

A Brief Introduction to R-Shiny and Dashboards

Ryan Hafen & J. Hathaway

Agenda

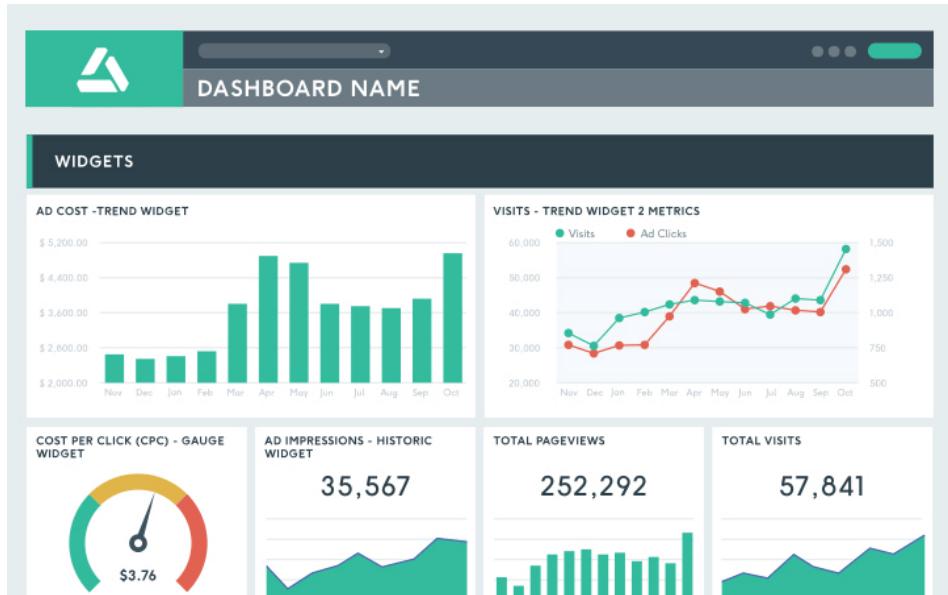


1. Introduction to R-Shiny and Dashboards
2. Making our first R-Shiny dashboard
3. A few rules for dashboards
4. How do I learn more?

Introduction to R-Shiny and Dashboards

:Dashboards:

Opinionated views for decision making and insight



What is R-Shiny?

An R package that makes it easy
to build interactive web apps
straight from the R language.

[RStudio Shiny website](#)



What can I build with Shiny?

Government / Public sector

Mostly open data



Freedom of Press Index



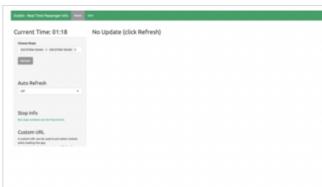
Voronoys - Understanding voters' profile
in Brazilian elections



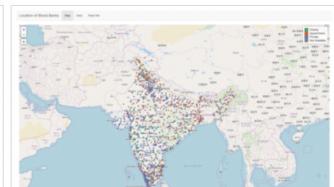
Crime Watch



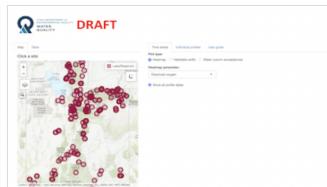
Pasture Potential Tool for improving dairy
farm profitability and environmental
impact



