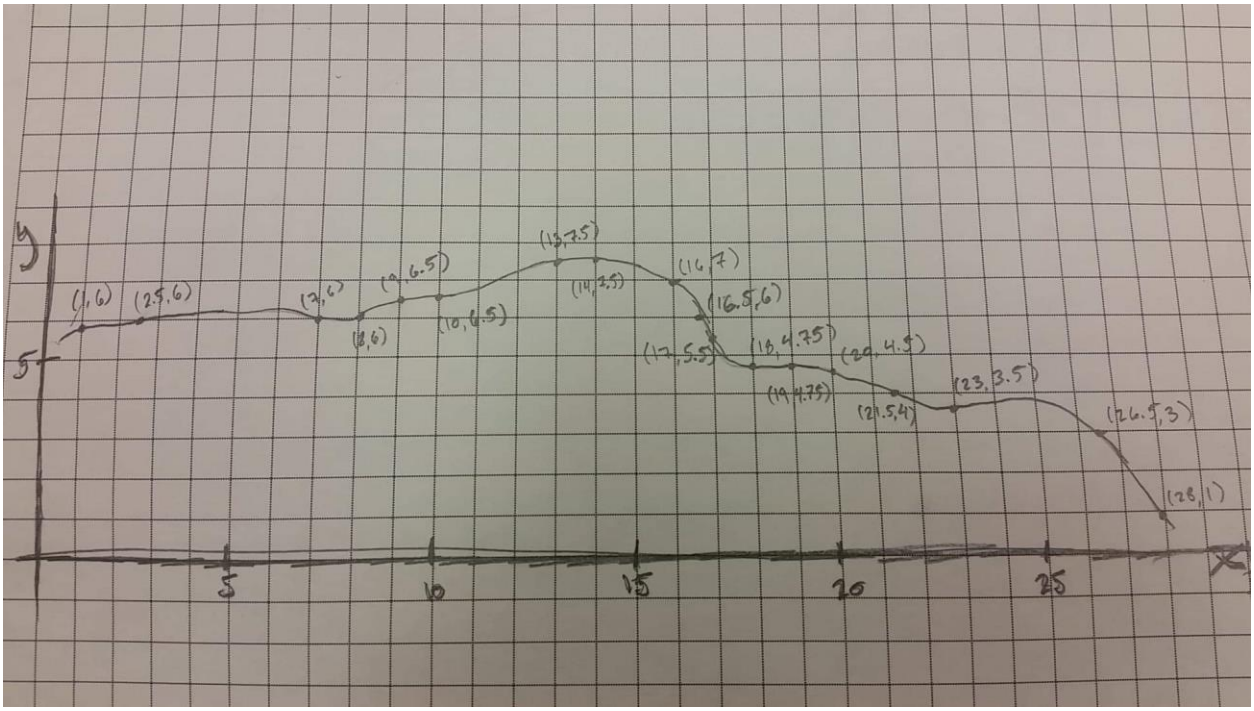
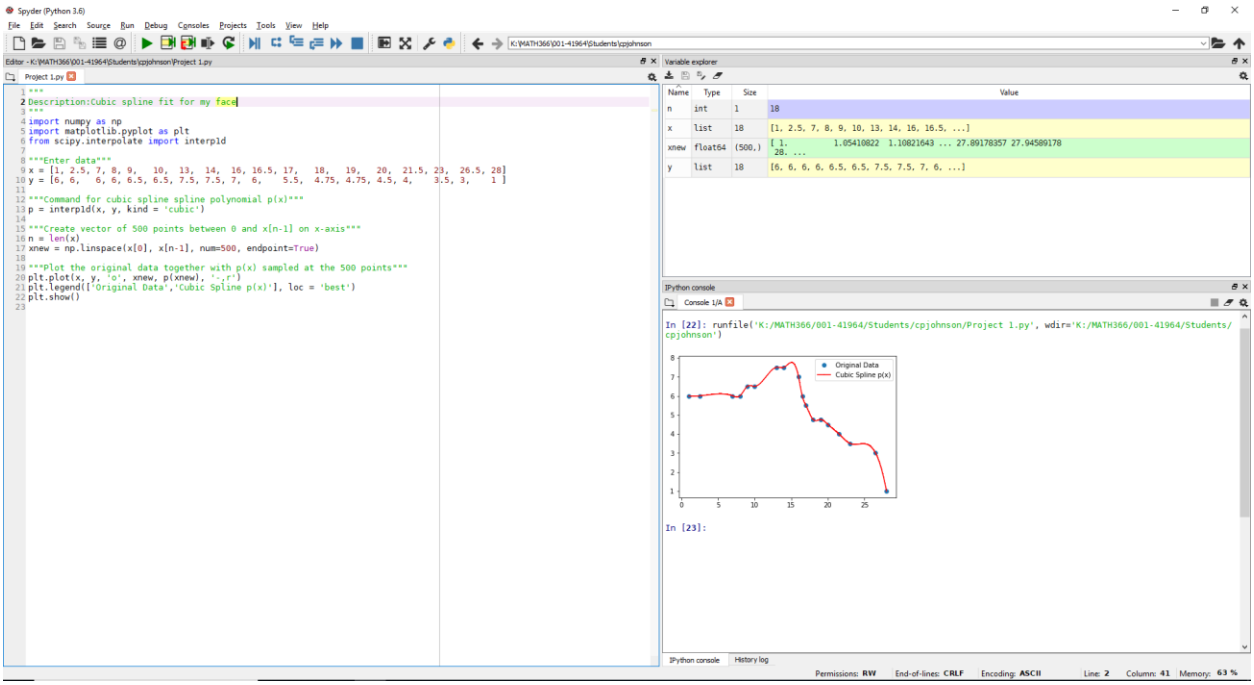
MATH 366 Methods of Applied Mathematics II Clayton Johnson

