

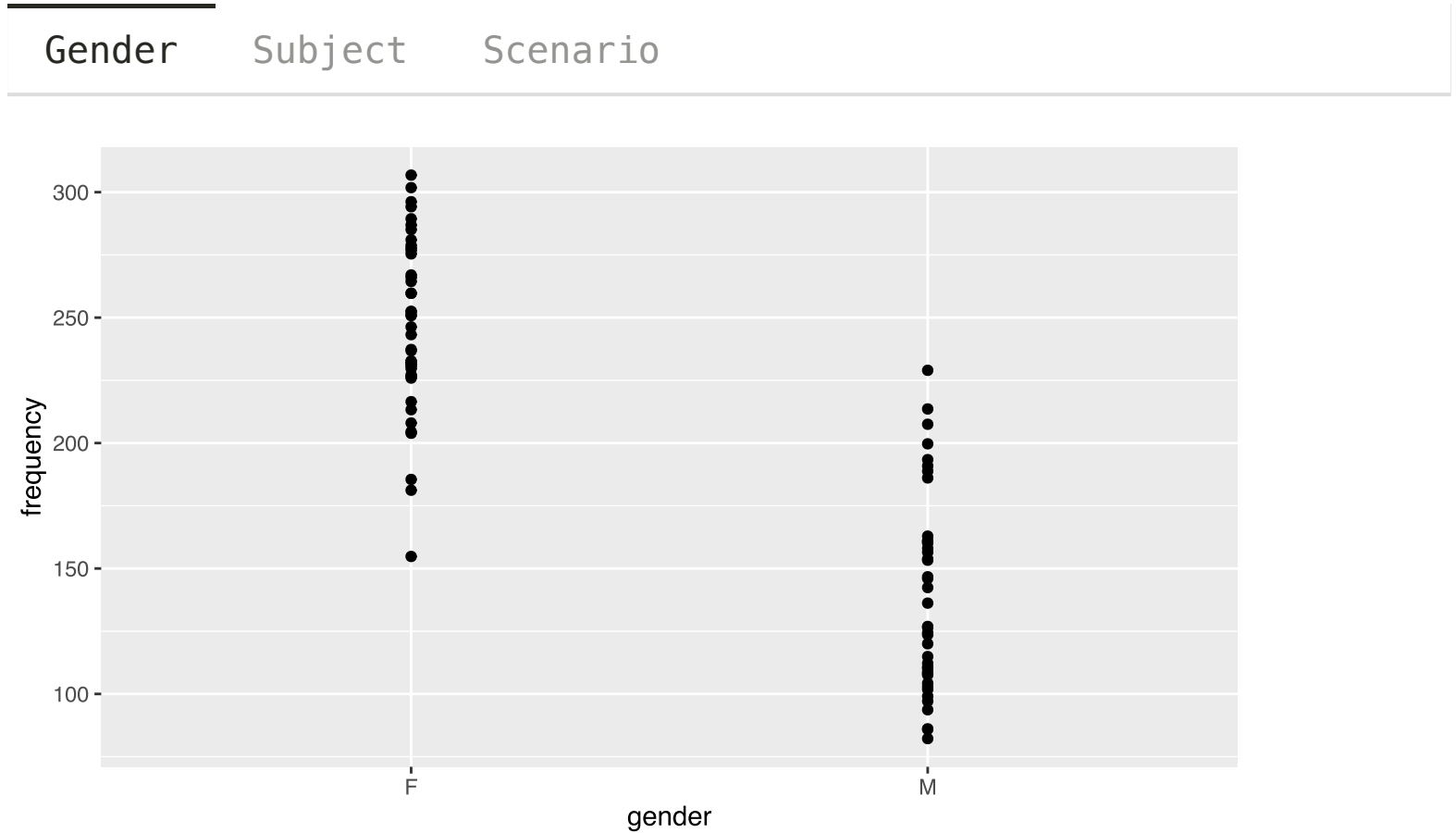
Visual Inference for Graphical Diagnostic of Linear Mixed Models

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Linguistic Case



Linear Mixed Model

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\mathbf{b} + \mathbf{e}$$

where

- \mathbf{y} is a $\mathbf{N} \times \mathbf{1}$ vector of observations, outcome variable
- \mathbf{X} is a $\mathbf{N} \times \mathbf{p}$ matrix
- $\boldsymbol{\beta}$ is a $\mathbf{p} \times \mathbf{1}$ vector of the fixed effect
- \mathbf{b} is a $\mathbf{N} \times \mathbf{q}$ matrix
- \mathbf{b} is a $\mathbf{q} \times \mathbf{1}$ vector of the random effect
- $E[\mathbf{y}] = \mathbf{X}\boldsymbol{\beta}$ and $V(\mathbf{y}) = \boldsymbol{\Omega} = \mathbf{Z}\boldsymbol{\Gamma}\mathbf{Z}^\top + \mathbf{R}$

How can we implement the LME?

