

VISUAL LAMBDA MANUAL

DDMATH PROJECT

**Digital learning in mathematics
for blind students**

ERASMUS+ Program

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DDMATH



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VISUAL LAMBDA USER MANUAL

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1. Presentation

What is VisulaLambda? It is a Prototype of a new Lambda for doing maths for visually impaired, mobility impaired and dyscalculia students.

VisulaLambda is a new product derived directly from the Lambda programme, of which it exploits the positive features that have been pointed out by teachers and operators who have tested it extensively and experimented it effectively and by those who have used it in various situations, including at a distance with users with disabilities and special needs very different from those for which Lambda was designed.

It is well known that Lambda is appreciated for its linear writing to offer spoken mathematics, for its exclusive use of the keyboard to write mathematics, and for the many compensatory functions it has.

Visual Lambda is dedicated:

- those who have a severe motor disability but are experienced in using special keyboards such as those with enlarged keys, or membrane keyboards, or keyboards with reduced size, or with pointer and eye control,
- visually impaired children who need speech synthesis to support on-screen representation, who require ease of writing mathematical symbols on the keyboard and limited use of the mouse. In fact, in many cases it is problematic to use the mouse to access the sign palette to select the mathematical elements each time, and they have found it easier to use Lambda to write the signs on the keyboard. The only drawback is the need for a greater magnification of the characters and the display window, and to have customised enlargements, greater contrast and customised colours.
- For children with dyscalculia who enjoyed speech synthesis and the orderly handling of mathematical symbology in linear mode, and who found writing signs extremely easy and took advantage of the compensatory solutions offered by the Lambda programme.

This new version of VisulaLambda will be able to start a new research and development path in the future, to deepen the effectiveness of linear writing. In

fact, the Lambda linear writing no longer dedicated to blind people could be optimised with new symbologies and simplified screen representations by being able to use colours, bold, underlined or framed text. Ultimately, the presence of markers could be reduced for better readability and additional writing speed, potentially replacing the cumbersome way of writing mathematics on the computer in mathematical editors (such as Equation Editor), which require access to mathematical objects by mouse to insert them in a defined space, and complete them with numbers on the keyboard. To this end, it is reported that it has become common practice for mathematics teachers who have a blind student in their class and who adopt Lambda and use it skilfully, to prefer to produce the work (e.g. for a class assignment or exercise), directly and more quickly with Lambda rather than with MSWord's Equation editor, being able to do the work, in addition, once and for all the children in the class. Such a new linear encoding would also become functional for dictation with speech recognition systems.

VisualLambda as we have said is a new program derived from the Lambda program, but with a new interface, including the possibility of customising the insertion of mathematical elements from the keyboard (to be functional with special keyboards), the possibility of enlarging the screen and contrast for visually impaired users is integrated, a second window is set up in static mode for reading the mathematical text in two-dimensional graphical mode inserted in linear mode.

Mathematical formulae are written in textual form with a regular sequence of characters of the same size.

Graphics are always visible in a partition of the screen.

The system is fully compatible with the MathML version 2.0 mathematical marking language, defined by the international W3C consortium, which is now the most widely used conversion and transformation standard in the world. Through MathML the LAMBDA code will therefore be convertible, in input and output, with the most widespread mathematical writing formats.

It is also possible to obtain an instant graphic version of the mathematical text for printing or display on screen using MathML.

Visual lambda - [Tutorial - compound fractions.lambdax]

File Libri Modifica Strumenti Visualizza Inserisci Profili Aiuto

Tutorial - compound fractions X

Example of solving the sum of compound fractions

$$\begin{aligned} & \text{// } x^2 - 4 \text{ } \cancel{\text{//}} \text{ } x^2 + 4x + 4 \text{ } \backslash\backslash + \text{// } 4 \text{ } \cancel{\text{//}} \text{ } x \\ & \text{// } (x+2) (x-2) \cancel{\text{//}} (x+2)^2 \backslash\backslash - \\ & \text{// } (x-2) \cancel{\text{//}} (x+2) \backslash\backslash + \text{// } 4 \cancel{\text{//}} x + 2 \backslash\backslash \\ & \text{// } (x-2+4) \cancel{\text{//}} (x+2) \backslash\backslash = \\ & \text{// } (x+2) \cancel{\text{//}} (x+2) \backslash\backslash = 1 \end{aligned}$$

testo (apertura)

Riga: 1 Colonna: 1

2. Installation

The complete installation of Visual Lambda requires just a few simple steps.

2.1 Visual Lambda installation

First of all, the Visual Lambda program must be installed by running the file VisualLambdaSetup.exe.

The procedure is very simple and is carried out automatically by the installation programme.

You can customise the installation by choosing the language, working directory etc., or do a default installation. The program will be installed in: c/Programs (x86), in a Visual Lambda folder. On the desktop you will find the icon for starting the program.

2.2 In case of problems with the installation

You need to be a system administrator to be able to install the programme, whereas you do not need to be an administrator to run it. Generally you need to check this if you are installing on a networked PC. If you are installing on your personal PC, it is very likely that you are already an administrator and can proceed. If you are installing on a networked PC, check your access rights or ask your network administrator.

2.3 Configuration for Visual Lambda on-screen display

The visually impaired pupil needs special attention in the configuration of Visual Lambda as he is required to make a greater effort to discriminate symbols and long mathematical strings.

The programme provides a number of features that allow the student to work autonomously and with a remarkable speed of operation and research.

Initially, one must deal with enlarging characters and/or use a black screen against glare.

Start with FILE, scroll down the drop-down menu and search for PREFERENCES.

The window that opens will have some fields to consider:

INTERFACE

- **Font** size (choose the size from 10 to 96 by doing some tests to see which display is best for the pupil)
- **high contrast**: if you need a black screen to avoid fatigue or glare, choose yes;

The cursor does not change colour automatically and is therefore invisible. In order to make it visible, we must use the high-contrast Windows system display. In the left-hand window, select High Contrast, in the section Use High Contrast, select Enable High Contrast and click on Enable; a reboot will probably be required to activate the settings.

GRAPHICS

- **Docking position** (choose low to have the graphic bar horizontal, this is the best choice as it leaves the top of the screen free and therefore more space to write).
- **docked** window size (choose a window size that allows you to see the graphics at the chosen magnification without sacrificing too much operating space)→ small, medium or large.
- **zoom** (choose the magnification of the graphic part)→ the drop-down menu shows the percentage of the magnification.
- **display single expression** (if I choose **yes**, I will only see the expression I am working on in the graphic, if I choose **no** I will see the whole document and the cursor will be positioned on the first line of the document and I will move with the sidebar).

TEXT TO SPEECH

enabled (if yes, speech synthesis is activated)→

active voice (you can choose the type of voice: Elsa for Italian voice, Zira for English voice)

3. The general environment of the Visual Lambda editor .

The management environment of the Visual Lambda mathematical editor is similar to that of a common writing programme.

You will find the usual commands for opening a file and saving it, correcting and deleting, selecting, copying, pasting, etc... All the most common operations are handled as in any word processor.

A special feature of the Visual Lambda editor is the ability to move the cursor anywhere on the screen, even where there is no text.

For example, with two lines of the type:

a+1

ab+a+2

if the cursor is on line 2 of the second line, with a normal text editor pressing the "up arrow" key would move the cursor to the end of the previous line, i.e. after the number 1 in our case.

With the Visual Lambda editor, on the other hand, it will be positioned exactly above where it was previously, even if it is outside the existing line.

a+1 _

ab+a+2

This way of moving the cursor allows access to all points on the screen by moving freely along the vertical and horizontal axes; in a mathematical environment, it will prove useful in many situations.

4. Mathematical symbols

To write a mathematical text requires a much larger number of symbols than a normal literary text.

Each of these must be associated:

- a graphic symbol for on-screen representation and ink printing;
- a textual expression to be pronounced through speech synthesis.

The Visual Lambda editor offers several support tools for entering characters not present on the keyboard and facilitates their recognition: their full name appears on the status line, bottom left, and can be read using the windows magnifying glass (windows key + +; windows key + esc to exit).

Very important in a linear code are the marking symbols (tags) that act in relation to each other to define a block, i.e. a portion of text delimited by an opening and a closing.

A block may be enclosed by the usual brackets (round, square and curly) but also by symbols delimiting a fraction (numerator and denominator), or a root, exponent or other.

The Visual Lambda system recognises these relationships and offers various tools to efficiently manage both the markers linked to each other and the portion of text they define: it will be possible to automatically switch from one to the other, delete both with a single operation (which is very useful in the simplification phase), select the entire content of a block (from the "open" symbol to the corresponding "closed" one) to copy, move, delete, temporarily hide the text contained between the brackets to highlight the general structure of the formula, and more.

The text that is entered into Visual Lambda must respect some simple formal rules. For example, for each symbol that opens a block (e.g. a parenthesis) there must be a corresponding closing symbol that the program inserts itself.

The programme has various tools designed to facilitate the input of formally correct mathematical text.

4.1 Screen representation in the writing partition

Each mathematical symbol is represented on the screen by a graphic character. Many of them are easily recognisable because they are similar to or can be traced back to their usual graphic notation. But some of them, such as the markers indicating a fraction, are specific to linear systems and have no equivalent in graphic mathematical texts; they will therefore be represented with symbols that we are not used to using in other contexts.

To improve the readability of the text presented on the video, graphic symbols are also associated with colours:

- are red the open/closed structure markers, and any intermediate, that delimit a block;
- operators and single markers (without closure) are green;
- isolated numbers, letters and symbols are black.

4.2 Textual elements

Some mathematical elements do not have associated symbols but are usually indicated in textual form. For example, trigonometric functions (sin, cos, sec...), logarithms (log, ln), the limit (lim).

In Visual Lambda they are also written and represented in textual mode and therefore a normal alphabetical text. However, they too are managed and recognised by the system as a single element and can only be deleted, selected and moved globally, not by acting on the individual characters that make it up.

5. Distinguishing between text and mathematics

The need to write a mixed document, text and formulae, is very frequent in all schools: it may be the text of a problem, the heading of an assignment, the proof of a theorem or other.

