ACHIEVING OUR COLLECTIVE GOALS
ACHIEVING OUR COLLECTIVE GOALS
COORDINATION NEGLECT: HOW LAY THEORIES OF ORGANIZING COMPLICATE COORDINATION IN ORGANIZATIONS
COORDINATION NEGLECT: HOW LAY THEORIES OF ORGANIZING COMPLICATE COORDINATION IN ORGANIZATIONS

Out of Sight, Out of Sync: Understanding Conflict in Distributed Teams

The Mutual Knowledge Problem and Its Consequences for Dispersed Collaboration

The team scaling fallacy: Underestimating the declining efficiency of larger teams

Who’s in Charge Here? How Team Authority Structure Shapes Team Leadership

Team Familiarity, Role Experience, and Performance: Evidence from Indian Software Services

The Influence of Shared Mental Models on Team Process and Performance

Some unintended consequences of job design

HOW MIGHT COMPUTING AUGMENT US IN ACHIEVING OUR COLLECTIVE GOALS?
WORKER COLLECTIVE ACTION

Socio-technical infrastructure for collective action amongst crowd workers

[Salehi et al. 2015]

Amazon's Mechanical Turk workers protest: 'I am a human being, not an algorithm'

A Christmas email campaign is asking Amazon's CEO Jeff Bezos to improve terms for workers providing cheap digital labour.
FUTURE OF CROWD WORK

Micro-internships
[Suzuki et al. 2016]

Guild-style collective accreditation
[Whiting et al. 2017]
DOMINANT ARCHITECTURE: ALGORITHMS

**Modularize** and pre-define all possible behaviors into workflows

Computation decides which behaviors are taken, when, and by whom; optimizes, error-checks, and combines submissions
LIMITS OF ALGORITHMIC COORDINATION

So far, goals such as invention, production, and engineering have remained largely out of reach [Kittur et al. 2013]
LIMITS OF ALGORITHMIC COORDINATION

So far, goals such as invention, production, and engineering have remained largely out of reach [Kittur et al. 2013]

Reason: open-ended, complex goals are fundamentally incompatible with a requirement to modularize and pre-define every behavior [Van de Ven, Delbecq, and Koenig 1976; Rittel and Weber 1973; Schön 1984]
LIMITS OF OPEN SOURCE AND OPEN INNOVATION

“Peer production is limited not by the total cost or complexity of a project, but by its modularity.” [Benkler 2002]

“With the Linux kernel [...] we want to have a system which is as modular as possible. The open-source development model really requires this, because otherwise you can’t easily have people working in parallel.” [Torvalds 1999]
This architecture confines collaborations to goals so predictable that they can be entirely modularized and pre-defined.
An alternative architecture: collaborations structured not as algorithms, but as computationally augmented organizations
1) **Flash Organizations**
Create on-demand organizations capable of complex work

2) **Dream Team**
Find effective team structures

3) **Crowd Research**
Provide access to research opportunities to thousands around the world
Flash organizations

Valentine, Retelny, To, Rahmati, Doshi, Bernstein. CHI 2017.
Flash organizations: rapidly assembled and reconfigurable organizations composed of online collaborators
Computation affords rapid coordinated adaptation

- Android app
- UX
- UI
- QA
- node.js server
- Video and website
Flash organizations carry out open-ended, complex goals that were previously out of reach for crowdsourcing: product design, software development, and game production.
FOUNDRY

Web platform that supports authoring, reconfiguring, and running flash organizations
COORDINATION SANS ALGORITHMS

Inspiration: film crews and disaster response teams
[Bigley 2001; Bechky 2006; Klein et. al 2006; Valentine & Edmondson 2015]

Role structures enable interaction based on knowledge of roles rather than asset-specific knowledge of each other.
COMPUTATIONAL ORGANIZATIONAL STRUCTURES

**Roles:** parametrize required expertise

**Teams:** groups of workers with shared goal

**Hierarchy:** nested roles that determine decision rights
ON-DEMAND HIRING FROM UPWORK

Task Available

Congratulations! You are at No. 1 position on the hiring queue. However, to reinforce your position, you will need to accept this position.

Please read the following information carefully.

For the project: Question and Answer Web Application, you are at No. 1 position. Please do not close this page; this page will be removed from the hiring queue (only for this position).

This is YOUR task. You can now end this tour, and click on the task rectangle and click start to read about your task, and start tracking work time. Note that time for reviewing the previous materials, etc. are accounted for as work time.

Pay close attention to the task description, the 'inputs' (what other workers have handed off to you), and the deliverables you are expected to create.

As stated in the job description, the estimated working hours on this project is 3 hours and 45 minutes.

Project overview:

Foundry hiring queue
CHALLENGE: RECONFIGURATION

Organizational structures require constant reconfiguration so that the organization can adapt as it proceeds.

How can a computational system keep a distributed crowd in sync as the plan evolves?
VERSION CONTROL

To enable reconfiguration of the organizational structures: branching and merging inspired by version control
VERSION CONTROL IN FOUNDRY

Any member can **branch**, **edit**, and make **pull requests** against any organizational structure: roles, teams, hierarchy, tasks.

