Multi-level Analyses

• Many times in behavioral sciences, students are nested in other “levels” (not the same levels in an independent variable).
  • Think of birds in one nest, another nest, then another nest.
  • Nesting can occur in many ways

• There are now multiple sources of variance
  • That due to the students
  • That due to the teacher
  • That due to the school...etc.

• We call this Hierarchical data
Hierarchical Data

• **Data structures are often hierarchical**

• **Examples:**
  - Children nested within classrooms (two levels)
  - Schools nested within districts (two levels)
  - Children nested within classrooms nested within teachers (3 levels)
Hierarchical Data: Two levels
Hierarchical Data: Three levels

Level 3
- School 1
- School 2
- School n

Level 2
- Class 1
- Class 2
- Class 3
- Class 4
- Class 5
- Class x
- Class y
- Class z

Level 1
- Child 1
- Child 2
- Child 3
- Child 4
- Child 5
- Child 6
- Child 7
- Child 8
- Child 9
- Child 10
- Child 11
- Child 12
- Child 13
- Child 14
- Child 15
- Child 16
- Child 17
- Child 18
- Child 19
- Child 20
- Child 21
- Child 22
- Child 23
- Child 24
- Child 25
- Child 26
- Child 27
- Child 28
- Child 29
- Child 30
- Child 31
- Child 32
- Child 77
- Child 78
- Child 79
- Child 80
- Child 81
- Child 82
- Child 83
- Child 84
- Child 85
- Child 86
- Child 87
- Child 88
- Child 89
- Child 90
- Child 91
- Child 92
- Child 93
- Child 94
- Child 95
Intraclass Correlation (ICC)

- Data from the same “nest” will typically be more similar than data from different “nest”
  - E.g. Children in the same class will perform more similarly to each other than children from different classes
  - Lack of independence
  - Creates problems in ANOVA/Regression

- The ICC measures this variability
  - E.g. the variability between classrooms

- Tells us amount of variance explained at each level
  - General rule is less than .1 (or 10%) of variance should be explained at higher levels
  - If it is higher than that, then the differences are in the teachers and not the students
Very Simple Example

All variance on outcome

Variance explained by students

Variance explained by classrooms

Variance explained by students roughly 50%

Variance explained by students now roughly 30%
For practical applications

• Data can be hierarchical and this hierarchical structure can be important
  • Most education analyses simply ignore the hierarchy

• HLM is more conservative

• Like all statistics, there is disagreement on how and when to use HLM.
  • For example, some say you need 50 observations (teachers) at the second level before you use HLM.
Examples of HLM in Educational Research


More Examples...

- JONES


Books for HLM


Software & Resources for HLM

- **STATA (BUGS & GLLAMM)**: [https://www.stata.com/](https://www.stata.com/)
- **R (JAGS)**: [https://www.rstudio.com/](https://www.rstudio.com/)
- **Mplus**: [http://www.statmodel.com/](http://www.statmodel.com/)
- **University of Texas, Comparison of Outputs**: [https://stat.utexas.edu/images/SSC/Site/hlm_compariso...](https://stat.utexas.edu/images/SSC/Site/hlm_comparison-1.pdf)
- **University of Indiana, Estimating Multilevel Models using Stata, SAS, SPSS, & R**: [http://www.indiana.edu/~statmath/stat/all/hlm/hlm.pdf](http://www.indiana.edu/~statmath/stat/all/hlm/hlm.pdf)
- **Free course on HLM**: [http://www.cmm.bris.ac.uk/lemma/](http://www.cmm.bris.ac.uk/lemma/)