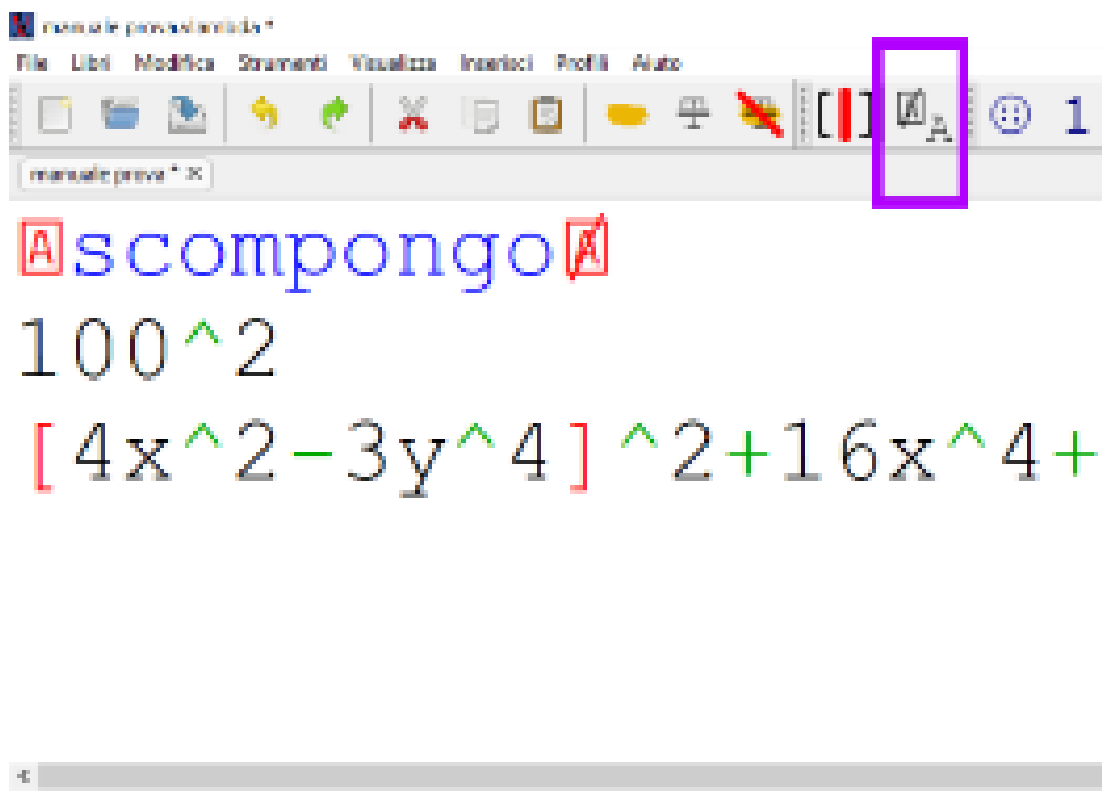
The mathematical environment of Visual Lambda follows rather strict structure rules and is not suitable for handling simple text. In mathematics, for example,

speech synthesis always reads one letter at a time, as if they were names of variables, whereas in a text they obviously have to be linked together and read as words.

The Visual Lambda editor has two separate environments, one for text and one for mathematics, and it is possible to switch freely between them, even on the same line.

The mathematical rules and functions described in this manual only apply in a mathematical environment. In the textual environment, the commands available are the basic commands of a common text editor.

Any new Visual Lambda document opens by default in the mathematical environment. To enter the textual environment, type CTRL + J or use the "change context" button on the toolbar.



When a text section is opened, the closing marker is also automatically inserted, with the cursor positioned within the two markers A and crossed-out A (text and end of text).

The two symbols are read out by speech synthesis.

It is therefore easy to tell where you are by the opening marker and the crossed-out closing marker, and by the colour of the text entered.

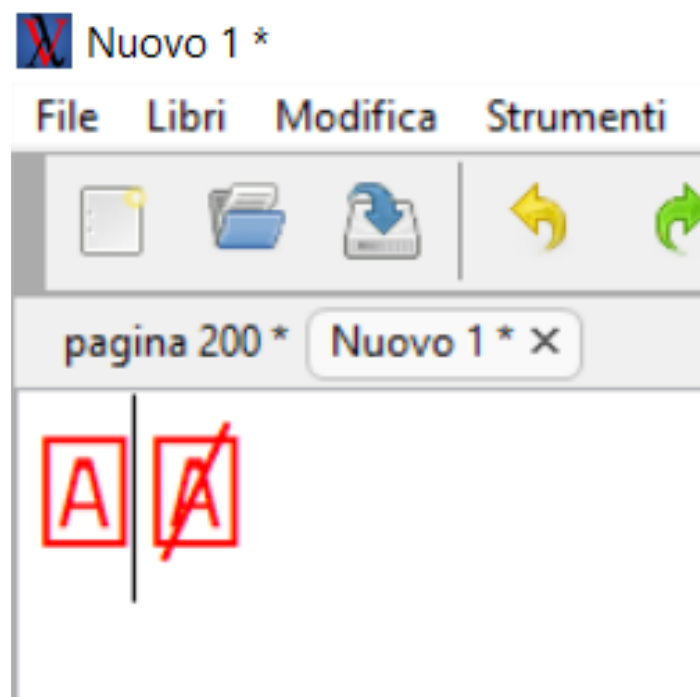
On the screen, the textual part appears all in blue, while the mathematical part uses three different colours (black, green, red; while on the top contrast white, green, red) depending on the type of elements.

If you are in a mathematical environment, the name of the element on which the cursor is positioned appears in the status bar at the bottom left, whereas if you are in a textual environment, the corresponding alphabetical letter always appears.

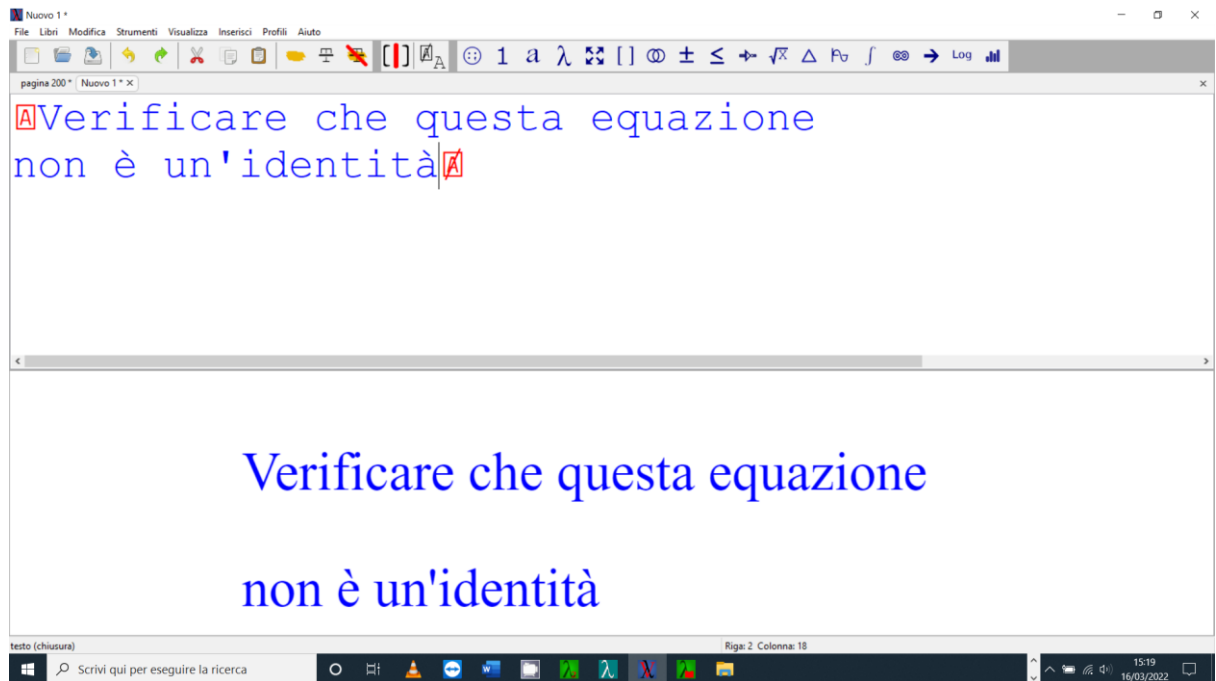
To exit the text section and switch to the maths section, move to the right with the cursor arrow when you are at the end of the text, thus stepping over the closing marker.

Example

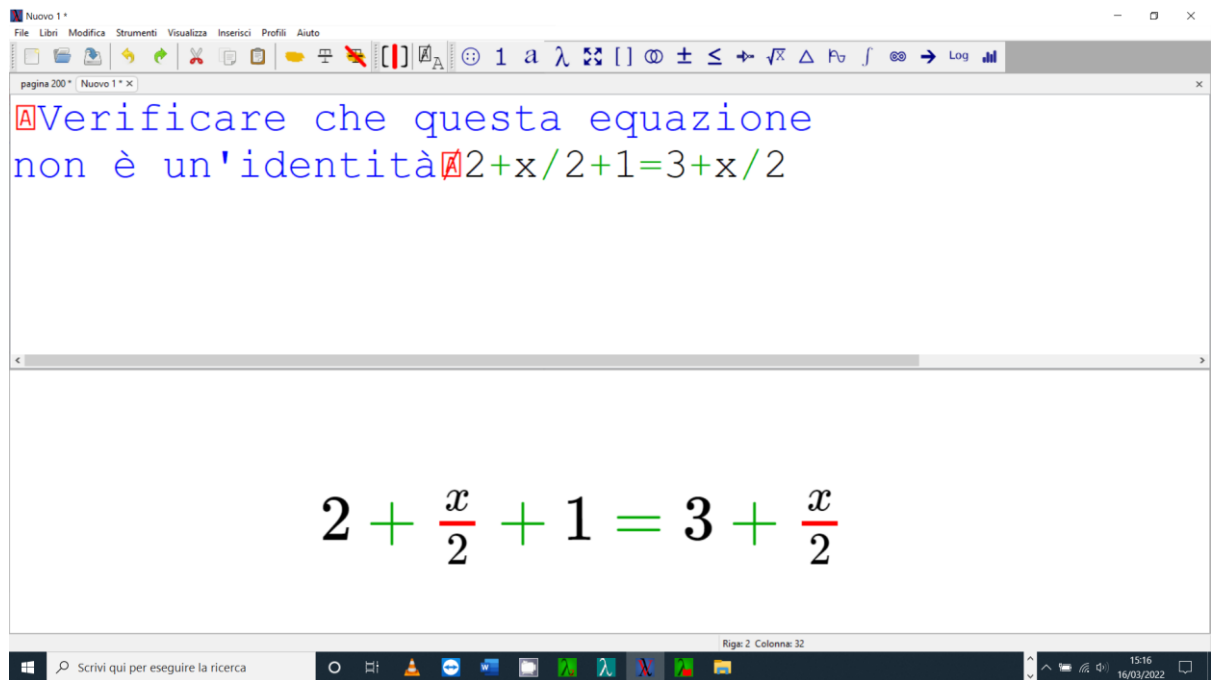
Typing Crlt + J inserts both text markers, open and closed, and the cursor is positioned between the two.



The non-mathematical text is written freely and the speech synthesis reads the words in the usual way.



At the end of the text you move the cursor out of the text area with the right arrow key. We are in the mathematical area: all the commands for mathematical editing offered by Visual Lambda are active and the synthesis pronounces the name of the various mathematical elements.



