Welcome to Stanford

Double, Deep, Sudden Impact

Reflections on Stan50 and GHG75

Charlie Van Loan
Cornell University

44 Comic Sans

History is Nonlinear
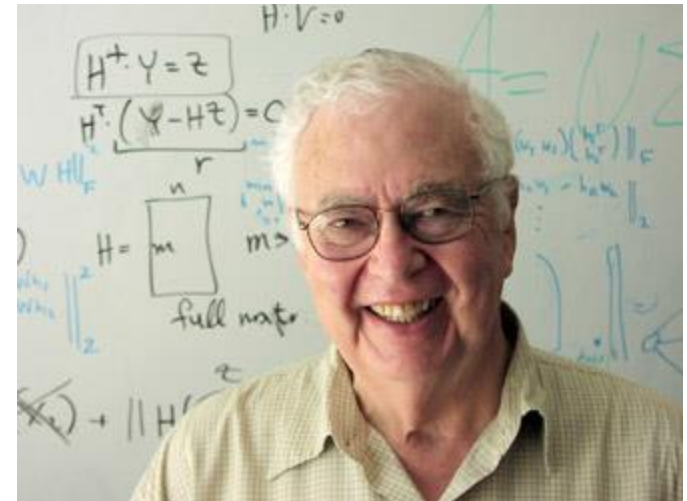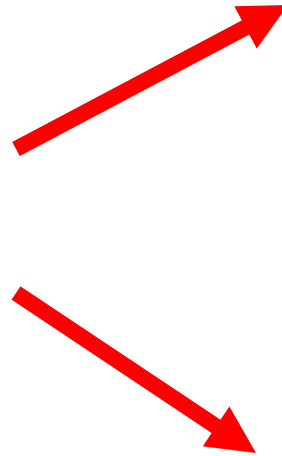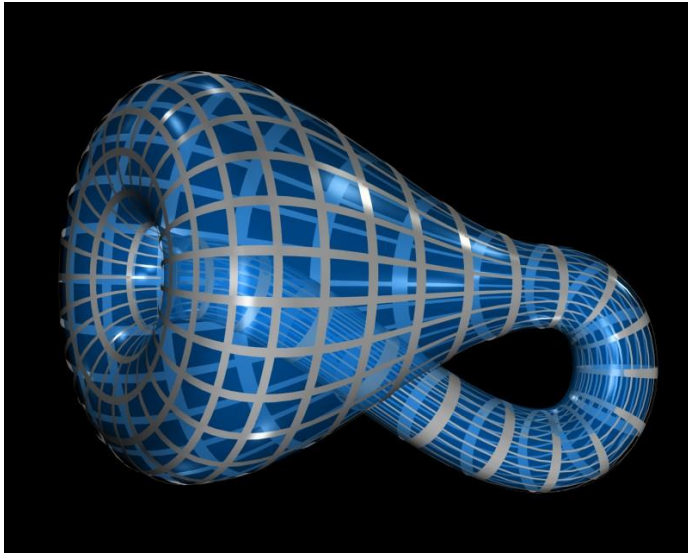
In the beginning there was…

Gottfried Leibniz

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

1646--1716

who begat ...

Jacob Bernoulli

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

1654--1705

who begat ...

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 ...

Leonhard Euler

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

1707--1783

who begat ...

reluE drahnoeL

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

3871--7071

... tageb ohw

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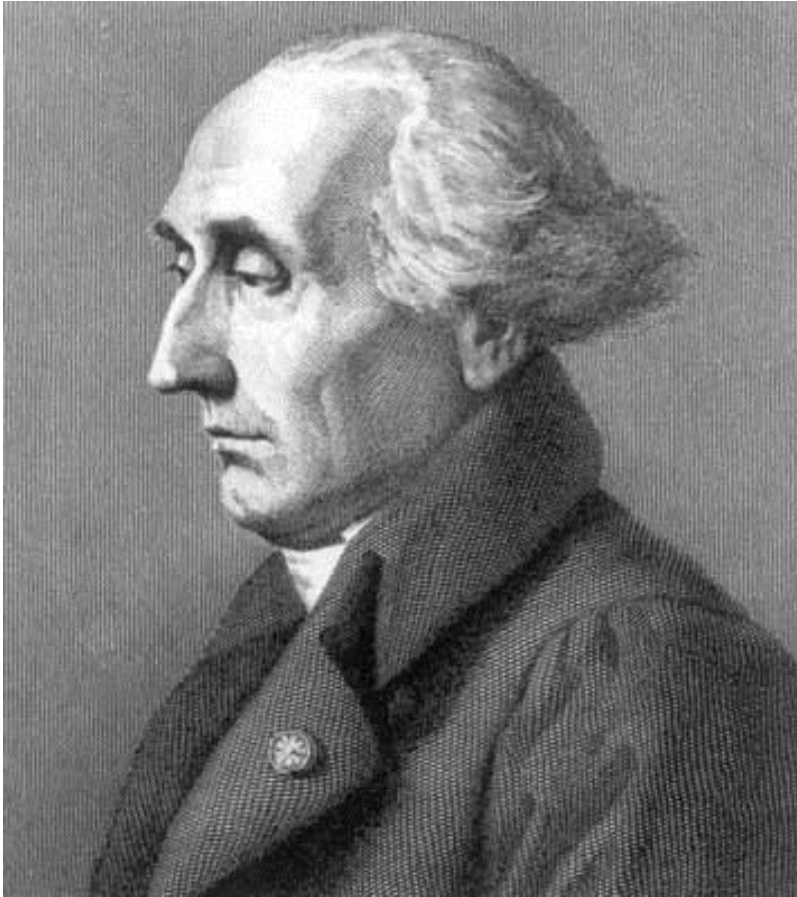
$$\nabla \Big[f(x, y) + \lambda (g(x, y) - c) \Big] = 0$$

1736--1813

who begat ...

Jean-Baptiste Fourier

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

1768--1830

who begat ...

Gustav Dirichlet

$$y(x) = f(x) \quad \forall x \in \partial\Omega$$
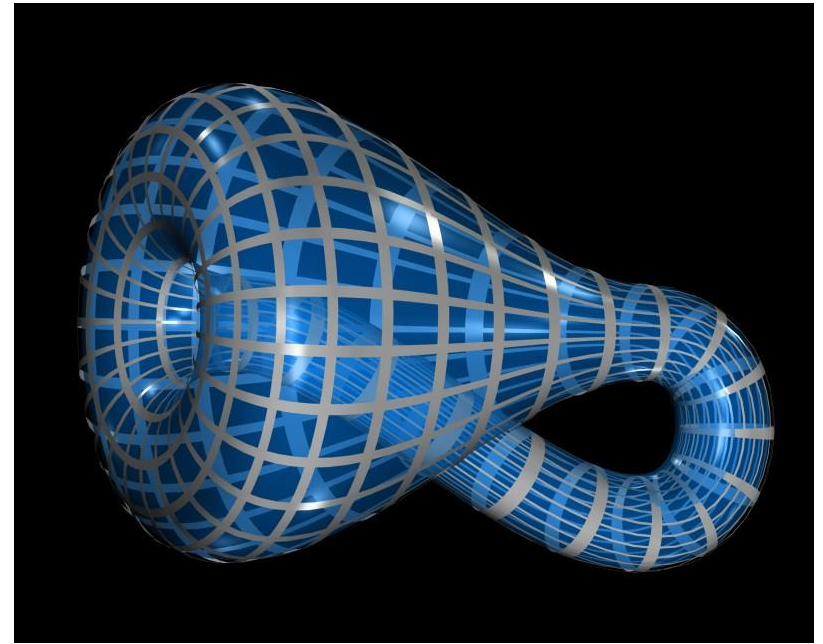
1805--1859

who begat ...

