We consider a two-dimensional Markov process \( \{(X_1(t), X_2(t))\} \) on the nonnegative integers, which we would refer to as a 2-d reflecting random walk with homogeneous transitions: \( X_1 \) and \( X_2 \) may change by at most one unit at each transition, and the jump probabilities are independent of \( X_1 \) and \( X_2 \) if both are different from zero, with similar assumption if \( X_1 \) or \( X_2 \) is equal to zero. The process is assumed to be irreducible and positive recurrent, with stationary distribution \( \pi_{n_1,n_2} = \lim_{t \to \infty} P[X_1(t) = n_1, X_2(t) = n_2] \).

The stationary distribution is said to have product form if it is factored as \( \pi_{n_1,n_2} = \alpha n_1 \beta n_2 \), where \( \alpha \) and \( \beta \) are two probability densities. In a first step, we investigate the conditions under which it holds. This is of theoretical interest of course but, in a second step, we show how to use the knowledge to find product form approximations for otherwise unmanageable random walks.