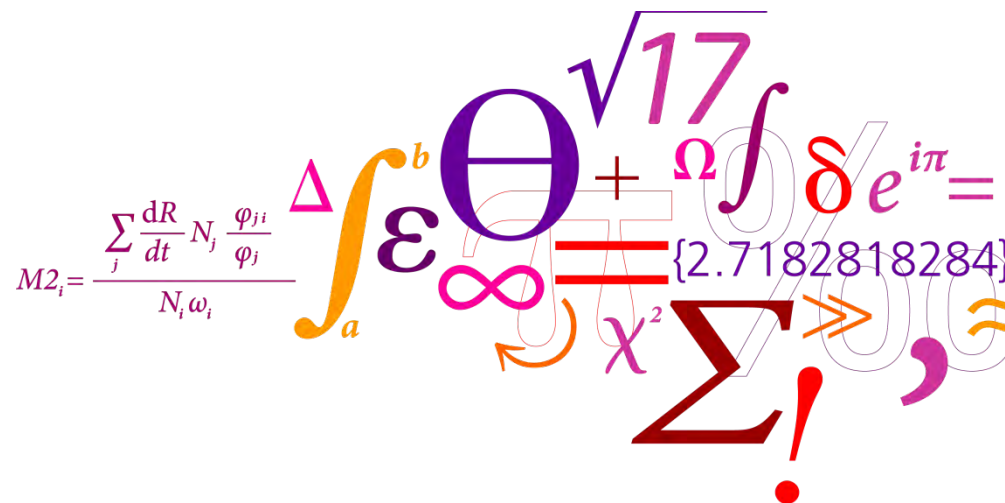


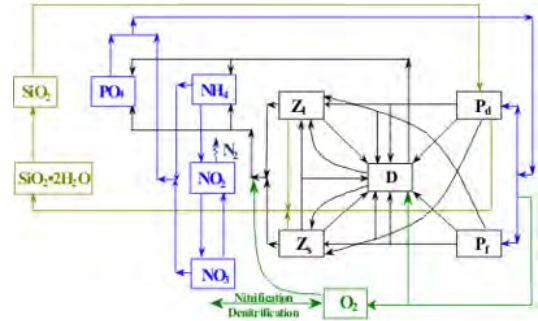
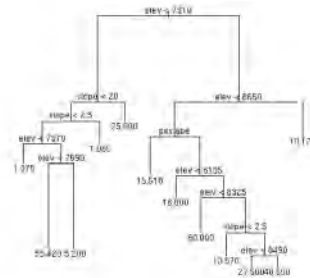
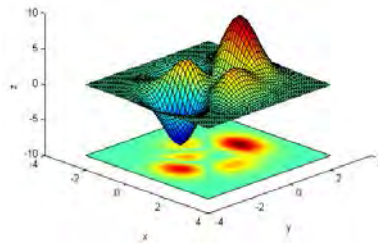
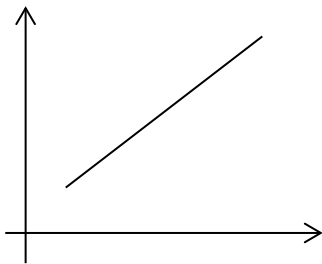
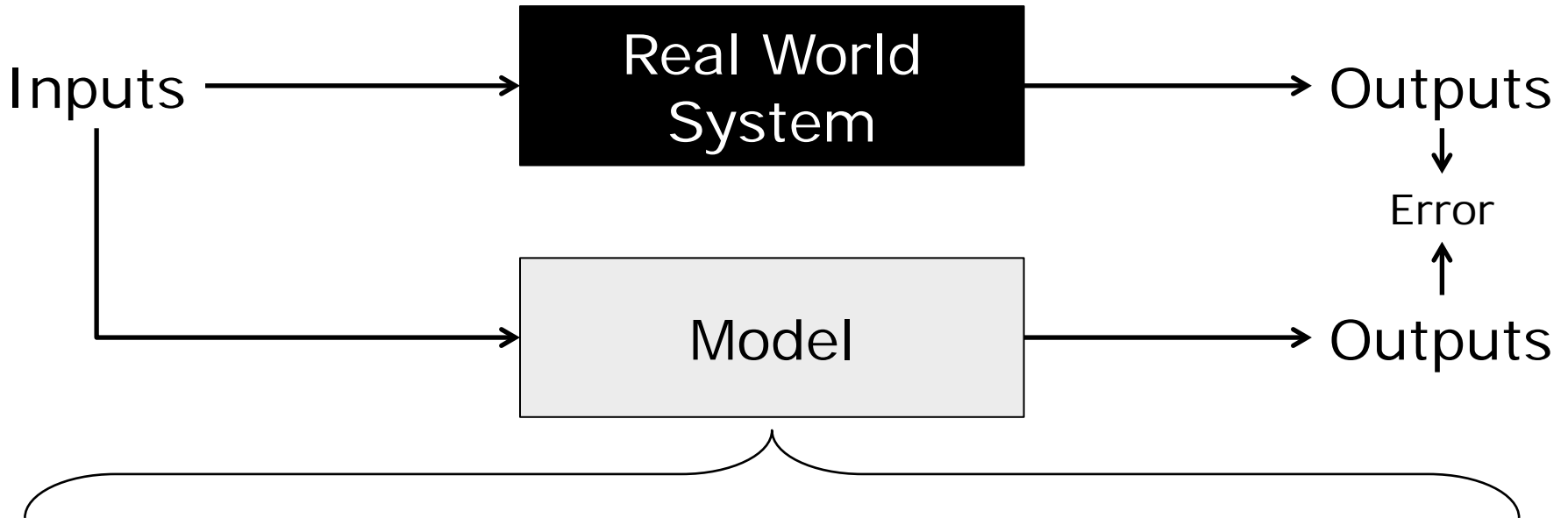
A statistical approach to structural-uncertainty

