
Next Steps in Addressing Impact

Julia Lane

American Institutes for Research

University of Strasbourg

University of Melbourne

Key ideas

Conceptual Framework: Theory of change

- Basic unit of analysis is individual scientists/teams
- Core outcome is creation, transmission and adoption of ideas

Empirical Framework

- Leverage existing data and tools
- Build analytical community (e.g. SciSIP)

Overview

- Conceptual Framework
- Empirical Approach
- Examples

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Impact Evaluation in Practice

Paul J. Gertler, Sebastian Martinez,
Patrick Premand, Laura B. Rawlings,
Christal M. J. Vermeersch

Conceptual Framework: Measuring Impact

- What is the impact or causal effect of a program on outcome of interest?
- Is a given program effective compared to the absence of the program?
- When a program can be implemented in several ways, which one is the most effective?

Classic Example: Measuring Impact

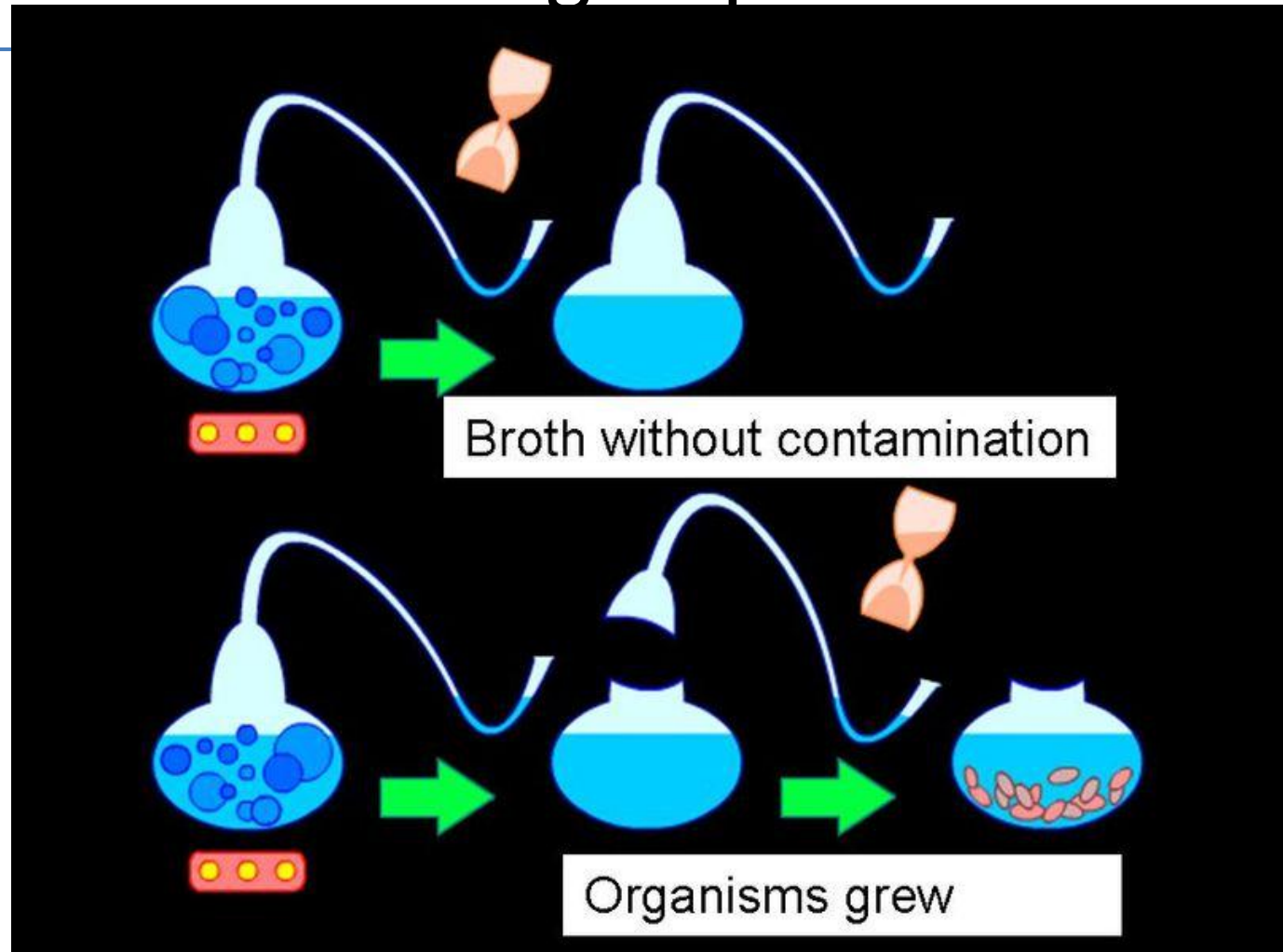


Illustration of swan-necked flask experiment used by Louis Pasteur to test the hypothesis of spontaneous generation

Classic Challenge: Identifying Counterfactual

- “A key goal of an impact evaluation is to identify a group of program participants (the treatment group) and a group of nonparticipants (the comparison group) that are statistically identical in the absence of the program.” World Bank

Figure 3.1 The Perfect Clone

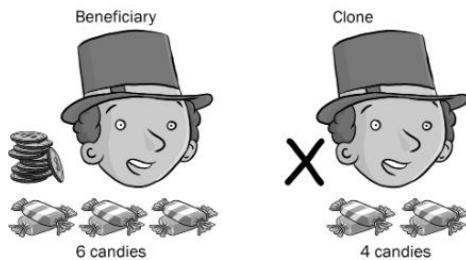
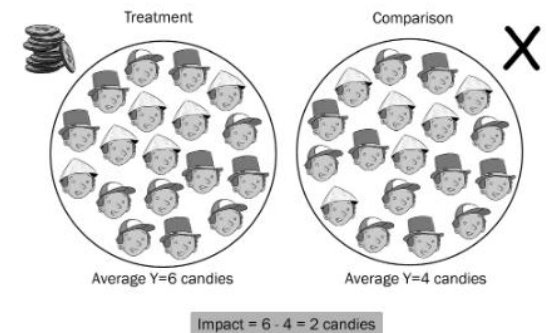
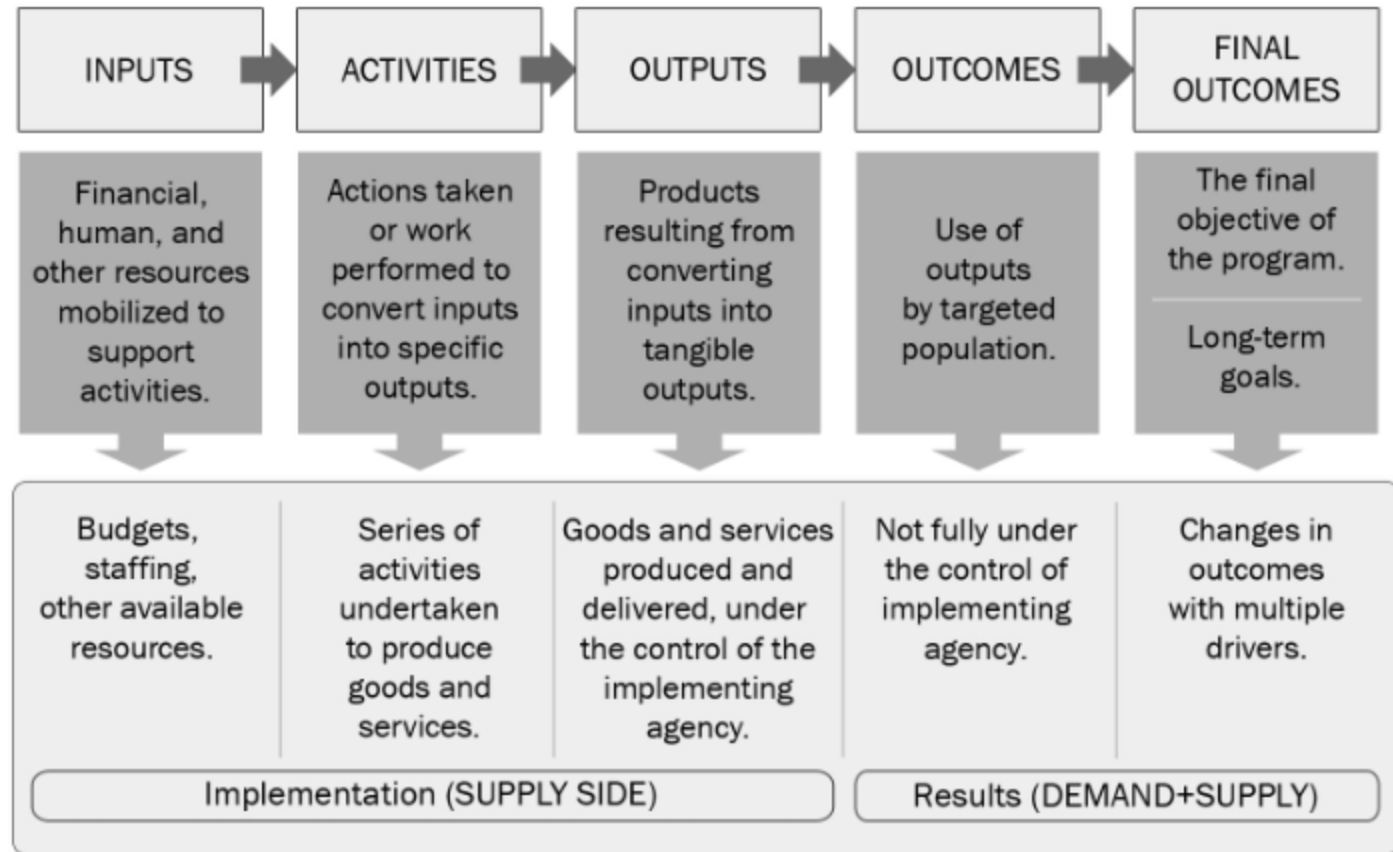


