Visualization for Data Science in R

Angela Zoss

Data Matters 2018

http://bit.ly/RVis2018

Objectives/Outline

Day 1: Static visualizations

- Visualization and data science
- Basic ggplot2 syntax
- Charts for exploration
- Charts for communication
- Advanced topics: mapping, saving charts out

Day 2: Interactivity

- Simple interactive plots
- Arranging charts into dashboards
- Incorporating Shiny elements into documents, dashboards
- Advanced topics: full Shiny apps

Interactivity

Why make charts interactive?

- Easier for data exploration
  - Drill-down to data subsets of interest
  - Details on demand
  - Customize look-and-feel of chart
- Can be more engaging for users

Visual information seeking mantra

Overview first,
zoom and filter,
then details-on-demand

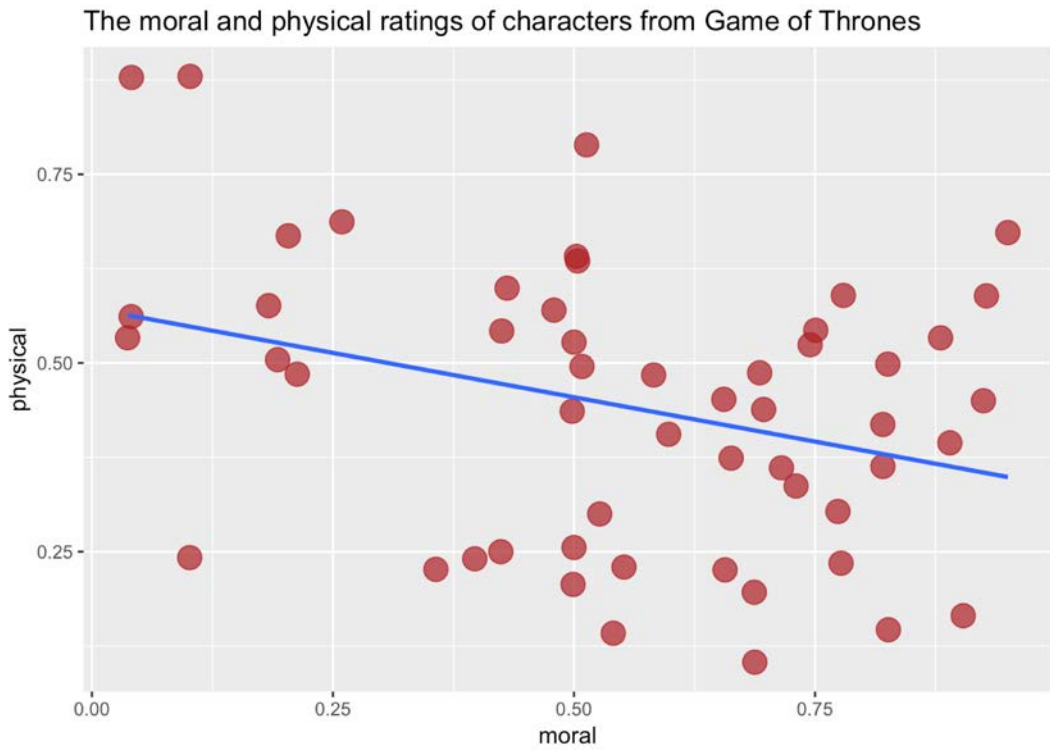
Shneiderman, B. (1996). The eyes have it: A task by data type taxonomy for information visualization.
In *VL '96 Proceedings of the 1996 IEEE Symposium on Visual Languages.*

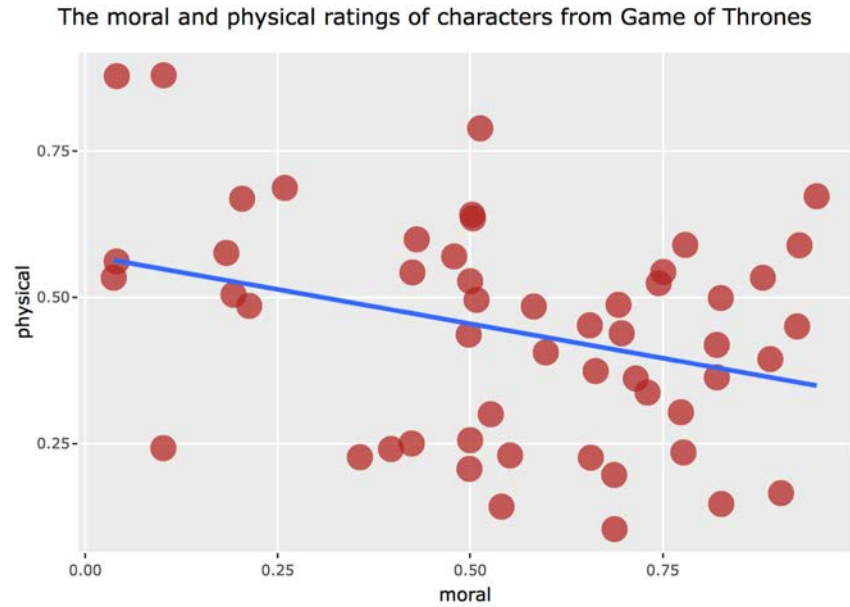
Interactivity in R Markdown

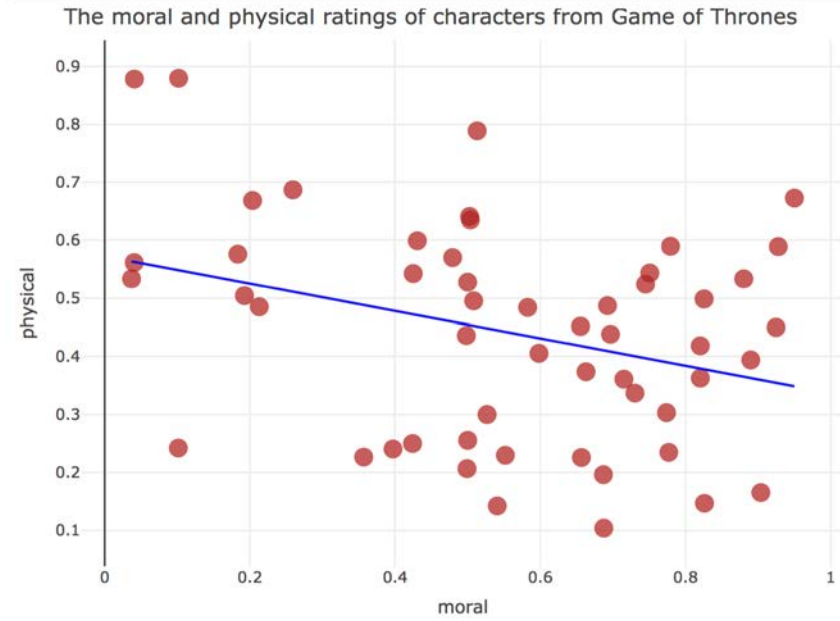
- R Markdown gets compiled into HTML
- Some R packages can create interactive elements by converting R output to JavaScript code for the final HTML document
- We will use the **plotly** package to create interactive charts

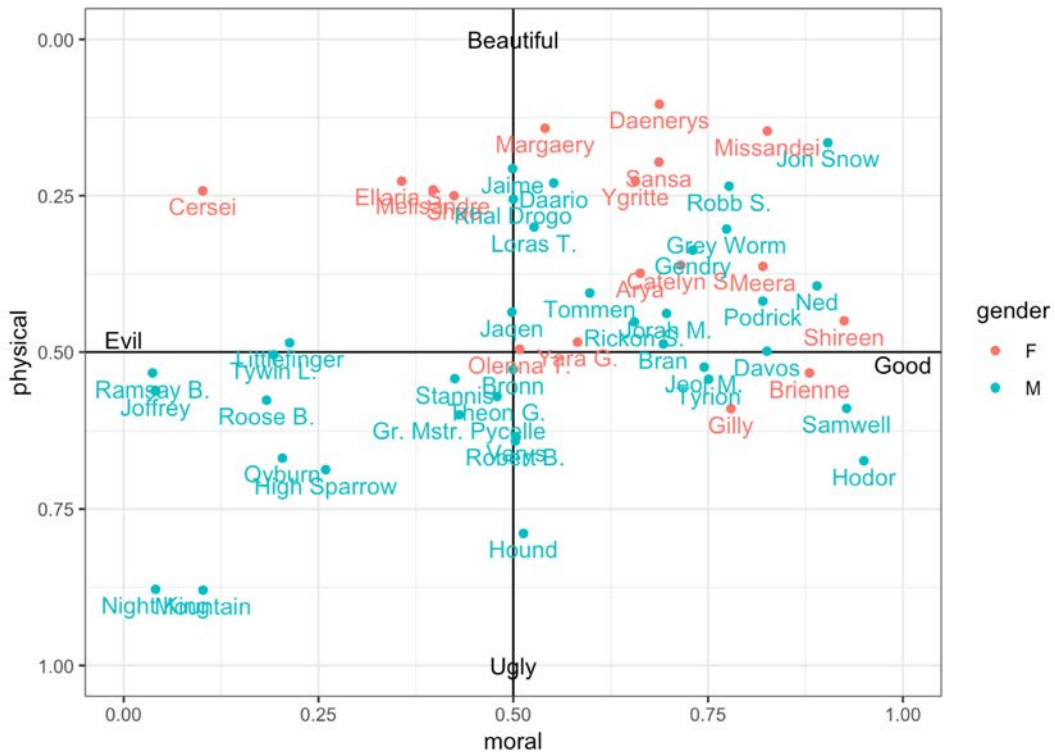
http://www.htmlwidgets.org/

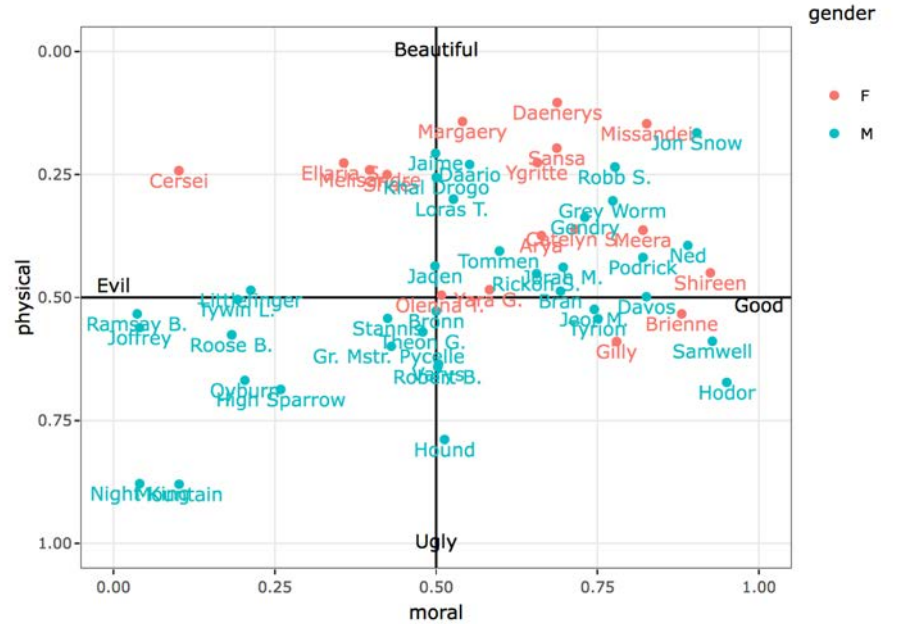
Exercise 1: Make yesterday's charts interactive

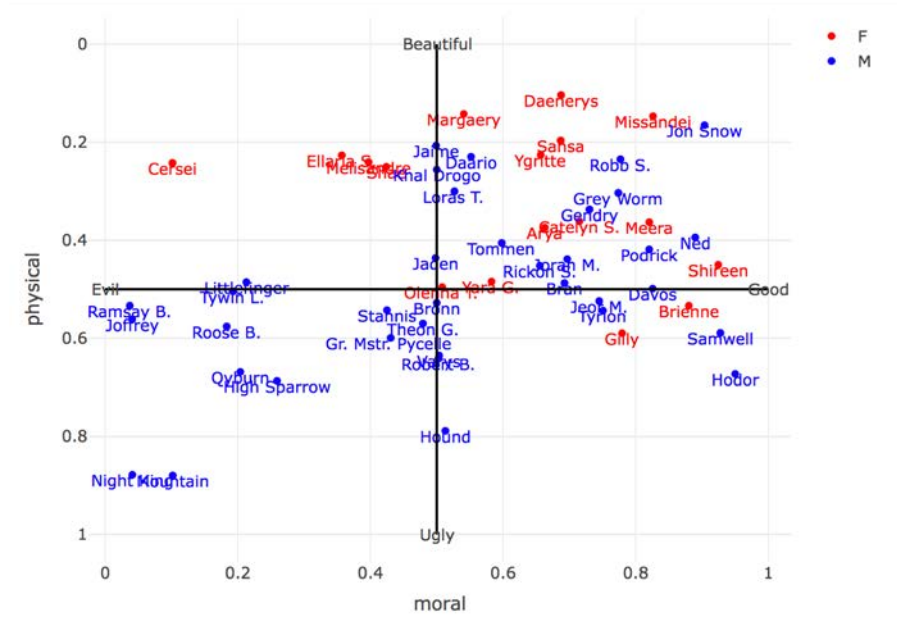

The moral and physical ratings of characters from Game of Thrones
physical
moral
0.75
0.50
0.25
0.00
0.25
0.50
0.75


