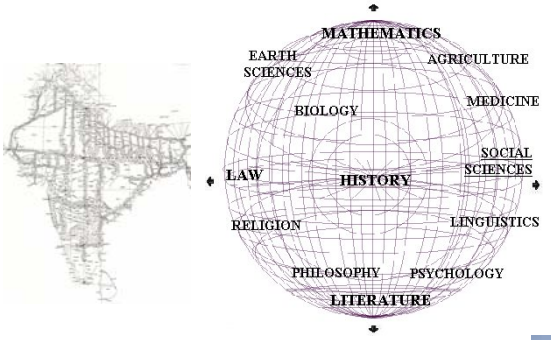
The History and Development of Domain Maps:

With a Focus on The Topic of Law



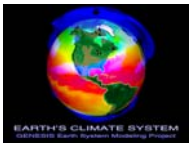
Peter A. Hook, J.D., M.S.L.I.S.
Electronic Services Librarian, Indiana University School of Law--Bloomington
Doctoral Student, School of Library and Info. Science
http://ella.slis.indiana.edu/~pahook
May 11, 2007, Monroe County Public library

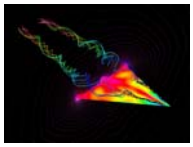
Visualization:

- The use of "the dynamic, interactive, inexpensive medium of graphical computers to devise new external aids enhancing cognitive abilities"
  - Card, S. K., Mackinlay, J. D., & Shneiderman, B. (1999). Information Visualization. In S. K. Card, J. D. Mackinlay & B. Shneiderman (Eds.), Readings in information visualization : using vision to think. San Francisco: Morgan Kaufmann Publishers.

2 Varieties

- Scientific Visualization
  - Literal, observable, experimental data not capable of being understood otherwise.



- Information Visualization
  - Using layout techniques to spatially visualize, non-spatial information.

Purposes

- (1) Discovery
- (2) Understanding
- (3) Communication
- (4) Education

These may be collapsed into two general purposes:

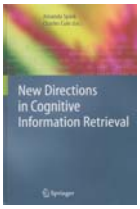
- (1) Discovery and (2) Explanation

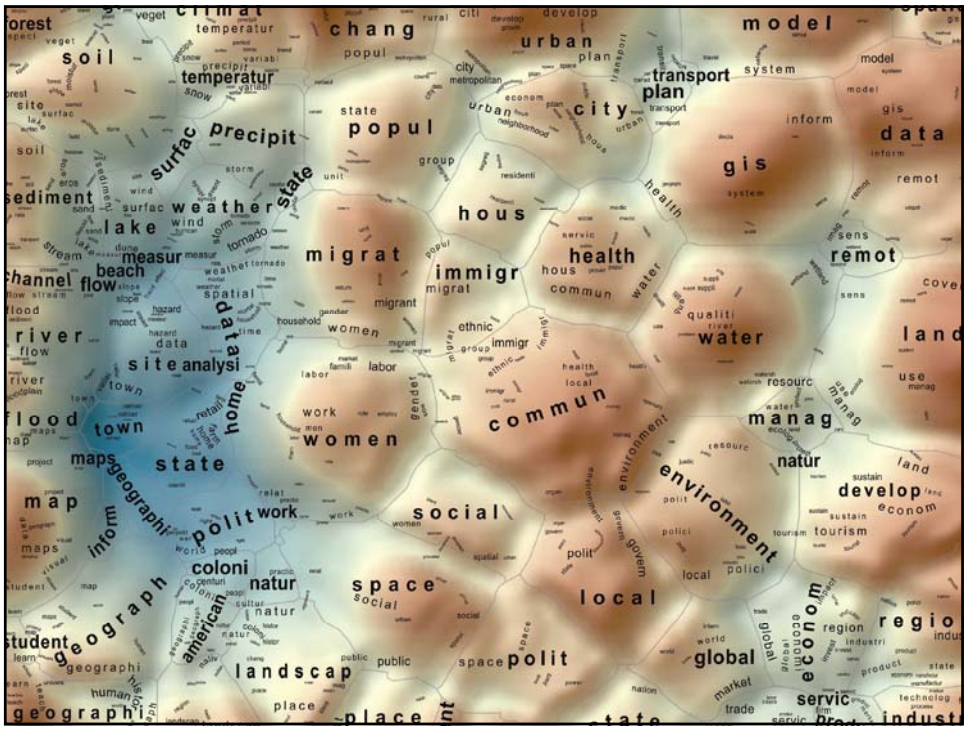
Knowledge Domain Visualizations

- **"Knowledge domain visualizations** (KDVs) are the graphic rendering of bibliometric data designed to provide a global view of a particular domain, its structural details, or its salient characteristics (most cited authors or papers, bursting concepts, etc.)."

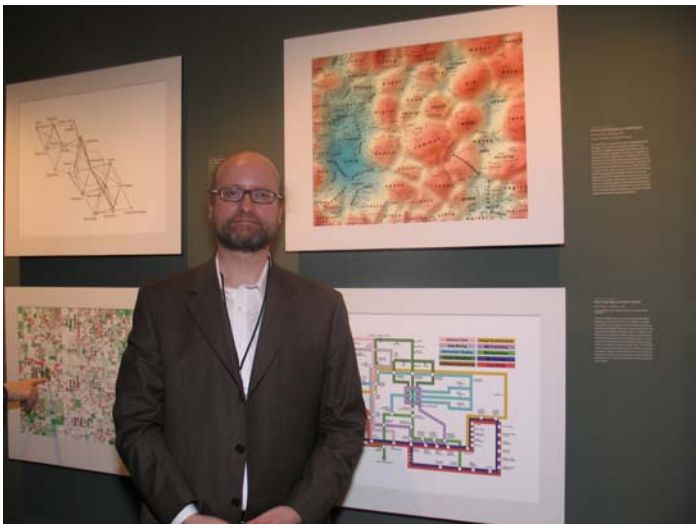
  Hook, Peter A. and Börner, Katy. (2005) Educational Knowledge Domain Visualizations: Tools to Navigate, Understand, and Internalize the Structure of Scholarly Knowledge and Expertise. In Amanda Spink and Charles Cole (eds.) New Directions in Cognitive Information Retrieval. Springer-Verlag.

- KDVs are also referred to as domain maps and the process of their creation as domain mapping.
- Information Cartography
- Data Landscapes





2005



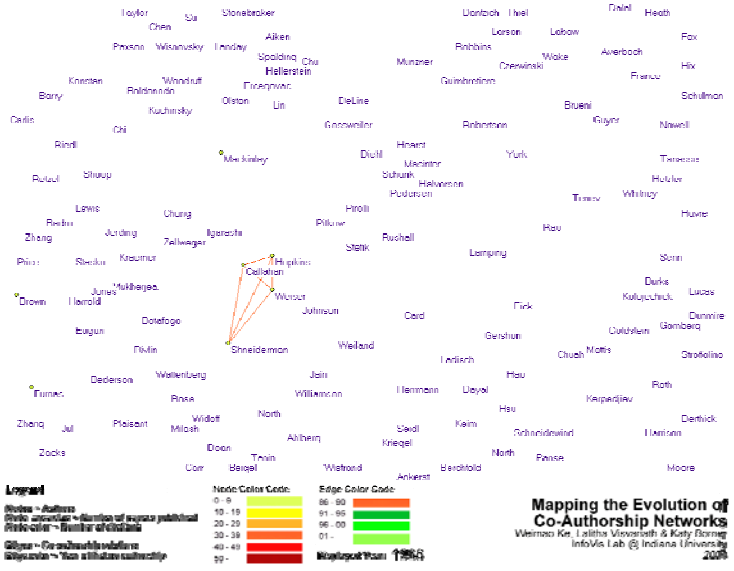
Information space of 22,000 conference abstracts submitted to the American Association of Geographers (AAG) annual meeting from 1993-2002.

Andre Skupin, April 3, 2006, Places and Spaces Exhibit, New York Public Library Science and Business Branch.

See: Skupin, A., and Hagelman, R. (2005) Visualizing Demographic Trajectories with Self-Organizing Maps. *GeoInformatica*. 9(2).

Mapping the Evolution of Co-Authorship Networks in Information Visualization, 1988 - 2004

Ke, Visvanath & Börner, (2004) Won 1st price at the IEEE InfoVis Contest.



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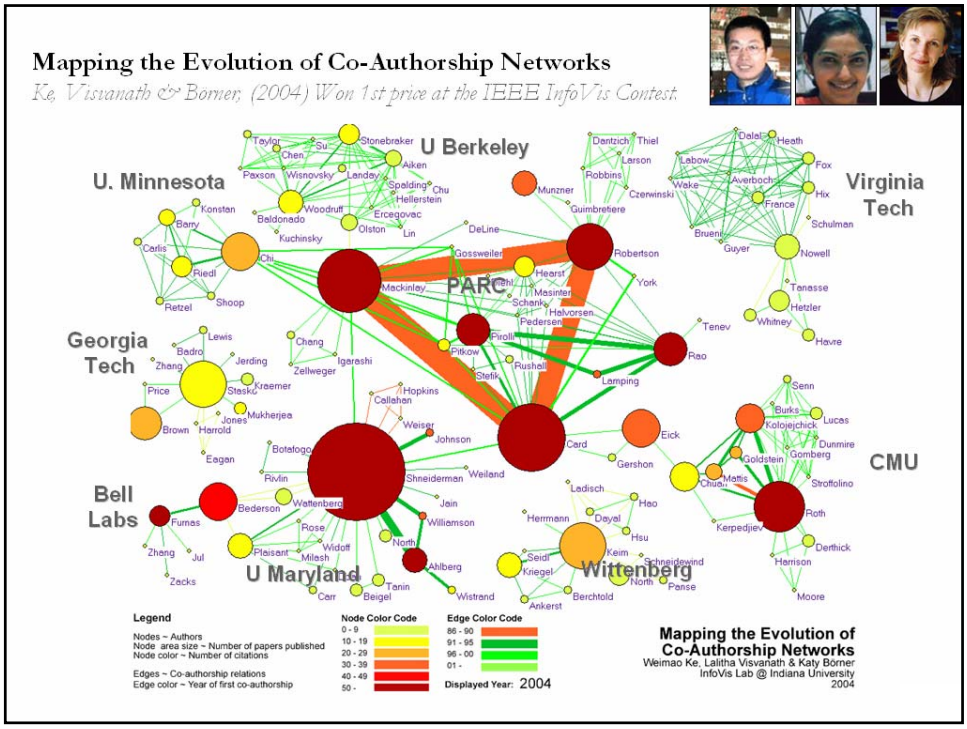
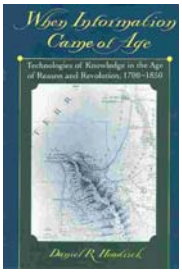


Descriptive → Scientific Cartography

Prior to the 1600's cartography was merely descriptive. Advances in calculating location on the planet made it scientific.

