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# **Project Overview**

"Our proposition is that freely-available open software, open textbooks, and other open curricular materials can allow teachers everywhere to transform the undergraduate mathematics curriculum by tightly and seamlessly integrating mathematics software with more traditional curricular materials."

# Components

#### Sage: Open Source Software for Mathematics

"Creating a viable free open source alternative to Magma, Maple, Mathematica and Matlab." Includes over 100 open source packages Over 300,000 lines of new Python code

# Sage Cell Server

Sage as a web service Add live Sage code to any web page Computations performed on remote public server

#### SageMath Cloud

Complete computing environment in a web browser LAT<sub>F</sub>X with preview and reverse search Sage worksheets Terminal for Ubuntu Linux High availability and reliability

**Textbooks: Open Source Mathematics Textbooks** Beezer, A First Course in Linear Algebra Judson, Abstract Algebra: Theory and Applications

# **AIM Editorial Board**

Review and recommend open texts in mathematics Organized through American Institute of Mathematics

# UTMOST **Undergraduate Teaching of Mathematics** with Open Software and Textbooks

# **National Science Foundation DUE-1022574**

# Tom Judson

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Free Open Source Math Software



# SageMath Cloud



Project - Getting Started with LaTeX and Sage, Math 290 - Mozilla Firefox Q U I Projects Getting Started.. salvus@beezer.cotse.net websocket 11ms 🕞 Files 🕘 Recent 🕒 New 🗮 Log 🖌 in-terminal.term ААС 🗈 /Math290F13/sage ~\$ cd Math290F13/sage /Math290F13/sage\$ ls \*.sagews CB-11.sagews RREF.sagews EE-demo.sagews IVLT.sagews MR.sagews SS.sagews CB-12.sagews FS-11.sagews LT.sagews NM-11.sagews SD-demo.sagews VR-11.sagews CB.sagews MISLE-11.sagews NM-12.sagews SLT-11.sagews VR-12.sagews FS-12.sagews SLT-12.sagews VR.sagews class-pre-exam-V.sagews FS.sagews MISLE-12.sagews NM.sagews ILT.sagews MISLE.sagews PDM-demo.sagews SLT.sagews CRS-11.sagews IVLT-11.sagews MR-11.sagews RREF-11.sagews SS-11.sagews CRS-12.sagews RREF-12.sagews SS-12.sagews CRS.sagews IVLT-12.sagews MR-12.sagews /Math290F13/sage**\$ git push** Username for 'https://github.com': rbeeze Password for 'https://rbeezer@github.com' Everything up-to-date /Math290F13/sage**\$ pvtho** Pvthon 2.7.3 (default, Sep 26 2013, 20:03:06) [GCC 4.6.3] on linux2 Type "help", "copyright", " 'credits" or "license" for more information >> import math >>> print math.sin(0.9) 0.783326909627 >>> exit() /Math290F13/sage\$ sage Sage Version 5.12, Release Date: 2013-10-07 Enhanced for the Sagemath Cloud Type "help()" for help. ge: N(sin(0.9), digits=60) .7833269096274834142334952 sage: exit Exiting Sage (CPU time Om0.05s , Wall time Om21.45s Math290F13/sage\$ octave GNU Octave, version 3.6.2 Copyright (C) 2012 John W. Eaton and others warning: X11 DISPLAY environment variable not set octave:1> sin(0.9) ans = 0.78333 octave:2> exit ~/Math290F13/sage\$

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# Susan Lynds

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Wide integration of technology Driven by teachers themselves

Linear Algebra Textbook with Knowls	\$
Subsection AM: Adjoint of a Matrix	
The combination of transposing and conjugating a matrix will be important in subsequent sections, such as <b>Subsection MINM.UM</b> and <b>Section OD</b> . We mak definition here and prove some basic results in the same spirit as those above.	æ a <mark>key</mark>
<b>Definition A: Adjoint.</b> If A is a matrix, then its <b>adjoint</b> is $A^* = (\overline{A})^t$ .	
You will see the adjoint written elsewhere variously as $A^H$ , $A^*$ or $A^{\dagger}$ . Notice the <b>Theorem MCT</b> says it does not really matter if we conjugate and then transpose transpose and then conjugate.	at se, or
<b>Theorem AMA: Adjoint and Matrix Addition.</b> Suppose A and B are m of the same size. Then $(A + B)^* = A^* + B^*$ . <b>Proof</b>	atrices
Proof of Theorem AMA:	
$(A + B)^* = \left(\overline{A + B}\right)^t \qquad \begin{array}{l} \text{Definition A} \\ = \left(\overline{A} + \overline{B}\right)^t & \begin{array}{l} \text{Theorem CRMA} \\ = \left(\overline{A}\right)^t + \left(\overline{B}\right)^t & \begin{array}{l} \text{Theorem TMA} \\ = A^* + B^* & \begin{array}{l} \text{Definition A} \end{array}$	
<b>Definition A: Adjoint.</b> If <i>A</i> is a matrix, then its <i>adjoint</i> is $A^* = (\overline{A})^t$ . (in contex	( <b>t</b> )
./knowls/definition.A.knowl	
Is a scalar and A is a matrix. Then $(\alpha A)^* = \overline{\alpha} A^*$ . Proof Linear Algebra Textbook with Sage Ce Sage PREE: Reduced Pow Echelon Form	lls
There has been a lot of information about using Sage with vectors and mate in this section. But we can now construct the coefficient matrix of a system equations and the vector of constants. From these pieces we can easily construct the augmented matrix, which we could subject to a series of row operations. Computers are suppose to make routine tasks easy so we can concentrate on bigger ideas. No exception here, Sage can bring a matrix (augmented or not) to reduced row echelon form with no problem. Let's re Example SAB with Sage.	edo
1 ▼ coeff = matrix(QQ, [[-7, -6, -12], [5, 5, 7], [1, 0, 4]]) 4 const = vector(QQ, [-33, 24, 5]) aug = coeff.augment(const)	
6 aug.rref()	
6 aug.rref() Evaluate	lighting



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# **Project Activities**

# **CCLI Phase 2 Grant** September 2010 to August 2014

# ge Cell Server: sagecell.sagemath.org

mbed live Sage code in web pages, online textbooks Easily share computations with permalinks Powers Webwork problems, iOS and Android apps 400 computations per day

# geMath Cloud: cloud.sagemath.com

ery scalable, so highly reliable Co-hosted at Google vailable now

Fast-paced development effort ,000 new accounts per month

# xtbooks: Conversion to Worksheets

Converting textbooks to Sage worksheets Converting textbooks to highly interactive web versions

# orkshops: Sage Educational Days

une 2011, 2012, 2013, 2014

# M Editorial Board

50 textbooks evaluated, 25 approved Vebsite guide provides key information for each

# st Sites

undergraduate mathematics departments mplement Sage and open textbooks in the classroom Calculus, linear algebra, abstract algebra...

#### sessment

Ethnography & Evaluation Research, Univ of Colorado