IE6600 Computation and Visualization for Analytics

Application of Data Visualization

Zhenyuan Lu

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Applicatin of Data Visualization

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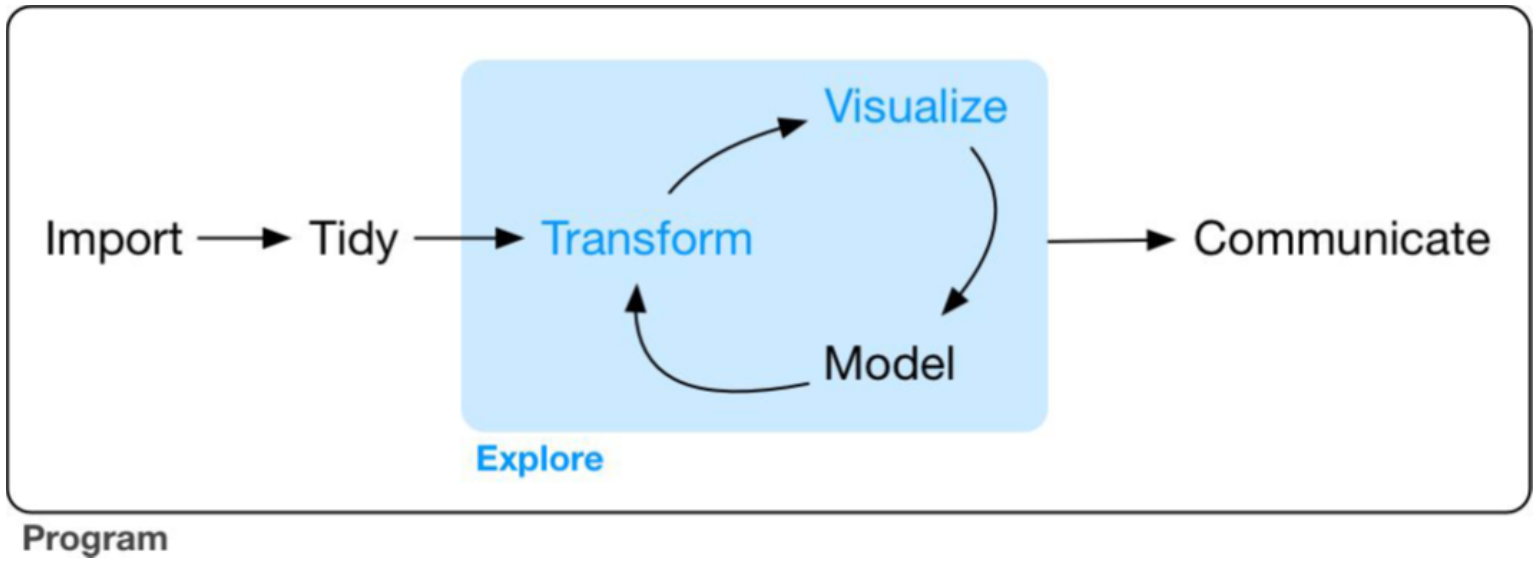
Goal



Wickham, Hadley, and Garrett Grolemund. R For Data Science. OReilly, 2017.

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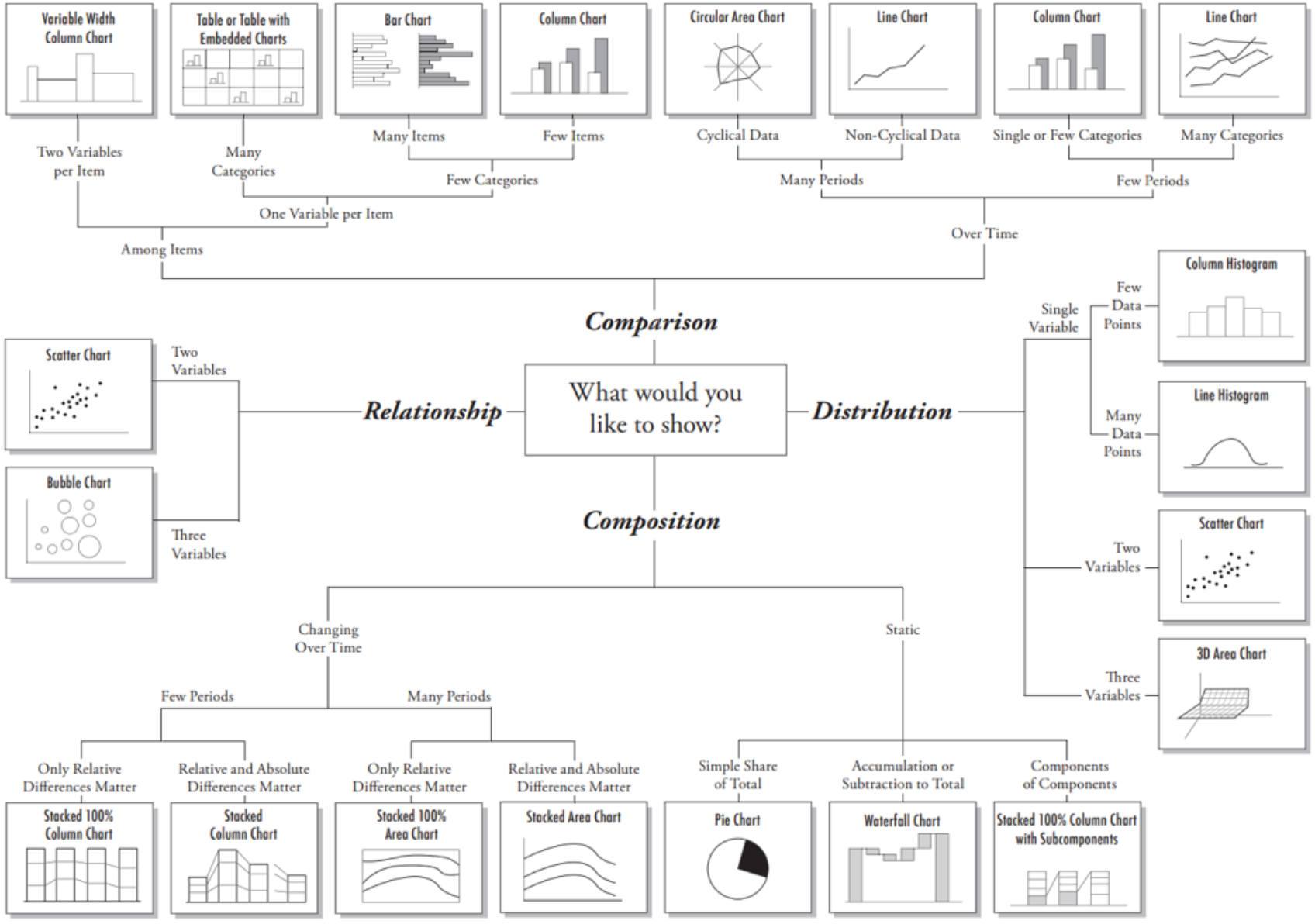

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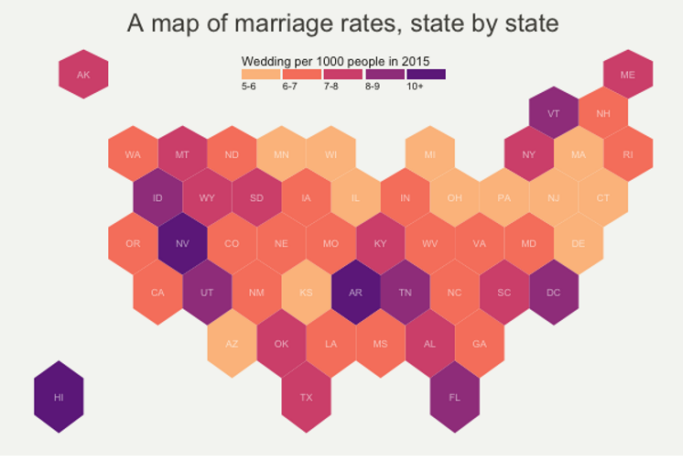
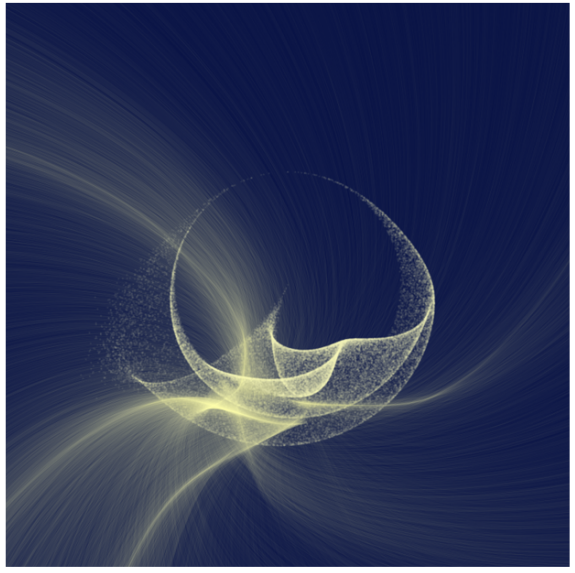
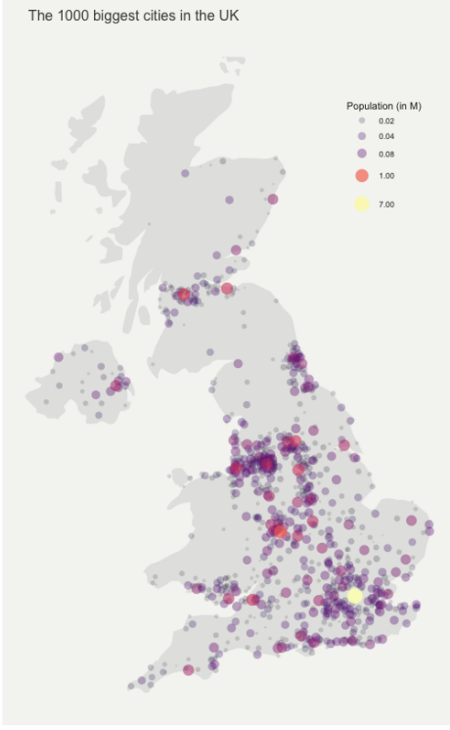
All the figures above are generated by ggplot2! Yes, included the middle one!







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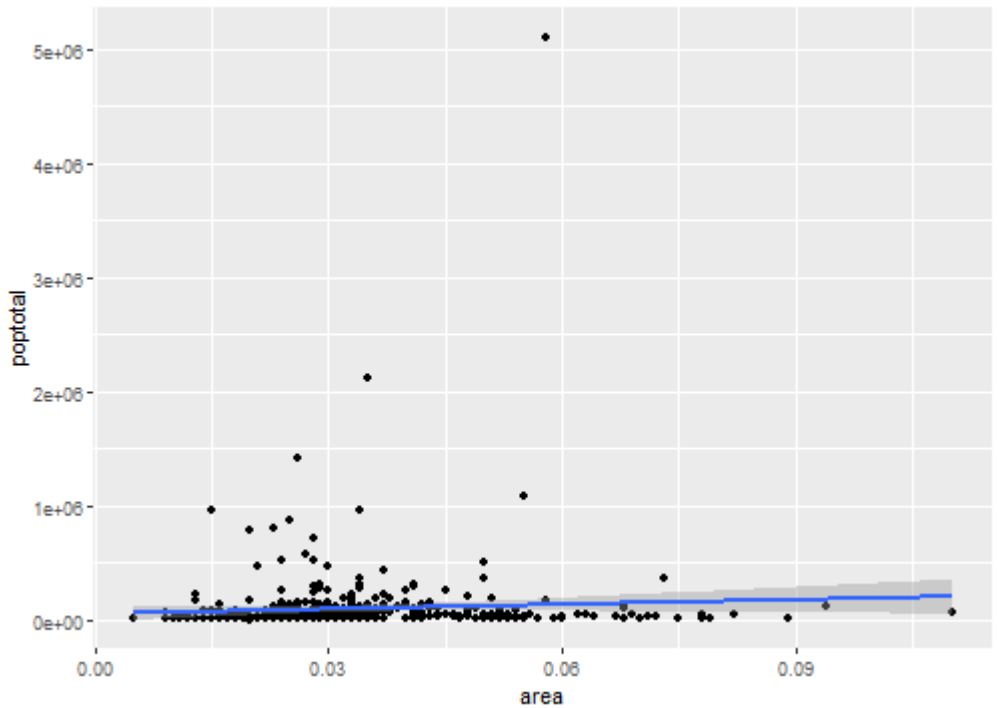
ggplot2 - simple plot

```
library(tidyverse)
# area and poptotal are columns in 'midwest'
midwest %>%
  ggplot(aes(x=area, y=poptotal)) +
  geom_point() + geom_smooth(method="lm")
```



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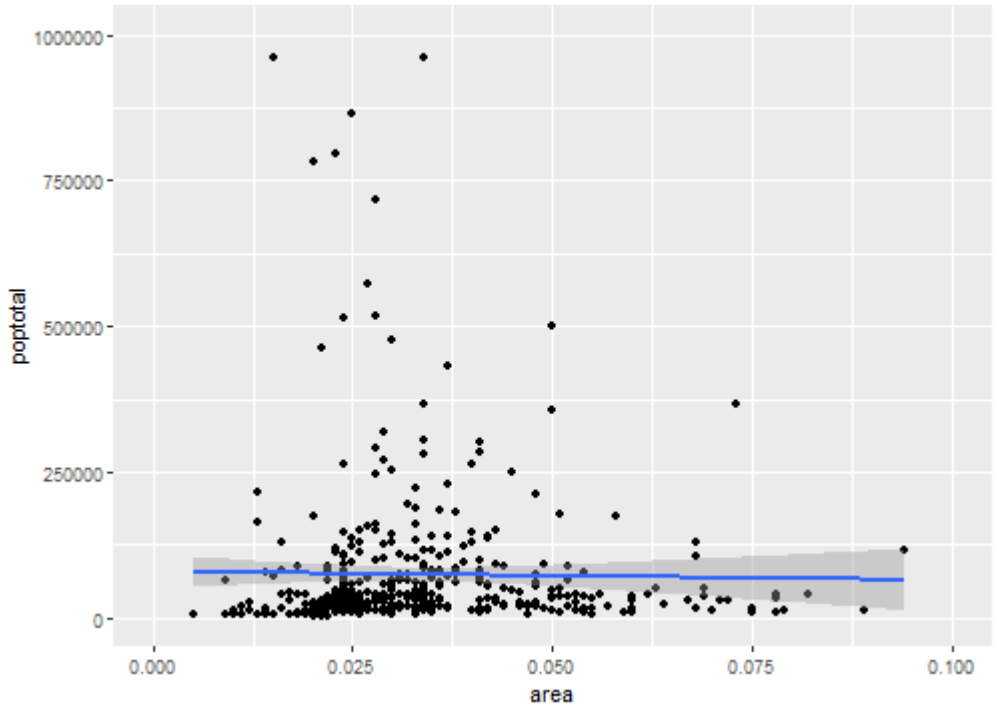
Adjustment of X And Y Axis Limits

`Method 1`: deleting the points outside the range

```
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point() +
  geom_smooth(method = "lm") +
  xlim(c(0, 0.1)) + ylim(c(0, 1000000))
```



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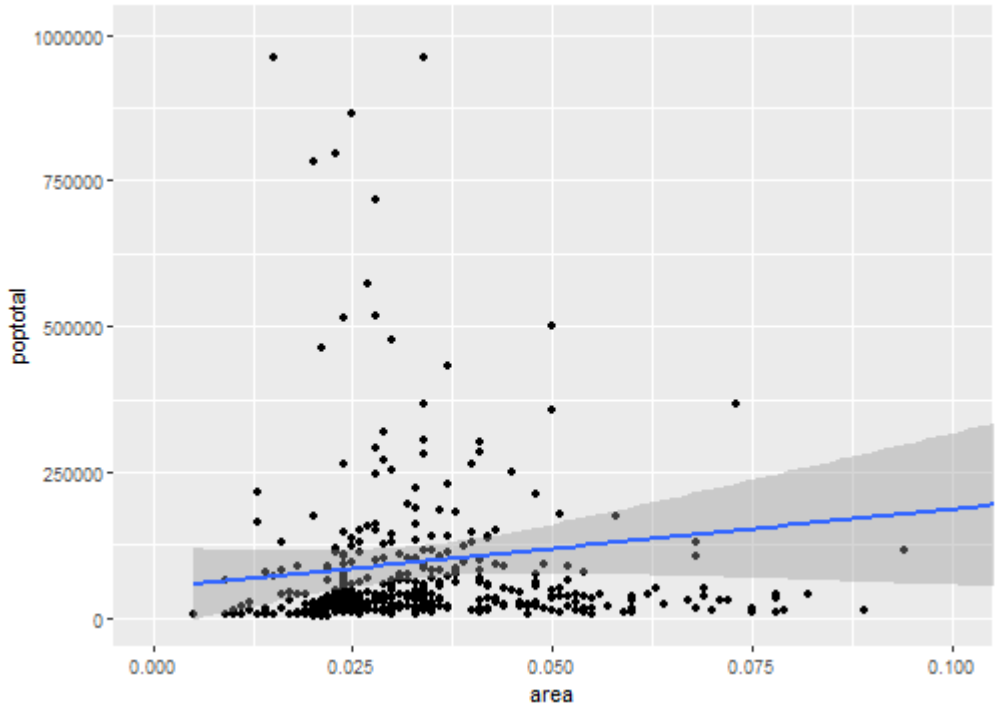
Adjustment of X And Y Axis Limits

Method 2: zooming in

```
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point() +
  geom_smooth(method = "lm") +
  coord_cartesian(xlim = c(0, 0.1), ylim = c(0, 1000000))
```



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Titles and Axis Labels

Two different ways to change the titles and labels `Method 1`

```
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point() +
  geom_smooth(method = "lm") +
  coord_cartesian(xlim = c(0, 0.1), ylim = c(0, 1000000))+
  labs(title="Area Vs Population",
       subtitle="From midwest dataset",
       y="Population", x="Area", caption="Midwest Demographics")
```

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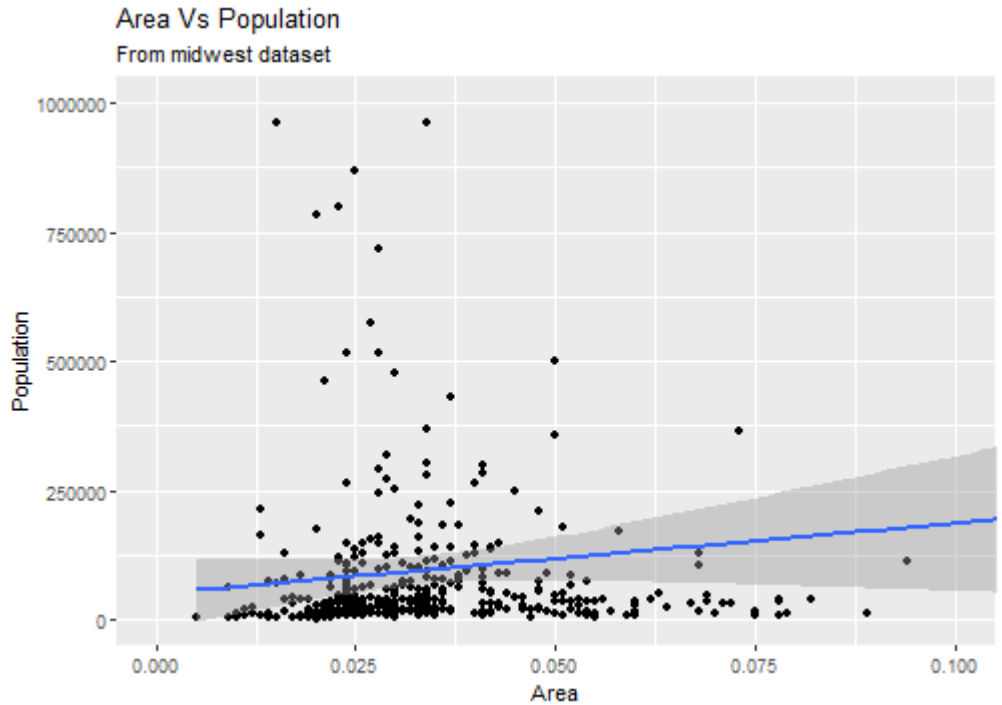
Method 2

```
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point() +
  geom_smooth(method = "lm") +
  coord_cartesian(xlim = c(0, 0.1), ylim = c(0, 1000000))+
  ggtitle("Area Vs Population", subtitle = "From midwest dataset") +
  xlab("Area") + ylab("Population")
```



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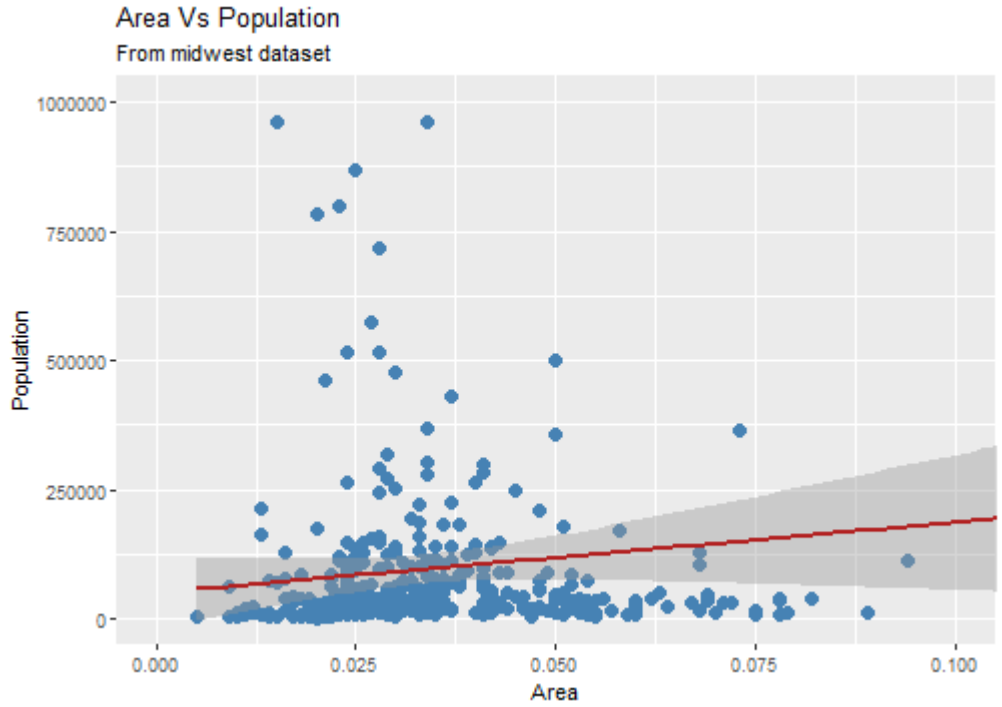
Color Changes

```
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point(col="steelblue", size=3) +
  geom_smooth(method = "lm", col="firebrick") +
  coord_cartesian(xlim = c(0, 0.1), ylim = c(0, 1000000))+
  ggtitle("Area Vs Population", subtitle = "From midwest dataset") +
  xlab("Area") + ylab("Population")
```



