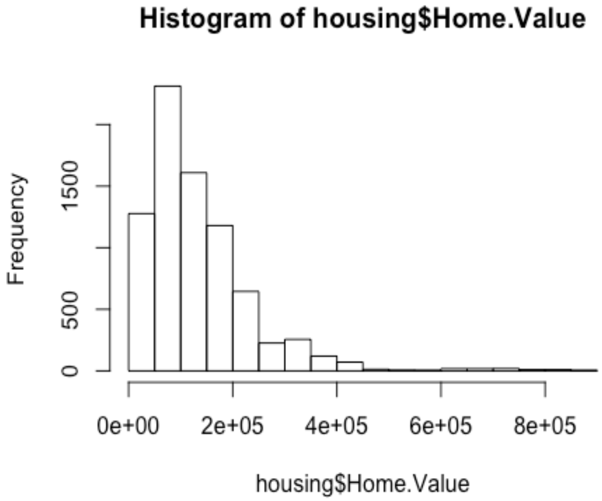
ggplot2 tutorial

```
## ggplot2 tutorial from harvard.edu
## http://tutorials.iq.harvard.edu/R/Rgraphics/Rgraphics.html#orgheadline19
############## 1. Geometric Objects and Aesthetics ###############
housing = read.csv("dataSets/landdata-states.csv")
head(housing[1:5])
```

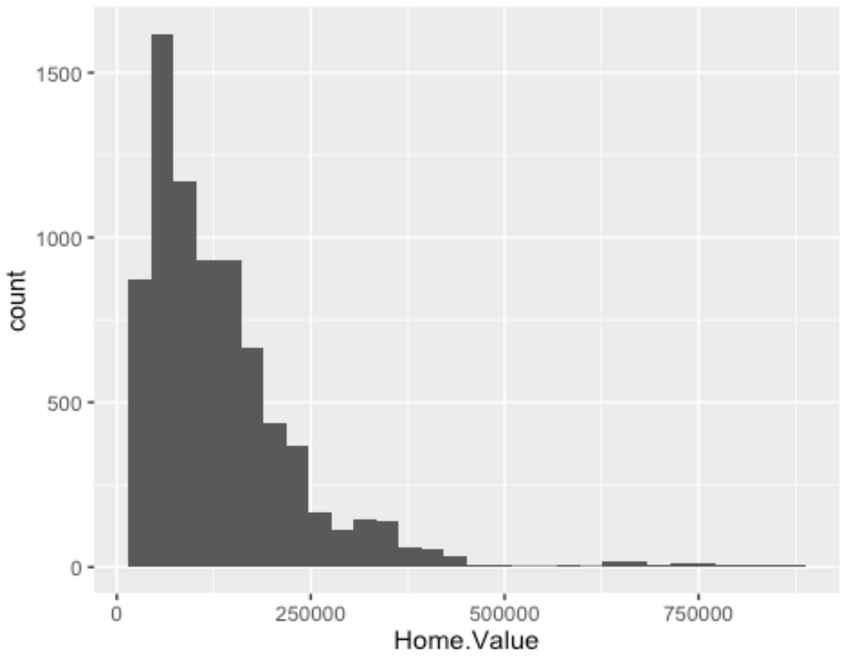
```
##   State region  Date Home.Value Structure.Cost
## 1    AK   West 20101     224952         160599
## 2    AK   West 20102     225511         160252
## 3    AK   West 20093     225820         163791
## 4    AK   West 20094     224994         161787
## 5    AK   West 20074     234590         155400
## 6    AK   West 20081     233714         157458
```

```
# Base graphics histogram
hist(housing$Home.Value)
# ggplot2 histogram
library(ggplot2)
```

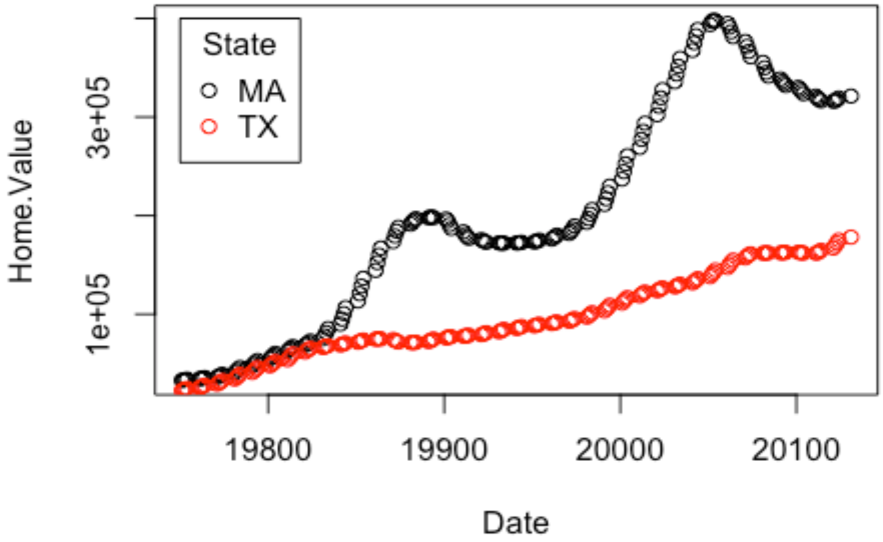


```
ggplot(housing, aes(x = Home.Value)) +
  geom_histogram()
```

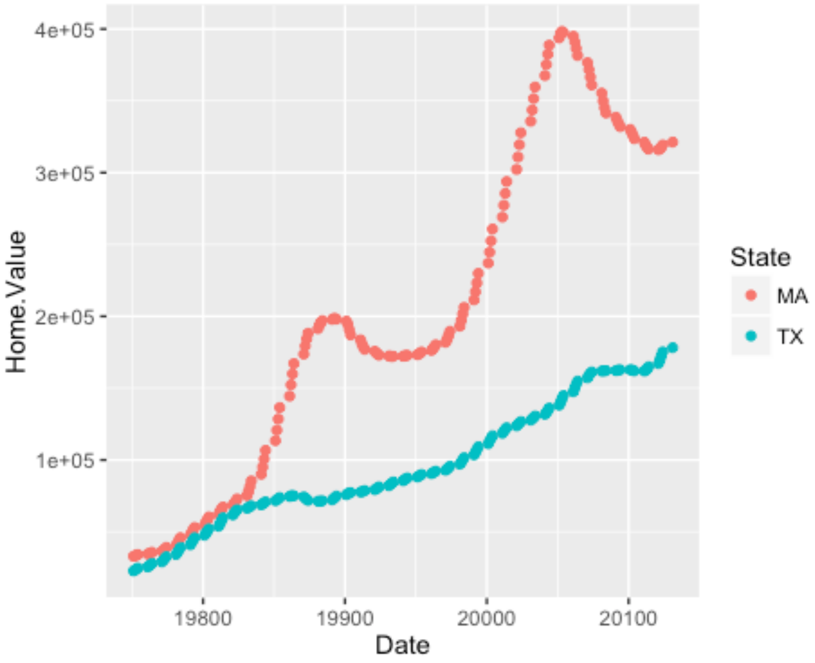
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



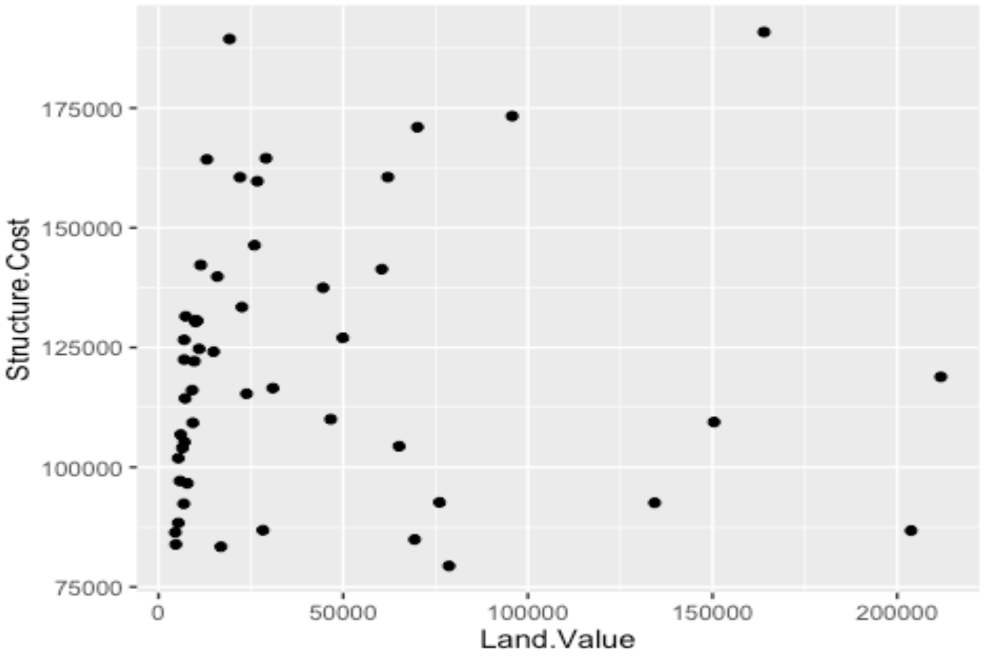
```
# Base color scatter plot
plot(Home.Value ~ Date,data = subset(housing, State == "MA"))
points(Home.Value ~ Date, col="red", data = subset(housing, State == "TX"))
legend(19750, 400000, c("MA", "TX"), title="State", col=c("black", "red"),
pch=c(1, 1))
```



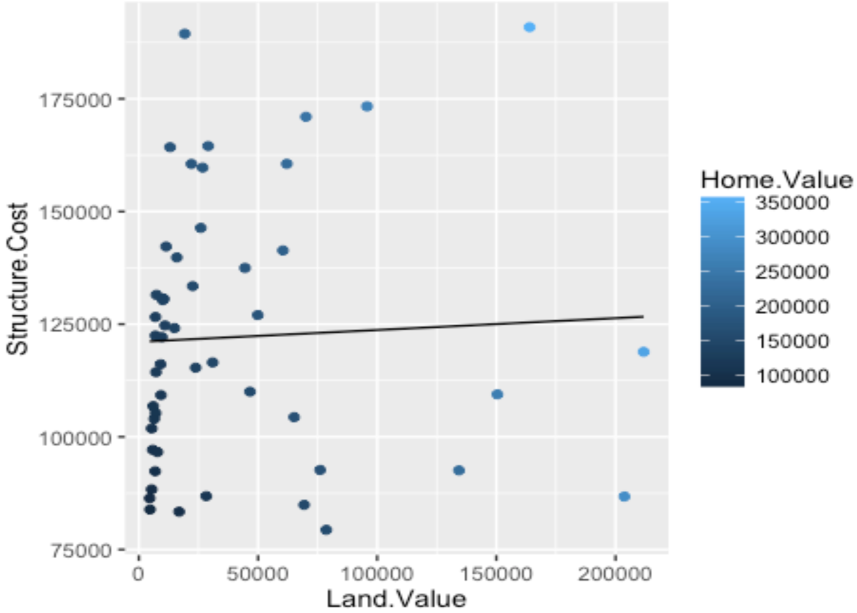
```
# ggplot2 color scatter plot
ggplot(subset(housing, State %in% c("MA","TX")), aes(x = Date, y = Home.Value,
color = State)) +
  geom_point()
```



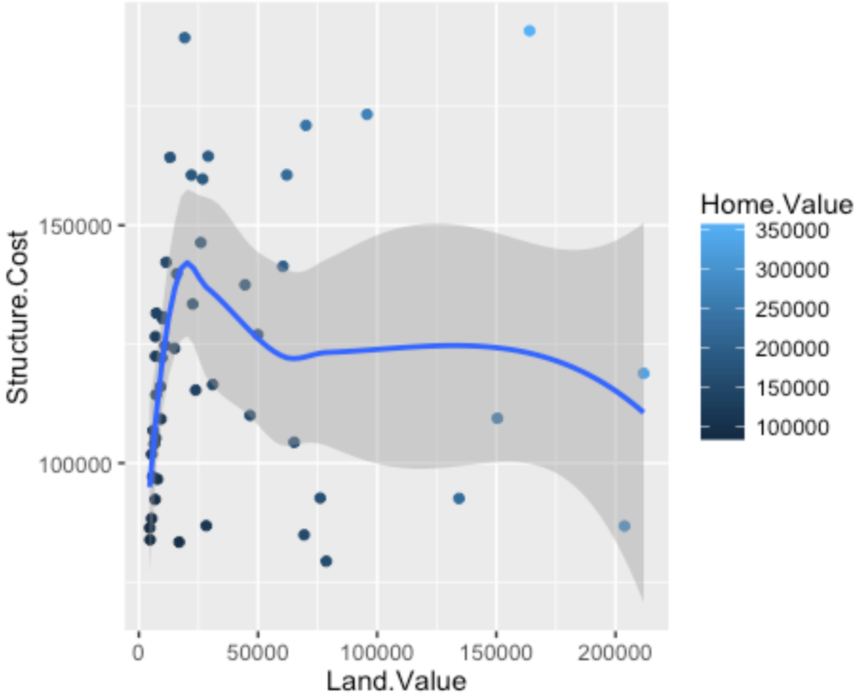
```
################################################################################
# Points(Scatterplot)
hp2001Q1 = subset(housing, Date == 20011)
ggplot(hp2001Q1, aes(x = Land.Value, y = Structure.Cost)) +
  geom_point()
```