The moral and physical ratings of characters from Game of Thrones
physical
moral
0.75
0.50
0.25
0.00
0.25
0.50
0.75


The moral and physical ratings of characters from Game of Thrones
physical
moral
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.2
0.4
0.6
0.8
1


Beautiful
Ugly
Evil
Good
physical
moral
gender
F
M
0.00
0.25
0.50
0.75
1.00
Daenerys
Margaery
Missandei
Jon Snow
Sansa
Cersei
Jaime
Ellaria S.
Melisandre
Daario
Ygritte
Robb S.
Khal Drogo
Loras T.
Grey Worm
Gendry
Catelyn S.
Meera
Arya
Tommen
Ned
Podrick
Jaden
Rickon S.
Shireen
Littlefinger
Tywin L.
Olenna T.
Yara G.
Bran
Davos
Ramsay B.
Joffrey
Stannis
Bronn
Jeor M.
Tyrion
Brienne
Roose B.
Theon G.
Gilly
Samwell
Gr. Mstr. Pycelle
Varys
Robert B.
Qyburn
High Sparrow
Hodor
Hound
Night King
Mountain


Beautiful
Ugly
Evil
Good
physical
moral
gender
F
M
0.00
0.25
0.50
0.75
1.00
Daenerys
Margaery
Missandei
Jon Snow
Sansa
Cersei
Jaime
Ellaria S.
Melisandre
Daario
Ygritte
Robb S.
Khal Drogo
Loras T.
Grey Worm
Gendry
Catelyn S.
Meera
Arya
Tommen
Ned
Podrick
Jaden
Rickon S.
Shireen
Littlefinger
Tywin L.
Olenna T.
Yara G.
Bran
Davos
Ramsay B.
Joffrey
Stannis
Bronn
Jeor M.
Tyrion
Brienne
Roose B.
Theon G.
Gilly
Samwell
Gr. Mstr. Pycelle
Varys
Robert B.
Qyburn
High Sparrow
Hodor
Hound
Night King
Mountain


Beautiful
Ugly
Evil
Good
physical
moral
F
M
0
0.2
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0.6
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1
Daenerys
Margaery
Missandei
Jon Snow
Sansa
Cersei
Jaime
Ellaria S.
Melisandre
Daario
Ygritte
Robb S.
Khal Drogo
Loras T.
Grey Worm
Gendry
Catelyn S.
Meera
Arya
Tommen
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Podrick
Jaden
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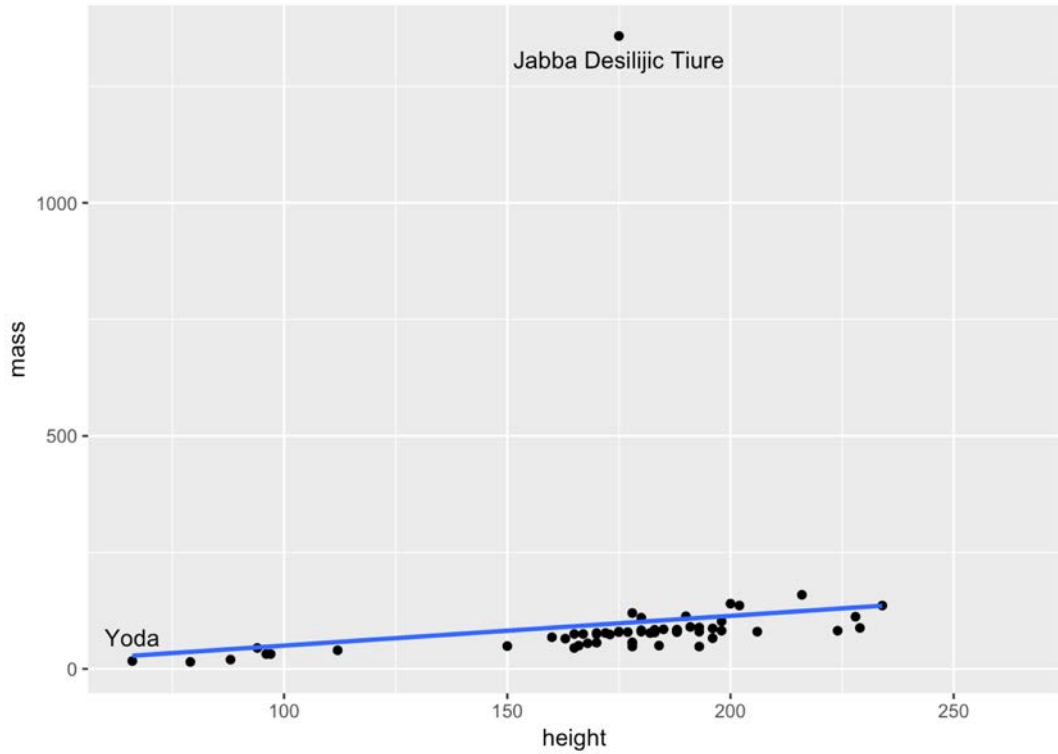
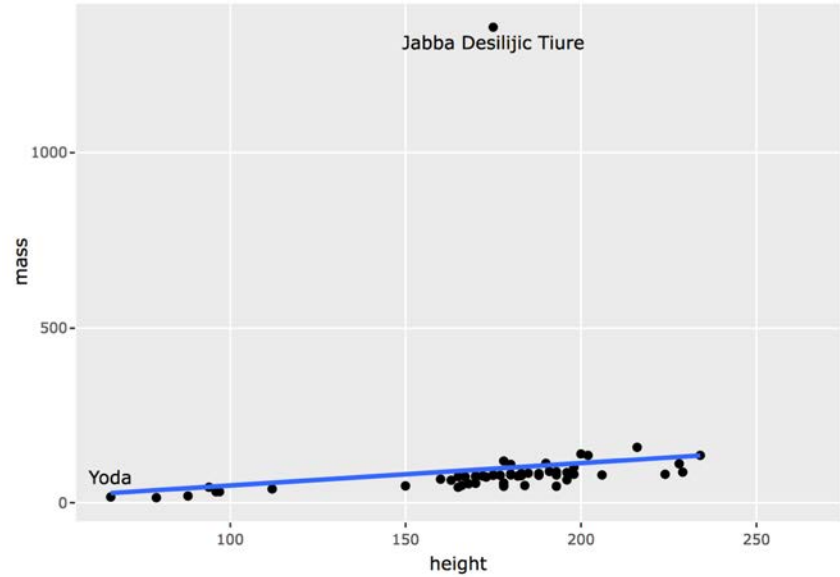
Varys
Robert B.
Qyburn
High Sparrow
Hodor
Hound
Night King
Mountain


Jabba Desilijic Tiure
Yoda
1000
500
0
mass
100
150
200
250
height


Jabba Desilijic Tiure
Yoda
1000
500
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mass
100
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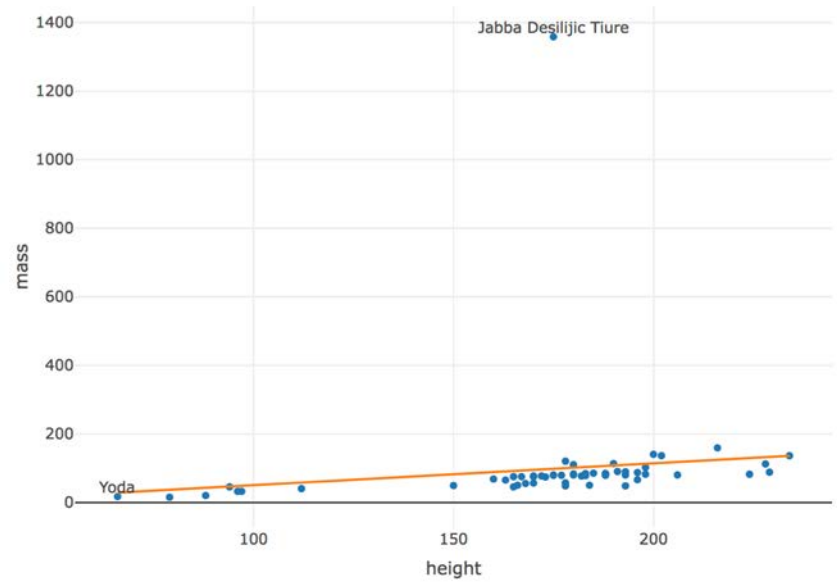
250
height


Jabba Desilijic Tiure
Yoda
1400
1200
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800
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400
200
0
mass
100
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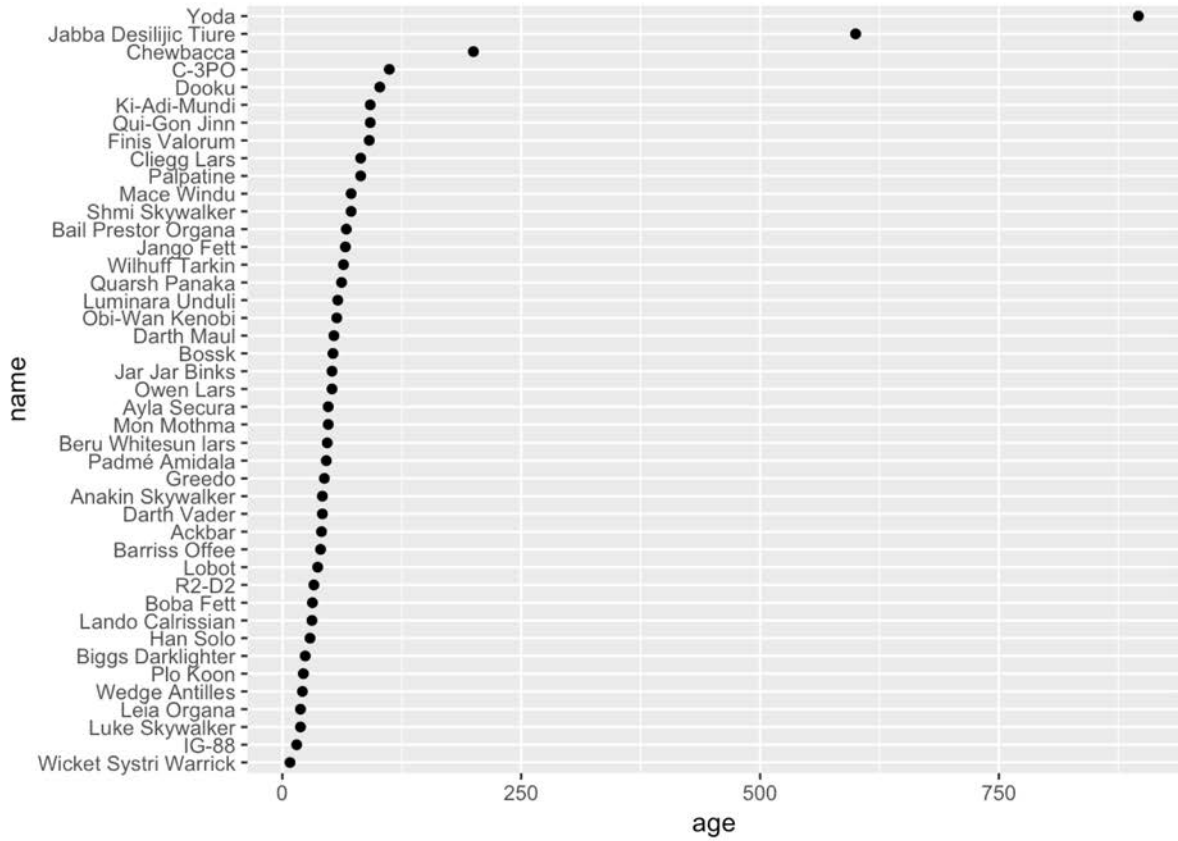
200
height


