**Homework 8**

1. Describe (in pseudo code) the algorithm of fast least squares method via SRHT projection and evaluate its relative error on the following inputs A.

Let be a real matrix where m >> n. We do the following steps:

1. Generate an *m x n* Gaussian random matrix *M* (where entries are i.i.d. .
2. Compute SVD of matrix *M* = .
3. Generate a diagonal matrix S = diag(, ..., ) where σi’s are uniformly chosen in the range (1, ). Change the value of to 1 and to .
4. Compute matrix A as A =
5. Generate an m-dimensional Gaussian random vector b.

The following is the pseudo code for the solving the over-strained least square approxiamtion problem via a SRHT projection. The algorithm will return a vector *x\_output* that will satisfy the relative bounds stated in class.

Input: and .

Output: x\_output .

1. Let c be the sampling parameter, choose a c value that is more than
2. Let *P* be an empty matrix.
3. For i = 1 to c, select uniformly at random and with replacement an integer from = {1 to m}. Update the value of element at jth row and ith column of P randomly to either , or 0 with different probability. The probability of Pij to be or is the same. J is the number representing the cth row number from matrix A.
4. Let be a normalized Hadamard transform matrix.
5. Let be a diagonal matrix where each with probability .
6. Compute and return *x\_output* .

Task: Take reasonable values of m, n, and sampling parameter c, compare the relative approximation error ∥*Ax\_output* − b∥2 / ∥*A\_xopt* − b∥2, where *x\_output* is the solution produced by the randomized algorithm, and *x\_opt* is the solution produced by a deterministic least square method.