Chapter 6: Multivariate Continuous Data

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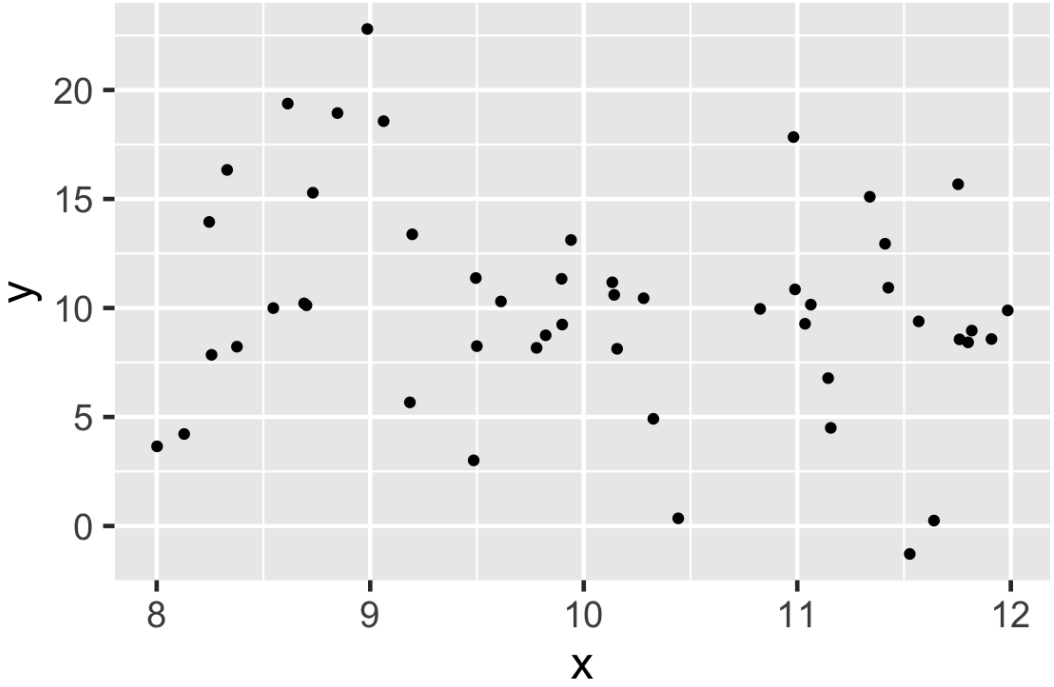
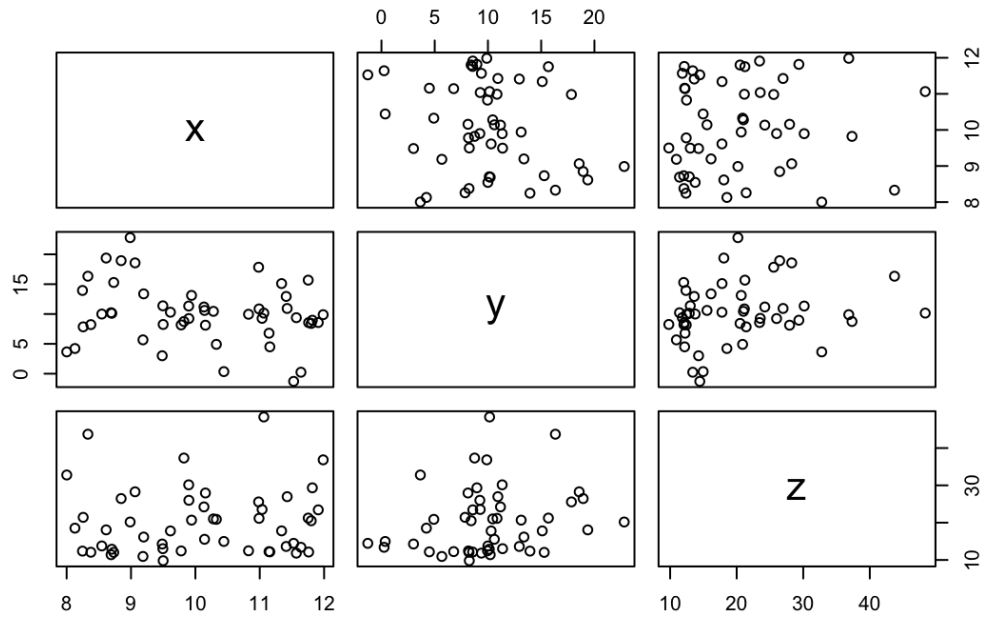
Two continuous variables: scatterplot

```
library(tidyverse)
theme_set(theme_grey(18))
x <- runif(50, 8, 12)
y <- rnorm(50, 20, 5) - x
df <- data.frame(x, y)
gscat <- ggplot(df, aes(x, y)) + geom_point()
gscat
```



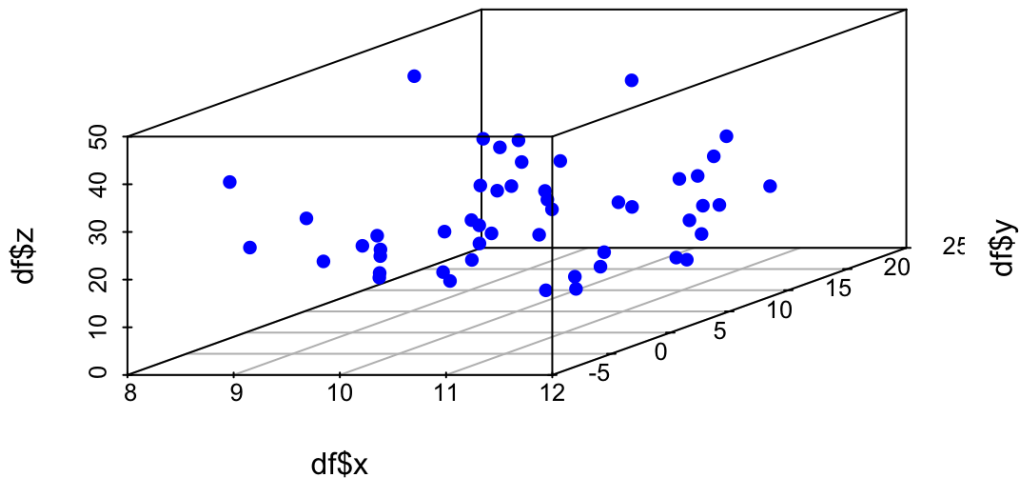
Three continuous variables: scatterplot matrix

```
df <- df %>% mutate(z = rexp(50, .1) + x)
plot(df)
```



Three continuous variables: 3D scatterplot

```
library(scatterplot3d)
scatterplot3d(df$x, df$y, df$z, pch = 16, color = "blue")
```

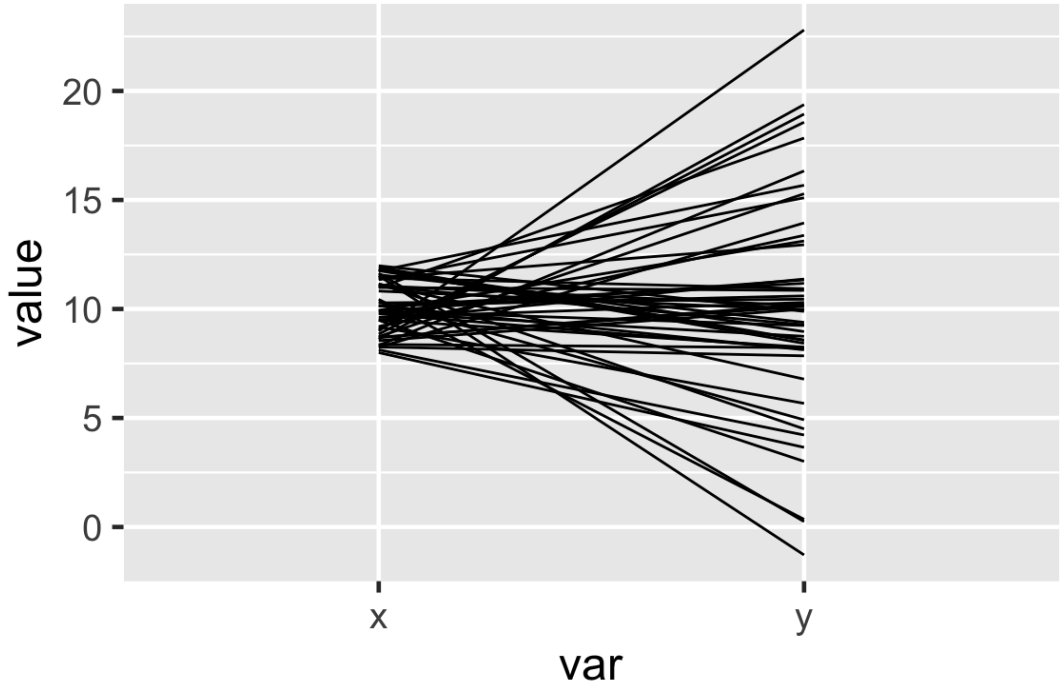


Three continuous variables: interactive 3D scatterplot

```
library(plotly)
plot_ly(df, x = ~x, y = ~y, z = ~z, mode = "markers",
        marker = list(size = 4)) %>% add_markers()
```

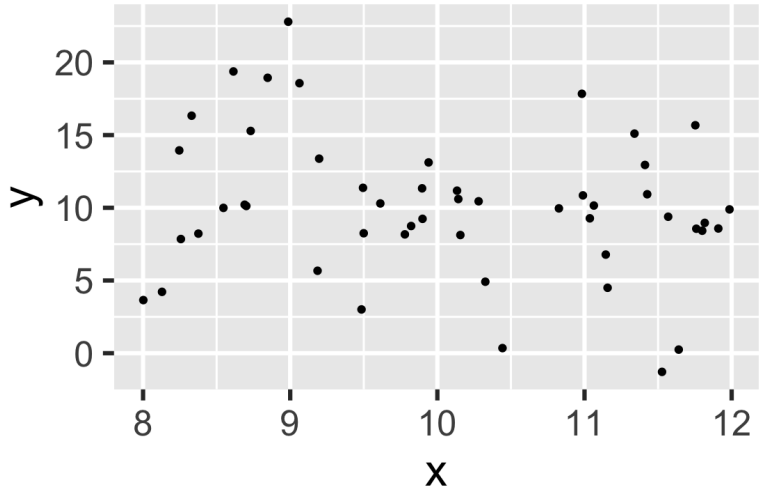
Slope graph

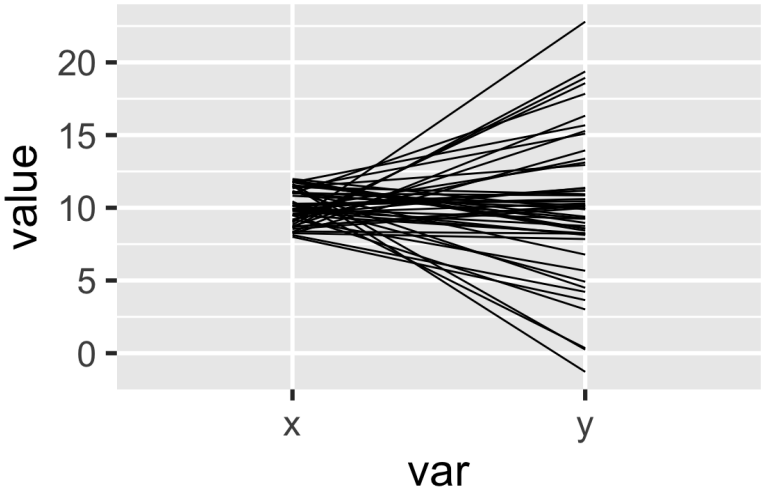
```
tidydf <- df %>% select(x, y) %>% rownames_to_column("ID") %>%
  gather(var, value, -ID)
gslope <- ggplot(tidydf, aes(x = var, y = value, group = ID)) +
  geom_line()
gslope
```



