Readings

- Ecology
  - Biological modeling: [Bul] , [HilMan] (data applications).
  - Phylogenies and birth-death models: [Etienne], [Nee].
- Math
  - Stochastic differential equations modeling: [Wil], [Pellin] (applied to cell differentiation).
  - GLM: [DobBar].
  - DGlars: [Augugliaro].

Some first steps

We define

- X_t: Number of species on time t.
- λ: Speciation rate.
- δ : Extinction rate.
- T_i: Time when the event i (speciation or extinction) occurs.
- $T^{(\lambda,j)}$: Random variable corresponding to the time when an speciation occurs after the event $j-1$.
- $T^{(\delta,j)}$: Random variable corresponding to the time when an extinction occurs after the event $j-1$.

We assume that λ and δ are constant. We also assume that any species have same probability to speciate and same probability to get extinct, moreover for any $j \in \{1, 2, ..., X_{j-1}\}$ we have

$$T^{(\lambda,j)} \sim exp(\lambda)$$

and

$$T^{(\delta,j)} \sim exp(\delta)$$

then

$$T_i \sim exp(X_{T_{i-1}}(\lambda + \delta))$$

Given the whole phylogenic tree (data), we are interested in estimate λ and δ. For that, three methods are sugested:

- MLE
- Bayesian inference
- Method of moments

References

[HilMan] R. Hilborn and M. Mangel. *The Ecological Detective, Confronting models with data*, 1997.

[Bul] M. Bulmer. *Theoretical Evolutionary Ecology*, 1994.

[Wil] D. J. Wilkinson. *Stochastic Modelling for Systems Biology*, 2006.

[DobBar] A. J. Dobson, A.G. Barnett *An Introduction to Generalized Liner Models*, 2008.

[Etienne] R. S. Etienne et al. *Diversity-dependence brings molecular phylogenies closer to agreement with the fossil record*, 2011.

[Nee] S. Nee. *Birth-Death Models in Macroevolution*, 2006.

[Pellin] P. Pellin et al. *A stochastic model for cell differentiation, efficient parameters estimation and model selection*, 2016.

[Augugliaro] L. Augugliaro, A.M. Mineo and E.C Wit. *Differential geometrix least angle regression: a differential geometric approach to sparse generalized models*, 2012.