APPM 4720: Homework 5 Problem 3 Reference

April 29, 2016

Problem 3 Due to the computational time of the Monte Carlo and RSVD methods, I used $m = 10^5$ and $m = 10^4$ iterations, respectively. All simulations and simulations were run using the driver code below and slightly modified monte carlo DRIVER and DRIVER RSVD functions.

(a) The resulting error histogram for $n = 1000$ is found in Figure 3. At each iteration, the driver script calls the Monte Carlo Driver function using the specified vector where $n = 10, 10^2, 10^3, 10^4, 10^5$ and returns the resulting error value to our error array. To plot the resulting error histogram, we simply only pull the values in row 1. As you can see, running the Monte Carlo algorithm for 10^5 iterations produces a relatively smooth probability density function.

(b) To investigate the scaling of the variance of the error, we iterate over each value of $n = 10, 10^2, 10^3, 10^4, 10^5$ and calculate the variance using the function $s(n) = (1/(m-1)) \sum_{j=1}^{m} e_j^2$. This calculation is found on Line 44 of the attached HW05.m file. After this is done, we can create a plot with $1/\sqrt{n}$ on the horizontal axis and $\sqrt{s}$ on the vertical axis. The resulting plot is found in Figure 2. As you can see, there is a linear relation between the scaling of the two expressions.

(c) Now, we can run the same script, except this time, we plot the RSVD errors using $q = 0$ and $p = 0, 10, 20, 30$. In this case, due to the more taxing method, we will use $m = 10^4$ iterations. Using our slightly modified RSVD driver function, we return the computed error value at each iteration into a $4 \times m$ array named $ersvd0$ where each row refers to a different value of p. The resulting histogram plots can be found in Figures 3–6. In this case, we use the *hist* function instead of the *histogram* function due to the small variance between each error value and modify it using different number of bins to create better looking plots. At $p = 0$, we get another smooth looking histogram, however at $p = 10, 20, 30$, out histograms become very tall with a few outliers to produce very lopsided looking graphs.

(d) Now we run the same script using the same values of p, however, $q = 2$ in this case since we are using a power method. The resulting errors are held in the variable $ersvd2$. The histograms can be found in Figures 7–10 in this case. In this case, we get a lopsided histogram again, but when $p = 0$. However, with $p = 10, 20, 30$, we get 3 more smooth looking probability density function graphs.

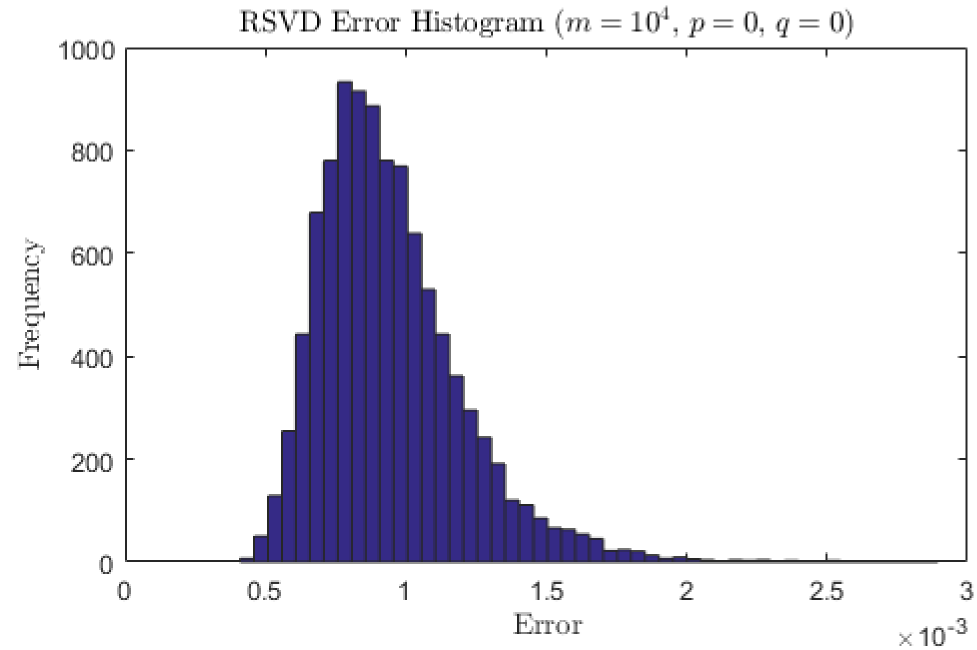

Figure 1: Errors of RSVD ($p = 0$, $q = 0$)

