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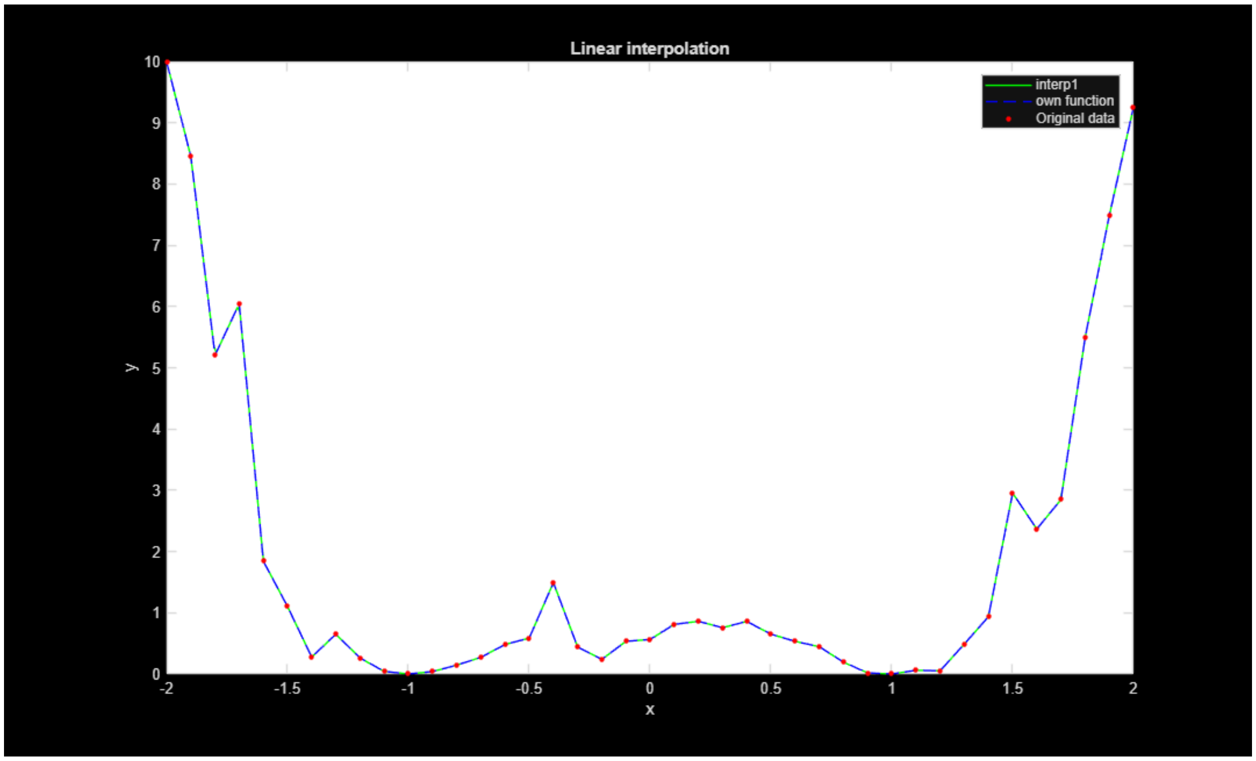
```
% main script

% Task 1.
```

Task 1.1.

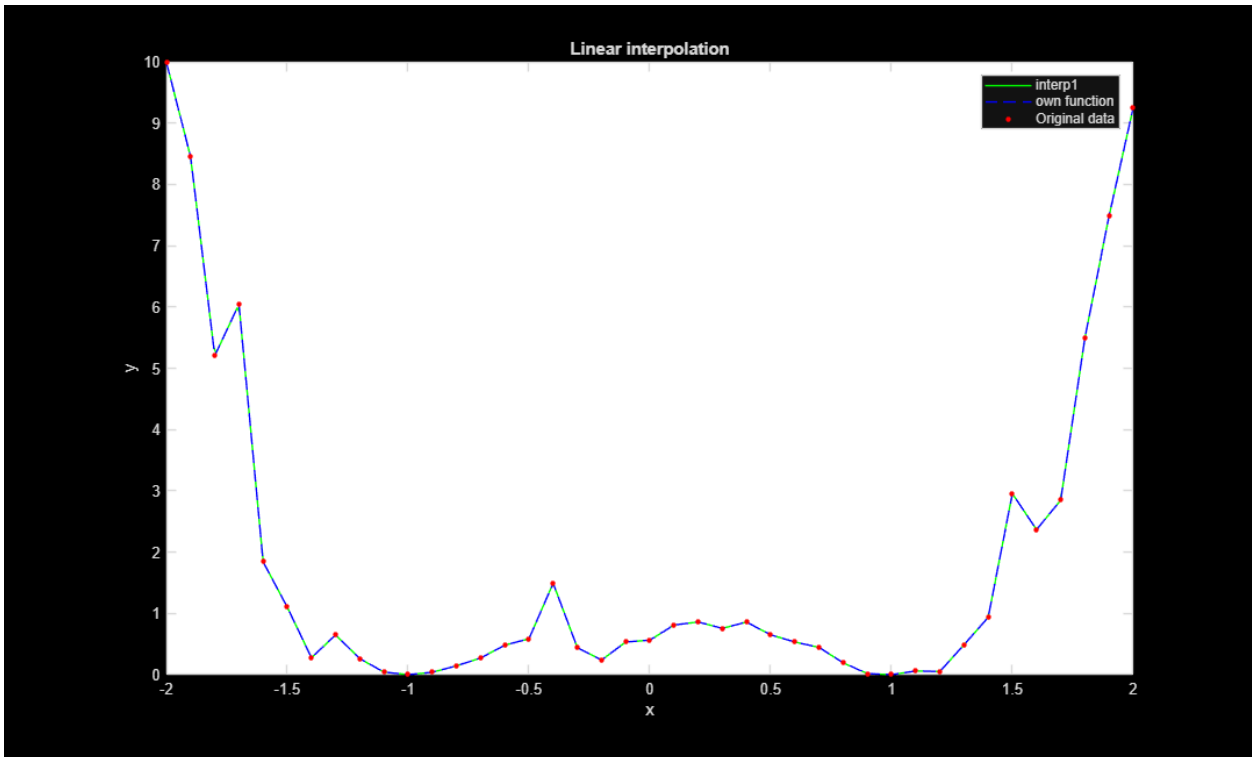
```
clear all
close all
clc

% import data_set_1

load('data_set_1.mat');

% linear interpolation using own function

stepsize1_1 = 10;

[x_olinint, y_olinint] = linearInterpolation(x,y, stepsize1_1);

% linear interpolation using matlab function

x_mlinint = linspace(x(1),x(end), length(x)*stepsize1_1);
y_mlinint = interp1(x,y,x_mlinint);

figure(1)
plot(x_mlinint, y_mlinint, '-g', x_olinint, y_olinint, '--b', x,y, '.r',
'MarkerSize', 10)
set(gca, 'color', 'w') % this is only necessary if you're using the dark
mode...
title('Linear interpolation')
legend('interp1', 'own function', 'Original data')
xlabel('x')
ylabel('y')
```

