Case study: Multispecies models for marine fish stocks

stats545.5 545.5 Extending the linear model

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Combining data sets raises issues

- Weight given to each
- Do they all indicate the same model?

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Several data sets means several likelihood components

In ADAPT

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

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

the weighting factors w_{ay} need to be specified, since age groups are like data sets.
Complex data means means the components are not even of same form!

Length distributions

Multinomial?
Test assumptions using samples of survey stations, picking n fish from each.
Variance should be from binomial.
Covariance from multinomial.
Conclusion: Assumption fails very badly.

Effect of wrong variance assumptions

Linear model theory: Minor issue, just affects variance estimates, parameter estimates are still unbiassed.

But: If the base model is wrong for a small part of the data, may create havoc!

Example: Wrong weights in ADAPT

Weights on juveniles seem important - can drive entire assessment.

Likelihoods - Estimation procedure

Gadget is a statistical estimation model.
Internal dynamics are complex so deterministic forward projections are used.
Maximum likelihood estimation is used.

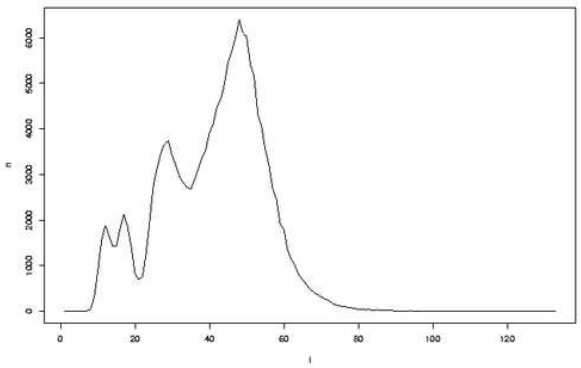
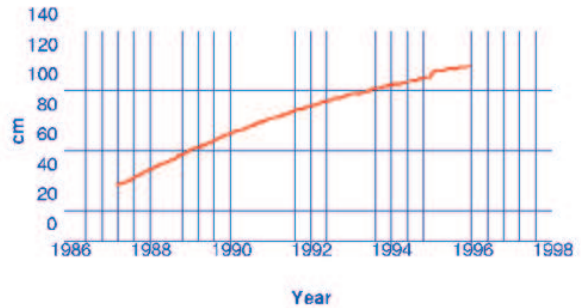


Figure: Length distributions are count data and are often assumed to come from a multinomial distribution, possibly with overdispersion.

Estimation: (Negative log) likelihood functions
Gaussian, weighted
Multinomial

$$min_{\theta \in R^n} \sum_k w_k l_k(\theta)$$



Simple example of complexity problem

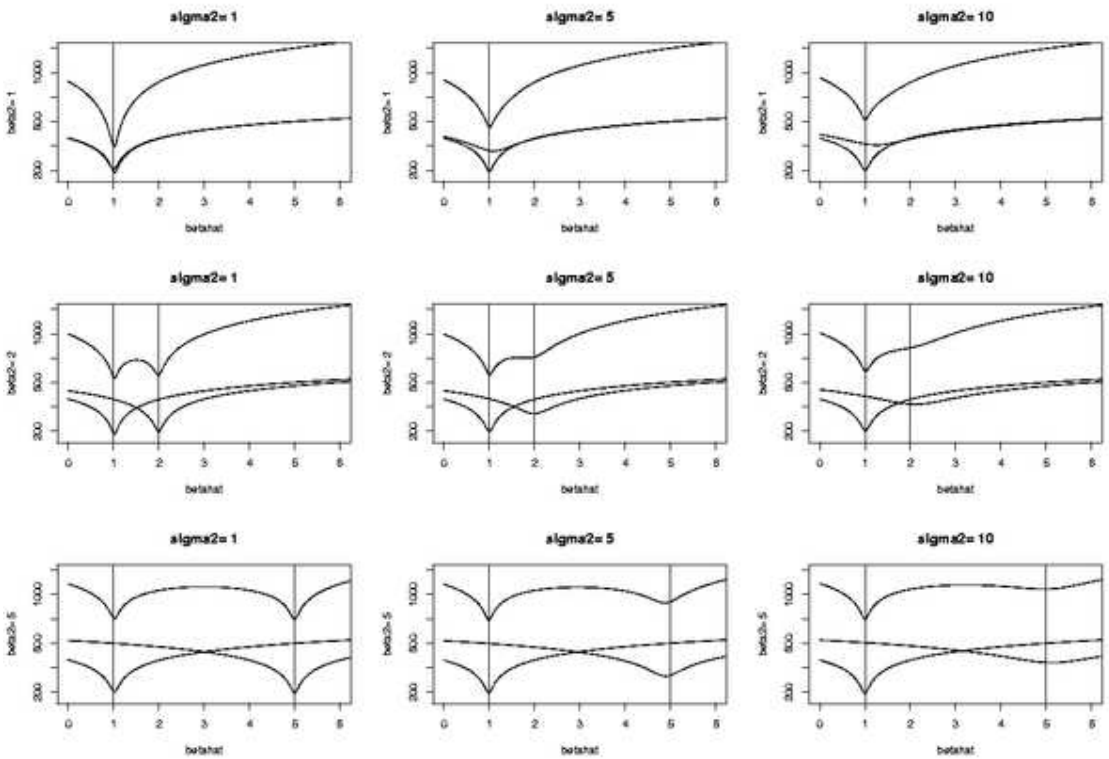
Take a simple problem

$$Y_{ij} \sim n(\alpha_i + \beta_i x_{ij}, \sigma_i^2), \quad j = 1, \ldots, n_i \quad i = 1, 2,$$

but suppose we don't know the slopes are different, so fit

$$Y_{ij} \sim n(\alpha_i + \beta x_{ij}, \sigma_i^2), \quad j = 1, \ldots, n_i \quad i = 1, 2,$$

Simple example of complex problem



MLE is not always the ideal thing...