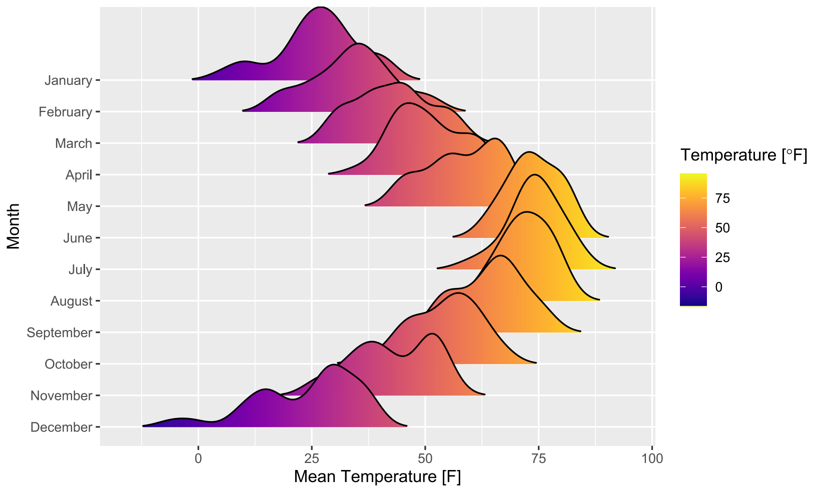
HEALTH
UNIVERSITY OF UTAH

Graphics

Andrew Redd, PhD.

R Bootcamp 2020


January
February
March
April
May
June
July
August
September
October
November
December
Month
0
25
50
75
100
Mean Temperature [F]
Temperature [°F]
75
50
25
0

Plots

Packages

Must have

- `ggplot2` (https://cran.r-project.org/package=ggplot2)
- `viridis` (https://cran.r-project.org/package=viridis)

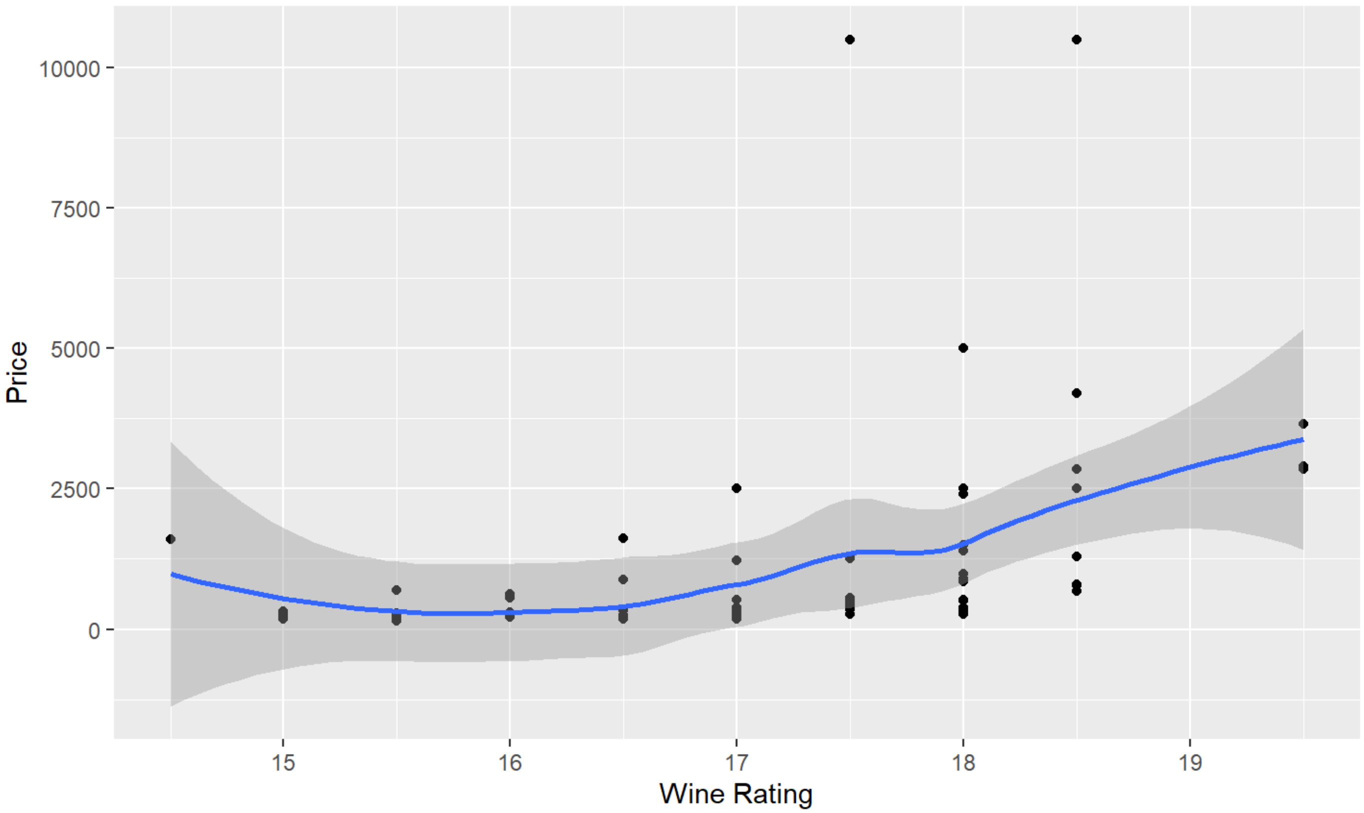
Extras to check out

- `ggridges` (https://cran.r-project.org/package=ggplot2)

Thought Exercise:

What are we trying to do with graphics?

Example: What are the components?



Graphics Systems

There are esentially 3 graphics systems in R:

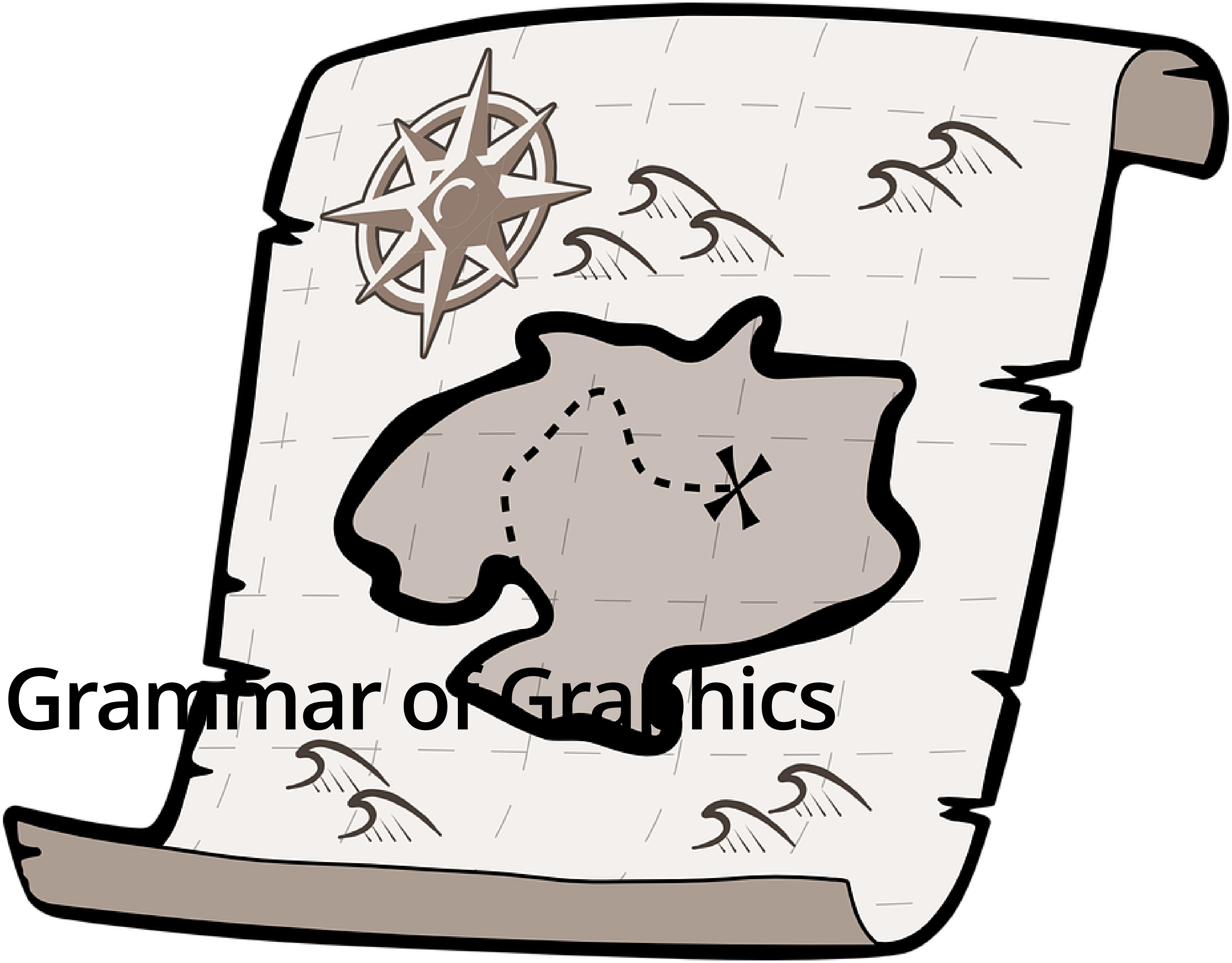
1. Base graphics
2. Grid graphics
3. ggplot2

Base Graphics

Don’t waste your time

Base Graphics

An even bigger waste of time



Grammar of Graphics

Gramar of Graphics

Building blocks of data visualizations.

