Using WMI2

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1 Introduction

This list of examples gives a short overview about the capabilities of WMI2. The tool can be used immediately pointing the web browser to `http://matek.hu`.

Typewriter font texts are to be entered into the input box manually, below the bear logo (which can be switched off by clicking on the text "matek.hu" below it). Underlined texts are special keys or calculator icons.

Note that this list is incomplete. WMI2 has more than 70 actions which offer a wide variety of mathematical functions which are unable to be covered by this short list.

The references are Hungarian textbooks for 15-17 years pupils (Sokszínű matematika [SM], authors: J. Kosztolányi, I. Kovács, K. Pintér, J. Urbán, I. Vincze, Mozaik Kiadó, Szeged, 2002).

2 In secondary school

2.1 Simple calculator

Problem	Solution	Comment	References
$5^{12} \lessgtr \left(5^5\right)^2$	`5 ^ 12` Enter `( 5 ^ 5 ) ^ 2` Enter	Entering the "^" sign may be tricky on some keyboards. Enter starts the last action which is "evaluation" by default.	SM9 39/1a
$125^4 \cdot 64^3 \lessgtr 100^7$	`125 ^ 4` Space `64 ^ 3` Enter `100 ^ 7` Enter	Not needed to use "*" for multiplication.	SM9 39/1f

Simplify:
$\left(\frac{2x}{y}\right)^3 \cdot \left(\frac{xy^2}{2}\right)^2 \cdot \left(\frac{1}{x}\right)^4$
	`( 2 x / y ) ^ 3`
	`( x y ^ 2 / 2 )`
	`^ 2 ( 1 / x ) ^ 4`
	Enter
		Very fast way of math typing. Evaluation automatically simplifies the expression.	SM9 39/3d

2.2 Symbolic calculator

Problem	Solution	Comment	References
Expand: $(2x+3)(3x^2-6x+5)$	`(2x+3) (3x^2-6x+5)` $\underline{a^2+a}$	"Expansion" takes place on "Secondary school" layout (this is the default), in the block to the right from "Multiplication".	SM9 47/4e
Convert to complete square: $16x^4+8x^2+1$	`16x^4+8x^2+1` $\underline{a(a+1)}$	"Factorization" takes place at the same block.	SM9 50/1

Factorize:
$8a^2b^3-8a^4b^2+2a^6b$
	`8a^2b^3`
	`-8a^4b^2`
	`+2a^6b`
	Enter
		"Enter" stands for the last action which is „factorization". This makes WMI2 very fast for solving similar problems at the same time.	SM9 55/4c

Simplify: $\sqrt[5]{a} \cdot \sqrt{a}$	`a^(1/5)a^(1/2)` Enter		SM10 56/3f

2.3 Number theory

Problem	Solution	Comment	References
Prove: $10 \mid 426^{19} + 2^{58}$	`(426^19+2^58)` $\equiv$	"Evaluation" takes place in the block to the right from "Subtraction" (green equal sign). This calculation shows high precision capabilities.	SM9 67/2
Greatest common divisors of 73125 and 7425	`73125,7425` $\underline{(a,b)}$	"GCD" takes place in the block to the right from „Division".	SM9 68/2a

2.4 Functions

Problem	Solution	Comment	References
Plot: $f(x) = 3x$, $g(x) = x$, $h(x) = -2x$, $k(x) = -x$	`3x,x,-2x,-x` 	"Plot" takes place in the block below the "ce" key. Colors are respectively red, green, blue, magenta. Try zoom in and out by clicking in the graph and the icon.	SM9 81/3
Plot: $g(x) = \|\|\|x\| - 2\| - 1\|$	`abs(abs(abs (x)-2)-1)` 	The pipe character will not work.	SM9 85/4b
Plot: $2500(t^2 - 12t + 40)$	`x^2-12x+40` 	Always use the x variable for one dimension plotting. WMI2 cannot autoadjust the view for the graph.	SM9 92/4
Plot: $\sqrt{x+5}$	`sqrt(x+5)` 	Square root can also be entered by clicking 	SM9 95/2b
Plot: $x \cdot \left[\frac{1}{x}\right]$	`x floor(1/x)` 	Try zoom in. Floor also can be entered by using the "Elementary school" layout  and clicking $\underline{\lfloor x \rfloor}$. `ceil` is also available.	SM9 106/2c

