Maplesoft

Mathematics • Modeling • Simulation
A Cybernet Group Company

Not Using Maple 2018 Yet?
See What You've Been Missing

Okay, we get it. We know you love Maple, but some years you find yourself wondering if it's worth the bother of upgrading. People use Maple to do many different things, so it's inevitable that each new release will include some features you care about and some features you really don't need.

But if you aren't using Maple 2018 yet, you are really missing out. Maybe more than you realize.

To help you make up your mind, this whitepaper outlines some of what has gone into Maple for each of the last three releases. There are many more improvements and additions than we can cover in this article, so we have purposely limited ourselves to one item per category. Much more information about current and past releases is always available at What's New in Maple.

Once you've had a chance to learn about what has gone into Maple since you last upgraded, ask yourself - is Maple 2018 something you want to do without? We think you'll be surprised by how much you've been missing!

What Are You Interested In?

▶ Just Tell Me about the Math

▶ Point-and-Click Problem Solving

▶ Command-Driven Problem Solving

▶ Algorithm Development

▶ Application Development

▶ Education

▶ Staff Favorites
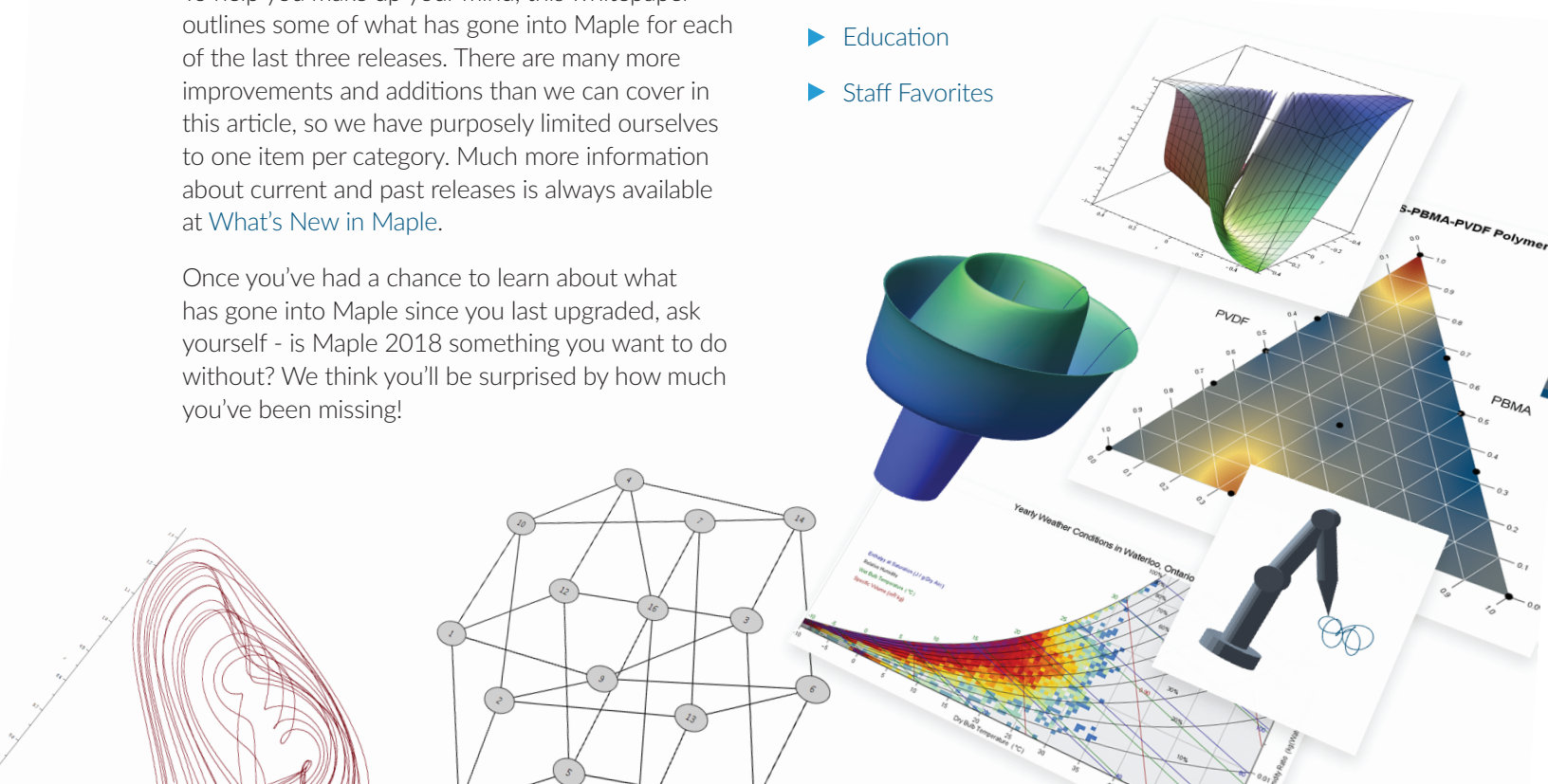
Just Tell Me about the Math

