Abstract

Linear Algebra, my undergraduate text, has long been freely available online.

I recently adapted it for paper. I will discuss some differences in delivering work in the two formats that current authors can apply, and some things about today's landscape of print on demand.

Moving an Online Book to Paper

Jim Hefferon, jhefferon@smcvt.edu
Lon Mitchell, l3c@orthogonalpublishing.com

TEX Users Group, 2014-July

Linear Algebra

- Available for download since 1996-ish, with LaTeX source.
- Standard US sophmore course, for students who are not future PhD's, necessarily.
- 497 pages, with extensive question sets, worked answers for every question, and with classroom beamer slides and a lab manual.
- Under the GNU Free Documentation License or the Creative Commons CC BY-SA license (for Wikibooks).

Linear Algebra

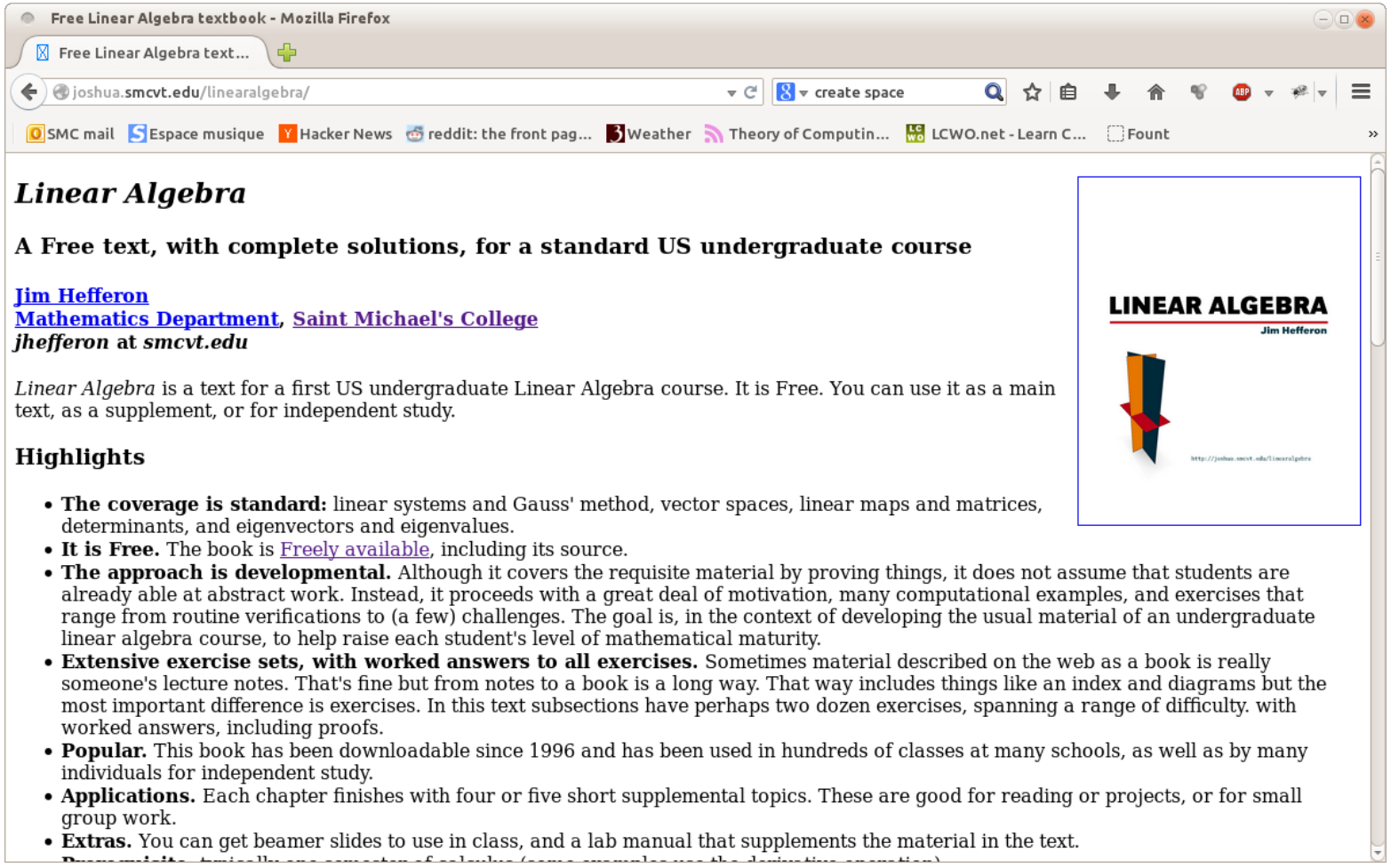
- Available for download since 1996-ish, with LaTeX source.
- Standard US sophmore course, for students who are not future PhD's, necessarily.
- 497 pages, with extensive question sets, worked answers for every question, and with classroom beamer slides and a lab manual.
- Under the GNU Free Documentation License or the Creative Commons CC BY-SA license (for Wikibooks).

In part because of its early start, and perhaps because of some merit, it is on the first page of a Google search for "`linear algebra`."

I get 30K–40K downloads per week (I have seen a million but that may have been some script run amok).

Until recently how you got it

In 1996 I spent a lot of time online reading about how the future is online. I decided to distribute via downloads.



The model

In the past how it worked is that an instructor printed the PDF, copied that, put it in a comb binding, and students paid what it took to defray the cost. Thus, students had copies of copies.

- Page size is US letter, 8.5 x 11 inches.
- In 1996 printers were 300 dpi. Some shading and graphics vanished, or did Morié effects.
- Computer Modern characters had dropouts so I went to the Concrete font with Euler for math.
- Instructors might omit printing parts such as the Preface, the Bibliography, or some optional material.
- Colors in the PDF became gray when printed. You can't be ambitious with color.

Desire for other versions, from users …

Sometimes self-studiers ask for physical copies.

> *Send me a copy at this address … . You didn't say how much a copy costs. Enclosed is a check for $50. If that is not enough put a note in the envelope and I'll send you more.*

Desire for other versions, from users …

Sometimes self-studiers ask for physical copies.

> *Send me a copy at this address … . You didn't say how much a copy costs. Enclosed is a check for $50. If that is not enough put a note in the envelope and I'll send you more.*

Sometimes potential adopters tell me that they did not use it because it requires them to have it printed. (Even at my home college, having the printshop cart copies directly to the bookstore nearly got both managers fired.)

... from entrepeneurs ...

From: XXXXXXXXXX
Sent: Tuesday, April 01, 2014 21:33
To: Hefferon, James S.
Subject: [**Possible SCAM email**] Love your textbook work

Mr. Hefferon,

My name is XXXXXXX, and I'm the CEO/cofounder of a startup called XXXXXXX(http://www.XXXXX.com), we provide a platform for textbook writers and publishers to publish their books over the web.

I found a link to your textbook at this website: http://www.randomhacks.net/articles/2007/03/07/hefferon-linear-algebra-review, and I gotta say: I think your work is impressive!

