CSSS 569 Visualizing Data and Models

Replication: HW1 - Problem 2

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Introduction

- Let's start with a quick review of last week

Grammar of graphics

- A statistical graphic is a **mapping** of **data** variables to **aes**thetic attributes of **geom**etric objects. (Wilkinson 2005)

Grammar of graphics in `ggplot2`

- *What* data do you want to visualize?

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Grammar of graphics in ggplot2

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- *Which* geometric shapes do you use to represent the data?

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- *Which* geometric shapes do you use to represent the data?
  - `geom_{}`:
    - `geom_point`, `geom_line`, `geom_ribbon`, `geom_polygon`, `geom_label`...

ggplot2: A layered grammar

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- Within each `geom_{}` layer, two things are *inherited* from previous layers
  - Data: inherited from the master data
  - Aesthetics: inherited (`inherit.aes = TRUE`) from the master aesthetics
  - They are convenient but create unintended consequences
    - We'll revisit them very soon and learn how to overwrite them

Tidy data

- `ggplot2` works well only with tidy data
  - *Tidy data*:
    - Each **variable** must have its own **column**
    - Each **observation** must have its own **row**
    - Each value must have its own cell

- Example: `iverRevised.csv` for Homework1

```
## # A tibble: 6 x 4
##   country   povertyReduction effectiveParties partySystem
##   <chr>                <dbl>            <dbl> <chr>
## 1 Australia             42.2             2.38 Majoritarian
## 2 Belgium               78.8             7.01 Proportional
## 3 Canada                29.9             1.69 Majoritarian
## 4 Denmark               71.5             5.04 Proportional
## 5 Finland               69.1             5.14 Proportional
## 6 France                57.9             2.68 Majoritarian
```

Building a plot from scratch

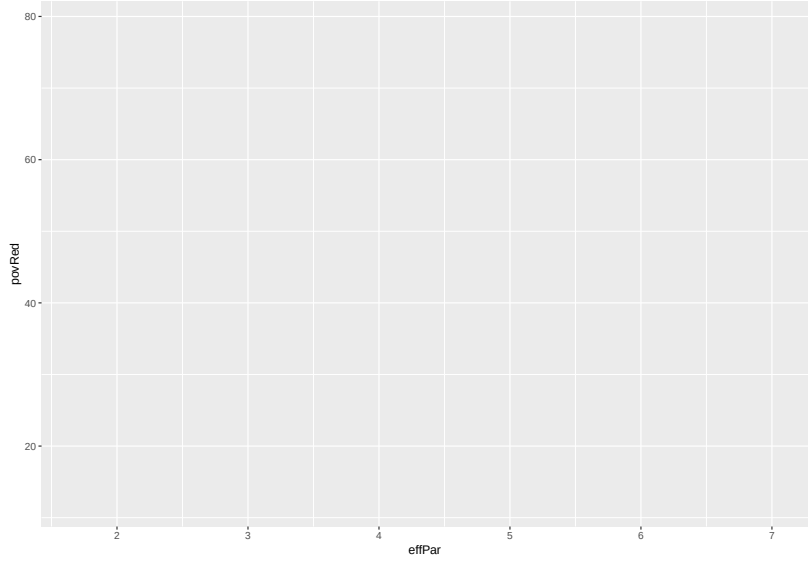
```
# Load packages
library(tidyverse)
library(RColorBrewer)
library(ggrepel)
#install.packages("MASS")

# Load data
iver <- read_csv("data/iverRevised.csv")

# Shorten the variable names
iver <- iver %>%
  rename(povRed = povertyReduction,
         effPar = effectiveParties,
         parSys = partySystem)
```

Building a plot from scratch

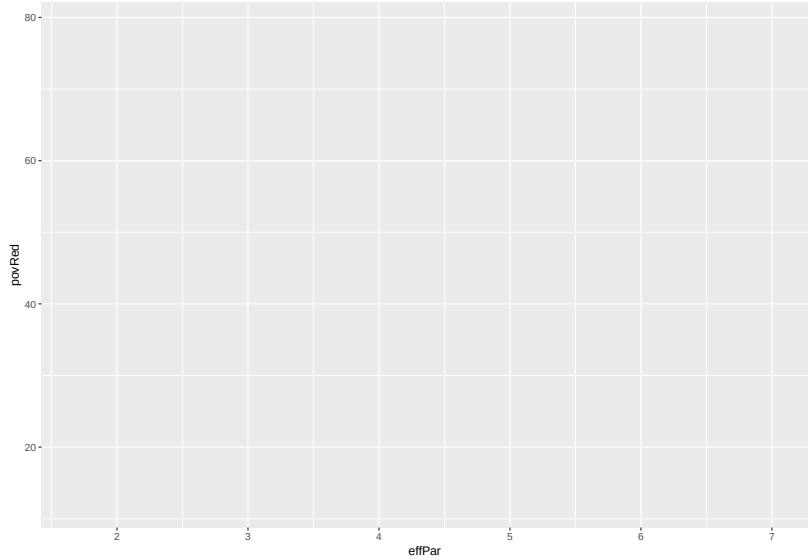
```
ggplot(
  data = iver,
  mapping = aes(y = povRed,
                x = effPar)
  )
```