Fundamentally, Maple is a math tool, and all the fancy interface improvements in the world won't matter if the math is not there. Every release represents an expansion of the depth and breadth of Maple's mathematical power. This article lists just three of the many new and improved areas of mathematics. It's worth noting that every release also includes on-going work on the fundamentals, like polynomial system solving, integration, simplification, performance, and much more.

Maple 2018: Computational Geometry

Maple 2018 contains a new Computational Geometry package, which applies computational methods to polygons and clouds of points. Computational geometry problems occur in many applications involving points in two- or higher-dimensional spaces, such as feature recognition, predicting vapor-liquid phase diagrams, delineating closely related regions for scattered data, and more.

Maple 2017: Partial Differential Equations

Maple is the world leader in finding symbolic, closed-form solutions to differential and partial differential equations. Every year, Maple pushes the frontiers with new methods that can tackle new classes of problems. In Maple 2017, there was particular emphasis on solving PDEs with boundary conditions, with the introduction of several new algorithms that allow Maple to find analytic solutions for many more of these problems.

(Maple 2018 includes even more advancements in PDEs and DEs, too.)

Maple 2016: Number Theory

The completely rewritten Number Theory package introduced in Maple 2016 provides a comprehensive coverage of topics from number theory, including working with primes, lattices, integral bases, modular operations, cyclotomic polynomials, and much more. The new package is easier to learn and use, and many of its operations are now available from the context-sensitive menus.

Point-and-Click Problem Solving

All the math power in the world won't help you if you can't get at it. Maplesoft pioneered a Clickable Math™ approach to mathematical problem solving and investigations, and every Maple release continues to make it even easier to access the power of Maple without worrying about commands or syntax.

Maple 2018: Intelligent Context Panel

The intelligent Context Panel brings together and enhances some of Maple's most powerful Clickable Math tools. The Context Panel offers point-and-click access to a wide variety of mathematical operations as well as other Maple tools, and provides a highly discoverable way of exploring Maple's functionality.
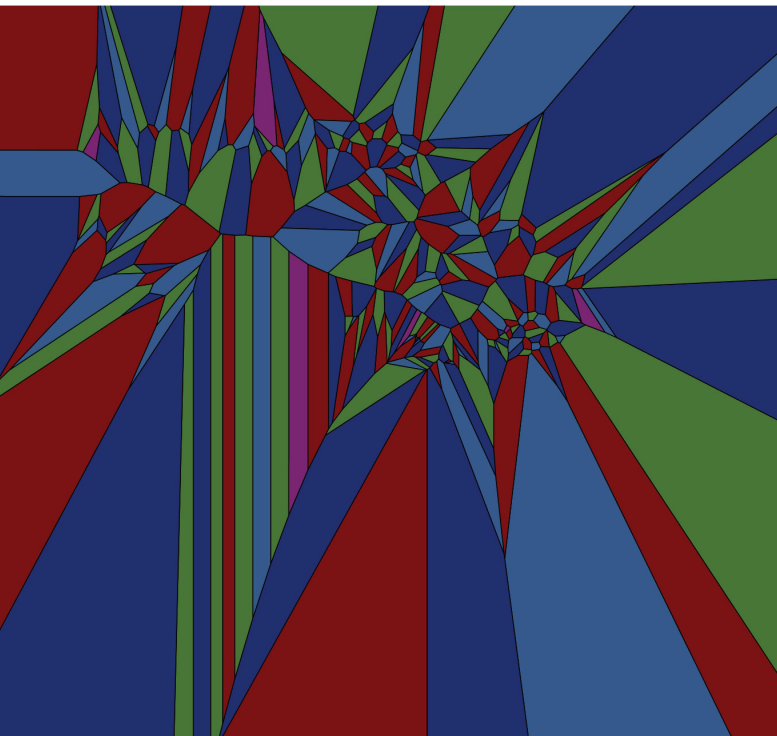
When you click on a mathematical expression, Maple analyzes your expression and then presents you with a list of the most relevant operations and tools in the context panel. Options could include solving for *x*, plotting your expression, finding a determinant, converting from one unit to another, applying a Fourier transform, integrating with respect to *t*, changing the numeric formatting in your result, calculating the average of your data, and much more, all depending on what makes sense. Simply selecting one of these options performs the operation. In addition, you can also use the context panel to customize the appearance of plots, change the properties of tables, and more. No knowledge of Maple syntax or Maple commands is required.
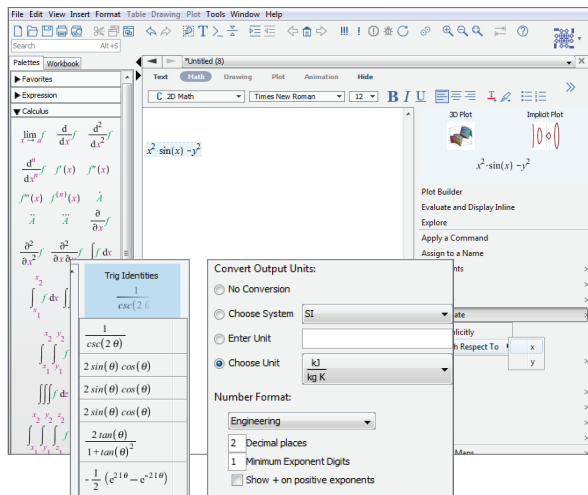
Maple 2017: Interactive Plot Builder

