Popularity dynamics and preference of memes on complex networks

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We study the origin of the criticality of the meme-spreading dynamcis on non-growing and growing networks based on the competition induced criticality model. From the direct Mote Carlo simulations and the exact mapping into the position dependent biased random walk (PDBRW), we find that the meme popularity distribution sat- isfies a very robust power- law with exponent $\alpha = 3/2$ if there is an innovation process. On the other hand, if there is no innovation, then we find that the meme popularity distribution is bounded and highly skewed for early transient time periods, while it satisfies a power-law with exponent $\alpha \neq 3/2$ for intermediate time periods. The exact mapping into PDBRW clearly shows that the balance between the creation of new memes by the innovation process and the extinction of old memes is the key factor for the criticality. We confirm that the balance for the criticality sustains for relatively small innova- tion rate. Therefore, the innovation processes with significantly in uential memes should be the simple and fundamental processes which cause the critical distribution of the meme popularity in real social networks. We also explain the log-normal distribution of popularity of the trending memes from the meme propagation model with fitness. In this model, each meme has its own fitness. In the propagation process, a meme is selected by considering the fitness of the meme and those of the other memes on the network. If there occurs the innovation in which a meme with a suitably-high fitness is created among the background of the memes with low fitness, then the popularity distribution of the created meme satisfies the log-normal distribution under the condition that only the propagation processes happen after the innovation. Of course, the created meme stands for the trending meme in social networks. If the fitness of the created meme is very high, we find the delta-function type distribution instead of the log-normal distribution.

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