Computer Algebra Systems: An Introduction

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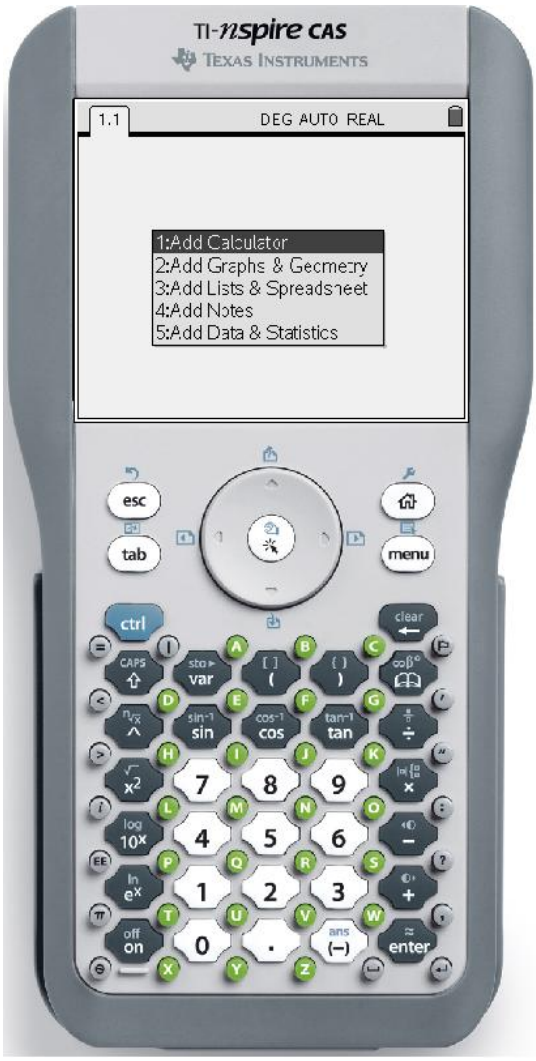
Topic: An Introduction to Computer Algebra Systems (CAS)

Updated to OS1.6

Notes to the Teacher:

This activity is designed to use the CAS on the TI-Nspire CAS calculator to enhance understanding and instruction. All screen shots are from the TI-Nspire CAS. Note: the blue TI-Nspire does not have a CAS installed. You need the grey TI-Nspire CAS.



Computer Algebra Systems: An Introduction

What is a CAS?

A computer algebra system (CAS) is a program on a calculator or a computer that can perform algebraic manipulations. The CAS may also be known as a symbolic manipulator.

Starting a CAS

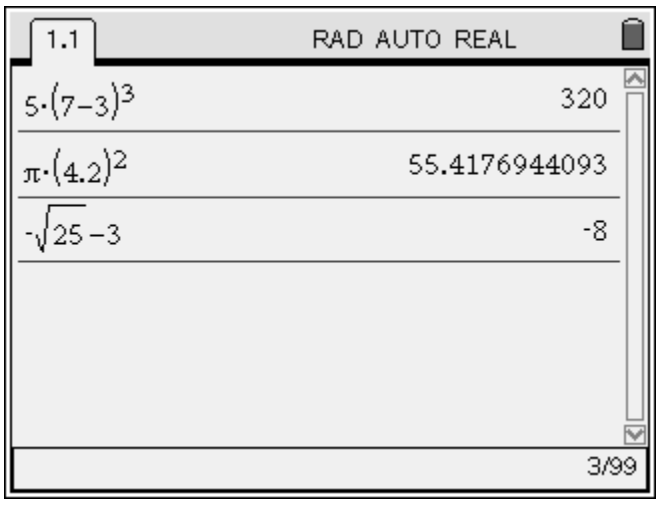
1. a) Turn on the CAS. Press the  key and select **8:System Info**.
b) Select **2:System Settings**.
c) Tab down to **Auto or Approx**, and ensure that **Auto** is selected.
d) Tab down to **OK** and press **enter**.
e) Press the  key and select **6:New Document**.

You can select the kind of page you want to open. You have several choices.

