Rags to riches: the teacher-scholar model in action at California Polytechnic State University from 1990-2020 for computing researchers

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Context

California has two large University systems: CSU and UC

CSU:

23 campuses with a focus on undergraduate education

Serving 477,466 students (2021)

Context

California has two large University systems: CSU and UC

UCs:

9 campuses with a focus on research, including graduate and undergraduate education (10th campus UCSF graduate only)

Serving 280,000 students

California student demographics

As a state with a diverse student population, both systems strive to serve the students of our state.

Racial and ethnic composition as of the 2020 census [hide]

Race and ethnicity[182]	Alone		Total	
Hispanic or Latino[note 3]	—		39.4%	
White (non-Hispanic)	34.7%		38.3%	
Asian (non-Hispanic)	15.1%		17.0%	
African American (non-Hispanic)	5.4%		6.4%	
Native American (non-Hispanic)	0.4%		1.3%	
Pacific Islander (non-Hispanic)	0.3%		0.7%	
Other (non-Hispanic)	0.6%		1.3%	

Budget acknowledgment

Teacher scholar model

Cal Poly, San Luis Obispo began to informally increase consideration and discussion of scholarship in the tenure, promotion process in the late 1990s and formally adopted the teacher-scholar model in 2011.

WHEREAS,   The Teacher-Scholar Model, as proposed in Boyer (1990), characterizes the engagement of faculty in both teaching and scholarship; therefore, be it

RESOLVED: That Cal Poly faculty adopt the Teacher-Scholar Model defined as participation in both teaching and scholarship; and be it further

RESOLVED: That the Teacher-Scholar Model include, when possible, meaningful student engagement in faculty scholarly activity and inclusion of scholarship in teaching to create vibrant learning experiences for students; and be it further

RESOLVED: That scholarship be defined in general terms as the scholarships of discovery, application, integration, and teaching/learning (Boyer, 1990), implemented in a discipline-specific manner while mindful of Cal Poly's mission; and be it further

Our research question

MAVAC map showing all UCs and CSUs (log scale markers for #publications)

Has the adoption of the teacher scholar model changed academic collaborations at Cal Poly?

We measure this via examining change in publications and collaborations for (computing) researchers over time for a university that consistently had a research focus (UCSB), versus a university enhancing the role of scholarship and research for newer faculty (Cal Poly).

Our research question

These two universities:

- are regionally close (~100 miles)
- represent an R1 (UCSB)
- primarily undergraduate university (Cal Poly)

school	students	Instructional faculty
UCSB	~26,000	1,208
Cal Poly	~22,000	1,400

Network data

We use bibliometric data for collaboration and publication data is from the SCOPUS database and via the ICSR Databricks team.

- **Central Calif data:** SCOPUS open due to COVID19 (30,000 *seed* researchers and 473,854 *collaborator*s) - large portion of the Cal Poly and UCSB STEM researchers (tangential fields to computing) 1970-2021
- **Full California:** International Center for the Study of Research (ICSR) Databricks research access to SCOPUS (All UCs and CSU computing related research) (51,759 seed researchers and 154,167 collaborators) 2000-2022

Network data

Gender inference is made using NamSor (only for researchers with probability of accurate inference > 60%) for the Central California dataset. (Future work is to extend to the Full Calif. dataset).

Namsor is a service that categorize names by gender. Research has shown that it works well with American and European names.

The Network

In our network *seed* vertices represent researchers from the two public university systems in California: The University of California system and the California State University system. *Collaborator* vertices represent the researchers that collaborate with the seed vertices.

Two researchers (seed or collaborator) are connected if they have ever collaborated on a publication together.

Example

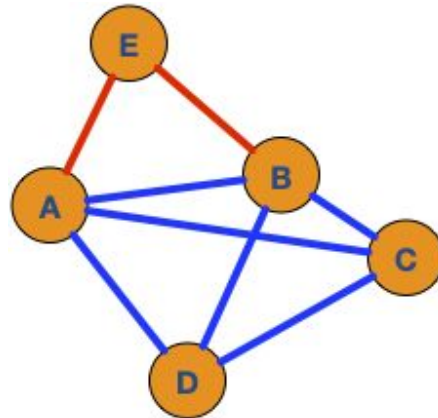Suppose that there is a paper on which researchers A, B, C and D are co-authors. Suppose that A is a seed vertex, and B, C, and D are collaborator vertices. Then there will be a clique on four vertices representing this collaboration.
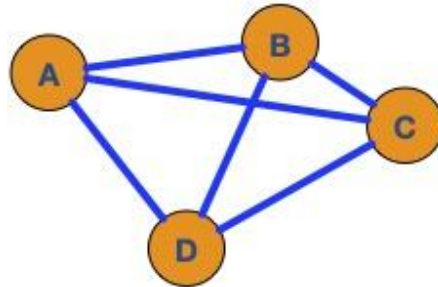
Example

Now suppose that there is also a paper on which researcher A, B, and E are co-authors. E is a collaborator vertex. Then the additional two edges AE and BE will be added.
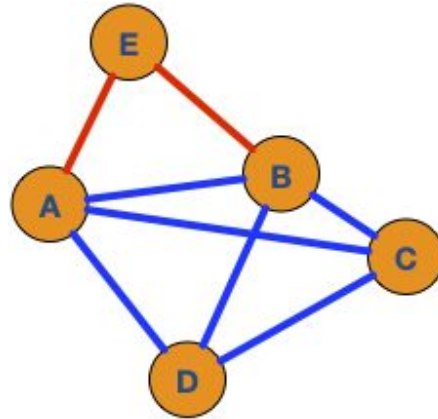
Example