Mark R Payne

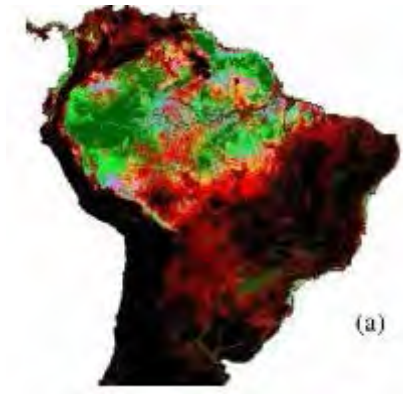
mpay@aqua.dtu.dk



Structural uncertainty

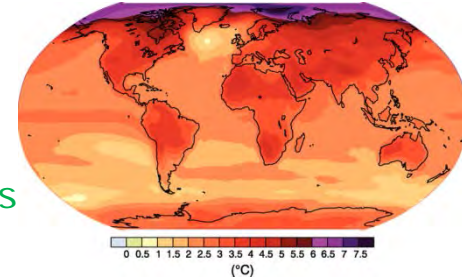


Model structure trade-offs (Levins 1966)



e.g. Species
Distribution
Models

Empirical
models



e.g. IPCC-class
GCMs

Mechanistic
models

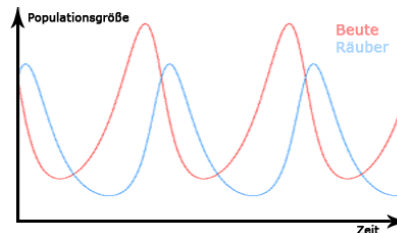
Analytical
models

e.g. Lotka-Volterra

Precision

Generality

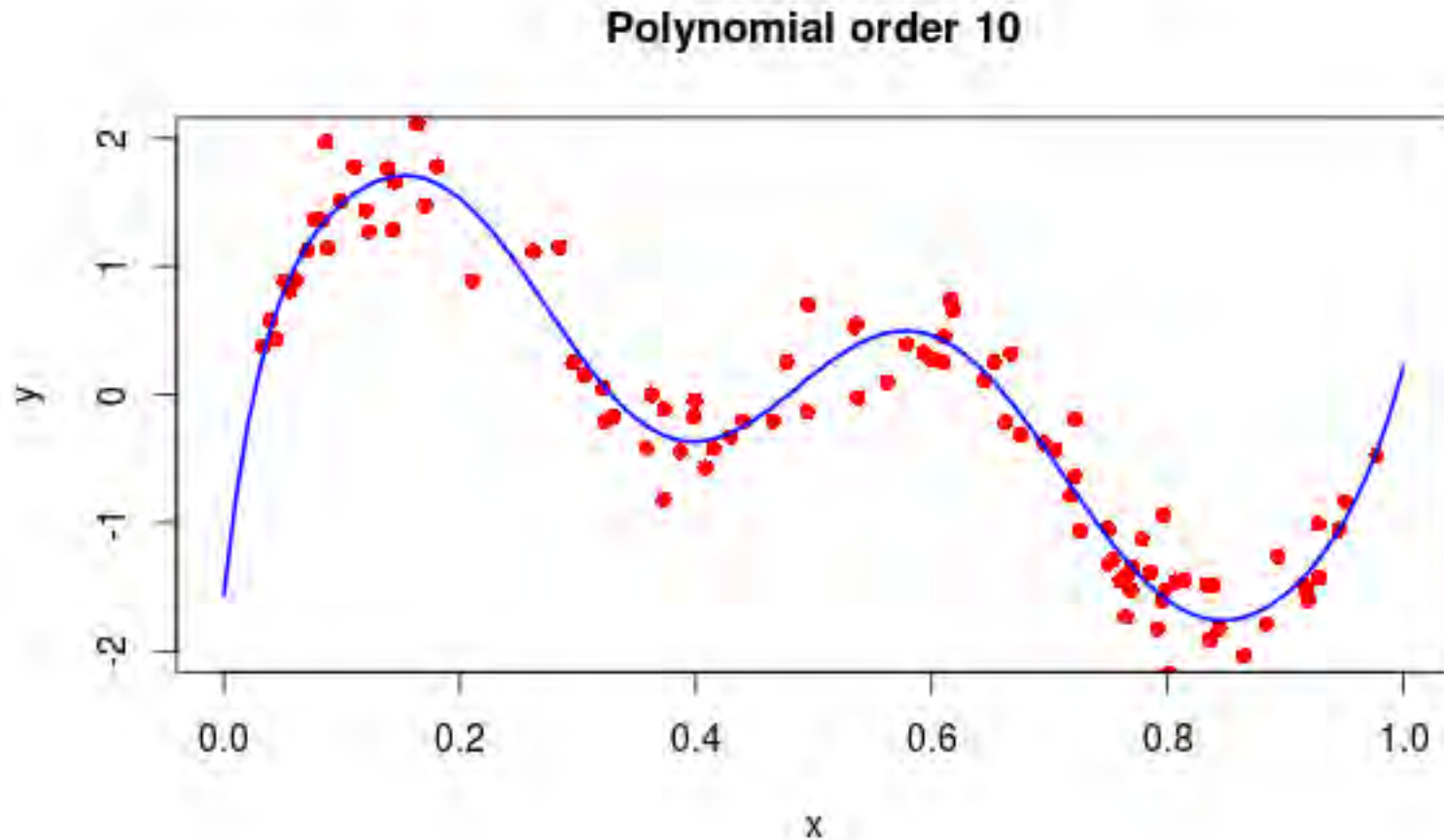
Realism



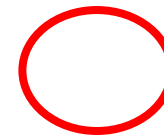
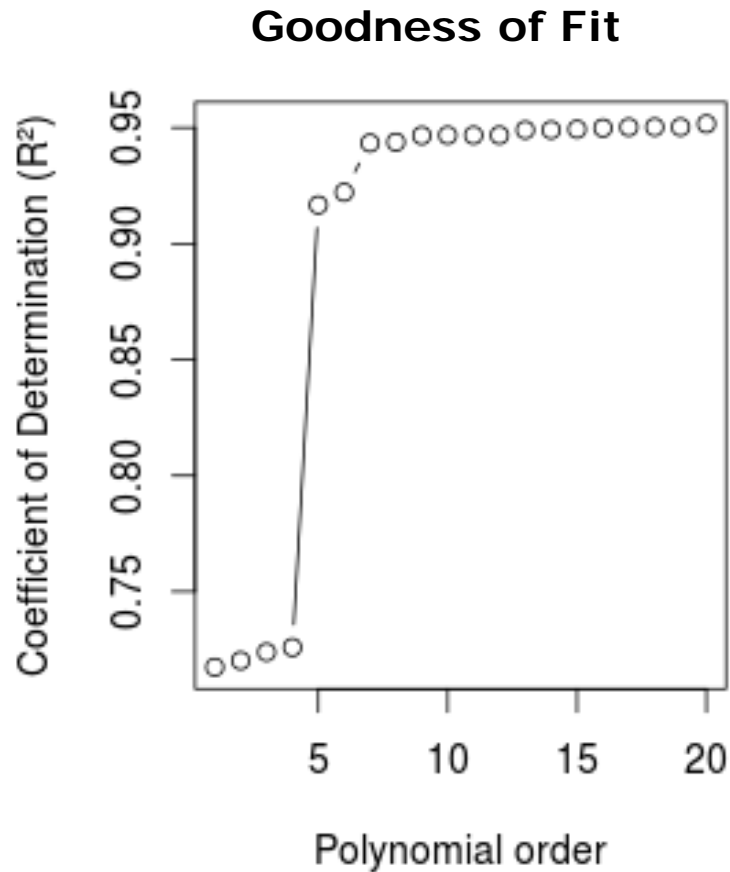
*"...all models are wrong
but some are useful"*

