

Maple (software)

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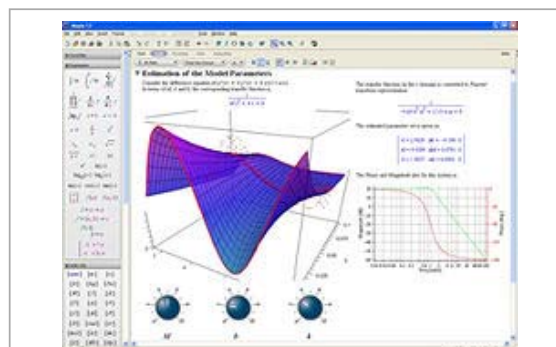
Maple is a general-purpose commercial computer algebra system. It was first developed in 1980 by the Symbolic Computation Group at the University of Waterloo in Waterloo, Ontario, Canada.

Since 1988, it has been developed and sold commercially by Waterloo Maple Inc. (also known as Maplesoft), a Canadian company also based in Waterloo, Ontario. The current version is Maple 12 which was released in May 2008. Its main competitor is Mathematica.^{[1][2]}

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Maple



Maple 12 interface

Developed by	Waterloo Maple Inc. (Maplesoft)
Latest release	12 / May, 2008
OS	Cross-platform
Type	Computer algebra system
License	Proprietary
Website	www.maplesoft.com/products/maple/

Overview

Core functionality

Users can enter mathematics in traditional mathematical notation. Custom user interfaces can also be created. There is support for both numeric and symbolic computation, as well as visualization. Examples of symbolic computations are given below.

Maple incorporates a dynamically typed imperative-style programming language. The language permits variables of lexical scope. There are also interfaces to other languages (C, Fortran, Java, Matlab, and Visual Basic). There is also an interface with Excel.

Architecture

Maple is based around a small kernel written in C which provides the Maple language. Most functionality is

provided by libraries from a variety of sources which follow a variety of design conventions. Those written in the Maple language come with source code. Some numerical computations are written in the Maple language and performed in the kernel but many are performed in the NAG Numerical Libraries, ATLAS libraries or GMP libraries. Different functionality in Maple requires numerical data in different formats, symbolic expressions are stored in memory as directed acyclic graphs. The standard interface and calculator interface are written in JAVA while the classic interface is written in C.

Examples of Maple code

Sample imperative programming constructs:

```
myfac := proc(n::nonnegint)
  local out, i;
  out := 1;
  for i from 2 to n do
    out := out * i
  end do;
  out
end proc;
```

Integration

Find $\int \cos\left(\frac{x}{a}\right) dx$.

```
integrate(cos(x/a), x);
```

Answer: $a \sin\left(\frac{x}{a}\right)$

Solution of linear differential equations

Compute an exact solution to the linear ordinary differential equation $\frac{d^2y}{dx^2}(x) - 3y(x) = x$ subject to initial conditions $y(0) = 0$, $\left.\frac{dy}{dx}\right|_{y=0} = 2$

```
dsolve( {diff(y(x),x,x) - 3*y(x) = x, y(0)=0, D(y)(0)=2}, y(x) );
```

Answer: $y(x) = \frac{7}{18}\sqrt{3}e^{\sqrt{3}x} - \frac{7}{18}\sqrt{3}e^{-\sqrt{3}x} - \frac{1}{3}x$

Root finding

Numerically calculate the root of the equation $e^x = x^2 + 2$ starting at the point $x = -1$; evaluate the answer to 75 decimal digits.

```
evalf[75](RootOf(exp(x)=x^2+2,x,-1));
```

Answer: 1.31907367685736535441789910952084846442196678082549766925608900490512707635

Determinant

Compute the determinant of a matrix.

```
M:= Matrix([[1,2,3], [a,b,c], [x,y,z]]); # example Matrix
```

