CSE 599K

Empirical Research Methods

Winter 2025

Conceptual and statistical modeling

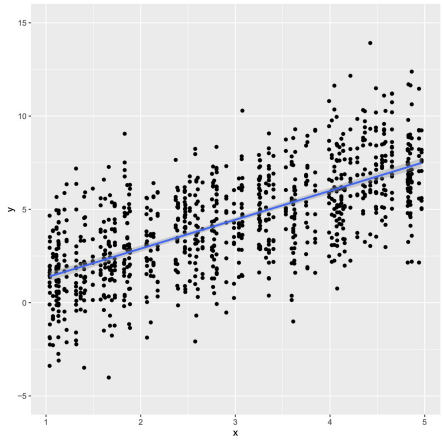
Today

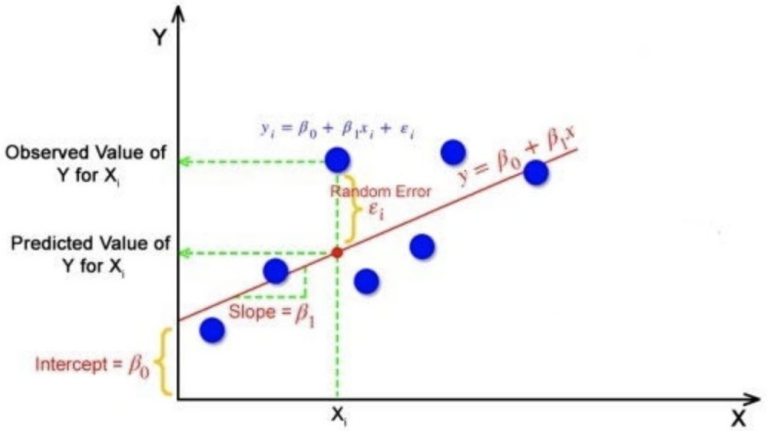
- NHST: a concrete application
- (Generalized) Linear (Mixed) Models
- From conceptual to statistical modeling

A concrete NHST application: live demo

Linear Models

LM: Linear regression models





What are the use cases for linear models?

LM: Linear regression models

Two (and a half) use cases

- Statistical inference: parameter estimation
- Prediction (also explained variance): model accuracy

What are the key assumptions underlying linear models?

LM: Linear regression models

Assumptions

- Linearity
- Normality (residuals)
- Homoscedasticity (residuals)
- Independence (observations)
- Little to no multicollinearity (for inference).

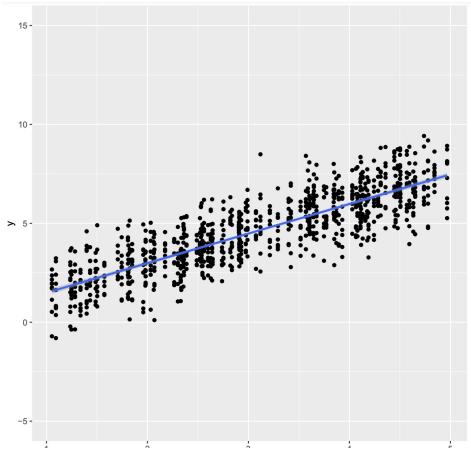
How do we assess and interpret a linear model?

LM: Linear regression models

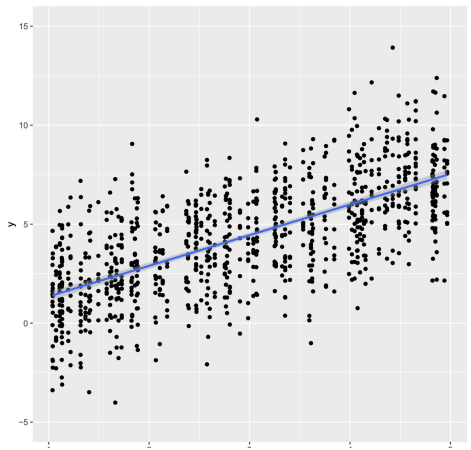
Interpretation of results

- Model fit: goodness of fit (R^2)
- Inference: significance of coefficients

R^2=0.7



R^2=0.4



Which fitted linear model is “better”?

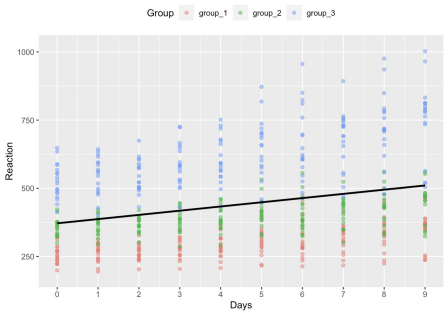
Linear models: live demo

Working with clustered (grouped) data

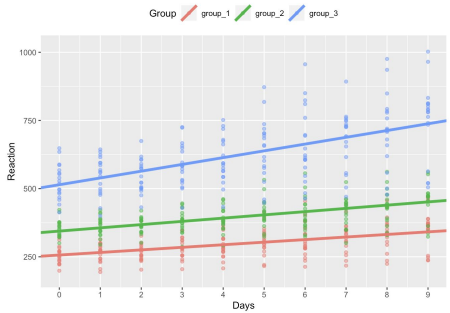
(Generalized) Linear Model

- Split the data set by groups.
- Independently model outcome as a function of variables of interest.