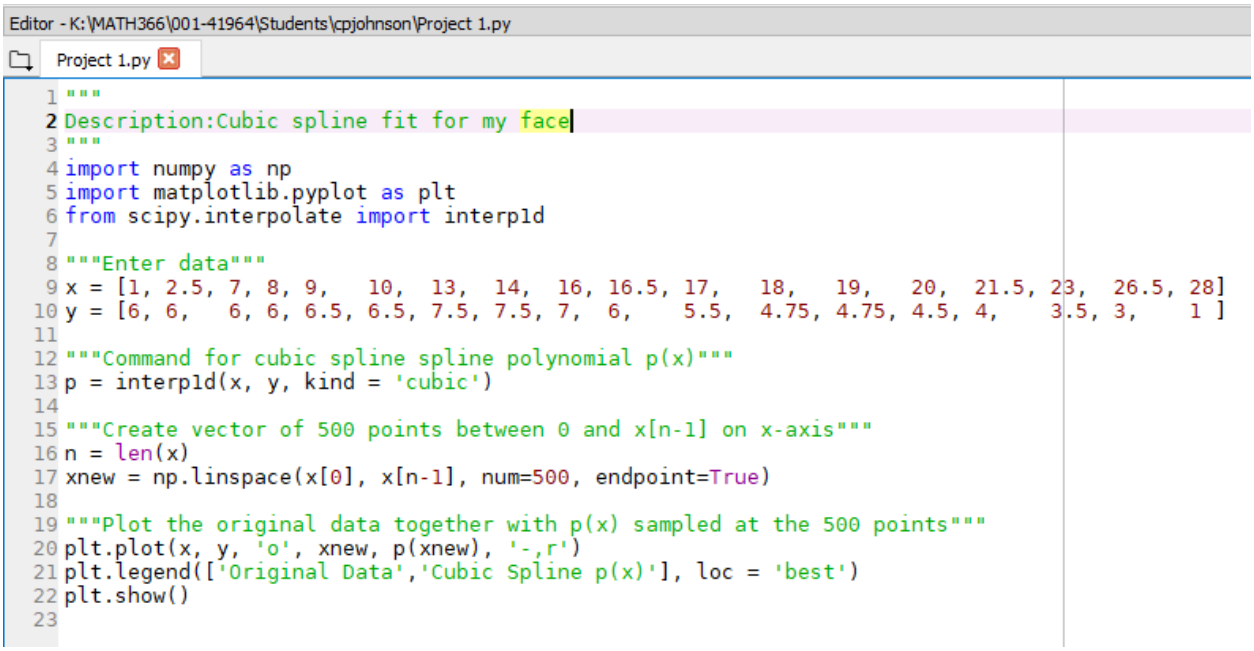
Project 1: Ch 19.4 Cubic Splines

Original Data



Python


Spyder (Python 3.6)
File Edit Search Source Run Debug Consoles Projects Tools View Help
Editor - K:\MATH366\001-41964\Students\cpjohnson\Project 1.py
Project 1.py
"""
Description:Cubic spline fit for my face
"""
import numpy as np
import matplotlib.pyplot as plt
from scipy.interpolate import interp1d
"""Enter data"""
x = [1, 2.5, 7, 8, 9, 10, 13, 14, 16, 16.5, 17, 18, 19, 20, 21.5, 23, 26.5, 28]
y = [6, 6, 6, 6, 6.5, 6.5, 7.5, 7.5, 7, 6, 5.5, 4.75, 4.75, 4.5, 4, 3.5, 3, 1]
"""Command for cubic spline spline polynomial p(x)"""
p = interp1d(x, y, kind = 'cubic')
"""Create vector of 500 points between 0 and x[n-1] on x-axis"""
n = len(x)
xnew = np.linspace(x[0], x[n-1], num=500, endpoint=True)
"""Plot the original data together with p(x) sampled at the 500 points"""
plt.plot(x, y, 'o', xnew, p(xnew), '-,r')
plt.legend(['Original Data','Cubic Spline p(x)'], loc = 'best')
plt.show()
Variable explorer
Name Type Size Value
n int 1 18
x list 18 [1, 2.5, 7, 8, 9, 10, 13, 14, 16, 16.5, ...]