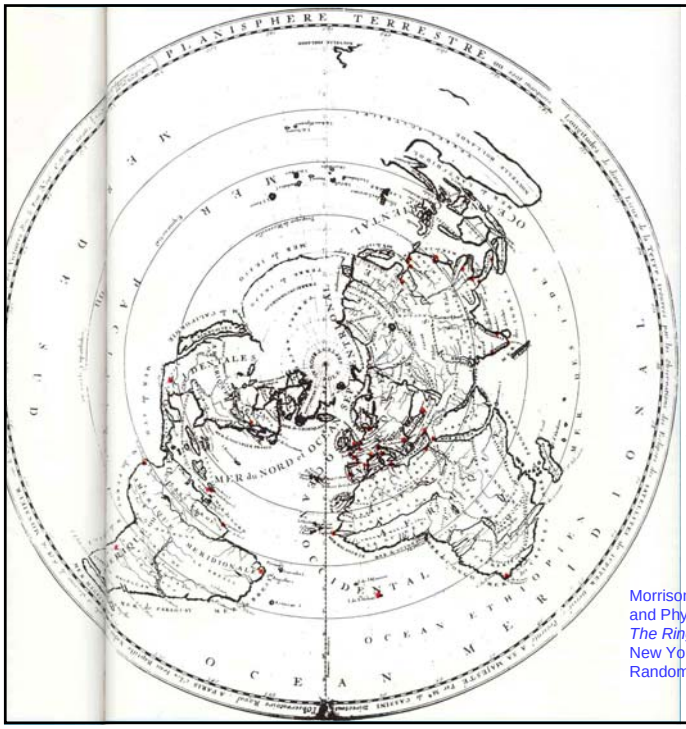
- Triangulation over large distances from a known base measure.
- Using the moons of Jupiter to establish longitude on land.
- Using accurate time pieces to establish longitude at sea.
- Accurately measuring depth and altitude, and representing them on maps.



Headrick, Daniel R. (2000). *When Information Came of Age: Technologies of Knowledge in the Age of Reason and Revolution, 1700-1850.* New York: Oxford University Press.

The same has now occurred with domain mapping.

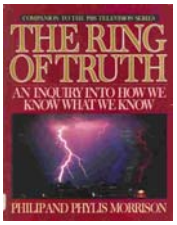
- The descriptive has become methodologically rigorous.

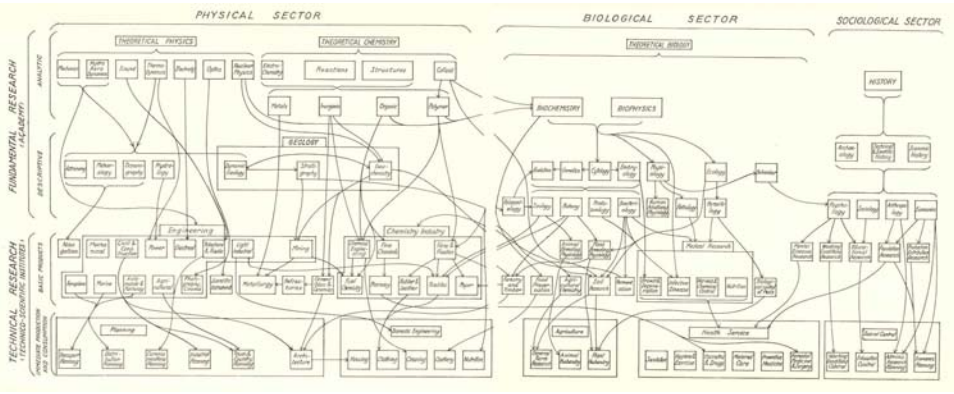


1696

- First Accurate Map of the Earth
- 40 points of accurate longitude
- Based on Moons of Jupiter to compare with local time in Paris.
- Cassini.

Morrison, Philip and Phylis (1987). *The Ring of Truth.* New York: Random House.

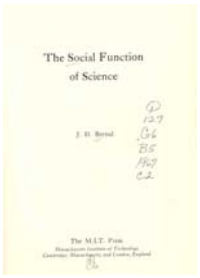


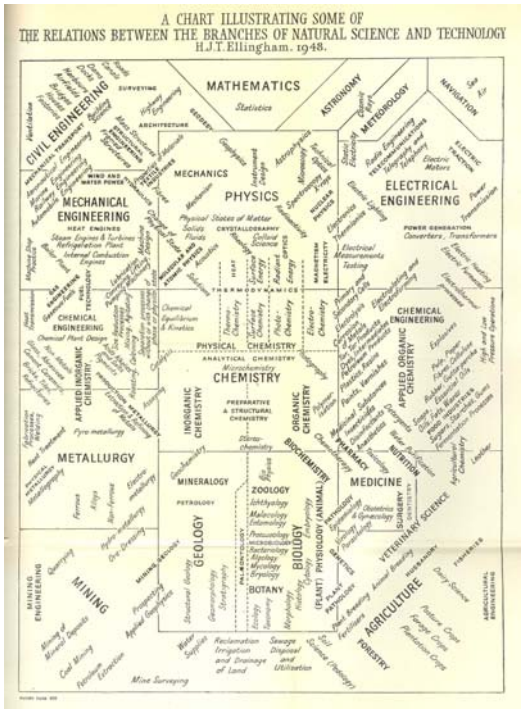


1939

John D. Bernal was a world renowned physicist, a historian of science, and a sociologist of science. He is considered to have produced one of the first 'maps' of science.

Bernal, J.D. (1939). *The Social Function of Science.* London: Routledge & Kegan Ltd.





1948

Ellingham, H. J. T. (1948), Divisions of Natural Science and Technology, in Reports and Papers of the Royal Society Scientific Information Conference, 21 June – 2 July, 1948. London: The Royal Society, Burlington House.

Distance—Similarity Metaphor

1654

Madeleine de Scudéry (b. 1607-d. 1701), *Clélie, histoire romaine, première partie (Clélie: A Roman Story, part I)*, Paris, 1654, Reserve of Rare and Precious Books, Rés. Yý. 1496

"*Carte du tendre (Map of Affection)*, engraved by François Chauveau and inserted in the first part of the novel. A salon game, the Map sparked a fad for "amorous geography" that took the form of allegorical almanacs and imaginary maps."

From: *Creating French Culture: Treasures from the Bibliotheque Nationale de France*, Library of Congress, Available at:http://www.loc.gov/exhibits/bnf/bnf0004.html

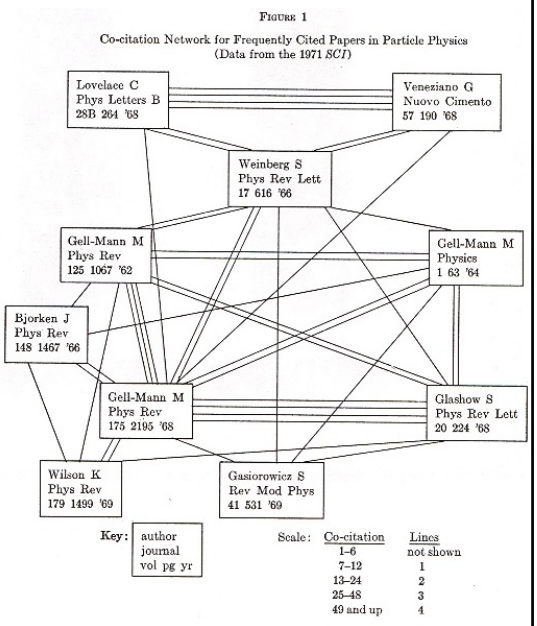
1973

Co – Discoveries / Implementation

Using Co-Citation to create domain maps.

• Small, H. (1973). Co-citation in the scientific literature: A new measure of the relationship between two documents. JASIS, 24, 265-269.

• Marshakova, I.V. (1973). A system of document connections based on references. Scientific and Technical Information Serial of VINITI, 6, 3-8.

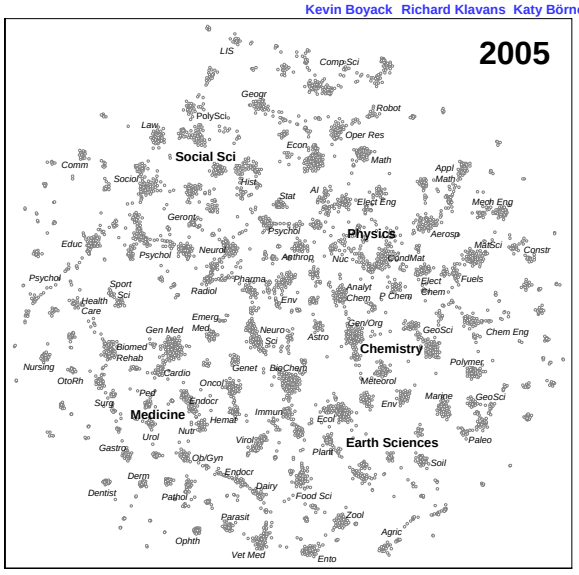


Map of all Science & Social Science



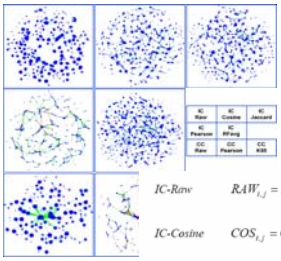
Kevin Boyack Richard Klavans Katy Börner

- The map is derived from the citation linkages between 7,121 journals from the year 2000.
- ISI Data (science citation index and the social science citation index).



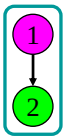
Boyack, K.W., Klavans, R., & Börner, K. (2005). Mapping the backbone of science. *Scientometrics*. Vol. 64, No. 3, 351-374

Different Similarity Metrics

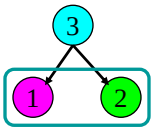


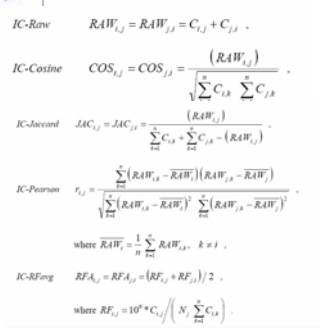
- 10 different similarity metrics
  - 6 Inter-citation (raw counts, cosine, modified cosine, Jaccard, RF, Pearson)
  - 4 Co-citation (raw counts, cosine, modified cosine, Pearson)

Inter-citation
1 cites 2



Co-citation
1 and 2 are co-cited





Boyack, K.W., Klavans, R., & Börner, K. (2005). Mapping the backbone of science. *Scientometrics*. Vol. 64, No. 3, 351-374

1951 Visualizations
(Thurston & Degan)

- Factorial / Vector Analysis of Co-Voting
- 1943 & 1944 Terms
- 9 Vectors (one for each Justice) in 3 dimensions

TABLE 1

INTRACLASS ϕ COEFFICIENTS R

		1	2	3	4	5	6	7	8	9
Black	1	..	0.59	0.42	0.40	−0.15	−0.25	−0.41	−0.46	−0.66
Douglas	2	0.59	..	0.30	0.35	−0.10	−0.16	−0.36	−0.45	−0.60
Rutledge	3	0.42	0.30	..	0.46	−0.19	−0.21	−0.36	−0.38	−0.50
Murphy	4	0.40	0.35	0.46	..	−0.25	−0.28	−0.42	−0.32	−0.39
Reed	5	−0.15	−0.10	−0.19	−0.25	..	−0.13	0.29	0.07	−0.07
Jackson	6	−0.25	−0.16	−0.21	−0.28	−0.13	..	−0.05	0.26	0.03
Stone	7	−0.41	−0.36	−0.36	−0.42	0.29	−0.05	..	0.19	0.23
Frankfurter	8	−0.46	−0.45	−0.38	−0.32	0.07	0.26	0.19	..	0.40
Roberts	9	−0.66	−0.60	−0.50	−0.39	−0.07	0.03	0.23	0.40	..

