

CROWD DATA SOURCING & CROWDSOURCING

DATABASE QUESTIONS
HUMAN FACTORS
OPEN QUESTIONS

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Roma Tre course
8 May 2019



(2 HOURS)

- INTRODUCTION TO CROWDSOURCING
- DATABASE QUERY PROCESSING WITH THE CROWD
- TASK DEPLOYMENT STRATEGIES

(1 HOUR)

YOUR ASSIGNMENT

(2 HOURS)

- CROWDSOURCING AND HUMAN FACTORS
- OPEN QUESTIONS

A rough classification of tasks

- **Micro-tasks**

- audio transcription, text translation, image tagging, citizen science
- implicit collaboration
- consensus usually achieved with majority voting

- **Collaborative tasks**

- a group of individuals *collectively* working to achieve a goal
- collaborative editing, fan-subbing, solution outsourcing (e.g., Netflix contest)
- Consensus achieved when crowd converges

How do workers find tasks on AMT?

The screenshot shows the Amazon Mechanical Turk homepage. At the top, there's a navigation bar with 'Your Account', 'HITs', and 'Qualifications' buttons. To the right, it displays '190,184 HITs available now'. On the far right, there's a 'Sign In' link. Below the navigation, there are three links: 'All HITs', 'HITs Available To You', and 'HITs Assigned To You'. A search bar allows users to 'Find HITs containing' specific keywords, with a 'GO!' button. Below the search bar are two checkboxes: 'for which you are qualified' and 'require Master Qualification', both of which are checked. The main content area is titled 'All HITs' and shows results 1-10 of 1518. It includes columns for requester information, HIT expiration date, reward, and time allotted.

All HITs

1-10 of 1518 Results

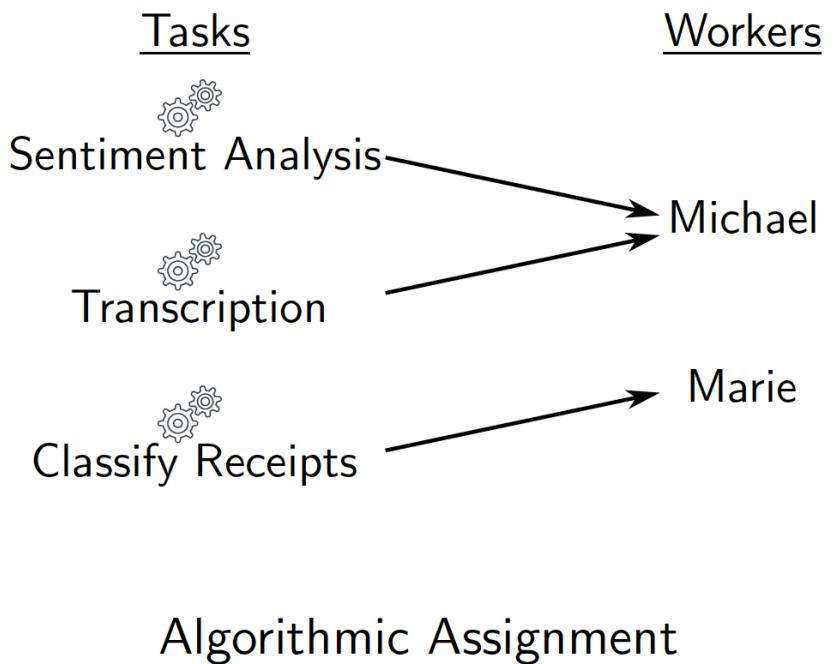
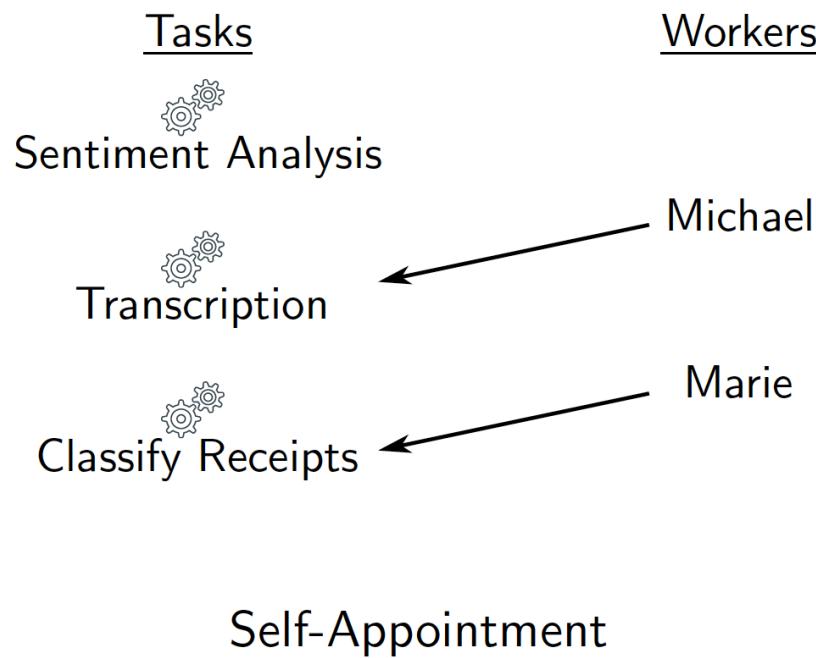
Sort by: Expiration Date (soonest first) Show all details | Hide all details [1](#) [2](#) [3](#) [4](#) [5](#) > [Next](#) >> [Last](#) Items per Page: 10

CTRP: Type name, date and total of a receipt		View a HIT in this group
Requester: CopyText Inc.	HIT Expiration Date: Jan 14, 2016 (9 minutes 46 seconds) Reward: \$0.01	Time Allotted: 4 minutes

Improve a Transcript		View a HIT in this group
Requester: CastingWords	HIT Expiration Date: Jan 14, 2016 (10 minutes 50 seconds) Reward: \$0.19	Time Allotted: 8 hours

Identify groups announced from audio recording (Level 2)		View a HIT in this group
Requester: TestNotice	HIT Expiration Date: Jan 14, 2016 (19 minutes 59 seconds) Reward: \$0.25	Time Allotted: 10 minutes

Algorithmic task assignment



Algorithmic task assignment

- Helps workers find tasks on AMT
- Matches workers' profiles to tasks based on
 - skills
 - skills and motivation
 - availability
 - ...
- A decision process:
 - Input: workers and tasks
 - Output: an assignment of tasks to workers

Goal: form one team per task



- **Input:** tasks to complete, human workers
- **Output:** completed tasks
- Each task has Expertise/Quality/Cost requirements
 - *English comprehension* for audio transcription
- Each worker has human factors: *Skill, Wage, Acceptance ratio*

Senjuti Basu Roy, Ioanna Lykourentzou, Saravanan Thirumuruganathan, Sihem Amer-Yahia, Gautam Das: Task assignment optimization in knowledge-intensive crowdsourcing. VLDB J. 24(4): 467-491 (2015)

Objective: maximize crowd-work quality

$$\text{Maximize } \mathcal{V} = \sum_{\forall t \in T} v_t$$

aggregated worker skills and wages

$$v_t = \begin{cases} W_1 \times \sum_{\forall j \in \{1..m\}} q_{tj} + W_2 \times (1 - \frac{w_t}{W_t}) & \text{if } q_{tj} \geq Q_{tj} \\ 0 & \text{otherwise} \end{cases}$$

task quality constraint

$$\wedge w_t \leq W_t$$

$$\text{if } q_{tj} < Q_{tj}$$

$$\vee w_t > W_t$$

task budget

where $W_1, W_2 \geq 0$ and $W_1 + W_2 = 1$.

Example Cont'd (ILP formulation)

worker selected
or not

worker's
acceptance ratio

worker's skill

$$q_{t_j} = \sum_{u \in U} u_t \times p_u \times u_{s_j} \geq Q_{t_j}, \forall j \in \{1..m\}$$

$$w_t = \sum_{u \in U} u_t \times p_u \times w_u \leq W_t$$

$$u_t = [0/1]$$

$$X_l \leq \sum_{t \in T} \{u_t\} \leq X_h$$

bounds on number of tasks

Task Assignment Solution Overview

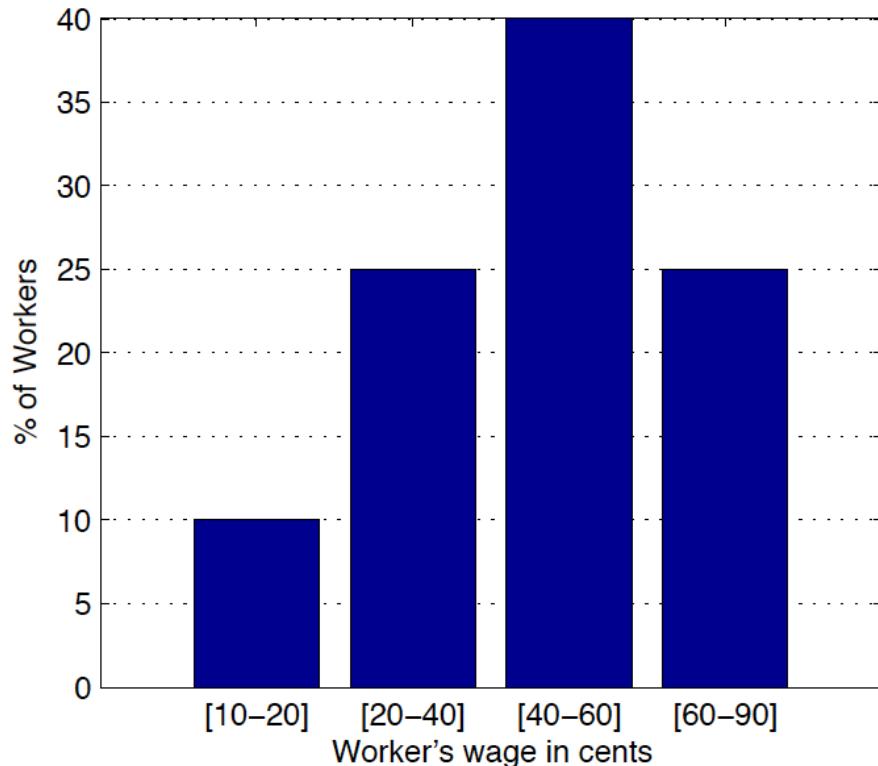
NP-hard (reduction using Multiple-Knapsack Problem)

- Our approach: Offline indexing for a workload of tasks
 - Assume a given set of tasks
 - Optimize for that set
 - Our implementation uses the primal-dual barrier method to solve the ILP
- Solution:
 - A greedy randomized algorithm with a $2/5$ approximation factor when objective function is sub-modular
 - A greedy deterministic algorithm with a $1 - 1/e$ approximation factor when objective function is sub-modular and monotonic

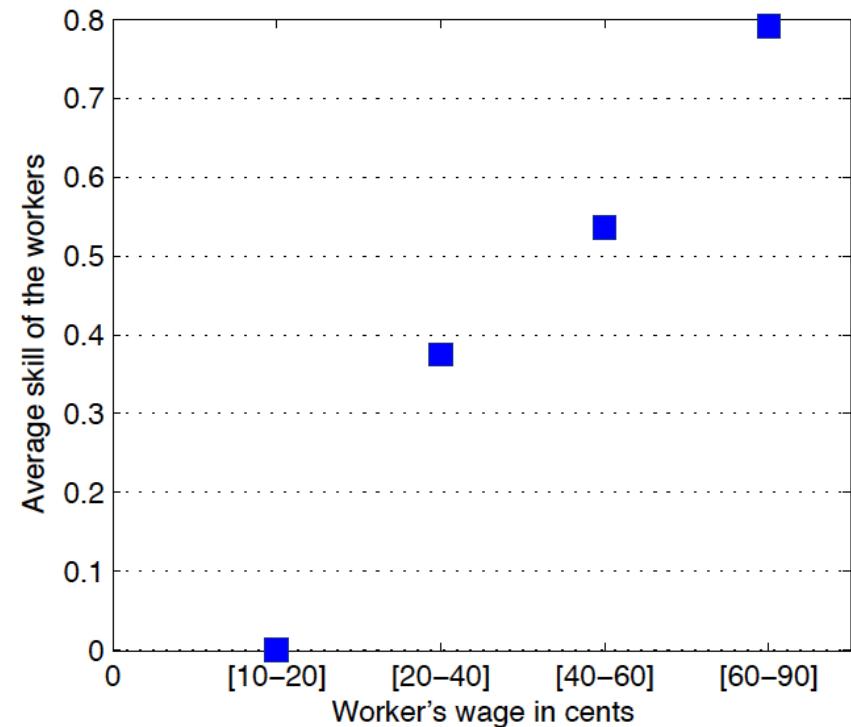
Quality Experiments

- **Phase 1:** 8 multi-choice questions/task, to assess skills
- **Phase 2:** Collaborative Document Editing task
 - 20 workers asked to produce reports on 5 different topics:
 - 1) *Political unrest in Egypt,*
 - 2) *NSA document leakage,*
 - 3) *Playstation games,*
 - 4) *All electric cars*
 - 5) *Global warming*
- **Phase 3:** Completed tasks evaluated by crowd workers
 - 150 AMT workers evaluated Completeness, Grammar, Neutrality, Clarity, Timeliness, Added-Value

