Basic Guidelines for Computing

When you respond to the request "place the insertion point in the expression," place the insertion point within, or immediately to the right of, the expression. The position immediately to the left of a mathematical expression is not valid. You can check the state of the **Toggle Text/Math** button to verify that your insertion point is in mathematics or text.

Evaluating Expressions

- > To enter a mathematics expression for a computation
- Begin a new line with the mathematics expression.

 or
- Type the expression immediately to the right of text or a text space.

If you enter mathematics immediately to the right of other mathematics, the expressions will be combined in ways you may not intend. A safe way to begin is to press **enter** and start on a new line.

- > **To add** 3 **and** 8
- 1. Click T (or press **ctrl** + **m**) to toggle to mathematics mode, so that the **Text/Math** button



- 2. Type 3 + 8.
- 3. Leaving the insertion point in the expression 3 + 8, do one of the following:
 - Click the **Evaluate** button on the **Compute** toolbar.

or

- From the Compute menu, choose Evaluate.
 or
- Press ctrl + e.

This sequence of actions inserts = 11 to the right of the 3 + 8, resulting in the equation 3 + 8 = 11.

Note The contents of gray boxes (shaded background) display the mathematical expressions you enter, together with the results of the indicated operation. In general, throughout this document, the mathematical contents of gray boxes display both the input for an action and the results. In the case of plots, the input is displayed in the gray box and the results are displayed immediately following the gray box.

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By following the **same** procedure, you can carry out the following operations and perform a vast variety of other mathematical computations.

Add

Evaluate

$$235 + 813 = 1048$$

$$49.3 + 2.87 = 52.17$$

$$\frac{2}{3} + \frac{1}{7} = \frac{17}{21}$$

$$(x+3) + (x-y) = 2x - y + 3$$

Subtract

▶ Evaluate

$$96 - 27 = 69$$

$$(2x^{2} - 5) - (3x + 4) = 2x^{2} - 3x - 9$$

$$49.3 - 2.87 = 46.43$$

$$\frac{2}{3} - \frac{8}{7} = -\frac{10}{21}$$

Multiply

► Evaluate

$$82 \times 37 = 3034$$

 $(936)(-14) = -13104$

$$14.2 * 83.5 = 1185.7$$

$$\frac{2}{3} \frac{8}{7} = \frac{16}{21}$$

Divide

▶ Evaluate

$$82 \div 37 = \frac{82}{37}$$

$$36/14 = \frac{18}{7}$$

$$\frac{14.2}{83.5} = 0.17006$$

$$\frac{-\frac{2}{3}}{\frac{8}{7}} = -\frac{7}{12}$$

Important Except that it be mathematically correct, there are almost **no rules** about the form for entering a mathematical expression in **Scientific WorkPlace** and **Scientific Notebook**.

For example, the expressions

$$\frac{\frac{2}{3}}{\frac{8}{7}}$$
 $\frac{2}{3} \div \frac{8}{7}$ $\frac{2}{3} / \frac{8}{7}$ $(2/3)/(8/7)$

are equally acceptable ways of entering a quotient of fractions. Also,

$$(936)(14)$$
 $936 \cdot 14$ 936×14 $(936) * 14$

and many other variations are acceptable for the same product.

Note One of the few exceptions to the claim of "no rules" is that "vertical" notation such as

used when doing arithmetic by hand is not generally recognized. Write sums, differences, products, and quotients of numbers in natural "linear" or fractional notation, such as 24+15 and 235-47 and 36×14 and 364/2 or $\frac{364}{2}$ or $364\div2$.

Certain constants are recognized in their usual forms—such as π , i, and e—as long as the context is appropriate. On the other hand, they are recognized as arbitrary constants, variables, or indices when appropriate to the context, helping to provide a completely natural way for you to enter and perform mathematical computations.

Note The number of digits in answers to numerical problems depends on settings that you can change in the Tools + Computation Setup dialog. The examples in this documentation may differ in this respect from the answers you get with your system, and different examples in this documentation use different settings.

Interpreting Expressions

If your mathematical notation is ambiguous, it may still be accepted. However, the way it is interpreted may or may not be what you intended. To be safe, remove an ambiguity by placing additional parentheses in the expression.

