Nano Social Science: An Emerging Specialization?

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Outline

- Approach and Methods: Georgia Tech Nano Data Mining

- Nano in the Social Sciences: Networks & Trends

- Nano in the Social Sciences:
  Citation Pattern Overlay Mapping

Roots

- Georgia Tech nano data compilation & explorations
  - Supporting NSF projects: CNS-ASU and Nano PFI, NC State
- CNS-ASU is the Center for Nano in Society hosted by Arizona State University
- Related NSF project at Georgia Tech(Richard Barke) focuses on the interchange of key ideas regarding active nanostructures among science, science fiction, and policy communities
- We seek to answer:
  - Who, What, Where & When? questions about the evolution of nano R&D
- In support of CNS explorations of alternative futures and "Real Time Technology Assessment"

Nano Societal Initiatives

- The 21st Century Nanotechnology Research and Development Act (P.L. 108-153) of **2003**
  - A mission to integrate societal concerns into nano R&D
  - Requires Nano research centers (NSECs) to address societal implications
- FY 2009 National Nanotechnology Initiative (NNI) allocates 2.7% to societal and educational concerns
- NSF has created two NSECs focused on societal issues
  - CNS-ASU
  - CNS-UCSB
  - Also, Nanoscale interdisciplinary research teams supported: Univ of South Carolina, Michigan State Univ, Harvard, UCLA
- European Union's Sixth Framework Programme initiated support for research into the societal dimensions of nano

Nanotechnology Science & Engineering (NS&E) Publication Trend

Georgia Tech nano dataset based on Science Citation Index –
508,000 articles for 1991-2007

Nano S&E Research Articles 1991-2007
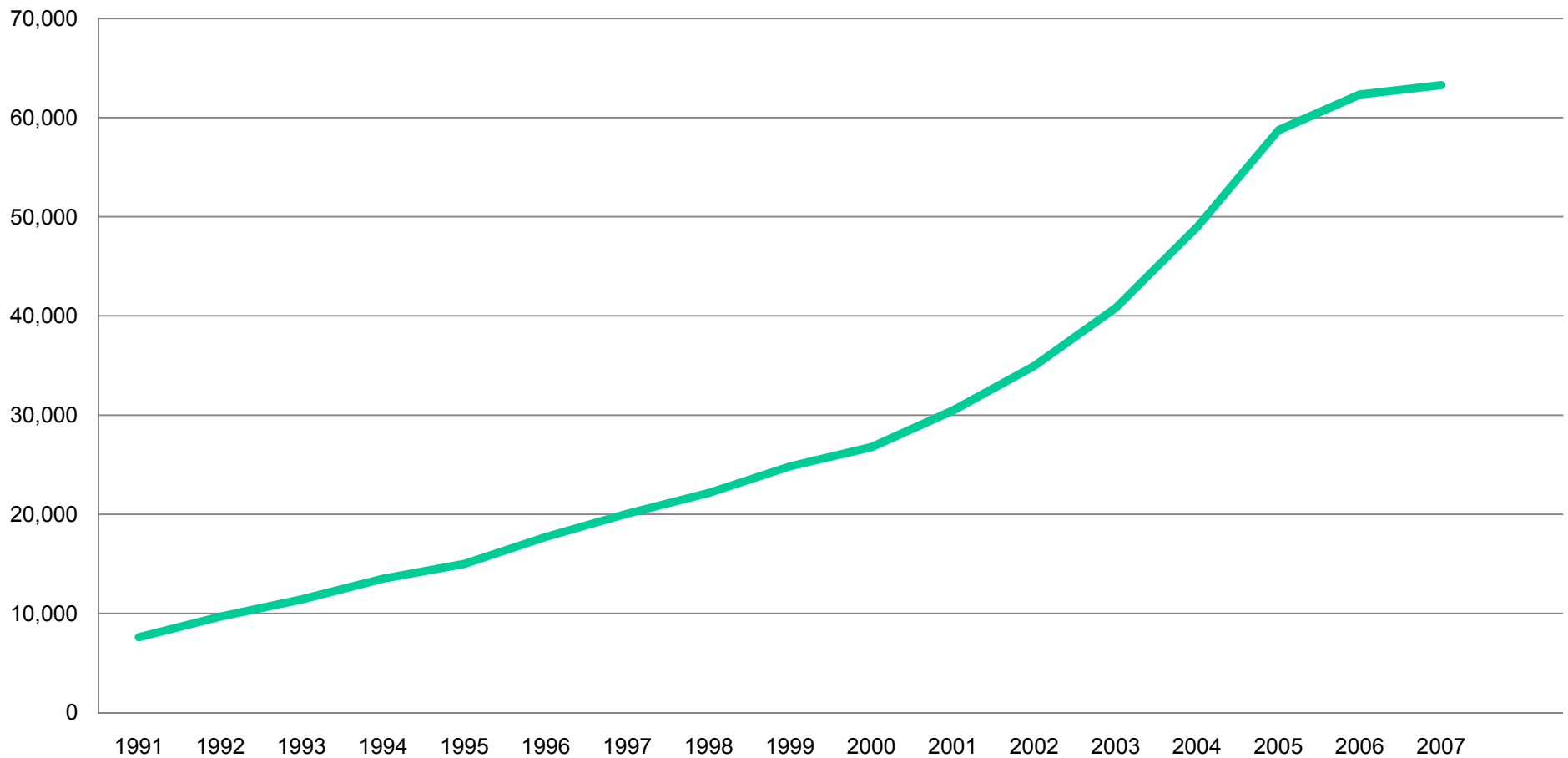
Nano in the Social Sciences

