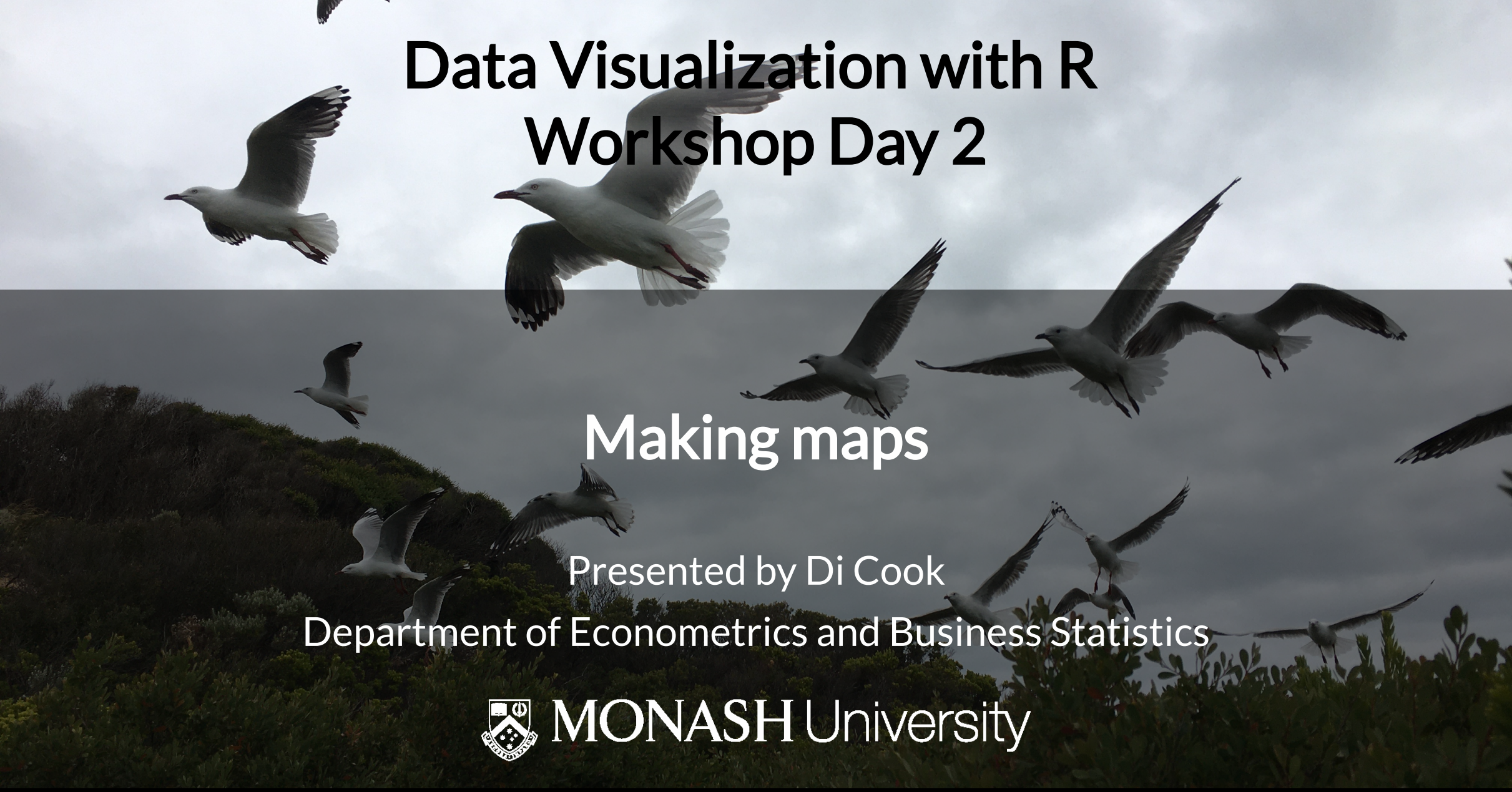
# Data Visualization with R
# Workshop Day 2



## Making maps

Presented by Di Cook

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MONASH University

16th April 2021 @ Statistical Society of Australia | Zoom

# Tuberculosis incidence

The TB data is from the WHO.

```
## # A tibble: 40,800 x 5
##    country      year age_group sex   count
##    <chr>       <dbl> <fct>     <chr> <dbl>
##  1 Afghanistan  1997 15-24     m        10
##  2 Afghanistan  1997 25-34     m         6
##  3 Afghanistan  1997 35-44     m         3
##  4 Afghanistan  1997 45-54     m         5
##  5 Afghanistan  1997 55-64     m         2
##  6 Afghanistan  1997 65-       m         0
##  7 Afghanistan  1997 15-24     f        38
##  8 Afghanistan  1997 25-34     f        36
##  9 Afghanistan  1997 35-44     f        14
## 10 Afghanistan  1997 45-54     f         8
## # … with 40,790 more rows
```

# What is a choropleth map?
# Why use a choropleth map?

# How do we get a map?

A polygon map of the world can be extracted from the `maps` package.

```
world_map <- map_data("world")
world_map %>%
  filter(region %in% c("Australia", "New Zealand")) %>%
      DT::datatable(width=1150, height=100)
```

