The 33rd Annual Conference of the Japanese Society for Artificial Intelligence, 2019

Effect of Visible Meta-Rewards on Consumer Generated Media

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Consumer Generated Media(CGM) are useful for sharing information, but information does not come without cost. Incentives to discourage free riding (receiving information, but not providing it) are therefore offered to CGM users. The public goods game framework is a strong tool for analyzing and understanding CGM and users' information behaviors. Although it is well known that rewards are needed for maintaining cooperation in CGM, the existing models hypothesize the linkage hypothesis which is unnatural. In this study, we update the meta-reward model to identify a realistic situation through which to achieve a cooperation on CGM. Our model reveals that restricted public goods games cannot provide cooperative regimes when players are myopic and never have any strategies on their actions. Cooperative regimes emerge if players that provide first-order rewards know whether cooperative players will give second-order rewards to the first-order rewarders. In the context of CGM, active posting of articles occurs if potential commenters/responders can ascertain that the user posting the article will respond to their comments.

1. Introduction

Consumer generated media (CGM) are the most active information sharing platforms in which users generate contents by voluntary participation. They include information sharing sites such as Wikipedia and TripAdviser, and question/answer forums such as Yahoo Answers. CGM reflect positive traits of the Internet because, in CGM, aggregating users' voluntary participation bears values, and thus they have network externality in which the more active users are, the more the values of the CGM are.

CGM rely on user-provided information and thus fail if information is not provided. Getting users to provide information generally requires effort costs including time costs and click costs[Nakamura 14]. Therefore, CGM users are given incentives to discourage free riding, a situation in which users receive information, but do not provide it. While huge CGM never worry about freeriding, many managers of small-sized CGM pay attention to it. CGM can be regarded as a kind of public goods game–a social dilemma game in which users may refrain from paying costs (that is, free riding), although they could benefit substantially if they contributed.

To avoid the free-rider problem, many CGM adopt incentive systems for users to receive comments as appreciation for posting articles. These comments are considered rewards for contributing to the public goods game. Moreover, many real CGM systems provide Like buttons to react to comments, which can be regarded as meta-rewards. This is because comments also give psychological benefits to original article providers as well as Like buttons give psychological benefits to their receivers.

Toriumi et al. [Toriumi 16] used a public goods game model to show that meta rewards are required to maintain cooperation. A meta reward is a reward for those who gave a reward to cooperative users. Many CGMs implement a function that allows other users to express their gratitude to those who provided information, and the users who expressed their gratitude can also be given something as a reward.

However, the model has an unrealistic hypothesis which called Linkage hypothesis: Whoever performs the first-order sanction (rewards) also performs the second-order one. This hypothesis is needed for the theoretical rationale of meta sanctions because, if the second-order sanctions are independent of the first-order sanctions, third-order free riders who shirk the second-order sanctions only are possible, and thus cooperation through meta sanctions collapses. Experimental studies have no consensus on this linkage hypothesis. Some experiments support the linkage between the first-order sanctions and cooperative behaviors [Horne 01, Horne 07] while others deny it [Yamagishi 12, Egloff 13]. The linkage hypothesis between the first-order and second-order sanctions is partially supported by an experiment of a one-shot public goods game [Kiyonari 08].

In this paper, we will model our CGM public goods game without assuming the linkage hypothesis between the first- and second-order rewards. While a previous model [Toriumi 16] uses the same parameter, r_i, as the probabilities of giving rewards and giving meta rewards, our model separates the former probability from the latter.

2. Models and Methods

In this section, we develop a model that reflects real CGM by extending the CGM model proposed by Toriumi et al. [Toriumi 12]. We then define an adaptive process of players in the model to explore feasible solutions of strategies for promoting and maintaining cooperation. Third, we introduce several scenarios to provide insight for managing real CGM by comparing their performances. Finally, we set parameter values to perform our simulation.

2.1 A restricted meta reward game model

We consider N agents playing a restricted meta reward game. The game is run for a discrete time and each period is referred to as a round. In each round, all agents play three

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sequential steps in serial order. Using the case of Agent i as an example, Agent i has its own strategy denoted by (b_i, r_i, rr_i), which we will explain later.

