CS 61A Spring 2024

Structure and Interpretation of Computer Programs

Midterm 1 Solutions

INSTRUCTIONS

This is your exam. Complete it either at exam.cs61a.org or, if that doesn't work, by emailing course staff with your solutions before the exam deadline.

This exam is intended for the student with email address `<EMAILADDRESS>`. If this is not your email address, notify course staff immediately, as each exam is different. Do not distribute this exam PDF even after the exam ends, as some students may be taking the exam in a different time zone.

For questions with **circular bubbles**, you should select exactly *one* choice.

- ◯ You must choose either this option
- ◯ Or this one, but not both!

For questions with **square checkboxes**, you may select *multiple* choices.

- ☐ You could select this choice.
- ☐ You could select this one too!

You may start your exam now. Your exam is due at <DEADLINE> Pacific Time. Go to the next page to begin.

Preliminaries

You can complete and submit these questions before the exam starts.

(a) What is your full name?

(b) What is your student ID number?

(c) What is your @berkeley.edu email address?

(d) Sign (or type) your name to confirm that all work on this exam will be your own. The penalty for academic misconduct on an exam is an F in the course.

1. (8.0 points) What Would Python Display?

Assume the following code has been executed already.

```
one = 1

def choose(one):
    if big(one):
        print('A')
        if huge(one):
            print('B')
    elif big(one) or huge(one):
        print('C')
    if big(one) or print('D'):
        print('E')
    else:
        print('F')

big = lambda x: x >= one
huge = lambda x: x > one

def which():
    one = 3
    def this():
        return one
        return one + 1
    return this
    one = 4
```

(a) (6.0 pt) Which lines are displayed by the interactive Python interpreter after evaluating `choose(one + one)`? **Select all that apply.**

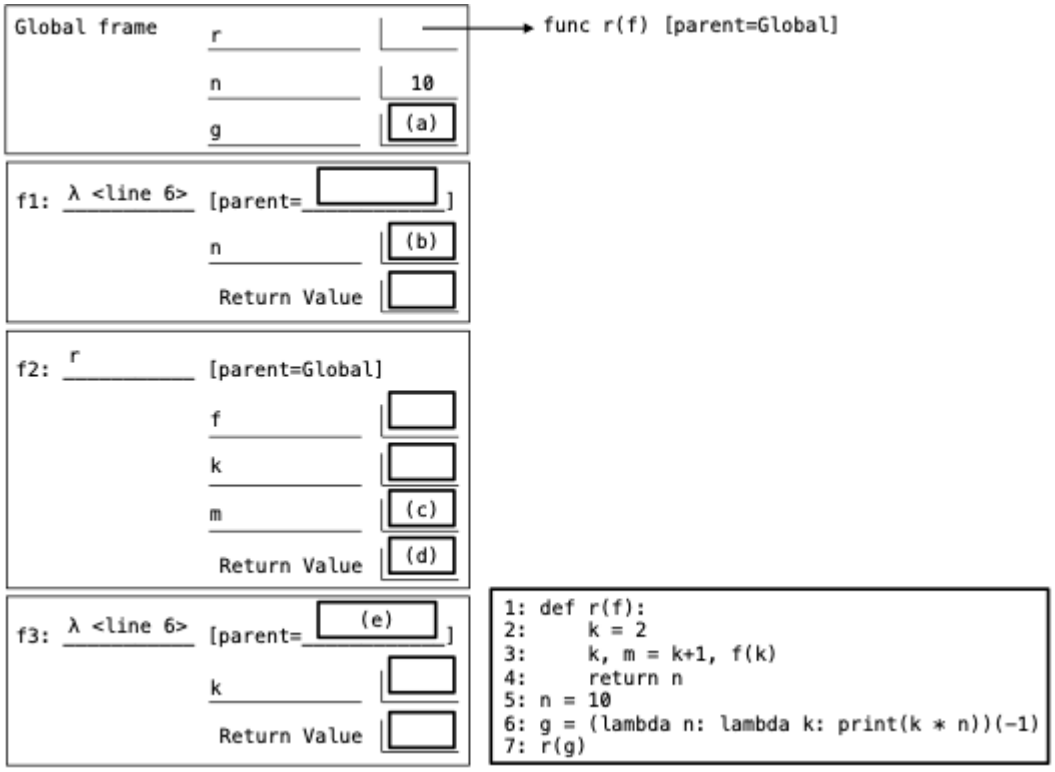
- [x] `A`
- [x] `B`
- [ ] `C`
- [ ] `D`
- [x] `E`
- [ ] `None`
- [ ] None of the above

(b) (2.0 pt) What is displayed by the interactive Python interpreter after evaluating `which()()`?