Figure 3.2 A Valid Comparison Group



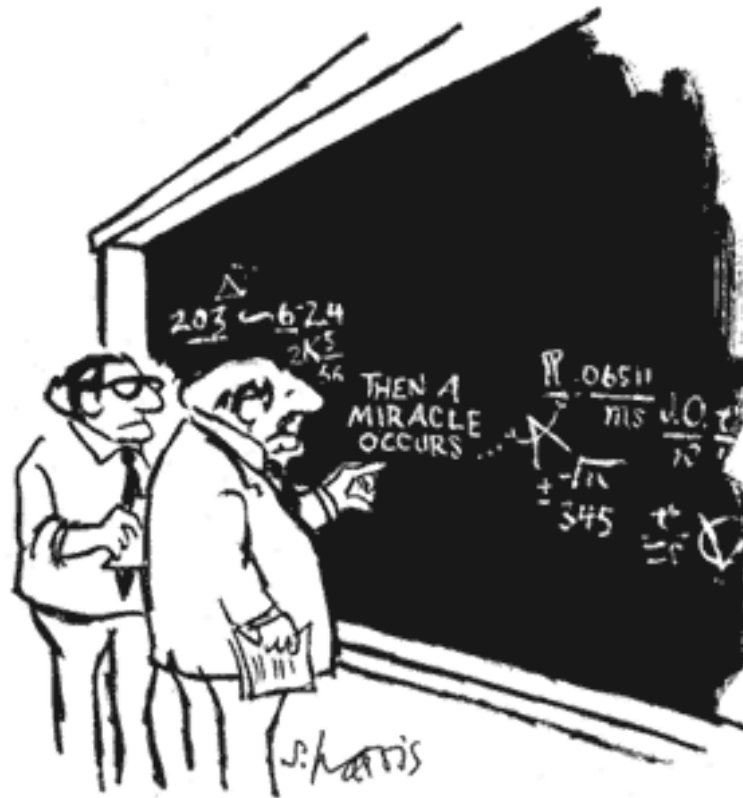
Source: Authors.

Classic Challenge: Theory of Change



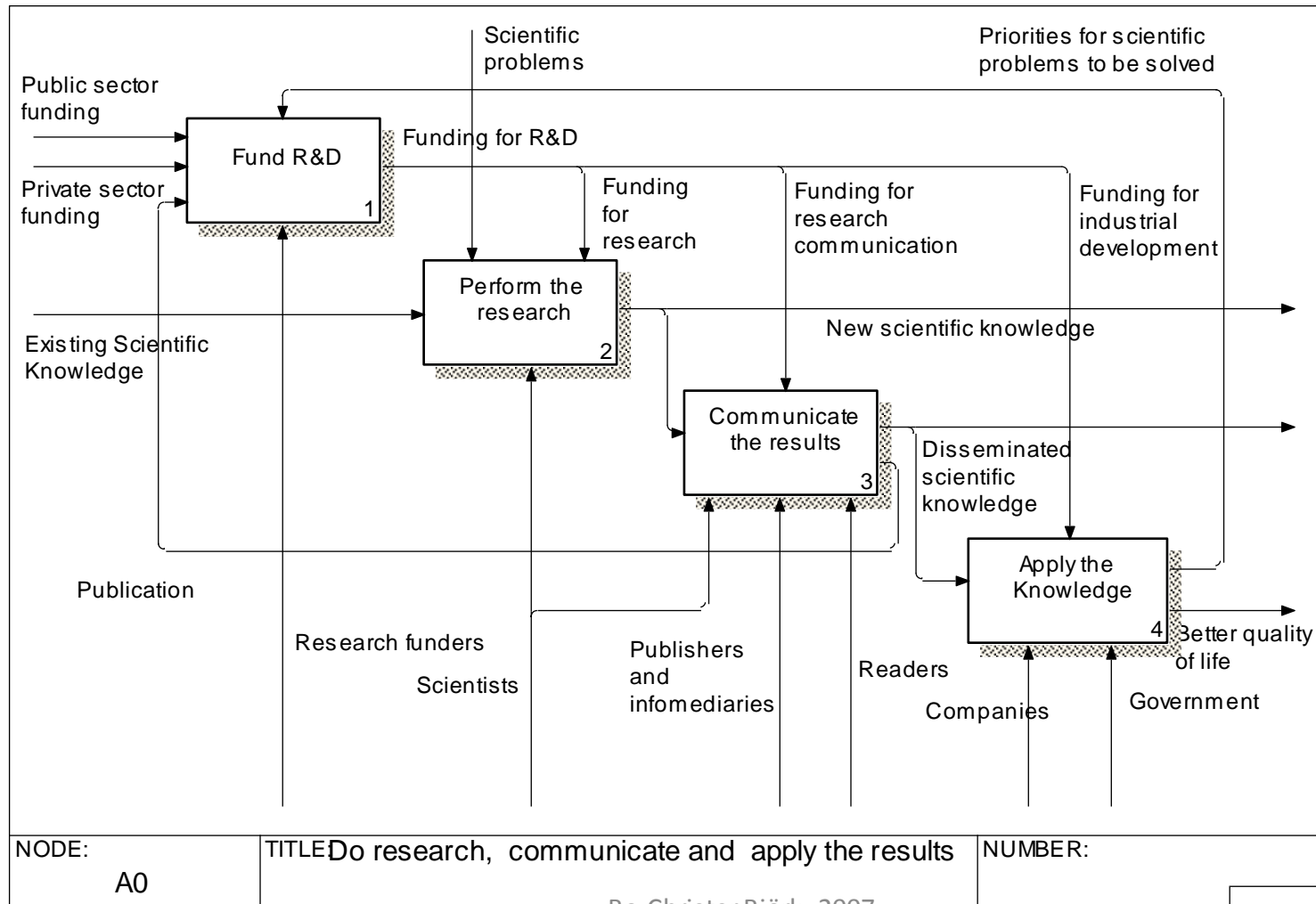
Source: Authors, drawing from multiple sources.

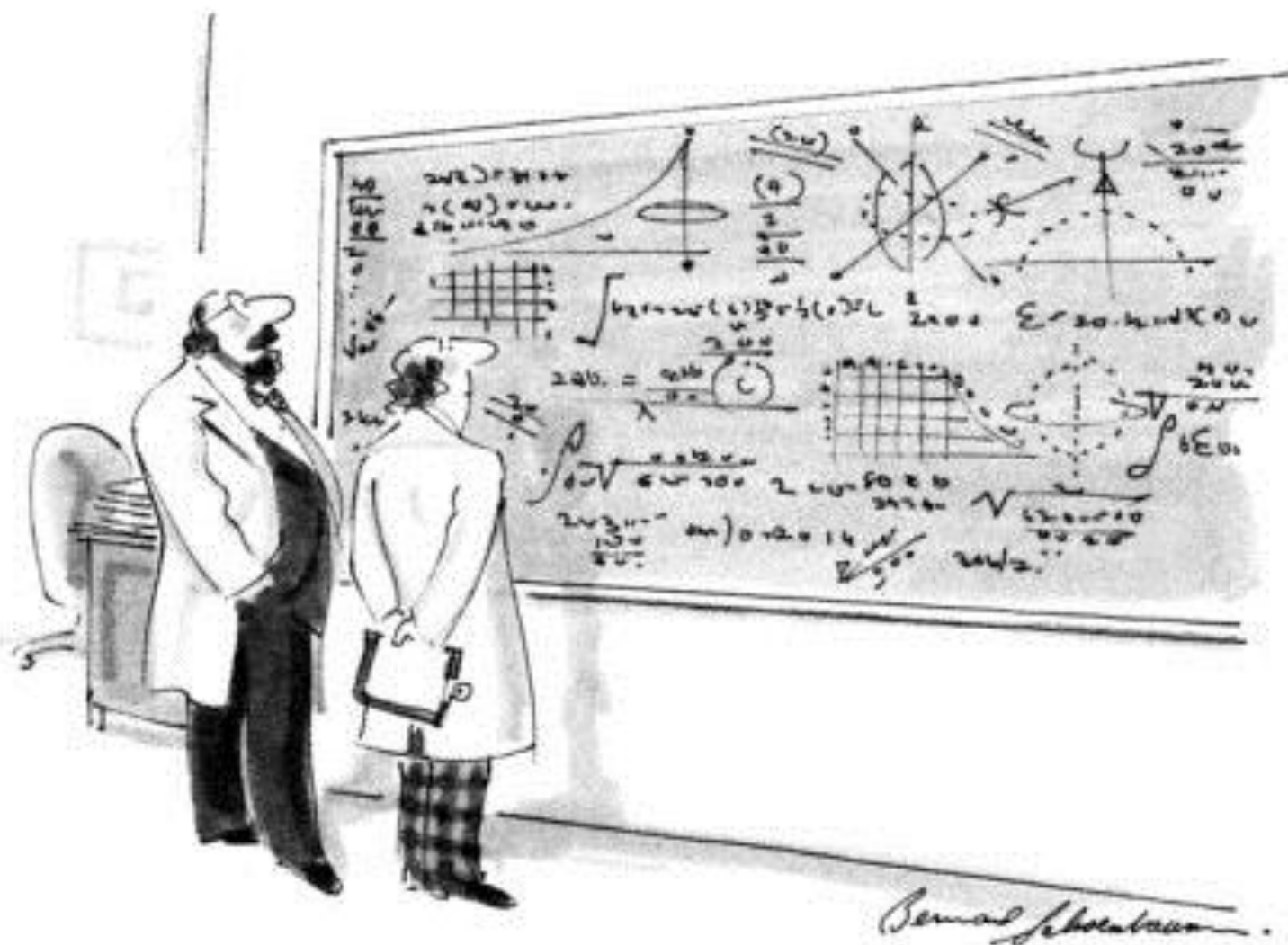
Move beyond “Black Box”



