

Sage Cells: Making Sage Accessible to Students, Teachers, and Authors

Thomas W. Judson

Stephen F. Austin State University

judsontw@sfasu.edu

January 7, 2017

Open-Source Software for Mathematics

- Sage is open-source alternative to Maple, Mathematica, Magma, and MATLAB.

Open-Source Software for Mathematics

- Sage is open-source alternative to Maple, Mathematica, Magma, and MATLAB.
- William Stein founded SageMath in 2005. Rather than reinventing the wheel, Sage (which is written mostly in Python and Cython) integrates many specialized mathematics software packages into a common interface, for which a user needs to know only Python.

Open-Source Software for Mathematics

- Sage is open-source alternative to Maple, Mathematica, Magma, and MATLAB.
- William Stein founded SageMath in 2005. Rather than reinventing the wheel, Sage (which is written mostly in Python and Cython) integrates many specialized mathematics software packages into a common interface, for which a user needs to know only Python.
- The Sage community has been the driving force for developing Sage. Developers include both students and professionals.

Open-Source Software for Mathematics

- Sage is open-source alternative to Maple, Mathematica, Magma, and MATLAB.
- William Stein founded SageMath in 2005. Rather than reinventing the wheel, Sage (which is written mostly in Python and Cython) integrates many specialized mathematics software packages into a common interface, for which a user needs to know only Python.
- The Sage community has been the driving force for developing Sage. Developers include both students and professionals.
- The philosophy of SageMath is to use existing open-source libraries wherever they exist, including Maxima, R, GAP, and NumPy to name only a few.

Open-Source Software for Mathematics

- Sage is open-source alternative to Maple, Mathematica, Magma, and MATLAB.
- William Stein founded SageMath in 2005. Rather than reinventing the wheel, Sage (which is written mostly in Python and Cython) integrates many specialized mathematics software packages into a common interface, for which a user needs to know only Python.
- The Sage community has been the driving force for developing Sage. Developers include both students and professionals.
- The philosophy of SageMath is to use existing open-source libraries wherever they exist, including Maxima, R, GAP, and NumPy to name only a few.
- Stein launched SageMathCloud is a web-based cloud computing and course management platform for computational mathematics in 2013.

- **Sage is for gearheads???**. Although Sage has extensive documentation and examples on the Internets, a few students (and faculty?) have expressed frustration learning Sage.

- **Sage is for gearheads???**. Although Sage has extensive documentation and examples on the Internet, a few students (and faculty?) have expressed frustration learning Sage.
- **Sage cells make life easy**. Sage cells are self-contained Sage calculations that can be embedded in any web page. This allows Sage commands to be executed on a remote server.

- **Sage is for gearheads???**. Although Sage has extensive documentation and examples on the Internet, a few students (and faculty?) have expressed frustration learning Sage.
- **Sage cells make life easy**. Sage cells are self-contained Sage calculations that can be embedded in any web page. This allows Sage commands to be executed on a remote server.
- **A Sage cell repository**. Project UTMOST is creating a repository of Sage cells organized by mathematical topic to help authors work more efficiently and to allow authors with minimal Sage knowledge to incorporate Sage into their documents.

Sage Cell Origins

- In 2011, William Stein and Jason Grout implemented a proof-of-concept “Single Cell” server designed to be a web interface for a single Sage computation. A team led by Jason (with UTMOST NSF funding and a Drake University grant) designed and implemented the first version of SageMathCell in the summer of 2011.

Sage Cell Origins

- In 2011, William Stein and Jason Grout implemented a proof-of-concept “Single Cell” server designed to be a web interface for a single Sage computation. A team led by Jason (with UTMOST NSF funding and a Drake University grant) designed and implemented the first version of SageMathCell in the summer of 2011.
- Ira Hanson worked with Michael Gage, Jason Aubrey, Davide Cervone, and John Travis to allow Sage cells to be embedded in WeBWork problems and other external pages.

Sage Cell Origins

- In 2011, William Stein and Jason Grout implemented a proof-of-concept “Single Cell” server designed to be a web interface for a single Sage computation. A team led by Jason (with UTMOST NSF funding and a Drake University grant) designed and implemented the first version of SageMathCell in the summer of 2011.
- Ira Hanson worked with Michael Gage, Jason Aubrey, Davide Cervone, and John Travis to allow Sage cells to be embedded in WeBWork problems and other external pages.
- The Android and iOS apps, which relied on SageMathCell, were built by Ivan Andrus and Volker Braun.

Sage Cell Origins

- In 2011, William Stein and Jason Grout implemented a proof-of-concept “Single Cell” server designed to be a web interface for a single Sage computation. A team led by Jason (with UTMOST NSF funding and a Drake University grant) designed and implemented the first version of SageMathCell in the summer of 2011.
- Ira Hanson worked with Michael Gage, Jason Aubrey, Davide Cervone, and John Travis to allow Sage cells to be embedded in WeBWork problems and other external pages.
- The Android and iOS apps, which relied on SageMathCell, were built by Ivan Andrus and Volker Braun.
- SageMathCell is now supported by SageMathCloud and the NSF UTMOST Project and is currently maintained by Andrey Novoseltsev (University of Alberta).

