



SIAM 2008

I. E. Block Lecture

Stylish Mathematics

Dan Rockmore

John G. Kemeny Parents Professor of Mathematics

Dartmouth College

External Faculty, Santa Fe Institute

Matter or Anti-Matter?

A cache of Pollocks?

If found to be authentic, the collection of drip paintings and drawings could be worth millions.

May 11, 2005: 6:54 PM EDT

NEW YORK (CNN) - The son of a New York photographer says he has discovered 32 unrecorded works by the late American abstract painter Jackson Pollock.



Newsmakers

[+ See more stories](#)



Pollock...or Not?



NOT!

(According to Pollock-Krasner Foundation)

NYT - online
2/8/06

Doubts Cast on a Trove of Supposed Pollocks

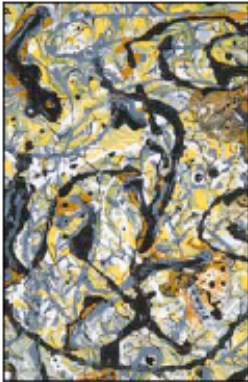
By **RANDY KENNEDY**
Published: February 9, 2006

A physicist who is broadly experienced in using computers to identify consistent patterns in the drip paintings of **Jackson Pollock** has determined that half a dozen small paintings recently discovered and claimed by their owner to be original Pollocks do not exhibit the same patterns.

[Sign in to E-Mail This](#)
[Printer-Friendly](#)
[Single-Page](#)
[Reprints](#)
[Save Article](#)

ARTICLE TOOLS
SPONSORED BY
NIGHT WATCH
POLLOCK-KRASNER FOUNDATION

[Enlarge This Image](#)



Courtesy of Alex Matter

One of the works that is claimed to be an original Jackson Pollock.

The finding, by Richard P. Taylor, a physics professor at the University of Oregon, does not conclusively prove that Pollock did not paint the works, among a cache of 24 paintings found in 2003 in Wainscott, N.Y. by Alex Matter, whose father, Herbert, and mother, Mercedes, were friends of Pollock's. But it casts serious doubt on their authenticity, even as plans are being made by Mr. Matter for a major exhibition of the paintings later this year. And the finding could deepen a dispute among a once-unified

Why?

Physical evidence, detective work, connoisseurship

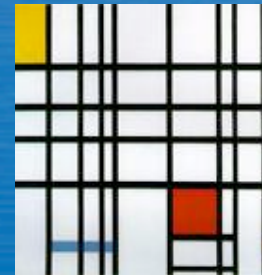
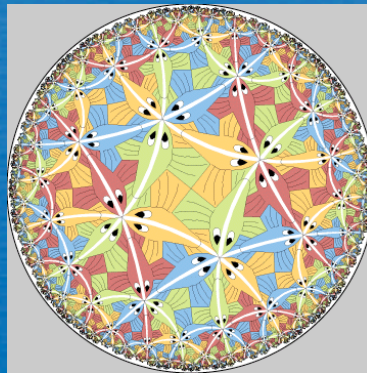
R. Taylor's mathematical (fractal) analysis revealed statistical inconsistencies

Can Pollock's style be quantified?

Can STYLE be quantified?

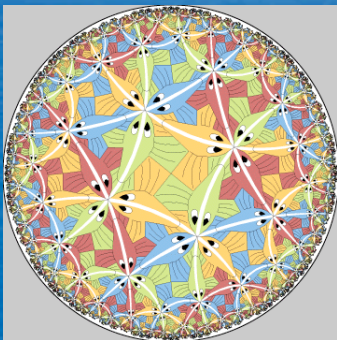
Mathematics and Style

- Math as Muse
 - Greek aesthetic of ratio and proportion: musical harmony, visual beauty
 - Symmetry
 - Cubism/Constructivism/Abstract/Pop
 - Underwear?



Mathematics and Style

- Math as Muse
 - Greek aesthetic of ratio and proportion: musical harmony, visual beauty
 - Symmetry
 - Cubism/Constructivism/Abstract/Pop
- Math as Maker
 - Symmetry
 - Perspective
 - Digital Music/Art, Hypertext



Mathematics and Style

- Math as Muse
 - Greek aesthetic of ratio and proportion: musical harmony, visual beauty
 - Symmetry
 - Cubism/Constructivism/Abstract/Pop
- Math as Maker
 - Symmetry
 - Perspective
 - Digital Music/Art, Hypertext
- Math as Measure?