Building a plot from scratch

`data =...` and `mapping =...` can be omitted for simplicity

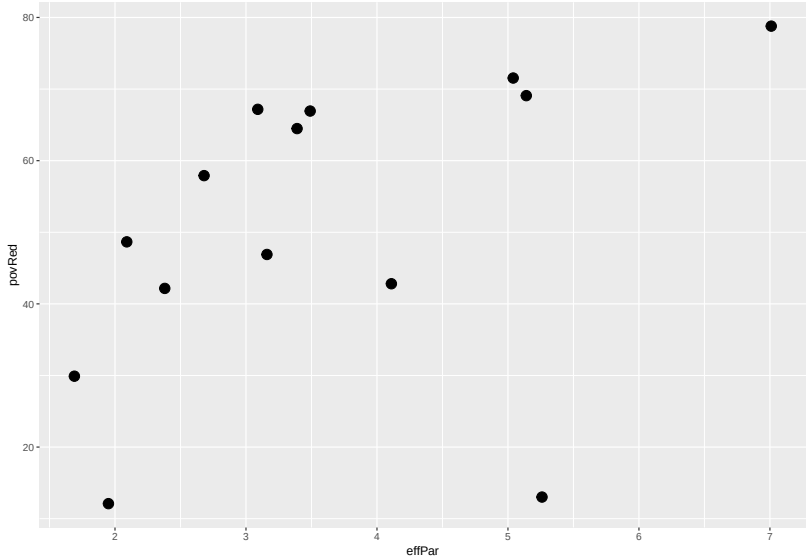
```
ggplot(
  iver,
  aes(y = povRed, x = effPar)
  )
```



Building a plot from scratch

No data will be drawn until you supply `geom_{}`

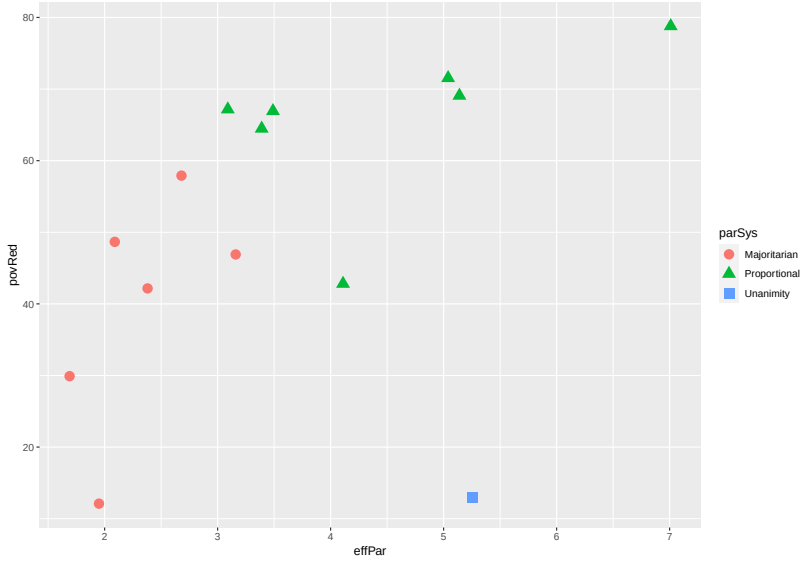
```
ggplot(
  iver,
  aes(y = povRed, x = effPar)
  ) +
  geom_point()
```



Building a plot from scratch

Map variable `partySystem` to aesthetics

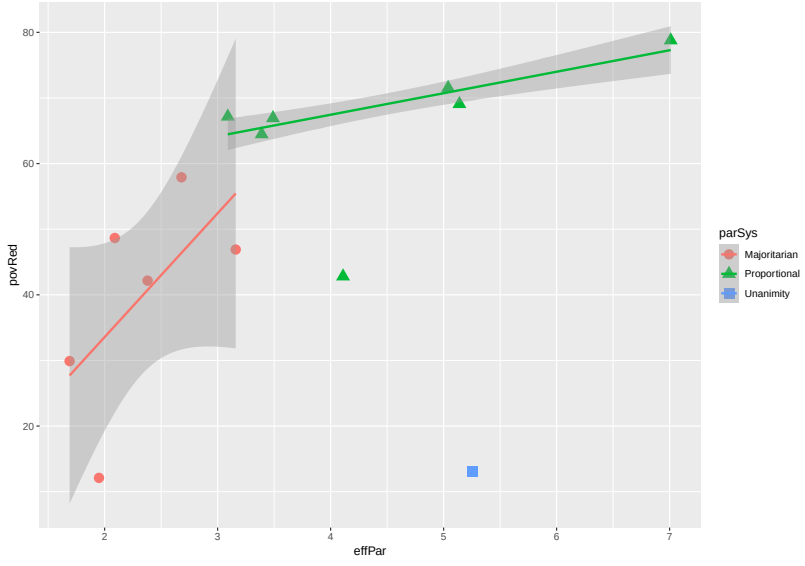
```
ggplot(
  iver,
  aes(y = povRed, x = effPar,
      colour = parSys,
      shape = parSys)
  ) +
  geom_point()
```



Building a plot from scratch

Why does it produce multiples smooth curves?

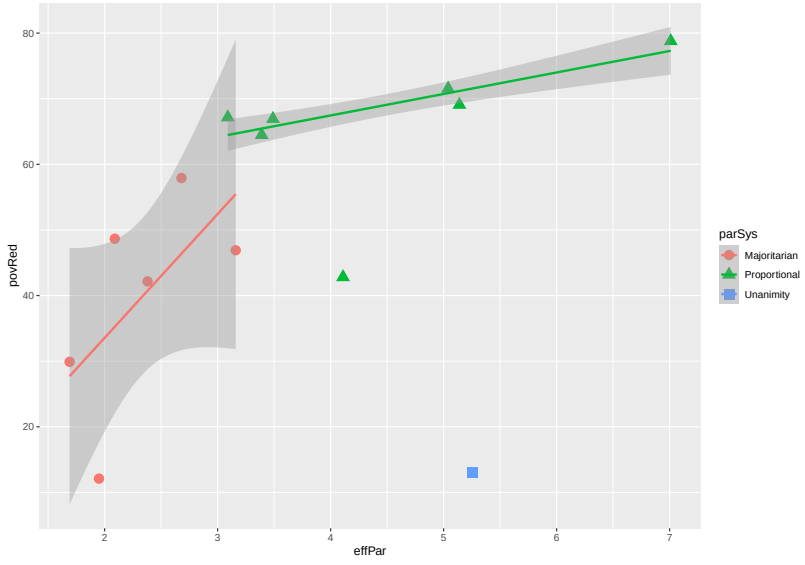
```
ggplot(
  iver,
  aes(y = povRed, x = effPar,
      colour = parSys,
      shape = parSys)
  ) +
  geom_point() +
  geom_smooth(method = MASS::rlm)
```



