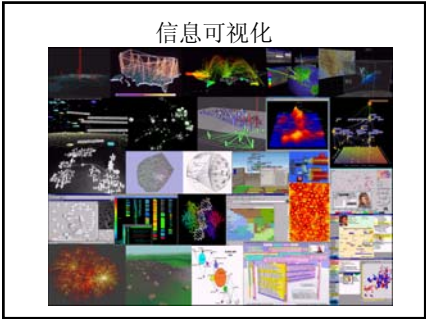
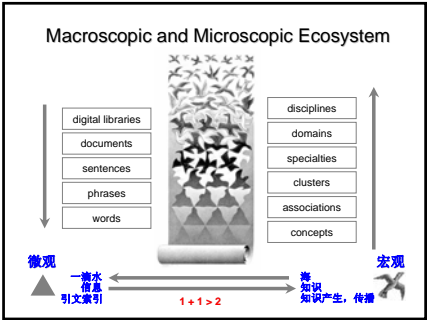


- 信息可视化
- 知识计量学
 - 宏观
 - 微观



地理位置的作用

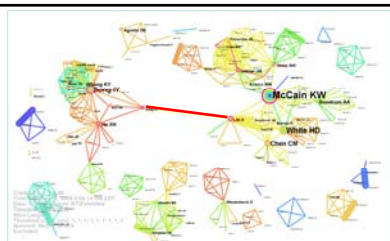
5 slides of copyrighted materials

抽象网络空间
社会网络的结构分析

7 slides of copyrighted materials

从微观到宏观的升华，跃迁

1 slide of copyrighted materials



Social Network of Coauthorship

引文索引和网络

7 slides of copyrighted materials

知识计量学：特征

- The Unit of Analysis = A knowledge domain (分析单元=知识领域)
 - The entirety of science as a complex, self-organized system
 - 学科整体作为一个复杂系统，自组织系统
 - A specialty of a scientific field, its growth and decay
 - 科学领域自身的消长
 - A prolonged scientific debate
 - 持续长久的科学争论，争议，对立学派。...
 - The impact of an external event on a field of research
 - 外部事件的影响
 - The diffusion of knowledge across disciplinary boundaries
 - 跨越学科的知识传播

知识计量学：背景

- Scientific revolutions (科学革命的结构) – Thomas Kuhn (1962)
- Collective intelligence (集体智慧) – Douglas Englebart
- Trailblazing through human knowledge (融会贯通人类知识) – Vannevar Bush (1945)
- Science of science (科学学) – Derek Price (1965)
- Citation index (引文索引) – Eugene Garfield (1965)
- Science mapping (科学图谱) – Henry Small (1974), Howard White (1980)

Our unit of analysis is a complex system

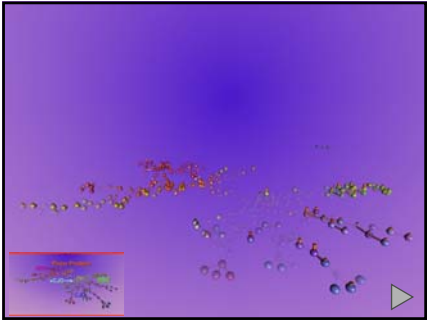
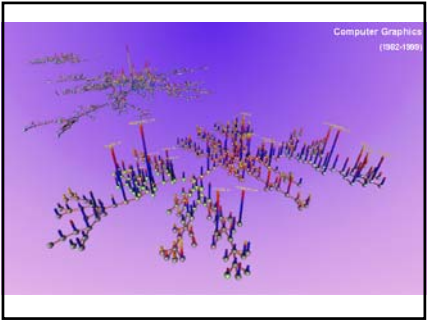
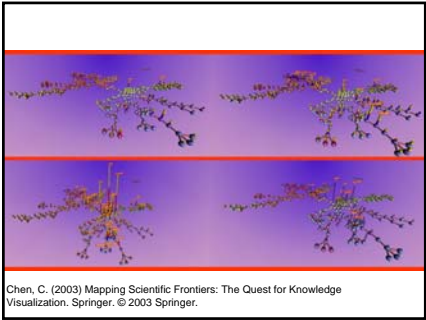
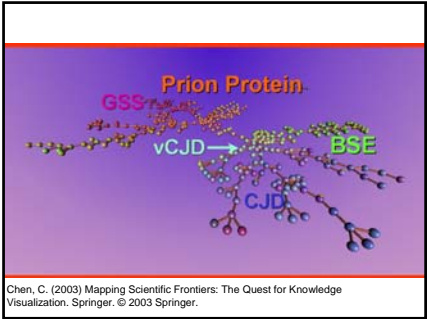
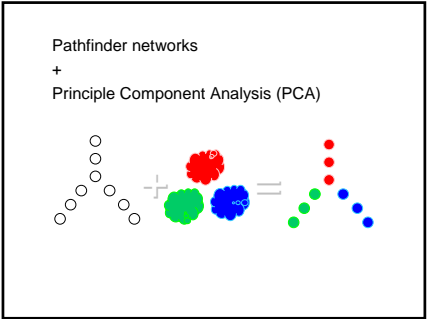
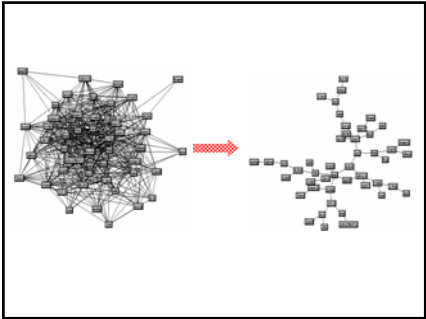
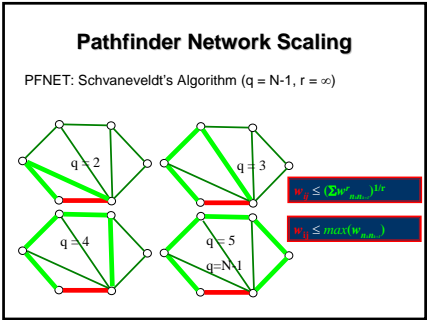
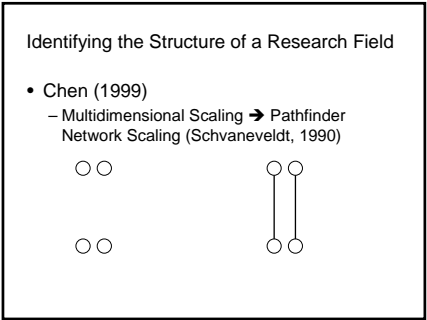
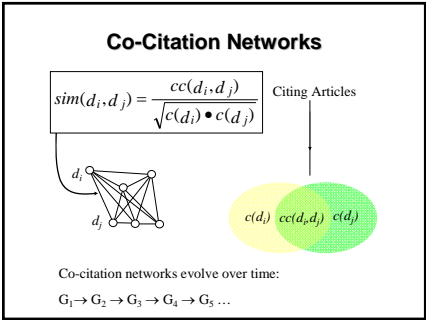
- | A complex system: | A knowledge domain: |
|--|--|
| – Emergence <i>stock market</i> | – Emergence <i>new paradigm</i> |
| – Open | – Open |
| – Self-organized criticality <i>sand piles</i> | – Self-organized criticality <i>paradigm shift</i> |
| – Dynamic | – Dynamic |
| – Nonlinear <i>butterfly effect</i> | – Nonlinear |
| – More than the sum of its components | – More than the sum of its components |
| – Blurred boundaries | – Blurred boundaries |

