ICSI213/IECE213 Data Structures

Project 03 by Qi Wang

The following parts are included in this document:

- Part I: General project information
- Part II: Project grading rubric
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- Part IV: A. How to test?
  B. Project description

Proper use of the course materials including the source codes:

All course materials including source codes/diagrams, lecture notes, etc., are for your reference only. Any misuse of the materials is prohibited. For example,

- Copy the source codes/diagrams and modify them into the projects.
  - Students are required to submit the **original work** for the projects. **For each project, every single statement for each source file and every single class diagram for each design (if any) must be created by the students from scratch.**
- Post the source codes, the diagrams, and other materials online.
- Others

Part I: General Project Information

- All work is individual work unless it is notified otherwise.
- Work will be rejected with no credit if
    - The work is not submitted via Duifene.
    - The work is late.
    - The work is partially or entirely written in Chinese.
    - The work is not submitted properly.
        - Blurry, wrong files, not in required format, crashed files, etc.
    - The work is a copy or partial copy of others' work (such as work from another person or the Internet).
- Students must turn in their original work. Any cheating violation will be reported to the college. Students can help others by sharing ideas, but not by allowing others to copy their work.
- Documents to be included/submitted as a zipped folder:
    - UML class diagram(s) – created with Violet UML or StarUML
    - Java source file(s) with Javadoc style inline comments
    - Supporting files if any (For example, files containing all testing data.)

  Lack of any of the required items or programs with errors will result in a low credit or no credit.

- **How to prepare a zipped folder for work submission?**
    - Copy the above-mentioned files into a folder, rename the folder using the following convention:
      [*Your_first_name*][*your_last_name*]*ProjectNumber*
        - For example*, JohnSmithProject02*
    - Zip the folder. A zipped file will be created.
        - For example*,* a file with name *JohnSmithProject01.zip* will be created*.*
    - Submit the zip file on Duifene.
    - You must submit a project in this format. **Submissions not in the required format may be rejected or will result in a low credit or no credit.**

- **Grades and feedback**: Co-instructors will grade. Feedback and grades for properly submitted work will be posted on Duifene. For questions regarding the feedback or the grade, students should reach out to their co-instructors first. Students have limited time/days from when a grade is posted to dispute the grade. Check email daily for the grade review notifications sent from the co-instructors. **Any grade dispute request after the dispute period will not be considered.**

Part II: Project grading rubric

Project 3: (100 points) **Performance Indicator (PI)**	**LEVELS OF PERFORMANCE INDICATORS**				**Points Earned**
	UNSATISFACTORY	**DEVELOPING**	**SATISFACTORY**	**EXEMPLARY**	
PI1: (10 points) UML design	None/Not correct at all. (0)	Visibility, name, and type/parameter type/return type present only for some members for some classes. Some class relationships are incorrect. (<=5)	Visibility, name, and type/parameter type/return type present for each member for all classes with minor issues, class relationships are correct with minor issues. (<=7)	Visibility, name, and type/parameter type/return type present for each member for all classes without issues, class relationships are correct. (<=10)	
	Instructor's Comments:				
PI2(5 points): Comments (Javadoc format) All tags must be included correctly.	None (0)	Some comments are written properly. (<=2)	Most comments are written properly. (<=4)	All comments are written properly. (<=5)	
	Instructor's Comments:				
PI3(5 points): Variable/method naming	Single-letter names everywhere	Many abbreviations (<=2)	Full words most of the time (<=4)	Full words, descriptive (<=5)	
	Instructor's Comments:				
PI4(20 points): The interface: ADT Stack	No methods are designed correctly. (0)	Some of the methods are designed correctly. Have a lot of issues. (<=5)	Most of the required methods are designed correctly. Have minor issues. (<=15)	All required methods are designed correctly. Have no issues. (<=20)	
	Instructor's Comments:				
PI5(30 points): The arrayList-based implementation of an ADT stack	No methods are implemented correctly. Have a lot of issues. (0)	Some of methods are implemented correctly. Have a lot of issues. (<=10)	Most of the required methods are implemented correctly. Have minor issues. (<=20)	All required methods are implemented correctly. Have no issues. (<=30)	
	Instructor's Comments:				
PI6(20 points):	No methods are tested correctly.	Some of the methods are tested correctly.	Most of the required methods are tested	All required methods are tested	

