Research on the Reputation Model Based on Active Degree of Crowd-sourcing Workers

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Abstract—**Usually crowd-sourcing worker are free and anonymous, and are committed to maximizing their own interests, which results in inefficient crowd-sourcing. In order to improve the quality of crowd--sourcing tasks and motivate the workers, this paper puts forward the concept of active factor and historical factor according to the active degree and credibility of the workers, and improves the result of the most recent task in the overall credit value. And based on it, a worker quality model based on the activity degree and reputation value is proposed. Finally, the comparison experiment shows that, in the range of the low threshold, the worker quality model selection can finish the crowd-sourcing task more quickly and have better activity.**

Index Terms—**active degree, crowd-sourcing, reputation value, workers' reputation model**

I. INTRODUCTION

Studies have shown that productivity of different crowd-sourcing workers in the crowd-sourcing projects[1] gains of up to 10 to 40 times over the same crowd-sourcing task[9]. The increase in the number of individuals leads to an increase in group diversity, resulting outcome uncertainty increases in a final crowd-sourcing task and the quality of crowd-sourcing tasks does not improve as the number of the crowd-sourcing workers increases. In order to improve the efficiency and quality of crowd-sourcing, it is the most direct means to improve the crowd-sourcing efficiency by selecting high-quality crowd-sourcing workers to accept crowd-sourcing tasks.

The average reputation model[2] proposed by Jurca and Faltings is widely used in real-world scenarios. The model computes the workers reputation value with workers' all historical tasks, the average of the cumulative qualities is the reputation of the workers value. The average reputation model has the advantage of being able to adjust the completion time and quality of crowd-sourcing tasks according to the reputation threshold, controlling the number and quality of the workers. But the disadvantage is that all the historical tasks of the default worker are equivalent to the workers' current influence[5], and choose workers only from the perspective of the credibility, and it does not take into account the active factor of workers involved in

crowd-sourcing activities.

This paper proposes a crowd-sourcing worker reputation model based on workers' active factor, which not only combines the advantages of the average reputation model, but improves the proportion of the quality of the most recent task results to the overall reputation. Attention to the quality of the current task to complete, in addition, taking into account the activity of workers to encourage workers to participate in crowd-sourcing activities, higher quality to complete the crowd-sourcing task.

II. DESIGN OF REPUTATION MODEL FOR CROEDCOURCING WORKERS BASED ON ACIVE DEGREE

A. Design Goal of Reputation Model

Crowd-sourcing workers' reputation model considers workers' reputation value and active degree as quality reference factors. Workers with high active degree are selected to participate in crowd-sourcing while guaranteeing workers' reputation. The design goals of the model are:

(1)Alert target: Alert workers not to submit unreliable crowd-sourcing results, the quality of the results of the last task of the workers will have a relatively large impact on his quality value, so if the workers present The results of failure, it will be on the quality of the subsequent impact of a larger change.

(2)Incentive target: Encourages workers to remain active. If a worker submits a task every day, his quality value will be higher than the worker who occasionally submits the task.

(3)Equity target: Increases the active factor to balance the worker's reputation, since there is no higher activity for workers with fewer tasks, so there is no case that the amount of historical task is low while the reputation value of crowd-sourcing workers is high.

B. Active Degree of workers

One of the main goals of the crowd-sourcing workers' reputation model is to select more active workers to take over. In order to measure the active degree of crowd-sourcing workers, the number of active days L and the active factor P are defined.

Definition 1 Number of active days L: The number of days that a crowd-sourcing worker has received a package of tasks in the last 30 days, in the range [0,30].

Definition 2 Active factor P: The coefficient representing the activity of the worker based on the worker's recent active days. Its relationship with active days is:

$$P = \frac{arctan(L - \beta) + arctan \beta}{\frac{\pi}{2} + arctan \beta} \qquad (1)$$

