CPSC-354 Report

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Abstract

Short summary of purpose and content.

Contents

1 Introduction

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```

This document is a collection of homework assignment answers as requested by Prof. Kurz. This report will replace a generic midterm and final exam and will be thought of as a take home exam to be worked on throughout the semester in addition to a final project.

2 Homework

This section will contain your solutions to homework. For every week, you will have a subsection that contains your answers.

2.1 Week 1

```
print("Please enter integer A")
aString = input("a: ")
while True:
    try:
        a = int(aString)
        break
    except ValueError:
        print("Not an integer. Please try again.")
        print("Please enter INTEGER A")
        aString = input("a: ")

print("Please enter integer B")
bString = input("b: ")
while True:
    try:
        b = int(bString)
        break
    except ValueError:
        print("Not an integer. Please try again.")
        print("Please enter INTEGER B")
        bString = input("b: ")

a = int(aString)
b = int(bString)

while (a != b):
    if (a > b):
        a = a - b
    elif (b > a):
        b = b - a

print ("The greatest common divisor is: " + str(a))
```

This program works by first asking the user to input an integer named ”A”. The program stores this input in a variable called ”aString” and then utilizes error checking to make sure the user’s input can be converted into an integer. If the input cannot be converted into an integer, the program loops until the user enters valid input. If the user’s input passes error checking, the program then prompts the user for an integer named ”B” and follows the same error-checking process. Once the user passes error checking for both variables, the program enters a loop. In the loop, if integer A is greater than integer B, then integer A is replaced with the value of integer A - integer B. If integer B is greater than integer A, then integer B is replaced with the value of integer B - integer A. This process repeats until integer A is equal to integer B. When this is reached, the greatest common divisor of the original integer A and original integer B is printed out to the user.

For example, if we took A to be an integer representing the value of 9, and B to be an integer representing the value of 33, the program would follow this process: Because B, which equals 33 is greater than A, which equals 9. B's value would be replaced with B - A, which is 24. B is still greater than A, so B's value would be replaced by B - A again which now equals 15. 15 is still greater than 9, so B would become 6. Now, A with a value of 9 is greater than B which has a value of 6. A would be replaced with A - B which equals 3. This makes B greater than A again. B is now replaced with B - A, or 6 - 3, which equals 3. Now that A and B are equal, the greatest common divisor, which is 3 because both A and B equal 3, is output to the user.

2.2 Week 2

```
import Data.List
import System.IO

select_evens :: [Int] -> [Int]
select_evens (x:xs) = [(x:xs)!!y | y <- (y:ys)]
  where (y:ys) = [1,3..(length (x:xs)-1)]

select_odds :: [Int] -> [Int]
select_odds (x:xs) = [(x:xs)!!y | y <- (y:ys)]
  where (y:ys) = [0,2..(length (x:xs)-1)]

member :: Int -> [Int] -> Bool
member _ _ = False
member x (y:ys)
  | x == y = True
  | otherwise = member x ys

append :: [Int] -> [Int] -> [Int]
append (x:xs) (y:ys) = x:xs ++ y:ys

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

less_equal :: [Int] -> [Int] -> Bool
less_equal (x:xs) (y:ys)
  | x >= y = False
  | length (xs) == 0 && length (ys) == 0 = True
  | otherwise = less_equal xs ys

Select_Evens Computation:
select_evens [1,2,3,4,5] =
[] : [(1,2,3,4,5)!!1 | 1 <- ([1,3]) =
2 : [(1,2,3,4,5)!!3 | 3 <- ([1,3]) =
[2, 4]

Select_Odds Computation:
select_odds [1,2,3,4,5] =
[] : [1,2,3,4,5)!!0 | 0 <- ([0,2,4]) =
1 : [(1,2,3,4,5)!!2 | 2 <- ([2,4]) =
1 : (3 : [(1,2,3,4,5)!!4 | 4 <- ([4]) =
[1,3,5]

Member Computation:
```

```
member 1 [3, 2, 1] =
1 == 3 = False, so member 1 [2,1] =
1 == 2 = False, so member 1 [1] =
1 == 1 = True, so 1 is a member of [3, 2, 1]

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

Revert Computation:
revert [1,2,3,4,5] =
append (revert [2,3,4,5]) ([1]) =
append (append (revert [3,4,5]) ([2])) ([1]) =
append (append (append (revert [4,5]) ([3])) ([2])) ([1]) =
append (append (append (append (revert [5]) ([4])) ([3])) ([2])) ([1]) =
append (append (append (append (append (revert []) ([5])) ([4])) ([3])) ([2])) ([1]) =
append (append (append (append (append [] ([5])) ([4])) ([3])) ([2])) ([1]) =
append (append (append (append (append [] ([5])) ([4])) ([3])) ([2])) ([1]) =
append (append (append (append ([5]) ([4])) ([3])) ([2])) ([1]) =
append (append (append ([5,4]) ([3])) ([2])) ([1]) =
append (append ([5,4,3]) ([2])) ([1]) =
append ([5,4,3,2]) ([1]) =
[5,4,3,2,1]

Less_Equal Computation:
less_equal [1,2,3] [2,3,4] =
1 >= 2 = False, so less_equal [2,3] [3,4] =
2 >= 3 = False, so less_equal [3] [4] =
3 >= 4 = False, so less_equal [] [] =
True
```