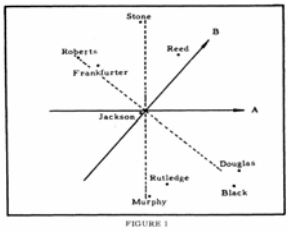


FIGURE 1

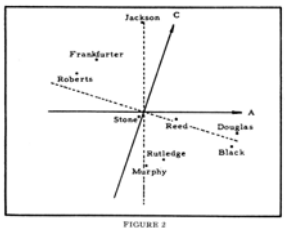


FIGURE 2

Thurstone, L. L. & Degan, J. W. (1951) A Factorial Study of the Supreme Court, *Proceedings of the National* Academy *of Sciences of the United States of America,* Vol. 37, No. 9 (Sept. 15, 1951), 628-635.

1985 Diagrams

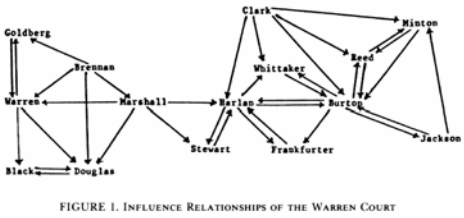


FIGURE 1. INFLUENCE RELATIONSHIPS OF THE WARREN COURT

Warren Court (1953 – 1969)

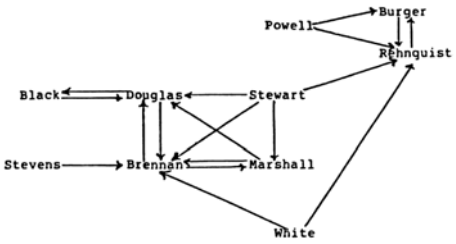
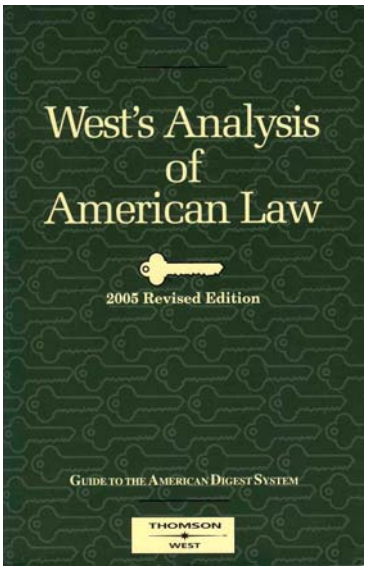


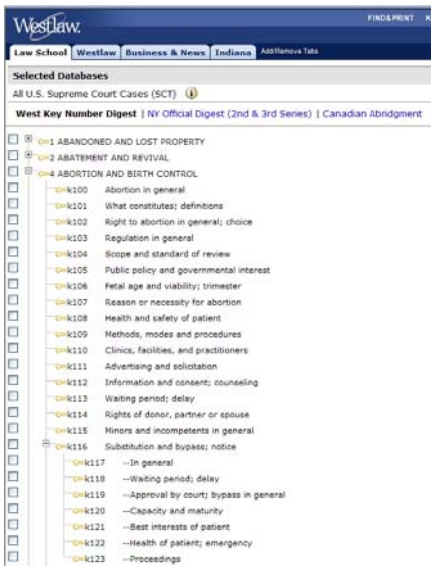
FIGURE 2. INFLUENCE RELATIONSHIPS OF THE BURGER COURT

Burger Court (1969 – 1986)

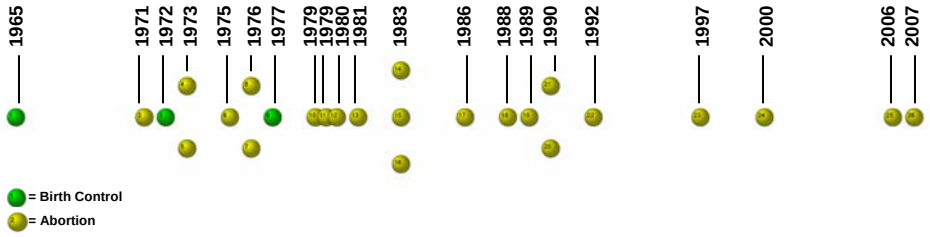
Spaeth, Harold J. & Altfeld, Michael F. (1985) Influence Relationships within the Supreme Court: A Comparison of the Warren and Burger Courts, *The Western Political Quarterly,* Vol. 38., No. 1. (March 1985), pp. 70-83.

Relational Infrastructure of the Law





26 “Abortion and Birth Control” Cases in the S.Ct.



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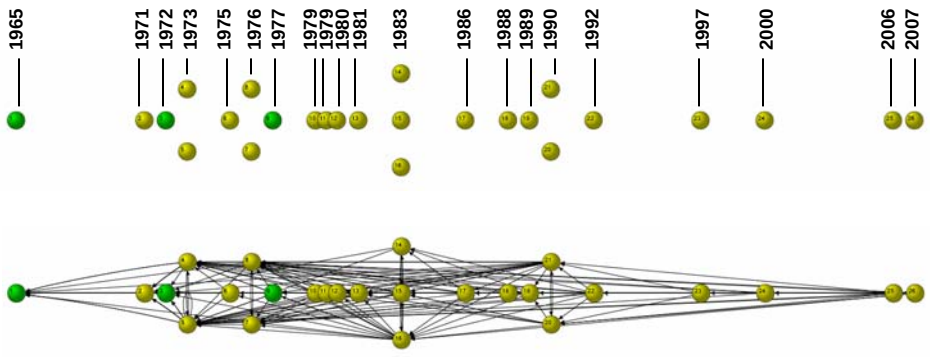
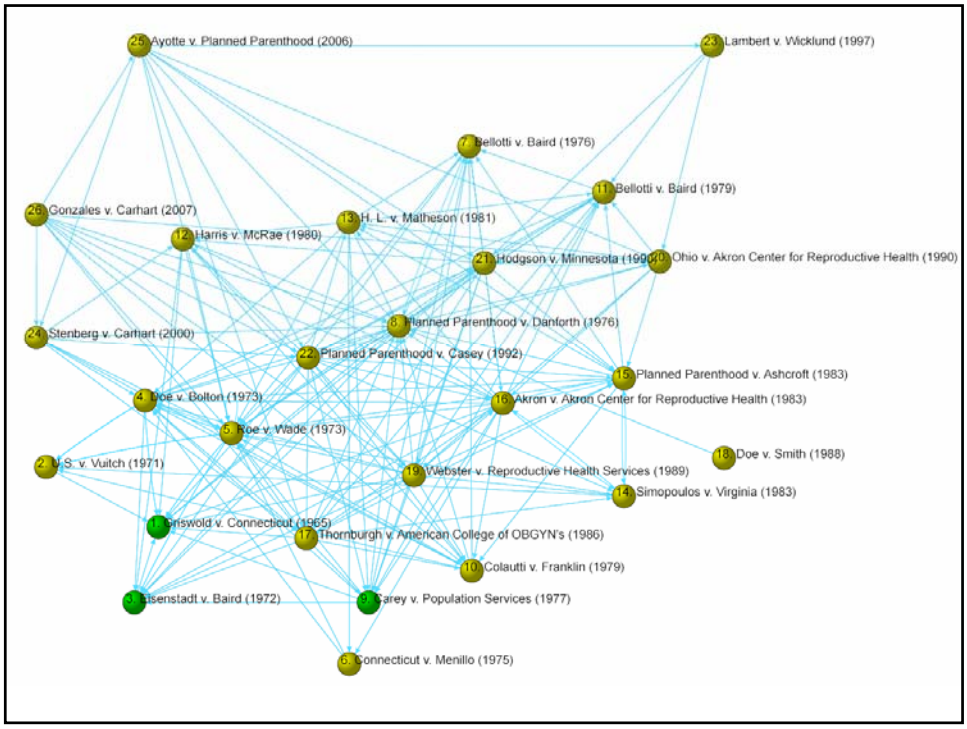




Relational Infrastructure of the Law

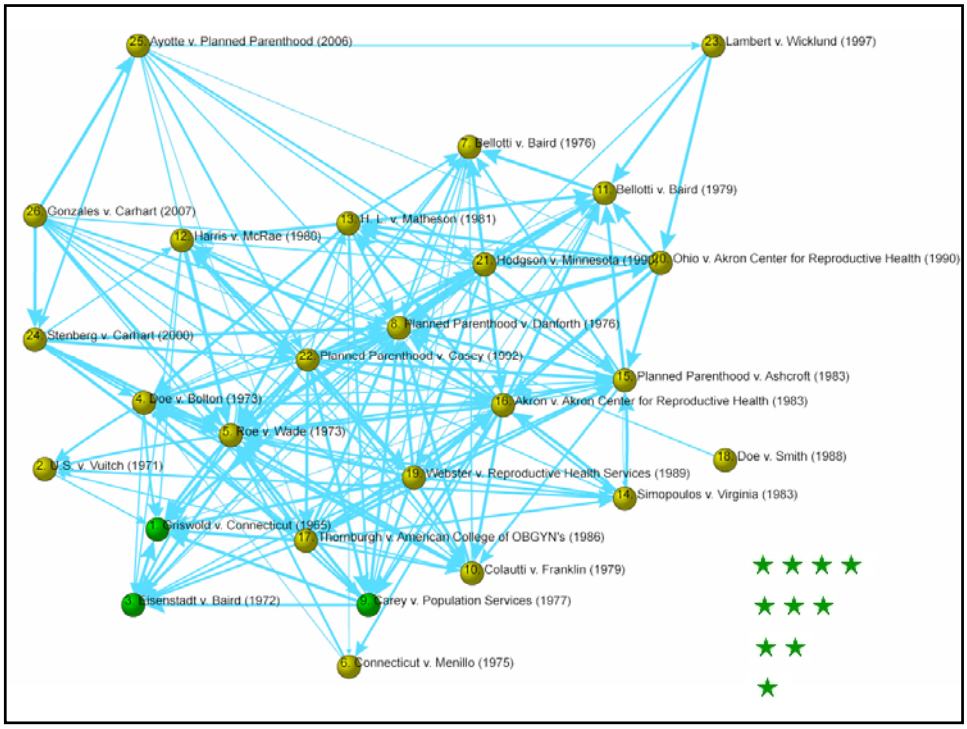
KeyCite

Roe v. Wade
410 U.S. 113, 93 S.Ct. 705
U.S.Tex.,1973.
January 22, 1973

First Part | Next Part>>

125 Cases Cited in Roe v. Wade

51 Griswold v. Connecticut, 85 S.Ct. 1678 (U.S.Conn. 1965) ★★★★ 715+
52 U.S. v. Guest, 86 S.Ct. 1170 (U.S.Ga. 1966) ★ 734
53 Gunn v. University Committee to End War in Viet Nam, 90 S.Ct. 2013 (U.S.Tex. 1970) ★ 711
54 Hammett v. State, 209 S.W. 661 (Tex.Crim.App. 1919) ★★ 726
55 Investment Co. Institute v. Camp, 91 S.Ct. 1091 (U.S.Dist.Col. 1971) ★★ 714
56 Jackson v. State, 115 S.W. 262 (Tex.Crim.App. 1908) ★★ 710
57 Jacobson v. Commonwealth of Massachusetts, 25 S.Ct. 358 (U.S.Mass. 1905) ★★ 727
58 Katz v. U.S., 88 S.Ct. 507 (U.S.Cal. 1967) ★★ 726+
59 Keeler v. Superior Court, 470 P.2d 617 (Cal. 1970) ★ 729


