

# Midterm 1 from Fall 2021

## STUDENT NAME

## Q1 Introduction

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. You can also use `irb` and `utop`. 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

- PL Concepts
- Regular Expressions
- Ruby: What's the Input?
- Ruby Code: Fill-in-the-Blank
- Ruby Coding
- OCaml Typing
- OCaml: What's the Input?
- OCaml Fill-In-The-Blank
- OCaml Coding

### General Advice

You can complete answers in any order, and we urge you to look through all of the questions at the beginning so you can accurately 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 75 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

11 Points

The following true/false and multiple-choice questions test your knowledge of a variety of programming language concepts.

### Q2.1 Static typing

1 Point

OCaml is statically typed while Ruby is dynamically typed.

- True
- False

Save Answer

### Q2.2 Let expression

2 Points

Fill in the blanks such that the below expression demonstrates shadowing and returns 6.

```
let x = ___#1___ in
let x = ___#2___ + 1 in
x
```

#1

Enter your answer here

#2

Enter your answer here

Save Answer

### Q2.3 Tuples and lists

1 Point

Tuples in OCaml are homogeneous (same type) while lists are heterogeneous (can be formed by different types)

- True
- False

Save Answer

### Q2.4 Types and syntax

2 Points

What is wrong with the following code?

```
let f x y = if x + 1 = y then x +. y else x;;
```

- Syntax error
- Type error
- Both syntax error and type error

Save Answer

### Q2.5 Ruby Objects

2 Points

Which of the following are objects in Ruby? (1pt)

{1 => 2}

nil

[1,2,3]

{ |x| x + 1 }

Save Answer

### Q2.6 Closures

1 Point

What variables must be in the environment of the closure for function `foo` in the following code?

```
let foo =  
  let c = ref 0 in  
  let m = 2 in  
  fun x -> c := !c + x * m; !c
```

- c, m, and x
- c and m
- x
- m and x
- c and x

Save Answer

### Q2.7 Ref counter

2 Points

```
let next =  
  let c = ref 0 in  
  fun () -> c:=!c+1; !c
```

List.map next \_\_\_\_\_

Select one of the following inputs so that the code above evaluates to [1; 2; 3; 4]

- [1; 1; 1; 1]
- [1; 2; 3; 4]
- [(); (); (); ()]
- [0; 0; 0; 0]

Save Answer

### Q3 Regular Expressions

8 Points

The following problems ask to write or talk about regular expressions for matching input patterns.

#### Q3.1 Regex Translation

4 Points

Write a regular expression to match on ISBN-13 numbers, ISBN-13 numbers have 13 digits and are of the format: ISBN-13: <A>-<B>-<C>-<D>-<E>

A: Prefix

B: Group identifier

C: Publisher identifier

D: Title identifier

E: Check digit

ISBN prefixes are 3 digits long, group identifiers are 1 digit, publisher identifiers are 2 or 3 digits long, title identifiers are 5 or 6 digits long, and check digits are a singular digit.

For example:

```
ISBN-13: 978-3-16-148410-0
ISBN-13: 978-1-876-86197-9
```

Save Answer

### Q3.2 Date Format

4 Points

Make only one change to the following regular expression such that it **exactly** matches strings with the format: MM/DD/YYYY

```
^\d{1,2}\.\d{1,2}\.\d+$
```

Save Answer

### Q4 Ruby: Fill in the blanks, output, or input

17 Points

#### Q4.1 Hashes

3 Points

```
h = {}
for i in 1..3 do
  if i % 2 == 0 then
    h["even"] += 1
  else
    h["odd"] += 1
  end
end
puts h["even"]
puts h["odd"]
```

What is the output of the above code? If it throws any error, type in "Error"

Enter your answer here

Save Answer

## Q4.2 Codeblocks

4 Points

Consider the following Ruby code

```
h = {1 => "one", 2 => "two", 3 => "three"}  
x = h.keys.collect { _____ }
```

Fill in the blanks so that the content of `x` is the following?

```
["one", "two", "three"]
```