In the first step, the agent provides its own token into a public pool with probability b_i and otherwise does not. In CGM, a contribution and a non-contribution are, respectively, regarded as an information-providing behavior and a non-providing behavior. If a token is provided by Agent i, i must pay a cost κ_0, also the other $N-1$ players receive a benefit, ρ_0.

In the second step, rewards for providing a public good may occur. In CGM, posting a comment to an information provider is regarded as a reward. If and only if Agent i provides a token, the other $N-1$ agents consider whether or not they will give a reward to Agent i. Agent $j(\neq i)$ gives a reward to Agent i with probability $p_{r_{i\to j}}$ and otherwise does not. This probability is calculated as $p_{r_{i\to j}} = \varepsilon \cdot r_j$, where r_j is j's own reward parameter and ε is an expected rate of meta rewards newly introduced in this model to consider the third challenge of the above-mentioned prior studies. If a reward is given, Agent i gains a constant benefit, ρ_1, while Agent j must pay a constant cost, κ_1.

In the third step, meta rewards for giving rewards may occur. In our model, meta rewards from contributors are possible in the first step only to consider the second challenge of the previous studies, thus making this model a restricted game. In CGM, a reply to comments is regarded as a meta reward. If and only if Agent i received a reward from Agent j, Agent i can decide whether to give a meta reward to Agent j with probability rr_i, and otherwise not. While Toriumi et.al.[Toriumi 12] assumes that $r_i = rr_i$, our model assumes that these are independent of each other to consider the linkage hypothesis. If a meta reward is given, Agent j gains a constant benefit, ρ_2, while Agent i must pay a constant cost, κ_2.

Each agent plays the above three steps four times in each round. When all agents complete these steps, each agent's final payoff at each round is regarded as its fitness value.

2.2 Simulation scenarios

In the restricted meta reward game, there is no incentive to give meta rewards, and thus players never provide meta incentives. To consider this point, we introduce players' expectations of meta rewards. We then explore how these expectations are reflected in the probability of providing rewards using the following three scenarios that are different values of expected rates of meta rewards, ε.

1. No reference ($\varepsilon = 1.0$): players do not use any reference
2. Social reference ($\varepsilon = \frac{1}{N}\sum_k rr_k$): players use the average rate of meta rewards in the group
3. Individual reference ($\varepsilon = rr_i$): players use cooperator i's probability of meta rewards

Scenario 1 is a baseline. Scenario 2 describes a situation that players can get information on a providing rate of meta rewards in CGM. For instance, we suppose a system in which seeing all meta rewards for rewards by others is possible. Scenario 3 describes a situation that visualizes a providing rate of meta rewards for information provided in CGM. In this scenario, we assume that players can decide whether or not to provide meta rewards to a cooperator after they check the providing rate of meta rewards of the focal cooperator.

Table 1: Simulation Parameters

Param	Value
N	100
Simulation steps	1000
μ (benefit-cost ratio)	2.0
δ (discount ratio)	0.8
ρ_0 (benefit of cooperation)	2.0
κ_0 (cost of cooperation)	1.0

2.3 Parameter setting

For simplicity, we set the values of the parameters above by installing two new intervening parameters: δ and μ.

$$\kappa_0 = 1.0 \tag{1}$$

$$\rho_n = \mu \cdot \kappa_n \tag{2}$$

$$\kappa_n = \delta \cdot \kappa_{n-1}, \tag{3}$$

where $n = 1, 2$.

At first, we simulate the case of $\mu = 2$ and $\delta = 0.8$ to clarify the performances of each scenario. Then, we investigate the influences of the cost-reward ratios in Section 3.2. Table 1 shows the values of the other parameters in the simulation.

3. Simulation Results

3.1 Comparison of three scenarios

We simulate 100 runs with different random seeds in each scenario, and show the averages and the variances of values using error-bars in Figs.1, 2, and 3. In these figures, the vertical axes show the step numbers while the horizontal axes show the average parameter values: Cooperation indicates cooperation rates, b_i, Reward indicates reward rates, r_i, and MetaReward indicates meta reward rates, rr_i.