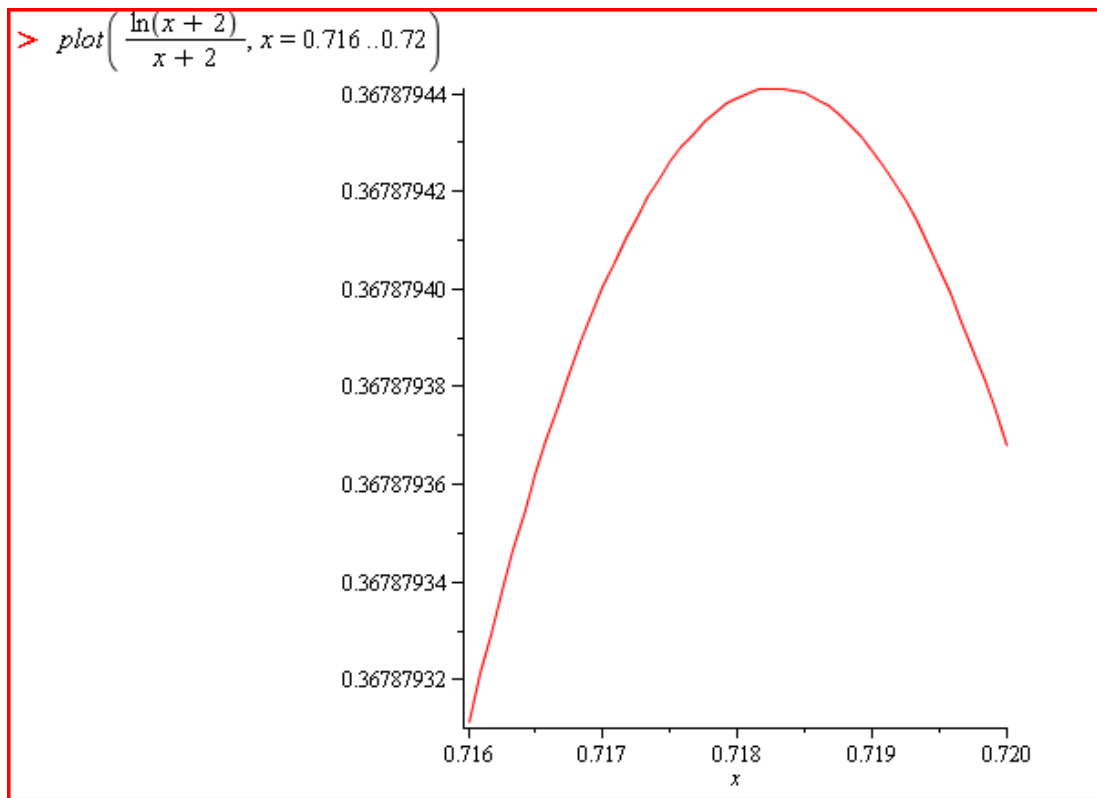
$$\begin{bmatrix} 1 & 2 & 3 \\ a & b & c \\ x & y & z \end{bmatrix}$$

```
LinearAlgebra:-Determinant(M);
```

Answer: $bz - cy + 3ay - 2az + 2xc - 3xb$

Plotting of function of single variable

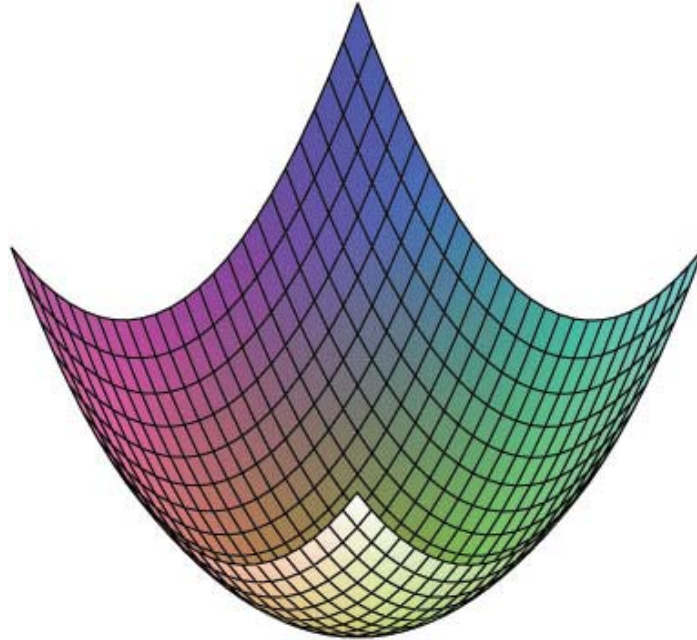
Below is an example of plotting a function of a single variable:



Plotting of function of two variables

Plot $x^2 + y^2$ with x and y ranging from -1 to 1

```
plot3d(x^2+y^2, x=-1..1, y=-1..1);
```



System of partial differential equations

Solve the system of partial differential equations

$$\begin{aligned}\frac{\partial}{\partial x}v(x,t) &= -u(x,t)v(x,t) \\ \frac{\partial}{\partial t}v(x,t) &= -v(x,t)\frac{\partial}{\partial x}u(x,t) + v(x,t)(u(x,t))^2 \\ \frac{\partial}{\partial t}u(x,t) + 2u(x,t)\frac{\partial}{\partial x}u(x,t) - \frac{\partial^2}{\partial x^2}u(x,t) &= 0\end{aligned}$$

with $v(x,t) \neq 0$.

```

eqn1:= diff(v(x, t), x) = -u(x,t)*v(x,t):
eqn2:= diff(v(x, t), t) = -v(x,t)*(diff(u(x,t), x))+v(x,t)*u(x,t)^2:
eqn3:= diff(u(x,t), t)+2*u(x,t)*(diff(u(x,t), x))- (diff(diff(u(x,t), x), x)) = 0:
pdsolve({eqn1,eqn2,eqn3,v(x,t)<>0}, [u,v]): op(%);

```

Answer:

$$v(x,t) = e^{\sqrt{-c_1}x} _C3 e^{-c_1 t} _C1 + \frac{-C3 e^{-c_1 t} _C2}{e^{\sqrt{-c_1}x}}, \quad u(x,t) = -\frac{\sqrt{-c_1} \left(_C1 \left(e^{\sqrt{-c_1}x} \right)^2 - _C2 \right)}{_C1 \left(e^{\sqrt{-c_1}x} \right)^2 + _C2}$$

Integral equations

Find functions f that satisfy the integral equation $f(x) - 3 \int_{-1}^1 (xy + x^2y^2)f(y)dy = h(x)$.

```
eqn:= f(x)-3*Integrate((x*y+x^2*y^2)*f(y), y=-1..1) = h(x):
intsolve(eqn, f(x));
```

Answer: $f(x) = \int_{-1}^1 (-15x^2y^2 - 3xy)h(y)dy + h(x)$

History

The first concept of Maple arose from a meeting in November 1980 at the University of Waterloo. Researchers at the university wished to purchase a computer powerful enough to run Macsyma. Instead, it was decided that they would develop their own computer algebra system that would be able to run on more reasonably priced computers. Thus, the project began with the goal of creating a symbolic algebra system accessible to researchers and students.

The initial development of Maple proceeded very quickly, with the first limited version appearing in December 1980. Researchers tried and discarded many different ideas creating a continually evolving system. Maple was demonstrated first at conferences beginning in 1982. The name "Maple" is not an abbreviation or acronym, but simply a reference to Maple's Canadian heritage.

By the end of 1983, over 50 universities had copies of Maple installed on their machines. Due to the large number of support and licensing requests, in 1984, the research group arranged with WATCOM Products Inc to license and distribute Maple.

In 1988, due to the increasing requests for support, Waterloo Maple Inc. was founded. The company's original goal was to manage the distribution of the software. Eventually, the company evolved to have an R&D department where much of Maple's development is done today. Significant development of Maple continues at university research labs including: the Symbolic Computation Laboratory at the University of Waterloo; the Ontario Research Centre for Computer Algebra at the University of Western Ontario; and labs at other universities worldwide.

In 1989, the first graphical user interface for Maple was developed and included with version 4.3 for the Macintosh. Prior versions of Maple included only a command line interface with two dimensional output. X11 and Windows versions of the new interface followed in 1990 with Maple V.

In 1999, with the release of Maple 6, Maple included some of the NAG Numerical Libraries,^[3] and made improvements to arbitrary precision arithmetic.