2.3 Week 3

```
Tower Of Hanoi correct computations for a tower of 5
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
```

Hanoi appears in the computation 31 times. We can express the number of times "hanoi" appears for any number n of disks with the formula:
$numHanoi = 2^{numDisks} - 1$

2.4 Week 4

```
Concrete Syntax Trees

1. 2+1
           Exp
         /       \
       Exp  +   Exp1
        |         |
      Num        Num
        |          |
        2          1
```

```
2. 1+2*3
           Exp
         /       \
       Exp  +   Exp1
        |          |
      Num         Exp1
        |          /   \
        1        Exp1 * Exp2
                   |       |
                 Num      Num
                  |         |
                  2         3
```

```
3. 1+(2*3)
           Exp
         /       \
       Exp  +   Exp2
        |          |
      Num        ( Exp 1 )
        |          /   \
        1        Exp1 * Exp2
                   |       |
                 Num      Num
                  |         |
                  2         3
```

```
4. (1+2)*3
           Exp1
         /       \
       (Exp)  *   Exp2
      /       \      |
    Exp  +  Exp1     Num
      |      |        |
      Num   Num       3
      |       |
      1       2
```

```
5. 1+2*3+4*5+6
                  Exp
               /       \
            Exp    +     Exp1
            /                 \
         Exp                       Exp
        /     \                /         \
      Num       Exp1            Exp1        Num
       |      /      \         /      \       |
       1    Exp1 * Exp2       Exp1 *  Exp2    6
              |       |        |        |
             Num   Num       Num       Num
              |        |        |        |
             2         3       4         5
```

```
Abstract Syntax Trees

1. 2+1
        +
      /    \
     2      1

2. 1+2*3
             +
           /   \
          1     *
              /    \
             2      3

3. 1+(2*3) (Same as 2 because parantheses are not in the grammar)
             +
           /   \
          1     *
              /    \
             2      3

4. (1+2)*3 (Same as 2 because parantheses are not in the grammar)
             +
           /   \
          1     *
              /    \
             2      3

5. 1+2*3+4*5+6
                  +
            /          \
          +             +
       /     \       /      \
     1       *        *      6
           /   \    /  \
          2    3    4  5
```

