CPSC-354 Report

Tyler Lewis
Chapman University

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Abstract

Updated throughout Fall 2022 for 354 Programming Languages at Chapman Univ.

Contents

1 Introduction

Tylers introduction. Yeah, this will get some work before final submission.

2 Homework

2.1 Week 1

Euclid's Algorithm

Input: Two whole numbers (integers) called a and b, both greater than 0.
(1) if a $<$ b then replace a by (a - b).
(2) if b $>$ a then replace b by (b - a).
(3) Repeat from (1) if a $\neq b$

Output: a.

Code (Golang)

```
package main
import ( "fmt"; "strconv"; "os")
// Calculate GCD of a & b using Euclid's algorithm
func Euclid-GCD( a int, b int ) int {
    if a > b { return Euclid_GCD( a-b, b ) } // recursive GCD function
    if a < b { return Euclid_GCD( a, b-a ) } // Subtract lesser from greater
   return a // a == b End recursive function
} func main() {
    // Args(str) int conversion
   a, err1 := strconv.Atoi(os.Args[1]); b, err2 := strconv.Atoi(os.Args[2])
    // If no errors:
   if err1 == nil && err2 == nil {
      gcd := Euclid_GCD( a, b ) // Evaluate GCD of args(int) => a, b
      fmt.Println(gcd) // Print divisor to console
      return // End script
    } fmt.Println("Error", err1, err2) // Errors happened
}
```

Explaination

Following the steps of Euclids algorithm detailed in section **Euclid's Algorithm**, the GCD between any two numbers is determined. The Golang function, **Euclid-GCD**, detailed step-by-step in section **Code (Golang)**, determines the GCD by recursively subtracting one non-zero integer by the other.

How to run:

1–3 need only be done once:

(1) Install Golang
(2) Init Golang project: `go mod init`
(3) Compile: `go build gcd.go`
(4) Run: `./gcd.go [int arg1] [int arg2]`

2.2 Week 2

Task 1

```
select_evens :: [a] -> [a]
select_evens [] = []
select_evens (x:xs) = select_odds(xs)

select_odds :: [a] -> [a]
select_odds [] = []
select_odds (x:xs) = [x] ++ select_evens(xs)

revert :: [a] -> [a]
revert [] = []
revert (x:xs) = revert xs ++ [x]
```

```
append :: [a] -> [a] -> [a]
append [] x = x
append (x:xs) b = x : append xs b
```

Task 2

append [2,5,4,3] 5
-> [2]:[5]:[4]:[3]: 5
-> [2,5,4,3,5]

2.3 Week 3

Completed 'fill in the dot' execution:

```
hanoi 5 0 2
  hanoi 4 0 1
    hanoi 3 0 2
      hanoi 2 0 1
        hanoi 1 0 2 = move 0 2
        move  0 1
        hanoi 1 2 1 = move 2 1
      move 0 2
      hanoi 2 1 2
        hanoi 1 1 0 = move 1 0
        move  1 2
        hanoi 1 0 2 = move 0 2
    move 0 1
    hanoi 3 2 1
      hanoi 2 2 0
        hanoi 1 2 1 = move 2 1
        move 2 0
        hanoi 1 1 0 = move 1 0
      move 2 1
      hanoi 2 0 1
        hanoi 1 0 2 = move 0 2
        move 0 1
        hanoi 1 2 1 = move 2 1
  move 0 2
  hanoi 4 1 2
    hanoi 3 1 0
      hanoi 2 1 2
        hanoi 1 1 0 = move 1 0
        move 1 2
        hanoi 1 0 2 = move 0 2
      move 1 0
      hanoi 2 2 0
        hanoi 1 2 1 = move 2 1
        move 2 0
        hanoi 1 1 0 = move 1 0
    move 1 2
    hanoi 3 0 2
      hanoi 2 0 1
        hanoi 1 0 2 = move 0 2
        move  0 1
        hanoi 1 2 1 = move 2 1
```

```
        move 0 2
        hanoi 2 1 2
           hanoi 1 1 0 = move 1 0
           move  1 2
           hanoi 1 0 2 = move 0 2
        |
     |
  |
|
```

```
The word 'hanoi' appears 31 times for a tower of height 5. Hanoi will execute {2^n - 1}  times

Javascript-ish formula to solve Tower of Hanoi with n discs:
```

