Multilevel Visualization

Andrew Grogan-Kaylor

2024-05-25

Table of contents

# 1. Multilevel Visualization

“Persist and verify… The power that we abdicate to others out of our insecurity - to others who insult us with their faux-intuition or their authoritarian smugness - that comes back to hurt us so deeply… But the power we wrest from our own certitude - that saves us.” (Cash 2017)

## 1.1 Introduction

Below, I describe the use of [Stata](https://www.stata.com/) (StataCorp 2023), [R](https://www.r-project.org/)[[1]](#footnote-22) (R Core Team 2023; Wickham 2016), and [Julia](https://www.julialang.org/) (Bezanson et al. 2017) to visualize multilevel models.

|  |  |
| --- | --- |
|  | **Comparison of Software**  See my discussion of the advantages and disadvantages of different software in the Appendix on estimation of multilevel models with different software. |

## 1.2 The Data

The examples use the simulated\_multilevel\_data.dta file from [*Multilevel Thinking*](https://agrogan1.github.io/multilevel-thinking/simulated-multi-country-data.html). Here is a [direct link](https://github.com/agrogan1/multilevel-multilingual/raw/main/simulated_multilevel_data.dta) to download the data.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 1.1: Sample of Simulated Multilevel Data  Table continues below   | country | HDI | family | id | identity | intervention | physical\_punishment | | --- | --- | --- | --- | --- | --- | --- | | 1 | 69 | 1 | 1.1 | 1 | 0 | 3 | | 1 | 69 | 2 | 1.2 | 1 | 1 | 2 | | 1 | 69 | 3 | 1.3 | 0 | 1 | 3 | | 1 | 69 | 4 | 1.4 | 1 | 0 | 0 | | 1 | 69 | 5 | 1.5 | 1 | 0 | 4 | | 1 | 69 | 6 | 1.6 | 0 | 1 | 5 |      | warmth | outcome | | --- | --- | | 3 | 57.47 | | 1 | 50.1 | | 2 | 52.92 | | 5 | 60.17 | | 4 | 55.05 | | 3 | 49.81 | |

# 2. Graphs

|  |  |
| --- | --- |
|  | **Order of Variables**  Across software platforms pay attention to the order of variables. I generally use x for an *independent* variable along the horizontal axis and y for a *dependent* variable along the vertical axis. Different software asks for the variables to be listed in different order so it is worth paying close attention to the syntax. |

## 2.1 Scatterplots

A scatterplot is one of the most basic of all data visualizations. At the same time, a scatterplot can be tremendously informative because it provides: the location of every data point (data points may be overprinted); a sense of the distribution of both the *x* and *y* variables; and a sense of the overall trend in the relationship between the two variables, if there is one.

### Stata

#### 2.1.0.1 Get The Data

use simulated\_multilevel\_data.dta

#### 2.1.0.2 Scatterplot

twoway scatter outcome warmth, ///  
 xtitle("warmth") ytitle("outcome") ///  
 title("Outcome by Parental Warmth")   
  
quietly graph export scatter.png, replace

|  |
| --- |
| Figure 2.1: Outcome by Parental Warmth (Stata) |

### R

#### 2.1.0.3 Get The Data

library(haven)  
  
df <- read\_dta("simulated\_multilevel\_data.dta")

#### 2.1.0.4 Scatterplot

library(ggplot2)  
  
ggplot(df,  
 aes(x = warmth,  
 y = outcome)) +  
 geom\_point() +  
 labs(title = "Outcome by Parental Warmth")

|  |
| --- |
| Figure 2.2: Outcome by Parental Warmth (R) |

### Julia

#### 2.1.0.5 Get The Data

using Tables, MixedModels, StatFiles, DataFrames, CategoricalArrays, DataFramesMeta  
  
df = DataFrame(load("simulated\_multilevel\_data.dta"))

#### 2.1.0.6 Scatterplot

using StatsPlots  
  
@df df scatter(:warmth, :outcome,   
 title = "Outcome by Parental Warmth",  
 ylabel = "outcome",  
 xlabel = "parental warmth")

|  |
| --- |
| Figure 2.3: Outcome by Parental Warmth (Julia) |

## 2.2 Line Graph (Linear Trend)

A line graph of the data focuses in on the linear trend in the data.

