Classroom Tips and Techniques: The Maple Portal

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Introduction

You've installed and/or launched a copy of Maple 12 to do something mathematical. But how? How do you get Maple to do the math you want?

Access the Maple Portal by entering the command ?Portal and pressing the Enter key. The resulting worksheet is pictured in Figure 1.

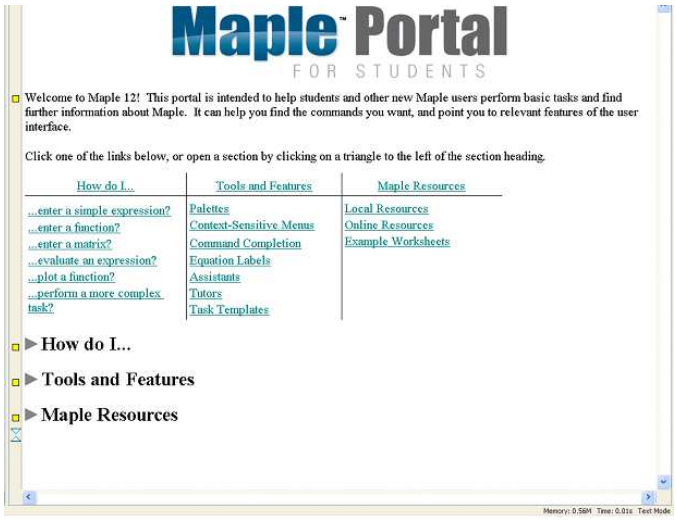


Figure 1 The Maple Portal

The Maple Portal was designed to provide answers to the question "How do I...?", where the 140 action-items that complete the question are found in the links in the leftmost column. The middle column provides links to explanations of the ease-of-use features that allow for syntax-free computing, and the rightmost column provides links to various resources that will illustrate the use of Maple for performing a wide spectrum of mathematical tasks.

Corresponding to the Headers "How do I...", "Tools and Features", and "Maple Resources", there are three collapsed sections containing the targets to which the listed links lead. Either follow the links in the visible columns, or dive directly into the collapsed sections and search for a topic of interest.

The Leftmost Column

The first five links is the left-hand column provide answers to the most common questions a user might ask about Maple. First, before any mathematical calculations can be done in Maple, some sort of mathematical expression must be entered. The first three links lead to explanations of how to enter a simple mathematical expression, a Maple function, or a matrix.

If what is entered requires an evaluation (suppose the expression is $1/2 + 1/3$) then the fourth link provides the requisite information. Finally, the fifth link leads to information on the various plotting options available in Maple.

The sixth link in the left-hand column points to the largest portion of the Portal. Some 140 completions of the question "How do I...?" are grouped under the headings listed in Table 1.

Constructing algebraic objects Algebraic manipulations Algebraic solvers Polynomial arithmetic Plotting Differential calculus in one variable Integral calculus in one variable Multivariate calculus Vector calculus Complex arithmetic ODEs Linear Algebra Statistics Integer Manipulations Units, Errors, and Tolerances Recurrence Equations
Table 1 The categories in which some 140 completions of the question "How do I...?" are listed

Figure 2 contains, for example, the contents of the section "Complex arithmetic."

Complex arithmetic

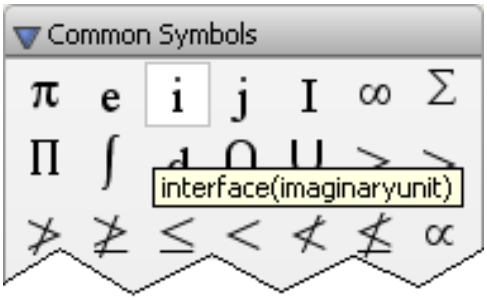
enter a complex number	• Example 6.1: Enter a complex number using *i*, *j*, or *I* from the Common Symbols palette
obtain the real and	• Task: Real Part

imaginary parts of a complex number	• Task: Imaginary Part
obtain the magnitude and argument of a complex number	• Task: Modulus • Task: Argument
express a complex number in polar form	• Task: Polar Form
convert a complex number to rectangular form	• Task: Rectangular Form

Figure 2 The completions of the question "How do I...?" in the section on complex arithmetic.

