Lab Session 7

MA423: Matrix Computations July-November 2024 S. Bora

Important instructions:

(i) **Switch to `format long e` for all experiments.**

(ii) **Submit a single livescript program that contains all comments, answers and codes necessary to produce the required outputs. Ensure that the answers are correctly numbered and the file does not include any irrelevant material. The livescript program should be saved as MA423YourrollnumberLab7.mlx**

1. Perform experiments in Exercises 4.2.19-4.2.21 of *Fundamentals of Matrix Computations*. You will find them on page 272-273 of the second edition and pages 271-272 of the third edition. Write a small description of your experiments.

   The aim of the experiment in Exercise 4.2.21 of *Fundamentals of Matrix Computations* is to show that the Rank Revealing QR Decomposition is less efficient than the SVD method when detecting numerical rank deficiency.

2. This is a demonstration of image compression techniques using SVD. The following commands will first load a built-in 320×200 matrix X that represents the pixel image of a clown, computes its SVD $X = U\Sigma V^T$ and then displays the image when X is approximated by its best rank k approximation $X_k = \sum_{i=1}^{k} \sigma_i u_i v_i^T$ for a chosen value of k.

   ```
   load clown.mat; [U, S, V] = svd(X); colormap('gray');
   image(U(:, 1:k)*S(1:k, 1:k)*V(:,1:k)')
   ```

   The storage required for A_k is $k(m+n) = 520k$ words whereas the storage required for the full image is $n \times m = 6400$ words in this case. Therefore, $\frac{520k}{6400}$ gives the compression ratio for the compressed image. Also the relative error in the representation is $\frac{\sigma_{k+1}}{\sigma_1}$. Run the above commands for various choices of k and make a table that records the relative errors and compression ratios for each choice.