All our books are published via both the web, print, and mobile devices. We also are pioneering an open-publication system, where anyone can suggests errata via version control/pull requests, so that you remain in control whether you want to accept the changes or not. Our users own their book for life, so they immediately receive all updates, making our texts, in a way, become living (i.e. the books never really expire, and quality tends to increase over time with each revision). All of our books are accessible to people with disabilities (blind, and dyslexic). We also spend a lot of time researching usability patterns to make our books as easy to read as possible. Our system also utilizes a lot of different systems to make every text searchable. We take every highlight done using our system as a signal indicating which parts of the text are most important, thus creating a highlight heat map of the text.

… and from those who push the entrepeneurial envelope

Amazon.com: hefferon linear algebra: Books

Amazon.com: hefferon li...

www.amazon.com/s/ref=sr_st_relevancerank?keywords=hefferon+linear+algebra&

beamer color of alert

SMC mail | Espace musique | Hacker News | reddit: the front pag... | Weather | Theory of Computin... | LCWO.net - Learn C... | Fount

5.

Linear Algebra by Hefferon, Jim unknown Edition [Paperback(2009)] (1000)

Formats	Price	New	Used
Paperback		$999.98	$55.11

6.

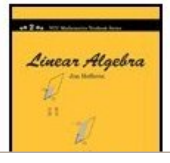
Linear Algebra by Hefferon, Jim published by Virginia Commonwealth University Mathematics (2009) (0001)

Formats	Price	New	Used
Paperback		$555.99	$55.34

7.

Linear Algebra BYHefferon by Hefferon (2009)

Formats	Price	New	Used
Paperback		$136.16	$28.72

8. 

Linear Algebra (09) by Hefferon, Jim [Paperback (2009)] (2009)

Formats	Price	New	Used
Paperback			$51.99

A note from Lon Mitchell

My first semesters using your book were marred, however, by student reviews … students commented that they did not like using untested and unproven course material – they did not like being "guinea pigs."

… I also noticed that many students, for whatever reason, refused to print out a copy to have in class. I'm still at a loss to explain this phenomenon: why will students sacrifice potential educational benefits for $10-$15 when they are paying so much more in tuition?

… Studies have shown that many students, even up to 75%, still prefer a print edition to an electronic textbook. Studies have also shown that many students forgo purchasing a required textbook to try and save money.

… My course evaluations went significantly higher once the print version was available, although I feel I taught essentially the same course.

A note from Lon Mitchell

My first semesters using your book were marred, however, by student reviews … students commented that they did not like using untested and unproven course material – they did not like being "guinea pigs."

… I also noticed that many students, for whatever reason, refused to print out a copy to have in class. I'm still at a loss to explain this phenomenon: why will students sacrifice potential educational benefits for $10-$15 when they are paying so much more in tuition?

… Studies have shown that many students, even up to 75%, still prefer a print edition to an electronic textbook. Studies have also shown that many students forgo purchasing a required textbook to try and save money.

… My course evaluations went significantly higher once the print version was available, although I feel I taught essentially the same course.

He proposes to go down the rabbit hole, to paper

My project to produce a print version of your text was to try and reply to these concerns. In particular, I wanted a book that would look professional enough that students would not have a reason to believe it was anything less than professional quality (or at least the quality of other linear algebra books). I also wanted something they could find in the bookstore.

He started a low-profit company, an L3C, to look for more open-source books to help into print. (If you are interested, write him at `l3c@orthogonalpublishing.com`.)

He proposes to go down the rabbit hole, to paper

My project to produce a print version of your text was to try and reply to these concerns. In particular, I wanted a book that would look professional enough that students would not have a reason to believe it was anything less than professional quality (or at least the quality of other linear algebra books). I also wanted something they could find in the bookstore.

He started a low-profit company, an L3C, to look for more open-source books to help into print. (If you are interested, write him at `l3c@orthogonalpublishing.com`.)

I’m pretty innocent at this

From the selfpub.net FAQ

How do I get my book listed on Amazon.com and BarnesandNoble.com?

...You will want your book to be listed in the Ingram distribution channel. When Amazon or Barnes and Noble wants to purchase a book they first look to Ingram who carries millions of book titles in their inventory.

... If the retailer does not have the title in stock they will request a copy from Ingram. If Ingram does not have a copy in stock the order will be sent to your print-on-demand printer who will print and likely drop-ship the book to the customer. You just sit back and collect your check for your percentage of the sales made.

Two popular print-on-demand companies who distribute to Ingram are:

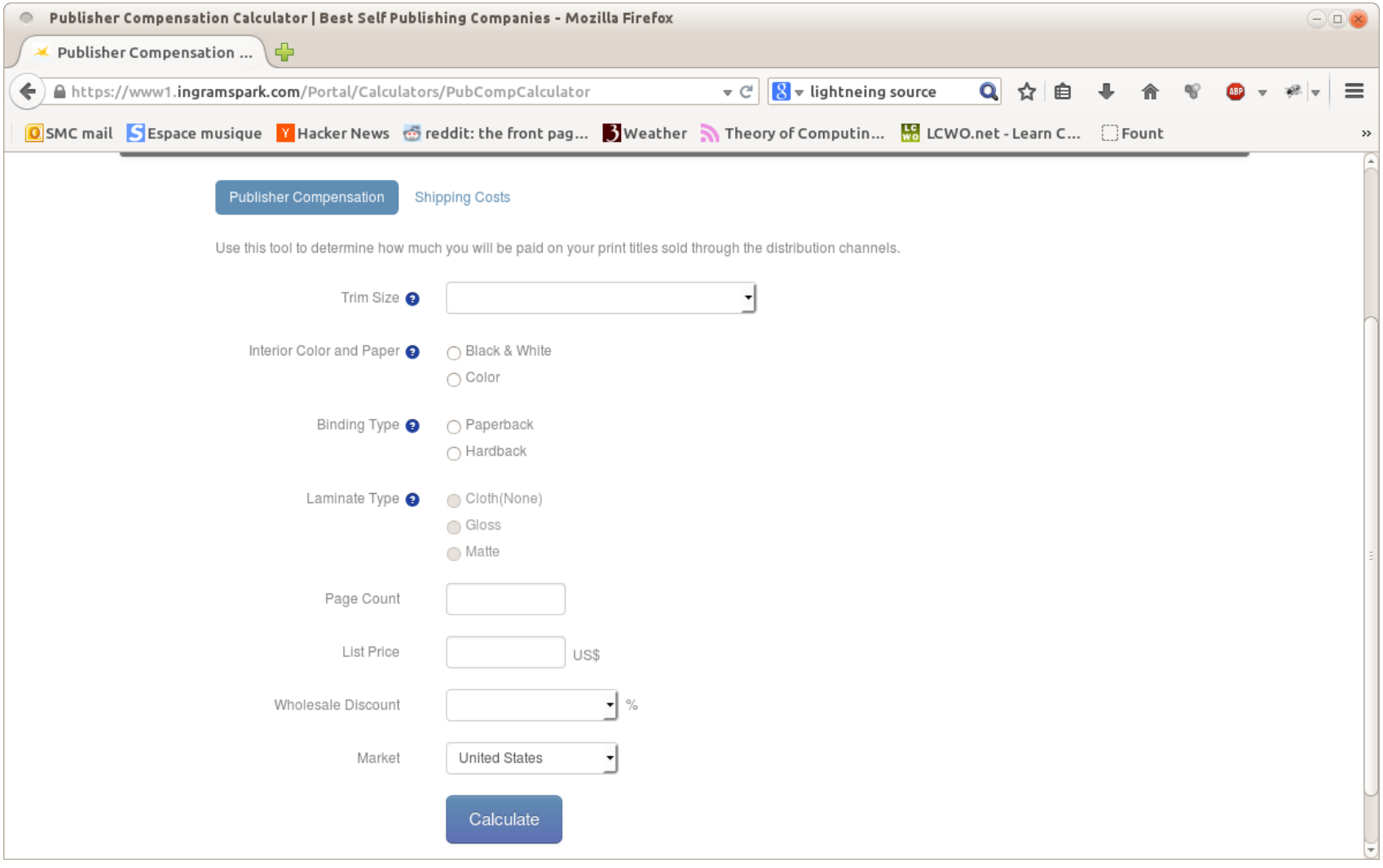
Lightning Source which is owned by Ingram and offers print-on-demand book printing for self-publishing authors and small press publishers.

