Bayesian generalised mixed models

with *MCMCglmm*

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$$\boldsymbol{y} = X\boldsymbol{\beta} + Z\boldsymbol{u} + \boldsymbol{\epsilon}$$

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A **mixed model** is a statistical model containing both **fixed** effects and **random** effects.

Fixed effects

Our predictors. Some specific trait of the samples that explain what we measure.

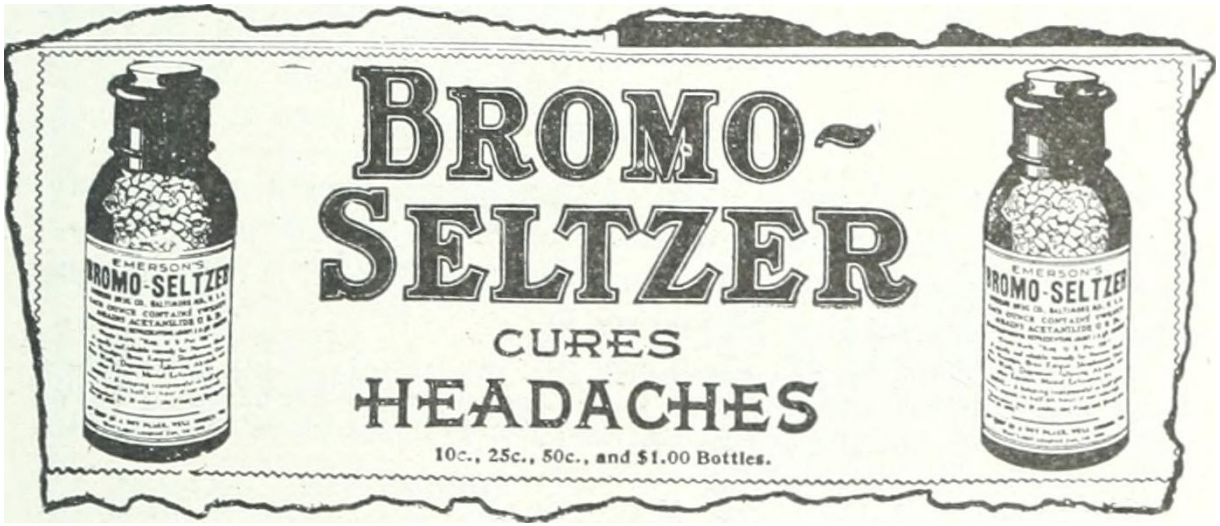
Data has been gathered from all the levels of the factor that are of interest.

Random effects

Some arbitrary ”label” of our measure that add extra variation.

The factor has many possible levels, but only a random sample of levels is included in the data.

Testing a new drug



Fixed effects

Age, sex, pregnancy.

Random effects

Hospital, City, Person.

In a way, we want to control the variation due to uncontrolled (~random) noise, so we can see if the fixed terms have significant effects.

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Bayesian

generalised

mixed models

with *MCMCglmm*

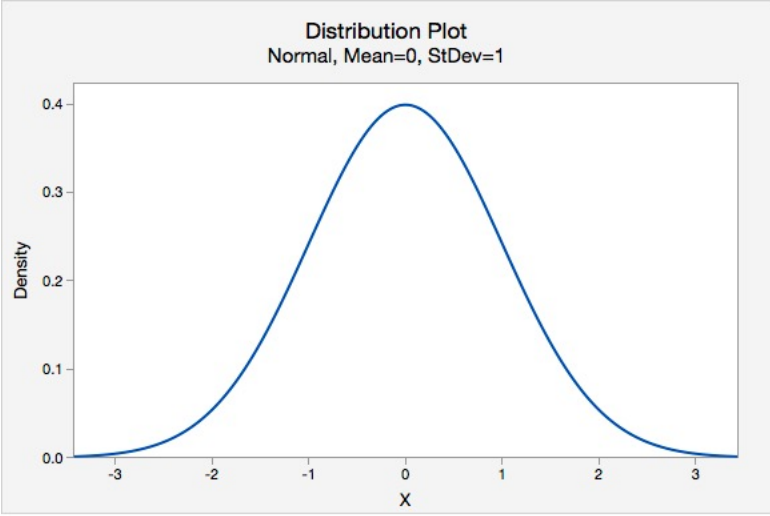
e.g. bear body size

Normal distribution

Poisson distribution

Binomial distribution

…



Bayesian
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Bayesian *data analysis*

generalised

mixed models

with *MCMCglmm*

- Can deal with very complex problems
  (i.e. estimate many parameters at once)

