Data Visualization Using R & ggplot2

Naupaka Zimmerman (@naupakaz) and Andrew Tredennick (@ATredennick)
(and Karthik Ram (@_inundata))

August 6, 2017

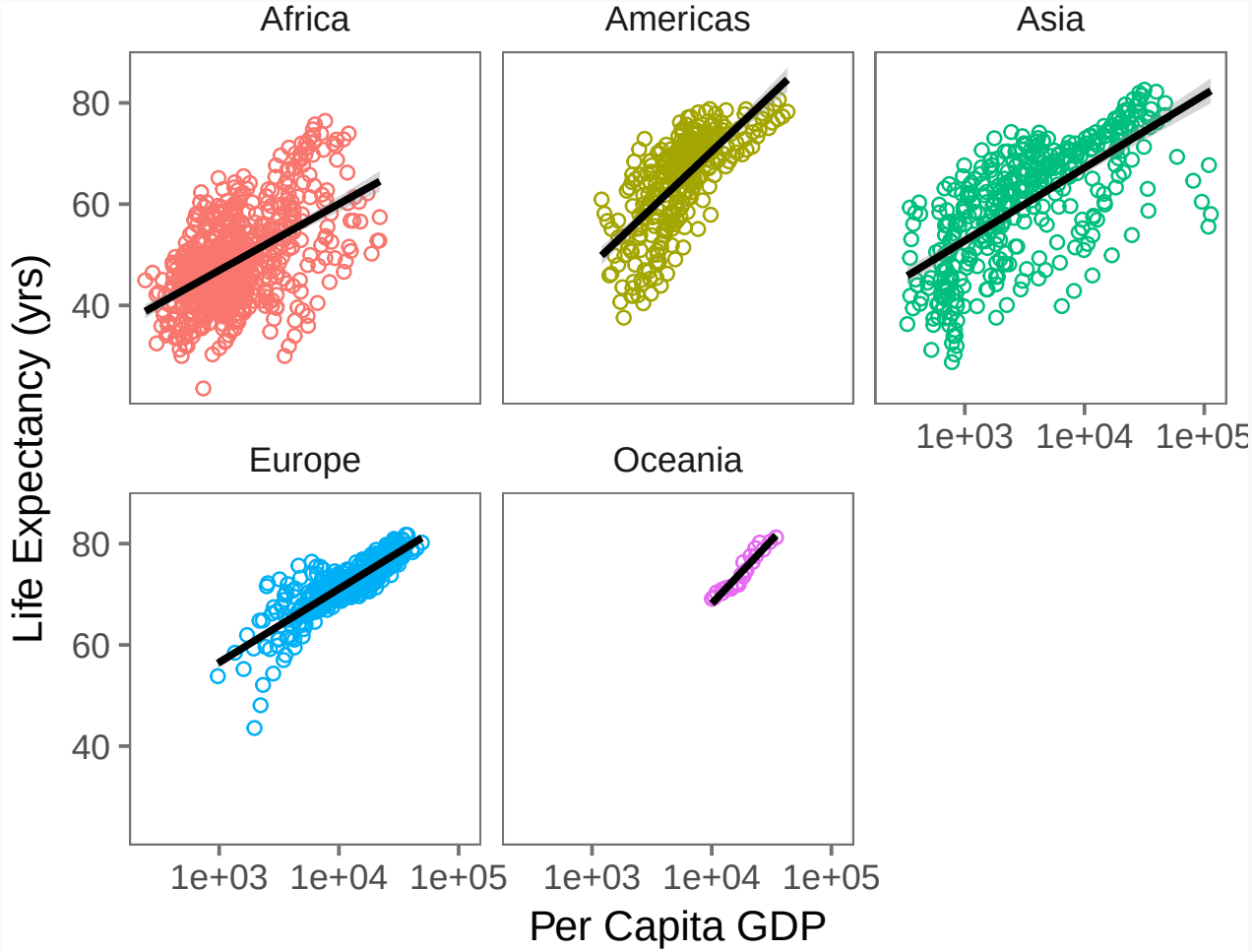
Some housekeeping

Install some packages

```
install.packages("ggplot2", dependencies = TRUE)
install.packages("ggthemes")
install.packages("tidyr")
install.packages("dplyr")
```

Why ggplot?

