A Distributed Approach for Mobile Crowdsourcing Network

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Abstract
Crowdsourcing is a term that describes the act of outsourcing tasks, processed by employees or contractors, to a large group of collaborator by means of an open call. The great development of the Internet of Things, smartphones, smart devices offered vast computing resources for crowdsourcing. Crowdsourcing has been coined by Jeff Howe in 2008. Since then, a lot of work has focused on different filed such as computational techniques, data collection, etc., In this paper, we give a distributed computation model of optimizing resource allocation or task allocation for the system. We proposed a system model, following an optimization problem and using the alternating direction method of multipliers(ADMM) to get the global optimal solution.

1. Introduction

The term crowdsourcing has been coined by Jeff Howe in 2006 [1]. Crowdsourcing is a distributed problem-solving model in which a complex problem will be solved by a crowd of undefined size through an open call [1]. In order to solving a task, its owner, also called the requester, submit the task to a crowdsourcing platform. Things which can accomplish the task, called worker, can collaborative to work on it and devise solution. Worker then submit these solution(contributions) to the requester via the crowdsourcing platform(CSP) [2]. Depend on contribution's quality, the requester might reward those workers. A solution of the task can be solved by one or more individual worker. The requester can choose contributions that reach accepted level of quality for the outcome [3].

Nowadays, mobile and wearable devices are usually equipped with abundant sensors, which allows them to collect various types or data such as image, voices, location, and ambient information [4]. With the rapid development of mobile and communication technologies has brought powerful capabilities that allows them to perform many complex computing tasks [5]. Thus, offered vast resources for mobile crowdsourcing model(CSM). The diversification of contributor in the CSM with increasing the numbers of spammer workers. Those spammers will lie on the contributions to exploit the benefit from reward of requester. Thus, truthfully required in the CSP to ensure the quality of services and whole system. Nowadays, many research has focused in CSM. Mostly, Considering about the architecture, development. Meanwhile, ranking the workers, or identify whether honest worker or spammer worker are till the reaming problem. Due to large scale network, several challenging ranking and identifying are raised in CSM.

In this article, we aim to establish CSM based on ranking of the worker that help the requester improving the results and accomplish the task with highest quality.

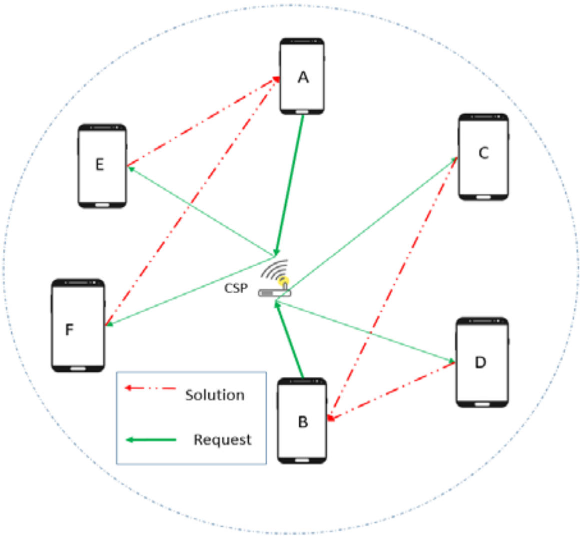

Figure 1: System model

2. System model and Problem formulation

In this paper, we consider a network consisting number of requesters (Cloud server, Mobile edge server etc.,) that request a task accomplish to CSP, on a fixed location; and a set of workers (mobile users, electric vehicle etc.,) are available in that location. Each worker has to submitted those request to the CSP. CSP will broadcast those requests to the workers. Each worker has different quality of the task solving called as truthful coefficient(TC). The more TC means that the results from that worker is high quality. In the figure 1, node A and B are requester, node C, D, E, F are worker, and access point is CSP. The green signal represents for request signal from requesters to CSP, and workers. The green signal is the solution from workers to requesters. In this paper, we assume that access point having computational and storage that can handle the request, and the contributions of worker, respectively. Let denoted set of *M* workers as *W*, and *N* requesters as *R*. Where each *w* in *W = {TC, price/unit, location}*, and each *r* in R = {Size of the task}. Assuming that each worker can be solved fraction of the task. Depend on the fraction that the worker has completed, requester will pay an amount of sensitive. Following that definition, we define the cost function as:

$$f_i(x) = \sum_{j=1}^{M} x_{ij} \times p_j \, (1)$$

Where xij is the fraction of task that worker j completed for worker i. On the other hand, TC affected decision of requester. Let denoted the truthfully function as:

$$g_i(y) = \sum_{j=1}^{M} c_j y_{ij} \, (2)$$

Where y_{ij} is the decision variable whether requester i accept the contribution of worker j or not. To ensure the request of requester is served, we defined the constrain that all of the contribution should satisfied the demand as:

$$\sum_{j=1}^{M} x_{ij} = D_i, \forall i \in N \, (3)$$

From all of the equation above, we formulated as an optimization problem following:

$$\begin{aligned} &\underset{x}{\text{maximize}}: \sum_{i=1}^{N} (g_i(y) - f_i(x)) (4) \\ &\text{subject to}: \\ &\qquad \sum_{j=1}^{M} x_{ij} = D_i, \forall i \in N \qquad (4) \\ &\qquad x_{ij} \geq 0, y_{ij} \in \{0,1\} \end{aligned}$$

