Lecture 2

Computer Programming and Applications I

MATLAB

First Program, Expressions, and Matrices

Duration: 3 hours

Explanation + Activities + Practice
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1. Learning Objectives

At the end of this lecture, students will be able to:

1. Understand the basic idea of what a computer program is.
2. Write a simple MATLAB program.
3. Perform basic mathematical operations in MATLAB.
4. Enter data using matrices (arrays).
5. Apply simple operations to data.

2. Introduction (10 minutes)

Opening Question

Ask students:

How does a medical device such as a heart rate monitor work?

Expected answers:

1. It collects data
2. It processes the data
3. It shows the result

Explain:

A computer program works in the same way. This fundamental concept underpins all computing applications, from simple calculators to complex medical diagnostic systems. Understanding this input-process-output model is essential for grasping how software interacts with data.

Input → Processing → Output

Example in Biomedical Engineering:

Patient heart rate measurements:

72, 80, 76

The computer processes them and calculates results such as the average. This demonstrates how raw data is transformed into meaningful information that healthcare professionals can use for decision-making.

3. What is a Program?

Explain in a very simple way:

A program is a set of instructions written by a human so the computer can perform a task. Programs are the bridge between human intentions and machine execution. They translate our ideas into precise, executable steps that computers can follow reliably and repeatedly.

Example from Daily Life:

Instructions for making tea:

- Boil water
- Add tea
- Pour into cup

Computers also need step-by-step instructions. Just as making tea requires following a specific sequence of actions, computer programs require carefully ordered instructions to produce the desired results.

4. First MATLAB Program

Ask students to open MATLAB → Command Window. The Command Window is the primary interface for interactive computing in MATLAB, where users can enter commands and immediately see results.

Write this example:

```
a = 5;
b = 3;
c = a + b
```

Explain each line:

Line	Meaning
a = 5	store value 5 in variable a
b = 3	store value 3 in variable b
c = a + b	add the two values

Output:

```
c = 8
```

Activity 1 (3 minutes)

Ask students to type:

```
x = 10;
y = 4;
z = x - y
```

Question for students:

What is the result?

Answer: 6

5. Mathematical Operations in MATLAB

Explain that MATLAB works like a calculator. One of MATLAB's greatest strengths is its intuitive handling of mathematical operations. Users can perform calculations directly in the Command Window without the need for complex programming structures.

Operation	Symbol
Addition	+
Subtraction	-
Multiplication	*
Division	/
Power	^

Example:

1. `5 + 3`
2. `10 - 4`
3. `6 * 3`
4. `10 / 2`
5. `2 ^ 3`

Activity 2

Ask students to calculate:

```
(5 + 3) * 2
```

Then ask:

Why is the result different from:

```
5 + 3 * 2
```

Explain order of operations. MATLAB follows the standard mathematical order of operations (PEMDAS/BODMAS): Parentheses first, then Exponents, Multiplication and Division (left to right), and finally Addition and Subtraction (left to right). This is why (5 + 3) * 2 = 16, but 5 + 3 * 2 = 11.

6. Example from Biomedical Data

Example: Heart rate measurements of three patients

Values:

72, 80, 76

In MATLAB:

```
HR = [72 80 76]
```

Explain:

This is called a Matrix (or Array). A matrix is a group of numbers stored together in a single variable. In MATLAB, matrices are the fundamental data structure, making it exceptionally powerful for mathematical and scientific computing. The square brackets [ ] are used to define matrices.

A matrix is a group of numbers stored together.

Activity 3

Ask students to enter heart rate data for five patients:

70, 75, 80, 72, 78

Solution:

```
HR = [70 75 80 72 78]
```

7. Creating Multi-Row Matrices

Example: Blood pressure data

Patient	Systolic	Diastolic
1	120	80
2	130	85
3	110	75

MATLAB:

```
BP = [120 80;
      130 85;
      110 75]
```

Explain:

The symbol ; moves to the next row. Within each row, spaces or commas separate elements. This syntax allows you to create multi-dimensional data structures that can represent complex datasets, such as patient records with multiple measurements.

Activity 4 (Small Group Work)

Ask students to create the matrix:

```
1 2 3
4 5 6
```

Solution:

```
A = [1 2 3;
```

```
    4 5 6]
```

8. Generating Numbers Automatically

MATLAB can generate sequences of numbers automatically. This powerful feature saves time when working with large datasets or when you need to create evenly spaced values for calculations, plotting, or simulation.

Example:
```
1:10
```
Output:
```
1 2 3 4 5 6 7 8 9 10
```

Another example:
```
1:2:10
```
Output:
```
1 3 5 7 9
```

Explain:
```
start : step : end
```

The colon operator creates evenly spaced vectors. When you specify two numbers (start:end), MATLAB creates a sequence with a default step of 1. When you specify three numbers (start:step:end), MATLAB uses your custom step value. This is particularly useful for creating time vectors, index arrays, or any sequence of evenly spaced values.

Activity 5

Ask students to create numbers from 0 to 20 with step 5

Solution:
```
0:5:20
```

9. Transpose Operation

Example:
```
A = [1 2 3]
A'
```

Result:
```
1
2
3
```

Explain:

This operation converts a row into a column. The transpose operator (single quote ') is one of the most frequently used operations in MATLAB, especially when working with matrix algebra, data organization, and preparing data for various computations.

This is called Transpose.

Activity 6

Ask students to run:

```
B = [10 20 30 40]
B'
```

10. Mini Challenge (5 minutes)

Ask students to write a small MATLAB program:

1. Enter temperatures of five patients
2. Store them in a matrix
3. Convert them into a column

Example solution:

```
T = [36.5 37 36.8 37.2 36.9]
T'
```

Quick Quiz

1. What is a computer program?
2. What is a matrix in MATLAB?
3. What does the operator : do?

Homework

Write a MATLAB program that:

1. Enters heart rate values for five patients.
2. Stores them in a matrix.
3. Converts the row into a column.