Maple™ 9.5 Functionality & Specifications

Functionality

Mathematics

Maple 9.5 includes over 3,500 computational functions to deliver the richest set of computation tools for any area in mathematics, science, or engineering.

MAJOR TOPICS INCLUDE:

Algebra
- Exact symbolic arithmetic with real and complex numbers
- Factor, expand, combine, and simplify algebraic expressions
- Sequences and series

Calculus
- Compute derivatives, integrals, and limits
- Continuity testing
- Asymptotic expansion, and directional and multidirectional limits

Differential Equations
- Exact and numerical solutions of ODEs and ODE systems*
- Exact and numerical solutions of PDEs and PDE systems*
- Exact and numerical solutions of Boundary Value Problems for PDEs
- Numerical solutions for Differential Algebraic ODE initial value problems (DAEs)**
- Differential elimination for ODE and PDE systems
- Structural analysis and order-reduction of ODEs and PDEs
- Interactive Maplet™ Assistant for numeric and symbolic solutions of ODEs and ODE systems*

Linear Algebra
- Over 100 functions for constructing, solving, programming, and querying topics in linear algebra*
- Symbolic and numeric computations
- Eigenvalues and eigenvectors, both classical and generalized
- Sophisticated algorithms for modular linear algebra
- Many Matrix factorizations and system solvers
- State-of-the-art numerical methods for dense and sparse systems with a high degree of user control
- Modular linear algebra includes applying forward and backward substitution with a square lower triangular mod m Matrix to a mod m Matrix and Vector

Solvers
- Solve equations and systems of algebraic equations symbolically and numerically for closed form and approximate solutions*
- Inequalities and systems of inequalities*
- ODEs*, PDEs*, and DAEs**
- Numerous specialized solvers including routines for equations over the integers, equations over the integers mod m, recurrence equations*, linear functional series equations, and q-difference equations*

Vector Calculus
- Directional derivatives, gradients, Hessian Matrices, and Laplacians of a function
- Curl and divergence of a Vector field
- Jacobian and Wronskian Matrices of a list of functions
- Cross products and dot products of Vectors and differential operators

OTHER TOPICS INCLUDE:

Abstract Algebra
- Groups, rings, Galois groups, and fields

Algebraic Curves
- Holomorphic differentials and genus of an algebraic curve
- Normal forms for elliptic and hyperelliptic curves

Combinatorial Functions
- Permutations and combinations
- Construction of random combinations, partitions, and permutations
- Stirling numbers of the first and second kind, polynomials, and Fibonacci numbers

Combinatorial Structures
- Computation and solution of a system of generating function equations associated with an attribute grammar
- Generation of random combinatorial objects and counting the objects of a given size

Complex Arithmetic and Functions
- Complex numbers, fractions, constants, and variables

Curve Fitting
- B-spline basis functions, polynomial interpolation, least-squares approximation, rational interpolation, and splines

Differential Algebra
- Manipulation and reduction of differential equations
- Development of the solutions into formal power series

Differential Forms
- Create, manipulate, and compute with differential forms

Discrete Transforms
- Fast Fourier transform and inverse transform of single or multidimensional data

Euclidean Geometry
- Close to 300 routines for constructing, computing, plotting, and translating 2-D and 3-D objects

Financial Mathematics
- Annuities, cash flows, growing annuities, growing perpetuities, level coupons, and perpetuities
- Amortization, Black-Scholes option pricing, effective rate, future value, present value, and yield to maturity

Gaussian Integers
- Chinese remainder, GCD, and LCM of Gaussian integers; Gaussian integer factorization; extended Euclidean algorithm for Gaussian integers; and more

Generating Functions
- Tools for determining and manipulating generating functions, including ordinary and exponential generating functions

Graph Theory
- Over 75 routines to create and study networks

Groebner Bases*
- Hilbert dimensions, polynomial, and series of an ideal

Group Theory
- 34 routines include calculating the elements of a permutation group, order computations, and finding a permutation of a group

Integral Transforms
- Laplace, inverse Laplace, Fourier sine, Hankel, Hilbert, inverse Mellin, and Z transforms

