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```
% Kathryn Atherton
% ABE 30100
% Quiz 5

clear;
clc;

xdata = [0; 0.4; 2; 3.5; 5; 6; 6.8; 8; 9; 10; 11; 12; 13; 14; 15; 16];
y = [0; 1; 2.8; 3.5; 3.5; 2.3; 1.5; 1; 0.75; 0.6; 0.55; 0.5; 0.5; 0.8;
 0.6; 0.5];
```

Part 1

```
p3_model = polyfit(xdata,y,3); % regression polynomial model of 3rd
 order
f3 = polyval(p3_model,xdata);
figure('Name','Third Order Regression') % plot of the model vs the
 data
plot(xdata,y,'o',xdata,f3,'-');
ylim([0,4]);
xlim([0,16]);
title('Third Order Regression');
xlabel('length (cm)');
ylabel('height (cm)');
r_3 = sqrt(1 - ((sum((y - f3).^2))/sum(((y - mean(y)).^2)))); %
 regression coefficient for third order model
fprintf('The third order regression model is y = %fx^3
 + %fx^2 + %fx + %f. The regression coefficient is %f.
\n',p3_model(1),p3_model(2),p3_model(3),p3_model(4),r_3)
fprintf('This model is not satisfactory as it does not match the
 drawing well and the regression coefficient is relatively low.\n\n')

p5_model = polyfit(xdata,y,5); % regression polynomial model of 5th
 order
f5 = polyval(p5_model,xdata);
figure('Name','Fifth Order Regression') % plot of the model vs the
 data
plot(xdata,y,'o',xdata,f5,'-');
ylim([0,4]);
xlim([0,16]);
title('Fifth Order Regression');
xlabel('length (cm)');
```

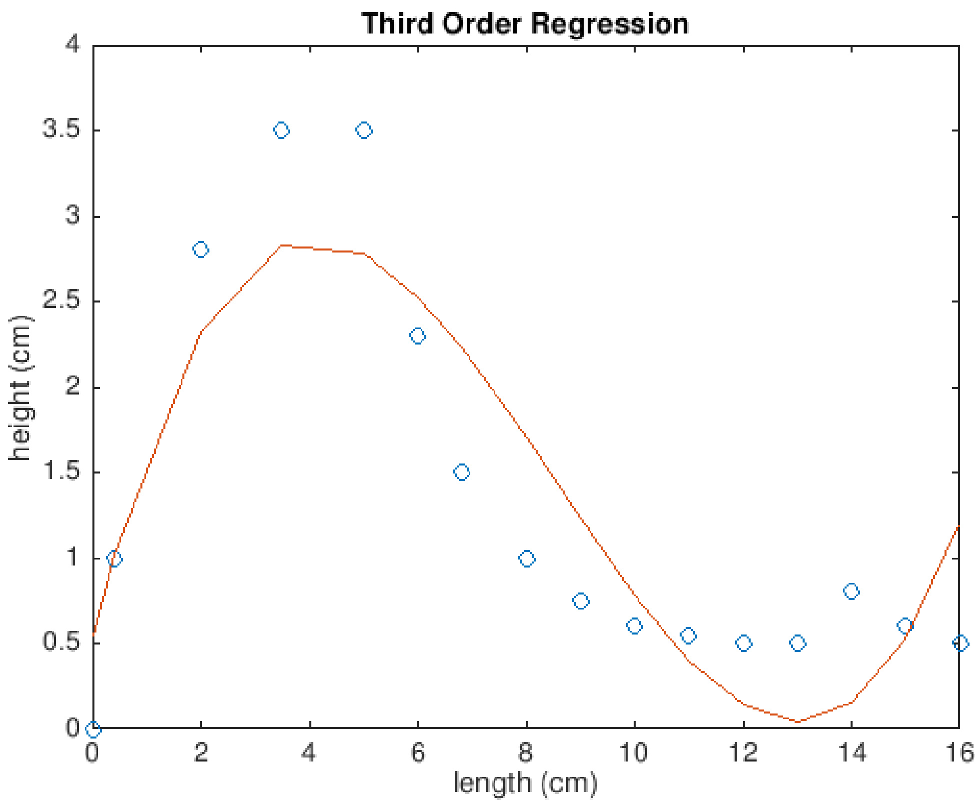
```
ylabel('height (cm)');
r_5 = sqrt(1 - ((sum((y - f5).^2))/sum(((y - mean(y)).^2)))); %
 regression coefficient for fifth order model
fprintf('The fifth order regression model is y = %fx^5 + %fx^4
 + %fx^3 + %fx^2 + %fx + %f. The regression coefficient is %f.
\n',p5_model(1),p5_model(2),p5_model(3),p5_model(4),p5_model(5),p5_model(6),r_5)
fprintf('This model is satisfactory as the shape is pretty close to
 the drawing and the regression coefficient is close to 1.\n')
area_5 = 2 * trapz(xdata,f5); % area under the curve
fprintf('The area under the model is %f cm^2.\n\n',area_5)