AMT Worker Distributions (Egypt task)



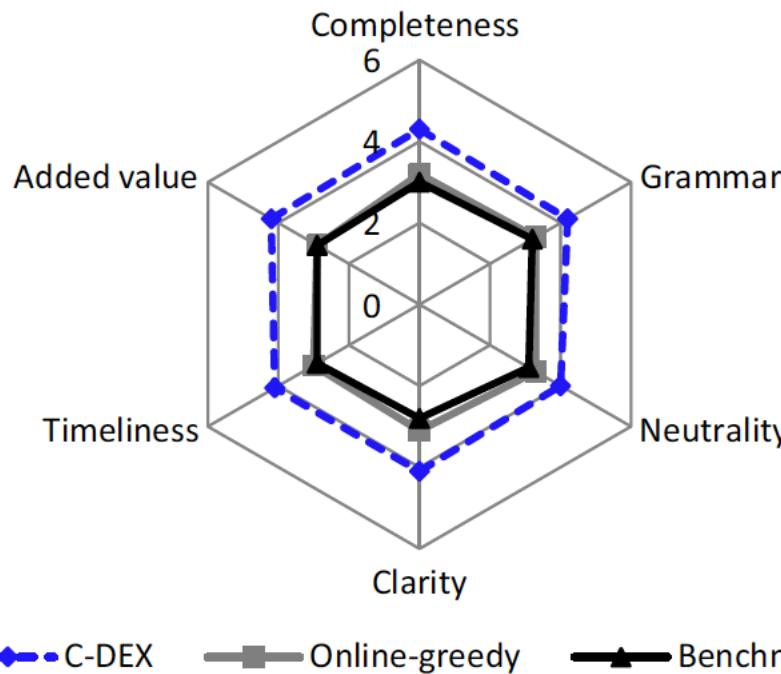
(c) Wage distribution



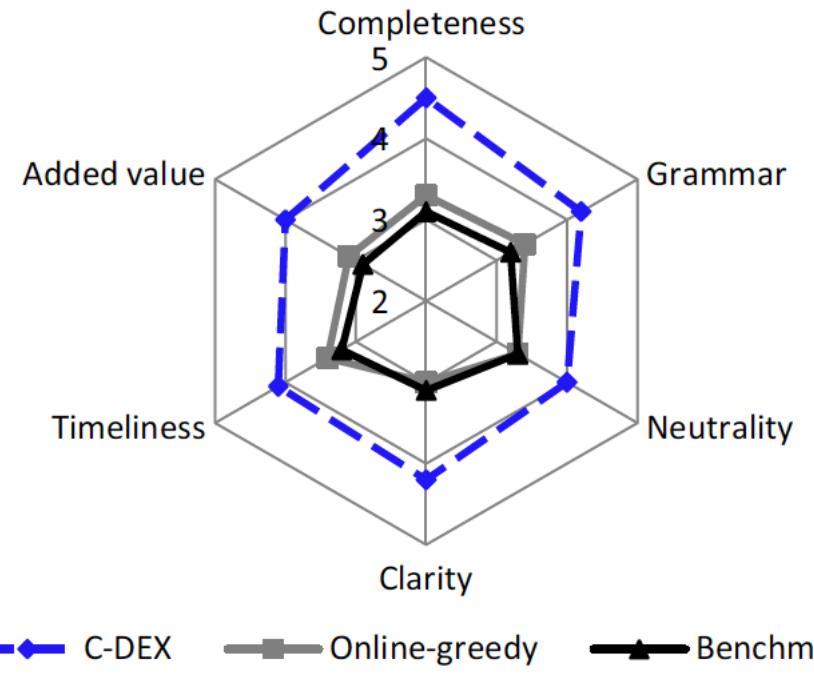
(d) Strong positive correlation between worker skill and wage

Outcome Quality Assessment

Playstation Games



Egypt Political Unrest



Challenges of dealing with human workers

- Workers may not accept tasks assigned to them
 - How to replace a worker who is not available for a task?
- Worker and task churn
 - How to handle new workers/tasks?
- Online index maintenance
 - Solve a marginal ILP problem (on a much smaller instance)

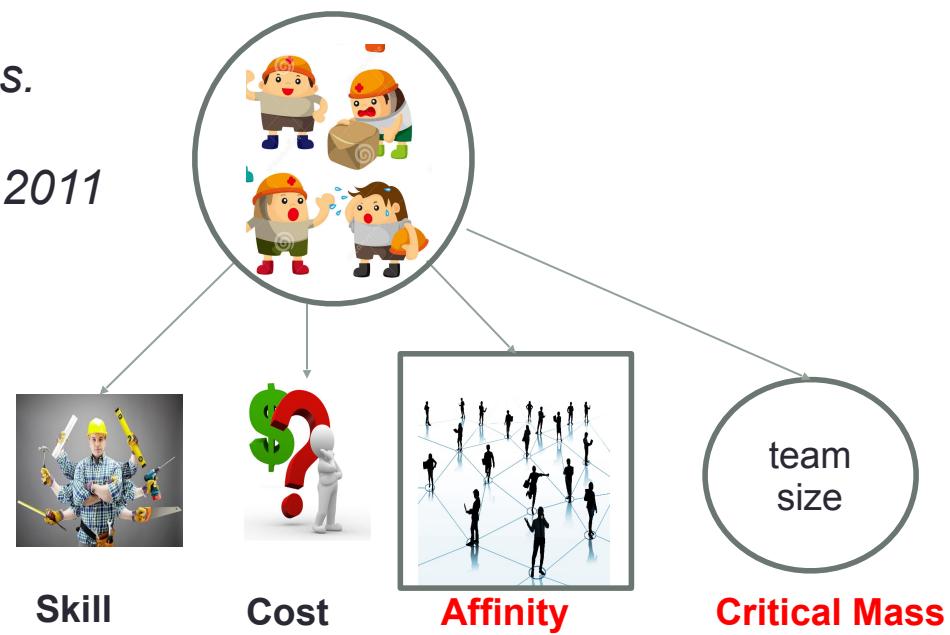
Group-aware human factors

- In some cases, outcome quality was low
 - Conflicting opinions
 - Edit wars
 - Proliferation of edits

Synergetic effects in working teams.

G. Hertel and G. Hertel.

Journal of Managerial Psychology 2011



Affinity

- Type Indicator: MBTI. Myers and Briggs. **Consulting Psychologists Press 1988**
- Are two heads better than one? Crowdsourced translation via a two-step collaboration of non-professional translators and editors. R. Yan et. al. **ACL 2014**

- Intra-team distance: e.g., edit wars

$$DiaDist(\mathcal{G}) = \text{Max}_{\forall u_i, u_j \in \mathcal{G}} dist(u_i, u_j)$$

Critical Mass

Managing research quality: critical mass and optimal academic research group size. R. Kenna et. al. IMA Journal of Management Mathematics 2012

Objective, revisited

$$\text{Minimize } \{ DiaDist(\mathcal{G}) + \sum_{\forall G_i, G_j \in \mathcal{G}} SumInterDist(G_i, G_j) \}$$

- Under:

$$\begin{aligned}
 & \sum_{\forall u_i \in \mathcal{G}} u_{d_i} \geq Q_i \quad \forall d_i \\
 & \sum_{\forall u \in \mathcal{G}} w_u \leq C \\
 & |G_i| \leq K \quad \forall i = \{1, 2, \dots, x\}
 \end{aligned}$$

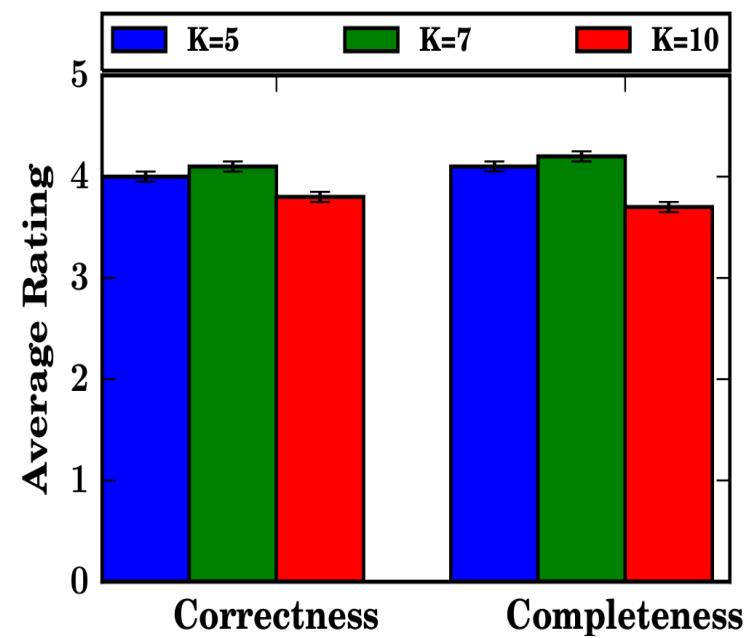
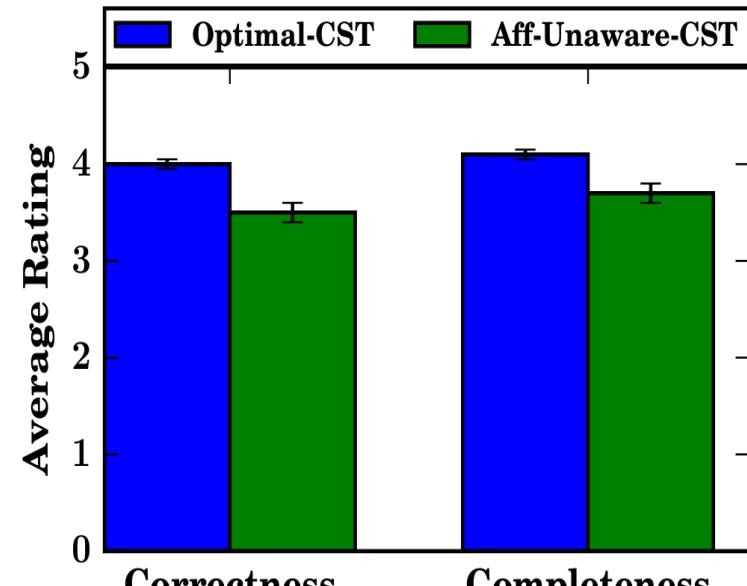
Habibur Rahman, Senjuti Basu Roy, Saravanan Thirumuruganathan, Sihem Amer-Yahia, Gautam Das: Task Assignment Optimization in Collaborative Crowdsourcing. ICDM 2015: 949-954