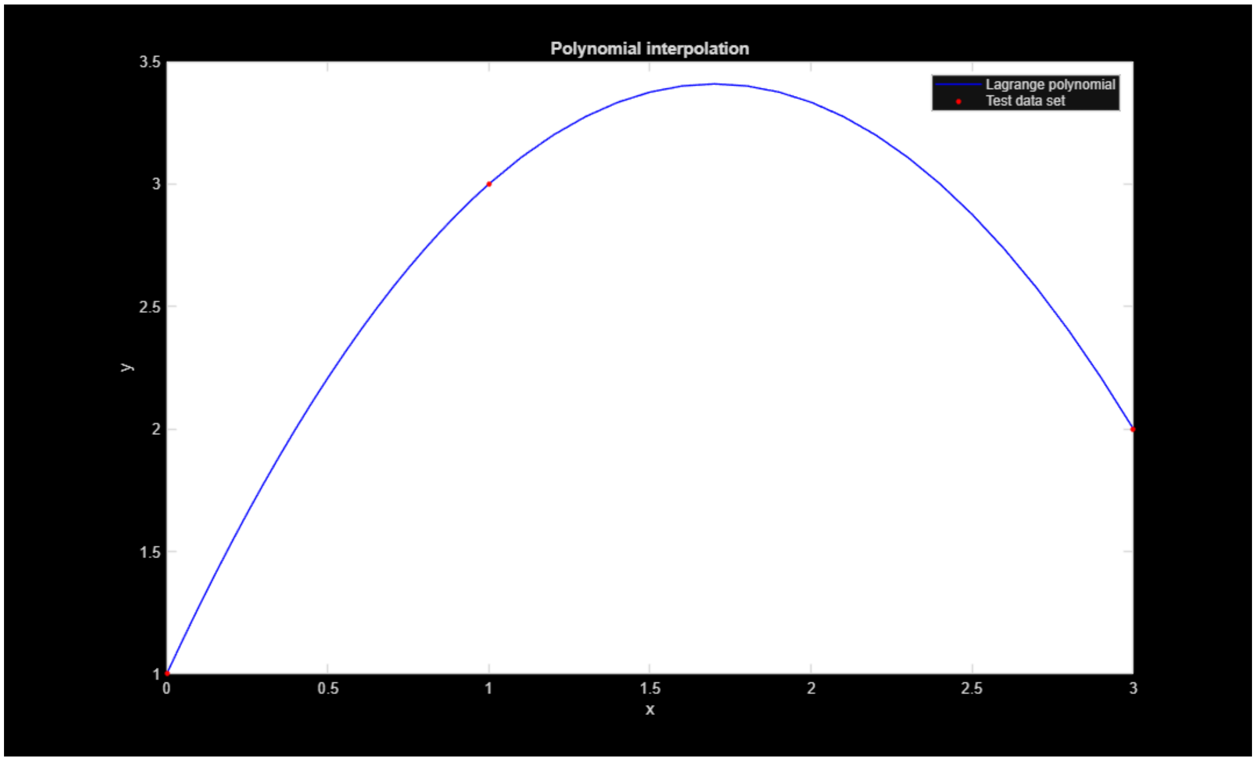


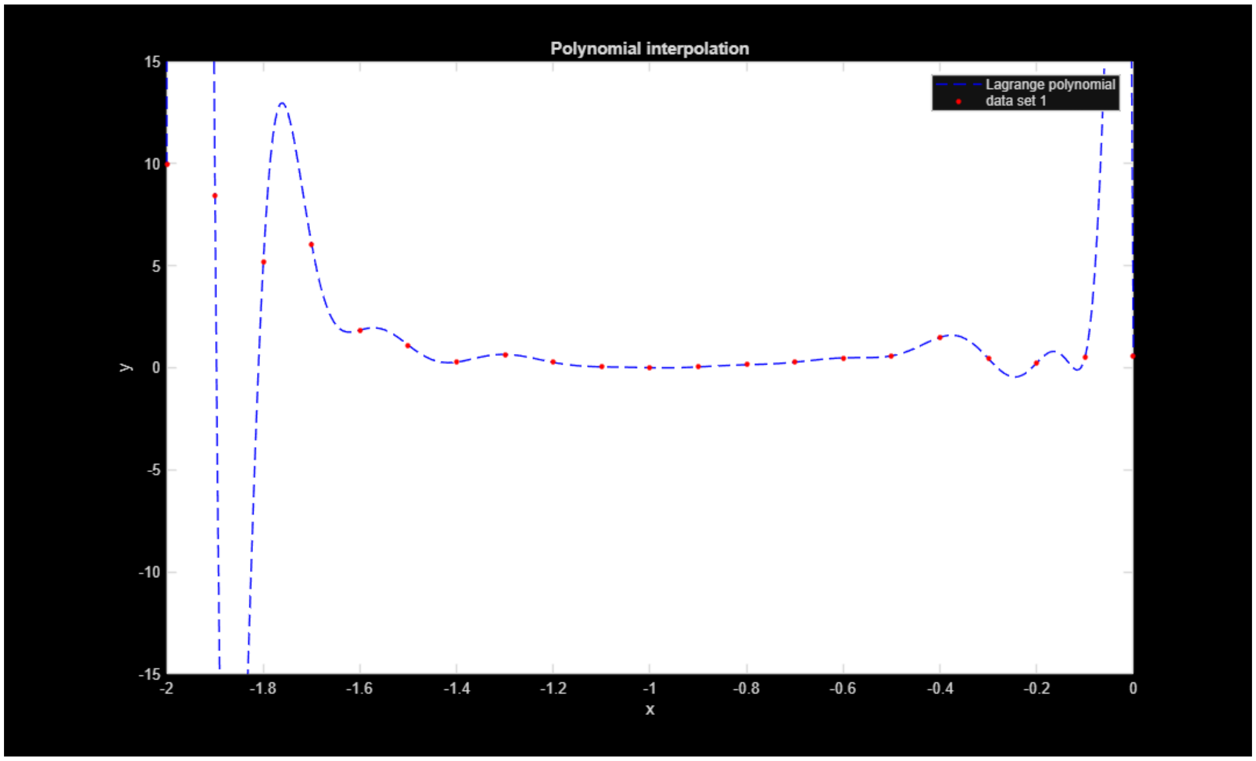
Task 1.2.

```
% create test data set tx and ty

tx = [0 1 3];
ty = [1 3 2];

% test function with test data

stepsize1_2 = 20;

[x_tpolint, y_tpolint] = polynomialInterpolation(tx, ty, stepsize1_2);

% plot the results

figure(2)
plot(x_tpolint, y_tpolint, '-b',  tx, ty, '.r', 'MarkerSize', 10)
set(gca, 'color', 'w') % this is only necessary if you're using the dark
mode...
title('Polynomial interpolation')
legend('Lagrange polynomial', 'Test data set')
xlabel('x')
ylabel('y')

% testing with data set 1

% setting specified limit
```

```
xpol = x(1:1:21);
ypol = y(1:1:21);

[x_opolint, y_opolint] = polynomialInterpolation(xpol, ypol, stepsize1_2);

% plot the results

figure(3)
plot(x_opolint, y_opolint, '--b', xpol, ypol, '.r', 'MarkerSize', 10)
set(gca, 'color', 'w') % this is only necessary if you're using the dark
mode...
title('Polynomial interpolation')
legend('Lagrange polynomial', 'data set 1')
xlim([-2 0])
ylim([-15 15])
xlabel('x')
ylabel('y')
```