The Plot Builder in Maple 2017 was redesigned to make it even easier to create and customize a wide variety of 2-D and 3-D plots, simply and without knowing a single plot command. The plot appears directly in your document and is updated immediately every time you make a change to the plot options, with no preview window required. You can switch seamlessly between the plot builder and the rest of your document.
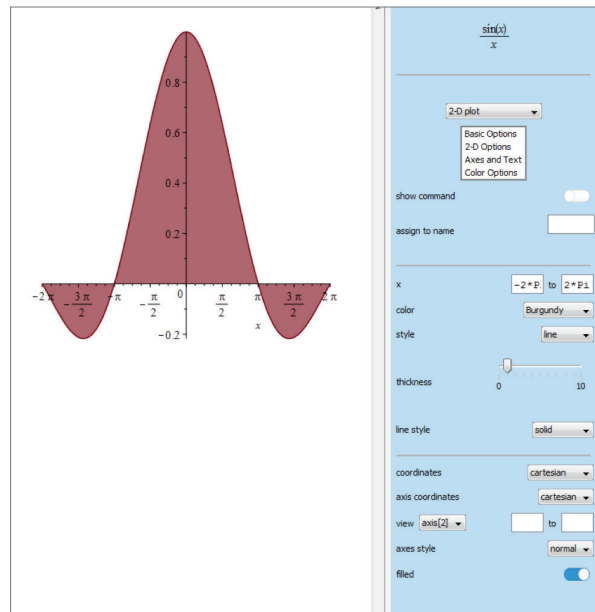
The Plot Builder has been incorporated into the Context Panel in Maple 2018.

Maple 2016: More Clickable Operations

Expanded Clickable Math support added to Maple 2016 lets you perform new operations at the click of a button, from writing fractions as repeating decimals, to computing cross products and dot products in multivariate calculus, to converting Maple code to the Julia programming language.

Command-Driven Interactions

Not everyone likes to click, and not every possible Maple operation is available using a Clickable Math approach. Here are some of the improvements for those situations when you want to talk to Maple one command at a time.
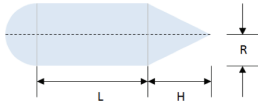
Maple 2018: Using Units

Most computations in science and engineering, and many applications, are done using quantities that have units associated with them. Maple has many tools to help you keep track of your units

and avoid the problems that come from getting them wrong. While not all mistakes are as costly as losing a $125 million space probe, it's still better to avoid them! Maple 2018 provides substantial improvements to unit support in Maple, with even deeper integration of units with the Maple computation engine.