Lie Symmetries
- Lie group symmetry methods for differential forms

Linear Functional Systems of Equations
- Transformations of a Matrix recurrence system into an equivalent system with nonsingular leading and trailing Matrices
- Rational and formal power series solutions of a linear functional system of equations with polynomial coefficients

Linear Operators
- Numerous functions to manipulate d'Alembertian terms
- Conversions among Ore polynomial structures, linear ODEs, linear recurrence equations, and factored OrePoly structures

Linear Programming
- Solve linear programs using symbolic and numeric methods, including simplex

Linear Recurrence Equations*
- Polynomial, rational, and hypergeometric solutions of linear recurrence equations
- Solutions of divide and conquer recurrence equations

Logic*
- Commands for manipulating Boolean expressions

Numerical Approximations
- Infinite precision numerical computations
- Chebyshev-Pade and minimax rational approximation
- Conversion of a rational function to continued-fraction form and a polynomial to Horner form

Number Theory
- Primality testing
- Computation of the nth Fermat number and the nth Mersenne prime
- Computation of the nth convergent, denominator, and numerator of simple and regular continued fraction

Optimization**
- Numeric methods for the solution of optimization problems
- Interactive Maplet assistant for defining and solving problems
- Solvers for linear, quadratic, and nonlinear programs, including constrained and unconstrained problems
- Solvers for linear and nonlinear least-squares problems

Orthogonal Polynomials
- Routines to generate the nth Gegenbauer, Hermite, Laguerre, Legendre, and Jacobi polynomials

P-adic Numbers
- Routines for p-adic evaluation, expansion, and functions
- Computation of the order and the leading coefficient of a p-adic expansion of a rational function

Polynomials*
- Factor, expand, manipulate, and compute properties of polynomials

Q-Difference Equations*
- Solve linear q-difference equations with polynomial coefficients

Rational Normal Forms
- Computation of the first and second rational canonical forms of a rational function and the polynomial normal form
- Computation of the first and second minimal representations of a hypergeometric term

Real Domain Computations
- Restrict calculations to the domain of real numbers

Series Expansions
- Compute generalized and Taylor series expansions

Scientific Constants
- Support for over 70 scientific constants including the Newtonian constant of gravitation, magnetic flux quantum, and conductance quantum
- Properties of all elements and isotopes of the Periodic Table

Scientific Error Analysis
- Representation and construction of numerical quantities that have a central value and associated error

Special Functions
- Airy Ai and Bi wave functions, Bessel, Chebyshev, Legendre, Jacobi functions, and more

Symbolic-Numeric Algorithms for Polynomials
- Algebraic manipulation of numerical polynomials

Statistics
- Standard statistical functions, including mean, variance, covariance, and kurtosis
- Least-squares and least-median-squares linear regression
- Visualization and transformation features include box plots, histograms, scatter plots, scales, and shifts of the x, y, z coordinates of 2-D and 3-D plots

Tensors
- Routines that deal with tensors, their operations, and their use in General Relativity, both in the natural basis and in a moving frame

Units and Dimensions
- Support for over 500 units and dimensions defined using exact conversions
- Systems of units include Atomic, CGS, Electromagnetic, Electrostatic, FPS, MKS, MTS, and SI
- Over 50 base quantities include acceleration, area, dynamic viscosity, electric resistance, energy, heat transfer, light, magnetic flux, and mass
- Ability to add and remove systems and dimensions

Variational Calculus
- Euler-Lagrange equations and first integrals
- Solve Jacobi differential equation for conjugate points
- Weierstrass excess function

Mathematics Education

Maple 9.5 includes educational packages and resources to assist students by furthering their understanding of concepts presented in mathematics courses.