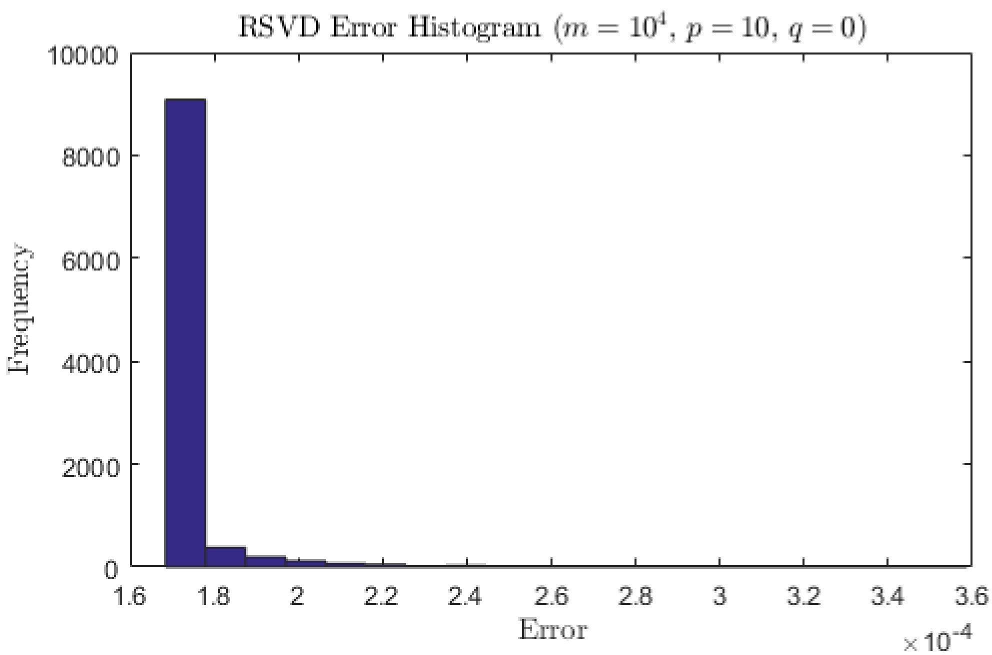

Figure 2: Errors of RSVD ($p = 10$, $q = 0$)