p9_model = polyfit(xdata,y,9); % regression polynomial model of 9th
 order
f9 = polyval(p9_model,xdata);
figure('Name','Ninth Order Regression') % plot of the model vs the
 data
plot(xdata,y,'o',xdata,f9,'-');
ylim([0,4]);
xlim([0,16]);
title('Ninth Order Regression');
xlabel('length (cm)');
ylabel('height (cm)');
r_9 = sqrt(1 - ((sum((y - f9).^2))/sum(((y - mean(y)).^2)))); %
 regression coefficient for ninth order model
fprintf('The ninth order regression model is y = %fx^9
 + %fx^8 + %fx^7 + %fx^6 + %fx^5 + %fx^4 + %fx^3 +
 %fx^2 + %fx + %f. The regression coefficient is %f.
\n',p9_model(1),p9_model(2),p9_model(3),p9_model(4),p9_model(5),p9_model(6),p9_mod
fprintf('This model is acceptable as the shape is pretty close to the
 drawing and the regression coefficient is very close to 1.\n')
area_9 = 2 * trapz(xdata,f9); % area under the curve
fprintf('The area under the model is %f cm^2.\n\n',area_9)

p10_model = polyfit(xdata,y,10); % regression polynomial model of 10th
 order
f10 = polyval(p10_model,xdata);
figure('Name','Tenth Order Regression') % plot of the model vs the
 data
plot(xdata,y,'o',xdata,f10,'-');
ylim([0,4]);
xlim([0,16]);
title('Tenth Order Regression');
xlabel('length (cm)');
ylabel('height (cm)');
r_10 = sqrt(1 - ((sum((y - f10).^2))/sum(((y - mean(y)).^2)))); %
 regression coefficient for tenth order model
fprintf('The tenth order regression model is y = %.10fx^10
 + %fx^9 + %fx^8 + %fx^7 + %fx^6 + %fx^5 + %fx^4 + %fx^3
 + %fx^2 + %fx + %f. The regression coefficient is %f.
\n',p10_model(1),p10_model(2),p10_model(3),p10_model(4),p10_model(5),p10_model(6),
