Programming Project 2 Problem #2

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MA 427

Lots of shapes are defined not by functions of the form y = f(x), but rather by parametric functions x = f(t) and y = g(t), where t is an independent parameter. In particular, circles are best described this way, and also letters in fonts.

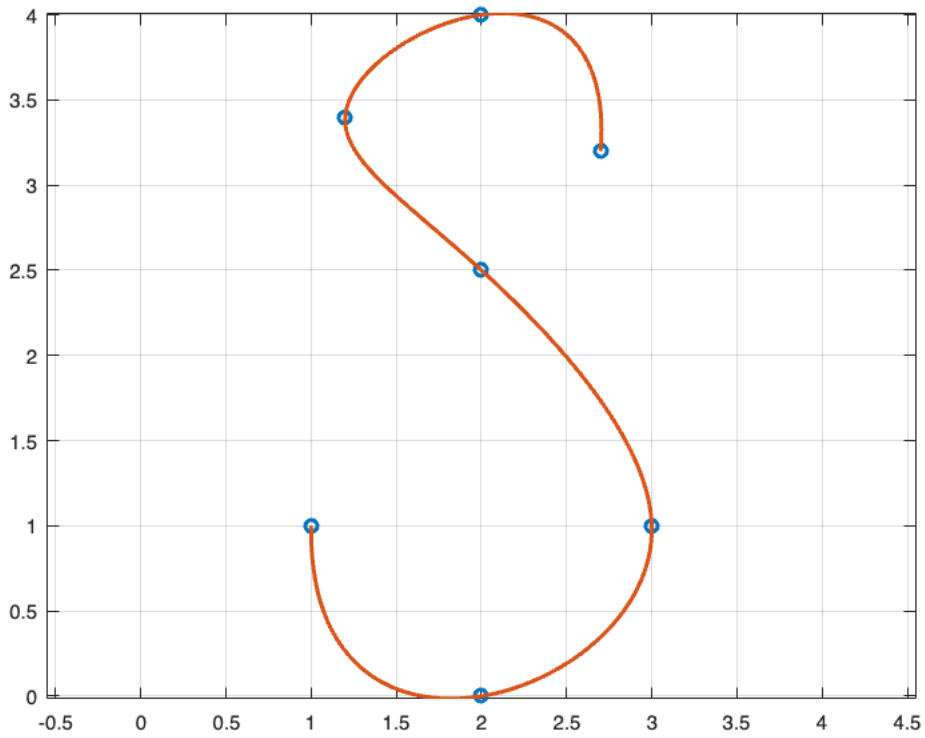
When you print a document that contains writing, or read it on a computer screen, the shape, size and appearance of each letter is determined by the font. When font designers create a font, they want to control each letter by manipulating a small set of points, and then having the computer fill in the shape through these points: they use splines to interpolate the points.

In particular, they combine the idea of a spline through a relatively small number of points, with the use of parametric equations: We'll have a small number of x- and y-values, view these as parameterized by t, and then interpolate x and y as functions of t.

2.

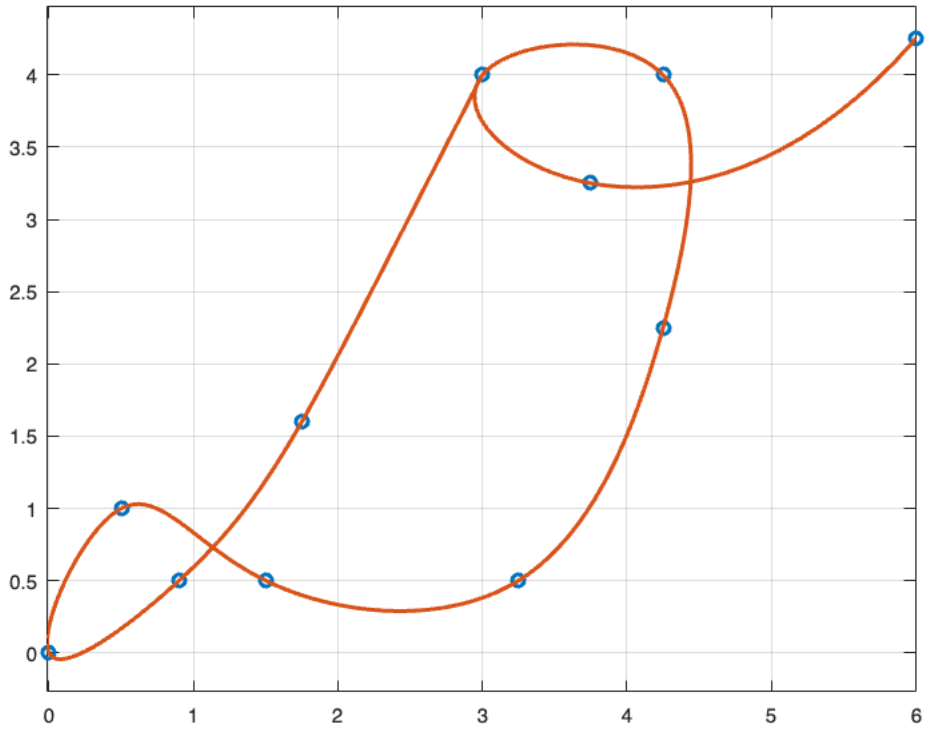
a.

```
x = [1 2 3 2 1.2 2 2.7];
y = [1 0 1 2.5 3.4 4 3.2];
n = length(x);
t = 0:1:n-1;
tq = linspace(0,n-1,200);
xq = interp1(t,x,tq,'spline');
yq = interp1(t,y,tq,'spline');
plot(x,y,'o',xq,yq,LineWidth=2)
axis equal
grid on
```



