Multilevel Statistical Models in Public Health
Syllabus
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CONTENT FOR BIO656: MULTI-LEVEL MODELS
http://www.biostat.jhsph.edu/~fdominic/teaching/bio656/ml.html

Approach

- Case-based with primary emphasis on translating subject-area questions into statistical models, then implementing models and interpreting outputs
- Highlight the linkage between statistical and subject-area science and policy aspects of the models

Motivating examples

- Social & behavioral sciences, clinical and field studies, health services research
- Multi-center clinical and community trials
- Profiling of medical providers
- Environmental and Social Epidemiology

Analysis Goals

- Make inferences for individuals or for populations, accounting for:
    - Clustering
    - Covariates (fixed effects): Systematic variation across and within clusters
    - Variance components (random effects): random variation within and between clusters
- Estimate associations between predictors and outcomes
    - Predictors operate at the cluster and within-cluster levels
        - e.g., person, family, neighbor, state
    - Allocate predictive effects, taking into account possible interactions
- Compare results from multi-level models with standard regression approaches
- Model criticism: evaluate fit of the assumed fixed and random effects assumptions

Software

- Stata will be used throughout the course
- Winbugs will be introduced for Bayesian analyses

Textbook:
Multilevel and Longitudinal Modeling Using Stata, Rabe-Hesketh and Skrondal
http://www.stata-press.com/books/mlmus2.html

Reading List:
http://www.biostat.jhsph.edu/~fdominic/teaching/bio656/references/references.html

1. **Introduction to Multi-level models**
    a. Course information and description
    b. Natural Extension to Longitudinal data analysis: longitudinal data are a special case of clustered data!
    c. Marginal Models versus Random Effects (Conditional) Models
2. **The two stage normal-normal model (variance component model)**
    a. The Bayes Theorem
    b. Shrinkage Estimation
    c. Testing in schools
    d. The six cities study
3. **Linear random intercept models**
    a. Guinea pig example
    b. Connection between linear model with random intercept and marginal model with uniform correlation structure
4. **Linear models with random intercept and slope**
    a. Rat Example
    b. Inner-London School data
    c. Growth-curves models
5. **Three Levels variance component models for continuous outcomes**
    a. Which method is best for measuring respiratory flow?
    b. Television School and Family Smoking Prevention and Cessation project
6. **Applications of Multilevel Models for continuous data to the National Morbidity Mortality Air Pollution study**
    a. The two stage normal-normal model and covariate at the second stage
    b. Effect modification of short-term effects of ozone on mortality
    c. Two level model with spatially correlated random effects
    a. Three level variance component model
7. **Logistic Regression with Random intercept**
    a. Connection between logistic model with random intercept and marginal model
    b. Which treatment is best for toenail infection?
8. **Applications of Multilevel Models for binary data to Profiling of Health Care Providers**
    a. Ranking of Hospitals
    b. Fitting Multilevel Models in Winbugs (a toy example)
    c. Comparing performance of hospital providers
9. **Three levels Logistic Random Intercept Model**
    a. Guatemala Immunization case study
10. **Poisson regression with random intercept and slope**
    a. Did the German health care reform reduce the number of doctor visits?
11. **Applications of Multilevel models for count data to disease mapping**
    a. Spatially correlated random effects
    b. Pellagra data set
    c. Lip cancer case study
12. **Case Studies in Linear models with random intercept and slope**
    a. Pulmonary function and age and height in children
    b. Study of the influence of menarche on change in Body Fat Accretion
    c. Randomized Trial of HIV-1 Reverse Transcriptase Inhibitors