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Algorithmic Management and Algorithmic Competencies: Understanding and Appropriating Algorithms in Gig work

Mohammad Hossein Jarrahi¹ and Will Sutherland²

¹ University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, USA
jarrahi@unc.edu

² University of Washington, Seattle, WA 98195, USA
willsk88@uw.edu

Abstract. Data-driven algorithms now enable digital labor platforms to automatically manage transactions between thousands of gig workers and service recipients. Recent research on algorithmic management outlines information asymmetries, which make it difficult for gig workers to gain control over their work due to a lack of understanding how algorithms on digital labor platforms make important decisions such as assigning work and evaluating workers. By building on an empirical study of Upwork users, we make it clear that users are not passive recipients of algorithmic management. We explain how workers make sense of different automated features of the Upwork platform, developing a literacy for understanding and working with algorithms. We also highlight the ways through which workers may use this knowledge of algorithms to work around or manipulate them to retain some professional autonomy while working through the platform.

Keywords: Algorithmic management, algorithmic competency, gig work, online freelancing.

1 Introduction

The “datafication” of many organizational processes and activities has paved the way for algorithms to aggregate and analyze data, and thereby contribute to the processes of management and decision-making [1]. Algorithms are now beyond simple data-processing code, as they prescribe protocols for work in different organizational contexts [2, 3]. Due to their analytical capacities, algorithms and smart agents are replacing some of the tasks that were seen as the responsibility of middle managers [4, 5]. For example, sensor data and algorithmic processing can provide a more accurate prediction about the arrival or departure of flights or recommendation about high performing stocks [6].

With the increasing reliance on algorithms in various contexts of decision-making, researchers have begun to voice concerns over the opaque nature of algorithms and “blind” dependence on the algorithmic approach [7]. Given the automatic quality of the

algorithm, it is easy for one to develop a kind of “complacency”, or overreliance on smart systems to make autonomous decisions [8]. To work effectively with algorithms, the human decision-maker (at all levels) still needs to retain an understanding of algorithms and the process through which they transform data into decisions, recommendations etc. [1, 9].

1.1 Algorithmic Management in the Gig Economy

Algorithmic management has emerged in digital labor platforms as a method of organizing and coordinating extremely large groups of workers and clients in an automated way [4, 10, 11]. By reducing the hiring and transacting processes programmatically, the platform can facilitate a large number of short term, and often on-demand projects [12]. The digital platform then is an organizing model, which produces flexibility through a process of scaling and automation [10, 13].

The work of coordinating and organizing workers at scale was traditionally the work of middle managers and human foremen [5], but the algorithm-based platform gains some efficiency by offloading this work to information-based decision systems [14]. This means that many of the tasks which were the responsibility of that class of managers are now carried out by automated systems, including matching workers and service recipients, assigning tasks, evaluating gig workers’ performance (through summary statistics of ratings and comments), providing information to transacting parties, and even implementing human resource management decisions [15]. The goals of this process, scaling and automation, require the minimization of human intervention, such that transactions can be carried out quickly and efficiently [4].

A consequence of this transition is that much of the process of management and decision-making is subducted into opaque algorithmic processes [16, 17]. The exact process by which an algorithm produces decisions may be convoluted and inaccessible to the common worker [2, 18]. For this reason, the decision produced by an algorithmic system can seem impenetrable, erratic, and unpredictable, and workers can become frustrated with the inscrutability of this decision-making system [15, 16].

As such, monitoring and attempting to grasp the functions of various algorithms has become an important component of gig work [19-21]. Digital platforms, which have become some of the primary facilities for the gig economy [11], operate largely on programmatic processes, and are characteristically convoluted, presenting a complex working environment for the gig worker [17, 22, 23]. However, gig workers are creative in investigating these algorithmic systems, and such investigations serve as a foundation for gaming the system, working around constraints, and generally mobilizing the algorithmic platform for the benefit of the worker’s autonomy [15, 20].

It is in fact critical not to overlook the agency of workers in adapting and leveraging algorithmic working environments. Our objective in this paper is therefore to observe the moments of agency in which workers develop a functional understanding of an algorithm, or how to use or subvert that algorithm. The platform Upwork serves as a good context for this particular line of investigation because it supports a variety of skilled knowledge work, which is hard to deskill or decompose [14, 24]. **The coordinating core**

of the Upwork platform is a suite of algorithms which match workers with clients, support transactions, and police user behavior. However, the nature of this work makes it difficult to measure, verify, and decompose algorithmically.