- Observers of NS&E have posited that it is -- or is not -- a convergent research domain
[we believe that it is "cohering" piecewise]
- This prompts an inquiry into the nature of the social sciences communit(ies) exploring nano. In particular, our central research question:
- Is social science research building a self-influential body of work concerning nano?
- We hypothesized that the early social science work would draw on
  - General (not nano-focused) social science
  - NS&E "science"
  - Nano-focused science fiction

Data

- Searches in Web of Science on the Social Science Citation Index and Arts and Humanities Citation Index (SSCI/AHCI)
- Search strategy: "nano*" in topic-related terms
  - Enhanced modestly with related terms (e.g., quantum, molecular motor/engineering, self-assembly)
  - Yielding 540 items
  - Reduced by our NS&E search "exclusion terms" and additionally inappropriate social science terms (e.g., "Nanook of the North," nano in archeological or art uses)
  - Retained only journal articles (removing largely editorials, book reviews, and news or meeting announcements)
  - Yielding ~330 articles

More Data

- Search in the Scopus database
- Search strategy: "nano*" AND social sciences
    - Yielded 6206 items, but review mandated winnowing to eliminate non-articles (~20%) and NS&E content
    - Limited to 4 subjects: business, management & accounting (393); arts and humanities (292); social sciences (130); and economics, econometrics & finance (39).
    - Reduced by suitable "exclusion terms"
    - Retained 215 articles
- Moved to combine SSCI/AHCI and Scopus articles
    - Removed duplicates
    - Individually checked items for salience
    - Yielding 307 articles (~2/3 from SSCI/AHCI)
- [Also explored Google Scholar – but set aside]

Tools

- VantagePoint "text mining" functions
  - Data consolidation [fuzzy matching; thesauri]
  - Journal-to-Subject Category thesaurus [evolving; based on 30261 article set from 6 weekly USA-authored samples in WOS]
  - Co-author social network maps & Cross-correlation author maps based on shared term usage
- Pajek maps
- ~244 Subject Categories (SCs), including social sciences & humanities [Rafols & Porter]
- We have derived 21 (14) "macro-disciplines"
  - Principal Components Analyses (PCA) based

Results: Nano in the Social Sciences

- A small, but **accelerating**, literature
  - The 307 articles are published 1982 - 2007 (2007 incomplete; only 3 prior to 1991)
  - 24 in the 1990's
  - 70 from 2000-04
  - 210 from 2005-07
- The US dominates
  - 46% US (vs. 24% by the US in NS&E literature)
  - 15% UK
  - All others <10% each (including China at 2.4%)

Results (cont.)