`geom_line()`

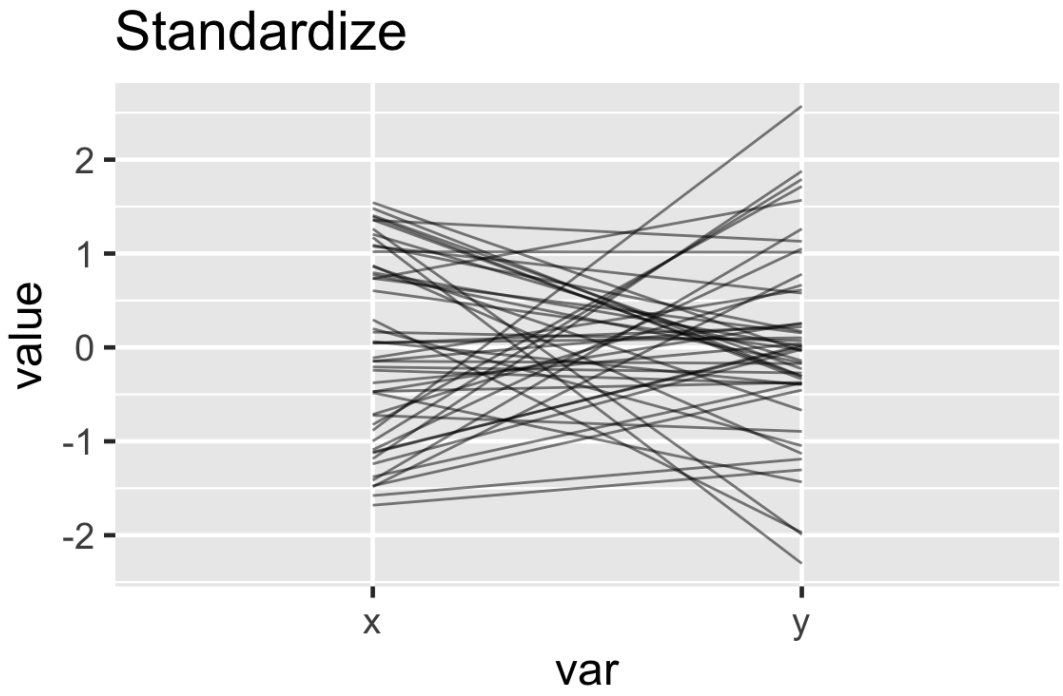
Scatterplot vs slope graph





Standardize data

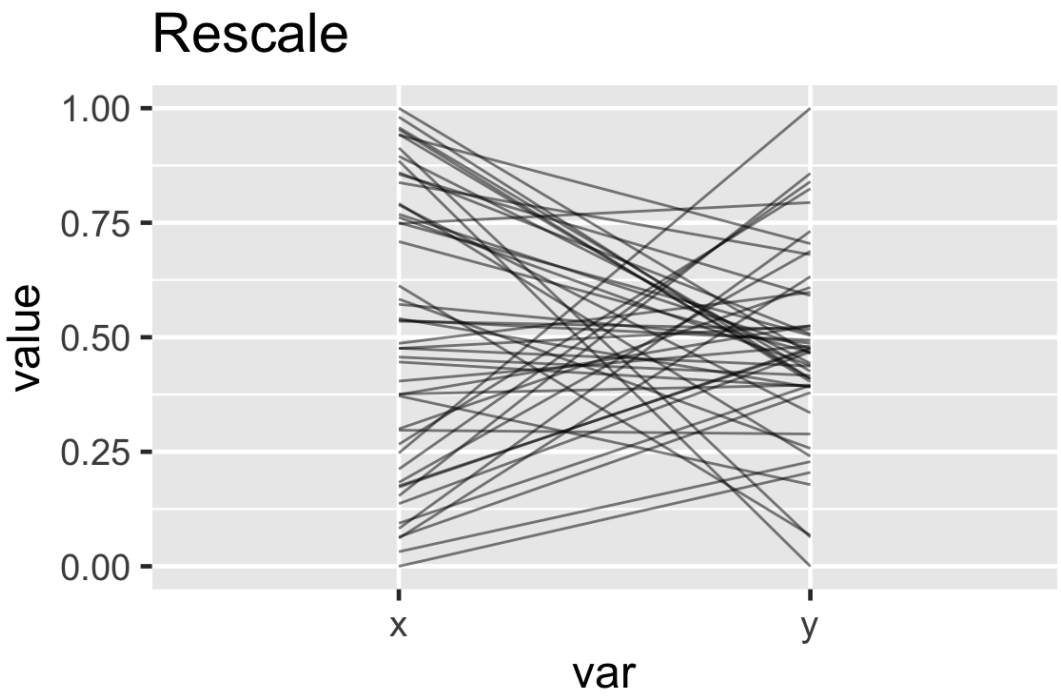
```r
standardize <- function(x) (x-mean(x))/sd(x)
df2 <- tidydf %>% group_by(var) %>%
  mutate(value = standardize(value)) %>% ungroup()
g0 <- ggplot(df2, aes(x = var, y = value, group = ID)) +
  geom_line(alpha = .5) + ggtitle("Standardize")
g0
```



`geom_line()`

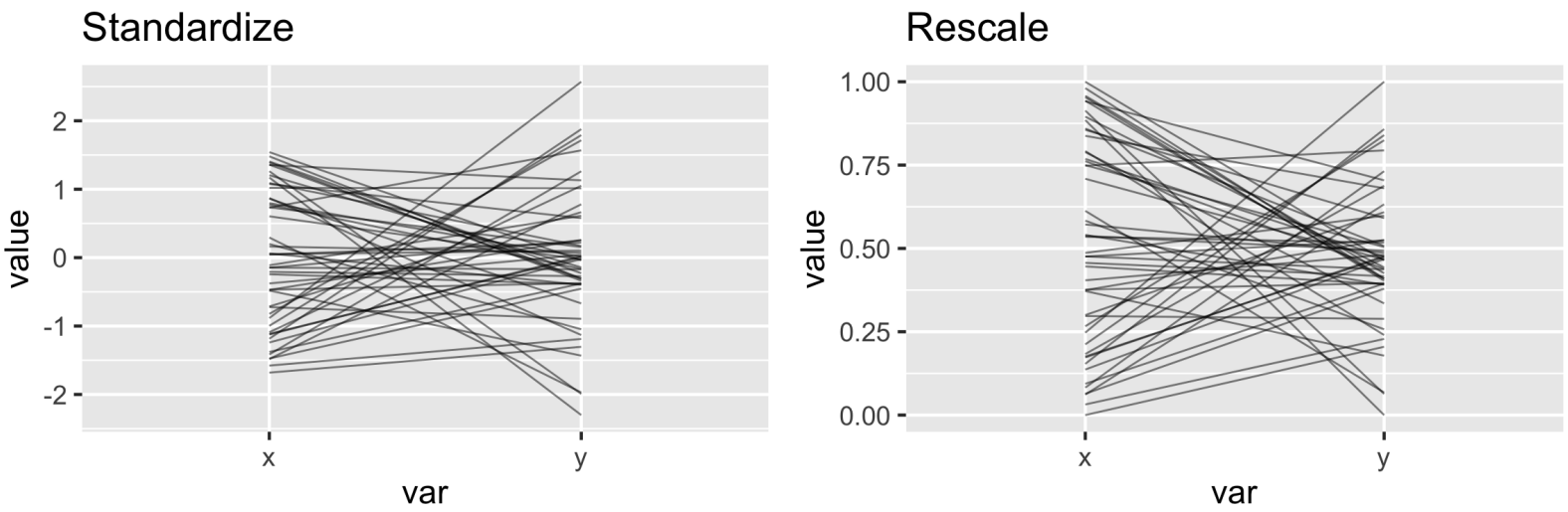
Rescale data to [0,1]

```
df2 <- tidydf %>% group_by(var) %>%
  mutate(value = scales::rescale(value)) %>% ungroup()
g1 <- ggplot(df2, aes(x = var, y = value, group = ID)) +
  geom_line(alpha = .5) + ggtitle("Rescale")
g1
```



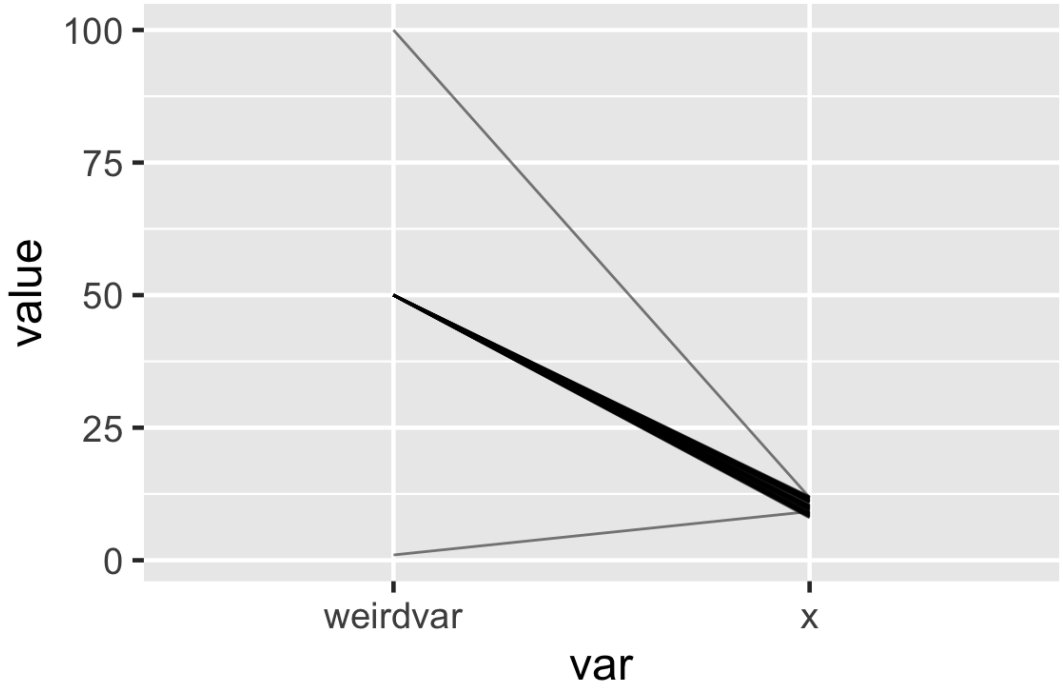
`geom_line()`

Compare

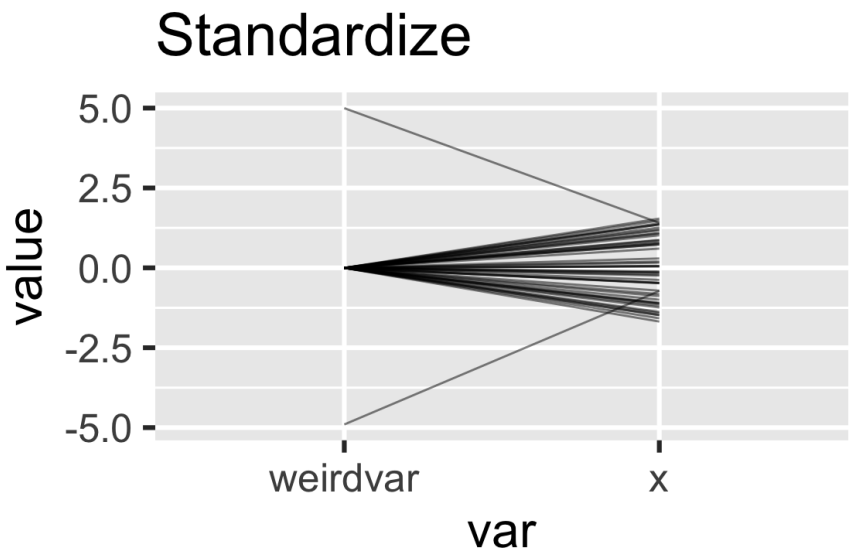

Standardize
value
2
1
0
-1
-2
x
y
var
Rescale
value
1.00
0.75
0.50
0.25
0.00
x
y
var