2.5 Week 5

```
1. x
EVar
  |
Ident
  |
  x

2. x x
EApp
|    \
EVar  EVar
|       |
Ident   Ident
|       |
x       x

3. x y
EApp
|    \
EVar  EVar
|       |
Ident   Ident
|       |
x       y

4. x y z
EApp
|    \
EApp  EVar
|   \     \
EVar  EVar Ident
|       |     |
Ident Ident   z
|       |
x       y

5. \ x.x
EAbs
|    \
Ident EVar
|      |
x      Ident
        |
        x

6, \ x.x x
EAbs
|    \
Ident EApp
|     |   \
x    Evar   Evar
      |     |
      x     x

7. (\ x . (\ y . x y)) (\ x.x) z
EApp
|      \
EApp      EVar
|      \          \
EAbs      EAbs       Ident
|     \    \    \           \
Ident  EAbs Ident EVar        z
|       |   \    \    \
x       y   EApp  x   Ident
             |  \         \
             EVar  EVar     x
             |       |
             Ident Ident
             |       |
             x       y

8. (\ x . (\ y . x y)) (\ x.x) z
EApp
|   -------------------\
EApp                 EVar
|   ---------\          -----------\
EApp         EVar                  Ident
|    \            -------------\      |
EAbs    EAbs             Ident        c
|   \      |   \             |
Ident EVar Ident  EApp       b
|      |     |     |    \
x   Ident    y   EApp    EVar
      |      |    \      |
      a     EVar  EVar   Ident
             |     |       |
            Ident Ident    z
             |     |
             x     y

Part 2

1. (\x.x) a -> a

2. \x.x a -> a (Short form)

3. (\x. \y.x) a b ->  a

4. (\x.\y.y) a b -> b

5. (\x.\y.x) a b c -> a

6. (\x.\y.y) a b c -> b

6. (\x.\y.x) a (b c) -> a

7. (\x.\y.y) a (b c) -> (b c)

8. (\x.\y.x) (a b) c -> (a b)

9.  (\x.\y.y) (a b) c -> c
```

```
10. (\x.\y.x) (a b c) -> (abc)

11. (\x.\y.y) (a b c) -> Not enough arguments

12. (\x.x)((\y.y)a)
evalCBN(\x.x)((\y.y)a) =
evalCBN(\x.x)((\y0.y0)a) =
(\x.x)(a)
```

2.6 Week 6

```
(\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)) (\f2.\x2. f2 (f2 (f2 x2))))
=
((\n. (\f.\x. f (f x)) n) (\f2.\x2. f2 (f2 (f2 x2))))
=
(((\f.\x. f (f x)) (\f2.\x2. f2 (f2 (f2 x2)))))
=
(((\x. (\f2.\x2. f2 (f2 (f2 x2))) ((\f2.\x2. f2 (f2 (f2 x2))) x))))
=
(((\x. (\x2. ((\f2.\x2. f2 (f2 (f2 x2))) x) (((\f2.\x2. f2 (f2 (f2 x2))) x) (((\f2.\x2. f2 (f2 (f2 x2))
=
(((\x. (\x2. ((\x2. x (x (x x2)))) (((\f2.\x2. f2 (f2 (f2 x2))) x) (((\f2.\x2. f2 (f2 (f2 x2))) x) x2))
=
(((\x. (\x2. (x (x (x (((\f2.\x2. f2 (f2 (f2 x2))) x))))) (((\f2.\x2. f2 (f2 (f2 x2))) x) x2)))))
=
(((\x. (\x2. (x (x (x (((\x2. x (x (x x2)))))))) (((\f2.\x2. f2 (f2 (f2 x2))) x) x2)))))
=
(((\x. (\x2. (x (x (x (((x (x (x (((\f2.\x2. f2 (f2 (f2 x2))) x) x2)))))))))))))
=
(((\x. (\x2. (x (x (x (((x (x (x (((\x2. x (x (x x2)))) x2)))))))))))))
=
(\x.(\x2.(x(x(x(x(x(x(x(x(x x2))x2)))))))))
```

