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Assignemnt - 4

Regula Falsi

```
% Name         : Mohamed Mafaz
% Roll Number : AM25M009
% Department   : Applied Mechanics

clc;
clear;
close all;
```

Part 1 (Preprocessing)

```
f = @(x) sin(10*x) + cos(3*x);
a = 3;
b = 6;

tolerance = 1e-4;
loop = 0;

root_true = 5.67903;
```

Part 2 (Processing)

```
% Ensure the initial bracket is valid
if f(a) * f(b) > 0
    error('f(a) and f(b) must have opposite signs.');
end

% Initial c
c = b - (f(b) * (b - a)) / (f(b) - f(a));

iter_arr  = []; err_arr  = [];

while abs(f(c)) > tolerance
    if f(a) * f(c) < 0
        b = c;
    else
        a = c;
    end
```

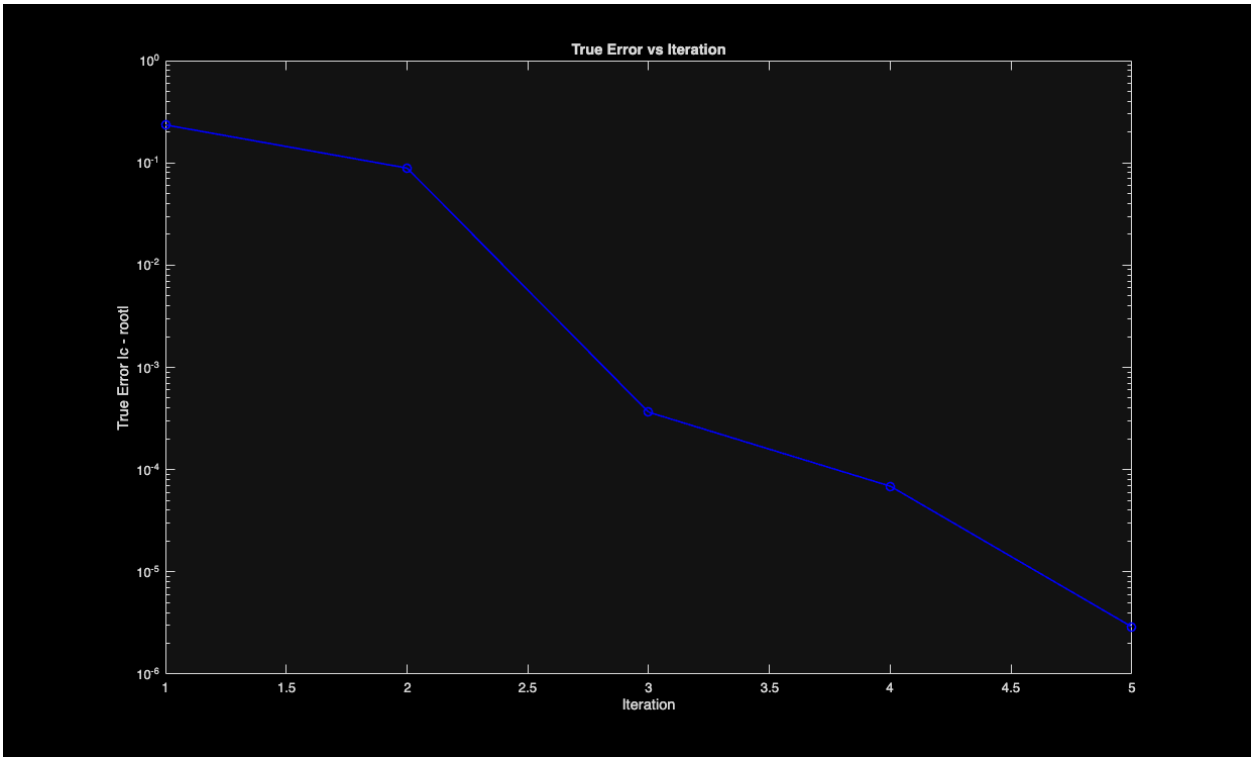
```
    c = b - (f(b) * (b - a)) / (f(b) - f(a));
    loop = loop + 1;
    iter_arr(loop) = loop;
    err_arr(loop)  = abs(c - root_true);
    fprintf('Loop: %d | c: %.8f | f(c): %.8e | err: %.8e\n', loop, c, f(c),
abs(c - root_true));
end
```

```
Loop: 1 | c: 5.91401698 | f(c): 9.69659416e-01 | err: 2.34986977e-01
Loop: 2 | c: 5.76798184 | f(c): 9.30085758e-01 | err: 8.89518365e-02
Loop: 3 | c: 5.67939418 | f(c): 4.55902619e-03 | err: 3.64176874e-04
Loop: 4 | c: 5.67896118 | f(c): -9.05018365e-04 | err: 6.88220505e-05
Loop: 5 | c: 5.67903290 | f(c): 2.83382033e-07 | err: 2.89624794e-06
```

Part 3 (Post Processing / Plotting)

```
fprintf('\nRoot ≈ %.8f found in %d iterations\n', c, loop);
semilogy(iter_arr, err_arr, 'b-o', 'LineWidth',1.2); hold on;
xlabel('Iteration');
ylabel('True Error |c - root|');
title('True Error vs Iteration');


% --- Estimate order R from the last few iterations ---

% R = [ ln(e_n+1 / e_n) ] / [ ln(e_n / e_n-1) ]

Rvals = zeros(1,length(err_arr)-2);

for k = 3:length(err_arr)
    Rvals(k-2) = abs(log(err_arr(k)/err_arr(k-1)) / log(err_arr(k-1)/
err_arr(k)));
end

R_est = mean(Rvals);  % mean of last few
fprintf('\n\nEstimated order R = %.4f\n', R_est);
```

```
Root ≈ 5.67903290 found in 5 iterations


Estimated order R = 1.0000
```