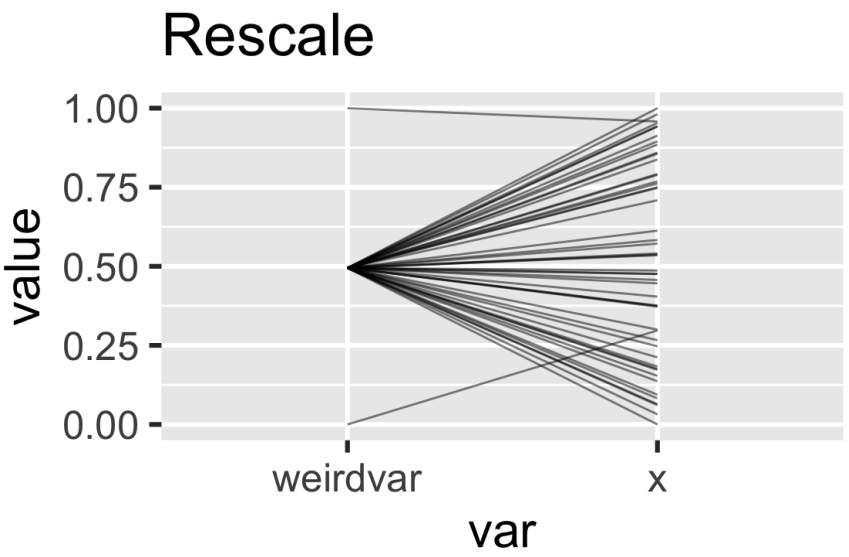
Compare different distributions

```
weirdvar <- c(1, rep(50, 48), 100)
df <- data.frame(x, weirdvar)
tidydf <- df %>% rownames_to_column("ID") %>% gather(var, value, -ID)
ggplot(tidydf, aes(x = var, y = value, group = ID)) +
  geom_line(alpha = .5)
```



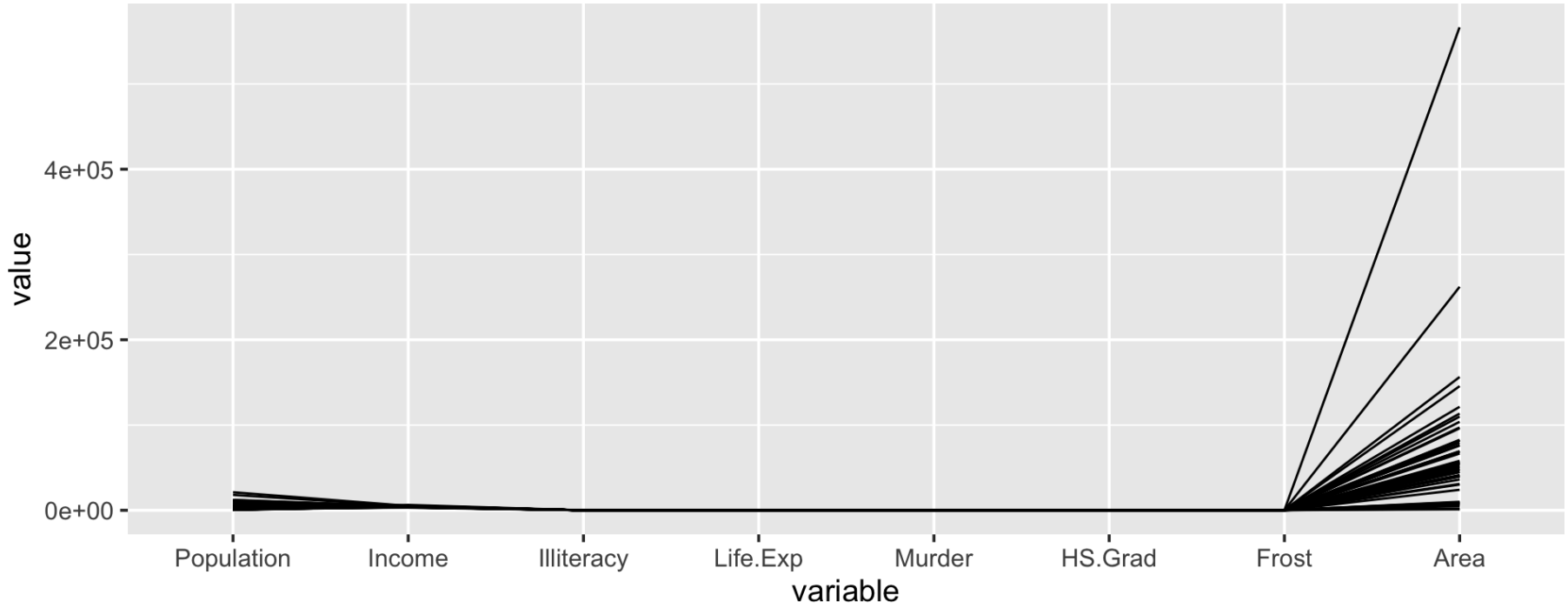
Compare


Standardize
5.0
2.5
0.0
-2.5
-5.0
value
weirdvar
x
var


Rescale
1.00
0.75
0.50
0.25
0.00
value
weirdvar
x
var

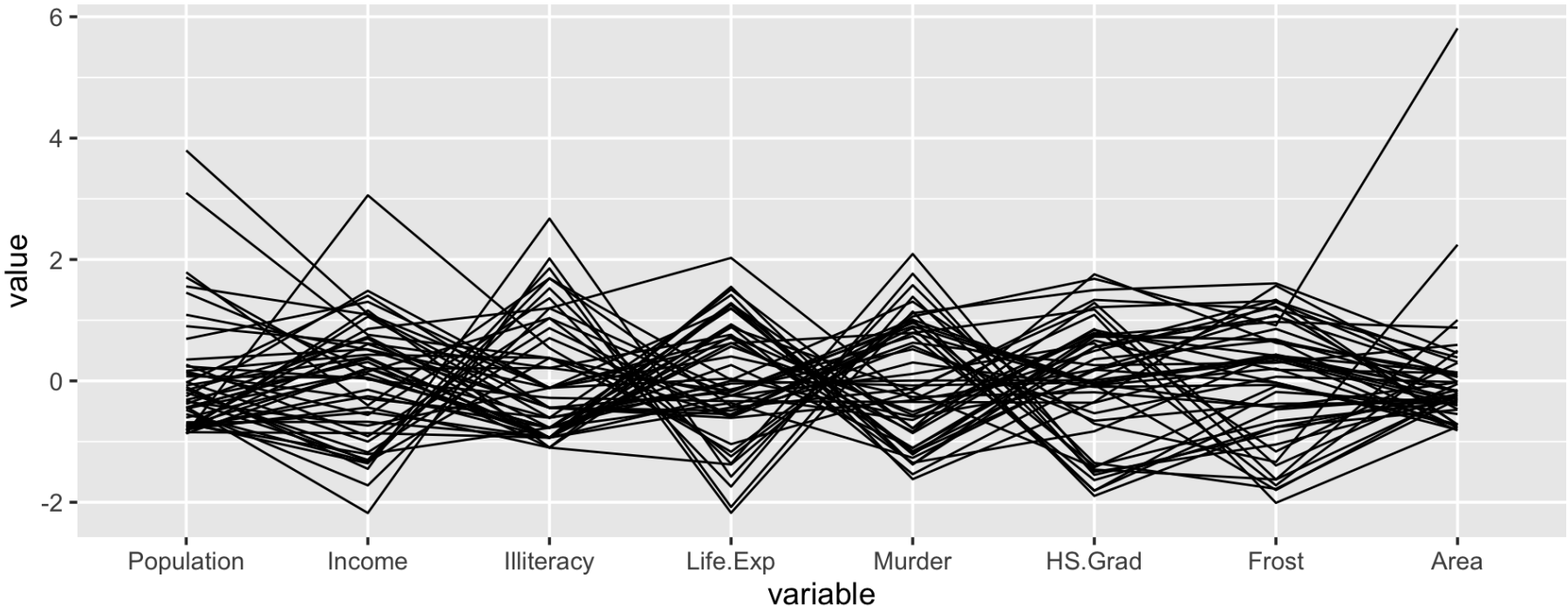
Scale = “globalminmax”

```
library(GGally)
theme_set(theme_grey(14))
# scale = globalminmax
mystates <- data.frame(state.x77) %>%
    rownames_to_column("State") %>%
    mutate(Region = factor(state.region))
# state.region is a separate vector -- see: ?state
mystates$Region <- factor(mystates$Region,
                          levels = c("Northeast", "North Central",
                                     "South","West"))
ggparcoord(mystates, columns = 2:9, scale = "globalminmax")
```



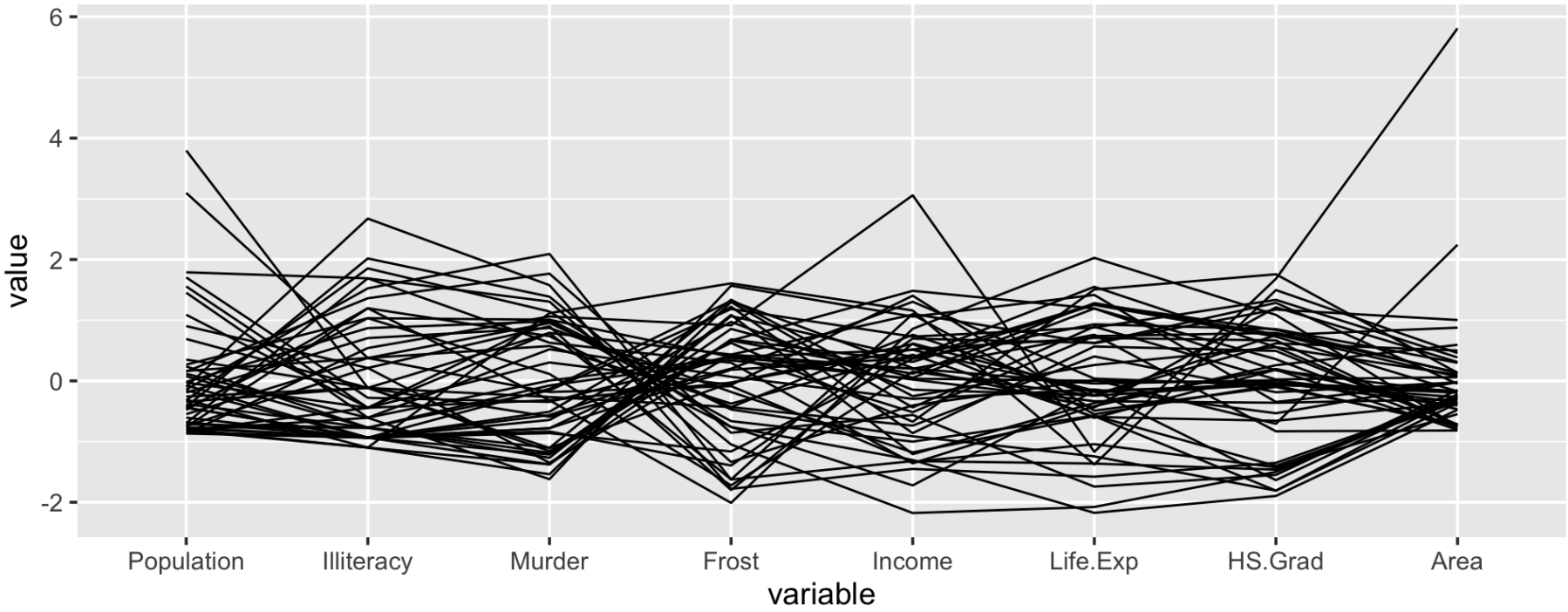
Scale = “std” (default)

```
# scale = std (default)
ggparcoord(mystates, columns = 2:9)
```



