Programming in Scilab - Sections 1, 2 and 3

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1 Introduction

Scilab is free software for numerical computing. It includes hundreds of predefined mathematical functions, in addition to a high-level the programming language, allowing access to advanced data structures and graphical functions in 2 and 3 dimensions. It has a large number of features such as control, simulation, optimization, signal processing, and Xcos, a model and simulator of hybrid dynamic systems that are provided with the platform.

1.1 Download and installation

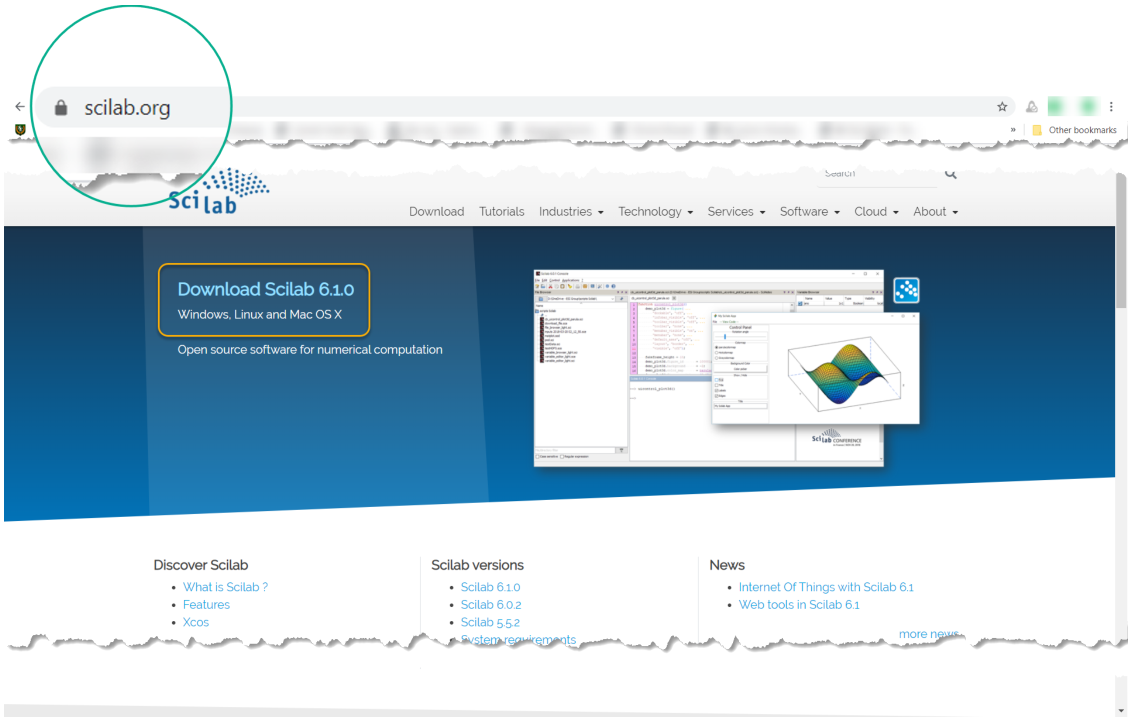


Figure 1: 2020-05-28_13-39-17

https://www.scilab.org/

2 Getting started with Scilab

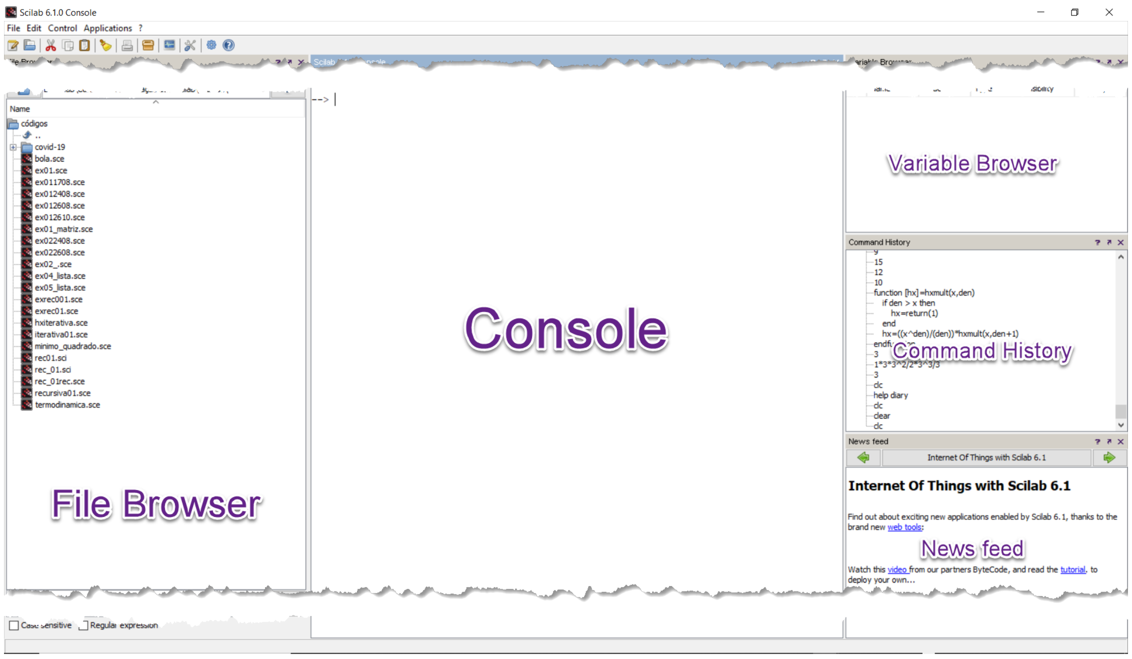
2.1 Scilab interface

2.1.1 The basic interface activated when starting Scilab