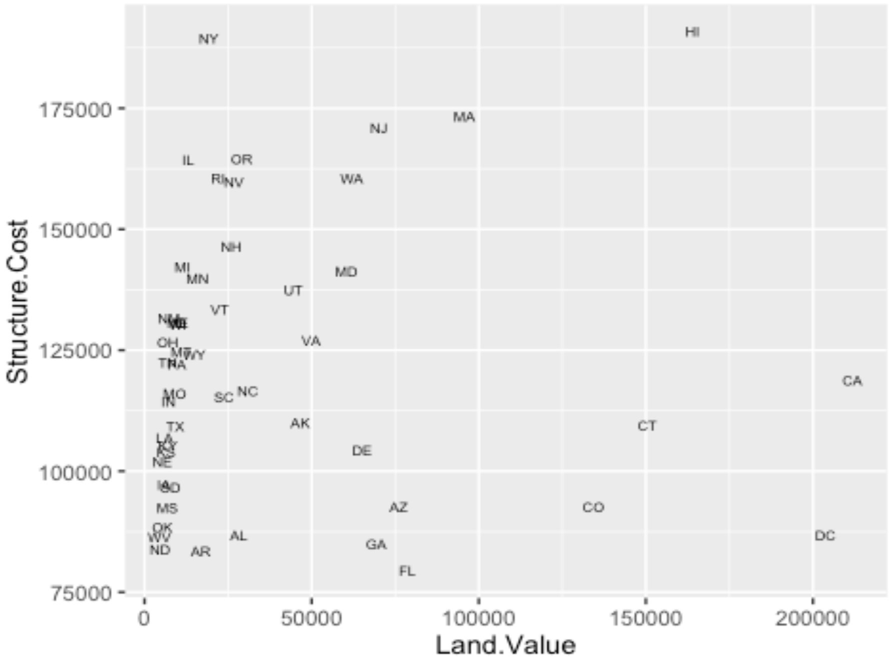
```
# Lines(Prediction Line)
hp2001Q1$pred.SC = predict(lm(Structure.Cost ~ Land.Value, data = hp2001Q1))
p1 = ggplot(hp2001Q1,aes(x = Land.Value, y = Structure.Cost))
p1 + geom_point(aes(color = Home.Value)) +
  geom_line(aes(y = pred.SC))
```



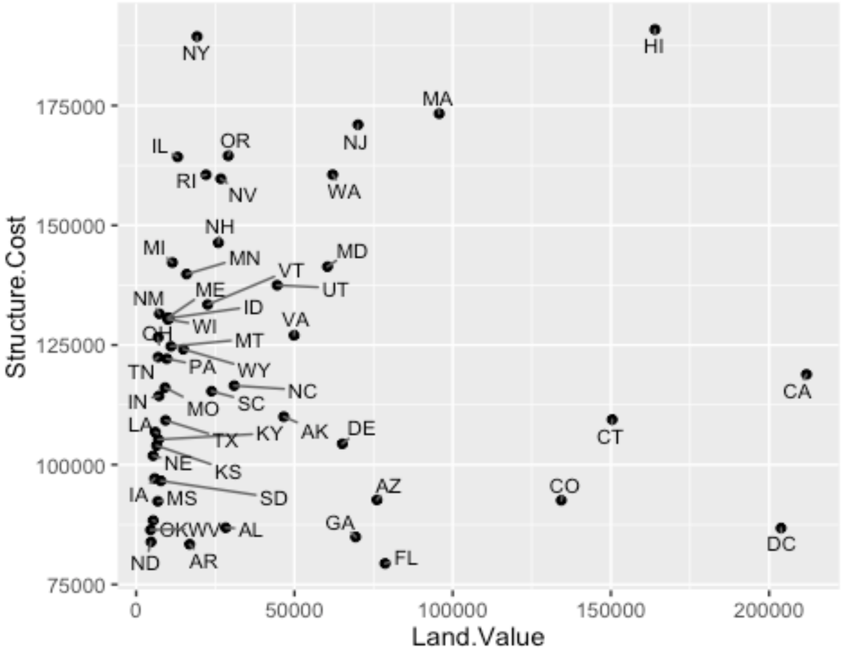
```
# Smoothers (model = lm)
p1 + geom_point(aes(color = Home.Value)) +
  geom_smooth()
```



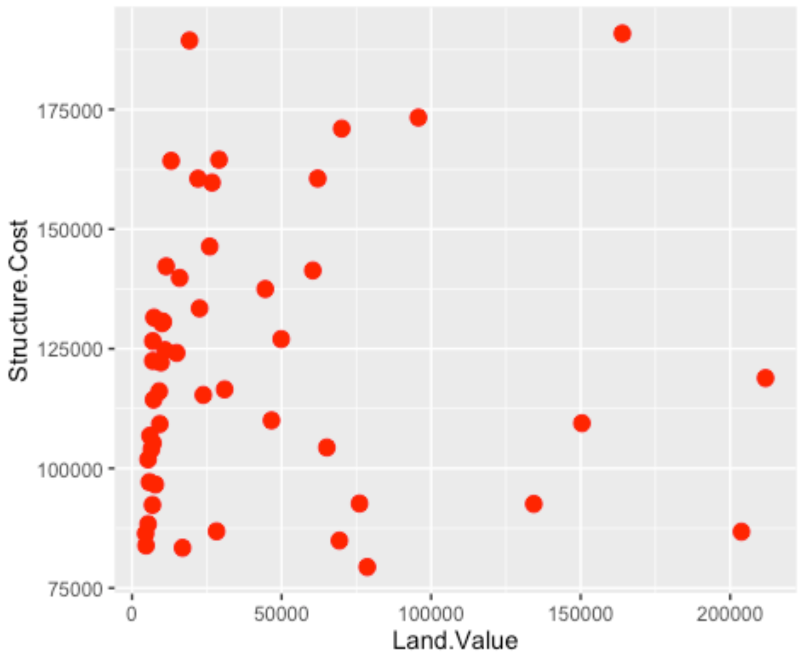
```r
# Text(Lable Points)
p1 + geom_text(aes(label = State), size = 2)
```



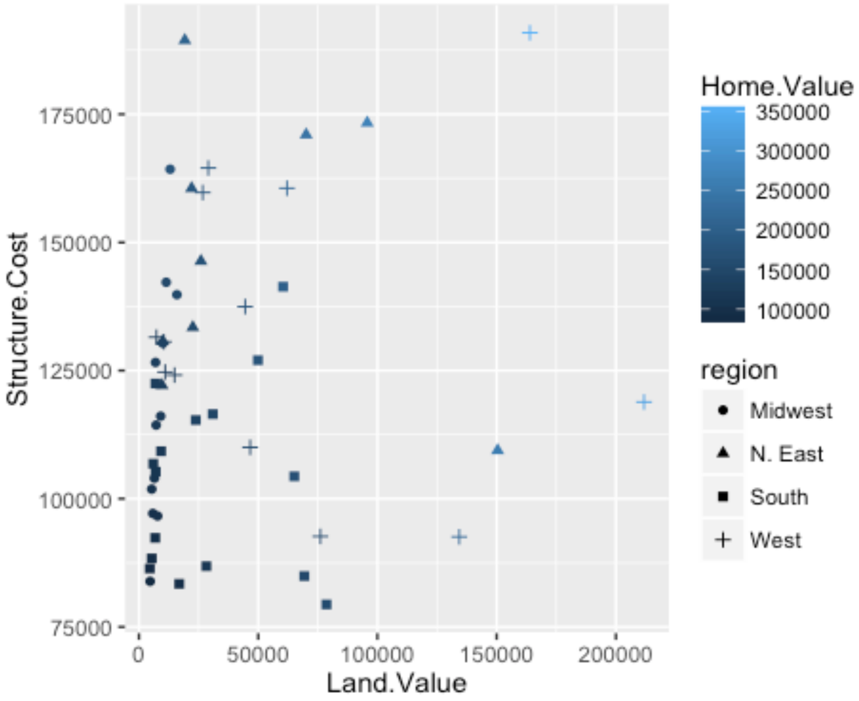
```r
# Text repel
library("ggrepel")
p1 + geom_point() +
  geom_text_repel(aes(label = State), size = 3)
```



```r
#Aesthetic Mapping vs Assignment
p1 + geom_point(color = "red",size = 3)
```

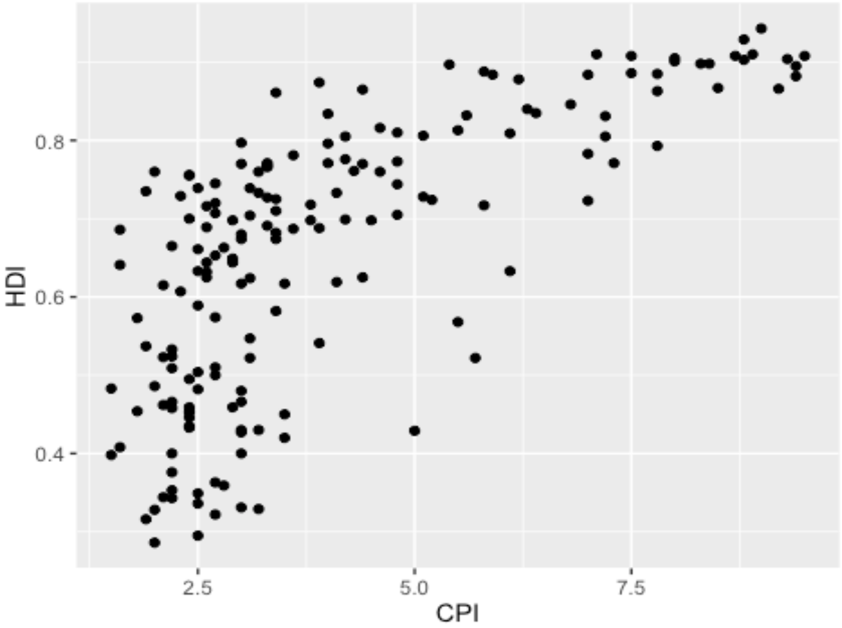


```
# Mapping variables tp other Aesthetics
p1 + geom_point(aes(color = Home.Value, shape = region))

## Warning: Removed 1 rows containing missing values (geom_point).
```

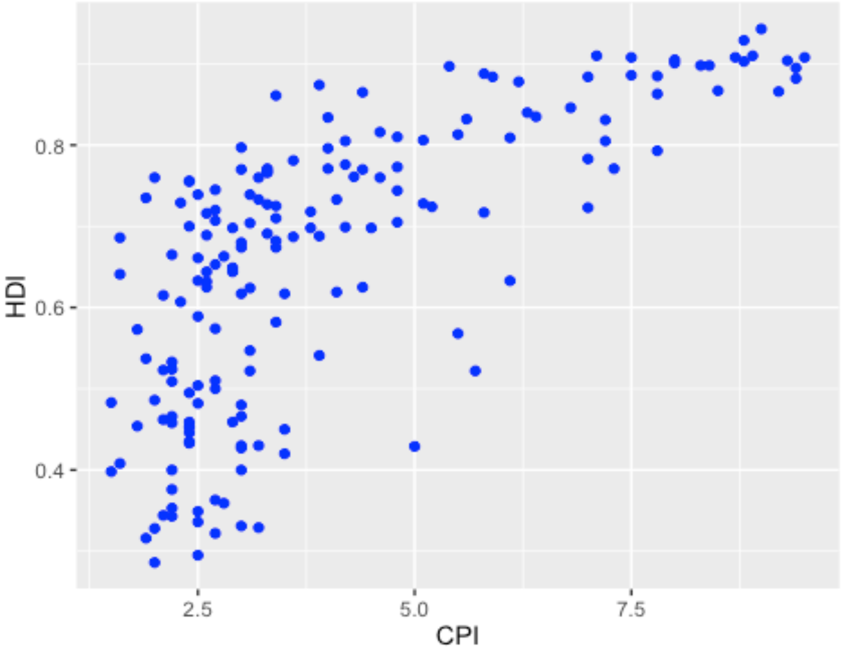


```
## Exercise 1
# These data consist of Human Development Index and Corruption Perception
Index scores for several countries
# 1. Create a scatter plot with CPI on the x axis and HDI on the y axis
```