To unpack the value of Upwork as a research context briefly, it is helpful to look at the kind of work that is done on the platform. To date, research on algorithmic management has primarily focused on the microwork or ridesharing contexts of gig work [e.g., 2, 15, 16, 19, 22, 23]. Online freelancing—as a more knowledge intensive form of gig work—presents different work dynamics [25], and therefore workers’ engagement with algorithmic management can be different. Online freelancing typically requires specialized skills, and personal professional development. For example, on online freelancing platforms such as Upwork or Fiverr, gig workers are presented with opportunities to customize a profile, take proficiency tests and promote themselves as knowledge experts in different domains [26]. Evaluation of workers performance is also more dynamic and qualitative, and projects often involve close communication between the freelancer and their clients.

We therefore chose Upwork (as the largest online freelancing platform) with the premise that this environment gives workers more room to maneuver in the face of algorithmic constraints, or leverage them to their own benefit [27]. This makes it a valuable space in which to broaden our understanding of how workers have reacted and adapted to the inscrutability of the gig platforms as a working environment. To support this contribution, we build on an empirical study of gig workers on Upwork and their encounters with algorithms that manage their work. More specifically, this study examines how Upworkers generate an understanding of algorithms, and use this understanding to leverage algorithms to their professional advantage on the online freelance marketplace provided by Upwork.

2 Methods

Our findings are based on 33 interviews with Upwork workers, and 26 policy statements and help documents collected from Upwork’s website, as well as 98 threads collected from Upwork related online forums. The study is designed to first give the researchers an understanding of the Upwork community and its context through the forum and Upwork page data, and second to use that data to guide a more directed investigation through interviews. The forum and help page data allowed the researchers to become familiar with the services and policies operating on the Upwork platform, and acquire a broad overview of common strategies, problems, interests, and complaints of the Upwork user community surrounding those services and policies. The researchers were able to move back and forth between the two sources, discovering worker concerns or strategies in relation to Upwork’s algorithms in the forum data, and then comparing those accounts with official accounts in the help documentation. The forum data and help documentation was then used to inform a more directed investigation through interviews.

Forum data was collected from two separate forums, the “Community Discussions” section of Upwork’s website, and from a subforum known as r/Upwork on the forum

site Reddit. The Upwork forum was selected because it was moderated by Upwork directly, and was a place where workers could interact with Upwork representatives, while the Reddit forum was chosen because it is not associated with Upwork (and it is semi-anonymous), and therefore allows users a little more openness in discussing things which contravene Upwork policy. The r/Upwork was also chosen because it has a large, active community. The authors scanned the forums and collected posts that had at least one response, and which had some relevance to the Upwork platform itself, rather than focusing solely on the worker's trade. Posts were collected and analyzed iteratively, until new posts were no longer introducing new concepts. Help documentation was collected from different sections of upwork.com, including help pages and policy statements from a section devoted to technical support, and articles and recommendations from the "hiring headquarters". All the documents in the forum data and help documentation ranged between 2015 and 2018.

Interview participants were selected for diversity in the kind of work that they do. They were identified on Upwork itself, through social media platforms such as Reddit, Quora, and Twitter, and through professional websites maintained by the workers themselves. Of the 33 participants recruited this way, 20 had only used the platform as freelancers, and 13 had experience using the platform as both a client and as a freelancer. Their ages ranged from 20 to 58, and there was a high variation in profession (e.g., UX design, copywriting, industrial design, voice acting, legal writing, and animation). In order to surface latent understandings workers had about algorithms as tools and as a managerial structure, we focused on breakdowns and solutions to breakdowns in the worker's experiences with the platform and its algorithms.

More specifically, the interview protocol included questions inquiring about:

- 1) The general experience of the workers with the Upwork platform.
- 2) How they use the platform to find work.
- 3) What they know about the underlying algorithms, and how they function.
- 4) How they perceive the job recommender algorithm.
- 5) How they understand the rating and evaluation algorithms.
- 6) How they seek information about the ways the platform actually works.
- 7) How they deal with the notion of algorithmic control.

All interviews were conducted through video conferencing software, and they on average lasted one hour in length.