Finally suppose that there is a paper on which researchers B, C, and E are co-authors. Since B, C, and E are all collaborator vertices, no additional edges are added to the graph.
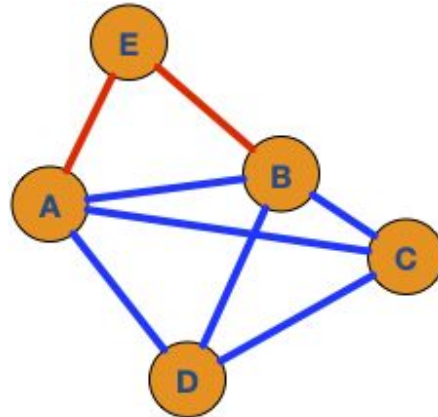
Example - Take Away

Edges are only included in the graph for publications that involve seed vertices.

Collaboration Networks and Gender

Women Have Fewer Collaborators than Men [1]

Women Collaborate More with the Same Co-Authors [1]

A Higher Fraction of Women's Co-Authors are Co-Authors with Each Other [1]

Researchers Preferentially Co-Publish with Authors of the Same Gender [2]

Gender Homophily Increases Over Time [3]

[1] Lorenzo Ductor, Sanjeev Goyal, and Anja Prummer.
Gender & collaboration.
Cambridge working papers in economics, Faculty of Economics, University of Cambridge, 2018.

[2] Eduardo B. Araújo, Nuno A. M. Araújo, André A. Moreira, Hans J. Herrmann, and José S. Andrade, Jr.
Gender differences in scientific collaborations: Women are more egalitarian than men.
PLOS ONE, 12(5):1–10, 05 2017.

[3] Luke Holman and Claire Morandin.
Researchers collaborate with same-gendered colleagues more often than expected across the life sciences.
PLOS ONE, 14(4):1–19, 04 2019.

MAVAC in general

This is a part of a larger project on mapping and visualizing academic collaboration (MAVAC)
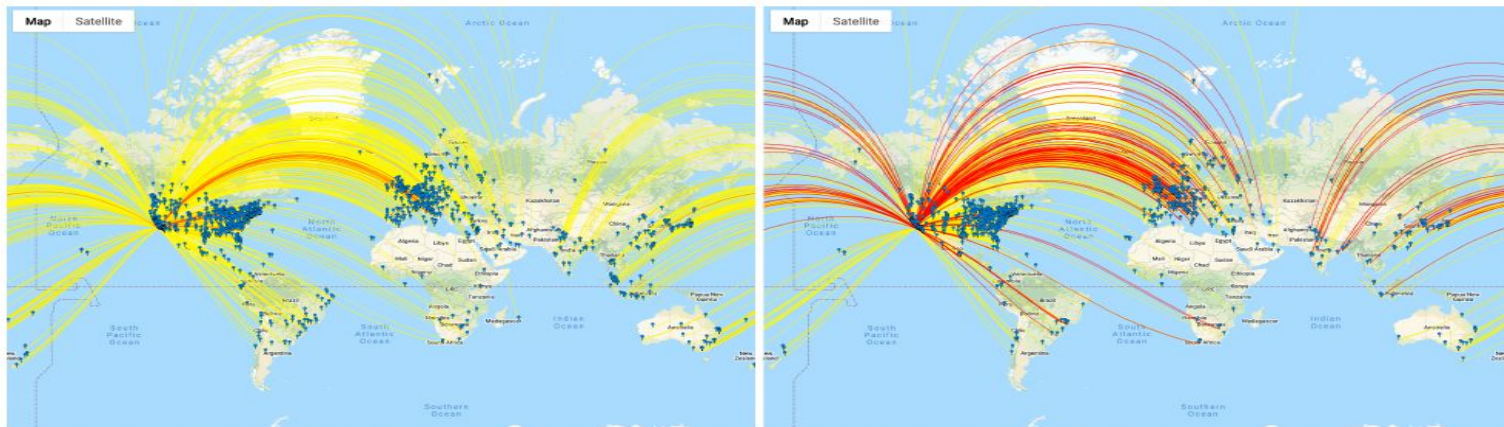

