Assessment For All (a4a)

The stock assessment model

The a4a team

European Commission
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The a4a stock assessment framework

The a4a stock assessment framework is a statistical catch-at-age model written in R with ADMB underneath (to find the parameters). It was written with the aim of quickly developing stock assessment models for stocks with limited time series.

The a4a stock assessment framework

A model is defined by submodels, which specify the different parts of a statistical catch-at-age model.

There are 5 submodels in operation:

- a model for F-at-age
- a model for the initial age structure
- a model for recruitment
- a (list) of model(s) for abundance indices catchability-at-age
- a list of models for the observation variance of catch-at-age and abundance indices.

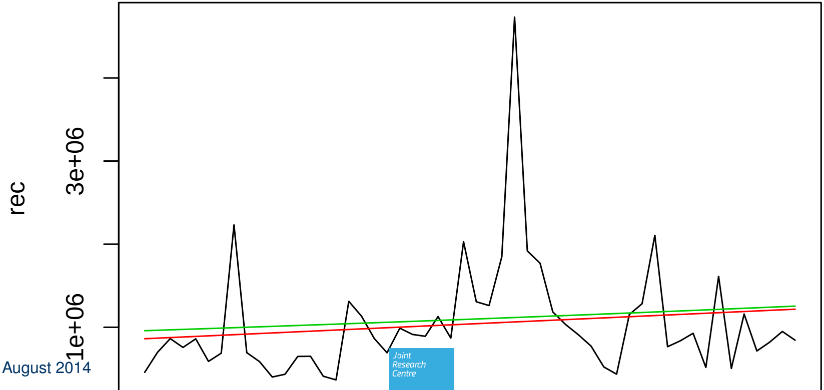
The a4a stock assessment framework

The submodels form use linear models. This opens the possibility of using the linear modelling tools available in R: see for example the mgcv gam formulas, or factorial design formulas using lm(). In R's linear modelling language, a constant model is coded as ~ 1, while a slope over age would simply be $\sim age$. For example, we can write a traditional year/age separable F model like $\sim factor(age) + factor(year)$.

linear model example

```
rec <- c(rec(ple4)) year <- as.numeric(dimnames(rec(p
rlm <- lm(rec   year) scafit <- sca(ple4, ple4.indic
srmodel =  year)
```

linear model example



The a4a stock assessment framework

There are two basic types of assessments available in a4a: the management procedure fit and the full assessment fit. The management procedure fit does not compute estimates of covariances and is therefore quicker to execute, while the full assessment fit returns parameter estimates and their covariances at the expense of longer fitting time.

Model detail

$$e^{\mathrm{E}[\log C]} = \frac{F}{F+M}\left(1 - e^{-F-M}\right) R e^{-\sum F+M}$$

and

$$e^{\mathrm{E}[\log I]} = Q R e^{-\sum F+M}$$

and

$$\mathrm{Var}\left[\log C_{ay}\right] = \sigma^2_{ay} \qquad \mathrm{Var}\left[\log I_{ays}\right] = \tau^2_{ays}$$

Model detail

linear models for

- log F
- log Q
- log observation variances
- log initial age structure

Recruitment is modelled as a fixed variance random effect with linear models for

- log a
- log b

where relevant. Models available: Ricker, Beverton Holt, smooth hockeystick, geometric mean

Linear models

It is not always obvious that stock assessments are often composed of linear models.

For example, the classical separable F assumption is simply that

$$F_{ay} = S_a \times F_y$$

which, in linear modelling parlance is

$$\log F \sim \text{age} + \text{year}$$

Intuitive Modelling

The "language" of linear models has been developing within the statistical community for many years:

- 1965 J. A. Nelder, notation for randomized block design
- 1973 Wilkinson and Rodgers, symbolic description for factorial designs
- 1990 Hastie and Tibshirani, introduced notation for smoothers
- 1991 Chambers and Hastie, further developed for use in S

Many modelling software use this language: Minitab, spss, genstat, SAS, R, S-plus.

Some examples

A separable model where the level of F is smooth through time

$$\log F \sim \text{age} + \text{s(year)}$$

Some examples

A separable model where F is smooth over age

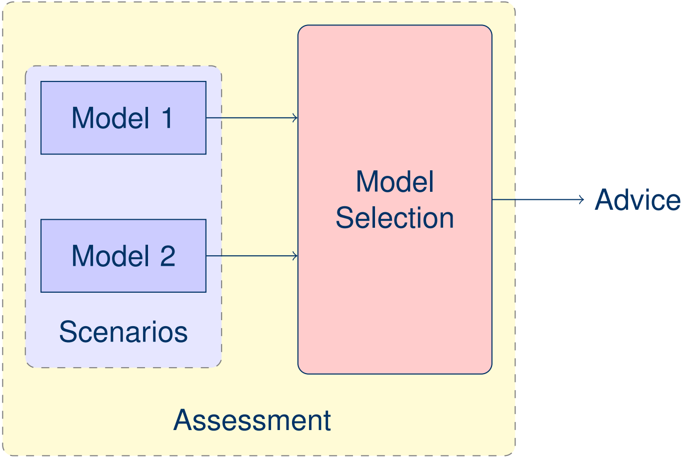
$$\log F \sim \mathrm{s}(\mathrm{age}) + \mathrm{year}$$

Some examples

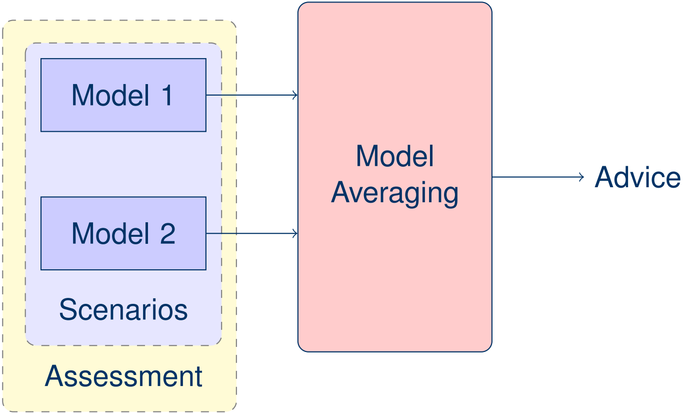
F is smooth over age and year

$$\log F \sim \mathrm{s}(\mathrm{age}, \mathrm{year})$$

An Assessment Process



Model Averaging can help automation



Expert knowledge for model specification

Different plausible models for different levels

- Management area level (North Sea, Baltic Sea, ...)
- Species type (roundfish, flatfish, pelagic, Nephrops)
- specific groups (North Sea gadoids)

This provides a framework for setting up plausible models for new species.

Can lots of simple models averaged = a good model?
Kearns: Can a set of weak learners create a single strong learner

Thank you for listening!

What we can do, what we can't do

Can:

- missing values: missing at random
- multiple surveys
- variable Q, F, variance
- splines (fixed degreed of freedom)
- stock recruit relationship (fixed variance)
- stock recruit relationship (estimated variance) SLOW
- *fixed variance random effects: RW1, RW2, seasonal, user specified*

Can't:

- estimate random effect variance
- estimate smoothing parameters
- estimate growth parameters

What we can do

- simulate from the distribution of model params
    - normal approx
    - avoids the need for delta approx
    - can be biased, but we can also use MCMC if desired
- we can approximate the (joint) distribution of
    - terminal year Fs and Ns
    - terminal year Fbar and Fmsy
    - F / Fmsy