GNU Octave: History and Outlook for the Future

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Introduction

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I will provide an overview of Octave's history, some information about how many people are using Octave and what they are doing with it, and briefly describe some new features that are on the horizon.

What is Octave?

Octave is a freely available (GNU GPL) interactive system for numerical computations with a language that is mostly compatible with MATLAB[1]

Features:

- N-d arrays and linear algebra
- Nonlinear equations
- Differential equations
- Image processing
- Signal processing
- Statistics
- Polynomials
- Sparse matrices
- Special functions
- Control theory
- Audio
- Graphics
- Finance
- Much more!

[1] MATLAB is a registered trademark of The MathWorks, Inc.

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- **Octave is portable** to POSIX systems with a standard C++ compiler. Octave can also be ported to other exotic systems (you have the source!)

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- MATLAB compatibility? Another crazy idea.
- Why is it called Octave? Because Levenspiel is too hard to type.
- In addition to writing some software, we hoped to create a community of users and developers.

Development Timeline

??/1989	First discussions about textbook and software.
2/1992	Development begins.
1/1993	First announcement on Usenet (version 0.60).
2/1994	First release (ready for wider distribution?)
12/1996	Second major version (2.0) included dynamically linked functions, many new functions, try/catch and other language features, port to Windows (with Cygwin).
11/2004	2.9 branch in preparation for 3.0 release.
??/2006	Version 3.0 will have multidimensional arrays, integer arrays, sparse matrices, more compatible graphics, a package system, and much more.

Distribution

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  - Mac OS X (`hpc.sourceforge.net` or `fink.sourceforge.net` or `darwinports.opendarwin.org`)
  - Windows (`www.cygwin.com`)
- Octave is also available on bootable live CD/DVDs
  - Quantian `dirk.eddelbuettel.com/quantian.html`
  - MPITB `atc.ugr.es/javier-bin/mpitb`

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Octave Forge (website and collection of contributed code):

- More than 70,000 downloads of the binary package of Octave 2.1.50 for Windows (27 months).
- About 40,000 page views per month (total for site).

Mailing Lists

Postings to the primary Octave mailing lists for 2005:

List	Subscribers	Messages Posted (2005)
help@octave.org	450	4000
bug@octave.org	100	1100
maintainers@octave.org	120	900

- Participation is increasing.
- Traffic has more than doubled in the last two years.

Who is Using Octave and what are they doing with it?

Primary uses include research, teaching, and industrial activities:

- Analyzing EEG data
- Atomic and plasma physics
- Bioinformatics
- Computer vision
- Control system design
- Data analysis
- Filter design
- Finite elements
- Fish stock assessment
- High school math
- Music
- Parallel processing
- Robotics
- Signal processing
- Teaching programming
- Telecommunications
- Ultrasound imaging

And we were originally just hoping that it could be used to solve a few reactor problems!

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- **Active-set QP solver** (Gabriele Pannocchia; Università di Pisa)
- **Integer data types** (jwe)
  Includes N-d signed and unsigned 8-, 16-, 32-, and 64-bit integer arrays (with "saturation" semantics compatible with the latest MATLAB).

Add-on Packages

- **Octave Forge** (`octave.sf.net`) is a collection of contributed functions for Octave managed by Paul Kienzle (NIST) and hosted at SourceForge. Intended as a place on the web for collaborative development of new Octave functionality. Some highlights include additional signal and image processing functions.

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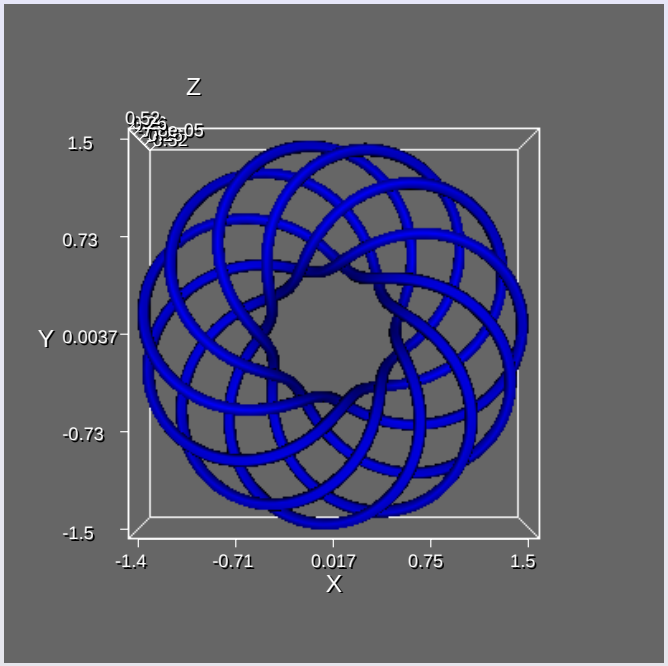
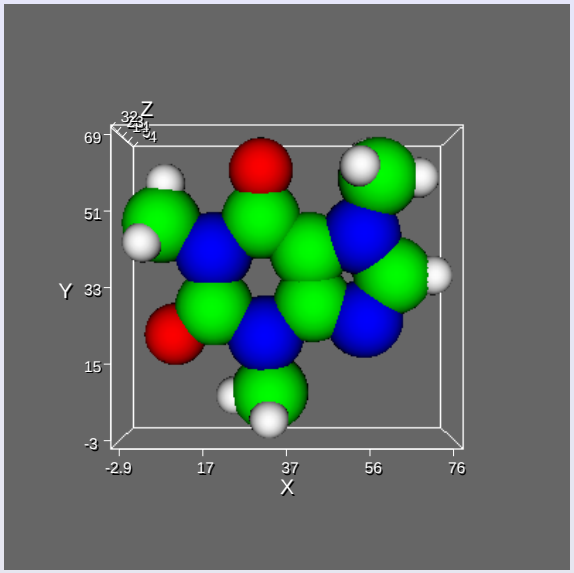
- **Octaviz** (`octaviz.sourceforge.net`) provides an interface to VTK (`www.vtk.org`) for Octave. Written by Dragan Tubic (Université Laval).