George E.P. Box, 1976

How do we choose the best model?



How do we choose the best model?



Underfitting ← → Overfitting

Information Theoretic Approach

- Aikaike Information Criteria (AIC)

$$AIC = \underbrace{-2 \ln(L)}_{\text{Goodness of fit}} + \underbrace{2K}_{\text{Penalty on number of parameters}}$$

Goodness
of fit

Penalty on number
of parameters

L = likelihood of observations

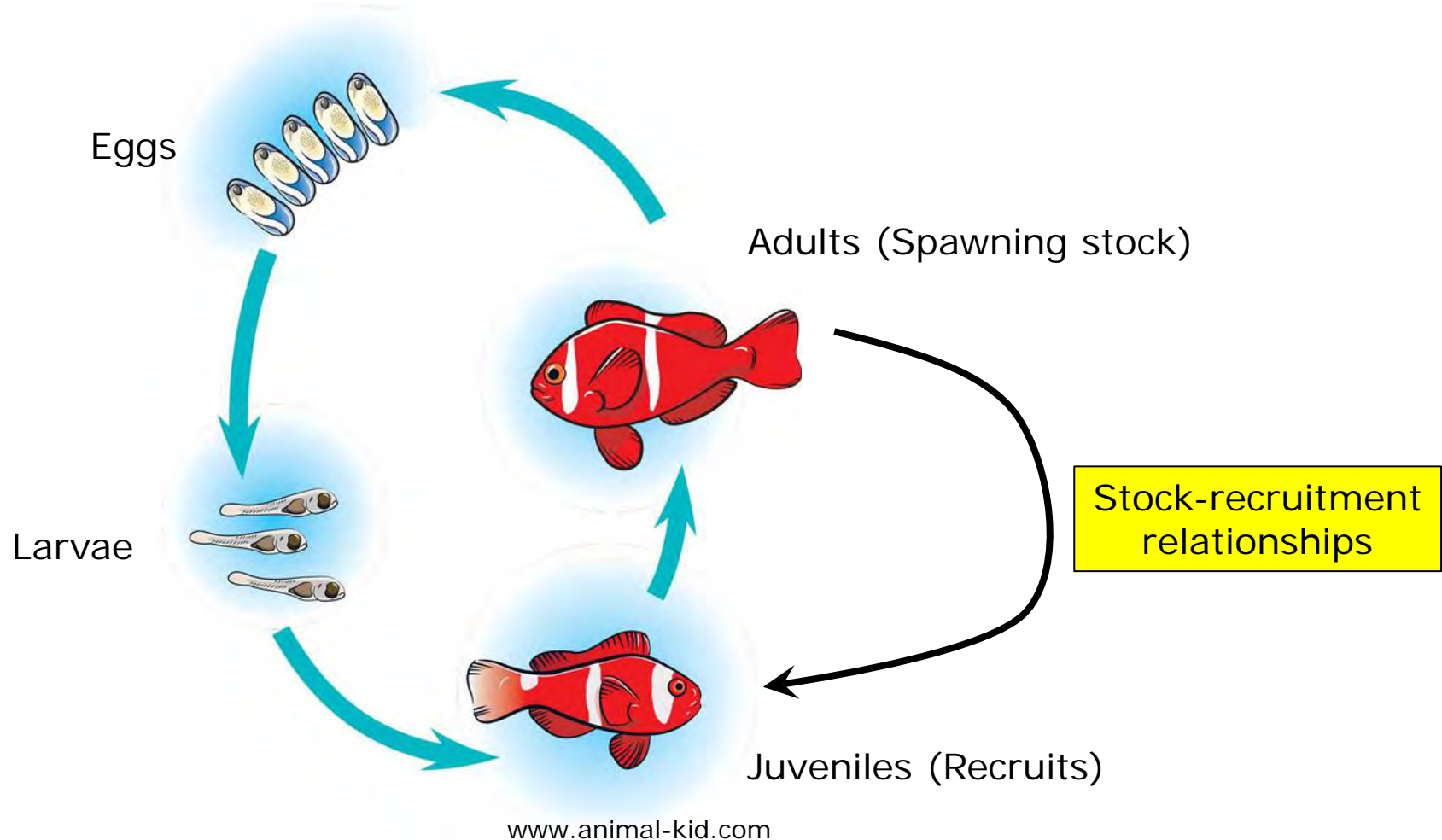
K = number of parameters



Hirotugu Akaike

- Lower AIC = more parsimonious model
- Ranks competing hypothesis
- Generate model ensembles

