Commented Demonstrations of Scilab, The free platform for Numerical Computation

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Scilab

Licence and Project

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- This demonstration is based on the open source collection of demonstrations available at:

  `http://forge.scilab.org/index.php/p/scidemo/`

Introduction

Goal of this presentation

- An overview of some classical numerical methods available in Scilab
- A simple demo for selected functions

Contents

- Complex Elementary Functions : the acosh function
- Dense Linear Algebra : the spec function
- Optimization : the optim function
- Differential Equations : the ode function
- Probabilities/Statistics : the grand function

Complex Elementary Functions

Elementary Functions

- More that 60 elementary functions: cos, sin, exp, log, ...
- Degree-based (sind, cosd,) for accuracy (Matlab compatibility)
- Special functions : gamma, beta, erf, etc...
- Open Source Libraries : SLATEC (e.g. bessel*), SPECFUN (e.g. calerf).
- Discrete maths: factorial, gamma, gammaln, binomial, ...

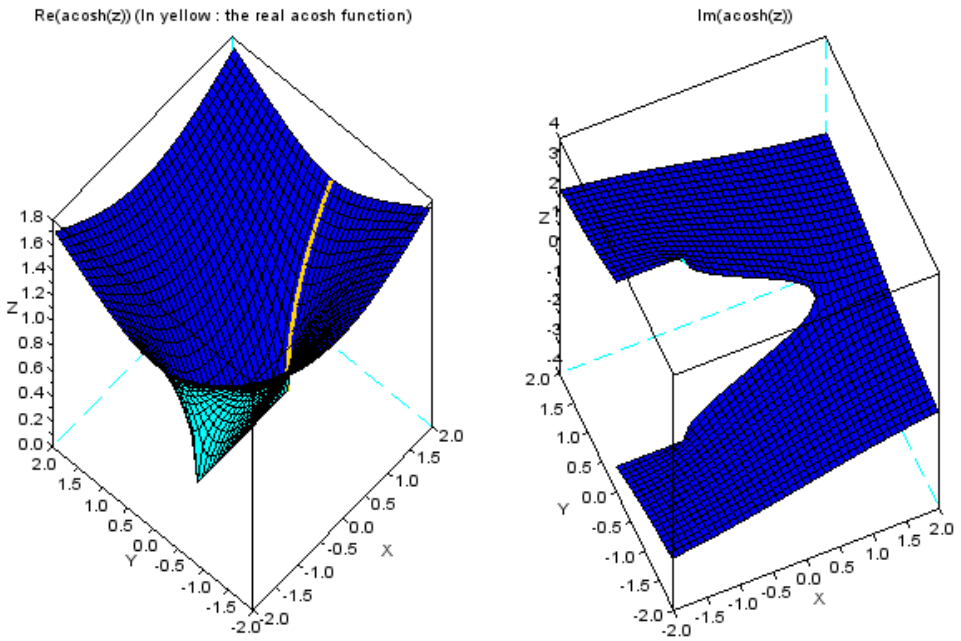
Mathematics

- Elementary functions are extended to complex arguments.
- A branch cut is a line of discontinuity of an inverse function.

Complex Elementary Functions

Elementary Functions

- Example : the branch cut for acosh are $z \leq -1$ and $z \geq 1$
- Demonstration : Demos / scidemo / complex_functions / acosh
- Authors : Pincon 2001, Maréchal 2008, Baudin 2010



Dense Linear Algebra

Dense Linear Algebra

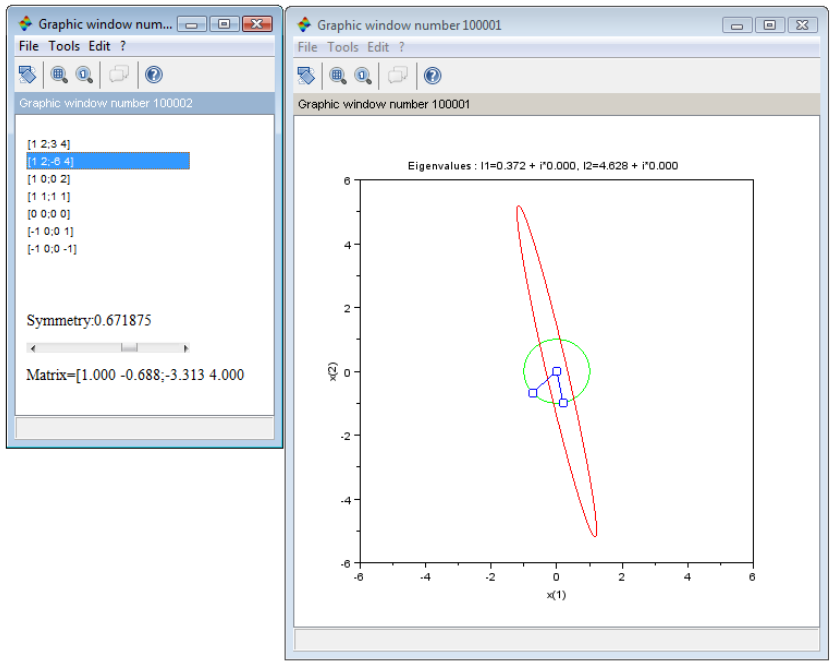
- Matrix algebra: +, -, *, ./ , ^, etc
- Matrix functions : expm, pow, logm, cosm, etc...
- More than 50 dense high level linear algebra functions: backslash, lu, spec, svd, chol, lsq, etc
- Open Source Libraries : BLAS, LAPACK

