

**Uniform Cover Sheet
For Development Programs in
The Office of the Provost**

I. Please include all the following information in your proposal or application for faculty and staff development support.

Title of Funding Program or Initiative: Undergraduate Assistantship Program

Date of Submission: 1 Feb 2011

Applicant's Name: Jason Grout

Applicant's Title: Assistant Professor

Department/Program/Unit: Department of Mathematics and Computer Science

Faculty/Staff Collaborators: _____

Project Title: Scalable Internet Interface for Sage

Total Amount Requested: \$2,340

II. Please answer the following questions regarding your proposal.

1. Does the proposed project involve student labor or student collaboration?

YES

a. If so, have the student collaborators or workers been recruited?

YES, several have been recruited, but no one has been selected yet

2. Does your proposed project require Institutional Review Board or Animal Use and Care Committee approval? (In many cases, the use of student's course-related work governed by IRB protocols).

NO

a. If so, has it secured approval?

3. Do the Program or Initiative guidelines require a statement of support from a department chair, program director, supervisor, and/or dean?

YES

a. If so, from whom?

The dean

b. Have you requested that statement of support?

YES

c. If so, on what date?

01 Feb 2011

4. Does your proposed project involve the participation of other Drake faculty or staff not listed as collaborators above?

NO

- a. If so, have you recruited collaborators and/or participants?
 - b. If so, have you secured provisional commitments?
 - c. If so, from whom?
5. Did you consult with the Academic Affairs Fellow before submitting this proposal? (This is *not* a requirement for consideration)

NO

Thank you for your proposal.

Scalable Internet Interface for Sage

Jason Grout

February 1, 2011

This proposal is for funding two Drake student assistants to assume a leading role in designing, writing, and documenting a scalable freely-available public Internet interface to the Sage mathematics software. The design and code from this interface is also intended to later serve as the core of a replacement for the more advanced current freely-available Internet interface to Sage. Funded student assistants will also serve as mentors to other Drake students working on this project.

The immediate fruits of this project will be a web page in which anyone can enter mathematical expressions or Sage commands. Clicking a button will send the commands to a Sage server, Sage will compute the answer, and then return the answers, graphs, or interactive applets to the user's web browser. As time allows, this may also include the ability to let the user easily create and manipulate sliders, buttons, etc., to affect the answer (for example, the user could easily create a slider which, when adjusted, changes the slope of a line in a graph or prints out more digits in a computation). This project is designed to be very scalable (hundreds of simultaneous users at a time) and also secure (preventing malicious users from exploiting the server).

1 Context of Project

The Sage project [5] is a large free open-source mathematical software project (similar to Wolfram Mathematica) involving hundreds of developers around the world. It is used by tens of thousands of people worldwide. Academic users range from high school classes and faculty and students at smaller institutions (for example, where costly proprietary software is not an option) to many research mathematicians and students at top research universities. Sage can be freely downloaded and run on a personal computer. For most users, however, online Sage notebook servers at various institutions (including Drake [2]) are the primary interfaces to the software. The popularity of Sage has increased dramatically in the past several years (for example, there are now over 40,000 accounts on the largest public Sage server at the University of Washington [3]). However, this popularity has placed an increasing strain on the current architecture of the online notebook, to the point that as few as 50 simultaneous users can cause the interface to slow down or become unavailable. Additionally, the current Internet Sage notebook code and design is complicated and difficult to extend and improve. There have also been many users and prospective users desiring a lighter-weight interface to Sage than the current full-blown notebook interface.

The proposed student assistantships will fund two Drake students to play a leading role in redesigning and reimplementing the Sage notebook. In particular, the students will help design, implement, test, and document a lightweight simple-to-use public Internet interface to Sage. This lightweight interface is also intended to serve as the core of the replacement for the current Internet Sage notebook. This project is designed to scale to hundreds of simultaneous users, and will probably serve as the primary interface to Sage for many users. The funded students will also act as mentors for other Drake students involved in the project.

2 Detailed Description of Assistantships

The funded students will have a variety of responsibilities that reflect their leading roles in this project. The project naturally has two main components (a web browser component and a Sage server backend component), so the students' roles will complement each other well.

The funded students will have the following responsibilities:

1. Help design and document an architecture for a scalable public Sage interface, with one student taking the lead on the web browser front end, and the other student taking the lead on the Sage server backend. As students do this, they will be directly applying ideas from many computer science courses to a real-world project, including computer networking design, database design, Web 2.0 Internet programming, technical writing, writing clear specifications and interfaces, standard security practices, and much more.
2. Write a test suite to measure the scalability of the project. Students will learn to measure the success of the goals of the project and use that to guide project decisions.
3. Implement and document the Internet interface to Sage. Students will learn and use a variety of current and emerging technologies and software frameworks that are widely used in industry¹. We will also emphasize well-established practices for writing clear documentation and code, both of which are very valuable skills in the workplace.
4. Submit the project implementation for inclusion in Sage under an open-source license. Students will use Mercurial, an industry-standard system for managing, coordinating, and reviewing source code. Students will also learn and practice well-established methods for reviewing and revising their source code. Additionally, students will learn about broader ethical issues surrounding open-source software and releasing source code.
5. Attend regular meetings (e.g., weekly or biweekly meetings), present status reports, and coordinate efforts. In doing this, the students will develop their communication skills and gain experience in estimating timelines. These real-world skills are crucial in the workplace.