fprintf('This model is acceptable as the shape is pretty close to the
 drawing and the regression coefficient is very close to 1.\n')
area_10 = 2 * trapz(xdata,f10); % area under the curve
fprintf('The area under the model is %f cm^2.\n\n',area_10)
```

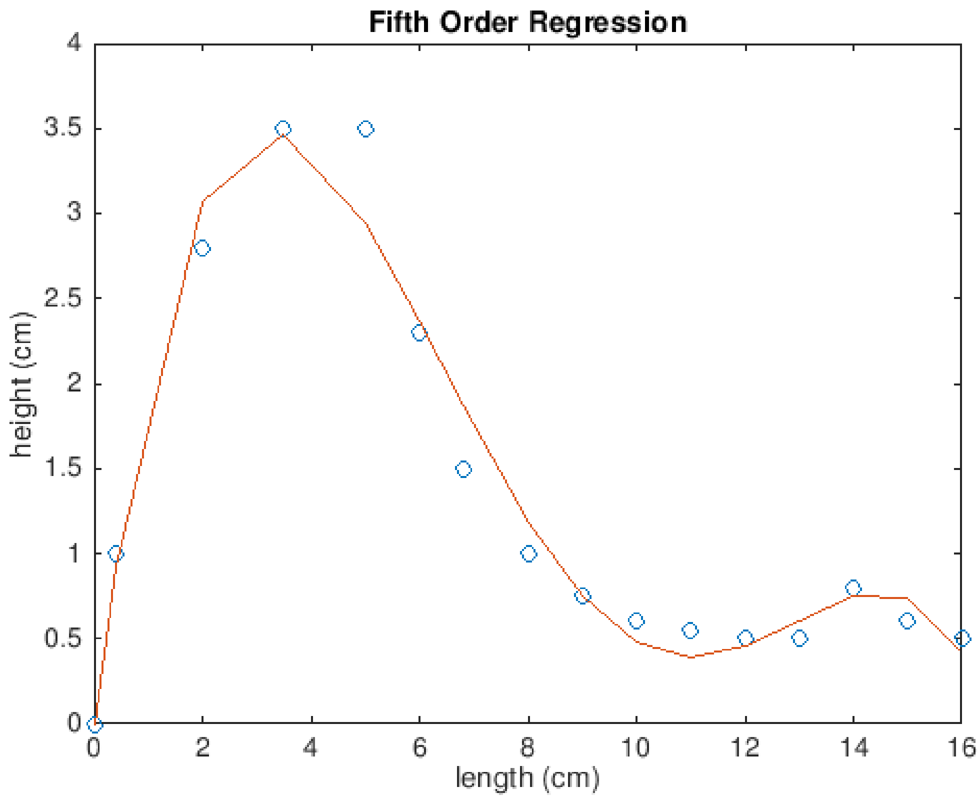
```
p15_model = polyfit(xdata,y,15); % regression polynomial model of 15th
 order
f15 = polyval(p15_model,xdata);
figure('Name','Fifteenth Order Regression') % plot of the model vs the
 data
plot(xdata,y,'o',xdata,f15,'-');
ylim([0,4]);
xlim([0,16]);
title('Fifteenth Order Regression');
xlabel('length (cm)');
ylabel('height (cm)');
r_15 = sqrt(1 - ((sum((y - f15).^2))/sum(((y - mean(y)).^2)))); %
 regression coefficient for fifteenth order model
fprintf('The fifteenth order regression model is y =
 %.10fx^15 + %.10fx^14 + %fx^13 + %fx^12 + %fx^11 + %fx^10
 + %fx^9 + %fx^8 + %fx^7 + %fx^6 + %fx^5 + %fx^4 + %fx^3
 + %fx^2 + %fx + %f. The regression coefficient is %f.
\n',p15_model(1),p15_model(2),p15_model(3),p15_model(4),p15_model(5),p15_model(6),
fprintf('This model is acceptable as the shape is pretty close to the
 drawing and the regression coefficient is 1.\n')
area_15 = 2 * trapz(xdata,f15); % area under the curve
fprintf('The area under the model is %f cm^2.\n\n',area_15)
```

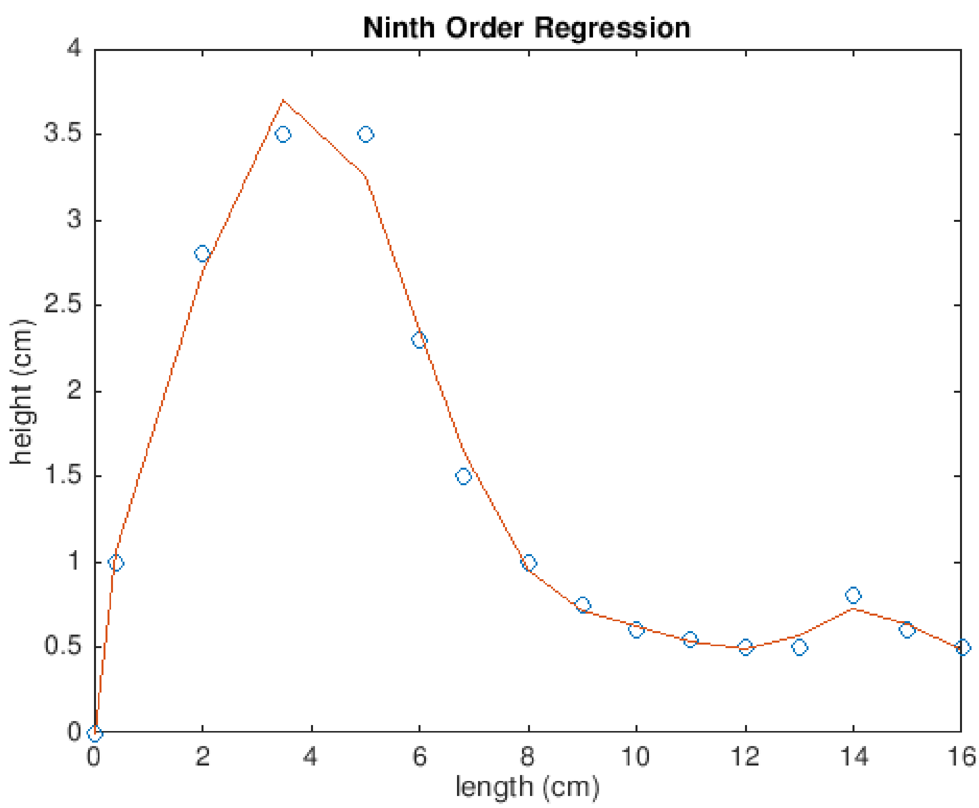
```
The third order regression model is y = 0.007937x^3 + -0.203537x^2 +
 1.265611x + 0.543660. The regression coefficient is 0.883007.
This model is not satisfactory as it does not match the drawing well
 and the regression coefficient is relatively low.

