Computer Application (MATLAB)

تطبيقات الحاسبة (ماتلاب)
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Lecture 6

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Learning Objectives

- Understand how to use **for** loops to repeat operations in MATLAB.
- Understand the purpose and structure of **while** loops in MATLAB.
- Common Built-in Functions

Understanding for Loops

- Definition: A for loop repeats a block of code a specified number of times.
- Usage: Ideal for iterating over arrays, performing calculations repeatedly, and automating repetitive tasks.
- Basic Structure:

```
for index = start:step:end
    % Code to execute
end
```

Basic Syntax of a for Loop

- Structure:

```
for i = 1:5
   disp(i);  % Displays values from 1 to 5
end
```

- Explanation:
  - i = 1:5 sets the loop to run from 1 to 5, incrementing by 1 each time.
  - Inside the loop, disp(i) displays the current value of i.

Using Custom Step Sizes

- Syntax: Define step sizes by specifying start:step:end.
- Example:

```
for j = 1:2:10
    disp(j);  % Displays odd numbers from 1 to 9
end
```

- Explanation: The loop starts at 1, increments by 2 each time, and stops at 10.

Iterating Over Arrays

- Purpose: for loops are commonly used to access each element in an array.
- Example:

```
A = [3, 6, 9, 12];
for k = 1:length(A)
   disp(A(k));  % Displays each element in A
end
```

- Explanation: The loop runs from 1 to length(A), displaying each element in A sequentially.

Using Nested for Loops

- Definition: A for loop inside another for loop.
- Common Use: Useful for iterating over matrices and multidimensional arrays.
- Example:

```
for i = 1:3
    for j = 1:3
        disp([i, j]);  % Displays all combinations of i and j
    end
end
```

- Explanation: The outer loop runs for each row, while the inner loop iterates through each column.

Example: Sum Array

- Problem: Write a for loop to calculate the sum of all elements in an array.
- Solution:

```
A = [1, 2, 3, 4];
total = 0;
for i = 1:length(A)
    total = total + A(i);
end
disp(total);  % Displays 10
```

Using break in a for Loop

- Purpose: break stops the loop when a condition is met.
- Example:

```
A = [3, 5, 8, 2];
for i = 1:length(A)
    if A(i) == 8
        disp('Found 8');
        break;  % Exit loop once 8 is found
    end
end
```

- Explanation: The loop stops immediately when A(i) == 8.

Using continue to Skip Iterations

- Purpose: continue skips to the next iteration without executing the remaining code in the loop.
- Example:

```
for i = 1:5
    if mod(i, 2) == 0
        continue;  % Skip even numbers
    end
    disp(i);  % Displays only odd numbers
end
```

- Explanation: The loop displays only odd numbers, as it skips even iterations.

Example: For Loop

```
A = [1, 2, 3, 4];
total = 0;
for i = 1:length(A)
   total = total + A(i);
end
disp(total);
```

