Analysis of enhancement in game system with the random walk model

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The random walk model has been used to analyze stochastic systems. Now we apply a random walk model to enhancement of an item in online game system. In some game system, equipment is enhanced with some risks. In the process of enhancement, sometime equipment is broken or enhanced. We analyze the statistical properties of enhancements with failure through the random walk model. The model is simply described by follows. First, let's assume that we have m-th enhanced item. When we try to enhance our m-th enhanced item, the item is successfully enhanced and become $(m+1)$-th enhanced item with probability p_{m+1}. Otherwise, the m-th enhanced item is broken and become 0-th enhanced item with probability $1-p_{m+1}$. The model is simple. Let's assume that an 1D lattice. A random walker is moved to the right position $x = m+1$ with probability p_{m+1} if the walker was in position $x = m$. With probability $1-p_{m+1}$, the walker go to the origin of the lattice. If we assume the simplest case $p_m = p$, the average number C_n of tries of enhancement for n-th enhanced item is calculated as follows. C_1 is clearly driven as $1/p$. C_2 also calculated as $C_2 = (C_1+1)/p$, because, in the average sense, C_1 step is needed for the walker is in 1st position. Similarly, the recursive relation $C_{n+1} = (C_n+1)/p$ is driven. Finally, C_n is calculated as $C_n = \frac{p^{-n}-1}{1-p}$. Only the average number C_n of tries for the simplest can be simply obtained. The average, variance, and the number of failed tries (and return to the origin) are also considered for the general case. We first suggest a numerical analysis using matrix analyze. The model is considered analytically by partition function. Finally, we perform a Monte-Carlo simulations of the model to verify the analytical and numerical results. We also confirm that the analytic and numerical results are consistent. Finally, we suggest an analytical form of expected costs for enhancement of item in online-game through the random walk model.

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