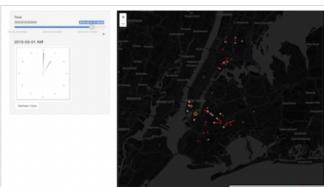
Dublin Transport Info



Locating Blood Banks in India



Utah Lake Water Quality Profile
Dashboard



Animated NYC metro traffic



<https://shiny.rstudio.com/gallery/>

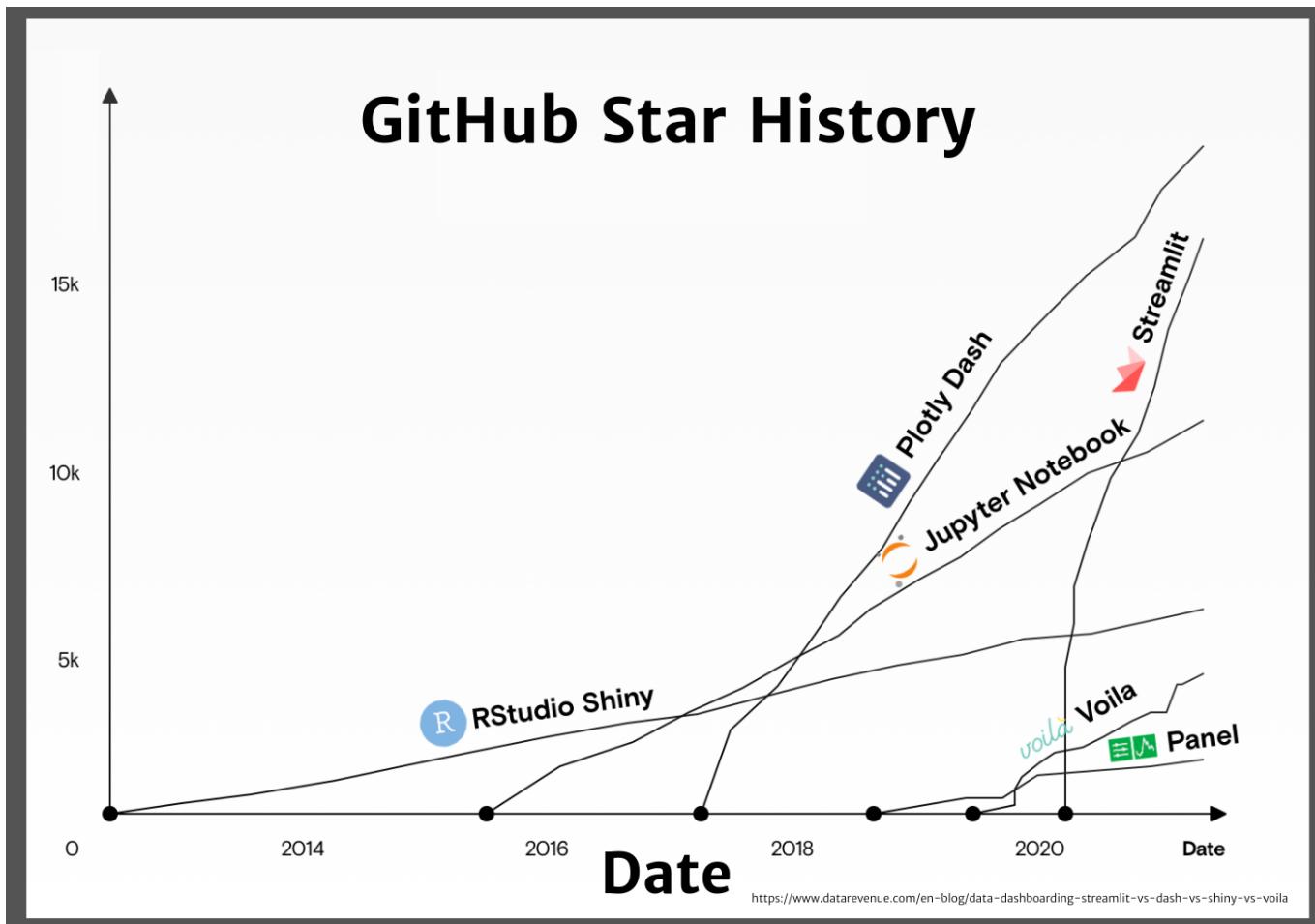
Why use R Shiny?

- Great for fast prototyping
- Only need to know R (usually*)
- Easy to make use of R's stats/modeling/visualization packages
- Good for dashboards or very simple apps used internally at your organization
- More customizable than many BI tools

Why not use R Shiny?

