

# Welcome to Stanford



*I love Stanford. It is the only university with a cell phone tower in its logo.*

# Double, Deep, Sudden Impact

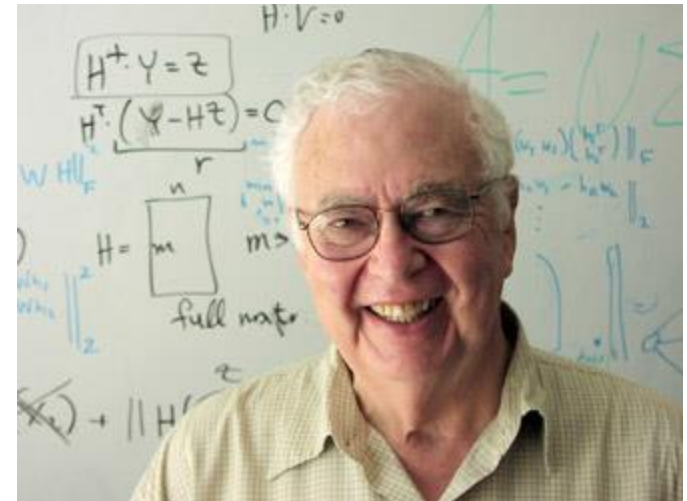
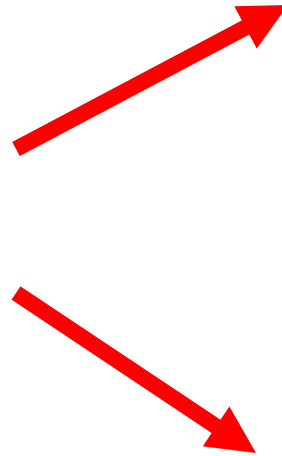
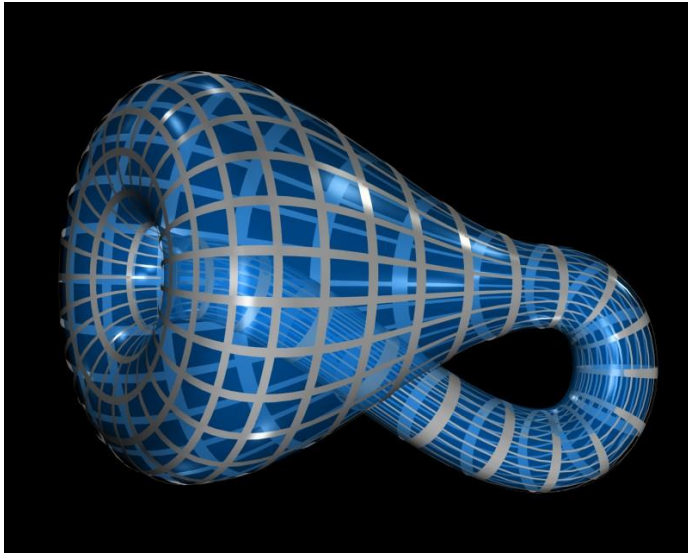
*Reflections on Stan50 and GHG75*

Charlie Van Loan  
Cornell University

# 44 Comic Sans

*In French this means "Middle-Aged Without Funny". PowerPoint forces after-dinner speakers to use this font.*

# History is Nonlinear



Let's walk the surface.

*In the beginning there was...*

# Gottfried Leibniz



1646--1716

$$\frac{d}{dx}(uv) = u \frac{dv}{dx} + v \frac{du}{dx}.$$

*who begat ...*

It took 300+ years for his "Let us calculate" to become "Let you calculate". We owe grad students big time!

# Jacob Bernoulli



1654--1705

$$\frac{x}{e^x - 1} = \sum_{n=0}^{\infty} B_n \frac{x^n}{n!}$$

*who begat ...*

1, -1/2, 1/6, -1/30, ..., -236364091/2730, ...

# Johann Bernoulli



$$y = a \cdot \cosh\left(\frac{x}{a}\right) = \frac{a}{2} \cdot \left(e^{x/a} + e^{-x/a}\right)$$

1667--1748

*who begat ...*

(He had higher GRE scores.)



# Leonhard Euler



1707--1783

$$y_{n+1} = y_n + h f(x_n, y_n)$$

*who begat ...*

# reluE drahnoel

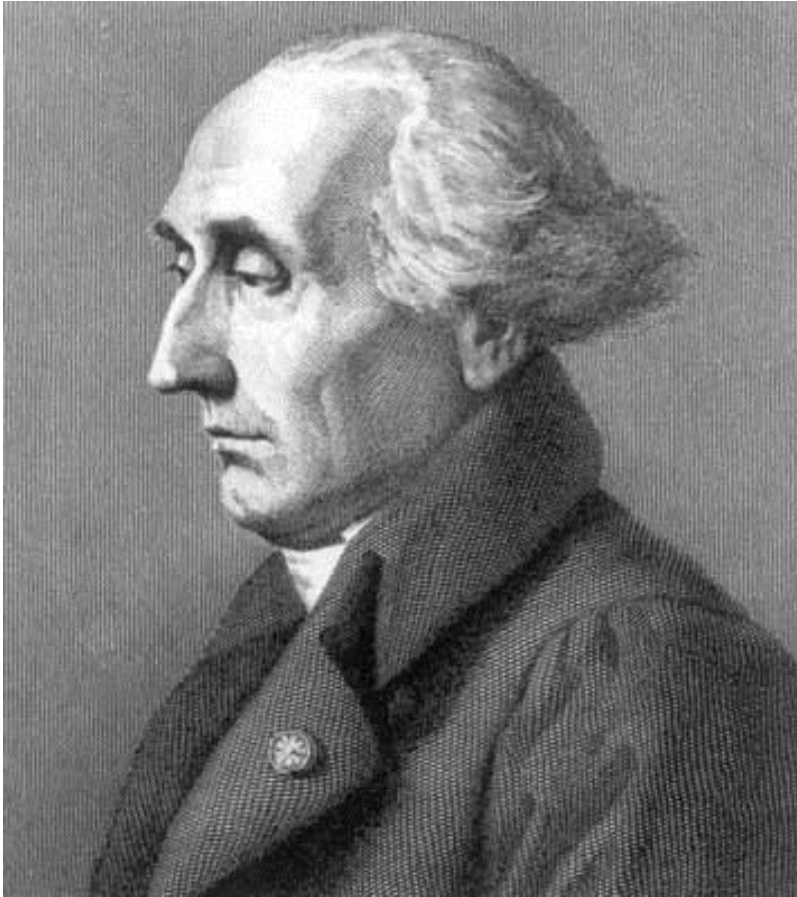


3871--7071

$$y_{n+1} = y_n + h f(x_{n+1}, y_{n+1})$$

*... tageb ohw*

# Joseph Lagrange



1736--1813

$$\nabla [f(x, y) + \lambda(g(x, y) - c)] = 0$$

*who begat ...*

# Jean-Baptiste Fourier



1768--1830

$$X(\omega) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} x(t) e^{-i\omega t} dt$$

