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% ME564 HW6 Q2

clc;
clear all;

% Given matrix A
A = [0.0974, -0.1178, 0.7876, -0.1168, 0.0178;
     0.1291, -0.1174, 1.2850, 0.0302, 0.0971;
     0.0528, 0.1119, 0.1325, 0.7668, 0.0637;
     0.0424, 0.2647, 0.2806, 1.7644, 0.1195];

% a
% Perform SVD on A
[U, S, V] = svd(A);

% Display U, S, and V
disp('Matrix U:');
disp(U);
disp('Matrix S (Sigma):');
disp(S);
disp('Matrix V:');
disp(V);

% Extract and display singular values
singular_values = diag(S);
disp('Singular values:');
disp(singular_values);

% b
% Extract and sort singular values
[sorted_singular_values, indices] = sort(singular_values, 'descend');

% Select the two largest singular values to form Sigma_r
Sigma_r = diag(sorted_singular_values(1:2));

% Extract corresponding columns from U and V to form U_r and V_r
U_r = U(:, indices(1:2));
V_r = V(:, indices(1:2));

% Display U_r, Sigma_r, and V_r
disp('Reduced Matrix U_r:');
disp(U_r);
disp('Reduced Matrix Sigma_r:');
disp(Sigma_r);
disp('Reduced Matrix V_r:');
disp(V_r);

% c
% Compute A_r = U_r * Sigma_r * V_r'
A_r = U_r * Sigma_r * V_r';

% Display the reduced-order matrix A_r
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disp('Reduced-order matrix A_r:');
disp(A_r);

% d
% Compute the difference between A and A_r
A_diff = A - A_r;

% Compute the Frobenius norm of the difference
Frobenius_norm = norm(A_diff, 'fro');

% Display the Frobenius norm
disp('Frobenius norm of (A - A_r):');
disp(Frobenius_norm);

Matrix U:
-0.0655    0.5331    0.7658   -0.3536
-0.2167    0.8175   -0.4888    0.2140
-0.3905   -0.0789    0.4022    0.8243
-0.8923   -0.2031   -0.1135   -0.3868

Matrix S (Sigma):
 2.0000         0         0         0         0
         0    1.5000         0         0         0
         0         0    0.0400         0         0
         0         0         0    0.0300         0

Matrix V:
-0.0464    0.0965    0.6978    0.6772   -0.2076
-0.1234   -0.1476   -0.4467    0.2130   -0.8474
-0.3161    0.9353   -0.0873   -0.0939   -0.0944
-0.9364   -0.3043    0.0984   -0.0868    0.1156
-0.0769    0.0397   -0.5443    0.6926    0.4653

Singular values:
 2.0000
 1.5000
 0.0400
 0.0300

Reduced Matrix U_r:
-0.0655    0.5331
-0.2167    0.8175
-0.3905   -0.0789
-0.8923   -0.2031

Reduced Matrix Sigma_r:
 2.0000         0
         0    1.5000

Reduced Matrix V_r:
-0.0464    0.0965
-0.1234   -0.1476
-0.3161    0.9353
-0.9364   -0.3043

```

-0.0769 0.0397

Reduced-order matrix A_r :

0.0832	-0.1019	0.7893	-0.1207	0.0418
0.1384	-0.1275	1.2839	0.0327	0.0820
0.0248	0.1138	0.1362	0.7674	0.0553
0.0534	0.2651	0.2791	1.7638	0.1251

Frobenius norm of $(A - A_r)$:

0.0500

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