

UTMOST

Undergraduate Teaching of Mathematics with Open Software and Textbooks

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Free Open Source Math Software

Free Open Source Textbooks & Curriculum

Wide integration of technology Driven by teachers themselves

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

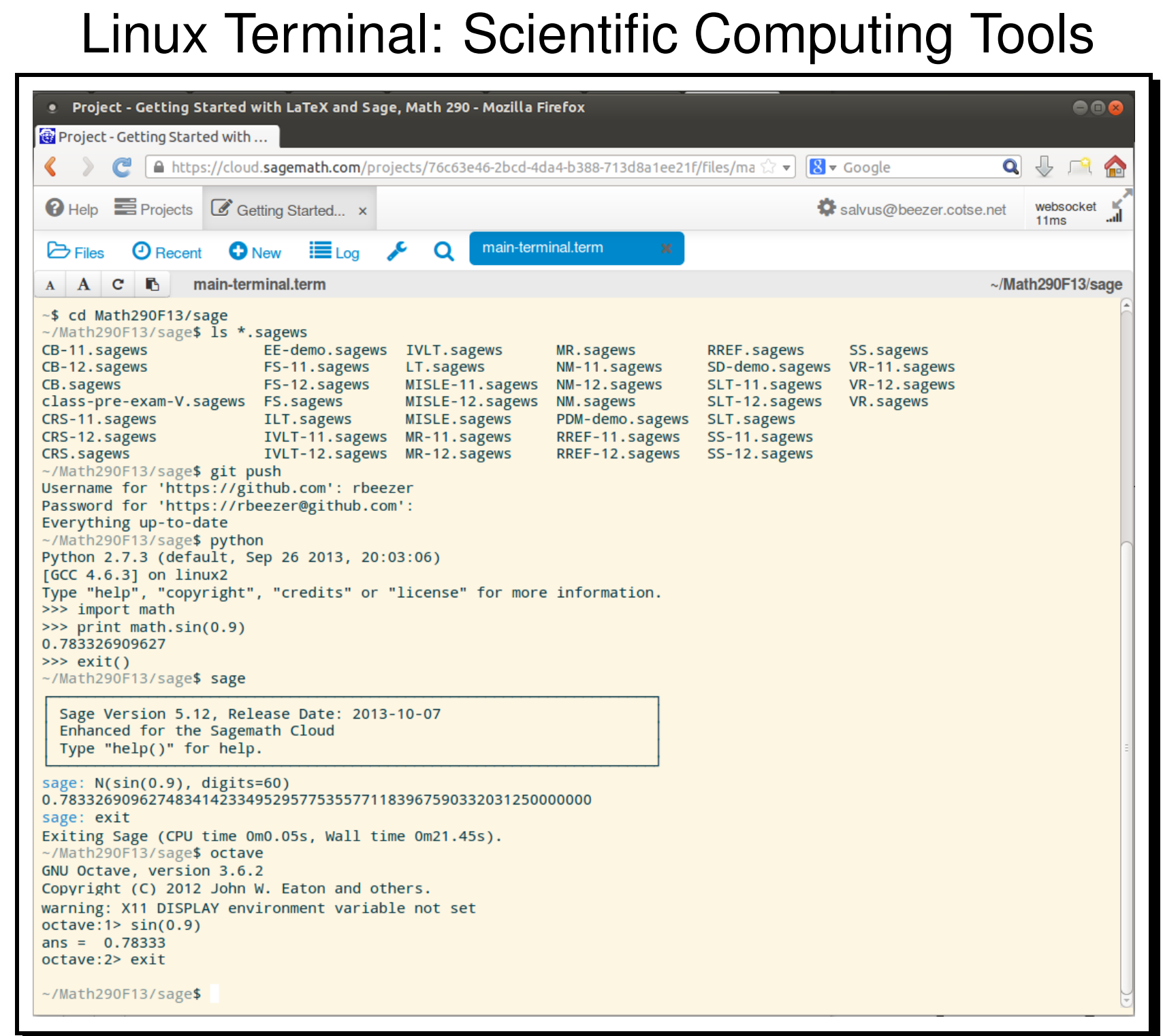
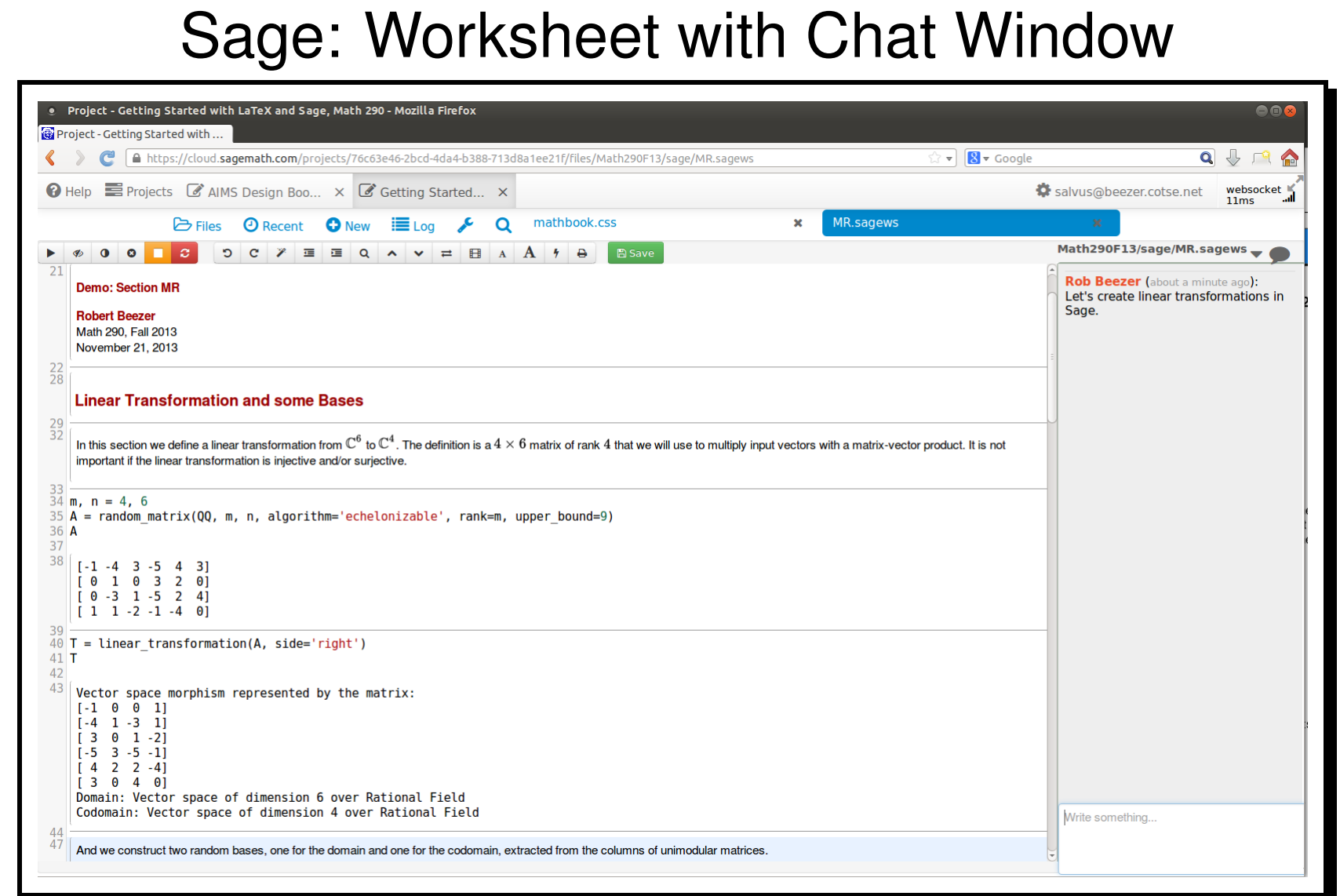
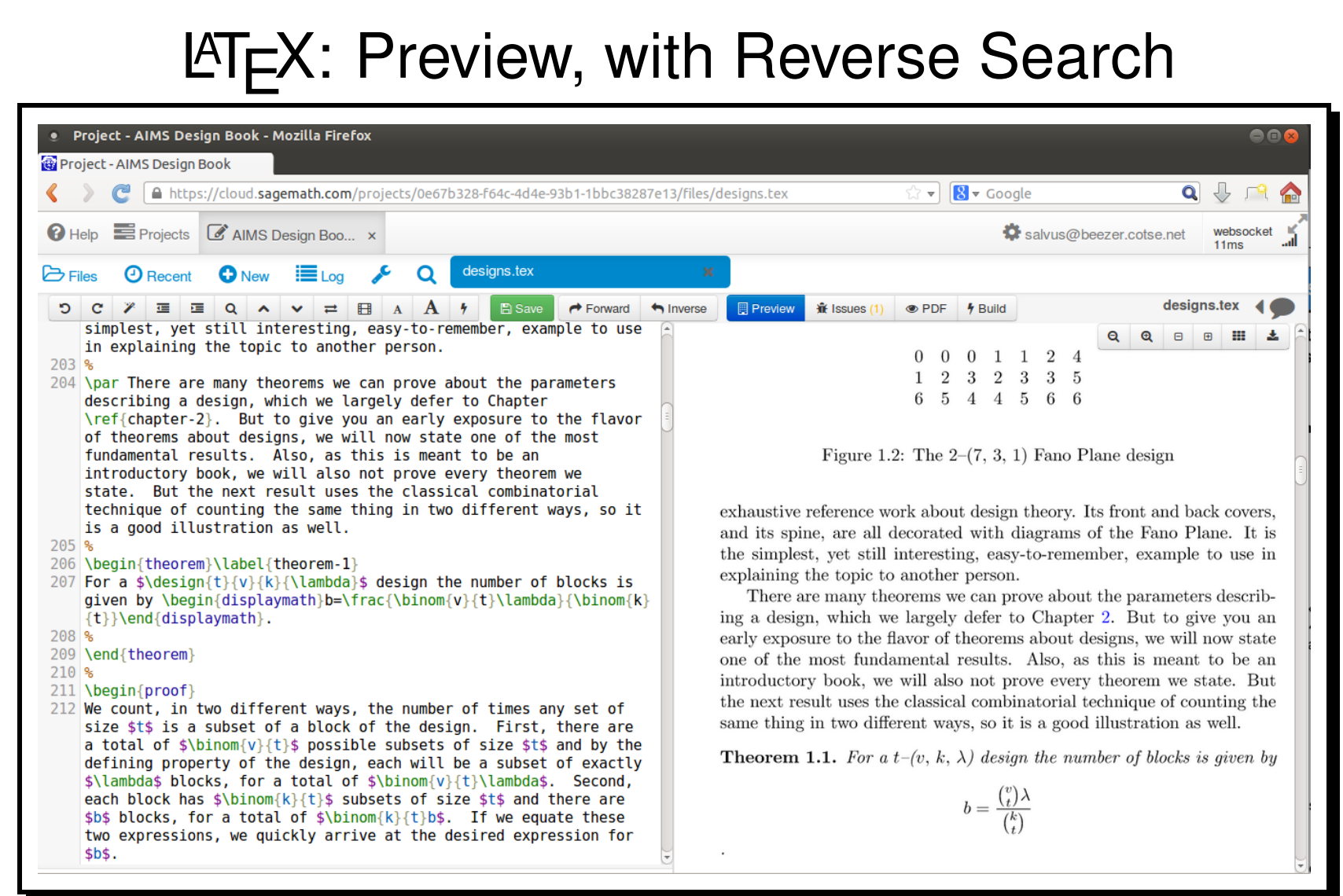
Sage Cell Server
Sage as a web service
Add live Sage code to any web page
Computations performed on remote public server