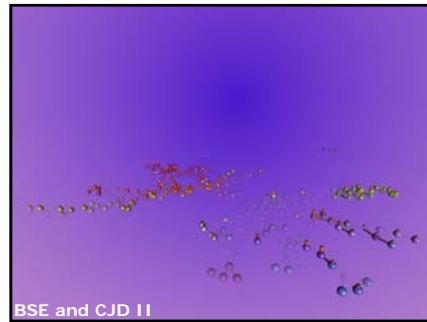
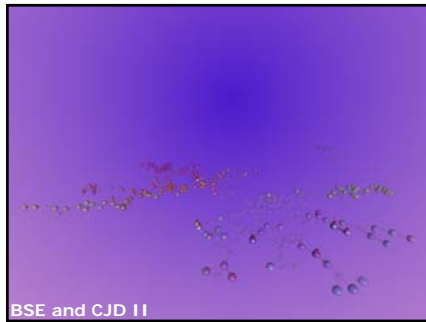
Identifying the **Perceived** Structure of a Research Field

确认一个领域在大家**眼里**心目中的结构

- White and McCain (1998)
 - Author Co-Citation Analysis (ACA)
 - 作者被共引分析
 - Visualizing the proximity of co-citation profiles
 - Pearson's $r \rightarrow$ Multidimensional Scaling (MDS)
 - Identifying specialties
 - Principle Component Analysis (PCA)

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Searching for Turning Points

寻找知识体系发展中的转折点

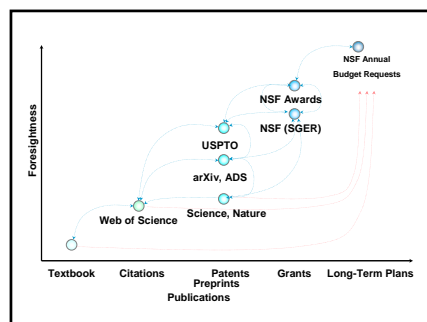
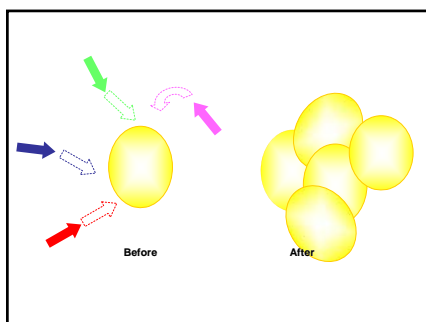
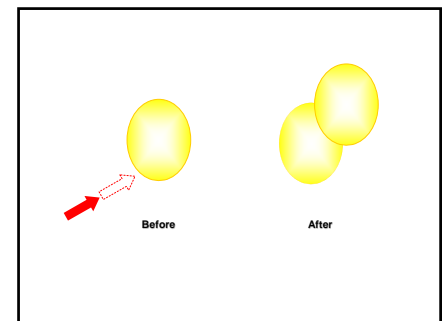
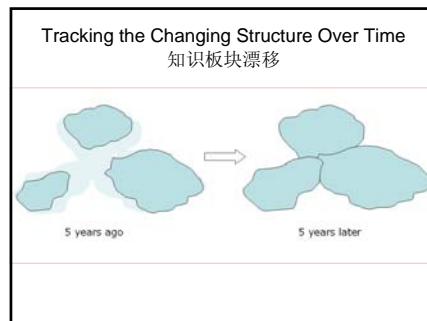
科学革命的结构

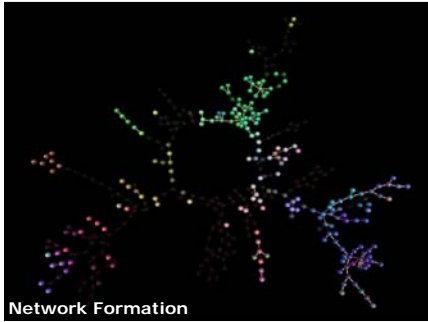
Thomas Kuhn
库恩

The Structure of Scientific Revolutions (1962)

