Т.ШИРИН, В.Ф.БАБАК

E-mail: ksucta@elcat.kg.

PROGRAMMING WITH "MAXIMA" FOR EDUCATION

Компьютердик Алгебра Системасы (КАС) математика жана инженерия илимдерин сабак берүүдө жана изилдөөдө чоң таасир тийгизди. Аларды туура колдонгондо, көп маселелерди чечип берет, мисалы оор маселелерди чечүү, визуализация, сабакка машыгуу жана мотивация кылуу. «Maxima» ар бир колдонуучуга «өз эсептөөлөрүн» түзүү мүмкүнчүлүгүн пайда кылат. Бул макалада биз КАСтын билим берүү тармагында колдонулуусу жөнүндө баяндадык, программа түзүү методдорун жана вектордук алгебрадагы кээ бир мисалдарды көрсөттүк.

Системы Компьютерной Алгебры (СКА) положительно влияют на преподавание и изучение математики и инженерии. При правильном использовании они могут быть исспользованы для решения многих задач, таких как решение сложных задач, визуализация, упражнения и мотивация к учебе. "Maxima" представляет возможности создания "собственных вычислений" для любого пользователя. В этой статье даются методы использования СКА в образовательных целях и показаны методы программирования и некоторые примеры в векторной алгебре.

Computer Algebra Systems (CASs) are affecting positively teaching and learning of mathematics and engineering. If they are used in correct way, they can be a cure for many challenges such as; solving complex problems, visualization, exercising and motivation in studying. "Maxima" presents the possibilities to set up "own computations", to any user. In this paper, we mentioned about the educational use of CASs and showed programming methods and gave some examples in vector algebra.

1. Introduction:

Some negative results of traditional; "teacher centered and *old style curriculum*-based" teaching model, have been forcing educators to change the methods of teaching and learning and redesign the curriculum. In the new style, lecturers are becoming "facilitators of learning", guiding students to reach of the "result" of the lesson by themselves. They are encouraging the students explore and supporting them share ideas with other relaters. This "constructivist" process aims to teach the students "learn by doing". The curriculum has being redesigned according to "personal, group and direct instruction" methods /1, 2/.

Computers are seen as "good tools" in sliding the education to more constructivist style. They are used to support and provide personal instruction; learning by doing and corporative studies. It has also time component. Any user can repeat his course at any time/where he/she wants. Computers offer drill and practice to students, making broadened lecturer's presentations by using the simulations and graphical

representations. CAS also give students immediate feedback and answers to the questions and make mathematics enjoyable and interesting /3/.

2. Principles for a successful CAS session in the classroom

Allen et al. declared some principles that lecturers must pay attention, for a successful CAS session in the classroom as;

    1- Motivate the students:

Lecturers must explain the importance of use of CAS to the students and the benefits of "CAS use" in their courses.

    2- Convince students:

Lecturers must explain the importance of CAS in detail. Beside the introductory examples and the use of CAS for simple operations, lecturer must give examples for further/ complex examples with CAS. Students must understand "the advantages of use of CAS" for their overall studies.

    3- Be a perfect example in using CAS.

Lecturers must be well prepared for CAS demonstrations. Mistakes and hesitations of lecturers discourage the students to use CAS.

    4- Evaluate students' works:

Lecturers must give "mark" for students' CAS studies. This enhances the motivation of students to study with CAS.

    5- Move step by step:

Examples and demonstrations must be at the students' level. Presentations with CAS must be given step by step; from easier to complex ones.

    6- Short Periods:

Demonstrations must be short. Students can lose their attention during long demonstrations.

    7- Make available in the classroom your works:

Lecturer must make available to students worksheets and demonstrations used in the classroom.

    8- Be an expert user of CAS:

Lecturers must be an expert user of CAS. Lecturers do not "wing it!"/4/.

We can understand that preparation for a CAS session is very important and detailed work for a lecturer. This is a reason for the lecturers who are not "expert user of CAS" to avoid the use CAS in the classroom.

Kutzler, put forward 4 basic ideas about the use of technology;

    1- Using technology makes us dealing with (more) ***complex and more realistic problems***,

    2- "***Experimentation***" in learning: "*It enables students to experiment within almost all topics treated in mathematics teaching. There is no limit to the number of examples, which, the student can do and the electronic assistant guarantees the properness of the results. The great genius*

Johann Wolfgang Goethe called for „learning through doing and observing“. Using algebraic calculators we can now meet Goethe's demand".