In response to the question "How do I enter a complex number?" there is the fully-worked Example 6.1, whose content is shown in Figure 3.

Example 6.1 - How Do I Enter a Complex Number?

Step	Description	Illustration
1	In Maple, the default representation of the imaginary unit $i = \sqrt{-1}$ is I. To enter the imaginary unit in Maple, click on one of the symbols *i*, *j*, or *I* from the Common Symbols palette, found on the left-hand side of the Maple window. Typing the letter *I* is equivalent to selecting it from this palette	
2	Shown at the right are a few examples of complex numbers. Note that simply typing *i* will not produce the imaginary unit, but typing *I* will. Also, the imaginary unit $i = \sqrt{-1}$ is displayed with a capital *I*, no matter which symbol was used for input.	$(3 \cdot \mathrm{i} + 5) \cdot (5 - 3 \cdot \mathrm{i}) = 34$ $3 \cdot \mathrm{i} + 4 = 4 + 3\,\mathrm{I}$ $(3 \cdot i + 4) \cdot (4 - 3 \cdot i) = (3\,i + 4)\,(4 - 3\,i)$ $(3 \cdot \mathrm{j} + 5) \cdot (5 - 3 \cdot \mathrm{j}) = 34$ $3 \cdot \mathrm{j} + 5 = 5 + 3\,\mathrm{I}$ $3 \cdot I + 5 = 5 + 3\,\mathrm{I}$
	To change the symbol used for the imaginary unit, (both for input and	

3	output), use the **interface** command as shown to the right, where $\sqrt{-1}$ has been set to *j*. Thereafter, clicking on *i*, *j*, or *I* in the Common Symbols palette, or typing the letter *j*, will produce the imaginary unit, and its symbol will be *j*.	*interface*(*imaginaryunit*=*j*) : From the palette: $j^2 = -1$ By typing: $j^2 = -1$
4	The **Complex** command may also be used to enter complex numbers in both Math and Text modes. See the examples to the right.	*Complex*(5, 2) = 5 + 2 I `> Complex(5,2);` 5 + 2 I

Return to the MaplePortal

Figure 3 One of the fully-worked examples that answer a completed "How do I...?" question

Other questions about complex arithmetic are answered with a link to an appropriate Task Template. The full suite of Task Templates is detailed via one of the links in the middle column of the Portal. Figure 4 shows the Task Template that would answer the question "How do I express a complex number in polar form?"

Convert a Complex Number to Polar Form

Obtain the polar form of a complex number.

Polar Form of a Complex Number		
Enter a complex number:	> 1 + 2 *I* 1 + 2 I	**(2.1.1)**
Convert to polar form:	> *convert*(**(2.1.1)**, polar) polar($\sqrt{5}$, arctan(2))	**(2.1.2)**

>

Figure 4 The Task Template for converting a complex number to its polar form

The Middle Column

The seven links in the column headed "Tools and Features" lead to descriptions of the ease-of-use features and tools available in Maple 12.

Palettes

As described by the link in the middle column, the Palettes are accessed through the View menu by selections in the Palettes option. One of the more useful palettes, the Expression palette, is shown in Figure 5.

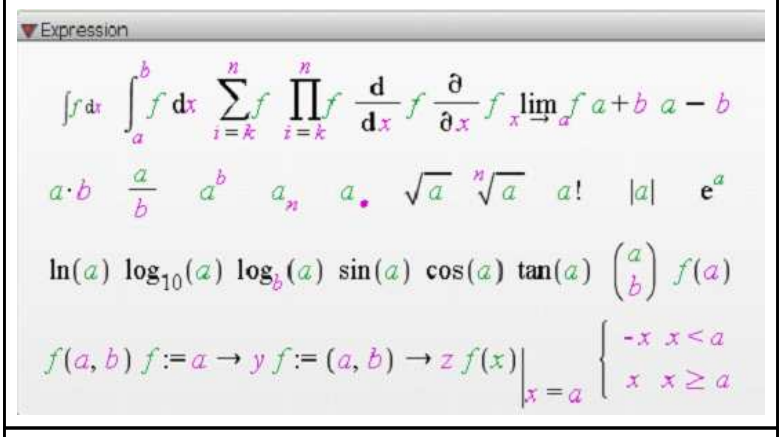


Figure 5 The Expression palette

Clicking on one of the templates in this palette inserts a copy into the Maple workspace. Filling in the fields of a template is equivalent to entering the corresponding Maple command.