Precalculus*
- Study lines, polynomials, rational functions, compositions of functions, and more using interactive tutors and visualization routines

Calculus*
- Single step through differentiation, integration, and limit problems
- Visualization routines display a function and its derivative, Taylor series approximation, Newton's method, approximating integrals, antiderivatives, surfaces of revolution, and more
- Explore these Calculus 1 concepts using interactive tutors

Linear Algebra*
- Single step through Gaussian elimination; Gauss-Jordan elimination; and the computation of the inverse, eigenvalues, and eigenvectors of a Matrix using interactive tutors
- Visualization routines display the cross product of two Vectors, a system of 2-D or 3-D linear equations, the projection of a Vector onto a subspace, and more
- Over 65 routines for computing with Matrices and Vectors

Multivariate Calculus**
- Interactive routines use Maplet technology to assist you to work through the standard problems of multivariate calculus in a visually directed manner
- Visualization routines to aid in the understanding of concepts including Taylor approximation, change of variables, center of mass, gradient, Jacobian, surface area, and more

Dictionary**
- Over 5,000 definitions of mathematical and engineering terms and concepts fully incorporated into the Help system
- Includes over 300 figures to clearly explain the concepts

Programming

Flexible programming language, tools, and base routines.

- Advanced programming language
- Procedural and functional programming
- Operator overloading
- Exception handling
- Debugging*, profiling, and library management* tools
- Analysis of the code complexity of a Maple procedure and module
- Ability to create new worksheets, programs, packages, modules, and help pages
- Source code of most routines available for viewing
- Assumptions on variables
- Create and manipulate many kinds of objects, including sets, strings, lists, and libraries*
- Extend existing types
- Generate and manipulate Maple worksheets through its XML representation

Custom Interface Creation

Maple lets you create custom user interfaces to access built-in and user-written routines.

Maplet Application
- Create custom Java™-based graphical user interfaces to access the Maple kernel and libraries, or user-written Maple functions

Continued on reverse...

- Graphical elements include text areas, buttons, equation editors, slider bars, tool tips, plotting windows, and numerous built-in dialogs
- Perform calculations and display graphs without seeing the Maple code

Context-Sensitive Menu*

- Design a context-sensitive menu or edit an existing menu

Visualization

Maple includes a comprehensive set of visualization tools to make problem exploration easier.

- 2-D and 3-D graphs
- 2-D and 3-D animations
- 2-D and 3-D implicit plots
- Conformal mapping
- 2-D and 3-D contour plots
- Vector fields
- 2-D and 3-D complex plots
- ODE and PDE plots
- Light modeling, legends, axis control, titles, and transparency
- Scale and pan 2-D and 3-D plots and animations**
- Real-time rotation of 3-D plots
- Interactive control of parameters through slider controls
- Wide variety of coordinate systems
- Layering of graphics and animations of different types
- Standard geometric objects, regular solids, and polyhedra, including ellipses, hyperbolae, polygons, cones, spheres, torii, dodecahedra, icosahedra, and tetrahedra
- Over 40 visualization routines display concepts presented in calculus*, precalculus*, multivariate calculus**, and linear algebra* courses
- Plot builder assistant* for creating and modifying plots and animations

User Interface

Maple includes many features to automate tasks and interact with Maple without the need to learn the Maple commands and syntax.

- Mathematical expression editor
- Context-sensitive menus
- Palettes* for expressions, symbols, Matrices, and Vectors
- Comprehensive word-processing help create professional reports*
- Spell checker that knows standard math terms
- Command completion*
- Symbolic spreadsheets
- Over 40 interactive tutors display concepts presented in precalculus, calculus, multivariate calculus, and linear algebra courses
- Task assistants for many tasks including analyzing ODEs and ODE systems, creating plots and matrices, and converting units

Connectivity

Maple adheres to international standards for data communication by enhancing tool interoperability and Web connectivity.

- Access Maple algorithms and data structures in compiled C, Java** and Visual Basic®** programs using OpenMaple™
- MathML 2.0 presentation and content support
- Import and export of XML documents
- TCP/IP socket connectivity
- External calling to Java, C, and Fortran
- Code Generation
  - Generate Visual Basic, MATLAB®, Java, C, and Fortran code
  - Override or add to code translations specified in the existing definition or specify an entirely new language definition
- Link to MATLAB
  - From within Maple, use MATLAB to compute the Cholesky factorization, determinant, dimensions, eigenvalues, LU decomposition, and more
  - Call out to MATLAB to compute and retrieve the results of MATLAB expressions.
- Link to Microsoft® Excel 2000 on Windows
  - Access the Maple kernel from within Excel
  - Copy and paste between Maple and Excel
  - Maple Function Wizard steps through the creation of a Maple function
- Mathematica® Notebook conversion and command translation tools**
- Export worksheets to HTML, XML, MathML, LaTeX, and RTF
- Export plots to BMP, DXF, EPS, GIF, HPGL, JPEG, PCX, POV, TEK, and WMF
- Import data from ASCII, Matrix Market, MATLAB, and more
- Direct links to the Maple Application Center™, Maple Student Center™, Maplesoft™ corporate Web site, and more

* Enhanced features in Maple 9.5

** New features in Maple 9.5

Resources

Maple includes an extensive help system and access to a large and expanding collection of free supplementary material.

