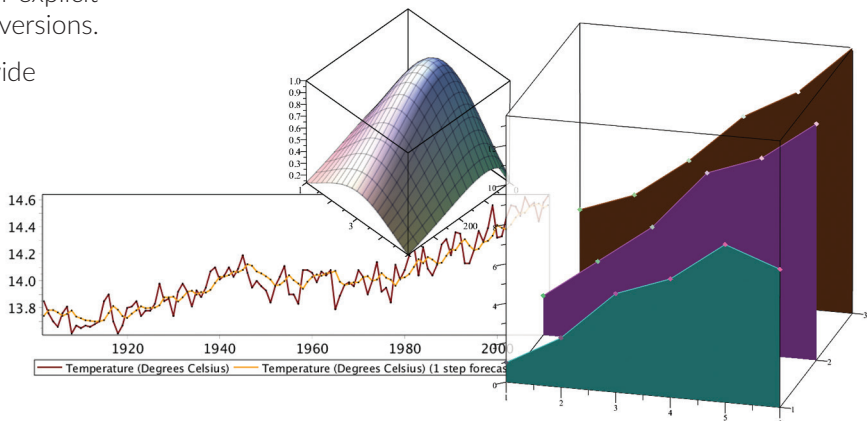# What's New in Maple™ 2015

▶ Data Sets

Maple™ 2015 features a powerful new infrastructure for accessing and working with millions of data sets from both built-in and online data sources.

- Easily access the entire collection of curated time series data provided by Quandl, an organization that hosts data from hundreds of sources. Through Quandl, Maple users can access a growing collection of over 12 million data sets to use in their Maple applications, free of charge.

- Select from a huge list of topics from finance, economics, and society, such as current data on stocks and commodities, foreign exchange rates, macroeconomic data on labor market indicators, population statistics, and much more.

- Use the standard Maple search box to locate available data sets, whether they are online or come from new country and city data tables built into Maple.

- Incorporate the data into your Maple computations, without the need for explicit downloading or data structure conversions.

- Easily visualize your data set in a wide variety of ways.

- Instantly create your own customized search application that makes it easy to filter your data, such as by specifying a time period and frequency, and assign the results to a variable for further manipulation.

▶ Data Plots

Plotting data is substantially easier in Maple 2015. A comprehensive new *dataplot* command can be used to display many kinds of numerical data using a variety of 2-D and 3-D plots and animations.
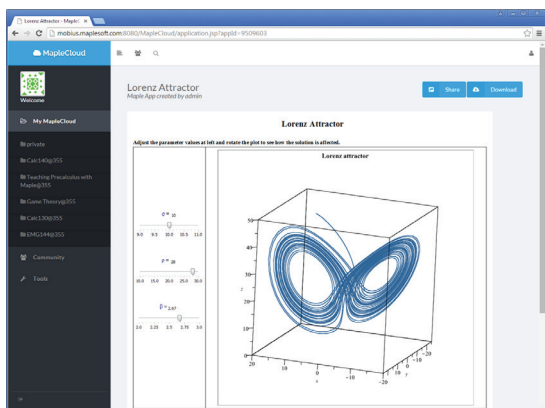
- Makes it easy to visualize data as points, surfaces, contours, density plots, bar charts, histograms, tree maps, pie charts, and more

- Supports a wide variety of plot options for customization, such as animation, symbols, color, and color palettes

- Available through both a command and from the context-sensitive menu

- Works with many different data structures, such a matrices, lists, arrays, and datasets, without the need for conversions

▶ MapleCloud™

The MapleCloud is now accessible from a web browser, giving you a powerful new option for deploying and sharing your Maple content.
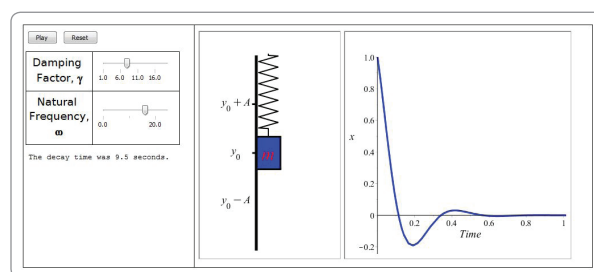
- The MapleCloud is now accessible from a web browser, from both computers and tablets, at **maplecloud.maplesoft.com**. You can browse and search collections of Maple content, read documents, and even interact with Maple applications, all without Maple.