The fifth order regression model is y = -0.000013x^5 + -0.000738x^4 +
 0.041232x^3 + -0.572866x^2 + 2.524008x + -0.003409. The regression
 coefficient is 0.982889.
This model is satisfactory as the shape is pretty close to the drawing
 and the regression coefficient is close to 1.
The area under the model is 48.461202 cm^2.

Warning: Polynomial is badly conditioned. Add points with distinct X
 values,
reduce the degree of the polynomial, or try centering and scaling as
 described
in HELP POLYFIT.
The ninth order regression model is y = 0.000000x^9 + -0.000020x^8 +
 0.000630x^7 + -0.010697x^6 + 0.105567x^5 + -0.607462x^4 + 1.951738x^3
 + -3.391274x^2 + 3.813615x + -0.031956. The regression coefficient is
 0.995771.
This model is acceptable as the shape is pretty close to the drawing
 and the regression coefficient is very close to 1.
The area under the model is 48.368634 cm^2.

Warning: Polynomial is badly conditioned. Add points with distinct X
 values,
reduce the degree of the polynomial, or try centering and scaling as
 described
in HELP POLYFIT.
```

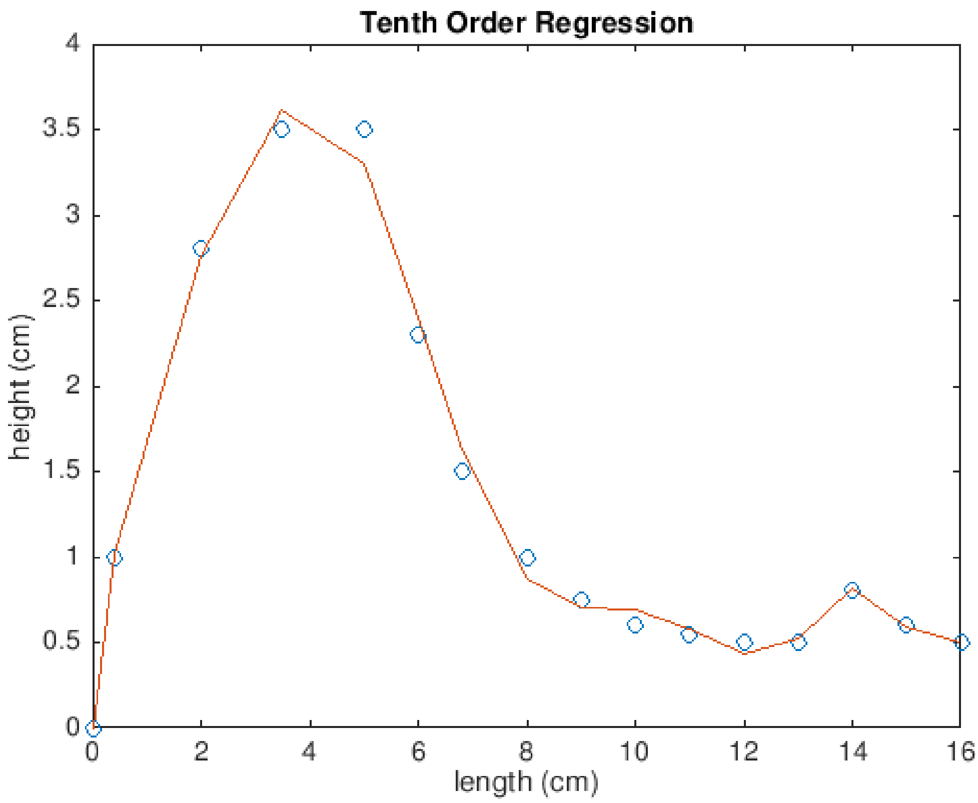
The tenth order regression model is y = 0.0000000405x^10 + -0.000003x^9 + 0.000087x^8 + -0.001344x^7 + 0.011316x^6 + -0.045661x^5 + 0.019652x^4 + 0.486188x^3 + -1.735491x^2 + 3.195643x + -0.010554. The regression coefficient is 0.996973.
This model is acceptable as the shape is pretty close to the drawing and the regression coefficient is very close to 1.
The area under the model is 48.302057 cm^2.

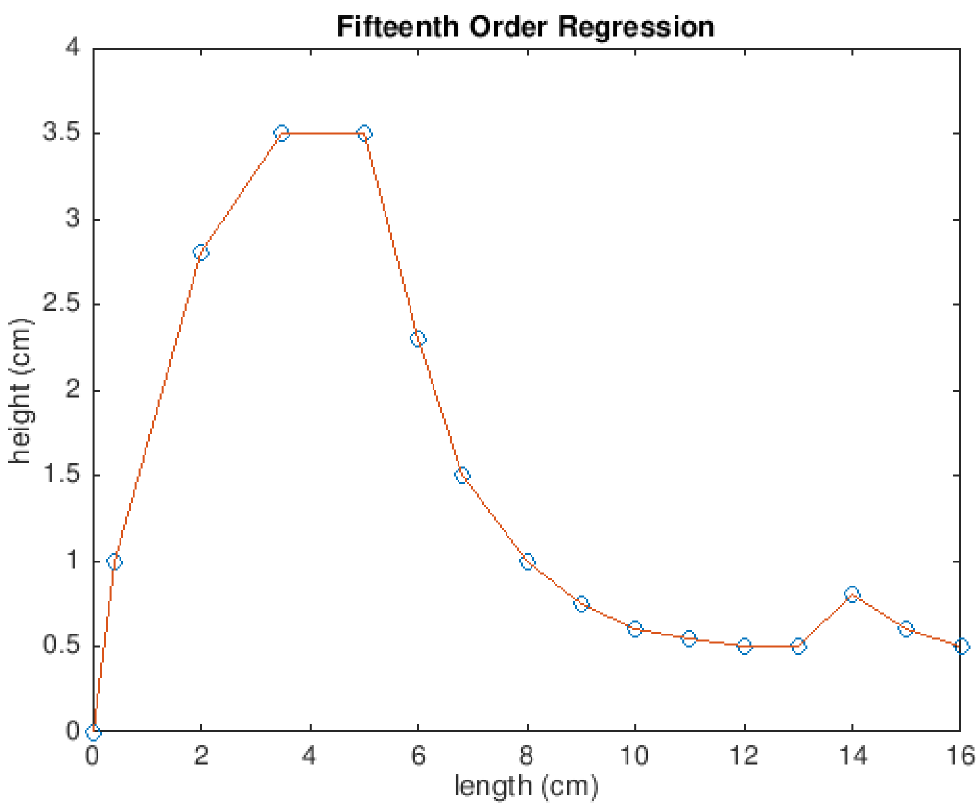
Warning: Polynomial is badly conditioned. Add points with distinct X values,
reduce the degree of the polynomial, or try centering and scaling as described
in HELP POLYFIT.
