CS 88 Fall 2019 — Computational Structures in Data Science

Final

INSTRUCTIONS

- The exam is worth 75 points, across 7 questions.
- You should have 6 sheets in your exam booklet.
- You have 2 hours to complete the exam. **Do NOT open the exam until you are instructed to do so!**
- The exam is closed book, closed notes, closed computer, closed calculator, except two hand-written 8.5” × 11” crib sheets of your own creation and the official CS 88 Final study guide.
- Mark your answers **on the exam itself**. We will *not* grade answers written on scratch paper.

Full Name	
Student ID Number	
Official Berkeley Email (@berkeley.edu)	
TA	
Name of the person to your left	
Name of the person to your right	
By my signature, I certify that all the work on this exam is my own, and I will not discuss it with anyone until exam session is over. **(please sign)**	

POLICIES & CLARIFICATIONS

- If you need to use the restroom, bring your phone and exam to the front of the room.
- You may use built-in Python functions that do not require import, such as `min`, `max`, `pow`, `len`, and `abs`.
- You **may not** use example functions defined on your study guide unless a problem clearly states you can.
- For fill-in-the-blank coding problems, we will only grade work written in the provided blanks. You may only write one Python statement per blank line, and it must be indented to the level that the blank is indented.
- Unless otherwise specified, you are allowed to reference functions defined in previous parts of the same question.

1. **(12 points) What Would Python Display?**

   For each of the expressions in the table below, write the output displayed by the interactive Python interpreter when the expression is evaluated. The output may have multiple lines. If an error occurs, write "Error", but include all output displayed before the error. If evaluation would run forever, write "Forever". To display a function value, write "Function". The first two rows have been provided as examples.

   The interactive interpreter displays the value of a successfully evaluated expression, unless it is `None`.

   Assume that you have first started `python3` and executed the statements on the left.

```
they = lambda x: return len(x())

def cant(y, x):
    return lambda: [y(x + 1)
        for i in range(x) if x % 2 == 0]

def stop(naruto_running):
    if naruto_running > 0:
        print('SASUKEEE')
    return 2019

of = ['high', 'school']
of = of + [of[0] + of[1]]
us = len(of)
def all(in_this, together):
    if 'highschool' in in_this:
        return 2
    if together % 7 == 3:
        return 3
    else:
        print('musical')

class Clown:
    fles = 1
    def __init__(self, se, lf):
        self.se = lf
        se.lf = self
        self.fles = Clown.fles
        Clown.fles += self.fles

stop = Clown(Clown, Clown)
no = Clown(stop, Clown)
why = Clown(no, stop)
```