> To check the interpretation of a mathematical expression

- 1. Leave the insertion point in the expression.
- 2. Press ctrl, and while holding it down, type?
 - or -

Choose Compute + Interpret.

$$1/3x + 4 = \frac{1}{3}x + 4$$

$$1/(3x+4) = \frac{1}{(3x+4)}$$

$$(1/3)x + 4 = \frac{1}{3}x + 4$$

$$1/(3x) + 4 = \frac{1}{3x} + 4$$

$$1/3(x+4) = \frac{1}{3}(x+4)$$

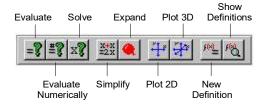
Tip Although in most cases different shapes of brackets are interchangeable, as a general rule standard parentheses $(3 + \pi)$ are better for grouping mathematical expressions than other types of brackets. This is because in a few very special cases, other brackets can be interpreted in a way you don't intend. For similar reasons, the **expanding** brackets you enter from the **Insert** menu or the **Math Templates** toolbar or with various keyboard shortcuts are better for grouping mathematical expressions than the single brackets on the keyboard.

The Compute Menu and the Compute Toolbar

Click **Compute** at the top of the screen and a drop-down menu will appear with a number of computing choices, beginning with **Evaluate**, **Evaluate Numerically**, **Simplify**, **Combine**, **Factor**, and **Expand**.

Important Throughout this documentation, whenever computing choices are specified, the preceding **Compute** is implied. For example, when you see **Evaluate**, perform **Compute** + **Evaluate**.

The Compute Toolbar contains some of the most often used choices from the compute menu.



> To perform a mathematics computation

- 1. Place the insertion point inside or to the right of the expression on which you want to perform an operation.
- 2. Click the button or menu item for the operation you want to perform.

Keyboard Shortcuts for Compute Menu Items

Commands on the **Compute** menu can be executed from the keyboard following standard procedures.

> To execute a command on the Compute menu from the keyboard

- · Press alt and, while holding down this key,
 - Press **c** (for **Compute**), followed by the command letter underlined on the drop-down menu that appears.
 - If the command is followed by an arrow on the right of the menu, press **enter** followed by another underlined command letter.

Some commands have a shorter keyboard shortcut. (ctrl + key is an abbreviation for "Press ctrl and, while holding down this key, press key.")

Shortcut	Command
ctrl + e	Compute + Evaluate
ctrl + shift + e	Compute + Evaluate (in-place replacement)
ctrl +=	Compute + Definitions + New Definition

There are many other keyboard shortcuts available. For a list of keyboard shortcuts for both mathematics and text, from the **Help** menu, choose **Search** + **keyboard shortcuts** + **keyboard shortcuts**.

Selecting Mathematical Expressions

There are more ways than one to select a mathematical expression, as explained in the following sections. When you perform a mathematical operation, a mathematical expression is automatically selected for the operation, depending on the position of the insertion point and the operation involved. These will be called **automatic selections**. You can also force other selections by selecting mathematics with the mouse. The latter will be called **user selections**.

Understanding Automatic Selections

When you place the insertion point in a mathematical expression and choose an operation from the **Compute** menu, the automatic selection depends primarily on the operation you choose. It also depends on the location of the mathematics, such as in-line, in a matrix, or in a display. The following two

possibilities occur for mathematical objects that are typed in-line:

• Selection of an expression, that part of the mathematics containing the insertion point that is enclosed between a combination of text and the class of symbols—such as =, <, or ≤—known as **binary**

relations. (Click on the symbol panel to see the full panel of binary relations.)

· Selection of the entire mathematical object, such as an equation or inequality.

The following examples illustrate situations where these two types of selections occur.

Operations that Select an Expression

The majority of operations select an expression enclosed between text and binary operations.

- > To select an expression enclosed between text and binary operations
 - Place the insertion point anywhere inside the expression or immediately to the right of the expression, and choose a command that operates on expressions.

For example, place the insertion point anywhere in the **left** side of the equals sign in the equation 2x + 3x = 1 + 4 except to the left of the 2, and choose **Evaluate**.

▶ Evaluate

$$2x + 3x = 5x = 1 + 4$$

The expression = 5x is inserted immediately after the expression 2x + 3x. This happens because only the expression on the left side of the equation was selected for evaluation. The left side of the equation is bounded on the left by text and on the right by the binary operation =.

Since the result of the evaluation was equal to the original expression, the result was placed next to the expression, preceded by an equals sign. After the operation is performed, the insertion point appears at the right end of the result so that you can select another operation to apply to the result without moving the insertion point.

