Calculator

Due 8 October

Assignment 5
CSC 062: Fall, 2017

Objectives

For this assignment you will:

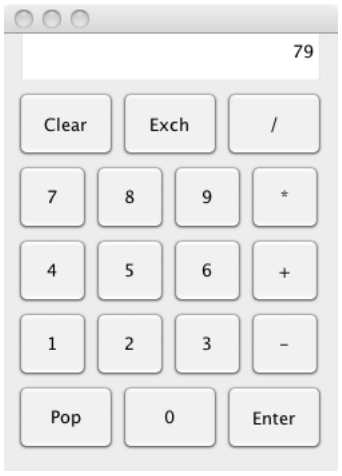
- Gain practice using the Stack data structure
- Implement an ActionListener
- Gain more practice with Java GUIs and events
- Gain more experience with unit testing

Description

Your next program is to implement a postfix calculator application. The calculator should take expressions input in postfix notation and display the results of the computation.

In postfix notation, the operator comes after the operands. For example, the expression 3 + 5 would be written as 3 5 +. As another example, the expression 52 - (5 + 7) * 4 would be written as:
52 5 7 + 4 * -

It is not necessary for this assignment that you know how to convert from infix to postfix since you can assume that the user of your calculator will input all expressions in postfix notation. You are only responsible for evaluating such expressions and displaying the result.



Lets look at a few examples of evaluating postfix expressions using your calculator. To evaluate the postfix expression `5 3 +` (which is `3+5` in normal infix notation), click on `3, enter, 5, +`. The enter button is used to signal the end of a number being input. Without the enter, we would not know whether the user was inputting the number 3 or the number 35. The user can also click on an operator button to signal the end of a number being input. Notice that in our example the user clicked the enter button only after the digit 3. After the digit 5, the user clicked the + button. When we see the + button, we know the user has finished entering a number and we can now add those numbers together. The answer should then be displayed.

Here is another example. To calculate `3+5*7` (which is written `3 5 7 * +` in postfix notation), click on `3, enter, 5, enter, 7, *, +`. Again, note that the only thing clicking `enter` does is to signal the end of the number being input.)

A version of this program running as an applet can be found at
`http://www.cs.pomona.edu/classes/cs062/assignments/demos/CalculatorApplet/CalculatorApplet.html`.

Classes

There are four classes for this project: `Calculator`, `State`, `DigitButtonListener`, and `OpButtonListener`, where the last three implement the `ActionListener` interface. Of these 4 classes, you are expected to complete the `DigitButtonListener` class and the `State` class.

Once you have both of these classes working properly, you must add one or more new buttons to the calculator.

Possibilities include a squaring button, factorial, or xy. You should add the new button so that it looks nice, add an appropriate listener (created from OpButtonListener if you like), and make sure that the state knows how to handle that operation.

Calculator class

We have provided you with the code for the main `Calculator` class. This relieves you of the burden of layout of the buttons and display of the calculator.

We have also provided listeners for the clear, pop, and enter buttons. Recall that listeners for `JButton`s consists of an object from a class that implements `ActionListener`, where `ActionListener` is an interface with only one method, `actionPerformed(ActionEvent evt)`. Because this interface has only a single method we can use a lambda expression with the body of the method as the listener:

```
clearButton = new JButton("   Clear        ");
clearButton.addActionListener((ActionEvent evt) -> {calcState.clear();});
topPanel.add(clearButton);
```

The code that is an argument for `addActionListener` is the body of the `actionPerformed` method if we wrote it out the long way. We can see that it takes an `evt` parameter and then simply calls the `clear` method on the state. The listeners for the pop and enter buttons are similar.

OpButtonListener class

The listeners for operation buttons (plus, times, etc.) are more complicated, so it is easiest to write out the full listener class.

The `OpButtonListener` is a listener class for the operation buttons: +, -, *, /. When a listener is set up for one of these operations, the listener takes as a parameter the operation that it is responding to so that it knows what operation to respond to. When the button is pressed, the listener sends a `doOp` to `calcState` with a string representing the operation to be performed. The state should then pop the top two elements off of the stack, perform the operation on them (make sure you get the order of the operands correct) and then push the answer back on the stack.

Read through the `OpButtonListener` class until you are confident that you understand how it operates. This class provides a useful example for you when you are implementing the `DigitButtonListener` class.

DigitButtonListener class

This class contains the code to be executed when the user clicks on a digit button. Make sure you understand how the `DigitButtonListener`s are being used in the Calculator class. Each digit key has its own specialized DigitButtonListener which is responsible for knowing which number key it is listening to. When a button is clicked, the code in the `actionPerformed()` method is executed. This methods should inform the state what digit has been clicked on so that the state can use the digit to build the number being typed in.

StateTest JUnit class

`StateTest` is a `JUnit` test class for the `State` class. It is partially written for you. You must finish writing unit tests for the remaining methods i.e. you must fill in the unit tests for the methods that are not yet implemented. As you probably discovered in last weeks assignment, its not uncommon to have multiple unit tests for a single method. In the same way, feel free to add additional unit tests to the StateTest class.

State class

A `State` object represents the memory of the calculator. You may think of it as representing the printed circuit and memory in the calculator. Its purpose is to keep track of the current state of the computation. For instance, it has to keep track of whether the user is entering a number, and what the number is so far. It must also keep track of the display window of the calculator (a `JTextField` that displays the current state of the calculator).

