bioconductor Project Package Repository 1.30.4
BiocStyle Standard styles for vignettes and other Bioconductor documents 2.12.0
BiocVersion Set the appropriate version of Bioconductor packages 3.9.0
bitops Bitwise Operations 1.0-6
BMA Bayesian Model Averaging 3.18.14

First Box: Daily Numbers



Rmd file


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Run Document
Insert
Run
Daily Numbers
```{r}
colorsdt <- c("dailycases"="salmon2", "dailytests" ="steelblue")
renderPlot({
ggplot(Ind_daily1) + geom_line(aes(x=as.Date(date, "%y-%m-%d"), y=dailycases, color= "dailycases"),size=1.25) +
geom_line(aes(x=as.Date(date, "%y-%m-%d"), y=dailytests, color= "dailytests"),size=1.25) +
labs(x = "Date",y = " ") +
scale_color_manual(" ", values = colorsdt,
labels=c("dailytests"="Tests Done","dailycases" = "Confirmed Cases"),
guide = guide_legend(direction="horizontal")) +
# scale_x_date(date_breaks = "2 month", date_labels = "%b %Y") +
scale_y_continuous(labels = function(x) format(x, scientific = FALSE)) + theme_classic() +
theme(legend.title = element_text(size=12),
legend.position = "top",
legend.text = element_text(size=12,face="bold"),
axis.text.x = element_text(size=12,face="bold"),
axis.text.y = element_text(size=12,face="bold"),
axis.title = element_text(face="bold",size=14))
The plots in the box
COVID-19 Dashboard India
R Markdown
Console
R version 3.6.1 (2019-07-05) -- "Action of the Toes"
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Environment History
Import Dataset
Global Environment
Data
dat 16999 obs. of 12 variables
dat1 21 obs. of 2 variables
data1 12 obs. of 2 variables
datmat num [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ...
dattest num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
idd int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...
out 40001 obs. of 4 variables
outp02 40001 obs. of 4 variables
outp04 40001 obs. of 4 variables
Files Plots Packages Help Viewer
Install Update
Name Description Version
System Library
abind Combine Multidimensional Arrays 1.4-5
additivityTests Additivity Tests in the Two Way Anova with Single Sub-class Numbers 1.1-4
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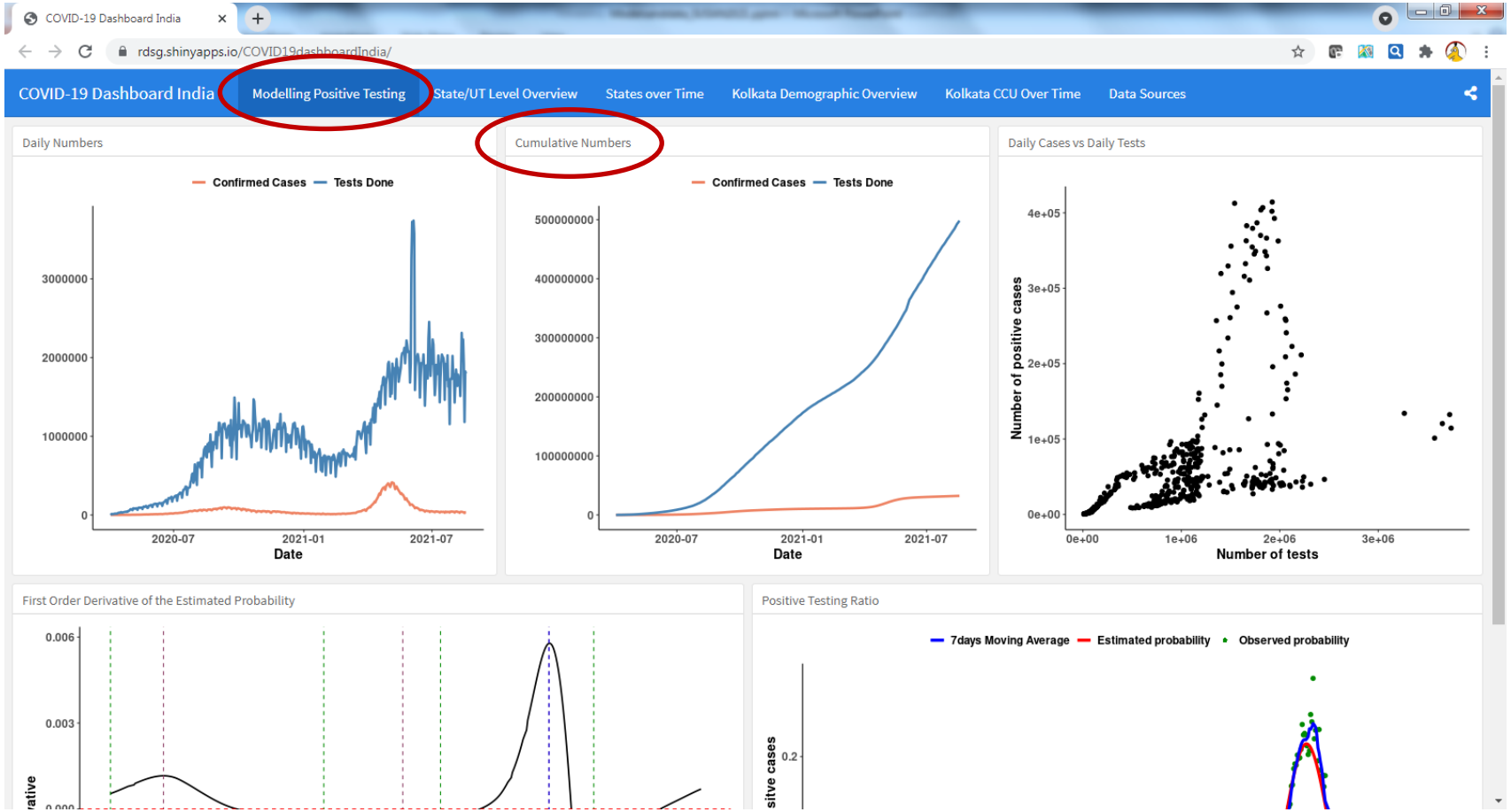
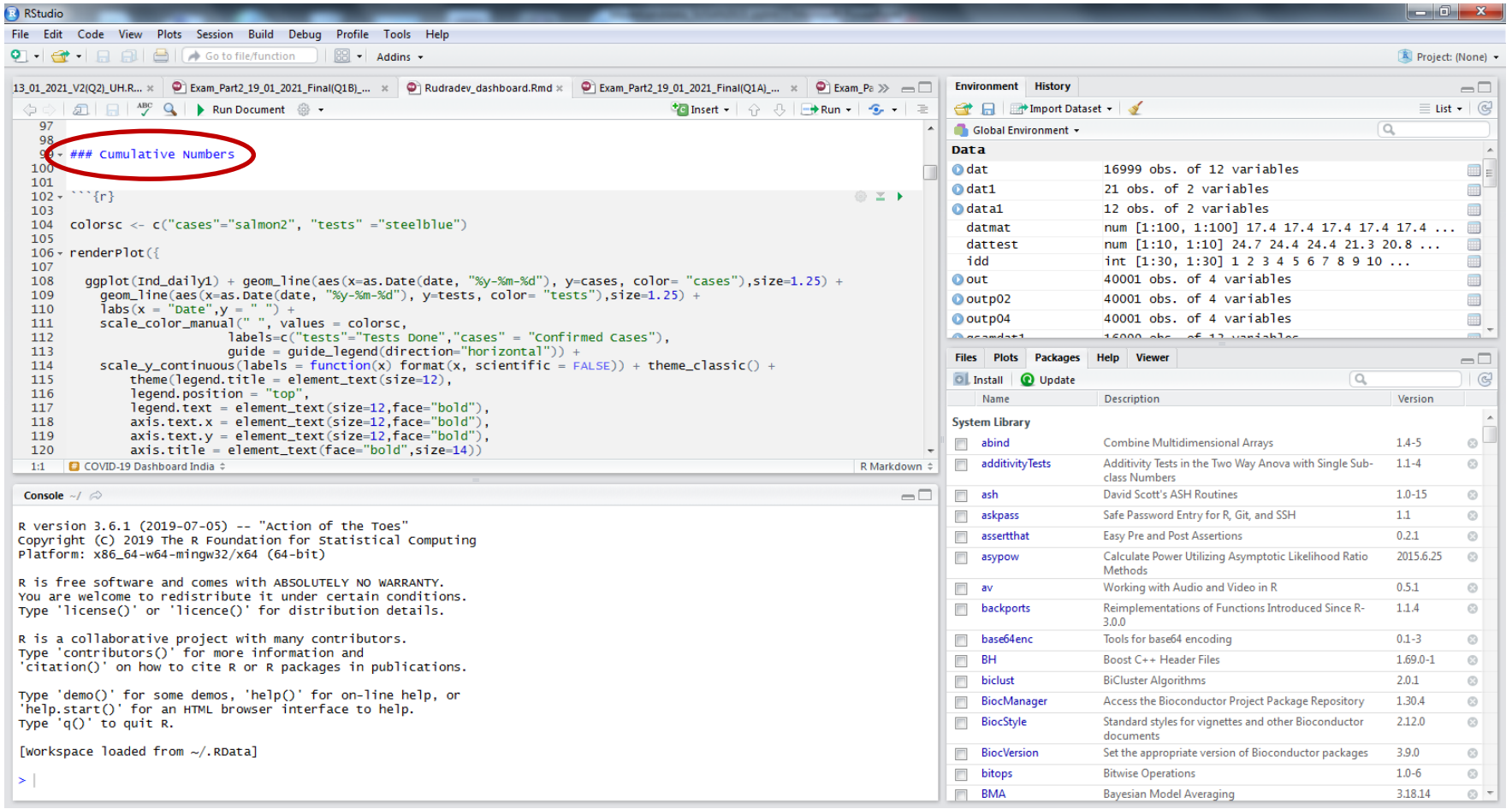
BiocVersion Set the appropriate version of Bioconductor packages 3.9.0
bitops Bitwise Operations 1.0-6
BMA Bayesian Model Averaging 3.18.14
```