- Aesthetics
    - location
    - size
    - shape
    - height
    - width
    - area
    - color
        - fill
        - border
    - transparency
    - ~~time/animation~~

Gramar of Graphics

Building 🧱blocks🧱 of data visualizations.

- Aesthetics…
- Data
    - map variables from data to aesthetics
    - Summarizations
        - outliers, Q1, Median Q3, outliers → Box plots
        - binning → histograms
        - density → density, violin, etc.
        - smoothing: loess, splines, etc.

Gramar of Graphics

Building blocks of data visualizations.

- Aesthetics…
- Data
- Coordinate System
    - Cartesian
    - Geographic
    - Polar
    - Scaling
        - Logarithmic
        - Square-root

Gramar of Graphics

Building blocks of data visualizations.

- Aesthetics…
- Data
- Coordinate System
- Facets
    - Grid
    - Strip
    - Wrap

Gramar of Graphics

Building blocks of data visualizations.

- Aesthetics…
- Data
- Coordinate System
- Facets
    - Grid
    - Strip
    - Wrap

Terminology

Terminology

Data

What we are visualizing

Geometry

The type of visualization.

Mapping

How variables translate variables from data to aesthetic components of the graph.

Statistic

If and how variables are to be summarized prior to being mapped to aesthetics.

Terminology

Terminology

Coordinates

How Axes are displayed.

Facets

How a visualization is to be broken into parts.

Position

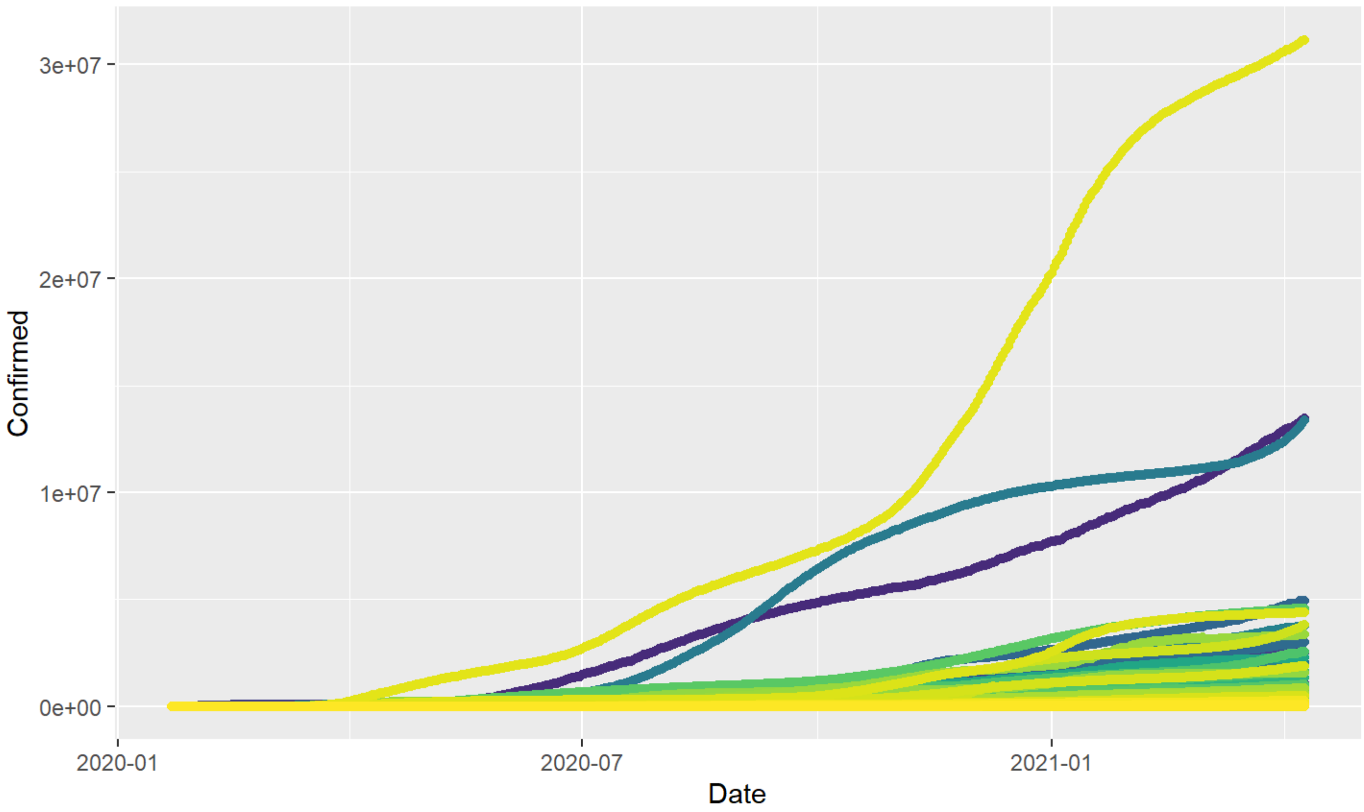
How elements should be positioned; sitter, stacked, dodge, etc.

Example

```
library(ggplot2)
load("data/covid.data.long.final.RData")
plot1 <-
ggplot(data=covid.data.long.final) +               #< Our 'data' component
    geom_point(                         #< a point geometry layer
        aes( x = Date  #< our mappings
           , y = Confirmed
           , col = `Country/Region`
           )
      , stat = 'unique'                 #< our statistic
      , position = 'identity'           #< how to position data
    ) +
    scale_color_viridis_d(guide=FALSE)
```

Example

```
plot1
```



We can do better.

Layers

Terminology

Layers

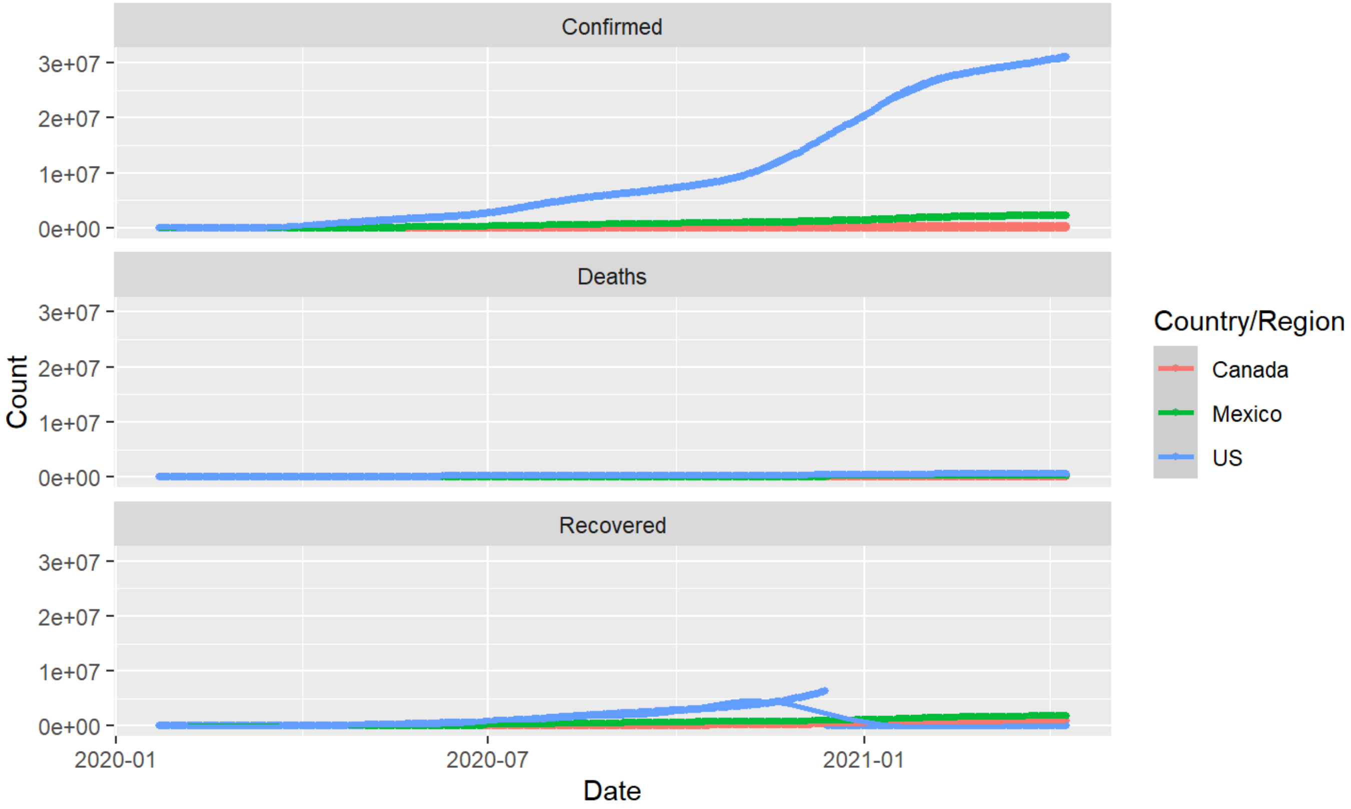
Layers are the combination of a geometry, data, mapping, statistic, and position.