Building a plot from scratch

There is a hidden `inherit.aes = TRUE` default argument in every `geom_{}`

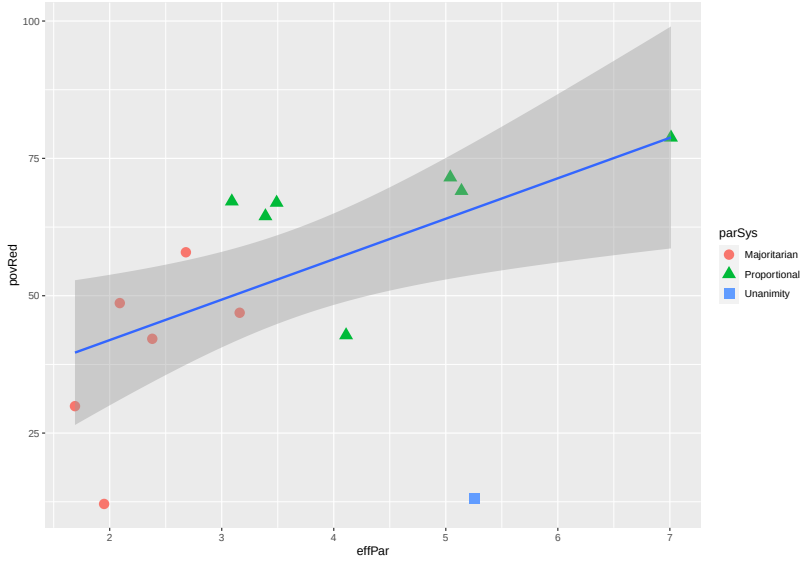
```
ggplot(
    iver,
    aes(y = povRed, x = effPar,
        colour = parSys,
        shape = parSys)
  ) +
  geom_point(
    inherit.aes = TRUE,
    aes(y = povRed, x = effPar,
        colour = parSys,
        shape = parSys)
 ) +
  geom_smooth(
    inherit.aes = TRUE,
    aes(y = povRed, x = effPar,
        colour = parSys,
        shape = parSys),
    method = MASS::rlm
  )
```



Building a plot from scratch

One solution: localize different aesthetic settings to specific layers

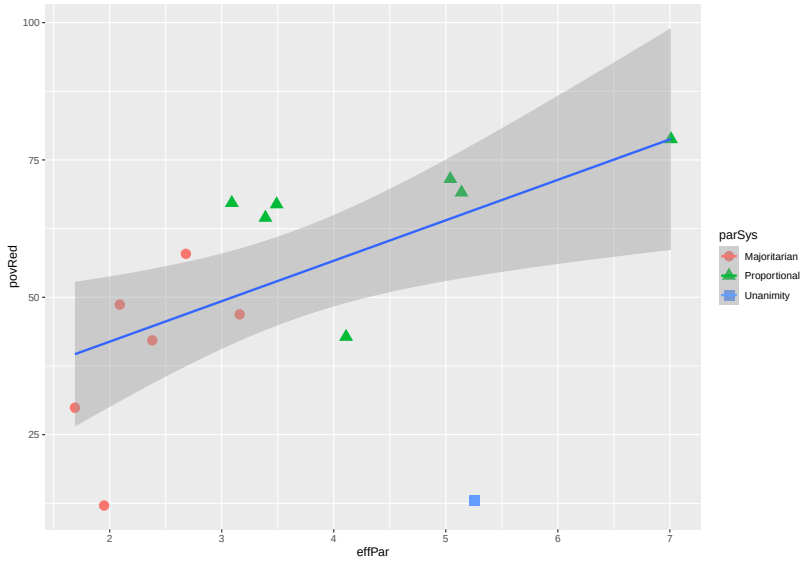
```
ggplot(
  iver,
  aes(y = povRed, x = effPar)
  ) +
  geom_point(
    aes(colour = parSys,
        shape = parSys),
    size = 4
  )+
  geom_smooth(method = MASS::rlm)
```



Building a plot from scratch

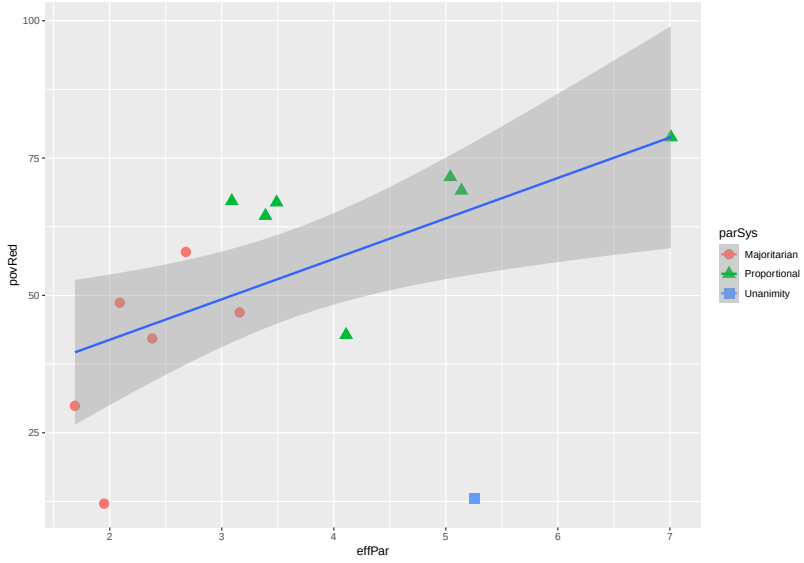
Another solution: override the grouping with `aes(group = 1)`

```
ggplot(
  iver,
  aes(y = povRed, x = effPar,
      colour = parSys,
      shape = parSys)
  ) +
  geom_point()+
  geom_smooth(
    aes(group = 1),
    method = MASS::rlm
  )
```