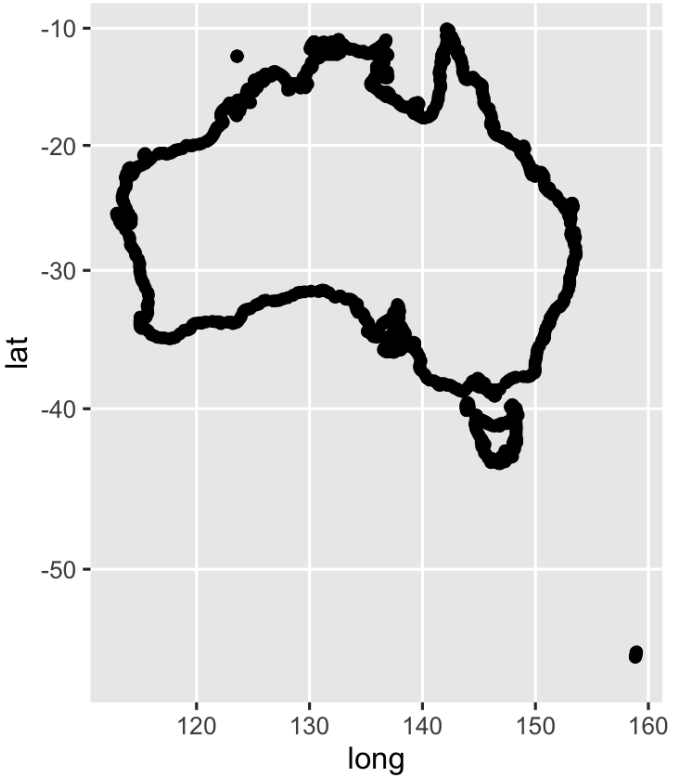
Show 10 entries Search:

| | long | lat | group | order | region | subregion |
|---|---|---|---|---|---|---|
| 1 | 123.594528198242 | -12.4256830215454 | 133 | 7115 | Australia | Ashmore and Cartier Islands |
| 2 | 123.595207214355 | -12.4359369277954 | 133 | 7116 | Australia | Ashmore and Cartier Islands |
| 3 | 123.573150634766 | -12.4341802597046 | 133 | 7117 | Australia | Ashmore and Cartier Islands |
| 4 | 123.572463989258 | -12.4239253997803 | 133 | 7118 | Australia | Ashmore and Cartier Islands |
| 5 | 123.594528198242 | -12.4256830215454 | 133 | 7119 | Australia | Ashmore and Cartier Islands |
| 6 | 158.878799438477 | -54.7097625732422 | 139 | 7267 | Australia | Macquarie Island |
| 7 | 158.84521484375 | -54.7492179870605 | 139 | 7268 | Australia | Macquarie Island |

# Maps are basically groups of connected dots

These are the points, defining the country boundary for Australia

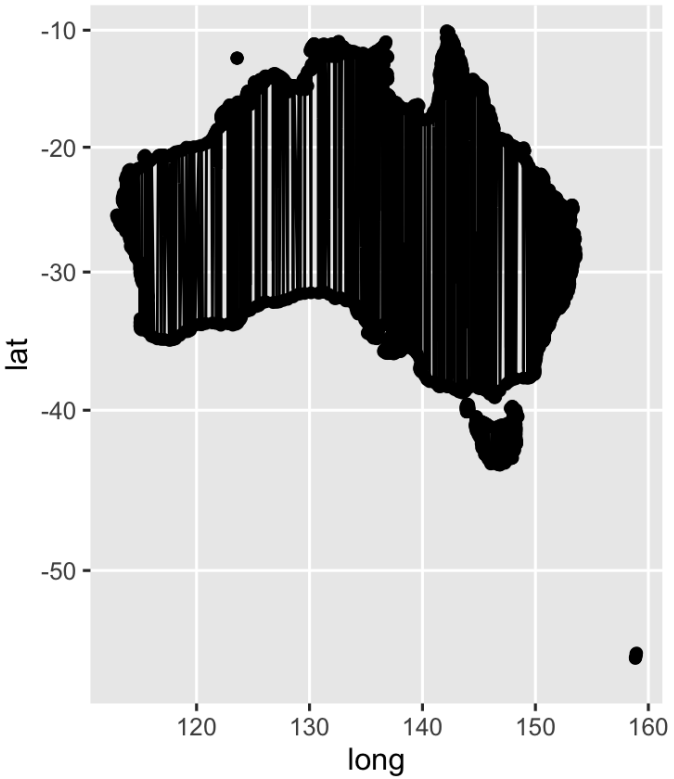
```
oz <- world_map %>%
  filter(region == "Australia")
ggplot(oz, aes(x = long, y = lat)) +
  geom_point() +
  coord_map()
```



## Connect the dots

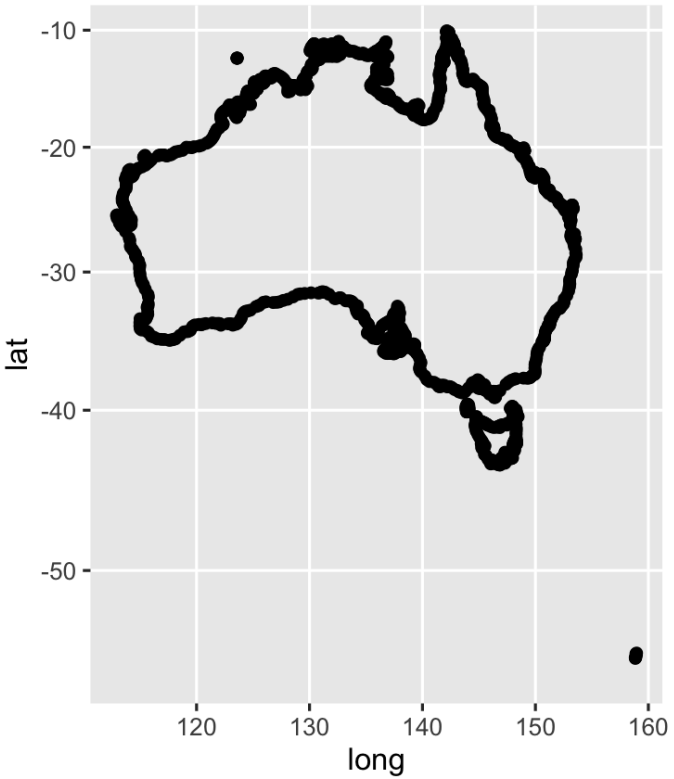
```
ggplot(oz, aes(x = long, y = lat,
               group = group)) +
  geom_point() +
  geom_line() +
  coord_map()
```