(a) inferred male author subnetwork   (b) inferred female author subnetwork

Fig. 2: Visualization of two subnetworks for the Cal Poly Collaboration network based on inferred gender of the seed author. Lines represent a shared publication and line coloring denotes the strength of the collaboration with red indicating a stronger collaboration (greater than 100 publications).
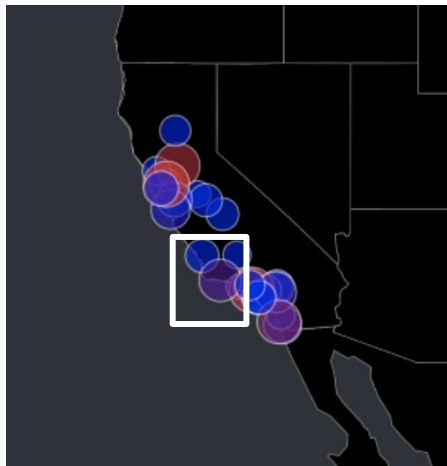
MAVAC
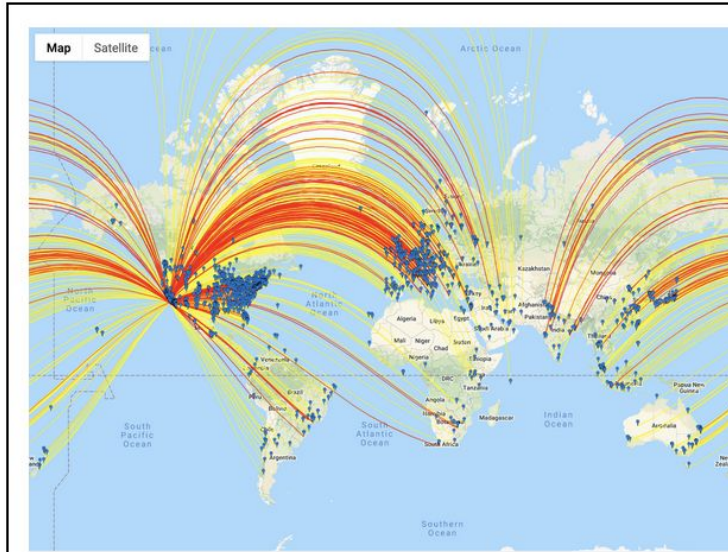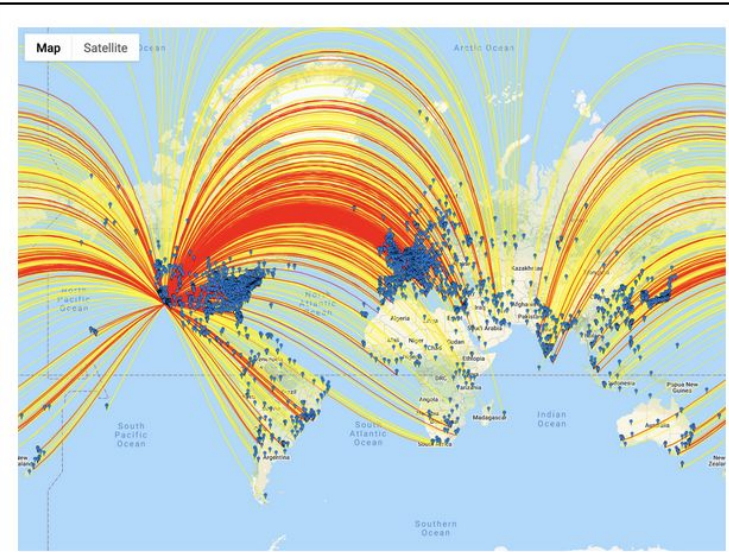
| Cal Poly SLO | Compared with UCSB |

Our research question

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MAVAC map showing all UCs and CSUs (log scale markers for #publications)
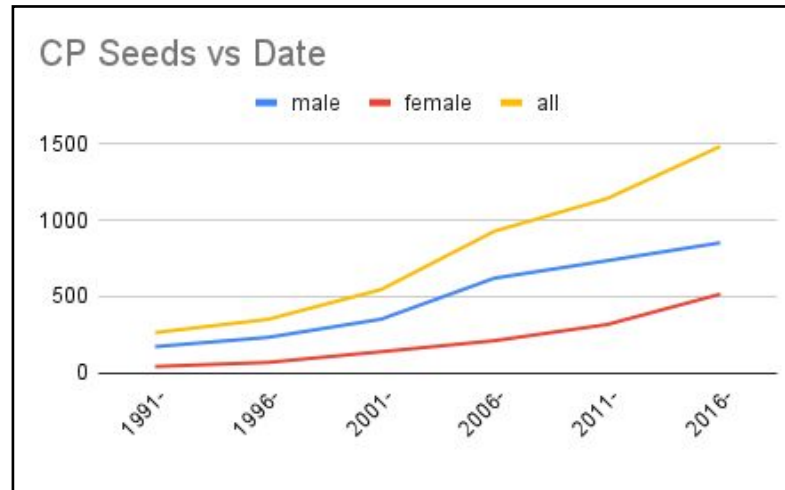
Longitudinal look

We examine the change over time in 5 year increments from 1991-2021 for the research population publishing (in fields related to computing) at these institutions to consider the impact of the teacher-scholar model

Cal Poly over time

Central Calif data: Number of Cal Poly researchers over time - researchers includes students and staff