- The best way to estimate uncertainties in the data and parameters
  (Very efficient way to get credible intervals around your parameters)

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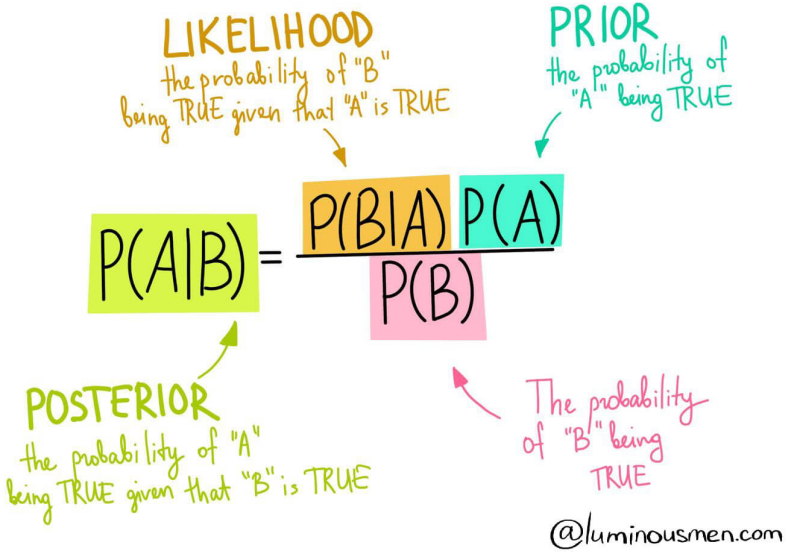
BAYES THEOREM



[Can you solve the false positive riddle?](#)
by *Alex Gendler*

TEDEd

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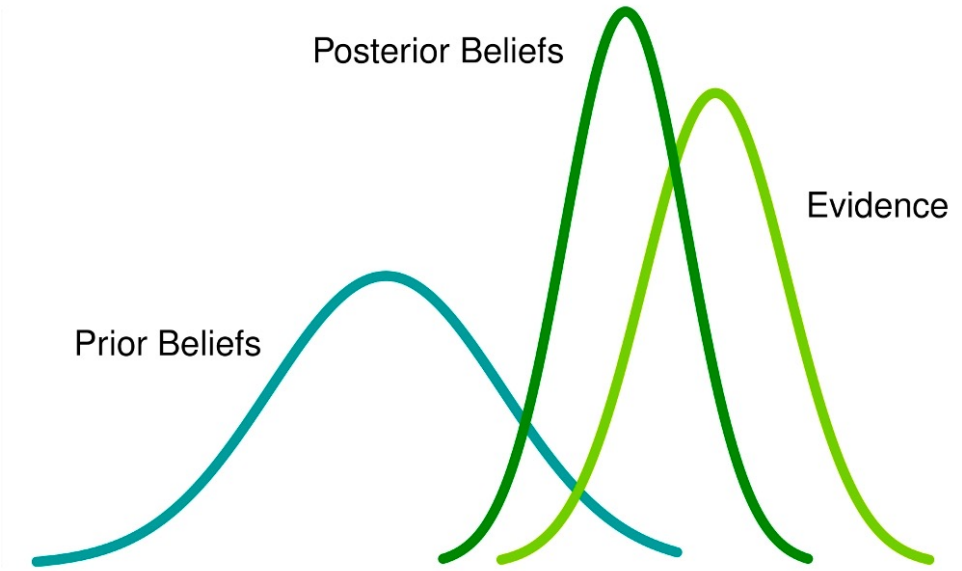
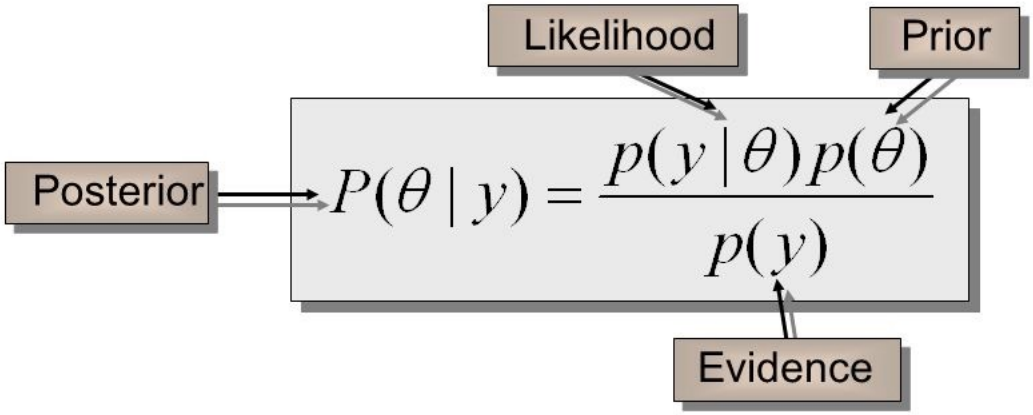
BAYES THEOREM