- For non-trivial apps the codebase can become very complex and hard to follow
- Difficult to transition a shiny app to a support team, even if they know R/Shiny
- Deployment requires a special server setup and hosting can be complicated or expensive
- In most cases, not suitable for production environments
- R is not a natural environment for specifying UI/UX
- Performance: UI interactions requiring round trips to R that could easily be handled in the web browser

What are some alternatives to R-Shiny?



Making our first R-Shiny dashboard

Thanks to [shinyintro](#) by [Lisa Debruine](#)

- We recommend her book for a smooth entrance into Shiny
- For our app we will use RStudio's '[shinydashboard](#)' package

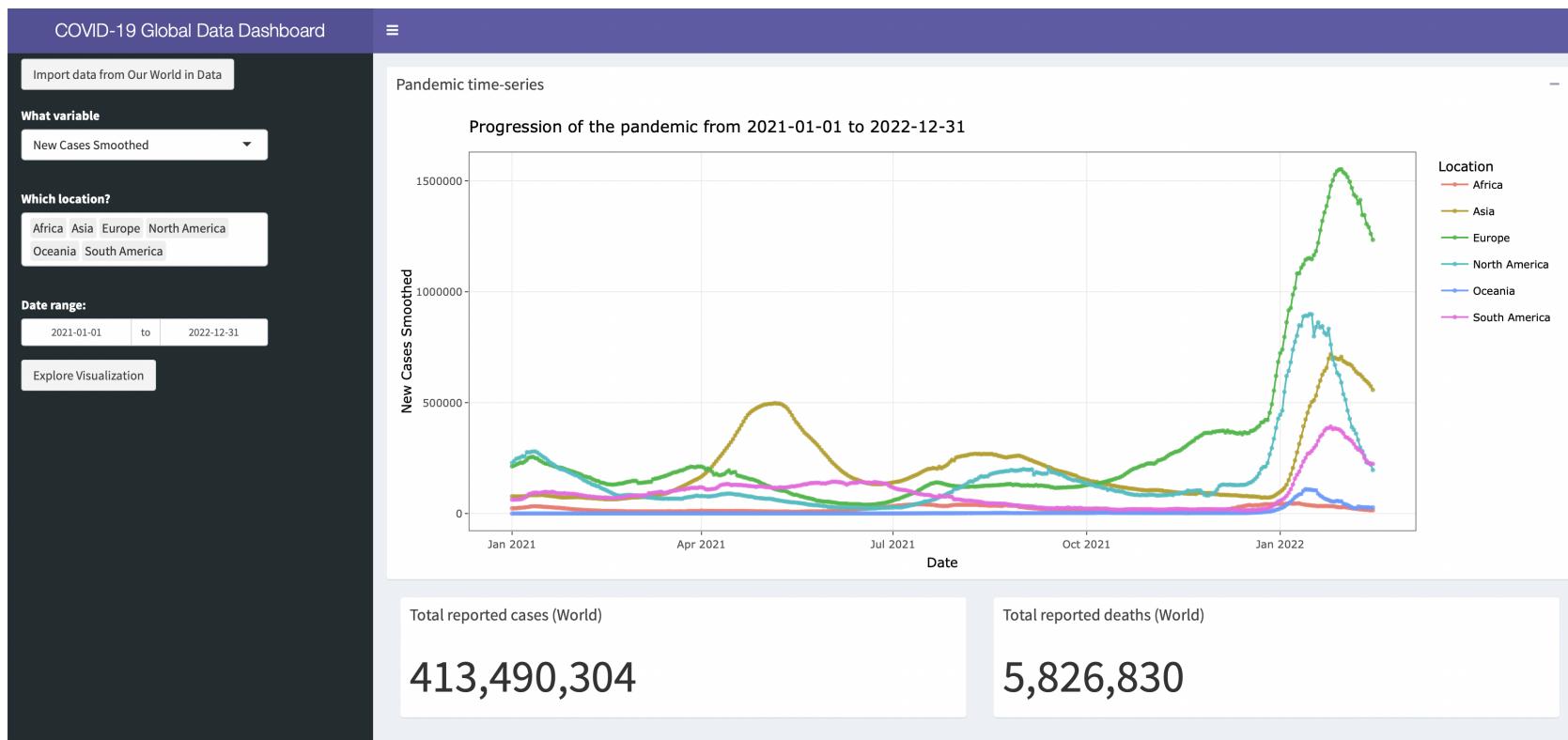
Using the shinydashboard package

The [shinydashboard](#) package is a collection of functions that make it easy to create dashboards.