## What happened?



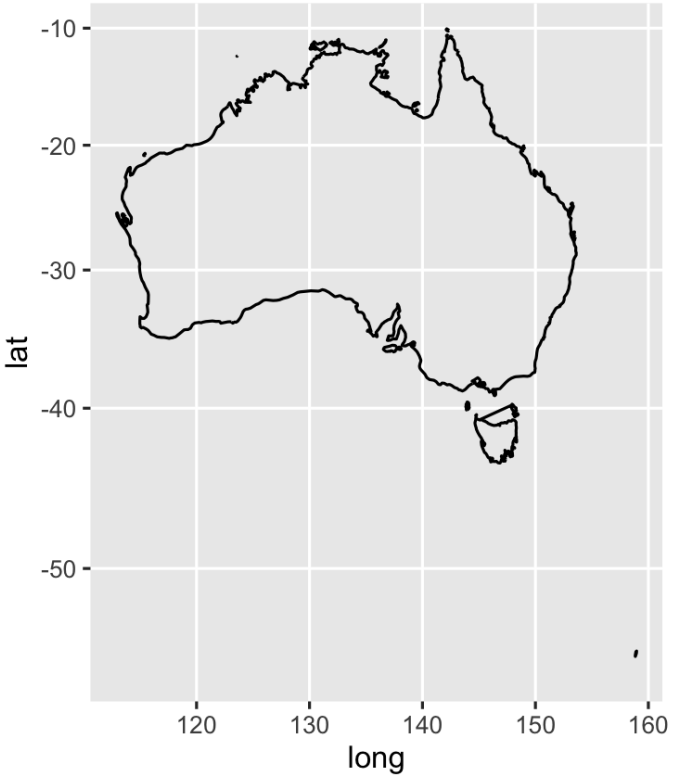
# Connect the dots

```
ggplot(oz, aes(x = long, y = lat,
               group = group)) +
  geom_point() +
  geom_path() +
  coord_map()
```



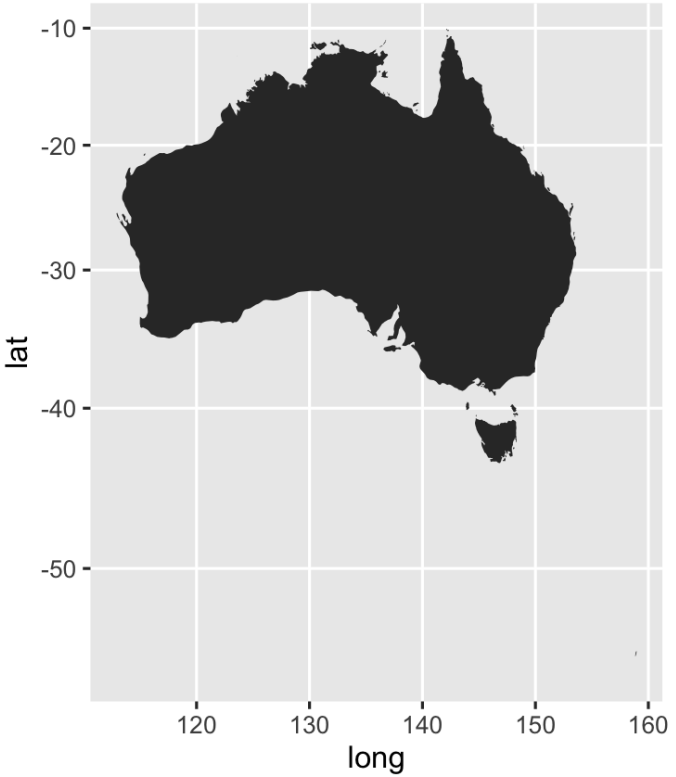
This map doesn't have states and territory connections.

```
ggplot(oz, aes(x = long, y = lat,
               group = subregion)) +
  geom_path() +
  coord_map()
```



We can also plot the map using `geom_polygon`, and fill with colour.

```
ggplot(oz, aes(x = long, y = lat,
               group = group)) +
  geom_polygon() +
  coord_map()
```