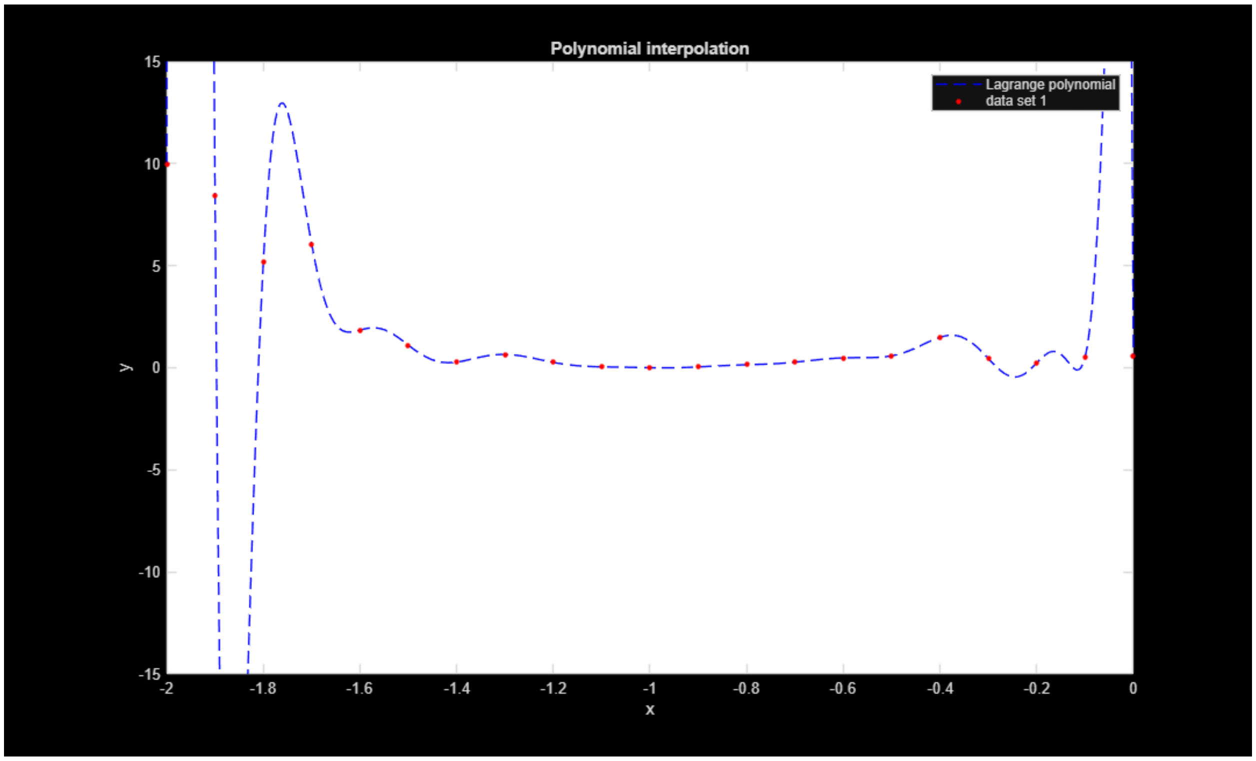


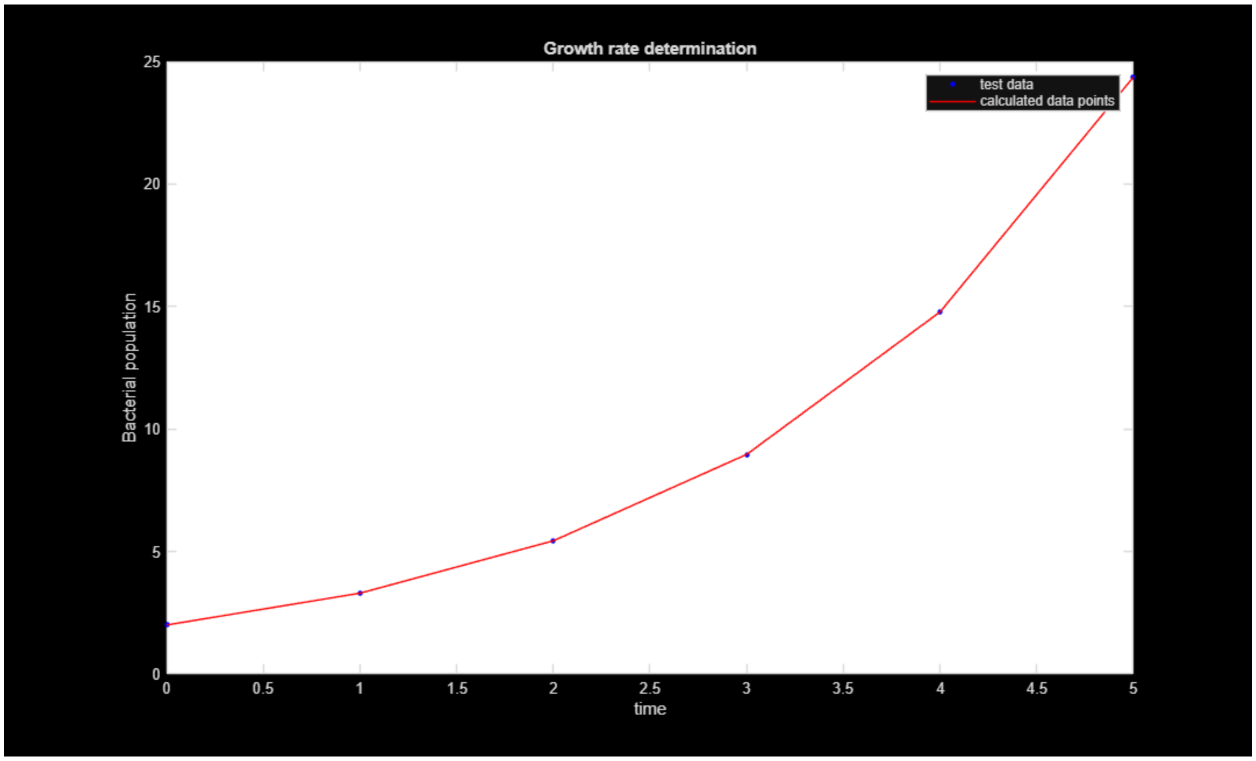
Task 2.1.