Context-Sensitive Menus

Expressions can be evaluated and transformed by making selections from the pop-up (Context-Sensitive) menus obtained by right-clicking (Windows) or the equivalent in other operating systems. The options available in the pop-up menus are programmatically tailored to the object clicked on. For example, the Context Menu for the expression $\sin(x)$ would contain options to differentiate, integrate, plot, and perform other relevant manipulations in a syntax-free manner.

Command Completion

The initial part of many expressions and commands can be completed automatically by invoking "command completion," either from the Tools menu, or from the keyboard. (Control + Spacebar in Windows, with equivalents in other operating systems.) Completion of commands provides a template for options. Figure 6 shows the options provided by completing "dsol" in an attempt to enter **dsolve**. Amongst these options are various completions of the **dsolve** command, and these are provided with place-holders for the appropriate options.

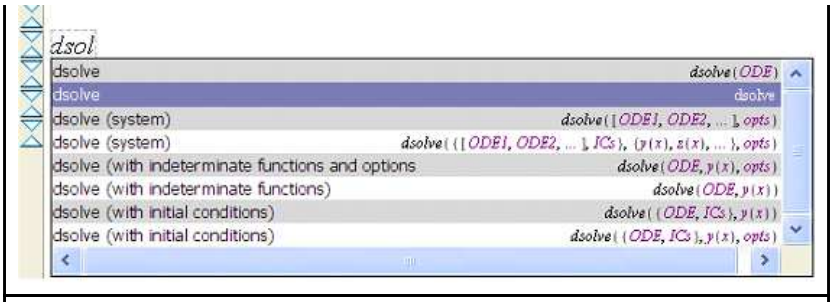


Figure 6 Command completion options for *dsol*

Equation Labels

Maple 12 marks each output with an equation label on the right-hand edge of the workspace. These equation labels can be used to reference the labeled quantities (Control + L in Windows). Hence, instead of assigning computed results to a name as in $q := simplify(1/x + 1/y)$, just execute the simplification and refer to the result by the equation label to its right. The Context Menu for the equation label provides an option for displaying the quantity rather than its label.

Assistants

The *Assistants* option in the Tools menu provides access to some 14 pop-up tools, the most useful of which are the Curve Fitting, Data Analysis, ODE Analyzer, Optimization, and Plot Builder Assistants. These tools can be accessed directly from the Tools menu, or from the Context Menu applied to a relevant object. Figure 7 shows the Curve Fitting Assistant finding the parabola that interpolates the points $(1, 1), (3, 7), (6, -2)$.

