

EDUC 231D
Advanced Quantitative Methods: Multilevel Analysis
Winter 2025

Course Overview

Lecture 1 Presentation Slides

January 7, 2025

Today's Topics

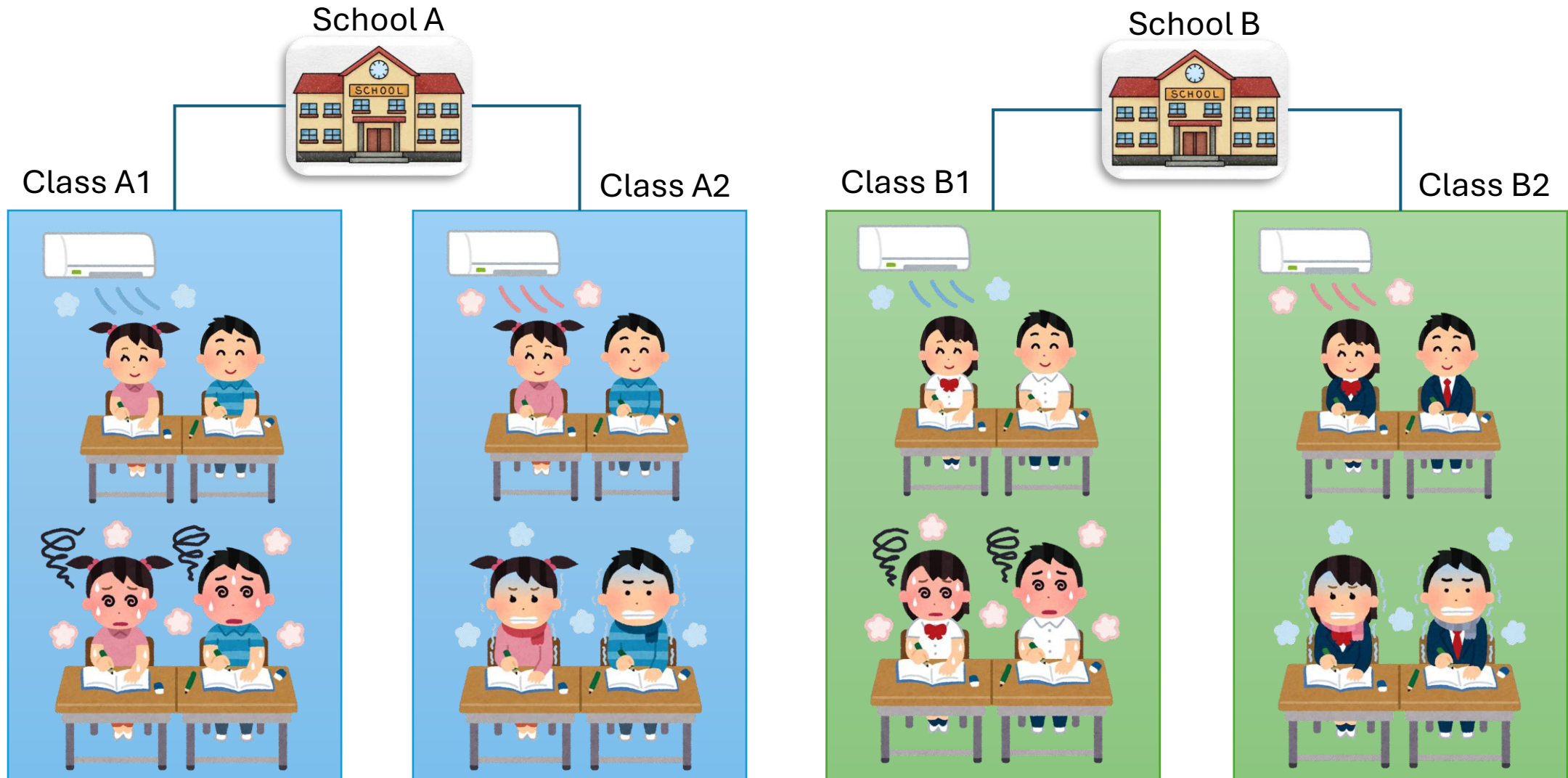
- Introductions
- Rationale for multilevel models
- Review course syllabus and BruinLearn page
- Course introduction survey