The Quantification of Style

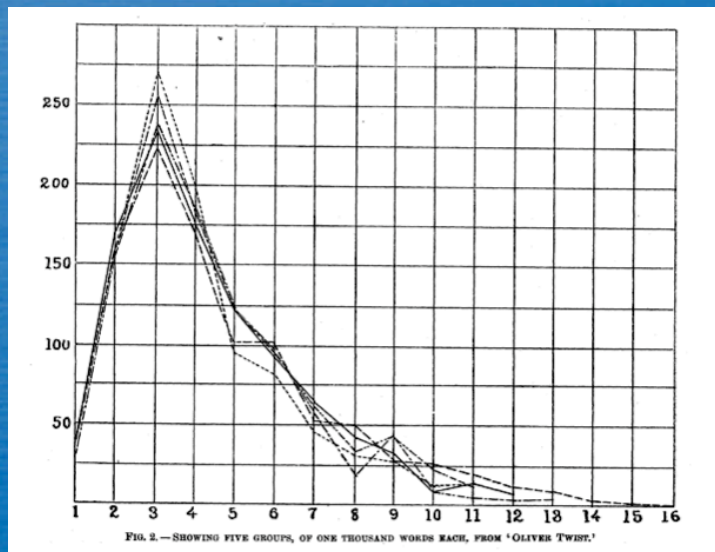
- Literature - “stylometry”
 - Who wrote this?
- Painting - “authentication”
 - Who painted this?
- Dance
 - Who moves like that?
- Music
 - Who composed that?
- Personality, Marketing,...



(Literary) Stylometry

— A thumbnail history

- 1851: Augustus de Morgan - thought that he might be able to distinguish writings (Epistles of St. Paul) via average word length
- 1880s: Thomas Mendenhall - tried to use word length distribution to distinguish among Charles Dickens, William Thackeray, John Stuart Mill, as well as among Marlowe, Bacon, and Shakespeare (Shakespeare seemed to use inordinate percentage of 4-letter words!)



“Characteristic Curves” (“Word Spectrum”) for Oliver Twist



(Literary) Stylometry

— A thumbnail history (cont.)

- 1897: Wincenty Lutoslawski (1863-1954) - uses a mathematical technique to study relative chronology of Plato's Dialogues by considering over 500 different statistics related to word usage, calls the approach "*stylometry*"
- 1967: Attribution of the Federalist Papers (Mosteller/Wallace)
 - 77 works ("Publius"): Jay (5), Hamilton (43), Madison (14)
 - Unknown (12), H-M joint (3)
 - Result: WITH HIGH LIKELIHOOD all 12 unknowns due to Madison (Bayesian inference)
- Things took off once computers enter (Project Gutenberg)...
- Applications: Attribution/identification, scholarship, Homeland Security...
- Methods: Many and various...



Word Frequency

Most techniques work in some manner or another with word frequencies - i.e., the proportion of time a given word is used in an author's writings.



Rare words

Favorite words, turns of phrase, idiosyncratic constructs

Eg., Donald Foster and J. Klein's Primary Colors

Common words

Function words (express grammatical relationships as opposed to lexical meaning - lexical "glue"):

- prepositions (in, on,..)
- conjunctions (and, or,...)
- pronouns (he, she,...)
- articles (the, that,..)
- participles (if, then,..) -