[Monty Hall Problem (extended math version)]

Hint: Always switch!





The **posterior probability** is proportional to **prior probability** multiplied by the **likelihood**. The frequentist approach only deals with the likelihood.

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Advantages:
- conceptually coherent (we can test a hypothesis given the data)
- very complex models possible

Disadvantages:
- not always clear how to determine the priors
- computationally intensive (e.g. Markov chain Monte Carlo algorithm)

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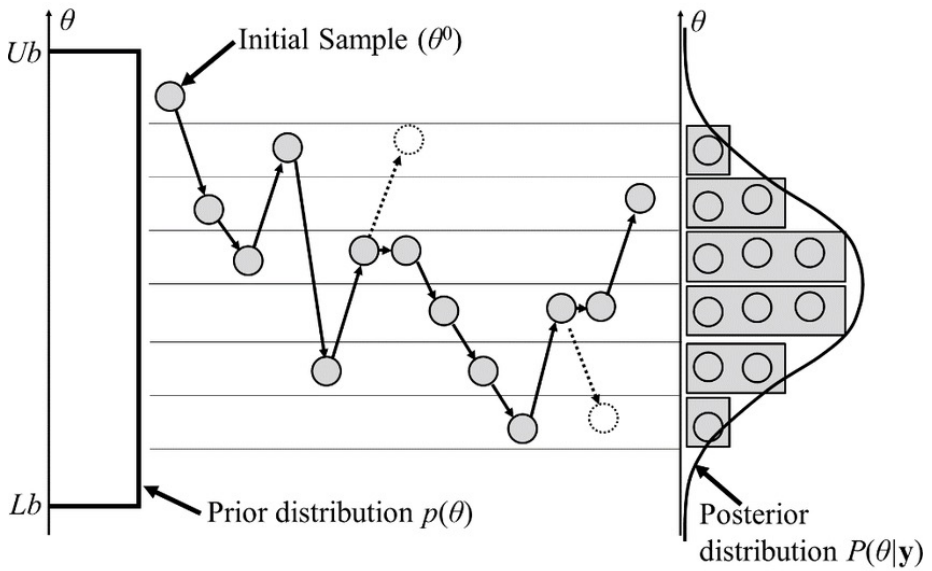
Markov chain Monte Carlo



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Chocolate hills example
https://www.youtube.com/watch?v=XV4yj4T4PBQ

