CS471 Programming Language Structure I
Spring 2002

Homework 4

Goal

To understand the ideas behind higher-order functions, and use of functions as first-class values in Scheme and ML.

Problem Description

1. A finite sum of a series can be expressed as:

$$\sum_{a}^{b} f(n) = f(a) + \cdots + f(b)$$

where *f* is any function, and *a* and *b* are integers. Write a function in Scheme or in ML that will return the value of the sum, given parameters *f*, *a* and *b*. Show how your function could calculate the sum of the first n integers, starting at 1, and also the sum of the even squares of the first n integers (e.g. 4, 16, 36, etc.)

2. The definite integral of a function f between the limits a and b can be approximated by the formula:

$$\int_a^b f = \left[f\left(a + \frac{dx}{2}\right) + f\left(a + dx + \frac{dx}{2}\right) + f\left(a + 2dx + \frac{dx}{2}\right) + \cdots \right] dx$$

Write a function in Scheme or in ML that will return the value of the integral, given parameters f, a, b and dx. You must use your function sum defined in part 1 to help you define this integral function. Show how the function works by evaluating:

$$\int_0^1 x^3 dx$$

and

$$\int_0^1 \left(2x^2 + 3x + 1\right) dx$$

Grading

This assignment is worth 50 points. Part 1 is worth 15 points, and part 2, 35 points..

Submission

This assignment must be submitted through WebCT, so it must be prepared electronically. Read the drop box information page before submitting it. Pay close attention to the availability "window" of the assignment. When the window closes, you will not be able to submit an answer.

Notes

There is no need to run these functions through a Scheme or ML interpreter to get full points. However, if you wish, a Scheme interpreter is available by typing:

~rth/public/Scheme/scm/scheme

The complete definition of the standard version of the language is on the web site at:

http://www.cs.nmsu.edu/~rth/cs/cs471/r4rs.html

A file of Scheme definitions may be loaded by typing (load "filename") at the prompt. Exit the interpreter by typing (quit) at the prompt.

The Standard ML interpreter may be executed by typing:

sml

An introduction to ML is at:

http://www.cs.nmsu.edu/~rth/cs/cs471/sml.html

A file of ML definitions may be loaded by typing:

use "filename";

at the ML prompt. Exit the interpreter by typing control-D.