- **1. Add Calculator** lets you perform calculations.
- **2. Add Graphs & Geometry** lets you plot functions and other graphs, or draw sketches similar to dynamic geometry software.
- **3. Add Lists & Spreadsheet** allows you to work with lists in a spreadsheet environment.
- **4. Add Notes** lets you type notes.
- **5. Add Data & Statistics** lets you work with your lists.

f) Select **1: Add Calculator**.

This procedure will clear any values or functions defined by a previous use or user of the calculator. Otherwise, you may encounter unexpected results.



3. Try some calculations to familiarize yourself with the keyboard and display.

a) $5(7 - 3)^3$ Answer: 320

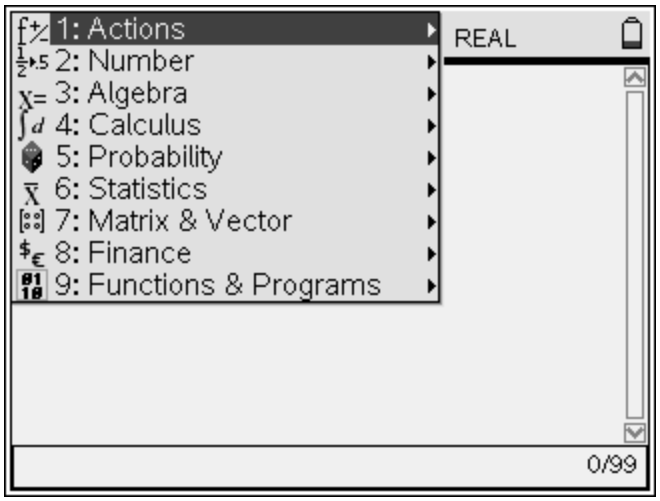
b) $\pi(4.2)^2$ Answer: 55.42

c) $-\sqrt{25} - 3$ Answer: –8

Tech Tip: If you press a key in error, you can usually cancel its effect by pressing the **ESC** (Escape) key.

Keep in mind the difference between the negative key **(-)**, which makes a number negative, and the subtract key, which is used between two operands.

4. Note that the TI-Nspire CAS does not have Function keys like the TI-89 series. Instead, it has a menu structure along the lines of computer operating systems such as Microsoft Windows®.



a) Press **menu** to see the first level menu.

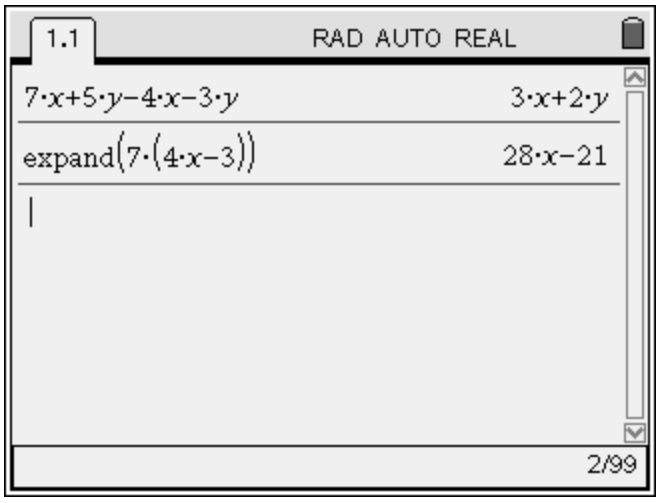
b) Investigate some of the second level menus to see what kinds of commands and operations are available. Use the **esc** key to move back up through the menus.

c) Press **3:Algebra** to see the algebra functions that the TI-Nspire CAS can perform.

Simplifying or expanding expressions

1. Consider an algebraic expression such as $7x + 5y – 4x – 3y$.

Type the expression, and press **enter**.



Note that the CAS has collected the like terms for you.

2. Try some other algebraic expressions. Include terms with exponents.

3. The CAS can expand algebraic expressions such as $7(4x – 3)$ using the distributive property.

Press **menu**, select **3:Algebra** and then **3:Expand**.

Type the expression$7(4x – 3)$.

• Press **enter**.

Note that nested brackets are required. If you get an error message while using this operation, check that you have the same number of open and close brackets, and that they are placed properly.

