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Pachinko. (English) Zbl 1380.05188

Summary: Inspired by the Japanese game Pachinko, we study simple (perfectly “inelastic” collisions) dynamics of a unit ball falling amidst point obstacles (pins) in the plane. A classic example is that a checkerboard grid of pins produces the binomial distribution, but what probability distributions result from different pin placements? In the 50-50 model, where the pins form a subset of this grid, not all probability distributions are possible, but surprisingly the uniform distribution is possible for \( \{1, 2, 4, 8, 16\} \) possible drop locations. Furthermore, every probability distribution can be approximated arbitrarily closely, and every dyadic probability distribution can be divided by a suitable power of 2 and then constructed exactly (along with extra “junk” outputs). In a more general model, if a ball hits a pin off center, it falls left or right accordingly. Then we prove a universality result: any distribution of \( n \) dyadic probabilities, each specified by \( k \) bits, can be constructed using \( O(nk^2) \) pins, which is close to the information-theoretic lower bound of \( \Omega(nk) \).

MSC:
05C99 Graph theory

Keywords:
Pachinko; probability distributions

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References:

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