Second Box: Cumulative Numbers



Rmd File


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Run Document
Insert
Run
Cumulative Numbers
```{r}
colorsc <- c("cases"="salmon2", "tests" ="steelblue")
renderPlot({
ggplot(Ind_daily1) + geom_line(aes(x=as.Date(date, "%y-%m-%d"), y=cases, color= "cases"),size=1.25) +
geom_line(aes(x=as.Date(date, "%y-%m-%d"), y=tests, color= "tests"),size=1.25) +
labs(x = "Date",y = " ") +
scale_color_manual(" ", values = colorsc,
labels=c("tests"="Tests Done","cases" = "Confirmed Cases"),
guide = guide_legend(direction="horizontal")) +
scale_y_continuous(labels = function(x) format(x, scientific = FALSE)) + theme_classic() +
theme(legend.title = element_text(size=12),
legend.position = "top",
legend.text = element_text(size=12,face="bold"),
axis.text.x = element_text(size=12,face="bold"),
axis.text.y = element_text(size=12,face="bold"),
axis.title = element_text(face="bold",size=14))
COVID-19 Dashboard India
R Markdown
Console
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dat1 21 obs. of 2 variables
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datmat num [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ...
dattest num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
idd int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...
out 40001 obs. of 4 variables
outp02 40001 obs. of 4 variables
outp04 40001 obs. of 4 variables
Files Plots Packages Help Viewer
Install Update
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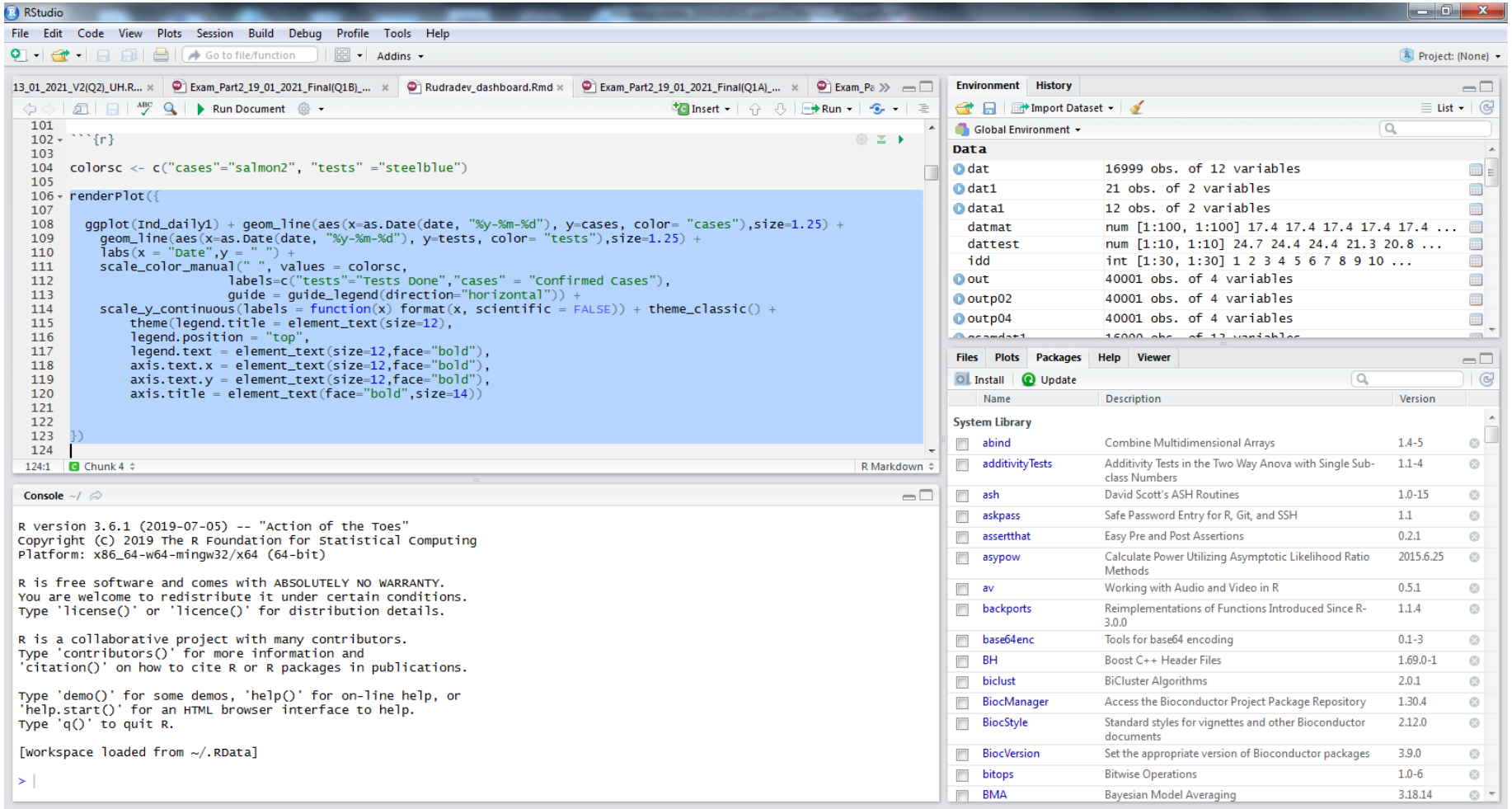
bitops Bitwise Operations 1.0-6
BMA Bayesian Model Averaging 3.18.14
```

