Academic Betadiversity and Future of Biological Collaboration

* Abstract
* Introduction:

Innovative discoveries often come from collaborations among from differing fields. The importance of cross-disciplinary work is a key goal highlighted by the National Science Foundation and the National Institutes of Health. The mixing of biological disciplines has spurred both theoretical and methodological progress. The melding of quantitative genetics and evolutionary theory gave rise to the modern synthesis, the growth of cell biology is in part due to biochemistry, and the current omics age is fueled by a tremendous expansion of bioinformatics. An ever-growing list of challenges, from the evolution of antibiotic resistance to ecosystem engineering requires scientists to embrace a wider view of life sciences.

Despite the critical importance of interdisciplinary work, it is difficult to assess the relative specialization and connections of biological disciplines. While studies have focused on citation indexes as a proxy of academic success, there is a wider tidal shift that slowly drives academic fields together and apart. By studying the emergent properties of life-sciences as an interconnected and complex system, we can identify areas of interdisciplinary research and highlight potential opportunities for future growth.

The emergence of network biology provides a rubric for visualizing and quantifying interdisciplinary research. Network biology harnesses graph theory to represent connections among group members, and has been used extensively in social sciences, anthropology, and in microbiology. Graph theory is a branch of discrete mathematics that quantifies interactions among members of a set, called nodes, by measuring connections, called links, based on an interaction currency. To visualize the totality of life sciences requires constructing an adjacency matrix where each academic discipline is compared to every other discipline. This matrix consists of the degree of niche overlap between disciplines, as measured by the abundance of articles published by individual authors in each discipline. The goal of this analysis was to determine, 1) Which fields act as bridges to connect fields within life sciences? 2) Which fields have become more insular, and which more interdisciplinary? 3) Where is there potential growth among disciplines?

To measure dissimilarity among life science fields, I queried all articles from 1995-2015 for 700 biologicals journals. Each of these journals were classified into twenty seven biological fields (Table S1). Using the authors from these XXXXXX publications, I tallied the number of publications by each of xxxxx authors in each of the biological fields. After computing niche overlap among disciplines, I created a network to calculate the connectedness, betweeness and degree of each field. These measures all measure the centrality in graph networks. In addition, I calculated the change in link strength between disciplines over time to quantify the shifting connections and affinities for biological collaboration.

Results

I classify XXXXX articles, from XXX journals consisting of XXXXXX authors. After discarding extremely weak links, the disciplines were ordered from most connected to least connected (Table 1). On average, fields were connected to X other fields, with an average dissimilarity of XX. Overall, the life sciences network is highly modular, with two distinct compartments. compartments comprising X,Y,Z and X,Y,Z. Visualizing the network showed that these modules were connected by X,Y disciplines.

Overall, temporal patterns among reasonably connected disciplines were fairly static. The ten largest increases in connectivity all included X,Y,Z while the ten largest decreases in connectivity included X,Y,Z. The patterns of temporal change were largely robust to x,y,z. When publication records were randomized with respect to discipline, I found x,y,z.