Example: For Loop

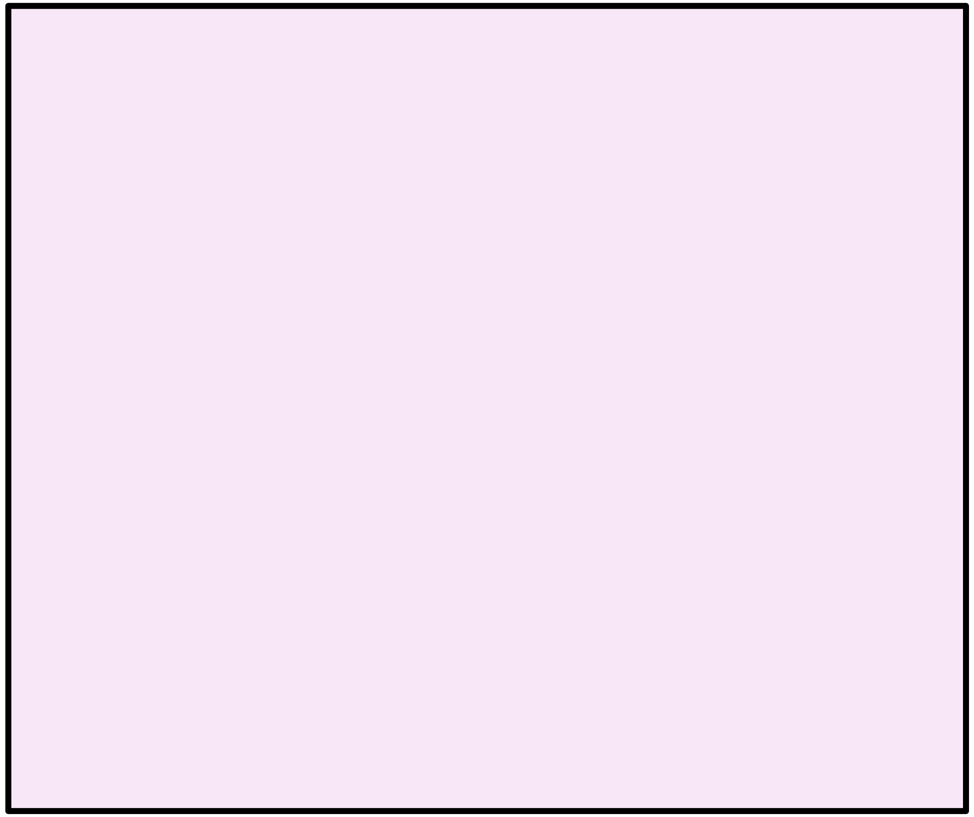
```
A = [3, 5, 2, 7];
total = 0;
for i = 1:length(A)
    total = total + A(i);
end
disp(total);
```

Memory

Example: For Loop

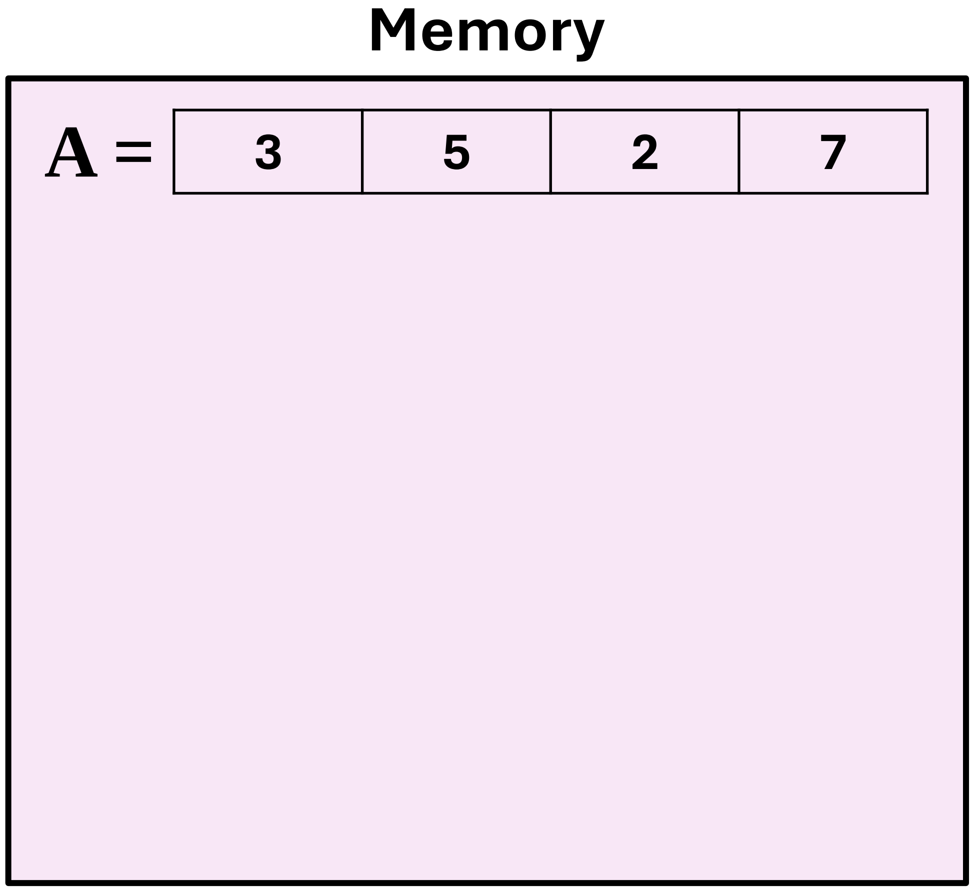
```
➡ A = [3, 5, 2, 7];
  total = 0;
  for i = 1:length(A)
      total = total + A(i);
  end
  disp(total);
```

