

## A Simple Calculator

Write a C++ program that implements a simple arithmetic calculator. Input to the calculator consists of lines composed of real numbers, combined with arithmetic operators: +, −, \*, /. The arithmetic expressions in input lines are given in *postfix* forms, which eliminates the need of using parentheses.

You can use a stack container (of type double) to evaluate a *postfix* expression. The main () routine defines an empty stack and gets the input from the stdin token by token until the EOF, where a token is defined as a C++ string that doesn't contain any white spaces. For each token in the input stream, it calls the following routine to process the token.

- **void process\_token (const string& token, stack < double >& S):** Inspects each character in token in sequence and takes the proper action for the inspected character in token. If the character is a digit, a unary −/+ sign that can be determined by the *predicate* unarySign (), or a valid decimal point that can be determined by the *predicate* floatPoint (), it calls the routine getNumber () to get all characters of the corresponding number from token (whose description and the descriptions of the two helper functions in this process are given below) and puts the number in stack S.
- **bool unarySign (const char& c, const string& token, const unsigned& i):** Checks if the character c in position i in token is a valid unary −/+ sign, which is considered valid if it's not the last character in token and the character follows it is either a digit or a decimal point.
- **bool floatPoint (const char& c, const string& token, const unsigned& i):** Checks if the character c in position i in token is a valid decimal point, which is considered valid if it's not the last character in token and the character follows it is a digit.
- **double getNumber (const char& c, const string& token, unsigned& i, const bool& floatPointFlag):** Starts with the character c in position i in token and constructs a double-precision floating number from a set of consecutive characters in token. It also counts the total number of decimal points in the corresponding number, and in case that the number contains more than one decimal point, it indicates the error by printing out an error message on stderr. Otherwise, it calls the routine stringToDouble () to convert the processed substring to a number and returns to the routine process\_token (). The last argument floatPointFlag indicates if c is a decimal point.

If a character inspected in the routine process\_token () is a valid binary operator that can be determined by the *predicate* isValidOperator (), then it pops two top numbers from stack S, computes the corresponding operation on these numbers by calling the

helper function operation (), and puts the resulting number in stack S. To pop a number from stack S, routine popStack () can be used.

- **bool isValidOperator (const char& c):** Checks if the character c is one of the four valid operators in {+, -, \*, /}.
- **double operation (const char& c, const double& x, const double& y):** Applies the operator c on numbers x and y and returns the resulting number to the calling routine.
- **double popStack (stack < double >& S):** Checks if stack S is empty, and if it's, it prints out an error message on stderr to indicate the error. Otherwise, it removes and returns the number at the top of stack S to the calling routine.

If a character inspected in process\_token () is an equal sign (=), it calls printResult () to print out the number at the top of stack S, and if the character is 'c', it calls emptyStack () to empty stack S. If the inspected character is not part of a number and if it's not one of the valid operators, it prints out an error message on stderr to indicate the error.

- **void printResult (const stack < double >& S):** Checks if stack S is empty, and if it's, it prints out an error message on stderr to indicate the error. Otherwise, it prints out the top number in S on stdout by exactly two digits after the decimal point.
- **void emptyStack (stack < double >& S):** Pops the top element from stack S and continues by popping the top element until S becomes empty.

This is an interactive calculator, so you can enter numbers (positive or negative) and operators from the keyboard, and in case of an error, your program needs to print out an error message on stderr, but it doesn't stop the execution. Execution is terminated only when you enter <ctrl>-D from the keyboard.

Put the declarations of all routines that you use in your program in the header file prog7.h, and the implementation of all routines in the source file prog7.cc. At the top of your source file, insert the following statement: #include "prog7.h".