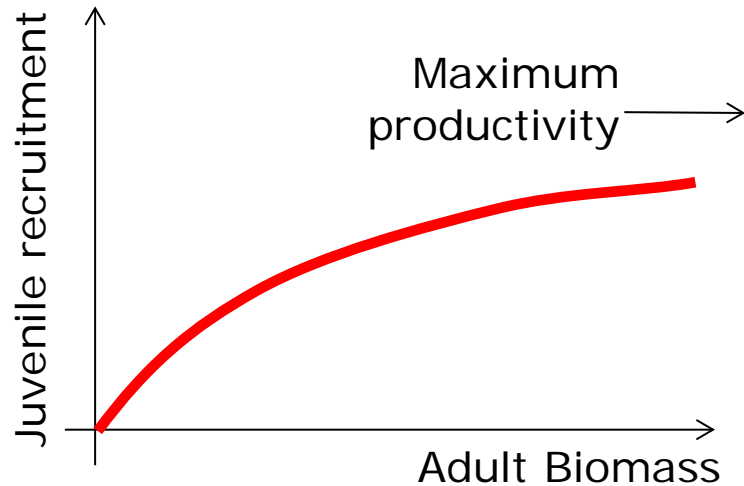
A Worked Example Fish Stock Recruitment



A Worked Example

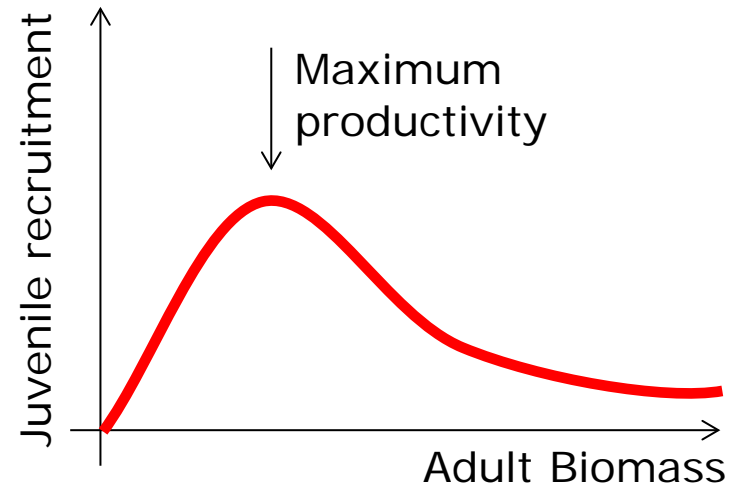
Competing hypotheses

Beverton-Holt