Enter your answer here

Save Answer

## Q4.3 Classes and mixin

6 Points

Consider the following Ruby code

```
class A  
  def m1()  
    puts "class A method 1"  
  end  
  def m2()  
    puts "class A method 2"  
  end  
end  
  
module M  
  def m1()  
    puts "module M method 1"  
  end  
end  
  
class B < A  
  include M  
end  
  
x = _____#1  
y = _____#2  
  
x.m1  
y.m1
```

Fill in the blanks so that the following is printed?

```
class A method 1
module M method 1
```

#1

#2

Save Answer

## Q4.4 Expand

4 Points

The function `expand` takes an array of two-element arrays where each tuple array contains a frequency `f` and an element `x` and returns an array of arrays such that each inner array contains `f` copies of `x`.

Example

```
expand [] ==> []
expand [[1, '2'], [3, '4']] ==> [['2'], ['4', '4', '4']]
```

Fill in the blanks to complete this implementation. (Hint: `Array.new(4){1} ==> [1, 1, 1, 1]`)

```
def expand(l)
  l.map { |freq, elem| _____ }
end
```

Save Answer

## Q5 Ruby Coding

16 Points

As students come back to campus since the COVID-19 outbreak, QR codes have been placed all over several buildings to enable contact tracing. You are given the task to write a program that reads contact tracing data to find the students who may have come into close contact with other students who test positive for COVID19. You will be given a file that will include the data for the QR code scans for a given time period. Each line of the file corresponds to a single scan that a student has made, and has the following format:

```
<firstname> <lastname>,<location>
```

You can assume that `firstname` and `lastname` will always be a student's first and last name, defined as a single upper case letter, followed by at least one lowercase letter, and that `location` will always be three upper-case letters followed by 4 digits. You can also assume that there will be no duplicate lines, and that no student's name will appear more than once.

A short example of one of these files may look like the following:

```
David Smith,IRB0324
Michael Yang,IRB0324
Roger Eastman,IRB0324
John Chadley,ESJ0224
Master Yoda,VMH0201
Little Timmy,TWS1212
Covid Man,IRB0324
```

Your task is to fill in the blanks to complete the following class:

```
class covid_detector
  def initialize
    # Q1 TODO: Set up any data structures you may need
  end

  def read_files(scans_file)
    File.readlines(scans_file).each do |line|
      # Q2 TODO: Implement the body of this loop
    end
  end

  def close_contact(name)
    #Q3 TODO: Implement this function
  end
end
```

### Q5.1 initialize

5 Points

This is the class constructor -- it takes no arguments and should be used to initialize any data structures you may need to implement the other two main functions.

Save Answer

### Q5.2 read\_files(scans\_file)

5 Points

This function takes a file as its argument, reads the file, and stores all relevant data from them into the class.

Enter your answer here

Save Answer

### Q5.3 close\_contact(name)

6 Points

This function takes a student's name and returns the UID's of all students that they may have come into close contact with. If, in the example file defined above, the student "Covid Man" tested positive for COVID19, and we called `close_contact("Covid Man")`, it should return `["David Smith", "Michael Yang", "Roger Eastman"]`, since they were all in the same place as Covid Man.

Enter your answer here

Save Answer

### Q6 OCaml Typing

12 Points

Each of the following questions asks you to write an OCaml expression that has the given type.

**Do not use type annotations.**

#### Q6.1 `int * int -> bool`

4 Points

Without using type annotations, write an OCaml expression that has type `int * int -> bool`

Enter your answer here

Save Answer

#### Q6.2 `int list -> int -> float list`

4 Points

Without using type annotations, write an OCaml expression that has type

`int list -> int -> float list`

Enter your answer here

Save Answer

### Q6.3 `int -> int list`

4 Points

Without using type annotations, write an OCaml expression to fill in the blank so that *entire expression* has type `int -> int list`

```
((fun x -> (fun y -> ____#1____)) ____#2____ )
```

#1

#2

Save Answer

### Q7 Where is the bug

5 Points

Identify what specific portion of the below code is causing the type error and what you can change to have it output the correct value.

```
let rec f a b = match a with  
| [] -> []  
| (x, _)::t -> (x, b) @ (f t b);;
```

