Spring 2019 CS 1110 Prelim 1 Solutions

Please turn off and stow away all electronic devices. You may not use them for any reason during the exam. Do not bring them with you if you leave the room temporarily.

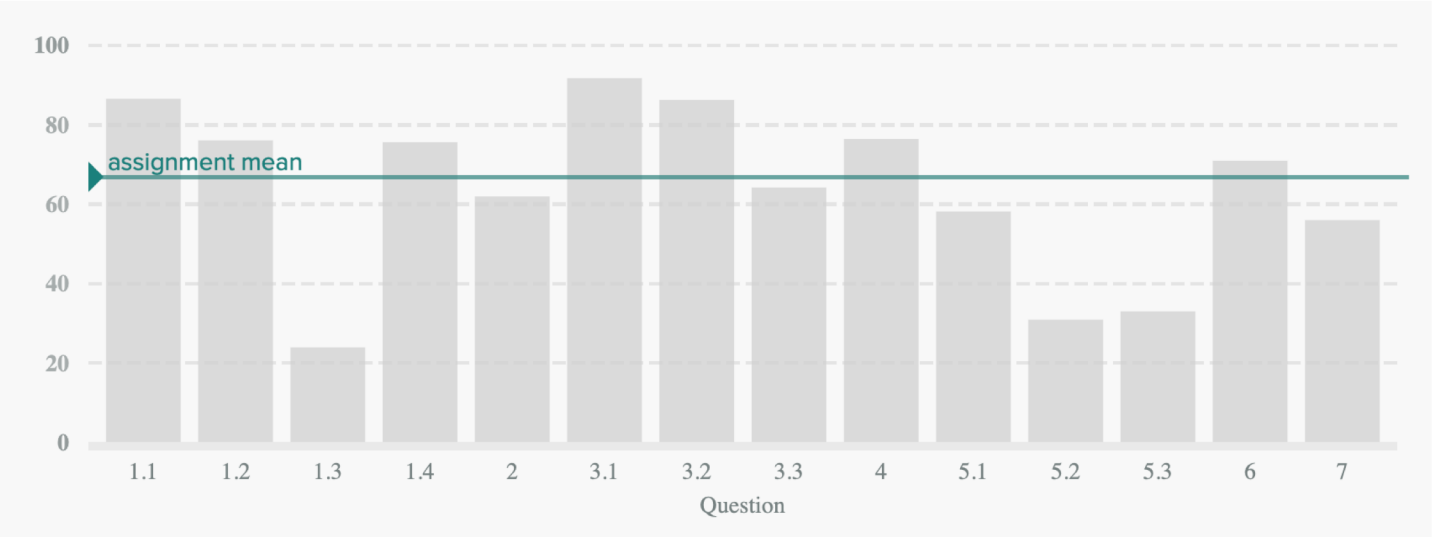
This is a closed book and notes examination. You may use the reference sheet provided.

There are **7 problems**. Make sure you have the whole exam.

You have **90 minutes** to complete 90 points. Use your time accordingly.

Question	Points	Score
1	8	
2	12	
3	17	
4	15	
5	13	
6	14	
7	11	
Total:	90	

bottom 5%	31.0
bottom 10%	38.6
bottom 25%	51.0
bottom 33%	55.3
MEDIAN	62.0
top 33%	69.0
top 25%	73.5
top 10%	79.8
top 5%	82.0
MAX	87



1. Start Your Engines

(a) [2 points] Python is a *dynamically typed* language. This means that a variable can hold values of any type and a variable can hold different types at different times. Write 2 lines of Python code that illustrate this.

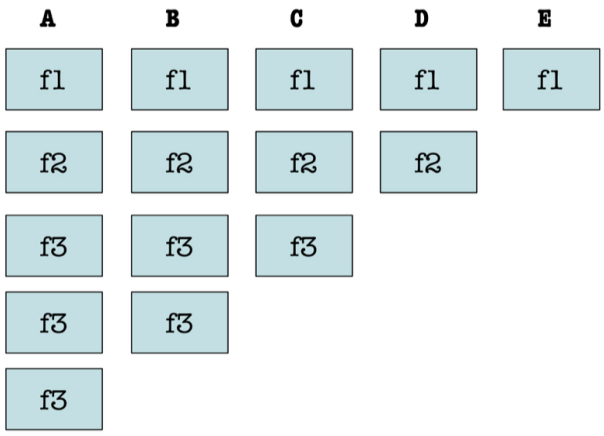
```
x = 1
x = "hi"
```

(b) [2 points] A type is defined as "a set of values and operations on these values". The meaning of an operator can change depending on the type. Give an example of an operator that has two *distinct* meanings when used in the context of two different types. What are these two meanings?