Rationale for Multilevel Models

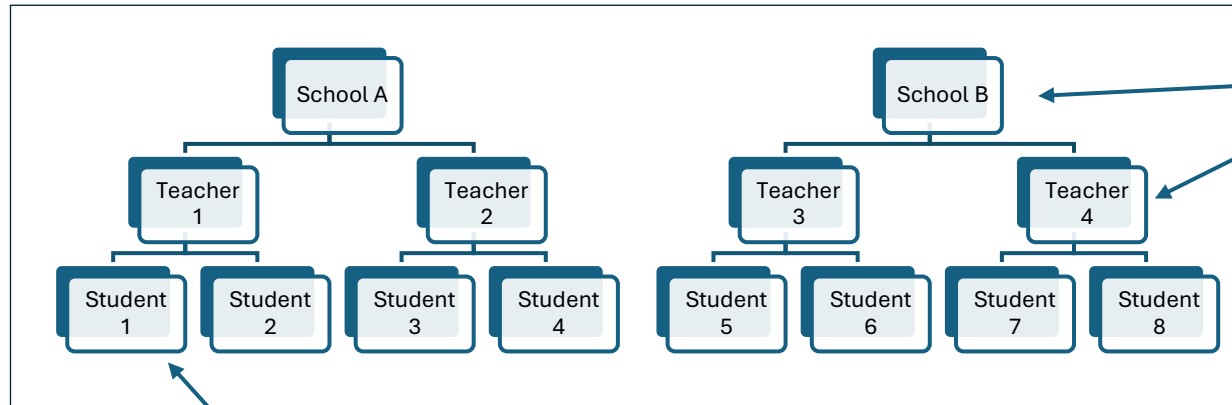
What is a multilevel model?

- Multilevel models explicitly address the non-independence of data that arises when the data have *nested* or *clustered* properties
- They can be referred to as *multilevel*, *hierarchical*, or *mixed* models
 - Multilevel = the data consist of observations or units at multiple levels
 - Hierarchical = the data generation or structure is hierarchical
 - Mixed = the models estimate *fixed effects* like an ordinary least squares(OLS) regression model and *random effects* like an analysis of variance (ANOVA) model

Examples of a multilevel data structure

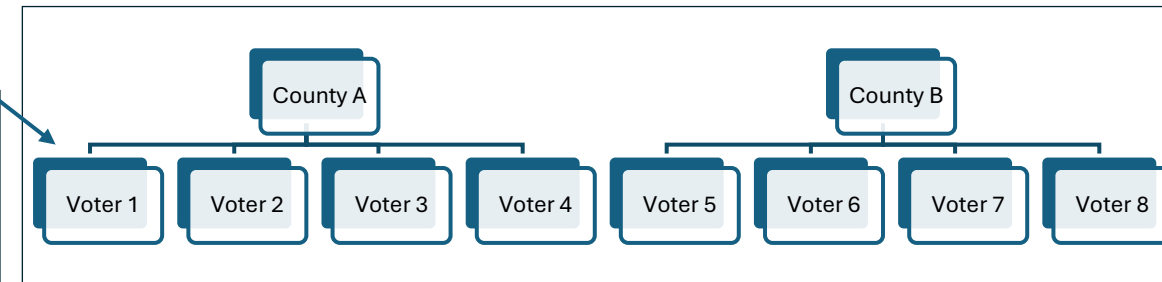
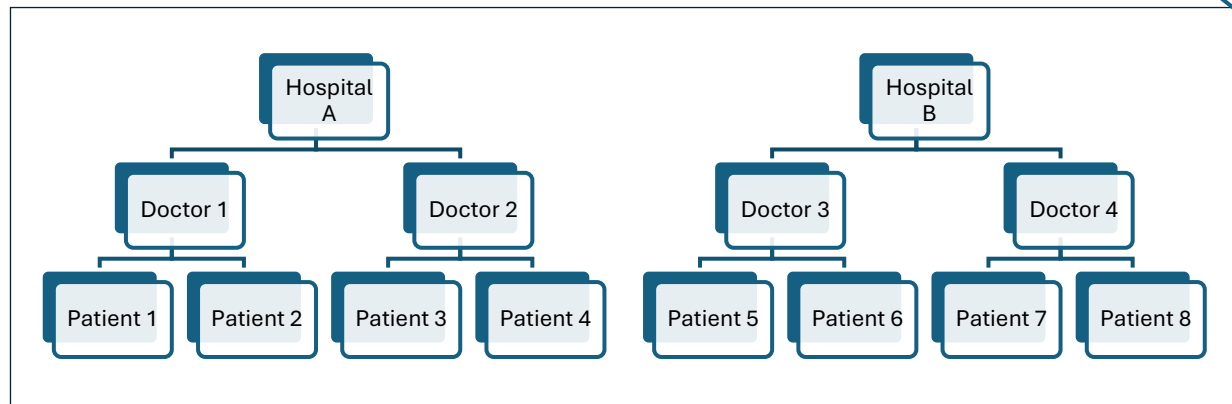
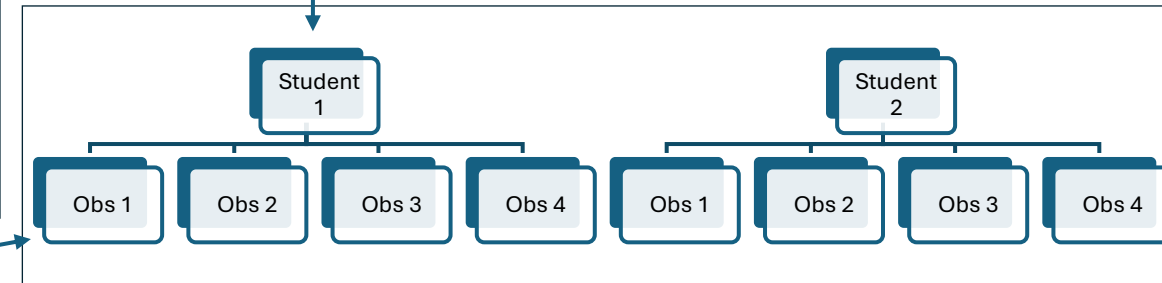


