■ Model Convergence Cheat Sheet (R / ordinal::clmm, lme4::glmer, etc.)

■ Signs of Good Convergence

- `fit$convergence == 0`
- max|grad| (maximum gradient) close to 0 (≤ 1e-3 is good)
- Iterations did not hit maximum (e.g. niter 320(1000) = fine, niter 500(500) = bad)
- Standard Errors finite, not absurdly large or NA
- Condition number (cond.H) moderate (10^2–10■). Very high (≥ 10■) = instability; very low = singular fit
- No warnings like 'failed to converge' or 'Hessian is singular'

■ Signs of Poor Convergence

- fit$convergence != 0
- max|grad| > 1e-3 (gradients far from zero)
- Iterations = maximum allowed (niter == max)
- NA or gigantic SEs
- Hessian singular or near-singular (cond.H huge)
- Random effect variance = 0 when unexpected

■ Fixes if Convergence Fails

- Check data balance (merge rare categories, sparse grouping levels)
- Relevel factors (set most common category as baseline)
- Simplify the model (drop random effects, reduce predictors)
- Try different optimizers (e.g. BFGS for clmm, bobyqa for glmer)
- Scale continuous predictors (center/scale for stability)

■ Quick R code snippet to check convergence

- fit$convergence # 0 = converged
- if (!is.null(fit$gradient)) max(abs(fit$gradient))
- fit$optim$niter # iterations used
- fit$cond.H # Hessian condition number
- summary(fit)$coefficients # check SEs