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

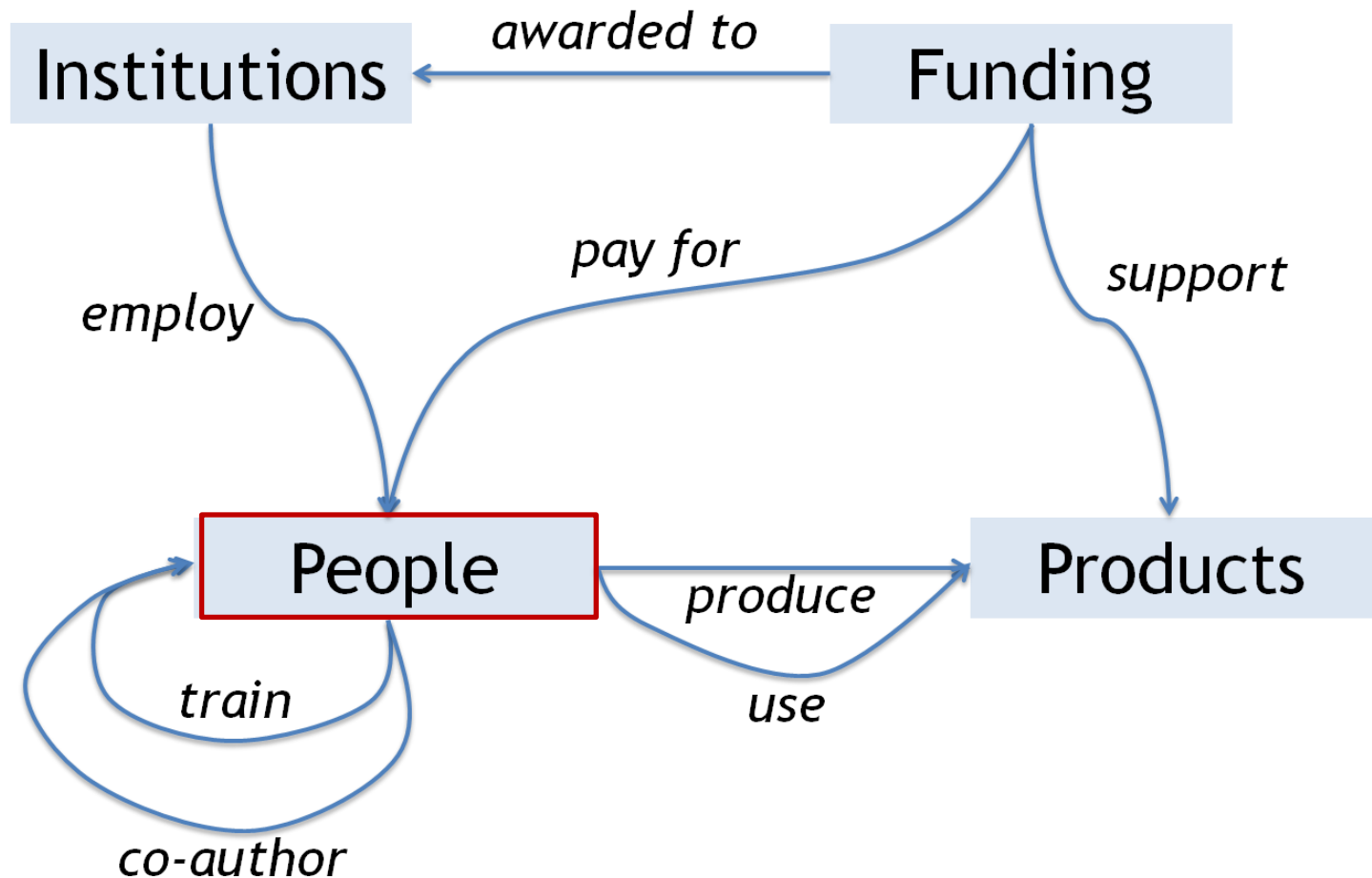
The Black Box





"Oh, if only it were so simple."

Opening the Black Box: Networks of Scientists



Adapted from Ian Foster, University of Chicago

Opening the Black Box

- [How to start a movement](#)

Overview

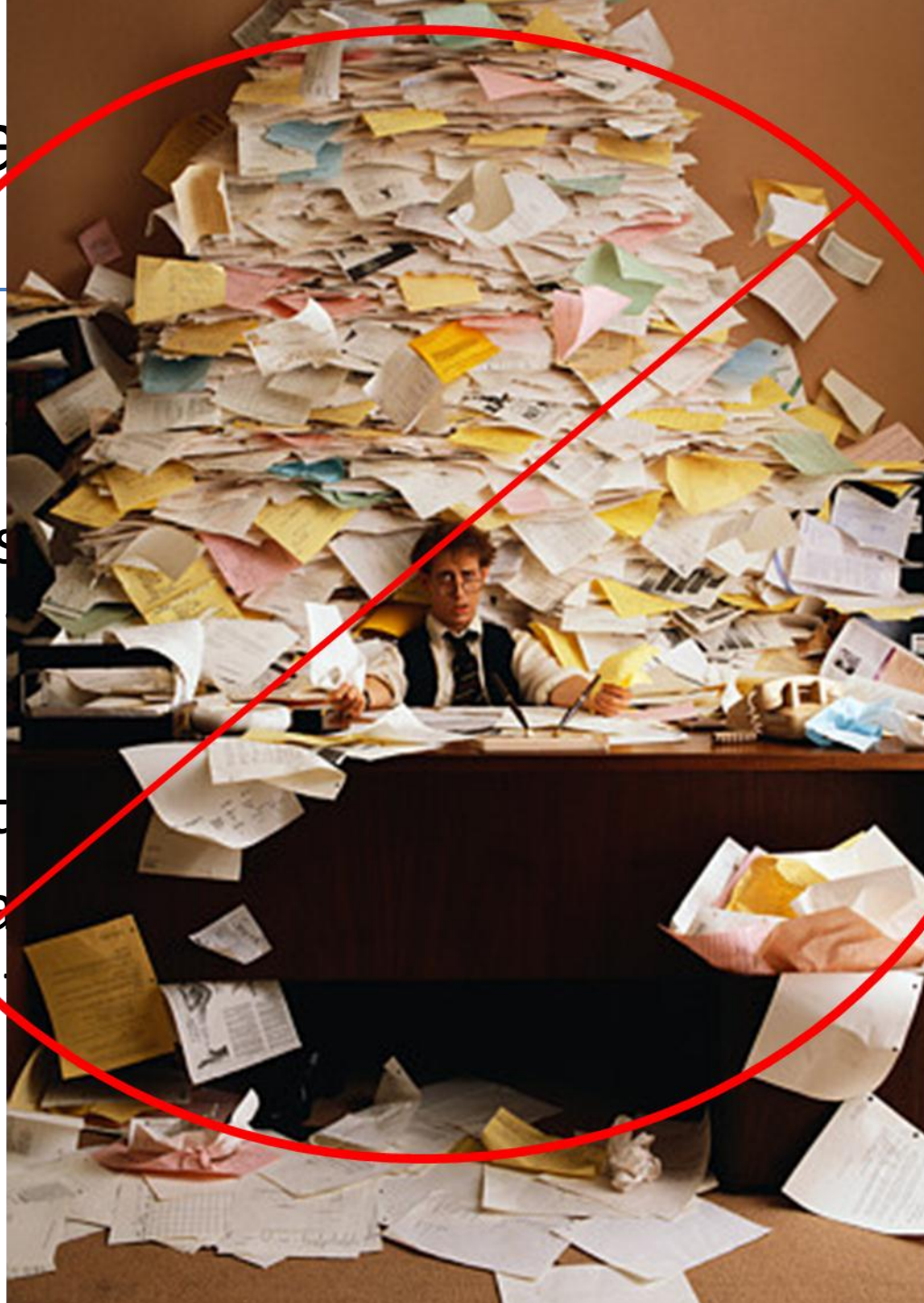
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Empirical

