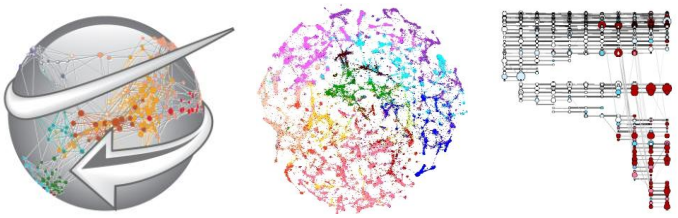
SciTech Strategies, Inc.

BETTER MAPS • BETTER DETECTION



Science Mapping of Gaps and Overlaps in a Research Portfolio

NIH Portfolio Analysis Symposium
Washington, DC
July 24, 2012

Kevin W. Boyack, SciTech Strategies

Agenda

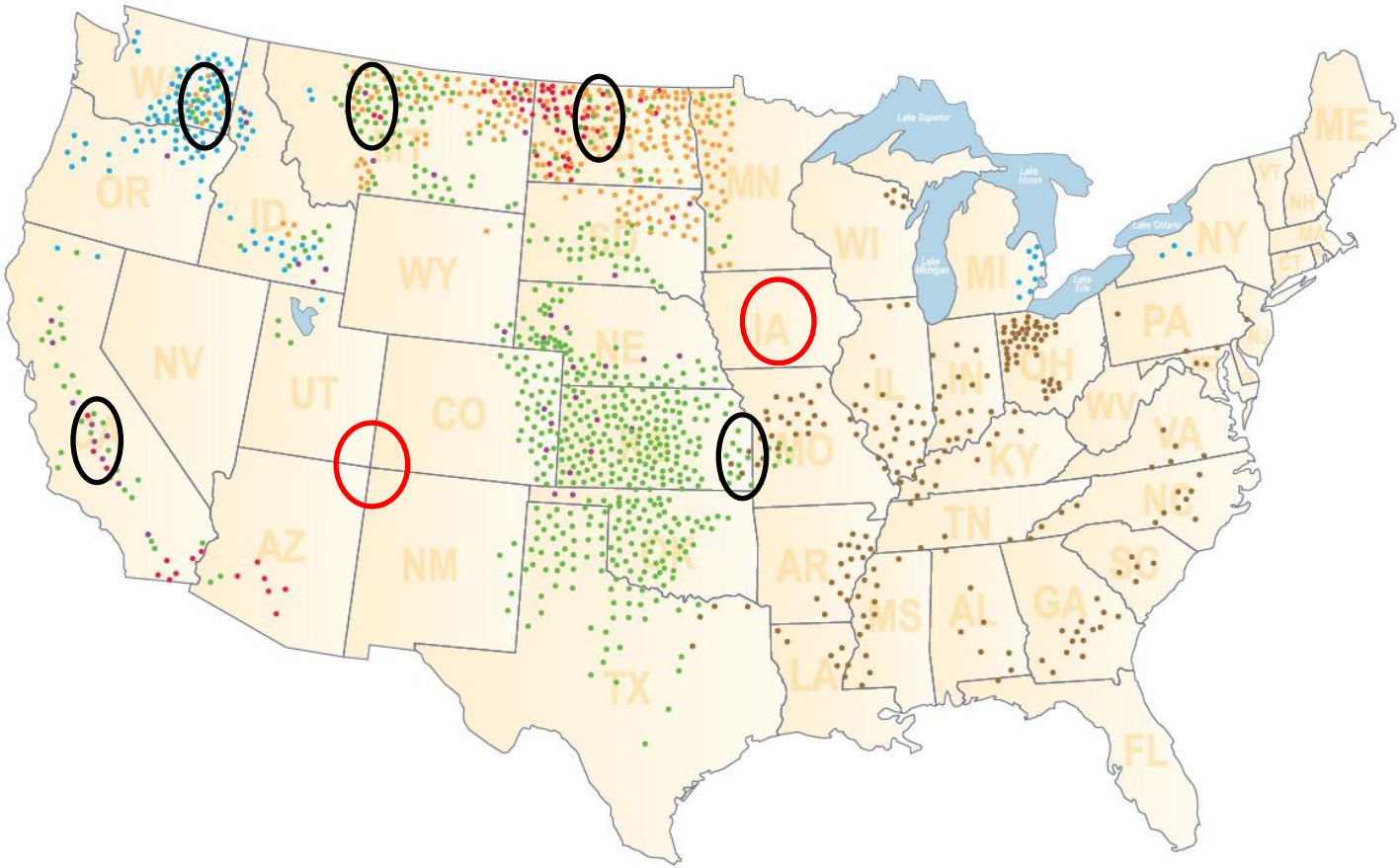
- A Geographic Analogy
- A Detailed Global Map of Science
- Overlaps
- Gaps
- Identifying Potentially Transformative Research
- Summary

Geographic Maps

- Maps show physical space
  - Existence
  - Location
  - Distance
- Maps provide a basis on which other features can be displayed and compared
  - Resources
  - Production
  - …
- Overlaps and gaps in features

Wheat Production in the U.S.

Overlaps in wheat types



Gaps in wheat production

HARD RED WINTER · HARD RED SPRING · SOFT RED WINTER · SOFT WHITE · HARD WHITE · DURUM

Science Maps Can Be Used the Same Way

- **GEOGRAPHIC MAPS**
- Maps show physical space
  - Existence
  - Location
  - Distance
- Maps provide a basis on which other features can be displayed and compared
  - Resources
  - Production
  - …
- Overlaps and gaps in features

- **SCIENCE MAPS**
- Maps show abstract space
  - Existence
  - Relative location
  - Relative distance
- Maps provide a basis on which other information can be displayed and compared
  - Resources (e.g., funding)
  - Production (e.g., articles)
  - …
- Overlaps and gaps in features

PORTFOLIO

Partition Size and Stability

SCALE

~ 10 Fields for all of science
(e.g., Clinical Medicine)

~ 500 Disciplines for all of science
(e.g., Endoscopic Surgery)