4. Try some other expansions. Include a product of binomials, such as $(2x – 3)(3x + 1)$, or even the product of a binomial and a trinomial such as $(5z – 2)(3z^2 + z – 4)$.

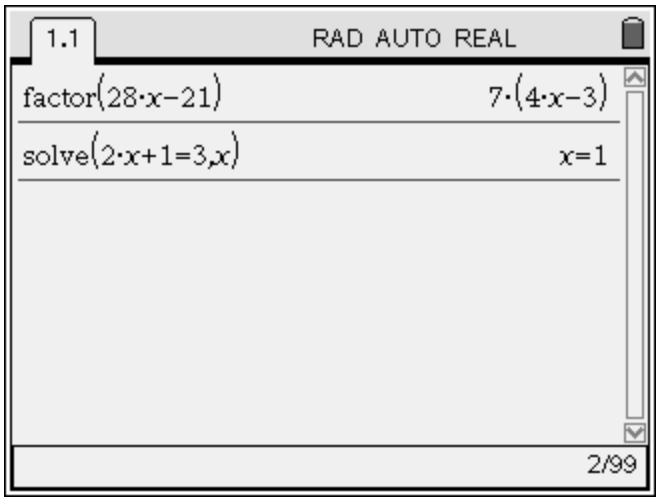
Factoring expressions

1. Press **menu**, select **3:Algebra** and then **2:Factor**.

Type $28x + 21$.

Press **enter**.

Compare the result to the expansion in part 3 of the previous section.



2. Try factoring some other expressions, including $6x^2 – 7x – 3$.

Solving equations

The CAS can solve equations.

1. Press **menu**, select **3:Algebra** and then **1:Solve**.

Type $2x + 1 = 3,x$.

Press **enter**.
The solution is displayed.

Note that you must specify the variable that you would like the CAS to solve for.

Try solving a few more equations of your choice.

The CAS can solve for a variable in a formula. Consider the motion equation $v = u + at$. Suppose that you want to solve this formula for time, t.

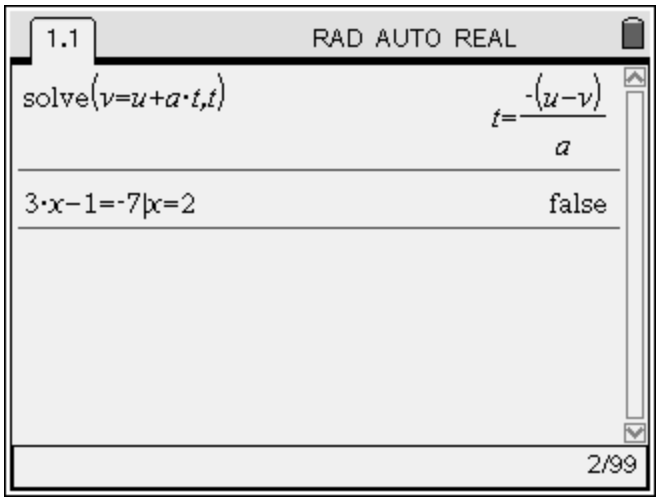
2. Press **menu**, select **3:Algebra** and then **1:Solve**.

Type $v = u + a \times t, t$.

Tech Tip: be sure to type the multiplication operation between the a and the t. Otherwise, the CAS will treat at as a single variable with the name at.

Press **enter**.

Tech Tip: the new form of the formula is sometimes displayed in an unusual manner.



Try solving other formulas, such as $V = \pi r^2 h$ for r.

Checking the solution to an equation

You can use the CAS to test a solution to an equation. As an example, test whether $x = 2$ is a solution for the equation $3x – 1 = –7$.

1. Type $3x – 1 = –7$. Then, press the **|** (such that) key, followed by $x = 2$.

Press **enter**.

Note that the CAS returns a value of **false**. Hence, $x = 2$ is not a solution for the equation. Try the check again with $x = –2$. Note that this time the CAS returns a value of **true**. Hence, $x = –2$ is a solution.