Figure 2

2.1.2 The basic interface and the script editor activated from the activation of the highlighted icon

Figure 3



```
códigos
..
covid-19
bola.sce
ex01.sce
ex011708.sce
ex012408.sce
ex012608.sce
ex012610.sce
ex01_matriz.sce
ex022408.sce
ex022608.sce
ex02_.sce
ex04_lista.sce
ex05_lista.sce
exrec001.sce
exrec01.sce
hxiterativa.sce
iterativa01.sce
minimo_quadrado.sce
rec01.sci
rec_01.sci
rec_01rec.sce
recursiva01.sce
termodinamica.sce
```

```
-->
```

```
9
15
12
10
function [hx]=hxmult(x,den)
  if den > x then
    hx=return(1)
  end
  hx=((x^den)/(den))*hxmult(x,den+1)
endfunction
3
1*3*3^2/2*3^3/3
3
clc
help diary
clc
clear
clc
```

Internet Of Things with Scilab 6.1

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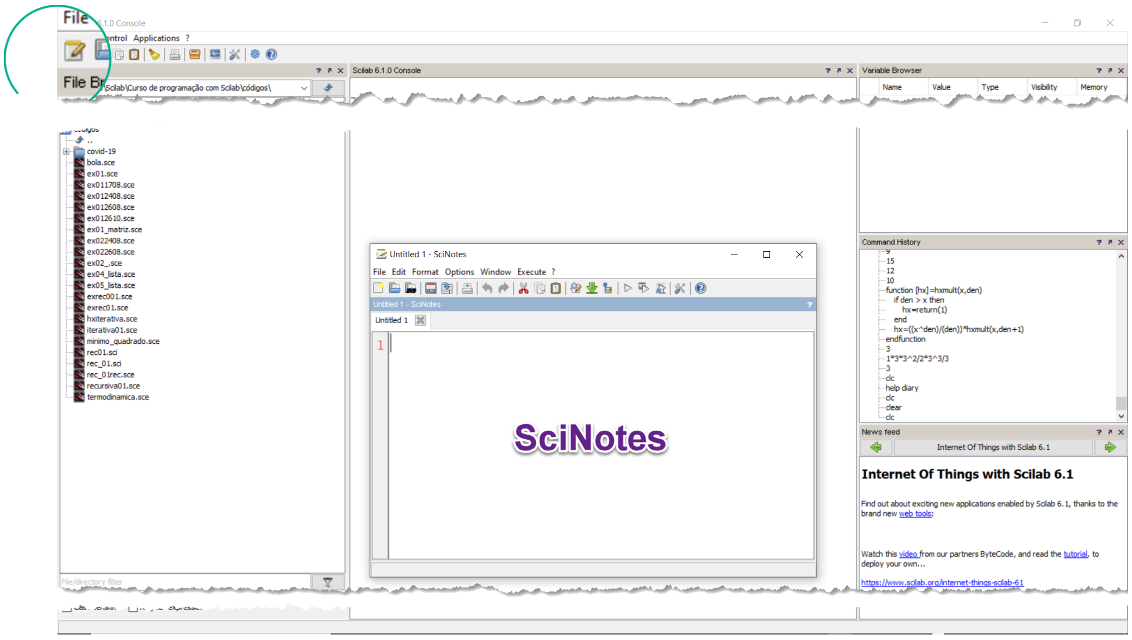
Figure 2: 2020-05-26_17-34-04

