

Workshop: Introduction to Scilab

Problems contributed by FOSSEE Group, IIT Bombay, <http://fossee.in> and <http://scilab.in>

1. Getting Started

- (a) Perform the following calculations on the scilab command line:

$$\text{phi} = \frac{\sqrt{5} + 1}{2} \quad \text{psi} = \frac{\sqrt{5} - 1}{2}$$

Find $1/\text{phi}$ and $1/\text{psi}$.

- (b) Verify Euler's identity: Is $e^{\pi i} + 1$ close to zero?
Compare with $\cos(\pi) + i \cdot \sin(\pi)$.

2. Matrix Operations

- (a) In Scilab, enter the following Matrices:

$$A = \begin{bmatrix} 1 & 1/2 \\ 1/3 & 1/4 \\ 1/5 & 1/6 \end{bmatrix}$$

$$B = [5 \quad -2], \quad C = \begin{bmatrix} 4 & 5/4 & 9/4 \\ 1 & 2 & 3 \end{bmatrix}$$

Using Scilab commands, compute each of the following, if possible.

- i. $A * C$
- ii. $A * B$
- iii. $A + C'$
- iv. $B * A - C' * A$
- v. $(2 * C - 6 * A') * B'$
- vi. $A * C - C * A$
- vii. $A * A' + C' * C$

Explain the errors, if any.

- (b) From the video:
- i. Find $E(:, :)$
 - ii. Extract the second column of E
 - iii. Display just the first and last columns¹ of E.

(c) If $A = \begin{bmatrix} 1 & -1 & 0 \\ 2 & 3 & 1 \\ 4 & 1 & 5 \end{bmatrix}$

Use a suitable sequence of row operations on A to bring A to upper triangular form.²

- (d) Represent the following linear system as a matrix equation. Solve the system using the inverse method:

$$\begin{aligned} x + y + 2z - w &= 3 \\ 2x + 5y - z - 9w &= -3 \\ 2x + y - z + 3w &= -11 \\ x - 3y + 2z + 7w &= -5 \end{aligned}$$

- (e) Try solving the above system using the backslash method.
- (f) Verify the solution from the previous question.
- (g) Try $\det(A)$, A^2 , A^3 and Eigenvalues of A (from the previous question). Also multiply A by an identity matrix of the same size.

3. Scripts and Functions

- (a) Create a scilab script file to display time on console window. (hint: `clock()`)
- (b) Create a scilab script file to display product of a matrix A and inverse of A . $A = [1, 1; 1, -1]$
- (c) Create a scilab script file to plot 'sin(x)' vs 'x'. 'x' varies from $-2p$ to $2p$, where p is specified at the beginning of the script file.
- (d) Create a function file to calculate sum and difference of any two numbers. The output should be the sum and the difference of numbers.
- (e) Create a function file to calculate the rowwise and columnwise mean and standard deviation of a user defined matrix. Display the matrix, its mean and standard deviation in output. (hint; `mean()`, `stdev()`)

¹Tip: from a given matrix E , desired columns can be specified by defining a vector v consisting of just the desired column indices and using $E(:, v)$. Similarly for rows also.

²Upper triangular matrix: all elements below the North-West to South-East diagonal of the matrix are zero.

- (f) Create an inline function to sort the elements of a random vector in descending order. (hint: gsort())
- (g) Create an inline function to round off the elements of a vector [1.9, 2.3, -1.1, 50.5] to the nearest integer. (hint: round())
- (h) Create a function file to calculate LU factorization of a matrix. (hint: lu()).
- (i) Create a function file that takes two matrices A and B as input, calculates their trace, and does the following.
 - i. If trace of A is greater than trace of B, then display 1.
 - ii. If trace of B is greater than trace of A, then display -1.
 - iii. If both traces are equal, then display 0.
- (j) Create a function file to evaluate and plot following function of x (x varies from -1 to 1 with step size of 0.1).

$$f(x) = x^2 - \sin(x), \quad x \leq 0$$

$$x(x) = \cos(x), \quad x > 0$$

(hint : if else)

- (k) Create an inline scilab function file to 3-d plot of parametric curve (Given a=2).
t = varies form 0 to 2π (with 100 intermediate points).

$$x = a * \cos(t); \quad y = a * \sin(t);$$

(hint : linspace(), param3d())

4. Conditional Branching

Note the importance of 'end' at the end of the 'if-then-else-end' construct.

- (a) Write a code to check if a given number n is less than or equal to 10, if yes, display its square.(for $n = 4, 13$ and 10)
- (b) Write a code to check if a number is less than 10, if yes, then display '> 10', if it is greater than 10, then

display '> 10', else display the number. (for $n = 4, 13$ and 10)

- (c) Write the previous code in one line.
- (d) Write a code using select case conditional construct to check whether a given number is a multiple of 10 (take 5 values/multiples), and if so, display the number.

5. Iteration

- (a) Create a vector starting from 1 to 10
- (b) Create a vector from 2 to 20 with an increment of 3
- (c) Write a for loop to display all the even numbers between 1 to 50
- (d) Write a code that takes as input a vector $x=1:10$, displays the values of x one by one and comes out of loop when the value of x is 8.
- (e) Write a code that takes an input vector $x=1:2:10$ and displays only last two values of the vector.
- (f) Find summation of vector $x = [1 \ 2 \ 6 \ 4 \ 2]$, using iterative procedure. Hint: Check length(), add each number using 'for' loop.
- (g) Write a code using while loop to display odd numbers in the range 1 to 25.
- (h) Write a code using while to which take input from 0 to 15 in increments of 1 and display number 10 and 15

6. Plotting

- (a) Create a linearly spaced vector from 0 to 1 with 10 points
- (b) Also create a linearly spaced vector from 0 to 1 with 11 points
- (c) plot sin(x) versus x.
- (d) Use plot2d and try changing the color to red. Also try style = -1
- (e) Plot sin(x) and cos(x) on the same window.
- (f) Save your plot as a file.