

Scilab

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Introduction

What is Scilab?

A free alternative to MATLAB

What can it do?

- ① Advanced calculator
- ② Programming
- ③ Plotting, visualisation

Simple calculations

Try out these and see if they give expected results

```
1 2+3-4
2 4^2
3 4**4
4 6/4
5 2+(2^2-(1/2))
6 1e-3 + 1d-2
```

See what happens when you add a semicolon

```
6/4;
```

Variables

All calculations are stored by default in `ans`

```
6/4;
```

```
ans
```

You can specify a variable to store the value instead

```
pi_approx = 22/7;
```

And see its value later

```
pi_approx
```

```
disp(pi_approx)
```

More on variables

Some useful pre-defined variables

```
1 %pi
2 %e
3 %i
4 %t
5 %f
6 %inf
7 %nan
8 %eps
```

Pre-defined functions

See if the outputs of these lines are as expected

```
1 abs(-2)
2 min(3,4,5)
3 max(-2,-3,-4)
4 sin(%pi/2)
5 cos(%pi)
6 tan(%pi/4)
7 asin(1)/(%pi/2)
8 exp(2)/%e^2
9 log10(100)
10 log(%e)
```

Auto-completion: hit **TAB**

Other Scilab windows

► Variable Browser

- Only lists user-defined variables
- To list all variables:

```
whos
```

- You can delete all or specific user-defined variables

```
pi_approx = 22/7;  
disp(pi_approx)  
clear pi_approx  
disp(pi_approx)
```

► Command History

- Execute an old command by double clicking
- Can also navigate using ↑ and ↓ keys
- Clear screen using `clc`

► File Browser

- Useful when working with multiple files

Basic matrix creation

Wrap inside `[]`, use `,` and `;` to separate columns and rows

```
x = [1,2,3]
y = [4;5;6;7]
A = [1,0;0,1]
```

Scilab will warn you if the dimensions are inconsistent

```
B = [1,2,3;4,5]
```

Adding `'` will transpose the matrix

```
B = [1,2,3;4,5,6];
B'
```

You can fill matrices with pre-existing matrices

```
row1 = [1,2,3,4];
row2 = [5,6,7,8];
M = [row1;row2]
```


Special functions for matrix creation

Creating ranges

```
i = 1:10  
j = 1:2:10  
x = 0:0.1:1  
y = linspace(0,1,25)
```

Some useful commands for creating dummy matrices of required size

```
A = zeros(2,2)  
B = ones(3,2)  
M = eye(3,3)
```

Can you make sense of this result?

```
M = [[zeros(1,2);ones(1,2);eye(2,2)],ones(4,1)]
```

Matrix operations

Scalar operations affect all elements of matrices

```
A = eye(3,3);  
A*2  
A/4  
A+5
```

Scilab automatically figures out matrix operations too

```
B = 2*ones(3,3)  
A+B  
A*B  
B^2
```

Special element wise operations

```
A.*B  
A.^B  
A./B  
A.^2
```

How is `A^2` different from `A.^2` ?

Matrix functions

Most Scilab functions can operate element-wise on matrices

```
A = %pi/2*[0,1;2,3];  
sin(A)
```

Some special functions for matrices

```
length(A)  
size(A)  
sum(A)  
det(A)  
inv(A)  
trace(A)
```

Matrix indexing

Access elements using (row,col)

```
A = eye(3,3);  
A(1,2) = 2;  
A
```

A single index can also be used:
increments column-wise

```
A(4)
```

Extract rows and columns using :

```
A(:,2)  
A(1,:)
```

Special symbol \$

```
A($,3)
```

Arrays can also be used to access
and modify

```
A([1,2],2)  
A(4,:) = [10,20,30]
```

See if this makes sense

```
A = eye(4,4);  
j = [2,4];  
A(1,j) = j  
A([7,8]) = 50  
A($,$) = -1  
B = [9,10;j];  
A(B) = 100
```

Strings

Wrap in `"""` or `' '`

```
fname = "Vachan";  
lname = 'Potluri';  
fname + lname
```

Function `string` converts variables to strings

```
A = eye(2,2)  
string(A)
```

Saving and loading data

Scilab has a working directory

```
pwd
```

Working directory can be changed from File Browser (and also using `cd` or `chdir`)

Function `save` saves user-defined variables to a file in working directory

```
x = 1.5;  
A = [1,2;3,4]  
save("data.dat")
```

These variables can be loaded for use later

```
listvarinfile("data.dat")  
load("data.dat")
```

Accessing help

Scilab's built-in help functionality is very useful

```
help
```

```
help save
```

Exercises¹

Exercise

The pressure drop Δp required for a flow rate Q in a pipe of diameter D is

$$\Delta p = 4.52 \frac{Q^{1.85}}{C^{1.7} D^{4.87}}$$

Find Δp for these combinations of flow rates and diameters:

- ▶ $Q = 50, 100, 200, 400$ and 1000
- ▶ $D = 0.5, 1, 1, 2$ and 4

Use $C = 2.5$ for all cases

Exercise

A magic square is a matrix in which all rows, columns and diagonals sum to same number.