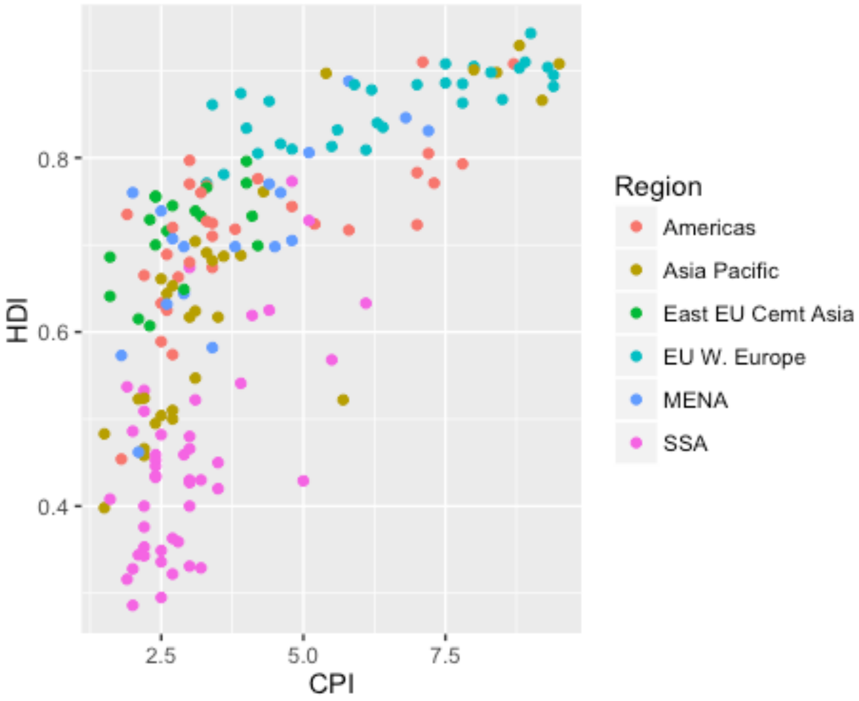
```
dat <- read.csv("dataSets/EconomistData.csv")
e1 = ggplot(dat, aes(x = CPI, y = HDI))
e1 + geom_point()
```



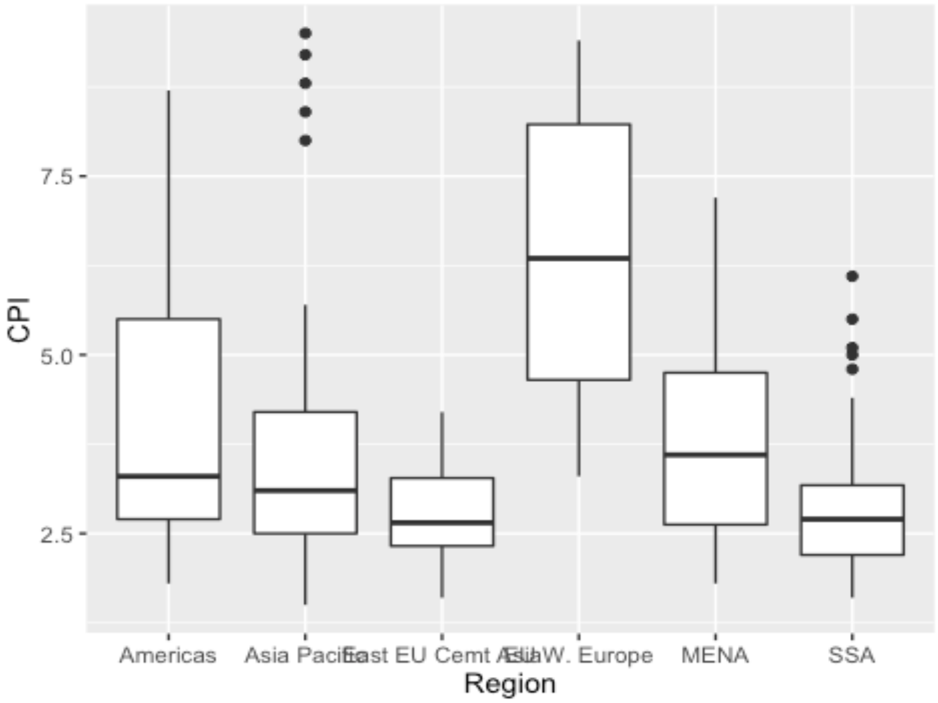
```
# 2. Color the points in the previous plot blue
e1 + geom_point(col = "blue")
```



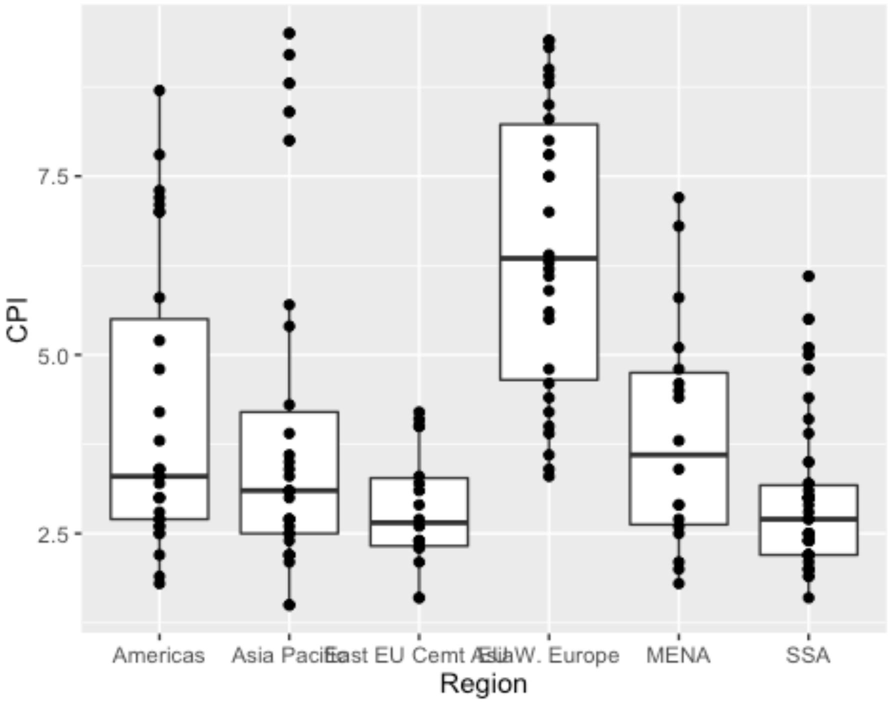
```
# 3. Color the points in the previous plot according to Region
e1 + geom_point(aes(col = Region))
```



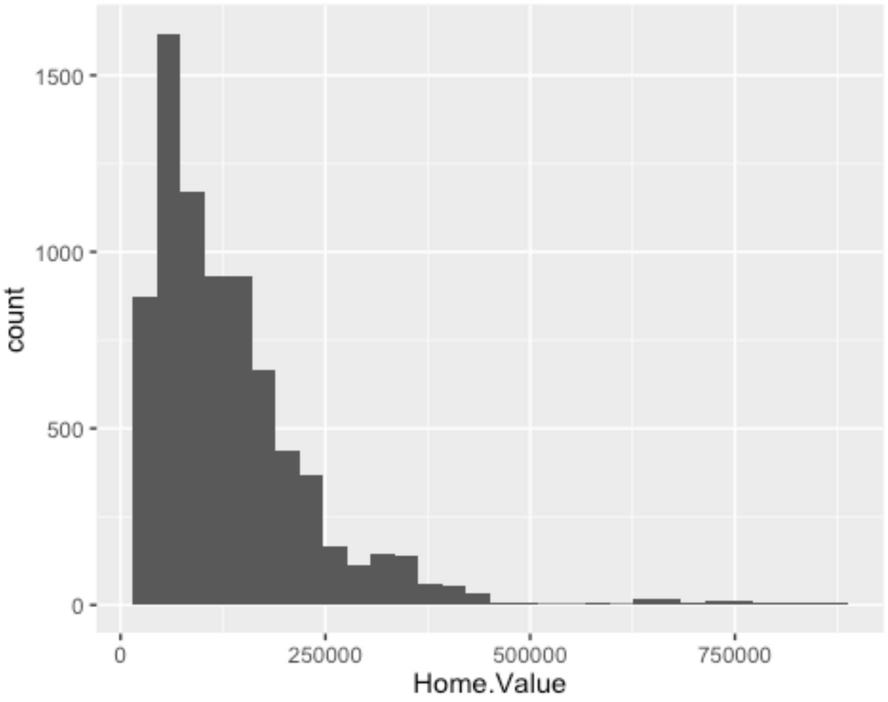
```
# 4. Create boxplots of CPI by Region
ggplot(dat, aes(x = Region, y = CPI)) + geom_boxplot()
```



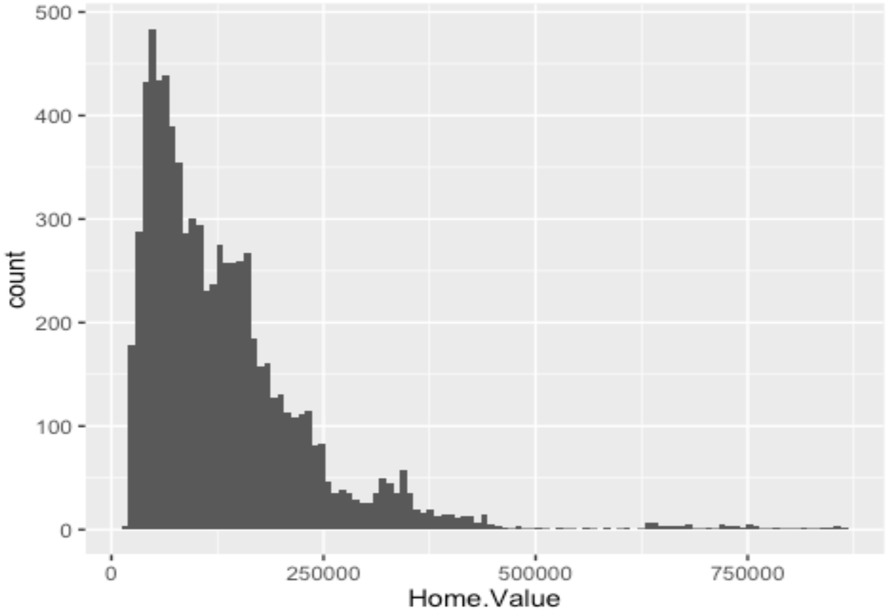
```
# 5. Overlay points on top of the boxplots
ggplot(dat, aes(x = Region, y = CPI)) + geom_boxplot() + geom_point()
```