The R function renderPlot()

- In each box, the graphical output is defined using the function renderPlot().
- Plots are produced using the ggplot2 package.
- Flexibility to integrate figures produced using plotly, leaflet, ….

renderPlot()


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Rudradev_dashboard.Rmd
Run Document
Insert
Run
101
102 ```{r}
103
104 colorsc <- c("cases"="salmon2", "tests" ="steelblue")
105
106 renderPlot({
107
108 ggplot(Ind_daily1) + geom_line(aes(x=as.Date(date, "%y-%m-%d"), y=cases, color= "cases"),size=1.25) +
109 geom_line(aes(x=as.Date(date, "%y-%m-%d"), y=tests, color= "tests"),size=1.25) +
110 labs(x = "Date",y = " ") +
111 scale_color_manual(" ", values = colorsc,
112 labels=c("tests"="Tests Done","cases" = "Confirmed Cases"),
113 guide = guide_legend(direction="horizontal")) +
114 scale_y_continuous(labels = function(x) format(x, scientific = FALSE)) + theme_classic() +
115 theme(legend.title = element_text(size=12),
116 legend.position = "top",
117 legend.text = element_text(size=12,face="bold"),
118 axis.text.x = element_text(size=12,face="bold"),
119 axis.text.y = element_text(size=12,face="bold"),
120 axis.title = element_text(face="bold",size=14))
121
122
123 })
124
124:1 Chunk 4 R Markdown
Console ~/
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[Workspace loaded from ~/.RData]
>
Environment History
Import Dataset
Global Environment
Data
dat 16999 obs. of 12 variables
dat1 21 obs. of 2 variables
data1 12 obs. of 2 variables
datmat num [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ...
dattest num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
idd int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...
out 40001 obs. of 4 variables
outp02 40001 obs. of 4 variables
outp04 40001 obs. of 4 variables
Files Plots Packages Help Viewer
Install Update
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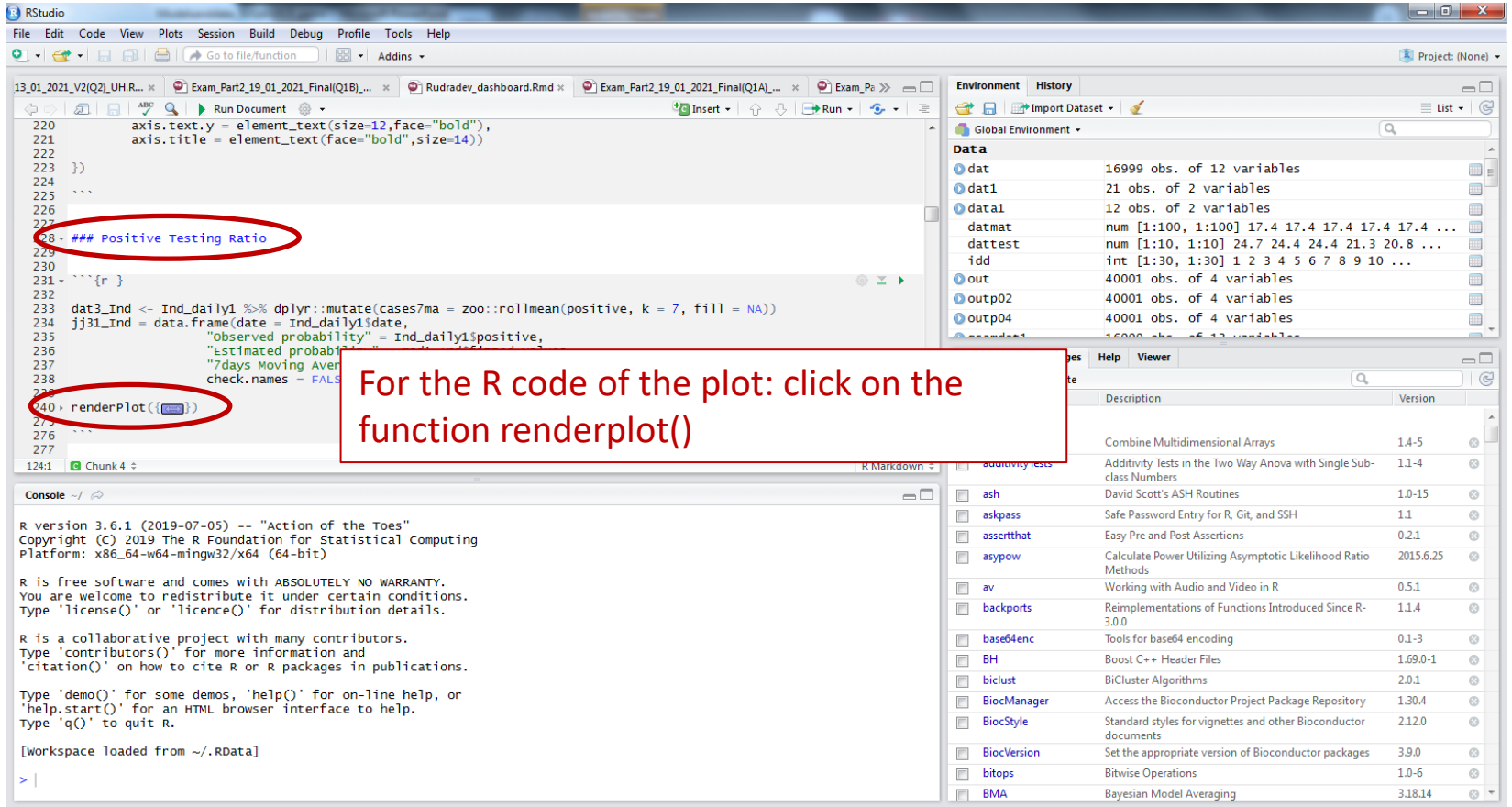
BiocVersion Set the appropriate version of Bioconductor packages 3.9.0
bitops Bitwise Operations 1.0-6
BMA Bayesian Model Averaging 3.18.14