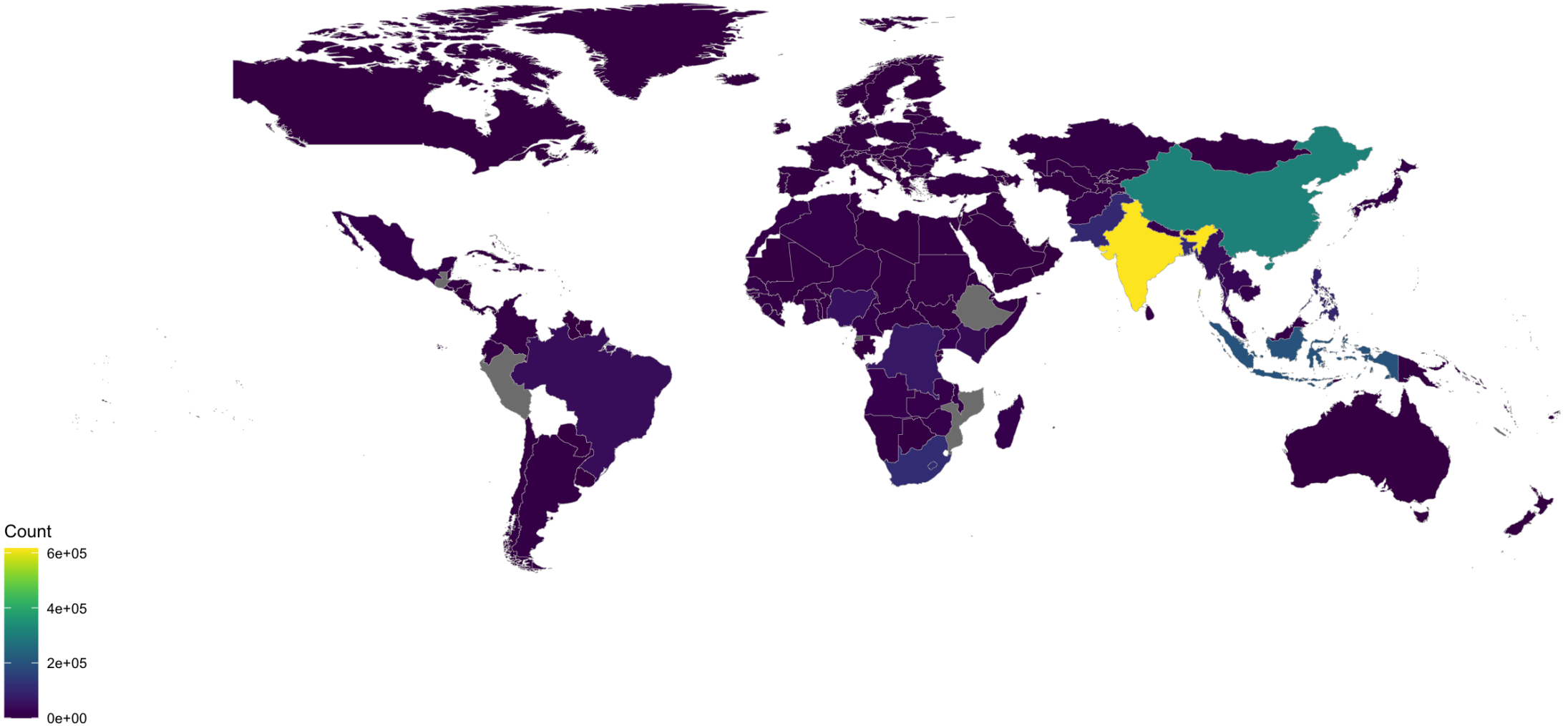
# Using a map theme makes the result look more map like

```
ggplot(oz, aes(x = long, y = lat,
               group = group)) +
  geom_polygon() +
  coord_map() +
  theme_map()
```

# Let's make a choropleth map of tuberculosis

# Aggregate counts across sex and age group for 2012

```
tb_2012 <- tb %>%
  filter(year == 2012) %>%
  rename(region = country) %>%
  group_by(region) %>%
  summarise(count = sum(count))
ggplot(tb_2012, aes(map_id = region)) +
    geom_map(aes(fill = count), map = world_map,
             color="grey70", size = 0.1, na.rm = TRUE) +
    expand_limits(x = world_map$long, y = world_map$lat) +
    scale_fill_viridis("Count") +
    theme_map()
```


Count
6e+05
4e+05
2e+05
0e+00

# What happened to the USA? UK?

# Check the name matching

```
wm_names <- world_map %>%
  select(region) %>%
  distinct()
tb_names <- tb %>%
  filter(year == 2012) %>%
  select(country) %>%
  distinct()
tb_miss_from_wm <- anti_join(tb_names, wm_names,
                             by=c("country" = "region"))
DT::datatable(tb_miss_from_wm, width = 1150, height = 100)
```

Show 10 entries Search:

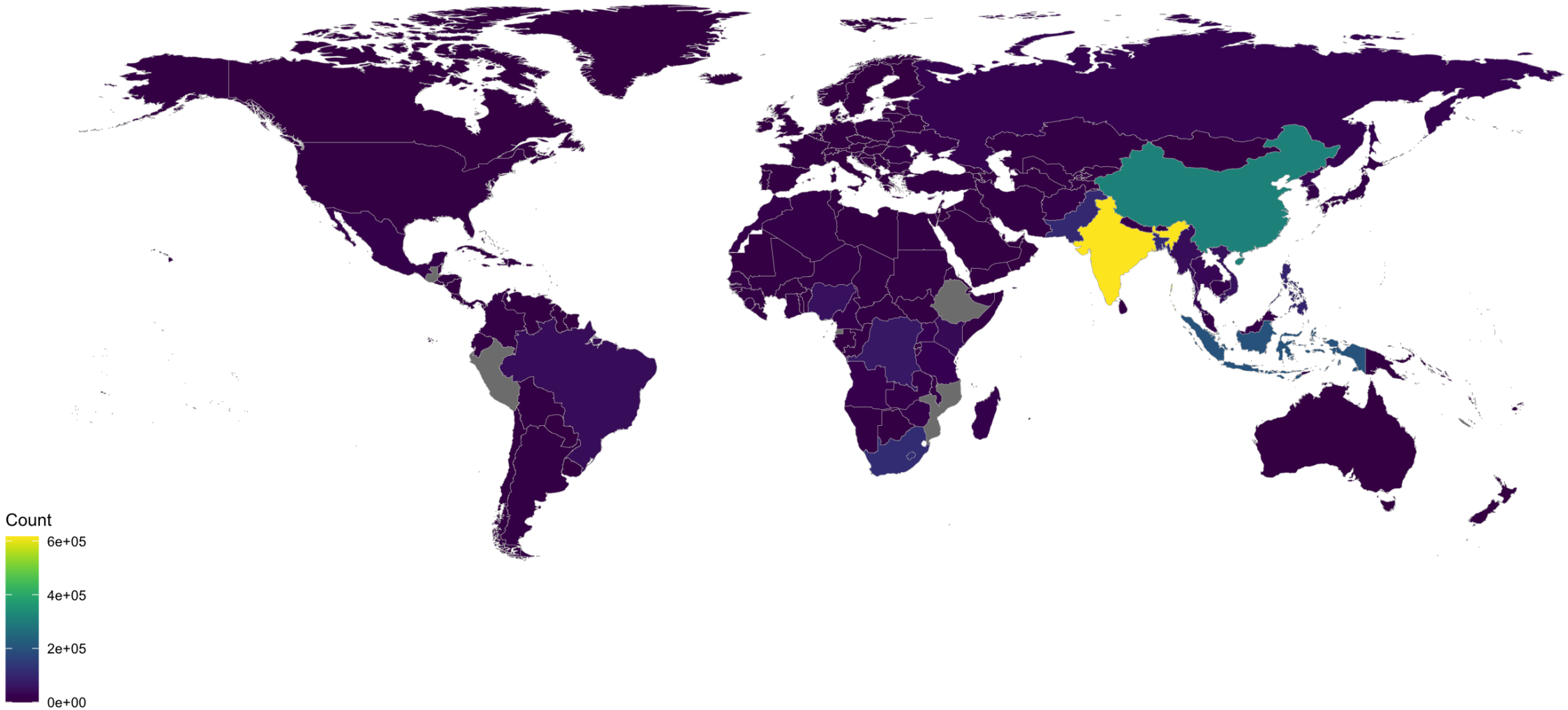
| | country |
|---|---|
| 1 | Antigua and Barbuda |
| 2 | Bolivia (Plurinational State of) |
| 3 | British Virgin Islands |
| 4 | Brunei Darussalam |

```
tb_fixed <- tb %>%
  mutate(region=recode(country,
                       "United States of America" = "USA",
                       "United Kingdom of Great Britain and Northern Ireland" = "
                       "Russian Federation" = "Russia",
                       "Viet Nam" = "Vietnam",
                       "Venezuela (Bolivarian Republic of)" = "Venezuela",
                       "Bolivia (Plurinational State of)" = "Bolivia",
                       "Czechia" = "Czech Republic",
                       "Iran (Islamic Republic of)" = "Iran",
                       "Iran (Islamic Republic of)" = "Laos",
                       "Democratic People's Republic of Korea" = "North Korea",
                       "Republic of Korea" = "South Korea",
                       "United Republic of Tanzania" = "Tanzania",
                       "Congo" = "Republic of Congo"))
```

