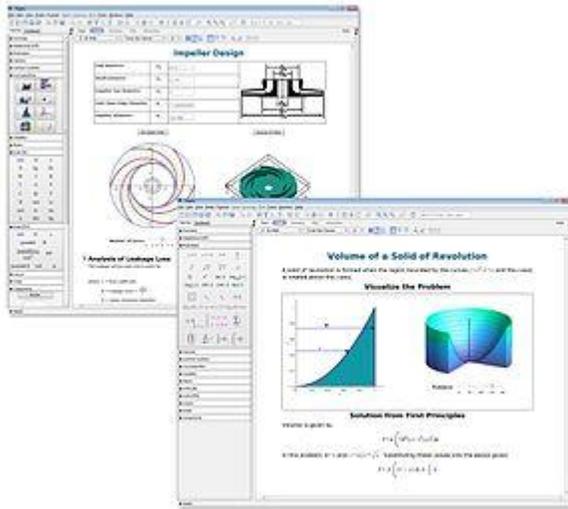


Maple (software)

Maple



Maple interface

Developer(s) [Waterloo Maple](#) (Maplesoft)

Initial release 1982

Stable release 2019.1 (28 May 2019; 8 months ago) [\[±\]^{\[1\]}](#)

Written in [C](#), [Java](#), Maple

Platform [Windows](#) (7, 8 and 10), [macOS](#),
[Linux](#)

Available in [English](#), [Japanese](#), and limited support
in additional languages^[2]

Type [Computer algebra system](#), [Numeric
computation](#)

License [Proprietary commercial software](#)

Website www.maplesoft.com/products/Maple/

Maple is a [symbolic](#) and [numeric](#) computing environment, and is also a [multi-paradigm programming language](#).

Developed by [Maplesoft](#), Maple also covers other aspects of technical computing, including visualization, data analysis, matrix computation, and connectivity.

A toolbox, [MapleSim](#), adds functionality for multidomain physical modeling and code generation.



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Overview

Core functionality

Users can enter mathematics in traditional [mathematical notation](#). Custom user interfaces can also be created. There is support for numeric computations, to arbitrary precision, as well as symbolic computation and visualization. Examples of symbolic computations are given below.

Maple incorporates a [dynamically typed](#) imperative-style [programming language](#) which resembles [Pascal](#).^[3] The language permits variables of lexical [scope](#). There are also interfaces to other languages ([C](#), [C#](#), [Fortran](#), [Java](#), [MATLAB](#), and [Visual Basic](#)). There is also an interface to [Excel](#).

Maple supports [MathML 2.0](#), a W3C format for representing and interpreting mathematical expressions, including their display in Web pages.^[4]

Architecture

Maple is based on a small [kernel](#), written in [C](#), which provides the Maple language. Most functionality is provided by libraries, which come from a variety of sources. Most of the libraries

are written in the Maple language; these have viewable source code. Many numerical computations are performed by 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](#).

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 lower cost computers. The first limited version appearing in December 1980 with Maple demonstrated first at conferences beginning in 1982. The name is a reference to Maple's [Canadian heritage](#). By the end of 1983, over 50 universities had copies of Maple installed on their machines.

In 1984, the research group arranged with [Watcom Products Inc](#) to license and distribute the first commercially available version, Maple 3.3.^[5] In 1988 [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 most of Maple's development is done today with the rest done at university research labs worldwide including: the Symbolic Computation Laboratory at the [University of Waterloo](#) and the Ontario Research Centre for Computer Algebra at the [University of Western Ontario](#)^[who?].

In 1989, the first graphical user interface for Maple was developed and included with version 4.3 for the [Macintosh](#). X11 and Windows versions of the new interface followed in 1990 with Maple V. In 1992, Maple V Release 2 introduced the Maple "worksheet" that combined text, graphics, and input and typeset output.^[6] In 1994 a special issue of a newsletter created by Maple developers called *MapleTech* was published.^[7]

In 1999, with the release of Maple 6, Maple included some of the [NAG Numerical Libraries](#).^[8] 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;^[9] improvements have been made in later versions, although the Maple 11 documentation^[10] recommends the previous ("classic") interface for users with less than 500 MB of physical memory.