Last Box: Positive Testing Ratio

Rmd File


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Rudradev_dashboard.Rmd
Run Document
Insert
Run
Positive Testing Ratio
```{r }
dat3_Ind <- Ind_daily1 %>% dplyr::mutate(cases7ma = zoo::rollmean(positive, k = 7, fill = NA))
renderPlot({
For the R code of the plot: click on the function renderplot()
Environment History
Import Dataset
Global Environment
Data
dat 16999 obs. of 12 variables
dat1 21 obs. of 2 variables
data1 12 obs. of 2 variables
datmat num [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 17.4 ...
dattest num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
idd int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...
out 40001 obs. of 4 variables
outp02 40001 obs. of 4 variables
outp04 40001 obs. of 4 variables
Console
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'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
[workspace loaded from ~/.RData]
Help Viewer
Description Version
Combine Multidimensional Arrays 1.4-5
Additivity Tests in the Two Way Anova with Single Sub-class Numbers 1.1-4
ash David Scott's ASH Routines 1.0-15
askpass Safe Password Entry for R, Git, and SSH 1.1
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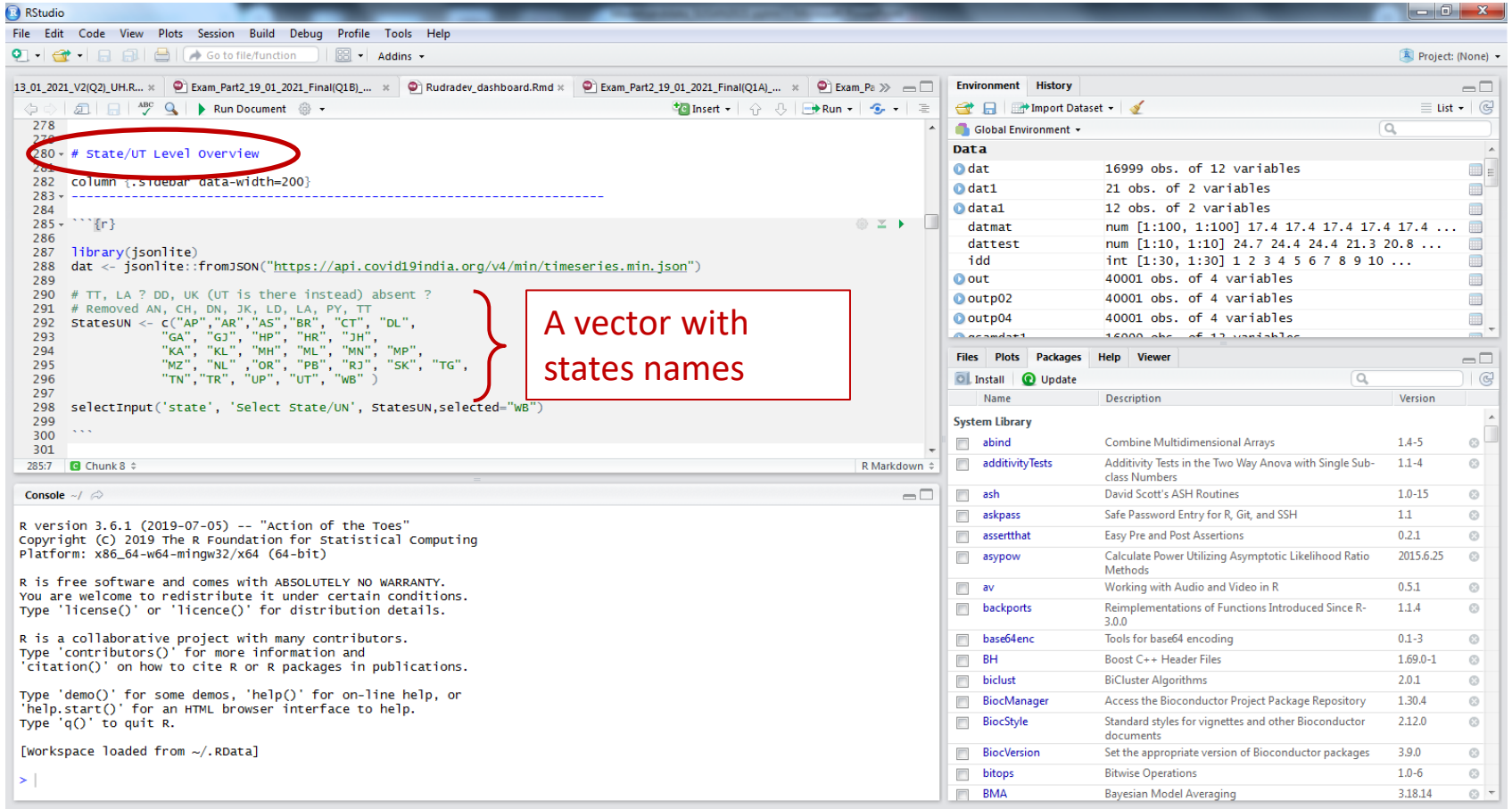
BiocVersion Set the appropriate version of Bioconductor packages 3.9.0
bitops Bitwise Operations 1.0-6
BMA Bayesian Model Averaging 3.18.14
```