Yoda
Jabba Desilijic Tiure
Chewbacca
C-3PO
Dooku
Ki-Adi-Mundi
Qui-Gon Jinn
Finis Valorum
Cliegg Lars
Palpatine
Mace Windu
Shmi Skywalker
Bail Prestor Organa
Jango Fett
Wilhuff Tarkin
Quarsh Panaka
Luminara Unduli
Obi-Wan Kenobi
Darth Maul
Bossk
Jar Jar Binks
Owen Lars
Ayla Secura
Mon Mothma
Beru Whitesun lars
Padmé Amidala
Greedo
Anakin Skywalker
Darth Vader
Ackbar
Barriss Offee
Lobot
R2-D2
Boba Fett
Lando Calrissian
Han Solo
Biggs Darklighter
Plo Koon
Wedge Antilles
Leia Organa
Luke Skywalker
IG-88
Wicket Systri Warrick
name
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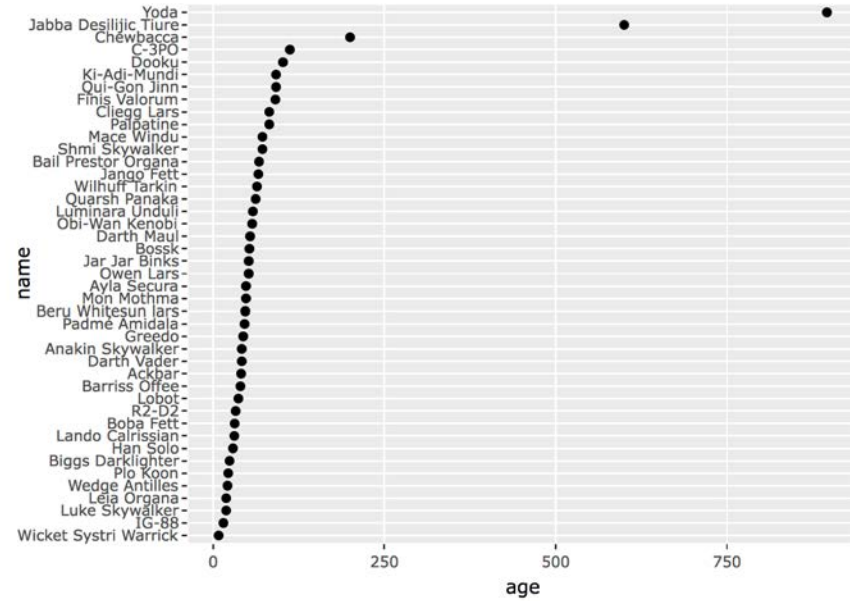
250
500
750
age


Yoda
Jabba Desilijic Tiure
Chewbacca
C-3PO
Dooku
Ki-Adi-Mundi
Qui-Gon Jinn
Finis Valorum
Cliegg Lars
Palpatine
Mace Windu
Shmi Skywalker
Bail Prestor Organa
Jango Fett
Wilhuff Tarkin
Quarsh Panaka
Luminara Unduli
Obi-Wan Kenobi
Darth Maul
Bossk
Jar Jar Binks
Owen Lars
Ayla Secura
Mon Mothma
Beru Whitesun lars
Padmé Amidala
Greedo
Anakin Skywalker
Darth Vader
Ackbar
Barriss Offee
Lobot
R2-D2
Boba Fett
Lando Calrissian
Han Solo
Biggs Darklighter
Plo Koon
Wedge Antilles
Leia Organa
Luke Skywalker
IG-88
Wicket Systri Warrick
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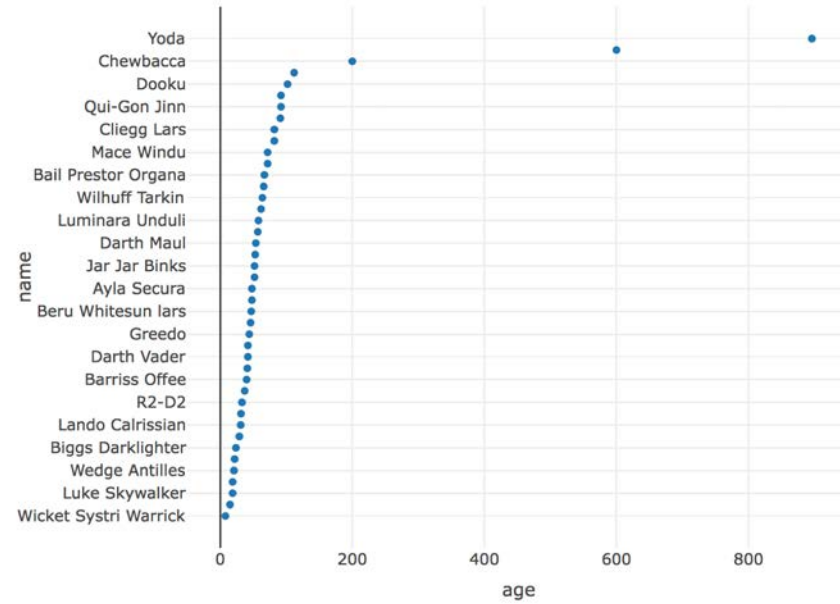
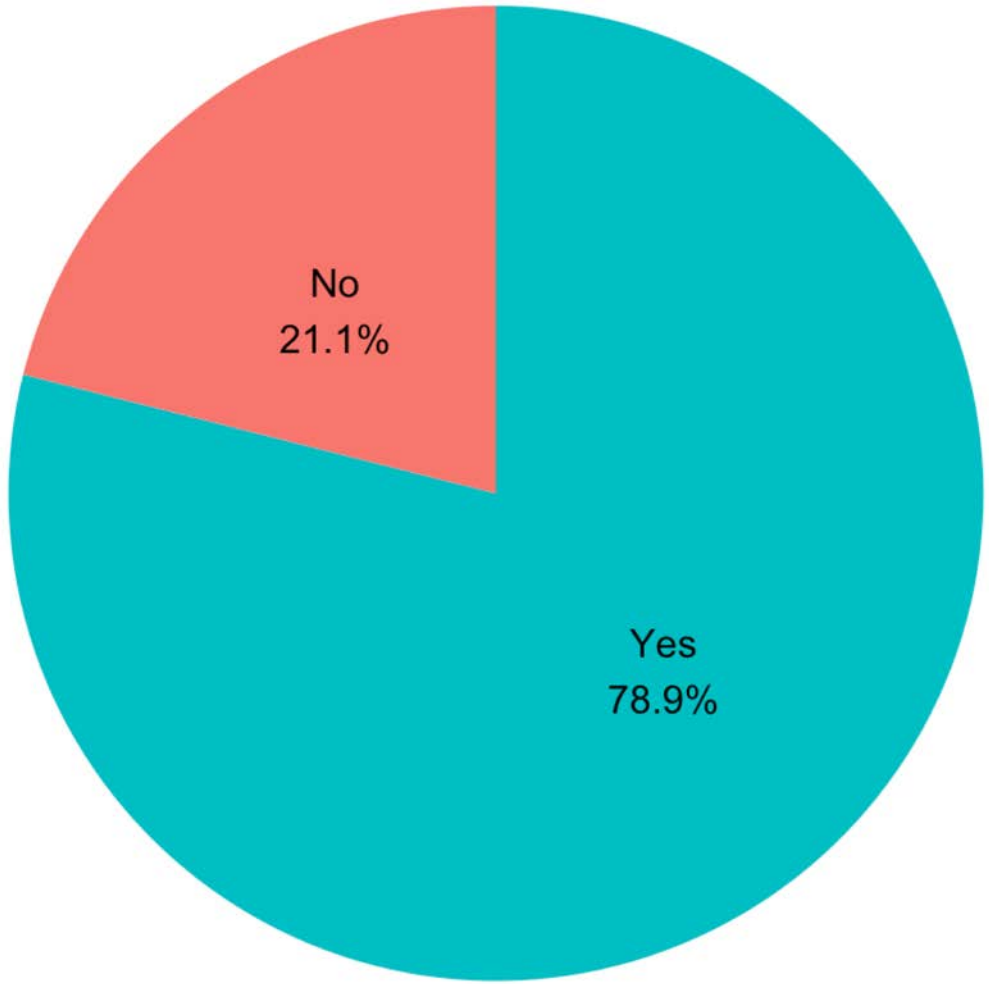
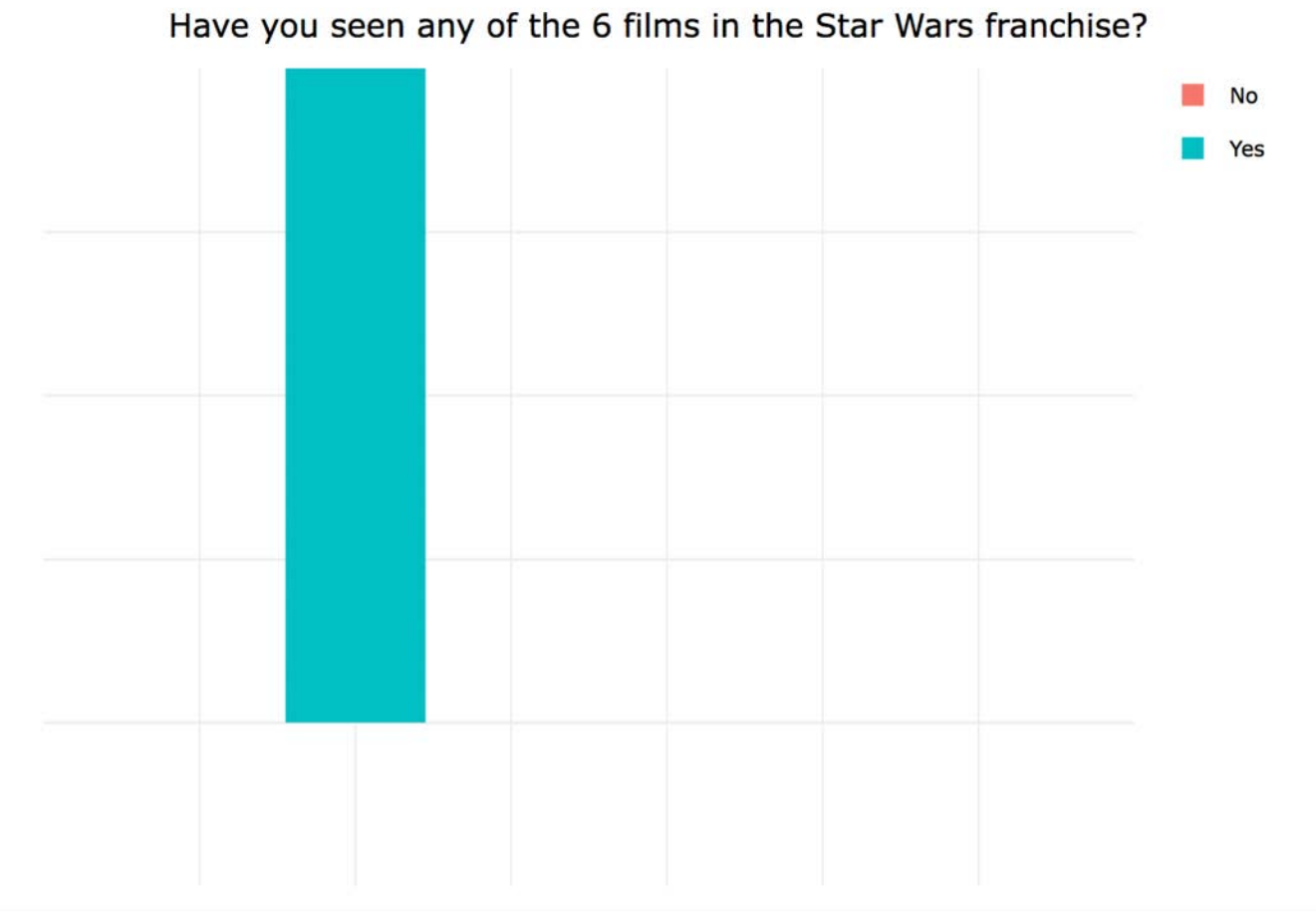
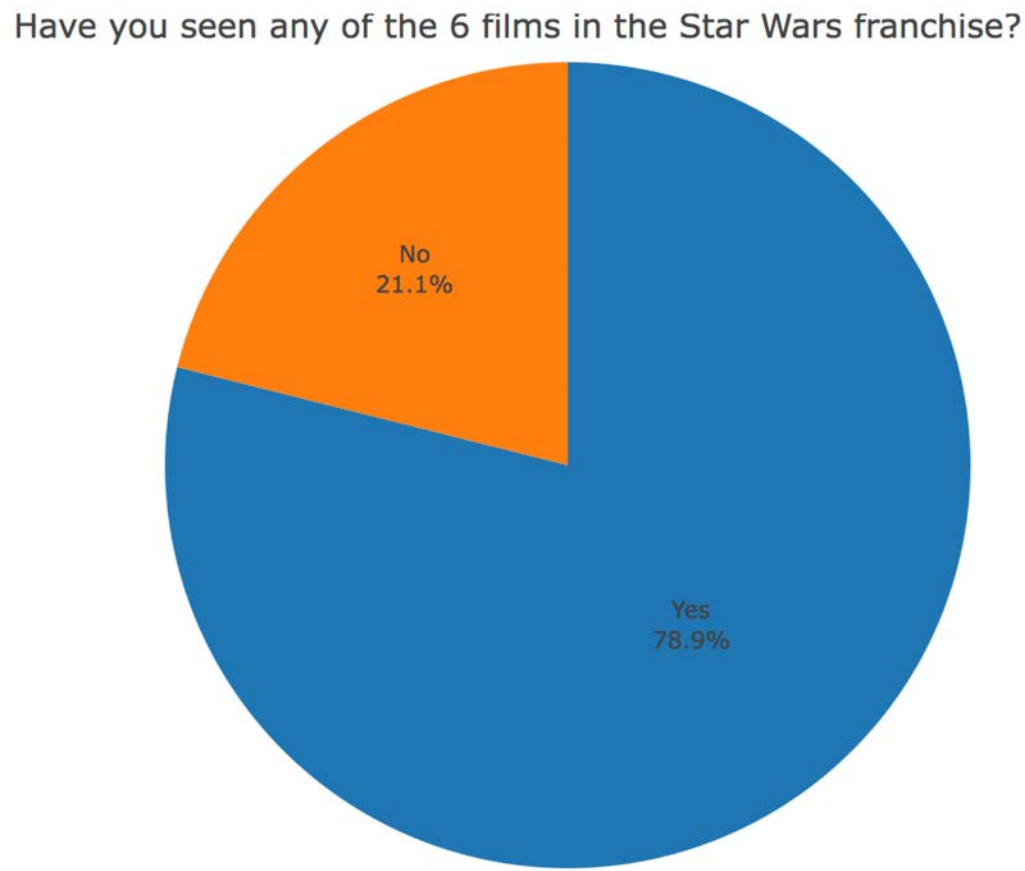
age