25 Ayotte v. Planned Parenthood (2006)
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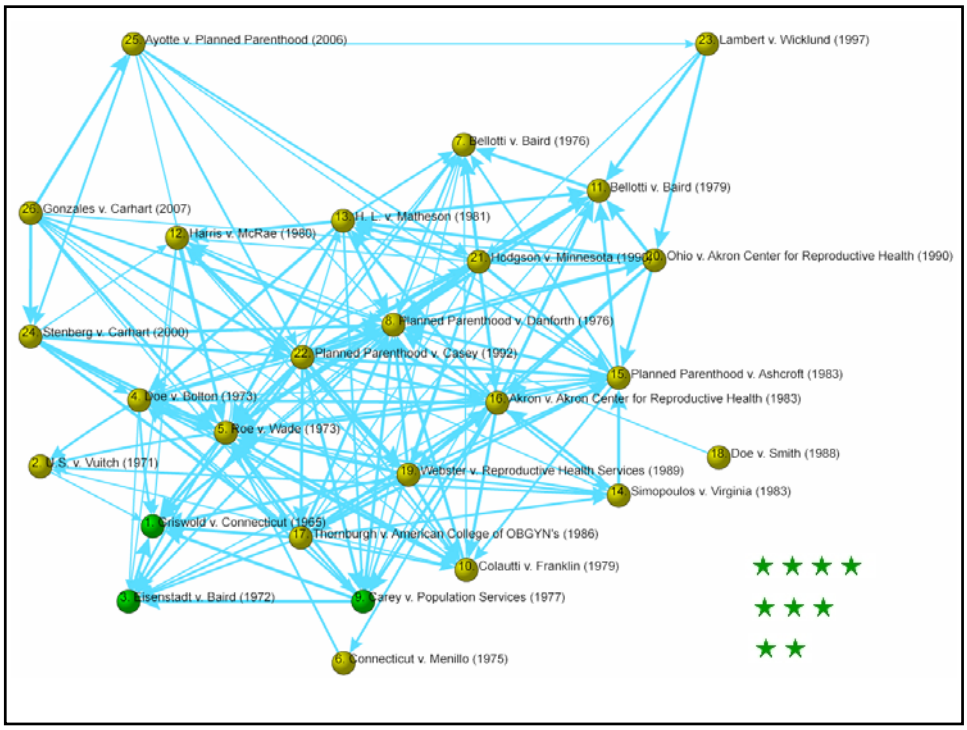
6 Connecticut v. Menillo (1975)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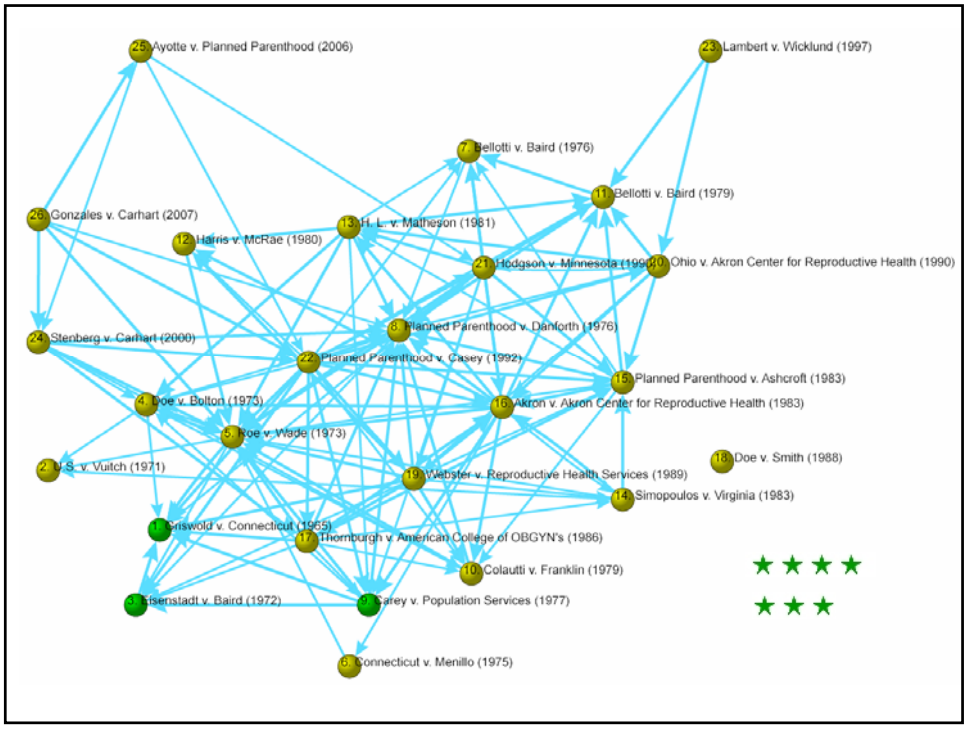
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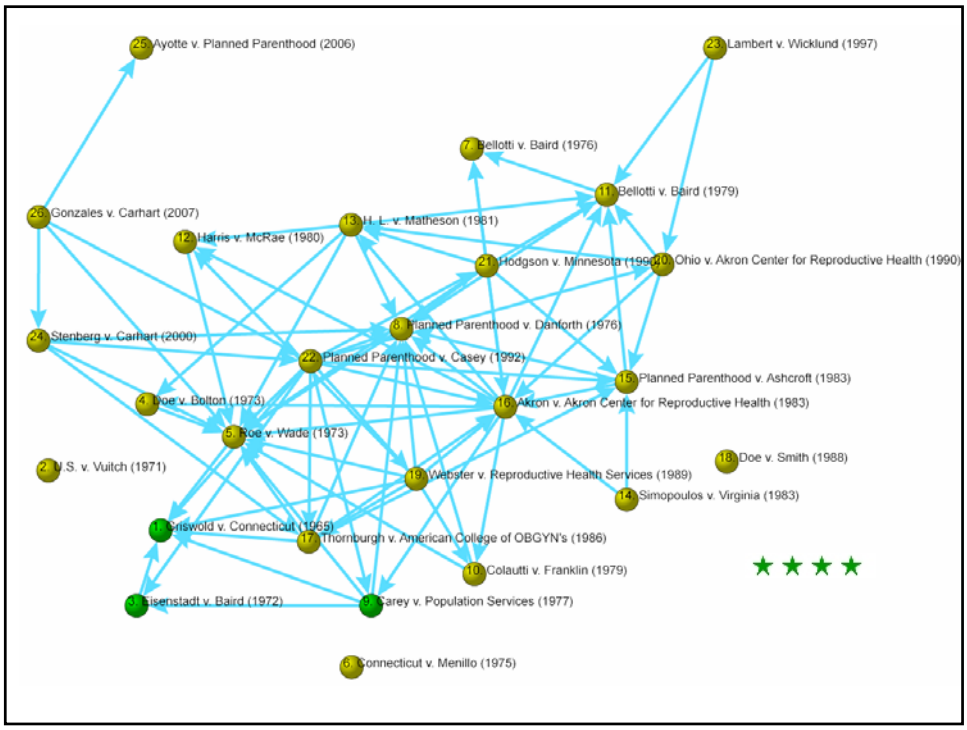
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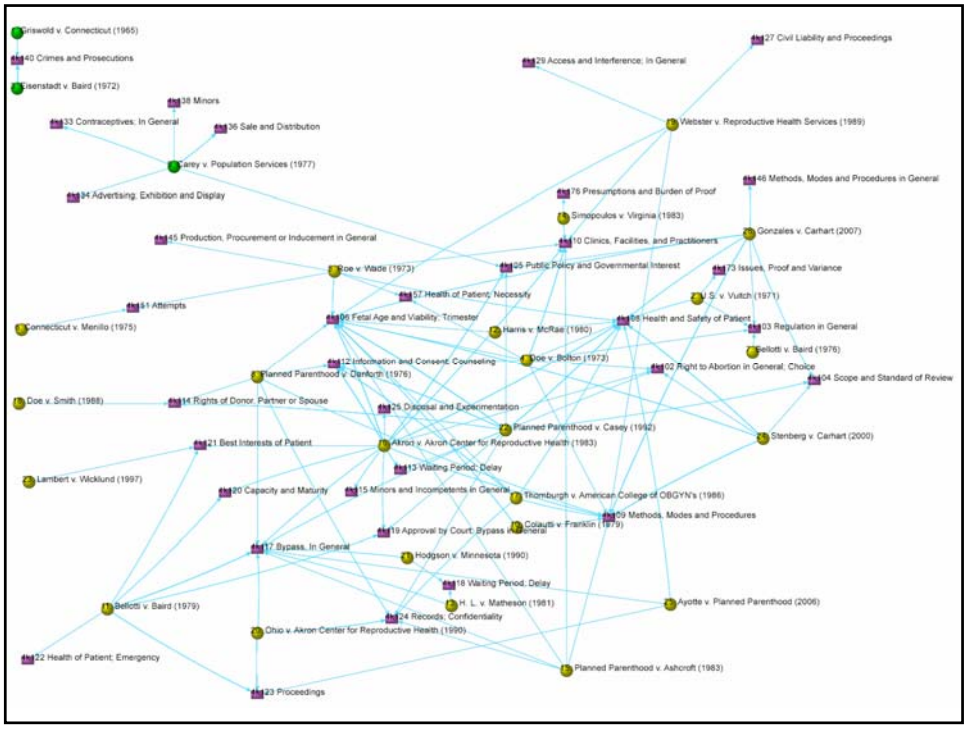
3 Eisenstadt v. Baird (1972)
9 Carey v. Population Services (1977)
6 Connecticut v. Menillo (1975)



1. ***Griswold v. Connecticut,*** 381 U.S. 479 (June 07, 1965)

92k82(7) Constitutional Law, Privacy In General

1. Griswold v. Connecticut (1965)

"The First Amendment has a penumbra where privacy is protected from governmental intrusion."
– West Publishing

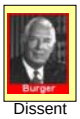
4k140 Crimes and Prosecutions

"Connecticut law forbidding use of contraceptives unconstitutionally intrudes upon the right of marital privacy."
– West Publishing

3. ***Eisenstadt v. Baird,*** 405 U.S. 438 (March 22, 1972)

Main Opinion

vs.



Dissent

Took No Part

Concurrence

Concurrence

4k140 Crimes and Prosecutions

"Massachusetts statute permitting married persons to obtain contraceptives to prevent pregnancy but prohibiting distribution of contraceptives to single persons for that purpose violates equal protection clause."