In particular, more top level computation functions can now accept expressions involving units as arguments, and return results that include in the appropriate unit information:

- Solve equations numerically or symbolically (*fsolve, solve*)

- Solve optimization problems using a variety of solvers (Optimization package)

- Solve integrals numerically or symbolically (*int*)

▼ **Example: Optimizing the Design of a Fuel Pod**
You are designing a fuel pod with a hemispherical cap, cylindrical mid-section and conical cap.

What are values of L, H and R that minimize the surface area while maintaining the volume V at 3 m³?

> restart :

Objective function - surface area of pod
> $obj := \frac{1}{2} 4 \pi R^2 + 2 \pi R L + \pi R \sqrt{H^2 + R^2}$:

Constraint on the volume area of pod
> $cons1 := \frac{1}{2} \frac{4}{3} \pi R^3 + \pi R^2 L + \frac{1}{3} \pi R^2 H = 3 m^3$:

All dimensions must be greater than 0
> $cons2 := 0 \leq R, 0 \leq L, 0 \leq H$:

Hence the optimized dimensions are
> $dimensions := Optimization:-Minimize(obj, \{cons1, cons2\}, initialpoint = \{H = 1m, L = 1m, R = 1m\})$
$dimensions := [10.2533536615869920\ m^2, [H = 0.785093823049978\ m, L = 0.392546902492684\ m, R = 0.877761593519080\ m]]$
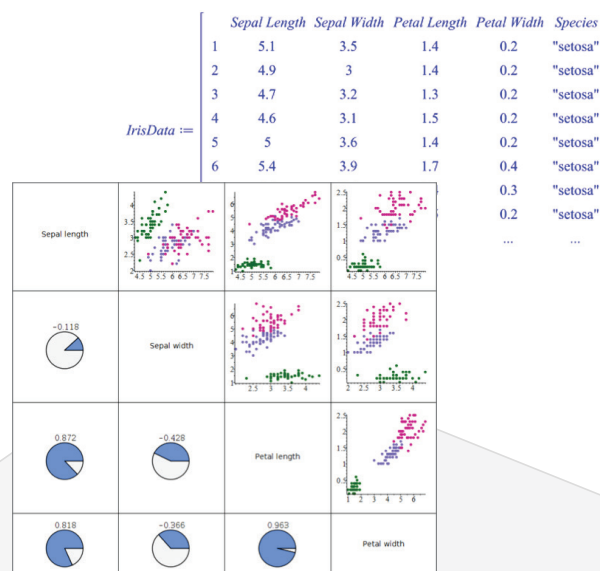
 And if you don't mind a little clicking – the units formatting dialog has been redesigned and moved to the context panel, so it can be accessed more easily, and fewer mouse clicks are required for each unit change. Unit and numeric formatting can now be done much more efficiently through the context panel rather than by navigating through two different dialogs.

Maple 2017: Making Assumptions

The assumption facility allows you to ask Maple to perform computations while assuming certain conditions hold, such as 'x is real and positive', or 'a < b'. It also enables you to ask questions about what properties are true, or could be true, given your assumptions. In Maple 2017, this facility was enhanced to expand its power and scope, including better handling of multiple or complicated assumptions and new functional properties, such as assuming | x | < 1.

Maple 2016: Organizing Data

Flexible and intuitive data containers help you organize and analyze labeled heterogeneous data, making them highly suitable for analyzing real-world data, or any application where you need to deal with related information that spans different data types. These fundamental data structures introduced in Maple 2016 can be used for any kind of statistical or observational data, and support the organization of heterogeneous data that spans multiple data types, such as strings, integers, and floats. They include column and row labels that make it easier to index and select subsets of data as well as providing useful meta-information for data visualizations.

$IrisData :=$

|	Sepal Length	Sepal Width	Petal Length	Petal Width	Species
1	5.1	3.5	1.4	0.2	"setosa"
2	4.9	3	1.4	0.2	"setosa"
3	4.7	3.2	1.3	0.2	"setosa"
4	4.6	3.1	1.5	0.2	"setosa"
5	5	3.6	1.4	0.2	"setosa"
6	5.4	3.9	1.7	0.4	"setosa"
				0.3	"setosa"
				0.2	"setosa"
				...	...

Algorithm Development

Maple includes a sophisticated programming language for developing your own algorithms and procedures. Improvements in this area include both enhancements to programming tools and to the language itself.

