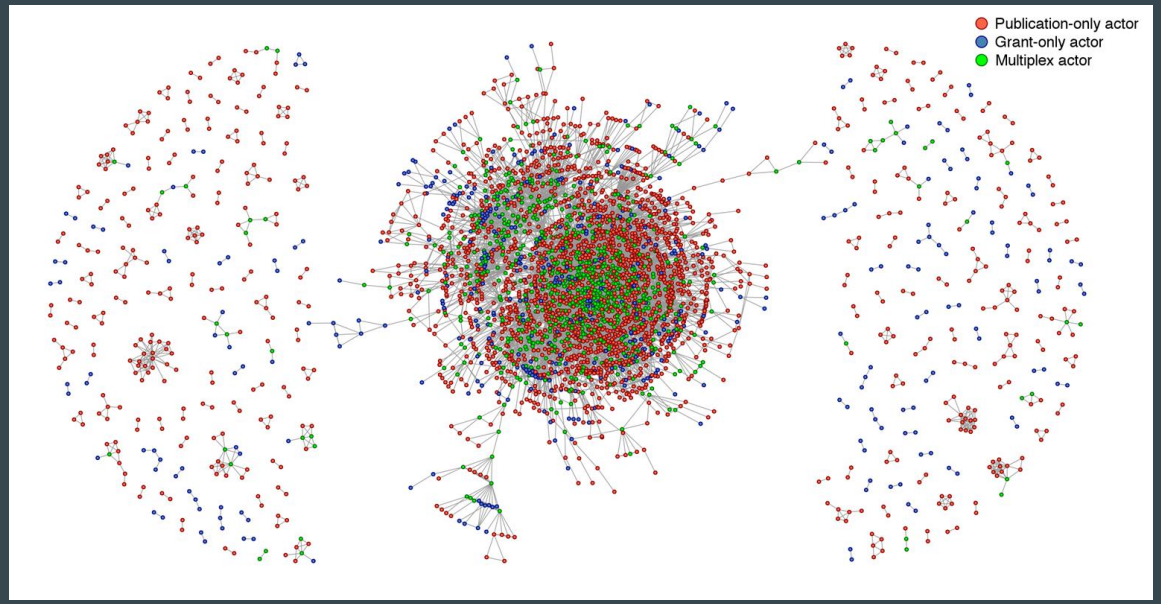
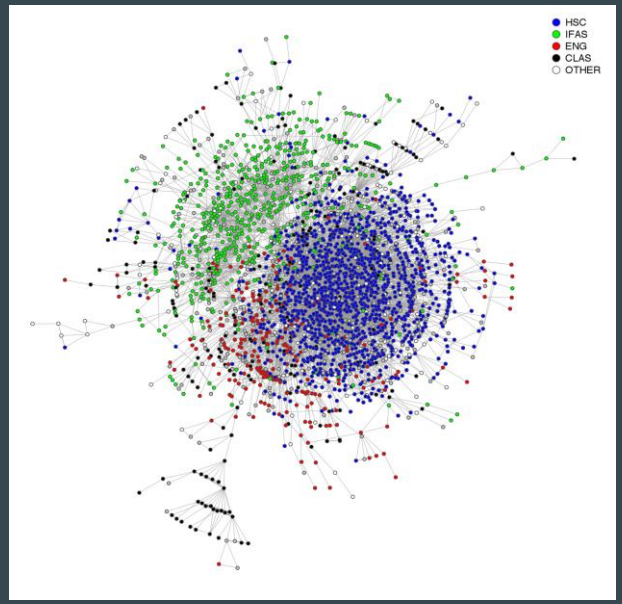
Identifying Emerging Research Fields Through Community Detection in Scientific Collaboration Networks at a Research University





UF UNIVERSITY of FLORIDA

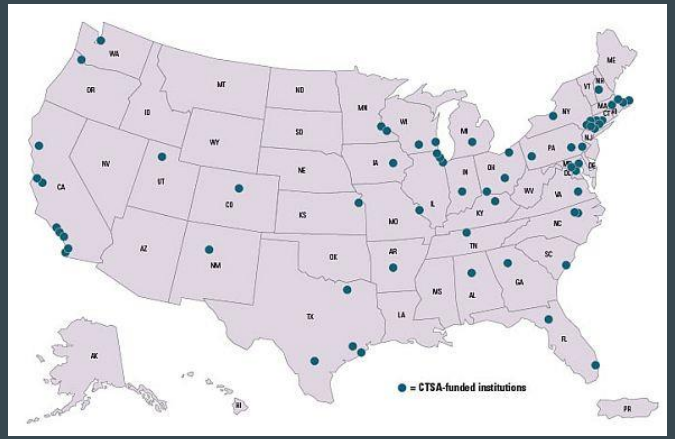
Therese Kennelly Okraku, Raffaele Vacca, Valerio Leone Sciabolazza, Christopher McCarty
XXXVI Sunbelt Conference - April 10, 2016

Acknowledgments

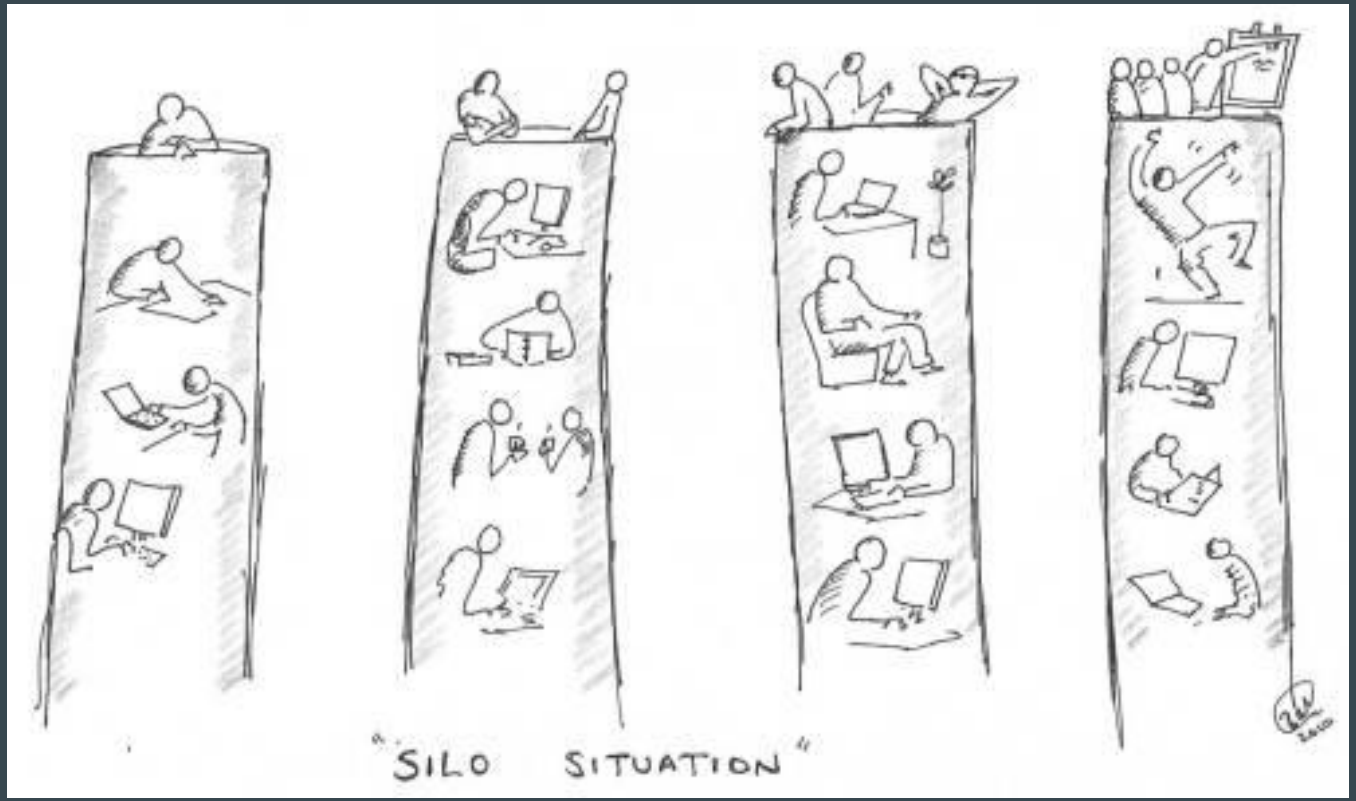
Research reported in this presentation was supported by the University of Florida Clinical and Translational Science Institute, which is supported in part by the NIH National Center for Advancing Translational Sciences under award number UL1TR001427. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