*who begat ...*

# Gustav Dirichlet



1805--1859

$$y(x) = f(x) \quad \forall x \in \partial\Omega$$

*who begat ...*

# Rudolf Lipschitz



1832--1903

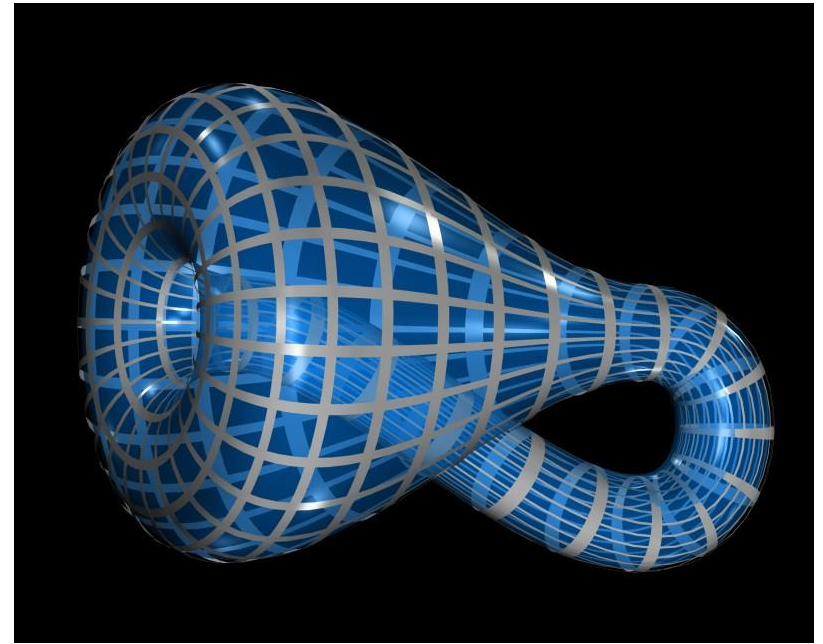
$$|f(x) - f(y)| \leq \delta |x - y|$$

*who begat ...*

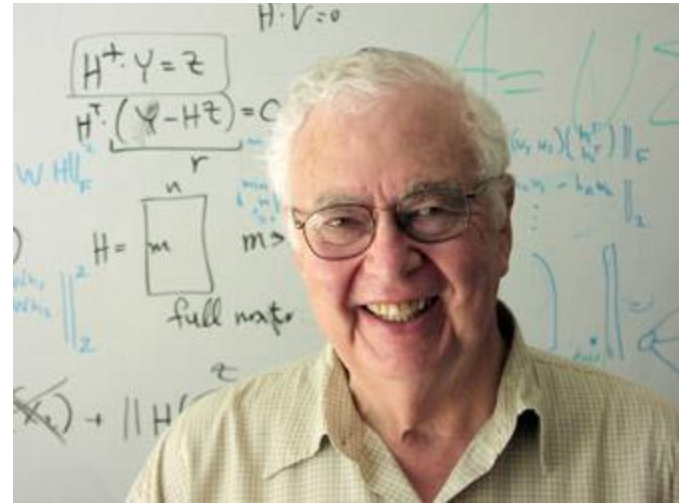
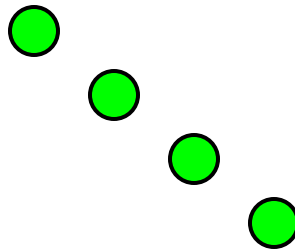
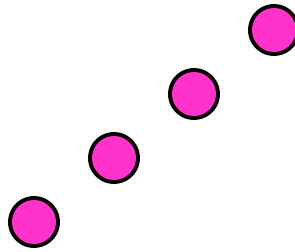
# C. Felix Klein



1849--1925



*who in five  
generations begat ...*



Who are the dots?