Other commands, including **Evaluate Numerically**, **Simplify**, **Combine**, **Factor**, and **Expand**, make similar selections under similar conditions.

Operations that Select an Equation or Inequality

- > To select an equation
 - Place the insertion point anywhere inside the equation or immediately to the right of the equation, and choose a command that operates on equations.

For example, place the insertion point anywhere within the equation 2x + 3x = 1 and click



or, from

the Solve submenu, choose Exact.

▶ Solve + Exact

$$2x + 3x = 1$$
, Solution is: $\frac{1}{5}$
 $3x + 5 \le 5x - 3$, Solution is: $4 \le x$

In these cases, the entire mathematical object—that is, the equation—was selected. The solution is not equal to the selection, so it is not presented as a part of the original equation.

The other choices on the **Solve** submenu and the operation **Check Equality** also select an equation. If the mathematics is not appropriate for the operation, no action is taken. For example, applying one of the **Solve** commands to x = y = z causes a syntax error, because of the pair of equals signs. You receive the message "No solution found." For other inappropriate mathematics, you may see an error message, hear a beep, or see no action, depending on the **Error Notification** setting. You can change this setting in the Engine Setup dialog on the **Tools** menu.

Selections Inside Displays and Matrices

Operations may behave somewhat differently when mathematics is entered in a display or in a matrix. If you place the insertion point inside a display or matrix, the automatic selection is the entire array of entries, for any operation. Some operations apply to a matrix, and others to the entries of a matrix or contents of a display. If the operation is not appropriate for either a matrix or its entries or for all the contents of a display, you may receive a report of a syntax error.

Selections Inside a Display

Inside a display, the automatic selection is **all** the mathematics, and the result is generally returned outside the display.

- > To select mathematics in a display
 - Place the insertion point anywhere inside the display, and choose a command that operates on expressions or equations.

When you click the **Evaluate** button on the **Compute** toolbar or apply **Evaluate** with the insertion point in the left side of the displayed equation

$$2x + 3x = 3 + 5$$

you get the result : 5x = 8 in line outside the display. Because the automatic selection includes all of the mathematics, this action evaluates both sides of the equation.

A multiple line display is useful for solving systems of equations, or equations with initial value conditions.

$$5x + 2y = 3$$

$$6x - y = 5$$

, Solution is:
$$[x = \frac{13}{17}, y = -\frac{7}{17}]$$

Selections Inside a Matrix

You can use a **matrix** to arrange mathematical expressions in a rectangular array.

> To create a matrix





or

Choose Matrix from the Insert menu.

- 2. Set the number of rows and columns.
- 3. Choose OK.
- 4. If you see nothing on your screen, choose View and turn on Helper Lines or Input Boxes.
- 5. Type a number or any mathematical expression in each of the input boxes of the matrix.

> To select mathematics in a matrix

Combine submenu behave similarly.

• Place the insertion point anywhere inside the matrix or immediately to the right of the matrix, and choose a command that operates on expressions.

When you click or apply **Evaluate** to a matrix of expressions, all the expressions will be evaluated and the result will be returned as a matrix. **Evaluate Numerically**, **Simplify**, **Factor**, and choices from the

► Evaluate (or Simplify)

$$\left(\begin{array}{cc} x+x & 5+3 \\ 5/2 & 6^2 \end{array}\right) = \left(\begin{array}{cc} 2x & 8 \\ \frac{5}{2} & 36 \end{array}\right)$$

▶ Evaluate Numerically

$$\begin{pmatrix} x+x & 5+3 \\ 5/2 & 6^2 \end{pmatrix} = \begin{pmatrix} 2.0x & 8.0 \\ 2.5 & 36.0 \end{pmatrix}$$

▶ Factor

$$\begin{pmatrix} x+x & 5+3 \\ 5/2 & 6^2 \end{pmatrix} = \begin{pmatrix} 2x & 2^3 \\ \frac{5}{2} & 2^2 3^2 \end{pmatrix}$$

Selections Inside Tables

If you have mathematics in a table, placing the insertion point in the mathematics will automatically select all of the mathematics in the cell that contains the insertion point. For example, **Evaluate** will select an equation if one is present, rather than just an expression. The result of the operation will appear in the cell. The table itself is not a mathematical object, and the behavior is somewhat different than for mathematics in a matrix or display.

For example, in the table $\frac{x+x+5+3}{5/2-6^2}$, place the insertion point in the cell containing x+x and choose

Evaluate.