- ○ 2
- ● 3
- ○ 4
- ○ 5
- ○ A function
- ○ An error occurs before anything is displayed

2. (8.0 points) Silence of the Lambda

Complete the environment diagram below and then answer the questions that follow. There is one question for each labeled blank in the diagram. The blanks with no labels have no questions associated with them and are not scored. If a blank contains an arrow to a function, write the function as it would appear in the diagram.



(a) (2.0 pt) Fill in blank (a). The line number has been omitted for simplicity.

- ○ -1
- ○ 1
- ○ -10
- ○ `func lambda(n) [parent = Global]`
- ○ `func lambda(k) [parent = Global]`
- ○ `func lambda(n) [parent = f1]`
- ● `func lambda(k) [parent = f1]`

(b) (1.0 pt) Fill in blank (b).

- ● -1
- ○ 2
- ○ 3
- ○ 10

(c) **(1.0 pt)** Fill in blank (c).

- ○ `-3`
- ○ `-2`
- ○ `20`
- ○ `30`
- ● `None`

(d) **(1.0 pt)** Fill in blank (d).

- ○ `-1`
- ○ `2`
- ○ `3`
- ● `10`

(e) **(1.0 pt)** Fill in blank (e).

- ○ `Global`
- ● `f1`
- ○ `f2`
- ○ `f3`

(f) **(2.0 pt)** What is printed by the call to `print` on line 6?

- ○ `-3`
- ● `-2`
- ○ `20`
- ○ `30`
- ○ `None`

3. (8.0 points) Nearly Square

Implement `near_square`, which takes positive integer `n` and non-negative integer `k`. It returns the largest integer less than or equal to `n` which is the product of two positive integers that differ by `k` or less. You may use `solve`, which is provided.

```
def near_square(n, k):
    """Return the largest integer that is less than or equal to n and
    equals a * b for some positive integers a and b where abs(a - b) <= k.

    >>> near_square(125, 0)  # 11 * 11 = 121 and abs(11 - 11) = 0
    121
    >>> near_square(120, 3)  # 10 * 12 = 120 and abs(10 - 12) = 2
    120
    >>> near_square(120, 1)  # 10 * 11 = 110 and abs(10 - 11) = 1
    110
    """
    while True:

        gap = k

        while _______:
                (a)
            x = _______
                  (b)
            if _______:  # Check if x is a whole number
                 (c)

                return _______
                         (d)

            _______
              (e)

        _______
          (f)

def solve(b, c):
    """Returns the largest x for which x * (x + b) = c

    >>> solve(2, 120)  # x=10 solves x * (x + 2) = 120
    10.0
    >>> solve(2, 121)  # x=10.045... solves x * (x + 2) = 121
    10.045361017187261
    """
    return (b*b/4 + c) ** 0.5 - b/2
```

(a) (2.0 pt) Fill in blank (a). Select **all** that apply.

- ☐ `gap`
- ☐ `gap != 0`
- ☐ `gap > 0`
- ■ `gap >= 0`

(b) (2.0 pt) Fill in blank (b).

```
solve(gap, n)
```

(c) (1.0 pt) Fill in blank (c). The `round` function is demonstrated on the Midterm 1 Study Guide (page 2 righthand side).

- ◯ `round(x)`
- ◯ `x % 10`
- ● `x == round(x)`
- ◯ `x == x % 10`

(d) (1.0 pt) Fill in blank (d).

- ● `n`
- ◯ `k`
- ◯ `gap`
- ◯ `True`

(e) (1.0 pt) Fill in blank (e).

- ◯ `n = n - 1`
- ◯ `n = k - 1`
- ◯ `n = n - k`
- ● `gap = gap - 1`
- ◯ `gap = k - 1`
- ◯ `k = k - 1`

(f) (1.0 pt) Fill in blank (f).

- ● `n = n - 1`
- ◯ `n = k - 1`
- ◯ `n = n - k`
- ◯ `gap = gap - 1`
- ◯ `gap = k - 1`
- ◯ `k = k - 1`

4. (16.0 points) Nice Dice

A **dice integer** is a positive integer whose digits are all greater than or equal to 1 and all less than or equal to 6.

(a) (8.0 points)

Implement `streak`, which takes a positive integer `n`. It returns `True` if `n` is a **dice integer** whose digits are all the same and `False` otherwise.

```
def streak(n):
    """Return whether positive n is a dice integer in which all the digits are the same.

    >>> streak(22222)
    True
    >>> streak(4)
    True
    >>> streak(22322)  # 2 and 3 are different digits.
    False
    >>> streak(99999)  # 9 is not allowed in a dice integer.
    False
    """
    d = n % 10

    if _______:
         (a)

        return False

    while n:

        if _______:
             (b)

            _______
              (c)

        n = n // 10

    return _______
             (d)
```

i. (2.0 pt) Fill in blank (a).

