```
% CMSC/AMSC 460  Fall 2007
% Fitting the elephant
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% Modified by Sima Taheri, 28 Sept. 2007
%
% Here is a program which you can use to experiment with
% different interpolations to the outline of an elephant.
%
% Inputs are the interpolating points which are picked
% by user from the image of elephant in two steps,
%     1- points from the upper profile of the elephant (xup,yup)
%     2- points from the lower profile of the elephant (xlo,ylo)
%
% Outputs are:
%     1- The x- and y-coordinates of the sorted
%     interpolating points (with respect to x-coordinates)
%     2- A figure with four subplots each corresponding to
%     a particular interpolating method
%         1- Polynomial interpolation
%         2- Piecewise linear interpolation
%         3- Cubic spline interpolation
%         4- Hermite cubic interpolation
%
% This program uses following Matlab functions for interpolation
%     1- P = POLYFIT(X,Y,n)
%            for polynomial interpolation
%            n = degree of polynomial = number of interpolating points-
1
%     2- Ye = INTERP1(X,Y,Xe)
%            for piecewise linear interpolation
%            Ye is the values of the p.w. polynomial at the points in
the array Xe
%     3- P = SPLINE(X,Y)
%            for cubic spline interpolation
%     4- Ye = PCHIP(X,Y,Xe)
%            for hermite cubic interpolation
%     5- Ye = POLYVAL(P,Xe)
%            for polynomial evaluation at the points in the array Xe


% Load the elephant picture stored in elephant.tif
clc
close all
clear all

figure(1)
[I,map] = imread('elephant.tif');
imagesc(I)
colormap(gray)

% Pick the interpolation points for the upper profile.

% Because of the way imagesc displays pictures, the y coordinates
% need to be negated to make our interpolated elephants right-side up.
```
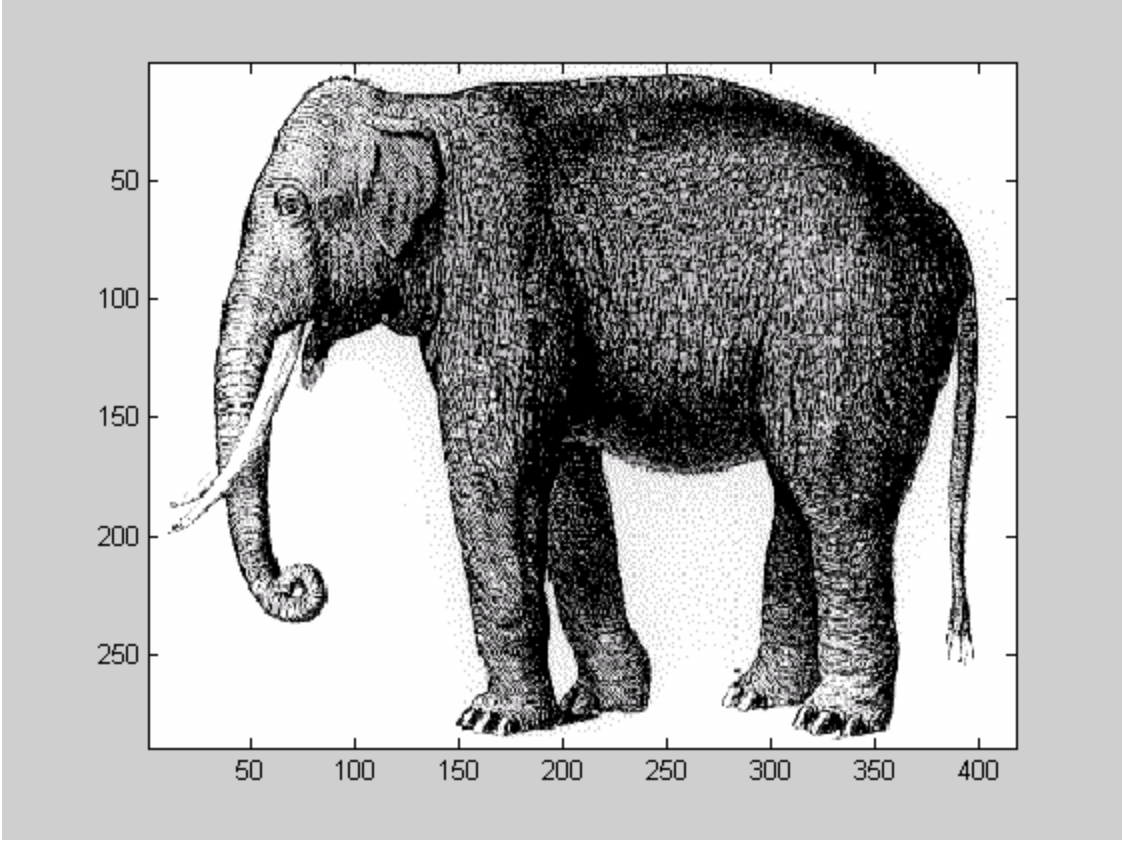
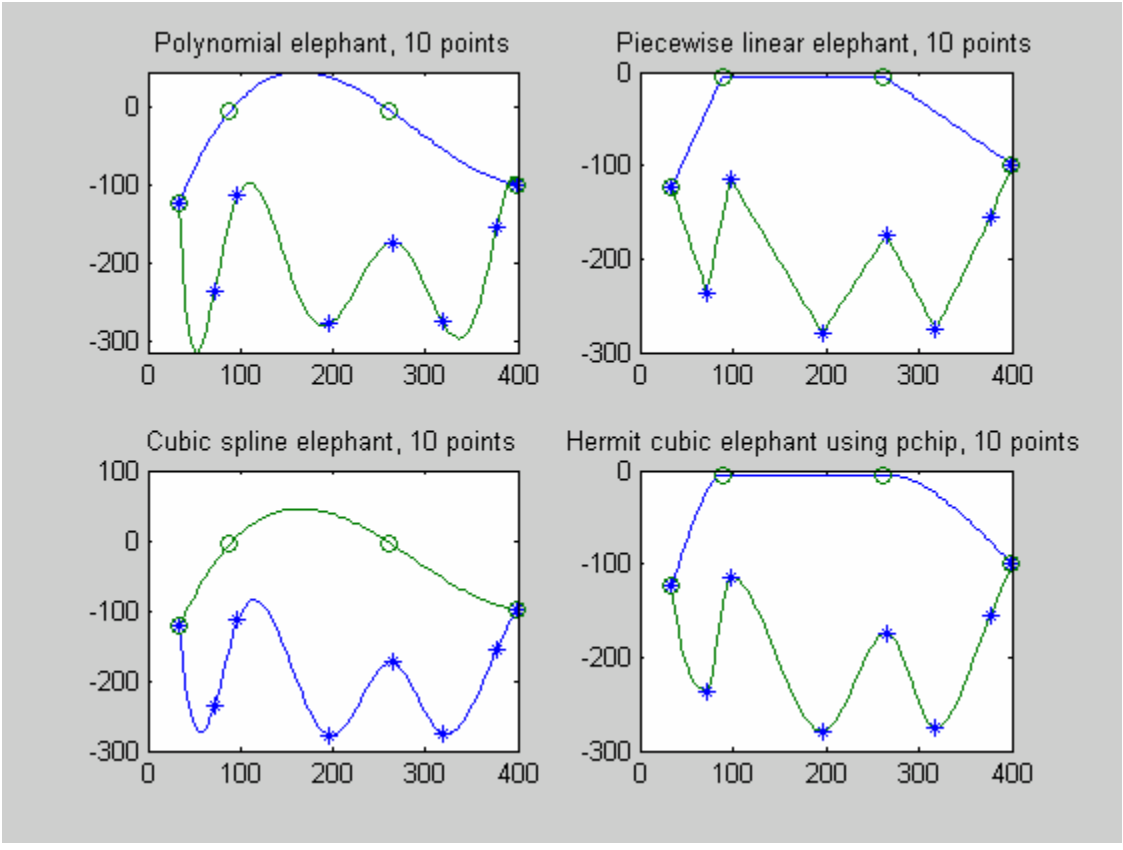

```
disp('Pick interpolation points for the upper profile of the
elephant.')
[xup,yup] = ginput;
yup = - yup;

%%%%%%%%%%%%%%%%%%
% Note that the x-coordinates must be in ascending order in order
% for the piecewise linear, the cubic spline and Hermite cubic fits to
% be correct. Therefore, we sort the x-coordinates in ascending order.
% Y = SORTROWS(X) sorts the rows of the matrix X in ascending order
%
% Sort the x-coordinates of the upper profile in ascending order

InpUp = [xup,yup];
SInpUp = sortrows(InpUp);
xup = SInpUp(:,1);
yup = SInpUp(:,2);
%%%%%%%%%%%%%%%%%%

% Pick the interpolation points for the lower profile.

disp('Pick interpolation points for the lower profile.')
disp('The two endpoints from the upper will be reused.')
