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Natasa Jovanovic, Jan Korst, Ramon Clout, Verus Pronk and Ludo Tolhuizen

Candle in the Woods: Asymptotic Bounds on Minimum Blocking Sets

We consider the problem of determining the minimum number N_d of unit disks that is required to block all rays emanating from a point P in the two-dimensional space, where each disk has at least a distance d to point P and to any other disk. We study the asymptotic behavior of N_d , as d tends to infinity. By deriving upper bounds and lower bounds, we prove that $\pi^2 / 16 \leq \lim_{d \rightarrow \infty} (N_d / d^2) \leq 18 / \pi^2$, where the upper bound is based on establishing an interesting link between unit disks positioned on a regular triangular grid and Farey sequences from number theory. By positioning point P as well as the centers of the disks on the grid points of such a triangular grid, we create hexagonal rings of disks around P . We prove that we need exactly $d - 1$ of these hexagons to block all rays emanating from P .