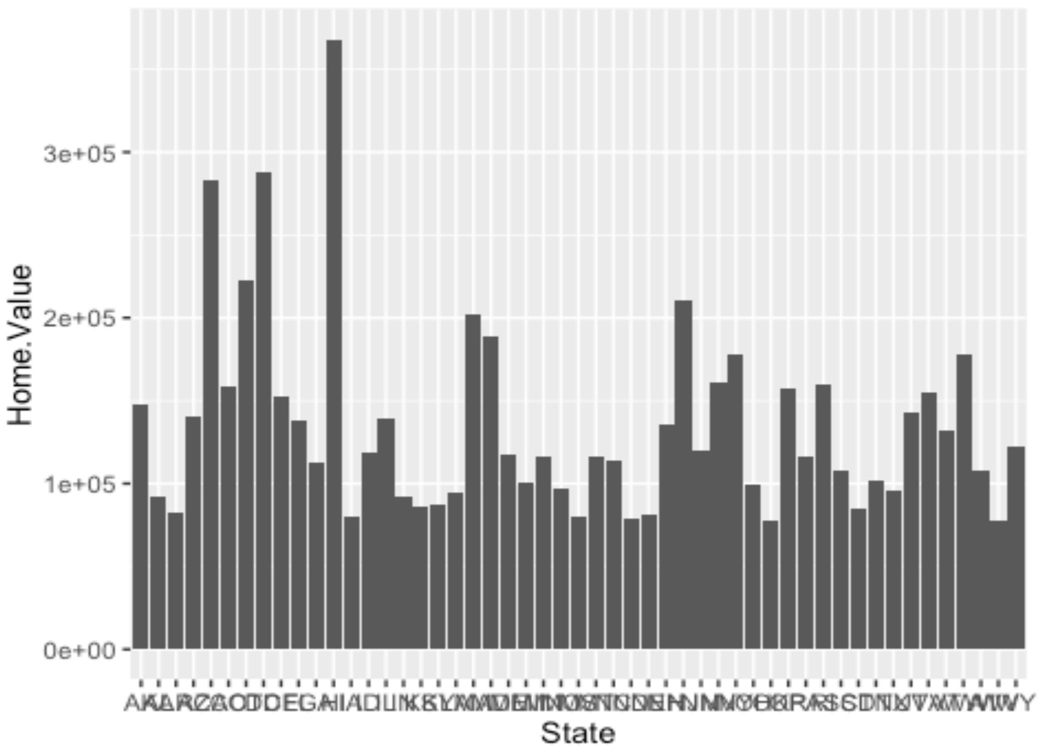
```
############### 2. Statistical Transformations ###############
# Default histogram of Home.Value
p2 = ggplot(housing, aes(x = Home.Value))
p2 + geom_histogram()

## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



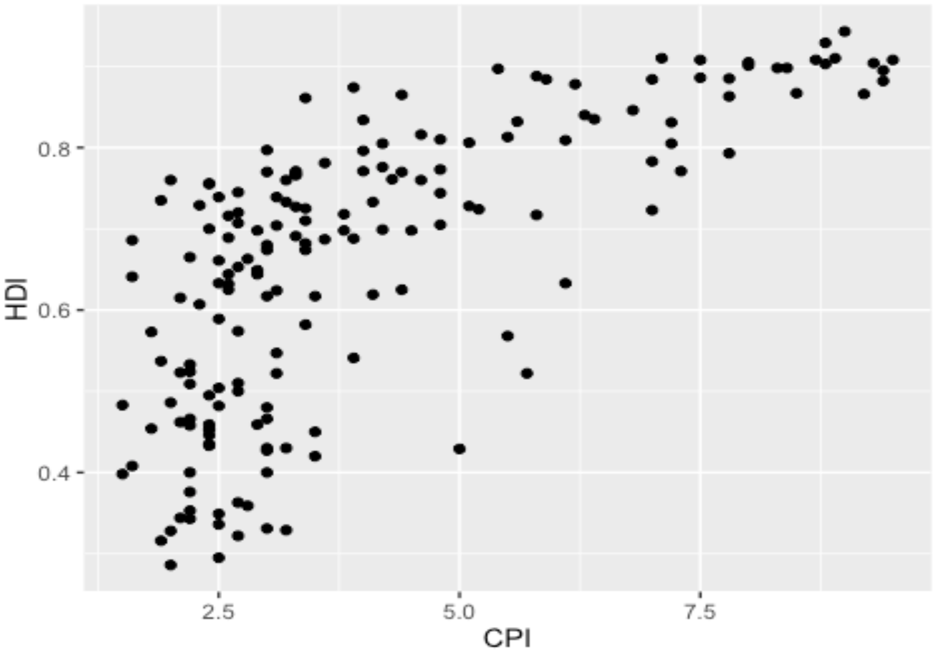
```r
# Change the binwidth
p2 + geom_histogram(stat = "bin", binwidth = 8000)
```



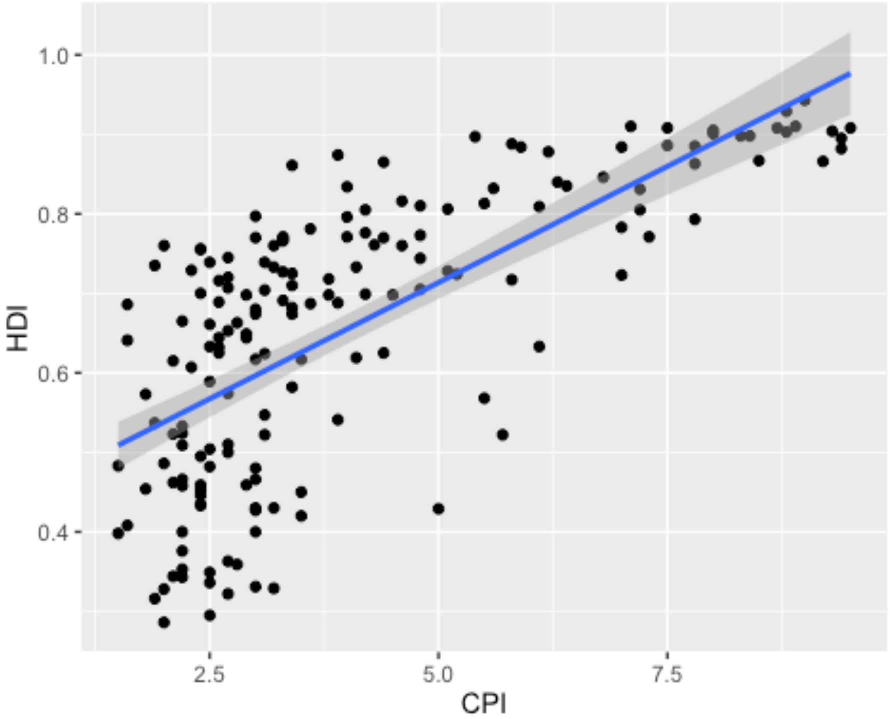
```r
# Changing the statistical transformation
housing.sum = aggregate(x = housing["Home.Value"], by = housing["State"], FUN
= mean)
rbind(head(housing.sum), tail(housing.sum))

##    State Home.Value
## 1     AK  147385.14
## 2     AL   92545.22
## 3     AR   82076.84
## 4     AZ  140755.59
## 5     CA  282808.08
## 6     CO  158175.99
## 46    VA  155391.44
## 47    VT  132394.60
## 48    WA  178522.58
## 49    WI  108359.45
## 50    WV   77161.71
## 51    WY  122897.25

