COMS W3101-2 – Spring 2010

Homework 5

The main goal of the first homework is to have you practice with math and linear algebra tools in MATLAB

For this assignment you should write a principal m-script file called `hw5.m`. At the top of the file you should put your name and ID in a comment. There are 4 exercises in this assignment, for a total of 100 points. For each exercise you will have to write a single or series of MATLAB commands. Make sure you place a comment before the code solving each of the exercises, in order to specify which part of code solves what exercise and to write the answers to the exercise.

This homework is due on April 13, at beginning of class, no exceptions. Put your code (.m files) and any additional files in a single folder, name it youruni_hw_5 and zip it. Upload the zipped folder to CourseWorks . Also, bring a printout of your code to class.

Exercises:

This homework will lead you into the state of beautiful mind that animated John Nash. No, not paranoid schizophrenia! It's mathematical thinking. He could mentally solve all these problems in the blink of an eye…luckily we have MATLAB to help us!

1. (**30 points**)
   - 1.1. Write a function called *manualDet()* that takes as input a square matrix and computes its determinant using cofactor expansion. You can look here for a reference on how to do it http://comp.uark.edu/~jjrencis/femur/Learning-Modules/Linear-Algebra/solving/determinant/cofactor_expansion.html (HINT: think recursively!)
   - 1.2. Verify that your function is correct by comparing its output to the one provided by the MATLAB *det()* function on a 3x3, a 7x7 and a 10x10 matrix.

2. Given the function $f(x) = e^{-x^2}$,
   2.1. **(10 points)** Determine with MATLAB an integration interval large enough to estimate $\frac{2}{\sqrt{\pi}}\int_0^\infty f(x)dx$ with 10 decimals of precision
   2.2. **(10 points)** Use both trapz() and quad() to compute the integral, and comment on the behavior of the two methods

3. (**25 points**) Consider the function

$$f(x) = \begin{cases} -2 + 2\sin(x) & if\ x \leq \pi/2 \\ 2 - 2\sin(x) & otherwise \end{cases}$$

   3.1. Interpolate the function in the interval [-4,4] with a polynomial of 8th degree
   3.2. Interpolate the function in the interval [-4,4] with a polynomial of 12th degree
   3.3. Plot in the same figure the graphs of the original function and of the 2 interpolations
   3.4. Determine numerically which interpolation approximates better the original function by computing the overall approximation error and the values of maximum distance between the curves.
   3.5. Create a new plot with the 3 curves represented in a small interval around the points of maximum error. Plot red vertical lines between the approximation curves and the original one in the points of maximum error.

4. (**25 points**) Write a MATLAB script that determines the x coordinates of the intersection points between the two functions

$$y(x) = x + \sin(10x)$$
$$f(x) = \tan(x)$$

   in the interval $x = [0.5, 4]$

   4.1. Try to find directly the "best" intersection in the interval
   4.2. Plot the two curves and manually select 2 starting x coordinates (other than the one found at point 4.1) close to which to look for intersection points between the two curves
   4.3. Compute the difference between the two functions at the three intersection points found in Exercises 4.1 and 4.2. Is there any strange outcome? Why is that?