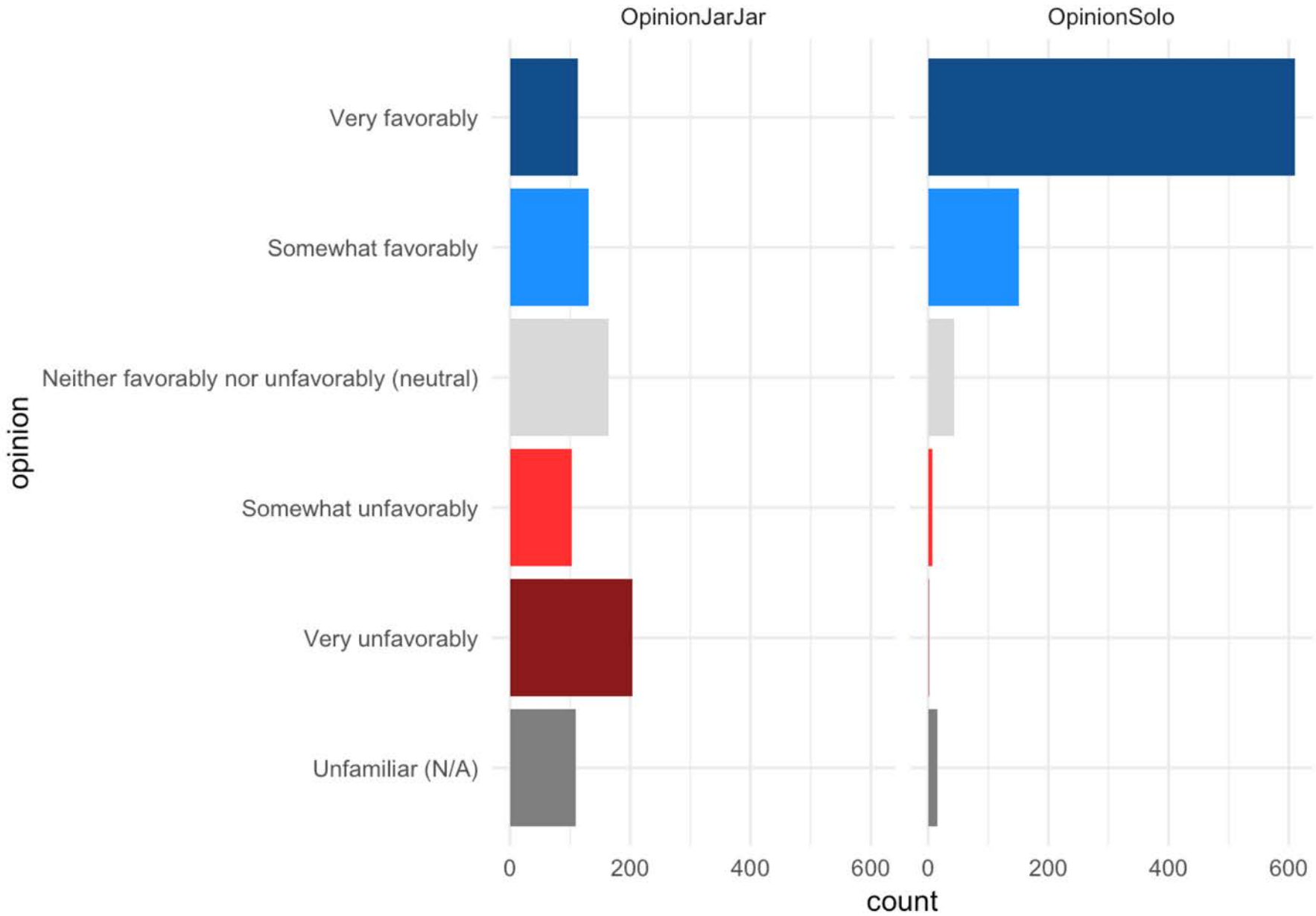

Yoda
Chewbacca
Dooku
Qui-Gon Jinn
Cliegg Lars
Mace Windu
Bail Prestor Organa
Wilhuff Tarkin
Luminara Unduli
Darth Maul
Jar Jar Binks
Ayla Secura
Beru Whitesun lars
Greedo
Darth Vader
Barriss Offee
R2-D2
Lando Calrissian
Biggs Darklighter
Wedge Antilles
Luke Skywalker
Wicket Systri Warrick
name
0
200
400
600
800
age

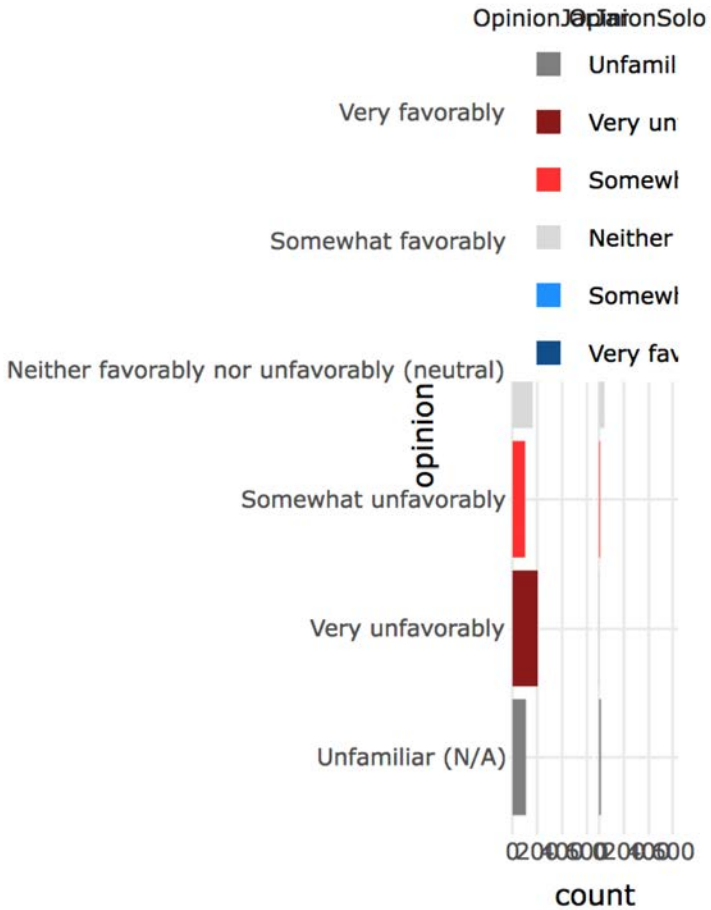
Have you seen any of the 6 films in the Star Wars franchise?