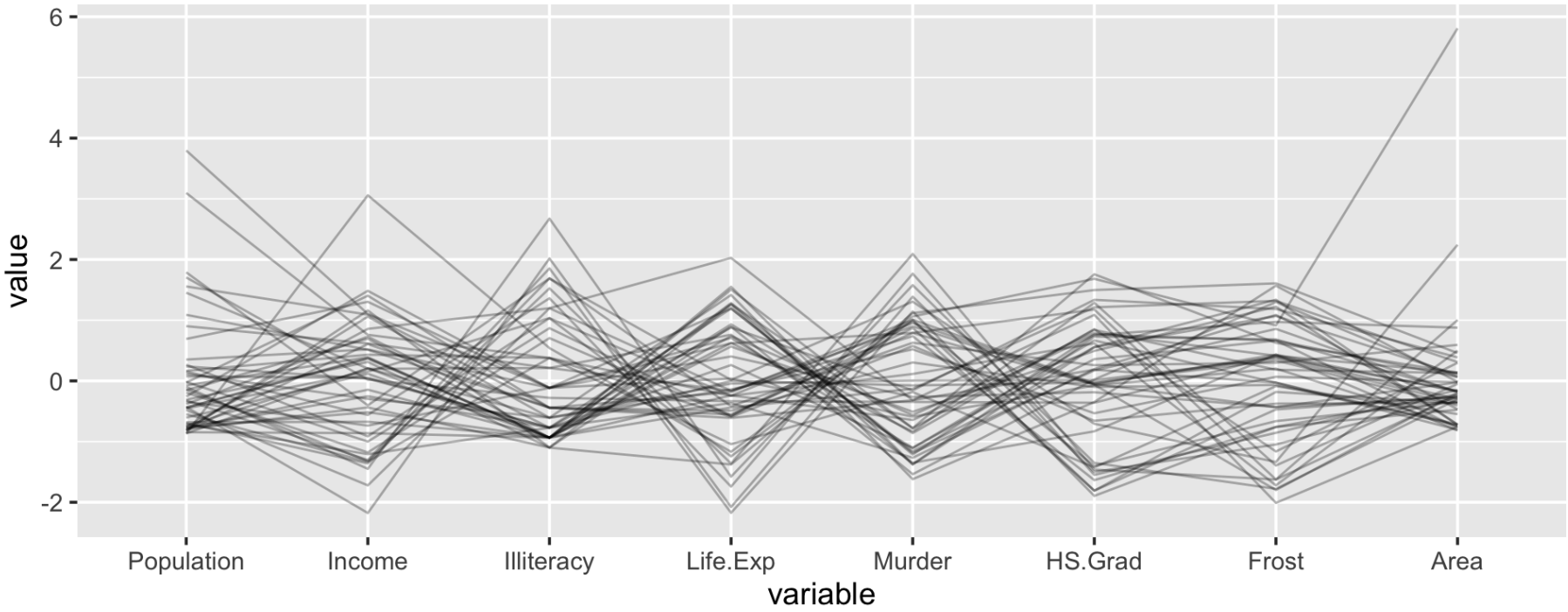
Reordered

```
# scale = std (default)
ggparcoord(mystates, columns = c(2, 4, 6, 8, 3, 5, 7, 9))
```



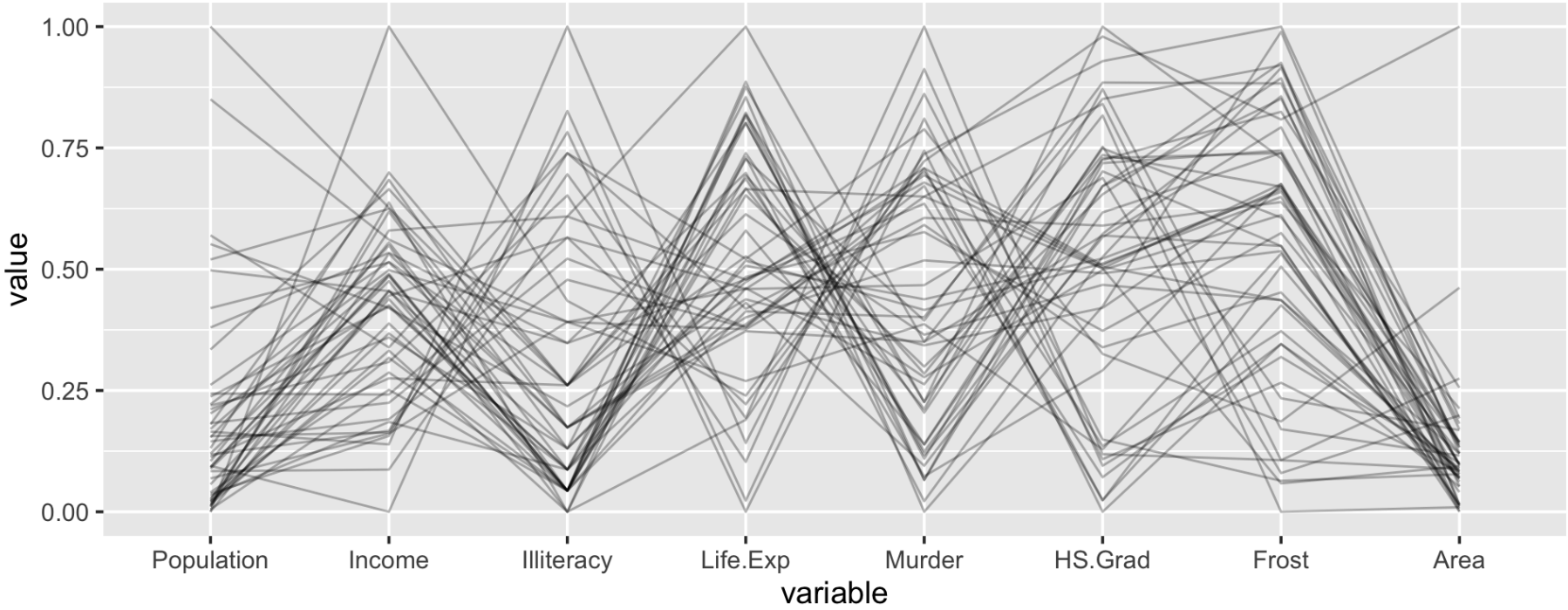
Alpha

```
# scale = std (default)
ggparcoord(mystates, columns = 2:9, alphaLines = .3)
```



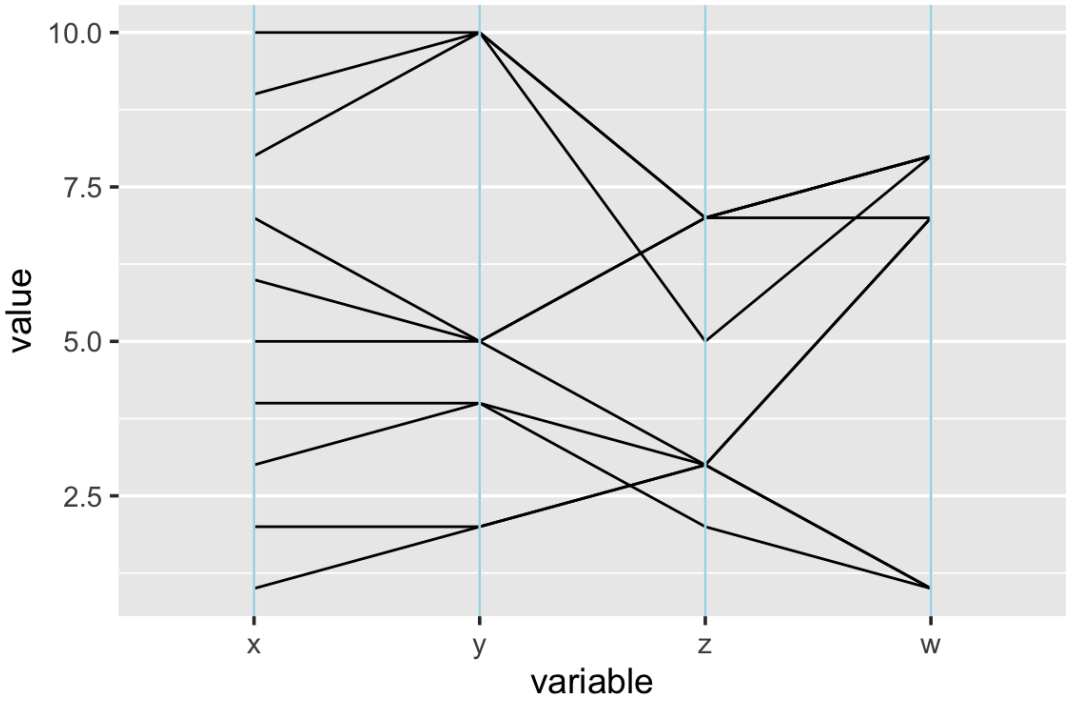
Alpha + rescale

```
# scale = std (default)
ggparcoord(mystates, columns = 2:9, alphaLines = .3,
           scale = "uniminmax")
```



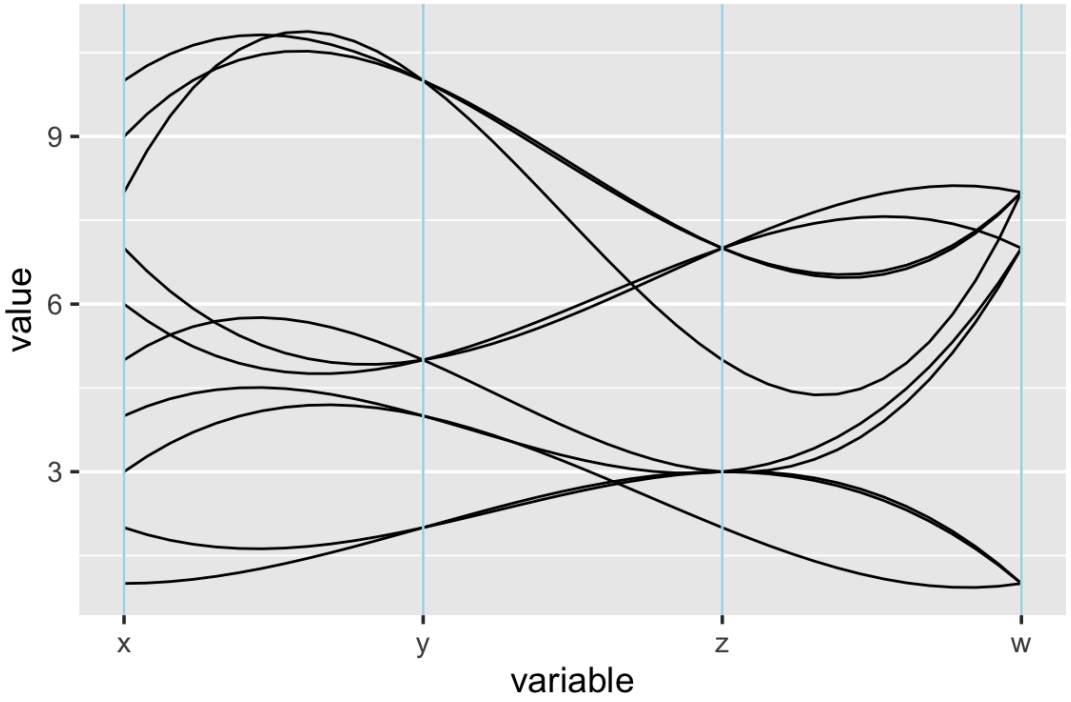
Dataset with repeats

```
x <- 1:10
y <- c(2,2,4,4,5,5,5,10,10,10)
z <- c(3,3,2,3,3,7,7,5,7,7)
w <- c(1, 1, 1, 7, 7, 7, 8, 8, 8, 8)
df <- data.frame(x,y,z, w)
g0 <- ggparcoord(df, columns = 1:4, scale = "globalminmax") + geom_vline(xintercept = 1:4, color = "lightblue")
g0
```

