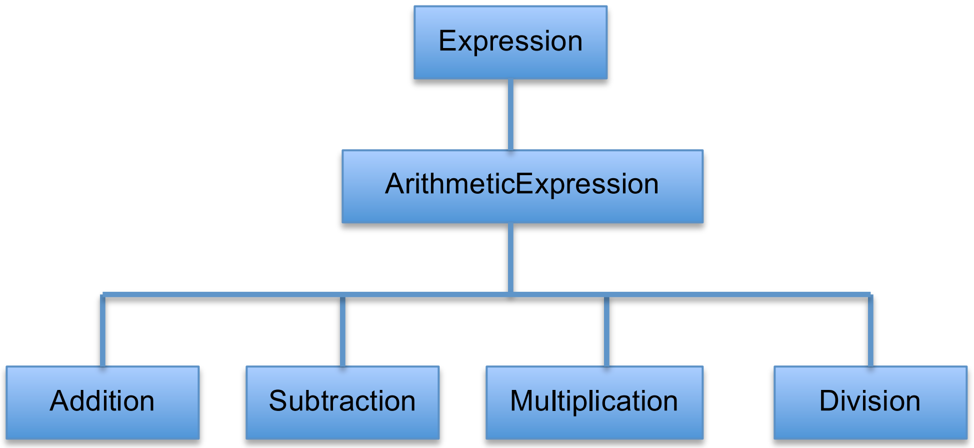
SfwrEng/CompSci 2S03 Fall 2015 Homework 6

In a **group of 3**, you are to implement a calculator in C++ that is capable of evaluating basic arithmetic (+, -, *, /) expressions. You may work in a different group of 3 from HW4. The system shall take as input a string of **integer** arithmetic expression, e.g (1 * 2 / (4 + 5))/9. It will (1) check if the input is valid, (2) parse the input into expression tree, and (3) evaluate the expression.

Class-Hierarchy

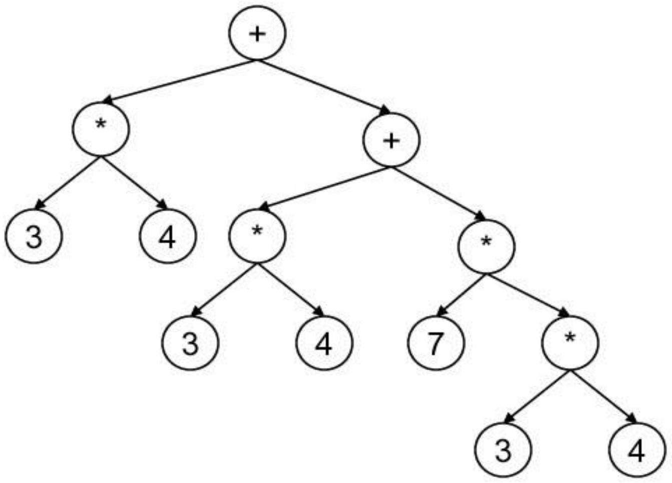


```
class Expression{
      virtual string evaluate(); // evaluate expression and return string
                                    representation of the result.
      virtual void print(); // prints expression

}
class ArithmeticExpression : public Expression{
      Expression *left;
      Expression *right;
      string evaluate (){ //evaluate left expression and right expression
      void print(); // prints expression
            …
      }
      float convert (string s){ // Converts a string (as would be returned by
evaluate) to a float
      }
}
//Add two expression
class Addition: public ArithmeticExpression{
      string evaluate(){ … }
      void print(){ … } // (left `+` right)
}
//Subtract two expression
class Subtraction: public ArithmeticExpression{
      string evaluate(){ … }
      void print(){ … }  // (left `-` right)
 }
```

```
//Multiply two expression
class Multiplication: public ArithmeticExpression{
      string evaluate(){ … }
      void print(){ … }  // (left `*` right)
 }
//Divide two expression
class Division: public ArithmeticExpression{
      string evaluate(){ … }
      void print(){ … }  // (left `/` right)
 }
```

Expression Tree of expression (3*4) + ((3*4) + (7* (3*4))) is the following



This expression tree should be constructed by dynamically allocating appropriate objects of Expression classes.