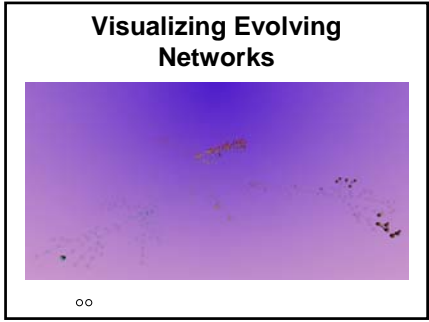
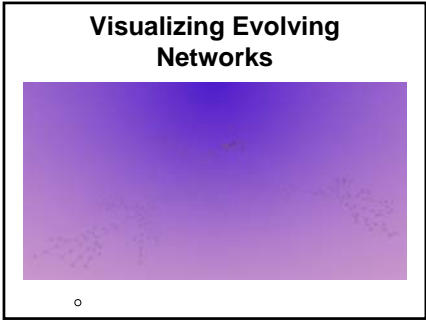
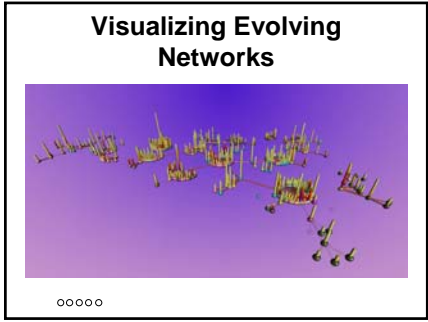
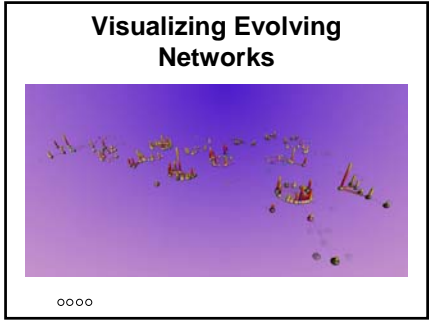
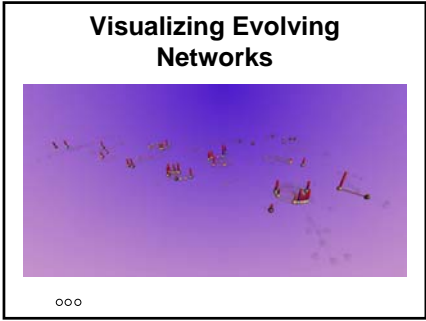
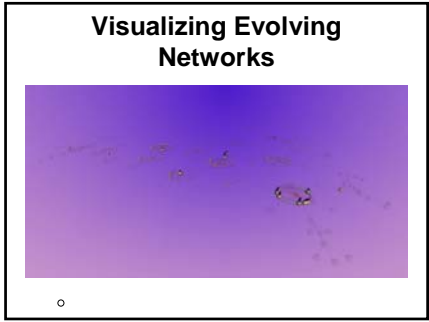
Paradigms = conceptual world-views, consisting of formal theories, classic experiments, and trusted methods.

... Normal Science → Crisis → Paradigm Shift → Normal Science ...

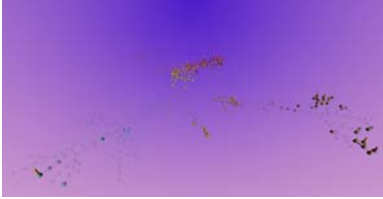




MST versus Pathfinder
最小生成树 与 Pathfinder

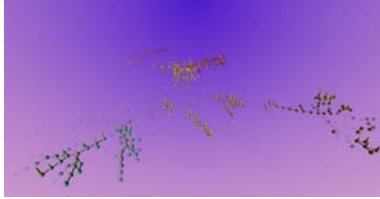


Visualizing Evolving Networks



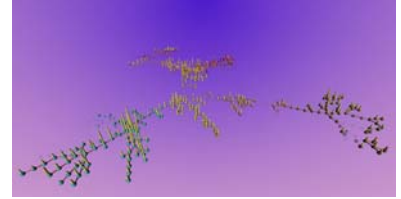
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Visualizing Evolving Networks



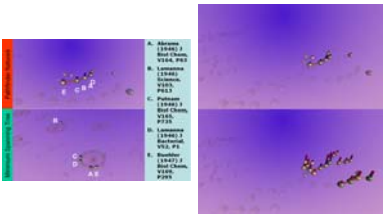
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Visualizing Evolving Networks



ooooo

PFNET reveals more accurate details



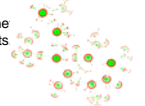
Two Criteria

- **Static**
 - 1) What are the preferred topological properties for network visualization?
- **Dynamic**
 - 2) What are the additional criteria for visualizing the evolution of a network?

Chen and Morris (2003) InfoVis'03.

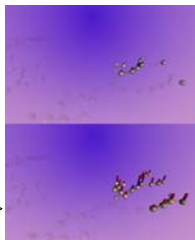
Criterion I: Topological Properties

- The presence of hubs and star-like patterns in a network.
- Why?
 - Efficient algorithms available, e.g. MST, BFS.
 - Such networks are easier to understand.
 - First, understand how super-nodes are connected.
 - Second, explore lower-level details.
 - In small-world networks, star-rich ne relatively high clustering coefficients



Criterion II: Dynamical Properties

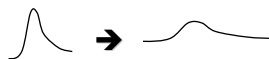
- The changes of topological properties over time must preserve the integrity of emergent trends or patterns.
- Why?
 - A stronger sense of progression.
 - More accurately match the chronological / historical sequence.



Animation Botox (1945-2003)
Animation BSE+CJD (1981-2001)

Tracking the Changing Structure Over Time

- Naturalistic views were the first logical step to delineate significant underlying intellectual turns.
- Paradigm shifts, such as superstring revolutions, did not lead themselves directly to sharp changes in the citation skyline, at least not clear-cut ones as we hoped.



Information Foraging and Sense Making
如何寻找热点?

Information Foraging Theory

策略：优化利润对成本的比例

- People adapt their search strategies to maximize their profitability, or the profit-investment ratio.
 - Profit: finding relevant information
 - Cost: time spent
- People may adapt their search by reconfiguring the information environment.

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Information Scent

- *Information scent* is the perception of the value, cost, or accessible path of information sources.

- # Information Scent
- *Information scent* is the perception of the value, cost, or accessible path of information sources.

Information Foraging at Macroscopic Levels through Information Networks



GALEA S, 2002, NEW ENGL J MED ...
NORTH CS, 1999, JAMA-J AM MED ASSOC ...

FRYKBERG ER, 1988, ANN SURG
COOPER GJ, 1983, J TRAUMA ...