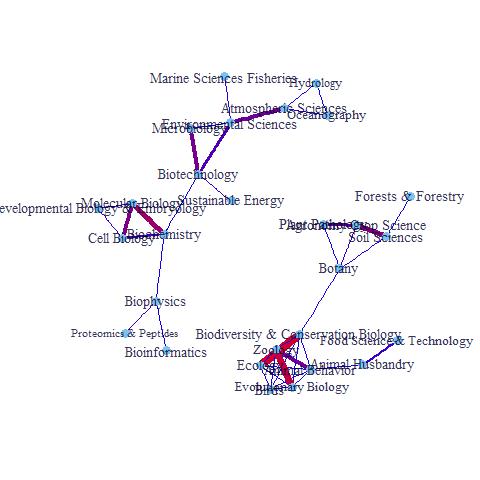


Figure 1

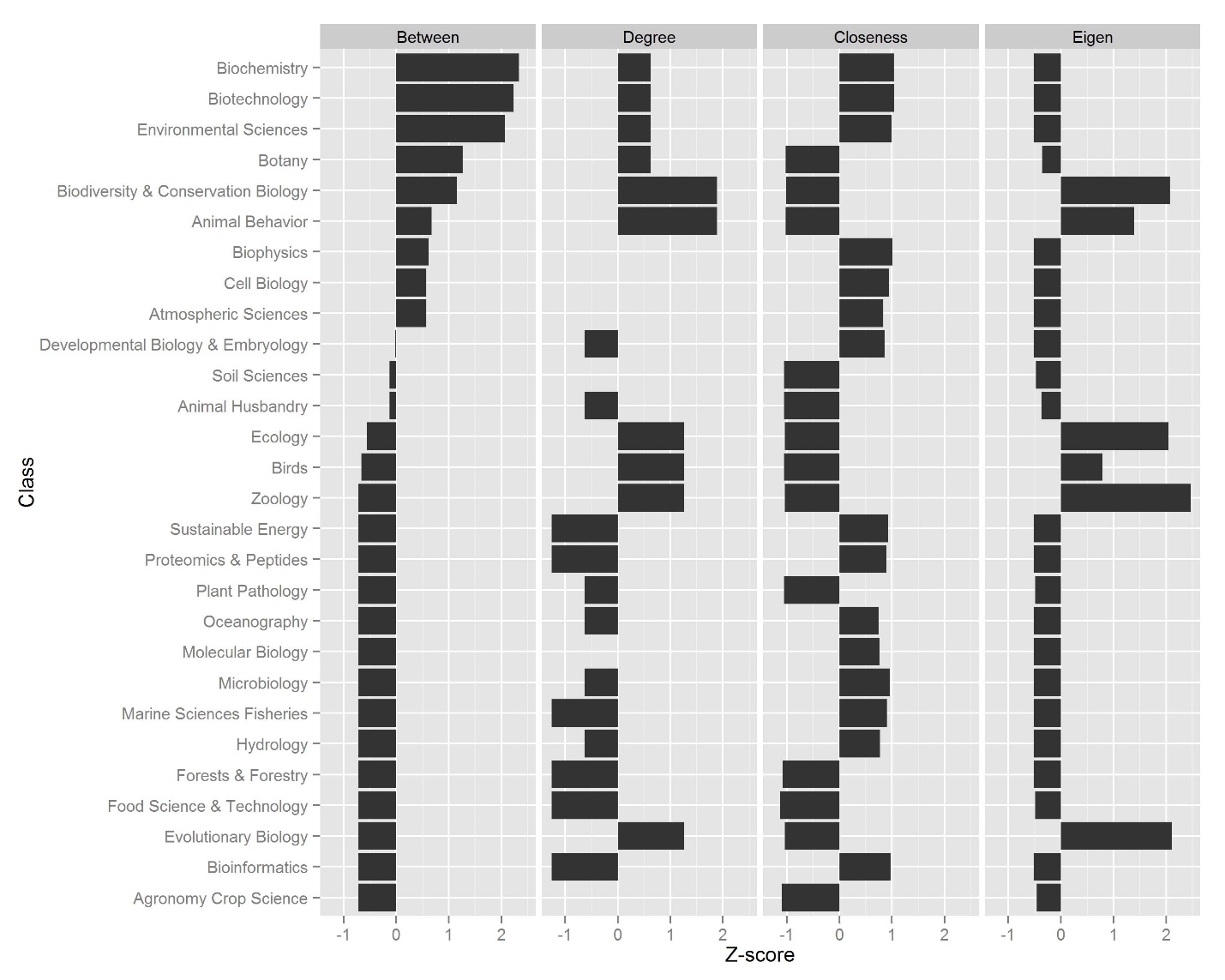
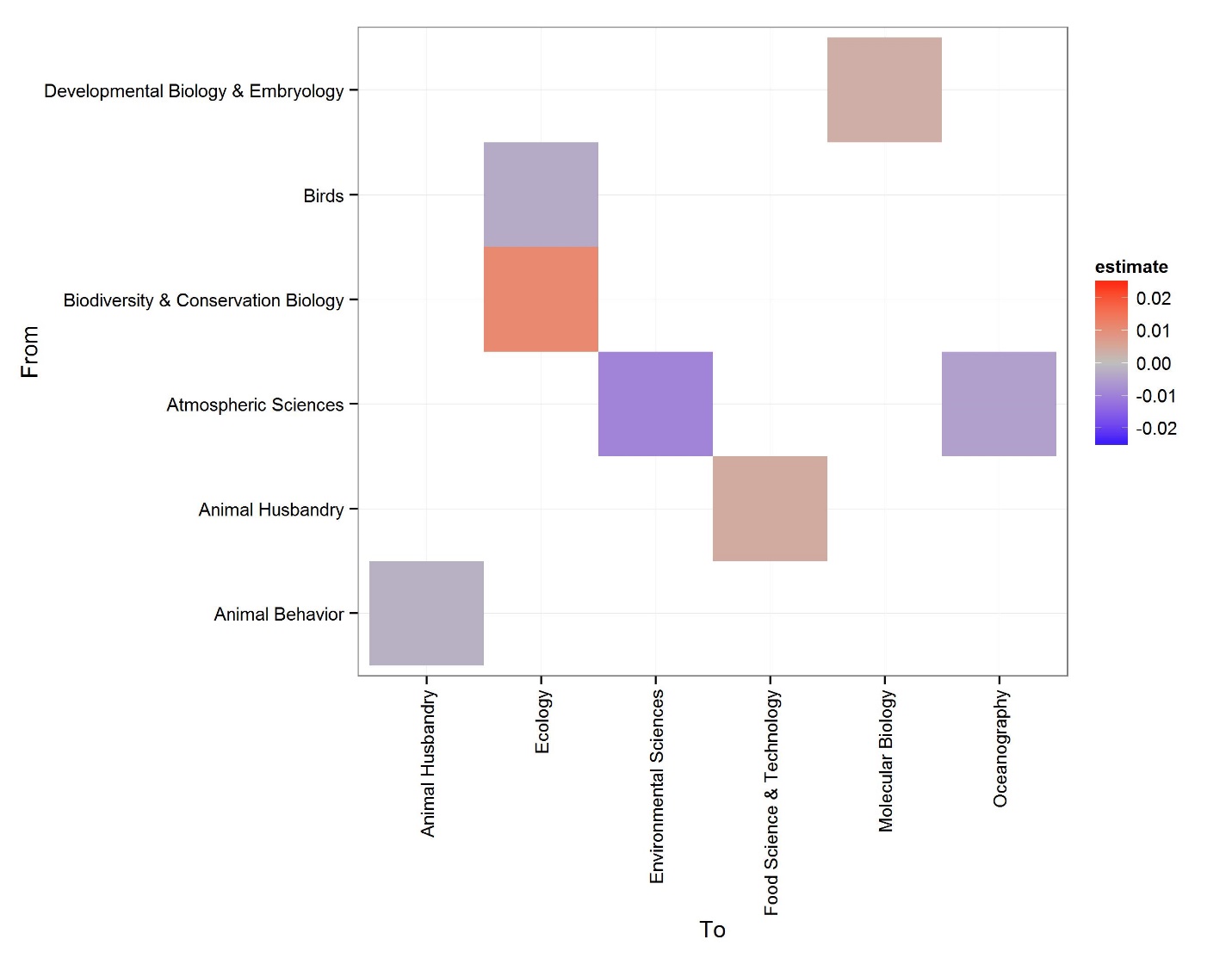


Figure 2



* Methods
  + Scopus archives
  + Each classification consisted of twenty journals. While the boundaries of discrete classifications will always be difficult to define, the vast majority of journals can be placed between one or two categories.
  + Journal Classification
  + Defining Niche overlap
  + Search Terms
    - Temporal Search
  + Network statistics
  + Change through time
* Results
* Discussion
  + Academic networks and future for evaluation
  + Promoting collaboration and indexes through citation sharing (cites)
  + On why we see strong interaction among certain fields
  + Caveats
  + The potential for future growth

**Appendix**