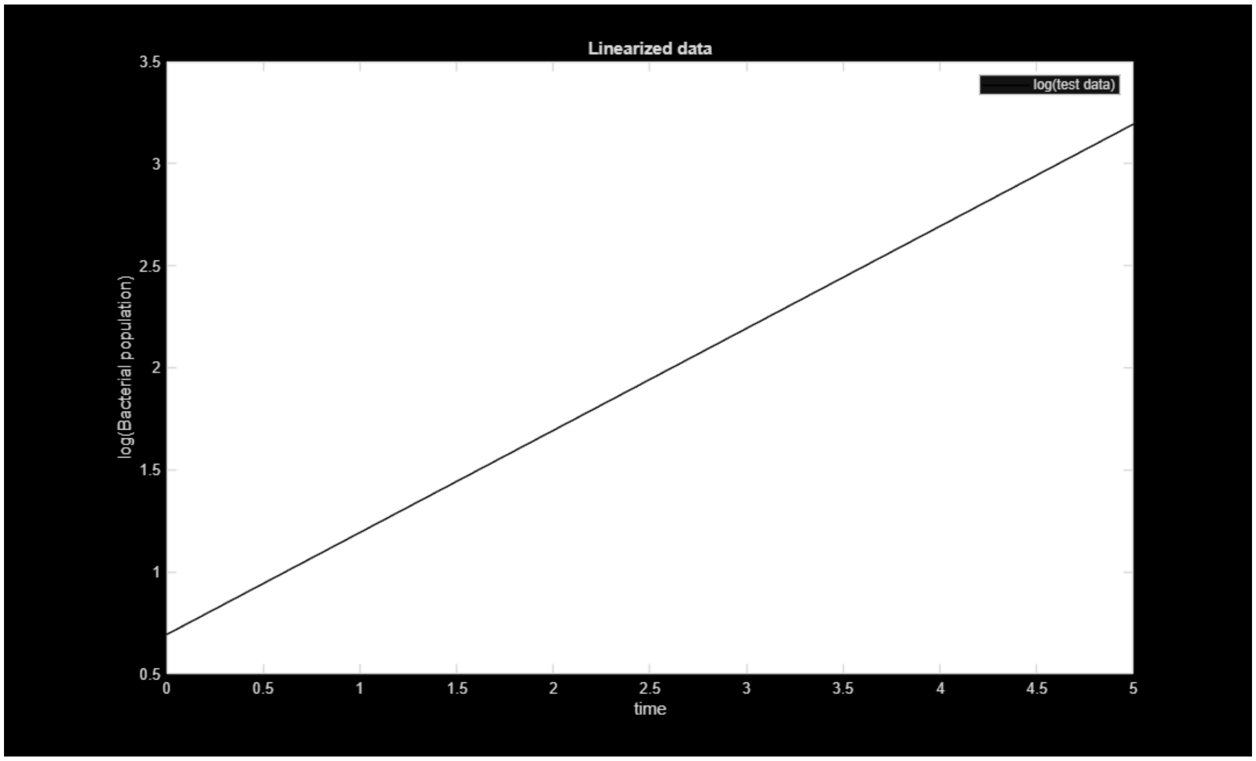
```
% create test_data_set
```

```
tt = [0 1 2 3 4 5];
tx = [2];

for i = 2:1:length(tt)

    tx(i) = tx(1)*exp(0.5 * tt(i));

end

% Give time dependent function

sprintf('X(t) = X_0 * e(µ*t) \n \nln(X(t)) = ln(X_0) + µt')

% determine mu in test data set

[mu, cx0, ln_x] = mu_determination(tt,tx);

% calculate data with determined mu

ecx1 = [cx0];

for i = 2:1:length(tt)

    ecx1(i) = cx0 * exp(mu * tt(i));

end

% plot the results

figure(4)
plot(tt, tx, '.b', tt, ecx1, '-r', 'MarkerSize', 10)
set(gca, 'color', 'w') % this is only necessary if you're using the dark
mode...
title('Growth rate determination')
legend('test data', 'calculated data points')
xlabel('time')
ylabel('Bacterial population')

figure(5)
plot(tt, ln_x, '-k')
set(gca, 'color', 'w') % this is only necessary if you're using the dark
mode...
title('Linearized data')
legend('log(test data)')
xlabel('time')
ylabel('log(Bacterial population)')
```

```
ans =

    'X(t) = X_0 * e(µ*t)

     ln(X(t)) = ln(X_0) + µt'
```


Polynomial interpolation
Lagrange polynomial
data set 1
x
y
15
10
5
0
-5
-10
-15
-2
-1.8
-1.6
-1.4
-1.2
-1
-0.8
-0.6
-0.4
-0.2
0


Growth rate determination
test data
calculated data points
time
Bacterial population
25
20
15
10
5
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

