Actual Final Exam

测验, 13 个问题

12 points

1。
Check a box if and only if it is an accurate description of Racket.

- `(define (f x y) e)` is syntactic sugar for the curried function definition `(define f (lambda (x) (lambda (y) e)))`.
- Without `let*`-expressions, Racket programmers could just use nested `let`-expressions, but the result would have more parentheses.
- It is a run-time error for the first argument to an `if`-expression not to be a boolean.
- A struct definition for a struct with *n* (immutable) fields adds *n+2* functions to the environment.
- A struct definition is syntactic sugar for introducing several functions that operate over Racket lists.
- A function call always evaluates each argument exactly once, but a macro use may not evaluate each argument exactly once.

---

4 points

2。
This incorrect Racket code is supposed to bind to `longer-strings` a stream where the N^{th} element of the stream is the string containing the character A *N* times.

```
(define longer-strings
  (lambda ()
    (letrec ([f (lambda(s)
                  (cons s (f (string-append "A" s))))])
      (f "A"))))
What is wrong with this code?

```

- `longer-strings` is bound to a function, but it should be bound to a pair.
- Calls to `longer-strings` will never terminate because there is too little thunking.
- Calls to `longer-strings` will never terminate because the function bound to `f` needs a conditional.
-

Calls to **longer-strings** will never terminate because the function bound to **f** is returning a procedure somewhere where it needs to return a call to the procedure.

---

4 points

3。

Which statement below accurately describes the function bound to **mystery** in this Racket code?

```
(define (mystery s)
  (lambda ()
    (let ([pr (s)])
      (if (car pr)
          (cons (car pr) (mystery (cdr pr)))
          ((mystery (cdr pr)))))))
```

- It takes a stream and generates all its elements, causing an infinite loop for any call to **mystery**.
- It takes a stream and generates a list of its elements up to the first **#f** in the stream.
- It takes a list and returns a stream that repeatedly generates the elements in the list in order.
- It takes a stream and returns a stream that is like the stream it takes except all **#f** elements are removed.

---

5 points

4。

What is the difference between these two pieces of Racket code? (Here we assume **e1** and **e2** are arbitrary, unspecified Racket expressions. We also assume **e1** does not contain a use of **y**.)

```
(define f (let ([x e1]) (lambda (y) e2))) ; call this code A

(define f (lambda (y) (let ([x e1]) e2))) ; call this code B
```

- Code A evaluates **e1** once whereas Code B evaluates **e1** once every time the function bound to **f** is called.
- Code B evaluates **e1** once whereas Code A evaluates **e1** once every time the function bound to **f** is called.
- Code A evaluates **e1** only if, at run-time, **e2** uses the variable **x**, but Code B always evaluates **e1** assuming **f** is used at least once.
- Code B evaluates **e1** only if, at run-time, **e2** uses the variable **x**, but Code A always evaluates **e1** assuming **f** is used at least once.

- There is no semantic difference: although the order of the code is different, code A and code B are equivalent for any **e1** and **e2**.

4 points

5。

In this question, RUPL is like the language MUPL except it is really small, containing only integers, variables, additions, and let-expressions. What is wrong with this implementation?

```
(struct var  (string) #:transparent);; a variable, e.g., (var "foo")
(struct int  (num)    #:transparent) ;; a number, e.g., (int 17)
(struct add  (e1 e2)  #:transparent) ;; add two expressions
(struct mlet (var e body) #:transparent) ;; a local binding
                                         ;; (let var = e in body)

(define (envlookup env str)
  (cond [(null? env) (error "unbound variable" str)]
        [(equal? (car (car env)) str) (cdr (car env))]
        [#t (envlookup (cdr env) str)]))

(define (eval-under-env e env)
  (cond [(var? e) (envlookup env (var-string e))]
        [(int? e) e]
        [(add? e)
         (let ([v1 (eval-under-env (add-e1 e) env)]
               [v2 (eval-under-env (add-e2 e) env)])
           (if (and (int? v1)
                    (int? v2))
               (int (+ (int-num v1)
                       (int-num v2)))
               (error "RUPL addition applied to non-number")))]
        [(mlet? e)
         (let ([v (eval-under-env (mlet-e e) env)])
           (eval-under-env (mlet-body e) env))]
        [#t (error "bad RUPL expression")]))

(define (eval-exp e)
  (eval-under-env e null))
```

- The case for variables is wrong because we should recursively call **eval-under-env** in this case.
- The case for integer expressions is wrong: we should return **(int-num e)**.
- The case for addition expressions is wrong: we should write **e1** and **e2** where we have **(add-e1 e)** and **(add-e2 e)**.
- The case for **mlet**-expressions is wrong: we do not use the correct environment to evaluate the let-expression body.

12 points

6。

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In this question, we consider what would happen if we ported (i.e., rewrote) Racket code to ML. Assume we write the code by only changing the syntax as follows: Racket functions become ML functions, Racket conditionals become ML conditionals, Racket addition becomes ML addition, Racket **car** becomes ML **hd**, and Racket **null** becomes ML `[]`.

For each function below, check the box if and only if the ML rewrite of the function would type-check (with some type). (Always assume we port the code so that the ML code parses correctly.)