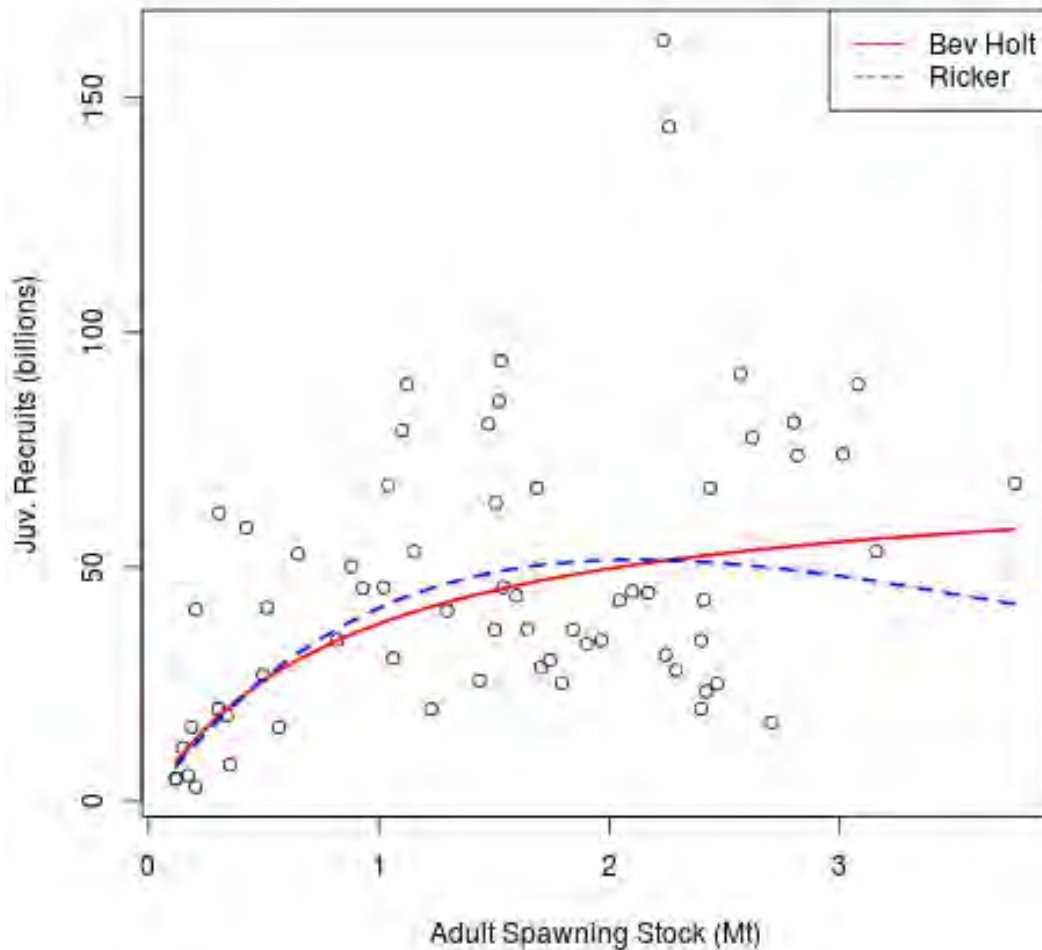
- Carrying-capacity limitation

Ricker



- Scramble competition

A Worked Example North Sea herring



Clupea harengus L.



"Sol over Gudhjem"

