Feedback — Quiz 1: Real, Observed, and Expected Change (manual)

Help Center

You submitted this quiz on **Thu 18 Jul 2013 10:31 AM PDT**. You got a score of **3.00** out of **3.00**.

Question 1

Preparation

In this exercise you will perform an analog simulation (!) of the evolution of a short piece of DNA. It is the aim to show you that (1) not all substitution events are detected when directly comparing sequences (the problem of multiple or superimposed substitutions), (2) we can compute how much observable change we would expect if a certain amount of actual change takes place, (3) we can also use the formula from (2) in reverse, and calculate how much actual change there probably was based on an observed difference.

You will need the following:

- An ordinary six-sided die (or, alternatively, this web-based dice roller)
- A starting sequence + site-selector table (print or make your own on a piece of paper; explanation will follow): [Download link]

First die roll:	1-3						4-6					
Second die roll:	1	2	3	4	5	6	1	2	3	4	5	6
Sequence:	A	A	A	A	A	A	A	A	A	A	A	A

- A mutation table: [Download link]

Mutation table:

Initial nucleotide	die roll 1-2	3-4	5-6
A	C	G	T
C	A	G	T
G	A	C	T
T	A	C	G

Simulation

You will now simulate the evolution of a short stretch of DNA (12 bp) that is evolving along a branch in a phylogenetic tree according to the Jukes and Cantor model (all substitutions are equally likely). Let us assume that the branch corresponds to, say, 100 million years of evolution, and that during this timespan 8 substitution events will occur in our 12-bp piece of DNA. This is the same as saying that the branch length is 8 substitutions per 12 sites, or 0.67 substitutions per site. Use the following equation to compute how much observable change (D) you would expect given that the actual distance (d) is 0.67 substitutions per site:

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- **Question:** What is the expected amount of observable change (D), when the actual amount of change (d) is 0.67?

You entered:

0.443

Your Answer		Score	Explanation
0.443	✔	1.00	
Total		1.00 / 1.00	

Question 2

- **Determine site of substitution:** Roll the die two times. The first roll selects one particular 6-bp stretch of the sequence (1-3 selects the first half, 4-6 selects the second half). The second roll selects one specific site within the chosen stretch of 6 bp. This selection scheme is also indicated schematically above the sequence. Make sure to note which site you selected.
- **Determine new nucleotide at site:** Roll the die again and use the mutation table above to select the new nucleotide. In each case the interpretation of the roll depends on the nucleotide that is present at the site initially (e.g., if the original nucleotide is A and you roll a 3, then the new nucleotide should be G). Write the new nucleotide in the proper place below the sequence.
- **Repeat 8 times:** You should repeat the above steps 8 times, corresponding to 8 substitution events. Occasionally a site will experience multiple substitutions.
- **Question:** When you are done, count the number of observable substitutions (the number of non-A sites in your sequence) and use that to compute the observed distance per site (divide by 12)

You entered:

0.417

Your Answer		Score	Explanation
0.417	✔	1.00	
Total		1.00 / 1.00	

Question Explanation

If you have ended up with 5 sites that are non-A after the above simulation, then the observed distance will be: *[Math Processing Error]*. We can obviously only check your response to the degree that it is within the possible range of values resulting from 8 simulated mutations in a 12-

bp piece of DNA.

Question 3

- **Estimate actual change from observed chance:** Use the following equation to estimate the actual amount of change from your observed amount of change. This is the inverse of the equation shown before (and is the same as the equation shown in the slides concerning JC correction)

  [Math Processing Error]

- **Question:**Based on your observed distance, what would the estimated, JC-corrected actual distance be?

You entered:

0.609

Your Answer		Score	Explanation
0.609	✔	1.00	
Total		1.00 / 1.00	

Question Explanation

Note that if your observed change was different from what the expected observable distance was, then this estimate will be different from the actual distance, which we here know to be 0.67. This problem will be less prominent the more sequence we have (since the actual observed distance will then probably be closer to the expected value). We will aim at combining all the students responses to see (1) The distribution over observed values. (2) How the average will be closer to the actual value. Stay tuned for an announcement later in the course!