Non Self-Correction and Possibility of Phase Transition in Information Cascade

SP08120 Ai Sugimoto Non-linear Physics laboratory

1 Introduction

It has been said that the information cascade is self-correcting. Even if the choice sequence is sub-optimal, it will eventually be corrected and turn to be optimal after many people's selections. Self-correction certainly occurs. However, the result of our survey from November 2011 to December 2011(in the talk by Y. Kishi) , the self-correction does not necessarily occur. We performed laboratory experiments of information cascade in canonical social learning environments. The data were examined and analyzed through the lens of statistical physics, which clarified the possibility of non self-correction and phase transition in information cascade.

2 Experimental Design

We recruited 33 students from the department of physics, Kitasato University in January 2012 and performed a voting experiment. In the experiment, we use three values of the signal quality q and q takes values 2/3, 5/9 and 8/15.The number of the subjects is T=33. We randomly assigned ID number to the subject ($1 \leq \mathrm{ID} \leq T = 33$). For the q=n/m treatment, urn-R contained n red balls and m-n blue balls and the urn-B contained m-n red balls and n blue balls. We prepare T urns which is assigned R or B randomly and has its own ID number ($1 \leq \mathrm{UID} \leq T$). Subjects need to answer T=33 times. In the t-th answer ($1 \leq t \leq T$), he/she answers to the urn with UID= (ID+t-2) mod 33+1. Each subject then independently selected one ball from the randomly chosen urn on their screen to know its color. Subjects were paid 10 yen for each correct choice.

3 Results

The results of the experiment are as follows. We define Z(t) as the ratio of correct choice up to t-th subject for each urn. Figures 1 show the distribution functions p(Z(t)) of Z(t) in each treatment: A for q=2/3, B for q=5/9 and C for q=8/15. Each graph has two peaks. The observed peaks are at less than 0.2 and at more than 0.8 for A, at less than 0.4 and at more than 0.6 for B and at less than 0.4 and at more than 0.6 for C. If subjects choose based only on their own information, the distribution functions should be binomial distribution Bi (T, q). However, we clearly see the discrepancies from the binomial distribution. We find that subjects are clearly influenced by other subjects. In particular, in figure 1C, the distributions are clearly separated and there is a wide gap between the two peaks. In other words, when the state of the choice sequence is in the lower peak, it is very difficult to get out of it. This means that the non self-correcting phase may exist in information cascade, when q is small.

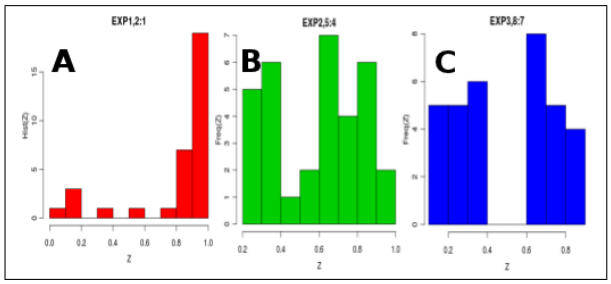

Figure 1: Plot of p(Z(t)) （A ; q=2/3,B ; q=5/9,C ; q=8/15） .

In order to discuss whether the system is in the self-correcting phase or not, we need to study the thermodynamics limit of the system. The self-correcting phase is the state where p(Z(t))has one peak(more than 50 %) and Var(Z(t))=0 in the limit t $\to\infty$. In the non self-correcting phase, p(Z(t)) has two peaks and Var(Z(t)) remains in the limit t $\to\infty$.

Figure 2 shows the plot of Var(Z(t)) as a function of t. For q=2/3, Var(Z(t)) decreases very slowly as t increases. The system is in the self-correcting phase. For q=5/9 and 8/15, it decreases at first and then it increases. In the latter two cases, it is highly probable that Var(Z(t)) remains in the limit t $\to \infty$. The systems are in the non self-correcting phase. We will also talk how people choose under social information. We propose a stochastic model that describe the human's selection and study the thermodynamics of the model system. In particular, we clarify the possibility of the non self-correcting phase and the phase transition in the system.

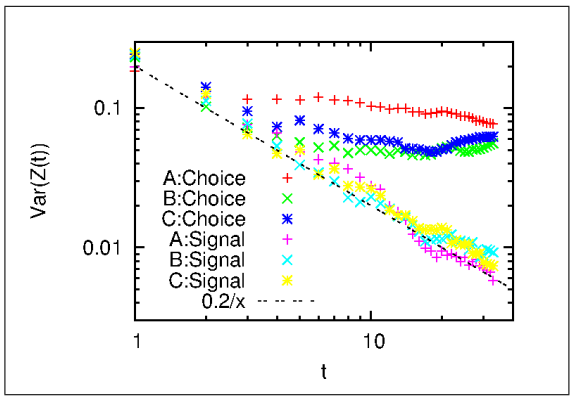

Figure 2: Plot of Var(Z(t)) as a function of t.