~ 8,000 Specialties

~ 100,000 Problems

10^6

10^5

10^4

10^3

10^2

10^1

10^0

documents / partition / year

EVOLUTION

No morphological change

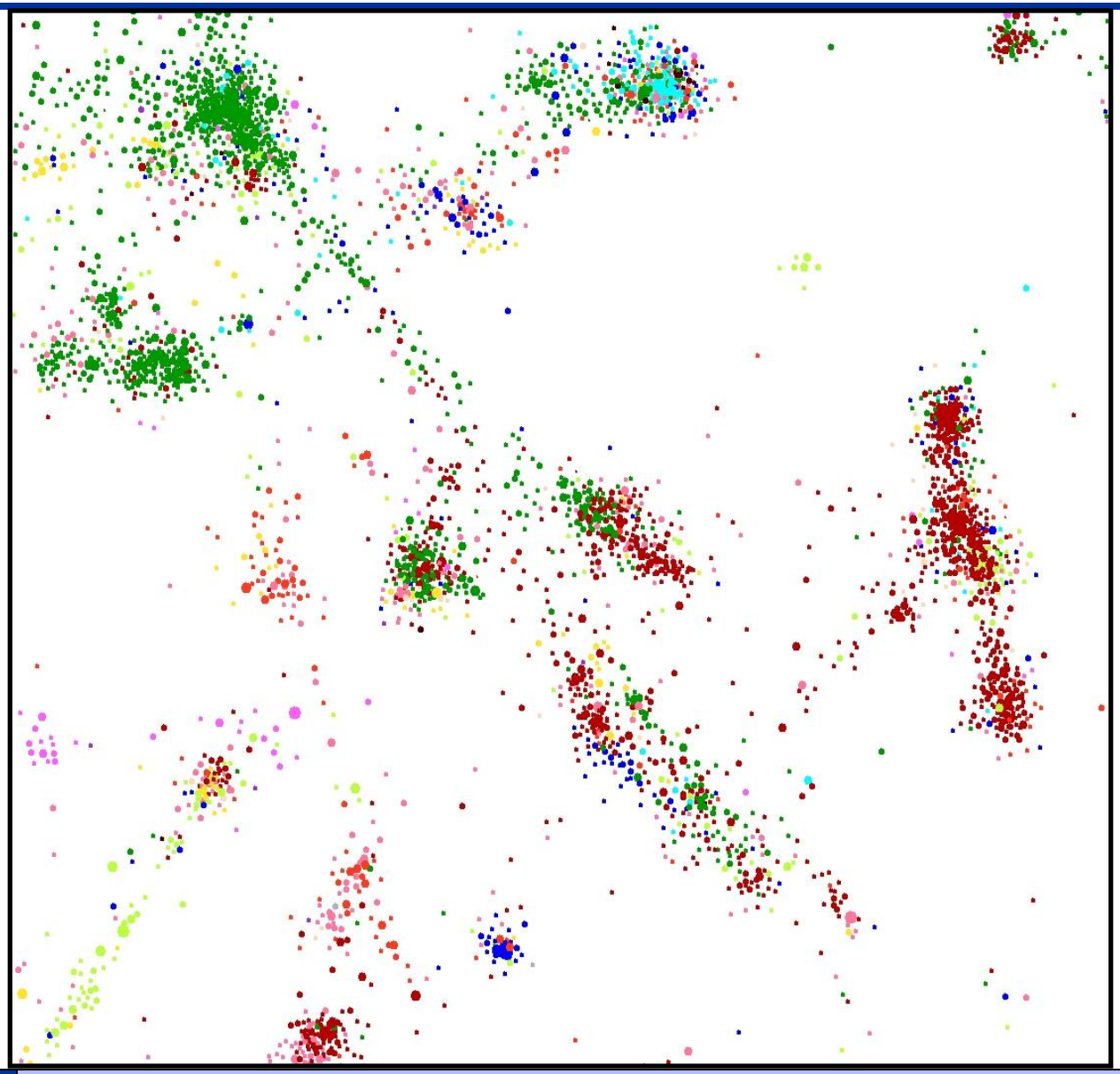
99+% Survival Rate/year

95% Survival Rate/year

56% Survival Rate/year

A Detailed Global Map of Science

Scopus data
2010
1.7M articles
116,000 topics



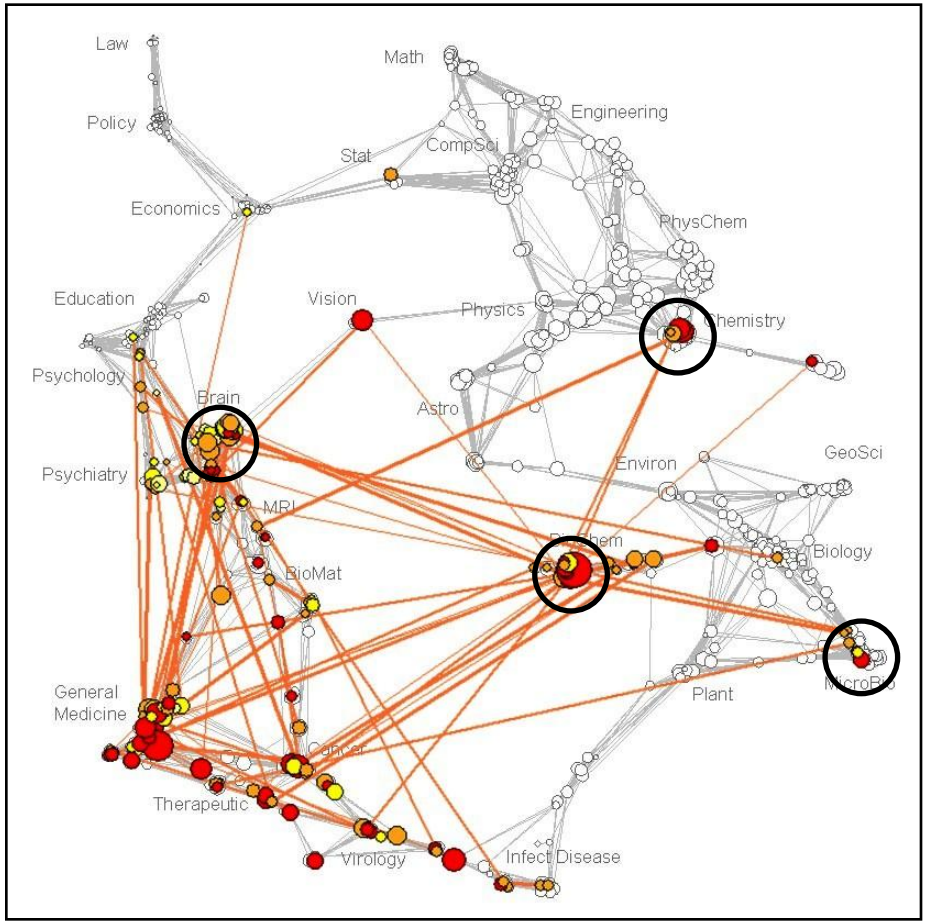
- Infectious Disease
- Medical Specialties
- Health Sciences
- Brain Research
- Humanities
- Social Sciences
- Computer Sciences
- Math / Physics
- Chemistry
- Engineering
- Earth Science
- Biology
- Biotechnology

