Arithmetic Expression Evaluator

Software Requirements Specifications

Version <1.1>

Revision History

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Software Requirements Specifications

# Introduction

The following document will capture the complete software requirements for the system. It will be referred to throughout the *Arithmetic Expression Evaluator* project.

## Purpose

The purpose of the Software Requirements Specifications (SRS) document is to detail the external needs of the application. It describes all nonfunctional requirements along with interfaces, constraints, and functionality. It will be referred to throughout the project to ensure organization.

## Scope

This SRS applies to the *Arithmetic Expression Evaluator* application. It is associated with the Use-Case model for the entire system and its functions. The organization of software requirements and functionality revolve around this document.

## Definitions, Acronyms, and Abbreviations

See *Glossary* in Appendices

See *Project Glossary* in Annexes of *Software Development Plan*

## References

* Software Development Plan – 9/22/2023, CAVJAC Group

## Overview

The rest of this document will capture the complete software requirements for the system. It contains many aspects of the project such as interfaces and functionality. It is organized by specification, starting general is an overview of the project and ending with specific requirements.

# Overall Description

*[This section of the* ***SRS*** *describes the general factors that affect the product and its requirements. This section does not state specific requirements. Instead, it provides a background for those requirements, which are defined in detail in Section 3, and makes them easier to understand. Include such items as:*

## Product perspective

### System Interfaces

### User Interfaces

### Hardware Interfaces

### Software Interfaces

### Communication Interfaces

### Memory Constraints

### Operations

## Product functions

## User characteristics

## Constraints

## Assumptions and dependencies

## Requirements subsets

# Specific Requirements

## Functionality

### Binary Operators

Binary operators are operators that require two operands. The operator is preceded by its first operand and proceeded by its second. Their operands shall be either constant numbers or expressions which produce numerical values when evaluated. If either of their operands lacks a numerical value, or the operator has fewer than two operands, an error exists, as specified in sections 3.1.5.2 and 3.1.5.1 respectively. All binary operators shall evaluate to a numerical value.

#### Addition

The calculator shall be able to perform addition. Addition shall be represented with the “+” symbol. It shall conform to the requirements for binary operators as defined in section 3.1.1. Its value shall equal the sum of its operands.

#### Subtraction

The calculator shall be able to perform subtraction. Subtraction shall be represented with the “-” symbol. It shall conform to the requirements for binary operators as defined in section 3.1.1. Its value shall equal the difference between its first operand and its second.

#### Multiplication

The calculator shall be able to perform multiplication. Multiplication shall be represented with the “\*” symbol. It shall conform to the requirements for binary operators as defined in section 3.1.1. Its value shall equal the product of its operands.

#### Division

The calculator shall be able to perform integer division. Division shall be represented with the “/” symbol. It shall conform to the requirements for binary operators as defined in section 3.1.1. Its value shall equal the quotient of its first and second operands. Its value shall be an integer, truncating any fractional values. If its second operand is zero, an error exists, as defined in section 3.1.5.3.

#### Modulo

The calculator shall be able to perform modulo. Modulo shall be represented with the “%” symbol. It shall conform to the requirements for binary operators as defined in section 3.1.1. Its value shall equal the value of its first operand mod its second, or the remainder of its first operand divided by its second. If its second operand is zero, an error exists, as defined in section 3.1.5.4.

#### Exponentiation

The calculator shall be able to perform exponentiation. Exponentiation shall be represented with the “^” symbol. It shall conform to the requirements for binary operators as defined in section 3.1.1. Its value shall equal its first operand to the power of its second operand, or one multiplied by its first operand a number of times equal to its second operand. The second operand may not be negative; if it is, an error exists, as specified in section 3.1.5.4.

### Unary Operators

Unary operators are operators that require one operand. The operator precedes its operand. Its operand shall be either a constant number or an expression which produces a numerical value when evaluated. If its operand lacks a numerical value, or the operator has no operands, an error exists, as specified in sections 3.1.5.2 and 3.1.5.1 respectively.

#### Negation

The calculator shall be able to perform negation. Negation shall be represented with the “-” symbol. It shall conform to the requirements for unary operators as defined in section 3.1.2. Its value shall equal the value of its operand, multiplied by negative one.

#### Absolute Value

The calculator shall be able to perform absolute value. Absolute value shall be represented with the “+” symbol. It shall conform to the requirements for unary operators as defined in section 3.1.2. Its value shall equal the absolute value of its operand, or the square root of the square of its operand.

### Parentheses

The calculator shall be able to use parentheses to control operator execution. Parentheses consist of two symbols: “(” to ‘open’ the parentheses, and “)” to ‘close’ them. All symbols within the open and close of parentheses are said to be in the parentheses. If a “(” does not have a corresponding “)”, or vice versa, an error exists, as defined in section 3.1.5.5. “(” and “)” shall be paired as follows: the equation is evaluated left-to-right; each time a “(” is encountered, it is added to a stack; each time a “)” is encountered, it is paired with the “(” on the top of the stack, and that “(” is removed from the stack. *Note: this is merely an analogy; use of a stack is not required in implementation; any method which produces the same results is acceptable.* The value of parentheses shall be equal to the value of the expression contained in them. If there is not an expression in the parentheses, or if the expression in the parentheses lacks numerical value, an error exists, as specified in sections 3.1.5.1 and 3.1.5.2 respectively Expressions within parentheses shall be executed following the precedence rules defined in section 3.1.4.

### Operator Precedence

In equations with more than one operator, operations shall be performed with the standard operator precedence, as follows.