UF Clinical and Translational Science Institute
UNIVERSITY of FLORIDA

NIH
National Center for Advancing Translational Sciences



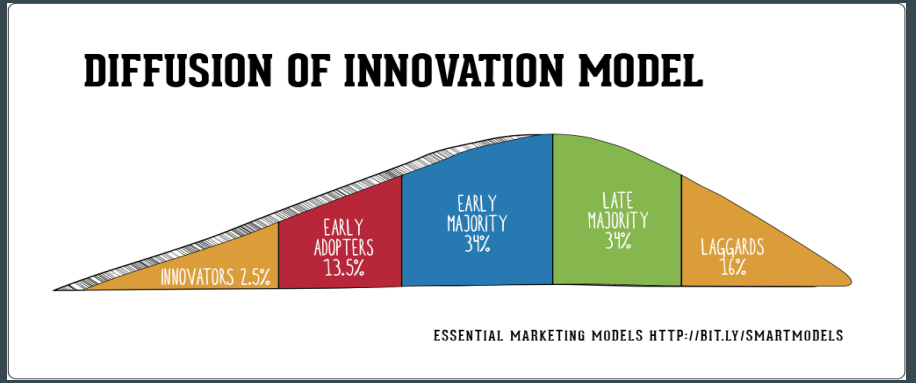
Research Problem

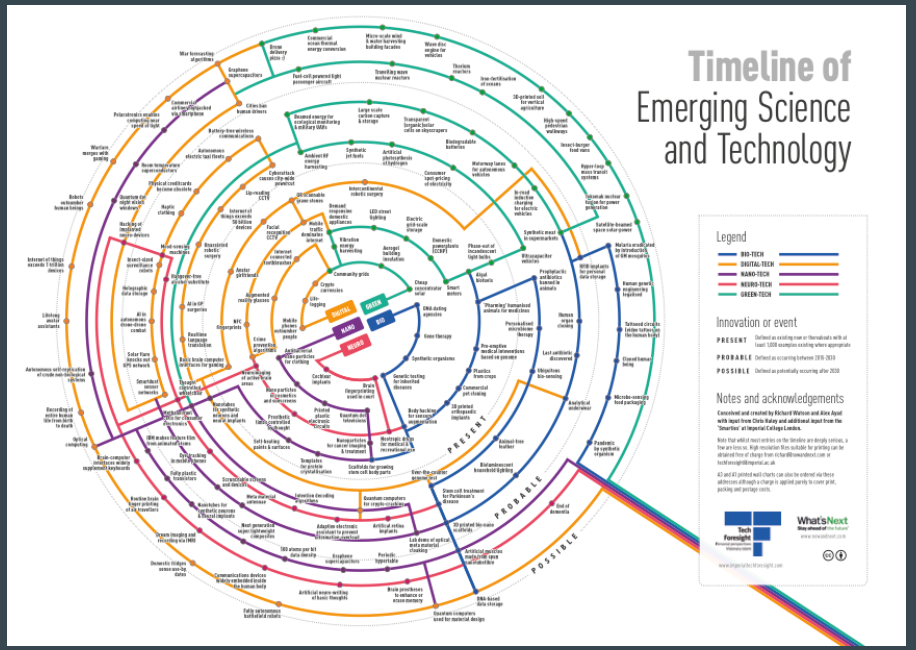


Scientific Importance

Scientific collaboration networks are a crucial channel for the diffusion of knowledge and innovation across disciplines and universities

Our project's aim is to use community detection algorithms to identify emerging research fields and network ethnography to describe and better understand these processes



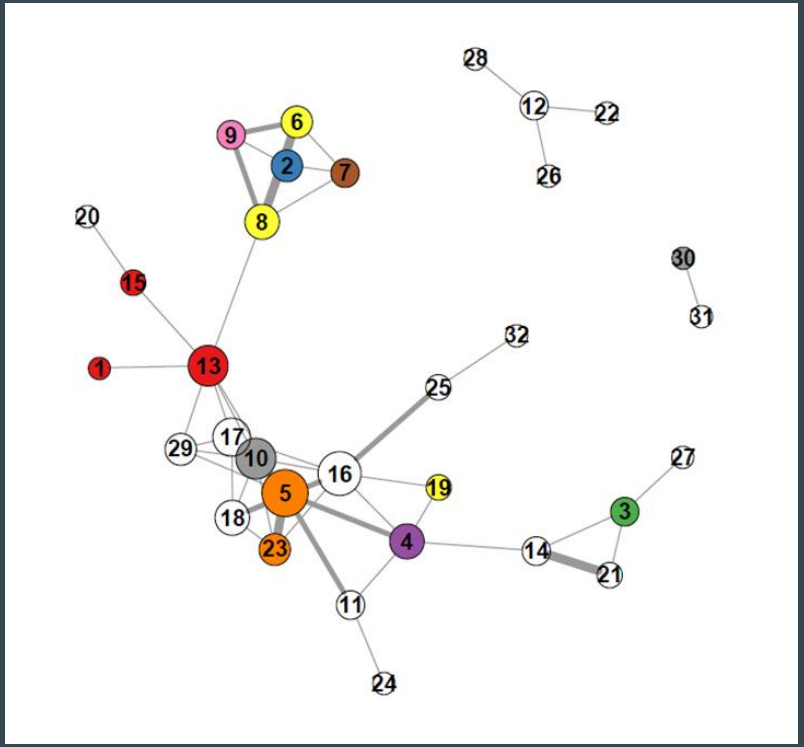


Literature Review

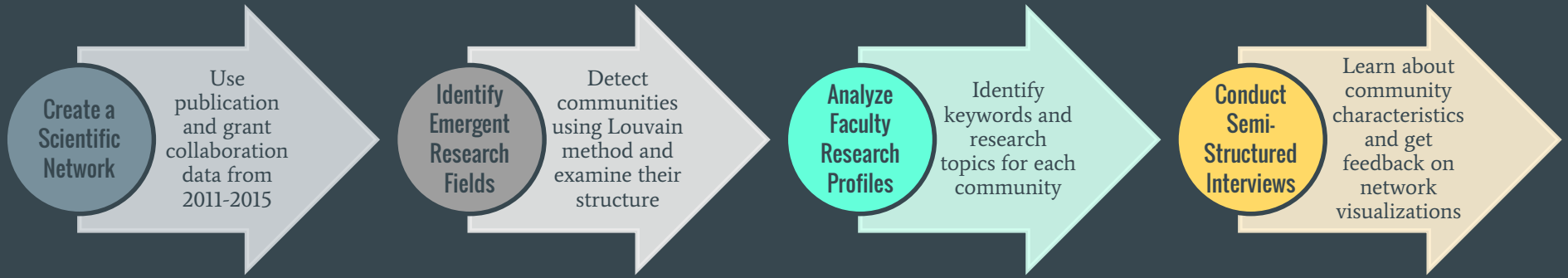
Scientific Collaboration	•Collaboration between scientists is growing and central to innovation •Newman 2004; Sonnenwald 2007
Team Science	•More science is being done in large interdisciplinary teams •Wuchty et al. 2007; Stokols et al. 2008; Borner et al. 2010
Community Detection	•It is helpful to compare and contrast communities within a larger network •Newman and Girvan 2004; Girvan 2004; Blondel et al. 2008
"New" Science of Networks	•The study of networks has become more interdisciplinary which provides more perspectives and tools for analyzing networks •Watts 2004
Network Interventions	•Using network data to promote behavior change •Valente 2012; Valente et al. 2015; Vacca et al. 2015

Research Questions

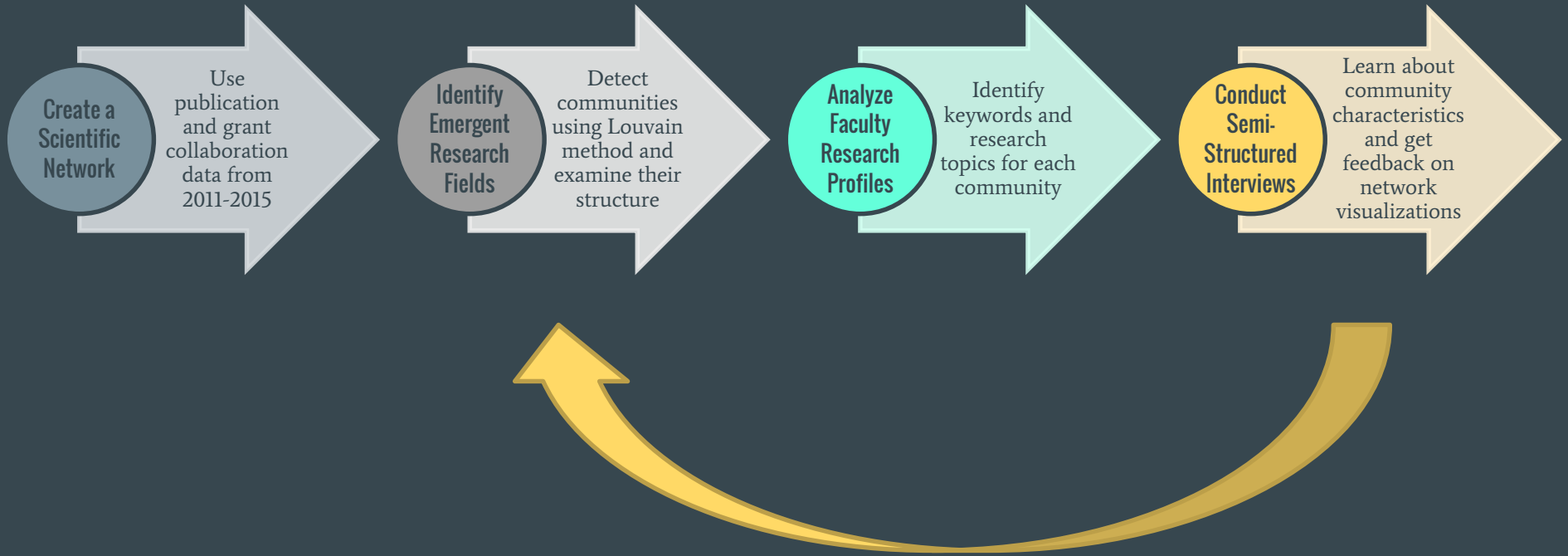
- What scientific fields are emerging at UF?
- What is their network composition?
- What is the level of collaboration and communication between researchers within this emerging field?
- How does disciplinary and college affiliation shape these collaborations and their communication dynamics?
- What collaboration details are missing from these networks?



