Workshop: Introduction to Scilab

Funded by the National Mission on Education through ICT

Indian Institute of Technology Bombay, 26 January, 2011

Organised by FOSSEE Group, IIT Bombay, http://scilab.in

(The sequence of spoken tutorials to be listened/followed is same as that of exercise sets below.)

1. **Getting Started**
   Solve the following examples on the Scilab Console as soon as the relevant topic is explained in the tutorial.

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

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

   Find 1/phi and 1/psi.

   (b) Verify Euler's identity: Is $e^{\pi i}+1$ close to zero?

   (c) $\sqrt[4]{256}$

   (d) $256^{0.25}$

   (e) $e^{i\pi}$

   (f) tan(45)

   (g) $tan^{-1}(1)$

2. **Vector Operations**
   Solve the following examples on the Scilab Console as soon as the relevant topic is explained in the tutorial.

   (a) Define two vectors A,B with 1,5,8,19 and 19,8,5,1 elements respectively.
   Calculate A*B-B*A
   Calculate A*A+B*B

   (b) In Scilab, enter the following Matrices:

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

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

   Using Scilab commands, compute each of the following, if possible and explain the errors, if any.

   (c) $A * CC * A$

   (d) $2 * C - 6 * A$

   (e) $(2 * C - 6 * A') * B'$

   (f) $(2 * C - 6 * A') * C'$

3. **Matrix Operations**
   Solve the following examples on the Scilab Console as soon as the relevant topic is explained in the tutorial.

   (a) If A = $\begin{bmatrix} 1 & -1 & 0 \\ 2 & 3 & 1 \\ 4 & 1 & 5 \end{bmatrix}$
   Find $A(:,:)$
   Extract the second column of A

   (b) Determine the determinant and eigenvalues of the matrix, $A^2 + 2 * A$.

   (c) Define a 3x3 matrix A with all elements equal to 1. Multiply 1st and 2nd row with scalars, 3 and 4 respectively, and determine the determinant of the resultant matrix.

   (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) If A = $\begin{bmatrix} 2 & 3 & 1 \\ 4 & 6 & 5 \\ 1 & 3 & 6 \end{bmatrix}$
   Use a suitable sequence of row operations on A to bring A to upper triangular form.[1]

4. **Scripts and Functions**
   Solve the following examples on the Scilab Console as soon as the relevant topic is explained in the tutorial.

   (a) Create a scilab script file to display time on console window. (hint: clock())

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

(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 function file to calculate sum and difference of any two numbers. The output should be the sum and the difference of numbers.

(d) 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())

(e) Create an inline function to sort the elements of a random vector in descending order. (hint: gsort())

(f) 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())

(g) Create a function file to calculate LU factorization of a matrix. (hint: lu()).

5. **Plotting**

(a) 01:12: Create a linearly spaced vector from 0 to 1 with 10 points

(b) 01:12: Also create a linearly spaced vector from 0 to 1 with 11 points

(c) 01:35: plot sin(x) versus x.

(d) 02:50: Use plot2d and try changing the color to red. Also try style = -1

(e) 03:53: Put a title: "Sine", and labels, 'x axis' and 'y axis'

(f) 05:50: Plot sin(x) and cos(x) on the same window.

(g) 06:08: Create a legend for the above plots.

(h) 09:25: Now plot sin(x) and cos(x) as subplots within the same window.

(i) 10:10: Save your plot as a file.

6. **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)

7. **Iteration**

(a) Write a for loop to display all the even numbers between 1 to 50

(b) Find summation of vector x = [1 2 6 4 2], using iterative procedure. Hint: Check length(), add each number using 'for' loop.

(c) Write a code using while loop to display odd numbers in the range 1 to 25.

8. **Polynomials**

(a) Construct a polynomial with 3 repeated roots at 4 and 2 repeated roots at 0. Check the roots of the derivative of this polynomial. (Use derivat)

(b) Write a function that takes a polynomial and gives out only real roots as output.
(hint isreal)

(c) Write a function that takes a polynomial and gives the INVERSE polynomial, i.e. all roots are inverses of each other.
(Hint: Coefficients are to just be reversed.)
(Check that no root was at zero: check this within the function, and display error, and exit.)

(d) Write a function that takes a polynomial and gives all the maxima/minima candidates.
(Hint: find all real roots of the derivative).

9. **Ordinary Differential Equations**

Solve the follwoing differential equations using Scilab and plot the dependent variable vs independent variable

(a) $dy/dx + y/x = -x^3; (x > 0)$

(b) $cos(x)dy/dx + sin(x)y = x^2; y(0) = 4$

(c) $dy/dx = (-x^3 - y)/x; (y(1) = 0)$

(d) $dy/dx + y = 2x + 5; (y(1) = 1)$

(e) $dy/dx + y = x^4; (y(0) = 0)$

(f) $dy/dt + (t - 1)y = 0; (y(4) = 5)$

(g) $dy/dt + 2ty = t; (y(2) = 4)$

(h) $dy/dx + 2xy = 10xe^{-x^2}; (y(0) = 1)$

(i) $2x^2dy/dx - yx = 3; (y(1) = 0)$