

INF380E: Crowdsourcing Uncovered - A Literature Review

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ABSTRACT

As the price and scope of information processing, and in some cases generation, continues to grow various institutions have begun to turn to crowdsourcing in an effort to alleviate some of the burden on their own resources. This literature review takes a broad look at the current state of crowdsourcing as it finds itself being put into use by various institutions. While crowdsourcing itself exists as a separate entity from the idea of human computation, it does share many of the same attributes. In the course of evaluating different concepts we have identified as components of crowdsourcing as we know it, such as the specific qualities of requesters and workers we also discuss the various challenges associated with implementing crowdsourcing.

Keywords

Crowdsourcing, human computation, workers, requesters, literature review.

INTRODUCTION

The word "crowdsourcing" first entered the lexicon only a few years ago in a Wired magazine article and has become a widely used term since that moment. According to Merriam-Webster, **crowdsourcing** is the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, and especially from an online community, rather than from traditional employees or suppliers. As the Wired magazine article put it, "Technological advances in everything from product design software to digital video cameras are breaking down the cost barriers that once separated amateurs from professionals. Hobbyists, part-timers, and dabblers suddenly have a market for their efforts, as smart companies in industries as disparate as pharmaceuticals and television discover ways to tap the latent talent of the crowd. The labor isn't always free, but it costs a lot less than paying traditional employees. It's not outsourcing; it's crowdsourcing."

The beauty of crowdsourcing lies in the seemingly endless pool of participants that have the ability to take part in a task whether through some altruistic ideal or through monetary incentives as their motivation. In the seven years

since the Wired Magazine article crowdsourcing and human intelligence tasks(or HITs) have become potential solutions to deal with massive amounts of data and provide a low cost alternative to conventional information generation and processing. A wide range of institutions have begun to embrace crowdsourcing as a viable option for their endeavors. These organizations, ranging from academic institutions to private companies, have turned to crowdsourcing in an attempt to drive down the cost of labor and deal with processing the data they currently have on hand and that will be generated in the future.

Through our research we will attempt to focus on crowdsourcing as a whole and serve as a response to the apparent growth of crowdsourcing in varying arenas. In addition to merely defining and exploring the uses of crowdsourcing, we hope to identify the problems and associated solutions involving crowdsourcing as a tool. With the amount of data being generated and transferred it has become a daunting task to transform the data into information for human consumption while providing incentives and a streamlined system for the participants of crowdsourcing.

The ultimate aim of this literature review is to explore crowdsourcing in its current form and see how it will develop in the future as more organizations seek to use it for their own purposes. To do this we began with some basic questions that guided our search for literature and synthesizing basic concepts. We first begin with the seemingly simple question, what exactly is crowdsourcing as defined by the institutions and researchers currently using it as a tool? Is it merely a cost cutting method or does it mean something more both for the entities and users?

Once that question has been addressed we are then able to move on to our second question, what challenges does crowdsourcing face? Can the solutions provided within the articles and by researchers apply to crowdsourcing as a whole? Or do some of these solutions work exclusively for processing or creation of content?

Crowdsourcing as a tool is a new and unproven method for tasks associated with information synthesizing and processing. As a result of the "newness" there are certain

limitations involved in crowdsourcing which need to be addressed and studied as the use of it continues to grow. In this way we can potentially put together a system which utilizes a collective of human wisdom concentrated on a collaborative effort in various fields.

The first section of this literature review will attempt to define crowdsourcing by defining the generally identifiable traits associated with the concept. The following section will focus on the methods employed by entities which use crowdsourcing. The third section examines the participants involved in crowdsourcing, both the requesters and workers. The fourth section explores the various fields which have embraced crowdsourcing and fields which might benefit from its use. The next section will detail the policies and challenges associated within the subject. We will conclude this literature with a general discussion of the literature we have mentioned and discuss possible future work that others might explore as it relates to crowdsourcing.

DEFINITION AND DEVELOPMENT OF ATTRIBUTES

How do we define crowdsourcing?