Try again!

😄

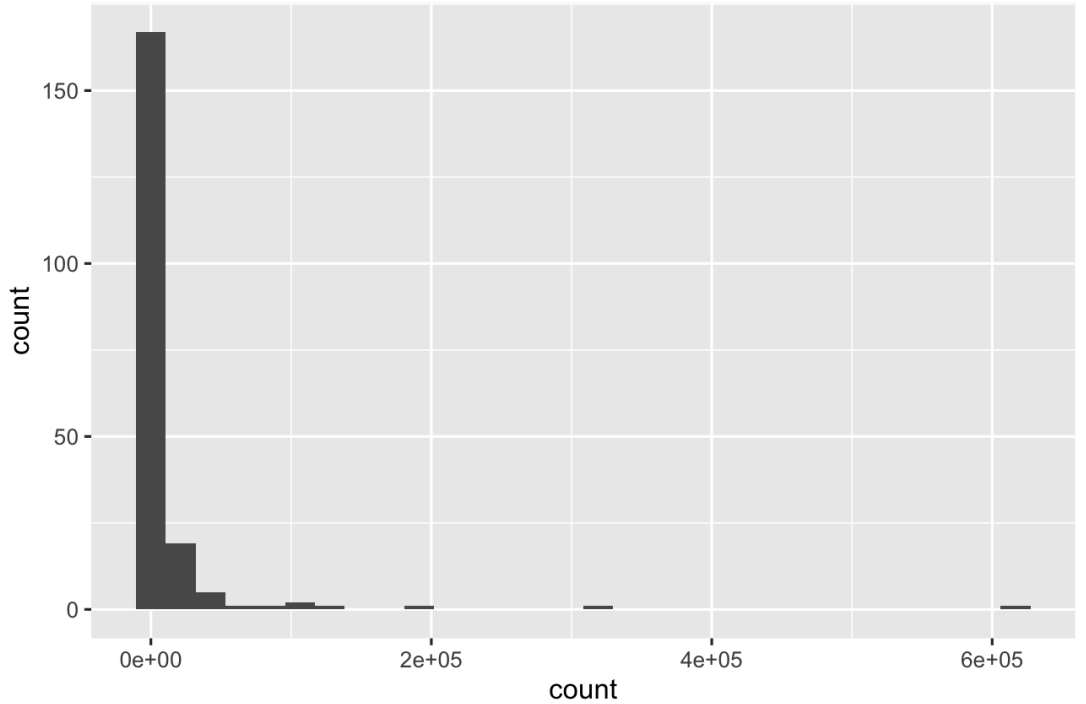
```
tb_2012 <- tb_fixed %>%
  filter(year == 2012) %>%
  group_by(region) %>%
  summarise(count = sum(count))
ggplot(tb_2012, aes(map_id = region)) +
    geom_map(aes(fill = count), map = world_map,
             color = "grey70", size = 0.1, na.rm = TRUE) +
    expand_limits(x = world_map$long, y = world_map$lat) +
    scale_fill_viridis("Count") +
    theme_map()
```


