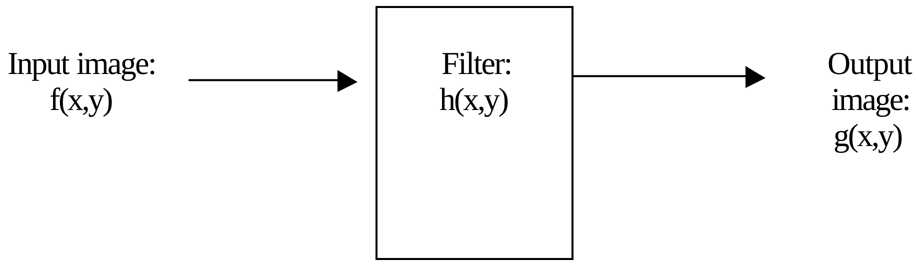
CONVOLUTION



Convolution: continuous form

We define the convolution of f(x, y) by h(x, y) by the integral

$$g(x,y) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(a,b) \quad h(x-a, y-b) \quad da \quad db \qquad (1)$$

Convolution: discrete form

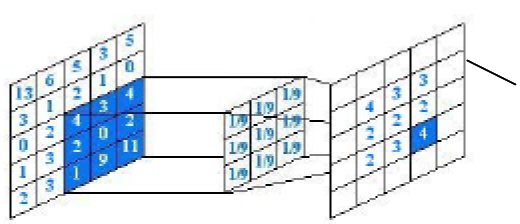
In the discrete form the convolution is defined as

$$g(x,y) = \sum_{-\infty}^{\infty}\sum_{-\infty}^{\infty} f(a,b) \quad h(x-a, y-b) \qquad (2)$$

We denote convolution as

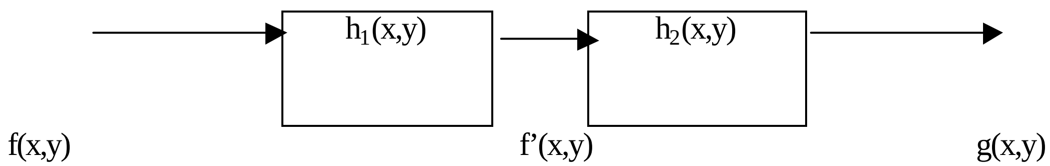
$$g(x,y) = f(x,y) * h(x,y)$$

Convolution: example



Input image Kernel Output image

Convolution: multiple filters



$$
\begin{aligned}
f'(x,y) &= f(x,y) * h_1(x,y) \\
g(x,y) &= f'(x,y) * h_2(x,y) \\
&= \{f(x,y) * h_1(x,y)\} * h_2(x,y) \\
&= f(x,y) * \{h_1(x,y) * h_2(x,y)\}
\end{aligned}
$$

Convolution: Equivalent terminology

- Impulse response
- Convolution kernel
- Mask
- Operator
- Filter