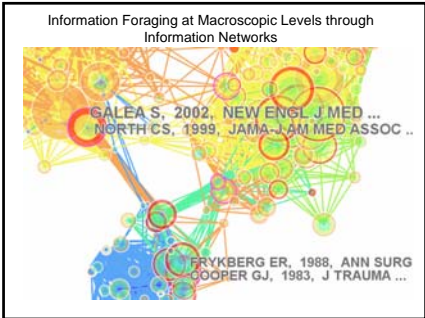
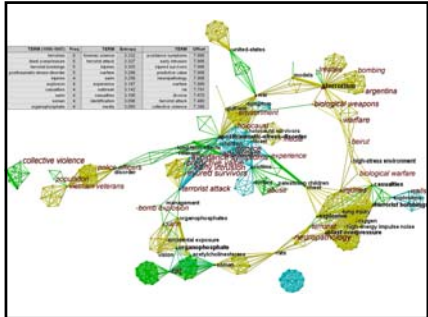
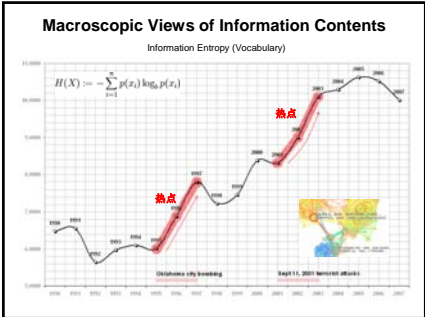


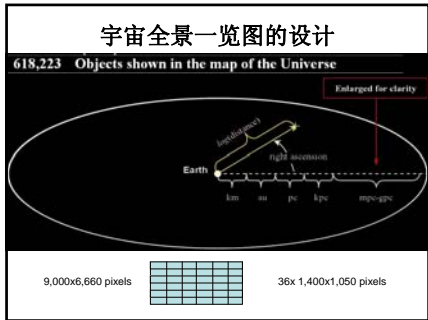
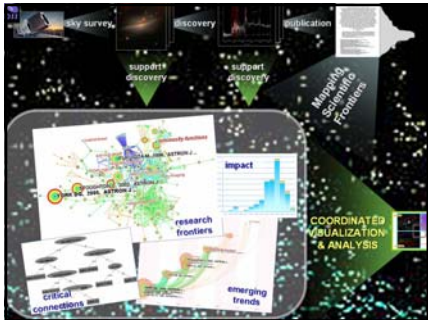
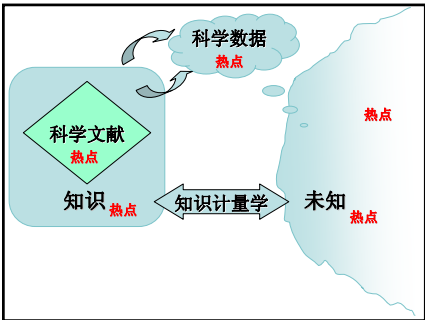
Figure 1: Macroscopic Views of Information Contents. The figure consists of two parts. The top part is a line graph showing 'Information Entropy (Vocabulary)' on the y-axis (ranging from 0.0000 to 10.0000) against years on the x-axis (from 2010 to 2017). The graph shows a fluctuating upward trend with a red shaded area representing a confidence interval. Two points are labeled '热点' (Hot Spot) in red: one around 2012 and another around 2014. The bottom part is a map of China with a red dot indicating the location of Chongqing, labeled 'Chongqing city breeding'.

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寻找科学研究和应用中的热点：
宇宙的起源：
宇宙全景图和知识前沿热点图