- Your Math Apps and Maple applications can be used by anyone you choose to share them with, to explore concepts, perform computations, and visualize results. Any Maple document that makes use of interactive embedded components, such as sliders, dials, and math entry boxes, can be used and not just viewed, even by people who do not have Maple.

- You can continue to share your Maple documents in the MapleCloud at a click of a button from inside Maple. You can share your documents with members of a private group, such as the students in your class or colleagues on a research project, post them for your own personal use, or make them freely accessible by everyone.

- There are hundreds of interactive Math Apps available in the MapleCloud that explore concepts from calculus, statistics, graphing, physics, engineering, and more. You can use these Math Apps in your classes and direct your students to them for additional learning.

▶ Math Apps

Math Apps in Maple are interactive learning tools that can be used to explore concepts and engage students. With Maple 2015, there are now more than 400 Math Apps included with Maple.

- 60 new interactive Math Apps for students and teachers to explore

- Topics taken from math, physics, statistics, chemistry, finance, and more

- Math Apps can be used from within Maple, from the free Maple Player™, and from the online MapleCloud using only a web browser
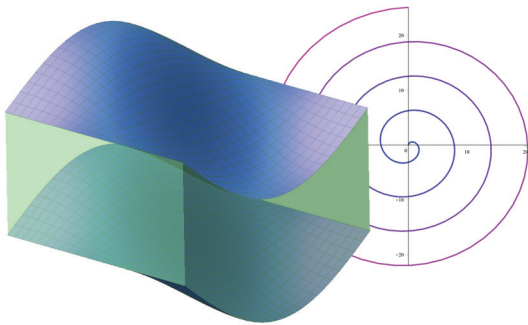

▶ Visualization

Maple 2015 includes many new abilities and customization options for visualizations.

- New visualization tools are available for iterative maps, groups, polyhedral sets, and more.

- A new command makes it easy to shade between two curves or surfaces.

- Default ranges are now available for 3-D plots, so you no longer have to specify the range every time when using the command.

- The color scheme option, which was available for surfaces, is now available for curves, so you can specify a start and end color for your curve and Maple will modulate the color from one to the other along the length of the curve.

- Data visualization is greatly simplified with a new command that unifies point plots, surfaces, contours, density plots, bar charts, histograms, and more in a single command.

- A new line style for curves combines points with lines.

- Tree maps provide a new method of data visualization that use nested rectangles to show the magnitude of various elements in a set of data.

▶ One-Step App Creation with *Explore*

Maple provides the *Explore* command as an easy-to-use tool for creating interactive applications, as well as interactive *Explore* functionality available from the context menu. Maple 2015 introduces significant updates and additions to the *Explore* command, including:

- Initialization code for your application can be automatically included in the start-up code of your new application when it is created in a separate document.

- Slider controls can be placed vertically or horizontally.

- Parameter names for sliders are displayed in standard math notation.

- You can customize the appearance and position of markers in a 2-D plot exploration.

- Images are now used on Play/Pause/Loop animation controls.

- Check boxes are available for parameters whose value can be true or false.

- Document properties, such as author and subject, can be set in the metadata section of your new document as part of the application.

▶ Programmatic Content Creation

For many years, Maple has made it easy to create rich technical documents and interactive applications. Now, with Maple 2015, it is possible to generate this content programmatically as well as interactively. This ability allows you to generate documents whose content depends on the results of earlier computations, supports the creation of interactive applications without manual editing, and more.

- Programmatically generate rich technical content that includes math, text, tables, plots, sections, and more.

- Create interactive applications without ever touching the mouse.

- Use programmatic content to create entire documents or portions of documents.

- Make updates to applications quickly by modifying the defining code rather than going through the individual component properties.

- Quickly create a whole series of related content by passing in different parameters to a procedure that creates the final document or application.

Using this functionality, many Maple routines now include options to display results inside a document table for greater readability, including a new command that displays lists, matrices, and other structured data types in tables.

▶ Interactive Components

Maple includes a wide variety of interactive components, such as buttons, sliders, and dials, that can be embedded in your worksheet to create interactive applications. Maple 2015 offers new and improved components to give you more flexibility in your application development.

- New microphone and speaker components let you capture and play back audio in your Maple application.

- New customization options include resizable sliders, angle ranges and image backgrounds on dials, hidden borders and line numbers in code edit regions, wrapping in text boxes, and multiple selection options on list boxes.

