CS 88 Spring 2022 Computational Structures in Data Science

MIDTERM

INSTRUCTIONS

- **Do NOT open the exam until you are instructed to do so!**
- You **must not** collaborate with anyone inside or outside of CS88.
- You **must not** use any internet resources to answer the questions.
- If you are taking an online exam, at this point you should have started your Zoom / screen recording. If something happens during the exam, focus on the exam! Do not spend more than a few minutes dealing with proctoring.
- When a question specifies that you must rewrite the completed function, you should **not** recopy the doctests.
- The exam is closed book, closed computer, closed calculator, except your hand-written 8.5" x 11" cheat sheets of your own creation and the official CS88 Reference Sheet

Full Name	
Student ID Number	
Official Berkeley Email (@berkeley.edu)	
What room are you in?	
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.
- For fill-in-the-blank coding problems, we will only grade work written in the provided blanks.
- Unless otherwise specified, you are allowed to reference functions defined in previous parts of the same question.
    - **Online Exams: You may start you exam as soon as you are given the password.**
    - **You may have a digitial version of the CS88 Reference Sheet, or the PDF, but no other files.**

Exam Clarifications: https://docs.google.com/document/d/1-zKDRM84o6cr5lGel3C8CuF-ttPNkQVILAKa39_caDk/edit?us
Reference Sheet: https://drive.google.com/file/d/1vGqbiXnxiUu19hjrB9MNizo5kd-al5iU/view

1. (5.0 points) What Would Python Do (WWPD)

```
>>> def f1(x, y):
        if x > (x + y):
            print(x)
            y = x
        if x > (x - y):
            print(y)
            x = y
        return x + y
>>> def f2(a, b):
        if a:
            return b and a
        else:
            return a or b
>>> f3 = lambda lst: lst[1:] + lst.pop(0)
```

(a) (1.0 pt) `>>> f1(3, -5)`

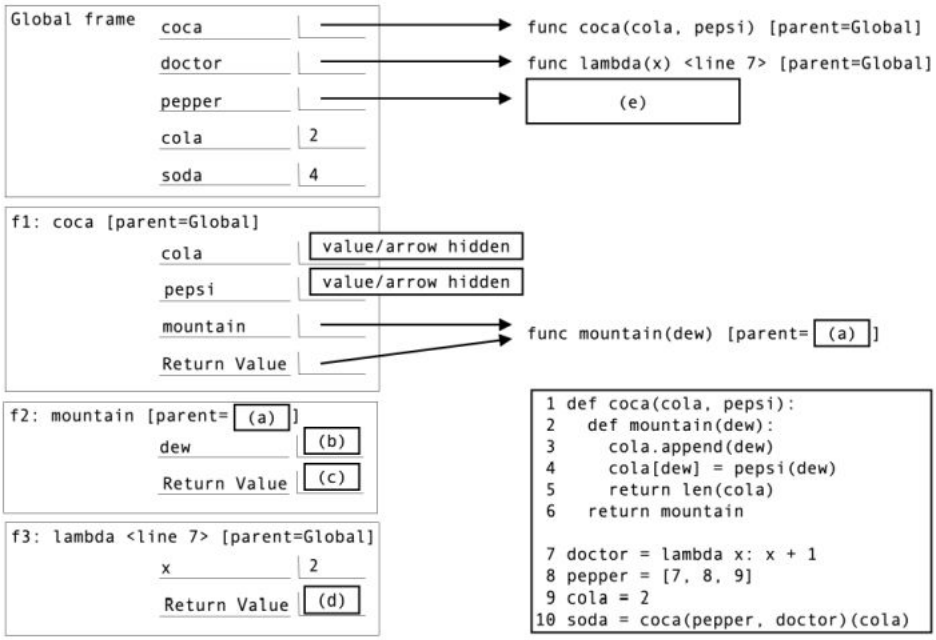
(b) (1.0 pt) `>>> f1(-4, 7)`

(c) (1.5 pt) `>>> f2(print('a'), 10 % 3)`

(d) (1.5 pt) `>>> f3([[10, 20], 30, 40])`

2. (6.0 points) Soft Drinks

Fill in the blanks to complete the environment diagram. All the code used is in the box to the right, and the code runs to completion with no errors. Some arrows have been removed from the diagram. You may wish to draw in those arrows, but it is not required.