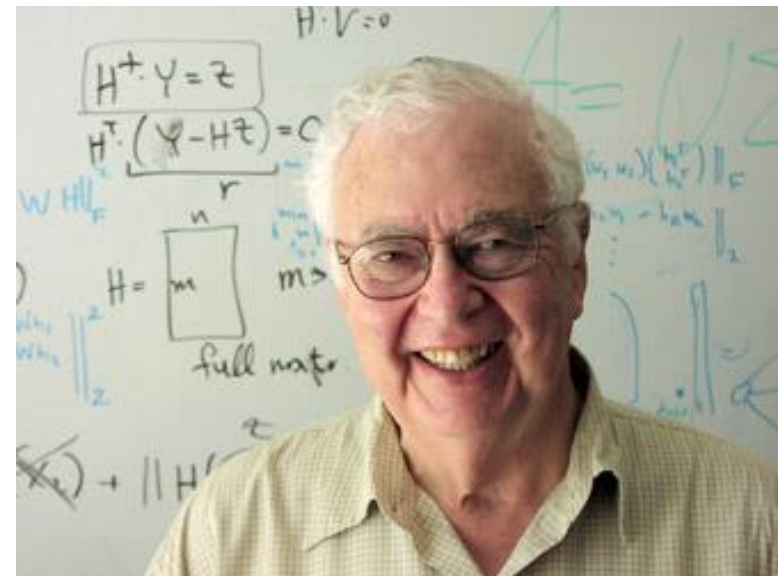


# George Forsythe



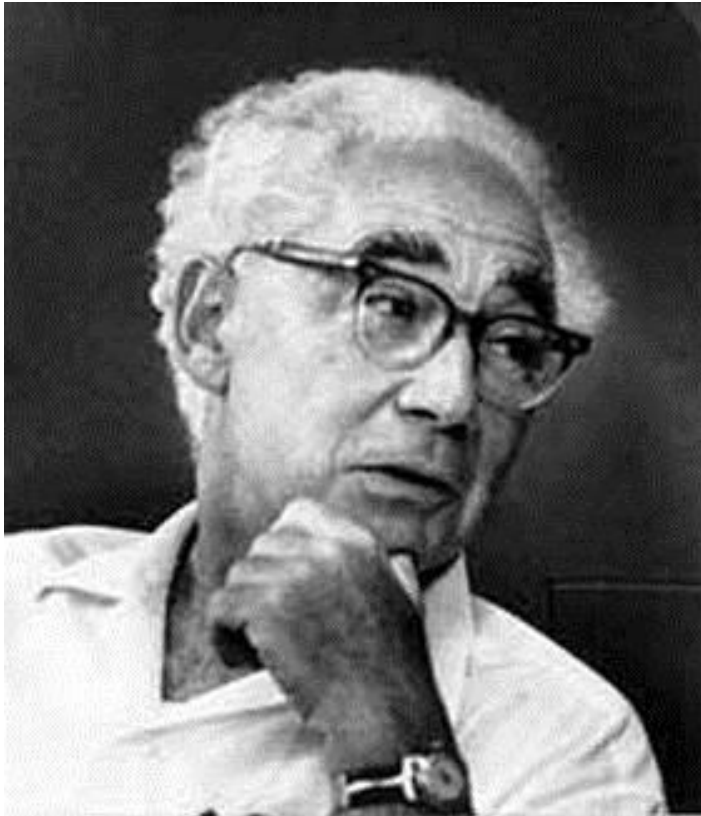
*was a student of ...*

# Gene Golub



*was a student of ...*

# Willi Feller



1906--1970

*was a student of ...*

# Abe Taub



1911--1999

*was a student of ...*

# Richard Courant



1888--1972

*was a student of ...*

# Howard P. Robertson



1903--1961

*was a student of ...*

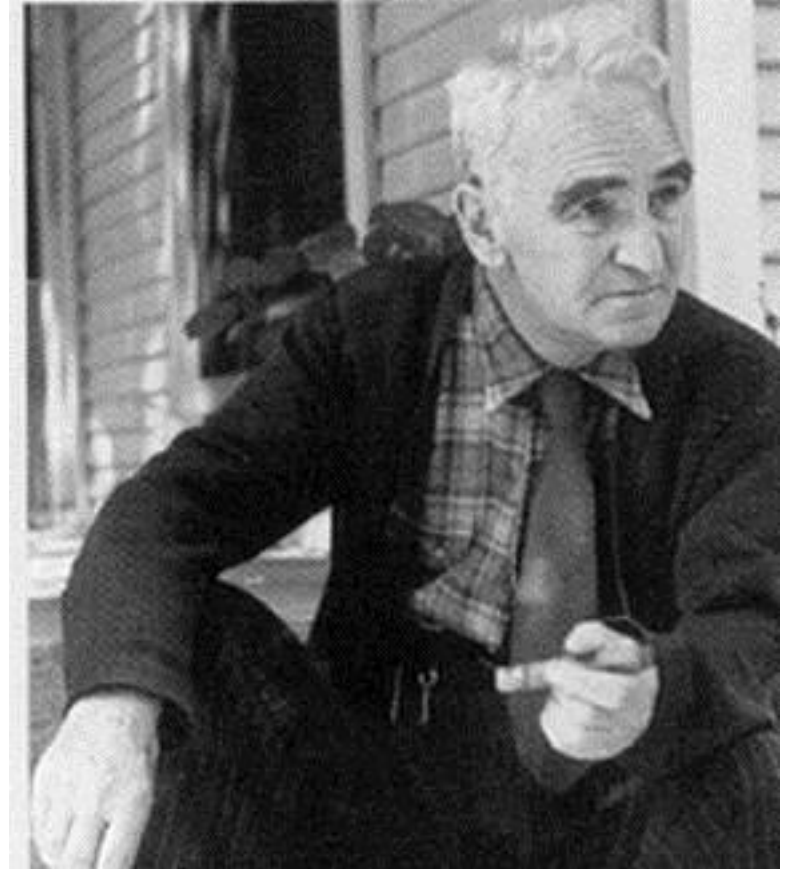
# David Hilbert



1862--1943

*was a student of ...*

# Eric Temple Bell

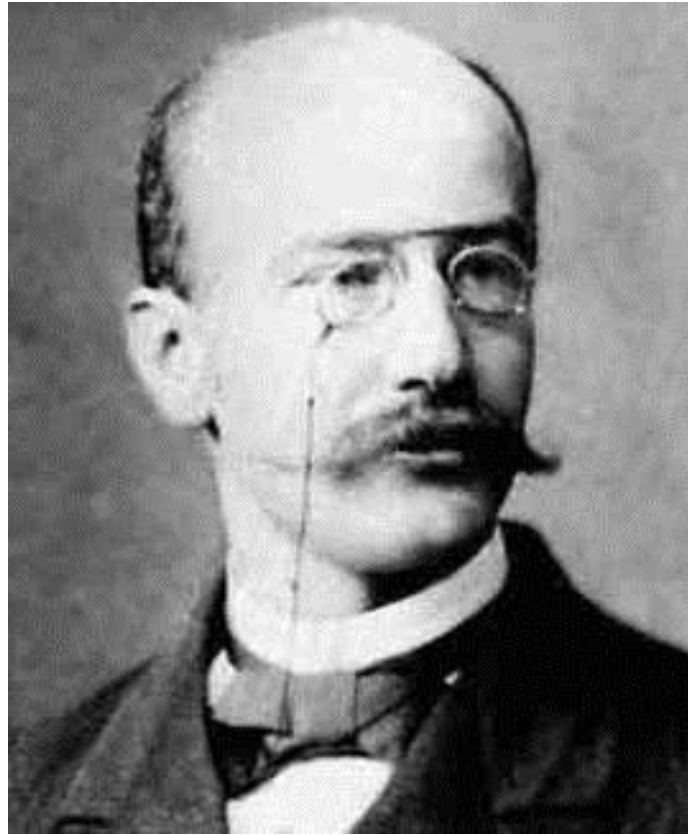


1883--1960

*was a student of ...*

*In the Humanities Hilbert is often referred to as the "Little Gatsby".*

# C.L.F. Lindemann



1852--1939

*was a student of ...*

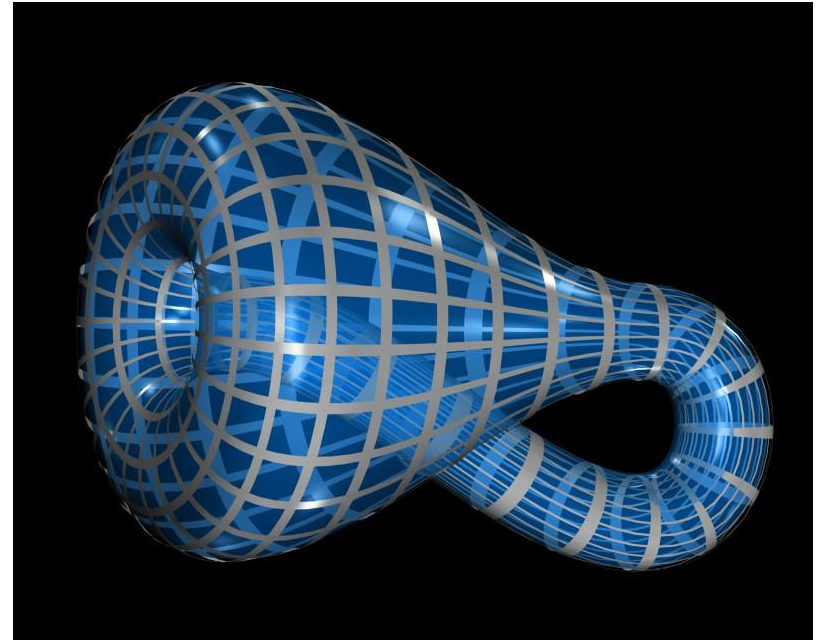
# Frank Cole



1861--1926

*was also a student of ...*

# C. Felix Klein

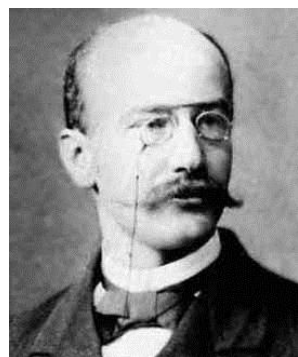


1849--1925

*Great-Great-Great-Grandfather Klein. George and Gene are 5<sup>th</sup> cousins.*

"If I have seen further it is  
by standing on the shoulders  
of giants."

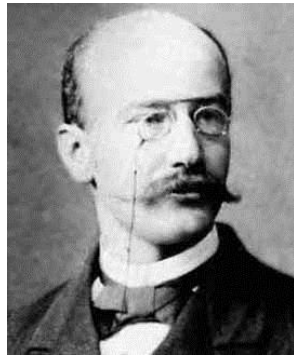
-- Newton



*By honoring our Stanford heroes we honor those who came before.*



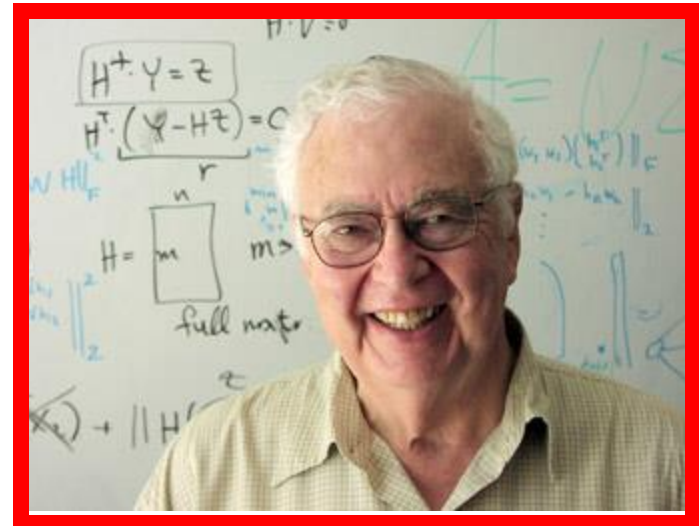
$H_3 =$



Incidentally, the 3-by-3 Hair transform is diagonally dominant. Proof: Just use the Gerschgorin Toupee Theorem.

# Double Impact

## *The Personal Legacy*



# Two Great Papers

"Pitfalls in Computation, or Why a Math Book Isn't Enough." (1970)

"Some Modified Matrix Eigenvalue Problems." (1973)



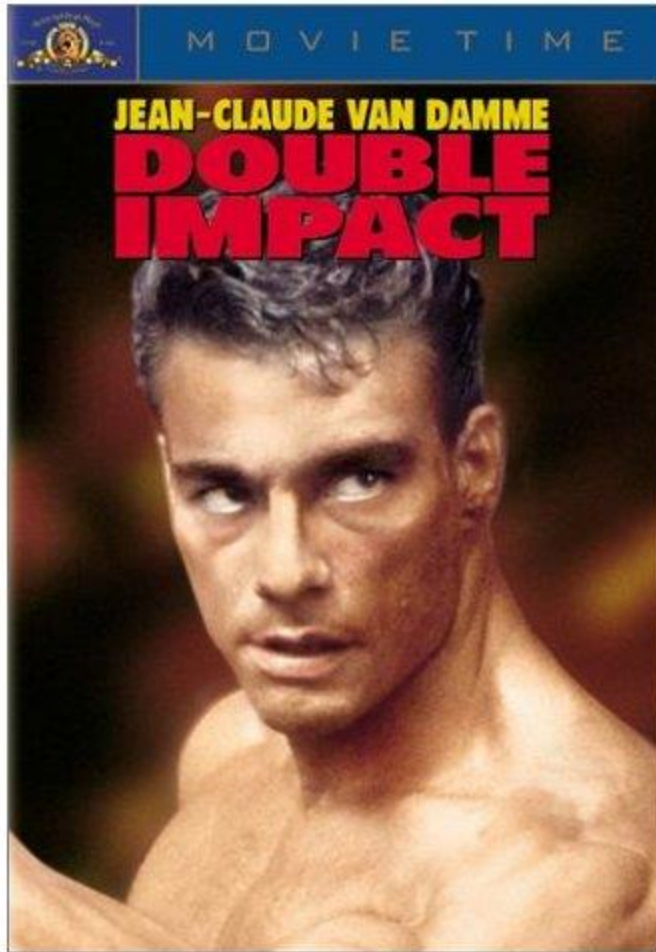
Web [Images](#) [Video](#) [News](#) [Maps](#) [Desktop](#) [more »](#)

**Double Impact**

Google Search

I'm Feeling Lucky

# You Get the Movie !!!



*Muscles from Brussels. Notice that the American release focuses on the "mind" of the hero.*

# Idea For a Sequel !!!



*Starring Van Dam Van Loan*

We Need a Better Title !!!

