0/33 Questions Answered
32 questions with unsaved changes

Final Exam

STUDENT NAME

Search students by name or email...

Q1
0 Points

Please **carefully read** the instructions below:

Ground Rules

This exam is open-note, which means that you may refer to your own notes and class resources during the exam. However, doing so will cause you to have less time to complete the exam. You can also use `irb` and `utop` (or other programs). You may **not** work in collaboration with anyone else, regardless of whether they are a student in this class or not. If you need to ask a question about the exam, post a private question on Piazza.

Sections

Section	Points
PL Concepts	**[20 pts]**
Ruby Code	**[8 pts]**
Ruby Coding	**[8 pts]**
OCaml Code	**[8 pts]**

Section	Points
OCaml Coding	**[8 pts]**
OCaml Coding	**[8 pts]**
FSMs	**[8 pts]**
Grammars	**[8 pts]**
OpSem	**[7 pts]**
Lambda Calc	**[8 pts]**
Rust Coding	**[3 pts]**
Rust COde	**[8 pts]**
Syntax vs Semantics	**[6 pts]**

General Advice

You can complete answers in any order, and we recommend you look through all of the questions before first so you can gauge how long you should spend on each question. Refer to the counter in the top left corner to ensure you have completed all questions.

Submission

You have 120 minutes to complete this exam (see the timer in the upper right corner for remaining time). Once you begin, you can submit as many times as you want until your time is up. You can even leave this page and come back, and as long as the time hasn't expired, you'll be able to update your submission. This means that if you accidentally submit, refresh, or lose internet temporarily, you'll still be able to work on the test until the time is up. If you come back, click "Resubmit" in the bottom-right corner to resume.

Honor Pledge

Please copy the honor pledge below:

> I pledge on my honor that I have not given or received any unauthorized assistance on this examination.

Enter your answer here

Signature

By entering your name below, you agree that you have read and fully understand all instructions above.

Enter your answer here

Save Answer

Q2 PL Concepts

20 Points

Q2.1

2 Points

Lexers don't care if the input is grammatically incorrect

- (●) True
- ( ) False

Save Answer *Unsaved Changes

Q2.2

2 Points

Not all programming languages are turing complete

- (●) True
- ( ) False

Save Answer *Unsaved Changes

Q2.3
2 Points

Not all NFAs can be represented by a regular language

- ( ) True
- (●) False

Save Answer *Unsaved Changes

Q2.4
2 Points

Any set of strings that a Regular Expression describes can also be described by a CFG

- (●) True
- ( ) False

Save Answer *Unsaved Changes

Q2.5
2 Points

Rust's ownership rules help prevent memory issues found in other languages like C

- (●) True
- ( ) False

Save Answer *Unsaved Changes

Q2.6
2 Points

Operational Semantics focus on describing a program based on mathematical objects

- ○ True
- ◉ False

Save Answer ***Unsaved Changes**

Q2.7
2 Points

Keywords like `mut`, `int`, `void*`, describe segments of memory, rather than how the compiler/interpreter should treat the data.

- ○ True
- ◉ False

Save Answer ***Unsaved Changes**

Q2.8
3 Points

Choose Ruby, Ocaml or Rust, and describe why we would want to use that language over the other 2.

answers will vary

Save Answer ***Unsaved Changes**

Q2.9
3 Points

Why do so many languages exist when we could just use one?

answers will vary

Save Answer *Unsaved Changes

Q3 Ruby Code

8 Points

Q3.1

2 Points

Consider the following Ruby Code:

```
result = []
myhash = {"one"=>[11,20,8],"two"=>[17,12],"three"=>[17,8,4]}
myhash.each {|k,v|
 sum = 0
 v.each {|x| sum+=x}
 result.append(sum/v.length())
}
puts result
```

What is the output?

13
14
9

Save Answer *Unsaved Changes

Q3.2

2 Points

Consider the following:

```
def function(a,b)
  arr = [a,b]
  if a > 10
    yield arr
  else
    yield [10,10]
  end
end

function(1,2) {___Blank 1__}
function(11,1) {__Also Blank 1__}
```

What could we replace `Blank 1 with so that the following is printed?

```
20
20
22
2
```

```
|x,y|
puts x*2
puts y*2
```

Save Answer ***Unsaved Changes**

Q3.3

4 Points

Consider the following code:

```
1  a = "Android 2B, Deployed at Location: Desert along with 9S"
2  b = "Android A2, Deployed at Location: City Ruins along with 2P"
3  re = Regexp.new(/^Android \d[A-Z], Deployed at Location: ([[a-zA-Z]\s]+

4  hash = {}
5  for i in [a,b]
6   if i =~ re
7     puts $1
8     hash[$1] = [$2,$3]
9   end
10 end
```

```
11 if hash["2B"][1] == hash["A2"][1]
12   puts "deployed in same area"
13 else
14   puts "Not deployed in same area"
15 end
```

Why does this not print ..."Not deployed in same area" (ie. Why is the guard on line 11 true)?