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Legend Removing

```
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point(aes(color=state), size=3) +
  geom_smooth(method = "lm", col="firebrick") +
  coord_cartesian(xlim = c(0, 0.1), ylim = c(0, 1000000))+
  ggtitle("Area Vs Population", subtitle = "From midwest dataset") +
  xlab("Area") + ylab("Population") +
  theme(legend.position="None")
```

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Color Palette Changing

```
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point(aes(color=state), size=3) +
  geom_smooth(method = "lm", col="firebrick") +
  coord_cartesian(xlim = c(0, 0.1), ylim = c(0, 1000000))+
  ggtitle("Area Vs Population", subtitle = "From midwest dataset") +
  xlab("Area") + ylab("Population") +
  theme(legend.position="None") +
  scale_colour_brewer(palette = "Set1")
```

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Show more color palette

```
library(RColorBrewer)
head(brewer.pal.info, 10)
```

```
##          maxcolors category colorblind
## BrBG            11      div       TRUE
## PiYG            11      div       TRUE
## PRGn            11      div       TRUE
## PuOr            11      div       TRUE
## RdBu            11      div       TRUE
## RdGy            11      div      FALSE
## RdYlBu          11      div       TRUE
## RdYlGn          11      div      FALSE
## Spectral        11      div      FALSE
## Accent           8     qual      FALSE
```

```
#Exp. scale_colour_brewer(palette = “BrBG")
```

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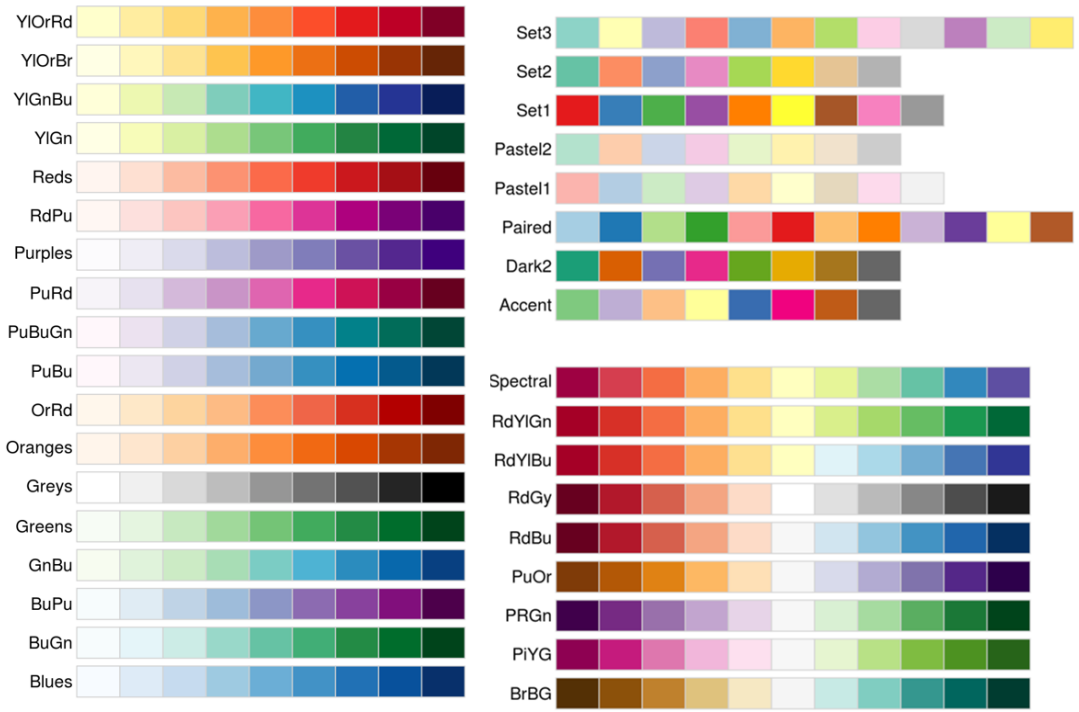
More color palette



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Change the Default Themes

```
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point(aes(col=state), size=3) +
  geom_smooth(method = "lm", color="firebrick") +
  coord_cartesian(xlim = c(0, 0.1), ylim = c(0, 1000000))+
  ggtitle("Area Vs Population", subtitle = "From midwest dataset") +
  xlab("Area") + ylab("Population") +
  theme(legend.position="None") +
  scale_colour_brewer(palette = "Set1") +
  theme_bw() + labs(subtitle="BW Theme")
```

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Change the Default Themes (cont'd)

```
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point(aes(col=state), size=3) +
  geom_smooth(method = "lm", color="firebrick") +
  coord_cartesian(xlim = c(0, 0.1), ylim = c(0, 1000000))+
  ggtitle("Area Vs Population", subtitle = "From midwest dataset") +
  xlab("Area") + ylab("Population") +
  theme(legend.position="None") +
  scale_colour_brewer(palette = "Set1") +
  theme_classic() + labs(subtitle="Classic Theme")
```

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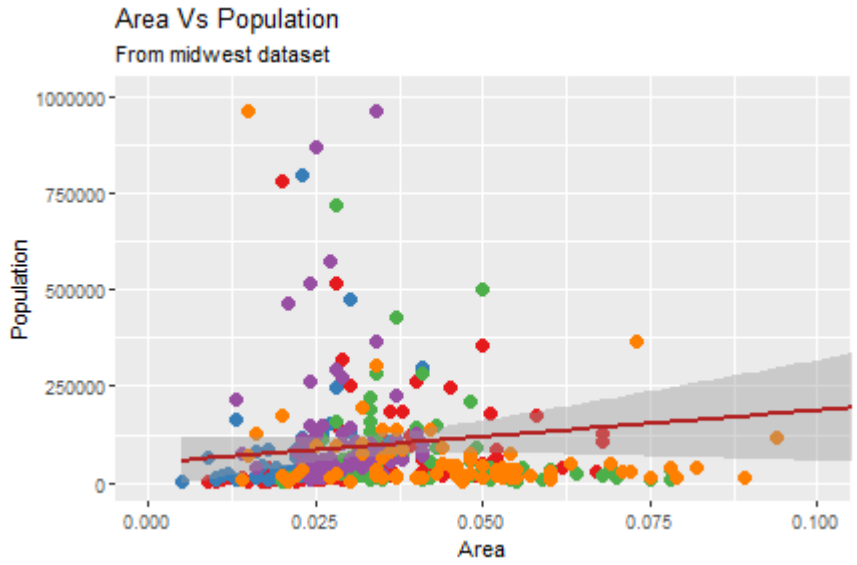
Default plot assigned

```
gg <- ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point(aes(col = state), size = 3) +
  geom_smooth(method = "lm", color = "firebrick") +
  coord_cartesian(xlim = c(0, 0.1), ylim = c(0, 1000000)) +
  ggtitle("Area Vs Population", subtitle = "From midwest dataset") +
  xlab("Area") + ylab("Population") +
  theme(legend.position = "None") +
  scale_colour_brewer(palette = "Set1")
plot(gg)
```



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Customizing Titles

```
#Customizing Titles
# title
gg + theme(plot.title=element_text(size=20, face="bold", family="American Typewriter", color="tomato", hjust=(
# subtitle
plot.subtitle=element_text(size=15, family="American Typewriter", face="bold", hjust=0.5),
# caption
plot.caption=element_text(size=15),
# X axis title
axis.title.x=element_text(vjust=10, size=15),
# Y axis title
axis.title.y=element_text(size=15),
# X axis text
axis.text.x=element_text(size=10, angle = 30, vjust=.5),
# Y axis text
axis.text.y=element_text(size=10))
```

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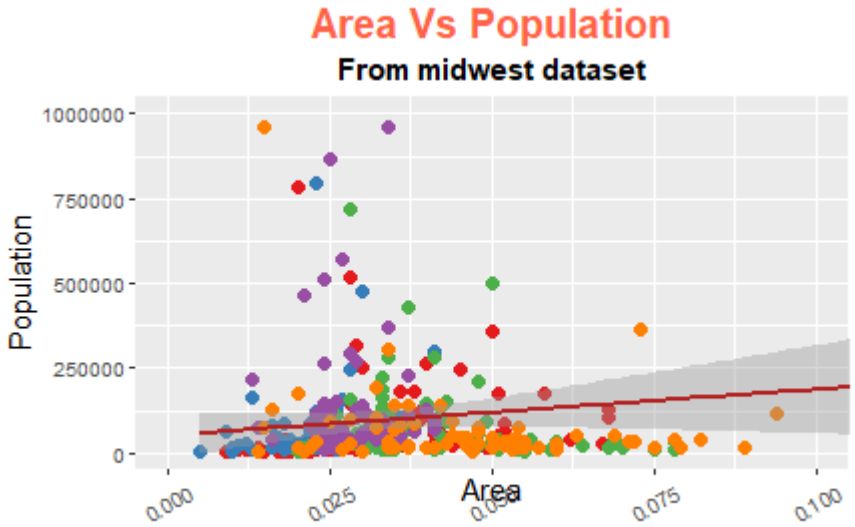
Customizing Titles (cont'd)



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Legend Position

```
# No legend
gg + theme(legend.position="None") + labs(subtitle="No Legend")

# Legend to the left
#labs(subtitle="Legend on the Left")

# legend at the bottom and horizontal
#labs(subtitle="Legend at Bottom")

# legend at bottom-right, inside the plot
#labs(subtitle="Legend: Bottom-Right Inside the Plot")

# legend at top-left, inside the plot
#labs(subtitle="Legend: Top-Left Inside the Plot")
```

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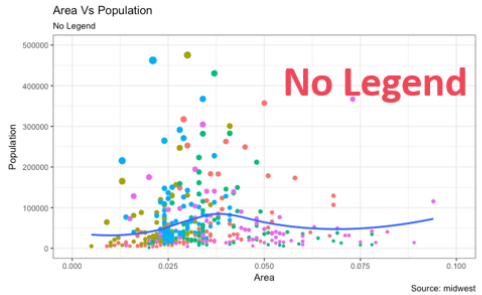
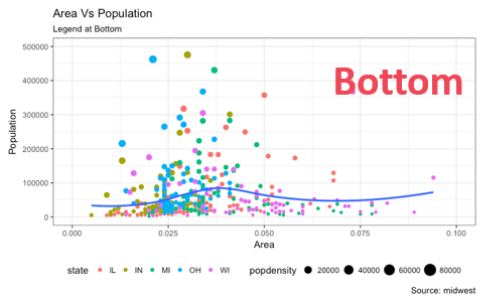
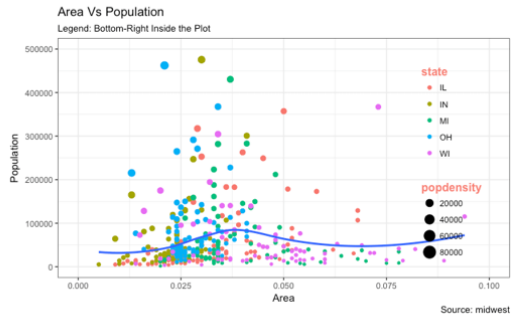
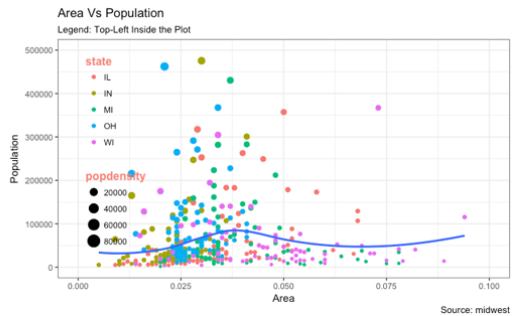
Legend Position (cont'd)





Inside, bottom right





Inside, top left

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Label, Text, and Annotation

```
# Filter required rows.
midwest_sub <- midwest %>% filter(poptotal > 300000) %>%
  mutate(large_county = ifelse(poptotal > 300000, county, ""))
# Base Plot
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point(aes(col = state, size = popdensity)) +
  geom_smooth(method = "loess", se = F) + xlim(c(0, 0.1)) + ylim(c(0, 500000)) +
  labs( title = "Area Vs Population",
    y = "Population",
    x = "Area",
    caption = "Source: midwest"
  ) +
  # Plot text
  geom_text(data = midwest_sub, aes(label = large_county), size = 2) +
  labs(subtitle = "With ggplot2::geom_text") + theme(legend.position = "None") +
  # label
  geom_label(
    data = midwest_sub,
    aes(label = large_county),
    size = 2, alpha = 0.25
  ) + labs(subtitle = "With ggplot2::geom_label") + theme(legend.position = "None")
```

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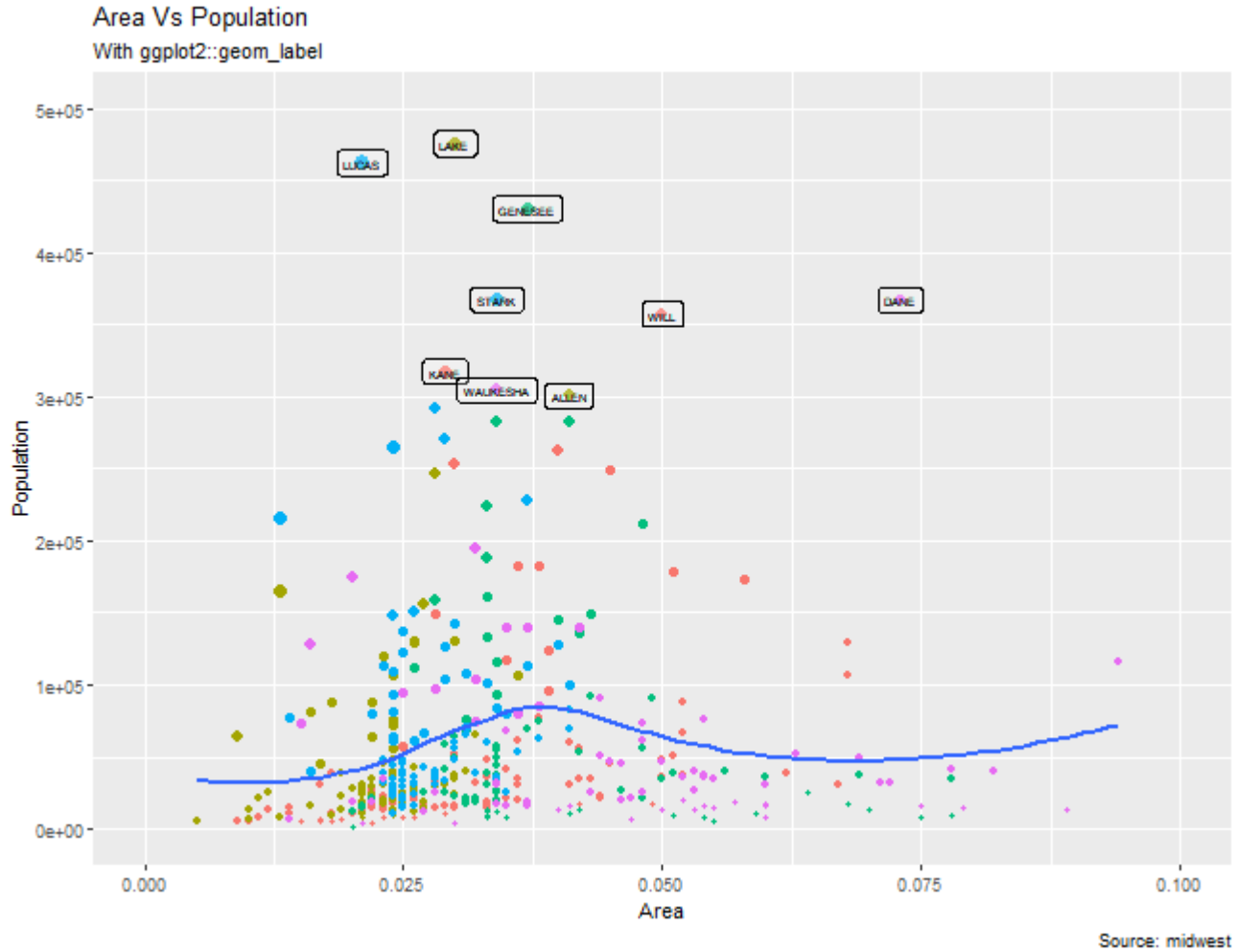
Label, Text, and Annotation



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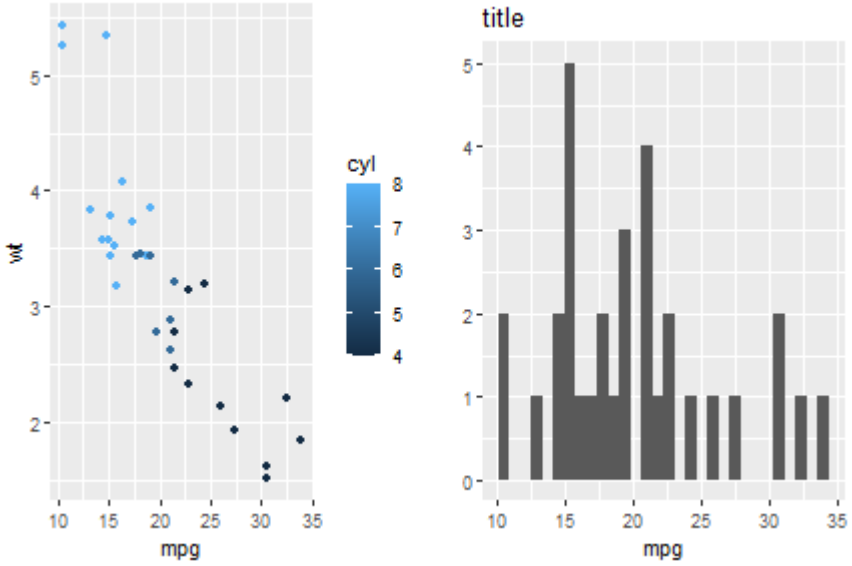
Multiple plots

```
library(gridExtra)
p1 <- qplot(mpg, wt, data = mtcars, colour = cyl)
p2 <- qplot(mpg, data = mtcars) + ggtitle("title")
grid.arrange(p1, p2, nrow = 1)
```



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Charts

1.Correlation

1. Scatterplot
2. Scatterplot With Encircling
3. Jitter Plot
4. Counts Chart
5. Bubble Plot
6. Correlogram

2.Deviation

1. Diverging Bars
2. Diverging Lollipop Chart
3. Diverging Dot Plot
4. Area Chart

3.Ranking

1. Ordered Bar Chart
2. Lollipop Chart
3. Dot Plot
4. Slope Chart
5. Dumbbell Plot

4.Distribution

1. Histogram
2. Density Plot
3. Box Plot
4. Dot + Box Plot
5. Tufte Boxplot
6. Violin Plot
7. Population Pyramid

5.Change

1. Time Series Plots
2. Stacked Area Chart
3. Calendar Heat Map
4. Seasonal Plot
5. Heat Map

6.Groups

1. Dendrogram

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Correlation, scatterplot

```
ggplot(midwest, aes(x=area, y=poptotal)) +
  geom_point(aes(col=state, size=popdensity)) +
  geom_smooth(method="loess", se=F) +
  xlim(c(0, 0.1)) +
  ylim(c(0, 500000)) +
  labs(subtitle="Area Vs Population",
       y="Population",
       x="Area",
       title="Scatterplot",
       caption = "Source: midwest")
```

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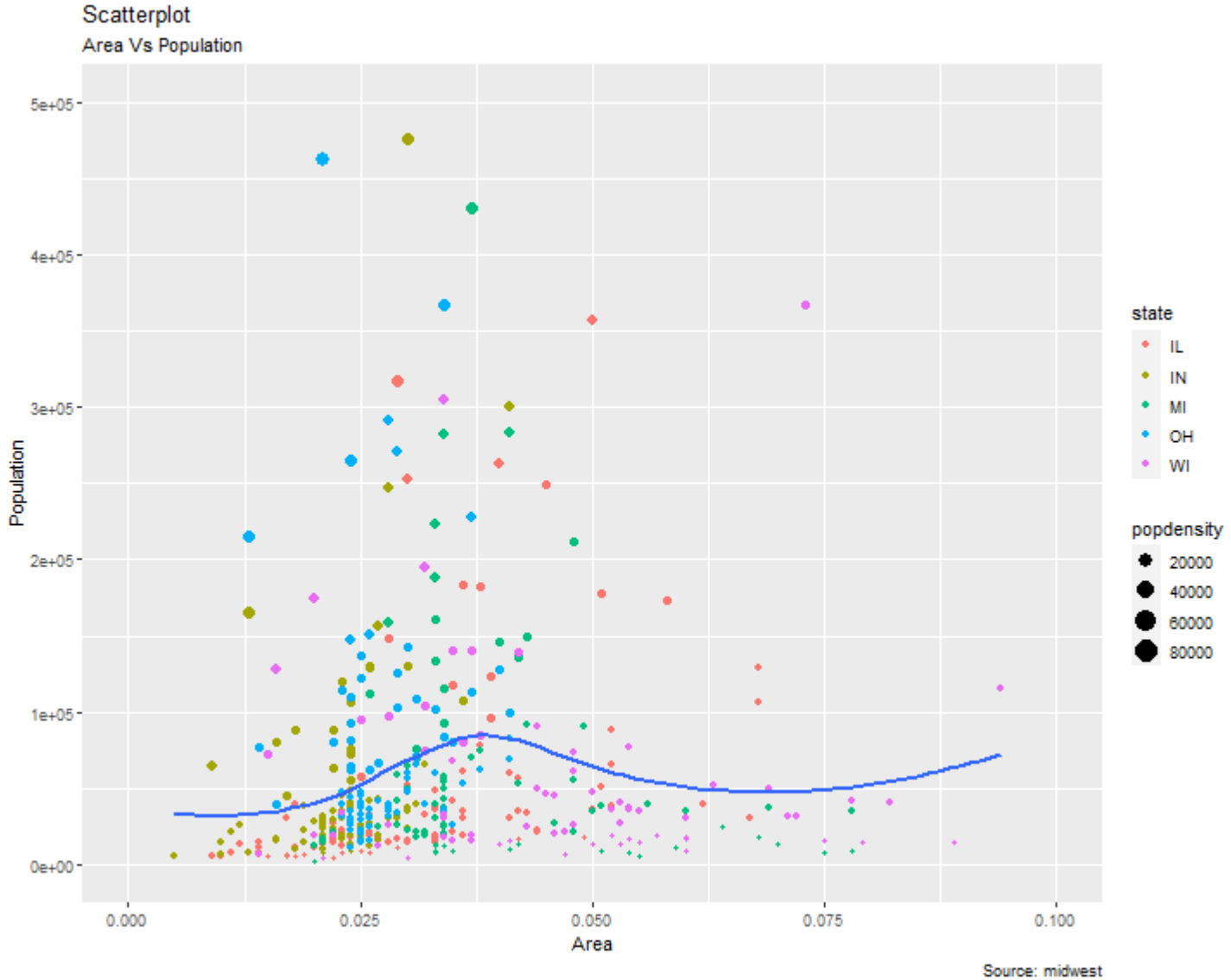

