Measuring Interdisciplinarity in the Area of Emerging Technologies

Fang Xiao, Doctoral Student
Julia Melkers, Associate Professor

Interdisciplinarity and Collaboration Networks: Research and Methodological Questions

▸ Interdisciplinary knowledge integration encourages scientists to work across disciplinary boundaries, and to be able to establish and maintain ties with people from distinct disciplines.

▸ Emerging areas of science and technology bring researchers from different disciplines together in pursuit of similar interests.

   ▸ *Are scientists in new areas of science more interdisciplinary the scientists in more traditional fields?*

   ▸ *How can we use bibliometric data to develop a more robust measure of interdisciplinarity for our survey respondents?*

▸

Identifying Interdisciplinary Collaborative Ties

▸ In order to study interdisciplinary networks, the disciplinary nature of the tie must be determined.

▸ Expectation: The more a scientist's collaborators are from different disciplines, the more interdisciplinarity he or she may be

Using Survey Data to Measure Interdisciplinarity

▶ Affiliation

  ▶ Self-Reported Discipline (PhD or working discipline)

  ▶ Departmental Affiliation

    ▶ Problems: not standardized, difficult to code and correlate

▶ Production

  ▶ Approximately what percentage of your publications would others in your discipline recognize as interdisciplinary? (0-100%)

    ▶ Problems: self-reported data, not very accurate, don't have data on alter necessarily

A New Cross-Project Opportunity Presents Itself!

▸ Can we use the bibliometric data we have on 1598 academic scientists to develop a more robust measure of interdisciplinarity?

▸ New Approach:

  ▸ Use Vantage Point to:

    ▸ organize NETWISE bibliometric data

    ▸ Calculate integration scores on survey respondents based on bibliometric data

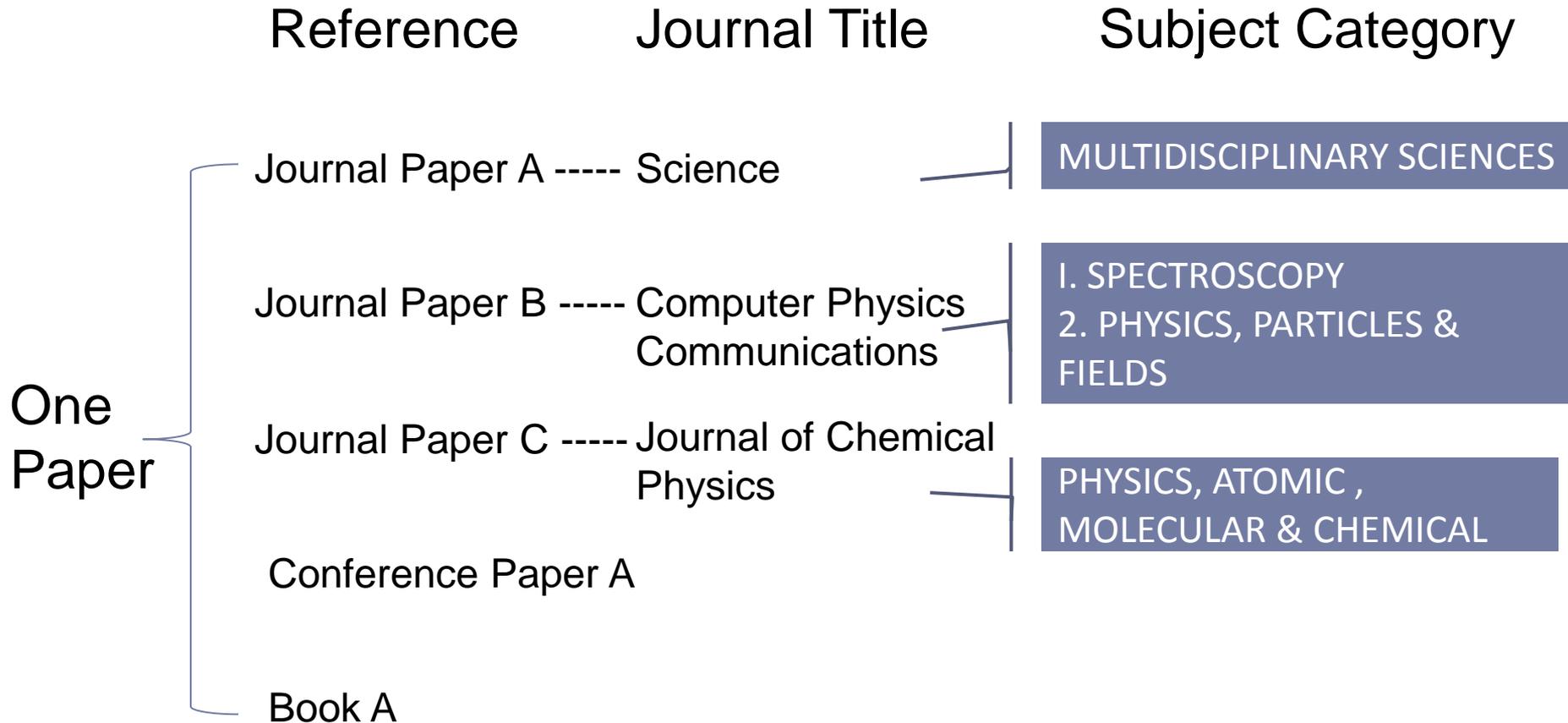   ▸ Merge integration scores together with traditional and social network survey data