Overview of Algorithmic Solutions

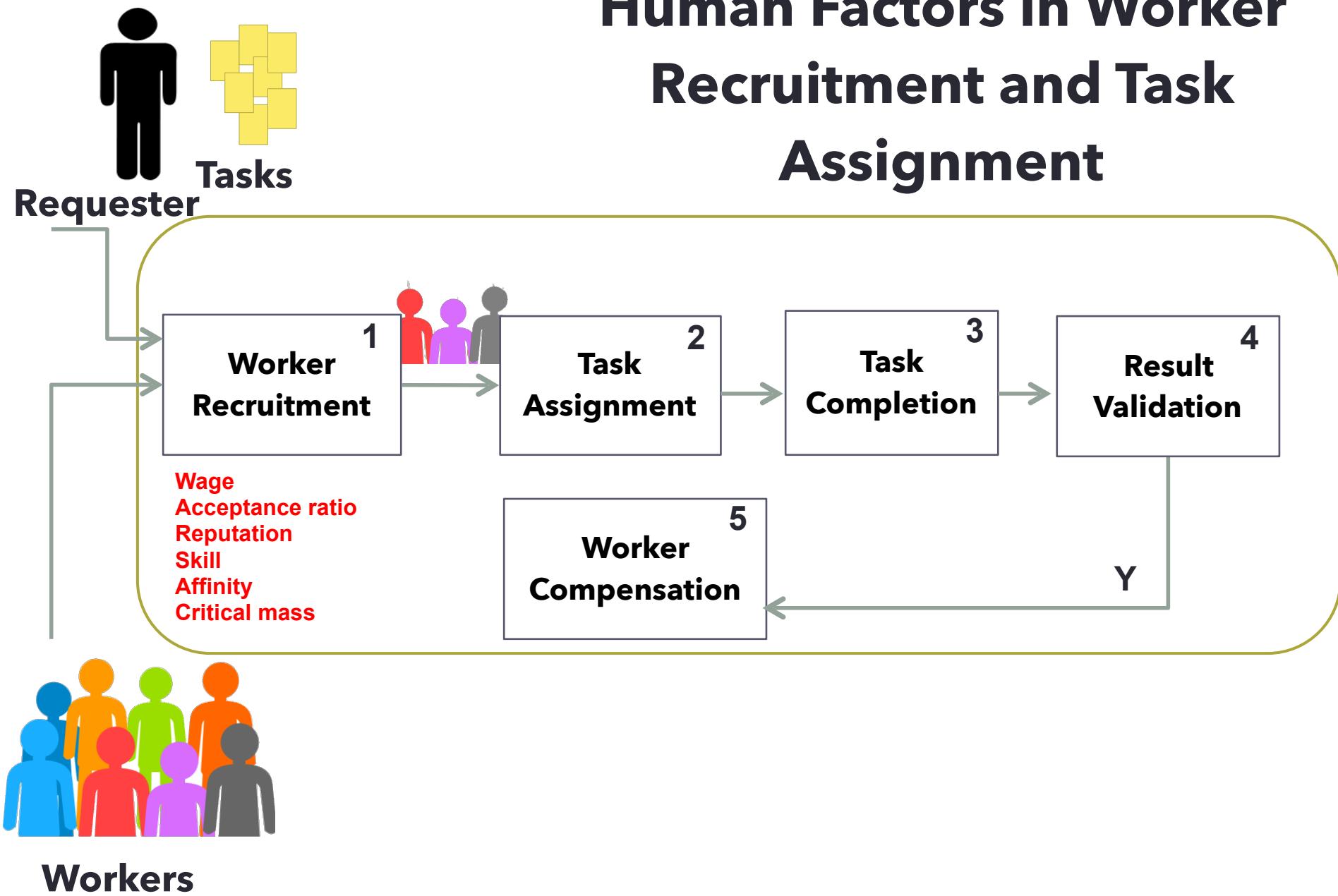
- A two-stage approach
 1. Form a single team that **maximizes intra-affinity**, and satisfies skill and cost (*NP-hard, reduction of Min-Dia, a variant of Compact Location*)
 2. Decompose into smaller teams, each satisfies critical mass and **inter-affinity across teams is maximized** (*NP-hard, reduction of Minimum Bisection*)
- Algorithms
 1. An instance optimal exact algorithm and a 2-approximation algorithm (when distance is a metric)
 2. A 3-approximation algorithm (akin to Min k-cut)

Experiments with Affinity and Critical Mass

- Translation task with 120 AMT workers
- Region- and age/gender-based affinities
- Results
 - Higher affinity impacts positively quality
 - A group beyond size 10 is less effective
 - Region more effective than age/gender



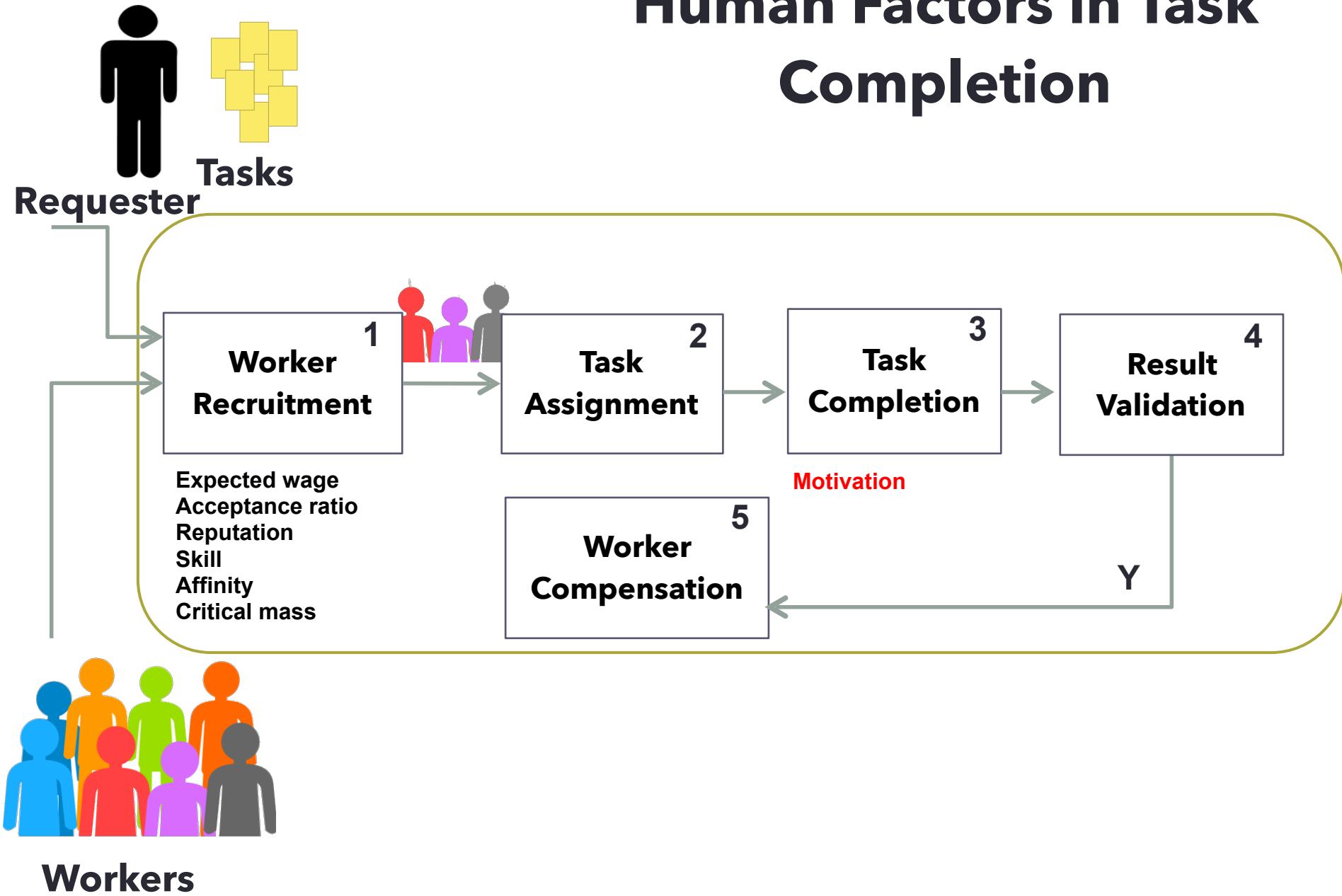
Human Factors in Worker Recruitment and Task Assignment



Summary and Takeaways

- The crowd is an incredible resource
- Human factors are essential in crowdsourcing
- Their importance differs for different kinds of tasks
- They affect task assignment and task completion

Human Factors in Task Completion

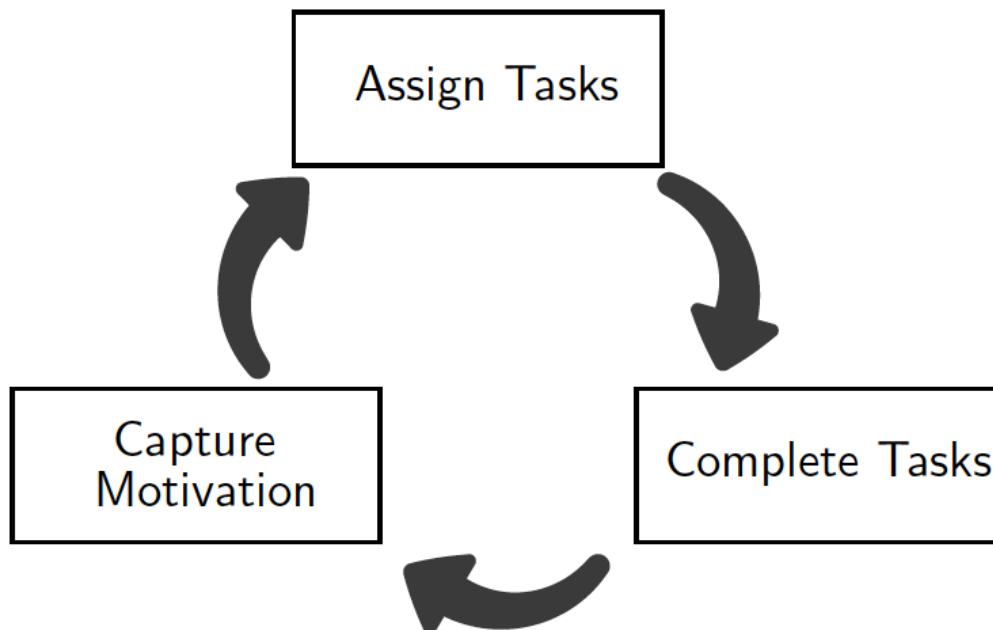


Worker motivation

- In practice, workers are involved in a series of tasks
- Different from entertaining workers during task completion (*Dai et al, CSCW 2015*), or incentivizing workers with gradually increasing pay (*Gao et al, PVLDB 2014*)
- Algorithmic approach
 - Observe workers and adaptively assign tasks that maximize their motivation

Going beyond one-shot task assignment

Observe, optimize... continuously



Motivation theory in job redesign

- 658 employees in 62 heterogeneous jobs (*white collar, blue collar, industry, services, urban and rural settings*) in 7 organizations.
- Study which job dimensions stimulate which Psychological States: *experienced meaningfulness of the work, experienced responsibility for the work outcomes, knowledge of the actual results of the work.*

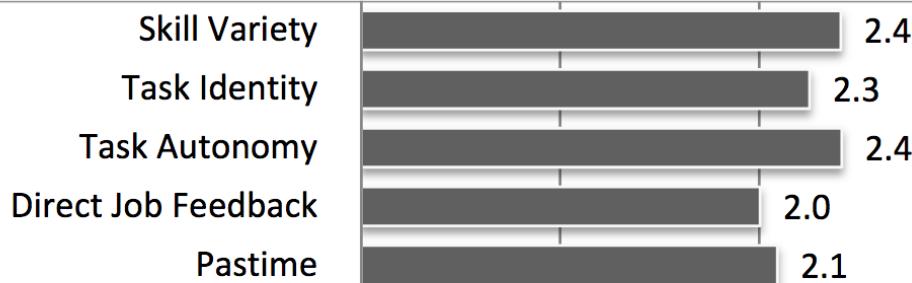
Motivation through the design of work: Test of a theory. J. Hackman and G. R. Oldham. Organizational behavior and human performance, 1976

Somewhat theoretical result (an old version)

$$\text{Motivating Potential Score (MPS)} = \frac{\left[\begin{array}{c} \text{Skill} + \text{Task} + \text{Task} \\ \hline \text{Variety} + \text{Identity} + \text{Significance} \end{array} \right]}{3} \times \text{Autonomy} \times \text{Feedback}$$