Rudolf Lipschitz

$$|f(x) - f(y)| <= \delta|x - y|$$
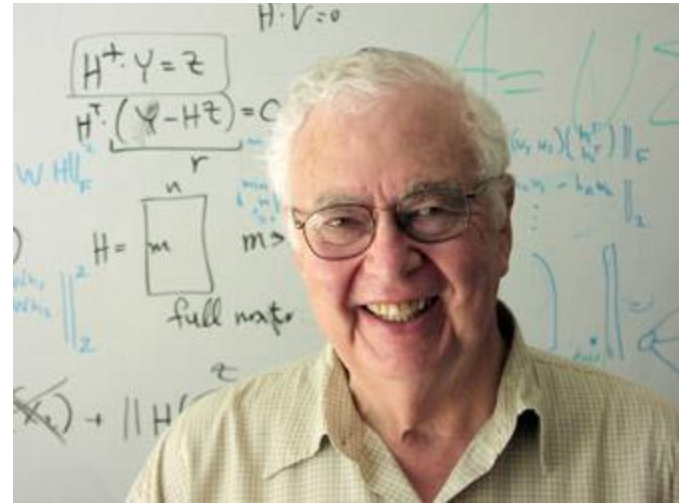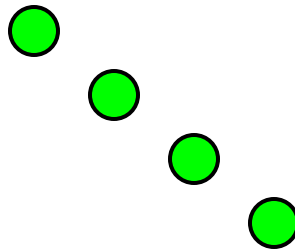
1832--1903

who begat ...
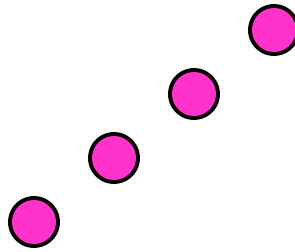
C. Felix Klein

1849--1925

who in five generations begat ...

Who are the dots?

George Forsythe

Gene Golub

was a student of …

was a student of …

Let us reverse the direction of our search.
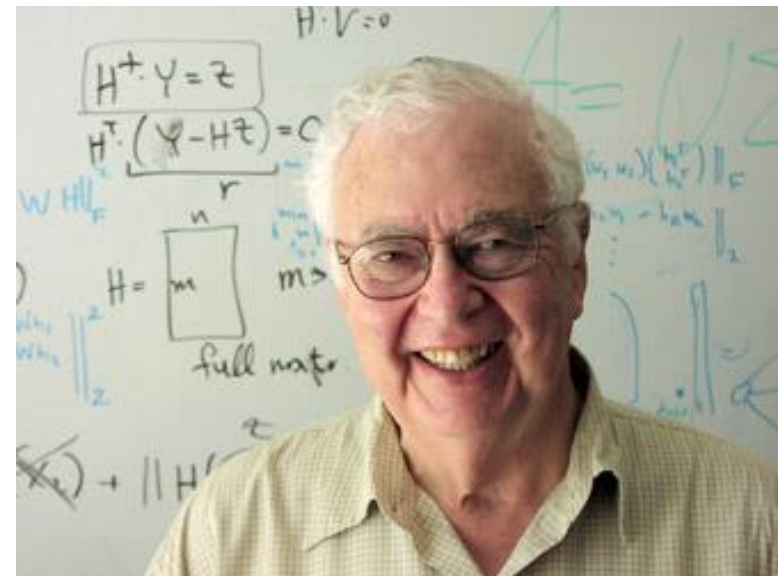
Willi Feller
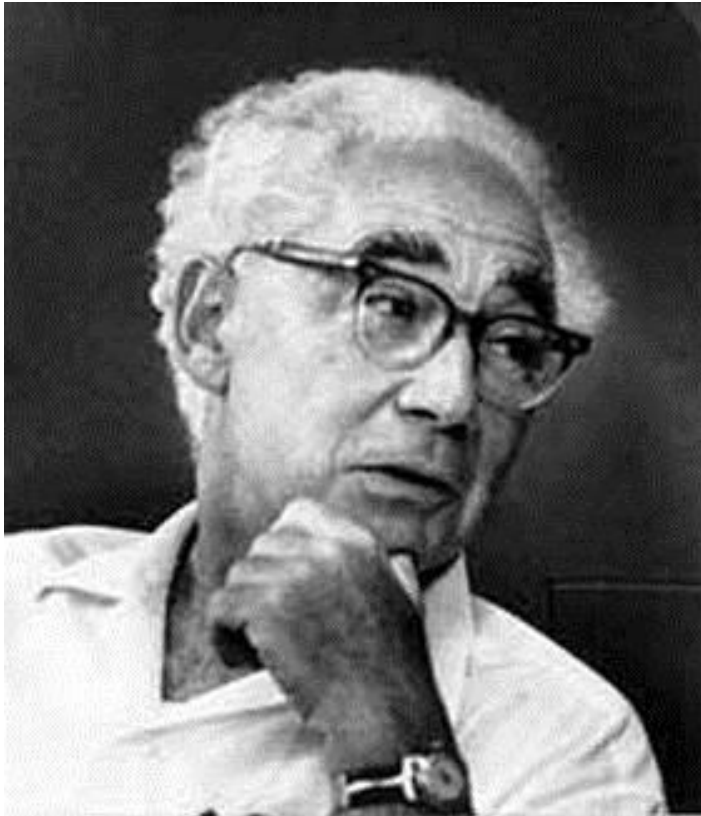
1906--1970

was a student of ...

Abe Taub

1911--1999

was a student of ...

Richard Courant

1888--1972

was a student of ...

Howard P. Robertson

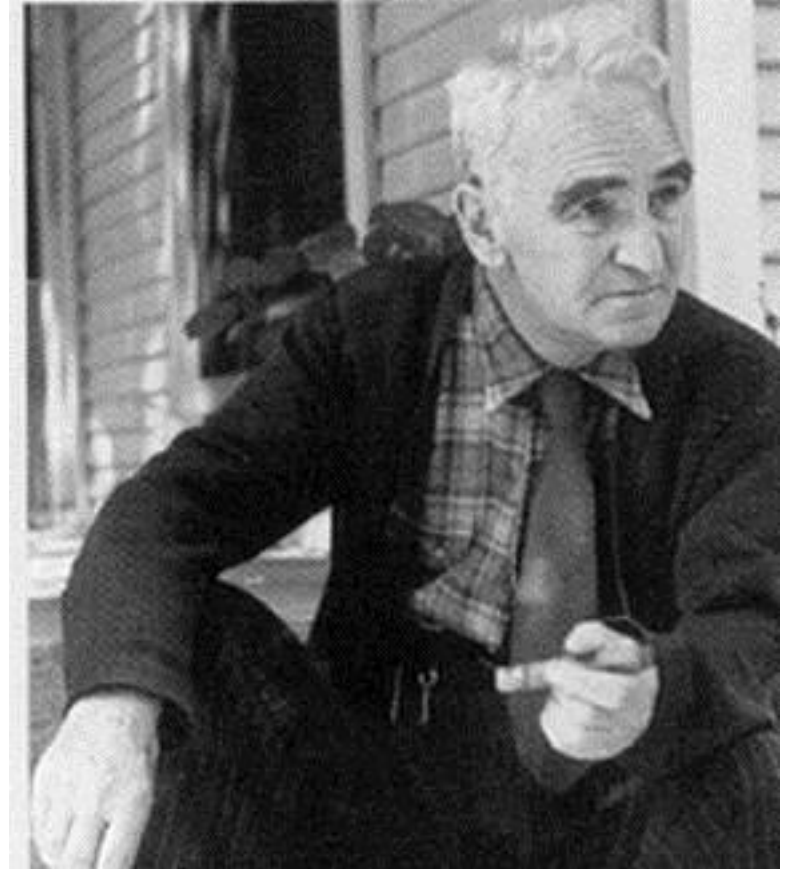1903--1961

was a student of ...