A New Index of Interdisciplinarity: Integration Score

▸ A new index of interdisciplinarity developed by Alan Porter and his colleagues.

▸ The index captures not only the number of disciplines cited by a paper, but also how disparate (i.e. how different) these disciplines are.

▸ The discipline-specific item is research papers citations.

  ▸ Each cited journal is associated with one or more Subject Categories (SC) in the Web of Science (WoS)

  ▸ Different WOS Subject Categories represent different knowledge resources papers use.

  ▸ How many SCs one researchers' articles cite and how disparate these SCs are at a given time together reflect the degree of interdisciplinarity of the person's work during that period.

▸

Integration Score

Reference	Journal Title	Subject Category
Journal Paper A -----	Science	MULTIDISCIPLINARY SCIENCES
Journal Paper B -----	Computer Physics Communications	I. SPECTROSCOPY 2. PHYSICS, PARTICLES & FIELDS
Journal Paper C -----	Journal of Chemical Physics	PHYSICS, ATOMIC , MOLECULAR & CHEMICAL
Conference Paper A		
Book A		

One Paper

▸ There is a total of 244 SCs in WoS.

Integration Score: an example

Paper A – 5 Journal References		Paper B – 5 Journal References	
Subject Category	*#Instance*	*Subject Category*	*#Instance*
Biophysics	3	Communication	3
Biology	4	Biology	4

	Biophysics	Biology	Communication
Biophysics	1	0.738407	0.001839
Biology	0.738407	1	0.007074
Communication	0.001839	0.007074	1

$$I = 1 - \sum_{i,j} \left(S_{i,j} P_i P_j \right)$$

Integration Score of Paper A < Integration Score of Paper B

Integration Score

▸ The higher one paper's integration score is, the more different research resources this paper draws, the more diverse knowledge is integrated by the authors.

  ▸ If one paper cites references which are all associated with a single SC, or it cites references which are associated with two SCs that are were extremely close, the paper has an integration score of 0 or very close to 0.

Collaborative Networks in Emerging Technology

▸ <u>Research question:</u> Are scientists working in emerging areas of science more interdisciplinary than others?

▸ Emerging Technologies are

  ▸ Latest scientific innovations which have a potential impact on industry structure, have a significant influence on economy, and have been recently commercialized *(Porter, Roessner et al. 2002, Day and Schoemaker 2000, Lung, Masanet et al. 2006)*

▸ Examples include

  ▸ Nano - nanomedicine, nanoelectronics

  ▸ Bio - biomolecular and biomimmetic materials

  ▸ Other – nuclear reprogramming, optical technology

▸

Emerging Technology Scientists in Our Survey

- NETWISE Data
    - Respondents were offered a list of a number of emerging technology areas, most of which are drawn from the most recent list of "top ten emerging technologies" identified by *TechnologyReview*

    - 25% of respondents (391 of 1598) indicate that they are currently conducting funded research in a recognized area of emerging technology
   - Of these, 170 are working on nano-related areas: nanobiomechanics, nanomedicine, nanoelectronics, etc.

