ASYMPTOTIC INDEPENDENCE OF (SIMPLE) TWO-DIMENSIONAL MARKOV PROCESSES

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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 $\pi_{n_1,n_2} = \lim_{t\to\infty} \mathrm{P}[X_1(t) = n_1, X_2(t) = n_2]$.

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 α and β 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.