SageMath Cloud
Complete computing environment in a web browser
L^AT_EX 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

SageMath Cloud



Open Textbooks Online

Linear Algebra Textbook with Knowl^s

Subsection AM: Adjoint of a Matrix
The combination of transposing and conjugating a matrix will be important in subsequent sections, such as [Subsection MINM.UM](#) and [Section OD](#). We make a key definition here and prove some basic results in the same spirit as those above.

Definition A: Adjoint. If A is a matrix, then its **adjoint** is $A^* = (\overline{A})^t$.

You will see the adjoint written elsewhere variously as A^H , A^* or A^\dagger . Notice that [Theorem MCT](#) says it does not really matter if we conjugate and then transpose, or transpose and then conjugate.

Theorem AMA: Adjoint and Matrix Addition. Suppose A and B are matrices of the same size. Then $(A + B)^* = A^* + B^*$.

Proof of Theorem AMA:

$$(A + B)^* = (\overline{A + B})^t = \overline{(A + B)}^t = (\overline{A} + \overline{B})^t = (\overline{A})^t + (\overline{B})^t = A^* + B^*$$

Definition A: Adjoint. If A is a matrix, then its **adjoint** is $A^* = (\overline{A})^t$ (in context)

Theorem AMSM: Adjoint and Matrix Scalar Multiplication. Suppose $\alpha \in \mathbb{C}$ is a scalar and A is a matrix. Then $(\alpha A)^* = \overline{\alpha} A^*$.

Linear Algebra Textbook with Sage Cells

Sage RREF: Reduced Row-Echelon Form

There has been a lot of information about using Sage with vectors and matrices in this section. But we can now construct the coefficient matrix of a system of 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 redo [Example SAB](#) with Sage.

```
coeff = matrix(QQ, [[-7, -6, -12],
                   [1, 0, 4]],
               [1, 0, 4])
const = vector(QQ, [-33, 24, 5])
aug = coeff.augment(const)
aug.rref()
```

Powered by SAGE

And the solution $x_1 = -3, x_2 = 5, x_3 = 2$ is now obvious.

Project Activities

CCLI Phase 2 Grant
September 2010 to August 2014

Sage Cell Server: sagecell.sagemath.org
Embed live Sage code in web pages, online textbooks
Easily share computations with permalinks
Powers Webwork problems, iOS and Android apps
1400 computations per day

SageMath Cloud: cloud.sagemath.com
Very scalable, so highly reliable
Co-hosted at Google
Available now
Fast-paced development effort
3,000 new accounts per month

Textbooks: Conversion to Worksheets
Converting textbooks to Sage worksheets
Converting textbooks to highly interactive web versions

Workshops: Sage Educational Days
June 2011, 2012, 2013, 2014

AIM Editorial Board
50 textbooks evaluated, 25 approved
Website guide provides key information for each

Test Sites
8 undergraduate mathematics departments
Implement Sage and open textbooks in the classroom
Calculus, linear algebra, abstract algebra. . .

Assessment
Ethnography & Evaluation Research, Univ of Colorado