ggplot(housing.sum, aes(x = State, y = Home.Value)) + geom_bar(stat =
"identity")
```



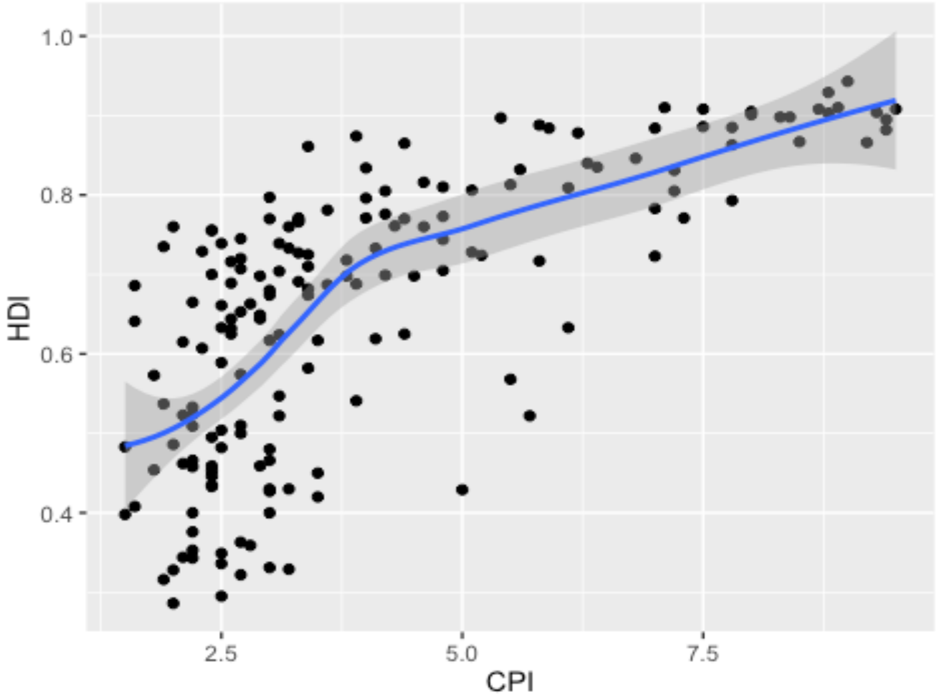
```
## Exercise 2
# 1. Re-create a scatter plot with CPI on the x axis anf HDI on the y axis
e2 = ggplot(dat, aes(x = CPI, y = HDI))
e2 + geom_point()
```



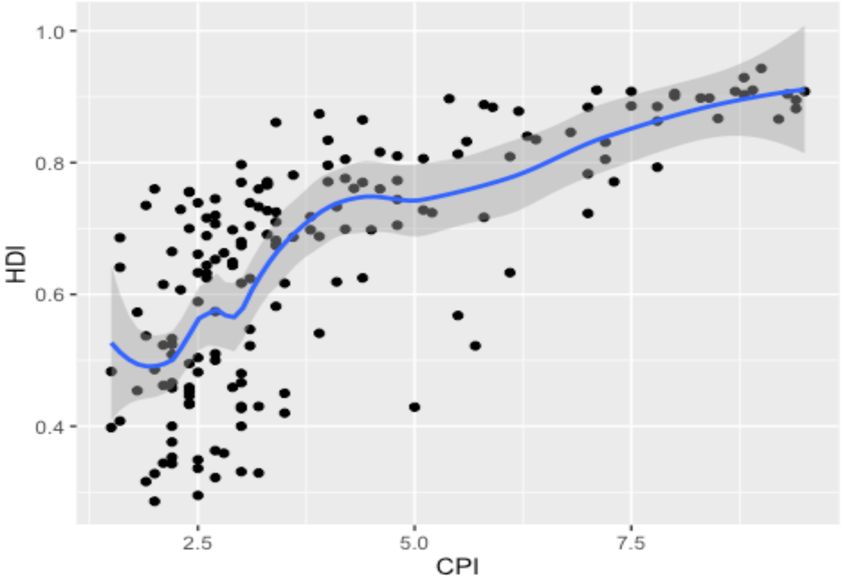
```
# 2. Overlay a smoothing line on the top of the scatter plot using the lm
method
e2 + geom_point() + geom_smooth(method = "lm")
```



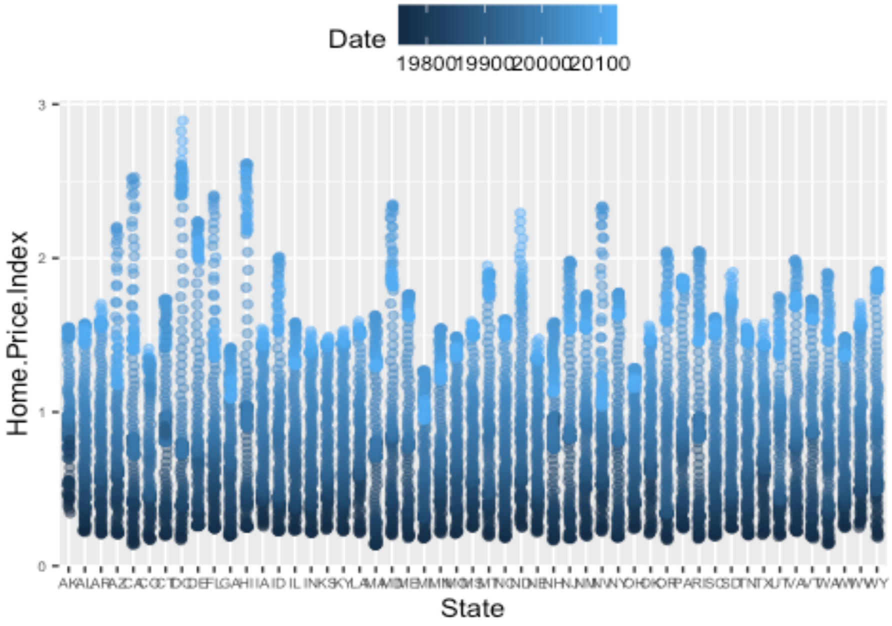
```
# 3. Overlay a smoothing line on top of the scatter plot using the default
method
e2 + geom_point() + geom_smooth()
```



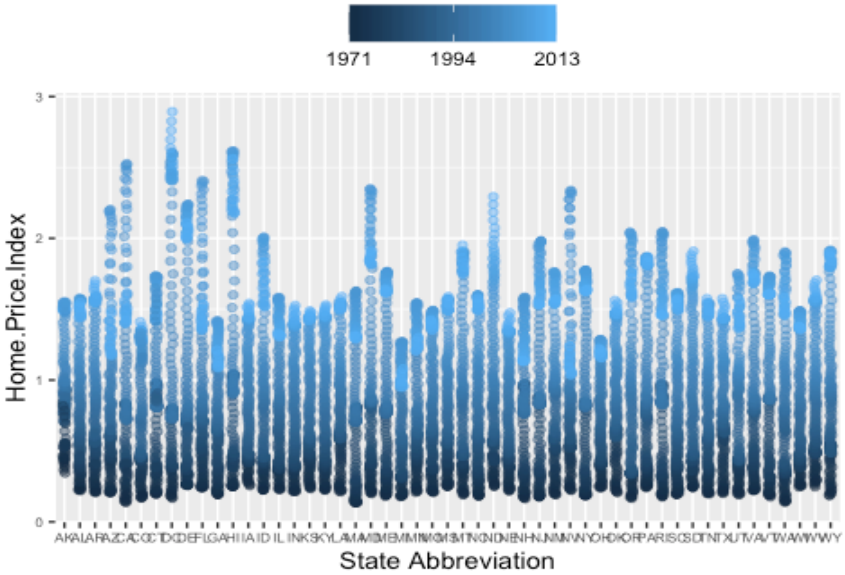
```
# 4. Overlay a smoothing line on top of the scatter plot using the default
loess method, but make it less smooth
e2 + geom_point() + geom_smooth(span = 0.4)
```



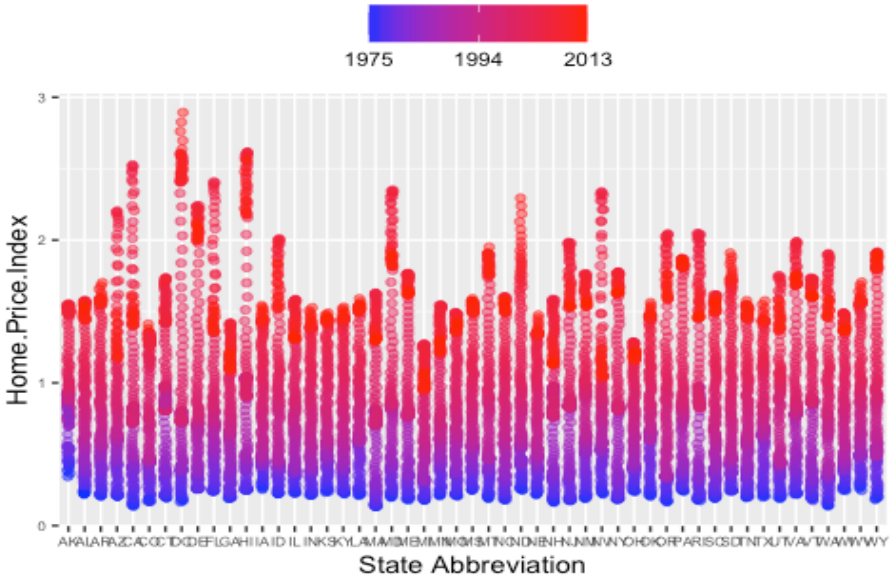
```
############## 3. Scales ###############
# Scale modification examples
# Start by constructing a dotplot showing the distribution of home valuus by
Date and State
p3 = ggplot(housing, aes(x = State, y = Home.Price.Index)) +
  theme(legend.position = "top", axis.text = element_text(size = 6))
p3 + geom_point(aes(color = Date), alpha = 0.5, size = 1.5, position =
position_jitter(width = 0.25, height = 0))
```



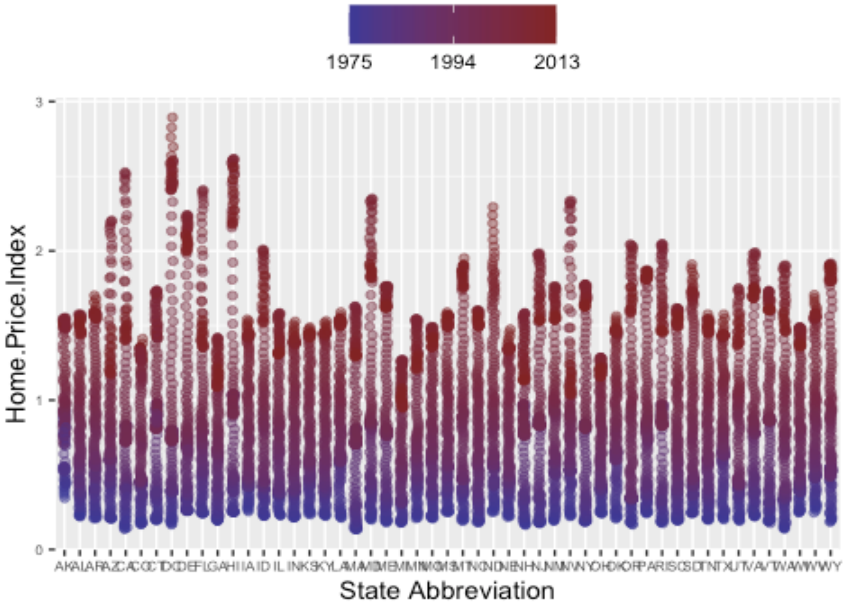
```
# Modify the breaks and labels for the x axis and color scales
p4 = p3 + geom_point(aes(color = Date), alpha = 0.5, size = 1.5, position =
position_jitter(width = 0.25, height = 0))
p4 + scale_x_discrete(name = "State Abbreviation") +
  scale_color_continuous(name = "",
                         breaks = c(19751,19941,20131),
                         labels = c(1971,1994,2013))
```



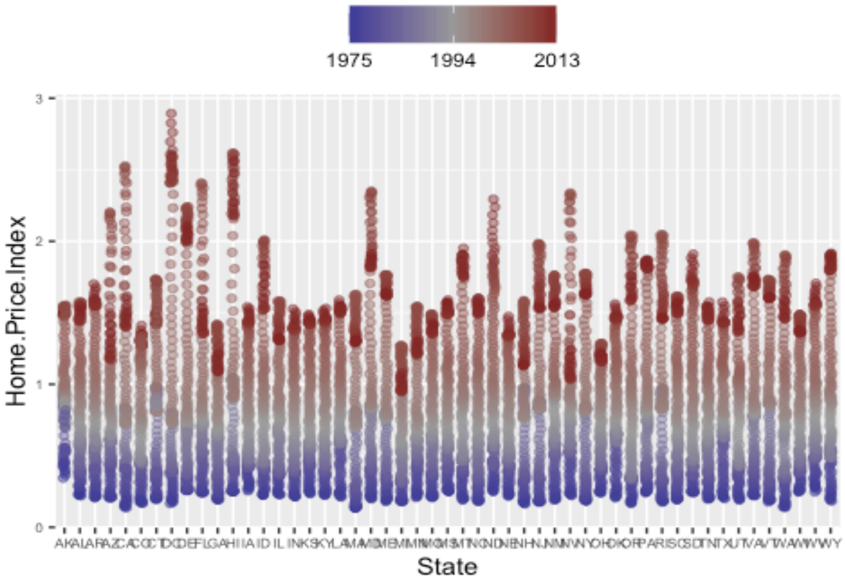
```
# Change the low and high values to blue and red
p4 + scale_x_discrete(name = "State Abbreviation") +
  scale_color_continuous(name = "",
                         breaks = c(19751,19941,20131),
                         labels = c(1975,1994,2013),
                         low = "blue", high = "red")
```



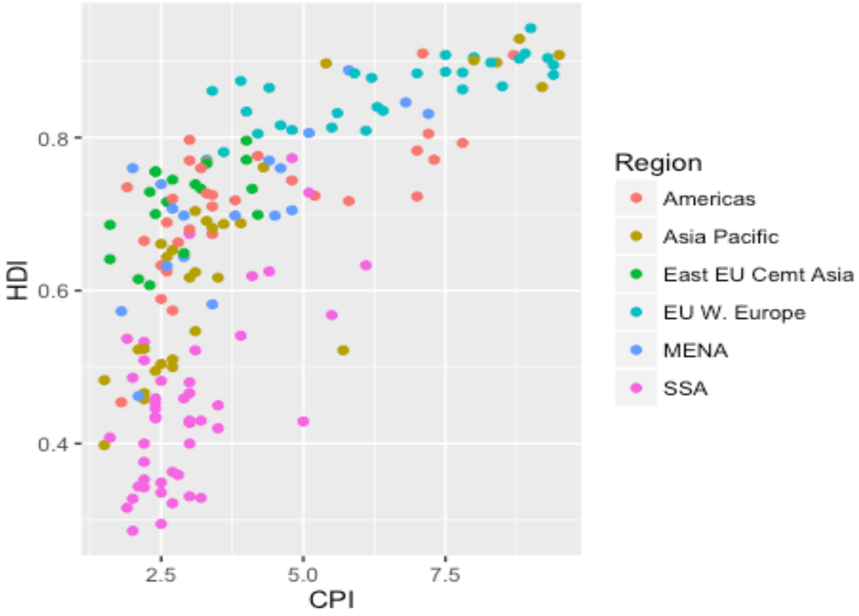
```
library("scales")
p4 + scale_x_discrete(name = "State Abbreviation") +
  scale_color_continuous(name = "",
                         breaks = c(19751,19941,20131),
                         labels = c(1975,1994,2013),
                         low = muted("blue"), high = muted("red"))
```



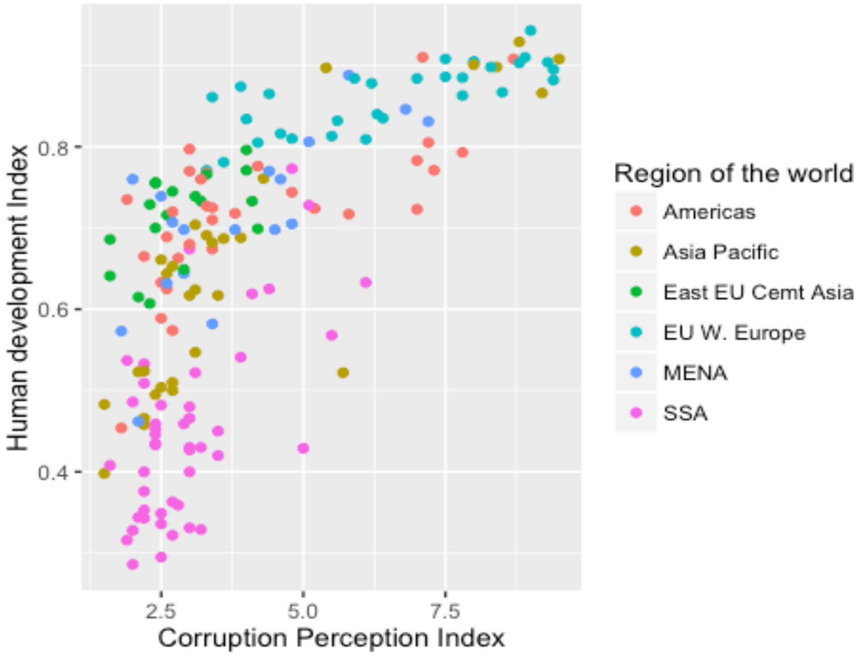
```
# Using different color scales
p4 + scale_color_gradient2(name = "",
                           breaks = c(19751,19941,20131),
                           labels = c(1975,1994,2013),
                           low = muted("blue"), high = muted("red"), mid =
"gray60", midpoint = 19941)
```



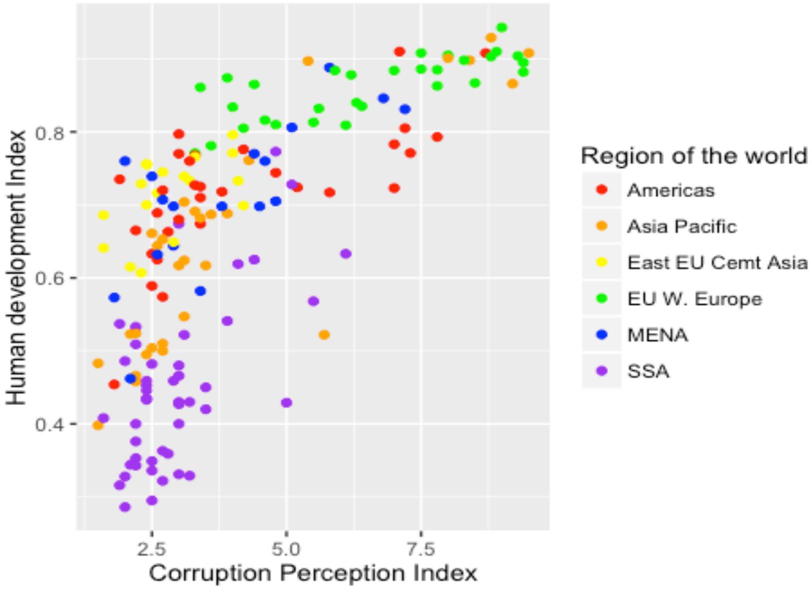
```
## Exercise 3
# 1. Create a scatter plot with CPI on the x axis and HDI on the y axis. Color
the points to indicate region
e3 = ggplot(dat, aes(x = CPI, y = HDI, color = Region))
e3 + geom_point()
```



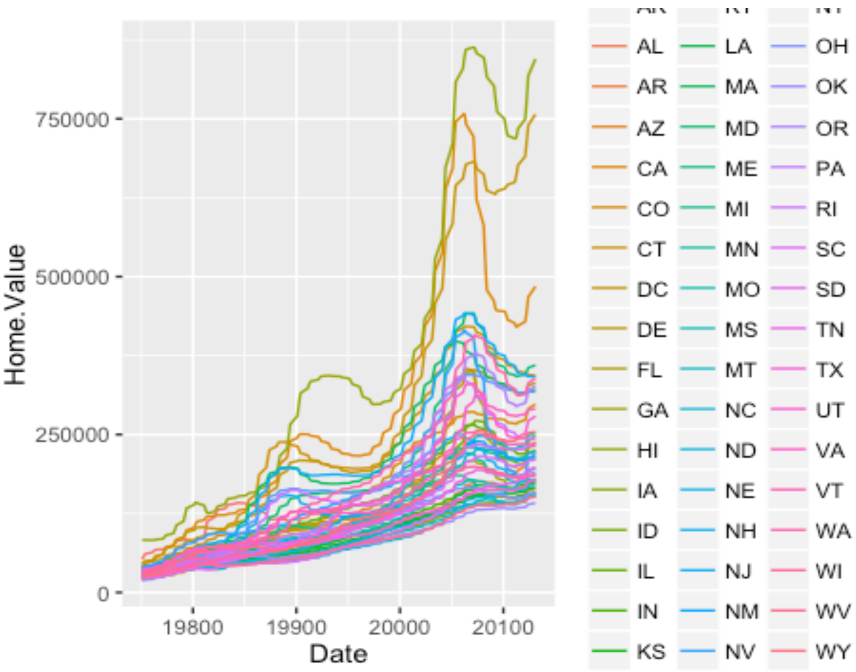
```