You can find the code for this example at our [RShinyDashboards Repository](#).

Our first R Shiny Dashboard

Our Design Goal: Give our user the opportunity to see various daily COVID-19 metrics for selected locations over a specified time window using a dataset from [Our World in Data](#).



Data

Source: [Our World in Data](#)

```
# A tibble: 161,909 x 67
  iso_code continent location     date   total_cases new_cases new_cases_smoothed total_deaths new_deaths
  <chr>    <chr>    <chr>    <date>      <dbl>      <dbl>            <dbl>      <dbl>      <dbl>
1 AFG      Asia     Afghanistan 2020-02-24      5          5              NA        NA        NA
2 AFG      Asia     Afghanistan 2020-02-25      5          0              NA        NA        NA
3 AFG      Asia     Afghanistan 2020-02-26      5          0              NA        NA        NA
4 AFG      Asia     Afghanistan 2020-02-27      5          0              NA        NA        NA
5 AFG      Asia     Afghanistan 2020-02-28      5          0              NA        NA        NA
6 AFG      Asia     Afghanistan 2020-02-29      5          0              NA        NA        NA
7 AFG      Asia     Afghanistan 2020-03-01      5          0              0.714     NA        NA
8 AFG      Asia     Afghanistan 2020-03-02      5          0              0         NA        NA
9 AFG      Asia     Afghanistan 2020-03-03      5          0              0         NA        NA
10 AFG     Asia     Afghanistan 2020-03-04      5          0              0         NA        NA
# ... with 161,899 more rows, and 58 more variables: new_deaths_smoothed <dbl>,
#   total_cases_per_million <dbl>,
#   new_cases_per_million <dbl>, new_cases_smoothed_per_million <dbl>,
#   total_deaths_per_million <dbl>,
#   new_deaths_per_million <dbl>, new_deaths_smoothed_per_million <dbl>,
#   reproduction_rate <dbl>,
#   icu_patients <dbl>, icu_patients_per_million <dbl>, hosp_patients <dbl>,
#   hosp_patients_per_million <dbl>,
#   weekly_icu_admissions <dbl>, weekly_icu_admissions_per_million <dbl>,
#   weekly_hosp_admissions <dbl>, weekly_hosp_admissions_per_million <dbl>,
#   new_tests <dbl>, total_tests <dbl>,
#   total_tests_per_thousand <dbl>, new_tests_per_thousand <dbl>, new_tests_smoothed <dbl>, ...
```

Starting with our chart (part 1)

```
# load packages and read data for chart
library(ggplot2)
library(readr)
library(dplyr)
library(snakecase)

d <- read_csv("https://raw.githubusercontent.com/owid/covid-19-data/master/public/data/owid-covid-data.csv")

# our potential inputs
variable <- "new_deaths_smoothed_per_million"
locations <- c("Africa", "Asia", "Europe", "North America",
  "Oceania", "South America")
date_range <- as.Date(c("2020-01-01", "2022-12-31"))

ggplot(data = filter(d, location %in% locations,
  date >= date_range[1], date <= date_range[2]),
  aes_string("date", variable, color = "location")) +
  geom_point(size = 0.8, alpha = 0.8) +
  geom_line() +
  theme_bw() +
  labs(
    x = "Date",
    y = to_title_case(variable),
    color = "Location"
  ) +
  guides(color = guide_legend(
    override.aes = list(lty = NA, size = 5, shape = 15)))
```

