Multilevel Structure

true

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Contents

1 Introduction

Associations between two variables can be *very different* (or even *reversed*) depending upon whether or not the analysis is "aware" of the grouped, nested, or clustered nature of the data.

Thus, a model that is "aware" of the clustered nature of the data may provide very different–likely better–substantive conclusions than a model that is not aware of the clustered nature of the data.

2 Call The Libraries

```
library(ggplot2) # beautiful graphs

# library(gganimate) # animated ggplots

library(lme4) # MLM

# library(pander) # nice tables

library(sjPlot) # nice tables for MLM
```

3 Simulate Some Data

```
e <- rnorm(10, 0, 1) # error

# group 1

group1 <- rep(1, 10)

x1 <- seq(1,10)

y1 <- 10 + -1 * x1 + e

# group 2

group2 <- rep(2, 10)

x2 <- seq(11, 20)

y2 <- 30 + -1 * x2 + e

# group 3

group3 <- rep(3, 10)

x3 <- seq(21, 30)

y3 <- 50 + -1 * x3 + e

# combine into a dataframe

x <- c(x1, x2, x3)

y <- c(y1, y2, y3)

group <- factor(c(group1, group2, group3))

mydata <- data.frame(x, y, group)
```

4 Graphs

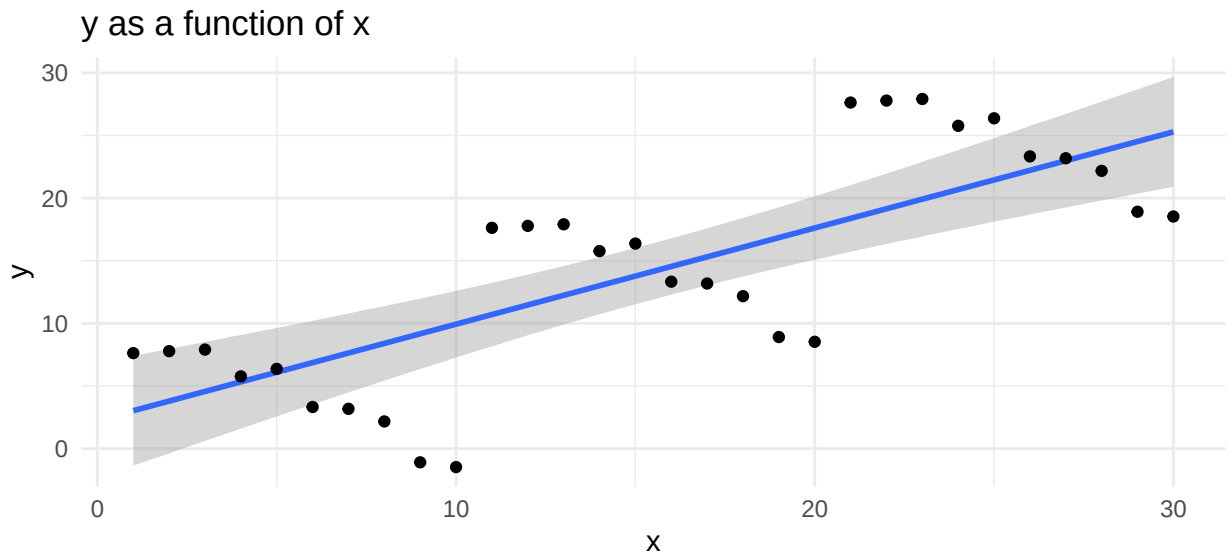
4.1 A "Naive" Graph

This "naive" graph is unaware of the grouped nature of the data.

```
library(ggplot2)

p0 <- ggplot(mydata,
             aes(x = x,
                 y = y)) +
  geom_smooth(method = "lm") +
  labs(title = "y as a function of x") +
  theme_minimal()
```

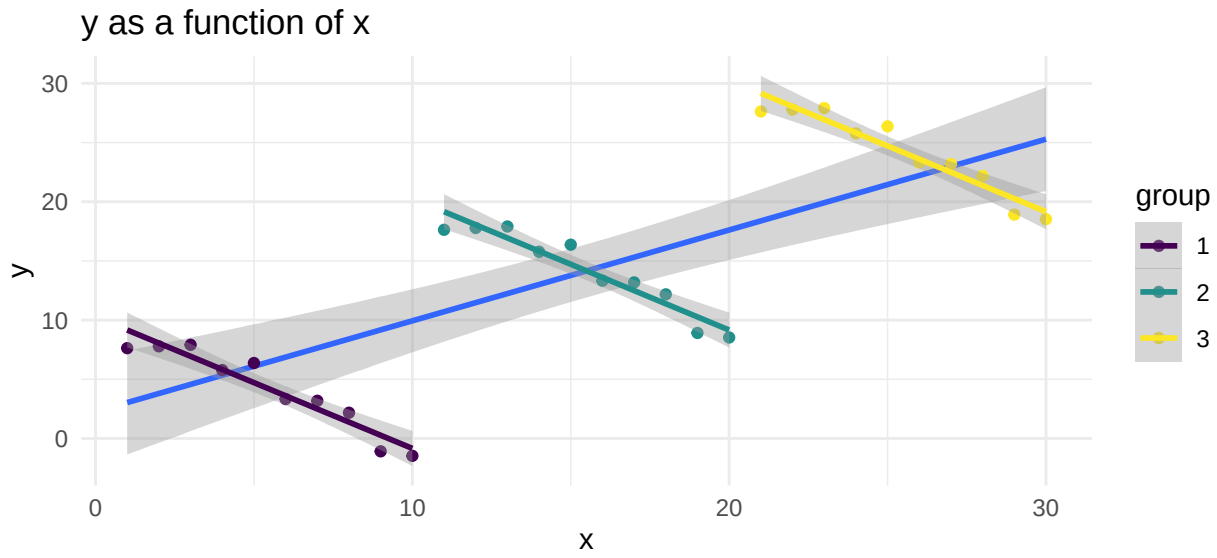
```
p0 + geom_point() # replay and add points
```



4.2 An "Aware" Graph

This "aware" graph is aware of the grouped nature of the data.

```
p0 +
  geom_point(aes(color = group)) + # points with group color
  geom_smooth(aes(color = group), # smoothers with group color
              method = "lm") +
  scale_color_viridis_d()
```



5 Regressions

5.1 A "Naive" OLS Analysis

The OLS model with only x as a covariate is not aware of the grouped structure of the data, and the coefficient for x reflects this.

```
myOLS <- lm(y ~ x, data = mydata)

sjPlot::tab_model(myOLS,
                  show.se = TRUE,
                  show.ci = FALSE,
                  show.stat = TRUE)
```

y

Predictors

Estimates

std. Error

Statistic

p

(Intercept)

2.26

2.25

1.01

0.323

x

0.77

0.13

6.05

<0.001

Observations

30

R2 / R2 adjusted

0.567 / 0.552

5.2 An "Aware" MLM Analysis

The multilevel model is aware of the grouped structure of the data, and the coefficient for x reflects this.

```r
myMLM <- lmer(y ~ x + (1 | group), data = mydata)

sjPlot::tab_model(myMLM,
                  show.se = TRUE,
                  show.ci = FALSE,
                  show.stat = TRUE)
```

y

Predictors

Estimates

std. Error

Statistic

p

(Intercept)

31.33

12.22

2.56

0.016

x

-1.11

0.07

-16.64

<0.001

Random Effects

2

1.10

00 group

444.59

ICC

1.00

N group

3

Observations

30

Marginal R2 / Conditional R2

0.176 / 0.998