

Cascaded dilations



f



$dilate(f, w_1)$



$dilate(f, w_1, w_2)$



$dilate(f, w_1, w_2, w_3)$

$$dilate[dilate(f, w_1), w_2] = dilate(f, w)$$

$$\text{where } w = dilate(w_1, w_2)$$



Cascaded erosions

- Cascaded erosions can be lumped into single erosion

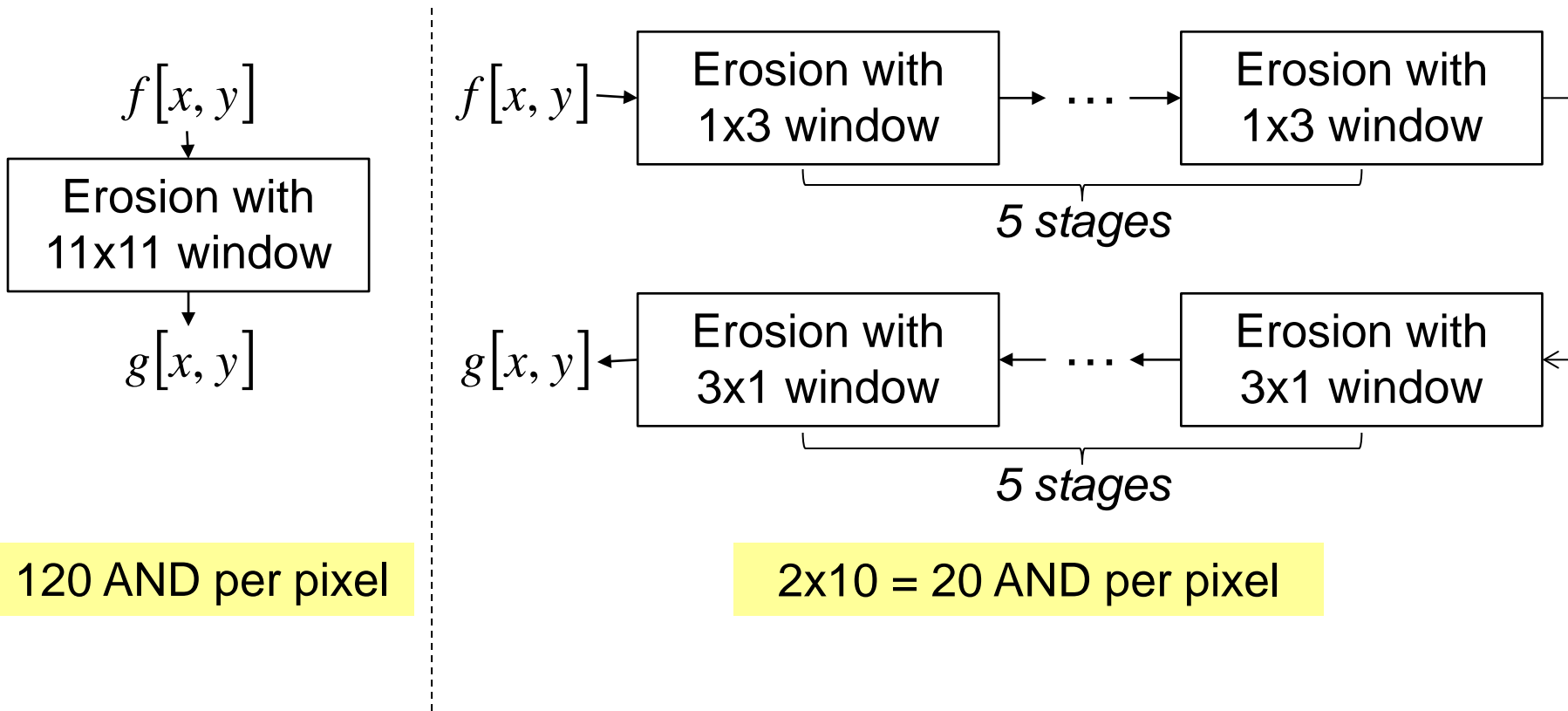
$$\begin{aligned} \text{erode}\left[\text{erode}(f, w_1), w_2\right] &= \text{erode}\left[-\text{dilate}(-f, w_1), w_2\right] \\ &= -\text{dilate}\left[\text{dilate}(-f, w_1), w_2\right] \\ &= -\text{dilate}(-f, w) \\ &= \text{erode}(f, w) \end{aligned}$$

$$\text{where } w = \text{dilate}(w_1, w_2)$$

- New structuring element (SE) is not the erosion of one SE by the other, but dilation.

Fast dilation and erosion

- Idea: build larger dilation and erosion operators by cascading simple, small operators
- Example: binary erosion by 11x11 window



120 AND per pixel

$2 \times 10 = 20$ AND per pixel