2.1.3 Components of the basic interface menu items (click in the console area)



```
\Scilab\Curso de programação com Scilab\códigos\
```

```
..
covid-19
bola.sce
ex01.sce
ex011708.sce
ex012408.sce
ex012608.sce
ex012610.sce
ex01_matriz.sce
ex022408.sce
ex022608.sce
ex02_.sce
ex04_lista.sce
ex05_lista.sce
exrec001.sce
exrec01.sce
hxiterativa.sce
iterativa01.sce
minimo_quadrado.sce
rec01.sci
rec_01.sci
rec_01rec.sce
recursiva01.sce
termodinamica.sce
```

```
9
15
12
10
function [hx]=hxmult(x,den)
  if den > x then
    hx=return(1)
  end
  hx=((x^den)/(den))*hxmult(x,den+1)
endfunction
3
1*3*3^2/2*3^3/3
3
clc
help diary
clc
clear
clc
```

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https://www.scilab.org/internet-things-scilab-61

Figure 3: 2020-05-26_17-40-00

2.1.4 File

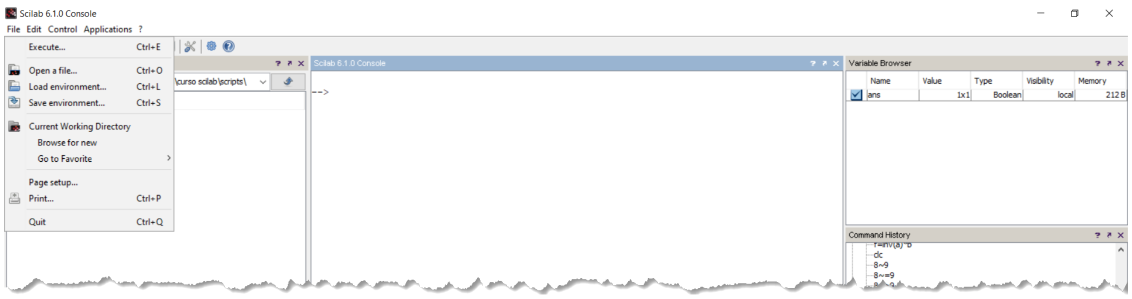


Figure 4: 2020-05-27_15-18-35

- Run or Ctrl + E: Run script files
- Open a File or Ctrl + O: Load script files
- Load environment or Ctrl + L: Load binary files (of variables) saved with save
- Save environment or Crtl + S: Saves a binary file containing variables
- Current Working Directory: Change working directory
- Page setup or Ctrl + P: Print scripts
- Quit or Crtl + Q: Close the section and exit the Scilab environment