2.7 Week 7

```
evalCBN: Bound variable
Binder: evalCBN :: Exp -> Exp
Scope:
evalCBN (EApp e1 e2) = case (evalCBN e1) of
    (EAbs i e3) -> evalCBN (subst i e2 e3)
    e3 -> EApp e3 e2
evalCBN x = x

e1: Bound variable
```

```
Binder: (EApp e1 e2)
Scope:
(EApp e1 e2) = case (evalCBN e1) of
    (EAbs i e3) -> evalCBN (subst i e2 e3)
    e3 -> EApp e3 e2

e2: Bound variable
Binder: (EApp e1 e2)
Scope:
(EApp e1 e2) = case (evalCBN e1) of
    (EAbs i e3) -> evalCBN (subst i e2 e3)
    e3 -> EApp e3 e2

e3: Free variable

subst: Bound variable
Binder: subst :: Id -> Exp -> Exp -> Exp
Scope:
subst id s (EAbs id1 e1) =
    let f = fresh (EAbs id1 e1)
        e2 = subst id1 (EVar f) e1 in
        EAbs f (subst id s e2)

id: Free variable

s: Free variable

id1: Bound variable
Binder: (EAbs id1 e1)
Scope:
let f = fresh (EAbs id1 e1)
     e2 = subst id1 (EVar f) e1 in
     EAbs f (subst id s e2)

e1: Bound variable
Binder (Eabs id1 e1)
Scope:
let f = fresh (EAbs id1 e1)
     e2 = subst id1 (EVar f) e1 in
     EAbs f (subst id s e2)

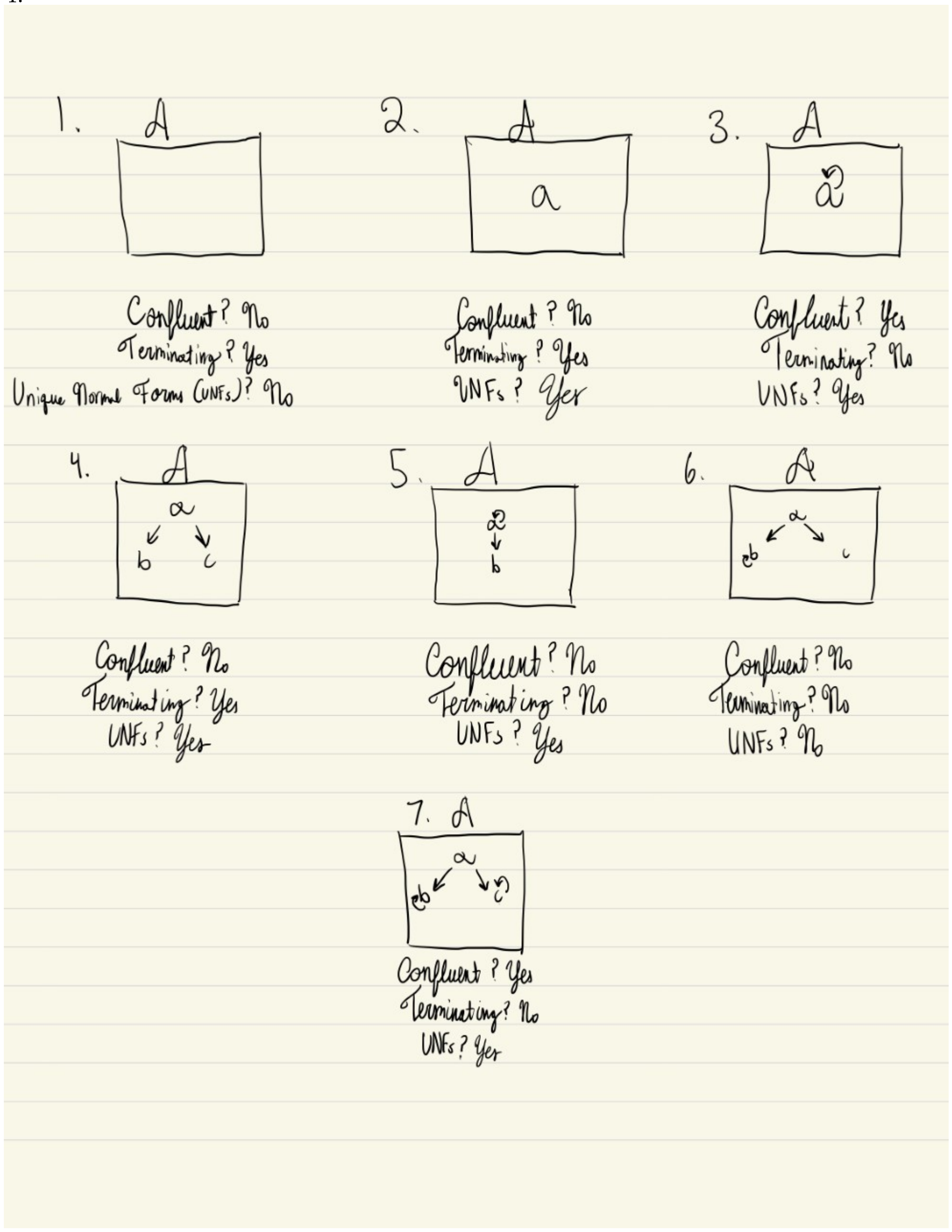
f: Bound variable
Binder: let f = fresh (EAbs id1 e1)
Scope:
e2 = subst id1 (EVar f) e1 in
EAbs f (subst id s e2)

3. '(\x\y.x) y z'
(\x\y.x) (y z) = evalCBN (subst i (\x(\y.x))) y z
(Line 26 and 27)
```

```
evalCBN (subst i (\x(\y.x))) y z = evalCBN (EApp (subst i (\x(\y.x)) y) (subst i (\x(\y.x)) x))
(Line 49)

evalCBN (EApp (subst i (\x(\y.x)) y) (subst i (\x(\y.x)) x)) = evalCBN (EApp (\x(\y.x)) (\x(\y.x)))
(Line 47)
```