Data collection and analysis proceeded concurrently, allowing us to iteratively identify and refine themes iteratively, as per Maxwell [28]. Data analysis involved two major steps, and was inductive, following iterative protocols like those of grounded theory building [29]. First, the initial analysis involved subjecting the interview transcripts and forum data to interpretation using open coding [30], which resulted in common themes. Common themes were elicited based on problems or solutions in the worker's experiences with the gig algorithms that directly influenced their work. These themes were refined after the earliest interviews, and refined again after the continuous conversation between the researchers. These themes helped us identify relevant statements in the interviews and enabled us to compare them through meaning condensation. Specifically, we identified moments/statements where the worker shows some cognizance of

the algorithm’s process, or takes action to mobilize or adapt the algorithm towards their own ends.

3 Findings

Management of large groups of highly independent, highly skilled gig workers on Upwork is achieved through a variety of algorithms. The proceduralization of evaluation and decision-making processes in the form of a constellation of algorithms is a significant aspect of Upwork managerial function. However, users may experience these algorithms differently; that is, for some, algorithms and their role in organizing gig work is visible. For instance, workers involved in niche areas paid less attention towards algorithms since the platform worked relatively well for them and they were operating in an area with low labor supply. Likewise, more established gig workers in our dataset were not as cognizant of algorithms and their impact on their work, since the algorithm tended to reinforce their positions (e.g., by listing them higher in searches).

This noted, accounts provided in interviews and the dominant sentiments on the online forums portrayed a rather different picture about users’ interactions with algorithmic management: many gig workers keep abreast of Upwork algorithms and their functioning. In the remainder of this article, we outline three related activities that enable users to raise their understanding of algorithms, and to engage more effectively with algorithmic management.

3.1 Sensemaking

While the platform is easy to join and easy to use initially, it is in fact a large and complex collection of services, often coordinated automatically. Many workers put in a significant amount of time and effort developing a more sophisticated understanding of Upwork’s various ratings, timeframes, policies, and procedures. For instance, workers monitor the functioning of the platform’s rating and score-calculating algorithms very closely as they are critical to a worker’s ability to find work and charge higher rates. Participant 3 discovered that clients could leave hidden feedback after he had a bad interaction with a client and noticed that his job success score dropped afterwards: “They told me they were not going to leave me a review as long as I didn’t leave them one, so I held up my end of the bargain. A few days after the contract ended, I noticed my job success score went down from 99 to 93%.” Upwork does mention the fact that clients can leave “private” ratings in a help page, but much of the workers’ understanding of features like this and more importantly, their impact on ratings comes from close personal observation.

Workers also attempt to get a better understanding of algorithms by approaching them from the client side of the platform. This involves making a client account in order to see what information is presented about a worker, the order in which worker bids are displayed, the prominence of certain ratings or badges, and other functions of the platform’s algorithms. For example, even though Participant 3 never posted a job as a client, he used a client account to ascertain how the results of technical competency tests

he had taken changed his position in search results. He found that he was the highest rated gig workers residing in the US in that technical area and consequently used that as a promotional element in the proposals he sent to clients through Upwork.

Sensemaking is not necessarily a personal activity. Workers may use social channels such as online forums to share knowledge about underlying algorithms or collectively bring together different pieces of experiences and generate a more comprehensive understanding about algorithms. The forums were a resource for people seeking advice about how to deal with difficult clients or how to interpret certain Upwork policies. It also makes it easy to maintain a detailed perspective of many features and policies, which make up the platform. Participant 26 stated that the forums were good for “keeping on top of the platform changes, so specifically like this is the new thing and the terms of service you have to look out for, or like this change is going to affect top rated freelancers because they’re doing this, and they kind of summarize and do all of this for me, so I don’t have to dig through the documentation every time they change it.” Some workers also learn directly from other, more experienced workers. Participants 15 and 17 both took classes from an experienced Upwork freelancer, which provided concrete strategies for promoting oneself on the platform. For instance, it was from this class that Participant 15 learned that most of the jobs on Upwork are hidden, and can only be acquired on invitation from the clients, not by applying through the bidding system.