The Shiny app basics

Every Shiny app has two key elements: `ui` and `server`. When using `shinydashboard` the layout of our `ui` is handled for us and we just need to stick the appropriate controls and outputs in the right place.

```
header <- dashboardHeader(CODE FOR THE HEADER UI)
sidebar <- dashboardSidebar(CODE FOR THE INPUTS)
body <- dashboardBody(CODE FOR THE RESULTS OUTPUTS)

ui <- dashboardPage(
  skin = 'purple',
  header,
  sidebar,
  body
)
```

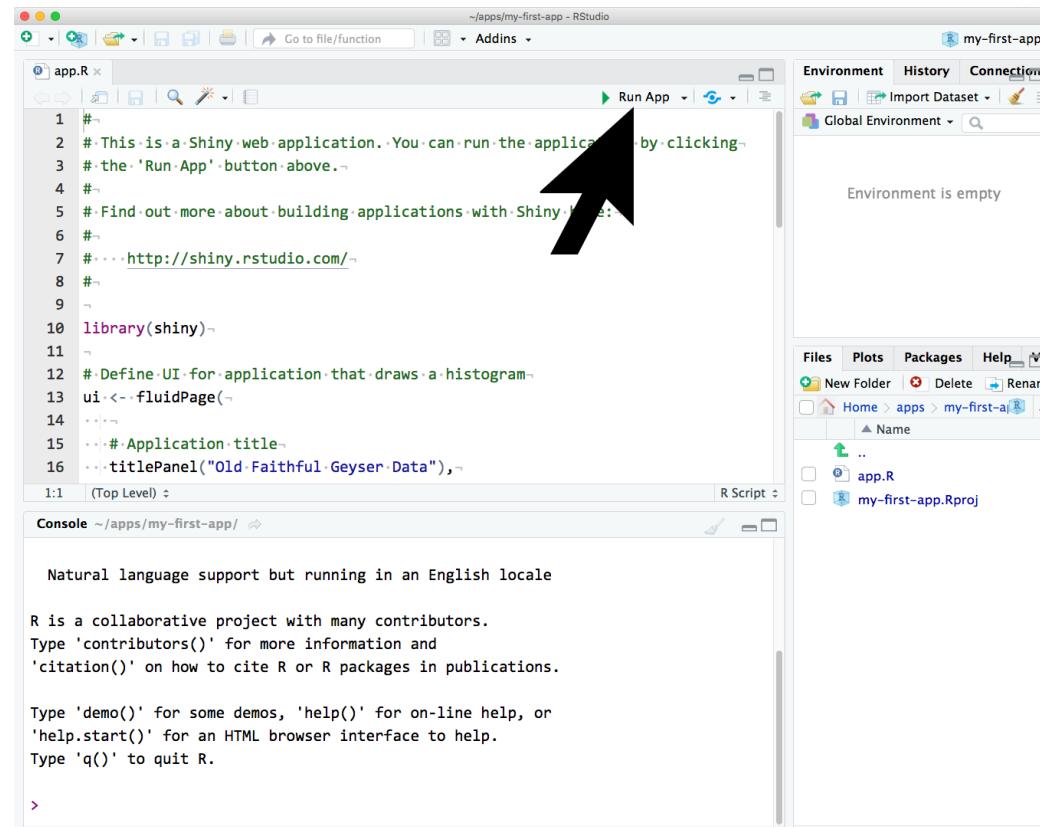
```
server <- function(input, output) {
  THE CODE THAT CREATE CHARTS, TABLES, AND TEXT FROM INPUTS
}
```

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

The '[app_global.R](#)' code for our dashboard is in the `app` folder of our [repository](#).

Using R-Studio for app development

Start R-Studio and create a new script `app_global.R` in a new project or folder. Once we have our script built we will click on Run App.



