CPSC-354 Report

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Abstract

Short summary of purpose and content.

Contents

1 Introduction

This is the report for CPSC 354 Programming Languages. It will contain homework for each week, as well as project work and analysis.

2 Homework

This section will contain your solutions to homework.

2.1 Week 1

HW 1 - Greatest Common Divisor

```
def gcd(n, m):
    while n != m:
        if  n > m:
            n = n-m
        else:
            m = m-n
    return n
```

The code above implements Euclid's algorithm to find the greatest common divisor in python. Below is an explanation given sample input gcd(9,33).

While n != m, the code will compare whether or not n is greater than m. If n > m, n will become n – m. Otherwise if n < m, m will become m – n. When n == m, the greatest common divisor has been found.

Keeping this logic in mind, let n = 9, m = 33.

```
gcd(9,33) =
gcd(9,24) =
gcd(9,15) =
gcd(9,6) =
gcd(3,6) =
gcd(3,3) =
3
```

Since n == m and the value of both is 3, the greatest common divisor is 3 for this example.

2.2 Week 2

HW 2 - Recursion in Functional Programming

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

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

member :: (Eq a) => a -> [a] -> Bool
member a [] = False
member a (x:xs)
    | a == x = True
    | otherwise = a `member` xs

append :: (Ord a) => [a] -> [a] -> [a]
append [] [] = []
append [] ys = ys
append (x:xs) (ys) = x:append(xs) (ys)

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

```
less_equal :: (Ord a) => [a] -> [a] -> Bool
less_equal [] [] = True
less_equal (x:xs) (y:ys)
    | x > y   = False
    | otherwise = xs `less_equal` ys
```

The code above implements select_evens, select_odds, member, append, revert, less_equal as recursive functions in Haskell. Below are explanations showing computations for given inputs.

Select Evens example:

Select Evens [”a”,”b”,”c”,”d”]

```
select_evens ["a","b","c","d"] =
    "b" : (select_evens ["c","d"]) =
    "b" : ("d" : (select_evens [])) =
    ["b","d"]
```

Select Odds example:

Select Odds [”a”,”b”,”c”,”d”]

```
select_odds ["a","b","c","d"] =
    "a" : (select_odds ["c","d"]) =
    "a" : ("c" : (select_odds [])) =
    ["a","c"]
```

Member example:

Member 2 [5,2,6]

```
member 2 [5,2,6] =
    member 2 [2,6] =
    True
```

Append example:

Append [1,2,3] [4,5]

```
append [1,2,3] [4,5] =
    1 : (append [2,3] [4,5]) =
    1 : (2 : (append [3] [4,5])) =
    1 : (2 : (3 : (append [] [4,5]))) =
    1 : (2 : (3 : [4,5])) =
    [1,2,3,4,5]
```

Revert example:

Revert [1,2,3]

```
revert [1,2,3] =
    append(revert [2,3], [1]) =
    append(append (revert [3]) [2]) [1] =
    append(append (append (revert []) [3]) [2]) [1] =
```

```
append(append (append [] [3]) : [2]) [1] =
append(append [3] [2]) [1] =
append 3 : (2) [1] =
append [3,2] [1] =
3 : (append [2] [1]) =
3 : (2 : (append [] [1])) =
3 : (2 : 1) =
[3,2,1]
```

Less Equal example:

Less Equal [1,2,3] [2,3,4]

```
less_equal [1,2,3] [2,3,4] =
    less_equal [2,3] [3,4] =
    less_equal [3] [4] =
    True
```

2.3 Week 3

HW 3 - Towers of Hanoi

```
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
```

In order to solve the puzzle, the moves are as follows:

```
move 0 2
move 0 1
move 2 1
move 0 2
move 1 0
move 1 2
move 0 2
move 0 1
move 2 1
move 2 0
move 1 0
move 2 1
move 0 2
move 0 1
move 2 1
move 0 2
move 1 0
move 1 2
move 0 2
move 1 0
move 2 1
move 2 0
move 1 0
move 1 2
move 0 2
move 0 1
move 2 1
move 0 2
move 1 0
move 1 2
move 0 2
```

The word "hanoi" appears in the computation 31 times.