Since its initial definition presented in 2006, crowdsourcing has evolved into a powerful process with a seemingly endless supply of participants. Holley (2010) seeks to broaden the general definition to one that includes acknowledging the expanded effort involved that takes it beyond the realm of simple social engagement by individuals over a period of time. These individuals, who can come from varying backgrounds and locations, find themselves as possible participants of human computation Quinn (2011). While crowdsourcing is capable of partaking in human computation tasks, Quinn et al. attempt to make a clear distinction between the two general concepts. However, crowdsourcing itself shares many qualities with human computing and the way in which crowdsourcing has developed emphasizes the similarities between the two concepts. Crowdsourcing as explained by Quinn et al. means utilizing members of a crowd to take on the job normally done by traditional workers or employees whereas human computation denotes tasks undertaken by humans that cannot be completed by computers. Crowdsourcing finds itself entrenched within the idea of human computation as well as existing on its own. Sticking with Quinn et al. we find that the manner in which they classify human computation overlaps heavily with the idea of crowdsourcing.

The key classifications can be summarized as follows:

- Motivation – pay, altruism, enjoyment, reputation, implicit work.

- Quality Control – output agreement, input agreement, economic models, defensive task design, redundancy, statistical filtering, multilevel review, automatic check, reputation system.
- Aggregation – collection, wisdom of crowds, search, iterative improvement, genetic algorithm, none.
- Human Skill – visual recognition, language understanding, basic human communication.
- Process order – Computer → Worker → Requester, Worker → Requester → Computer, Computer → Worker → Requester → Computer, Requester → Worker.
- Task-Request Cardinality – one-to-one, many-to-many, many-to-one, few-to-one. (Quinn et al. 2001)

Each of these specific classifications find themselves rooted in conventional crowdsourcing examples. The classification system that has been assembled by Quinn and Bederson (2011) presents human computation and, by extension, crowdsourcing as a multifaceted entity which can take on numerous jobs. The list of general terms also provides an interesting groundwork from which future human computation study and, specifically, crowdsourcing can learn from as the field moves forward. This works particularly well when choosing a set vocabulary for each of the general ideas involved in human computation and its accompanying disciplines. While we will not completely explore each of these classifications in depth we will, however, discuss the more salient components in the section which focuses on crowdsourcing participants.

Method

Methods are applied into crowdsourcing field mainly solve the problem matching the requesters and workers in order to make sure the efficiency and quality of the work. Some also consider the effect of certain factors that might affect the process and result of crowdsourcing.

Schall (2012) uses hierarchical clustering approach to identify the relationship between keywords and the tasks the requesters posted, in order to help workers find the task in a more convenient way. They borrow methods and techniques from information retrieval field, “including term-frequency metrics, measuring similarities, and hierarchical clustering”, and apply them into this approach. They come up with “hierarchical clustering to structure the flat set of task-based keywords into a hierarchy”. They calculate “the co-occurrence frequency of each keyword and second group pairs of keywords into clusters based on a distance metric”. At the beginning, every keyword itself is its own cluster. After pairing them, clusters are merged, based on the level of the keywords, then form into a

hierarchy. After testing different kinds of clustering algorithms, they find that “pairwise average-link” can merge the highest cohesion through progress of pairing, and they use “city-block distance” to calculate the cohesiveness of each clusters. They choose 300 keywords as their data set and choose the keywords that had a frequency of co-occurrence at least 10 times with other keywords. And as a result their algorithm come out 328 clusters. Then they use the structure of keyword hierarchy to create communities from clusters, by associating collections of HITs to clusters. Schall (2012) also uses “community detection techniques” to explore the online social media which relate to crowdsourcing, in order to identify the trends and find the most important communities and requesters with high reliability. They use the result from hierarchical clustering and certain algorithm to determine the popularity of communities then decide the tasks posted by the most reliable requesters. Thus, workers’ payment can be guaranteed through this crowdsourcing platform.

Mashhadi et al. (2013) talk about use of crowdsourcing to map the whole world with highly positional accuracy. They use OpenStreetMap (OSM) as an example to investigate what contextual factors correlate with coverage of OSM information in urban settings. They found out that “population density, dynamic population, distance from the center, poverty and other different contextual factors” are correlated with information coverage. This is the first step towards planning interventions, such as developing incentives to nudge the community to take part in a more guided crowdsourcing act. They think that being aware of the contextual factors that affect coverage of crowdsourcing urban information is more important for end-users too, so that to understand where they can rely on the crowd-sourced information. They use dataset from OSM, and use the “nodes, ways, and relations” of different spatial object to present the position, sequence and relation among them. To narrow down their research, they mainly choose nodes that present leisure places because in these places people check in the most, so that it is easier to conduct the research. They choose users who contribute with “an excessive number of edits in a very short time”, and choose London, an urban city with many socio-economic factors to explore with. They use coordinates and the name of the place to locate, and find the geographic errors and lexicographic errors with Points-of-Interest (POI) matching algorithm. They take a perspective from contributors or workers to explore the factors that may affect them and then find a way to better understanding how crowdsourcing make the world a difference.