3.2 Circumventing

Understanding the algorithms and algorithmic management through sensemaking is in itself useful; this understanding provides workers with more confidence and sense of control [10]. However, as algorithms impose some constraints on the worker, gig workers may seek ways to avoid algorithmic processes, or to substitute them with outside tools. Upwork’s work diary, for instance, which tracks user activity for hourly contracts by taking intermittent screenshots and recording the number of clicks, introduces a variety of challenges for workers. Some workers are not comfortable with the surveillance it requires, and for others it becomes problematic because it does not fit into the tasks and workflows of different jobs (e.g., art and design). Participant 1 worked largely on a tablet, which would not run the tracking application. She also spent time walking when she was thinking about a particularly difficult design problem. The time tracker would not capture this kind of work, and would make it look as if she was not working at all. She, and many others, therefore avoided the time tracking system by arranging fixed price contracts, which do not require the use of the work diary and tracking system. Avoiding certain aspects of the platform in this way is a required skill for workers, as the platform presents a large number of resources, many of which may serve as a means of control or surveillance, or may not fit into a worker’s own professional habits and processes.

Similarly, the contracting system, with its automated escrow and invoicing features, is also avoided by some workers due to its transaction fee (Upwork’s commission). In these situations, the worker is leveraging the matching capabilities, profile system, and

bidding system of the platform, but actively avoiding the security provided by the contracting system. Workers find circumventing this part of the platform risky, so they often create a careful process to move transactions off the programmatically-driven contracting system (on Upwork) into a trust-based transaction through Paypal or another payment platform. Participant 6 described the need to build rapport with the client before taking payment processing off-platform: “Well after the first time they actually see that I’m not a freak and I do a good job and will do the work that’s when I’ll usually ask.” In this sense, circumvention is not just ignoring or avoiding some component of the platform, but actively extending contracts on the platform into external, third-party applications.

The challenge of using Upwork’s algorithmic resources then becomes an issue of leveraging those resources selectively, and sometimes integrating outside tools to fill in the gaps. External communication tools were specifically leveraged by Upworkers. Upwork reinforces the use of its communication channels, particularly its messaging application, which allows automatic recording and monitoring of conversations. The algorithm reacts to the use of terms such as skype or phone when typed into the chat box. However, workers often go around this communication channel and employ other communication and information sharing tools. For example, they may switch to email once a project is arranged, or join the project management tools of their clients. Participant 15 uses the Upwork messenger in addition to other communication and cloud services to coordinate and communication with clients. Like several other participants, he shares large work deliverables (e.g. images) via Dropbox and shares his writing with clients via Dropbox Paper (a collaborative document-editing service), but leaves traces of these as completed milestones in the Upwork messenger so that Upwork has a record of transactions (as evidence just in case of a disputes with a client).

3.3 Manipulating Algorithms

By providing different inputs to the platform’s various data collection processes, workers can alter, observe and improve its output, manipulating various platform algorithms. This allows workers to make better use of some parts of the system. One of the well-known inefficiencies in the Upwork platform is the inaccuracy of its job recommendations. Participant 9 described how inaccurate these ratings could be: “a lot of jobs I was kind of just throwing my hands in the air and saying this is an entirely different branch from what I am doing, why are you suggesting this? Like they’re looking for a special effects artist in this 3D thing and ...I’m a 3D character artist and animator.” However, Participants 6 and 15 both learned that they could ‘save’ searches with the Upwork platform. Through experimentation with the platform, they discovered these saved searches would be used by Upwork’s recommender system to improve the recommendations it made to them. This is a lesser known feature amongst the other workers we interviewed, and many, like Participant 9 complained about the inaccuracy of the platform’s recommendations.

Even without understanding the intricacies of an algorithm’s rules, workers are able to manipulate their results simply by changing the data that goes into it. For instance,

Participant 29 described how he helped a subcontractor improve his hourly rate by altering the hours they reported to the platform: “he did like 4 hours for me but he wanted to do it as 1 hour of work on Upwork at four times the rate so it looks like he’s getting a much higher payment.” Having a higher rate recorded on the subcontractor’s profile would help him get a higher rate on future projects. In a similar way, Participant 21 would close and reopen contracts in order to acquire more ratings: “every time you spend over \$5 on the platform you can basically close a contract and get a rating.” Working long-term projects means receiving fewer total ratings, which makes it more difficult to maintain a solid job success score because a single bad rating has more influence. This strategy is an effective way for Participant 21 to bolster his overall base of good ratings, thereby generating more professional stability on the platform.

