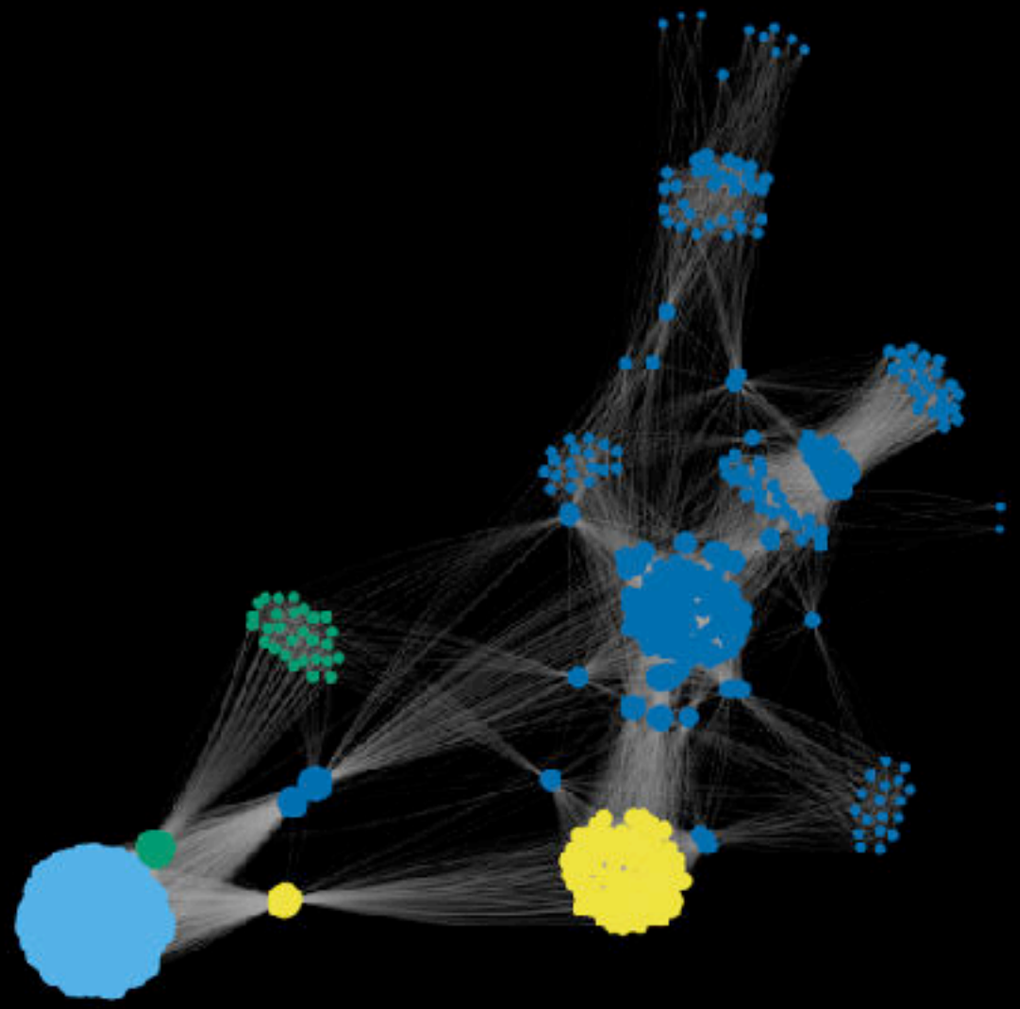
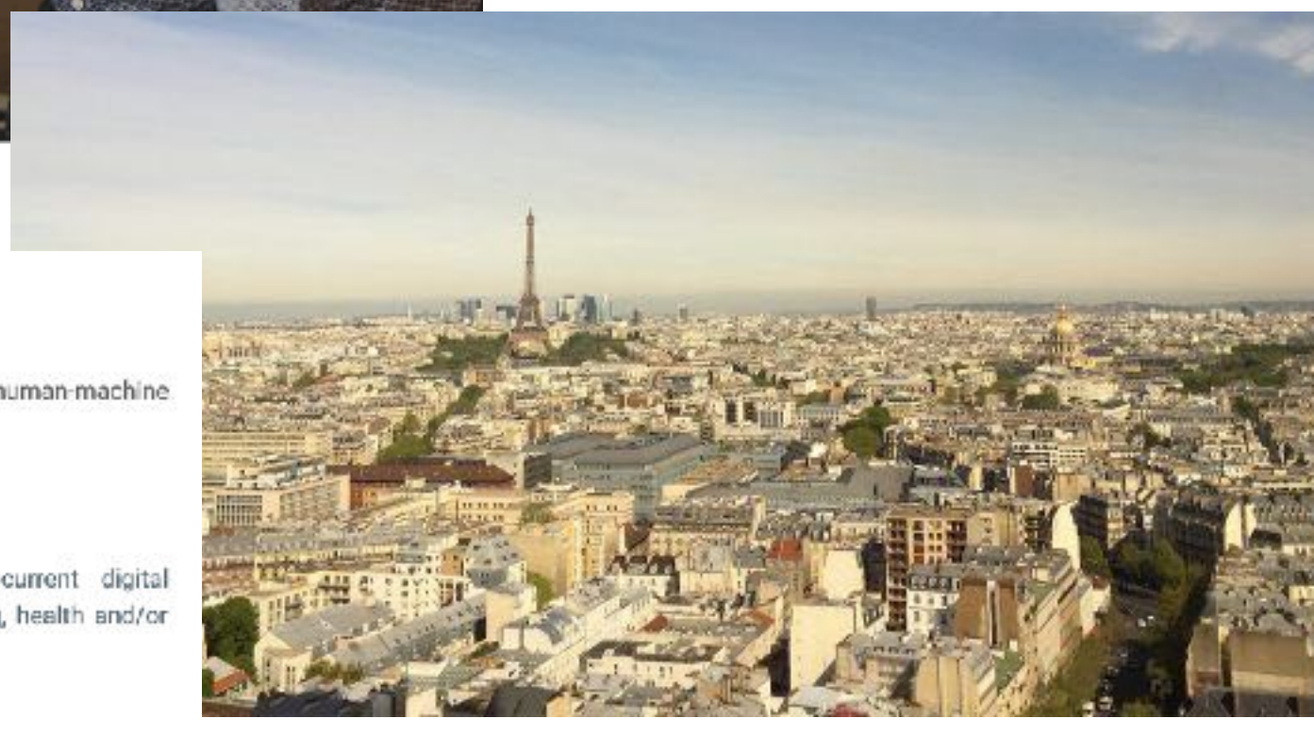
THE NETWORKS BEHIND COLLABORATIVE LEARNING AND SOLVING

Marc Santolini | CRI Paris



@msantolini

CRI



Open health

from data-rich research to development of frugal software and hardware solutions

Open learning

from understanding learning to human-machine paradigms

Open synthetic and systems biology

from foundational understanding of living systems to open biotech and open pharma solutions.

Open AI

Understanding and shaping current digital transition in context of learning, health and/or human-machine paradigms.

Open phronesis

tackling ethical challenges of our time.

research.cri-paris.org

torvalds / linux

Watch 7.1k | Star 92.6k | Fork 32.2k

Code | Pull requests 324 | Actions | Projects 0 | Security 0 | Insights

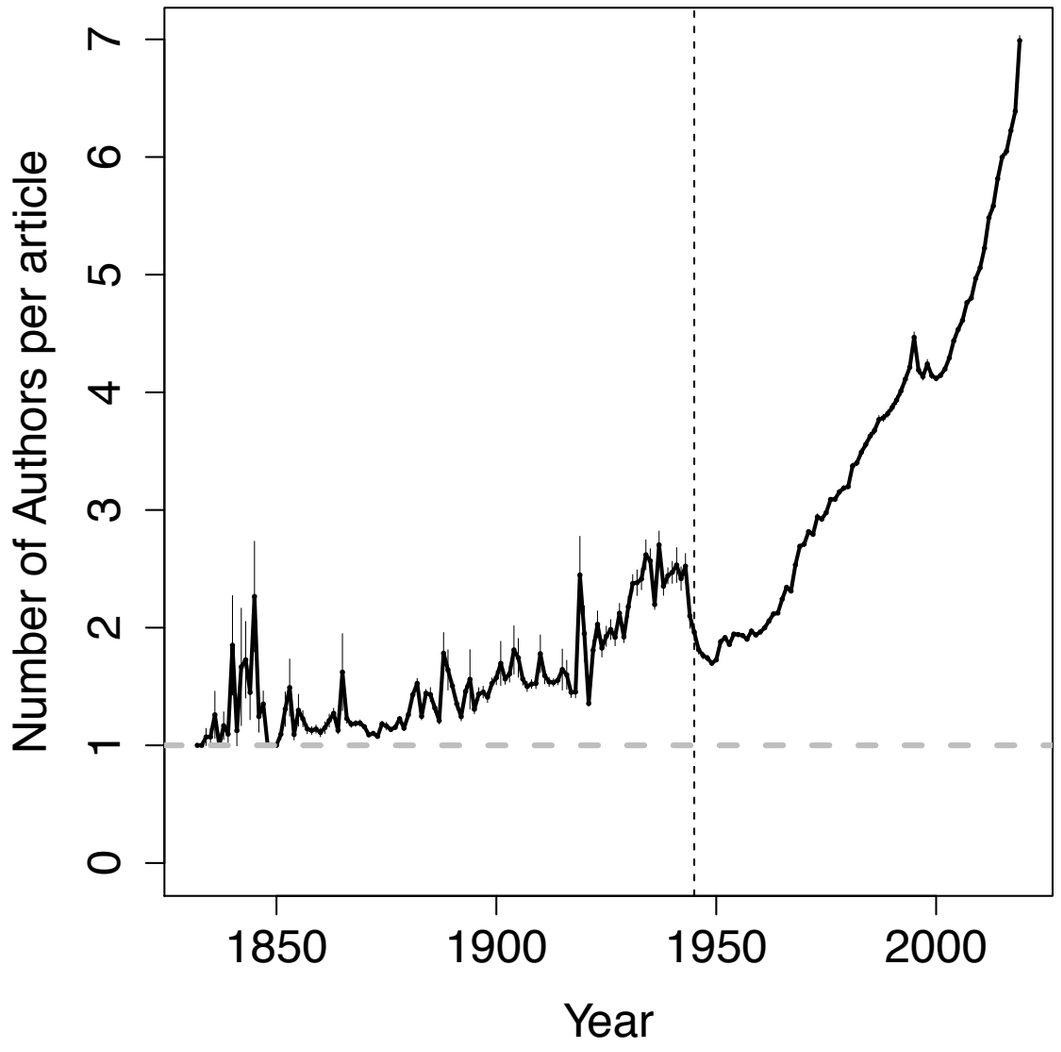
Linux kernel source tree

932,822 commits | 1 branch | 0 packages | 654 releases | ∞ contributors | View license

Branch: master | New pull request | Create new file | Upload files | Find file | Clone or download

torvalds Merge tag 'dma-mapping-5.8-3' of git://git.infradead.org/users/hch/dm... ... Latest commit 1b50440 15 hours ago

The rise of collaborative science



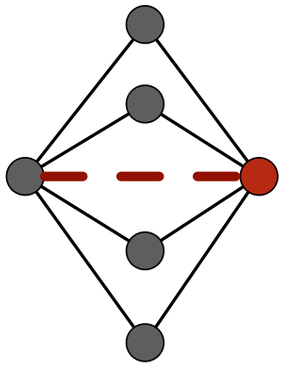
(Springer Nature database)

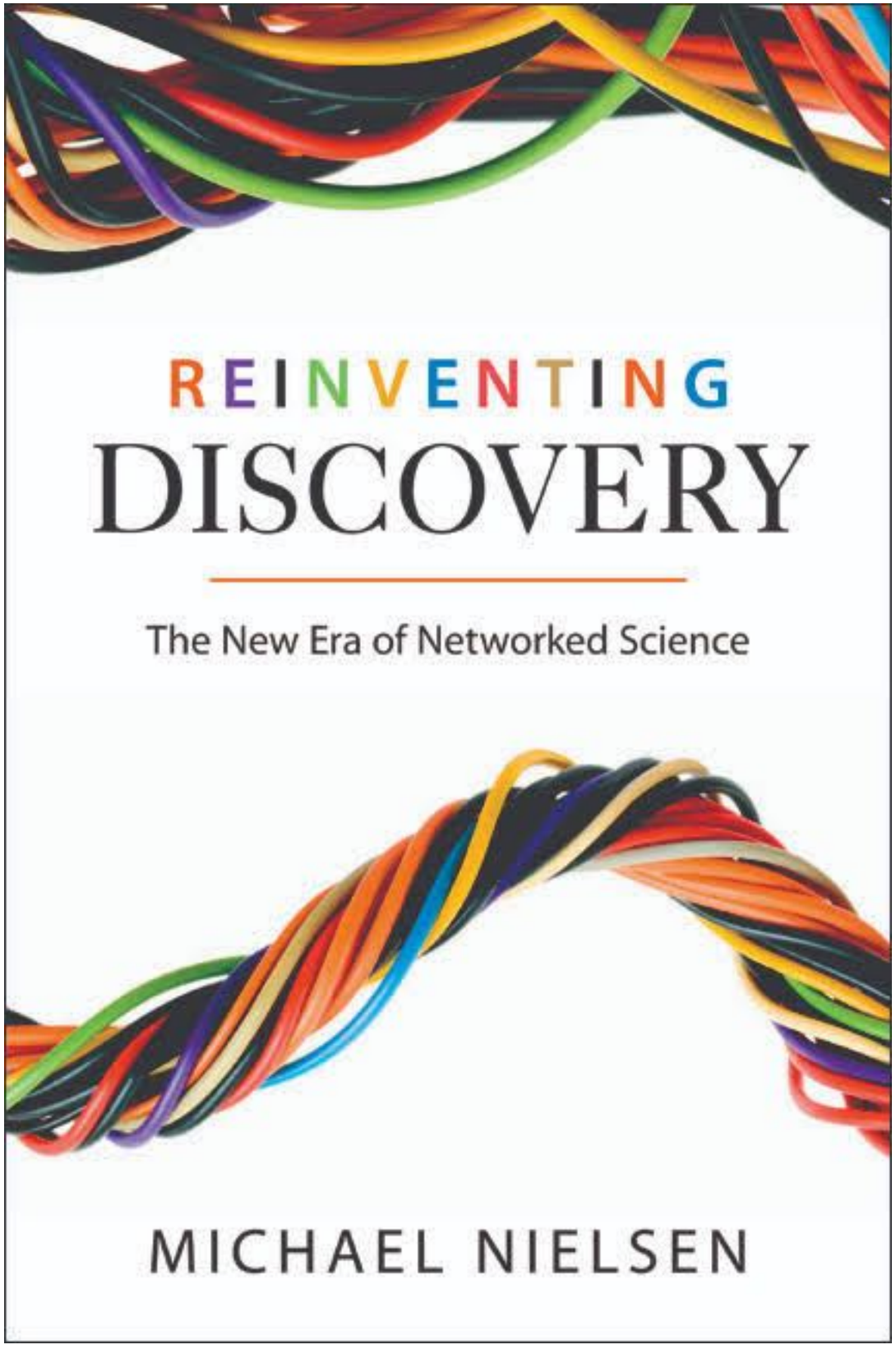
The age of communities

"Designed serendipity"

"once the collaboration gets large enough **participants cannot possibly pay attention to everything that's going on**. […]

Ideally, the **architecture of attention** will **direct participants to places where their particular talents are best suited to take the next step."**

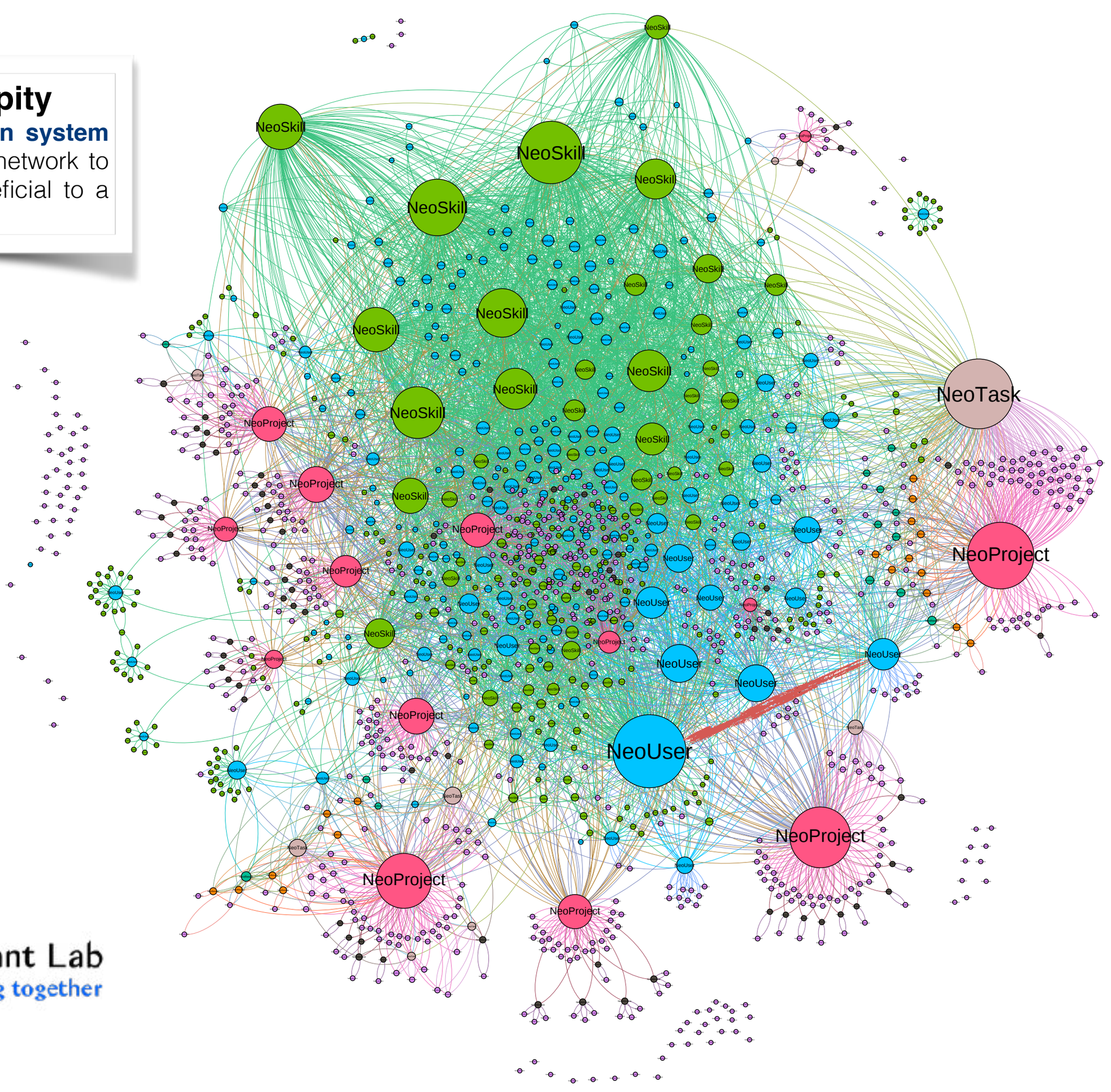




2011

Designing serendipity

Create a **recommendation system** based on the underlying network to **create connections** beneficial to a project



Just One Giant Lab
learning & solving together

Studying collaborative learning and solving

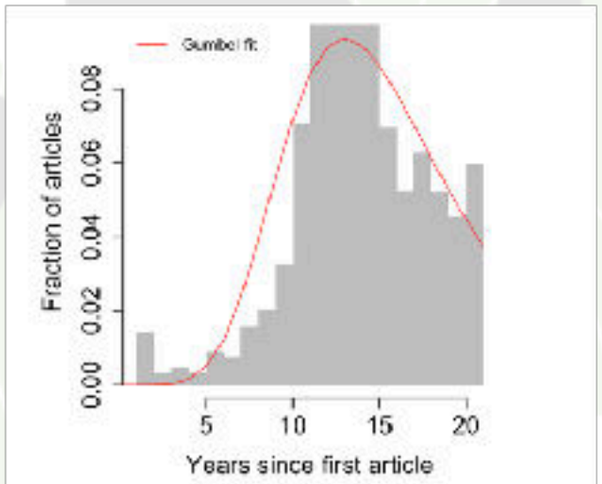
From studying to enhancing collaborative Science

Research on innovation, learning, and collaborations

Collaborative solving

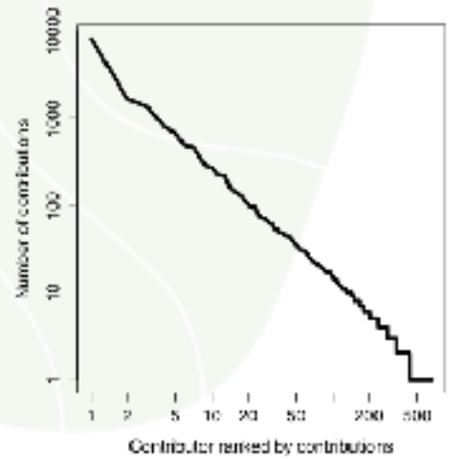
- What types of team collaborations underlie team performance?

Science innovation



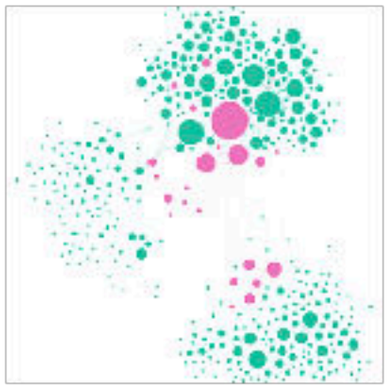
- Can we quantify innovation in science and predict the emergence of new fields?

Open-source communities



- How are large-scale open source communities organized?

Collaborative learning



- How do we learn together? An analysis of collaborative learning in rural Madagascar.

Leo Blondel
Harvard

Megan Palmer
Stanford

Laszlo Barabasi
Northeastern

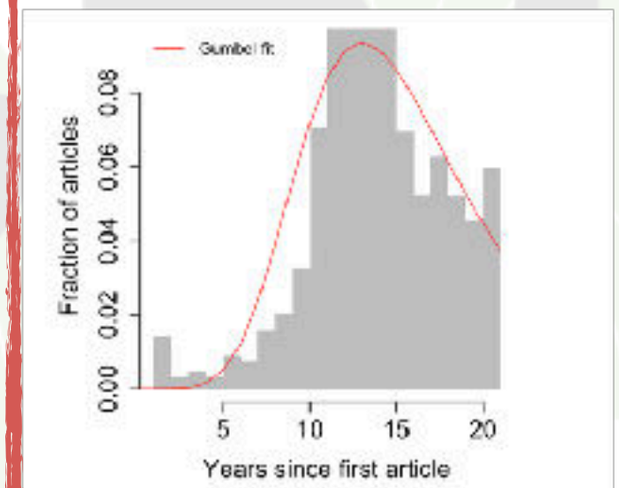
Rathin Jeyaram
Research assistant

Research on innovation, learning, and collaborations

Collaborative solving

- What types of team collaborations underlie team performance?

Science innovation



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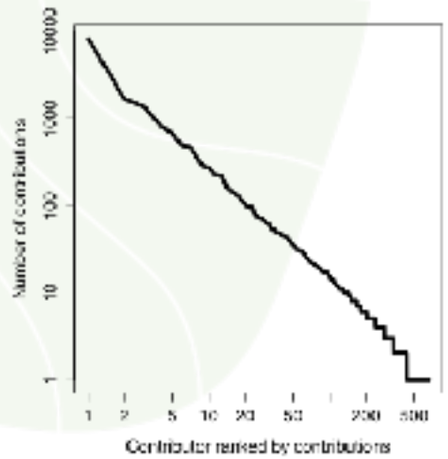
Open-source communities



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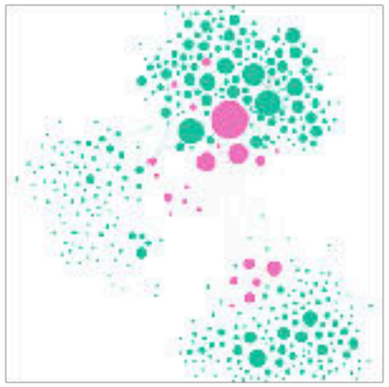
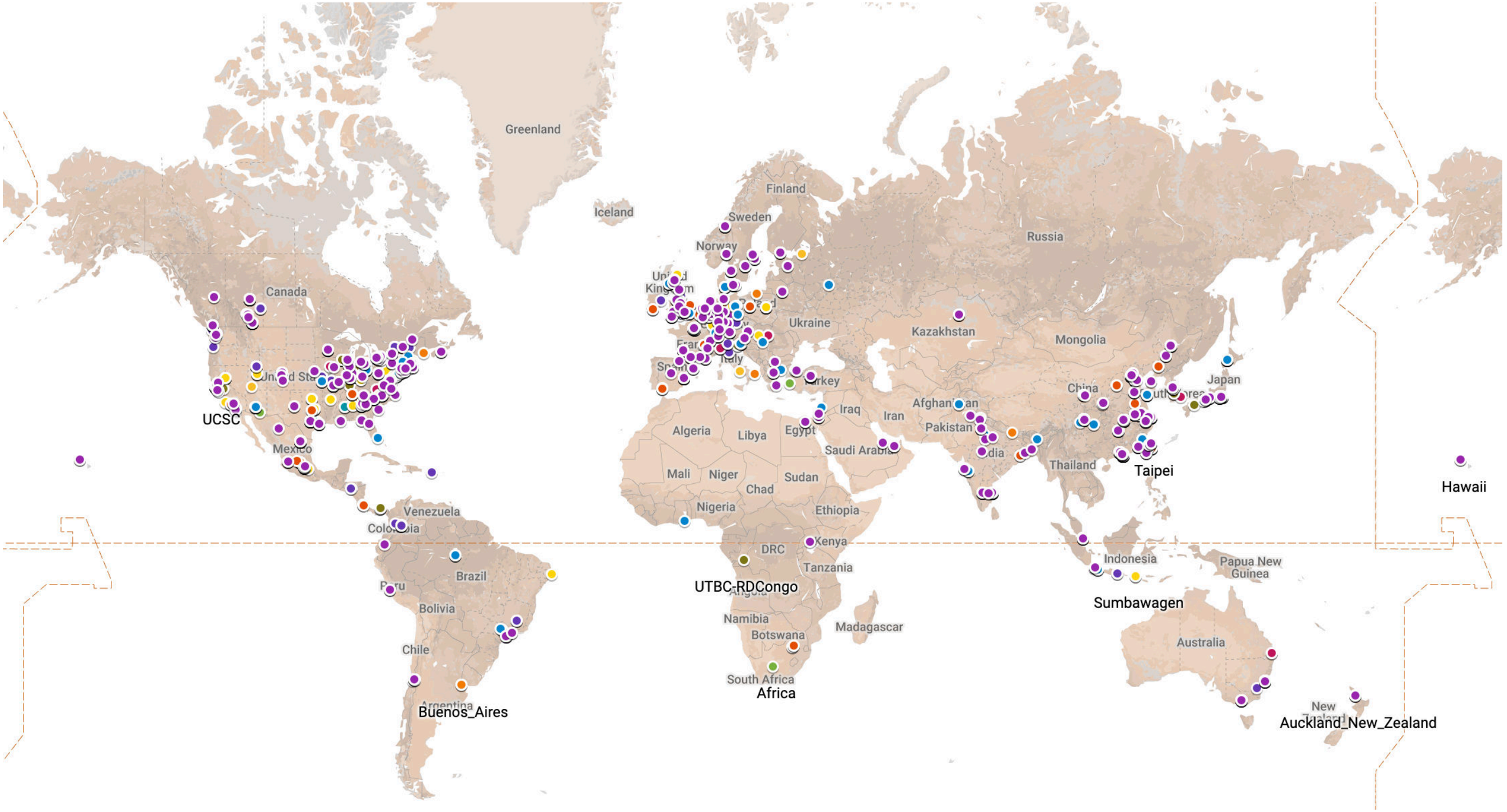
Collaborative learning



- How do we learn together? An analysis of collaborative learning in rural Madagascar.


GIANT 20
JAMBOREE 14
GIANT 20
JAMBOREE 14


GIANT 20
JAMBOREE 14
GIANT 20
JAMBOREE 14
iGEM
challenge-based
“coopetition”
synthetic biology
6 month projects
14 years
3,000+ teams
medals, prizes…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Finland
Sweden
Norway
Russia
Ukraine
Kazakhstan
Mongolia
China
Japan
Turkey
Iraq
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Pakistan
India
Thailand
Taipei
Hawaii
Algeria
Libya
Egypt
Saudi Arabia
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Kenya
DRC
Tanzania
UTBC-RDCongo
Namibia
Botswana
Madagascar
South Africa
Africa
Indonesia
Papua New Guinea
Sumbawagen
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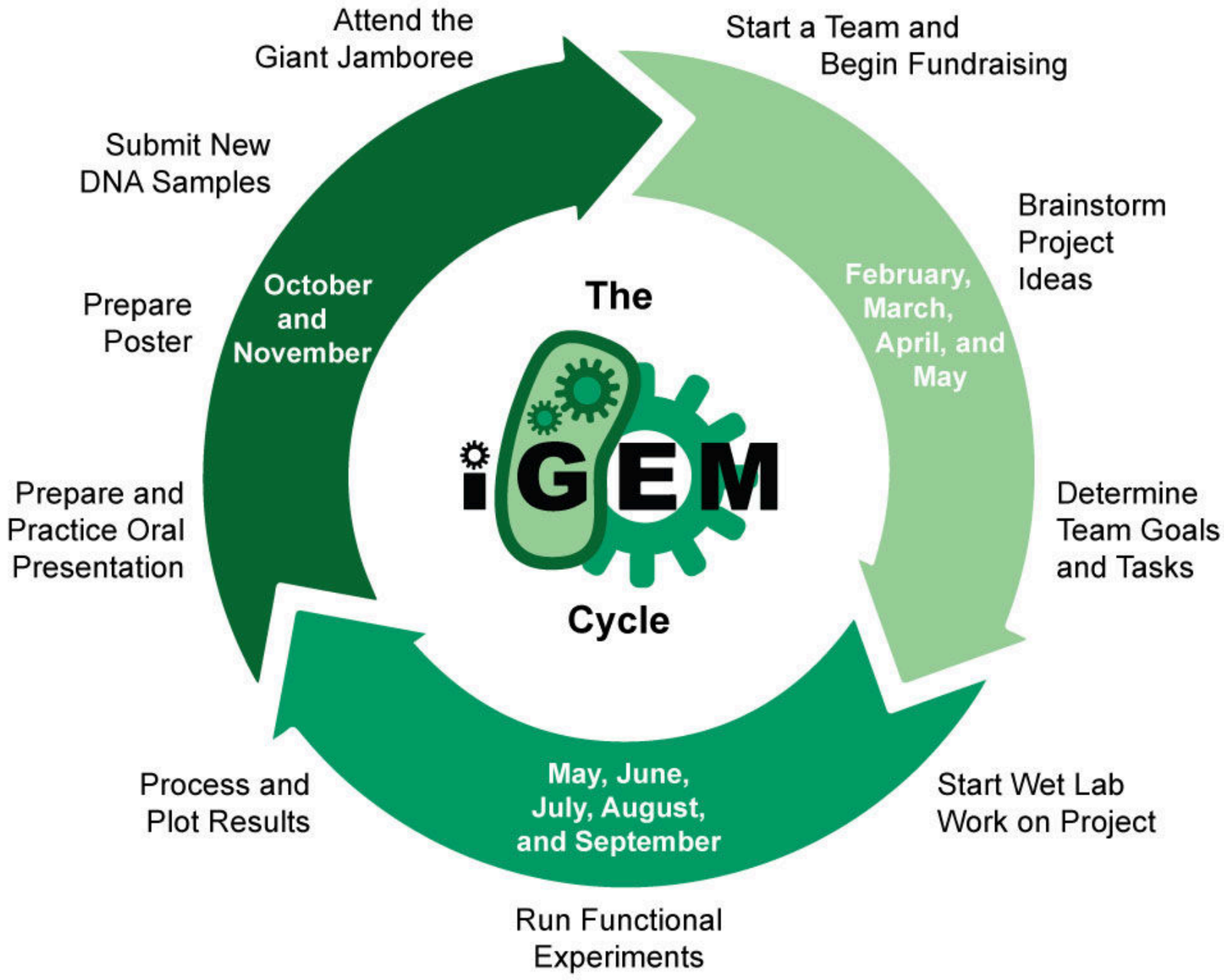
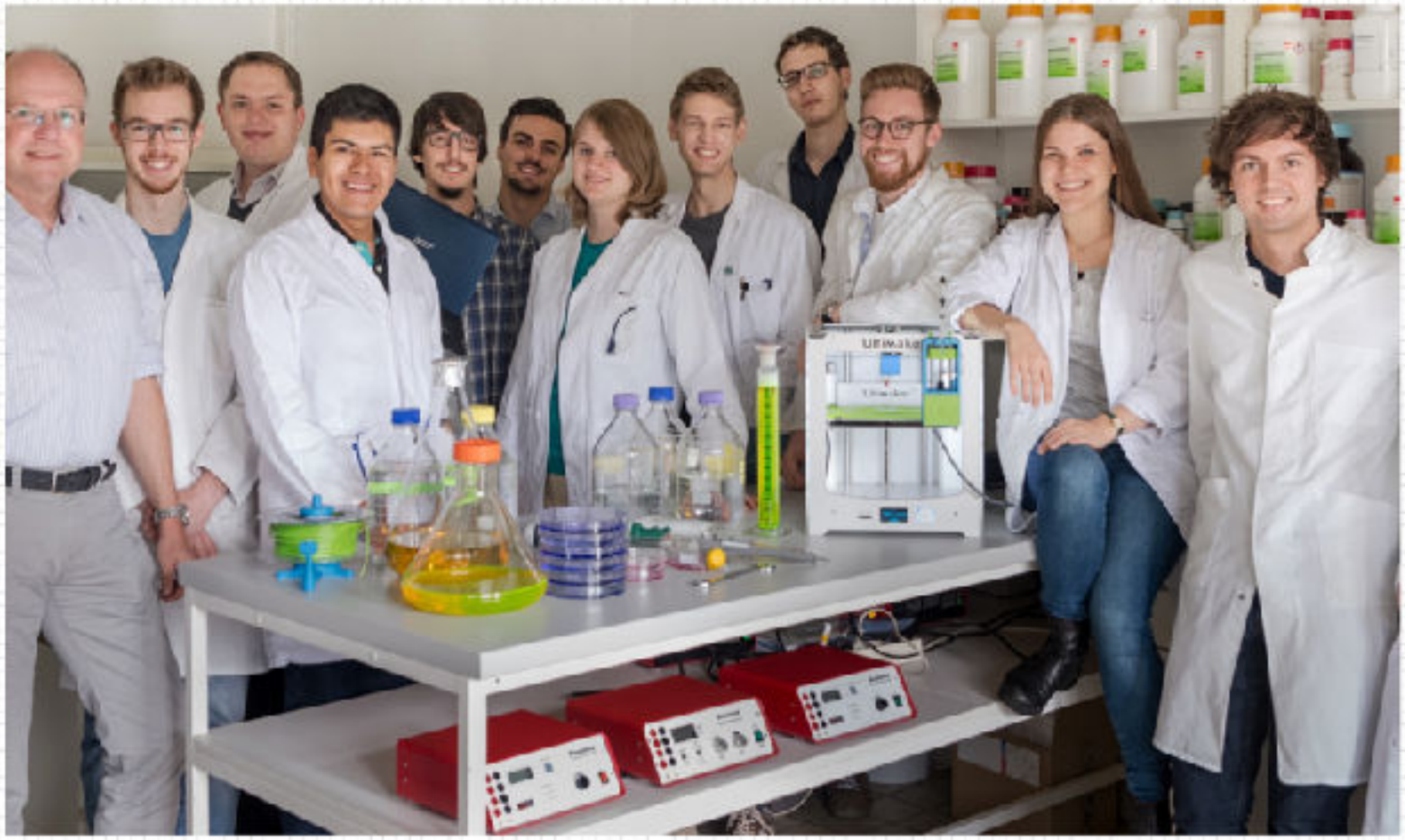
Bolivia
Chile
Argentina
Buenos_Aires



- **Synchronized** temporal dynamics (simulates an experimental condition)



Abstract: bio(t)INK - rethINK tissue printing

We are living in an aging society that is facing a decreasing supply of donor organs for medical transplantation. To confront this pressing issue, we developed a game-changing approach to bioprint tissues for biomedical applications. Our interdisciplinary work aims to create a unique ink, named bio(t)INK, to revolutionize bioprinting. The printing process uses a **hijacked 3D printer** and two components of biotINK to induce an instantaneous **polymerization reaction**, creating three-dimensional multi-cellular structures in a user-definable manner. The principle of this two-

Revision history of "Team:Aalto-Helsinki"

Browse history

From year (and earlier): 2016 From month (and earlier): all Go

Diff selection: Mark the radio boxes of the revisions to compare and hit enter or the button at the bottom.
Legend: **(cur)** = difference with latest revision, **(prev)** = difference with preceding revision, **m** = minor edit.

