CSC 270: Assignment 2

Due: at beginning of tutorial, Fri. Oct. 17, 1997.

1. **Adaptive Integration.** The example integration program discussed in class is in the directory `~jepson/src/integrate/`. Copy all the files in this directory to your own directory.

a) For each of the following integrals, modify the main program, compile it using the the UNIX make facility, and run to find the result.

$$\int_{-1}^{1} e^{-|x|}dx, \quad \int_{0}^{1} \sqrt{x}dx, \quad \int_{0}^{2\pi} \sin(x)dx, \quad \int_{-1}^{1} H(x)dx.$$

Here $S(x)$ is the step function

$$S(x) = \begin{cases} -1 & \text{for } x <= 0; \\ 1 & \text{for } x > 0. \end{cases}$$

Do NOT simplify the integral for $S(x)$ (or any other case). Rather, treat these as test cases for which the answer is easy to work out. In each case use `tol = 1.0e-3` `tol = 1.0e-6`. What are the errors in the computed results? Does the method seem to work?.

b) Modify the program by adding a routine, with prototype `void printStack()`, to stack.c. The routine should print the fields `l` and `r` from each `stackElement`, starting at the top and working down. Do NOT use `stackPop` to do this, simply follow the pointers, `next`. Your routine should never modify the stack. In order to use this new routine, add several tatements to `adaptiveTrapInt` in file `integrate.c` which call `printStack` and cause the stack to be printed the first 10 times (and no more) a successful sub-interval has been found (i.e. one that passes the error tolerance test). Test your modified program on one or two of the examples above.

c) Add precisely two printf statements (and nothing else) to the original code so that it also prints out the sample points used, in order, from `a` to `b`. Make sure you include both of these end points. Explain why your solution works. (Hint: Do part (b) first.) Similarly, which two lines of the orginal code need to be interchanged so that the routine will then do the integration backwards, from `b` to `a`? No other changes besides this switch should be made. Explain why your idea works.

d) Test the original program on

$$\int_{1}^{b} 1/x dx,$$

for $\texttt{b} = 1000$ and also $1.0e6$. Use $\texttt{tol} = \texttt{1.0e} - \texttt{3}$. (You should get an error message for the longer integral.) What happened and why?

e) Test the original program on

$$\int_{-10}^{1} 00 e^{-|x|} dx.$$

This is just the Laplace function used in part (a), but with a longer asymmetric interval. Since $e^{-|x|} > 0$, our result here should be larger than the one in part (a). It isn't. How come? Explain in detail how you would try to fix this. (Hint: You may want to rely on the user to help specify properties of the function, $f(x)$, being integrated.)