

Seminar

Student

& GAMECOCK MATH CLUB

Mathematics of Juggling: Prime Patterns and Generalized Eulerian Numbers

by Jeffrey Davis USC Undergraduate Student



Jeffrey Davis

The mathematics of juggling has been studied over the past 30 years. We extend the work of Fan Chung and Ron Graham on "primitive juggling sequences" by investigating "prime juggling sequences." A juggling pattern can be described by a closed walk in a (directed) state graph, where each vertex (or state) is a landing pattern for the balls and directed edges connect states which can occur consecutively. A juggling pattern is prime if the closed walk is a cycle. For the case of two balls we give an expression for the number of prime juggling patterns of length n by establishing a connection with partitions of n into distinct parts. From this we show the number of two-ball prime juggling patterns of length n is $(\gamma - o(1))2^n$, where $\gamma = 1.32963879259...$ We also give a generalization of Eulerian numbers which count the number of placements of cn rooks on an $n \times n$ board (each rook placement corresponds to a juggling sequence) so that c rooks are in each row and column and exactly k rooks are below the main diagonal.

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