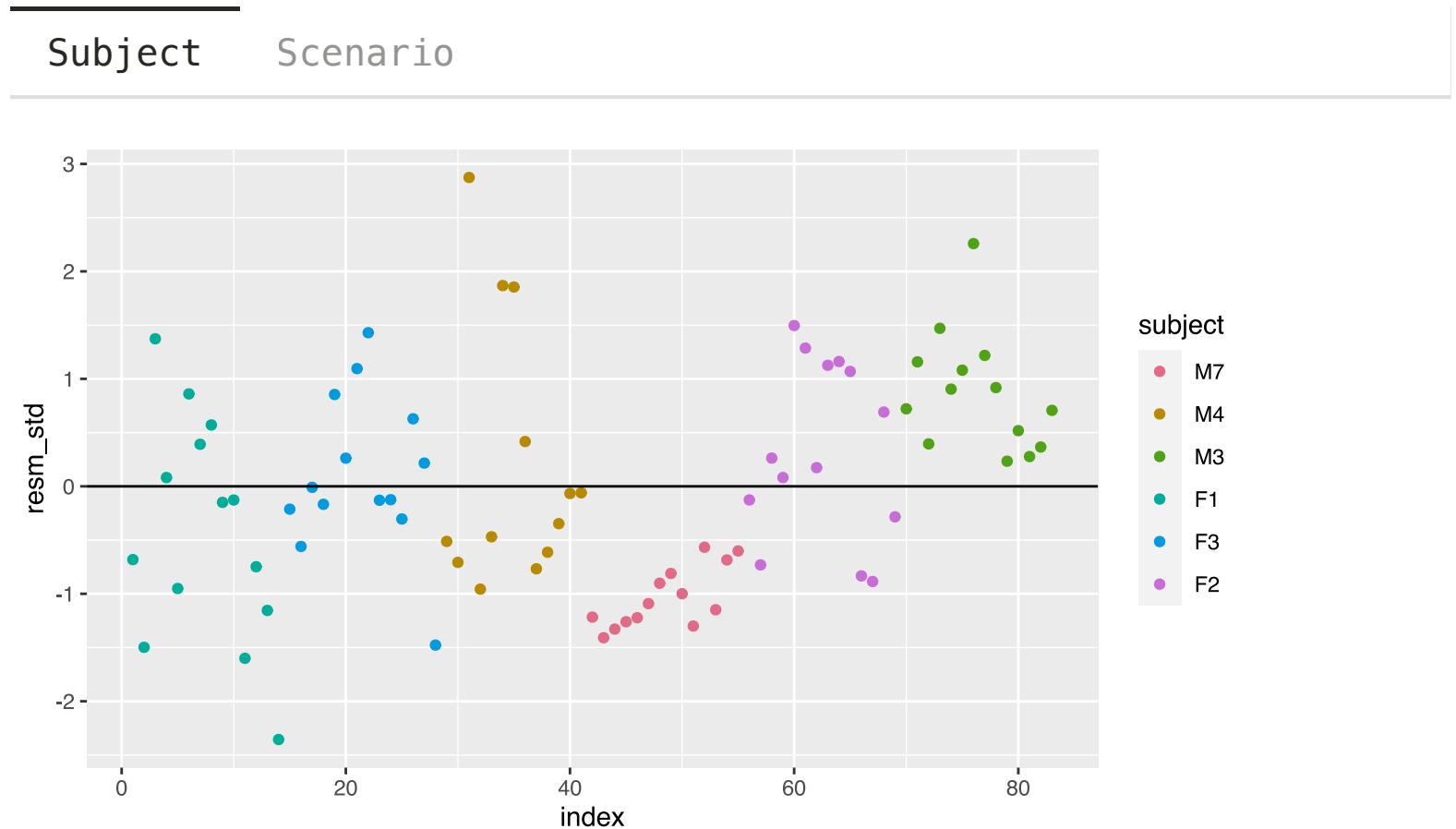
- `lmer` function from `lme4` package
- `mmer` function from `sommer` package