- ◯ `d < 1 and d > 6`
- ● `d < 1 or d > 6`
- ◯ `n < 1 and n > 6`
- ◯ `n < 1 or n > 6`
- ◯ `min(n) < 1 and max(n) > 6`
- ◯ `min(n) < 1 or max(n) > 6`

The loop checks the remaining digits.

ii. **(2.0 pt)** Fill in blank (b).

```
d != n % 10
```

iii. **(1.0 pt)** Fill in blank (c).

- ◯ `d = n % 10`
- ◯ `d = (n // 10) % 10`
- ◯ `result = False`
- ● `return False`

iv. **(1.0 pt)** Fill in blank (d).

- ● `True`
- ◯ `result`
- ◯ `d == n`
- ◯ `d == n % 10`

v. (2.0 pt) Fill in the blank of `changes`, which takes a dice number `n`. It returns the number of digits of `n` that are different from the digit to their left.

```
def changes(n):
    """Return the number of adjacent digits that are different in dice number n.

    >>> changes(22222)
    0
    >>> changes(222255)
    1
    >>> changes(22322)
    2
    >>> changes(22366666622)
    3
    >>> changes(52431)
    4
    """
    count = 0
    while n >= 10:

        if _______:

            count = count + 1
        n = n // 10
    return count
```

- ○ `n != n % 100`
- ○ `n != n // 10`
- ○ `n != (n // 10) % 10`
- ○ `n != (n // 10) % 100`
- ○ `n % 10 != n % 100`
- ○ `n % 10 != n // 10`
- ● `n % 10 != (n // 10) % 10`
- ○ `n % 10 != (n // 10) % 100`

(b) (2.0 pt) Fill in the blank of `count_if`, which takes a one-argument function `f`. It returns a function that takes a positive integer `n` and returns the count of its digits for which `f` returns a true value.

```
def count_if(f):
    """Return a function that takes a positive integer n and returns
    the count of its digits for which f returns a true value.

    >>> is_three = lambda d: d == 3
    >>> count_threes = count_if(is_three)  # count_threes returns the number of threes in n
    >>> count_threes(431663334231)         # 3 appears 5 times
    5
    """
    def g(n):
        count = 0
        while n:
            if _______:
                count += 1
            n = n // 10
        return count
    return g
```

```
f(n % 10)
```

(c) (2.0 pt) Fill in the blank of `count_at_least`, which takes a positive integer `k`. It returns a function that takes a positive integer `n` and returns the count of its digits that are greater than or equal to `k`.

```
def count_at_least(k):
    """Return a function that returns how many of the digits of its argument are at least k.

    >>> above_3 = count_at_least(3)  # above_3 returns the # of digits greater than or equal to 3
    >>> above_3(431663334231)
    9
    """
    return count_if(_______)
```

- ○ `lambda: n % 10 >= k`
- ○ `lambda: n >= k`
- ○ `lambda: d >= k`
- ○ `lambda: d >= n % 10`
- ○ `lambda d: n % 10 >= k`
- ○ `lambda d: n >= k`
- ● `lambda d: d >= k`
- ○ `lambda d: d >= n % 10`
- ○ `lambda d: lambda k: n % 10 >= k`
- ○ `lambda d: lambda k: n >= k`
- ○ `lambda d: lambda k: d >= k`
- ○ `lambda d: lambda k: d >= n % 10`

(d) (4.0 pt) Fill in the blank of `times`, which takes a non-negative integer `k`, a positive integer `n`, and a digit `d`. It returns `True` if `n` contains digit `d` exactly `k` times and `False` otherwise. You may use `count_if`.

```
def times(k, n, d):
    """Returns whether n contains digit d exactly k times.

    >>> times(3, 6132344561, 4)   # 4 only appears 2 times
    False
    >>> times(3, 61323445614, 4)  # 4 appears exactly 3 times
    True
    """
    return _______
```

```
k == count_if(lambda i: i == d)(n)
```

(e) (0.0 pt) This A+ question is not worth any points. It can only affect your course grade if you have a high A and might receive an A+. Finish the rest of the exam first!

Fill in the blank to implement `streak` using `count_if`. You may not write `else` or `*` or `**`.

The expression is long, so you may use multiple lines to write it.

```
def streak(n):
    """Return whether positive n is a dice integer in which all the digits are the same.

    >>> streak(22222)
    True
    >>> streak(4)
    True
    >>> streak(22322)  # 2 and 3 are different digits.
    False
    >>> streak(99999)  # 9 is not allowed in a dice integer.
    False
    """
    return ______
```

```
count_if(lambda d: True)(n) == count_if(lambda d: d > 0 and d < 7 and d
== n % 10)(n)
```

No more questions.