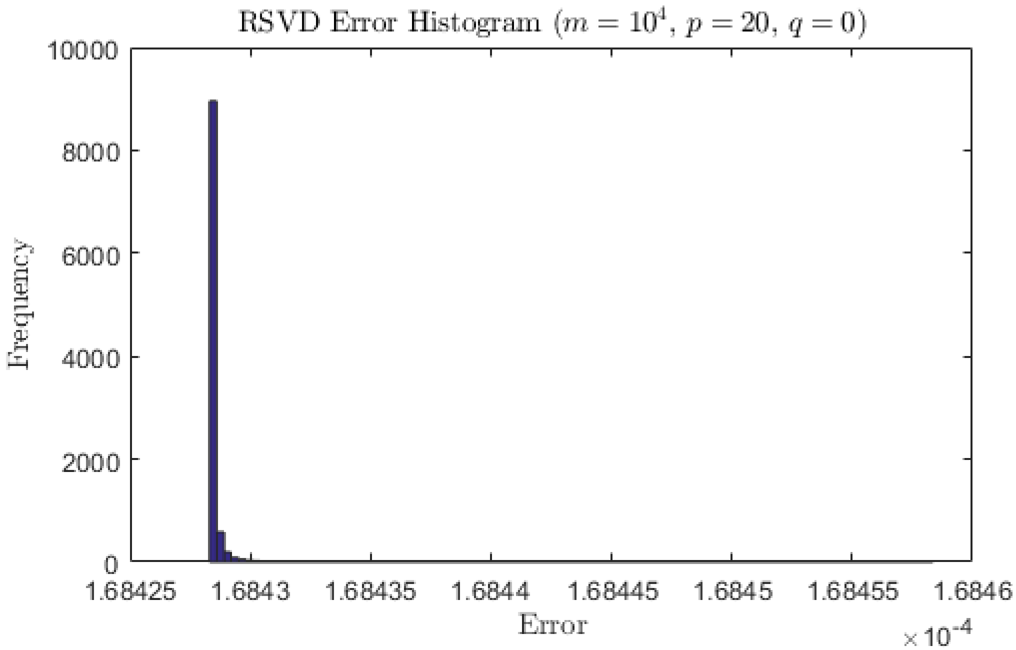

Figure 3: Errors of RSVD ($p = 20$, $q = 0$)

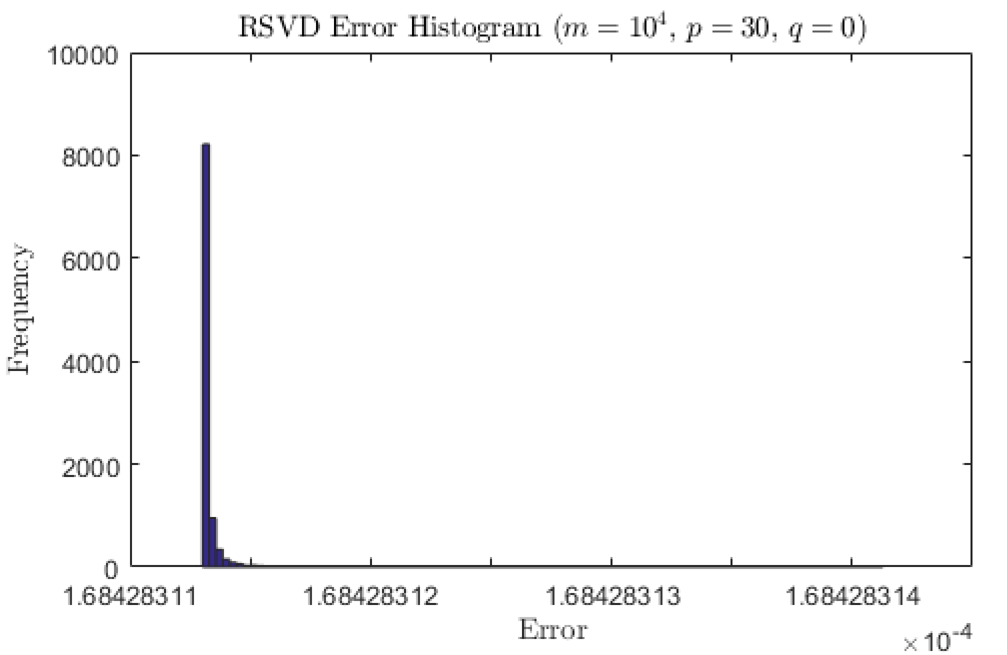

Figure 4: Errors of RSVD ($p = 30$, $q = 0$)