(newest | oldest) View (newer 50 | older 50) (20 | 50 | 100 | 250 | 500)

Compare selected revisions

- (cur | prev) 09:05, 2 October 2015 Riikkah (Talk | contribs) **m** . . (25,480 bytes) **(-778)**
- (cur | prev) 15:09, 18 September 2015 Jrusanen (Talk | contribs) . . (26,258 bytes) (-206) . . *(-lab results)*
- (cur | prev) 13:15, 17 September 2015 Hyrkkal1 (Talk | contribs) **m** . . (26,464 bytes) (-161)
- (cur | prev) 11:09, 17 September 2015 Hyrkkal1 (Talk | contribs) . . (26,625 bytes) (-36) . . *(Undo revision 293083 by Hyrkkal1 (talk))*
- (cur | prev) 11:09, 17 September 2015 Hyrkkal1 (Talk | contribs) . . (26,661 bytes) (+36)
- (cur | prev) 10:56, 17 September 2015 Hyrkkal1 (Talk | contribs) . . (26,625 bytes) (+180)
- (cur | prev) 10:11, 17 September 2015 Riikkah (Talk | contribs) . . (26,445 bytes) (+98) . . *(trying to add things that show only with IE)*
- (cur | prev) 10:10, 17 September 2015 Riikkah (Talk | contribs) . . (26,347 bytes) (+119) . . *(trying to add things that show only with IE)*
- (cur | prev) 10:05, 17 September 2015 Riikkah (Talk | contribs) **m** . . (26,228 bytes) (+211)
- (cur | prev) 10:03, 17 September 2015 Riikkah (Talk | contribs) . . (26,017 bytes) (+285) . . *(trying to add things that show only with IE)*
- (cur | prev) 09:47, 17 September 2015 Riikkah (Talk | contribs) . . (25,732 bytes) (+309) . . *(trying to add things that show only with IE)*
- (cur | prev) 05:59, 17 September 2015 Riikkah (Talk | contribs) **m** . . (25,423 bytes) (+147)
- (cur | prev) 05:19, 17 September 2015 Riikkah (Talk | contribs) **m** . . (25,276 bytes) (+32)
- (cur | prev) 17:08, 16 September 2015 Jrusanen (Talk | contribs) . . (25,244 bytes) (+14) . . *(design project -> continuous production)*
- (cur | prev) 16:04, 16 September 2015 Riikkah (Talk | contribs) **m** . . (25,230 bytes) (+190) . . *(added design to navbars)*
- (cur | prev) 15:33, 16 September 2015 Taalam (Talk | contribs) . . (25,040 bytes) (-169)
- (cur | prev) 15:27, 16 September 2015 Taalam (Talk | contribs) . . (25,209 bytes) (+169) . . *(added Future)*
- (cur | prev) 05:05, 16 September 2015 Riikkah (Talk | contribs) **m** . . (25,040 bytes) (+174) . . *(added future to navbars)*
- (cur | prev) 14:44, 15 September 2015 Riikkah (Talk | contribs) . . (24,866 bytes) (-4) . . *(bootstrap.min.js linked from a page that doesn't contain .js ending, let's see if this helps for the mobilenav)*
- (cur | prev) 14:55, 14 September 2015 Hyrkkal1 (Talk | contribs) **m** . . (24,870 bytes) (-2)

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4     879  Team:Alberta  2012-10-04T01:38:00  Rick24568509  (3,694 bytes)
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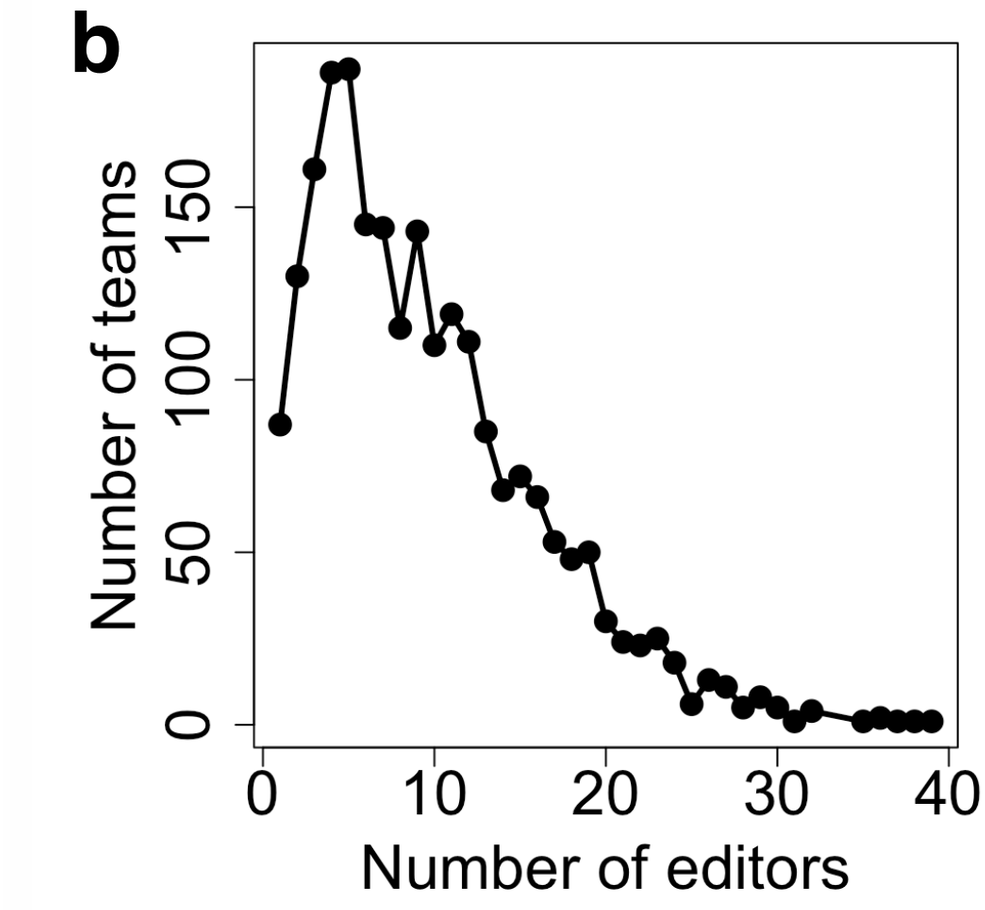
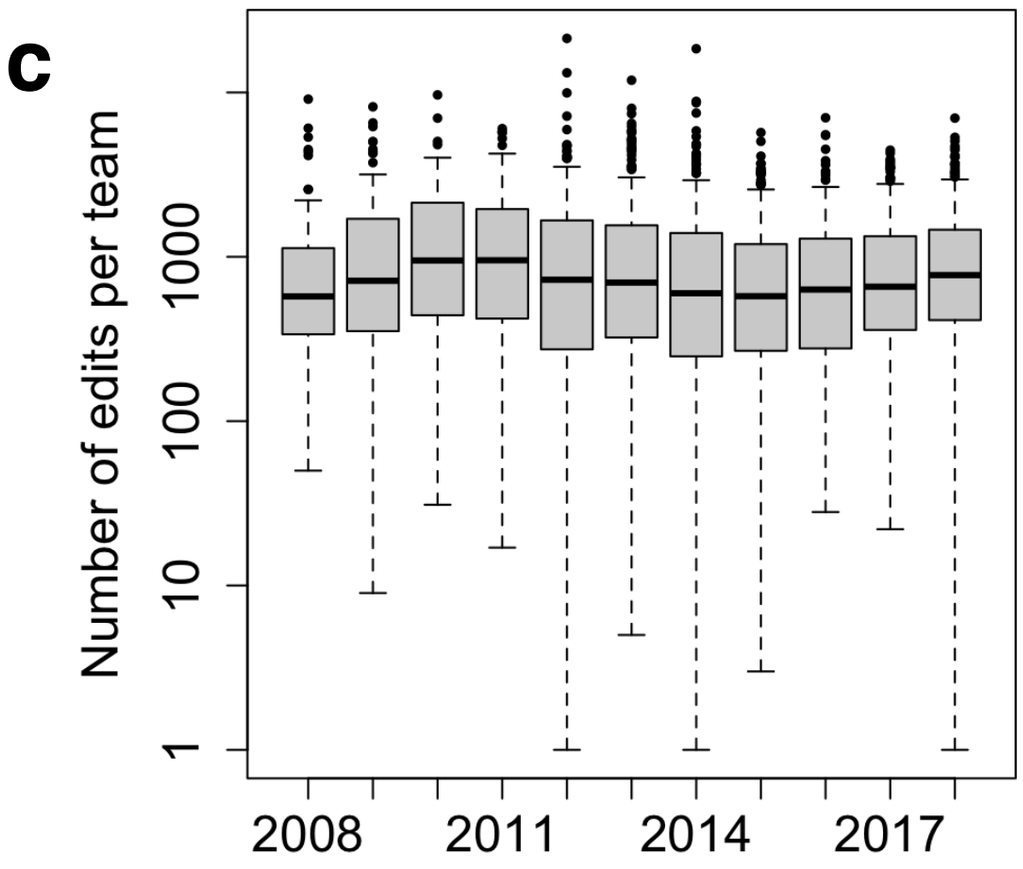
WIKI DATA

Team size



Team effort



Stability across competitions

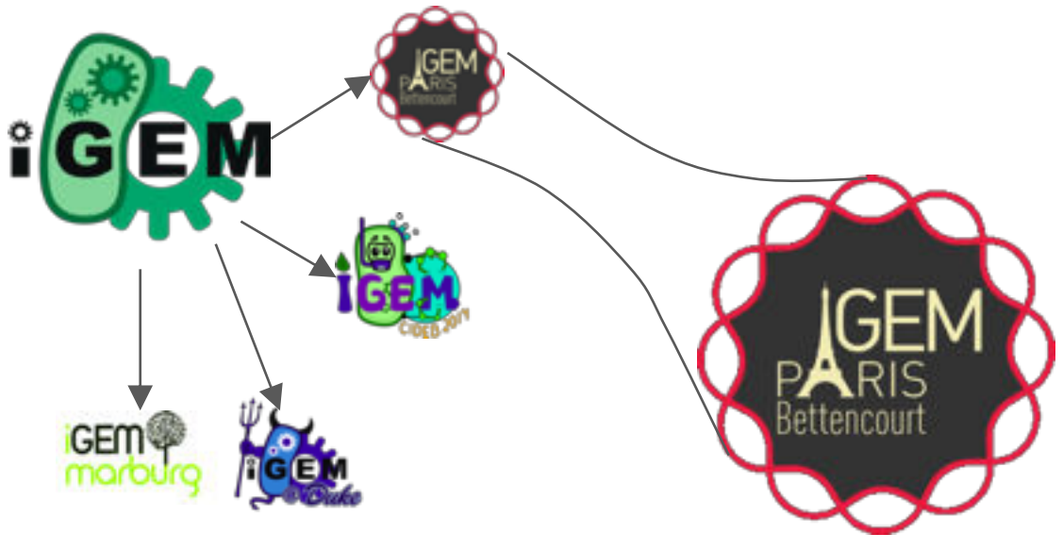
PERFORMANCE DATA

	Team	Medal	Award
⊖	**Aachen**	🥇	Best Manufacturing Project, Overgrad
	Region: **Europe** | Section: **Overgrad** | Official Team Profile View this team's Wiki | Poster | Presentation Slides | Presentation Video		
⊕	**Aachen**	🥇	Nominated for Best Software Tool, Overgrad
⊕	**Aalto-Helsinki**	🥇	
⊕	**AHUT_China**	🥈	
⊕	**Aix-Marseille**	🥉	
⊕	**Amoy**	🥈	
⊕	**Amsterdam**	🥇	
⊕	**ANU-Canberra**	🥉	
⊕	**ATOMS-Turkiye**	🥈	Nominated for Best New Composite Part, Undergrad
⊕	**AUC_TURKEY**	🥇	Nominated for Best New Composite Part, High School

- 6 judges per team, grade 60 criteria from 1 to 5

- **Medals**: fulfill requirements
- **Prizes**: special award
- **Winner**: best team

A TESTBED TO UNDERSTAND COLLABORATIONS

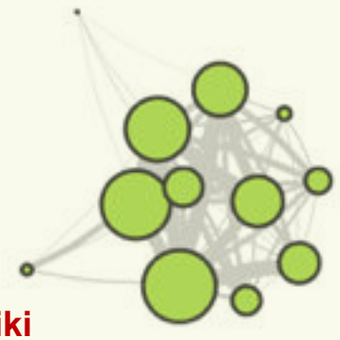


Biobricks Network

BioBricks made

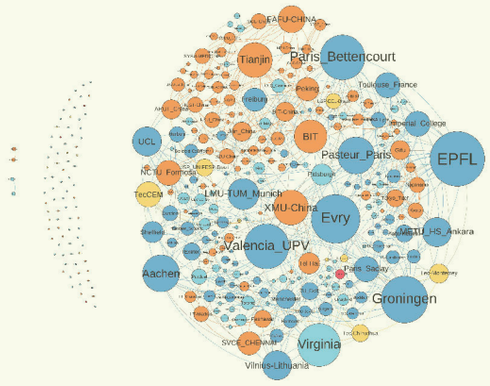
Re-used by other BioBricks

Team Interaction Network



Interactions traced from wiki

Teams Collaboration Network



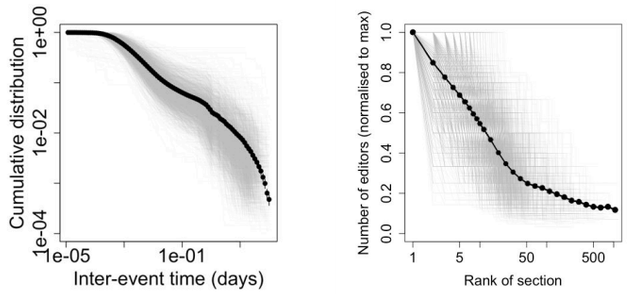
Success Measures

Medals

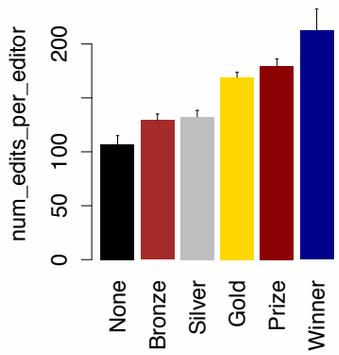
What underlies team organisation, performance, and improvement?

Team features space

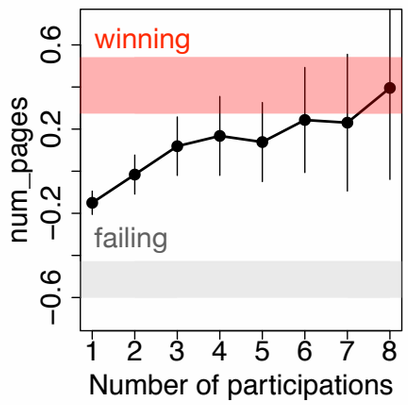
1. Universal aspects of team work

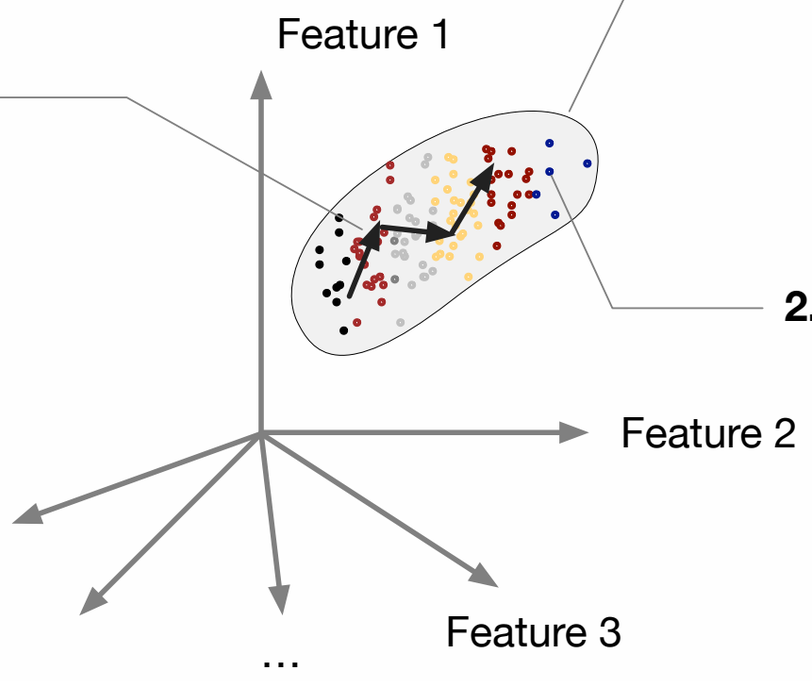


2. Features underlying team performance



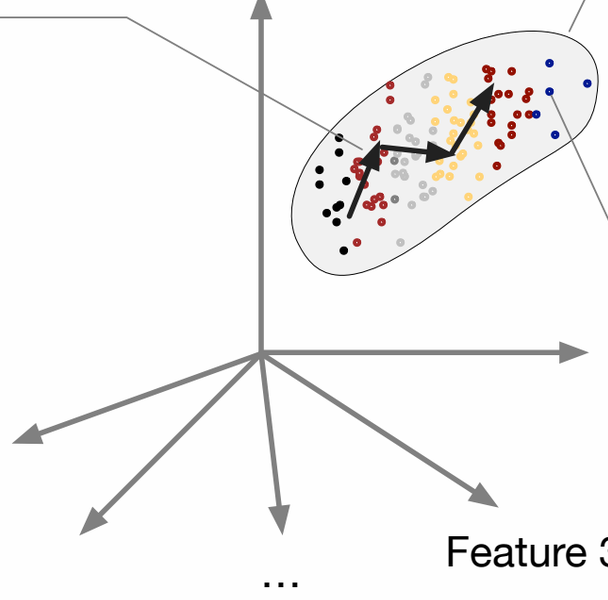
3. Team improvement through reparticipation



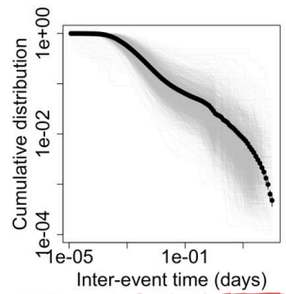


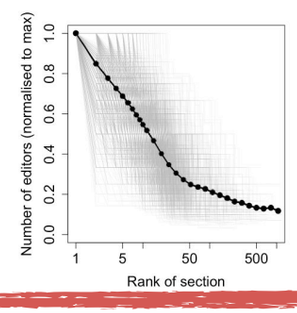
THE TEAM SPACE

Team features space

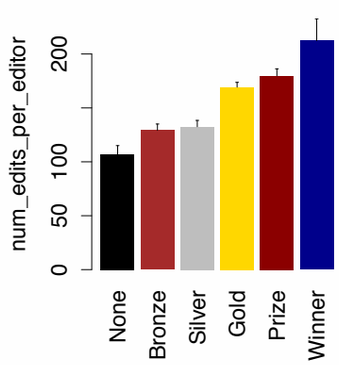


1. Universal aspects of team work





2. Features underlying team performance



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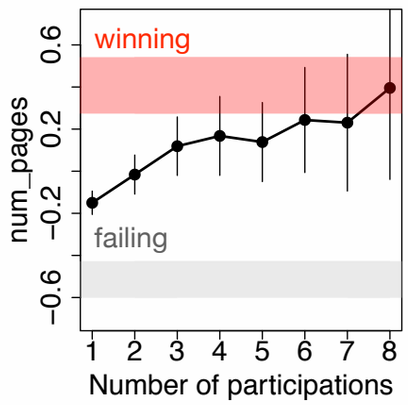
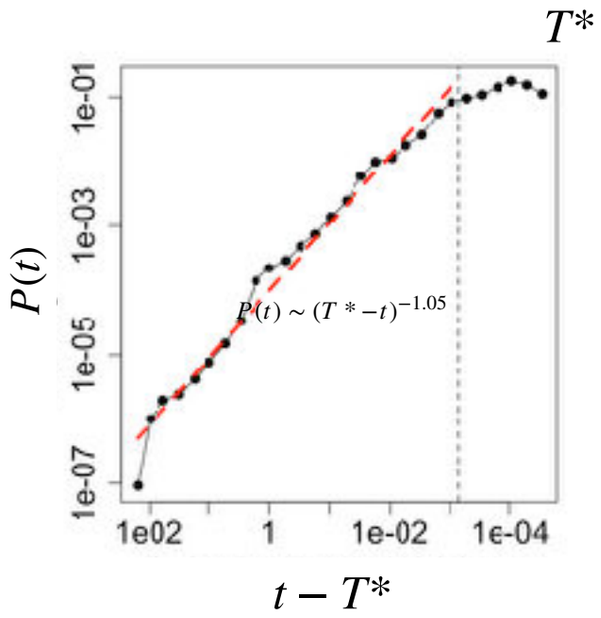


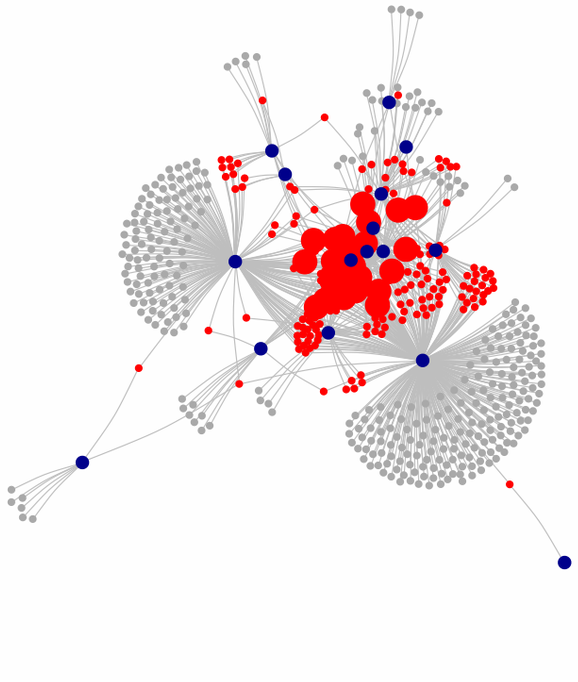
TEAM WORK

shared properties of team work in iGEM

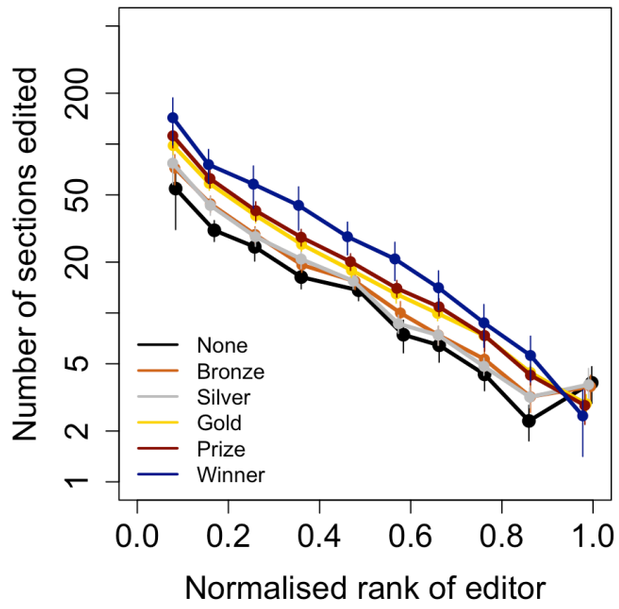
Deadline effect

as observed for conference registrations



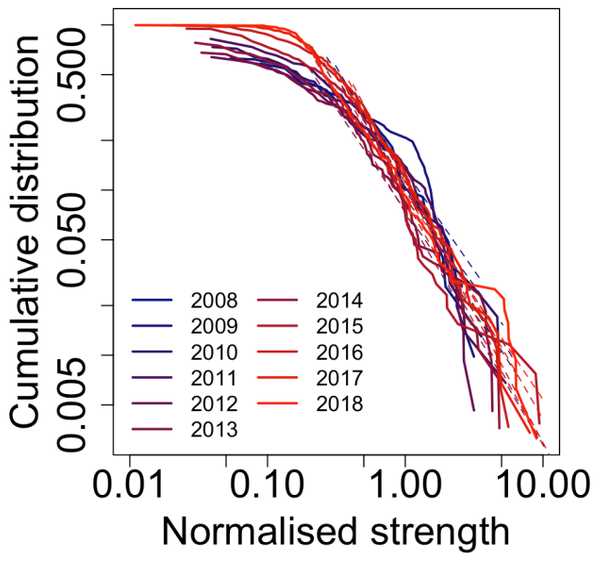


Workload inequality

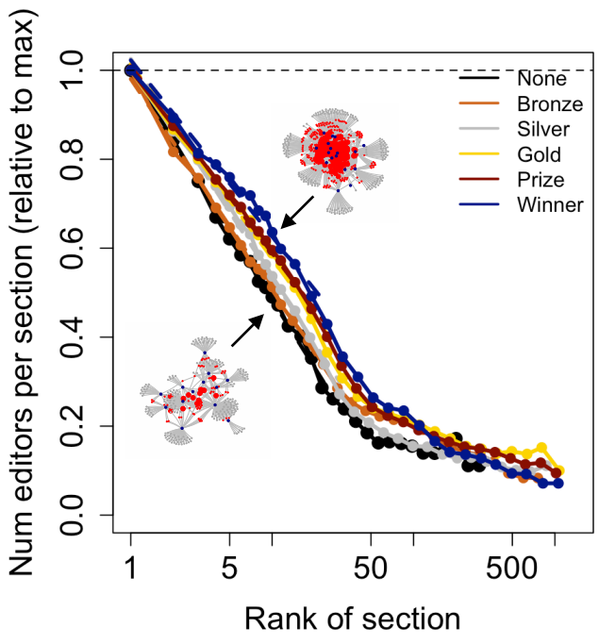


Inter-team collaborations

preferential attachment



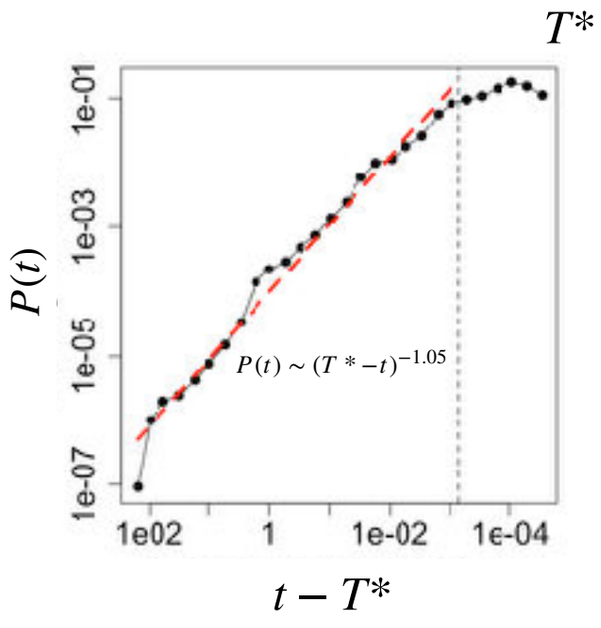
Collaborative core

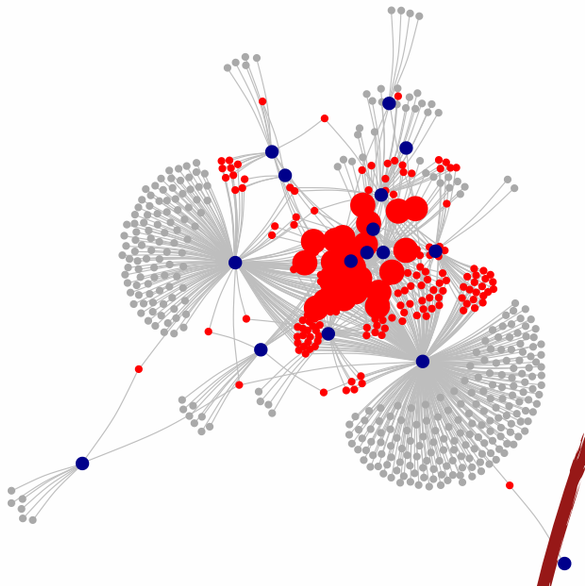


TEAM WORK

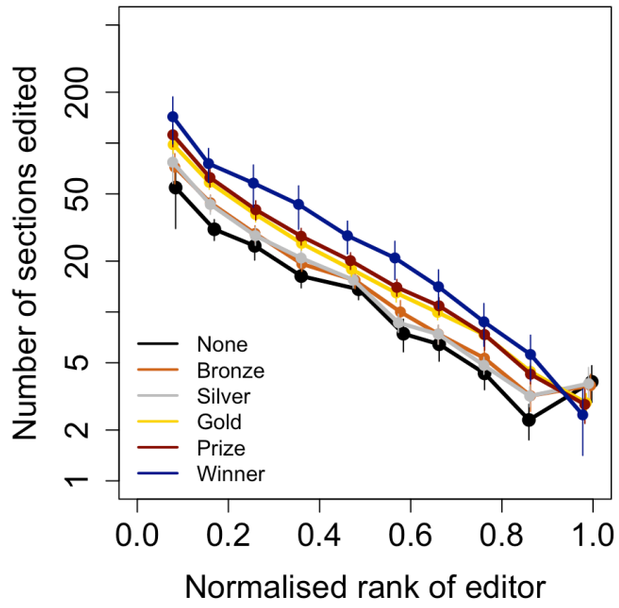
"**universals**" of team work in iGEM

Deadline effect

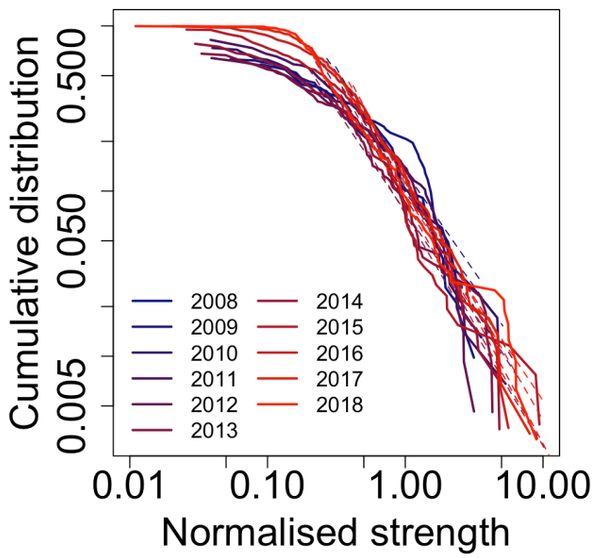




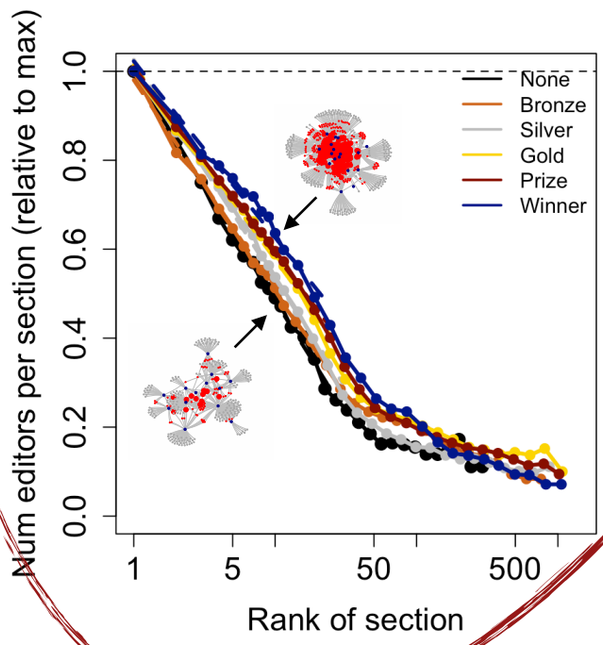
Workload inequality



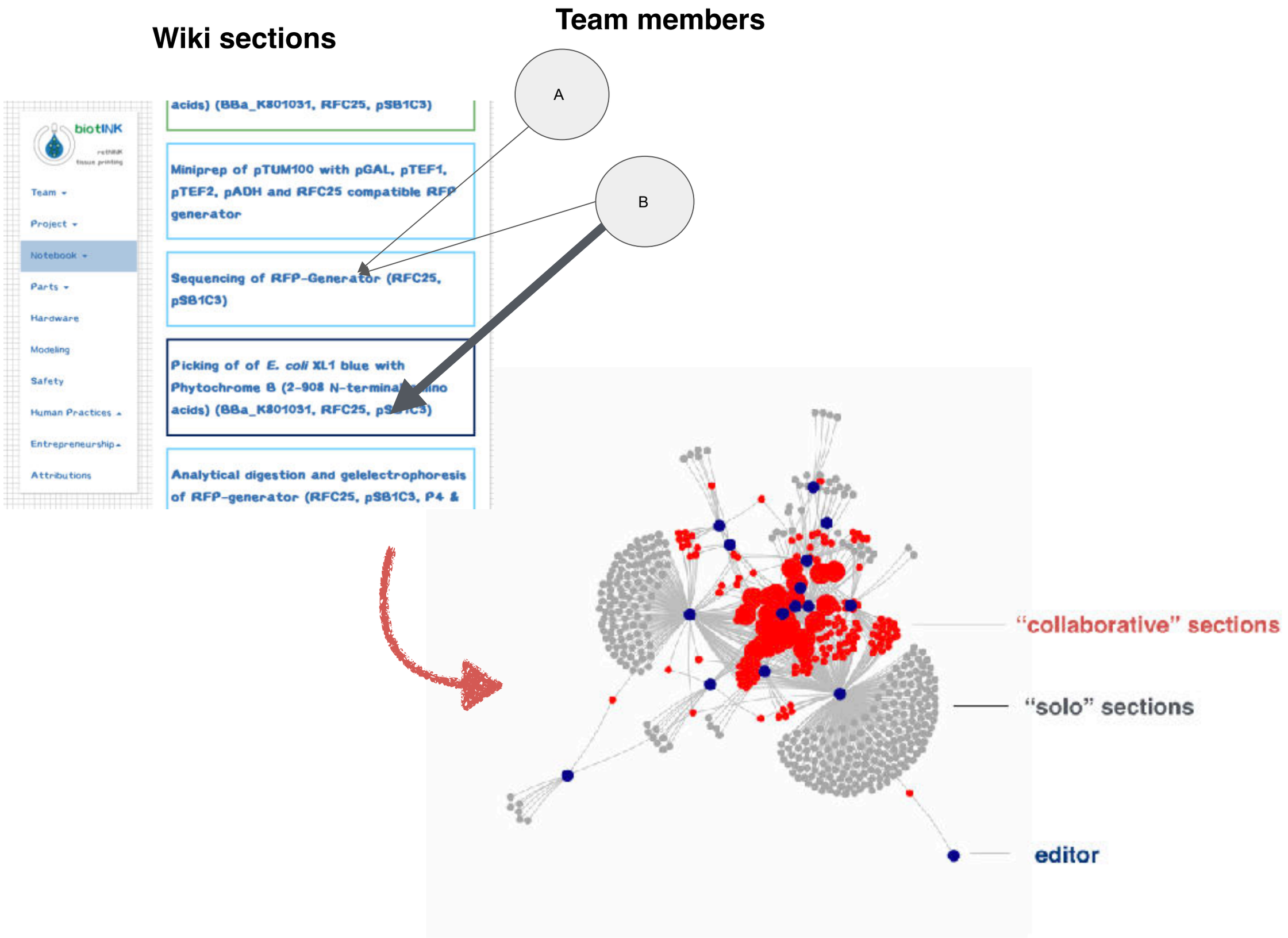
Inter-team collaborations



Collaborative core

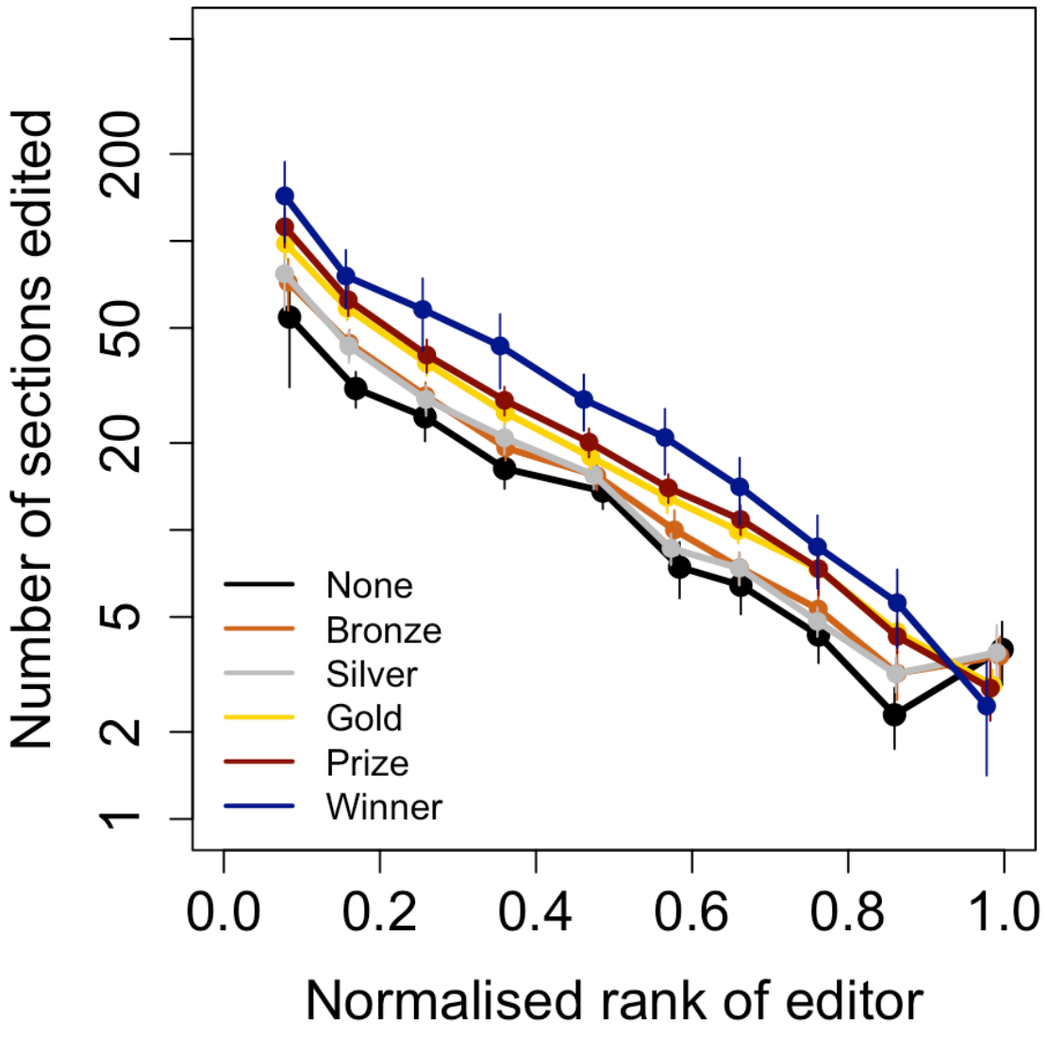


TEAM BIPARTITE NETWORK



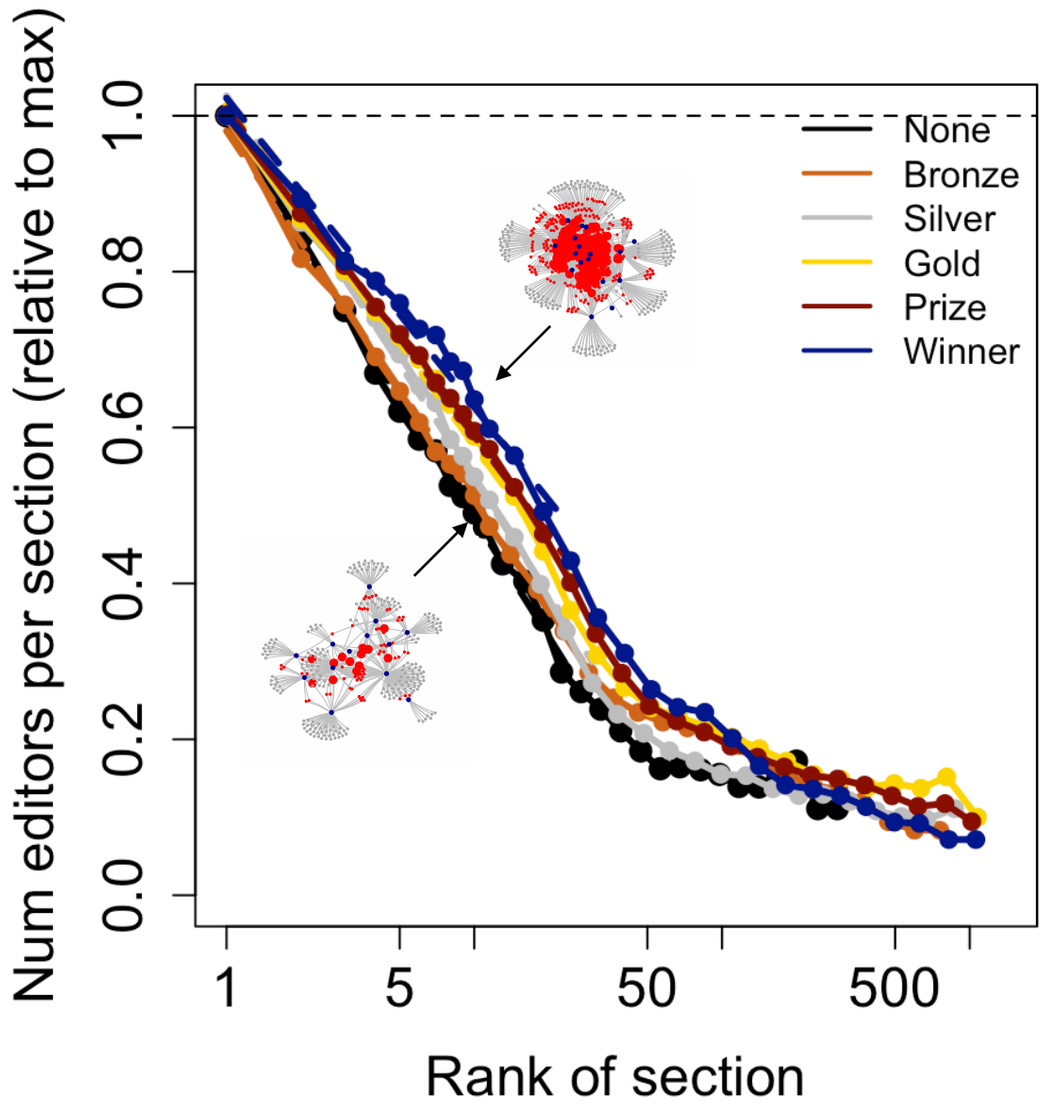
COLLABORATION STRUCTURE

Work distribution



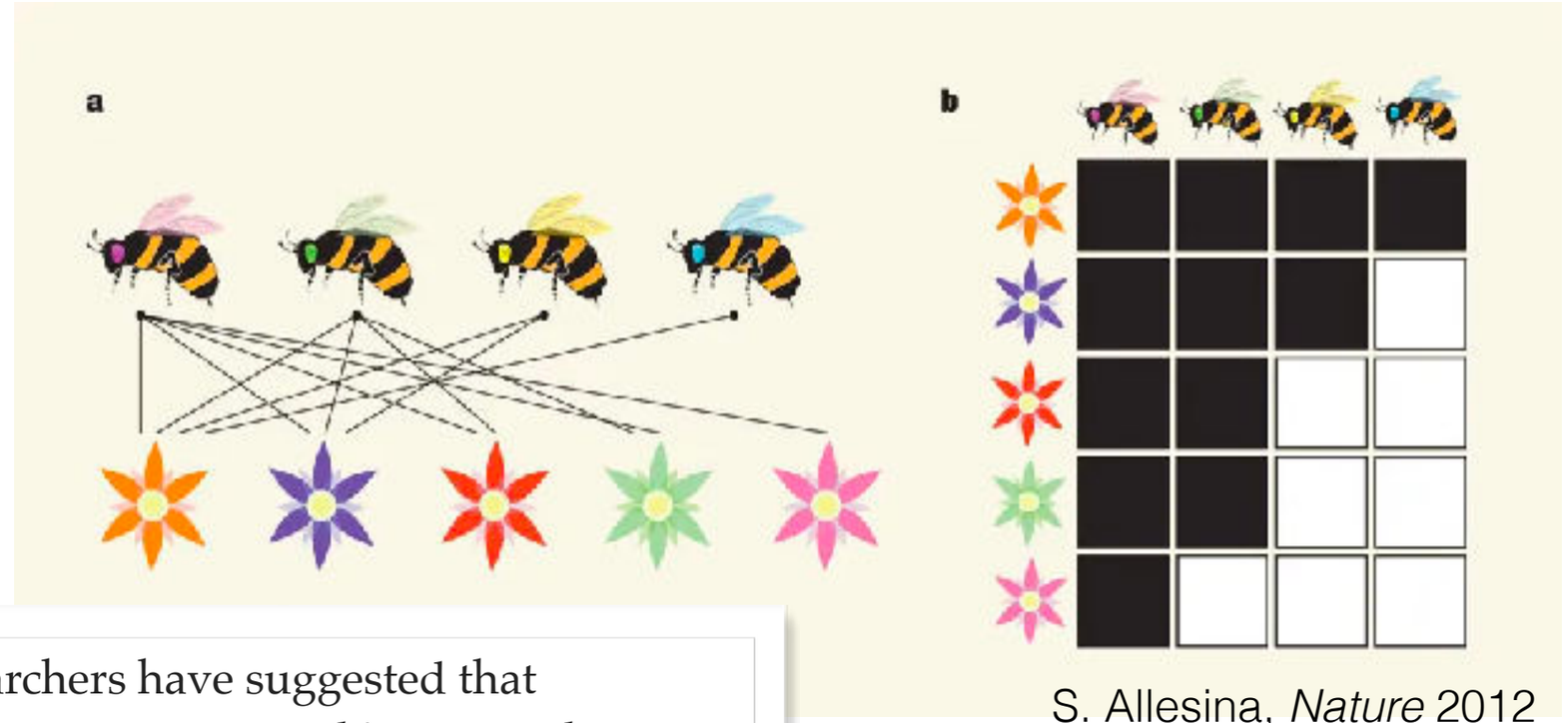
no difference in workload distribution, just more total effort

Collaboration structure



Forst 50 sections constitute a **“collaborative core”**

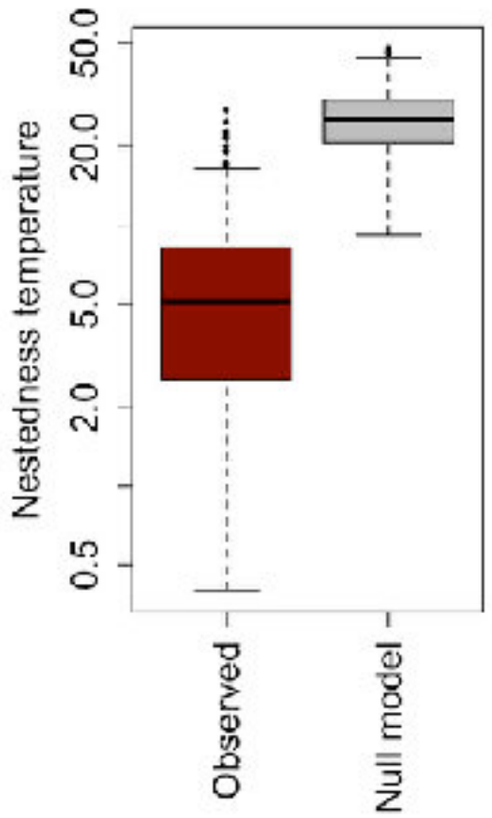
COLLABORATION STRUCTURE



S. Allesina, *Nature* 2012

"some researchers have suggested that ecological systems structured in a nested way are […] **more likely to persist over time**"

"**nested**" collaboration structure (editor to section)



PERPSECTIVE: MODELS

ecological models can reproduce **degree distributions**, **nestedness** and **modularity** of bipartite mutualistic networks

usually combine **specialisation** (trait value dictates number of connections) and **complementarity** (connect species with similar trait)

doi:10.1038/nature07532 nature

LETTERS

A simple model of bipartite cooperation for ecological and organizational networks

Serguei Saavedra[1,2,3], Felix Reed-Tsochas[2,4] & Brian Uzzi[5,6]

2008

Simple rules yield complex food webs

Richard J. Williams & Neo D. Martinez

Romberg Tiburon Center, Department of Biology, San Francisco State University, PO Box 855, Tiburon, California 94920, USA

2000

OPEN ACCESS Freely available online PLoS BIOLOGY

Linkage Rules for Plant–Pollinator Networks: Trait Complementarity or Exploitation Barriers?

