```
% Alvaro Gonzalez Martinez A01646343
m=@(x,y) y-3.*x;
yexact=@(x) 7*exp(x)+3*x+3;
y0=10
```

```
y0 =
10
```

```
x0=0
```

```
x0 =
0
```

```
xf=3
```

```
xf =
3
```

```
% dx = 1
h = 0.5
```

```
h =
0.5000
```

```
% define error array store the relative error at each step

x=x0:h:xf
```

```
x = 1×7
         0    0.5000    1.0000    1.5000    2.0000    2.5000    3.0000
```

```
y=zeros(size(x))
```

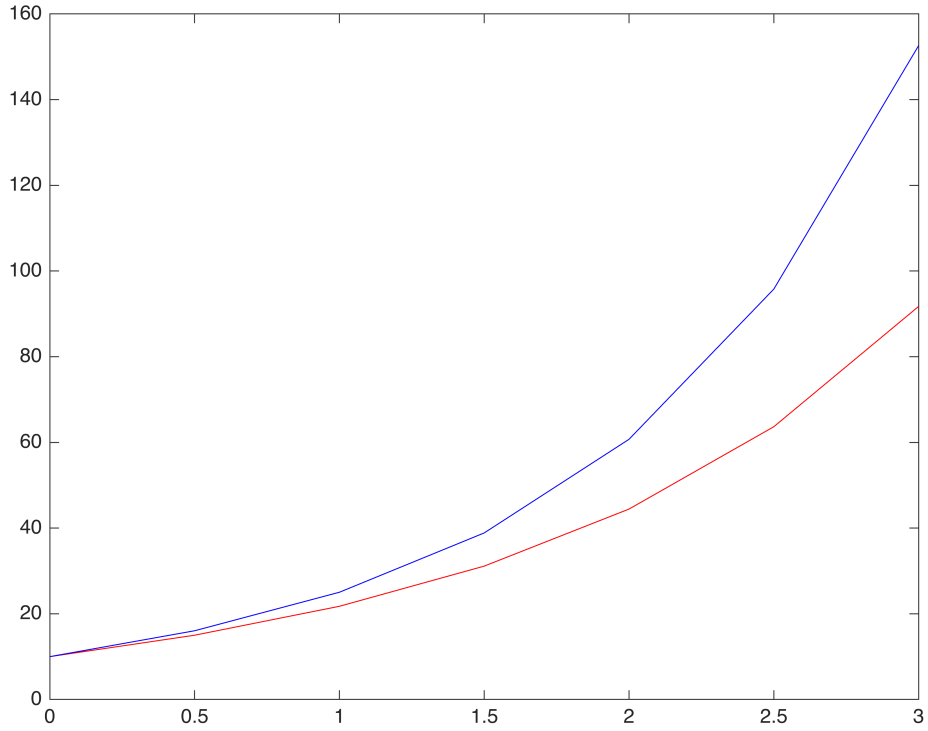
```
y = 1×7
     0     0     0     0     0     0     0
```

```
% m_array=zeros(size(x))
y(1) = y0
```

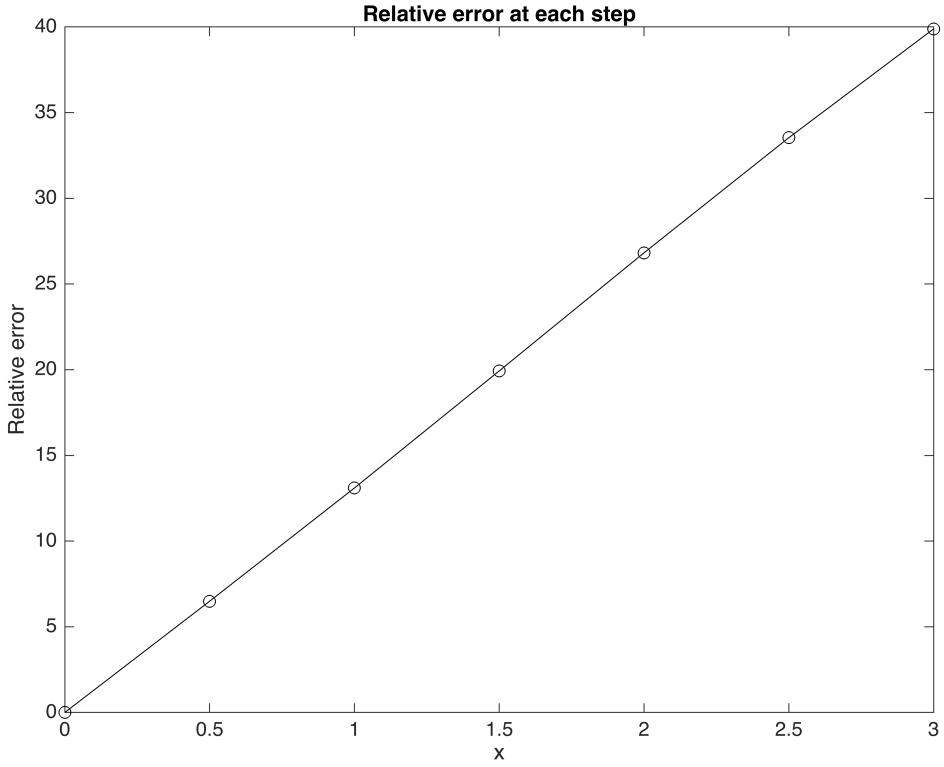
```
y = 1×7
    10     0     0     0     0     0     0
```

```
error_rel = zeros(size(x));


% inside for we need to calculate the error
for i=1:length(x)-1
    y(i+1)=y(i)+h*m(x(i),y(i));

    error_rel(i+1) = abs((yexact(x(i+1)) - y(i+1))/yexact(x(i+1)))*100; %
PERCENTAGE
end
error_rel_euler = error_rel;

% plot(x,y, 'r')
plot(x,y, 'r')
```

```
hold on
plot(x,yexact(x), 'b')
hold off
```




```
figure;
plot(x, error_rel, 'k-o');
xlabel('x');
ylabel('Relative error');
title('Relative error at each step');
```




```
% First improvement over Eulers method
m=@(x,y) y-3.*x;
yexact=@(x) 7*exp(x)+3*x+3;
y0=10
```

```
y0 =
10
```

```
x0=0
```

```
x0 =
0
```

```
xf=3
```

```
xf =
3
```

```
% dx = 1
h = 0.5
```

```
h =
0.5000
```

```
% define error array store the relative error at each step

x=x0:h:xf
```

```
x = 1×7
         0    0.5000    1.0000    1.5000    2.0000    2.5000    3.0000
```

