MAA PREP REPORT: "SAGE: USING OPEN-SOURCE MATHEMATICS SOFTWARE WITH UNDERGRADUATES" (ONLINE WORKSHOP, SUMMER 2011)

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1. Short Description of Program

The Sage PREP program was an online workshop organized and led by Karl-Dieter Crisman and Jason Grout. The program was spread throughout the summer. The online group video conferences consisted of two 2-hour sessions on each of four days: 24 May, 7 June, 14 June, and 21 June, 2011. Blackboard Collaborate (formerly Elluminate) servers provided conferencing technology and a Sage server at the Math Association of America provided the mathematics software (including collaboration/sharing capabilities). Additionally, online office hours were held between group sessions and an email list was used to carry on discussions.

The core references for our workshop were a set of specially-created tutorials covering a variety of areas in Sage. See `http://wiki.sagemath.org/prep/2011/` for the main workshop page, `http://wiki.sagemath.org/prep/2011/sessions` for the session schedule and information page, and `http://sage.maa.org/pub/` for the workshop Sage server, including a listing of shared tutorials and participants' published worksheets (this workshop server may soon be renamed to `http://sagenb.maa.org/pub/`). Participants also referenced the standard documentation of Sage, including the official tutorial and reference (available at `http://www.sagemath.org`).

The participants had a summer-long goal of learning enough about Sage to produce two worksheets for use in one of their fall courses. The participants mostly achieved this, and (as last summer) some went far above and beyond this.

This is the second year that a Sage PREP workshop has been funded, and many of the comments below will mention how the 2011 Sage PREP workshop improved on the 2010 Sage PREP workshop.

2. Attendance

We had 25 participants enrolled. All of these attended most of the sessions, with perfect attendance for the first session. We had several participants who had previously-unannounced absences (including to teach classes!), which was frustrating since one of our criteria for accepting people was whether they would be able to make all of the sessions. However, these participants reappeared after their family or work events and interacted with us as much as others. This was an improvement on the 2010 workshop.

As with the previous workshop, some people who missed one or two group sessions or were not as active in the formal sessions asked for help and advice on the email list or in online office hours. The recorded videos of the group sessions helped participants to catch up or review concepts; for example, one participant missed the final sessions due to being on a jury in a capital murder case, but he still watched the videos later and had questions about using R in Sage.

3. Preparatory Component

Before the initial day of the workshop, participants were asked to open and work through two basic tutorials in Sage, one being absolutely introductory (e.g., how to log into Sage and compute simple addition problems) and one involving basics of functions and plotting. We also signed participants up to the workshop's MAA email listserv and requested they bring questions to that forum. Participants were asked to test the video conferencing software (BB Collaborate) and to create accounts on the Sage server for the workshop.

The introductory day of the workshop (24 May) involved two video conference sessions. After introductions, about half of the time was spent reviewing the introductory worksheets to make sure all participants were on board with the most basic functionality. The other half was mostly split between introducing participants to the resources available for Sage, and having the first of several roundtable discussions among leaders and participants about effective use of technology in the classroom. At the conclusion of last year's workshop, we strongly felt that the conversation about effective use of technology should be started on the first day. We felt that this worked very well this year. This first discussion focused on grading technology assignments and stimulated many mailing list posts following the videoconference.

After the first day, participants were asked to work through a calculus tutorial and create a very simple worksheet to prepare for the intensive component of the workshop. We also hosted online office hours to address participant questions, in addition to being available via the mailing list.

As in the 2010 program, the preparatory component of the program was very successful. The participants were highly motivated and brought a wide range of experience using the internet and computers in the classroom. Everyone (including us leaders) learned a lot the very first day about Sage and different ways to use technology in the classroom.

The two weeks between this component and the intensive component of the workshop was sufficient for people to experiment with and at least be comfortable with basic things in Sage (and many people experimented with more advanced features of Sage). One activity that spawned a lot of discussion on the mailing list during this time was requesting each participant to email the list with a question. Active discussions ensued which ranged from using technology in teaching to different features in Sage.

