The purpose of this homework is to give you experience working with the mixed logit model. To this end, consider a mixed logit model with ‘true’ form given by

\[ U_{nj} = \beta_n' X_{nj} + \varepsilon_{nj}, \quad n = 1, \ldots, N, \quad j = 1, \ldots, 4, \quad \text{dim}(\beta_n) = 4 \times 1, \quad \text{dim}(X_{nj}) = 4 \times 1, \quad \varepsilon_{nj} \sim EV, \]

where \( \beta_n \) is a parameter vector containing random and fixed elements. Consider experimental data consistent with this model and of the following form:

- \( N = 400 \)
- \( X_{nj} \) a vector of explanatory variables where \( X_{nj} \sim \text{UNIF}(0,3) \)
- \( \beta_{n1} = \beta_1 = 1 \) deterministic and \( \beta_{n3} = \beta_3 = 1 \) deterministic
- \( \beta_{n2} \sim N[3,(1.50)^2]; \beta_{n4} \sim N[3,(2.0)^2] \).

1. Simulate a single data set \( X, \beta, (N \times 4) \), and \( Y \) for this model and complete the following:
   - Estimate the six ‘unknowns’ in the model using \( R = 200 \) Halton draws for the two random coefficients. Note you will need to use the function \textit{halton.m} (see the class website) and create a function \textit{mxl_like.m} as we discussed in lecture.
   - Report and interpret your findings. Are you able to successfully estimate the standard deviations on the random coefficients?
   - Repeat the exercise for \( N = 1000 \) and \( R = 400 \). Report and interpret your findings. In particular, do you get better resolution on the standard deviations of the random coefficients?

2. Consider now looping over multiple data sets and obtaining parameter estimates for each, similar to what we did in HW1. In particular, for \( N = 400 \) generate a single matrix \( X \) of explanatory variables. Keeping \( X \) fixed, use a loop to generate \( M = 200 \) realizations of \( \beta \) and \( Y \). Construct and store estimates of the six ‘unknown’ parameters in the model using \( R = 200 \) Halton draws for \( m = 1, \ldots, M \). Summarize your findings as follows:
   - Report means and standard errors of the estimated parameters
   - Display histograms (preferably all on a single page) for each of the six estimated parameters.

Notes and hints:

- Running your program for 1 should be fairly quick – probably less than 5 minutes. The program for 2 will require looping and multiple calls to the estimation routine and could take a couple hours depending on your machine. You might set and print to the screen a counter so you can monitor progress.
- When using \textit{fminunc} for 2 you do not need to request the Hessian as an output – the extra calculation slows down the program and is not needed for this part of the exercise.
- In 2 you should generate the Halton sequences once, outside of the loop. In the loop you will need to generate \( \beta \), the utility levels, and \( Y \) and then carry out the estimation.
- In the code as we have designed it the \textbf{signs of the estimated standard deviations on the random parameters are irrelevant} and should be interpreted as positive. Make sure to take absolute values before summarizing the results.