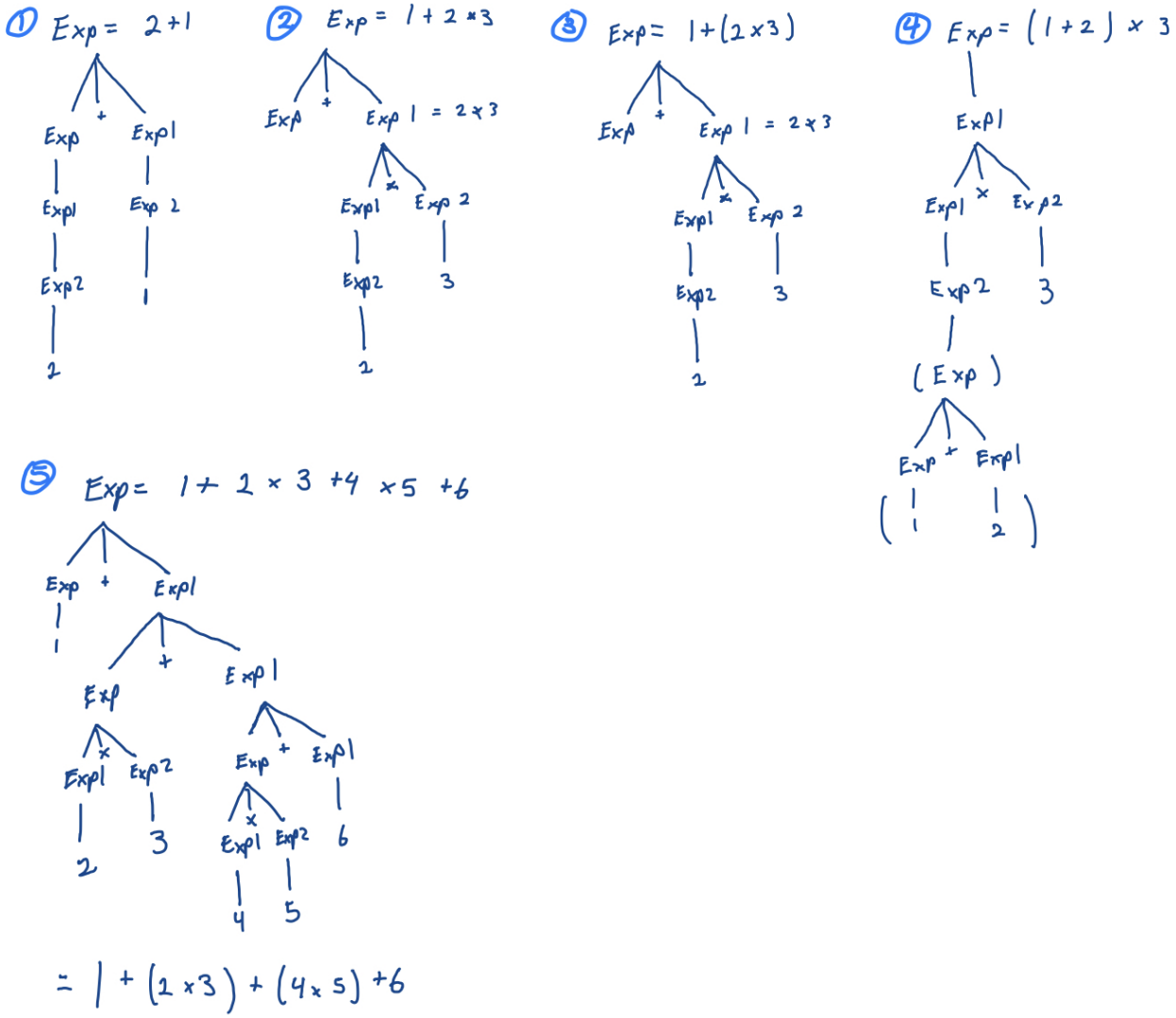
```
func hanoi( n, x, y ) {
   switch( n ) {
      case 1:
         move( x, y );
         break;
      default:
         hanoi ( n-1, x, other( x, y ) );
         move( x, y );
         hanoi ( n-1, other( x, y ), y );
         break;
   }
}

func move( x, y ) {
    // move top disk of position x to position y
}

func other( x, y ) {
   return (2 * ( x + y )) % 3;
}
```