Maple 2018: Code Editor

Whether your write a lot of procedures, or simply want to add some lines to the start-up code for your worksheet, put a sequence of commands in a code edit region, or include a button or slider in your application, you'll find yourself using Maple's code editing tools. Maple 2018 includes substantial improvements to code editing that make it easier to write, debug, and maintain your code. Here are some of them:

- The code analysis tool, mint, is now incorporated into Maple's code editing tools, where it automatically provides information about programming issues that go well beyond syntax errors. This tool provides information that assists with both debugging and code maintenance, such as parameter naming conflicts, unreachable code, unused parameters or variables, and more.

- Command completion is displayed automatically as you type, making it faster to enter function names, and eliminating problems due to misspelled names.

- For the code editor, which is used for startup code and for defining the behavior of interactive components, there is a new console window that lets you test your code from directly inside the code editor.
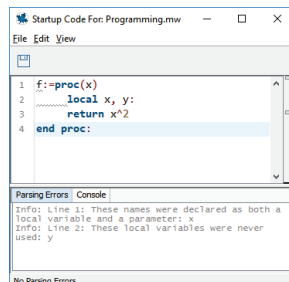
Maple 2017: Package Creation Tools

New tools for programmatically authoring and editing Maple packages make it easier to turn your own work into a shareable Maple package. Then, if you choose, it's a simple matter to share your package with the entire Maple user community through the Package group in the MapleCloud™.

Maple 2016: Code Parallelization

Maple is the only technical computing system that allows you to take advantage of multithreading in your own programs. Maple 2016 introduced additional tools to help you develop thread-safe programs for performing large computations more quickly, including a new thread safety check and a lock option.

Application Development

Whether you are creating a lesson for your students, an analysis tool for your engineers, a detailed technical report for your research colleagues, or any other Maple-based application, advancements in recent releases make creating applications and sharing your work with others easier.

Maple 2018: Protecting Your Content from Changes

Maple 2018 includes the ability to protect your content from accidental changes. In addition to aiding your content creation process, this ability allows you to share your work without having to deal with users who accidentally break your application (and then complain!).

You can control whether or not entire documents, or the content of individual tables, can be modified. Non-editable content is viewed in "Player mode", where interactive components, such as buttons and sliders, continue to work.

This feature can be useful in a variety of ways. For example:

You can give your application to students and colleagues, and there is no risk that they will accidentally, and perhaps unknowingly, modify its content, appearance, or behavior.

For situations where randomized output can vary every time the commands are executed, you can set your document to non-editable in order to freeze your results at a particular instance. This way, you can be sure your readers will always see the specific example you discuss in the surrounding text.

If you have spent time laying out information carefully in a table, you can lock down that table to keep it safe from accidental modification as you work on the rest of your document.

Maple 2017: Password Protected Worksheets

As of Maple 2017, you can password-protect individual worksheets stored inside a Maple Workbook, so they can only be viewed by those who have the password. These worksheets can still be executed, so you can pass parameters into the protected content, run its code, and get results out. As a result, you can share your work without sharing your IP.

(Maple 2018 also offers encrypted procedures as another method of protecting your content. Encrypted procedures behave like ordinary procedures but their definition cannot be viewed.)

Maple 2016: Workbook

The Maple Workbook, introduced in Maple 2016, makes it easy to organize and share your projects and Maple applications, simply and reliably. All related Maple documents, data, source code, variables, and other attachments are kept together in a single project file, so individual components cannot get lost or out of sync with the rest of the application. References to files in the Workbook do not rely on external file locations, so you can be

confident the application will run properly when it is moved or shared, even between operating systems.

Education

Much of what Maple does is directly applicable to educators and students, so much of the information in this whitepaper is relevant to education, especially the section on Point-and-Click Problem Solving. Maple also provides tools and resources specifically to support the needs of education. Here are some recent additions.

Maple 2018: Practice Sheets

Student packages in Maple offer focused learning environments in which students can explore and reinforce fundamental concepts in the same way their instructor does in class. Student packages are available for a variety of core subjects, including calculus, precalculus, linear algebra, statistics, vector calculus, multivariate calculus, numerical analysis, and more. In Maple 2018, the Student Basics package has been expanded to give instructors a way to provide drill-and-practice exercises for students that Maple will grade automatically, giving the students immediate feedback.

The new *PracticeSheet* command generates a grid of practice problems for drilling math skills. You can create practice sheets that test arithmetic basics, algebra skills, calculus problems, factorization, and more. Each problem is generated using randomized

parameters. Students complete the problems, and then simply click on a button to find out how they did. If a student wants more practice, another click brings up a new sheet of problems to try.