Books in Hyperspace

Book

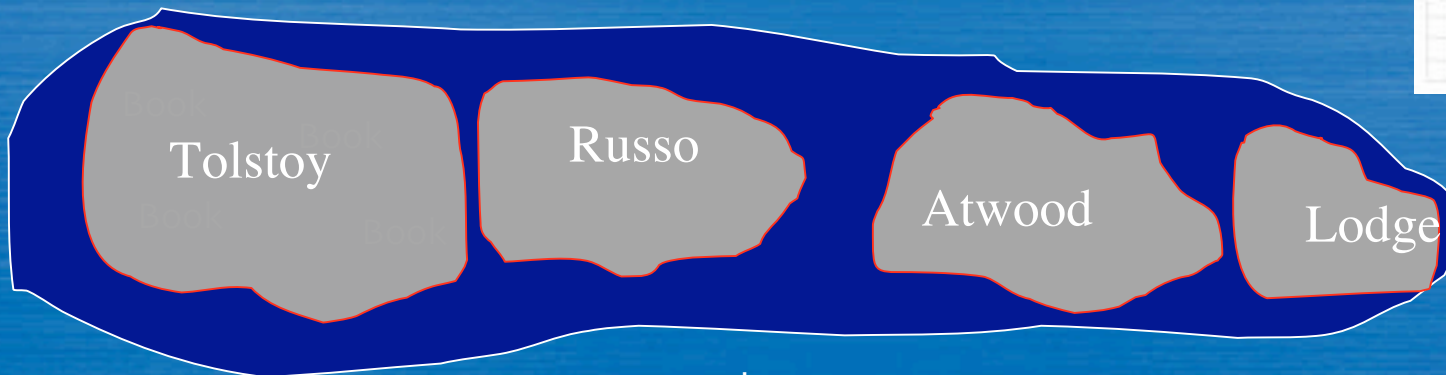
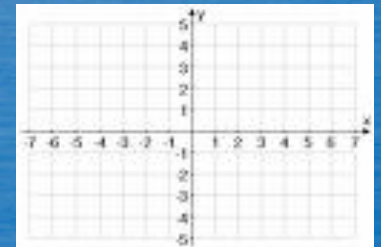
→ $(f_a, f_{as}, \dots, f_{however}, \dots, f_{such}, \dots, f_{their}, \dots, f_{yet})$

Feature
vector

E.g., f_a = fraction of times 'a' occurs in Book

Book $\Rightarrow (.13, .04, \dots, .002)$ - *a list of 50 Numbers...*

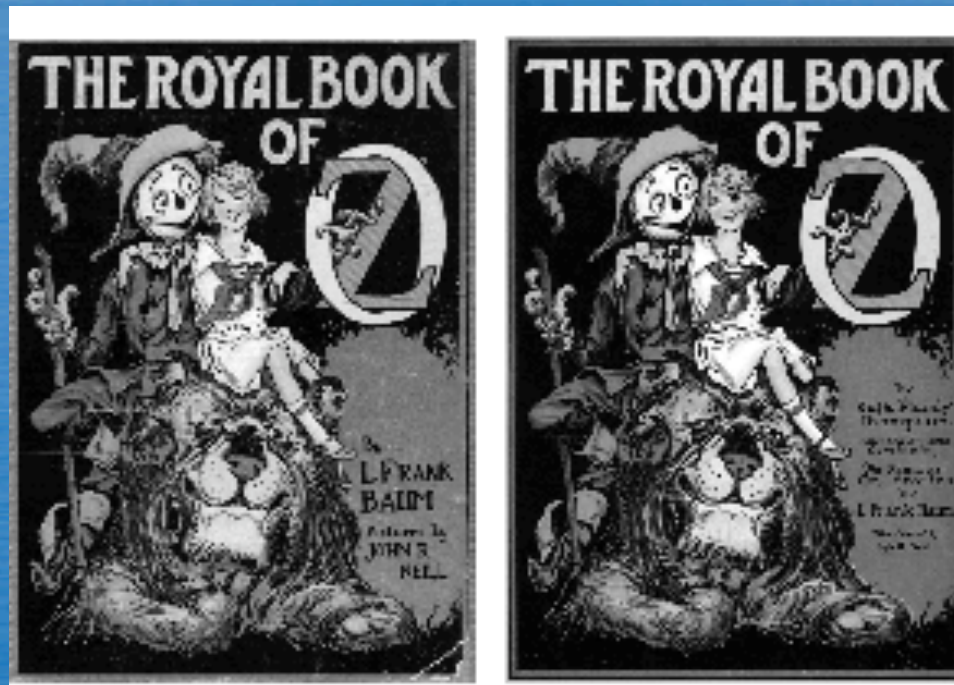
List of 50 numbers = point in 50-dimensional space!