35 years later on Amazon Mechanical Turk

Enjoyment Based Motivation



Community Based Motivation



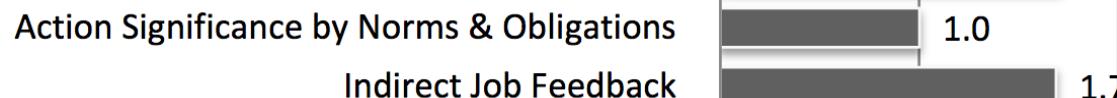
Immediate Payoffs



Delayed Payoffs

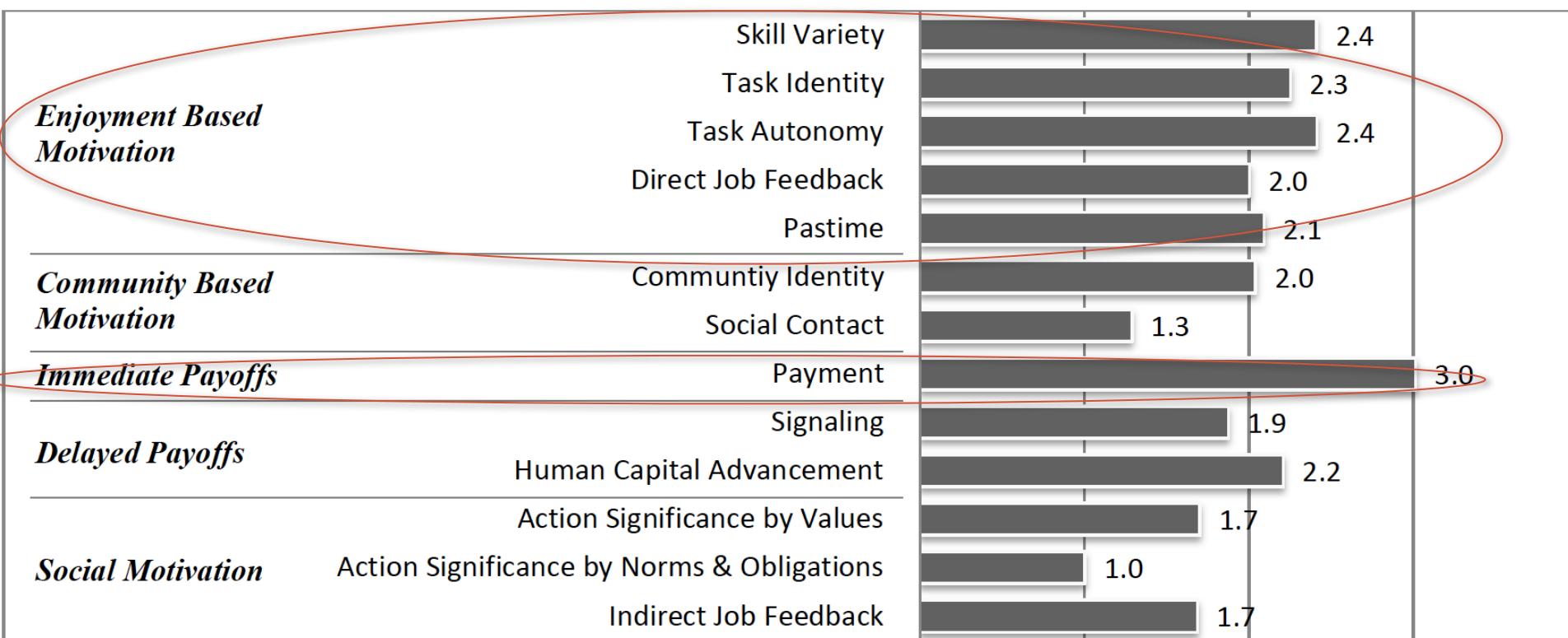


Social Motivation



More than fun and money. Worker motivation in crowdsourcing - A study on mechanical turk. N. Kaufmann, T. Schulze, and D. Veit. AMCIS 2011

What to observe?



Adaptive Task Assignment (motivation)



balance between 2 factors, e.g.,

intrinsic factor, *task diversity*, and

extrinsic factor, *task payment/reward*



$$\begin{aligned} motiv(\mathcal{T}, w) = & \alpha_w TD(\mathcal{T}) \\ & + \beta_w \times TR(\mathcal{T}, w) \end{aligned}$$

Adaptive Task Assignment (optimization)

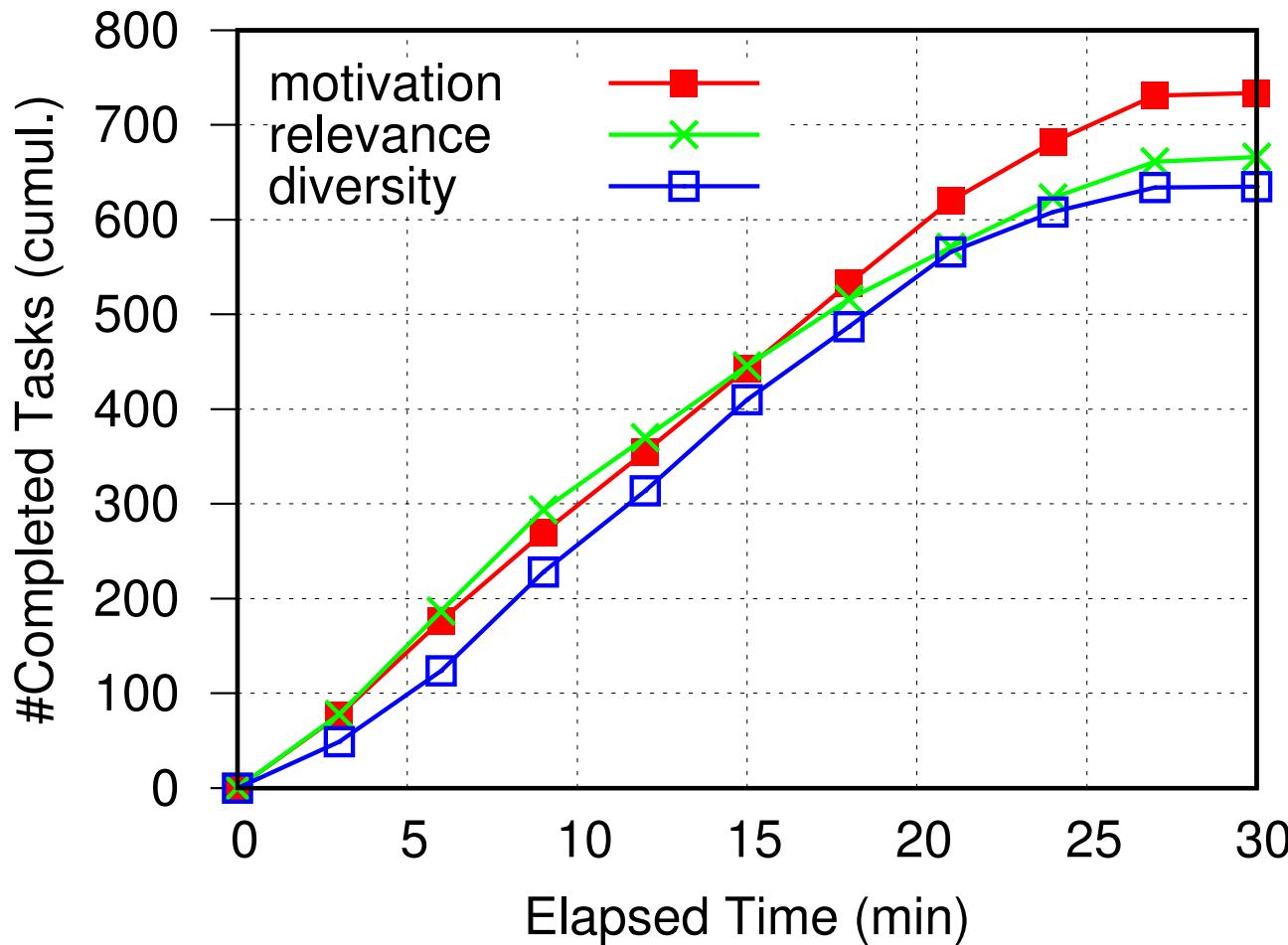
Solve an optimization problem at each iteration that finds a set of tasks for each worker, maximizing:

$$\arg \max \sum_{w \in \mathcal{W}^i} \text{motiv}(\mathcal{T}_w^i, w)$$
$$\forall w \in \mathcal{W}^i, |\mathcal{T}_w^i| \leq X_{max} \quad (C_1)$$
$$\forall w, w' \in \mathcal{W}^i, \mathcal{T}_w^i \cap \mathcal{T}_{w'}^i = \emptyset \quad (C_2)$$

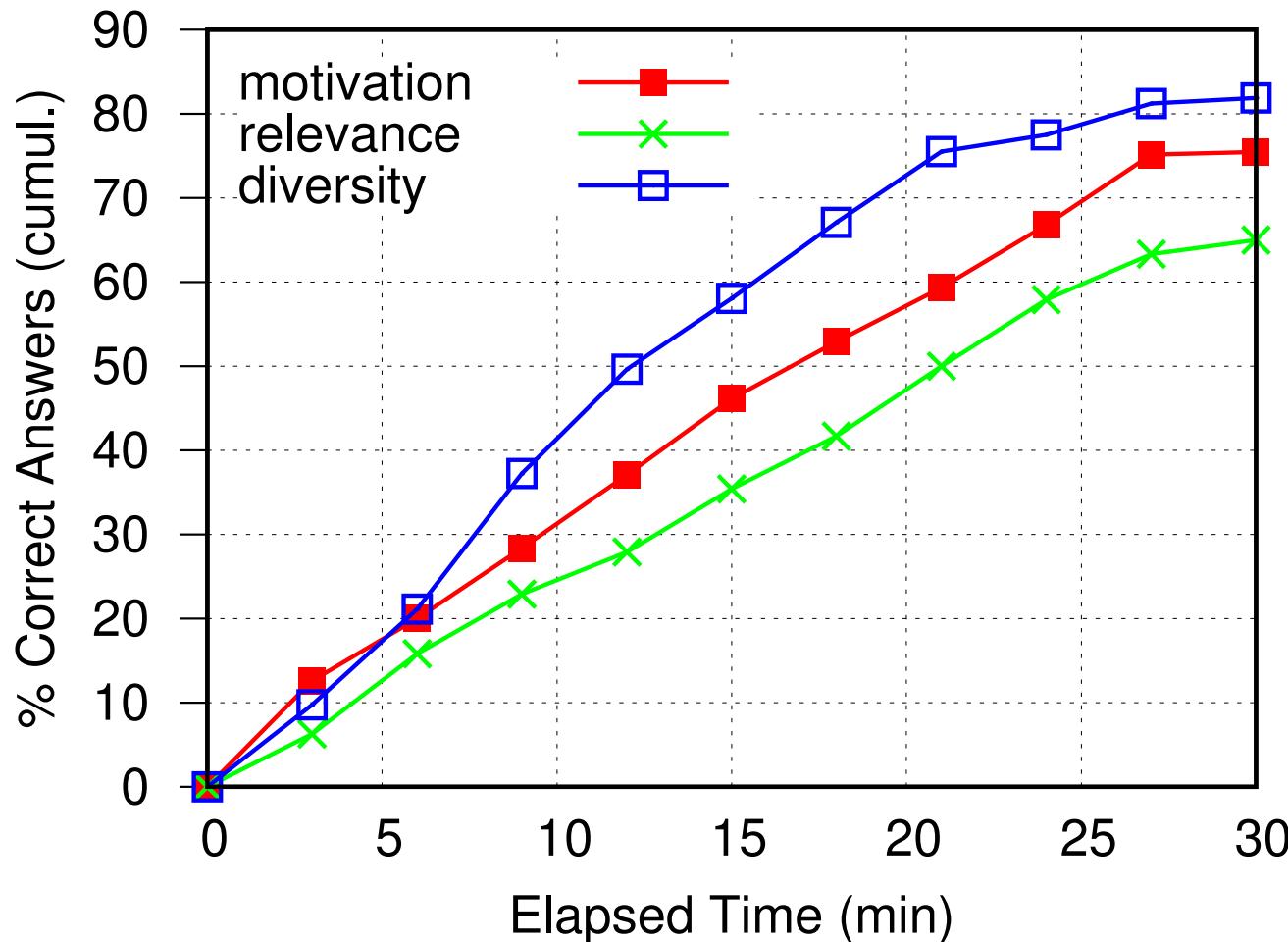
Adaptive task assignment

- 158,018 tasks from CrowdFlower in 22 kinds
 - tweet classification, image tagging, sentiment analysis, entity resolution, news entity identification
- 58 workers in AMT who completed 2,715 tasks in 80 iterations in total
- At each iteration, use one of 3 task assignment strategies:
 - motivation: balance between payment and diversity
 - relevance
 - diversity