Pull requests are reviewed up the hierarchy and merged through a three-way diff.
**EVALUATION**

Field study: System deployment with outside leaders willing to crowdsource their complex open-ended goals

<table>
<thead>
<tr>
<th>Leader</th>
<th>Medical resident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-ended goal</td>
<td>Develop prototype application for EMTs to transmit patient information en route to hospital</td>
</tr>
</tbody>
</table>
EVALUATION

Field study: System deployment with outside leaders willing to crowdsourcetheir complex open-ended goals

<table>
<thead>
<tr>
<th>Leader</th>
<th>EMS Report</th>
<th>True Story</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical resident</td>
<td>Develop prototype application for EMTs to transmit patient information en route to hospital</td>
<td>Storytelling podcast kickstarter team</td>
</tr>
<tr>
<td>Open-ended goal</td>
<td>Design and manufacture a storytelling card game with accompanying mobile application</td>
<td></td>
</tr>
</tbody>
</table>
# EVALUATION

Field study: System deployment with outside leaders willing to crowdsourced their complex open-ended goals

<table>
<thead>
<tr>
<th>Leader</th>
<th>EMS Report</th>
<th>True Story</th>
<th>Workshop Portal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical resident</td>
<td>Storytelling podcast kickstarter team</td>
<td>Tech lab employee of a large company</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Open-ended goal</th>
<th>EMS Report</th>
<th>True Story</th>
<th>Workshop Portal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop prototype application for EMTs to transmit patient information en route to hospital</td>
<td>Design and manufacture a storytelling card game with accompanying mobile application</td>
<td>Develop a workshop planning portal consistent with enterprise standards and branding</td>
<td></td>
</tr>
</tbody>
</table>
End users spun up and led entire organizations in six weeks, convening new workers on-demand within fourteen minutes on average.
2 mobile applications, 3 full-stack web applications consisting of 52,000 lines of code, 2 illustrated card decks
639 tasks across 566 pull requests, 3261 person-hours of work across 35-46 days including engineers, designers, testers, and poets
Passed quality review by neutral experts
TRUE STORY GAME
TRUE STORY GAME

CRUSHING
Subtle looks, pounding pulse
However long the hover lasts
Between friend zone and fun zone
TRUE STORY GAME

Android companion app spun up in the final week
FLASH ORGANIZATIONS: REFLECTION

Flash organizations suggest a future where organizations are **fluidly assembled and adapted** within globally networked collectives.

Open questions:

Might data help suggest effective organizational structures?

How can researchers support industry norms, labor organization, and legislation to encourage a prosocial future of work?

Do flash organizations change the transaction costs core to the Theory of the Firm?
Dream Team

WHAT IS THE BEST WAY FOR TEAMS TO ORGANIZE THEMSELVES?

Organizations rely on teaming and ad-hoc collaboration
[Edmondson 2012]
WHAT IS THE BEST WAY FOR TEAMS TO ORGANIZE THEMSELVES?

Organizations rely on teaming and ad-hoc collaboration [Edmondson 2012]

But: Should teams be flat or hierarchical? Encouraging or critical? Enforcing equal turn-taking?
WHAT IS THE BEST WAY FOR TEAMS TO ORGANIZE THEMSELVES?

Organizations rely on teaming and ad-hoc collaboration [Edmondson 2012]

But: Should teams be flat or hierarchical? Encouraging or critical? Enforcing equal turn-taking?

These roles, norms, and interaction patterns define team structures [Ilgen et al. 2005]
WHAT IS THE BEST WAY FOR TEAMS TO ORGANIZE THEMSELVES?

Organizations rely on teaming and ad-hoc collaboration [Edmondson 2012]

But: Should teams be flat or hierarchical? Encouraging or critical? Enforcing equal turn-taking?

These roles, norms, and interaction patterns define team structures [Ilgen et al. 2005]

Researchers theorize ideal structures, then build systems nudging teams toward those structures [Olsen & Olsen 2000; Ackerman 2000; Dourish & Bellotti 1992; Erickson & Kellogg 2000; Winograd 1986; Lykourentzou et al. 2017]
ORG. BEHAVIOR: THERE ARE NO UNIVERSALLY IDEAL STRUCTURES

**Structural contingency theory**: the best team structures depend on the task and the team members [Donaldson 1999]
ORG. BEHAVIOR: THERE ARE NO UNIVERSALLY IDEAL STRUCTURES

Structural contingency theory: the best team structures depend on the task and the team members [Donaldson 1999]

The wrong structures will doom teams to dysfunction [Ilgen et al. 2005; Schippers, Edmondson, & West 2014; Ancona, Okhuysen & Perlow 2001]
ORG. BEHAVIOR: THERE ARE NO UNIVERSALLY IDEAL STRUCTURES

**Structural contingency theory**: the best team structures depend on the task and the team members [Donaldson 1999]

The wrong structures will doom teams to dysfunction [Ilgen et al. 2005; Schippers, Edmondson, & West 2014; Ancona, Okhuysen & Perlow 2001]

Managers — who are trained and paid for choosing effective team structures — are not effective at the task [de Brujin, Ten Heuvelhof, & In 't Veld 2002]
DREAMTEAM

Rapid self-experimentation with different team structures to converge on one that works well for the team and task.
DREAMTEAM

Rapid self-experimentation with different team structures to converge on one that works well for the team and task
DREAMTEAM