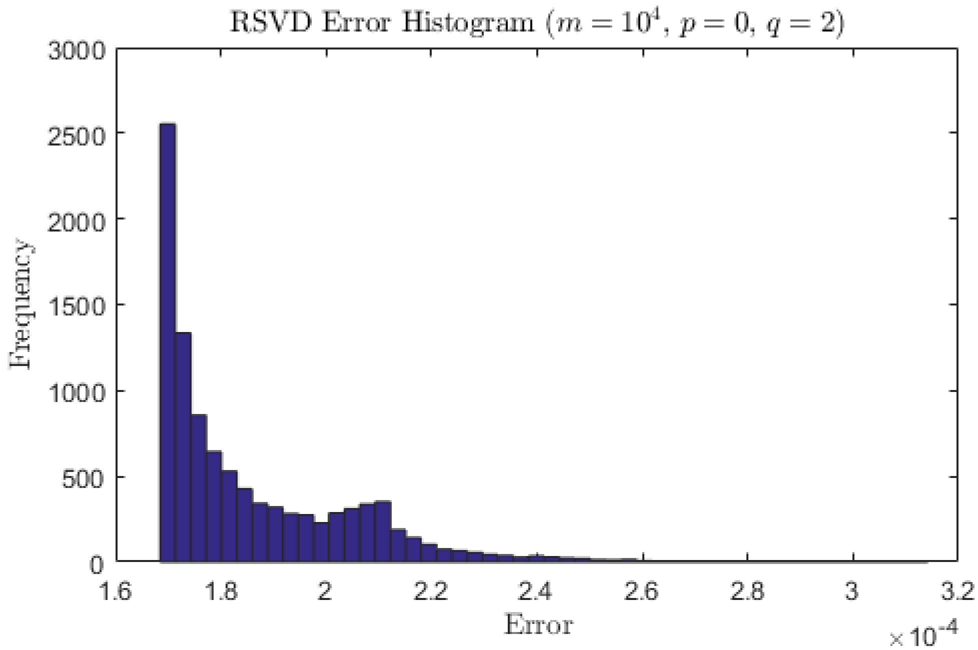

Figure 5: Errors of RSVD ($p = 0$, $q = 2$)

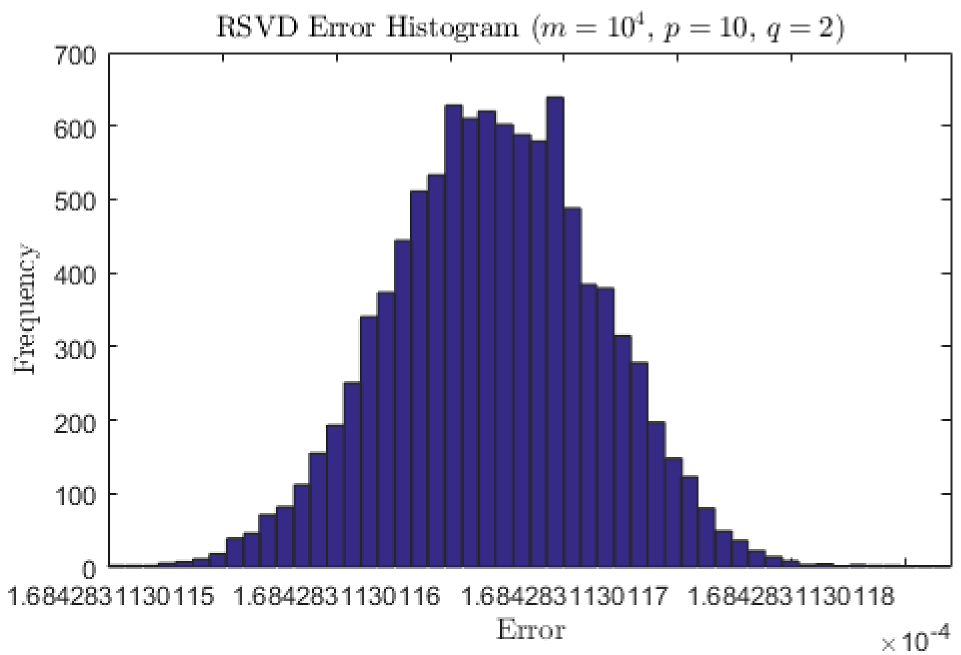

Figure 6: Errors of RSVD ($p = 10$, $q = 2$)