Gender inferred via NamSor

UCSB

Central Calif data: The UCSB researcher population is approximately 4x larger than Cal Poly (despite similar instructional faculty size). Seed researchers include graduate students....
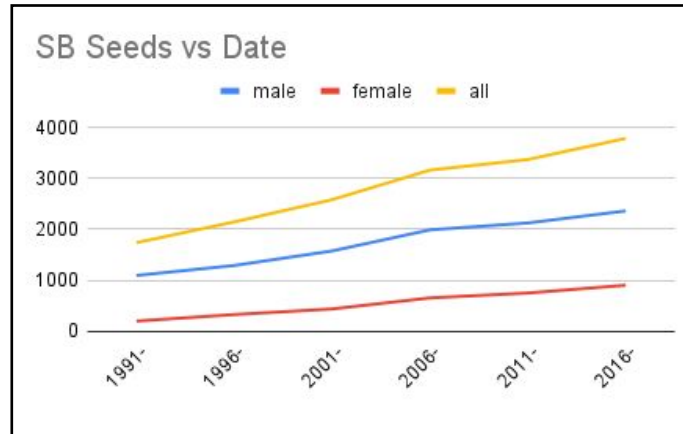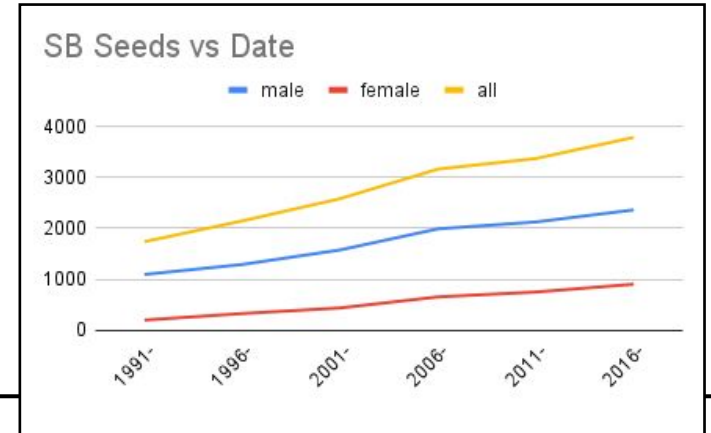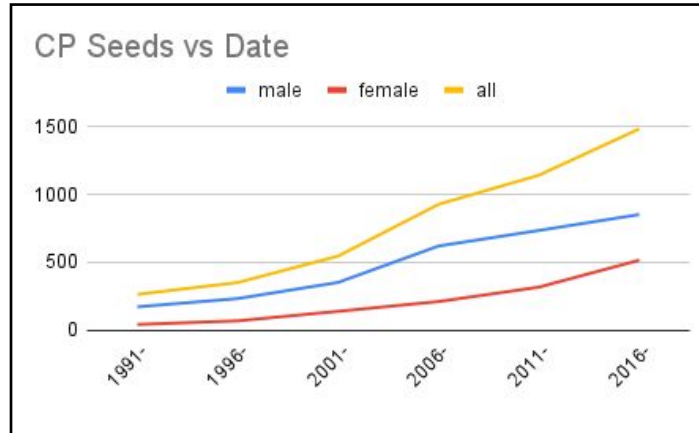

Figure 2. Number of UCSB researchers over time

Comparative growth over time

During the time period studied, the number of seed researchers at Cal Poly increased by an average of 8.45% per year while UCSB's researchers increased by 3.41% per year. (This occurs from an increase in total counts of ~41 per year for Cal Poly and ~68 per year for UCSB)

Another look

To understand the changing research landscape, we consider the average number of collaborations per seed researcher. For example with a researcher publishing a paper with two other people counting as two collaborations.

Number of collaborators capped

Note we only consider collaborations of size 20

Why? Large teams are great for big challenges but swamp the network statistics...

Comparison of collaborations

Considering the percentage increase, again Cal Poly had a larger increase with the average researcher increasing their collaborations by 3.2% each year and the average UCSB researcher increasing their collaborations by about 1.5% per year during the same time period. (Cal Poly had an increase of 0.14 collaborations per researcher per year whereas UCSB's increased by 0.25 collaborations, again with a larger overall research community of ~4x as many collaborations per researcher).

CP Avg Degree vs Date

SB Avg Degree vs Date
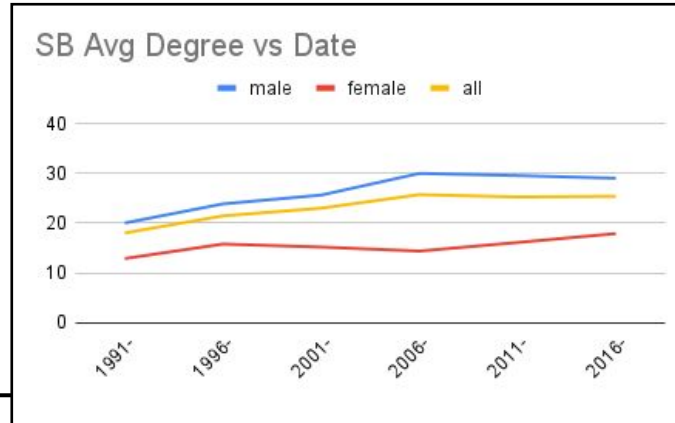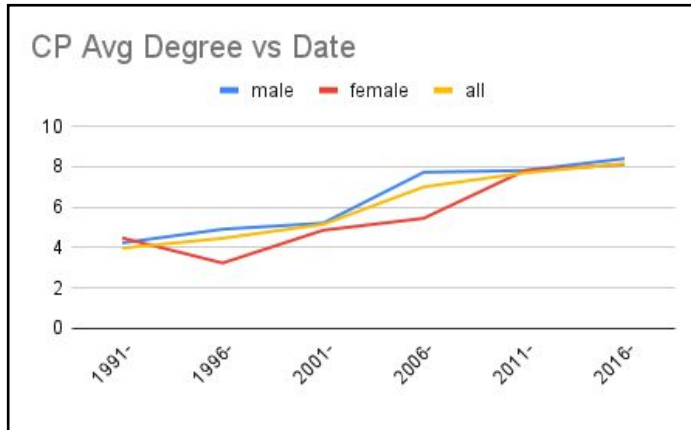
Inferred gender

As shown in Figure 3 and 4, we see that gains in both publications and collaborations are similar for both inferred male and female researchers with stronger similarity/equity in collaboration patterns for inferred female and male researchers for Cal Poly seed researchers versus UCSB researchers).