existing

- Scientific
- New appl
- New ways
- New appl
- New data
computat

=> Potential
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question



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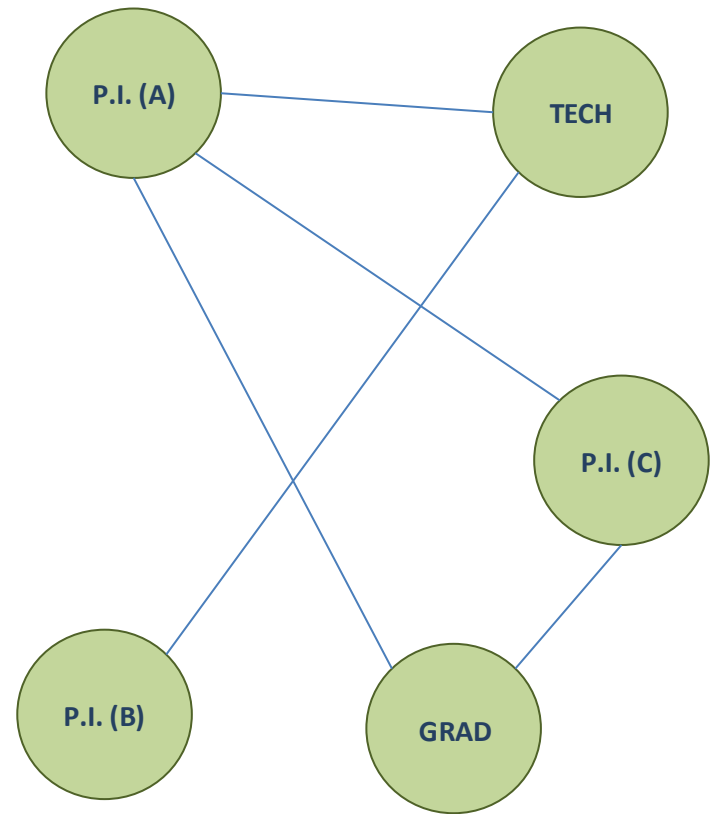
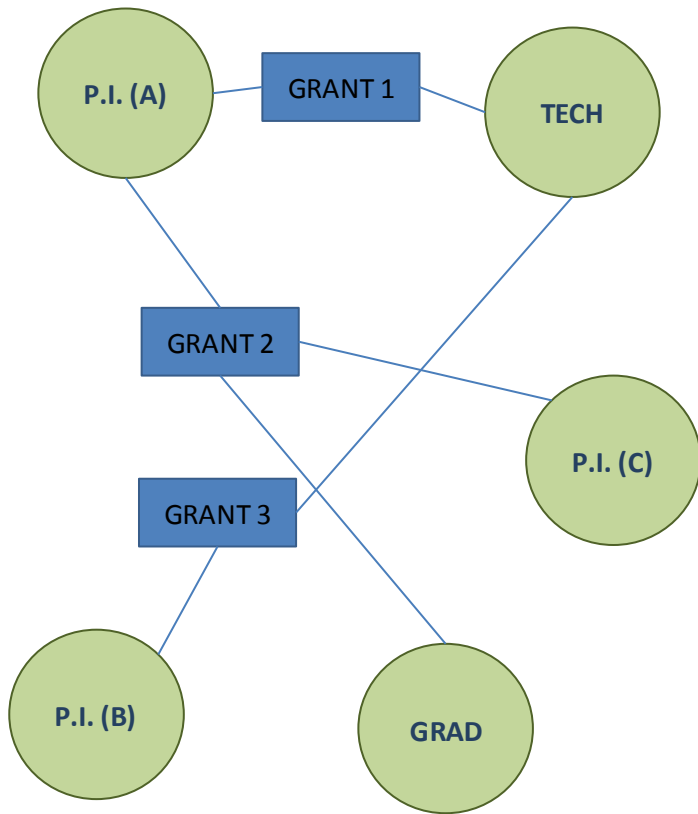
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Overview

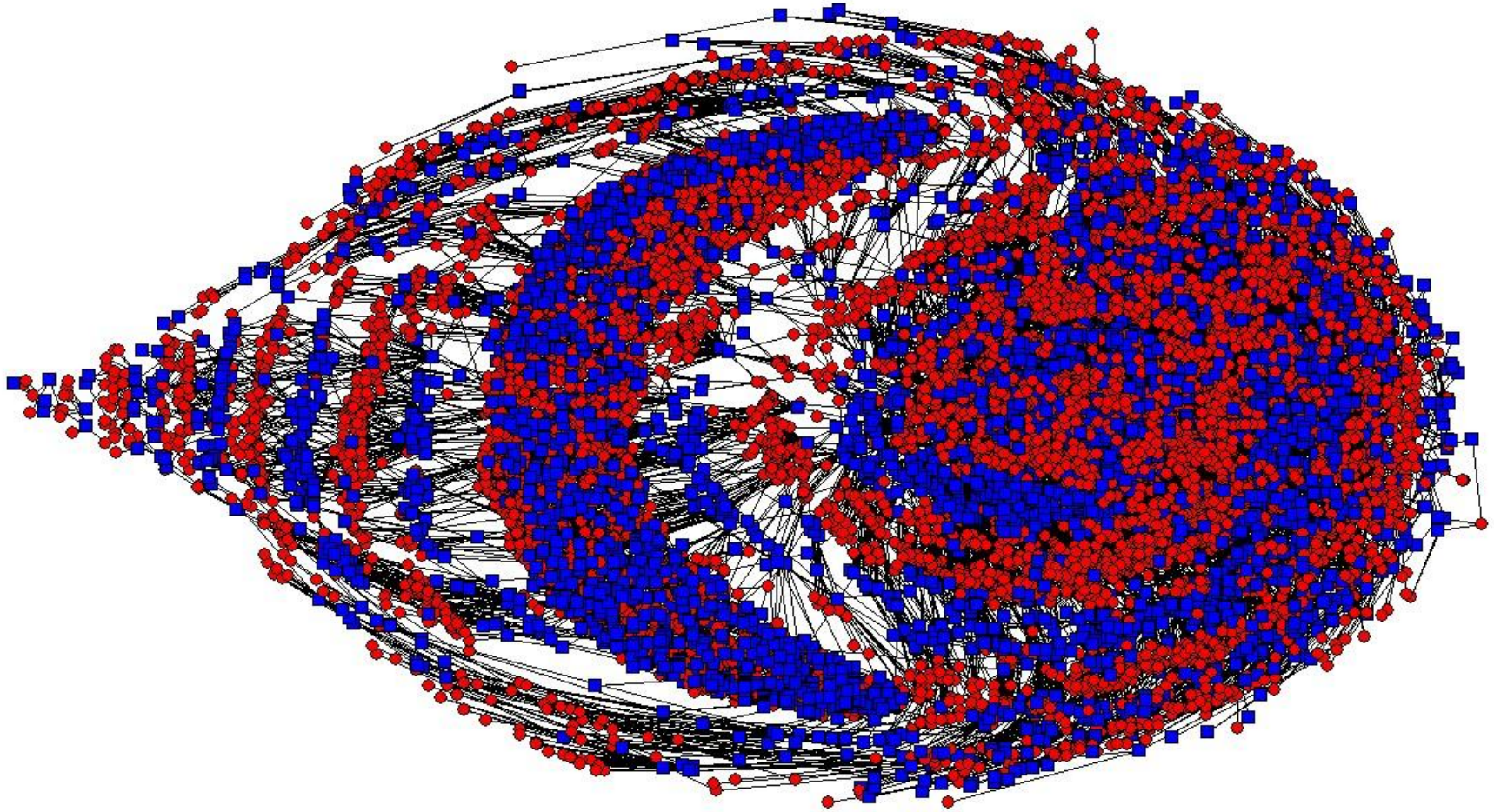
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Example 1: University of Michigan