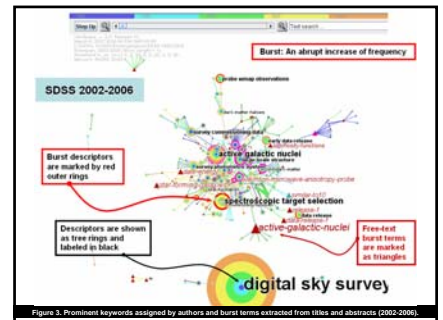
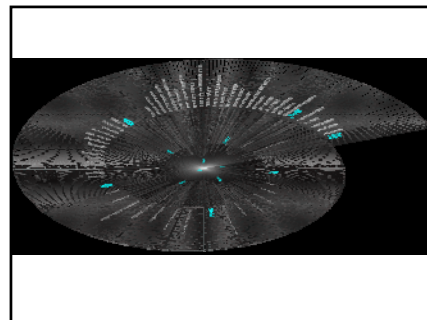
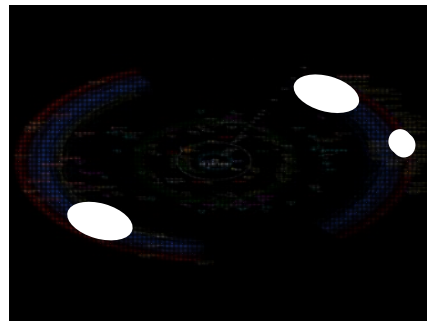
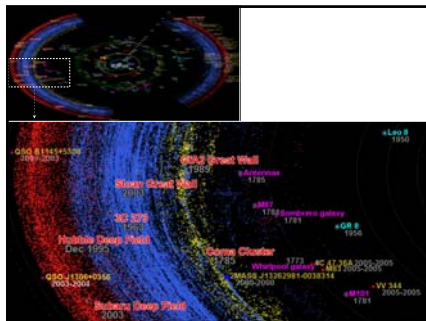
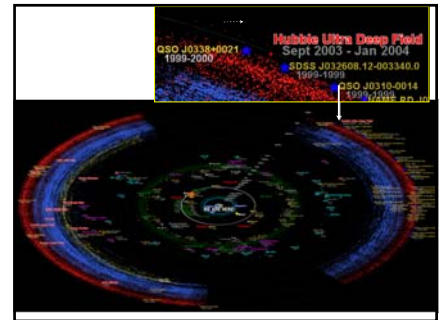
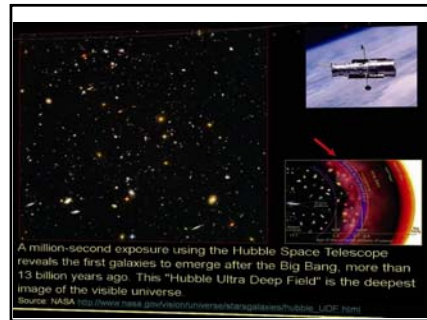
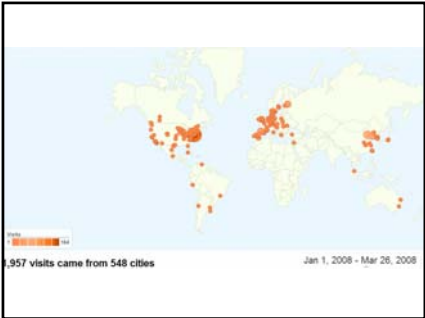
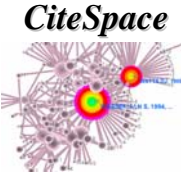
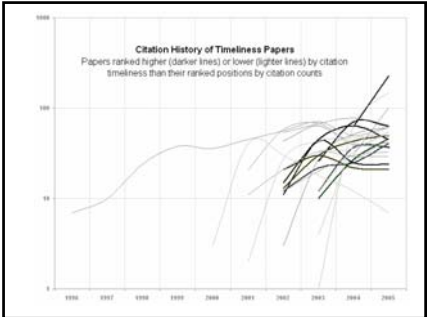
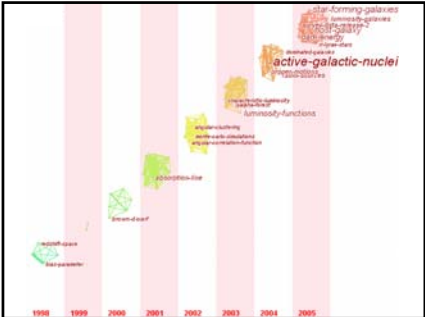
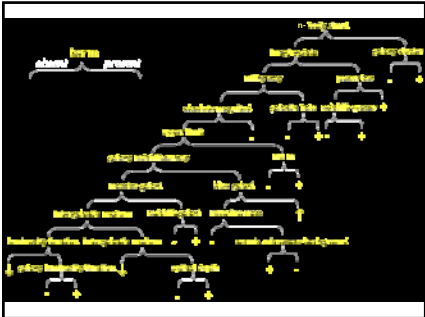
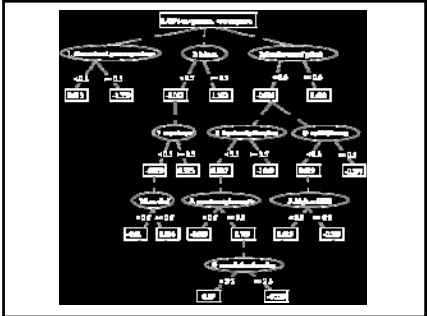
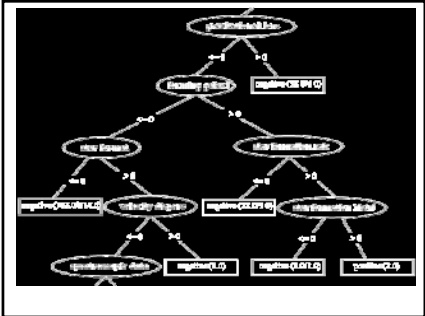


Figure 3. Prominent keywords assigned by authors and burst terms extracted from titles and abstracts (2002-2006).

宏观现象的微观解释



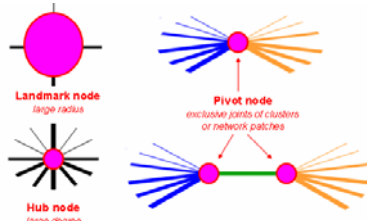
1,957 visits came from 49 countries/territories

Country/Territory	Visits	Visits/Day	Avg. Time on Site	Visits/Day
1. United States	634	2.02	00:02:19	00:02:19
2. China	102	2.71	00:03:29	00:03:29
3. Spain	102	3.13	00:04:40	00:04:40
4. Germany	102	2.67	00:04:40	00:04:40
5. United Kingdom	98	2.67	00:03:02	00:03:02
6. Canada	94	2.17	00:02:28	00:02:28
7. France	48	1.64	00:03:08	00:03:08
8. Japan	36	1.75	00:02:16	00:02:16
9. South Korea	36	3.12	00:04:08	00:04:08
10. Sweden	32	2.45	00:02:26	00:02:26

Usage in China and Western Europe

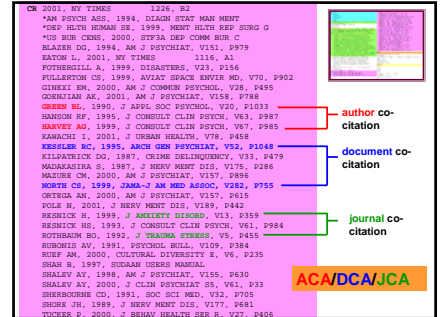
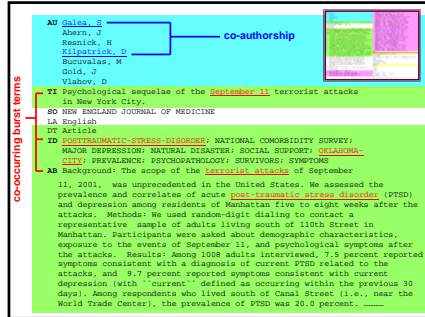
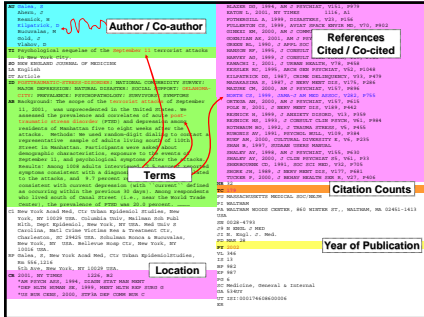
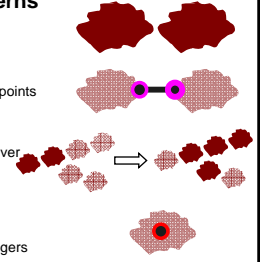


CiteSpace



Expected Patterns

- Thematic grouping
- Intellectual turning points
- Thematic change over time
- Abrupt changes associated with triggers