Rapid self-experimentation with different team structures to converge on one that works well for the team and task.
DREAMTEAM

Rapid self-experimentation with different team structures to converge on one that works well for the team and task.
DREAMTEAM

Rapid self-experimentation with different team structures to converge on one that works well for the team and task.
DREAMTEAM

Rapid self-experimentation with different team structures to converge on one that works well for the team and task.
DREAMTEAM

Rapid self-experimentation with different team structures to converge on one that works well for the team and task.
sdumais  9:21 AM
hello

jteevan  9:21 AM
hi

merrie   9:21 AM
Hi everyone!
sdumais 9:21 AM
hello

ejeevan 9:21 AM
hi

merrie 9:21 AM
Hi everyone!

puzzle-robot 9:21 AM
INSTRUCTIONS

SUBMISSION
puzzle-robot  APP  9:21 AM

END OF ROUND
END OF ROUND

(feedback to DreamTeam system)
<feedback to DreamTeam system>

puzzle-robot  9:21 AM
END OF ROUND

dreamteam-robot  9:21 AM
This round change the following...
Be super cheery! Make sure to write encouraging comments to all your teammates, despite any losses!
Hierarchy
None, Centralized, Decentralized

Interaction Patterns
Emergent, Round-robin, Equally distributed

Norms of Engagement
None, Professional, Informal

Decision-Making Norms
None, Divergent, Convergent, Informed, Rapid

Feedback Norms
None, Encouraging, Critical
Hierarchy
None, Centralized, Decentralized

Interaction Patterns
Emergent, Round-robin, Equally distributed

Norms of Engagement
None, Professional, Informal

Decision-Making Norms
None, Divergent, Convergent, Informed, Rapid

Feedback Norms
None, Encouraging, Critical
Hierarchy
None, Centralized, Decentralized

Interaction Patterns
Emergent, Round-robin, Equally distributed

Norms of Engagement
None, Professional, Informal

Decision-Making Norms
None, Divergent, Convergent, Informed, Rapid

Feedback Norms
None, Encouraging, Critical

Time
NETWORK OF MULTI-ARMED BANDITS

Multi-armed bandits efficiently explore multiple options over time.

However, this results in so much simultaneous change that **teams become quickly overwhelmed**
Multi-armed bandits efficiently explore multiple options over time. However, this results in so much simultaneous change that teams become quickly overwhelmed.
TEMPORALLY CONSTRAINED BANDITS

Model when teams are open to change, and how much change they are open to simultaneously

e.g., teams are most open to change at the midpoint of their progress
[Okhuysen and Waller 2002]

e.g., teams are resilient to exploring hierarchical structures early on, but less resilient to changing them later
[Marks, Mathieu, & Zaccaro 2001]
TEMPORALLY CONSTRAINED BANDITS

Model when teams are open to change, and how much change they are open to simultaneously

e.g., teams are most open to change at the midpoint of their progress [Okhuysen and Waller 2002]

e.g., teams are resilient to exploring hierarchical structures early on, but less resilient to changing them later [Marks, Mathieu, & Zaccaro 2001]
TEMPORALLY CONSTRAINED BANDITS

Redistribute the probability of arm selection via Thompson sampling to respect desired expected value of changes

\[ \theta_1 = 0.4 \]
\[ \theta_2 = 0.4 \]
\[ \theta_3 = 0.2 \]

CURRENT ARM
TEMPORALLY CONSTRAINED BANDITS

Redistribute the probability of arm selection via Thompson sampling to respect desired expected value of changes.
TEMPORALLY CONSTRAINED BANDITS

Redistribute the probability of arm selection via Thompson sampling to respect desired expected value of changes

\[ \theta_1 = .4 \]
\[ \theta_2 = .4 \]
\[ \theta_3 = .2 \]

\[ \theta_1 = .1 \]
\[ \theta_2 = .1 \]
\[ \theta_3 = .8 \]

\[ \delta = .25 \]
TEMPORALLY CONSTRUANCED BANDITS

Redistribute the probability of arm selection via Thompson sampling to respect desired expected value of changes.

\[ \theta_1 = .4 \]
\[ \theta_2 = .4 \]
\[ \theta_3 = .2 \]

\[ .4(1-\delta) = .3 \]
\[ \delta = .25 \]

\[ \theta_1 = .1 \]
\[ \theta_2 = .1 \]
\[ \theta_3 = .8 \]

CURRENT ARM
TEMPORALLY CONSTRAINED BANDITS

\[ \theta'_i = \begin{cases} 
\theta_i \delta, & \text{if } i \neq c \\
\theta_i + \sum_{j \neq c} \theta_j (1 - \delta), & \text{if } i = c 
\end{cases} \]

- \[ \theta_1 = .4 \]
- \[ \theta_2 = .4 \]
- \[ \theta_3 = .2 \]

CURRENNT ARM

\[ \delta = .25 \]

- \[ \theta_1 = .1 \]
- \[ \theta_2 = .1 \]
- \[ \theta_3 = .8 \]
Global constraint on expected number of changes
Prioritize which bandits can change and when
EVALUATION METHOD

135 workers on Mechanical Turk randomized into 45 teams

Measure & bandit reward: team performance on a collaborative intellective task — score on Codewords puzzle

