A very small intro to Diversification Models

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Diversification in Macroevolution

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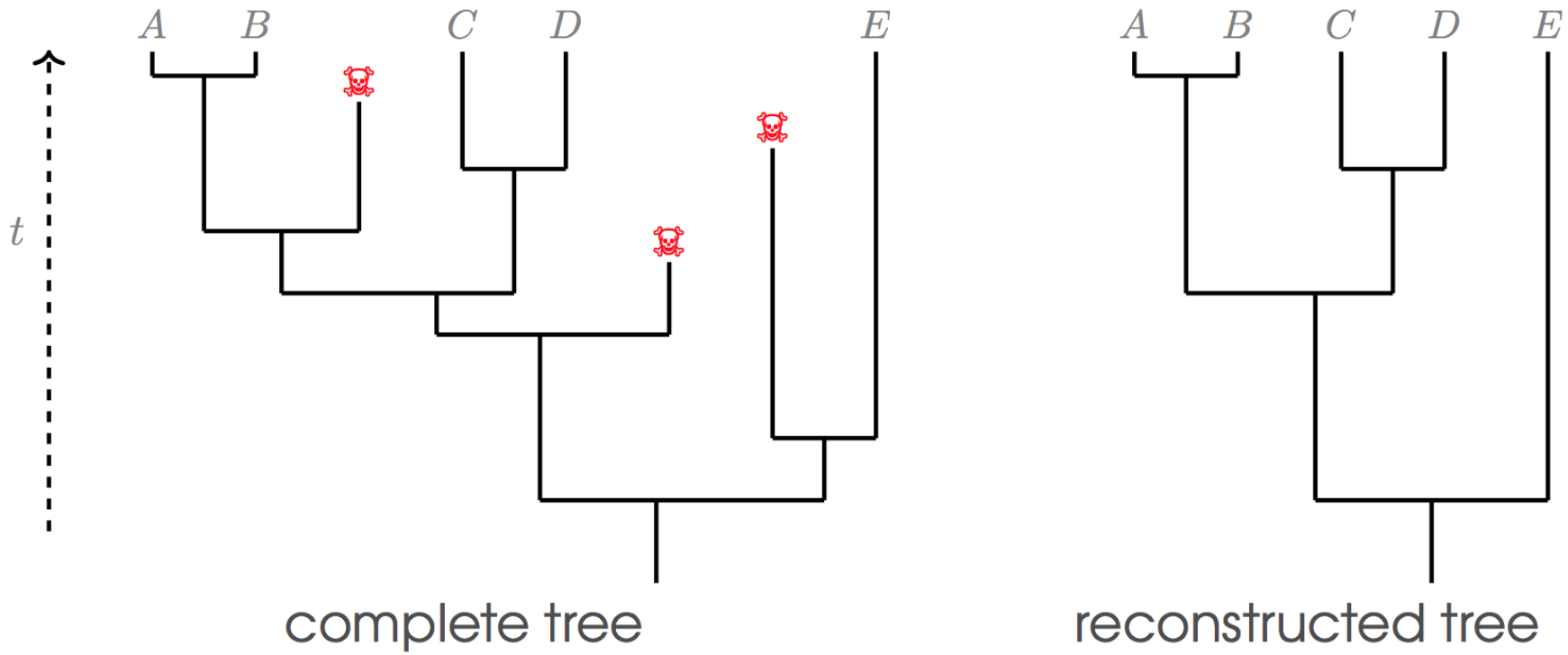
Questions of trait evolution are intrinsically linked with diversification