Overlaps

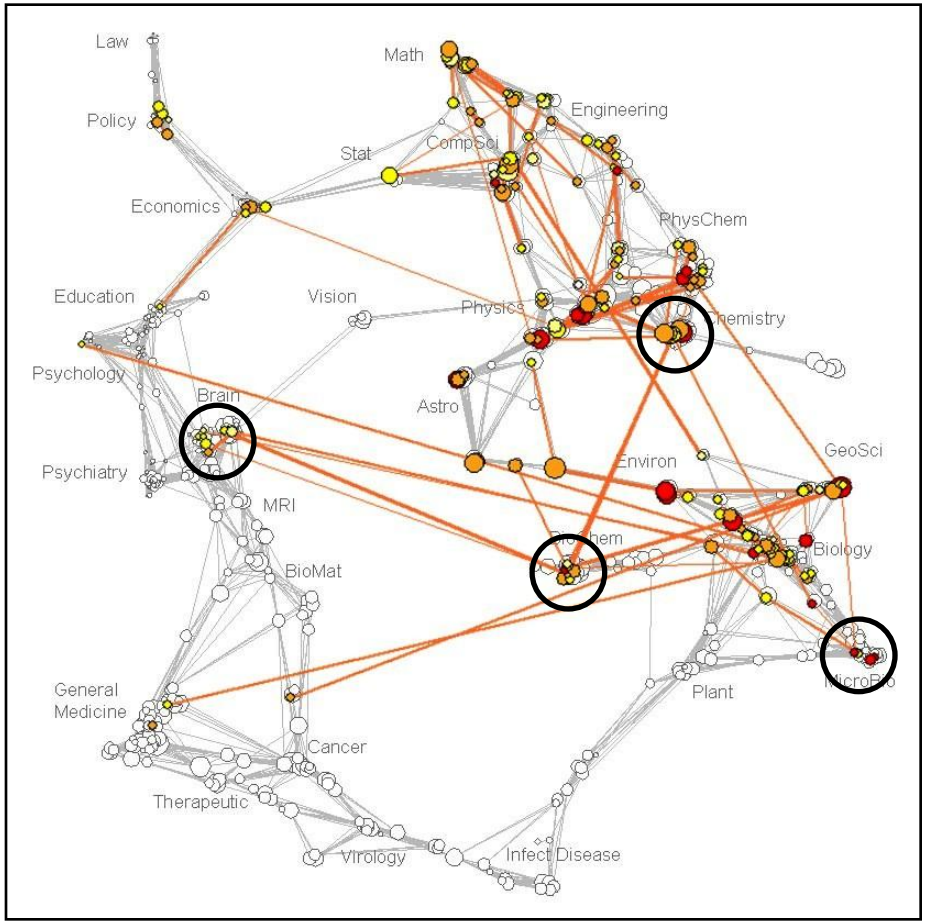
- Relatively simple to calculate or display
  - Can be shown on a single map or side-by-side
- Can occur on a variety of levels
  - Agency (e.g., NIH, NSF)
  - Institute (e.g., NCI, NLHBI)
  - Study sections
  - Programs

