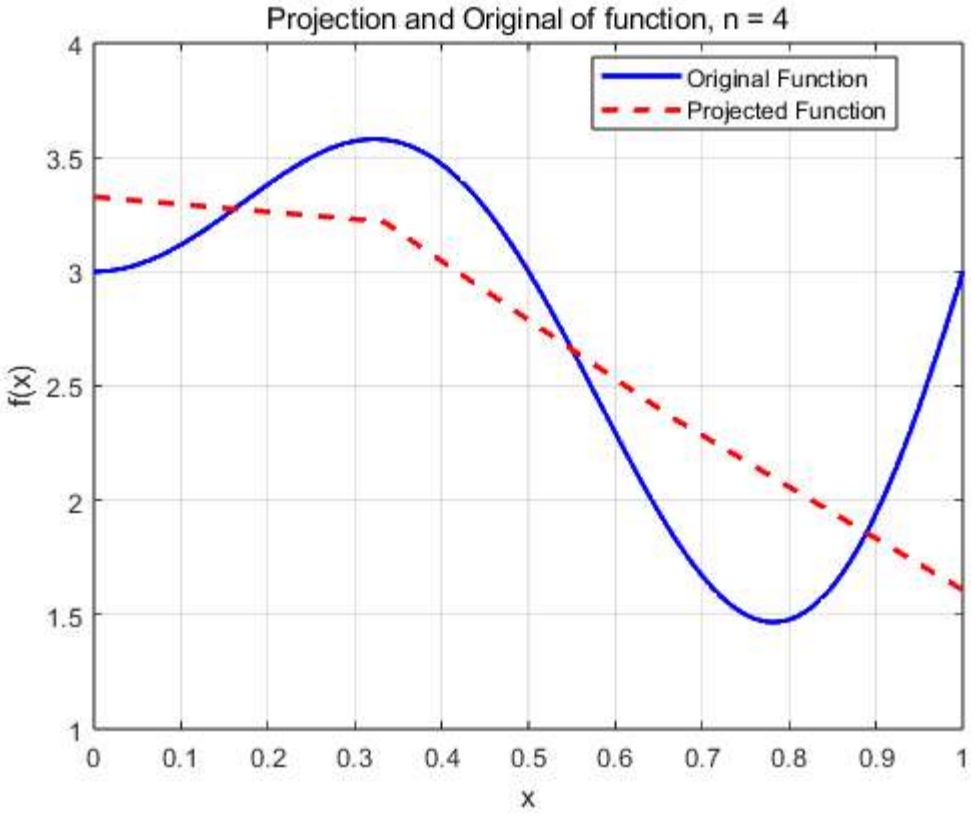
Contents

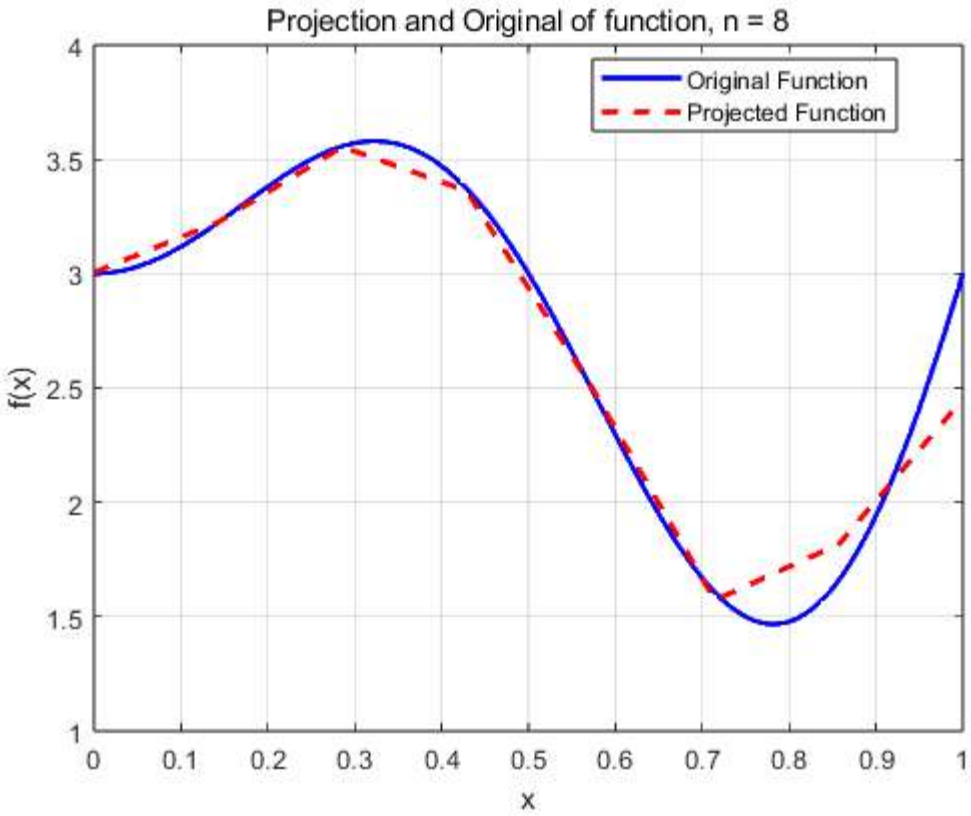

```
clc;
clear;
close all;



% 주어진 함수 정의
f = @(x) (2*x).*sin(2*pi * x) + 3;

% error 값 생성
n_values = [4, 8, 16, 32, 64]; % n 값을 다양하게 설정
error_values = zeros(size(n_values));

for k = 1:length(n_values)
    n = n_values(k); % 행 및 열의 개수
    x = linspace(0, 1, n);

    % Projection 계산
    projected_function = l2_projection_1D(x, f);

    % error 계산
    error = 0;
    for i = 1:n-1
        intervalLength = x(i + 1) - x(i);
        projected_integral = 0.5 * intervalLength * (projected_function(i) + projected_function(i + 1));
        exact_integral = integral(f, x(i), x(i + 1));
        error = error + (projected_integral - exact_integral)^2;
    end
    error_values(k) = sqrt(error);

    % 결과 플롯
    x_values = linspace(0, 1, 1000); % 더 많은 점으로 그래프를 그리기 위해
    figure;
    plot(x_values, f(x_values), 'b', 'LineWidth', 2); hold on;
    plot(x, projected_function, 'r--', 'LineWidth', 2);
    legend('Original Function', 'Projected Function', 'Location', 'best');
    xlabel('x');
    ylabel('f(x)');
    title(['Projection and Original of function, n = ', num2str(n)]);
    grid on;
    hold off;
end



% error plot
figure;
loglog(n_values, error_values, '-o', 'LineWidth', 2);
xlabel('n');
ylabel('Error');
title('Convergence Error');
grid on;

% error rate
rate = -(log(error_values(2:end) ) - log(error_values(1:end-1))) / log(2);
disp(rate)
```