Octaviz example 1




```
nmer  = 6;
nlong = 11;
phi = (0:pi/1000:2*pi)';
mu = phi*nmer;
x = cos(mu).*(1+cos(nlong*mu/nmer)/2.0);
y = sin(mu).*(1+cos(nlong*mu/nmer)/2.0);
z = sin(nlong*mu/nmer)/2.0;
vtk_line3(x, y, z, "Radius", 0.05);
```

Octaviz example 2




```
o = [30 62 19;  8 21 10];
n = [31 21 11; 18 42 14; 55 46 17; 56 25 13];
c = [ 5 49 15; 30 50 16; 42 42 15; 43 29 13;
     18 28 12; 32  6  8; 63 36 15; 59 60 20];
h = [23  5  7; 32  0 16; 37  5  0; 73 36 16;
     69 60 20; 54 62 28; 57 66 12;  6 59 16;
      1 44 22;  0 49  6];

ms = "MarkerSize";
mc = "MarkerColor";
```

```
vtk_plot3(o(:,1), o(:,2), o(:,3), ms,  8, mc, [1 0 0]);
vtk_plot3(n(:,1), n(:,2), n(:,3), ms, 10, mc, [0 0 1]);
vtk_plot3(c(:,1), c(:,2), c(:,3), ms, 10, mc, [0 1 0]);
vtk_plot3(h(:,1), h(:,2), h(:,3), ms,  5, mc, [1 1 1]);
```

Package System

Søren Hauberg has implemented a package system for Octave that will allow the equivalent of "toolboxes" for Octave.

- Packages can be released and maintained independent of the release schedule for Octave.
- Categories of functions that are currently released together as part of Octave Forge will be split into separate smaller packages for easier maintenance and more timely releases.

DAEs and Sensitivities

A new package to provide interface to SUNDIALS (SUite of Nonlinear and DIfferential/ALgebraic equation Solvers; Hindmarsh, LLNL) is under development.

SUNDIALS includes the following solvers:

CVODE	solves initial value problems for ordinary differential equation (ODE) systems.
CVODES	solves ODE systems and includes sensitivity analysis capabilities (forward and adjoint).
IDA	solves initial value problems for differential-algebraic equation (DAE) systems.
KINSOL	solves nonlinear algebraic systems.

Current focus is CVODES (we need sensitivity analysis for solving parameter estimation problems with ODE models).

Graphics and GUIs

Octave's interface to `gnuplot` (`www.gnuplot.info`) was a quick way to get graphics in Octave, but many users see it as a weak point (especially those who are familiar with the current graphics in MATLAB).

In 3.0, Octave will provide more MATLAB-compatible graphics capabilities.

- Octave will manage the data for the handle graphics system.
- External packages will do the actual plotting.
- Since no one can seem to agree on the best graphics package or GUI toolkit, the choice should be left to the user (we will provide some default packages).

Interface to COMEDI

We plan to provide an interface to COMEDI (COntrol and MEasurement Device Interface; `www.comedi.org`), a collection of drivers for a variety of common data acquisition plug-in boards. The drivers are implemented as a core Linux kernel module providing common functionality and individual low-level driver modules.

With an interface to the COMEDI hardware drivers, it will be possible to use Octave on Linux systems to run laboratory data acquisition and control tasks.

Version 3.0

We hope to release version 3.0 sometime in 2006, but there is more to do:

- Reasonable start on handle graphics code.
- Incorporate package system.
- Update user guide.

After Version 3.0, Much Work Remains

- More handle graphics improvements
- GUI tools
- Compiler (Octave to C++? Just-In-Time?)
- Profiler
- ...

Contributors

- Kurt Hornik and students (Technische Universität Wien)
- A. Scottedward Hodel and students (Auburn University)
- Rick Niles (NASA, MITRE)
- Fook Fah Yap (University of Cambridge)
- Tony Richardson (University of California, San Diego)
- Dirk Eddelbuettel (Queens University, Goldman Sachs Canada)
- Paul Kienzle (NIST)
- Steven G. Johnson (MIT)
- Ben Sapp (LANL)
- Mumit Khan (Wisconsin)
- Petter Risholm (Norges Teknisk-Naturvitenskapelige Universtet)
- Andy Adler (University of Ottawa)
- Gabriele Pannocchia (Università di Pisa)
- David Bateman (Motorola)
- And many others!