By understanding how certain components of the platform work, workers can improve their functionality, or even make alternative uses of a certain feature. Some participants were able to do this with Upwork’s large collection of proficiency tests (e.g., knowledge of English grammar or user experience design). While some participants perceived these tests as useful, most did not think they were accurate reflections of their skills and therefore did not take them, partially because they did not think that clients looked at them. Those participants who also worked as clients largely confirmed this. However, Participant 15 found that taking the skills tests provided by Upwork made him more prominent in search results for terms related to his skill. In this way, he was able to make use of the tests not to better present his skills on his profile, but to appear more competitive to the search algorithm.

4 Discussion

Algorithms undergirding important functions such as reputation and search systems serve as key resources in managing digital platforms and mediating the transaction of services, but they also act as a means of coordinating and controlling workers. Therefore, algorithmic management may diminish workers’ sense of autonomy by impeding their ability to navigate and control important aspects of their work due to the complex and opaque nature of the algorithms themselves.

However, research findings presented here make it clear that workers are not passive recipients of algorithmic management and control. They develop what we call *algorithmic competencies* to deal with and appropriate algorithmic management exercised by the platform. Sensemaking activities allow users to create a working understanding about algorithms and how they may affect their work. Gig workers use sensemaking strategies to open the black box of algorithms used by digital platforms, or at least gain enough familiarity with the platform’s functions to effectively work with and around them.

Building on this learning process, workers may decide to circumvent or manipulate the algorithms to their advantage. They may go around the constraints posed by the algorithm by pulling together other resources and technologies, or may use their knowledge of algorithms to manipulate them for desired outcomes. As such, the plat-

form’s algorithms, which can be understood as an automated manifestation of the interests of the platform organizer (here Upwork Global Inc.) are not deterministic rules [2]. Rather, workers appropriate and extend the digital platform’s system of programmatic processes as part of an information infrastructure [14].

It is clear then that the relationships established between gig workers and algorithms are mutually constitutive. As shown in Fig. 1, algorithms shape workers and clients interactions on the platform, but are simultaneously shaped by worker activities. In this process, workers develop and draw on their algorithmic competency, which we define as a form of “data infrastructure literacy” [23] or “infrastructural competency” [31] needed to effectively interact with algorithms. Algorithmic competency refers to workers’ understanding of algorithms that assign and assess work conducted on gig platforms, and learning how to work with and around those algorithms. Our data suggests algorithmic competency here is comprised of three key practices of sensemaking, circumventing and manipulating algorithms.

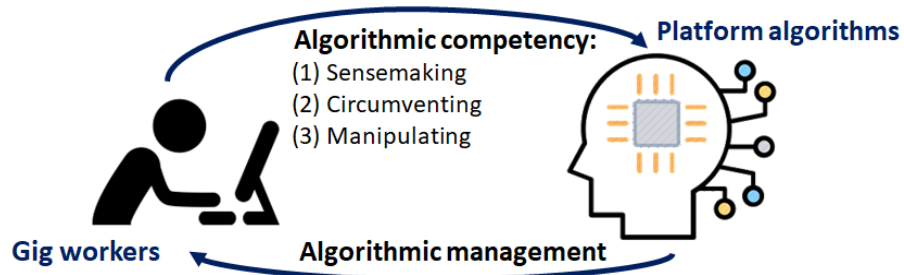


Fig. 1. The mutual shaping of gig workers and platform algorithms.

A consequence of this agency is that the platform’s algorithms are embedded in the professional and personal contexts of the platform’s population of users. Algorithmic management is therefore a sociotechnical process that emerges as the result of continuous interactions between platform algorithms and users. It is not only the algorithms that shape the work practices of the gig worker; how workers encounter algorithms also shape algorithmic outcomes and decision-making. For example, previous research indicates social biases against certain races or genders (in rating and reviews done by the user) can be easily fed back into the recommendation and search algorithms [15]. Therefore, these interactions can be understood as example of “heteromated systems” whereby both algorithms and humans are reconfigured [16].