STAR METRICS: Rich Collaborative Universe

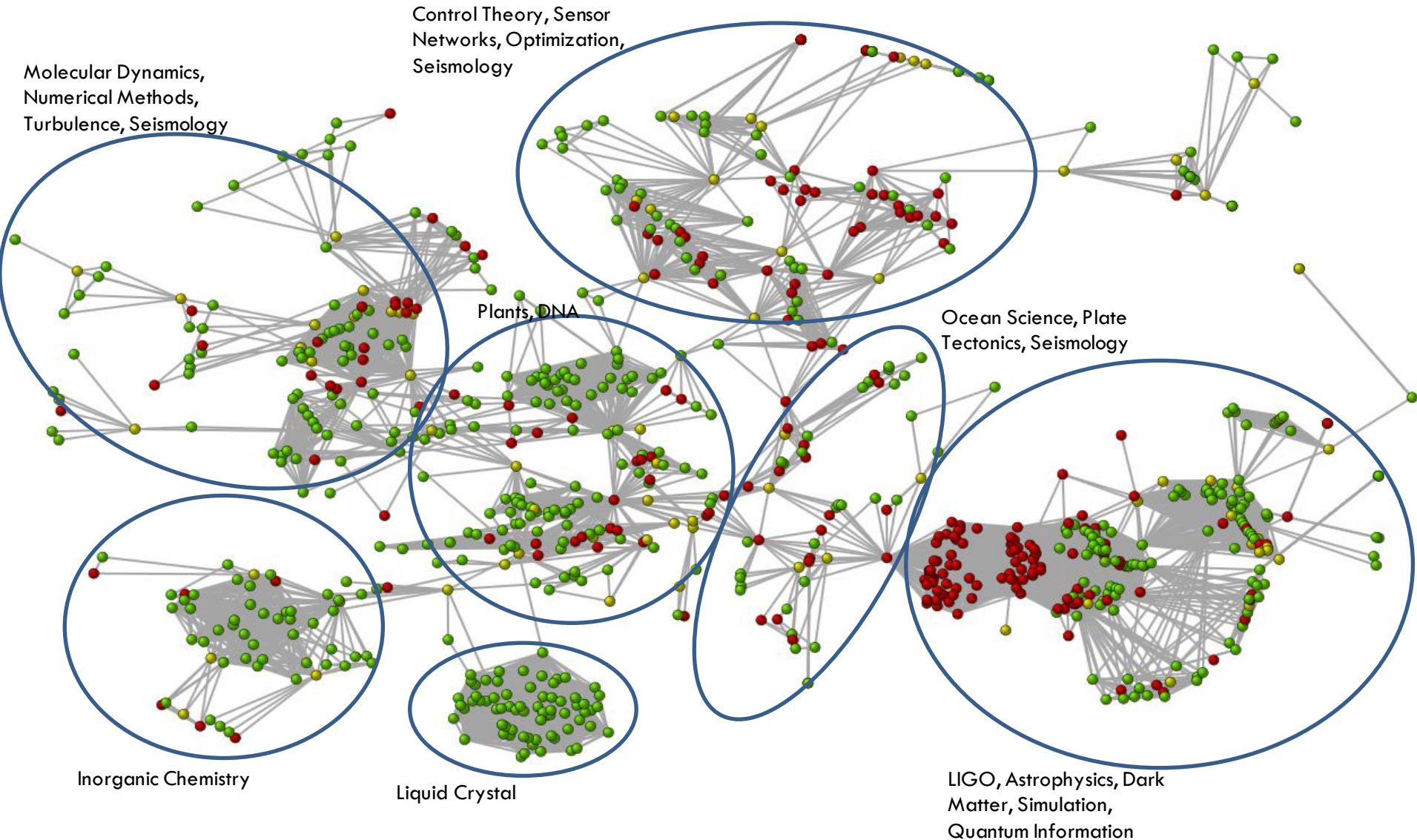


STAR METRICS: Rich Collaborative Universe

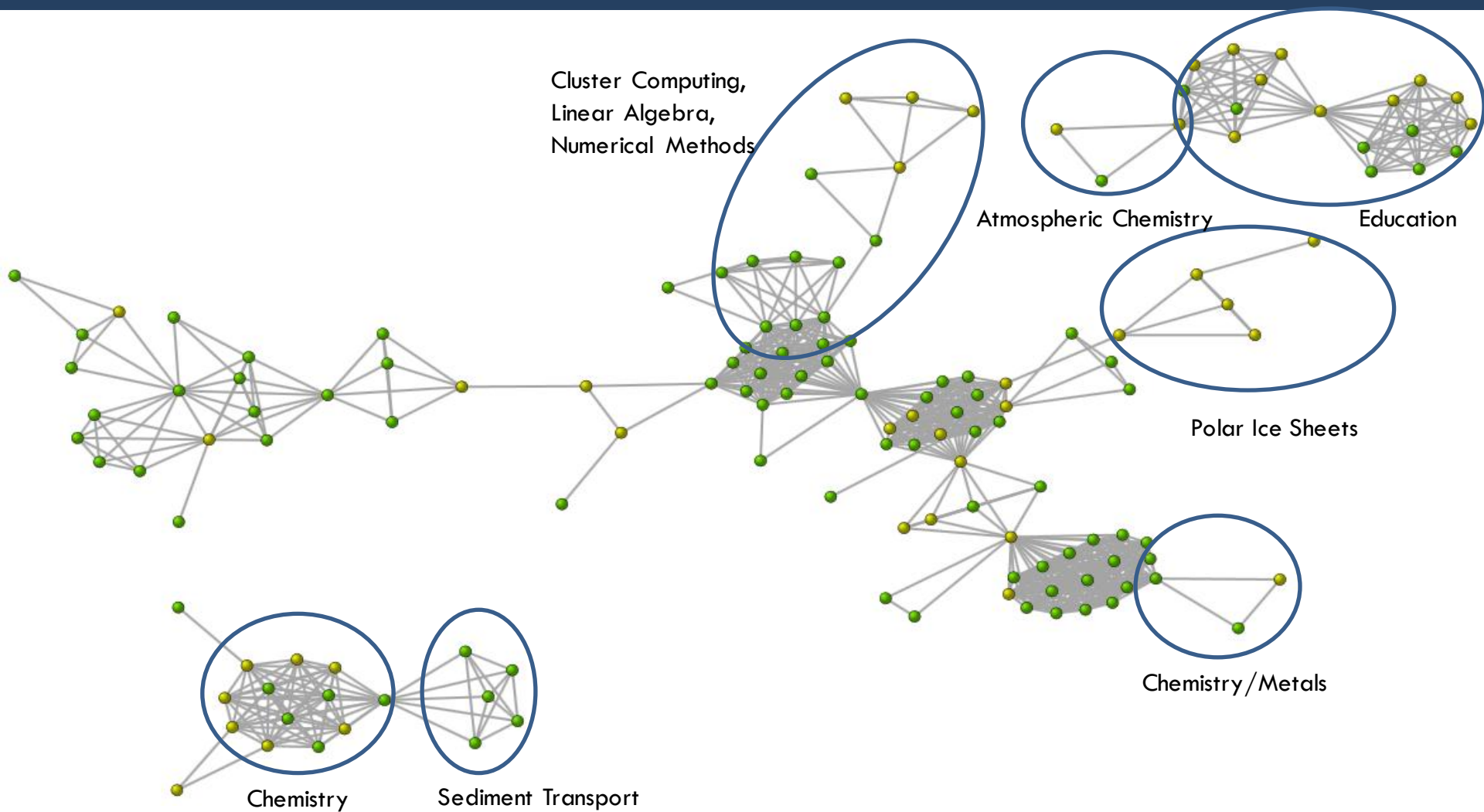


Researchers & Grants

STAR METRICS: Private university, Aed



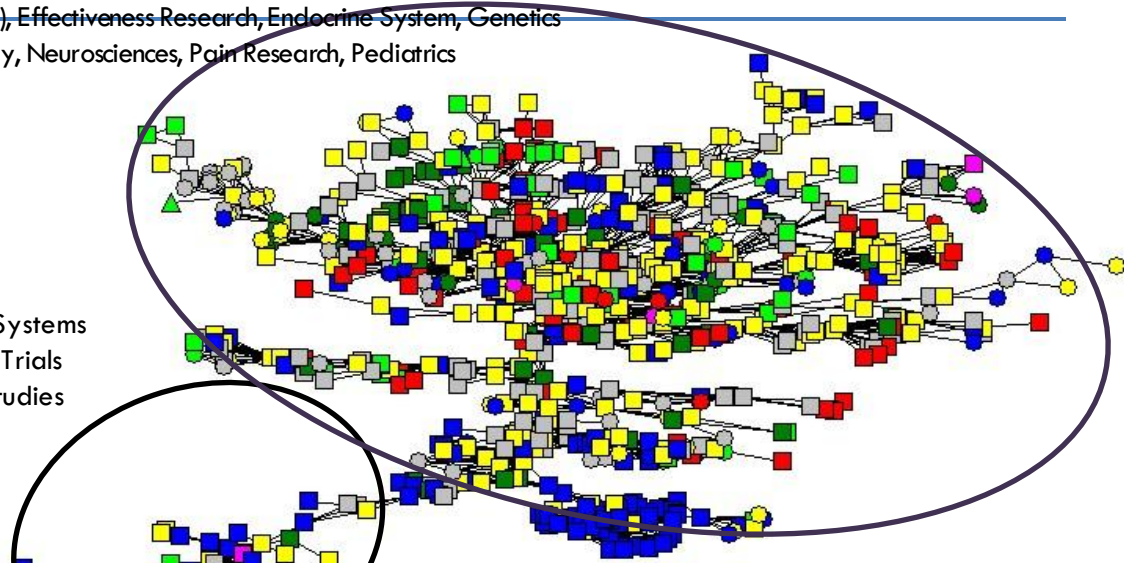
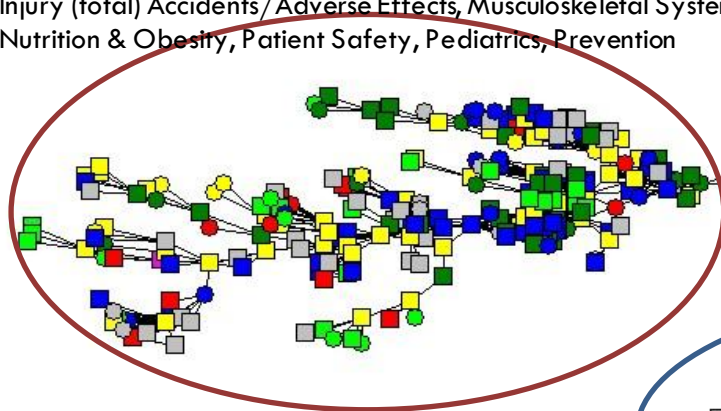
STAR METRICS: Public university, Med



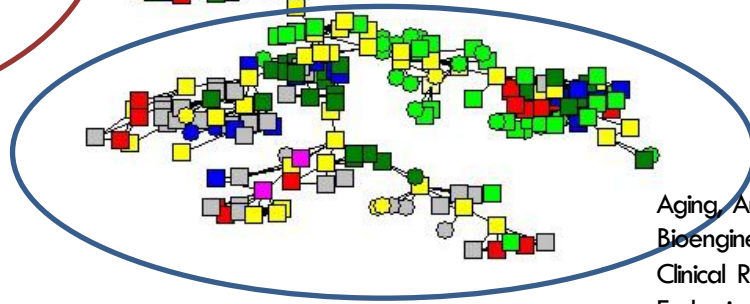
STAR METRICS: Public university, Med

Behavioral and Social Science, Brain Disorders, Cancer, Chronic Disease and Organ Systems, Clinical Research & Trials
~~Depression, Diabetes, Digestive Diseases, Drug Abuse (NIDA Only), Effectiveness Research, Endocrine System, Genetics~~
 HIV/AIDS, Infectious Diseases, Lung, Mental Health, Mind and Body, Neurosciences, Pain Research, Pediatrics
 Pneumonia & Influenza, Prevention, Stem Cell Research

Asthma, Behavioral and Social Science, Bioengineering
 Biomedical Information Resources, Chronic Disease and Organ Systems
 Climate-Related Exposures and Conditions, Clinical Research & Trials
 Contraception/Reproduction, Epidemiology And Longitudinal Studies
 HIV/AIDS, Immune System, Infectious Disease and Bioterrorism
 Injury (total) Accidents/Adverse Effects, Musculoskeletal System
 Nutrition & Obesity, Patient Safety, Pediatrics, Prevention