Methods


Create a Scientific Network
Use publication and grant collaboration data from 2011-2015
Identify Emergent Research Fields
Detect communities using Louvain method and examine their structure
Analyze Faculty Research Profiles
Identify keywords and research topics for each community
Conduct Semi-Structured Interviews
Learn about community characteristics and get feedback on network visualizations

Methods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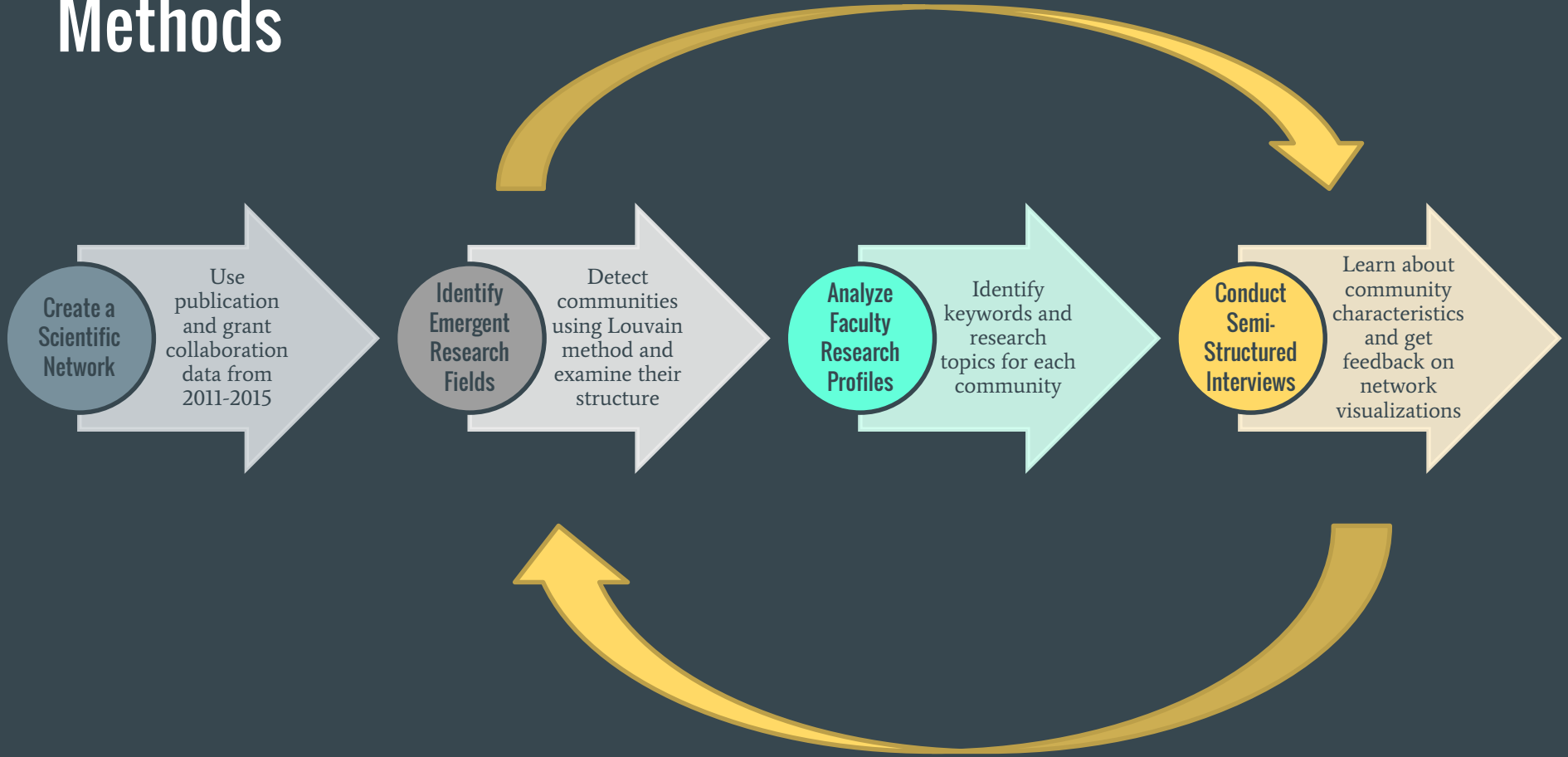
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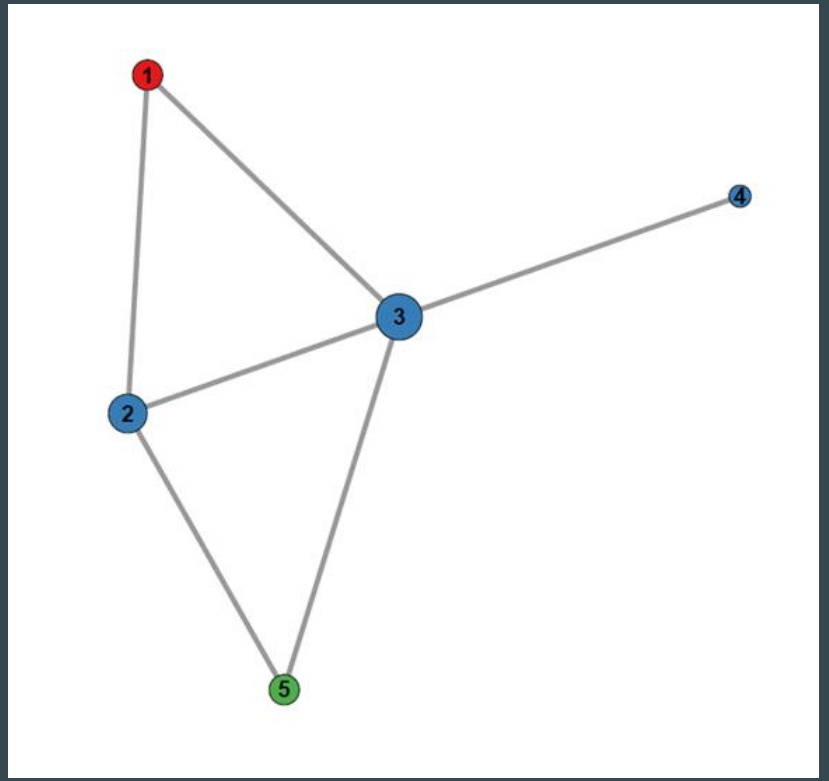
Operational Definitions

