DEPARTMENT OF SOFTWARE ENGINEERING
FALCULTY OF COMPUTER SCIENCE AND ENGINEERING
HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY - VNU-HCM


# Computer Architecture

# (CO2007)

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## Assignment

## Convolution Operation in MIPS Assembly

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# Contents

# 1 Introduction

Convolution is a fundamental operation in signal processing and image processing, widely used in various applications such as filtering, edge detection, and feature extraction. This report presents the implementation of a convolution operation using MIPS assembly language. The program reads input data from a file, performs convolution on an image matrix with a kernel matrix, and outputs the resulting matrix. The implementation includes handling of padding and stride, as well as error checking for invalid inputs.

# 2 Program Overview

1. Read Input Data
2. Validate Input
3. Calculate Output Size
4. Convolution Operation
5. Output Results

# 3 Program Flow and Logic

## 3.1 Main Flowchart

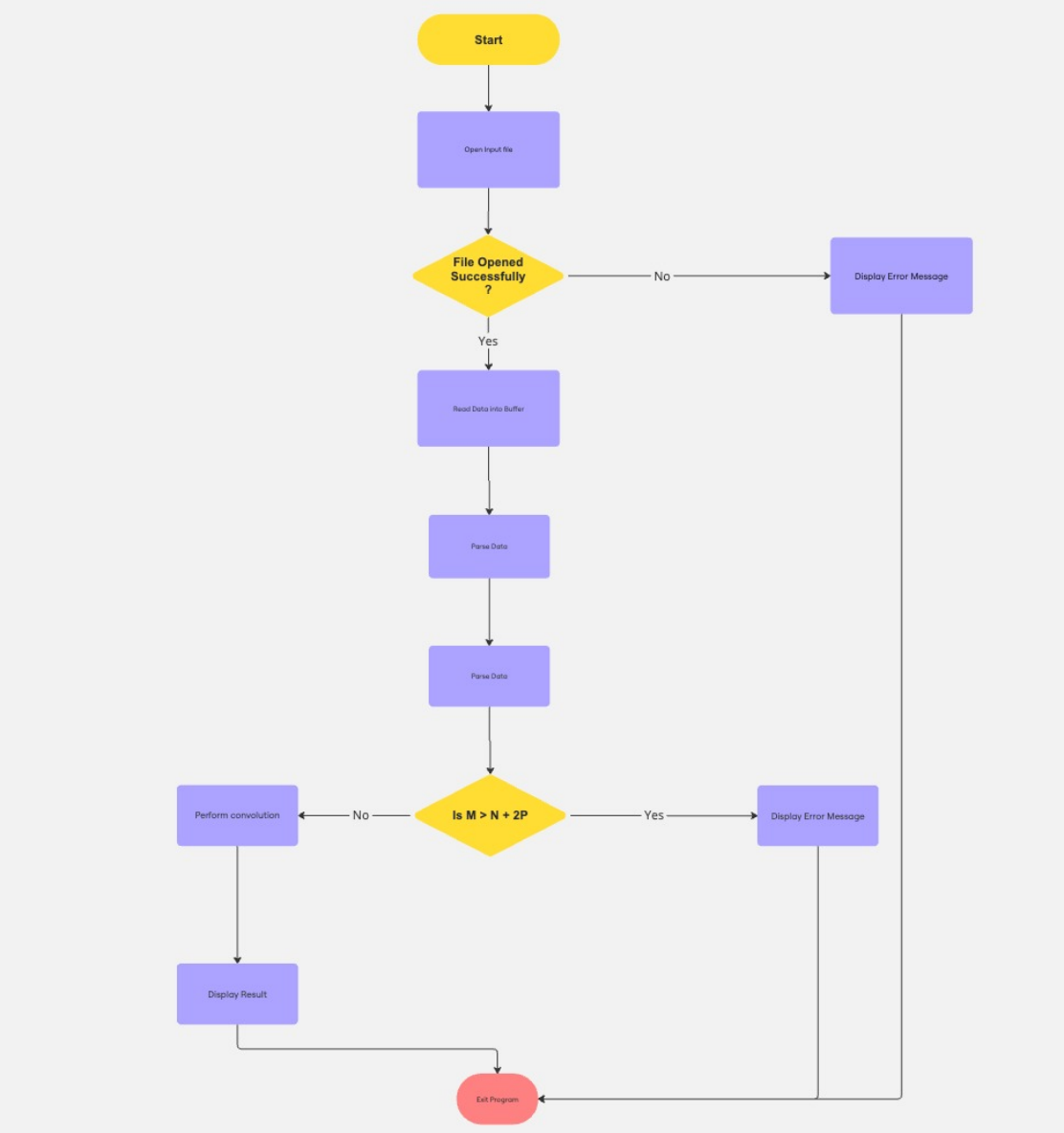


Figure 1. Main program Flowchart

## 3.2 Use Stack in mips code

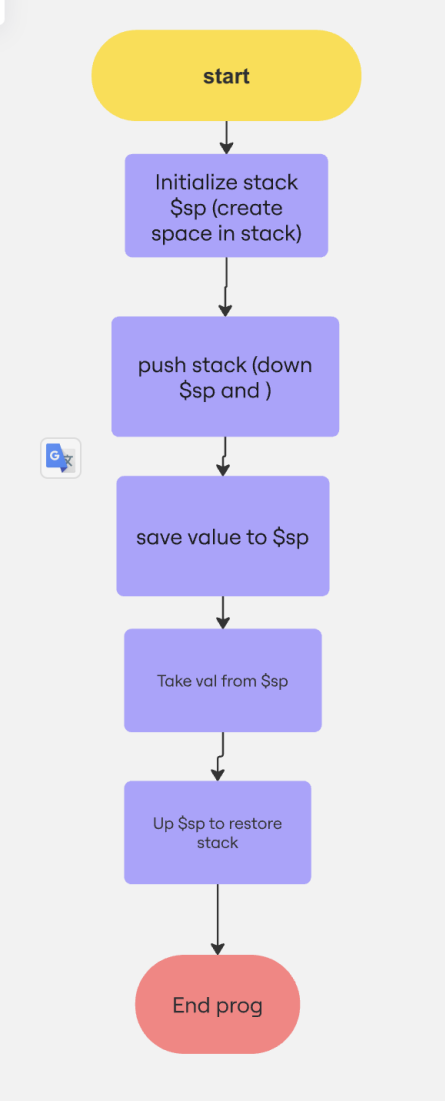


Figure 2. Stack in mips

## 3.3 Calculate Output size

- Computes the size of the output matrix using the formula:

$$\text{outputSize} = \left(\frac{N + 2P - M}{S}\right) + 1$$

- Flowchart:

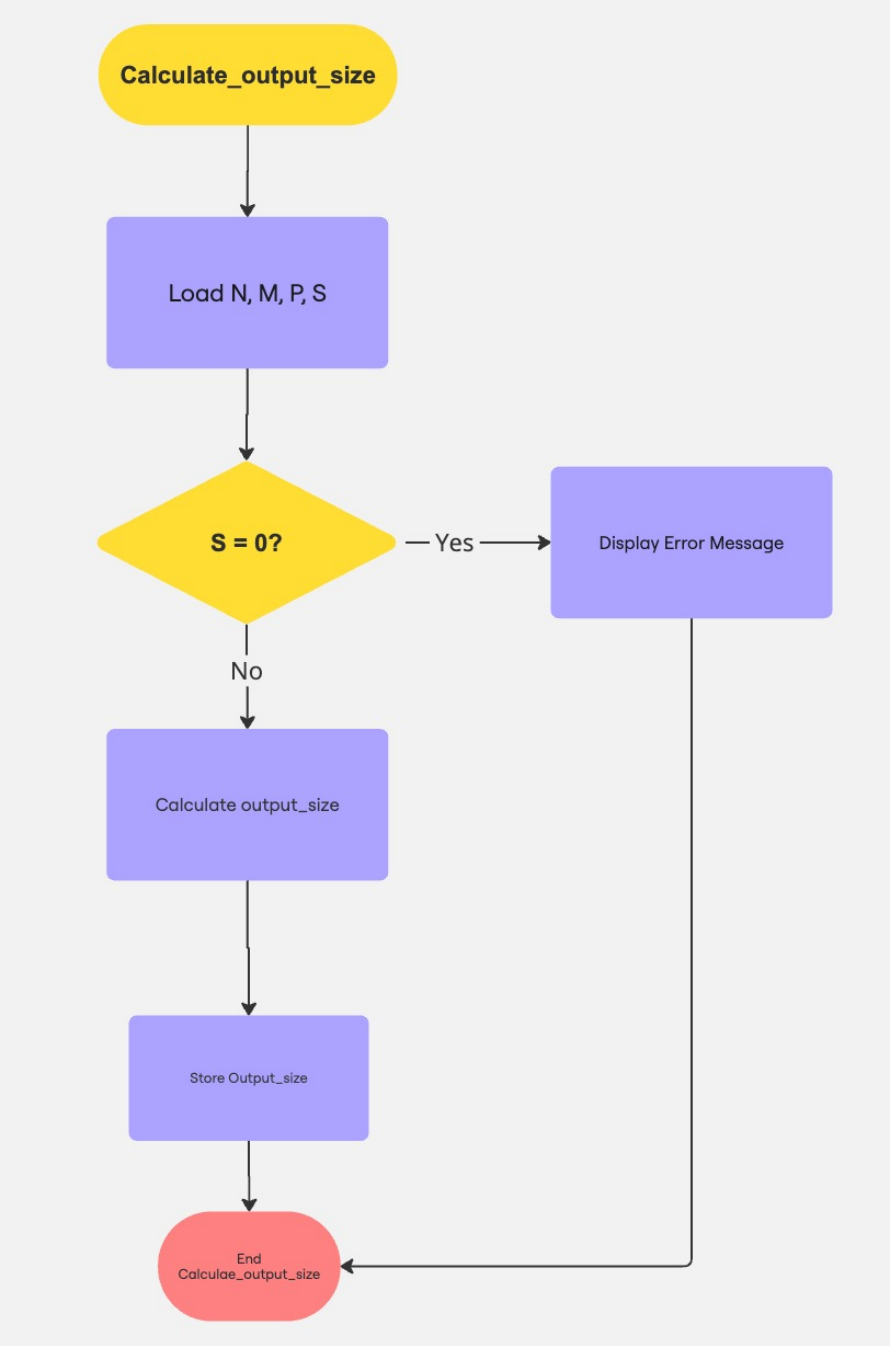


Figure 3. Calculate outputsize function

## 3.4 Validate Kernel Size

- Checks if the kernel size M is larger than the image size plus padding. If the condition is true, displays an error message and exits.

- Flowchart:

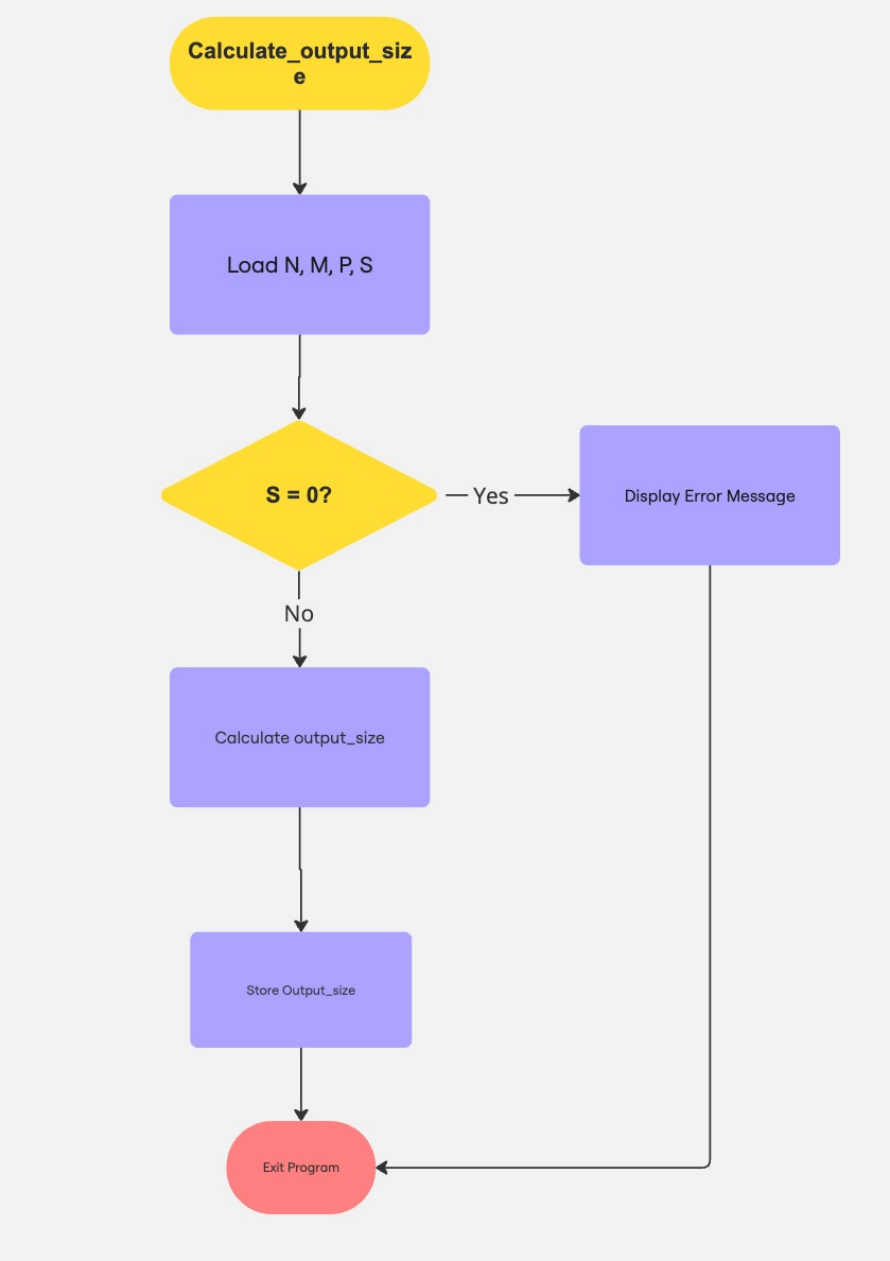


Figure 4. Main program Flowchart

## 3.5 Convolution function

- Flowchart of paddedImage:

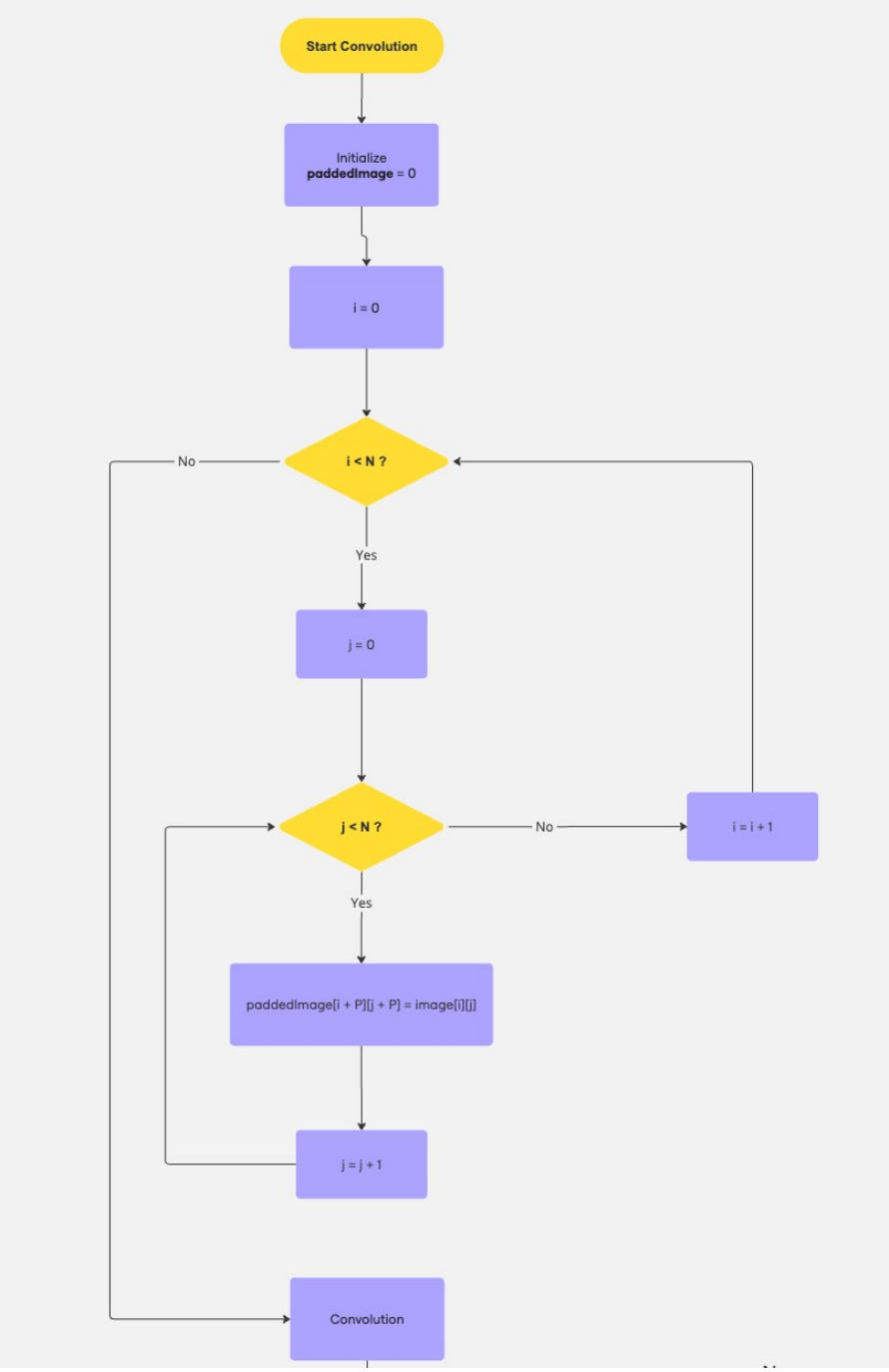


Figure 5. padded Image

- Flowchart of Convolution with padded image:

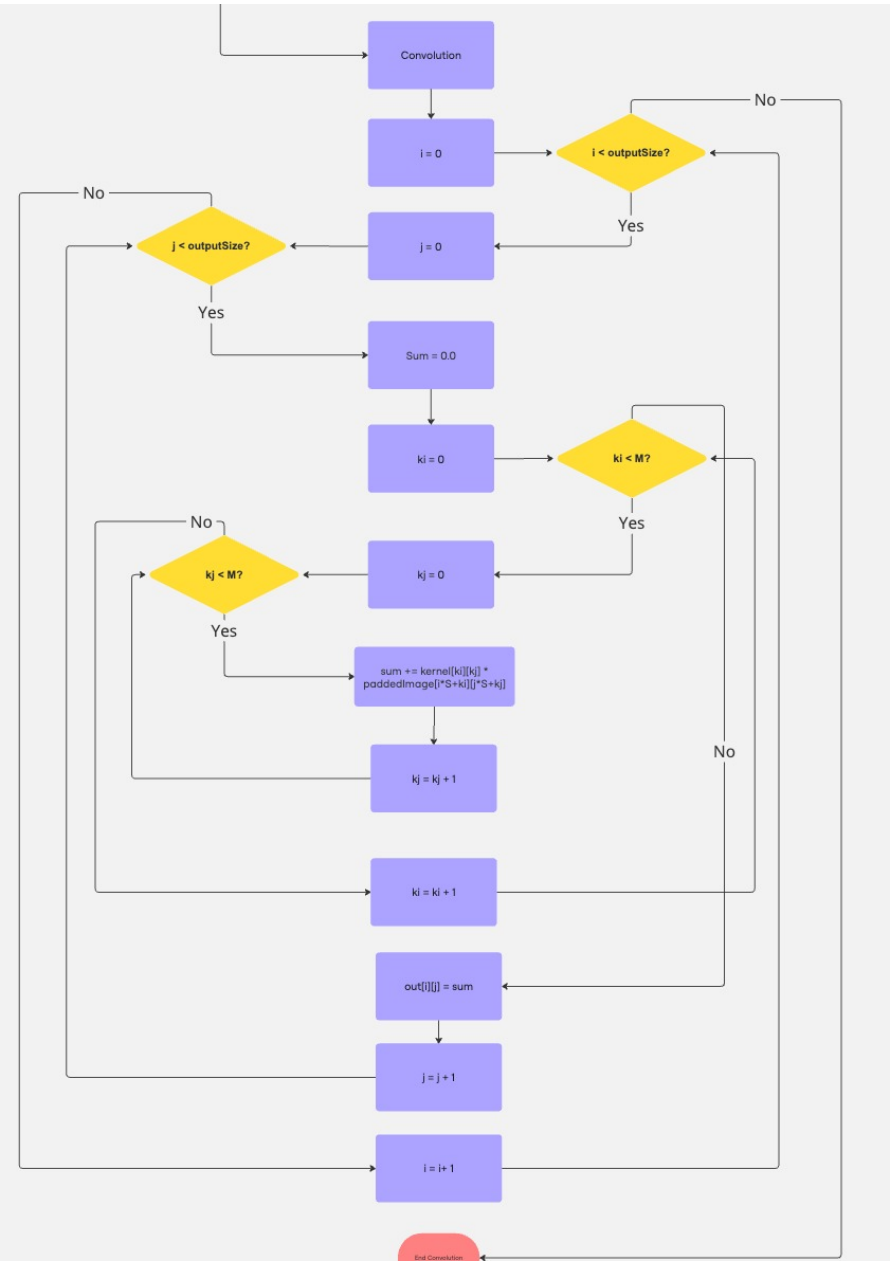


Figure 6. Perform Convolution

## 3.6 Print result and write to file output

### 3.6.1 Error input

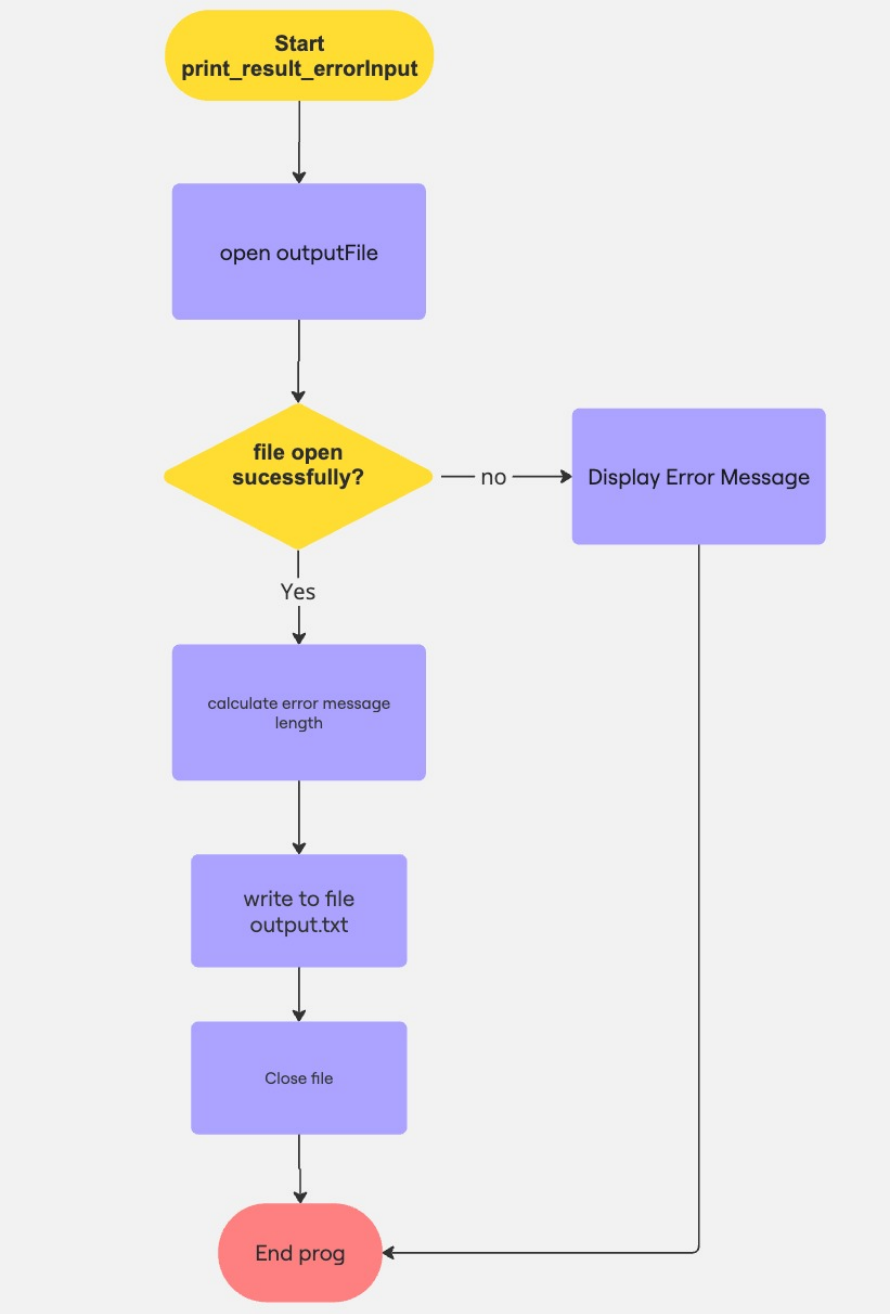


Figure 7. Perform Convolution

### 3.6.2 Print_matrix_to_file

**Objective:** write outputMatrix to file output.txt

1. Calculate information about matrix output: address, size, number of elements in matrix output.
2. Open file out.txt to write
3. loop elements in matrix and write them into file out.txt.

### 3.6.3 Float_to_String

Objective: convert float elements to string.