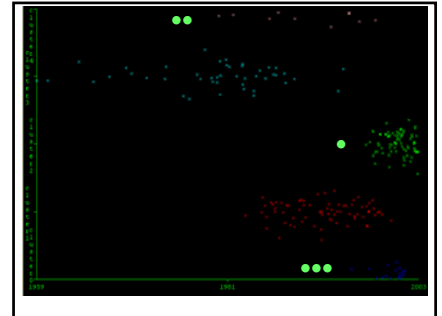
Importance

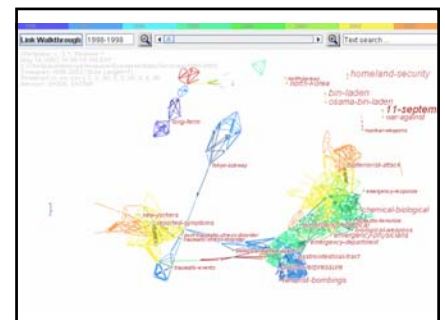
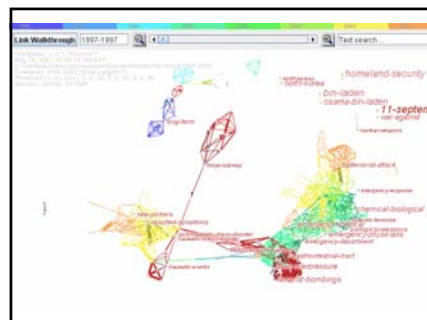
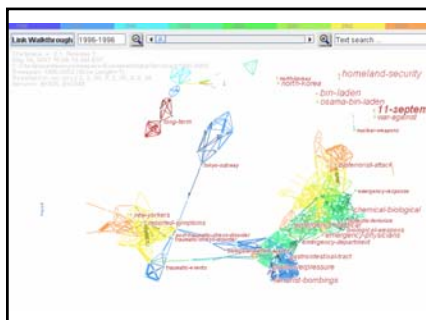
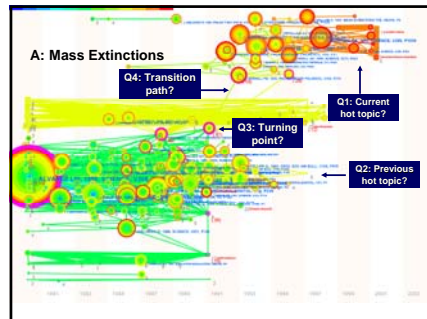
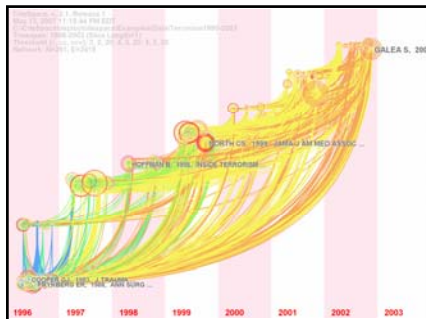
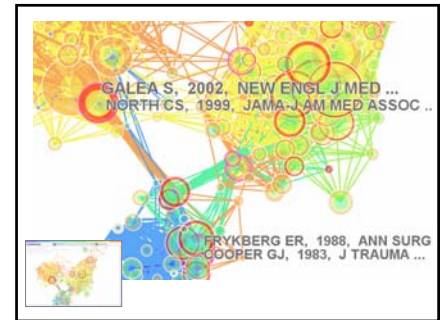
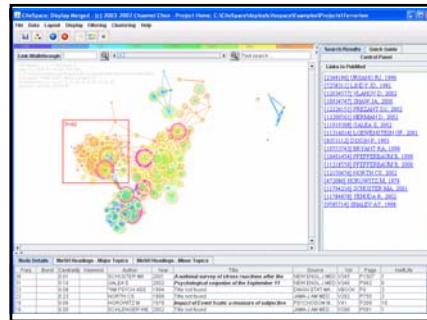
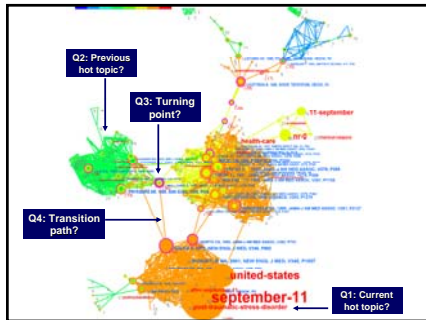
- Citation: Highly cited ↑
- Centrality: Strategically located ↑
- More recent: Publication age ↓
- Rapid growth => Short Cited_By Half-Life ↓

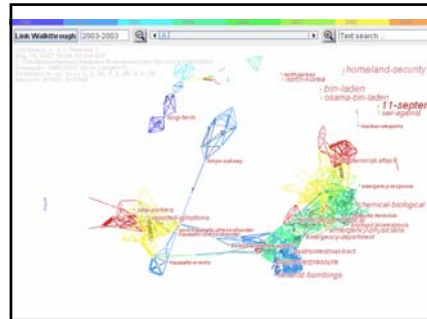
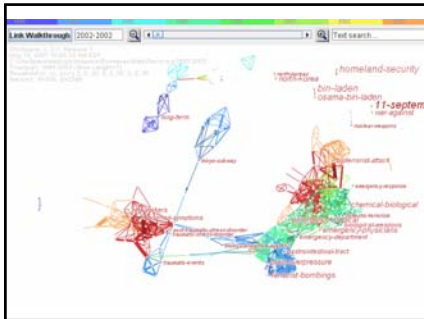
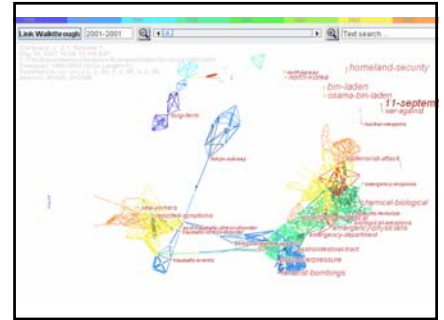
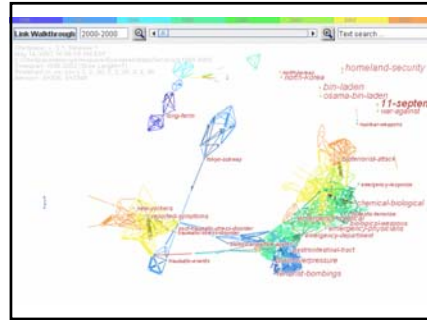
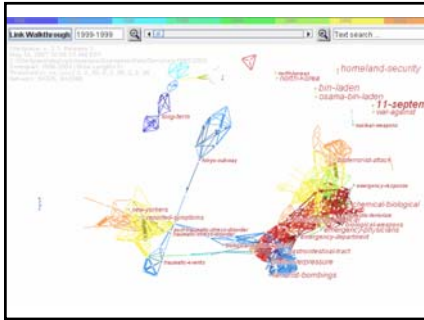
$$\text{Importance} = \frac{k \cdot \text{BC} \cdot \text{Citation}}{\text{Age} \cdot \text{HL}}$$