Mathematics

- The right eigenvector x and eigenvalue s of a matrix 2-by-2 real matrix A are satisfying the equation : Ax=sx.
- If x is along the unit circle, Ax is allong an ellipse.
- If the matrix A is symmetric, the major and minor axes of the ellipse are the two eigenvectors and the eigenvalues are real.

Dense Linear Algebra

- Example : the spec function computes the eigenvalues/eigenvectors
- Demonstration : Demos / scidemo / eigenvalue_show
- Authors : DIGITEO - Michael Baudin - 2010



Optimization

Optimization

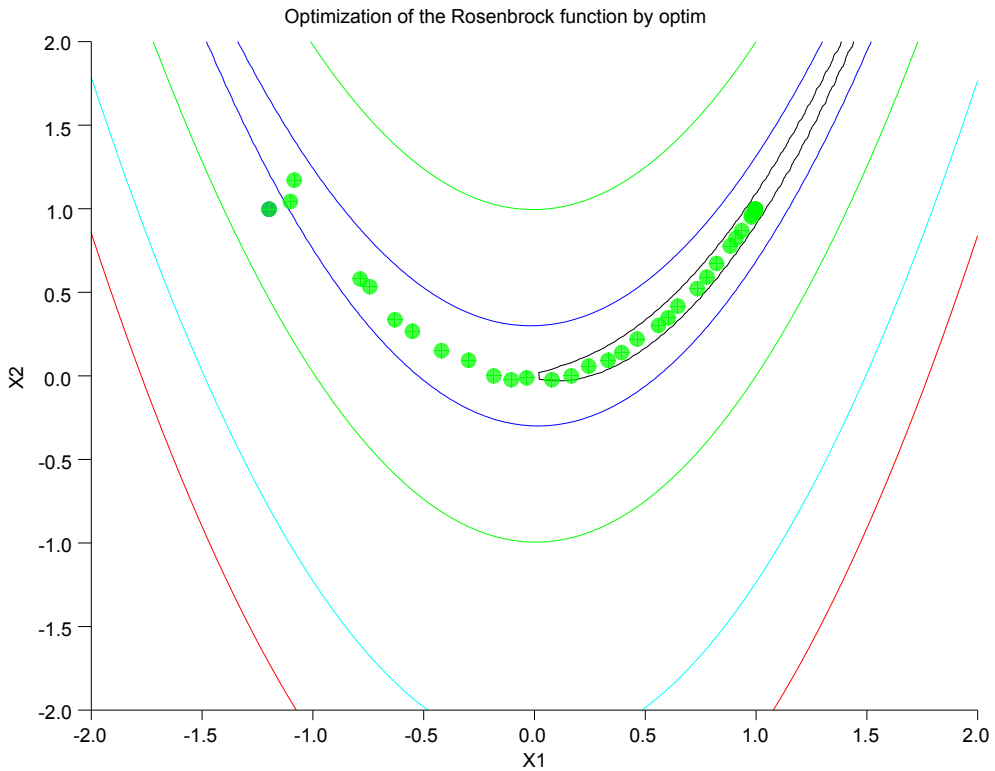
- Nonlinear unconstrained (or bounds) optimization : optim
- Nonlinear least squares: leastsq, lsqrsolve
- Derivative-free nonlinear optimization: fminsearch
- Linear, quadratic optimization: qld, karmarkar, qpsolve
- Global optimisation: optim_ga, optim_sa
- Open Source Libraries : qld, Modulopt

Mathematics

- The Rosenbrock problem: $\min.\ 100(x_2 - x_1^2)^2 + (1 - x_1)^2$
- The starting point is: $x = (-1.2, 1)^T$
- The global minimum is: $x = (1, 1)^T$

Optimization

- Example : the `optim` function
- Demonstration : Demos / scidemo / rosenbrock_show
- Authors : DIGITEO - Michael Baudin - 2010