- Most frequent Keywords
  - science, technology, nanoscience, ethics, patterns, innovation, biotechnology, future, collaboration, emergent technology, indicator, and interdisciplinary
- Most frequent Subject Categories (SSCI/AHCI only)
  - Information Science & Library Science; Computer Science, Interdisciplinary Applications; Multidisciplinary Sciences; Planning & Development; Ethics

Most Cited Other Publications by Nano-Social Science Articles

Engines of Creation: The Coming Era of Nanotechnology.	Drexler, K.E.	Anchor Books	1986	45
Nanoscience and nanotechnologies: opportunities and uncertainties	Royal Society	UK	2004	30
Why the Future Doesn't Need Us	Joy, B.	Wired	2000	26
Converging Technologies for Improving Human Performance	Roco, M and Bainbridge, WS	J Nanoparticle Research, Springer	2002+	24
Societal Implications of Nanoscience and Nanotechnology.	Roco, M and Bainbridge, WS	Springer	2001	21

Most Cited Articles by Nano-Social Science Articles

Does science push technology? Patents citing scientific literature	Meyer, M	Research Policy	2000	55
Patent citations in a novel field of technology - What can they tell about interactions between emerging communities of science and technology	Meyer, M	Scientometrics	2000	22
Multidisciplinarity, interdisciplinarity, and patterns of research collaboration in nanoscience and nanotechnology	Schummer, J	Scientometrics	2004	22
Nanotechnology - Interdisciplinarity, patterns of collaboration and differences in application	Persson, O; Meyer, M	Scientometrics	1998	21
Nanoscience and nanotechnology on the balance	Braun, T; Schubert, A; Zsindely, S	Scientometrics	1997	20

Nano in the Social Sciences:
Most Cited Authors in 307 papers

Cited Authors	# Records	# Instances
ROCO MC	71	111
DREXLER KE	62	116
Schummer, J.	31	46
Meyer, M.	30	92
Smalley, R.E.	25	34
Joy, B.	24	25
Braun, T.	22	26
BAINBRIDGE WS	21	59
Feynman, R.	21	24
Cobb, M.	20	26
Malsch, I.	20	27
Rip, A.	20	36
Kurzweil, R.	19	27
Mnyusiwalla, A.	19	19
Gaskell, G.	18	29
CRICHTON M	17	18
Hullman, A.	17	17
Latour, B.	17	24
Nordmann, A.	17	24
ARNALL AH	16	17
Leydesdoff, L.	16	68
Nelson, R.	16	19
Freitas, R.	15	22
MacOubrie, J.	15	19
PORTER AL	15	21
Whiteside, G.	15	15

8 Dimensions of the highly cited Authors (Judgmental!)

- **Technology trajectories and implications**: with M.C Roco as a centrally-cited author in the nanoscience citation space.

- **Governance**: Nordmann, A.; Jones, R.; Renn, O.; Wood, S.; MacNaghten, P.; Wilsdon, J.; Berube, D.; Wynne, B.

- **Public perception and deliberation**: Bainbridge WS; Cobb, M.; Gaskell, G.; Arnall AH; Macoubrie, J.; Etc Group; Lewenstein BV; Slovic, P.; Priest, S.

- **Ethics**: Kurzweil, R.; Mnyusiwalla, A.; Daar, A.S.; Singer, P.A.; Altmann, J.

- **Science and technology (S&T) studies**: Latour, B; Brown, N.; Jasanoff, S.

- **Science visions**: Drexler KE; Smalley, R.E.; Joy, B.; Feynman, R.; Crichton M; Freitas, R.; Whiteside, G.; Baum, R.; Crandall BC; Service, R.

- **Science mapping**: Schummer, J.; Meyer, M.; Braun, T.; Malsch, I.; Rip, A.; Hullman, A.; Leydesdoff, L.; Porter AL; Kostoff, R.; Darby, M.; Narin, F.; Callon, M.; Gibbons, M.; Bachmann, G.; Tijssen, R.; Zucker, LG; Hicks, D.; Noyons, CM; Price, DJD; Schmoch, U.; Zitt, M.