# Deep Impact

## *The Student Legacy*

1968 Richard Bartels 1969 Michael Jenkins 1969 Lyle Smith 1970 George Ramos 1971 Richard Brent 1972 Michael Saunders 1974 John Palmer 1975 Richard Underwood 1976 Dianne Prost O'Leary 1976 John Lewis 1976 Margaret Wright 1978 Michael Heath 1978 Franklin Luk 1979 Michael Overton 1981 Petter Bjørstad 1981 Eric Grosse 1982 Stephen Nash 1989 Mark Kent 1989 Ray Tuminaro 1993 Hongyuan Zha 1995 Oliver Ernst 1997 Xiaowei Zhan 1998 Tong Zhang 1998 Michaela Vanderveen 2000 Nhat Nguyen 2002 Urmo Holz 2003 Yong Sun 2006 Sou-Cheng Choi 1976 John Strikwerda 1978 Tony Chan 1978 Ken Bube 1980 Bill Coughran Jr. 1981 Robert Higdon 1982 Marsha Berger 1982 John Bolstad 1982 William Gropp 1982 Nick Trefethen 1982 Randall LeVeque 1986 Steve Caruso 1987 Chris Fraley 1987 Wei-Pai Tang 1988 William Skamarock 1988 Pat Worley 1995 Patrick Witting 1995 Amala Mahadevan 1996 Xiaolei Zhu 1997 Margot Gerritsen 2003 James Lambers 1960 Eldon Hansen 1962 Donald Fisher 1962 Betty Stone 1962 James Ortega 1962 Beresford Parlett 1963 Ramon Moore 1964 Robert Causey 1964 Donald Grace 1965 Cleve Moler 1966 William McKeeman 1966 Roger Hockney 1967 James Varah 1968 Paul Richman 1971 Richard Brent 1971 J. Alan George 1972 David Stoutemeyer 1973 Michael Malcolm





Web [Images](#) [Video](#) [News](#) [Maps](#) [Desktop](#) [more »](#)

**Deep Impact**

Google Search

I'm Feeling Lucky

# You Get Another Movie !!!



# But It's Based On a Great Paper !!!



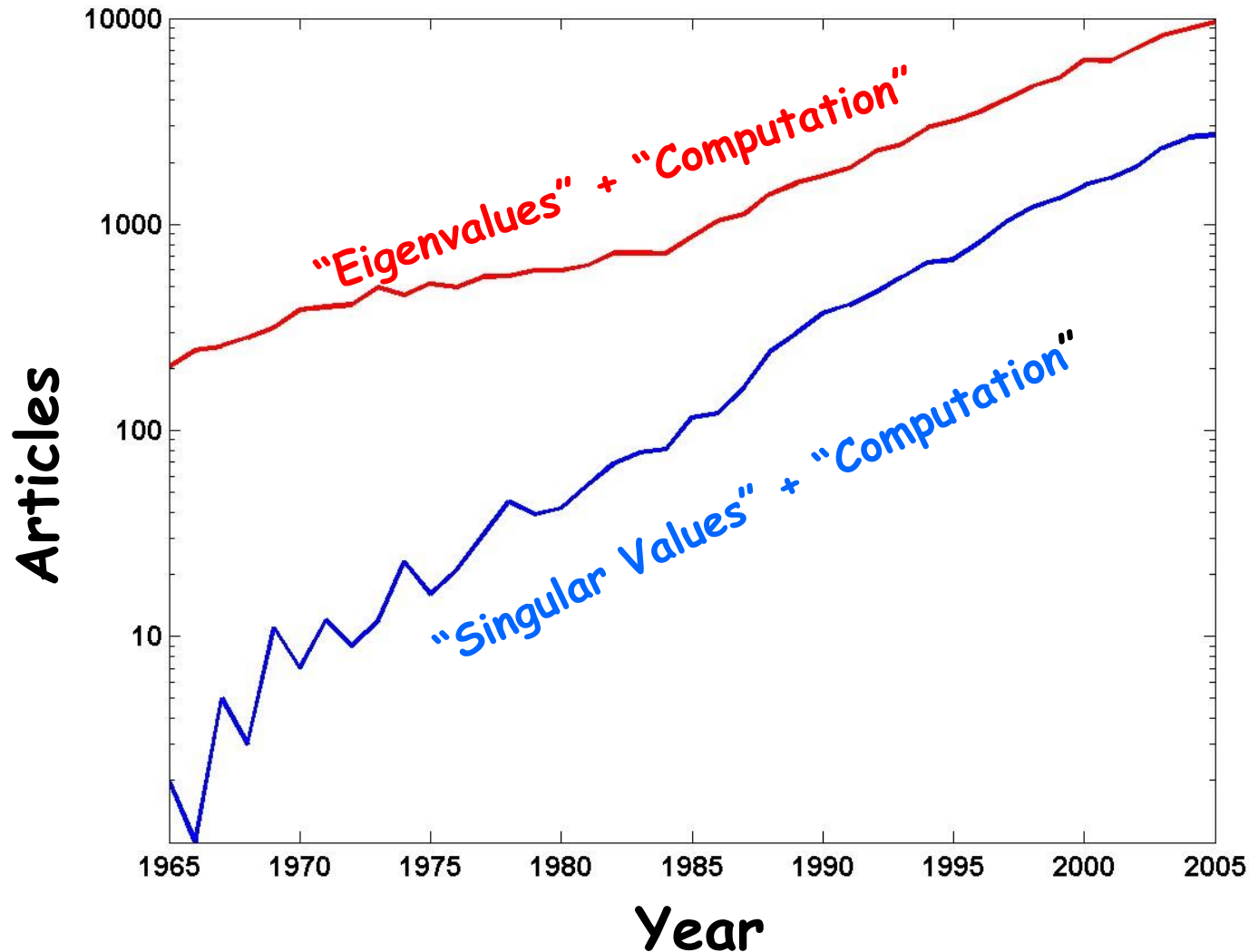
G.E. Forsythe and G.H. Golub (1965), "On the Stationary Values of A Second Degree Polynomial on the Unit Sphere," SIAM J. Applied Math, 4, 1050—1068.

*Their only joint paper.*

Still Need a Better Title !!

# Sudden Impact

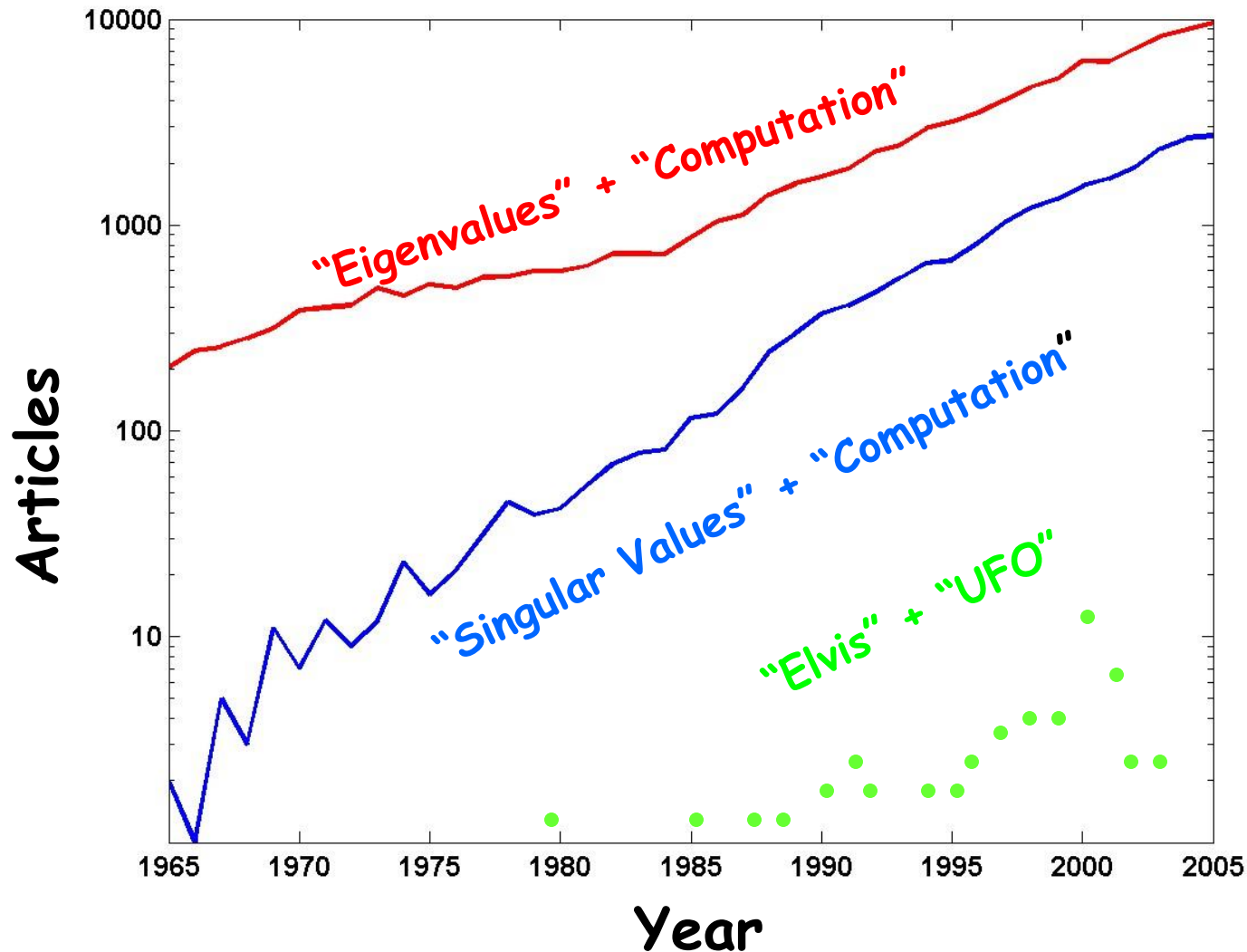
## *The Research Legacy*



Ratio of blue to red is converging to .28.