1 minute

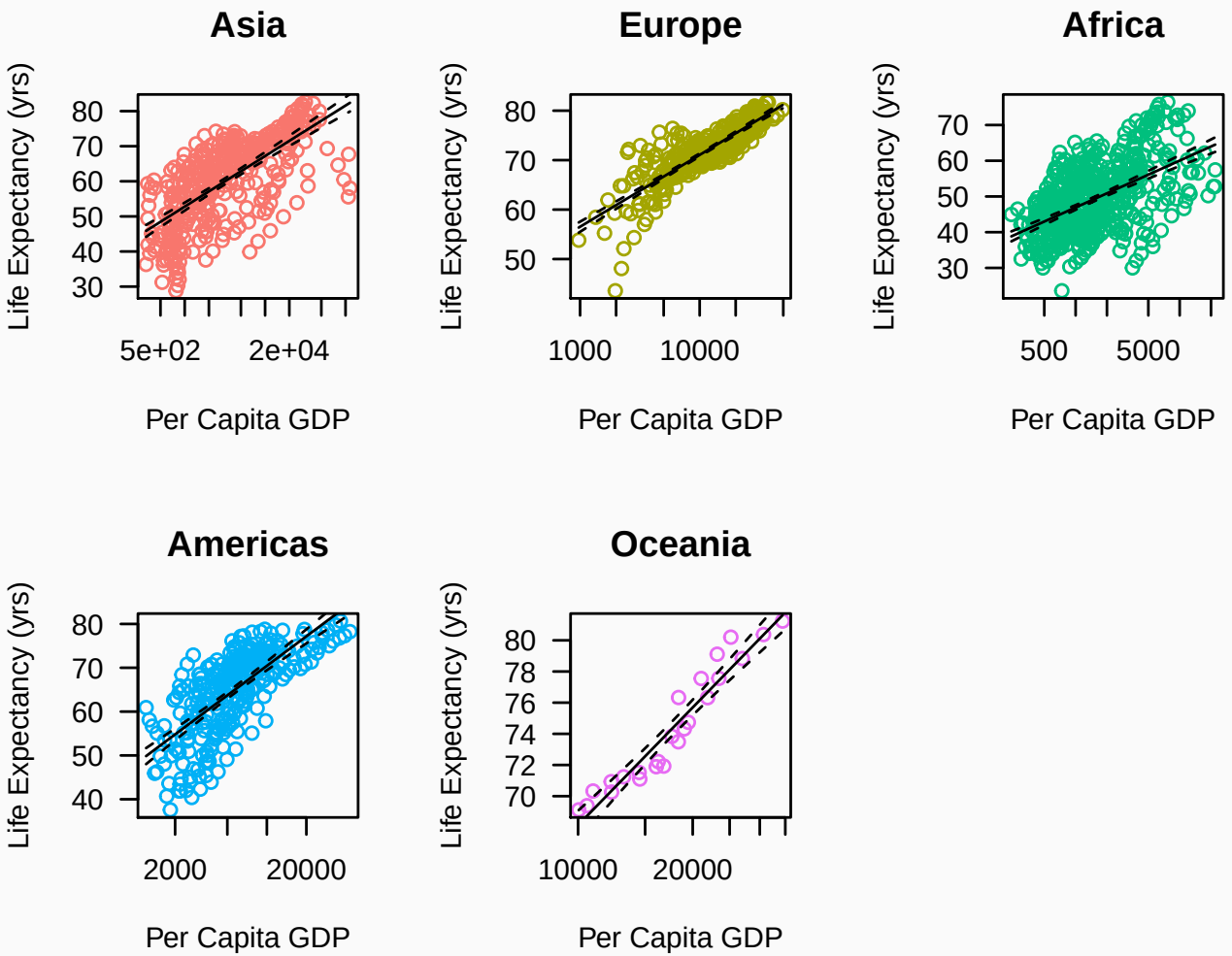

Africa
Americas
Asia
Europe
Oceania
Life Expectancy (yrs)
80
60
40
1e+03
1e+04
1e+05
Per Capita GDP

1 minute

```
library(ggplot2)
library(gapminder)
library(ggthemes)

ggplot(gapminder, aes(x = gdpPercap, y = lifeExp)) +
  geom_point(shape = 1, aes(color = continent)) +
  stat_smooth(method = "lm", size = 1, color = "black") +
  scale_x_log10() +
  xlab("Per Capita GDP") +
  ylab("Life Expectancy (yrs)") +
  facet_wrap(~continent) +
  theme_few() +
  guides(color = FALSE)
```

30 minutes


Asia
Life Expectancy (yrs)
80
70
60
50
40
30
5e+02
2e+04
Per Capita GDP
Europe
Life Expectancy (yrs)
80
70
60
50
1000
10000
Per Capita GDP
Africa
Life Expectancy (yrs)
70
60
50
40
30
500
5000
Per Capita GDP
Americas
Life Expectancy (yrs)
80
70
60
50
40
2000
20000
Per Capita GDP
Oceania
Life Expectancy (yrs)
80
78
76
74
72
70
10000
20000
Per Capita GDP

30 minutes

```
library(scales)
library(gapminder)
gapminder <- as.data.frame(gapminder)
conts <- unique(gapminder[,"continent"])
cols <- scales::hue_pal()(length(conts))
par(mfrow = c(2,3))
counter <- 1
for (i in conts) {
  plot(gapminder[which(gapminder$continent == i), "gdpPercap"],
       gapminder[which(gapminder$continent == i), "lifeExp"], col = col
       xlab = "Per Capita GDP", ylab = "Life Expectancy (yrs)",
       main = i, las = 1, log = "x")
  fit <- lm(gapminder[which(gapminder$continent == i), "lifeExp"] ~
```

But wait, there's more...

```
log(gapminder[which(gapminder$continent == i), "gdpPercap"]))
  pred <- predict(fit, interval = "confidence")
  lines(sort(gapminder[which(gapminder$continent == i), "gdpPercap"]),
  lines(sort(gapminder[which(gapminder$continent == i), "gdpPercap"]),
  lines(sort(gapminder[which(gapminder$continent == i), "gdpPercap"]),
  counter <- counter + 1
}
```

Why ggplot?