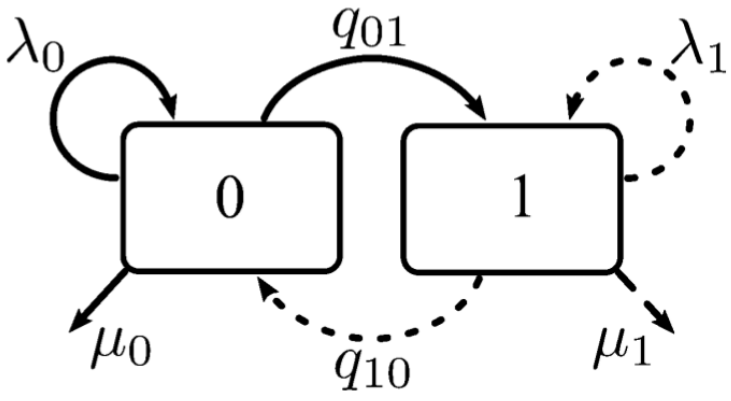
The Birth-Death model

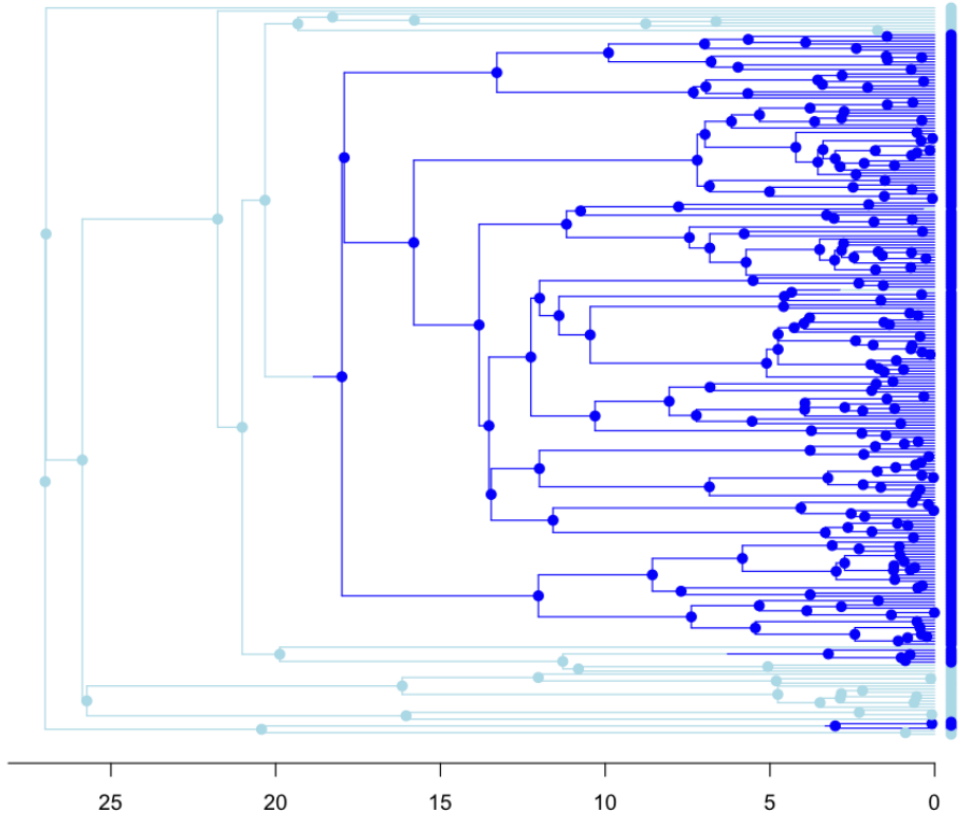
- Continuous Time Markov Chain. Create a new lineage with rate λ and a lineage goes extinct with rate μ



State dependent diversification models

- State diversification models are birth and death models + trait evolution models





Mathematics of BiSSE are more complex

Since the number of lineages that speciate or go extinct are infinite, the Q-matrix that BiSSE defines is infinite!

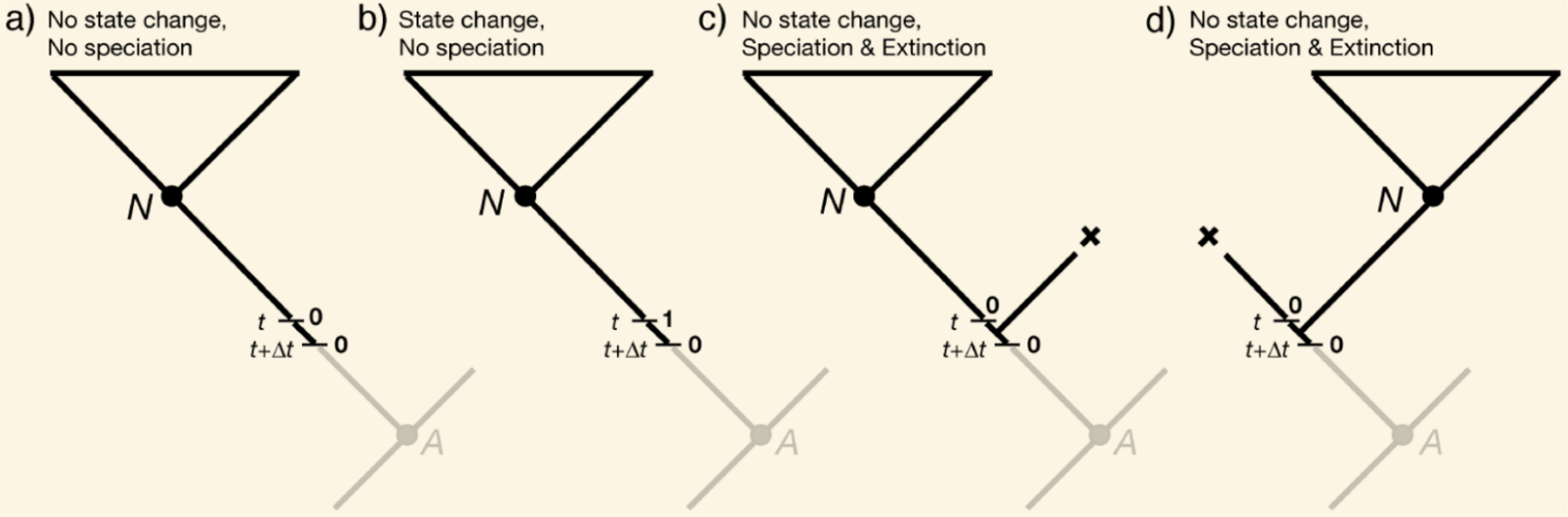
$$Q = \begin{pmatrix} - & \lambda_0 & 0 & 0 & \infty \\ \mu_0 & - & \lambda_0 & 0 & \infty \\ 0 & \mu_0 & - & \lambda_0 & \infty \\ \vdots & \ddots & \ddots & \ddots & \infty \end{pmatrix}$$

And we need the exponential?

Calculating the probabilities of a BiSSE (and any SSE)

Remember that the Q is the derivative of the probabilities so that defines a series of equations

Within branches



$$\frac{dD_{N0}(t)}{dt} = -\left(\lambda_0 + \mu_0 + q_{01}\right) D_{N0}(t) + q_{01} D_{N1}(t) + 2\lambda_0 D_{N0}(t) E_0(t)$$

$$\frac{dD_{N1}(t)}{dt} = -\left(\lambda_1 + \mu_1 + q_{10}\right) D_{N1}(t) + q_{10} D_{N0}(t) + 2\lambda_1 D_{N1}(t) E_1(t)$$

Diversification Models in RevBayes

We are going to connect two models as building blocks
The discrete trait model with a birth-death model

Potential pitfalls of state dependent diversification models

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- Diversification rates are in most of the cases heterogeneous by default (Beaulieu and O'Meara, 2016)
- Spurious significant differences in diversification can be the result of a single shift of trait (Maddison and Fitzjohn, 2015)