(a) (1.0 pt) What is the parent frame of the `mountain` function in the `f2` frame?

(b) (1.0 pt) What is the value of `dew` in the `f2` frame?

(c) (1.0 pt) What is the return value of the `f2` frame?

(d) (1.0 pt) What is the return value of the `f3` frame?

(e) (2.0 pt) What is the value of `pepper` in the `global` frame when the environment diagram is complete?

3. (6.0 points) BeReal

BeReal is a popular new social media app that sends alerts to users at a certain time in the day. Users then have 2 minutes after the alert to post a picture, otherwise their post will be marked as late.

Complete `bereal` that takes in an `alert` time and returns a function `capture`. `capture` takes in a `post` time and returns three possible strings:

- `"on time"` if the post is less than or equal to 2 minutes of the alert.
- `"x minutes late"` if the post is less than an hour late.
- `"x hours late"` if the post is greater than or equal to an hour late, where `x` is rounded down to the nearest hour.

The `alert` and `post` arguments are both integer values representing the time of day in minutes after midnight (e.g. 10 AM is 600 minutes), and the `post` time will never be earlier than the `alert` time. (`str(x)` converts a number `x` to a string.)

```
def bereal(alert):
    """
    >>> today = bereal(600) # 10:00 AM
    >>> today(601) # 10:01 AM
    'on time'
    >>> today(602) # 10:02 AM
    'on time'
    >>> today(630) # 10:30 AM
    '30 minutes late'
    >>> today(730) # 12:10 PM
    '2 hours late'
    """
    def capture(post):
        difference = _________________
        if ___________________:
             return str(_______________) + ' hours late'
        elif _________________:
             return str(_________________) + ' minutes late'
        else:
            return 'on time'
    ________________________
```

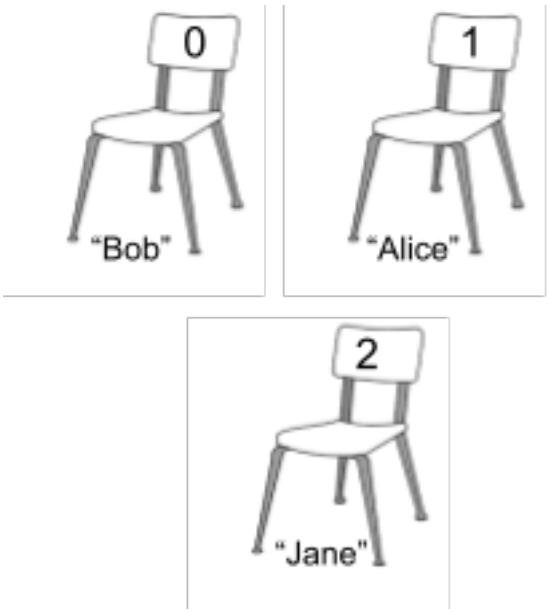
(a) (6.0 pt)

```
def bereal(alert):
    def capture(post):

        difference = ____________________________________________

        if ____________________________________________________:

                return str(_____________________________) + ' hours late'

        elif ____________________________________________________:

                return str(_____________________________) + ' minutes late'
        else:
                return 'on time'


    ____________________________________________________________________________
```

4. (6.0 points) Musical Chairs

A group of people sitting in a circle of chairs can be represented as a list of strings. We'll call this representation a "chair list" and look at an example of a "chair list" named `people`.

```
>>> people = ["Bob", "Alice", "Jane"]
```



There are `len(people)` total chairs in the circle and they are labeled `0, 1, ..., len(people) - 1` in the clockwise direction. The i-th element in the list `people` is the name of the person in the chair labeled with integer `i`.