A Worked Example

Weights and Evidence Ratios

- AICs

–Beverton Holt	-32.23
–Ricker	-32.20

- Suggest that Beverton-Holt is best

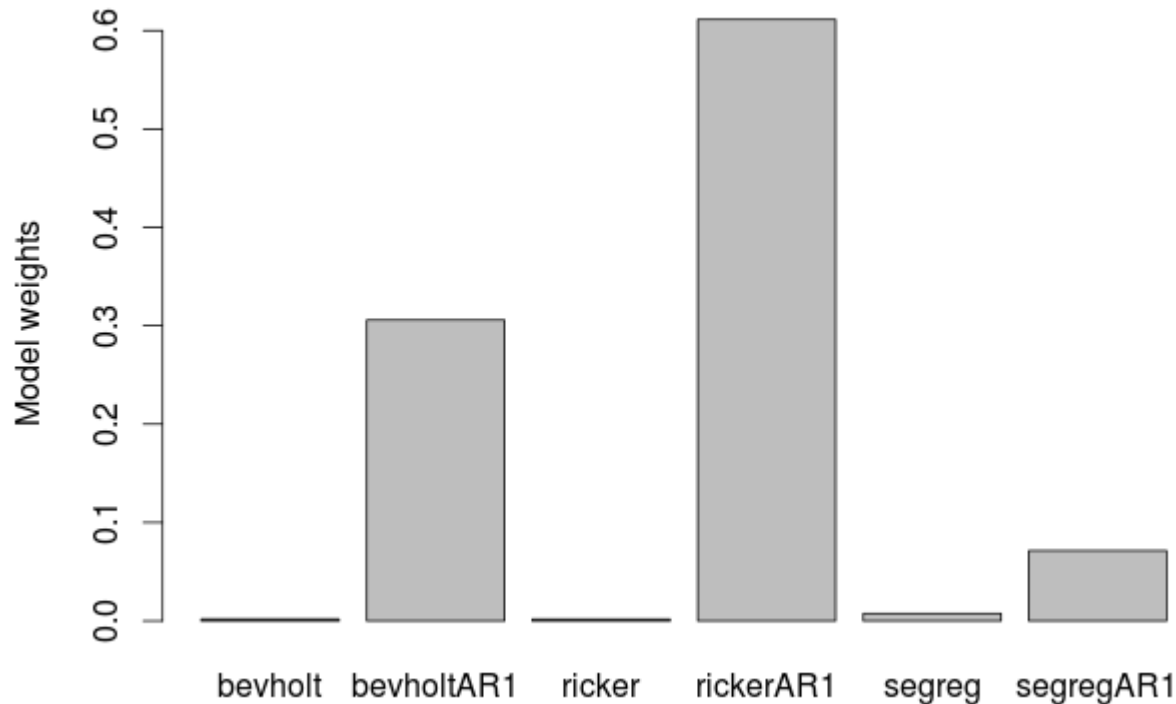
- Convert to "model probabilities"

–Beverton Holt	0.503
–Ricker	0.496

- Evidence ratio = $0.503 / 0.496 = 1.02$

A Worked Example

Multiple Hypotheses (Structures)



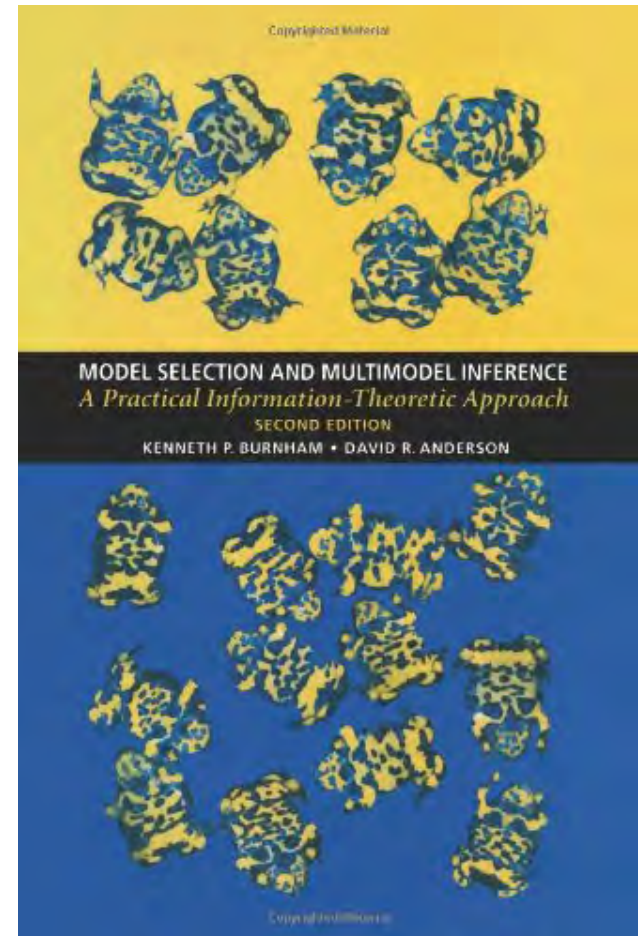
- Use the weights to average models into one multi-model ensemble

In Perspective...

- We can rank competing hypotheses
- Assess relative evidence supporting each model
- Generate multi-model ensembles
- But!
 - Cannot tell us about the absolute quality of a model

If you want to learn more...

Burnham, K. P., &
Anderson, D. R. (2002).
*Model selection and multimodel
inference: a practical information-
theoretic approach*



Acknowledgements



The research leading to these results has received funding from the European Union 7th Framework Programme (FP7 2007-2013) under grant agreement number 308299 (NACLIM project).