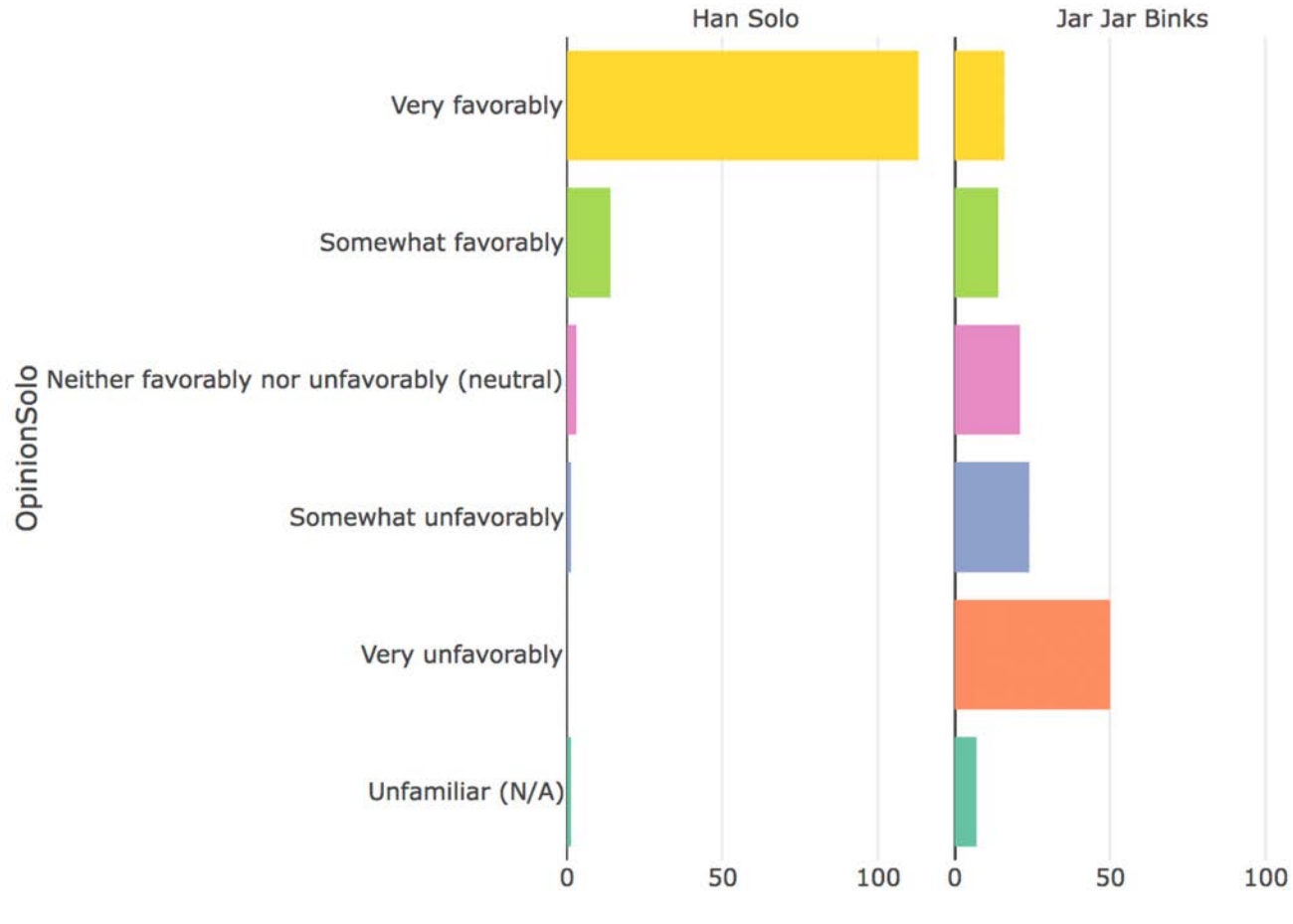


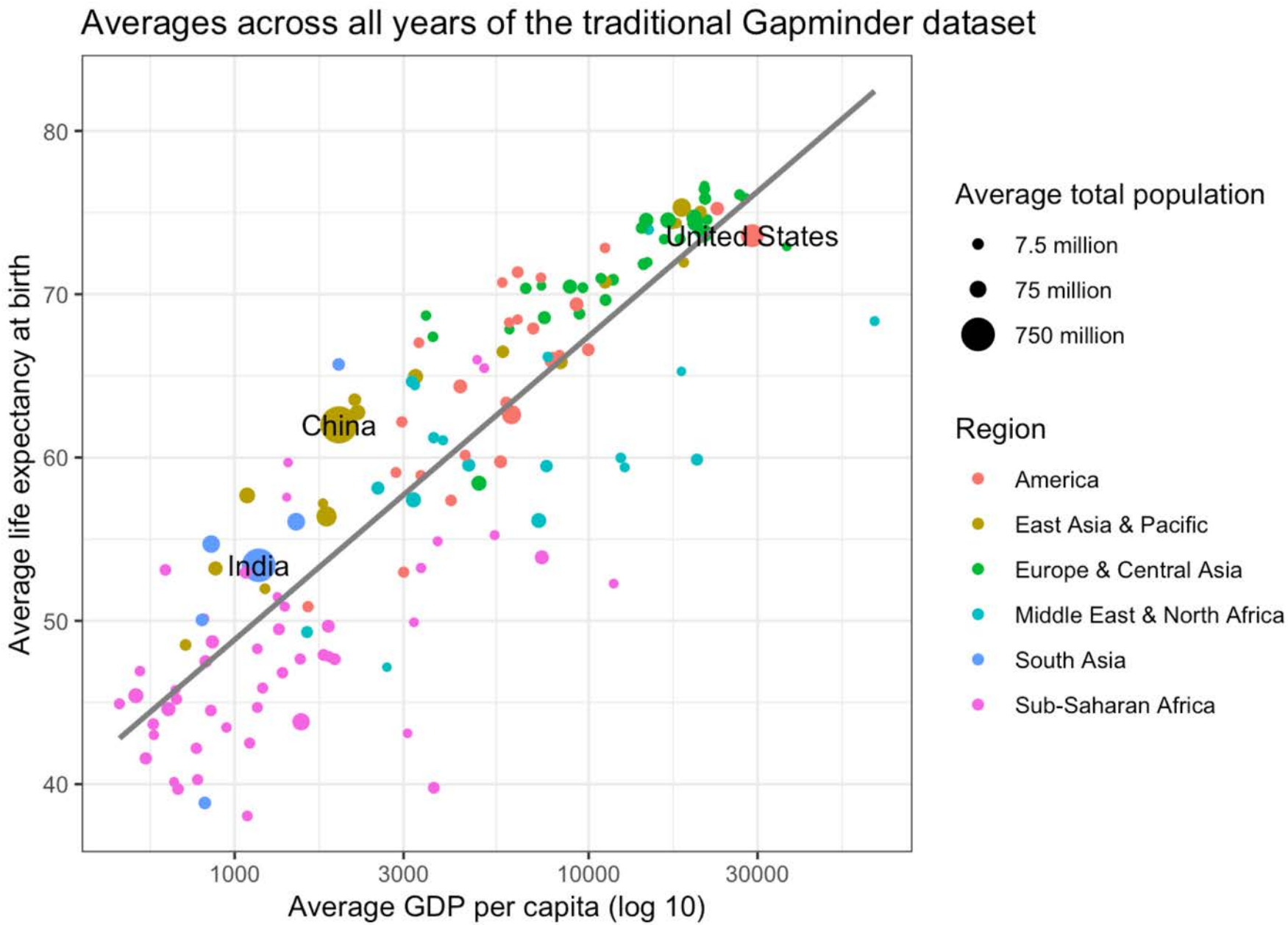

Have you seen any of the 6 films in the Star Wars franchise?
No
Yes


Have you seen any of the 6 films in the Star Wars franchise?
No
21.1%
Yes
78.9%


OpinionJarJar
OpinionSolo
Very favorably
Somewhat favorably
Neither favorably nor unfavorably (neutral)
Somewhat unfavorably
Very unfavorably
Unfamiliar (N/A)
opinion
0
200
400
600
count


OpinionJarJar
OpinionSolo
Unfamil
Very un
Somewł
Neither
Somewł
Very fav
Very favorably
Somewhat favorably
Neither favorably nor unfavorably (neutral)
Somewhat unfavorably
Very unfavorably
Unfamiliar (N/A)
opinion
count


Han Solo
Jar Jar Binks
Very favorably
Somewhat favorably
Neither favorably nor unfavorably (neutral)
Somewhat unfavorably
Very unfavorably
Unfamiliar (N/A)
OpinionSolo
0
50
100
0
50
100


Averages across all years of the traditional Gapminder dataset
Average life expectancy at birth
80
70
60
50
40
1000
3000
10000
30000
Average GDP per capita (log 10)
United States
China
India
Average total population
7.5 million
75 million
750 million
Region
America
East Asia & Pacific
Europe & Central Asia
Middle East & North Africa
South Asia
Sub-Saharan Africa

Dashboards in R Markdown

“Normal” R Markdown

- R Markdown elements like headings, text

```
# Heading 1
## Heading 2
Regular text
* Bulleted text
```

- Code chunks

````
```{r}

```
````

Markdown for flexdashboards

Page

==========

Column (or Row)

Chart titles

Regular text
* Bulleted text

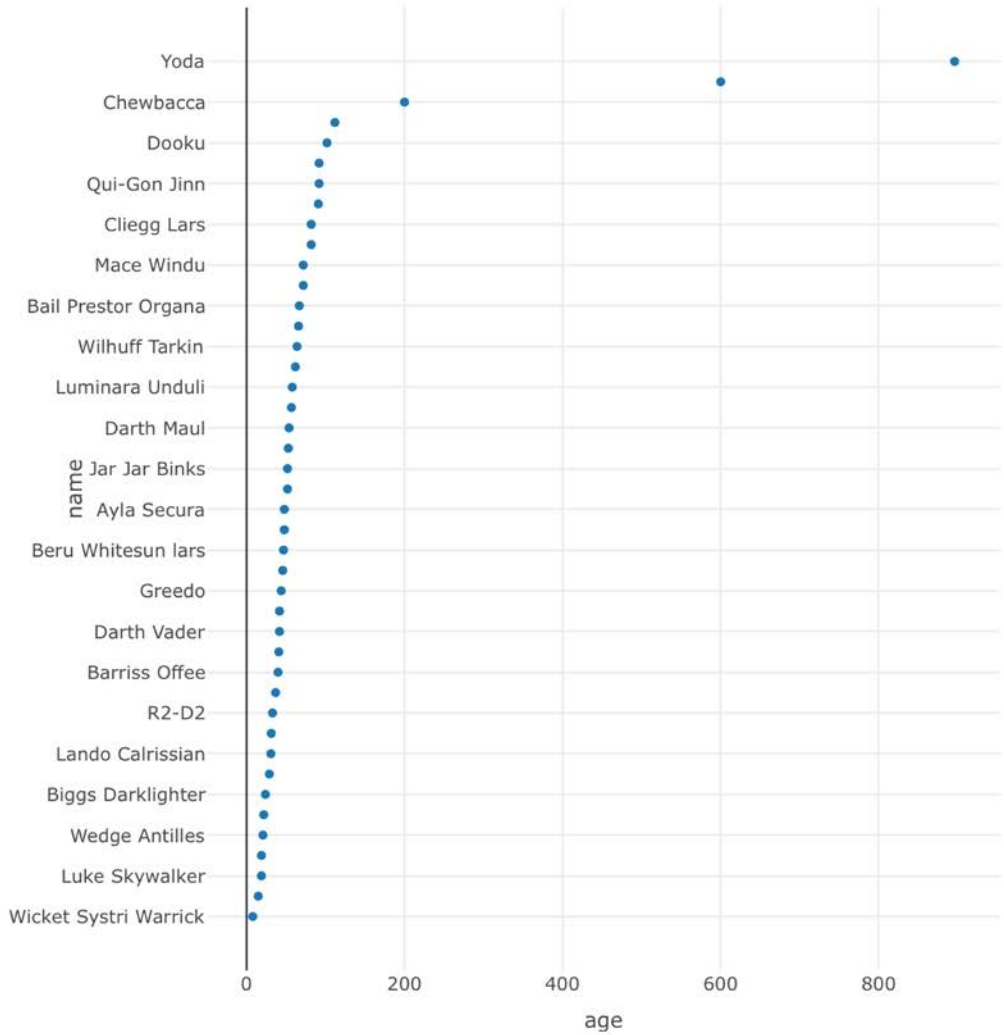
```{r}

```

Exercise 2: Star Wars dashboard

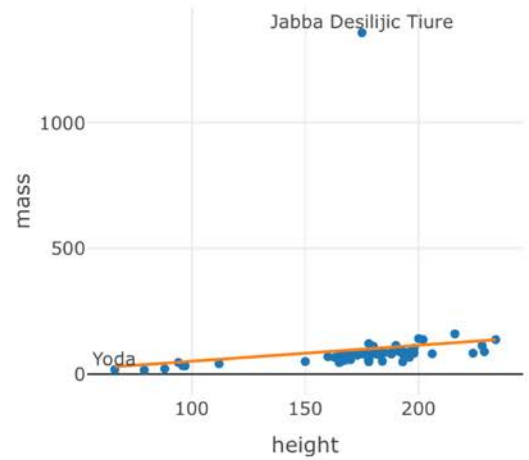
Simple dashboards with flexdashboard

Angela Zoss — 8/14/2018

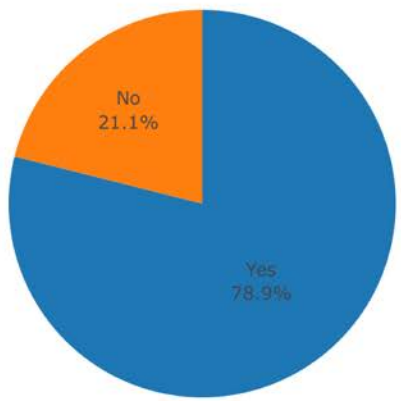
Star Wars characters by birth year



Star Wars characters by mass and height



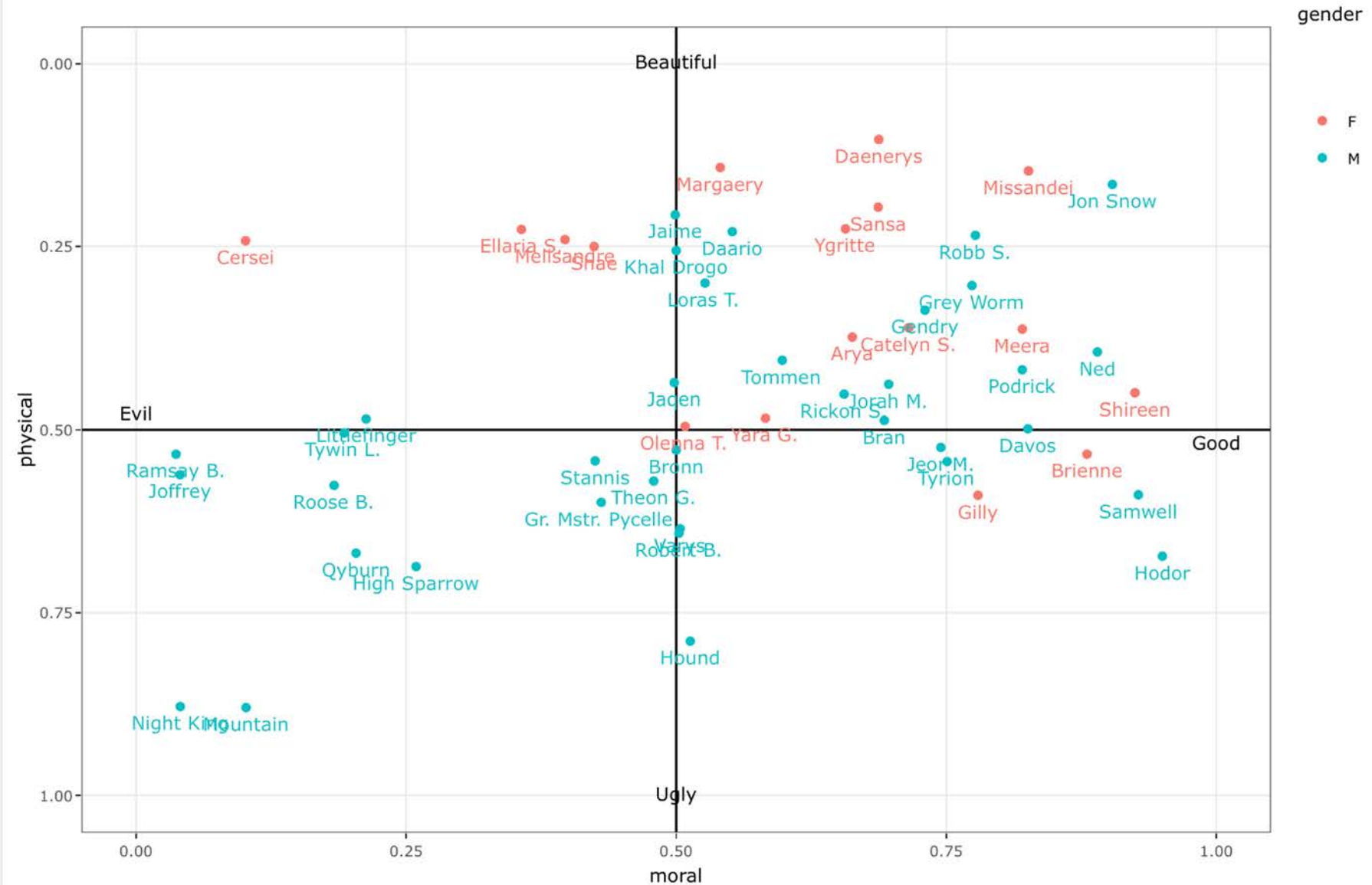
Have you seen any of the 6 films in the Star Wars franchise?