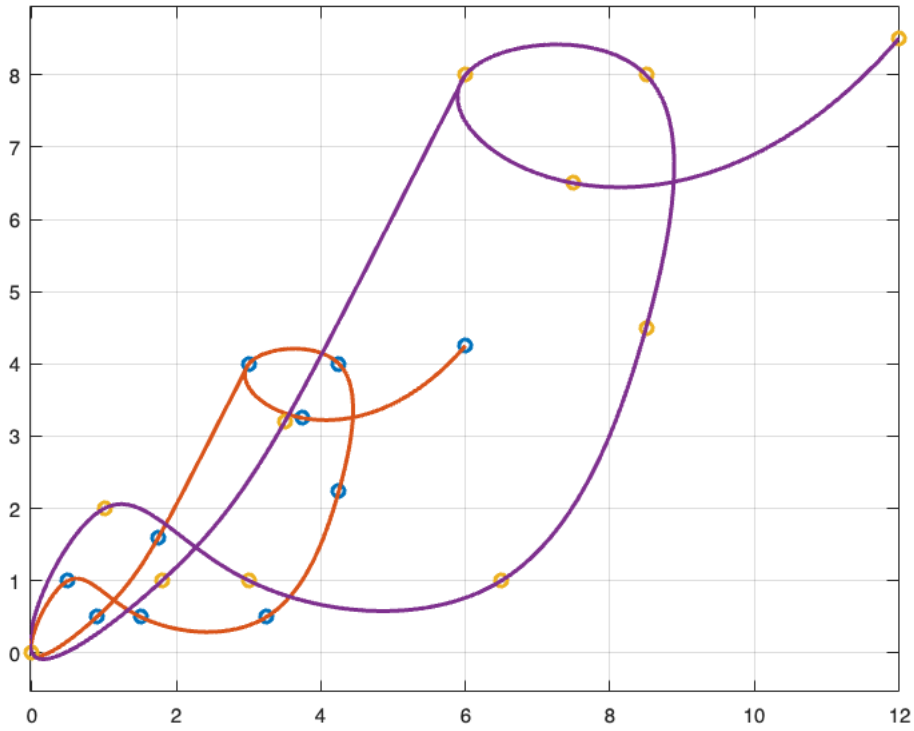
b.

```
x = [3,1.75,0.9,0,0.5,1.5,3.25,4.25,4.25,3,3.75,6];
y = [4,1.6,0.5,0,1,0.5,0.5,2.25,4,4,3.25,4.25];
n = length(x);
t = 0:1:n-1;
tq = linspace(0,n-1,200);
xq = interp1(t,x,tq,'spline');
yq = interp1(t,y,tq,'spline');
plot(x,y,'o',xq,yq,LineWidth=2)
axis equal
grid on
```