1 training round, 1 baseline round, 10 performance rounds
EVALUATION METHOD

135 workers on Mechanical Turk randomized into 45 teams
Measure & bandit reward: team performance on a collaborative intellective task — score on Codewords puzzle
1 training round, 1 baseline round, 10 performance rounds

Conditions:
1. Manager-chosen
2. Collectively-chosen
3. Control
EVALUATION METHOD

135 workers on Mechanical Turk randomized into 45 teams

Measure & bandit reward: team performance on a collaborative intellective task — score on Codewords puzzle

1 training round, 1 baseline round, 10 performance rounds

Conditions:
1. Manager-chosen
2. Collectively-chosen
3. Control
4. Unconstrained bandit-chosen
5. DreamTeam-chosen
DREAMTEAM TEAMS OUTPERFORM OTHER CONDITIONS BY ~40%

DreamTeam outperformed:

- Manager-chosen by 46%
- Collectively-chosen by 45%
- Unconstrained bandit-chosen by 41%
- Control by 38%

Repeated measures ANCOVA $p<0.05$, all post-hoc Tukey pairwise comparisons to Dreamteam $p<0.05$. $N=45$. Non-intervention training round used as a covariate to adjust for teams’ initial performance.
DREAMTEAM: REFLECTION

The heuristics we use to decide on our team structures can be risk-averse, avoiding fruitful exploration and adaptation.

But, raw algorithms overcompensate and overwhelm, leading people to ignore them. Design can help.

Open questions:

How might we combine voices equitably in the reward feedback?
Can we adapt when membership changes? When tasks change? Over the long term? In traditional organizations?
DREAMTEAM TEAMS OUTPERFORM OTHER CONDITIONS BY ~40%

DreamTeam outperformed:

- Manager-chosen by 46%
- Collectively-chosen by 45%
- Unconstrained bandit-chosen by 41%
- Control by 38%

Repeated measures ANCOVA p<0.05, all post-hoc Tukey pairwise comparisons to Dreamteam p<0.05. N=45. Non-intervention training round used as a covariate to adjust for teams’ initial performance.
DREAMTEAM: REFLECTION

The heuristics we use to decide on our team structures can be risk-averse, avoiding fruitful exploration and adaptation. But, raw algorithms overcompensate and overwhelm, leading people to ignore them. Design can help.

Open questions:

- How might we combine voices equitably in the reward feedback?
- Can we adapt when membership changes? When tasks change? Over the long term? In traditional organizations?
Crowd research

RESEARCH: THE DOMAIN OF THE PRIVILEGED FEW

Those able to attend prestigious universities can access research experiences that support open-ended inquiry and launch careers [Russell et al. 2007]

...but the vast majority of people cannot [Bowen and Bok 2016; Bianchini 2011]

Top 50 global universities, US News 2017
RESEARCH: THE DOMAIN OF THE PRIVILEGED FEW

Those able to attend prestigious universities can access research experiences that support open-ended inquiry and launch careers [Russell et al. 2007]

...but the vast majority of people cannot [Bowen and Bok 2016; Bianchini 2011]

Top 50 global universities, US News 2017
RESEARCH: THE DOMAIN OF THE PRIVILEGED FEW

Those able to attend prestigious universities can access research experiences that support open-ended inquiry and launch careers [Russell et al. 2007]

...but the vast majority of people cannot [Bowen and Bok 2016; Bianchini 2011]

A research ecosystem that under-represents minorities and developing regions, and a literature that overlooks their perspectives
CROWD RESEARCH

A **crowdsourcing technique** enabling a global crowd to work together on an **open-ended research project**

Participants collaborate as one large team to brainstorm, execute and publish the project under the leadership of a PI.
GOALS

Enable access to training and research experiences in support of upward career and educational mobility

Convene hundreds or thousands of people on a single ambitious project
WE ARE NOT EQUIPPED FOR LARGE SCALE, OPEN ENDED RESEARCH

Research is not a linear path from idea to result: it is an iterative process of exploration
[Gowers 2000]

In contrast, citizen science efforts today focus on **pre-defined goals** in order to structure the crowd’s contributions
[Cooper et al. 2010]
COORDINATION:
How do we prevent the project from moving in 1,000 directions at once, across easily 6,000 messages per week?

CREDIT:
How can we provide proof that participants made substantial contributions to the project, when no one central authority can assert this?
CROWD RESEARCH

Iterative crowdsourcing technique:
Weekly cycle of open contribution, synchronous collaboration, and peer assessment

Decentralized credit:
Participants allocate finite credits to each other, enabling a graph centrality algorithm to determine credit and author order
THREE PARALLEL PROJECTS

HCI

Michael Bernstein, Stanford

Building a new crowd marketplace

Easier, more equitable crowdsourcing

Daemo results will automatically improve
Workers who do your task well are rewarded with early access. Over time, the workers you identify complete most of your work.
THREE PARALLEL PROJECTS

Computer vision

James Davis, UCSC
Serge Belongie, Cornell Tech

Hybrid crowd-computer vision algorithms
THREE PARALLEL PROJECTS

Data science
Sharad Goel, Stanford
Hundreds of experiments testing the wisdom of the crowd
CROWDSOURCING PROCESS

open call
CROWDSOURCING PROCESS

open call → group meeting
CROWDSOURCING PROCESS

open call → group meeting → milestone deadline
CROWDSOURCING PROCESS

open call → group meeting → milestone deadline → peer assessment
CROWDSOURCING PROCESS

open call → group meeting → milestone deadline → peer assessment
TASK PLANNING

MILESTONES

Getting Started

Click first: how does this work?
Each week, you (and/or your team) sign up for at least one milestone here on Trello. See more...