Tutorial: Pigeons & Doves

Example data from Lapiedra *et al.*, (2014) *Proc Royal Soc B*

https://doi.org/10.1098/rspb.2012.2893

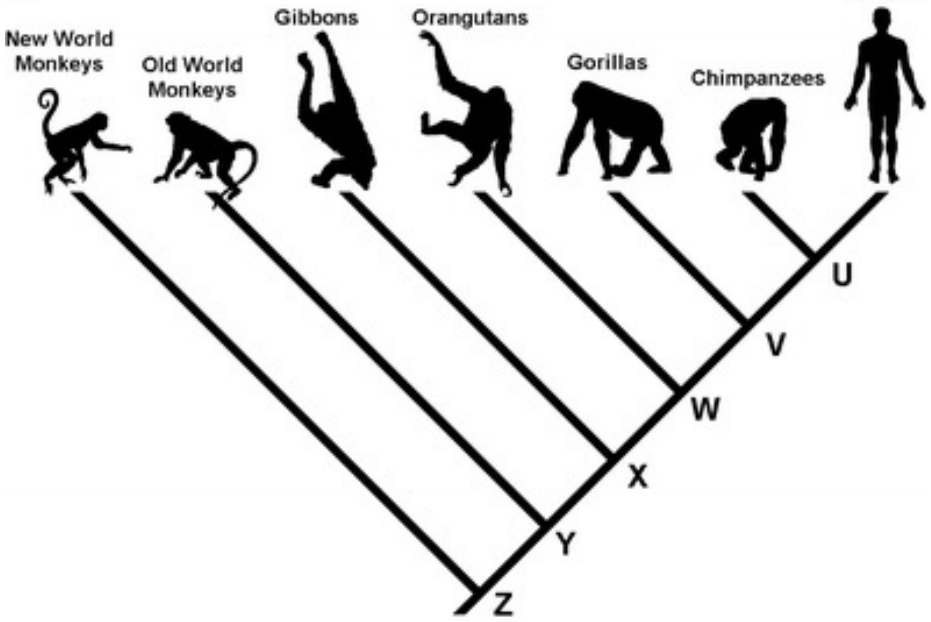
Terrestrial species

Arboreal species

Phylogenetic autocorrelation

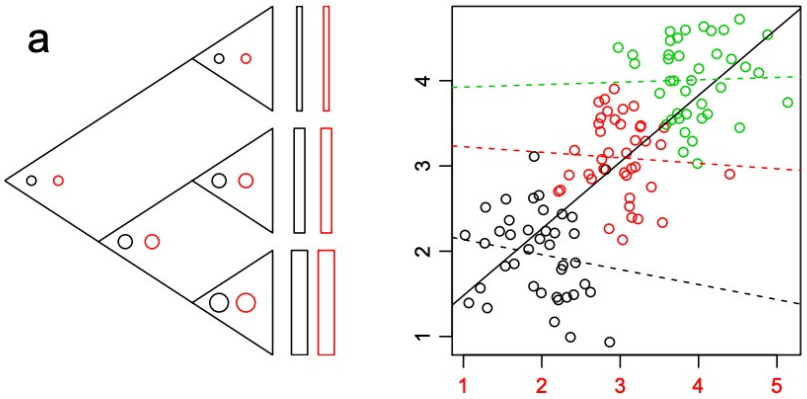
"Everything is related to everything else, but near things are more related than distant things".

Waldo R. Tobler



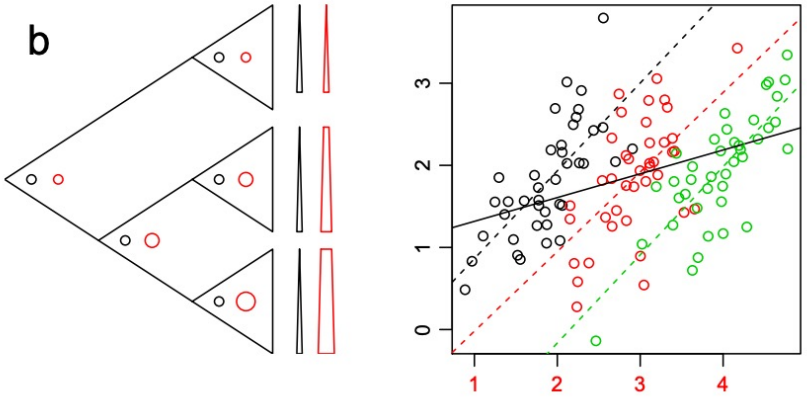
Phylogenetic autocorrelation

caper R-package (Orme, D. *et al*., (2013)



Simple regression (solid line) suggest strong relationship

No consistent relationship (dashed lines) within groups.

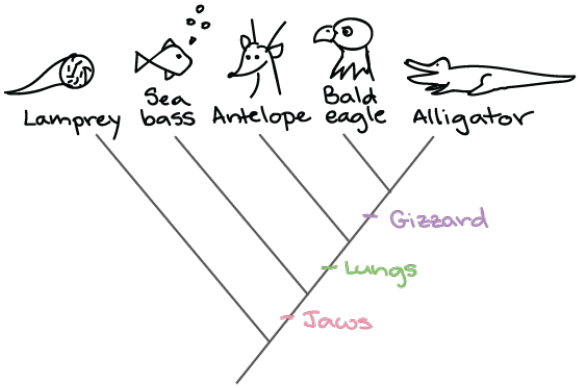


Simple regression (solid line) suggests weak relationship

Strong positive relationships between the traits within groups.