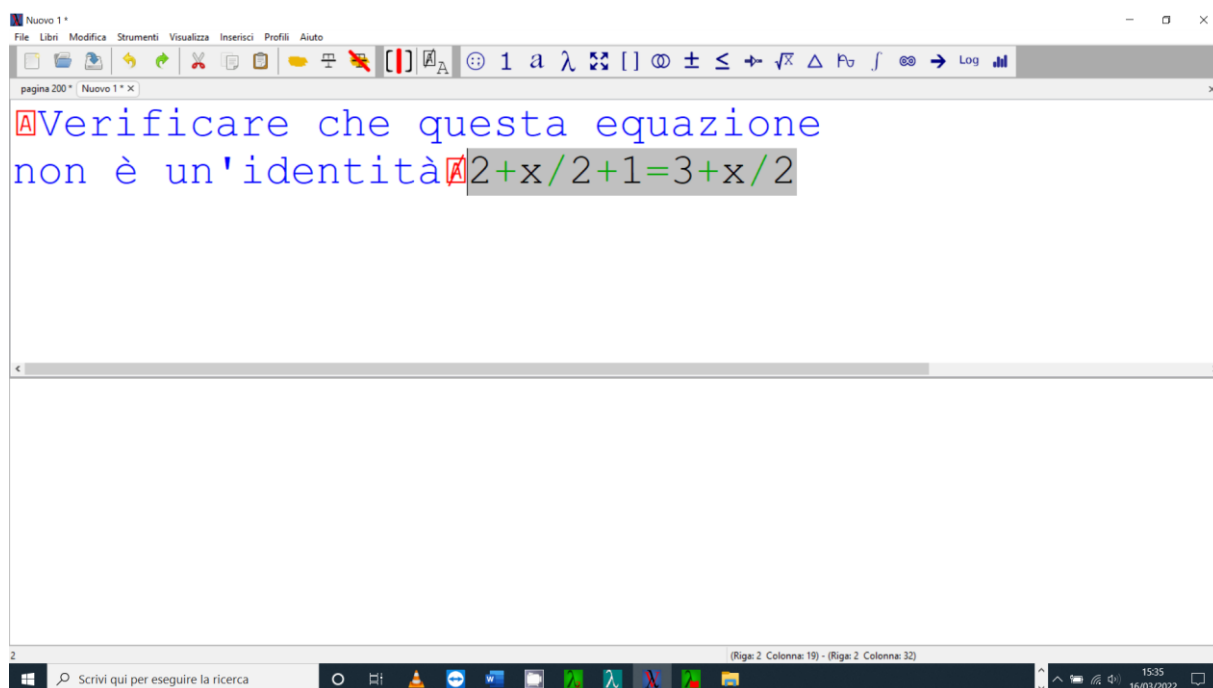
The distinction between the two environments, text and mathematics, is strict. Their functioning is completely different and any ambiguity must be avoided. For this reason, both markers must always be present, and must therefore be inserted or deleted at the same time.

It is therefore not possible to delete markers to turn a text into mathematics or vice versa: markers can only be deleted together with the text contained within them.

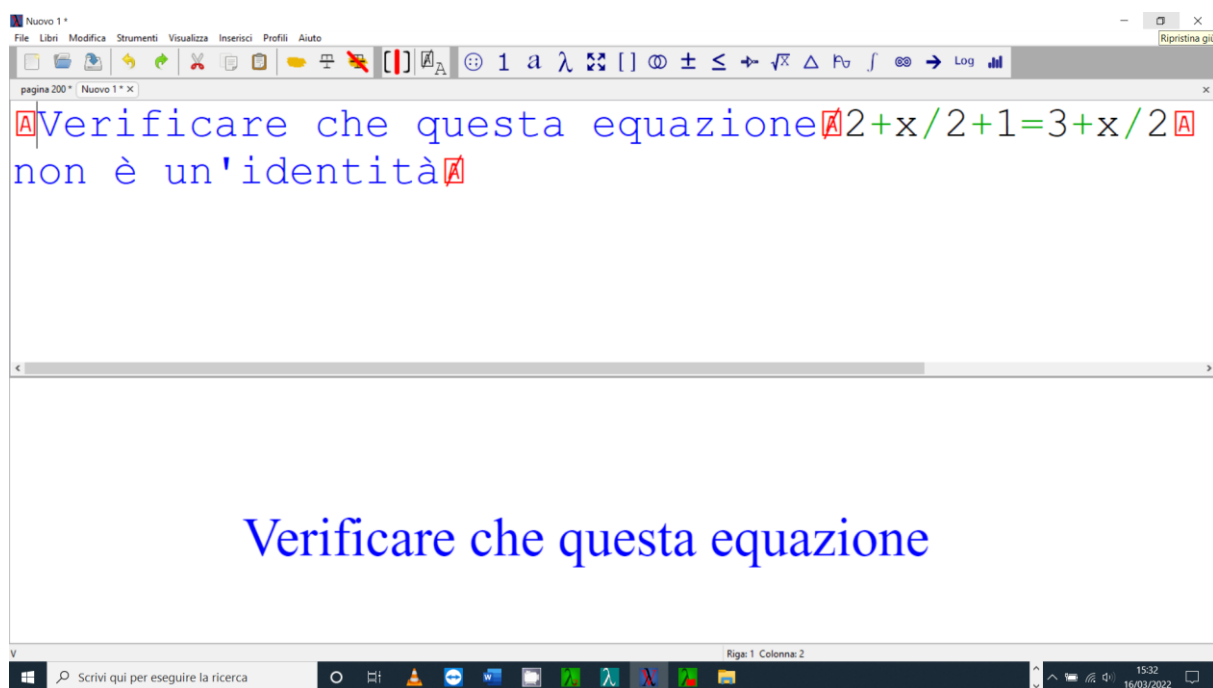
Any text selection copied and pasted into a mathematical block will be automatically delimited by the two text markers. The same thing will happen if you copy a mathematical selection into a text selection.

Example

We transform the example above by inserting the formula within the text. Select the mathematical part, cut it with CTRL + X.



When inserted with CTRL V, the two resulting blocks of text are automatically marked correctly with new closing and opening symbols. Note that if the two blocks are present in the line, the graphic part only shows the text or maths when the cursor is positioned within the desired range.



6. Voice synthesis

Visual Lambda gives the possibility to use a voice synthesis that will read both the mathematical part, with all the symbols used, and the textual part.

It is not possible to read a file automatically but it is necessary to move line by line.

As mentioned before it reads the opening and closing text symbols.

It does not read the drop-down menus of the toolbar. To remedy this, e.g. F5→ type in the name of the symbol (the drop-down menu that appears is not enlarged)→ use the Windows magnifying glass (windows+ + key to zoom in, windows+ - key to zoom out, windows+ esc key to exit the magnifying glass) with a suitable magnification.

When using the calculator (F9) it reads the numbers entered but not the result.

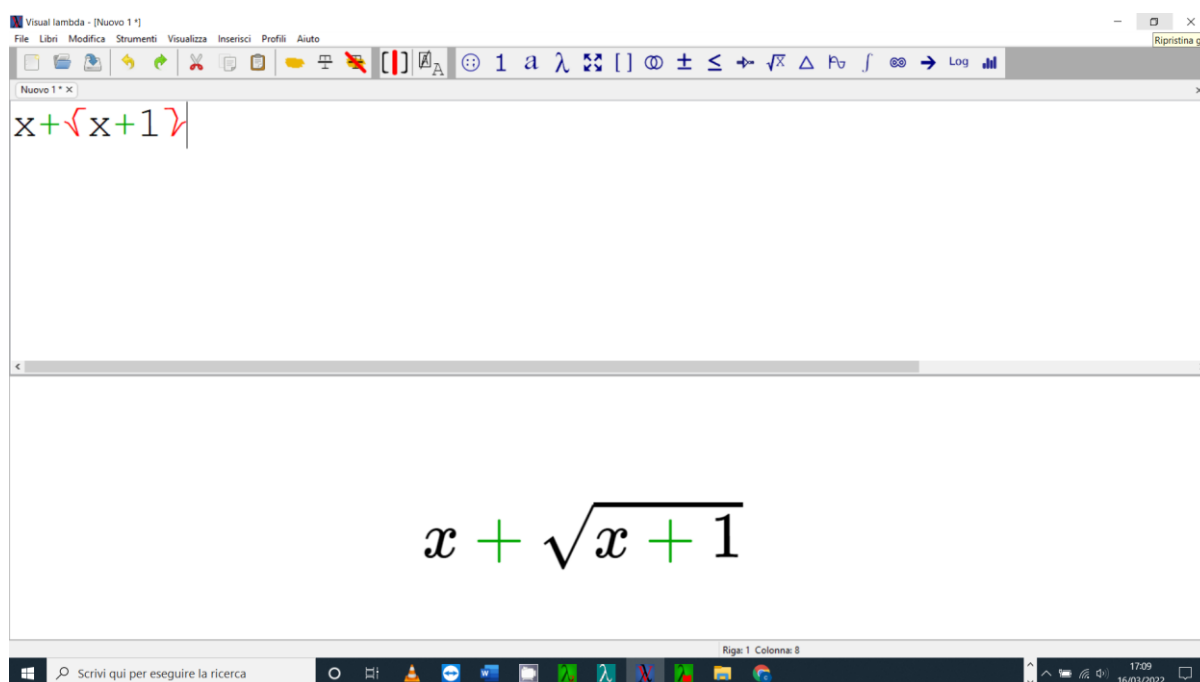
7. Linear mathematical writing

In a linear code, the role of markers (or tags), i.e. codes that delimit mathematical structures, is crucial.

For example, in this expression: $[x + \text{square root of } (x+1)]$, the graphic symbol of the root not only indicates the operation to be performed but also delimits, by its shape and extension, the part of the formula on which it is to be performed, i.e. $(x+1)$ in this case.

This double information can only be provided in linear notation by using a specific pair of symbols to indicate the start and end of the operand.

In linear notation Visual Lambda will therefore be:

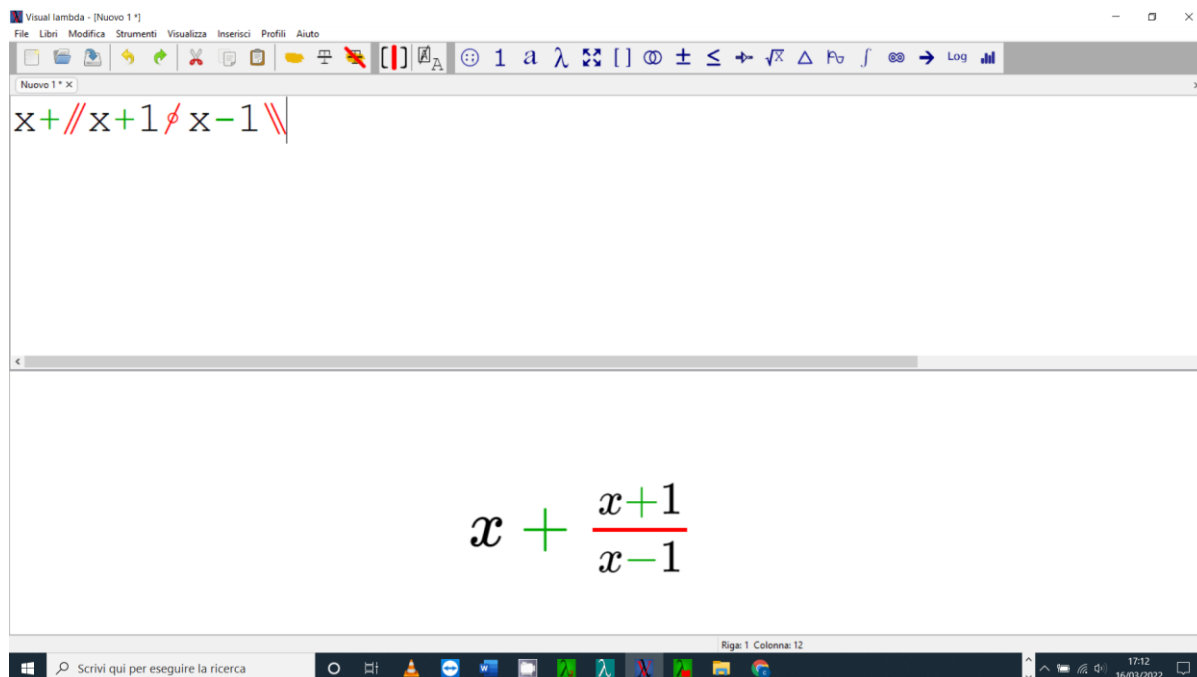


For some mathematical elements that enclose two objects, in addition to a start and end marker, an intermediate separator is also required. The most common case is

that of the fraction: $[x + \text{fraction with } (x+1) \text{ over } (x-1)]$.