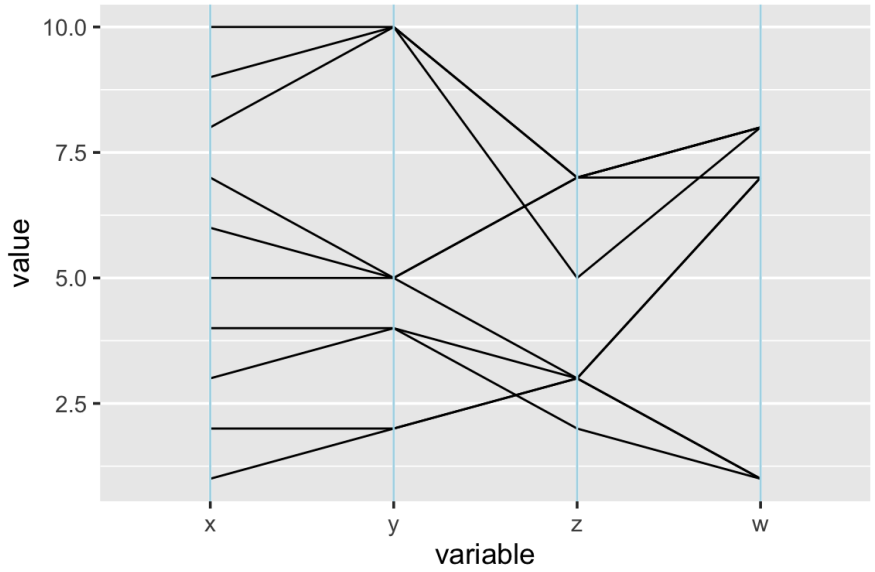


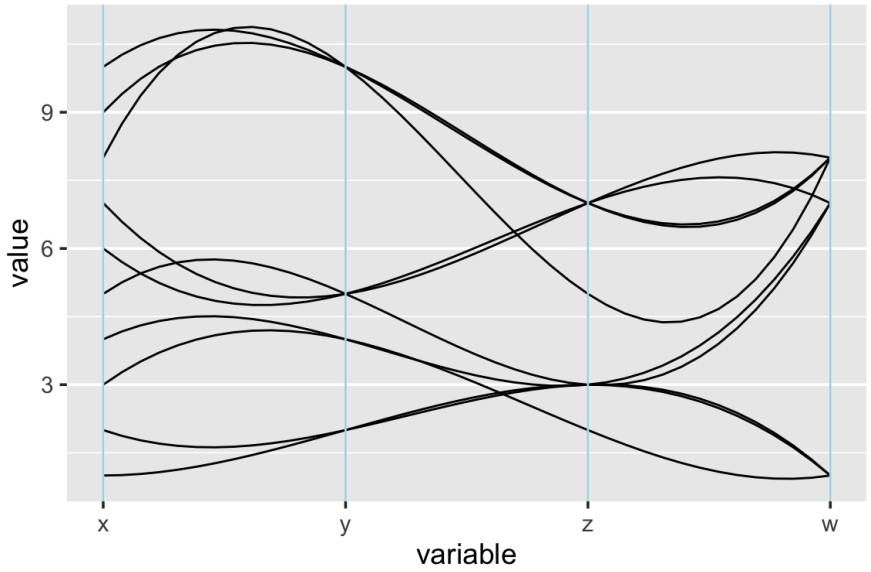
Splines

```
g1 <- ggparcoord(df, columns = 1:4, scale = "globalminmax",
                 splineFactor = 10) +
  geom_vline(xintercept = 1:4, color = "lightblue")
g1
```



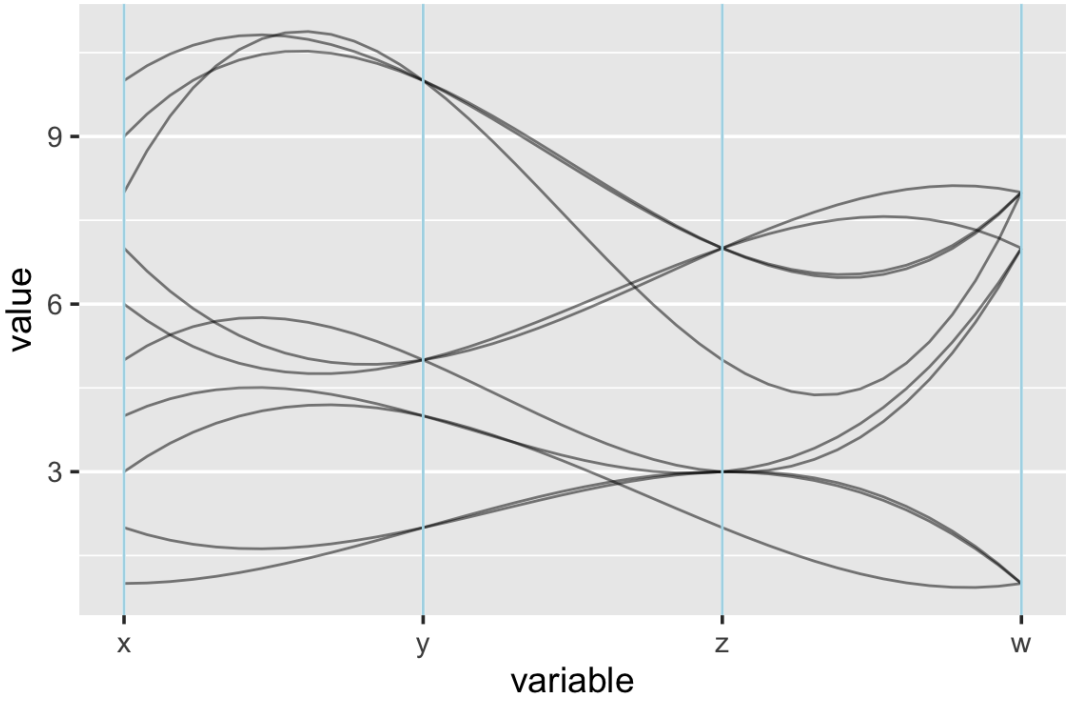
Compare





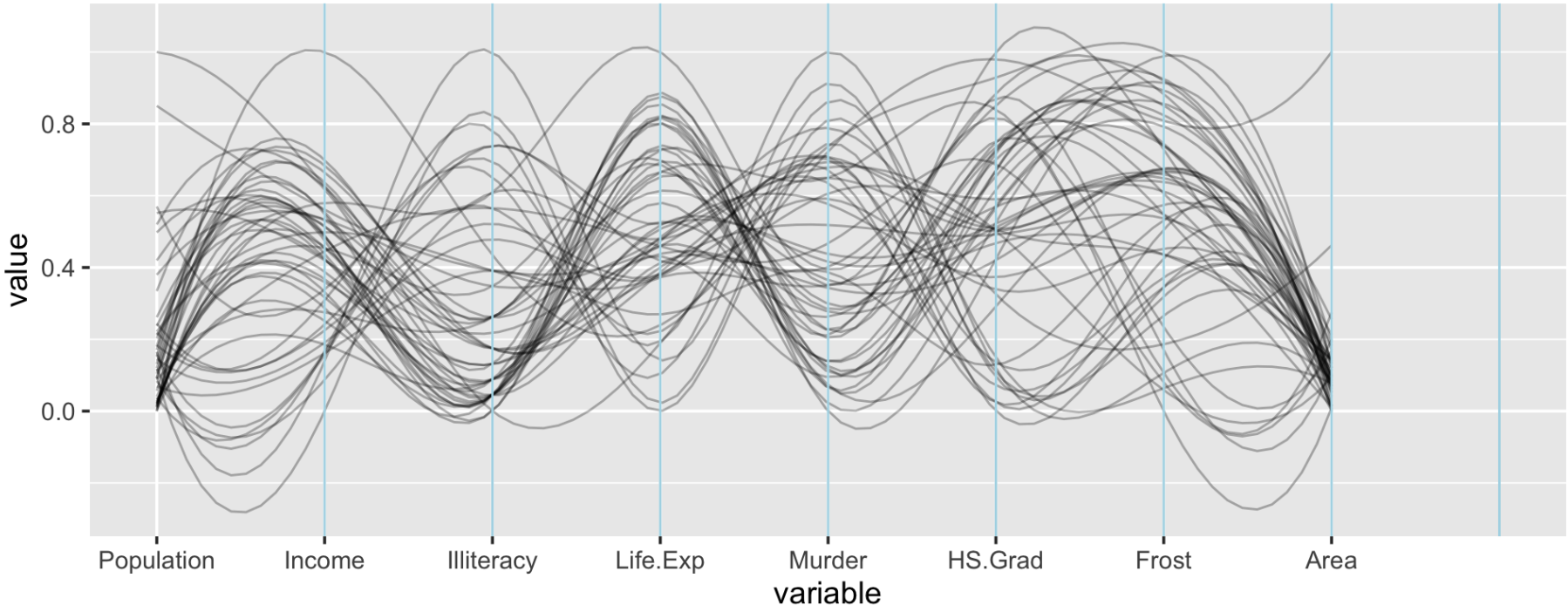
Alpha

```
g1 <- ggparcoord(df, columns = 1:4, scale = "globalminmax",
                 splineFactor = 10, alphaLines = .5) +
  geom_vline(xintercept = 1:4, color = "lightblue")
g1
```



