CSC148 Assigment 1

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1) Get the starter code and read the documentation

1. Download the zip file that contains the starter code here a1.zip
2. Unzip the file and place the contents in pycharm in your a1 folder (remember to set your a1 folder as a sources root)
3. You should see the following files:
    - *course.py*
    - *criterion.py*
    - *grouper.py*
    - *survey.py*
    - *tests.py*
    - *example_tests.py*
    - *example_usage.py*
    - *example_course.json*
    - *example_survey.json*

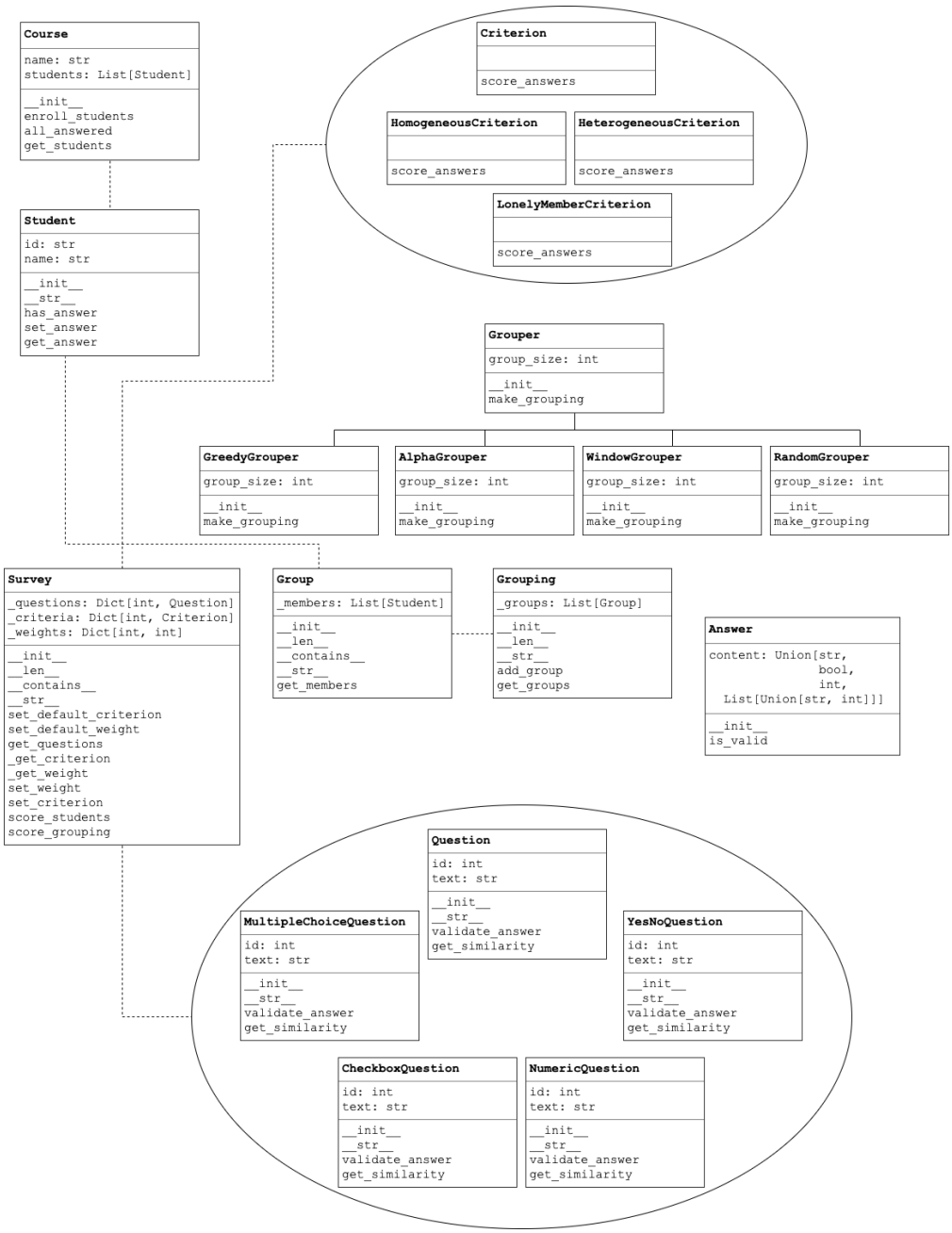
For this assignment, you will be required to edit and submit the following files only:

- course.py
- criterion.py
- grouper.py
- survey.py
- tests.py

If you look at these files you will notice that you have been given the signature and docstrings for all classes and methods. Read through these docstrings carefully; they describe how you are expected to implement these classes and methods.

