**Math 4397/6397, Fall 2009**
**Problem Set 7, due Tuesday, Oct 13**

Problem 1. Forced expiratory volume FEV is a standard measure of pulmonary function. We would expect that any reasonable measure of pulmonary function would reflect the fact that a person's pulmonary function declines after age 20. Suppose we test this hypothesis by looking at 10 nonsmoking males ages 35-39, heights 68-72 inches and measure their FEV initially and then once again 2 years later. We obtain this data.

| **FEV** Person | Year 0 | Year 2 | Person | Year 0 | Year 2 |
|---|---|---|---|---|---|
| 1 | 3.22 | 2.95 | 6 | 3.25 | 3.20 |
| 2 | 4.06 | 3.75 | 7 | 4.20 | 3.90 |
| 3 | 3.85 | 4.00 | 8 | 3.05 | 2.76 |
| 4 | 3.50 | 3.42 | 9 | 2.86 | 2.75 |
| 5 | 2.80 | 2.77 | 10 | 3.50 | 3.32 |

a. Create the relevant confidence interval and interpret.

b. Assuming that the random variables measuring FEV are normal, then we know that the random variable $(n-1)S^2/\sigma^2$ is chi-square distributed with $n-1$ degrees of freedom. If we drop the $\sigma^2$, then we obtain a random variable $(n-1)S^2$ which follows a gamma distribution with shape parameter $\frac{n-1}{2}$ and scale parameter $2\sigma^2$. Plot the likelihood function for the variance of the change in FEV using the R function `dgamma` with suitable arguments. (Note that this likelihood function could be used to estimate $\sigma^2$.)

Problem 2. Another aspect of the preceding study involves looking at the effect of smoking on baseline pulmonary function and on change in pulmonary function over time. We must be careful since FEV depends on many factors, particularly age and height. Suppose we have a comparable group of 15 men in the same age and height group who are smokers and we measure their FEV at year 0. The data are given (For purposes of this exercise assume equal variances where appropriate).

| **FEV** Person | Year 0 | Year 2 | Person | Year 0 | Year 2 |
|---|---|---|---|---|---|
| 1 | 2.85 | 2.88 | 9 | 2.76 | 3.02 |
| 2 | 3.32 | 3.40 | 10 | 3.00 | 3.08 |
| 3 | 3.01 | 3.02 | 11 | 3.26 | 3.00 |
| 4 | 2.95 | 2.84 | 12 | 2.84 | 3.40 |
| 5 | 2.78 | 2.75 | 13 | 2.50 | 2.59 |
| 6 | 2.86 | 3.20 | 14 | 3.59 | 3.29 |
| 7 | 2.78 | 2.96 | 15 | 3.30 | 3.32 |
| 8 | 2.90 | 2.74 | | | |

Calculate a confidence interval to determine if there is evidence to suggest that the change in pulmonary function over 2 years is the same in the two groups. State your assumptions and interpret your results.

Problem 3. In a trial to compare a new fertilizer A with a commericially available fertilizer B, 260 bean sprouts received A and 289 received B for a 3-month period. The mean growth lengths were 9.78 inch with (sample) standard deviation 7.51 inch for A and 12.83 inch with (sample) standard deviation 8.31 inch for B. Is this good evidence that, in general, one of these fertilizers is better than the other at improving growth? If so, within what limits would the average annual difference in growth be expected to be?