xnew float64 (500,) [1. 1.05410822 1.10821643 ... 27.89178357 27.94589178 28. ...
y list 18 [6, 6, 6, 6, 6.5, 6.5, 7.5, 7.5, 7, 6, ...]
IPython console
Console 1/A
In [22]: runfile('K:/MATH366/001-41964/Students/cpjohnson/Project 1.py', wdir='K:/MATH366/001-41964/Students/cpjohnson')
Original Data
Cubic Spline p(x)
In [23]:
IPython console
History log
Permissions: RW End-of-lines: CRLF Encoding: ASCII Line: 2 Column: 41 Memory: 63 %


Editor - K:\MATH366\001-41964\Students\cpjohnson\Project 1.py
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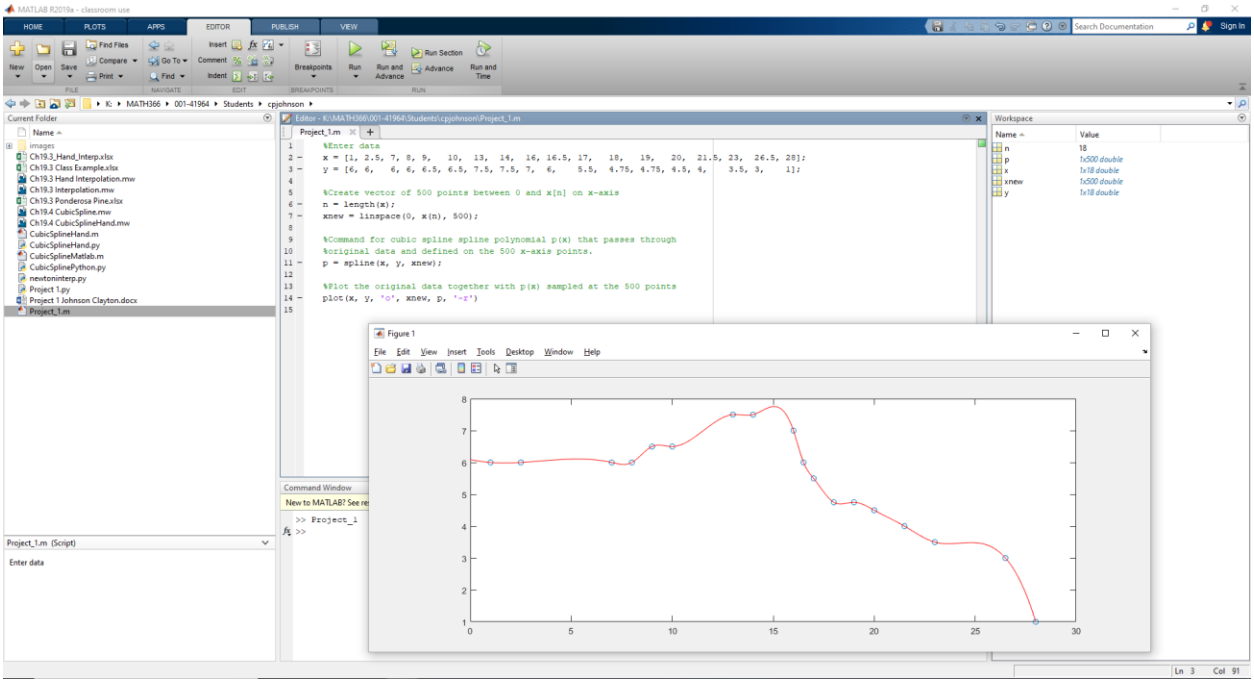
x = [1, 2.5, 7, 8, 9, 10, 13, 14, 16, 16.5, 17, 18, 19, 20, 21.5, 23, 26.5, 28]
y = [6, 6, 6, 6, 6.5, 6.5, 7.5, 7.5, 7, 6, 5.5, 4.75, 4.75, 4.5, 4, 3.5, 3, 1]
"""Command for cubic spline spline polynomial p(x)"""
p = interp1d(x, y, kind = 'cubic')
"""Create vector of 500 points between 0 and x[n-1] on x-axis"""
n = len(x)
xnew = np.linspace(x[0], x[n-1], num=500, endpoint=True)
"""Plot the original data together with p(x) sampled at the 500 points"""
plt.plot(x, y, 'o', xnew, p(xnew), '-,r')
plt.legend(['Original Data','Cubic Spline p(x)'], loc = 'best')
plt.show()

