

Project Summary

“The Project Summary should be written in the third person, [...] understandable to a scientifically or technically literate lay reader. It should not be an abstract of the proposal.” 4,600 character limit, including spaces.

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 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 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

(e.g., including abstract algebra, number theory, algebraic geometry, combinatorics and differential equations). The main technical hurdles 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 our 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 their 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 planned interactive homework system would increase the value of SageMathCloud, so there would be far more paying customers. The resulting revenue could then provide a more sustainable source of support for open source mathematical software development, which would allow us to address quality issues in many open source math projects that have so far been hard to get funded via NSF grants (as they don’t involve NSF’s core mission). With open source software, moving beyond a small user base of highly technical users involves addressing a huge number of “the devil is in the details” boring technical issues. Expanding the value of open source math software would have very far reaching positive societal impacts.

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.