CreateSpace which is part of Amazon. They offer two services for distribution. The first option lists your book for sale on Amazon.com. With their expanded distribution, your book will be distributed through Ingram and made available to all retailers.

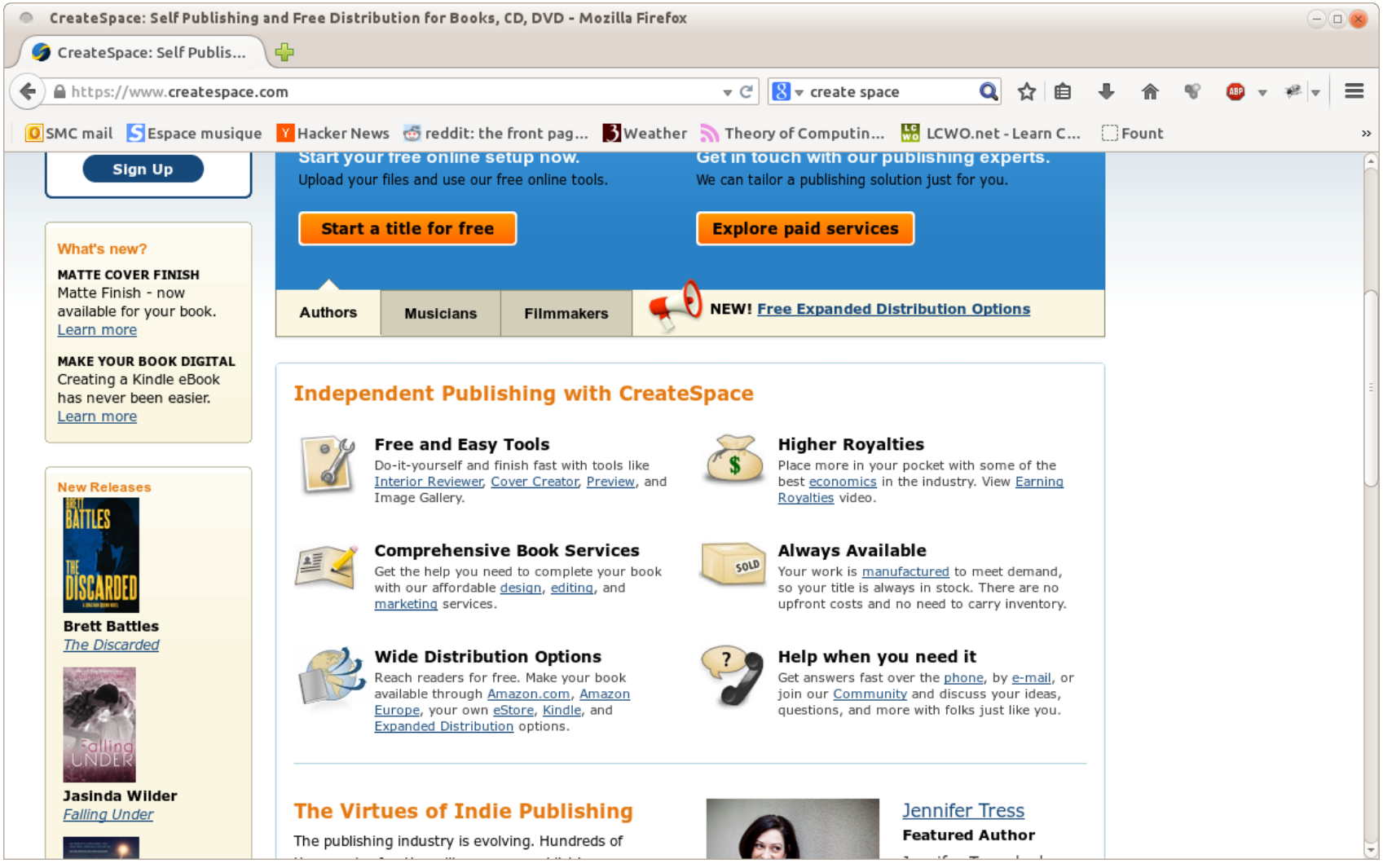
Who to choose? The big two

Who to choose? The big two

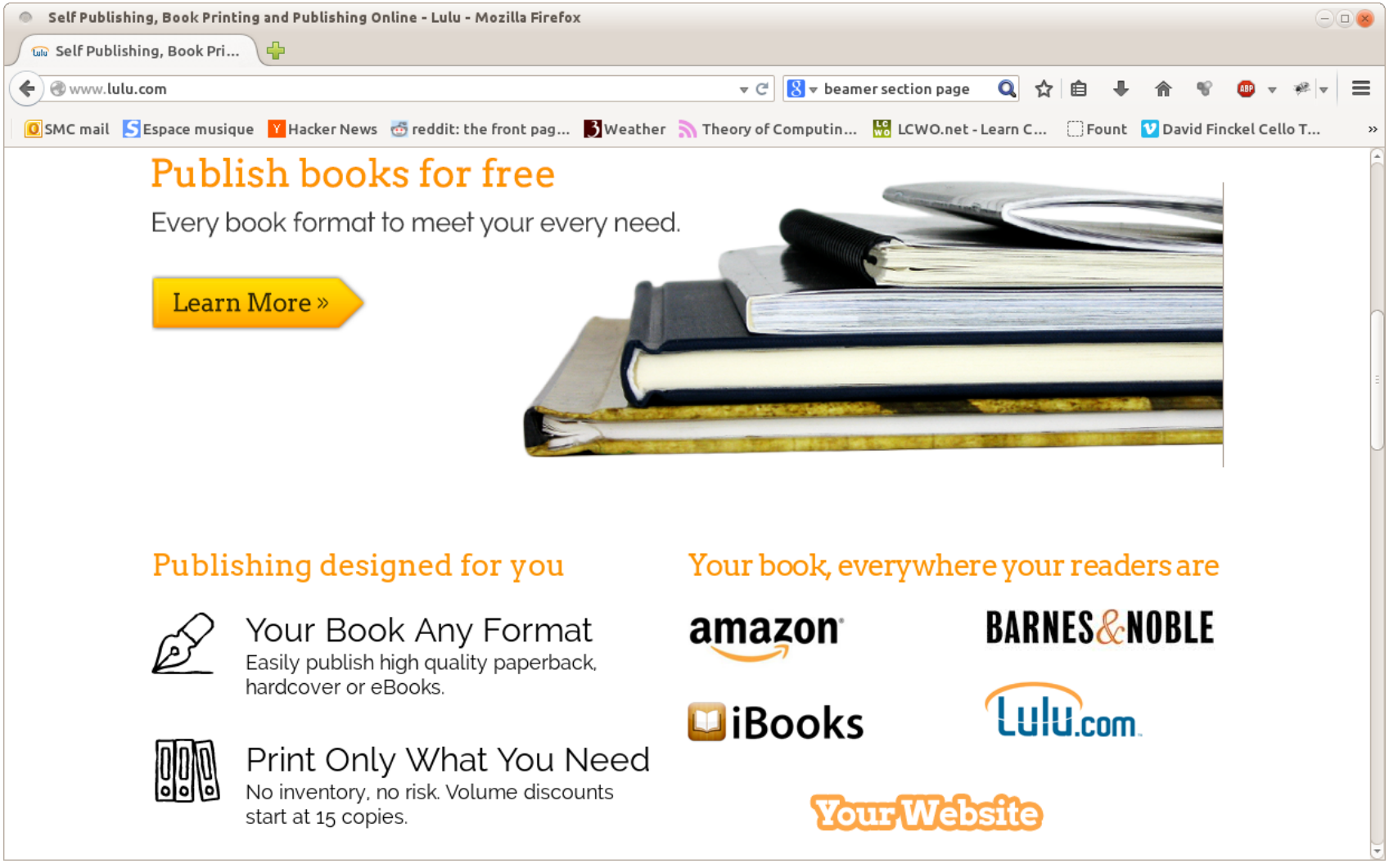
Ingram (Lightning Source)



