We first construct a corresponding flow network with rows, named a_i for row i, as the sources and columns, named b_i for column i, as the sinks. Since each row and column can exist only one rook, form a super source for rows with edges of capacity one and a super sink for columns with edges of capacity one. For every cell (a_i, b_i) in row i and column i, if it is not under any bishop's attack, which means there is no bishops in diagonal cells, connect vertex a_i and b_i with a directed edge of capacity 1, meaning a rook can be placed in cell (a_i, b_i). We now run the Edmons-Karp algorithm to find the maximal flow through such a network. The max flow is the largest number of black rooks we can place on the board.

Time complexity: Constructing a network and running the Edmons-Karp algorithm $= O(|V||E|^2) = O(|n||n^2|^2) = O(n^5)$