2.5 Equations

Problem	Solution	Comment	References
$\frac{x^3}{x(x^2-1)} = 1$	`x^3/ (x(x^2-1))=1` $x = ?$	"Equation solving" is also below "ce". Try to change the right hand side of the equation by clicking on the red text in the worksheet and re-edit the input. Use `Enter` for using last action.	SM9 151/4d
$x^2 \leq -3x + 4$	`x^2,-3x+4` 	The graph will help to find intersection points of the geometrical forms according to the sides.	SM9 169/1c
$\begin{cases} x - 3y = 3 \\ 3x - 9y = 8 \end{cases}$	`x-3y=3, 3x-9y=8` $x = ?$	Try to change 8 to a different value to get infinitely many solutions. Also try to investigate 2-variable functions $f(x,y) = x - 3y - 3$ and $g(x,y) = 3x - 9y = 8$ plotting in a 3 dimensional space using "Calculus" layout and "Plotting a function in 3D":  `x-3y-3,3x-9y-8` 	SM9 189/3
$\begin{cases} a + b = 9 \\ a + c = 16 \\ b + c = 17 \end{cases}$	`a+b=9, a+c=16, b+c=17` $x = ?$	Do not use the special letters (e, i).	SM9 198/2
$2x^4 - 3x^3 - x^2 - 3x + 2 = 0$	`2x^4-3x^3 -x^2-3x+2=0` $x = ?$	Only the left hand side must be typed if the right hand side is zero.	SM10 76/5

2.6 Approximation

Problem	Solution	Comment	References
Simplify: $\sqrt{\sqrt{13} - 2 \cdot \sqrt{\sqrt{13} + 2}}$	`sqrt(sqrt13-2) sqrt(sqrt13+2)` $\approx$	WMI2 cannot autosimplify this problem, but approximation still works. Raising to the square, both "Expansion" and "Simplifaction" $\frac{2}{4} = \frac{1}{2}$ will give the exact (non-numerical) result.	SM10 40/5a
Solve: $\cos x = x$	`cosx=x,0,2` $x \approx ?$	WMI2 will search for an approximate solution between 0 and 2.	SM11 183/3

3 College and university examples

3.1 Calculus

Problem	Solution	Comment
Differentiate: $\sin\cos\sqrt{\pi x}$	Click $\underline{\sin}$ $\underline{\cos}$ $\underline{\sqrt{x}}$ $\underline{\pi}$ $\underline{\times}$ $\underline{x}$ $\underline{f'(x)}$	Beware of auto-parentheses. (To quit a paranthesis, press "$\underline{)}$").
Show that $\int(\sin\cos\sqrt{\pi x})'dx = \sin\cos\sqrt{\pi x} + c$	Click on the previous output and click $\underline{\int}$	Try out how fast and intuitive is the "one click copy" method in WMI2. Try out the following: click $\underline{1}$ $\underline{+}$ $\underline{1}$ $\underline{/}$ and now click on the output a few times. Finally, click $\underline{1}$ and $\underline{=}$. (Indeed, WMI2's input box is too narrow for such tricks! You'd better use a "professional" CAS for such investigations. ;-)
Show that $\sum_{k=1}^{n} k^2 = \frac{n(n+1)(2n+1)}{6}$	Type `n^2`, then click $\underline{\sum a_n}$ and $\underline{a(a+1)}$	Remember that "Factorization" is taking place on "Secondary school" layout.

3.2 Linear algebra

Problem	Solution	Comment
Calculate the inverse of $\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$ and show that multiplying each other gives the unit matrix	Type `[[1,2],[3,4]]` then click $\underline{A^{-1}}$. Now click on the first input, then click $\underline{A \cdot B}$, then click on the first output, then click on $\underline{=}$	Try out the reverse order, i.e. show that $A \cdot A^{-1} = A^{-1} \cdot A$ in this special case.
Calculate the eigenvalues of $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 10 \end{pmatrix}$	*(Draft — try to solve it by yourself! WMI2 gives the eigenvalues using the Cardano formula which is difficult to handle. Instead, ask for the characteristic polynomial and get an approximate solution after plotting the polynomial and isolating its roots by zooming in and out.)*	Save your work by clicking the "Save" icon at the bottom right corner.