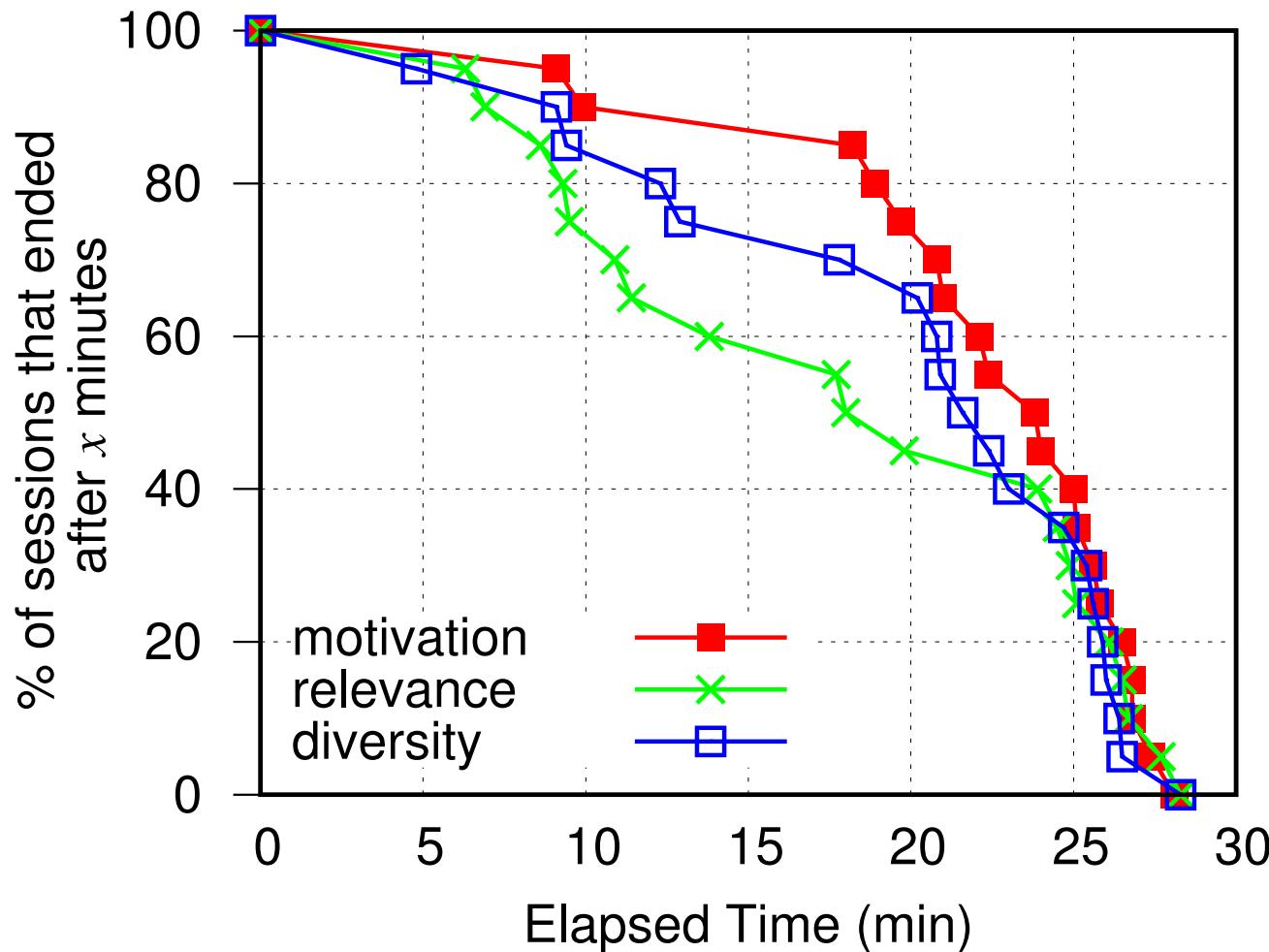
Task throughput



Contribution quality



Worker retention



Summary and Takeaways

- The crowd is an incredible resource
- Human factors are essential in crowdsourcing
- Their importance differs for different kinds of tasks
- They affect task assignment and task completion
- Their evolving nature requires to re-think how they are integrated into crowdsourcing processes
- Combining them with data-quality goals is open

(2 HOURS)

- INTRODUCTION TO CROWDSOURCING
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(1 HOUR)

YOUR ASSIGNMENT

(2 HOURS)

- CROWDSOURCING AND HUMAN FACTORS
- OPEN QUESTIONS



"On the Internet, nobody knows you're a dog."

Qualification test

QUALIFICATION EVALUATION

Please choose the most suitable name of the point of interest based on your experience. This would judge your fitness to take the travel itinerary evaluation task in the next section.



- Empire State Building
- Rockefeller Center
- Chrysler Building

- Flatiron Building
- Saint Patrick's Cathedral
- Trinity Church

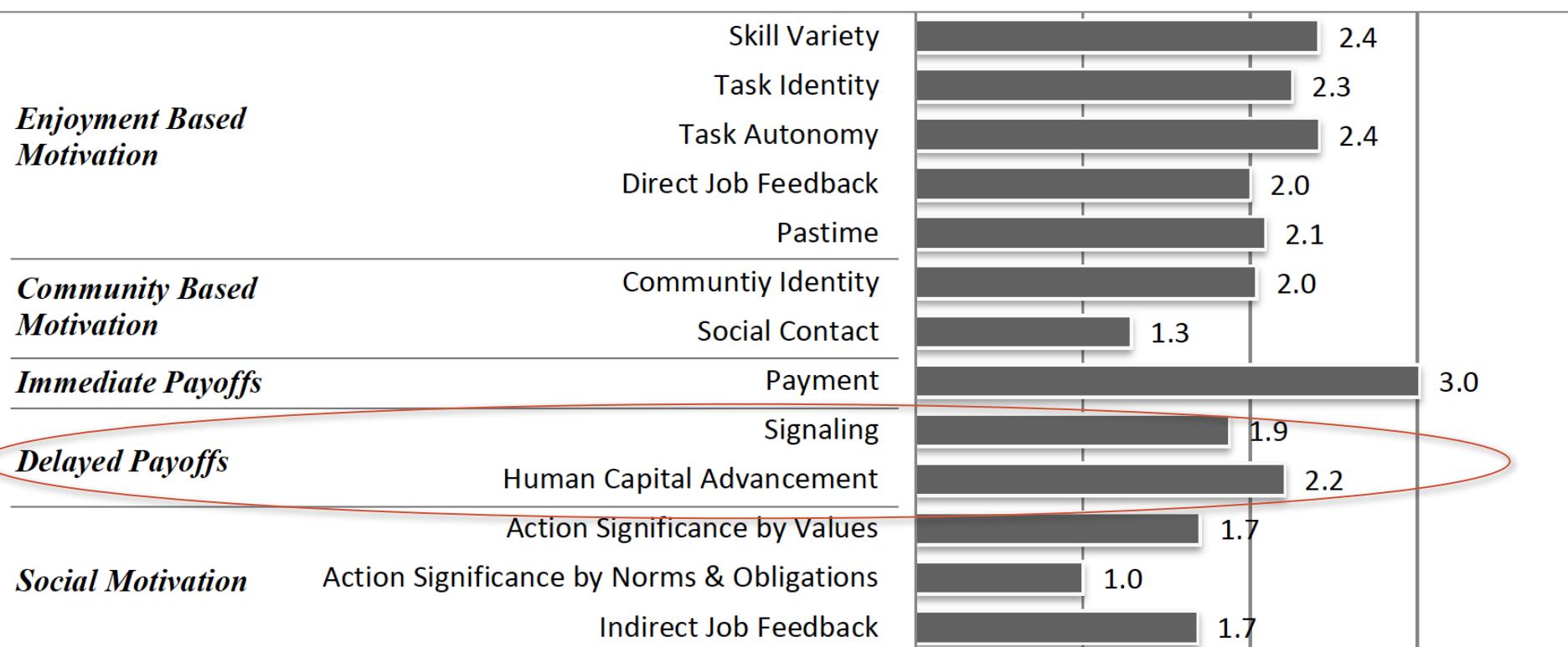
- Herald Square
- Washington Sq Park
- Lincoln Center

Skill Aggregation Functions

- Examples
 - *Maximum*: e.g., collaborative editing $\mathbf{q}_\ell = \max_j \mathbf{p}_\ell^j$
 - *Minimum*: e.g., fan-subbing $\mathbf{q}_\ell = \min\{1, \sum_{j=1}^{|Q|} \mathbf{p}_\ell^j\})$
 - *Multiplicative*: e.g., citizen science $\mathbf{q}_\ell = (1 - \prod_{j=1}^{|Q|} (1 - \mathbf{p}_\ell^j))$
- **Research opportunity**: revisit task assignment with different functions

Worker models

More than fun and money. worker motivation in crowdsourcing-a study on mechanical turk. N. Kaufmann, T. Schulze, and D. Veit. **AMCIS 2011**



More human factors

Mentoring and learning

- Formulate mentoring/learning and build teams to optimize it

Rakesh Agrawal, Behzad Golshan, Evangelos E. Papalexakis: Toward Data-Driven Design of Educational Courses: A Feasibility Study. EDM 2016

Mohammadreza Esfandiari, Sihem Amer-Yahia, Dong Wei, Senjuti Basu Roy: Optimizing Peer Learning in Online Groups with Affinities, KDD 2019 (to appear)

- From social computing

The seven attributes of distributed mentoring

Sarah Evans, Katie Davis, Abigail Evans, Julie Ann Campbell, David P. Randall, Kodlee Yin, Cecilia R. Aragon: More Than Peer Production: Fanfiction Communities as Sites of Distributed Mentoring. CSCW 2017: 259-272

Summary and Takeaways

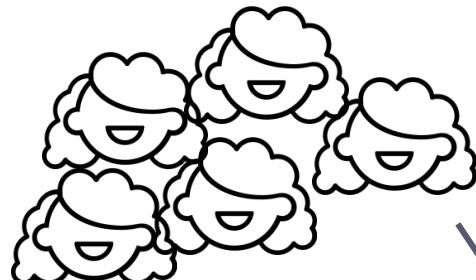
- The crowd is an incredible resource (if treated well!)
- **Many open questions**
- **Solutions to be grounded in Social Science**
- **And borrow from computing**
- **A great opportunity for us to re-think algorithms to enable human-in-the-loop data science**

Open questions

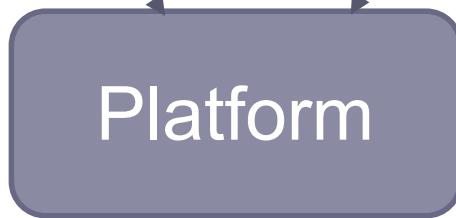
- **SQL-like optimization**
 - Blend crowd SQL with deployment strategies
- **Models and algorithms**
 - Adaptive micro-task assignment
 - Integrate human-centric goals: learn human models for different kinds of tasks
 - Algorithms for collaborative task assignment
 - Integrate different skill aggregation functions
 - Integrate team structure: star, peer
 - Integrate human-centric goals: learning gain
 - Adaptive team formation

**One ongoing question
Discrimination in online job markets**

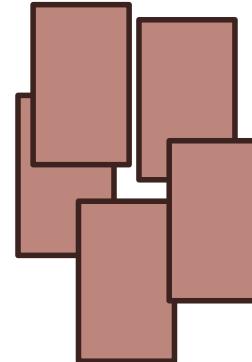
Online labor markets



workers



Platform



micro-gigs by requesters

- résumé preparation
- website design
- plumbing
- assembling furniture



Discrimination

The unbalanced targeting of workers based on their **protected** attributes

The French Criminal Law
(and many others) lists
such attributes
including any combination thereof



<http://www.allenavery.com/publications/en-gb/Pages/Protected-characteristics-and-the-perception-reality-gap.aspx>

National Labour Law Profile: Italy

The Italian Constitution (art. 3) provides for the concept of equality of all citizens before the law *without difference of sex, race, language, religion, political views, personal and social position.*

Other illegal kinds of discrimination are **AIDS** discrimination (Act 135, 5 June 1990), **age** discrimination (Sect. 37 of Constitution) and **handicap** discrimination (Act 104, 5 February 1992).

The Constitutional Court has ruled that equality is a fundamental right of **foreigners** as well. For citizens of European Union countries, Sect. 48 of the EEC Treaty abolishes all discrimination at work, wage and other conditions of work. Act 40, of 6 March 1998 affirms equality between other foreign workers legally resident in Italy and Italian workers.

There is a **fast track procedure** on following grounds: (i) discrimination for **union views** (Sect. 28 Workers' statute); (ii) **race, ethnical, national or religious** discrimination (Sect. 44 of Act 286 of 1998); (iii) **men-women** discrimination at work (Sect. 15 of Act 903 of 1977). For **other kinds of discrimination** there is the general fast track procedure (Sect. 700 of Civil procedure Code).

Opportunity

In the physical world:

Lack of data

Lack of proof

In the virtual world:

Many online services

Data easily accessible

Online help

The Fiverr homepage features a large, professional photograph of a woman with dark skin and long, braided hair (dreadlocks). She is smiling warmly at the camera. In the bottom left corner of the photo, there is a small semi-transparent watermark that reads "CecilyWidner Web Developer". The Fiverr logo is in the top left corner of the page. At the top right, there are links for "Fiverr Pro Home", "Become a Seller", "Sign In", and a prominent "Join" button. The main headline "Don't Just Dream, Do" is displayed in large, bold, white font. Below it, the tagline "Freelance services. On demand." is shown in a smaller, white font. A search bar with the placeholder "What service are you looking for?" is positioned below the headline. To the right of the search bar is a green "Search" button. Below the search bar, there is a call-to-action button labeled "See for yourself" with a play icon.