This computation can be expressed as a formula that works for moving any number of disks n as:

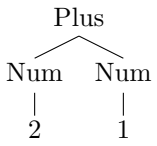
```
hanoi(n+1) x y = hanoi n x(other x y)
move x y
hanoi n(other x y)y
```

```
hanoi 1 x y = move x y

hanoi (n+1) x y =
  hanoi n x (other x y)
  move x y
  hanoi n (other x y) y
```

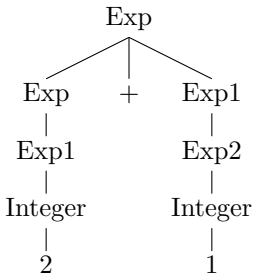
2.4 Week 4

HW 4 - Parsing and Context-Free Grammars

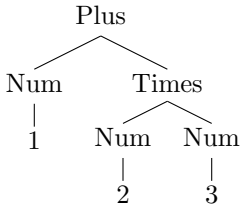
```
Abstract Syntax Tree: 2 + 1
   Plus (Num 2) (Num 1)
```



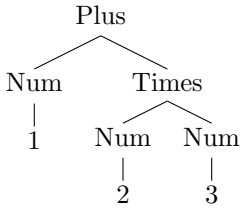

```
Concrete Syntax Tree: 2 + 1
```



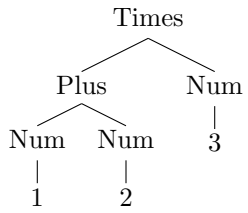

```
Abstract Syntax Tree: 1 + 2 * 3
   Plus (Num 1) (Times (Num 2) (Num 3))
```



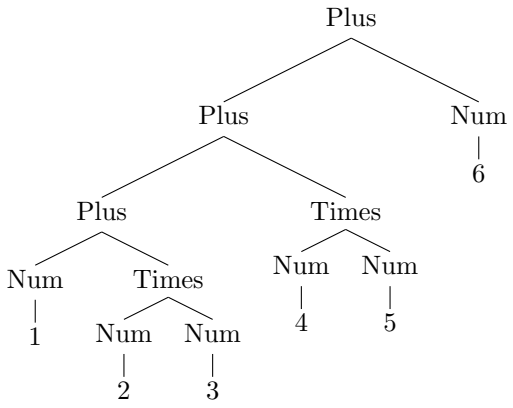

```
Abstract Syntax Tree: 1 + (2 * 3)
   Plus (Num 1) (Times (Num 2) (Num 3))
```



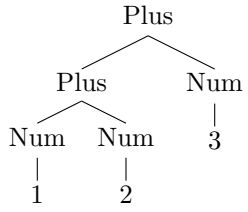
```
Abstract Syntax Tree: (1 + 2) * 3
    Times (Plus (Num 1) (Num 2)) (Num 3)
```



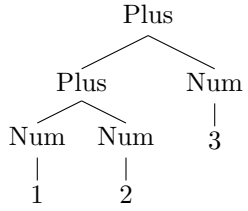

```
Abstract Syntax Tree: 1 + 2 * 3 + 4 * 5 + 6
    Plus (Plus (Plus (Num 1) (Times (Num 2) (Num 3))) (Times (Num 4) (Num 5))) (Num 6)
```



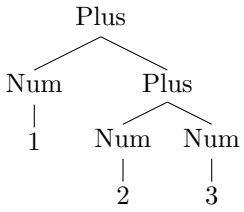

```
Abstract Syntax Tree: 1 + 2 + 3
    Plus (Plus (Num 1) (Num 2)) (Num 3)
```




```
Abstract Syntax Tree: (1 + 2) + 3
    Plus (Plus (Num 1) (Num 2)) (Num 3)
```




```
Abstract Syntax Tree: 1 + (2 + 3)
    Plus (Num 1) (Plus (Num 2) (Num 3))
```

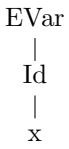



```
The abstract syntax tree of 1+2+3 is identical to the one of (1+2)+3, but not the one of 1+(2+3).
```