The fifteenth order regression model is y = 0.0000000001x^15 + -0.0000000111x^14 + 0.000001x^13 + -0.000021x^12 + 0.000476x^11 + -0.007546x^10 + 0.086574x^9 + -0.725675x^8 + 4.436182x^7 + -19.513667x^6 + 60.105270x^5 + -123.678192x^4 + 156.603082x^3 + -104.132206x^2 + 25.655881x + 0.000000. The regression coefficient is 1.000000.
This model is acceptable as the shape is pretty close to the drawing and the regression coefficient is 1.
The area under the model is 48.370003 cm^2.




Fifth Order Regression
height (cm)
length (cm)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
2
4
6
8
10
12
14
16


Ninth Order Regression
height (cm)
length (cm)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
2
4
6
8
10
12
14
16

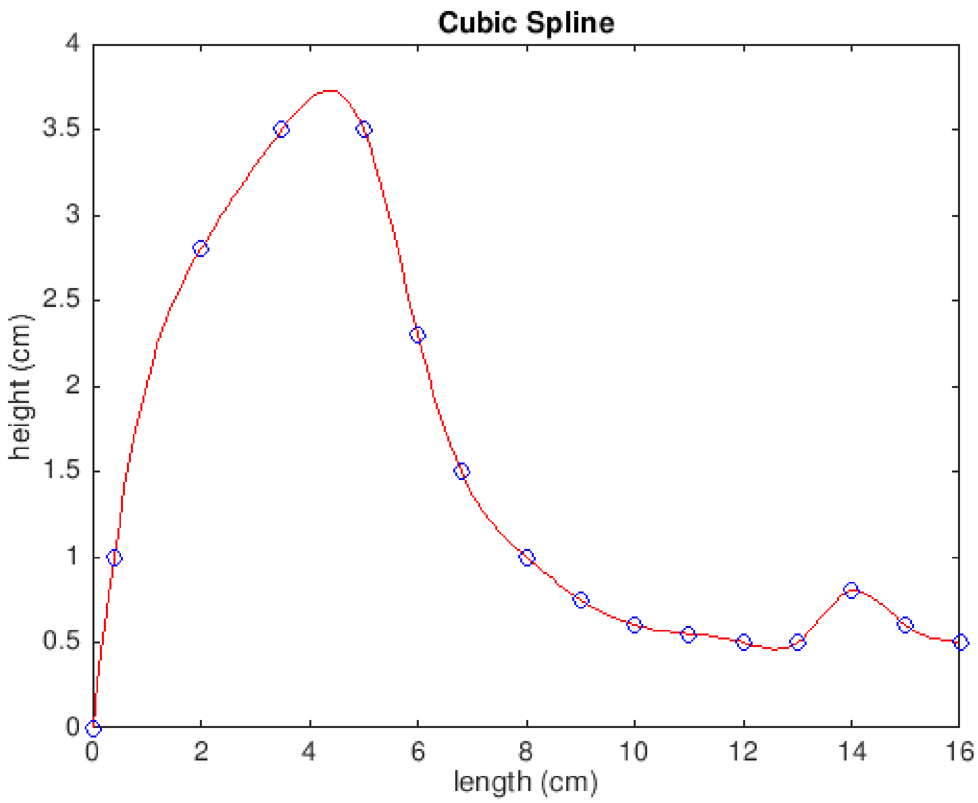

Tenth Order Regression
height (cm)
length (cm)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
2
4
6
8
10
12
14
16


Fifteenth Order Regression
height (cm)
length (cm)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
2
4
6
8
10
12
14
16

Part 2