Between the mid 1995 and 2005 Maple lost significant market share to competitors due to a weaker user interface.^[11] In 2005, Maple 10 introduced a new "document mode", as part of the standard interface that it has been further developed over the following years.

In September 2009 Maple and Maplesoft were acquired by the Japanese software retailer [Cybernet Systems](#).^[12]

Version history

- Maple 1.0: January, 1982
- Maple 1.1: January, 1982
- Maple 2.0: May, 1982
- Maple 2.1: June, 1982
- Maple 2.15: August, 1982
- Maple 2.2: December, 1982
- Maple 3.0: May, 1983
- Maple 3.1: October, 1983
- Maple 3.2: April, 1984
- Maple 3.3: March, 1985 (first public available version)
- Maple 4.0: April, 1986
- Maple 4.1: May, 1987
- Maple 4.2: December, 1987
- Maple 4.3: March, 1989
- Maple V: August, 1990
- Maple V R2: November 1992
- Maple V R3: March 15, 1994
- Maple V R4: January, 1996
- Maple V R5: November 1, 1997
- Maple 6: December 6, 1999
- Maple 7: July 1, 2001
- Maple 8: April 16, 2002
- Maple 9: June 30, 2003
- Maple 9.5: April 15, 2004
- Maple 10: May 10, 2005
- Maple 11: February 21, 2007
- Maple 11.01: July, 2007
- Maple 11.02: November, 2007
- Maple 12: May, 2008
- Maple 12.01: October, 2008
- Maple 12.02: December, 2008
- Maple 13: April 28, 2009^[13]
- Maple 13.01: July, 2009
- Maple 13.02: October, 2009
- Maple 14: April 29, 2010^[14]
- Maple 14.01: October 28, 2010
- Maple 15: April 13, 2011^[15]
- Maple 15.01: June 21, 2011
- Maple 16: March 28, 2012^[16]
- Maple 16.01: May 16, 2012
- Maple 17: March 13, 2013^[17]
- Maple 17.01: July, 2013
- Maple 18: Mar 5, 2014^[18]
- Maple 18.01: May, 2014

- Maple 18.01a: July, 2014
- Maple 18.02: Nov, 2014
- Maple 2015.0: Mar 4, 2015^[19]
- Maple 2015.1: Nov, 2015
- Maple 2016.0: March 2, 2016^[20]
- Maple 2016.1: April 20, 2016
- Maple 2016.1a: April 27, 2016
- Maple 2017.0: May 25, 2017^[21]
- Maple 2017.1: June 28, 2017
- Maple 2017.2: August 2, 2017
- Maple 2017.3: October 3, 2017
- Maple 2018.0: March 21, 2018^[22]
- Maple 2019.0: March 14, 2019^[23]

Features

Features of Maple include:^[24]

- Support for symbolic and numeric computation with [arbitrary precision](#)
- [Elementary](#) and [special mathematical function](#) libraries
- [Complex numbers](#) and interval arithmetic
- Arithmetic, [greatest common divisors](#) and [factorization](#) for [multivariate polynomials](#) over the rationals, [finite fields](#), [algebraic number fields](#), and [algebraic function fields](#)
- Limits, series and [asymptotic expansions](#)
- [Groebner bases](#)
- Differential Algebra
- [Matrix manipulation](#) tools including support for [sparse arrays](#)
- Mathematical [function graphing](#) and animation tools
- Solvers for [systems of equations](#), [diophantine equations](#), [ODEs](#), [PDEs](#), [DAEs](#), [DDEs](#) and [recurrence relations](#)
- Numeric and symbolic tools for discrete and continuous [calculus](#) including definite and [indefinite integration](#), definite and [indefinite summation](#), automatic differentiation and continuous and discrete [integral transforms](#)
- Constrained and unconstrained local and global [optimization](#)
- [Statistics](#) including model fitting, [hypothesis testing](#), and [probability distributions](#)
- Tools for data manipulation, visualization and analysis
- Tools for probability and [combinatoric](#) problems
- Support for time-series and unit based data
- Connection to online collection of financial and economic data
- Tools for financial calculations including bonds, annuities, derivatives, options etc.
- Calculations and simulations on random processes
- Tools for [text mining](#) including [regular expressions](#)
- Tools for [signal processing](#) and linear and non-linear [control systems](#)
- [Discrete math](#) tools including [number theory](#)
- Tools for visualizing and analysing directed and undirected [graphs](#)
- Group theory including permutation and finitely presented groups