50-d space

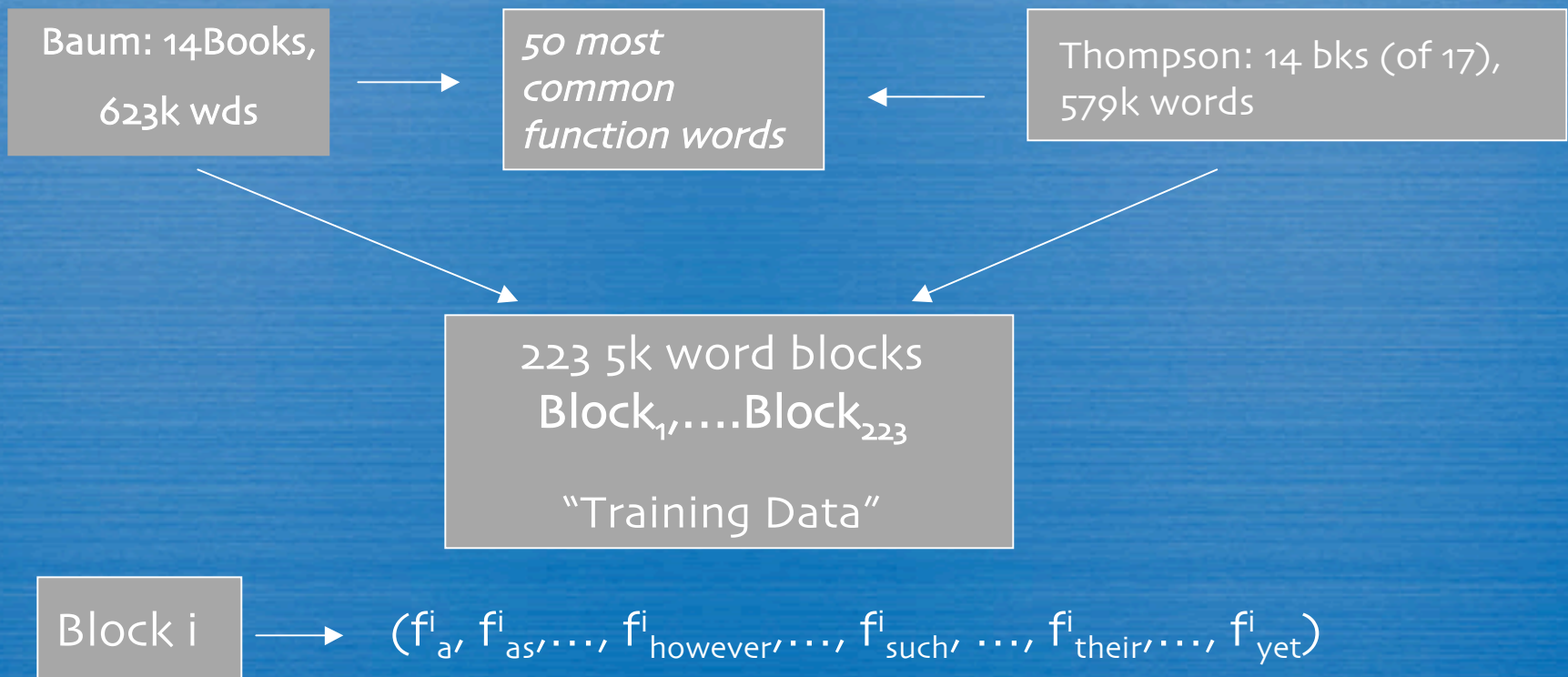
Example: The Royal Book of Oz

(J. Binongo, 2003)

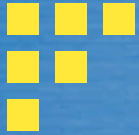


Who wrote the 15th book in the Oz series? Frank Baum, or the woman who took over the franchise when he died - Ruth Thompson?

The Geometry of Oz



Oz corpus: 223 points in 50-dimensional space!!



Dimension Reduction

“Dimension reduction” tool - find the “best” plane (two dimensions) that fits the 50-dimensional data.

