

## ADOPTING MAXIMA AS AN OPEN-SOURCE COMPUTER ALGEBRA SYSTEM INTO MATHEMATICS TEACHING AND LEARNING

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### Short description of the workshop: aims and underlying ideas

*In this workshop, a computer algebra system (CAS) Maxima will be introduced. The primary audience of this workshop is mathematics educators, particularly school teachers and university professors who have experience in teaching Calculus and Linear Algebra with a CAS and those who would like to introduce a possible alternative CAS into their classrooms. Maxima is a computer software can be used for the manipulation of symbolic and numerical expressions, including limit calculation, differentiation, integration, Taylor series, systems of linear equations, polynomials, matrices and tensors. It can also sketch some graphical objects with excellent quality. Some examples from Calculus will be presented and how Maxima plays a role in enhancing students' understanding will also be discussed.*

### Planned structure:

The planned structure of the workshop is presented as follows.

Planned time line	Topic	Material/Working format/Presenter
5 minutes	Introduction	Material: Slide Working format: Presentation Presenters: N. Karjanto
5 minutes	<i>Maxima</i> installation Participants can install <i>Maxima</i> to their computers or smartphones	Material: Printed handout Working format: Audience participation Presenters: N. Karjanto and H.S. Husain
5 minutes	Brief demonstration	Material: Slide Working format: Demonstration Presenter: N. Karjanto
5 minutes	Sharing session Participants share experience in embedding CAS into their teaching	Material: – Working format: Audience participation Presenters: N. Karjanto
60 minutes	Problem-solving Some problems from Calculus or Linear Algebra will be discussed. Good examples that help students to learn better will be identified.	Material: Slide and <i>Maxima</i> worksheet Working format: Audience participation Presenters: N. Karjanto and H.S. Husain
10 minutes	Conclusion	Material: – Working format: Discussion Presenters: N. Karjanto and H.S. Husain

During the problem-solving session, the participants will be divided into two groups. One group will work on Calculus and the other will work on Linear Algebra. After 25–30 minutes, the groups will switch the topics. The group works on Calculus will now works on Linear Algebra and vice versa. Instead of three topics that were initially proposed earlier, we now propose only two topics, namely Calculus and Linear Algebra. The topic on Arithmetic can be included in the beginning of the session or during the brief introduction of the workshop.

During the problem solving session, the participants will be assigned to solve problems from Calculus and Linear Algebra. In addition, they are also strongly encouraged to identify good examples in assisting the students to understand better particular mathematical concepts using *Maxima*. The following is potential examples that can be discussed during the workshop:

- How to help your students to comprehend better the Fundamental Theorem of Calculus using *Maxima*? Provide concrete examples.
- Using Taylor series expansion and graphical plots, help your students to understand polynomial approximation and an interval of convergence of the corresponding series.
- Assisting students to grasp the meaning of linear (in)dependent in generalized vector space using *Maxima*. Provide some easy-to-understand examples.
- Show how linear transformation affecting the shape of certain geometrical objects.

Since the organizing committee will not be able to provide a computer lab and a technical assistant, we propose the following strategy. Each group is divided into several teams, where participants can work in a small team of size two or three. A minimum of one laptop or tablet in each team is desirable. The participants should have installed *Maxima* in their respective devices. Participants who need an assistance in installing *Maxima* can be shown a quick demonstration in the beginning of the workshop. Currently, *Maxima* can run on the following operating systems natively without emulation: *Windows*, *Mac OS X*, *Linux*, *BSD*, *Solaris* and *Android*. The installation file for *Windows* operating system is available for download at <http://sourceforge.net/projects/maxima/files/Maxima-Windows/>. Simply double click the executable file and follow the installation instruction. After the installation is completed, the software is ready to be launched. The whole process takes less than three minutes in total.

## References

<http://maxima.sourceforge.net/>

<http://www.linuxjournal.com/content/exploring-advanced-math-maxima>

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