5 Conclusion

Many gig workers are considered independent, contingent workers, but what may make them distinct from other traditional independent workers is their usage of digital labor platforms, which are a cornerstone of the gig economy [32, 33]. A defining character-

istic of digital labor platforms is their reliance on algorithms that perform many management functions previously conducted by human managers in traditional work organizations. Algorithmic management therefore has an important bearing on the overall experience of gig workers. The lack of clarity and transparency are often intentional elements of algorithmic management, since the platform organizers do not wish the workers to game the system [15, 17, 34]. Nevertheless, previous research indicates transparency about algorithmic decisions provides users with a higher level of trust, resulting in more effective cooperation with smart technologies [35, 36].

Our findings suggest that the inner workings of many algorithms on Upwork are not completely clear to the gig workers, and this information asymmetry may hinder the workers' ability to gain control over their work. The ability to understand and make use of algorithms has therefore become a core competency of workers attempting to retain autonomy in the dynamic and uncertain working conditions, which have emerged in the gig economy.

Online labor platforms extend the reach of online freelancers by providing a marketplace to land new projects [24], but the global scale of this platform often results in fierce competition with people all over the world. Algorithmic competency can therefore also be seen as a source of personal competitive advantage in this global marketplace, whereby gig workers can distinguish themselves from thousands of online workers competing for the same type of projects/gigs. In addition to other key competencies such as social or knowledge skills (to keep up with the different and changing knowledge domains) that support all forms of independent, self-employed work [33], gig workers need to understand how to interact effectively with platform algorithms that assign and evaluate work.

References

1. Newell, S., Marabelli, M.: Strategic opportunities (and challenges) of algorithmic decision-making: A call for action on the long-term societal effects of 'datification'. *The Journal of Strategic Information Systems* 24, 3-14 (2015)
2. Wagenknecht, S., Lee, M., Lustig, C., O'Neill, J., Zade, H.: Algorithms at Work: Empirical Diversity, Analytic Vocabularies, Design Implications. *Proceedings of the 19th ACM Conference on Computer Supported Cooperative Work and Social Computing Companion*, pp. 536-543. ACM (2016)
3. Schildt, H.: Big data and organizational design—the brave new world of algorithmic management and computer augmented transparency. *Innovation* 19, 23-30 (2017)
4. Möhlmann, M., Zalmanson, L.: Hands on the wheel: Navigating algorithmic management and Uber drivers' autonomy. *proceedings of the International Conference on Information Systems (ICIS 2017)*, December 10-13, Seoul, South Korea, (2017)
5. Howcroft, D., Bergvall-Kåreborn, B.: A Typology of Crowdwork Platforms. *Work Employ. Soc.* 0950017018760136 (2018)
6. McAfee, A., Brynjolfsson, E.: Big data: the management revolution. *Harv. Bus. Rev.* 90, 60-66, 128 (2012)