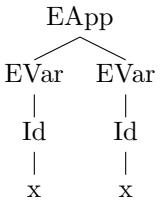
2.5 Week 5

HW 5 - Syntax + Semantics of Lambda Calculus Syntax

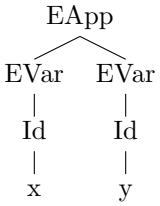
```
x = EVar (Id "x")
```



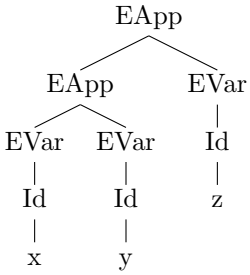

```
x x = EApp (EVar (Id "x") EVar (Id "x"))
```



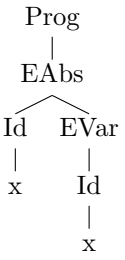

```
x y = EApp (EVar (Id "x") EVar (Id "y"))
```



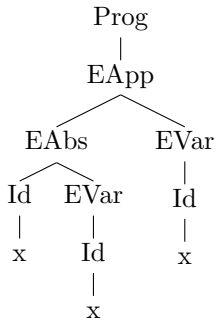

```
x y z = EApp (EVar (Id "x") EVar (Id "y")) EVar (Id "z"))
```



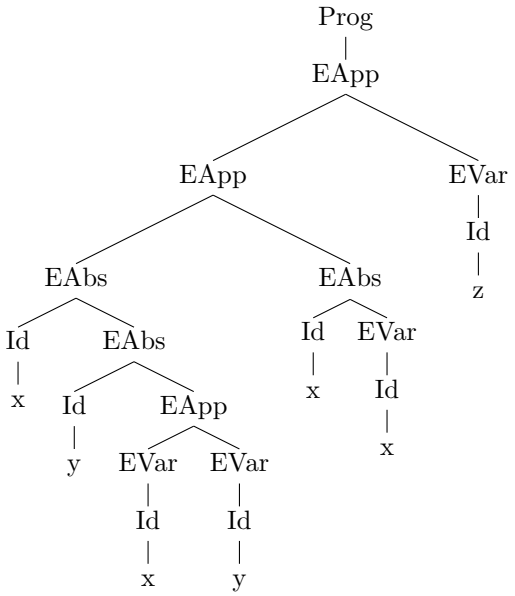

```
\ x.x = Prog (EAbs(Id "x" EVar(Id "x")))
```



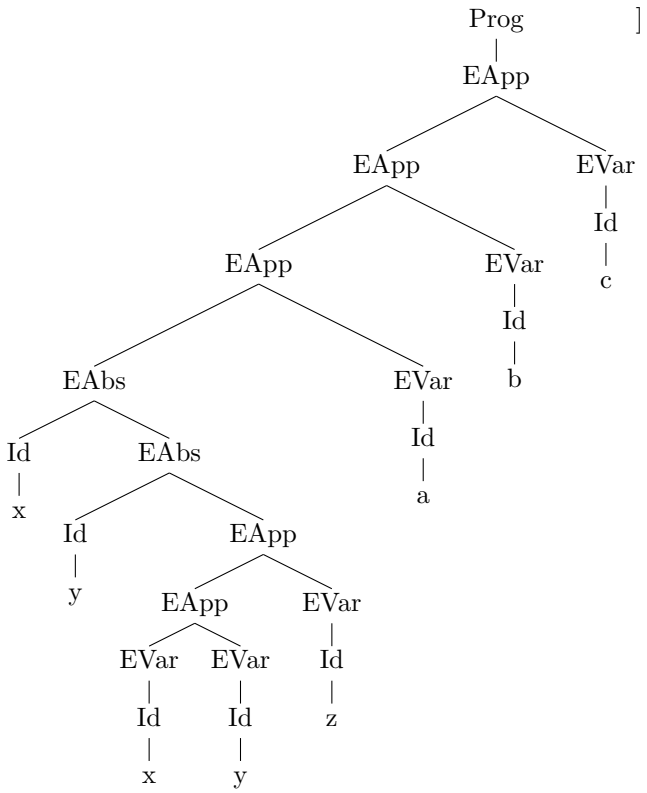

```
(\x.x) x = Prog(EApp(EAbs(Id "x" EVar(Id "x")) EVar(Id "x")))
```




```
(\ 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")))
```