Level 5: Parentheses

Level 4: Exponentiation

Level 3: Multiplication, division, and modulo

Level 2: Negation and absolute value

Level 1: Addition and Subtraction

Operations shall be executed from highest precedence level to lowest. In the case of a conflict, operations shall be executed left-to-right. Equations inside parentheses shall be evaluated with the highest priority; within the parentheses, the operators shall be executed in the order specified in this section, as described in section 3.1.3.

### Errors

An error shall be produced if the user-given equation does not conform to the requirements listed herein. If an error exists, this shall be communicated to the user as defined in section 3.1.8. Each error has an error message which describes to the user why an error exists.

#### Missing Operand Error

A missing operand error exists if any operator or parentheses has fewer operands than required.

Its error message is: “{operator symbol} is missing an operand!”.

#### Operator as Operand Error

An operator as operand error exists if the operand of any operator or parentheses is a non-unary operator, or if it is a unary operator that lacks an operand, such as in the equations “1+\*1” or “(-)”.

Its error message is: “cannot use operator as operand!”.

#### Divide By Zero Error

A divide by zero error exists when the second operand of a division operator is zero (either as a numeric constant or the result of another operator).

Its error message is: “cannot divide by zero!”.

#### Negative Operand Error

A negative operand error exists if the second operand of an exponentiation or modulo operation is negative.

Its error message is: “{operator symbol}’s second operand cannot be negative!”

#### Unmatched Parentheses Error

An unmatched parentheses error exists if it is not possible to match all the opening parentheses in the equation to closing parentheses, and vice versa. For example, if the numbers of opening and closing parentheses are not equal, or if a closing parentheses is not preceded by an opening parentheses, such as in the case: “)(”.

Its error message is: “unmatched parentheses!”

### User Input

The system shall be able to take in an equation from the user. The method for acquiring this equation is defined in section 3.1.8. The equation shall consist of characters from the following sets:

Operator characters (“+-\*/^%()”)

Numeric characters (0-9)

Spaces (“ ”)

If the equation contains any characters which are not included in these character sets, an error exists, as described in section 3.1.5.

The characters in the equation shall be translated into operations and numeric values as follows:

Each operator character shall correspond to an operation, as defined in sections 3.1.1 - 3.1.3. When one symbol may refer to multiple operations, the operation shall be chosen in such a way that no errors exist, if possible. For example, in the case of 1--1, if both of the “-” referred to subtraction, an error would exist, while if the first referred to subtraction and the second referred to negation, an error would not exist, and thus the first shall be subtraction and the second negation.

Numeric characters shall correspond to constant numeric values. All adjacent numeric characters shall be combined to form one numeric value. Two characters are adjacent if they are not separated by any characters, including spaces. All numeric values shall be integers.

Spaces shall not correspond to any equation elements.

### System Output

The system shall have two categories of outputs: the numerical value of the user-provided equation, or an error message. These will be communicated to the user as described in section 3.1.8.

The system shall be able to output up to twelve characters of numerical output (enough characters to display a negative, 32-bit integer). The numerical output shall be an integer in base ten. The system shall output only characters necessary to communicate the numerical value; there shall be no preceding zeroes. Numerical output shall consist only of the digits 0-9, and ‘-’.

The system shall output error messages in the following format: “Error: [message]”, where the message shall be a message relevant to the error, as defined in section 3.1.5.

### User Interface

The user shall be able to interact with the calculator through a textual interface. The user shall be able to type an equation consisting of the symbols specified in section 3.1.6. The user may input symbols outside this set of symbols; however, this will result in an error, as described in section 3.1.5.

The user shall be able to evaluate their equation by pressing the Enter key. At this point, the calculator shall display to the user the numerical result of their equation, or the relevant error if an error has occurred, as specified in section 3.1.7.

The user shall be able to edit their equation after evaluation. This shall not change the displayed output until the equation is evaluated again.

The user shall be able to exit the calculator by pressing the window closing button standard to the current operating system.

## Use-Case Specifications

A diagram of a algorithm

Description automatically generated with medium confidence

## Supplementary Requirements

### Programming Language

The calculator shall be developed using C++.

### Design Methodology

The system shall be implemented using an object-oriented approach.

# Classification of Functional Requirements

*[List, usually in a table, all functional requirements and order them by Type (Essential, Desirable, and Optional) or by order of appearance in the document.]*

| **Functionality** | **Type** |
| --- | --- |
| Binary Operators | Essential |
| Addition | Essential |
| Subtraction | Essential |
| Multiplication | Essential |
| Division | Essential |
| Modulo | Essential |
| Exponentiation | Essential |
| Unary Operations | Essential |
| Negation | Essential |
| Absolute Value | Essential |
| Parentheses | Essential |
| Operator Precedence | Essential |
| Missing Operand Error | Essential |
| Operator as Operand Error | Essential |
| Divide by Zero Error | Essential |
| Negative Operand Error | Essential |
| Unmatched Parentheses Error | Essential |
| User Input | Essential |
| System Output | Essential |
| User Interface | Essential |

# Appendices

*(Not considered part of the requirements)*

**5.1 Glossary**

Base Ten: a method of assigning a place value to numbers (ie. Each digit in a position of a number can be an integer value from 0 to 9)

Modulo: produces the remainder of an integer division

Operand: object that is operated on by an operator

OOP (Object-oriented programming): a programming model that centers software design around data (objects), rather than functions and logic

32-bit integer (signed): minimum values of -2,147,483,648 and a maximum value of 2,147,483,647 (inclusive)

32-bit integer (unsigned): minimum value of 0 and a maximum value of 4,294,967,295 (inclusiv

Truncating division: division where a fraction result is converted to an integer

Unary: consisting of or involving a single element or component