MATLAB



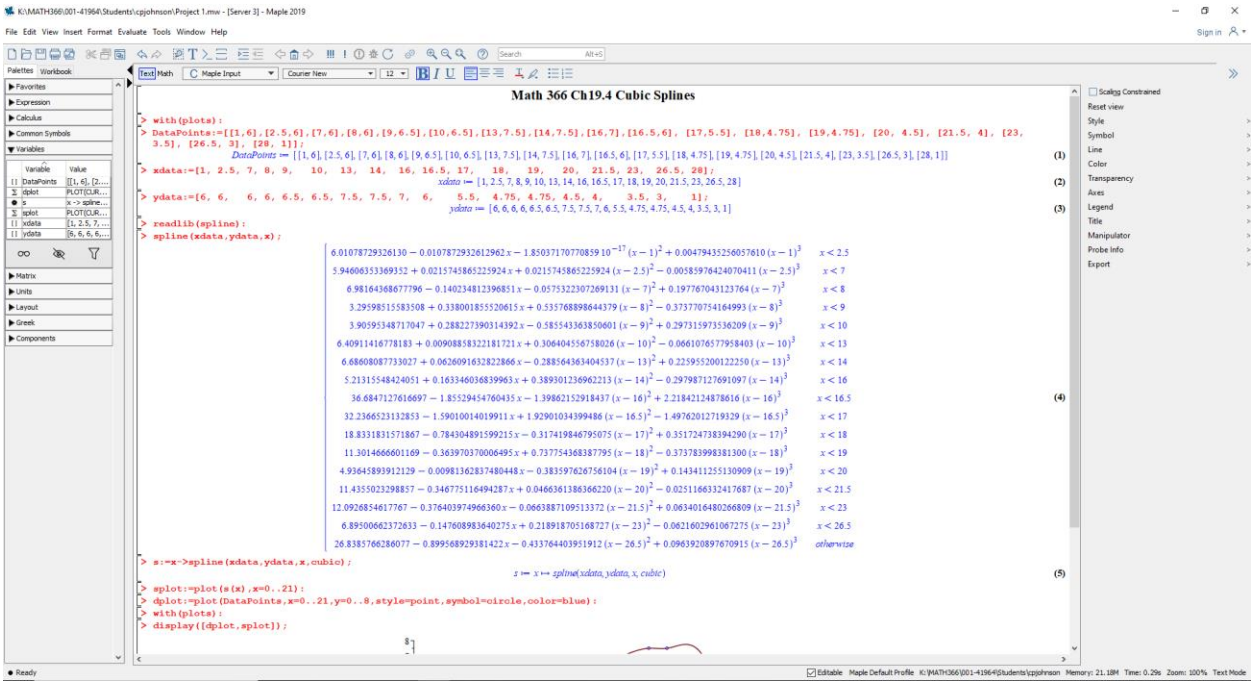
K: ▸ MATH366 ▸ 001-41964 ▸ Students ▸ cpjohnson ▸

