

## Math 4513, Homework 3, Due on 10/22/2014

1. (6 points) Given  $x_0 = 0$ ,  $x_1 = 2$ ,  $x_2 = 3$ ,  $x_3 = 5$ ,  $x_4 = 6$  and  $f(x) = x^3$ , compute  $f[x_0, x_1, x_2, x_3]$  and  $f[x_0, x_1, x_2, x_3, x_4]$ . Explain your result using the following property of Newton's divided difference:

$$f[x_0, x_1, \dots, x_n] = \frac{f^n(\xi)}{n!}.$$

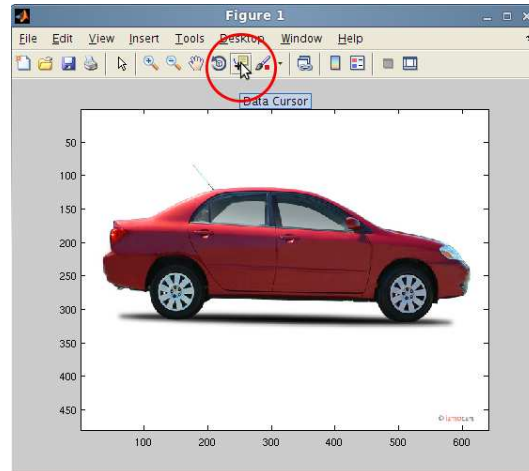
2. (6 points) A car traveling along a straight road is clocked at a number of points. The data from the observations are given in the following table, where the time is in seconds, the distance is in feet, and the speed is in feet per second.

Time	0	3	5	8	13
Distance	0	225	383	623	993
Speed	75	77	80	74	72

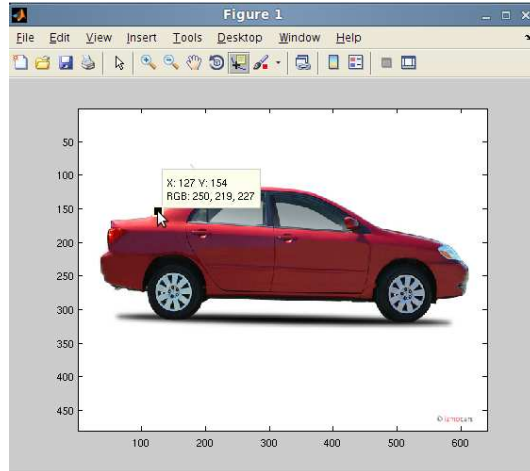
- (a) Use a Hermite polynomial to predict the position of the car and its speed when  $t = 10$ .
- (b) Use the derivative of the Hermite polynomial to determine whether the car ever exceeds a 55 mi/h speed limit on the road. If so, what is the first time the car exceeds this speed?
- (c) What is the predicted maximum speed for the car?
3. (8 points) Take the side view of one of your favorite car. Save the image file, for example `car.jpg`, and read it to Matlab using

```
>>carimage = imread('car.jpg');
>>image(carimage)
```

This will plot the image of the car as shown below. Now, click the menu item inside the red circle.



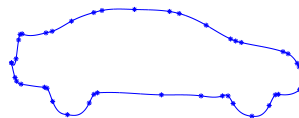
Clicking this menu item will allow you to click anywhere on the image and retrieve the coordinate information. For example, in the following graph, by clicking on a randomly chosen point I retrieved its coordinate  $X = 127$  and  $Y = 154$ . Note that for images,  $X$  coordinate counts from left to the right (same as the usual Cartesian coordinate), while  $Y$  coordinate counts from top to bottom (different from the usual Cartesian coordinate).



Collect the coordinates of several points on the edge of the car. Then one can use cubic spline to draw a curve that fit the shape of the car, as shown below.



Here we have to draw the upper and lower boundary separately, since the current algorithm introduced in class requires  $x_0 < x_1 < \dots < x_n$ , which means the curve can not bend backward. Nevertheless, we can combine the two pieces together and draw a complete shape of the car by using `hold on` and `hold off` commands. `hold on` allows one to draw several curves inside one Matlab figure. `hold off` turns off this feature.



Pick a car and draw its shape using the cubic spline. You can also use the provided “car.jpg”. Remark: instead of drawing the upper and the lower boundary of the car separately, another and more popular approach is to use the parametric curve  $(X(s), Y(s))$ , which allows one to reconstruct any curve in one step.