As shown in Fig.1, the cooperation rate in Scenario 1 decreases at about 100 steps while increasing at the beginning. This is due to the decrease in reward rates. The rate gradually decreases immediately after the beginning and reaches 0.1 at 20 steps. No reward never bears cooperation.

Scenario 2 faces the same mechanism and thus neither scenario can maintain a cooperative regime.

In Scenario 3, on the other hand, the cooperation rate increases from the beginning, then the meta reward rate also increases and, finally, the reward rate increases, therefore maintaining a stable cooperative regime as shown in Fig.3.

Why does Scenario 3 promote cooperative regimes while Scenario 1 does not? This is quite surprising because parameter value ε is 1 in Scenario 3 while it is less than 1 in

Scenario 1. We then analyzed the time series of cooperation rates, reward rates, and meta reward rates in Scenario 3 in comparison with Scenario 1. At the beginning of the simulation, cooperative rates increased in both scenarios. However, the next phenomena are different. In Scenario 3, the meta reward rates increased before the reward rates increased. This is because players with high meta reward rates tend to receive more rewards than those with low meta reward rates. If the number of players who give rewards is sufficiently large, the high meta reward rates bear the benefit of the rewards and are larger than the costs of meta rewards. Therefore, players with high meta reward rates benefit more than those with low meta reward rates.

The more players with high meta reward rates there are, the greater the probability of receiving meta rewards when giving rewards. Therefore, players who tend to give rewards gain more benefit than those who do not, and thus the reward rates increase. High reward rates enhance the benefit of cooperation and, therefore, cooperative players have an advantage over defective players. Cooperative regimes stay robust.

3.2 Influence of cost-reward ratios

In our model, the rate of the reward benefit on the reward cost is important for promoting cooperative regimes[Toriumi 16]. Therefore, we simulated many cases with different values of μ and δ. Figure 4 shows the average rate of cooperation in 1000th step with in 50 runs per each case. In this figure, the x axis indicates μ, the y axis indicates δ, and the color bar indicates the average cooperation rates.

The scopes of μ and δ are, respectively, $0.0 \leq \mu \leq 5.0$ and $0 \leq \delta \leq 1.0$. This figure shows that

1. Cooperative regimes emerge only in Scenario 3
2. Cooperative regimes never emerge if $\mu < 1.4$ and
3. Cooperative regimes emerge if approximately $\mu \cdot \delta > 1.0$

Among these, Result 2 is consistent with a previous study [Toriumi 12] that demonstrated that cooperative regimes require a substantially large benefit of rewards compared with their costs. Our result adds the insight that it also requires a sufficiently larger value of μ in our model than the previous study's model. This is because the expected values of meta rewards are small if μ is small, and thus the incentive to give rewards vanishes.

Next, we consider Result 3. As a result of our simulation, condition $\mu \cdot \delta > 1.0$ is necessary for promoting cooperation. In terms of the relationship between rewards and meta rewards, if the benefit of meta rewards is greater than the cost of rewards, players may receive a benefit through giving rewards, and thus there are incentives to give rewards. This indicates that

$$\rho_2 > \kappa_1 \tag{4}$$

is required. If $\kappa_1 > 0$ is satisfied, equations $\rho_2 = \mu \cdot \kappa_2 = \mu \cdot \delta\kappa_1$ are satisfied, and thus the necessary condition of reward behaviors is

$$\mu \cdot \delta = \frac{\rho_2}{\kappa_1} \quad > \quad 1.0. \tag{5}$$

Strictly on this point, players do not always receive meta rewards and thus we should consider the average rate of meta rewards, $\overline{rr_i}$. Therefore,

$$\overline{rr_i} \cdot \mu \cdot \delta > 1.0 \tag{6}$$

is the necessary condition.

If this condition is satisfied, players who give rewards to other players at sufficiently large rates of meta rewards have an advantage. This also means that cooperative agents are given incentives from which they should receive a large amount of meta reward rates. This mechanism works and therefore players with large amounts of both reward rates and meta reward rates have survival advantages and, finally, cooperative regimes emerge.

