Bonus: Continuous Time AR1

- In SAS, use <u>REPEATED</u> TYPE=SP(POW)(*time*): $\boxed{\sigma^2 \rho^{d_{ij}}}$

  - SP(POW) = "spatial power" structure (up to 4 dimensions!), using a continuous time variable as the 2 dimensions here

  - 2 parameters build the covariance between any occasions i and j:
    - $\boldsymbol{\sigma^2}$ = constant variance over time (total if R-only; of residuals if G and R)
    - $\boldsymbol{\rho}$ = AR1 correlation (total if R-only; of residuals if G and R)
  - $\boldsymbol{d}$ = distance in time between occasions i and j creates the exponent
    - I *think* this means time can be unbalanced and unequal-interval!

- Example continuous time AR1 R matrix using integer time

$$\sigma^2 \begin{bmatrix} 1 & \rho^{d_{12}} & \rho^{d_{13}} & \rho^{d_{14}} \\ \rho^{d_{21}} & 1 & \rho^{d_{23}} & \rho^{d_{24}} \\ \rho^{d_{31}} & \rho^{d_{32}} & 1 & \rho^{d_{34}} \\ \rho^{d_{41}} & \rho^{d_{42}} & \rho^{d_{43}} & 1 \end{bmatrix}$$

But each person could have their own version of the R matrix for their particular occasions, still built from 2 common ingredients!

Bonus: Continuous Time AR1

- In R GLS or LME,
  use TYPE=corCAR1
  - ➢ From p. 48 of nlme manual

Examples

```
## covariate is Time and grouping factor is Mare
cs1 <- corCAR1(0.2, form = ~ Time | Mare)

# Pinheiro and Bates, pp. 240, 243
fm1Ovar.lme <- lme(follicles ~
                sin(2*pi*Time) + cos(2*pi*Time),
      data = Ovary, random = pdDiag(~sin(2*pi*Time)))
```

Usage

```
corCAR1(value, form, fixed)
```

Arguments

value	the correlation between two observations one unit of time apart. Must be between 0 and 1. Defaults to 0.2.
form	a one sided formula of the form ~ t, or ~ t | g, specifying a time covariate t and, optionally, a grouping factor g. Covariates for this correlation structure need not be integer valued. When a grouping factor is present in form, the correlation structure is assumed to apply only to observations within the same grouping level; observations with different grouping levels are assumed to be uncorrelated. Defaults to ~ 1, which corresponds to using the order of the observations in the data as a covariate, and no groups.
fixed	an optional logical value indicating whether the coefficients should be allowed to vary in the optimization, or kept fixed at their initial value. Defaults to FALSE, in which case the coefficients are allowed to vary.

Value

an object of class corCAR1, representing an autocorrelation structure of order 1, with a continuous time covariate.