▶ Integration

Maple 2015 can find solutions for new classes of integrals, and produces results in more compact forms.

- Maple can now find analytic, closed-form solutions of new classes of indefinite integrals, including those involving inverse hyperbolic functions.

- Many integrals that used to be expressed in terms of lengthy complex sign (*csgn*) expressions are now given in more compact forms.

- Maple can compute definite integrals of non-smooth integrands, for which previous versions of Maple only could compute an indefinite integral.

▶ Group Theory

The database of small groups included in the *GroupTheory* package has been greatly expanded to include all groups of order less than 512. In addition, you can now search both the small groups database and the transitive groups database using new search tools. Other improvements include the ability to construct and visualize Cayley graphs of small groups, construct free groups, compute exponents, element order, and complex products, and test if a group is cyclic.

▶ Limits

The *limit* command has been enhanced for improved handling of bivariate rational functions with non-isolated singularities. Many such limits could not be determined previously, but are now computable. Maple can also determine if the limit does not exist, in which case it returns *undefined*.

▶ Differential Equations

Maple can now find numeric solutions to delay differential initial value problems. The RKF45, CK35, and Rosenbrock methods all accommodate delay terms, and so can be used to solve ordinary differential and differential-algebraic equations with delays.
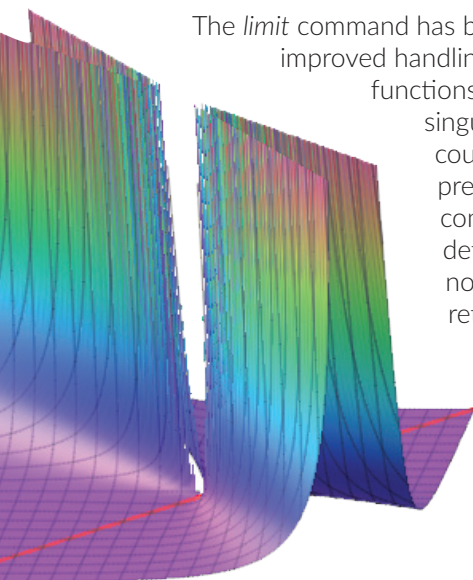
▶ Ordinals

Maple 2015 includes a new package for computing with ordinal numbers in Cantor normal form. The Ordinals package can represent and handle all ordinal numbers that can be obtained from non-negative integers and ω, the ordinal for the standard ordering of the natural numbers $\mathbb{N}$, in a finite number of steps by ordinal addition, multiplication and exponentiation.

▶ Physics

Maple provides a state-of-the-art environment for algebraic computations in physics, with emphasis on ensuring the computational experience is as natural as possible. The theme of the Physics project for Maple 2015 has been vector analysis, symbolic tensor manipulations, quantum mechanics, and general relativity.

- More than 400 enhancements throughout the entire package increase robustness and versatility.

- More than 100 metrics were added to the database of solutions to Einstein's equations.

- The formalism of tetrads in general relativity was implemented within Physics as a new package.

- Expanded support for commutators, anticommutators, and parametrized algebra rules aid in computations with products of non-commutative operators.

- Improved simplification algorithms and new options for automatic simplification using assumptions on variables make the system easier to work with and the results easier to interpret.

- Improved tensors are more powerful, and make handling symmetries, substitutions, and other operations more flexible and natural.

- New commands provide more tools for programming and interactive computations.

- And more!

▶ Mathematical Functions

Maple provides a rich collection of definitions, identities, and properties for a large set of mathematical functions. Maple 2015 adds many new mathematical formulas and properties to the mathematical functions database, new conversion routines, and more tools for exploration and computation.