Memory



Example: For Loop

```
A = [3, 5, 2, 7];  ✓
➡ total = 0;
for i = 1:length(A)
    total = total + A(i);
end
disp(total);
```



Memory

A =	3	5	2	7

Example: For Loop

```
A = [3, 5, 2, 7];  ✓
total = 0;  ✓
for i = 1:length(A)
    total = total + A(i);
end
disp(total);
```

Memory

A =	3	5	2	7
total =	0			

Example: For Loop

```
  A = [3, 5, 2, 7]; ✓
  total = 0; ✓
→ for i = 1:length(A)
      total = total + A(i);
  end
  disp(total);
```

Memory

A =	3	5	2	7
total =	0			

MATLAB®

Example: For Loop

```
A = [3, 5, 2, 7]; ✓
total = 0; ✓
for i = 1:length(A) ➔ i =1 ⟶ 4
➡ total = total + A(i);
end
disp(total);
```

Memory

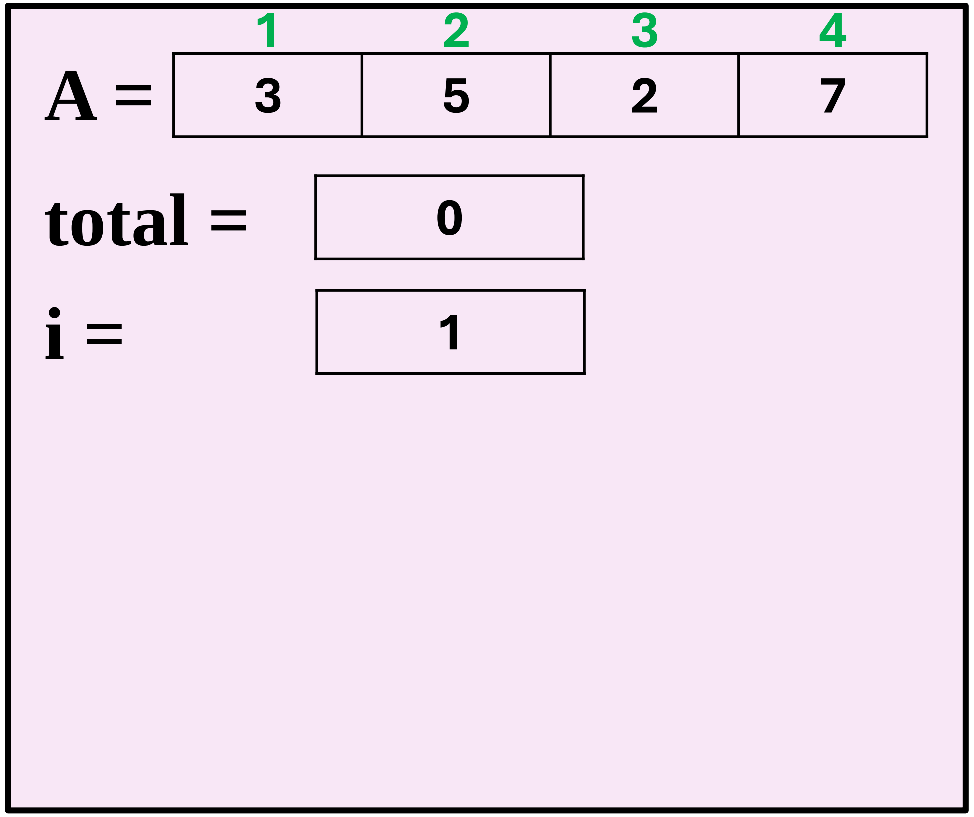
	1	2	3	4
A =	3	5	2	7

total =	0
i =	1

Example: For Loop

```
A = [3, 5, 2, 7];  ✓
total = 0;  ✓
for i = 1:length(A) ➔ i =1 ⟶ 4
➡  total = total + A(i); ➔ 0 +  3
end
disp(total);
```

Memory



	1	2	3	4
A =	3	5	2	7

total = 0

i = 1

MATLAB®

Example: For Loop

```
A = [3, 5, 2, 7];  ✓
total = 0;  ✓
for i = 1:length(A)  ➔ i =1 ⟶ 4
   total = total + A(i);  ✓
end
disp(total);
```

Memory

	1	2	3	4
A =	3	5	2	7

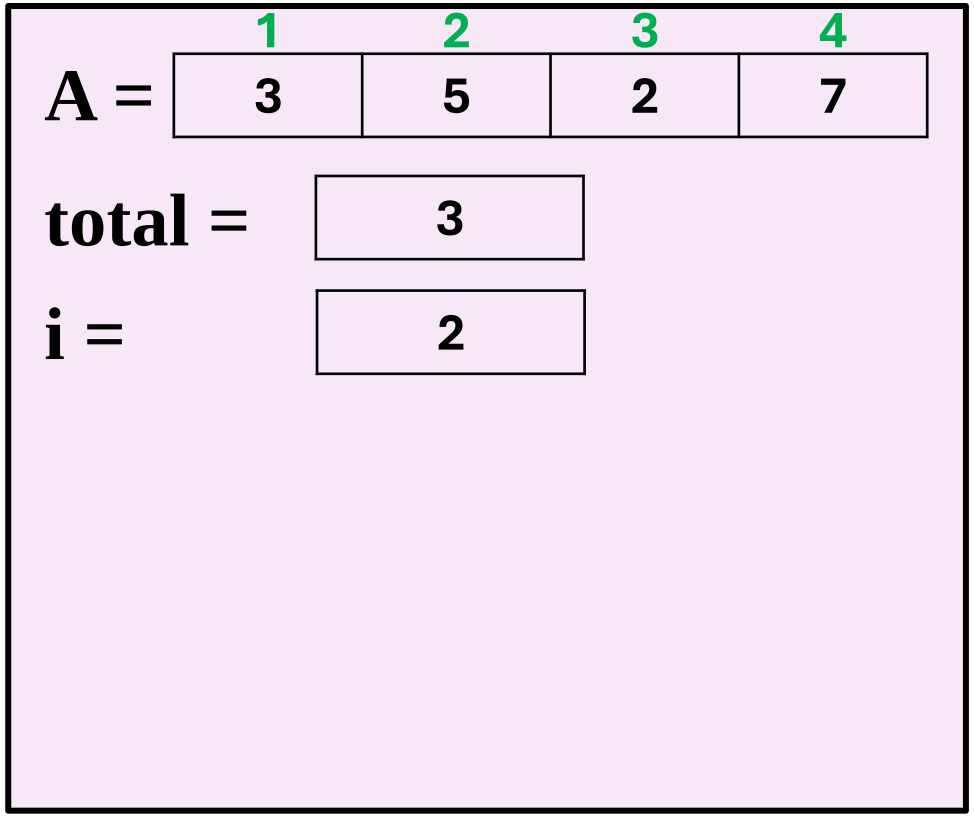
total = 3

i = 1

Example: For Loop

```
  A = [3, 5, 2, 7]; ✓
  total = 0; ✓
➡ for i = 1:length(A) ➔ i =1 ⟶ 4
      total = total + A(i); ✓
  end ✓
  disp(total);
```