Amazon


CreateSpace: Self Publishing and Free Distribution for Books, CD, DVD - Mozilla Firefox
CreateSpace: Self Publis...
https://www.createspace.com
create space
SMC mail
Espace musique
Hacker News
reddit: the front pag...
Weather
Theory of Computin...
LCWO.net - Learn C...
Fount
Sign Up
What's new?
MATTE COVER FINISH
Matte Finish - now available for your book.
Learn more
MAKE YOUR BOOK DIGITAL
Creating a Kindle eBook has never been easier.
Learn more
New Releases
Brett Battles
The Discarded
Jasinda Wilder
Falling Under
Start your free online setup now.
Upload your files and use our free online tools.
Start a title for free
Get in touch with our publishing experts.
We can tailor a publishing solution just for you.
Explore paid services
Authors
Musicians
Filmmakers
NEW! Free Expanded Distribution Options
Independent Publishing with CreateSpace
Free and Easy Tools
Do-it-yourself and finish fast with tools like Interior Reviewer, Cover Creator, Preview, and Image Gallery.
Higher Royalties
Place more in your pocket with some of the best economics in the industry. View Earning Royalties video.
Comprehensive Book Services
Get the help you need to complete your book with our affordable design, editing, and marketing services.
Always Available
Your work is manufactured to meet demand, so your title is always in stock. There are no upfront costs and no need to carry inventory.
Wide Distribution Options
Reach readers for free. Make your book available through Amazon.com, Amazon Europe, your own eStore, Kindle, and Expanded Distribution options.
Help when you need it
Get answers fast over the phone, by e-mail, or join our Community and discuss your ideas, questions, and more with folks just like you.
The Virtues of Indie Publishing
The publishing industry is evolving. Hundreds of
Jennifer Tress
Featured Author

There are others: Lulu



Into the dark

It may well be that Amazon is so powerful now that having a book only for sale there is enough, and students will certainly be able to find it that way. Amazon seems to have a good reputation for some things, including ease of author use and customer service. If someone wants to work on their own then that may be the best way.

Into the dark

It may well be that Amazon is so powerful now that having a book only for sale there is enough, and students will certainly be able to find it that way. Amazon seems to have a good reputation for some things, including ease of author use and customer service. If someone wants to work on their own then that may be the best way.

However, the deal may come with strings.

For instance, you can offer an ebook as free to read on the Kindle for two weeks but you have to agree to exclusivity with Amazon.

Revenue

We tell retailers what price to charge buyers. They deduct a certain percentage, the *discount*, and then give the rest to us, for the printing and for profit.

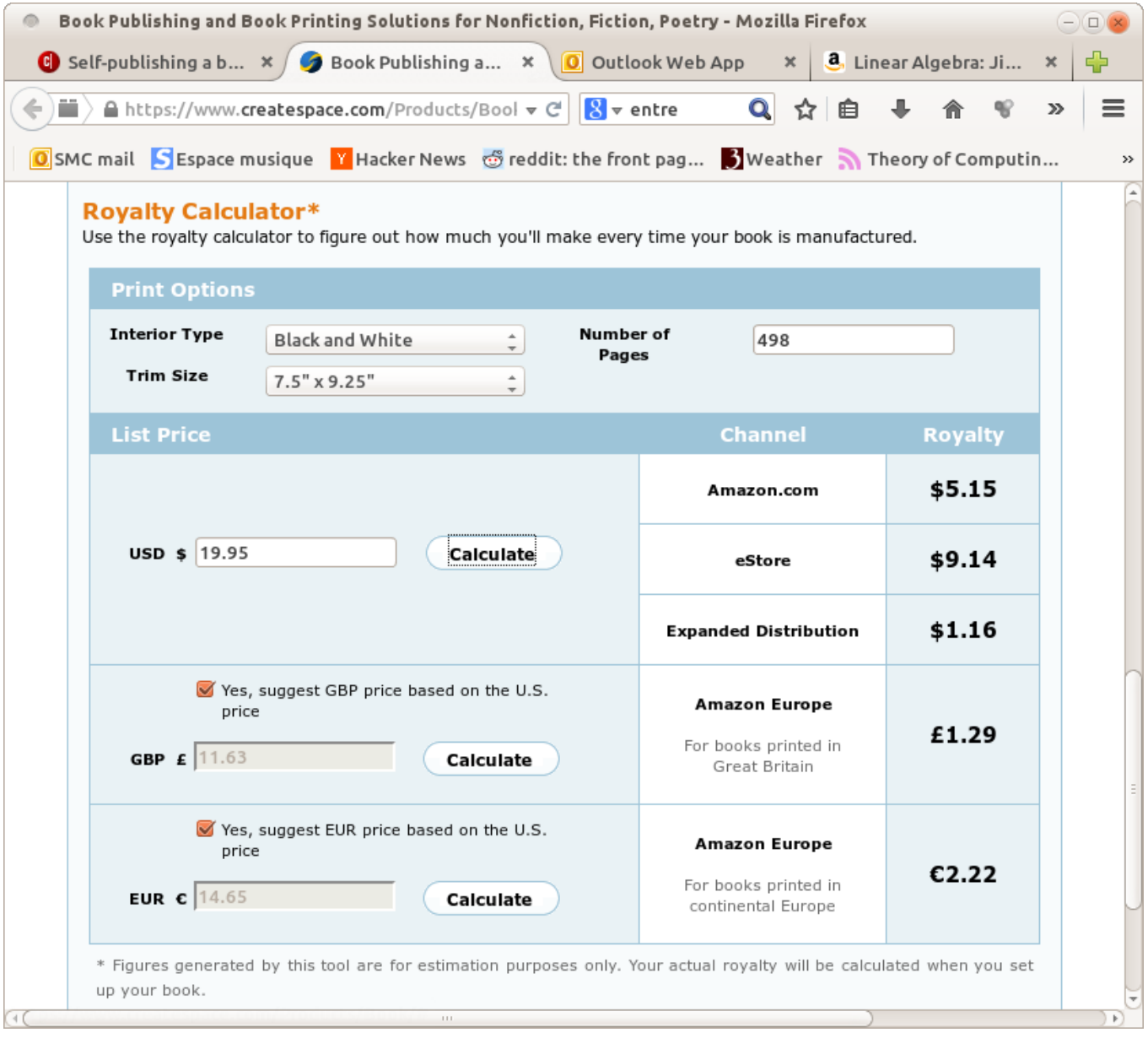
Revenue

We tell retailers what price to charge buyers. They deduct a certain percentage, the *discount*, and then give the rest to us, for the printing and for profit.

