Problem A1:

cqr.m | mqr.m | experiment.m | qr_calcs.m | +

```
% Compute the QR factorization using algorithm 7.1 (Classical QR Decomposition).
function [Q, R] = cqr(A)
    [m, n] = size(A);

    % Allocate memory for Q and R.
    Q = zeros(m, n);
    R = zeros(n, n);

    % Initialize the first column of Q by taking the first column vector of A and normalizing.
    Q(:, 1) = A(:, 1) / norm(A(:, 1), 2);

    % Compute the entries of Q and R.
    for j = 1:n
        v_j = A(:, j);

        for i = 1:j-1
            R(i, j) = Q(:, i)' * A(:, j);
            v_j = v_j - R(i, j) * Q(:, i);
        end

        R(j, j) = norm(v_j, 2);
        Q(:, j) = v_j / R(j, j);
    end
end
```

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cqr.m | mqr.m | experiment.m | qr_calcs.m | +

```
% Compute the QR factorization using algorithm 8.1 (Modified QR Decomposition).
function [Q, R] = mqr(A)
    [m, n] = size(A);

    % Allocate memory for Q and R.
    Q = zeros(m, n);
    R = zeros(n, n);

    % This is basically the same as the first for loop setting v_i = a_i.
    V = A;

    % Compute the entries of Q and R.
    for i = 1:n
        R(i, i) = norm(V(:, i), 2);
        Q(:, i) = V(:, i) / R(i, i);

        for j = i+1:n
            R(i, j) = Q(:, i)' * V(:, j);
            V(:, j) = V(:, j) - R(i, j) * Q(:, i);
        end
    end
end
```

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cqr.m | mqr.m | experiment.m | qr_calcs.m

```matlab
[U, X] = qr(randn(80));
[V, X] = qr(randn(80));
S = diag(2 .^ (-1:-1:-80));
A = U*S*V';

[QC, RC] = cqr(A);
[QM, RM] = mqr(A);

r_vals_c = log(diag(RC));
r_vals_m = log(diag(RM));
j = (1:80)';

figure
scatter(j, r_vals_c);
hold on;
scatter(j, r_vals_m);
hold off;

xlabel('j');
ylabel('log(R_{jj})');
title('log(R_{jj}) vs. j');
legend('Classical QR (GS)', 'Modified QR (GS)');
```

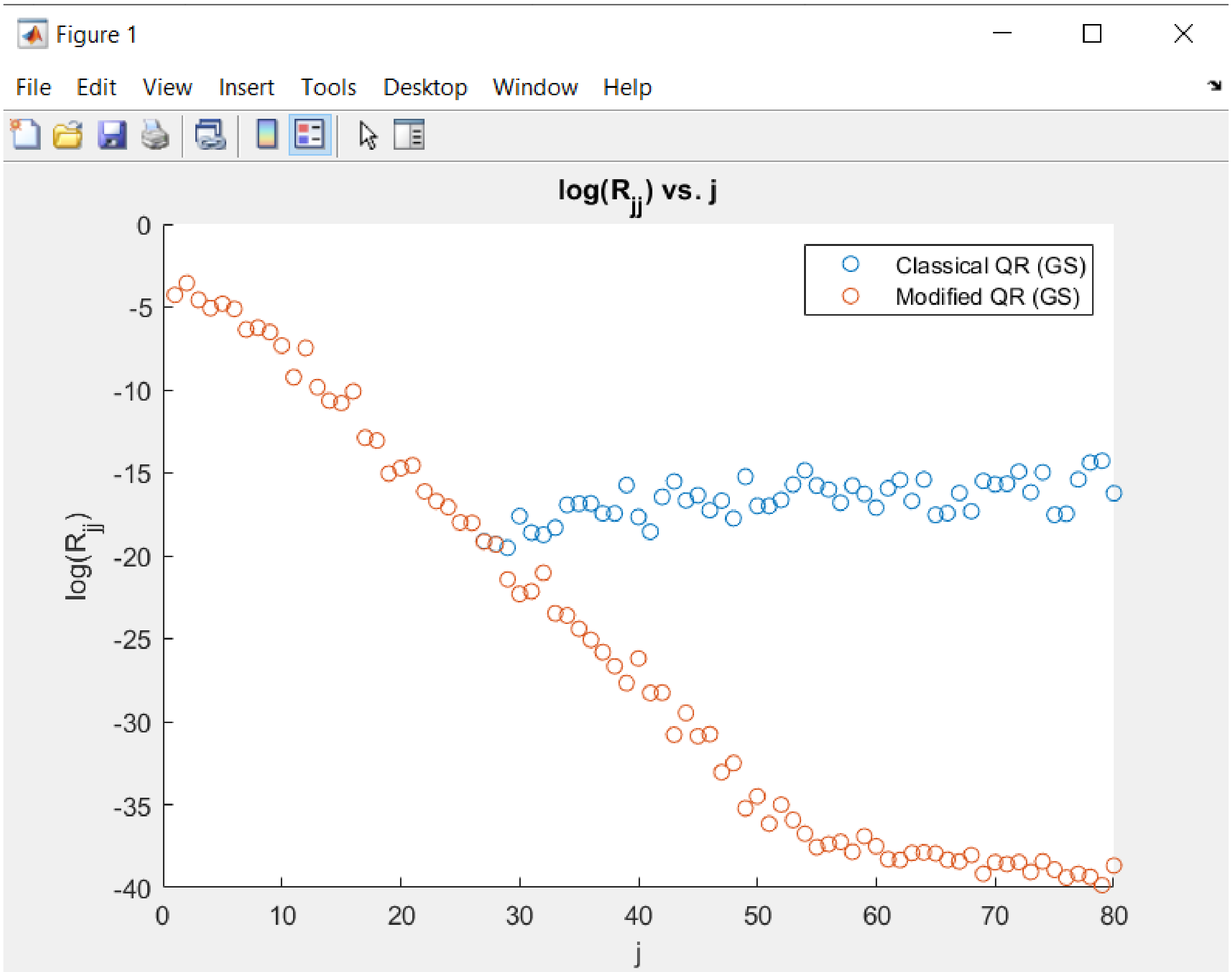
Figure 1
File Edit View Insert Tools Desktop Window Help
log(R_jj) vs. j
Classical QR (GS)
Modified QR (GS)
log(R_jj)
j
0
-5
-10
-15
-20
-25
-30
-35
-40
0
10
20
30
40
50
60
70
80