Lang and Rios-Ross (2011) present a project which uses the Amazon Mechanical Turk to find participants to transcribe historical letters. The driving force behind this project is the time and cost needed to transcribe the handwritten documents by following traditional methods. Lang and Rios-Ross use various methods to include a quality

assurance aspect to the transcriptions that include multiple user proofreading and inserting words/letter to ensure thorough proofreading by secondary users in different Human Intelligence Tasks (HITs). To assurance the accuracy, they have each document transcribed twice by two different workers so that the second one can work as a proof of the first transcription, with micropayments. They also have to come up a balance between the cost and the speed and quality of their transcription process by workers since workers have their choices from the crowdsourcing market. So the strategy here is to calculate HITs within certain cost and acceptance days of the work. This process calls “design stage” by them. During the second stage, they upload both the original manuscript image and the first edition of transcription to the workers, and have the workers to help correct the mistakes to assure the quality.

CROWDSOURCING PARTICIPANTS

Workers

As we have come to find out and anticipated from the onset of this review, the main component of any form of crowdsourcing is the worker that chooses to participate in the task. Whether the task has been offered by the requester or by simply generating content, workers comprise the crowd needed for crowdsourcing to take place. For most workers the idea of participation comes from different motivations and even combinations of motivating circumstances.

Pay

With the advent of the Amazon Mechanical Turk or Mturk, the ability to pay workers for each of the jobs they complete has become an easy job for requesters. The nature of the MTurk allows requesters to set a specific monetary amount to be awarded, which enables requesters to find what could be considered the “right” amount for any given task. Although, as Quinn et al. (2011) point out, there could be instances in which workers attempt to cheat the system in order to obtain rewards for little or no work.

With rates as they are presently set, our method offers transcription and proofreading at a rate of \$0.18 per page, plus the 10% service charge to Mechanical Turk. Thus, our services can be implemented by private collectors for roughly \$0.20 per page. Should one choose to add another stage of proofreading, this might increase to \$0.30 per page. The exact cost will depend on exactly how long you are willing to wait for the transcription and proofreading process. (Lang and Rios-Ross 2011)

The rewards dispersed vary widely for any given posting on Mturk and have an impact on how workers decide which HITs to undertake. While the above example from Lang and Rios-Ross shows the finalized rewards, which exceed \$0.10, they initially began with a target reward offering of around \$0.08 and below but found the motivation of the

workers to be lacking, resulting in an extended amount of time taken to complete the transcription tasks assigned to them.

Similarly, Mason et al. (2010) experimented using the Mturk and found that no matter how difficult a particular HIT appeared or how difficult it actually was to complete workers chose to take on the tasks where the pay was higher. This reinforces our initial thoughts going into the literature review that higher pay would draw in more participants. Given that the quantities of pay remain at relatively low levels versus the higher cost of paying experts of employees, crowdsourcing can continue to motivate workers through pay. This motivation appears to be acceptable despite workers often times believing they should get paid more for the work they have done. (Mason et al. 2010)

Reputation and Feedback

While pay serves to motivate most crowdsourced workers, another catalyst for completing HITs and increasing the quality of work comes in the form of reputation and feedback.

Horton (2010) explored how workers increased their qualitative output when given the ability to look at high quality work and evaluate it themselves. While pay factored in to the experiments in the form of bonuses for peer evaluated entries, the influx of good and bad examples of work provided feedback for the workers as they moved forward with their own labeling tasks. Following the same general idea about feedback and reputation facilitating improved work and motivation by workers, Dow et al. (2012) take evaluation a step further by showing the difference between work which had no assessment, self-assessment, and external assessment. With the implementation of their *Shepherd* application, researchers were able to provide real-time feedback for participants in crowdsourcing tasks. This circumvents the normal process in which feedback for workers comes at the time of payment and generally has no impact on increasing the quality of work submitted by a worker, "The fact that someone else is paying close attention may motivate workers to take more responsibility for their work (Dow et al. 2012). Whereas Quinn et al. (2011) mention reputation as caring about public recognition and what other people think thus being motivated in that way directly, feedback works in much the same way but on a much smaller scale and in some cases recognizing the quality of your own contribution.