Examples of a multilevel data structure



The *units of observation* are at the lowest level

The *groups* or *clusters* are at higher levels



Examples of a multilevel data structure

Example data from the Early Childhood Longitudinal Study

	schid	childid	childage	glrscore	schfrpl
	-----:	-----:	-----:	-----:	-----:
Students nested within schools	1002	10000412	79.79	86.1223	40
	1002	10001485	90.48	109.5244	40
	1002	10001694	84.79	120.3605	40
	1002	10003310	86.37	97.9395	40
	1002	10004098	81.11	98.1132	40
	1003	10000621	79.30	109.1871	5
	1003	10001334	90.54	129.9432	5
	1003	10001932	83.38	101.9795	5
	1003	10002472	82.13	122.5299	5
	1003	10003241	85.78	109.7861	5
	1006	10000401	87.48	68.4920	82
	1006	10001380	87.02	115.8582	82
	1006	10001435	92.09	109.5571	82
	1006	10001734	82.06	97.8143	82
	1006	10002167	84.26	106.3718	82
	1006	10003456	85.55	97.2966	82

Students in the same school have the same school-level data

Why should we care about the data structure?

- Dependence among observations can be a problem
 - Standard statistical approaches assume independence among observations
 - Ignoring the multilevel data structure could violate this assumption: observations in the same group tend to be more similar than, and have more common experiences, than observations in different groups (*intraclass correlation*)
 - Ignoring within-group dependencies overestimates the amount of information in our data (*design effect*): standard errors are too small → spurious significant results
- ✓ Multilevel models account for within-group dependencies

Why should we care about the data structure?

- Small within-group sample size can be a problem
 - May be inefficient or uninformative to estimate quantities separately for each group
 - ✓ Multilevel models “borrow” information from the full data set to get more reliable estimates of within-group quantities