Memory



	1	2	3	4
A =	3	5	2	7

total = 3

i = 2

MATLAB®

Example: For Loop

```
A = [3, 5, 2, 7]; ✓
total = 0; ✓
for i = 1:length(A) ➔ i =1 ⟶ 4
➔ total = total + A(i); ➔ 3 +  5
end
disp(total);
```

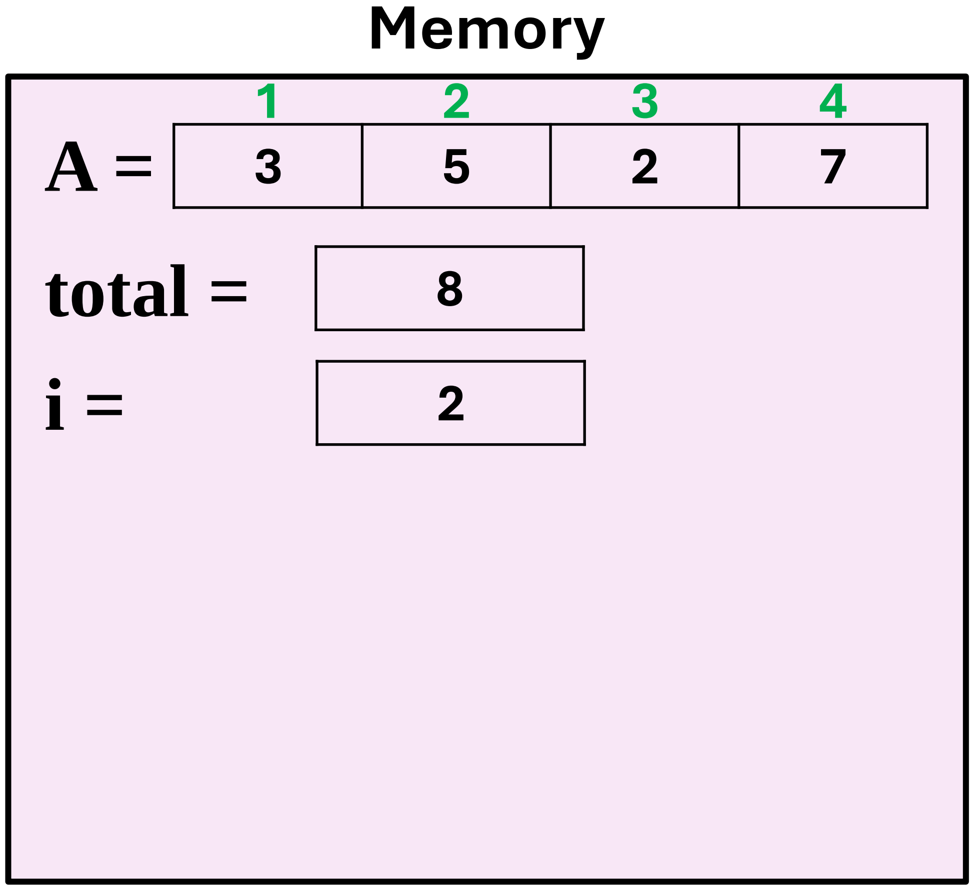
Memory

	1	2	3	4
A =	3	5	2	7

total =	3
i =	2

Example: For Loop

```
  A = [3, 5, 2, 7];  ✓
  total = 0;  ✓
  for i = 1:length(A) ➔ i =1 ⟶ 4
     total = total + A(i);  ✓
➡ end
  disp(total);
```