A picture!

It might be difficult to imagine how all the classes defined in these files will interact before you start writing the code itself. To help you out, here is a diagram of all the classes you will be asked to contribute to for this assignment:



Note that the attributes and methods shown in this diagram are only the ones that we have given you in the starter code. You may need to define additional private attributes or private helper methods.

Legend:

- dashed lines indicate a composition relationship between classes
- solid lines indicate an inheritance relationship between classes
- a solid circle around a group of classes indicates that there exists an inheritance relationship between these classes but it is not defined (you get to decide!)

Test your code!

- Try running the example_tests.py file: all of the tests should fail because you haven't written any code yet!
- Try running example_usage.py file: you should get an error since you haven't written any code yet!
- Open up the tests.py file: it is empty! This is where you will be writing all of your tests for this assignment

Something to think about!

Unlike A0, you will be submitting code split across multiple files. Open up each of the files and look at which functions and classes are defined in each file. Why do you think the files were organized in this way? Is there a different way we could have organized these files?

2) Complete the Student Class

The Student class represents a student who can be enrolled in a university course.

The starter code for the *Student* class can be found in *course.py*. Open up this file and read through the docstrings for each of the the *Student* class's methods. Then, implement each of the methods in the *Student* class.

Remember: you may need to define additional private attributes or private helper methods!

Test your code!

- Write at least one unit test for each method in *Student*. You are not required to write tests for initializers.
- You should write these tests in the *tests.py* file.
- Once you have finished writing these tests, run all the tests in *test.py*. Make sure your code passes all your tests before moving on.
- Run the tests in *example_tests.py*, the tests in the *TestStudent* class should now pass.

Something to think about!

The *Student.has_answer* method asks you to check if a student has a valid answer to a given question. Do we have a way to determine if an answer is valid or not yet? Answer: no and we won't until we complete step 4. You may need to come back and finish this method after completing step 5.

3) Complete the Course Class

The *Course* class represents a university course.

The starter code for the *Course* class can be found in *course.py*. Open up this file and read through the docstrings for each of the the *Course* class's methods. Then, implement each of the methods in the *Course* class. You may find the function *sort_students* helpful.

Remember: you may need to define additional private attributes or private helper methods!

Test your code!

- Write at least one unit test for each method in *Course*. You are not required to write tests for initializers.
- You should write these tests in the *tests.py* file.
- Once you have finished writing these tests, run all the tests in *test.py*. Make sure your code passes all your tests before moving on.
- Run the tests in *example_tests.py*, the tests in the *TestCourse* class should now pass.
- Something to think about!
- The *Course.all_answered* method asks you to check if all students have a valid answer for every question in a *Survey*. Which steps do you need to complete before you can finish this method? You may have to come back later to finish the *Course.all_answered* method.

4) Complete the Question Classes

The file *survey.py* contains an abstract *Question* class, and the following classes for representing different types of questions that you might find on a survey:

- Question
- MultipleChoiceQuestion
- NumericQuestion
- YesNoQuestion

- CheckboxQuestion

As well as defining the text of the question itself, these classes also specify what are valid answers to these questions.

Open up *survey.py* and read through the docstrings for the methods in these question classes.

You might notice that we have not defined any inheritance hierarchy between these classes. You get to decide what it should be. However, in doing so you must follow these rules:

1. The abstract Question class should not inherit from any class other than object.
2. All other *Question* classes should inherit from the abstract *Question* class either directly or indirectly.
3. At least one non-abstract *Question* class should inherit from another non-abstract Question class.
4. There are many possible inheritance structures you could choose. Remember that one of the requirements for this assignment is to avoid writing duplicate code. Think about which sort of inheritance structure best lets you avoid duplicate code.