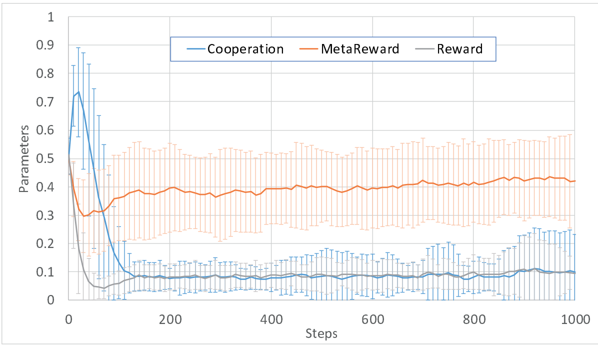

Figure 1: Result of Scenario 1

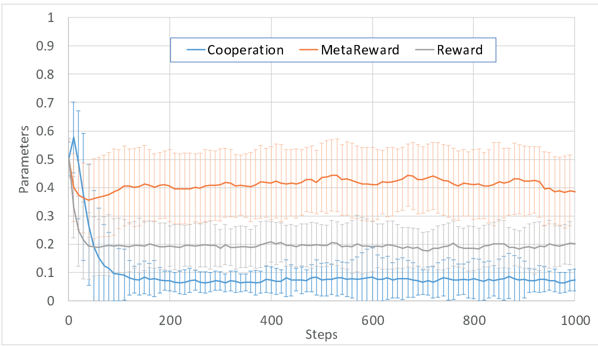

Figure 2: Result of Scenario 2

4. Discussion

While our main results support the importance of meta-rewards for activating CGM, we must state the

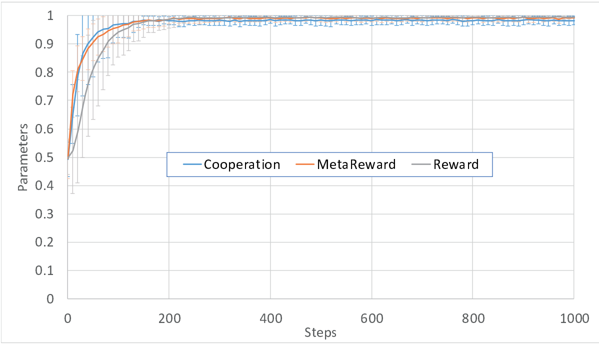

Figure 3: Result of Scenario 3

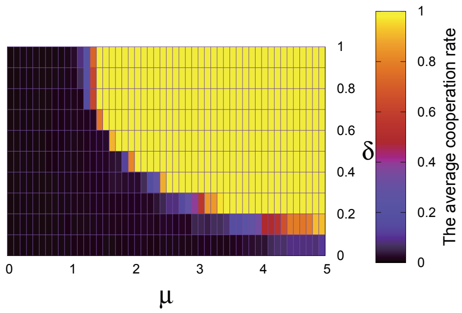

Figure 4: Change μ, δ in Scenario 3

other important drivers of real posting including brand image[Kim 16], attention seeking, communication, archiving, and entertainment[Sung 16]. Moreover, we have no option but to accept the future study on the empirical data that support that the original article providers respond to other commenters replies to sustain posting on CGM.

We developed a restricted public goods games model to overcome the mismatches found between previous models and actual CGM. Our model reveals that restricted public goods games cannot provide cooperative regimes when players are myopic and never have any strategies on their actions. Cooperative regimes emerge if players that give first-order rewards are given information that reveals whether cooperative players will give second-order rewards to the first-order rewarders. In the context of CGM, if users who post articles reply to commenters/responders, active posting of articles occurs if potential commenters/responders can ascertain that the user posting the article will respond to their comments.

This study should be extended. First, the present version of our model describes two types of players actions: cooperation as posting information and defect as non-posting. However, defect behaviors in CGM can be divided into two types: do nothing and post inadequate information. This issue should be introduced in a future version. Second, while our model assumes that all players can observe all information, this is not realistic. We are interested in the influence when the frequency of information accessibility depends on the quality of the information.

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