▶ Evaluate

$$\begin{array}{|c|c|c|c|} \hline x + x = 2x & 5 + 3 \\ \hline 5/2 & 6^2 \\ \hline \end{array}$$

Understanding User Selections

You can restrict the computation to a selection you have made and so override the automatic choice.

> To make a user selection

Hold down the left mouse button while moving the mouse over the material you want to select, then
release the left mouse button.

- Place the insertion point immediately to the right of the material you want to select and, while pressing ctrl, use the left arrow to make a selection.
- Place the insertion point immediately to the left of the material you want to select and, while pressing ctrl, use the right arrow to make a selection.

Your selection is the information that appears on the screen in reversed colors. This procedure will often be referred to as select with the mouse.

There are two options for applying operations to a user selection—operating on a selection displays the result of the operation but leaves the selection intact, and replacing a selection replaces the selection with the result of the operation. Following are two examples illustrating the behavior of the system when operating on a selection. The option of replacing a selection is referred to as computing in place, and examples are shown in the following section.

> To operate on a user selection

• Use the mouse or press **shift** + **arrow** to select 2+3 in the expression 2+3-x. From the **Compute** menu, choose **Evaluate**. The answer appears to the right of the entire expression, following a colon.

$$2 + 3 - x : 5$$

• Use the mouse or press **shift** + **arrow** to select $(x + y)^3$ within the expression $(x+y)^3(7x-13y)^3+\sin^2 x$. From the **Compute** menu, choose **Expand**. The answer appears to the right of the whole expression, following a colon.

$$(x+y)^3(7x-13y)^3 + \sin^2 x : x^3 + 3x^2y + 3xy^2 + y^3$$

In general, the result of applying an operation to a user selection is not equal to the entire original expression, so the result is placed at the end of the mathematics, separated by something in text (in this case, a colon). You can use the word-processing capabilities of your system to put the result where you want it in your document.

Replacing a user selection, an in-place computation, is described in the following section.

Computing in Place

You can replace part of an expression with the result of a computation on that part.

> To replace a user selection

- Use the mouse or press **shift** + **arrow** to select an expression.
- Press and hold **ctrl** while applying a command to the expression.

To replace the selection by its evaluation, press **ctrl** + **shift** + **e**.

The system replaces the selected expression with the output of the command.

• To replace an expression by its value, select the entire expression, hold down **ctrl**, and click or choose **Evaluate**; or press **shift** + **e**.



► ctrl + Evaluate or ctrl + shift + e

394876 + 205583 is replaced by its value: 600459

2/3 is replaced by $\frac{2}{3}$

$$146 + 529 - 19 + 6$$
 is replaced by 662

• To replace $(x-2y)^2$ in the expression $(x-2y)^2(7x-13y)(x^2+1)$ with its expansion, select $(x-2y)^2$,

or choose **Expand**. Your selection, $(x-2y)^2$, is replaced by hold down the **ctrl** key, and click its expansion. The expansion has no parentheses around it, but since it remains selected, you can

to add the needed parentheses.

ctrl + Expand

$$(x-2y)^2(7x-13y)(x^2+1)$$
 is replaced by $x^2-4xy+4y^2(7x-13y)(x^2+1)$. Click obtain $(x^2-4xy+4y^2)(7x-13y)(x^2+1)$

You can return the expression to a factored form by selecting $(x^2 - 4xy + 4y^2)$, holding down the **ctrl** key, and choosing Factor.

To factor in place the subexpression $-b + b^2$ inside the expression $a - b + b^2$, first insert a + before the -b to get $a + -b + b^2$, then select the expression $-b + b^2$, and while holding down the **ctrl** key, apply Factor.

▶ ctrl + Expand

$$a-b+b^2$$
, Change to $a+-b+b^2$, select $-b+b^2$ and apply the command to obtain $a+b(-1+b)$

With the help of the **ctrl** key, you can perform any computation in place; that is, you can replace an expression directly with the results of that computation. This feature, combined with copy and paste, allows you to "fill in the steps" in demonstrating a computation.

Example To replace
$$(x-2y)^2$$
 in the expression $(x-2y)^2(7x-13y)(x^2+1)$ with its expansion,

select
$$(x-2y)^2$$
, hold down the **ctrl** key, and click or choose **Expand**. Your selection, $(x-2y)^2$, is replaced by its expansion. The expansion has no parentheses around it, but since it remains selected, you can click to add the needed parentheses.