[xlo,ylo] = ginput;
ylo = -ylo;

%%%%%%%%%%%%%%%%
% Sort the x-coordinates of the lower profile in ascending order

InpLo = [xlo,ylo];
SInpLo = sortrows(InpLo);
xlo = SInpLo(:,1);
ylo = SInpLo(:,2);
%%%%%%%%%%%%%%%%

% To connect the upper interpolation to the lower one reuse the
% end points
% By this way, we do not have inappropriate connection
% between lower and upper interpolation polynomials

if xup(1) < xlo(1)
    xlo = [xup(1);xlo];
    ylo = [yup(1);ylo];
else
    xup = [xlo(1);xup];
    yup = [ylo(1);yup];
end
if xup(end) > xlo(end)
    xlo = [xlo;xup(end)];
    ylo = [ylo;yup(end)];
else
    xup = [xup;xlo(end)];
    yup = [yup;ylo(end)];
end
```

```
nup = length(xup);
nlo = length(xlo);

disp('Sorted interpolation points from the upper profile:')
[xup,yup]

disp('Sorted interpolation points from the lower profile:')
[xlo,ylo]


% Compute and evaluate the interpolating functions:

xplot = linspace(min(xlo),max(xlo),100);
xloe = xplot;
xupe = xplot;

figure(2)
kplot = 1;

npts = nlo + nup - 2;


% First, the polynomial

  polyPup = polyfit(xup,yup,nup-1);
  yup_poly = polyval(polyPup,xupe);
  yup_plot = polyval(polyPup,xplot);

  polyPlo = polyfit(xlo,ylo,nlo-1);
  ylo_poly = polyval(polyPlo,xloe);
  ylo_plot = polyval(polyPlo,xplot);


  subplot(2,2,kplot)
  plot(xplot,yup_plot,xplot,ylo_plot)
  hold on
  plot(xlo,ylo,'*',xup,yup,'o')
  axis([0 400 max(-1000,min(ylo_plot)),min(500,max(yup_plot))])
  pp = sprintf('Polynomial elephant, %d points',npts);
  title(pp)
  kplot = kplot + 1;


% Next, the piecewise linear.
% I chose to use the Matlab function interp1, but
% using the book's functions would be fine.

ylo_plot = interp1(xlo,ylo,xplot);
yup_plot = interp1(xup,yup,xplot);

ylo_lin = interp1(xlo,ylo,xloe);
yup_lin = interp1(xup,yup,xupe);
```

```
subplot(2,2,kplot)
plot(xplot,yup_plot,xplot,ylo_plot)
hold on
plot(xlo,ylo,'*',xup,yup,'o')
pl = sprintf('Piecewise linear elephant, %d points',npts);
title(pl)
kplot = kplot + 1;

% the cubic spline

coef_lo = spline(xup,yup);
coef_up = spline(xlo,ylo);

ylo_plot = ppval(coef_lo,xplot);
yup_plot = ppval(coef_up,xplot);

ylo_spline = ppval(coef_lo,xloe);
yup_spline = ppval(coef_up,xupe);


subplot(2,2,kplot)
plot(xplot,yup_plot,xplot,ylo_plot)
hold on
plot(xlo,ylo,'*',xup,yup,'o')
cs = sprintf('Cubic spline elephant, %d points',npts);
title(cs)
kplot = kplot + 1;

% Finally, the Hermite cubic,

% Here I chose to use the pchip function in Matlab

ylo_plot = pchip(xlo,ylo,xplot);
yup_plot = pchip(xup,yup,xplot);

ylo_Hermite = pchip(xlo,ylo,xloe);
yup_Hermite = pchip(xup,yup,xupe);

subplot(2,2,kplot)
plot(xplot,yup_plot,xplot,ylo_plot)
hold on