50 dimensions -----> 2 dimensions

Example (3d -> 2d):

What kind of camel?



Side view is most informative

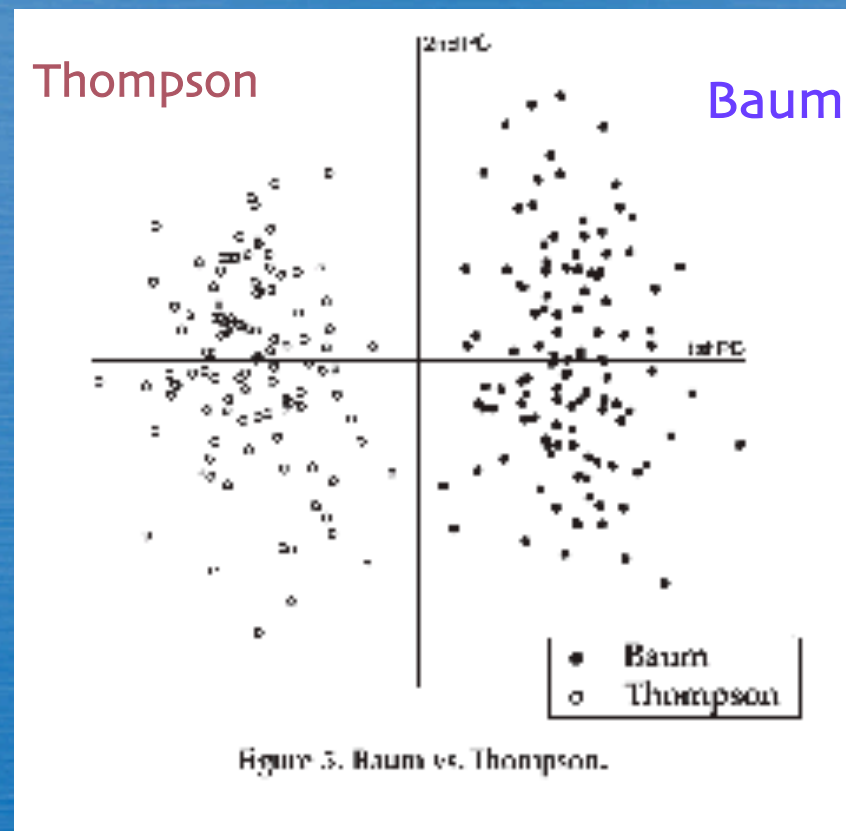


Bactrian



Arabian (dromedary)

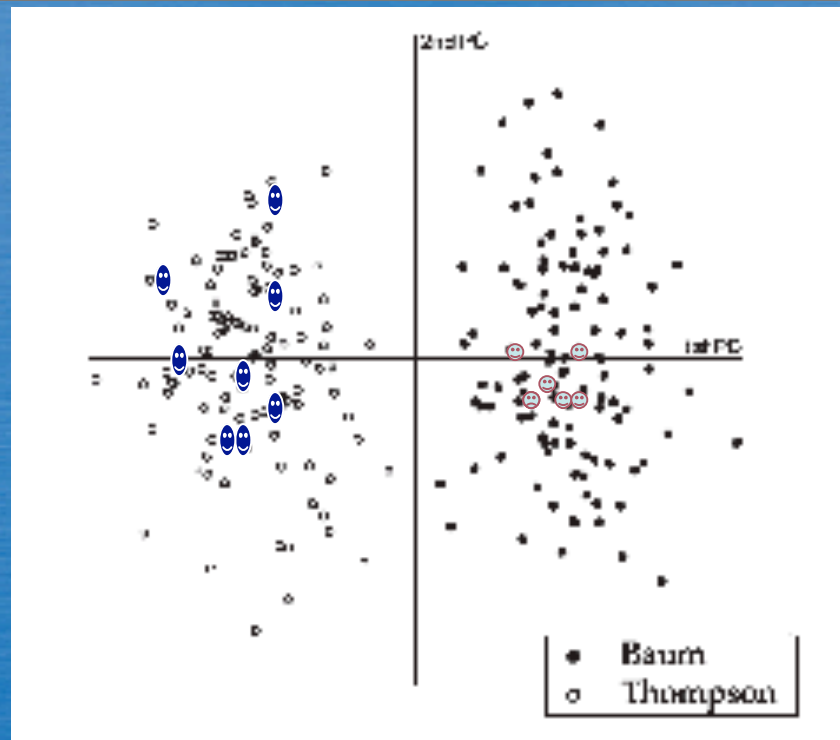
The Training Data



From Binongo, *Chance*, vol. 16, No. 2, 2003



The Results!