Why ggplot?

- More elegant and compact code than with base graphics
- More aesthetically pleasing defaults than lattice
- Very powerful for exploratory data analysis

Why ggplot?

- gg is for grammar of graphics (term by Lee Wilkinson)
- A set of terms that defines the basic components of a plot
- Used to produce figures using coherant, consistant syntax

Why ggplot2?

- Supports a continuum of expertise
- Easy to get started, plenty of power for complex figures

The Grammar

Some terminology

Data

- Must be a data frame (`data.frame()`, `as.data.frame()`)
- Gets pulled into the `ggplot()` object

tidyr

Helps your data play nice with ggplot

Aesthetics

Some terminology

aesthetics

- How your data are represented visually
- a.k.a. mapping
- which data on the x
- which data on the y
- but also: color, size, shape, transparency

Geometries

Some terminology

geometry

- The geometric objects in the plot
- points, lines, polygons, etc.
- functions: `geom_point()`, `geom_bar()`, `geom_line()`

Basic structure

```
ggplot(data = iris, aes(x = Sepal.Length, y = Sepal.Width)) +
  geom_point()

# Equivalently...
myplot <- ggplot(data = iris, aes(x = Sepal.Length, y = Sepal.Width))
myplot + geom_point()
```

- Specify the data and variables inside the `ggplot()` function.
- Anything else that goes in here becomes a *global* setting.
- Then add layers: geometric objects, statistical models, and facets.

Don’t be tempted!

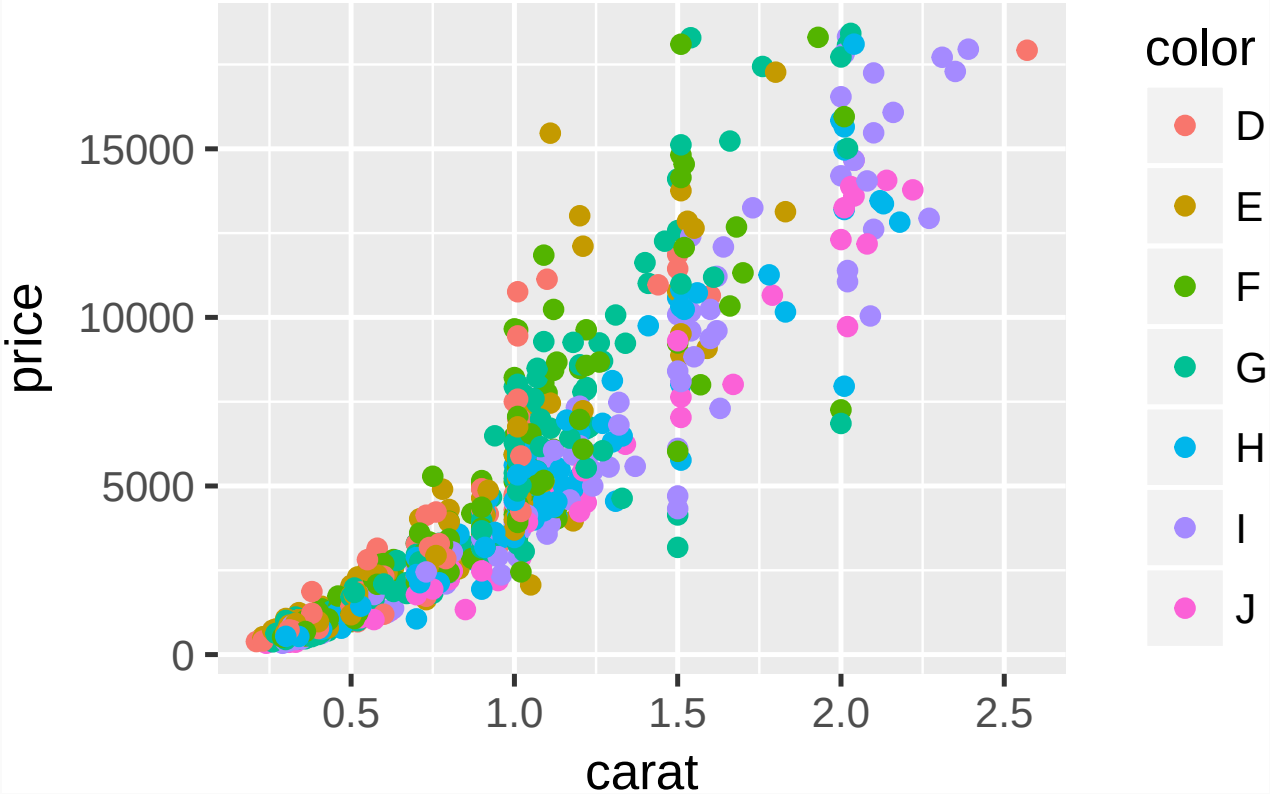
- NEVER use `qplot()` - short for quick plot.
- You‘ll end up unlearning and relearning a good bit.