Building the interface incrementally: Copy this code and paste it into `app_global.R`

```
# Setup ----
library(shiny); library(shinydashboard); library(readr); library(dplyr)
library(ggplot2); library(stringr); library(plotly); library(snakecase)
header <- dashboardHeader(title = "COVID-19 Global Data Dashboard", titleWidth = 400)
# Define UI ----
sidebar <- dashboardSidebar(width = 400,
  actionButton("load", label = "Import data from Our World in Data"),
  selectInput("variable", "What variable", "(data not loaded)",
    multiple = FALSE, selected = "(data not loaded)"),
  selectInput("location", "Which location?", "(data not loaded)",
    multiple = TRUE, selected = "(data not loaded)"),
  dateRangeInput("daterange", "Date range:",
    start = "2020-01-01", end = "2022-12-31"),
  actionButton("makeplot", label = "Explore Visualization")
)
body <- dashboardBody(
  box(title = "Pandemic time-series", solidHeader = TRUE, width = 16, collapsible = TRUE,
    plotlyOutput("timeseries", height = 500, width = "auto")),
  box(title = "Total reported cases (World)", solidHeader = TRUE, width = 6,
    div(style = "font-size:50px", textOutput("casetotal"))),
  box(title = "Total reported deaths (World)", solidHeader = TRUE, width = 6,
    div(style = "font-size:50px", textOutput("deathtotal")))
)

# Run the application ----
ui <- dashboardPage(skin = "purple", header, sidebar, body)
server <- function(input, output, session) {}
shinyApp(ui, server)
```

Inputs

- `actionButton("load", ...)`: a button that will load the data
- `selectInput("variable", ...)`: a dropdown menu listing all of the variables that can be plotted
- `selectInput("location", ...)`: a dropdown menu listing all of the geographic locations we can plot data for
- `dateRangeInput("daterange", ...)`: a date range picker
- `actionButton("makeplot", ...)`: a button that when pressed will create the visualization for the specified parameters

These are all **inputs**. Their values will be made available in the app server as `input$load`, `input$variable`, etc.

Outputs

- `box()`: a UI element in the `shinydashboard` package that designates a content area in the dashboard
- `plotlyOutput("timeseries", ...)`: specifies where the time series visualization will be placed
- `textOutput("casetotal")`: specifies where the case total for the specified location(s) will go
- `textOutput("deathtotal")`: specifies where the death total for the specified location(s) will go

These are all **outputs**. Their values will be made available in the app server as `output$timeseries`, `output$casetotal`, `output$deathtotal`.

Server: Add body elements

Include these `reactiveVal()` assignments before the `server` function.

```
covid_data <- reactiveVal()  
plot_data <- reactiveVal()
```

A "reactive value" is a special object in Shiny that causes other elements of the application to update, or "react" when the variable is initialized or changed.

A reactive value can be **set** by calling it with an argument, e.g.
`covid_data(my_data_frame)`

A reactive value is **accessed** by calling it with no arguments, e.g.
`covid_data()`

Server: Add body elements (Data & Totals)

Now include our data import event within the
server <- function(input, output, session) { SERVER CONTENTS }.

```
# Data ingestion and total number calculations. Set to work after `input$load` occurs from clicking on Import Data.
observeEvent(input$load, {
  url <- "https://raw.githubusercontent.com/owid/covid-19-data/master/public/data/owid-covid-data.csv"
  owid_data <- readr::read_csv(url)
  covid_data(owid_data) # This reactive item now has is composed of the COVID-19 data.
  # assigning them into the output object allows them to be called by the `ui`
  output$deathtotal <- renderText(owid_data %>% filter(location == "World", date == max(date)) %>%
    pull(total_deaths) %>% sum() %>% format(big.mark = ","))
  
  output$casetotal <- renderText(owid_data %>% filter(location == "World", date == max(date)) %>%
    pull(total_cases) %>% sum() %>% format(big.mark = ","))

  # update inputs to reflect options found in the data
  choices <- names(owid_data); names(choices) <- to_title_case(choices)
  updateSelectInput(session, "variable", choices = choices,
    selected = "total_cases_per_million")
  updateSelectInput(session, "location", choices = unique(owid_data$location),
    selected = "World")
})
```

Server components

- `observeEvent(input$load, { ... })`: responds to the input "load" button -- in this case it executes the code in `{...}` whenever the load button is clicked
- `covid_data(owid_data)`: sets the `covid_data` reactive value with OWID data
- `output$deathtotal`: sets the "deathtotal" output to the default ("World") location's death total
- `updateSelectInput(...)`: updates the options available in the dropdown menus now that the data has been loaded

Server: Add body elements (Chart).