Altruism

Holley (2010) reinforces the idea of feedback and reputation by acknowledging increased volunteer performance when dealing with a non-pay system. This sense of altruistic motivation permeates many aspects of crowdsourcing. To reduce the incentive to cheat (e.g., for

money or glory), altruistic crowdsourcing approaches leverage the intrinsic motivation of a community interested in a domain (Sabou et al. 2012) This idea of capitalizing on interest in a domain provides an interesting answer for one of our initial questions regarding what exactly crowdsourcing means to the users or workers.

REQUESTERS

Most researches in crowdsourcing users focus more on the workers, from motivations to mechanism to make sure they are well paid. However, there are seldom researches focusing on the requesters, people who use crowdsourcing platform to find workers achieve their works. Afra et al. (2013) classify users of crowdsourcing into two categories: requesters and workers. As requesters, who pay for collecting works, they are always considering the coordination of the work and task decomposition, making sure their task can be well divided into several parts to contribute workers complete them in a more organized way, which could reducing the future works on reorganizing. Requesters also regard quality control as an important issue, since all employers always want their task completed with good or at least acceptable quality within certain costs. All of these factors may request them addressed through workflow mechanisms, such as electronically mediated collaboration.

Current situation of crowdsourcing often cannot satisfy the need of various kinds of more professional work due to insufficient support of complexity, creativity, and skills from workers. So requesters need a better system to help them divide more professional work to its users. Besides, Cavallo and Jain (2012) think that the goal for the requesters is to procure the best submission for the lowest possible price. Afra et al. (2013) propose several strategies to meet this need, enable complex crowd work process in certain fields: designing, workflows, assigning tasks, supporting hierarchical structure, enabling real-time crowd work, supporting synchronous collaboration, and controlling quality.

FIELDS AND APPLICATIONS

By utilizing the power of crowds, academic institutions have the opportunity to hand off work to the masses and process data at a much faster rate than would normally be possible. Crowdsourcing has been successful in a number of cases and continues to be utilized by different institutions ranging from libraries to scientific fields such as biology and astronomy. (Oomen and Aroyo. 2011) Despite some of the successes enjoyed by members of the galleries, archives, libraries and museums or GLAM groups the use of crowdsourcing by organizations across these groups has yet to be seen. Holley (2010) champions the use of crowdsourcing and provides potential guidelines for putting specific goals at the forefront of libraries which could

include both processing and creating content. The Written Rummage project, as detailed by Lang and Rios-Ross (2011) displayed how processing archival records and transcribing could be done by crowdsourced workers. This work could work wonder for clearing some of the backlog archives routinely deal with as they seek to process the entirety of their collection and future collections. The GLAM institutions have the possibility of learning from various scientific outreach organizations and the methods they have used in dealing with crowdsourcing.

These scientific outreach organizations include:

Zooniverse

By accessing the power of the crowd, Zooniverse has created a collection of scientific endeavors built upon the idea of citizen participation. It initially began as a singular project, Galaxy Zoo, and has since expanded into other aspects of scientific disciplines including biology and climatology. In addition to these science topics Zooniverse crowdsourcing has a hand in humanities projects, most notably the Oxyrhynchus collection which is being used to help transcribe ancient Greek texts.

Open Dinosaur Project

In order to create a database which lists the limb bone measurements of dinosaurs, the Open Dinosaur project (ODP) turned to crowdsourcing as a way to form this comprehensive database. In addition to the creation of the database itself, and what makes the ODP very intriguing, is the way in which the creators call the entire endeavor an open research project. This draws upon the crowd to not just create the data but to partake in the research itself.

FoldIt

FoldIt revolves around folding proteins in to specific shapes so as to understand the structure of it. The ultimate aim of FoldIt is to show that human folders do the job more efficiently than computers. With the help of crowdsourced workers, an eventual goal of FoldIt is to actually design proteins which could potentially have real world implications.