Adolescent Sexual Activity, Behavioral and Social Science, Brain Disorders, Cancer
 Chronic Disease and Organ Systems, Clinical Research & Trials, Contraception/Reproduction
 Diagnostic Radiology, Drug Abuse (NIDA Only), Epidemiology And Longitudinal Studies
 Genetics, HIV/AIDS, Kidney and Urologic, Mental Health, Mind and Body, Neurosciences
 Pediatrics, Prevention, Rehabilitation, Translational Research



Aging, Autoimmune Disease, Behavioral & Social Science
 Bioengineering, Brain Disorders, Cancer, Cardiovascular
 Clinical Research & Trials, Diabetes, Digestive Diseases
 Endocrine System, Epidemiology And Longitudinal Studies
 Genetics, HIV/AIDS, Huntington's Disease, Neurosciences
 Nutrition & Obesity, Rare Diseases

Comparison of Social Networks

Private (no Med)	Public (no Med)	Public (Med)
2000 people paid by 450 science agency grants	4000 people paid by 900 science agency grants	5000 people paid by 3500 science agency grants
26.8% Isolated	31.3% isolated	13.6% isolated
53.8% Reachable	10.6% Reachable	28.4% Reachable
Density = .038, CC = .896, Constraint = .321	Density = .007, CC = .877, Constraint = .425	Density = .007, CC = .878, Constraint = .483
Research Staff (shared instrumentation?) & faculty are powerful bridges	Faculty are more often powerful bridges, but very little reachability and diversity	Faculty and Research staff bridge projects
Potential topic gaps in component	Topic gaps less clear	Significant connections and overlaps between topics in component

Sidebar: Interim Developments

- Private and public universities with no medical schools are funded by NSF
 - Easier identification and linking of topics
- Public university with a medical school is primarily funded by NIH
 - No easy way to pull or identify projects by the 233 NIH Research, Condition, and Disease Categorization (RCDC) codes
 - *Our linking of NIH RCDC codes is *novel* and makes possible new linkages between STAR METRICS data and broader scientific and economic impacts*

El Dorado: Comparative, Dynamic Networks

- Estimating effects of:
 - New construction +/or acquisitions
 - Institutional seed funding
 - Large scale grants (e.g. CTSA, ERC, STC)
- Documenting process and outcomes of training efforts
- Explaining (predicting?) sources of new breakthroughs
- Enabling active ‘portfolio management’ by e.g. hiring committees
 - “moneyball for science”

The University's Economic Geography



Does the University gash through or stitch together the larger region?

Estimating Impact of Federal R&D \$\$

- **Direct (STAR METRICS does pretty well)**
 - New University Jobs
 - Discoveries (Pubs Patents)
 - Revenue for local Vendors/Subcontractors
- ***Indirect (other data needed)**
 - Job retention/creation effect of local spending
 - Regional economic resilience
 - University start-ups
 - Corporate “discovery premium” to “spillovers” from hiring research trained graduates
 - University “discovery premium” from stronger industry connections
 - New funding shifts collaboration networks changing amount and character of science

More on *Indirect Impact of Fed R&D

- Indirect impact measures can be estimated from the Longitudinal Employer Household Dynamics (LEHD) dataset using network methods. Exciting possibilities in organization and individual level links between STAR METRICS & LEHD.

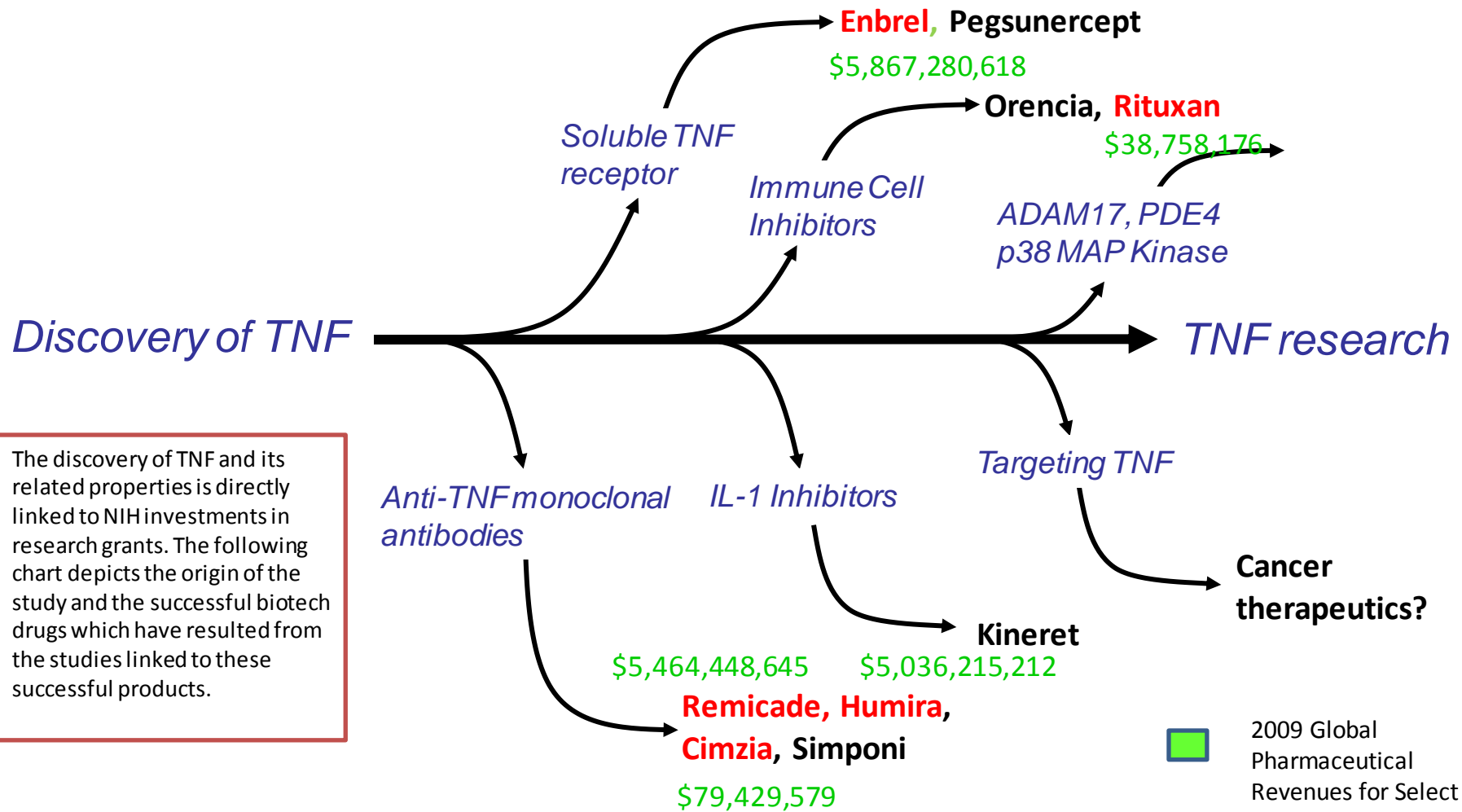
Summation

- The scientific and economic impact of federal R&D spending at universities depends on:
 - Collaborative organization of research on campus
 - *Test with intra-university networks extracted from STAR METRICS*
 - The economic geography of a university's location
 - *Test with Regional/State data from LEHD*
 - Position a university occupies in its region
 - *Test with linked STAR METRICS/LEHD data that locate universities in regional employment networks*

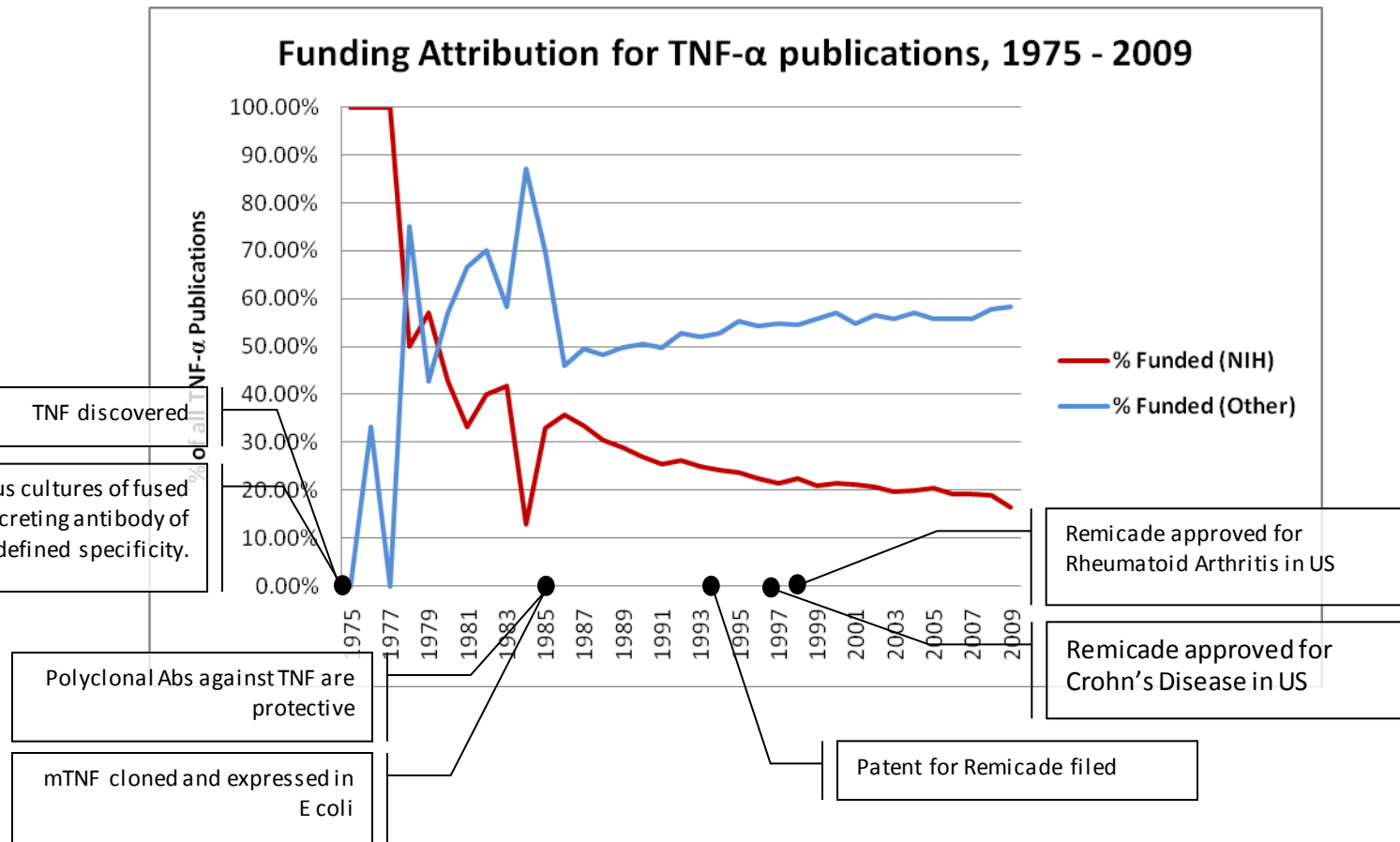
Example 2:

- Scientific networks and social/economic impact

Enbrel & Remicade



Funding trends in TNF- α publications



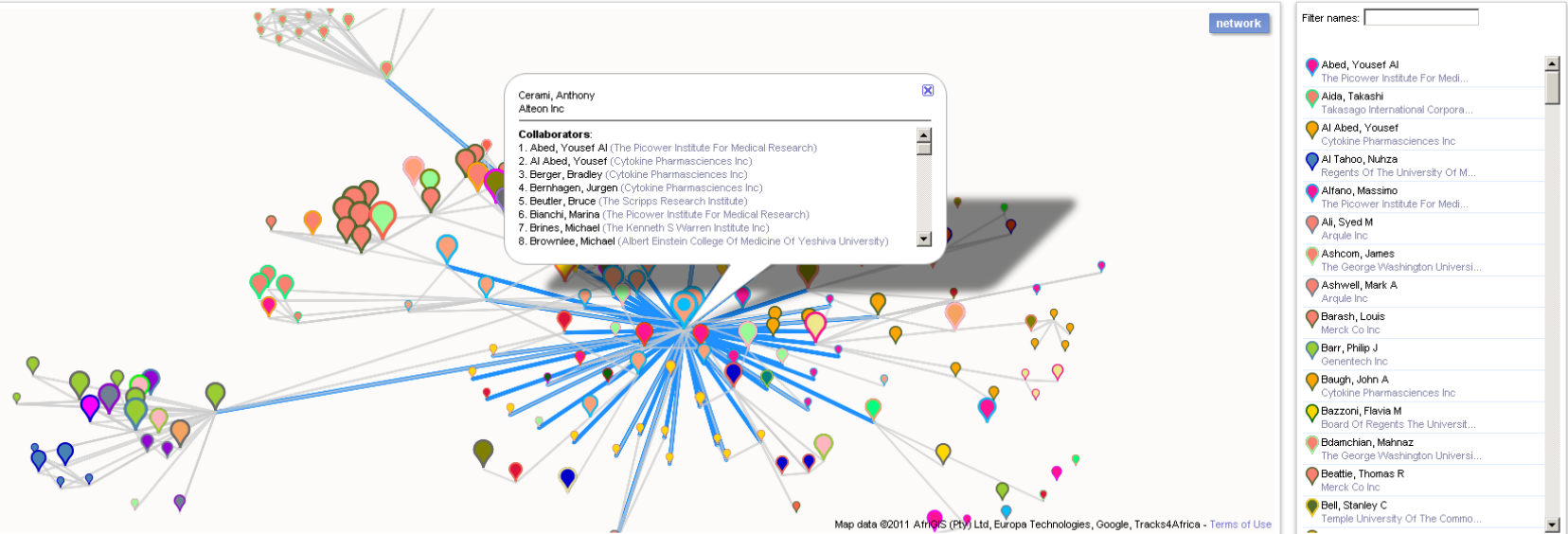
The Networks that Did It



[Return to timeline](#) | [See all Scientists](#)

Anthony C. Cerami, PhD

[Curriculum Vitae](#) [Discovery Highlights](#) [NIH Grants](#) [Patents](#) [Network](#)



Brief explanation: The visualization above is a (granted) patent collaboration network map (1975-2009) where vertices (nodes) represent individual scientists and edges (connections) are created through joint patenting. The diagram centers on the primary scientist, so every node in the graph is within 2 connections or less of the primary. Scientists are attributed to the latest firm within their patenting history. Colors are assigned by firms although disambiguation errors may cause slight discrepancies. Scientists specifically identified in this study are indicated with a smaller center circle. The network map utilizes the Fruchterman-Reingold layout.

The rendering time of the network map depends on its complexity and may utilize a clustering algorithm.

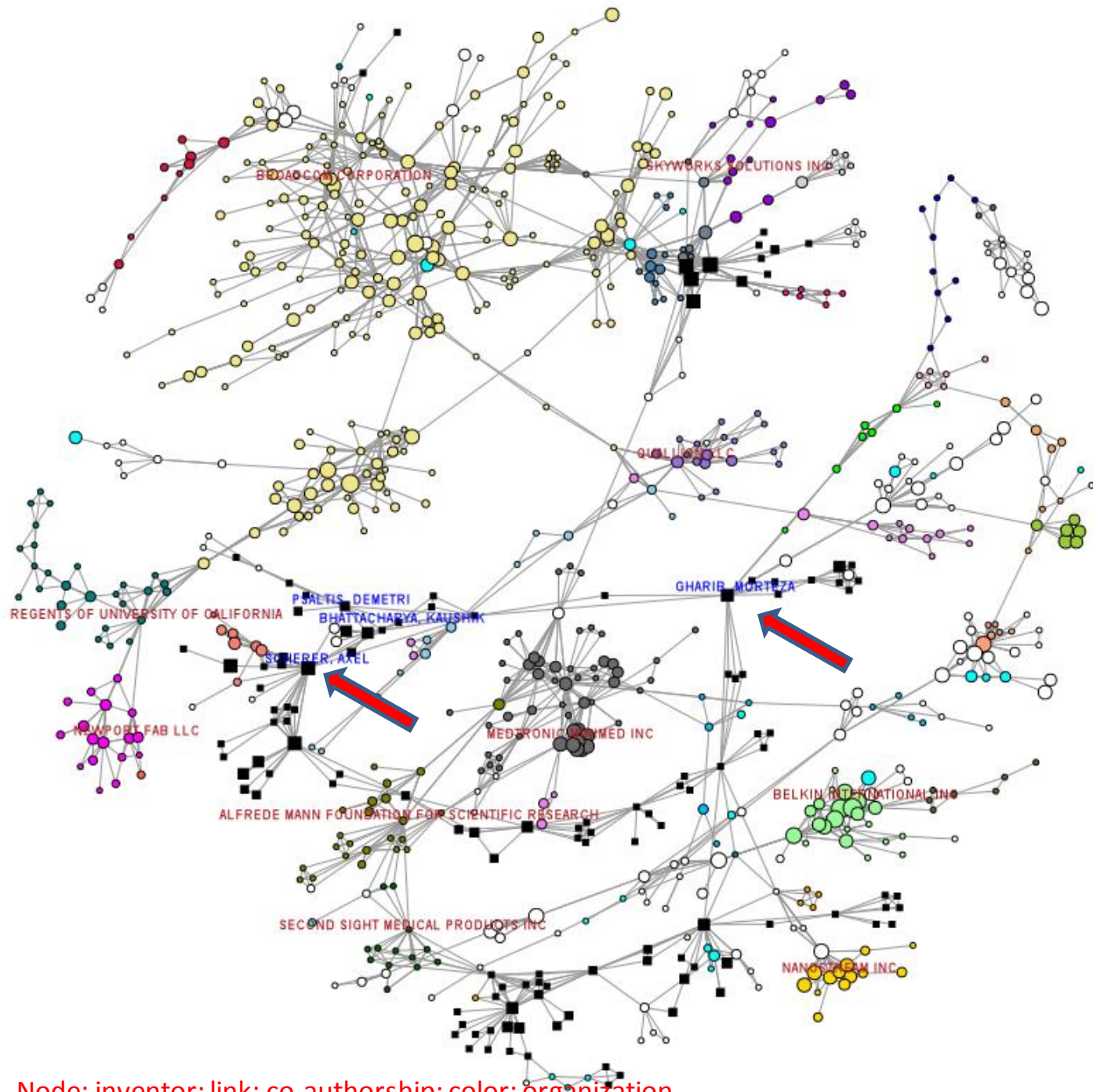
This network map is preliminary and generated through open source software (graph), public APIs (Google Maps) and the HBS Patent Collaboration Network database.

