# CSC148 Summer 2018: Midterm 1 Practice

The questions in this practice encompass more than would be on a midterm. The questions are designed to cover a breadth of topics. Within each category are multiple questions that address various topics, and then one question at the end that is more "test" styled (i.e. a question that would be fair for a test) at the end.

In addition to answering the questions within this document, you should work through the labs and past exams.

## Class Design

1. Below are the definitions for the superclass `Ghost` and its subclass `Spectre`.

```
class Ghost:
    """
    A class representing a Ghost.

    age - The age of the ghost
    """
    age: int

    def __init__(self, age: int) -> None:
        """
        Initialize this Ghost with the age age.
        """
        self.age = age

    def make_sound(self) -> None:
        """
        Make this Ghost make a sound.
        """
        print("Boo!")

class Spectre(Ghost):
    """
    A class representing a Spectre.

    age - The age of the spectre
    size - The size of the spectre
    """
    age: int
    size: int

    def __init__(self, age: int, size: int) -> None:
        """
        Initialize this Spectre with the age age and size size.

        >>> s = Spectre(10, 3)
        >>> s.size
        3
        """
        super().__init__(age)
```

```
        self.size = size
```

a) What happens when we run the following lines of code?

```
        s = Spectre(10, 3)
        s.make_sound()
```

"Boo!" is printed (the behaviour is inherited from its superclass: Ghost).

b) Suppose we want to make another subclass of `Ghost` called `Ghoul`. A `Ghoul` has an `age`, as well as a `name`. Implement its `__init__` method.

See ghost.py

c) We want all ghosts to have a `__str__` method that prints out its age in the format

```
        Type of Ghost (Age)
```

For example, a `Spectre` with an age of 10 should have the str form:

```
        Spectre (10)
```

A Ghost should not have its str method implemented (i.e. it should raise NotImplementedError).

Write the `__str__` methods for `Ghost`, `Spectre`, and `Ghoul`.

See ghost.py

d) Suppose we want a Ghoul's `make_sound()` method to make whatever sound a Ghost does, but to also print out '`Grr...`' afterwards. Implement the `make_sound()` method.

See ghost.py

2. Assume the class for which the methods below are written have a super class. For each of the methods below, label whether they extend, override, or inherit the behaviour of a parent method. Docstrings have been omitted.

a)
```
def raise_hand(self) -> None:
    super().raise_hand()
    print("Me!")
```
Extends

b)
```
def increase_count(self) -> None:
    self.count += 1
```
Overrides

c)
```
def turn_around(self) -> None:
    super().turn_around()
```
Inherits

d)
```
def say_answer(self) -> None:
    print(super().say_answer() + ", I think.")
```
Extends

3. What does it mean to extend a method?

Extending a method means doing everything your superclass does and more (i.e. you call your superclass' implementation of the method, and then add your own additional steps to it.)

4. What does it mean to override a method?

Overriding a method means replacing your superclass' implementation with your own, without calling on your superclass' implementation at all.

5. How do we define a private attribute?

A private attribute is created by prefixing its name with an underscore (_). I.e. self._name instead of self.name.

6. Suppose we have a `Stack`, but instead of having a private `_content` attribute, it has a public `content` attribute, with `content` being a list of items in the `Stack`.

a) Suppose we have client code that creates a Stack and stores it in the variable `s`. Using the `content` attribute, how could we find the current size of the Stack?

Supposing the Stack is named s (i.e. s = Stack())

len(s.content)

b) Suppose we wanted to implement our Stack using a `LinkedList` instead of a list. Are we able to make that change? Would the client code from (a) have to change?

No, we can't change that within our code as all client code that uses Stack's content attribute would have to change to suit it.

If we wanted to change it, then all client code like the one from (a) would have to change (i.e. to s.content.size).

c) If `content` was a private attribute (`_content`) and stored as a list, how would we have to provide the size of our Stack to our client? Write code that the client would have to call in order to get the size of our Stack. The client code should not access the private `_content` attribute.

We would have to write a method to get the size of the stack since they can't call on _content directly. For example, calling something like s.get_size()

d) Continuing from (c), what methods within our Stack would have to change?
(Code is not needed, but it would be good practice for all topics: class design, stacks,

and linked lists.)

We would have to implement a get_size method as follows:

```
def get_size(self) -> int:
    """
    Return the number of items in this Stack.

    >>> s = Stack()
    >>> s.add(1)
    >>> s.get_size()
    1
    """
    return len(self._content)
```

e) Continuing from (d), suppose we wanted to switch our implementation from using a list for `_content` to using a LinkedList. Would the client code have to change?

No, the client code would not have to change. We would have to change how our methods are implemented, though (e.g. add(), remove(), is_empty(), get_size()) but none of this will affect the client code.

