CogSci 109 Assignment 2 : Reading and Practice problems (50 points)

C. Alex Simpkins

October 1, 2007

1   Description

In order to remind you of some mathematical concepts which are relevant to this course (and to help you fill some holes in knowledge if you did not take certain mathematical courses), this homework will be to practice a few problems and to do some preparatory reading on greek letters, mathematical symbols and operators, and Matlab.

If you have trouble with the math problems, please come to office hours, email, IM, or review on your own the material. Start with going to the course page and looking at the homework 2 hints, then if still unsure, go to mathworld, the link is on the course web page for quick definitions and references. Then if still unsure, go to the library and check out some of the references there that are on our site. You will see some references listed at the end of this document, and when you see [2], you can look at that list for what the associated reference is for a particular problem section.

There is an old saying when solving problems : *Garbage in equals garbage out.* We hope to avoid garbage in this class as much as possible by putting emphasis on the steps to solve things rather than just the final answer. Garbage is just plain smelly!

2   Reading

If you haven't completed assignment 1, please do that now...

- Read the homework 2 hints document/math review section from the handouts page

- *Read and review the brief pdf* **Greek letters, Mathematical Symbols and Operators** *handout downloadable from the course page handouts section at*

  http://maelabs.ucsd.edu/alex/pages/cogsci109_fa07

- *Read* **Getting Started with Matlab**, *pdf downloadable from the course handouts page, pages (1.2-1.8,2.1-2.32 , 4.2-4.7, 6.1-6.24).* It is quick reading, so it goes by fast. If you have access to Matlab from home, it helps to follow along with the reading, otherwise you could go to a computer lab with Matlab installed (CSB115) - we will go over how to run Matlab remotely (ie from a computer which does not have Matlab installed)

3   Math problems - do at least 3 per section as completely as possible, but do a total of 12 problems minimum.

- You may use Matlab to perform the actual calculations (in fact you should gain practice by doing so), but you must write down all steps of the hand calculations.

- Where the assignment requests a matlab plot, you must plot what is asked for in matlab to get full credit. Where the problem asks you to 'sketch' a plot, you may either plot by hand or plot using matlab

- List the Matlab command you used with a one sentence description of what the command does (ie show your work, and know what the commands you use do).

- Each problem is worth 4 points (the last 2 out of the 50 total are free!!!)

- If you complete all problems, show work and get more than 80% of them correct, you receive an extra 5 points.

2

- For all Matlab plots, include axis labels and a title. Where appropriate include a legend as well.

3.1 Precalculus (choose at least 3, 4pts. each, if there is a part a, b, c...do all of them for the 4 points)[2]

3.1.1

$g(x) = x^2 + 2x - 3$

Find each of the following: $g(0)$, $g(2)$, $g(-x)$, $g(1 - h)$ where h is some constant

3.1.2

Find the domain and range for:

a) $f(x) = 3x + 1, -1 < x < 6$

b) $g(x) = \frac{1}{5x-3}$

3.1.3

Sketch a graph and find the domain

a) $f(x) = -3 + 2x$

b) $f(x) = ln(x)$, where ln denotes the 'natural log'

3.1.4

For this problem, use the definition of continuity and properties of limits to show that the function is continuous on the given interval. Use Matlab to plot the function over the interval $[1, 100]$ in increments of 0.1. Use Matlab to include a title, and label the x and y axes, respectively.

$$f(x) = x/10 + \sqrt{x - 1}, \ [1, \infty)$$

3.1.5

Explain why the function is discontinuous at the given point. Plot the graph of the function over an interval that contains the discontinuity using Matlab. Use as fine a step size for the x variable as necessary to show the details of the shape of $f(x)$.

$$f(x) = \frac{x^2 - 4}{x + 2}, \ a = -2$$

3.2 Calculus - Derivatives and Integrals (choose at least 3, 4pts. each, if there is a part a, b, c...do all of them for the 4 points)[2]

For each of the following problems you choose, after finding the derivative (or integral as requested), plot using Matlab the function and derivative on the same page (as separate plots) using the *subplot* command, then plot over a reasonable range.