- [ ] `(define (f1 x) (if x 37 42))`
- [ ] `(define (f2 x) (if x x x))`
- [ ] `(define (f3 x) (if x 42 x))`
- [ ] `(define (f4 x) (car null))`
- [ ] `(define (f5 x) (+ (car x) 42))`
- [ ] `(define (f6 x) (car (+ x 42)))`

---

10 points

7。

For each of the following, check the box if and only if it is an accurate description of an advantage of static typing over dynamic typing.

- [ ] Static typing catches some simple bugs without having to test your code.
- [ ] Static typing can produce faster code because the language implementation does not need to perform type tests at run time.
- [ ] Static typing lets you change the type of a function as its requirements evolve without ever having to change any of the function's callers.
- [ ] Static typing is necessary to avoid the security and reliability problems of weak typing.
- [ ] Static typing does not make sense for OOP.

---

9 points

8。

This question uses this Ruby class definition:

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```
class A
  attr_accessor :x
  def m1
    @x = 4
  end
  def m2
    m1
    @x > 4
  end
  def m3
    @x = 4
    @x > 4
  end
  def m4
    self.x = 4
    @x > 4
  end
end
```

For each statement below, check the box if and only if the statement is true. In all cases, consider only a definition of class B, not code that makes any changes to class A.

- It is possible to define a class B such that evaluating `B.new.m2` causes the method `m2` defined in class A (not an override of `m2`) to return `true`.
- It is possible to define a class B such that evaluating `B.new.m3` causes the method `m3` defined in class A (not an override of `m3`) to return `true`.
- It is possible to define a class B such that evaluating `B.new.m4` causes the method `m4` defined in class A (not an override of `m4`) to return `true`.

4 points

9。

This problem uses this Ruby class definition, which includes a mixin:

```
class MyRange
  include Enumerable
  def initialize(low,high)
    @low = low
    @high = high
  end
  def each
    i=@low
    while i <= @high
      yield i
      i=i+1
    end
  end
end
```

Given this definition, the expression `MyRange.new(4,2).any? {|i| i <= 4}` evaluates to `false`. Why?

- Because instances of `MyRange` do not have a method `any?`.
- Because the each method for the object created by `MyRange.new(4,2)` never calls its block.
- Because the superclass of `MyRange` is `Object`, which has an `any?` method that always returns `false`.
-

Because the **each** method in **MyRange** implicitly returns **nil** and in Ruby **nil** is like **false**.

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14 points

10。

Check the box if and only if the statement is true.

- [ ] In Ruby, it is a run-time error to create an array holding instances of different classes.
- [ ] In Ruby, you cannot store a block in an array, but you can pass a block to **lambda** and store the result in an array.
- [ ] It does not make sense to consider adding multiple inheritance to a dynamically typed language because the purpose of multiple inheritance is to make type-checking less restrictive.
- [ ] In Ruby, **is_a?** and **instance_of?** are synonyms: the two methods are defined for every object and always compute the same result.
- [ ] In Ruby, anything returned by a method is an object.
- [ ] Double dispatch is special to Ruby -- it is a programming pattern that does not work in most other OOP languages.
- [ ] A Ruby mixin method included in a class can get and set instance variables of **self**.

4 points

11。

This problem and the next problem relate to this Ruby code:

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```
class A
  def initialize a
    @arr = a
  end
  def get i
    @arr[i]
  end
  def sum
    @arr.inject(0) {|acc,x| acc + x}
  end
end

class B < A
  def initialize a
    super
    @ans = false
  end
  def sum
    if !@ans
      @ans = @arr.inject(0) {|acc,x| acc + x}
    end
    @ans
  end
end
```

Which technique that we studied is mostly closely related to the code in class B?

- Thunking
- Memoization
- Mixins
- Double dispatch

4 points

12。
This problem uses the code in the previous problem. Class A and class B are not equivalent. In particular, there are ways to fill in the ... in the code below so that `s3` and `s4` hold different numbers. Which change would make the two classes equivalent?

```
v = [4,19,74]
a = A.new v
b = B.new v
s1 = a.sum
s2 = b.sum
...
s3 = a.sum
s4 = b.sum
```

- Have the initialize method in class A store a copy of its argument in `@arr`.
- Remove the method `get` from class A.
- Change the `sum` method in both classes to use an explicit loop instead of `inject` and a block.
- Change class A to use a class variable `@@arr` in place of the instance variable `@arr`.

14 points

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13。

This problem uses the made-up language from the lectures for studying subtyping. Recall:

- The language has records with mutable fields.
- We write types for records and functions like in ML.
- Records have width and permutation subtyping.
- Function subtyping has contravariant arguments and covariant results.

Assume these bindings for functions exist and have given types:

```
val f1 : {a:int, b:int} -> {a:int, b:int};
val f2 : {a:int, c:{x:int, y:int}, b:int} -> {a:int, b:int};
val f3 : int -> {a:int,b:int,c:int};
val f4 : ({a:int,b:int,c:int} -> {a:int,b:int}) -> int;
```

For example, `f1` is bound to a function that takes a record of type `{a:int, b:int}` and returns a record of the same type.

For each call below, check the box if and only if the call type-checks.

- [ ] `f1 {a=3, b=4, c=5}`
- [ ] `f2 {a=3, c={x=4, y=5, z=6}, b=7}`
- [ ] `f1 (f3 4) (* call f1 with result of call (f3 4) *)`
- [ ] `f2 (f3 4) (* call f2 with result of call (f3 4) *)`
- [ ] `f4 f1`
- [ ] `f4 f2`
- [ ] `f4 f3`

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