Implement each of the methods in the Question classes. You may remove a method that we included in the starter code for a child class if you wish to simply inherit the parent's method rather than to override it.
Remember: you may need to define additional private attributes or private helper methods!

Test your code!

- Write at least one unit test for each method in each of the Question classes. You do not need to write tests for abstract methods or initializers but you do need to write tests for inherited methods.
- For example, even if you structure your code so that a child class inherits its *validate_answer* method without modification from the parent class, you still need to write separate tests for the *validate_answer* method in the parent class and the child class.
- You should write these tests in the *tests.py* file.
- Once you have finished writing these tests, run all the tests in *test.py*. Make sure your code passes all your tests before moving on.
- Run the tests in *example_tests.py*, the tests in the *TestMultipleChoiceQuestion*, *TestNumericQuestion*, *TestYesNoQuestion*, and *TestCheckboxQuestion* class should now pass.

Something to think about!

The *validate_answer* methods ask you to check if an answer is a valid answer for this question. Do we have a enough information about the *Answer* class in order to complete this method now? You may need to come back and finish this method after completing step 4.

5) Complete the Answer Class

The *Answer* class represents an answer to one of the questions you wrote classes for in Step 3.

The starter code for the *Answer* class can be found in *survey.py*. Open up this file and read through the docstrings for each of the the *Answer* class's methods. Then, implement each of the methods in the *Answer* class.

Remember: you may need to define additional private attributes or private helper methods!

If you have not implemented the *validate_answer* methods in the *Question* classes, the *Course.all_answered* and the *Student.has_answer* methods yet, go back and finish them now.

Test your code!

- Write at least one unit test for each method in *Answer*. You are not required to write tests for initializers.
- You should write these tests in the *tests.py* file.
- Once you have finished writing these tests, run all the tests in *test.py*. Make sure your code passes all your tests before moving on.
- Run the tests in *example_tests.py*, the tests in the *TestAnswer* class should now pass.

Something to think about!

The *Answer* class is one of the simplest classes that we will implement in this assignment. What is the advantage of creating such a simple class? Are there any disadvantages?

6) Complete the Criterion Class

A criterion is a way of judging the quality of a group based on the group members' answers to a particular question. For example, one criterion could be to want groups with homogeneous answers to a question asking what year they are in.

The starter code defines several Criterion classes in *criterion.py*. Open up this file and read through the docstrings for each of the the *Criterion* class' methods. The *Criterion* classes are the classes in this file that have "Criterion" in their name:

- *Criterion*
- *HomogeneousCriterion*
- *HeterogeneousCriterion*
- *LonelyMemberCriterion*

You might notice that we have not defined any inheritance hierarchy between these classes. You get to decide what it should be. However, in doing so you must follow these rules:

1. The abstract *Criterion* class should not inherit from any class other than object.
2. All other *Criterion* classes should inherit from the abstract *Criterion* class, either directly or indirectly.
3. At least one non-abstract *Criterion* class should inherit from another non-abstract Criterion class.
4. There are many possible inheritanceses. You should NOT implement an initializer for these classes.

Remember: You may remove a method defined in a child class if you wish to simply inherit the parent's method directly. structures you could choose. Remember that one of the requirements for this assignment is to avoid writing duplicate code. Think about which sort of inheritance structure best lets you avoid duplicate code.

Implement each of the methods in the *Criterion* classes. You should NOT implement an initializer for these classes.
Remember: you may need to define additional private helper methods!

Test your code!

- Write at least one unit test for each method in each of the *Criterion* classes. You do not need to write tests for abstract methods but you do need to write tests for inherited methods.
- For example, even if you structure your code so that a child class inherits its *score_answers* method without modification from the parent class, you still need to write separate tests for the *score_answers* method in the parent class and the child class.
- You should write these tests in the *tests.py* file.
- Once you have finished writing these tests, run all the tests in *test.py*. Make sure your code passes all your tests before moving on.
- Run the tests in *example_tests.py*, the tests in the *TestHomogeneousCriterion*, *TestHeterogeneousCriterion*, and *TestLonelyMemberCriterion* classes should now pass.