Differential Equations

Differential Equations

- 9 solvers for ODEs and integration: ode, bvode, dassl, etc...
- Can manage Right Hand Sides as macros or compiled functions.
- Includes a collection of algorithms, for example :
- Stiff problems : Backward Differentiation Formula (BDF)
- Non-stiff problems : Adams method
- Open Source Libraries : Odepack

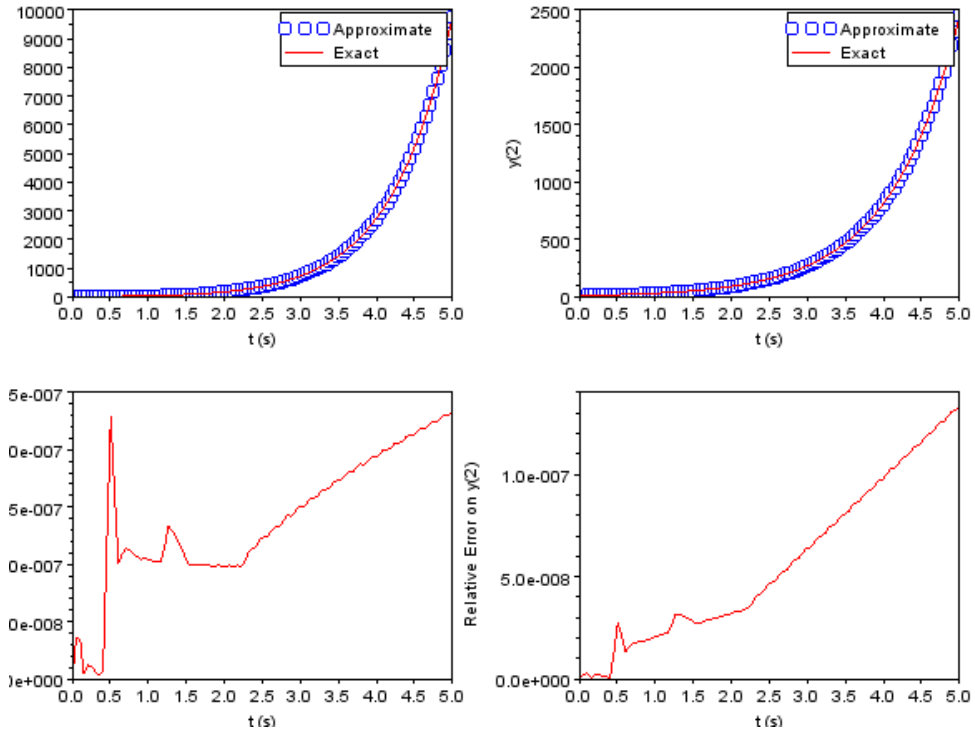
Mathematics

- Consider the linear equation: $\frac{dy}{dt} = Ay(t)$
- with initial state $y(0) = y_0$
- The solution is $y(t) = y_0 e^{At}$

Differential Equations

Differential Equations

- Example : ode (approximate solution), expm (exact solution)
- Demonstration : Demos / scidemo / edolinear_show
- Authors : DIGITEO Michael Baudin - 2010



Probabilities/Statistics

Probabilities/Statistics

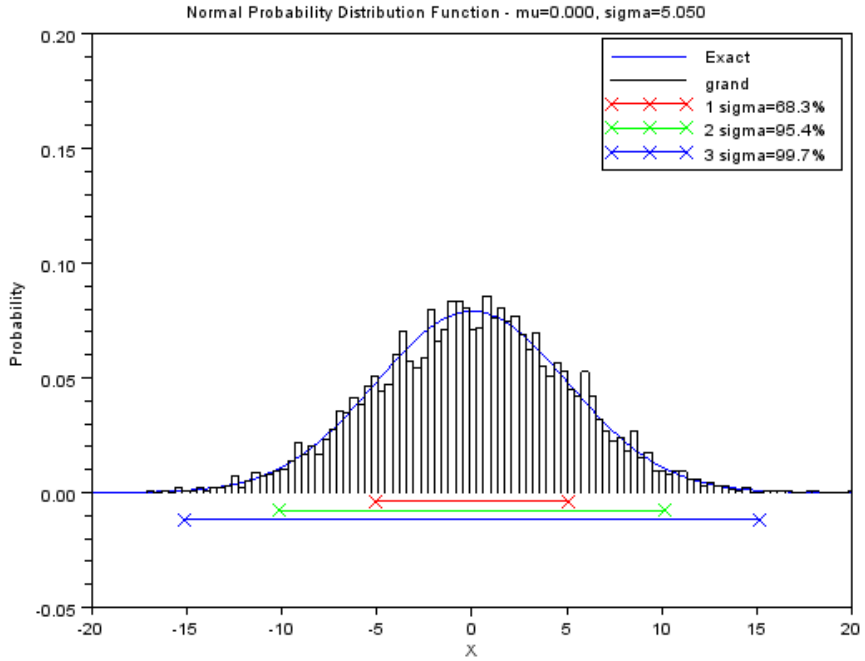
- Most common tools: mean, variance, pca, etc
- 11 Cumulated Density Functions: cdfnor, cdfpoi, etc
- 6 Uniform Random Number Generators e.g. grand(mt) is Mersenne-Twister
- 16 Non-Uniform RNGs: e.g. grand(nor), grand(chi), etc
- Open Source Libraries : Dcdflib
- ATOMS/lowdisc: Low Discrepancy Sequences: Halton, Sobol, etc