Building a plot from scratch:

How to override the default colors? Let's learn how to get nice colors first



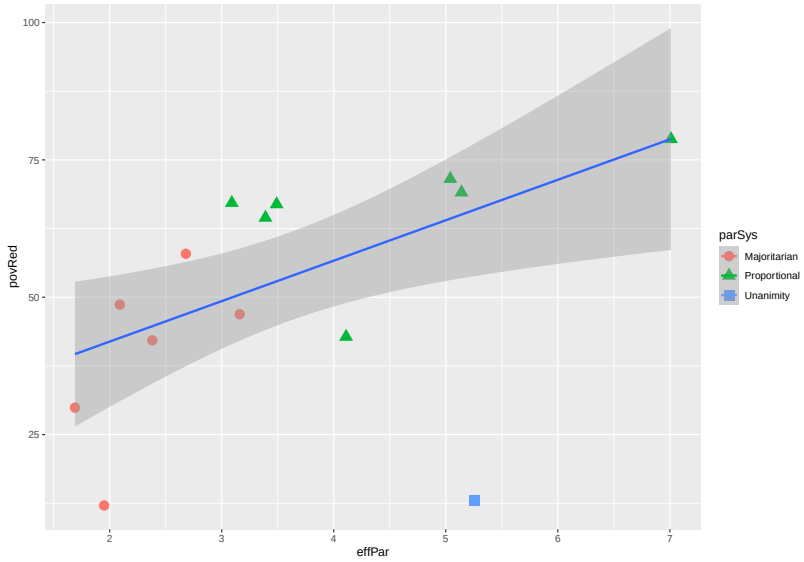
Building a plot from scratch:

Get nice colors with `RColorBrewer` package; see here for palettes

```
library(RColorBrewer)
colors <- brewer.pal(n = 3, "Set1")
red <- colors[1]
blue <- colors[2]
green <- colors[3]

print(c(red, blue, green))
```

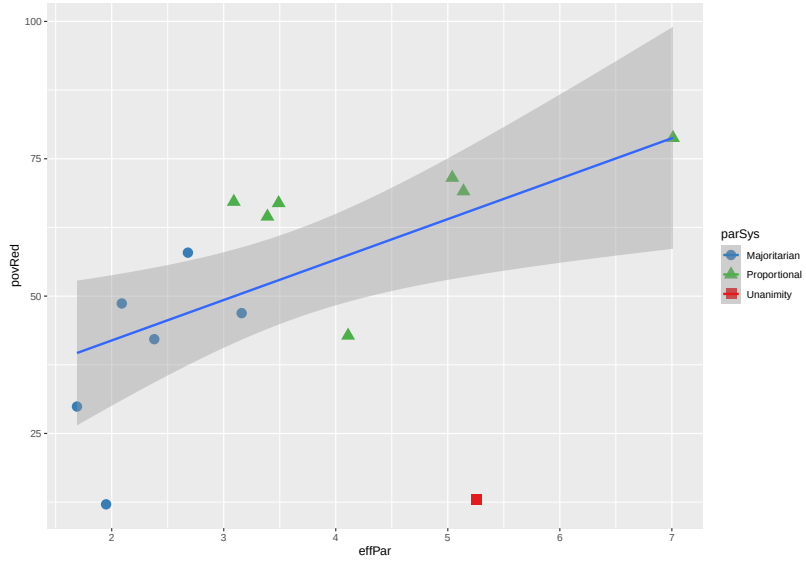
```
## [1] "#E41A1C" "#377EB8" "#4DAF4A"
```



Building a plot from scratch:

You can `scale` every aesthetic
(i.e. overwrite the default) you mapped

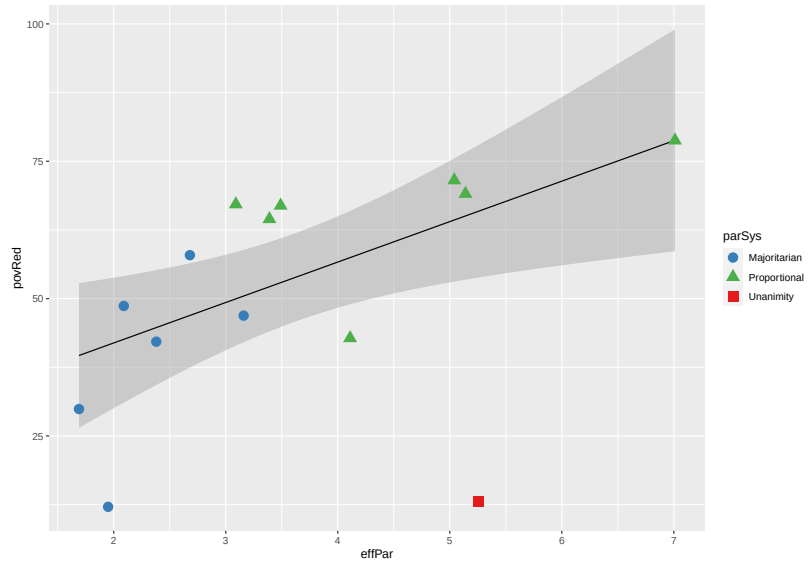
```
ggplot(
  iver,
  aes(y = povRed, x = effPar,
      colour = parSys,
      shape = parSys)
  ) +
  geom_point()+
  geom_smooth(
    aes(group = 1),
    method = MASS::rlm
  ) +
  scale_color_manual(
    values = c(
      "Majoritarian" = blue,
      "Proportional" = green,
      "Unanimity" = red
    )
  )
```