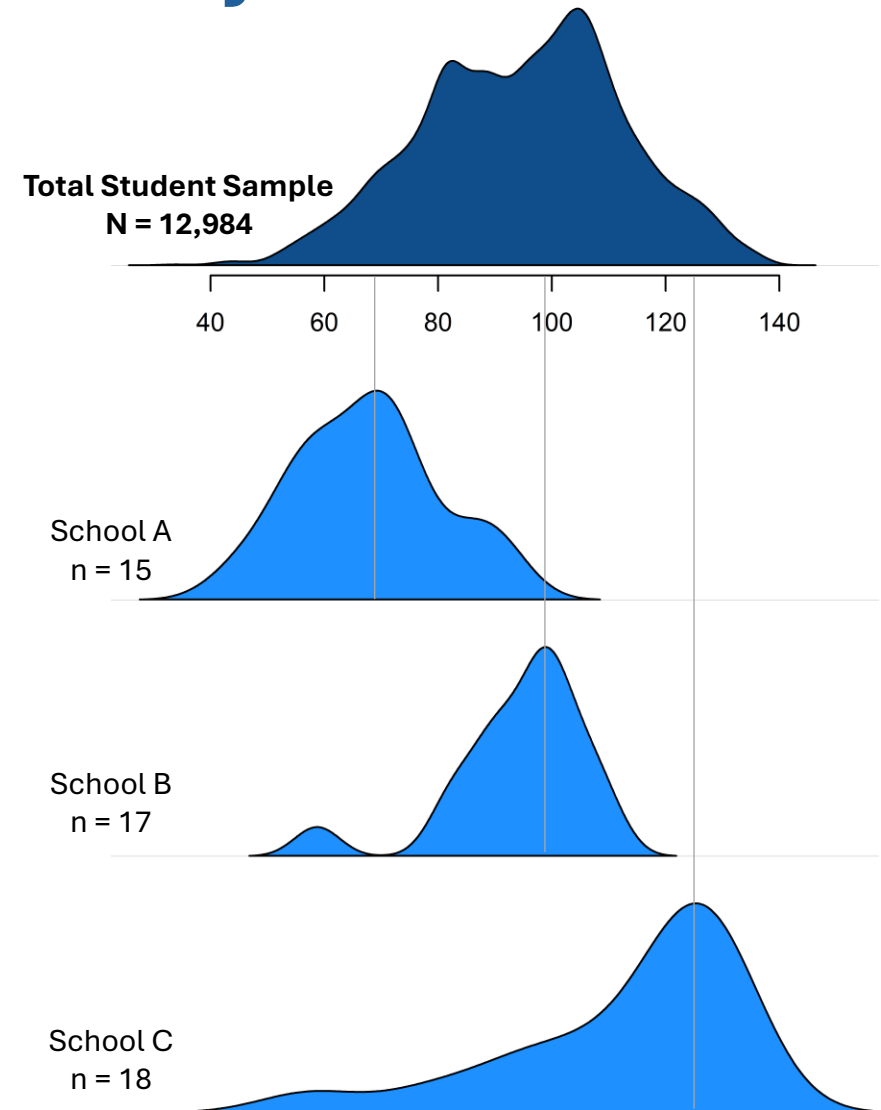
Why should we care about the data structure?

- Interest in understanding variation across groups
 - Ignoring between-group differences could mask important findings
 - How do unit-level outcomes (e.g., student sense of belonging) differ across groups (e.g., schools)?
 - Standard statistical approaches are not designed to efficiently estimate *cross-level* relationships
 - How do unit-level disparities (e.g., achievement gaps) relate with group-level factors (e.g., school climate)?
- ✓ Multilevel models broaden the types of questions we can address

Data example: group dependency

Does student achievement systematically differ across schools?

Example data from the Early Childhood Longitudinal Study: Distribution of grade 1 reading scores

