University of Arizona, Department of Computer Science

CSc 520 — Assignment 5 — Due noon, Wed May 7 — 10%

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April 17, 2008

1 Introduction

The purpose of this assignment is for you to become familiar with Scheme, DrScheme, writing recursive functions, and the concept of a *meta-circular interpreter*.

Before starting this assignment, set your DrScheme language level to **Standard (R5RS)**.

All your function definitions should be *pure*, i.e. they should not use any of Scheme's imperative features such as `set!`. Also, never use iteration, always recursion.

Every function should be commented. At the very least, the comments should state what the function does, which arguments it takes, and what result it produces.

You may work in teams of two.

This assignment is graded out of 100. It is worth 10% of your final grade.

2 Simple functions

1. Define a recursive function `(copy-string s n)` which returns a string consisting of `n` copies of the string `s`: [10 points]

   ```
   (define (copy-string s n)
      (cond
         [(<= n 0) ...]
         [(= n 1) ...]
         [else ...]
      )
   )
   ```

   Your function should have the following behavior:

   ```
   > (copy-string "hello" -1)
   ""
   > (copy-string "hello" 0)
   ""
   > (copy-string "hello" 1)
   "hello"
   > (copy-string "hello" 2)
   "hellohello"
   ```

```
> (copy-string "hello" 10)
"hellohellohellohellohellohellohellohellohellohello"
```

2. Define a recursive function `(power-of-two? n)` which returns `#t` if `n` is a power of two (i.e. $n = 2^m$), and `#f` otherwise: [10 points]

```
(define (power-of-two? n)
    (cond
        ....
    )
)
```

Your function should have the following behavior:

```
> (power-of-two? 0)
#f
> (power-of-two? -4)
#f
> (power-of-two? 1)
#f
> (power-of-two? 2)
#t
> (power-of-two? 3)
#f
> (power-of-two? 4)
#t
> (power-of-two? 6)
#f
> (power-of-two? 8)
#t
```

3 A Metacircular Interpreter

Extend the metacircular interpreter from lecture notes #40 with the functionality below. In all cases you can assume that the input programs are correct, i.e. you don't need to check for error conditions.

1. `(display` *`arg`*`)`: [10 points]

```
> (mEval '(display 55))
5555
```

Note that `display` returns the value it has just printed, so the output should be `5555`!

2. `(newline)`: [10 points]

```
> (mEval '(newline))

()
```

`newline` returns `null`.

3. `(begin` *`arg1`* `···` *`argn`*`):` [10 points]

   ```
   > (mEval '(begin (display 55) (newline) (display 66) (newline) (+ 4 5)))
   55
   66
   9
   ```

   Note that the last value (9) is in the output not because `display` printed it, but because `begin` returns the last value evaluated.

4. `(cond (`*`expr1 arg1`*`)` `···` `(`*`exprn argn`*`)):` [20 points]

   ```
   > (mEval '(cond ((eq? 1 2) (display 55)) ((eq? 2 2) (display 66))))
   66
   ```

   Don't use Scheme's built-in `cond`-function in your implementation (you can use `if`, however)! Also add the constants `#t` and `#f` to the interpreter, so that you can say things like:

   ```
   > (mEval '(cond
               ((eq? 1 2) 44)
               ((equal? (quote (1 2)) (quote (1 (2)))) 55)
                (#t 66))
            ))
   66
   ```

5. `(equal?` *`expr1 expr2`*`):` [20 points]

   ```
   > (mEval '(equal? (quote (1 (2))) (quote (1 (2)))))
   #t
   > (mEval '(equal? (quote (1 (2))) (quote (1 (2 (3))))))
   #f
   ```

   Don't use Scheme's built-in `equal?`-function in your implementation (you can use `eq?`, however)! In other words, you need to write a recursive version of `equal?` that implements *deep equivalence.*

4 Extension [20 points]

Add `define` and variable references:

```
> (mEval '(begin
           (define x 44)
           (display x) (newline)
           (define x (+ x 11))
           (display x) (newline))
)
44
55
```

To implement this functionality you need to add an argument `Env` to each function. `Env` stores current variable values. You can implement `Env` as an association-list of variable/value pairs.

5 Submission and Assessment

The deadline for this assignment is noon, Wed May 7. It is worth 10% of your final grade.

You should submit the assignment electronically using the `Unix` command

```
turnin cs520.5 interp.scm README.
```

Don't show your code to anyone, don't read anyone else's code, don't discuss the details of your code with anyone. If you need help with the assignment see the instructor or the TA.