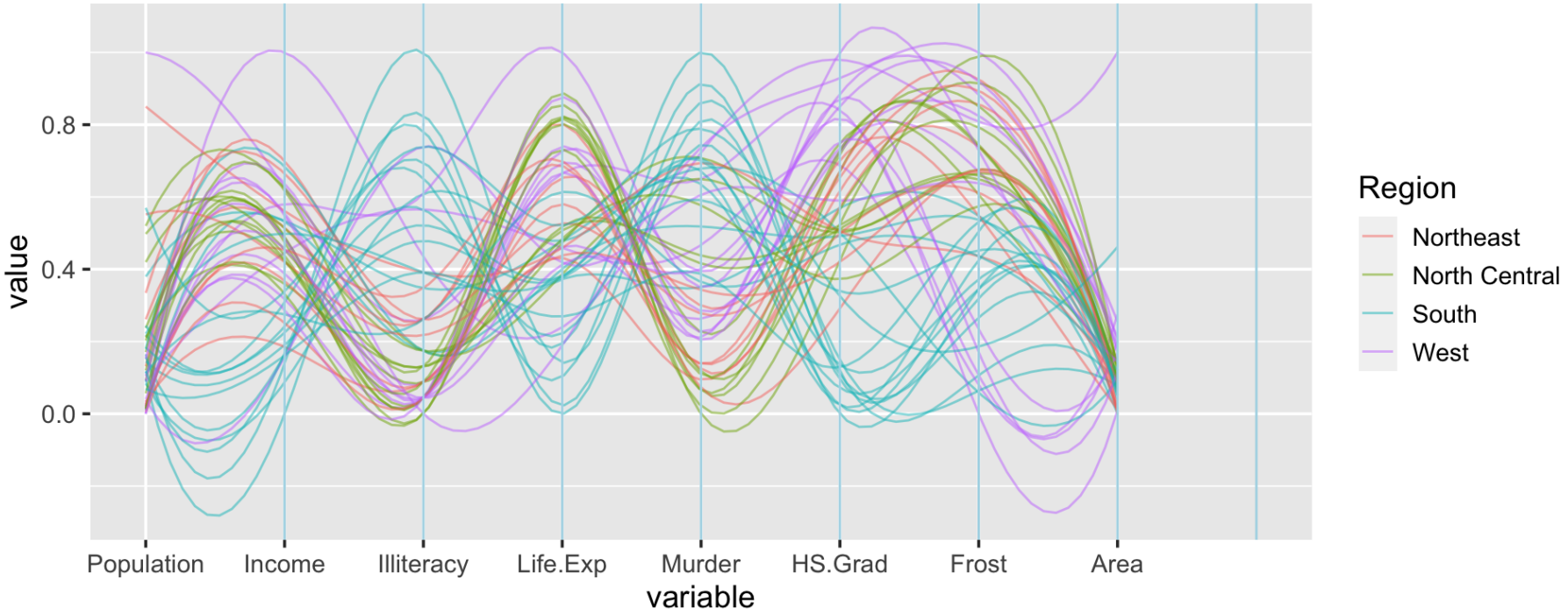
Alpha + rescale + splines

```
# scale = std (default)
ggparcoord(mystates, columns = 2:9, alphaLines = .3,
           scale = "uniminmax", splineFactor = 10) +
  geom_vline(xintercept = 2:9, color = "lightblue")
```



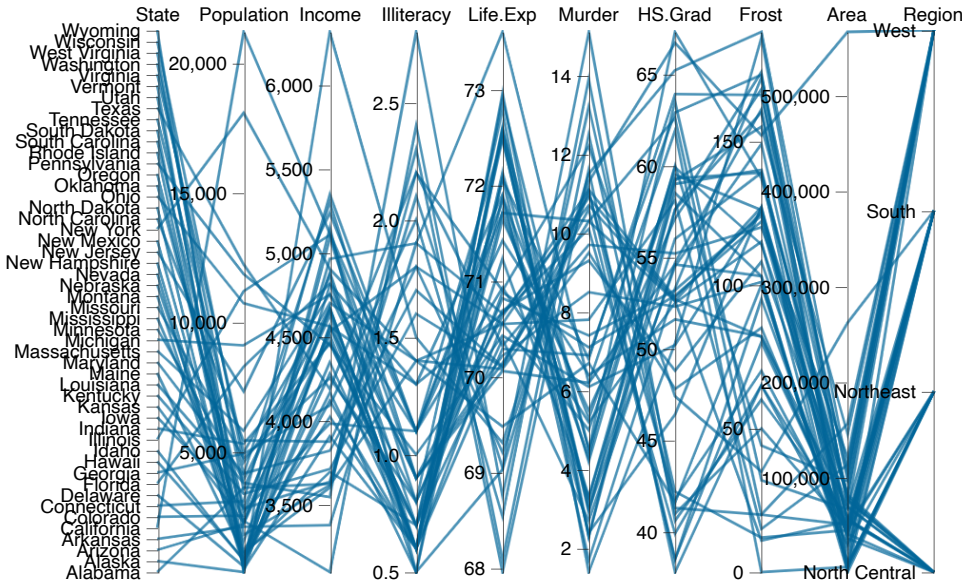
Alpha + rescale + splines + group

```
# scale = std (default)
ggparcoord(mystates, columns = 2:9, alphaLines = .5,
           scale = "uniminmax", splineFactor = 10, groupColumn = 10) +
  geom_vline(xintercept = 2:9, color = "lightblue")
```



Html widget: parcoords

```
# See: http://www.buildingwidgets.com/blog/2015/1/30/week-04-interactive-parallel-coordinates-1
# devtools::install_github("timelyportfolio/parcoords")
library(parcoords)
mystates  %>% arrange(Region) %>%
  parcoords(
    rownames = F
    , brushMode = "1D-axes"
    , reorderable = T
    , queue = T
    )
```

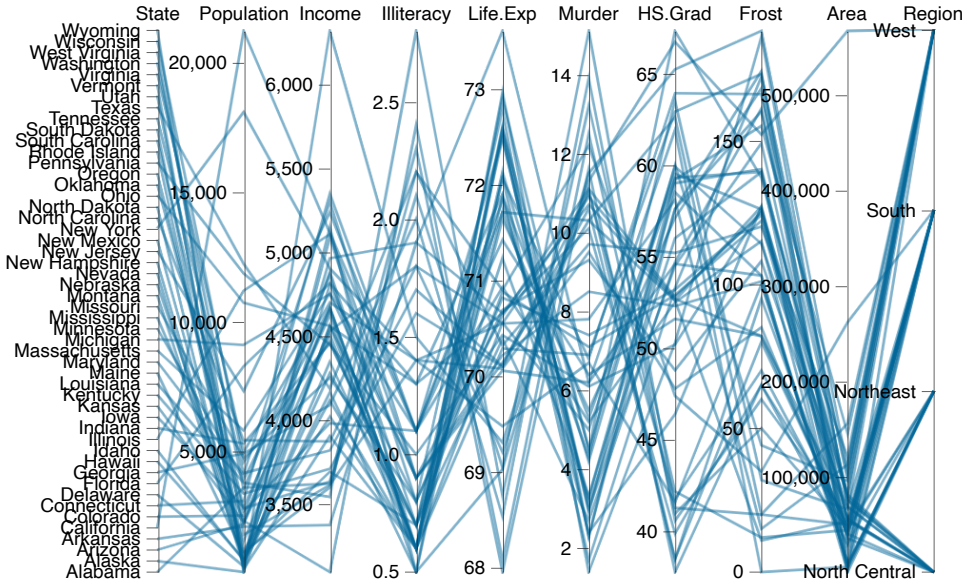


`parcoords::parcoords()`

http://www.buildingwidgets.com/blog/2015/1/30/week-04-interactive-parallel-coordinates-1

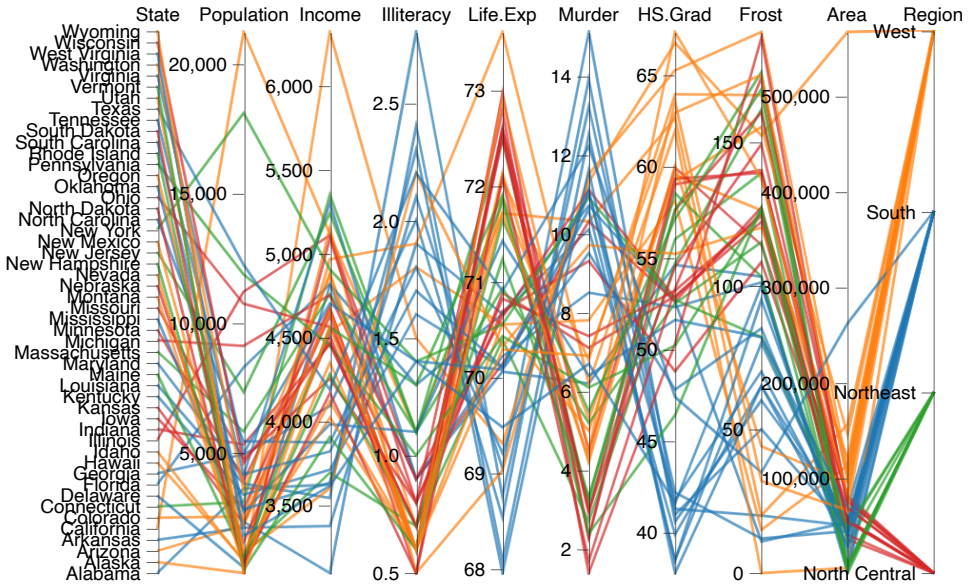
Add alpha blending

```
# with alpha
mystates  %>% arrange(Region) %>%
  parcoords(
    rownames = F
    , brushMode = "1D-axes"
    , reorderable = T
    , queue = T
    , alpha = .5
    )
```



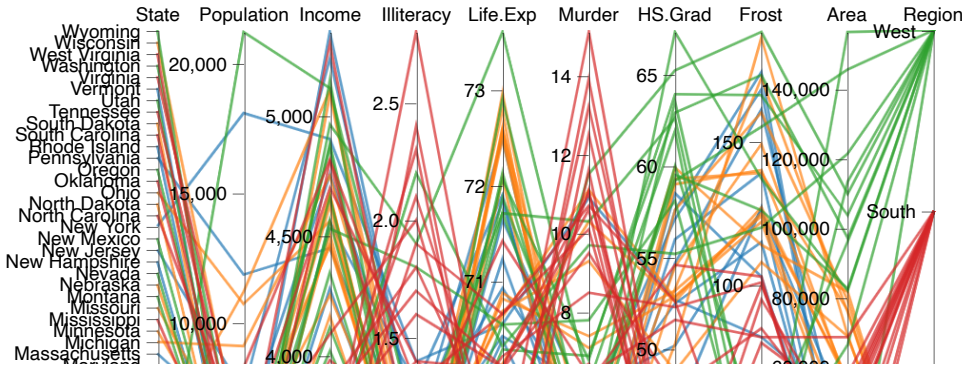
Color

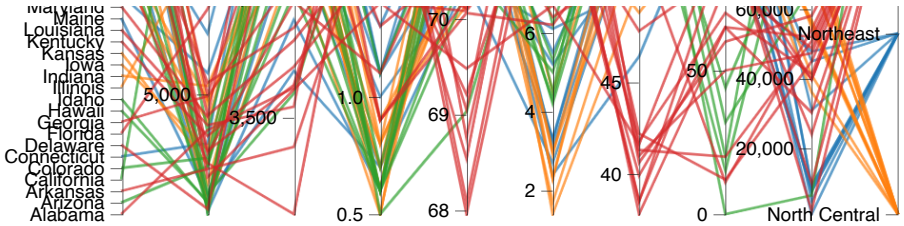
```
parcoords(mystates
  , rownames = F
  , brushMode = "1D-axes"
  , reorderable = T
  , queue = T
  , color = list(
    colorBy = "Region"
    ,colorScale = "scaleOrdinal"
    ,colorScheme = "schemeCategory10"
    )
  , withD3 = TRUE
  )
```