4. Intensive Component

The intensive component consisted of three one-day sessions, each separated by a week. These took place on 7 June, 14 June, and 21 June. Each day consisted of two 2-hour online sessions. We also hosted two hours of 'office hours' each week at a variety of times we hoped would be equally accessible on each coast.

The improvements we made in the schedule this year resulted in a much more successful intensive component compared to last year. For almost all participants, the regular pacing of a session each week was frequent enough to maintain a high level of interest and activity both during and between sessions, but not overwhelming regarding new content and topics. The general enthusiasm and sense of investment was much higher than in 2010. Many participants contributed major ideas or a slew of references to discussions both during sessions and on the email list. Because several participants were from the same institution or knew each other previously, there was also a lot of esprit de corps.

We tried hard to make each workshop day well-balanced for a variety of interests. In general, each day had most of the following components.

(1) At least one discussion among all participants about some pedagogical issue involving technology
(2) Some introductions to using Sage in specific sub-disciplines of undergraduate mathematics
(3) Additional tutorials or class-tested demonstrations provided by the leaders
(4) Participant demonstrations of their own created worksheets

We will elaborate on each of these components in turn.

(1) **Pedagogical discussion:** Nearly all participants had meaningful contributions in terms of questions or ideas during the actual sessions. We believe a small minority were unfamiliar enough with using computers in this context that they did not participate very much, but we contacted each of these individually and are satisfied that they were content to listen and learn, trying things out on their own time. As with the 2010 program, it was very helpful to once again have several participants with significant experience using computers in the classroom.

   The most popular discussion by far was a quite long one about ways to avoid technology becoming a crutch, which really broadened the scope of discussion beyond simply using software.

(2) **Sage introductions:** The 'quickstart' introductions and other tutorials from the 2010 workshop were updated and refined, but in general held up quite well, and we were very pleased at their reception. In several instances, we immediately incorporated answers to questions people asked. It was sometimes difficult to guess which subject introduction would be most popular on a given day, even after we explicitly asked the participants to vote on topics, but the multivariate and single-variable calculus ones were, unsurprisingly, among the most popular.

(3) **Additional material:** The additional demos and tutorials were very well received. There was a lot of interest and technical questions especially about setting up a Sage server and using SageTeX (a package to use Sage inside of LaTeX) to help create tests.

   Several of our participants are involved heavily in the WeBWorK project (including Michael Gage, the cofounder of WeBWorK), and we were especially pleased to have Michael give a great introduction to WeBWorK, highlighting some of the work that's been done toward making Sage and WeBWorK integrate more easily. The founder of Sage, William Stein, also gave a brief presentation on the history and future of Sage.

(4) **Participant demos:** By the end of the preliminary session, many participants had concrete ideas about what they wanted to work on, and over the next two weeks quite a few shared their worksheets with us and each other. Even the first of the intensive sessions had two great worksheets shared by participants: one demonstrating how to do a useful Mathematica command which is a little harder to find in Sage, and the other demonstrating an interesting limit concept.

   We were very impressed with the creative ways that the participants approached classroom examples with Sage, especially in using Sage to show pitfalls of blindly trusting in finite precision arithmetic and ignoring round-off errors. Two participants made several useful worksheets for college algebra/precalculus, a current weak spot in available Sage resources.

   Of course, not all participants shared worksheets with the others – there hardly would have been time – but probably just over half did at one point or another, and nearly everyone else shared something with the organizers. The final day included participant demos from a variety of disciplines, including business math, number theory, vector calculus, statistics,

and probability. Again, we want to emphasize that we felt a lot of creativity and enthusiasm from the participants in these worksheets.

A final comment is in order regarding one thing we think helped the workshop. Five participants were able to join the workshop leaders and many other people in Seattle for a separate "Sage Education Days" (which was funded by the NSF-funded UTMOST grant, `http://utmost.aimath.org`, which is sponsoring three of the PREP participants to implement open-source curriculum and software in their classrooms). This face-to-face meeting of five participants with the leaders gave energy and camaraderie to the whole workshop and led to several participants being confident and able to help answer each others' questions on the email list. It would be interesting to explore how online sessions and face-to-face sessions might enhance each other in future PREP workshops. For example, having an online preparatory day two weeks before a shortened face-to-face workshop might be a very interesting format to try.

