

# Open Software and Open Textbooks for Mathematics

Korean Mathematical Society Invited Lecture

---

Rob Beezer

April 29, 2017

Chosun University, Gwangju, Korea

Department of Mathematics and Computer Science

University of Puget Sound

beezer@pugetsound.edu

# Overview

- Open Licenses
- Sage Mathematical Software
  - Python Library
  - Sage Cell Server
  - SageMathCloud
- Open Online Mathematics Textbooks

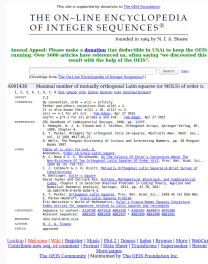


# Open Licenses

---

# Mathematics on the Web

- The Internet is an amazing thing
- Online Encyclopedia of Integer Sequences
- Also: kitten videos
- Your own:
  - computer in the cloud
  - collaboration space
  - printing press
  - shipping and distribution network
  - marketing (i.e. Google Page Rank)



- Copyright is a government-granted monopoly
- Korea: 1908, then 1957, 1986
- An open license provides additional freedoms
  - Unlimited copying
  - In perpetuity
  - Modifications for personal use
  - Possibly: the right to distribute modifications
  - “Copyleft”

“freely available”  
≠  
distribute with an explicit open license



# Sage Mathematical Software

---

- Software for mathematics, with an open license
- Founded in 2005 by William Stein
- Over 400 mathematician-programmer contributors (for example, Kwankyu Lee, Heesung Shin)
- Uses over 100 mature open-source packages
- Glued together as a Python library (genius!)
- Free!
- Mission Statement:

Creating a viable free open source alternative to Magma, Maple, Mathematica and Matlab.



## Sage: Locally, at Command Line

SageMath version 7.6, Release Date: 2017-03-25

```
sage: A = matrix(QQ, [[ 204,   98, -26, -10],
.....:                [-280, -134,  36,  14],
.....:                [ 716,  348, -90, -36],
.....:                [-472, -232,  60,  28]])
sage: A.eigenvalues()
[4, 0, 2, 2]
sage: A.eigenmatrix_right()
(
[4 0 0 0]  [ 1      1  1  0]
[0 0 0 0]  [-1  -4/3  0  1]
[0 0 2 0]  [ 2  10/3  7  3]
[0 0 0 2], [ 5  -4/3  2  2]
)
```



Go to:

`mathbook.ups.edu/kms.html`

Evaluate, then edit:

`integrate( sin(x) * cos(x), x )`

Go to:

`mathbook.ups.edu/kms.html`

Evaluate, then edit:

`integrate( sin(x) * cos(x), x )`

Result:  $-1/2*\cos(x)^2$

# Sage Cell Server

- Created: ~2011
- Running copies of Sage on public servers
- Very easy to embed into web pages
- Low-level protocol for applications
- Free!
- Feature: No login or setup needed
- Shortcoming: No storage available
- (We will see it again soon)



- Sage (and more) hosted in the cloud
- Open source software
- Free! (but no service guarantee)
- \$7/month for hosting and storage
- Includes
  - Ubuntu Linux computer (via terminal)
  - Sage worksheets
  - Jupyter notebooks
  - Pre-installed open source software: Sage, R, SymPy, GAP, Octave, Anaconda Python, Julia, C++, ...
  - $\text{\LaTeX}$  editor
  - Course & assignment management
  - Collaboration features



## SAGEMATHCLOUD DEMO



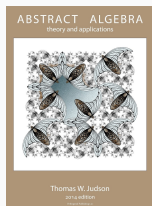
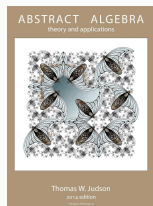
# Open Online Textbooks

---

# An Open Textbook, Online

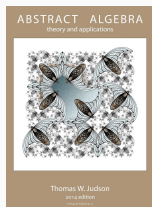
## *Abstract Algebra: Theory and Applications*, by Tom Judson

- #2 in Google “abstract algebra”
- Openly licensed
- Hardcopy: 30,000 KRW
- PDF download: Free! (Legally!)
- Online: Includes Sage Cell examples



# Abstract Algebra Demonstration

## ABSTRACT ALGEBRA DEMONSTRATION





- An authoring system for scholarly documents
- Clearly indicate structure, no presentation
- Enforces *semantic* source, rigorously
  - “semantic”: relating to meaning
- Benefit: multiple outputs, easily
- Benefit: powerful navigation, organization



## MathBook XML Example

```
<theorem xml:id="power-rule">
  <title>Power Rule</title>
  <index>power rule</index>

  <statement>
    <p>The derivative of <m> $f(x)=x^n$ </m>
    is <m> $f'(x)=nx^{n-1}$ </m>.</p>
  </statement>

  <proof>
    <p>Apply induction to the product
    <me> $f(x)=x^n=x\cdot x^{n-1}$ </me>
    using <xref ref="product-rule"/>.</p>
  </proof>
</theorem>
```

**Theorem 4.4** (Power Rule). *The derivative of  $f(x) = x^n$  is  $f'(x) = nx^{n-1}$ .*

*Proof.* Apply induction to the product

$$f(x) = x^n = x \cdot x^{n-1}$$

using [Theorem 4.1](#).



**Theorem 4.4** (Power Rule). *The derivative of  $f(x) = x^n$  is  $f'(x) = nx^{n-1}$ .*

*Proof.* Apply induction to the product

$$f(x) = x^n = x \cdot x^{n-1}$$

using [Theorem 4.1](#). □

≡ Contents	Index	< Prev	^ Up	Next >
Front Matter	<div><p><b>Theorem 4.4 Power Rule.</b> <i>The derivative of <math>f(x) = x^n</math> is <math>f'(x) = nx^{n-1}</math>.</i></p><p><i>Proof.</i></p><div><p>Apply induction to the product</p><math display="block">f(x) = x^n = x \cdot x^{n-1}</math><p>using <a href="#">Theorem 4.1</a>.</p></div><p><b>Corollary 4.5.</b> <i>Suppose <math>f(x)</math> is a continuous function. Then</i></p></div>			
1 Introduction				
2 The Fundamental Theorem				
3 Computing Integrals with Sage (f)				
4 An Interesting Corollary				
5 Some Facts and Figures				
6 Some Advanced Ideas				

# KOREAN ARTICLE DEMONSTRATION

## Next Steps

---

# How to Get Involved

- Use Sage for course preparation
- Show Sage to your students
- Integrate Sage into course activities

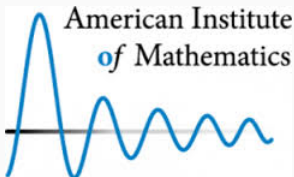
# How to Get Involved

- Use Sage for course preparation
- Show Sage to your students
- Integrate Sage into course activities
- Use open source textbooks for your course
  - American Institute of Mathematics  
Open Textbook Initiative  
has about 50 approved mathematics textbooks



# How to Get Involved

- Use Sage for course preparation
- Show Sage to your students
- Integrate Sage into course activities
- Use open source textbooks for your course
  - American Institute of Mathematics  
Open Textbook Initiative  
has about 50 approved mathematics textbooks
- Write an open source textbook with MathBook XML



Thank-you for your attention

[buzzard.pugetsound.edu/talks.html](http://buzzard.pugetsound.edu/talks.html)

Partial support for this work was provided by the National Science Foundation's Improving Undergraduate STEM Education (IUSE) program under Award No. 1626455. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.