7. Why do we use private attributes?

So we can hide *how* we implement a class from the client -- this allows us to make changes to the implementation and the data structures we use without having to worry about breaking the client code (so long as all of our methods still work as intended).

8. What is encapsulation?

Encapsulation is the notion of restricting access to attributes (i.e. forcing clients to use getters and setters as opposed to accessing and modifying an attribute directly). See the answer to (7) for the reasoning behind why we do this.

9. Why do we use getters and setters?

See the answer to (7). If we use getters and setters, we can adjust how we store attributes and how we return their values whenever we want without worrying about breaking client code. In many cases, we might switch out one implementation for a version that's more efficient.

10. Below are the definitions for the class Owner and Pet.

```
class Pet:
    """
    A class representing a Pet.

    name - The pet's name.
```

```
    fullness - The pet's fullness
    """
    name: str
    fullness: int

    def __init__(self, name: str) -> None:
        """
        Initialize this Pet with the name name and no fullness.

        >>> p = Pet("Froggy")
        >>> p.name
        'Froggy'
        >>> p.fullness
        0
        """
        self.name = name
        self.fullness = 0

class Owner:
    """
    A class representing an Owner.

    pet - The pet of this Owner.
    name - The Owner's name.
    """
    pet: Pet
    name: str

    def __init__(self, name: str, pet: Pet) -> None:
        """
        Initialize this Owner with the name name and pet pet.

        >>> o = Owner("Sophia", Pet("Stinky"))
        >>> o.name
        'Sophia'
        """
        self.name = name
        self.pet = pet
```

a) Suppose we create an Owner using the code:

```
o = Owner("Sophia", Pet("Stinky"))
```

What line of code would we have to run to get the pet's name?

`o.pet.name`

b) Suppose we want a method in the `Owner` class called `feed_pet` which increases the pet's fullness by 5. Implement the method `feed_pet`.

See pet.py

c) Implement an `__eq__` method for `Pet`. Two Pets are equal if they're both Pets, have

the same name, and the same fullness.

d) Implement an `__eq__` method for `Owner`. Two Owners are equal if they're both Owners, have the same name, and their pets are equal.

See pet.py

e) Implement a `__str__` method for `Pet`. The `__str__` of a pet should return a string in the form:

```
Name (Fullness)
```

See pet.py

f) Implement a `__str__` method for `Owner`. The `__str__` of an owner should return a string in the form:

```
Name: the str of the pet
```

Use the pet's str in the Owner's `__str__` method.

See pet.py

11. When is the ___str___ method used?

When we use the str() function or when we print something. For example:

```
>>> c = MyClass()
>>> print(c)
The __str__ of MyClass gets printed
```

12. When is the ___repr___ method used?

When we call repr() or try to look at the value of something without using print. For example:

```
>>> c = MyClass()
>>> c
The __repr__ of MyClass
>>> [c, 2, 3]
[The __repr__ of MyClass, 2, 3]
```

14. Describe a scenario wherein ___str___ and ___repr___ would logically have very different results.

Typically, ___str___ is for human readability/nice formatting/etc. While ___repr___ is for the programmer's sake, giving general information about the class.

Suppose we have a game of TicTacToe. When we print out a board, we would want to see something like:

```
 O | 2 | 3
-----------
 X | X | 6
-----------
 O | 8 | 9
```

While the ___repr___ might just be something like:

```
O (1, 7) - X (4, 5) - Next Player: O
```

For example, if we had a list of boards, it'd be much easier to read:

```
[O (1, 7) - X (4, 5) - Next Player: O, O (1) - X () - Next Player: X, O
(7) - X (5) - Next Player: O]
```

Than to read something like:

```
[ O | 2 | 3 \n----------\n X | X | 6 \n----------\n O | 8 | 9, O | 2 | 3
\n----------\n  4  |  5  |  6  \n----------\n  7  |  8  |  9,  1  |  2  |  3
\n----------\n 4 | X | 6 \n----------\n O | 8 | 9]
```

15. Below is an implementation of the class `Meal`, which represents a meal that people can eat.

```
class Meal:
    """
    A Meal class.

    name - name of the meal
    price - price of the meal
    """
    name: str
    price: int

    def __init__(self, name: str, price: int) -> None:
        """
        Initialize this Meal with the name name and price price.
        """
        self.name = name
        self.price = price

    def __str__(self) -> str:
        """
        Return the string representation of this Meal.
        """
        return "{} (${})".format(self.name, self.price)

    def is_healthy(self) -> bool:
        """
        Return whether this meal is healthy or not.
```

```
        """
        raise NotImplementedError
```

Implement the following subclasses:

- HealthyMeal: Which also has a main ingredient. `is_healthy()` should return `True`, and the `__str__` for a HealthyMeal should return a string in the form:
  `name ($price): main ingredient`
- JunkMeal: Whose is_healthy() should return False.