### Stata

#### 2.2.0.1 Get The Data

use simulated\_multilevel\_data.dta

#### 2.2.0.2 Line Graph

twoway lfit outcome warmth, ///  
 xtitle("warmth") ytitle("outcome") ///  
 title("Outcome by Parental Warmth")   
  
quietly graph export lfit.png, replace

|  |
| --- |
| Figure 2.4: Outcome by Parental Warmth (Stata) |

### R

#### 2.2.0.3 Get The Data

library(haven)  
  
df <- read\_dta("simulated\_multilevel\_data.dta")

#### 2.2.0.4 Line Graph

library(ggplot2)  
  
ggplot(df,  
 aes(y = outcome,  
 x = warmth)) +  
 geom\_smooth(method = "lm") +  
labs(title = "Outcome by Parental Warmth")

|  |
| --- |
| Figure 2.5: Outcome by Parental Warmth (R) |

### Julia

#### 2.2.0.5 Get The Data

using Tables, MixedModels, StatFiles, DataFrames, CategoricalArrays, DataFramesMeta  
  
dfL = DataFrame(load("simulated\_multilevel\_data.dta"))

#### 2.2.0.6 Line Graph

To make our plot with a smoother in Julia, we set the markercolor and markerstrokecolor to be *white*, and the smooth option to :true.

using StatsPlots  
  
@df dfL scatter(:warmth, :outcome,   
 title = "Outcome by Parental Warmth",  
 ylabel = "outcome",  
 xlabel = "warmth",  
 markercolor = "white",  
 markerstrokecolor = "white",  
 smooth=:true)

|  |
| --- |
| Figure 2.6: Outcome by Parental Warmth (Julia) |

## 2.3 Spaghetti Plots

A *spaghetti plot* might be considered the most *multilevel* of the visualizations here considered. A spaghetti plot shows the group specific slopes and intercepts for all of the groups in the data.

### Stata

In Stata, spaghetti plots are most easily generated using the user written spagplot command. Type findit spagplot to install this command.

#### 2.3.0.1 Get The Data

use simulated\_multilevel\_data.dta

#### 2.3.0.2 Spaghetti Plot

|  |  |
| --- | --- |
|  | **Installing spagplot**  spagplot is a user written command. Type findit spagplot to install. |

spagplot outcome warmth, ///  
 id(country) ///  
 xtitle("parental warmth") ytitle("outcome") ///  
 title("Outcome by Parental Warmth")   
  
quietly graph export spagplot.png, replace

|  |
| --- |
| Figure 2.7: Outcome by Parental Warmth (Stata) |

### R

#### 2.3.0.3 Get The Data

library(haven)  
  
df <- read\_dta("simulated\_multilevel\_data.dta")

#### 2.3.0.4 Spaghetti Plot

library(ggplot2)  
  
df$country <- factor(df$country)  
  
ggplot(df,  
 aes(y = outcome,  
 x = warmth)) +  
 geom\_smooth(aes(color = country,  
 group = country),   
 method = "lm",  
 se = FALSE) +  
 geom\_smooth(method = "lm", linewidth = 3) +  
labs(title = "Outcome by Parental Warmth")

|  |
| --- |
| Figure 2.8: Outcome by Parental Warmth (R) |

### Julia

#### 2.3.0.5 Get The Data

using Tables, MixedModels, StatFiles, DataFrames, CategoricalArrays, DataFramesMeta  
  
dfL = DataFrame(load("simulated\_multilevel\_data.dta"))

#### 2.3.0.6 Spaghetti Plot

using StatsPlots  
  
@df dfL scatter(:warmth, :outcome,   
 title = "Outcome by Parental Warmth",  
 ylabel = "outcome",  
 xlabel = "warmth",  
 markercolor = "white",  
 markerstrokecolor = "white",  
 group = :country,  
 legend = false,  
 smooth=:true)

|  |
| --- |
| Figure 2.9: Outcome by Parental Warmth (Julia) |

# References

Bezanson, Jeff, Alan Edelman, Stefan Karpinski, and Viral B. Shah. 2017. “Julia: A Fresh Approach to Numerical Computing.” *SIAM Review* 59 (1): 65–98. <https://doi.org/10.1137/141000671>.

Cash, Roseanne. 2017. “Roseanne Cash Reads ’Power’ by Adrienne Rich.” In *The Universe in Verse*.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. <https://www.R-project.org/>.

StataCorp. 2023. *Stata 18 Graphics Reference Manual*. Stata Press.

Wickham, Hadley. 2016. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. <https://ggplot2.tidyverse.org>.

1. In R, I use the ggplot2 (Wickham 2016) library. [↑](#footnote-ref-22)