Maxima in Teaching Basic Matrix Algebra

T. Mylläri, A. Mylläri

School of Arts and Sciences

St. George's University

Grenada, West Indies

We discuss usage of computer algebra system Maxima in teaching basic matrix algebra in St. George's University.

"…Учебник возник из желания соавторов материализовать разделяемое ими убеждение, что **нельзя учить математике, натаскивая на рутинных операциях, которые студенты в своей будущей жизни никогда не применят.**"

Вавилов Н.А., Халин В.Г., Юрков А.В.
Mathematica для нематематика: учебное пособие для вузов
Электронное издание
М.: МЦНМО, 2021

Modern technology (computers, gadgets, computer algebra systems) changes the way **to do** mathematics and the way **to teach** mathematics and natural sciences.

DIFFERENTIATION

START

TRY APPLYING

CHAIN RULE POWER RULE

QUOTIENT RULE PRODUCT RULE

ETC

DONE?

NO

YES

DONE!

INTEGRATION

START

TRY APPLYING

INTEGRATION BY PARTS SUBSTITUTION

DONE?

HAHA, NOPE!

CAUCHY'S FORMULA

????

???!?

???

??

?

PARTIAL FRACTIONS

???

RIEMANN INTEGRATION

INSTALL MATHEMATICA

?

?

???

RISCH ALGORITHM

???

STOKES' THEOREM

?

?

?????

???

WHAT THE HECK IS A BESSEL FUNCTION??