+ means addition for integers and concatenation for strings

(c) [2 points] If Python has just executed line 6 and is about to execute line 7, what does the call stack look like?

```
1  def f3():
2      print("f3")
3
4  def f2():
5      print("f2")
6      f3()
7      f3()
8      f3()
9
10 def f1():
11     print("f1")
12     f2()
13
14 f1()
```



Correct Answer: D

(d) [2 points] After the following lines of code have been executed:

```
x = [0, 1, 2, 3, 4]
z = x
y = x[1:4]
z[y[1]] = y[2]
```

What does `x[2]` evaluate to? Correct Answer: 3

2. [12 points] **The Sticking Point**

Consider the Point3 class as it was used in lecture, with 3 attributes: `x`, `y`, and `z`.

```
1  import shapes
2
3  def stick(p1, p2):
4      p2.y = p1.x
5      y = x
6      z = y + x
7      return z
8
9  x = 1
10 y = 2
11
12 p1 = shapes.Point3(3,4,5)
13 p2 = shapes.Point3(6,7,8)
14 p3 = p1
15 p1.z = 9
16
17 x = stick(p2, p1)
```

Lines 1-17 execute without any error. After they are executed, what would the following python expressions evaluate to?

(a) `x`

Correct Answer: 2

(b) `y`

Correct Answer: 2

(c) `z`

Correct Answer: Error

(d) `p1.y`

Correct Answer: 6

(e) `p2.y`

Correct Answer: 7

(f) `p3.y`

Correct Answer: 6 *In order to get points for this question, your answer needed to match your answer for (d). This way if you made a mistake for part (d) you still received points for recognizing that `p3` and `p1` refer to the same folder.*

3. **Above your pay grade.** iClicker software creates a list of iClicker scores for each student. Each score is the iClicker participation points for one lecture. If a student is *absent*, the software does **not** enter a zero; the student receives no score for that day, making the length of the `scores` list shorter than the total number of lectures. To calculate each student's average iClicker score, Professor Bracy wants a zero added to the `scores` list for each missed lecture. She implements a function `make_complete_scores(scores, num_lectures)` which takes `scores`, a (possibly empty) list of floats with values > 0.0 but <= 2.0 that represent a student's iClicker grades, and `num_lectures`, a non-negative integer that represents the current number of lectures in the semester. `num_lectures` >= the length of `scores`. (Since each lecture is worth at most 2 points, the ordering of the `scores` list doesn't matter.) It returns a list of scores of length `num_lectures`, with zeroes explicitly present at the end of the list for missed lectures.

   (a) [9 points] Write **3 conceptually distinct test cases** for `make_complete_scores(scores, num_lectures)`. Make sure your input values are ordered `scores`, `num_lectures`.

   There were many correct answers. Here are some we came up with.

   Test case #1
   Input: [], 5
   Output: [0.0, 0.0, 0.0, 0.0, 0.0]
   Rationale: student absent for the whole time

   Test case #2
   Input: [2.0, 1.0, 2.0], 4
   Output: [2.0, 1.0, 2.0, 0.0]
   Rationale: student with some iclicker points

   Test case #3
   Input: [2.0, 2.0, 1.5], 3
   Output: [2.0, 2.0, 1.5]
   Rationale: student with full attendance

(b) [6 points] The famous clock maker, Timex, would like to donate an alarm clock to anyone who seems to be struggling to make it to class. To identify students who would benefit from an alarm clock, the head TA for CS 1110 writes a function `needs_alarm(complete_scores, num_lectures)`. For this function, `complete_scores` will represent a student's iClicker scores fully constructed from `make_complete_scores()`. The second parameter `num_lectures` is identical to that used in `make_complete_scores()`. This function will return a `bool`; `True` if the student has missed between 1/3 and 2/3 (exclusive) of the `num_lectures` and `False` otherwise. (If they skip 2/3 or more of the lectures, they probably just need more sleep, not an alarm clock.)