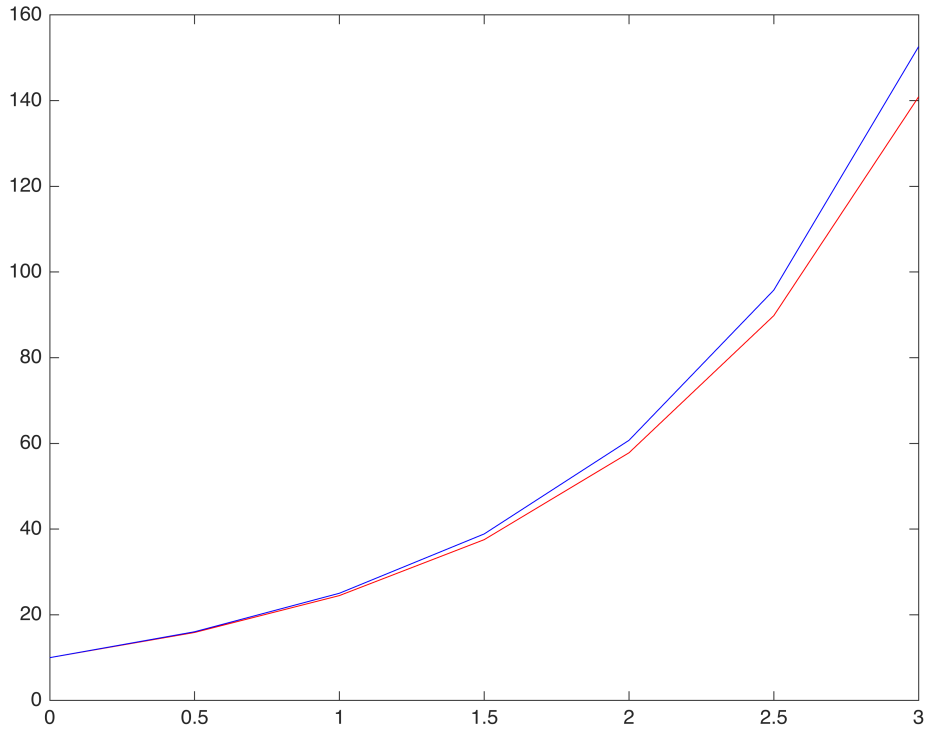
```
y=zeros(size(x))
```

```
y = 1×7
     0     0     0     0     0     0     0
```