Explore The Marketplace

Get inspired to build your business



Graphics & Design



Digital Marketing



Writing & Translation



Video & Animation

Resumes. Proofreading.

Online and offline help

[Services](#)[Log in](#)[Become a Tasker](#)

The convenient & affordable way
to get things done around the home

Choose from over 140,000 vetted Taskers for help without breaking the bank.

[Mounting & Installation](#)[Moving & Packing](#)[Furniture Assembly](#)[Home Improvement](#)[General Handyman](#)[Heavy Lifting](#)

Need something different?

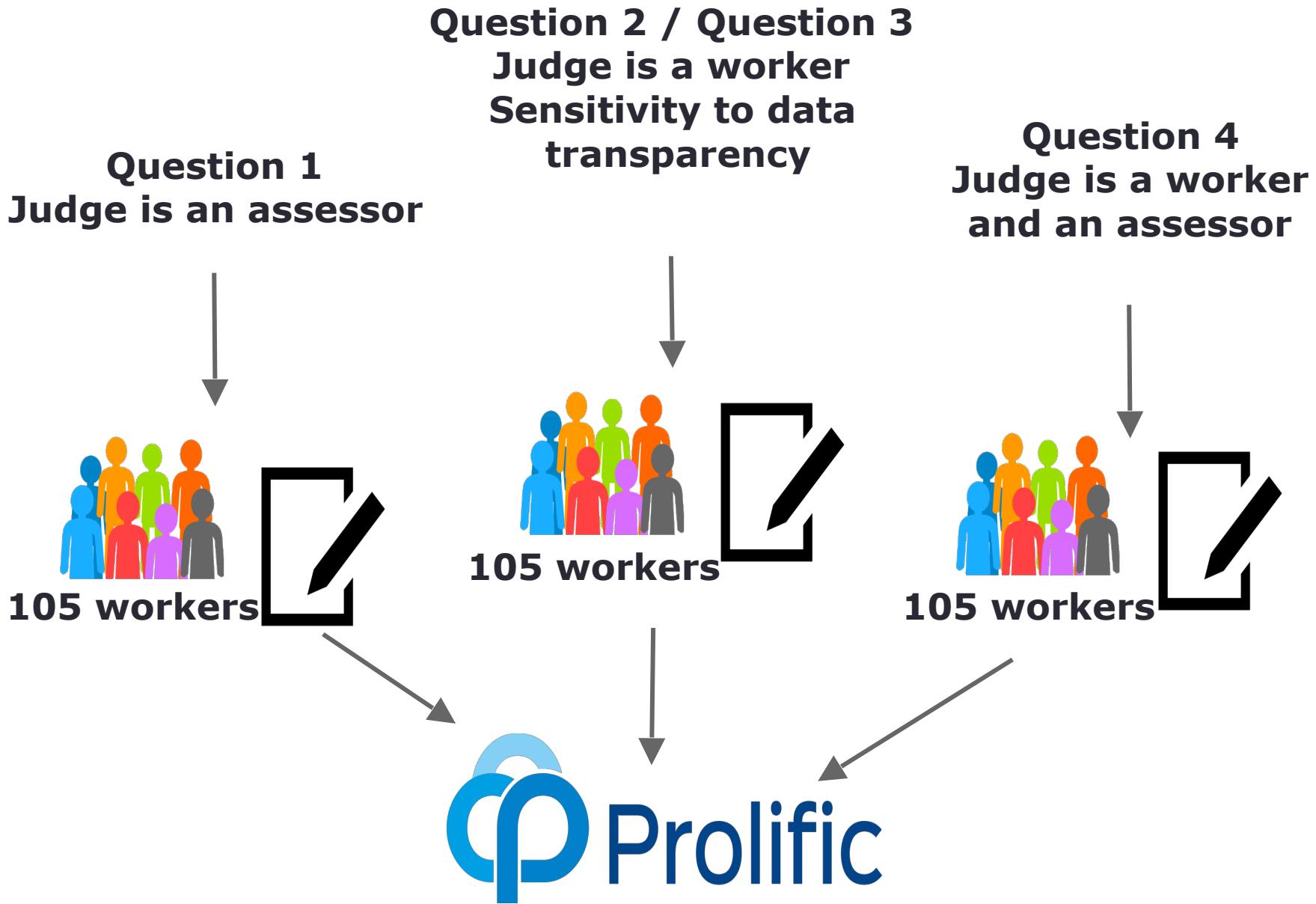
2 complementary approaches

1. The judge is a human

- opportunity: provide a tool to auditors
- Challenges: design user studies, only perceived discrimination can be measured

2. The judge is an algorithm

- opportunity: observe and quantify discrimination automatically on different platforms
- challenges: many definitions of fairness, scalability can be a bottleneck



You are an assessor. A requester has deployed on a crowdsourcing platform an audio transcription task in English (example : English subtitles for a video). The requester chooses the workers to do the task. Here are two cases : in the first you are given the worker's data and the requester's decision, in the second you are only given the process by which the requester decides.

Case 1 :

Let there be 5 workers :

W1 : English level : 60%, Ratio of accepted work : 30%

W2 : English level : 80%, Ratio of accepted work : 90%

W3 : English level : 85%, Ratio of accepted work : 70%

W4 : English level : 65%, Ratio of accepted work : 60%

W5 : English level : 80%, Ratio of accepted work : 60%

Assigned task to : **W2, W3, W5**

Not assigned to : **W1, W4**

Case 2 :

If a worker has : English level * 0.6 + Ratio of accepted work
0.4 > 70% then Assign task else Don't assign task.

Assigned task to : **W2, W3, W5**

Not assigned to : **W1, W4**

The judge is a human

Judges prefer transparency of data to the transparency of the assignment process: they consider that they can better judge the discriminatory power of an assignment (even opaque!) if the data of the participants and the tasks assigned to them are provided to them.

Workers are not sensitive to the dissemination of their personal data to requesters - they also prefer that their computed data be made available to the requesters (considering that the assignment of tasks will be fairer to them).

Confirmed a theory in economics: workers prefer to be part of a transparent assignment process rather than an opaque one even if it is fairer to them!

DISTANCE

Rayon de recherche

30 km

NIVEAU D'EXPÉRIENCE

<input type="checkbox"/> Débutant (< 2 ans)	601
<input type="checkbox"/> Intermédiaire (2 à 5 ans)	559
<input type="checkbox"/> Confirmé (> 5 ans)	1 753

NIVEAU D'ÉTUDES

<input type="checkbox"/> Aucun diplôme	562
<input type="checkbox"/> CAP, BEP ou équivalent	33
<input type="checkbox"/> Niveau Bac	44
<input type="checkbox"/> Bac Obtenu	125
<input type="checkbox"/> Bac +2	652
<input type="checkbox"/> Bac +3	735
<input type="checkbox"/> Bac +4	298
<input type="checkbox"/> Bac +5	431
<input type="checkbox"/> > Bac +5	33

RECHERCHER DES CANDIDATS

Où ?



2 913 résultats correspondent à votre recherche


Thanh-van L.

Courdimanche

1 an et 9 mois d'expérience (tous métiers confondus)

Dernière formation : Communication Visuelle

Dernière connexion il y a 1 jour

Derniers postes

Assistant / Assistante chef de projet

Chef de projet

Web designer


Aurelien N.

Caluire-et-Cuire

19 ans et 6 mois d'expérience (tous métiers confondus)

Dernière formation : BTS attaché technico commercial

Dernière connexion il y a 1 jour

Derniers postes

Consultant / Consultante en recrutement

Négociateur / Négociatrice en immobilier

 Délégué commercial / Déléguée commerciale
en biens d'équipement auprès des entreprises

Thierry marcellin F.

Paris

6 ans et 10 mois d'expérience (tous métiers confondus)

Dernière formation : Développeur Intégrateur En

Derniers postes

Téléconseiller / Téléconseillère

Agent / Agente de planning informatique

A ranking formulation

Input: a task (query) and a set of workers

Output: a ranking of workers

$$f(u) = 0.3 \times \text{LanguageTest}(u) + 0.7 \times \text{ApprovalRate}(u)$$

User	Gender	Country	Birth	Language	Ethnicity	Experience	Test	Approval	f(u)
U1	Female	America	2000	English	White	5	0.76	0.56	0.620
U2	Female	India	2004	English	Indian	0	0.50	0.20	0.290
U3	Male	America	1976	English	White	14	0.89	0.92	0.911
U4	Male	India	1976	Indian	White	6	0.65	0.65	0.650
U5	Male	Other	1963	Other	Indian	18	0.64	0.76	0.724
U6	Female	India	1963	Indian	Indian	21	0.85	0.90	0.885
U7	Male	America	1995	English	Black	2	0.42	0.20	0.266
U8	Female	America	1982	English	Black	16	0.95	0.98	0.971
U9	Male	Other	2008	English	Other	0	0.30	0.15	0.195
U10	Male	Other	1992	English	White	2	0.32	0.25	0.271

protected attributes

inferred attributes

In the literature

- Fairness studied for classification and ranking [1]
- Many definitions for **group fairness** [2]
 - Demographics parity
 - Disparate treatment
 - Disparate impact
- Single-attribute groups and empirically [3]

[1] A. J. Biega et. al: **Equity of Attention: Amortizing Individual Fairness in Rankings**. SIGIR 2018

[2] A. Singh, T. Joachims: **Fairness of Exposure in Rankings**. KDD 2018

[3] A. Hannak et. al: **Bias in Online Freelance Marketplaces: Evidence from TaskRabbit and Fiverr**. CSCW 2017: 1914-1933

Algorithmic approach

- Find a partitioning of workers (on protected attributes) that exhibits the highest discrimination
- **Algorithmic approach helps unveil and quantify discrimination automatically and for any group of workers and any service**

On TaskRabbit

An empirical evaluation found that

- **Blacks** are ranked lower than **Whites**
- **Asians** are ranked higher regardless of **gender**
- **White women and Black men** are ranked lower

Our algorithm found that

- **Ethnicity** is most discriminatory feature
- Followed by **ethnicity-gender** combinations unbalanced targeting of workers based on their **protected** attributes

Our problem statement

Given a set of workers W and a scoring function $f : W \rightarrow R$

- ▶ Identify the subgroups that exhibit the highest unfairness with respect to f
- ▶ Quantify the amount of unfairness that a scoring function f on W

Most unfair partitioning problem

Given W and f , find partitioning $P = \{p_1, p_2, \dots, p_k\}$ such that:

$$\begin{aligned} & \underset{P}{\operatorname{argmax}} \quad \text{unfairness}(P, f) \\ & \text{subject to } \forall i, j \quad p_i \cap p_j = \emptyset \\ & \quad \bigcup_{i=1}^k p_i = W \end{aligned} \tag{1}$$

where

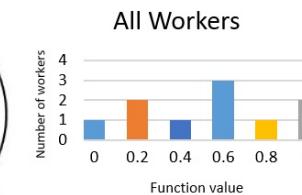
$$\text{unfairness}(P, f) = \operatorname{avg}_{i,j} EMD(h(p_i, f), h(p_j, f)) \tag{2}$$

and $h(p_i, f)$ is a histogram of the scores of individuals in p_i using f .