Overlaps – Agency

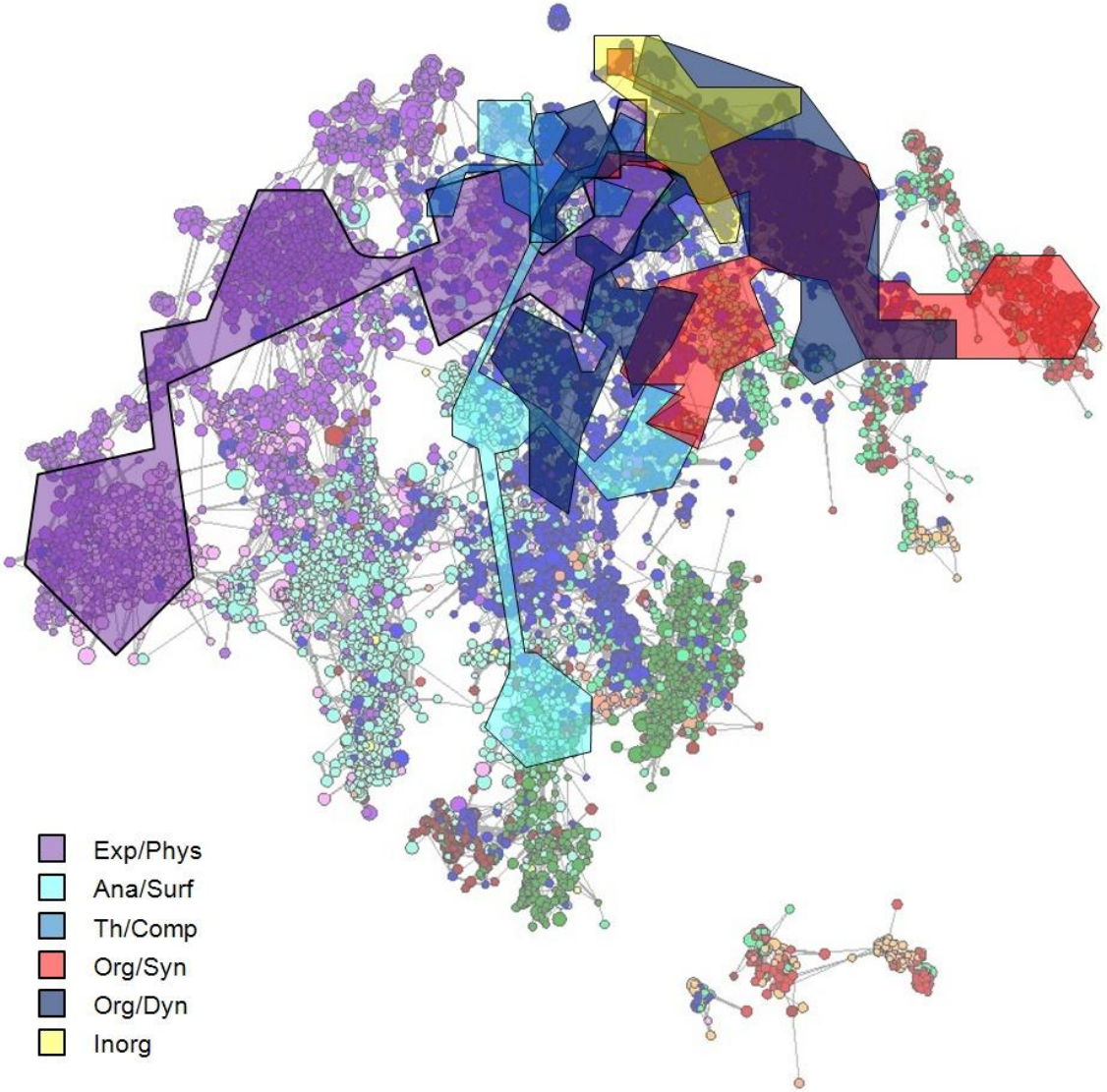
NIH



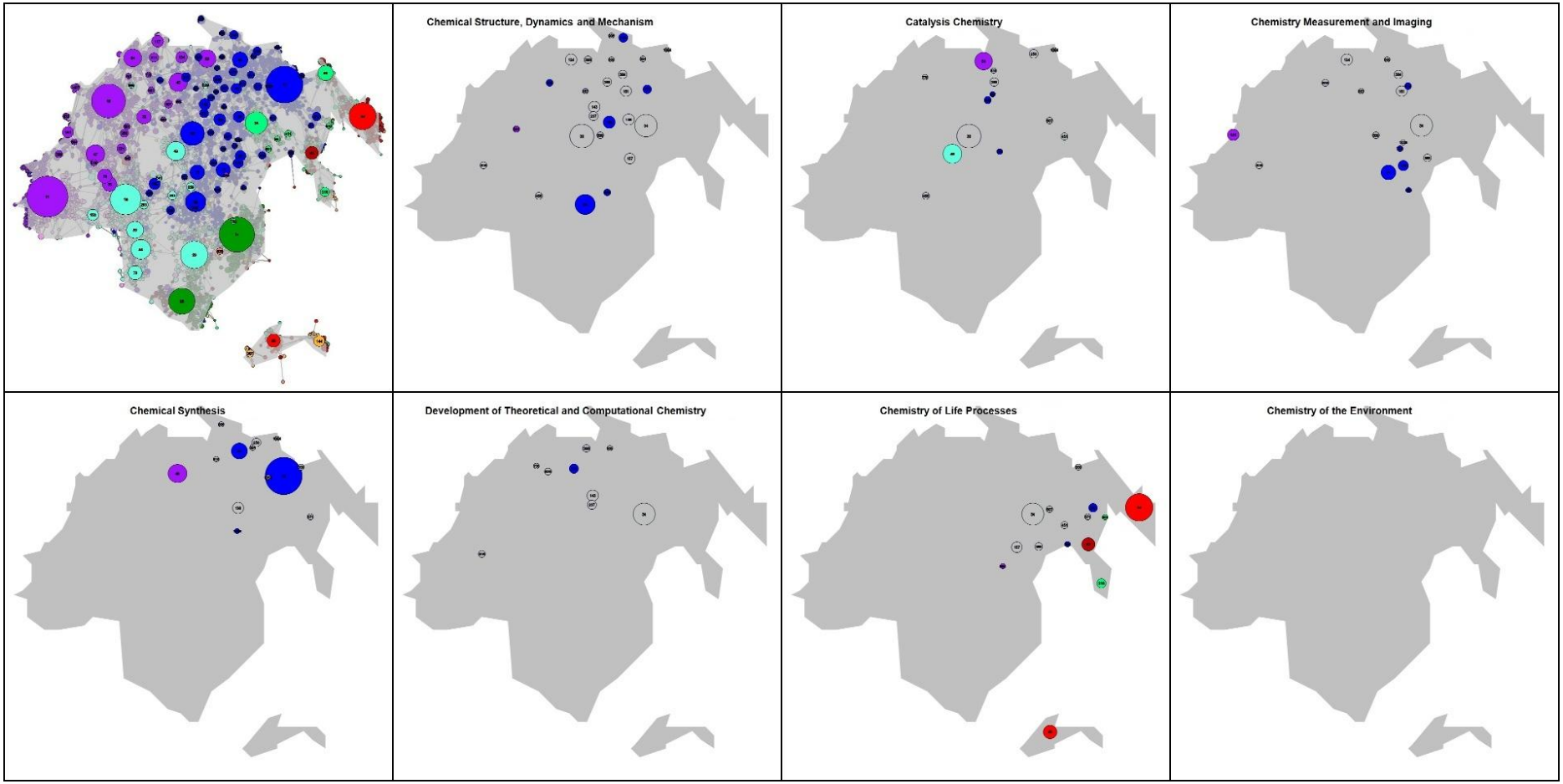
NSF



Overlaps – Program (Before)



Overlaps – Program (After)