Entire data set



Split by groups

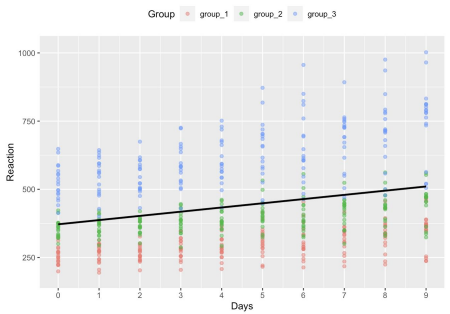


An alternative approach: (G)LMMs

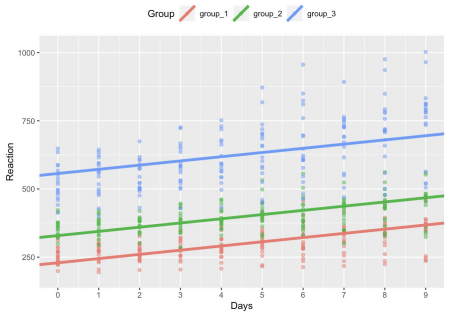
(Generalized) Linear Mixed Model

- Model fixed and random effects.
- Allow intercepts and/or slopes to vary.

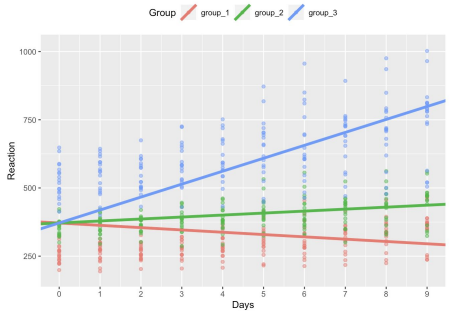
Fixed intercept, **fixed** slope



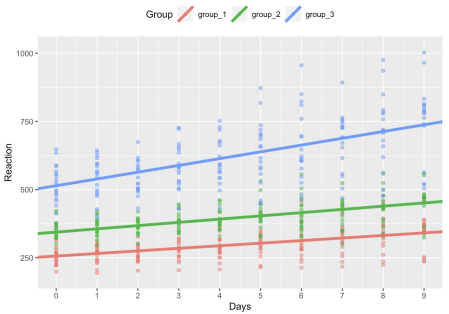
Random intercept, **fixed** slope



Fixed intercept, **Random** slope



Random intercept, **Random** slope

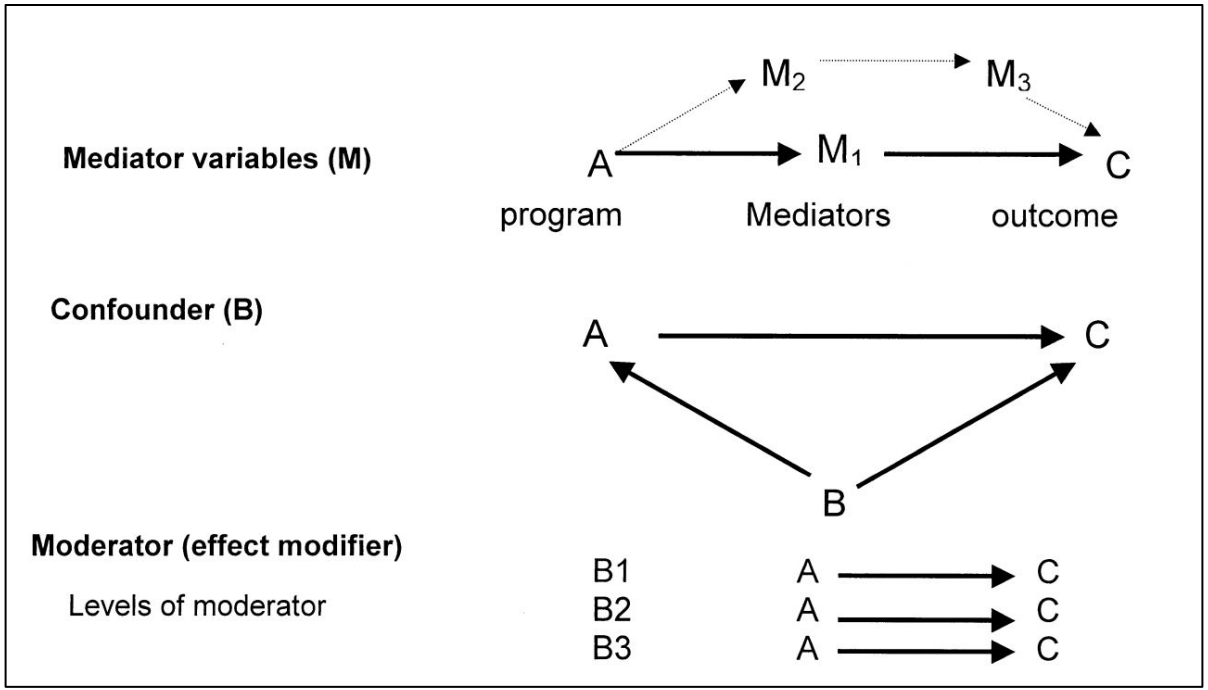


https://glennwilliams.me/r4psych/mixed-effects-models.html

Mixed models are commonly used for dependent observations.

Conceptual modeling vs. statistics

Confounding, Mediation, Moderation



Bauman et al., American Journal of Preventive Medicine, 2002