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Assignemnt - 4

Bisection

```
% Name         : Mohamed Mafaz
% Roll Number : AM25M009
% Department   : Applied Mechanics

clc
clear
close all
```

Part 1 (Preprocessing)

```
loop = 0;
f = @(x) sin(10*x) + cos(3*x);
a = 3;
b = 6;

tolerance = 1e-4;
root_true = 3.74575;

iter_arr = [];  err_arr = [];
```

Part 2 (Processing)

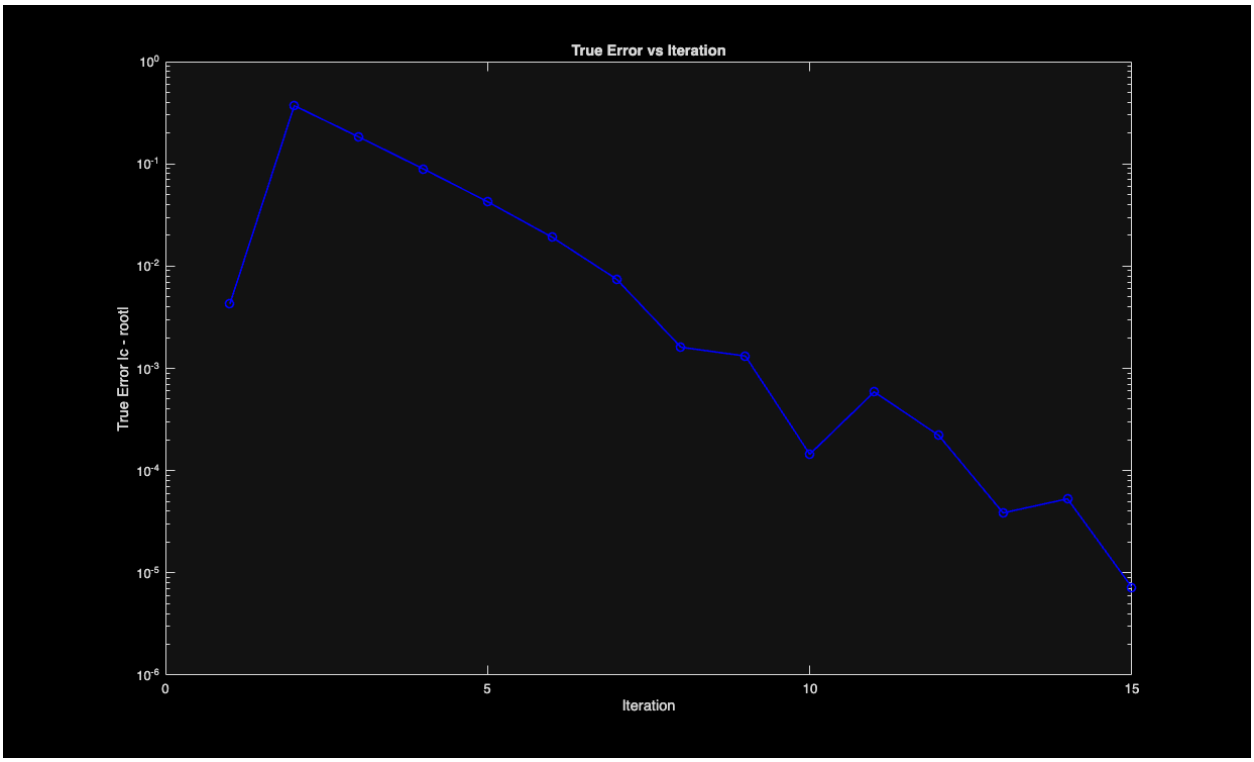
```
c = (b + a)/2;
while abs(f(c)) > tolerance
    if f(a) * f(c) < 0
        b = c;
    else
        a = c;
    end

    c = (b + a) / 2;
    loop = loop + 1;
    iter_arr(loop) = loop;
    err_arr(loop)  = abs(c - root_true);

    fprintf("Loop: %d | c: %f\n", loop, c)
end
```

```
semilogy(iter_arr, err_arr, 'b-o', 'LineWidth',1.2); hold on;
xlabel('Iteration');
ylabel('True Error |c - root|');
title('True Error vs Iteration');
```

```
Loop: 1 | c: 3.750000
Loop: 2 | c: 3.375000
Loop: 3 | c: 3.562500
Loop: 4 | c: 3.656250
Loop: 5 | c: 3.703125
Loop: 6 | c: 3.726562
Loop: 7 | c: 3.738281
Loop: 8 | c: 3.744141
Loop: 9 | c: 3.747070
Loop: 10 | c: 3.745605
Loop: 11 | c: 3.746338
Loop: 12 | c: 3.745972
Loop: 13 | c: 3.745789
Loop: 14 | c: 3.745697
Loop: 15 | c: 3.745743
```



Part 3 (Post Processing / Plotting)

```
% R = [ ln(e_n+1 / e_n) ] / [ ln(e_n / e_n-1) ]

Rvals = zeros(1,length(err_arr)-2);

for k = 3:length(err_arr)
    Rvals(k-2) = log(err_arr(k)/err_arr(k-1)) / log(err_arr(k-1)/
```

```
err_arr(k-2));
end

R_est = mean(Rvals);  % mean of last few
fprintf('\n\nEstimated order R = %.4f\n', R_est);
```

```
Estimated order R = 0.8519
```

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