University of Toronto

CSCB70S—Data Structures and Techniques, Spring 1998

Assignment 1: Numerical Integration

Due: Friday January 30 at 4:00 pm.
Worth: 10%.

The problem

You are to implement three methods of numerical integration: Riemann, trapezoid, and Simpson's. The methods are quite similar, so most of the code you write for one method can be used for the other two. You'll be provided with a 'skeleton program' and will have to write code for the bodies of three functions, one for each integration method.

Make a directory in your account:

```
% cd
% mkdir a1
% cd a1
```

and copy the skeleton file into it from:

```
http://www.cs.toronto.edu/~daniel/teaching/B70/integrate.c
```

Compile and test the skeleton program:

```
% gcc integrate.c -o integrate
% integrate
```

Usage:

```
% integrate method a b n coefficients
```

where

- 'method' is one of: r (Riemann), t (trapezoid), or s (Simpson);
- 'a' and 'b' define the interval of integration;
- 'n' is the number of intervals; and
- 'coefficients' define the polynomial to integrate in decreasing order of power (e.g. t^2, then t^1, then t^0).

Example:

```
% integrate s 1 4 100 12.3 -4.7 0 1 0
```

corresponds to

method:	SIMPSON
range:	$[1, 4]$
intervals:	100
polynomial:	$12.3t^4 + -4.7t^3 + 0t^2 + 1t^1 + 0t^0$
computed integral = 0	

Note that the computed integral is 0. That's because the integration code still has to be written in the program (your task!).

Programming

Read and understand the complete program, integrate.c. Implement the three integration methods by adding code to the three corresponding functions in integrate.c. You do not need to add code outside those functions, but you may do so if you wish and if you document your additions.
Provide good comments in your code, including a comment above each of the three functions.

Testing

Test all three integration methods with the two functions provided on the Web page. Test all three integration methods with one other function that you choose. Each of these nine tests should be run with 10, 100, and 1000 intervals. For each of the nine tests, provide one separate page of program output (captured from the screen). On that page, calculate the exact value of the integral and, for each of 10, 100, and 1000 intervals, the absolute error and the relative error.

How to hand in your assignment

Write a short report (at most one page long) comparing the three methods. From your test results, discuss their relative speed and their relative accuracies. Do certain methods performs very accurately for certain classes of polynomials? For each method, how does the accuracy increase as the number of intervals increases by a factor of 2, 4, 8, and so on? Discuss any other interesting things that you discovered.
For the function that you chose for testing, write one or two sentences explaining what interesting characteristic of numerical integration is demonstrated by that function. You should have chosen an interesting function.
Hand in the following:

- the cover page (included below);
- a hardcopy printout of your program;
- nine pages, one for each of the test functions; and
- a one-page report.

Put this into an ENVELOPE. Write the following on the outside of the envelope:

- your account name;
- your name (with surname underlined);
- your tutorial section; and
- your student number.

Your programs must also be submitted electronically by the deadline. You must submit your integrate.c program by executing EXACTLY THIS COMMAND:

```
% submit -N a1 cscb70s integrate.c
```

You may, if you wish, also submit a README file that the tutor will read. For more information on the submit command, type 'man submit'. The tutor will compile and run your program. MAKE SURE that the following command works with the program that you submit:

```
% gcc -o integrate integrate.c
% integrate ...
```

YOU WILL LOSE MARKS if you don't follow these submission instructions exactly. This is because the tutor will be marking about 150 of these assignments and any deviations from these instructions will cost him time and frustration. Please help to keep the tutors happy.

COVER SHEET FOR ASSIGNMENT 1

Account name:

Surname:

Given Name(s):

Student Number:

Tutorial:

I declare that this assignment is my own work and is submitted in accordance with the University of Toronto Code of Behavior on Academic Matters, the Code of Student Conduct, and the guidelines for avoiding plagiarism described in the course syllabus.

I discussed this assignment with the following people:

Signature

GRADING

Program		
Correctness	______	/ 20
Style (including comments)	______	/ 5
Test output (nine pages)	______	/ 5
Report		
Content	______	/ 10
Style and readability	______	/ 5
Total	______	/ 45