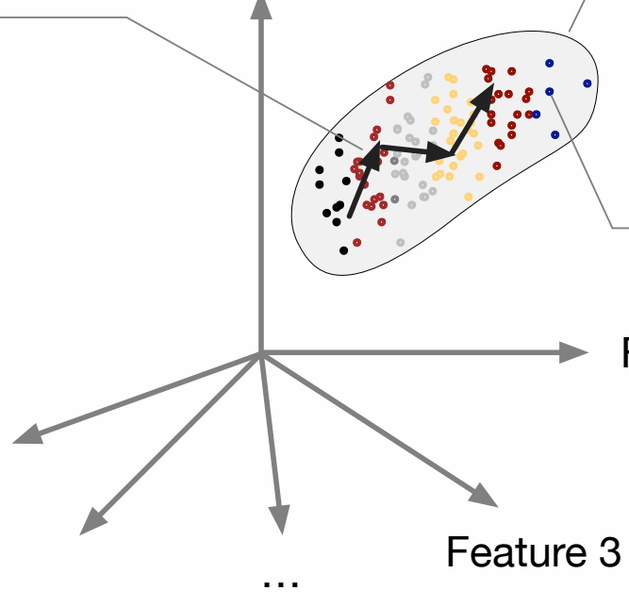
Luis Santamaría[1]*, Miguel A. Rodríguez-Gironés[2]

1 Mediterranean Institute for Advanced Studies, University of the Balearic Islands/Spanish Council for Scientific Research, Esporles, Mallorca, Spain, 2 Estación Experimental de Zonas Áridas, Spanish Council for Scientific Research, Almería, Spain

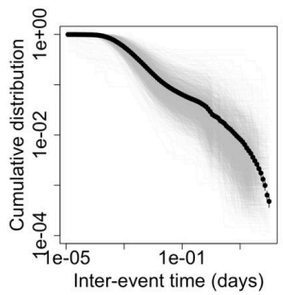
2007

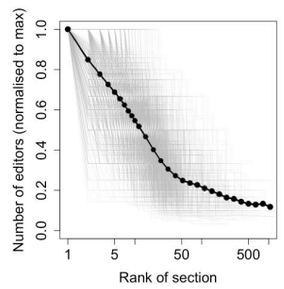
THE TEAM SPACE

Team features space

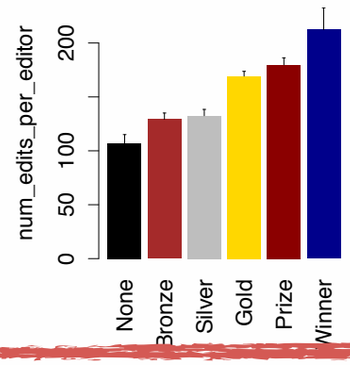


1. Universal aspects of team work

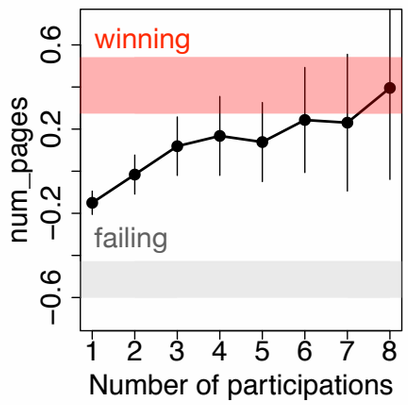




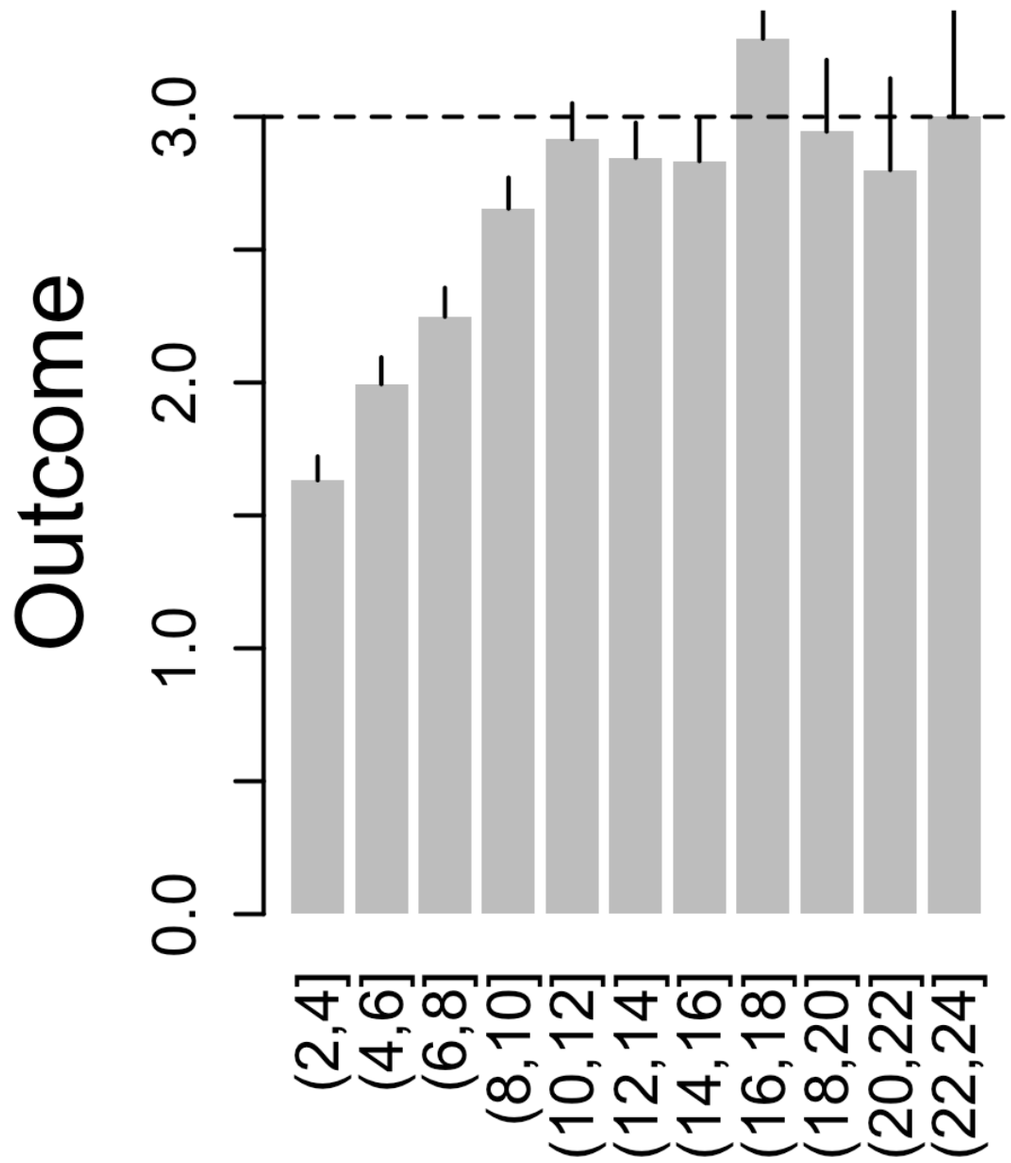
2. Features underlying team performance



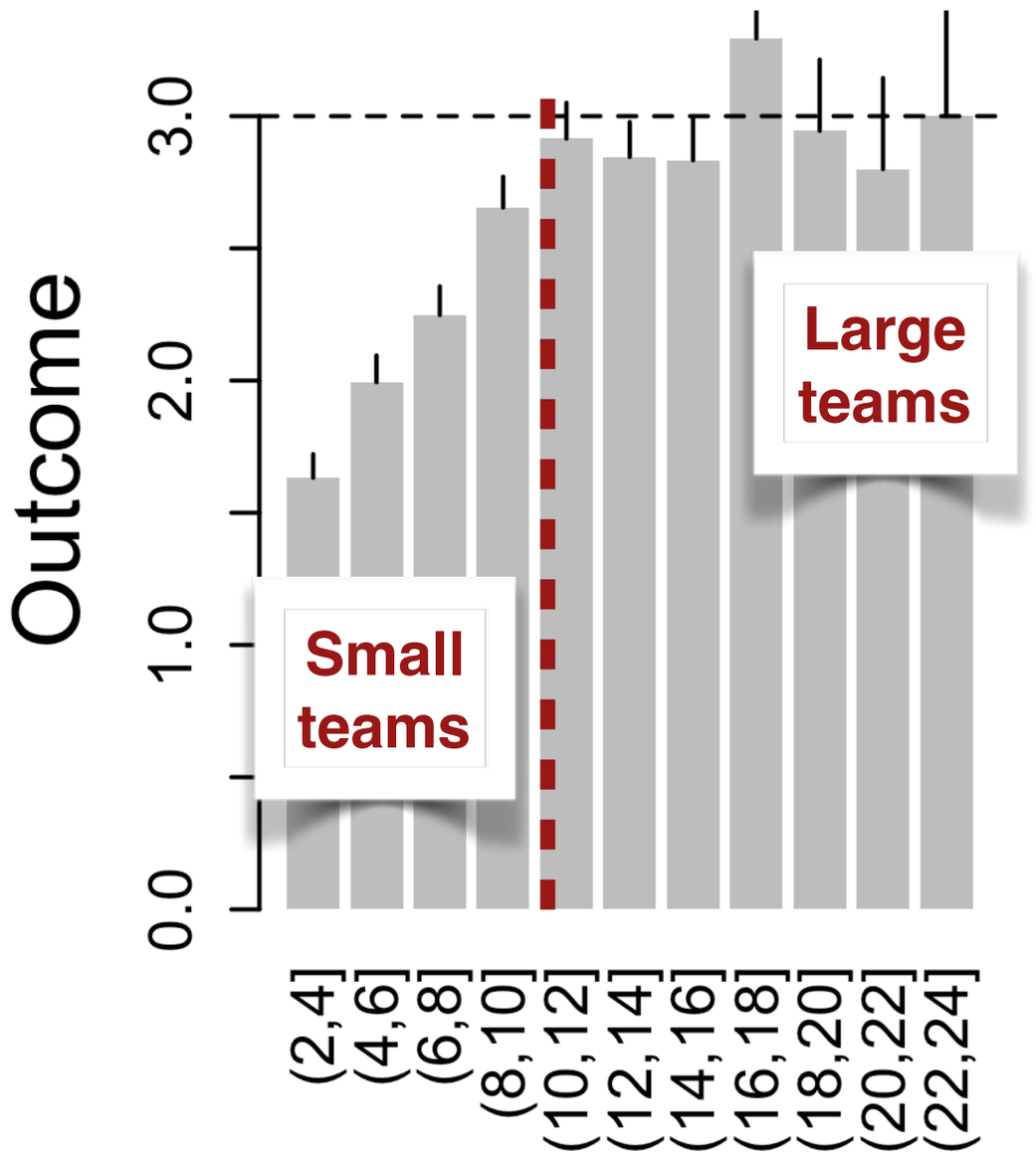
3. Team improvement through reparticipation



PERFORMANCE AND TEAM SIZE

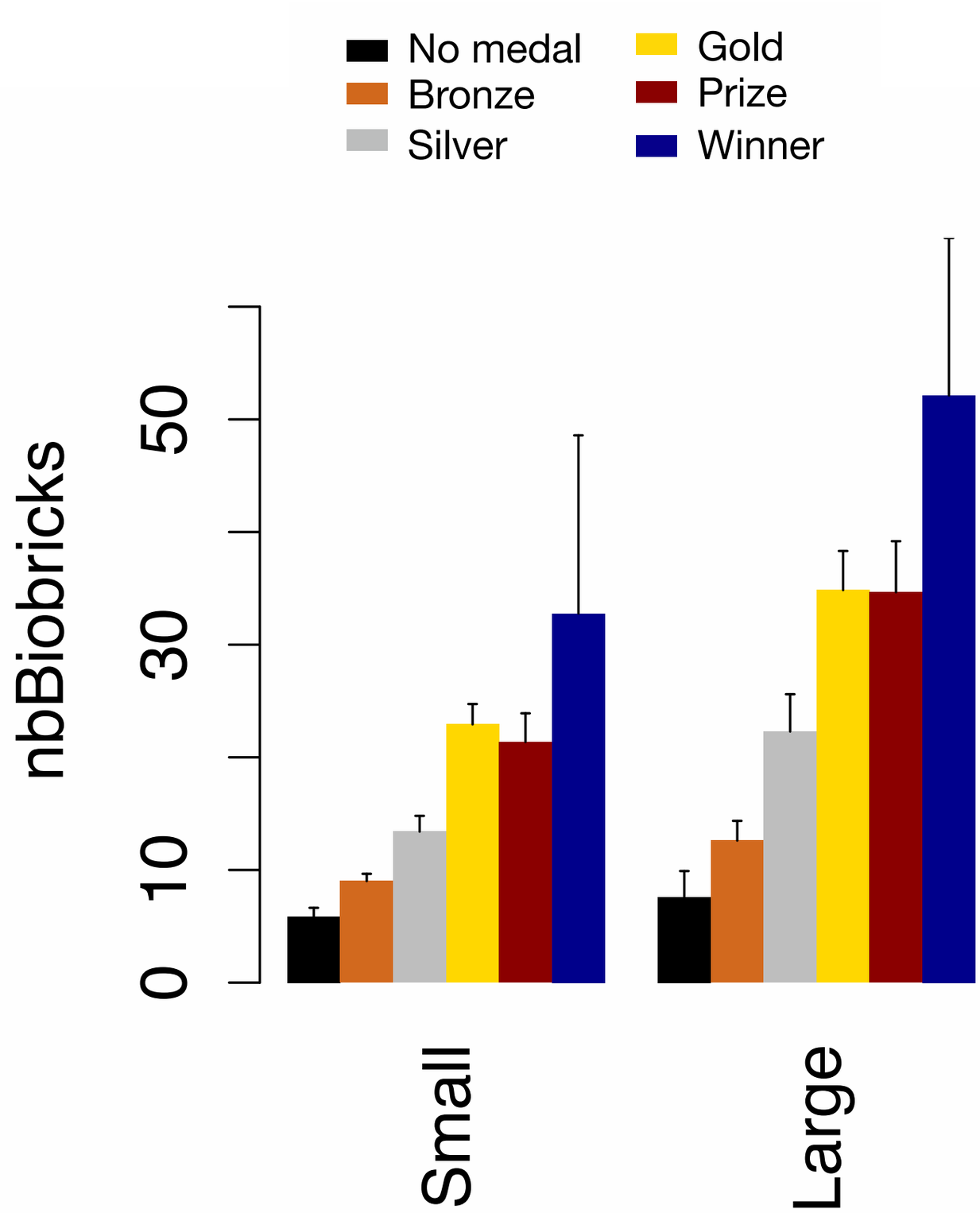


Performance and team size



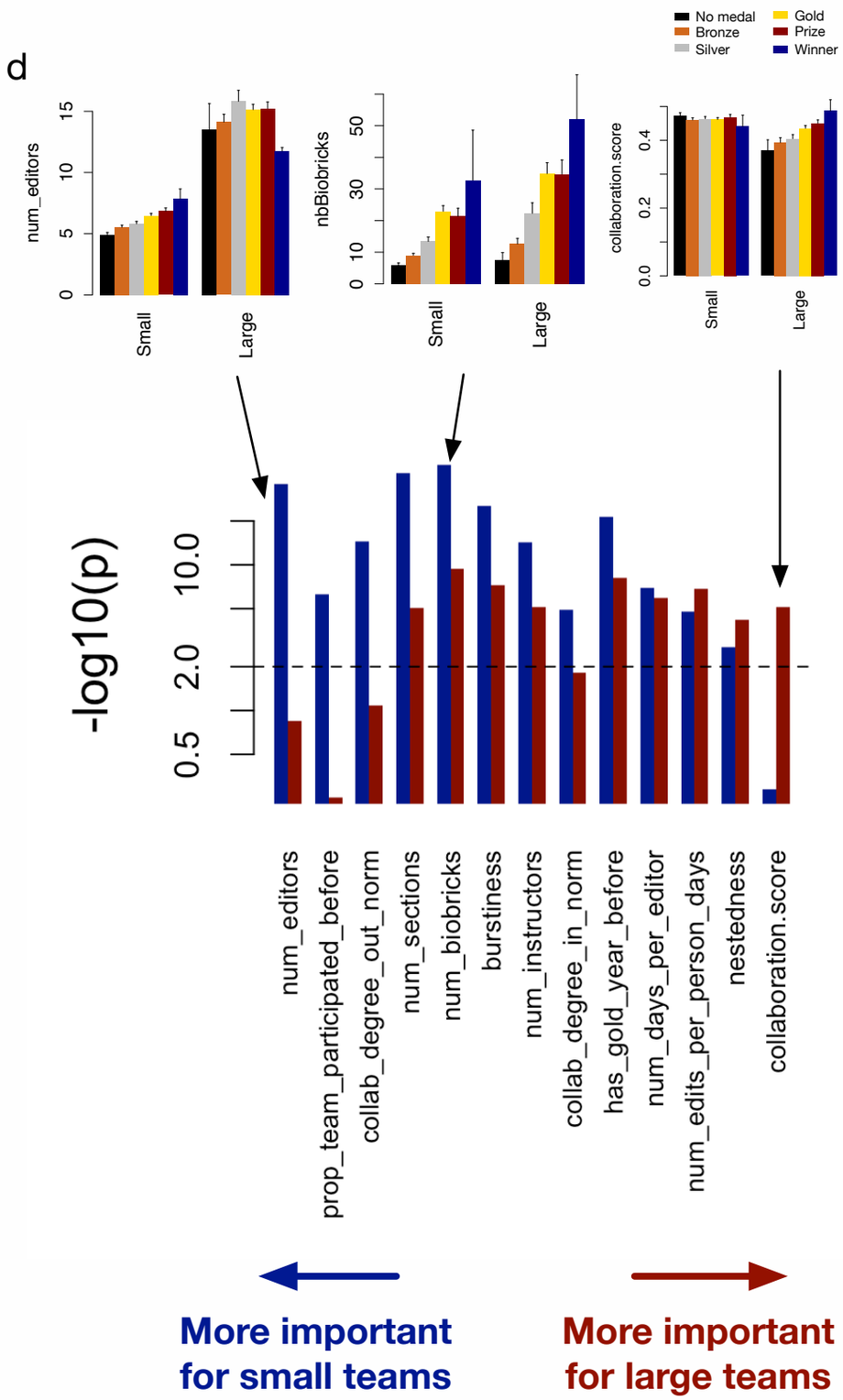
PERFORMANCE PREDICTION

- Small teams vs large teams
- Correlation with performance



PERFORMANCE PREDICTION

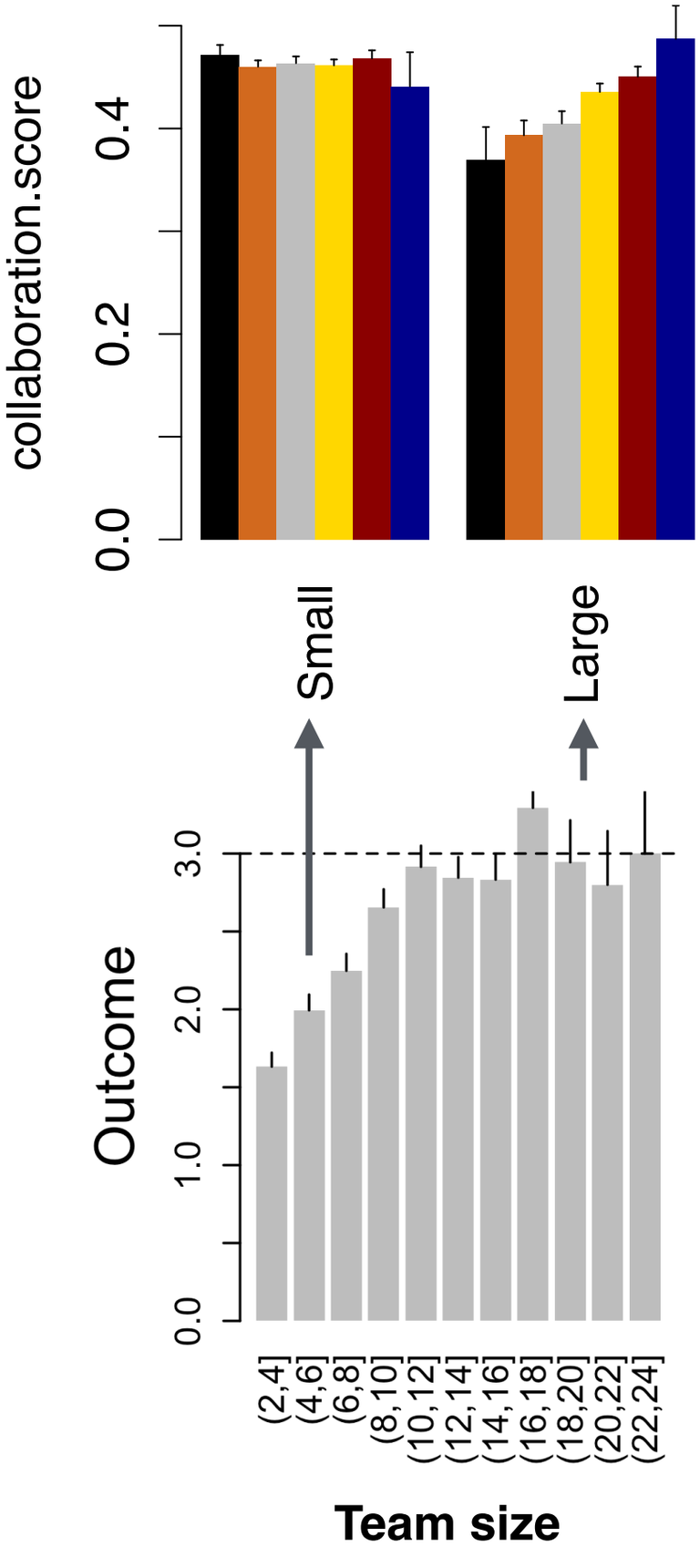
"Team-wide" association study

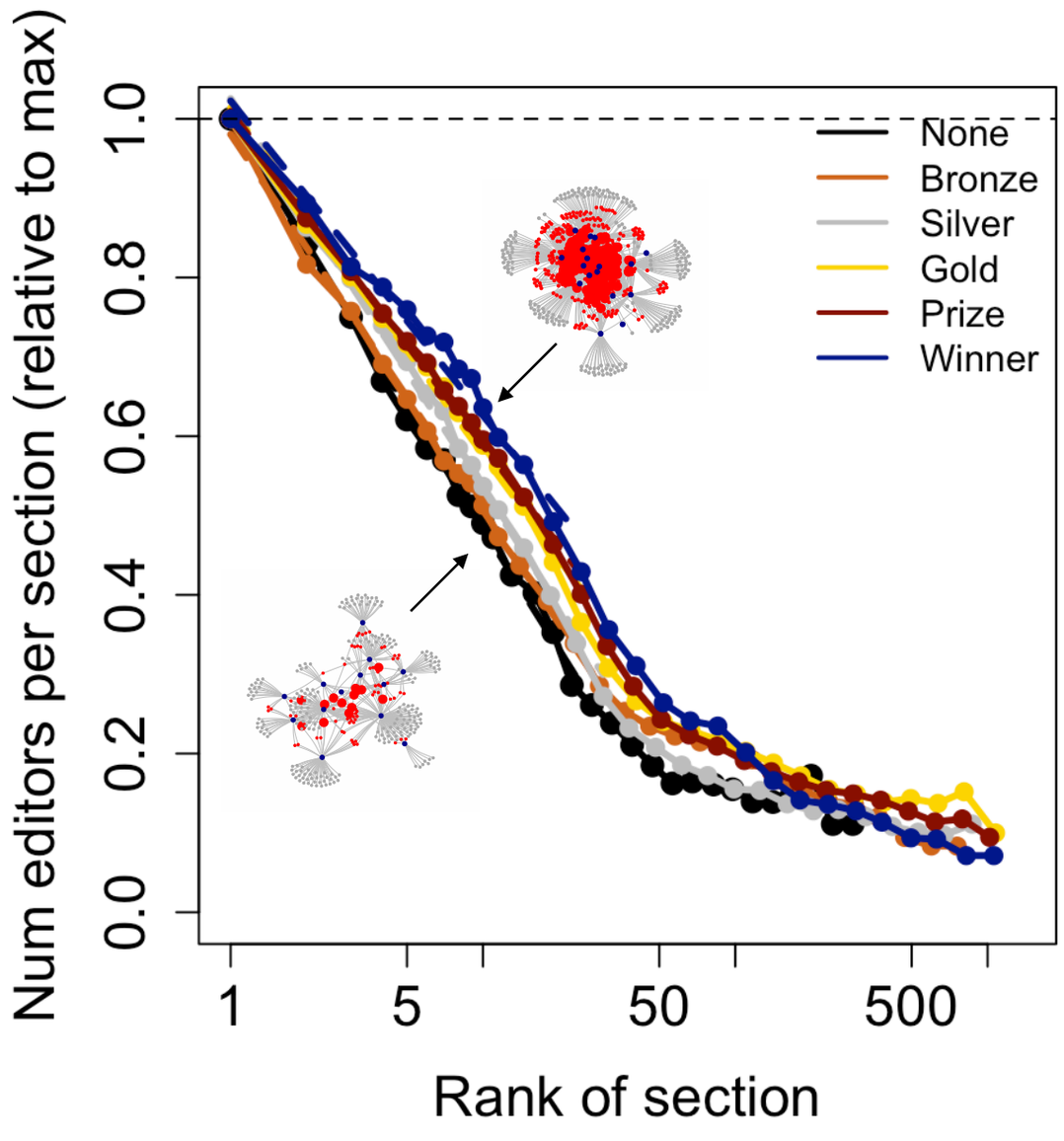


Associations with performance

- **in both cases:**
  - productivity / effort
  - prior success
  - supervision structure
- **small teams only:**
  - team size
  - prior participation
  - collaboration with other teams
- **Large teams only:**
  - internal collaboration

COLLABORATION SCORE





THE TEAM SPACE

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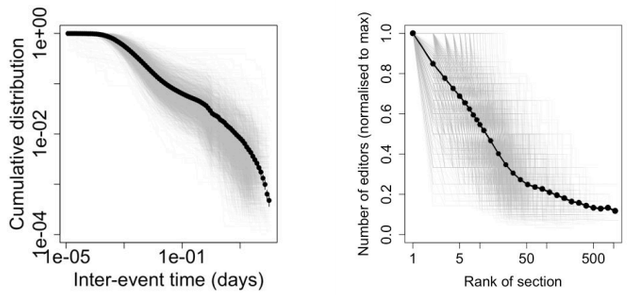

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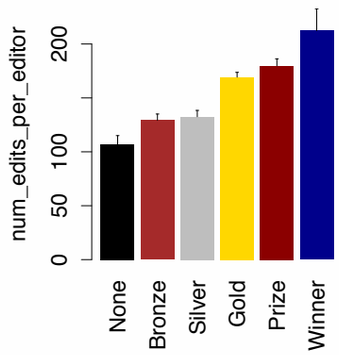

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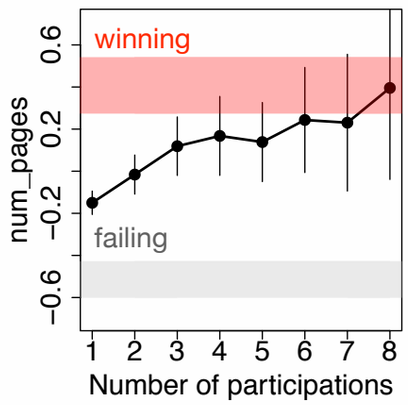
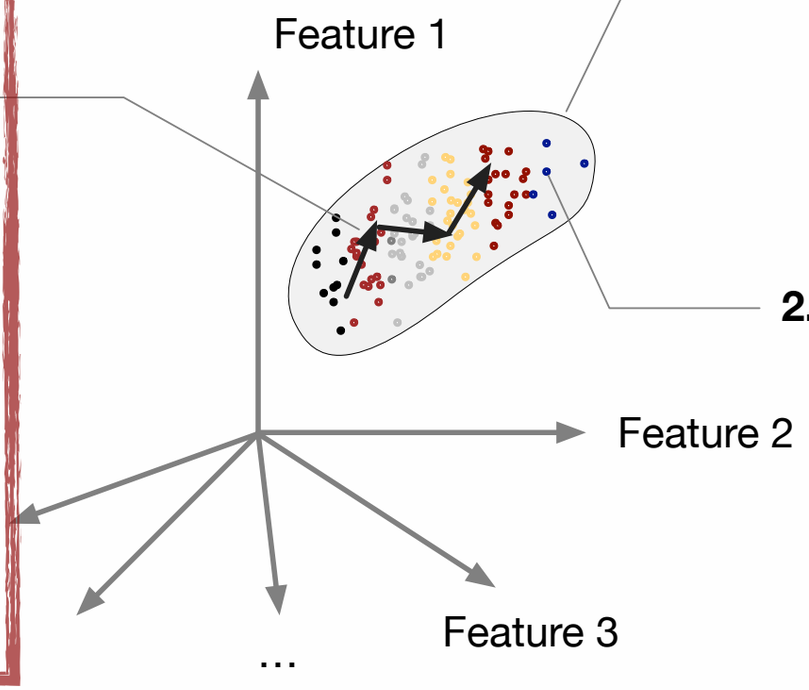
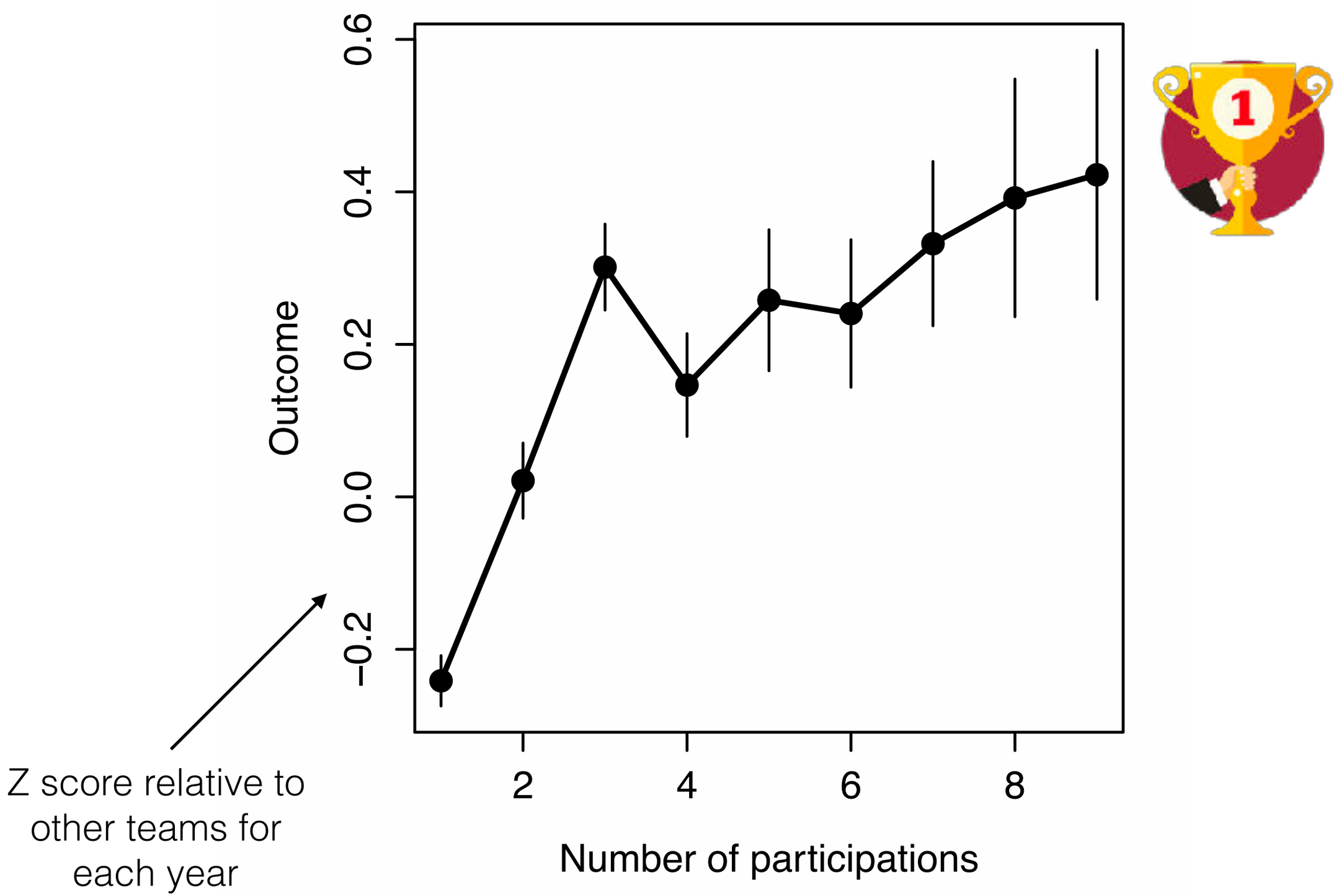


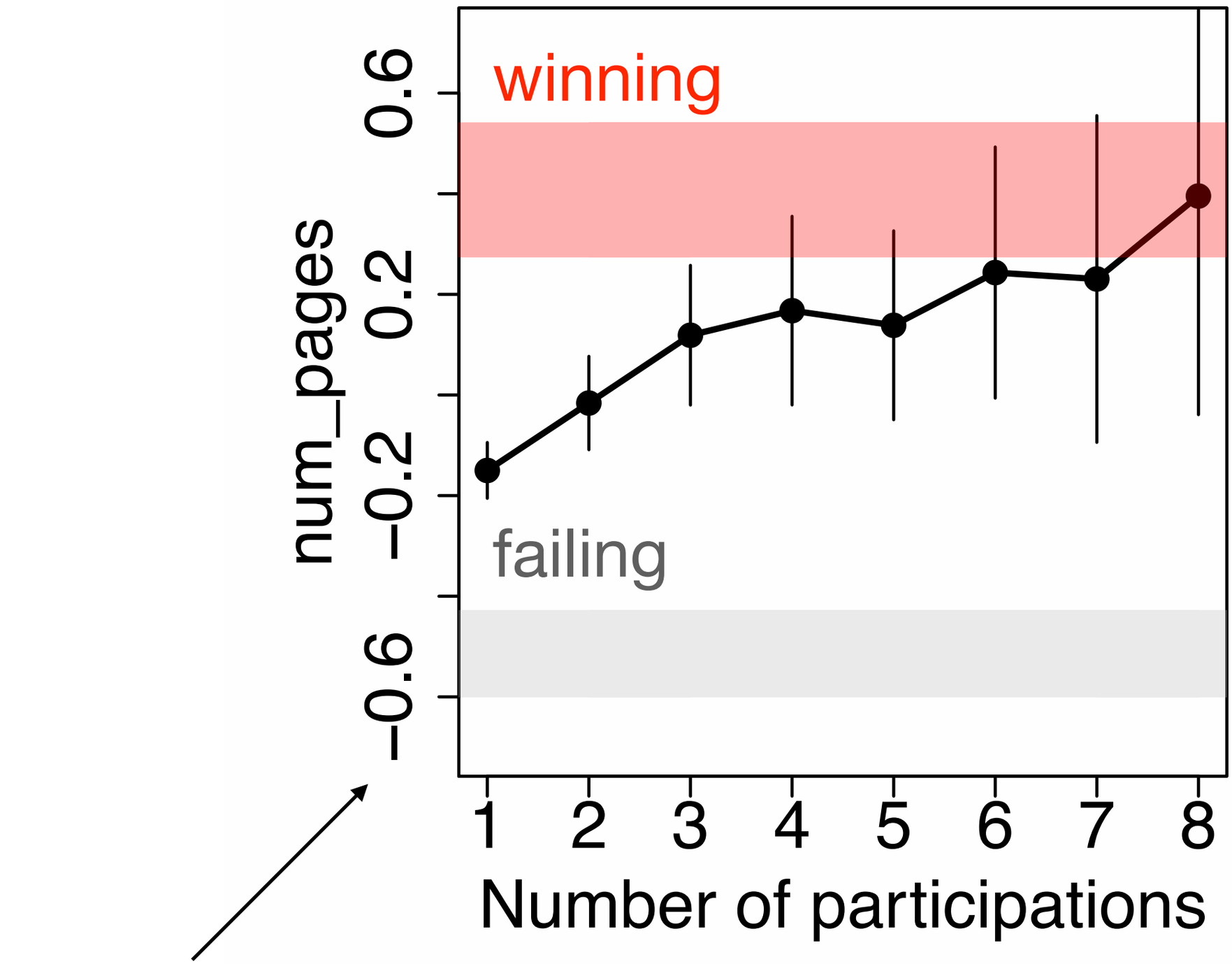


LONGITUDINAL DATA

Teams **reparticipate** and **improve** over years
(~20% overlap of team members from one year to the next)



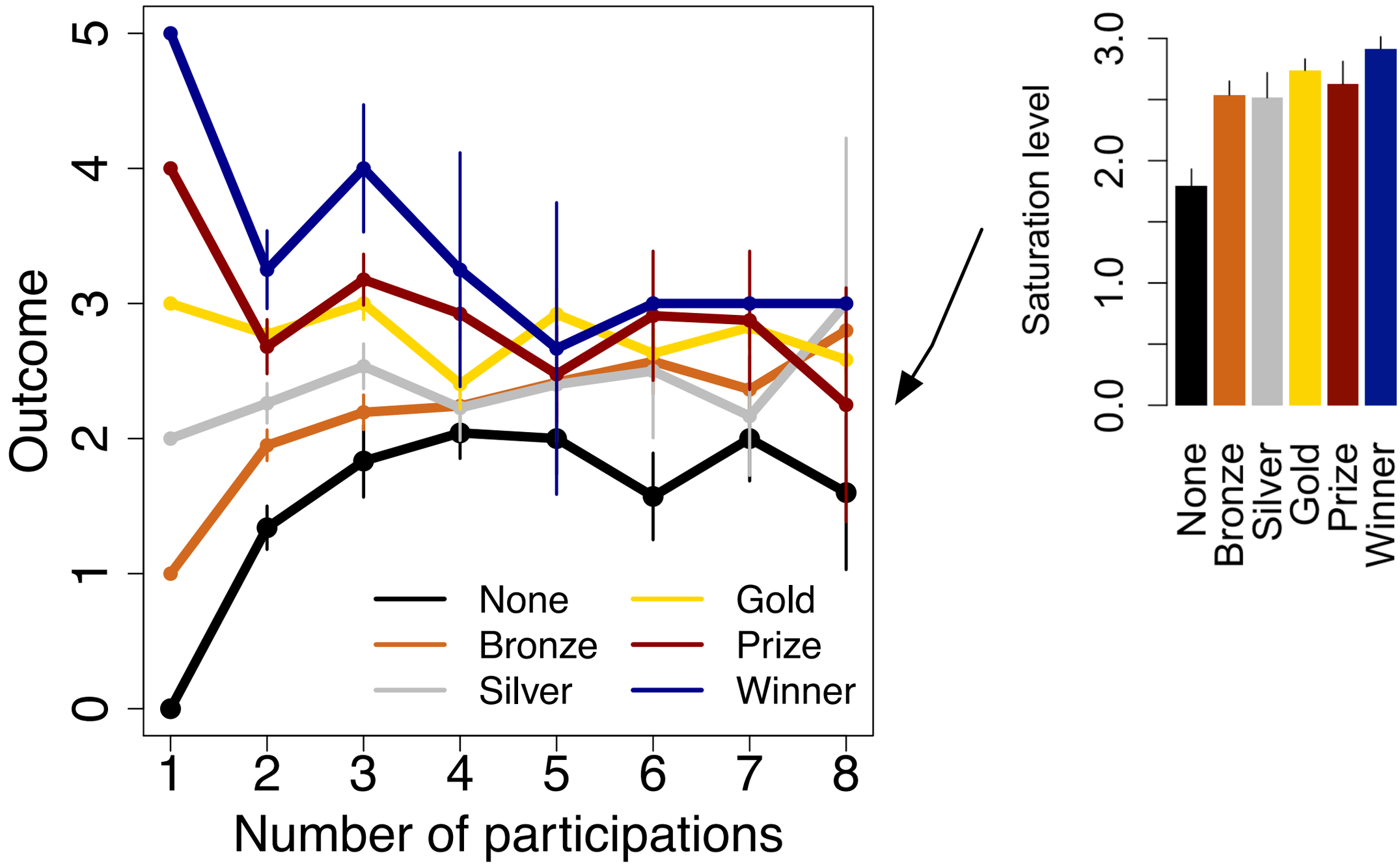
TEAM IMPROVEMENT



LOCK-IN EFFECT

However, there is a **lock-in effect** depending on initial performance

(see also artist careers in Fraiberger et al, *Science* 2018)