The odd part is that we get to set an upper limit on the retailer's percentage. The bricks and mortar standard is 55%. If we set the percentage too low then these retailers will not offer the book. But online retailers are fine with 25% (college bookstores also accept this low percentage) so I went with this.

Amazon's Createspace or Lulu don't have a discount because you are already working with the retailer. The downside is that you may have restricted distribution, or face a double mark-up such as Lulu books that are sold on Amazon.

Amazon's calculator



Printing costs

Printing prices are significantly less for certain book sizes. US paper size 8.5 x 11 inches is expensive. Cheaper are 6 x 9, 6.14 x 9.21, 6.69 x 9.61, 7.5 x 9.25, and 7.44 x 9.69.

The 6.14 x 9.21 size is common for upper-level textbooks. The smaller width means more reformatting, however, and lower-level textbooks are often larger, so I went with 7.5 x 9.25. Besides, this size retains the option for an instructor to print the text onto 8.5 x 11.

Additional considerations

Our other costs are setup fees ($105), ISBNs ($25 each), and an annual listing fee ($13).

ISBN costs are a downside to frequent updates, as traditionally any major or even many minor changes in a book should result in a new edition with a new ISBN (the disadvantage is clear of students purchasing editions with the same ISBN that are significantly different).

Having a little extra revenue from each copy helps with things like advertising, such as free books for the Joint Math Meeting.

Finally, with a Free book anyone could undercut the price. However most people go to my web page for the book and I point to my edition.

Additional considerations

Our other costs are setup fees ($105), ISBNs ($25 each), and an annual listing fee ($13).

ISBN costs are a downside to frequent updates, as traditionally any major or even many minor changes in a book should result in a new edition with a new ISBN (the disadvantage is clear of students purchasing editions with the same ISBN that are significantly different).

Having a little extra revenue from each copy helps with things like advertising, such as free books for the Joint Math Meeting.

Finally, with a Free book anyone could undercut the price. However most people go to my web page for the book and I point to my edition.

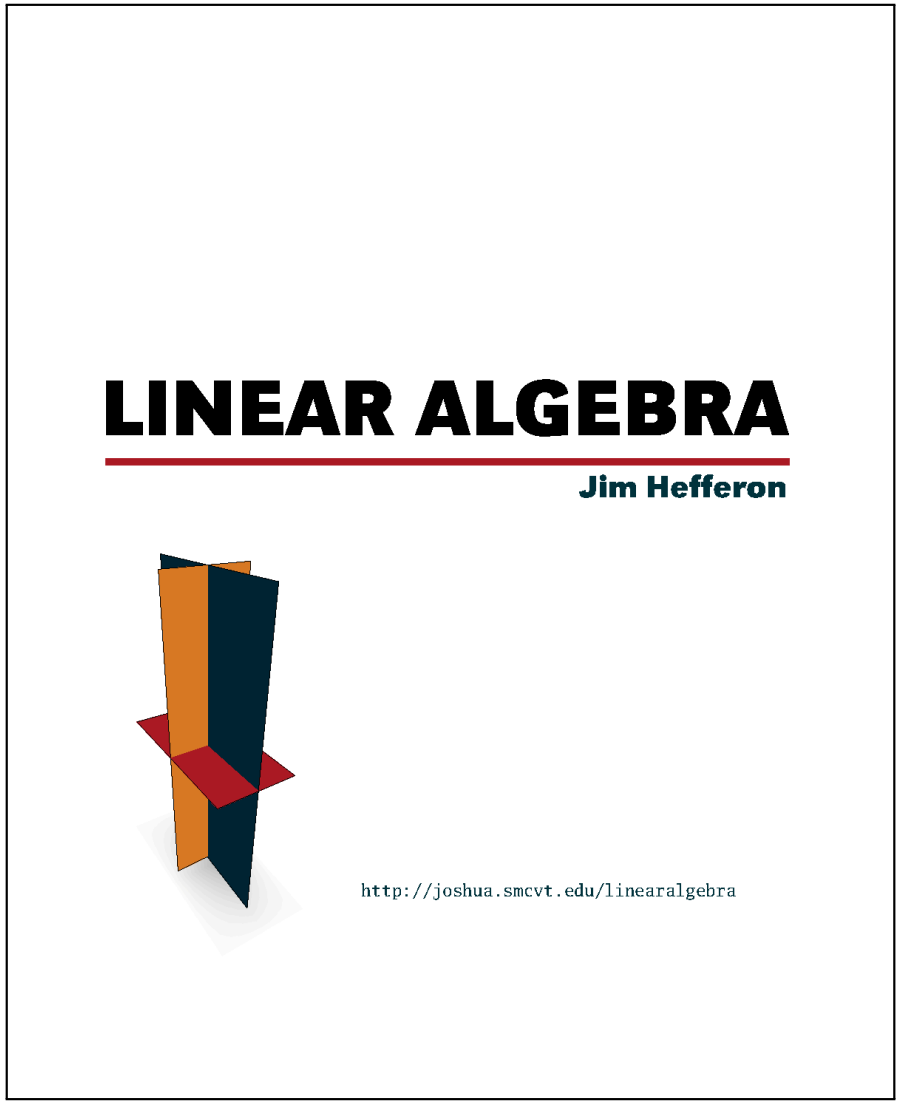
The takeaway: We used Lightning Source at a $20 list price, which splits about into thirds for printing, for the retailer, and for Lon and I.

Cover

- The cover is one file, with front, back, and spine. If a revision adds or removes pages then the size of the spine changes so you want to create the cover using a process that can be easily redone (I arranged it all in LaTeX `picture` environment).
- There is no printing on the inside of the cover. My driver `.tex` file got a flag so that if the PDF is for paper then it makes an extra inside sheet holding the page with the list of symbols. (This flag also makes hyperlinks in the book's body show as black instead of the electronic PDF's blue.)
- My 498 pages gives a spine width of 1.001 inches.
- The back cover has some marketing text. The ISBN and bar code go at the bottom of the back, in a box about an inch tall.

Cover art

I have no artistic ability, at all. I seem also to have no ability to get others to use *their* artistic ability.



Binding energy

The 7.5 x 9.25 inche book size allows me to keep LaTeX's default line length of 345 points and printing onto US 8.5 x 11 paper is not too bad.

```
% Set page margins, etc.
\usepackage[papersize={7.5in,9.25in},
            textwidth=345pt, % textheight=550pt,  % LaTeX defaults
            inner=.8in, top=.85in, bottom=.85in, % squeeze a lot on the paper
            headsep=12pt,
            bindingoffset=0.4in,
            ]{geometry}
```

The more pages there are, the more the binding will use up page space, so the inside margins needed to be set a little larger.

