Module Interface Specification for Library of Linear Algebraic Equation Solver

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1 Revision History

Date	Version	Notes
Date 1	1.0	Notes
Date 2	1.1	Notes

2 Symbols, Abbreviations and Acronyms

See SRS Documentation at: https://github.com/deviprasad135/CAS741/blob/master/Doc/SRS/CA.pdf

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3 Introduction

The following document details the Module Interface Specifications for

Complementary documents include the System Requirement Specifications and Module Guide. The full documentation and implementation can be found at https://github.com/deviprasad135/CAS741.

4 Notation

The structure of the MIS for modules comes from **?**, with the addition that template modules have been adapted from **?**. The mathematical notation comes from Chapter 3 of **?**. For instance, the symbol := is used for a multiple assignment statement and conditional rules follow the form $(c_1 \Rightarrow r_1|c_2 \Rightarrow r_2|...|c_n \Rightarrow r_n)$.

The following table summarizes the primitive data types used by Program Name.

Data Type	Notation	Description
character	char	a single symbol or digit
integer	$\mathbb{Z}$	a number without a fractional component in (-∞, ∞)
natural number	$\mathbb{N}$	a number without a fractional component in [1, ∞)
real	$\mathbb{R}$	any number in (-∞, ∞)

The specification of Program Name uses some derived data types: sequences, strings, and tuples. Sequences are lists filled with elements of the same data type. Strings are sequences of characters. Tuples contain a list of values, potentially of different types. In addition, Program Name uses functions, which are defined by the data types of their inputs and outputs. Local functions are described by giving their type signature followed by their specification.

5 Module Decomposition

The following table is taken directly from the Module Guide document for this project.

Level 1	**Level 2**
Hardware-Hiding	
Behaviour-Hiding	Input Computing Module Output computing Module Library of Linear Algebraic Equation Solver Module
Software Decision	Gaussian Elimination Module Gauss-Jordan Elimination Module

Table 1: Module Hierarchy

6 MIS of Library of Linear Algebraic Equation Solver Module

6.1 Module

LLAES

6.2 Uses

This is the top level module which interacts with the external program. This module uses all other modules in the library.

6.3 Syntax

Name	In	Out	Exceptions
Linear Algebraic Equation Methods	Linear Algebraic Equation Method	-	-
A	$n \times n$ matrix $\in \mathbb{R}$ and n > 0	-	-
b	$1 \times n$ matrix $\in \mathbb{R}$ and n > 0	-	-

6.4 Semantics

6.4.1 State Variables

6.4.2 Access Routine Semantics

- transition:
- output:
- exception:

7 MIS of Gaussian Elimination Module

7.1 Module

GEM

7.2 Uses

This module is used to solve the system of Linear Algebraic Equations.

7.3 Syntax

Name	In	Out	Exceptions
A	$n \times n$ matrix $\in \mathbb{R}$ and n > 0	-	-
b	$1 \times n$ matrix $\in \mathbb{R}$ and n > 0	-	-

7.4 Semantics

Pseudo Code

for $k = 1$ to $n - 1$
find a pivot p such that
$|a_{pk}| \geq |a_{ik}|$ for $K \leq i \leq n$
if $|a_{pk}| = 0$ do
return "Singular Matrix"
end the entire loop
else interchange row p and k
for $i = k + 1$ to n
$factor_{ik} = \frac{a_{ik}}{a_{kk}}$
for $j = k + 1$ to n
$a_{ij} = a_{ij} - factor_{ik} * a_{kj}$
end for
end for
end for
$x_n = \frac{b_n^{'}}{a_{nn}}$
for i in n-1 to 1
for j in i+1 to n
$sum = a_{ij}x_j$
end for
$x_i = \frac{b_n^{'} - sum}{a_{ii}}$
end for

7.4.1 State Variables

7.4.2 Access Routine Semantics

- transition:

- output:
- exception:

8 MIS of Gauss-Jordan Elimination Module

8.1 Module

GJEM

8.2 Uses

This module is used to solve the system of Linear Algebraic Equations.

8.3 Syntax

Name	In	Out	Exceptions
A	$n \times n$ matrix $\in \mathbb{R}$ and n > 0	-	-
b	$1 \times n$ matrix $\in \mathbb{R}$ and n > 0	-	-

8.4 Semantics

Pseudo Code

for $k = 1$ to $n - 1$
find a pivot p such that
$|a_{pk}| \geq |a_{ik}|$ for $K \leq i \leq n$
if $|a_{pk}| = 0$ do
return "Singular Matrix"
end the entire loop
else interchange row p and k
for $i = k + 1$ to n
$factor_{ik} = \frac{a_{ik}}{a_{kk}}$
for $j = k + 1$ to n
$a_{ij} = a_{ij} - factor_{ik} * a_{kj}$
end for
end for
end for
Assuming that the matrix is not singular
for k = n to 2
for i = k+1 to 1

$factor_{ik} = \frac{a_{ik}}{a_{kk}}$
for j = k-1 to 1
$a_{ij} = a_{ij} - factor_{ik} * a_{kj}$
end for
end for
end for
for i in 1 to n
$x_i = \frac{b_n^{'}}{a_{ii}}$
end for

8.4.1 State Variables

8.4.2 Access Routine Semantics

- transition:
- output:
- exception:

9 Appendix