– West Publishing

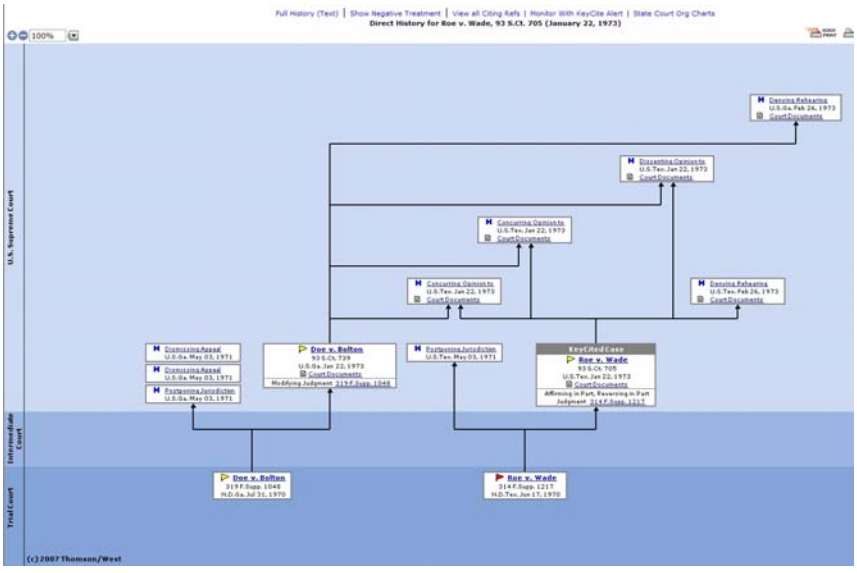
1. Griswold v. Connecticut (1965)

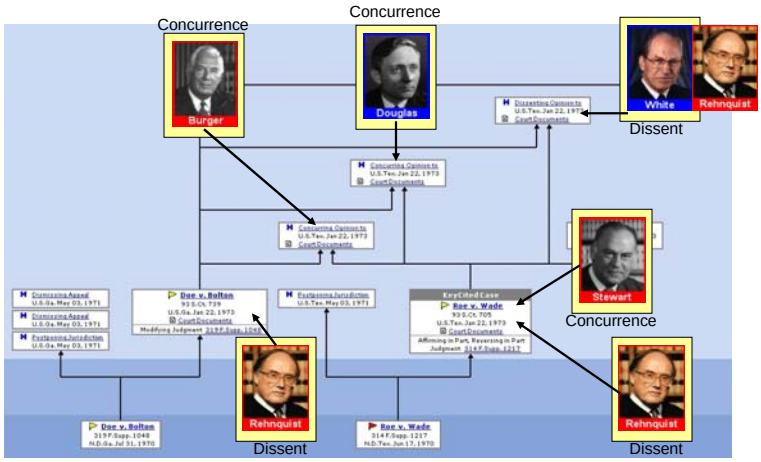
92k82(10) Constitutional Law, Privacy In General

"Under right of privacy, individual, married or single, has right to be free from unwarranted governmental intrusion into matters so fundamentally affecting a person as decision whether to bear or beget a child."

– West Publishing

4. ***Doe v. Bolton,*** 410 U.S. 179 (Jan. 22, 1973)
5. ***Roe v. Wade,*** 410 U.S. 113 (Jan. 22, 1973)



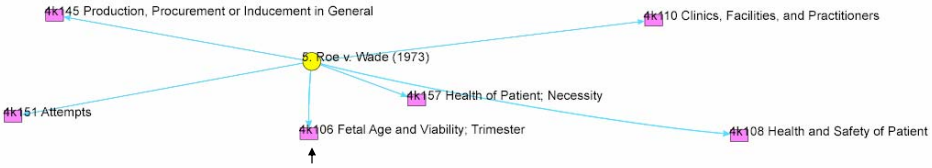


Main Opinions

7

2

5. ***Roe v. Wade,*** 410 U.S. 113 (Jan. 22, 1973)



4k106 Fetal Age and Viability: Trimester

- "Prior to approximately the end of the first trimester of pregnancy, the attending physician in consultation with his patient is free to determine, without regulation by state, that in his medical judgment the patient's pregnancy should be terminated, and if that decision is reached such judgment may be effectuated by an abortion without interference by the state."
- "From and after approximately the end of the first trimester of pregnancy, a state may regulate abortion procedure to extent that the regulation reasonably relates to preservation and protection of maternal health."
- "If state is interested in protecting fetal life after viability, it may go so far as to proscribe abortion during that period except when necessary to preserve the life or the health of the mother."

– West Publishing

19. ***Webster v. Reproductive Health Services,*** 492 U.S. 490 (July 03, 1989)

vs.

"State's interest in protecting potential human life does not come into existence only at point of viability and thus, there should not be rigid line allowing state regulation of abortion after viability but prohibiting regulation before viability. (Per Chief Justice with two Justices concurring.)."

"Today, Roe v. Wade, and the fundamental constitutional right of women to decide whether to terminate a pregnancy, survive but are not secure."

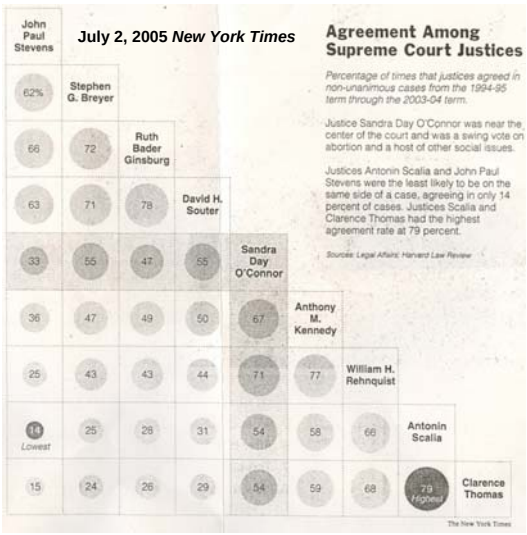
"I fear for the future. I fear for the liberty and equality of the millions of women who have lived and come of age in the 16 years since *Roe* was decided. I fear for the integrity of, and public esteem for, this Court."

22. ***Planned Parenthood of SE Penn. v. Casey,*** 492 U.S. 490 (June 29, 1992)

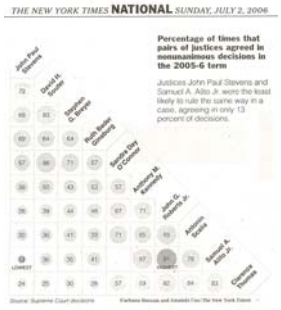
vs.

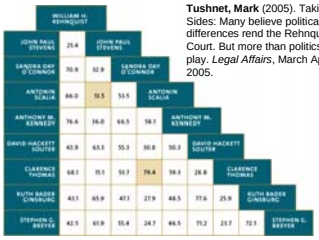
"Reliance on *Roe v. Wade* rule's limitation on state power required reaffirmance of *Roe's* essential holding under doctrine of stare decisis; for two decades of economic and social developments, people organized intimate relationships and made choices that defined their views of themselves and their places in society in reliance on availability of abortion in event of contraceptive failure."

Mania for Co-Voting Data



July 2, 2005 *New York Times*





Tushnet, Mark (2005). Taking Sides: Many believe political differences rend the Rehnquist Court. But more than politics are in play. *Legal Affairs*, March April 2005.

Visualizing the Harvard Law Review Supreme Court Statistics

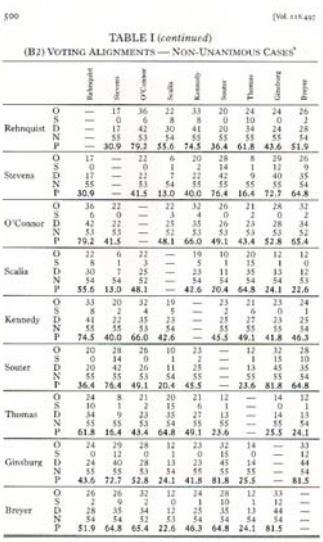
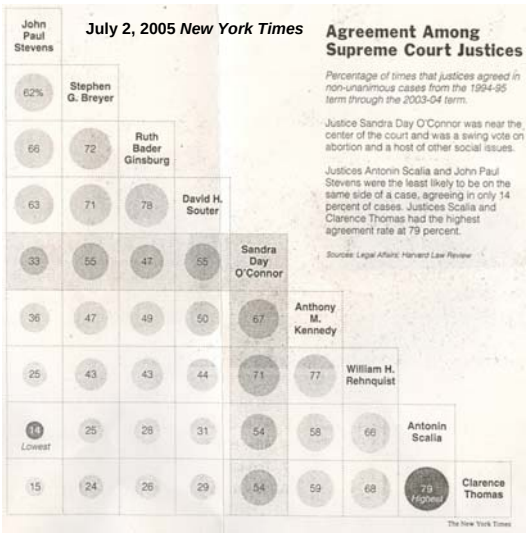


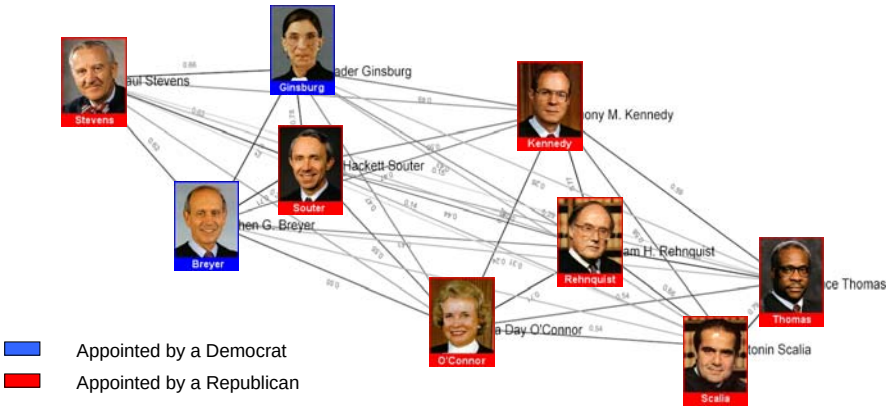
TABLE I (*continued*)
(B2) VOTING ALIGNMENTS — NON-UNANIMOUS CASES*

		Rehnquist	Stevens	O'Connor	Scalia	Kennedy	Souter	Thomas	Ginsburg	Breyer
Rehnquist	O	—	17	36	22	33	20	24	24	26
	S	—	0	6	8	8	0	10	0	2
	D	—	17	42	30	41	20	34	24	28
	N	—	55	53	54	55	55	55	55	54
	P	—	30.9	79.2	55.6	74.5	36.4	61.8	43.6	51.9
Stevens	O	17	—	22	6	20	28	8	29	26
	S	0	—	0	1	2	14	1	12	9
	D	17	—	22	7	22	42	9	40	35
	N	55	—	53	54	55	55	55	55	54
	P	30.9	—	41.5	13.0	40.0	76.4	16.4	72.7	64.8
O'Connor	O	36	22	—	22	32	26	21	28	32
	S	6	0	—	3	4	0	2	0	2
	D	42	22	—	25	35	26	23	28	34
	N	53	53	—	52	53	53	53	53	52
	P	79.2	41.5	—	48.1	66.0	49.1	43.4	52.8	65.4
Scalia	O	22	6	22	—	19	10	20	12	12
	S	8	1	3	—	5	1	15	1	0
	D	30	7	25	—	23	11	35	13	12
	N	54	54	52	—	54	54	54	54	53
	P	55.6	13.0	48.1	—	42.6	20.4	64.8	24.1	22.6
Kennedy	O	33	20	32	19	—	23	21	23	24
	S	8	2	4	5	—	2	6	0	1
	D	41	22	35	23	—	25	27	23	25
	N	55	55	53	54	—	55	55	55	54
	P	74.5	40.0	66.0	42.6	—	45.5	49.1	41.8	46.3
Souter	O	20	28	26	10	23	—	12	32	28
	S	0	14	0	1	2	—	1	15	10
	D	20	42	26	11	25	—	13	45	35
	N	55	55	55	54	55	—	55	55	54
	P	36.4	76.4	49.1	20.4	45.5	—	23.6	81.8	64.8
Thomas	O	24	8	21	20	21	12	—	14	12
	S	10	1	2	15	6	1	—	0	1
	D	34	9	23	35	27	13	—	14	13
	N	55	55	53	54	55	55	—	55	54
	P	61.8	16.4	43.4	64.8	49.1	23.6	—	25.5	24.1
Ginsburg	O	24	29	28	12	23	32	14	—	33
	S	0	12	0	1	0	15	0	—	12
	D	24	40	28	13	23	45	14	—	44
	N	55	55	53	54	55	55	55	—	54
	P	43.6	72.7	52.8	24.1	41.8	81.8	25.5	—	81.5
Breyer	O	26	26	32	12	24	28	12	33	—
	S	2	9	2	0	1	10	1	12	—
	D	28	35	34	12	25	35	13	44	—
	N	54	54	52	53	54	54	54	54	—
	P	51.9	64.8	65.4	22.6	46.3	64.8	24.1	81.5	—