Project UTMOST

- The first UTMOST (**U**ndergraduate **T**eaching in **M**athematics with **O**pen **S**oftware and **T**extbooks) project was a National Science Foundation CCLI Type 2 grant (2010-2014) that promoted open-source software and open-source curriculum in the undergraduate mathematics classroom. DUE-1022574 (AIM), DUE-1022036 (Drake U.), DUE-1020957 (Stephen F. Austin State U.), DUE-1020687 (U. Colorado at Boulder), and DUE-1020378 (U. Washington).

Project UTMOST

- The first UTMOST (**U**ndergraduate **T**eaching in **M**athematics with **O**pen **S**oftware and **T**extbooks) project was a National Science Foundation CCLI Type 2 grant (2010-2014) that promoted open-source software and open-source curriculum in the undergraduate mathematics classroom. DUE-1022574 (AIM), DUE-1022036 (Drake U.), DUE-1020957 (Stephen F. Austin State U.), DUE-1020687 (U. Colorado at Boulder), and DUE-1020378 (U. Washington).
- Products of the UTMOST project include
 - SageMathCloud: a comprehensive cloud computing environment for education and scientific computing.
 - Sage Cell Server: embed live computations into any webpage.
 - MathBook XML: a framework for writing mathematical material to publish in a variety of formats.
 - Sage Education Workshops: workshops for learning how to use Sage in education.
 - AIM Open Textbook Initiative: quality open-source textbooks.

Project UTMOST—Part 2

- The second phase of UTMOST was launched in Fall 2016. This phase is supported by the National Science Foundation: DUE–1626455 (AIM), DUE–1625223 (Stephen F. Austin State U.), DUE–1624998 (U. Colorado at Boulder), and DUE–1624634 (U. Michigan).

Project UTMOST—Part 2

- The second phase of UTMOST was launched in Fall 2016. This phase is supported by the National Science Foundation: DUE–1626455 (AIM), DUE–1625223 (Stephen F. Austin State U.), DUE–1624998 (U. Colorado at Boulder), and DUE–1624634 (U. Michigan).
- The goals of the new UTMOST project are:
 - To study students' use of electronic textbooks when these are made freely available in a variety of formats and on a variety of devices.
 - To further develop and support MathBook XML.
 - To develop and support the AIM open textbook initiative.
 - To develop a Sage cell repository.

A Look at Sage Cells

- An example from Rob Beezer's *First Course in Linear Algebra (FCLA)*: <http://linear.ups.edu/html/section-RREF.html>

A Look at Sage Cells

- An example from Rob Beezer's *First Course in Linear Algebra (FCLA)*: <http://linear.ups.edu/html/section-RREF.html>
- An example from Tom Judson's *Abstract Algebra: Theory and Applications (AATA)*: <http://abstract.ups.edu/aata/cyclic-sage.html>

A Look at Sage Cells

- An example from Rob Beezer's *First Course in Linear Algebra (FCLA)*: <http://linear.ups.edu/html/section-RREF.html>
- An example from Tom Judson's *Abstract Algebra: Theory and Applications (AATA)*: <http://abstract.ups.edu/aata/cyclic-sage.html>
- An example from Tom Judson's *The Ordinary Differential Equations Project (The ODE Project)*:
<http://faculty.sfasu.edu/judsontw/ode/html/systems02.html>

A Look at Sage Cells

- An example from Rob Beezer's *First Course in Linear Algebra (FCLA)*: <http://linear.ups.edu/html/section-RREF.html>
- An example from Tom Judson's *Abstract Algebra: Theory and Applications (AATA)*: <http://abstract.ups.edu/aata/cyclic-sage.html>
- An example from Tom Judson's *The Ordinary Differential Equations Project (The ODE Project)*:
<http://faculty.sfasu.edu/judsontw/ode/html/systems02.html>
- The Sage cell repository lives at the CuratedCourses project:
<https://curatedcourses.org>

Resources

- MathBook XML—A lightweight XML application for authors of scientific articles, textbooks and monographs by R. Beezer (<http://mathbook.pugetsound.edu>).
- The SageMathCloud—collaborative environment for doing mathematics by W. Stein (<https://cloud.sagemath.com>).
- The Sage cell repository—an repository of Sage cells at the CuratedCourses project: <https://curatedcourses.org>
- SageMathCell—an easy-to-use web interface to Sage (<https://sagecell.sagemath.org>).
- SageMath—a free open-source mathematics software system licensed under the GPL (<http://www.sagemath.org>).
- UTMOST—An NSF project that promotes open-source software and open-source curriculum in the undergraduate mathematics classroom (<http://utmost.aimath.org>).

Contact Info

Thomas W. Judson, Associate Professor
Department of Mathematics and Statistics
Stephen F. Austin State University
P.O. Box 13040-3040 SFA Station
Nacogdoches, TX 75962
EMAIL: judsontw@sfasu.edu
WEB PAGE: <http://faculty.sfasu.edu/judsontw/>