¹Technologies we intend to use include SQL and NoSQL databases, web servers, web application frameworks, javascript libraries, and Python, one of the most popular computer languages.

6. Mentor and coordinate other students (e.g., freshmen or sophomores) as needed in their contributions to the project. This includes reviewing code and documentation from other students and offering suggestions for improvement. There is already at least one sophomore that is also interested in participating in the project, but is not eligible for funding under this grant because of their sophomore standing.
7. As time allows, start working on expanding this project into a replacement for the more advanced Sage notebook that is currently in use.
8. Write and submit a brief reflection on the experience. This will help the students internalize lessons they have learned.

As active Sage developers, students will also develop relationships with people in the international Sage community, which includes many students and faculty in mathematics. These professional contacts can be valuable as the students apply for additional opportunities or graduate school at other institutions.

The faculty mentor/supervisor (Jason Grout) will accept the following responsibilities:

1. Recruit and select students based on merit and necessary qualifications per the grant solicitation requirements, including sustaining a 3.00 GPA and junior or senior standing.
2. Mentor and coordinate the students through regular meetings, teach necessary technologies and skills, help guide design discussions and implement software, and help the students integrate into the broader international Sage community.
3. Submit a brief report at the end of the project which includes a reflection on the successes and shortcomings of the experience.

3 Current Status

In January 2011 at a Sage workshop in Seattle, the faculty mentor and other Sage leaders drafted a preliminary design for this project. There are now several people in the Sage community (the faculty mentor included) eager to collaborate with students in this project and its extensions. Prompt funding of this proposal, if selected for an award, will help Drake students play a leading role in the project. However, even if the project is started elsewhere first, students funded on this proposal will still be able to collaborate on this project and extend the work towards a much-needed scalable replacement for the more advanced current Sage web interface.

Prior to writing this proposal, the faculty mentor arranged for interested Drake computer science students to meet on Feb 3, 2011 to discuss working on this project. At least four students (including one sophomore and one junior) are coming to this meeting. We will begin by reviewing the necessary technologies and preliminary design immediately. Funding for this proposal will enable us to recruit students more effectively and will enable the funded students to spend the necessary time for a successful project and mentoring experience.

4 Future Opportunities

In addition to the valuable skills the students will learn immediately in working on this project, they will also be very strong applicants for outside grant funding to continue working on the Sage notebook. For example, the National Science Foundation has recently awarded two large grants [1, 4] that include support for students to work on more complex Sage notebook projects, as well as support for travel to international Sage programming workshops. As one of the senior personnel on one of these grants, the faculty mentor will continue to work on the Sage notebook and its implementation in the classroom for at least the next three years. This assistantship project provides both a foundation for later work with students over the next few years and a learning experience for students to gain experience with the technologies in the project. Now is the perfect time for students to start working on this, as they will be in a natural position to continue working closely with the faculty mentor in the years ahead.

5 Budget

The budget is \$2,340 and will be used to pay for two student assistants at \$9/hour for 10 hours each week for the remainder of the spring 2011 semester (13 weeks). Depending on the timeline for a funding decision and recruited student availability, though, we may need to be flexible in converting part or all of the grant to summer funding for student assistant(s).

6 Conclusion

In these assistantships, the funded students will apply many ideas learned in the computer science classes to real-world situations. They will develop specific skills in industry-standard tools and technologies. They will also develop broader skills in coordinating with others, communication, developing timelines, and measuring progress that are all important in professional development and life-long learning. The fruits of the project will be freely available open-source software, reflecting the values of global citizenship that Drake espouses. The connections and preparation that these student assistantships afford will also lead to strong potential for future work and funding in this project and many other professional and academic opportunities.

References

- [1] Rob Beezer, Jason Grout, Marja-Liisa Hassi, Kiran Kedlaya, Tom Judson, and William Stein. Utmost: Undergraduate teaching in mathematics with open software and textbooks, 2010–2013. Collaborative NSF CCLI grants DUE-1022574, DUE-1022036, DUE-1020957, DUE-1020687, DUE-1020378.
- [2] Jason Grout. Drake Sage server. URL <http://sage.cs.drake.edu>.

- [3] William Stein. Public Sage notebook. URL <http://www.sagenb.org>.
- [4] William Stein and John Palmieri. Sage: Unifying mathematical software for scientists, engineers, and mathematicians, 2010–2013. NSF COMPMATH grant DMS-1015114.
- [5] W.A. Stein et al. *Sage Mathematics Software*. The Sage Development Team. <http://www.sagemath.org>.