The driver program and its testing helper class	(0)	Have a lot of issues. (<=5)	correctly. Have minor issues. (<=15)	correctly. Have no issues. (<=20)	
	Instructor's Comments:				
PI7(10 points): Expression class	No methods are implemented correctly. Have a lot of issues. (0)	Some of methods are implemented correctly. Have a lot of issues. (<=5)	Most of the required methods are implemented correctly. Have minor issues. (<=7)	All required methods are implemented correctly. Have no issues. (<=10)	
	Instructor's Comments:				
				Not submitted as a zipped folder	-10
				Total out of 100	
				Total out of 60	

Part III: Examples on complete a project from start to finish

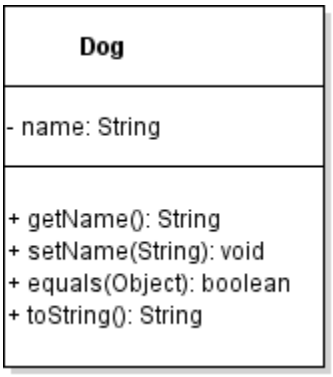
To complete a project, the following steps of a software development cycle should be followed. These steps are not pure linear but overlapped.

Analysis-design-code-test/debug-documentation.

1) Read project description to understand all specifications (**Analysis**).
2) Create a design (an algorithm for method or a UML class diagram for a class) (**Design**)
3) Create Java programs that are translations of the design. (**Code/Implementation**)
4) Test and debug, and (**test/debug)**
5) Complete all required documentation. (**Documentation**)

The following shows a sample design and the conventions.

- *Constructors* and *constants* should not be included in a class diagram.
- For each *field* (instance variable), include *visibility*, *name*, and *type* in the design.
- For each *method*, include *visibility*, *name*, *parameter type(s)* and *return type* in the design.
    - DON'T include *parameter names*, only *parameter types* are needed.
- Show class relationships such as dependency, inheritance, aggregation, etc. in the design. Don't include the driver program or any other testing classes since they are for testing purpose only.
    - Aggregation: For example, if Class A has an instance variable of type Class B, then, A is an aggregate of B.



The corresponding source codes with inline Javadoc comments are included on next page.

```
import java.util.Random;

/**
 * Representing a dog with a name.
 * @author Qi Wang
 * @version 1.0
 */
public class Dog{
    /**
     * The name of this dog
     */
    private String name;

    /**
     * Constructs a newly created Dog object that represents a dog with an empty name.
     */
    public Dog(){
        this("");
    }

    /**
     * Constructs a newly created Dog object wit
     * @param name The name of this dog
     */
    public Dog(String name){
        this.name = name;
    }

    /**
     * Returns the name of this dog.
     * @return The name of this dog
     */
    public String getName(){
        return this.name;
    }

    /**
     * Changes the name of this dog.
     * @param name The name of this dog
     */
    public void setName(String name){
        this.name = name;
    }

    /**
     * Returns a string representation of this dog. The returned string contains the type of
     * this dog and the name of this dog.
     * @return A string representation of this dog
     */
    public String toString(){
        return this.getClass().getSimpleName() + ": " + this.name;
    }

    /**
     * Indicates if this dog is "equal to" some other object. If the other object is a dog,
     * this dog is equal to the other dog if they have the same names. If the other object is
     * not a dog, this dog is not equal to the other object.
     * @param obj A reference to some other object
     * @return A boolean value specifying if this dog is equal to some other object
     */
    public boolean equals(Object obj){
        //The specific object isn't a dog.
        if(!(obj instanceof Dog)){
            return false;
        }
        //The specific object is a dog.
        Dog other = (Dog)obj;
        return this.name.equalsIgnoreCase(other.name);
    }
}
```

Class comments must be written in Javadoc format before the class header. A **description** of the class, author information, and version information are required.

Comments for fields are required.

Method comments must be written in Javadoc format before the method header. The first word must be a verb in title case and in the **third** person. Use punctuation marks properly.

A description of the method, comments on parameters if any, and comments on the return type if any are required.

A Javadoc comment for a formal parameter consists of three parts:
- parameter tag,
- a name of the formal parameter in the design ,
  (The name must be consistent in the comments and the header.)
- and a phrase explaining what this parameter specifies.

A Javadoc comment for return type consists of two parts:
- return tag,
- and a phrase explaining what this returned value specifies

More inline comments can be included in single line or block comments format in a method.

Part IV:

A. How to test?

There can be many classes in a software design. **A UML class diagram should contain the designs of all classes and the class relationships (For example, is-a, dependency, or aggregation).**

- First, test each class separately in its own driver.
  - Create instances of the class (If a class is abstract, the members of the class will be tested in its subclasses.). For example, the following creates Dog objects.

    Create a default Dog object.

    ```
    Dog firstDog = new Dog();
    ```

    Create a Dog object with a specific name.