July 2, 2005 *New York Times*

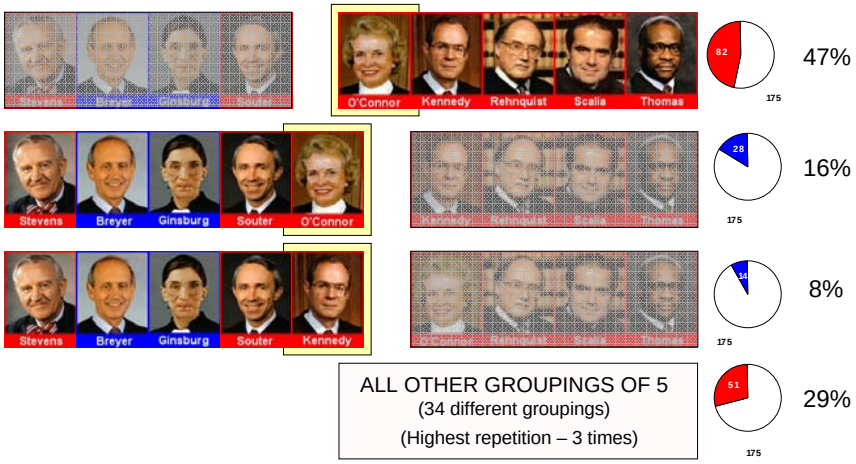
Ideological Landscape of the Justices (1994 – 2003)



Voting frequencies represented as the edge weight between nodes and presented visually as a graph. (Rendered with Pajek using a stochastic, spring force algorithm.)

Frequency of Voting Blocks in 5-4 Cases

(1994 -2003 Supreme Court Terms)

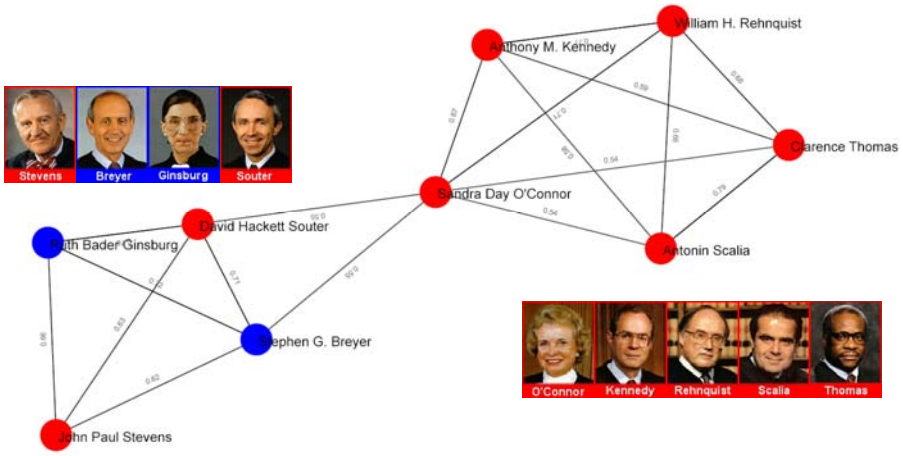


ALL OTHER GROUPINGS OF 5
(34 different groupings)
(Highest repetition – 3 times)

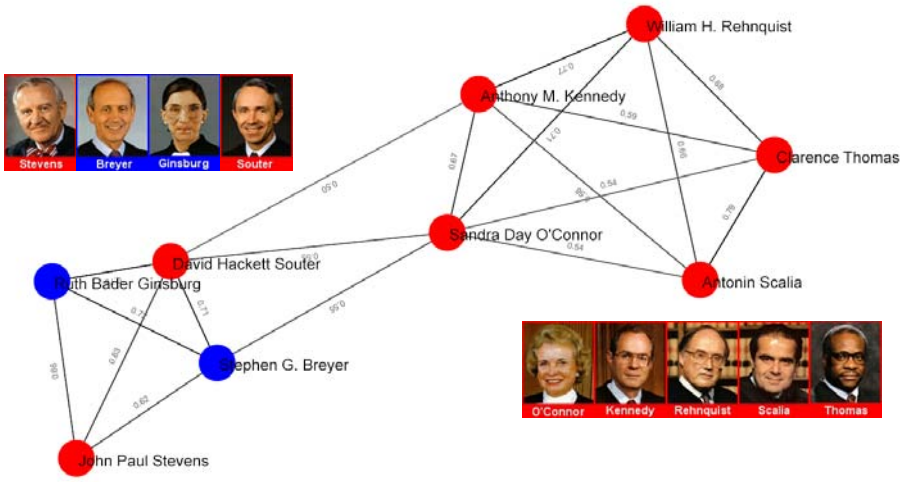
Total 5 to 4 Cases = 175

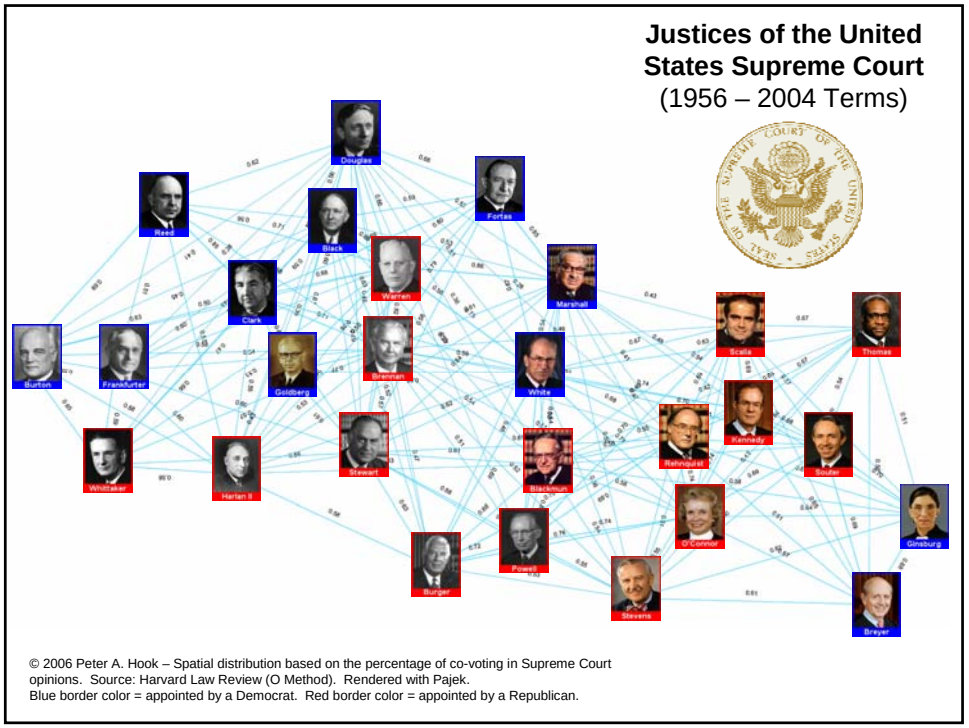
Source: Statistics harvested from the Harvard Law Review

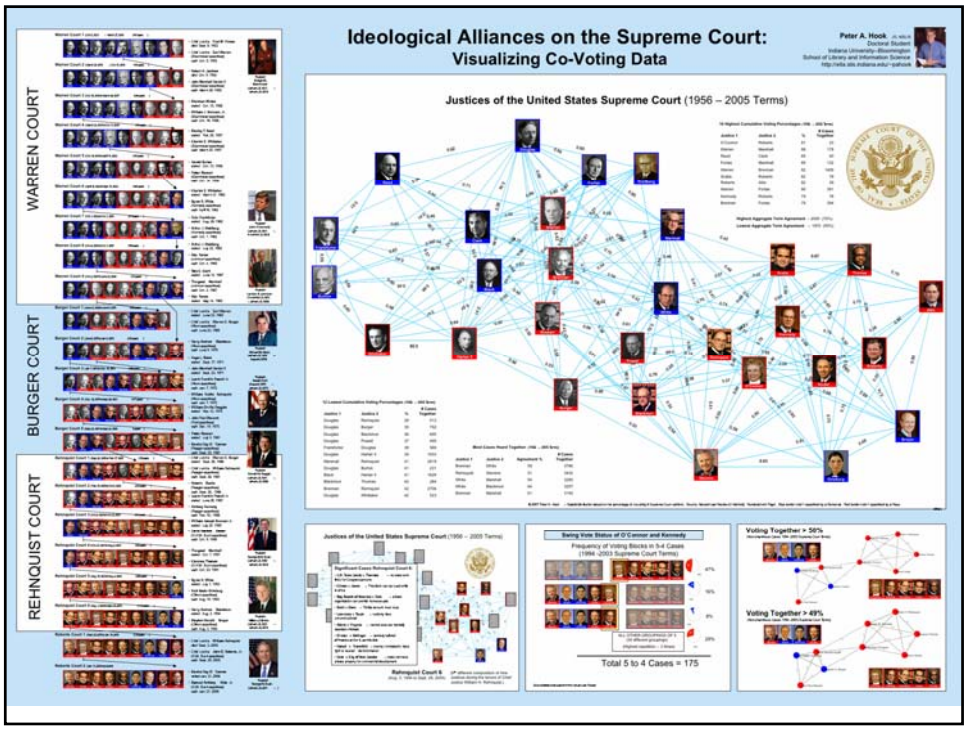
Thresholding (Voting Together > 50%) Reveals Ideological Cliques



Thresholding (Voting Together > 49%) Reveals Ideological Cliques

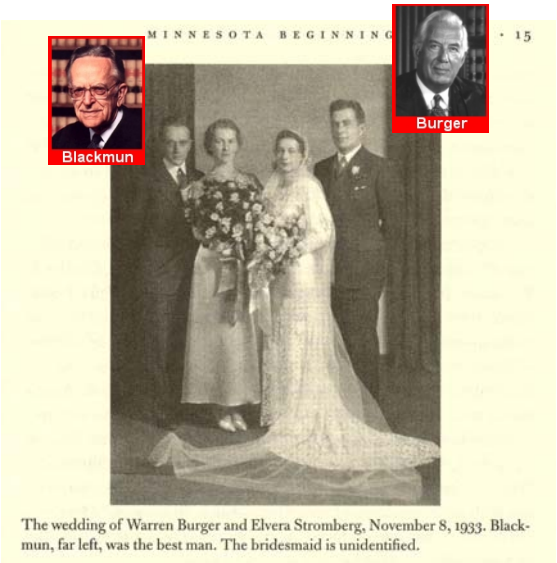


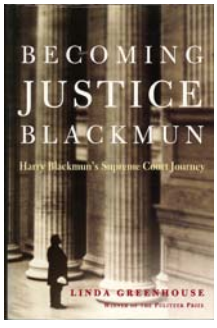

Justices of the United States Supreme Court
(1956 – 2004 Terms)
Douglas
Reed
Black
Fortas
Warren
Marshall
Clark
Scalia
Thomas
Burton
Frankfurter
Goldberg
Brennan
White
Kennedy
Souter
Rehnquist
Stewart
Blackmun
Whittaker
Harlan II
O'Connor
Ginsburg
Powell
Burger
Stevens
Breyer
© 2006 Peter A. Hook – Spatial distribution based on the percentage of co-voting in Supreme Court opinions. Source: Harvard Law Review (O Method). Rendered with Pajek.
Blue border color = appointed by a Democrat. Red border color = appointed by a Republican.


