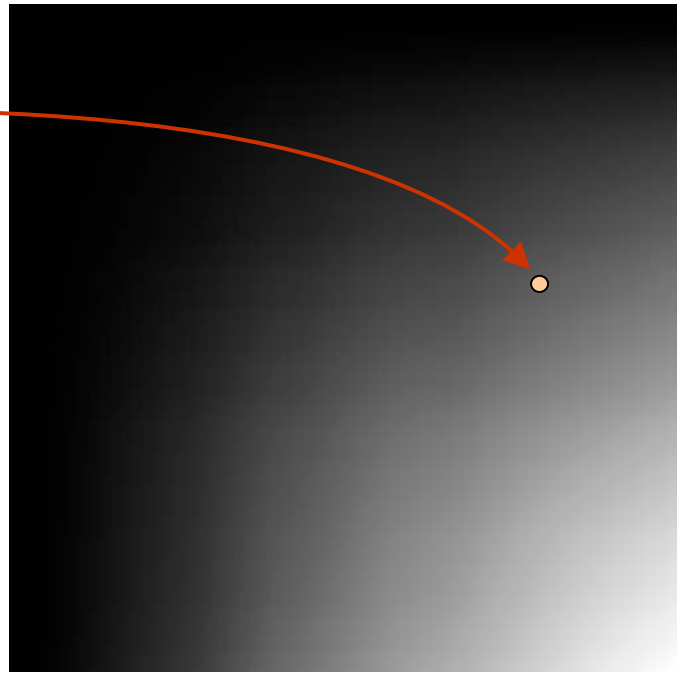
Integral image

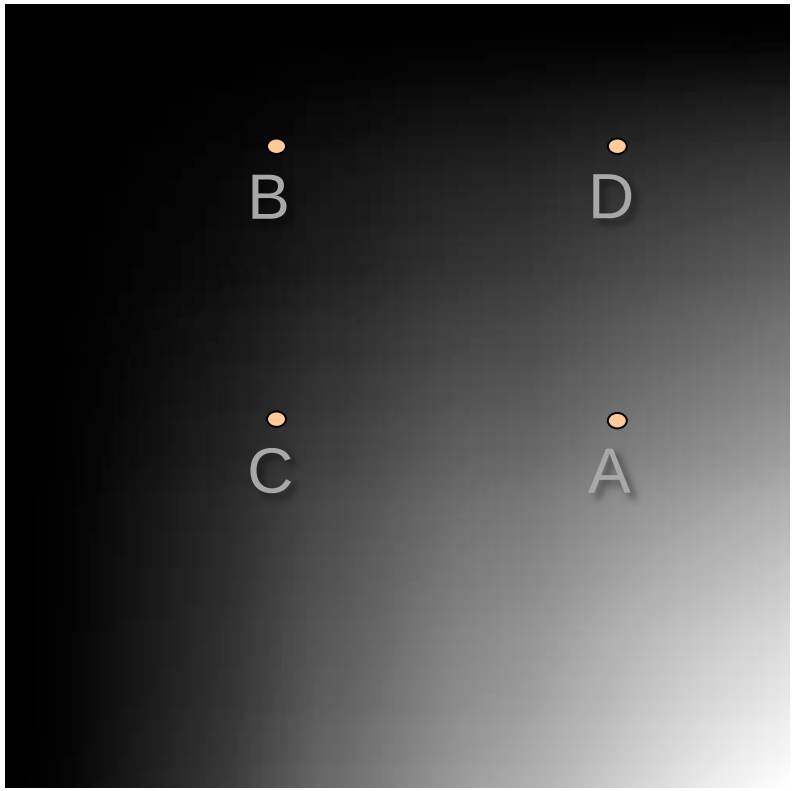


$$j[x,y] = j[x,y-1] + f[x,y]$$
$$i[x,y] = i[x-1,y] + j[x,y]$$

$$f[x,y]$$

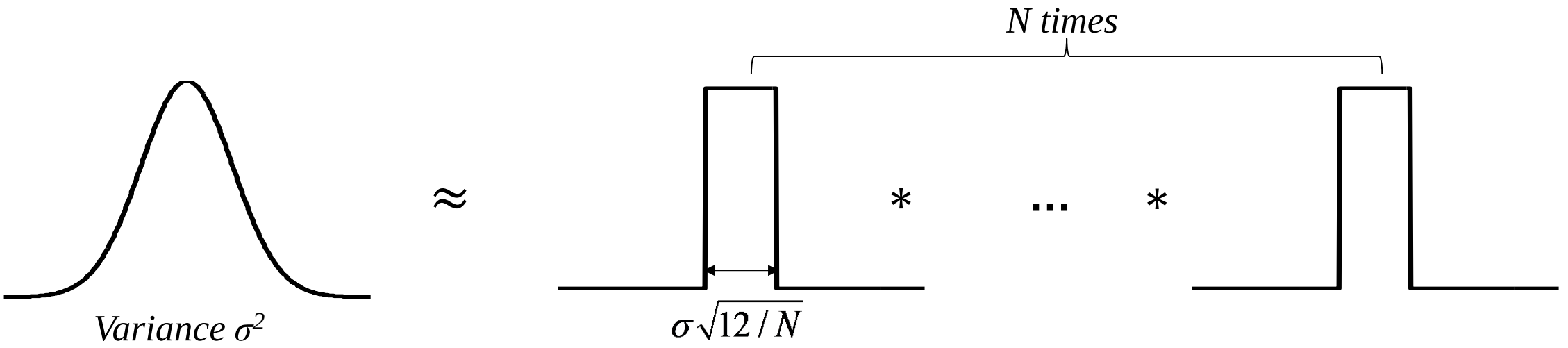
$$i[x,y] = \sum_{u=0}^{x} \sum_{v=0}^{y} f[u,v]$$

Box filtering with integral image



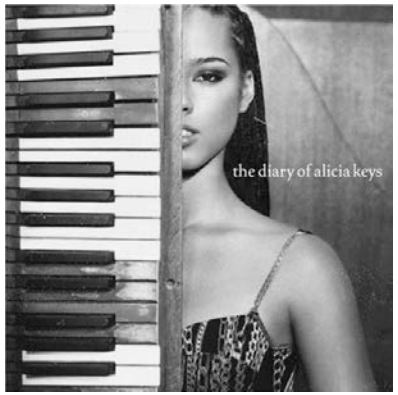
Sum = A + B – C – D

Gaussian filtering by repeated box filtering

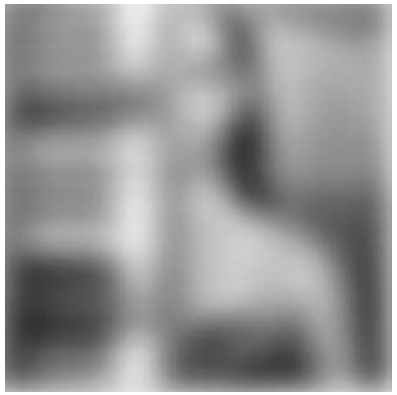


- Approximate convolution with Gaussian kernel by convolution with box kernel, repeated N times
- Convolution with box kernel can be computed efficiently using integral image

Gaussian filtering by repeated box filtering



Original image
500x500



Gaussian filtered
σ = 20, 81x81 kernel

Direct implementation:
6561 multiplications and
6560 additions per pixel

x-y separable filtering:
162 multiplications and
160 additions per pixel

20 additions or subtractions per pixel

Box filtered
after N = 1

Box filtered
after N = 2

Box filtered
after N = 3

Box filtered
after N = 4