- Symbolic tensor functions
- Import and export filters for data, image, sound, [CAD](#), and document formats
- Technical word processing including [formula editing](#)
- Programming language supporting [procedural](#), [functional](#) and [object-oriented](#) constructs
- Tools for adding [user interfaces](#) to calculations and applications
- Tools for connecting to [SQL](#), [Java](#), [.NET](#), [C++](#), [Fortran](#) and [http](#)
- Tools for generating code for [C](#), [C#](#), [Fortran](#), [Java](#), [JavaScript](#), [Julia](#), [Matlab](#), [Perl](#), [Python](#), [R](#), and [Visual Basic](#)
- Tools for [parallel programming](#)

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;
```

Simple functions can also be defined using the "maps to" arrow notation:

```
myfac := n -> product( i, i=1..n );
```

Integration

Find

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

Answer:

Determinant

Compute the determinant of a matrix.

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

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

Series expansion

```
series(tanh(x), x=0, 15)
```

Solve equation numerically

High order polynomial equation

```
f := x^53-88*x^5-3*x-5 = 0
```

```
fsolve(f)
```

```
-1.097486315, -.5226535640, 1.099074017
```

Solve equation set

```
f := (cos(x+y))^2 + exp(x)*y+cot(x-y)+cosh(z+x) = 0:
```

```
g := x^5 - 8*y = 2:
```

```
h := x+3*y-77*z=55;
```

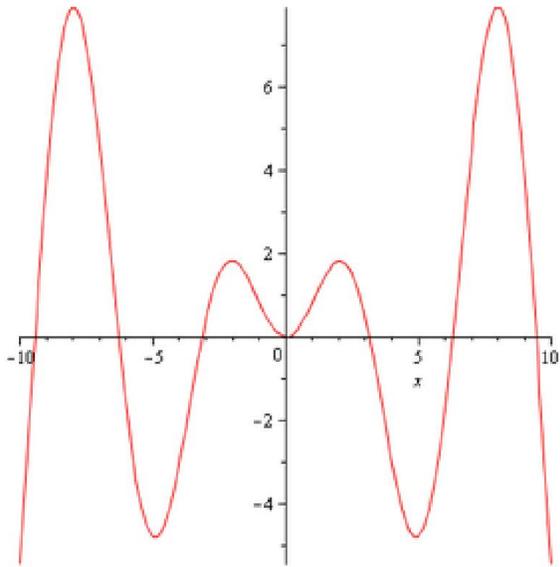
```
fsolve( {f,g,h} );
```