plot(xlo,ylo,'*',xup,yup,'o')
ch = sprintf('Hermit cubic elephant using pchip, %d points',npts);
title(ch)

% Here I chose to use the van Loan's software for
% Hermite cubic interpolation

% Find the derivative values at the interpolation points

sup = (yup(2:end)-yup(1:end-1))./(xup(2:end)-xup(1:end-1));
slo = (ylo(2:end)-ylo(1:end-1))./(xlo(2:end)-xlo(1:end-1));
```

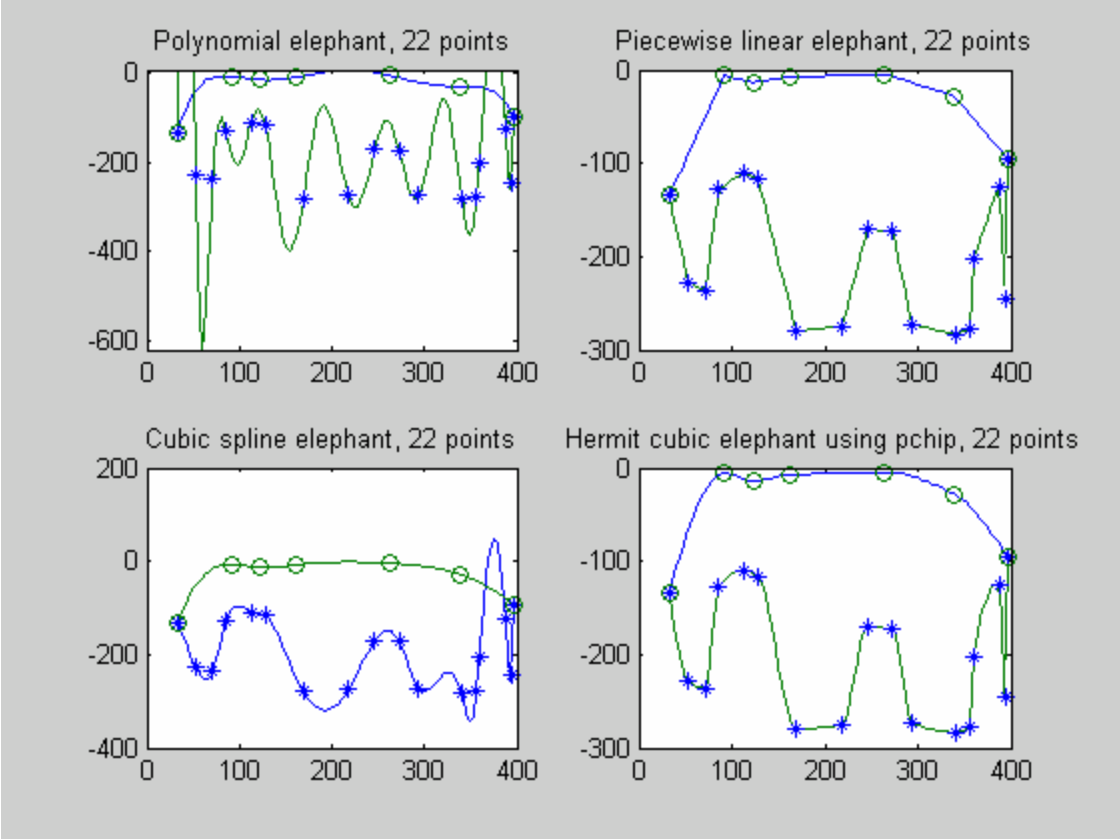
```
sup = [sup;slo(end)];
slo = [sup(1);slo];


[alo,blo,clo,dlo] = pwC(xlo,ylo,slo);
[aup,bup,cup,dup] = pwC(xup,yup,sup);

ylo_plot = pwCEval(alo,blo,clo,dlo,xlo,xplot);
yup_plot = pwCEval(aup,bup,cup,dup,xup,xplot);

ylo_Hermite = pwCEval(alo,blo,clo,dlo,xlo,xloe);
yup_Hermite = pwCEval(aup,bup,cup,dup,xup,xupe);

-----------------------------------------------------------------

1-

Pick interpolation points for the upper profile of the elephant.
Pick interpolation points for the lower profile.
The two endpoints from the upper will be reused.
Sorted interpolation points from the upper profile:

ans =

   33.6486 -122.6067
   88.4159   -5.1477
  261.3652   -4.3026
  399.7247  -98.9459

Sorted interpolation points from the lower profile:

ans =

   33.6486 -122.6067
   72.0818 -235.8406
   97.0634 -114.1564
  196.0288 -278.9371
  265.2085 -174.1535
  318.0541 -275.5570
  376.6647 -155.5629
  399.7247  -98.9459
```


50
100
150
200
250
50
100
150
200
250
300
350
400


Polynomial elephant, 10 points
Piecewise linear elephant, 10 points
Cubic spline elephant, 10 points
Hermit cubic elephant using pchip, 10 points
0
-100
-200
-300
100
0
100
200
300
400

2-

```
Pick interpolation points for the upper profile of the elephant.
Pick interpolation points for the lower profile.
The two endpoints from the upper will be reused.
Sorted interpolation points for the upper profile:

ans =

   32.6878 -133.5921
   91.2984   -5.9927
  123.0058  -13.5980
  161.4389   -7.6827
  263.2869   -4.3026
  338.2316  -27.9635
  396.8422  -95.5658

Sorted interpolation points for the lower profile:

ans =

   32.6878 -133.5921
   52.8652 -228.2354
   71.1210 -235.8406
   85.5334 -128.5219
  112.4366 -109.9313
  127.8099 -116.6915
  169.1256 -279.7822
  218.1279 -274.7120
  245.9919 -170.7734
  272.8952 -172.4635
  294.0334 -273.0219
  340.1532 -283.1623
  356.4873 -277.2471
  359.3698 -202.8845
  387.2339 -124.2968
  393.9597 -245.1360
  396.8422  -95.5658
```


Polynomial elephant, 22 points
0
-200
-400
-600
0
100
200
300
400
Piecewise linear elephant, 22 points
0
-100
-200
-300
0
100
200
300
400
Cubic spline elephant, 22 points
200
0
-200
-400
0
100
200
300
400
Hermit cubic elephant using pchip, 22 points
0
-100
-200
-300
0
100
200
300
400