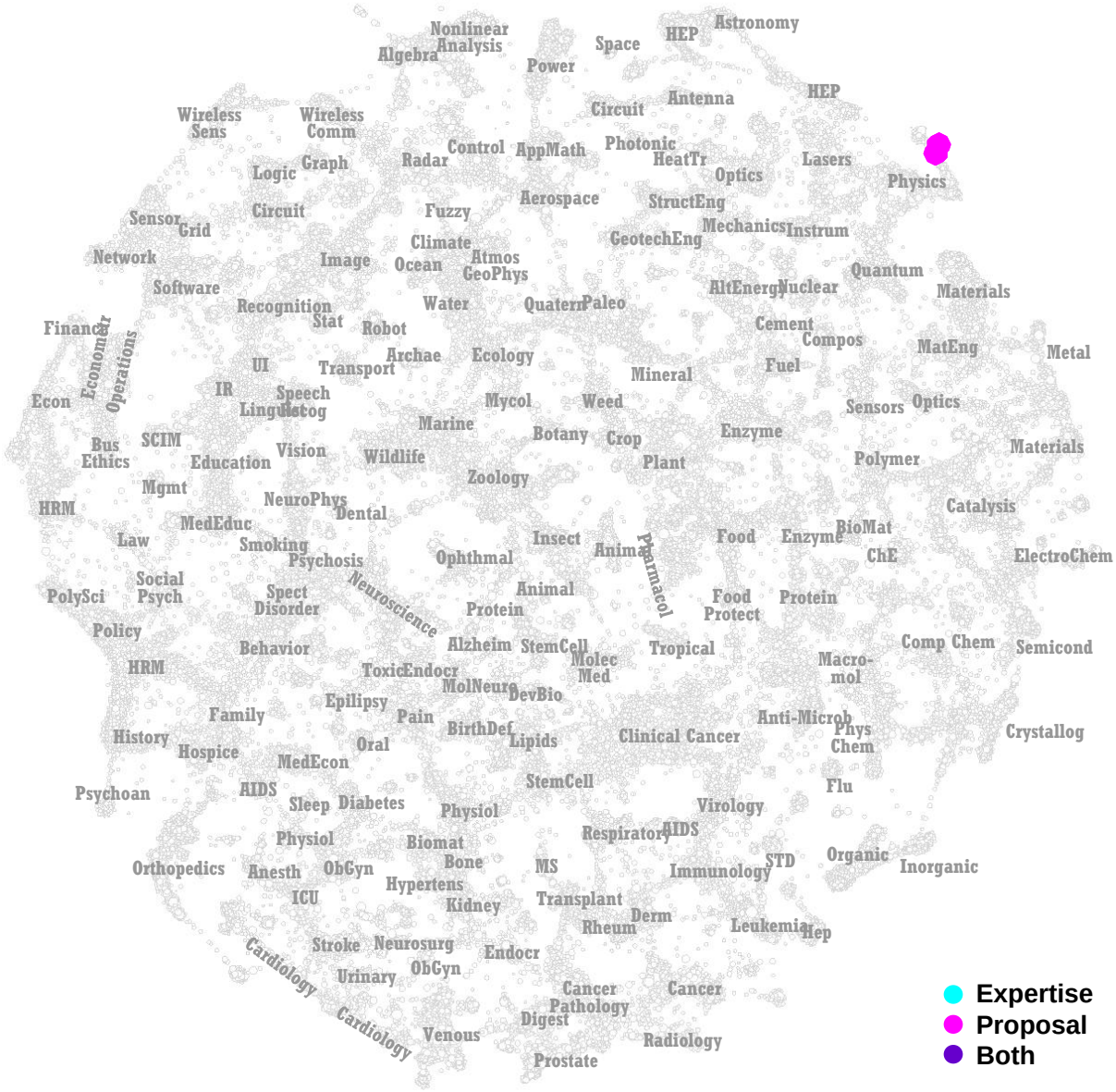


Gaps

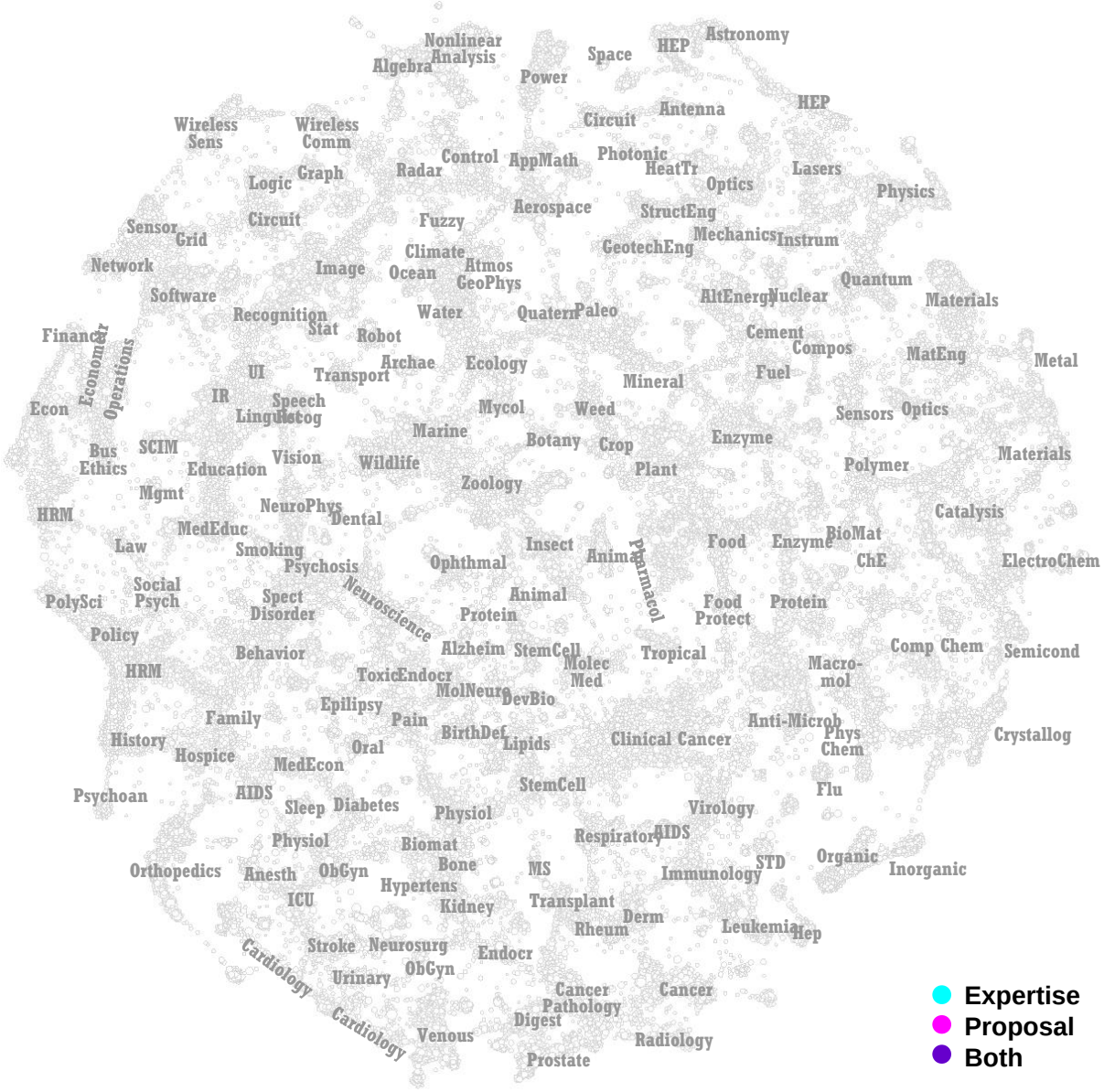
- Identifying gaps assumes a reference standard
  - The problem is that this standard often doesn't exist