4.



1. Confluent? No
Terminating? Yes
Unique Normal Forms (UNFs)? No

2. Confluent? No
Terminating? Yes
UNFs? Yes

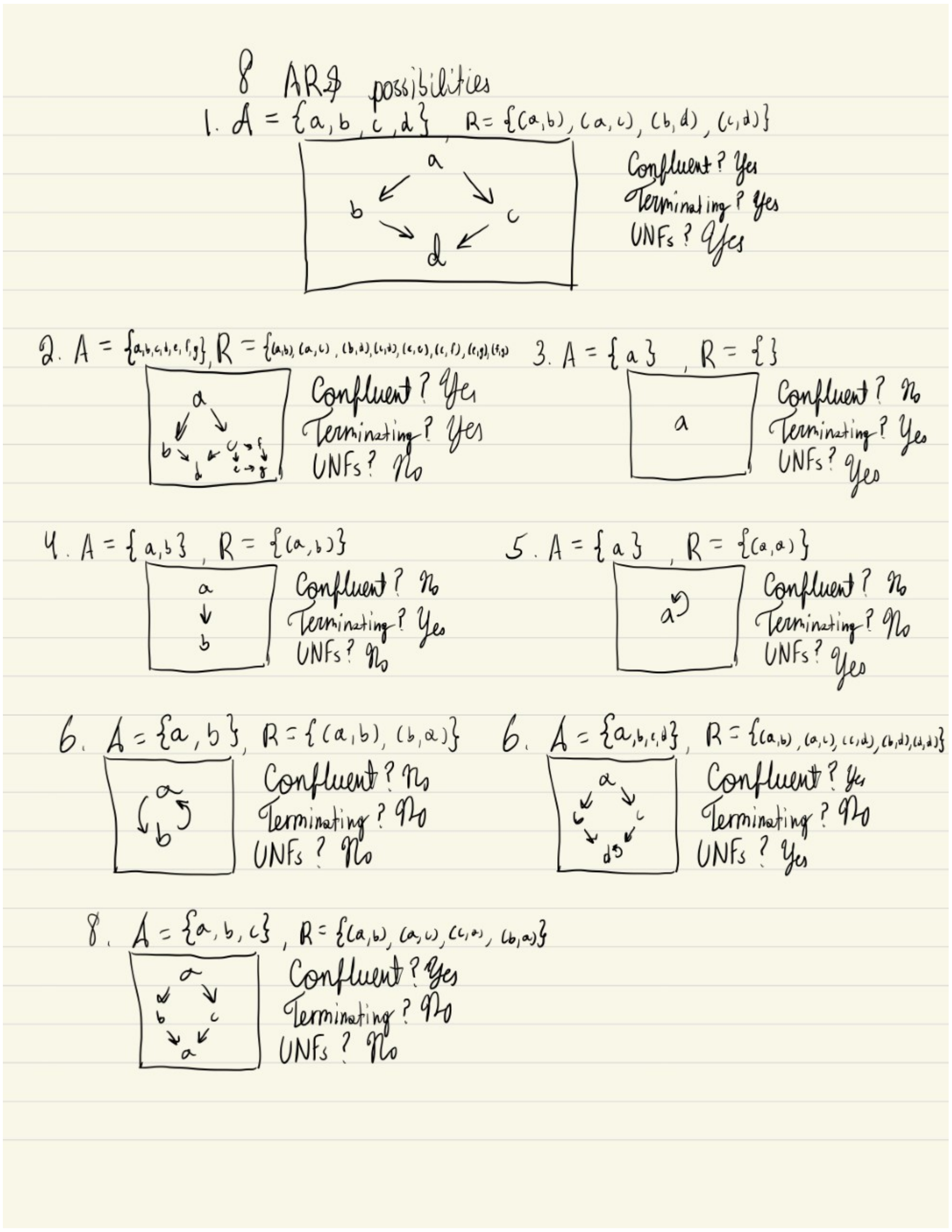
3. Confluent? Yes
Terminating? No
UNFs? Yes