Understanding lives of workers
Try being a worker on oDesk (now Upwork.com) or other large project platforms.

Hello, world! Getting started with our code
Work on one of our open feature requests on GitHub

Get your hands dirty and set up our Hello, World example

Related work/papers: read and comment
Read the MobileWorks paper
Read Flash Teams paper
Read paper on the future of work...
ENGINEERING

MILESTONES

Apr 5, 2015 – Oct 26, 2015
Contributions to develop2, excluding merge commits

Contributions: Commits

- **dmorina**: 502 commits / 141,286 ++ / 365,266 -- #1
- **nistala**: 249 commits / 1,671,624 ++ / 1,442,878 -- #2
PROTOTYPING

MILESTONES

A worker has a question about a posted task, and contacts the requester.

Requester answers to ensure work is done as required.

Both parties are satisfied.

One of the parties has a problem with the other.

The profiles are utilized to clear up confusion before further resolution is required.

Both parties are satisfied.

A Web Page

http://workerview.com

Tasks Available

- Requester 1: Task 1
- Requester 2: Task 2
- Requester 3: Task 3

Strength
Weakness
HTs
Task Recently Completed

Profile

Pod of requesters interested in solving different problems (See fig 1)

Requestor Representative
WRITING

MILESTONES

1. Anyone can pitch an idea. If it gets enough support, it goes to the next election and needs majority support from both workers+requesters.
   - (original) Direct democracy: anyone can pitch a policy idea, and once it gets past a threshold of support (e.g., 1000 votes), it goes up on a ballot. Twice a year, ideas go out to a direct vote for everyone on the platform. If it gets majority support from both workers and requesters, it passes.

2. Members get elected as worker or requester representatives (3 each) to a panel. Tiebreaking from a 7th member (jointly elected president).
   - (original) Representative democracy: once a year, members of the platform can be elected as either worker or requester representatives for a small panel (e.g., six people). Anybody can pitch a policy idea, and once it gets past a threshold of support (e.g., 1000 votes), the elected representatives must discuss it and vote on it.

3. Wikimocracy: the site's rules and policies are a wiki. Anyone can discuss, and if they edit, policies change directly.

4. Any idea that gets enough support enters a public one-month voting period. It's completely voluntary to vote. (Like a Kickstarter campaign.)
   - Original: Fast-paced referendums: similar concept as direct democracy, but instead of per year, you do it as vote thresholds within a month (within time of posting), and it's completely voluntary to vote. Kinda like a campaign on Kickstarter. Fast pace and flexible deadlines will help the ideas continually flowing in.

5. For low-level changes, highlight the interface and suggest changes directly. Upvote/downvote directly on the interface.
<table>
<thead>
<tr>
<th>Upvote</th>
<th>Milestone Title</th>
<th>Milestone Type</th>
<th>Contributors</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sustainable Reputation Mechanism</td>
<td>MILESTONE-5-MOCKUP</td>
<td>Neil</td>
<td>3 Comments</td>
</tr>
<tr>
<td></td>
<td>Chat and Rating Prototypes for Crowdsourcing Social Media Platform</td>
<td>MILESTONE-5-STORYBOARD</td>
<td>Kristine Hoang</td>
<td>3 Comments</td>
</tr>
<tr>
<td></td>
<td>Leveling, Rating and Categorisation</td>
<td>MILESTONE-5-MOCKUP</td>
<td>Soroosh Bateni</td>
<td>2 Comments</td>
</tr>
<tr>
<td></td>
<td>Worker Requester Mentorship</td>
<td>MILESTONE-5-STORYBOARD</td>
<td>Mike Young</td>
<td>4 Comments</td>
</tr>
<tr>
<td></td>
<td>EmpathySociety: Triggering Empathy via Smart Mechanisms!</td>
<td>MILESTONE-5-STORYBOARD</td>
<td>Saiph Savage</td>
<td>5 Comments</td>
</tr>
<tr>
<td></td>
<td>Compensation Suggestion Tool</td>
<td>MILESTONE-5-MOCKUP</td>
<td>Trygve Cossette</td>
<td>2 Comments</td>
</tr>
</tbody>
</table>
1500 participants from six continents
2% high school, 73% undergrad, 22% master’s, 3% PhD
RECRUITMENT: PROVIDING ACCESS

Matching affiliations to Times Higher Education Global Rankings: 75% come from universities ranked below 500.