Count
6e+05
4e+05
2e+05
0e+00

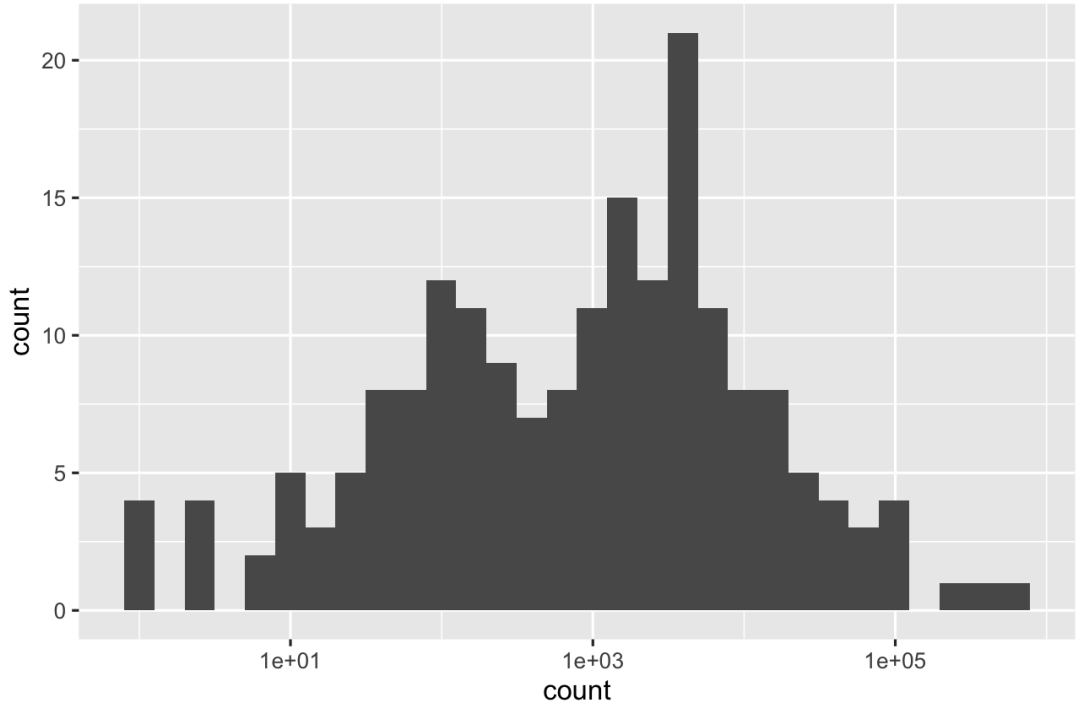
# Counts are typically skewed

may be best to symmetrise

```
ggplot(tb_2012, aes(x = count)) +
  geom_histogram()
```

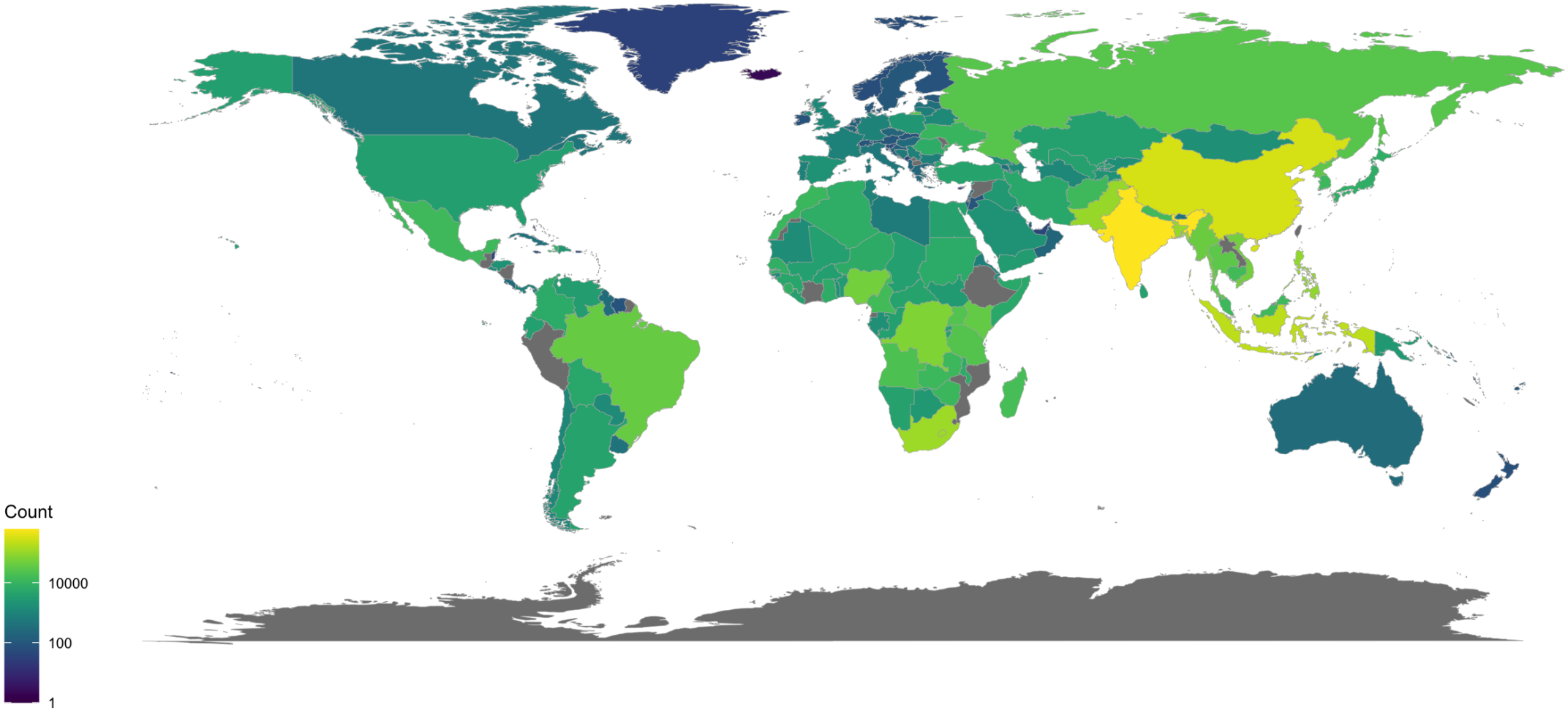


```
ggplot(tb_2012, aes(x = count)) +
  geom_histogram() +
  scale_x_log10()
```