➤ Select subexpression, choose ctrl + Expand, add parentheses

$$(x-2y)^2(7x-13y)(x^2+1)$$
 is replaced by $(x^2-4xy+4y^2)(7x-13y)(x^2+1)$

You can return the expression to a factored form by selecting $(x^2 - 4xy + 4y^2)$, holding down the **ctrl** key, and choosing **Factor**.

Example To illustrate the associative law for addition, first make two copies of the sum.

$$(5+8)+7=(5+8)+7$$

Then in the second copy, select the sum 5+8 with the mouse and, while pressing **ctrl**, choose **Evaluate**. The result will be the equality

$$(5+8)+7=(13)+7$$

Then carry out similar steps with the other association to get

$$5 + (8 + 7) = 5 + (15)$$

Now apply Evaluate to each of the sums.

$$(13) + 7 = 20$$

$$5 + (15) = 20$$

Important This "computing in place"— that is, holding down the **ctrl** key as you choose an operation from the **Compute** menu—is a key feature. It provides a convenient way for you to manipulate expressions into the forms you desire.

Stopping a Computation

Most computations are done more or less instantaneously, but some may take several minutes to complete, and some may take a (much) longer time. So it is convenient to be able to interrupt the computing and regain control of your document.

> To stop a computation

• Click the stop sign on the **Stop** toolbar.

or

Press ctrl + break.

Try it out by applying **Factor** to a very, very large number. If the number is large enough (how large depends on your computer), this can take longer than you want to wait, but you can stop the computation with the stop sign.

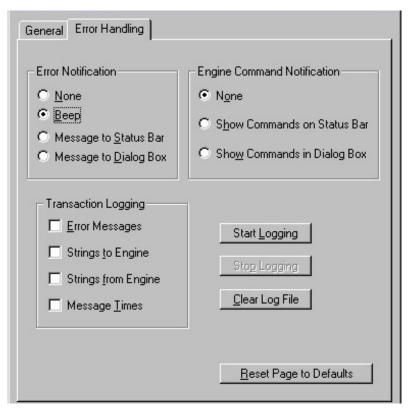
Computational Engine

The computational engine provided with *Scientific WorkPlace* and *Scientific Notebook Version 5.5* is MuPAD 3.1. To see if this engine is active in your system, or to deactivate the engine, choose **Tools** + **Computation Setup** + **Engine Selection**.

Click Tables of Equivalents for a list of menu commands, a partial list of functions and constants available, and a description of these commands and functions in terms of the native commands of MuPAD, or go to **Help** + **Search** + **function** and choose **a brief description of commands and functions**.

Error Handling

From the **Tools** menu, choose **Engine Setup** and click the **Error Handling** tab. On this page you choose the default settings for **Error Notification**, **Engine Command Notification**, and **Transaction Logging**.



Under **Error Notification** you can choose **None**, choose to be notified with a **Beep**, or choose **Message to Status Bar** or **Message to Dialog Box**. These are responses to various syntax errors in the mathematics being sent to the computing engine. If you choose to have messages shown, you will see some information concerning these errors.

Under Engine Command Notification, you can choose None, or choose Show Commands on Status Bar or Show Commands in Dialog Box. If you choose to have commands displayed, you see the form of commands being sent to the computing engine.

The factory defaults for the choices are

- · Error Notification: Beep
- Engine Command Notification: None.

To return to these defaults, choose Reset Page to Defaults and choose OK.

Under **Transaction Logging**, you can choose to have some, all, or no records of mathematical messages sent to the computing engine recorded in an ASCII log file. **Transaction Logging** always resets to the default of not logging. To accumulate entries in the log file, you must take the following action *each time you open a session*:

- > To start logging transactions
- 1. From the **Tools** menu, choose **Engine Setup**, and click the **Error Handling** tab.
- 2. Check any or all of the choices for Transaction Logging:
 - a. Error Messages
 - b. Strings to Engine
 - c. Strings from Engine.
- 3. If you want the times recorded in the log file, check Message Times.
- 4. Choose Start Logging.
- 5. Choose **OK**.

With **Start Logging** activated, your system will create a file named **engine.log** on the root directory of your **Scientific WorkPlace** or **Scientific Notebook** system, and record all of your transactions in this file for the rest of the session or until you press **Stop Logging**. The transactions you have logged will be saved in this file until you choose **Clear Log File**. You can read the file **engine.log** with any ASCII editor.

- Related topics
- **Ⅲ Index**