Implement the function as described, ignoring the need for any preconditions for now.

```
def needs_alarm(complete_scores, num_lectures):
    """checks to see if the student could benefit from an alarm clock
    Returns: True if the student has missed between 1/3 and 2/3 of all
    lectures. (a missed lecture is indicated by a score of 0)
    Otherwise, returns False"""

    num_absent = complete_scores.count(0)
    skip_rate = num_absent/num_lectures
    if skip_rate > 1/3 and skip_rate < 2/3:
        return True
    return False
```

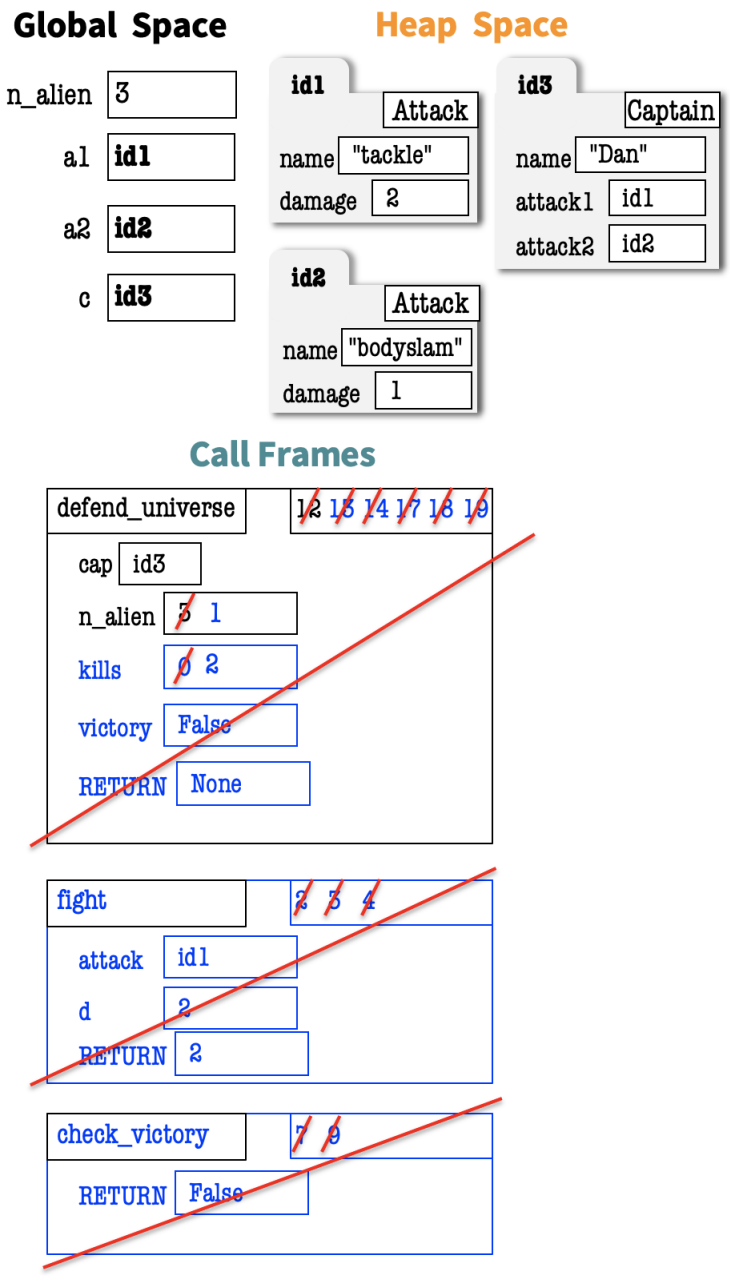
(c) [2 points] What is **one** precondition you should add to the specification of the function above? In other words, what condition (if violated) would cause your implementation to either behave incorrectly or raise an error?

