Longitudinal Data Analysis: A Brief Overview on Practical Considerations

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Outline

- Introduction
- Examples of longitudinal data
- Purpose of longitudinal data
- Capturing
  - Mean trajectory
  - Between-subject variability
  - Within-subject variability
- Modeling options & software

Introduction

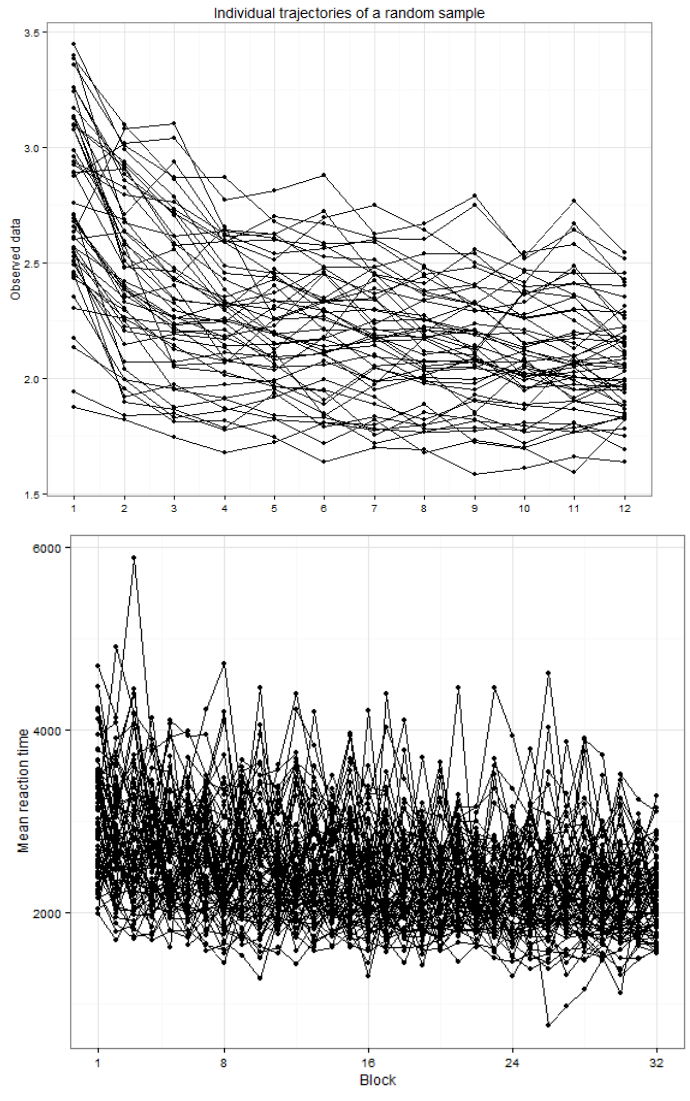
- What is longitudinal data?
  - Repeated measures of the same individual (or unit of analysis) gathered over time
- What are the elements of longitudinal data analysis?
  - Overall trajectory
  - Between-subject variability
  - Within-subject variability

Examples of Longitudinal Data

- Academic achievement
  - Mathematics & reading
  - National and international settings
- Response time
  - Spatial attention experiment
  - Educational context
- Academic choices
- MRI data

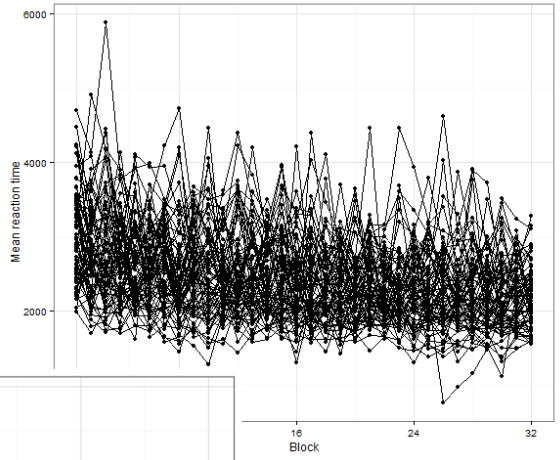
Purpose of Longitudinal Data Analysis

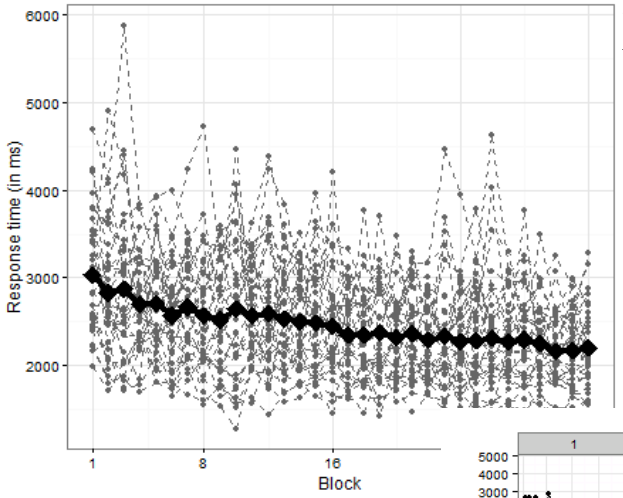
- Focus depends on the research question
  - Mean trajectory description
  - Individual differences
    - Random-effects or between-subject variability
  - Within-subject variability
- But we can think of general steps to follow