The idea of gamification appears to be a novel way to motivate workers and help apply crowdsourcing in various fields of study. While FoldIt uses gamification for scientific purposes, this type of crowdsourcing can be used for things as simple as annotations and even the generation of content. Tuite et al. (2011) take gamification to an interesting new level with their experiment called PhotoCity. PhotoCity is an interesting use of crowdsourcing to create 3D models of various buildings in a specific location. Participants take photos of buildings from different angles in an attempt to “capture” flags and locations. This kind of experiment provides the groundwork for interactive and beneficial crowdsourced work on a smaller but intensive scale. Surprisingly, and perhaps even encouragingly, the

participant numbers remained relatively small but they contributed a vast amount of useable data all in the name of entertainment. Eickhoff et al. (2012) note that Rather than rely on monetary compensation they were able to show that simply providing entertainment was acceptable for HITs. Even without being paid the annotations provided by the crowdsourced workers resulted in high quality results and a low presence of cheating normally associated with crowdsourced work.

Annotating images and text by using these crowdsourced workers has the ability to help information retrieval by generating annotations for a whole host of multimedia and text documents. Additionally, Sabou et al. (2012) mention natural language processing (NLP) as an area that could potentially embrace crowdsourcing beyond its use in small projects. By generating large batches of resources, NLP and crowdsourcing have the chance to advance information retrieval as it moves toward a more semantic way of dealing with searches.

POLICY

Policies need to be made regarding the platform of crowdsourcing to ensure the fairness and efficiency of the entire process.

Grier and Alan (2013) think that crowdsourcing need four different elements: “person, usually called the crowdsourcer, who manages the process; a group of people, called the crowd, who do work; a market, usually called the crowdmarket, that’s used to help manage the contributions of the crowd (crowdmarkets are often found on Internet sites that are called crowdsites or platforms); and means of communicating with the crowd – usually the Internet.”

Rules and policies imposed on the crowdmarket, which usually works on a system for crowdsourcers and crowd interact with each other to achieve certain goals. The system, always works as a crowdsourcing platform, usually a website gives crowdsourcers access to work on crowdsourcing. There are two kinds of rules, one is called “the contract or contest rule”, another one is called “collaborative market”.

The contract or contest rules means requesters make rules to decide how to pay the crowd: they can pay every member who contributes to their project or select the person who does the best job which is called “winner-take-all”. There is also a difference between contract crowd market and contest crowd market. In contract crowd market, there are two forms of crowdsourcing- “macrotasking and microtasking” applied to the field. In the macrotask market, workers are usually paid by the hours they work, no matter how much work they have done for the project. While, in the microtask market, requesters always pay workers by how much of the task or how many tasks they have accomplished but do not consider how much the time they spent on the task. The problem here is that for macrotask

market, requesters might face a risk that workers would not accomplish a certain quality and quantity of work they expected within certain cost. And for the microtask, workers may not get well paid compared with the contribution they devote into the task. In contest crowd market, there is always a contest between workers, and it is always the requesters who decide who can get paid in the end. This “winner-take-all” policy can make sure requesters get their best or most satisfactory work with a settled cost. One of forms in this area is “self-organized crowds”. Workers themselves form their team and work together to compete with other workers or crowds to get the reward from requesters. After requesters decide the best submission and have paid for the best work, the crowd itself decides who gets how much pay within the team. The advantage of this kind of strategy is people form into a team to improve the competitive power in order to win the contest to get paid. Requesters also do not need to care about how to divide or pay their worker since the crowds make the decision themselves. A well-organized team can benefit all of its members, which increase the market competitiveness. A collaborative market means in which requesters separate their work or project into several units to encourage workers to collaborate to complete the job. Workers do their job separately, which is called an independent market. Grier and Alan (2013) think that “macrotasking is probably the most flexible form of crowdsourcing and, because it allows for collaboration, people can think of it as a collaborative form of crowdsourcing”. An independent market means workers work separately.

Based on these two different forms of rules, the different extent of collaboration and the different ways to pay, crowd markets can be divided into four categories. If it is in an independent market and requesters only pay one member of the crowd who do the best job then it is called crowdcontest. And a self-organized crowd can form when it is in a collaborative market. When all members of the crowds need to be paid, which means in a contract market, independent market means a microtasking market and collaborative market means a macrotasking market.