# 2. Modify the x,y, and color scales so that they have more easily-understood
names
# (e.g., spell out "Human developent Index instead of "HDI")
e3 + geom_point() + scale_x_continuous(name = "Corruption Perception Index") +
  scale_y_continuous(name = "Human development Index") +
  scale_color_discrete(name = "Region of the world")
```



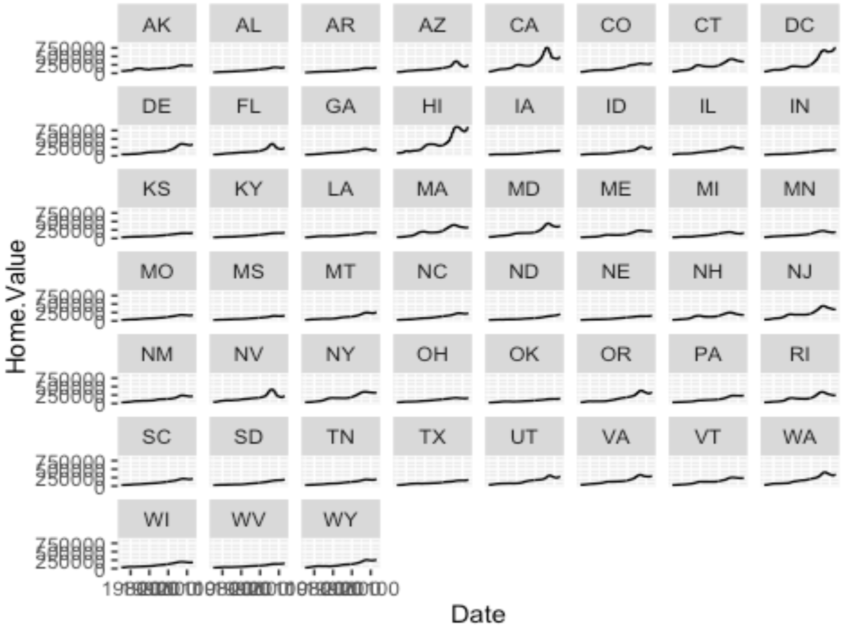
```
# 3. Modify the color scale to use specific values of your choosing
e3 + geom_point() + scale_x_continuous(name = "Corruption Perception Index") +
  scale_y_continuous(name = "Human development Index") +
  scale_color_manual(name = "Region of the world",
                     values =
c("red","orange","yellow","green","blue","purple"))
```



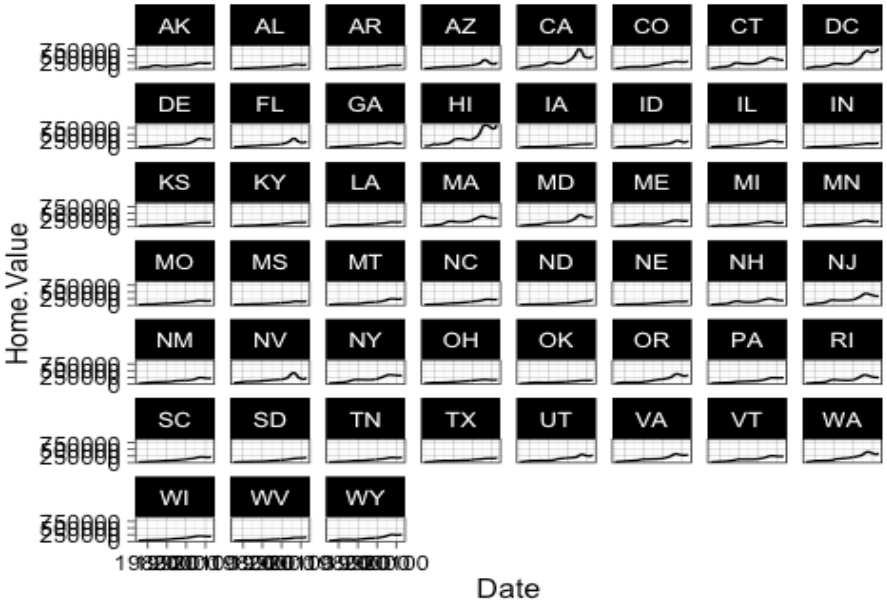
```
############## 4. Faceting ###############
p5 = ggplot(housing, aes(x = Date, y = Home.Value))
p5 + geom_line(aes(color = State))
```



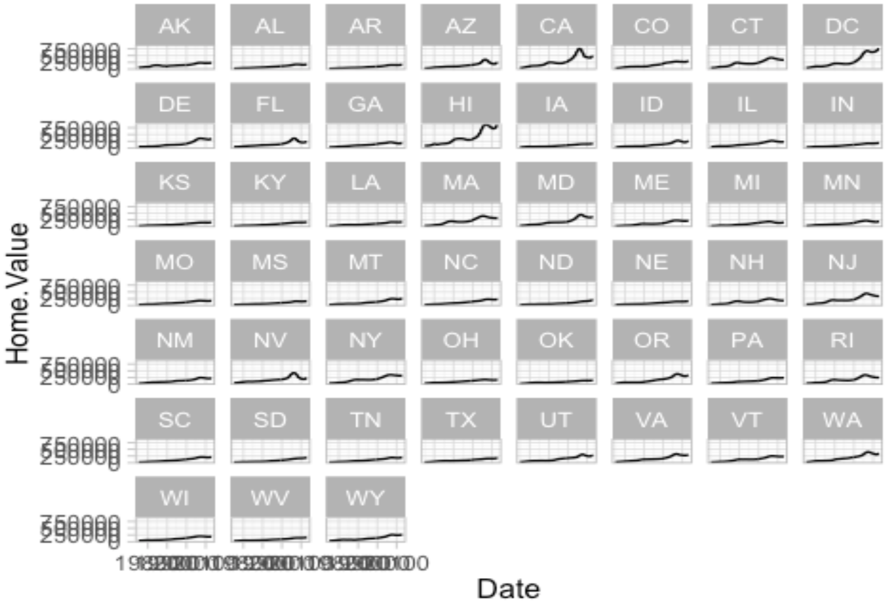
```
# Plot by faceting by state rather than mapping state to color
p5 + geom_line() +
  facet_wrap(~ State, ncol = 8)
```



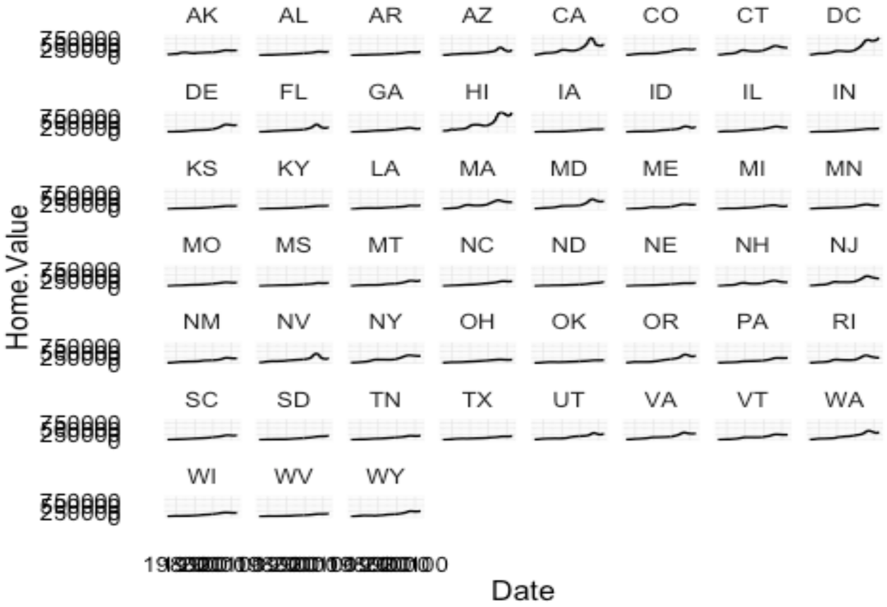
```
############## 5. Themes ###############
p5 = p5 + geom_line() +
  facet_wrap(~ State, ncol = 8)
p5 + theme_linedraw()
```



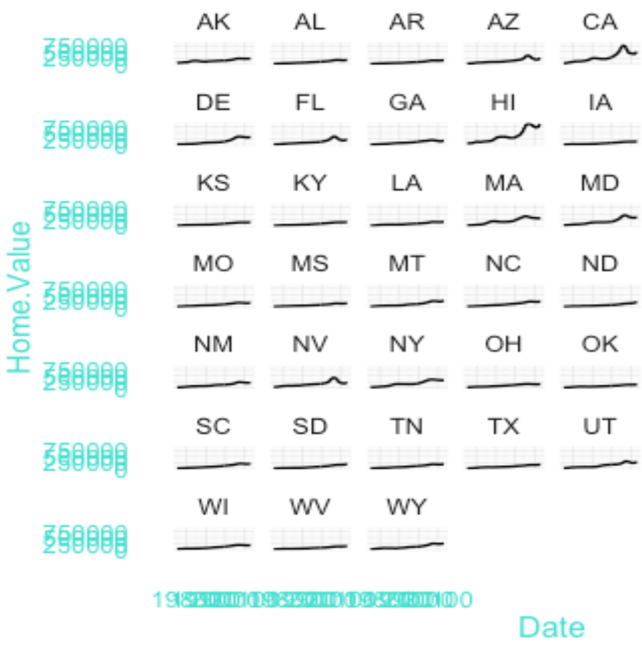
```
p5 + theme_light()
```



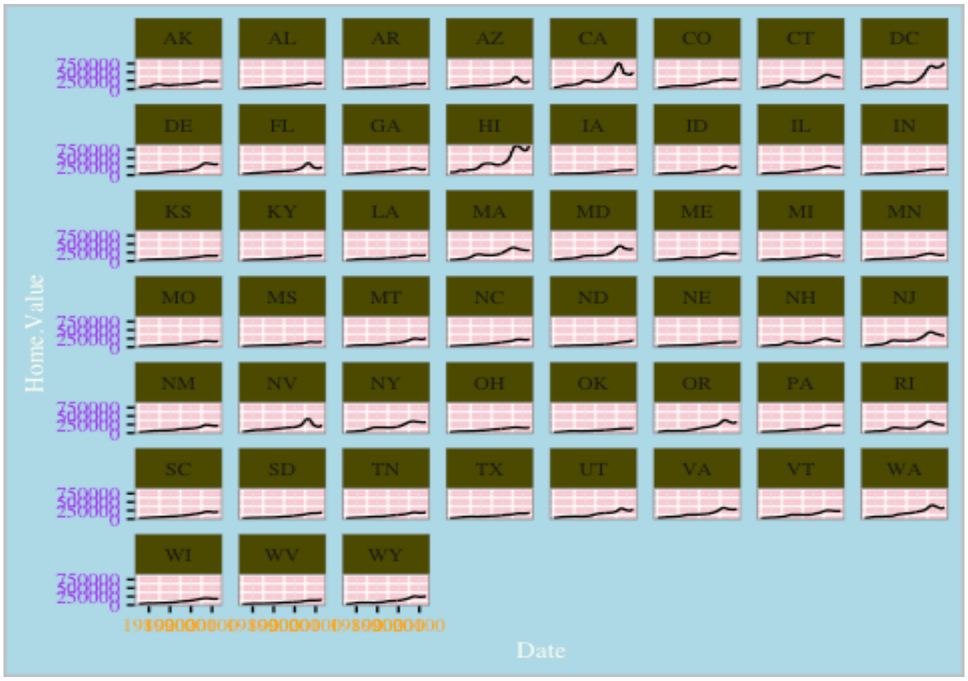
```
p5 + theme_minimal()
```



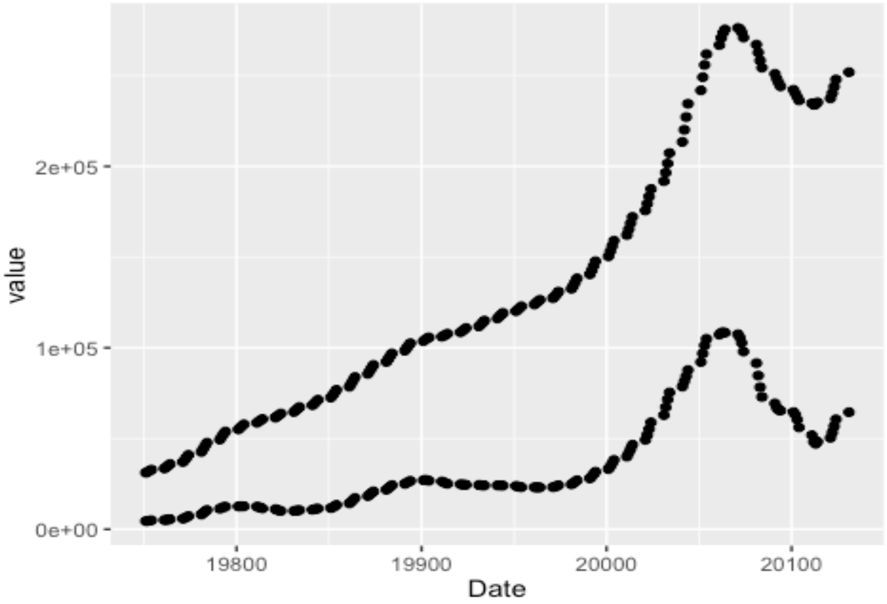
```
# Overriding theme defaults
p5 + theme_minimal() +
  theme(text = element_text(color = "turquoise"))
```



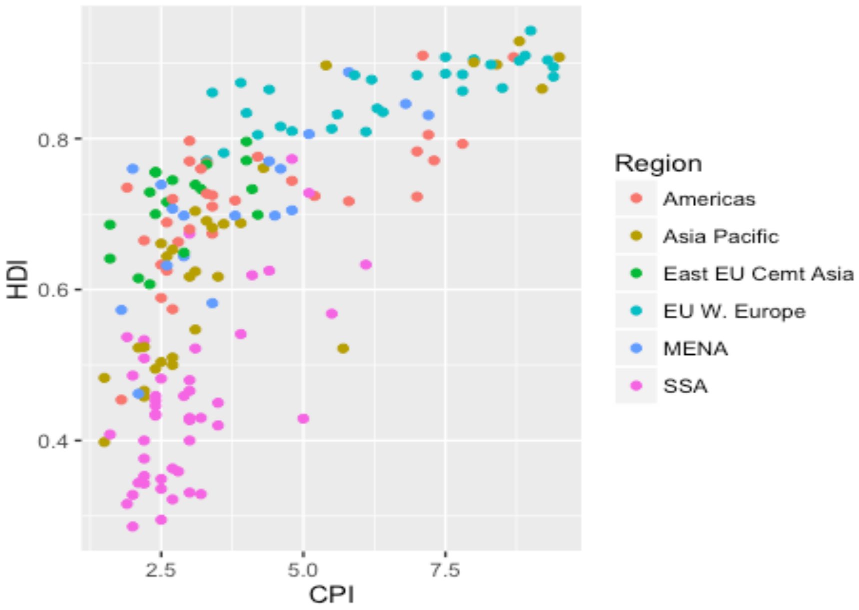
```r
# Creating and saving new themes
theme_new = theme_bw() +
  theme(plot.background = element_rect(size = 1, color = "grey", fill =
"lightblue"),
        text = element_text(size = 10, family = "serif", color = "ivory"),
        axis.text.x = element_text(color = "orange"),
        axis.text.y = element_text(color = "purple"),
        panel.background = element_rect(fill = "pink"),
        strip.background = element_rect(fill = muted("yellow")))
p5 + theme_new
```



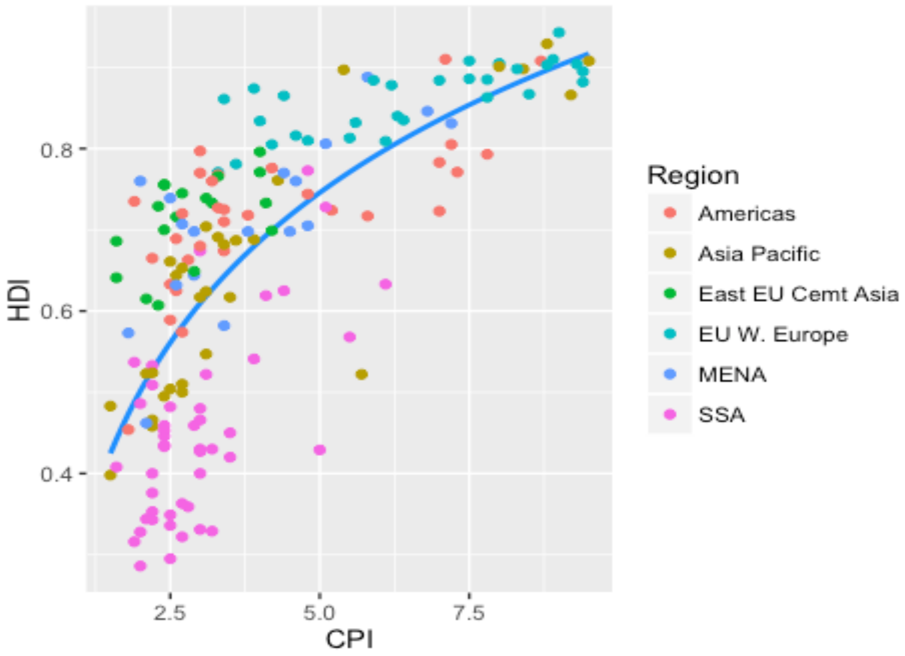
```
# Map Aesthetic to different columns
library(tidyr)
housing.byyear = aggregate(cbind(Home.Value, Land.Value) ~ Date, data =
housing, mean)
home.land.byyear = gather(housing.byyear,
                          value = "value",
                          key = "type",
                          Home.Value, Land.Value)
ggplot(home.land.byyear, aes(x = Date, y = value)) +
  geom_point()
```



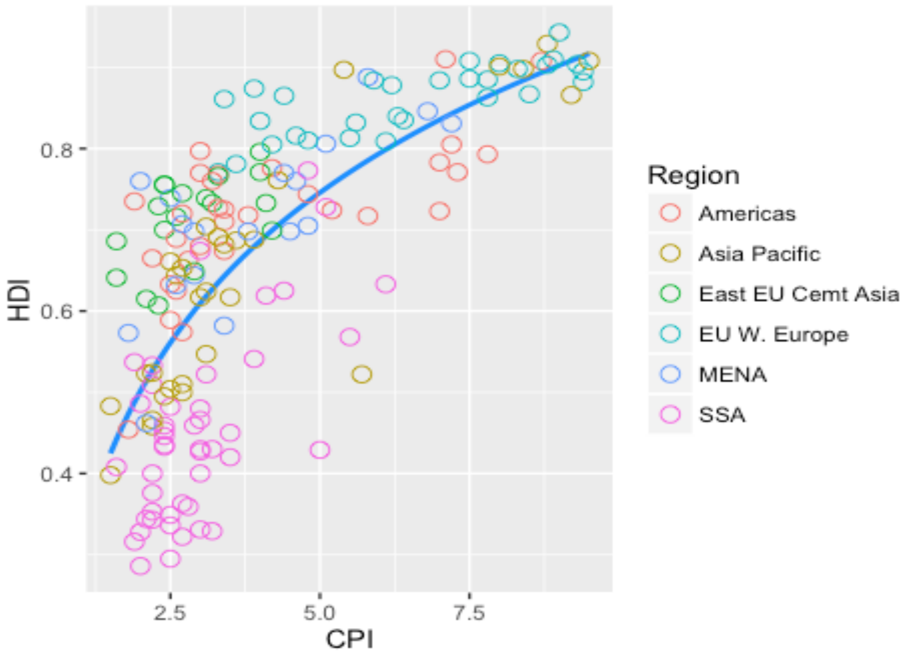
```
## Challenge problem
data = read.csv("dataSets/EconomistData.csv")
# Basic graph
c1 = ggplot(data,aes(x = CPI, y = HDI, color = Region))
c1 + geom_point()
```



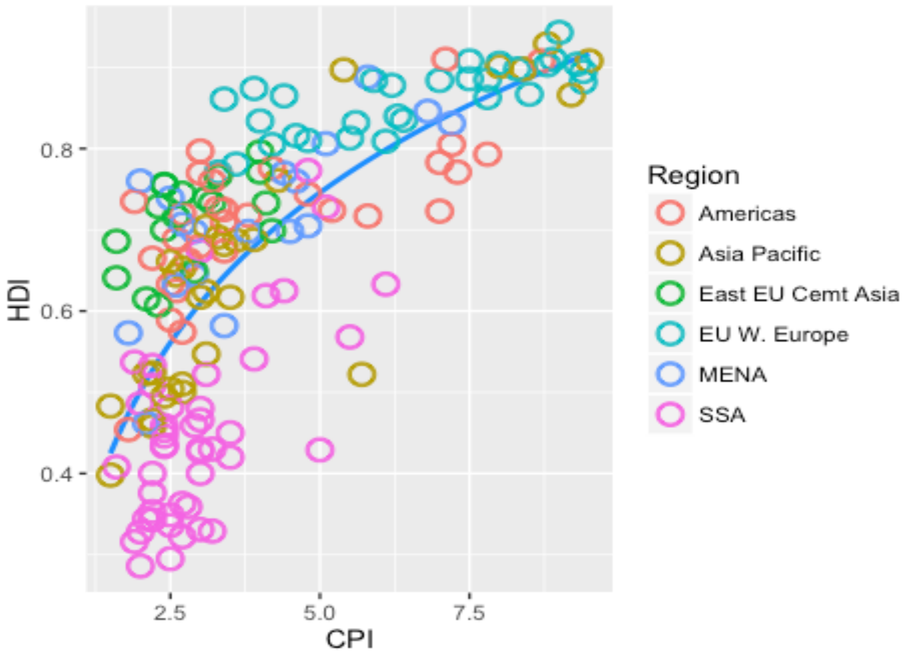
```
# 1. Add a trend line
c2 = c1 + geom_smooth(aes(group = 1),
                      method = "lm",
                      formula = y ~ log(x),
                      se = FALSE,
                      color = "dodgerblue")
c2 + geom_point()
```



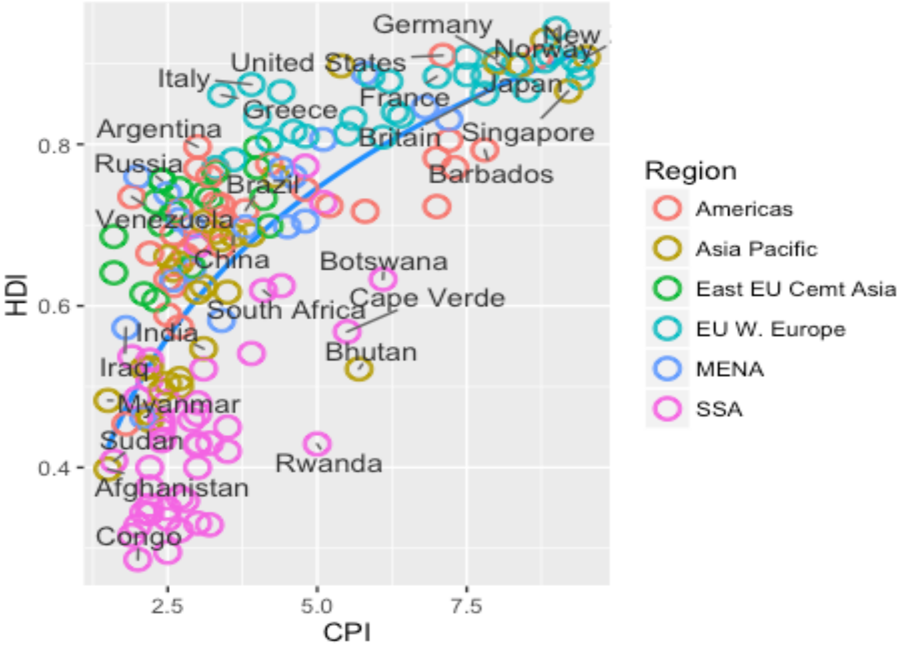
```
# Comments: group = 1 fits a single line of best fit