Semantics

```
- Evaluate using pen-and-paper the following expressions:

(\x.x) a = a

\x.x a = \x.x a

(\x.\y.x) a b = (\y.a) b = a

(\x.\y.y) a b = (\y.y) b = b

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

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

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

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

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

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

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

(\x.\y.y) (a b c) = \y.y
```

```
- Evaluate (\x.x)((\y.y)a) by executing the function evalCBN

evalCBN(EApp (EAbs (Id "x") (EVar (Id "x"))) (EApp (EAbs (Id "y") (EVar (Id "y"))) (EVar (Id
    "a")))) = line 6
evalCBN (EApp (EAbs (Id "x") (EVar (Id "x"))) subst (Id "y") (EVar (Id "a")) (EVar (Id "y"))) =
    line 15
evalCBN (EApp (EAbs (Id "x") (EVar (Id "x"))) EVar (Id "a")) = line 6
evalCBN (subst (Id "x") (EVar (Id "a")) (EVar (Id "x"))) = line 15
evalCBN (EVar (Id "a")) = line 8
EVar (Id "a")
```

2.6 Week 6

Evaluate

```
(\exp.\two.\three. exp two three)

(\m.\n. m n)

(\f.\x. f (f x))

(\f.\x. f (f (f x)))

Substitute the terms as shown in the following:

((\m.\n. m n) \two. \three. two three) =

((\m.\n. m n) (\f.\x. f (f x)) \three. three) =

((\m.\n. m n) (\f.\x. f (f x)) (\f.\x. f (f (f x)))) =

((\m.\n. m n) (\f0.\x0. f0 (f0 x0)) (\f1.\x1. f1 (f1 (f1 x1)))) =

((\n. (\f0. \x0. f0 (f0 x0)) n) (\f1. \x1. f1 (f1 (f1 x1)))) =

((\f0.\x0. f0 (f0 x0)) (\f1.\x1. f1 (f1 (f1 x1)))) =

((\x0. (\f1.\x1. f1 (f1 (f1 x1))) ((\f1.\x1. f1 (f1 (f1 x1))) x0))) =

((\x0. (\f1.\x1. f1 (f1 (f1 x1))) ((\f1.\x1. f1 (f1 (f1 x1))) x0))) =

((\x0. (\x1. ((\f1.\x1. f1 (f1 (f1 x1))) x0) (((\f1.\x1. f1 (f1 (f1 x1))) x0) (((\f1.\x1. f1 (f1
    (f1 x1))) x0) x1))))) =

((\x0. (\x1. ((\x1. x0 (x0 (x0 x1)))) (((\f1.\x1. f1 (f1 (f1 x1))) x0) (((\f1.\x1. f1 (f1 (f1
    x1))) x0) x1))))) =

((\x0. (\x1. ((\x1. x0 (x0 (x0 x1)))) (((\x1. x0 (x0 (x0 x1)))) (((\f1.\x1. f1 (f1 (f1 x1))) x0)
    x1))))) =

((\x0. (\x1. ((\x1. x0 (x0 (x0 x1)))) (((\x1. x0 (x0 (x0 x1)))) (((\x1. x0 (x0 (x0 x1)))) x1))))) =

((\x0. (\x1. ((\x1. x0 (x0 (x0 x1)))) (((\x1. x0 (x0 (x0 x1)))) (((x0 (x0 (x0 x1))))))))) =

((\x0. (\x1. ((\x1. x0 (x0 (x0 x1)))) (((x0 (x0 (x0 ((x0 (x0 (x0 x1)))))))))))) =
```

```
((\x0. (\x1. (x0 (x0 (x0 (((x0 (x0 (x0 ((x0 (x0 (x0 x1)))))))))))))) =

(\x0. (\x1. (x0 (x0 (x0 (x0 (x0 (x0 (x0 (x0 (x0 x1))))))))))
```

2.7 Week 7

Explain whether each variable is bound or free - if it is bound, say the binder and scope of the variable.

```
Lines 5-7
evalCBN (EApp e1 e2) = case (evalCBN e1) of
    (EAbs i e3) -> evalCBN (subst i e2 e3)
    e3 -> EApp e3 e2
```

e1 (line 5)