David Hilbert

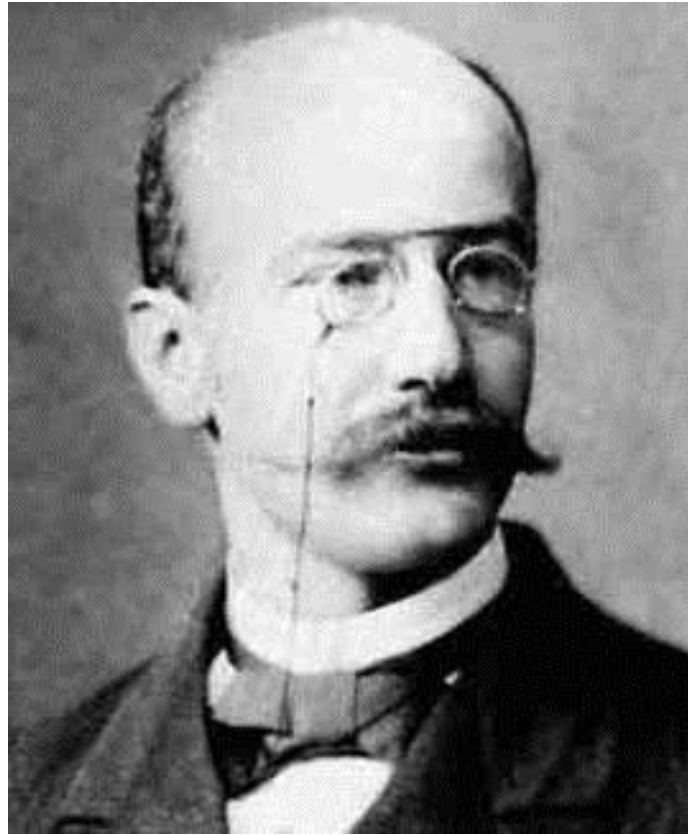# Eric Temple Bell

1862--1943
was a student of …

1883--1960
was a student of …

C.L.F. Lindemann

1852--1939

was a student of ...

Frank Cole

1861--1926

was <u>also</u> a student of ...

C. Felix Klein
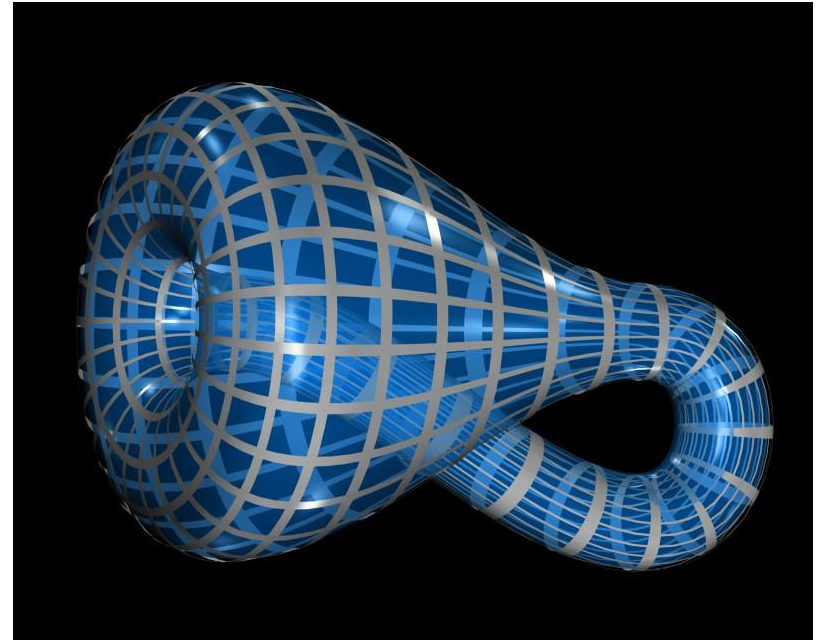
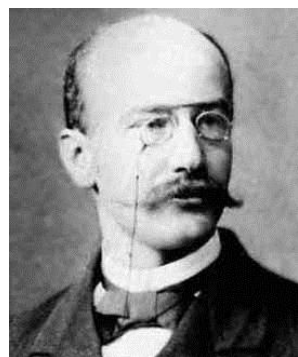1849--1925

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

-- Newton

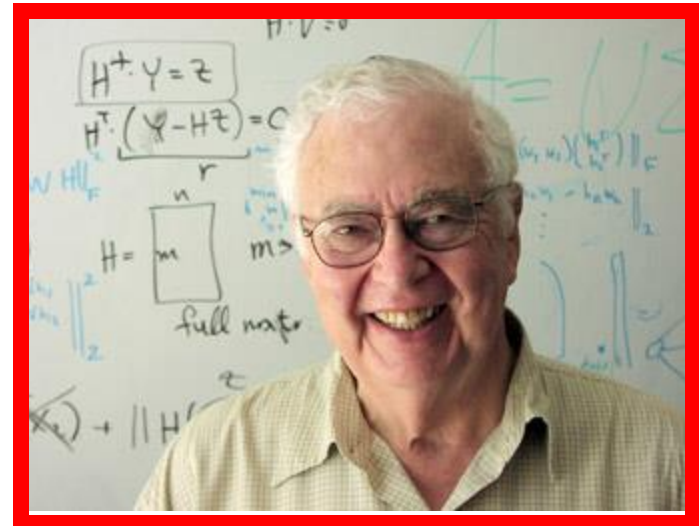By honoring our Stanford heroes we honor those who came before.