In 2003, the current "standard" interface was introduced with Maple 9. This interface is primarily written in Java (although portions, such as the rules for typesetting mathematical formulae, are written in the Maple language). The Java interface was criticized for being slow;^[4] improvements have been made in later versions, although the Maple 11 documentation^[5] recommends the previous ("classic") interface for users with less than 500 MB of physical memory. This classic interface is no longer being maintained.

Between the mid 1995 and 2005 Maple lost significant market share to competitors due to a weaker user interface.^[6] But in 2005, Maple 10 introduced a new "document mode", as part of the standard interface. The main feature

of this mode is that math is entered using two dimensional input, so that it appears similar to formulae in a book. In 2008, Maple 12 added additional user interface features found in Mathematica, including special purpose style sheets, control of headers and footers, bracket matching, auto execution regions, command completion templates, syntax checking and auto-initialization regions. Additional features were added for making Maple easier to use as a Matlab toolbox.^[7]

Past releases

- Maple 12: May, 2008
- Maple 11: February 21, 2007
- Maple 10: May 10, 2005
- Maple 9.5: April 15, 2004
- Maple 9: June 30, 2003
- Maple 8: April 16, 2002
- Maple 7: July 1, 2001
- Maple 6: December 6, 1999
- Maple V R5: November 1, 1997
- Maple V R4: January, 1996
- Maple V R3: March 15, 1994
- Maple V R2: November 1992
- Maple V: August, 1990
- Maple 4.3: March, 1989
- Maple 4.2: December, 1987
- Maple 4.1: May, 1987
- Maple 4.0: April, 1986
- Maple 3.3: March, 1985 (first publicly available version)
- Maple 3.2: April, 1984
- Maple 3.1: October, 1983
- Maple 3.0: May, 1983
- Maple 2.2: December, 1982
- Maple 2.15: August, 1982
- Maple 2.1: June, 1982
- Maple 2.0: May, 1982
- Maple 1.1: January, 1982
- Maple 1.0: January, 1982

Use of the Maple engine

The Maple engine is used within several other products from Maplesoft:

- Maple T.A., Maplesoft's online testing suite, uses Maple to algorithmically generate questions and grade student responses.
- MapleNet allows users to create JSP pages and Java Applets. MapleNet 12 also allows users to upload and work with Maple worksheets containing interactive components.
- Maple Reader, Maplesoft's platform for DRM-controlled electronic books uses the Standard Maple interface.
- MapleSim, an engineering simulation tool.

Listed below are third party commercial products that no longer use the Maple engine:

- Versions of MathCad released between 1994 and 2006 included a Maple-derived algebra engine (MKM, aka Mathsoft Kernel Maple), though subsequent versions use Mupad.
- Symbolic Math Toolbox in MATLAB contains a portion of the Maple 10 engine but will use a different engine from September 2008.

- Older versions of the mathematical editor Scientific Workplace included Maple as a computational engine, though current versions include MuPAD.

Versions available

Maplesoft sells both student and professional editions of Maple, with a substantial difference in price (US\$99.00 compared to US\$1,895.00, respectively). Later student editions (from version 6 onwards) have not placed computational limitations, but rather come with less printed documentation. More recently the academic version and student version have also required additional purchases to access MapleNet, Matlab Toolbox and maintenance which are all included in the standard purchase.^[8]

See also

- Comparison of computer algebra systems
- Mathematical software
- Waterloo Maple - the creator and distributor of Maple

References

1. ^ History of computing at Waterloo University Wes Graham Fonds
2. ^ Open, Dynamic Content and e-Learning Management Infrastructure for Engineering and Natural Sciences Journal of e-Learning
3. ^ Maple 6.0 Macworld, Feb 2001
4. ^ Capturing knowledge with pure maths, Scientific Computing World.
5. ^ Maple 11 Installation Guide
6. ^ Interview with Gaston Gonnet, co-creator of Maple, SIAM History of Numerical Analysis and Computing, March 16, 2005
7. ^ New in Maple 12 Maplesoft
8. ^ Welcome to the Maplesoft Web Store - Math Software for Engineers, Educators & Students

External links

- Maplesoft, division of Waterloo Maple, Inc. home website
- MaplePrimes - a community website for Maple users
- Maple Wiki - a community wiki for Maple™, other CAS, scientific computing and typesetting, programming, mathematics, physics, and other interesting things.

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