Summary
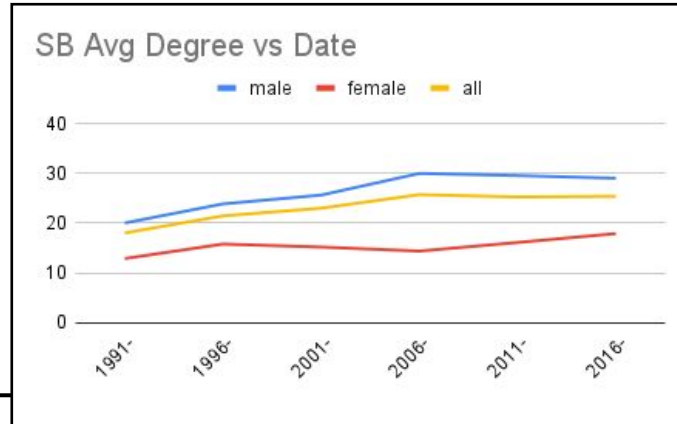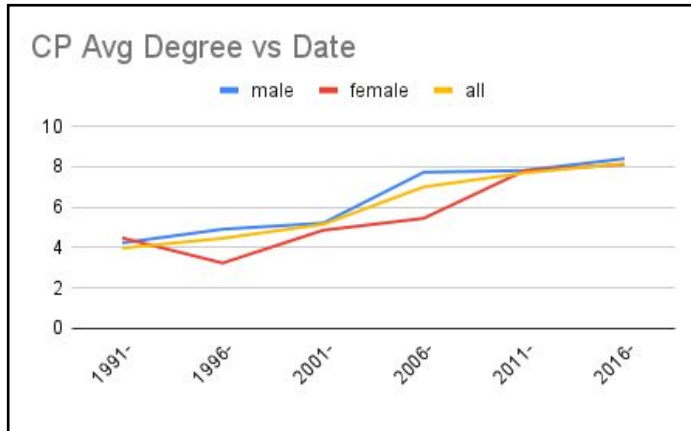
	Cal Poly	UC Santa Barbara
Table 1: Summary of institutions and academic collaboration changes over time		
Number of Students	22,000	26,000
Number of Instructional Faculty	1,400	1,208
Average Annual Increase in Researchers from 1991 to 2021	8.45%	3.41%
Average Annual Increase in Collaborators from 1991 to 2021	3.2%	1.5%

Summary

Our examination shows that during this 30 year period, Cal Poly has seen relatively more growth in **researchers and their corresponding collaborations** each year than UCSB.

This early analytical work appears to show that the teacher-scholar model has positively impacted the overall research and collaboration community within Cal Poly.

What is missing?

More collaborations is great, **but is it the right metric?**

What is the right measures for teacher scholar? (many of our students go into industry….)

Number of Papers,
Amount of Funding,
Citation Index,
Number of students involved in research

Cal Poly and UCSB with Full California data

Consistent with the Central California dataset (*Note gender inference for Full California data is ongoing work*)

This is more focused on computing and does not have years 1991 to 2001
Cal Poly seeds increased on average 12.26% each year
UCSB seeds increased on average 3.80% each year
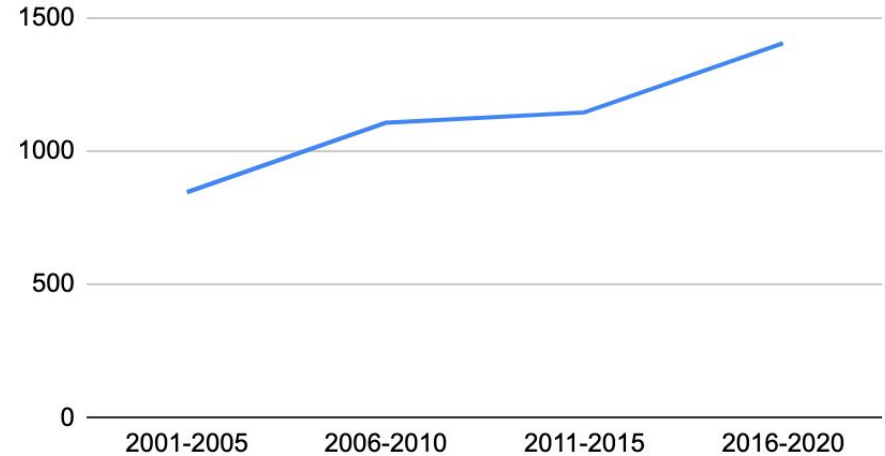
Compared with California wide data