- **Evolutionary economics**: Nelson, R.; Dosi, G.; Pavitt, K.; Rosenberg, N.

Co-citation Map of the most cited authors by the 307 nano social science papers

Ethics

Perception

Governance

Visions

Science Mapping

Evolutionary Economics

LEWENSTEIN BV
Gaskell, G.
Cobb, M.
Slovic, P.
MacOubrie, J.
BAINBRIDGE WS
Daar, A.S.
Singer, P.A.
Mnyusiwalla, A.
ARNALL AH
Renn, O.
Wilsdon, J.
Nordmann, A.
MacNaghten, P.
ROCO MC
Jones, R.
Wood, S.
Kurzweil, R.
CRICHTON M
Joy, B.
DREXLER KE
Whiteside, G.
Smalley, R.E.
Freitas, R.
Kostoff, R.
PORTER AL
Hullman, A.
Schummer, J.
Rip, A.
Feynman, R.
Latour, B.
ZUCKER LG
Darby, M.
Braun, T.
Malsch, I.
Meyer, M.
Gibbons, M.
Callon, M.
Leydesdoff, L.
Rosenberg, N.
Nelson, R.
Tijssen, R.
Pavitt, K.
Bachmann, G.
Dosi, G.

Nano Emphases over Time:
"Science Visions" dominated the early literature;
Social science facets are on the rise
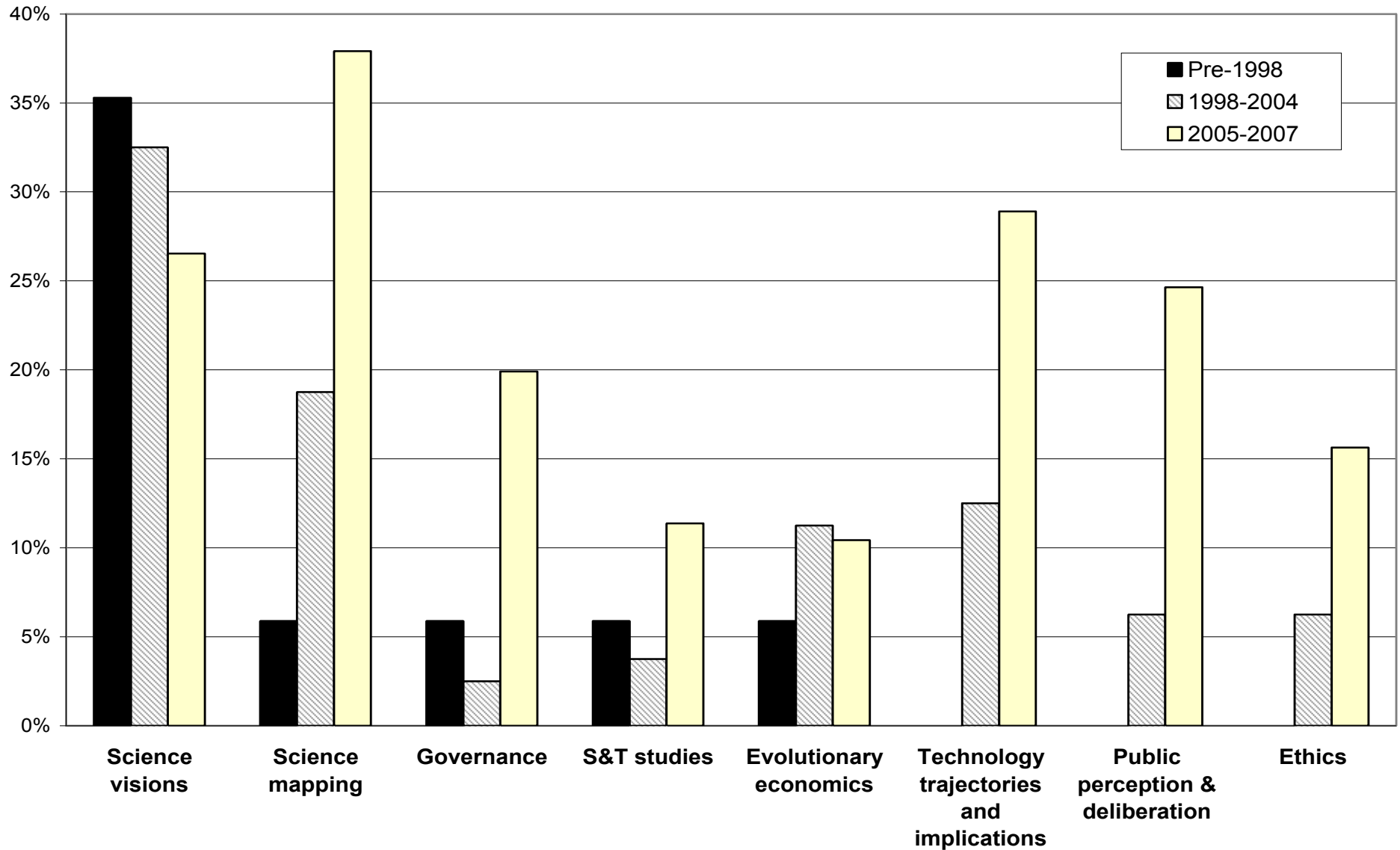
Another Perspective: Cited Subject Categories