Scientific Collaboration

Co-authorship on publications or co-investigator status on research grants

Interdisciplinary Collaboration

Collaborations between individuals from different departments

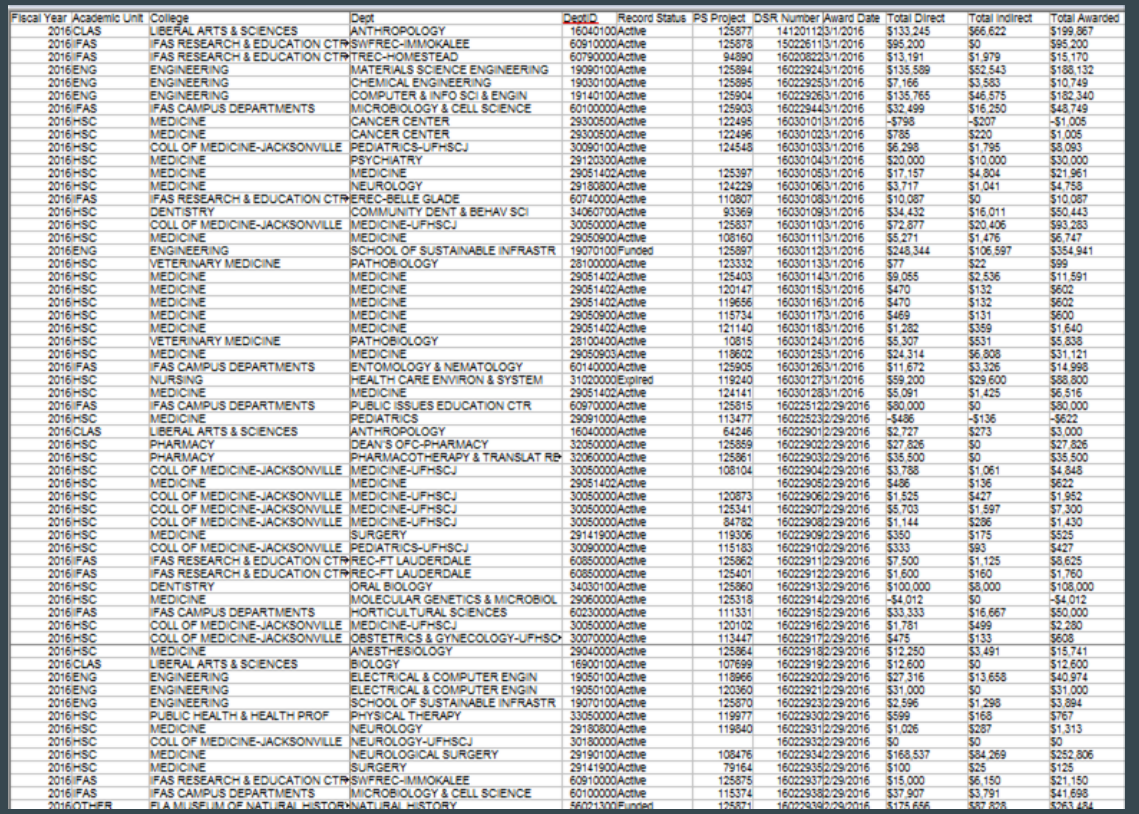


Grant Data

Transactions with the Division of Sponsored Programs (2011-2015)

Challenges:

- Data not designed for SNA
- Each line represents a credit or debit
- Two IDs on the same line don't necessarily collaborate



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2016	CLAS	LIBERAL ARTS & SCIENCES	ANTHROPOLOGY	16040100	Active	125877	14120112	3/1/2016	$133,245	$66,622	$199,867
2016	FAS	FAS RESEARCH & EDUCATION CTR	SWFREC-IMMOKALEE	60910000	Active	125878	15022611	3/1/2016	$95,200	$0	$95,200
2016	FAS	FAS RESEARCH & EDUCATION CTR	TREC-HOMESTEAD	60790000	Active	94890	16020822	3/1/2016	$13,191	$1,979	$15,170
2016	ENG	ENGINEERING	MATERIALS SCIENCE ENGINEERING	19090100	Active	125984	16022924	3/1/2016	$135,589	$52,543	$188,132
2016	ENG	ENGINEERING	CHEMICAL ENGINEERING	19030100	Active	125895	16022925	3/1/2016	$7,166	$3,583	$10,749
2016	ENG	ENGINEERING	COMPUTER & INFO SCI & ENGIN	19140100	Active	125904	16022926	3/1/2016	$135,765	$46,575	$182,340
2016	FAS	FAS CAMPUS DEPARTMENTS	MICROBIOLOGY & CELL SCIENCE	60100000	Active	125903	16022944	3/1/2016	$32,499	$16,250	$48,749
2016	HSC	MEDICINE	CANCER CENTER	29300500	Active	122495	16030101	3/1/2016	-$798	-$207	-$1,005
2016	HSC	MEDICINE	CANCER CENTER	29300500	Active	122496	16030102	3/1/2016	$785	$220	$1,005
2016	HSC	COLL OF MEDICINE-JACKSONVILLE	PEDIATRICS-UFHSCJ	30090100	Active	124548	16030103	3/1/2016	$6,298	$1,795	$8,093
2016	HSC	MEDICINE	PSYCHIATRY	29120300	Active		16030104	3/1/2016	$20,000	$10,000	$30,000
2016	HSC	MEDICINE	MEDICINE	29051402	Active	125397	16030105	3/1/2016	$17,157	$4,804	$21,961
2016	HSC	MEDICINE	NEUROLOGY	29180800	Active	124229	16030106	3/1/2016	$3,717	$1,041	$4,758
2016	FAS	FAS RESEARCH & EDUCATION CTR	REC-BELLE GLADE	60740000	Active	110807	16030108	3/1/2016	$10,087	$0	$10,087
2016	HSC	DENTISTRY	COMMUNITY DENT & BEHAV SCI	34060700	Active	93369	16030109	3/1/2016	$34,432	$16,011	$50,443
2016	HSC	COLL OF MEDICINE-JACKSONVILLE	MEDICINE-UFHSCJ	30050000	Active	125837	16030110	3/1/2016	$72,877	$20,406	$93,283
2016	HSC	MEDICINE	MEDICINE	29050900	Active	108160	16030111	3/1/2016	$5,271	$1,476	$6,747
2016	ENG	ENGINEERING	SCHOOL OF SUSTAINABLE INFRASTR	19070100	Funded	125897	16030112	3/1/2016	$248,344	$106,597	$354,941
2016	HSC	VETERINARY MEDICINE	PATHOBIOLOGY	28100000	Active	123332	16030113	3/1/2016	$77	$22	$99
2016	HSC	MEDICINE	MEDICINE	29051402	Active	125403	16030114	3/1/2016	$9,055	$2,536	$11,591
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2016	HSC	MEDICINE	MEDICINE	29050900	Active	115734	16030117	3/1/2016	$469	$131	$600
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2016	HSC	VETERINARY MEDICINE	PATHOBIOLOGY	28100400	Active	10815	16030124	3/1/2016	$5,307	$531	$5,838
2016	HSC	MEDICINE	MEDICINE	29050903	Active	118602	16030125	3/1/2016	$24,314	$6,808	$31,121
2016	FAS	FAS CAMPUS DEPARTMENTS	ENTOMOLOGY & NEMATOLOGY	60140000	Active	125905	16030126	3/1/2016	$11,672	$3,326	$14,998
2016	HSC	NURSING	HEALTH CARE ENVIRON & SYSTEM	31020000	Expired	119240	16030127	3/1/2016	$59,200	$29,600	$88,800
2016	HSC	MEDICINE	MEDICINE	29051402	Active	124141	16030128	3/1/2016	$5,091	$1,425	$6,516
2016	FAS	FAS CAMPUS DEPARTMENTS	PUBLIC ISSUES EDUCATION CTR	60970000	Active	125815	16022512	2/29/2016	$80,000	$0	$80,000
2016	HSC	MEDICINE	PEDIATRICS	29091000	Active	113477	16022523	2/29/2016	-$486	-$136	-$622
2016	CLAS	LIBERAL ARTS & SCIENCES	ANTHROPOLOGY	16040000	Active	64246	16022901	2/29/2016	$2,727	$273	$3,000
2016	HSC	PHARMACY	DEAN'S OFC-PHARMACY	32050000	Active	125859	16022902	2/29/2016	$27,826	$0	$27,826
2016	HSC	PHARMACY	PHARMACOTHERAPY & TRANSLAT RE	32060000	Active	125861	16022903	2/29/2016	$35,500	$0	$35,500
2016	HSC	COLL OF MEDICINE-JACKSONVILLE	MEDICINE-UFHSCJ	30050000	Active	108104	16022904	2/29/2016	$3,788	$1,061	$4,848
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2016	HSC	COLL OF MEDICINE-JACKSONVILLE	MEDICINE-UFHSCJ	30050000	Active	120873	16022906	2/29/2016	$1,525	$427	$1,952
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2016	HSC	COLL OF MEDICINE-JACKSONVILLE	MEDICINE-UFHSCJ	30050000	Active	84782	16022908	2/29/2016	$1,144	$286	$1,430
2016	HSC	MEDICINE	SURGERY	29141900	Active	119306	16022909	2/29/2016	$350	$175	$525
2016	HSC	COLL OF MEDICINE-JACKSONVILLE	PEDIATRICS-UFHSCJ	30090000	Active	115183	16022910	2/29/2016	$333	$93	$427
2016	FAS	FAS RESEARCH & EDUCATION CTR	REC-FT LAUDERDALE	60850000	Active	125862	16022911	2/29/2016	$7,500	$1,125	$8,625
2016	FAS	FAS RESEARCH & EDUCATION CTR	REC-FT LAUDERDALE	60850000	Active	125401	16022913	2/29/2016	$1,600	$160	$1,760
2016	HSC	DENTISTRY	ORAL BIOLOGY	34030100	Active	125860	16022914	2/29/2016	$130,000	$8,000	$138,000
2016	HSC	MEDICINE	MOLECULAR GENETICS & MICROBIOL	29060000	Active	125318	16022914	2/29/2016	-$4,012	$0	-$4,012
2016	FAS	FAS CAMPUS DEPARTMENTS	HORTICULTURAL SCIENCES	60230000	Active	111331	16022915	2/29/2016	$33,333	$16,667	$50,000
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2016	ENG	ENGINEERING	SCHOOL OF SUSTAINABLE INFRASTR	19070100	Active	125870	16022923	2/29/2016	$2,596	$1,298	$3,894
2016	HSC	PUBLIC HEALTH & HEALTH PROF	PHYSICAL THERAPY	33050000	Active	119977	16022930	2/29/2016	$599	$168	$767
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2016	OTHER	FLA MUSEUM OF NATURAL HISTORY	NATURAL HISTORY	56021300	Funded	125871	16022939	2/29/2016	$175,656	$87,828	$263,484