Ideological Alliances on the Supreme Court:
Visualizing Co-Voting Data
Peter A. Hook
WARREN COURT
BURGER COURT
REHNQUIST COURT
Justices of the United States Supreme Court (1956 – 2005 Terms)
Total 5 to 4 Cases = 175
Voting Together > 50%
Voting Together > 49%

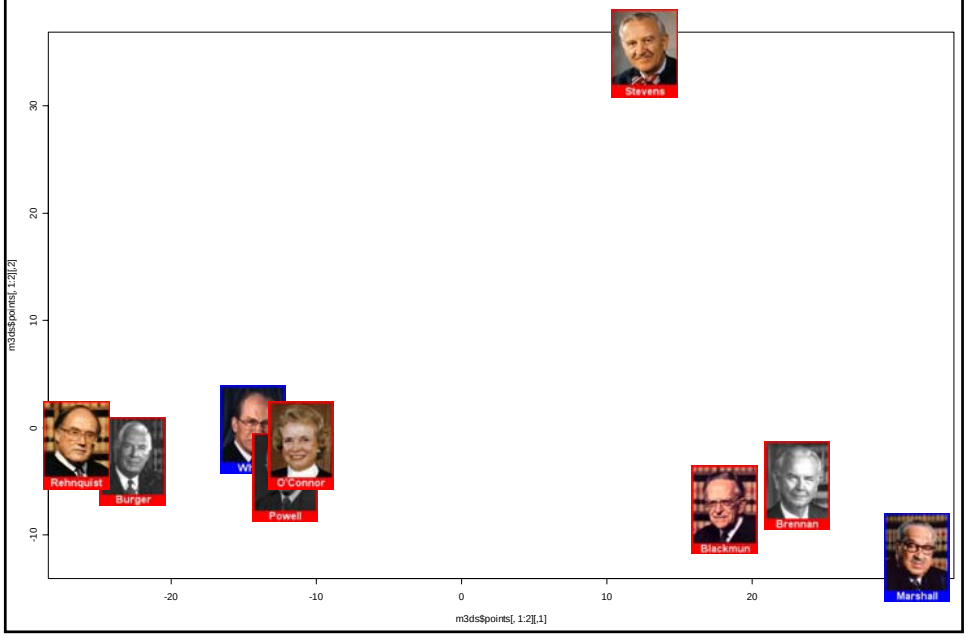
The Minnesota Twins Story

Two Friends End Up on the Supreme Court

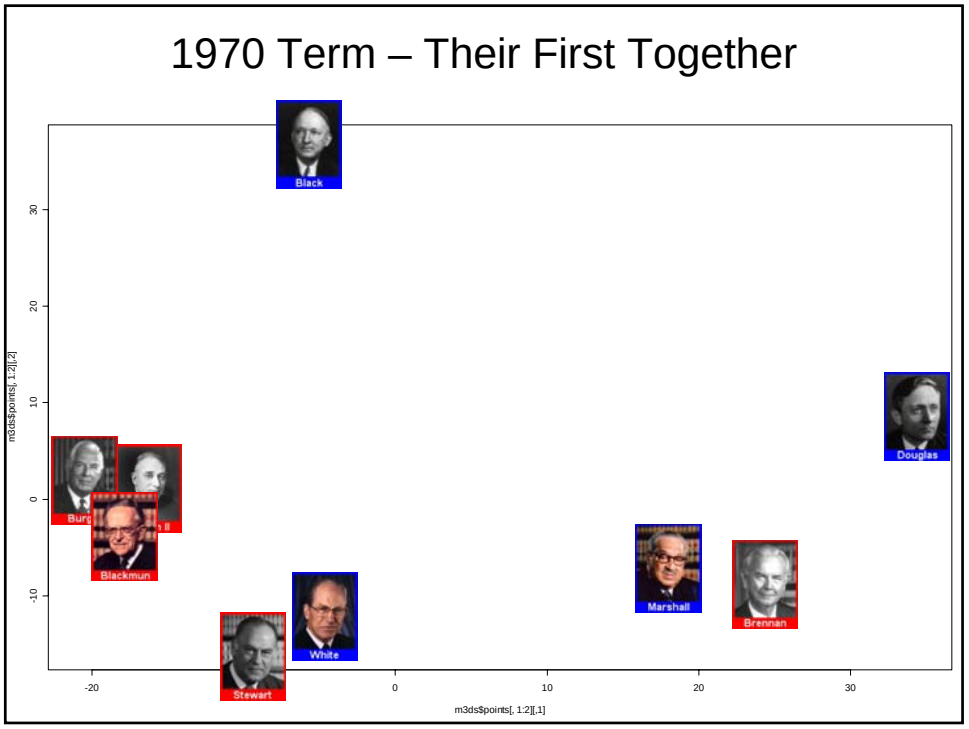




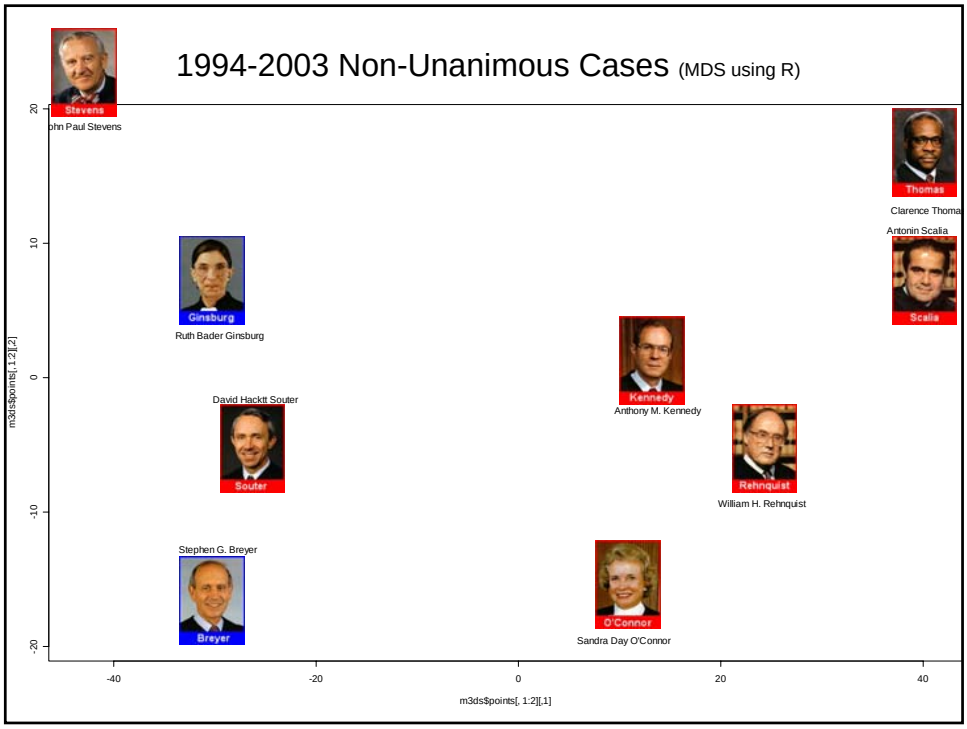
1985 Term – Their Last Together



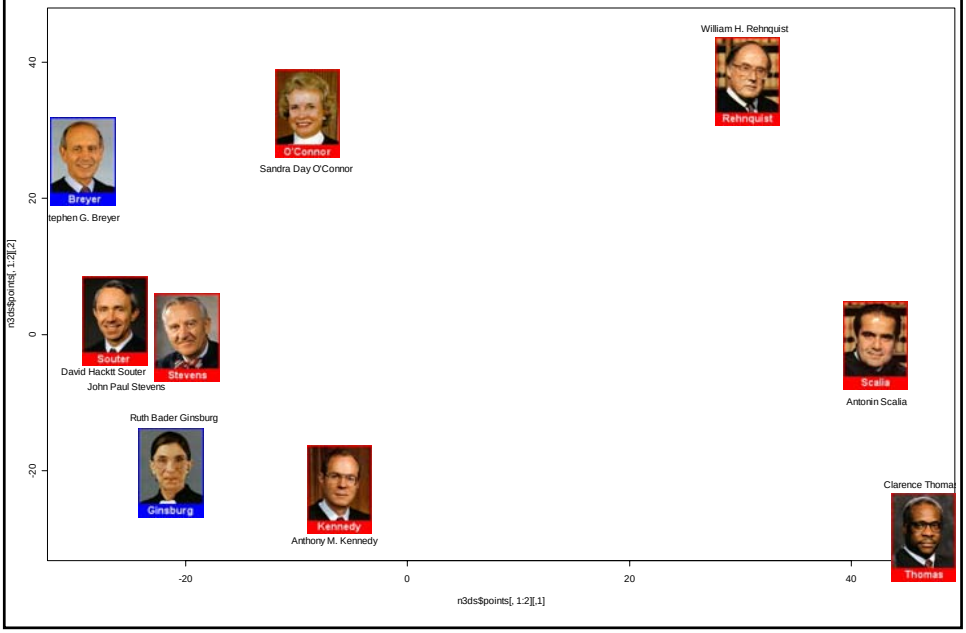
1970 Term – Their First Together



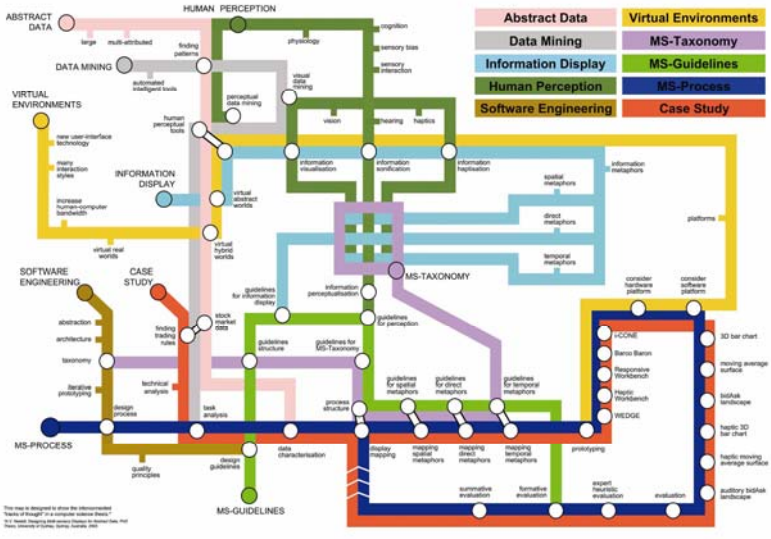
Aggregate vs. Specific Topics
(Potential for different spatial distributions)



1994-2003 Freedom of Speech Cases (MDS using R, O method)



2004



Intersecting threads of thought of Keith Nesbitt's doctoral dissertation.