Visual Lambda linear notation has a start marker, an intermediate separator (corresponding to the fraction sign) and a final marker.

Here is the Visual Lambda linear representation of the example:



The Visual Lambda system makes great use of these pairs of open-closed markers, with the possible intermediate, which can be inserted several times one inside the other and thus represent all possible mathematical structures in a linear manner.

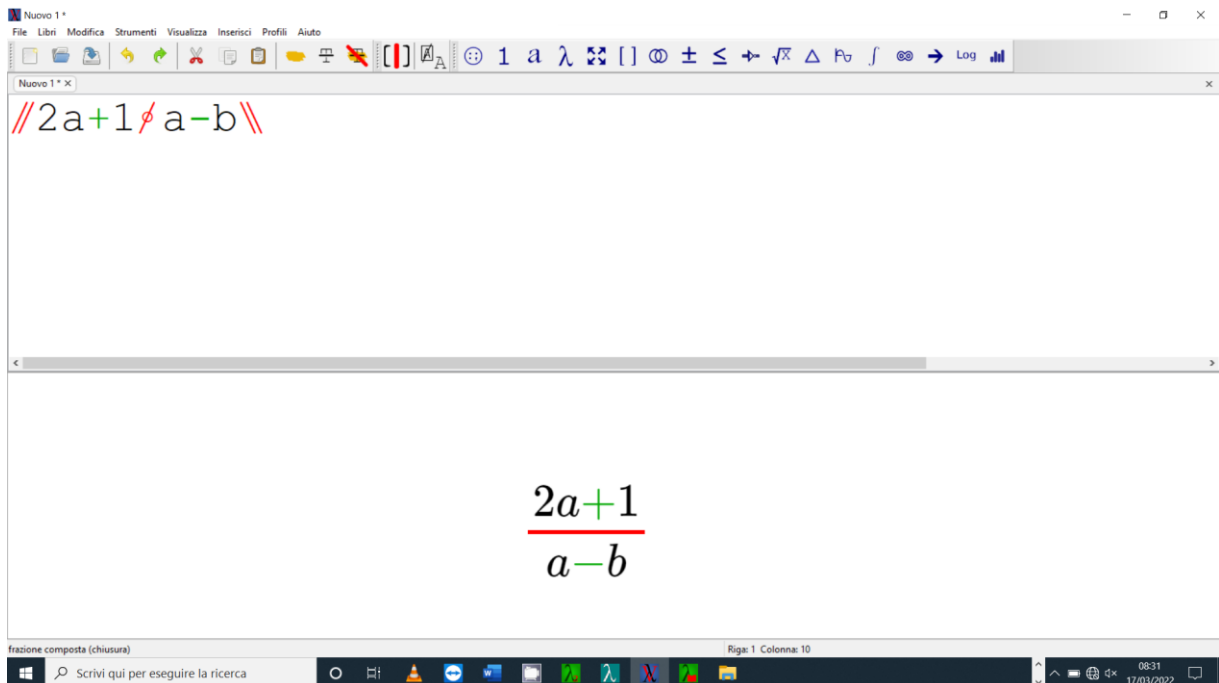
8. Main structures in LAMBDA

The LAMBDA system provides several dozen block structures, with open and closed markers as well as any intermediate markers. The programme independently closes everything that needs to be closed in mathematics (e.g. parentheses, complex fractions, complex roots, limits...).

Some of the most frequently used structures are described here.

Note that the shortcut keys for the intermediate are always the same: CTRL+I

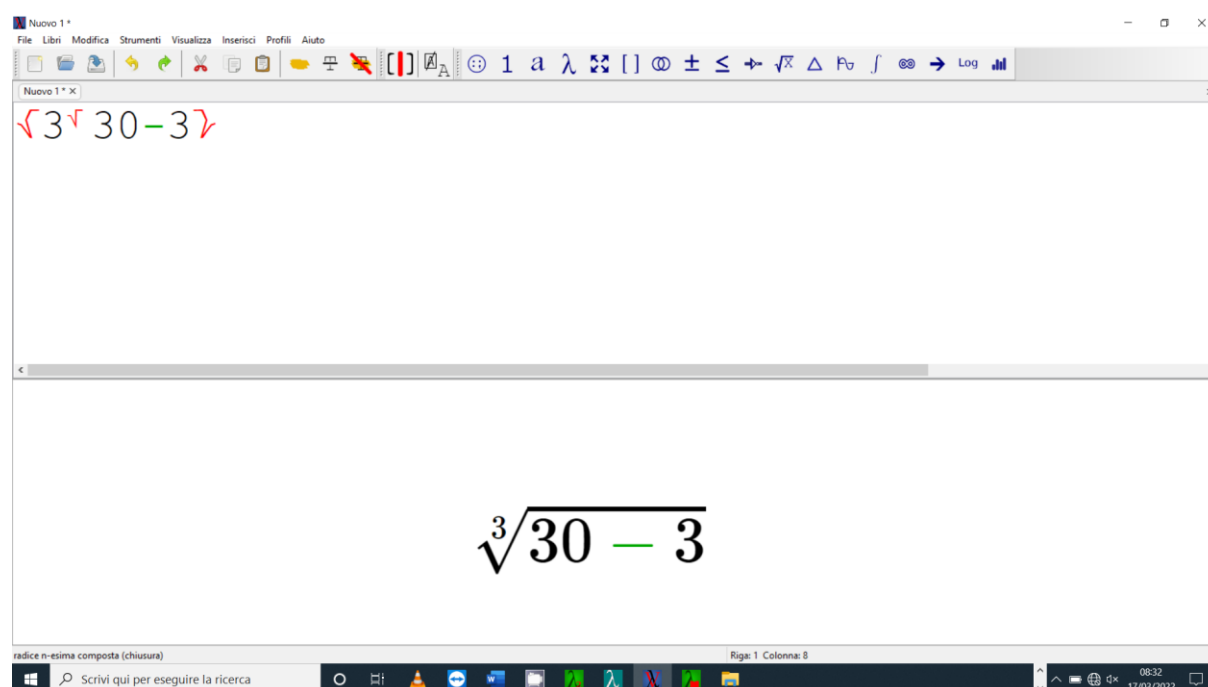
Fraction: Visual Lambda linear structure and graph: $[(2a+1) \text{ fraction } (a-b)]$.



Shortcut keys:

Open: CTRL+Q

Root: Visual Lambda linear structure and graph: $[\text{cube root of } (30-3)]$.

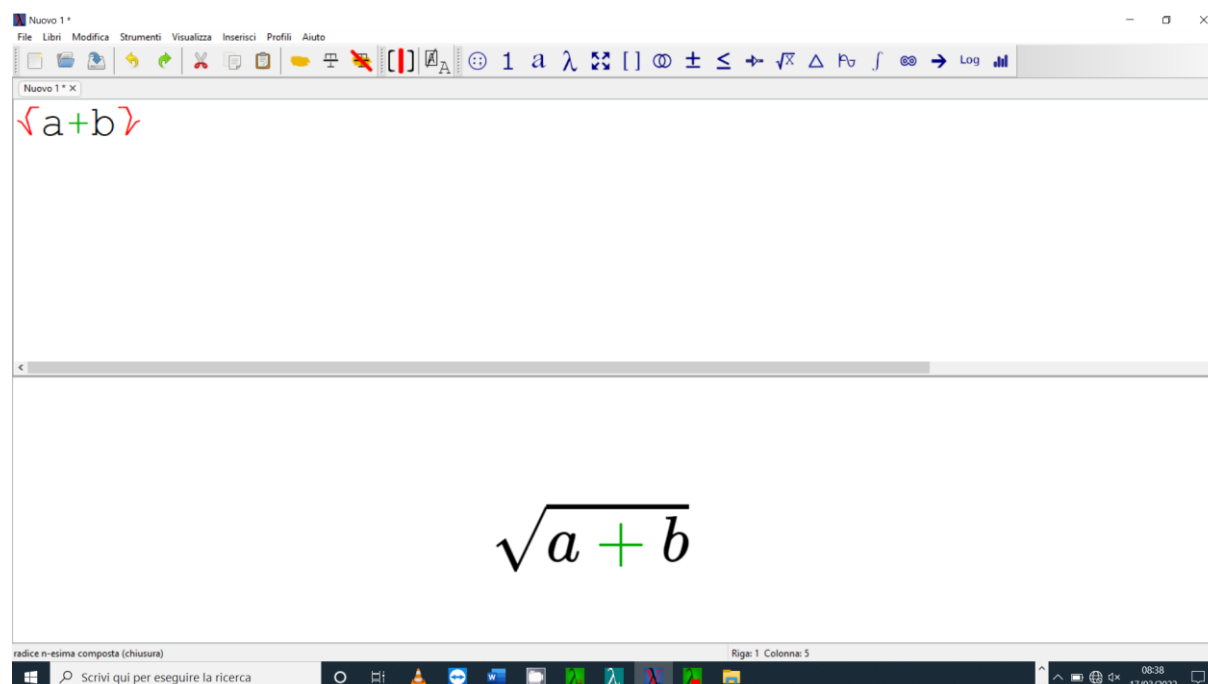


Shortcut keys:

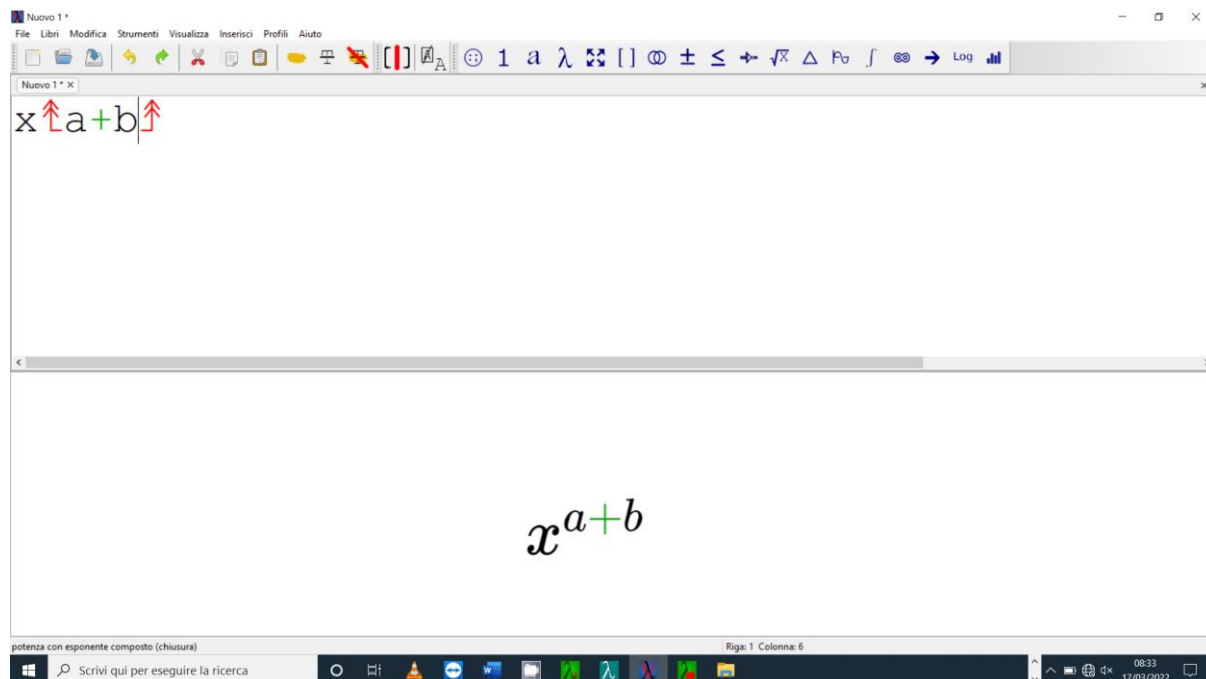
Open: CTRL+SHIFT+R

Intermediate: CTRL+I

The index can be omitted (and in this case the separator is not needed) with square roots: [root of (a+b)].



Exponent: Visual Lambda linear structure and graph:



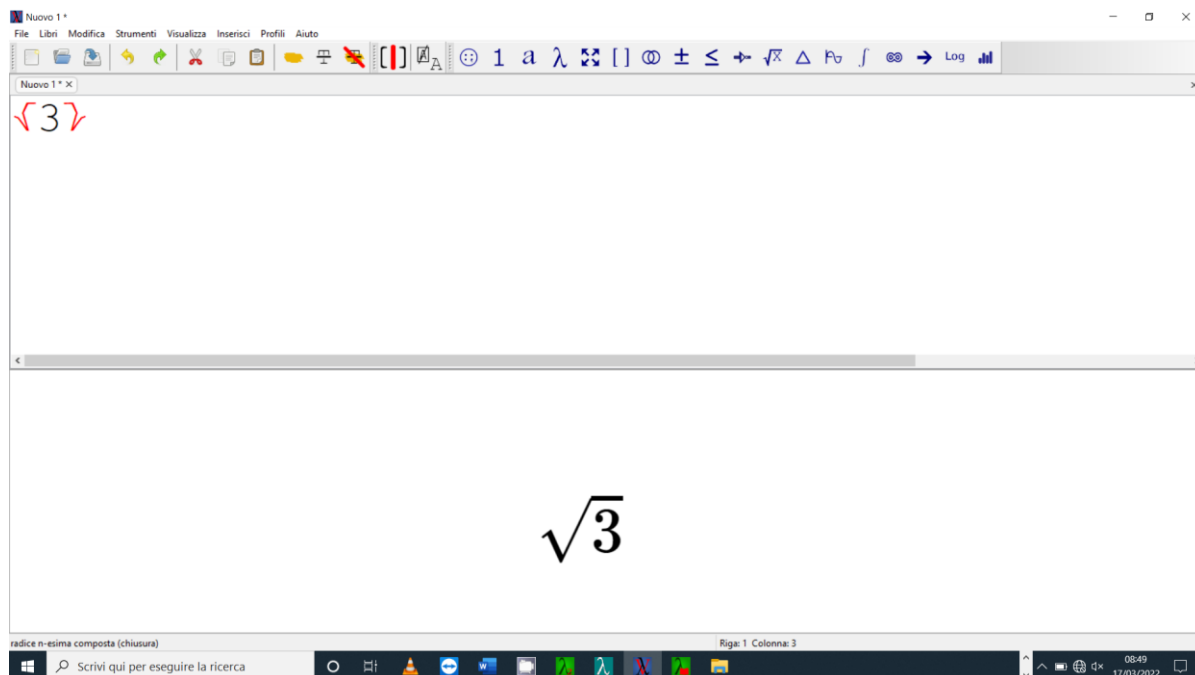
Shortcut keys:

Open: CTRL+SHIFT+I

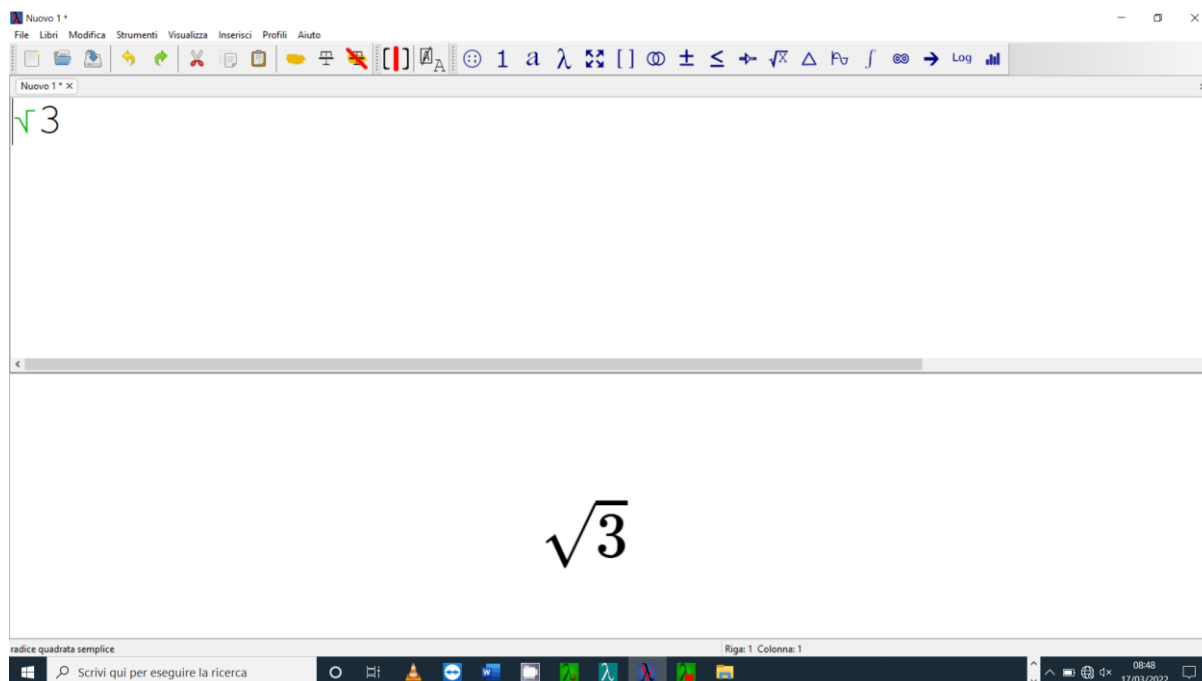
8.1 Abbreviations

For simple objects, i.e. those consisting of a single, well-defined element, a shorter notation without a closing marker should also be provided. This is a useful abbreviation strategy to speed up writing operations and make the mathematical text more compact.

To represent, for example, 3 [root of 3].



Instead of the complete structure we can simply write



The three most common structures (fraction, square root and exponent) also have an

simple version in addition to the compound version.

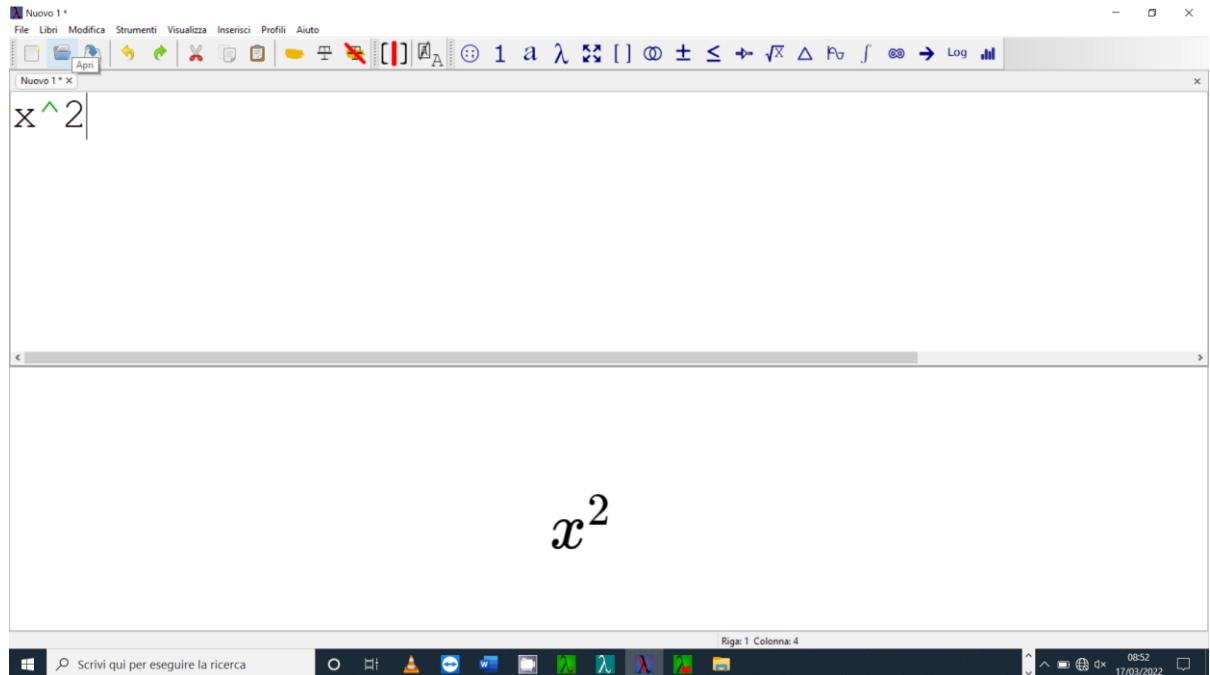
Simple fraction

The screenshot shows the VisulaLambda software interface. The title bar reads "Nuovo 1* x". The menu bar includes "File", "Libri", "Modifica", "Strumenti", "Visualizza", "Inserisci", "Profili", and "Aiuto". The toolbar contains various icons for mathematical operations and editing. The main workspace displays the simple fraction $\frac{a}{b}$. The status bar at the bottom indicates "Riga: 1 Colonna: 4". The Windows taskbar is visible at the bottom of the screen.