4. Confluent? No
Terminating? Yes
UNFs? Yes

5. Confluent? No
Terminating? No
UNFs? Yes

6. Confluent? No
Terminating? No
UNFs? No

7. Confluent? Yes
Terminating? No
UNFs? Yes



8 ARS possibilities

1. $A = \{a, b, c, d\}$, $R = \{(a,b), (a,c), (b,d), (c,d)\}$

$$\begin{tikzcd} & a \arrow[dl] \arrow[dr] & \\ b \arrow[dr] & & c \arrow[dl] \\ & d & \end{tikzcd}$$

Confluent? Yes
Terminating? Yes
UNFs? Yes

2. $A = \{a,b,c,d,e,f,g\}$, $R = \{(a,b), (a,c), (b,d), (c,d), (c,e), (c,f), (e,g), (f,g)\}$

$$\begin{tikzcd} & a \arrow[dl] \arrow[dr] & & \\ b \arrow[dr] & & c \arrow[dl] \arrow[r] \arrow[d] & f \arrow[d] \\ & d & e \arrow[r] & g \end{tikzcd}$$

Confluent? Yes
Terminating? Yes
UNFs? No

3. $A = \{a\}$, $R = \{\}$

a

Confluent? No
Terminating? Yes
UNFs? Yes

4. $A = \{a, b\}$, $R = \{(a,b)\}$

$$\begin{tikzcd} a \arrow[d] \\ b \end{tikzcd}$$

Confluent? No
Terminating? Yes
UNFs? No

5. $A = \{a\}$, $R = \{(a,a)\}$

$$\begin{tikzcd} a \arrow[loop right] \end{tikzcd}$$

Confluent? No
Terminating? No
UNFs? Yes

6. $A = \{a, b\}$, $R = \{(a,b), (b,a)\}$

$$\begin{tikzcd} a \arrow[d, bend right] \\ b \arrow[u, bend right] \end{tikzcd}$$

Confluent? No
Terminating? No
UNFs? No

6. $A = \{a,b,c,d\}$, $R = \{(a,b), (a,c), (c,d), (b,d), (d,d)\}$

$$\begin{tikzcd} & a \arrow[dl] \arrow[dr] & \\ b \arrow[dr] & & c \arrow[dl] \\ & d \arrow[loop right] & \end{tikzcd}$$

Confluent? Yes
Terminating? No
UNFs? Yes

8. $A = \{a, b, c\}$, $R = \{(a,b), (a,c), (c,a), (b,a)\}$

$$\begin{tikzcd} & a \arrow[dl] \arrow[dr] & \\ b \arrow[dr] & & c \arrow[dl] \\ & a & \end{tikzcd}$$

Confluent? Yes
Terminating? No
UNFs? No

2.8 Week 8

1. The ARS does not terminate because the rewrite rules ba $\Longrightarrow$ ab and ab $\Longrightarrow$ ba allow for an infinite loop that doesn't terminate. There is no measure function for this ARS.
2. The normal forms are an empty word, a, and b.
3. We are unable to change this ARS to have unique normal forms while maintaining the same equivalence relations because the relation onf ba $\Longrightarrow$ ab and ab $\Longrightarrow$ ba remaining in the ARS do not allow for unique normal forms.