Repaginating the mathematics took longer than you would think. The microtype package helps with linebreaks, and using `\raggedbottom` and forbidding widows and orphans helps with pagebreaks, but neither help nearly enough.

Lurking culprits

At the first submission, besides the binding margin there was only one thing to fix: a non-embedded type 3 font somewhere in the document. Using XPDF's `pdffonts` showed that it was on pages 295 and 296. The only unusual things to see there was graphs from *Sage*.

Some spelunking[1] revealed that I needed to pass to the Sage plot the parameter `typeset=latex`. That bug ticket was only a couple of months old.

[1] `http://trac.sagemath.org/ticket/14664`

Lurking culprits

At the first submission, besides the binding margin there was only one thing to fix: a non-embedded type 3 font somewhere in the document. Using XPDF's `pdffonts` showed that it was on pages 295 and 296. The only unusual things to see there was graphs from *Sage*.

Some spelunking[1] revealed that I needed to pass to the Sage plot the parameter `typeset=latex`. That bug ticket was only a couple of months old.

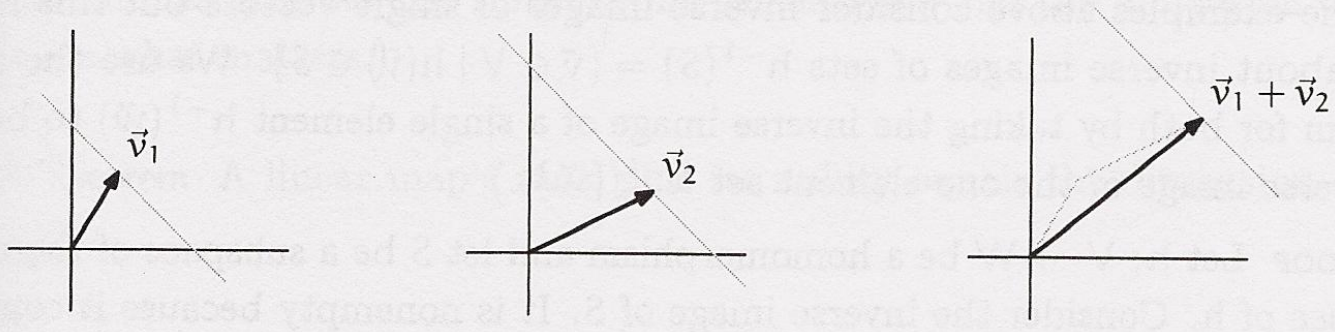
[1] `http://trac.sagemath.org/ticket/14664`

There's 0.85 gray and then there's 0.70 gray

2.8 Example A homomorphism can express an analogy between spaces that is more subtle than the prior one. For the map from Example 2.6

$$\begin{pmatrix} x \\ y \end{pmatrix} \xmapsto{h} x+y$$

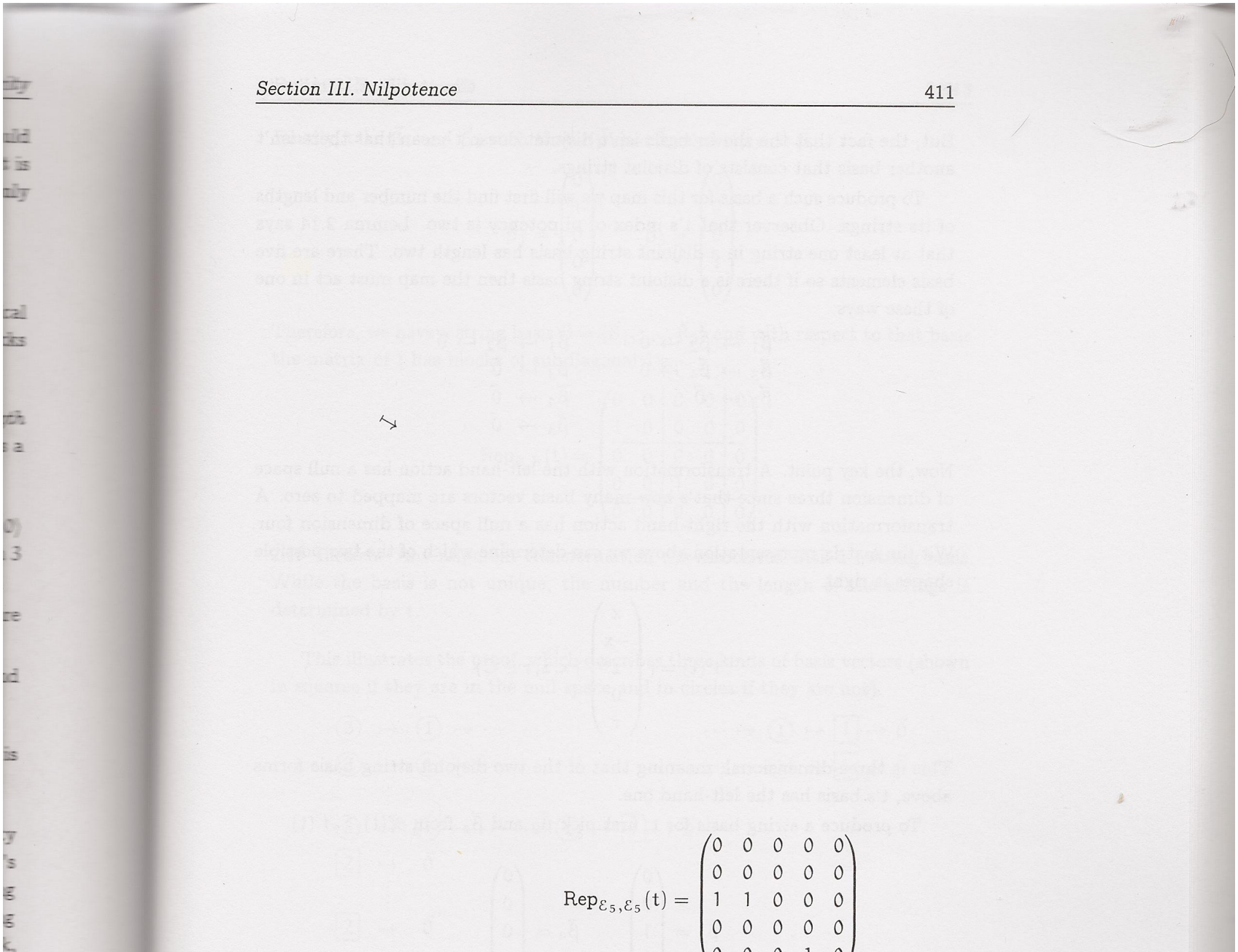
fix two numbers in the range $w_1, w_2 \in \mathbb{R}$. A $\vec{v}_1$ that maps to w_1 has components that add to w_1, so the inverse image $h^{-1}(w_1)$ is the set of vectors with endpoint on the diagonal line $x+y=w_1$. Think of these as "w_1 vectors." Similarly we have "w_2 vectors" and "w_1+w_2 vectors." The addition preservation property says this.



a "w_1 vector" plus a "w_2 vector" equals a "w_1+w_2 vector"

Restated, if we add a w_1 vector to a w_2 vector then h maps the result to a w_1+w_2 vector. Briefly, the sum of the images is the image of the sum. Even more briefly, $h(\vec{v}_1)+h(\vec{v}_2)=h(\vec{v}_1+\vec{v}_2)$.