PHONE CALLS TO MATHEMATICIANS

OH NO

BURN THE EVIDENCE

As we have reported earlier, St. George's University School of Arts and Sciences comprise mainly of local and Caribbean students with poor background in mathematics. It is real challenge to teach Mathematics, especially topics that are new to the students. Quite often students have problems dealing with the material that they have studied earlier and are supposed to know, but when the concepts are really new, students put a mental barrier and the process goes really hard.
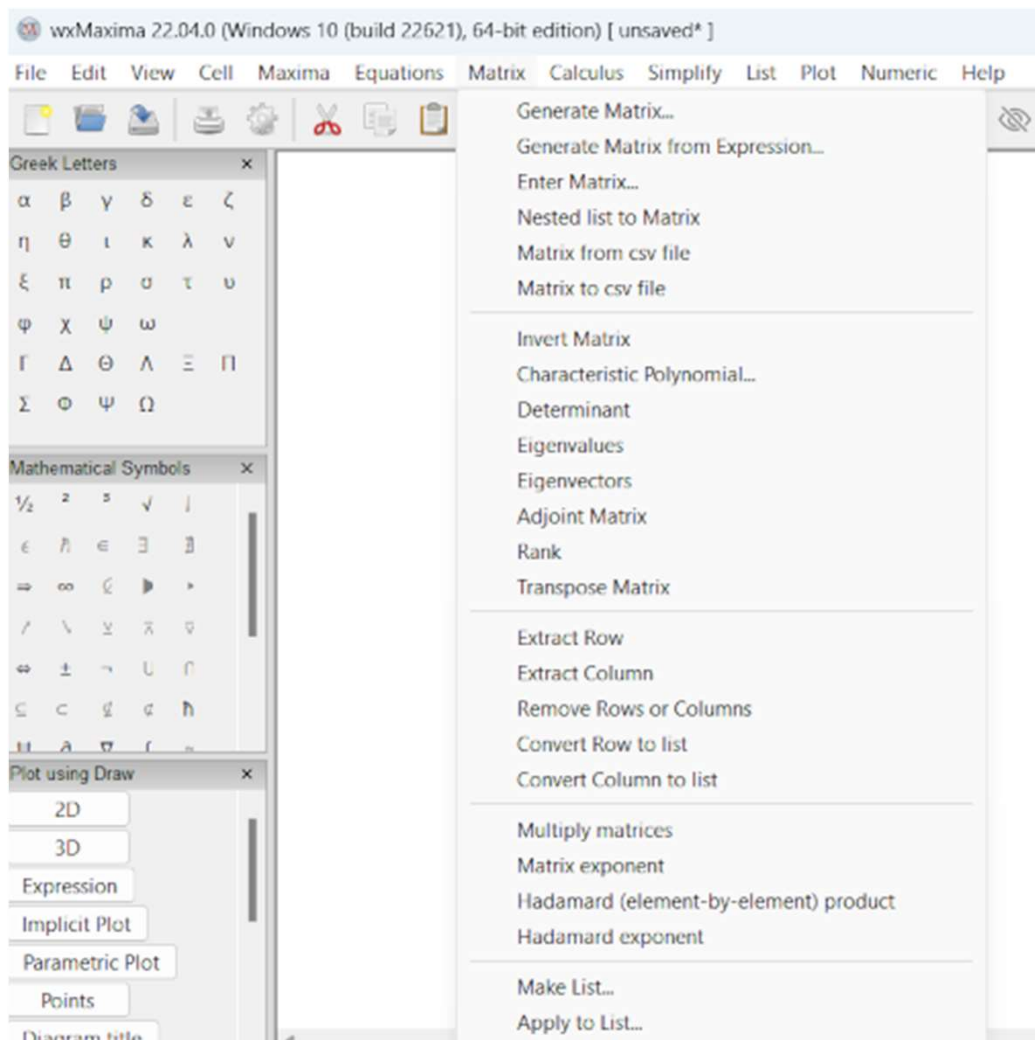
One of the examples is matrices and systems of linear equations. This looks very complicated to students because they were not dealing with matrices earlier and there is only a small number of classes to consider this material, and it is really new kind of problems for them. And that's the moment when Computer Algebra Systems (CAS) come to help.
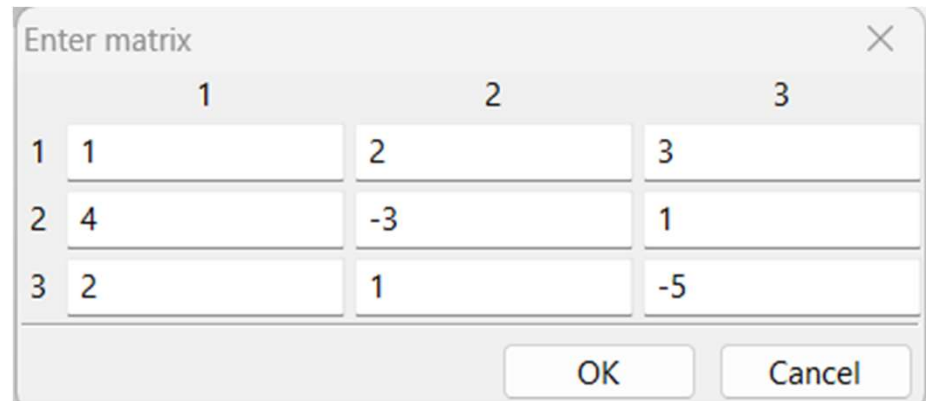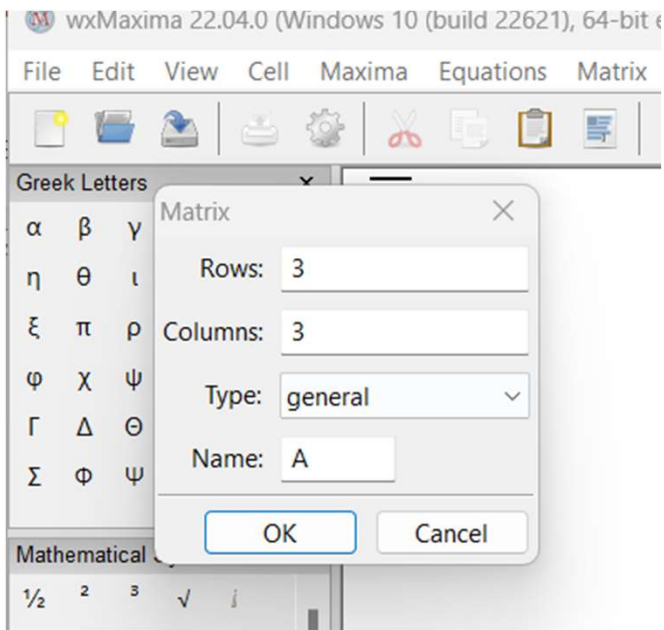
Reasons for choosing Maxima

- Free for users
- Good Graphic User Interface
- Easy to install
- Easy to use
- Is available for Windows, Android, Mac

We explain in the class basic operations on matrices for small sizes. After students get the basic knowledge, Maxima is recommended to use to check the answers received manually and/or to work with more complicated problems.