Publication Data

Co-authorship from Web of Science (2011-2015)

Challenges:

- Not designed for SNA
- Need to disambiguate and associate name with ID (VIVO helps)
- Accuracy on an individual level

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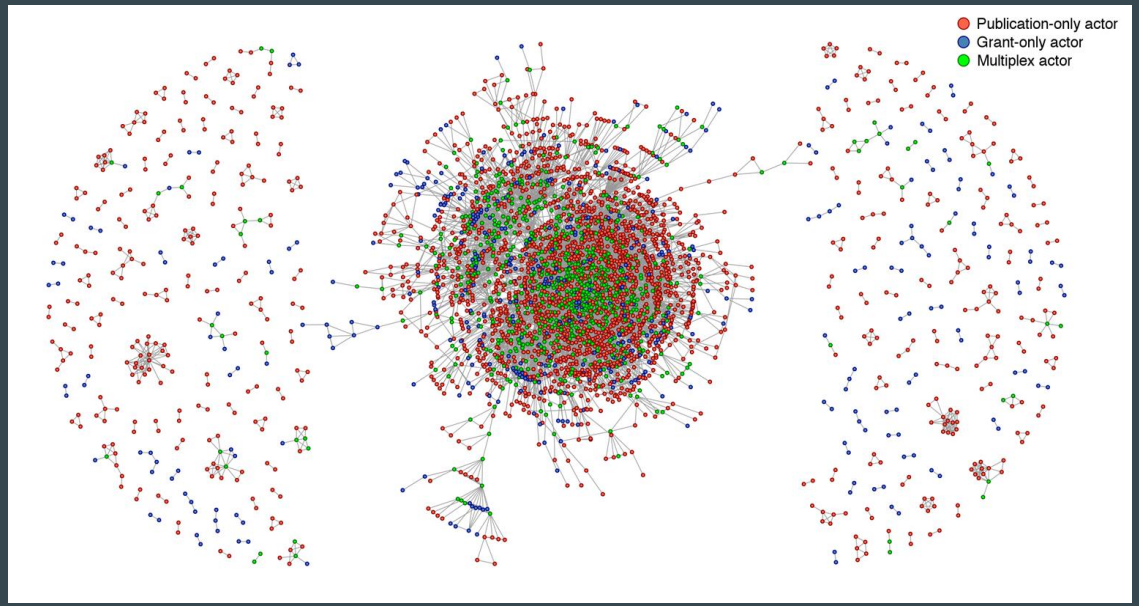
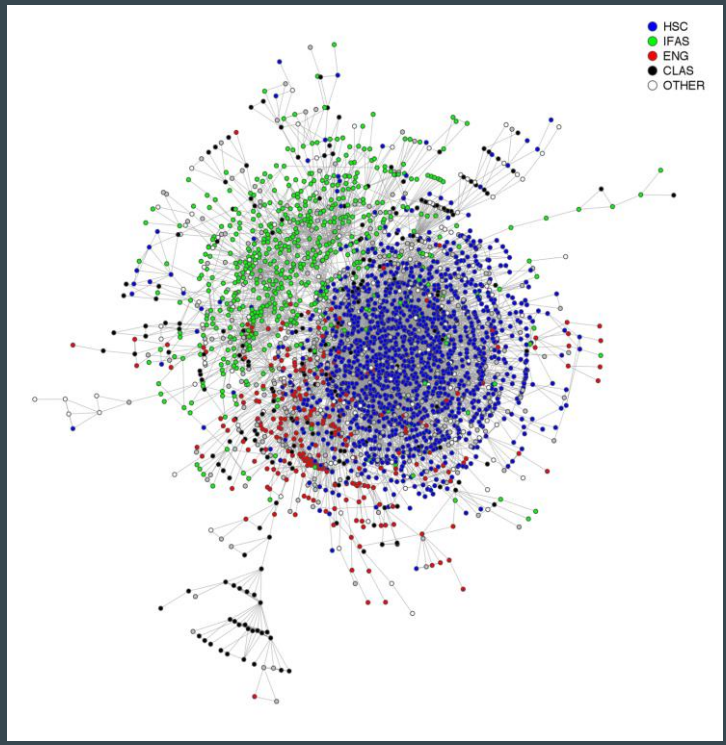
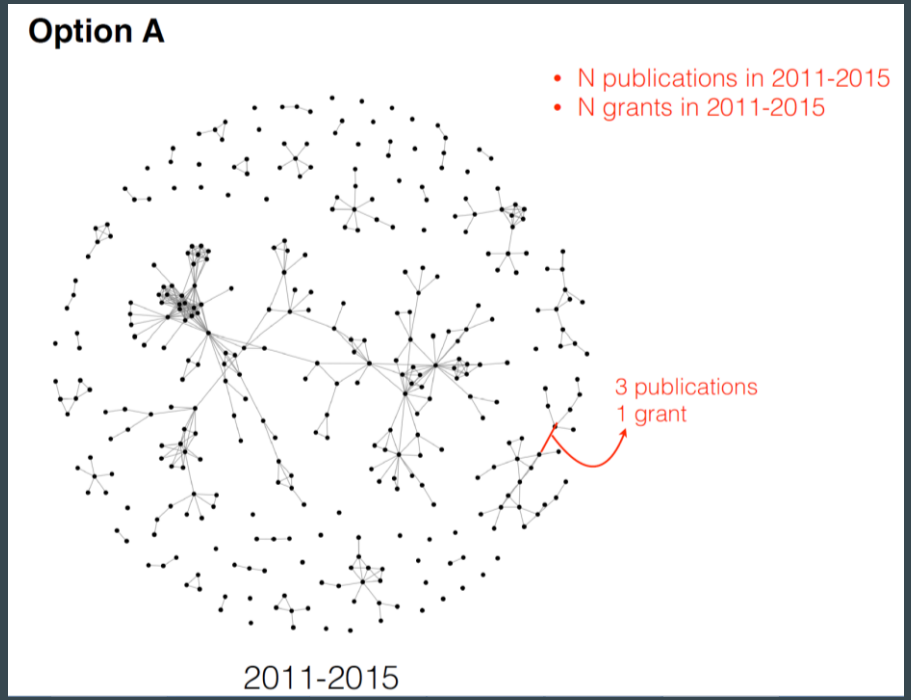
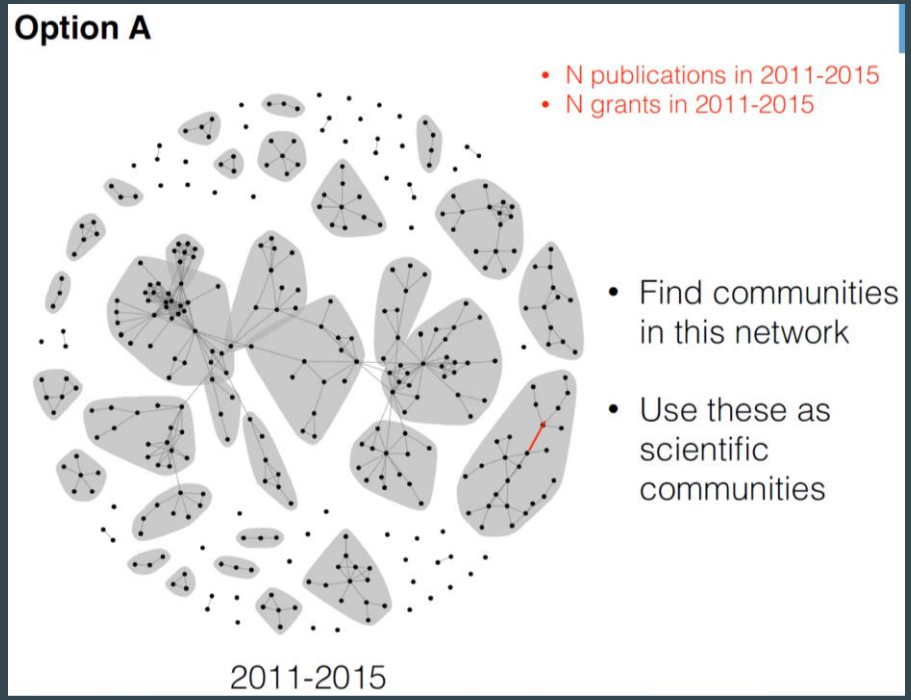
Union of Publication and Grant Data 2013