Research Challenges & Opportunities

▸ To effectively study interdisciplinary networks, the index should also be created for the "alter" or collaborator.

▸ Ego integration scores, however, will allow analysis of:

  ▸ Changes in interdisciplinary production over time

  ▸ Overall network characteristics by level of ego interdisciplinarity (social network data)

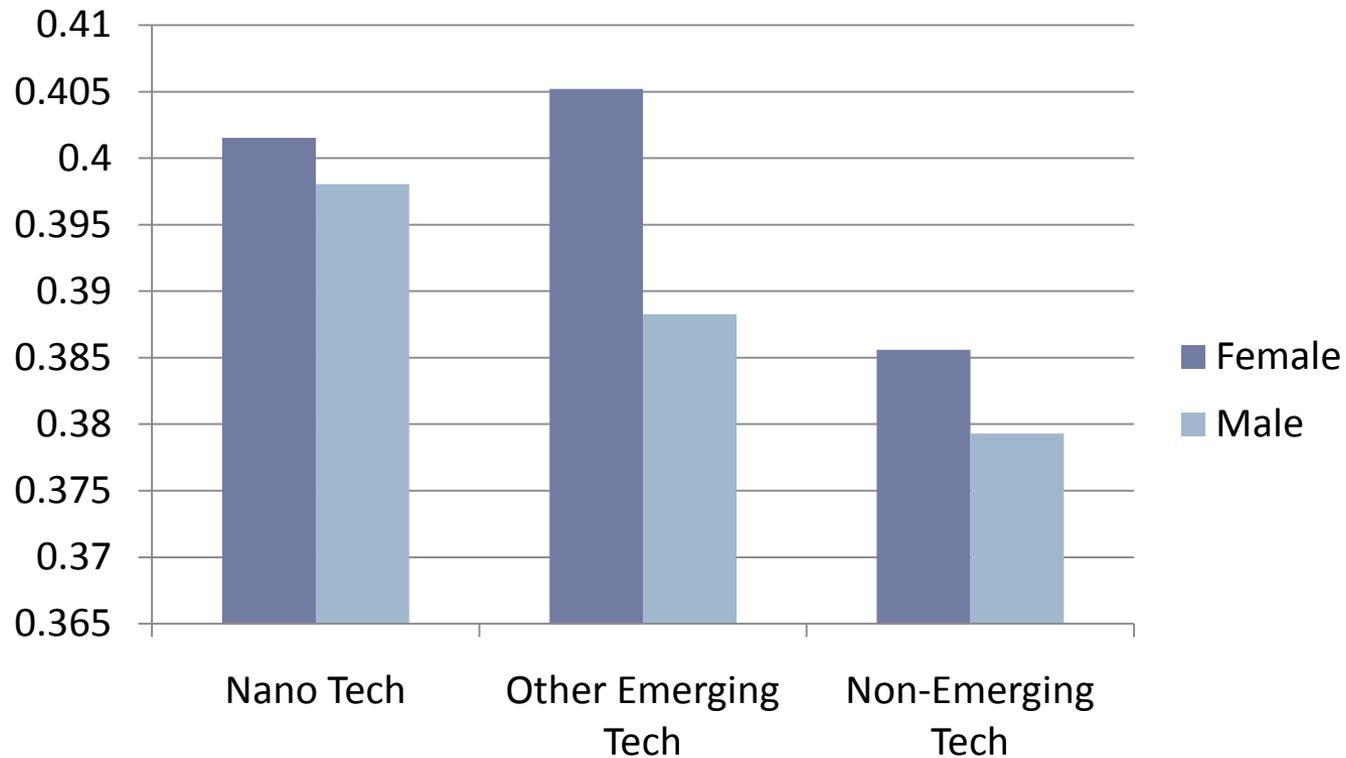 ▸ Various factors that explain interdisciplinarity (traditional survey and social network measures)