$2 and $3 don't exist in the regex so they return nil, making the hashes the same

Change a single line from lines 3-10 such that "2B\nA2\Not deployed in same area" is printed

change line 3 to
re = Regexp.new(/^Android (\d[A-Z]|[A-Z]\d), Deployed at Location: ([[a-zA-Z]\s]+) along with (\d[A-Z])$/)

Save Answer *Unsaved Changes

Q4 Ruby Coding

8 Points

Let's write an interpreter. Instead of a AST though, you will be given arrays to represent data.
Here is the grammar

$$\begin{aligned} R \Rightarrow \quad & R + R \\ & |R - R \\ & |R * R \\ & |R / R \\ & |(R) \\ & |n \end{aligned}$$

where n is any integer.
Here is an array that represents a sentence:

```
["add","3","4"] # 3 + 4
["sub",["mult","1","5"],"7"] # 1 * 5 - 7
["div",["add","4","6"],["sub","5","0"]] # (4+6)/(5-0)
```

- Each array will be a size of 3
  - The first element of an array will be either `"add","sub","mult","div"`
  - The second element will be either an array or string of an integer. It will represent the left expression of the operator
  - The third element will be either an array or string of an integer. It will represent the left expression of the operator
- You can assume that you will be passed in a grammatically correct sentence
- Division will be integer division
- You may want to use `.class`

examples:

```
eval ["add","3","4"] => 7
eval ["sub",["mult","1","5"],"7"] => -2
eval ["div",["add","4","6"],["sub","5","0"]] # 2
```

```
def eval expr
```

```
if expr[0] == "add" then (eval expr[1]) + (eval expr[2])
elsif expr[0] == "sub" then (eval expr[1]) - (eval expr[2])
elsif expr[0] == "mult" then (eval expr[1]) * (eval expr[2])
elsif expr[0] == "div" then (eval expr[1]) / (eval expr[2])
else expr.to_i
end
```

```
end
```

Save Answer ***Unsaved Changes**

Q5 Ocaml Code

8 Points

Q5.1

2 Points

Give an expression of the type `'a -> 'b -> 'c`. All pattern matching must be exhaustive.

```
let rec f a b = f a b
```

Save Answer *Unsaved Changes

Q5.2

2 Points

```
fold (_blank 1_) 0 [(1,2,3);(4,5,6)]
```

Fill in the blank such that the code segment will return the sum of second item each tuple in the list. For example, the above code should return 7.

Blank 1

```
fun a (_,b,_) -> a + b
```

Save Answer *Unsaved Changes

Q5.3

4 Points

```
1 let rec f x y =
2 match x with
3 [] -> 0
4 |[(a,b)] -> let (c,d) = y in c +. d
5 |(a,b)::t -> a + b
```

Why will this code not compile?

type error, expecting int, but line 4 gives a float

Rewrite a single line from 3-5 so that it does.

change line 4 to
|[(a,b)] -> let (c,d) = y in c + d

Save Answer *Unsaved Changes

Q6 OCaml Coding

8 Points

Given two lists of integers ranging from zero to infinity, write a function that sums together items at the same index and then returns the largest of these sums.

NOTE: You may **only** use map and fold provided above and declare any helper function. Do not use `rec` keyword for the function itself, but the helper function may be recursive.

- You may assume that two lists are going to be of equal length.
- When both lists are empty, just return 0

Examples:

```
largest_sum [1;2;3;4;5] [10;11;12;13;14] = 19
largest_sum [] [] = 0
largest_sum [5;7] [4;3] = 10
```

