Evolutionary Dynamics: Population Genetics and Ecological Models

WS 2019/2020   course number: MA4453-KP05

Christmas assignment   due: January 14

The points you can get by solving the following exercises are bonus points.

Reindeer coalescent (4 extra P.)

Santa Claus got the genomes of three of his reindeers sequenced. Here, you can see the results for a small stretch of their DNA:

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Rudolph:	AGTCACAACGC
Comet:	ATTCACAACGT
Donder:	ATTCACAAGGT

Draw the coalescent tree for which the minimum number of mutations is required to obtain the observed pattern.

The mutation for red nose color (4 extra P.)

The nose color of reindeers is determined by a single locus. The allele for red nose color is R, and the allele for black nose color is B. Allele B is dominant, i.e. only reindeers that are homozygous for the R allele have red noses.

   Rudolph, the red-nosed reindeer, and Dancer (who has a black nose) fell in love, and Dancer will soon give birth to a baby reindeer. Santa Claus wants to know the probability that the baby will have a red nose. Unfortunately, he did not get Dancer's genome sequenced. However, he has the following information about Dancer's family tree.
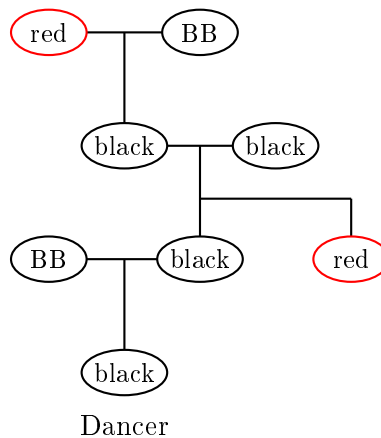
Dancer

Show that the probability that Dancer's and Rudolph's baby has a red nose is $\frac{1}{6}$.

The reindeer microbiome (4 extra P.)

Scientists have discovered that reindeers whose gut microbiome contains the bacterium *B. volans* can fly longer distances than those whose microbiome does not contain this species, probably due to its effect on hay digestion. Santa Claus therefore adds a small inoculum of *B. volans* to the food of his reindeers. Each of them receives 100 bacterial cells. The rate of cell division of an ingested *B. volans* cell is 1.02 while rare. The death rate is 1. What is the probability that a population of *B. volans* successfully establishes in a given reindeer? What is the probability that the treatment is successful in all of his nine reindeers at the first try? How large would he need to choose the inoculum such that the chance that all reindeers contain an established *B. volans* population after the first treatment is 90%? Determine the solution numerically.