Graphs may have and often do have many layers in them.

Layered Example

```
library(ggplot2)
load("data/covid.data.long.final.RData")
plot.data <- covid.data.long.final %>%
            filter(iso3c %in% !!c('USA', 'CAN', 'MEX')) %>%
            pivot_longer( Confirmed:Recovered
                        , names_to = 'Metric'
                        , values_to= 'Count'
                        )
plot2 <-
ggplot(data= plot.data
      , aes( x = Date
           , y = Count
           , col = `Country/Region`
           )
      ) +
    geom_point( stat = 'unique'
              , size = 1         #< An explicit aesthetic.
              ) +
    geom_smooth(method='gam', formula=y ~ s(x, bs = "cs")) +   #< new 'smooth' layer
    facet_wrap(~Metric, 3, 1)  #< faceting
```

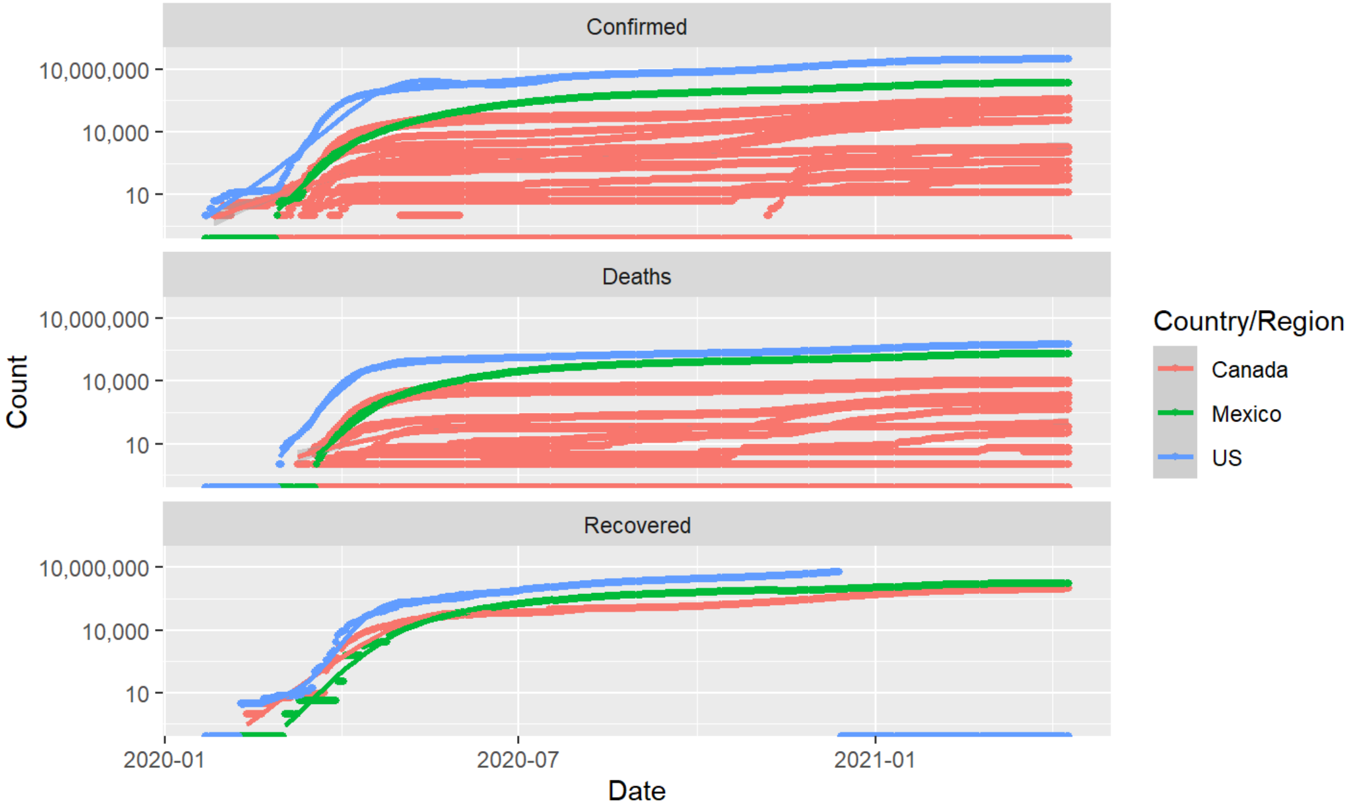
Layered Example



Scales

Reference (https://ggplot2.tidyverse.org/reference/#section-scales)

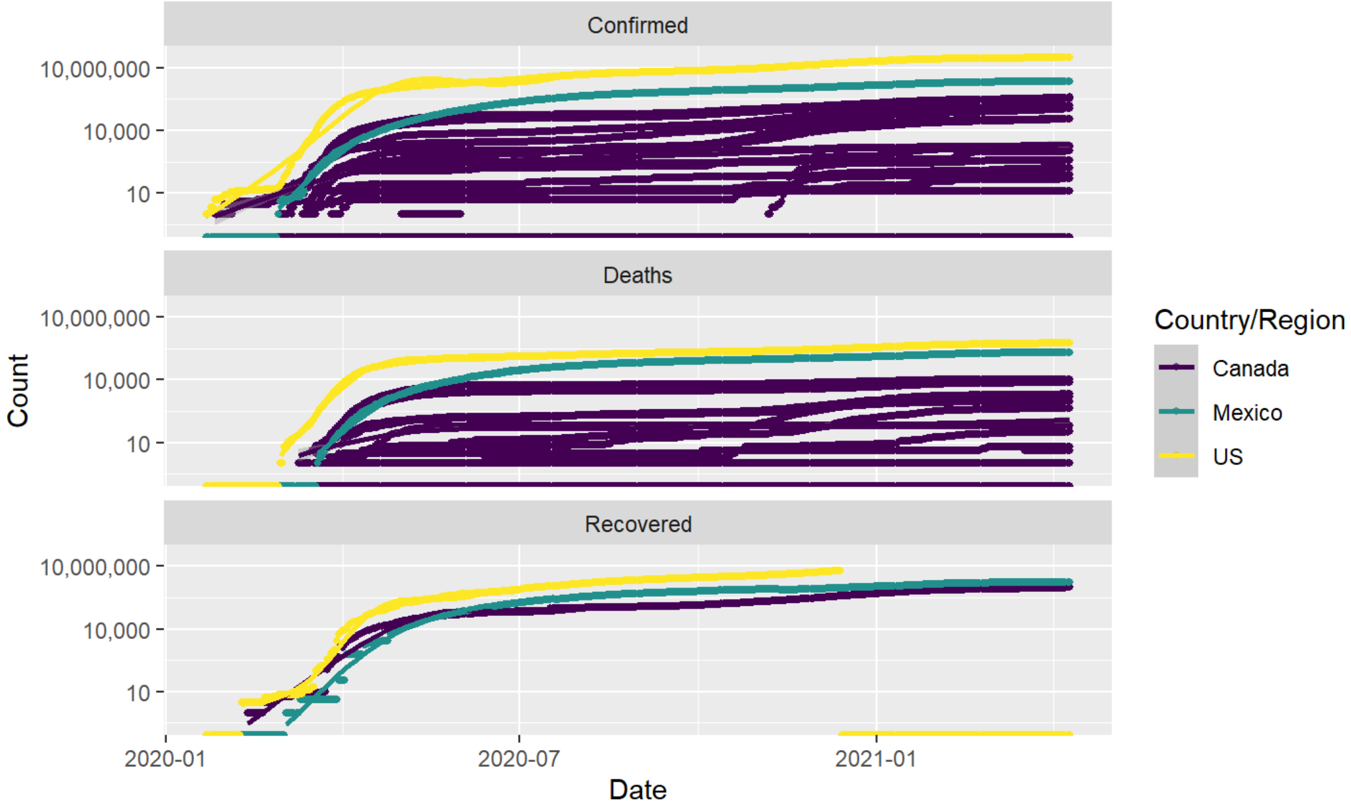
Scales


Confirmed
Deaths
Recovered
10,000,000
10,000
10
Count
2020-01
2020-07
2021-01
Date
Country/Region
Canada
Mexico
US