2.1.5 Edit

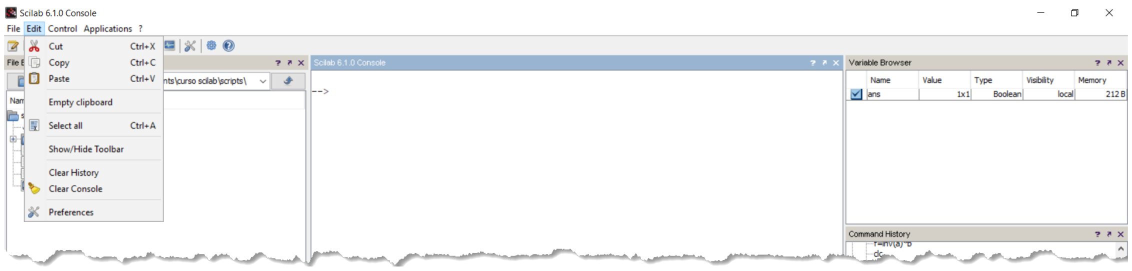
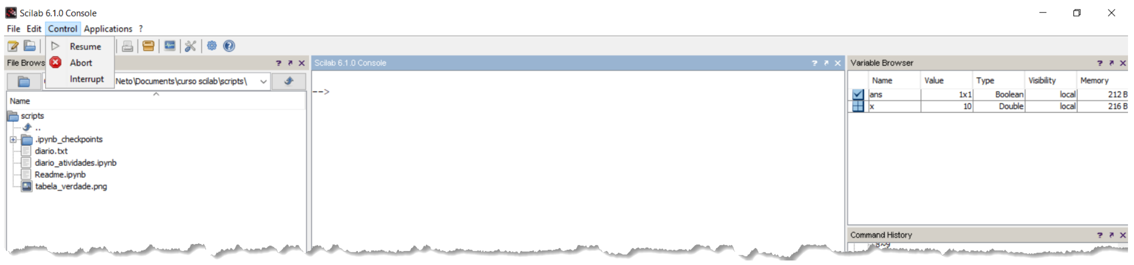


Figure 5: 2020-05-27_15-43-34

- Cut or Ctrl + X: 'Cut' a text
- Copy or Ctrl + C: Copy selected text to the clipboard
- Paste or Ctrl + V: 'Paste' what was copied
- Empty clipboard: 'Clean' the clipboard
- Select all or Ctrl + A: Select all the current text in the environment
- Clear History: 'Clear' the history area
- Clear Console: 'Clear' the console area
- Preferences: Customize the Scilab environment

2.1.6 Control



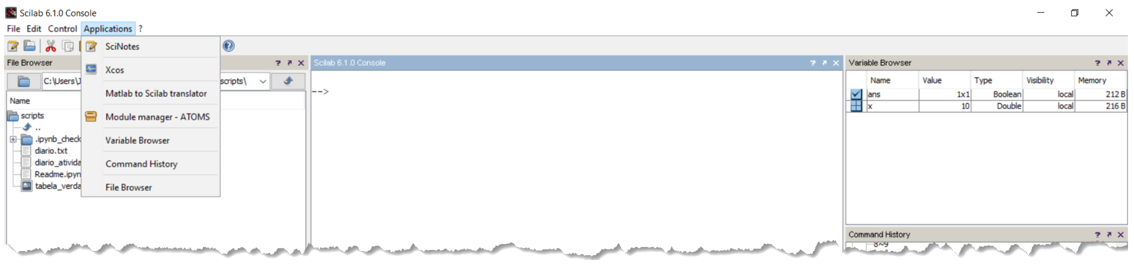
Name	Value	Type	Visibility	Memory
ans	1x1	Boolean	local	212 B
x	10	Double	local	216 B

```
scripts
  ..
  .ipynb_checkpoints
  diario.txt
  diario_atividades.ipynb
  Readme.ipynb
  tabela_verdade.png
```

Figure 6: 2020-05-27_16-05-18

- Resume: The execution of the execution of an instruction continues after a pause or due to a stop
- Abort: Stop the execution of a process
- Interrupt: Stop a process, equivalent to Ctrl + C