Examples:

```
f [(0, 0); (0, 0); (0, 0)] 1 = [(0, 1); (0, 1); (0, 1)]  
f [("h", 3); ("i", 15); ("j", -3)] "d" = [("h", d); ("i", d); ("j", d)]  
f [(1, "KIM"); (2, "AVW")] "Iribe" = [(1, "Iribe"); (2, "Iribe")]
```

Save Answer

### Q8 OCaml: What's the Input?

10 Points

For these questions, you are shown some OCaml code along with an execution of it that produces a particular output. Your job is to figure out what input could produce that output. (There are no syntax or type errors in the code given.)

### Q8.1 Partial application

5 Points

```
let f a b c = a + b - c in
let g = f 12 in
let h = g 3 in
let a = 4 in
h x
```

What should `x` be for the expression to evaluate to 8?

Save Answer

### Q8.2 Fold

5 Points

```
let op f = List.fold_left f 0 [1; 2; 3; 4; 5]
```

What should `f` be for `op f` to evaluate to 5?

Save Answer

### Q9 OCaml Fill-In-The-Blank

8 Points

The problems here will show you partial implementations of OCaml functions. Complete each implementation by filling in the blanks.

#### Q9.1 Recursion

4 Points

```
type 'a t =
| Pair of ('a * 'a t)
| Empty

let rec f x m =
  match x with
  | Empty -> 0
  | Pair(a, b) ->
    if a = m then
      1 + (f b m)
    else
      (f b m)
```

What should `x` be for `f x "a"` to evaluate to 3?

Save Answer

## Q9.2 Area

4 Points

Complete the function `areas` that, when given a list of shapes, returns their areas as a list.

For example:

```
areas [Circle 3; Rect (3,4); Square(9)] = [27; 12; 81]
areas [] = []
```

Suppose shapes are defined as:

```
type shape =
  | Circle of int
  | Rect of int * int
  | Square of int;;
```

Note: To keep things simple, use  $\pi = 3$

```
let areas lst =
  let areas_helper s =
    match s with
    | Circle r -> ___#1___
    | ___#2___ -> 1 * b
    | ___#3___ -> 1 * 1 in
  fold (fun a x -> ___#4___) [] lst;;
```

#1

#2

#3

#4

Save Answer

## Q10 OCaml Coding

12 Points

Complete solutions to the following problems in OCaml. You are welcome to use `fold_left` (the same as the `fold` function shown earlier), `fold_right`, `map`, `mem`, or other functions from the `List` module, or you are welcome to write your code entirely, including (recursive) helper functions.

### Q10.1 Merge lists

6 Points

Given 2 lists of the same length, implement `merge_lists`, which merges them into one list that alternates elements from the first and second lists.

```
merge_lists [1; 5; 2] [7; 4; 8] = [1; 7; 5; 4; 2; 8]
merge_lists [1; 0] [1; 5] = [1; 1; 0; 5]
merge_lists [] [] -> []
```

Enter your answer here

Save Answer

### Q10.2 add\_k\_n\_times

6 Points

Write a method `add_k_n_times` that inserts into a list `lst`, an element `k` exactly `n` times at a given index `i`. If `i` is greater than the length of the list insert at the end.

The arguments are (in order): list, element to add, number of times to add it, and index at which to add it.

```
add_k_n_times [2; 3] 4 2 0 = [4; 4; 2; 3] (* adds `4` two times at the index `0` *)
add_k_n_times [1; 5; 7] 3 1 1 = [1; 3; 5; 7]
add_k_n_times ["bad"; "good"; "meh"] "neat" 3 2 =
  ["bad"; "good"; "neat"; "neat"; "neat"; "meh"]
```

Enter your answer here

Save Answer

### Q11 Survey

1 Point

How would you characterize the time pressure you felt to complete the exam?

- Finished early, not rushed at all
- Finished in time
- Finished, but rushed
- The exam is too long. I did not finish

Save Answer

Save All Answers

Submit & View Submission >