Modified From
Binongo, *Chance*,
vol. 16, No. 2, 2003

☺ “Royal Book” - Thompson

☹ “Glinda” - Baum

Take-away: Informative features yield useful geometry for classification of “style” (quantitative fingerprint) - A general idea...



Mathematics in the Visual Arts

Math as Muse and Maker:

- ratio and proportion, geometry, digital arts, etc.

Math as Measure:

- Materials analysis (dating)
 - X-ray analysis
 - Signature analyses
-
- Room for new mathematical tools?
 - YES - esp. w/digitization

Possibility for quantification of artistic style
i.e., "Stylometry" for the visual arts

Digitization - from pictures to numbers

Digital image - pixels



Numbers

Grayscale:

Black

intensity

White

0

255

134	23	255
12	57	0
211	147	89

...

...

...

...

...

...



Color = Red, Green, Blue - RGB



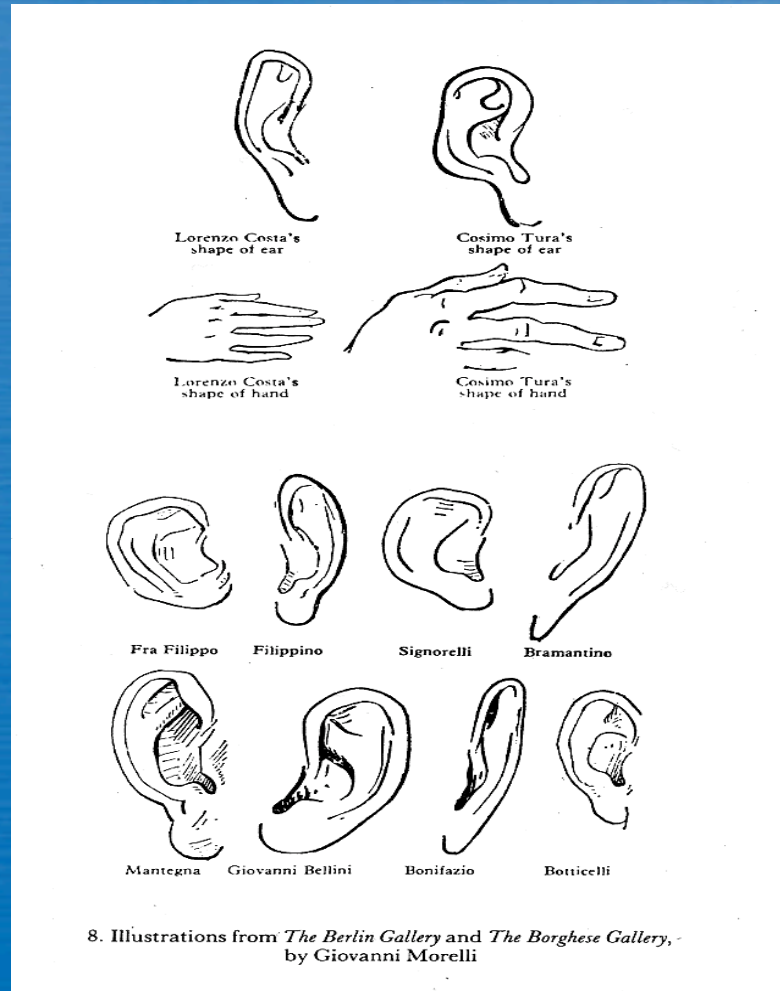
3 numbers,
one per color



Visual Stylometry



Giovanni Morelli
(1816-1891)





A Wavelet Approach to Visual Stylometry

(Farid, Lyu, Rockmore)



Detail from *Pastoral Landscape* (1552), P. B. the Elder