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Homework Assignment 1
CS 663: Digital Image Processing

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Exercise-3

We are given two images I and J whose intensity values (in each location) are randomly drawn from the known probability mass functions (PMFs) $p_I(i)$ and $p_J(j)$ respectively. Let image K be defined as $I + J$ Assuming that intensity values lie in the set $\{0, 1, 2, ...L - 1\}$, intensity values in image K will lie in the set $\{0, 1, 2, ...2L - 2)\}$.

Let (x_0, y_0) denote a pixel in each image: K, I, J. The probability that $K(x_0, y_0) = k$ will be equal to the sum of the probability for [($I(x_0, y_0) = 0$ and $J(x_0, y_0) = k$) or ($I(x_0, y_0) = 1$ and $J(x_0, y_0) = k - 1$) or ($I(x_0, y_0) = 2$ and $J(x_0, y_0) = k - 2$) ..... or ($I(x_0, y_0) = k$ and $J(x_0, y_0) = 0$)]. Mathematically, this can be computed as:

$$\begin{aligned} p_K(k) &= (p_I(0) \times p_J(k)) + (p_I(1) \times p_J(k-1)) + (p_I(2) \times p_J(k-2)) + ... + (p_I(k) \times p_J(0)) \\ &= \sum_{m=0}^{k} p_I(m) p_J(k-m) \\ &= (p_I * p_J)(k) \end{aligned} \tag{1}$$

The expression resembles the **convolution** operation!