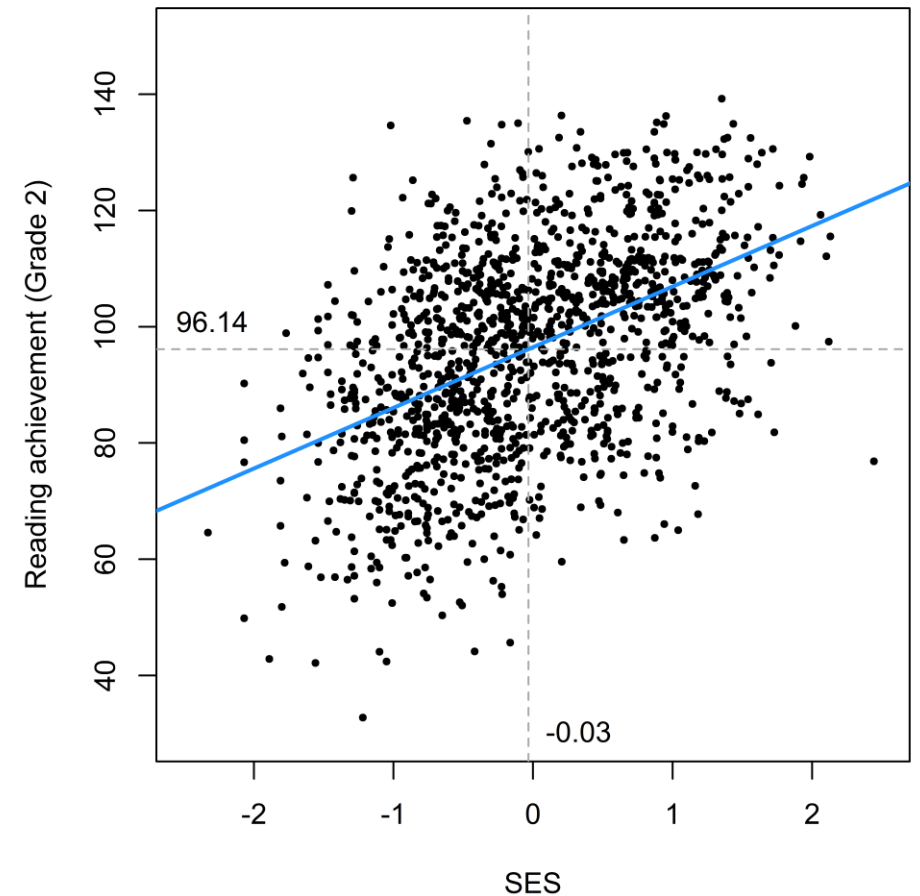


Data example: variation in relationships

Does the relationship between SES and student achievement systematically differ across schools?

Example data from the Early Childhood Longitudinal Study: Distribution of grade 1 reading scores

- Relationship for all students

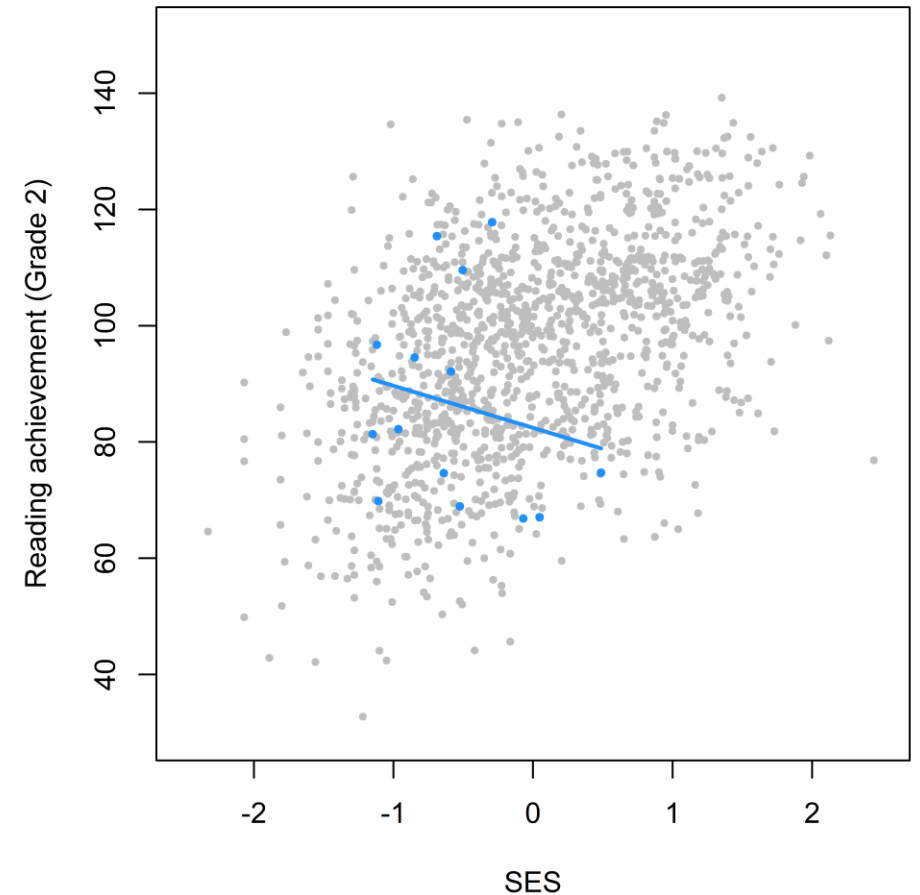


Data example: variation in relationships

Does the relationship between SES and student achievement systematically differ across schools?