- bound on the left of =
- scope is the end of line 7

e2 (line 5)

- bound on the left of =
- scope is the end of line 7

i (line 6)

- bound on the left of -¿
- scope is the end of line 6

e3 (line 6)

- bound on the left of -¿
- scope is the end of line 6

e3 (line 7)

- bound on the left of -¿
- scope is the end of line 7

x (line 8)

- bound on the left of =
- scope is the end of line 8

```
Lines 18-22
subst id s (EAbs id1 e1) =
    -- to avoid variable capture, we first substitute id1 with a fresh name inside the body of the
        lambda-abstraction, obtaining e2. Only then do we proceed to apply substitution of the
        original s for id in the body e2.
    let f = fresh (EAbs id1 e1)
        e2 = subst id1 (EVar f) e1 in
        EAbs f (subst id s e2)
```

id (line 18)

- bound on the left of =
- scope is to the end of line 22

s (line 18)

- bound on the left of =
- scope is to the end of line 22

id1 (line 18)

- bound on the left of =
- scope is to the end of line 22

e1 (line 18)

- bound on the left of =
- scope is to the end of line 22

f (line 20)

- bound on the left of =
- scope is to the end of line 22

e2 (line 21)

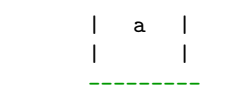
- bound on the left of =
- scope is to the end of line 22

```
- Evaluate (\x.\y.x) y z by executing the function evalCBN

evalCBN(EApp (EAbs (Id "x") (EAbs (Id "y") (EVar (Id "z")))) (EVar (Id "y")) (EVar (Id "z"))) --
    line 6
evalCBN (subst (Id "x") (EVar (Id "y")) (EVar (Id "x")) (EAbs (Id "y") (EVar (Id "x")))(EVar (Id
    "z"))) -- line 15
evalCBN (EApp (EAbs (Id "y") (EVar (Id "y1"))) EVar (Id "z")) -- line 6
evalCBN (subst (Id "y") (EVar (Id "z")) (EVar (Id "y1"))) -- line 15
evalCBN (EVar (Id "z")) -- line 8
EVar (Id "z")
```

Rewriting Introduction

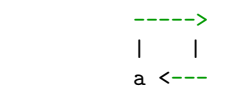
```
1. A = {}
---------
|       |
|       |
---------

- terminates - yes
- confluent - yes
- unique normal forms - yes
```

2. A = {a} and R = {}



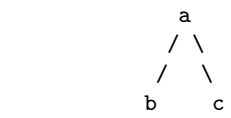
- terminates - yes
- confluent - yes
- unique normal forms - yes

3. A = {a} and R = {(a,a)}



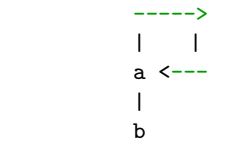
- terminates - no
- confluent - yes
- unique normal forms - no

4. A = {a,b,c} and R = {(a,b),(a,c)}



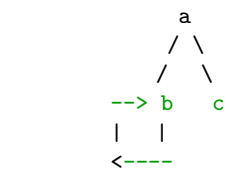
- terminates - yes
- confluent - no
- unique normal forms - no

5. A = {a,b} and R = {(a,a),(a,b)}



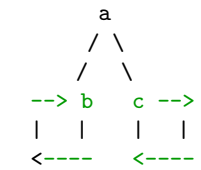
- terminates - no
- confluent - yes
- unique normal forms - yes

6. A = {a,b,c} and R = {(a,b),(b,b),(a,c)}



- terminates - no
- confluent - no
- unique normal forms - no

7. A = {a,b,c} and R = {(a,b),(b,b),(a,c),(c,c)}



- terminates - no
- confluent - no
- unique normal forms - no

Find an example of an ARS for each of the possible 8 combinations - draw pictures.

