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Fighting intelligent fires

The Firefighter Problem is a simplified model for the spread of a fire (or disease or computer virus) in a network. A fire breaks out at a vertex in a connected graph, and spreads to its neighbours over discrete time-steps. A firefighter saves one vertex in each time-step which is not yet burned. Since its introduction by Hartnell in 1995, there is a steadily growing corpus of both structural and algorithmic results on the Firefighter problem.

While maximizing the number of saved vertices usually requires a strategy on the part of the firefighter, the fire itself spreads without any strategy. Consider a variant of the problem where the fire is intelligent but burns slowly. For a fixed positive integer k, the fire chooses to burn at most k unsaved neighbours in a given time-step. The *surviving rate* of G is defined as the expected percentage of vertices that can be saved when a fire breaks out at a random vertex of G.

Using spectral techniques, we establish asymptotic bounds on the surviving rate for random regular graphs. We consider the limiting survival rate for countably infinite graphs. In particular, we show that the limiting survival rate of the infinite random graph can be any real number in $[0, 1]$.