All UCs and CSUs: Average increase for all UC/CSU seeds was 5.89%

California Universities Seeds vs Date
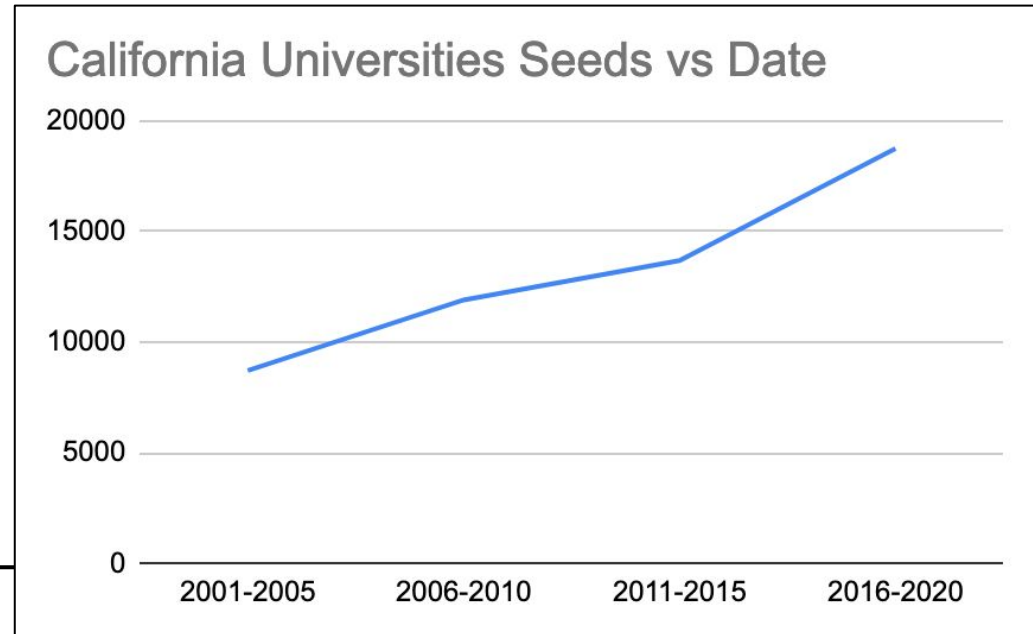
Average degree Full California dataset

Again consistent with Central California dataset

Cal Poly average degree increased on average 4.49% each year
UCSB average degree increased on average 0.91% each year

Cal Poly Average Degree vs Date

UCSB Average Degree vs Date
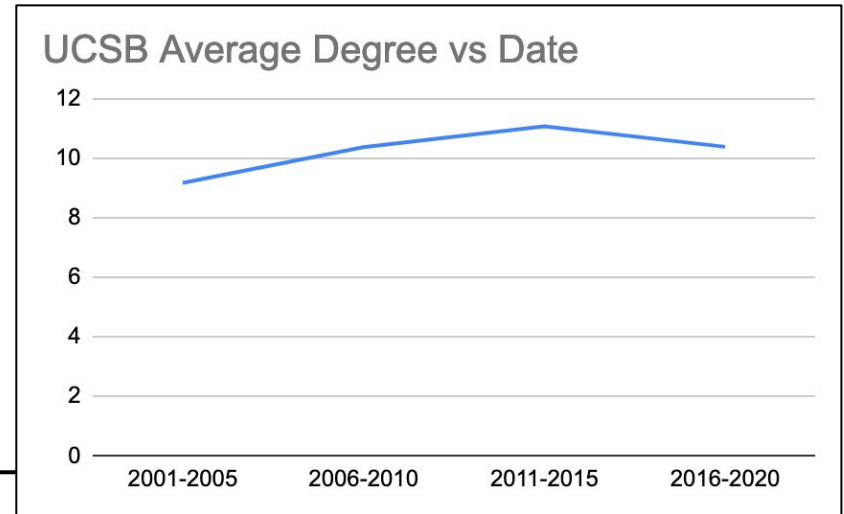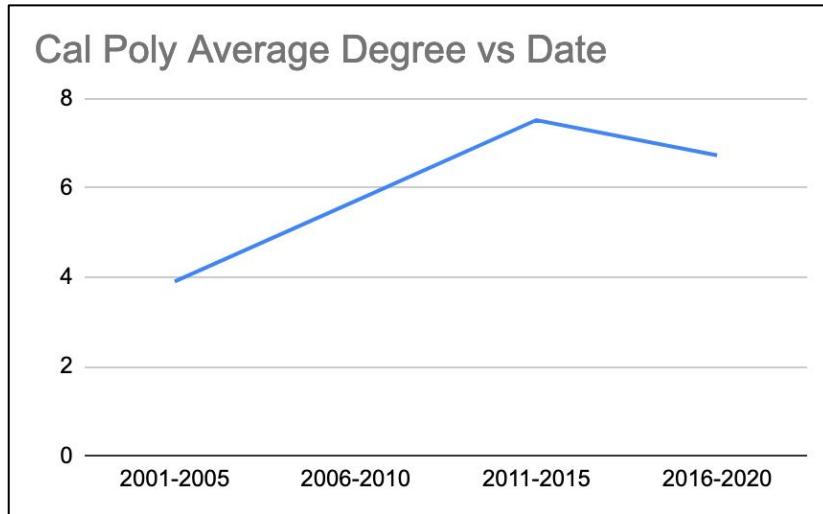
Compared with California wide

All UCs and CSUs: average degree decreased by 0.29%

We see less change over this time period, perhaps from established institutions UC Berkeley and UCLA. This suggests that looking at the local level comparison is good for understanding the change at Cal Poly due to teacher scholar.