Exercise 3: Vis Portfolio

R Visualization Portfolio Angela Zoss — 8/14/2018 | Game of Thrones | Star Wars | Gapminder

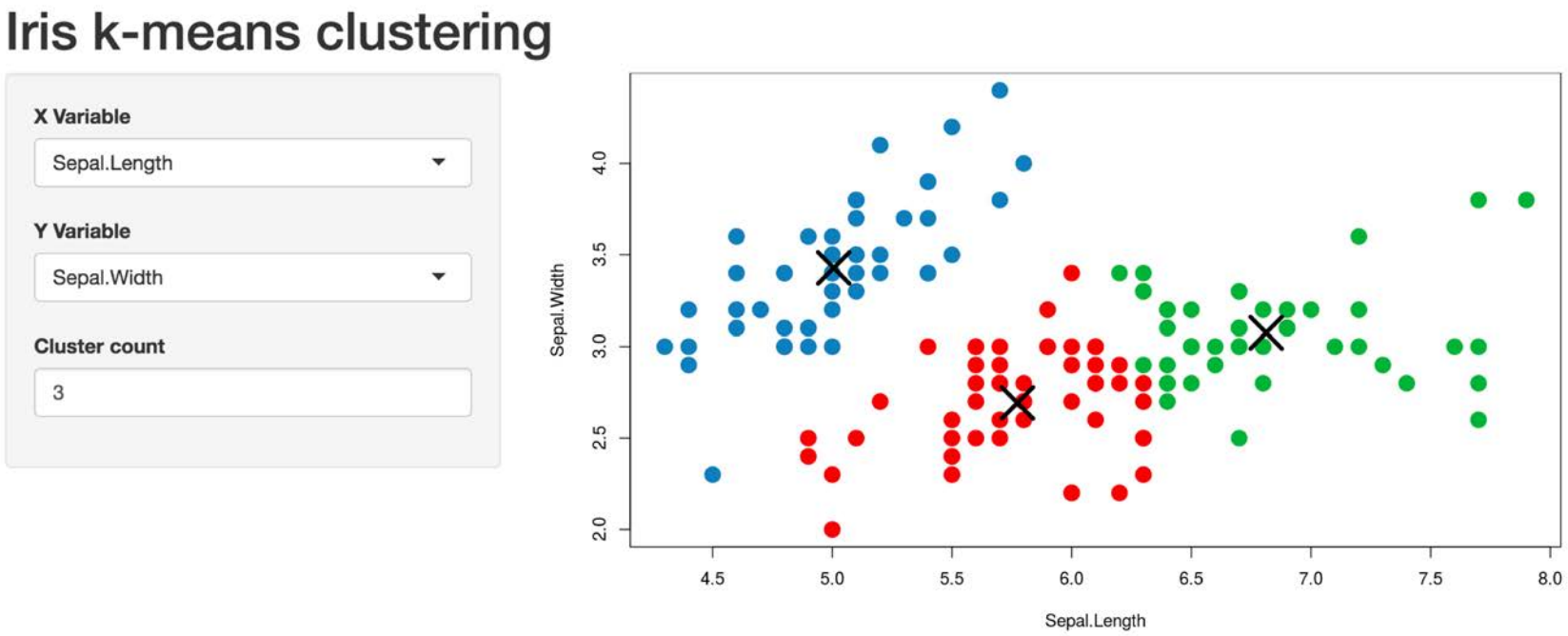
Goodness vs. Beauty | Quadrant visualization



Shiny

What is Shiny?

An interactive interface onto an R program



http://shiny.rstudio.com/

How can you use Shiny for visualization?

- Use Shiny to control some kind of simulation interactively, then visualize the results
- Use Shiny to change components within the chart (e.g., switch the mappings)
- Use Shiny to filter data to subsets to highlight patterns
- Change type of regression, plot results

Shiny examples

Gallery

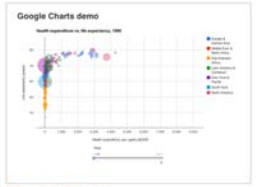
Interactive visualizations

Shiny is designed for fully interactive visualization, using JavaScript libraries like d3, Leaflet, and Google Charts.


SuperZip example


Bus dashboard

Movie explorer

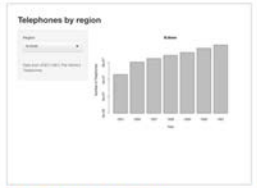


Google Charts

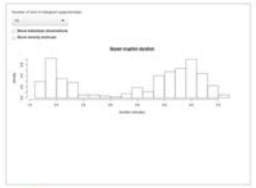
Start simple

If you're new to Shiny, these simple but complete applications are designed for you to study.

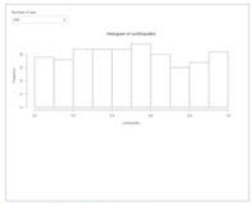
Kmeans example



Telephones by region

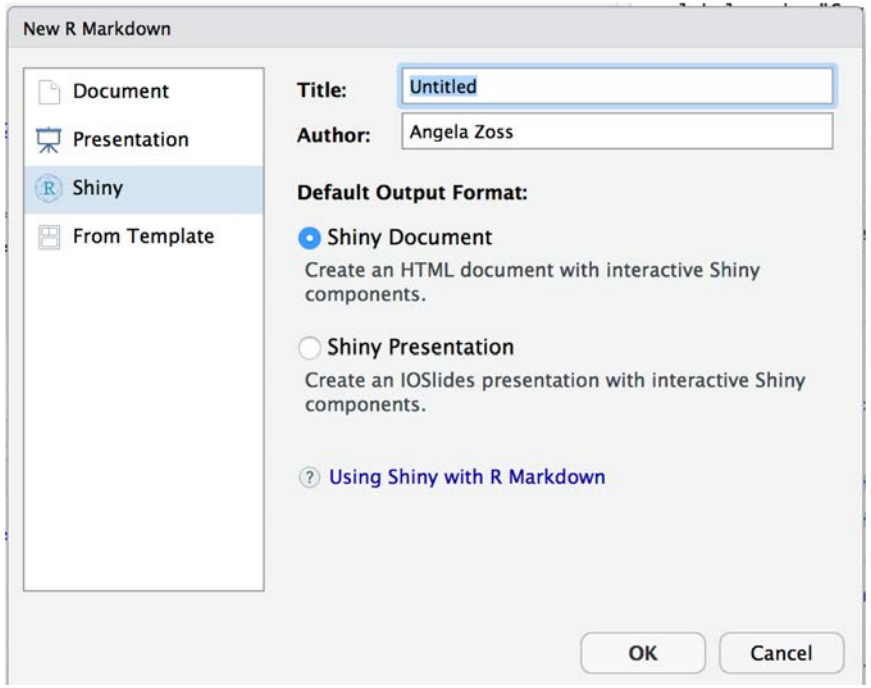

Faithful

Word cloud


Single-file shiny app

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

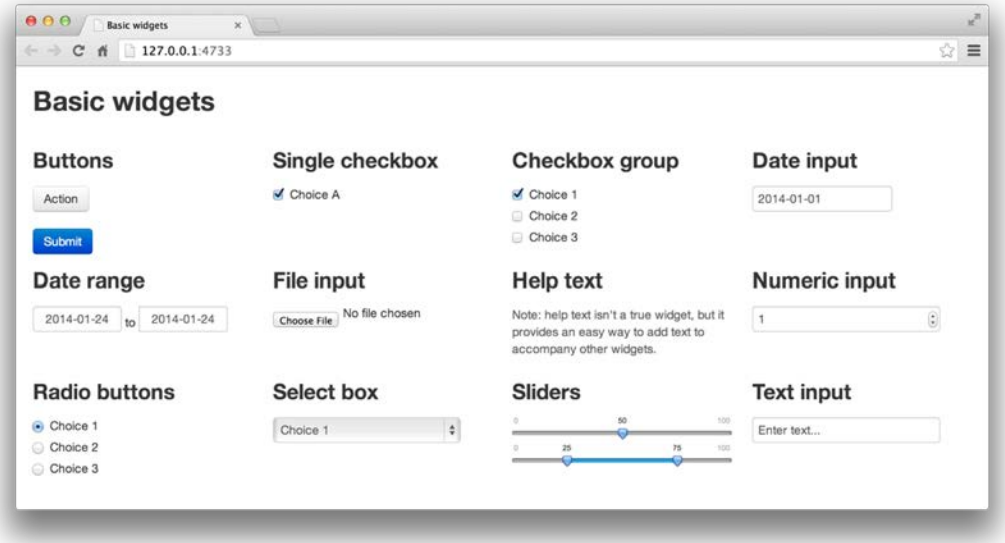
Shiny in R Markdown



Components

Some kind of **input widget**

(e.g., selectInput, sliderInput)



Some kind of **render object**

(e.g., renderPlot, renderTable)

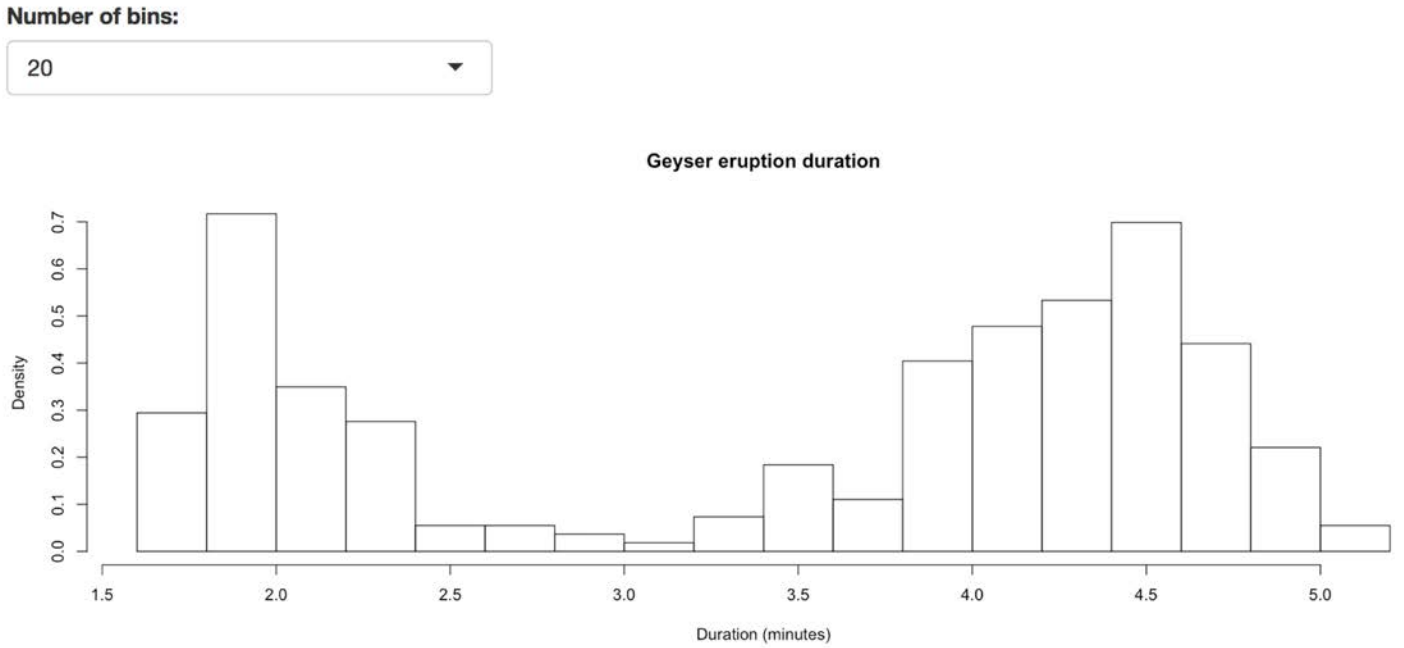
renderPlot wraps around something like a ggplot() plot

Layout

- In this case, Shiny elements are included to change/control individual charts
- The overall layout of the file is just using normal R Markdown syntax, and Shiny elements get embedded whenever the right code chunk comes up

Both components go in same code chunk

```r
selectInput("n_breaks", label = "Number of bins:",
              choices = c(10, 20, 35, 50), selected = 20)

renderPlot({
  hist(faithful$eruptions, probability = TRUE, breaks = as.numeric(input$n_breaks),
       xlab = "Duration (minutes)", main = "Geyser eruption duration")
})
```



Anatomy of a widget

- **Name** for the widget (internal only)
- **Label** (will be visible)
- Check documentation for other required arguments