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Correlation, scatterplot with encircling

```
library(ggalt)
midwest_select <- midwest[midwest$poptotal > 350000 &
                          midwest$poptotal <= 500000 &
                          midwest$area > 0.01 &
                          midwest$area < 0.1,]
# Plot
ggplot(midwest, aes(x = area, y = poptotal)) +
  geom_point(aes(col = state, size = popdensity)) +   # draw points
  geom_smooth(method = "loess", se = F) +
  xlim(c(0, 0.1)) +
  ylim(c(0, 500000)) +   # draw smoothing line
  geom_encircle(
    aes(x = area, y = poptotal),
    data = midwest_select,
    color = "red",
    size = 2,
    expand = 0.08
  ) +   # encircle
  labs( subtitle = "Area Vs Population",
    y = "Population",
    x = "Area",
    title = "Scatterplot + Encircle",
    caption = "Source: midwest"
  )
```

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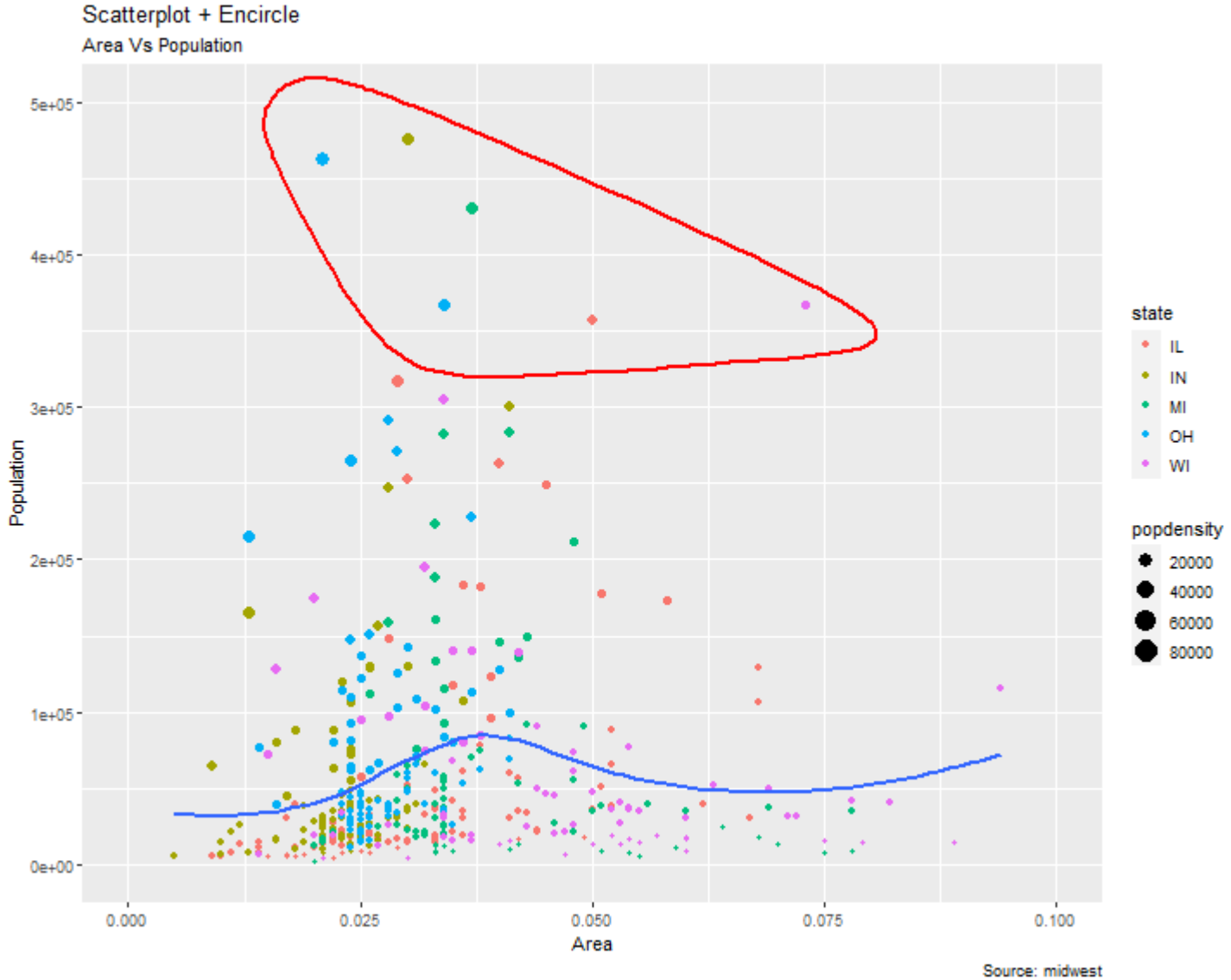

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Correlation, jitter plot

```
ggplot(mpg, aes(cty, hwy)) + geom_point() +
  geom_smooth(method = "lm", se = F) +
  labs(
    subtitle = "mpg: city vs highway mileage",
    y = "hwy",
    x = "cty",
    title = "Scatterplot with overlapping points",
    caption = "Source: midwest"
  ) +
  theme_bw()
```

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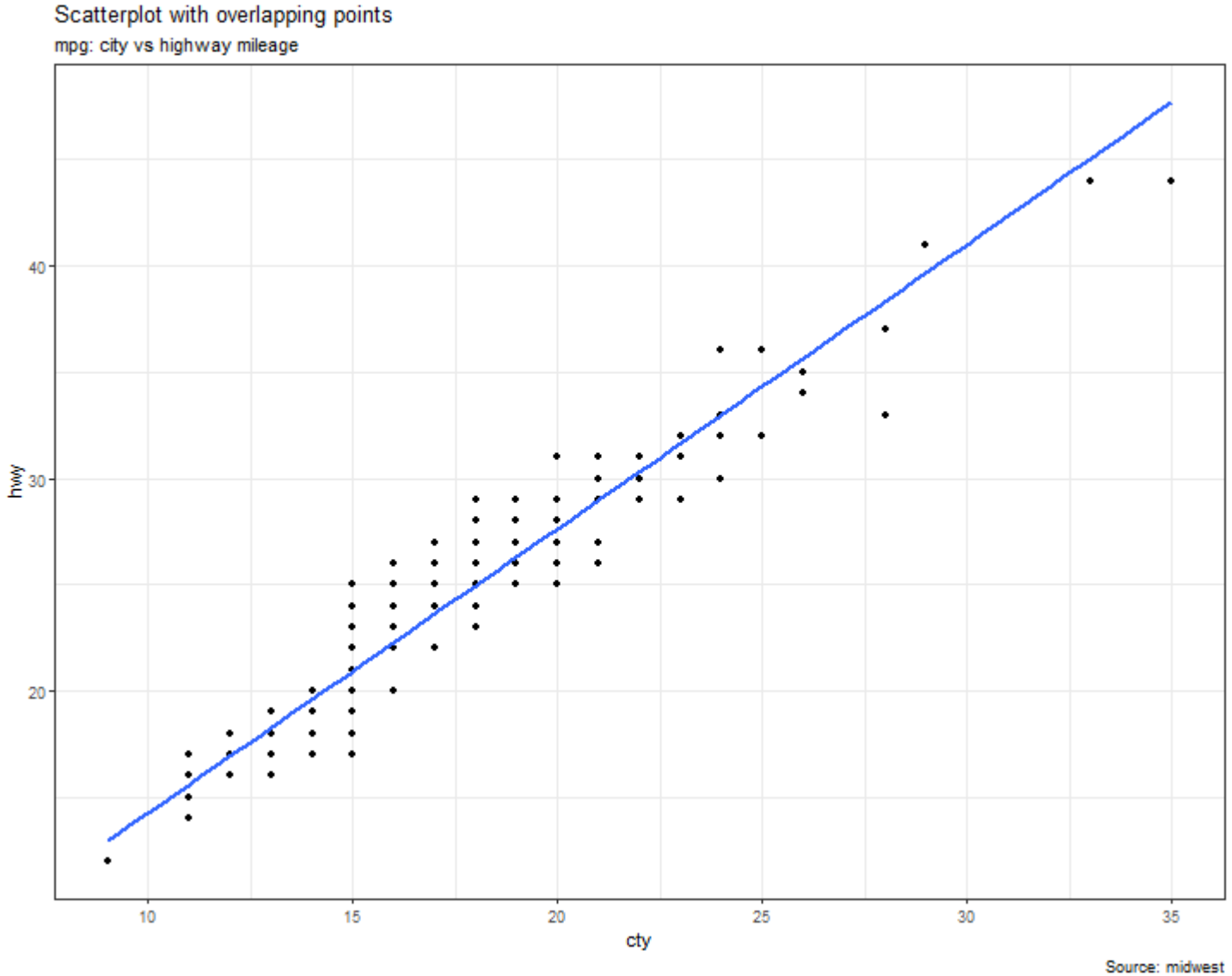

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Correlation, jitter plot

```
ggplot(mpg, aes(cty, hwy)) +
  geom_jitter(width = .5, size = 1) +
  labs(
    subtitle = "mpg: city vs highway mileage",
    y = "hwy",
    x = "cty",
    title = "Jittered Points"
  )+
  theme_bw()
```

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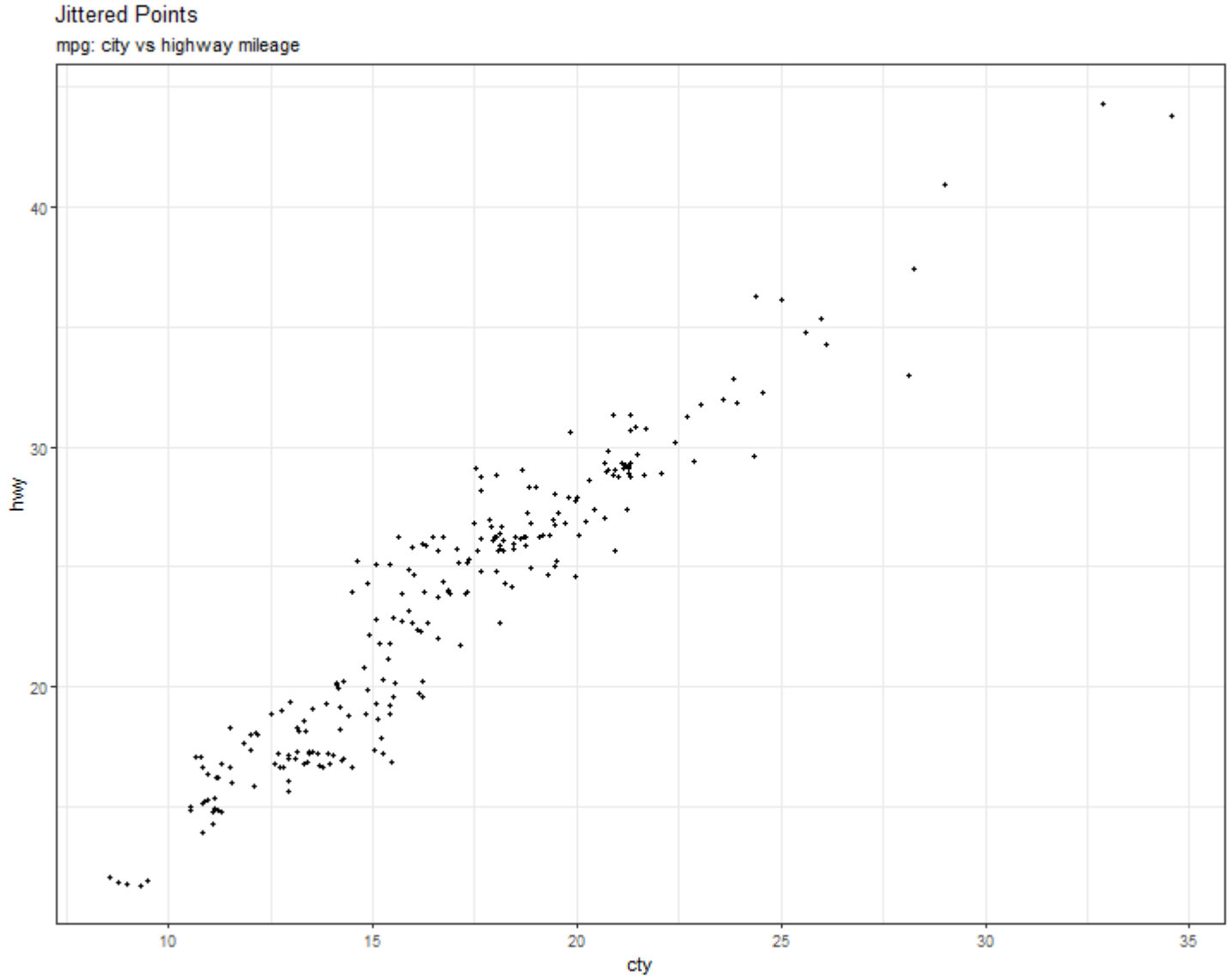

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Correlation, bubble plot

```
mpg %>%
  filter(manufacturer %in% c("audi", "ford", "honda", "hyundai")) %>%
  ggplot(aes(displ, cty)) +
  labs(subtitle = "mpg: Displacement vs City Mileage",
  title = "Bubble chart") +
  geom_jitter(aes(col = manufacturer, size = hwy)) +
  geom_smooth(aes(col = manufacturer), method = "lm", se = F) +
  theme_bw()
```

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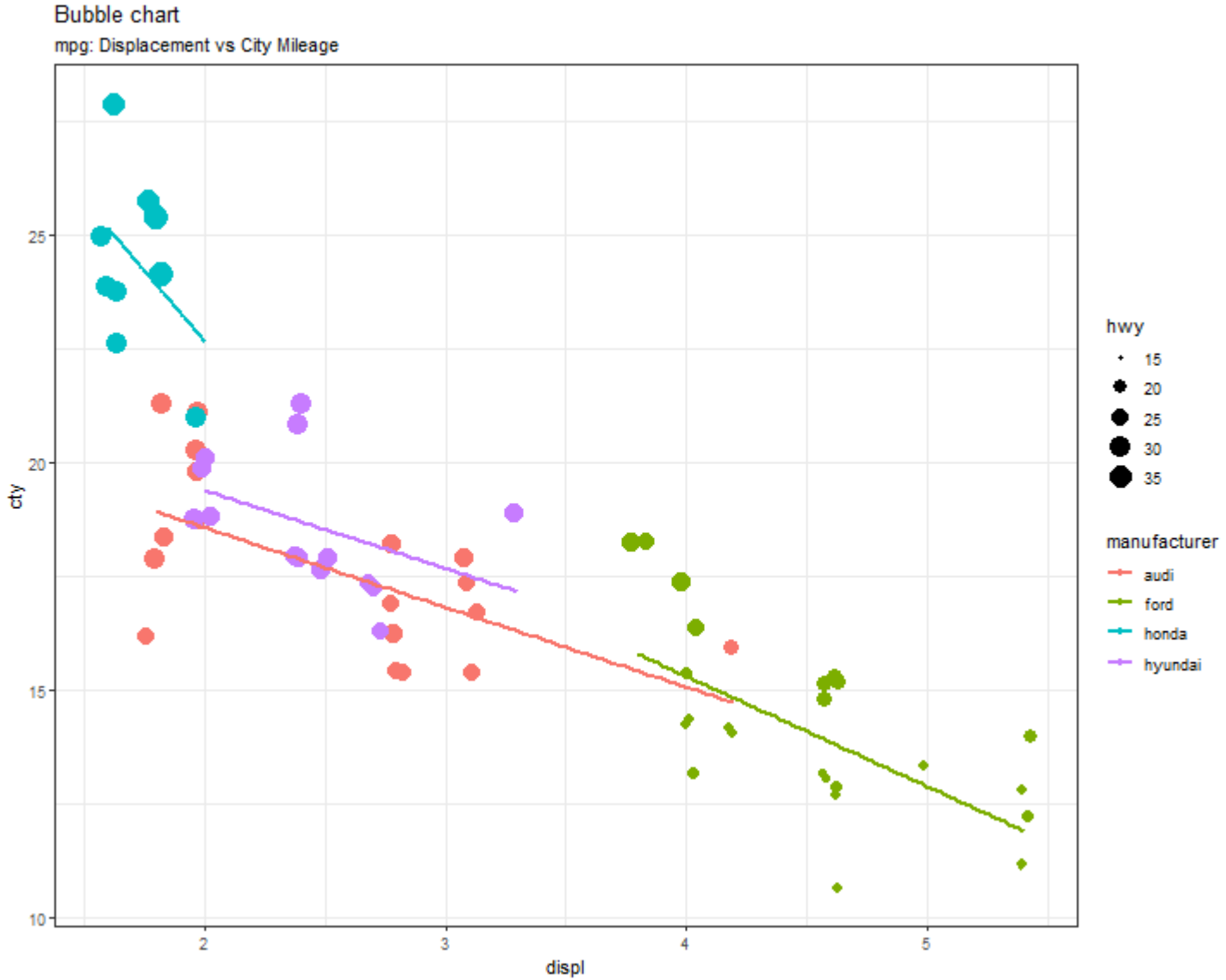

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Correlation, correlogram

```
library(ggcorrplot)
corr <- round(cor(mtcars), 1)
ggcorrplot(corr, hc.order = TRUE,
           type = "lower",
           lab = TRUE,
           lab_size = 3,
           method="circle",
           colors = c("tomato2", "white", "springgreen3"),
           title="Correlogram of mtcars",
           ggtheme=theme_bw)
```

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```
## Error in library(ggcorrplot): there is no package called 'ggcorrplot'
```

```
## Error in ggcorrplot(corr, hc.order = TRUE, type = "lower", lab = TRUE, : could not find function "ggcorrplot"
```

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Deviation, diverging bar

```
# Data Prep
data("mtcars")  # load data
mtcars$`car name` <- rownames(mtcars)  # create new column for car names
mtcars$mpg_z <- round((mtcars$mpg - mean(mtcars$mpg))/sd(mtcars$mpg), 2)  # compute normalized mpg
mtcars$mpg_type <- ifelse(mtcars$mpg_z < 0, "below", "above")  # above / below avg flag
mtcars <- mtcars[order(mtcars$mpg_z), ]  # sort
mtcars$`car name` <- factor(mtcars$`car name`, levels = mtcars$`car name`)  # convert to factor to retain sor

# Diverging Barcharts
ggplot(mtcars, aes(x=`car name`, y=mpg_z, label=mpg_z)) +
  geom_bar(stat='identity', aes(fill=mpg_type), width=.5)  +
  scale_fill_manual(name="Mileage",
                    labels = c("Above Average", "Below Average"),
                    values = c("above"="#00ba38", "below"="#f8766d")) +
  labs(subtitle="Normalised mileage from 'mtcars'",
       title= "Diverging Bars") +
  coord_flip()
```

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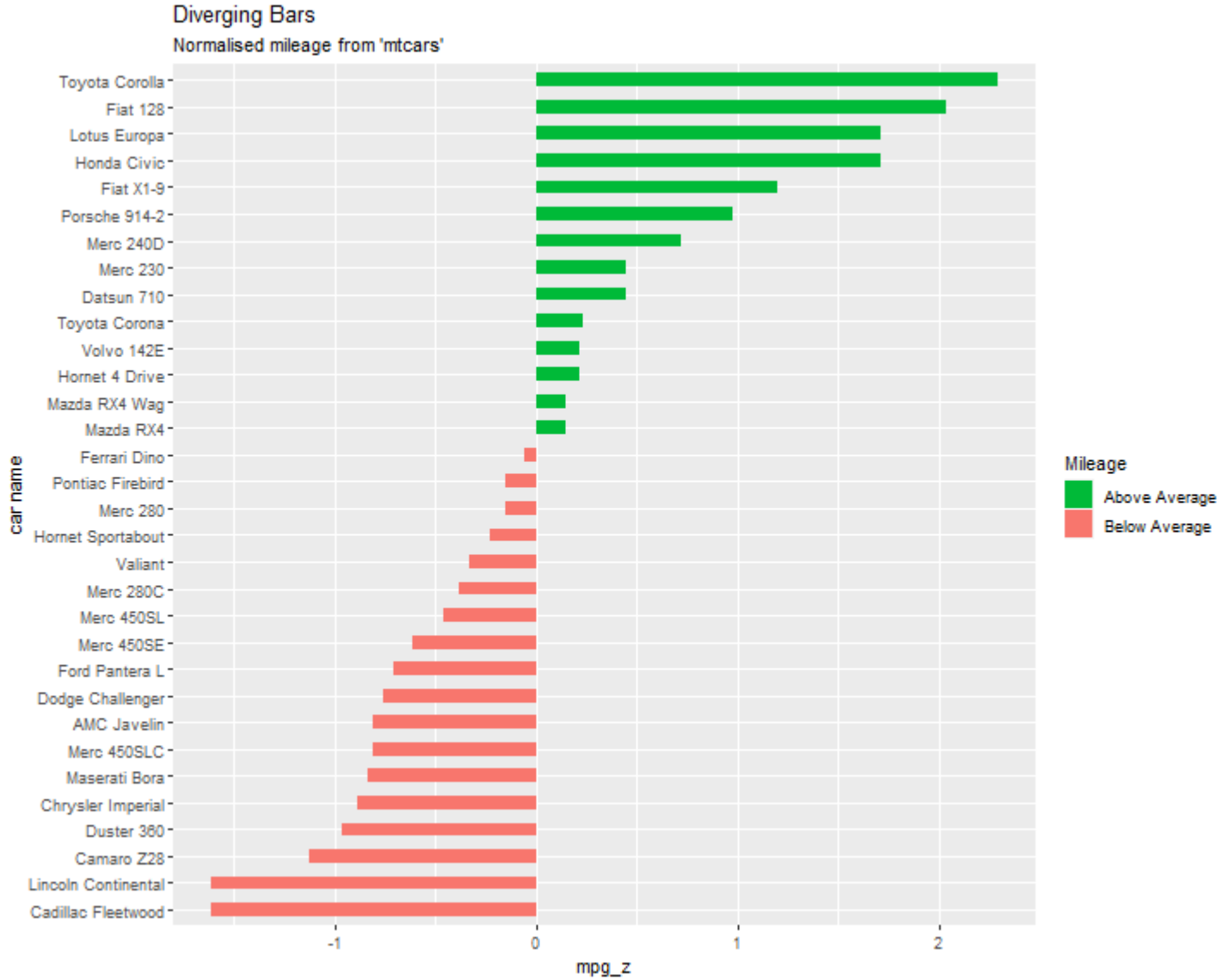

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Deviation, diverging lollipop bar