California Universities Average Degree vs…
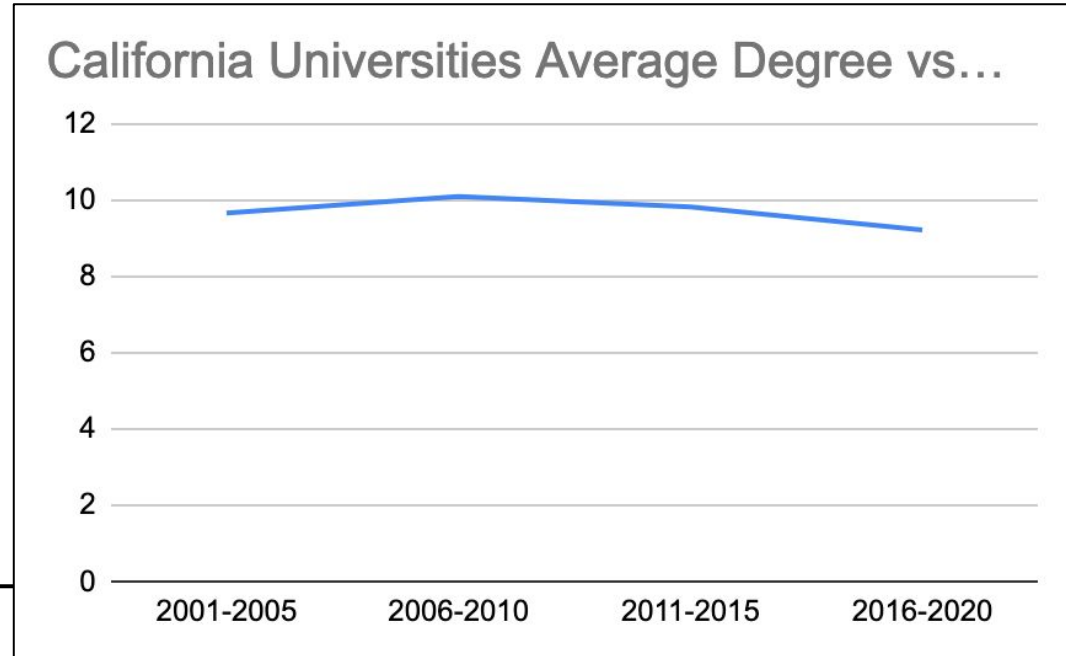
MAVAC visualization

Absolute scale on markers for the number of publications for UCs and CSUs

   Note size of UCLA, UC Berkeley (and UC San Diego and UC Davis) all red circles, compared with UCSB and Cal Poly for example. *These schools are and have been well established and success research Universities (Berkeley was founded in 1868, while Cal Poly is granted collegiate status in 1940).*

Future work

(1) More research on collaboration and diversity. This is challenging because inference of ethnicity based on names is more difficult.

-Do different subgroups of researchers collaborate differently?

-Do more diverse groups of researchers produce a different impact?

(2) More systematic comparison with broader set of universities.

Thank you and acknowledgments

Full MAVAC student team!

Any suggestions

This is ongoing work...

Challenges with NamSor

In the process of using NamSor, the chronic under-representation of Black non-Hispanic researchers in particular became very apparent. Namely, NamSor race/ethnicity calibration is not always reflective of local demographics and **in particular with the unequal distribution of faculty jobs.** For example, the following two examples are taken from the dataset for a researcher name for a general google image search and a google image search using the same name but with an added academic term "University California".

Results form a Google search for particular name with 50% probability inferred ethnicity as Black-nonhispanic (general public)
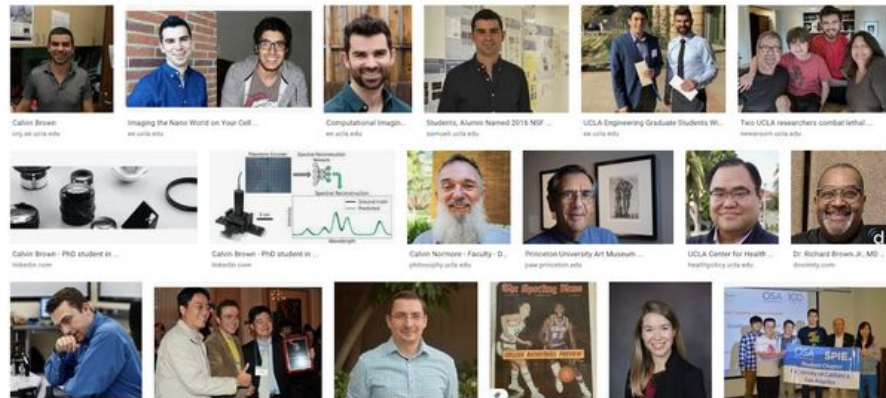
Same name search with California University academic institution qualifier

