Homework 8

Math 469 (section 500), Spring 2019

This homework is due on Thursday, March 7.

0. *(This problem is not to be turned in.)*
   (a) Read Section 3.1
   (b) Skim Sections 3.2–3.6 (see problem 1 below).
   (c) Read Section 3.7
   (d) Explore `opentreeoflife.org`

1. Is anything in Sections 3.2–3.6 related to the paper you are reading for the final project? Explain briefly.

2. Assume the hypotheses of the Hardy-Weinberg Law (Theorem 3.2) for a gene with alleles A and a. Assume that after one generation, 16% of the population has genotype aa.
   (a) What percentage of the population (after one generation) has genotype AA? What percentage has Aa?
   (b) If originally 10% of the population had genotype aa, what percentage originally had AA? What percentage had Aa?

3. The following 5×5-matrix D has two unknown parameters x and y:

$$D = \begin{pmatrix} 0 & 4 & 10 & 8 & 7 \\ 4 & 0 & 12 & 10 & 9 \\ 10 & 12 & 0 & x & 7 \\ 8 & 10 & x & 0 & y \\ 7 & 9 & 7 & y & 0 \end{pmatrix}.$$

   Draw the set of all points (x, y) in the plane for which D is a metric. In your diagram, mark all points (x, y) for which D is a tree metric.

4. Let d be the metric which gives the pairwise distances (in miles) among the four cities College Station, Dallas, Austin, and Houston. Build a phylogenetic tree on these "taxa" by applying the Neighbor-Joining Algorithm to d.

5. Read the first three pages of Michael Reed's article, "Why Is Mathematical Biology So Hard?", available at `https://www.ams.org/notices/200403/comm-reed.pdf`. Which issues that he brings up (for instance, no fundamental laws of biology or the problems of levels) are relevant for the paper you are reading for your project? *You may complete this problem together with your project partner – if so, only one of you needs to turn in this part, but state clearly on both homeworks that you are doing this.*