**Arrow-and-lag interface for simultaneous and lagged effects**

Agenda section E: Code tutorial

Goal:

1. Understand arrow-and-lag notation
2. Fit simultaneous and lagged effects in a time-series model

*Step 1: Simulate data (20 minutes)*

Please write an R script that simulates abundance at age for ages and years with the following simplified dynamics:

Where process errors , median age-0 recruitment , recruitment variation , demographic variation , and natural mortality .

Now imagine that we can only sample abundance-at-age from a sampling gear with logistic selectivity:

Where age at 50% selection and the logit-slope . We then observe:

*Step 2: Fit model using dsem*

Write out the arrow-and-lag notation whereby is caused by abundance the preceding age and year. This will presumably involve several one-headed arrows:

Where is the predictor, the response, represents a time-lag, and is a parameter name (you can use the same name multiple times to force a single parameter value to be estimated and shared across lines)

Next, modify this arrow-and-lag notation to represent the assumption that exogenous variation at age1 (representing recruitment deviations) will be different than subsequent ages (representing demographic variation). This will presumably involve several two-headed arrows:

where these always have a lag of zero.

*Step 3: Retrospective skill testing*

Finally, conduct a “leave-future-out” crossvalidation by dropping the final five years of simulated data. To do so, modify `tsdata` by replacing values (measurements) with NAs (representing missing data). This will ensure that the model still predicts those missing values.