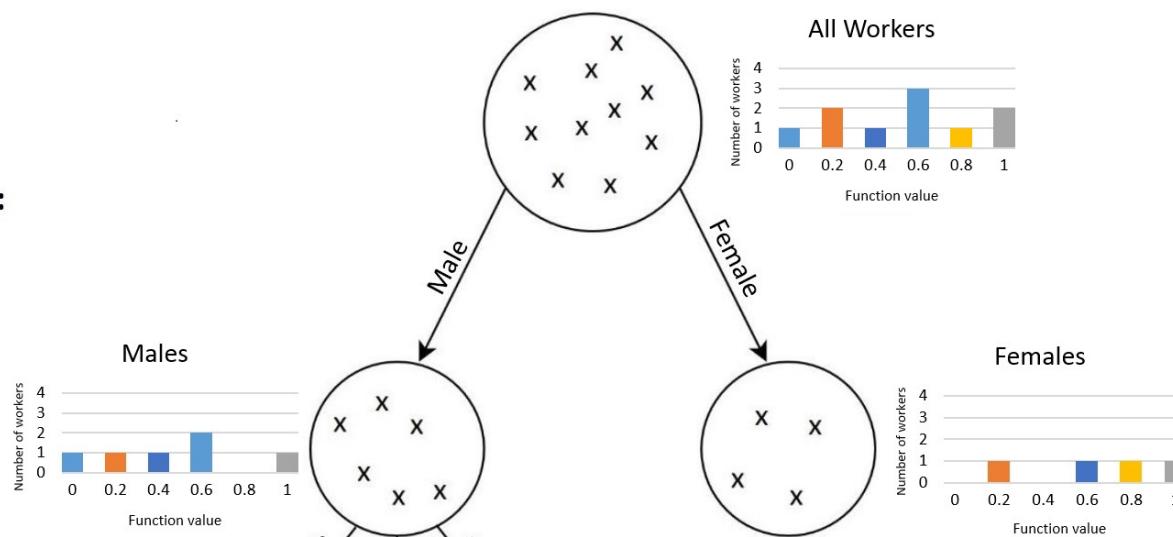
Partitioning space

Various heuristics

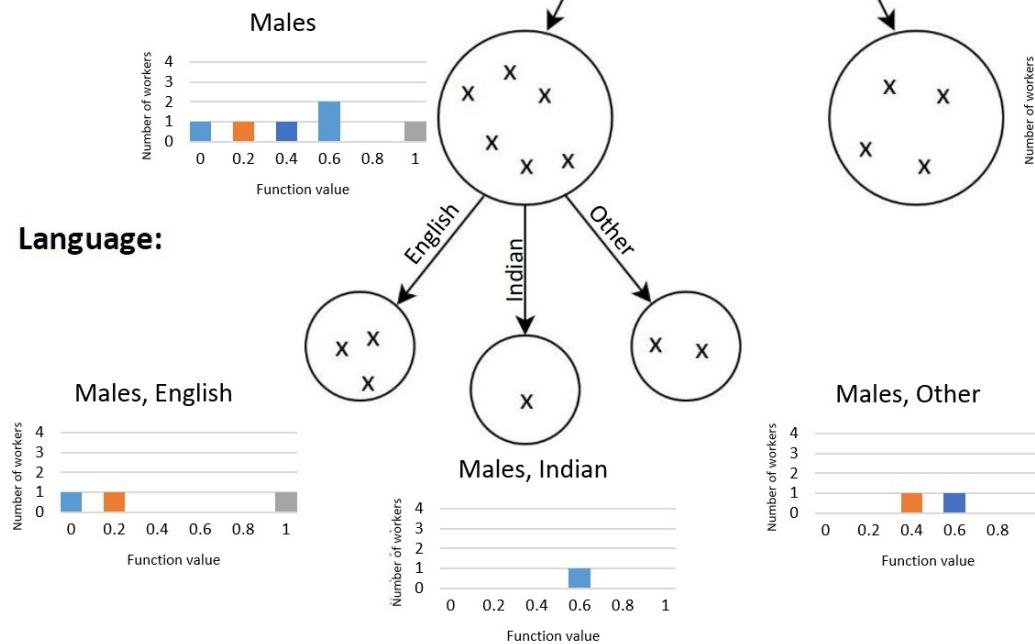
All Workers:



Gender:

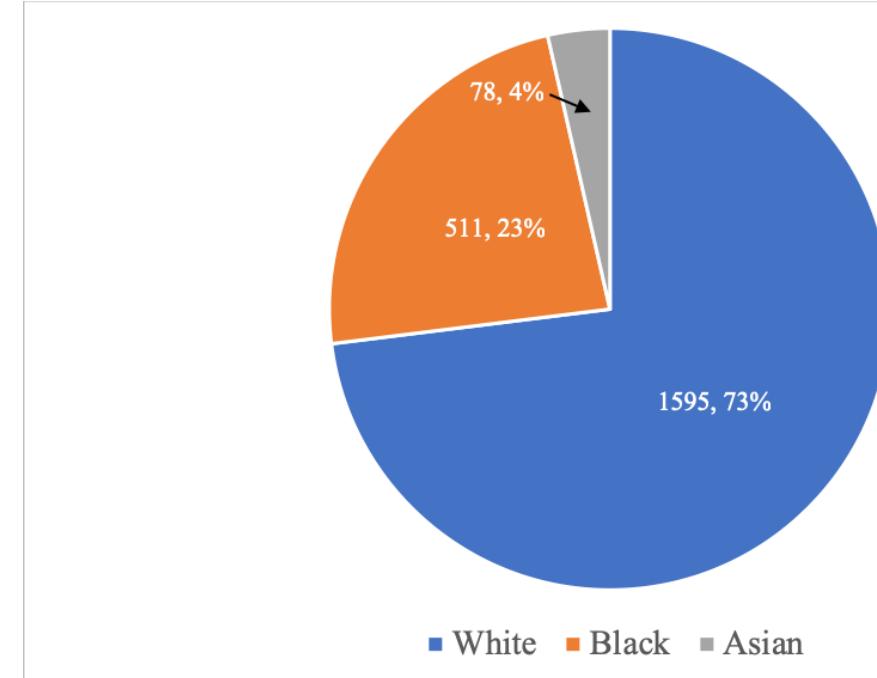
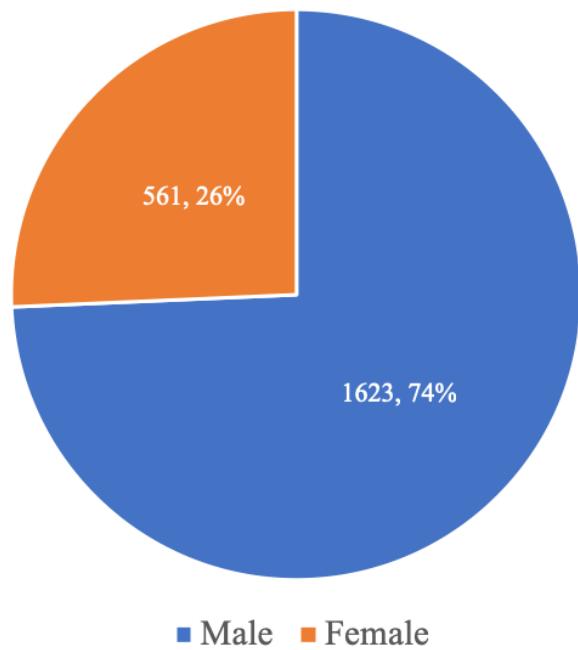


Language:

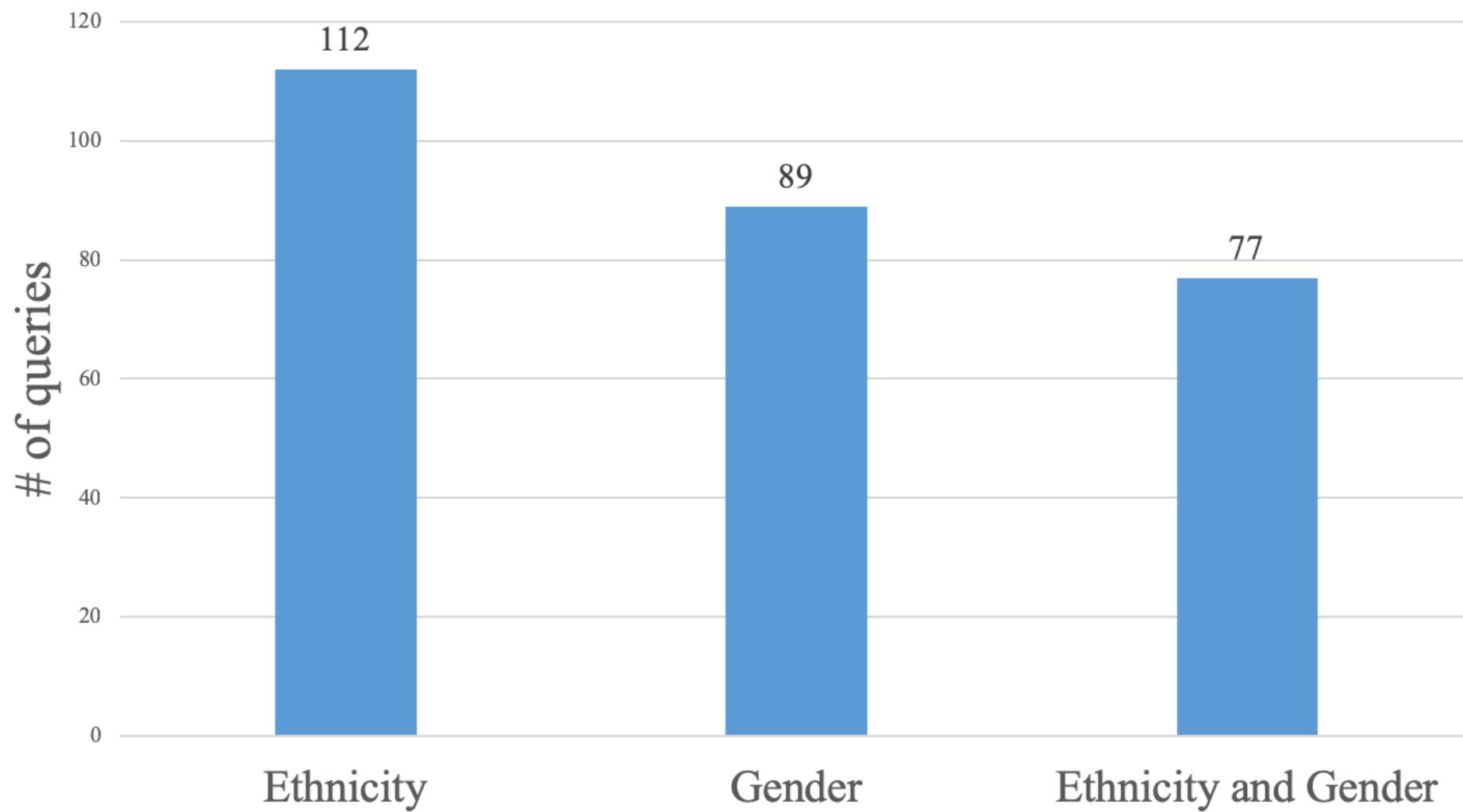


TaskRabbit

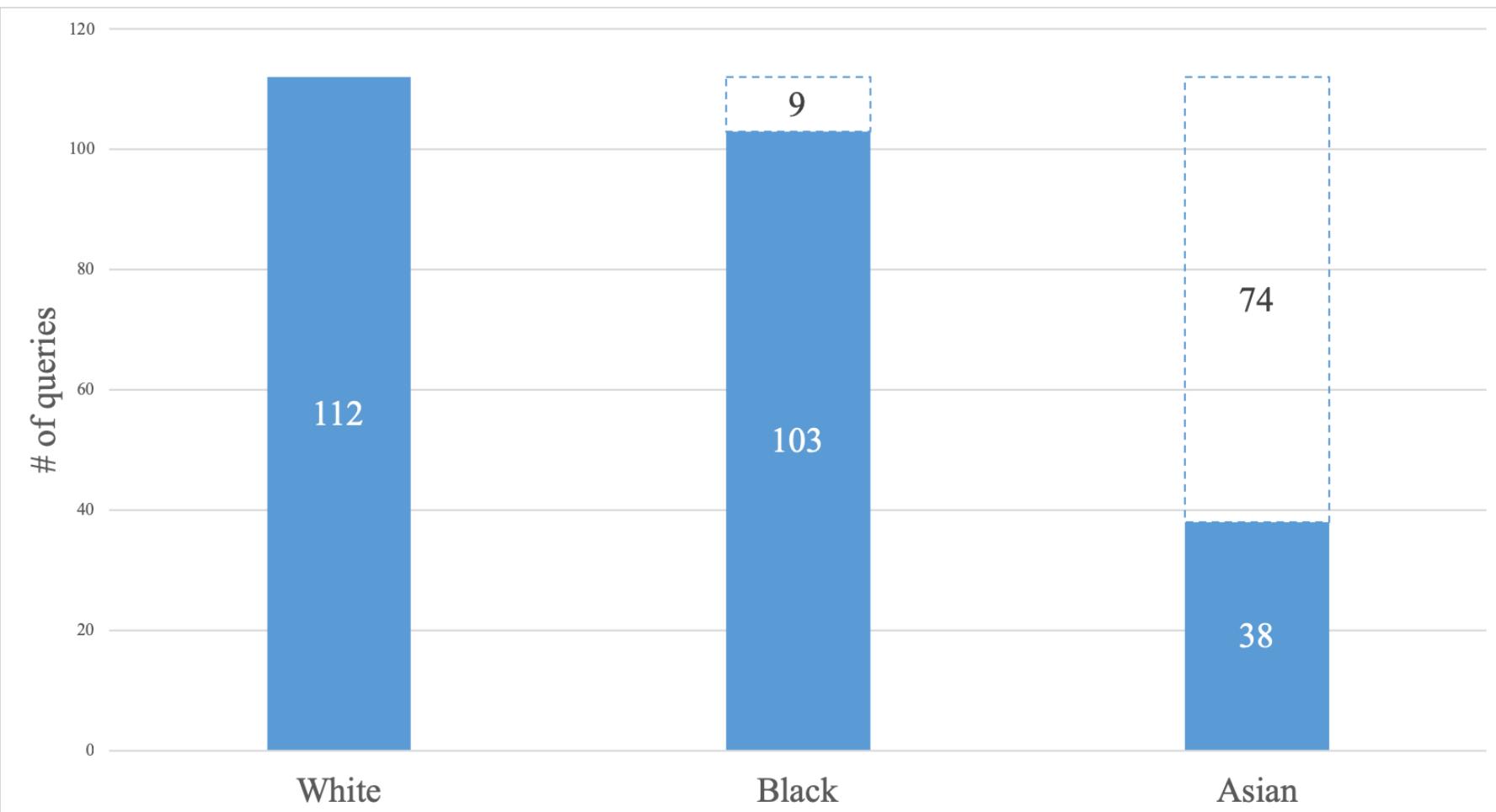
- 20 most popular services in 45 US cities
- 2,182 unique taskers, 287 queries: Home Cleaning
- Rank of each tasker, picture (used to assign gender, ethnicity), badge, reviews, and hourly rate