let largest_sum lst1 lst2 =

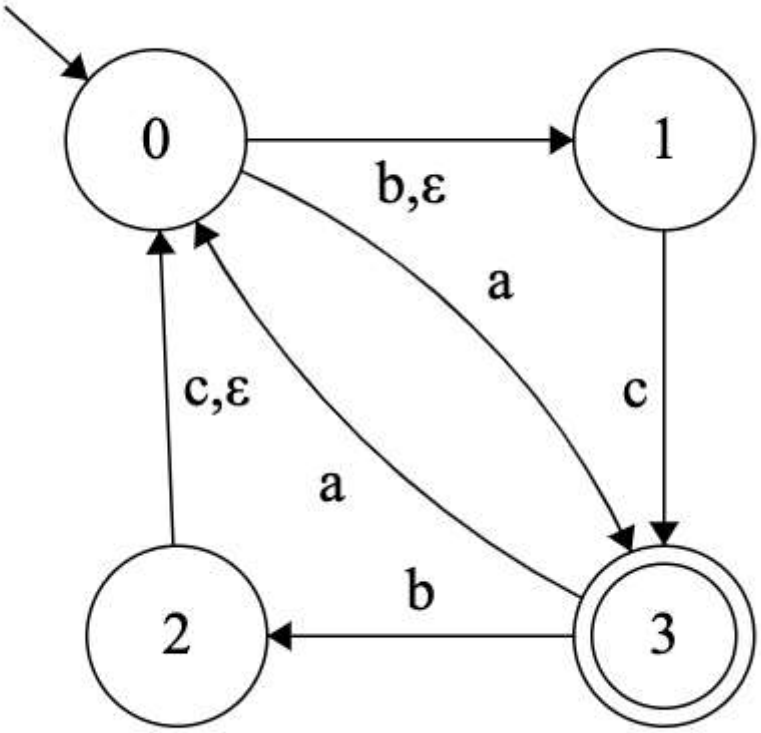
let rec helper l1 l2 =
match (l1,l2) with
([],[]) -> [0]
|(h1::t1),(h2::t2) -> (h1+h2)::(helper t1 t2) in
fold (fun a b -> if b > a then b else a) 0 (helper lst1 lst2);;

Save Answer ***Unsaved Changes**

Q7 FSM

8 Points

Use this NFA for the following questions:



Q7.1

2 Points

What is the regex of the machine?

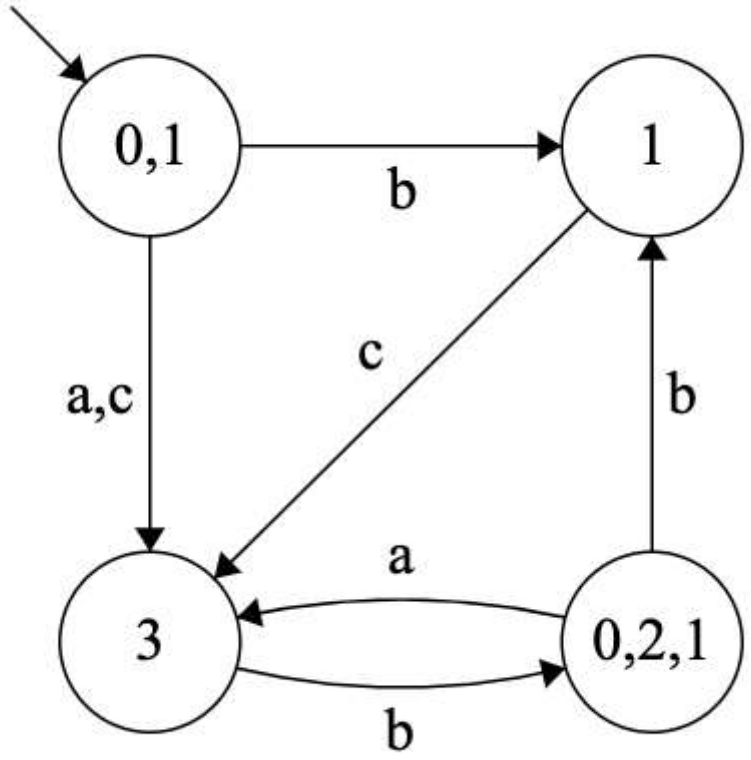
(alb?c)((albc?)(ab?c))*

Save Answer ***Unsaved Changes**

Q7.2

6 Points

I attempted to use NFA to DFA but I am missing some things.



Using the naming conventions we used in the class, give the name of the state(s) I am missing separated by semicolons if more than 1

[0,1,3]

Using the syntax from the project (eg: ([0],"a",[2])), give the transitions missing.

[0,2,1],"c",[0,1,3]
[0,1,3],"a",[0,1]
[0,1,3],"b",[0,2,1]
[0,1,3],"c",[c]

Which states should be marked as final states?

