Programming Language Structure I
Spring 2001

Homework 3: Computing p using functionals

A. Write a functional (a function that takes one or more functions as an argument) called `series_product`, in Scheme, or ML, that combines a collection of terms in a mathematical series, using multiplication. The function should have four parameters: the upper and lower bounds of the series, `lb` and `ub`, a function, `term`, that produces a value to be combined, and a function, `next`, that calculates the next number in the range.

For example, if the function was defined as:

Scheme: `(define (series_product lb ub term next) ... )`
ML: `fun series_product(lb, ub, term, next) = ...`

For example, with this function, the value of the expression

Scheme: `(series_product 1 5 square addone)`
ML: `series_product(1, 5, square, addone)`

where `square` and `addone` are names of defined functions, gives the value of the product

$$\prod_{1}^{5} n^2 = 1 \cdot 4 \cdot 9 \cdot 16 \cdot 25$$

B. Show how your function can compute the factorial of a given number.

C. Then show how an approximation to π can be computed by giving `series_product` the appropriate arguments to compute the formula:

$$\frac{p}{4} = \frac{2 \cdot 4 \cdot 4 \cdot 6 \cdot 6 \cdot 8 \ldots}{3 \cdot 3 \cdot 5 \cdot 5 \cdot 7 \cdot 7 \ldots}$$

where there is always an equal number of factors in the numerator and denominator.

Points will not be taken off for bad syntax in either language, but will be taken off if the recursive strategy is not clear. It will be very helpful to explain your strategy rather than simply writing out the code.

Due Date:

Wednesday, April 18th in class.

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/scm", without the quotes, at the command prompt.

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)", without the quotes, at the prompt.

The Standard ML interpreter is avilable on Linux machines by typing "sml" without the quotes at the command prompt.