$H_3 =$
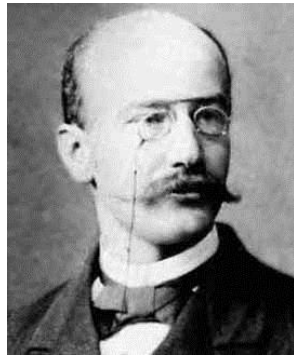
Double Impact
The Personal Legacy

Two Great Papers

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

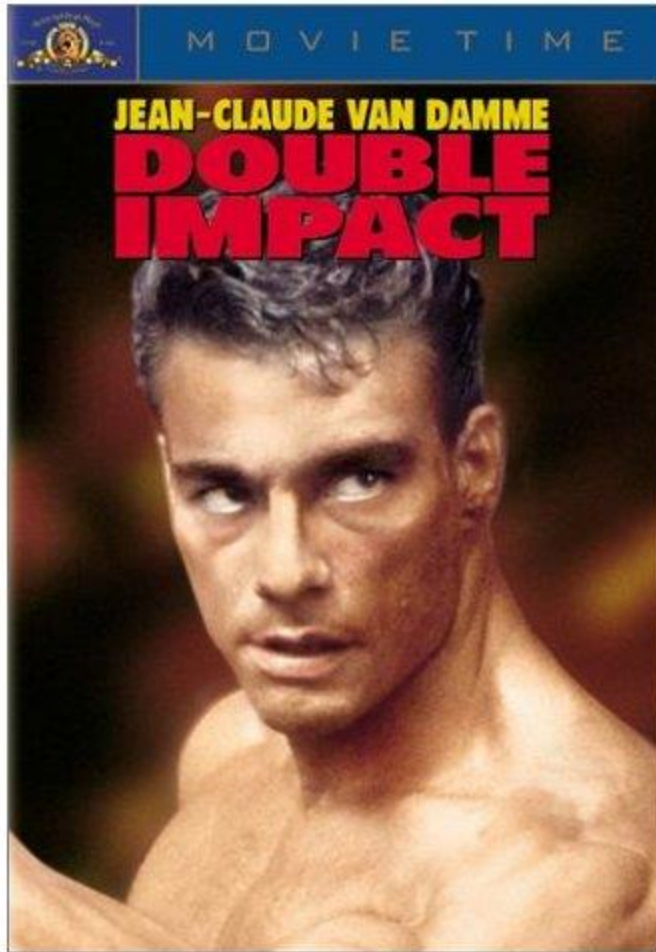"Some Modified Matrix Eigenvalue Problems." (1973)

One created a space for numerical mathematics and the other laced it with brilliant ideas. These papers are metaphors.

Google™

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 !!!

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

Google ™

Deep Impact

Google Search   I'm Feeling Lucky

And so?

You Get Another Movie !!!
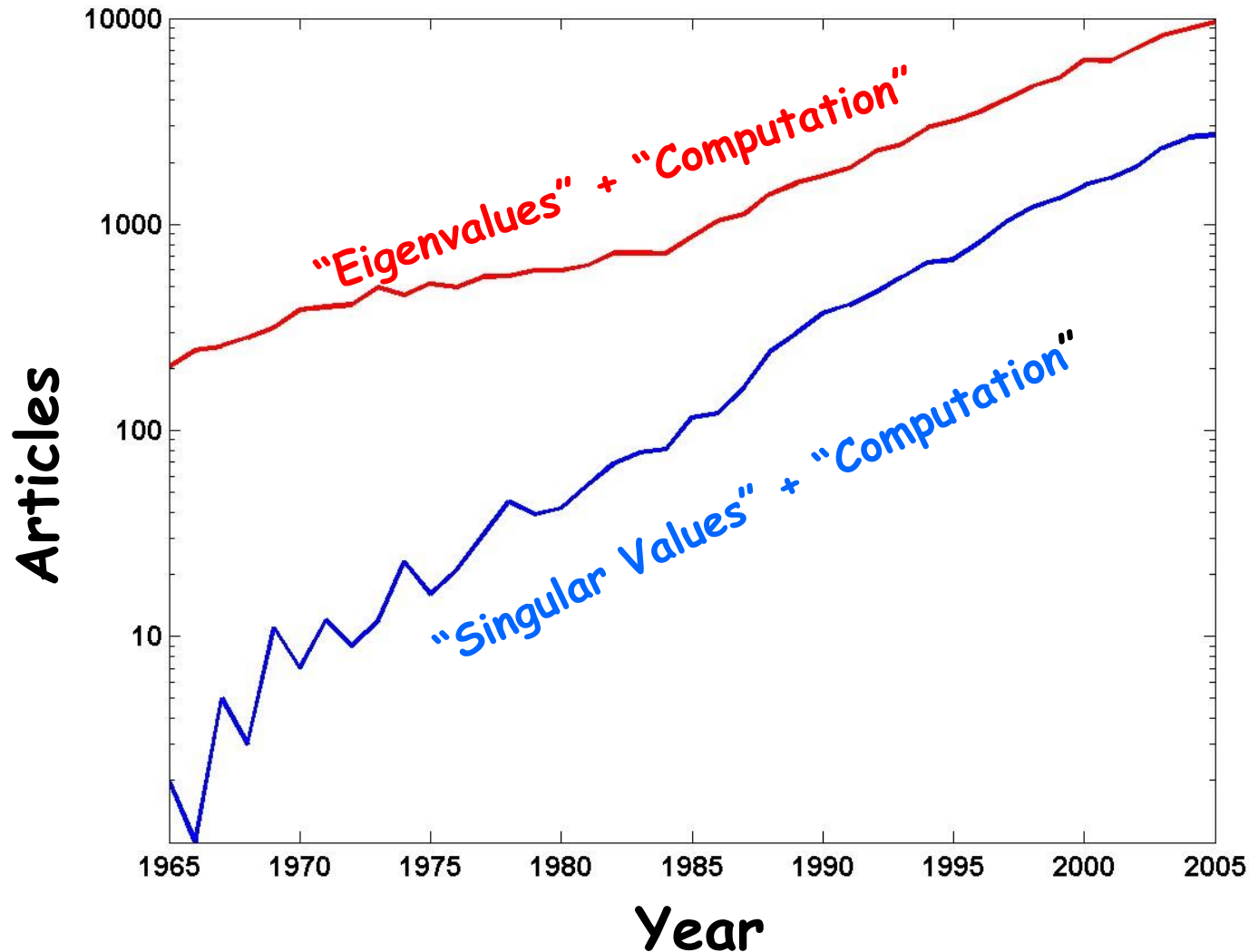
But It's Based On a Great Paper !!!

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.

Still Need a Better Title !!!