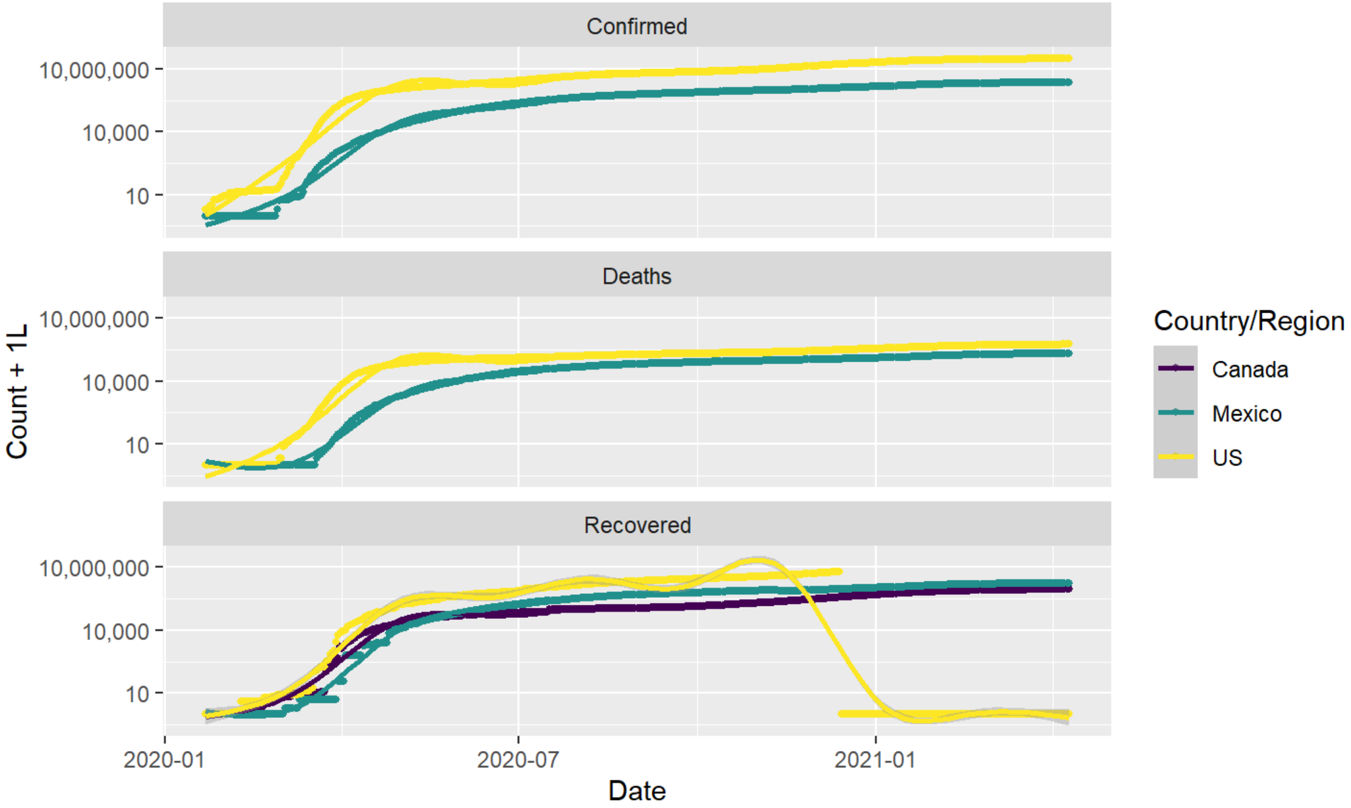
A comment about color

viridis (https://ggplot2.tidyverse.org/reference/scale_viridis.html)

```
plot3 + scale_color_viridis_d()
```



## Fix Canada


Confirmed
Deaths
Recovered
10,000,000
10,000
10
Count + 1L
2020-01
2020-07
2021-01
Date
Country/Region
Canada
Mexico
US

Themes

Themes are what control the non-data elements of a visualization

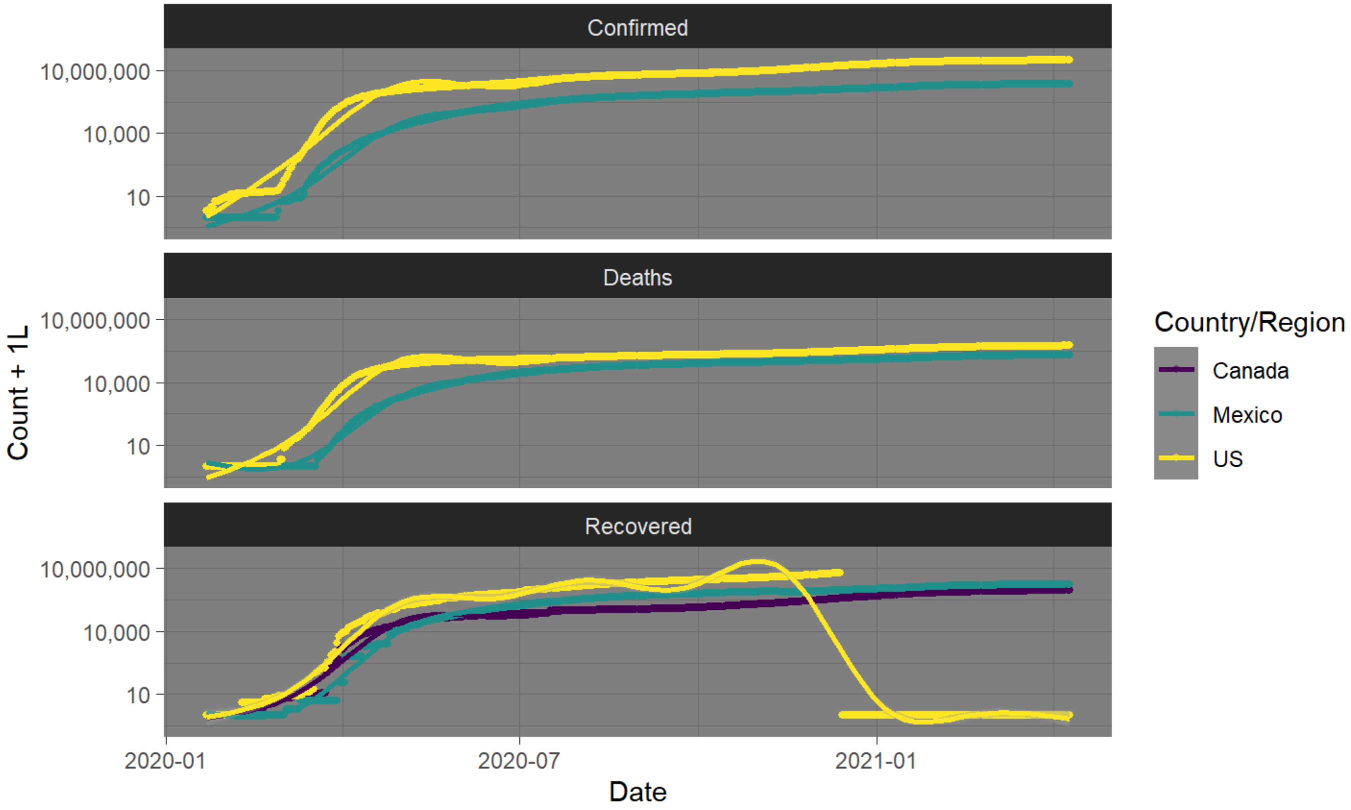
- Axes
- Grid
- Background
- Legend positioning, etc.

Built-in themes

- `theme_grey`
- `theme_bw`
- `theme_linedraw`
- `theme_light`
- `theme_dark`
- `theme_minimal`
- `theme_classic`

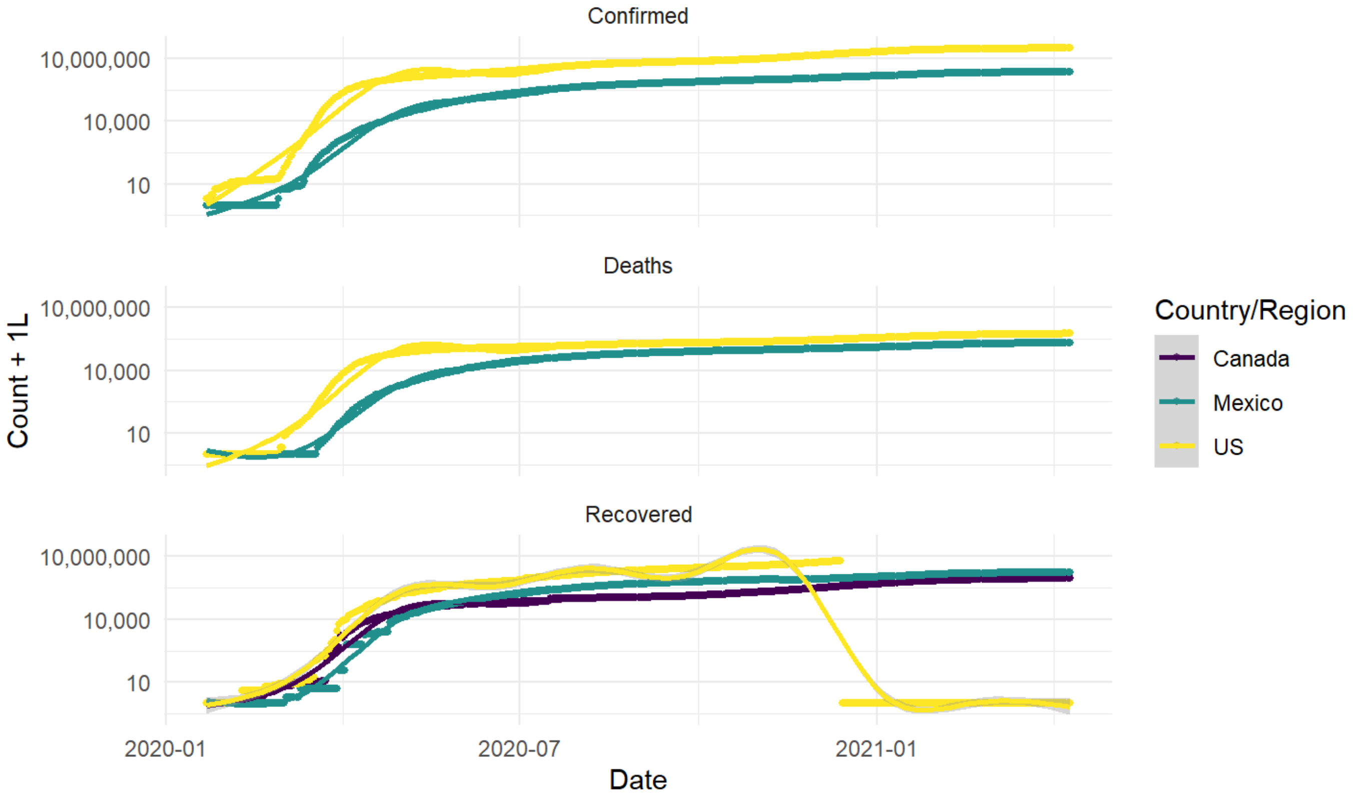
Theme Example, Dark

```
plot4 + theme_dark()
```



