# Computer Programming with MATLAB


## Lesson 6: Loops

by

Akos Ledeczi and Mike Fitzpatrick

# Loops

VANDERBILT UNIVERSITY

- The loop is a new control construct that makes it possible to repeat a block of statements a number of times.
- We have already used loops without knowing it:

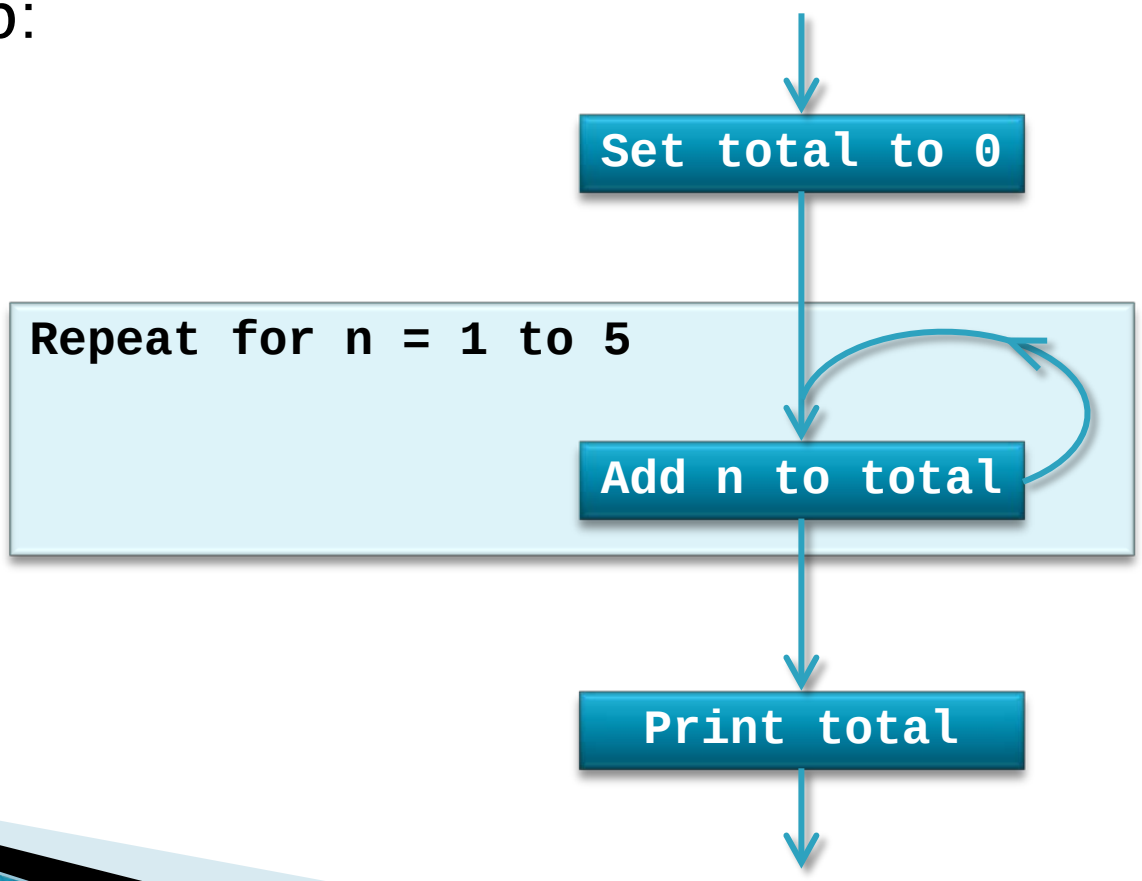
```
>> n = 1:5;
>> total = sum(n);
```

- MATLAB uses loops internally both to compute the result of the colon operator and to compute the sum of the elements of the vector **n** above.
- Implicit loop

# Schematic of a loop

VANDERBILT UNIVERSITY

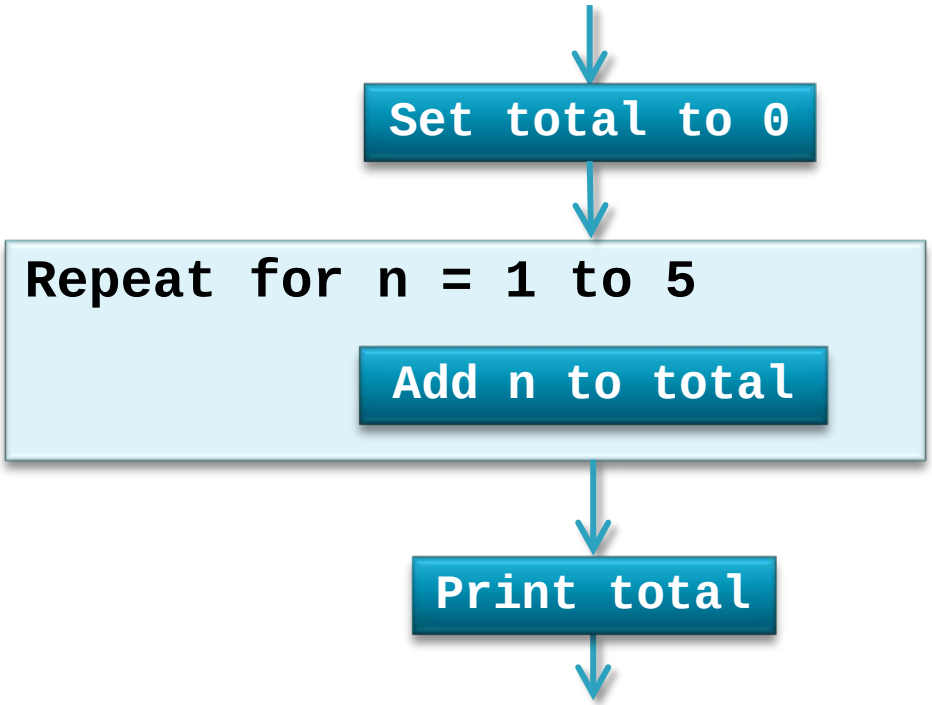
- Let's compute the sum of 1 trough 5 *without* using the built-in sum function!
- Use a loop:



# Execution of a loop

VANDERBILT UNIVERSITY

- Set total to 0
- Set n to 1
- Execute Add n to total (total equals 1)
- Set n to 2
- Execute Add n to total (total equals 3)
- Set n to 3
- Execute Add n to total (total equals 6)
- Set n to 4
- Execute Add n to total (total equals 10)
- Set n to 5
- Execute Add n to total (total equals 15)
- Print total



# for-loop

VANDERBILT UNIVERSITY

- MATLAB implementation using a for-loop:

```
total = 0;
for n = 1:5
    total = total + n;
end
fprintf('total equals %d\n',total);
```

# Parts of a for-loop

VANDERBILT UNIVERSITY

```
total = 0;
for n = 1:5
    total = total + n;
end
fprintf('total equals %d\n',total);
```

loop

control statement

body

# Colon operator is not required

VANDERBILT UNIVERSITY

- Here is another example:

```
list = rand(1,5); % assigns a row vector of random numbers
for x = list
        if x > 0.5
                fprintf('Random number %f is large.\n',x)
        else
                fprintf('Random number %f is small.\n',x)
        end
end
```

```
Random number 0.141890 is small.
Random number 0.421760 is small.
Random number 0.915740 is large.
Random number 0.792210 is large.
Random number 0.959490 is large.
```

# Example revisited

VANDERBILT UNIVERSITY

- Notice that we do not need the list variable at all:

```
for x = rand(1,5)
        if x > 0.5
        fprintf('Random number %f is large.\n',x)
        else
                fprintf('Random number %f is small.\n',x)
        end
end
```

# Observations

VANDERBILT UNIVERSITY

- The values assigned to the loop index do not have to be
  - integers,
  - regularly spaced, or
  - assigned in increasing order,
- In fact, they do not have to be scalars either:
  - The loop index will be assigned the columns of the array
- Any other control construct can be used in the body of the for-loop
  - if-statements
  - other loops
  - etc.

# while-loop

VANDERBILT UNIVERSITY

- for-loops work well when we know the number of necessary iterations before entering the loop
- Consider this problem:
  - Starting from 1, how many consecutive positive integers do we need to add together to exceed 50?
  - The only way to solve this with a for-loop is to guess a large enough number for the number of iterations and then use a break statement.
  - There is a better solution: a while-loop!

# while-loop example

VANDERBILT UNIVERSITY

```
function [n total] = possum(limit)
total = 0;
n = 0;
while total <= limit
    n = n + 1;
    total = total + n;
end
fprintf('sum: %d   count: %d\n', total, n);
```

# while-loop example

VANDERBILT UNIVERSITY

```
function [n total] = possum(limit)
total = 0;
n = 0;
while total <= limit
    n = n + 1;
    total = total + n;
end
fprintf('sum: %d   count: %d\n', total, n);

>> possum(50)
sum: 55   count: 10

ans =

    10
```

# while-loop example

VANDERBILT UNIVERSITY

```
function [n total] = possum(limit)
total = 0;
n = 0;
while total <= limit
    n = n + 1;
    total = total + n;
end
fprintf('sum: %d   count: %d\n', total, n);
```

loop

control statement

body

# General form

VANDERBILT UNIVERSITY

```
while conditional
      block
end

if conditional
      block
end
```

- Difference:
  - while condition is evaluated repeatedly
  - block is executed repeatedly as long as condition is true

# Logical indexing

VANDERBILT UNIVERSITY

- Problem: given a vector, v, of scalars, create a second vector, w, that contains only the non-negative elements of v

# Logical indexing

VANDERBILT UNIVERSITY

- Traditional solution:

```
w = [];
jj = 0;
for ii = 1:length(v)
     if v(ii) >= 0
          jj = jj + 1;
          w(jj) = v(ii);
     end
end
```

# Example revisited

VANDERBILT UNIVERSITY

- MATLAB provides a more elegant solution:

```
w = [];
for ii = 1:length(v)
     if v(ii) >= 0
          w = [w v(ii)];
     end
end
```

# Example with logical indexing


- The ultimate solution needs only a single line:

```
w = v(v >= 0);
```

- This is an example of logical indexing.
- To understand why and how this works, we need to introduce logical arrays