4. The normal forms here mean that two of the same character are rewritten to just one of the characters and two different characters are rewritten in reverse order. This function could be used for taking the square root of numbers. This is because the square root of two numbers that are the same is just the number before they are multiplied together, and the square root of two different numbers multiplied together equals the square root of those two numbers multiplied together in reverse order.

2.9 Week 9

PEG.js Calculator Extension Project Milestones

- Get a grasp on Javascript by following the tutorials on learnjavascript.online. There is no direct deliverable for this requirement. I will need to learn Javascript in order to work with the parser generator PEG.js. A potential deliverable would be showing completion of Chapters 1 - 7 (The free chapters) in screenshots, but I feel like that would be tedious and that if needed, completion can be verified visually in office hours or right before or after class if needed. Milestone 1 is due by November 13th
- Implement assignment, exponentiation, in the calculator project. Use this time to gain a foothold in using PEG.js and find out if capture by avoiding substitution is needed. This can be tested through the PEG.js parser generator website. This can also be physically submitted as a .pegjs file containing my calculator's grammar. I can include instructions to compile and run the code. Milestone 2 is due by November 30th
- Implement integrals and derivatives in the calculator. This can be verified via a submitted .pegjs file containing the calculator's grammar, similar to the deliverable for Milestone 2. Milestone 3 is due by December 16th
- Finalize the project by verifying that everything works as expected. Create basic documentation that will detail how to run the project and what the project does.

ARS Exercise
ba $\Longrightarrow$ ab
ab $\Longrightarrow$ ba
ac $\Longrightarrow$ ca
ca - $\Longrightarrow$ ac
bc $\Longrightarrow$ cb
cb $\Longrightarrow$ bc
aa $\Longrightarrow$ b
ab $\Longrightarrow$ c
ac $\Longrightarrow$
bb $\Longrightarrow$
cb $\Longrightarrow$ a
cc $\Longrightarrow$ b
This ARS is not terminating because there is possibility for infinite loops.
The normal forms in this ARS are the empty word, a, b, and c.
We can characterize equivalence classes in this case by normal forms.
Equivalence Classes: ab, ba, ac, ca, bc, cb, (ac, bb), (aa, cb), (ab), (cc), empty word
This ARS is not confluent because of the only one-step computations that compute to the same element (aa $\Longrightarrow$ b and cc $\Longrightarrow$ b, ac $\Longrightarrow$ empty word, bb $\Longrightarrow$ empty word), none of the elements they compute to lead back to them.

2.10 Week 10

$$fix_F 2$$

```
fix_F2 = \y.\n. if n == 0 then 1 else f(2-1)*2(fix_F2)
\y.\n. if n == 0 then 1 else f(2-1)*2(fix_F2) = fix_F1 * 2
fix_F1 * 2 = ((fix_F0 * 1) * 2)
((fix_F0 * 1) * 2) = ((1) * 2)
((1) * 2) = 2
```

2.11 Week 11

Answers:

1. I think it's beneficial for them to learn because they'll be able to gain a different perspective on how to view contracts. Because we all think differently, it might be easier for some people to visualize contracts through this language. Additionally, they could potentially end up learning this language and then using their knowledge to create a program that will allow people to administer and create contracts with others in an easy-to-understand digital format.

2. I agree with Eli. I think the use of combinators is able to account for only contracts able to be constructed with the set of combinators and data types that we have available to us in the implementation.

Question:

What are the tests listed in appendix A of Contract.hs symbolizing? Along with that, what is the tolerance symbolizing? Do the tests and tolerance have a connection to real world tests used in finance?

2.12 Week 12

Apply the method of analysis from the Hoare logic lecture to:

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

Precondition: {z = 1 ∧ x = n}

Postcondition: $\{z = y^n\}$

Table of the Execution

t	x	y	z
0	100	2	1
1	99	2	2
2	98	2	4
3	97	2	8

Therefore, we can give the following invariants:

$t + x = 100$

$z = y^t$

Loop invariant: $z = y^{(x-100)}$

The precondition implies the invariant: $z = 1 \land x = n \implies z = y^{(x-n)}$

The invariant implies the postcondition: $z = y^{(x-n)} \implies z = y^n$

This is true because at the end of the loop, $x = 0$

3 Project

Introductory remarks ...