Sudden Impact
The Research Legacy
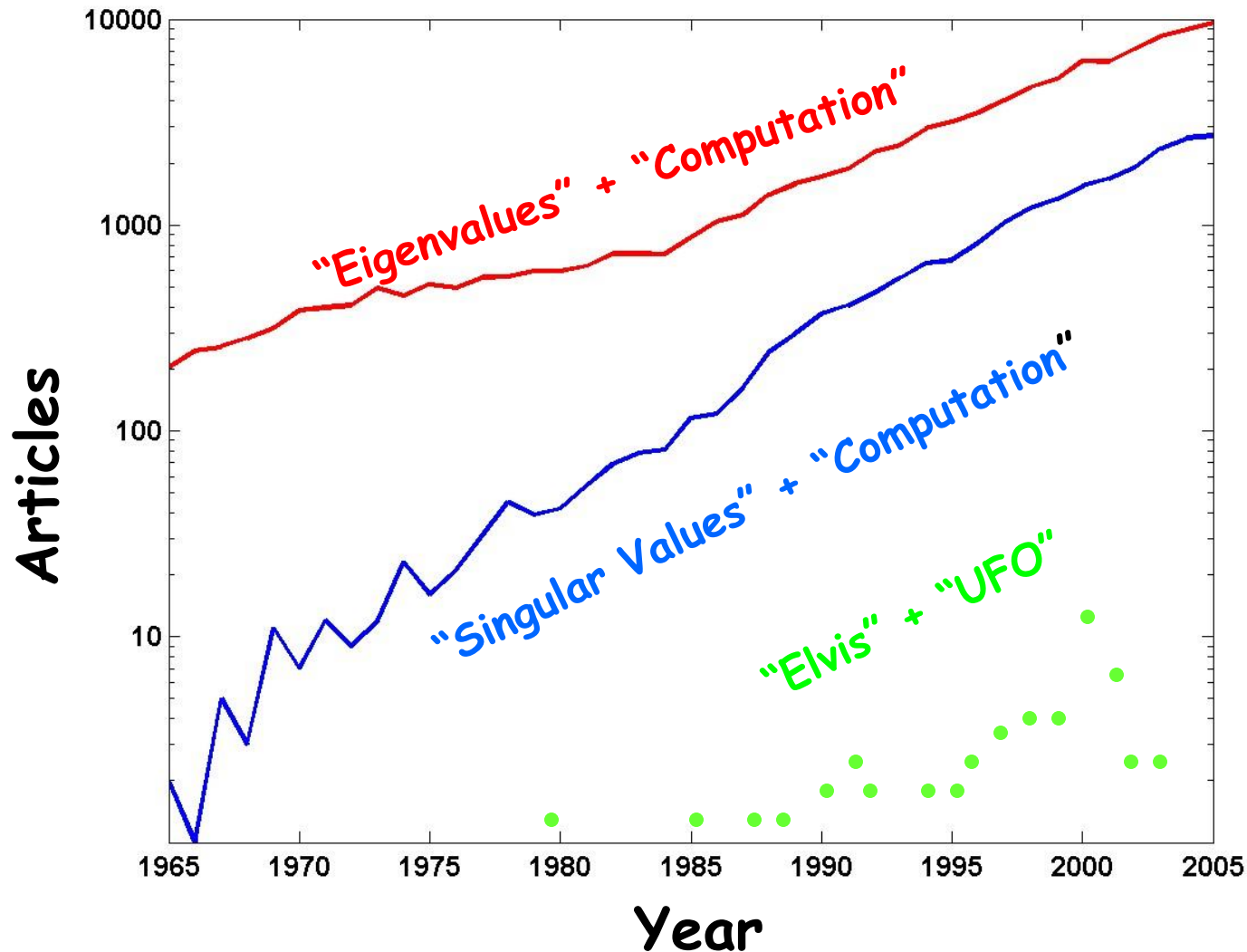
Sudden Impact
The Research Legacy

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.

Google™

Sudden Impact

Google Search   I'm Feeling Lucky

You Get a Movie and a Car !!!
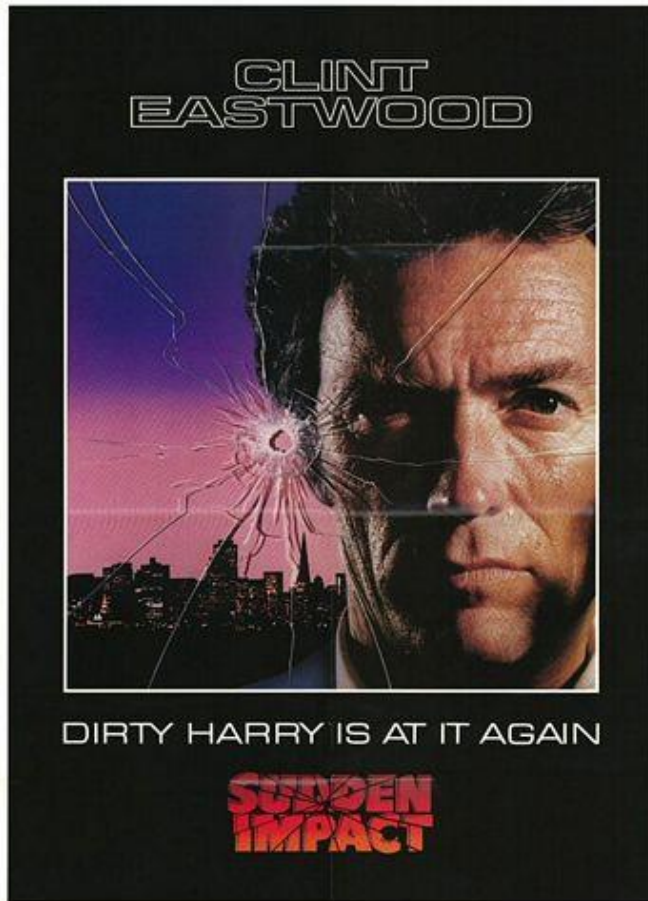
And an Idea for a Car Movie !

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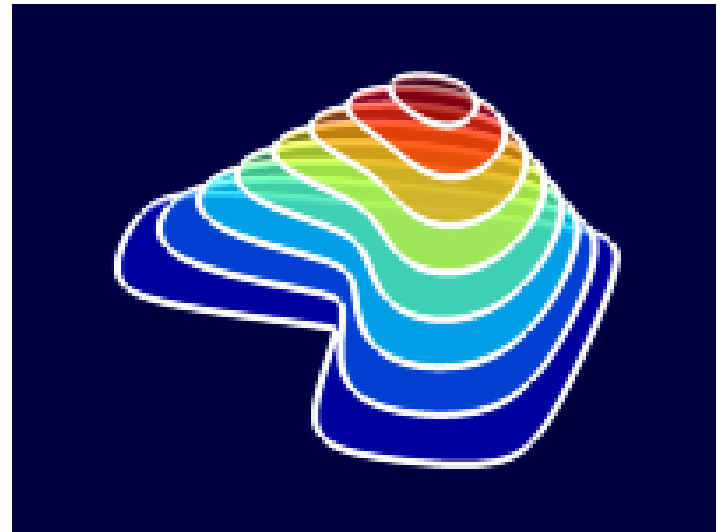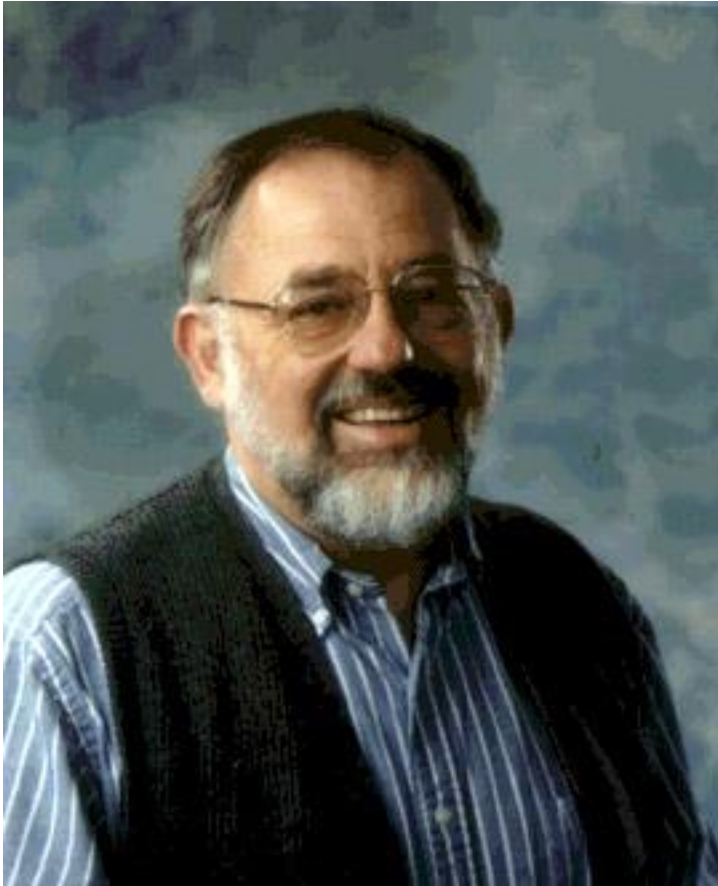
"As teacher, Ph.D. advisor, and force behind Matlab, Cleve has defined the way I look at mathematics and computing."