(a) (2.0 pt) Complete the function `shift_right` which takes in a "chair list" named `people` and returns a new "chair list" in which every person moves to the chair directly to their right. The original list `people` should not be modified.

```
def shift_right(people):
    """
    >>> p0 = ["Bob", "Alice", "Jane"]
    >>> p1 = shift_right(p0)
    >>> p0
    ['Bob', 'Alice', 'Jane'] # p0 remains unchanged
    >>> p1
    ['Jane', 'Bob', 'Alice']
    >>> p2 = shift_right(p1)
    >>> p2
    ['Alice', 'Jane', 'Bob']
    """
    return ____________________________________
```

```
return ____________________________________________________________
```

(b) (4.0 pt) Complete the function `shift_right_n_times` which takes in a "chair list" named `people` and an integer `n` and returns a new "chair list" in which every person moves `n` chairs to their right. The original list `people` should not be modified.

```
def shift_right_n_times(people, n):
    """
    >>> shift_right_n_times(['Bob', 'Alice', 'Jane'], 2)
    ['Alice', 'Jane', 'Bob']
    >>> shift_right_n_times(['W', 'X', 'Y', 'Z'], 8)
    ['W', 'X', 'Y', 'Z']
    """
```

In your solution, you may assume that `shift_right` correctly. You may not need to use all the lines provided. (You may use any valid Python you have learned in CS88 in your solution.)

```
def shift_right_n_times(people, n):

    ------------------------------------------------------------------------

    ------------------------------------------------------------------------

    ------------------------------------------------------------------------

    ------------------------------------------------------------------------
```

5. (6.0 points) Aggregate

Complete the `aggregate` function, which aggregates certain digits of `n` from right to left using the two argument function `func`. `aggregate` only aggregates a digit `d` if `cond(d)` evaluates to `True` and `d` is not consecutively repeated. For example, if you have `n = 222` and the digit 2 satisfies `cond`, you will only aggregate using one of the three consecutive 2's. Finally, the first time `func` is called on a digit of `n`, pass `base` as one of the arguments. Note that the order in which arguments are passed to `func` does not matter, i.e. `func(x, y)` equals `func(y, x)`.

```
def aggregate(n, func, cond, base):
    """
    >>> from operator import add, mul
    >>> add_times_three = lambda x, y: (x + y) * 3
    >>> is_even = lambda x: x % 2 == 0
    >>> aggregate(122, add_times_three, is_even, 0) # (0 + 2) * 3
    6
    >>> aggregate(4212, add, is_even, 0) # (((0 + 2) + 2) + 4)
    8
    >>> aggregate(222, add, is_even, 1) # 1 + 2
    3
    >>> aggregate(111, mul, is_even, 2) # 2
    2
    """
    result = base
    while ________________________________________:
        digit = ____________________________________
        n = ________________________________________
        if _________________ and ____________________:
            ____________________________________
    return result
```

(a) (6.0 pt)

```
def aggregate(n, func, cond, base):
    result = base

    while ____________________________________________________:

        digit = ____________________________________________

        n = ________________________________________________

        if ___________________________ and ___________________________:

            ____________________________________________________
    return result
```

6. (6.0 points) Forming Teams

Given a list of captain names `captains`, a list of player names `players`, and a two argument function `are_compatible`, the `form_teams` method returns a dictionary of compatible teams, where the key is the team captain and the value is a list of players on each team.

Compatibility between captains and players is determined by the `are_compatible` function, which returns `True` if a captain and a player are compatible and `False` otherwise. The order in which arguments are passed to this function does not matter, i.e. `are_compatible(p, c)` will return the same output as `are_compatible(c, p)`.

Players are added to the first captain they are compatible with. If players cannot be paired with any of the captains, they become a captain of their own solo team.

The current code has **3** different errors which you need to find!

```
def form_teams(captains, players, are_compatible):
    """
    >>> same_len = lambda x, y: len(x) == len(y)
    >>> captains = ['bob', 'mary', 'tim']
    >>> players = ['adam', 'kit', 'katie', 'margaret', 'tony', 'dory']
    >>> form_teams(captains, players, same_len)
    {'bob': ['kit'], 'mary': ['adam', 'tony', 'dory'], 'tim': [], 'katie': [], 'margaret': []}
    >>> same_first_or_last_char = lambda x, y: x[0] == y[0] or x[-1] == y[-1]
    >>> form_teams(captains, players, same_first_or_last_char)
    {'bob': [], 'mary': ['margaret', 'tony', 'dory'], 'tim': ['adam'], 'kit': [], 'katie': []}
    """
1.  teams = {}
2.  for c in captains:
3.      teams[c] = []
4.  for p in players:
5.      added_to_team = False
6.      for c in captains:
7.          if are_compatible(p, c):
8.              teams[c] = [p]
9.              added_to_team = True
10.         else:
11.             added_to_team = False
12.     if not added_to_team:
13.          teams[p] = []
14.  return teams
```

In each box, identify and fix each of the errors. Specify the line number(s) you would modify or delete for each error, and in the case of modification, give the modified line of code. You may not add new lines of code.