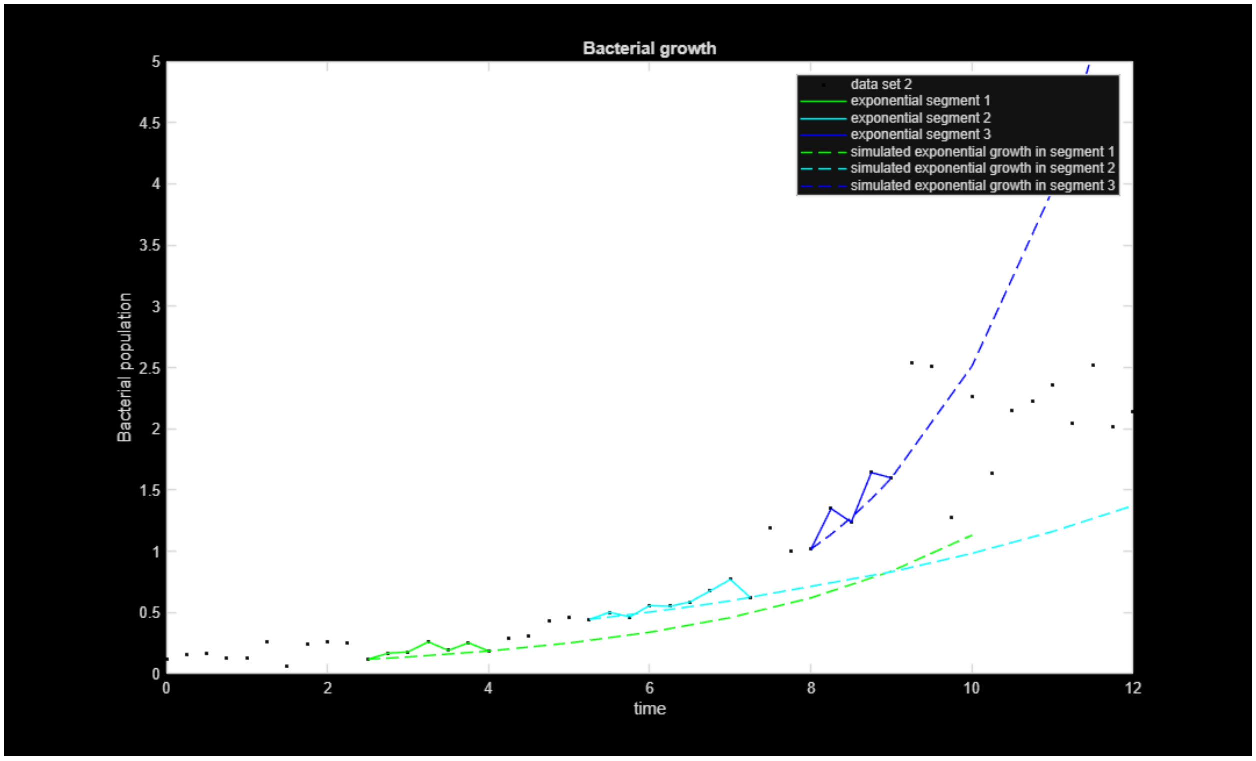


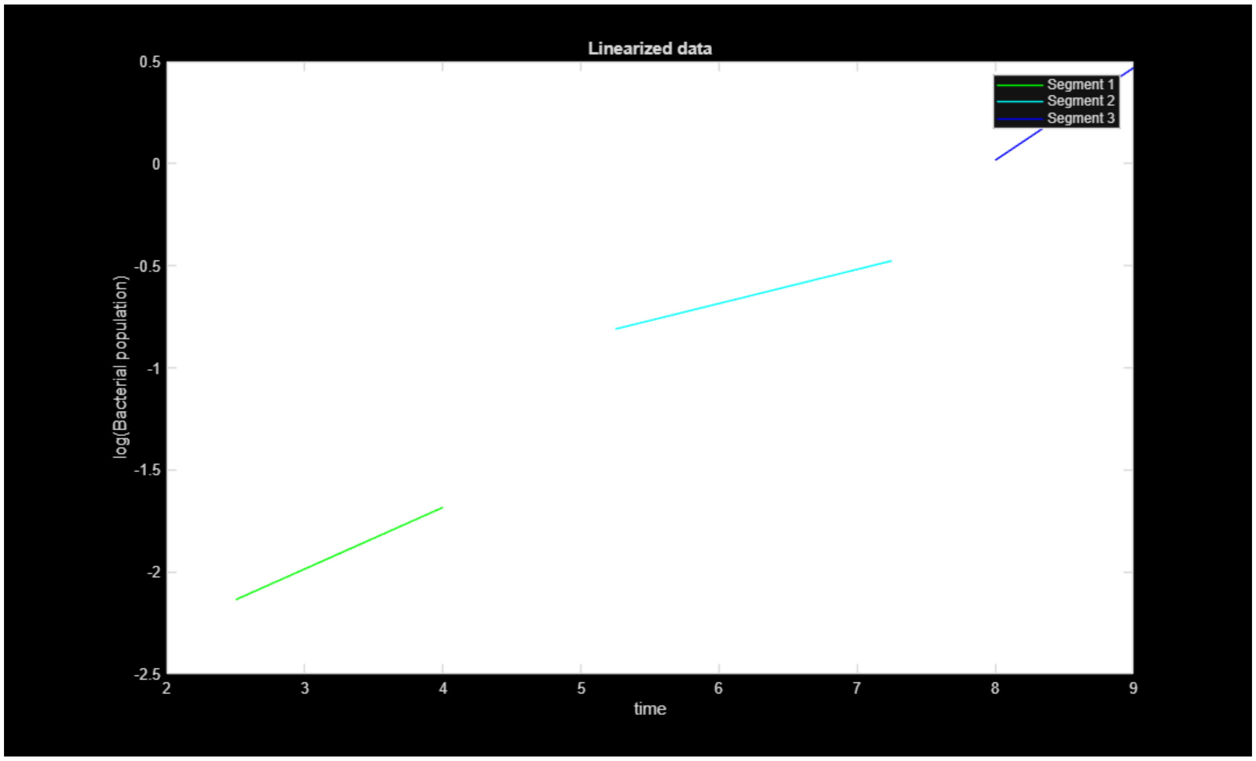
Task 2.2

```
% import data_set_2

load('data_set_2.mat');

% select exponential growth segments

window = 5;
precision = 0.33;
allowed_outliers = 2;
[et, ex] = exponential_selector(time, bio_r, window, precision,
allowed_outliers);

% determine mu for each segment

[emu1, ecx0_1, eln_x1] = mu_determination(et{1},ex{1});
[emu2, ecx0_2, eln_x2] = mu_determination(et{2},ex{2});
[emu3, ecx0_3, eln_x3] = mu_determination(et{3},ex{3});

peln_x1 = [eln_x1(1) eln_x1(end)];
pet1 = [et{1}(1) et{1}(end)];
peln_x2 = [eln_x2(1) eln_x2(end)];
pet2 = [et{2}(1) et{2}(end)];
peln_x3 = [eln_x3(1) eln_x3(end)];
pet3 = [et{3}(1) et{3}(end)];

% calculate bacterial population with determined mu
```

```
ecx1 = [ecx0_1];
et1 = et{1};

for i = 2:1:12

    if i < length(et1)

        % Subtracting the start time ensures the model begins from the
correct point.

        ecx1(i) = ecx0_1 * exp(emu1 * (et1(i) - et1(1)));

    else

        % values after exponential segment

        i = round(et1()) + 1;
        et1(i) = i;
        ecx1(i) = ecx0_1 * exp(emu1 * (et1(i) - et1(1)));

    end

end

ecx2 = [ecx0_2];
et2 = et{2};

for i = 2:1:12

    if i < length(et2)

        % Subtracting the start time ensures the model begins from the
correct point.

        ecx2(i) = ecx0_2 * exp(emu2 * (et2(i) - et2(1)));

    else

        % values after exponential segment