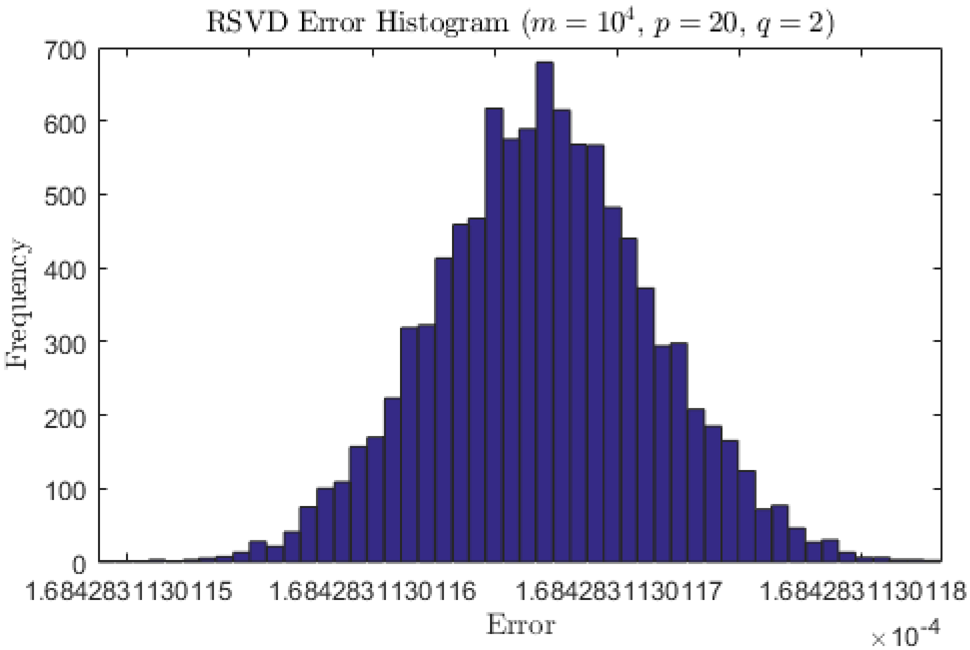

Figure 7: Errors of RSVD ($p = 20$, $q = 2$)

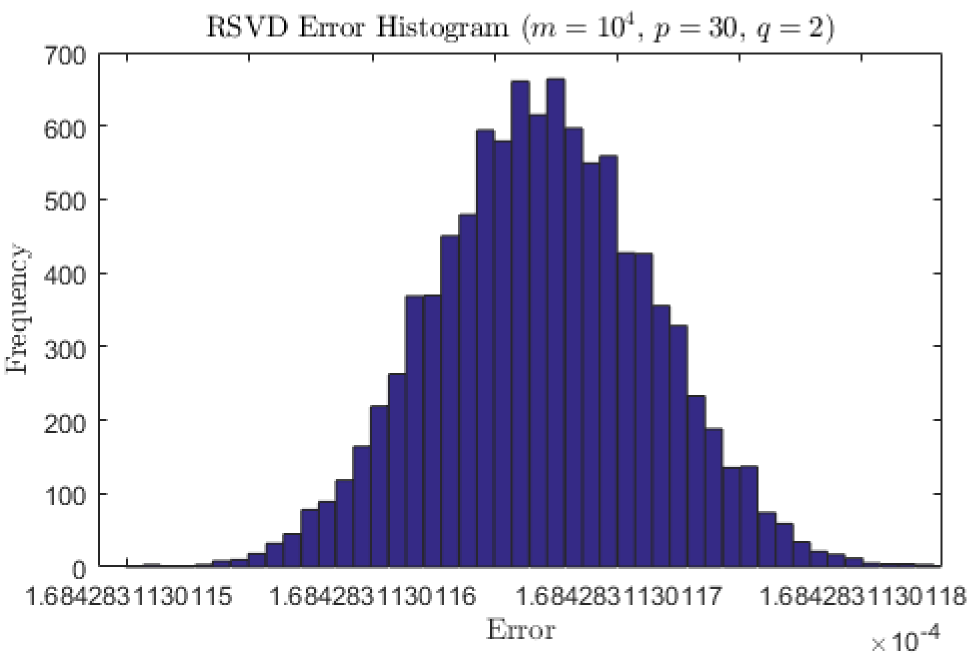

Figure 8: Errors of RSVD ($p = 30$, $q = 2$)