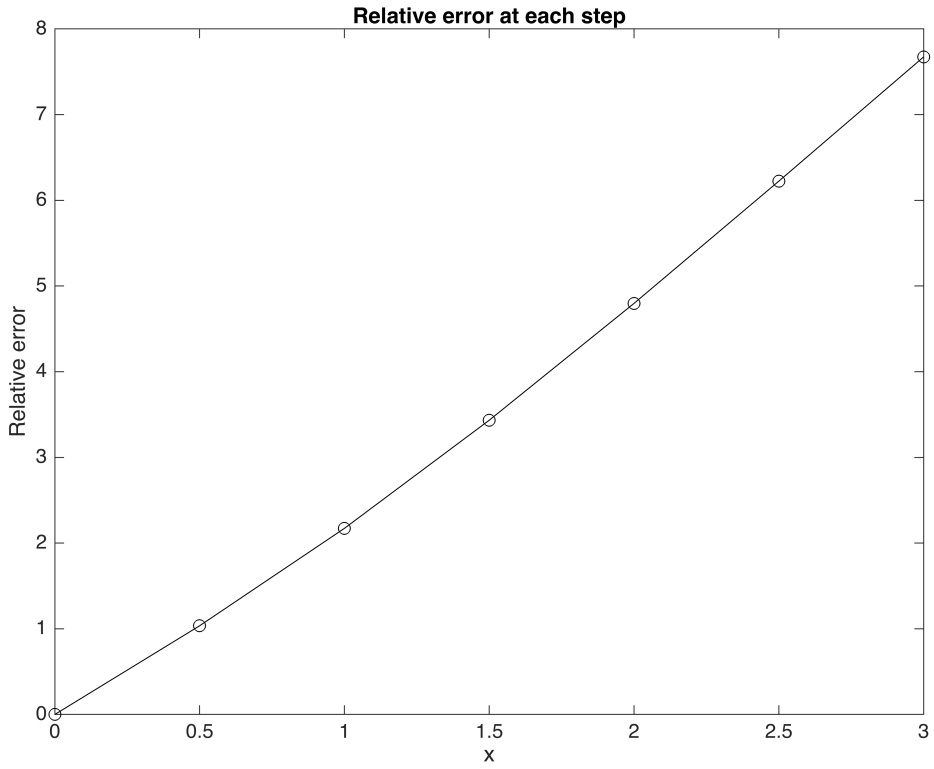
```
% m_array=zeros(size(x))
y(1) = y0
```

```
y = 1×7
    10     0     0     0     0     0     0
```

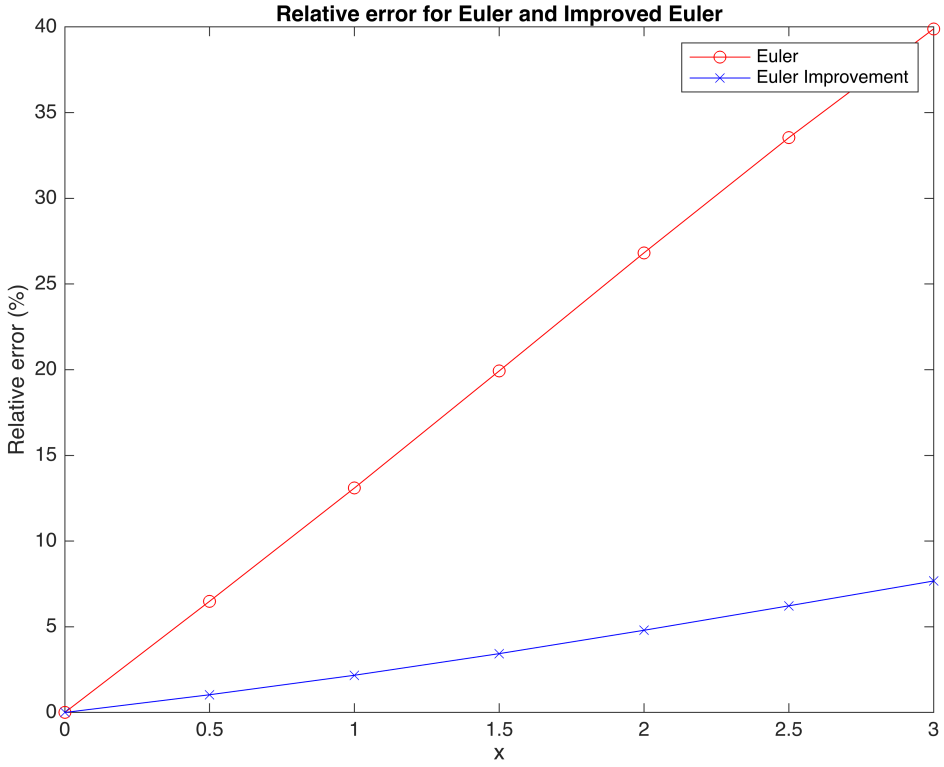
```
error_rel = zeros(size(x));


% inside for we need to calculate the error
for i=1:length(x)-1
    % mi current slope
    mi = m(x(i), y(i));
    % Calculate next prediction
    y_predict = y(i) + h * mi;
    % Calculate next slope
    mf = m(x(i+1), y_predict);
    % average
    m_avg = (mi + mf) / 2;
    % next aproach
    y(i+1) = y(i) + h * m_avg;


    error_rel(i+1) = abs((yexact(x(i+1)) - y(i+1))/yexact(x(i+1)))*100; %
PERCENTAGE
end
error_rel_heun = error_rel;

% plot(x,y, 'r')
plot(x,y, 'r')
hold on
plot(x,yexact(x), 'b')
hold off
```




```
figure;
plot(x, error_rel, 'k-o');
xlabel('x');
ylabel('Relative error');
title('Relative error at each step');
```




```
figure;
plot(x, error_rel_euler, 'r-o', 'DisplayName', 'Euler');
hold on;
plot(x, error_rel_heun, 'b-x', 'DisplayName', 'Euler Improvement');
xlabel('x');
ylabel('Relative error (%)');
title('Relative error for Euler and Improved Euler');
legend show;
hold off;
```


Relative error for Euler and Improved Euler
Euler
Euler Improvement
Relative error (%)
x
0
5
10
15
20
25
30
35
40
0
0.5
1
1.5
2
2.5
3