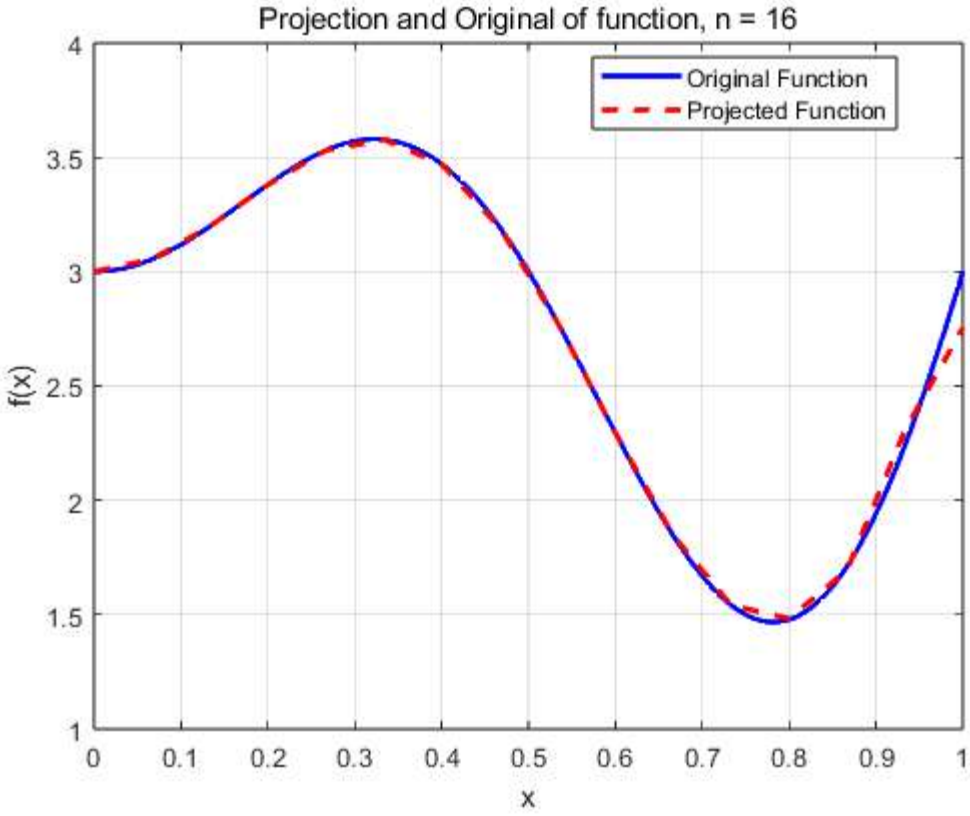
Projection 함수 정의

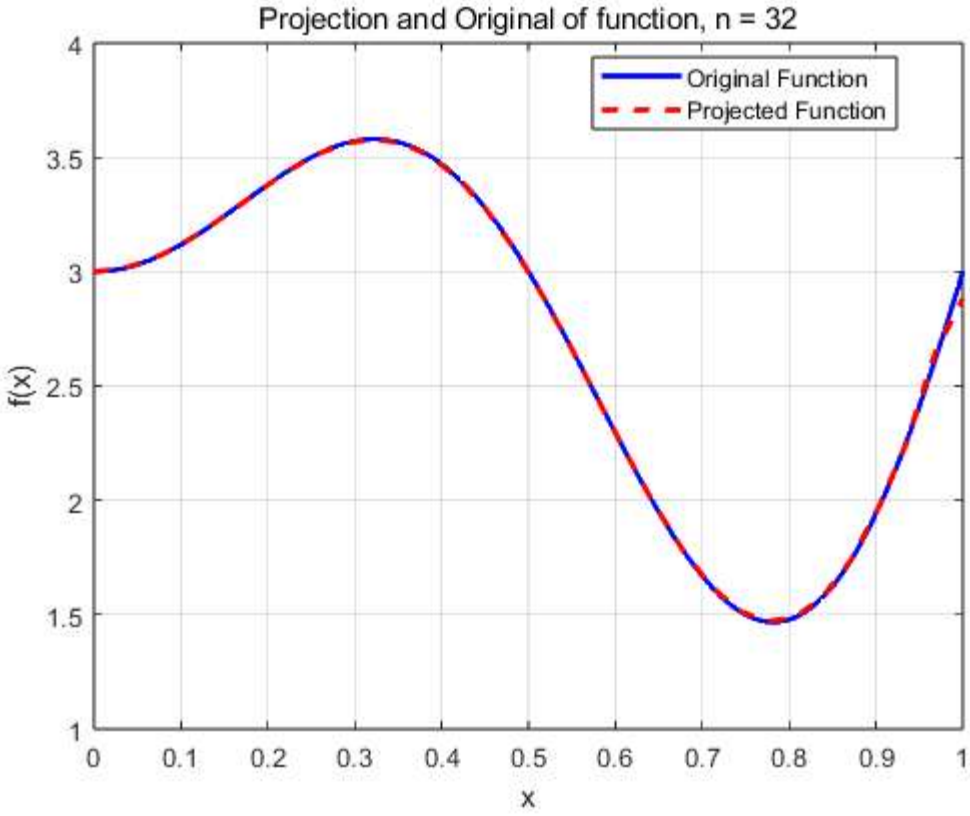
```
function [projected_function] = l2_projection_1D(x, f)
    n = length(x);
    h = x(2) - x(1);


    % loadVector를 계산(GQ).
    loadVector = zeros(n, 1);
    for i = 1:n-1
        intervalLength = x(i + 1) - x(i);
        nGQ = 4; % 가우스 적분의 점의 개수
        approx_values = GQIntegral1D(f, x(i), x(i+1), nGQ, 10);
        loadVector(i) = loadVector(i) + approx_values/2;
        loadVector(i + 1) = loadVector(i + 1) + approx_values/2;
    end


    % local_M 행렬 생성
    local_M = [h/3, h/6; h/6, h/3];
    % M_matrix
    M = sparse(n, n);
    for i = 1:n-1
        M(i:i+1, i:i+1) = M(i:i+1, i:i+1) + local_M;
    end

    x_solution = M \ loadVector;
    projected_function =  x_solution;
end
```