```
ggplot(mtcars, aes(x=`car name`, y=mpg_z, label=mpg_z)) +
  geom_point(stat='identity', fill="black", size=6)  +
  geom_segment(aes(y = 0,
                   x = `car name`,
                   yend = mpg_z,
                   xend = `car name`),
               color = "black") +
  geom_text(color="white", size=2) +
  labs(title="Diverging Lollipop Chart",
       subtitle="Normalized mileage from 'mtcars': Lollipop") +
  ylim(-2.5, 2.5) +
  coord_flip()
```

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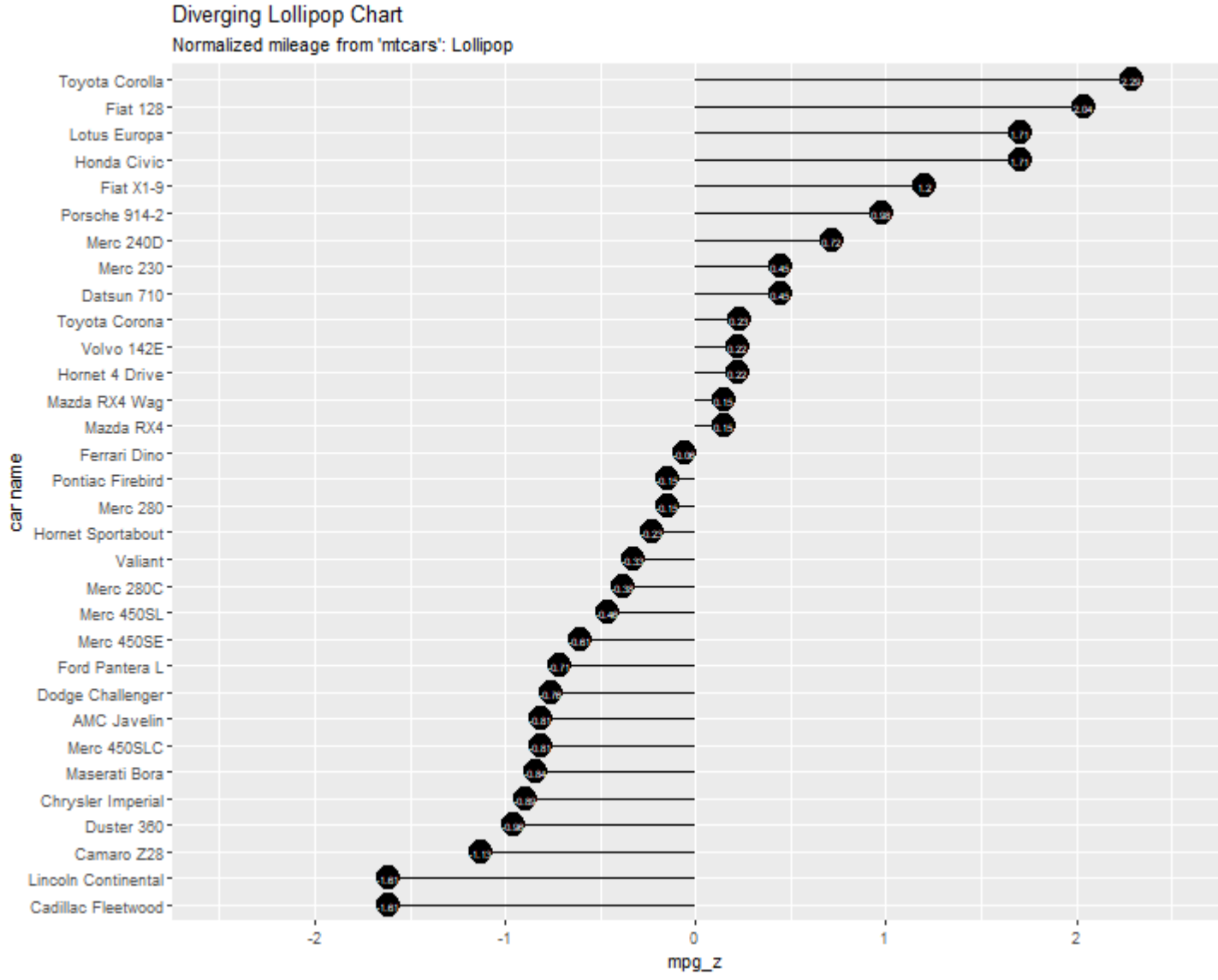

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Deviation, diverging lollipop bar

```
ggplot(mtcars, aes(x=`car name`, y=mpg_z, label=mpg_z)) +
  geom_point(stat='identity', aes(col=mpg_type), size=6)  +
  scale_color_manual(name="Mileage",
                     labels = c("Above Average", "Below Average"),
                     values = c("above"="#00ba38", "below"="#f8766d")) +
  geom_text(color="white", size=2) +
  labs(title="Diverging Dot Plot",
       subtitle="Normalized mileage from 'mtcars': Dotplot") +
  ylim(-2.5, 2.5) +
  coord_flip()
```

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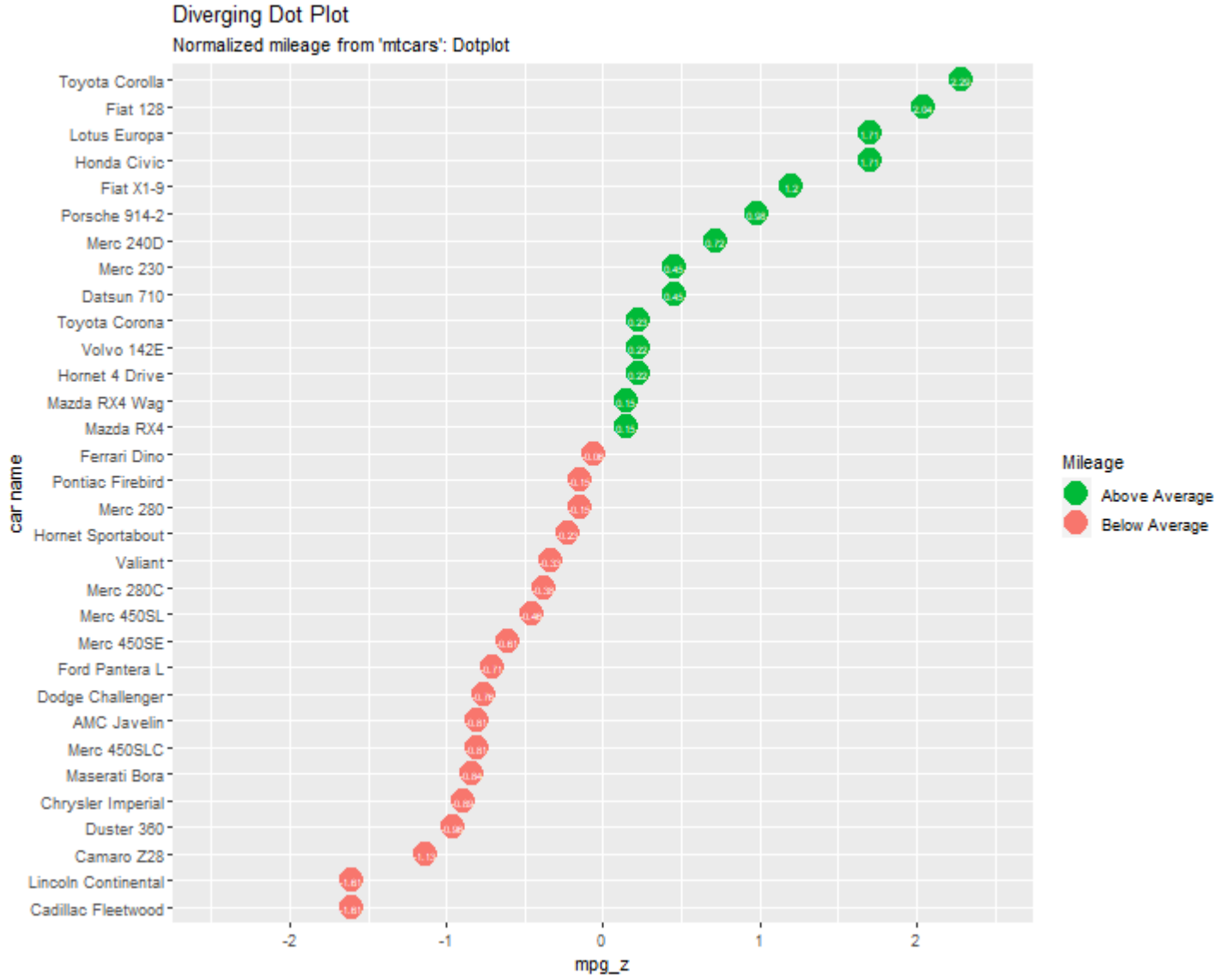

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Deviation, area chart

```
economics$returns_perc <- c(0, diff(economics$psavert)/economics$psavert[-length(economics$psavert)])

# Create break points and labels for axis ticks
brks <- economics$date[seq(1, length(economics$date), 12)]
lbls <- lubridate::year(economics$date[seq(1, length(economics$date), 12)])

# Plot
ggplot(economics[1:100, ], aes(date, returns_perc)) +
  geom_area() +
  scale_x_date(breaks=brks, labels=lbls) +
  theme(axis.text.x = element_text(angle=90)) +
  labs(title="Area Chart",
       subtitle = "Perc Returns for Personal Savings",
       y="% Returns for Personal savings",
       caption="Source: economics")
```

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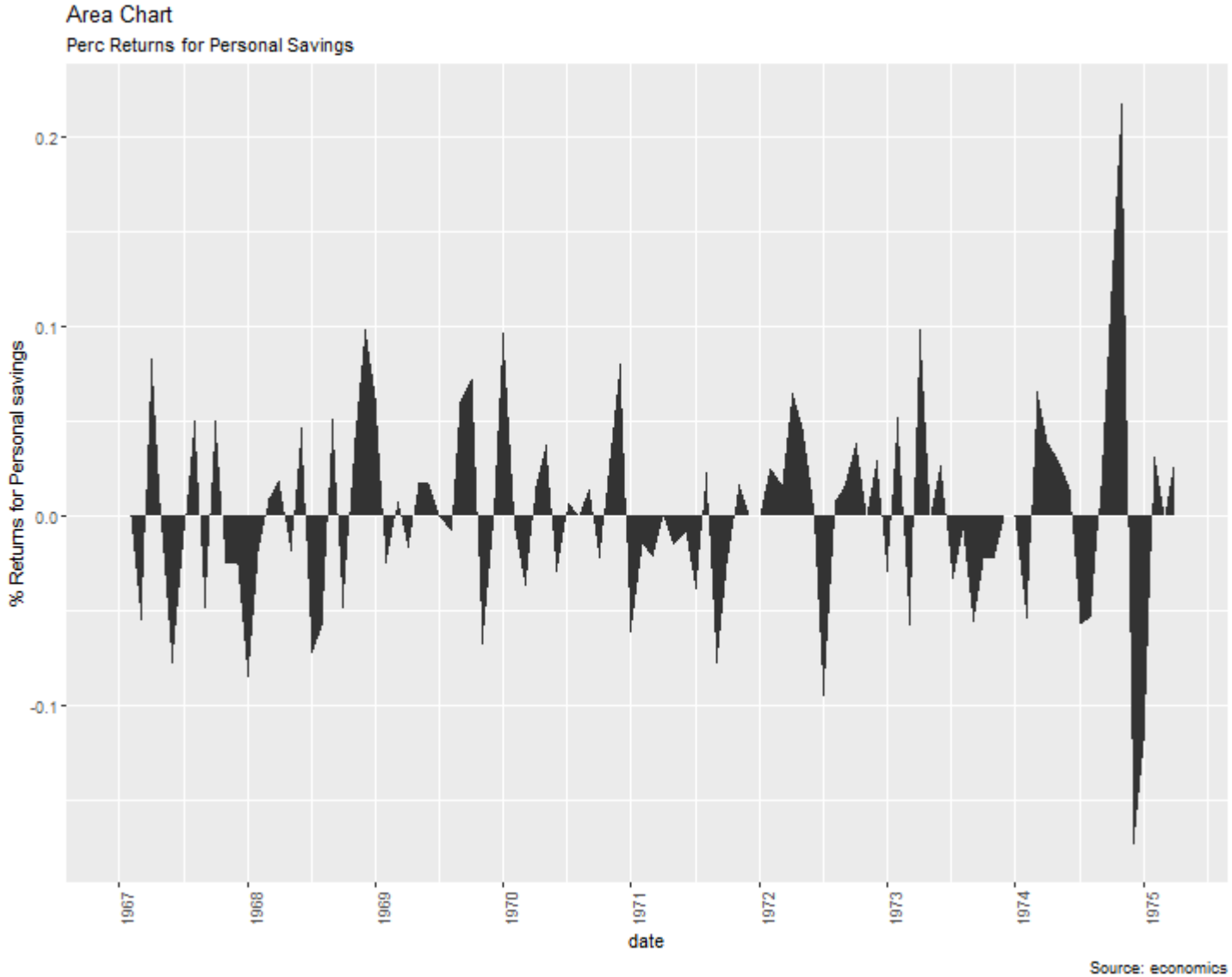

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Ranking, ordered bar chart

```
# Prepare data: group mean city mileage by manufacturer.
cty_mpg <- aggregate(mpg$cty, by=list(mpg$manufacturer), FUN=mean)  # aggregate
colnames(cty_mpg) <- c("make", "mileage")  # change column names
cty_mpg <- cty_mpg[order(cty_mpg$mileage), ]  # sort
cty_mpg$make <- factor(cty_mpg$make, levels = cty_mpg$make)  # to retain the order in plot.
ggplot(cty_mpg, aes(x=make, y=mileage)) +
  geom_bar(stat="identity", width=.5, fill="tomato3") +
  labs(title="Ordered Bar Chart",
       subtitle="Make Vs Avg. Mileage",
       caption="source: mpg") +
  theme(axis.text.x = element_text(angle=65, vjust=0.6))
```

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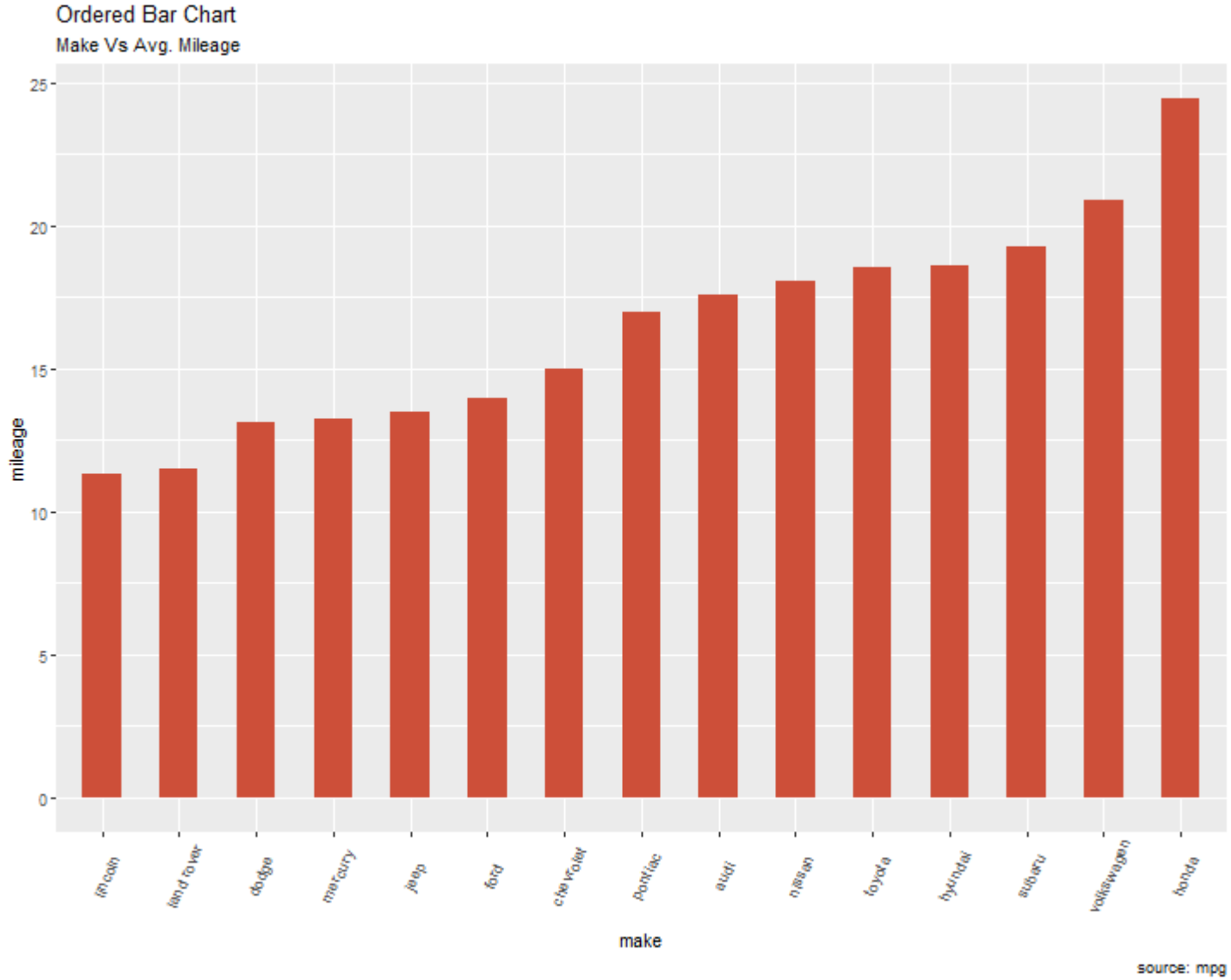

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Ranking, lollipop chart

```
ggplot(cty_mpg, aes(x=make, y=mileage)) +
  geom_point(size=3) +
  geom_segment(aes(x=make,
                   xend=make,
                   y=0,
                   yend=mileage)) +
  labs(title="Lollipop Chart",
       subtitle="Make Vs Avg. Mileage",
       caption="source: mpg") +
  theme(axis.text.x = element_text(angle=65, vjust=0.6))
```

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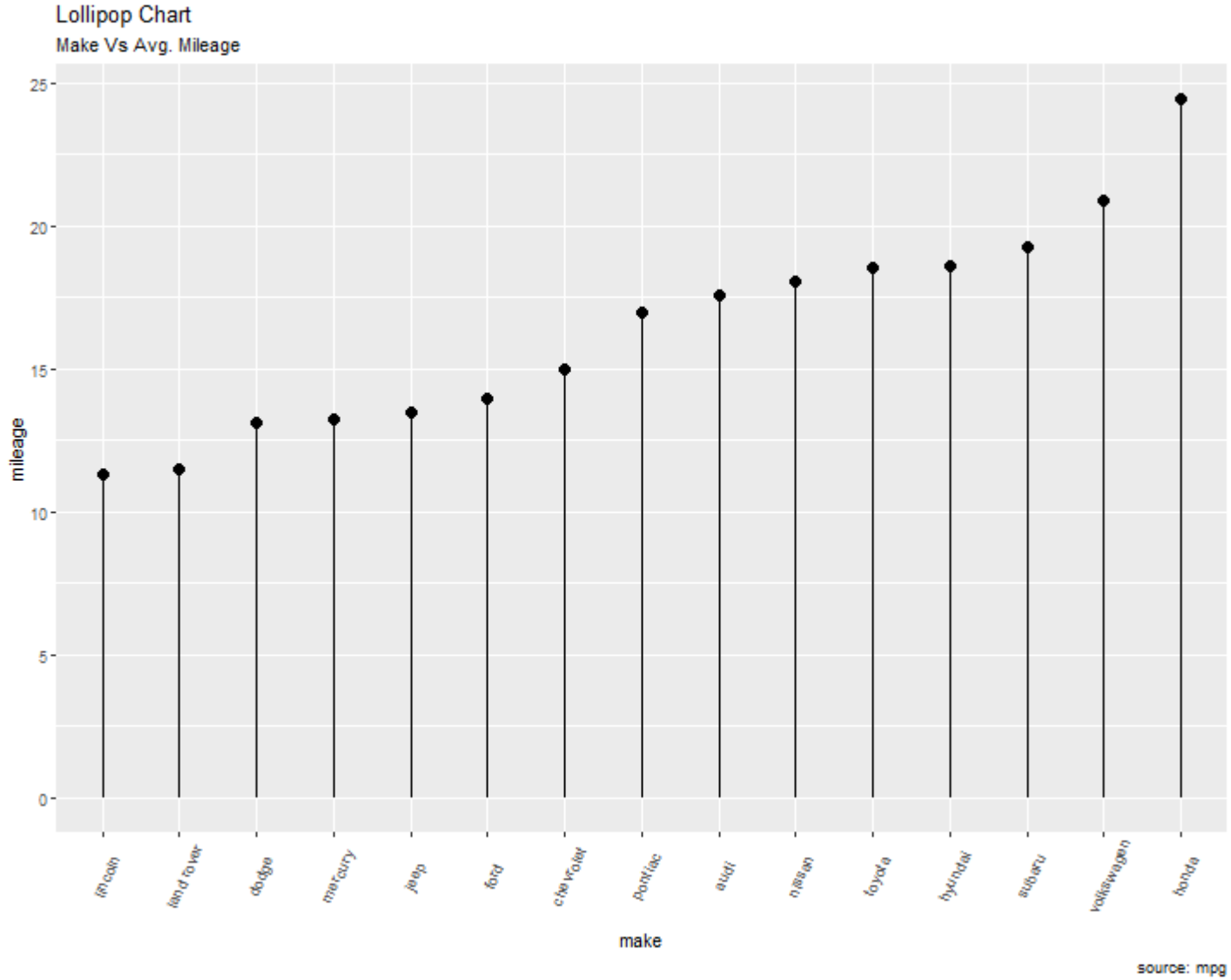

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Ranking, dot plot