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…

Rip-Off

50-by-50 times table

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

Hey! That's a Rank-1 Matrix!

A(i,j) = i*j
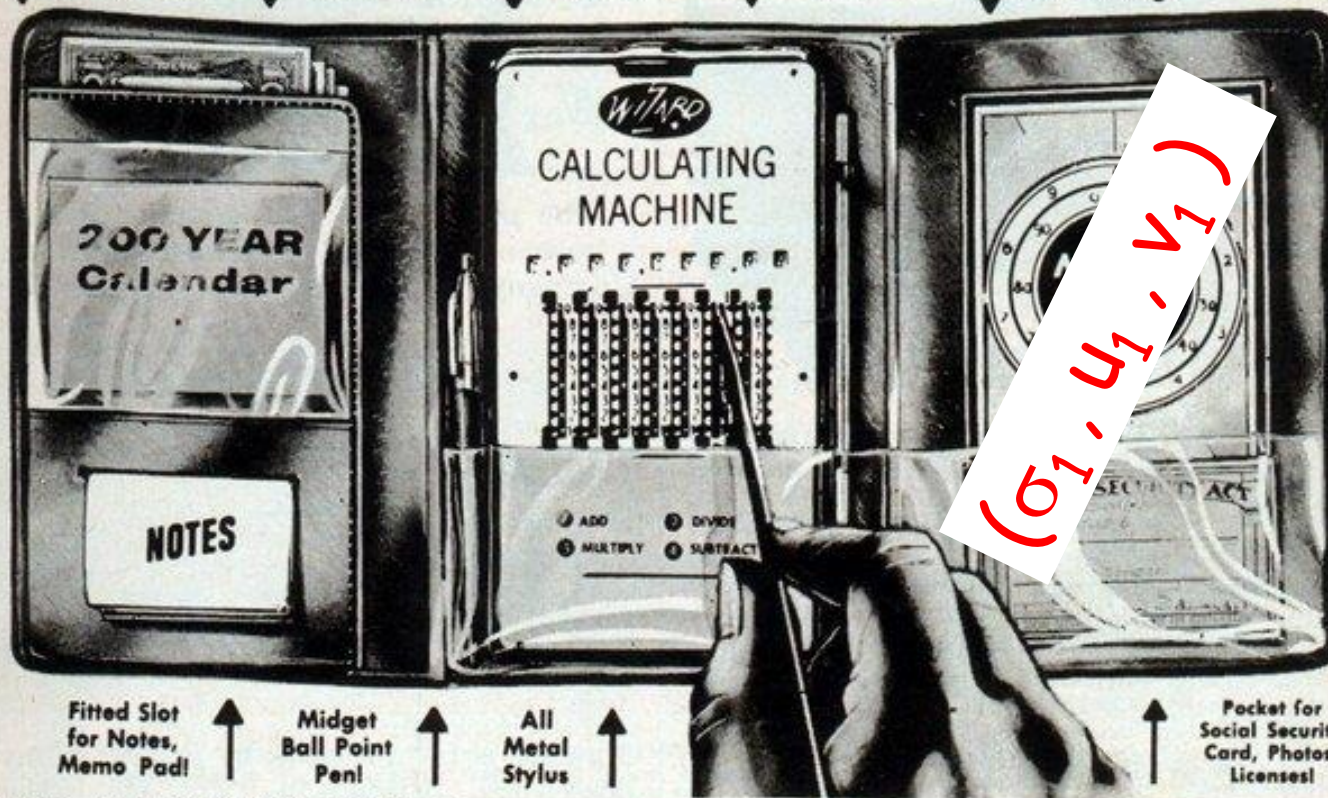
I learn that there is no need to store the matrix explicitly.
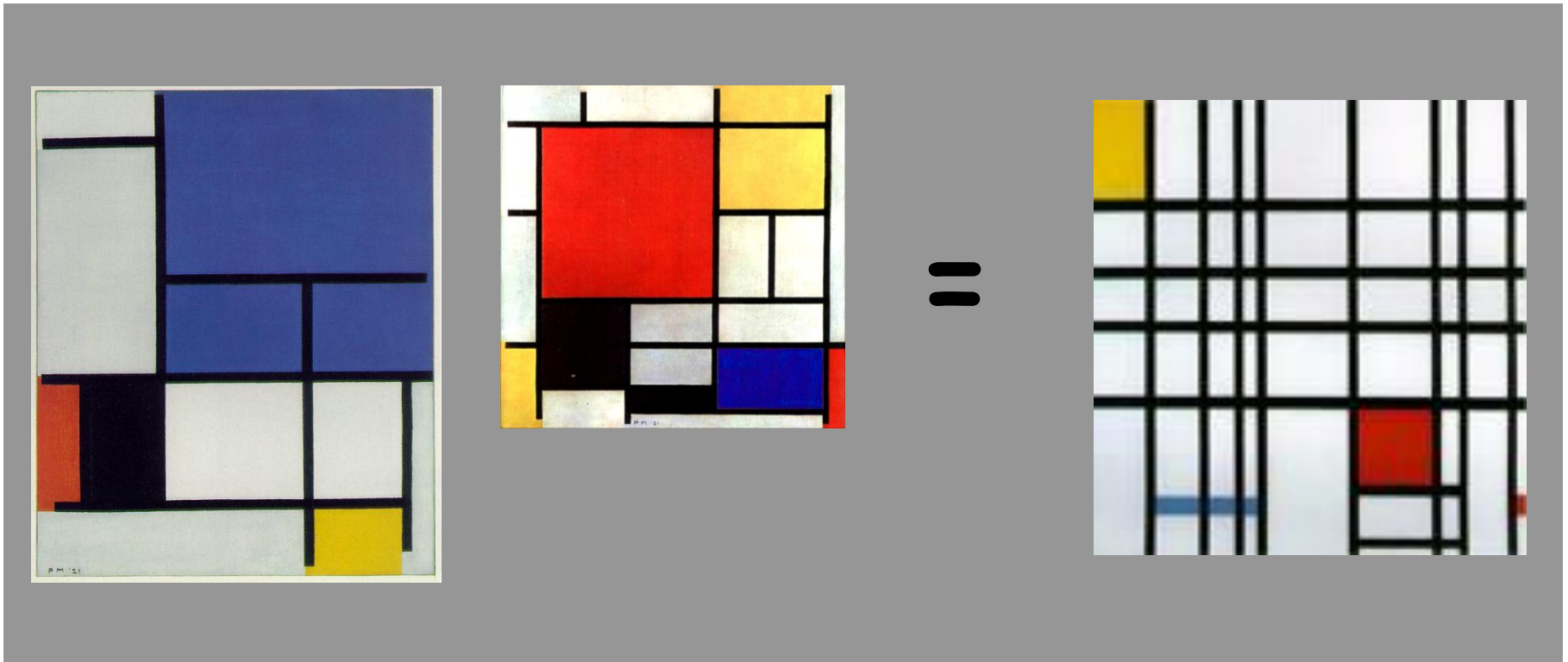
In Closing