Google image search illustration

From data
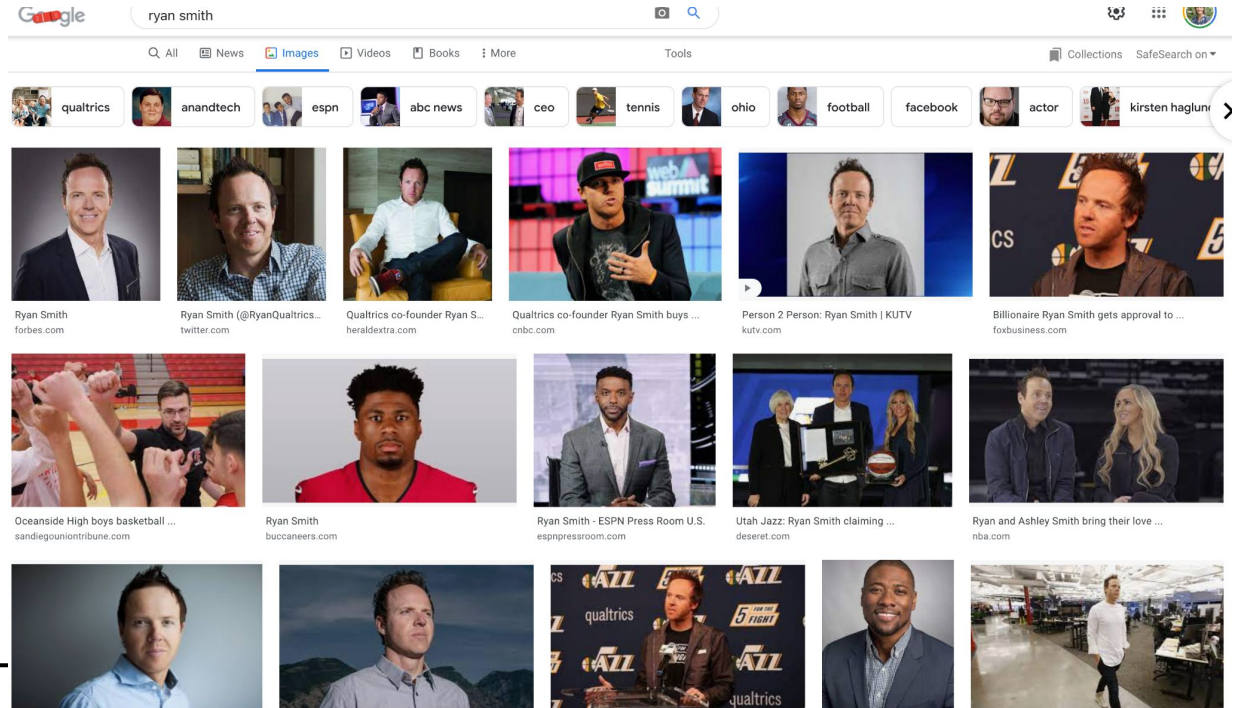
'Ryan Smith'

Google image search illustration

From data

'Ryan Smith+

California

University'

Ongoing work on mapping application

Edges colored based on collaborations - note UCSB shows the larger scale of overall research
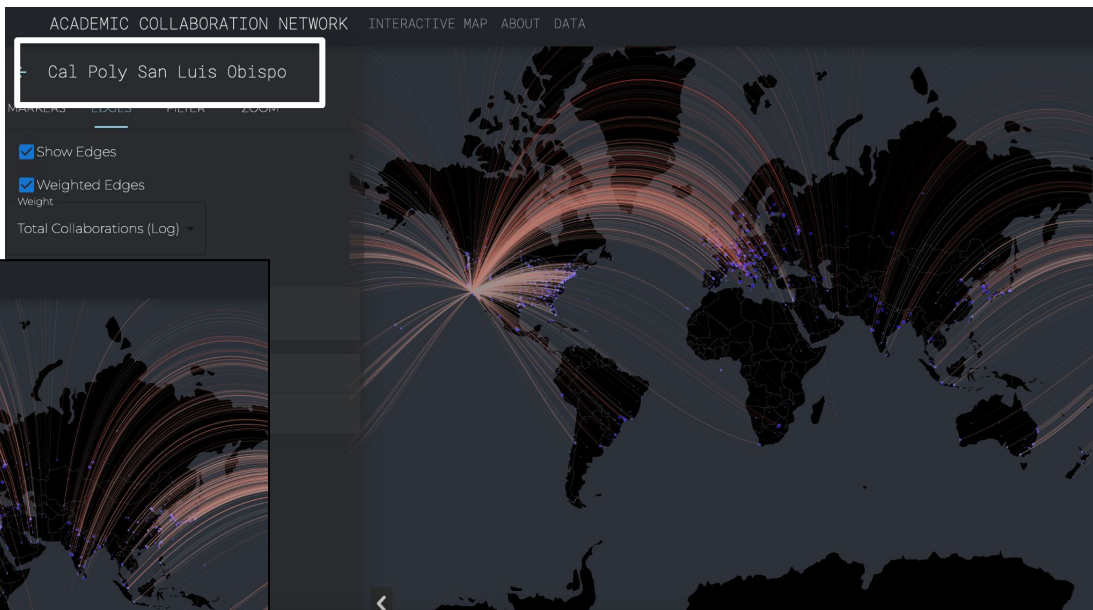
Any suggestions on visualizations?