▶ Polyhedral Sets

Maple 2015 has new functionality for working with polyhedral sets defined either by a set of equalities and inequalities (*H-Representation*), or by a set of vertices and rays (*V-Representation*). The added functionality lets you explore the geometric and topological properties of a set, perform standard set operations, and apply linear transformations.
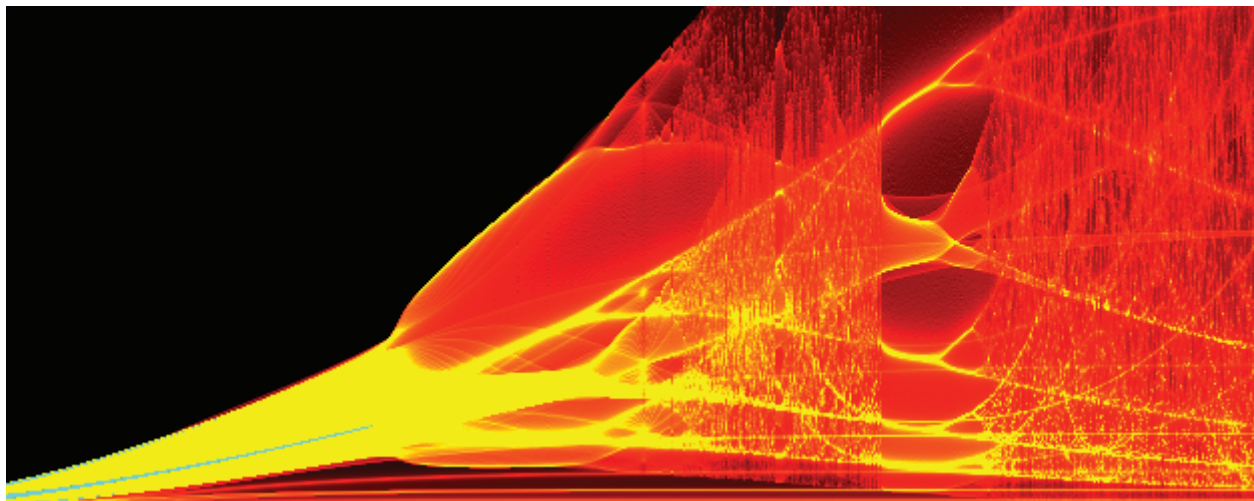
▶ Finance

The Finance package now includes support for 10 more Greeks, quantities often used in risk management to represent the sensitivity of the price of a derivative to changes in underlying parameters on which the value of a financial instrument is dependent.

In addition, Maple can now return amortization tables in the form of an embedded table in the document, automatically generating a cleaner, easier to read result.

▶ Iterative Maps

New iterative maps can be used to compute graphic images representing bifurcation diagrams, escape-time and related fractals, and attractors.
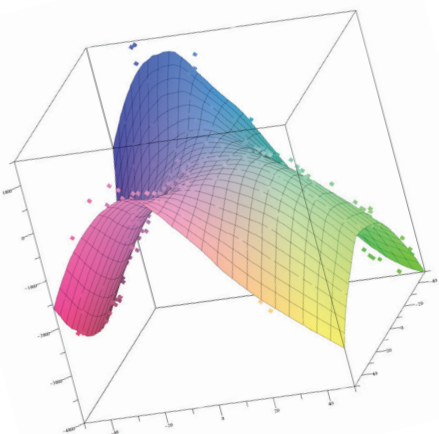
- Supports attractor, bifurcation, and escape maps

- Produces stunning visualizations

- Provides automatic parallelism that takes full advantage of the processing power of your computer for faster results

- Can be made interactive when combined with the *Explore* command, so you can see the changes in the visualization as you modify the parameters

▶ Statistics

Maple 2015 further broadens its support for statistics with new computation and visualization abilities.
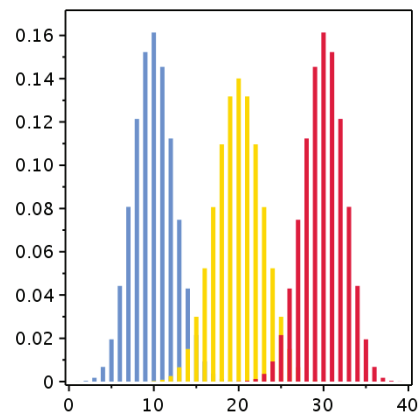
- The Lowess (locally weighted scatterplot smoothing) method for visualizing a smoothed curve or surface has been expanded to return a function whose graph is the smoothed graph, allowing programmatic manipulation and the ability to handle data points in any finite dimensions.

- The Lowess algorithm has also been improved to produce better plots and to achieve lower computation times.

- Maple can now calculate robust linear regressions using a repeated median estimator, giving less weight to outliers and better results in the presence of noise.

- A new command centers and scales a sample list or matrix, which is useful in applications such as computing standard scores.

- Visualization improvements include new tree maps, support for time series objects in bubble plots, and the new data plot command which provides a single interface to perform many statistical plots.