Considering country of origin: 66% come from countries ranked over 50 in GDP per capita
Boomerang: Rebounding the Consequences of Reputation Feedback on Crowdsourcing Platforms


Stanford Crowd Research Collective, Stanford University
daemo@cs.stanford.edu

ABSTRACT
Paid crowdsourcing platforms suffer from low-quality work and unfair rejections, but paradoxically, most workers and requesters have high reputation scores. These inflated scores, which make high-quality work and workers difficult to find, stem from social pressure to avoid giving negative feedback. We introduce Boomerang, a reputation system for crowdsourcing platforms that elicits more accurate feedback by rebounding the consequences of feedback directly back onto the person who gave it. With Boomerang, requesters find that their highly-rated workers gain earliest access to their future tasks, and workers find tasks from their highly-rated requesters at the top of their task feed. Field experiments verify that Boomerang encourages early access among crowd workers and increases the quality of their work, leading to improved reputation scores.
Crowd Guilds: Worker-led Reputation and Feedback on Crowdsourcing Platforms

Mark E. Whiting, Dilrukshi Gamage, Snehalkumar (Neil) S. Gaikwad, Aaron Gilbee, Shirish Goyal, Alipta Ballav, Dinesh Majeti, Nalin Chhibber, Angela Richmond-Fuller, Freddie Vargus, Tejas Seshadri Sarma, Varshine Chandrakanthan, Teogenes Moura, Mohamed Hashim Salih, Gabriel Bayomi Tinoco Kalejaiye, Adam Ginzberg, Catherine A. Mullings, Yoni Dayan, Kristy Milland, Henrique Orefice, Jeff Regino, Sayna Parsi, Kunz Mainali, Vibhor Sehgal, Sekandar Matin, Akshansh Sinha, Rajan Vaish, Michael S. Bernstein
Stanford Crowd Research Collective
daeemo@cs.stanford.edu

ABSTRACT
Crowd workers are distributed and decentralized. While decentralization is designed to utilize independent judgment to promote high-quality results, it paradoxically undercuts behaviors and institutions that are critical to high-quality work. Reputation is one central example: crowdsourcing systems depend on reputation scores from decentralized workers and requesters, but these scores are notoriously inflated and uninformative. In this paper, we draw inspiration from historical worker guilds (e.g., in the silk trade) to design and implement crowd guilds that enable workers to form federations, share reputation information, and maintain governance over their federations. We present Crowd Guilds, a platform for building federations that rely on double-blind peer reviews, and a feedback system that uses crowdsourced aggregated reviews to determine worker reputation levels. We conclude with lessons for leveraging historical inspiration to design modern, scalable, and trustworthy systems that support high-quality work in the modern crowdsourcing ecosystem.
INCREASED ACCESS TO RESEARCH

Coauthors’ universities that are ranked below 500 worldwide

<table>
<thead>
<tr>
<th>Conference</th>
<th>Crowd Research</th>
<th>All other papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>UIST 2016</td>
<td>57%</td>
<td>12%</td>
</tr>
<tr>
<td>CSCW 2017</td>
<td>58%</td>
<td>11%</td>
</tr>
</tbody>
</table>
INCREASED ACCESS TO RESEARCH

Coauthors’ universities that are ranked below 500 worldwide

<table>
<thead>
<tr>
<th>Conference</th>
<th>Crowd Research</th>
<th>All other papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>UIST 2016</td>
<td>57%</td>
<td>12%</td>
</tr>
<tr>
<td>CSCW 2017</td>
<td>58%</td>
<td>11%</td>
</tr>
</tbody>
</table>

Coauthors whose countries are ranked below 50 worldwide in GDP per capita

<table>
<thead>
<tr>
<th>Conference</th>
<th>Crowd Research</th>
<th>All other papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>UIST 2016</td>
<td>42%</td>
<td>2%</td>
</tr>
<tr>
<td>CSCW 2017</td>
<td>35%</td>
<td>6%</td>
</tr>
</tbody>
</table>
ATTAINMENT: PROVIDING ACCESS

Participants have gone on to programs at UC Berkeley, and Carnegie Mellon University, and MIT.

21 of 33 surveyed were admitted to at least one program, despite a median of 0 other letter writers from institutions ranked better than 500 worldwide.
Crowd Guilds: Worker-led Reputation and Feedback on Crowdsourcing Platforms

Mark E. Whiting, Dilrukshi Gamage, Snehal Kumar (Neil) S. Gaikwad, Aaron Gilbee, Shirish Goyal, Alipta Ballav, Dinesh Majeti, Nalin Chhibber, Angela Richmond-Fuller, Freddie Vargus, Tejas Seshadri Sarma, Varshine Chandrakanthan, Teoggenes Moura, Mohamed Hashim Salih, Gabriel Bayomi Tinoco Kalejaiye, Adam Ginzberg, Catherine A. Mullings, Yoni Dayan, Kristy Milland, Henrique Orefice, Jeff Regino, Sayna Parsi, Kunz Mainali, Vibhor Sehgal, Sekandar Matin, Akshansh Sinha, Rajan Vaish, Michael S. Bernstein
Stanford Crowd Research Collective
daemo@cs.stanford.edu

ABSTRACT
Crowd workers are distributed and decentralized. While decentralization is designed to utilize independent judgment to promote high-quality results, it paradoxically undercuts behaviors and institutions that are critical to high-quality work. Reputation is one central example: crowdsourcing systems depend on reputation scores from decentralized workers and requesters, but these scores are notoriously inflated and uninformative. In this paper, we draw inspiration from historical worker guilds (e.g., in the silk trade) to design and implement a worker-led reputation system that rewards individuals whose aggregated reviews are consistently high, causing a positive feedback loop that enhances the quality of the work. This system can be used to improve the quality of work and fair compensation of workers.
Boomerang: Rebounding the Consequences of Reputation Feedback on Crowdsourcing Platforms