        et2(i) = i;
        ecx2(i) = ecx0_2 * exp(emu2 * (et2(i) - et2(1)));

    end

end

ecx3 = [ecx0_3];
et3 = et{3};

for i = 2:1:12

    if i < length(et3)
```

```
        % Subtracting the start time ensures the model begins from the
correct point.

        ecx3(i) = ecx0_3 * exp(emu3 * (et3(i) - et3(1)));

    else

        % values after exponential segment

        j = i + 4;
        et3(i) = j;
        ecx3(i) = ecx0_3 * exp(emu3 * (et3(i) - et3(1)));

        if j == 12

            break

        end

    end

end

% plot the results

figure(6)
plot(time, bio_r, '.k', et{1}, ex{1}, '-g', et{2}, ex{2}, '-c', et{3},
ex{3}, '-b', ...
    et1, ecx1, '--g', et2, ecx2, '--c',et3, ecx3, '--b')
set(gca, 'color', 'w') % this is only necessary if you're using the dark
mode...
title('Bacterial growth')
ylim([0 5])
legend('data set 2', 'exponential segment 1', 'exponential segment 2',
'exponential segment 3', ...
    'simulated exponential growth in segment 1', 'simulated exponential
growth in segment 2', 'simulated exponential growth in segment 3')
xlabel('time')
ylabel('Bacterial population')

figure(7)
plot(pet1, peln_x1, '-g', pet2, peln_x2, '-c', pet3, peln_x3, '-b')
set(gca, 'color', 'w') % this is only necessary if you're using the dark
mode...
title('Linearized data')
legend('Segment 1', 'Segment 2', 'Segment 3')
xlabel('time')
ylabel('log(Bacterial population)')
```