Memory

	1	2	3	4
A =	3	5	2	7

total = 8

i = 2

Example: For Loop

```
  A = [3, 5, 2, 7];  ✓
  total = 0;  ✓
→ for i = 1:length(A)  ➔ i =1 ⟶ 4
      total = total + A(i);
  end
  disp(total);
```

Memory

	1	2	3	4
A =	3	5	2	7

total =	8
i =	3

Example: For Loop

```
  A = [3, 5, 2, 7]; ✓
  total = 0; ✓
  for i = 1:length(A) ➔ i =1 ⟶ 4
➡   total = total + A(i); ➔8+2
  end
  disp(total);
```

Memory

	1	2	3	4
A =	3	5	2	7

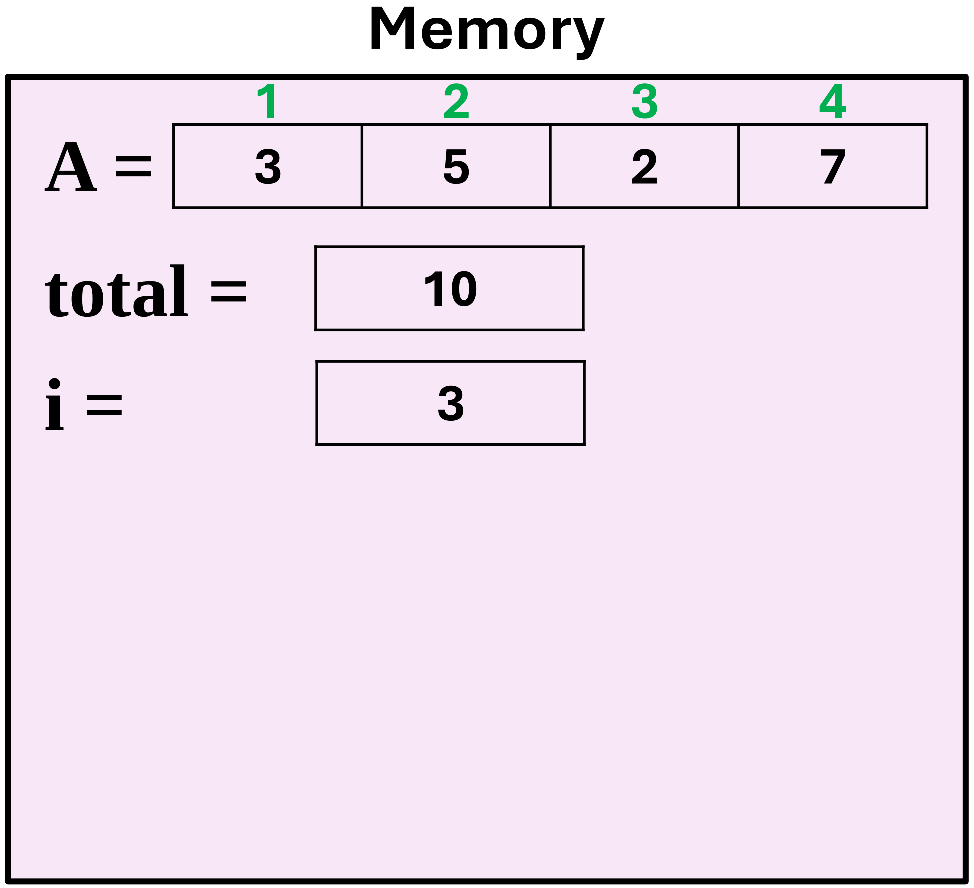
total = 8

i = 3

MATLAB®

Example: For Loop

```
  A = [3, 5, 2, 7]; ✓
  total = 0; ✓
  for i = 1:length(A) ➔ i =1 ⟶ 4
     total = total + A(i); ✓
➡ end
  disp(total);
```



