Gaussian Elimination with Parameters

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Basic mathematics courses, at all levels, involve *many* opportunities to include CAS packages like *Mathematica* [2], Maple [1], REDUCE [3], Sage [4], amongst many others. Computer algebra packages assist with the preparation of:

- classroom slides/notes,

- individualized homework assignments,

- in-class, randomized quizzes,

- class projects,

- extra-credit, further reading,

- final examinations,

- etc.

In this paper we discuss an aspect which affects all of the areas above, i.e., that of solving Gaussian elimination with parameters, in particular for the teaching of basic, first-semester linear algebra.

Right from the beginning of the semester, students are shown how to perform row reduction. As we know, they need to show that there are either no solutions, one unique solution (and what it is), or an infinite number of solutions (and what they are). Are the standard functions of the available packages prepared to show these three possibilities?

The linear systems are then "complicated" by including input parameters. The students need to continue to solve these systems, and specify, based on the input parameters, the same three questions above. Again, do the standard, available functions supply all of the necessary solutions? As we shall show, not all solutions and special cases are covered.

Three approaches are presented (using *Mathematica*), including one which gets back to basic, row reduction. We compare these, demonstrating that some have more satisfying results than the others, handling all special cases, and *not* unnecessary ones.

We end off with applying a final approach to most of the exercises posed in the remainder of the linear algebra course.

Keywords

References

Maple at `www.maplesoft.com/products/Maple`
Mathematica at `www.wolfram.com/mathematica`
REDUCE at `reduce-algebra.com`
Sage at `www.sagemath.org`