Filter out Alaska / Texas

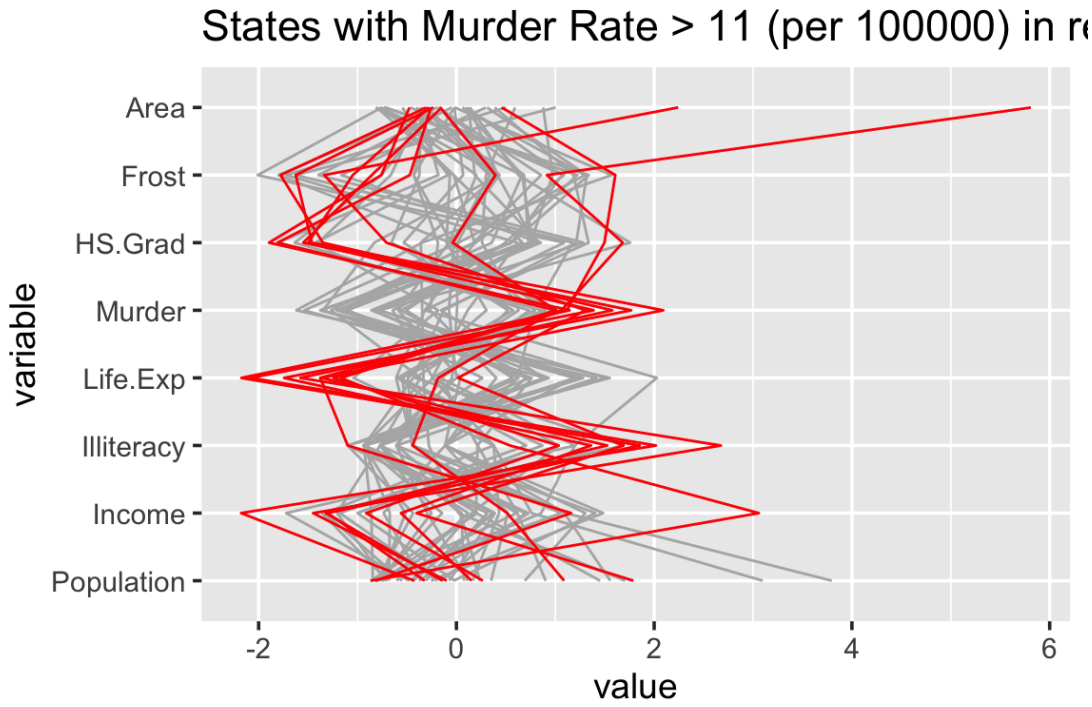
```
# filter out Alaska, Texas, group by Region
myregionorder <- mystates %>% group_by(Region) %>%
    summarize(n = n()) %>% arrange(n)
mystates$Region <- factor(mystates$Region,
                          levels = myregionorder$Region)
data.frame(mystates)  %>% filter(State != "Alaska") %>%
  filter(State != "Texas") %>% arrange(Region) %>%
  parcoords(
    rownames = F
    , brushMode = "1D-axes"
    , reorderable = T
    , queue = T
    , color = list(
      colorBy = "Region"
      ,colorScale = "scaleOrdinal"
      ,colorScheme = "schemeCategory10"
      )
    , withD3 = TRUE
  )
```




Maryland
Maine
Louisiana
Kentucky
Kansas
Iowa
Indiana
Illinois
Idaho
Hawaii
Georgia
Florida
Delaware
Connecticut
Colorado
California
Arkansas
Arizona
Alabama
5,000
3,500
1.0
0.5
70
69
68
6
4
2
50
45
40
60,000
40,000
20,000
0
Northeast
North Central

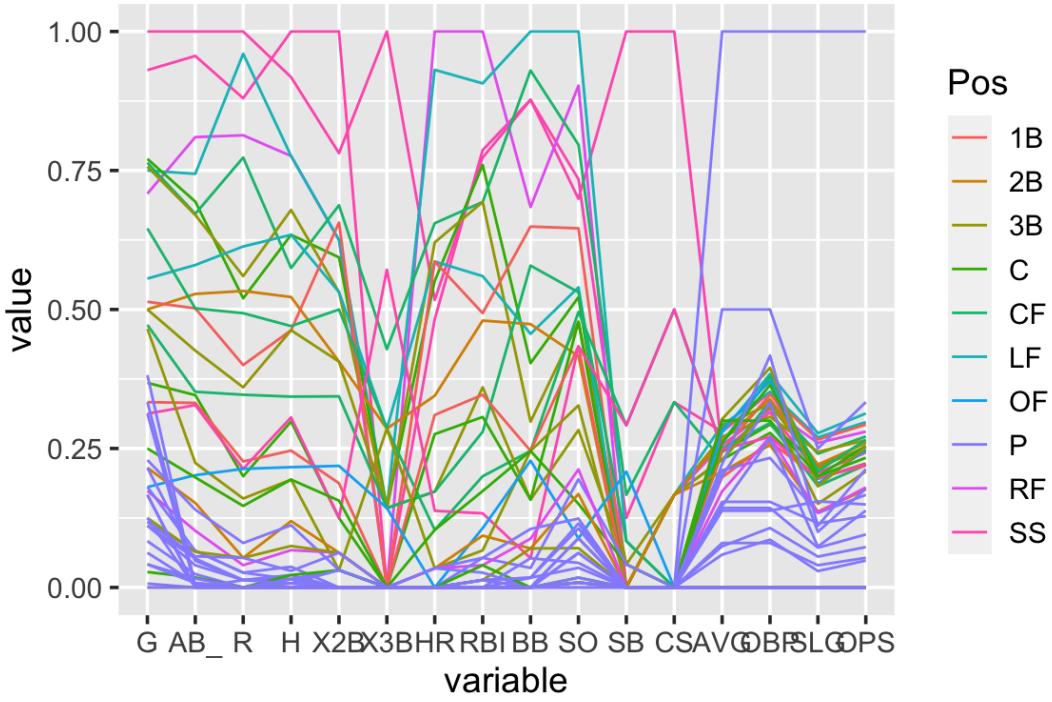
Highlighting a trend

```
mystates <- mystates %>%
    mutate(color = factor(ifelse(Murder > 11, 1, 0))) %>%
    arrange(color)
ggparcoord(mystates, columns = 2:9, groupColumn = "color") +
    scale_color_manual(values = c("grey70", "red")) +
    coord_flip() + guides(color = FALSE) +
    ggtitle("States with Murder Rate > 11 (per 100000) in red")
```



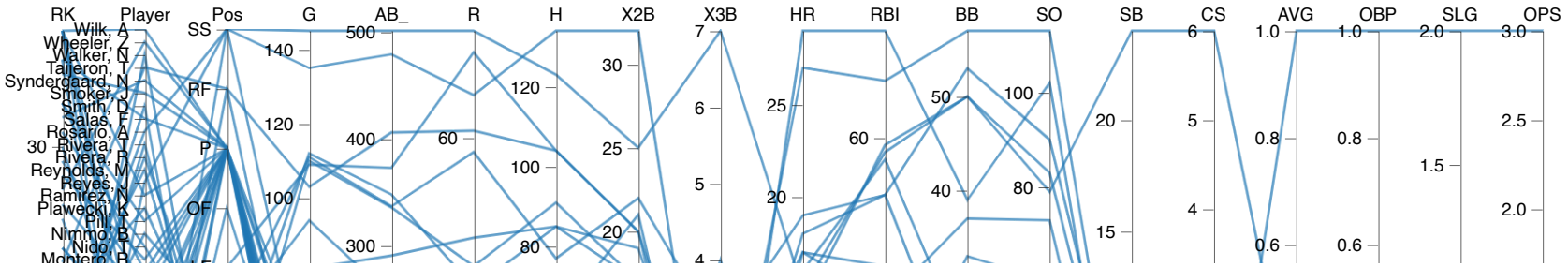
2017 Mets

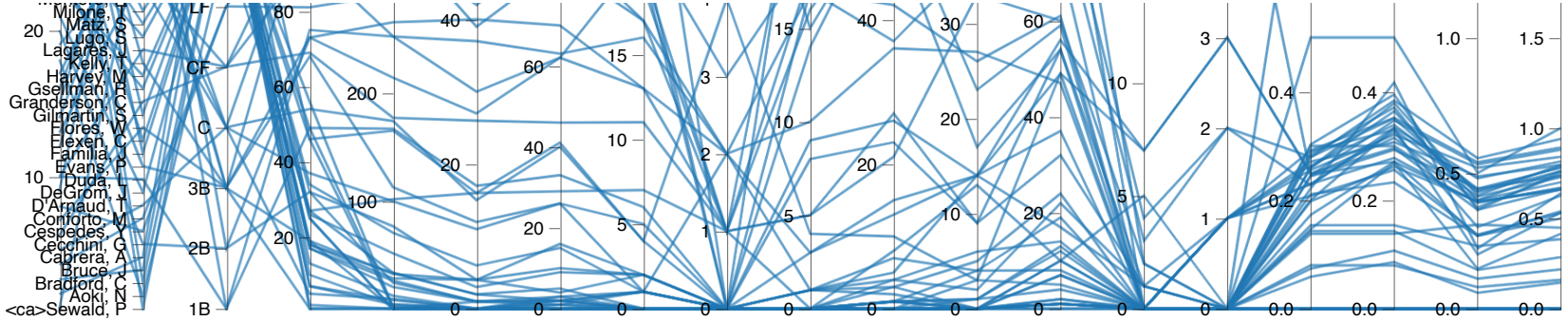
```
# Data from http://mlb.mlb.com/stats/
baseball <- read.csv("MetsStats2017.csv")
ggparcoord(baseball, columns = 5:20, groupColumn = "Pos",
           scale = "uniminmax")
```



2017 Mets (Interactive)

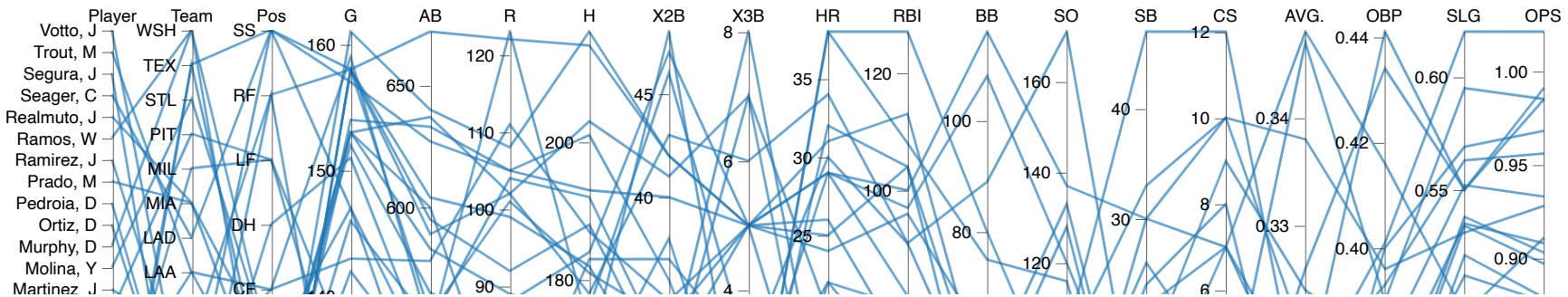
```
baseball <- read.csv("MetsStats2017.csv")
myposorder <- baseball %>% group_by(Pos) %>%
    summarize(n = n()) %>% arrange(n)
baseball$Pos <- factor(baseball$Pos,
                       levels = myposorder$Pos)
data.frame(baseball) %>% arrange(Pos) %>%
    select(-Team) %>%
  parcoords(
    rownames = F # turn off rownames from the data.frame
    , brushMode = "1D-axes"
    , reorderable = T
    , queue = T
    , color = list(
      colorBy = "Region"
      ,colorScale = "scaleOrdinal"
      ,colorScheme = "schemeCategory10"
      )
    , withD3 = TRUE
    , width = 1000
    , height = 400
  )
```