The most important feature of the State is its stack, which represents those numbers stored on the calculator. Use `java.util.ArrayDeque` rather than writing your own stack.

Lets look at how you would evaluate the example from earlier (3, enter, 5, +). First, you must keep track of the number being constructed. When the enter button is clicked, you know this number is complete. We would then push the number, 3, onto the stack. The next number is a 5. We would push this number onto the stack as well. Finally, since the user clicks + we would pop the two numbers off the stack, add them to get 8, and then push 8 back onto the stack.

Here are some more details:

- If the enter button is clicked, the current number being constructed is complete. This new number is stored on top of the stack with any previous numbers sitting below.
- If an operator button is clicked, and there are at least two elements on the stack, then the top two elements are popped off, the operation is performed, and the answer is pushed back on top of the stack. The calculator display always shows the number on top of the stack. Make sure that you perform the operation on the numbers in the correct order!
- If the user makes a mistake, e.g. dividing by 0 or trying to perform an operation when there are fewer than two elements on the stack, then the display should show Error and the calculator should be reset. You can detect divide by zero yourself or let the system throw an ArithmeticException when a divide by zero occurs. Either way, you must handle the error (i.e., your program should not crash and no ugly red stuff) and have the display show Error.
- If the clear button is clicked, the calculator is cleared and reset.
- If the pop button is clicked, and you are currently building a number, then that number should be thrown away. Otherwise, if the pop button is clicked, then the top element of the stack should be popped and thrown away. The calculator display should be updated to show the new top element of the stack (or zero if the stack is empty). It is not considered an error if the user pushes the pop button when there is nothing on the stack. Just ignore the event.
- If the exch button is clicked, you should exchange the top two elements of the stack. It is not considered an error if the user clicks the exch button and there are fewer then two elements on the stack. Just ignore the key press.
- If the stack is empty, the display should show 0.

Getting Started

1. All startup code is available in /common/cs/cs062/assignments/assignment05. You can copy the starter code using Finder as usual, or you can use the command line (after creating an Eclipse project named Assignment05):

```
cp -r /common/cs/cs062/assignments/assignment05/* ~/Documents/cs062/workspace/Assignment05/src
```

A quick note about shell commands for the curious: shell commands consist of arguments separated by spaces. So the above command has three arguments:

- `-r`

- `/common/cs/cs062/assignments/assignment05/*`
- `~/Documents/cs062/workspace/Assignment05/src`

The `cp` command takes all of its arguments except the last one, and copies them into the directory specified by the last argument. The -r argument is called a flag, switch, or option and tells the cp program to trigger some special behavior (in this case, copy things recursively, so target all subdirectories and files under the source file(s) given).

You can use the command `man <program>` to see information about what flags a program accepts and what they do, and most programs also accept either `-h` or `--help` and will print out some help text if you give them that argument. Now the * character in the second argument is special: before calling the `cp` program, the shell application will take the * wildcard character and replace any argument containing it with all possible arguments that fit the pattern given, where the * can be replaced by any valid file or folder. So this command will target all of the files in the assignment05 directory.

The ~ character is also special: the shell replaces it with the current users home directory. The cool thing about the command line is that you can write a bunch of commands into a file, and then run that file as a script. Essentially, when you use the shell, you are programming. Accordingly, the shell supports things like variables (using $ signs) and you can use it to automate any common task you do on your computer. In fact, if you open up the submit script, youll see that it just contains a bunch of shell commands.

2. You might find it easier to write the code first under the assumption that the user must push the "enter" button after punching in each number. However, for full credit, it should also handle the case where the user punches in a number followed immediately by an operation. The result should be equivalent to sticking in an intervening "enter". That is punching in `5, enter, 7, +` should give the same results as `5, enter, 7, enter, +`. (Think about what pressing the enter key actually does. What is the difference between pressing `3 7` and `3 Enter 7`? It makes a difference.)

Grading

You will be graded based on the following criteria:

criterion	points
`JUnit` tests for each method in State	3
Digits and "Enter" handled appropriately	3
Arithmetic operations handled correctly	3
Appropriately handle errors and show message	2
Misc keys handled correctly	3
Digit listener	2
Extra method/calculator functionality	2
appropriate comments (including JavaDoc)	3
style and formatting	2
Submitted correctly	1
Extra credit	2

Submitting your work

Export your project from Eclipse and submit it as usual using the instructions at `http://www.cs.pomona.edu/classes/cs062/handouts/eclipse_submission.pdf`. Please follow these very carefully. If you do not, your program will NOT be submitted correctly and you will not receive credit for your assignment (and you and we will all be very sad!). Dont forget to fill out the `asg05.json` file! In particular, don't forget to set the `ec` field to true if you did extra credit.

The Next Step

If you are interested in extra credit, I suggest that you add a decimal point button so that your calculator can handle floating point numbers. Be sure to check that the user does not input an illegal number (e.g., with two decimal points). Possibilities for new buttons with this include square root, trig functions (e.g., sin, cos, tan, etc.), inverse trig functions, x^y, e^x,factorial, inverses, or logarithms.

See the class Math in package `java.lang` for a list of available mathematical functions in Java. Make sure the basic functions of your calculator are working correctly before moving on to extra credit. You may find the floating point does not work with the auto-grader compatibility test this is fine, but please name your folder `Assignment05_Name_ExtraCredit` and set the `ec` field in your `asg05.json` file to true so that we can look out for that.