Mathematics

- Consider the normal distribution: $f(x) = \frac{1}{\sigma\sqrt{2\pi}} exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$

Probabilities/Statistics

- Example : `grand`, `histplot`, `intg` (quadrature)
- Demonstration : Demos / scidemo / normdist_show
- Authors : DIGITEO - Michael Baudin - 2010



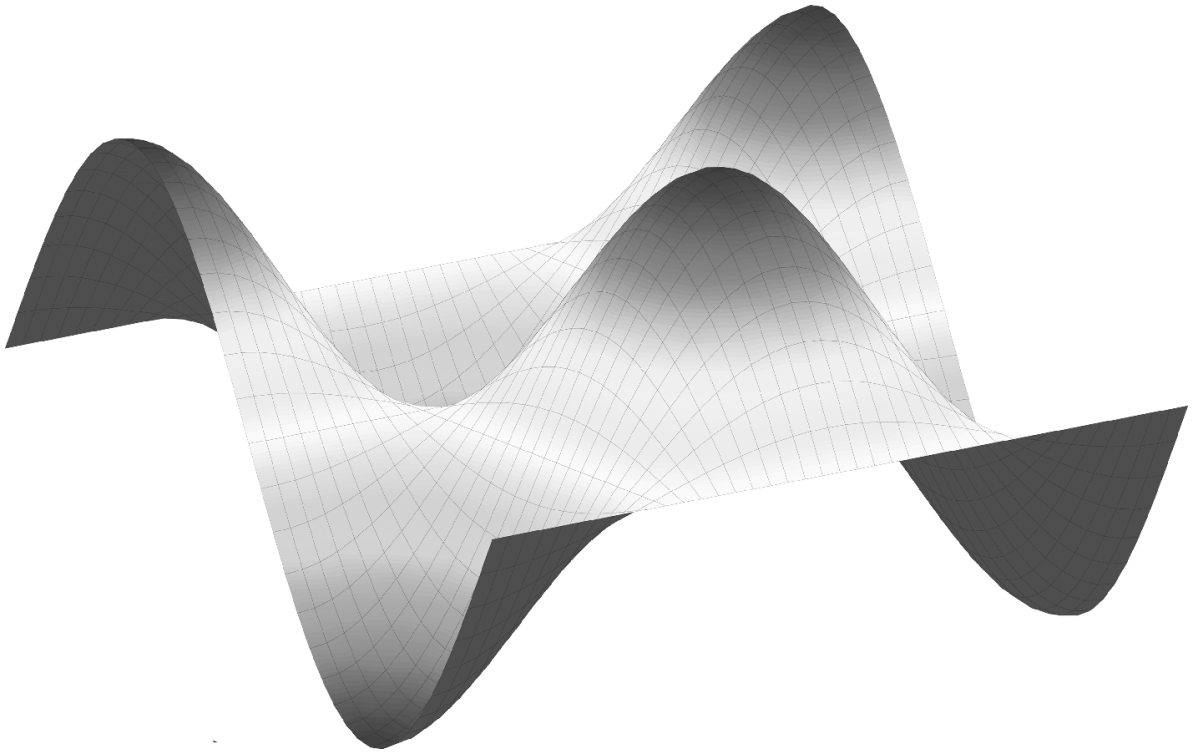
References

- Main Portal: `http://www.scilab.org`
- Tutorials:

  `http://www.scilab.org/support/documentation/tutorials`
- Introduction to Scilab, Consortium Scilab DIGITEO, Michael Baudin, 2010
- Introduction to probabilities with Scilab, Consortium Scilab DIGITEO, Michael Baudin, 2010
- Optimization with Scilab, Consortium Scilab DIGITEO - INRIA, Michael Baudin, Vincent Couvert, Serge Steer, 2010
- Low Discrepancy Sequences :

  `http://atoms.scilab.org/toolboxes/lowdisc`

Thanks for your attention



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