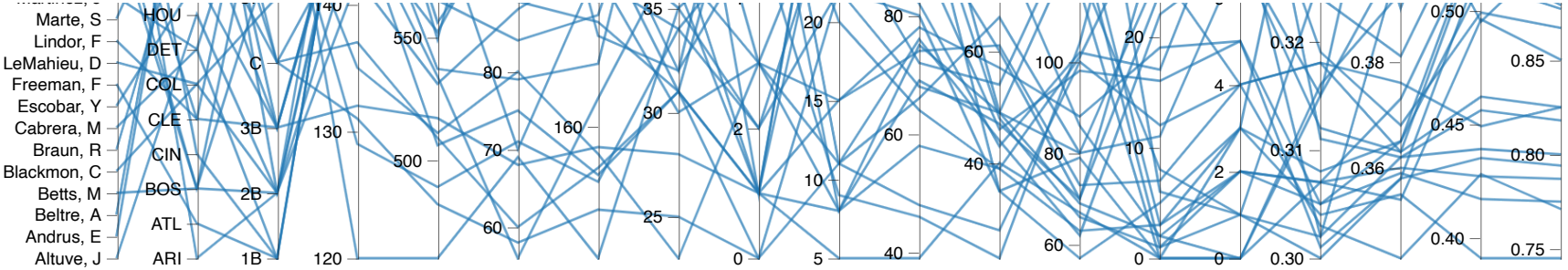



Milone, T
Matz, S
Lugo, S
Lagares, J
Kelly, T
Harvey, M
Gsellman, R
Granderson, C
Gilmartin, S
Flores, W
Flexen, C
Familia, J
Evans, P
Duda, L
DeGrom, J
D'Arnaud, T
Comforto, M
Cespedes, Y
Cecchini, G
Cabrera, A
Bruce, J
Bradford, C
Aoki, N
<ca>Sewald, P
LF
CF
C
3B
2B
1B

2016 Top Hitters (25 highest AVG)

```
baseball <- read.csv("TopHitters2016.csv")
myteamorder <- baseball %>% group_by(Team) %>%
    summarize(n = n()) %>% arrange(n)
baseball$Team <- factor(baseball$Team,
                        levels = myteamorder$Team)
data.frame(baseball)  %>% arrange(Team) %>%
  parcoords(
    rownames = F # turn off rownames from the data.frame
    , brushMode = "1D-axes"
    , reorderable = T
    , queue = T
    , color = list(
      colorBy = "Region"
      ,colorScale = "scaleOrdinal"
      ,colorScheme = "schemeCategory10"
      )
    , withD3 = TRUE
    , width = 1000
    , height = 400
  )
```

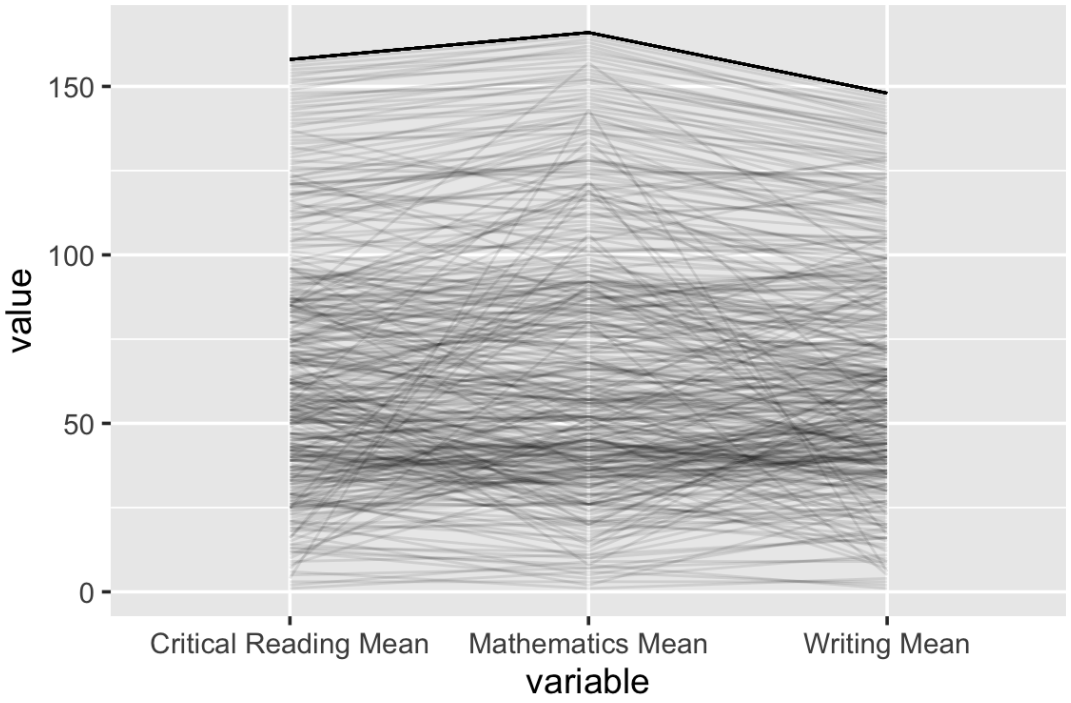



Marte, S
Lindor, F
LeMahieu, D
Freeman, F
Escobar, Y
Cabrera, M
Braun, R
Blackmon, C
Betts, M
Beltre, A
Andrus, E
Altuve, J
HOU
DET
COL
CLE
CIN
BOS
ATL
ARI
C
3B
2B
1B
140
130
120
550
500
80
70
60
160
35
30
25
2
0
20
15
10
5
80
60
40
100
80
60
40
20
10
2
0
4
0
0.32
0.31
0.30
0.38
0.36
0.50
0.45
0.40
0.85
0.80
0.75

SAT data

https://data.cityofnewyork.us/Education/SAT-College-Board-2010-School-Level-Results/zt9s-n5aj/data

```
library(tidyverse)
library(GGally)
sat <- read_csv("SAT2010.csv")
ggparcoord(sat, columns = c(4, 5, 6), alphaLines = .1, scale = "globalminmax")
```

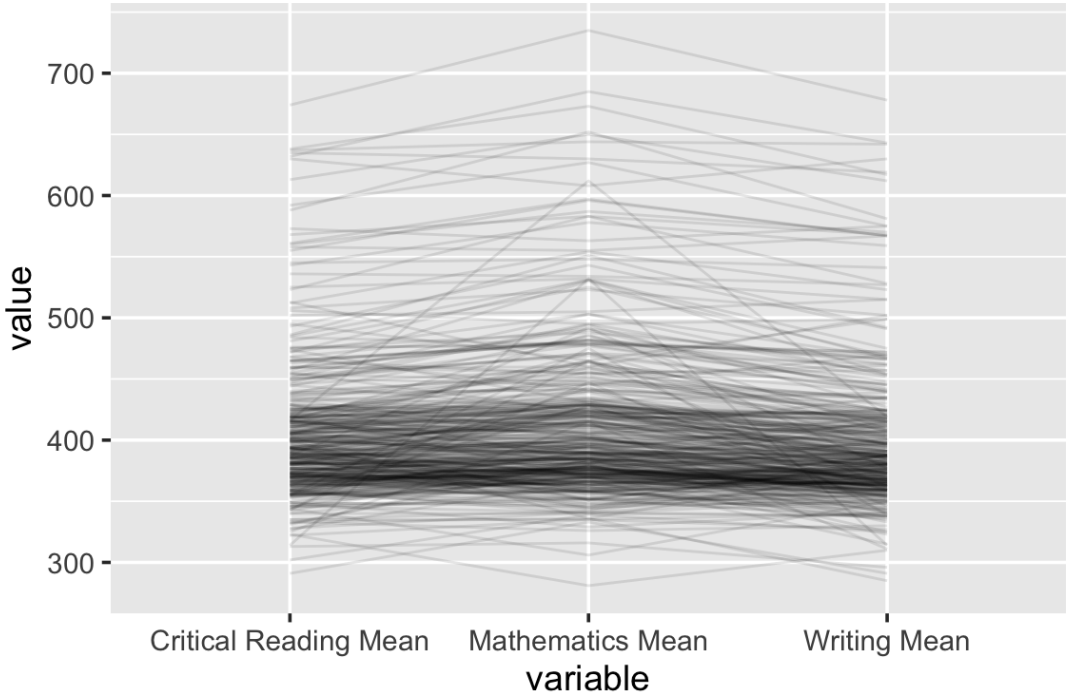


What's wrong?

SAT data

https://data.cityofnewyork.us/Education/SAT-College-Board-2010-School-Level-Results/zt9s-n5aj/data

```
library(tidyverse)
library(GGally)
sat <- read_csv("SAT2010.csv")
sat$`Critical Reading Mean` <- as.numeric(sat$`Critical Reading Mean`)
sat$`Mathematics Mean` <- as.numeric(sat$`Mathematics Mean`)
sat$`Writing Mean` <- as.numeric(sat$`Writing Mean`)
ggparcoord(sat, columns = c(4, 5, 6), alphaLines = .1, scale = "globalminmax")
```

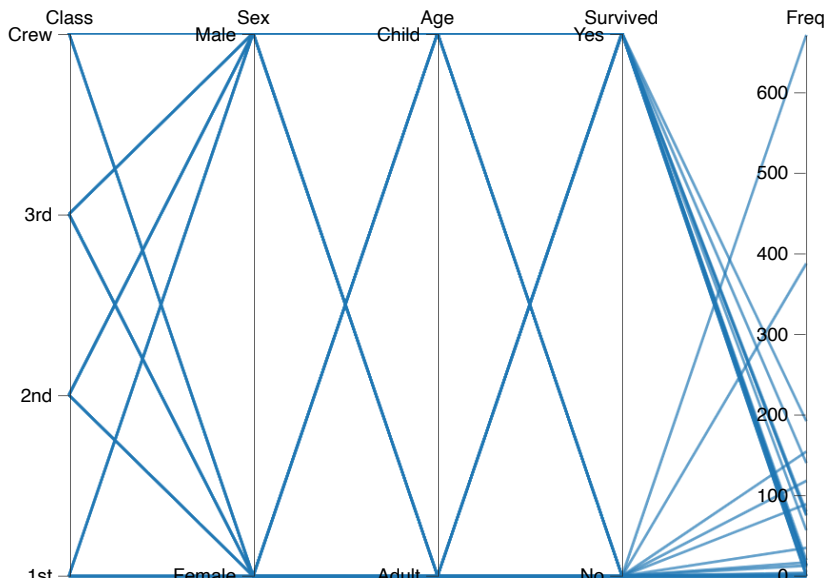


```
library(parcoords)
sat |> select(c(2, 4, 5, 6)) |> filter(`Writing Mean` > 500) |>

  parcoords(
    rownames = F
    , brushMode = "1D-axes"
    , reorderable = T
    , queue = T
    , alpha = .5
    )
```

Watch out for categorical variables

```
# parcoords package (htmlwidget)
data.frame(Titanic)  %>%
  parcoords(
    rownames = F # turn off rownames from the data.frame
    , brushMode = "1D-axes"
    , reorderable = T
    , queue = T
    , color = list(
      colorBy = "Region"
      ,colorScale = "scaleOrdinal"
      ,colorScheme = "schemeCategory10"
      )
    , withD3 = TRUE
  )
```



Parallel coordinate plots

- `ggplot2::geom_line()`
- `GGally::ggparcoord()` (static, ggplot2)
- `MASS:: parcoord()` (static, base)
- `parcoords::parcoords()` (interactive)
  devtools::install_github("timelyportfolio/parcoords")
  http://www.buildingwidgets.com/blog/2015/1/30/week-04-interactive-parallel-coordinates-1