Exercise 1

Exercise 1

```
# Make a small sample of the diamonds dataset
d2 <- diamonds[sample(x = 1:nrow(diamonds), size = 1000), ]
```

The make this plot:



Stats

Some terminology

stats

- Statistical transformations and data summary
- All geoms have associated default stats, and vice versa
- e.g. binning (the stat) for a histogram or fitting a linear model

Facets

Some terminology

facets

- Subsetting data to make lattice plots
- Really powerful
- I use in almost every publication

Scales

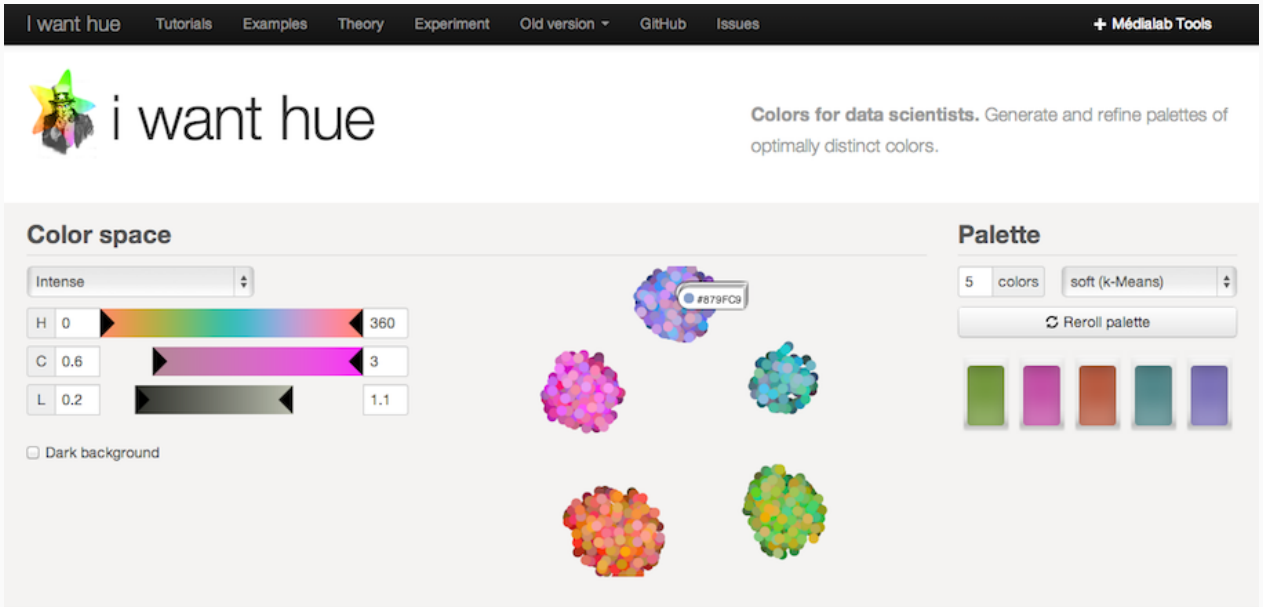
Some terminology

scales

- Control the *mapping* from data to aesthetics
- Often used for adjusting color mapping (i.e., setting colors manually)

Refer to a color chart for beautiful visualizations

http://tools.medialab.sciences-po.fr/iwanthue/



Some common scales

```
scale_fill_discrete(); scale_colour_discrete()
scale_fill_hue(); scale_color_hue()
scale_fill_manual();  scale_color_manual()
scale_fill_brewer(); scale_color_brewer()
scale_linetype(); scale_shape_manual()
```