- Several statistics commands have been improved so the output is easier to read.

- Context-menu operations are now available for matrix data sets.

- New code generation tools for R allow you to automatically convert your Maple expressions and programs to R code.

▶ Statistics Education

Maple 2015 further expands support for teaching and learning statistics with new Clickable Statistics tools.

- 18 new interactive Math Apps for statistics make it easy to explore confidence intervals, different distributions, chi-square tests, z-tests, stem and leaf displays, and more.

- A new palette helps students construct random variables based on different distributions.

- New commands generate probability and critical tables instantly, based on the given distribution and parameters.

- New tutors offer a command-free method for generating probability and critical tables.

- The Test Guide tutor command has been expanded to accept data samples as arguments, so the data does not need to be entered manually from inside the tutor.

▶ Units

Computations involving units are now easier and more natural than ever.

- Keyboard shortcuts are available for inserting units.

- A new interactive tool for formatting units makes it easy to convert between both individual units and systems of measurement.

- Maple now provides the ability to work with absolute temperatures in addition to relative temperatures.

▶ Code Generation

Code generation in Maple has been further expanded with support for R and JavaScript®. In addition, all code generation tools now include an option for the generated code to appear in a text component, making it easier to read and copy.

▶ Import/Export

Maple 2015 makes it easier than ever to import and export data in Maple.

- New Import and Export commands provide a unified approach to all data import and export activities, replacing the need to use different commands in different situations.

- These commands can be used with any type of data, without having to specify, or even know, the format the data is stored in. They can be used with numeric and tabular data, images, audio, specialized text file formats like XML, and even special-purpose mathematical formats for linear optimization and graph theory.

- The list of supported import formats now includes JSON (JavaScript Object Notation), a human-readable, text-based standard for describing structured data.

▶ Performance

Performance and efficiency improvements continue to be made in key areas of Maple. These improvements to fundamental operations result in faster, more efficient computations throughout the product. Improvements in Maple 2015 include:

- Maple's 'garbage collector', which is responsible for finding and reclaiming memory that is no longer needed by the evaluation engine, has been improved to perform even more operations in

parallel. Greater parallelism during collection leads to better overall performance.

- Several linear algebra commands, when working with default double precision, are now faster in Maple 2015 on the 64-bit Windows platform.

- The performance when computing greatest common divisors of multivariate polynomials modulo a prime number has increased significantly, with orders of magnitude improvements in some cases.

- More special functions are now implemented in *evalhf*, for fast hardware precision evaluation.

- The evaluation of elementary and special functions in different floating point computation environments has been improved to handle branch cuts consistently.

▶ Grid Computing

Unlimited same-machine parallel execution is built into Maple. You can spawn as many parallel processes as you want without requiring any additional toolbox or licensing. Maple 2015 makes it even easier to initiate parallel jobs with new commands that abstract away MPI-like message passing protocols. The result is a very simple and intuitive interface for running commands and dealing with data in parallel.

▶ Language and Programming

In addition to the ability to create content programmatically, there were several other improvements to the Maple language and core functions.

- You can now easily merge two tables together.

- The keyword *double* can now be used as a synonym for *float[8]*.

- Objects can now inherit properties from other object declarations.

- You can now easily concatenate a string with a constant.

- The *rand* command now accepts floating point values for the range.

▶ Additional Improvements

Maple 2015 includes many improvements, small and large, to enhance usability.

- New palettes are available for trigonometric and hyperbolic functions, and for constructing random variables based on statistical distributions.

- Improved 2-D Math editing now interprets the adjacent brackets in expressions such as $(x + y)(a + b)$ as implicit multiplication.

- New keyboard shortcuts support zooming, expanding and collapsing sections, and more.

- Plot thumbnails are now shown when Maple returns a plot structure, such as when you assign a plot to a variable, so you can easily verify if the result is what you intended.

- The Help Search Box can now also search for data sets and has a more compact display.

- User profiles allow you to select your system of units, set your preferred numeric formatting, and insert Maple commands into a worksheet's Startup Code region.

- Units and numeric formatting options allow you to control defaults both globally and locally.

- Documents can be saved to the MapleCloud directly from the File menu.

- Menus have been restructured to make them easier to navigate.

- Plot zooming is now easier with new zoom in/zoom out buttons on the toolbar.

- Commands entered in Maple syntax without the terminating semi-colon no longer display a warning with the result.

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