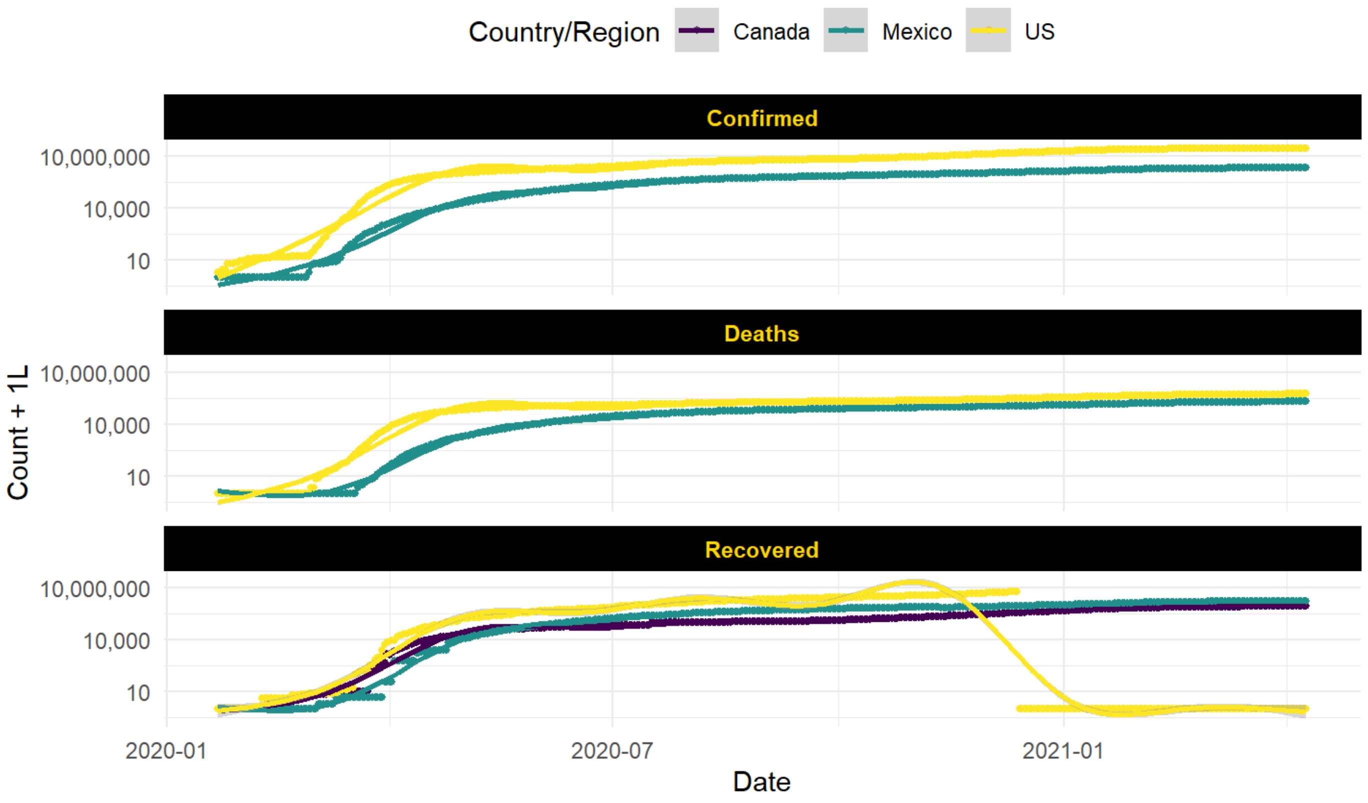
Theme Example, Minimal

```
plot4 + theme_minimal()
```



Customizing themes

```
plot4 + theme_minimal() +
    theme(legend.position="top"
         , strip.background=element_rect(fill='black')
         , strip.text= element_text(color='gold', face='bold'))
```



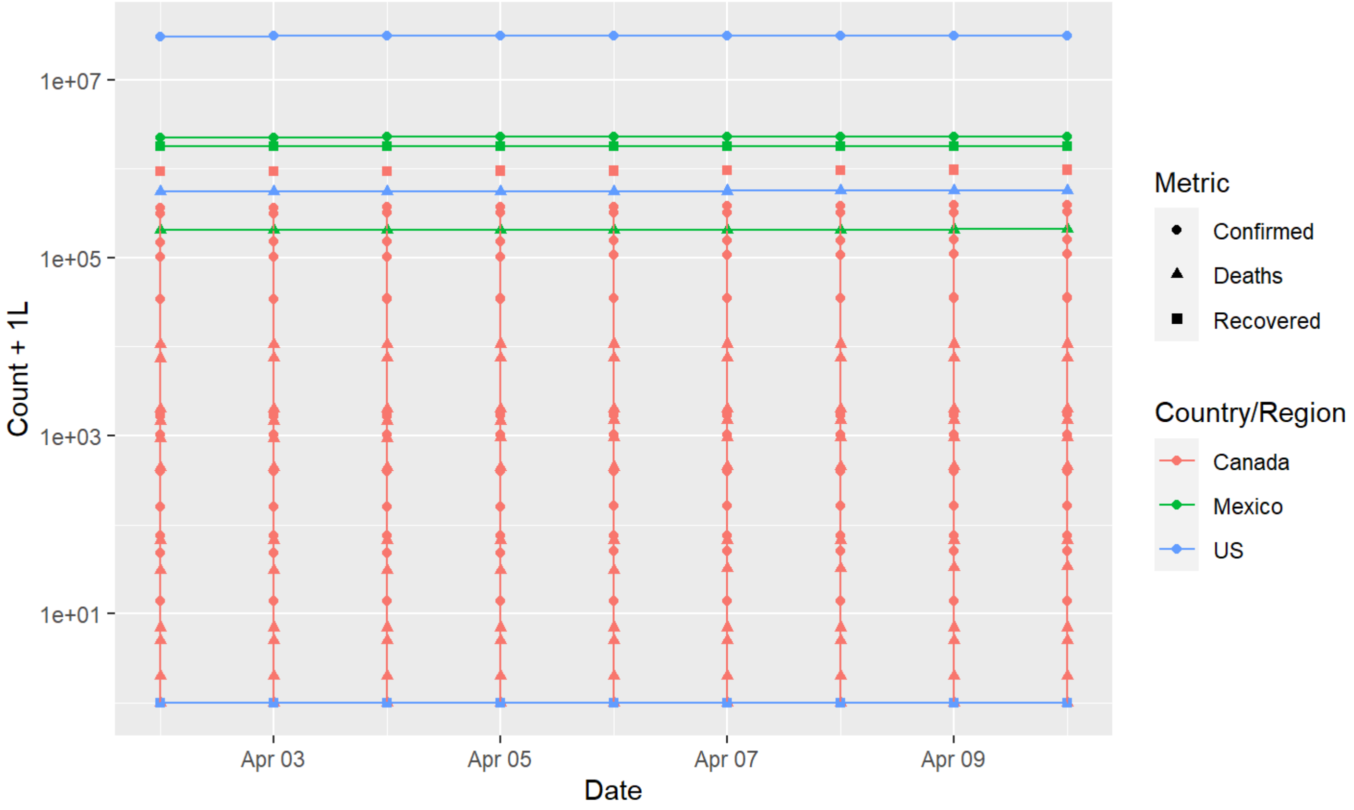
Reuse your theme

```
my.theme <- theme_minimal() + theme(legend.position="top",
    strip.background=element_rect(fill='black'),
    strip.text= element_text(color='gold', face='bold'))
ebola.plot1+my.theme
```

```
## Error in eval(expr, envir, enclos): object 'ebola.plot1' not found
```

The Shortcut qplot (quick plot)

```
qplot( Date, Count + 1L, color = `Country/Region`
     , shape= Metric
     , data=plot.data %>% filter(Date > "2021-04-01")) +
    geom_line()+
    scale_y_log10()
```



Exercises with Bordeaux Wines

1. Parker Points vs. Coates Points
2. Parker Points or Coates Points vs. Price
3. Price by First Growth or Cult Wine
4. A plot that includes at least
    1. Price
    2. Parker Points or Coates Points
    3. two of First Growth, Cult Wine, Pomerol, or Vintage Superstar

