Nonlinear estimation

fish610.060 EAFM Tools: Gadget

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Biological systems are typically nonlinear

- Growth
- Mortality

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so the models should be nonlinear

A relatively simple problem, ADAPT

The ADAPT assessment model

$$min_{N_{0,y},N_{a,0},q_a} \sum_{ay} w_{ay} \left(ln(I_{ay}) - ln(q_a N_{ay})\right)^2$$

$$\text{w.r.t.} N_{a+1,y+1} = \left(N_{ay} e^{-M/2} - C_{ay}\right) e^{-M/2}$$

where M is fixed and the catches, C_{ay} are given as numbers by age and year.
But the weighting factors w_{ay} need to be specified.

Gadget biological components

Core: Parametric forward simulation model

- Consumption: Suitability functions
- Mortality: Due to predation or other natural or fishing
- Growth: Can depend on consumption. Several growth update implementations
- Migration: Through migration matrices
- Maturation: Move from immature to mature stock component
- Spawning: Lose weight and generate yearclass
- Symmetric: All species implemented in same way - fleet is also a predator

Data are typically not Gaussian

- Length distributions
- Survey indices

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Data from a normal distribution are actually very rare in fishery science. Obvious modifications to assumptions such as the multinomial typically does not improve anything.

Nonlinearity is not an issue per se

- Use nonlinear minimisation algorithms for estimation
- Can handle a lot of unknown parameters
- Can in principle estimate variances using Hessian matrices or bootstrap

Consider each data set

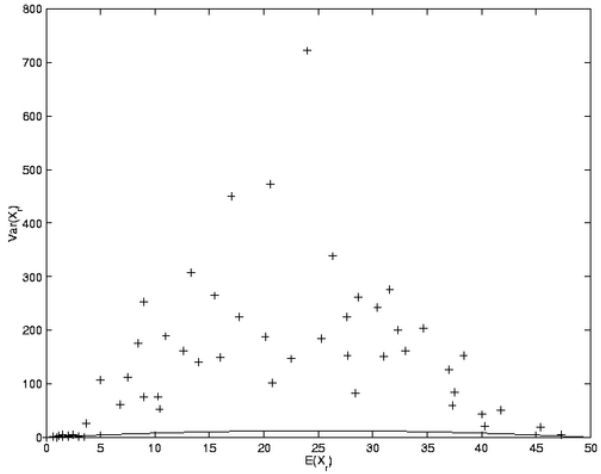
Look at single data sets and try to estimate true variances in each
Compare point estimates from each data set
Try to test formally whether results differ

Diagnostics for likelihood functions

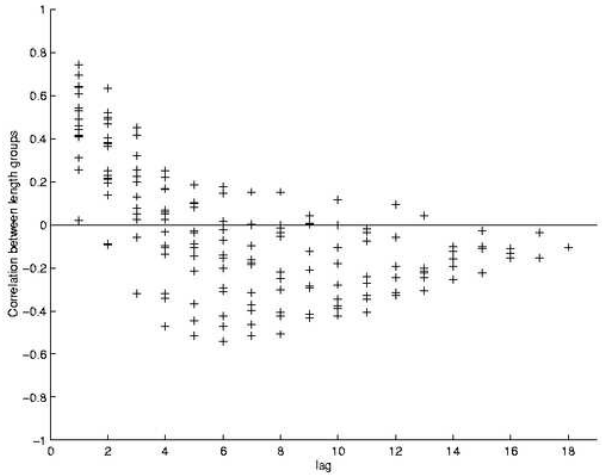
Most likelihood functions can be verified, e.g. using Kolmogorov-Smirnov tests.
One should not be happy with a model which is rejected!

Likelihoods - Assumption

Take 50 fish from each station - compare with binomial



Most assumptions fail - take multinomial



Parsimony and flexibility

If data sources indicate different outcomes then the model is wrong!
Data are just data - they are not wrong.
Example: Catchability may vary in time and fleets may increase their catchability.
Need to add parameters until model is appropriately flexible. Notably add time series parameters...