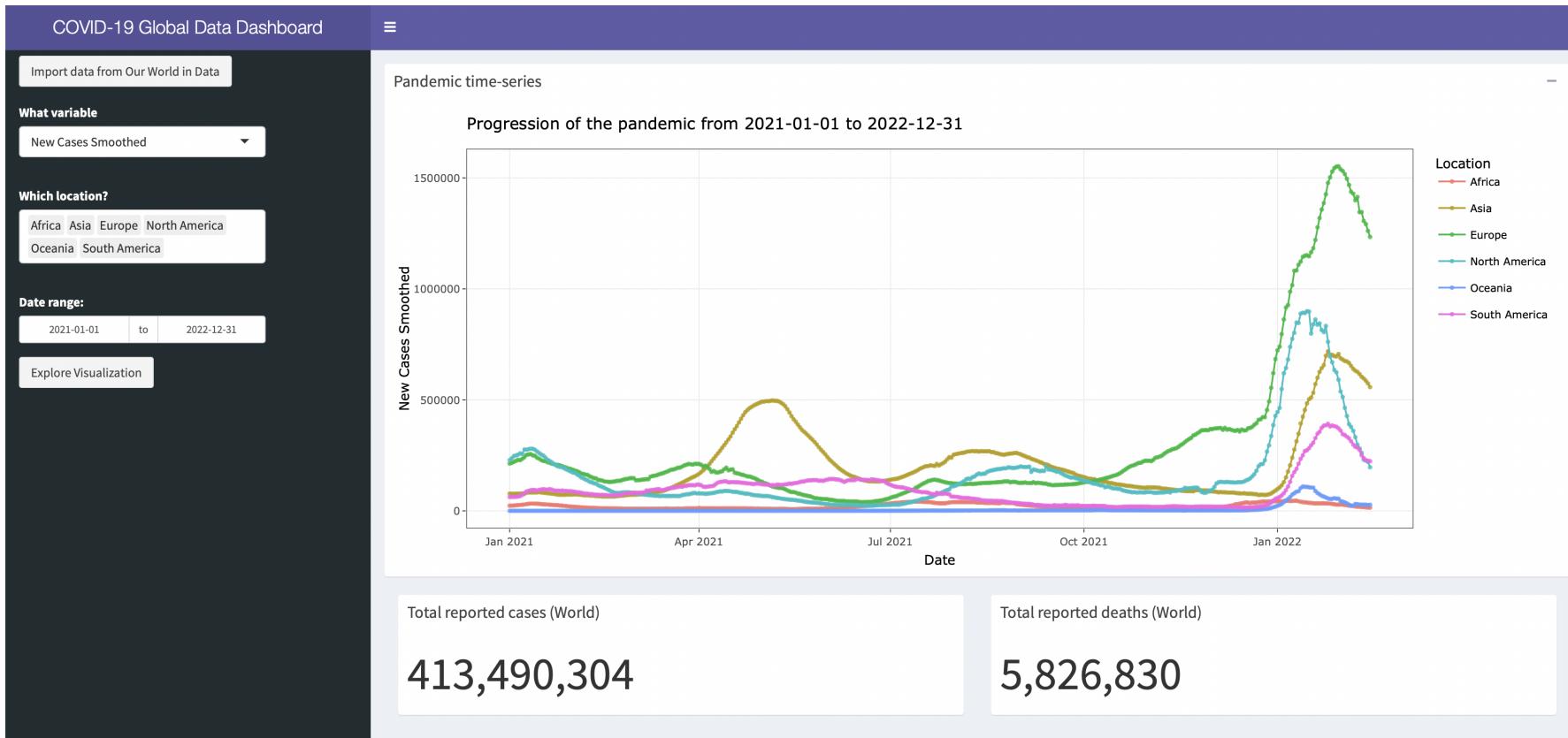
```
observeEvent(input$makeplot, {
  # notice use of `input$` to pull the user input values into the function.
  # "if" stops outputs from being created if user hasn't clicked import
  if (length(covid_data()) != 0) {
    newdat <- covid_data() %>%
      filter(location %in% input$location,
        date >= input$daterange[1],
        date <= input$daterange[2])
    # This reactive item now has is composed of the filtered data.
    plot_data(newdat)
    # notice the use of plot_data() as the data object to signal a reactive dataset.
    output$timeseries <- renderPlotly({
      ggplot(data = plot_data(),
        aes_string("date", isolate(input$variable), color = "location")) +
        geom_point(size = 0.8, alpha = 0.8) +
        geom_line() +
        theme_bw() +
        labs(
          title = paste0("Progression of the pandemic from ",
            input$daterange[1], " to ", input$daterange[2]),
          x = "Date",
          y = isolate(to_title_case(input$variable)),
          color = "Location") +
        guides(color = guide_legend(
          override.aes = list(lty = NA, size = 5, shape = 15)))
    })
  }
})
```