- Two types of gaps
  - Counterpart to overlaps – these are "coverage gaps" or "mismatch gaps"
    - Relatively simple to calculate or display
    - Can be shown on a single map or side-by-side
  - Potentially transformative research
    - Much more difficult to identify than mismatch gaps

Overlaps and Mismatch Gaps



Overlaps and Mismatch Gaps



Gaps = Potentially Transformative Research

- **This is where the action is!**
  - Structural holes (Chaomei Chen)
  - Interdisciplinarity (Alan Porter)
  - Emergence (FUSE)
  - Transformative research (Agencies)
  - Hot science

Gap Analysis: Many Methodological Choices

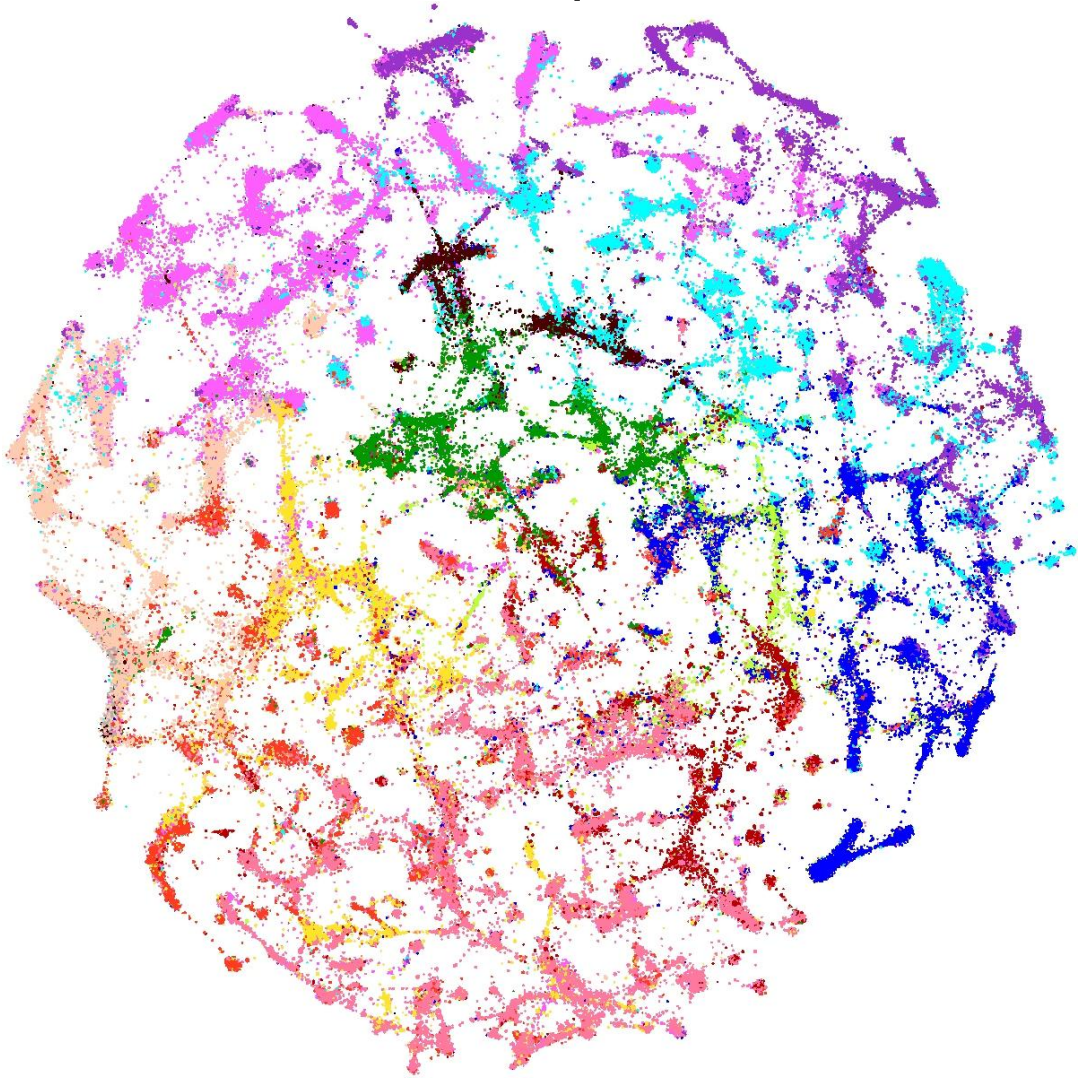
- We have much in common with the other presenters
  - » Common philosophies about science mapping and policy
    - Have co-authored with Katy & Chaomei and worked with Johan & Dewey
    - Correspond regularly with Alan & Loet
  - » Processes based on scientific method
  - » All interested in using more common terminology
- … and some differences
  - » Emphasis on accuracy
    - Global (all of science) rather than local (keyword defined sets)
    - Topic level rather than discipline level
    - Predictive modeling
    - We model a combination of stability and instability
- Details provided in the break-out session at 2:00 !