Example 3:

- Student/Faculty networks and social/economic impact

1st LCC in S. Cal

- **Broadcom:** networking and communications ICs for data, voice, and video applications
- **Medtronic**
- **Univ. of California**
- **Belkin Int'l:** computer connectivity hardware
- **Second Sight:** retinal prosthesis (cybernetic eyeglasses)
- **Alfred Mann Foundation:** funds medical device research



Node: inventor; link: co-authorship; color: organization

Zeroing in on PIs

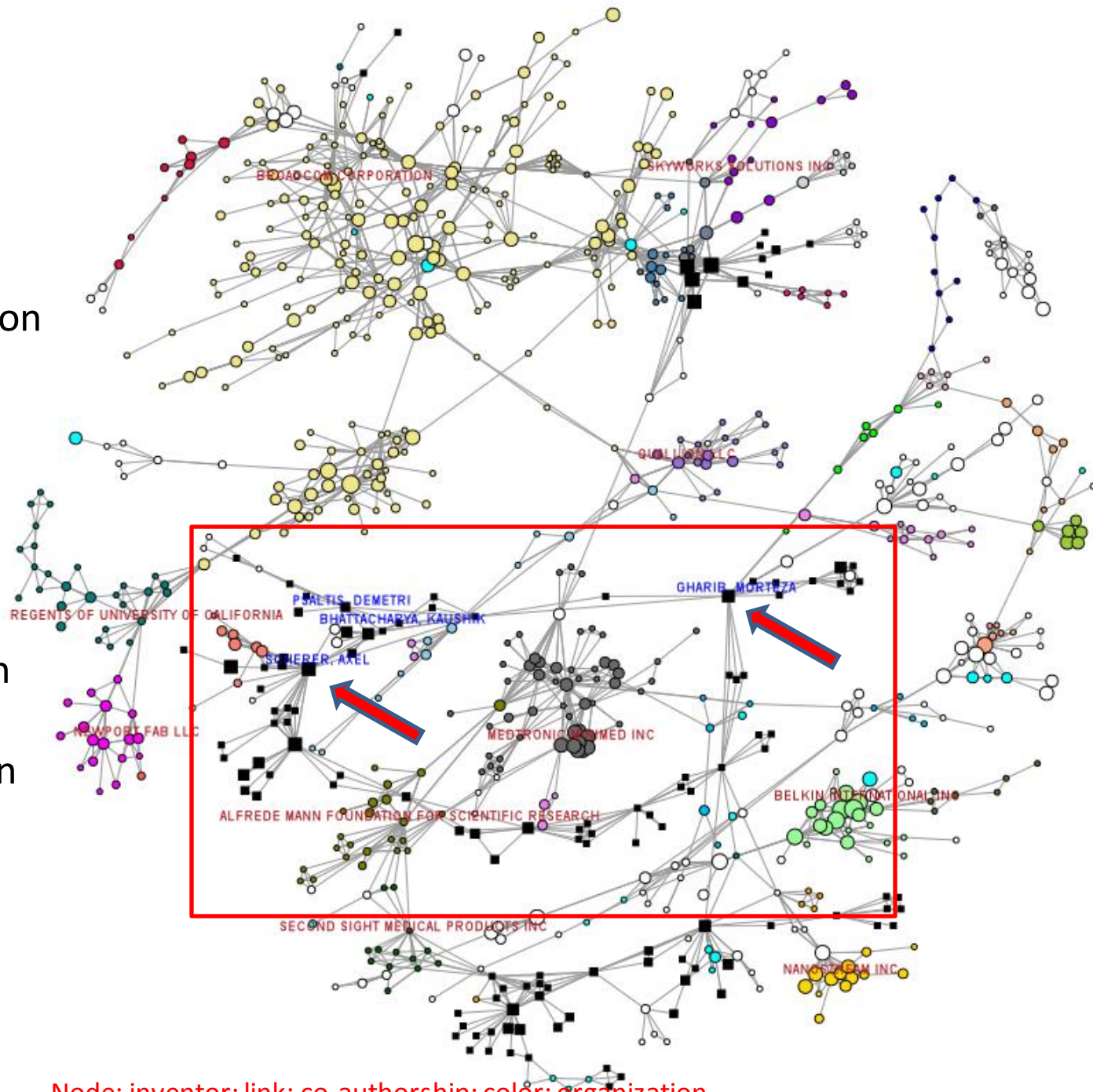
1. Knowledge Diffusion Three links out

(Singh 2005)

2. Sources of Links

- Student graduation
- Inventor mobility
- Direct collaboration

(Fleming 2007)



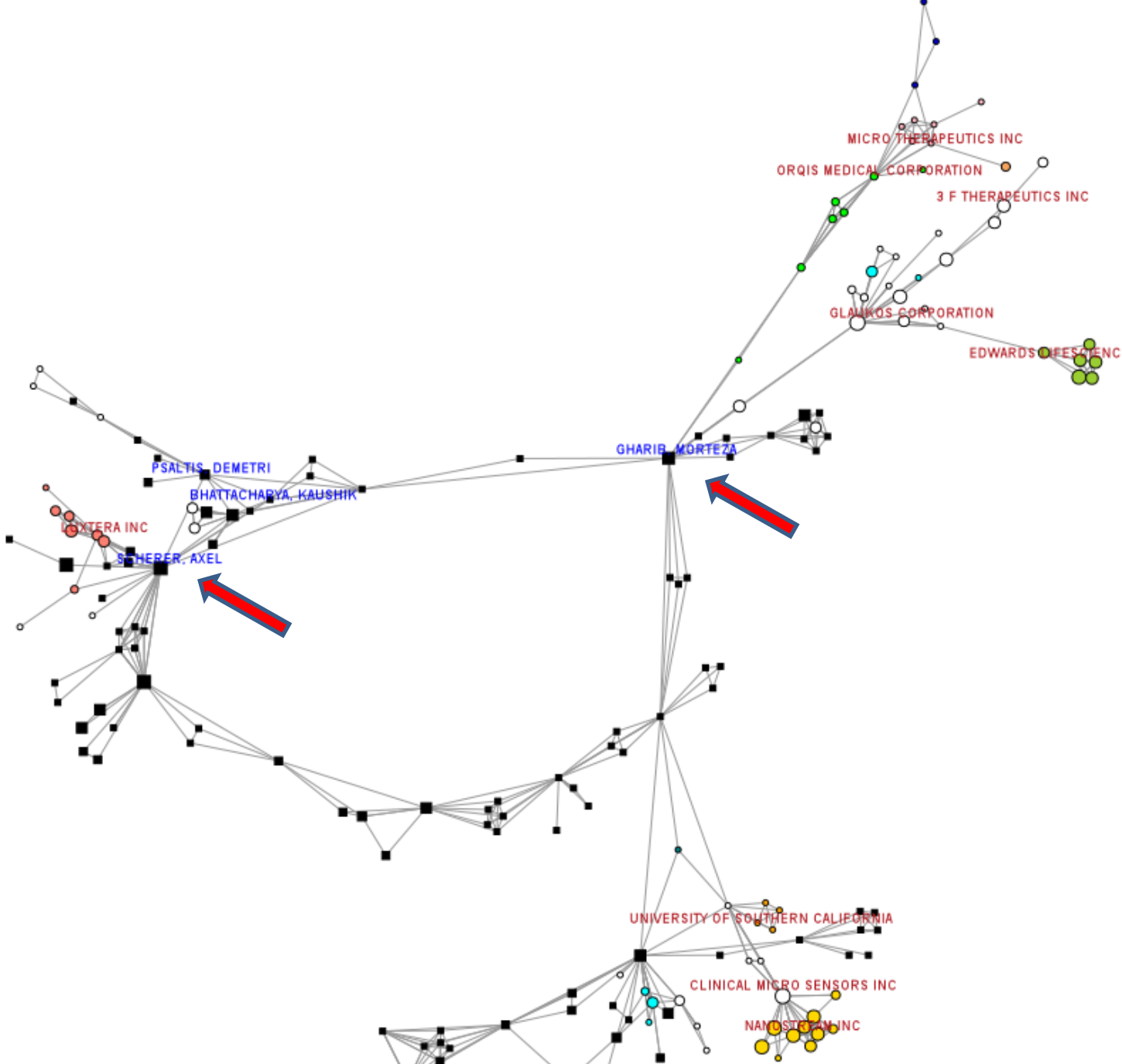
Node: inventor; link: co-authorship; color: organization

Zeroing in on PIs

Morteza Gharib (Hans W Liepmann Prof of Aeronautics and Bioengineering)

Axel Scherer (Neches Prof of Electrical Engineering, Applied Physics and Physics)

probably generating significant spillovers in local economy, *probably* through student mobility or direct collaboration



Node: inventor; link: co-authorship; color: organization

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- Closing Comments

Indicators of Collaboration

- ~~The number of internal and external collaborators within each project;~~
- The number of internal and external collaborators of I funded researchers working in the same research area;
- **The time it takes** for collaborations to move from idea to dissemination;
- **The number and proportion** of funded researchers in given topic area at time of funding;
- The number and proportion of funded researchers in subsequent periods.

Indicators of breadth of coverage

- New people (especially students) entering the field
- The number of **links to research organizations**;
- The number of **links to businesses** in each research area;
- The **industries** in which collaborators work;
- The institutions of researchers working on **similar topics internationally**

Key ideas

Conceptual Framework: Theory of change

- Basic unit of analysis is individual scientists/teams
- Core outcome is creation, transmission and adoption of ideas

Empirical Framework

- Leverage existing data and tools, particularly STAR METRICS and SciENCv
- Build analytical community (e.g. SciSIP)

Thank you

- Julia Lane
- jlane@air.org