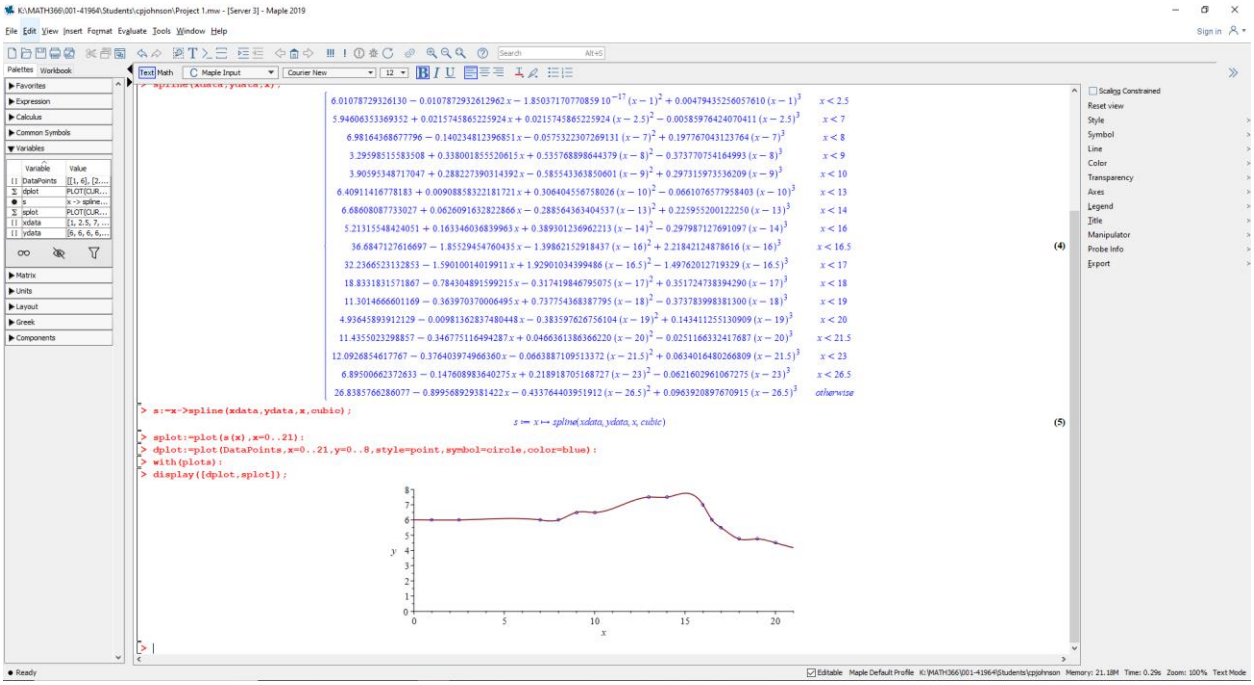
Editor - K:\MATH366\001-41964\Students\cpjohnson\Project_1.m

Project_1.m

```
1     %Enter data
2 -   x = [1, 2.5, 7, 8, 9,   10,  13,  14,  16, 16.5, 17,   18,   19,   20,  21.5, 23,  26.5, 28];
3 -   y = [6, 6,   6, 6, 6.5, 6.5, 7.5, 7.5, 7,  6,    5.5,  4.75, 4.75, 4.5, 4,    3.5, 3,    1];
4
5     %Create vector of 500 points between 0 and x[n] on x-axis
6 -   n = length(x);
7 -   xnew = linspace(0, x(n), 500);
8
9     %Command for cubic spline spline polynomial p(x) that passes through
10    %original data and defined on the 500 x-axis points.
11 -  p = spline(x, y, xnew);
12
13    %Plot the original data together with p(x) sampled at the 500 points
14 -  plot(x, y, 'o', xnew, p, '-r')
15
```