Integration - Power Rule

Integrate each expression using the power rule.

Do not include a constant of integration in your solution.

$\int x^{14}\,dx = \dfrac{x^{15}}{15}$	$\int x^3\,dx = \dfrac{x^4}{4}$
$\int x^{12}\,dx = \dfrac{x^{13}}{13}$	$\int x^8\,dx = \dfrac{x^9}{9}$
$\int x^{11}\,dx = \dfrac{x^{12}}{12}$	$\int x^{15}\,dx = $
$\int x^{17}\,dx = $	$\int x^4\,dx = $
$\int x^5\,dx = $	$\int x^{20}\,dx = $

[Check My Work]   [New Sheet]

Maple 2017: Streamlined Access to MapleCloud

Access to the MapleCloud has been redesigned to make it easier for students to use this service. Through the new interface, students can immediately access all publicly available Math Apps and documents. If they log in, they can also access any private groups you may have set up for your class, where they can easily obtain documents or applications you have shared privately with your students. The redesigned interface also makes it easier for students to upload documents to their class group, so they can hand in assignments or share details of their work with you.

Maple 2016: New Math Apps, Applications, and Examples

Maple 2016 provided dozens of additional pre-built Math Apps, applications, and examples that students can use to explore mathematical concepts, discover applications related to what they are learning in class, and learn more about Maple.

New Math Apps, which provide highly visual, interactive activities that help your students explore specific concepts, include the Sieve of Eratosthenes, tessellations, and different ways of visualizing the area of a circle. Other applications and examples cover a wide variety of topics, such as working with thermodynamic properties, building interactive applications, number theory, delay differential equations, principal component analysis, and more. In addition, new "How do I…" tutorials provide step-by-step instructions for more common tasks, including plotting multiple functions on the same axes and solving ordinary differential equations.

Staff Favorites

People with different interests and work methods get excited by different features. That's true of our customers, and of course it's true of the Maplesoft staff, as well. Here are some of our staff's personal favorites, large and small, that haven't been mentioned yet.

Large...

Maple 2018: Thermophysical Data

With Maple 2018, Maple's Thermophysical Data package has been expanded to enable you to perform calculations involving the thermodynamic properties of many more chemical species. Properties are available for over 2000 gases, liquids, and crystalline species. The data can be used to study chemical equilibrium composition, reaction constants and spontaneity, rocket performance, flame temperatures, explosion and detonation pressures, and for many other applications.
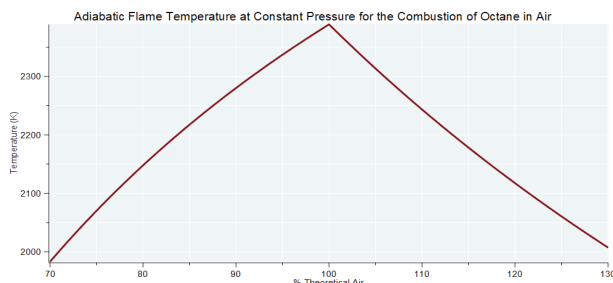
Maple 2017: MapleCloud Package Manager

Starting in Maple 2017, the MapleCloud gives you instant, seamless access to a rich collection of user packages that extend Maple's abilities, and makes it easier for you to share your own work with others. The ever growing list of available packages includes encryption, optimization, orthogonal series expansions, lattices, and more. With the MapleCloud package manager, you get one-click installation of packages for immediate use, and automatic notifications of updates to the packages you have installed.

### Maple 2016: Einstein's Field Equations

Maple provides a state-of-the-art environment for algebraic computations in physics, with emphasis on ensuring that the computational experience is as natural as possible. Maple 2016 included significant enhancements in general relativity, as well as over 300 enhancements throughout the entire Physics package. In particular, Maple 2016 added a database of all 971 solutions from the classic text *Exact Solutions of Einstein's Field Equations*, which you can search to find spacetime metrics with particular properties. You can then use these solution metrics, together with automatically derived related information, in your general relativity computations.

