# Introduction to Sage

## Sage Days 45:

Multiple Dirichlet Series, Combinatorics, and Representation Theory
ICERM, Providence, RI
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## Mission

**Sage Mission:** To create a viable, free, open source alternative to Magma, Maple, Mathematica, and Matlab.

## Goals:

- mathematical features with comparable speed
- high quality, interactive 2d and 3d graphics
- notebook interface
- IDE (interactive development environment) for programming
- books; full undergraduate curriculum
- support comparable to commercial support

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# History

- 2005, William Stein, "Software for Arithmetic and Geometric Experimentation"
- envisioned as whole new system, but this proved a large task
- initial implementation included wrapper linking PARI, GAP, Mathematica; focused on number theory and coding theory, technical audience
- soon extended to symbolic calculus, commutative algebra, links to Maxima, Singular; other early contributors included David Kohel, David Joyner
- workshop development model: first Sage Days February 2006
- the meaning of "SAGE" as an acronym went through a couple versions, changed to just the name "Sage" in 2007
- 2007: cleaner interface with Maxima made Sage useful for general symbolic calculus and undergraduate classroom use, brought wider recognition
- students hired to help develop Sage; increasing developer and user community
- 2008: Sage-Combinat began migration from MuPAD to Sage

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# Impetus

- open source

- user-driven development
- user-defined classes (data types)
- broad developer community, public mailing lists
- bug tracking and list of reported bugs
- IDE
- common interface to simplify use of many specialized mathematics software packages
- minimize duplication of efforts by researchers developing specialized software
- worldwide, multi-language accessible
- changes (patches) are peer-reviewed

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# Design

- built around Python, a mainstream, general-purpose programming language
- uses Cython compiler
- self-contained distribution, standard packages: http://wiki.sagemath.org/standard_packages_available_for_SAGE
- many optional packages: http://wiki.sagemath.org/optional_packages_available_for_SAGE, http://wiki.sagemath.org/experimental_packages_available_for_SAGE
- interfaces seamlessly with packages
- library implementing many new algorithms

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# Features

- command line
- notebook web app: http://demo2.sagenb.org/
- graphics: http://wiki.sagemath.org/pics
- SageTeX

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# Resources

- http://www.sagemath.org - about, download, tour, documentation, links to additional resources
- http://wiki.sagemath.org - news, workshops, community, resources
- http://nb.sagemath.org and http://www.sagenb.org - notebook information, live demo server, notebook server
- http://trac.sagemath.org - bug reports, feature requests, peer review of patches
- Google groups: sage-support, sage-devel, sage-release, sage-announce, sage-edu, sage-dsageng, sage-finance, sage-combinat-devel, sage-nt, sage-windows, sage-grid

- IRC channel: #sagemath on chat.freenode.net
- Sage Days workshops: http://wiki.sagemath.org/#Workshops
- books on Sage: http://sagemath.org/library-publications.html#books
- community: http://www.sagemath.org/development-map.html

- William Stein's history of Sage: http://wstein.org/mathsoftbio/history.pdf

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# Sage for Classroom Use

- textbooks using Sage include: differential calculus, linear algebra, differential equations, number theory, cryptography, group theory, discrete structures
- notebook server available for course use
- Interact, Animate: http://wiki.sagemath.org/interact, http://wiki.sagemath.org/animate

- sage-edu google group
- Sage Education Days