Maximizing submission quality is considered an important issue for the crowdsourcing. Lowering the cost to the agents or requesters is also needed when considering the crowdsourcing contest. Cavallo and Jain (2012) mention the major problem of crowdsourcing is that “There is inherent uncertainty in the production process, which in light of the deadline may warrant simultaneous production of multiple goods by multiple producers despite there being no marginal value for extra goods beyond the maximum quality good produced.” To deal with this, they bring about both an algorithmic aspect and an incentive mechanism to improve this process which expends non-zero effort in the efficient policy. The policy should also take consideration of both an optimal effort policy for the requesters and a solid payment mechanism, a broader agenda of incentives

in peer production system. In the context of a principal and agents that are self-interested and strategic, they use an algorithm to come up with extreme-effort policies that are optimal in certain contexts. The results they have “inform a designer of a crowdsourcing contest how to compute the optimal number of participants, given the principal’s value and the agents’ distribution over quality, and also tell the designer how to award the payments or prizes”, which is different with current prevalent winner-take-all schemes in crowdsourcing, overlooking the contribution from non-winner workers.

CHALLENGES

Crowdsourcing field also face some challenges that need to be solved in the future. Anhai Doan et al. (2011) discuss CS system on the World-Wide Web and foresaw three major directions for future works: “more generic platforms, more applications and structure, and more users and complex contributions”.

Oomen and Aroyo (2011) mentions “challenges in a lack of quality contributions and a lack of dedicated and informed participants associated with using crowdsourcing”.

Sabou et al. (2012) find the “problems of training, noise, and possible legal/ethical issues arise in dealing with crowdsourcing”. He mentions a problem of strategy to discover the job on current crowdsourcing platform.

Kittur et al. (2013) foresee that there would be twelve major areas related to the framework of crowdsourcing: “workflow, task assignment, hierarchy, real-time response, synchronous collaboration, quality control, crowds guiding AIs, AIs guiding crowds, platforms, job design, reputation, and motivation”. For the future, they are exploring a way that can improve the attraction of crowdsourcing system to both workers and requesters and a better system with high efficiency. Since workers are thought to be “homogenous and unskilled”, this would not guarantee the quality of the work. And also lead to a problem of current crowdsourcing situation: the current crowdsourcing system cannot “support the complexity, creativity and skills that are needed for many kinds of professional work that take place today”. This would also impede the improvement process of crowdsourcing, such as increase payment and complex work structures.

Challenges for crowdsourcing processes

Workflow

For the complex task, there’s always a need for workflows to “facilitate decomposing tasks into subtasks, managing the dependencies between subtasks, and assembling the result.” The order of the work here plays an important role for complex tasks.

Task assignment

On the crowdsourcing platform, how requesters divide the task and assign the task to workers is also an important factor that affects the quality of work. Current systems often assign the task to the workers who “come first” but not who are experts or best suited for the task. As a result this process potentially adds time and overall cost and this leads to a question that whether the workers or the crowdsourcing platform are better to determine the matching result of task assignment. This is challenging for workers to find the most appropriate tasks for them within the lowest cost of time and for platforms to help requester to find the most suitable workers.

Hierarchy

In crowd work, hierarchy can improve the process by “decomposing large and complex tasks” through optimizing the structure of the work. According to Kittur et al. (2013), hierarchies may also enable workers work into a team, to increase the efficiency and the quality of the work by the standard rules and making decision together. However, whether workers have a willingness to work in a team with hierarchy instead of being their own boss is still a problem to be solved. They think that the future structure of organization or team of crowd work may not exceed our expectation.

Real-time response

Current crowd work is time-consuming. For the time-limited tasks, there is always a demand for workers work synchronously in order to accomplish the task in a more efficient way. Workers still need to wait for the requesters to publishing the task. The challenges for real-time crowd work will be “scaling up to increased demand for real-time workers, and making workers efficient enough to collectively generate results ahead of time deadlines”. Moreover, the problems come when the task needs a large amount of workers working together and how to decide the order of the task in a real-time situation.

Synchronous collaboration

Current crowdsourcing work always focus on workers doing their job independently, since the workers in different places and hard to communicate. This is also because workers usually have different cultural background and different extend of expertise, which bring a gap between workers. So the conflict happens when requesters need to workers collaborate to accomplish the task. The synchronous collaboration is needed in the process in which the requesters propose the assignments to workers and the process in which the workers collaborate.

