

Unit 6: Data Structures

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Interactive Systems Group

Objectives

- Understanding different ways in which data can be organized and stored in memory
 - Vectors
 - Strings
 - Matrices
 - Cells
 - Structs

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Vectors

- What is a vector?
- How can we create a vector?
- What type of information can we store in a vector?
- How can we modify the data in a vector?
- How can we retrieve data stored in a vector?
- How can we increment the size of a vector?
- How can we concatenate vectors?
- How can we delete an element in a vector?

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Vectors

- One dimension matrices
- They are used as containers for storing **data of the same type**: integers, floats, char, ..
- Vector can dynamically change their size
- Vector elements can be accessed via their position within the vector itself
 - Example: `vect(4)` to obtain the element in the 4th position
- *Some useful functions*
 - *length (vector)* return the number of elements stored in a vector

vect

7
8
9
2
1

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Vectors

1. Creation

`varVector = [];`

`varVector = [1,2,3,4];`

`varVector = [0.0454, 3.56];`

`varVector = zeros(1,4);`

...

`varVector = 1;`

`varVector = 1:4;`

`varVector = ['a', 'b', 'c'];`

2. Use

- Retrieve an element: `varVector(position);`
- Retrieve a portion: `varVector(position_ini : position_fin);`
- Modify an element: `varVector(position) = value;`
- Delete an element: `varVector(position) = [];`

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Strings

- A string is a **vector of characters**
- Two options for creating a String:

1.- Create it the same way as we create a vector

```
varSt = ['R','e','a','d',' ','t','h','i','s'];
```

2.- Write the content of the string within quotes

```
varSt = 'Read this';
```

varSt

'R'
'e'
'a'
'd'
' '
't'
'h'
'i'
's'

- Once you created the String you can use it in the same way as any other vector

Retrieve a character: `varSt(pos)`

Save/Modify a character: `varSt(pos) = value` where value is a char

Delete a character: `varSt(pos) = ''`



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Strings

- To print the content of a string
 - You can print the characters one by one (in the same way as when you print the content of a vector of numbers)
 - You can print all its content at once with *fprintf* and the control character %s
 - *Example:*

```
>>var = 'Biomedical Engineering'
```

```
>>fprintf('\n %s', var);
```

Biomedical Engineering

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Strings

- Matlab provides many functions to work with Strings:
- `strcmp(s1, s2)` Compares the two strings and returns 1 if they are the same and 0 if they are different
- `strcmpi(s1, s2)` Works the same way as `strcmp` but ignoring the case (lowercase/uppercase)
- `s1 == s2` Return a vector containing 1s and 0s for each position in which the characters of the string are equal or different
- `s1=[s1, s2]` Concatenate the second string to the first one
- `strfind(s1, s2)` Returns the starting index of any occurrences of the string `s2` in the string `s1`
- `isempty(s)` Returns 1 if the string is the string is empty, 0 otherwise
- `[t, r] = strtok(s1, delim)` Returns the first token in the string `s1` delimited by the characters of `delim`. The remainder of the original string is

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Exercise

- What is the value of *var* after executing the following code lines?

```
s1 = 'University';
```

```
var = s1(5);
```

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Exercise

- What is the value of *var* after executing the following code lines?

```
s1 = 'University';  
var = s1(5);
```

Solution:
The value of *var* will be 'e'

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = 'Engineering';  
var = strfind(s1,'in');
```

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = 'Engineering';  
var = strfind(s1,'in');
```

Solution:
The value of *var* will be [4 9]

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = 'cat';
```

```
s2 = 'car';
```

```
var = strcmp(s1, s2)
```

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = 'cat';
```

```
s2 = 'car';
```

```
var = strcmp(s1, s2)
```

Solution:
The value of *var* will be 0

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Exercise

- What MATLAB will print in screen after executing these lines?

```
s1 = 'cat';
```

```
s2 = 'car';
```

```
(s1 == s2)
```

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Exercise

- What MATLAB will print in screen after executing these lines?

```
s1 = 'cat';
```

```
s2 = 'car';
```

```
(s1 == s2)
```

REMEMBER:

If you want to compare two strings use the function **strcmp** instead

Solution:

[1 1 0]

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Exercise

- What is the value of *var* after executing these lines?

s1 = 'Bio';

s2 = 'medical';

var = [s1 s2]

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Exercise

- What is the value of *var* after executing these lines?

s1 = 'Bio';

s2 = 'medical';

var = [s1 s2]

Solution:

The value of var will be 'Biomedical'

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Exercise

- What is the value of *var1* and *var2* after executing these lines?

```
s1 = 'Computer*Programming';  
[var1 var2] = strtok(s1, '*')
```

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Exercise

- What is the value of *var1* and *var2* after executing these lines?

```
s1 = 'Computer*Programming';  
[var1 var2] = strtok(s1, '*')
```

Solution:

The value of *var1* will be 'Computer'

The value of *var2* will be '*Programming'

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = 'Bio';
```

```
var = isempty(s1);
```

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = 'Bio';
```

```
var = isempty(s1);
```

Solution:

The value of var will be 0

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = “;
```

```
var = isempty(s1);
```

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = “;
```

```
var = isempty(s1);
```

Solution:

The value of var will be 1

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Exercise

- What is the value of *var* after executing these lines?