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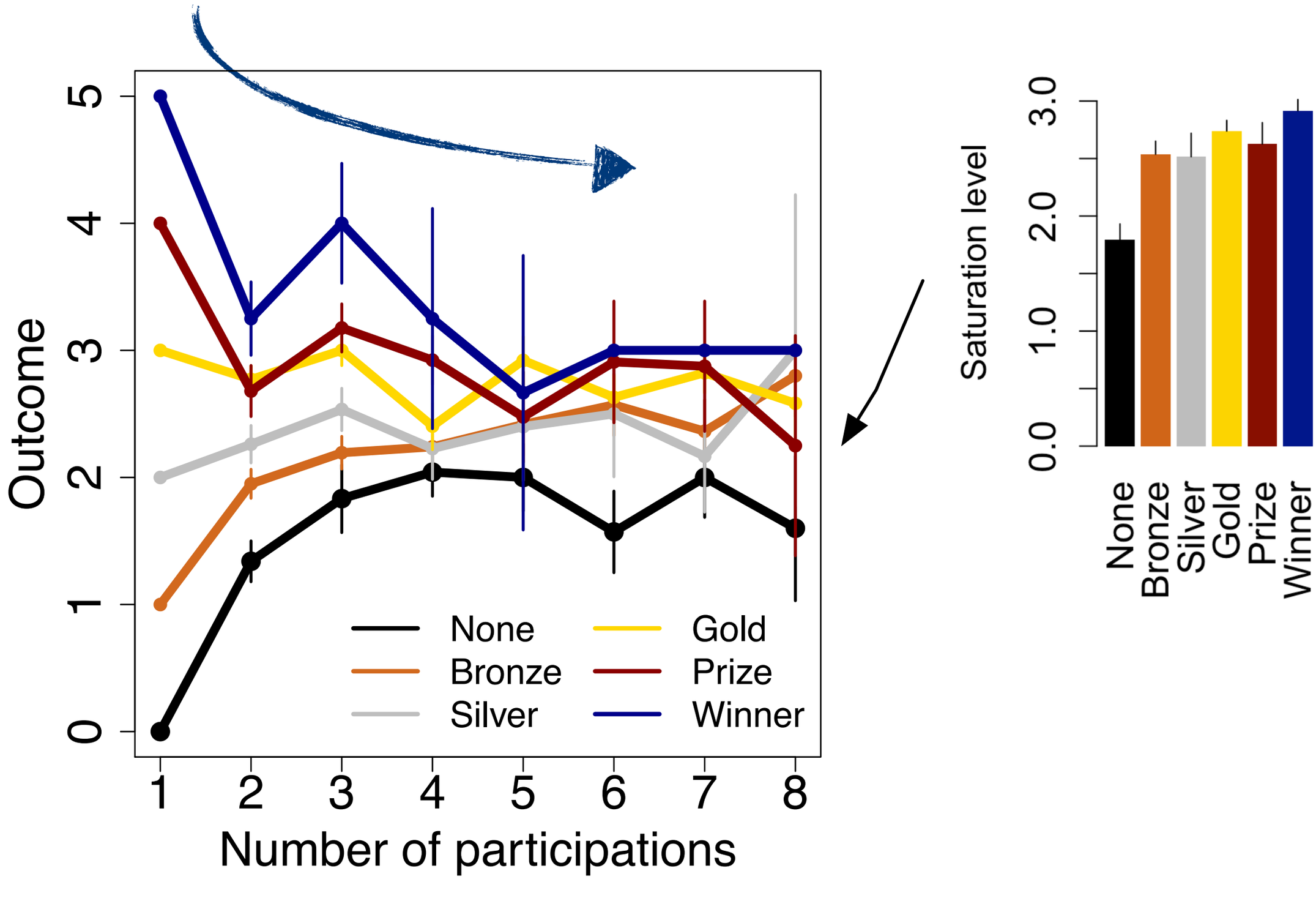

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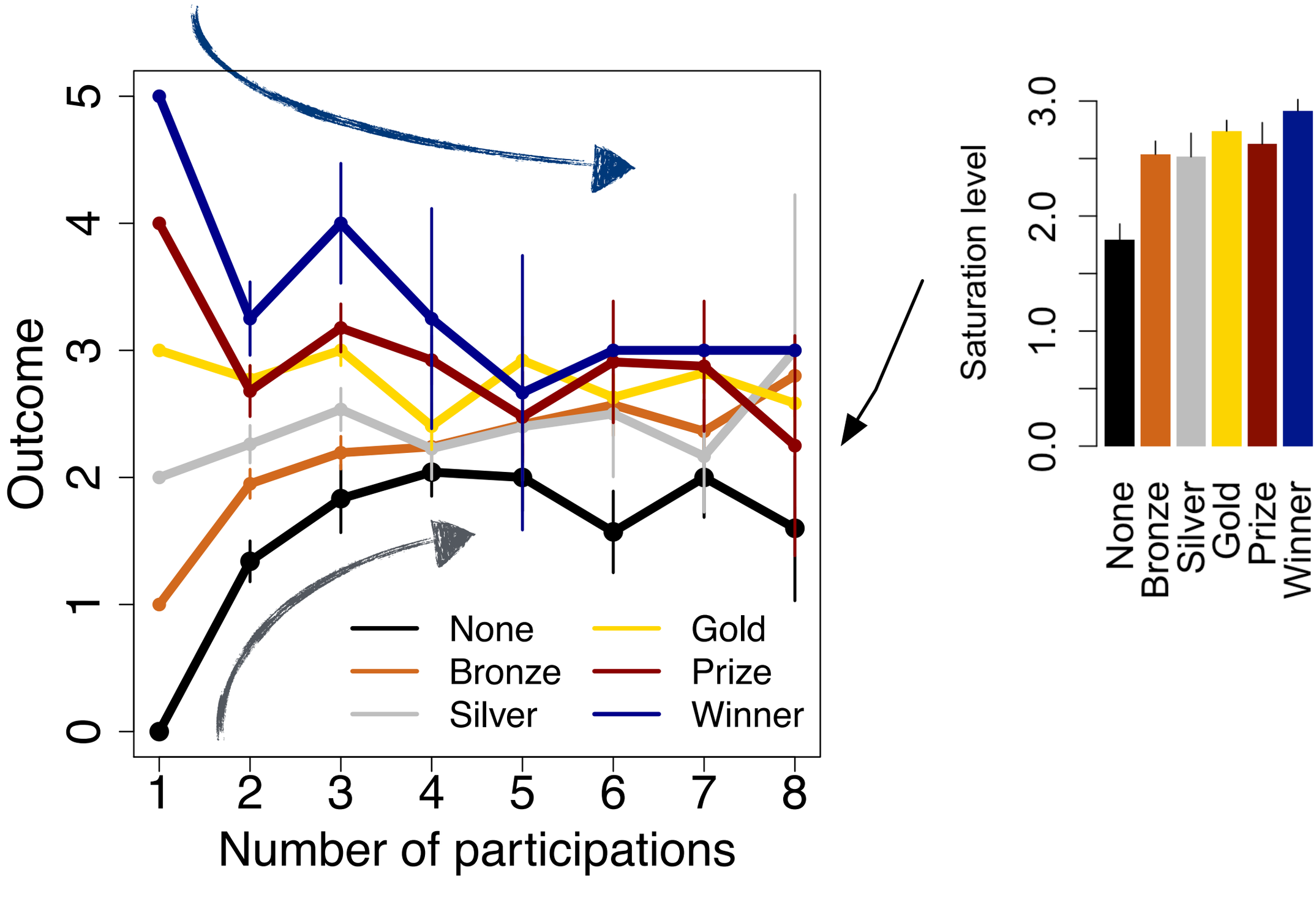
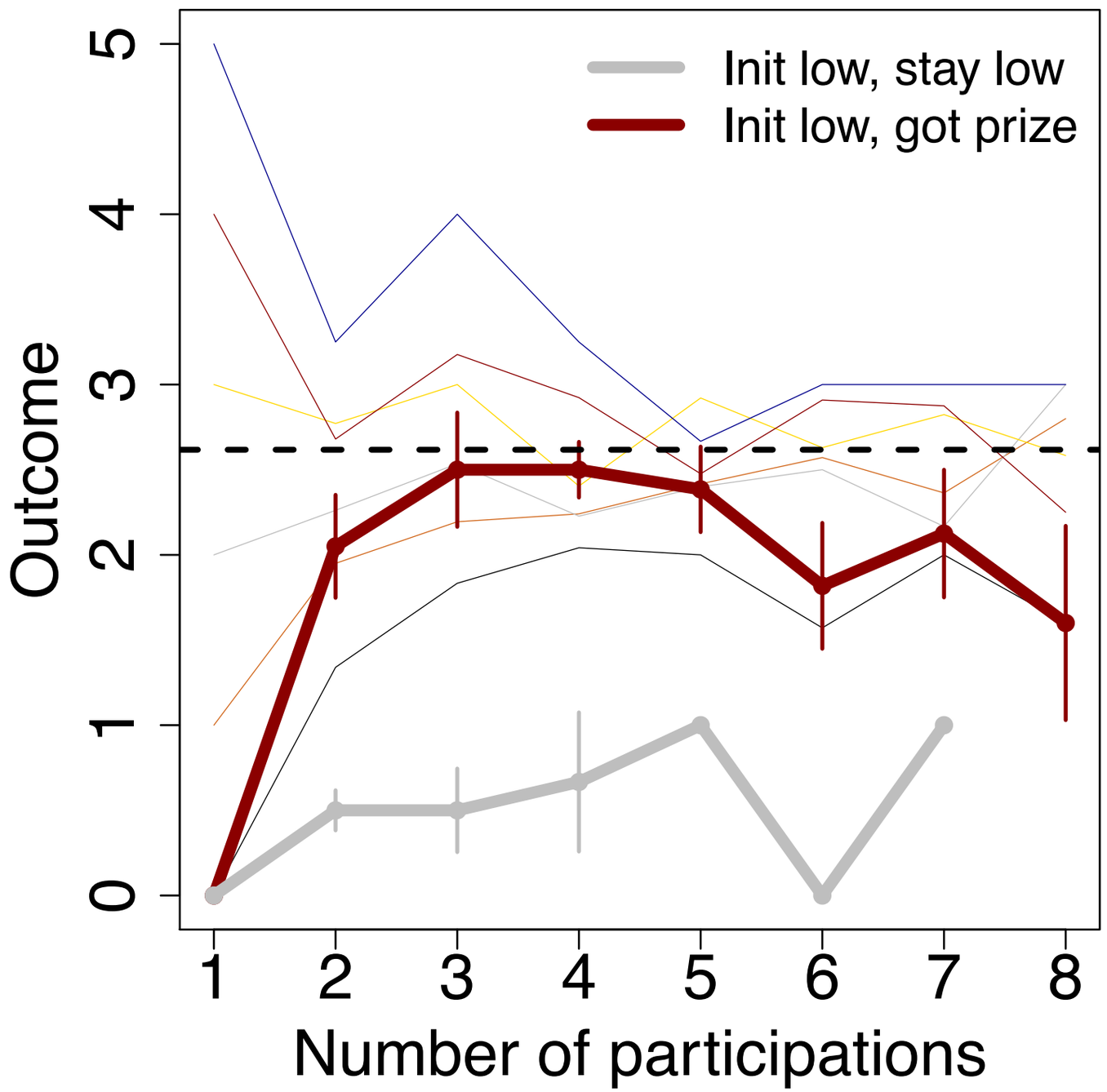


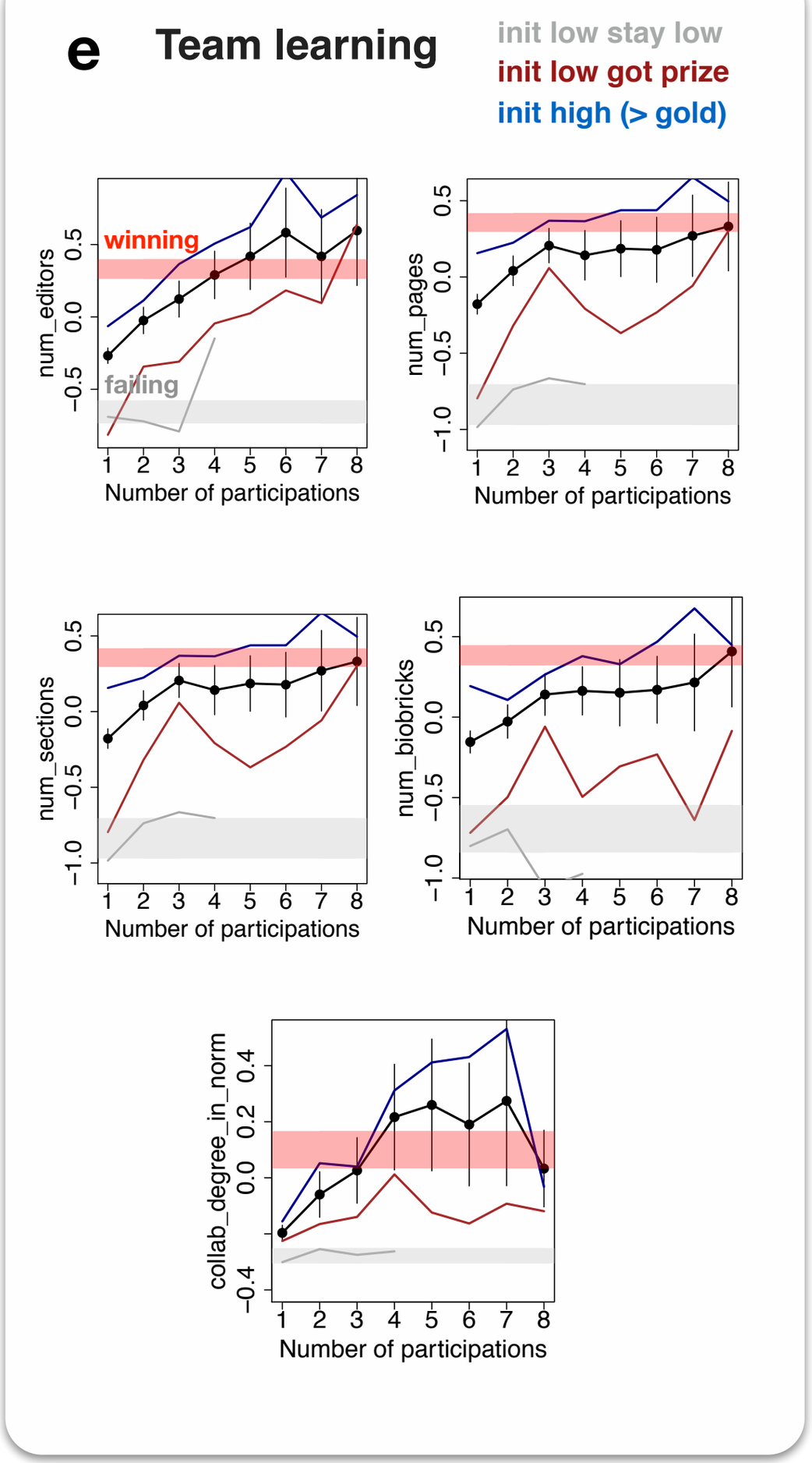
LOCK-IN EFFECT

How to get out of the lock-in effect?

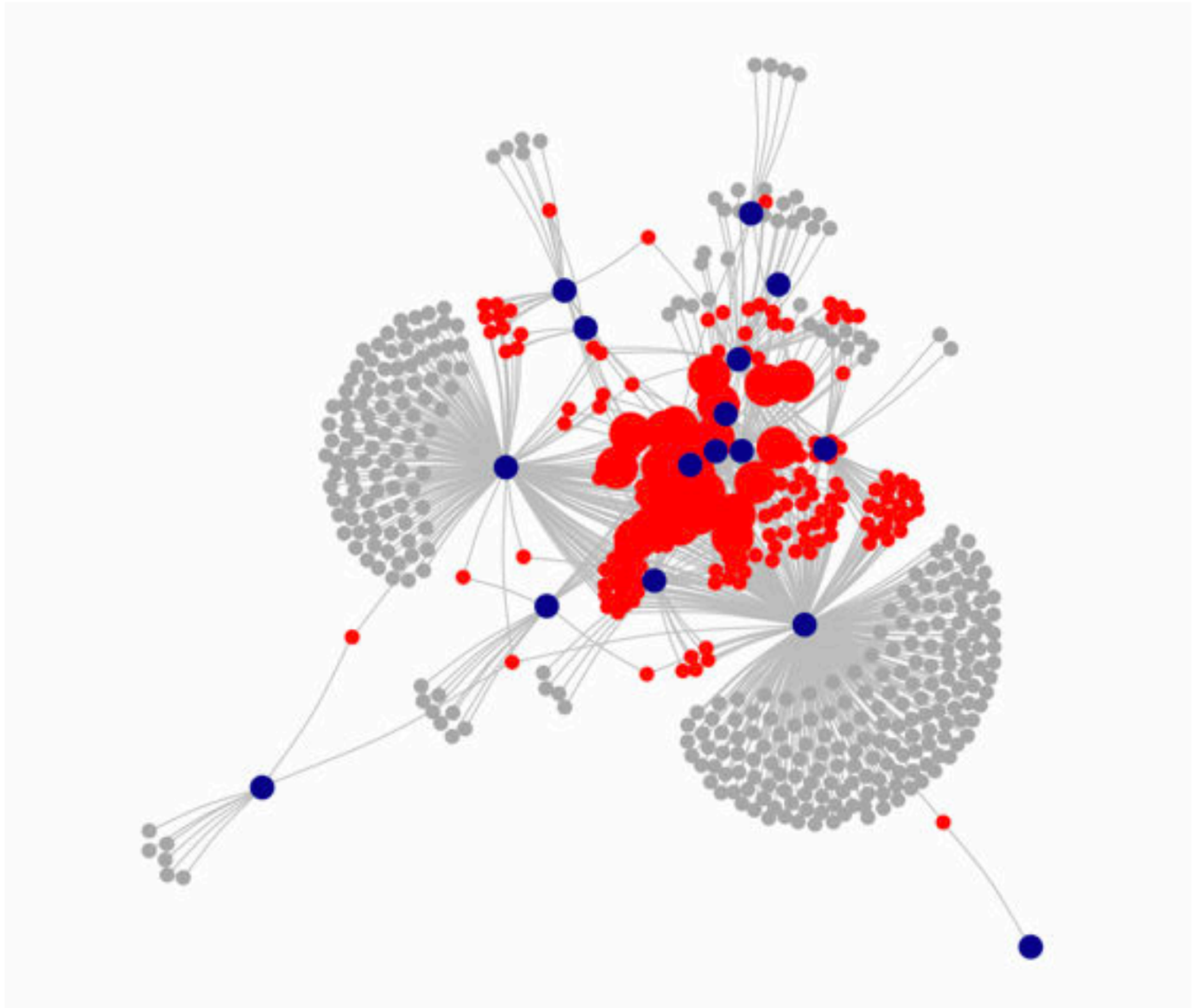


Teams that fail the first year (gray and red) with approx. same feature levels have **different fates based on their behavior on second participation**

perspective: model evolution of team performance



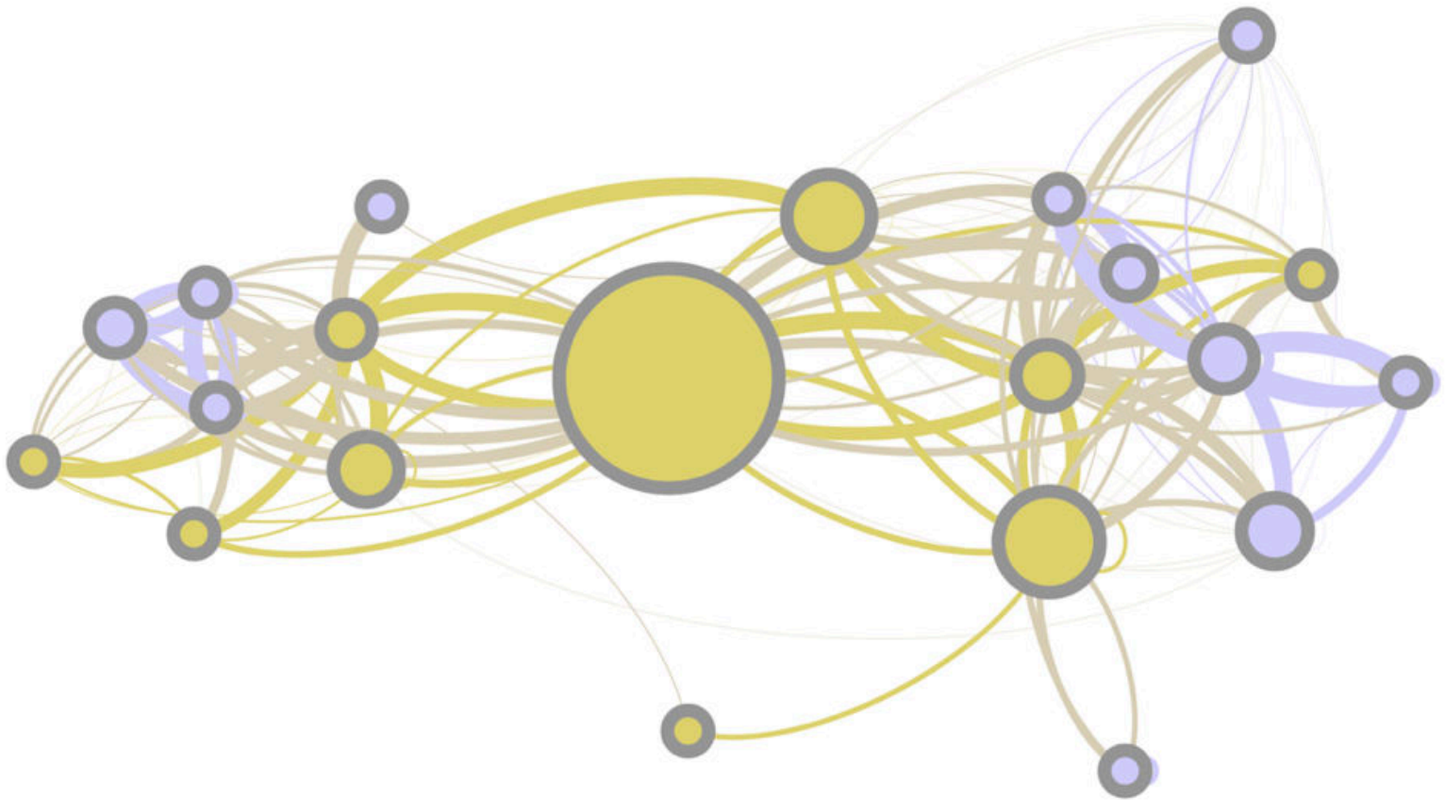
can we reconstruct the “real” *in situ* project dynamics?



iGEM TIES

(Team Interaction Study)

- ➡ **questionnaires** on social interactions
- ➡ **proximity** data (for Android now…)
- ➡ **task journaling** (what task was done, with whom)



Team network from 2019 questionnaire

Raphael Tackx
Postdoc

Radhika Beaumé
Game design, UI

Robbie Ward
Visiting PhD, GeorgiaTech

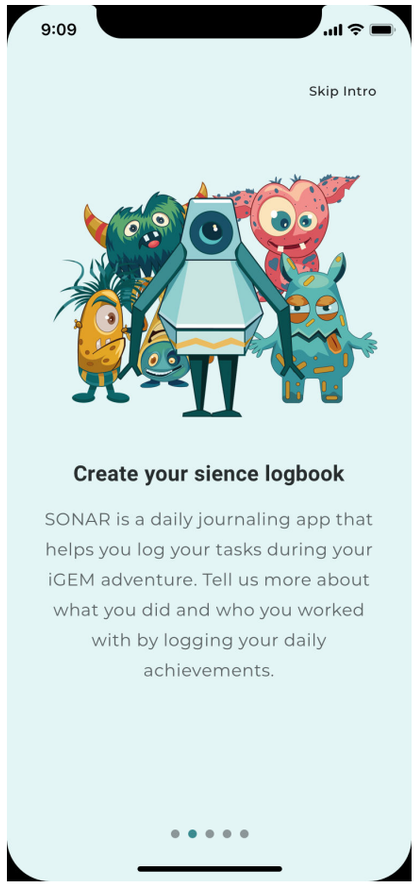
Rathin Jeyaram
Research assistant

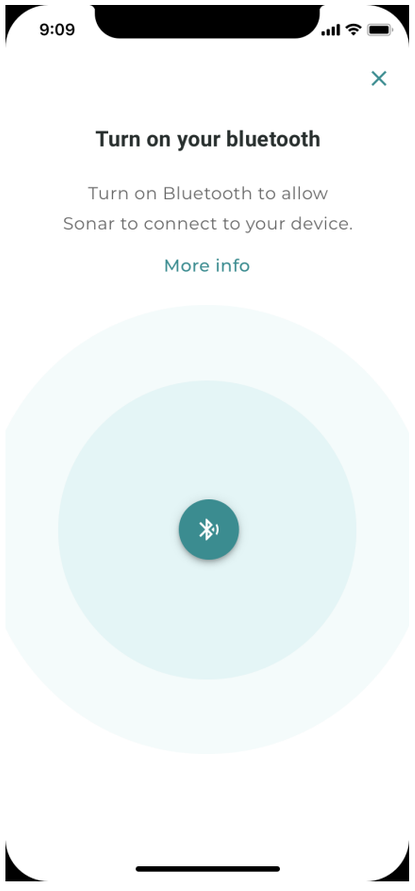
Savandara Besse
Communication manager

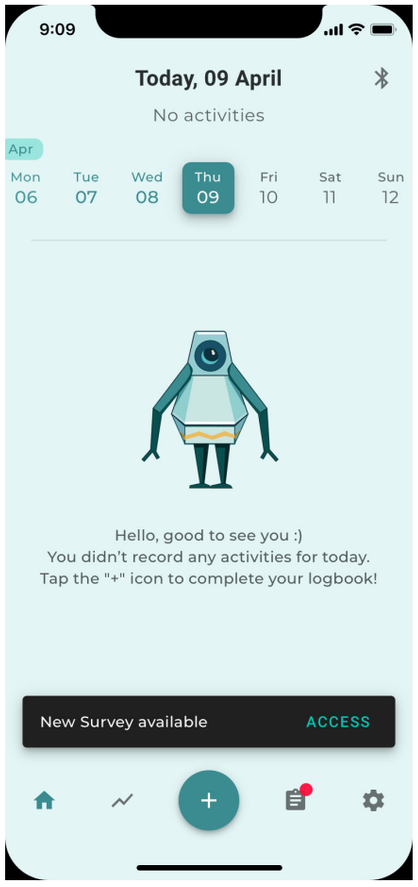
Lionel Deveaux
Digital Manager

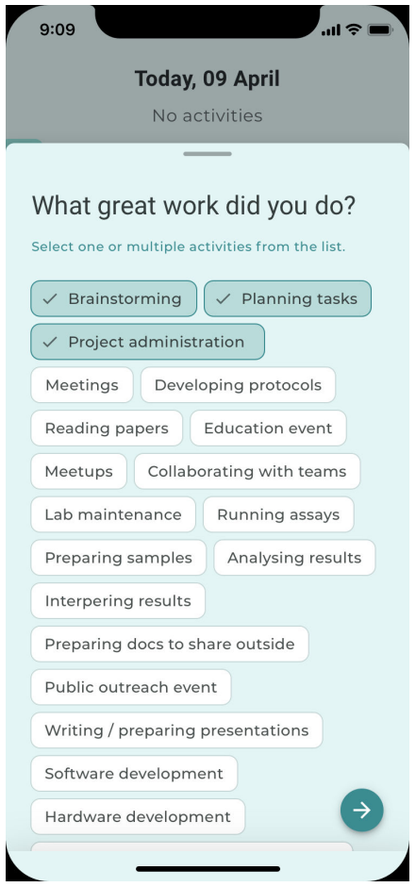
CoSo: a Collaborative Sonar app

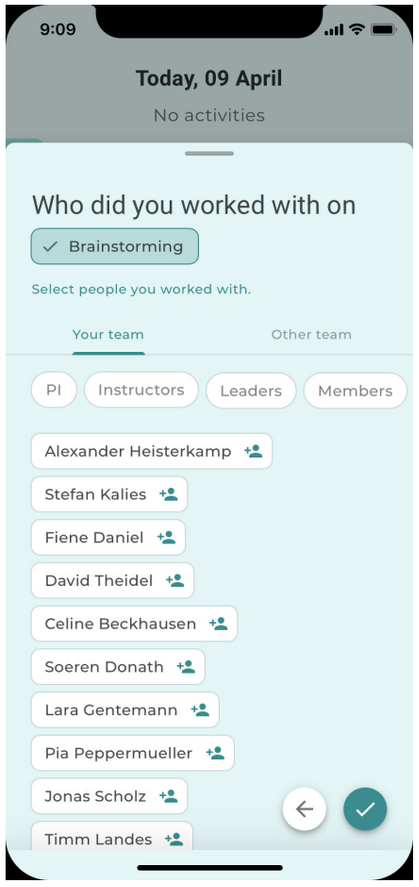
- **Daily diary** to collect data on collaborations on tasks
- **Notification** system
- Personalized **surveys**
- **ongoing pilot study!**









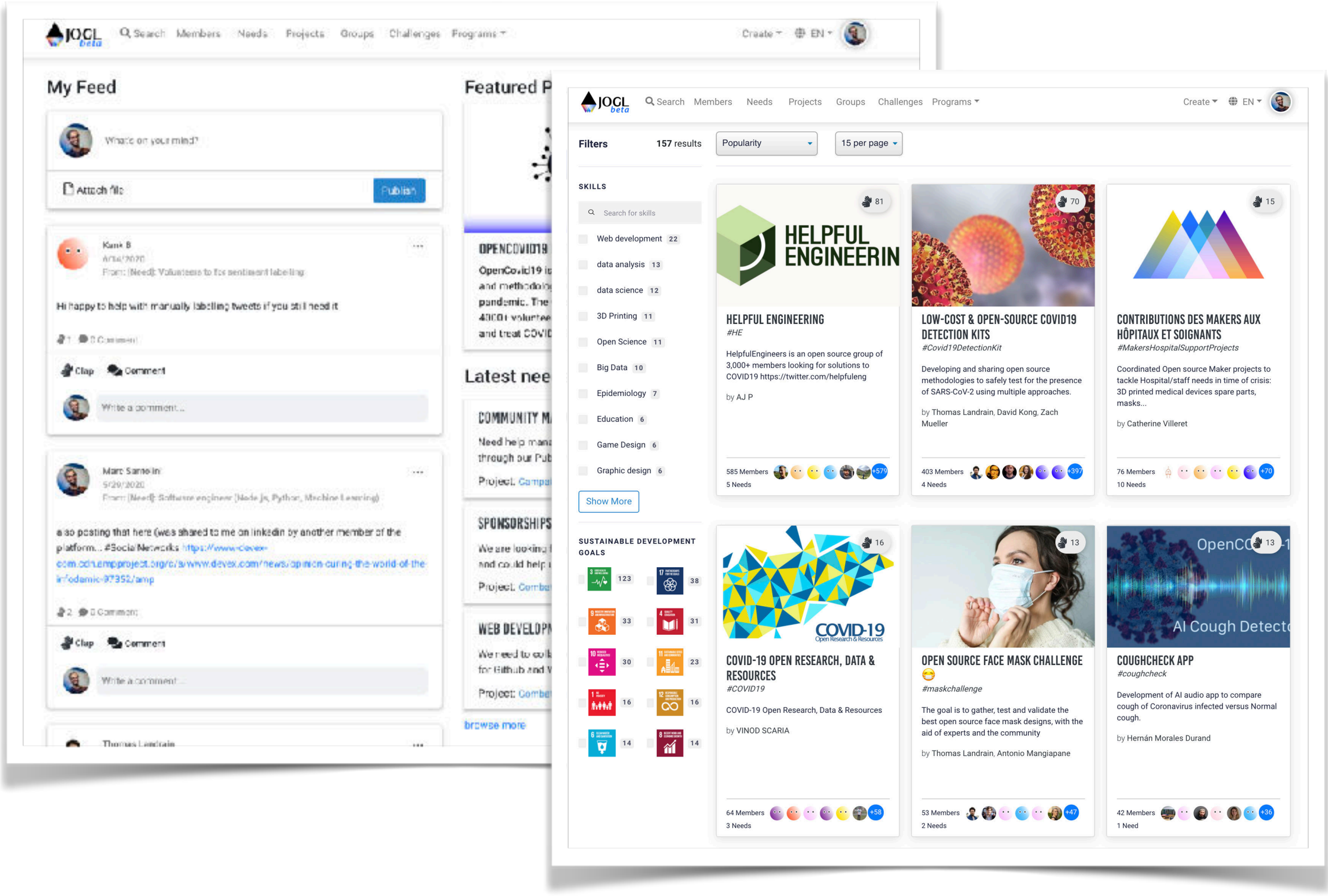


Designing collaborative Science

From studying to enhancing collaborative Science

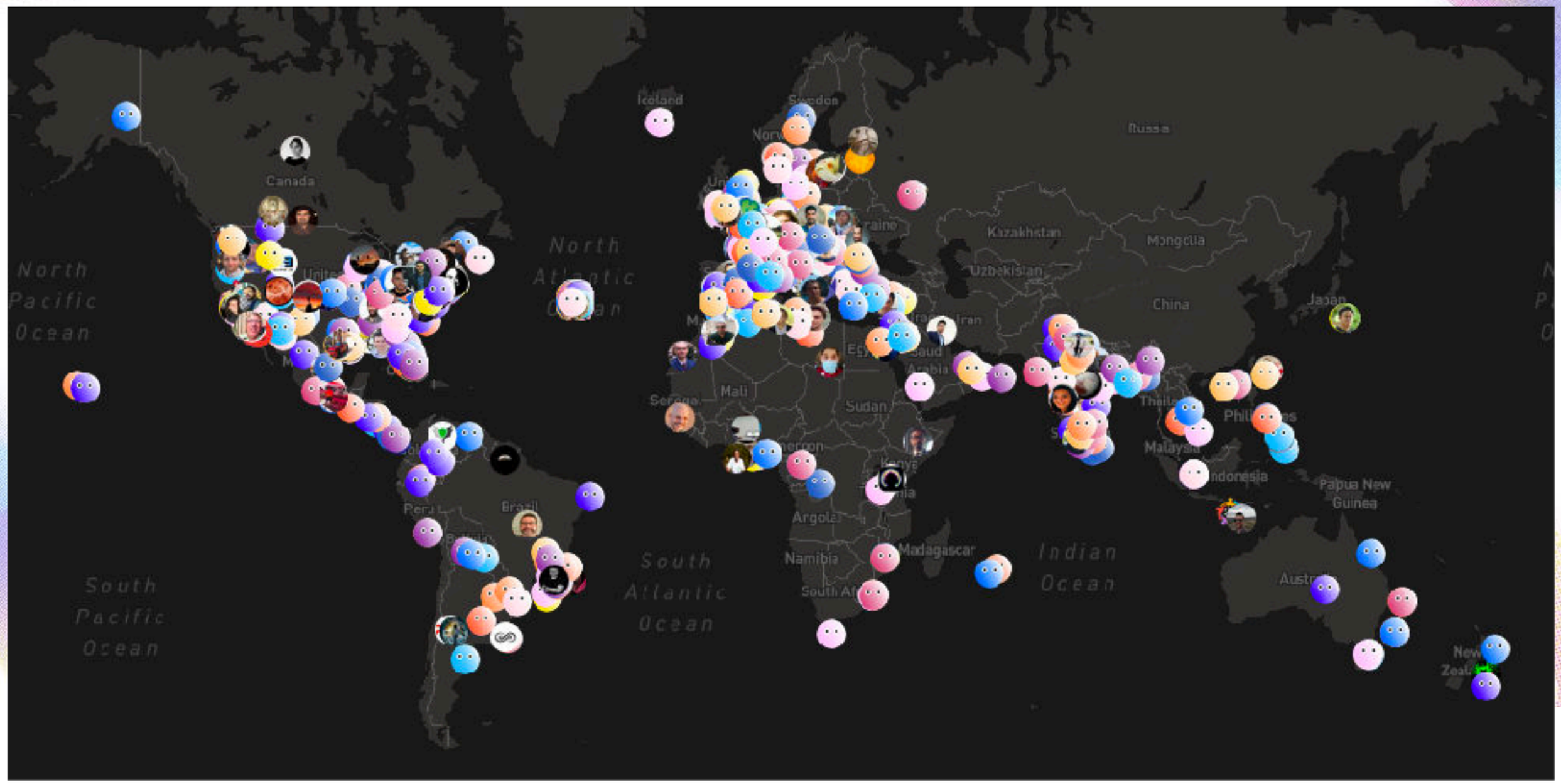
JUST ONE GIANT LAB (JOGL)

An open-source social network for open science, coordinated through research programs

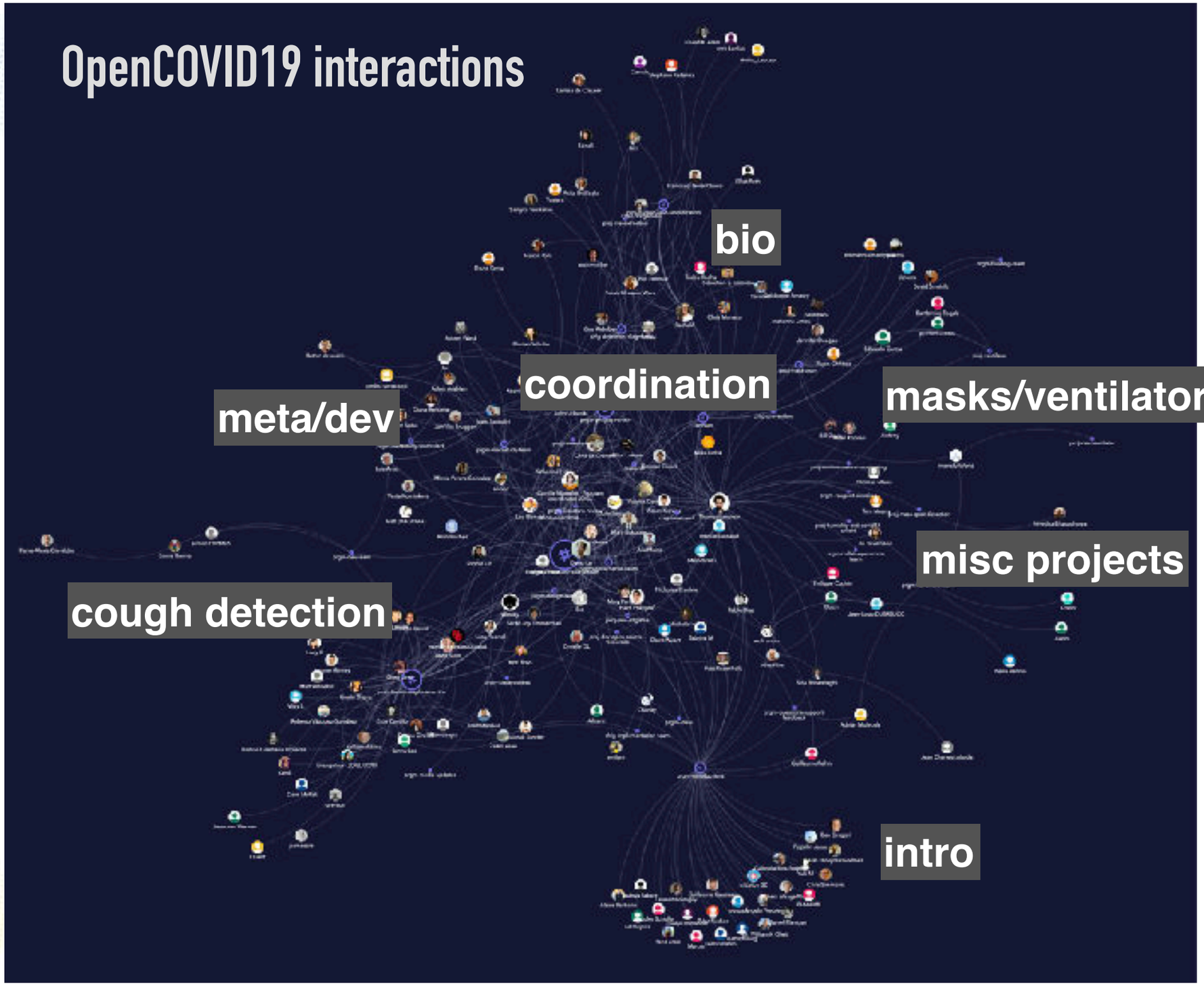


The OpenCOVID19 program

1,200 contributors
60 projects
open peer review
microgrants



OpenCOVID19 interactions



Skill Map

skills are linked if they appear together in projects

Data science

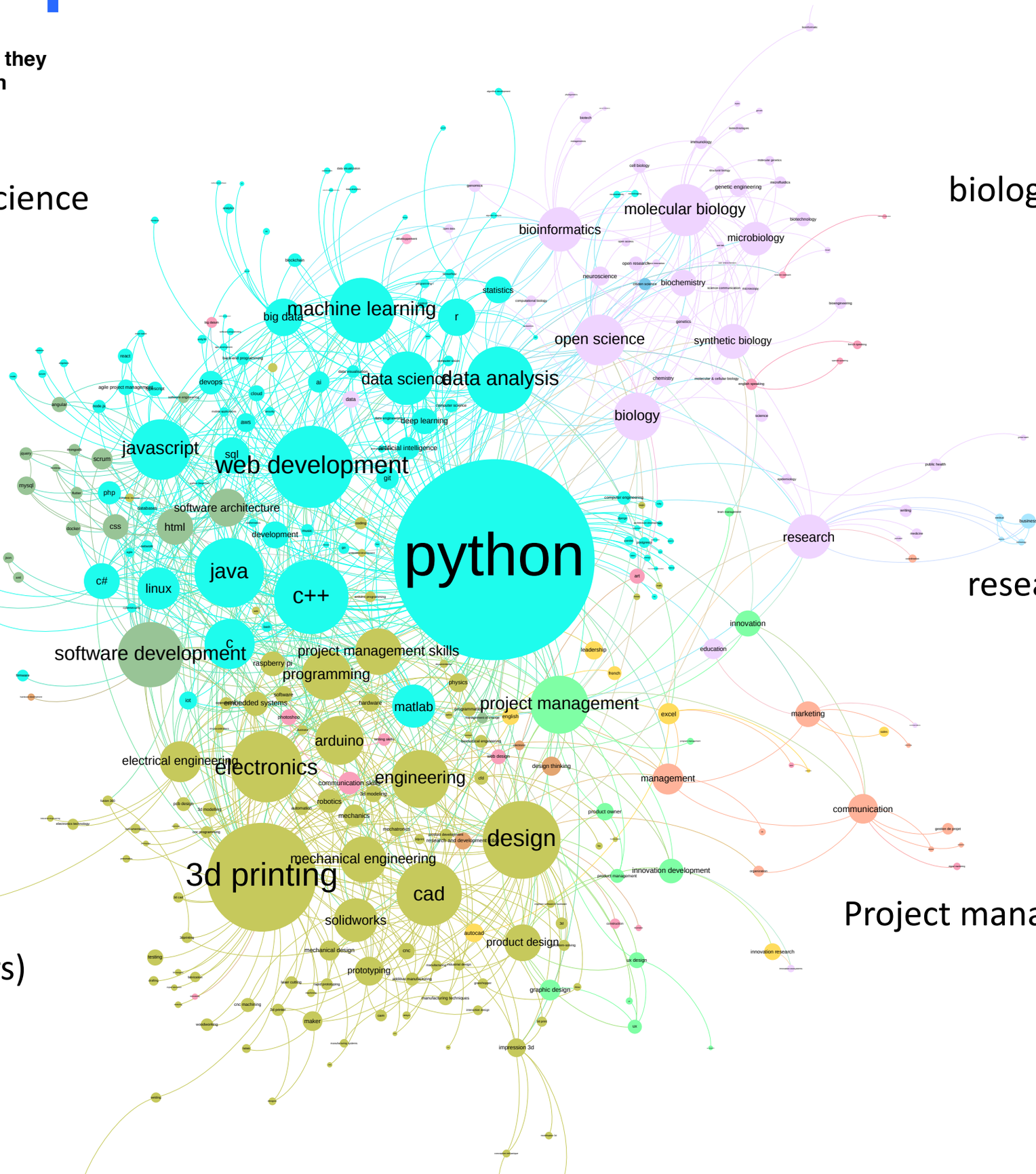
biology

Software

research/innovation/education

Project management

Hardware (makers)



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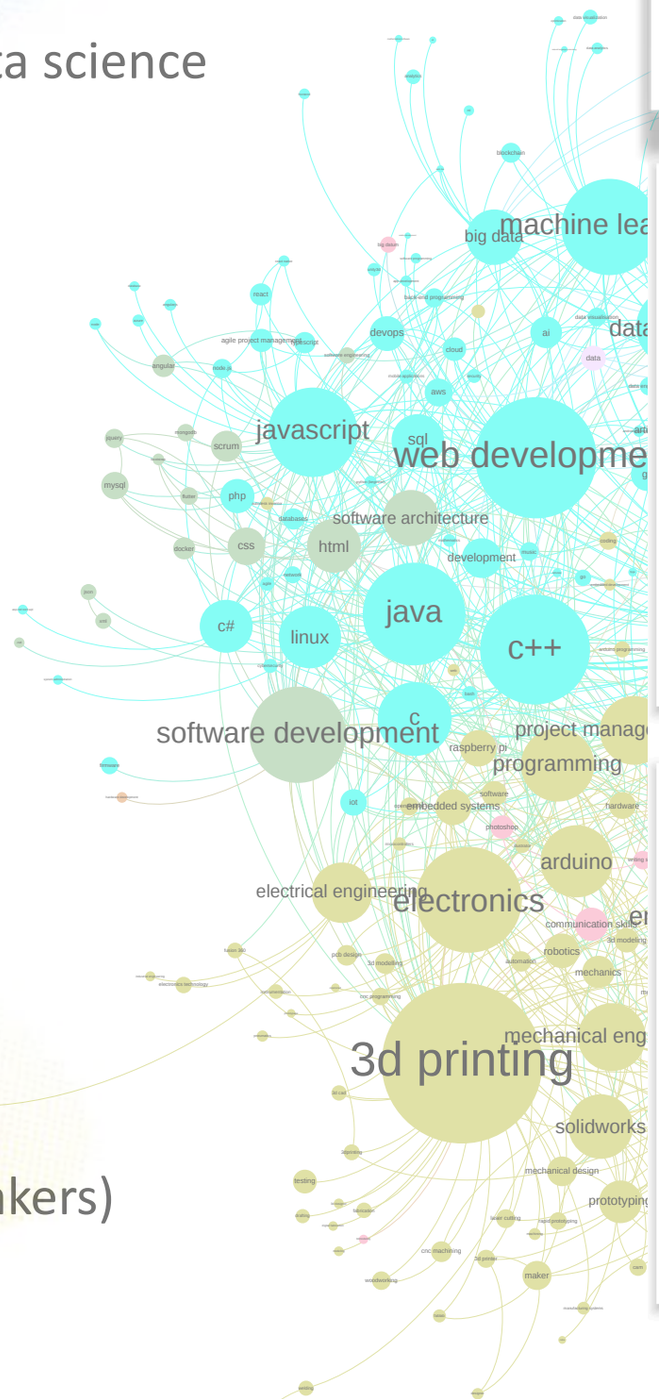


Needs: interfaces for collaborations

TEST THE PROTOCOLS IN A LAB

Project: The OpenCovid19 Initiative

We are looking for folks who have access to a biolab and can run the protocols we will be designing ...

