Homework #1 assignments

Prepare a 15-minute presentation (with or without powerpoint slides) discussing the following topics related to uncertainty estimation. In your presentation introduce the assigned problem, its significance, the approach you used to solve the problem, and then show some results and conclude. For any simulation portions of the assignments you may use any programming language that you are comfortable with.

NOTE: If you use powerpoint slides and want to use my computer for the presentation please convert to PDF. You do not need to turn anything in. Your presentation completes the assignment.

1. **David Park: Central limit theorem.** Demonstrate, by an example, the central limit theorem. The central limit theorem states that the sum of a large number of random variables, each drawn from any distribution, will approximate a Gaussian distribution. Pick one or more random distributions and demonstrate that as you increase the size of the sum the distribution approaches a Gaussian. Examples of random distributions could be (1) a box distribution from -1 to 1, (2) a double-peaked distribution, for example a box distribution from -1 to -0.5 and from 0.5 to 1. You may need to use the random number generator in your chosen programming language cleverly to make some of these distributions.

2. **Vinny Ravindran: Central limit theorem.** Same as the previous problem, but coordinate such that the two presentations will be different.

3. **Ryan Jackson: Uncertainty propagation.** For the expression

$$z = 2x^2 + \sqrt{y} + xy$$

derive the Gaussian error propagation formula and show the resulting error for several sizes of errors in x and y. Then do a simulation showing the error distributions of z for a few different mean and errors in x and y. For how big errors in x and y does the error distribution in z begin to deviate from a Gaussian distribution?

4. **Alan Huynh: Uncertainty propagation.** Same as the previous problem, but for the expression

$$z = \ln x - y^3 + 3 \tag{1}$$

5. **Tom Hall: Bootstrapping.** Create a problem in which a result is derived from a large number of individual observations and use the bootstrapping approach to obtain the uncertainty. Make it a problem for which you can also obtain the uncertainty in some other way and show that the bootstrapping approach produces the same result.

6. **Charles Bernson: Probability distributions.** Prepare a presentation on different types of probability distributions, discussing where they are used. Include some discussion of multi-variate distributions.