PTR – What Do We Look For?

- Should we evaluate white spaces?

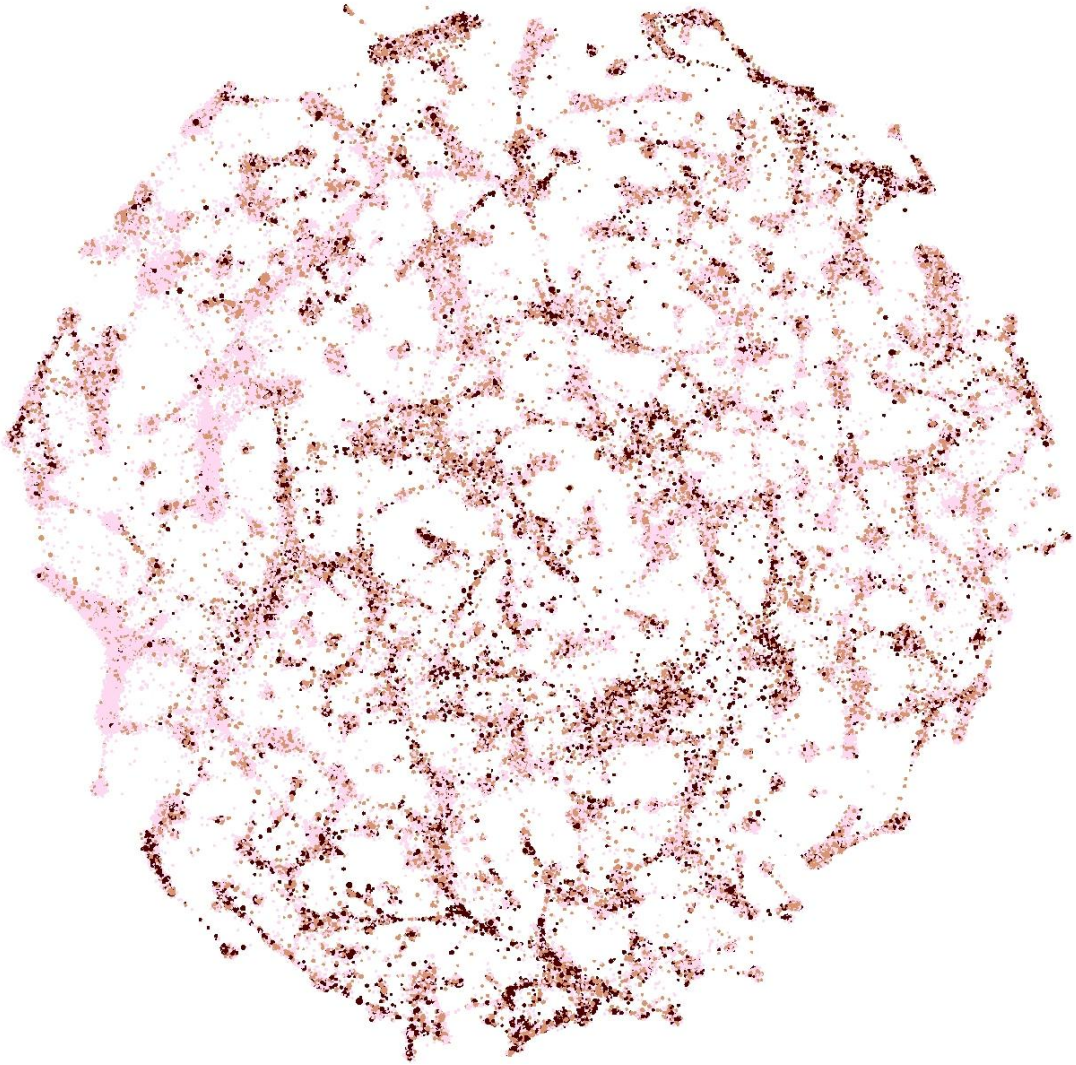
What Do We Look For?

- We add in ‘failures’ and ‘completed work’ from the past!



What Do We Look For?