2.1.7 Applications

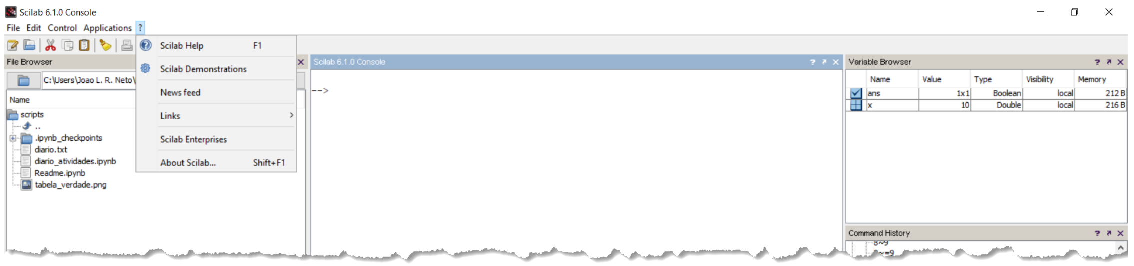


Name	Value	Type	Visibility	Memory
ans	1x1	Boolean	local	212 B
x	10	Double	local	216 B

Figure 7: 2020-05-27_16-17-05

- SciNotes: Load the script editor (text editor)
- Xcos: Load the modeler and simulator of hybrid dynamic systems, allowing to create block diagram and graphical interfaces
- Matlab to Scilab translator: Code conversion options from Matlab to Scilab
- Variable Browser: View the variable browser
- Command History: View the command history
- File Browser: View the file and folder browser

2.1.8 Help (?)



Name	Value	Type	Visibility	Memory
ans	1x1	Boolean	local	212 B
x	10	Double	local	216 B

```
scripts
  ..
  .ipynb_checkpoints
  diario.txt
  diario_atividades.ipynb
  Readme.ipynb
  tabela_verdade.png
```

Figure 8: 2020-05-27_16-46-02

- Scilab Help or F1: Scilab resources reference
- Scilab Dmonstrations: Application demonstrations with Scilab
- News feed: News about Scilab
- Link: Addresses about Scilab
- Scilab Interprises: Scilab developer and support provider
- About Scilab or Shift + F1: About Scilab

2.2 Start a diary session

[1]:
```
x=diary('diary.txt')
```

```
 x  =

   1.
```

[2]:
```
a=10
b=20
c=a+b
```

```
 a  =

   10.

 b  =

   20.

 c  =

   30.
```

Note: Check the creation of the file 'diary.txt' in the folder where you are working

3 Key Scilab items

3.1 Constants

Constants do not change the value during the execution of an algorithm

3.1.1 Predefined Constants

The value of the constant $\pi = 3.1415927$

[3]:
```
%pi
```

```
 %pi  =

   3.1415927
```

Base of natural logarithms e = 2.7182818

[4]:
```
%e
```

```
 %e  =

   2.7182818
```

Imaginary unit; square root of -1

[5]:
```
%i
```

```
 %i  =

   0. + i
```

Infinite

[6]:
```
%inf
```

```
 %inf  =

   Inf
```

True logical value

[7]:
```
%t
```

```
 ans  =

  T
```

False logical value

[8]:
```
%f
```

```
 ans  =

  F
```

not a number

```
[9]: %nan
```

```
 %nan  =

   Nan
```

```
[10]: %eps
```

```
 %eps  =

   2.220D-16
```

Scilab accuracy

```
[11]: %s
```

```
 %s  =

  s
```

Polynomial with a root at zero and variable s

```
[12]: %z
```

```
 %z  =

  z
```

Polynomial with a root of zero and variable z

3.2 Variables

They change the value during the execution of an algorithm. Variables are created dynamically. By assigning (operator =) a value to a valid identifier the variable is created.

Creating a variable represents referencing a space in main memory (RAM).

3.2.1 Valid identifiers

Characters from a . . . z and A . . . Z. Combinations of letters and numbers as long as it starts with a letter. Combinations with special characters #,!, $, _. Other special characters are not allowed.