[0,1,3],[3]

Save Answer *Unsaved Changes

Q8 Grammars
8 Points

Q8.1
4 Points

Provide two derivations with all steps shown that prove the following CFG is ambiguous.

$$\begin{aligned} \mathrm{S} &\rightarrow \mathrm{AB} \\ \mathrm{A} &\rightarrow \mathrm{AaA} \mid a \\ \mathrm{B} &\rightarrow \mathrm{BB} \mid b \end{aligned}$$

S -> AB -> AaAB -> aaAB -> aaAaAB -> aaaaAB -> aaaaaB

S -> AB -> AaAB -> AaAaAB -> aaAaAB -> aaaaAB -> aaaaaB

Rewrite the following CFG so that it still represents the same language but is no longer ambiguous.

S-> AB
A -> aaAlaaa
B -> bBlb

Save Answer *Unsaved Changes

Q8.2
4 Points

Define a CFG that describes the language.

$a^x b^y c^z$ where $z = x + 2y,\ x \geq 0$ and $y > 0$.

Note: To represent ϵ in the CFG, you can either copy and paste the symbol **ϵ**, type the word **epsilon** or just type the letter **e**.

S -> aScIT
T -> bTccIbcc

Save Answer *Unsaved Changes

Q9 Opsem

7 Points

Consider the following OpSem Rules:

$$\frac{}{A;\ \text{true} \Rightarrow \text{true}} \qquad \frac{}{A;\ \text{false} \Rightarrow \text{false}}$$

$$\frac{A;\ e_1 \Rightarrow \text{true}}{A;\ (\text{not } e_1) \Rightarrow \text{false}} \qquad \frac{A;\ e_1 \Rightarrow \text{false}}{A;\ (\text{not } e_1) \Rightarrow \text{true}}$$

$$\frac{A;\ e_1 \Rightarrow \text{true} \qquad A;\ e_2 \Rightarrow v_1}{A;\ (\text{if } e_1 \text{ then } e_2 \text{ else } e_3) \Rightarrow v_1}$$

$$\frac{A;\ e_1 \Rightarrow \text{false} \qquad A;\ e_3 \Rightarrow v_1}{A;\ (\text{if } e_1 \text{ then } e_2 \text{ else } e_3) \Rightarrow v_1}$$

$$\frac{A;\ e_1 \Rightarrow v_1 \qquad A;\ e_2 \Rightarrow v_2 \qquad v_3 \text{ is } v_1 \ \&\& \ v_2}{A;\ (e_1 \ \&\& \ e_2) \Rightarrow v_3}$$

Fill in the following derivation:

$$\dfrac{\dfrac{}{A;\ \#1 \Rightarrow \#1} \qquad \dfrac{\dfrac{}{A;\ \#4 \Rightarrow \#4} \qquad \dfrac{}{A;\ \#5 \Rightarrow \#5}}{A;\ \#3 \Rightarrow \#6}\ \#6 \text{ is} \#3}{A;\ \#2 \Rightarrow \#7}$$

$$\text{if } false \text{ then } true \text{ else not } (true \&\& false) \Rightarrow \#7$$

Blank 1

false

Blank 2

not(true&&false)

Blank 3

true&&false

Blank 4

true

Blank 5

false

Blank 6

false

Blank 7

true

Save Answer *Unsaved Changes

Q10 Lambda Calc

8 Points

Q10.1 Encodings

4 Points

Consider the following encodings,

$$\text{true} = (\lambda \text{x}.\ \lambda \text{y}.\ \text{x})$$
$$\text{false} = (\lambda \text{x}.\ \lambda \text{y}.\ \text{y})$$
$$\text{not} = (\lambda \text{x}.\ \text{x false true})$$
$$\text{if} = (\lambda \text{x}.\ \lambda \text{y}.\ \lambda \text{z}.\ \text{x y z})$$

Prove that $\text{if}\ (\text{not true})\ \text{false true} = \text{true}$

Note: You **must** make all parenthesis explicit before reducing the expression.

(not true) false true
(λx. x false true true) false true
(λx.(x false true true)) false true
(true false true) false true
(λx. λy. x false true) false true
(λy.false true) false true
(false) false true
((λx. λy. y) false) true
λy.y true
true

Save Answer *Unsaved Changes

Q10.2 Variables

2 Points

Consider the following Lambda expression
$\lambda x.\ y\ x\ (\lambda y.\ y\ y\ x)(\lambda x.\ x\ y\ x)\ x$
If we label each variable from left to right like so
$\lambda x_0.\ y_0\ x_1\ (\lambda y_1.\ y_2\ y_3\ x_2)(\lambda x_3.\ x_4\ y_4\ x_5)\ x_6,$

Which variables are the free variables?