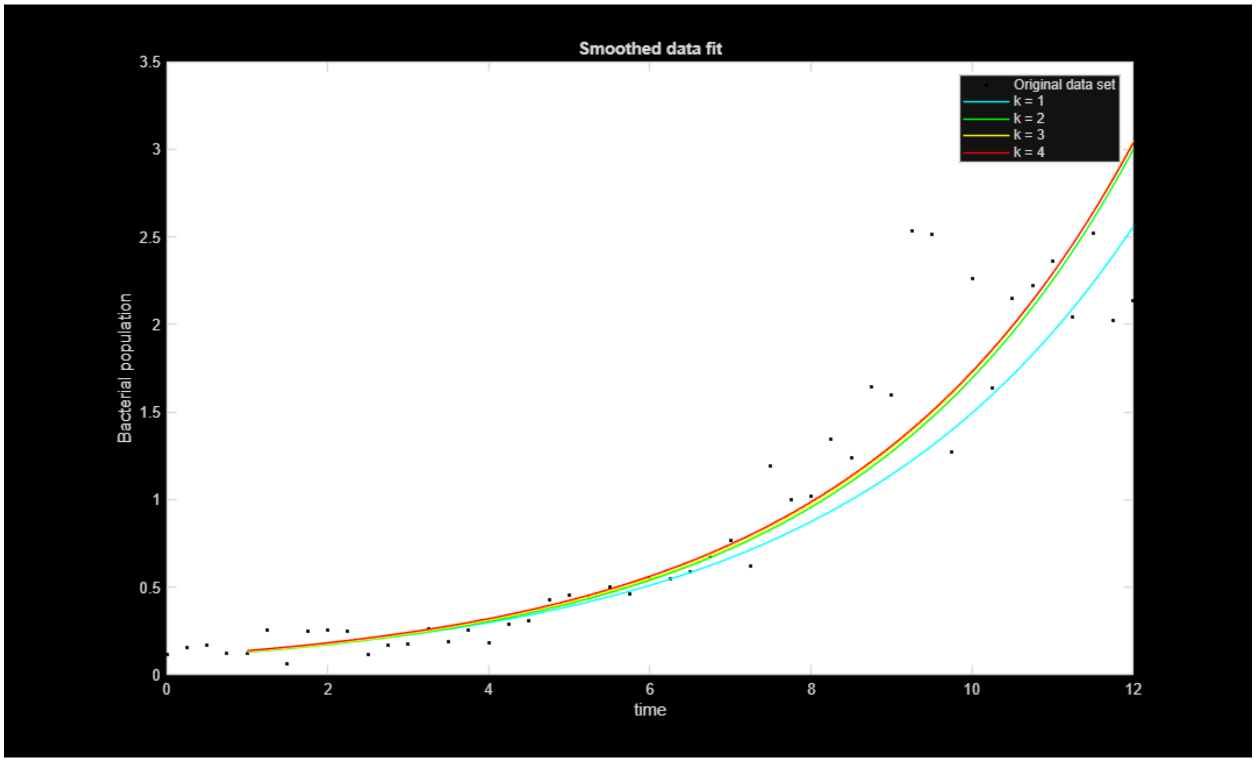




Task 3.1.

```
% study the influence of k
```

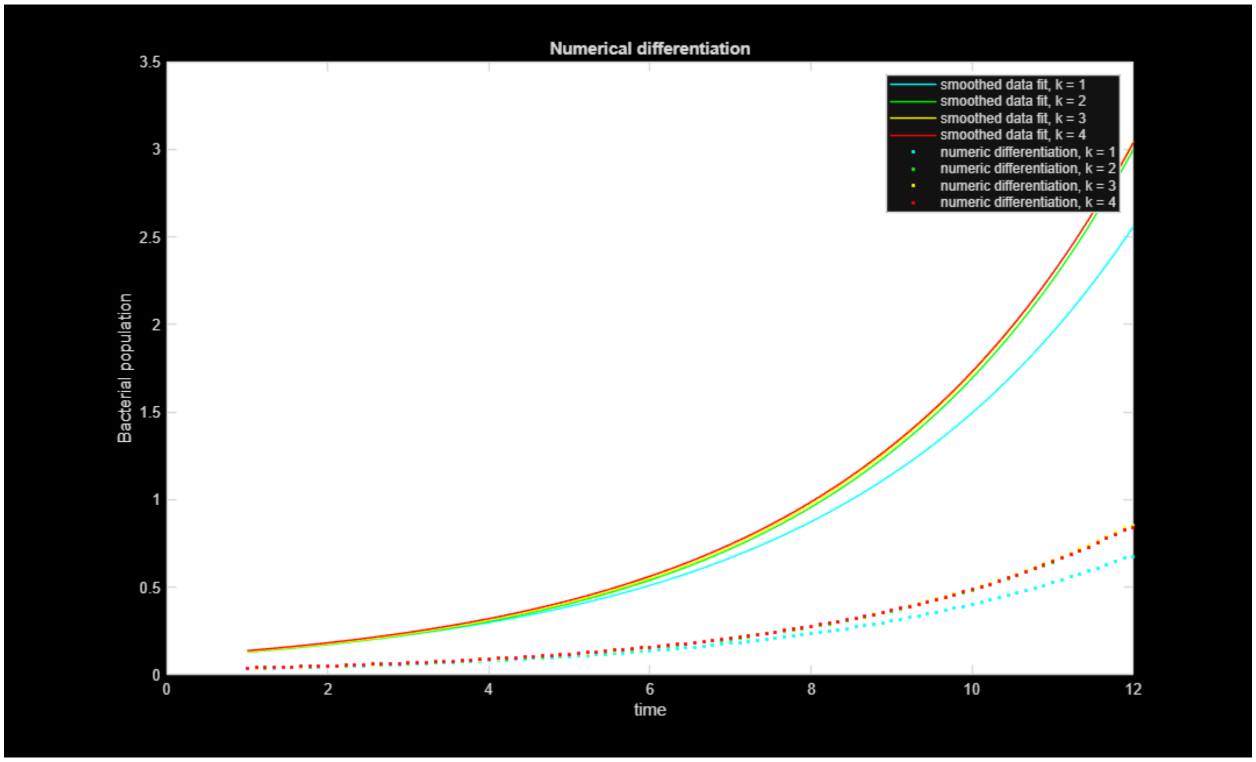
```
for k = 1:1:4

    [Ts(k,:), Xs(k,:)] = smoother(time, bio_r, k);

end

figure(8)
plot(time, bio_r, '.k', Ts(1,:), Xs(1,:), '-c', Ts(2,:), Xs(2,:), '-g', ...
    Ts(3,:), Xs(3,:), '-y', Ts(4,:), Xs(4,:), '-r')
set(gca, 'color', 'w') % this is only necessary if you're using the dark
mode...
title('Smoothed data fit')
legend('Original data set', 'k = 1', 'k = 2', 'k = 3', 'k = 4')
xlabel('time')
ylabel('Bacterial population')
```



Task 3.2.

```
% calculate first derivative

for k = 1:1:4

    fbar_y(k,:) = differentiator(Ts(k,:), Xs(k,:));

end

figure(9)
plot(Ts(1,:), Xs(1,:), '-c', Ts(2,:), Xs(2,:), '-g', Ts(3,:), Xs(3,:), '-y',
Ts(4,:), Xs(4,:), '-r', ...
```

```
    Ts(1,:), fbar_y(1,:), '.c', Ts(2,:), fbar_y(2,:), '.g', Ts(3,:),
fbar_y(3,:), '.y', Ts(4,:), fbar_y(4,:), '.r')
set(gca, 'color', 'w') % this is only necessary if you're using the dark
mode...
title('Numerical differentiation')
legend('smoothed data fit, k = 1', 'smoothed data fit, k = 2', 'smoothed
data fit, k = 3', 'smoothed data fit, k = 4', ...
    'numeric differentiation, k = 1', 'numeric differentiation, k = 2',
'numeric differentiation, k = 3', 'numeric differentiation, k = 4')
xlabel('time')
ylabel('Bacterial population')
```



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