Molecular biology | Genetics

7 Posts / 11 Comments

I'll help | Follow | Show more

OPEN METHODS FOR TESTING THE PRESENCE OF SARS-COV-2

Project: The OpenCovid19 Initiative

We are looking for someone who can help me find all existing methodologies to detect SARS-CoV-2 viru ...

Molecular biology | Bioinformatics | Medicine | +2

7 Posts / 3 Comments

I'll help | Follow | Show more

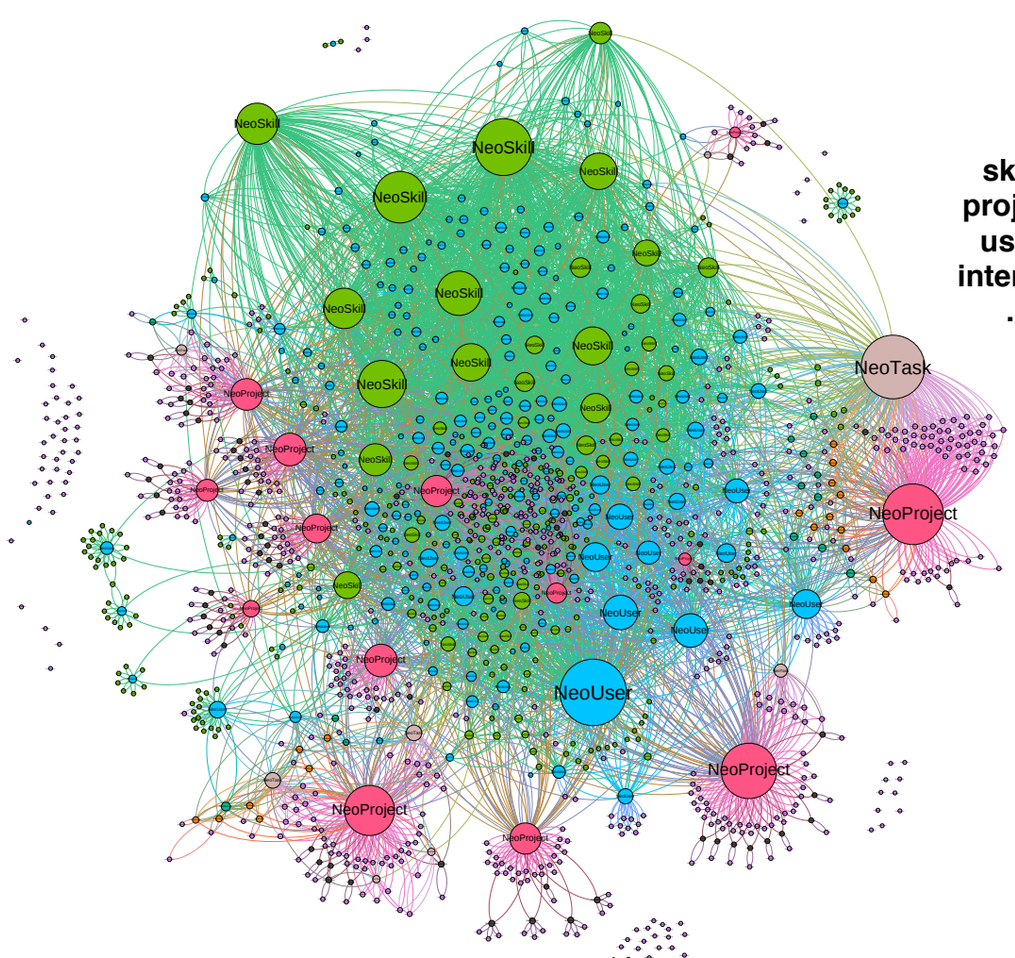
ovation/education

Recommender system

- Collective Intelligence grant from NESTA
- Experimental test of how matchmaking of needs to users fosters community self-organisation
- Uses "metapaths" in Heterogeneous Information Network

Pedro Morales
(Sciences Po Medialab)

Bastian Tsovaras
(CRI)



skills
projects
users
interests
...

HINPy

HINPy: Heterogeneous Information Networks for Python

Measuring Diversity in Heterogeneous Information Networks

Pedro Ramaciotti Morales

Sciences Po, médialab, Paris, France & Sorbonne Université, CNRS, LIP6, Paris, France

Robin Lamarche-Perrin

CNRS, ISC-PIF, LIP6, Paris, France

Raphaël Fournier-S'niehotta

CEDRIC, CNAM, Paris, France

Rémy Poulain, Lionel Tabourier

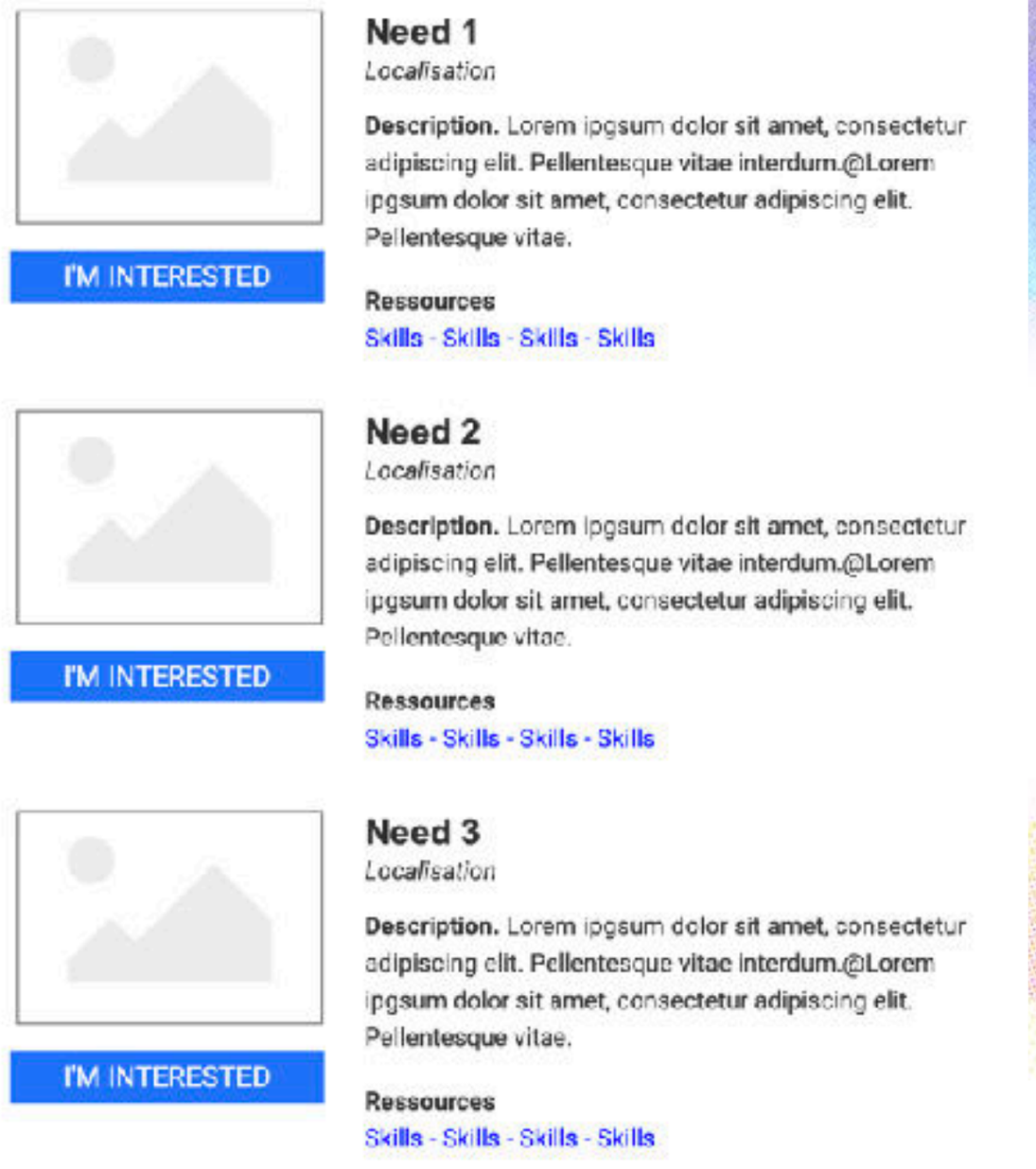
Sorbonne Université, CNRS, LIP6, Paris, France

Fabien Tarissan

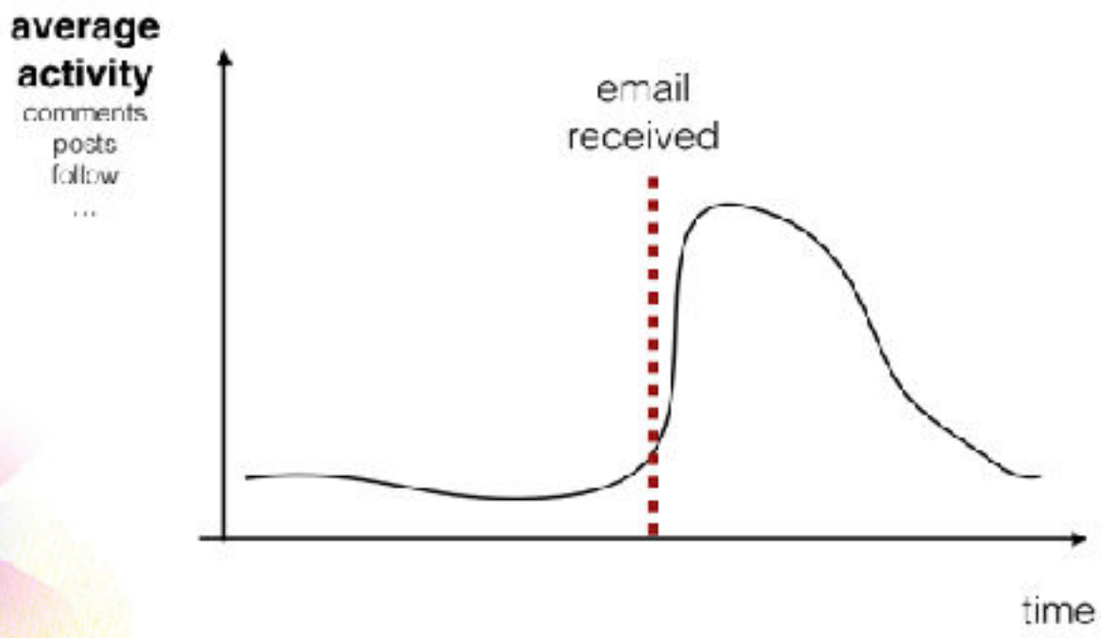
Université Paris-Saclay, CNRS, ISP, ENS Paris-Saclay, Cachan, France

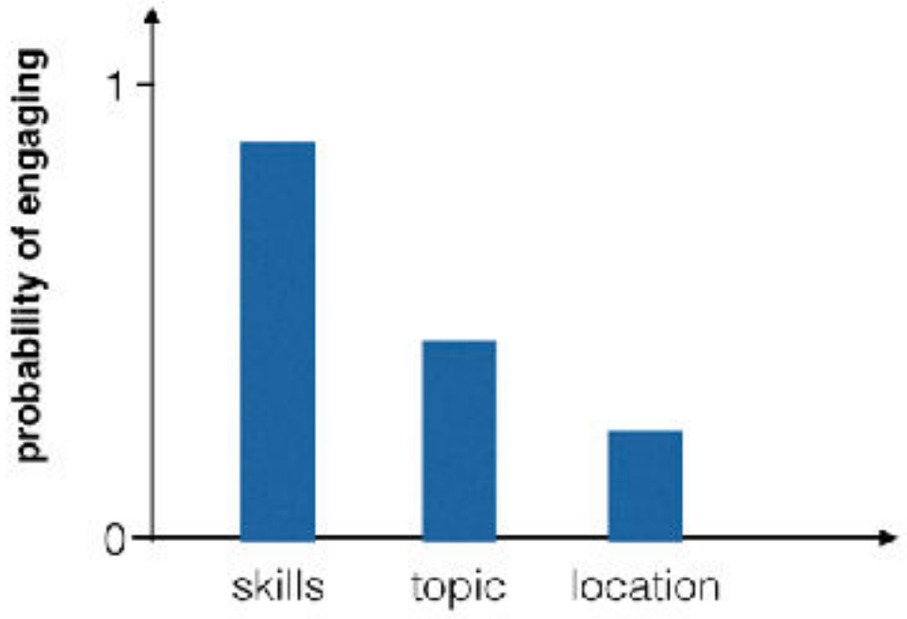
Experimental setup

- Send recommended (3) & featured (2) needs by email every week
- Measure which need was clicked on (i.e which user clicked), and keep track of what was done after on the platform



Goal

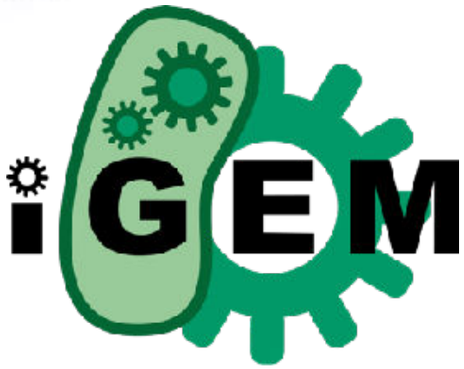




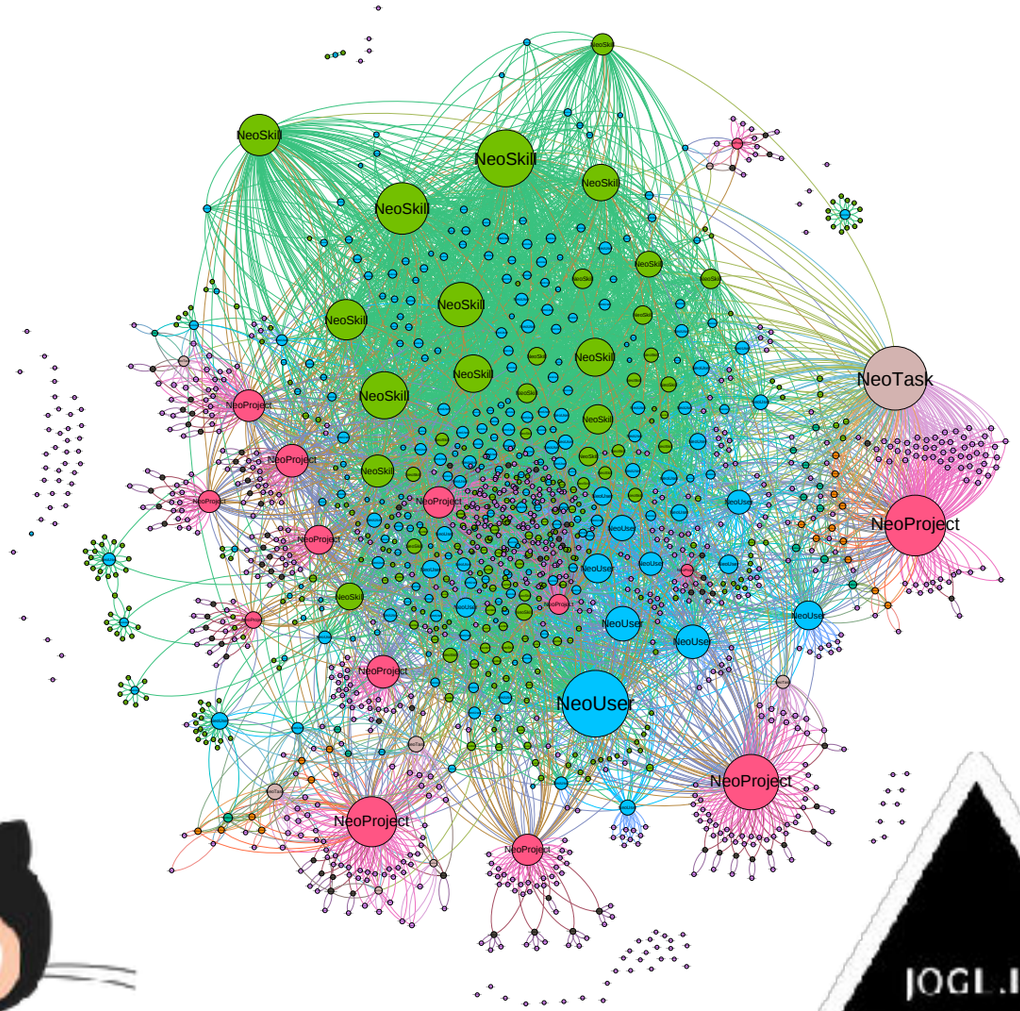
do email notifications trigger higher community engagement?
what are the most important features?

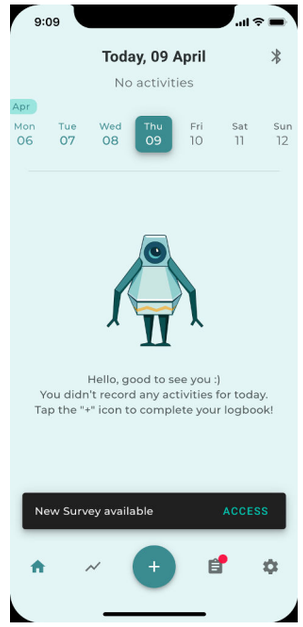
Perspective

- **Modeling collaborations as dynamic heterogeneous information networks**



user - wiki section





user - task

user - file

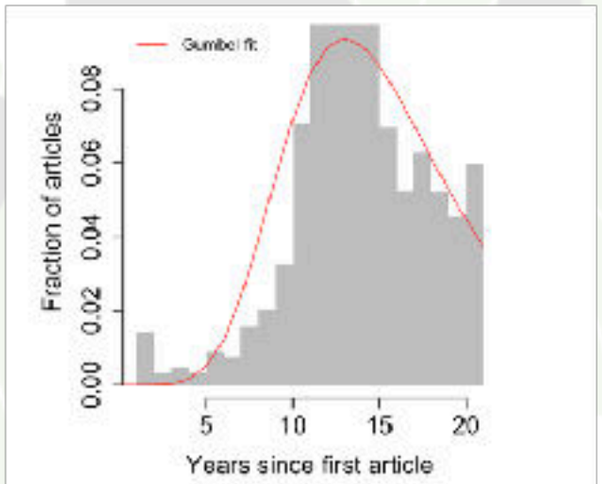
user - project / post / need

Research on innovation, learning, and collaborations

Collaborative solving

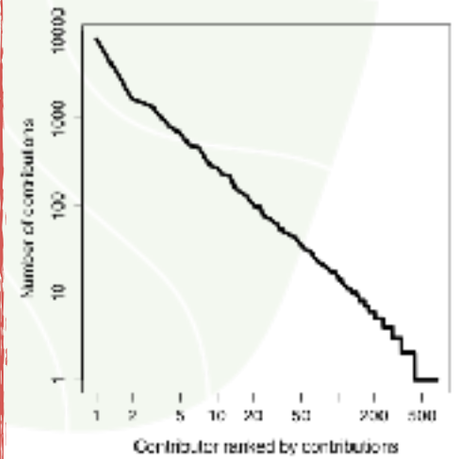
- What types of team collaborations underlie team performance?

Science innovation



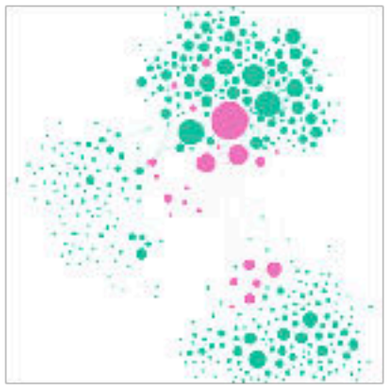
- Can we quantify innovation in science and predict the emergence of new fields?

Open-source communities



- How are large-scale open source communities organized?

Collaborative learning



- How do we learn together? An analysis of collaborative learning in rural Madagascar.

OPEN-SOURCE COMMUNITIES

Raphael Tackx
Postdoc

Henry Price
Imperial College

Massive open-source communities

How does community organize when **scaling**?

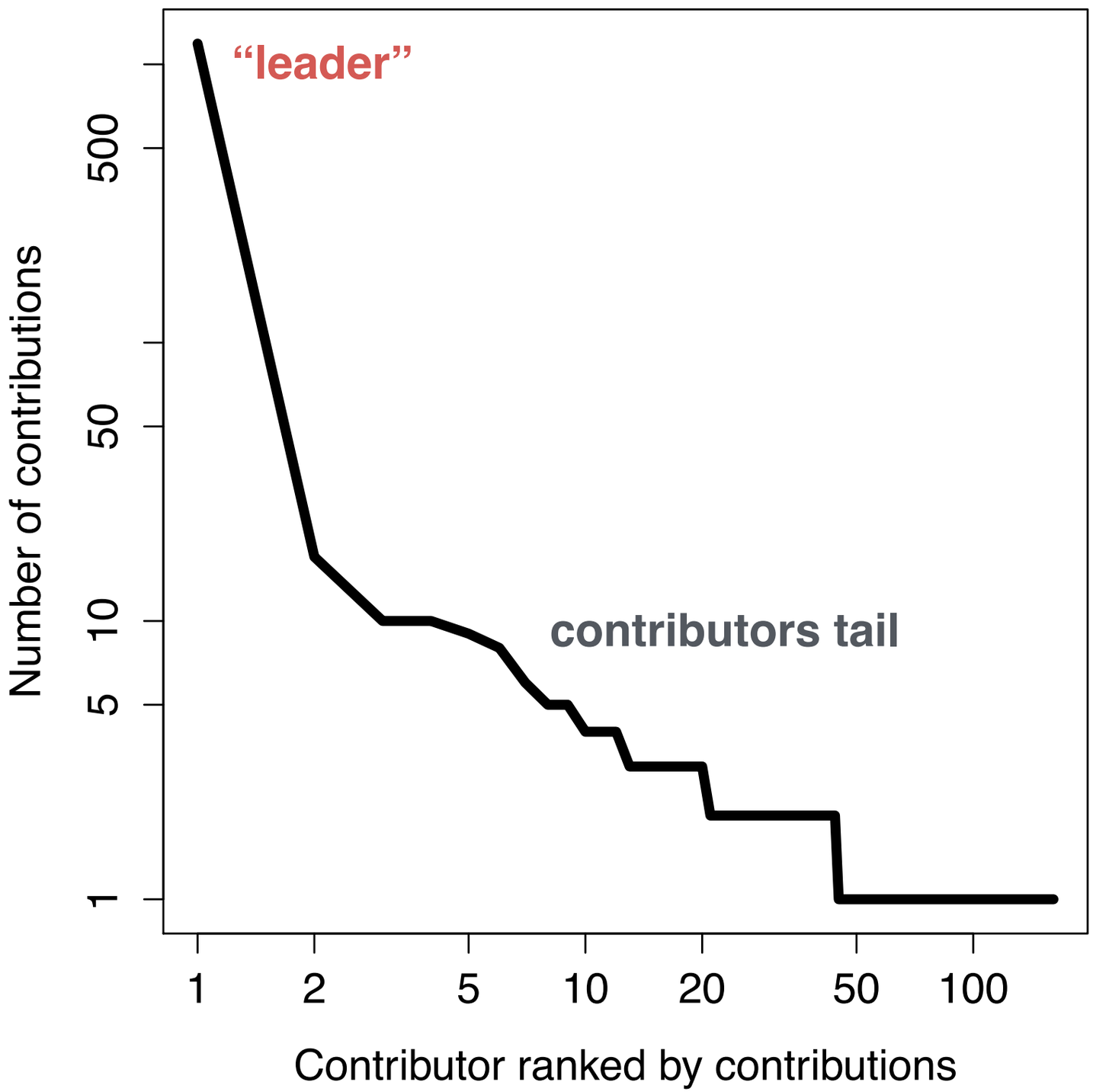
—> **7,000** most starred projects on GitHub

—> Look at **workload inequality** as repo grows in time

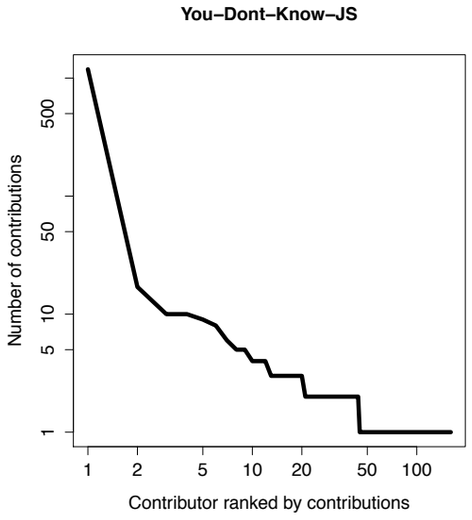
—> Large communities on GitHub adopt a **scale-free contribution structure**

—> mechanistic insights from user - file bipartite network

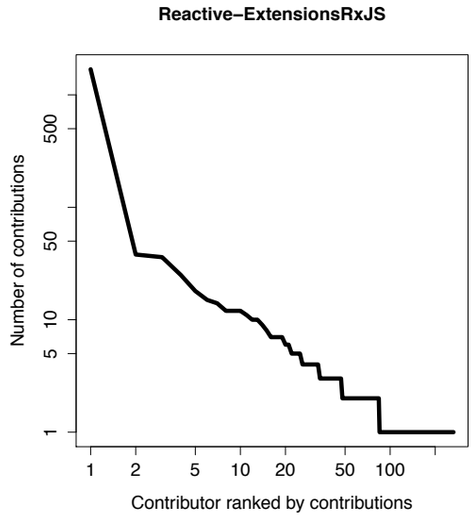
WORK SHARING



VARIATIONS ACROSS REPOSITORIES



a



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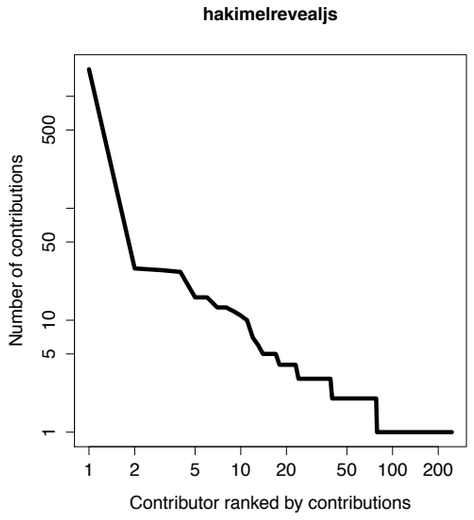
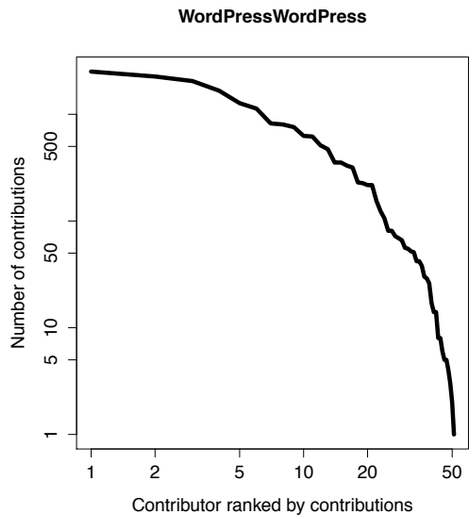
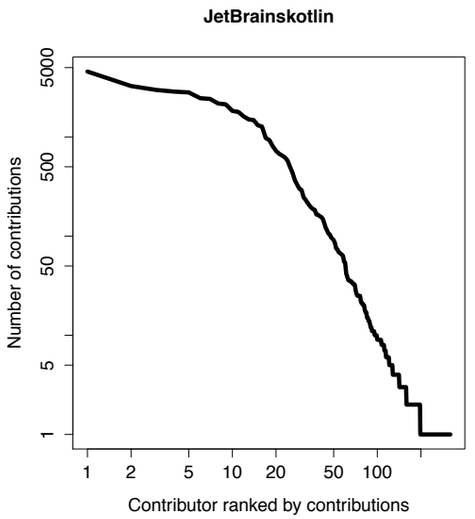