A Few Comments About the
GVL
Collaboration

Halloween 1997

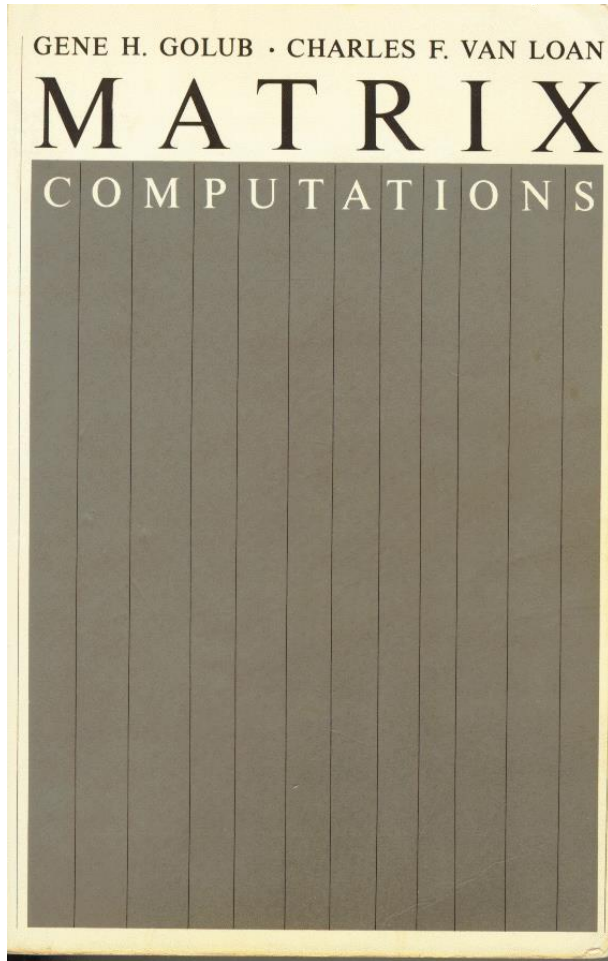*Fun because we complement each other in the spirit of Sonny and Cher!*

Partitioning is Overrated
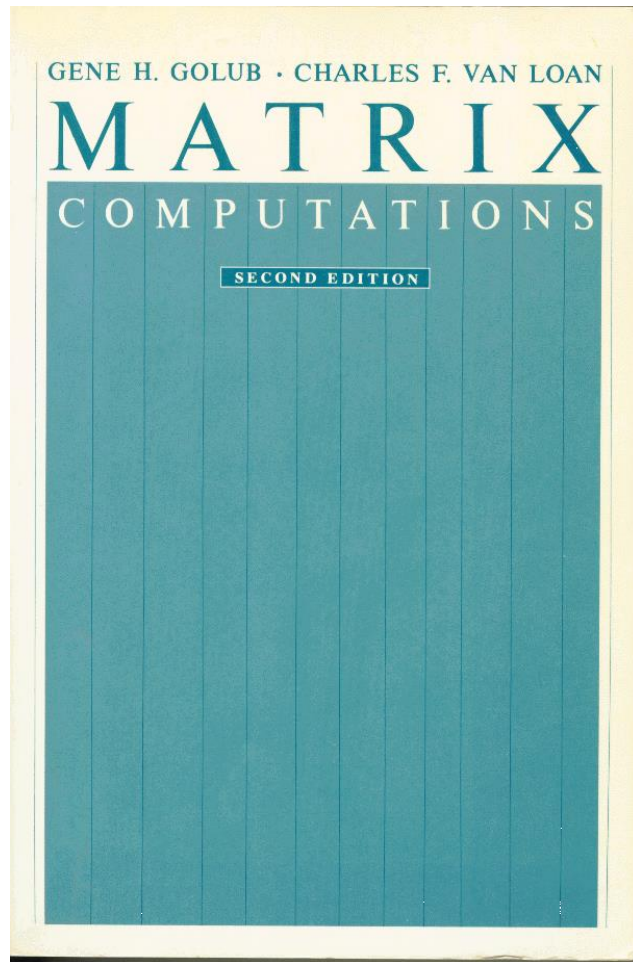
GVL First Edition (1983)

7 and 9

The Summer of 1978

7 Chinese Restaurants
in 9 days

GVL Second Edition (1989)

171

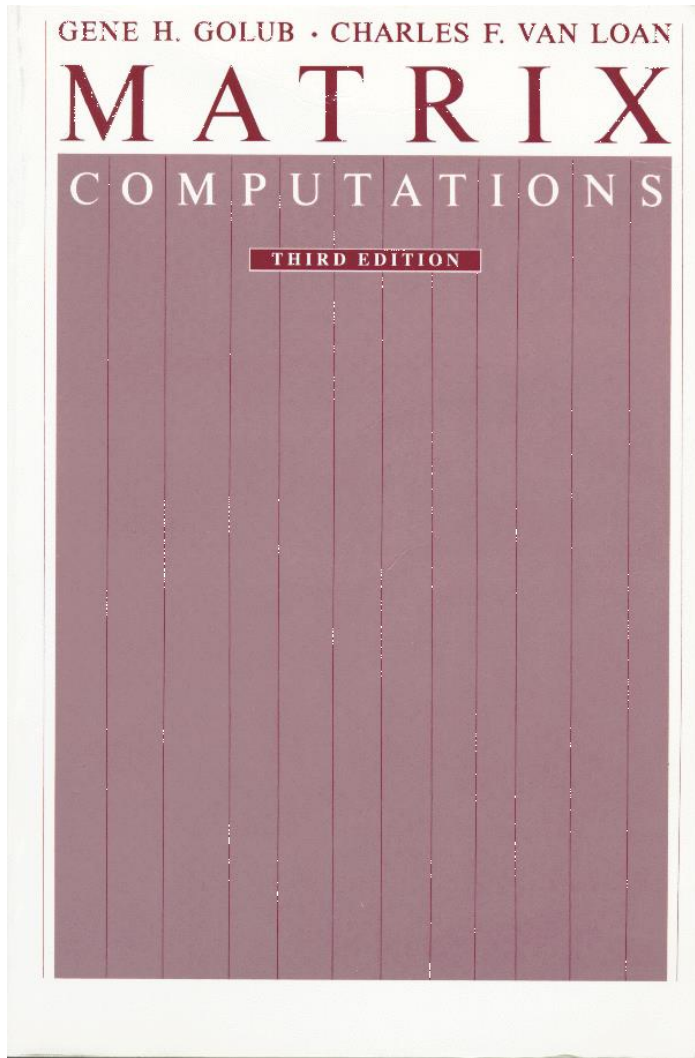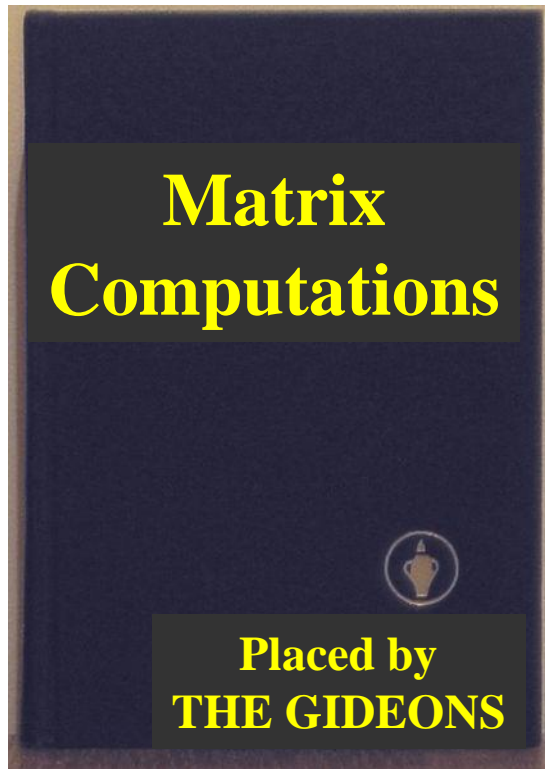# There Were 171 Episodes of L.A. Law. One with GVL2...