the parameter β acts to control the growth rate of the active factor, and Fig.1 shows the graph of the Equation(1).
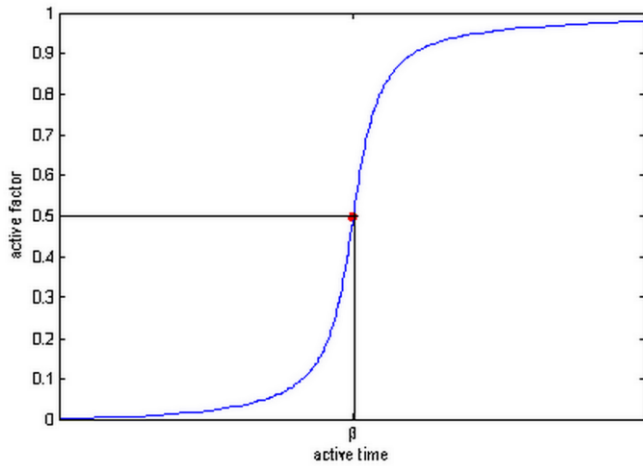

Fig.1. Function graph of equation(1).Active factor as a function of active time.

From the figure, when the number of active days L = β, the active factor P = 0.5, when the L value is close to β, the rate of change of the active factor P is large; when the L value is far away from β, the rate of change of active factor P decreases. When L>β, the side is rapidly higher than 0.9, and when L<β, the activity factor is rapidly below 0.1. It can be seen that L = β is a demarcation line of worker activity level. Active workers and inactive workers are significantly different in active factor values. Crowd-sourcing task publishers can adjust the value of β to control the average number of active days required to effectively adjust the overall workforce active factors and to encourage workers to maintain a high degree of activity[6].

C. Improved Worker's Historical Reputation Value

In the average reputation model[3], the reputation value R_i of the worker after the kth task is calculated as follows:

$$R_i = \frac{k-1}{k} R_{ik} + \frac{1}{k} r_{ik}(r_{ik} = 0 or 1) \qquad (2)$$

R_{ik} represents the reputation value of the worker i before the k-times completion of the crowd-sourcing task. r_{ik} represents the reputation award when worker i completes the k-times task. If the task is satisfied, $r_{ik} = 1$, otherwise $r_{ik} = 0$.

When k → ∞, (k-1) / k → 1, 1 / k → 0, it shows that in the average reputation model, with the increase of the total amount of tasks, the worker's reputation value will get closer to the average value of the historical reputation, and the current task of the credibility of the value will become smaller and smaller. If the worker has a small amount of historical tasks, the worker's reputation value can only refer to a few historical task completions, and the total amount of tasks that can be referred to may result in tasks that take only one or two tasks Who have a high reputation value, which is not fair for the long-term workers to submit the correct result, and will crack down on these workers to participate in the task of crowd-sourcing initiative.

Therefore, this section presents a new model for calculating the reputation value, which improves the proportion of the total quality of the most recent task results done by crowd-sourcing workers in the overall reputation value[10]. After the worker completes the kth task, his reputation value will be updated according to equation (3):

$$R_i = \alpha R_{ik} + (1 - \alpha) r_{ik}(r_{ik} = 0 or 1) \qquad (3)$$

The parameter α is called the historical factor[4], and its range is [0,1].When (1 - α)< 1/k, the influence of the current task on the overall reputation value is less than the average reputation model. When (1 - α)> 1/k, the influence of the current task on the overall reputation value is greater than the average reputation model. When (1-α) = 1/k, the influence of the current task on the overall reputation value is equal to the average reputation model. Thus, the historical factor α controls the impact of workers reputation when they last submitted the results of the task.

D. Workers' Reputation Value Based on Active Degree

Definition 3 Worker's reputation value: The index of the worker's ability to accept the package based on the recent activity factor[7] and the reputation value of the crowd-sourcing worker, expressed in terms of Ti.

$$T_i = P_i * R_i \qquad (4)$$

Then set the threshold T, we can decide whether to allow workers to undertake packet tasks according to equation (5):

$$\begin{cases} T_i \geq T , Trust \\ T_i < T , Distrust \end{cases} \qquad (5)$$

T represents the threshold of the reputation value and it decides the completion time and quality of crowd-sourcing tasks. When the threshold is low, the threshold is lowered, and more workers participate in the crowd-sourcing task. When the threshold is high, it can get a higher crowd-sourcing quality, but the number of workers involved in is small, thus extending the complete time of crowd-sourcing tasks. It can be seen that the number and quality of crowd-sourcing workers are directly related to the time and quality of the final outcome.