Include all documentation (docstrings, type annotations, etc.) excluding docstring examples in the subclasses and in any methods you define. Additionally, mention whether a method extends or overrides the parent method in the docstring.

See meal.py

## Stacks and Queues

1. What is a Stack?

   A Stack is a first-in-last-out data structure: the first item we add to the Stack is the last item we get out.

2. What is a Queue?

   A Queue is a first-in-first-out data structure: the first item we add to the Queue is the first item we get out.

3. Suppose we add "A" to a Stack. Afterwards, we add "B", and then "C". When we remove from the Stack, what do we get back?

   C

4. Suppose we add "A" to a Queue. Afterwards, we add "B", and then "C". When we remove from the Queue, what do we get back?

   A

5. Suppose we have a Stack that will contain only single character strings (e.g. 'A', 'b', '1'), and we want to implement it using a string as the Stack's `_content`. Let's call this a `StringStack`.

   Implement the `__init__()`, `add()`, `remove()` and `is_empty()` methods for `StringStack`.

   See midterm_practice_adts.py

6. Suppose we have a Queue that will contain only single character strings (e.g. 'A', 'b', '1'), and we want to implement it using a string as the Queue's `_content`. Let's call this a `StringQueue`.

   Implement the `__init__()`, `add()`, `remove()` and `is_empty()` methods for `StringQueue`.

   See midterm_practice_adts.py

7. Using only `type()`, `is_empty()`, `add()`, and `remove()`, implement the `__eq__` method of a Queue. Two Queues are equal if they contain the same items in the same order. The Queue should be in its original state by the end of the method (i.e. if you remove things from the Queue, you must put everything back in the original order). Do not access `_content`.

   See midterm_practice_adts.py

8. Using only `type()`, `is_empty()`, `add()`, and `remove()`, implement the `__str__` method of a Stack. The `__str__` method should take the form:

   ```
   Top -> items
   ```

   Where `items` are the contents of the queue in the order they're removed.

   The Stack should be in its original state by the end of the method (i.e. if you remove things from the Stack, you must put everything back in the original order). Do not access `_content`.

   See midterm_practice_adts.py

9. Using only `type()`, `is_empty()`, `add()`, and `remove()`, implement the `__str__` method of a Queue. The `__str__` method should take the form:

   ```
   Front -> items
   ```

   Where `items` are the contents of the queue in the order they're removed.

   The Queue should be in its original state by the end of the method (i.e. if you remove things from the Queue, you must put everything back in the original order). Do not access `_content`.

   See midterm_practice_adts.py

10. Read the docstring below and implement the body of the function.

```
def queue_to_stack(q: Queue) -> Stack:
    """
    Return a stack with the items from q. The stack returned should
    Have items removed in the same order as q.

    After calling this function, q should be in its original state (all
```

```
    Items in the same order).

    >>> q = Queue()
    >>> q.add(1)
    >>> q.add(2)
    >>> q.add(3)
    >>> s = queue_to_stack(q)
    >>> q.remove()
    1
    >>> s.remove()
    1
    >>> q.remove()
    2
    >>> s.remove()
    2
    >>> q.remove()
    3
    >>> s.remove()
    3
    """
```

See midterm_practice_adts.py

## Linked Lists

1. What does a LinkedListNode contain?

   A LinkedListNode contains its value and a pointer/reference to the node that comes after it.

2. What does a LinkedList contain?

   A LinkedList contains its size, and references to the front of the LinkedList and the back of the LinkedList.

3. Suppose we have a LinkedList named lnk. How would we get the front of lnk? If lnk is an empty LinkedList, what is the front of it?

   `lnk.front`

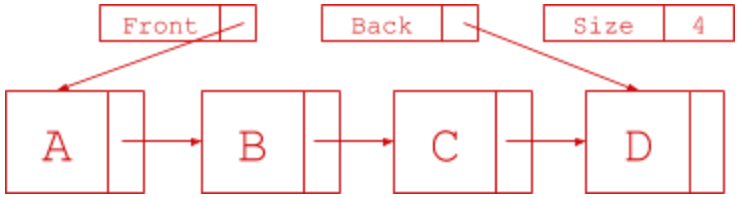
   If it's empty, `lnk.front == None`

4. Suppose we have a non-empty LinkedList named lnk. How would we get the value of 2nd node in our LinkedList?

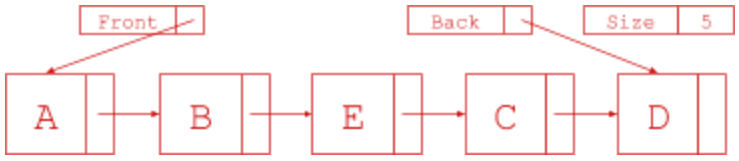
   `lnk.front.next_`

5. Suppose we have a LinkedList containing the items (from front to back) "A", "B", "C", "D".

a) Draw the LinkedList. Label the front, back, and size.




b) Suppose we want to add a new LinkedListNode with the value "E" between "B" and "C". Draw the new LinkedList, labelling the front, back, and size.




c) Continuing from (b): Which next pointers need to change?

