

Homework 10

due November 18, 2014

In addition to

4.1. 1, 5, 9, 11, 15, 19, 23, 27, 31, 35, 41, 45, 49, 53, 57, 59 65, 77, 79

4.2. 1, 3, 5, 7, 13, 15, 17, 19, 21, 23, 25, 27, 39, 41, 43, 47, 51, 55, 57, 61, 65, 67, 73, 91, 95, 97

4.5. 3, 7, 9, 13, 15, 17, 19, 21, 27, 31, 32, 33, 37

complete the following problems.

1. Shannon Entropy In a recent application of information theory to the field of genomics, a function called the Shannon entropy, H , was considered. A given gene is represented as a binary device: it can be either “on” or “off” (i.e. being expressed or not). If x is the probability that the gene is “on” and y is the probability that it is “off”, the Shannon entropy function for the gene is defined as

$$H = -x\ln(x) - y\ln(y)$$

(Note: the fact that x and y are probabilities means that they satisfy $0 < x \leq 1$, and $0 < y \leq 1$.) The gene can only be in one of these two states, so $x + y = 1$. Use these facts to show that the Shannon entropy for the gene is greatest when the two states are equally probable, i.e. for $x = y = 0.5$.

2. Consider this data on Red deer weight vs antler weight from Huxley’s *Problems of Relative Growth* (1932)

Weight class (kg)	Mean body weight (kg)	Mean antler weight (kg)
60-80	74.4	1.64
80-100	93.4	2.03
100-120	110.4	3.16
120-140	130.6	3.96
140-160	148.9	4.78
160-180	170.7	6.21
180-200	191.1	7.28
200-220	211.8	8.91

(a) Plot the mean body weight vs mean antler weight data on a log scale. To do this, modify the egg data spreadsheet linked on the website. Make your own copy before working on it: File -> Make a copy

(b) Use the data to create a power law relationship $r = Ba^m$ where r is the mean body weight of the red deer and a is the antler weight. That is, use the ‘Trendlines’ command in spreadsheet to get the equation for the best linear fit to the data, then derive the power law relationship from there.

(c) Use the power law to estimate the weight of a red deer whose antlers weigh 4 kg.

(d) Use the power law to estimate the weight of the antlers of a red deer that weighs 125 kg.

Note: For (a) turn in a printout: File -> Download as -> PDF document (.pdf)