c

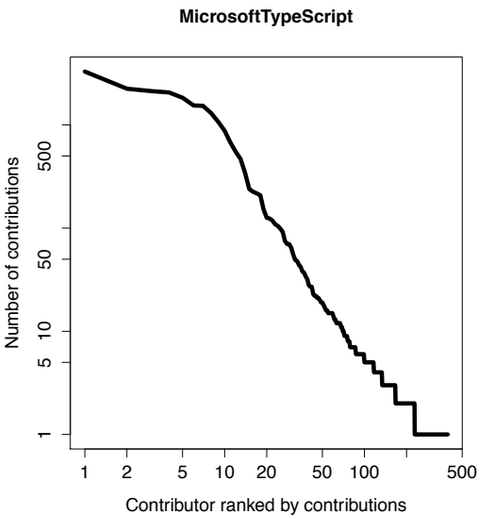
leader-based



d

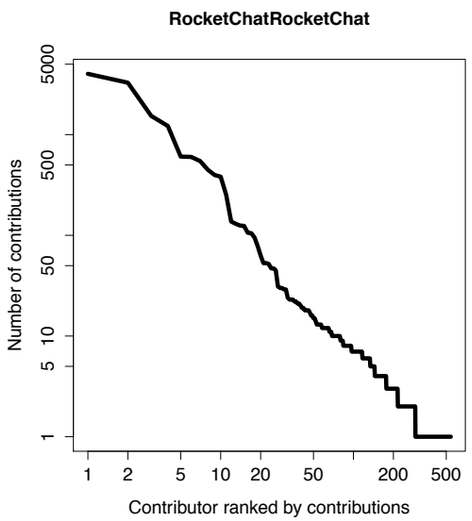


e

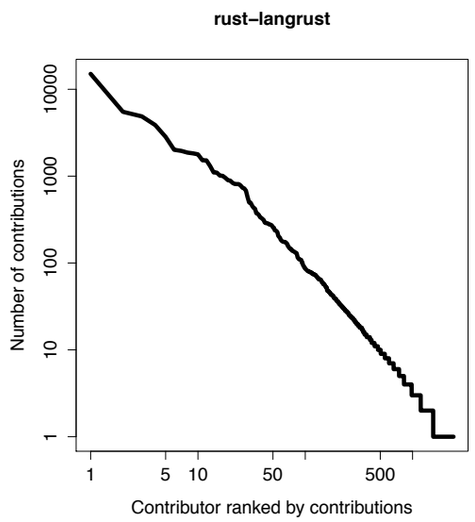


f

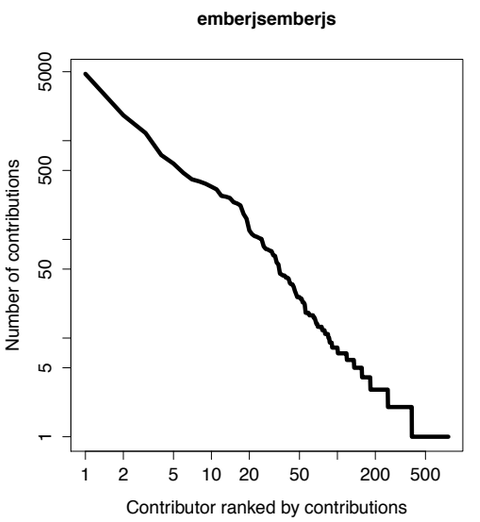
leadership group



g



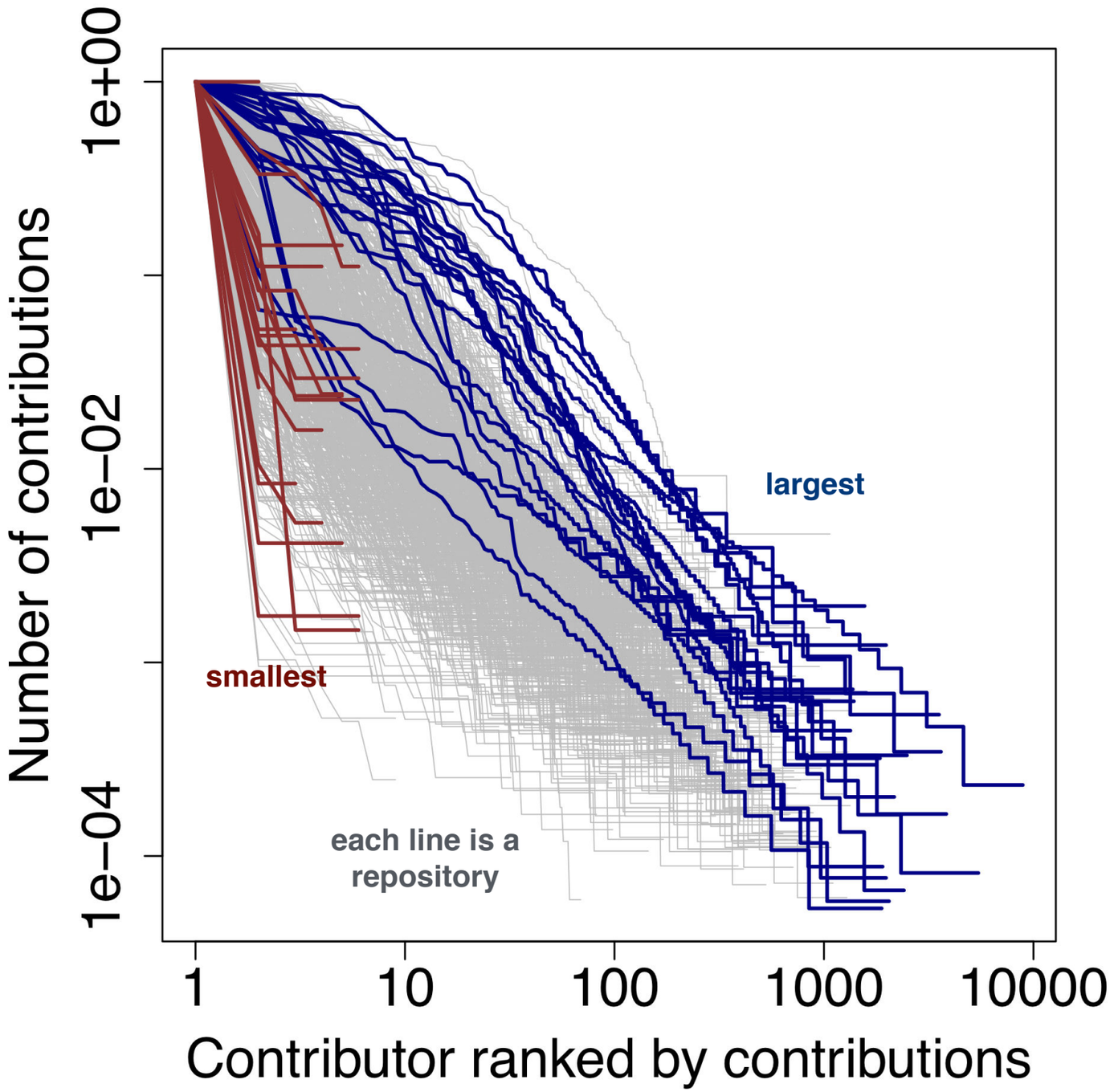
h



i

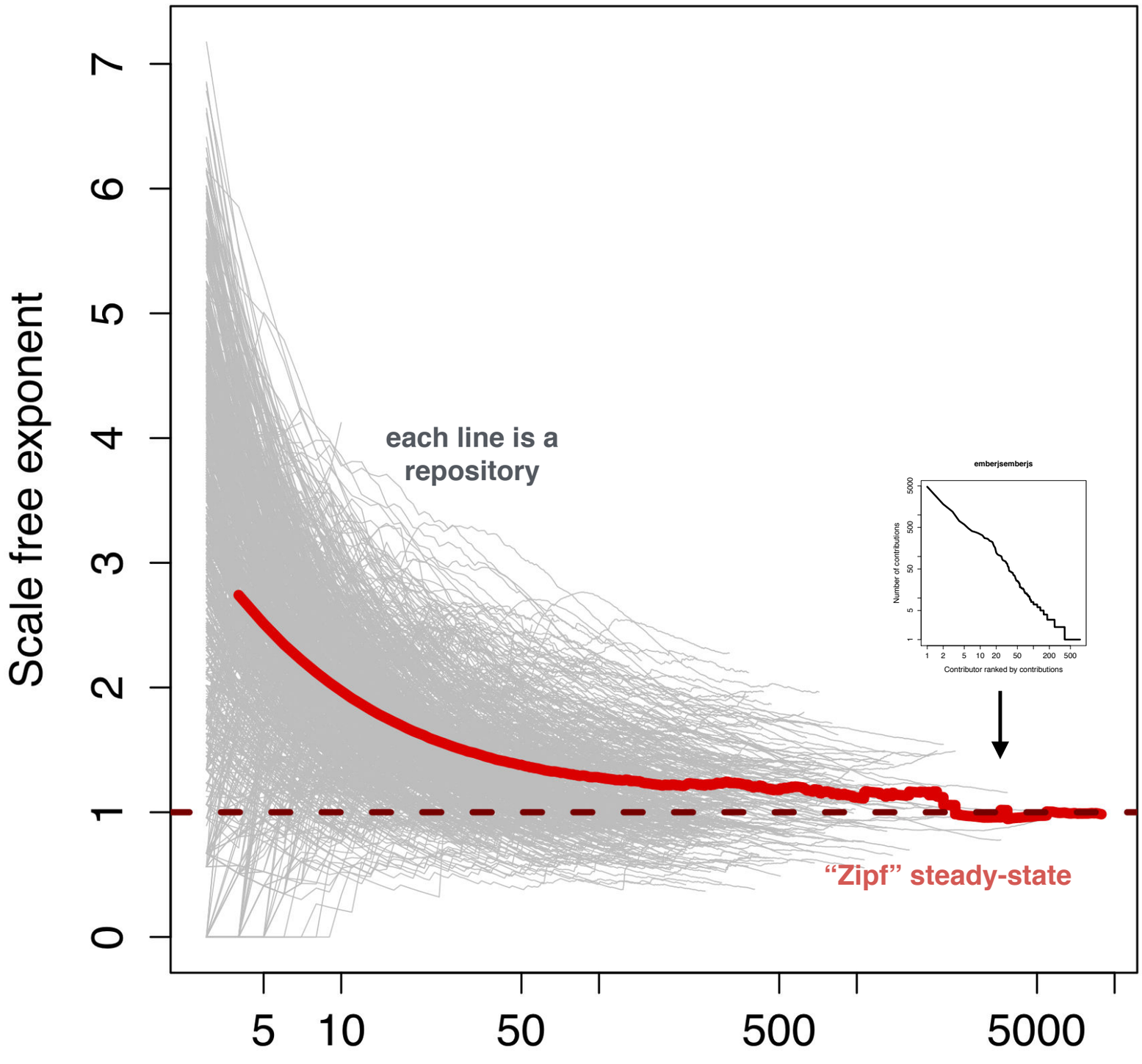
contributor-driven

Scaling properties



THE TRANSITION TO SELF-ORGANIZATION

Measure scale-free exponent of the tail at each step of the repo growth



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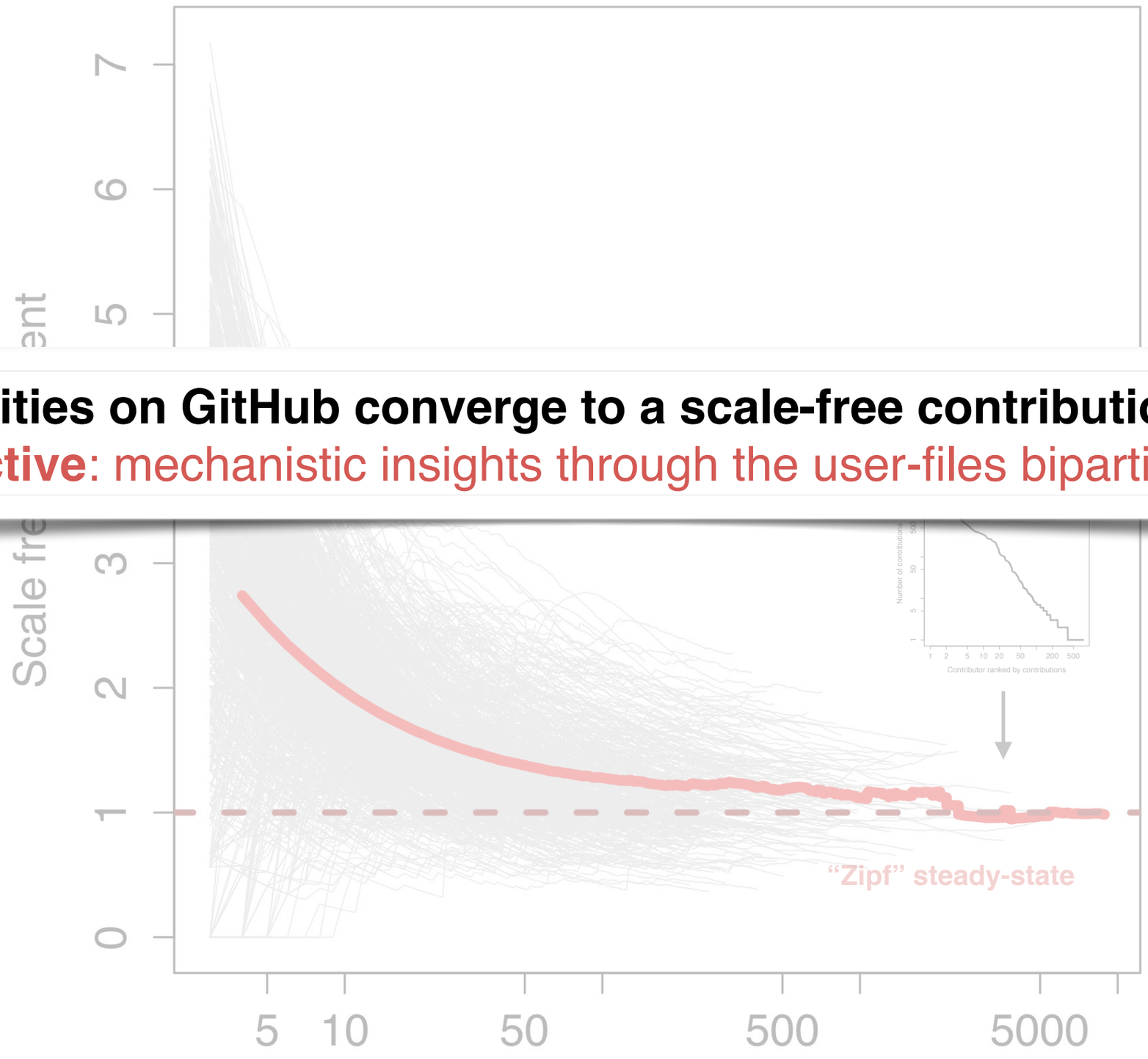
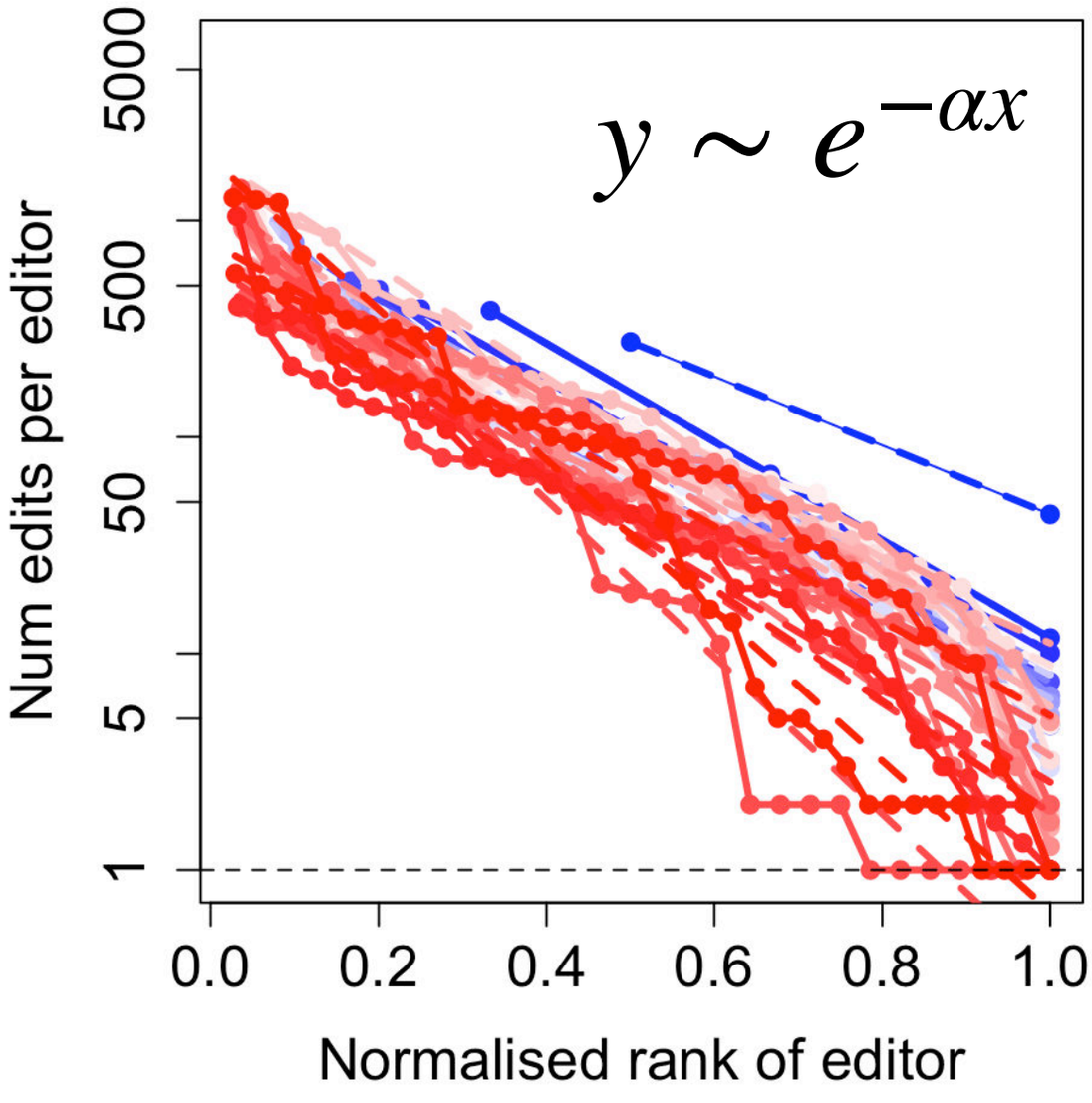


Communities on GitHub converge to a scale-free contribution structure

Perspective: mechanistic insights through the user-files bipartite structure

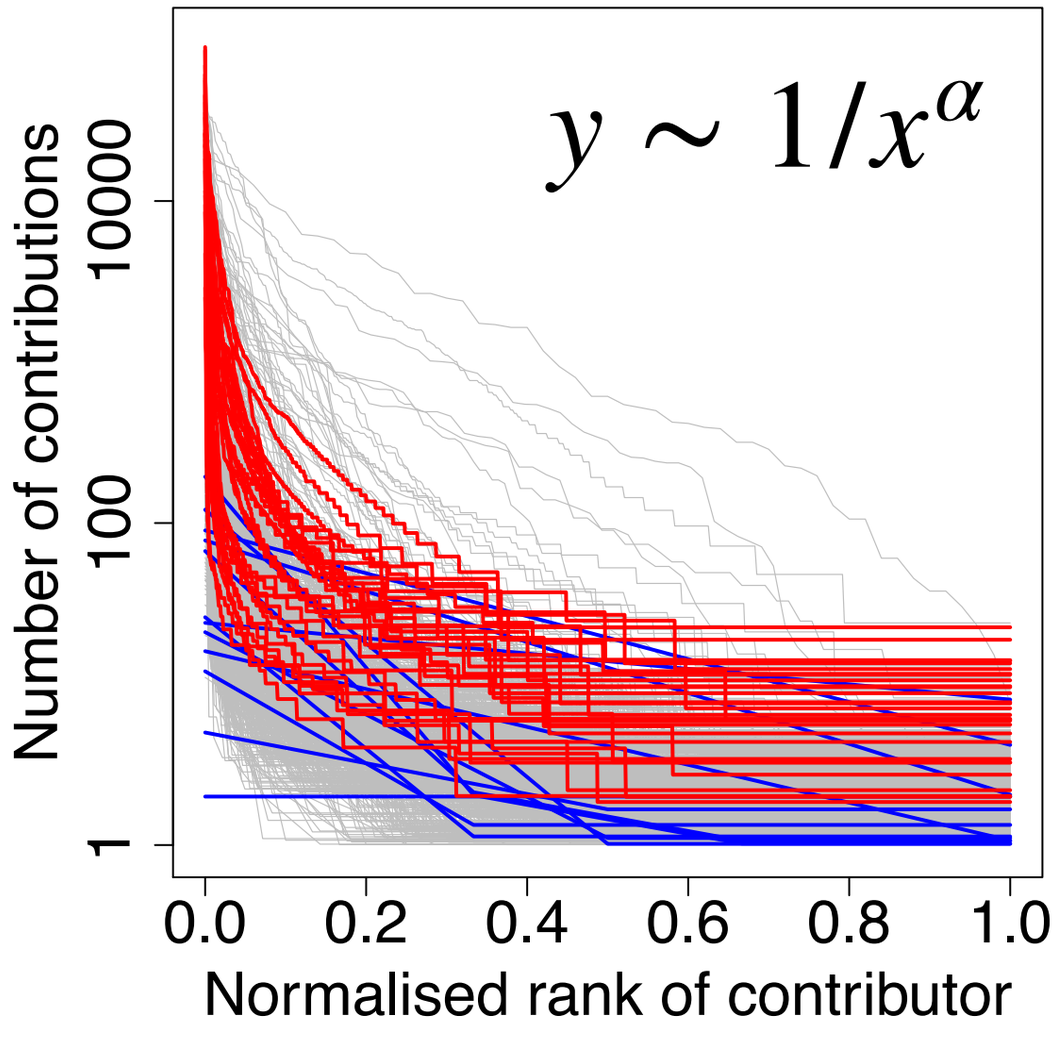
COMPARISON WITH IGEM

IGEM



local + closed

GitHub



distributed + open

PERSPECTIVE 2: COMPARISON WITH "TOP-DOWN" APPROACHES

Christos Ellinas

Christos Nicolaides

arXiv.org > cs > arXiv:2009.11752

Search...

Help | Advanced

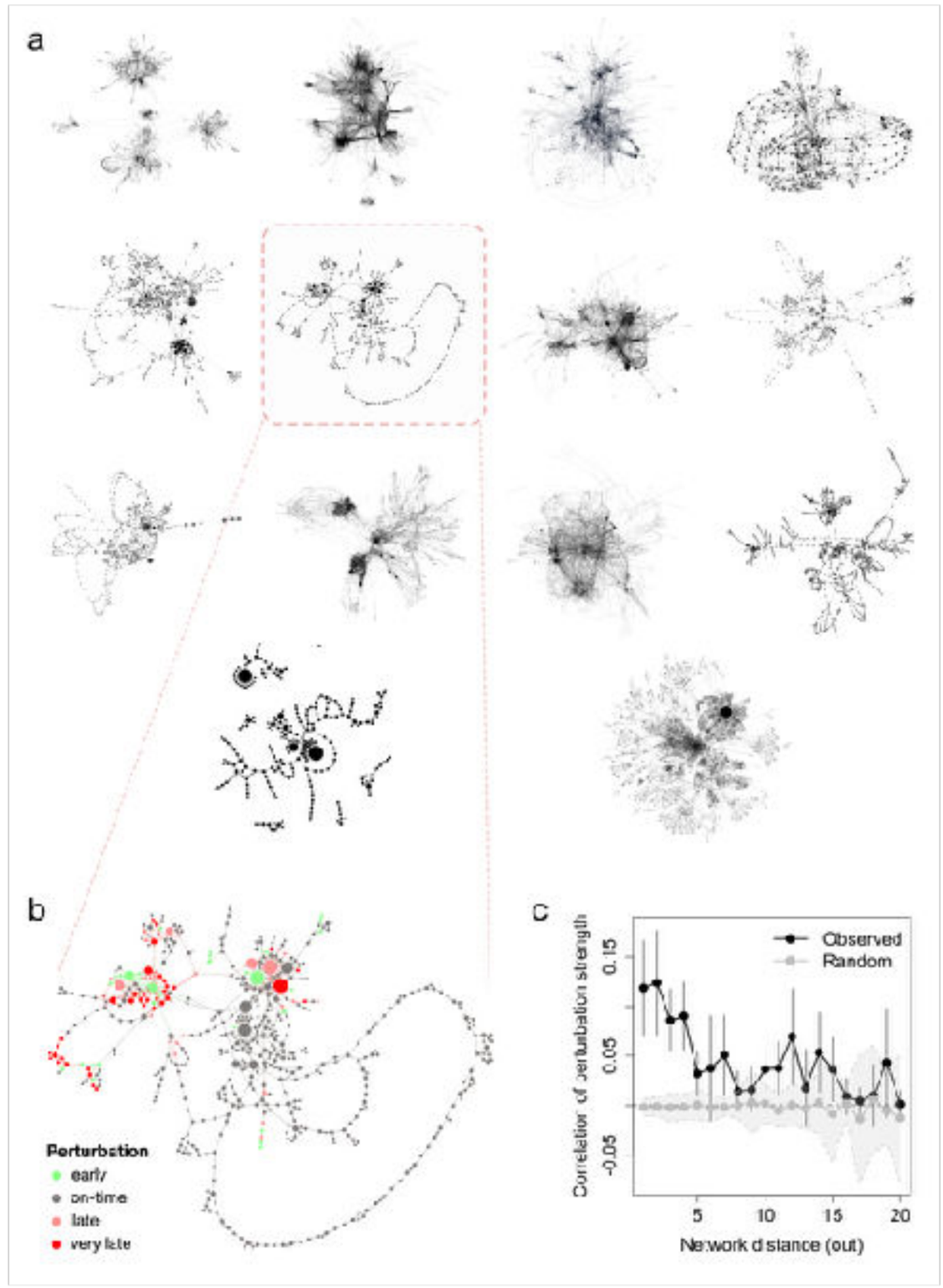
Computer Science > Social and Information Networks

(Submitted on 24 Sep 2020)

Uncovering the fragility of large-scale engineering project networks

Marc Santolini, Christos Ellinas, Christos Nicolaides

- 14 activity networks from large scale engineering projects, with delay data —> link between **network structure** and **project fragility**
- How do **self-organized "bottom-up" projects** compare to planned "top-down" projects?

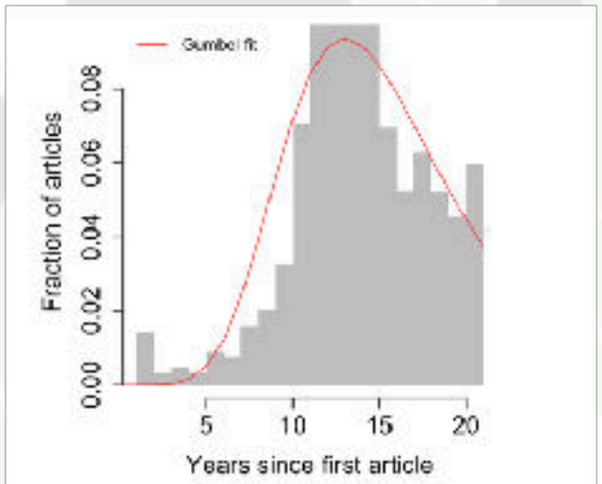


Research on innovation, learning, and collaborations

Collaborative solving

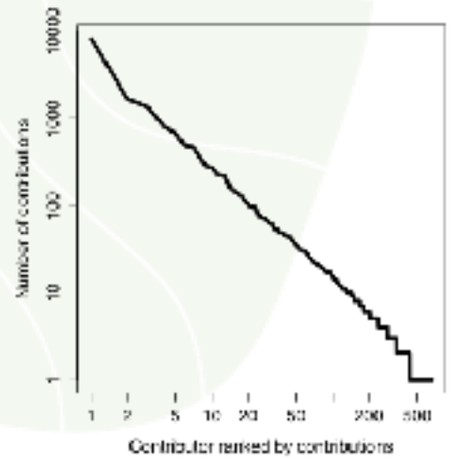
- What types of team collaborations underlie team performance?

Science innovation



- Can we quantify innovation in science and predict the emergence of new fields?

Open-source communities



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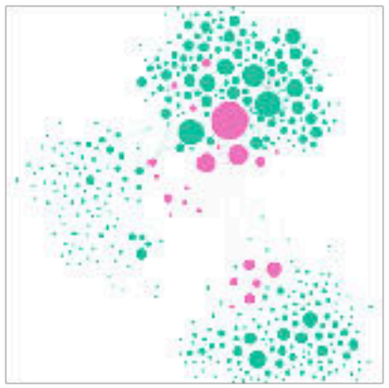
Collaborative learning



- How do we learn together? An analysis of collaborative learning in rural Madagascar.

PHONE CALL DATA

Stefania Rubrichi,
Orange Labs

Djihane Benzeggouta
Intern

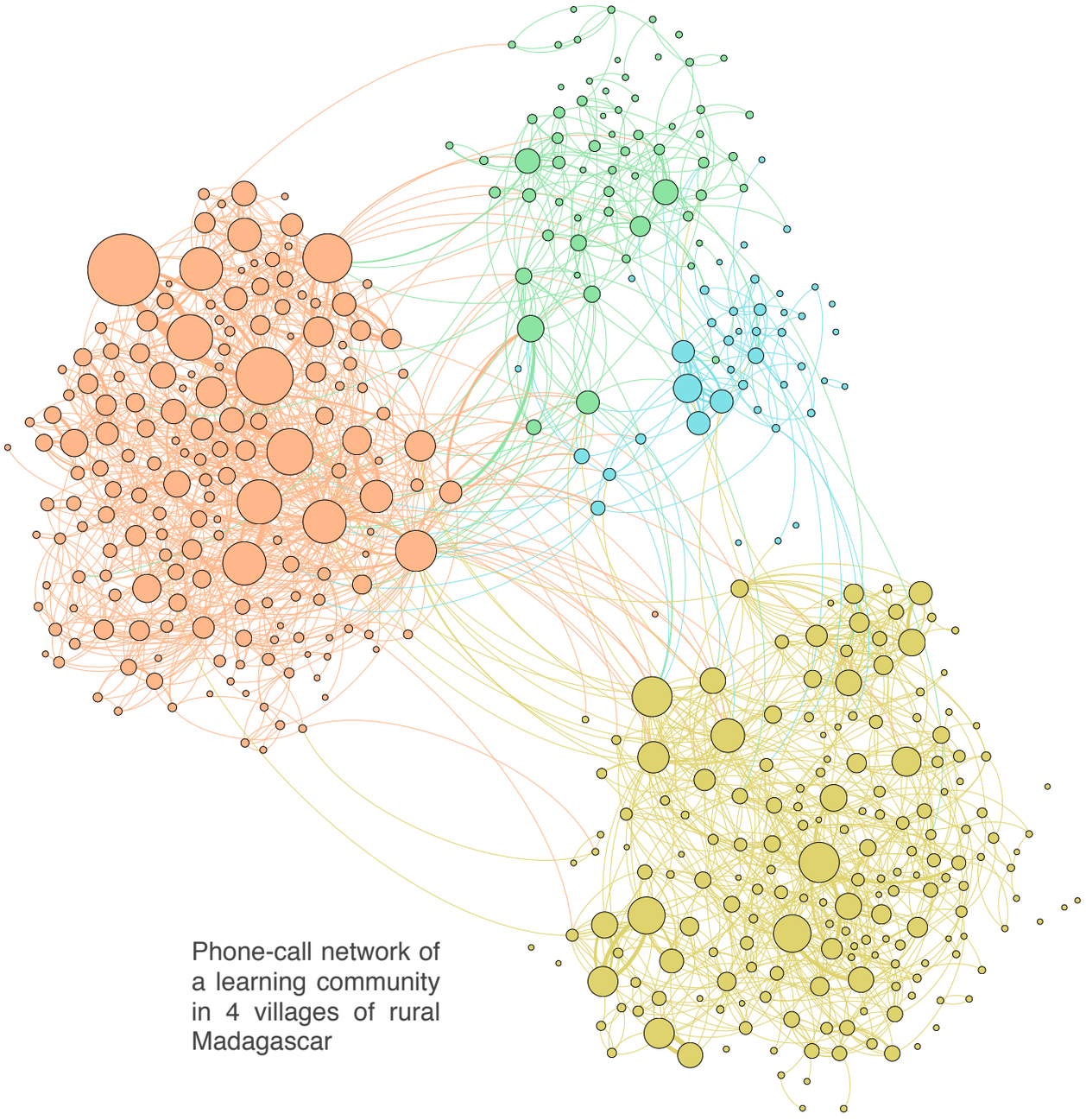
Christos Nicolaides
Univ Cyprus

Orange Labs data

Peer-influence in a collaborative learning training

Sasha Poquet
Univ. South Australia

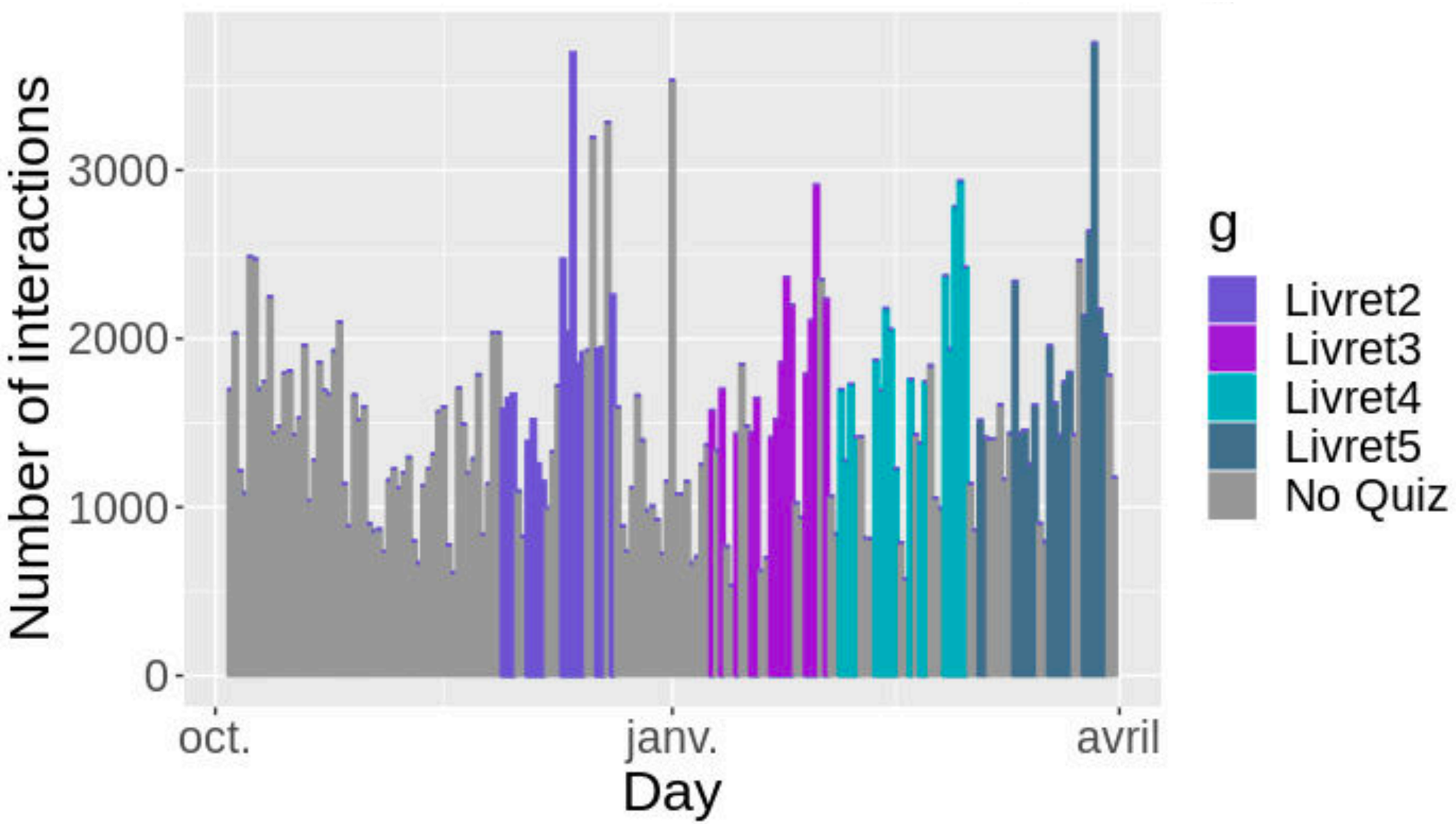
Rathin Jeyaram
Research engineer



Phone-call network of a learning community in 4 villages of rural Madagascar

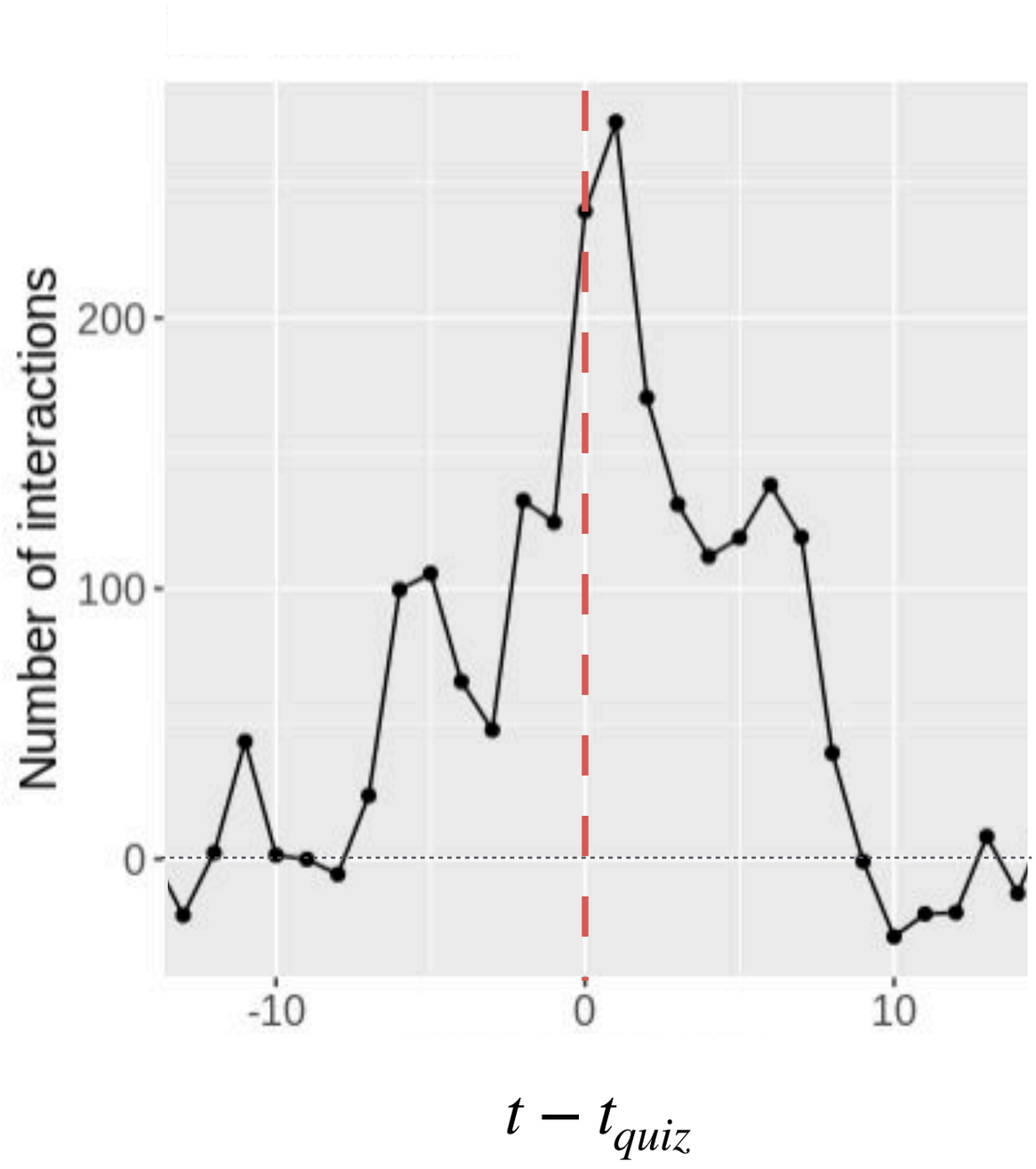
- **Temporal network:**
  - 6 months of phone call data
  - 450 learners
  - 60 quizzes by SMS
- Is there a **peer influence in quiz engagement and performance?**
- **Causal "contagion" analysis** using a **Regression discontinuity design** (w/ Christos Nicolaides)

QUIZZES GENERATE SOCIAL INTERACTIONS



QUIZZES GENERATE SOCIAL INTERACTIONS

Relative enrichment in interactions on Quiz days

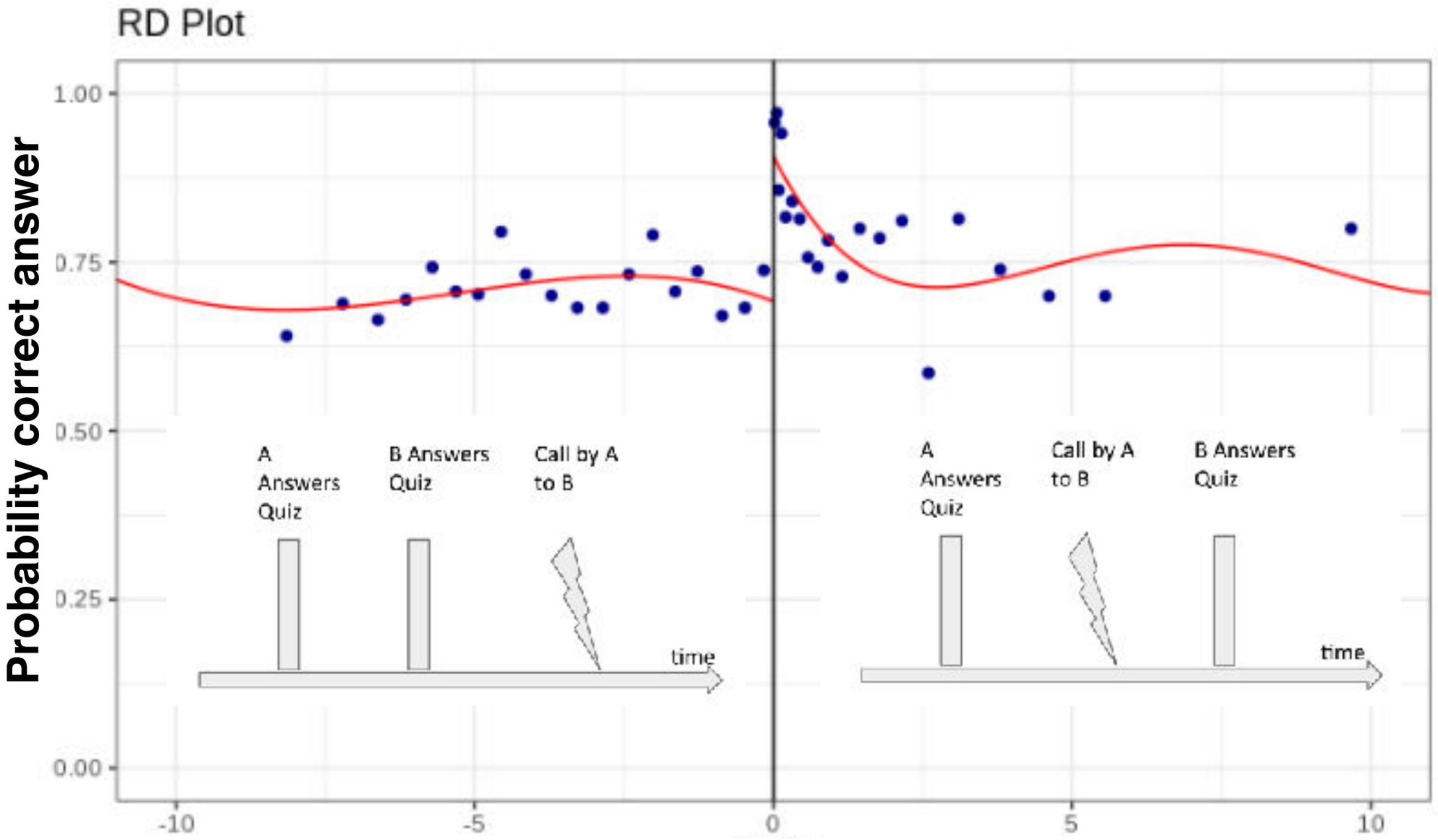


- **Interactions** associated with taking a **quiz**
- Can we infer **causality** between **interactions and performance**?

LEARNING CONTAGION PROCESS

Regression discontinuity design

20% effect (95% CI 15-27%)



Time since interaction with someone who answered correctly (h)

LEARNING CONTAGION PROCESS

Regression discontinuity design

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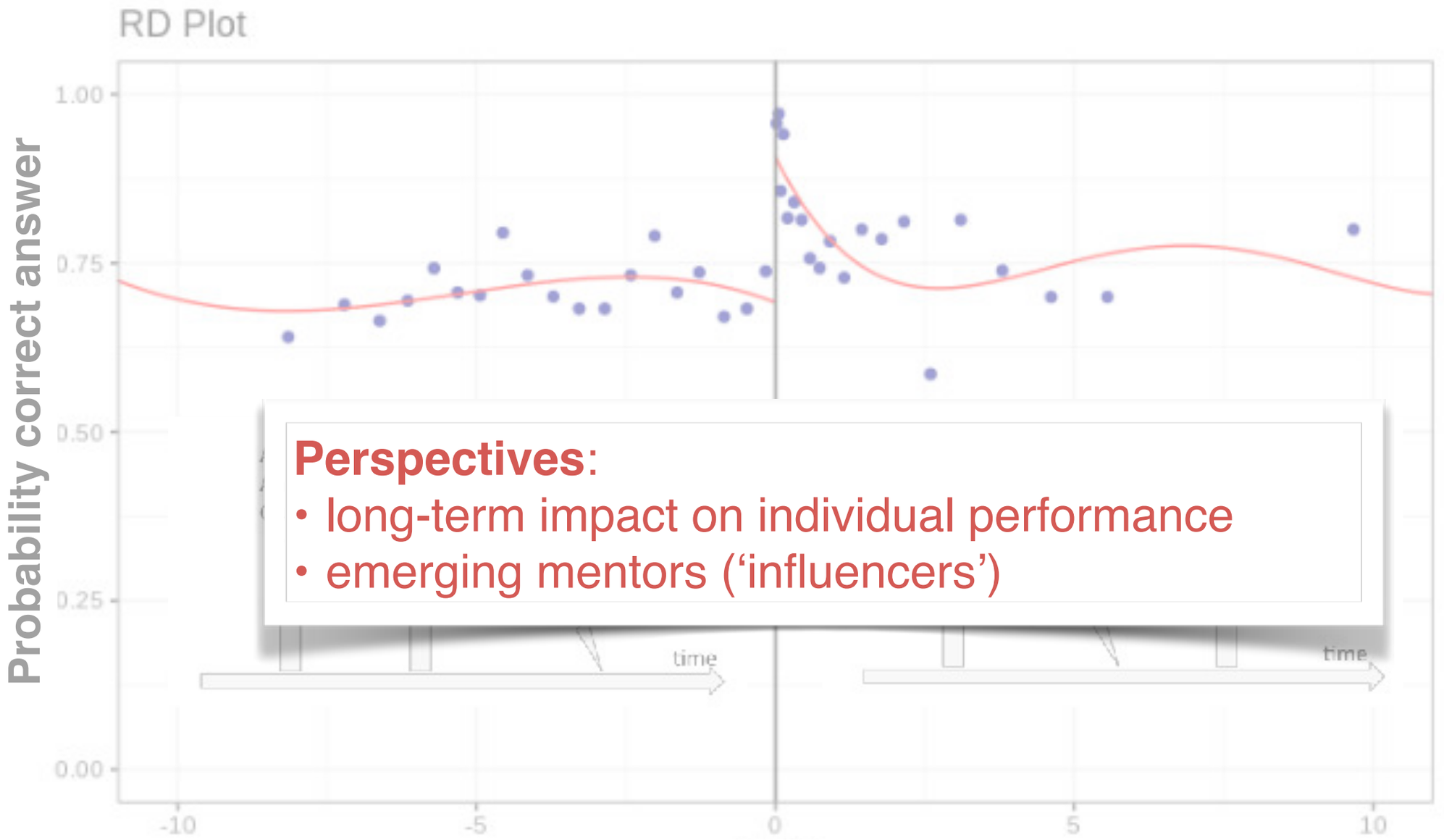

Perspectives:

- long-term impact on individual performance
- emerging mentors (‘influencers’)

Time since interaction with someone who answered correctly (h)

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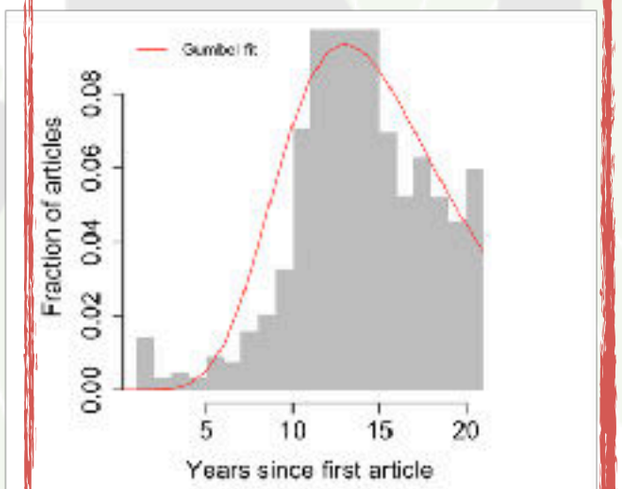
Science innovation



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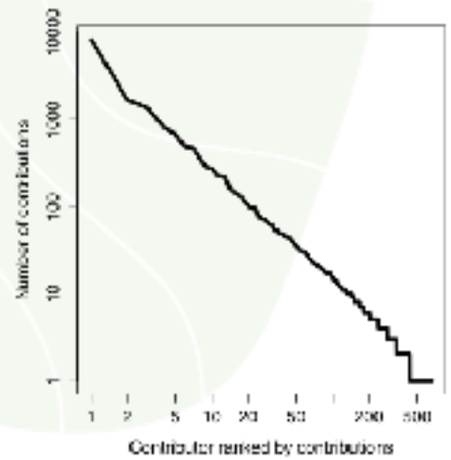

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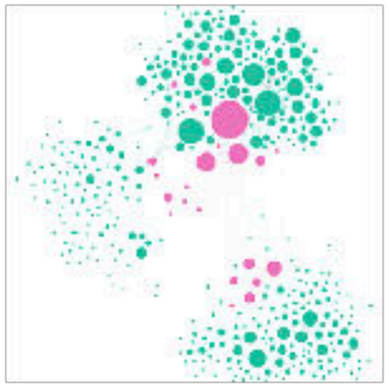
Collaborative learning



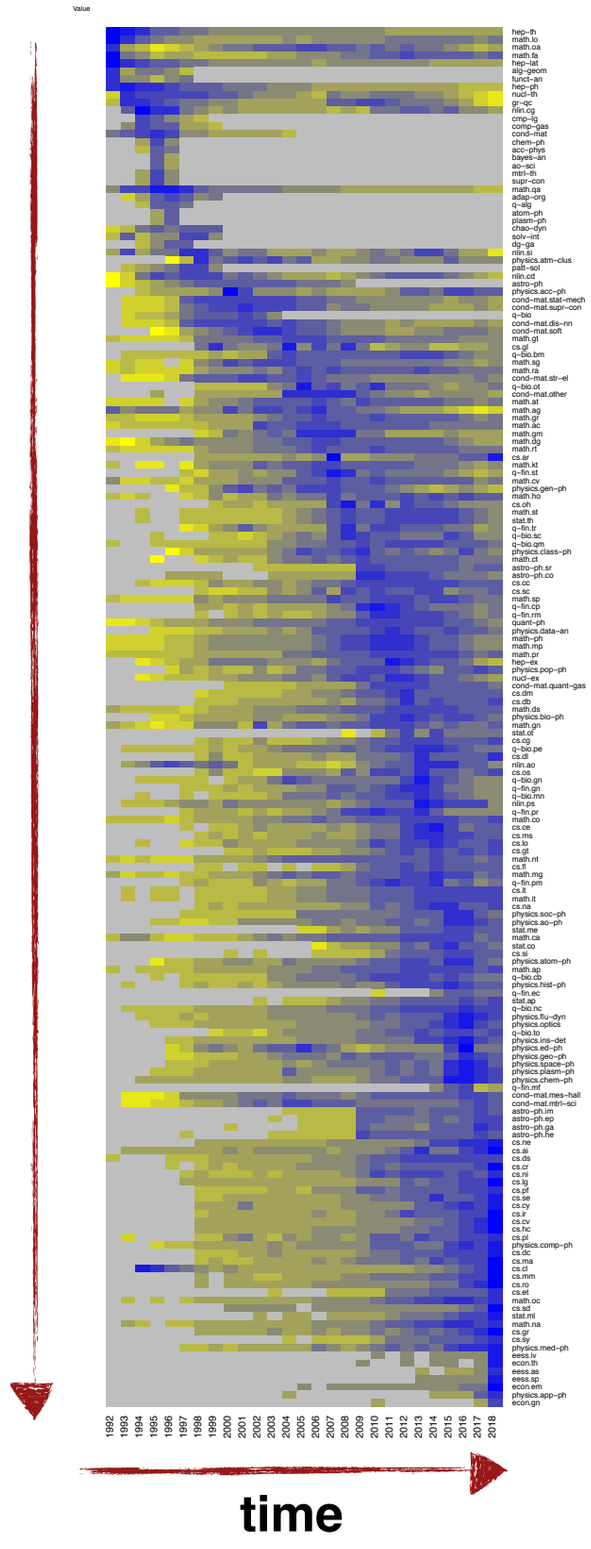
- How do we learn together? An analysis of collaborative learning in rural Madagascar.