- AND … identify existing topics with high novelty

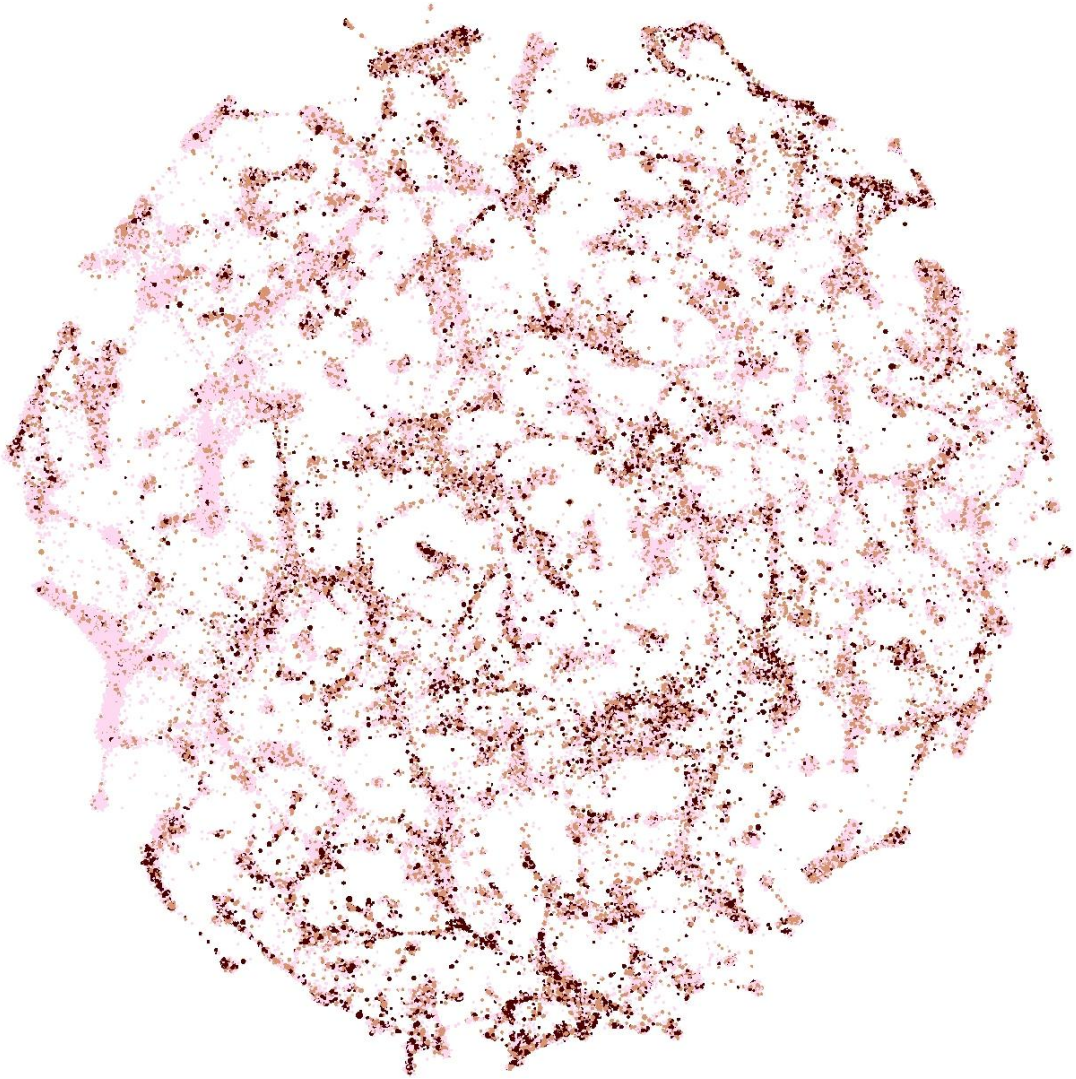


Not novel
Proven

Novel
Proven

Novel
Unproven

Top 20 PTR Opportunities

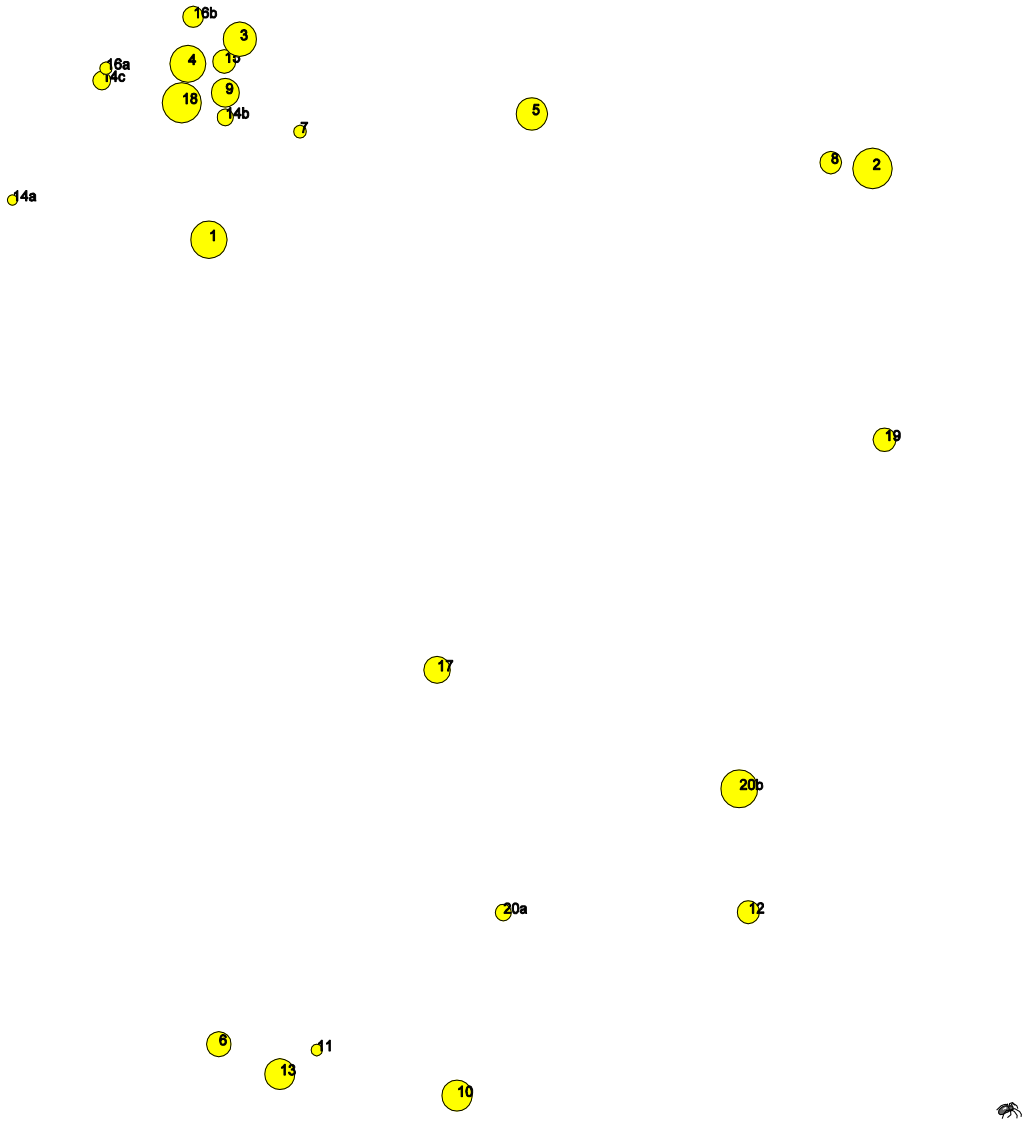


Not novel Proven

Novel Proven

Novel Unproven

Top 20 PTR Opportunities



Summary

- Science mapping can be used very effectively for portfolio analysis
  - Accuracy and detail are critical
  - Traditional overlaps and gaps (mismatches) are relatively simple to map
- Science mapping can also be used very effectively to identify potentially transformative research
  - The concept of novelty is key

Relevant Literature

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Thank you!