CSI33 Data Structures

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Designing an ADT, OOP version

- Write a specification first. What are the objects in the problem situation? Look for nouns that collect together pieces of information.
- What functions do you need? What are the verbs in the problem description?
- Write a function specification for each function. What does the function need to do?
- Of course you will need a constructor, accessor functions, and a string representation function for each type of object. Mutator functions too.

Implementing the ADT

- What data will you use in an object to represent the ADT? These are the instance variables for an object.
- Once you've decided on the data representation, then write the functions to meet the specification.
- Write the constructor, accessors, and a string representation function first. Those are the basics of an interface to an object.
- Write mutators as needed depending on the ADT details.
- Write any other functions in the specification.

Dataset example

- Dataset.py
- Notice that the specification says to create an empty data set and add elements to it. The Dataset object is active in collecting its entries.
- Do you really need to have all of the data elements in order to define the functions?

Implementation

- How will we store the data? Do we need to store all of the data?
- How will we implement the methods? Can we implement these functions without storing all the data?
- What if we store enough to compute the return values for the methods, but don’t store the all of the data?

Class invariant

- A class invariant is a set of properties that all objects in the class must satisfy.
- When we carryout computations In an object-oriented program, the states of the involved objects will change as the program executes, but the changes must happen in a controlled fashion. An invariant describes some properties and relationships that do not vary during the execution of a program, even though the values of variables change and objects change.
- A class invariant is an assertion that captures the properties and relationships which remain stable throughout the life-time of instances of the class.
- A class invariant:
  - acts as a general strengthening of preconditions and postconditions for methods.
  - expresses a criterion for the object to be valid.
  - must be fulfilled by the constructor.
  - must be maintained by the public methods.

Class invariant

- The class invariant is an assertion which must be true
  - just after the completion of the constructor and
  - in between executions of public operations on the class.
- Think of the class invariant as a criterion for an object to be valid.
- The class invariant must be fulfilled by all objects in between execution of public methods..
- As a precondition of every public method of the class, it can therefore be assumed that the class invariant holds. In addition, it can be assumed as a postcondition of every public operation that the class invariant holds.
- The class invariant serves as a guide to writing methods for the class. The programmer assumes the invariant is true before the method is executed, and writes the program code so that the invariant is again true once the method has executed, even though the method changes the state - the values of instance variables - of the object.

Class invariant for Dataset

- A Dataset object computes statistics for a set of numbers that have been entered into the Dataset. The statistics needed are minimum of elements, maximum of elements, average of elements, standard deviation of elements.
- A Dataset objects will have instance variables:
  - number - the number of elements entered
  - minelt – the minimum of all the elements entered.
  - maxelt – the maximum of all the elements entered
  - sumelts - the sum of all the elements entered
  - sumsqelts – the sum of the squares of all of the elements entered
- The constructor call creates a Dataset object in an empty state. No elements have been entered.
- The add method updates all of the instance variables appropriately taking into account the newly added element.

What is the class invariant for Dataset?

- A Dataset object computes statistics for a set of numbers that have been entered into the Dataset.
- instance variables:
  - number - the number of elements entered
  - minelt – the minimum of all the elements entered.
  - maxelt – the maximum of all the elements entered
  - sumelts - the sum of all the elements entered
  - sumsqelts – the sum of the squares of all of the elements entered
- Constructor creates an empty dataset object, with right values for that state.
- The add method updates all of the instance variables appropriately taking into account the newly added element.

Rational ADT

- An ADT for rational numbers p/q, p and q integers, q not zero.
- Functions – overload all the arithmetic operators and comparison operators

Using the Python List ADT

Unit testing with the Python unittest module

- See example test_Rational.py