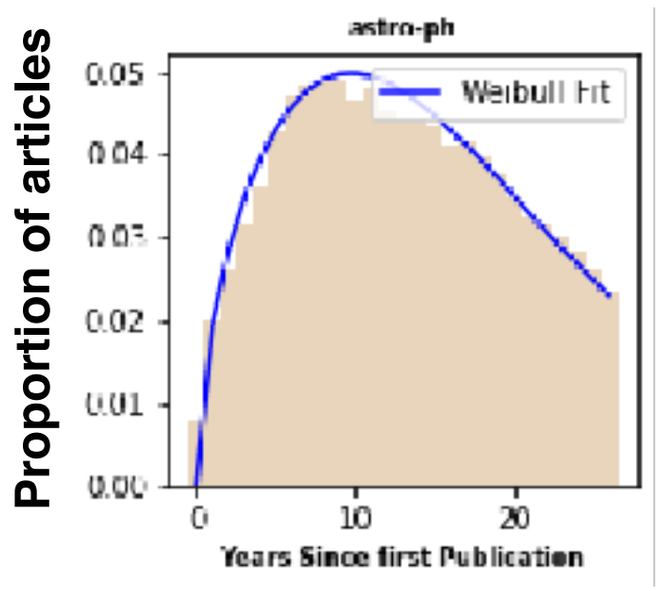
SCIENTIFIC INNOVATION

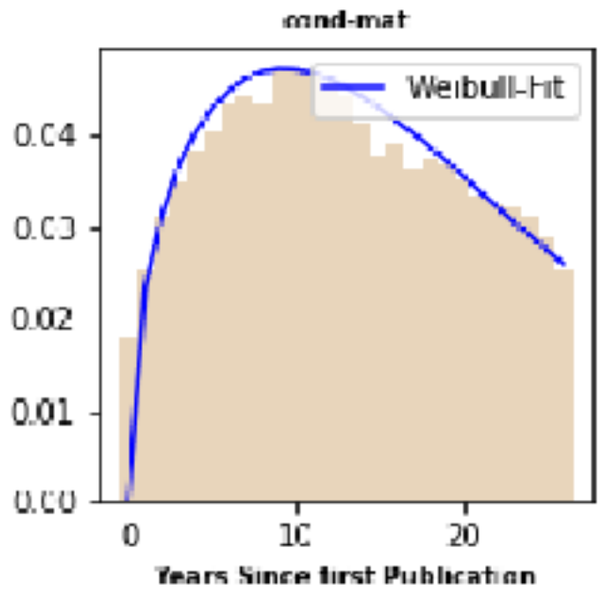
Chakresh Singh
Postdoc

Liubov Tupikina
CRI fellow, Bell labs

- **arXiv**: **1.5M articles, 170 fields**
- **Modeling rise and fall of scientific fields**
- **Levy flights** of knowledge exploration (exploration/exploitation)
- **Resource foraging**: link to local density/ citation field





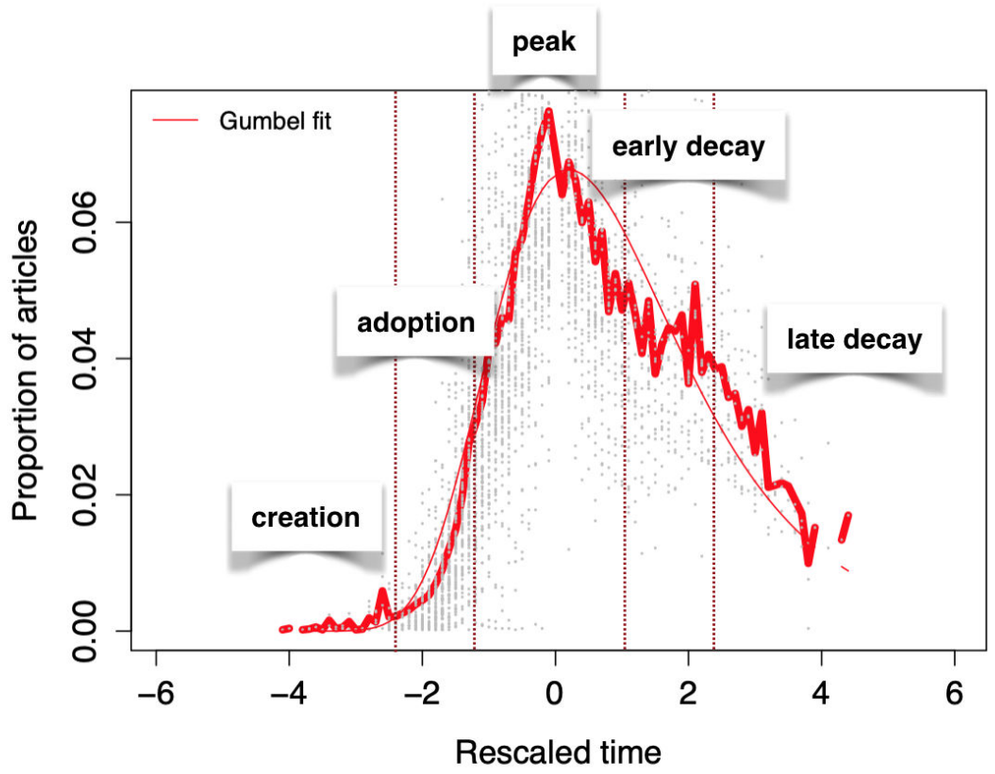


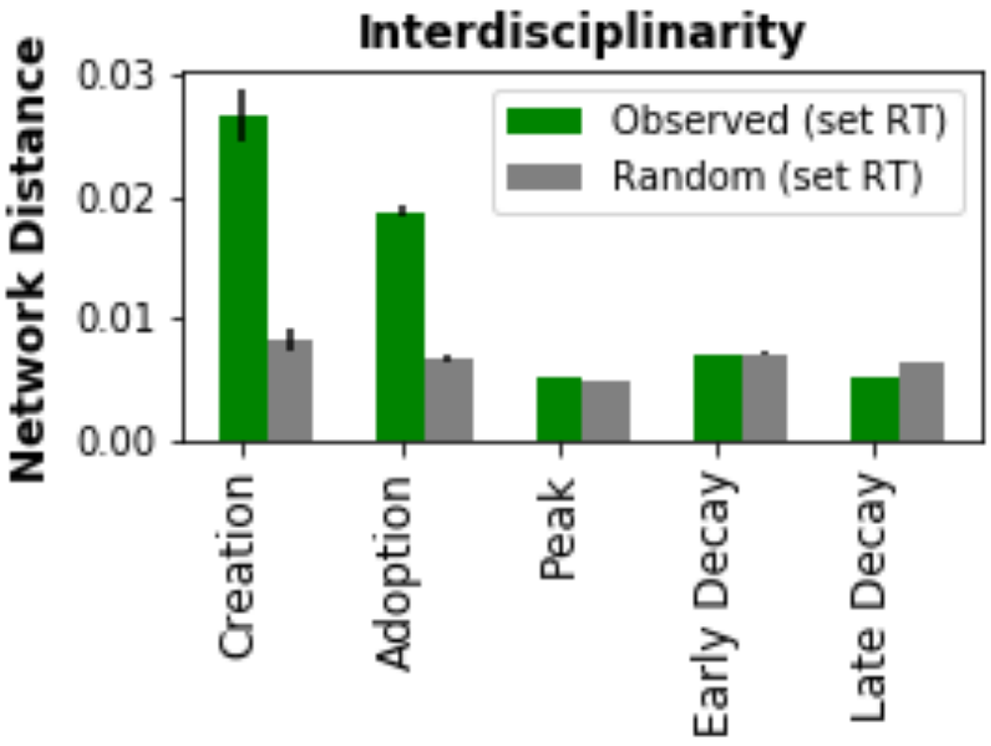
SCIENTIFIC INNOVATION

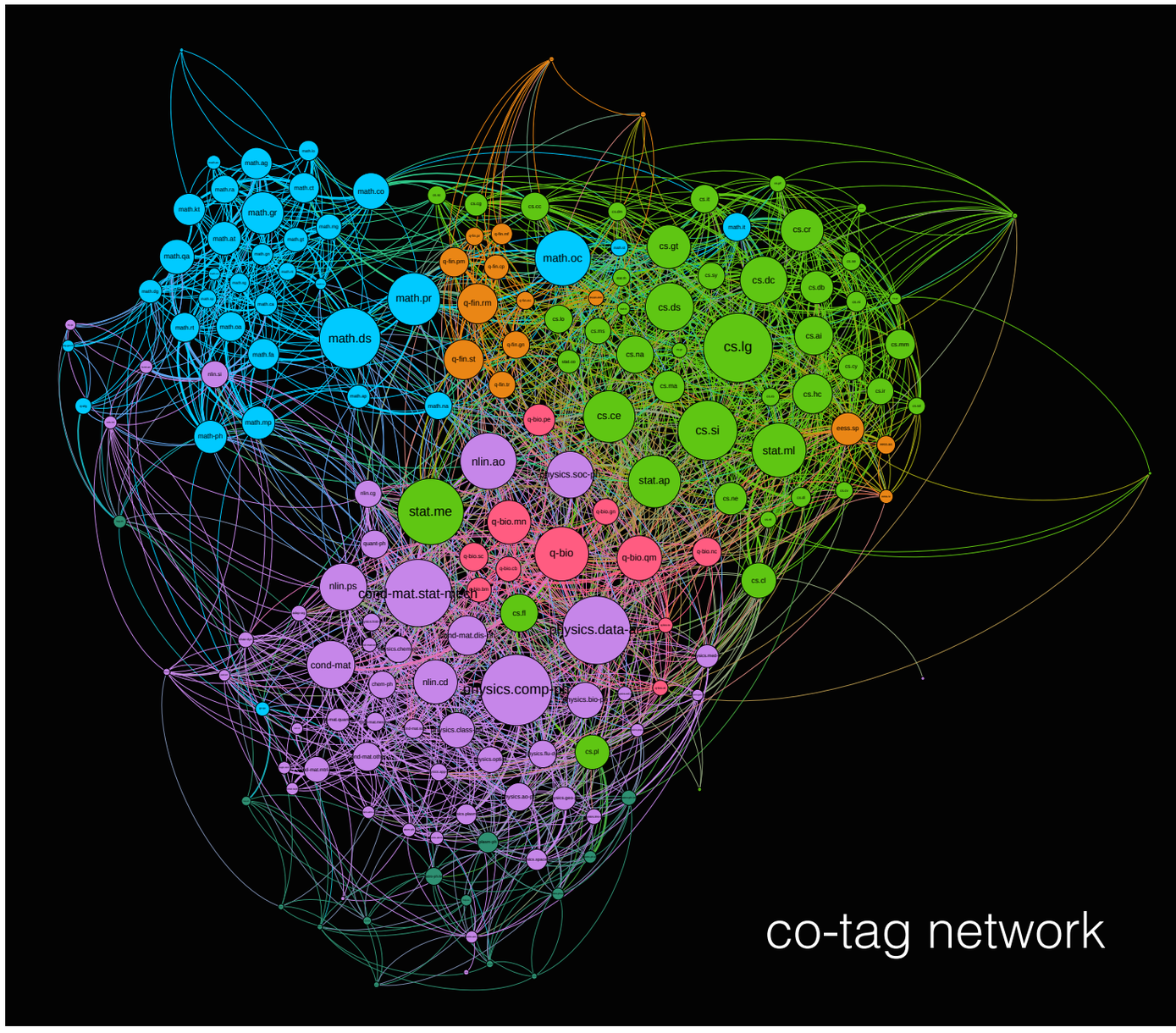
Chakresh Singh
Postdoc

Liubov Tupikina
CRI fellow, Bell labs

- **early articles in a field mix cognitively distant fields**







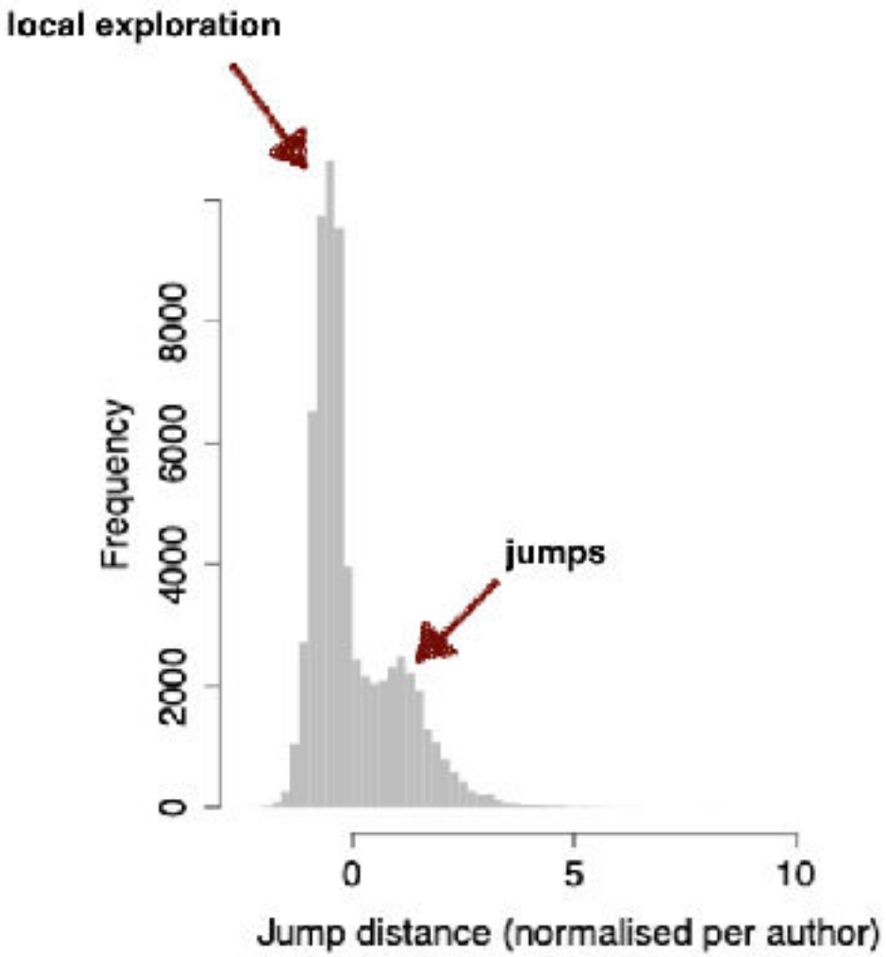
SCIENTIFIC INNOVATION

Chakresh Singh
Postdoc

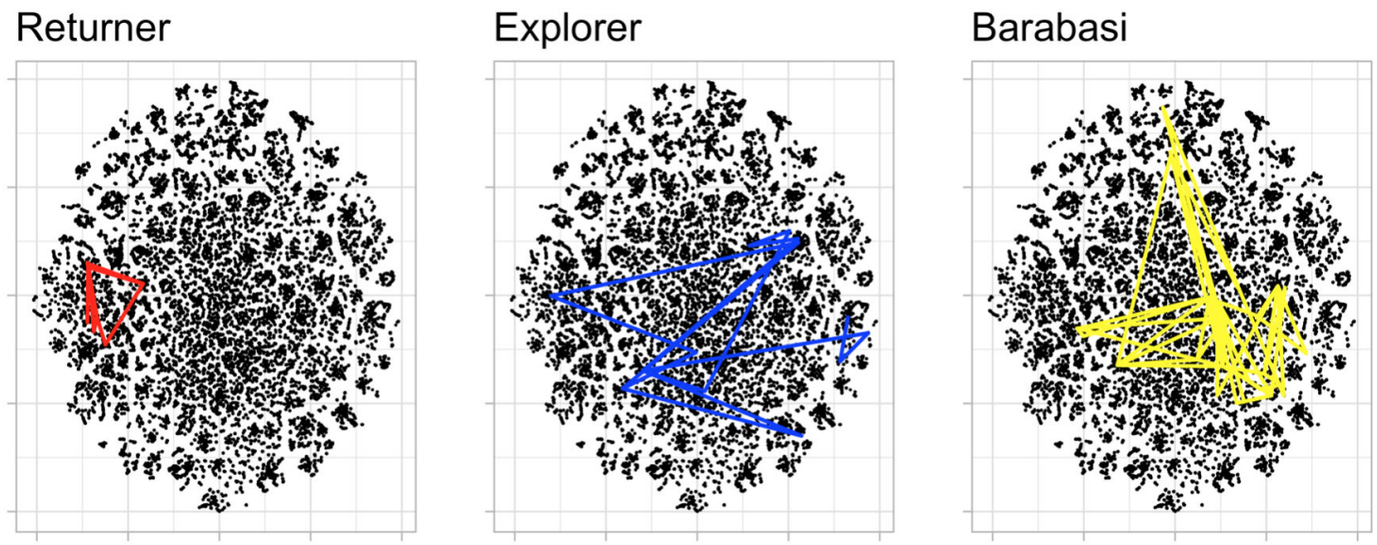
Liubov Tupikina
CRI fellow, Bell labs

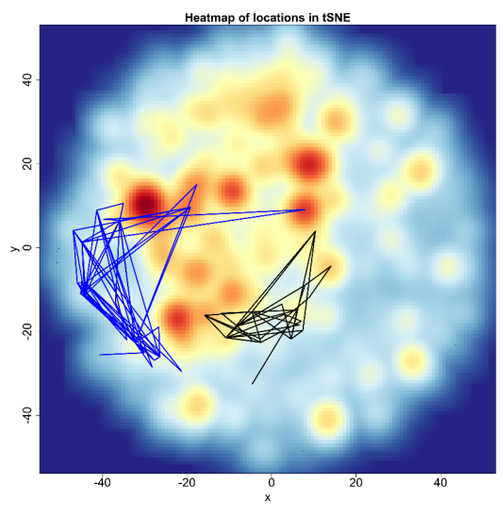
- **2D embedding to quantify exploration behavior**

Levy flights



Exploration behavior
(tSNE, but now shifting to UMAP)





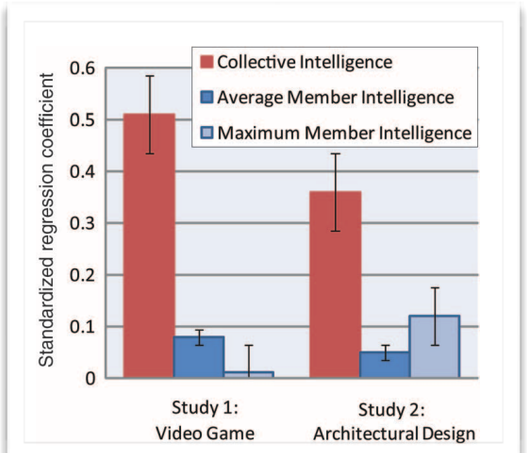
Field theory?
(density, citations…)

Enhancing collective intelligence

Science 2010

Evidence for a Collective Intelligence Factor in the Performance of Human Groups

Anita Williams Woolley,[1*] Christopher F. Chabris,[2,3] Alex Pentland,[3,4]
Nada Hashmi,[3,5] Thomas W. Malone[3,5]



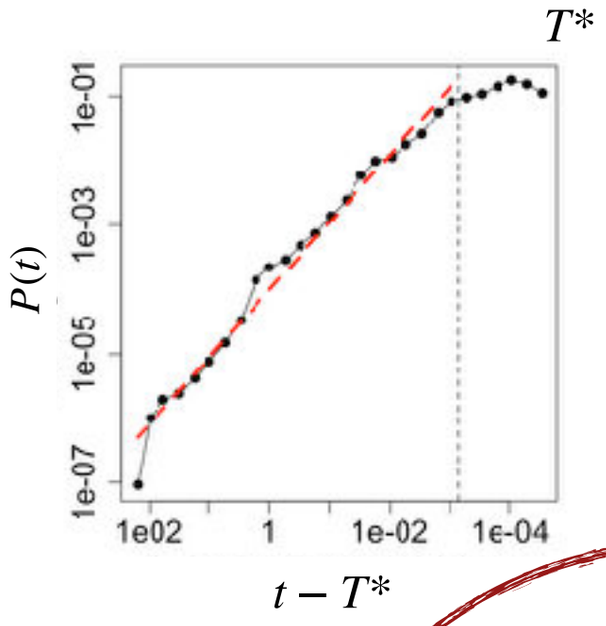
"it would seem to be **much** **easier to raise the intelligence of a group than an individual**.

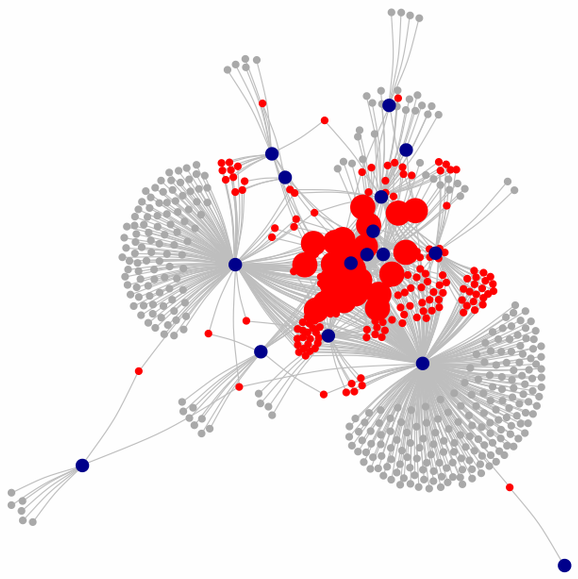
Could a group's **collective intelligence be increased by**, for example, **better electronic collaboration tools?** "

TEAM WORK

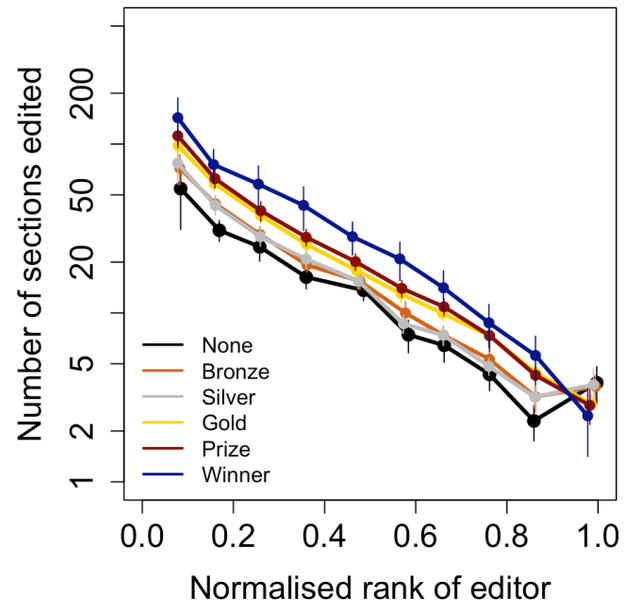
"**universals**" of team work in iGEM

Team dynamics

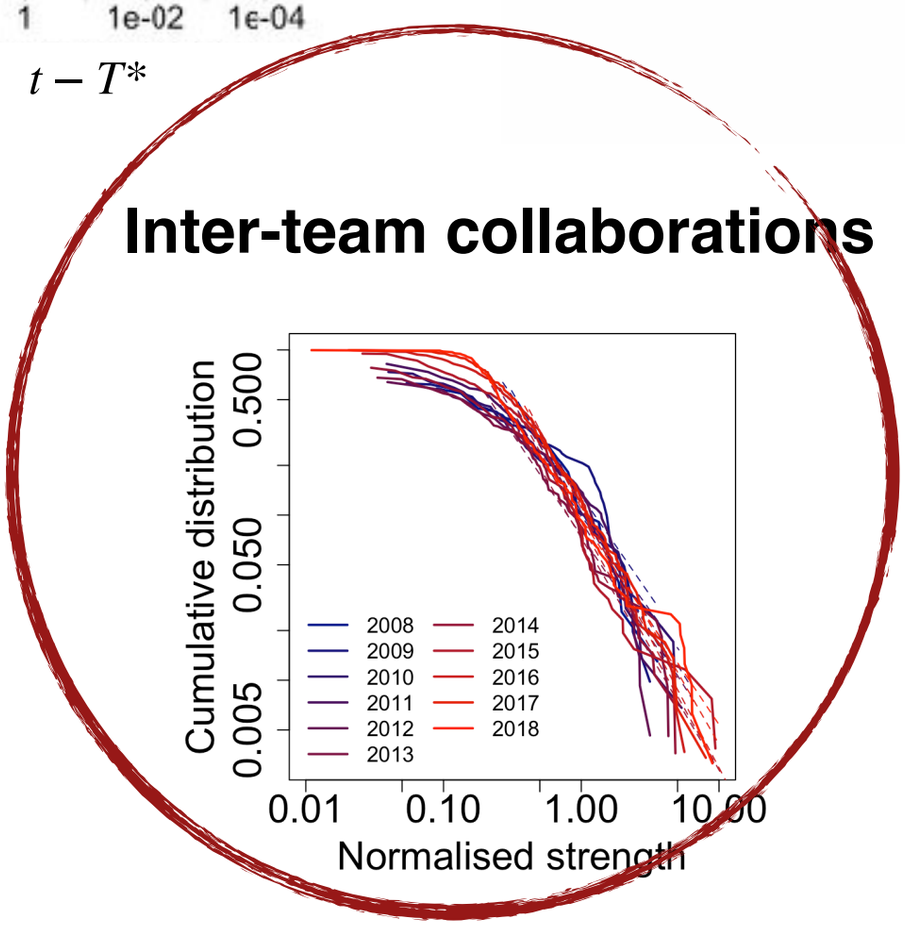




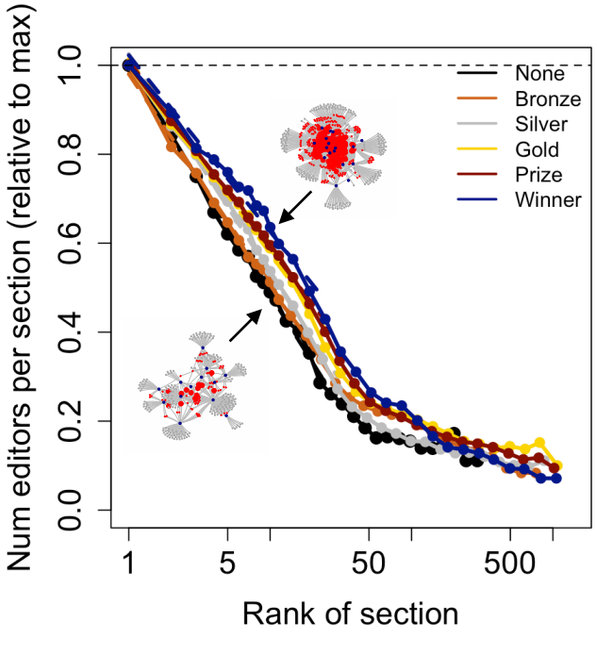
Workload inequality



Inter-team collaborations



Collaborative core

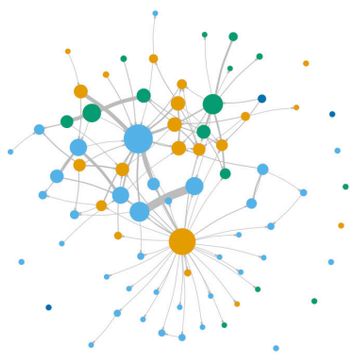


“TEAM OF TEAMS”

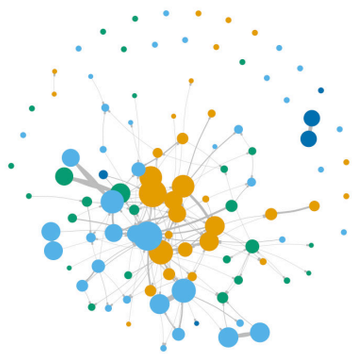
Inter-team collaborations

nodes = teams
links = collaborations
color = continent

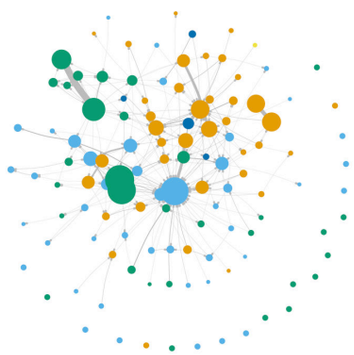
2008



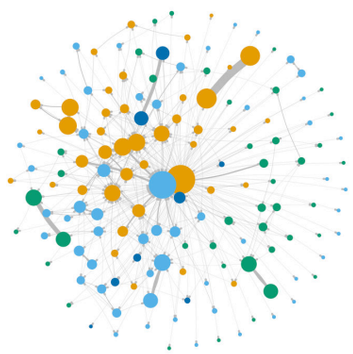
2009



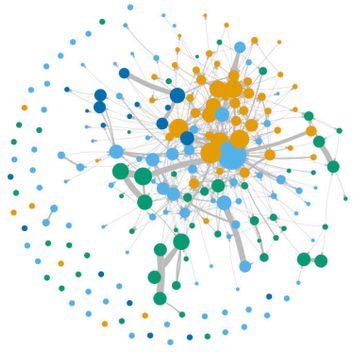
2010



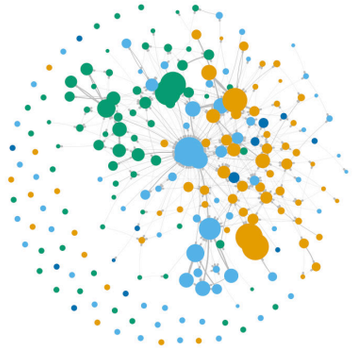
2011



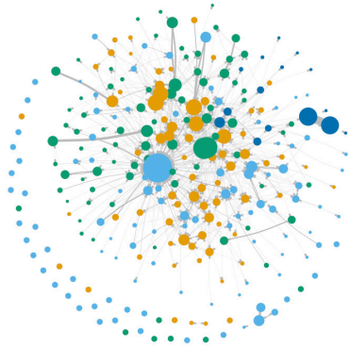
2012



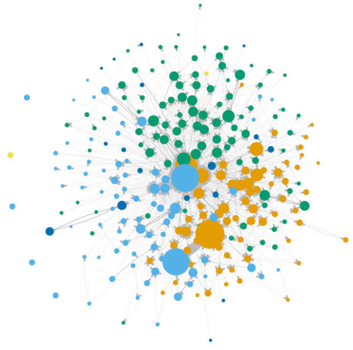
2013



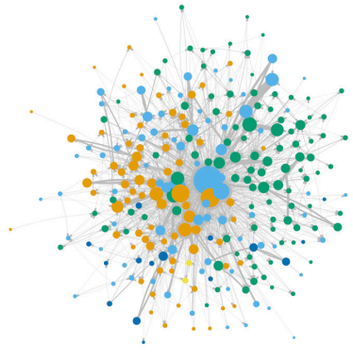
2014



2015

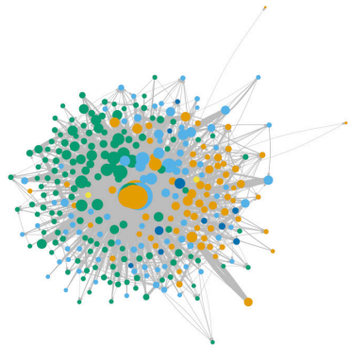


2016



2017

2018



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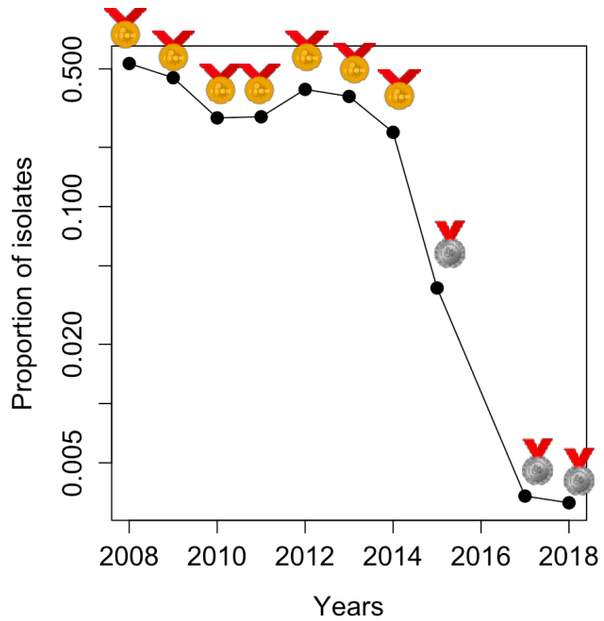
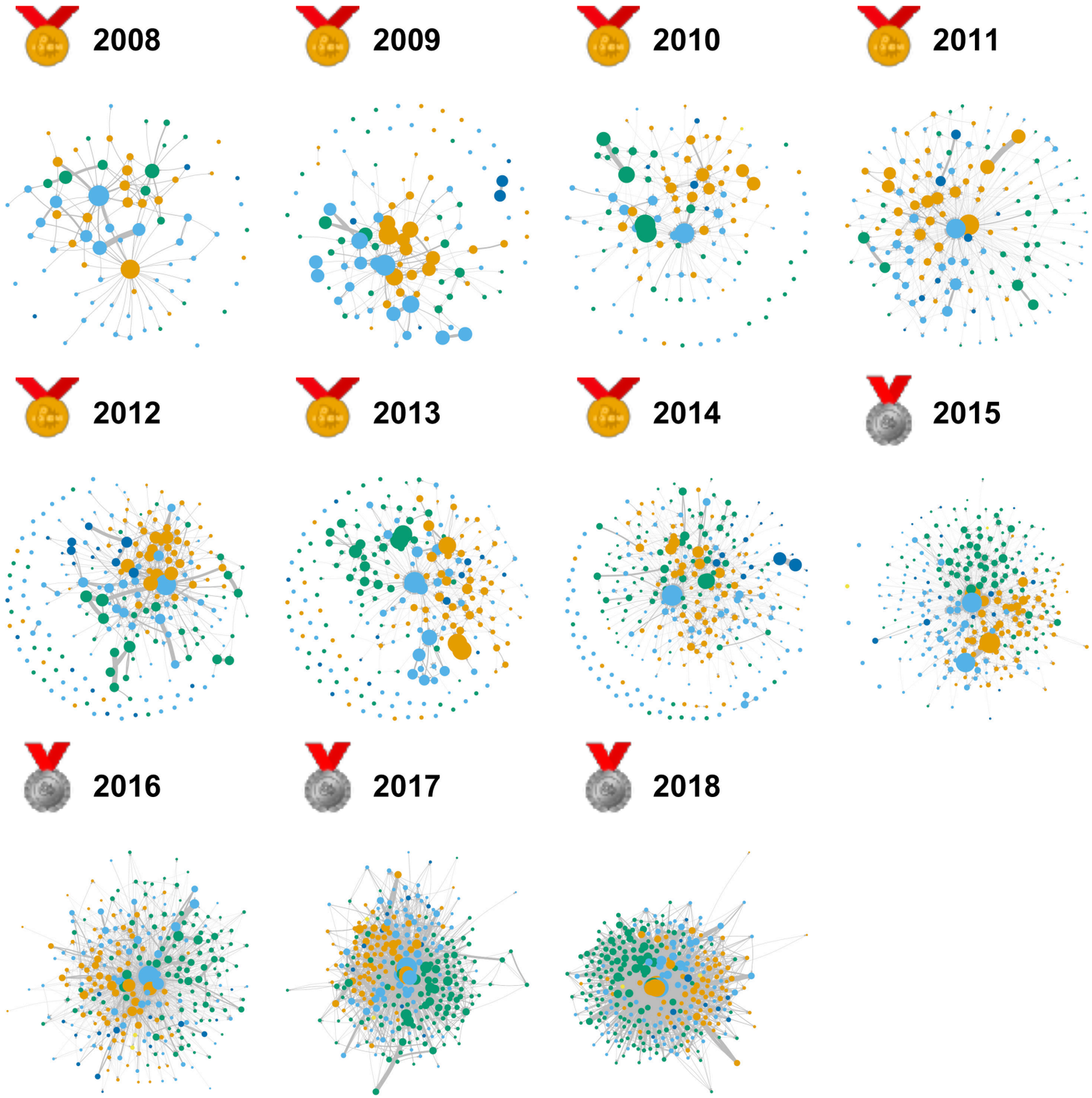
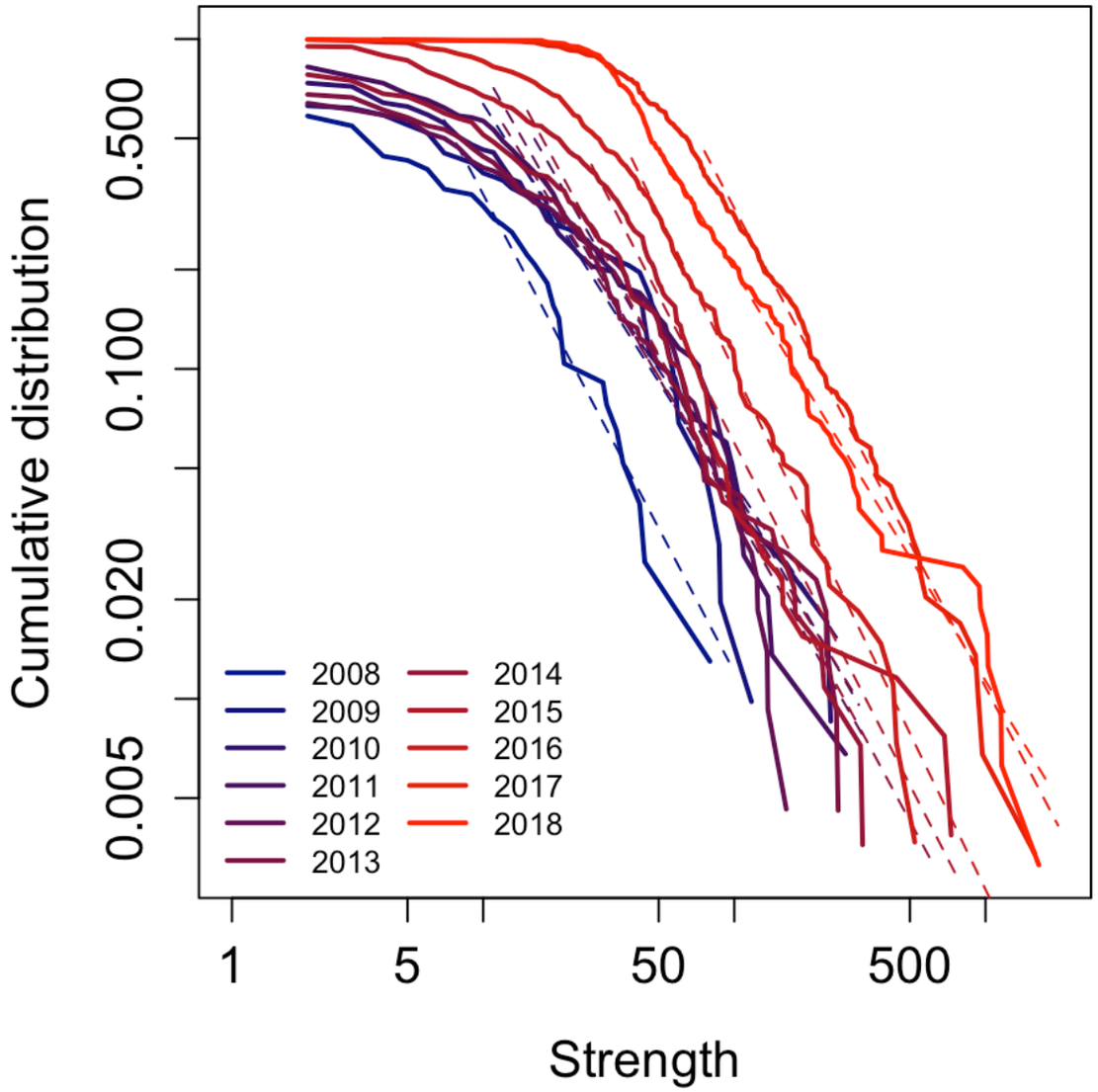
links = collaborations
color = continent



