Information Theory, model selection and model averaging in R

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Issues with Null-hypothesis testing

- Dependence on sample size
- P-values as measures of evidence
- Null hypothesis is always false
- Arbitrary significance levels

Other approaches

- Information-Theory
- Bayesian

Bayesian

- Use prior information to calculate prior probabilities
- Multiple working hypotheses
- Combines priors with probabilities of obtaining data under the competing hypotheses to produce refined levels of support

Reverend T. Bayes

Information Theory in Ecology

- Burnham and Anderson (and White)

Information Theory

- Simplicity and Parsimony
- Multiple working hypotheses
- ‘Strength of Evidence’

Parsimony

- Occam's Razor
  - *entia non sunt multiplicanda praeter necessitatem*
  - entities should not be multiplied beyond necessity
- In models, R^2 will always be higher with more variables, even if they add no more information

Multiple working models

- Instead of one hypothesis (and the converse null hypothesis), have multiple hypotheses

‘Strength of Evidence’

- Maximum likelihood methods
- Likelihood of the model given the data
- Akaike Information Criterion (AIC)
- “Best model” has lowest AIC

Some definitions

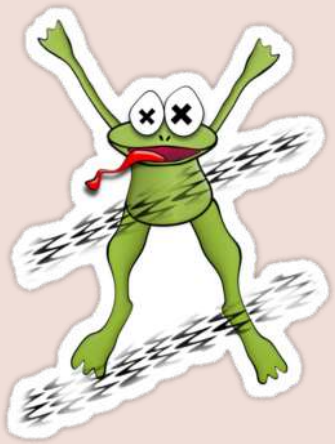
- **AIC_c** AIC corrected for small sample size
- Δ_i = AIC difference = $AIC_i - AIC_{min}$
- w_i = Akaike Weight = probability of model, given the data

Some rules of thumb (from Burnham & Anderson 2002)

Δ_i	Level of Support
0-2	Substantial
4-7	Considerably less
>10	Essentially none

Back to the Frog Roadkill

Landscape Variable	Abbreviation
Open land (ha)	OPEN.L
Montando with shrubs (ha)	MONT.S
Policulture (ha)	POLIC
Shrubs	SHRUB
Water reservoirs (ha)	WAT.RES
Length of water courses (km)	L.WAT.C
Length of paved road (km)	L.P.ROAD
Distance to water course	D.WAT.COUR
Distance to natural park (m)	D.PARK

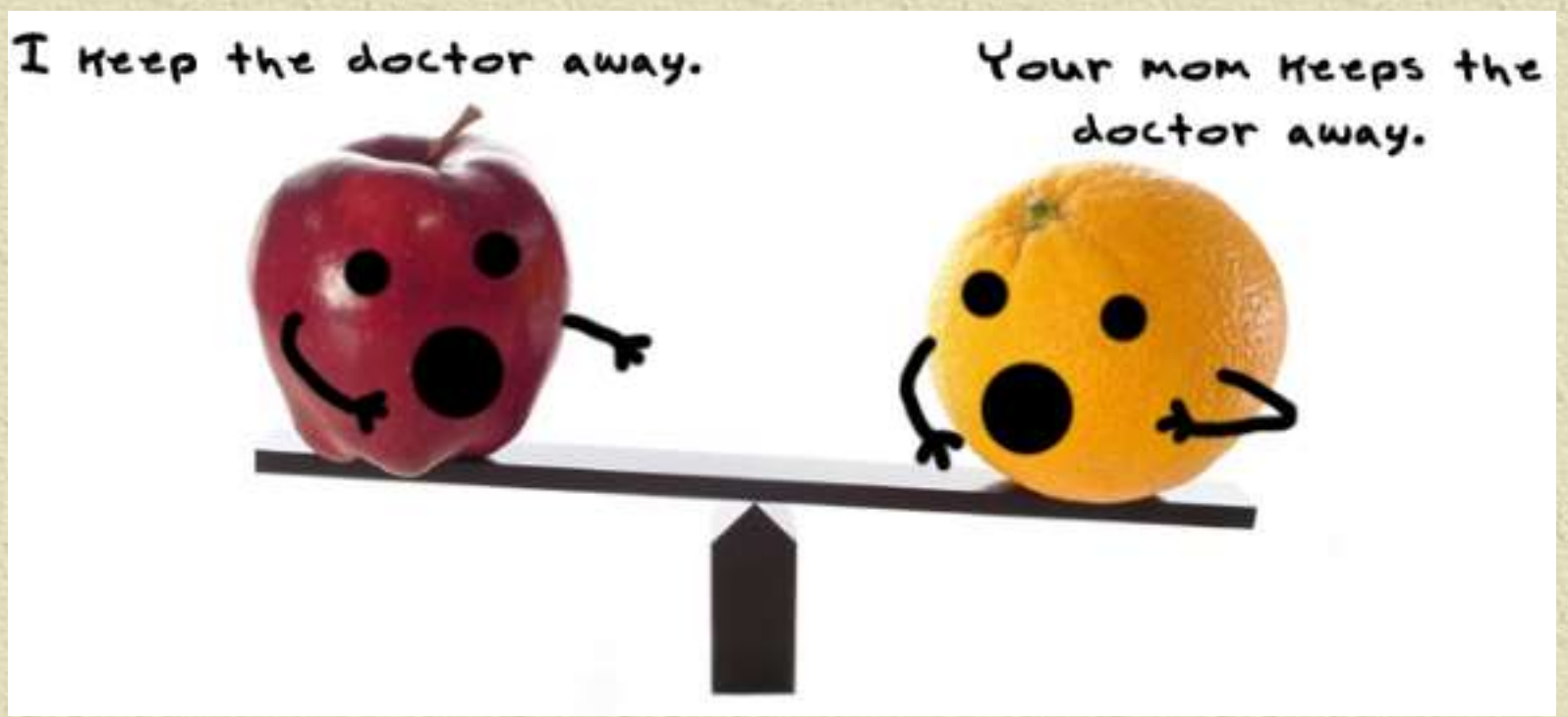


What we do in R?

- MuMIn package
- dredge, either all combinations or restrict by Δ
- Can be used for GLM, GLMM, GAM and GAMM

Standardization

- Make all variables have mean of 0 and SD of 1



Model averaging

- Recognise that there is not one best model
- Give the average value for each parameter weighted by Akaike weights (w_i)

$$w_i = \exp(-\Delta_i / 2) \Big/ \sum_{r=1}^{R} \exp(-\Delta_r / 2)$$

What we do in R?

- MuMIn package
- model.avg
- Gives model-averaged coefficients and relative importance values (sum of w_i)
- Can be used for GLM, GLMM, GAM and GAMM