Example data from the Early Childhood Longitudinal Study: Distribution of grade 1 reading scores

- Relationship within one school

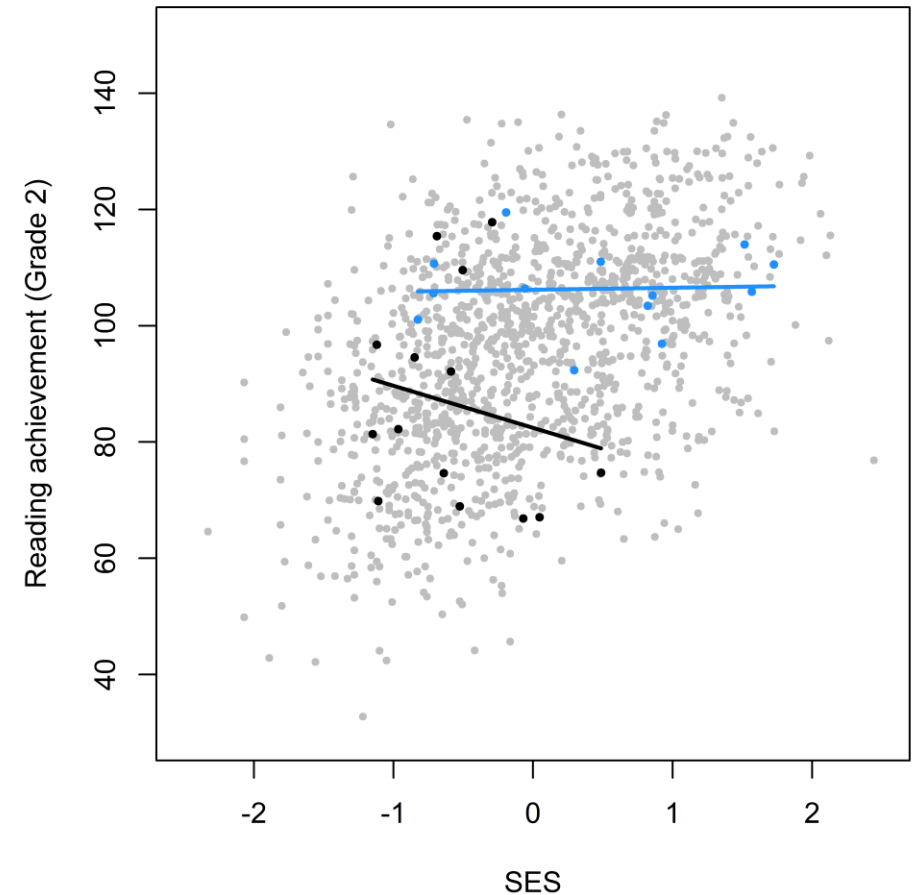


Data example: variation in relationships

Does the relationship between SES and student achievement systematically differ across schools?

Example data from the Early Childhood Longitudinal Study: Distribution of grade 1 reading scores