3- "***Visualization*** capabilities of graphic calculators/computers". He said, "*When using a calculator as a visualization tool, the immediate feedback is of central importance. If you enter into your calculator, for example, x^2, then press the right key, the corresponding graph appears only fractions of a second later. The resulting picture can be discussed; the graph can be associated with the expression, etc.*"

Table 1
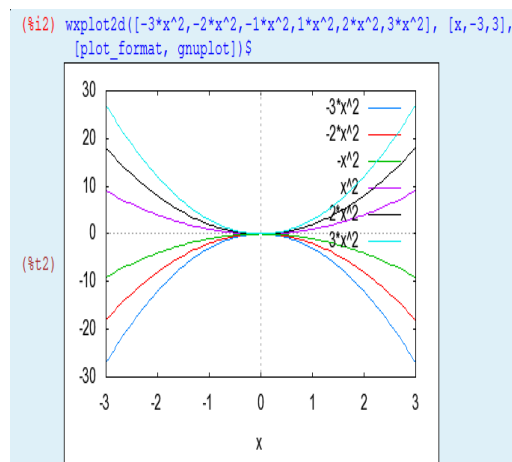
4- It provides ***motivation*** "*for the following exercises*" to the students.

He finished his words by saying, "*Not technology changes teaching, but technology is a catalyst for teachers to change their teaching methods and focus on topics and skills, aiming at a better teaching of mathematics*"/5/.

3. Maxima

"Maxima" is a full symbolic computation program. It is full featured doing symbolic manipulation of polynomials, matrices, rational functions, integration, and graphing. It has a symbolic debugger, source level debugger for maxima code. It is quite reliable, and has good garbage collection, and no memory leaks. It comes with hundreds of self-tests.

"Maxima" is perhaps the most popular general-purpose open source CAS. (David Joyner, 2006) Its latest release is 5.23.2. (11.04.0, in April 2011) "Maxima" is *copyleft* -free-version of descendant of trademark, the "*legendary*" , DOE-Macsyma. It was developed in the late 1960s at the Massachusetts Institute of Technology (MIT). "Maxima" was maintained by William Schelter from 1982 until he was dead in 2001. In 1998, he obtained permission to release the source code under the GNU General Public License (GPL). It was his efforts and skill, which have made the survival of Maxima possible. It is the most common used open source CAS. MACSYMA was revolutionary in its time, and many later systems, such as Maple and Mathematica, were inspired by it. It is written in LISP. "Maxima" is code based. Therefore, any-user can prepare its own package easily. In our work, we prepared some ".mac" files that are not included in its libraries. We showed the ways of "how to prepare your own .mac file for your own purposes". It is still

being developed by a group of volunteers. It can be downloaded from the website of "http://maxima.sourceforge.net"

"Maxima" includes a complete programming language with ALGOL-like syntax but Lisp-like semantics, so it can readily be used for teaching programming and computer algebra. It uses "gnu- plot" for drawing. Since Maxima is written in Common Lisp, it is easily accessed programmatically and extended, as the underlying Lisp can be called from Maxima /6/.

4. Examples of Programming with "Maxima"

Here we give four examples that are most commonly used in "vector algebra lectures". The first way of use "Maxima" is writing and showing codes in detail. But, if you make it a ".mac" file it will be your "own- .mac" file to use in the lectures. We represent here two ways with examples:
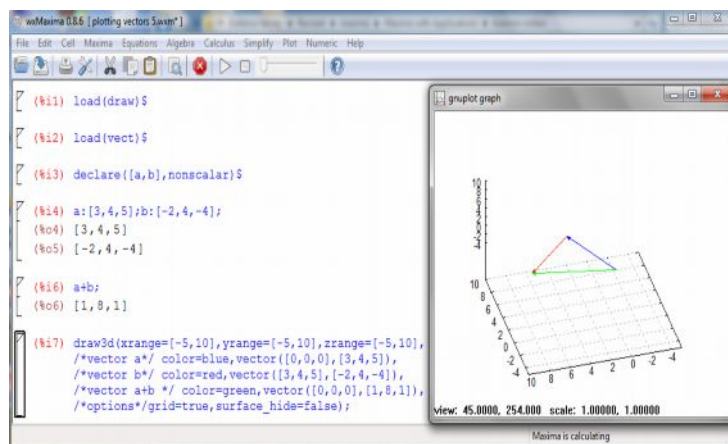
Example 1: Plotting two vectors in3-D and sum (resultant) of them with parallelogram method:

Table 2
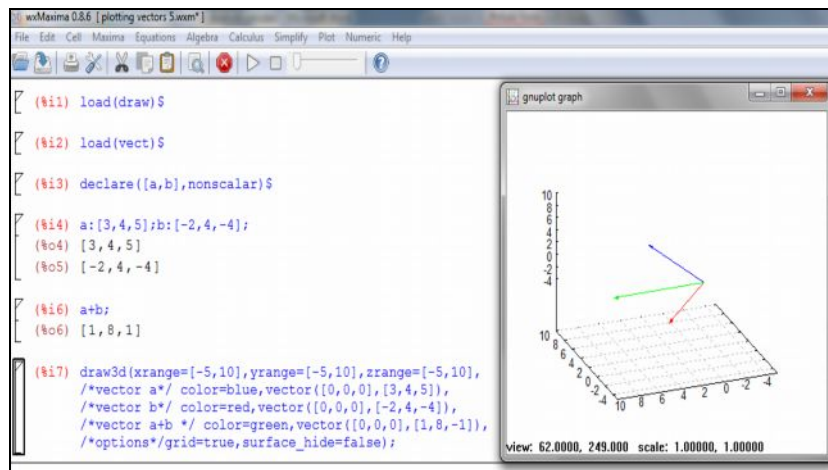
Example 2- Plotting two vectors in3-D and sum (resultant) of them with triangle method:

Table 3

Plotting vectors can be done as shown above. Any user can set up his/her own ".mac" file to do the operations with "a few click" as shown below.