Maple


K:\MATH366\001-41964\Students\cpjohnson\Project 1.mw - [Server 3] - Maple 2019
File Edit View Insert Format Evaluate Tools Window Help
Math 366 Ch19.4 Cubic Splines
with(plots):
DataPoints:=[[1,6],[2.5,6],[7,6],[8,6],[9,6.5],[10,6.5],[13,7.5],[14,7.5],[16,7],[16.5,6],[17,5.5],[18,4.75],[19,4.75],[20,4.5],[21.5,4],[23,3.5],[26.5,3],[28,1]];
xdata:=[1,2.5,7,8,9,10,13,14,16,16.5,17,18,19,20,21.5,23,26.5,28];
ydata:=[6,6,6,6.5,6.5,7.5,7.5,7,6,5.5,4.75,4.75,4.5,4,3.5,3,1];
readlib(spline):
spline(xdata,ydata,x);
s:=x->spline(xdata,ydata,x,cubic);
splot:=plot(s(x),x=0..21):
dplot:=plot(DataPoints,x=0..21,y=0..8,style=point,symbol=circle,color=blue):
with(plots):
display([dplot,splot]);
Ready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splot:=plot(s(x),x=0..21):
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with(plots):
display([dplot,splot]);
Ready

Math 366 Ch19.4 Cubic Splines

```
> with(plots):
> DataPoints:=[[1,6],[2.5,6],[7,6],[8,6],[9,6.5],[10,6.5],[13,7.5],[14,7.5],[16,7],[16.5,6], [17,5.5], [18,4.75], [19,4.75], [20, 4.5], [21.5, 4], [23,
  3.5], [26.5, 3], [28, 1]];
```

$$DataPoints := [[1, 6], [2.5, 6], [7, 6], [8, 6], [9, 6.5], [10, 6.5], [13, 7.5], [14, 7.5], [16, 7], [16.5, 6], [17, 5.5], [18, 4.75], [19, 4.75], [20, 4.5], [21.5, 4], [23, 3.5], [26.5, 3], [28, 1]] \quad (1)$$

```
> xdata:=[1, 2.5, 7, 8, 9,   10,  13,  14,  16, 16.5, 17,   18,   19,   20,  21.5, 23,  26.5, 28];
```

$$xdata := [1, 2.5, 7, 8, 9, 10, 13, 14, 16, 16.5, 17, 18, 19, 20, 21.5, 23, 26.5, 28] \quad (2)$$

```
> ydata:=[6, 6,   6, 6, 6.5, 6.5, 7.5, 7.5, 7,  6,    5.5,  4.75, 4.75, 4.5, 4,    3.5, 3,    1];
```

$$ydata := [6, 6, 6, 6, 6.5, 6.5, 7.5, 7.5, 7, 6, 5.5, 4.75, 4.75, 4.5, 4, 3.5, 3, 1] \quad (3)$$

```
> readlib(spline):
> spline(xdata,ydata,x);
```

$$\begin{cases} 6.01078729326130 - 0.0107872932612962\,x - 1.85037170770859\,10^{-17}\,(x-1)^2 + 0.00479435256057610\,(x-1)^3 & x < 2.5 \\ 5.94606353369352 + 0.0215745865225924\,x + 0.0215745865225924\,(x-2.5)^2 - 0.00585976424070411\,(x-2.5)^3 & x < 7 \\ 6.98164368677796 - 0.140234812396851\,x - 0.0575322307269131\,(x-7)^2 + 0.197767043123764\,(x-7)^3 & x < 8 \\ 3.29598515583508 + 0.338001855520615\,x + 0.535768898644379\,(x-8)^2 - 0.373770754164993\,(x-8)^3 & x < 9 \\ 3.90595348717047 + 0.288227390314392\,x - 0.585543363850601\,(x-9)^2 + 0.297315973536209\,(x-9)^3 & x < 10 \\ 6.40911416778183 + 0.00908858322181721\,x + 0.306404556758026\,(x-10)^2 - 0.0661076577958403\,(x-10)^3 & x < 13 \\ 6.68608087733027 + 0.0626091632822866\,x - 0.288564363404537\,(x-13)^2 + 0.225955200122250\,(x-13)^3 & x < 14 \\ 5.21315548424051 + 0.163346036839963\,x + 0.389301236962213\,(x-14)^2 - 0.297987127691097\,(x-14)^3 & x < 16 \\ 36.6847127616697 - 1.85529454760435\,x - 1.39862152918437\,(x-16)^2 + 2.21842124878616\,(x-16)^3 & x < 16.5 \\ 32.2366523132853 - 1.59010014019911\,x + 1.92901034399486\,(x-16.5)^2 - 1.49762012719329\,(x-16.5)^3 & x < 17 \\ 18.8331831571867 - 0.784304891599215\,x - 0.317419846795075\,(x-17)^2 + 0.351724738394290\,(x-17)^3 & x < 18 \\ 11.3014666601169 - 0.363970370006495\,x + 0.737754368387795\,(x-18)^2 - 0.373783998381300\,(x-18)^3 & x < 19 \\ 4.93645893912129 - 0.00981362837480448\,x - 0.383597626756104\,(x-19)^2 + 0.143411255130909\,(x-19)^3 & x < 20 \\ 11.4355023298857 - 0.346775116494287\,x + 0.0466361386366220\,(x-20)^2 - 0.0251166332417687\,(x-20)^3 & x < 21.5 \\ 12.0926854617767 - 0.376403974966360\,x - 0.0663887109513372\,(x-21.5)^2 + 0.0634016480266809\,(x-21.5)^3 & x < 23 \\ 6.89500662372633 - 0.147608983640275\,x + 0.218918705168727\,(x-23)^2 - 0.0621602961067275\,(x-23)^3 & x < 26.5 \\ 26.8385766286077 - 0.899568929381422\,x - 0.433764403951912\,(x-26.5)^2 + 0.0963920897670915\,(x-26.5)^3 & otherwise \end{cases} \quad (4)$$

```
> s:=x->spline(xdata,ydata,x,cubic);
```