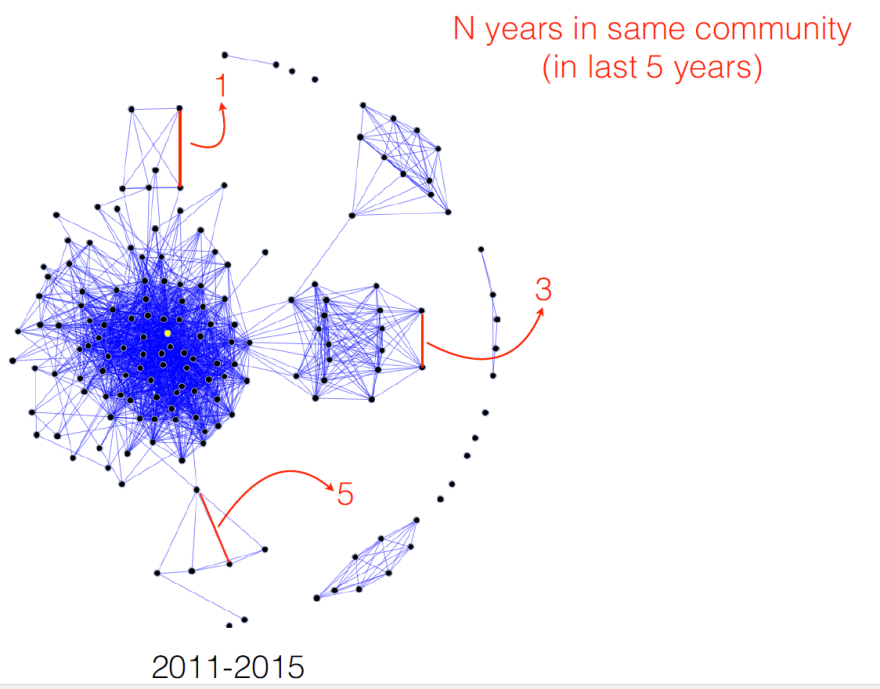


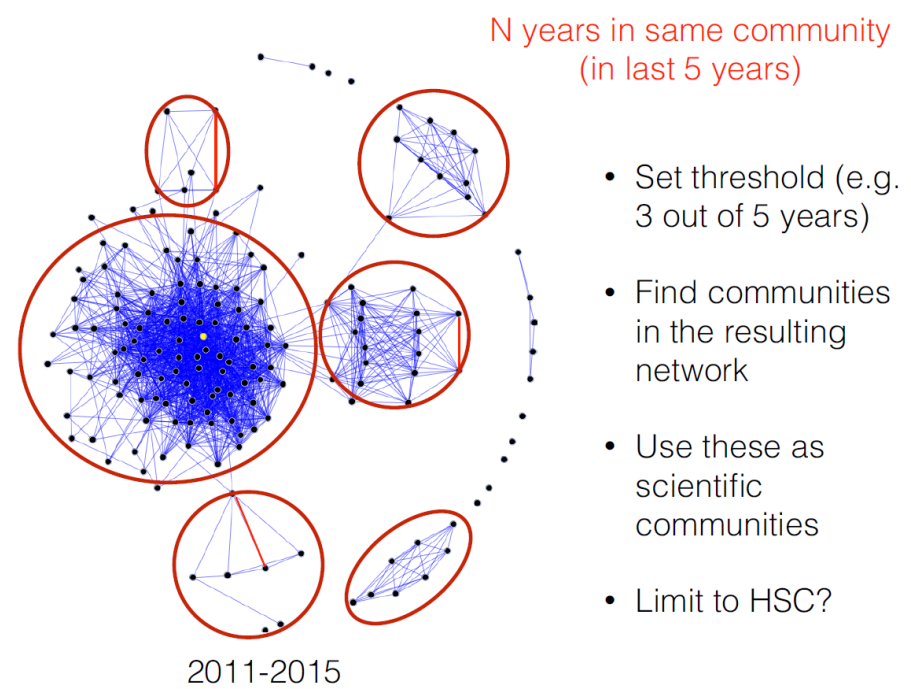
Sum


Option A
• N publications in 2011-2015
• N grants in 2011-2015
3 publications
1 grant
2011-2015


Option A
• N publications in 2011-2015
• N grants in 2011-2015
• Find communities in this network
• Use these as scientific communities
2011-2015

Co-Membership Set criteria at 5 years





- Set threshold (e.g. 3 out of 5 years)
- Find communities in the resulting network
- Use these as scientific communities
- Limit to HSC?

Methods for Community Detection

Cohesive Subgroups/Communities/Clusters

Options:

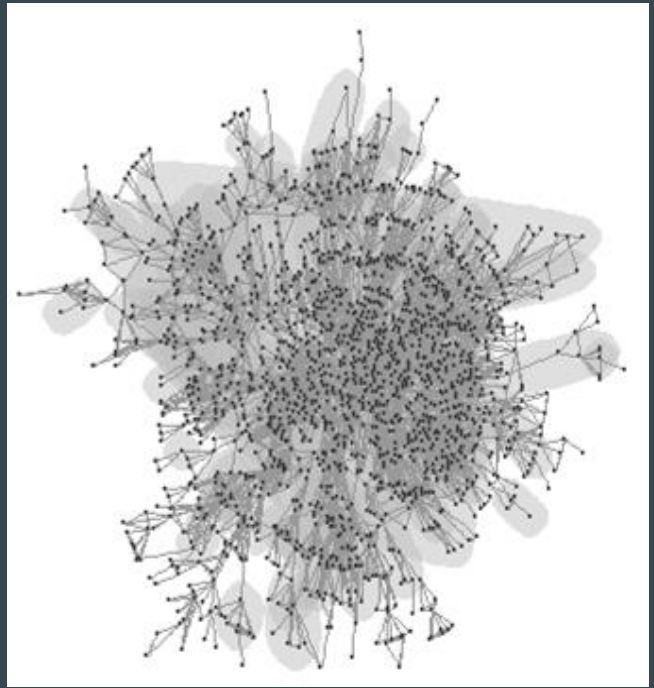
Clique

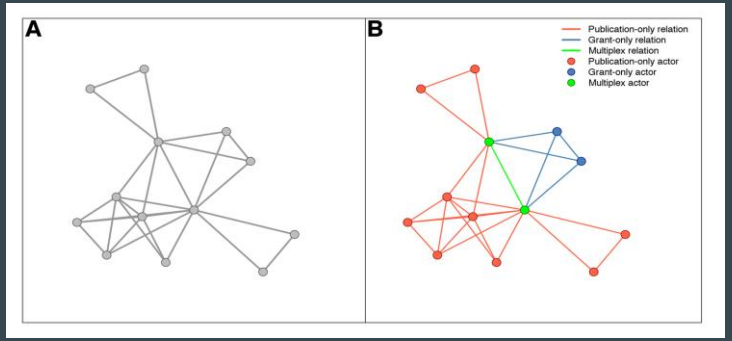
Cluster Analysis

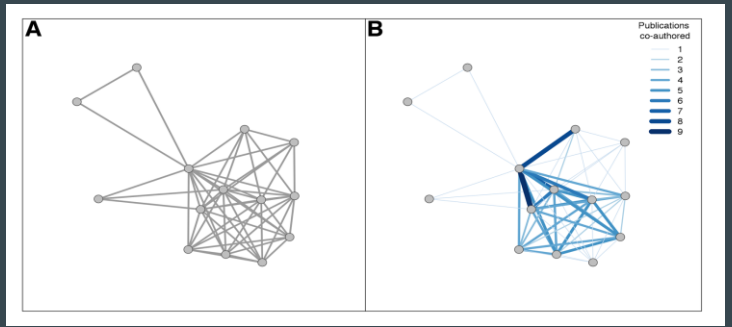
Blockmodeling

Girvan-Newman

Louvain





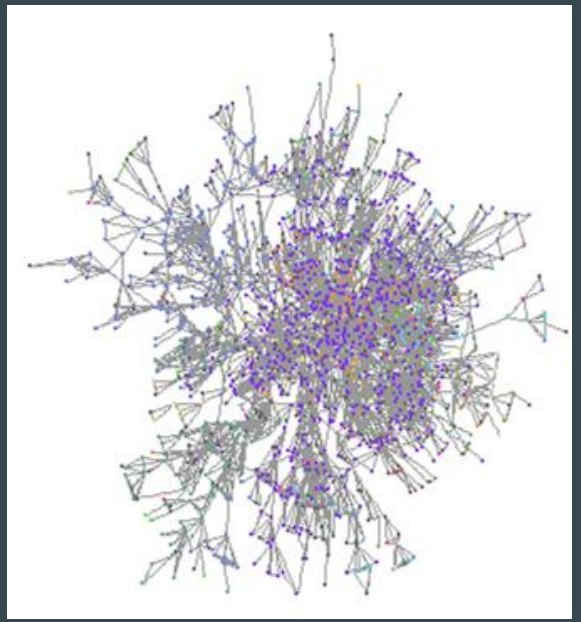


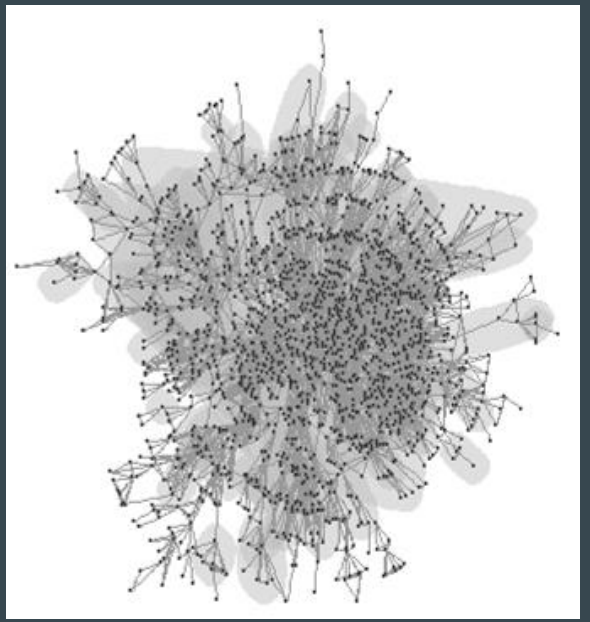
Comparison of Traditional Disciplines and Emergent Research Communities 2015