(%i2) vect3dtr(x1,y1,z1,x2,y2,z2):=(display(c:[x2+x1,y2+y1,z1+z2]), load(draw),draw3d(xrange=[-(abs(x2)+abs(x1))-2,2+abs(x2)+abs(x1)],yrange=[-(abs(y2)+abs(y1))-2,2+abs(y2)+abs(y1)], zrange=[-(abs(z2)+abs(z1)) - 2,2+abs(z1)+abs(z2)],color=blue, vector([0,0,0],[x1,y1,z1]),color= red, vector([0,0,0],[x2,y2,z2]),

color=green,vector([0,0,0],[x2+x1,y2+y1,z1+z2]),grid=true,surface_hide=false))

(%i3) vect3dpr(x1,y1,z1,x2,y2,z2):=(display(c:[x2+x1,y2+y1,z1+z2]),load(draw),draw3d(xrange=[-(abs(x2)+abs(x1))-2,2+abs(x2)+abs(x1)], yrange=[-(abs(y2)+abs(y1))-2,2+abs(y2)+abs(y1)], zrange=[-(abs(z2)+abs(z1))-2,2+abs(z1)+abs(z2)],color=blue,vector([0,0,0],[x1,y1,z1]),color= red,vector([x1,y1,z1],[x2,y2,z2]), color=green, label(["Resultant",(x2+x1)/2,(y1+y2)/2,(z1+z2)/2]), vector([0,0,0],[x2+x1,y2+y1,z1+z2]),grid=true,surface_hide=false))

For two dimensional vectors:

(%i4) vect2dpr(x1,y1,x2,y2):=(display(c:[x2+x1,y2+y1]),load(draw), wxdraw2d(xrange=[-(abs(x2)+abs(x1))-2,2+abs(x2)+abs(x1)],yrange=[-(abs(y2)+abs(y1))-2,2+abs(y2)+abs(y1)], color=blue,head_length=0.5,vector([0,0],[x1,y1]), color=red,head_length=0.5, vector([x1,y1],[x2,y2]), color=green, label(["Resultant",(x2+x1)/2,(y1+y2)/2]), head_length=0.5,vector([0,0],[x2+x1,y2+y1]), grid=true,surface_hide=false))

(%i5)vect2dtr(x1,y1,x2,y2):=(display(c:[x2+x1,y2+y1]),load(draw), wxdraw2d(xrange=[-(abs(x2)+abs(x1))-2,2+abs(x2)+abs(x1)], yrange=[- (abs(y2)+abs(y1))-2,2+abs(y2)+abs(y1)], color=blue,head_length=0.5,vector([0,0],[x1,y1]), color=red, head_length=0.5,vector([0,0],[x2,y2]), color=green,head_length=0.5, label(["Resultant",(x2+x1)/2,(y1+y2)/2]), vector([0,0],[x2+x1,y2+y1]), grid=true,surface_hide=false))

After writing as shown above, then "SAVE AS" from "file menu", "vectorsum.mac" file. Now you get "small package" program for your lectures.

4. Conclusion:

Computer Algebra Systems are enhancing the lectures. The main problem with them how use them and expensiveness of the programs such as Maple, Matlab and Mathematica. "Maxima" is a good alternative to them. If it is not included in its "libraries", you can easily set up your "myown.mac" files for your sessions with many "commas".

References:

1. Pierce R., & Stacey, K., A framework for monitoring progress and planning teaching towards the effective use of computer algebra systems. International Journal of Computers for Mathematical Learning, 9, 2004, P: 59 – 93.

2. D'Souza, Sabita and Wood, Leigh, *Engineering students' views of computer algebra systems,* Symposium presentation in UniServe Science Blended Learning Symposium Proceedings, 2005.

3. Silver A., Foundations for cognitive theory and research for mathematics problem solving. In A. H. Schofield E.D. Cognitive science and mathematics education. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Publishers, 1987.

4. Allen, G. D., Herod, J., Holmes, M., Ervin, V., Lopez, R., Marlin, et al., Strategies and guidelines for using a computer algebra system in the classroom. International Journal of Engineering Education, 15(6), 1999, P: 411 – 416.

5. *Kuztler Bernard, The Algebraic Calculator as a Pedagogical Tool for Teaching Mathematics,* Paper presented at the T3 Worldwide Conference. Tokyo, Japan, 2000.

6. Maxima Manual