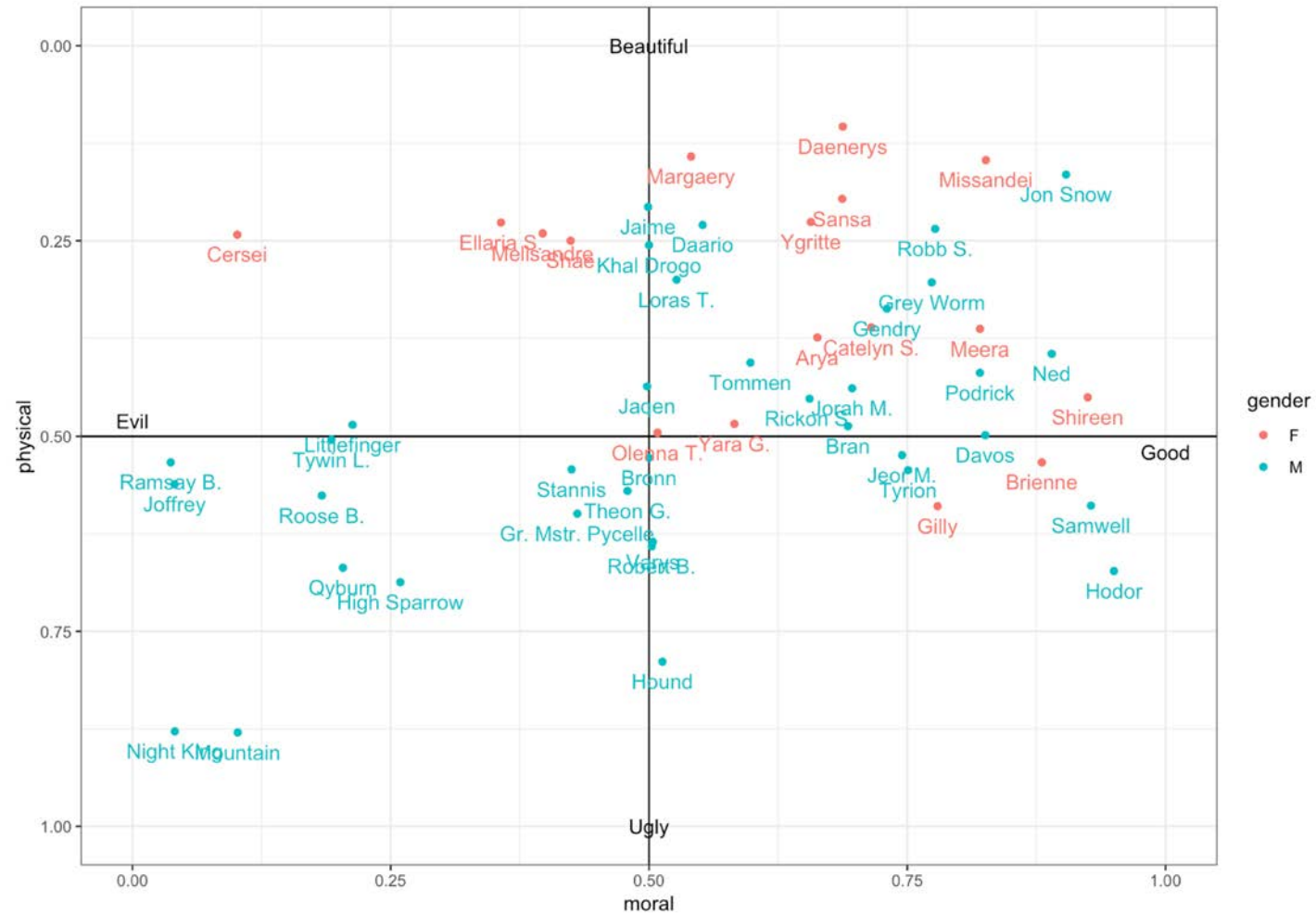
Exercise 4: Game of Thrones Markdown

Select Variable for Color:

gender

Change Label Font Size:

1 4 10

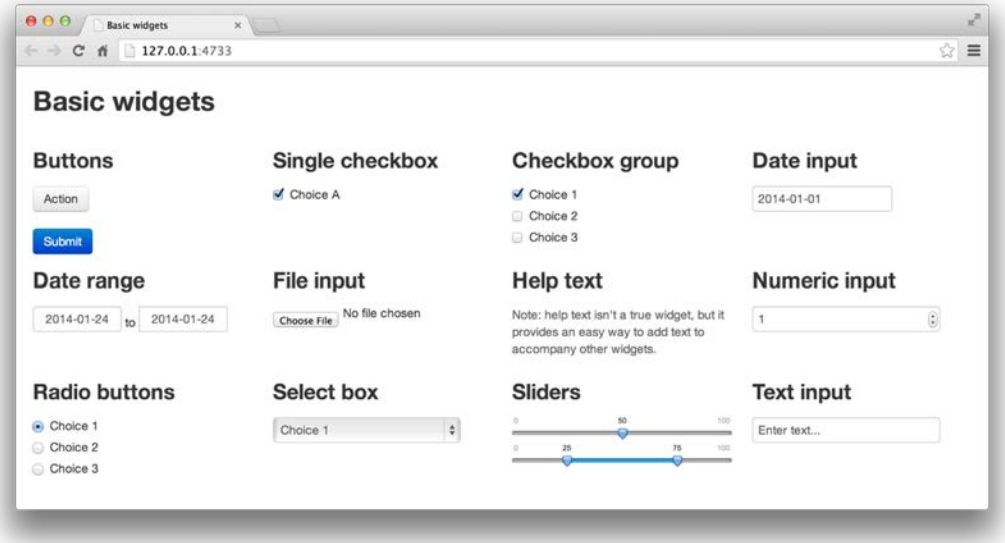


Shiny in Dashboards

Components (same as R Markdown)

Some kind of **input widget**

(e.g., selectInput, sliderInput)



Some kind of **render object**

(e.g., renderPlot, renderTable)

renderPlot wraps around something like a ggplot() plot

Layout (similar to normal flexdashboards)

Page

==========

Column {.sidebar)

Chart titles

Regular text
* Bulleted text

```{r}

(including Shiny input, render objects)

```

Exercise 5: Interactive Vis Portfolio

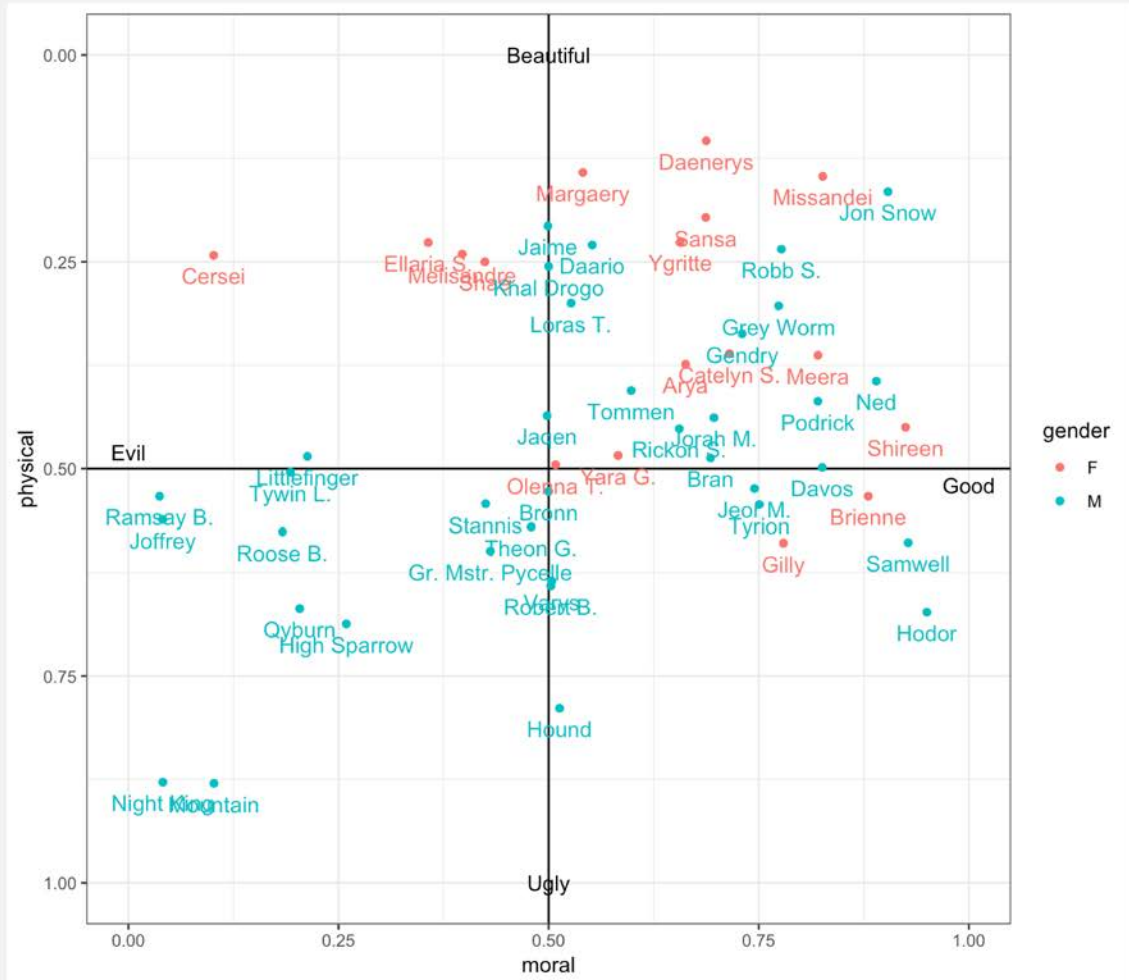
R Visualization Portfolio with Shiny Angela Zoss — 8/14/2018 Game of Thrones Star Wars

Select Variable for Color:

gender

Change Label Font Size:

1 4 10



Shiny Apps

How do you build a Shiny app?

User Interface (UI)

the website people will see and interact with

Server

takes values from the interface, does some calculations, and creates more content for the interface

Step 1: Create the interface

What to put in the UI?

- Layout elements
- Extra text/HTML elements
- Control widgets
- Placeholders for reactive output

Page layout

1. fluidPage
   - titlePanel
   - sidebarLayout
     - sidebarPanel
     - mainPanel
   - fluidRow
     - column
     - wellPanel
   - tabsetPanel
   - navlistPanel
2. fixedPage
   - fixedRow
3. navbarPage
   - tabPanel
   - navbarMenu
     - tabPanel

http://shiny.rstudio.com/articles/layout-guide.html

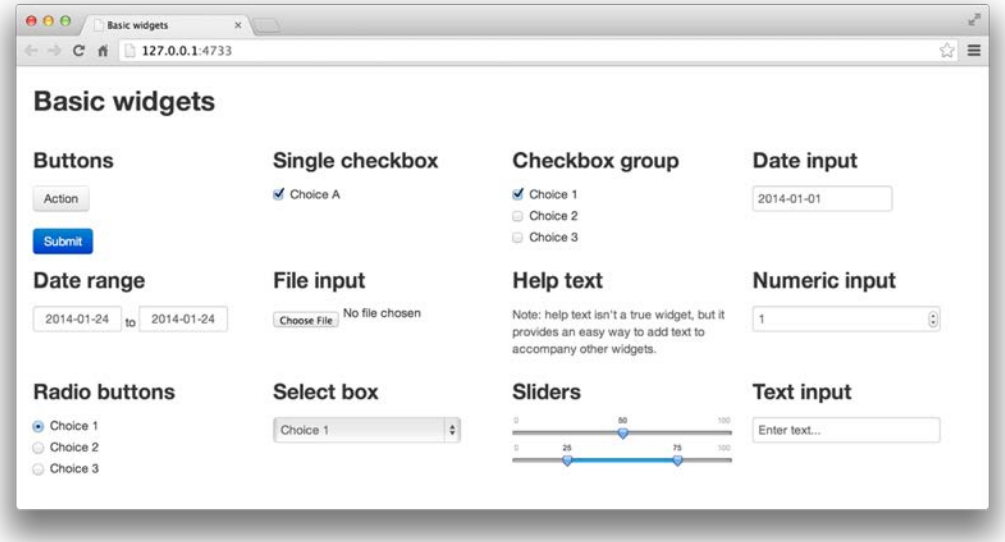
HTML elements

- Shiny has special wrapper functions for this – e.g., h2(), p()

