Comment: because all three models share the same mean structure ($X\beta \Rightarrow \text{rank}(X) = r$ for all 1)

```
> #  Compare the fit of various covariance
> #  structures.
>
> anova(o.cs, o.un)
      Model df    AIC    BIC logLik   Test L.Ratio p-value
o.cs      1 23 1466.8 1557.3 -710.4
o.un      2 49 1332.9 1525.7 -617.4 1 vs 2  185.92  <.0001
```

REML est. is based on the same likelihood function $\Rightarrow$ making AIC, BIC, logLik comparable

Smaller is better

unstructured Var-Cov matrix provides a much better fit

```
> anova(o.ar1, o.un)
      Model df    AIC    BIC logLik   Test L.Ratio p-value
o.ar1     1 23 1312.8 1403.3 -633.4
o.un      2 49 1332.9 1525.7 -617.4 1 vs 2  31.908  0.1962
```

$\Rightarrow$ lack sufficient evidence in favor of the unstructured Var-Cov-matrix $\Longrightarrow$ AR(1) structure provides best fit out of all three models

AIC and BIC for Repeated Measures in R

- $AIC = -2\ell(\widehat{\boldsymbol{\theta}}) + 2k$
- $BIC = -2\ell(\widehat{\boldsymbol{\theta}}) + k\ln(n)$

Reason for why D. Un had a larger AIC/BIC

- $k =$ number of mean parameters (rank of $\boldsymbol{X}$) $+$ number of variance parameters

Careful when basing model comparisons on AIC, BIC and LogL(θ) when using REML

- For REML,

$$n = \text{total number of observations} - \text{rank}(\boldsymbol{X})$$

- For ML,

$$n = \text{total number of observations}$$

More about Repeated Measures in R

If you are interested in learning about how to fit other variance-covariance structures in R, the following help commands may be useful.

```
?corClasses
```

```
?varClasses
```

explore functionalities of lme & gls before

To see functions for accessing `lme` and `gls` results, use

```
methods(class = 'lme')
```

```
methods(class = 'gls')
```

fitting different Repeated Measures Model

Fitting More Complex Models in R

// discussed during lecture 40

See `RepeatedMeasures.R` for several other examples, including

Note in R code model comparison is based on refitting all models using "MLE" because the mean structure is no longer the same

- treating time as a continuous variable and assuming a mean function that is quadratic in time for each program
- assuming random subject-specific coefficients when the mean function is quadratic in time for each program