`s1 = '9';`

`var = s1 + 2;`

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = '9';
```

```
var = s1 + 2;
```

You are trying to sum a character and a number. MATLAB will convert the character to its corresponding ASCII code, and then performs the operation.

Solution:

The value of var will be 59

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Exercise

- What is the value of *var* after executing these lines?

```
s1 = 9;
```

```
var = s1 + 2;
```

To know the ascii value of a character you can use the function `double`.

Example: the command `double('9')` returns the value **57**

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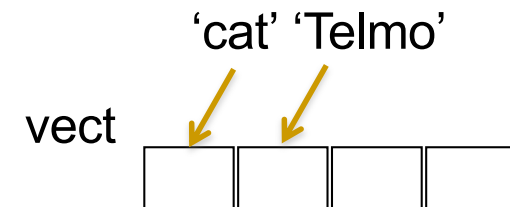
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Vectors/Matrices of Strings

- Sometimes you try to store Strings in a vector.. in the same way as you work with vectors. This is tricky. Be aware of this:

If you try to do

```
vect(1) = 'cat';
```



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Vectors/Matrices of Strings

- Sometimes you try to store Strings in a vector.. in the same way as you work with vectors. This is tricky. Be aware of this:

If you have a 3x3 matrix you could do

```
mat(1,:) = 'cat';
```

```
mat(2,:)= 'dog';
```

mat

c	a	t
d	o	g

This is fine. You put one character in each cell of the matrix

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Vectors/Matrices of Strings

- Sometimes you try to store Strings in a vector.. in the same way as you work with vectors. This is tricky. Be aware of this:

However, if you try to do something like

```
mat(1,:) = 'cat';
```

```
mat(2,:) = 'dog';
```

```
mat(3,:) = 'squirrel';
```

mat

c	a	t							
d	o	g							
s	q	u	i	r	r	e	l		

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Vectors/Matrices of Strings

- Conclusion:
 - You can save strings together putting each of them in a different row of matrix... but **only** when all the strings have **the same length**.
 - In the next week we will learn to overcome the problem of storing together strings with different lengths.

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Exercise

- Write a program that asks the user to introduce his/her name and surname and it prints the user initials as in the example:

Example:

Introduce your name: Bill

Introduce your surname: Gates

Your initials are B. G.

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Exercise

```
name = input('Introduce your name:', 's');  
surname = input('Introduce your surname:', 's');  
initials = [name(1) '.' ' ' surname(1) '.'];  
fprintf('\nYour initials are %s', initials);
```

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Example

- Write a program that asks the user to introduce word/sentences and it prints how many times the user introduces the word 'cat'. The program ends the execution when the user introduces a blank word (empty).

Example:

Introduce a word: House

Introduce a word: Cat

Introduce a word: Programming

Introduce a word: cat

Introduce a word: Table

Introduce a word:

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Example

```
count = 0;
word = input('Introduce a word:', 's');
while (isempty(word) == 0)
    if strcmpi(word, 'cat')
        count = count + 1;
    end
    word = input('Introduce a word:', 's');
end
fprintf('\n You introduced the word cat %d times', count);
disp('bye!');
```

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Example

- Write a program that asks the user to introduce word/sentences and prints those that end in a vowel. The program ends the execution when the user introduces a blank word (empty).

Example:

Introduce a word: House

House

Introduce a word: Programming

Introduce a word: Table

Table

Introduce a word:

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Example

```
word = input('Introduce a word:', 's');  
while (isempty(word) == 0)  
    maxpos = length(word);  
    finalchar = word(maxpos);  
    switch finalchar  
        case {'a','e','i','o','u', 'A','E','I','O','U'}  
            fprintf('%s\n', word);  
        end  
        word = input('\nIntroduce a word:', 's');  
    end  
end  
disp('bye!');
```

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Example

- Write a program that asks the user to introduce a character. Then it asks to introduce word/sentences and prints those that contains the character. The program ends the execution when the user introduces a blank word.

Example:

Introduce a character: **a**

Introduce a word: **House**

Introduce a word: **Programming**

Programming

Introduce a word: **Table**

Table

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Example

```
vchar = input('Introduce a character: ','s');  
word = input('Introduce a word: ','s');  
while (isempty(word) ==0)  
    vpos = strfind (word, vchar);  
    if isempty(vpos) == 0  
        fprintf('%s\n', word);  
    end  
    word = input('Introduce a word: ','s');  
end  
disp('Bye!');
```

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Example

- Write a program that asks the user to introduce a word. Then it asks to introduce sentences and prints those that contains the word. The program ends the execution when the user introduces a blank word.

Example:

Introduce a word: **cat**

Introduce a sentence: **Programming MATLAB**

Introduce a sentence: **The cat is black**

The cat is black

Introduce a sentence: **The cat is on the table**

The cat is on the table

Introduce a sentence:

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Example

EXACTLY THE SAME PROGRAM
AS THE PREVIOUS EXERCISE

```
word = input('Introduce a word: ','s');
sentence = input('Introduce a sentence: ','s');
while (isempty(sentence) == 0)
    vpos = findstr(sentence, word);
    if isempty(vpos) == 0
        fprintf('%s\n', sentence);
    end
    sentence = input('Introduce a sentence: ','s');
end
disp('Bye!');
```

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