## Introduction

This project demonstrates the implementation of a Python program that evaluates mathematical expressions using the stack data structure. The program reads expressions from an input file, processes them using a stack-based algorithm, and writes the evaluated results into an output file. This approach shows the importance of stacks in handling arithmetic operations, operator precedence, and parentheses effectively.

## Data Structures Used

The Stack data structure follows the Last In First Out (LIFO) principle, meaning the last element added is the first one removed. Stacks are particularly useful for parsing expressions and managing nested operations, such as parentheses. In this project, two stacks are used: one for operands (numbers) and another for operators (+, -, \*, /).

During expression evaluation, when an operator is encountered, it is compared with the top of the operator stack. If the precedence of the current operator is less than or equal to the operator on the stack, the program pops the top operator and applies it to the top two operands from the value stack.

## Program Design

The program design follows a modular approach with the following main components:

• Stack class – Implements push, pop, peek, and is\_empty functions.  
• evaluate\_expression() – Parses and evaluates each mathematical expression.  
• process\_files() – Reads expressions from input.txt and writes results to output.txt.

**Simplified Flowchart:**

A diagram of a process flow

AI-generated content may be incorrect.

**Testing and Results**

The program was tested using an input file containing several arithmetic expressions. Each expression was evaluated correctly, and the results were written to the output file. The program was tested using a sample input file (input.txt) containing several arithmetic expressions separated by dashed lines (-----). Each expression was evaluated correctly using the stack-based algorithm, which ensured proper handling of **operator precedence** and **parentheses**.

Below are sample test cases:

**Input File (input.txt):**  
3 + 5 \* 2  
-----  
(8 / 4) + 7 \* 2  
-----  
10 - (2 + 3) \* 4

**Expected Output (output.txt):**  
13  
-----  
17  
-----  
-10.

**Test Data**

**Input File (input.txt):**

3 + 5 \* 2

-----

(8 / 4) + 7 \* 2

-----

10 - (2 + 3) \* 4

**Execution Process**

* The program reads each line of the input file.
* If a line contains a separator (-----), it writes the same to the output file.
* If a line contains an arithmetic expression, it:
  1. Removes spaces and validates characters.
  2. Converts the expression into an evaluable format using stacks.
  3. Performs calculations while respecting operator precedence.
  4. Writes the computed result to the output file.

**Expected Output (output.txt):**

13

-----

17

-----

-10

**Result Summary**

All test cases produced the correct output. The results confirmed that:

* The stack operations (push, pop, and peek) functioned correctly.
* The program successfully handled **nested parentheses** and **mixed operators**.
* Output formatting matched the assignment requirements.

Overall, the testing phase verified that the expression evaluator works as intended, providing **accurate and consistent results** for different input scenarios.

**Conclusion**

In conclusion, this project successfully demonstrates how the **stack data structure** can be used to evaluate arithmetic expressions in Python. By implementing separate stacks for operands and operators, the program efficiently manages operator precedence and parentheses during computation. The approach ensures accuracy in handling complex mathematical expressions and provides a clear understanding of how stacks operate in real-world programming problems.

This project highlights how stacks simplify the evaluation of arithmetic expressions by maintaining operator precedence and managing parentheses. The stack-based approach ensures accurate and efficient computation, demonstrating the practical importance of stack data structures in computer science.

Furthermore, the project reinforces the importance of **data abstraction**, **modular programming**, and **algorithmic thinking** in problem-solving. Through this exercise, the principles of **Last-In-First-Out (LIFO)** behavior, **data manipulation**, and **structured programming** have been practically applied. Overall, this implementation not only deepens conceptual knowledge of data structures but also strengthens foundational programming skills essential for advanced computer science applications.

**References**

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