Simple square root

The screenshot shows the VisulaLambda software interface. The title bar reads "Nuovo 1* x". The menu bar includes "File", "Libri", "Modifica", "Strumenti", "Visualizza", "Inserisci", "Profili", and "Aiuto". The toolbar contains various icons for mathematical operations and editing. The main workspace displays the simple square root \sqrt{a} . The status bar at the bottom indicates "Riga: 1 Colonna: 3". The Windows taskbar is visible at the bottom of the screen.

Simple exponent

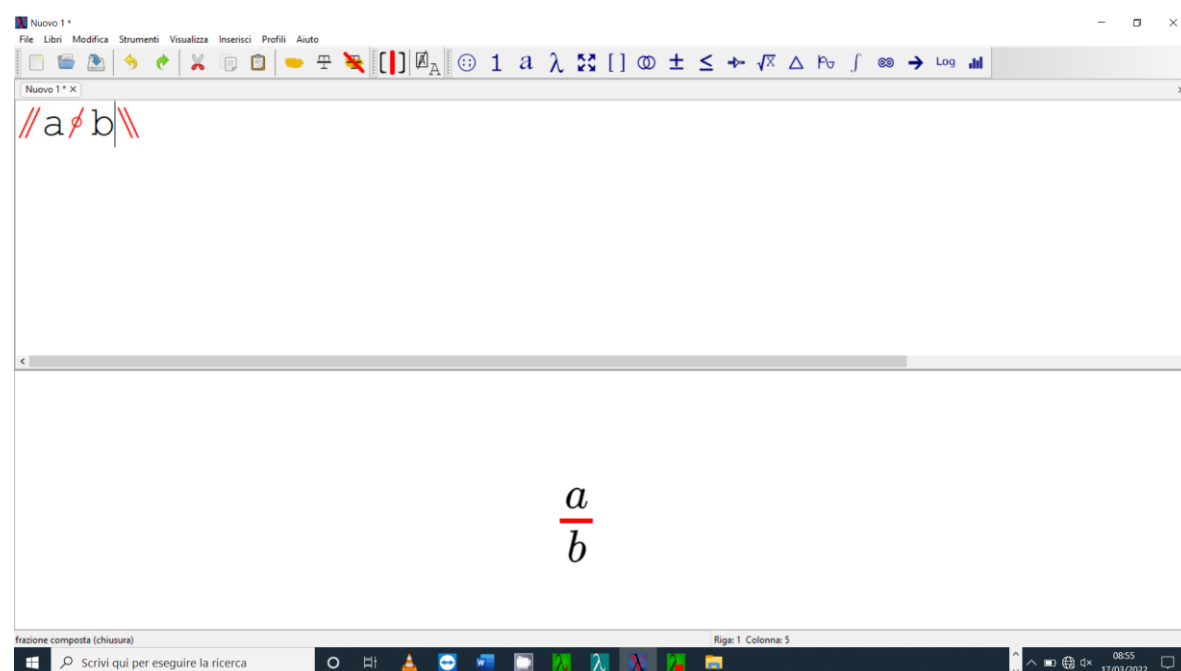


It is important to note that the markers of the simple versions are different from those of the corresponding compound versions, as are the commands to be entered for input.

When writing a fraction, a square root or a power it is necessary to decide straight away whether to use the simple or the compound form.

The user who wishes to do so can always use the compound form: he will have fewer symbols and commands to learn, but his mathematical text will be more verbose.

There is nothing to prevent, for example, a simple fraction being written using the compound structure:



However, we will have a text of 5 characters instead of 3, as in simple notation, and this in an expression with many fractions can result in a considerable expansion of the text.

9. Inserting symbols

The LAMBDA editor offers four possibilities to insert symbols that are not present in the keyboard:

- a combination of shortcut keys, some also on a numeric keypad
- selection from the menu
- search in the list of items
- selection from graphic buttons

9.1 Shortcut keys

Each element is associated with one or more quick-entry keys, to be used in combination with the CTRL key.

For more frequently used items, a second combination is provided on the numeric keypad to allow predominantly right-handed typing, speeding up the entry of mathematical text. Combinations on the numeric keypad are associated with the CTRL key.

A pair of characters has been defined for the less frequently used symbols: the first letter indicates the group, the second the associated key.

For example, to enter the Greek letter α (lowercase alpha) you would type CTRL g,a (i.e.: while holding down CTRL you would press g, release and then press a). All letters of the Greek alphabet will be entered in a similar way: CTRL g, associated Latin letter, upper or lower case.

A special type of shortcut key, particularly simple and intuitive, is used for elements represented in text mode, such as trigonometric and logarithmic functions. In this case, it is sufficient to write the text in the normal way on the keyboard and the system will recognise the associated element. For example, the key sequence required to enter the element "cos" (cosine) will be "cos".

The complete list of shortcut keys can be found in the index.

9.2 Entering with the numeric keypad

Many users find it convenient to use the numeric keypad when writing, with the Num Lock activated, because it can be operated with only the right hand, speeding up mathematical writing.

Obviously, the PC must be equipped with a numeric keypad or have an external keypad connected via USB.

In addition to numbers and arithmetic operators, other commonly used mathematical elements can also be entered on the numeric keypad using the LAMBDA editor.

The following table shows the organisation of the numeric keypad.

normale				con CTRL			
	separatore frazione semplice	*	-				
7	8	9	+	x		a	
4	5	6				b	
1	2	3	invio	([{	
0		.		=			

Some keys are associated with editor functions that will be described later.

The full list of shortcut keys, including those associated with the numeric keypad, is also included in the index.

The use of the numeric keypad can also be customised by the user according to their needs.

9.3 Selection from the menu

From the menu bar, open the INSERT menu and select the group of interest. Then select the symbol to be entered.

9.4 Searching the list of items

Pressing the F5 key, or the corresponding entry in the insert menu, opens the complete list of all items, in alphabetical order.

If you start typing the name of the item to be searched for in the box at the top, the list is reduced by showing only the names of items that contain words that begin with the text entered. Two or three characters are enough to obtain a list compact enough to be easily consulted with the Windows magnifying glass (increase magnification: windows + keys; decrease magnification: windows - keys; to exit: windows esc keys).

9.5 Selection from graphic buttons

It is possible to enter the mathematical elements via a graphic icon menu (tool bar).

The most common symbols include the generic commands and the one for inserting the intermediate marker can be found in the elements toolbar (group on the left), with direct access.

The other elements are instead available in the mathematical toolbar by first selecting the group and then, in the new menu that opens, the chosen symbol. The meaning of the symbols should be quite intuitive. If in doubt, place the mouse pointer over them; a small explanation window appears, accessible via the Windows magnifying glass.

The tool bar is fully active even if I am in the text section, of course the corresponding maths symbols will open and close if I am in the text area and vice versa.

10. Mathematical text manipulation

For a mathematical editor for school use, it is not enough to be able to write an expression or equation, it must also be able to process it to solve it properly.

The Visual Lambda editor offers various tools to facilitate these manipulations.

10.1 Resolution by transformation

In many circumstances, the easiest way to work on a mathematical text is to copy and paste the line and then make corrections to the copy.

With an expression or equation to be solved by successive transformations, it is normal to carry out many steps when transcribing a new line (calculations, simplifications...). It is much more efficient to work by correction, i.e. first copy the text and then read and edit it.

Copying and pasting a line is an operation that can be carried out with the normal editing tools available in Visual Lambda, following the usual procedures common to all writing programs.

For example:

- go to the beginning of the line and type `Ctrl A` to select it all
- type `Ctrl C` to copy it
- Move down with the cursor and type `Ctrl V` to copy the text to the new position.

10.2 Automatic line duplication

This variant of resolution by transformation offers the possibility of checking the steps carried out by means of unmodified control lines.

Corrections are made by overwriting (without insertion) so the overall structure of the expression remains unchanged.

Example:

Visual lambda - [Nuovo 1*]

File Libri Modifica Strumenti Visualizza Inserisci Profili Aiuto

Nuovo 1* x

$$2 [x (x-1) - 1 + x (3-x)] = 2 (1+6x) + 4$$

$$2 [x (x-1) - 1 + x (3-x)] = 2 - 12x + 4$$

Riga: 2 Colonna: 1

10:15 17/03/2022

Here is the complete solution of the previous example:

Visual lambda - [Nuovo 1*]

File Libri Modifica Strumenti Visualizza Inserisci Profili Aiuto

Nuovo 1* x

$$2 [-x-1+3x] = 2-12x+4$$

$$-2x-2+6x = -12x+6$$

$$-2+4x = -12x+6$$

$$+4x+12x = +6+2$$

$$16x = 8$$

$$x = 8/16$$

$$x = 1/2$$

Riga: 10 Colonna: 2

10:23 17/03/2022

To view the entire write operation, scroll up and down with the sidebar or arrow keys.

To view the whole operation in graphics:

file → preferences → graphics → display single expression → choose from drop-down menu NO → ok;

at this point you can view the whole operation by moving with the side and horizontal bars.

The procedure may seem much longer than normal, but in reality many operations are performed automatically and very quickly.

Note that if necessary, the whole process can be checked in reverse, verifying the various steps.

The Visual Lambda editor has a command (shortcut key CTRL + D) that automatically duplicates the line according to this method.

In particular, CTRL + D is used to perform these operations in sequence:

- 1 - the entire line on which the cursor is located is selected (it is not necessary to go to the beginning)
- 2 - copy once below the previous line;
- 3- at the end of the operation, the cursor is positioned at the beginning of the lowest line (working line).

10.3 Selection of blocks

It is possible to select, with a single command, the entire mathematical block within which the cursor is placed. By "block" we mean the portion of text enclosed between a pair of open/closed markers, such as two parentheses, a compound root or other.

The command is activated from the menu (SELECTION/SELECT BLOCK) or with the CTRL B shortcut.

At first, the smallest block containing the cursor is selected; the selection can be extended, again by typing CTRL B, to include the outermost open/closed structures, until the whole line is selected. Similarly, it is possible to reduce the

selection by going back to the previous inner blocks, until you reach the starting selection (smallest block containing the cursor).

Main controls:

Select block	CTRL B
Extend selection	CTRL B
Reduce selection	Max, CTRL, B

11. Alternative views of mathematical text

The linear representation loses a lot of structure information, which is evident in the normal graphic representation, even if, given the possibility of using the graphics always in evidence, there seems to be no misunderstanding in the identification of the various elements.

The problem mainly concerns complex mathematical objects, with many elements inserted one inside the other, on several levels (nesting).

The Visual Lambda editor has two alternative display modes designed to make it easier to understand the structure of formulas and internal relationships while overcoming, as far as possible, the limitations of linear notation.

As they are display tools, and not writing tools, it is not possible to edit text within them, but you can navigate freely by moving the cursor, which will retain its new position when you return to the normal window.

11.1 Compressed structure

The 'compressed structure' view shows the formula by emptying the contents of a block, from one marker to another. This makes it clear which marker each block is associated with and on which part of the formula it acts.

For example, the equation:

The screenshot shows the VisulaLambda software interface. At the top, there is a menu bar with options: File, Libri, Modifica, Strumenti, Visualizza, Inserisci, Profili, Aiuto. Below the menu is a toolbar with various icons for editing and visualization. The main workspace contains a text input field at the top with the formula: $1 + \sqrt{x^2 - y^2} / (x + y) = 0$. Below this, the rendered graphic representation of the formula is displayed:
$$1 + \sqrt{\frac{x^2 - y^2}{x + y}} (x - y) = 0$$

The loss of information, structure and relationship compared to graphic representation is evident.

