Homework 3

due Sept 16, 2015

In addition to

6.6. 1, 3, 5, 7, 13, 15, 23, 29, 31, 37, 43, 45, 59, 61, 63, 74

7.1. 3, 9, 11, 17, 21, 23, 25, 31, 32, 41, 52, 56, 68, 69, 70

Complete twenty integrals: https://www.math.psu.edu/files/141integrals1.pdf.

Notes: (1) Next week we'll learn a better way to handle some of these, for example #14 – but you CAN get the answer with the tools you already have.

(2) I know that the answers are provided. That means that there's no reason for you to get these wrong! You'll be graded on your work. Getting good at these integrals is all about practice. Practice, practice, practice, practice, practice, ...

and complete the following problems

1. Allometric scaling 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-log scale. 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. Include with your solution a plot on a log-log scale and the linear fit.

OPTIONS for (a) and (b): (1) Modify the MATLAB script provided (**note:** this week's coding prep reading may help). (2) Modify the provided EXCEL spreadsheet. (3) Upload the EXCEL spreadsheet to Google Spreadsheets (link) and modify there.

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

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

The power law giving the relationship between body weight vs antler weight is an example of an **allometric law** (look it up!).

2. Ebola epidemic data Consider the data below for the ebola epidemic in Liberia.

(a) Plot the time vs # of confirmed Ebola cases a log scale for the $y-$axis only. Use the data to create an exponential growth relationship $I = I_0 e^{rt}$ where r is the relative growth rate of the infection and I_0 is the initial number of cases. Include with your solution a plot on a log-linear scale and the linear fit.

OPTIONS for (a) and (b): (1) Modify the MATLAB script provided. (2) Modify the provided EXCEL spreadsheet. (3) Upload the EXCEL spreadsheet to Google Spreadsheets (link) and modify that way.

(b) In epidemics a key quantity is the "basic reproduction number" R_0, which gives the average # of people an infected person will make sick (in a completely susceptible population). It can be obtained using the formula $R_0 = 1 + rL$ where r is the relative growth rate and L is the duration of the infection (how long someone is sick, on average). For ebola the estimate for $L = 12$ days. Using the growth rate you've calculated, what is your estimate for R_0 for ebola? Chowell et al. (2014) estimate R_0 to be in the range of 1.4-1.7. Is your estimate consistent with their range?

(c) Infectious disease interventions, in general, aim to reduce R_0 to below 1. Interpret that statement in terms of the exponential relationship $I = I_0 e^{rt}$ and the formula for R_0, $R_0 = 1 + rL$: what does $R_0 < 1$ tell you about r? What would the long-time behaviour of $I(t)$ be?

# days since June 16, 2014	# of confirmed cases
0	12
6	28
8	33
9	35
12	41
13	43
15	48
17	49
21	62
24	64
31	70
34	71
38	86
40	92
47	132
49	137

# days since June 16, 2014	# of confirmed cases
57	176
60	194
62	208
63	236
65	263
70	322
73	369
77	406
78	590
79	608
80	620
81	622
82	628
83	648
84	700
86	790

Challenge problem Find all $y > 1$ satisfying

$$\int_1^y x \ln x \, dx = \frac{1}{4}.$$

Coding preparation problem Read Section 3, “M-Files, Scripts, and other files.” Do the Exercise on page 8. Name your function file “circlefunction_FirstInitialLastName.m” (for example, mine would be called circlefunction_JConway.m).

UPLOAD the .m files to the ANGEL “Homework #3 functions” DROPBOX in Lessons–>Homework–>.

TO BE GRADED

6.6. 5, 13, 23, 37, 45, 59, 61, 74
7.1. 9, 17, 23, 31, 32, 41, 52, 68, 69
Integrals page 1, 5, 8, 15-20

Allometric scaling problem

Ebola epidemic problem

Challenge problem

Coding preparation problem

Note: EACH person must turn in their plots from the **Coding Preparation** problem individually (in ANGEL Dropbox).