$$s := x \mapsto spline(xdata, ydata, x, cubic) \quad (5)$$

```
> splot:=plot(s(x),x=0..21):
> dplot:=plot(DataPoints,x=0..21,y=0..8,style=point,symbol=circle,color=blue):
> with(plots):
```


```
> spline(xdata,ydata,x);
```

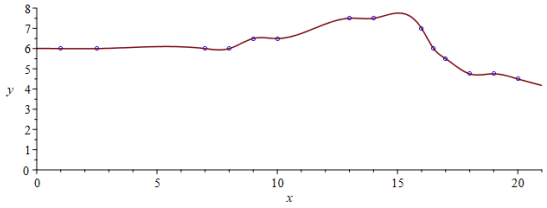
$$\begin{cases} 6.01078729326130 - 0.0107872932612962\,x - 1.85037170770859\,10^{-17}\,(x-1)^2 + 0.00479435256057610\,(x-1)^3 & x < 2.5 \\ 5.94606353369352 + 0.0215745865225924\,x + 0.0215745865225924\,(x-2.5)^2 - 0.00585976424070411\,(x-2.5)^3 & x < 7 \\ 6.98164368677796 - 0.140234812396851\,x - 0.0575322307269131\,(x-7)^2 + 0.197767043123764\,(x-7)^3 & x < 8 \\ 3.29598515583508 + 0.338001855520615\,x + 0.535768898644379\,(x-8)^2 - 0.373770754164993\,(x-8)^3 & x < 9 \\ 3.90595348717047 + 0.288227390314392\,x - 0.585543363850601\,(x-9)^2 + 0.297315973536209\,(x-9)^3 & x < 10 \\ 6.40911416778183 + 0.00908858322181721\,x + 0.306404556758026\,(x-10)^2 - 0.0661076577958403\,(x-10)^3 & x < 13 \\ 6.68608087733027 + 0.0626091632822866\,x - 0.288564363404537\,(x-13)^2 + 0.225955200122250\,(x-13)^3 & x < 14 \\ 5.21315548424051 + 0.163346036839963\,x + 0.389301236962213\,(x-14)^2 - 0.297987127691097\,(x-14)^3 & x < 16 \\ 36.6847127616697 - 1.85529454760435\,x - 1.39862152918437\,(x-16)^2 + 2.21842124878616\,(x-16)^3 & x < 16.5 \\ 32.2366523132853 - 1.59010014019911\,x + 1.92901034399486\,(x-16.5)^2 - 1.49762012719329\,(x-16.5)^3 & x < 17 \\ 18.8331831571867 - 0.784304891599215\,x - 0.317419846795075\,(x-17)^2 + 0.351724738394290\,(x-17)^3 & x < 18 \\ 11.3014666601169 - 0.363970370006495\,x + 0.737754368387795\,(x-18)^2 - 0.373783998381300\,(x-18)^3 & x < 19 \\ 4.93645893912129 - 0.00981362837480448\,x - 0.383597626756104\,(x-19)^2 + 0.143411255130909\,(x-19)^3 & x < 20 \\ 11.4355023298857 - 0.346775116494287\,x + 0.0466361386366220\,(x-20)^2 - 0.0251166332417687\,(x-20)^3 & x < 21.5 \\ 12.0926854617767 - 0.376403974966360\,x - 0.0663887109513372\,(x-21.5)^2 + 0.0634016480266809\,(x-21.5)^3 & x < 23 \\ 6.89500662372633 - 0.147608983640275\,x + 0.218918705168727\,(x-23)^2 - 0.0621602961067275\,(x-23)^3 & x < 26.5 \\ 26.8385766286077 - 0.899568929381422\,x - 0.433764403951912\,(x-26.5)^2 + 0.0963920897670915\,(x-26.5)^3 & otherwise \end{cases}$$

```
> s:=x->spline(xdata,ydata,x,cubic);
```

