

VCU Bioinformatics and Bioengineering Summer Symposium

Opening Problem Set

1. True story. Child #2 came home from school and announced that she her life was complete because she had won a Bingo game on the first five calls. The way the game worked, the teacher announces a letter-number combination (letter chosen from A to E, number chosen from 1 to 5), and each contestant crosses out the specified square in a 5x5 grid (see picture at right). The first person to complete a 5-unit line on the grid wins. (It was slightly more educational than that, but never mind). Should she have been excited? What is the likelihood that such a result would arise? Does it make any difference that she's been playing this game ten times every weekday for the past five years? (OK, not completely true story)

	A	B	C	D	E
1					
2					
3					
4					
5					

2. The 500 gallon fuel oil tank buried in your front yard has sprung a leak and you need to replace it. You'd like to minimize the damage to your lawn. You know precisely where the center of the tank is, and if you knew where the outer limits of the tank were, you could precisely dig down. Presuming that the tank is spherical, where should you dig?
3. You are about to return from a journey that marks the high point in your life. You have made contact with the Most High Grand Zen Master and have been bestowed with a great pearl, a set of 180 haikus (in Japanese with no punctuation) that contain the secret of life. You know from your last trip (a visit to the Second Most High Grand Zen Master) that Customs at the airport will thoroughly search your luggage and stamp on any paper they find "WE THANKS TO YOU FOR VISITING OUR HUMBLE COUNTRY!" in letters so big that whatever else is on the paper will be unreadable. Your only chance to bring the haikus out of the country is to put them on your miniscule 64 Kbyte memory device. Unfortunately, your last visit taught you that the device is not miniscule enough: Customs will surely find the device and write (electronically) on it:

WE THANKS TO YOU FOR VISITING OUR HUMBLE COUNTRY! WE THANKS
TO YOU FOR VISITING OUR HUMBLE COUNTRY! WE THANKS TO YOU...

with the basic unit repeated as text 1280 times. How can you use the memory device to bring the haikus out of the country and thereby enjoy eternal peace?

4. An ice cube is floating on water. The ice cube melts. Does the water level rise, fall, or stay the same? You may think you know the answer to this one. Not good enough. You get this question right only if:
 - a. All 13 of you submit the same answer
 - b. That answer accords with reality
5. In many cultures, male children are so valued that couples will continue to have children until they get one. Take the extreme case where all couples in a population have children until they get a male child, and then they stop. What is the male:female ratio in the population that results from this practice?

6. Somewhere hidden within the billions of DNA sequences available to us is the key to how certain genes are regulated or how transcripts are processed, etc. The clues are in the sequence, if we can only recognize them. If you stare at the sequence below,

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AAATATTTGTTGATTGTCAGTTGTCAGTTGTCAGTTGTCAGTTGTCAGTTGTCAGTGT  
CTATTGCTACTGACCACTGACCAATGACTAATGACTAA
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you'll eventually find interesting patterns, but at first it looks like a hodgepodge of letters. Humans generally detect patterns in sound more easily than patterns in letters. Don't believe me? Click on the audio supplement on the Intro to Institute web page (next to the link that got you to this problem set). It represents the same information as the sequence, using a very simple musical coding scheme. This exercise gives you the idea that a more clever encoding of DNA sequences into sound may enable people to pick out patterns more easily. For example, you might change the sound of a nucleotide depending on the number of identical nucleotides preceding it --- each C in the sequence CCCCC would produce a different sound than its predecessor. Come up with a plan to represent DNA sequences in sound that best allows humans to detect patterns.

7. You are a practicing hematologist who has 25 patients who have come to you because of complaints associated with sickle cell anemia, an autosomal recessive disorder. In examining the families of these patients, you find that all parents have a normal phenotype, and the families have a total of 165 children, of which 60 have sickle cell anemia. You are suspicious that there may be a new environmental cause to the disease, something in our water or air that is increasing the incidence of sickle cell anemia beyond what you would expect from pure genetic considerations.
- What number of affected children out of 165 would you have expected to be affected if the disease is determined solely by genetics?
 - Use an appropriate statistical test to determine whether the actual results support your idea that the environment is an important factor.
 - How do you account for the actual results?