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Group Operators (98-114 3rd Ed).

- i/. ~~examine~~ parts for calculations with regions
- ii/. implemented via Template Convolution

$$N_{x,y} = \sum_{x,y \text{ window}} \sum O_{x,y} \times w_i$$

point covered by template.

iii/. (direct) averaging

$w_i = 1/\text{window size in pixels}$

Border? — set it to black (0)

wrap around?

use smaller templates?

ex.

$$3 \times 3$$

$$w_i = 1/9$$

$$5 \times 5$$

$$w_i = 1/25$$

more averaging = more blurring  
less noise less noise

low pass filtering.

We can use Fourier.

$$N = F^{-1}(F(O) \cdot X \cdot F(T))$$

Fourier  $\nearrow$  point by point.  $\nearrow$  template padded with zeros  $\nearrow$

# V. Gaussian averaging

$$w_i = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2}$$

$\sum_{\text{window}} w_i$

implemented as window of  $3 \times 3$  pixels  
 and  $\sigma$  depends on window size.  
 0.7 0.9

vi) Median operator  
retains edges - removes noise.

vii) Note this is convolution!  
the template is flipped.  
either before or during application.