Mistakes look *really* bad in print



$$\mathrm{Rep}_{\mathcal{E}_5,\mathcal{E}_5}(t) = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$

Typical page

for numbers $m_1, \ldots, m_k$ that measure the quantities.

For the second fact, observe that an easy way to construct a dimensionally homogeneous expression is by taking a product of dimensionless quantities or by adding such dimensionless terms. Buckingham's Theorem states that any complete relationship among quantities with dimensional formulas can be algebraically manipulated into a form where there is some function f such that

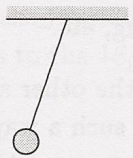
$$f(\Pi_1, \ldots, \Pi_n) = 0$$

for a complete set $\{\Pi_1, \ldots, \Pi_n\}$ of dimensionless products. (The first example below describes what makes a set of dimensionless products 'complete'.) We usually want to express one of the quantities, m_1 for instance, in terms of the others. For that we will assume that the above equality can be rewritten

$$m_1 = m_2^{-p_2} \cdots m_k^{-p_k} \cdot \hat{f}(\Pi_2, \ldots, \Pi_n)$$

where $\Pi_1 = m_1 m_2^{p_2} \cdots m_k^{p_k}$ is dimensionless and the products $\Pi_2, \ldots, \Pi_n$ don't involve m_1 (as with f, here $\hat{f}$ is an arbitrary function, this time of $n-1$ arguments). Thus, to do dimensional analysis we should find which dimensionless products are possible.

For example, again consider the formula for a pendulum's period.



quantity	*dimensional formula*
period p	$L^0M^0T^1$
length of string ℓ	$L^1M^0T^0$
mass of bob m	$L^0M^1T^0$
acceleration due to gravity g	$L^1M^0T^{-2}$
arc of swing θ	$L^0M^0T^0$

Typical section page

1.15 The proof of Lemma 1.5 contains a reference to the $i \neq j$ condition on the row combination operation.

(a) Write down a 2×2 matrix with nonzero entries, and show that the $-1 \cdot \rho_1 + \rho_1$ operation is not reversed by $1 \cdot \rho_1 + \rho_1$.

(b) Expand the proof of that lemma to make explicit exactly where it uses the $i \neq j$ condition on combining.

1.16 [Cleary] Consider the set of students in a class. Which of the following relationships are equivalence relations? Explain each answer in at least a sentence.

(a) Two students x, y are related if x has taken at least as many math classes as y.

(b) Students x, y are related if they have names that start with the same letter.

1.17 Show that each of these is an equivalence on the set of 2×2 matrices. Describe the equivalence classes.

(a) Two matrices are related if they have the same product down the diagonal, that is, if the product of the entries in the upper left and lower right are equal.

(b) Two matrices are related if they both have at least one entry that is a 1, or if neither does.

1.18 Show that each is not an equivalence on the set of 2×2 matrices.

(a) Two matrices A, B are related if $a_{1,1} = -b_{1,1}$.

(b) Two matrices are related if the sum of their entries are within 5, that is, A is related to B if $|(a_{1,1} + \cdots + a_{2,2}) - (b_{1,1} + \cdots + b_{2,2})| < 5$.

III.2 The Linear Combination Lemma

We will close this chapter by proving that every matrix is row equivalent to one and only one reduced echelon form matrix. The ideas here will reappear, and be further developed, in the next chapter.

The crucial observation concerns how row operations act to transform one

Typical chapter page

Chapter Two

Vector Spaces

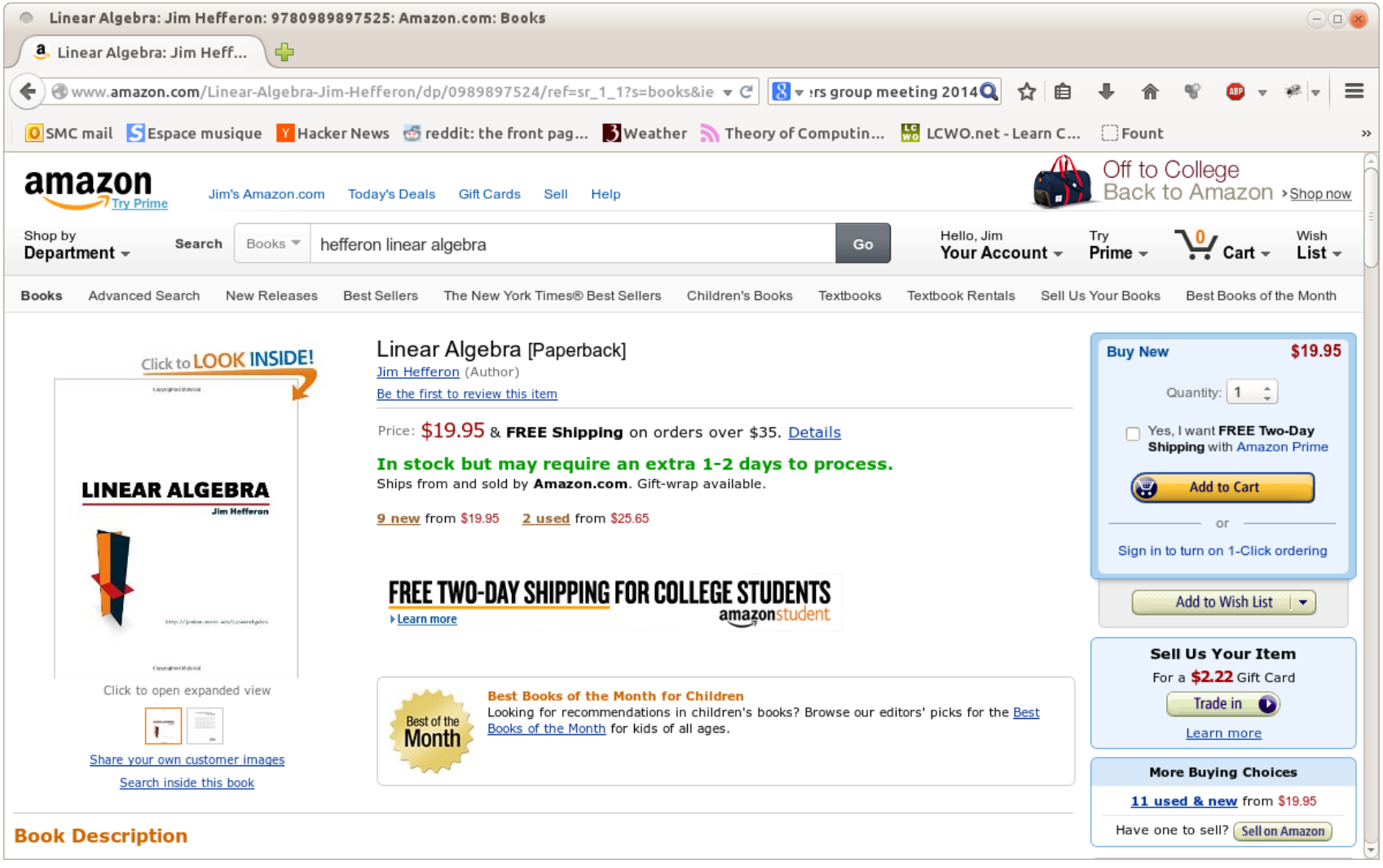
The first chapter finished with a fair understanding of how Gauss's Method solves a linear system. It systematically takes linear combinations of the rows. Here we move to a general study of linear combinations.