The compressed structure of this formula will be, at the highest level, as follows:

The screenshot shows the VisulaLambda software interface with a small window titled "Struttura" (Structure) open. The window displays the compressed structure of the formula: $1 + \sqrt{\text{ } / \text{ } \text{ } () \text{ } = 0$. The main workspace still shows the rendered graphic representation of the formula:
$$1 + \sqrt{\frac{x^2 - y^2}{x + y}} (x - y) = 0$$

By decreasing the level, the other blocks become visible:

The screenshot shows the DD MATH software interface. At the top, there is a menu bar with options: File, Libri, Modifica, Strumenti, Visualizza, Inserisci, Profili, Aiuto. Below the menu is a toolbar with various mathematical symbols and functions. The main workspace displays the formula $1 + \sqrt{x^2 - y^2} \phi(x+y) (x-y) = 0$ in a compact, compressed format. A 'Struttura' (Structure) window is open, showing the expanded structure of the formula: $1 + \sqrt{\frac{x^2 - y^2}{x+y}} (x - y) = 0$. The expanded structure view shows the formula with spaces and visible block boundaries, making it easier to understand the structure of the expression.

The initial level of compression depends on the position of the cursor (starting from the innermost complete block containing it) and can be easily changed with the Page Up and Page Down buttons.

11.2 Expanded structure

The 'expanded structure' view is similar to the previous one: hidden blocks are not deleted but replaced by spaces. The formula will be less compact but you will have useful information about the size of the blocks. (see example above)

Associated commands:

To enter the compressed structure view	F8
To return to the normal window	ESC
To switch to the expanded structure view (F8 toggles between structures)	F8
To reduce the display level	Back page (pg↑)
To increase the display level	Page forward (page down↓)

12. Graphic display

The linear formula written with the Visual Lambda editor is displayed in graphical mode in a window on the screen (bottom or side depending on the configuration chosen).

12.1 To print the graphics page

Place the mouse over the graphics window, right-click and choose: print. At this point, you choose which printer to use. If you choose to print the document directly, you must have a printer installed on your PC and click on that.

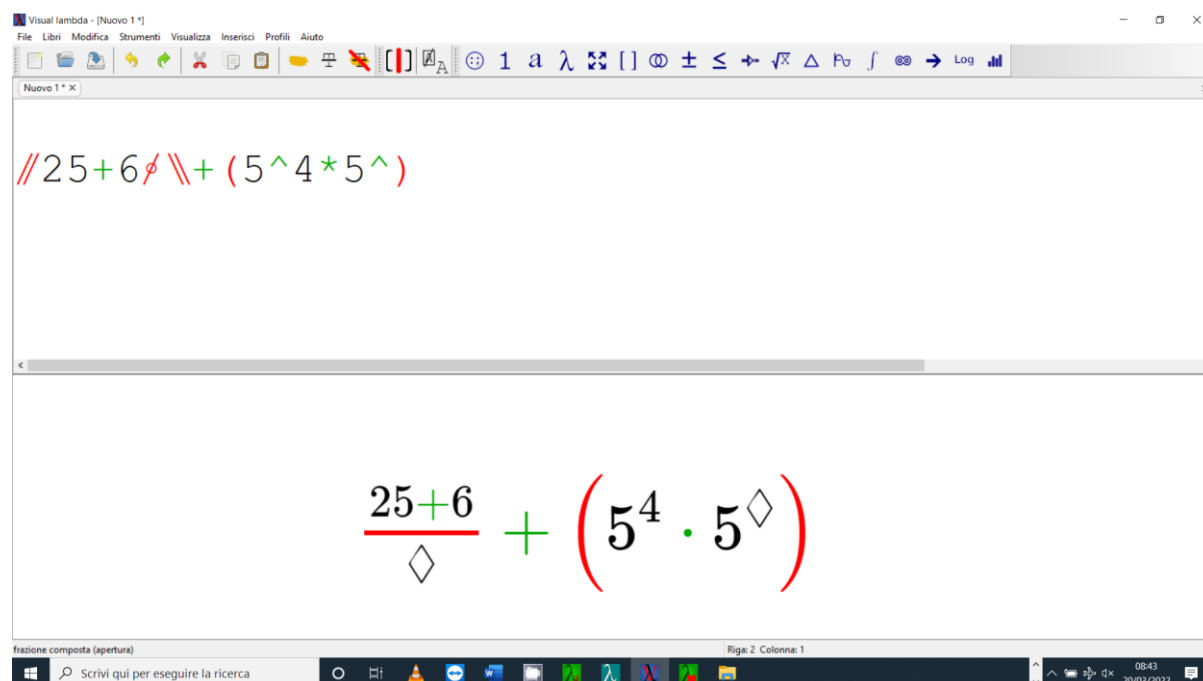
12.2 To save the graphics page as a PDF

If you choose to save the file in order to be able to print it at a later date, proceed as above until you choose the printer to be used, then click on the PDF creation program on your PC.

The most direct way to save a PDF file is to use the right mouse button, again from the graphics window: open in external browser; a browser window will open with our graphics page. Now save the file: right-click on the page, choose print and in the window that appears choose PDF.

12.3 If the formula is not correct

The display is possible even if the formula is not recognised by Visual Lambda, e.g. due to compilation errors or forgetfulness. The graphics will appear as in the example: the symbols \diamond will replace the missing data.



12.4 Appearance and content

Visual Lambda is a mathematical writing system oriented towards the content of the document and its graphic appearance. The transformation into a graphic display first involves converting the content into MathML, which is then displayed in graphic mode by the browser.

The formula displayed in the graphics retains the characteristics of the input script.

13. The calculator

Visual Lambda has a scientific calculator designed so that it can also be used easily with speech synthesis (although not fully accessible).

It can be used in two distinct ways: as a tool connected to the editor or as a stand-alone environment to be used in a separate window.

13.1 Window Calculator

In this calculator, expressions are entered in a text window and then calculated. The writing options are considerably reduced in comparison to the VISUAL LAMBDA editor and this system should therefore be used mainly for simple calculations that can be entered using the normal keyboard commands.

In addition to the numbers and the 4 operations (+, -, *, /), blunt brackets and the simple power sign ^ are accepted.

Other more complex calculations can be performed via the Operations menu: roots, logarithms, trigonometric functions and more.

When you leave the calculator environment and return to the editor, you can copy the result of the last operation performed anywhere on the page.

13.2 Calculator linked to editor

Calculations are performed directly in the editor or by activating the calculator. To be able to use the calculator directly in the editor, the calculations must be copied and pasted to an empty line, with the cursor at the end of the calculation, type F9. Exit with the ESC key, select the calculation again, paste result (CTRL SHIFT F9).

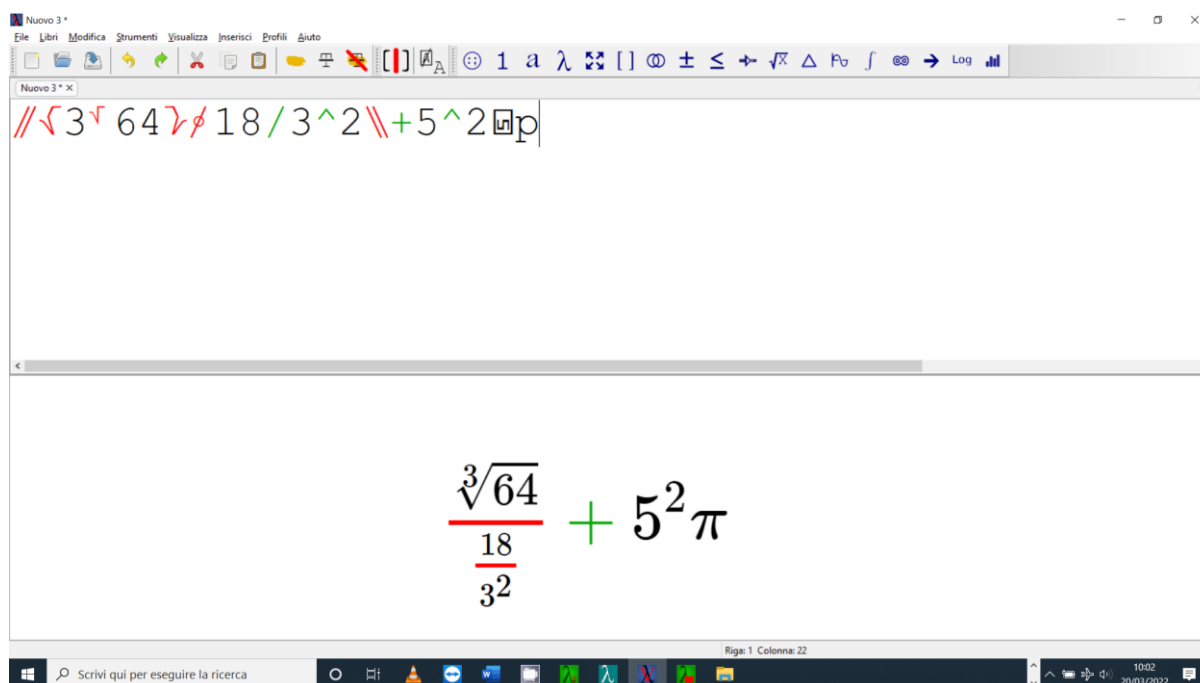
If the enlargement makes this step too laborious, we can open an additional file that we will use for calculations. I move between the two files with (CTRL TAB). Proceed as follows: copy calculation or block (CTRL B; CTRL C); move to second file (CTRL TAB); paste (CTRL V); calculation (CTRL F9); exit ESC; move to first file (CTRL TAB); paste result (CTRL SHIFT F9). As the block or

calculation is still selected, I will replace the selection with the result without wasting time.