- Suggests that the Nano in Social Sciences research community is developing its own knowledge core
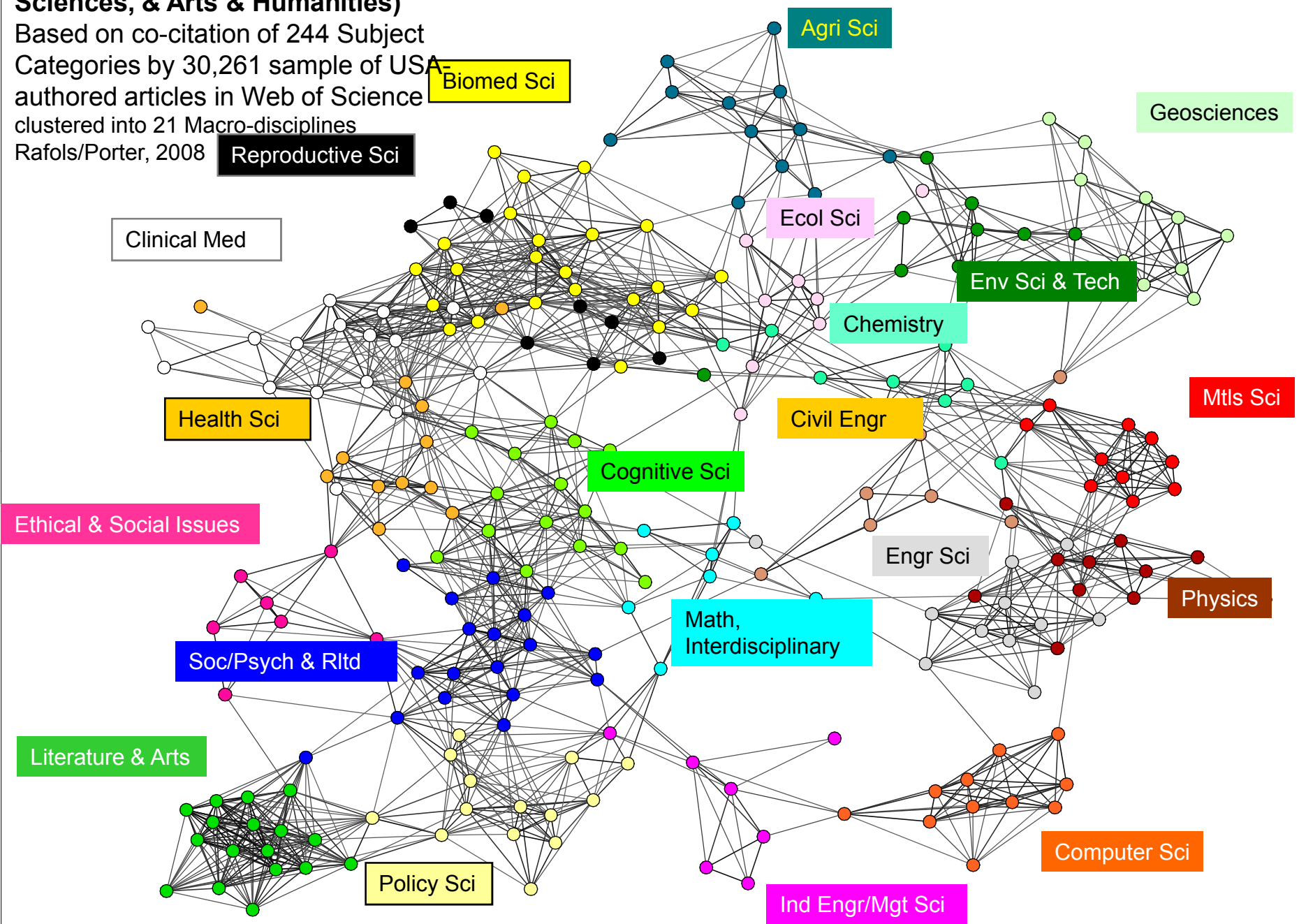
- Note also the breadth of research areas being cited