[13]:
```
a=10
A=5
a20=100
```

```
a  =

  10.

A  =

  5.

a20  =

  100.
```

[14]:
```
x!=10
```

```
x!  =

  10.
```

[15]:
```
c#3=30
```

```
c#3  =

  30.
```

[16]:
```
v$=0.3
```

```
v$  =

  0.3
```

```
[17]: a 9=5
```

```
a 9=5
  ^^
Error: syntax error, unexpected =, expecting end of file
```

Note: White space, for example, is not a valid special character in the character combination to create a variable

3.2.2 Data Types

Numeric

```
[18]: a1=27
      a2=4.56
```

```
 a1  =

   27.

 a2  =

   4.56
```

```
[19]: a3 = 4+%i
```

```
 a3  =

   4. + i
```

String and character

```
[20]: phrase = "This is a string variable"
```

```
 phrase  =

  "This is a string variable"
```

```
[21]: phrase = 'This is a string variable'
```

```
 phrase  =
 "This is a string variable"
```

```
[22]: character = "B"
```

```
character  =

 "B"
```

```
[23]: character = 'B'
```

```
character  =

 "B"
```

Logical: T (True) and F (False)

```
[24]: option = %f
```

```
option  =

 F
```

```
[25]: option = %t
```

```
option  =

 T
```

Homogeneous aggregates - matrices Note: Assign data to an identifier in square brackets (space or comma is column and semicolon is line)

```
[26]: matrix1 = [3 2 6 4;7 4 8 3;1,2,3,4]
```

```
matrix1  =

  3.   2.   6.   4.
  7.   4.   8.   3.
```

```
   1.   2.   3.   4.
```

[27]:
```
matrix2 = ["One","matrix";"with two rows","two columns"]
```

```
 matrix2  = 

  "One"             "matrix"     
  "with two rows"   "two columns"
```

[28]:
```
matrix3 = [4 5 "string"]
```

```
Undefined operation for the given operands.
check or define function %s_c_c for overloading.
```

Heterogeneous aggregates - lists

[29]:
```
list1 = list("personal data", ["name"; "address"],[1250.45 45])
```

```
 list1  = 


      list1(1)

  "personal data"

      list1(2)

  "name"   
  "address"

      list1(3)

   1250.45   45.
```

ans variable When we do not create any identifier, Scilab assigns data to a variable called ‘ans’, of answer. The ‘ans’ variable will always contain the content of the last operation performed.

[30]:
```
345
```

```
 ans  = 
  345.
```

```
[31]: "Another example"
```

```
 ans  =

  "Another example"
```

```
[32]: [4 3 6;6 4 7]
```

```
 ans  =

   4.   3.   6.
   6.   4.   7.
```

```
[33]: list(["name"],[5 3])
```

```
 ans  =


       ans(1)

  "name"

       ans(2)

   5.   3.
```

3.3 Arithmetic expressions

3.3.1 Arithmetic operators

Addition (+)

Subtraction (-)

Multiplication (*)

Division (/) Mumerator / Denominator

Division (\ ) Denominator / Numerator

```
[34]: x=20
```

```
 x  =

   20.
```

[35]:
```
x=x+5
```

```
 x  =

   25.
```

[36]:
```
y=10
```

```
 y  =

   10.
```

[37]:
```
z=x-y
```

```
 z  =

   15.
```

[38]:
```
a=5
b=10
```

```
 a  =

   5.

 b  =

   10.
```

[39]:
```
c=a*b
```

```
 c  =
  50.
```

```
[40]: d=a/b
```

```
 d  =

   0.5
```

```
[41]: e=a\b
```

```
 e  =

   2.
```

3.3.2 Scalar operations by an array

Note: When creating a matrix - space or comma is column change, and a semicolon is a new line.

```
[42]: m=[3 4 5 6 7 8]
```

```
 m  =

   3.   4.   5.   6.   7.   8.
```

```
[43]: n=5+m
```

```
 n  =

   8.   9.   10.   11.   12.   13.
```

```
[44]: l=[4;6;2;8]
```

```
 l  =

   4.
   6.
   2.
   8.
```

```
[45]: u=3+l
```

```
u  =

   7.
   9.
   5.
   11.
```

3.3.3 Matrix operations

Addition. The matrices must be the same size (equal number of rows and columns).