For example, students can find inverse matrix for matrices with the size 3x3 or higher, solve not only linear systems of the order 2 or 3, but also higher order systems.
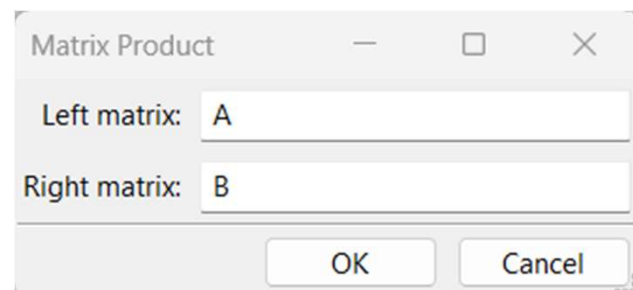
wxMaxima 22.04.0 (Windows 10 (build 22621), 64-bit

File   Edit   View   Cell   Maxima   Equations   Matrix

Greek Letters

α	β	γ
η	θ	ι
ξ	π	ρ
φ	χ	ψ
Γ	Δ	Θ
Σ	Φ	Ψ

Mathematical

½   ²   ³   √   i

Matrix

Rows: 3

Columns: 3

Type: general

Name: A

OK   Cancel

Enter matrix

	1	2	3
1	1	2	3
2	4	-3	1
3	2	1	-5

OK   Cancel

(%i1) A: matrix(
       [1,2,3],
       [4,−3,1],
       [2,1,−5]
       );

(%o1) $\begin{pmatrix} 1 & 2 & 3 \\ 4 & -3 & 1 \\ 2 & 1 & -5 \end{pmatrix}$

determinant(A);

88

(%i6) B:invert(A);

(%o6) $\begin{pmatrix} \dfrac{7}{44} & \dfrac{13}{88} & \dfrac{1}{8} \\ \dfrac{1}{4} & -\dfrac{1}{8} & \dfrac{1}{8} \\ \dfrac{5}{44} & \dfrac{3}{88} & -\dfrac{1}{8} \end{pmatrix}$

Matrix Product — □ ✕

Left matrix: A

Right matrix: B

OK   Cancel

(%i7) A.B;

(%o7) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(%i1) A: matrix(
[1,2,3],
[4,−3,1],
[2,1,−5]
);

$$(\%o1) \quad \begin{pmatrix} 1 & 2 & 3 \\ 4 & -3 & 1 \\ 2 & 1 & -5 \end{pmatrix}$$

(%i10) C: matrix(
[2,0,3],
[4,−5,1]
);

$$(\%o10) \quad \begin{pmatrix} 2 & 0 & 3 \\ 4 & -5 & 1 \end{pmatrix}$$

(%i13) C.A;

$$(\%o13) \quad \begin{pmatrix} 8 & 7 & -9 \\ -14 & 24 & 2 \end{pmatrix}$$

(%i12) A.C;

MULTIPLYMATRICES: attempt to multiply nonconformable matrices.
 -- an error. To debug this try: debugmode(true);

(%i14) D: matrix(
    [−3,2,1],
    [7,3,−5]
);

(%o14) $\begin{pmatrix} -3 & 2 & 1 \\ 7 & 3 & -5 \end{pmatrix}$

(%i10) C: matrix(
    [2,0,3],
    [4,−5,1]
);

(%o10) $\begin{pmatrix} 2 & 0 & 3 \\ 4 & -5 & 1 \end{pmatrix}$

(%i15) 2·C+3·D;

(%o15) $\begin{pmatrix} -5 & 6 & 9 \\ 29 & -1 & -13 \end{pmatrix}$

(%i18) E:transpose(C);

$$(\%o18) \quad \begin{pmatrix} 2 & 4 \\ 0 & -5 \\ 3 & 1 \end{pmatrix}$$

(%i19) C.E;

$$(\%o19) \quad \begin{pmatrix} 13 & 11 \\ 11 & 42 \end{pmatrix}$$

(%i20) E.C;

$$(\%o20) \quad \begin{pmatrix} 20 & -20 & 10 \\ -20 & 25 & -5 \\ 10 & -5 & 10 \end{pmatrix}$$

Students can use Maxima to deal with problems that are hard to solve in mind or by hand, they can quickly check correctness of solutions, experiment with different modifications of the original problem (parameter changes, etc.)

Easy way to check results of manual calculations with Maxima increases students' confidence in the case solutions are correct and helps to find the error if there is disagreement between results of manual solution and the one obtained by computer.

Students experience with Maxima

- from "was not using and don't plan to use" to "Wow! It's so easy! Will be using it all the time!"

Thank you for attention!