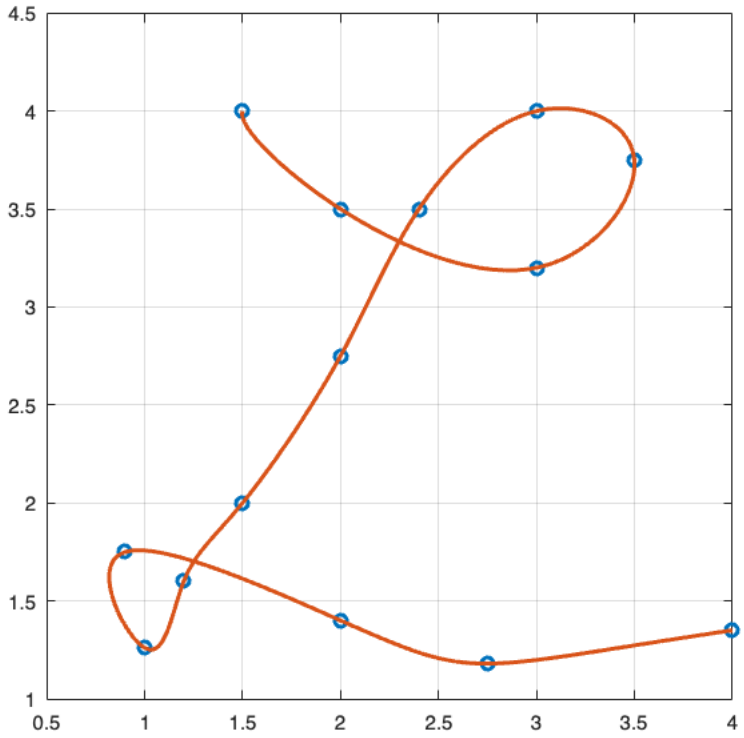
c.

```
plot(x,y,'o',xq,yq,LineWidth=2)
hold on
n = length(x);
t = 0:1:n-1;
tq = linspace(0,n-1,200);
xdoubled = 2*x;
ydoubled = 2*y;
xqdoubled = interp1(t,xdoubled,tq,'spline');
yqdoubled = interp1(t,ydoubled,tq,'spline');
plot(xdoubled,ydoubled,'o',xqdoubled,yqdoubled,LineWidth=2)
axis equal
grid on
hold off
```

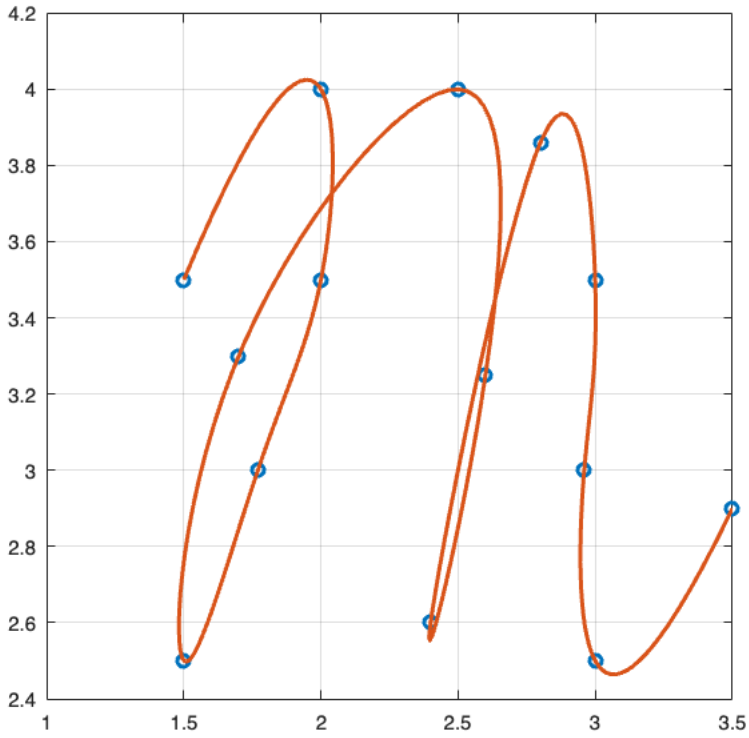


d.

```
x = [1.5,2,3,3.5,3,2.4,2,1.5,1.2,1,.9,2,2.75,4];
y = [4,3.5,3.2,3.75,4,3.5,2.75,2,1.6,1.26,1.75,1.4,1.18,1.35];
n = length(x);
t = 0:1:n-1;
tq = linspace(0,n-1,200);
xq = interp1(t,x,tq,'spline');
yq = interp1(t,y,tq,'spline');
plot(x,y,'o',xq,yq,LineWidth=2)
axis square
grid on
```