Something to think about!

You are asked not to implement an initializer for the *Criterion* classes. Why is an initializer not necessary for these classes? If the *Criterion* classes do not define an initializer, will it be impossible to create instances of these classes?

7) Complete the Group Class

The *Group* class represents a collection of one or more students.

The starter code for the *Group* class can be found in *grouper.py*. Open up this file and read through the docstrings for each of the the *Group* class's methods. Then implement each of the methods in the Group class.

Remember: you may need to define additional private attributes or private helper methods!

Test your code!

- Write at least one unit test for each method in *Group*. You are not required to write tests for initializers.
- You should write these tests in the *tests.py* file.
- Once you have finished writing these tests, run all the tests in *test.py*. Make sure your code passes all your tests before moving on.
- Run the tests in *example_tests.py*, the tests in the *TestGroup* class should now pass.
- Something to think about!

You may find the Python *set* type to be useful.

The *Group.get_members* method asks you to return a shallow copy of the *_members* private attribute instead of simply returning the list that _members refers to. A *shallow* copy of an object is a new object (with a different *id*) but whose contents are the same. For example,

```
>>> dicts = [{1:2, 3:9}, {5:18}, {"adieu":7}]
>>> copy = []
>>> for item in dicts:
...     copy.append(item)
...
>>> # dicts and copy are two different objects.
>>> id(dicts)
4485971264
>>> id(copy)
4485971200
>>> # But each item in copy is an alias for an item in dicts.
```

```
>>> For example:
>>> id(dicts[2])
4486046896
>>> id(copy[2])
4486046896
>>> # With a Python list, any time we slice we get a new list.
>>> # This provides an easy way to make a shallow copy.
>>> another_copy = dicts[:]
>>> id(another_copy)
4485971008
>>> id(another_copy[2])
4486046896
```

In contrast, a **deep copy** has new objects at every level, so it contains no aliases.

By returning a shallow copy, the *Group.get_members* method allows the client code to mutate the individual Student objects but not the Group object itself. The same reasoning holds for the *Grouping.get_groups* method in the next step.

8) Complete the Grouping Class

The *Grouping* class represents a collection of Group instances. An instance of a *Grouping* class can be used to represent every student in a course, divided up into groups.

The starter code for the Grouping class can be found in *grouper.py*. Open up this file and read through the docstrings for each of the the Grouping class's methods. Then, implement each of the methods in the *Grouping* class.

Remember: you may need to define additional private attributes or private helper methods!

Test your code!

- Write at least one unit test for each method in *Grouping*. You are not required to write tests for initializers.
- You should write these tests in the tests.py file.
- Once you have finished writing these tests, run all the tests in test.py. Make sure your code passes all your tests before moving on.
- Run the tests in *example_tests.py*, the tests in the *TestGrouping* class should now pass.

Something to think about!

An instance of the *Grouping* class starts out containing zero groups and more can be added later using the *Grouping.add_group*. On the other hand, an instance of the *Group* class starts out with some members and more cannot be added later. Why might we have chosen to implement these classes differently? What does this design choice tell us about how these classes are intended to be used?

9) Complete the Survey Class

The *Survey* class represents a collection of questions. It also associates each question with a criterion (indicating how to judge the quality of a group based on their answers to the question) and a weight (indicating the importance of this question in deciding how to group students).

The starter code for the *Survey* class can be found in *survey.py*. Open up this file and read through the docstrings for each of the the *GroupSurveying* class's methods. Then, implement each of the methods in the Survey class.

Hint: Read the documentation for *Survey._get_criterion* and *Survey._get_weight* carefully before you implement the initializer.

Note: The weights associated with the questions in in a survey do NOT have to sum up to any particular amount.
Remember: you may need to define additional private attributes or private helper methods!

Test your code!

- Write at least one unit test for each method in *Survey*. You are not required to write tests for initializers.
- You should write these tests in the *tests.py* file.
- Once you have finished writing these tests, run all the tests in *test.py*. Make sure your code passes all your tests before moving on.
- Run the tests in *example_tests.py*, the tests in the TestSurvey class should now pass.