The next_ pointer of the node with value "B" has to change, and the new node (with value "E") has to point to the node with the value "C".

d) Continuing from (b): How would we create our new LinkedListNode with the value "E"?

```
new_node = LinkedListNode("E")
```

e) Continuing from (d): How would we get to the LinkedListNode with "B" as its value and set its `next_` pointer to refer to our node from (d)?

```
cur_node = lnk.front
while cur_node != None and cur_node.value != "B":
    cur_node = cur_node.next_
cur_node.next_ = new_node
```

f) Continuing from (e): How would we update our new LinkedListNode's `next_` to point to C?

You would have to add the following line before changing cur_node.next_

```
new_node.next_ = cur_node.next_
```

Or you add:

```
prev_next_node = cur_node.next_
```

After the while-loop (before changing cur_node.next_), and then you add this to the end:

```
new_node.next_ = prev_next_node
```

g) Continuing from (f): How would we update the size of the LinkedList?

```
lnk.size += 1
```

h) Continuing from (g): Do we need to change the front or back pointers of our LinkedList?

No, since we're adding into the middle of the list and not adding before the front/after the back.

6. Suppose we want to implement a Stack using a LinkedList as the `_content` and that we'll call it LinkedListStack. The class definition and `__init__` have been provided for you. Write the `add()`, `remove()` and `is_empty()` methods. Assume you have `LinkedList` defined for you already, but you only have access to the `front`, `back`, and `size` attributes. Assume you have `LinkedListNode` defined for you too, but it only contains the `value` and `next` attributes.

```
class LinkedListStack:
    """
    A class representing a Stack, formed using a LinkedList.
    """

    def __init__(self) -> None:
        """
        Initialize an empty LinkedListStack.

        >>> s = LinkedListStack()
        >>> s.add(3)
        >>> s.add(2)
        >>> s.add(1)
        >>> s.remove()
        1
        >>> s.remove()
        2
        >>> s.remove()
        3
        """
        self._content = LinkedList()
```

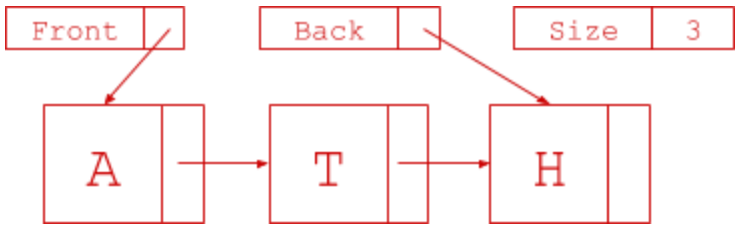
See midterm_practice_linkedlist.py

7. Below is the definition of the LinkedList method add_before.

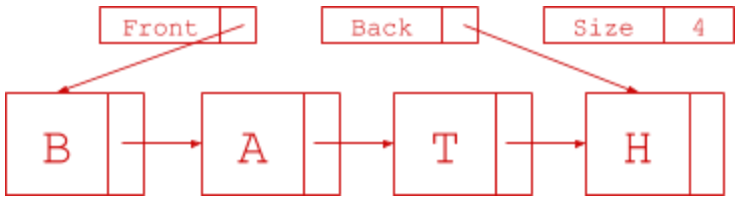
```
def add_before(self, new_value: Any, to_find: Any):
    """
    Add new_value to this LinkedList so it comes immediately
    before to_find.

    If to_find isn't in this LinkedList, don't modify this LinkedList.

    >>> lnk = LinkedList()
    >>> lnk.prepend("H")
    >>> lnk.add_before("A", "H")
```

```
>>> print(lnk)
A -> H -> |
>>> lnk.size
2
>>> lnk.add_before("C", "H")
>>> print(lnk)
A -> C -> H -> |
>>> lnk.size
3
>>> lnk.add_before("O", "B")
>>> print(lnk)
A -> C -> H -> |
>>> lnk.size
3
"""
```

a) Draw a LinkedList with the items from front to back being "A", "T", "H", labelling the front, back, and size.




b) Continuing from (a): Suppose that LinkedList is named `lnk`. Suppose we call `lnk.add_before("B", "A")`. Draw the new LinkedList, labelling the front, back, and size.




c) Implement the method `add_before()`.

See midterm_practice_linkedlist.py