```
# Plot
ggplot(cty_mpg, aes(x=make, y=mileage)) +
  geom_point(col="tomato2", size=3) +   # Draw points
  geom_segment(aes(x=make,
                   xend=make,
                   y=min(mileage),
                   yend=max(mileage)),
               linetype="dashed",
               size=0.1) +   # Draw dashed lines
  labs(title="Dot Plot",
       subtitle="Make Vs Avg. Mileage",
       caption="source: mpg") +
  coord_flip()
```

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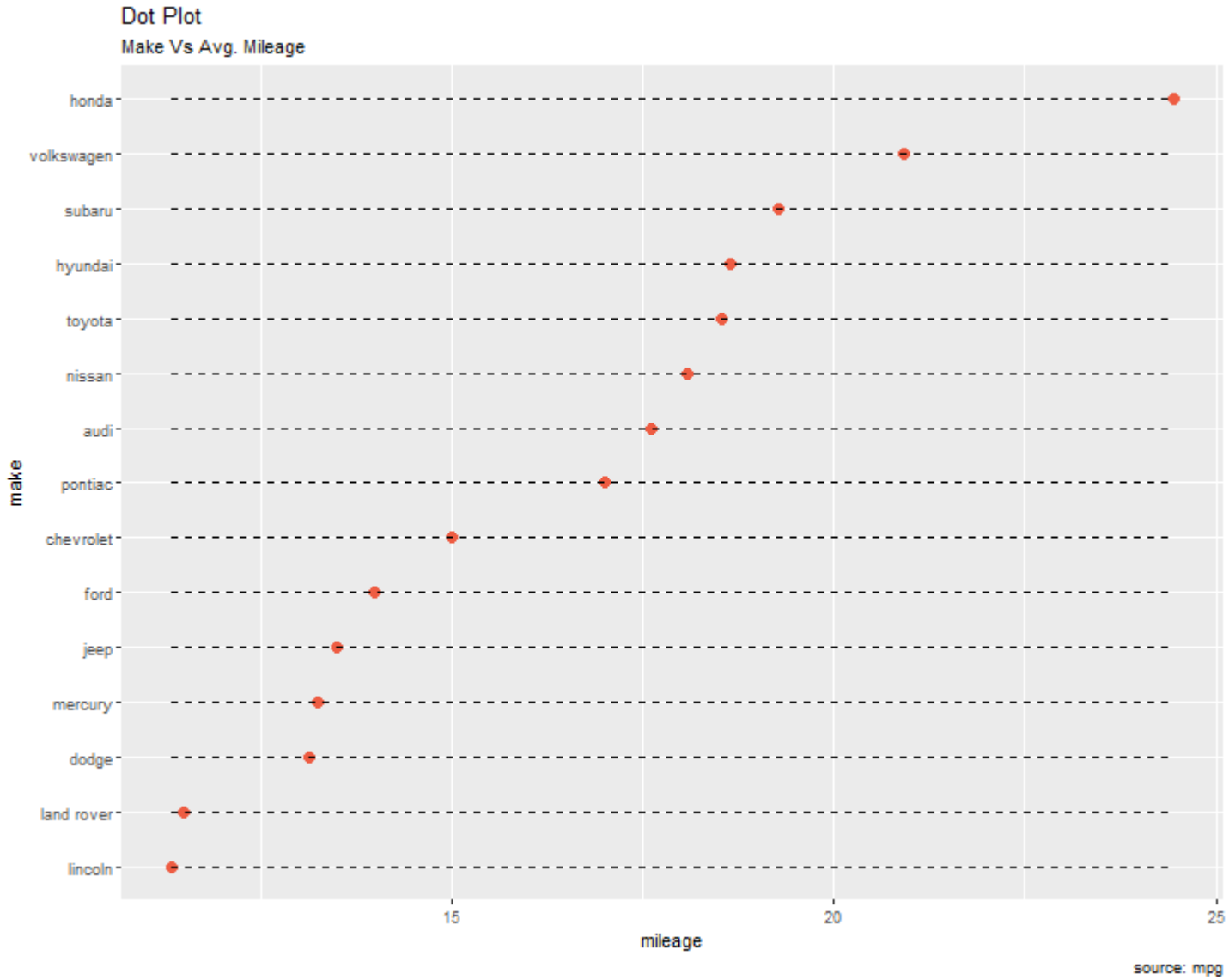

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Ranking, slop chart

```
# prep data
df <- read.csv("https://raw.githubusercontent.com/selva86/datasets/master/gdppercap.csv")
colnames(df) <- c("continent", "1952", "1957")
left_label <- paste(df$continent, round(df$`1952`),sep=", ")
right_label <- paste(df$continent, round(df$`1957`),sep=", ")
df$class <- ifelse((df$`1957` - df$`1952`) < 0, "red", "green")

# Plot
p <- ggplot(df) + geom_segment(aes(x=1, xend=2, y=`1952`, yend=`1957`, col=class), size=.75, show.legend=F) +
                  geom_vline(xintercept=1, linetype="dashed", size=.1) +
                  geom_vline(xintercept=2, linetype="dashed", size=.1) +
                  scale_color_manual(labels = c("Up", "Down"),
                                     values = c("green"="#00ba38", "red"="#f8766d")) +  # color of lines
                  labs(x="", y="Mean GdpPerCap") +  # Axis labels
                  xlim(.5, 2.5) + ylim(0,(1.1*(max(df$`1952`, df$`1957`))))  # X and Y axis limits

# Add texts
p <- p + geom_text(label=left_label, y=df$`1952`, x=rep(1, NROW(df)), hjust=1.1, size=3.5)
p <- p + geom_text(label=right_label, y=df$`1957`, x=rep(2, NROW(df)), hjust=-0.1, size=3.5)
p <- p + geom_text(label="Time 1", x=1, y=1.1*(max(df$`1952`, df$`1957`)), hjust=1.2, size=5)  # title
p <- p + geom_text(label="Time 2", x=2, y=1.1*(max(df$`1952`, df$`1957`)), hjust=-0.1, size=5)  # title

# Minify theme
p + theme(panel.background = element_blank(), panel.grid = element_blank(),
```

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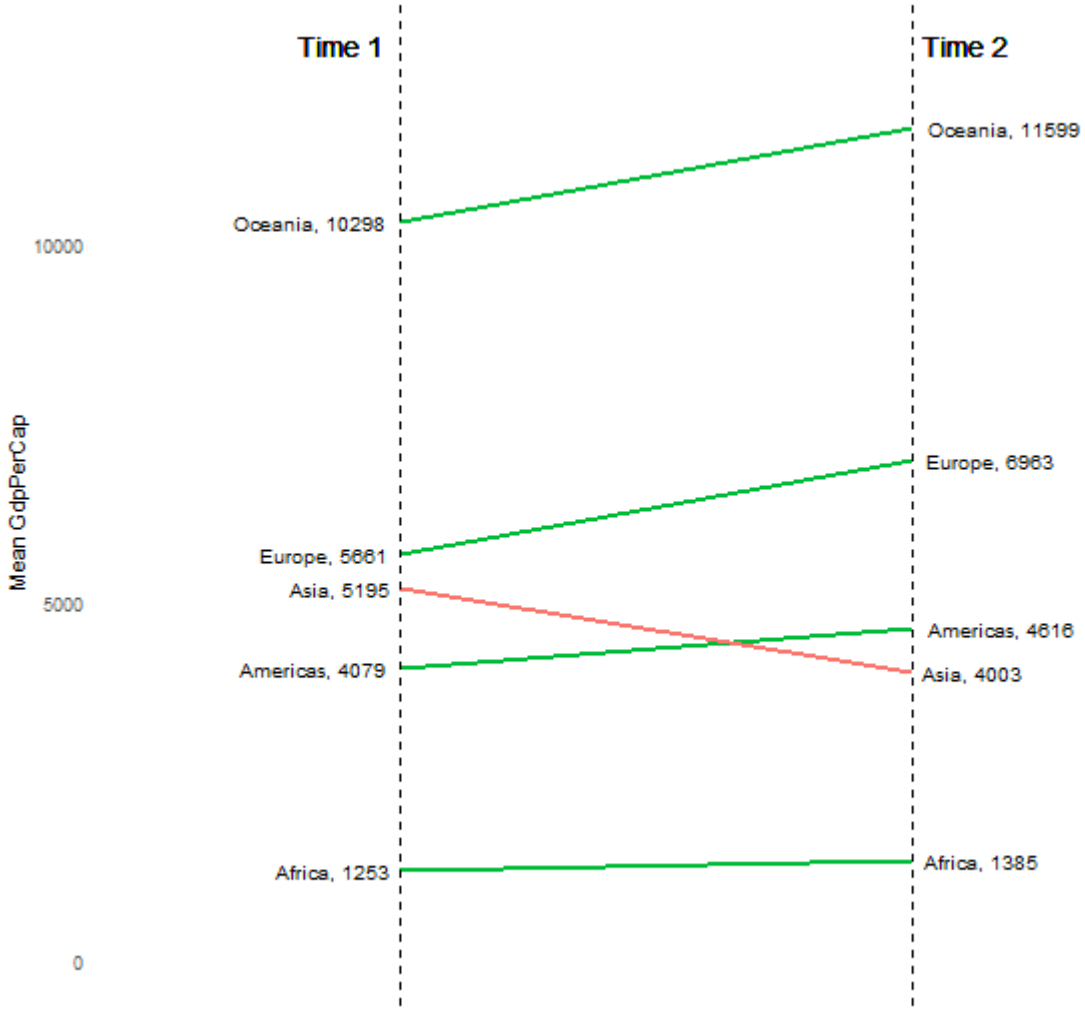

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Ranking, dumbbell

```
library(ggalt)
health <-
  read.csv("https://raw.githubusercontent.com/selva86/datasets/master/health.csv")
health$Area <-
  factor(health$Area, levels = as.character(health$Area))  # for right ordering of the dumbells
ggplot(health, aes(
  x = pct_2013,
  xend = pct_2014,
  y = Area,
  group = Area
)) +
  geom_dumbbell(color = "#a3c4dc",
                size = 0.75,
                point.colour.l = "#0e668b") +
  labs(
    x = NULL, y = NULL,
    title = "Dumbbell Chart",
    subtitle = "Pct Change: 2013 vs 2014",
    caption = "Source: https://github.com/hrbrmstr/ggalt"
  ) +
  theme(
    plot.title = element_text(hjust = 0.5, face = "bold"),
    plot.background = element_rect(fill = "#f7f7f7"),
    panel.background = element_rect(fill = "#f7f7f7"),
```

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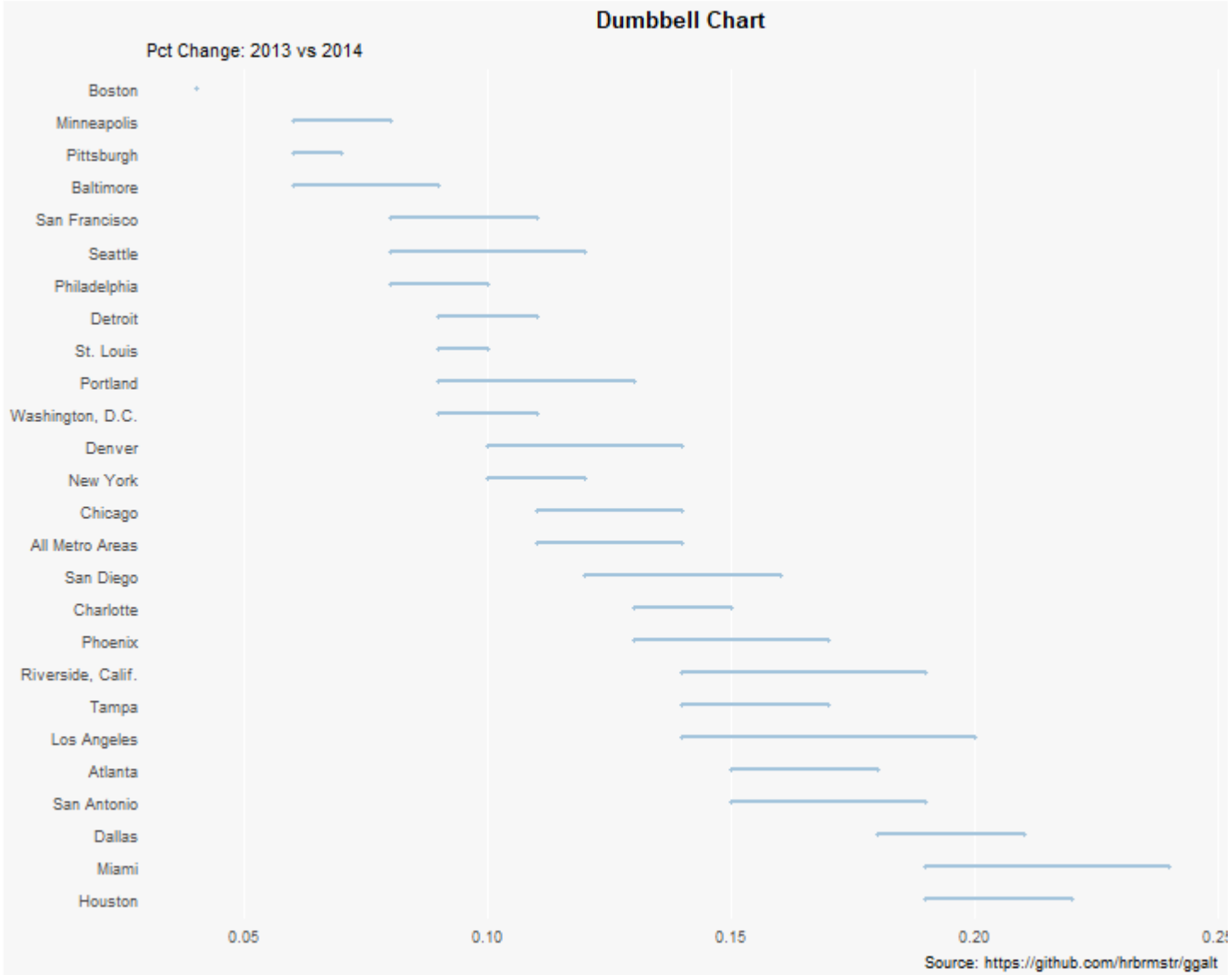

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Distribution, histogram

```
# Histogram on a Continuous (Numeric) Variable
g <- ggplot(mpg, aes(displ)) + scale_fill_brewer(palette = "Spectral")

g + geom_histogram(aes(fill=class),
                   binwidth = .1,
                   col="black",
                   size=.1) +  # change binwidth
  labs(title="Histogram with Auto Binning",
       subtitle="Engine Displacement across Vehicle Classes")
```

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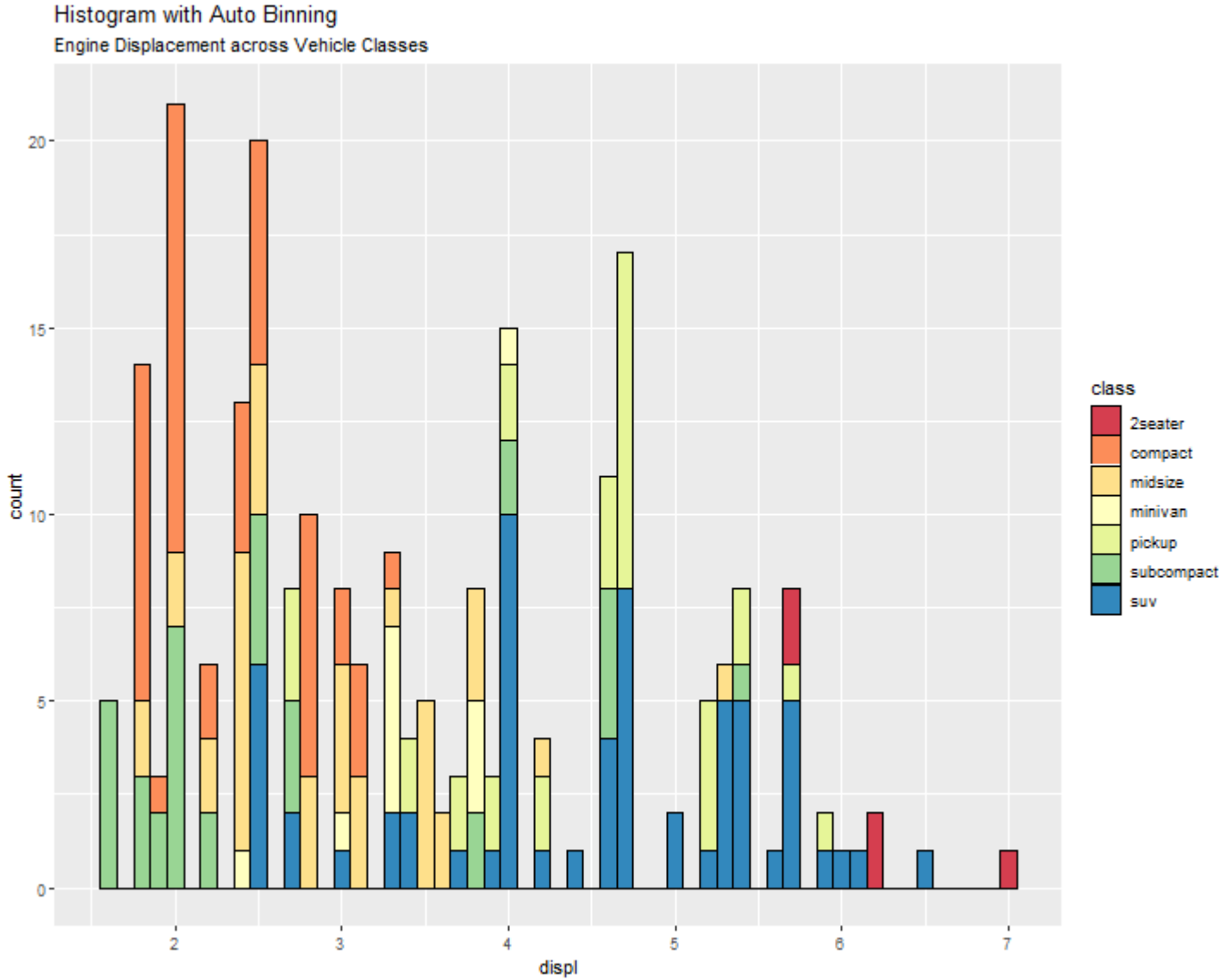

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Distribution, boxplot

```
library(ggthemes)
g <- ggplot(mpg, aes(class, cty))
g + geom_boxplot(aes(fill=factor(cyl))) +
  theme(axis.text.x = element_text(angle=65, vjust=0.6)) +
  labs(title="Box plot",
       subtitle="City Mileage grouped by Class of vehicle",
       caption="Source: mpg",
       x="Class of Vehicle",
       y="City Mileage")
```

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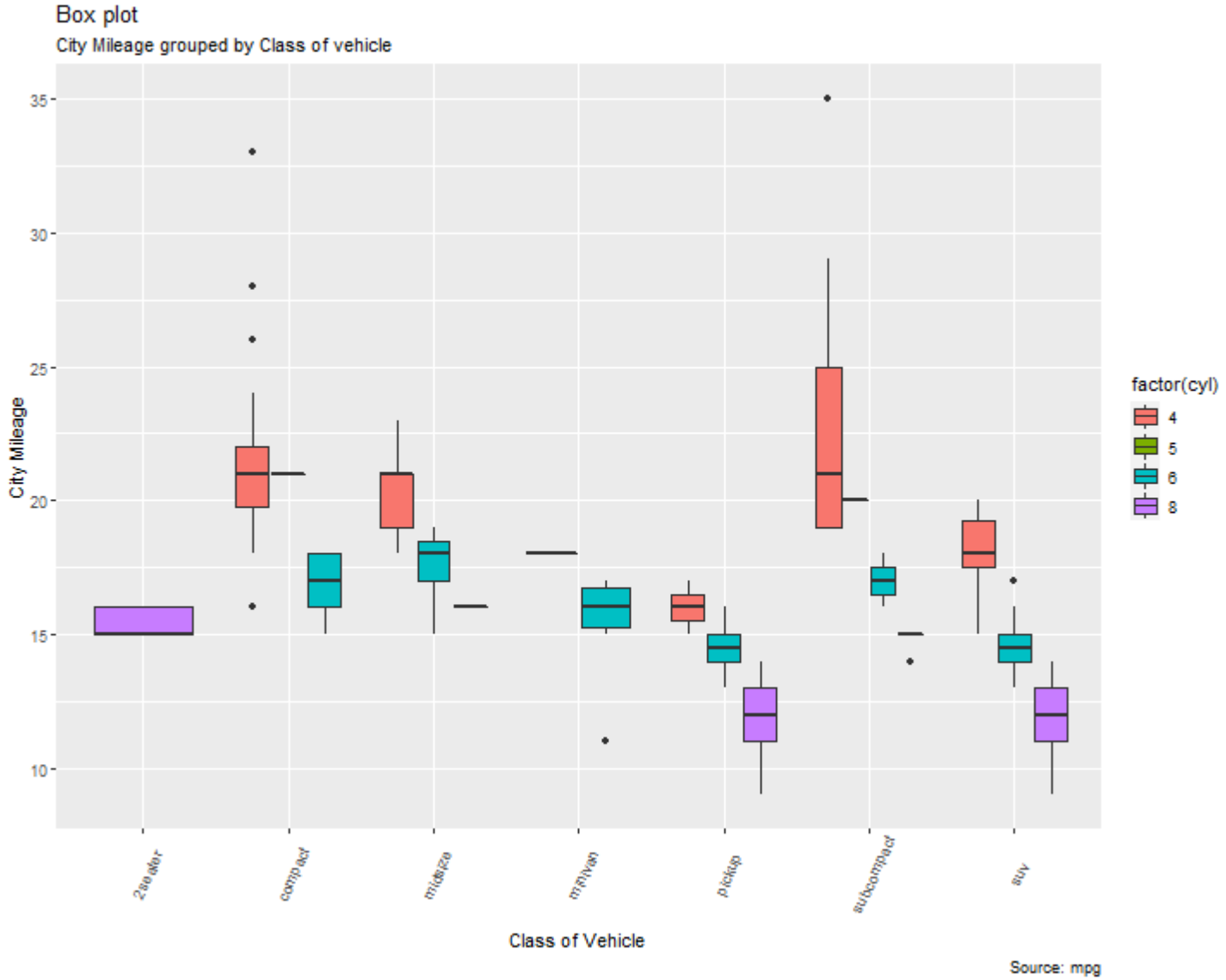

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Distribution, population pyramid

```r
library(ggplot2)
library(ggthemes)
# Read data
email_campaign_funnel <- read.csv("https://raw.githubusercontent.com/selva86/datasets/master/email_campaign_f

# X Axis Breaks and Labels
brks <- seq(-15000000, 15000000, 5000000)
lbls = paste0(as.character(c(seq(15, 0, -5), seq(5, 15, 5))), "m")

# Plot
ggplot(email_campaign_funnel, aes(x = Stage, y = Users, fill = Gender)) +   # Fill column
                              geom_bar(stat = "identity", width = .6) +   # draw the bars
                              scale_y_continuous(breaks = brks,   # Breaks
                                                 labels = lbls) + # Labels
                              coord_flip() +  # Flip axes
                              labs(title="Email Campaign Funnel") +
                              theme_tufte() +  # Tufte theme from ggfortify
                              theme(plot.title = element_text(hjust = .5),
                                    axis.ticks = element_blank()) +   # Centre plot title
                              scale_fill_brewer(palette = "Dark2")  # Color palette
```

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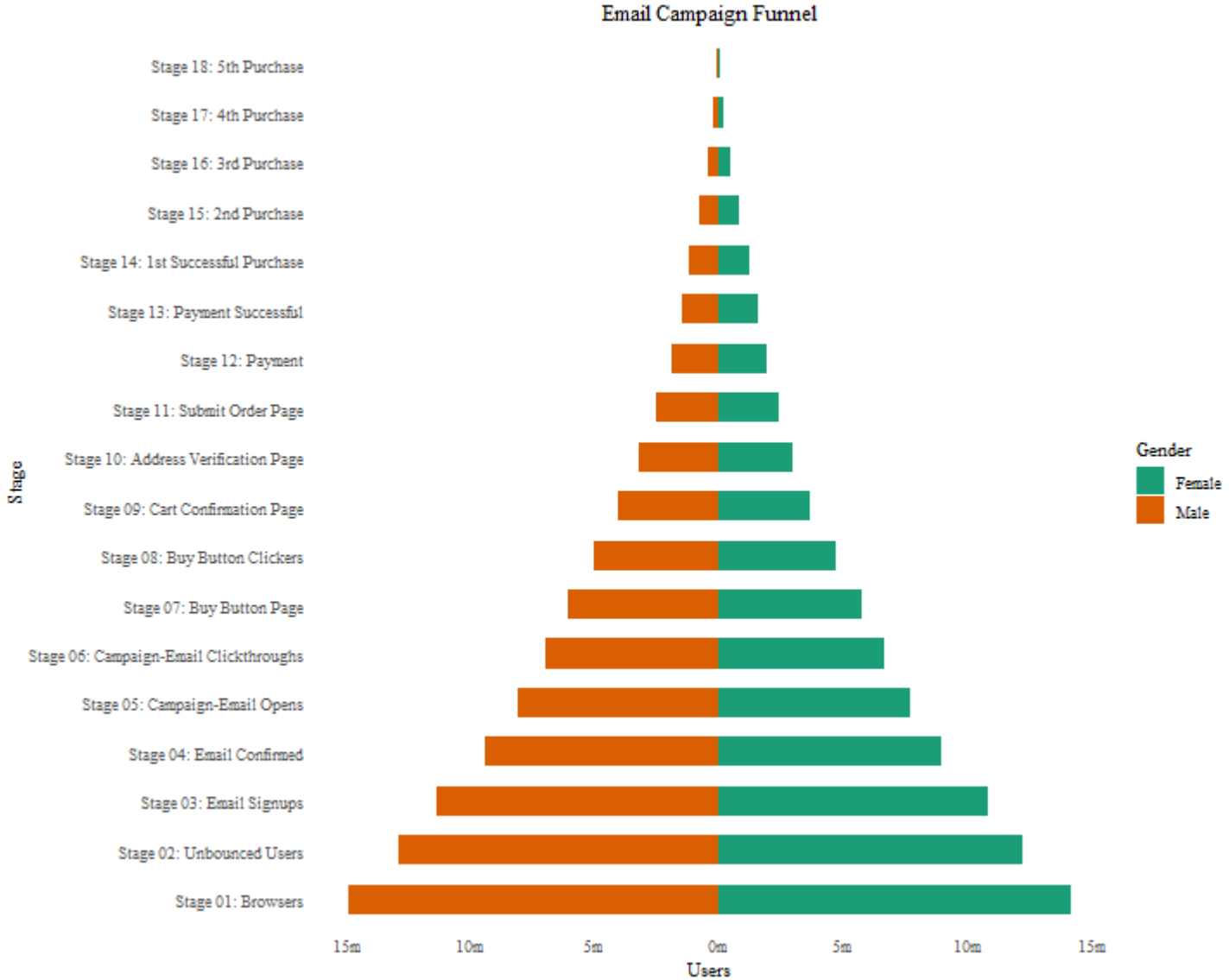

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Change, time series