Quality control

Kittur et al. (2013) think that “the most appealing aspects of crowd work” that challenge the quality of the work are “high throughput, low transaction costs, and

complex/subjective tasks”. This may also result from the workers with low expertise skills and unclear instructions from requesters. The current filter of the systems cannot satisfy their users to control the quality through this process. They propose several possibilities such as “relying on peer evaluation or data mining of low-level activity to predict output quality or using quality metrics map” to improve the current system.

Challenges for crowdsourcing technology

Artificial Intelligence (AI) has been playing an important role in crowdsourcing field to help improve crowd work to be more “efficient, skilled, and accurate” through machine learning or machine intelligence. The goal of AI is to deeply understand human’s intention and better balance the cost and performance to satisfy both workers and requesters. Since workers usually have different levels of skills, in order to accomplish the task in a more unified way or balance the difference between workers, AIs face the challenge of how to improve to “predict the expertise needs in advance, then train and adapt workers in an online fashion via automated tutoring or peer learning”. Maybe in one day, requesters can assign their task with rules, and then computer itself can figure a way to divide the work then assign the task to the proper workers. In the meanwhile balance the cost and the quality of the task for the requesters and make sure fair payments for workers in order to motivate workers for better job in the future.

Crowd work platforms also face the challenge to make the process effective, efficient and fair. Also, “negotiating the balance of power between interested parties is central to platforms and markets”. Similar to the traditional market in which labor face inequality, the crowdsourcing market also need to be regulate in the future to make sure the fairness. Policies need to be made, and more strengthening and perfecting systems and platforms are in desire. Sabou et al. (2012) give an example of Amazon Mechanical Turk explaining that they currently do not provide a proper way for requesters and workers to publish or search for the task. For workers, there is limitation for them to search or to be navigated to tasks they may have interest in or are willing to do. They think that the future trend of the crowdsourcing platform should have categories of different topics, thus workers can find their job based on desire topics. Also, for the requesters, they can select the keywords they want for their task but not limit to certain taxonomy or classification. And the challenge for this is that there are may a large amount of keywords describing same kind of task so that crowdsourcing platform like Amazon Mechanical Turk should figure out way to solve this. They also propose problems in crowdsourcing that the standardization of interfaces of crowdsourcing platforms still needs to be improved by future researchers to help requesters and workers better design and collaborate tasks online. The

rules also need to be made on constraints of requesters' availability and reliability on payment.

Challenges for crowd requesters and workers

Job design

In order to motivate the workers, the design of the job is a very important issue and also a challenge for requesters. To design a task in a more organized way, to motivate workers to fully devote into the task and use their talents to complete the task, is very important to make the worker satisfied. The balance of to what extent the system give the context to workers is also a challenge. They should consider this tradeoff to make the workers willing to perform and at the same time protect the privacy of requesters.

Reputation

Same as the traditional market, the reputation of employer also plays an important role in crowd work market. Reputation of workers, such as skill and education background, is also an important factor that requesters value a lot. The challenge here is the tradeoff for the requesters to have their task accomplished by the workers who can reach the requirement and in the meanwhile pay the lowest cost. So for the workers, there is benefit of pseudonymous, which should also be balanced with ethical risk. But how to make the policy considering the special situation in the context of crowdsourcing is a challenge for researchers.

CONCLUSION AND POSSIBLE FUTURE WORK

Crowdsourcing appears to be a viable option for many areas as it moves on from its young age. Despite the reluctance of some fields taking advantage of the crowd, such as GLAM institutions, the potential can already be seen. While there have been, are, and will be challenges for those choosing to operate within the world of crowdsourcing the benefits remain a tantalizing aspect to the entire endeavor. With that in mind some potential future work could involve determining the use of smaller crowds who have the ability to produce qualitative and quantitative results worthy of consideration, such as in the PhotoCity example. GLAM institutions in particular could capitalize on this form of a small but dedicated crowd who could quite possibly be altruistically driven to participate. This would eliminate the need for funding to go towards workers and help ease the financial burden some institutions find themselves facing year after year. Other future work could also be done in attempting to generate real time feedback which could greatly benefit both workers and requesters as they manage HITs.

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