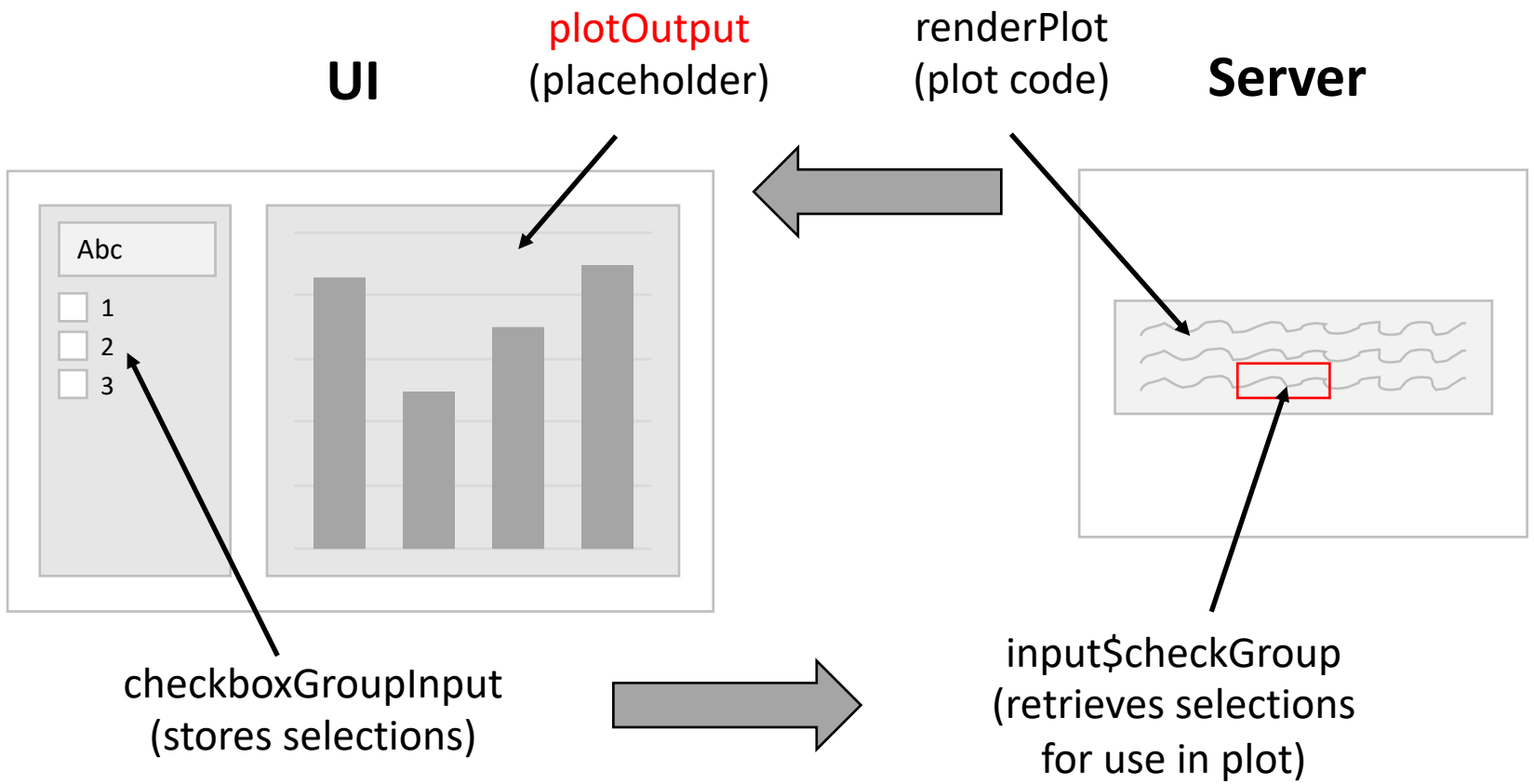
http://shiny.rstudio.com/tutorial/written-tutorial/lesson2/

Control widgets

- Button
- Checkboxes
- Date, date range input
- File input
- Numeric input
- Radio buttons
- Drop-down (select) box
- Slider bar
- Text input
- Text



http://shiny.rstudio.com/tutorial/written-tutorial/lesson3/
http://shiny.rstudio.com/gallery/widget-gallery.html

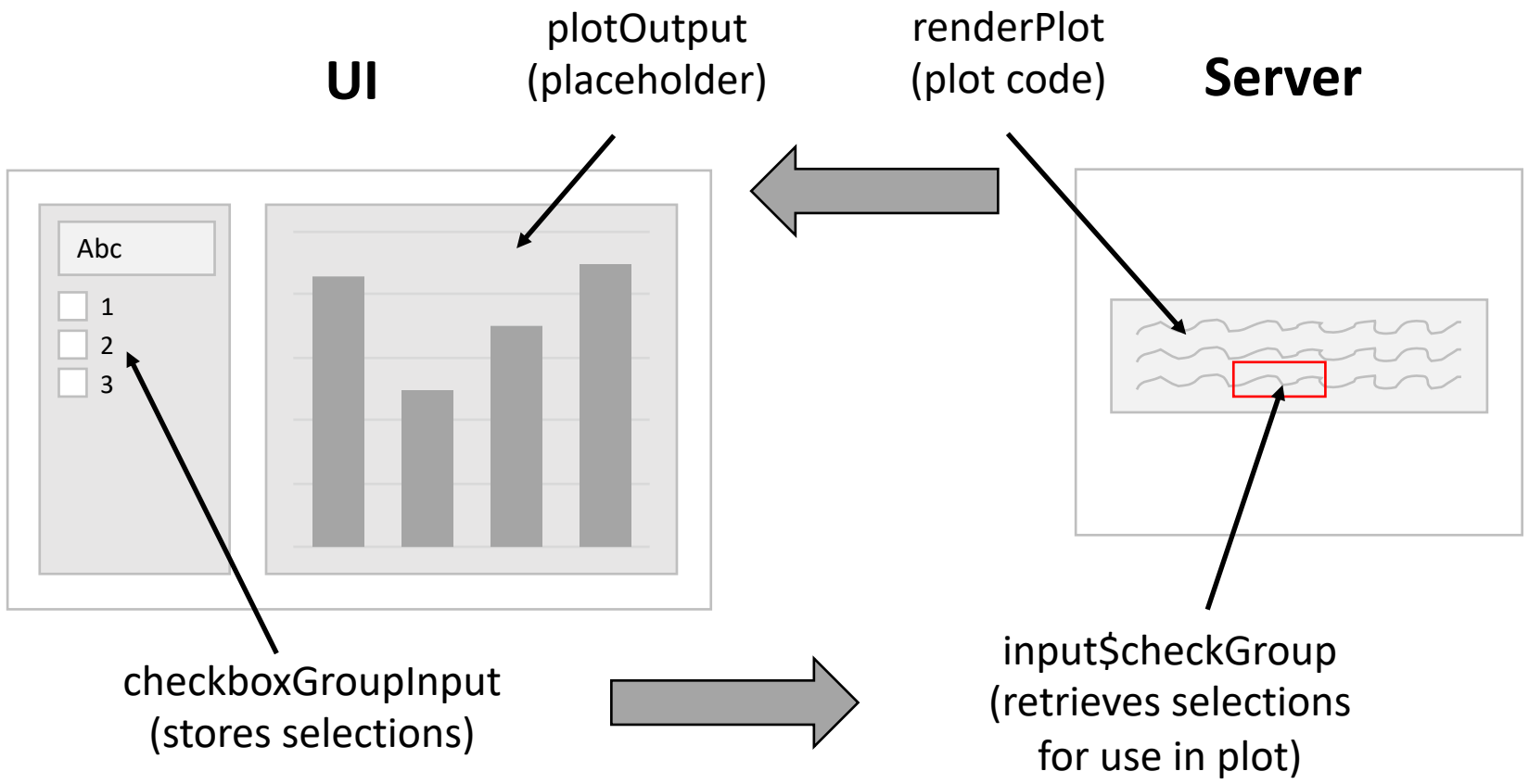

UI
plotOutput
(placeholder)
renderPlot
(plot code)
Server
Abc
1
2
3
checkboxGroupInput
(stores selections)
input$checkGroup
(retrieves selections
for use in plot)

Reactive output objects

UI	Server
htmlOutput	renderUI
imageOutput	renderImage
plotOutput	renderPlot
tableOutput	renderTable
textOutput	renderText
uiOutput	renderUI
verbatimTextOutput	renderPrint

http://shiny.rstudio.com/tutorial/written-tutorial/lesson4/

Step 2: Set up server to create dynamic objects


UI
plotOutput
(placeholder)
renderPlot
(plot code)
Server
Abc
1
2
3
checkboxGroupInput
(stores selections)
input$checkGroup
(retrieves selections
for use in plot)

What to put in the server

- R code
- Render objects with same names and types as the ones listed in UI
- Input objects with the same names as the control widgets

UI:

```
sliderInput("slider1")

textOutput("text1")
```

Server:

```
output$text1  <-  renderText({
                    input$slider1
                  })
```

http://shiny.rstudio.com/tutorial/lesson4/

Step 3: Test

Running the app

Set options in RStudio:

- Window
- Viewer
- External

Exercise 6: Portfolio as full Shiny App

R Visualization Portfolio with Shiny | Game of Thrones | Star Wars

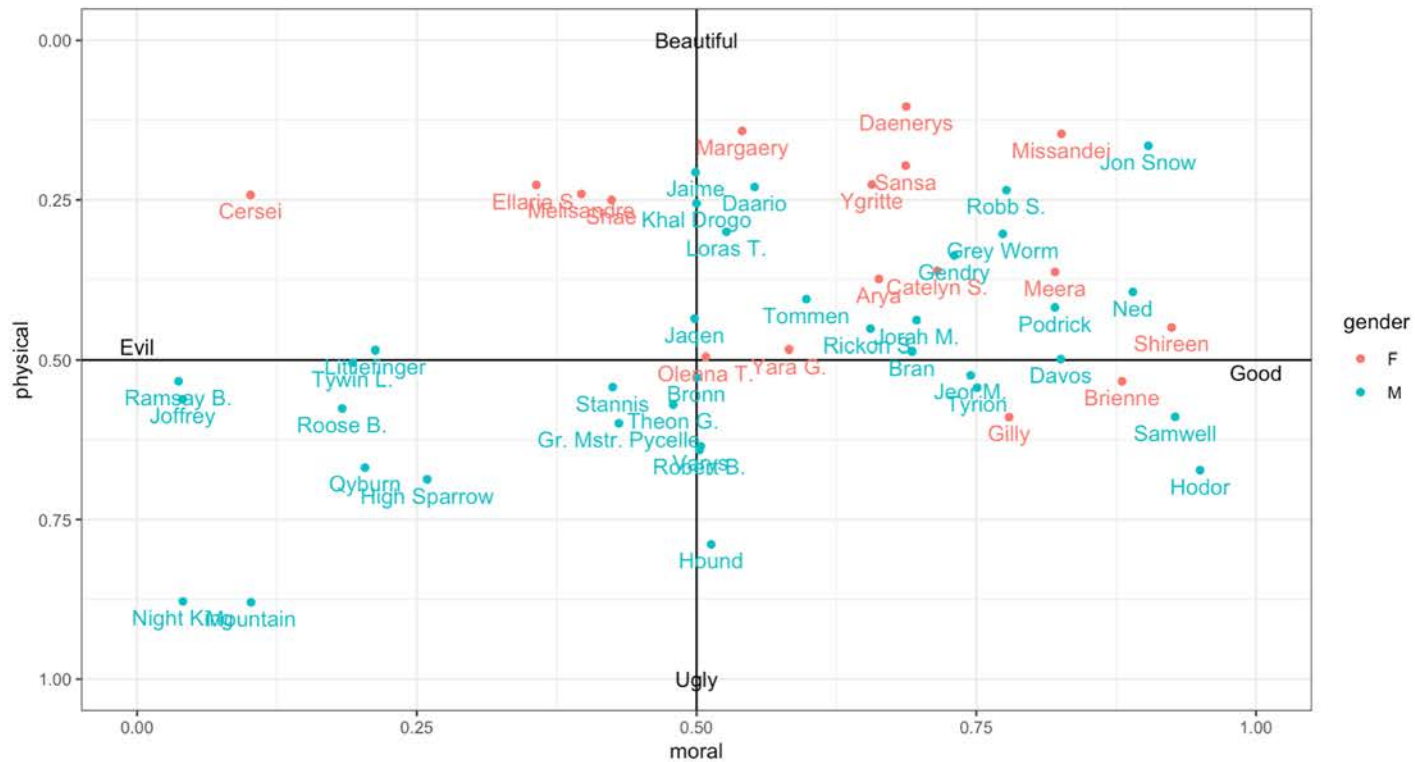
Select Variable for Color:

gender

Change Label Font Size:

1 4 10

1 2 3 4 5 6 7 8 9 10



Sharing an app

- Shiny Apps
  http://www.shinyapps.io/
- Shiny Server (free – host on your own server)
  https://github.com/rstudio/shiny-server/blob/master/README.md
- Shiny Server Pro (fee)
  https://www.rstudio.com/products/shiny/shiny-server/

Shiny resources

- http://shiny.rstudio.com/gallery/
- http://shiny.rstudio.com/tutorial/
- http://shiny.rstudio.com/articles/
- https://shiny.rstudio.com/reference/shiny/latest/
- https://www.rstudio.com/wp-content/uploads/2016/01/shiny-cheatsheet.pdf
- http://www.shinyapps.io/