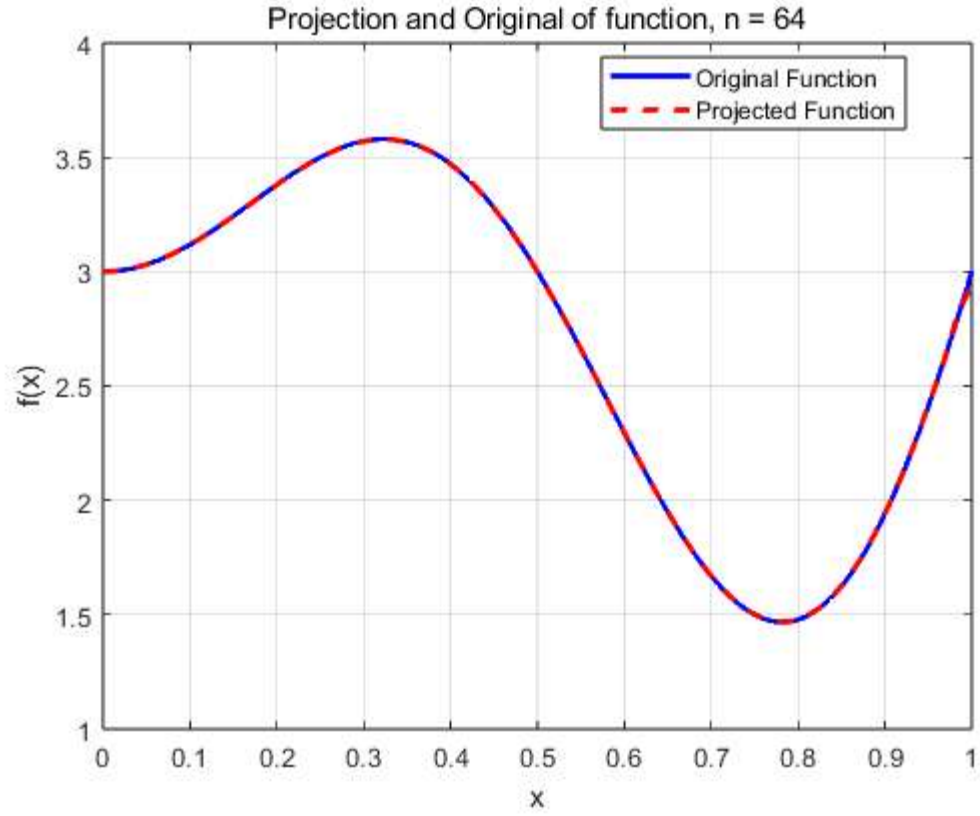
```
    0.8029    2.2539    2.1470    2.0767
```

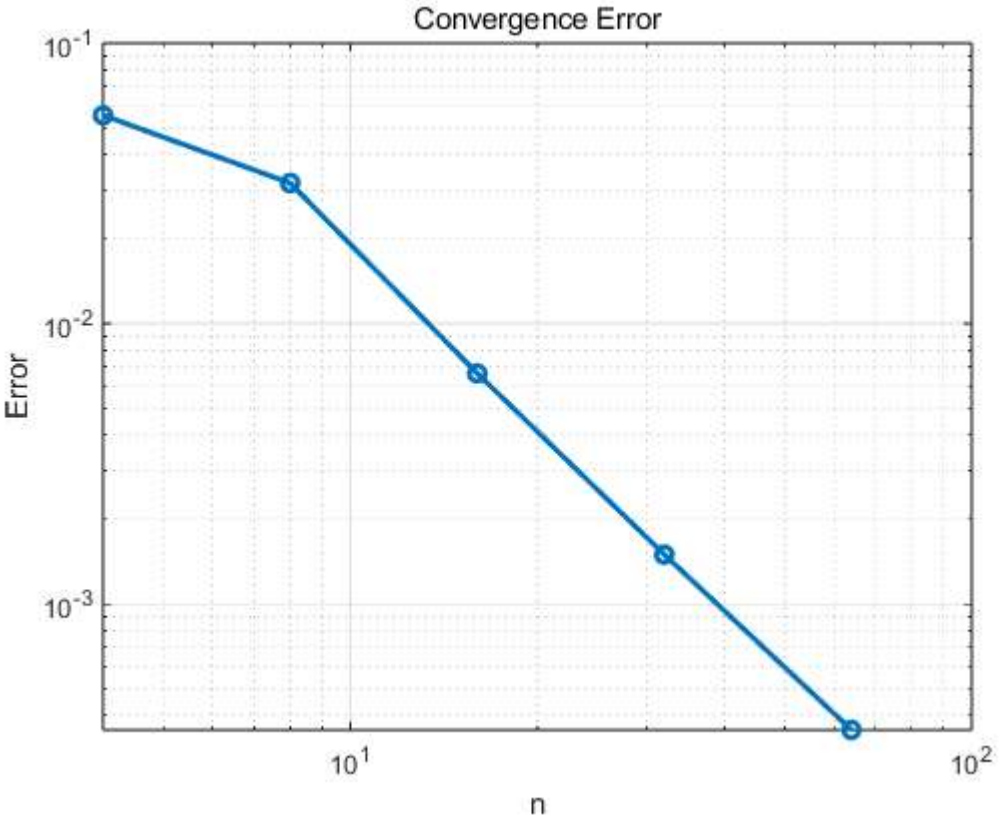

Projection and Original of function, n = 4
Original Function
Projected Function
f(x)
x
4
3.5
3
2.5
2
1.5
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Projection and Original of function, n = 8
Original Function
Projected Function
f(x)
x
4
3.5
3
2.5
2
1.5
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Projection and Original of function, n = 16
Original Function
Projected Function
f(x)
x
4
3.5
3
2.5
2
1.5
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Projection and Original of function, n = 32
Original Function
Projected Function
f(x)
x
4
3.5
3
2.5
2
1.5
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1





Published with MATLAB® R2023b