- Relationships within two schools

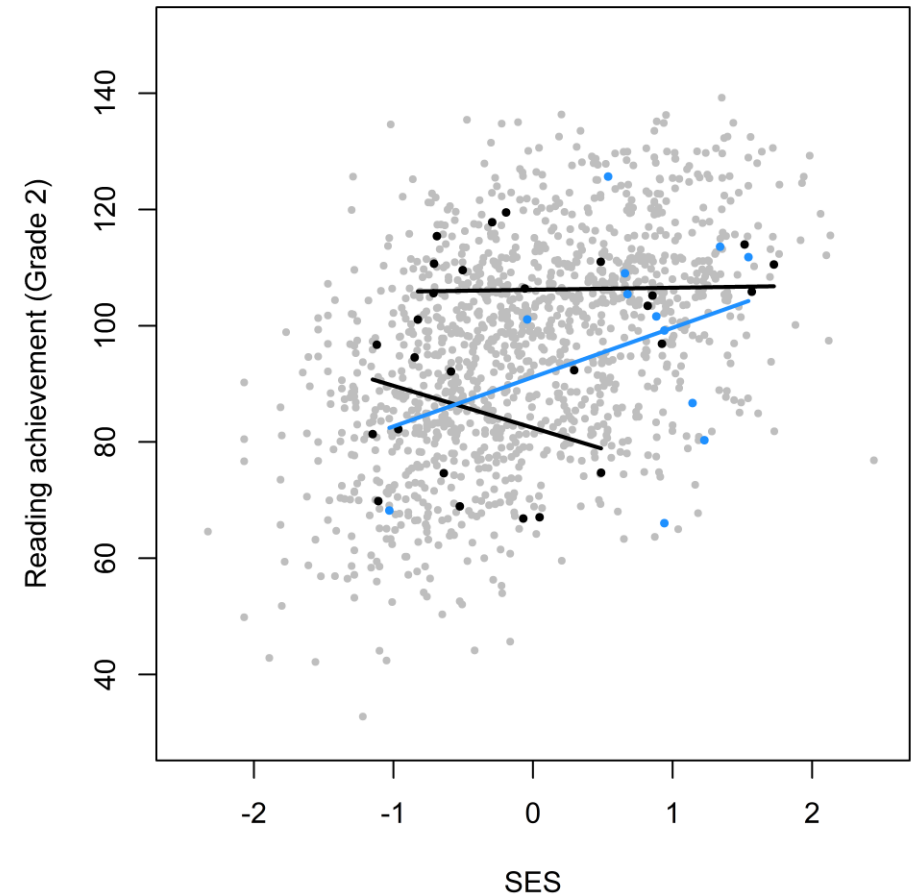


Data example: variation in relationships

Does the relationship between SES and student achievement systematically differ across schools?

Example data from the Early Childhood Longitudinal Study: Distribution of grade 1 reading scores

- Relationships within three schools

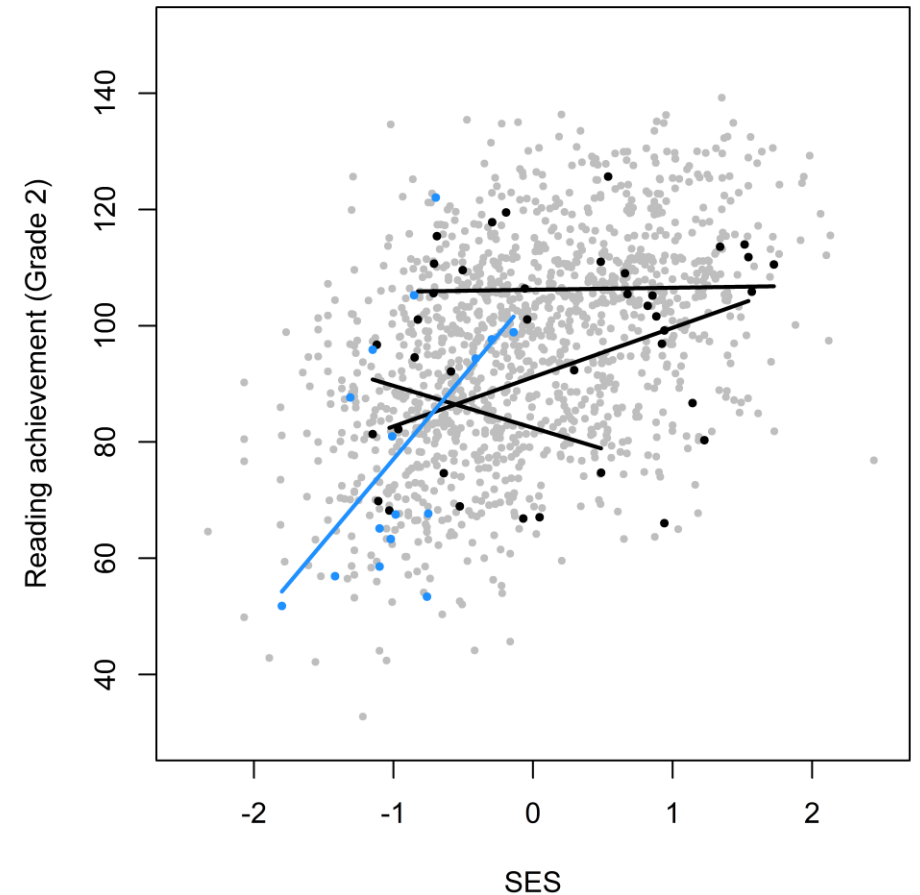


Data example: variation in relationships

Does the relationship between SES and student achievement systematically differ across schools?

Example data from the Early Childhood Longitudinal Study: Distribution of grade 1 reading scores

- Relationships within four schools



Some applications of multilevel models

- Describe the extent to which performance differs across organizations (e.g., schools) versus within organizations
- Test how disparities in individual opportunities and outcomes are associated with organizational or contextual factors
- Test the effects of group-level treatments on individual outcomes
- Explore variation in treatment effects across groups
- Describe how trajectories of student learning differ across individuals
- Incorporate contextual factors into analyses of intersectionality