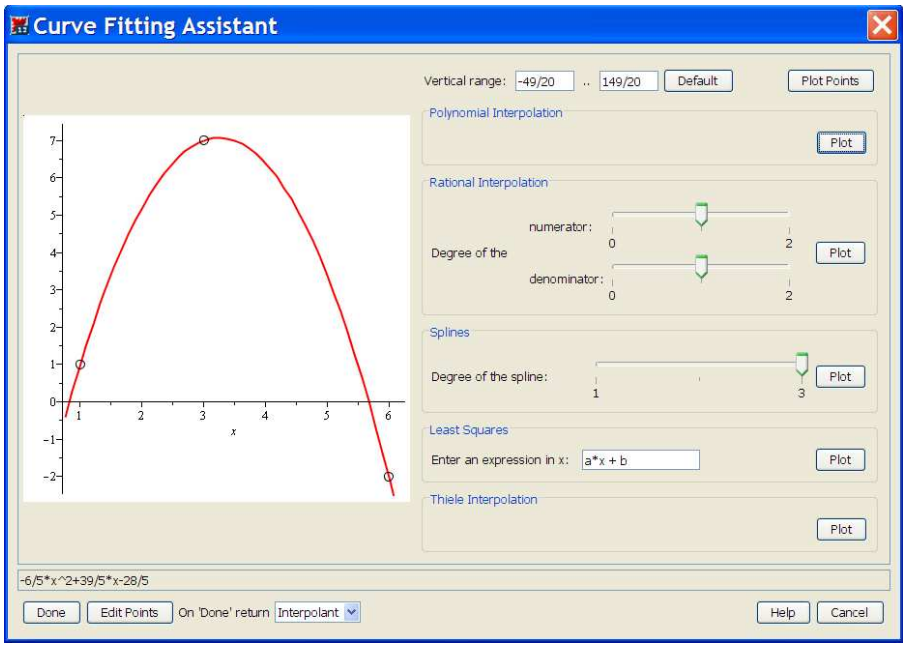


Figure 7 The Curve Fitting Assistant applied to the points $(1, 1), (3, 7), (6, -2)$

Tutors

The *Tutors* option in the Tools menu provides access to some 44 additional pop-up tools, more pedagogic in nature, and organized across the six subject areas: Precalculus, Calculus of a Single Variable, Multivariate Calculus, Differential Equations, Linear Algebra, and Vector Calculus. Tutors can be launched directly from the Tools menu, or from the Context Menu after the relevant Student package has been loaded.

There are tutors for analyzing conic sections, graphing feasible regions for sets of linear inequalities, computing limits, derivatives, and integrals stepwise, implementing Gaussian elimination stepwise, analyzing space curves and visualizing vector fields. Some tutors are designed to "give results," others are focused on providing visualizations, and yet others allow experimentation and exploration.

Task Templates

Maple 12 provides some 300 Task Templates for implementing specific tasks in a syntax-free way. Figure 8 shows the collapsed Table of Contents for the Task Templates, while Figure 9 shows the Task Template for interactively constructing a phase portrait of an autonomous system

of differential equations.

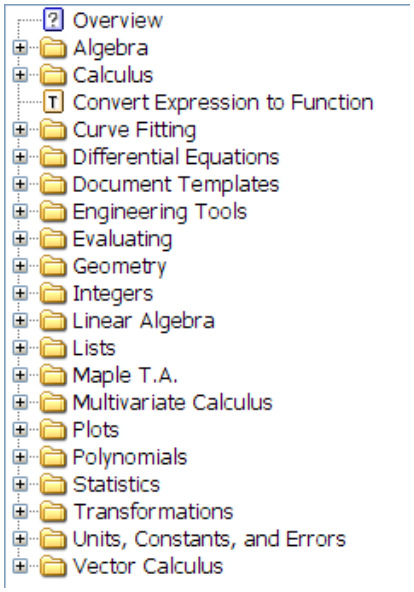


Figure 8 Table of Contents for the Task Templates

The Task Template in Figure 9 is located at

Tools≻Tasks≻Browse: Differential Equations≻ODEs≻Phase portrait - Autonomous Systems

Phase Portraits for Autonomous Systems

Plot an autonomous system of two ODEs, including the direction field, critical point(s), and phase portraits as desired.

Instructions

- To begin, enter the necessary information into the fields below:
  - the bounds for the plot window
  - $F(x, y)$ and $G(x, y)$, the right-hand sides of the autonomous ODEs $\dot{x} = F(x, y)$ and $\dot{y} = G(x, y)$
  - equilibrium (critical) points as lists $[a, b]$, and multiple such points in a sequence $[a, b]$, $[c, d]$
  - bounds for t, the independent variable of the ODEs, and hence, the parameter along orbits (trajectories or paths)
- Click the **Enter Data** button to obtain a direction field and all entered equilibrium (critical) points.
- Make sure that the pointer is  , execute code, and then click anywhere in the direction field to create a phase portrait through that point.
- The **Erase Phase Portrait** button erases all orbits and field arrows. The **Clear All** button clears every field in the template.