`len(complete_scores) == num_lectures`
or else the skip rate will be incorrectly calculated

`num_lectures > 0`
or else you'll have a divide by zero error

4. [15 points] **Stack Attack!** Aliens are invading the world. Captain Dan needs your help to save humanity. Are you up for the challenge? A Captain has two attacks, each attack is its own object with a name and damage attributes. The damage attribute determines how many aliens it can kill. The code below has begun executing, resulting in the memory diagram on the right. **Execute the code to completion**, *beginning at the line indicated in the current Call Frame*. Update existing variables and objects and draw new variables and call frames as needed. If you cross out a value or call frame, make sure it is still legible.

```
1  def fight(attack):
2      d = attack.damage
3      if d <= n_alien:
4          return d
5
6  def check_victory():
7      if n_alien <= 0:
8          return True
9      return False
10
11 def defend_universe(cap, n_alien):
12     kills = 0
13     if n_alien >= 2:
14         kills = fight(cap.attack1)
15     else:
16         kills = fight(cap.attack2)
17     n_alien = n_alien - kills
18     victory = check_victory()
19     if victory:
20         print("WE WON!")
21
22 n_alien = 3
23 a1 = Attack("tackle", 2)
24 a2 = Attack("bodyslam", 1)
25 c = Captain("Dan", a1, a2)
26 defend_universe(c, n_alien)
```



5. **What's the frequent problem, Kenneth?** Fix the errors in the code below. If you change a function *definition*, please update the calls to that function, as necessary.

The code from the previous page is copied here for your convenience.

```
1  def fight(attack):
2      d = attack.damage
3      if d <= n_alien:
4          return d
5
6  def check_victory():
7      if n_alien <= 0:
8          return True
9      return False
10
11 def defend_universe(cap, n_alien):
12     kills = 0
13     if n_alien >= 2:
14         kills = fight(cap.attack1)
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22 n_alien = 3
23 a1 = Attack("tackle", 2)
24 a2 = Attack("bodyslam", 1)
25 c = Captain("Dan", a1, a2)
26 defend_universe(c, n_alien)
```

(a) [4 points] The function `fight` sometimes triggers a Python error. Explain why and fix the problem by modifying the definition of `fight`.

The return statement is inside a conditional so sometimes the function will return None. This will cause a problem when the return value is subtracted on line 17. The solution is to return something unconditionally on line 5. *What the return value should be (`d`?,`n_alien`?,0?) was not specified nor graded. Fixing the error was all that matters.*

(b) [4 points] Even when Captain Dan kills all the aliens, the code never prints "WE WON!". Explain why and fix the problem by modifying the definition of `check_victory`.

`check_victory` is reading the global variable `n_alien` which will never change from its original value (in this case 3). The solution is to pass `n_alien` as an argument to the function. Code will need to be changed on lines 6 and the call on line 18.

```
1  def name(s):
2      print(s + " had a " + lamb())
3
4  def lamb():
5      print("little lamb")
6
7  def fleece():
8      print("Its fleece was white as snow")
9
10 def sing():
11     for i in range(2):
12         name(person)
13         if i == 0:
14             for j in range(2):
15                 lamb()
16     fleece()
17
18 person = "Mary"
19 sing()
```

(c) [5 points] The code to the left should print out the following lyrics:

```
Mary had a little lamb
little lamb
little lamb
Mary had a little lamb
Its fleece was white as snow
```

Instead, it throws an error. Explain why and fix code that causes the problem. Note: the for-loops (lines 11 and 14) are correct.

`lamb()` has no return value but its return value (None) is being concatenated with a string in line 2. The fixes are on line 5 (have `lamb()` return a string instead of printing it and 15 (`print(lamb())` now that returns rather than prints the string).

6. [14 points] **Hang in there!** In the game *Hangman*, a player must guess a hidden word in some number of guesses. At first, each letter is shown as a '_'. As the player correctly guesses the letters in the word, they are revealed. Complete the function `process_guess(hidden, shown, guess, guesses_left)` below so that it obeys the following specification in support of the game hangman. (Don't include a docstring.)