Memory

	1	2	3	4
A =	3	5	2	7

total = 10

i = 3

Example: For Loop

```
  A = [3, 5, 2, 7]; ✓
  total = 0; ✓
➡ for i = 1:length(A) ➔ i =1 ⟶ 4
      total = total + A(i);
  end
  disp(total);
```

Memory

	1	2	3	4
A =	3	5	2	7

total =	10
i =	4

MATLAB®

Example: For Loop

```
A = [3, 5, 2, 7]; ✓
total = 0; ✓
for i = 1:length(A) ➔ i =1 ⟶ 4
➡ total = total + A(i); ➔ 10 +7
end
disp(total);
```

Memory

	1	2	3	4
A =	3	5	2	7

total = 10

i = 4

Example: For Loop

```
  A = [3, 5, 2, 7]; ✓
  total = 0; ✓
  for i = 1:length(A) ➔ i =1 ⟶ 4
     total = total + A(i); ✓
➡ end ✓
  disp(total);
```

Memory

	1	2	3	4
A =	3	5	2	7

total = 17

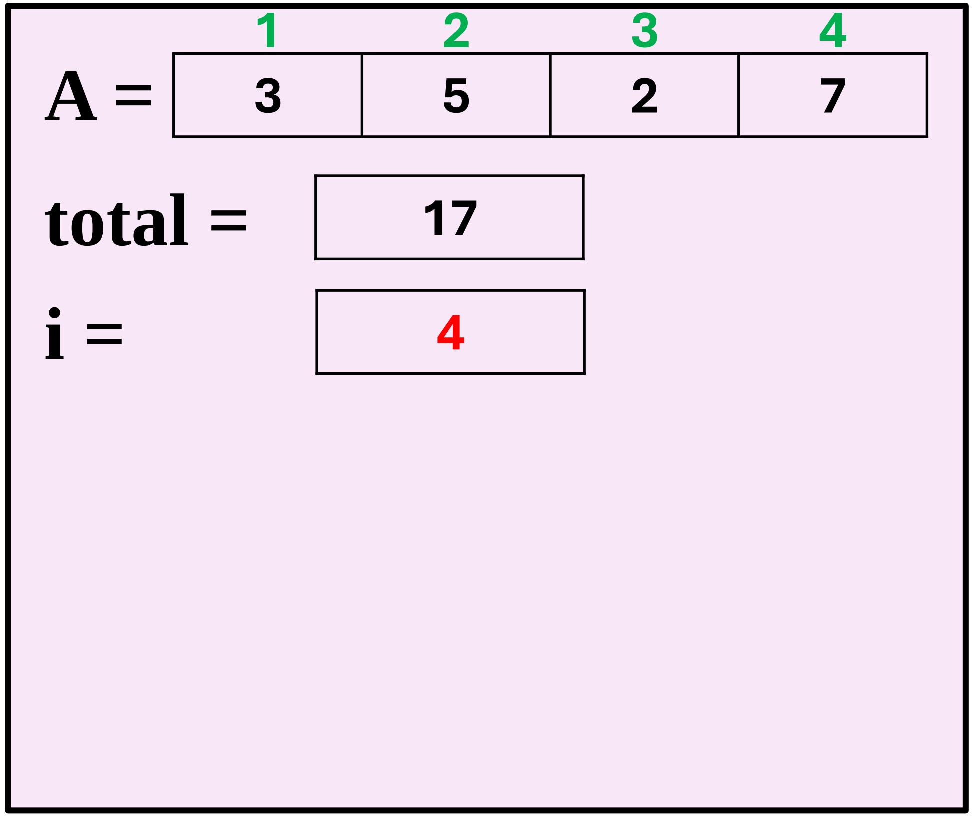
i = 4

Example: For Loop

```
A = [3, 5, 2, 7]; ✓
total = 0; ✓
for i = 1:length(A) ➔ i =1 ⟶ 4
   total = total + A(i); ✓
end ✓
disp(total);
```

What is the output of the following line?