2.4 Week 4

derivation trees



"More exercises"

Why do the following strings not have parse trees (given the context-free grammar above)?

```
2-1: No rule for subtraction
1.0+2: Only rules for integers
6/3: No specification for division
8 mod 6: No specification for modulus
```

Can you change the grammar, so that the strings in the previous exercise become parsable?

```
yes you can, I would assume for modulus as well
```

write out the abstract syntax trees for the following strings:

```
2+1: Plus (Num 2) (Num 1)
1+2*3: Plus (Num 1) (Times (Num 2) (Num 3))
1+(2*3): Plus (Num 1) (Times (Num 2) (Num 3))
(1+2)*3: Times (Plus (Num 1) (Num 2)) (Num 3)
```

Is the abstract syntax tree of 1+2+3 identical to the one of (1+2)+3 or the one of 1+(2+3)?

```
No particular right answer.
```

2.5 Week 5 (line 300)

Use the parser to generate linearized abstract syntax trees for the following expressions:
x

```
Prog (EVar (Id "x"))
```

x x

```
Prog (EApp (EVar (Id "x")) (EVar (Id "x")))
```

x y

```
Prog (EApp (EVar (Id "x")) (EVar (Id "y")))
```

x y z

```
Prog (EApp (EApp (EVar (Id "x")) (EVar (Id "y"))) (EVar (Id "z")))
```

\x.x

```
Prog (EAbs (Id "x") (EVar (Id "x")))
```

\x.x x

```
Prog (EAbs (Id "x") (EApp (EVar (Id "x")) (EVar (Id "x"))))
```

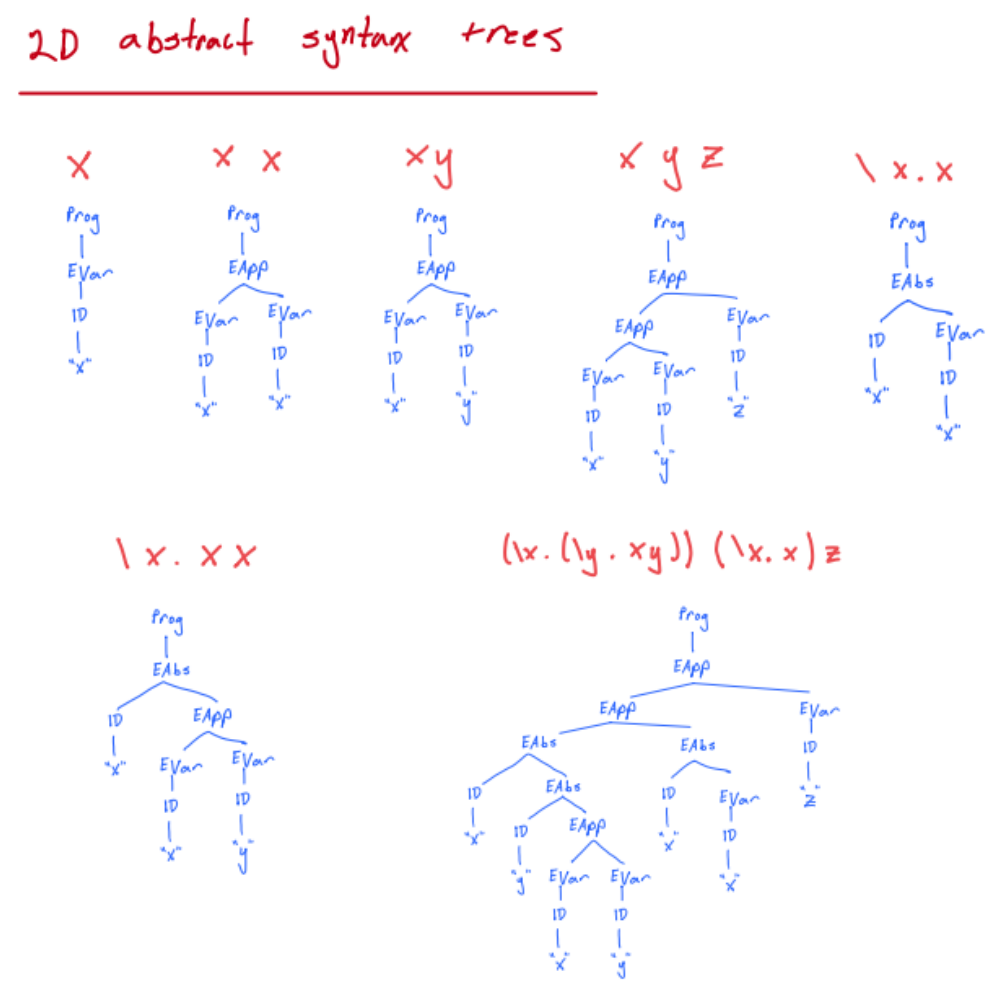
(\x . (\y . x y)) (\x.x) z

```
Prog (EApp (EApp (EAbs (Id "x") (EAbs (Id "y") (EApp (EVar (Id "x")) (EVar (Id "y"))))) (EAbs (Id "x")
(EVar (Id "x")))) (EVar (Id "z")))
```

