Linear Algebra

Introduction to MATLAB

LAB 1

My Rules

- After 10 minutes you cannot enter the class.
- No phone usage during class.
- No talking to each other about anything, if you have questions, ask me.
- Don’t use computer while explanation.

What is MATLAB and Why does it matter?

MATLAB's Origin

MATLAB stands for MATrix LABoratory. It was originally written to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (Eigen system package) projects. Commercially available since 1984, it is now considered a standard tool at most universities and industries worldwide.

MATLAB is a high-level programming language just like C++ that integrates computation, visualization, and programming in a single environment

Advantages

- Compared to other high-level languages, MATLAB's basic data element is an array that does not require dimensioning. It has powerful built-in routines enabling a very wide variety of computations, easy-to-use graphics commands

MATLAB Session

Command Window

The primary interface where you type commands at the >> prompt and see results immediately.

Workspace and Directory

The Workspace shows all active variables; the Current Directory panel lets you navigate your file system.

MATLAB as a Calculator: Variables

Basic Arithmetic and the ans variable

- MATLAB evaluates expressions typed at the prompt. If no output variable is specified, results are stored in the default variable ans. To assign a named variable, use the assignment syntax:

```
>> x = 1+2*3
x =
   7
>> 4*x
ans =
     28
```

Basic Arithmetic Operators

Symbol	Operation	Example
+	Addition	2 + 3
-	Subtraction	2 - 3
*	Multiplication	2 * 3
/	Division	2 / 3

Managing Variables, Workspace and Sessions

Creating and Overwriting Variables

- Variables are created with an assignment statement: variable_name = value or expression. Expressions can involve manual entry, built-in functions. Once created, a variable can be reassigned at any time. To suppress output from appearing in the Command Window, end the line with a semicolon (;):

```
>> t = 5;
>> t = t+1
t = 6
```

- If an expression is entered incorrectly (e.g., omitting the * multiplication sign), MATLAB returns an error message such as "Unexpected MATLAB expression." Rather than retyping a long command, use the up-arrow key ↑ to recall the previous command, then edit and re-execute it.

Managing Variables, Workspace and Sessions

Workspace Management Commands

- The workspace persists between commands, so results from one problem can affect the next. Best practice is to clear the workspace at the start of each new calculation.
  - Clear: Removes all variable from the workspace
  - Who: lists current variables
  - clc: clears the command window
  - Ctrl+c: aborts a running computation

Vectors and Matices

Entering Vectors and Matrices

- Vectors and matrices are entered using square brackets. Separate elements in a row with spaces or commas; use semicolons to separate rows:

```
>> v1 = [1 2 3 4]     % row vector
>> v2= [1; 2; 3; 4]  % column vector
>> A = [1 2; 3 4]     % 2x2 matrix
```

Array vs Matrix Operations

- MATLAB distinguishes between matrix operations (standard linear algebra, e.g., A*B) and element-wise array operations (e.g., A.*B, A./B, A.^n). The **dot prefix (.) forces element-by-element computation**.

Matrix and Operations

To create a Matrix

```
>> X = [4 5 6; 6 5 4]  % 2 (row) x 3 (column) matrix
>> Y = [9 4 3; 3 5 7;6 4 3]  % 3x3 matrix
```

Matrix Operations:

- Addition/Subtraction: Same size matrices can be added or subtracted (result will be same size).
- Multiplication: **result = X * Y,** but the dimensions of the matrix must be compatible in order to do multiplication.
- Division: **result = X / Y**, this is same as result = $X*Y^{-1}$

Element Wise operations

- Multiplication: **result = X .* Y,** but the dimensions of the matrix must be compatible in order to do multiplication (same size).
- Division: **result = X ./ Y**, but the dimensions of the matrix must be compatible in order to do multiplication (same size).

Matrix Generators (Special Matrices)

MATLAB provides built-in functions to generate common matrices quickly:

Function	Description
zeros(m,n)	Matrix of all zeros
ones(m,n)	Matrix of all ones
eye(n)	Identity matrix
diag(v)	Diagonal matrix from vector v