Expression	**Interactive Output**
`us`	3
`they`	Function

`[ (y,y) for y in`
`   [x for x in range(3)]`
`][0]`	

`they(cant(stop, all(of, us)))`	

`sleep = lambda zzz: zzz * 8`
`cant(sleep, len('well'))()`	

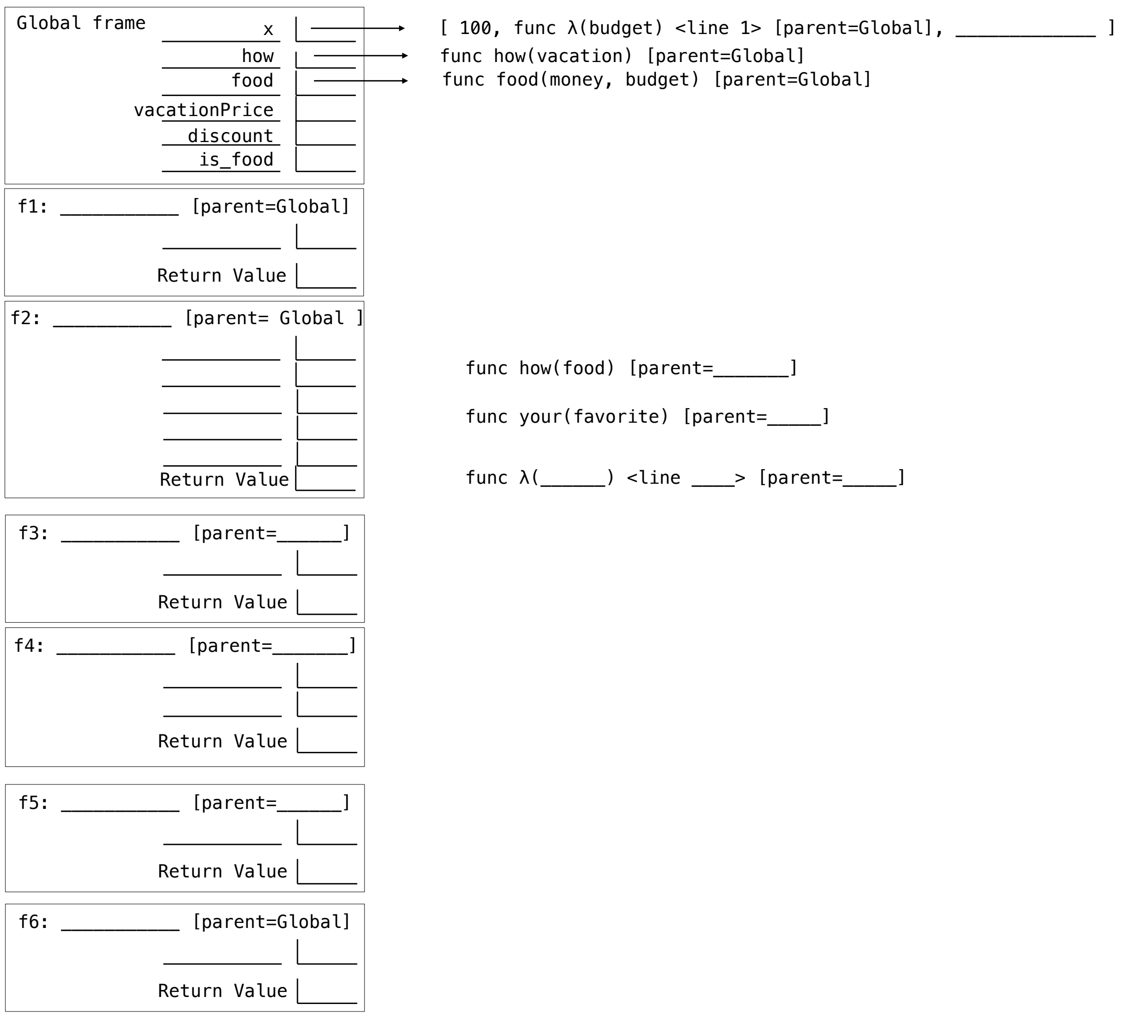
`Clown.fles`	
`why.se == why.lf`	
`assert isinstance(stop, Clown)`	

2. (8 points) Save the Environment!

Fill in the environment diagram that results from executing the code on the right until the entire program is finished, an error occurs, or all frames are filled.
A complete answer will:

- Add all missing names and parent annotations to all local frames.
- Add all missing values created or referenced during execution.
- Show the return value for each local frame.
- Hint: Integer division means the *floor* of `x/y`

```
1  x = [100, lambda budget: x[0]]
2  def how (vacation):
3     return vacation // 10 # integer division
4
5  def food (money, budget):
6      money = x[0]
7      work = x[1]
8      def how(food):
9         return how is your(food)
10     def your(fav):
11        while fav == 100:
12            x = lambda fav: work(money) - 2
13            fav = x(fav)
14     x.append(5)
15     return how
16 vacationPrice, discount = how(x[0]), 50
17 is_food = food(vacationPrice, discount)(100)
```



Global frame
x
how
food
vacationPrice
discount
is_food
[100, func λ(budget) <line 1> [parent=Global], ____________]
func how(vacation) [parent=Global]
func food(money, budget) [parent=Global]
f1: ___________ [parent=Global]
Return Value
f2: ___________ [parent= Global]
Return Value
func how(food) [parent=_______]
func your(favorite) [parent=_____]
func λ(______) <line ____> [parent=_____]
f3: ___________ [parent=______]
Return Value
f4: ___________ [parent=_______]
Return Value
f5: ___________ [parent=______]
Return Value
f6: ___________ [parent=Global]
Return Value

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3. (10 points) SQL: CS88Rising

We have compiled information on popular artists that are a part of the popular music group, 88rising. Knowledge of the group is not required to answer the following questions.
Given these following two tables, complete the following SQL queries so that they return the requested data. ("Hard coding" answers to return only the exact data will not receive credit.)

