OpenDreamKit: Open Digital Research Environment Toolkit for the Advancement of Mathematics[1]

OpenDreamKit Consortium

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About

OpenDreamKit is a Horizon 2020 European Research Infrastructure project (#676541) that will run for four years, starting from September 2015. It will provide substantial funding to the open source computational mathematics ecosystem, and in particular popular tools such as LinBox, MPIR, SageMath, GAP, Pari/GP, LMFDB, Singular, MathHub, and the IPython/Jupyter interactive computing environment.

From this ecosystem, OpenDreamKit will deliver a flexible toolkit enabling research groups to set up Virtual Research Environments, customised to meet the varied needs of research projects in pure mathematics and applications, and supporting the full research life-cycle from exploration, through proof and publication, to archival and sharing of data and code.

The project involves about 50 people spread over 15 sites in Europe, with a total budget of about 7.6 million euros. The largest portion of that will be devoted to employing an average of 11 researchers and developers working full time on the project. Additionally, the participants will contribute the equivalent of six other people working full time.

Abstract

OpenDreamKit will deliver a flexible toolkit enabling research groups to set up Virtual Research Environments, customised to meet the varied needs of research projects in pure mathematics and applications, and supporting the full research life-cycle from exploration, through proof and publication, to archival and sharing of data and code.

OpenDreamKit will be built out of a sustainable ecosystem of community-developed open software, databases, and services, including popular tools such as LinBox, MPIR, Sage(sagemath.org), GAP, PariGP, LMFDB, and Singular. We will extend the Jupyter Notebook environment to provide a flexible UI. By improving and unifying existing building blocks, OpenDreamKit will maximise both sustainability and impact, with beneficiaries extending to scientific computing, physics, chemistry, biology and more, and including researchers, teachers, and industrial practitioners.

We will define a novel component-based VRE architecture and adapt existing mathematical software, databases, and UI components to work well within it on varied platforms. Interfaces to standard HPC and grid services will be built in. Our architecture will be informed by recent research into the sociology of mathematical collaboration, so as to properly support actual research practice. The ease of set up, adaptability and global impact will be demonstrated in a variety of demonstrator VREs.

We will ourselves study the social challenges associated with large-scale open source code development and publications based on executable documents, to ensure sustainability.

OpenDreamKit will be conducted by a Europe-wide steered by demand collaboration, including leading mathematicians, computational researchers, and software developers with a long track record of delivering innovative open source software solutions for their respective communities. All produced code and tools will be open source.

Motivation

This proposal grew out of a reflection on the needs of the (pure) mathematics community in terms of computational software and databases. The highly successful development in the last decades of systems such as GAP, LinBox, LMFDB, PARI, Sage, or Singular, has proven the viability and power of collaborative open source development models, by users and for users, even for delivering general purpose systems targeting a large public (researchers, teachers, engineers, amateurs, . . .).

Yet some critical long term investments, in particular on the technical side, are in order to boost the productivity and lower the entry barrier:

- Streamline access, distribution, portability on a wide range of platforms, including High Performance Computers or cloud services.
- Improve user interfaces, in particular in the promising area of collaborative workspaces as those provided by SageMathCloud.
- Lower barriers between research communities and promote dissemination. For example make it easy for a specialist of scientific computing to use tools from pure mathematics, and reciprocally.

- Bring together the developers communities to promote tighter collaboration and symbiosis, accelerate joint development, and share best practices.
- Outsource as much of the development as possible to larger communities to focus the work forces on their core specialty: the implementation of mathematical algorithms and databases.

Many people in the community have been working really hard on the above items but lack crucially manpower or funding; the purpose is to supply them with such.

The European H2020 call EINFRA-9: e-Infrastructure for Virtual Research Environment was a natural fit: putting the emphasis on Virtual Research Environments nicely wraps up all the above needs in a single aim.

A great opportunity is the rapid emergence of key technologies, and in particular the Jupyter (previously IPython) platform for interactive and exploratory computing which targets all areas of science.

We built the consortium by gathering core European developers of the aforementioned systems for pure mathematics, and reaching toward the numerical community, and in particular the Jupyter community, to work together on joint needs.

By definition this project will be mostly funding actions in Europe; however those actions will be carried out, as usual, in close collaborations with the worldwide community.

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