Effect of Frequency-Dependent Behavior on Bullying in School Using Multi-Agent Simulation Model

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Abstract: The paper addresses simulation results on school bullying and the relevant interactions between classmates. We have proposed the multi-agent simulation (MAS) model composed of many agents mimicking student's behaviors. The bullying is defined as the emergence of isolated agents who have never the same values (formalized attributes of hobbies and interests). In particular, we clarified the effect of sequential frequency-dependent behaviors on the emergence of the bullying (or the victim) using the MAS model. As a result, it was necessary for reducing the number of victims that at least 20% students stop the frequency-dependent behavior.

1. Introduction

In recent years the bullying problem has been mentioned as a very serious social problem [1]-[4]. From a pedagogical, medical and sociological points of view to focus on the interaction between the classmates, many studies have been made, but the bullying is socially still a pending problem. The bullying is relevant to some kinds of interactions between the classmates. In particular, for junior or senior high school students to make friends, it was important that they try to find the same hobbies, similar interests, and common activities, so-called, the set of "value".

So far, from an engineering viewpoint, we have focused on the bullying behaviors and social interactions in school. Multi-agent simulation, or MAS, was an effective approach to clarify the mechanism of such interactions, because it is ethically impossible to treat experimentally the bullying phenomena observed between the actual students [5],[6]. In our MAS model, two qualitatively different agents are selected from the class. One is act, and the other is obj. Active agent act interacts with objective agent obj by a peer-to-peer interaction. Sociologists have recently insisted that sequential frequency-dependent behaviors give rise to the bullying in school. In terms of our MAS model, it means that the current act's behavior is based on the frequency of the behaviors from others to obj in obj's past interactions. In this study, we investigated the effect of the sequential frequency-dependent behaviors on the emergence of the bullying (or the victimization of agent).

2. Artificial School Class Model

We call the proposed MAS model the articficilal school class model composed of n agents. A flow chart of the artificial school class model is shown in Figure 1. In the initial state every agent is interested in m values from the total number of values, M (>m), randomly. One step is composed of the follofing three

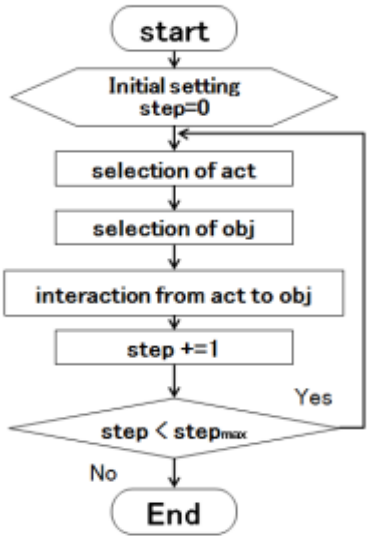

Figure 1. Flow chart of artificial school class model.

sub-steps, "selection of act", "selection of obj", and "interaction from act to obj". When the number of steps reaches step max , one simulation terminates.

We prepared four interations from from act to obj as follows: Conformity is the desire to see oneself as similar to others. The act is newly interested in one of the value which has already selected by obj, and then act discards one of the act's value which is not selected by obj. Inclusion is also desire to see oneself as similar to others. The act gets obj to select one of the value which has already selected by act, and then to discard one of the obj's value which is not selected by act. Distinction is the desire to see oneself as unique and is contrary to the above two interactions. The act is newly interested in one of the value which is not selected by obj, and then act discards one of the act's value which has already selected by both act and obj. Exclusion is exemplified by a small degree of teasing observed in the peer-to-peer communication. The act makes obj discard one of the value which has already selected by both act and obj. By means of one exclusion, obj necessarily loses one value.

On the frequency-dependent behavior, the act's action probability $p_k^{(fd)}$ which arises interaction k (=conformity, or inclusion, or distinction, and or exclusion) is given as follows:

$$p_k^{(fd)} = (b_k + 1) / (B+4), \quad (1)$$

where b_k is the number of interactions k, which is given to obj from others, and

$$B = b_{condormity} + b_{inclusion} + b_{distinction} + b_{exclusion} . \quad (2)$$

If there is no interactions in the initial state, then $b_k = 0$, $B = 0$ and $p_k^{(fd)} = 1/4$ for every k. For example, at some step,

we obtain $p_k^{(fd)} = 2/3$ if $b_k = 19$ and $B = 26$. When obj receives continuously a certain interaction from others, obj becomes the agent who receives easily the interaction. To verify the effect of the frequency-dependent behavior, we also used general human interactions obtained from the artificial school class game [7],[8]: $p_{conformity}^{(gh)} = 0.350$, $p_{inclusion}^{(gh)} = 0.543$, $p_{distinction}^{(gh)} = 0.046$, and $p_{exclusion}^{(gh)} = 0.061$.

We defined the agent who do not select any values by the exclusion from others as the victim.

3. Result and Discussion

We set the number of agents n = 20, the total number of values M = 25, the maximum number of values selected by agents m = 7, and the maximum number of steps step max = 2000. The iteration number of simulations is set to 50 to obtain statistically the mean and the standard deviation.

Simulation results are shown in Figure 2. The abscissa represents the ratio ϕ of the general human interaction obtained from the artificial school class game, and the ordinate represents the mean number of victims n 0 (vertical bars represent standard deviations). Label "RND" on the abscissa represents random action probability, i.e., p k = 1/4 for every k. As increasing the ratio of the general human interaction ϕ, the mean number of victims n 0 decreased, and finally, zero at ϕ = 0.5. In other words, to increase the ratio of the frequency-dependent behavior means that the number of victims increases. According to the statistical test (Kruskal-Wallis test and the multiple comparison), three cases of ϕ = 0.0, ϕ = 0.05, and ϕ = 0.1 were statistically significant compared with the case of RND. Therefore, the number of victims can be reduced as many as the case of RND if at least 20% students do not behave the frequency-dependent behavior.

4. Conclusion

We clarified the effect of sequential frequency-dependent behaviors on the emergence of the bullying (or the victim) using the MAS model. As a result, it was necessary for reducing the number of victims that at least 20% students stop the frequency-dependent behavior.

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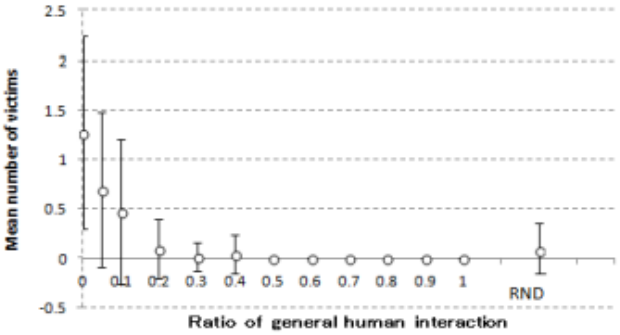

Figure 2. Mean number of victims against the ratio of general human interactions. The zero of abscissa represents that all agents behave the frequency-dependent behavior. The 100 of abscissa represents that all agents do not behave the frequency-dependent behavior. "RND" is the random case. white circles represent the mean and vertical bars represent the standard deviation.

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