Phylogenetic autocorrelation in MCMCglmm

What we need?



animal	jaws	lungs
Lamprey	no	no
Sea bass	yes	no
Antelope	yes	yes
Bald eagle	yes	yes
Alligator	yes	yes

- A phylogenetic tree (*pedigree*)
- Names in data matching tip labels (*animal*)

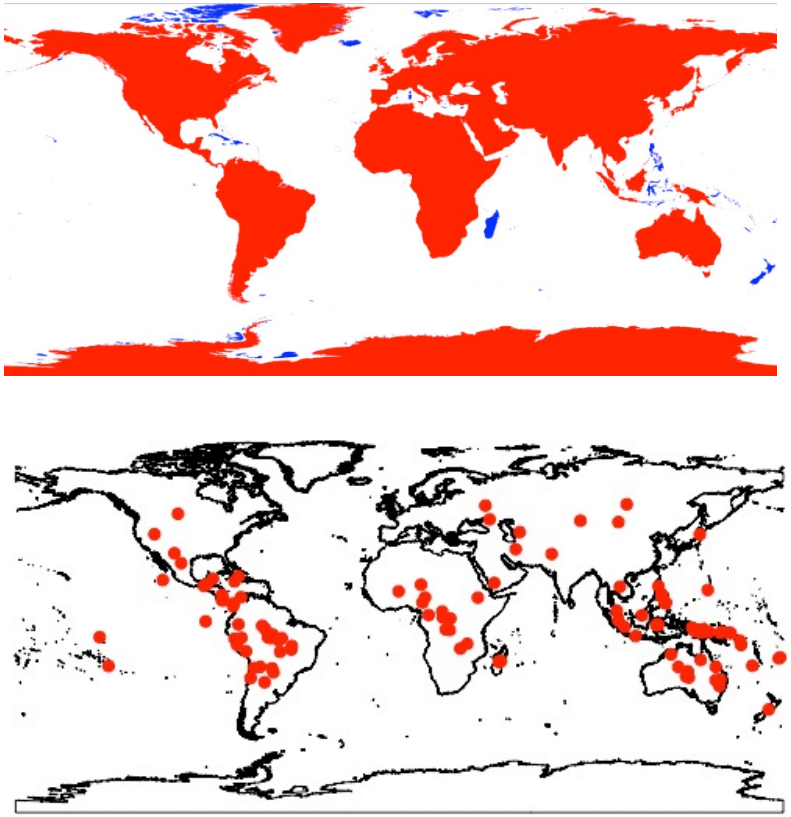
Combining Spatial analysis and MCMCglmm

- We can infer some species characteristics with spatial analysis

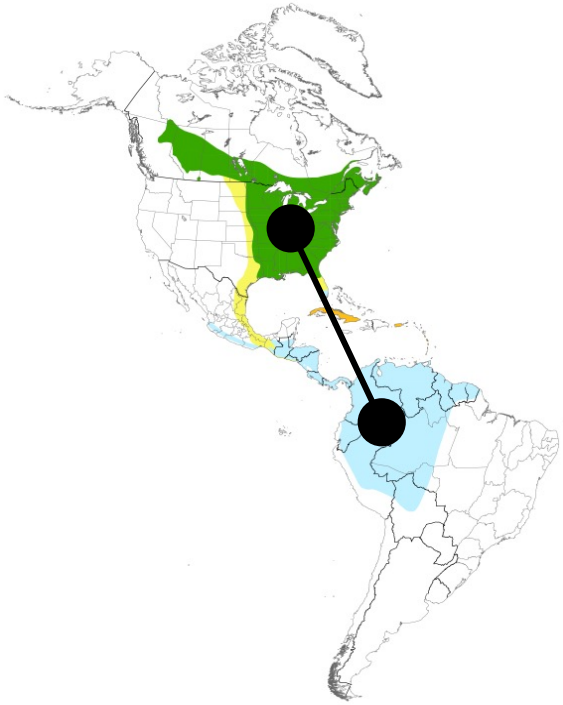
- We can them use this to run our analysis in MCMCglmm

Combining Spatial analysis and MCMCglmm

Island species



Migratory species



Thank you for attending!

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UCL

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