Employing the metro map metaphor.

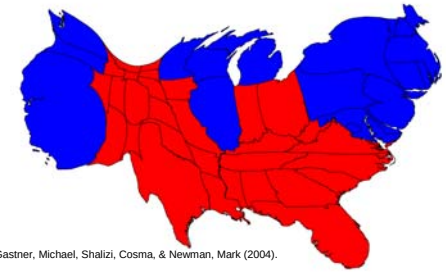
Nesbitt (2004). "Getting to more Abstract Places using the Metro Map Metaphor," IV'04, 8th International Conference on Information Visualisation London,2004.

DC BLOGS

- The DC Metro map became a navigational front end to D.C. related blogs.
- People self associated with stops both literally based on geography
- and metaphorically based on the reputation of the place.
- Alas, it died sometime during or after 2005.

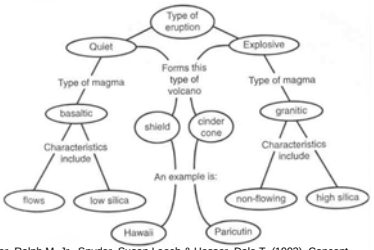
http://www.reenhead.com/map/metroblogmap.html

Thematic Map



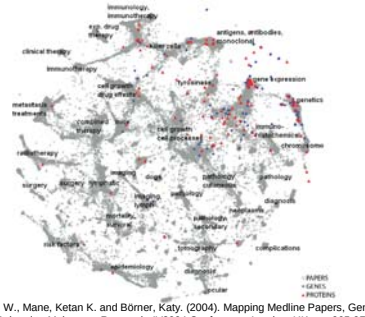
Gastner, Michael, Shalizi, Cosma, & Newman, Mark (2004).

Concept Map



Feather, Ralph M. Jr., Snyder, Susan Leach & Hesser, Dale T. (1993). Concept Mapping, workbook to accompany, Merrill Earth Science. Lake Forest, Illinois: Glencoe.

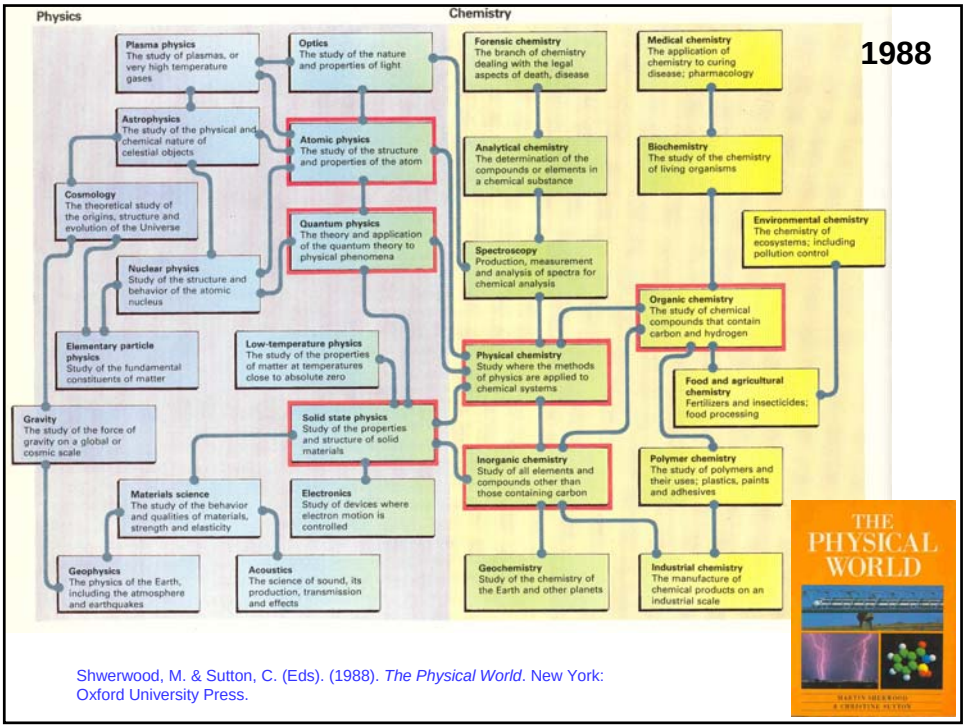
KDVs



Boyack, Kevin W., Mane, Ketan K. and Börner, Katy. (2004). Mapping Medline Papers, Genes, and Proteins Related to Melanoma Research. IV2004 Conference, London, UK, pp. 965-971

Metro Map Metaphor

Nesbitt, Keith V. (2004). Getting to more Abstract Places using the Metro Map Metaphor. (IV'04). IEEE.



Shwerwood, M. & Sutton, C. (Eds). (1988). *The Physical World*. New York: Oxford University Press.

Benefits of Domain Maps

- Provides a structure or scaffolding that students may use to organize the details of a particular subject.
- Information is better assimilated with the student's existing knowledge.
- Visualization enhances recall.
- Makes explicit the connections between conceptual subparts and how they are related to the whole.
- Helps to signal to the student which concepts are most important to learn.

Hook, Peter A. and Börner, Katy. (2005) Educational Knowledge Domain Visualizations: Tools to Navigate, Understand, and Internalize the Structure of Scholarly Knowledge and Expertise. In Amanda Spink and Charles Cole (eds.) New Directions in Cognitive Information Retrieval. Springer-Verlag.

Dual Coding Theory of Memory

- Humans store textual and visual information in different areas of the brain. (Paivio, 1987; Kulhavey & Stock, 1994).
- Visual/spatial images trigger memory of textual elements, and text triggers memory of images and locations.

Semantic Network Theory of Learning

- Human memory is organized into networks consisting of interlinked nodes.
- Nodes are concepts or individual words.
- The interlinking of nodes forms knowledge structures or schemas.
- Learning is the process of building new knowledge structures by acquiring new nodes.
- When learners form links between new and existing knowledge, the new knowledge is integrated and comprehended.

Jonassen, D. H., Beissner, K., & Yacci, M. (1993). Structural Knowledge: Techniques for Representing, Conveying, and Acquiring Structural Knowledge. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

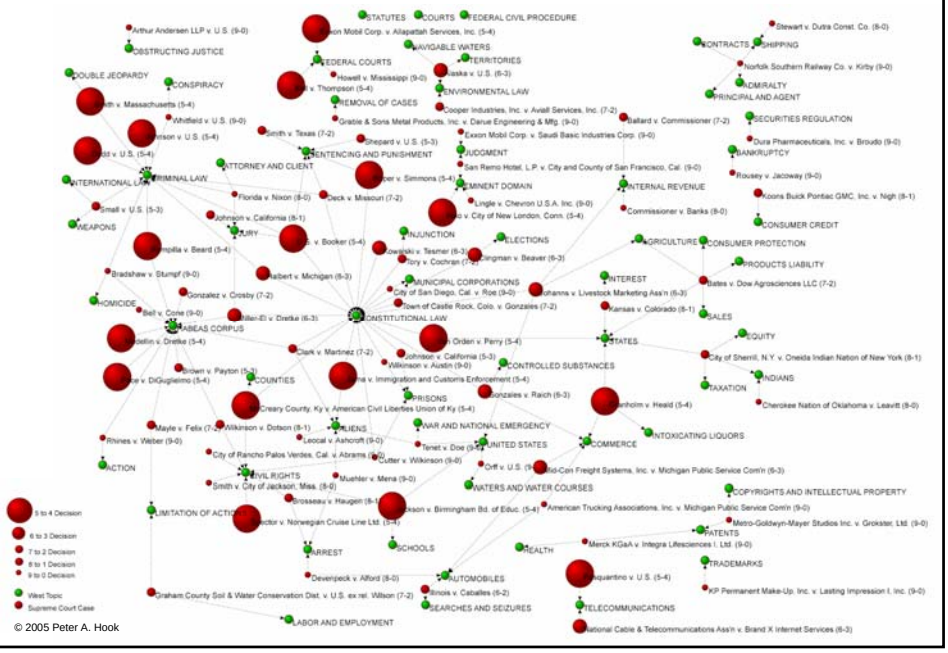
Neural Theory of Knowledge

- Associations between different sensory experiences result from consistent co-activation of different clusters of neurons.
- Eventually, these associations become fixed via the “recruitment of neural circuitry linking them.” In a similar process, abstract concepts also become linked.
- This gives rise to metaphors in which “highly structured neural ensembles in different regions of the brain” are associated together through repeated co-activation.
- All knowledge is built upon a series of ever more complex neural associations.

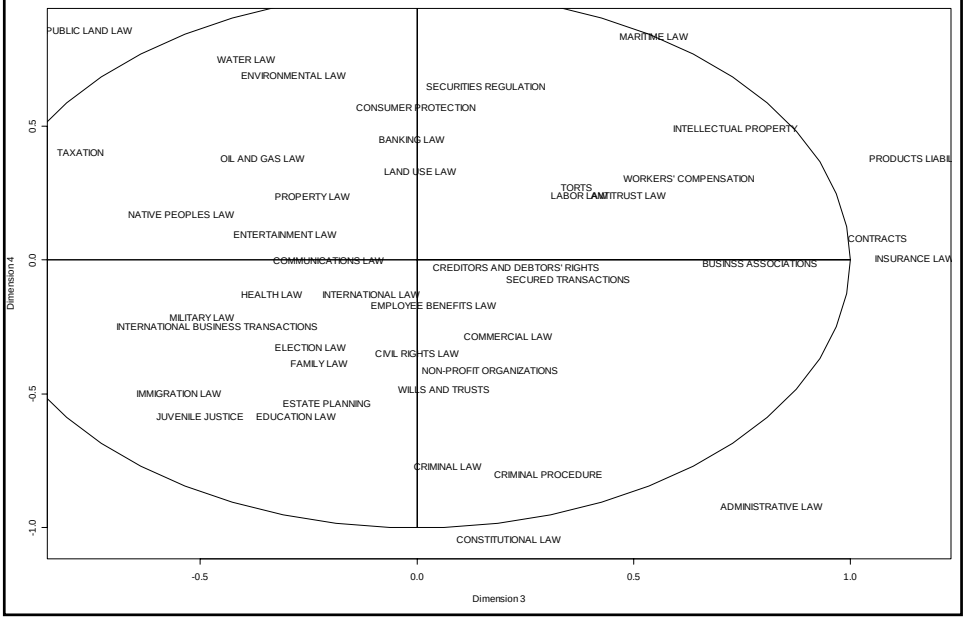
Lakoff, G., & Johnson, M. (2003 (1980)). Metaphors We Live By. Chicago: University of Chicago Press.

2004 Supreme Court Term West Topic Space

(Procedural Topics Removed)



PCA, Doctrinal Subjects Aggregated to Law School Course Offerings



THE END