Building a plot from scratch:

Two tweaks: (1) plot `geom_smooth` first, then `geom_point` (why?); (2) adjust the color and size of `geom_smooth` (no need in `aes`; why?)

```
ggplot(
  iver,
  aes(y = povRed, x = effPar,
      colour = parSys,
      shape = parSys)
  ) +
  geom_smooth(
    aes(group = 1),
    method = MASS::rlm,
    color = "black",
    size = 0.5
  ) +
  geom_point()+
  scale_color_manual(
    values = c(
      "Majoritarian" = blue,
      "Proportional" = green,
      "Unanimity" = red
    )
  )
```



Building a plot from scratch:

Let's first save what we have so far

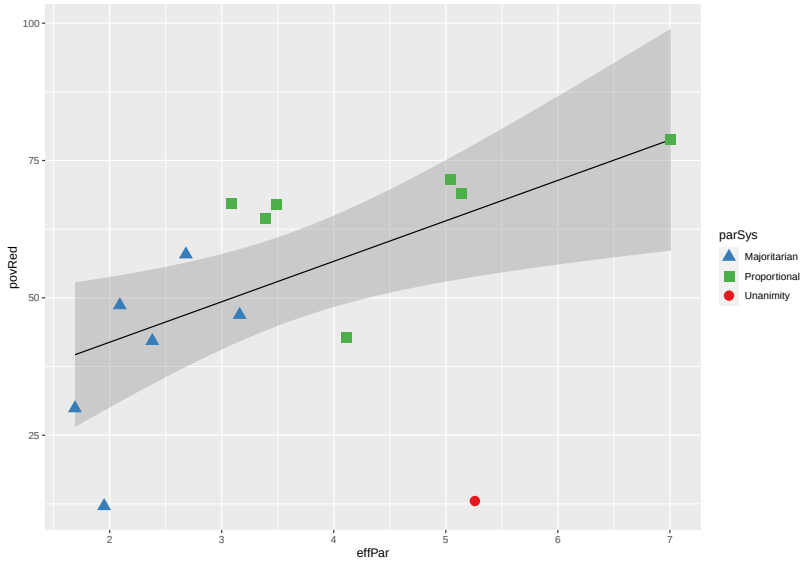
```
p <- ggplot(
    iver,
    aes(y = povRed, x = effPar,
        colour = parSys,
        shape = parSys)
  ) +
  geom_smooth(
    aes(group = 1),
    method = MASS::rlm,
    color = "black",
    size = 0.5
  ) +
  geom_point()+
  scale_color_manual(
    values = c(
      "Majoritarian" = blue,
      "Proportional" = green,
      "Unanimity" = red
    )
  )
```

Building a plot from scratch:

Similarly, you can scale `shape`; see here for all shapes.

```
p <- p +
  scale_shape_manual(
    values = c(
      "Majoritarian" = 17,
      "Proportional" = 15,
      "Unanimity" = 16
    )
  )

print(p)
```

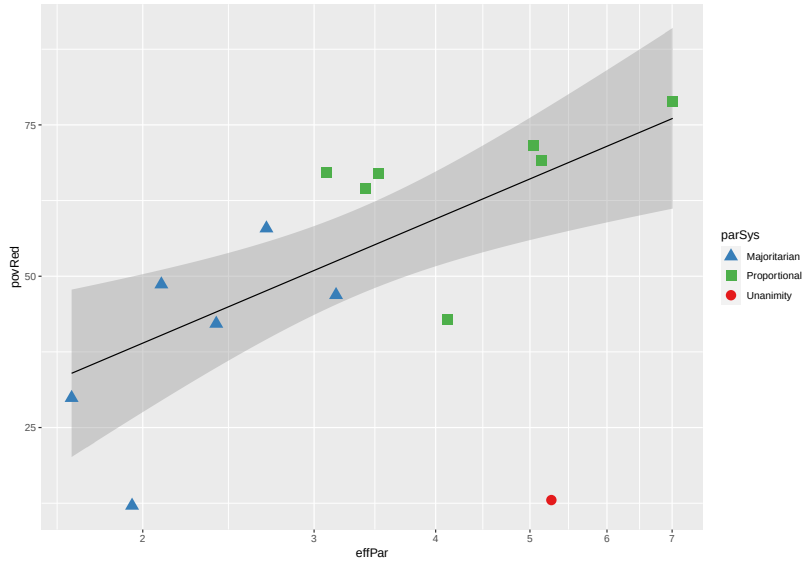


Building a plot from scratch:

Similarly, you can scale `y` and `x` (they are also inside aes!)

```
p <- p +
  scale_x_continuous(
    trans = "log",
    breaks = 2:7
  )

print(p)
```

