

Open Source Mathematical Software in Teaching

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Abstract

I have been using mathematical software in my teaching for a long time, and have created tools such as SageMath and CoCalc to make this easier for others.

I'll describe some of my experience over the years, then demo examples of how to use mathematical software in teaching.

Experiences

- ▶ UC Berkeley number theory grad student:
 - ▶ used and wrote math software for number theory research.
- ▶ Harvard:
 - ▶ taught undergrad and grad classes using math software.
 - ▶ started Sage, a Python-based free open source competitor to Mathematica, Maple, Matlab, and (especially!) Magma.
- ▶ UCSD:
 - ▶ Sage development gained momentum.
- ▶ Univ of Washington:
 - ▶ taught using Sage, from high school through grad school.
 - ▶ started CoCalc, which is a collaborative web application for using free open source math software.

Observations

- ▶ I'm a research mathematician who loves computer software because *it makes mathematics much more accessible and fun.*
- ▶ Hand calculation in math can be painful and tedious to do correctly: computing gcd's, differentiation, symbolic integration, echelon forms, drawing plots, composing permutations, ...
- ▶ Students get frustrated by being forced to become proficient at basic calculation before falling in love with mathematics.

A Sage Worksheet...

CoCalc is a way to use open source mathematical software that solves a bunch of problems:

- ▶ **Installation:** students do not install anything; can use Sage, LaTeX, on old laptops, tablets, etc.
- ▶ **Collaboration:** multiple simultaneous editing of Sage worksheets, etc.
- ▶ **Course management:** distribute assignments to students, collect, grade, return.
- ▶ **Virtual computer lab:** Watch and help students working in realtime and chat with them.
- ▶ **Reproducibility:** complete history of session is saved, so you never lose anything and can see exactly how you got there.