y0,y4

Save Answer *Unsaved Changes

Q10.3 CBV and CBN

2 Points

Consider the following Lambda expression

$(\lambda x.\ x\ y)\ \lambda x.\ x\ (\lambda x.(\lambda y.\ y)\ x)$

Evaluate following expression in both call by value and call by name. Make sure to make all parenthesis explicit and show all alpha conversion. If it cannot be further reduced, write "Cannot be reduced"

Call By Value:

(λx. (x y)) (λx. (x (λx.((λy. y) x))))
(λx. (x y)) (λa. (a (λb.((λc. c) b))))
(λx. (x y)) (λa. (a (λb.b)))
((λa. (a (λb.b))) y)
(y (λb.b))

Call By Name:

(λx. (x y)) (λx. (x (λx.((λy. y) x))))
(λx. (x y)) (λa. (a (λb.((λc. c) b))))
((λa.(a (λb.((λc.c) b)))) y)
(y (λb.((λc.c) b)))
(y (λb.(b)))
(y (λb.b))

Save Answer *Unsaved Changes

Q11 Rust Coding

3 Points

Given two descendingly sorted integer vectors, write merge that returns a vector that merged the two inputs in descending order.
Examples:

```
merge(vec![6,3,1],vec![5, 4, 2]) => vec![6,5,4,3,2,1]
merge(vec![],vec![5, 4, 2]) => vec![5,4,2]
merge(vec![10,9,8],vec![5, 4, 2]) => vec![10,9,8,5,4,2]
```

```
fn merge(v1:Vec<i32>,v2:Vec<i32>){
```

```
let mut ret = Vec::new();
   for i in v1.iter(){
      ret.push(*i)
   }
   for i in v2.iter(){
      ret.push(*i)
   }
   ret.sort();
   return ret
```

```
}
```

Save Answer *Unsaved Changes

Q12 Rust Code
8 Points

Q12.1
2 Points

Consider the following Rust Code:

```
fn main () {
  let mut a = String::from("Hello World");
  let b = a;
  let c = &b;
```

```
  function1(c);
  println!("{}",c);
  function2(b);
  println!("{}",b);
}
```

Does the following program compile? If so, write out the output. Otherwise, point out the line that causes the error and explain the error.

function2 takes in b, and then println!("{}",b); tries to use b after move.
It does not compile

Save Answer *Unsaved Changes

Q12.2

4 Points

Consider the following Rust Code

```
fn main() {
  let mut a = 42;
  let b = &mut a;
  let &mut d  = b;
  let e = a;
  let c = *&d;
  let f = &e;
}
```

Who owns the int 42 when the function ends?

e

How many borrows were there?

3

Save Answer *Unsaved Changes

Q12.3
2 Points

Consider the following Rust Code

```
struct Rectangle{
  width:i32,
  height:i32,
}
```

Write an implmentation block with one associated function called `perimeter` which gives the perimeter of a rectangle.

```
impl Rectangle{
fn perimeter(&self) ->i32{
return self.width*2 + self.height*2
}
}
```

Save Answer *Unsaved Changes

Q13 Semantics and Syntax
6 Points

Consider the following C code

```c
#include <stdio.h>
int mystery(int x){
    return x+1;
}
int main()
{
    int arr[5] = {1,2,3,4,5};
    int ret = 0;
    for (int i = 0; i < 5; i++){
        ret += mystery(arr[i]);
    }
    printf("ret: %d",ret);
}
```

Consider what this code segment does. Without simplifying the program (getting rid of any unnecessary), convert the code.
eg.

```
int x = 3;
printf("Hello");
```

would be converted to the following in java

```
int x = 3;
System.out.println("Hello");
```

Q13.1

2 Points

Convert this code segment to Ruby:

```
def mystery(x)
x + 1
end

def main
 a = [1,2,3,4,5]
ret = 0
for i in a
ret += mystery(i)
end
puts("ret: "+ ret.to_s)
end
```

Save Answer ***Unsaved Changes**

Q13.2

2 Points

Convert this code segment to OCaml:

```
let mystery x = x + 1 in
let main = let a = [1;2;3;4;5] in
let rec helper l = match l with
[]-> 0
|h::t -> (mystery h) + (helper t) in
let ret = helper a in
let _ = print_string "ret: " in
print_int ret in main
```

Save Answer ***Unsaved Changes**

Q13.3

2 Points

Convert this code segment into Rust:

```
fn mystery(x:i32)->i32{
    x+1
}
fn main()
{
    let arr = [1,2,3,4,5];
    let mut ret = 0;
    for i in arr.iter(){
      ret += mystery(*i)
  }
    println!("ret: {}",ret);
}
```

Save Answer ***Unsaved Changes**

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