```
library(ggfortify)
# Plot
autoplot(AirPassengers) +
  labs(title="AirPassengers") +
  theme(plot.title = element_text(hjust=0.5))
```

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```
## Error in library(ggfortify): there is no package called 'ggfortify'
```

```
## Error in `autoplot()`:
## ! Objects of type ts not supported by autoplot.
```

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Change, time series

```
library(ggplot2)
library(lubridate)


df <- economics_long[economics_long$variable %in% c("psavert", "uempmed"), ]
df <- df[lubridate::year(df$date) %in% c(1967:1981), ]

# labels and breaks for X axis text
brks <- df$date[seq(1, length(df$date), 12)]
lbls <- lubridate::year(brks)

# plot
ggplot(df, aes(x=date)) +
  geom_line(aes(y=value, col=variable)) +
  labs(title="Time Series of Returns Percentage",
       subtitle="Drawn from Long Data format",
       caption="Source: Economics",
       y="Returns %",
       color=NULL) +  # title and caption
  scale_x_date(labels = lbls, breaks = brks) +  # change to monthly ticks and labels
  scale_color_manual(labels = c("psavert", "uempmed"),
                     values = c("psavert"="#00ba38", "uempmed"="#f8766d")) +  # line color
  theme(axis.text.x = element_text(angle = 90, vjust=0.5, size = 8),  # rotate x axis text
        panel.grid.minor = element_blank())  # turn off minor grid
```

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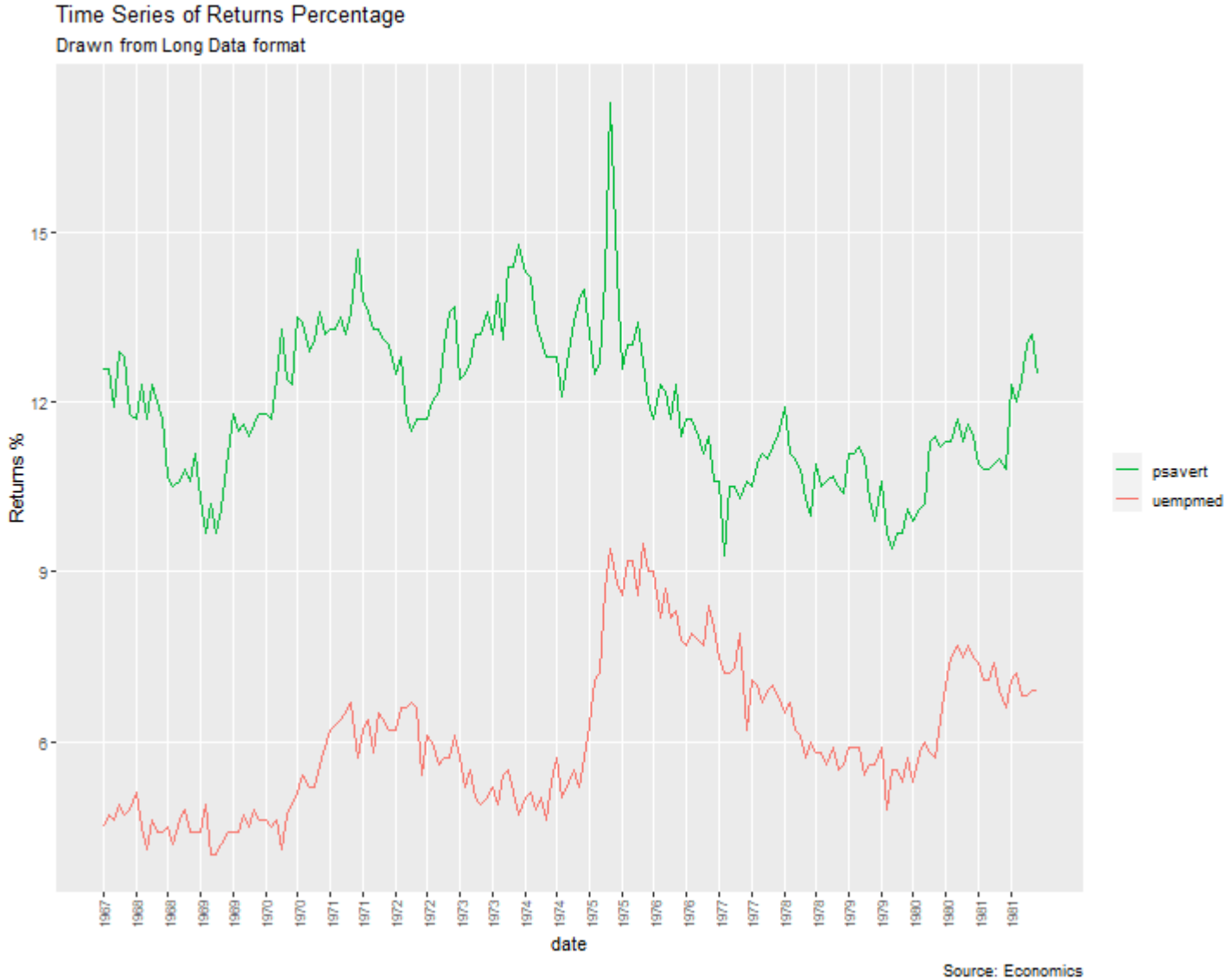

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Change, calendar map

```
# http://margintale.blogspot.in/2012/04/ggplot2-time-series-heatmaps.html
library(ggplot2)
library(plyr)
library(scales)
library(zoo)

df <- read.csv("https://raw.githubusercontent.com/selva86/datasets/master/yahoo.csv")
df$date <- as.Date(df$date)  # format date
df <- df[df$year >= 2012, ]  # filter reqd years

# Create Month Week
df$yearmonth <- as.yearmon(df$date)
df$yearmonthf <- factor(df$yearmonth)
df <- ddply(df,.(yearmonthf), transform, monthweek=1+week-min(week))  # compute week number of month
df <- df[, c("year", "yearmonthf", "monthf", "week", "monthweek", "weekdayf", "VIX.Close")]

# Plot
ggplot(df, aes(monthweek, weekdayf, fill = VIX.Close)) +
  geom_tile(colour = "white") +
  facet_grid(year~monthf) +
  scale_fill_gradient(low="red", high="green") +
  labs(x="Week of Month",
       y="",
       title = "Time-Series Calendar Heatmap",
```

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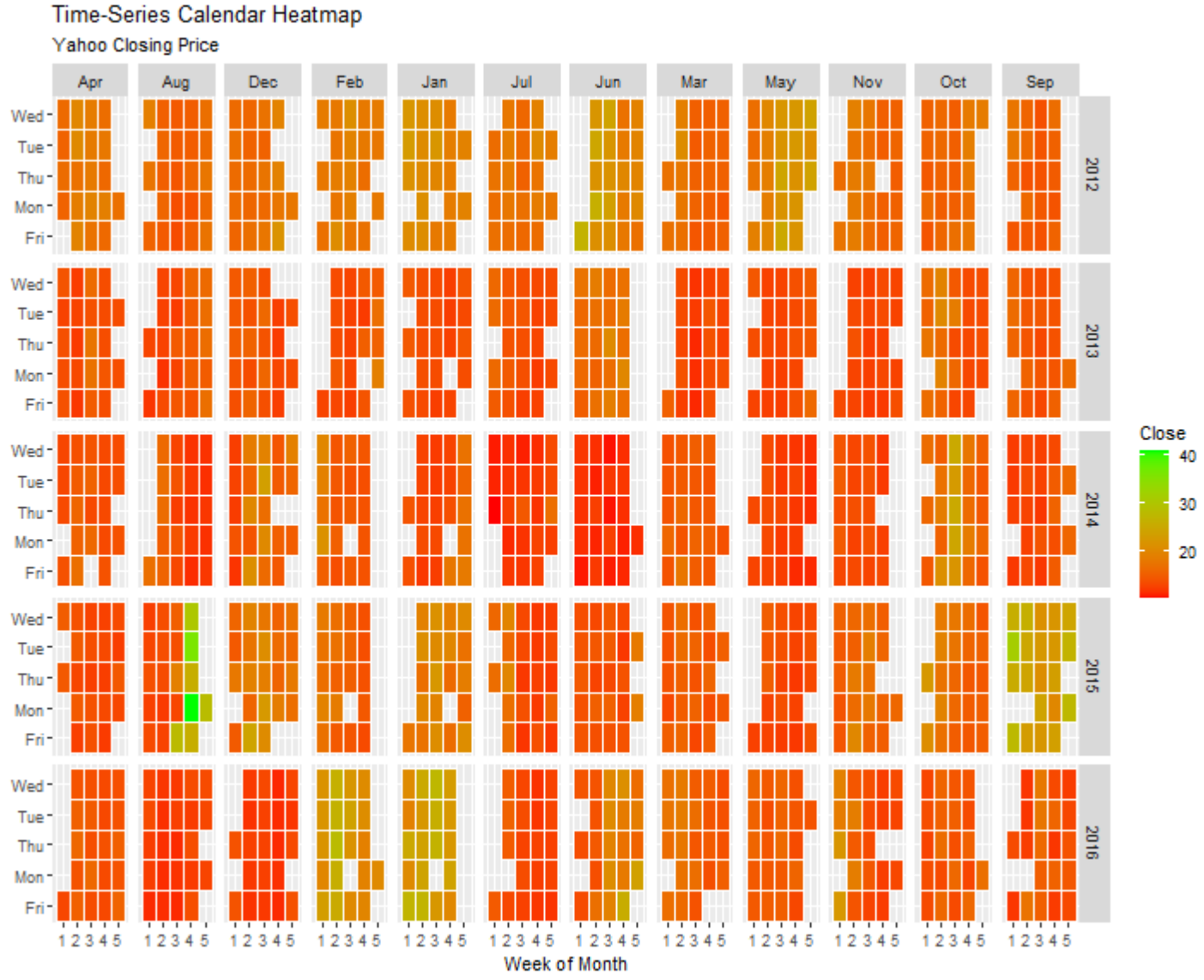

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Change, heat map

```
#Heat map
set.seed(41)
expand.grid(
  teams = c("Team A", "Team B", "Team C", "Team D")
  ,
  metrics = c("Metric 1", "Metric 2", "Metric 3", "Metric 4", "Metric 5")
) %>%
  mutate(performance = rnorm(5)) %>% # add variable: performance
  ggplot(aes(x = metrics, y = teams)) + geom_tile(aes(fill = performance))
```

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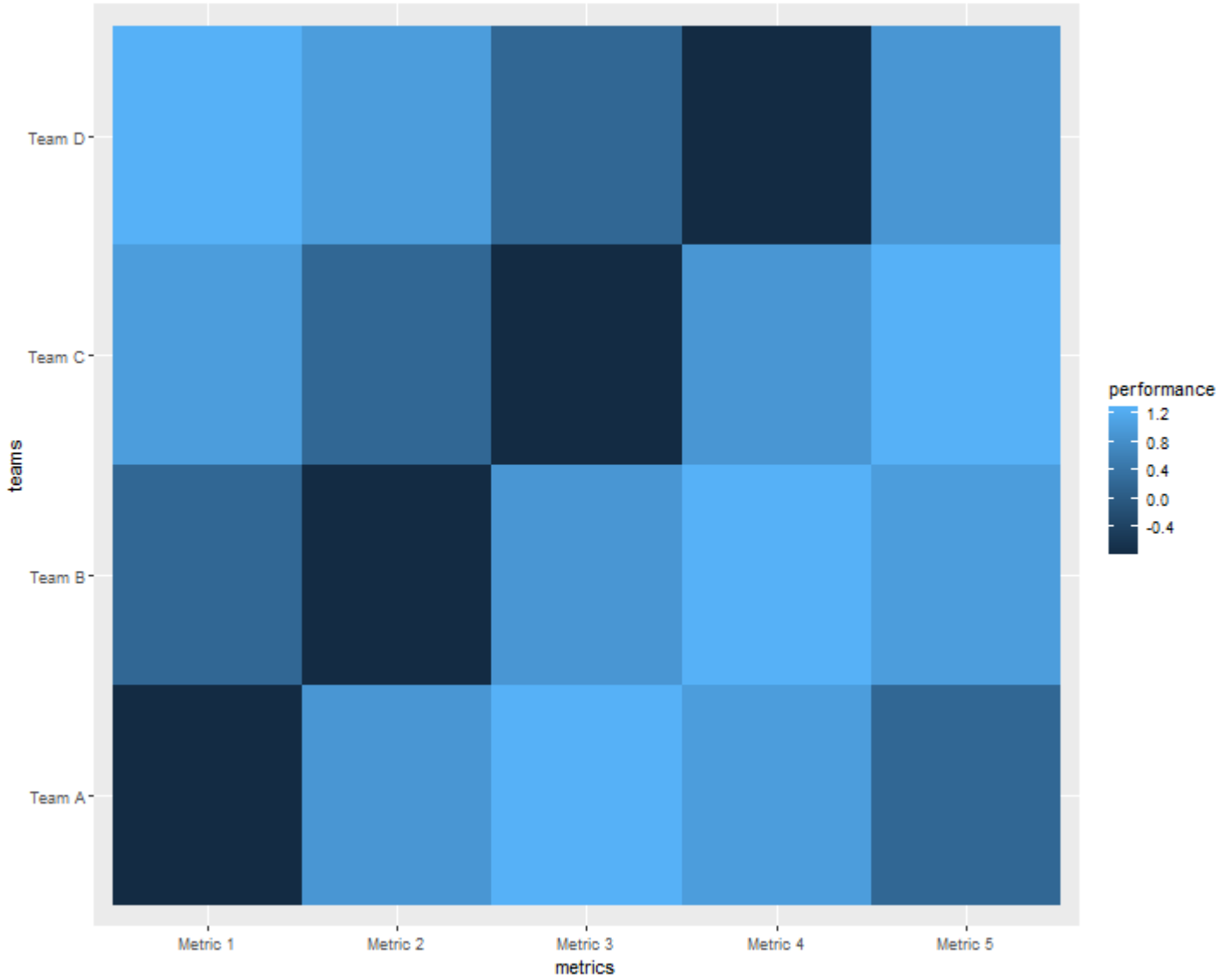

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Change, seasonal plot

```
library(ggplot2)
library(forecast)


# Subset data
window(nottem, start=c(1920, 1), end=c(1925, 12)) %>%   # subset a smaller timewindow
ggseasonplot() + labs(title="Seasonal plot: Air temperatures at Nottingham Castle")
```

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```
## Error in library(forecast): there is no package called 'forecast'
```

```
## Error in ggseasonplot(.): could not find function "ggseasonplot"
```

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Advanced Visualization

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Static, cluster

```
library(ggplot2)
library(ggalt)
library(ggfortify)
theme_set(theme_classic())
# Compute data with principal components
df <- iris[c(1, 2, 3, 4)]
pca_mod <- prcomp(df)  # compute principal components

# Data frame of principal components
df_pc <- data.frame(pca_mod$x, Species=iris$Species)  # dataframe of principal components
df_pc_vir <- df_pc[df_pc$Species == "virginica", ]  # df for 'virginica'
df_pc_set <- df_pc[df_pc$Species == "setosa", ]  # df for 'setosa'
df_pc_ver <- df_pc[df_pc$Species == "versicolor", ]  # df for 'versicolor'

# Plot
ggplot(df_pc, aes(PC1, PC2, col=Species)) +
  geom_point(aes(shape=Species), size=2) +   # draw points
  labs(title="Iris Clustering",
       subtitle="With principal components PC1 and PC2 as X and Y axis",
       caption="Source: Iris") +
  coord_cartesian(xlim = 1.2 * c(min(df_pc$PC1), max(df_pc$PC1)),
                  ylim = 1.2 * c(min(df_pc$PC2), max(df_pc$PC2))) +   # change axis limits
  geom_encircle(data = df_pc_vir, aes(x=PC1, y=PC2)) +   # draw circles
  geom_encircle(data = df_pc_set, aes(x=PC1, y=PC2)) +
```

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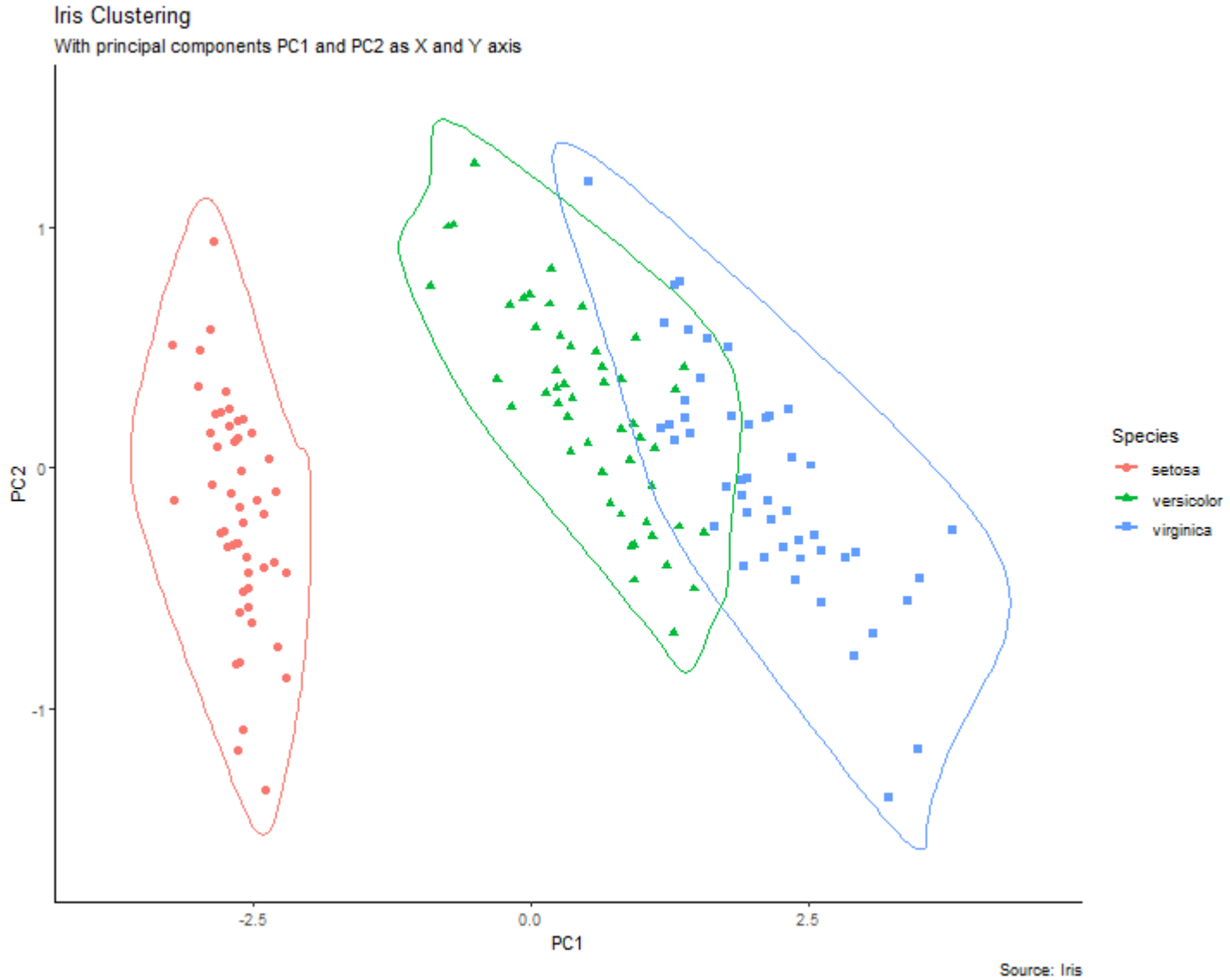
```
## Error in library(ggfortify): there is no package called 'ggfortify'
```



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Static, spatial

google needs api key for retrieving the map now Use ?reigister_google for more information

```
library(ggplot2)
library(ggmap)
library(ggalt)