Maple Help System

- Help pages for every Maple routine include calling sequences, descriptions, examples, and links to related topics.
- Several packages come with built-in example worksheets.
- New User's Tours help novice users in popular topic areas.

Dictionary**

- Over 5,000 definitions of mathematical and engineering terms and concepts fully incorporated into the Help system.
- Includes over 300 figures to clearly explain the concepts.

Maple Application Center™ *www.mapleapps.com*

- Over 2,500 user-contributed applications from over 100 categories, including Fluid Dynamics, Abstract Algebra, Financial Engineering, and Physics Education.

Maple PowerTools™ *www.mapleapps.com/powertools*

- PowerTool course materials includes Calculus I - IV, Differential Equations, Partial Differential Equations, Trigonometry, Geometry, Cryptography, Classical Mechanics, and Maple tutorials.
- PowerTool add-on packages include: Dynamics, Statics, Statistics, Java View, Electronic Circuit Analysis, and Multibody Dynamics.

Maple Student Center™ *www.maple4students.com*

- The Maple Student Center provides tutorials in mathematics and Maple to assist students.

MaplePrimes™ *www.mapleprimes.com*

- MaplePrimes is a controlled-access Web site that provides exclusive content to Maple users who subscribe to the Maplesoft Extended Maintenance Plan (EMP).

System Requirements

Windows®

Version	*CPU**	*Minimum RAM***	*Recommended RAM*	*Hard Disk*
Windows NT 4 (with Service Pack 5)	Intel Pentium III 650 MHz +	64 MB	128 MB	350 MB
Windows 98	Intel Pentium III 650 MHz +	64 MB	128 MB	350 MB
Windows ME	Intel Pentium III 650 MHz +	64 MB	128 MB	350 MB
Windows 2000 Professional	Intel Pentium III 650 MHz +	128 MB	256 MB	350 MB
Windows 2000 Server	Intel Pentium III 650 MHz +	256 MB	512 MB	350 MB
Windows XP Pro	Intel Pentium III 650 MHz +	128 MB	256 MB	350 MB
Windows XP Home	Intel Pentium III 650 MHz +	128 MB	256 MB	350 MB
Windows 2003 Professional	Intel Pentium III 650 MHz +	256 MB	512 MB	350 MB

Linux®

Vendor	*Version*	*CPU**	*Minimum RAM***	*Recommended RAM*	*Hard Disk*
Mandrake	8.1, 8.2, 9.0	Intel Pentium III 650 MHz +	128 MB	256 MB	400 MB
Redhat	7.1, 7.2, 7.3 , 8.0, 9.0	Intel Pentium III 650 MHz +	128 MB	256 MB	400 MB
SuSe	7.0, 7.2, 8.0, 8.1, 9.0	Intel Pentium III 650 MHz +	128 MB	256 MB	400 MB

Macintosh®

Vendor	*Processor*	*Operating System*	*Version*	*Minimum RAM***	*Recommended RAM*	*Hard Disk*
Apple	G3+	OS X	10.2.3 or later	128 MB	256 MB	300 MB

Java Runtime Environment 1.4.1 or higher installed.

UNIX®

Vendor	*Hardware*	*Operating System*	*Version*	*Minimum RAM***	*Recommended RAM*	*Hard Disk*
Sun	SPARC	Solaris	7, 8, 9	128 MB	256 MB	390 MB
HP	HP9000	HP-UX	11.0, 11i	128 MB	256 MB	485 MB
IBM	RS/6000	AIX	5.1	128 MB	256 MB	370 MB

** Running at less than the recommended memory requirements may limit performance and some features.

* Fully compatible CPUs may be substituted.

Maplesoft
command the brilliance

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