Modeling Covariance Structure in Repeated Measures

Pros: Can be more efficient, can yield useful models

Cons: Modeling process must be monitored, problems can occur for some data sets

The goal is usually to find a reasonable covariance model, not necessarily the perfect model. The main interest is usually in the fixed effect tests, and in many cases multiple covariance models give similar fixed effect results.

Use

Fit a series of covariance models to the data (more specifically, to the repeated measures structure), pick the one with best fit (using an IC measure). Then fixed effect tests are conducted using the best fitting model. A good general starting set of models is CS, HF, AR(1), ARH(1), and UN. Specific problems may lead to other models such as spatial covariance models or models for multiple repeated measures. Mixed models may also be used with covariates and not just factors as we have done. Typically you start with a model containing all fixed effects potentially of interest. Using that model , choose a best-fitting covariance structure. After fitting the best covariance structure, you can return to the fixed effect part of the model to see if any changes are needed.

Problems

The model may fail to converge. The model may converge, but the hessian may not be positive definite. Negative variance component estimates, or estimates of 0 may occur.

Possible reasons: Too much variation, and/or too small of a sample size. Too few levels of a random effect may have been sampled. The true variance of a random effect may be near zero. The data may be too unbalanced. The model may be inappropriate.

Random and Repeated together

The RANDOM and REPEATED statements may be used together, but care must be taken to ensure that they are not confounded. For example these two models

```
proc mixed data=weight2;
   class program subj time;
   model strength = program time program*time;
   random subj(program);
run;
```

and

```
proc mixed data=weight2;
   class program subj time;
   model strength = program time program*time;
   repeated / type=cs sub=subj(program) r rcorr;
run;
```

give the same model fit values and fixed effect tests, and usually the same parameter estimates. Given this confounding, the two statements should not be used together.

A more general rule is that

```
    random effect;
```
and
```
    repeated / type= ?? sub= effect;
```

should not be used together when the model (??) is CS, Toeplitz, or UN.

Reference:

Littell, R.C., Milliken, G.A., Stroup, W.W., and Wolfinger, R.D. (1996) SAS System for Mixed Models. Cary, NC: SAS Institute Inc.