Second page: State/UT Level overview

Rmd File


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Run Document
State/UT Level Overview
column {.sidebar data-width=200}
```{r}
library(jsonlite)
dat <- jsonlite::fromJSON("https://api.covid19india.org/v4/min/timeseries.min.json")
# TT, LA ? DD, UK (UT is there instead) absent ?
# Removed AN, CH, DN, JK, LD, LA, PY, TT
StatesUN <- c("AP","AR","AS","BR", "CT", "DL",
"GA", "GJ", "HP", "HR", "JH",
"KA", "KL", "MH", "ML", "MN", "MP",
"MZ", "NL" ,"OR", "PB", "RJ", "SK", "TG",
"TN","TR", "UP", "UT", "WB" )
selectInput('state', 'Select State/UN', StatesUN,selected="WB")
```
A vector with states names
Console
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[Workspace loaded from ~/.RData]
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dat1 21 obs. of 2 variables
data1 12 obs. of 2 variables
datmat num [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ...
dattest num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
idd int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...
out 40001 obs. of 4 variables
outp02 40001 obs. of 4 variables
outp04 40001 obs. of 4 variables
Files Plots Packages Help Viewer
Install Update
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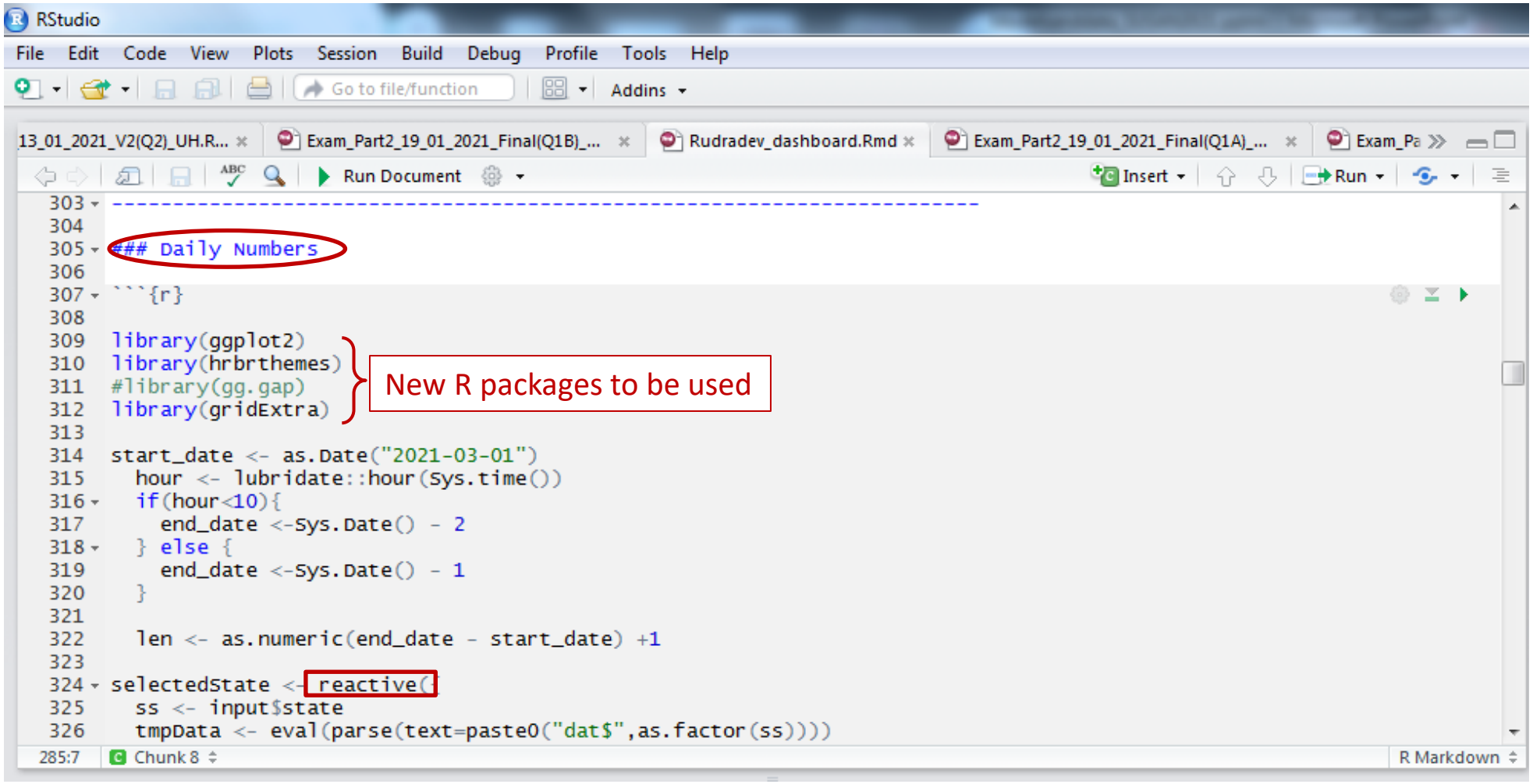
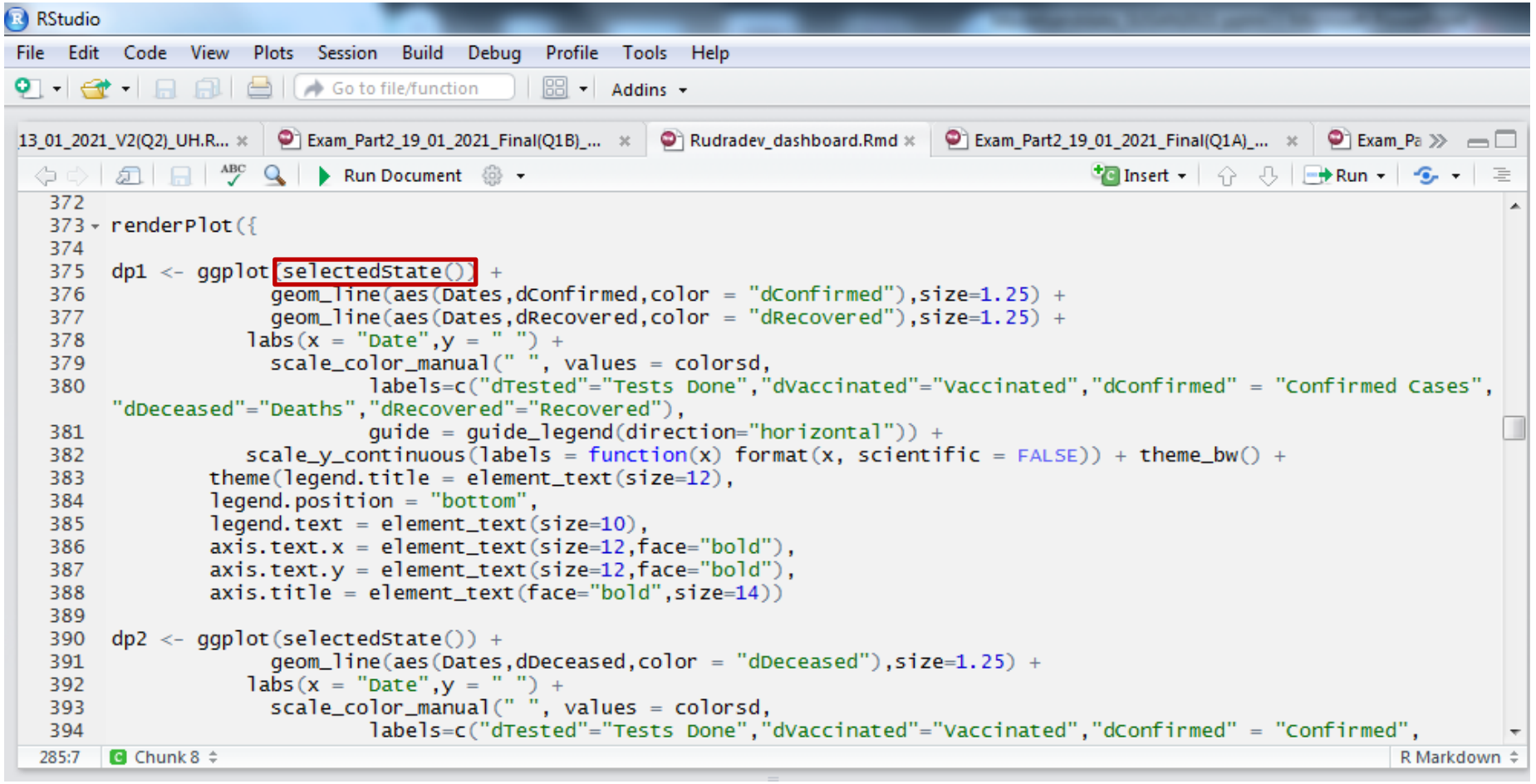
BiocVersion Set the appropriate version of Bioconductor packages 3.9.0
bitops Bitwise Operations 1.0-6
BMA Bayesian Model Averaging 3.18.14

First Box: Daily Numbers

Rmd File


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
13_01_2021_V2(Q2)_UH.R...
Exam_Part2_19_01_2021_Final(Q1B)_...
Rudradev_dashboard.Rmd
Exam_Part2_19_01_2021_Final(Q1A)_...
Exam_Pa
Run Document
Insert
Run
303 ----------
304
305 ### Daily Numbers
306
307 ```{r}
308
309 library(ggplot2)
310 library(hrbrthemes)
311 #library(gg.gap)
312 library(gridExtra)
313
314 start_date <- as.Date("2021-03-01")
315 hour <- lubridate::hour(Sys.time())
316 if(hour<10){
317 end_date <-Sys.Date() - 2
318 } else {
319 end_date <-Sys.Date() - 1
320 }
321
322 len <- as.numeric(end_date - start_date) +1
323
324 selectedState <- reactive({
325 ss <- input$state
326 tmpData <- eval(parse(text=paste0("dat$",as.factor(ss))))
New R packages to be used
285:7
Chunk 8
R Markdown