```
{x = -1.543352313, y = -1.344549481, z = -.7867142955}
```

Plotting of function of single variable

- Plot with ranging from -10 to 10

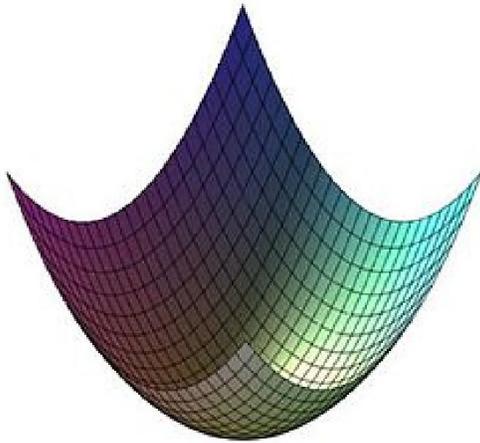
```
plot(x*sin(x), x=-10..10);
```



Plotting of function of two variables

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

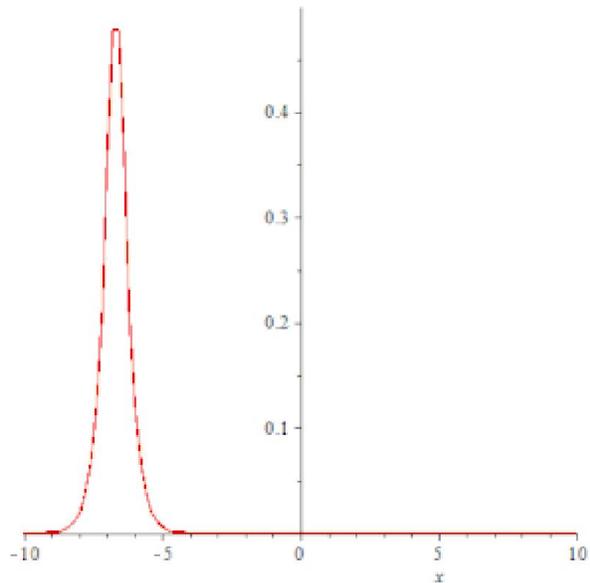
```
plot3d(x^2+y^2, x=-1..1, y=-1..1);
```



Animation of functions

- animation of function of two variables

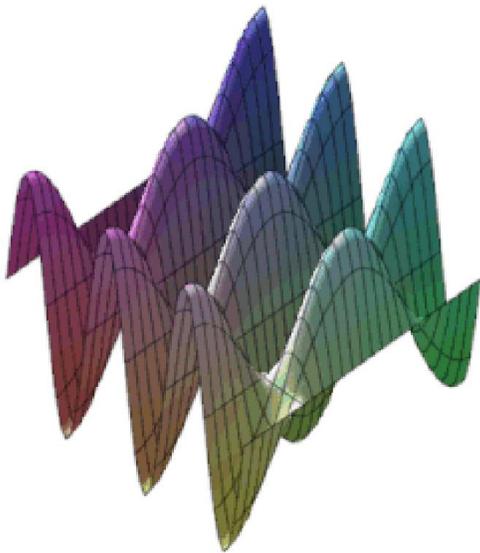
```
plots:-animate(subs(k = .5, f), x=-30..30, t=-10..10, numpoints=200,
frames=50, color=red, thickness=3);
```



2D bell solution

- animation of functions of three variables

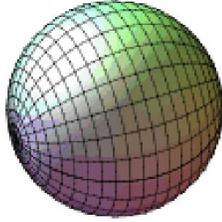
```
plots:-animate3d(cos(t*x)*sin(3*t*y), x=-Pi..Pi, y=-Pi..Pi, t=1..2);
```



3D animation of function

- Fly-through animation of 3-D plots. [\[25\]](#)

```
M := Matrix([[400,400,200], [100,100,-400], [1,1,1]], datatype=float[8]):
plot3d(1, x=0..2*Pi, y=0..Pi, axes=none, coords=spherical,
viewpoint=[path=M]);
```



Maple plot3D fly-through

Laplace transform

- [Laplace transform](#)

```
f := (1+A*t+B*t^2)*exp(c*t);
```

```
inttrans:-laplace(f, t, s);
```

- inverse Laplace transform

```
inttrans:-invlaplace(1/(s-a), s, x)
```

Fourier transform

```
inttrans:-fourier(sin(x), x, w)
```

Integral equations

Find functions that satisfy the [integral equation](#)

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

Use of the Maple engine

The Maple engine is used within several other products from [Maplesoft](#):

- Moebius, DigitalEd'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 and above also allow users to upload and work with [Maple worksheets](#) containing interactive components.
- [MapleSim](#), an engineering simulation tool.^[26]
- Maple Quantum Chemistry Package from RDMChem computes and visualizes the electronic energies and properties of molecules.^[27]

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](#) contained a portion of the Maple 10 engine, but now uses [MuPAD](#) (starting with MATLAB R2007b+ release).^[28]
- Older versions of the mathematical editor [Scientific Workplace](#) included Maple as a computational engine, though current versions include [MuPAD](#).

See also

- [Comparison of computer algebra systems](#)
- [Comparison of numerical analysis software](#)
- [Comparison of programming languages](#)
- [Comparison of statistical packages](#)
- [List of computer algebra systems](#)
- [List of computer simulation software](#)
- [List of graphing software](#)
- [List of numerical analysis software](#)
- [Mathematical software](#)
- [SageMath \(an open source algebra program\)](#)