III. EXPERIMENTAL RESULTS AND ANALYSIS

This paper puts forward the crowd-sourcing worker reputation model based on the analysis of the average reputation model. In order to verify the effectiveness of the reputation model, the crowd-sourcing verification experiment was carried out on the public information collection and crowd-sourcing platform. First of all, the interested points of the portal images to be validated on the map were designed as a crowd-sourcing verification task, then the crowd-sourcing workers receive the verification task through the mobile client, verifies the geo-interest point information on the spot, and submits the verification result to the server, finally counts and analyzes the crowd-sourcing result. A comparison experiment was conducted with the average reputation value model to verify the correctness and verification time of the results.

A. Experimental Data

30000 photos of points of interest were selected as the object of verification from the crowd-sourcing results of the crowd-sourcing platform, and 500 workers were selected as

the experimental workers. In addition, 20 professional reviewers of crowd-sourcing platform were organized as manual verification workers to provide reference data.

B. Experimental Results Analysis

The average reputation value and the workers' reputation value of 500 crowd-sourcing workers were calculated according to the average reputation model and the workers' reputation model based on active degree. The number of Verify workers with different reputation threshold as shown in Table 1.

The average credit threshold and the worker quality threshold were chosen to be 0.1,0.9. The results of the average reputation model verification were shown in Table 2.

The results of the workers reputation model based on active degree are shown in Table 3.

The results of the verification of 50 professional auditors are shown in Table 4.

The comparison between the average reputation model and the workers reputation model based on active degree verifies the results shown in Fig.2.

The comparison of verification time between the average reputation model and the worker quality model is shown in Fig. 3.

It can be seen from Fig.2 that both the average reputation model and the worker reputation model have a downward trend on the line graph and the trend of the line graph is close to the standard result of manual verification as the threshold value increases. The average credit model has been close to the standard result of manual verification. When the threshold is between 0.1 and 0.5, the error rate of the model is much smaller than that of the standard model. When the threshold is between 0.6 and 0.9, the two are almost have no gap with artificial verification results.

TABLE I NUMBER OF WORKERS OF DIFFERENT THRESHOLD

Model \ Threshold	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Average Reputation Model	499	482	471	433	395	324	207	136	58
Workers Reputation Model Based on Active Degree	482	451	421	380	253	189	148	55	15

TABLE II AVERAGE REPUTATION MODEL VERIFICATION RESULTS

Angle \ Threshold	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Qualified quantity	22151	21962	20957	20689	20543	20439	20383	20350	20309
Completion time(Day)	11.2	9.7	9.2	8.8	8.0	7.5	9.8	15.1	25.2

TABLE III WORKERS REPUTATION MODEL BASED ON ACTIVE DEGREE VERIFICATION RESULTS

Angle \ Threshold	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Qualified quantity	21987	20971	20703	20521	20436	20383	20318	20298	20285
Completion time(Day)	9.8	8.9	8.6	7.7	5.6	8.1	10.9	19.1	48.8

TABLE IV PROFESSIONAL WORKERS VERIFICATION RESULTS

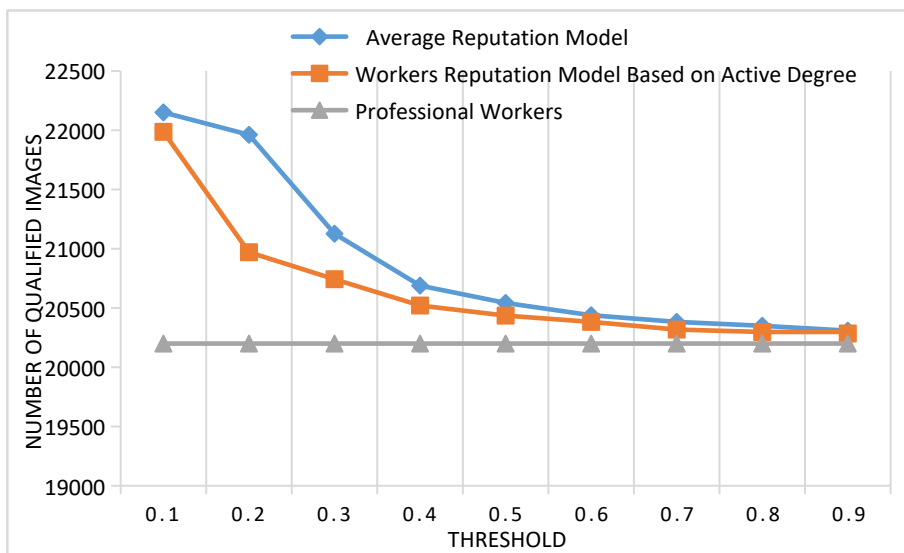| Picture situation	Qualified quantity	Non-positive quantity	Blurred quantity	Far away quannity	Others
30000	20288	2351	3220	2249	1892