# `geom_polygon` can also be used

```
tb_2012_map <- world_map %>% left_join(tb_2012)
ggplot(tb_2012_map, aes(x = long, y = lat, group=group)) +
    geom_polygon(aes(fill = count),
                 color="grey70", size = 0.1, na.rm = TRUE) +
    expand_limits(x = world_map$long*1.1, y = world_map$lat*1.1) +
    scale_fill_viridis("Count", trans = "log10") +
    theme_map()
```


Count
10000
100
1

# Let's try another one, COVID incidence in Victoria

- Choropleth
- Cartogram

# Get the data

This is extracted from https://www.covid19data.com.au/victoria

`data` R

Show 10 entries Search:

| | Date | NAME | cases |
|---|---|---|---|
| 1 | 2020-07-01 | Alpine | 1 |
| 2 | 2020-07-01 | Ararat | 5 |
| 3 | 2020-07-01 | Ballarat | 11 |
| 4 | 2020-07-01 | Banyule | 98 |
| 5 | 2020-07-01 | Bass Coast | 4 |
| 6 | 2020-07-01 | Baw Baw | 5 |
| 7 | 2020-07-01 | Bayside | 35 |
| 8 | 2020-07-01 | Benalla | 3 |
| 9 | 2020-07-01 | Boroondara | 76 |
| 10 | 2020-07-01 | Brimbank | 131 |

# Get the data

This is extracted from https://www.covid19data.com.au/victoria

data R

```
# Read the data
# Replace null with 0, for three LGAs
# Convert to long form to join with polygons
# Make the date variables a proper date
# Set NAs to 0, this is a reasonable assumption
covid <- read_csv(here::here("data/melb_lga_covid.csv")) %>%
  mutate(Buloke = as.numeric(ifelse(Buloke == "null", "0", Buloke))) %>%
   mutate(Hindmarsh = as.numeric(ifelse(Hindmarsh == "null", "0", Hindmarsh))) %>
   mutate(Towong = as.numeric(ifelse(Towong == "null", "0", Towong))) %>%
  pivot_longer(cols = Alpine:Yarriambiack, names_to="NAME", values_to="cases") %>
  mutate(Date = ydm(paste0("2020/",Date))) %>%
  mutate(cases=replace_na(cases, 0))
DT::datatable(covid, width=1150, height=100)
```

# Get a map from ozmaps

data R

- Read the LGA data from `ozmaps` package.
- This has LGAs for all of Australia.
- Need to filter out Victoria LGAs, avoiding LGAs from other states with same name, and make the names match covid data names. This is done using a regex expression removing () state and LGA type text strings

# Get a map from ozmaps

data R

```R
data("abs_lga")
vic_lga <- abs_lga %>%
  mutate(NAME = ifelse(NAME == "Latrobe (M) (Tas.)", "LatrobeM", NAME)) %>%
  mutate(NAME = ifelse(NAME == "Kingston (DC) (SA)", "KingstonSA", NAME)) %>%
  mutate(NAME = ifelse(NAME == "Bayside (A)", "BaysideA", NAME)) %>%
  mutate(NAME = str_replace(NAME, " \\(.+\\)", "")) %>%
  mutate(NAME = ifelse(NAME == "Colac-Otway", "Colac Otway", NAME))
vic_lga <- st_transform(vic_lga, 3395)
# 3395 is EPSG CRS, equiv to WGS84 mercator,
# see https://spatialreference.org/ref/epsg/?page=28
# cartogram() needs this to be set
```

# Join and colour the map

plot R

# Join and colour the map

plot R

```R
# Filter to final day, which is cumulative count
covid_cum <- covid %>%
  filter(Date == max(Date))

# Join covid data to polygon data, remove LGAs with
# missing values which should leave just Vic LGAs
vic_lga_covid <- vic_lga %>%
  left_join(covid_cum, by="NAME") %>%
  filter(!is.na(cases))

# Make choropleth map, with appropriate colour palette
p <- ggplot(vic_lga_covid) +
  geom_sf(aes(fill = cases, label=NAME), colour="white") +
  scale_fill_distiller("Cases", palette = "YlOrRd",
                       direction=1) +
  theme_map() +
```

# Get population data

`data` `R`

- Incorporate population data to make cartogram
- Population from https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future/tab-pages/victoria-in-future-data-tables
- Polygons are transformed so that area matches, as best possible, to the population

Show 10 entries Search:

| | NAME | pop |
|---|---|---|
| 1 | Alpine | 12578 |
| 2 | Ararat | 11746 |
| 3 | Ballarat | 103500 |
| 4 | Banyule | 127447 |
| 5 | Bass Coast | 33465 |
| 6 | Baw Baw | 49296 |
| 7 | Bayside | 102912 |
| 8 | Benalla | 13981 |

# Get population data

data R

```
pop <- read_xlsx("../data/VIF2019_Population_Service_Ages_LGA_2036.xlsx", sheet=3
  select(`...4`, `...22`) %>%
  rename(NAME = `...4`, pop=`...22`) %>%
  filter(NAME != "Unincorporated Vic") %>%
  mutate(NAME = str_replace(NAME, " \\(.+\\)", "")) %>%
  mutate(NAME = ifelse(NAME == "Colac-Otway", "Colac Otway", NAME)) %>%
  mutate(pop = round(pop, 0))
DT::datatable(pop, width=1150, height=100)

vic_lga_covid <- vic_lga_covid %>%
  left_join(pop, by="NAME")

# Compute additional statistics
vic_lga_covid <- vic_lga_covid %>%
  group_by(NAME) %>%
  mutate(cases_per10k = max(cases/pop*10000, 0),
```