- Based on Web of Science (SSCI/AHCI) articles only

Base Science Map (Science, Social Sciences, & Arts & Humanities)
Based on co-citation of 244 Subject Categories by 30,261 sample of USA-authored articles in Web of Science clustered into 21 Macro-disciplines
Rafols/Porter, 2008

Agri Sci

Biomed Sci

Geosciences

Reproductive Sci

Clinical Med

Ecol Sci

Env Sci & Tech

Chemistry

Mtls Sci

Health Sci

Civil Engr

Cognitive Sci

Ethical & Social Issues

Engr Sci

Physics

Math, Interdisciplinary

Soc/Psych & Rltd

Literature & Arts

Computer Sci

Policy Sci

Ind Engr/Mgt Sci

Pajek

Relative Nano in Social Sciences Citation Emphases: pre-2005

Nano in Social Sciences Articles' **Cited SCs** (from SSCI + Scopus, **pre-2005**) Overlay on the 244 Subject Category Web of Science map (normalized to 2005-07 total cites)

Agri Sci

Biomed Sci

Geosciences

Reproductive Sci

Ecol Sci

Env Sci & Tech

Clinical Med

Chemistry

Mtls Sci

Health Sci

Civil Engr

Cognitive Sci

Ethical & Social Issues

Engr Sci

Physics

Soc/Psych & Rltd

Math, Interdisciplinary

Literature & Arts

Policy Sci

Computer Sci

Ind Engr/Mgt Sci

Pajek
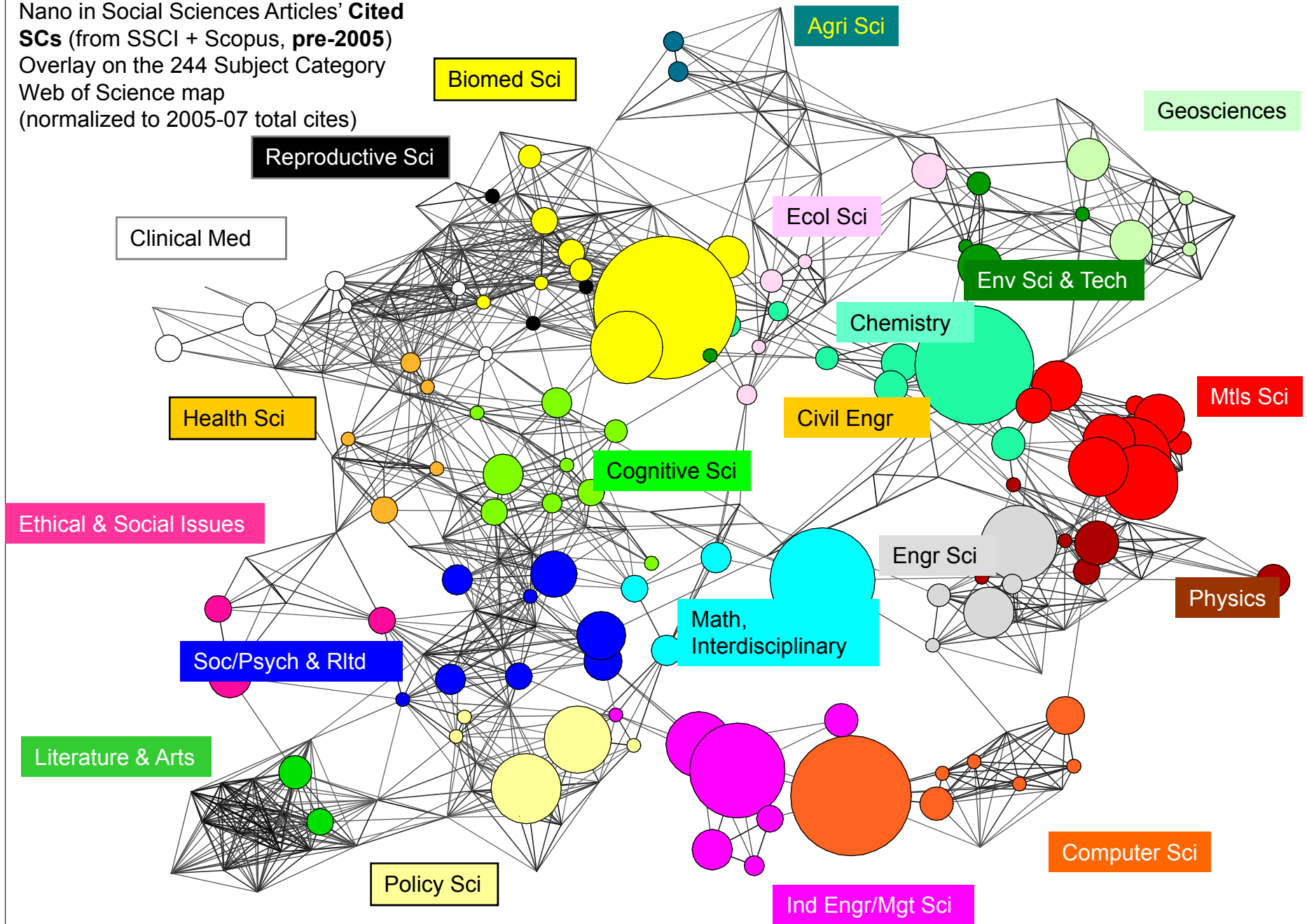
Relative Nano in Social Sciences Citation Emphases: 2005-07

Nano in Social Sciences Articles' Cited SCs
(from SSCI + Scopus for **2005-07**)
(Rafols/Porter, Aug 31, 2008).
NOTE: Enhanced research knowledge bases in the social sciences, compared to the earlier period.