7. Galliers, R.D., Newell, S., Shanks, G., Topi, H.: Datification and its human, organizational and societal effects: The strategic opportunities and challenges of algorithmic decision-making. *The Journal of Strategic Information Systems* 26, 185-190 (2017)
8. Cegarra, J., Hoc, J.M.: The role of algorithm and result comprehensibility of automated scheduling on complacency. *Human Factors and Ergonomics in Manufacturing & Service Industries* 18, 603-620 (2008)
9. Ananny, M., Crawford, K.: Seeing without knowing: Limitations of the transparency ideal and its application to algorithmic accountability. *New Media & Society* 20, 973-989 (2018)
10. Sutherland, W., Jarrahi, M.H.: The sharing economy and digital platforms: A review and research agenda. *International Journal of Information Management* 43, 328-341 (2018)
11. Newlands, G., Lutz, C., Fieseler, C.: Algorithmic Management in the Sharing Economy. *Academy of Management Global Proceedings* 130 (2018)
12. Wood, A.J., Graham, M., Lehdonvirta, V., Hjorth, I.: Good gig, bad gig: autonomy and algorithmic control in the global gig economy. *Work Employ. Soc.* (2018)
13. Newlands, G., Lutz, C., Fieseler, C.: Collective action and provider classification in the sharing economy. *New Technology, Work and Employment* (2018)
14. Alkhatib, A., Bernstein, M.S., Levi, M.: Examining Crowd Work and Gig Work Through The Historical Lens of Piecework. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, pp. 4599-4616. ACM (2017)
15. Lee, M.K., Kusbit, D., Metsky, E., Dabbish, L.: Working with Machines: The Impact of Algorithmic and Data-Driven Management on Human Workers. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, pp. 1603-1612. ACM (2015)
16. Rosenblat, A., Stark, L.: Algorithmic labor and information asymmetries: A case study of Uber's drivers. *International Journal of Communication* 10, 3758-3784 (2016)
17. Jhaver, S., Karpfen, Y., Antin, J.: Algorithmic Anxiety and Coping Strategies of Airbnb Hosts. In: *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, pp. 421. ACM, (Year)
18. Kumar, N., Jafarinaini, N., Bin Morshed, M.: Uber in Bangladesh: The Tangled Web of Mobility and Justice. *Proceedings of the ACM on Human-Computer Interaction* 2, 98 (2018)
19. Raval, N., Dourish, P.: Standing out from the crowd: Emotional labor, body labor, and temporal labor in ridesharing. *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*, pp. 97-107. ACM (2016)
20. Martin, D., O'Neill, J., Gupta, N., Hanrahan, B.V.: Turing in a Global Labour Market. *Comput. Support. Coop. Work* 25, 39-77 (2016)
21. Lampinen, A., Lutz, C., Newlands, G., Light, A., Immorlica, N.: Power Struggles in the Digital Economy: Platforms, Workers, and Markets. In: *Companion of the 2018 ACM Conference on Computer Supported Cooperative Work and Social Computing*, pp. 417-423. ACM, (Year)
22. Ma, N.F., Yuan, C.W., Ghafurian, M., Hanrahan, B.V.: Using Stakeholder Theory to Examine Drivers' Stake in Uber. In: *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, pp. 83. ACM, (Year)
23. Shapiro, A.: Between autonomy and control: Strategies of arbitrage in the "on-demand" economy. *new media & society* 20, 2954-2971 (2018)

24. Popiel, P.: "Boundaryless" in the creative economy: assessing freelancing on Upwork. *Critical Studies in Media Communication* 34, 220-233 (2017)
25. Shafiei Gol, E., Stein, M.-K., Avital, M.: Why Take the Risk? Motivations of Highly Skilled Workers to Participate in Crowdfunding Platforms. *ICIS 2018. Association for Information Systems* (2018)
26. Green, D.D., Walker, C., Alabulththim, A., Smith, D., Phillips, M.: Fueling the Gig Economy: A Case Study Evaluation of Upwork. *com. Management and Economics Research Journal* 4, 104-112 (2018)
27. Kalleberg, A.L., Dunn, M.: Good jobs, bad jobs in the Gig Economy. *Perspectives on Work* 20, (2016)
28. Maxwell, J.A.: *Qualitative research design: An interactive approach*. Sage publications (2012)
29. Strauss, A., Corbin, J.M.: *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications, Inc (1990)
30. Glaser, B.G.: *Advances in the methodology of grounded theory: Theoretical sensitivity*. Mill Valley, CA: Sociology Press (1978)
31. Sawyer, S., Erickson, I., Jarrahi, M.H., Thomson, L.: *Infrastructural Competence*. In: Ribes, D., Vertesi, J., Jackson, S.J. (eds.) *Digital STS Handbook*. Princeton University Princeton, NJ, in press. (2018)
32. Sutherland, W., Jarrahi, M.H.: *The Gig Economy and Information Infrastructure: The Case of the Digital Nomad Community*. *Proceedings of the ACM on Human-Computer Interaction* 1, (2017)
33. Barley, S.R., Bechky, B.A., Milliken, F.J.: *The Changing Nature of Work: Careers, Identities, and Work Lives in the 21st Century*. *Academy of Management Discoveries* 3, 111-115 (2017)
34. Eslami, M., Vaccaro, K., Karahalios, K., Hamilton, K.: "Be Careful; Things Can Be Worse than They Appear": Understanding Biased Algorithms and Users' Behavior Around Them in Rating Platforms. In: *ICWSM*, pp. 62-71. (Year)
35. Hannák, A., Wagner, C., Garcia, D., Mislove, A., Strohmaier, M., Wilson, C.: *Bias in Online Freelance Marketplaces: Evidence from TaskRabbit and Fiverr*. *CSCW*, pp. 1914-1933 (2017)
36. Lee, M.K.: Understanding perception of algorithmic decisions: Fairness, trust, and emotion in response to algorithmic management. *Big Data & Society* 5, 2053951718756684 (2018)