SCIE1000, Tutorial Week 3, Semester 1, 2011.

Aims

- This week you will work through some general calculation and discussion questions.
- As usual, you should recognise that the broad concepts and techniques we cover are more important than the specific examples. Do not try to commit lots of facts to memory; instead, know **how** to do things, and **when** certain models and approaches are appropriate.
- You should have an idea of which project topic you will choose, and starting to make some progress on it. **The requirements for submission, including the due date and time, are very strict.** Do not leave it until the last minute!

Questions

1. (Final exam, 2008. Worth 6 marks, so about 6 minutes to work.)

   (a) The rate of removal of alcohol from an individual's body is roughly constant (we will see why later in semester), so the graph of Blood Alcohol Content (BAC) over time after drinking is roughly a straight line.

   At 9pm a person's BAC is measured to be 1.6 g/L, and at 9.30pm it is 1.5 g/L. Find the rate of change of BAC $B(t)$ for this person. (Include units in your answer.)

   (b) Let $t = 2$ at 9pm. Find an expression for the person's BAC at any time t in hours after 7pm.

   (c) Estimate the **total change** in the person's BAC between 8pm and 11 pm.

2. A very widely used method of estimating the number or quantity of something that is otherwise hard to measure is to take a sample, and then extrapolate that to give the required estimate.

   (a) A marine biologist, wanting to estimate the number of fish N that live on an isolated reef, captured a sample of S_1 individuals, tagged them and released them. One month later, she collected another sample of size S_2 and found S_3 tagged individuals amongst them. Assuming that the population has remained constant, develop a formula to estimate N from these values. Explain your answer. How accurate is this approach?

   (b) There are a number of ways of measuring the volume of blood inside a person. Many of these methods use a technique closely related to the fish-counting approach in Part (a). Consider the following text taken from the documentation lodged as part of a patent.

   (www.patentstorm.us/patents/5685302/description.html)

   US Patent 5685302 - Method for determining plasma volume, determination of blood volume thereby, and apparatus therefore

   The subject invention provides a method for determining in a subject the volume of plasma in the subject's circulation which comprises:

   (i) introducing into the subject's circulation a predetermined amount of a pharmaceutically-acceptable solution comprising a predetermined quantity of biodegradable, nontoxic macromolecules, which macromolecules are sufficiently larger than endothelial junctions in the subject's capillaries so that they are incapable of permeating the subject's capillaries, and each of which macromolecules is labeled with a detectable marker;

   (ii) allowing the solution to circulate for a period of time sufficient to distribute the macromolecules throughout the subject's circulatory system;

(iii) obtaining a sample of plasma from the subject;

(iv) determining the concentration of macromolecules in the sample by quantitatively measuring the detectable marker in the sample; and

(v) calculating the volume of liquid which would dilute the sample to the concentration determined in step (iv) from the predetermined amount of solution introduced into the subject's circulation and the predetermined quantity of macromolecules contained therein, thereby determining the volume of plasma in the subject's circulation.

The subject invention also provides a method for determining in a subject the volume of blood in the subject's circulation which comprises determining the volume of plasma in the subject's circulation according to the aforementioned method.

Summarise briefly, in plain English, how the patent enables blood volume to be measured.

(c) Explain how the approaches in Parts (a) and (b) relate to each other.

3. In the first lecture we considered a model of blood alcohol concentration (BAC); we will return to this model later in semester. The model included a constant r, called the *Widmark factor*, which estimates the proportion of body weight that is water. In lectures we will encounter the following models for the values of r for females and males, where W is weight in kg and H is height in m.

   For females, $r = 0.31223 - 0.006446W + 0.4466H$. For males, $r = 0.3161 - 0.004831W + 0.4632H$.

   (a) Last week, we saw that when arrested in 2006, American actress Nicole Richie weighed 38.5 kg and was 1.55 m tall. Estimate the percentage of her body weight that was water.

   (b) In his younger days, Arnold Schwarzenegger (the current Governor of California) was a famous body builder. Estimate the percentage of his body weight that was water when he was 1.88 m tall and weighed 107 kg.

   (c) Repeat Parts (a) and (b), but for people with the other gender (that is, a male with Nicole Richie's height and weight, and a female with Arnold Schwarzenegger's height and weight). Explain the differences between these answers and your answers to Parts (a) and (b).

   (d) Consider a group of males and females of varying heights, but all of whom weigh 70 kg. Find expressions for the values of r for both genders, and plot graphs of the values of r for H between 1.4 m and 1.9 m.

   (e) Both expressions for r in Part (d) should be linear functions. Give some physical reasons why the y-intercepts and gradients of the (straight line) graphs of r differ between males and females.

4. In order to complete the computing tutorial sheet this week, you need to be familiar with the concept of *conditional* statements, represented by the `if` command in Python. Read Section A.4 of the lectures notes, Pages 406–411, if you have not already done so.

   (a) By hand, find the output from the following partial Python program.

```
x = 4
y = 1.5
if sqrt(x) < y:
    print "Hello sailor!"
else:
    print "Kiss me, red!"
```

   (b) Modify the program so that if x equals $\sqrt{y}$ then the message "You dirty rat!" is printed to the screen. (Hint: you will need to use the command `elif`. Also, note that you need to use "==" in Python to test whether two things are equal.)

The end