SAGE LAB: SIMPLE APPLICATIONS OF DERIVATIVES

MAT 167H FALL 2008

Directions: This is a group project. You may divide the work any way that you wish. One option would be that each student takes responsibility for one or more exercise(s). Another option (which I prefer) would be that the entire group meets and works together on all the exercises. However, no one should do nothing, and the group should meet at least once to discuss each problem. You must submit a short report that summarizes the results of each exercise, along with a printout of the SAGE worksheet(s) that you used to solve the exercises.

Group 1	Group 2	Group 3	Group 4	Group 5
Alex Arnold	Jonnedrian Davis	Olivia Hoff	Leslie Datsis	Suzanna Ellzey
Jeremy Britt	Michael Ma	Lucas Martin	Abby Havard	William Litchliter
Nicole Sherman	Johnathon Wilkes	Albert Nosser	Joel Huber	Kathryn Plunkett
Cononiah Watson	Stephen Williams	Jason Simpson	Meghan McCrary	Jacob Shoemaker

USEFUL RESOURCES

My email	john.perry@usm.edu
SAGE server 1	https://sage.st.usm.edu:8000/
SAGE server 2	https://atlas.st.usm.edu:8000/
Modules/Lessons	http://www.math.usm.edu/sage/calc1.html
	("An introduction to SAGE" would be helpful, if you haven't read it yet.)

PART I: WORKSHEET

Download and work through the lab, *Connecting two highways*. (You will find it on the same page as the modules and lessons.) A brief description of some of the SAGE commands used:

`diff(f,x)` computes the derivative of the expression f with respect to the variable x.

`point((a,b),rgbcolor=color,pointsize=r)`
: creates a plot of a point at (a,b), colored *color*, with a radius of r "dots". Possible colors include black, red, blue, brown, yellow, green, purple; indicate these in single quotes, e.g. `rgbcolor='red'`. You can obtain additional colors using `(r,g,b)` where r,g,b are values from `0` to 1 indicating the intenstity of red, green, and blue, e.g. `rgbcolor=(1,0,0)`.

`solve([eq1,eq2,...],[var1,var2,...])`
: solves the system of equations $eq_1, eq_2, \ldots$ for the variables listed by $var_1, var_2, \ldots$. For example, the command `solve([x+y==1,x-y==1],[x,y])` returns the solution `[[x == 1],[y == 0]]`.

PART II: ADDITIONAL

Now that you know what class of polynomial is best suited to connect two highways, do the following. You can use SAGE to help you with this if you like, but your submission report include all relevant explanations.

1. Given
   - the two highways in the worksheet, $f(x) = 4x$ and $g(x) = x/2$, and
   - two arbitrary points $x = a, b$,

   determine a formula for the best highway that will connect $(a, f(a))$ to $(b, f(b))$. It may be useful that $a \neq b$ (otherwise, you wouldn't need to build a connector).
2. Given
   - two arbitrary highways $f(x) = m_1 x$ and $g(x) = m_2 x$, and
   - two arbitrary points $x = a, b$,

   determine a formula for the best highway that will connect $(a, f(a))$ to $(b, f(b))$. It may be useful that $m_1 \neq m_2$ (otherwise, you wouldn't have two different highways).
3. Until this point, the two highways that need connecting, f and g, were linear functions, like the intersection of Highway 98 and I-59. Many highways are not linear functions at any reasonable point near their intersection, but are curved instead. How would you propose to determine the best way to build a connector for those highways? Naturally, I'm looking for an answer that involves calculus.