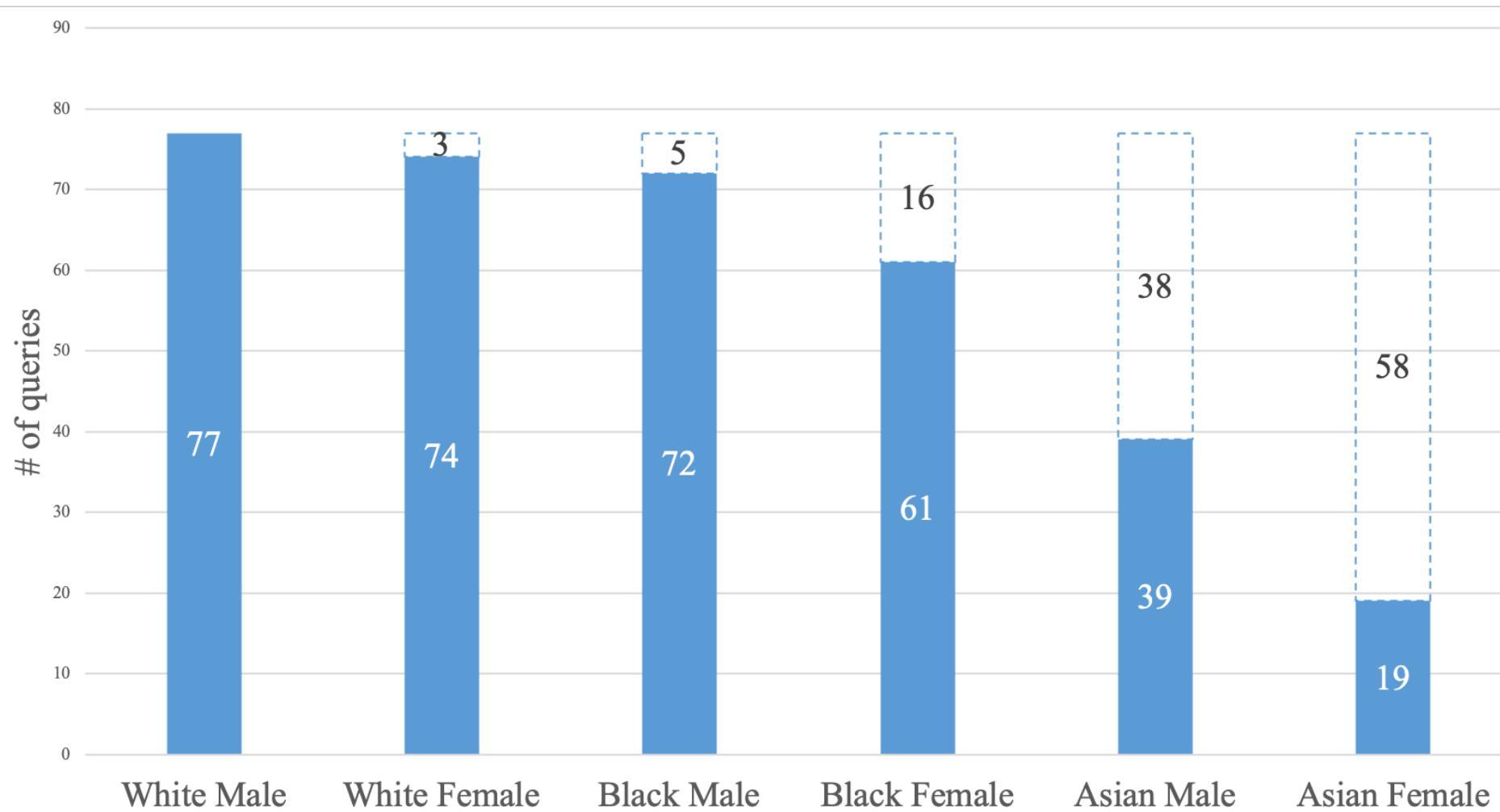
Number of queries for different partitionings

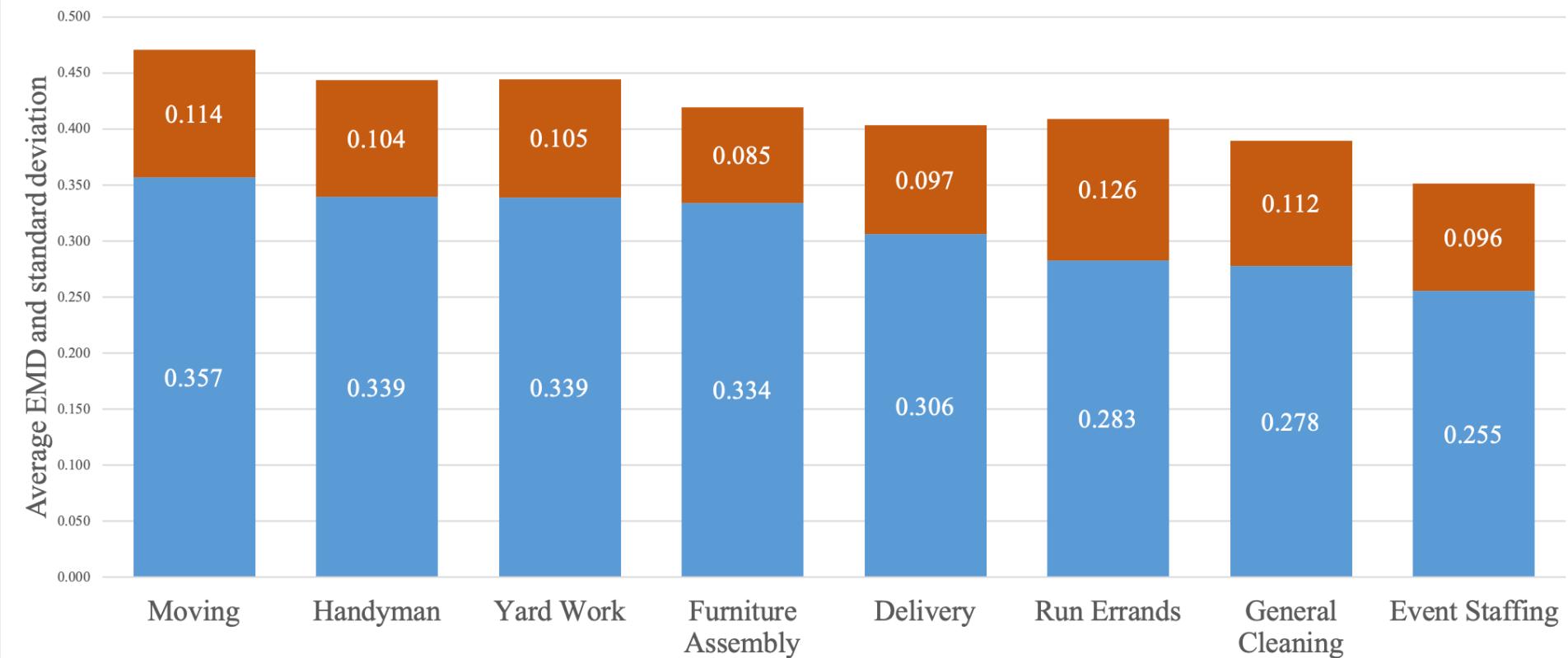


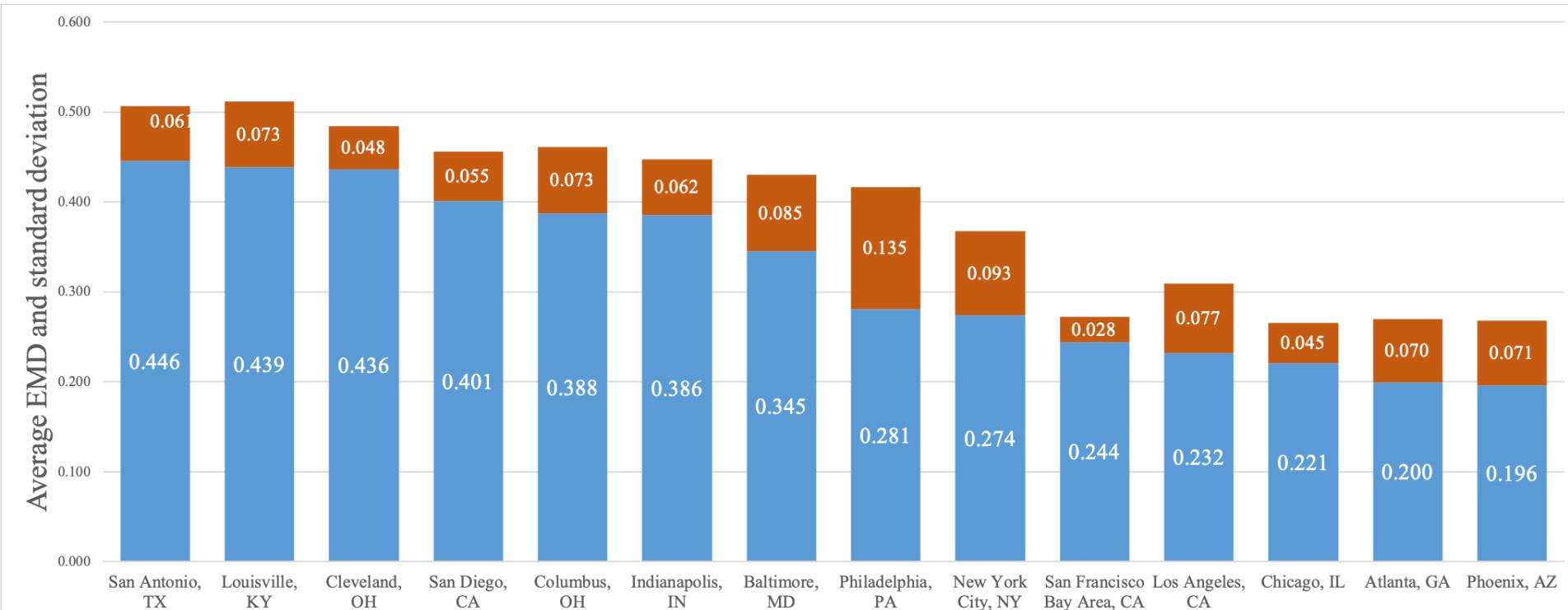
**All 112 queries returned white taskers in the top-50 rankings
(consistent with population distribution)
For the 89 queries (gender): 83% of top-50 are males
(deviation)**



Out of 77 queries (ethnicity and gender), 74 returned white females in top-50, 61 black females, 39 asian males







Conclusion

- Online job markets offer an unprecedented opportunity to quantify discrimination in ranking workers **algorithmically**
- Discrimination quantification is different from discrimination interpretation
- Many open questions
 - Repairing discrimination
 - Comparisons across multiple platforms (e.g., Web search and online labor markets)

References

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