Social Network Analysis (1992-2004)

Cluster	Instances	%	Prior Prob	Citation	Centrality	Year	H-L	Importance
0	17	8%	0.0765	24.41	0.0255	1999.76	1.43	10.3064
1	75	33%	0.3359	9.89	0.0005	1991.86	7.06	0.0009
2	77	34%	0.3446	7.22	0	2000.66	2.01	0.0108
3	45	20%	0.1898	17.21	0.0023	1978.34	18.67	0.0086
4	10	4%	0.0533	44.44	0.0753	1989.31	5.57	4.0951



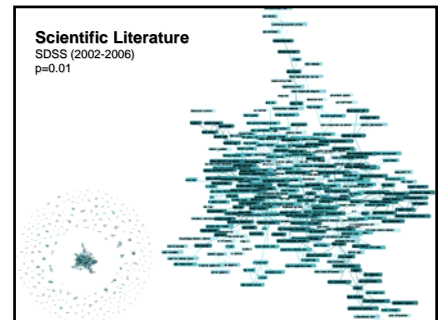
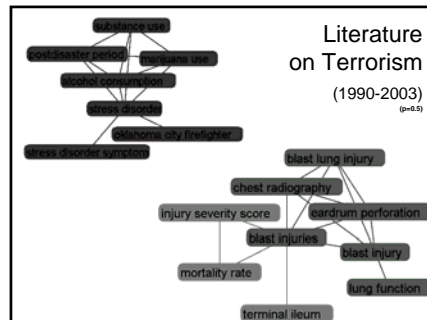




Selecting Groups of Terms
如何自动提取概念群

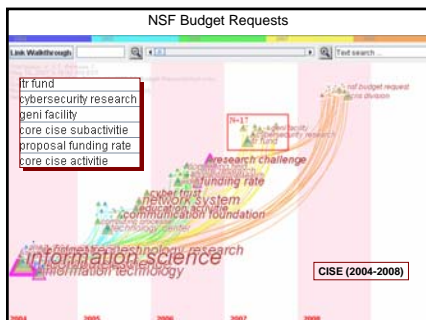
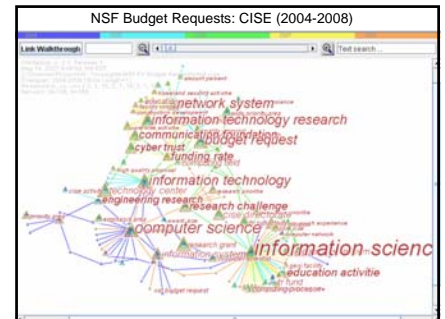
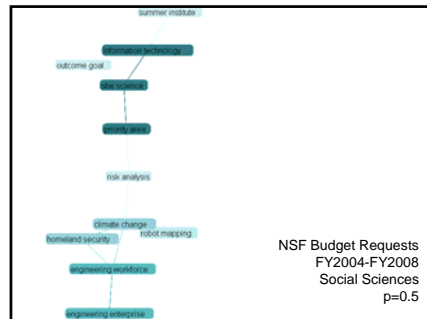
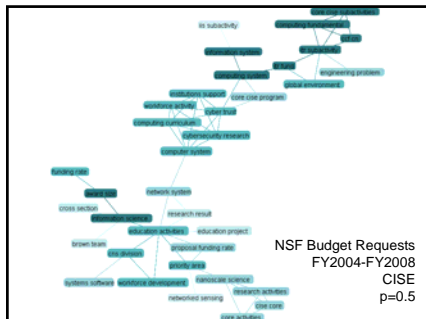
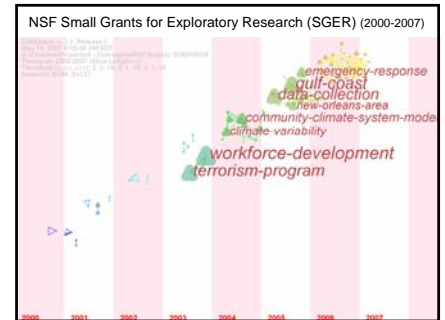
Scientific Literature: Terrorism Research (2002)

care physician	family physician	13.9428
child abuse	vulgar language humiliation	13.9428
marijuana use	postdisaster period	13.9428
soviet union	us policy	13.9428
learning activities	reading assignment	13.9377
bioterrorism preparedness	care physician	11.1774
bioterrorism preparedness	family physician	11.1774
alcohol consumption	marijuana use	11.1723
alcohol consumption	postdisaster period	11.1723
cold war	soviet union	10.1208
sdss war	us policy	10.1208
bioterrorism preparedness	bioterrorist attack	8.4152
distress level	new york	8.4101
alcohol consumption	substance use	8.4050
marijuana use	stress disorder	8.2167
postdisaster period	stress disorder	8.2167
oklahoma city firefighter	stress disorder	8.2165
missile diplomacy	north korea	7.9147
distress level	new york city	6.2041
alcohol consumption	stress disorder	5.4767