[46]:
```
a=[ 4 5 6 1;8 9 0 1]
```

```
 a  =

   4.   5.   6.   1.
   8.   9.   0.   1.
```

[47]:
```
b=[9 1 5 3;7 1 0.5 9 ]
```

```
 b  =

   9.   1.   5.    3.
   7.   1.   0.5   9.
```

[48]:
```
c=a+b
```

```
 c  =

   13.   6.    11.   4.
   15.   10.   0.5   10.
```

[49]:
```
e=[9 4; 9 0; 2 1;8 6]
```

```
 e  =

   9.   4.
   9.   0.
   2.   1.
   8.   6.
```

[50]:
```
f=a+e
```

```
Inconsistent row/column dimensions.
```

Subtraction. The same addition rules.

[51]:
```
x=[5 3 6;6 3 9]
```

```
 x  =

   5.   3.   6.
   6.   3.   9.
```

[52]:
```
y=[7 1 9; 0 3 1]
```

```
 y  =

   7.   1.   9.
   0.   3.   1.
```

[53]:
```
z=x-y
```

```
 z  =

  -2.   2.  -3.
   6.   0.   8.
```

[54]:
```
p=[4 2;5 6;9 3]
```

```
 p  =

   4.   2.
   5.   6.
   9.   3.
```

[55]:
```
w=z-p
```

```
Inconsistent row/column dimensions.
```

Matrix multiplication. Number of columns in one matrix must equal the number of rows in the other matrix.

[56]:
```
a=[4 6 1 4]
```

```
 a  =

   4.   6.   1.   4.
```

[57]:
```
b=[5 3 7;6 4 9;1 2 3;6 4 5]
```

```
 b  =

   5.   3.   7.
   6.   4.   9.
   1.   2.   3.
   6.   4.   5.
```

[58]:
```
c=a*b
```

```
 c  =

   81.   54.   105.
```

[59]:
```
d=[5 5 2;5 6 4]
```

```
 d  =

   5.   5.   2.
   5.   6.   4.
```

[60]:
```
e=[2 3 4;8 6 7]
```

```
 e  =

   2.   3.   4.
   8.   6.   7.
```

[61]:
```
f=d*e
```

```
Inconsistent row/column dimensions.
```

Point-to-point multiplication (. *). Matrices of the same size.

[62]:
```
x=[1 2 3;5 4 6;8 7 9]
y=[5 4 7;1 2 3;-9 4 0]
```

```
 x  =

   1.   2.   3.
   5.   4.   6.
   8.   7.   9.

 y  =

   5.   4.   7.
   1.   2.   3.
  -9.   4.   0.
```

[63]:
```
z=x.*y
```

```
 z  =

   5.    8.    21.
   5.    8.    18.
  -72.   28.   0.
```

Matrix division. The division operation will be the multiplication of the inverse of one matrix by the other matrix. Notes:

1) In this example we are using the rand () function. Randomly generates values.
2) We also use the inv () function, which calculates the inverse of a matrix.

[64]:
```
x=rand(3,3)
```

```
 x  =

   0.2113249   0.3303271   0.8497452
   0.7560439   0.6653811   0.685731
   0.0002211   0.6283918   0.8782165
```

[65]:
```
y=rand(3,1)
```

```
y =

  0.068374
  0.5608486
  0.6623569
```

[66]:
```
z=x\y
```

```
z =

 -0.3561912
  1.7908789
 -0.5271342
```

[67]:
```
z=inv(x)*y
```

```
z =

 -0.3561912
  1.7908789
 -0.5271342
```

Point-to-point division (./ and .\ ). Matrices of the same size.

