Product Specifications

MATHEMATICS

Maple includes over 4,000 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 commands 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

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, differential equations, series solutions, and q-difference equations*

Statistics
- Wide range of common statistical tasks, such as quantitative and graphical data analysis, simulation, and curve fitting
- Over 35 continuous and discrete probability distributions and tools for creating custom distributions
- Interactive data analysis assistant
- Statistical plots including box plots, bar charts, histograms, probability plots, and scatter plots*
- Tools for fitting linear and nonlinear models to data points and performing regression analysis
- Statistical Process Control (SPC) package with 11 different statistical control charts for process control variables and attributes

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, polynomials ideals, greatest common divisors, finite rings 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

Differential Geometry**
- Vector fields, differential forms and transformations; tensor analysis; calculus on jet spaces; Lie algebras and Lie groups, and transformation groups
- Complete course in Differential Geometry and its applications

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

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

Financial Mathematics
- Annuities and growing annuities, cash flows, perpetuities and growing perpetuities, and level coupons
- 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

Generating Functions
- Tools for determining and manipulating generating functions, including ordinary and exponential generating functions
- Tools for determining a probable generating function from initial terms

Graph Theory*
- Directed graphs, undirected graphs, and edge weights*
- More than 150 functions and 35 pre-defined special graphs**
- Visualization of graphs in two and three dimensions**

Groebner Bases* and Polynomial Ideals*
- Groebner bases over commutative and non-commutative domains
- Incorporates the FGb library, the world's fastest Groebner bases engine**
- Ideal membership and containment
- Radical, prime and primary decompositions
- Hilbert series, polynomials and dimensions

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

Integral and Discrete Transforms
- Laplace, Fourier, Fourier sine, Fourier cosine, Hankel, Hilbert, Mellin, Z transforms, and their inverses

Lie Symmetries
- Lie group symmetry methods for differential forms, ODEs, and PDEs**

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 commands 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
- Simplification and normal forms for Boolean expressions

Numerical Approximations
- Arbitrary precision numerical computations
- Chebyshev-Pade and minimax rational approximation
- Conversion of rational functions to continued-fraction form and Polynomials 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 fractions

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

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

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

Physics**
- Includes anticommutative and noncommutative variables and functions, spacetime tensors, algebraic vectors, and standard objects used in mathematical physics computations, including Pauli and Dirac matrices and the Kronecker delta
- Permits the use of standard notational abbreviations by allowing you to define a framework of notational conventions and spacetime properties

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 polynomial and rational normal forms, canonical forms of rational functions, and minimal representations of hypergeometric terms

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

Series Expansions
- Compute Taylor, Puiseux and asymptotic 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
- Tools for building custom scientific constants

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

Special Functions
- Over 100 special functions
- Includes Airy Ai and Bi wave functions, Bessel, Chebyshev, Ei, Si, Ci, Li, error function, Gamma, Zeta, Heun, Legendre, Jacobi functions

Statistical Process Control
- Supports 11 different control charts for process control variables and attributes, including EWMA, S, MA and X-bar charts
- Visualize both numeric and non-numeric quality characteristics

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

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

Tolerances
- Perform best- and worst-case computations with quantities involving tolerances, using standard notation
- Tolerances understood by arithmetic operators and by many built-in functions, including square roots, exponentials, trigonometric and special functions

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 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 tutors allow 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, and surface area

Vector Calculus*
- Computations, visualizations* and interactive problem solving involving the calculus of functions from $\mathbb{R}^n$ to $\mathbb{R}^m$
- Interactive tutors for exploring space curves and vector fields through plots and animations
- Supports 5 predefined coordinate systems

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

Graphing Calculator
- Traditional graphing calculator interface
- Standalone or over a MapleNet™ installation

Maple T.A. Assessment Tools
- Question authoring environment provides templates for creating common question types, such as fill-in- the-blank, Maple-graded, and multiple-choice questions.
- Questions can include algorithmically generated content
- Questions can contain plots, hints, feedback and algorithmically-generated variables.
- Assignments are used inside Maple, printed, or exported to Maple T.A.

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
- User-level routines for multi-threaded programming on multi-core computers**
- 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, arrays, and libraries*
- Tools for manipulating mathematical objects, including polynomials, integrals and sums*
- Extend existing types
- Generate and manipulate Maple worksheets through its XML representation
- Compiler package for dramatic speed-up of numerical computations

Custom Interfaces

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

Embedded Components*
- Components include buttons, sliders, plots, check boxes, list boxes, toggle buttons, and mathematical expression boxes for entering and displaying 2-D math
- Add components to your document using the Components palette
- Easily programmable to accept input, display results and plots, and interact with other elements of the document

Maplet Application
- Create custom Java™-based graphical user interfaces to access the Maple kernel and libraries, or user-written Maple functions
- Graphical elements include text areas, buttons, equation editors, slider bars, tool tips, plotting windows, and numerous built-in dialogs
- Can be created programmatically or through the point-and-click Maplet Builder
- Perform calculations and display graphs without seeing the Maple code

Context-Sensitive Menus
- Design a context 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*
- 2-D and 3-D contour plots
- 2-D and 3-D complex plots
- Conformal mapping
- Vector fields
- ODE and PDE plots*
- Light modeling, legends*, axis control*, titles*, glossiness, gridlines*, and transparency
- Display typeset text and mathematical expressions in plot titles, labels, legends, tickmark labels, and axes labels**
- International (non-English) characters in text**
- Plot annotations for 2-D plots include arrows, shapes, and drawing tools**
- 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 knowledge of Maple commands and syntax.
- Sophisticated 2-D Math editing
- Self-documenting context menus*
- Over 20 palettes for expressions, symbols, matrices, operators, including a handwriting palette* and favorites palette**
- Comprehensive word-processing* for creating professional reports and presentations**
- Spell-checker containing standard math terms
- Command completion
- Output automatically labeled for easy referencing*
- Tables, symbolic spreadsheets, embedded components; such as buttons and sliders*
- Over 40 interactive tutors display concepts presented in precalculus, calculus, multivariate calculus, vector calculus, and linear algebra courses
- Over 250 task templates for fill-in-the-blank problem solving*
- Task assistants for many tasks including analyzing ODEs and ODE systems, creating plots and matrices, converting units, and back-solving*
- Document blocks to write content with live calculations while hiding computation details*
- Help Navigator for searching help pages, tasks, tutors, definitions, and manuals
- Drawing canvas** includes shapes, lines, arrows, text, outline and fill color control, and provides alignment tools, grid controls, and a favorites palette

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 Cholesky factorization, determinants, dimensions, eigenvalues, LU decompositions
  - Call out to MATLAB to compute and retrieve the results of MATLAB expressions.*
- Easy import and export of Microsoft® Excel® data files
  - Programmatic and interactive use through the Data Import Assistant and Matrix Browser
  - Supports partial file import
- Link to Microsoft Excel 2000, Excel XP, and Excel 2003 on Windows
  - Access the Maple kernel from within Excel
  - 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, manipulate and export data from WAV, JPEG, and TIFF files*
- Import data from ASCII, CSV, 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 11

**New features in Maple 11

Maplesoft
command the brilliance

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