3.2.1

Find $f'(x)$ for $f(x) = x^4 + 3x^2$

3.2.2

Find $f'(x)$ for $f(x) = \sqrt{x - 100}$

3.2.3

Find $f'(x)$ for $f(x) = \frac{x^2}{x^3-1}$

3.2.4

Find $f'(x)$ for $f(x) = x(x^3 - 3x^2 + 11x)$

3.2.5

Find $f'(x)$ for $f(x) = 0.75 * sin(3x) + 0.25 * cos(2x) - x^2$

3.2.6

(hint: you can look up identities in your calculus book, or online to help with some of these)

Find $f'(x)$ for $f(x) = tan^2(x) + sin^2(x^3)$

3.2.7

Find $f'(x)$ for $f(x) = log(x) + 5/x$

3.2.8

Find $f'(x)$ for $f(x) = e^{-(x^2-x)}$

3.2.9

Find the integral of : $f(x) = x^2$

3.2.10

Find the integral of : $f(x) = cos(5x)$

3.2.11

Find the integral of : $f(x) = 10 * (e^x + e^{-x})$

3.3 Matrices and vectors (choose at least 3, 4pts. each, if there is a part a, b, c...do all of them for the 4 points)[1]

Do this by hand, but use Matlab to check your work. Turn in a printout of the Matlab command window showing the calculations (ie A=[1 0; 0 1]; B=blah; A*B...), or if you write a Matlab script, turn that in please.

3.3.1

Perform the following mathematical operation

$x = \{1, 2, 3, 4, 5\}$

$y = \{-2, -1, -9, -4, 7\}$

$x + y = ?$

3.3.2

Perform the following mathematical operation

$x = \{1, 2, 3, 4, 5\}$

$y = \{-2, -1, -9, -4, 7\}$

$x - y = ?$

3.3.3

Perform the following mathematical operation

$x = \{-2, -1, -9, -4, 7\}$

$\alpha = 10$

$\alpha * x = ?$

3.3.4

Perform the following mathematical operation

$x = \{1, 2, 3, 4, 5\}$

$y = \{-2, -1, -9, -4, 7\}$

$x \bullet y =?$ (ie dot product)

3.3.5

Perform the following mathematical operation

$x = \{-2, -1, -9, -4, 7\}$

$||x|| =?$ (ie 2-norm)

3.3.6

Perform the following mathematical operation

$A = \begin{bmatrix} -10 & 4 \\ 7 & 3 \end{bmatrix}$

$B = \begin{bmatrix} 1 & 50 \\ 10 & 2 \end{bmatrix}$

$A + B =?$

3.3.7

Perform the following mathematical operation

$A = \begin{bmatrix} -10 & 4 \\ 7 & 3 \end{bmatrix}$

$B = \begin{bmatrix} 1 & 50 \\ 10 & 2 \end{bmatrix}$

$A - B =?$

3.3.8

Perform the following mathematical operation

$$A = \begin{bmatrix} -10 & 4 \\ 7 & 3 \end{bmatrix}$$

$\alpha = 10$

$1/\alpha * A = ?$

3.3.9

Perform the following mathematical operation

$$A = \begin{bmatrix} -10 & 4 \\ 7 & 3 \end{bmatrix}$$

$$x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$A * x = ?$

3.3.10

Perform the following mathematical operation

$$A = \begin{bmatrix} -10 & 4 \\ 7 & 3 \end{bmatrix}$$

$$b = \begin{bmatrix} 3 \\ 10 \end{bmatrix}$$

$A * b = ?$

4 Appendix: List of useful Matlab commands and operators

Type *help functionname* to get help for the particular function (ie 'help plot')

- plot
- subplot
- xlabel
- ylabel
- title
- axes
- clc
- close all
- clear
- % (ie commenting code)
- ;
- .
- ^
- *
- -
- +
- /

References

[1] David C. Lay. *Linear Algebra and Its Applications*. Addison Wesley, 2nd edition edition, 1996.

[2] James Stewart. *Calculus, Early Transcendentals*. Brooks/Cole Publishing Company, 3rd edition, 1995.