# Sudden Impact

## *The Research Legacy*



*It is always important to confirm experimental results.*

# Numerical Mathematics has a 4300+ Year History

D. Knuth (1972), "Ancient Babylonian Algorithms," *CACM* 15, 671-677.

# 4300 Years → 365 Days

1957	GF Arrival
1965	SVD
1973	Met GHG
1983	GVL1
1998	Google

Dec 27
Dec 28
Dec 29
Dec 30
Dec 31

*Fifty years is but five days when we compress computational history down to a calendar year. A very sudden impact.*





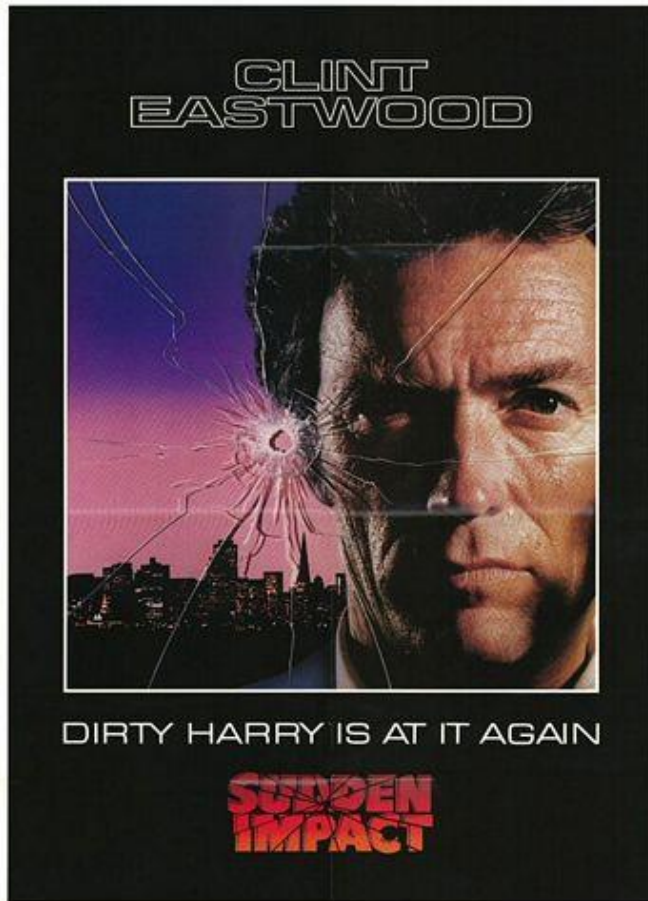
Web [Images](#) [Video](#) [News](#) [Maps](#) [Desktop](#) [more >>](#)

**Sudden Impact**

Google Search

I'm Feeling Lucky

# You Get a Movie and a Car !!!



Starring CLINT EASTWOOD and SONERA LOOKE Executive Producer FRITZ MANES  
Music by LAJO SCHIFFRIN Screenplay by JOSEPH C. STINSON Story by EARL E. SMITH & CHARLES B. PERCE  
Produced and Directed by CLINT EASTWOOD Technicolor® A WARNER COMMUNICATIONS COMPANY

# And an Idea for a Car Movie !



# DoubleDeepSudden Impact

*Reflections on Stan50 and GHG75*

Charlie Van Loan  
Cornell University

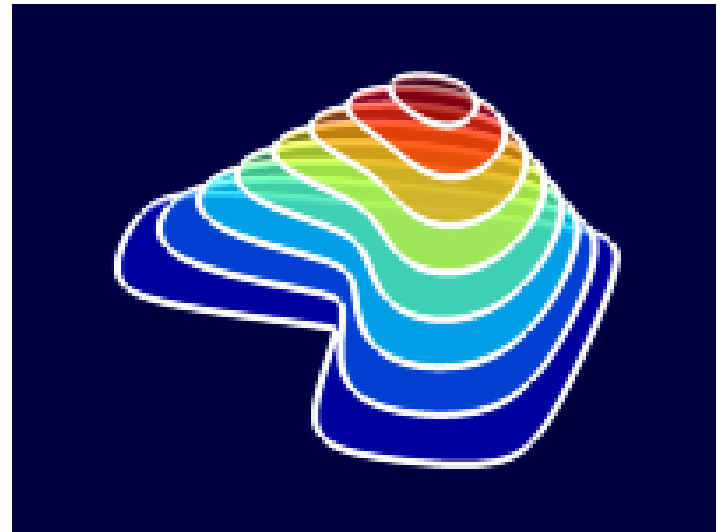
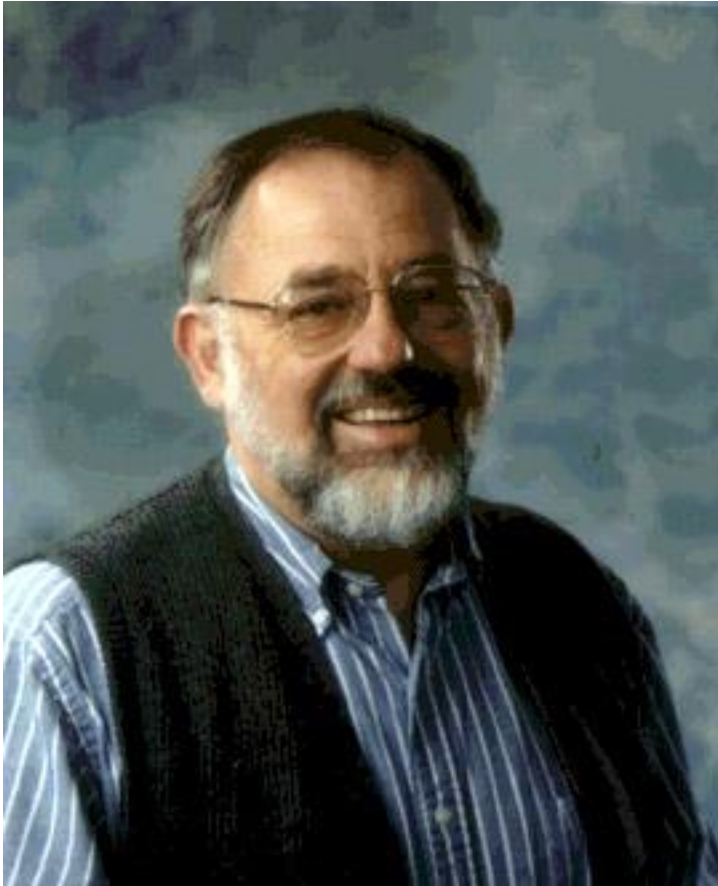
# More Forsythe Papers

Cyclic Jacobi method for computing the principal values of a complex matrix.  
(with Henrici, 1960)

Let's Not Discriminate against good work in design or experimentation. (1969)

The Role of Numerical Analysis in an Undergraduate Program (1959)

# Cleve Moler



*My first mentor is the quintessential Stanford graduate.*

"As teacher, Ph.D. advisor, and force behind Matlab, Cleve has defined the way I look at mathematics and computing."



1977 (with John Dennis)

*You may be surprised to learn that Gene and I have parallel careers.*



# While Gene was Coding the Illiac 1..



# I was cutting my teeth on...

**New 1960 German Adding Machine  
Adds & Subtracts to ONE BILLION!**

**Now with 9 NEW exclusive features--Still Only **1<sup>98</sup>****

- ↓ Pocket for Coins and \$1, \$5, \$10 Bills!
- ↓ 200 Year Perpetual Calendar!
- ↓ Fine Grain Fitted WALLET!
- ↓ Easy-Flow Clearing Lever!
- ↓ Magic Reckoner for Multiplying & Dividing!

**200 YEAR Calendar**

**NOTES**

**WIZARD CALCULATING MACHINE**

**MAGIC RECKONER**

**SOCIAL SECURITY CARD**

- ↑ Fitted Slot for Notes, Memo Pad!
- ↑ Midget Ball Point Pen!
- ↑ All Metal Stylus
- ↑ Pocket for Social Security Card, Photos, Licenses!

Now yours--the all-new 1960 Wizard Calculator--direct to you from the world's greatest importer of adding machines--TUDECEM

A present on my 13<sup>th</sup> birthday.

# New 1960 German Adding Machine Adds & Subtracts to ONE BILLION!

Now with **9** NEW exclusive features--Still Only **1<sup>98</sup>**

↓ Pocket for  
Coins and \$1,  
\$5, \$10 Bills!