- ① Generate a magic square of size 10
- ② Verify that all rows and columns sum up to the same value

Hint: search Scilab help for the function `testmatrix`, and use the `sum` function

¹Amos Gilat. *MATLAB: An Introduction with Applications*. 6th ed. Wiley, 2017.

SciNotes: built-in editor

- ▶ Console is only useful for short calculations
- ▶ A single file containing all commands is useful for large calculations
- ▶ Scilab can do this through “scripts” or “executables”
- ▶ SciNotes is Scilab’s builtin-in GUI for handling scripts
- ▶ Customary to save such files with `.sce` extension
- ▶ Comments being with `//`, or can be wrapped with `/* */`

```
// this is a single line comment
/* this is a
   multi-line comment */
```

Conditional statements

Can you make sense of this?

```
x=6;
remainder = modulo(x,3);

if remainder==0 then
    disp("3 divides x")
elseif remainder==1 then
    disp("x leaves remainder 1 when divided by 3")
else
    disp("x leaves remainder 2 when divided by 3")
end
```

Hint: look at help for function `modulo`

Logical expressions generally use

`==`, `~=`, `<`, `<=`, `>`, `>=`, `&&`, `||`, `%t`, `%f`

Loops

```
1 array = 1:10;
2 value = 5;
3
4 for a=array
5     if value==a then
6         disp("Value exists in
7             ↪array");
8         break;
9     end
10 end
```

What does `break` statement do?

Scilab always loops over columns

```
1 array=[1;2;3]
2 i=1;
3 for a=array
4     disp("Element " + string(i)
5         ↪+ " :")
6     disp(a)
7     i = i+1;
8 end
```

Functions

```
function [Tf,Tk] = centigradeToFarenhietKelvin(Tc)
    Tf = Tc*9/5 + 32;
    Tk = Tc + 273;
endfunction

[Tf,Tk] = centigradeToFarenhietKelvin(37);
disp(Tf)
disp(Tk)
```

Here `Tf` and `Tk` are the “return” values; `Tc` is the parameter

Can also have multiple parameters

```
function s = sum(a,b)
    s = a+b;
endfunction
disp(sum(1,2));
```

Exercises

Exercise

Write a function to calculate the cross product of two 3d vectors

```
function v = cross_product(v1,v2)
    // fill this
endfunction
```

Exercise

Write a function that takes in an array and a value, and returns the indices where the value occurs in an array.

Example: for `array=[1,2,1,4,5,2]` and `value=2`, the function should return `[2,6]` (since `array(2)=array(6)=value`)

```
function indices = multiple_find(array,value)
    // fill this
endfunction
```

Working with multiple files

- ▶ Many times we use different user-written functions to accomplish our task
- ▶ Having them all in a single file makes it hard to read and debug
- ▶ Splitting the script into multiple files is preferable
 - One for each function
 - One main file
- ▶ How to access content from another file?

my_function_file.sce

```
function y=my_function(x)
    // do something
endfunction
```

main.sce

```
// 'include' the file
exec("my_function_file.sce",-1);
// use the function
result=my_function(2.5);
```

Exercises

Exercise

- 1 Recall the `cross_product()` function you have written previously. Save it in a file `cross_product.sce`
- 2 Write a file `vector_norm.sce` which contains a function `vector_norm()` to calculate the length (norm) of a 3d vector
- 3 Now in the file `triangle_area.sce`, write a function to calculate the area of an arbitrarily oriented triangle with points p_1 , p_2 and p_3

```
function area = triangle_area(p1, p2, p3)
    // fill this
endfunction
```

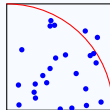
Hint: The area of a triangle is half the magnitude of cross product of any of its two sides

Exercise

We will calculate π approximately here

- 1 Write a function `get_random_point()` which generates a random point in a 2d square $x \in [0, 1]$, $y \in [0, 1]$
Hint: Use the `rand` function of Scilab
- 2 Now write a function `inside_circle()` which takes any point and returns a boolean value saying whether or not the point lies inside the unit circle $x^2 + y^2 = 1$
- 3 Now write a function `approximate_pi()` that takes N is an parameter and does the following
 - Generate N random points
 - Find out how many of these points (say N_i) lie inside the unit circle
 - Return the value N_i/N

$$\frac{N_i}{N} \rightarrow \frac{\pi}{4} \text{ as } N \rightarrow \infty$$



This is called as a Monte-Carlo simulation