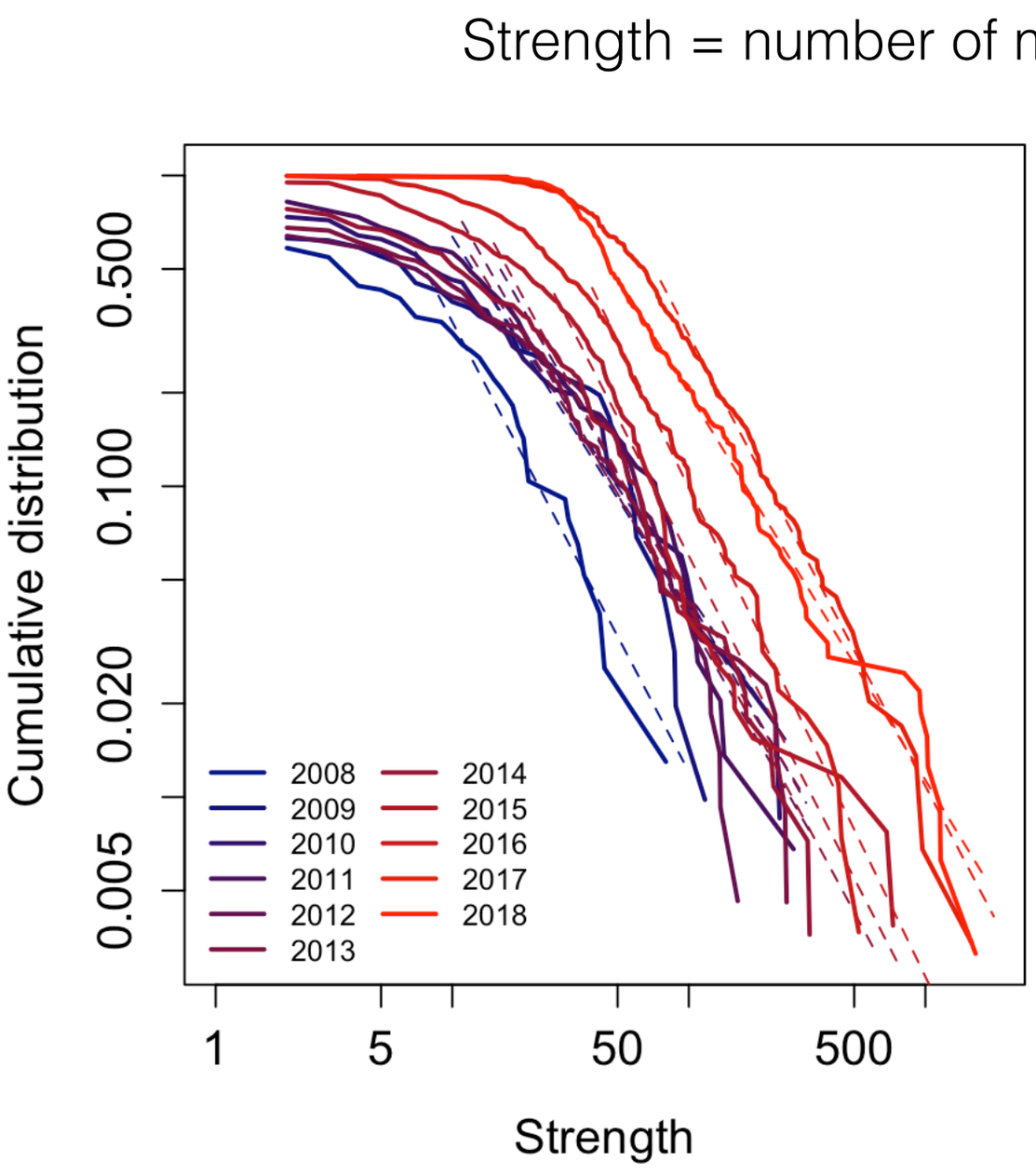


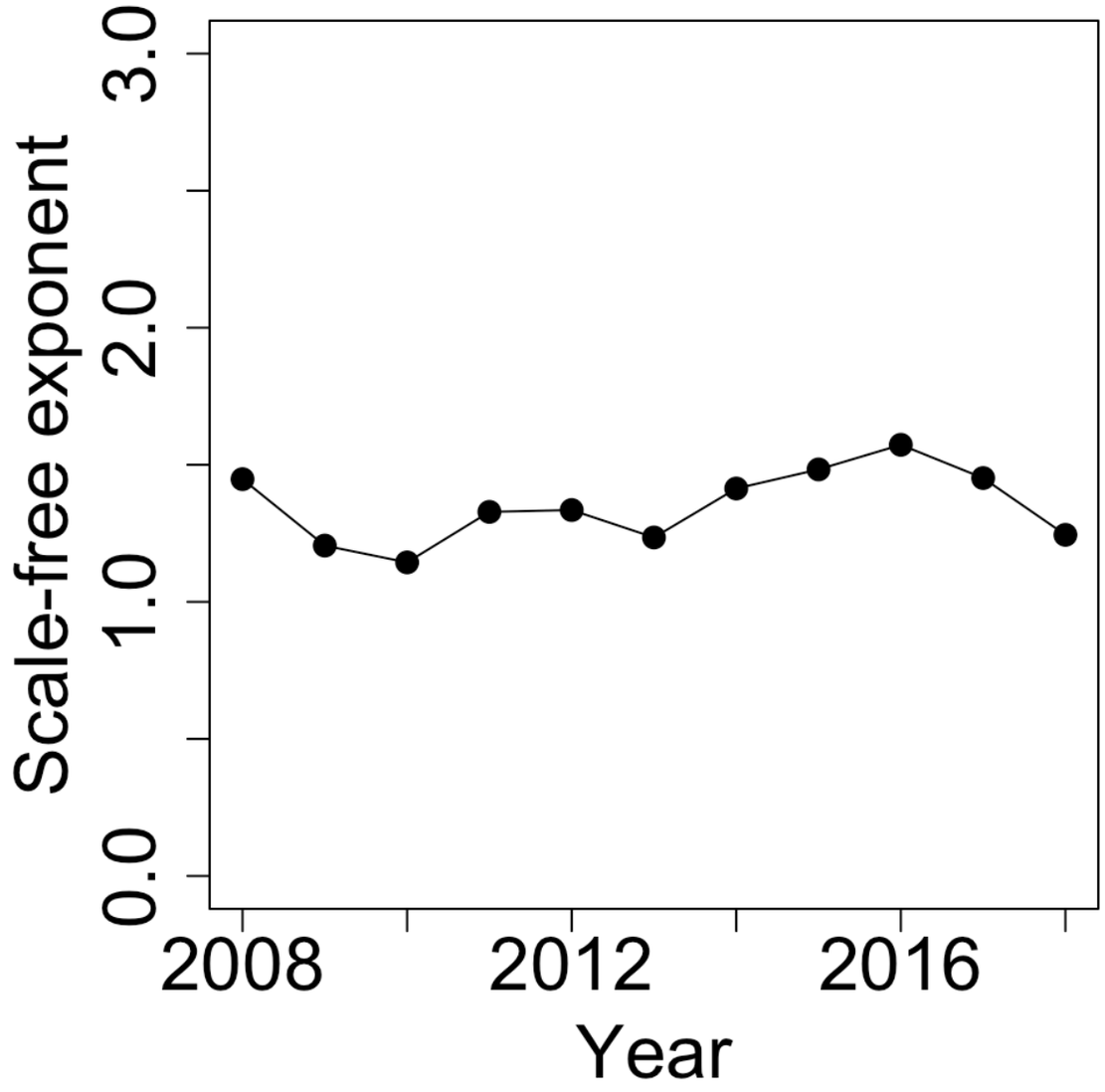
STABILITY OF COLLABORATION STRUCTURE

Strength = number of mentions to other teams in wiki

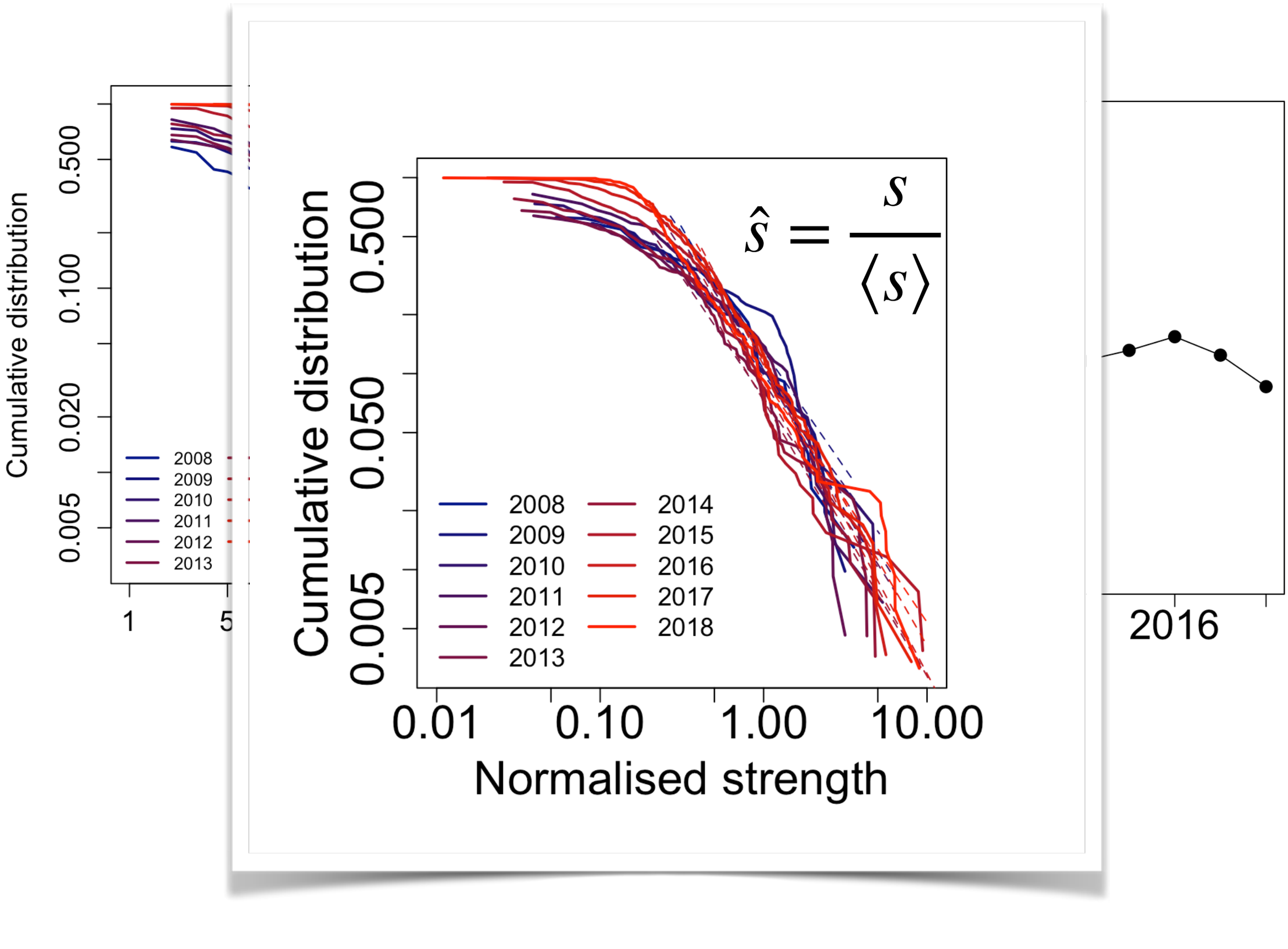


STABILITY OF COLLABORATION STRUCTURE

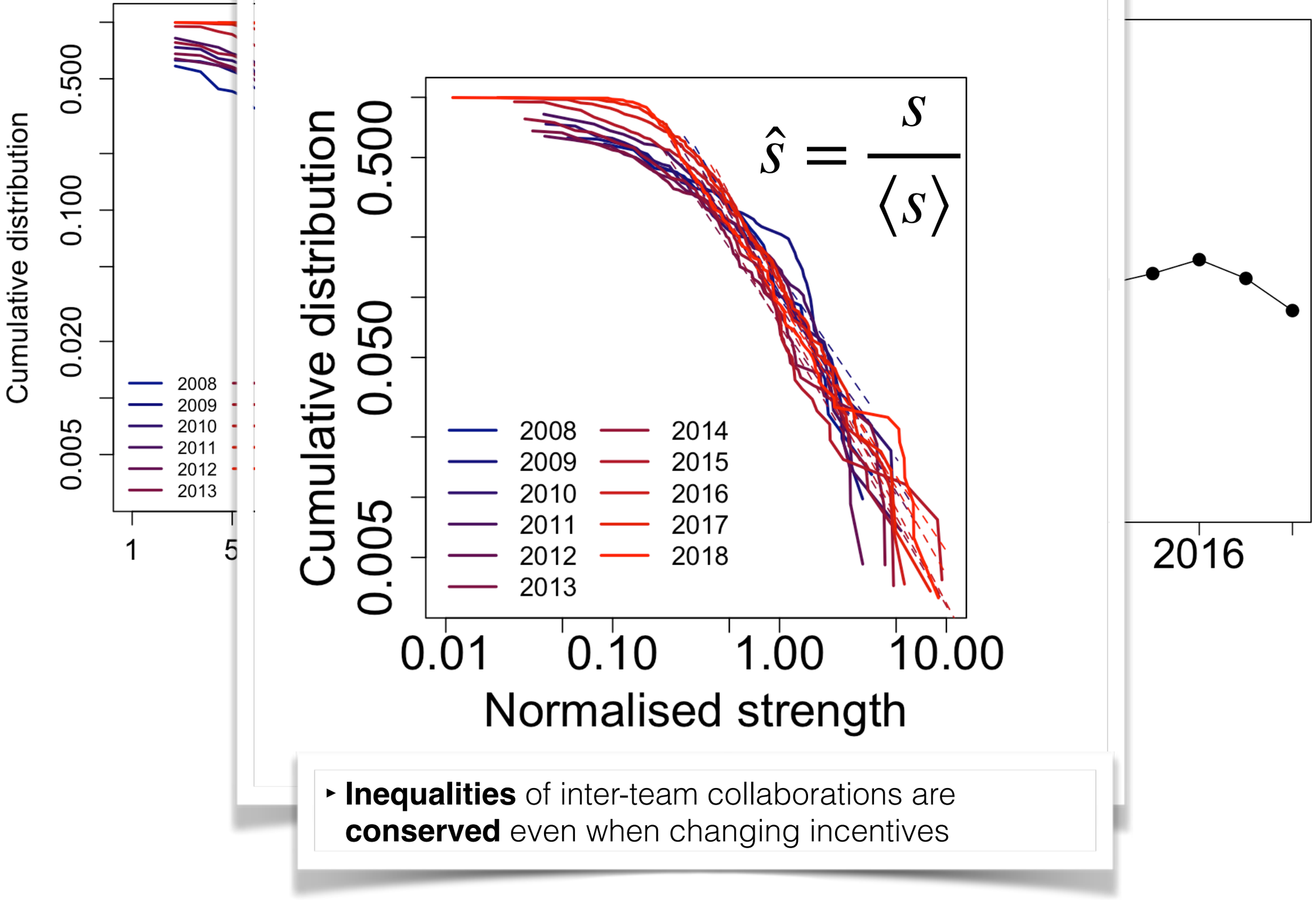




STABILITY OF COLLABORATION STRUCTURE



STABILITY OF COLLABORATION STRUCTURE

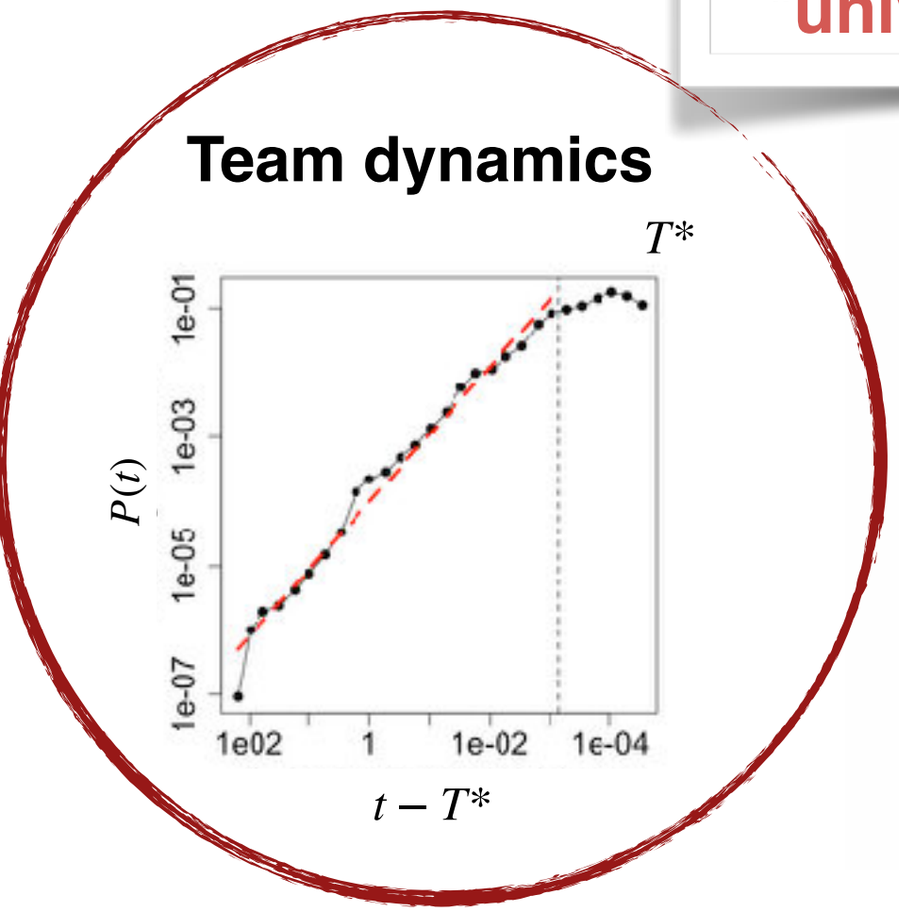


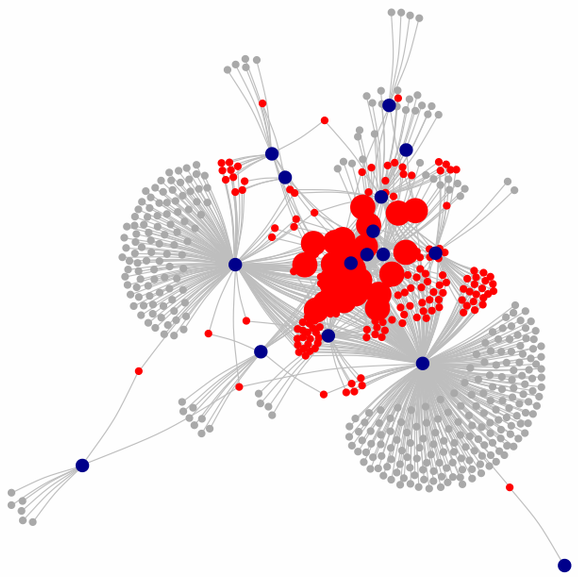
- **Inequalities** of inter-team collaborations are **conserved** even when changing incentives

TEAM WORK

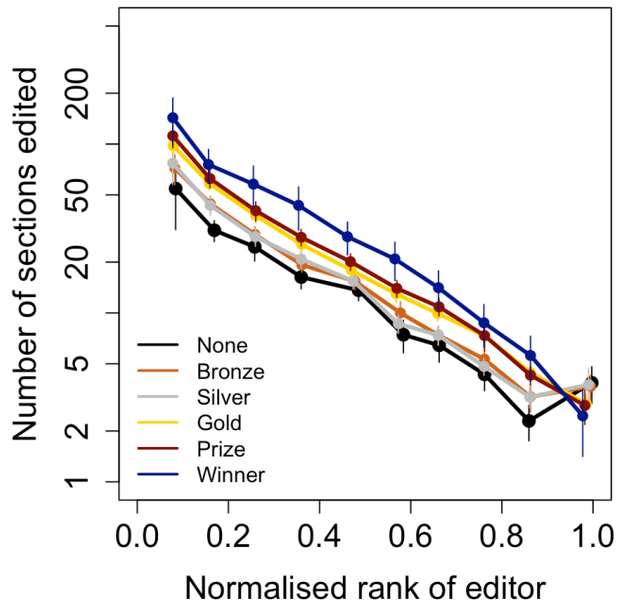
"**universals**" of team work in iGEM

Team dynamics

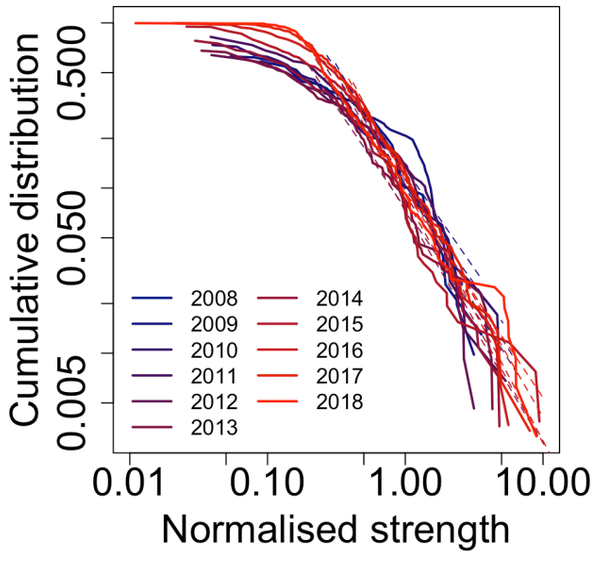




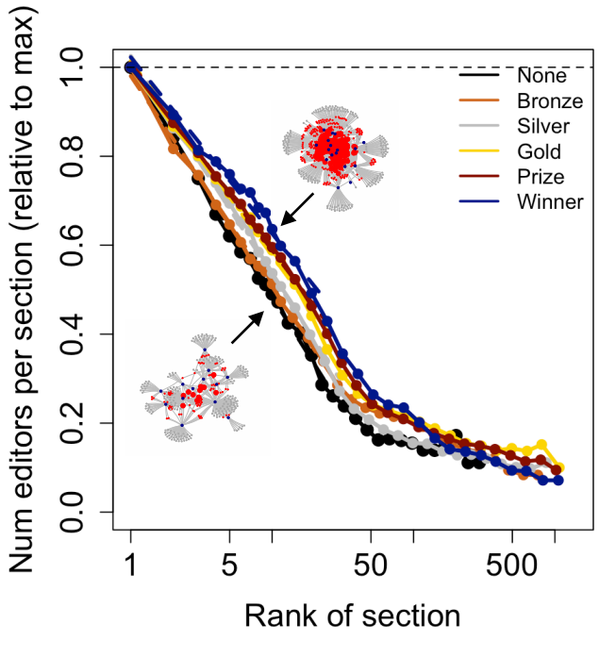
Workload inequality



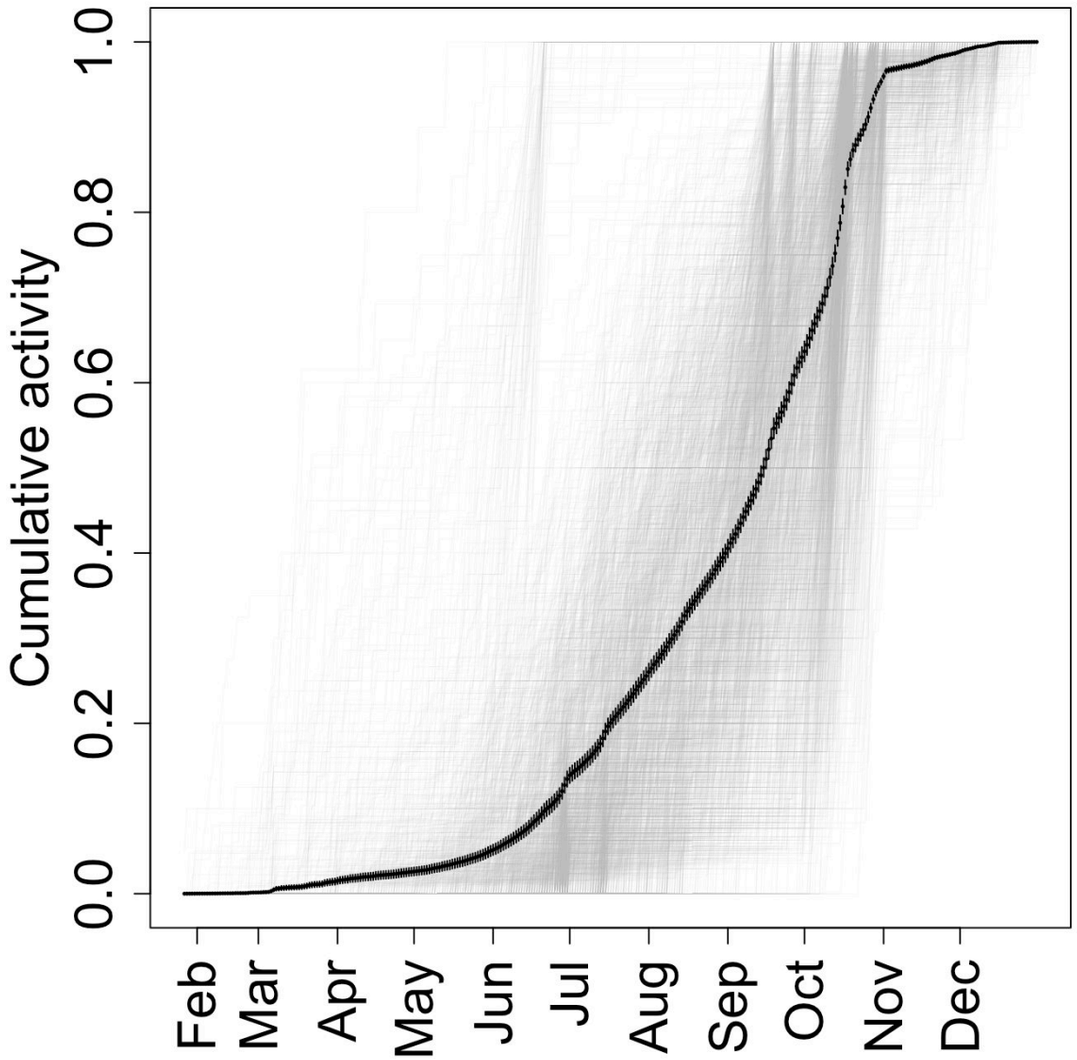
Inter-team collaborations

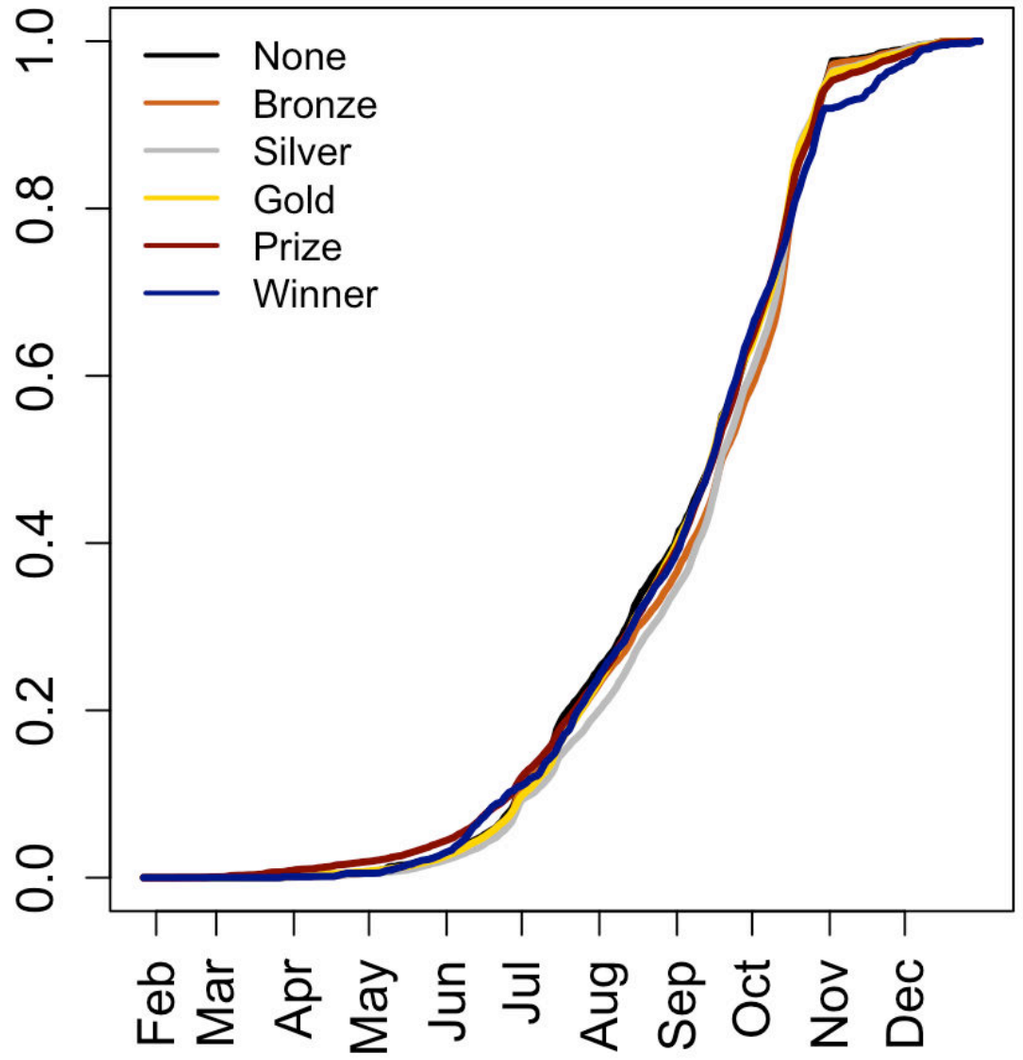


Collaborative core



TEMPORAL DYNAMICS





- **Synchronized** temporal dynamics

DEADLINE EFFECT

CORRESPONDENCE

Conference registration: how people react to a deadline

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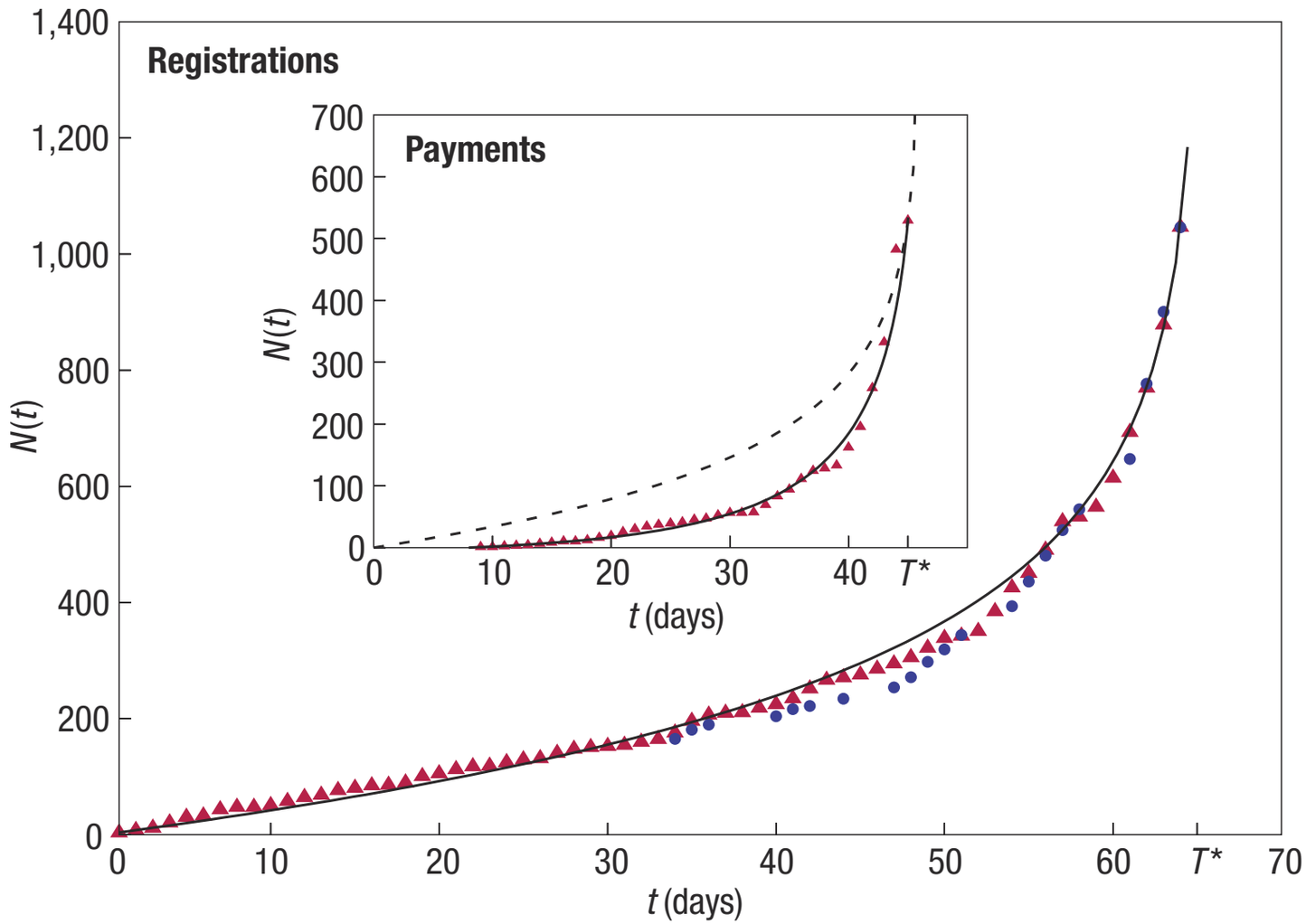
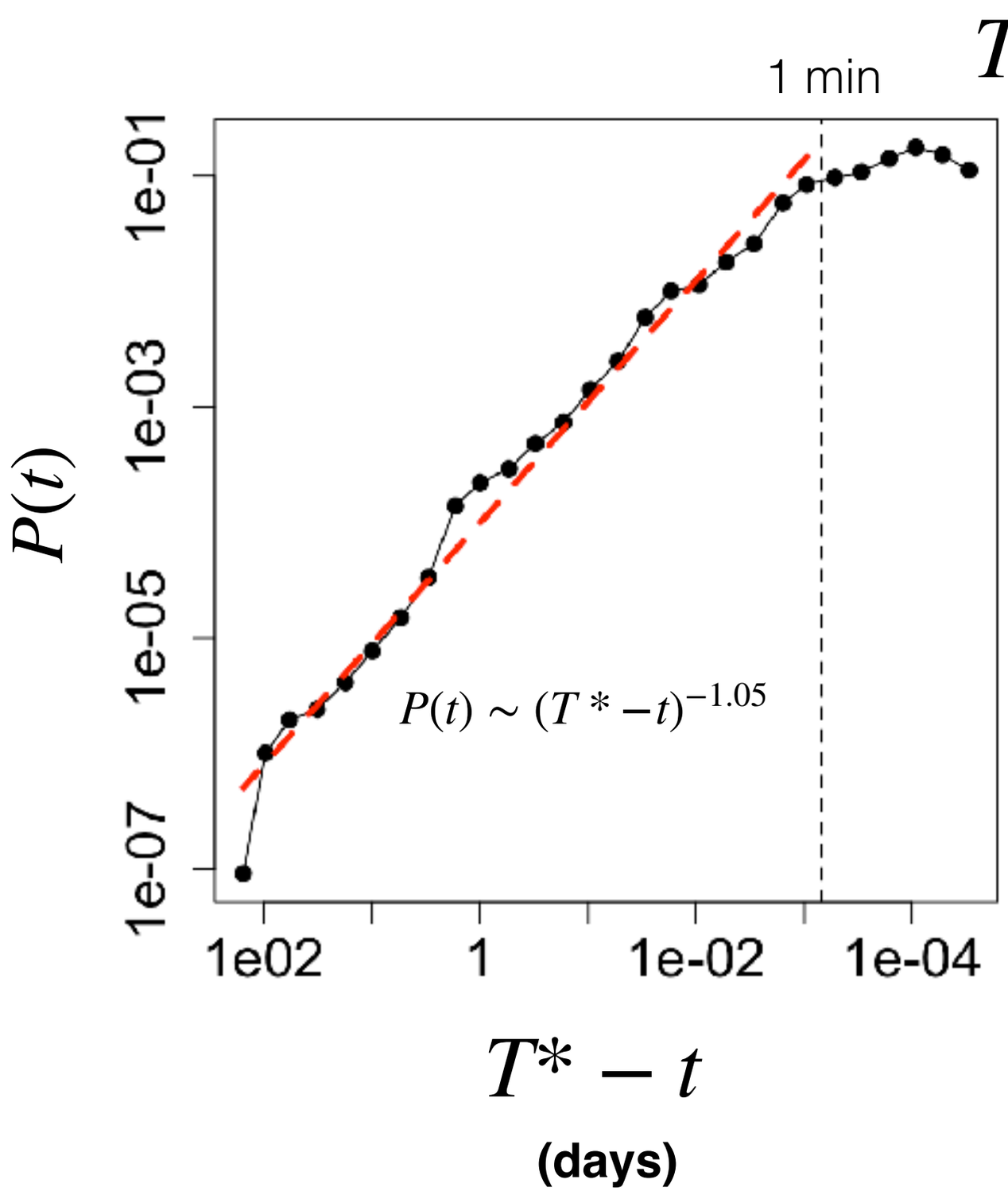
Nature Physics 2007

of the remaining time to the deadline. The probability $p(t)$ to register at time t is then $p(t) = C/(t - T^*)$, where T^* is the deadline



Deadline Effect



deadline effect
observed over
5 orders of magnitude

ONLINE FORUM DATA

Reconstructing student interaction networks from forum data

Are Forum Networks Social Networks? A Methodological Perspective

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ABSTRACT

The mission of learning analytics (LA) is to improve learner experiences using the insights from digitally collected learner data. While some areas of LA are maturing, this is not consistent across all LA specialisations. For instance, LA for social learning lack validated approaches to account for the effects of cross-course variability

CCS CONCEPTS

• **Networks**; • **Network properties**; • **Network structure**;

KEYWORDS

null models, online forums, online learning, social networks

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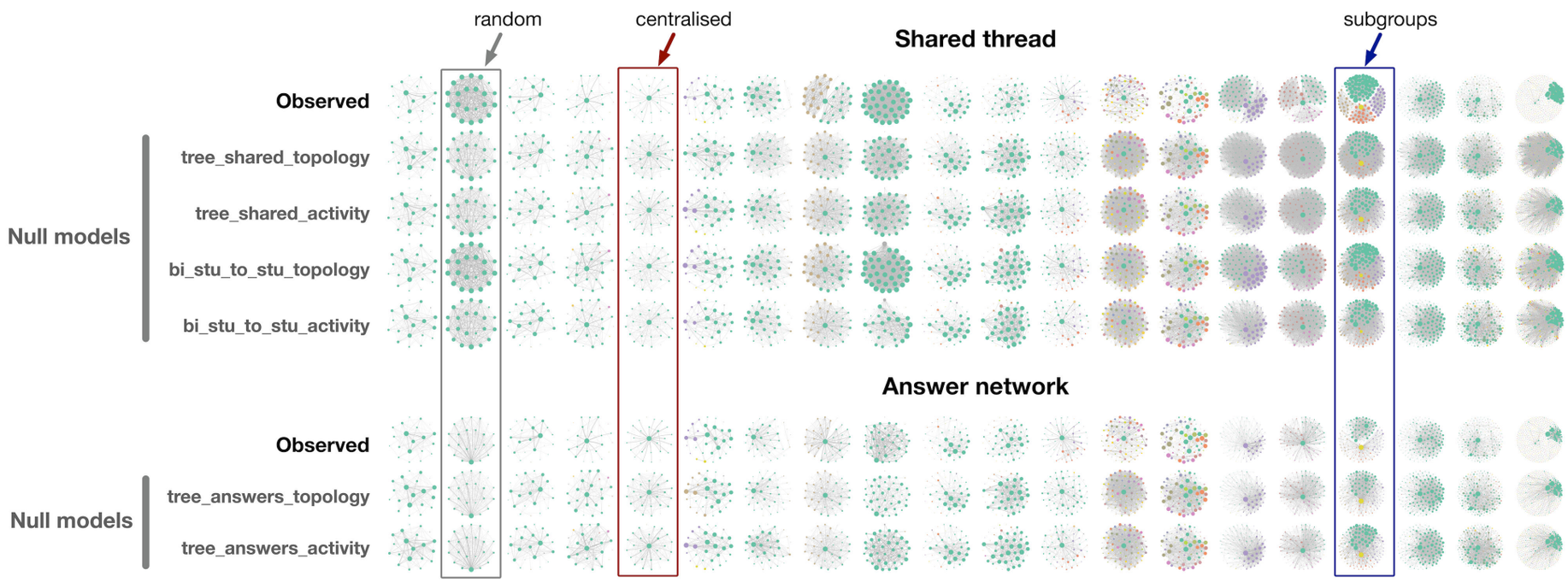
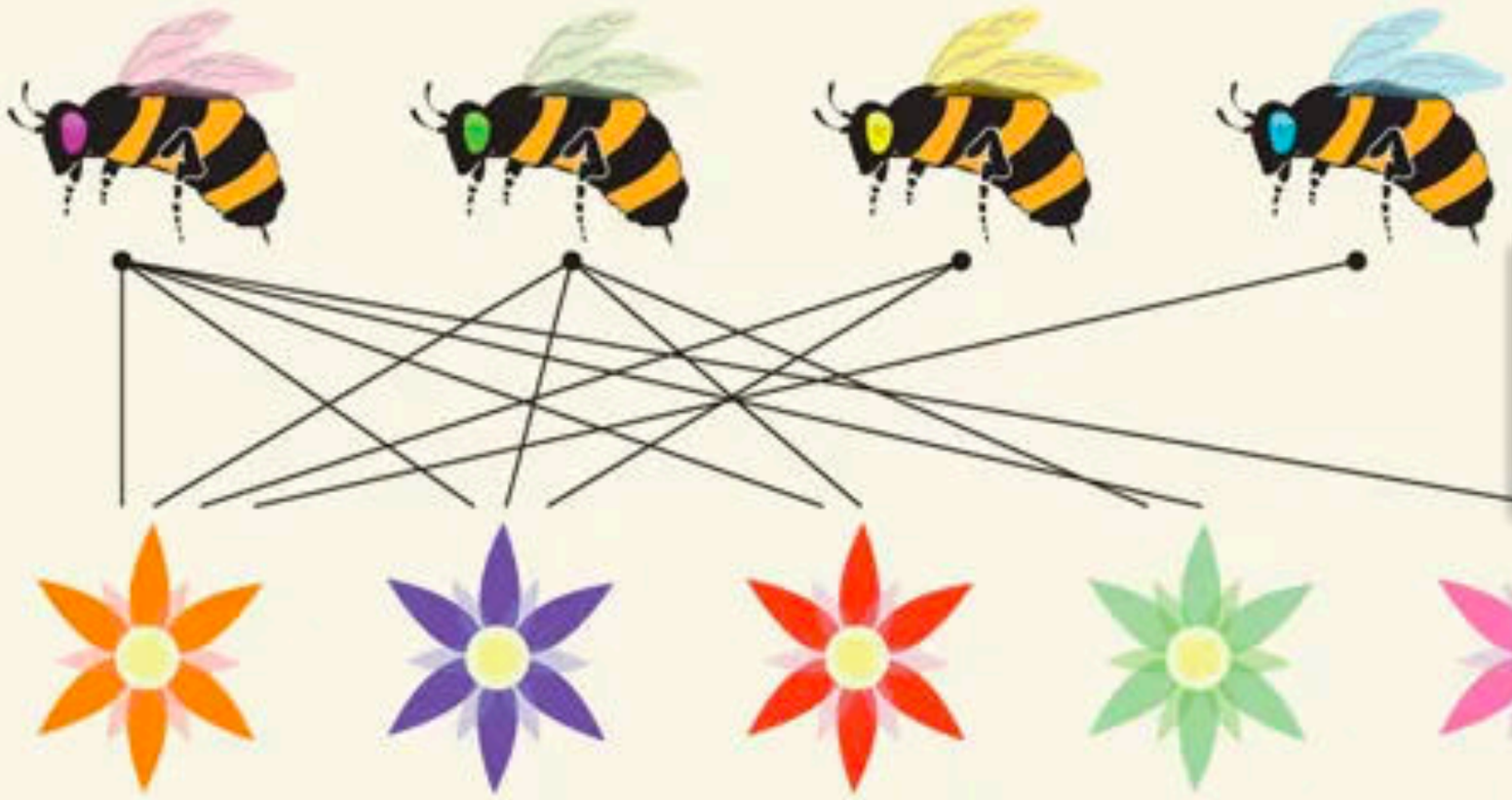
Published at LAK20 conference (~30% acceptance rate)



MUTUALISTIC NETWORKS

Class A (“Animals”)
foraging traits (efficiency, morphology, behaviour)



Class P (“Plants”)
rewards traits (quantity, quality, availability)

affects

environmental context
population density, geographic and temporal variation

affects

Traits impact number of partners with which a species cooperates