Rmd File


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
13_01_2021_V2(Q2)_UH.R...
Exam_Part2_19_01_2021_Final(Q1B)_...
Rudradev_dashboard.Rmd
Exam_Part2_19_01_2021_Final(Q1A)_...
Exam_Pa
Run Document
Insert
Run
372
373 renderPlot({
374
375 dp1 <- ggplot(selectedState()) +
376 geom_line(aes(Dates,dConfirmed,color = "dConfirmed"),size=1.25) +
377 geom_line(aes(Dates,dRecovered,color = "dRecovered"),size=1.25) +
378 labs(x = "Date",y = " ") +
379 scale_color_manual(" ", values = colorsd,
380 labels=c("dTested"="Tests Done","dVaccinated"="Vaccinated","dConfirmed" = "Confirmed Cases",
"dDeceased"="Deaths","dRecovered"="Recovered"),
381 guide = guide_legend(direction="horizontal")) +
382 scale_y_continuous(labels = function(x) format(x, scientific = FALSE)) + theme_bw() +
383 theme(legend.title = element_text(size=12),
384 legend.position = "bottom",
385 legend.text = element_text(size=10),
386 axis.text.x = element_text(size=12,face="bold"),
387 axis.text.y = element_text(size=12,face="bold"),
388 axis.title = element_text(face="bold",size=14))
389
390 dp2 <- ggplot(selectedState()) +
391 geom_line(aes(Dates,dDeceased,color = "dDeceased"),size=1.25) +
392 labs(x = "Date",y = " ") +
393 scale_color_manual(" ", values = colorsd,
394 labels=c("dTested"="Tests Done","dVaccinated"="Vaccinated","dConfirmed" = "Confirmed",
285:7
Chunk 8
R Markdown

Shiny: Mini Introduction

Shiny Environment

What?

- R package by Rstudio: install.packages(“shiny”)
- Web application framework to turn your R analysis in a fully interactive app

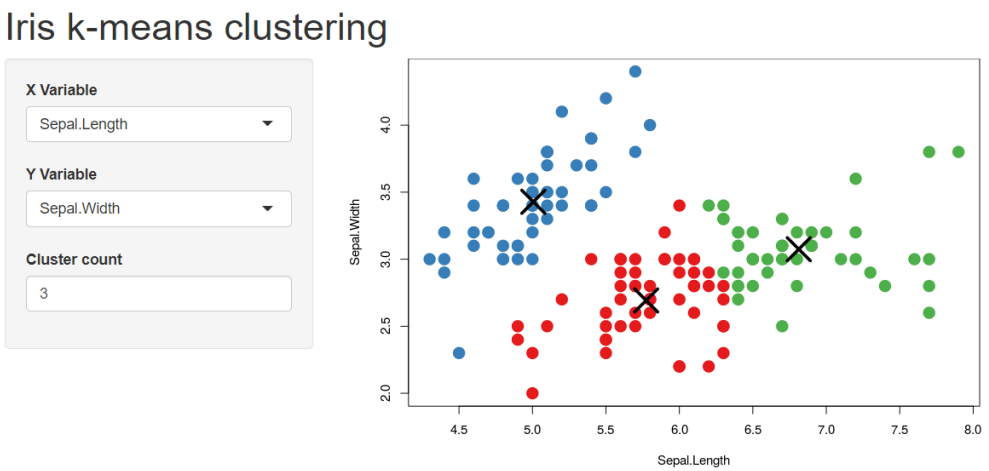
Why?

- Fully interactive environment that can be used by non-R users, customizable widgets
- Provide analysis from start to finish: Upload your data, Tweak the analysis parameters, View plots/tables/results, Download a generated report
- …
- It’s pretty cool

Shiny vs Shinydashboard

Shiny

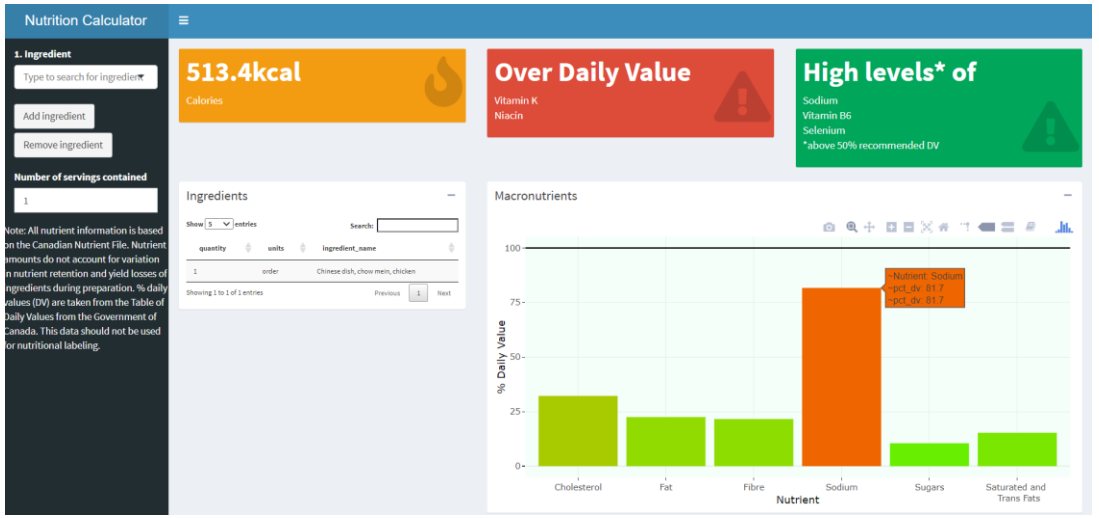
https://shiny.rstudio.com/



- Full flexibility for designing your app
- Many extensions
- More effort to create something modern- and good-looking

ShinyDashboard

https://rstudio.github.io/shinydashboard



- Dashboard ‘template’ for Shiny
- Lose flexibility
- Higher simplicity and easier to create a good-looking app with boxes, aligned plots,...
- Built-in flexibility for a log-in feature using Rstudio Pro

Shiny: The Basics

Shiny

Contains two .R scripts

ui.R

- Controls user interface
- Designs the layout of the app
  - Where do the plots go?
  - Where do the widgets (buttons, sliders, etc.) go?
- Determines how to app *looks*.

server.R

- Contains R code that runs in the background as the user interacts with the app
  - Code that recognises what the user inputs in the app
  - Code to run an analysis
  - Code to create a plot
  - ...
- Determines how the app *works.*

Shiny: The Basics

Shiny (Alternative Structure)
Contains 1 script

app.R

- Contains both **ui** and **server** parts
- *App.R*
  - ui <- fluidPage(
    ...
)

    server <- function(input, output){
    ...
    }

    shinyApp(ui = ui, server = server)

Notes:

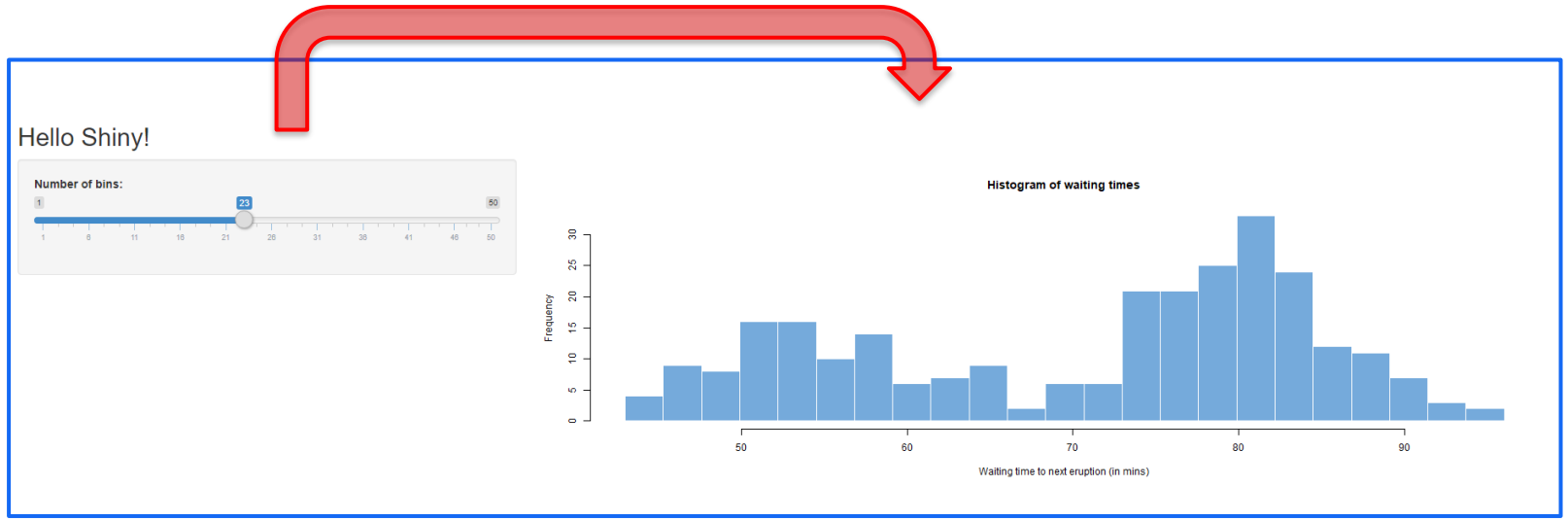
- Keep the exact names of **ui.R**, **server.R**, **app.R**. **Do not changes these!**

Shiny: Basic Example

Hello Shiny Example

- Open Shiny in R/Rstudio
- Run:

```
> library(shiny)
> runExample("01_hello")
```



- Similar example separated over 2 files: https://shiny.rstudio.com/gallery/example-01-hello.html

- When to separate?
  - Larger apps
  - Keeping your files more structured

Shiny: ui.R

- Essentially a **HTML** file
  - Could write this script completely in HTML code
  - shiny provides R functions that *wrap* this html code

- Html tags are used to build UI
  - names(tags) : shows all available tags

- Most commonly used tags (like h1, p, a, etc.) have wrapper functions, no need to prefix their names with tags$.

```
# Define UI for app that draws a histogram ----
ui <- fluidPage(
```

Function Name	Equivalent HTML tag	Provides utility to create
h1	<h1>	Sub-heading of type 1
h2	<h2>	Sub-heading of type 2
h3	<h3>	Sub-heading of type 3
h4	<h4>	Sub-heading of type 4
h5	<h5>	Sub-heading of type 5
h6	<h6>	Sub-heading of type 6
br	 	breaks the line
em		italicizes the text
strong	<strongs>	bolds the text
code	<code>	content written in coded style
p	<p>	paragraph
a	<a>	hyperlink
img	<img>	image
div		A new line of different styles.
span		Text in same line but of different styles.

```
  ''

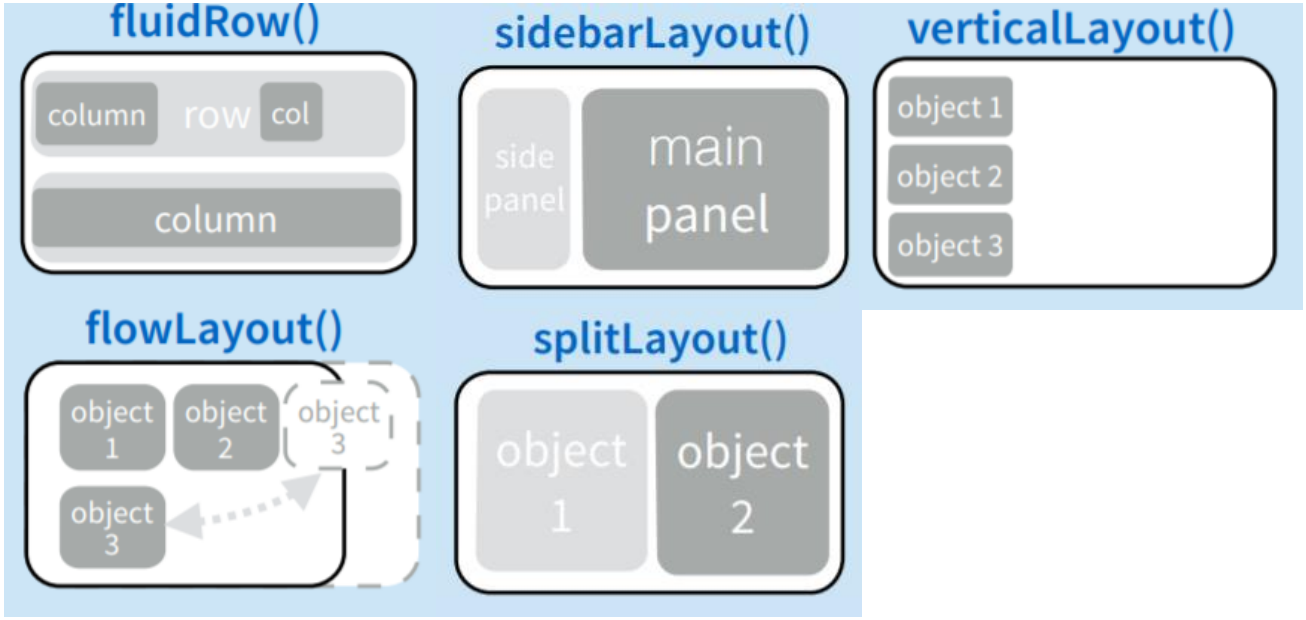
  # Main panel for displaying outputs ----
  mainPanel(

    # Output: Histogram ----
    plotOutput(outputId = "distPlot")

  )
 )
)
```