10:00

Solution: Preliminary

Fix the wine data so that the labels for indicators are a little nicer.

```
library(magrittr)
```

```
Message:##
## Attaching package: 'magrittr'
```

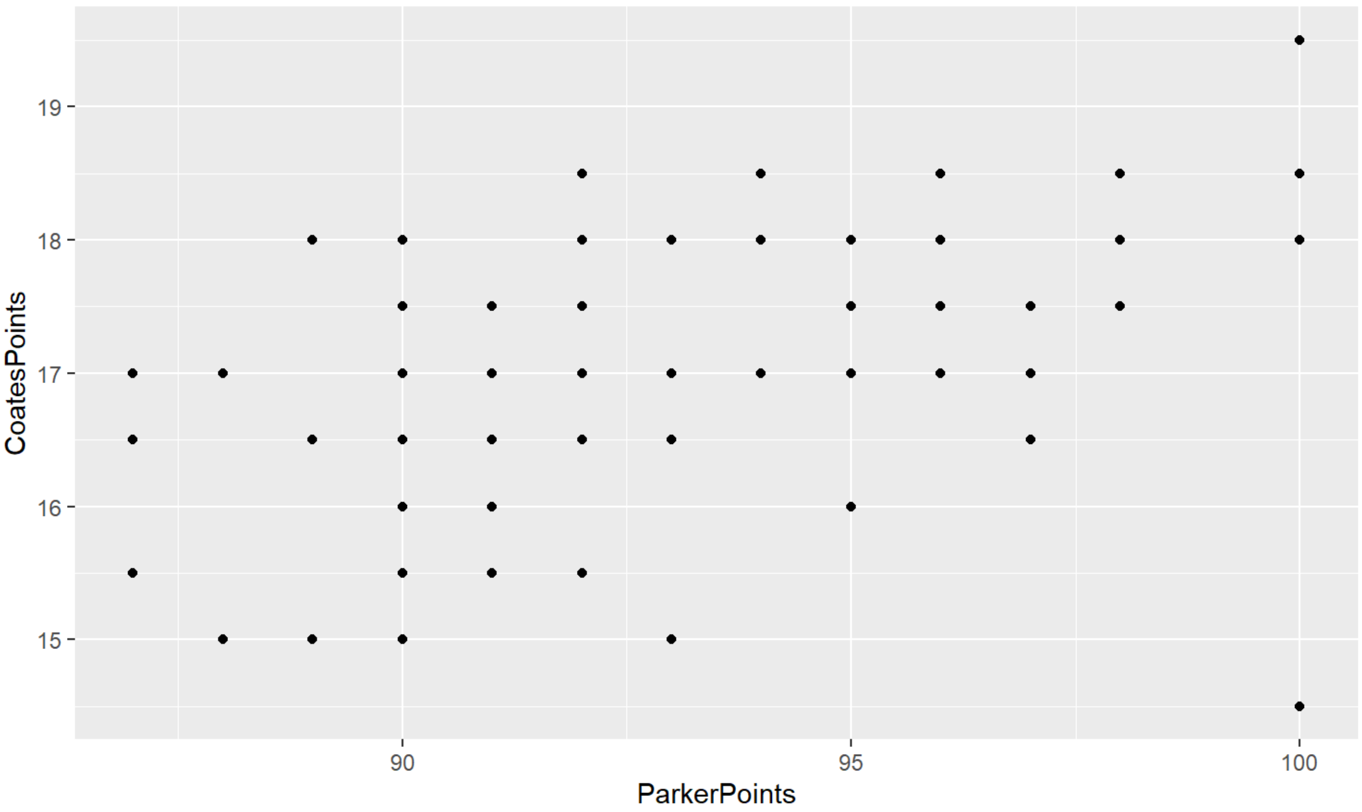
```
Message:## The following object is masked from 'package:purrr':
##
##     set_names
```

```
Message:## The following object is masked from 'package:tidyr':
##
##     extract
```

```
#assign back pipe
wine <- read.csv("data/Bordeaux.csv") %>%
        mutate_at( vars(FirstGrowth:VintageSuperstar)
                 , ~forcats::fct_recode(factor(.), No='0', Yes='1')
                 )
```

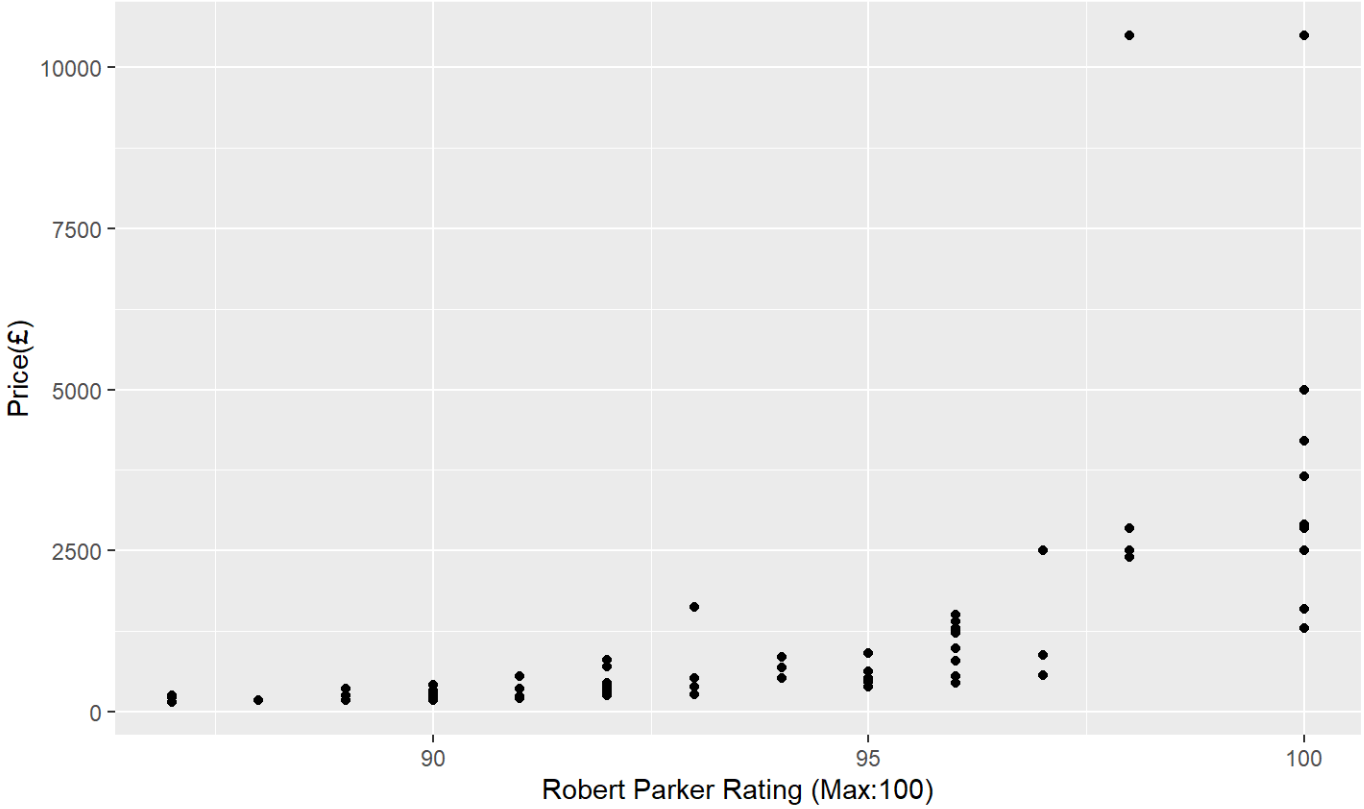
Solution: Parker Points vs. Coates Points

```
qplot(data=wine, ParkerPoints, CoatesPoints, geom='point')
```