...and small

Not every valuable change is something new and large. While the big new items tend to get the most attention, every release also includes hundreds of small improvements that make your life just a little easier. Here are examples of some of the small changes we particularly liked:

Maple 2018: Borderless Arrows on Plots

Maple lets you draw arrows on your graph programmatically, and it gives you control over color, size and other properties. But up until now, those arrows would always be drawn with a black outline. Customers asked if we could make that border optional, so now it is.
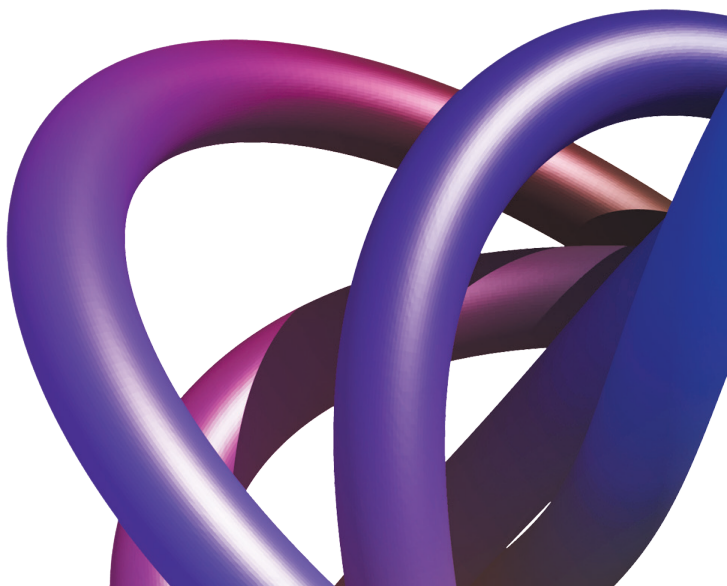
Maple 2017: Popups on Contour Lines

Contour plots now have labels on the contours that appear when the pointer is placed over a contour line, so it's easy to read the values of the lines. These popups are an example of new dynamic plot annotations, which you can add to your own graphs. The annotations will appear when you hover over specific points or curves, so you convey even more information in your graphs.
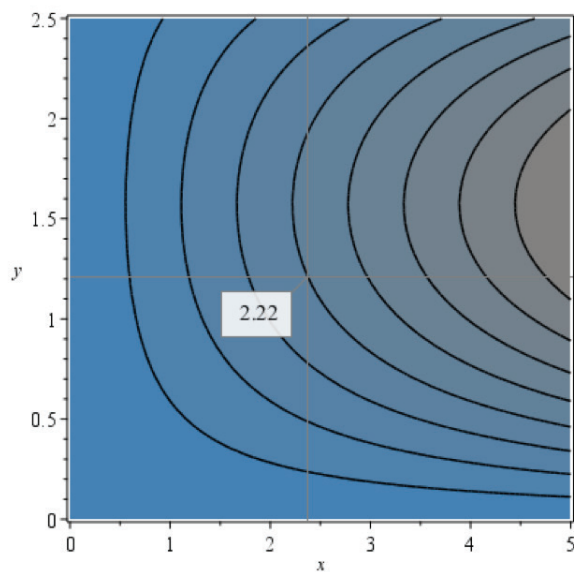
Maple 2016: Simplified Explore for One Step App Creation

The Explore facility offers an easy-to-use tool for creating interactive applications, and is available both interactively and through the Explore command. With Explore, you can create entire interactive applications to explore the effects of parameter changes on a plot or on the value of an expression, all in a single step. Maple 2016 included several updates and additions to the Explore command. One particularly useful change is the simplified calling sequence and parameter handling, which lets you create your application even more quickly and easily.

$$Explore\left(plot\left(\frac{\sin(a\,x)}{x}, x=-3\cdot\pi..3\cdot\pi \right), a=1.0..5.0 \right)$$
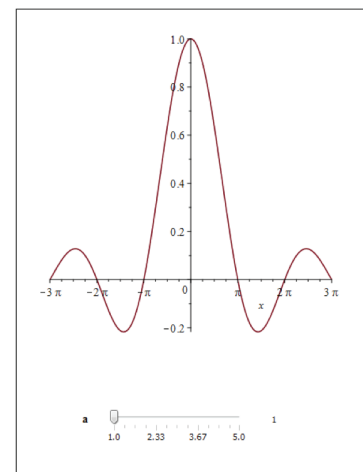
Conclusion

If you aren't using Maple 2018 yet, this article gives you a taste of what you are missing, though it is by no means a complete description of everything that has gone into the three most recent releases. With all the improvements, big and small, that go into each Maple release, it doesn't take long to fall far behind. Is Maple 2018 really something you want to do without?

Maple™

For more information:

Need to go further back? See Maple Product History for details about even earlier releases.

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