Shiny: **UI Layout**

- Layout functions are used to organize panels and elements into an existing layout:
  - sidebarLayout() creates a layout with a sidebar and main area -one of the most commonly used besides fluidRow(), flowLayout(), etc.




```
# Define UI for app that draws a histogram ----
ui <- fluidPage(

  # App title ----
  titlePanel("Hello Shiny!"),

  # Sidebar layout with input and output definitions ----
  sidebarLayout(

    # Sidebar panel for inputs ----
    sidebarPanel(

      # Input: Slider for the number of bins ----
      sliderInput(inputId = "bins",
                  label = "Number of bins:",
                  min = 1,
                  max = 50,
                  value = 30)

    ),

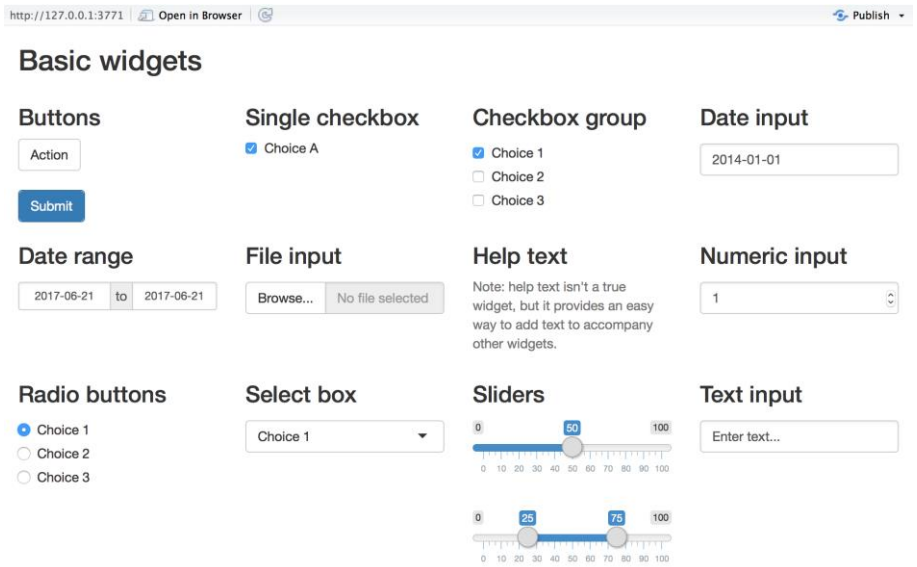
    # Main panel for displaying outputs ----
    mainPanel(

      # Output: Histogram ----
      plotOutput(outputId = "distPlot")

    )
  )
)
```

Shiny: UI Inputs/Widgets

- Widgets are web elements that users can interact with
  - Provide a way for the users to send messages to the Shiny app.
  - Collect values from the user
  - First 2 arguments: inputID (name) and label




```
# Define UI for app that draws a histogram ----
ui <- fluidPage(

  # App title ----
  titlePanel("Hello Shiny!"),

  # Sidebar layout with input and output definitions ----
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    ),

    # Main panel for displaying outputs ----
    mainPanel(

      # Output: Histogram ----
      plotOutput(outputId = "distPlot")

    )
  )
)
```

Shiny: Interactive Output

```r
# Define UI for app that draws a histogram ----
ui <- fluidPage(

  # App title ----
  titlePanel("Hello Shiny!"),

  # Sidebar layout with input and output definitions ----
  sidebarLayout(

    # Sidebar panel for inputs ----
    sidebarPanel(

      # Input: Slider for the number of bins ----
      sliderInput(inputId = "bins",
                  label = "Number of bins:",
                  min = 1,
                  max = 50,
                  value = 30)

    ),

    # Main panel for displaying outputs ----
    mainPanel(

      # Output: Histogram ----
      plotOutput(outputId = "distPlot")

    )
  )
)
```

We put a plot output in the main panel

In the server, we decide what to render in the output

```r
# Define server logic required to draw a histogram ----
server <- function(input, output) {

  # Histogram of the Old Faithful Geyser Data ----
  # with requested number of bins
  # This expression that generates a histogram is wrapped in a call
  # to renderPlot to indicate that:
  #
  # 1. It is "reactive" and therefore should be automatically
  #    re-executed when inputs (input$bins) change
  # 2. Its output type is a plot
  output$distPlot <- renderPlot({

    x    <- faithful$waiting
    bins <- seq(min(x), max(x), length.out = input$bins + 1)

    hist(x, breaks = bins, col = "#75AADB", border = "white",
         xlab = "Waiting time to next eruption (in mins)",
         main = "Histogram of waiting times")

    })

}
```

Reactive Input ->

Plot re-renders each time this input is updated (= ‘Reactivity’)

This code is re-run each time the reactive input changes

Shiny: Interactive Output

- Output (e.g. plot) gets updated automatically when an input widget changes.

- Example app:
  - Slider input in the sidebar panel controls the number of bins
  - A plot output in the main panel renders the histogram

- Required steps:
  - Register the output object in ui.R and specify where to put the output plot.
  - server.R tells Shiny how to render the output. (a plot in this example)

Shiny: Interactive Output

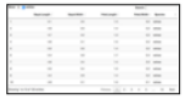
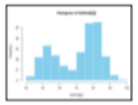
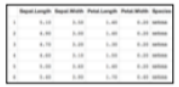
- Different pairs of **Output** and **Render** functions are available.
- Used to add R output to the UI

Output function	render function	creates
htmlOutput/uiOutput	renderUI	a Shiny tag object or HTML
imageOutput	renderImage	images (saved as a link to a source file)
plotOutput	renderPlot	plots
tableOutput	renderTable	data frame, matrix, other table like structures
textOutput	renderText	character strings
verbatimTextOutput	renderPrint	any printed output

Shiny: Interactive Output

- Different pairs of **Output** and **Render** functions are available.
- Used to add R output to the UI

Outputs - render*() and *Output() functions work together to add R output to the UI

		works with	
	DT::**renderDataTable**(expr, options, callback, escape, env, quoted)		**dataTableOutput**(outputId, icon, …)
	**renderImage**(expr, env, quoted, deleteFile)		**imageOutput**(outputId, width, height, click, dblclick, hover, hoverDelay, hoverDelayType, brush, clickId, hoverId, inline)
	**renderPlot**(expr, width, height, res, …, env, quoted, func)		**plotOutput**(outputId, width, height, click, dblclick, hover, hoverDelay, hoverDelayType, brush, clickId, hoverId, inline)
	**renderPrint**(expr, env, quoted, func, width)		**verbatimTextOutput**(outputId)
	**renderTable**(expr,…, env, quoted, func)		**tableOutput**(outputId)
foo	**renderText**(expr, env, quoted, func)		**textOutput**(outputId, container, inline)
	**renderUI**(expr, env, quoted, func)		**uiOutput**(outputId, inline, container, …) & **htmlOutput**(outputId, inline, container, …)

Shiny: Where to start?

- Many more important concepts!
  - **Reactivity, extensions,...**

- **Shiny Starting Points**
  - Shiny portal site:
    - Tutorial (get started) (Written tutorials: starting point)
    - Articles (go deeper)
    - Cheat Sheet
  - Shiny User Showcase:
    - Shiny Apps for the Enterprise
    - Industry Specific Shiny Apps
    - Shiny Apps as Analytics Tools
    - Shiny Apps that Extend Shiny
    - Shiny Apps with Popular Appeal
    - Shiny Apps for Teaching
  - Shiny Examples

Discussion

- Dashboard with R in the background
  - easy to implement different features
  - possible to automate the entire workflow
  - easy to integrate statistical models
  - visually appealing
  - interactive

References / Source Materials

- **Rmarkdown**
  - https://rmarkdown.rstudio.com/
  - https://www.rstudio.com/wp-content/uploads/2015/02/rmarkdown-cheatsheet.pdf
- **Flexdashboard**
  - https://rmarkdown.rstudio.com/flexdashboard/
  - https://rmarkdown.rstudio.com/flexdashboard/using.html
  - https://rmarkdown.rstudio.com/flexdashboard/examples.html
- **Htmlwidgets**
  - http://www.htmlwidgets.org/
- **CrossTalk**
  - https://rstudio.github.io/crosstalk/
- **Shiny**
  - https://shiny.rstudio.com/
  - https://rstudio.github.io/shinydashboard/
  - Shiny Tutorial Start: https://shiny.rstudio.com/tutorial/written-tutorial/lesson1/

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