GVL Third Edition (1996)

30,000,000

Is it Really "The Bible"?

Matrix Computations

Placed by THE GIDEONS

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

GVL4 (2008)

Many New Applications !

$$U^T \quad V =$$
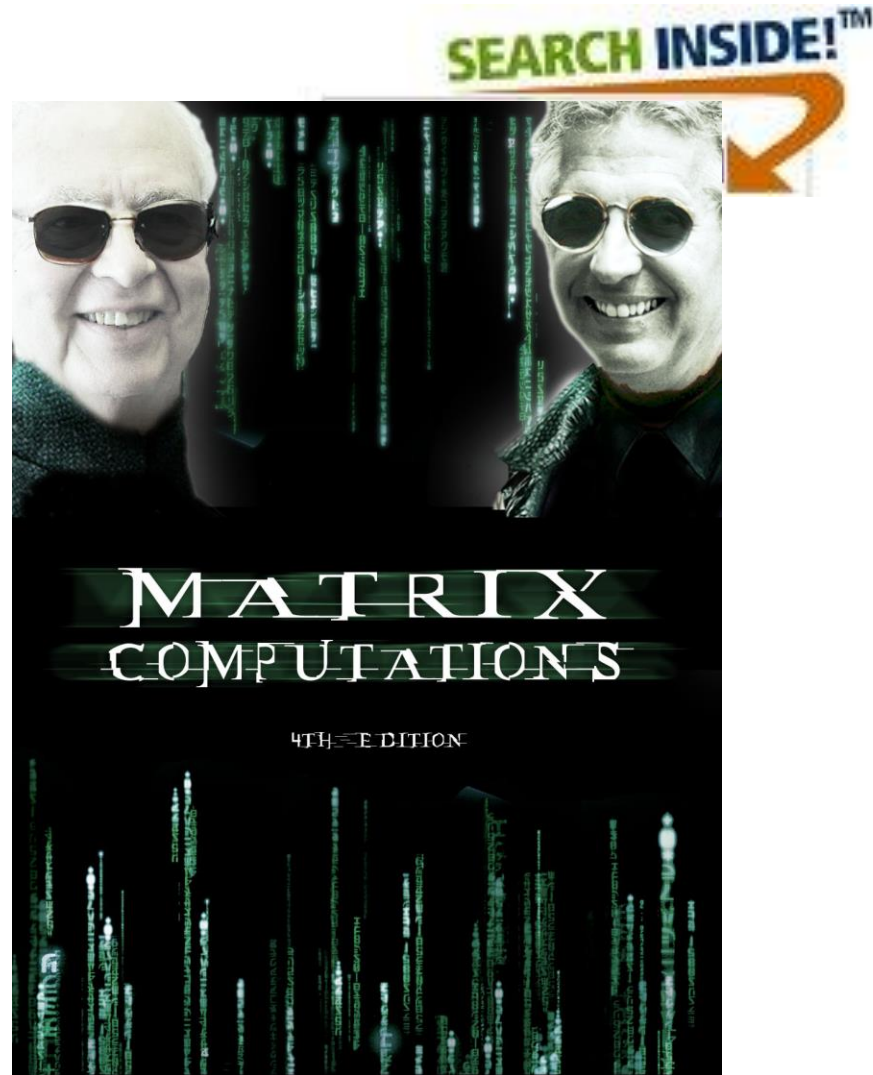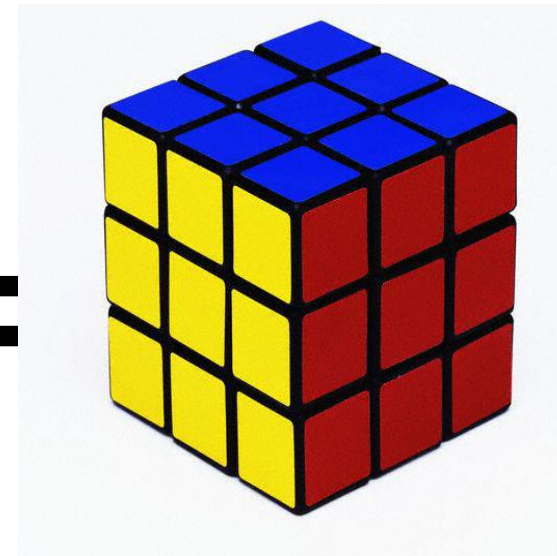
Gene, You Are the One
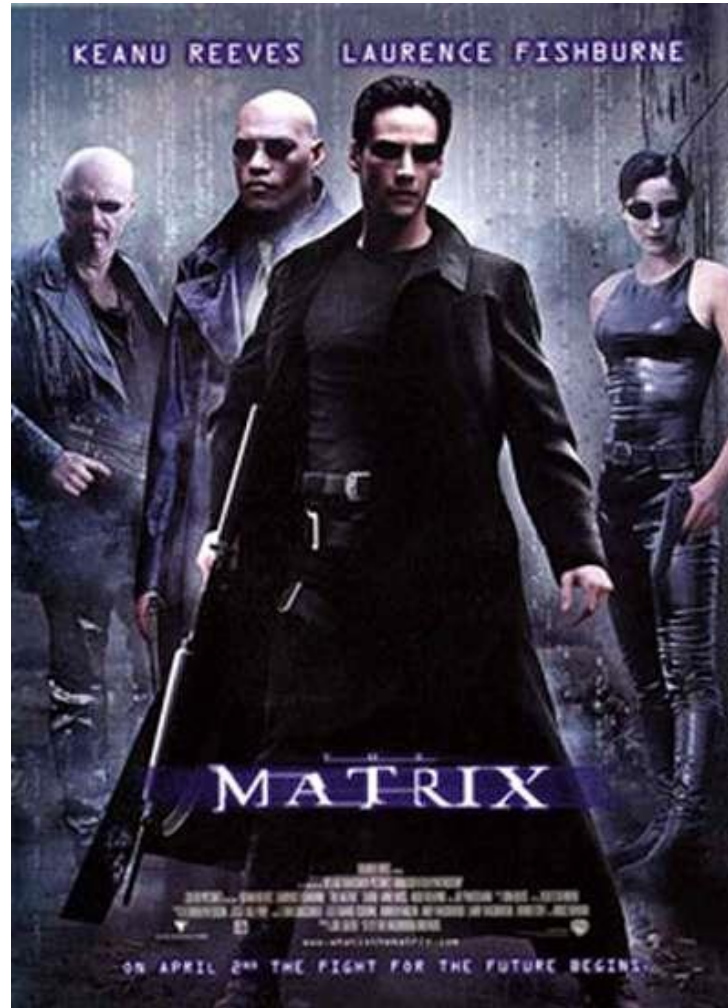
Max Toast

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.