Table: **Artists**

stage_name	real_name	place_of_birth	age
Joji	George Miller	USA	27
NIKI	Nicole Zefanya	Indonesia	20
Rich Brian	Brian Soewarno	Indonesia	20
Higher Bros.	更高兄弟	China	25
Oski Bear	Oski	USA	79

Table: **Songs**

title	artist	length (in seconds)
History	Rich Brian	307
Head in the Clouds	Joji	178
Indigo	NIKI	173
Hold Me Down	Higher Bros.	223
Sanctuary	Joji	180

A. Write a SQL query that retrieves the `stage_name` of all artists who are not from the USA.

____

B. Write a SQL query that lists the `real_name` and `place_of_birth` of all artists in descending order based on their age.

____

C. Write a SQL query that lists the `title` and `real_name` of a song's artist in descending order based on the `length` of the respective song.

____

____

D. Write a SQL query that gets all the `title`'s of all unique pairs of songs where both their respective artists are younger than 27.

____

____

4. (6 points) Lists of Lists of Lists of Lists...

Write a remove function that takes in a linked list and a number and returns a new linked list with that number removed in the new linked list. If the element does not exist in the linked list, return a copy of the original linked list.

```
>>> lnk_lst = Link(1, Link(2, Link(3, Link(4, Link(5)))))
>>> remove(lnk_lst, 2)
Link(1, Link(3, Link(4, Link(5))))
>>> lnk_lst
Link(1, Link(2, Link(3, Link(4, Link(5)))))

def remove(linked_lst, num):
```

What is the runtime of this function with respect to the length of the list? (Bubble one)

◯ Constant ◯ Logarithmic ◯ Linear ◯ Quadratic ◯ Exponential

```
class Link:
    """Reference of the Link class.
    """
    empty = ()

    def __init__(self, first, rest=empty):
        assert rest is Link.empty or isinstance(rest, Link)
        self.first = first
        self.rest = rest

    def __len__(self):
        return 1 + len(self.rest)

    def __repr__(self):
        if self.rest:
            rest_str = ', ' + repr(self.rest)
        else:
            rest_str = ''
        return 'Link({0}{1})'.format(self.first, rest_str)
```

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5. (6 points) Get Your Numbers in a Row

Complete the `isStrictlyIncreasing` function and its helper function below to return True if a number has strictly increasing digits from left to right and False otherwise. You may assume a single digit number is specified to be strictly increasing and that the number is always nonnegative.

Use the following lines of code, which are currently out of order as a basis for your solution. You may need to fill in the blanks.

```
return True
return helper(____________, ______________)
return False
if n == ___________:
else:
if prev ____  _________:
```

```
def isStrictlyIncreasing(num):
    """
    >>> isStrictlyIncreasing(8)
    True
    >>> isStrictlyIncreasing(21)
    False
    >>> isStrictlyIncreasing(133)
    False
    >>> isStrictlyIncreasing(569)
    True
    """
    def helper(n, prev):

        ______________________________________________________________________

        ______________________________________________________________________

        ______________________________________________________________________

        ______________________________________________________________________

        ______________________________________________________________________

        ______________________________________________________________________

    return helper(______________________, _______________________)
```

6. (15 points) One Hungry Artist

You are a famous artist and for your newest exhibit you decided to tape a banana to a wall. The banana starts out unripe, but when it ripens someone comes and eats your banana, and then you can replace banana back with an unripe banana once it is eaten. The banana in the artpiece can only be “UNRIPE”, “RIPE”, or “EATEN”.

```
def create_art(state):
  “””Create the art”””
  return { ‘banana?’: [state] }
```