Preconditions:
- `hidden` is a string with length >= 1 with only lower-case letters and **no repeating letters**
- `shown` is a string identical to `hidden`, but 1 or more (not guessed) letters are replaced by '_'
- `guess` is a lower-case character
- `guesses_left` is an int >= 1

`process_guess()` should:
(1) print "YOU WIN!" or "YOU LOSE!" when applicable:
- If after this `guess`, the whole hidden word is now known/shown, the player has won.
- If the player didn't just win the game and they only had 1 `guesses_left`, then they lose.

(2) return the string `shown`, updated in response to `guess`:
- If `guess` **is not** a letter in `hidden`, return `shown`.
- If `guess` is a letter in `hidden`, return `shown` but with the '_' corresponding to that letter replaced with `guess`.

Examples:

hidden	shown	guess	guesses_left	what to print	what to return
"world"	"_____"	'o'	6		"_o___"
"world"	"_o__d"	'e'	4		"_o__d"
"world"	"_o__d"	'o'	3		"_o__d"
"world"	"_o__d"	'r'	1	"YOU LOSE!"	"_or_d"
"world"	"w_rld"	'o'	1	"YOU WIN!"	"world"
"world"	"worl_"	'd'	4	"YOU WIN!"	"world"

```
def process_guess(hidden, shown, guess, guesses_left):

    i = hidden.find(guess)
    new_shown = shown
    if i != -1:
        new_shown = shown[:i]+guess+shown[i+1:]
    if (new_shown == hidden):
        print("YOU WIN!")
    elif guesses_left == 1:
        print("YOU LOSE!")

    return new_shown
```

There are many correct ways to do this. This is just one possible answer.

7. [11 points] **Home is where the `Address` folder specifies.**

Consider an `Address` class with the attributes:
- `num`: an `int` representing the street number
- `street`: a `str` representing the street name
- `city`: a `str` representing the city name
- `zip`: a `str` representing the zip code

If `a1` were a variable storing (the identifier of) an `Address` object, we could access the value of its `city` attribute with the expression `a1.city`

Consider a second class, `Contact`, with the attributes:
- `name`: a `name` representing a person's name
- `home`: the identifier of an `Address` representing where they live
- `work`: the identifier of an `Address` representing where they work

If `c1` were a variable storing (the identifier of) a `Contact` object, we could access the value of its `home` attribute (which stores (the identifier of) an `Address` object) with the expression `c1.home`

You may wish to draw object diagrams to make sure you understand the setup of the classes and attributes involved.

Your task is to write two functions `work_together(c1, c2)` and `live_together(c1, c2)` with the following specifications:

`live_together(c1,c2)`:
Preconditions: `c1` and `c2` are `Contact`s with distinct names and non-empty `home` addresses.
Returns `True` if `c1` and `c2`'s **home** addresses are the same. Return `False` if they differ.

`work_together(c1,c2)`:
Preconditions: `c1` and `c2` are `Contact`s with distinct names and non-empty `work` addresses.
Returns `True` if `c1` and `c2`'s **work** addresses are the same. Return `False` if they differ.

Two addresses are considered the same if all four attributes are equal.

Notice that these two functions have *almost* the same functionality. Instead of writing two separate functions that have a large overlap in behavior (*redundancy is bad!*), define a helper function that these two functions can both call to accomplish their overlapping work.

```
def address_equals(a1, a2):
    """
    Inputs: a1 and a2 are both Address objects
    Preconditions: a1 and a2 should have all 4 attributes of an Address

    Functionality: compares all 4 class attributes of the inputs
    to determine Address equality

    Returns True if all 4 attributes are equal. Otherwise False.
    """
    return (a1.num == a2.num) and (a1.street == a2.street) and \
        (a1.city == a2.city) and (a1.zip == a2.zip)


def live_together (c1, c2):
    """ c1 and c2 are Contacts with distinct names and non-empty home addresses
    Return True if c1 and c2's home addresses are the same, False otherwise
    """

    return address_equals(c1.home, c2.home)

def work_together (c1, c2):
    """ c1 and c2 are Contacts with distinct names and non-empty work addresses
    Return True if c1 and c2's work addresses are the same, False otherwise
    """

    return address_equals(c1.work, c2.work)
```