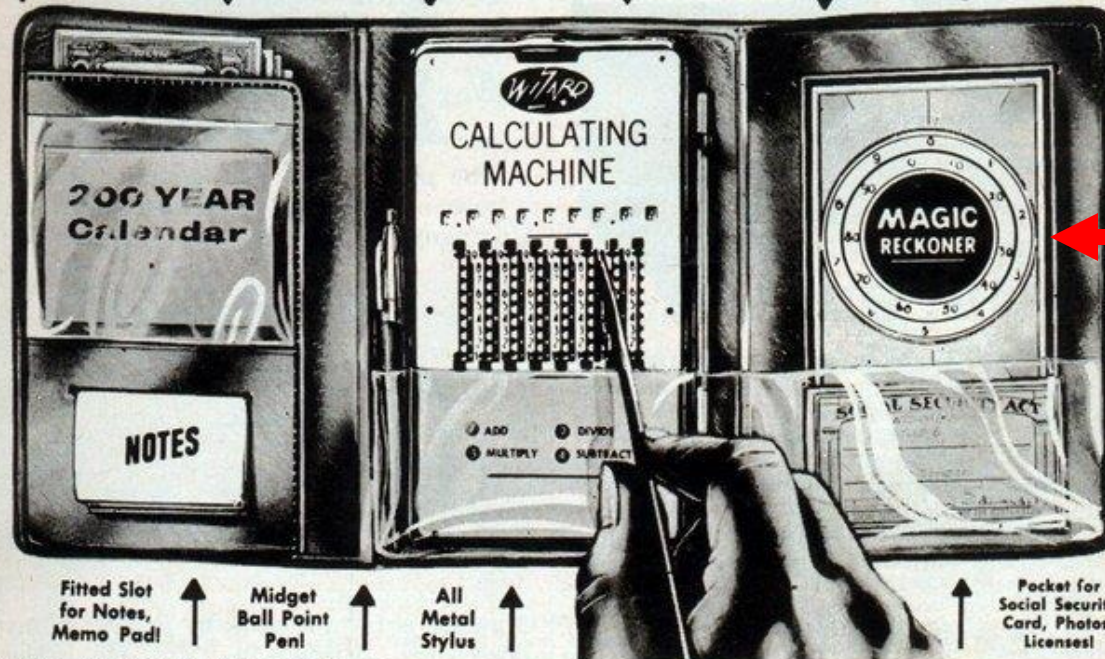
↓ 200 Year  
Perpetual  
Calendar!

↓ Fine Grain  
Fitted  
WALLET!

↓ Easy-Flow  
Clearing  
Lever!

↓ Magic Reckoner  
for Multiplying  
& Dividing!

**1<sup>98</sup>**



↑ Fitted Slot  
for Notes,  
Memo Pad!

↑ Midget  
Ball Point  
Pen!

↑ All  
Metal  
Stylus

↑ Pocket for  
Social Security  
Card, Photos,  
Licenses!

Now yours—the all-new 1960 Wizard Calculating Machine—direct to you from the world's greatest importer of adding machines—THORPE

Rip-Off

50-by-50  
times table

I learn early that few machines achieve peak performance.

While Gene Was Playing Around  
with puny 2-by-2 Block matrices...

$$Q^T \begin{bmatrix} O & A^T \\ A & O \end{bmatrix} Q = T$$

# I Was Out in the Real World Solving Problems

**New 1960 German Adding Machine Adds & Subtracts to ONE BILLION!**

Now with **9** NEW exclusive features--Still Only **1<sup>98</sup>**

- ↓ Pocket for Coins and \$1, \$5, \$10 Bills!
- ↓ 200 Year Perpetual Calendar!
- ↓ Fine Grain Fitted WALLET!
- ↓ Easy-Flow Clearing Lever!
- ↓ Magic Reckoner for Multiplying & Dividing!

**Fitted Slot for Notes, Memo Pad**   **Midget Ball Point Pen**   **All Metal Stylus**   **Pocket for Social Security Card, Photos, Licenses!**

Now yours—the all-new 1960 Wizard Calculator—direct to you from the world's greatest importer of adding machines—**TRUDEFFEN**

Hey! That's a Rank-1 Matrix!

$$A(i,j) = i*j$$

# New 1960 German Adding Machine Adds & Subtracts to ONE BILLION!

Now with **9** NEW exclusive features--Still Only **1<sup>98</sup>**

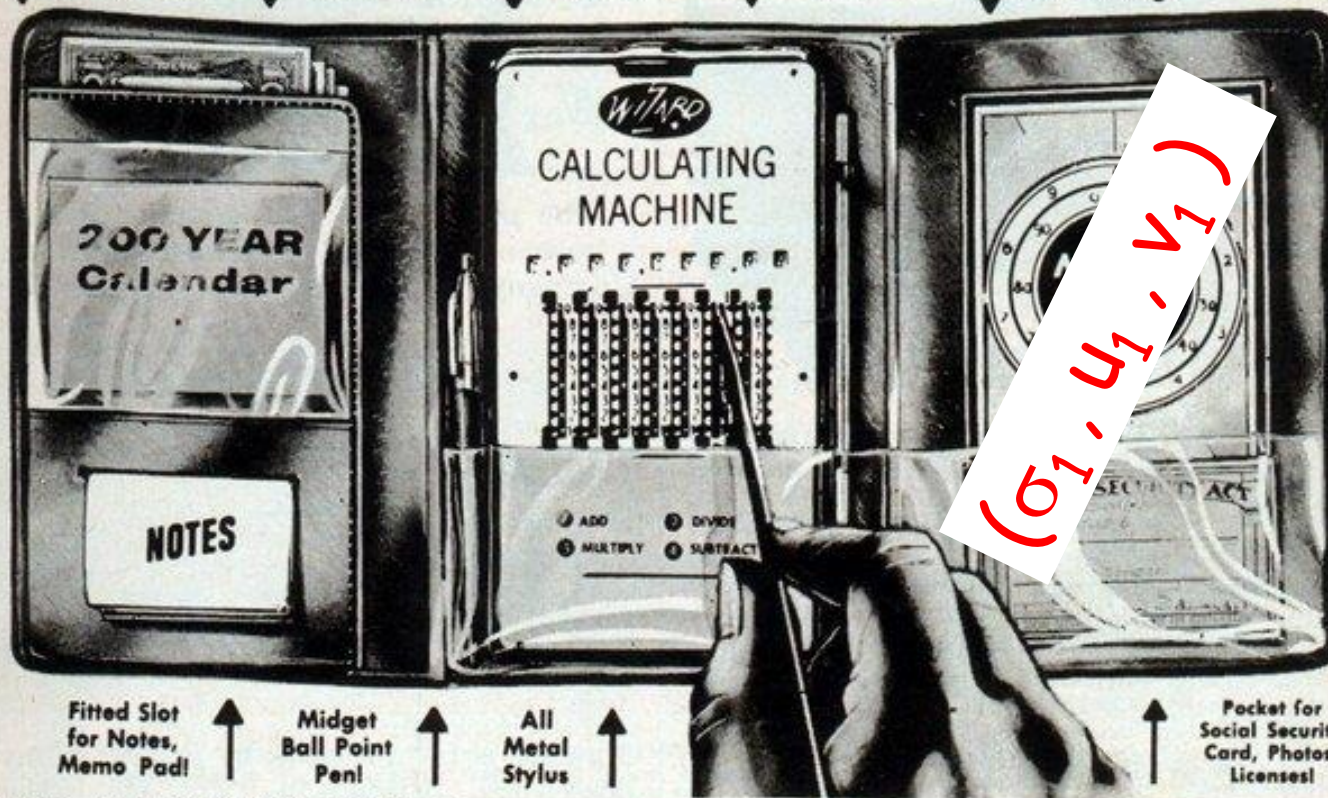
↓ Pocket for Coins and \$1, \$5, \$10 Bills!

↓ 200 Year Perpetual Calendar!

↓ Fine Grain Fitted WALLETS!

↓ Easy-Flow Clearing Lever!

↓ Magic Reckoner for Multiplying & Dividing!



↑ Fitted Slot for Notes, Memo Pad!

↑ Midget Ball Point Pen!

↑ All Metal Stylus!

↑ Pocket for Social Security Card, Photos, Licenses!

Now yours—the all-new 1960 Wizard Calculator—direct to you from the world's greatest importer of adding machines—T.M.P.E.S.E.M.

I learn that there is no need to store the matrix explicitly.

