The rules of engagement for this final exam are the same as for the midterm. You may only use R. You may use canned random number generators, statistical distributions and simple functions such as *summarize*. You can take up to 24 hours to take the exam. Any references you consult will cost you 10 points. R-Help, class notes, this year's section notes, code and problem sets are free. Past years' code, exams and problem set answers are off limits completely. My number is 925-360-6473. But better try email as well. Also, I am asking you to study something that you do not know the correct answer to from class. I am trying to get you to use a Monte Carlo to help you figure out "whether you have a problem" or not. Just follow the instructions and tell me what you learn. I will give you the full writeup in the answer key with the right references.

This problem is designed to help you visualize the consequences of measurement error in your dependent and independent variables. One way to explore the consequences of measurement error on your estimated coefficients is to figure this out analytically, which is the preferred way (which you can look up in any textbook). Another approach is to conduct a Monte Carlo experiment, where you control the DGP. Here we are going to explore what happens to the least squares estimator for varying degrees of measurement error in the left hand and right hand side variables. Assume that you have the following population model:

$$y_i^* = \beta_o + \beta_1 \cdot x_{1i} + \beta_2 \cdot x_{2i} + \varepsilon_i \tag{1}$$

Assume that ε_i is distributed i.i.d. standard normal ($N(0,1)$), and x_{1i} and x_{2i} are both drawn from a uniform with support $[-200, 200]$. ε is uncorrelated with the x variables. Assume that $\beta_o = 1$, $\beta_1 = -0.75$, $\beta_2 = 0.75$. Set your seed to 22092008.

1. Generate a random sample of 100 observations for x_{1i}, x_{2i} and ε_i.
2. Using the x_{1i} and x_{2i} from the step above and a 100 element vector of disturbances, generate the y_i. Estimate the three β coefficients using least squares. Calculate the difference between the true β and the estimated coefficient for each of the three β coefficients.
3. Now assume that your y_i is measured with error. It is in fact $y_i + r_i$, where r_i is drawn from a random normal distribution with mean zero and variance σ^2. Using the y_i from the previous step, add the measurement error r_i to them and use this measured with error dependent variable as your outcome. Estimate the three β coefficients using least squares. Do this for $\sigma^2 = [1\ 10\ 100]$.
4. Now assume that your x_{2i} is measured with error. You observe $x_2^* = x_{2i} + r_i$, where r_i is drawn from a random normal distribution with mean zero and variance σ^2 (Just reuse the r_i from the previous step.). Use the y_i from the first step (the one measured without error) and replace x_{2i} with x_2^* in your estimation. Estimate the three β coefficients using least squares on your data. Do this for $\sigma^2 = [1\ 10\ 100]$.
5. Repeat step 4 exactly, only now assume that your measurement error is not symmetric, but always positive. Simply take the absolute value of r_i (agin using the r_i from above) before generating your x_2^*. Only do this for $\sigma^2 = 100$.
6. Repeat step 4 exactly, only now assume that your measurement error is not symmetric, but always negative. Simply take the absolute value of r_i and multiply it times (-1) before generating your x_2^* (again using the r_i from above). Only do this for $\sigma^2 = 100$.

Repeat the above steps 10,000 times (set the seed only the first time, not each time) and calculate the bias for β_o, β_1 and β_2 for each setting and fill in the table below. What have you learned from this exercise that you did not know before? Was there anything surprising?

Table 1: Final Exam Results

	Bias β_o	Bias β_1	Bias β_2
Step 2			
Step 3 ($\sigma^2 = 1$)			
Step 3 ($\sigma^2 = 10$)			
Step 3 ($\sigma^2 = 100$)			
Step 4 ($\sigma^2 = 1$)			
Step 4 ($\sigma^2 = 10$)			
Step 4 ($\sigma^2 = 100$)			
Step 5			
Step 6			

Thank you all for paying attention all semester and not throwing hard objects at me for my bad jokes. I hope you get as much pleasure out of applying these tools as I do throughout your career.