# Make a cartogram

plot R

# Make a cartogram

plot R

```R
# Make a contiguous cartogram
vic_lga_covid_carto <- cartogram_cont(vic_lga_covid, "pop")
# This st_cast() is necessary to get plotly to work
vic_lga_covid_carto <- st_cast(vic_lga_covid_carto, "MULTIPOLYGON")

p <- ggplot(vic_lga_covid_carto) +
  geom_sf(aes(fill = cases, label=NAME), colour="white") +
  scale_fill_distiller("Cases", palette = "YlOrRd",
                       direction=1) +
  theme_map() +
  theme(legend.position="bottom")
p
```

# Resources

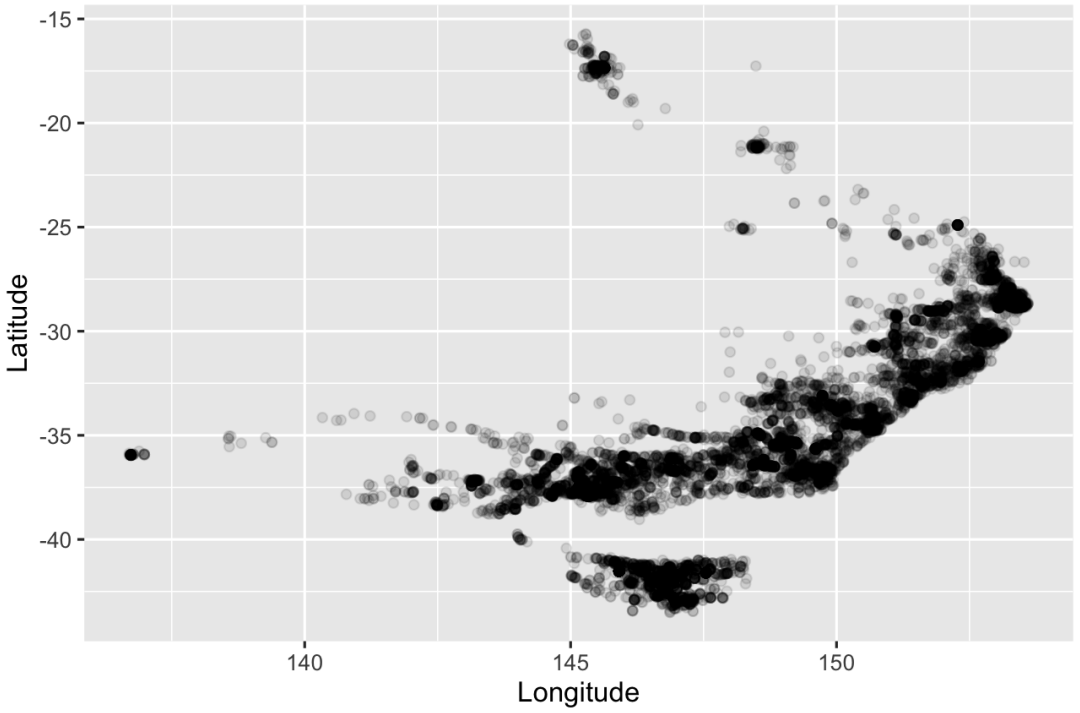
Where to go to get more help on maps

- `ozmaps` package: https://github.com/mdsumner/ozmaps, https://mdsumner.github.io/ozmaps/
- `eechidna` package https://docs.ropensci.org/eechidna/
- https://www.littlemissdata.com/blog/maps
- https://www.r-spatial.org/r/2018/10/25/ggplot2-sf.html
- https://www.paulamoraga.com/book-geospatial/sec-spatialdataandCRS.html

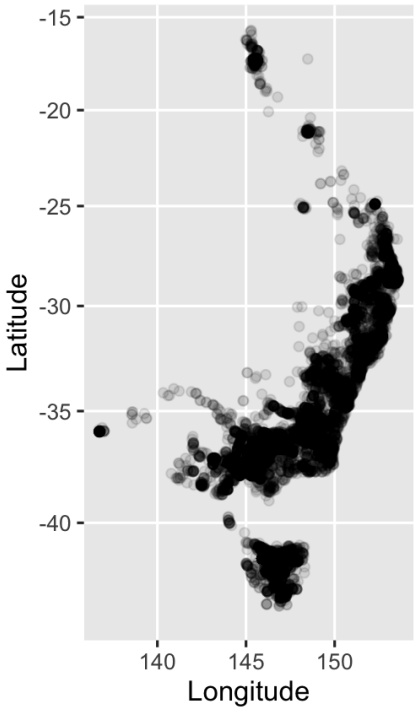
Note: It is important when converting spatial objects from a mapping software to a data analysis project is "thinning" the map to make it smaller and efficient to work with.

# Reading google maps and overlaying data

```
load(here::here("data/platypus.rda"))
p <- ggplot(platypus) +
  geom_point(aes(x = Longitude,
                 y = Latitude),
             alpha = 0.1)
p
```




```
p + coord_map()
```



# Extract Open Street Map using ggmap

```
oz_bbox <- c(112.9, # min long
             -45, # min lat
             159, # max long
             -10) # max lat
oz_map <- get_map(location = oz_bbox, source = "osm")
save(oz_map, file=here::here("data/oz_map.rda"))
```

```
load(here::here("data/oz_map.rda"))
ggmap(oz_map) +
  geom_point(data = platypus,
             aes(x = Longitude,
                 y = Latitude),
             alpha = 0.1,
             colour = "orange") +
  theme_map()
```

## </> Open `day2-exercise-02.Rmd`

15:00

# Session Information

```
devtools::session_info()
```

```
## ─ Session info ─────────────────────────────────────────────────────────────
##  setting  value
##  version  R version 4.0.1 (2020-06-06)
##  os       macOS  10.16
##  system   x86_64, darwin17.0
##  ui       X11
##  language (EN)
##  collate  en_AU.UTF-8
##  ctype    en_AU.UTF-8
##  tz       Australia/Melbourne
##  date     2021-04-07
##
## ─ Packages ─────────────────────────────────────────────────────────────────
##  package     * version   date       lib
```