Results: Integration Score Data Increases Over Time

Integration Score by Year and by Type of Technologies
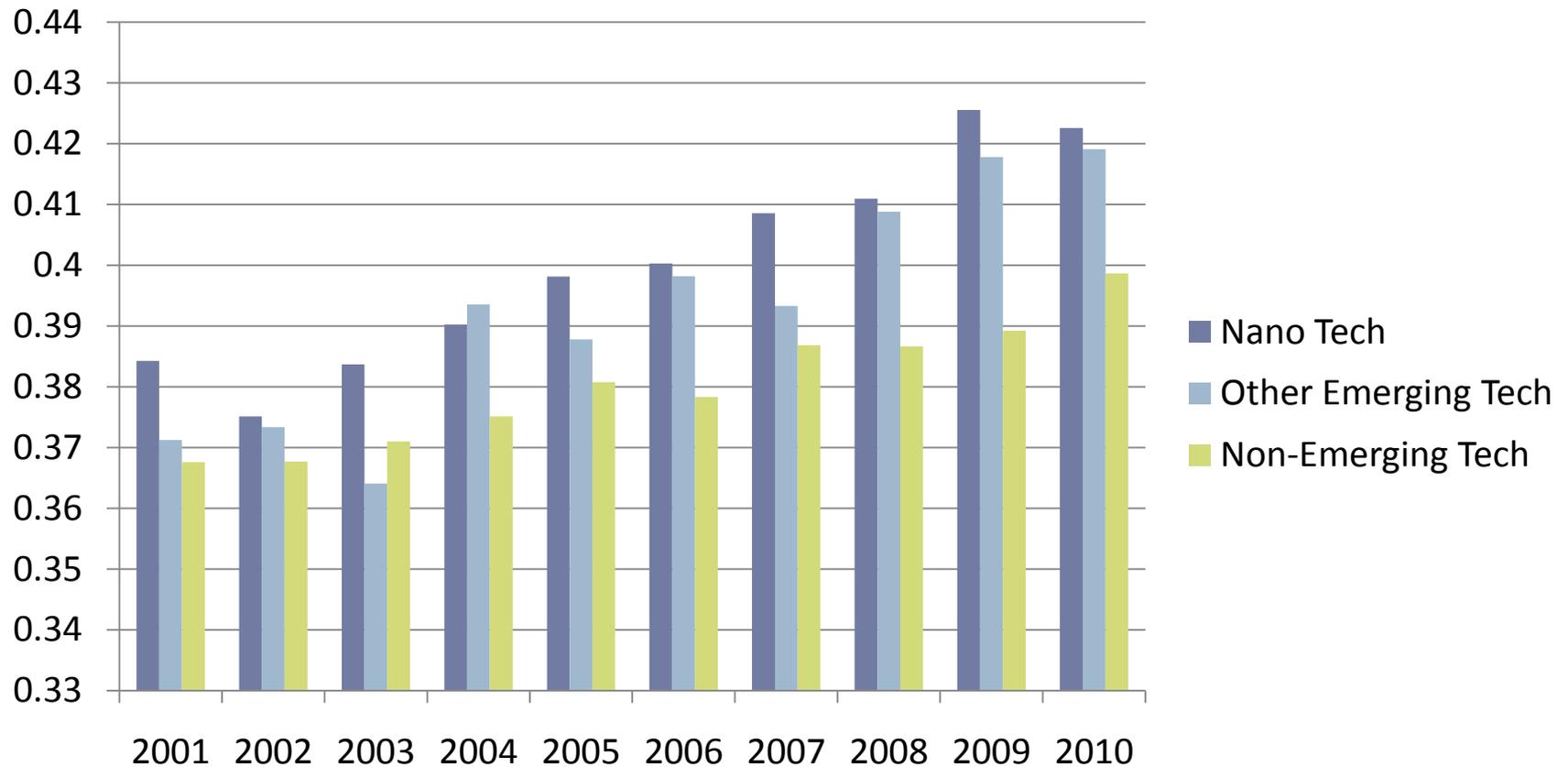
Integration Score Data
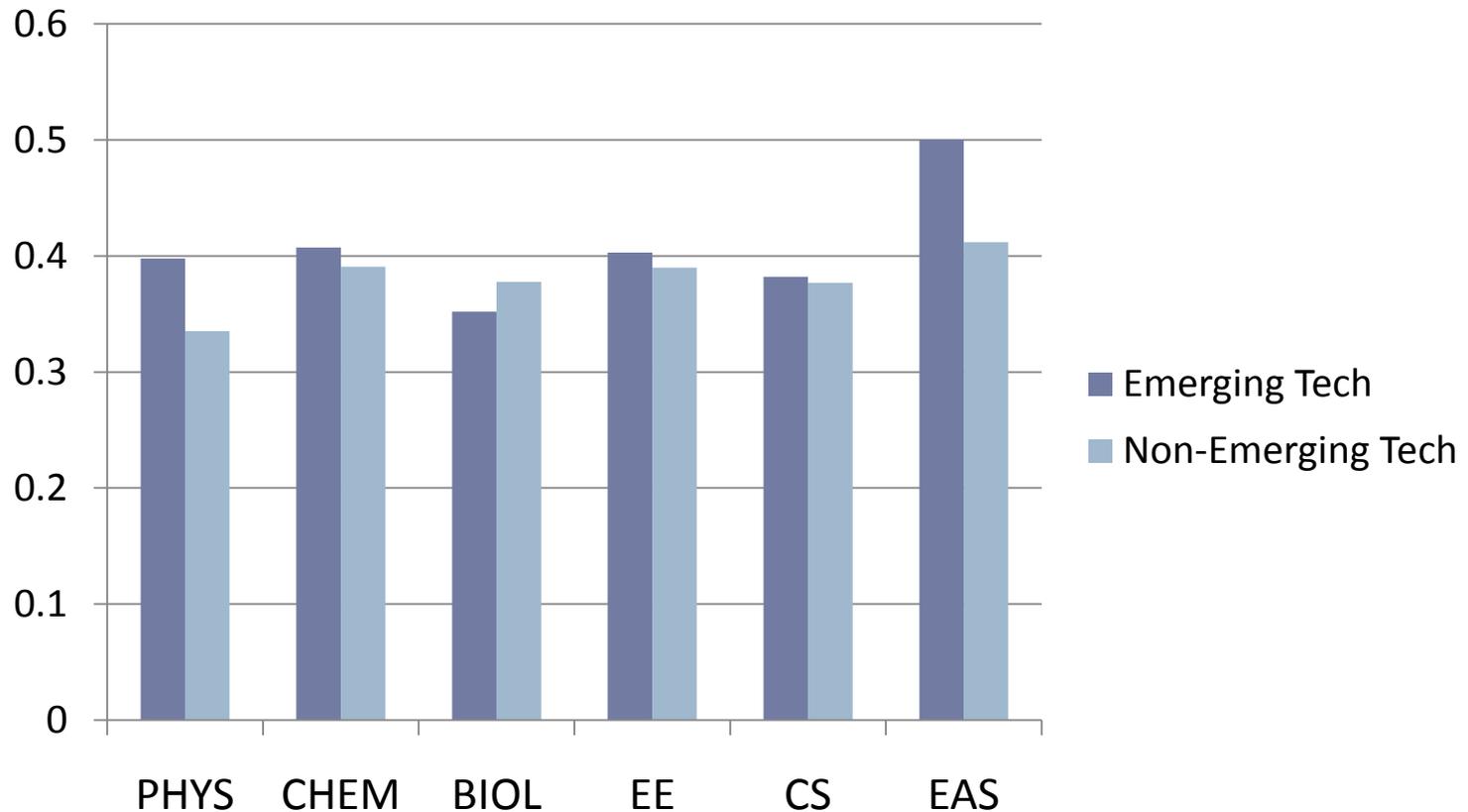# Shows Gender Differences

Integration Score by Gender and by Type of Technologies

Integration Score Data
Primary Field Differences

Integration Score by Field and by Type of Technologies

In Closing

▸ Scientific activities are becoming more interdisciplinary over the time.

▸ Scientists engaged in emerging technology areas appear to be more involved in interdisciplinary research. Nanotechnology scientists and engineers have the higher degree of interdisciplinarity than others.

▸ Female are more oriented to interdisciplinary research, which is consistent with some researchers' assumption.

▸ The degree of interdisciplinarity is different by field.