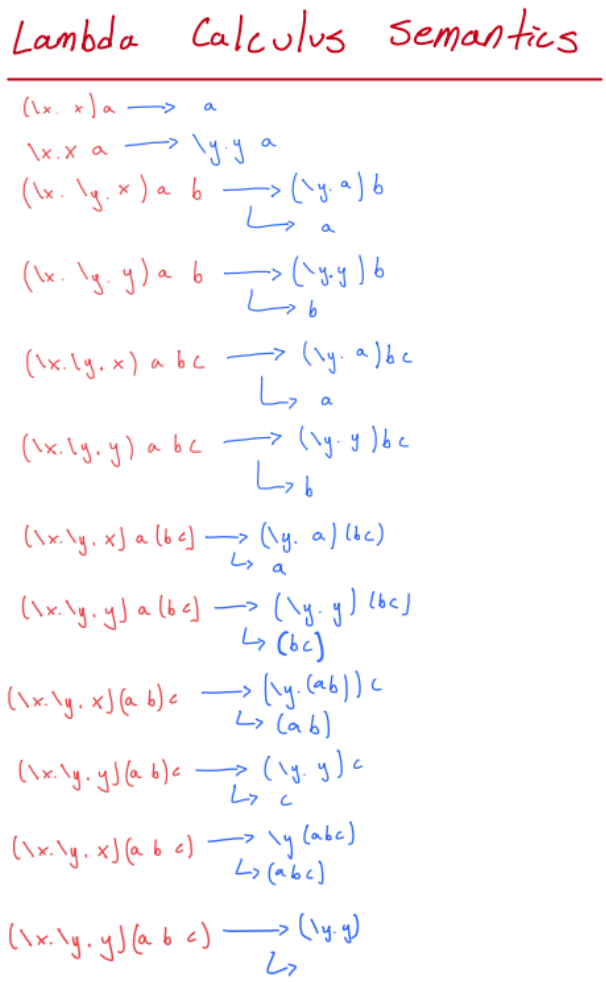
(\x . \y . x y z) a b c

```
Prog (EApp (EApp (EApp (EAbs (Id "x") (EAbs (Id "y") (EApp (EApp (EVar (Id "x"))
(EVar (Id "y"))) (EVar (Id "z"))))) (EVar (Id "a"))) (EVar (Id "b"))) (EVar (Id "c")))
```