# In Closing

A Few Comments About the  
GVL  
Collaboration

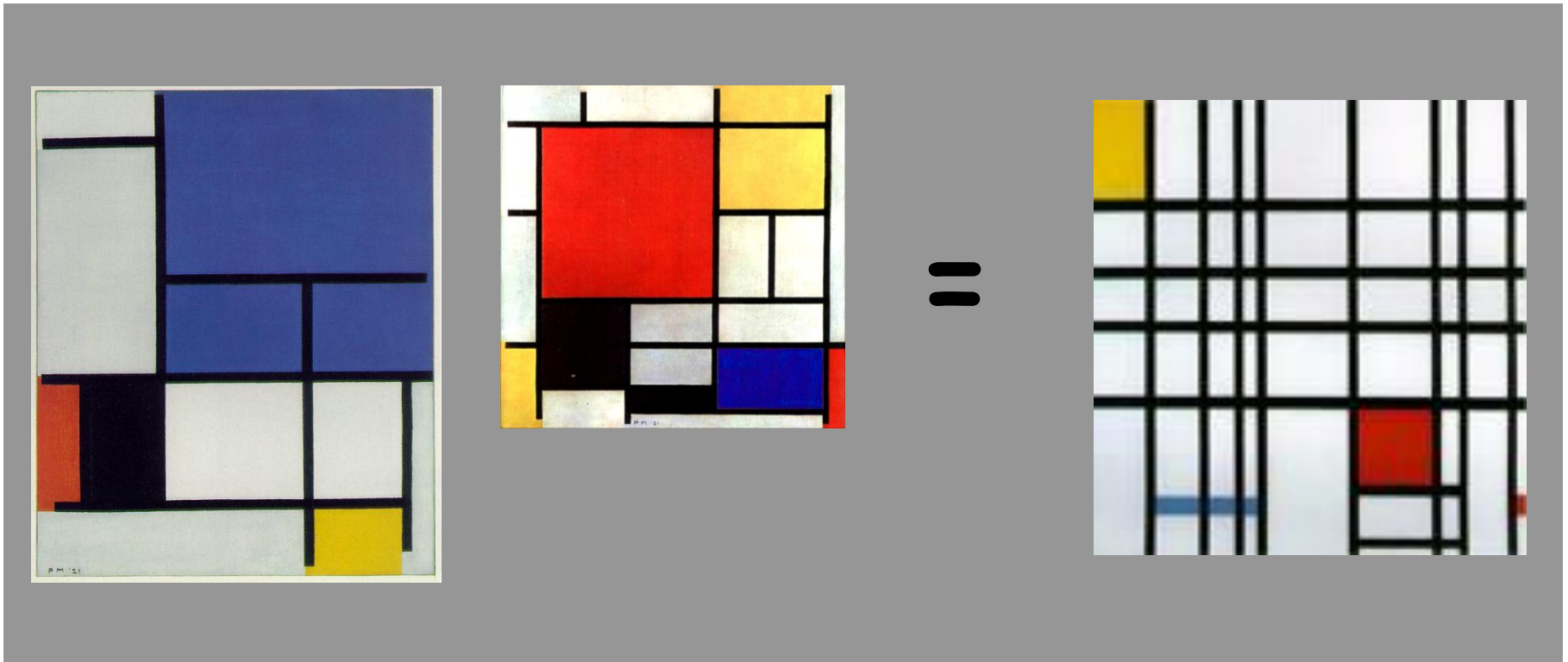


**Halloween 1997**

*Fun because we complement each other in the spirit of Sonny and Cher!*

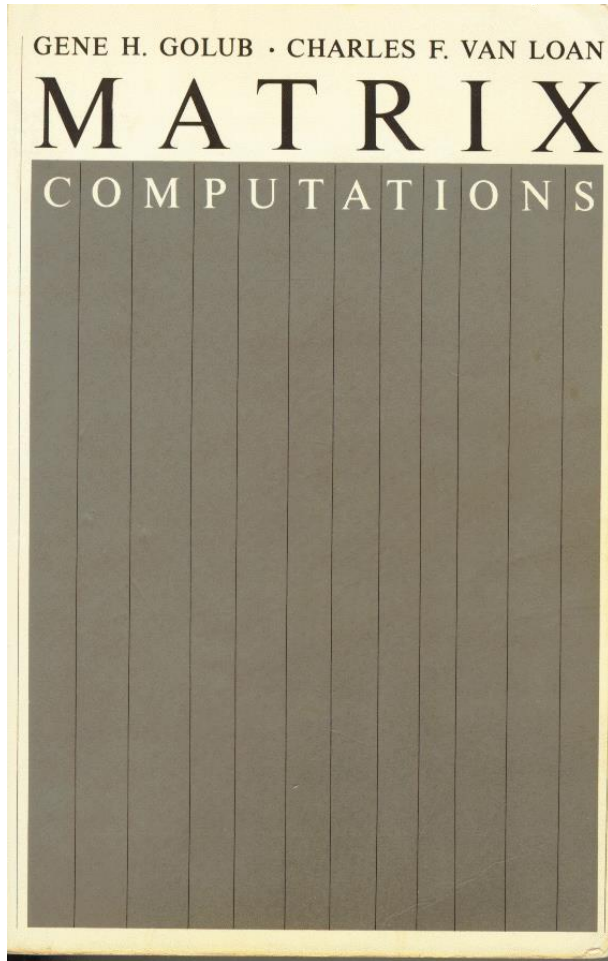


# Partitioning is Overrated



*A More Technical Explanation: A nonconformable matrix product can work!*

# GVL First Edition (1983)

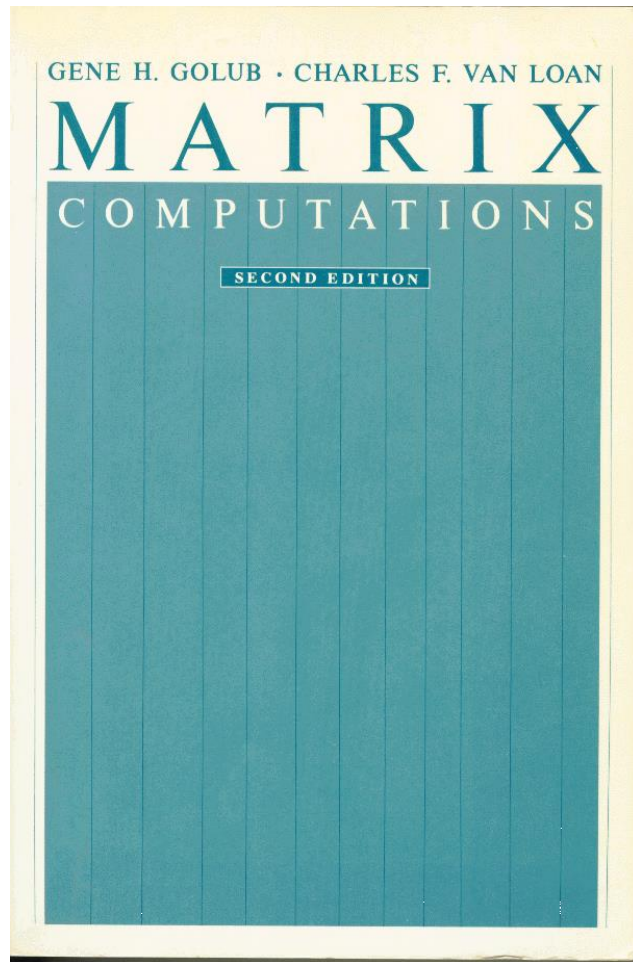


7 and 9

# The Summer of 1978

7 Chinese Restaurants  
in 9 days

# GVL Second Edition (1989)



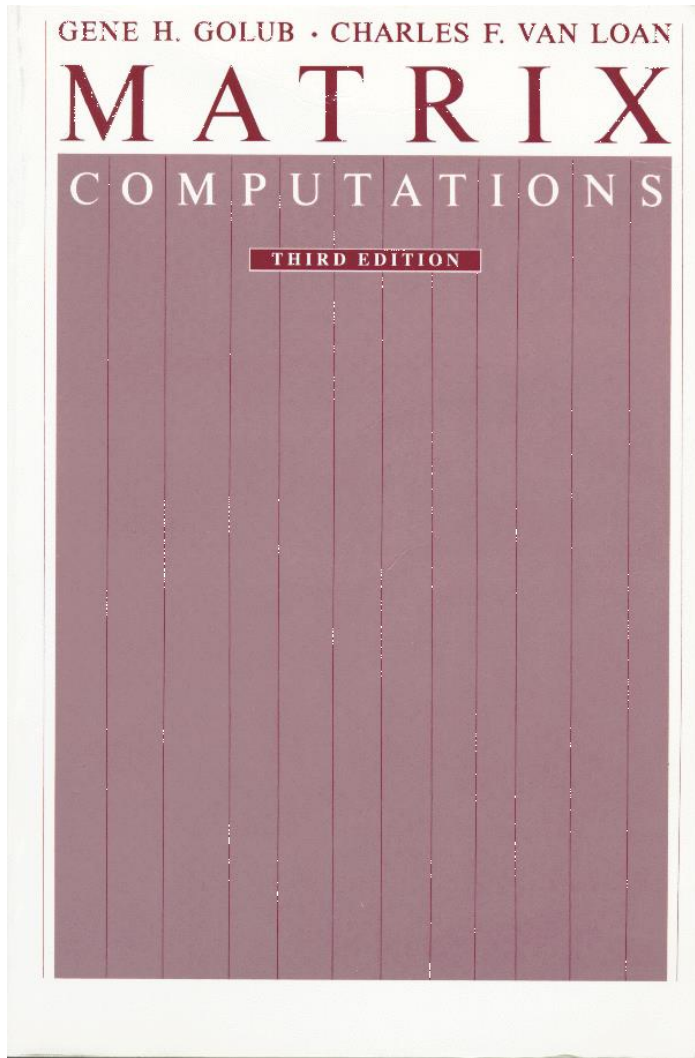
171

# There Were 171 Episodes of L.A. Law. One with GVL2...



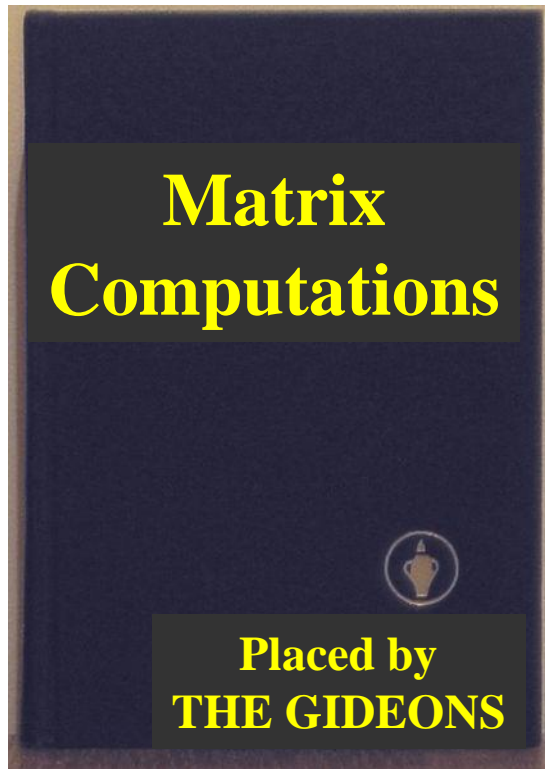