Something to think about!

What is the relationship between the *Survey.score_students* method and the *Survey.score_grouping* method?

10) Complete the helper functions in *grouper.py*

The file *grouper.py* contains helper functions that implement two different ways of dividing a list up into parts.

Open this file and read through the documentation for these functions. Then, implement the functions.

Test your code!

- Write at least one unit test for each function you implemented in this step.
- You should write these tests in the *tests.py* file.
- Once you have finished writing these tests, run all the tests in *test.py*. Make sure your code passes all your tests before moving on.
- Run the tests in *example_tests.py*. The *test_slice_list* and *test_windows* tests should now pass.

Something to think about!

Why are we writing these functions outside of a class? Why not make them instance methods of one of the *Grouper* classes instead?

11) Complete the Grouper Classes

The *Grouper* classes represent different techniques for deciding how to split all the students in a course into a groups. See the docstrings of each of these classes and their methods for implementation details. The file Grouper Explanation.pdfPreview the document walks through a detailed example for each of the groupers. Make sure you understand the algorithms before you start writing code.

The starter code for the *Grouper* classes can be found in *grouper.py*. Open up this file and read through the docstrings for each of the the *Grouper* class' methods.

The *Grouper* classes are the classes in this file that have "Grouper" in their name:

- *Grouper*
- *AlphaGrouper*
- *RandomGrouper*
- *GreedyGrouper*
- *WindowGrouper*

Unlike the *Criterion* classes and *Question* classes, the inheritance structure between the Grouper classes has been given to you. You should NOT change the inheritance structure between the *Grouper* classes.

Implement each of the methods in the *Grouper* classes. You may find the function *sort_students* (defined in the course module) helpful.

Remember: you may need to define additional private attributes or private helper methods!

Test your code!

- Write at least one unit test for each method in each of the Grouper classes. You do not need to write tests for abstract methods but you do need to write tests for inherited methods.
- For example, even if you structure your code so that a child class inherits a private helper method without modification from the parent class, you still need to write separate tests for the private helper method in the parent class and the child class.
- You should write these tests in the *tests.py* file.
- Once you have finished writing these tests, run all the tests in *test.py*. Make sure your code passes all your tests before moving on. Run the tests in *example_tests.py*. The tests in the *TestAlphaGrouper*, *TestRandomGrouper*, *TestGreedy* Grouper, and TestWindowGrouper classes should now pass.

A note on writing tests for methods that include randomness

When you test methods that include some randomness, you cannot simply test the return value since it will change from one call to the next. This is where property testing comes in (see the first lecture!).

For example, the tests in *TestRandomGrouper* test the following properties of the *Grouping* instance returned by the *RandomGrouper.make_grouping* method:

- the number of groups in the grouping
- the number of members in each group
- the uniqueness of all members in the grouping

Think about what other properties you could test for when you write your own tests for this class.

Something to think about!

Now that you have written all the code, go back and look at the diagram in Step 1. This is just one possible way to have designed this code. Think about:

- How could we have structured the classes differently?
- What other classes might we want to add to this code in the future?
- Imagine we wanted to add a class that keeps track of all of the courses in a university? How easy would it be to add this new class? Which existing classes (if any) would have to change?

12) Test the Code Again

Now that you have finished writing all the code, go back and run the *example_usage.py* file again. This file should now run without errors.

The *example_usage.py* file will create a course (from the data in *example_course.json*) and a survey (from the data in *example_course.json* and will use that survey to group the students into groups of 2 using the *AlphaGrouper* class. Then it prints the members of each group and an overall score for the grouping.

You may change the group size and the grouper type by modifying the two lines at the bottom of the *example_usage.py* file under this comment:

```
1     # change the two variables below to test your code with different
      group
2     # sizes and grouper types.
```

Why you should write your own tests

The *example_tests.py* file might catch some bugs in your code but it will certainly not catch them all. In order to make sure your code is bug free must write your own unit tests for each method.

Writing tests is also a great way to think about the code in a different way. If you find that you are getting stuck, try writing a test for the method you are stuck on; it just might help!

Also you will be graded on the tests you write so if nothing else you should do it for the marks.