5. Follow-up Component

There are several follow-up activities that we have incorporated. Most importantly, at the beginning of the workshop, the participants were supposed to commit to using Sage in a particular course immediately after the workshop in the fall. We have already initiated follow-up at this writing (early August) and will encourage participants to continue to follow up on the email list for ideas and help. Because of the long period between the workshop and the fall semester, we believe the workshop mailing list will be a valuable resource to help participants use Sage effectively.

We plan to organize a somewhat informal meeting at the Joint Meetings in January 2012 to discuss experiences. This proved to be very helpful last winter for the 2010 workshop, and also led to improvements for the 2011 workshop and in Sage.

6. Successes and Improvements

Technical aspects. As in the 2010 workshop, we felt that the technical side of things went very well. Instead of using an 'official' Sage server hosted at the University of Washington, we configured a server the MAA provided, which worked well. We anticipate participants using this MAA server throughout the fall for classes, and are in the process of upgrading the MAA server to take advantage of scalability improvements in the notebook over the summer to handle a greater courseload. The Blackboard Collaborate software seemed to work generally well too. The only problem we had at all in the technology we used was one participant using Linux whose Blackboard Collaborate instance caused a significant delay in his voice, thus preventing him from effectively communicating in the sessions. This problem was worked around after numerous support requests by the participant to his university and Blackboard over five weeks by using a USB mic.

Materials. We are also pleased with the materials created and revised for the workshop. We have licensed them under a Creative Commons license and anticipate these becoming part of the Sage official documentation (available freely to all) once we convert them to the proper format using some semi-automated tools recently developed by other Sage contributors. We also advertised resources prepared outside of the workshop, for example, a number of tutorial videos available on YouTube from the UTMOST workshop, which a number of the participants used. We also have notes on the comments from all four group discussions for participants' reference available on the wiki page for the workshop, though they are too rough and free-form to put in any form for wider distribution.

Office hours. We continue to wonder about the office hours concept. Some of them were quite well attended, but sometimes it also seemed that people just waited to come to office hours when they would otherwise have been happy using the list. There were several times where really having the screen control was crucial, but we feel that we were right in our decision to de-emphasize the office hours, and in the future would probably have no more office hours than we hosted this time.

Schedule. As mentioned before, the schedule of sessions worked out very well for most participants and the organizers. This schedule kept things relatively fresh while avoiding the overwhelming flood of material and associated organizer fatigue that occurred with our schedule in the 2010 workshop. As mentioned above, we will probably want to make clear in any future offering that the days of the workshop are expected to be essentially filled with the workshop and absences from sessions are not expected.

Followup. Another improvement we would like to make, after looking at several other workshops and interacting with the participants of ours, is to have a more explicit commitment and understanding when signing up for the workshop regarding using Sage in the next year in teaching (e.g., use at least two Sage-related activities in a course in fall semester). It is really easy to lose steam when the pressure of creating syllabi comes upon us, and this is probably especially true with several participants who have higher-than-average teaching loads.

Synergy. Finally, we were extremely pleased at how much synergy there was between several different constituencies. In addition to Michael Gage and Jason Aubrey being able to comment significantly on WeBWorK and the MAA, there were significant contributions to Sage itself by several people, including Jane Long helping write better instructions for our Windows interface. One of the participants was practically an encyclopedia of BibTeX references of articles about real-life modeling, and he created many worksheets to help others see how to use computational tools the way they are used in industry, rather than just as helps for computations traditionally done by hand. If there were ever an onsite version of this workshop, it would be wonderful to have an explicit peer help session during each day.

7. Conclusion

We feel the workshop was a huge success and enabled participants to feel confident and motivated to use Sage in their courses in the coming year. We are confident that this workshop is a very valuable tool to bring affordable, accessible technology to many teachers and ultimately to many more students.