Main method

You should create a file named HWK6_MACID.cpp which contains a main function that does the following:

- Reads the **integer** arithmetic expression as a string from the standard input
- Parses that string into an Expression tree. Expression objects should be created dynamically. If an input string is invalid (e.g., +2*3-), only print `“Expression is not well formed”`.
- When the input string is successfully parsed, the program should evaluate the resulting expression by calling `Expression::evaluate()` of the **top** `Expression` object. This should recursively evaluate the entire expression. The result should be shown as a floating point number with 2 decimal points. We are not concerned with division by zero errors.
- Prints the original string by calling the `Expression::print()` of the **top** `Expression` object, then an equal sign, followed by the final result of the evaluation. Again, printing

should be accomplished recursively. The print function does not have to print the input formula in the same format. It should be of the form:

“(“ left expression op right expression “)”

- Deallocates all dynamically created objects appropriately. If your program exhibits memory leaks, you will lose points.
- Will repeat this process until the string ‘#’ is received, at which point execution will terminate.

Requirements

- Evaluation should follow the correct order of operations (left to right). For Arithmetic expressions the order is BEDMAS.
- Keep results rounded to 2 decimal points when applicable
- You should follow the class hierarchy (names, inheritance, member functions, etc). You should not change the signature of member functions. However, you can add new private member variables and functions.

Example

```
Please enter an expression: 1 + 2 + 3 + 4

1 + 2 + 3 + 4 = 10

Please enter an expression: 1 + 2 / 3 + 4

1 + 2 / 3 + 4 = 5.67

Please enter an expression: (1 + 2) / 3 + 4

(1+2) / 3 + 4 = 5

Please enter an expression: 1 + 2 / * 3 + 4

Expression is not well formed

Please enter an expression: #
```

Submission

__Only one submission per group__

All files are to be submitted using the Avenue system. Please ensure you submit all files with the correct names, as described below:

- Upload a **ZIP** file named HWK6_MACID.zip
  - NOTE: the folder zipped must also be named HWK6_MACID, where MACID is the MACID of the submitting member.

The ZIP file must contain the following .cpp source files:

- HWK6_MACID.cpp (contains the main function)
- Expression.cpp
- Expression.h
- ArithmeticExpression.cpp
- ArithmeticExpression.h
- Addition.cpp
- Addition.h
- Subtraction.cpp
- Subtraction.h
- Multiplication.cpp
- Multiplication.h
- Division.cpp
- Division.h

- If you wish to have additional classes and, hence, cpp/h files, you have to submit a Makefile at your own responsibility; i.e., if the Makefile does not work properly, the program is deemed as incorrect.
- If you don't follow the above naming convention, you will receive no credit.
- If your program does not compile, you will receive 0. Your files must be submitted **by 8:30am Dec. 12, 2015,** on Avenue to Learn.

Documentation

Your program must be commented properly: each section of the code as well as each line.

Format

The following preamble **must** be written at the top of each .cpp source file:

/*
 * **Name:** [Full name of (no nicknames or chosen names) of each group member]
 * **MacID:** [MacIDs of all group members]
 * **Student Number:** [Student number of all group members]
 * **Description:** [This is an informative excerpt about this file.]
 ***/**

<u>Failure in meeting this format and file naming convention will result in 0 credit.</u>

Extra credit

If \`@' is entered, then the last expression should be re-evaluated by incrementing all numbers in the expression. For example, if the last entered expression was (3+4)*9, then upon entering \`@', (4+5)*10 will be evaluated. To this end, you need to implement the following:

- `Exresssion *NewExp = new Expression(OldExp);`

- `NewExp -> increment();`
- `NewExp -> evaluate();`

The first line should clone the entire old expression tree in the copy constructor, where `OldExp` is the last entered expression. Then, `increment()` will increment all numbers in the expression and `evaluate`() will re-evaluate the new expression. Of course, one can enter \`@' multiple times.