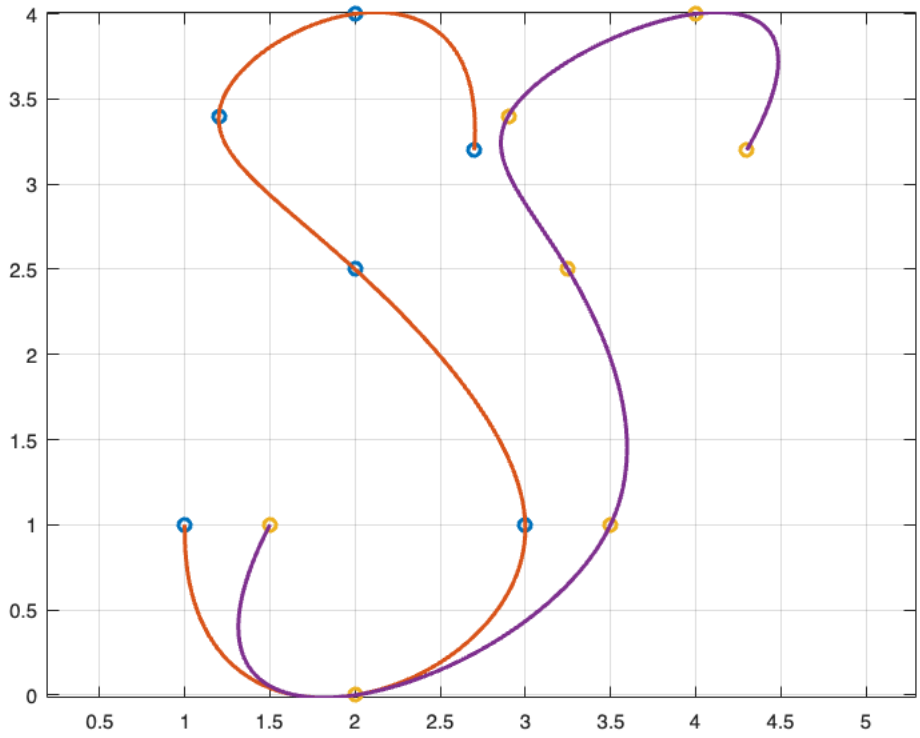

```
x = [1.5,2,2,1.77,1.5,1.7,2.5,2.6,2.4,2.8,3,2.96,3,3.5];
y = [3.5,4,3.5,3,2.5,3.3,4,3.25,2.6,3.86,3.5,3,2.5,2.9];
n = length(x);
t = 0:1:n-1;
tq = linspace(0,n-1,200);
xq = interp1(t,x,tq,'spline');
yq = interp1(t,y,tq,'spline');
plot(x,y,'o',xq,yq,LineWidth=2)
axis square
grid on
```



e.

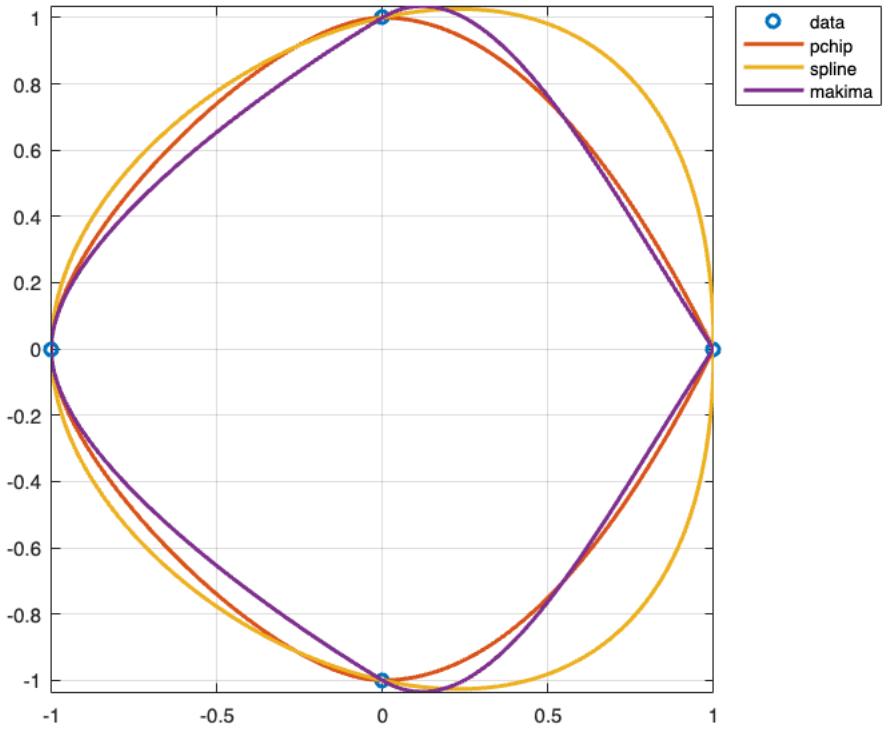
```
x = [1 2 3 2 1.2 2 2.7];
y = [1 0 1 2.5 3.4 4 3.2];
n = length(x);
t = 0:1:n-1;
tq = linspace(0,n-1,200);
xq = interp1(t,x,tq,'spline');
yq = interp1(t,y,tq,'spline');
plot(x,y,'o',xq,yq,LineWidth=2)
hold on
axis equal
grid on
x = [1 2 3 2 1.2 2 2.7];
y = [1 0 1 2.5 3.4 4 3.2];
data = [x;y];
H = [1,0.5;0,1];
sheared_data = H*data;
xshear = sheared_data(1,:);
yshear = sheared_data(2,:);
n = length(data);
t = 0:1:n-1;
tq = linspace(0,n-1,200);
xqshear = interp1(t,xshear,tq,'spline');
yqshear= interp1(t,yshear,tq,'spline');
```

```
plot(xshear,yshear,'o',xqshear,yqshear,LineWidth=2)
hold off
```