1. check negative number and convert it to positive.
2. separate the integer part and convert the integer part into string

# 4 Test Run

## 4.1 Test 1

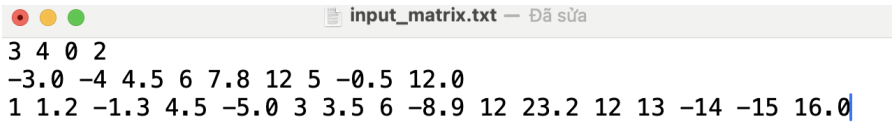


Figure 8. Test 1

**Result:**


Figure 9. Result

## 4.2 Test 2

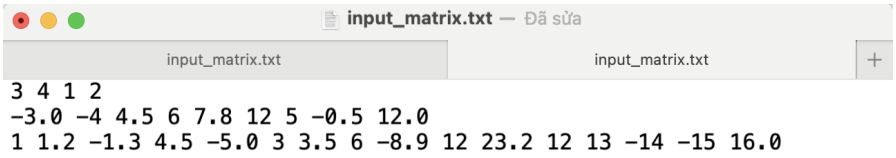


Figure 10. Test 2

**Result:**


Figure 11. Result

## 4.3 Test 3

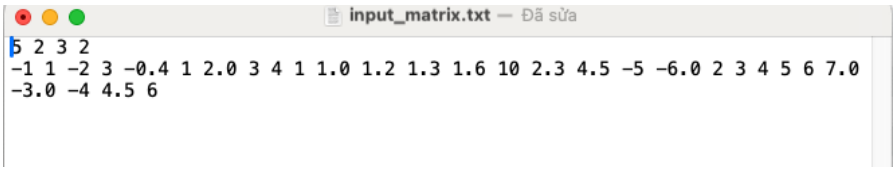


Figure 12. Test 3

**Result:**

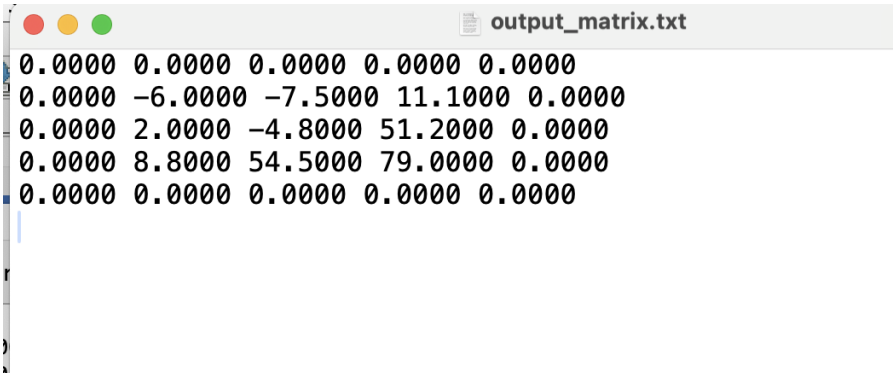


Figure 13. Result