The objective aims to maximize the quality of results also minimize the cost for requester by subtraction the TC with cost function. Because of the decision variable y is binary value then make optimization problem become mixed integer problem. It could be solved by mixed integer programing but consumed more resources and computational time. We proposed a distributed method that decompose the problem in the small sub-problem, and solving in the distributed way by using ADMM method.

3. Algorithm and Numerical results

a. Algorithm

In this section, we will provide a distributed algorithm and numerical analysis for the problem in (4)

Algorithm 1: Minimize Computation Offloading Time (MCOT)

1. Initial information for any $r \in R$ and $w \in W$
2. For each time slot $t \in \{1, 2, \ldots, T\}$
3. $x_{ij}^{(t+1)} = \arg\min_{x} \{ f_i(x_{ij}) + \lambda(x_{ij} - z_{ij}^t) + \frac{\rho}{2} \| x_{ij} - z_{ij}^t \|_2^2 \}$

   $y_{ij}^{(t+1)} = \Pi(x_{ij}^{t+1})$

   $\lambda^{(t+1)} = \lambda^t - \rho(x^{(t+1)} - z^{(t+1)})$
4. Update the objective value.
5. return results.

In the algorithm, by using the form of ADMM, we introduce a new variable z to control the variable x. Where xij solving by each worker j. After that, CSP collect all of the variable x, and compare with z. On the other hand, y variable could be compute by CSP through projection of x. After predefined time T, the algorithm will stop and all of solution will convergences into a stationary solution [6]. We first, random all of the value for TC, price and information about requesters. We then loop at most T step to update the objective value and variable x, y and z. After that update the Lagrangian multiplier lambda.

b. Numerical results

For simulation setup, our setting of constraint is provided in the follow table

Notation	Value
TC	Uniform[0, 1]
p	Uniform[0, 1]
M	[10, 50, 100, 500, 1000]

D_i	Uniform[10, 100]
N	[5, 10, 20]
T	1000

In the numerical analysis, we have used three different algorithms for performance comparison: Greedy algorithm, Centralized algorithm, and the last one is our proposed algorithm.

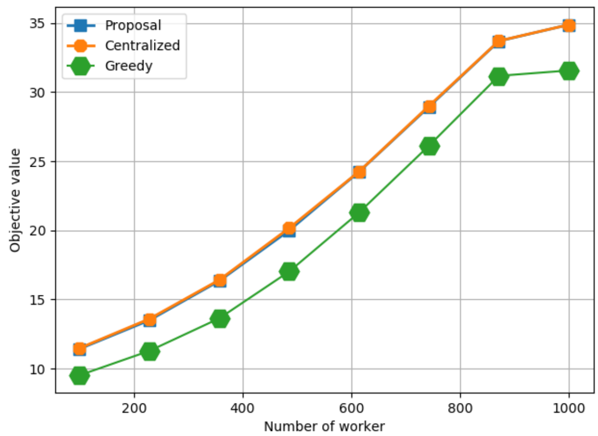

Figure 2: Objective value comparison

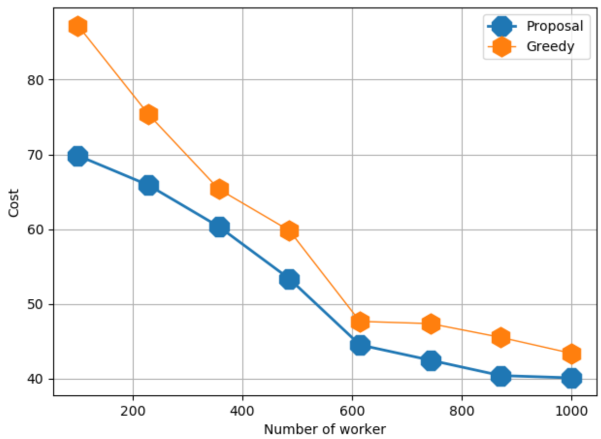

Figure 3: Comparison of cost value

Figure 2 has shown that our algorithm archive the optimal solution as centralized algorithm. And also the cost function lesser than greedy cost.

4. Conclusion

Crowdsourcing platform can help devices save energy, time for solving a complex problem. This study shows us that by applying a ADMM algorithm to determine whether the task will be allocated or not depending upon truthfully condition of the workers can significantly enhance the performance. Simulation have shown that proposed scheme significantly enhances the performance and achieves global optimal solution. Finally, a detailed study into the actual operating environment is required, as a future course, to validate our proposal and its performance

5. Acknowledgement

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