

Project Summary

Box 1: Overview, Key Words, and Subtopic Name

- Describe the potential outcome(s) of the proposed activity in terms of a product, process, or service.

The project will create a new approach to interactive online homework problems called “SageCloud Interactive Problems” (SCIP) that will initially target students taking courses involving advanced computational mathematics. SCIP will be cost effective by leveraging the SageMath open source software, cloud computing, and relentless optimization based on real world usage. SCIP will provide realtime feedback, detailed analytics, deeper computational problems than are offered by existing systems, and improved realtime interaction between students and instructors.

- Provide a list of key words or phrases that identify the areas of technical expertise to be invoked in reviewing the proposal; and the areas of application that are the initial target of the technology.

Pure mathematics, Cloud-based, interactive homework problems, open source software, Python, R, LaTeX, Web application

- Provide the subtopic name.

EA6. Computer Science and Information Technology for Education

Box 2: Intellectual Merit

Must start this way: “Briefly describe the technical hurdle(s) that will be addressed by the proposed R&D (which should be crucial to successful commercialization of the innovation), the goals of the proposed R&D, and a high-level summary of the plan to reach those goals.”

This Small Business Innovation Research Phase I project will create a completely new homework system that uniquely addresses needs in advanced mathematics, including abstract algebra, number theory, algebraic geometry, combinatorics and differential equations. The main technical hurdles that the team faces are to implement an easy-to-use user interface and language for creating problems, a way to automatically test problems, a workflow for peer review of problems, and a marketplace where problems may be shared, purchased, and assembled

into homework assignments. Additional hurdles involve dealing effectively with large amounts of user data and detecting cheating. To achieve these goals the team will build on their experiences developing Sage and SageMathCloud to implement minimal usable first versions, then get community feedback from a large community of users that the team has cultivated over many years, and use feedback to iterate on our initial product.

Box 3: Broader/Commercial Impact

“In the short term, the proposed R&D activity is expected to bring the innovation closer to commercialization under a sustainable business model. In this box, describe the potential impacts on society that would be created by the commercialization of the innovation. Examples include generating larger economic impacts, meeting societal needs, and enabling further scientific / technological understanding.”

The proposed interactive homework system would increase the value of SageMathCloud, so there will be more paying customers. The resulting revenue could then provide a sustainable source of support for open source mathematical software development, which would make it possible to address quality issues in many open source math projects that are difficult to address using funds from NSF grants (as they don’t involve NSF’s core research mission). With open source software, moving beyond a small user base of highly technical users involves addressing a huge number of difficult technical issues that have nothing to do with research mathematics (“the devil is in the details”).

Not only would expanding the value of open source math software have far reaching positive societal impacts, the freemium aspects of this project would make the computers needed to run open source math software more available in the developing world.

More directly, our proposed homework system would meet a gaping need in math-related education, especially at the advanced level, which will raise technological capabilities of the workforce. The free version will also be accessible online to people worldwide who are unable to afford advanced mathematical software.