Phil 5330 Fall 2017
Fourth Assignment

Part I: Find the book *Tree Thinking: An Introduction to Phylogenetic Biology* on Blackboard. Do the following problems:

Chapter 7 (exercises start on page 115 of the pdf): 1, 2, 3, 4, 6, 7, 12, 15.

For problem 12, they do not give you the state of the outgroup. For purposes of counting, for each tree you should assume that the ancestral state of a trait is whatever would minimize the number of changes required on that tree. For example, trait 1 on tree 1 requires a minimum of one total change – that is possible if T is the ancestral state.

Part II: Look at pages 203 and 204 in Sober's *Reconstructing the Past*.

2.1) What is the probability of a given character resulting in a 000 distribution on this tree? (Please leave your answer in a readable form similar to Sober's on page 204). Explain how you got your answer. HINT: Your answer should be a sum of the probabilities of all of the possible ways of ending up in 000. Each possible way of getting an outcome is itself a conjunction of this happened AND this happened AND ... and so to find the probability of one of those conjunctions, you multiply the probability of each of the conjuncts.

A reasonable way to check your answer is to make sure that if evolution is impossible (so that $e_1 = e_2 = e_3 = 0$) then P(000) = 1. Notice this also means that P(110)=P(101)=...=0 which it does if you look at Sober's formulas.

2.2) Now imagine that reversions are impossible. That is, once a trait goes to 1, it is impossible to go back to zero. Now what is the probability of ending up in 110? How about 101? If you did this right, it should be fairly easy to see that P(110) > P(101) [remember that since $e_3 < 1$, $e_2 * e_3 < e_2$].

2.3) Assume that all of the branch transition probabilities are ½ . So e_1 is ½, r_3 is ½, etc. Now what is the probability of ending up in 000? How about ending up with 110 (use Sober's formula here). You should get the same answer. Can you explain why it is the same and also why it is the particular number that it is?

2.4) Sober says on page 204 that "(110) exceeds (101) precisely when ..." and then gives a condition which is going to be almost always true (though notice that my question 2.3 violates this). Explain very carefully what this condition and the entire context/setup of these pages has to do with the question of whether Parsimony is statistically consistent?

Part III:
3.1) Evaluate the following argument: If homoplasy was extremely rare, then the most Parsimonious tree would be the true one. Therefore the Parsimony method assumes that

homoplasies are rare.

3.2) Imagine a defender of Parsimony reading Felsenstein's 1978 "Misleading Parsimony Methods" paper and responding with "I don't care about this paper, Felsenstein's model is unrealistic." On page 408, Felsenstein basically gives his answer by accepting that his model is unrealistic, but that this result is important anyway. And he ends his paper by saying that "if phylogenetic inference is to be a science, we must consider its methods guilty until proven innocent." What is he talking about when he says "guilty" and "innocent" and what does that have to do with his paper and responding to the criticism by the defender of Parsimony given above? Do you agree with Felsenstein here? The defender of Parsimony? Or do you have some third answer? (This is not just a yes/no question. Explain your answer).

Part IV:
(Question based on one due to Mike Titelbaum) Pink gumballs always make my sister sick. (They remind her of Pepto Bismol.) Blue gumballs make her sick half of the time (they just look unnatural), while white gumballs make her sick only one-tenth of the time. Yesterday, my sister bought a single gumball from a machine that's one-third pink gumballs, one-third blue, and one-third white. She got sick.

4.1) According to the Law of Likelihood, how does this observation bear on the hypotheses that it is pink, blue, or white? [Be careful! Remember that the Law of Likelihood says that favoring is contrastive].

4.2) Use Bayes' Theorem to determine how confident I should be that my sister's gumball was pink, blue, or white given that it made her sick.

4.2) Look at some proposed Bayesian measures of confirmation on page 16 of *Evidence and Evolution*. According to the difference measure, what is the degree of confirmation of pink, blue, and white? How about according to the ratio measure?

Due Date: You must submit your homework to me by email Monday, Nov 27th at 4:00pm. Any easily readable format such as .pdf or .docx is okay.

Collaboration: Collaboration on this assignment is encouraged. Students are free to discuss the topics with one another, read each other's papers, and offer suggestions. The only restriction is that each student must do their own work and write their own paper containing their own ideas and words.