# 2. Change the point shape to open circle
c2 + geom_point(shape = 1, size = 3)
```



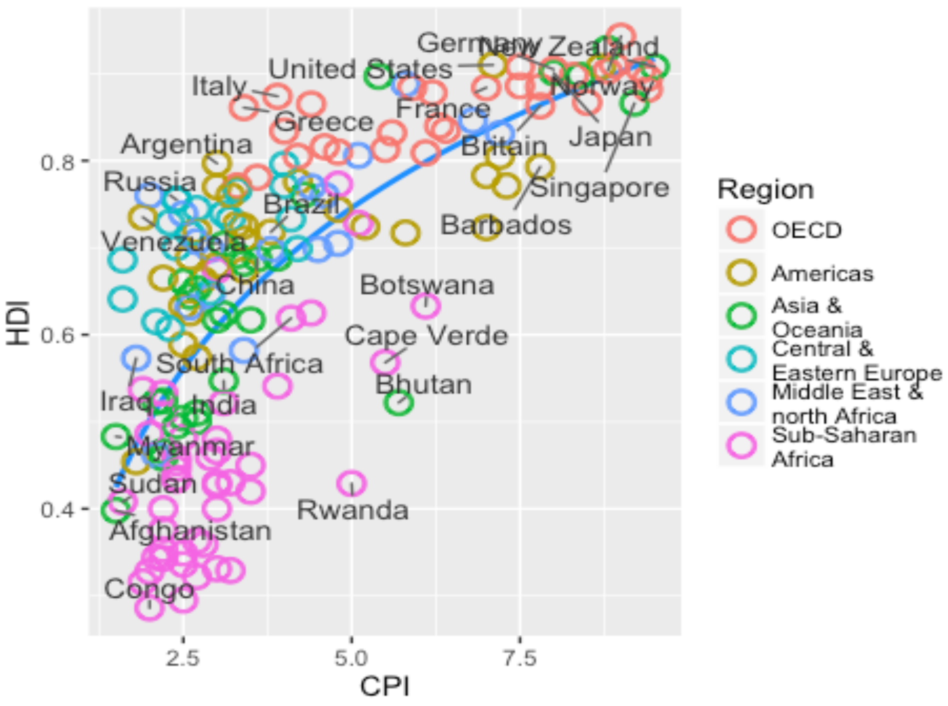
```r
# Multiple point layers of slightly different size
c3 = c2 + geom_point(size = 4.5, shape = 1) +
  geom_point(size = 4, shape = 1) +
  geom_point(size = 3.5, shape = 1)
c3
```



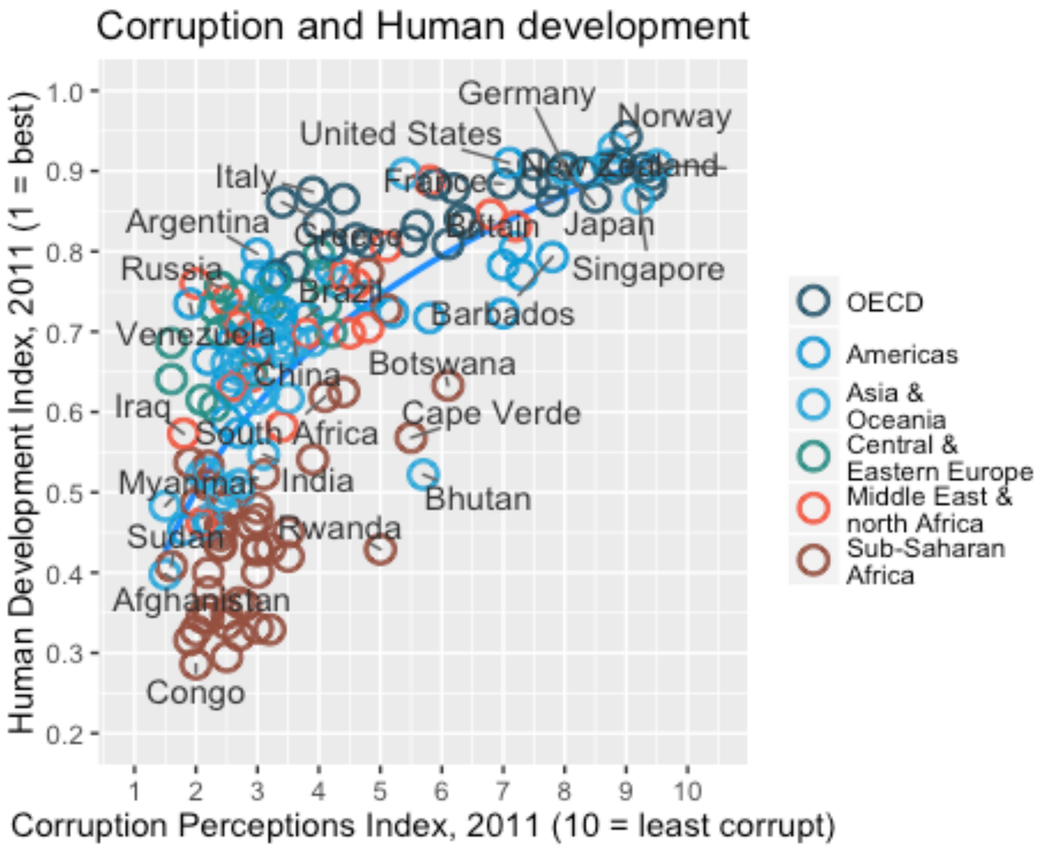
```r
# 3. Label select points
pointsToLabel = c("Russia", "Venezuela", "Iraq", "Myanmar", "Sudan",
                   "Afghanistan", "Congo", "Greece", "Argentina", "Brazil",
                   "India", "Italy", "China", "South Africa", "Spane",
                   "Botswana", "Cape Verde", "Bhutan", "Rwanda", "France",
                   "United States", "Germany", "Britain", "Barbados",
"Norway", "Japan",
                   "New Zealand", "Singapore")
library("ggrepel")
c4 = c3 + geom_text_repel(aes(label = Country),
                     color = "gray20",
                     data = subset(data, Country %in% pointsToLabel),
                     force = 10)
c4
```



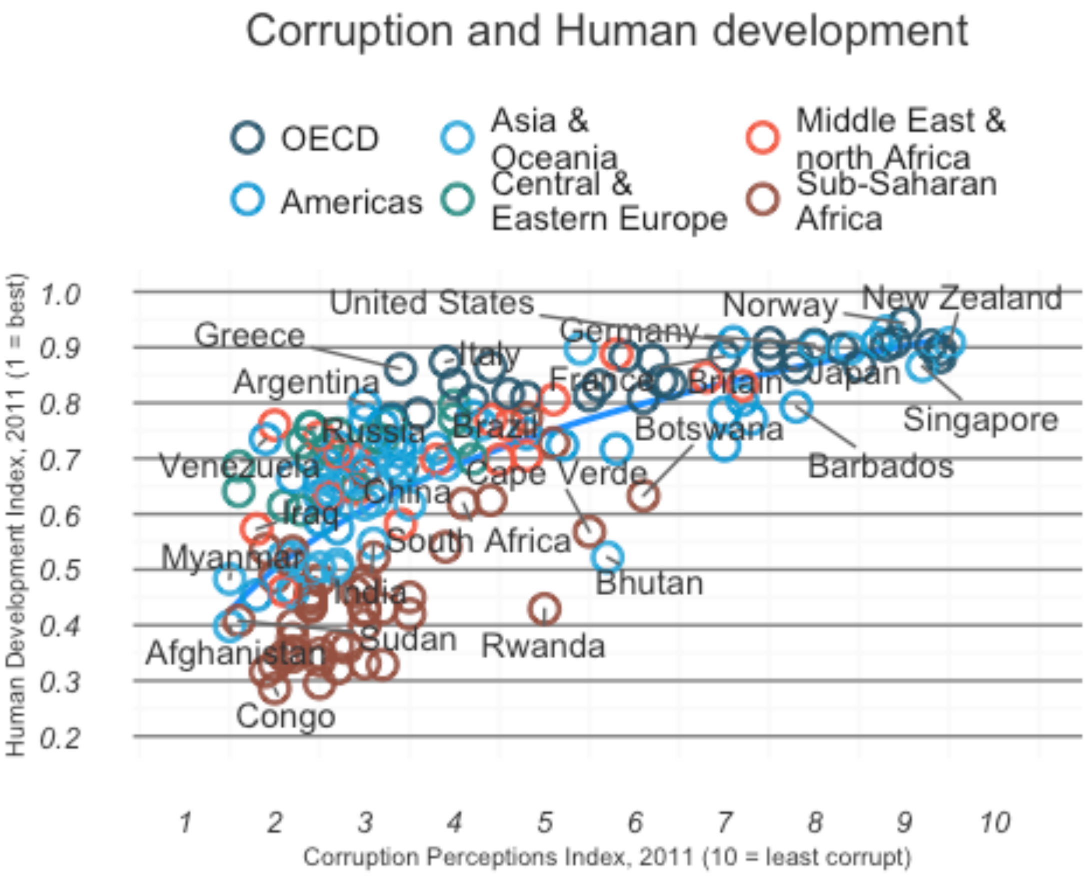
```
# Comments: Force of replusion between overlapping labels. Default is 1