$$s := x \mapsto spline(xdata, ydata, x, cubic) \quad (5)$$

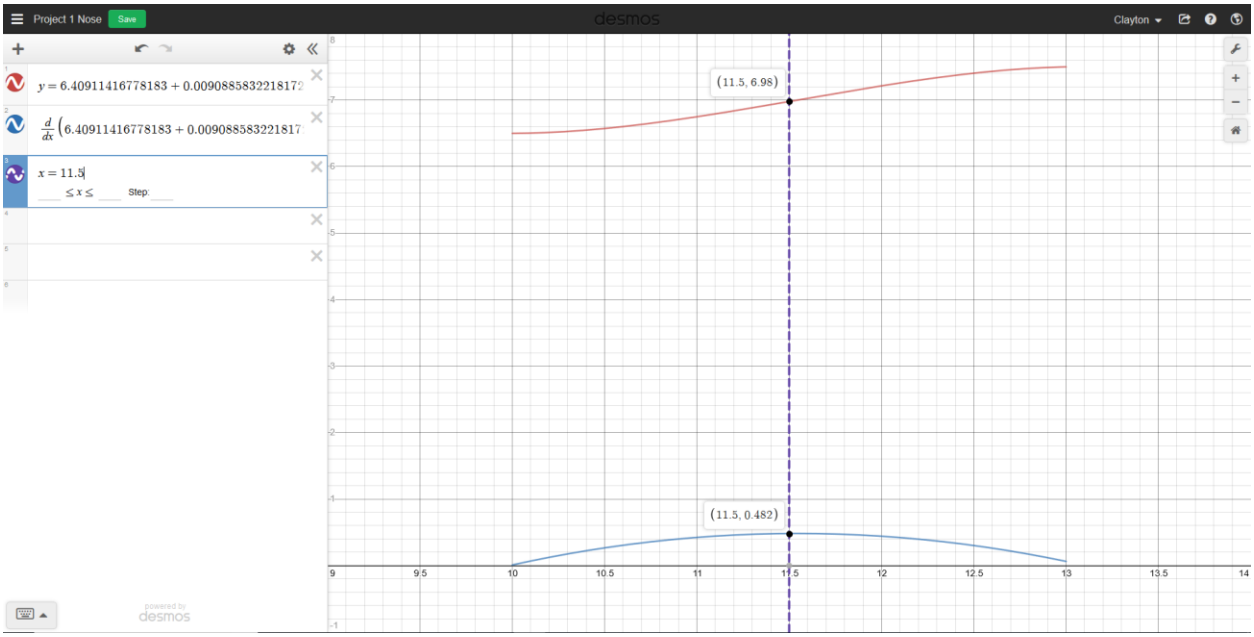
```
> splot:=plot(s(x),x=0..21):
> dplot:=plot(DataPoints,x=0..21,y=0..8,style=point,symbol=circle,color=blue):
> with(plots):
```


```
> display([dplot,splot]);
```




```
>
```

Desmos


Project 1 Nose
Save
desmos
Clayton
y = 6.40911416778183 + 0.009088583221817
d/dx (6.40911416778183 + 0.009088583221817
x = 11.5
≤ x ≤
Step:
(11.5, 6.98)
(11.5, 0.482)
powered by desmos