```
h = zeros(15,1); % interval sizes
for i = 1:15
    h(i,1) = xdata(i+1)-xdata(i);
end


a = y; % a coefficients

Avector = zeros(16,1); % ci coefficients solving by setting up A
 vector
for i = 2:15
    Avector(i,1) = 3*(a(i+1)-a(i))/h(i) - 3*(a(i)-a(i-1))/h(i-1);
end

Hmatrix = zeros(16,16);
Hmatrix(1,1) = 1;
Hmatrix(16,16) = 1;

for i = 2:15
    Hmatrix(i,i-1) = h(i-1);
    Hmatrix(i,i) = 2*(h(i-1) + h(i));
    Hmatrix(i,i+1) = h(i);
end

Hinv = inv(Hmatrix);


c = Hinv * Avector; % c coefficients (terminal values are zero for
 natural cubic spline)


b = zeros(15,1);
for i = 1:15
    b(i,1) = ((a(i+1) - a(i)) / h(i)) - (((c(i+1) + 2 * c(i)) *
 h(i)) / 3);
end

d = zeros(15,1); % d coefficients
for i = 1:15
    d(i,1) = (c(i+1) - c(i))/(3 * h(i));
end

spline_area = 0;
figure('Name','Cubic Spline');
for i = 1:15
    x = xdata(i):0.1:xdata(i+1);
    spline = a(i,1) + b(i,1).*(x-xdata(i)) + c(i,1).*(x-xdata(i)).^2 +
 d(i,1).*(x-xdata(i)).^3;
    plot(x,spline,'r-');
    hold on;
```

```
    fprintf('The cubic spline regression coefficient for S%d is 1 as
 the function matches up with the given data points.\n',i);
    spline_area = spline_area + trapz(x,spline); % calculating area
 under curve
end
plot(xdata,y,'bo');
title('Cubic Spline');
xlim([0,16]);
ylim([0,4]);
xlabel('length (cm)');
ylabel('height (cm)');

fprintf('This cubic spline model is satisfactory.\n');
spline_area = 2 * spline_area; % doubling for symmetry
fprintf('The area under the cubic spline is %f cm^2.\n',spline_area);

The cubic spline regression coefficient for S1 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S2 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S3 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S4 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S5 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S6 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S7 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S8 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S9 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S10 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S11 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S12 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S13 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S14 is 1 as the function
 matches up with the given data points.
The cubic spline regression coefficient for S15 is 1 as the function
 matches up with the given data points.
This cubic spline model is satisfactory.
The area under the cubic spline is 49.468730 cm^2.
```



Part 3

```
spline_cost = 1000 * 15 * spline_area * 1; %$
poly_cost = 1000 * 15 * area_15 * 1; %$

income = 1000*1000; %$

spline_profit = income - spline_cost;
poly_profit = income - poly_cost;

fprintf('The annual profit for the spline model is $%.0f.
\n',spline_profit);
fprintf('The annual profit for the polynomial model is $%.0f.
\n',poly_profit);

diff = (poly_profit - spline_profit) * 100 / spline_profit;

fprintf('If selected over the spline model, the polynomial model would
 only make 6%% more annual profit than the spline model would.\nAs
 the spline model more accuratley represents the vision of the artist
 and  has very little difference in profit, I recommend that the artst
 choose the spline model for their mold.\n');
```

The annual profit for the spline model is $257969.
The annual profit for the polynomial model is $274450.

If selected over the spline model, the polynomial model would only make 6% more annual profit than the spline model would.
As the spline model more accuratley represents the vision of the artist and has very little difference in profit, I recommend that the artst choose the spline model for their mold.

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