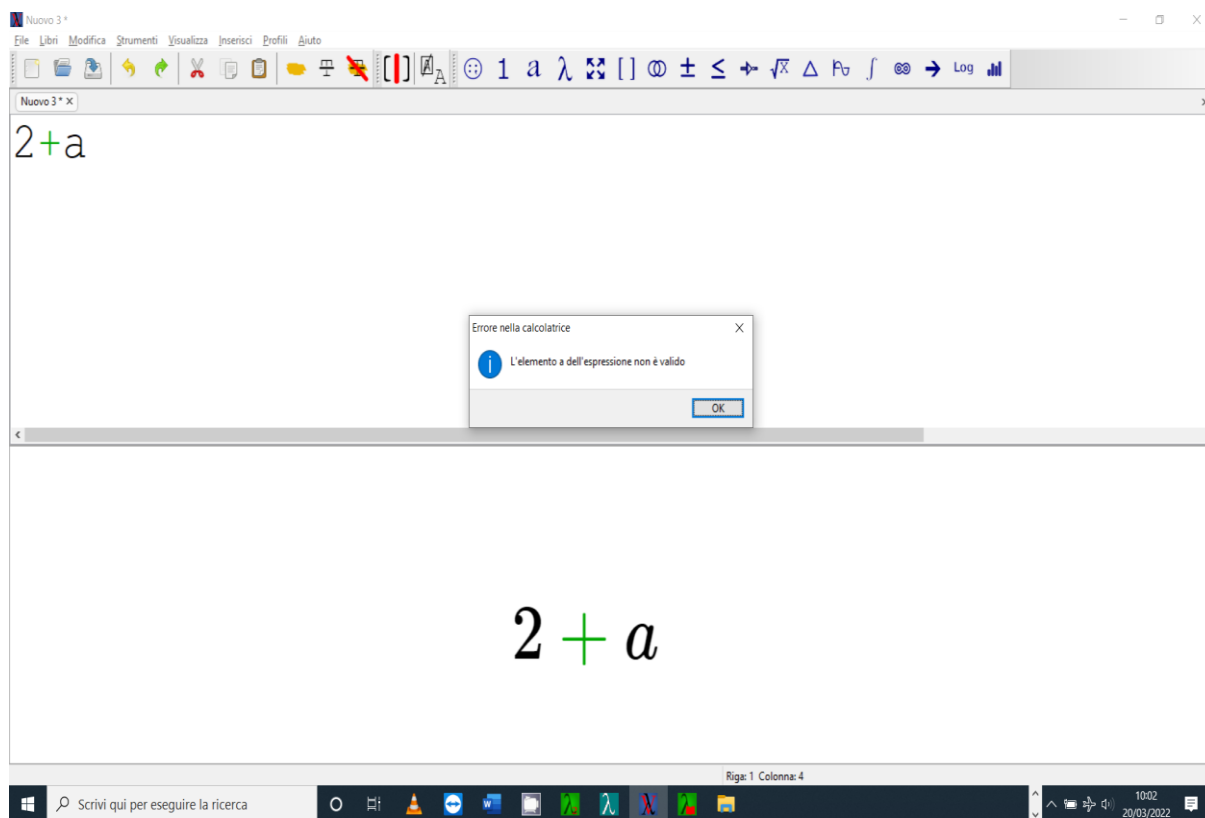
You can keep the result in memory and paste it later in the editor wherever and whenever you want.

The calculator can process any portion of text in a mathematical environment, including successive, nested calculations, provided that the data consists only of numbers or known, defined constants.

Expressions such as



But not expressions that contain undefined variables, in which case an error message like this would appear:



To operate the calculator connected to the editor we have these commands (each of them can be activated, in addition to the shortcut keys indicated here, with the relevant item in the tools menu)

Calculator commands active from the editor (calculator closed)

Open calculator	F9
Calculate expression (copied and pasted to blank line) and display expression with result	CTRL F9
Paste result (inserts the result of the last calculated expression at the current cursor position)	CTRL Shift V
Calculator commands active from the calculator window (calculator open)	
Calculate	Sending
Close calculator and return to the editor	ESC or Alt F4

13.3 Changing calculator settings

The settings are only defined in the calculator window but apply to both modes of operation. To change the settings of the calculator connected to the editor, you must also open the window of the other calculator.

They can be defined:

- the number of decimal digits displayed (0 to 17);
- the system for measuring angles, to be chosen from sexagesimal degrees, radians, gradients.

14. User profiles

The visual lambda editor can be adapted to the user's needs.

In particular, it is possible to simplify the input menu for mathematical elements by hiding those that are not used. It is possible to hide an entire group (e.g. trigonometry) or one or more elements, choosing them from those listed in the group.

It may also be appropriate to hide frequently used menus which are usually entered using direct keyboard commands. If their presence in the menus seems unnecessary, they should be removed to make them more compact and quicker to consult.

Each customisation is called a profile and will be saved in a special file; the name of the active profile is shown on the status bar (last item on the right).

In the profiles, it is also possible to modify the shortcut keys associated with the various mathematical elements.

Profiles can be constructed for the general needs of a student, i.e. for the type of studies followed and the class attended, but they can also vary according to particular, specific or contingent needs. We can, for example, design profiles for set theory, logic, trigonometry... in which access to frequently used symbols or operators is made more immediate, either through menus (by putting them in the first positions) or through shortcut keys (assigning simpler and more compact combinations).

14.1 Prepared profiles

Some user profiles, already prepared, are supplied with the programme.

Primary: this profile is suitable for primary and secondary school pupils; in addition to numbers, letters and basic operators, it contains the necessary elements for elementary algebra (brackets, fractions, roots, powers), some attributes for characters and numbers and the main symbols of numerical sets.

Biennium: this profile is suitable for students in the two-year period of secondary school. The profile is obtained by extending the primary profile with elements of set theory and logic, binomial coefficients, matrices and all the symbols needed

for these topics (arrows, Greek characters). There are also some elements of algebra that were not included in the primary profile, such as the system of equations, summations and productions.

Three-year BA/University: This is the most comprehensive profile, suitable for students in three-year colleges and universities. All the mathematical elements of the VISUAL LAMBDA system are present. Compared to the two-year profile, there are objects related to trigonometry, analysis, logarithms, with all the symbols necessary for the treatment of these topics.

15. List of shortcut keys in the LAMBDA editor:

15.1 Standard Windows commands

	Alphanumeric keyboard
Opening an existing document	CTRL O
New document	CTRL N
Closing a document	CTRL F4
Copy selected text to clipboard	CTRL C
Cut selected text on the clipboard	CTRL X
Paste the contents of the notes	CTRL V
Aborting an operation	ESC
Undoing an executed operation	CTRL Z
Restore or repeat an operation	CTRL Y
Save	CTRL S
Print	CTRL P
Select all	CTRL A
Close the application (exit Lambda)	ALT F4

15.2 Display or editing commands

	Alphanumeric keyboard	Numeric keypad
Displays the structure in expanded mode (typing F8 again - or CTRL 8 on the numeric keypad - switches to the compressed structure)	F8	CTRL 8
Display the structure in compressed mode (or double-click F8 - or CTRL in t.n.- to enter expanded mode and immediately switch to the other one)	SHIFT F8	
Commands active in display mode:		
Switch to other view	F8	CTRL 8
Increase display level	Page Forward	
Reduce display level	Page Back	
Back to normal editor	Esc	
Selects the block (from an open marker to the corresponding closed one)	CTRL B	
Active commands with block selected:		
Duplicate line (copy twice and remove spaces)	CTRL D	
Active commands with persistent blocks:		
Delete selected text	CANC	
Active commands in the buffer window:		
Paste displayed buffer and exit	CTRL V	
Exit	ESC	

15.3 Commands for inserting symbols or markers

Generali	Alphanumeric keyboard	Numeric keypad
Open the search and selection box	F5	
Intermediate marker (inserts intermediate marker)	CTRL I	
Insert a block of text section	CTRL J	
Most frequently used		
Compound fraction (opening marker)	CTRL Q	
Simple fraction (fraction sign)	/	/
Division (operator)	CTRL 7	
Complex exponent (opening marker)	CTRL ^	
Simple exponent (operator)	^	
Nth compound root (opening marker); - if the intermediate is missing it is compound square root	CTRL SHIFT R	
Simple square root (operator)	CTRL R	
Open round bracket ((CTRL 1
Open square brackets [ALT GR [CTRL 2
Open brackets {	ALT GR SHIFT [CTRL 3
Equal (=)	=	CTRL 0
Double characters		
Algebra / Analysis		
general prefix for Analysis and Algebra (always followed by another character)	CTRL M	

Natural logarithm	CTRL M, L	
Logarithm in generic base if there is no implied intermediate in base 10	CTRL M, SHIFT L	
Definite integral	CTRL M, I	
Double integral	CTRL M, I	
Limit	CTRL M, T	
Summation	CTRL M, S	
Manufacturing	CTRL M, P	
Decisive	CTRL M, D	
Sets		
general prefix for sets (always followed by another character)	CTRL E	
Empty set	CTRL E, 0 (zero)	
It belongs	CTRL E, E	
Intersection	CTRL E, I	
Union	CTRL E, U	
Logic		
general prefix for logic elements (always to be followed by another character)	CTRL L	
And	CTRL L, A	
Boolean sum	CTRL L, B	
Contradiction	CTRL L, C	
False	CTRL L, F	
For each	CTRL L, P	
Not	CTRL L, N	
Or	CTRL L, O	
Tautology	CTRL L, T	
There is	CTRL L, E	

True	CTRL L, V	
Geometry and trigonometry		
general prefix for geometry and trigonometry (always followed by another character)	CTRL T	
Corner	CTRL T, A	
Degrees	CTRL T, G	
Accident	CTRL T, I	
Parallel	CTRL T, P	
Carrier	CTRL T, V	
Breast	CTRL T, S	
Cosine	CTRL T, C	
Tangent	CTRL T, T	
Greek letters		
general prefix for Greek letters	CTRL G	
Greek letters are obtained by following the prefix CTRL G with the associated Latin letter, upper or lower case.		
Associations are generally easily identifiable; only the less obvious cases are reported here:		
Eta	CTRL G, h	
theta	CTRL G, j	
ksi	CTRL G, x	
khi	CTRL G, q	
psi	CTRL G, y	
omega	CTRL G, w	
A few examples:		
lowercase delta	CTRL G, D	
capital delta	CTRL G, SHIFT D	

tiny omega	CTRL G, W	
capital omega	CTRL G, SHIFT W	

Displays the active matrix in two-dimensional (tabular) mode	F10
Commands active from the two-dimensional view (table)	
Close the two-dimensional view	ESC or F4

15.4 Matrices

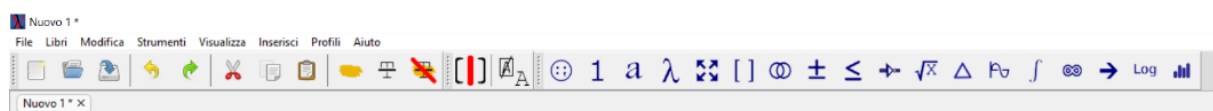
Commands active from the editor

15.5 Text section

Exit the text section (go to the beginning of the next maths section)	CTRL TAB
Insert maths section (or rather: split text section)	CTRL J

15.6 Selection with graphic buttons

The programme offers the possibility of entering mathematical elements via a graphic icon menu (tool bar).



The most common symbols: the command for inserting the intermediate marker and the context change, can be found in the elements toolbar (central group), with direct access.

The other elements are instead available in the mathematical toolbar (on the right and in blue colour) by first selecting the group and then, in the new menu that opens, the chosen symbol.

The meaning of the symbols is quite intuitive. If in doubt, place the mouse pointer over them; a small explanation window appears.

The tool bar is only fully active in the maths section. In the text section, the commands are still active, but when I choose a mathematical symbol, the program automatically opens and closes the mathematical section by inserting the chosen symbol inside.

15.7 Calculator

Calculator commands active from the editor (calculator closed)

Open calculator	F9
Calculate expression (copied and pasted in blank line) and display expression with result	CTRL F9
Paste result (inserts the result of the last calculated expression at the current cursor position)	CTRL Shift V
Calculator commands active from the calculator window (calculator open)	
Calculate	Sending
Close calculator and return to the editor	ESC or Alt F4



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