# Google Hybrid Map
neu_ggl_hybrid_map <-
  qmap("neu", zoom = 12,
       source = "google",
       maptype = "hybrid")
neu_places <- c("Northeastern University, MA",
                "MIT",
                "Harvard University",
                "Boston College, MA")
places_loc <- geocode(neu_places)
# Google Hybrid Map
neu_ggl_hybrid_map + geom_point(
  aes(x = lon, y = lat),
  data = places_loc,
  alpha = 0.7,
  size = 7,
  color = "tomato"
) +
```

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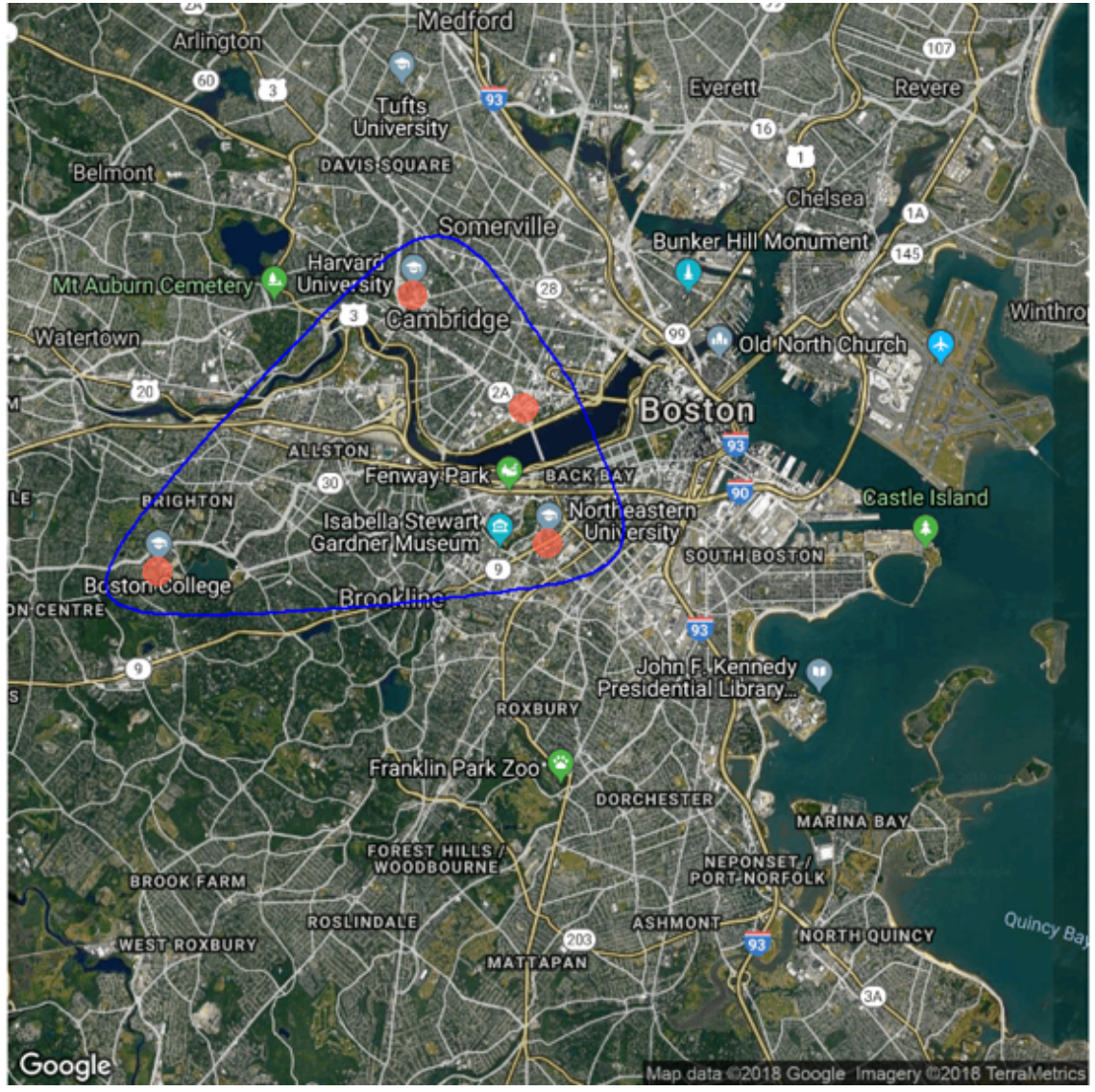

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Static, network

```
#Network Map
library(maps)
library(geosphere)
airports <- read.csv("E:/IE6600/IE6600_SEA_Spring2021/R/R/Network Data Sets/Dataset3-Airlines-NODES.csv",
                     header=TRUE)
flights <- read.csv("E:/IE6600/IE6600_SEA_Spring2021/R/R/Network Data Sets/Dataset3-Airlines-EDGES.csv",
                    header=TRUE, as.is=TRUE)
# Select only large airports: ones with more than 10 connections in the data.
tab <- table(flights$Source)
big.id <- names(tab)[tab>10]
airports <- airports[airports$ID %in% big.id,]
flights  <- flights[flights$Source %in% big.id &
                     flights$Target %in% big.id, ]

# Plot a map of the united states:
map("state", col="grey20", fill=TRUE, bg="black", lwd=0.1)
```

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Static, network (cont'd)

```
# Add a point on the map for each airport:
points(x=airports$longitude, y=airports$latitude, pch=19,
       cex=airports$Visits/80, col="orange")
col.1 <- adjustcolor("orange red", alpha=0.4)
col.2 <- adjustcolor("orange", alpha=0.4)
edge.pal <- colorRampPalette(c(col.1, col.2), alpha = TRUE)
edge.col <- edge.pal(100)
for(i in 1:nrow(flights))  {
  node1 <- airports[airports$ID == flights[i,]$Source,]
  node2 <- airports[airports$ID == flights[i,]$Target,]

  arc <- gcIntermediate( c(node1[1,]$longitude, node1[1,]$latitude),
                         c(node2[1,]$longitude, node2[1,]$latitude),
                         n=1000, addStartEnd=TRUE )
  edge.ind <- round(100*flights[i,]$Freq / max(flights$Freq))

  lines(arc, col=edge.col[edge.ind], lwd=edge.ind/30)
}
```

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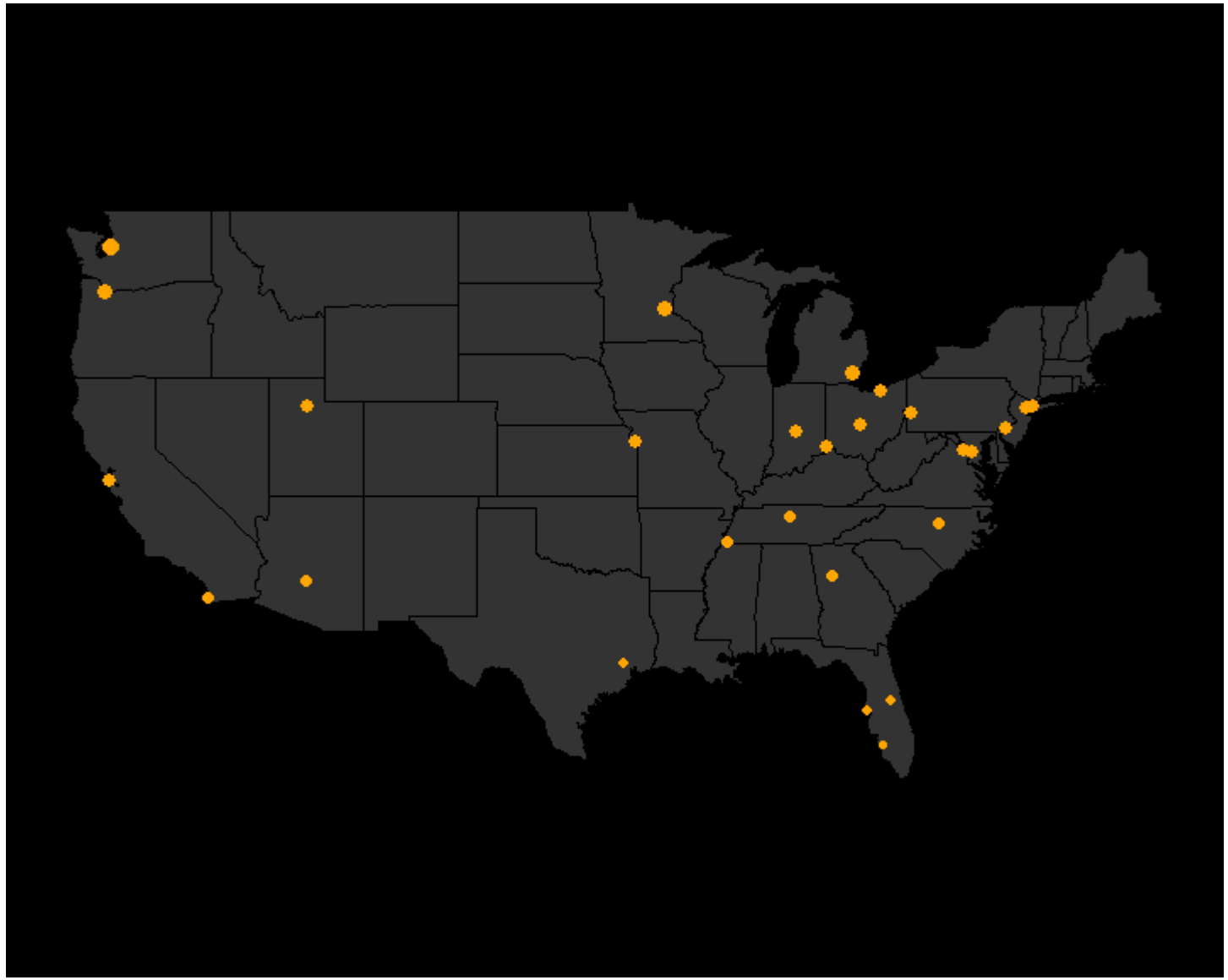
```
## Error in library(geosphere): there is no package called 'geosphere'
```



```
## Error in gcIntermediate(c(node1[1, ]$longitude, node1[1, ]$latitude), : could not find function "gcIntermediate"
```

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Animated, Box plot

```
library(ggplot2)
library(gganimate)
library(gifski)
ggplot(mtcars, aes(factor(cyl), mpg)) +
  geom_boxplot() +
  # Here comes the gganimate code
  transition_states(
    gear,
    transition_length = 2,
    state_length = 1
  ) +
  enter_fade() +
  exit_shrink() +
  ease_aes('sine-in-out')
```

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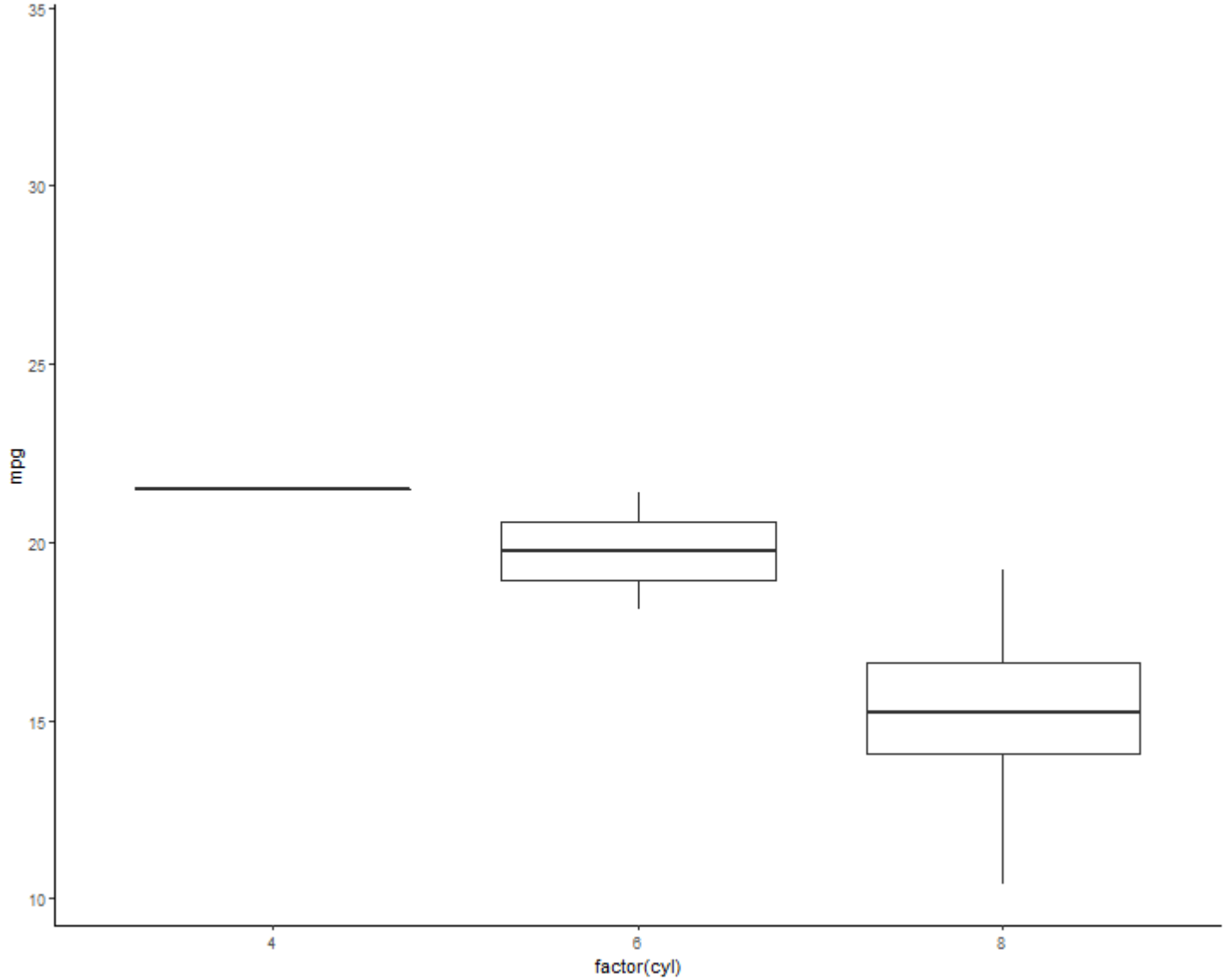
```
## Error in library(gifski): there is no package called 'gifski'
```



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Animated, Dot Plot

```
library(gapminder)

ggplot(gapminder, aes(gdpPercap, lifeExp, size = pop, colour = country)) +
  geom_point(alpha = 0.7, show.legend = FALSE) +
  scale_colour_manual(values = country_colors) +
  scale_size(range = c(2, 12)) +
  scale_x_log10() +
  facet_wrap(~continent) +
  # Here comes the gganimate specific bits
  labs(title = 'Year: {frame_time}', x = 'GDP per capita', y = 'life expectancy') +
  transition_time(year) +
  ease_aes('linear')
```

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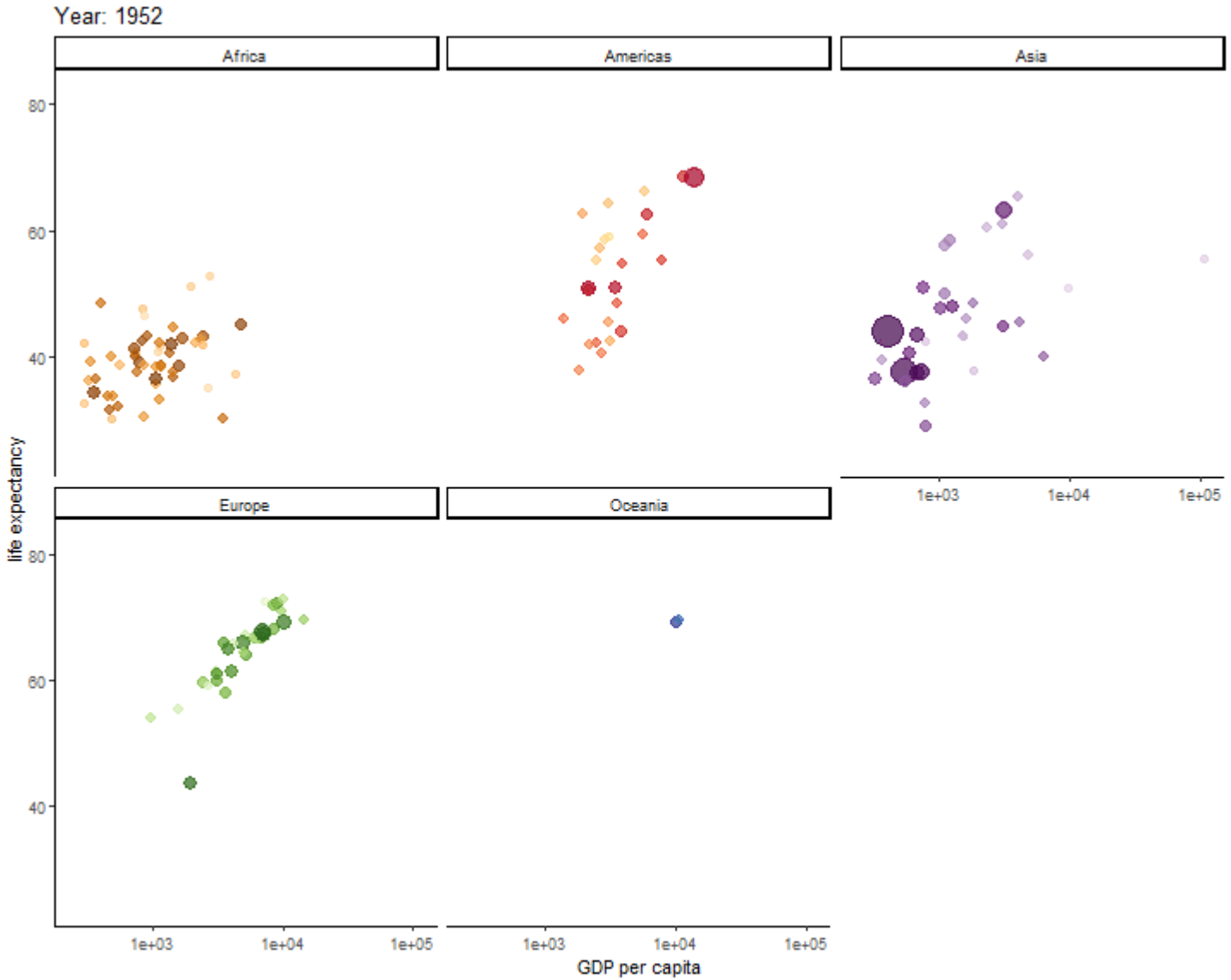

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Interactive plot with ggplotlly()

```
library(plotly)
g <- ggplot(txhousing, aes(x = date, y = sales, group = city)) +
  geom_line(alpha = 0.4)
ggplotly(g, tooltip = c("city"))
```

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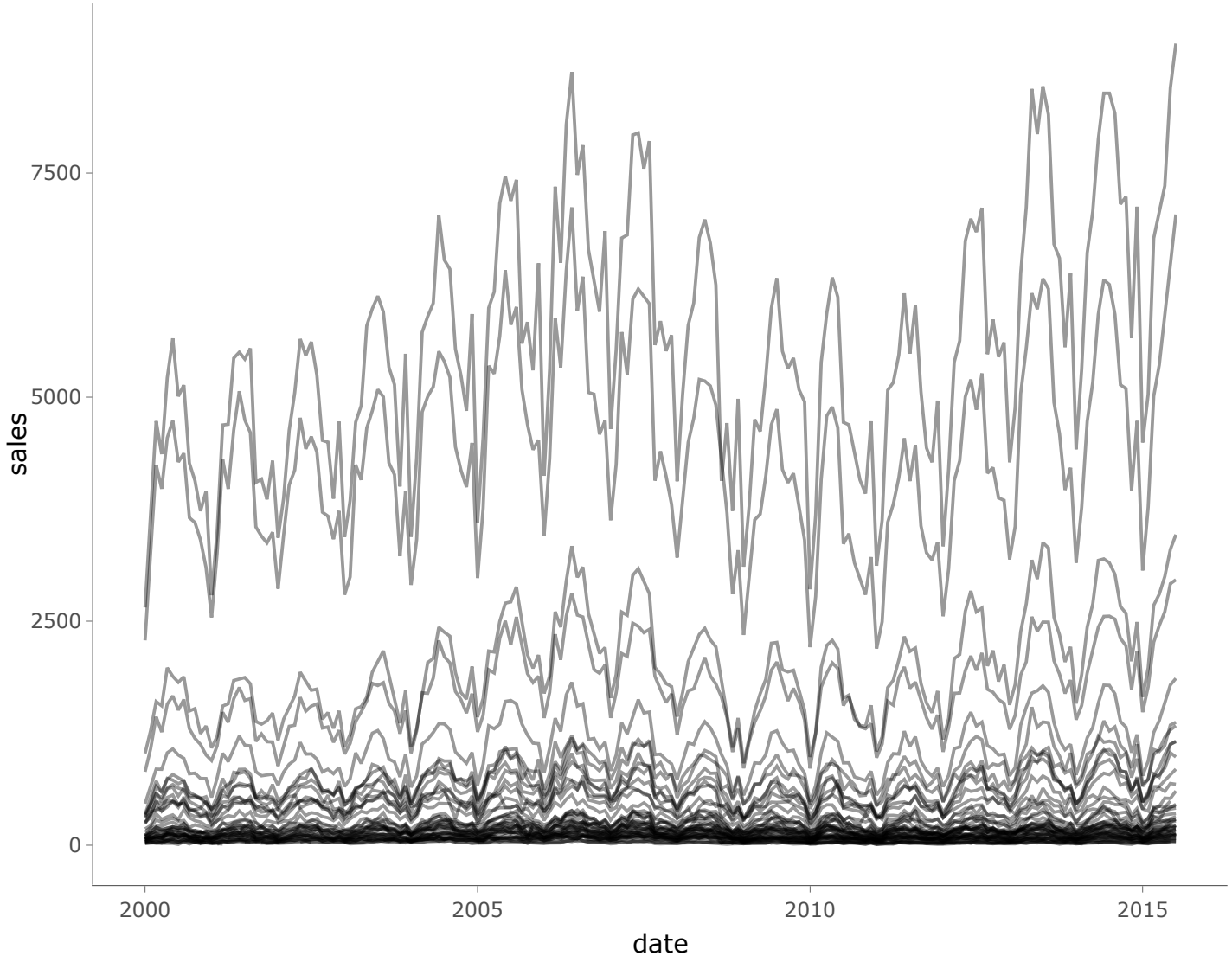

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Interactive plot, plotly