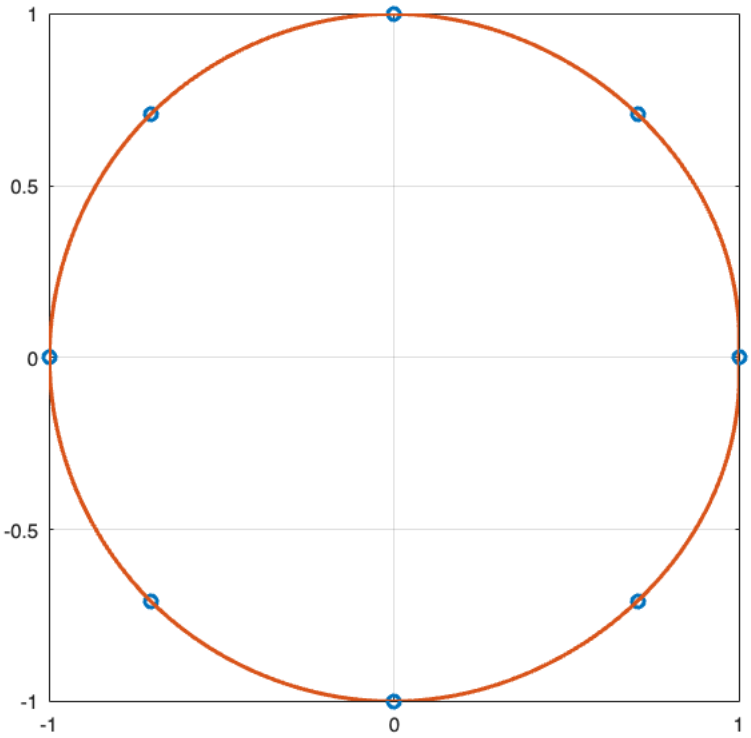
f.

```
x = [1,0,-1,0,1];
y = [0,1,0,-1,0];
n = length(x);
t = 0:n-1;
tq = linspace(0,n-1,200);
plot(x,y,'o',LineWidth=2)
hold on
methods = ["pchip","spline","makima"];
for method = methods
    xq = interp1(t,x,tq,method);
    yq = interp1(t,y,tq,method);
    plot(xq,yq,LineWidth=2)
end
legend(["data",methods],Location="northeastoutside")
hold off
axis equal tight
grid on
```



g.

```
points = linspace(0,2*pi,9);
x = cos(points);
y = sin(points);
n = length(points);
t = 0:n-1;
tq = linspace(0,n-1,200);
plot(x,y,'o',LineWidth=2)
hold on
xq = interp1(t,x,tq,'spline');
yq = interp1(t,y,tq,'spline');
plot(xq,yq,LineWidth=2)
hold off
axis equal tight
grid on
```


1
0.5
0
-0.5
-1
-1
0
1