---

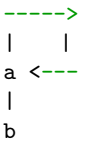
1. confluent, terminating, has unique normal forms
   A = {a,b} and R = {(a,b)}

2. confluent, terminating, doesn't have unique normal forms

   - not possible

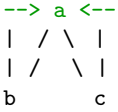
3. confluent, not terminating, has unique normal forms

   A = {a,b} and R = {(a,a),(a,b)}



4. confluent, not terminating, doesn't have unique normal forms

   A = {a,b,c} and R = {(a,b),(a,c),(b,a),(c,a)}

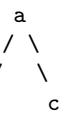


5. not confluent, terminating, has unique normal forms

   - not possible

6. not confluent, terminating, doesn't have unique normal forms

A = {a,b,c} and R = {(a,b),(a,c)}

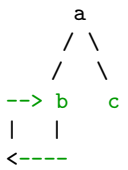


7. not confluent, not terminating, has unique normal forms

- not possible

8. not confluent, not terminating, doesn't have unique normal forms

A = {a,b,c} and R = {(a,b),(b,b),(a,c)}



2.8 Week 8

Answer the questions about the rewrite system

```
aa -> a
bb -> b
ba -> ab
ab -> ba
```

Why does the ARS not terminate?
The ARS doesn't terminate because the two rules ba -> ab and ab -> ba are circular.

What are the normal forms?
The normal forms are a, b, []

Can you change the rules so that the new ARS has unique normal forms (but still has the same equivalence relation)?
Yes, the rules can be changed so that the new ARS has unique normal forms. This can be done by removing the rule ab -> ba.

```
aa -> a
bb -> b
ba -> ab
```

What do the normal forms mean? Describe the function implemented by the ARS.
The normal forms mean that at that point, nothing can be reduced further. The ARS takes a string consisting of a's and b's. If there are doubles (ie aa or bb), then the length of those doubles is reduced. In the case of ba or ab, then the letters are flipped. Ultimately, the ARS reduces the length of the left-hand side of the string.

2.9 Week 9

```
Consider the ARS (A,->) where A is the set of words over the alphabet {a,b,c} and -> is defined
    via the following schema of rules.

ba -> ab
ab -> ba
ac -> ca
ca -> ac
bc -> cb
cb -> bc

aa -> b
ab -> c
ac ->
bb ->
cb -> a
cc -> b

The upper section of the ARS (involving ba, ab, ac, ca, bc, cb) is circular. There is a
    possibility that words could be arranged in a way to allow the lower section to come into
    play. If ba -> ab and to the right is another ba, then we would have abba. Then using bb -> ,
    the resulting form could potentially be aa, then b. However, it is unknown if this would ever
    be the case, as another possibility is that abba becomes abab or baba. Additionally, ab
    reduces both to ba and also c, adding yet another possibility.
```

2.10 Week 10

Activity and Homework:

Let F be $\lambda f.\lambda n.$ if n==0 then 1 else f(n-1)*n and reduce fix F 2.

fix F $\approx$ F fix F (computation rule)

```
fix F 2 = F fix F 2 = if 2 == 0 then 1 else fix F (2-1)*2 --> assume we have a function for 2-1
                = (fix F 1) * 2
                = (F fix F 1 = if 1 == 0 then 1 else fix F (1-1) * 1) * 2
                            = (fix F 0) * 2
                            = (F fix F 0 if 0 == 0 then 1) * 2
                            = 1 * 2
                            = 2
```

2.11 Week 11

Discussion Question:

```
In section 4.5, the paper states that contracts can only be valued over observables that we can
    model. Is there a case where this is untrue?
```

Discussion Responses:

```
Question 1: To further the question of how a software system built on this technology would take
    into account human behavior, legal requirements, security, etc. what are the limits of this
    language's applications? How difficult would it be to account for these limitations and would
```

this language still be worth using to generate contracts given the limits and ease of addressing them?

Response: I think that the language presented in the paper is able to define and generate lots of broad or general contracts, but there is definitely a limit when taking things into account like legality and security. I'm not even sure how it would begin to approach something like human behavior. While I think that the language as it is now is usable to an extent, I think there would definitely need to be additions made to the language in order for it to continue to be worth using in the future. The difficult thing is how to find out what additions need to be made, and how to represent intangible or unpredictable things such as human behavior.