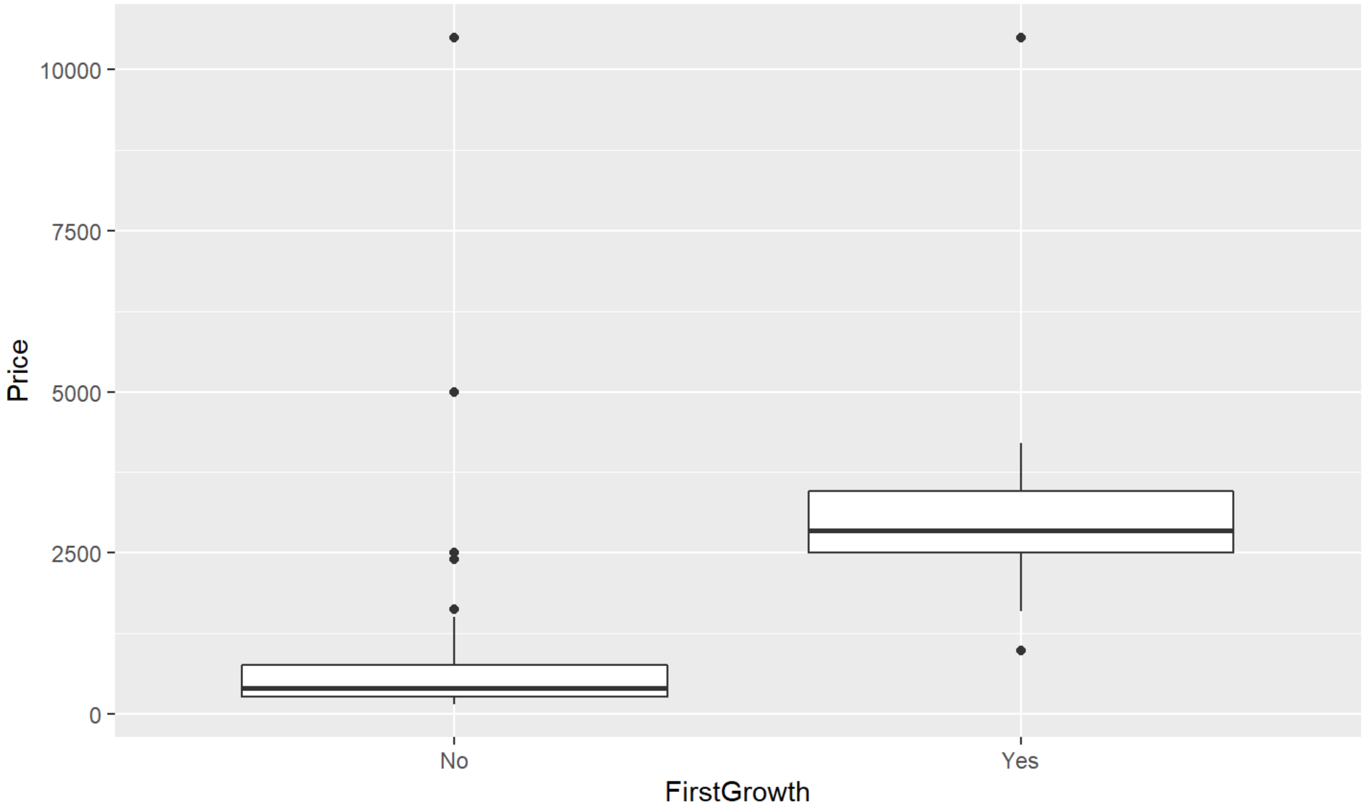
Solution: Parker Points vs. Price

```
qplot(data=wine, ParkerPoints, Price, geom='point') +
    labs(y = 'Price(\uA3)', x="Robert Parker Rating (Max:100)")
```



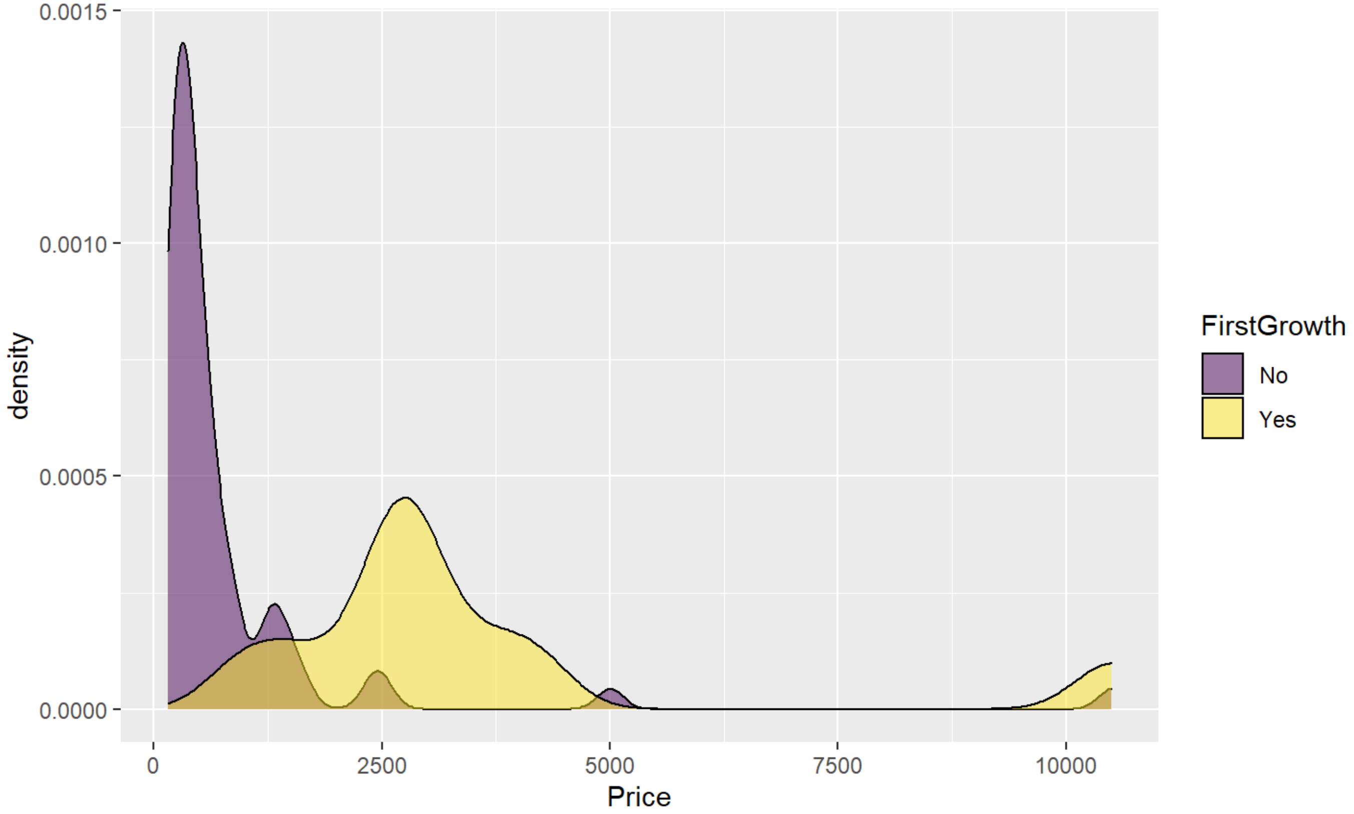
Solution: Price by First Growth Box plot

```
qplot(data=wine, x=FirstGrowth, y=Price
     , geom='boxplot', group=FirstGrowth) #< must include a group.
```



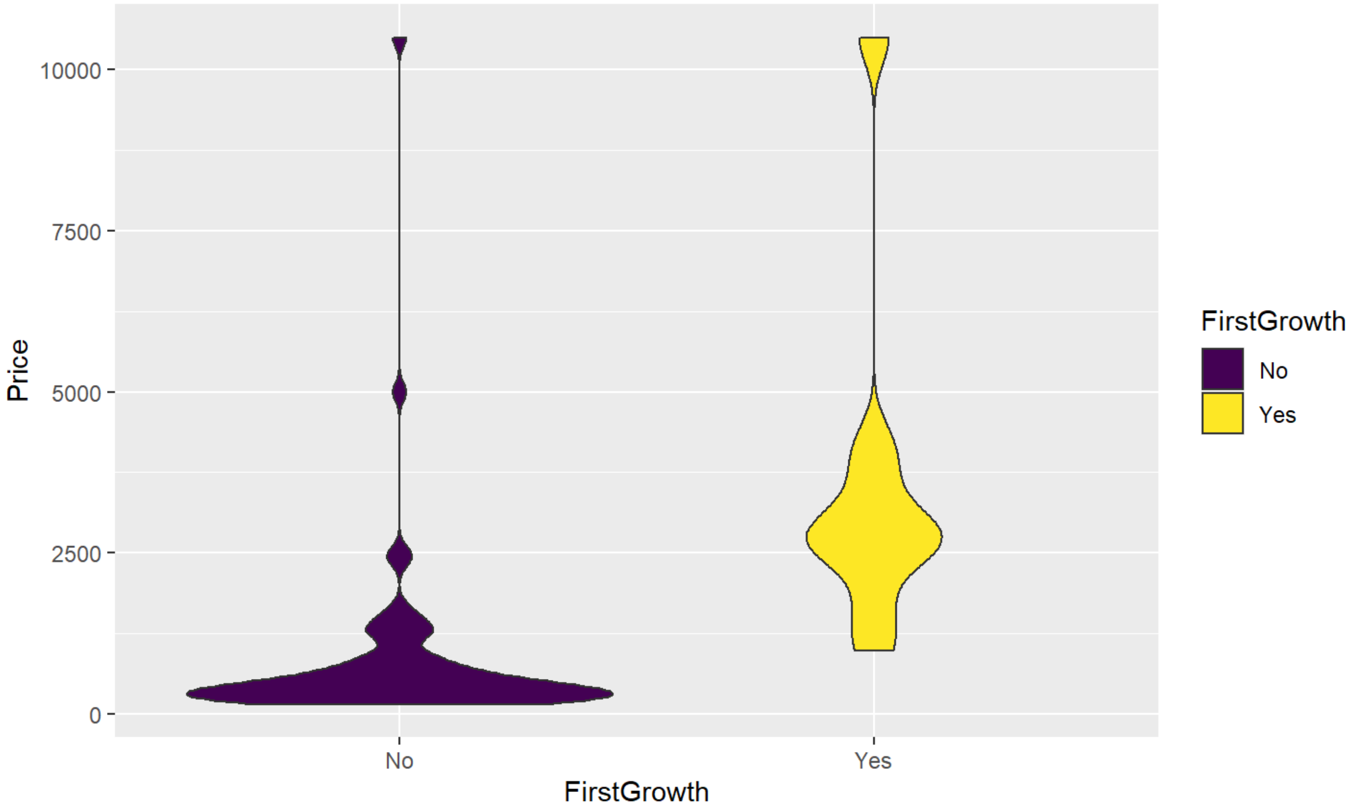
Solution: Price by First Growth Density

```
ggplot(data=wine) + geom_density(aes(x=Price, fill=FirstGrowth), alpha=0.5)+
    scale_fill_viridis_d()
```