Universities have similar departments and colleges

Departments allows universities to talk to each other

Identifying emergent fields highlights the unique research focuses of the university



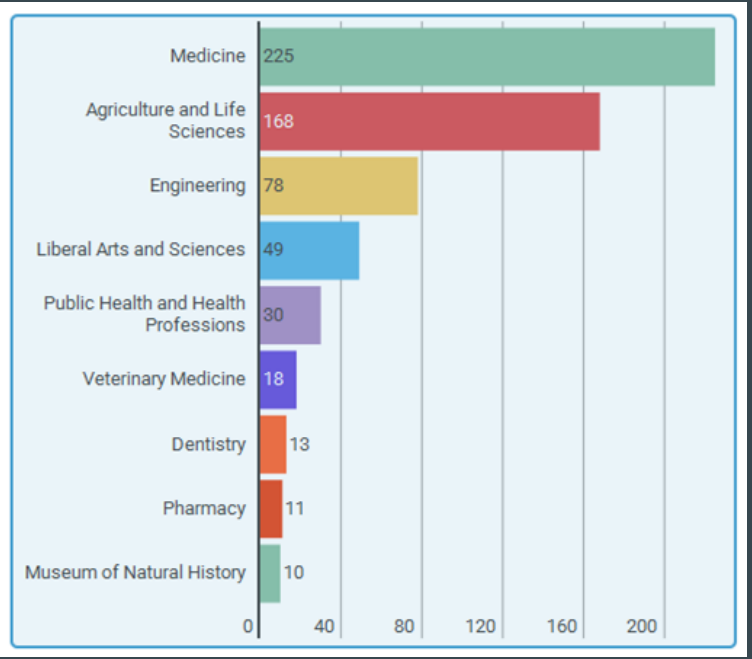


Composition of Emergent Research Communities

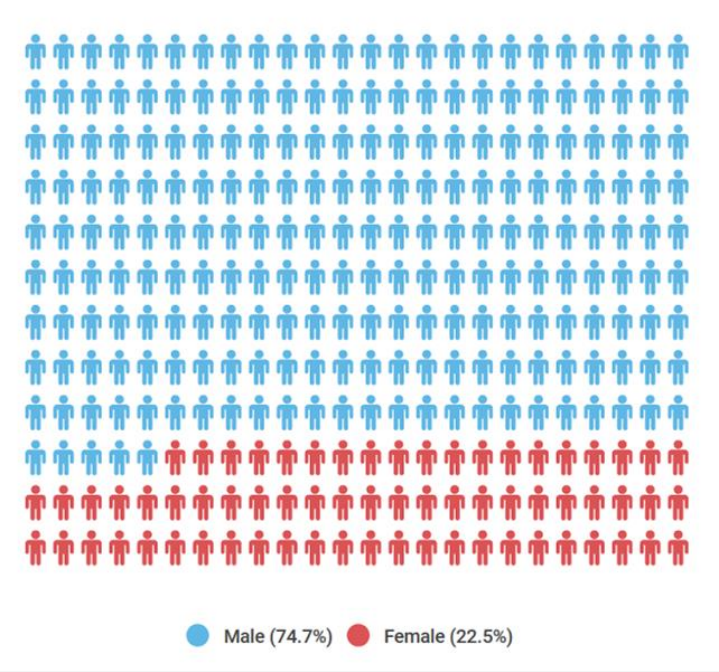
Descriptive statistics of 147 communities – Mean: 4.68 – Max: 51 – Min: 2