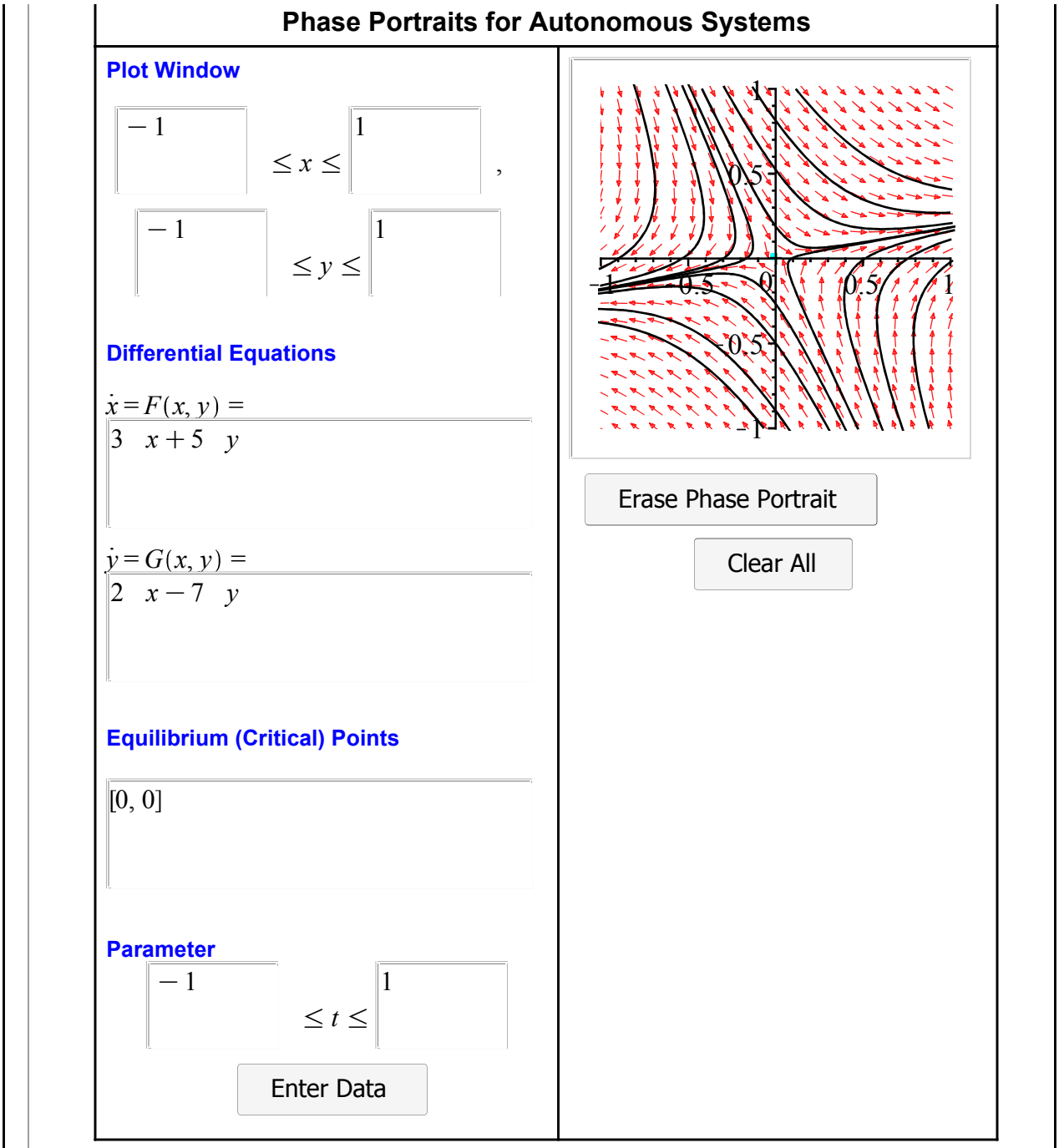


Figure 9 Task Template for interactively constructing a phase portrait of an autonomous system

The Rightmost Column

The three links in the rightmost column lead to information contained either in the Maple help system or on the Maple web site. The local resources are all in the help system, as is the collection of example worksheets listed under "Example Worksheets." The web-site resources include links to the

Student Resource Center, and to training videos. In addition, there is a link to the Maple Application Center, a repository for user-contributed materials available for download and use. Finally, there is also a link to the MaplePrimes site, the interactive home of the Maple user community.