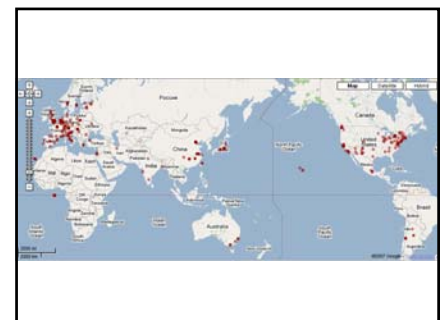


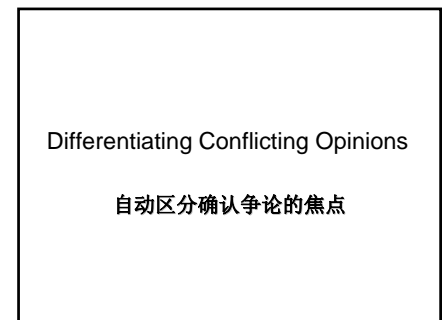
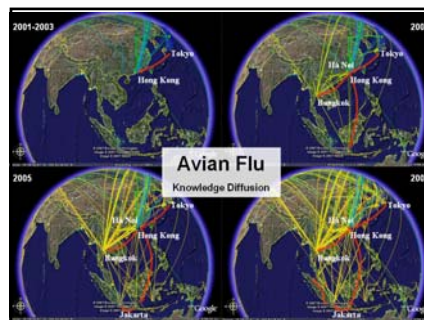
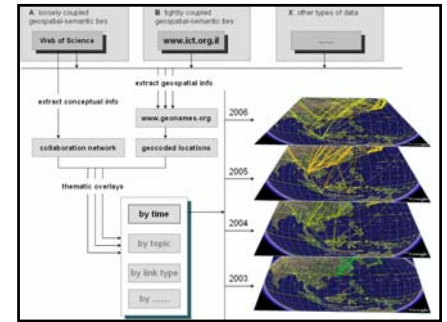
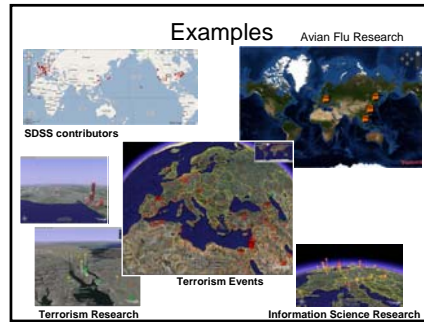
term	weight	begin	end
horizontal-karim	45.5661	2005	2005
information-system	13.7274	2002	2002
workforce-development	12.6672	2003	2004
labor-penchant	12.4674	2005	2005
science-fiction	12.1519	2006	2006
terrorism-program	10.8114	2003	2004
terror-network	10.5676	2004	2004
world-trade-center	10.4572	2001	2002
horizontal-karim	9.4759	2005	2005
place-call	8.8311	2003	2004
arms-urge	8.4602	2005	2005
engineering-education	8.1027	2003	2003
community-climate-system-model	7.9405	2004	2004
fluid-water	7.8815	2005	2005
stable-carbon-isotope-composition	7.1402	2002	2002
form-zone	7.1402	2002	2002
oil-fault	6.9709	2005	2005
space-weather	6.6122	2001	2002
climate-model	6.4192	2004	2004
gulf-coast	6.2953	2005	2005
geophysical-fluid-dynamics-laboratory	6.0176	2004	2004
pollard-institute	6.0176	2004	2004

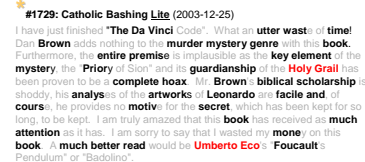
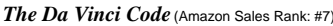
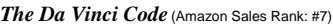
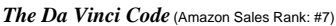
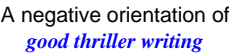
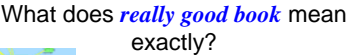
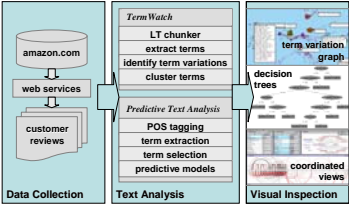
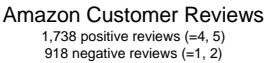
computing curriculum	cybersecurity research	10.89
computing curriculum	institutions support	10.89
computing curriculum	workforce activity	10.89
cybersecurity research	cybersecurity research	10.89
cybersecurity research	institutions support	10.89
institutions support	workforce activity	10.89
image processing algorithm	math science	10.87
cns division	workforce development	8.15
computer system	computing curriculum	8.15
computer system	cybersecurity research	8.15
computer system	institutions support	8.15
computer system	workforce activity	8.15
global environment	lir subactivity	7.12
education activities	priority area	7.09
computer science	data source	6.42
	cybersecurity research	6.42
	institutions support	6.42
	cyber trust	6.42
	workforce activity	6.42
	cyber trust	6.42
	lir fund	6.42

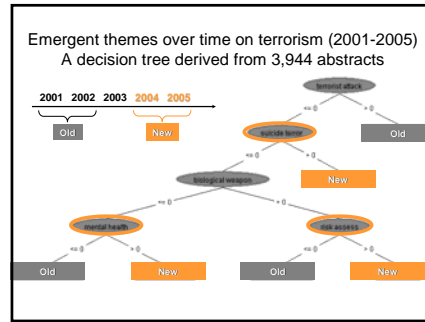
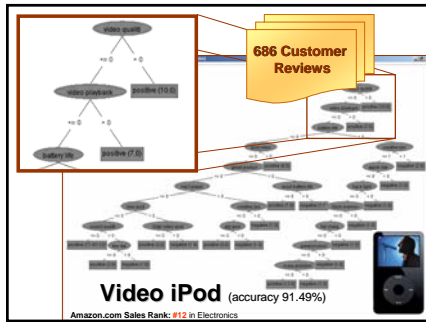


Accommodating Conceptual and Geospatial Views
重返地理空间: +概念空间









结束语

- 知识计量学同时具有宏观与微观的内涵
- 知识计量学是把知识发现和创造推进到实际运用中的关键
- 信息可视化, 数据挖掘, 自然语言处理, . . . , 是达到这一目的的手段

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SEI: Coordinated Visualization and Analysis of Sky Survey Data and Astronomical Literature

National Visualization and Analytics Center (NVAC)
Northeast Visualization and Analytics Center (NEVAC)

North-East Visualization and Analytics Center
www.nvasei.org

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