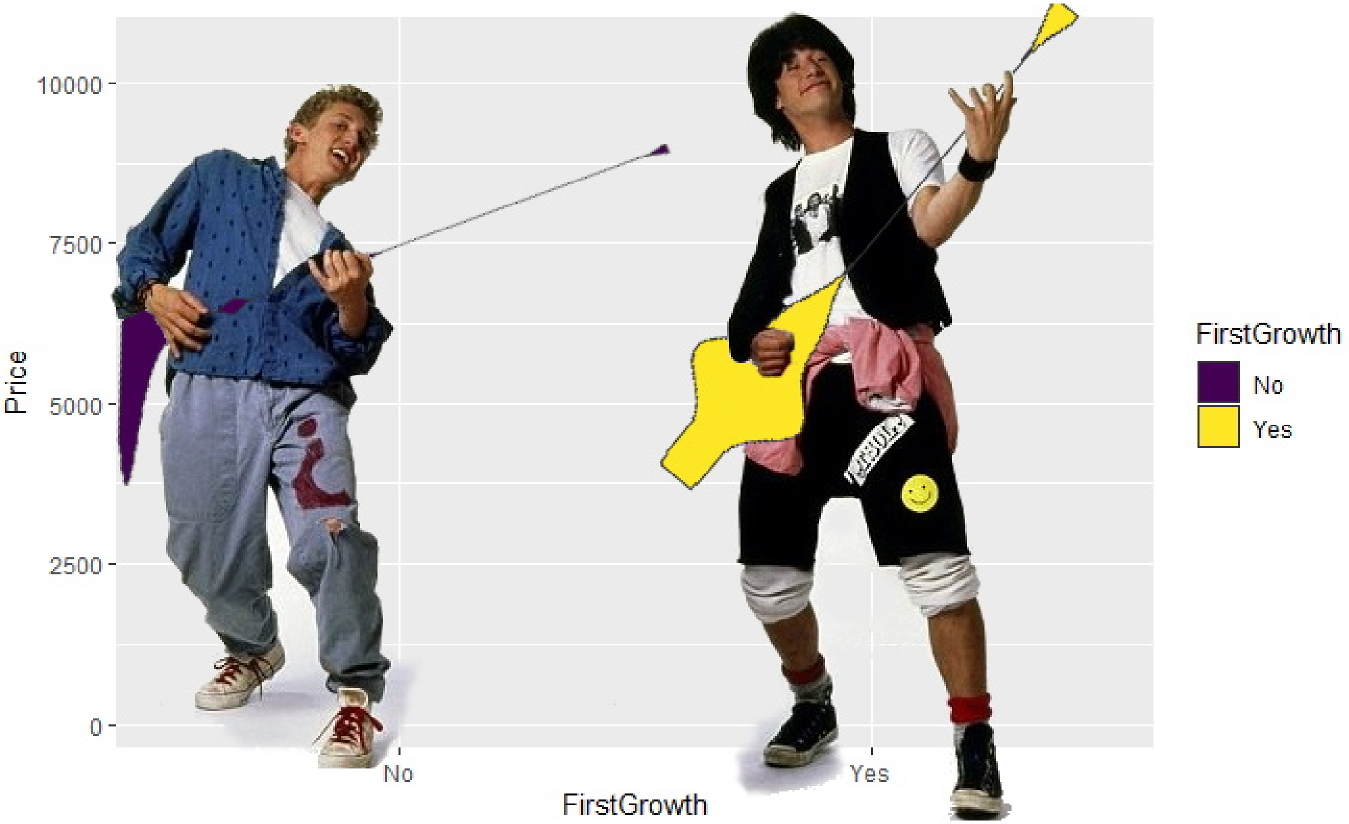
Solution: Price by First Growth Violins

```
ggplot(data=wine) + geom_violin(aes(y=Price, x=FirstGrowth, fill=FirstGrowth))+
    scale_fill_viridis_d()
```



Solution: Price by First Growth Guitar Plot

```
ggplot(data=wine) + geom_violin(aes(y=Price, x=FirstGrowth, fill=FirstGrowth))+
    scale_fill_viridis_d()
```

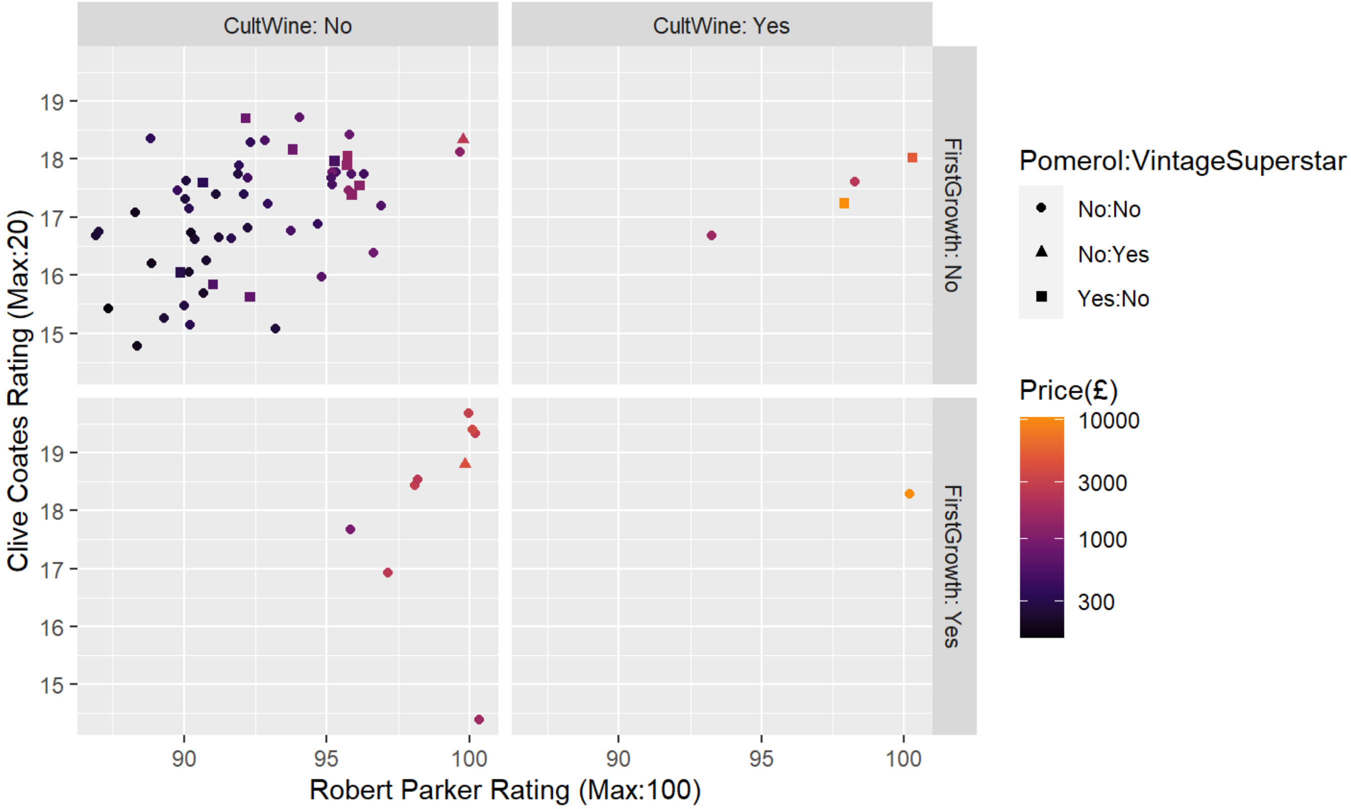


Solution: all the variables.

```
all.the.variables <- ggplot(data=wine) +
    # Five variables here.
    geom_point(aes( x   = ParkerPoints, y   = CoatesPoints
                  , col = Price, shape = Pomerol:VintageSuperstar
                  )
              # Jitter the position to avoid over-plotting
              , position=position_jitter(.4, .4))+
    # grid for two more variables
    facet_grid( FirstGrowth~CultWine
              , labeller=label_both
              ) + #^ Labels have both variable name and level.
    # Make colors pop for high value wines.
    scale_color_viridis_c(trans = 'log10', option="inferno", end=0.75) +
    labs( x = "Robert Parker Rating (Max:100)"
        , y = "Clive Coates Rating (Max:20)"
        , color = 'Price(\uA3)')
```

Solution: all the variables.

```
all.the.variables
```


CultWine: No
CultWine: Yes
FirstGrowth: No
FirstGrowth: Yes
Clive Coates Rating (Max:20)
Robert Parker Rating (Max:100)
Pomerol:VintageSuperstar
● No:No
▲ No:Yes
■ Yes:No
Price(£)