Coordinates

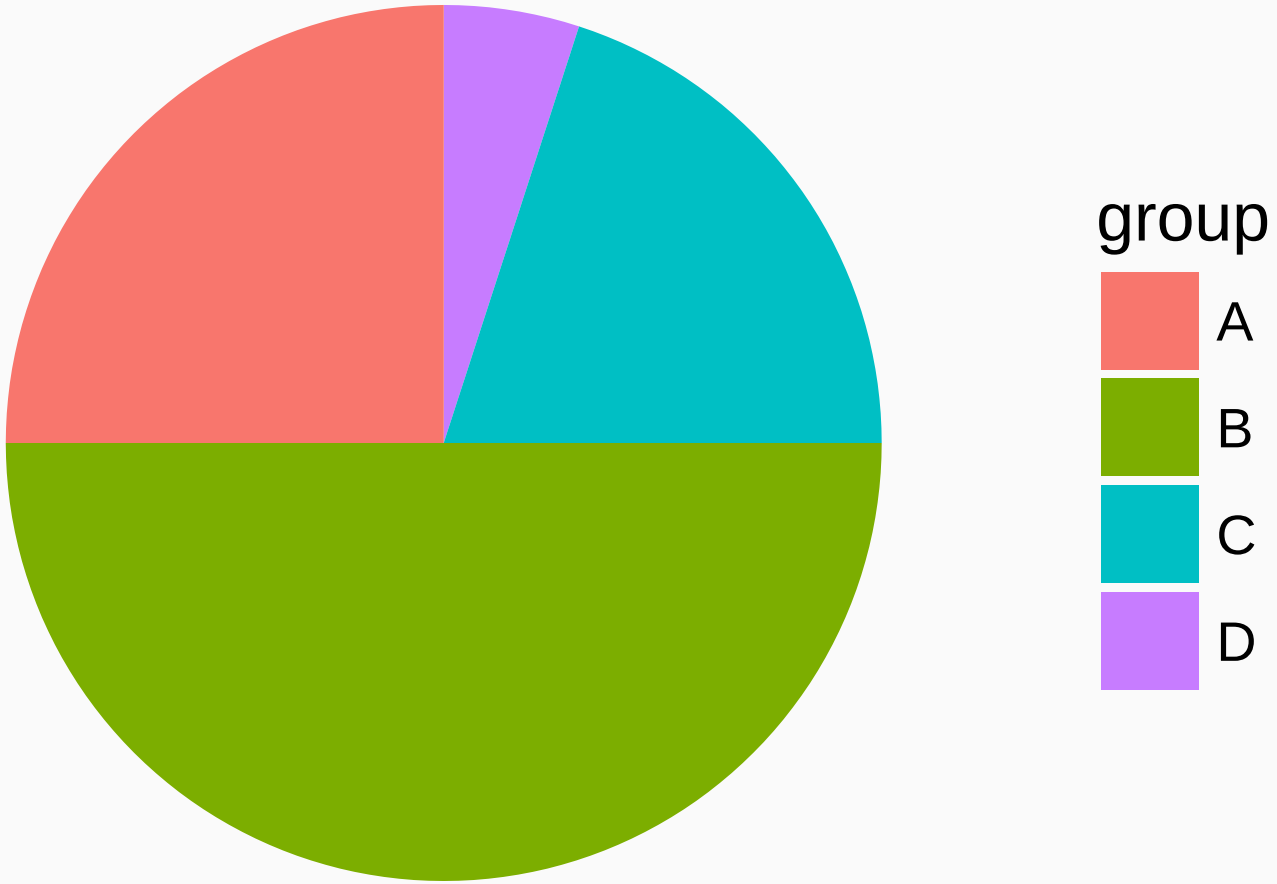
Some terminology

coordinates

- Not going to cover this in detail
- e.g. polar coordinate plots

Don't try this at home. . . please!

```
ggplot(mydata, aes(x = "", y = proportion, fill = group)) +
  geom_bar(stat = "identity", width = 1) +
  coord_polar("y", start=0) +
  theme_void()
```



Putting it all together with more examples

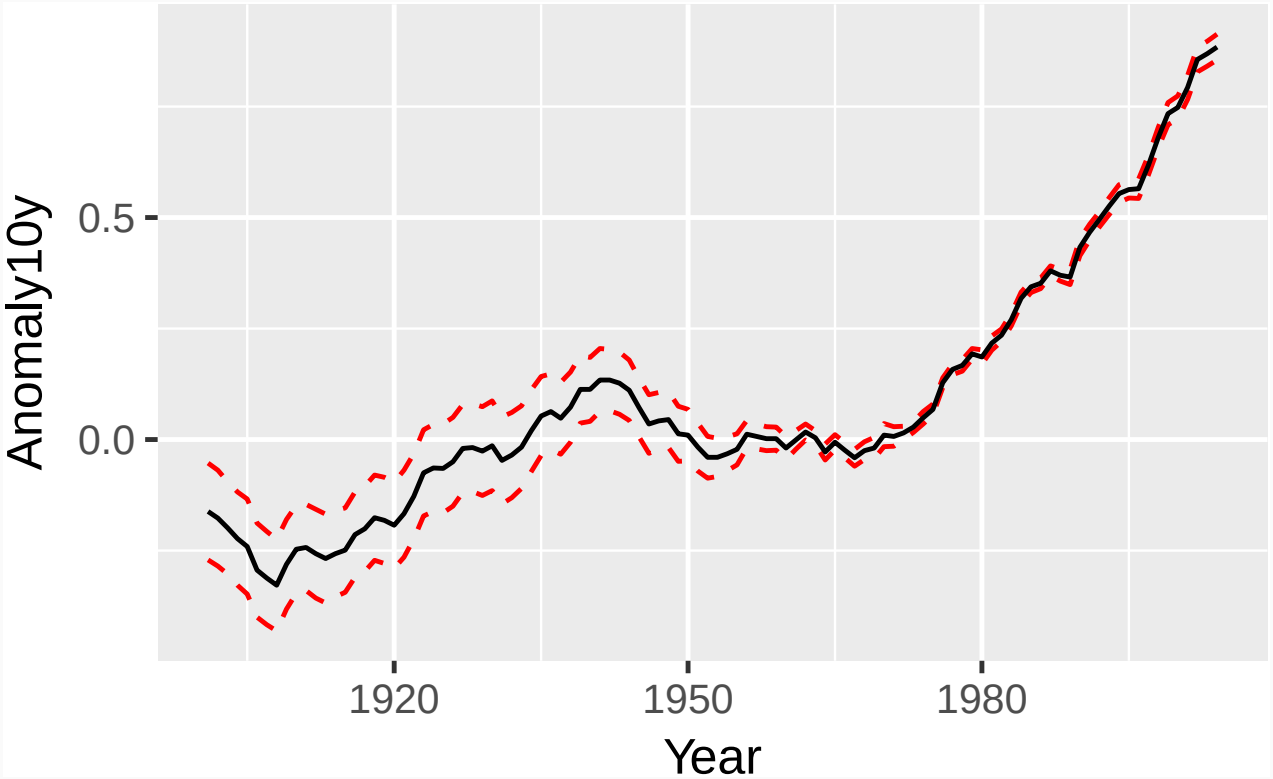
Histograms

Line plots

Exercise 2

Exercise 2

- Modify the last plot and change the ribbon to three separate lines, like below:

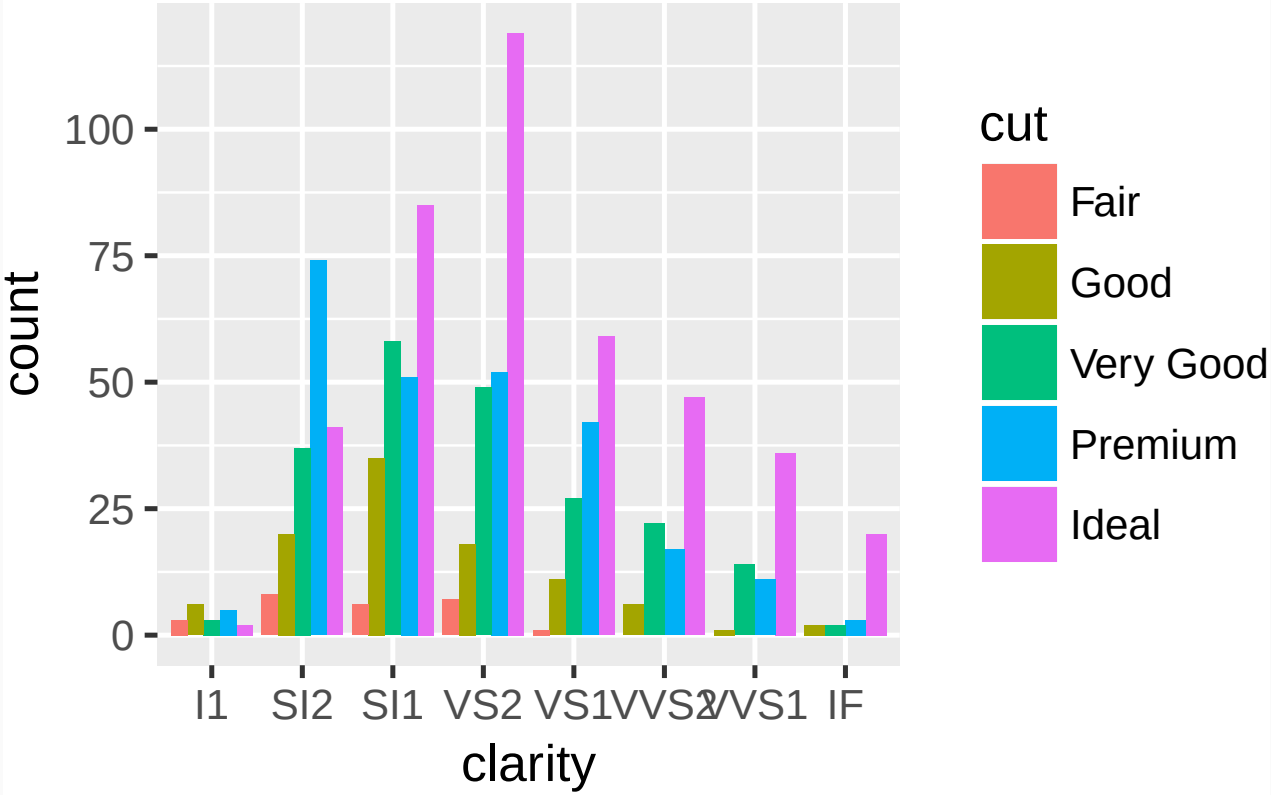


Bar plots

Exercises 3, 4, & 5

Exercise 3

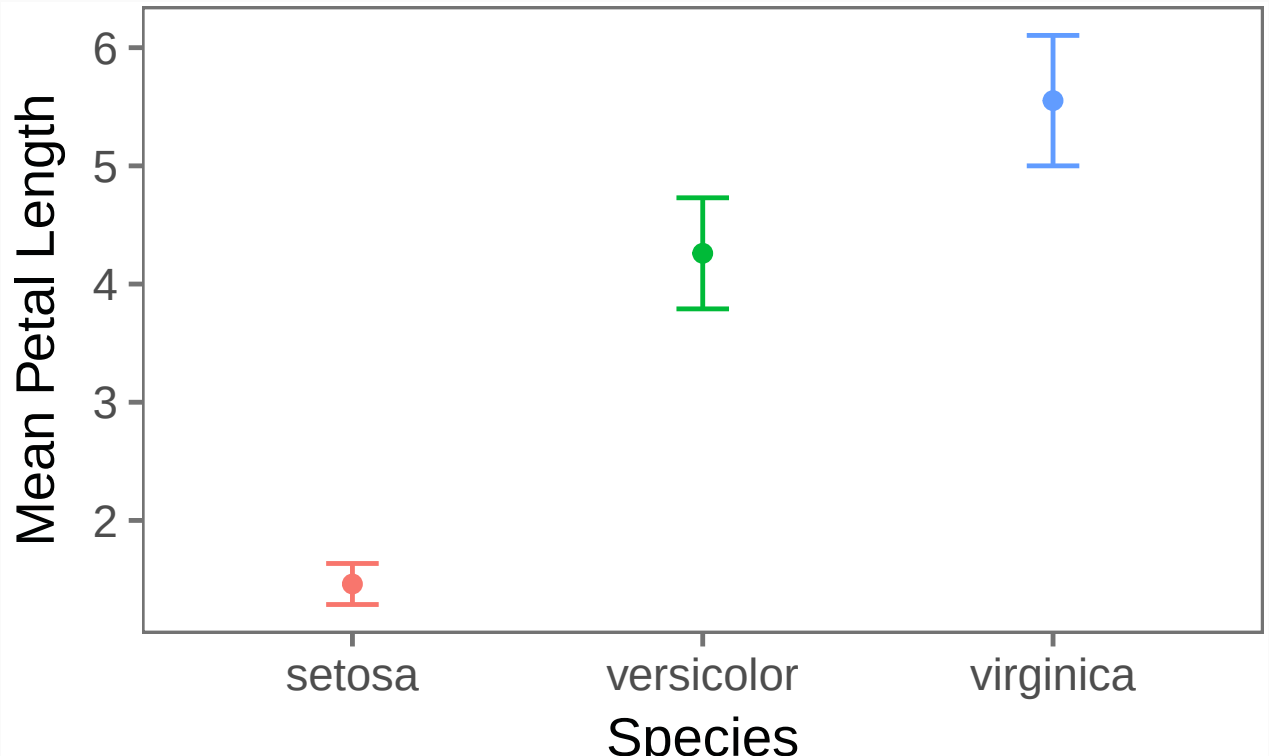
Using the d2 dataset you created earlier, make this plot:



Exercise 4

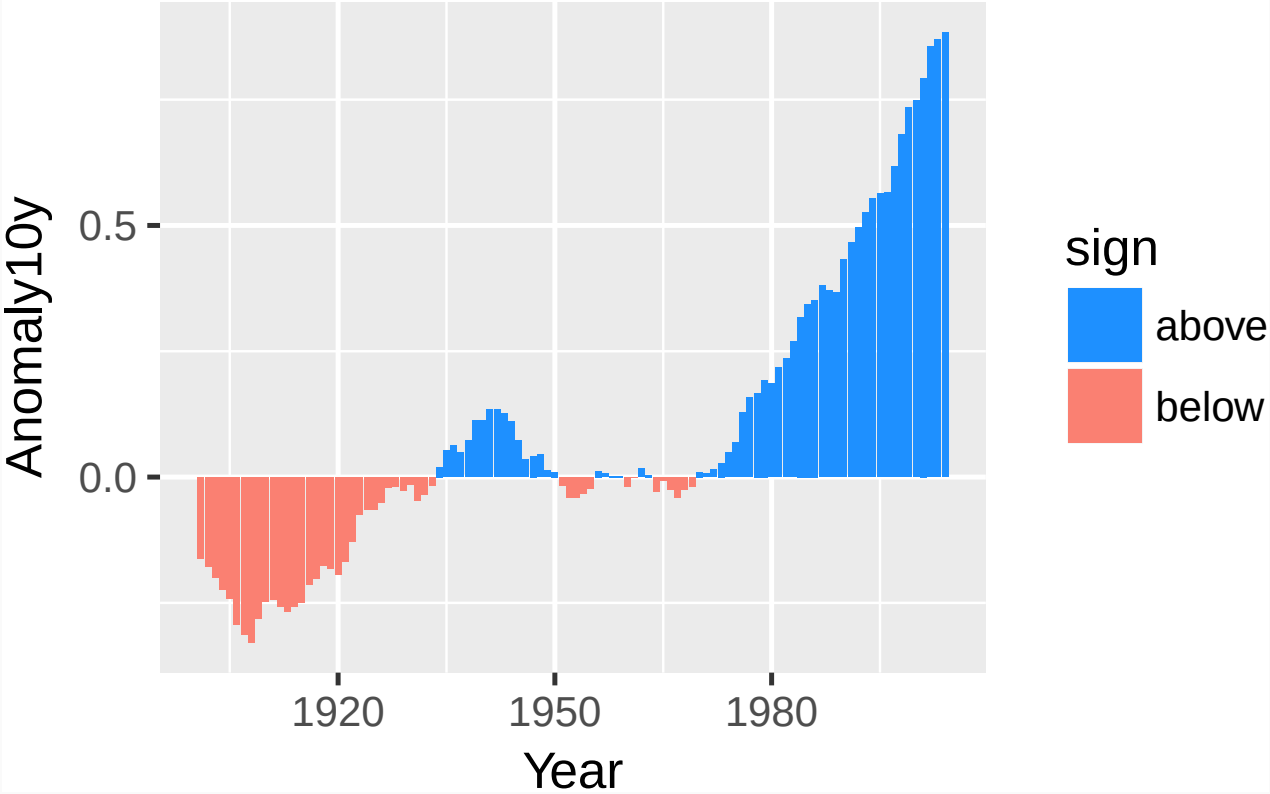
Use dplyr to summarize the iris data, then make the plot below.

```
iris_agg <- iris %>%
  group_by(Species) %>%
  summarise(mean_petal_len = mean(Petal.Length),
            sd_petal_len = sd(Petal.Length))
# ?geom_errorbar()
```



