Shaan Ul Haque(180070053)
Samarth Singh (180050090)
Niraj Mahajan (180050069)

1 Code

Below is the MATLAB routine function for SVD of a matrix.

```
function [U S V]=MySVD(A)
    [U eig_values1]=eig(A*A');
    [V eig_values2]=eig(A'*A);
    [m m]=size(U);
    [n n]=size(V);
    if m>n
        S=eig_values1(:,m-n+1:end);
    else
        S=eig_values2(n-m+1:end,:);
    end
    S=S.^(0.5);
    LHS=A*V;
    RHS=U*S;
    % To check for the sign of eigenvectors because with the constraint
    % a'a=1 two vectors a and -a are possible
    for i=1:n
        if norm(LHS(:,i)-RHS(:,i))>=10e-2
            U(:,i)=-1*U(:,i);
        end
end
```

2 Example

Let us generate a random 5×3 matrix using randi function and find its SVD and verify the theorem.

2.1 Parameters

- Seed = 0
- Range of random numbers = [0,10]
- Size = 5×3

$$A= \begin{bmatrix} 8 & 1 & 1 \\ 9 & 3 & 10 \\ 1 & 6 & 10 \\ 10 & 10 & 5 \\ 6 & 10 & 8 \end{bmatrix}$$

Shaan Ul Haque(180070053)
Samarth Singh (180050090)
Niraj Mahajan (180050069)

2.2 Output

$$U=\begin{bmatrix} 0.1894 & -0.7053 & -0.2011 & -0.6151 & 0.2187 \\ -0.0020 & 0.4422 & -0.7470 & -0.0899 & 0.4882 \\ -0.3272 & -0.5211 & -0.1428 & 0.6775 & 0.3770 \\ -0.5596 & 0.1702 & 0.4984 & -0.3370 & 0.5440 \\ 0.7375 & 0.0803 & 0.3644 & 0.2026 & 0.5251 \end{bmatrix}$$

$$S=\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 6.6128 & 0 & 0 \\ 0 & 9.0725 & 0 \\ 0 & 0 & 26.3051 \end{bmatrix}$$

$$V=\begin{bmatrix} -0.1972 & -0.7944 & 0.5745 \\ 0.8059 & 0.2023 & 0.5564 \\ -0.5583 & 0.5727 & 0.6003 \end{bmatrix}$$

Computing $U * S * V^T$ gives us back A. Hence, SVD stands verified. For better scrutiny, we have uploaded the MATLAB code as well.