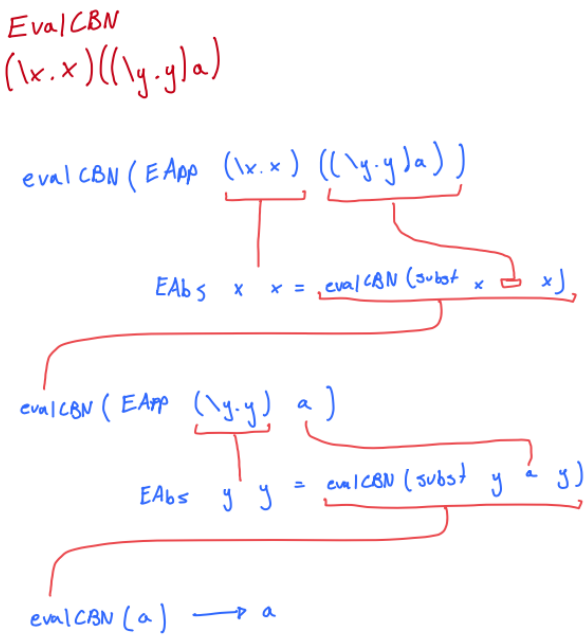
Write out the abstract syntax trees in 2-dimensional notation using pen and paper.



Evaluate using pen-and-paper [2] the following expressions:



Evaluate (.x)((.y)a) by executing the function evalCBN defined on line 26-28 in Interpreter.hs pen-and-paper. The function subst is doing capture avoiding substitution and you can reduce subst in one step in your pen and paper computation



2.6 Week 6 (line 350

Reduce the following lambda calculus expression:

```
(\exp . \two . \three . exp two three)
(\m.\n. m n)
(\f.\x. f (f x))
(\f.\x. f (f (f x)))


( (\m.\n. m n) (\f.\x. f (f x)) (\f.\x. f (f (f x))) )  -- Substitution

( (\m.\n. m n) (\f.\x. f (f x)) (\x0.\x1. x0 (x0 (x0 x1))) )  -- conversion

( (\n.  (\f.(\x. f (f x))) n) (\x0.(\x1. x0 (x0 (x0 x1)))) )  -- Substitution

( (\f.(\x. f (f x))) (\x0.(\x1. x0 (x0 (x0 x1)))) )  -- Substitution

( ((\x. (\x0.(\x1. x0 (x0 (x0 x1))))) ((\x0.(\x1. x0 (x0 (x0 x1)))) x))) )  -- Substitution

( ((\x. (\x0.(\x1. x0 (x0 (x0 x1))))) ((\x2.(\x3. x2 (x2 (x2 x3)))) x))) )  -- conversion

( ((\x. ((\x1. ((\x2.(\x3. x2 (x2 (x2 x3)))) x) (((\x2.(\x3. x2 (x2 (x2 x3)))) x)
(((\x2.(\x3. x2 (x2 (x2 x3)))) x) x1)))) )) )  -- Substitution

( ((\x. ((\x1. ((\x2.(\x3. x2 (x2 (x2 x3)))) x) (((\x4.(\x5. x4 (x4 (x4 x5)))) x)
(((\x6.(\x7. x6 (x6 (x6 x7)))) x) x1)))) )) )  -- conversion

( ((\x. ((\x1. (\x3. x (x (x x3))) (((\x4.(\x5. x4 (x4 (x4 x5)))) x)
(((\x6.(\x7. x6 (x6 (x6 x7)))) x) x1)) )))))  -- Substitution
```

```
    (\x. (\x1. (x (x (x ((((\x4.(\x5. x4 (x4 (x4 x5)))) x) ((((\x6.(\x7. x6 (x6 (x6 x7)))) x)
    x1)) )))))  -- Substitution

    (\x. (\x1. (x (x (x ((((\x5. x (x (x x5)))) ((((\x6.(\x7. x6 (x6 (x6 x7)))) x)
    x1)) )))))  -- Substitution

    (\x. (\x1. (x (x (x (x (x (x ((((\x6.(\x7. x6 (x6 (x6 x7)))) x) x1)))) )))))  -- Substitution

    (\x. (\x1. (x (x (x (x (x (x ((\x7. x (x (x x7))) x1)))) )))))  -- Substitution

    (\x. (\x1. (x (x (x (x (x (x (x (x x1)))))))) )))  -- Substitution, final
```

```
Algrbra formula:

    f(m,n) = n^m
```

3 Project

Introductory remarks ...
The following structure should be suitable for most practical projects.

3.1 Specification

For my project I wish to design an interpreter for a programming language of my own design.
Possible launch point

3.2 Prototype

3.3 Documentation

3.4 Critical Appraisal

...

4 Conclusions

Thanks, goodbye.

References

[PL] Programming Languages 2022, Chapman University, 2022.