Use the following formats for your answer:

- To delete a line: `delete line #`
- To modify a line: `line #: new line of code`

(a) (2.0 pt)

(b) (2.0 pt)

(c) (2.0 pt)

7. (5.0 points) Closet Overhaul

You've designed a closet abstract data type to help you organize your wardrobe.

A closet contains two things:

- `owner`: the name of the closet owner represented as a string
- `clothes`: the collection of clothes in the closet represented as a dictionary, where the key is the clothing item name and the value is the number of times the clothing item has been worn.

The `make_closet` constructor takes in `owner` (a string) and `clothes` (a **list** of strings representing clothing items) and returns a closet ADT.

Given this, you've implemented the abstract data type as follows:

```
def make_closet(owner, clothes):
    """ Create and returns a new closet. """
    clothes_dict = {}
    for item in clothes:
        clothes_dict[item] = 0
    return (owner, clothes_dict)

def get_owner(closet):
    """ Returns the owner of the closet """
    return closet[0]

def get_clothes(closet):
    """ Returns a dictionary of the clothes in the closet """
    return closet[1]
```

Given the closet ADT, implement the functions `wear_clothes` and `favorite_clothing_item`. You may not need all the lines provided, and you may need to change the indentation for some lines.

(a) (3.0 pt) Implement `wear_clothes`, which takes a closet `closet` and a list of clothing items `clothes_worn`, and increments the number of times each item is worn by 1. If the clothing item specified does not already exist in the closet, add it to the closet.

```
def wear_clothes(closet, clothes_worn):
    """ Updates the number of times each clothing item is worn.
    >>> adam_closet = make_closet("adam", ["polo", "tie", "shorts"])
    >>> wear_clothes(adam_closet, ["shorts", "tie", "shorts"])
    >>> get_clothes(adam_closet)
    {'polo': 0, 'tie': 1, 'shorts': 2}
    >>> wear_clothes(adam_closet, ["polo", "scarf"])
    >>> get_clothes(adam_closet)
    {'polo': 1, 'tie': 1, 'shorts': 2, 'scarf': 1}
    """
```

```
def wear_clothes(closet, clothes_worn):

    ____________________________________________________________________

    ____________________________________________________________________

    ____________________________________________________________________

    ____________________________________________________________________

    ____________________________________________________________________
```

(b) (4.0 pt) Implement `favorite_clothing_item`, which takes in a closet `closet` and returns the name of the most frequently worn clothing item. Assume there are no ties.

```
def favorite_clothing_item(closet):
    """ Finds the most frequently worn clothing item in a closet
    >>> adam_closet = make_closet("adam", ["polo", "tie", "shorts"])
    >>> wear_clothes(adam_closet, ["shorts", "tie", "shorts"])
    >>> favorite_clothing_item(adam_closet)
    'shorts'
    >>> wear_clothes(adam_closet, ["tie", "polo", "polo", "scarf", "polo"])
    >>> favorite_clothing_item(adam_closet)
    'polo'
    """
    return max(_______, key = _______)
```

```
def favorite_clothing_item(closet):

    return max(_____________________________________________________,

               key = _____________________________________________)
```