Stanford Crowd Research Collective, Stanford University
daemo@cs.stanford.edu

ABSTRACT
Paid crowdsourcing platforms suffer from low-quality work and unfair rejections, but paradoxically, most workers and requesters have high reputation scores. These inflated scores, which make high-quality work and workers difficult to find, stem from social pressure to avoid giving negative feedback. We introduce Boomerang, a reputation system for crowdsourcing platforms that elicits more accurate feedback by rebounding the consequences of feedback directly back onto the person who gave it. With Boomerang, requesters find that their highly-rated workers gain earliest access to their future tasks, and workers find tasks from their highly-rated requesters at the top of their task feed. Field experiments verify that Boomerang overcomes increasing,-size, non-popular feedback bias.
Daemo: a Self-Governed Crowdsourcing Marketplace

ABSTRACT:
Crowdsourcing marketplaces provide opportunities for automation and collaboration by allowing anyone to contribute. In these marketplaces, workers are typically paid for their contributions. However, the trust and second-order distribution of power among worker agents and contributions often evolve over time. We have developed a system that addresses these issues by providing a platform for workers to govern the platform itself. This platform allows workers to contribute to the development of the system itself, thereby providing a mechanism for workers to gain trust and influence in the marketplace.

Author Keywords: crowdsourcing, self-governance

ACM Classification Keywords: H.1.2 [Information Systems]: User/Machine Systems; I.2.8 [Computers and Society]: Public Policy Issues

Innovative Crowdsourcing: a Self-Governed Marketplace

ABSTRACT:
Previous work on crowdsourcing has primarily focused on the design of marketplaces for workers to contribute to projects. However, these marketplaces are often limited by the scalability and trustworthiness of the platform. We propose a novel approach for crowdsourcing that is based on self-governed marketplaces. Our approach provides a platform for workers to contribute to the development of the platform itself, thereby providing a mechanism for workers to gain trust and influence in the marketplace.

Author Keywords: self-governed, crowdsourcing

ACM Classification Keywords: H.1.2 [Information Systems]: User/Machine Systems; I.2.8 [Computers and Society]: Public Policy Issues

On Optimizing Human-Machine Task Assignments

ABSTRACT:
We present an algorithm for the efficient assignment of tasks to humans and machines. The algorithm is designed to minimize the total cost of completing a set of tasks, while ensuring that the quality of the final output is maintained. We evaluate the algorithm on a variety of datasets, and find that it is able to significantly reduce the cost of task completion while maintaining high quality.

Author Keywords: human-machine cooperation, task assignment

ACM Classification Keywords: I.2.8 [Computers and Society]: Public Policy Issues; I.6.7 [Simulation and Modeling]: Simulation methodologies

Investigating the “Wisdom of Crowds” at Scale

ABSTRACT:
We investigate the “wisdom of crowds” at scale by designing and implementing a large-scale crowdsourcing experiment. Our experiment involves 10,000 participants who were asked to classify a set of images. We find that the performance of the crowd is comparable to that of a single expert, and that the error rate decreases as the size of the crowd increases.

Author Keywords: crowdsourcing, wisdom of crowds

ACM Classification Keywords: I.2.8 [Computers and Society]: Public Policy Issues; I.2.7 [Computing Methodologies]: Artificial Intelligence

Additional Authors:
Yasmin Artin Arain
Sandeep Goyal

Robert J. Webber

Contributing Authors:
C. R. S. Chen
D. S. B. Chen
G. S. W. Chen
H. S. W. Chen

Introduction

Crowdsourcing is a growing field of research that has the potential to transform the way we design and build ambient computing systems. However, the effectiveness of crowdsourcing depends on the ability to design and deploy scalable systems that can support large numbers of participants. In this work, we present an architecture for crowdsourcing that is designed to support scalable, high-quality crowdsourcing systems.

Author Keywords: crowdsourcing, ambient computing

ACM Classification Keywords: I.2.8 [Computers and Society]: Public Policy Issues; I.1.1 [Computing Systems]: Programming Languages

RELATED WORK

Crowdsourcing has been used in a variety of domains, including information retrieval, image classification, and semantic annotation. However, most of these systems have been designed for small-scale, one-time tasks. The scalability and trustworthiness of these systems are limited by the size of the crowd and the quality of the output.

Author Keywords: crowdsourcing, scalability, trustworthiness

ACM Classification Keywords: I.2.8 [Computers and Society]: Public Policy Issues; I.1.1 [Computing Systems]: Programming Languages

Computer Vision

Data Science
INCREASED ACCESS TO RESEARCH

Coauthors’ universities that are ranked below 500 worldwide

<table>
<thead>
<tr>
<th>Conference</th>
<th>Crowd Research</th>
<th>All other papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>UIST 2016</td>
<td>57%</td>
<td>12%</td>
</tr>
<tr>
<td>CSCW 2017</td>
<td>58%</td>
<td>11%</td>
</tr>
</tbody>
</table>

Coauthors whose countries are ranked below 50 worldwide in GDP per capita

<table>
<thead>
<tr>
<th>Conference</th>
<th>Crowd Research</th>
<th>All other papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>UIST 2016</td>
<td>42%</td>
<td>2%</td>
</tr>
<tr>
<td>CSCW 2017</td>
<td>35%</td>
<td>6%</td>
</tr>
</tbody>
</table>
ATTAINMENT: PROVIDING ACCESS

Participants have gone on to programs at UC Berkeley, and Carnegie Mellon University, and MIT.