Question: With any consumer-facing software or program, its success ultimately relies on how well it is adopted by its target audience. While composing contracts and its use of combinators can have potentially huge benefits, what are some ways we can make it user-friendly and encouraging for financial experts to use this new method?

Response: I agree with Eli that visual scripting or drag/drop implementation would make things much simpler for users to understand. The idea and usage of combinators could be intimidating at first glance for people unfamiliar with the terminology or with programming, but I think drag/drop would definitely help users (whether first timers or more experienced users) feel more at ease with using the program.

2.12 Week 12

Hoare Logic
Apply the method of analysis from the lecture to

```
while (x!=0) do z:=z*y; x:= x-1 done
```

What is the invariant? Indicate the reasoning steps in which you apply the rules of Hoare logic.

Pre and post conditions:
$\{x \geq 0\}$ while (x!=0) do z:=z*y; x:= x-1 done $\{post\}$
The while loop's rule is:

$$\frac{\{I\}S\{I\}}{\{I\}whileBdoSdone\{\neg B \wedge I\}}$$

`S` represents z := z * y; x := x - 1, while `I` represents the while loop invariant.

Table of execution:
Where t is the number of times the loop executes, and assume program variables are as follows: x=5, y=2, z=1.

t	x	y	z
0	5	2	0
1	4	2	2
2	3	2	4
3	2	2	8
4	1	2	16
5	0	2	32

With precondition of `x` $\geq$ `0` $\wedge$ `z = 1`, the postcondition of `z =` y^x and the table, the invariants are `t + x = 5` and `z =` y^t. Hence, the invariant `z =` $y^{(5-x)}$.

The invariant is `z =` $y^{(m-x)}$, where `m` represents the number of loops. We add the variable `n` to the invariant, so that `z = n +` $y^{(m-x)}$. However, `n` would have to be 0, because we there is no addition in the postcondition that we found above. We then replace `y` with `k`. Thus, $\{I\}$ is `z =` $k^{(m-x)}$.

Returning to the loop rule: $\frac{\{I\}S\{I\}}{\{I\}whileBdoSdone\{\neg B \wedge I\}}$

Let $\{\neg B \wedge I\}$ be `z =` $k^{(m-x)}$. $\neg B$ is equal to $\neg(\neg(x = 0))$ or `x = 0` (we know that `x` is equal to 0 once the while loop terminates). That leaves us with $\{I\}$ `while B do S done` $\{z = k^{(m-x)}\}$.

The rule for composition is: $\frac{\{P\}S\{Q\}\{Q\}T\{R\}}{\{P\}S;T\{R\}}$

Plugging in our equations we get: $\frac{\{P\}z{:=}z{*}y\{Q\}\{Q\}x{:=}x{-}1\{I\}}{\{I \wedge B\}z{:=}z{*}y;x{:=}x{-}1\{I\}}$

Then, we calculate `Q` and `P` and get:

$$\frac{\{z+y=n+k^{(m-(x-1))}\}z{:=}z{*}y\{z=n+k^{(m-(x-1))}\}x{:=}x{-}1\{I\}}{\{I \wedge B\}z{:=}z{*}y;x{:=}x{-}1\{I\}}$$

Algebra:

z + k = n + $k^{(m-(x-1))}$
z + k = n + $k^{(m-x+1)}$
z + k = n + $k^{(m-x)}$ + k^1
z = n + $k^{(m-x)}$

Therefore, our invariant is `z = n +` $k^{(m-x)}$.

3 Project

This section details the project.

3.1 Specification

For this project, I plan to learn a combination of HTML and CSS to build a website. Since this course is about programming languages, it made me think about how one would go about learning programming languages (as well as other languages in general). Because this topic is fascinating to me, I've decided to use HTML and CSS to create a blog website containing my thoughts and personal experiences regarding language learning. It will compare my experience learning HTML, CSS, and other programming languages to my experience learning Japanese. The website will consist of posts which viewers can click on in order to read more about the content.

3.2 Milestones

Milestone 1 (11/28):

The first milestone due date is 11/28. It will consist of a short writeup on the history of html/css and why these languages are so widely used when building websites or webpages. Just what about these languages makes it ideal to use for this purpose, and what benefits are there compared to other languages? Additional questions like what influenced the development choices behind the making of these languages will also be considered in this milestone.