The following structure should be suitable for most practical projects.

3.1 Specification

For my course project, I will be using the parser generator PEG.js in order to create a calculator similar to the one we implemented in class, but with a few major differences. My parser generator will be able to integrate functions and take the derivative of them as well. My parser will additionally be able to work with assignment, including assigning functions.

3.2 Prototype

In the fall 2022 semester, we did not follow the past final project schedule. For instance, we did not have a prototype implementation or core section of a theoretical report due.

3.3 Documentation

This project is primarily an extension and my own web-implementation of the PEG.JS example calculator. The base of the project, from PEG.JS, had the capability to parse simple arithmetic expressions of addition, subtraction, multiplication, and division. I have extended this by adding the following features:

- Exponentiation
- Derivation capabilities
- Definite integration capabilities
- Integration of a single variable
- Integration of a constant

Originally, I had also planned to implement variable-to-integer assignment along with full integration capabilities for functions, but these proved difficult. Creating and assigning variables dynamically is not only difficult, but I found also dangerous, and full integration capabilities for functions is not supported by integral evaluation modules for JavaScript. I have found the following as alternatives:

- Instead of variable assignment, I made a CLI implementation of the calculator as well as a webpage-implementation.
- Instead of full integration of expression support, I implemented definite integration capabilities.

3.4 Critical Appraisal

The learning goals of this project were to familiarize myself with HTML and JavaScript as well as improve my knowledge and usage of parsers, interpreters, and context-free grammars(CFGs) by creating a program that can run on a webpage. I believe I have accomplished my goals while developing this program because of the many issues I faced and overcame in developing this project. Some of the issues I faced are as follows:

- Complications in getting HTML to recognize and use my JavaScript files and functions.
- Issues concerning the difference between CommonJS modules and ES modules and converting them.
- Difficulty adjusting to and modifying the PEG.JS grammar (Some documentation is missing and the PEG.JS project itself is a work in progress).

- Issues in finding a bundler that would allow my JavaScript files to work with HTML

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4 Conclusions

Professor Kurz's Programming Languages course at Chapman University offers students the opportunity to dive deeper into their knowledge of programming languages and learn how to construct one of their own. Students learn about the difference between imperative and functional programming, the function of parsers and interpreters, how to use Haskell, how to use Lambda Calculus, how to use LaTeX, and lots of theory and abstract concepts relating to programming.

This course is essential in preparing future software engineers and computer scientists for the technology industry. While anyone can program only knowing the syntax of a language and without knowing the concepts taught in this class, expert programmers need to know concepts taught in this course, such as how to create their own programming language and how a programming language works. This allows them to efficiently debug their coding problems and understand what is actually happening on the back-end. Beyond this, programmers also gain knowledge on insight on other valuable topics, such as context-free grammars, string rewriting, syntax trees, and more.

In addition to the skills students gain in this course, Professor Kurz encourages students to relate the course to real-world concepts and applications. One example of this is in the fall 2022 semester, Professor Kurz had students analyze and critically think about the implementation of contracts in Haskell. This is beneficial to the world of software engineering in that it encourages students to think about what things in real life can be implemented in programming languages as well as the benefits and drawbacks of such an implementation. It's important to expose students to how the course material relates to real-world applications and problems because it helps inspire them to find and solve these problems. Another way Professor Kurz helps students explore applications of programming languages to real-world problems is by requiring students to develop a project of their own over the later half of the course. Students may write an interpreter of their own, learn a programming language, develop a program of their own, and more.

The concepts and assignments in this course all come together to strengthen a programmer's knowledge and skill set in ways that prepare students for the workforce or to even just be efficient and knowledgeable independent programmers on their own. I, for example, developed a web-implementation of an extension for PEG.JS's example calculator, and in doing so learned a lot about how to develop my own web-application. The skills I gained with that project in particular, I foresee myself using in the future.

References

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