Agri Sci

Biomed Sci

Geosciences

Reproductive Sci

Clinical Med

Ecol Sci

Env Sci & Tech

Chemistry

Mtls Sci

Health Sci

Civil Engr

Cognitive Sci

Ethical & Social Issues

Engr Sci

Physics

Math, Interdisciplinary

Soc/Psych & Rltd

Literature & Arts

Computer Sci

Policy Sci

Ind Engr/Mgt Sci

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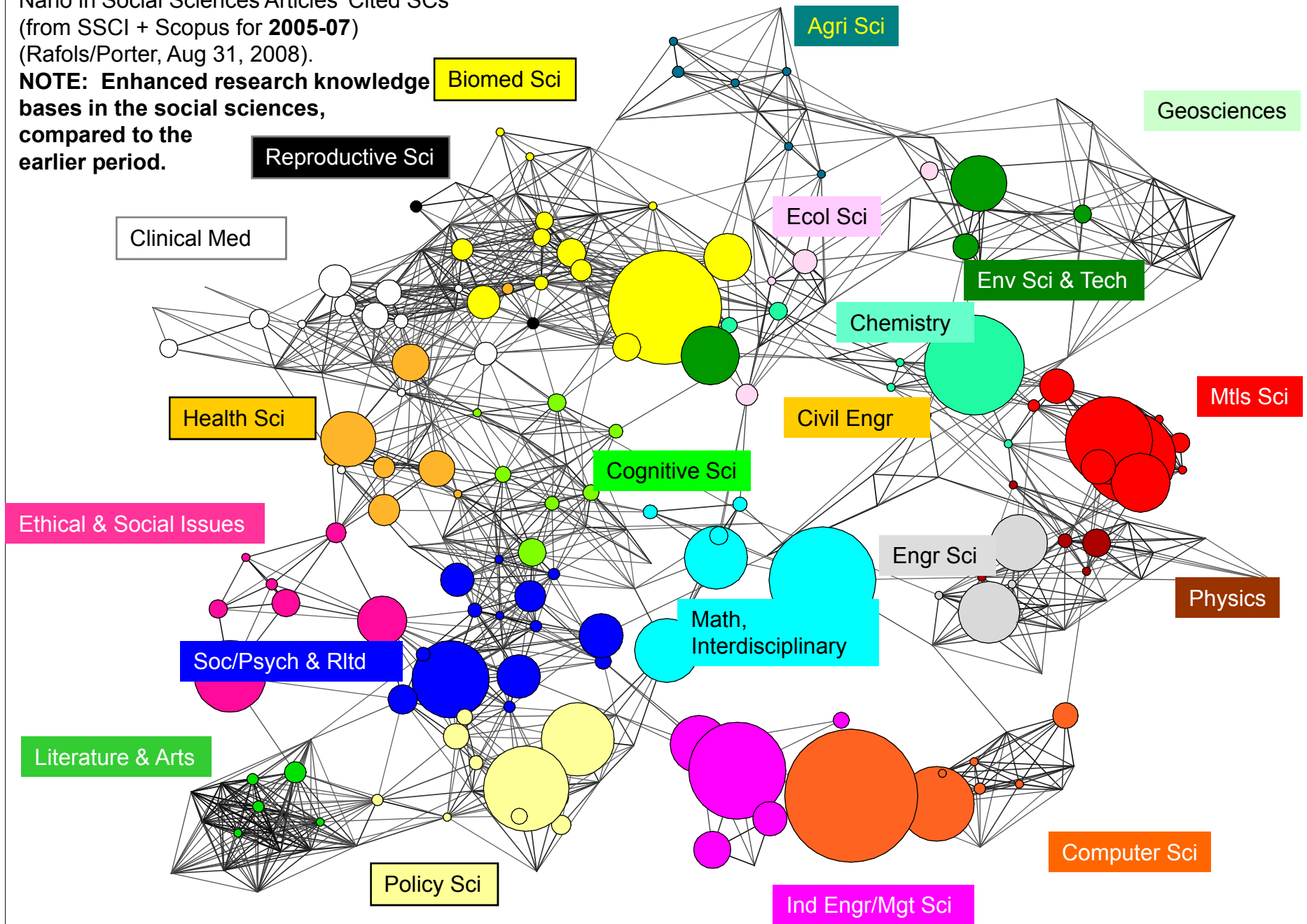
Nano Content of the 8 Dimensions

Category	%Nano-related
• **Technology trajectories and implications** (Roco)	100
• **Governance**:	51
• **Public perception and deliberation**:	71
• **Ethics**:	64
• **Science and technology (S&T) studies**:	4
• **Science visions**:	83
• **Science mapping**:	35
• **Evolutionary economics**:	0

Summing Up: Nano in the Social Sciences

- A Growing Community
  - Accelerating since 2005
  - Growth corresponds pretty well with National initiatives (beginning in 2003) to address societal dimensions of nano
- We suggest 8 dimensions based on co-citation grouping of the 60 most cited authors (some are not social scientists)
- In the earlier years, much of the referenced knowledge came from "science visions" [scientists and science fiction writers]; that is changing substantially