21 of 33 surveyed were admitted to at least one program, despite a median of 0 other letter writers from institutions ranked better than 500 worldwide.
DECENTRALIZED CREDIT: TRANSLATE INTO GRAPH PROBLEM

Each participant allocates **credit points** to other participants based on their assessment of who impacted the project.

Resulted: weighted directed graph
DECENTRALIZED CREDIT: TRANSLATE INTO GRAPH PROBLEM

Each participant allocates **credit points** to other participants based on their assessment of who impacted the project.

Resulted: weighted directed graph
DECENTRALIZED CREDIT: TRANSLATE INTO GRAPH PROBLEM

Each participants allocates **credit points** to other participants based on their assessment of who impacted the project.

Resulted: weighted directed graph.
GRAPH CENTRALITY: PAGERANK

Intuition: identify nodes that are receiving large amounts of credit, weigh those nodes’ allocations heavily, and iterate until convergence.

Propagate each node’s score in proportion to its outgoing wedge weights.
STRATEGIC BEHAVIOR

Speaking different languages or otherwise interacting with only a small part of the crowd: link ring

Strategically directing credit toward those who will return credit to you: such attacks occur in 360-degree reviews

Formulations of centrality algorithms can correct for most of these attacks
CREDDIT

Give everyone a say in how much credit each person deserves. For group projects, performance reviews, paper authorship, and more.

START

HOW IT WORKS

01 Add everyone in your team
02 Team members privately score each other
03 Creddit computes scores for each team member

creddit.stanford.edu
ANALYZING CREDDIT’S EFFECT

What impact did Creddit have on credit distribution?

Method: normalize raw summed credit scores, and Creddit-adjusted scores, to sum to 1.0

Regress both raw score and Creddit score on observable collaboration behaviors, and compare $\beta$ estimates across the regressions.
<table>
<thead>
<tr>
<th>Participation Measure</th>
<th>Creddit: $\beta_c$</th>
<th>Raw Votes: $\beta_{raw}$</th>
<th>$\beta_c - \beta_{raw}$</th>
</tr>
</thead>
<tbody>
<tr>
<td># Hangouts</td>
<td>0.0694***</td>
<td>0.0438*</td>
<td>0.0256</td>
</tr>
<tr>
<td># Files Uploaded</td>
<td>0.0352**</td>
<td>0.0293*</td>
<td>0.0059</td>
</tr>
<tr>
<td># GitHub commits</td>
<td>0.0171</td>
<td>-0.024*</td>
<td>0.0411***</td>
</tr>
<tr>
<td># Slack messages</td>
<td>0.0351*</td>
<td>0.1122***</td>
<td>-0.0770***</td>
</tr>
<tr>
<td># self-organized meetings</td>
<td>0.0239*</td>
<td>0.0115</td>
<td>0.0123</td>
</tr>
<tr>
<td>Milestone leader (binary)</td>
<td>0.0360***</td>
<td>0.0059</td>
<td>0.0300**</td>
</tr>
<tr>
<td>Weeks active</td>
<td>0.0252*</td>
<td>0.0141</td>
<td>0.011</td>
</tr>
</tbody>
</table>

All variables standardized
EFFECTS ON AUTHOR ORDER

Raw vote ranking

#2 and #4 have a high rank due to link ring
EFFECTS ON AUTHOR ORDER

PageRank-corrected author order
Influential coauthors reduced impact of link ring
CROWD RESEARCH: REFLECTIONS

What impact would decentralized credit have on traditional teams or organizations?

What kinds of research projects can operate at a larger technical scale than traditional CS research?
Rather than structuring the future of work as an algorithm, how might we design computationally augmented organizational structures?
Rather than structuring the future of work as an algorithm, how might we design computationally augmented organizational structures?

Organizations were originally designed with inspiration by mechanical systems. What might a computational infrastructure offer them?
Crowds, Computation, and the Future of Work

Thanks to...

Amazing students: Daniela Retelny, Niloufar Salehi, Rajan Vaish, Ranjay Krishna, Sharon Zhou

Amazing colleagues: Melissa Valentine, Fei-Fei Li, James Davis, Sharad Goel

Amazing supporters: NSF, Sloan, Accenture ATL, Microsoft, Toyota Human-Centered AI, Stanford Cyber Initiative, ONR, DARPA, Hasso Plattner Design Thinking Program

Amazing questions
THREE PARALLEL PROJECTS

HCI
Michael Bernstein,
Stanford
Building a new crowd marketplace
Crowds, Computation, and the Future of Work

Thanks to...

Amazing students: Daniela Retelny, Niloufar Salehi, Rajan Vaish, Ranjay Krishna, Sharon Zhou

Amazing colleagues: Melissa Valentine, Fei-Fei Li, James Davis, Sharad Goel

Amazing supporters: NSF, Sloan, Accenture ATL, Microsoft, Toyota Human-Centered AI, Stanford Cyber Initiative, ONR, DARPA, Hasso Plattner Design Thinking Program

Amazing questions