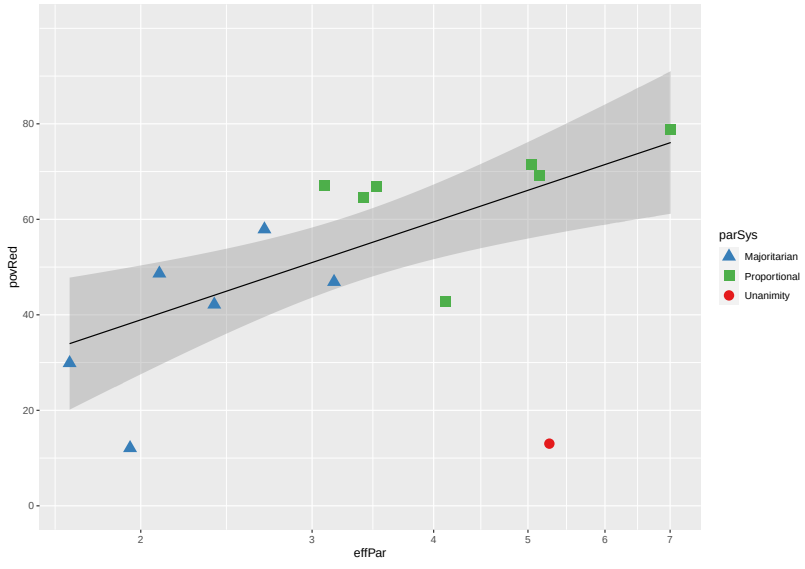


Building a plot from scratch:

But `limits` of `y` must be large enough to incorporate the confidence regions produced by `geom_smooth`

```
p <- p +
  scale_y_continuous(
    breaks = seq(0, 80, 20),
    limits = c(0, 100)
  )

print(p)
```

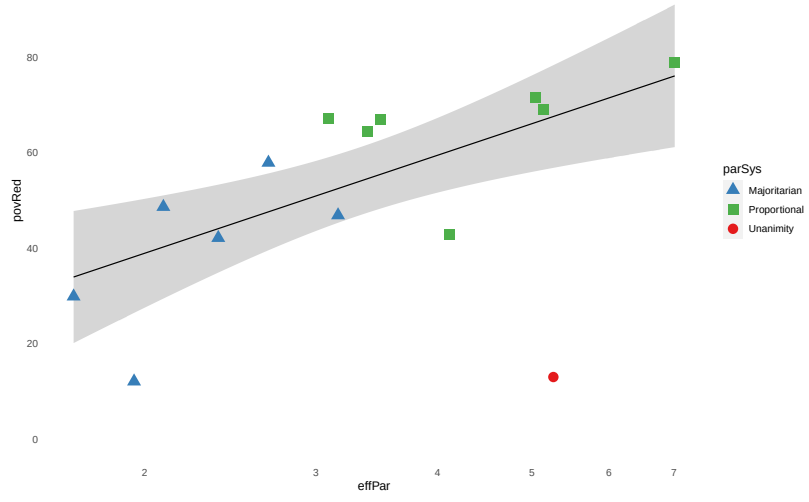


Building a plot from scratch:

Remove unhelpful elements (e.g. grey background, gridlines etc.) using `theme`

```
p <- p +
  theme(
    panel.background =
      element_rect(fill = NA),
    axis.ticks.x =
      element_blank(),
    axis.ticks.y =
      element_blank(),
  )

print(p)
```

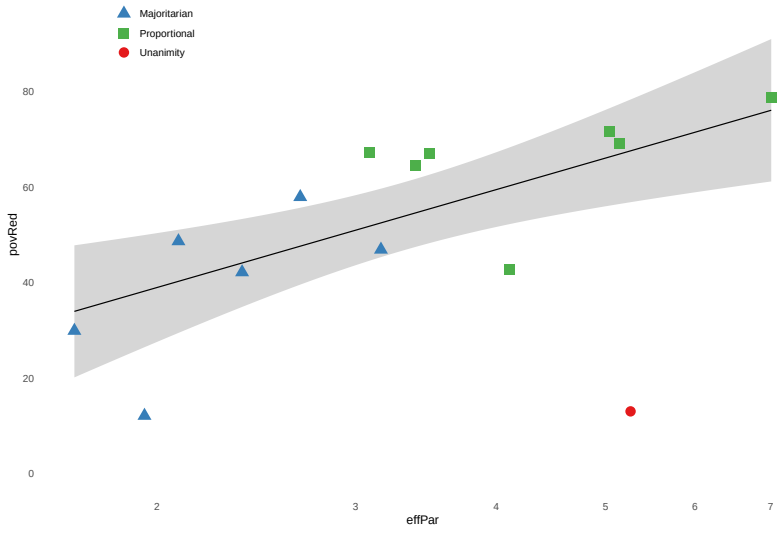


Building a plot from scratch:

How do we embed the legend within the plot and remove unhelpful elements?

```
p <- p +
  theme(
    legend.position =
      c(0.15, 0.8),
    legend.title =
      element_blank(),
    legend.background =
      element_blank(),
    legend.key =
      element_rect(fill = NA,
                   color = NA)
  )

print(p)
```



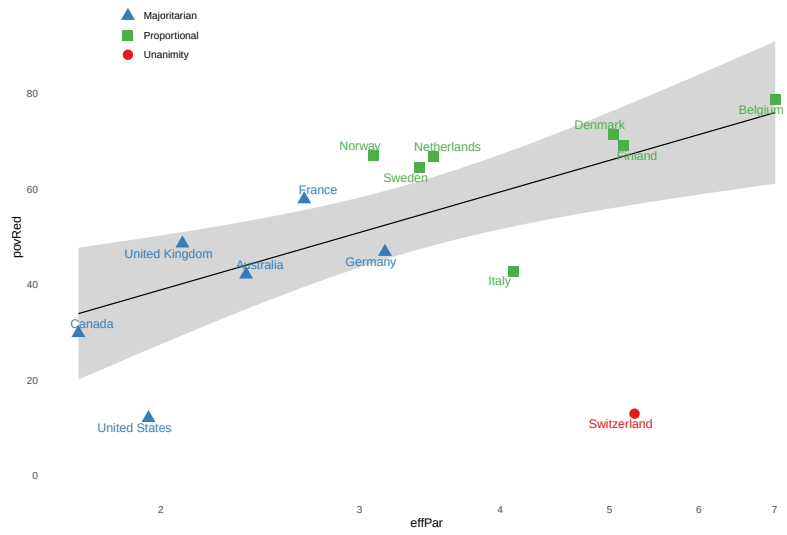
Building a plot from scratch:

With a much cleaner graph, we can augment the graph with more information: `label`

```
library(ggrepel)

p +
  geom_text_repel(
    aes(label = country)
  )

print(p)
```

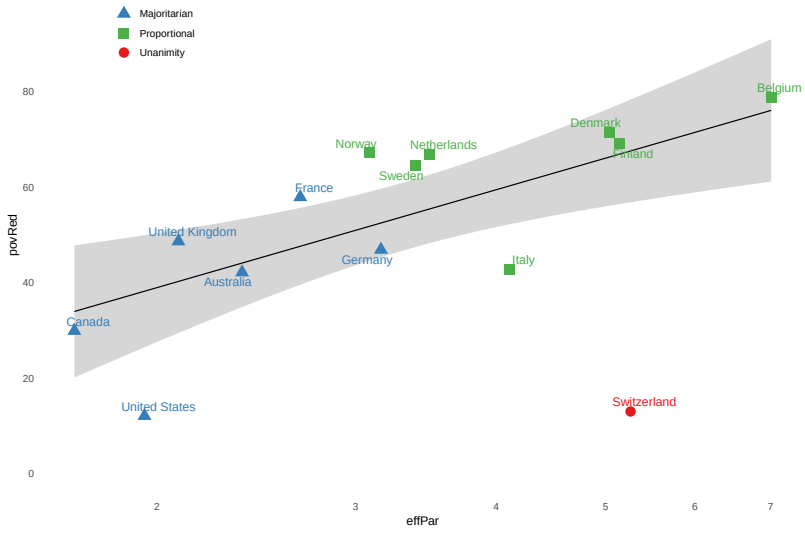


Building a plot from scratch:

Something is wrong with the legend once we have too many mappings:

```
p <- p +
  geom_text_repel(
    aes(label = country),
    show.legend = FALSE
  )

print(p)
```

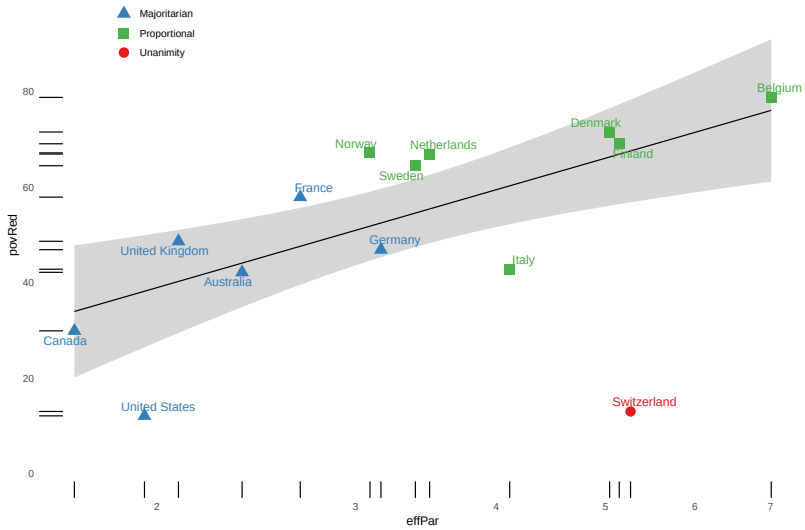


Building a plot from scratch:

With a much cleaner graph, we can augment the graph with more information: `geom_rug`

```
p <- p +
  geom_rug(color = "black")

print(p)
```

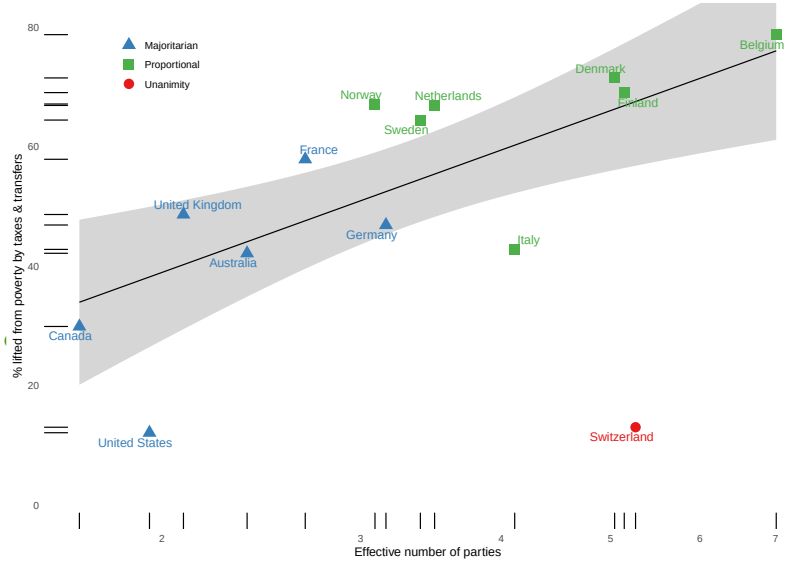


Building a plot from scratch:

Final tweaks: `x-axis title`, `y-axis title`, `coordinate limits`

```
p <- p +
  labs(
    x = "Effective number of parties",
    y = "% lifted from poverty by taxes",
    #title = ...
  ) +
  coord_cartesian(ylim = c(0, 80))

print(p)
```



