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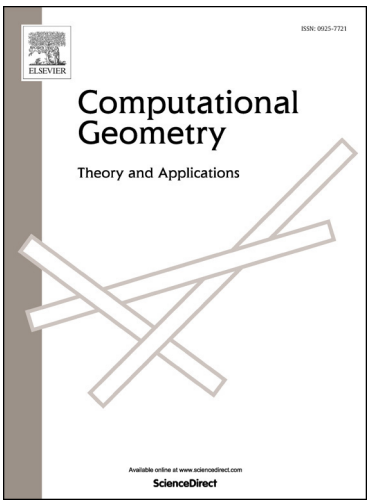

Pachinko

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Pachinko

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Abstract

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 $\Omega(nk)$.

In memory of our friend Ferran Hurtado.

1 Introduction

Pachinko [8, 7] is a popular mechanical gambling game found in tens of thousands of arcade parlors throughout Japan. The player fires Pachinko balls (ball bearings) into a vertical, nearly two-

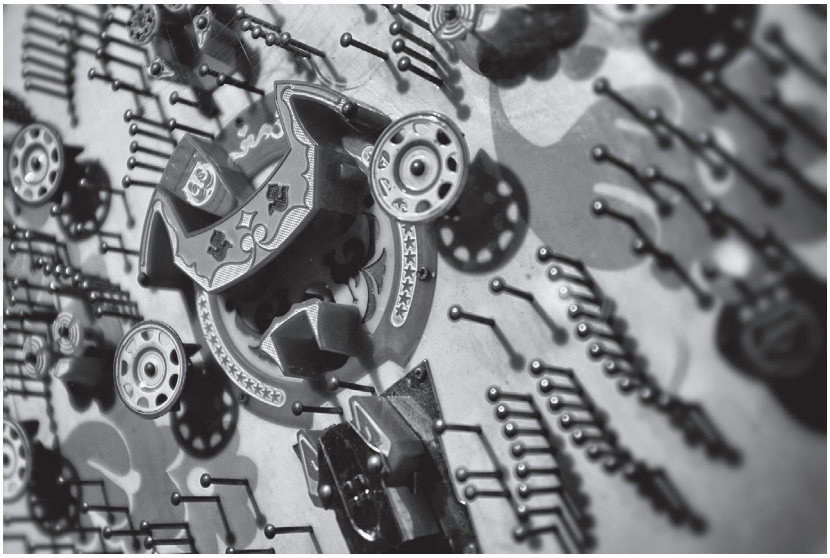

Figure 1: Close-up of Pachinko machine. Photo by Neil Heeney, 2012, used with permission. http://www.flickr.com/photos/heeney/8188927393