8. (6.0 points) One At A Time

(a) (6.0 pt) Implement the function `add_to_digit` which takes in two positive integers, `n` and `x`, and returns a new number that is the result of adding `x` to each digit of `n`. If the sum of `x` and a digit of `n` is more than 9, let the new digit be the rightmost digit of the sum.

```
def add_to_digit(n, x):
    """
    >>> add_to_digit(9, 5)      # 9 + 5 = 14
    4
    >>> add_to_digit(123, 5)    # 1 + 5 = 6, 2 + 5 = 7, 3 + 5 = 8
    678
    >>> add_to_digit(238, 5)    # 2 + 5 = 7, 3 + 5 = 8, 8 + 5 = 13
    783
    """
    new_digit = ____________________________________
    if ____________________________________:
        return ____________________________
    return ________________________ * 10 + ____________________________
```

```
def add_to_digit(n, x):

    new_digit = ____________________________________________________________________

    if ____________________________________________________________________________:

        return ____________________________________________________________________

    return ________________________________ * 10 + ___________________________________
```

9. (8.0 points) Cart Tracker

You are the owner of several "smart" grocery stores. In order to model the supply of your shopping carts, complete the class `CartTracker` which allows you to keep track of a line of shopping carts at different stores!

A cart is represented as a `Cart` object, using the `Cart` class defined below.

```
class Cart:
    counter = 0
    def __init__(self, store):
        self.store = store # name of store where this cart is located
        self.id = Cart.counter
        Cart.counter += 1

class CartTracker:
    """
    >>> joes_store = CartTracker(3, 'Joes') # Carts 0 1 2
    >>> sally = joes_store.checkout_cart()
    >>> beth = joes_store.checkout_cart()
    >>> print(sally.id, beth.id)
    2 1
    >>> joes_store.add_cart(sally)
    >>> anna = joes_store.checkout_cart()
    >>> elsa = joes_store.checkout_cart()
    >>> print(anna.id, elsa.id)
    2 0
    >>> joes_store.checkout_cart()
    -1
    >>> ralphs_store = CartTracker(4, 'Ralphs') # Carts 3 4 5 6
    >>> CartTracker.transfer_carts(ralphs_store, joes_store, 2)
    >>> noah = joes_store.checkout_cart()
    >>> reese = ralphs_store.checkout_cart()
    >>> print(noah.id, reese.id)
    5 4
    >>> noah.store
    'Joes'
    """
    def __init__(self, num_carts, store):
        self.carts = _____________________________________________
        self.store = _____________________________________________

    def checkout_cart(self):
        if _____________________________________________:
            return -1
        return _____________________________________________

    def add_cart(self, cart):
       ____________________________________________

    def transfer_carts(tracker1, tracker2, n):
        for i in range(_____________________________________):
            curr_cart = tracker1._____________________________________
            curr_cart.store = _____________________________________
            ____________________________________________
```

(a) (2.0 pt) First complete the `__init__` method which takes in an integer `num_carts` and assigns the instance attribute `carts` to a list of `Cart` objects of length `num_carts`, representing a line of shopping carts.

The `id` attributes of the `Cart` objects in the list should be increasing from left to right. For example if `num_carts` is 3, then the list might look like `[<Cart 0>, <Cart 1>, <Cart 2>]` where the integers `0`, `1`, `2` are the `id` values for each cart respectively. Crucially the rightmost element, `<Cart 2>`, is the cart at the "front" of the line.

```
def __init__(self, num_carts, store):

    self.carts = _____________________________________________

    self.store = _____________________________________________
```

(b) (3.0 pt) Next, complete the following two methods so customers can checkout and put back shopping carts:

- `checkout_cart`: returns `-1` if there are no carts available and otherwise removes the `Cart` object at the front of the line and returns it.
- `add_cart`: takes in a `Cart` object called `cart` and places it at the front of the shopping cart line (the right end of the list).

```
def checkout_cart(self):

    if _____________________________________________________:
        return -1

    return _____________________________________________

def add_cart(self, cart):

    ____________________________________________________
```

(c) (3.0 pt) Complete the class method `transfer_carts` which takes in two `CartTracker` objects representing different stores, `tracker1` and `tracker2`, and an integer `n`. `transfer_carts` removes `n` carts from `tracker1` by checking them out and adds them to `tracker2` in the same order they were checked out. Each transferred `Cart` object's `store` attribute should be updated since the cart now belongs to a new store.

```
def transfer_carts(tracker1, tracker2, n):

    for i in range(_____________________________________):

        curr_cart = tracker1._____________________________________

        curr_cart.store = _____________________________________

        ____________________________________________________
```

No more questions.