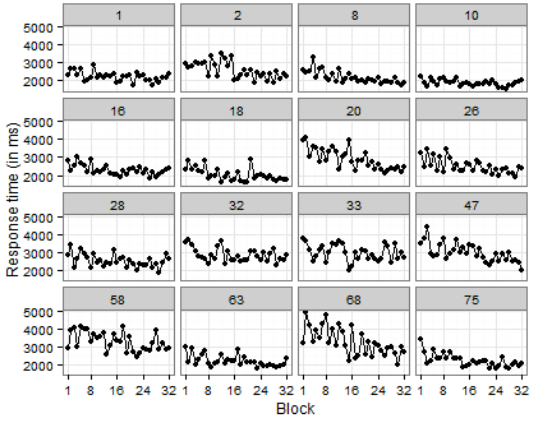


Capturing the Mean Trajectory

- Main tools
  - Spaghetti plots
  - Observed overall mean trajectory
  - Facet plots

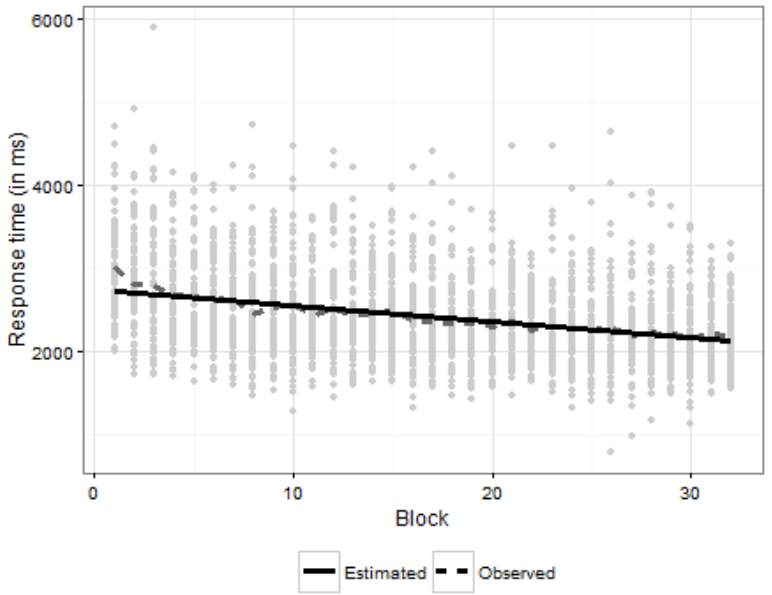


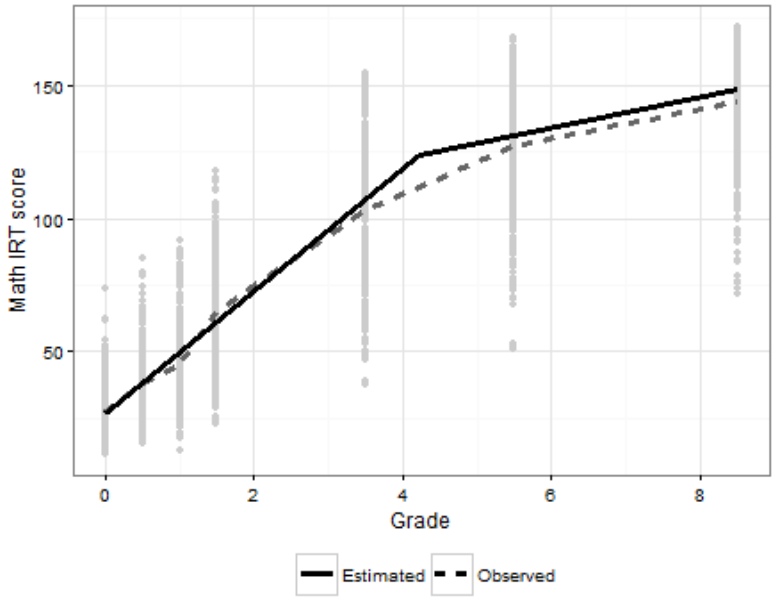




Capturing the Mean Trajectory

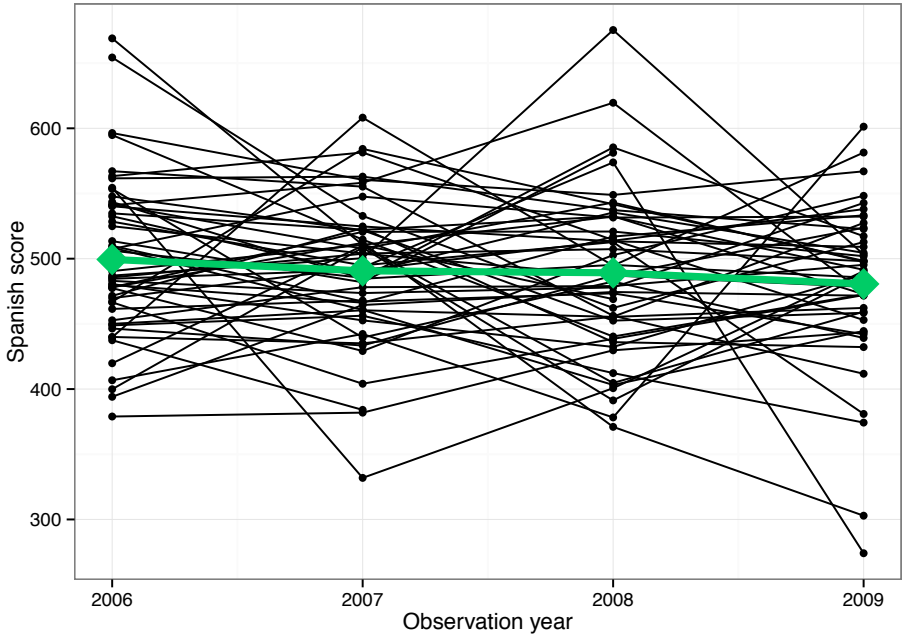
- Modeling alternatives
  - Linear model
    - Describe linear or curvilinear trajectories
    - Linear or polynomial functions
  - Nonlinear model
    - Describe unsteady trajectories, asymptotic behaviors
    - Parameter estimates answer questions
    - Examples: exponential or piecewise functions





Capturing Between-Subject Variability

- What does "between-subject variability" mean?
  - Variation in the outcome variable between individuals
  - Individual trajectories are expected to vary across individuals

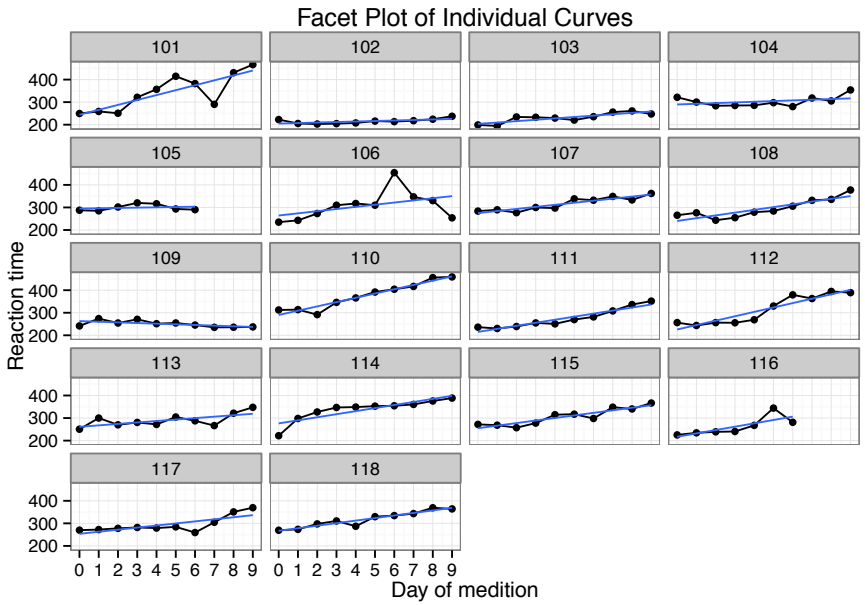


Capturing Between-Subject Variability

- How to capture it?
  - Introducing random-effects to the model
  - Through the covariance matrix associated to random-effects
- How to decide how many random-effects are needed?
  - Compare models with different number of random-effects
  - Start with the simplest model

Capturing Within-Subject Variability

- What does "within-subject variability" mean?
  - Inherent variability in an individual's responses over time
  - Random deviations from an individual's underlying trajectory



Capturing Within-Subject Variability

- How to capture it?
  - Through the covariance matrix associated to the errors within-subject
  - Different covariance structures
    - Examples: independent, unstructured, autoregressive, etc.
- How to decide on the covariance structure?
  - Previous research, research questions, data capabilities
  - Parsimony is key

Modeling Options for Longitudinal Data

		Distributional Assumption	
		Normal	Non-normal
Functional Form	Linear	LMEM	GLMEM
	Nonlinear	NLMEM	GNLMEM

LMEM: Linear mixed-effects models
NLMEM: Nonlinear mixed-effects models
GLMEM: Geneneralized LMEM
GNLMEM: Geneneralized NLMEM

Software Options for Longitudinal Data

Software Routines	LMEM	NLMEM	GLMEM	GNLMEM
SAS-NLMIXED	✓	✓	✓	✓
SAS-GLIMMIX	✓		✓	
R-lmer	✓			
R-nlmer		✓		
R-glmer			✓	
R-nlme		✓		
HLM7	✓		✓	

THANK YOU

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