```
library(plotly)
diamonds[sample(nrow(diamonds), 1000), ] %>%
  plot_ly(
  x = ~carat, y = ~price,
  color = ~carat, size = ~carat
)
```

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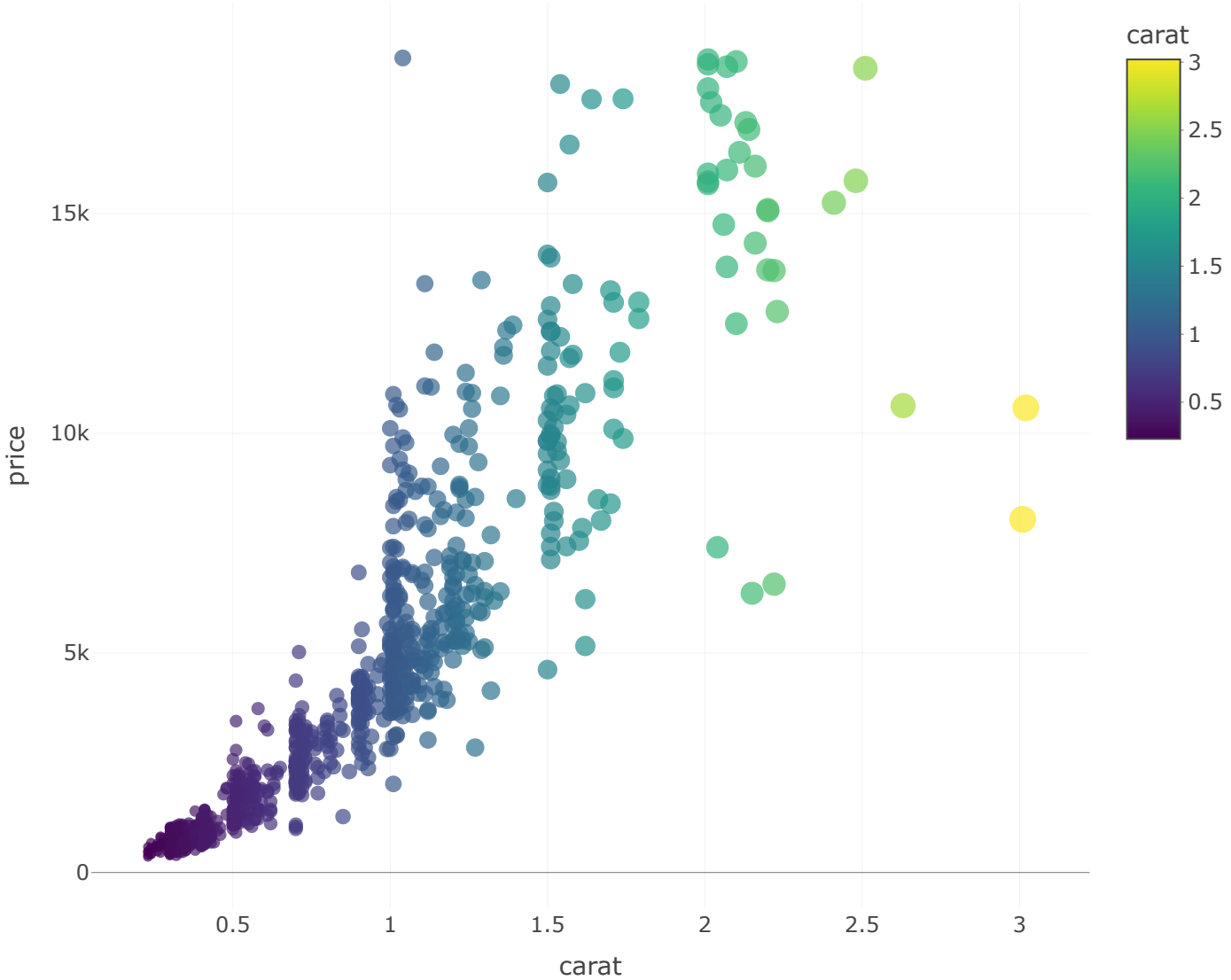

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Interactive plot, D3

```
library(networkD3)
forceNetwork(Links = MisLinks, Nodes = MisNodes, Source = "source",
             Target = "target", Value = "value", NodeID = "name",
             Group = "group", opacity = 0.9, Nodesize = 3,
             linkDistance = 100, fontSize = 20)
```

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```
## Error in library(networkD3): there is no package called 'networkD3'
```

```
## Error in forceNetwork(Links = MisLinks, Nodes = MisNodes, Source = "source", : could not find function "forceNetwo
```

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Applicatin in real life

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```
# Libraries
library(tidyverse)

# Get the world polygon and extract USA
library(maps)
USA <- map_data("world") %>% filter(region=="USA")
# Get a data frame with longitude, latitude, and size of bubbles (a bubble = a city)
data=world.cities %>% filter(country.etc=="USA")

# Left chart
ggplot() +
  geom_polygon(data = USA, aes(x=long, y = lat, group = group), fill="grey", alpha=0.3) +
  geom_point( data=data, aes(x=long, y=lat)) +
  theme_void() + ylim(20,56) + xlim(-125,-65)+coord_map()
```

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```
# Second graphic with names of the 10 biggest cities
library(ggrepel)
ggplot() +
  geom_polygon(data = USA, aes(x=long, y = lat, group = group), fill="grey", alpha=0.3) +
  geom_point( data=data, aes(x=long, y=lat, alpha=pop)) +
  geom_text_repel(data=data %>% arrange(pop) %>% tail(10), aes(x=long, y=lat, label=name), size=5) +
  geom_point( data=data %>% arrange(pop) %>% tail(10), aes(x=long, y=lat), color="red", size=3) +
  theme_void() + ylim(20,56) + xlim(-125,-65)+coord_map()  +
  theme(legend.position="none")
```

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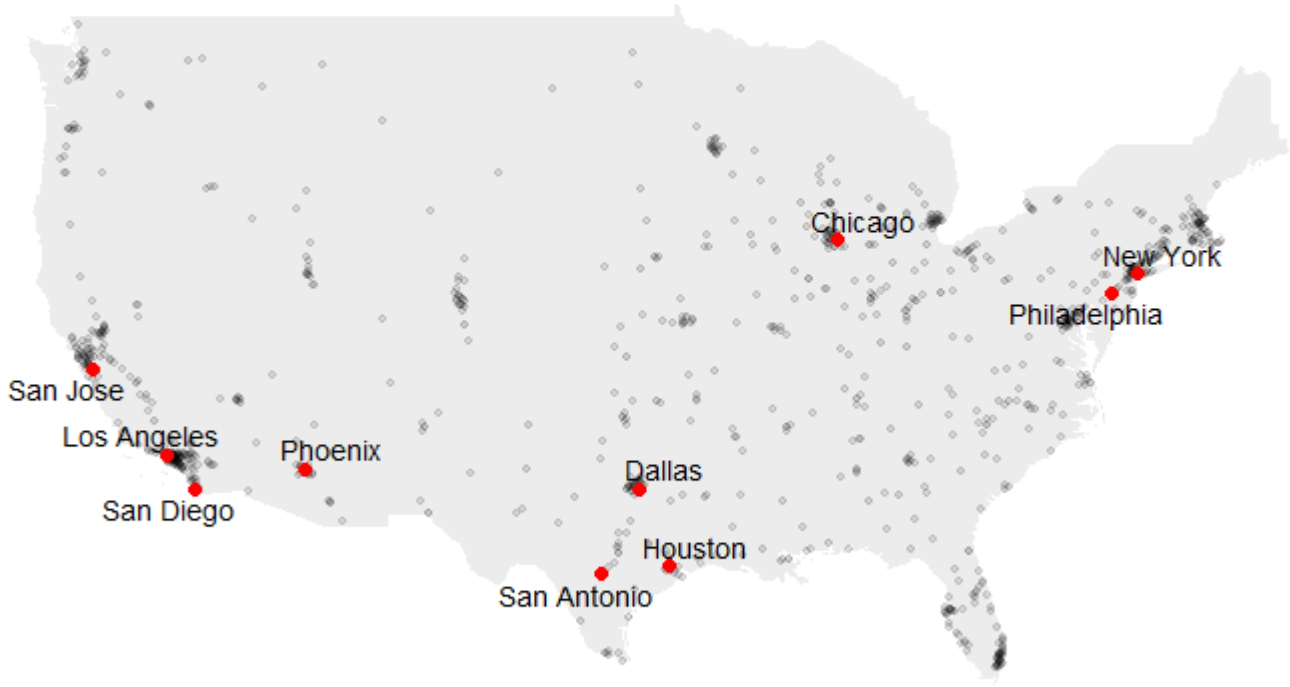

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```
library(viridis)
# first: use size and color
ggplot() +
  geom_polygon(data = USA, aes(x=long, y = lat, group = group), fill="grey", alpha=0.3) +
  geom_point( data=data, aes(x=long, y=lat, size=pop, color=pop)) +
  scale_size_continuous(range=c(1,12)) +
  scale_color_viridis(trans="log") +
  theme_void() + ylim(20,56) + xlim(-125,-65)+coord_map()
```

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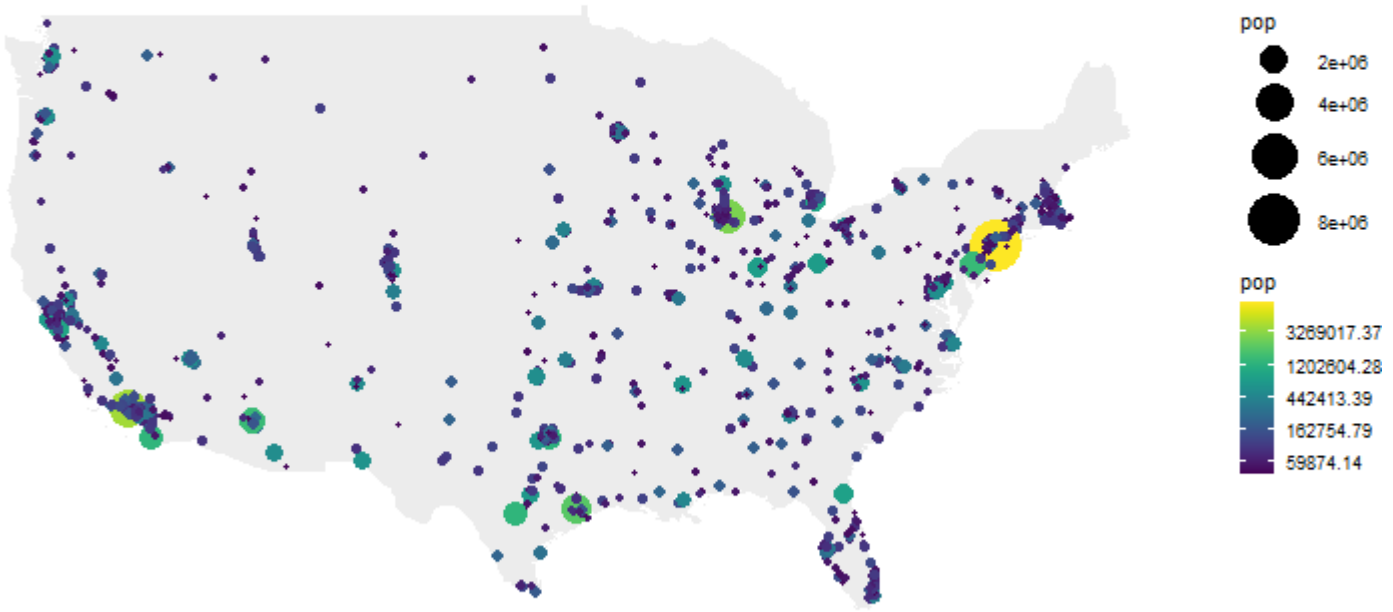

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```r
# second: reorder your dataset first! Big cities appear later = on top
data %>%
  arrange(pop) %>% # This reorder your data frame
  mutate( name=factor(name, unique(name))) %>% #this reorder the order of the levels of your factor --> this
  ggplot() +
  geom_polygon(data = USA, aes(x=long, y = lat, group = group), fill="grey", alpha=0.3) +
  geom_point( aes(x=long, y=lat, size=pop, color=pop), alpha=0.9) +
  scale_size_continuous(range=c(1,12)) +
  scale_color_viridis(trans="log") +
  theme_void() + ylim(20,56) + xlim(-125,-65)+coord_map()  + theme(legend.position="none")
```

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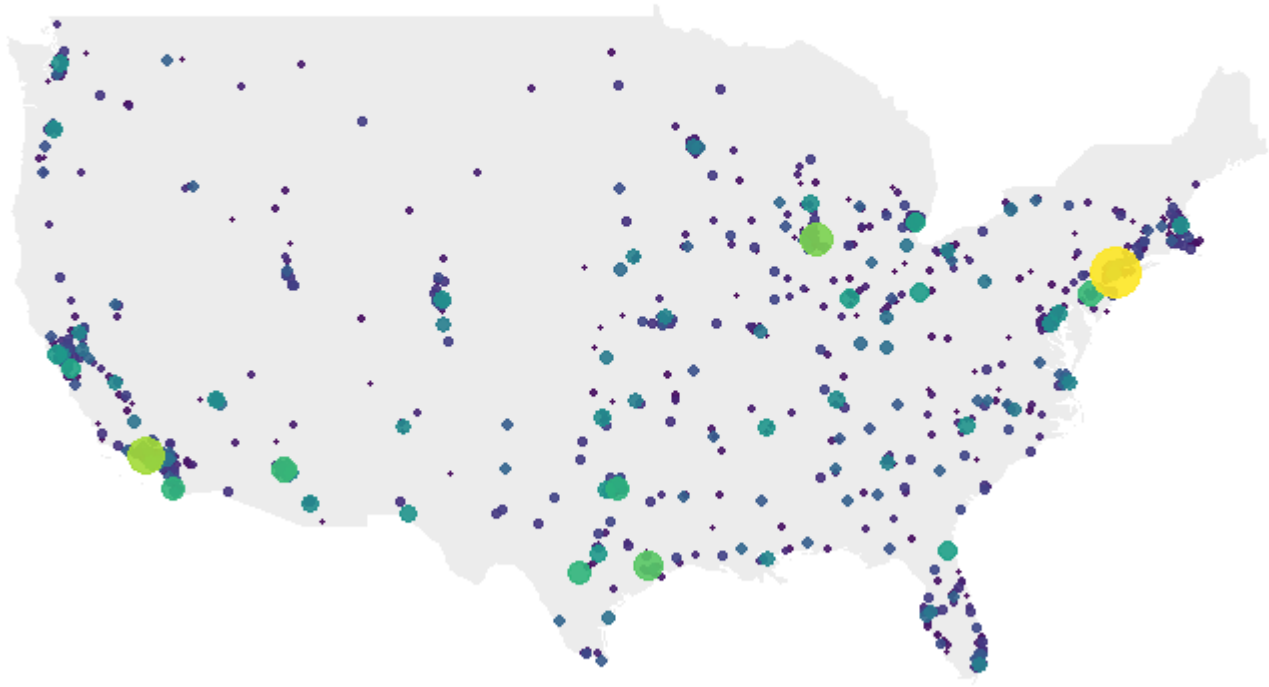

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```
library(viridis)
mybreaks=c(0.02, 0.04, 0.08, 1, 7)
data %>%
  arrange(pop) %>%
  mutate( name=factor(name, unique(name))) %>%
  mutate(pop=pop/1000000) %>%
  ggplot() +
  geom_polygon(data =USA, aes(x=long, y = lat, group = group), fill="grey", alpha=0.3) +
  geom_point(  aes(x=long, y=lat, size=pop, color=pop, alpha=pop), shape=20, stroke=FALSE) +
  scale_size_continuous(name="Population (in M)", trans="log", range=c(1,12), breaks=mybreaks) +
  scale_alpha_continuous(name="Population (in M)", trans="log", range=c(0.1, .9), breaks=mybreaks) +
  scale_color_viridis(option="magma", trans="log", breaks=mybreaks, name="Population (in M)" ) +
   theme_void() + ylim(20,56) + xlim(-125,-65)+coord_map() +
  guides( colour = guide_legend()) +
  ggtitle("The 1000 biggest cities in the USA") +
  theme(
    legend.position = c(0.85, 0.8),
    text = element_text(color = "#22211d"),
    plot.background = element_rect(fill = "#f5f5f2", color = NA),
    panel.background = element_rect(fill = "#f5f5f2", color = NA),
    legend.background = element_rect(fill = "#f5f5f2", color = NA),
    plot.title = element_text(size= 16, hjust=0.1, color = "#4e4d47", margin = margin(b = -0.1, t = 0.4, l = 
```

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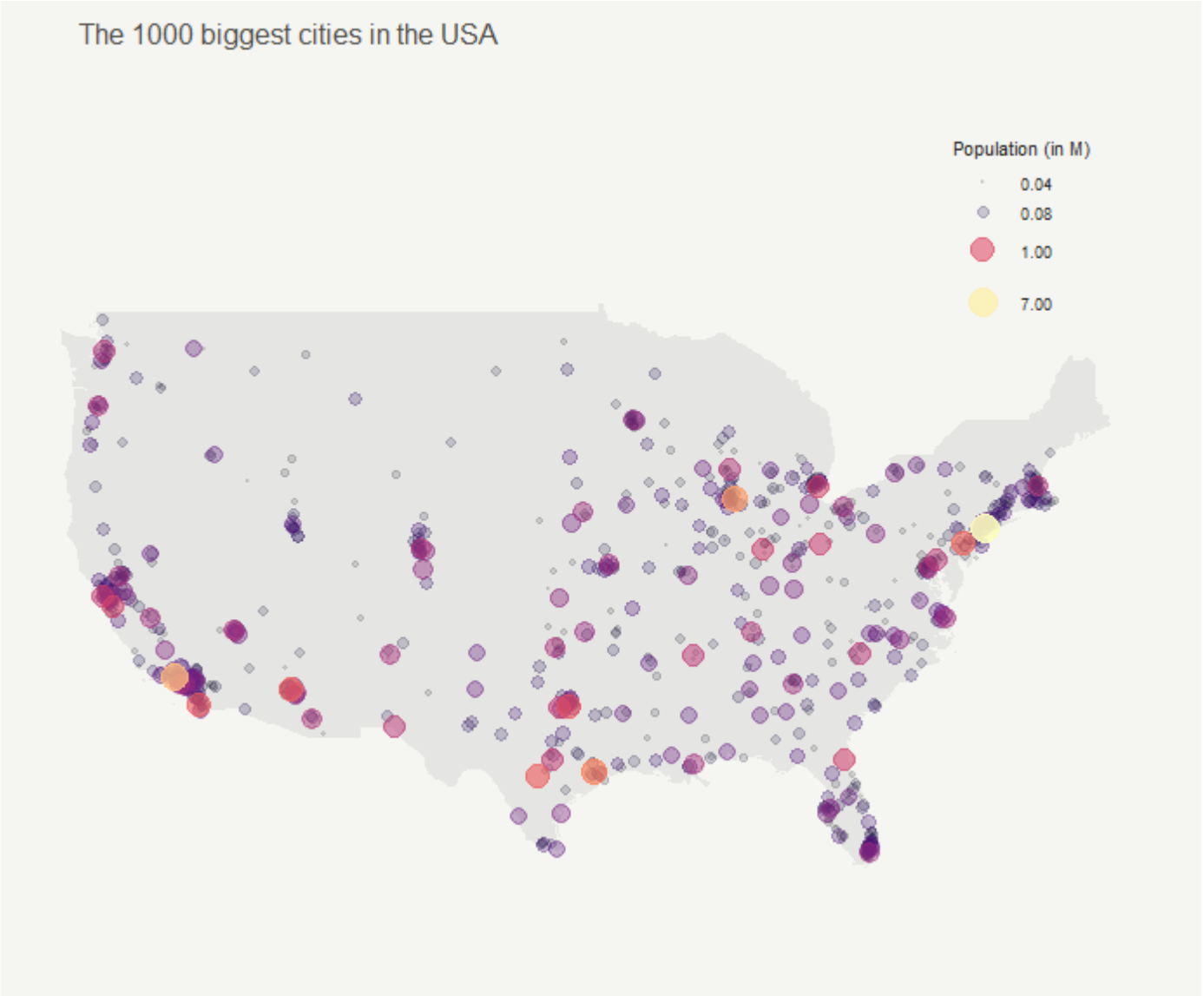

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```r
# Easy to make it interactive!
library(plotly)

# plot
p=data %>%

  arrange(pop) %>%
  mutate( name=factor(name, unique(name))) %>%
  mutate( mytext=paste("City: ", name, "\n", "Population: ", pop, sep="")) %>% # This prepare the text displa

  # Makte the static plot calling this text:
  ggplot() +
  geom_polygon(data = USA, aes(x=long, y = lat, group = group), fill="grey", alpha=0.3) +
  geom_point(aes(x=long, y=lat, size=pop, color=pop, text=mytext, alpha=pop) ) +

  scale_size_continuous(range=c(1,15)) +
  scale_color_viridis(option="inferno", trans="log" ) +
  scale_alpha_continuous(trans="log") +
  theme_void() +
  ylim(0,100) + xlim(-125,-65) +
  coord_map() +
  theme(legend.position = "none")

ggplotly(p, tooltip="text")
```

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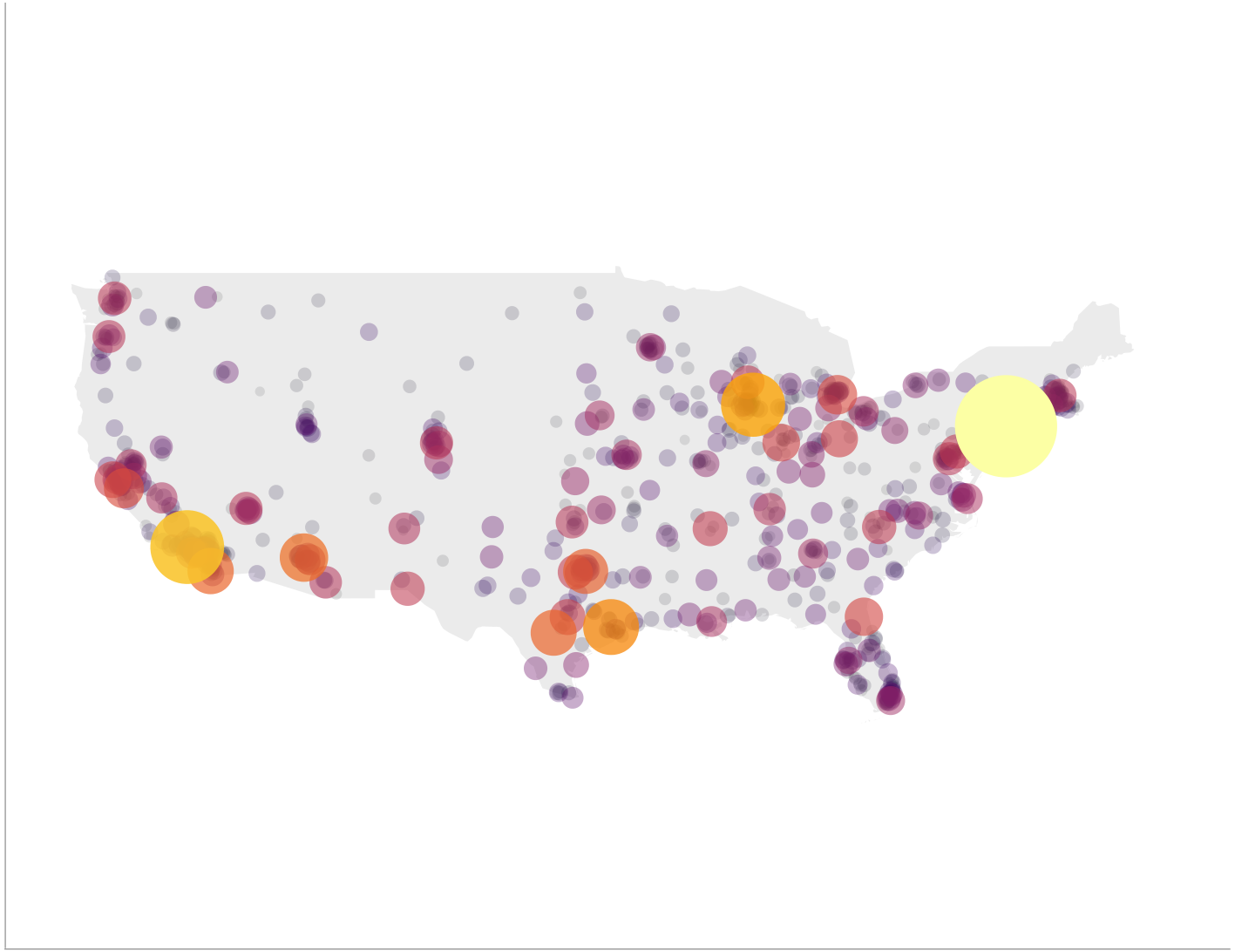

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