Use the following set of doctests to understand the behavior of the functions on the next page.

```
>>> art = create_art(“UNRIPE”)
>>> is_unripe(art)
True
>>> set_banana(“RIPE”, art)
>>> is_ripe(art)
True
>>> is_unripe(art)
False
>>> is_eaten(art)
False
>>> eat_banana(art) # We eat our ripe banana
>>> is_ripe(art)
False
>>> is_eaten(art)
True
>>> ripen_banana(art) # Does nothing
>>> exhibit = generator(art)
>>> next(exhibit)
“There is no banana.”
>>> next(exhibit)
“There is no banana.”
>>> replace_banana(art)
>>> next(exhibit)
“Eww, unripe banana.”
>>> ripen_banana(art)
>>> next(exhibit)
“The banana looks so delicious.”
>>> set_banana(“Broken Exhibit”, art) # set to a not expected value
>>> next(exhibit) # cause a StopIteration Exception
StopIteration: Unknown banana state
```

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Fill out the rest of the functions to get the corresponding doctest to have the right output.

```
def set_banana(banana, art):
  ‘Update the art’

   _________________________________________________________________

def is_ripe(art):
  “Return whether the art’s internal state is ‘RIPE’”

  _________________________________________________________________

def is_unripe(art):
  “Return whether the art’s internal state is ‘UNRIPE’”

  _________________________________________________________________

def is_eaten(art):
  “Return whether the art’s internal state is ‘EATEN’”

  _________________________________________________________________
```

For the next set of functions, you must not violate the *abstraction barrier!* Any abstraction violations will have points deducted.

```
def ripen_banana(art):
  ‘Only ripen banana if it is unripe’

  _________________________________________________________________

  _________________________________________________________________

def replace_banana(art):
  ‘Only replace banana if it is eaten’

  _________________________________________________________________

  _________________________________________________________________

def eat_banana(art):
  ‘Only eat banana if it is ripe’

  _________________________________________________________________

  _________________________________________________________________
```

```
def generate_art(art):
    ‘‘‘
    Yield the corresponding string based on the state of the banana.
    Raise an Exception if the art is in an unknown state.
    (Remember, you may not need all lines).
    ’’’

     while True:

        ____________________________________________________________

        ____________________________________________________________

        ____________________________________________________________

        ____________________________________________________________

        ____________________________________________________________

        ____________________________________________________________

        ____________________________________________________________

        ____________________________________________________________

        ____________________________________________________________

        ____________________________________________________________
```

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7. (10 points) We've Inherited Some Baking Skills

It's dessert time again! Fill in the `Chocolate` and `Cake` classes based on the doctests. Both these classes should inherit from our base `Dessert` class. Be sure to take advantage of inheritance whenever possible. You may not need all lines provided.

```
>>> cake = Cake('cake', 2, 2, 'chocolate')
>>> cake.eat()
Oh no! There is no more cake
>>> cake.bake()
Adding chocolate
Baking...
>>> cake.eat()
Yum, I ate 2 pieces of cake
>>> cake.eat()
Oh no! There is no more cake
>>> chocolate = Chocolate('chocolate', 5, 3)
>>> chocolate.eat()
Yum, I ate 3 pieces of milk chocolate
>>> chocolate.eat()
Oh no! There is no more milk chocolate
>>> chocolate.happiness
False

class Dessert:
    def __init__(self, name, portions_remaining, portion_size):
        self.name = name
        self.happiness = True
        self.portions_remaining = portions_remaining
        self.portion_size = portion_size

    def eat(self):
        if self.portions_remaining >= self.portion_size:
            self.portions_remaining -= self.portion_size
            print("Yum, I ate " + str(self.portion_size) + " pieces of " +
self.name)
        else:
            print("Oh no! There is no more " + self.name)
```

```
class ________________________________:

    def __init__(self, name, portions_remaining, portion_size):

        super().____________________________________________

    def eat(self):

       ____________________________________________________________________

       ____________________________________________________________________

       Dessert.____________________________________________

Class ____________________________________________:
    def __init__(self, name, portions_remaining, portion_size, ____________):

        Dessert.____________________________________________________________

        self.portions_to_be_made = _________________________________________

        ____________________________________________________________________

    def bake(self):

       ____________________________________________________________________

       ____________________________________________________________________

       ____________________________________________________________________
```