Linear Algebra with Sage and "A First Course in Linear Algebra"

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MTH 317: Linear Algebra

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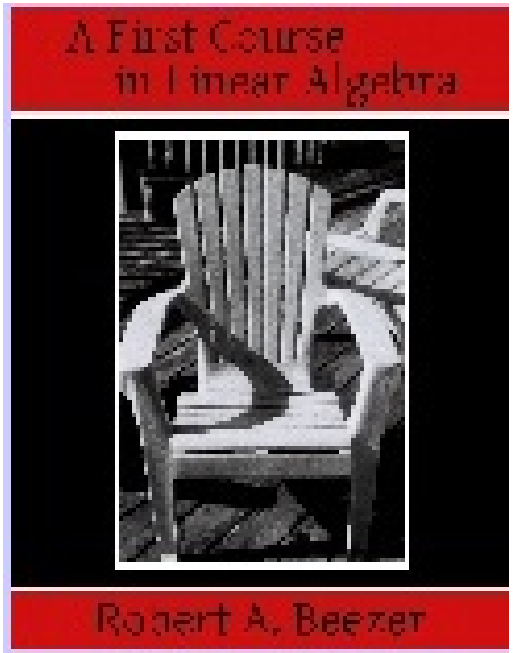
- Description: Matrices, systems of linear equations, linear vector spaces, functions from $\mathbb{R}^n$ to $\mathbb{R}^m$, determinants, eigenvalues and eigenvectors
- Prerequisites: Introduction to Modern Mathematics (MTH 311) and Calculus II (MTH 234) or consent
- Students: Junior math majors and minors, science majors (physics, chemistry, geology, biology)

Course Requirements

- Exams (70%)
- Project on an application of linear algebra (10%)
- Daily reading questions (5%)
- Homework from textbook (15%)
- Use of Sage expected

Textbooks

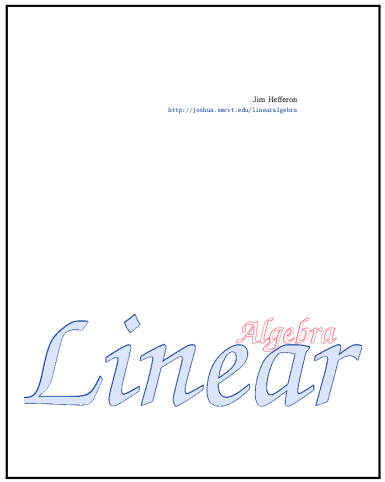
"A First Course in Linear Algebra" (FCLA) by Rob Beezer



- Freely available at linear.ups.edu
- Sage-enhanced version available

Textbooks

"Linear Algebra" by Jim Hefferon



- Freely available at joshua.smcvt.edu/math/hefferon.html
- Used for applications, including:
  - Stable populations, projective geometry, crystals, Markov chains
  - Cramer's rule, orthonormal matrices, line of best fit

My Response to FCLA

- Proof techniques section helpful for students without proofs course
- Liked the archetypes
- Liked the conversational style
- Liked the Sage-enhanced version
- Liked the reading questions
- Got used to the theorem labeling
- Too many solutions for my taste
- Printed it

Student Response to FCLA

- "I like it because it was free and it has lots of examples."
- "It took some getting used to, but after a while I liked it."
- "Not a bad book (GREAT that it's free!), but it is very wordy and sometimes confusing."
- Students had mixed feelings about theorem labeling

Student Response to FCLA

- "I do not like that the textbook is on the computer, since it is on the computer it is hard to read and flip between to exercises and the examples. Since the book is on the computer it is hard to do my work whenever because I need to carry my computer around, which I would prefer not to do."

How Students Read FCLA

- Most did not use Sage-enhanced version
- Kindle or computer screen
- (Print copy from Lulu.com)
- Most students do not own printers, pay for printing pages at library
- Students not overly excited that it was free

My Response to Hefferon's Linear Algebra

- Nice, concise, mostly self-contained application sections
- Difficult to find enough (9-10) projects of similar level
- Too many solutions for my taste
- Printed it
- Will use it again
- (Didn't ask students)

Use of Sage

- Student use not strictly required except for project
  - Example: Stable populations
  - Example: Slater Determinants (chemistry)
- In-class demonstrations
- Most students used for row-reduction and little else

Student Response to Sage

- "I do not use Sage because I do not like to use computer programs to do my work."
- "It's easier than hand-computing"
- "I am not comfortable with it."
- "For homework stuff like row reducing and what not, there is calculators on the internet that do it easier."
- "No, comfortable with java."

Student Response to Sage

- "I don't like sage because no one knew how to use the program. It seems to be pretty advanced and it's hard to learn & understand the code on top of the classwork. So on the end of semester projects over more complex topics the sage work was the biggest obstacle because I didn't know how to use to program well."

What I Learned

- If you don't MAKE them learn Sage, they won't!
  - Do I care if they really learn Sage?
- Too many solutions provided in FCLA
- Quality Sage worksheets/materials are key
- Adoption of Sage has caused department to reexamine goals

Next Time (This Fall)

- Author worksheets and require Sage homework
- More explorations/assignments, in Sage
- Continue to use FCLA and Hefferon for applications

Future Work: Single-Cell Server inside Learning Management Systems

- Idea: embed interacts into online content for face-to-face and fully online courses
- Students don't have to learn Sage
- Jason Grout's page
- Blackboard example
- D2L example
- Implementation details

Links

- Sage single-cell documentation:

  `sage.math.washington.edu/home/jason/sagecell/embedding.html`

- Try creating pages with cells: sage.math.washington.edu/home/jason/cellcanvas/
- FCLA Textbook: linear.ups.edu
- Hefferon Textbook: joshua.smcvt.edu/linearalgebra/
- My email: longjh@sfasu.edu