# 4. change the order and labels of Region
# To change the region labels and order, we need to use the factor function
data$Region = factor(data$Region,
                     levels = c("EU W. Europe","Americas","Asia Pacific",
                                "East EU Cemt Asia","MENA","SSA"),
                     labels = c("OECD","Americas","Asia &\nOceania",
                                "Central &\nEastern Europe","Middle East
&\nnorth Africa","Sub-Saharan\nAfrica"))
c4$data = data
c4
```



```
# 5. Add title and format axes
library("grid")
c5 = c4 + scale_x_continuous(name = "Corruption Perceptions Index, 2011 (10 =
least corrupt)",
                        limits = c(0.9,10.5),
                        breaks = 1:10) +
  scale_y_continuous(name = "Human Development Index, 2011 (1 = best)",
                     limits = c(0.2,1.0),
                     breaks = seq(0.2,1.0,by = 0.1)) +
  scale_color_manual(name = "",
                     values =
c("#24576D","#099DD7","#28AADC","#248E84","#F2583F","#96503F")) +
  ggtitle("Corruption and Human development")
c5
```



```
# 6. Theme tweaks
c6 = c5 + theme_minimal() + # start with the minimal theme and add what we
need
  theme(text = element_text(color = "gray20"),
        legend.position = c("top"),
        legend.direction = "horizontal",
        legend.justification = 0.1,
        legend.text = element_text(size = 11, color = "gray10"),
        axis.text = element_text(face = "italic"),
        axis.title.x = element_text(size = 8, vjust = -1), # move title away
from axis
        axis.title.y = element_text(size = 8, vjust = 2),
        axis.ticks.y = element_blank(),
        axis.line = element_line(color = "gray40",size = 0.5),
        axis.line.y = element_blank(),
        panel.grid.major = element_line(color = "gray50",size = 0.5),
        panel.grid.major.x = element_blank()
        )
c6
```



```
# 7. Add model R^2 and source note
mr2 = summary(lm(HDI ~ log(CPI), data = data))$r.squared
library(grid)
png(file = "images/econScatter10.png", width = 800, height = 600)
c6
grid.text("Sources: Transparency International; UN Human Development Report",
          x = 0.02, y = 0.02, just = "left", draw = TRUE)
grid.segments(x0 = 0.81, x1 = 0.825,
              y0 = 0.90, y1 = 0.90,
              gp = gpar(col = "red"),
              draw = TRUE)
grid.text(paste0("R² = ",
                 as.integer(mr2*100),
                 "%"),
          x = 0.835, y = 0.90,
          gp = gpar(col = "gray20"),
          draw = TRUE,
          just = "left")
dev.off()

## quartz_off_screen
##                  2
```