Fig.2. Comparison of Average Reputation Model and Worker 's Reputation Model Based on Active Degree Verification
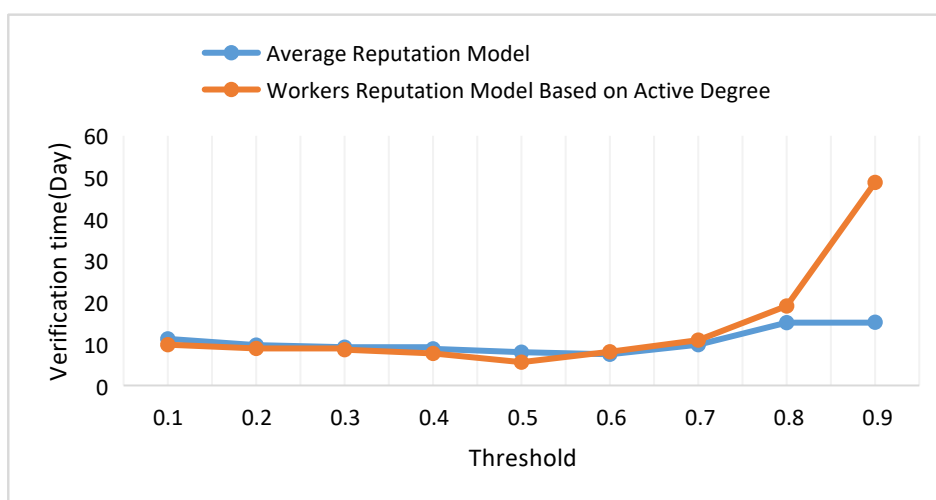

Fig.3Verification time comparison between the average reputation model and the workers' reputation model based on active degree

It can be seen from Fig.3 that when the quality model threshold is at 0.5, the minimum verification time is 5.6 days, and the average reputation model threshold is at 0.6, the minimum time is 7.5 days. The shortest time that the quality model can get is shorter than the average reputation model, but The maximum time obtained from the quality model is longer than the average reputation model.

According to Fig.2 and Fig.3, the error rate of verification results, reputation model has better than the average worker reputation model to be small, especially in the threshold for the 0.5 workers before the error rate of the model compared with the average credit reputation model is much higher, but after the threshold in 0.6, the error rate is almost consistent and that workers in the low reputation model threshold, can better reflect the actual workers undertaking ability and achieve high quality crowd-sourcing benefits, in the high threshold, both the strength and ability to assess workers similar close to 0 error rate; at the expense of verification time, the threshold before 0.6 cost, workers reputation model verification time to less than the average value in the credit model, the threshold of 0.6 after spending time to verify the credibility of the model workers greatly exceeded the average Reputation model, so it is not

recommended to use worker reputation model at high threshold. However crowd-sourcing service in the application of the scene will lower the threshold[8], the basic threshold control in the low range, this reputation model workers is particularly outstanding performance, especially when the threshold is 0.5, both to ensure high accuracy and in time reached the minimum value.

IV. CONCLUSION

By comparing the average reputation model and the work and quality model to verify the correctness and task completion time of the crowd-sourcing task, it is pointed out that the quality model is better than the average reputation model in quality and time cost, And the quality thresholds are given by experimental analysis. However, there are still some flaws in the completion time of crowd-sourcing tasks in the high threshold range. And the proposed model of worker quality value, taking into account the activity of the workers and the importance of the results of the most recent submission of the task, to encourage workers to pay attention to the quality of the completion of the task and maintain a good incentive to play active.

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