Why some are hot, so many are not: Emergence of bimodal popularity distribution from social choice dynamics

Anindya S. CHAKRABARTI[1] and Sitabhra SINHA[2,3]

[1]Department of Economics, Boston University, 270 Bay State Road, Boston, MA-02134, USA
[2]The Institute of Mathematical Sciences, CIT Campus, Taramani, Chennai 600113, India
[3]National Institute of Advanced Studies, IISc Campus, Bangalore 560012, India.

E-mail: [1]anindya@bu.edu, [2]sitabhra@imsc.res.in

Abstract

One of the most striking examples of nontrivial collective phenomenon resulting from the individual dynamics of many agents in society is the emergence of popularity (of products, ideas or entities). Such behavior is characterized by the appearance of a few "hits" or "stars" from a population of many competitors having similar qualities. Earlier studies have established several universal features (or empirical regularities referred to as *stylized facts*) of popularity distributions, including the existence of heavy tails, log-normality and an overall bimodal form that separates the "successes" from the "failures". Using the example of box-office performance of movies, we show that such bimodality can emerge via self-organization when agents take choice decisions independent of the others. For the specific context of movies, our model shows that timing the release of a new movie may be one of the most crucial factors deciding its eventual popularity.

Keyword: Social choice dynamics, Bimodal distribution, Movie popularity, Self-organization

Social systems often exhibit non-trivial features in the collective (macro) behavior arising from the individual (micro) actions of many agents. Even though the characteristics of individuals comprising a group may vary over a large range, it is sometimes possible to observe robust empirical regularities in the collective features. The existence of inequality in individual success, often measured by the popularity, is one such universal feature. This often has a heavy-tailed distribution [1] with a much higher range of variability than that observed in the inherent qualities. Popularity is also characterized by a strongly *bimodal* character with a clear segregation into two distinct classes, viz., successes and failures. While such distributions have been reported in many different contexts, e.g., gene expression, species abundance, wealth of nations, electoral outcomes, etc., one of the most robust demonstrations of bimodality is seen in the distribution of movie box-office success [2]. For this, popularity can be measured in terms of either the gross income at the opening weekend or the total gross calculated over the lifetime (i.e., the entire duration that a movie is shown) at theaters. Both exhibit strong bimodal distributions that can be fit by a combination of two log-normal distributions (Fig. 1). The fact that bimodality is manifested at the very beginning of a movie's life suggests that the divergence of outcomes cannot be simply attributed to social learning occurring over time as a result of diffusion of information about movie quality. Thus, while there have been earlier attempts to explain emergence of bimodality through interaction between agents, we need to look for an alternative explanatory framework.

Here we show that bimodal collective response can naturally emerge in a system of agents subjected to successive information shocks, where each agent makes choice decisions independent of other agents. Even in the absence of explicit interaction among agents, the system can exhibit self-organized coordination, characterized by the appearance of strongly bimodal distribution. For the specific example of box-office success, as the bimodal nature of the gross income distributions appear to be connected to the fact that movies usually open in either many or very few theaters, we focus on explaining the appearance of a bimodal distribution for the number of theaters in which movies open [3]. Agents achieve coherence in their actions because they respond to common stimuli, viz., new movies being introduced in the market. By contrast, decoherence is induced by the uncertainty under which a decision is made on releasing a new movie. We show that these competing effects can result in the appearance of bimodality in the distributions of theaters in which a movie opens, and consequently, its opening week gross and total lifetime gross. Our results show that the success of a particular movie cannot be simply connected to

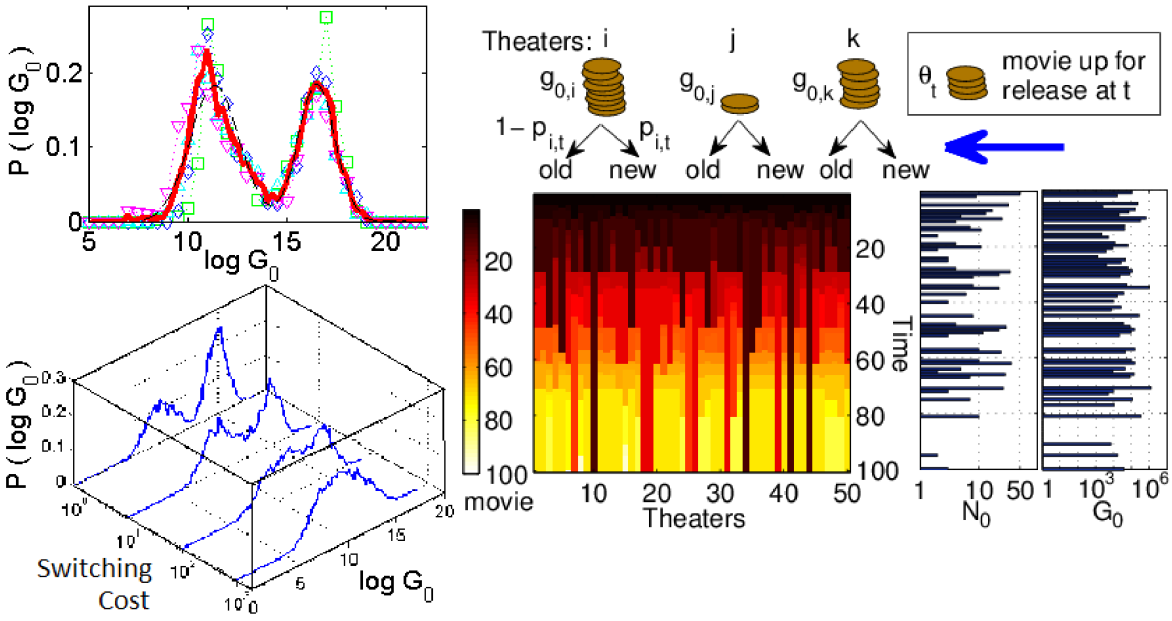

Figure1: (Left, top) Opening weekend income of movies released across USA over a span of two decades show bimodal distribution indicating movies either perform very well or very poorly. (Right) A model in which N theaters decide every week whether to continue showing the movie they are showing currently or to release a new movie that has just become available for distribution reproduces the observed behavior. The tunable parameter of the model is the cost of switching to a new movie. (Left, bottom) At low cost we see sharp bimodal distribution, but with increasing cost this smooths to a unimodal distribution.

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its perceived quality prior to release nor to its actual performance on opening. Under a suitable approximation, we have analytically solved the model and obtained closed form expressions for peaks of the resulting multimodal distribution that match our numerical results. An important implication of our study is that the box-office performance of a movie is crucially dependent on whether it is released close in time to a highly successful one, which supports the popular wisdom that correctly timing the opening of a movie determines its fate at box-office.

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