Maxima in Teaching Basic Matrix Algebra

Tatiana Mylläri and Aleksandr Mylläri

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

Introduction

Modern technology changes the way to do mathematics and to teach mathematics [1, 2]. As we have reported earlier [3, 4], 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 College 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 the linear equations. This looks very complicated to students especially because 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. We have reported earlier that Maxima was chosen for using in teaching Math in SGU since it is powerful and free of charge. In the class we explain basic operations on matrices for small sizes. After students get the basic knowledge, Maxima is recommended to use to check the answers received manually 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 size systems.

After students start to use Maxima they realize that in fact it is not so complicated as they were thinking a priory and students feel more relaxed and confident when dealing with this kind of problems. Also, teacher has more time to consider additional examples because it is enough to consider only simple cases in the class.

Maxima for Windows has very convenient GUI wxMaxima, and it is very easy to declare matrix as it is presented on Figure 1. Matrix elements could be

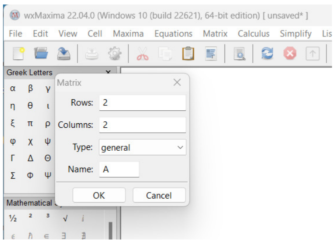

FIGURE 1. Declaration of matrix A

some parameters, not necessarily numbers (Figure 2). Using Maxima, it is easy to

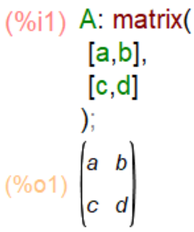

FIGURE 2. Initialization for the matrix

calculate the determinant of the matrix (Figures 3, 4). By default, the command for the determinant appears with the % (result of the last operation), but the % can be replaced by the name of the matrix (Fig. 4, right). We can use Maxima

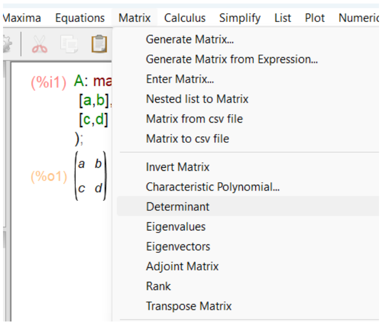

FIGURE 3. GUI for calculation of the determinant of the matrix

```
(%i2) determinant(%);
(%o2) a d−b c
```

```
(%i3) determinant(A);
(%o3) a d−b c
```

FIGURE 4. Calculation of the determinant of the matrix

```
(%i5) invert(A);
```

$$(\%o5)\quad \begin{pmatrix} \frac{d}{a\,d-b\,c} & -\frac{b}{a\,d-b\,c} \\ -\frac{c}{a\,d-b\,c} & \frac{a}{a\,d-b\,c} \end{pmatrix}$$

FIGURE 5. Inverse of the matrix

to find the inverse of the matrix (Figure 5). It is also very easy to calculate some algebraic expressions for matrices (Figure 6).

```
(%i6) B: matrix(
       [1,2,3],
       [4,−3,−5]
      );
```

$$(\%o6)\quad \begin{pmatrix} 1 & 2 & 3 \\ 4 & -3 & -5 \end{pmatrix}$$

```
(%i7) C: matrix(
       [−2,1,3],
       [2,−4,5]
      );
```

$$(\%o7)\quad \begin{pmatrix} -2 & 1 & 3 \\ 2 & -4 & 5 \end{pmatrix}$$

```
(%i10) 2·B+3·C;
```

$$(\%o10)\quad \begin{pmatrix} -4 & 7 & 15 \\ 14 & -18 & 5 \end{pmatrix}$$

FIGURE 6. Algebraic expression of matrices

Maxima can be used also to find the transpose matrix or to calculate the product of matrices (Figure 7).

```
(%i11) D:transpose(C);
```

$$(\%o11)\quad \begin{pmatrix} -2 & 2 \\ 1 & -4 \\ 3 & 5 \end{pmatrix}$$

```
(%i12) E: B.D;
```

$$(\%o12)\quad \begin{pmatrix} 9 & 9 \\ -26 & -5 \end{pmatrix}$$

FIGURE 7. Transpose matrix and product of matrices

We hope that with the use of technology students will be motivated to learn Math concepts in the learning environment.

References

[1] Vavilov N. A. *Computers as fresh mathematical reality. I. Personal account. Computer Tools in Education (2)*, pp. 5-26, 2020.

[2] Vavilov N. A., Halin V.G., Yurkov A. V. *Mathematica for non-mathematician:* University textbook, Moscow, 2021 (in Russian)

[3] Hypolite S., Mylläri A. *Use Of Computer Algebra Systems In Teaching Math At SGU.* Computer tools in education, pp. 96 - 100, No 3, 2021.

[4] Hypolite S., Mylläri T. *Teaching Math in SGU with Computer Algebra Systems.* In International Conference Polynomial Computer Algebra 2022, St. Petersburg department of Steklov Institute of Mathematics, RAS,, pp. 37 -39, 2022.

Tatiana Mylläri
SAS
St.George's University
St.George's, Grenada, West Indies
e-mail: `tmyllari@sgu.edu`

Aleksandr Mylläri
SAS
St.George's University
St.George's, Grenada, West Indies
e-mail: `amyllari@sgu.edu`