

# L09: Iteration

## For and while loops

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# Announcements

**Lab 03 is due on February 10 at 12 pm (noon)**

**Readings for this week**

- ▶ Chapters 5 and 6

**Today:**

- ▶ Iteration (`for` and `while` loops)

**Wednesday:**

- ▶ Recursion (*i.e.* when functions call themselves)

**Friday:**

- ▶ Discussion and practice questions (array operations versus loops)

# Introduction to iteration

1! equals 1

2! equals 2

3! equals 6

4! equals 24

5! equals 120

6! equals 720

7! equals 5040

8! equals 40320

9! equals 362880

10! equals 3628800

## To notice:

- ▶ Parts of the line are repeated from one line to the next
- ▶ Parts of the line change from one line to the next

## Iteration is used to repeat the execution of a section of code

- ▶ The code can produce different results at each step

# Syntax of for loops

```
>> for iteration_variable = row_vector  
>> % The code to be repeated goes here.  
>> % The code will be repeated once for  
>> % each value in row_vector. At each step,  
>> % iteration_variable will have the corresponding  
>> % value from the row vector  
>> end
```

## Notes:

- ▶ The `for` and `end` keywords and the equal sign are mandatory
- ▶ `row_vector` can be of class `char`, `double`, or `logical`
- ▶ You can use something other than a row vector of class `char`, `double`, or `logical`, but I recommend against it (more difficult to use)
- ▶ In E7 applications, the row vector will most often be of class `double`

## Examples of for loops

```
>> % Show the values of factorial(n) from n=1 to n=10
>> for i = 1:10
>>     fprintf('%d! equals %d\n', i, factorial(i));
>> end

>> % Show the values of factorial(n) from n=1 to n=10,
>> % calculating the factorial "manually" at each step
>> value = 1;
>> for i = 1:10
>>     value = value * i;
>>     fprintf('%d! equals %d\n', i, value);
>> end
```

More complex example: `my_sum.m`

## For loops: practice question

What will the value of the variable “x” be after executing the following code?

```
>> x = 1;  
>> for v = [2, 4, 6, 10]  
>>     if v > 5  
>>         x = x + v;  
>>     end  
>>     x = x + 1;  
>> end
```

(A) 1

(B) 5

(C) 21

(D) 2

(E) None of the above

## For loops: practice question

Assuming we start with an empty Workspace, what will the value of the variable "x" be after executing the following code?

```
>> x = 1;  
>> for i = 10:-2:4  
>>     x = x^2;  
>>     for j = 10:1  
>>         x = x * (y+1);  
>>     end  
>> end
```

- (A) 1
- (B) Inf
- (C) NaN
- (D) Error: Undefined function or variable 'y'

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Note: the inner `for` loop has zero iteration

# Syntax of while loops

```
>> while (logical expression)
>> % The code to be repeated goes here.
>> % At each iteration, the logical
>> % expression is evaluated. If it evaluates
>> % to true, the code here is executed. If it
>> % evaluates to false, the code here is not
>> % executed and the loop exits.
>> end
```

## Notes:

- ▶ The `while` and `end` keywords are mandatory
- ▶ If the logical expression never evaluates to false, then the while loop never exits (→ “infinite loop”)



## Examples of while loops

```
function index = my_index_while(vector, value)

% Returns the index of the first occurrence of non-NaN "value"
% in "vector" (returns -1 if value is not in vector)

n = numel(vector);
index = 0;
keep_looking = true;

while keep_looking
    index = index + 1;
    keep_looking = (vector(index) ~= value & index < n);
end

if vector(index) ~= value
    index = -1;
end

end
```

Other example: `my_integer_guess.m`

## While loops: practice question

What will the value of the variable “y” be after executing the following code?

```
>> vector = 1;  
>> while sum(vector) < 14  
>>     vector(end+1) = vector(end) + 1;  
>> end  
>> y = numel(vector);
```

- (A) 4
- (B) 5
- (C) 13
- (D) 14
- (E) This is an infinite loop!

## While loops: practice question

What will the value of the variable “y” be after executing the following code?

```
>> vector = 1;  
>> while sum(vector) ~= 14  
>>     vector(end+1) = vector(end) + 1;  
>> end  
>> y = numel(vector);
```

(A) 4

(B) 5

(C) 13

(D) 14

(E) This is an infinite loop!

# The break command

Use the command `break` to immediately exit a `for` or `while` loop (only the inner-most loop containing the `break` command is exited)

```
function index = my_index_break(vector, value)

% Returns the index of the first occurrence of non-NaN "value"
% in "vector" (returns -1 if value is not in vector)

for index = 1:numel(vector)
    if vector(index) == value
        break
    end
end

if vector(index) ~= value
    index = -1;
end

end
```

## The break command: practice question

What will the value of the variable “var” be after executing the following code?

```
>> for var = 1:2:100
>>     if sum(1:var) > 50
>>         break
>>     end
>> end
```

(A) 9

(B) 11

(C) 49

(D) 98

(E) 100

# For loop versus while loop

When to use a `for` loop versus a `while` loop?

If you know the number of steps you will need:

- ▶ Use a `for` loop

If you know the maximum number of steps you may need, but you may need fewer steps than that:

- ▶ Use a `for` loop with a `break`, or a `while` loop

If you do not know the number of steps that you will need:

- ▶ Use a `while` loop