Plot = Pair of mathematicians getting divorced. Discovered by Jack Dongarra during an early 1990's channel surf!

# GVL Third Edition (1996)



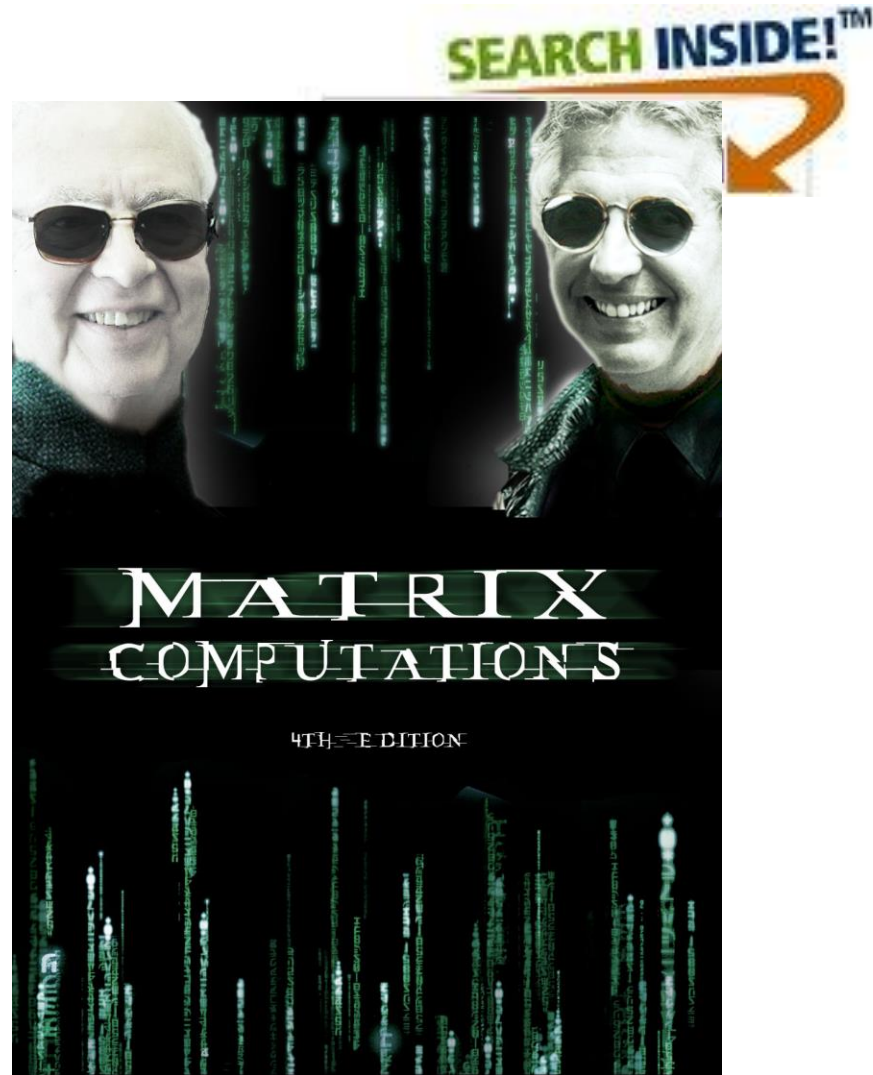
30,000,000

# Is it Really "The Bible"?



Hmmm. 30,000,000 Hotel Rooms. \$

# GVL4 (2008)



Yes, there will be a Fourth Edition!

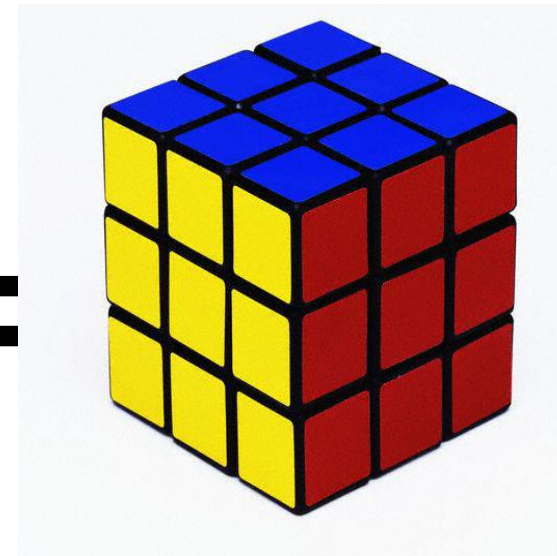


# Many New Applications !

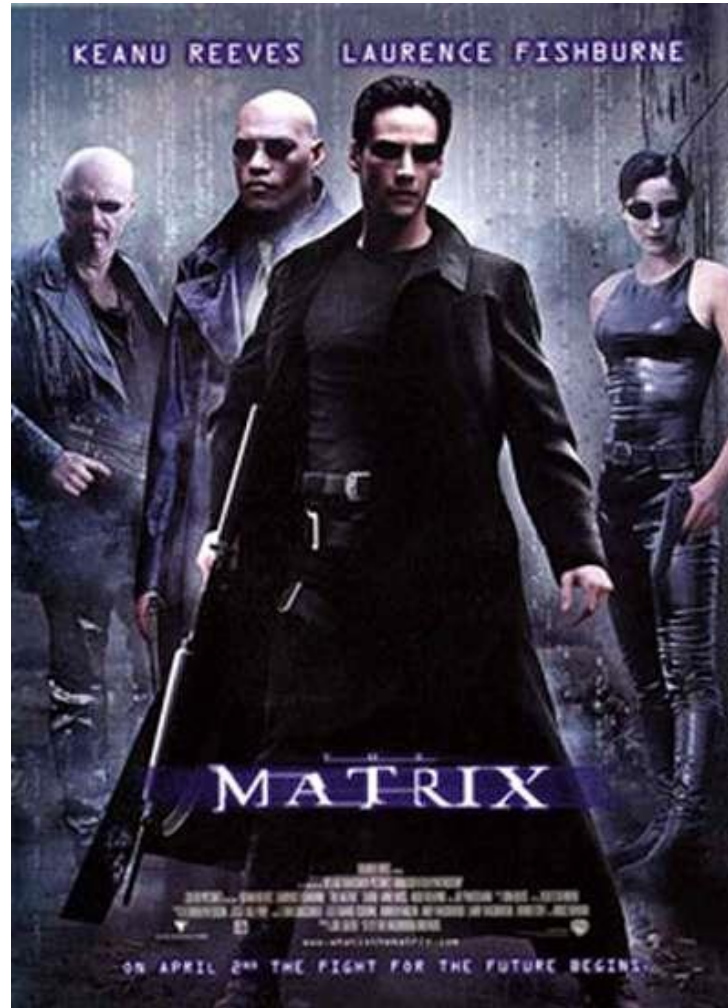
$U^T$

9	4		1		2		5	8
6				5				4
		2	4		3	1		
	2						6	
5		8		2		4		1
	6							8
		1	6		8	7		
7				4				3
4	3		5		9		1	2

$V =$



# Gene, You Are the One



# Max Toast

## The Titan's Goblet

*Thomas Cole*  
*1833*



The usual white wine Napa valley salute is just not good enough. You deserve the biggest and best.