Graphical diagnostic on residual analysis

- Types of residuals and corresponding residual diagnostic purpose:
 - Marginal residuals, $\hat{\xi} = \mathbf{y} - \mathbf{X}\hat{\beta}$
 - Linear of the effects fixed
 - Presence of outlying observations
 - Within-units covariance matrix
 - Conditional residuals, $\hat{\epsilon} = \mathbf{y} - \mathbf{X}\hat{\beta} - \mathbf{Z}\hat{\mathbf{b}}$
 - Presence of outlying observations
 - Homoskedasticity of conditional errors
 - Normality of conditional errors
 - Random effect residuals, $\mathbf{Z}\hat{\mathbf{b}}$
 - Presence of outlying subjects
 - Normality of the random effects

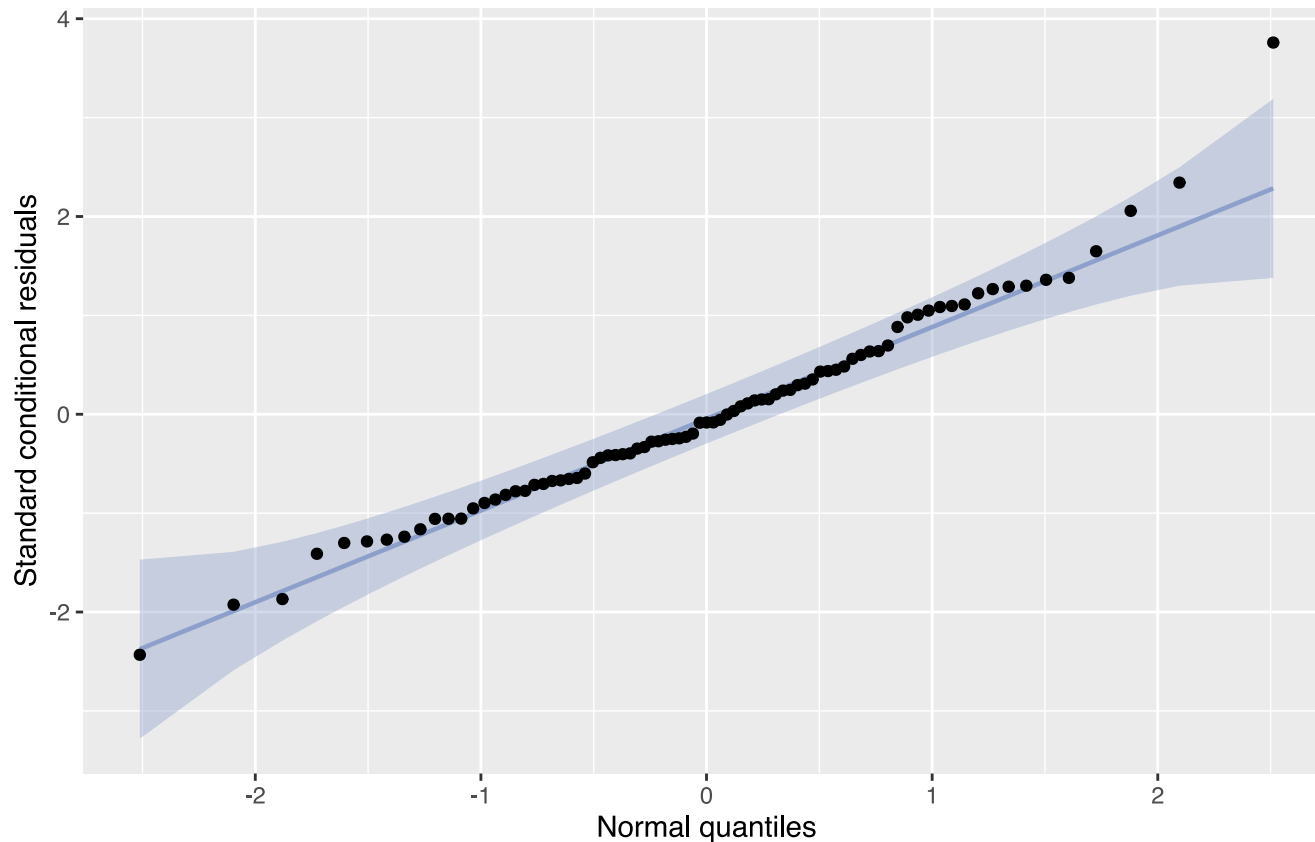
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Presence of outlying observations