Demographics of 688 researchers

College Distribution



Gender

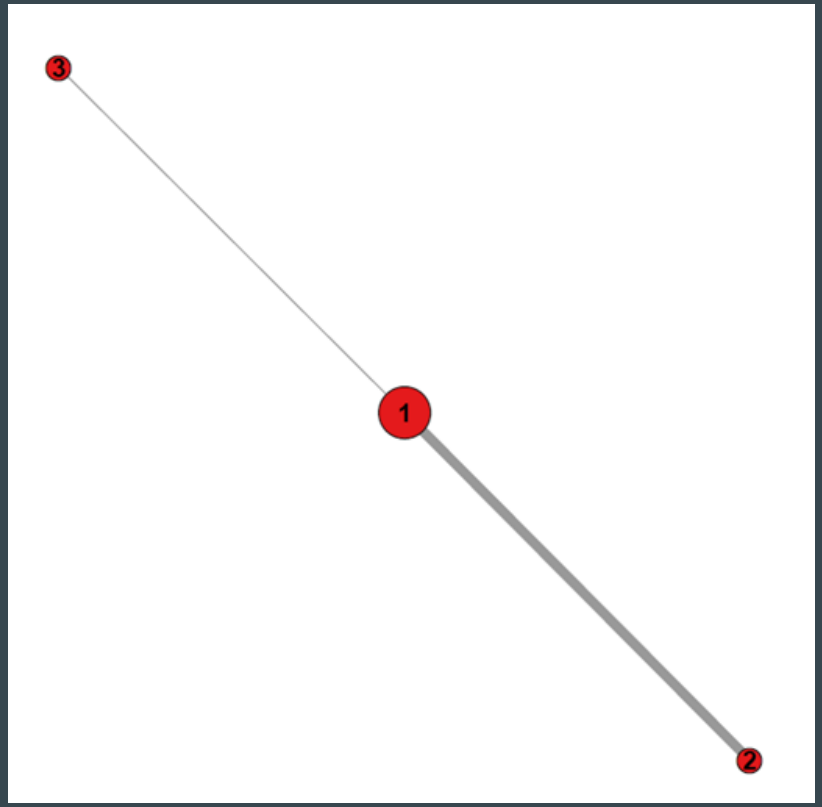


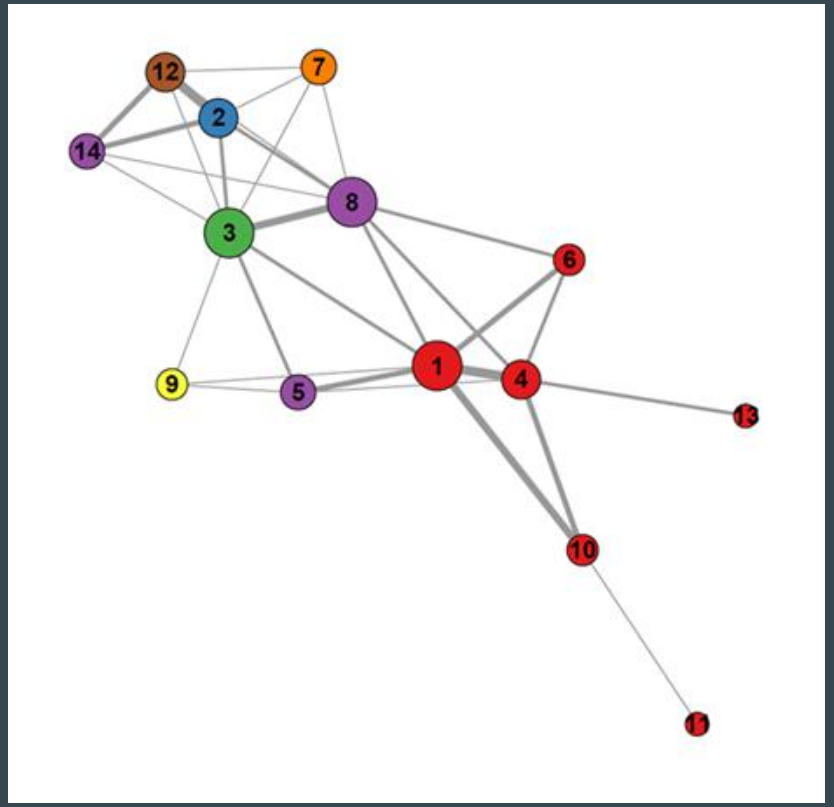
Text Analysis

Read and coded 688 faculty research profiles to identify group topics and themes

Group	Topic	Keywords
1	Unclear	Material science and engineering; Software Analysis and Advanced Materials Processing; graphene; detection of exposives
2	Pine forest management	Pine forest ecosystems; carbon; silviculture; Integrating Research, Education and Extension for Enhancing Southern Pine Climate Change
3	Aneurysm clinical trial	Neurosurgery; Aneurysm; angiogram; comprehensive stroke program;
4	RCT on aging and weight loss	Aging; cognitive training; gait speed; functioning; independence; women; older adults (70+); clincal trials; weight loss; activity; Sarcopenia
5	Aging	Clinical and behavioral epidemiology of medical conditions associated with aging; Frailty and Sarcopenia, Apoptosis, and Oxidative Stress
6	Infectious diseases	Infectious diseases; machine learning; Emerging pathagons; HIV/AIDS; pandemic; smallpox; influenza; analysis of epidemics; cholera; TB
7	Nicotine; Alpha 7-nicotinic receptors	Non-addictive treatments for nicotine, alcohol, and opioid addiction; alpha7 receptors; stress;learning and memory impairments; biosynth
8	Lungs	Lungs
9	Pediatrics	Pediatrics
10	Corn/maize genetics	Maize genetics
11	Water resource engineering management	Water resources; engineering; management
12	Forest conservation	Forest conservation
13	Thermal Sciences and Fluid Dynamics	Mechanical and aerospace engineering; Thermal Sciences and Fluid Dynamics; NASA
14	Brain tumors	Brain tumor surgery; radiosurgery; neurosurgery; head and neck cancers; "Phase I, Open-Label, Single-Arm, Clinical and Metabolomic S
15	Ecology; Avian flu	Avian flu; Igert; Igms; Conservation; Aquatics; Population and community ecology (especially of aquatic organisms); Spatial Ecology and
16	Designing ecological pathways	Ecology; Design
17	Parkinson's disease and mobility	Mobility; Parkinsons; deep brain stimulation; depression; interdiscplinary care; neurosurgery; clinical trials focusing on improved therapies
18	Liver disease	Liver; hepatology; gastroenterology; hepatitis; hepatocellular carcinoma (HCC); hematology
19	Oncology	Cancer; ongology
20	Developing structure-property-processing relationships	Engineering; developing structure-property-processing relationships in emerging functional materials
21	Diabetes	Trying to develop a cure for diabetes
22	Extension, climate change, and plant disease	Climate Variability to Climate Change: Extension Challenges and Opportunities in the Southeast USA; plant disease network; irrigation
23	Light production using chemicals	solar fuels; light harvesting; interaction of light with small molecules, polymers, and materials
24	Planning transportation systems	GIS; urban planning; transportation; traffic; safety
25	Citrus production	Citrus; disease
26	Unclear	
27	Unclear	
28	Vegetable production	Eggplant; tomatos;; vegetables; extension
29	Climate change and natural resource management	Resource management;wetlands; Southeast Climate Consortium (SECC) and the Florida Climate Institute (FCI). Both CAP and the SECC
30	Dairy cattle reproduction	Dairy cattle; reproduction; herd management; fertility
31	Biofuel and other biomass applications	Bioplastic; renewable fuels and chemicals; sorghum; bioenergy; gene therapy; biomass
32	Kidney and pancreas transplants	Develop drugs and practices for transplants
33	Tree of Life - Evolutionary relationships and genetics	Tree of life; iDigBio; Evolutionary relationships and genetics; phylogenetic relationships; social networks

Comparing Communities

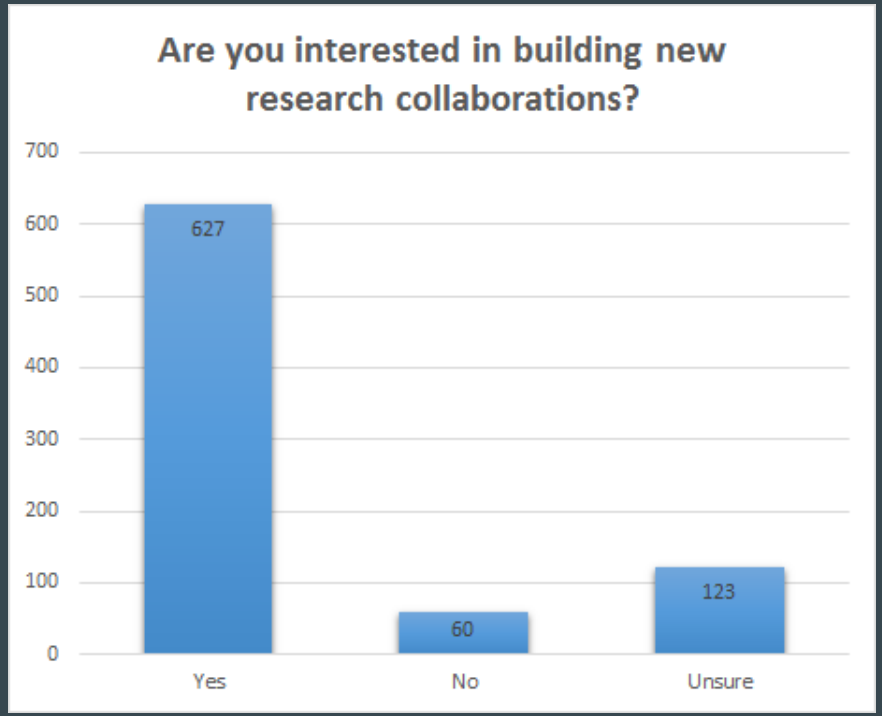


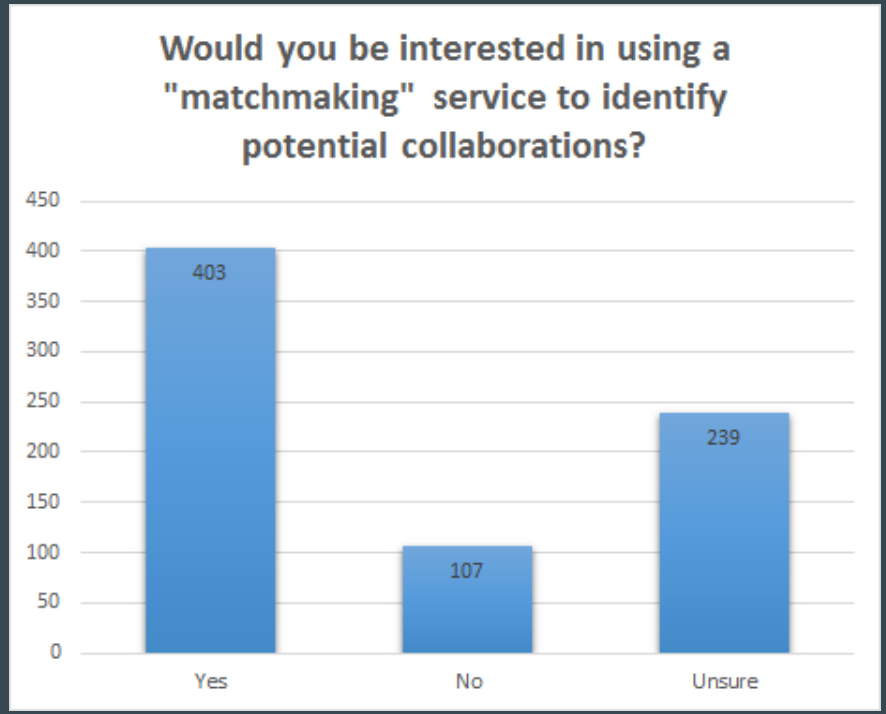


Interview Themes

Measurement	•Stable versus emergent communities; are we measuring what we think we are?
Criteria Limitations	•Networks looked simpler and more homogeneous than they actually are; need to refine and retest
Missing Data	•Some critical connections and people are missing from visualizations
Perceptions	•Did not highlight what respondent's self-identified as their most emergent research collaboration/topic; minimized their interdisciplinary work
Motivations	•Curiosity and passion for research project
Mentorship	•Mentors play a major role in introducing students to new collaborators; mentees provide new insights for mentor
Interdisciplinary	•More difficult but also more rewarding; different expectations, administrative barriers, norms, and language

Data from UF CTSI Research Collaboration and Barriers Survey 2015





Network Interventions Applications for distributing CTSI Seed Grants

1. No change

2. We could pick a set of pairs (dyads) that would **span** communities that appear to be forming but are **currently not well connected**. Perhaps we would select 5-10 pairs which they could choose from

3. We could create a "smart induction" solicitation around two or three communities that are currently **not well connected** but the network suggests are an **emergent** community

4. We could create a "smart induction" solicitation around a community that is **somewhat connected** and currently **does not fit an existing administrative boundary**, and that could benefit from additional ties to be more **cohesive**

5. We could create a "smart induction" solicitation around emerging communities. In the solicitation, we indicate that we may **combine** applicants into what we see as **more effective teams** from the network perspective. (Note that this is the only option that we can test the impact of the intervention)

Conclusions

We believe a mixed method approach can help to improve our understanding of scientific collaboration networks and create better network interventions

Thank you for listening. Do you have any questions or suggestions for us?

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Or you can visit my **website**: www.theresekennellyokraku.com

You can also follow me on **twitter**: @thereseokraku

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