Practice problem set
Systematics
April 2, 2009

1. Decide whether each of the following processes satisfy the Markov property.

a. Brownian motion - YES

b. $x_i = x_{i-1} + N(0,1)$ - YES

c. $x_i = \frac{x_{i-1}}{x_{i-2}}$

NO

d. Birth-death model - YES

e. A person shooting free throws - NO

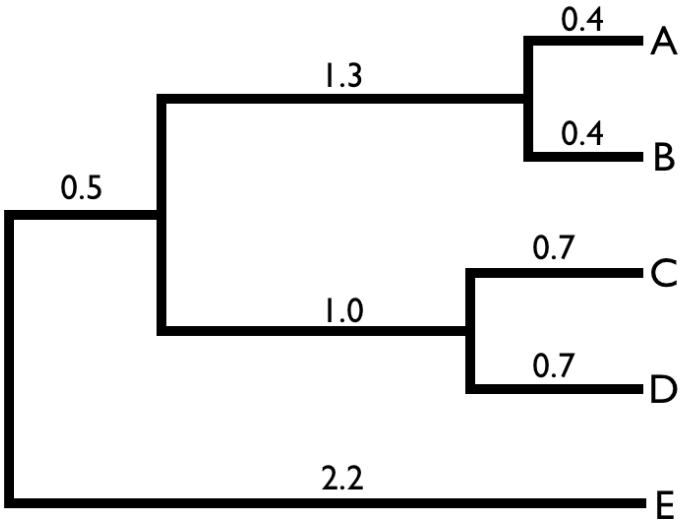
f. Flipping a coin - YES

2. There is a five-species phylogeny with branch lengths below.

a. Calculate the imbalance of this tree

$$I_c = \frac{\sum |T_R - T_L|}{\frac{(n-1)(n-2)}{2}} = \frac{(1-1)+(1-1)+(2-2)+(4-1)}{\frac{(5-1)(5-2)}{2}}$$

$$= \frac{3}{6} = 0.5$$



b. What is the probability of obtaining the (1,4) split observed at the root node of this tree in an ERM model?

n=5, k-1

$$\Pr[(n,k)] = \frac{2}{n-1} = \frac{2}{4} = 0.5$$

3. You fit pure-birth and birth-death models to a large phylogeny of lizards, and obtain the following results:

pure-birth model, lnL = -123.4

birth death model, lnL = -110.8

Carry out a model selection test on these results (there are two possibilities). What do you conclude?

Likelihood ratio test, 1 d.f.:

$$\Delta = 2(\ln L_1 - \ln L_2) = 2(-110.8 - -123.4)$$

$$\Delta = 25.2$$

$$P < 0.0001$$

AIC:

$$AIC_1 = 2k - 2\ln L_1 = 2(1) - 2(-123.4)$$
$$AIC_1 = 248.8$$
$$AIC_2 = 2k - 2\ln L_2 = 2(2) - 2(-110.8)$$
$$AIC_2 = 225.6$$

Either way, you can strongly reject the pure-birth model in favor of birth-death.

4. Data corresponding with the tree in question 2 are below.

Species	Trait value
A	2.3
B	3.1
C	4.5
D	3.2
E	6.0

a. Calculate a set of standardized independent contrasts for these data.

-1.4591692, -0.6812012, -0.8944272, 1.0987005

b. Estimate the rate of evolution in this clade (σ^2), assuming a Brownian motion model.

1.150088