[68]:
```
a=rand(3,3)
b=rand(3,3)
```

```
a =

  0.7263507   0.2320748   0.8833888
  0.1985144   0.2312237   0.6525135
  0.5442573   0.2164633   0.3076091

b =

  0.9329616   0.3616361   0.4826472
  0.2146008   0.2922267   0.3321719
  0.312642    0.5664249   0.5935095
```

[69]:
```
c=a./b
```

```
 c  =

   0.7785429   0.6417357   1.8302992
   0.9250403   0.7912479   1.964385
   1.7408324   0.3821571   0.5182884
```

[70]:
```
d=a.\b
```

```
 d  =

   1.2844507   1.558274    0.5463588
   1.0810339   1.2638265   0.5090652
   0.5744378   2.6167252   1.9294277
```

Power with matrices (^ and . ^)

[71]:
```
x=rand(2,3)
```

```
 x  =

   0.5015342   0.2693125   0.4051954
   0.4368588   0.6325745   0.9184708
```

[72]:
```
y=x^2
```

```
at line    20 of function %s_pow ( C:\Program
Files\scilab-6.1.0\modules\overloading\macros\%s_pow.sci line 32 )
at line     3 of function %s_p_s ( C:\Program
Files\scilab-6.1.0\modules\overloading\macros\%s_p_s.sci line 15 )

%s_pow: Wrong size for input argument #1: Square matrix expected.
```

[73]:
```
y=x.^2
```

```
 y  =

   0.2515365   0.0725292   0.1641833
   0.1908456   0.4001505   0.8435886
```

[74]:
```
a=rand(3,3)
```

```
 a  =

   0.0437334   0.4148104   0.7783129
   0.4818509   0.2806498   0.211903
   0.2639556   0.1280058   0.1121355
```

Note: With a square matrix it is possible to use the operator (ˆ). Noting that a matrix multiplication will occur.

```
[75]: b=a^2
```

```
 b  =

   0.4072294   0.2341861   0.2092143
   0.2122373   0.3057659   0.4582631
   0.1028222   0.1597703   0.2451392
```

3.4 Logical expressions

3.4.1 Relational operators

The logical operators, list two objects (constants, variables, expressions) and return False (F) or True (T). They are also called relational operators.

Greater (>)

Minor (<)

Greater than or equal (> =)

Less than or equal (<=)

Equal (==)

Different (~ =) or (<>)

Note: The equality relational operator is (==), different from the assignment operator (=).

```
[76]: a=5
      b=6
```

```
 a  =

   5.

 b  =
  6.
```

[77]:
```
c=a>b
```

```
c  =

 F
```

[78]:
```
d=a<b
```

```
d  =

 T
```

[79]:
```
e=a>=10
```

```
e  =

 F
```

[80]:
```
g=a~=b
```

```
g  =

 T
```

3.4.2 Logical operators

Tabela 1: A proposition can be a simple relation, an expression. In the Table 1 we consider two propositions any P and Q. These propositions can assume the values True (V) or False (F). In this way, all possible combinations are indicated in the first and second columns of the table.

[81]:
```
2>3 && 5<4
```

```
ans  =

 F
```

Table 1: Truth table

Proposition P	**Proposition** Q	**P and Q** P && Q	**P or Q** P | | Q	**notP** ∼ P	**notQ** ∼ Q
V	V	V	V	F	F
V	F	F	V	F	V
F	V	F	V	V	F
F	F	F	F	V	V

[82]:
```
2>3 & 5<4
```

```
ans  =

 F
```

[83]:
```
x=10
y=3
```

```
x  =

  10.

y  =

  3.
```

[84]:
```
x>y || x==y
```

```
ans  =

 T
```

[85]:
```
x>y | x==y
```

```
ans  =

 T
```

[86]:
```
~(x>y) || (x==y)
```

```
ans  =

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References

[1] Mário Leite. *Scilab: Uma abordagem Prática e Didática*. Editora Ciência Moderna, Rio de janeiro, 2009.

[2] `https://scilab.org`. Consulted on 05/28/2020.