Building a plot from scratch:

Full code to reproduce the graph:

```
ggplot(iver, aes(y = povRed, x = effPar, color = parSys, shape = parSys)) +
  geom_smooth(aes(group = 1), colour = "black", size = 0.25,
              method = MASS::rlm, method.args = list(method = "MM")) +
  geom_point(size = 2) +
  geom_text_repel(aes(label = country), show.legend = FALSE) +
  geom_rug(color = "black", size = 0.25) +
  scale_shape_manual(values = c(17, 15, 16)) +
  scale_color_manual(values = c(blue, green, red)) +
  scale_x_continuous(trans = "log", breaks = 2:7) +
  scale_y_continuous(breaks = seq(0, 80, 20), limits = c(0, 100)) +
  theme(panel.background = element_rect(fill = NA),
        axis.ticks.x = element_blank(),
        axis.ticks.y = element_blank(),
        legend.position = c(0.15, 0.89),
        legend.title = element_blank(),
        legend.background = element_blank(),
        legend.key = element_rect(fill = NA, color = NA)) +
  coord_cartesian(ylim = c(0, 80)) +
  labs(x = "Effective number of parties",
       y = "% lifted from poverty by taxes & transfers")
```

Building a plot from scratch:

How to save a graph into PDF?

```
width <- 8
ggsave("iverPlot.pdf", width = width, height = width/1.618, units = "in")
```

Customized theme

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  - Beginner-friendly defaults come at a cost of painstakingly overwritting them

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- Chris and I wrote a `ggplot2 theme` that implements visual principles taught in lectures and his graphic style

Customized theme

- You won't be alone in thinking that it's quite tedious. . .
  - Beginner-friendly defaults come at a cost of painstakingly overwritting them
- Chris and I wrote a `ggplot2` `theme` that implements visual principles taught in lectures and his graphic style
  - `theme_caviz.R` can be found here

Customized theme

- You won't be alone in thinking that it's quite tedious. . .
  - Beginner-friendly defaults come at a cost of painstakingly overwritting them
- Chris and I wrote a `ggplot2` `theme` that implements visual principles taught in lectures and his graphic style
  - `theme_caviz.R` can be found here
  - which contains three theme objects: `theme_caviz`, `theme_caviz_hgrid`, `theme_caviz_vgrid`

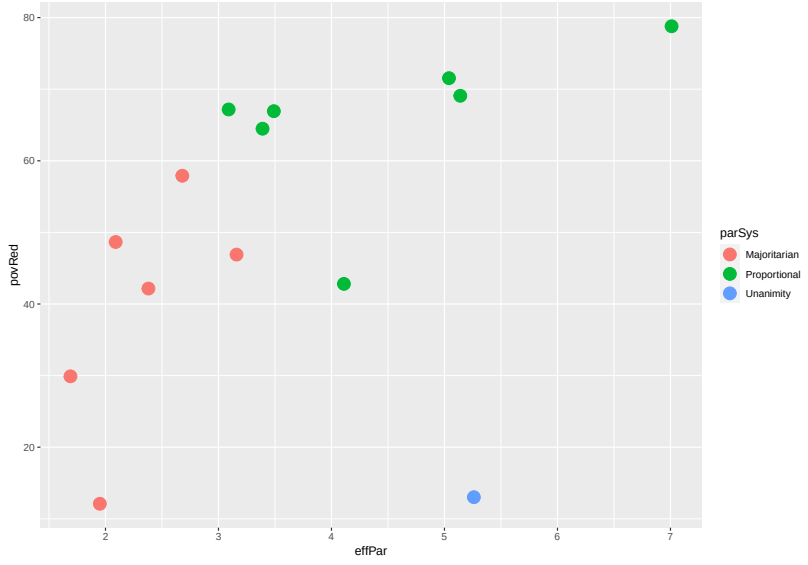
Customized theme

- To use it, simply:

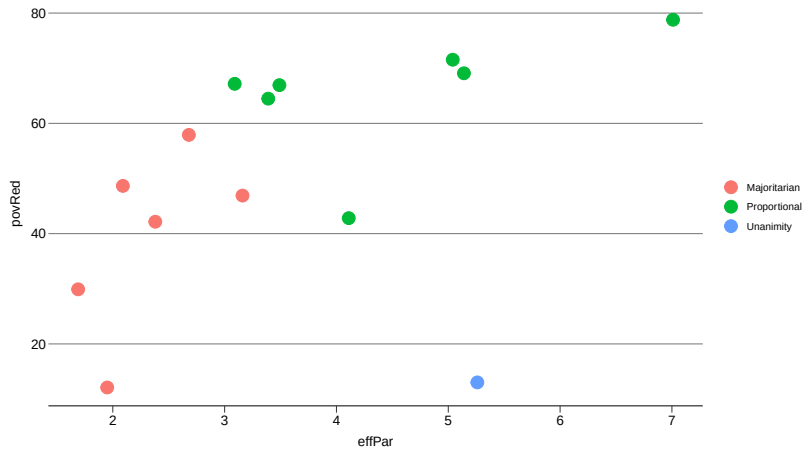
```
# Source the R script
source("your_local_directory/theme_caviz.R")

# Then add it to your ggplot object as usual
some_ggplot_object +
  theme_caviz
```

Quick showcase

```
ggplot(
  iver,
  aes(x = effPar, y = povRed,
      color = parSys)
  ) +
  geom_point(size = 5)
```




```
ggplot(
  iver,
  aes(x = effPar, y = povRed,
      color = parSys)
  ) +
  geom_point(size = 5) +
  theme_caviz_hgrid
```



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