Server components

- Our previous ggplot code is now wired to handle the inputs
- `observeEvent(input$makeplot, { ... })`: responds to the input "Explore visualization" button -- executing the code in `{...}` whenever the load button is clicked
- `plot_data(newdat)`: sets the `covid_data` reactive value with OWID data filtered to the currently-specified location(s) and date range
- `output$timeseries <- renderPlotly(...)`: updates the plot output based on this data
- `isolate(...)`: this keeps the plot from updating whenever inputs are changed (so that plot only updates when "Explore visualization" is clicked)

Our final dashboard

You can see the complete script at [app/app_global.R](#)



Additional features

These are features that would be nice to add to the app:

- Automatically load the data
- Provide a progress indicator for the data download
- Only allow up to 10 locations to be chosen at a time
- When a user input is changed, gray out the plot and text output areas until "explore visualization" is pressed again
- Don't allow the "to" date to be earlier than the "from" Date
- etc.

A few tips for creating dashboards

6 Know the user, they are not programmers

Define your production goals

- How often will it be used?
- How reliable does it need to be?
- What is the impact if it is inaccurate?



Design with a purpose

To design without purpose is to design without a goal, without an objective or without a target. It's just design for design's sake. Not nearly as fulfilling as design with a direction. Without purpose, design is just decoration—aesthetics without true meaning.

THEIL

How do I learn more?

Online Reading Material

- [Mastering Shiny](#)
- [Learn Shiny](#)
- [Get Started w/ shinydashboard](#)
- [Use shinydashboard](#)
- [Engineering Production-Grade Shiny Apps](#)
- [shinyjs](#)
- [shinydashboards](#)
- [Building Web Apps with R Shiny](#)
- [stat545 Shiny Tutorial](#)
- [R markdown: The Definitive Guide - Shiny](#)
- [YouTube: A Gentle Introduction to Creating R Shiny Webb Apps](#)
- [YouTube: Dynamic Dashboards with Shiny](#)

Short Courses

- [Building Web Applications with Shiny in R](#)
- [Shiny Fundamentals with R](#)
- [Building Data Apps with R and Shiny: Essential Training](#)
- [Creating Interactive Presentations with Shiny and R](#)
- [Interactive Visualization with R](#)

Shinyverse of R packages

There are so many packages available. [awesome-shiny](#) has an extensive list. Use the below list to start your journey.

- [shinydashboard](#)
- [shinydashboardPlus](#)
- [Shiny Themes](#)
- [shinymanager](#)
- [shiny.semantic](#)
- [shiny.react](#)
- [shiny.fluent](#)
- [shiny sense](#)

Thanks