We need a setting. At times in the first chapter we've combined vectors from $\mathbb{R}^2$, at other times vectors from $\mathbb{R}^3$, and at other times vectors from higher-dimensional spaces. So our first impulse might be to work in $\mathbb{R}^n$, leaving n unspecified. This would have the advantage that any of the results would hold for $\mathbb{R}^2$ and for $\mathbb{R}^3$ and for many other spaces, simultaneously.

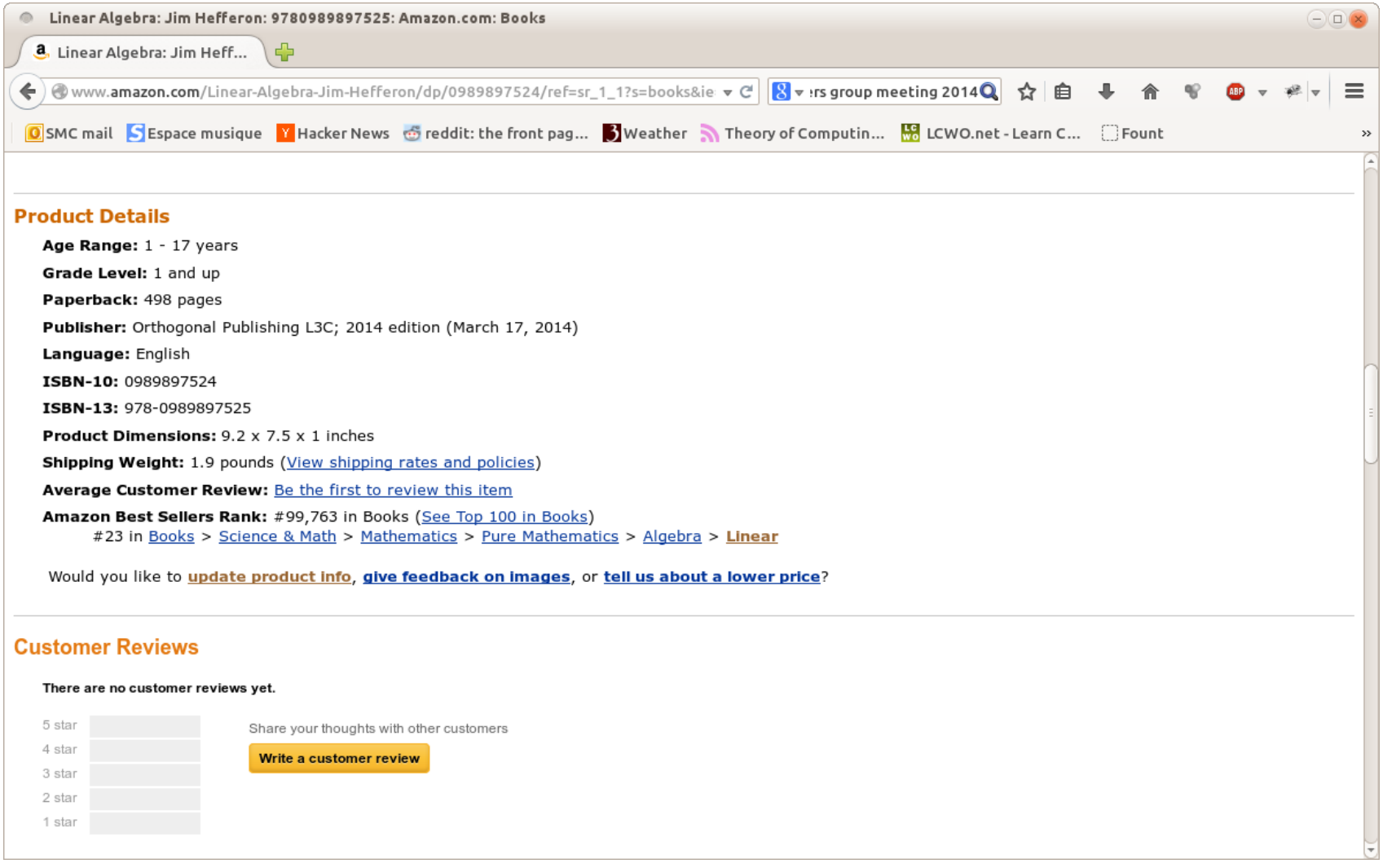
But if having the results apply to many spaces at once is advantageous then sticking only to $\mathbb{R}^n$'s is overly restrictive. We'd like our results to apply to combinations of row vectors, as in the final section of the first chapter. We've even seen some spaces that are not simply a collection of all of the same-sized column vectors or row vectors. For instance, we've seen a homogeneous system's solution set that is a plane inside of $\mathbb{R}^3$. This set is a closed system in that a linear combination of these solutions is also a solution. But it does not contain all of the three-tall column vectors, only some of them.

We want the results about linear combinations to apply anywhere that linear

Amazon.com


Linear Algebra: Jim Hefferon: 9780989897525: Amazon.com: Books
Linear Algebra: Jim Heff...
www.amazon.com/Linear-Algebra-Jim-Hefferon/dp/0989897524/ref=sr_1_1?s=books&ie
SMC mail
Espace musique
Hacker News
reddit: the front pag...
Weather
Theory of Computin...
LCWO.net - Learn C...
Fount
amazon
Try Prime
Jim's Amazon.com
Today's Deals
Gift Cards
Sell
Help
Off to College
Back to Amazon
Shop now
Shop by Department
Search
Books
hefferon linear algebra
Go
Hello, Jim
Your Account
Try Prime
Cart
Wish List
Books
Advanced Search
New Releases
Best Sellers
The New York Times® Best Sellers
Children's Books
Textbooks
Textbook Rentals
Sell Us Your Books
Best Books of the Month
Click to LOOK INSIDE!
LINEAR ALGEBRA
Jim Hefferon
Click to open expanded view
Share your own customer images
Search inside this book
Linear Algebra [Paperback]
Jim Hefferon (Author)
Be the first to review this item
Price: $19.95 & FREE Shipping on orders over $35. Details
In stock but may require an extra 1-2 days to process.
Ships from and sold by Amazon.com. Gift-wrap available.
9 new from $19.95
2 used from $25.65
FREE TWO-DAY SHIPPING FOR COLLEGE STUDENTS
amazonstudent
Learn more
Best of the Month
Best Books of the Month for Children
Looking for recommendations in children's books? Browse our editors' picks for the Best Books of the Month for kids of all ages.
Buy New
$19.95
Quantity: 1
Yes, I want FREE Two-Day Shipping with Amazon Prime
Add to Cart
or
Sign in to turn on 1-Click ordering
Add to Wish List
Sell Us Your Item
For a $2.22 Gift Card
Trade in
Learn more
More Buying Choices
11 used & new from $19.95
Have one to sell?
Sell on Amazon
Book Description

Take that, Mr 99,764



Felt pretty good