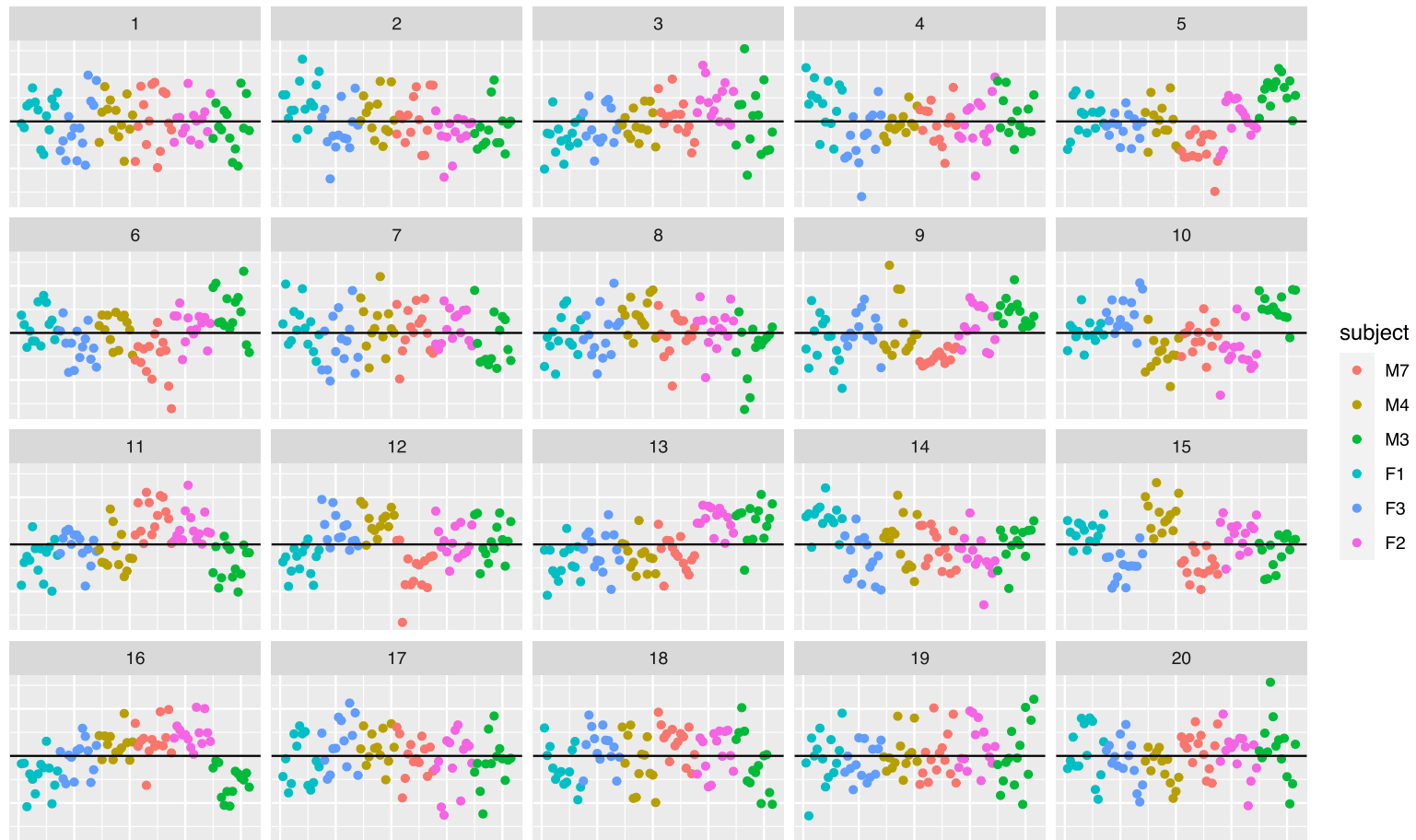


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Normality of conditional errors



Lineup Protocol



Lineup Protocol