Milestone 2 (12/2):

The second milestone due date is 12/2. This milestone will consist of a more fleshed out description and design of how the website will look and what it will contain. A clear plan of what needs to be implemented and the steps that need to be taken will be finalized. At this point, code will also be mailed to the professor

for a progress check and possible feedback.

Milestone 3 (12/7):
The third milestone due date is 12/7. This milestone will contain updated progress on the website. Additionally, it will include the beginnings of a synthesis on the process of learning html/css. This will be a commentary on my thoughts as I learned these languages, as well as things I wish I had learned sooner during the process. The ultimate goal is to try to put my learning process into words so that I can apply better learning techniques when I pick up new languages in the future.

3.3 Prototype

3.4 Documentation

History of HTML
Today, HTML is the primary structural markup language used for creating web pages and applications. HTML files are textual files that can be viewed and edited in plain text editors. HTML originated in 1990, with its intended use being for the distribution of simply structured documents. Its main users consisted of authors, scientists, and academics - people whose expertise was not in document formatting or printing. As use of the World Wide Web continued to grow, HTML needed to be enhanced to accommodate with new users' needs. Things like access to multimedia, layout/fonts, and additional support for interaction in applications needed to be considered now that more people were coming into contact with the web.

The original HTML was based on SGML (standardized generalized markup language), which was used to mark up text into structural units (i.e. paragraphs, headings, list items, etc). While SGML was good and accepted in the case of publishing workflows, it was predicted that it wouldn't be as widely accepted as a distribution format on the web. As such, iterations of HTML (1995), XHTML (1997), and XML (after XHTML) began to be developed. Since the web was being used for apps in addition to distributing documents however, HTML developers felt that focusing on XHTML would not address the needs of web developers.

HTML markup itself has no external dependencies. However, web pages that use external style sheets will of course depend on those external resources. For example, things like scripts in other programming languages can create dependencies and cause issues during runtime. However, this is not to say that HTML is not complementary or compatible with other languages. On the contrary, it commonly works in tandem with Javascript and css. Here, HTML is the structural markup for the content, CSS applies formatting to said content, and Javascript supports the interaction between the moving parts of the content.

History of CSS
The idea of CSS (cascading style sheets) originated in 1990 with HTML, but things only really got moving in 1994 when the web began to be used as a means of electronic publishing. From the beginning, developers of HTML aimed to separate document structure from document layout, and CSS was created to do just that.

Prior to the development and implementation of CSS, there was no way to style documents or personalize anything people put out on the web. Writers and authors of web pages wanted to have more influence over how their pages looked so that they could better express themselves and also catch the attention of potential viewers. They wanted to be able to do things like changing the font type and size, or changing the colors of certain elements on a web page to create a cohesive theme. HTML did not provide users the option to do such things at the time, since it was designed only to be a structural formatter.

Håkon published a draft of CSS in 1994, at the same time that Netscape was talking about releasing the first beta of Mozilla, complete with additional tags for authors to use. This brings conflicting ideas to a head and people began to consider: Should HTML really be turned into a page-description language? Or would it be better to build something to complement its functionality like the proposed CSS? There were also differing ideas on how much power one needed in order to customize a web page, as well as whether the user or the author or both parties should be able to customize what they were seeing. CSS took a new

approach and said that both the user and author, as well as the capabilities of their devices and browsers, would need to be taken into account in order to create the visuals that would be displayed.

Synthesis

HTML and CSS are used when building websites and web pages because that is the reason why they were designed. When people began using the web to publish documents, HTML was a simple way that they could format their text. As it became more popular, new users needs came up. How could they take the plain formatting of HTML that they had available to them and customize it to their liking? It was through such thoughts that CSS came into existence. In the case of both HTML and CSS, developers listened closely to the requests of users so that they could make their needs and ideas a reality.

3.5 Critical Appraisal

...

4 Conclusions

(approx 400 words)

In the conclusion, I want a critical reflection on the content of the course. Step back from the technical details. How does the course fit into the wider world of programming languages and software engineering?

References

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

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[C] CSS, W3.org, 2016