Exercise 5

- Using the `climate` dataset, create a new variable called `sign`. Make it categorical (above/below) based on the sign of `Anomaly10y`.
- Plot a bar plot and use sign variable as the fill.



Density plots

Adding smoothers

Themes!

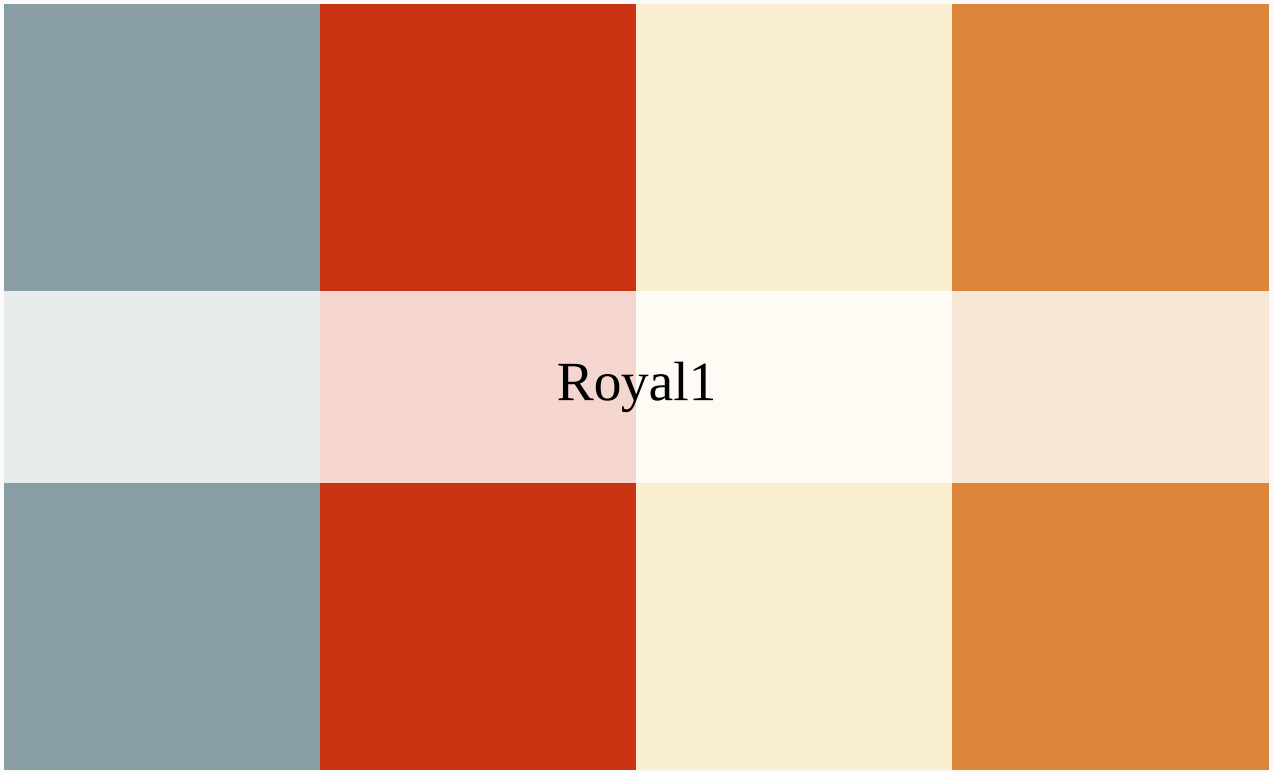
Adding themes

- Everything can be customized using `theme()` settings
- `http://ggplot2.tidyverse.org/reference/theme.html`

What about Wes Anderson?

There's a theme for that!

```
# install.packages('wesanderson')
library("wesanderson")
# display a palette
wes_palette("Royal1")
```



Save your beautiful plot

ggsave

- If the plot is on the screen

```
ggsave('~/path/to/figure/filename.png')
```

- If your plot is assigned to a named object

```
ggsave(plot1, '~/path/to/figure/filename.png')
```

- Specify size

```
ggsave(file = '~/path/filename.png', width = 4, height = 3, units = "in
```

- And format

```
ggsave(file = "/path/to/figure/filename.eps")
ggsave(file = "/path/to/figure/filename.jpg")
ggsave(file = "/path/to/figure/filename.pdf")
```

Further help

- We've only scratched the surface
- Practice
- Read: `http://ggplot2.tidyverse.org/index.html`
- Work together