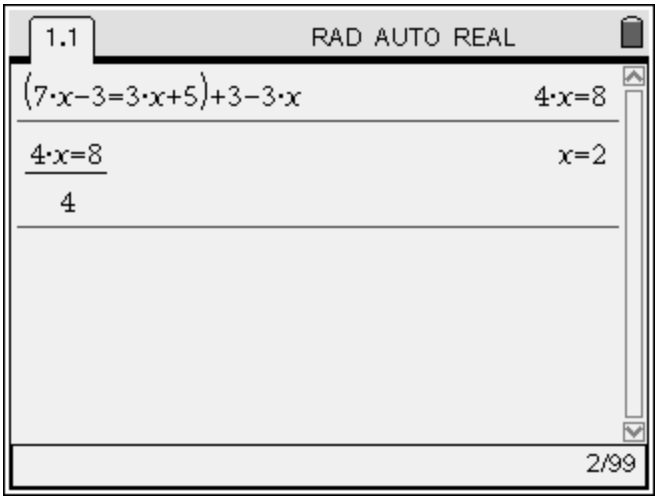
Try checking a few more solutions for other equations of your choice.

Operations on equations

You can use the CAS to apply the same operation to both sides of an equation. Consider the equation $7x - 3 = 3x + 5$. If you are solving this equation using pencil and paper, you begin by adding 3 to both sides and subtracting $3x$ from both sides. You can do this with the CAS.

1. Type the equation into the CAS, inside a set of brackets.

Outside the brackets, type + 3 – 3*x*. Press **enter**.



Tech Note: the syntax is somewhat different from that normally used in a pencil and paper approach.

The next step is to divide both sides by 4.

2. Open a set of brackets.

Type $4x = 8$.

Outside the brackets, type **÷** 4.

Press **enter**. Note that the expected answer is displayed.

Copying and Pasting

If you have entered a complicated expression at some point, and need to use it again, you can avoid retyping by copying and pasting.

Use the cursor keys to scroll up to the expression that you want. Press the **ctrl** key followed by c to copy the expression.

Scroll back down to the command line. Press **ctrl** and v to paste the expression.

The expression is pasted into the command line.

Try this with some expressions of your choice.

You may recognize **ctrl** c and **ctrl** v as Windows® shortcuts. Many windows shortcuts work on the TI-Nspire CAS, such as **ctrl** z to undo an operation.

Defining functions

1. You can assign a definition to a function using the CAS.

As an example, define

$f(x) = x + x^2 + x^3$.

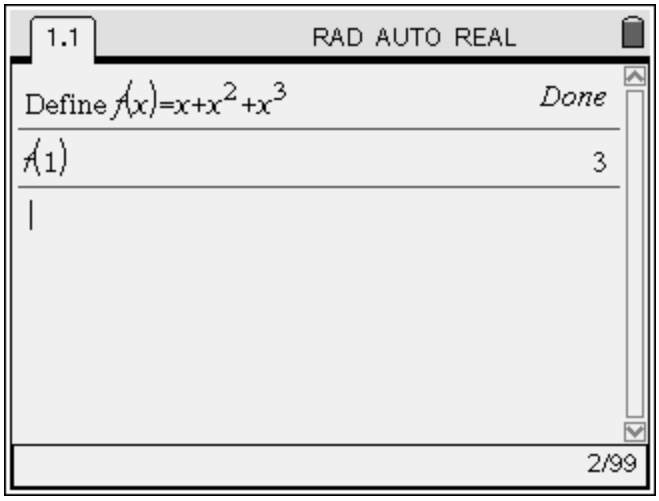
Press **menu**, select **1:Actions** and then **1:Define**.

Type $f(x) = x + x^2 + x^3$.

Press **enter**.

Type f(1), and press **enter**.

Evaluate the function for other values of x.



2. You can also define functions of more than one variable.

As an example, consider the formula for the volume of a cylinder $V = \pi r^2 h$.

Define a function $v(r, h)$ as $\pi r^2 h$.

Evaluate $v(1, 2)$.

Evaluate $v(r, h)$ for various other values of r and h.

If you would like the answer displayed as an approximate value, rather than a multiple of π, press **ctrl**, and then, **enter**, to access the approximation ≈.