Homework #0 • Numerical Analysis II (math 416) • Matlab Intro

- these are some warm-up exercises for using Matlab.
- due Wednesday 13 September – but the point is to get everyone on-board with Matlab.
- remember that the class e-mail is open for discussion.
- read the header of *hw00a.m* for help info.
- the class webpage can be accessed through *www.math.sfu.ca/~dmuraki*
- page limits for your written reports are indicated.
- *annotate* all plots (can be handwritten on plots).

A) Download and run *hw00a* to make a plot of $y(x)$. Modify the script to plot a curve of your choice – change as many things as possible (axis limits, titles, functions, more/fewer points, line types etc.). If you can't figure out how best to change something, send to class e-mail.

B) Download and run *hw00b* which calculates and plots the series y_j defined by the recursion

$$y_0 = 0 \qquad ; \qquad y_j = y_{j-1} + \frac{\pi}{N}\,\frac{1 + y_{j-1}^2}{4}$$

for $j = 1$ to N, where N is an integer of your choice (note that Matlab arrays cannot be indexed beginning from zero, so the script indices are from 1 to $N + 1$). Denote the last value (for a given N) by

$$Y(N) = y_N$$

(the above is sloppy notation, note the N in the recursion). What happens to $Y(N)$ as N is increased in the script? What is the obvious guess for the value of

$$L = \lim_{N\to\infty} Y(N) \ ?$$

C) (**2 page limit**) How can we substantiate the above limit numerically? Let's check the *rate of convergence* – it really just quantifies the idea of a limit. Define the residual

$$E(N) = |\, L - Y(N) \,|$$

so that clearly we want to verify that $E(N) \to 0$ as N is increased. Make a plot of $E(N)$ versus N – a log-log plot will be useful here (do *help loglog* at the matlab prompt). Also, increasing N by factors of 2 is a good choice (why?). Be aggressive, how large can you make N before stressing your poor computer (get used to this, that's what the all those MHz are for)? What does this plot tell you, and how well can you quantify this result? (bonus: put the matlab function *polyfit* to use.)

D) (**2 page limit**) Repeat the above procedure for the quantities defined by

$$\bar{Y}(N) = 2Y(2N) - Y(N) \qquad ; \qquad \bar{L} = \lim_{N\to\infty} \bar{Y}(N) \qquad ; \qquad \bar{E}(N) = |\, \bar{L} - \bar{Y}(N) \,|$$

this cute result is called Richardson extrapolation.