    ```
    Dog secondDog = new Dog("Sky");
    ```

  - Use object references to invoke instance methods. If an instance method is a value-returning method, call this method where the returned value can be used. For example, method getName can be called to return firstDog's name. You may print the value stored in firstDogName to verify.

    ```
    String firstDogName;
      …
    firstDogName = firstDog.getName();
    ```

  - If a method is a void method, invoke the method to simply performs the task. Use other method to verify that the method performs the task properly. For example, setName is a void method that changes the name of this dog. After this statement, the secondDog's name is changed to "Blue".

    ```
    secondDog.setName("Blue");
    ```

    Print the return value from getName to verify that the name has been changed correctly.

  - Repeat until all methods are tested.

- Next, test the entire design by creating a driver program and a helper class for the driver program. When completing these two classes, you will test and learn how to use the classes (e.g., Dog class) that you have designed. You may choose different identifiers for the class names. For this project, Driver and Helper are used as the class identifiers.
  - Create a helper class for the driver. The helper class can begin with the following three static methods.

```
public class Helper{
    public static void start(){
            This void method is decomposed into a few tasks:
            Create an empty list.
            Fill the list by calling create with a reference to the list.
            Print the list by calling display with a reference to the list.
           …
    }

    public static returnTypeOrVoid create(a reference to a list) {
            Create objects using data from an input file and store the objects into the list.
            …
    }

    public static returnTypeOrVoid display(a reference to a list) {
            Display the objects of the list.
           …
    }
   …
}
```

- Create a driver program. In *main* of the driver program, call *start* to start the entire testing process.

```
public class Driver{
   public static void main(String[] args){
         Helper.start();
   }
}
```

- There are more methods than what are invoked/tested by the previous three methods. You may add more statements in the methods or write additional methods to test the rest of the methods for all classes.
- **T**he driver and its helper class are for testing purpose only. They should not be included in the design diagram. But you will need to submit their source codes.

B. Project description

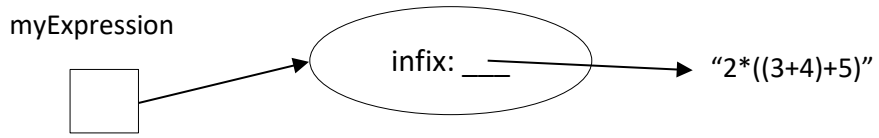
An expression evaluator

For this project, you will create an arithmetic expression evaluator. Assume that all arithmetic expressions are in valid format. An arithmetic expression contains tokens such as arithmetic operators (addition, subtraction, multiplication, and division), integer operands, spaces, and parentheses. For example, the first 5 expressions without spaces will result in 24. The last three expressions with spaces will result in 264, 264, 374, respectively.

2*((3+4)+5)
2*(3+(4+5))
2*((3+5)+4)
2*(3+(5+4))
2*((4+3)+5)
22 * ((3+4)+5)
22 * ((3 + 4) + 5)
22 * ((3 + 4) + 10)

To represent an arithmetic expression, *Expression* class needs to be designed. Each expression object contains an *infix*, a string. For example, the infix expression 2*((3+4)+5) can be represented as an *Expression* object like this

```
Expression myExpression = new Expression("2*((3+4)+5)");
```



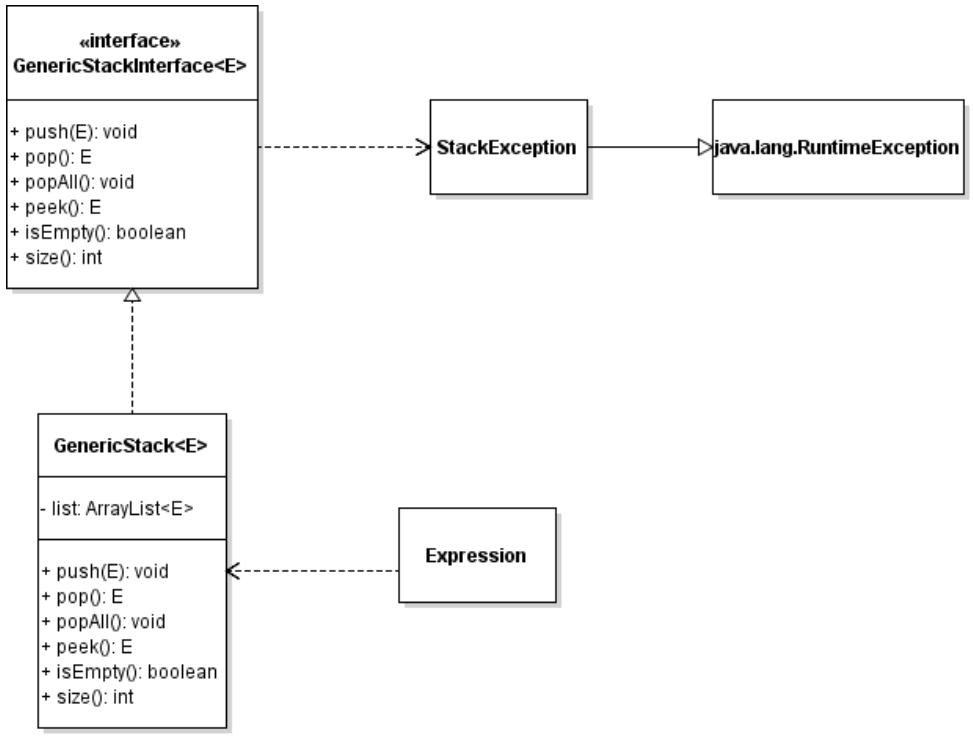
Specifications:

- A generic *ADT Stack*:
  To convert an infix to postfix or to evaluate a postfix, a stack is required. For this project, a generic *ADT Stack* implemented with *an array list* must be created and used. It is not allowed to use a Java JCF stack or any other stacks. The major operations of the generic ADT stack are shown on the next page.
- *Expression* class:
  - An instance variable for the *infix*
  - Overloading constructors
  - Getter/setter for the *infix*

- The following two instance methods must the *ADT stack* from the previous step.
  - An instance method that converts *this infix* to postfix and returns the postfix as a list of tokens
    - Use the *infix to postfix* algorithm discussed in class.
    - When splitting an infix into tokens, you should not use *charAt* method and expect all operands are single-digit tokens. Instead, you should split the infix by choosing proper delimiters. One way is to use operators, spaces and parentheses as delimiters and use them as tokens. Please check *StringTokenizer* class for proper methods that can be used.
  - An instance method that evaluates *this infix* and returns the result.
    - First, call the previous method to convert this infix to postfix.
    - And then, evaluate the postfix and return the result. Use the *postfix evaluation* algorithm discussed in class.
- Overridden *equals* and *toString*
- …

Design:

Complete the design that meets all the requirements. The following shows part of the design.



Code:

A generic *ADT Stack* implemented with *an array list* must be designed and used for this project. When using an instance of this stack to store tokens of an Expression object, the *type parameter* can be replaced with *String*. Each token of an *Expression* object can be represented as a *String* object.

Debug/Testing:

Note: It is required to store all testing data in an input text file.

It is not efficient to write everything in *main*. Method *main* should be small and the only method in a driver program.

- Create a driver program. In *main* of the driver program, call method *start* of the driver's Helper class(below) to start the entire testing process.

```
public class Driver{
   public static void main(String[] args){
        Helper.start();
 }
}
```

A helper class for the driver can begin with the following three methods.

- Create a helper class of the driver program with following methods included.

```
Public class Helper{
  public static void start(){
```

This void method is decomposed into a few tasks:
Create an empty array list that will be used to store a list of *Expression* objects.
Call *create* method with a reference to the list so that *create* will add expression objects into the list.
Call *display* method with a reference to the list so that *display* will print the list of expression objects.
Call *otherMethods* with a reference to the list for more testing.

```
  }

  public static returnTypeOrVoid create(A reference to an array list){
```

Create expression objects using data from an input file and store the objects into the list.
While there are more lines (You will use *hasNextLine* instead of *hasNext*.),
Read the next line from the input file as a string, create an expression and add it to the list.
Note: This will test the constructors.

```
  }

  public static returnTypeOrVoid displayAndMore(A reference to an array list){
```

Print the list of expressions as both infix and postfix.
Print the values of the list of expressions.

```
  }
}
```

- There are more methods than what are invoked/tested by the previous three methods. You may add more statements in the methods or write additional methods to test the rest of the methods for all classes. Can you create another static method that test other operations?

```
  public static returnTypeOrVoid otherMethods(a reference to a list){…}
```

The driver and its helper class are for testing purpose only. They should not be included in the UML design diagram. But you will need to submit their source codes.

The sample testing file may contain items like this. Add more expressions to the end of the list.

2*((3+4)+5)
2*(3+(4+5))
2*((3+5)+4)
2*(3+(5+4))
2*((4+3)+5)
22 * ((3+4)+5)
22 * ((3 + 4) + 5)
22 * ((3 + 4) + 10)

Documentation:

Complete all other documents needed.