Memory



	1	2	3	4
A =	3	5	2	7

total = 17

i = 4

Understanding while Loops

- Definition: A while loop repeats a block of code as long as a specified condition remains true.
- When to Use: Ideal when the number of iterations is not known in advance but depends on a condition.
- Basic Structure:

```
while condition
    % Code to execute repeatedly
end
```

Basic while Loop Syntax

- Structure:

```
x = 0;
while x < 5
    disp(x);
    x = x + 1;
End
```

- Explanation:
  - The loop will continue as long as **x < 5**.
  - Each iteration increments **x** by **1** and displays its value.

Avoiding Infinite Loops

- Explanation: If the loop condition is always true, the loop will run indefinitely.
- Solution: Ensure that a variable inside the loop changes so the condition can eventually become false.
- Example of Infinite Loop:

```
x = 1;
while x > 0
    disp(x);  % This will run indefinitely
end
```

- Fix: Increment or modify x within the loop to avoid infinite execution.

Using while Loops with Arrays

- Example: Finding the first negative element in an array.
- Solution:

```
A = [3, 5, -2, 8, -7];
i = 1;
while i <= length(A) && A(i) >= 0
    i = i + 1;
end
if i <= length(A)
    disp(['First negative element is ', num2str(A(i))]);
else
    disp('No negative elements found');
end
```

Using Nested while Loops

- Definition: A while loop inside another while loop, useful for multi-level conditions.
- Example: Filling a 3x3 matrix with increasing numbers until a limit.

```
limit = 9;
matrix = zeros(3);
i = 1;
j = 1;
count = 1;
while count <= limit
   while j <= 3
      matrix(i, j) = count;
      count = count + 1;
      j = j + 1;
   end
   j = 1;  % Reset column
   i = i + 1;  % Move to next row
end
disp(matrix);
```

Using break in a while Loop

- Purpose: break stops the loop immediately when a condition is met.
- Example:

```
A = [3, 5, 7, -2, 4];
i = 1;
while i <= length(A)
    if A(i) < 0
        disp(['Negative number found: ', num2str(A(i))]);
        break;  % Exit loop when a negative number is found
    end
    i = i + 1;
end
```

Built-in Functions for Arrays

- MATLAB provides several built-in functions for performing operations on arrays.
- Benefits: Simplifies code and improves readability.
- Examples: sum, max, min, mean,…

```
array = [1, 2, 3, 4];
sum_array = sum(array);
```

Basic Matrix Function - sum

- Computes the sum of elements along a specified dimension.
- Syntax: sum(A, dim)
  - dim = 1: Sum along columns.
  - dim = 2: Sum along rows.
- Examples:

```
A = [1, 2, 3; 4, 5, 6];
col_sum = sum(A, 1);
row_sum = sum(A, 2);
```

Basic Matrix Function - max and min

- max: Returns the largest element in an array or matrix.
- min: Returns the smallest element.
- Syntax: max(A, [], dim) and min(A, [], dim)
- Examples:

```
A = [1, 3, 5; 2, 4, 6];
max_val = max(A);
min_val = min(A);
```

Basic Matrix Function - mean and median

- mean: Calculates the average.
- median: Finds the middle value.
- Syntax: mean(A, dim) and median(A, dim)
- Examples:

```
A = [1, 3, 5; 2, 4, 6];
mean_val = mean(A);
median_val = median(A);
```

Basic Matrix Function - length and size

- length: Finds the longest dimension of an array.
- size: Returns the dimensions of a matrix.
- Examples:

```
A = [1, 3, 5; 2, 4, 6];
len = length(A);
[rows, cols] = size(A);
```

Review of Key Concepts

- Loop Structure: Use for to repeat a block of code.
- Step Sizes: Customize increments with start:step:end.
- Loop Structure: Use while to repeat code while a condition is true.

Let’s try MATLAB

Launch MATLAB and work towards the exercises