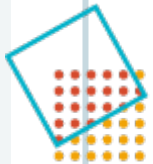
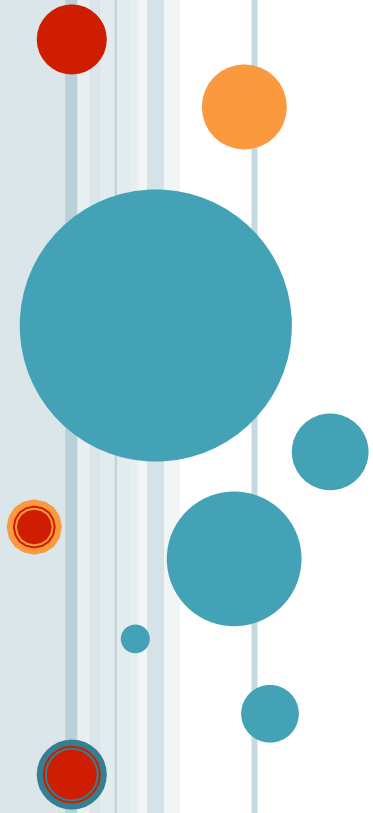


Laboratoire
Informatique
Robotique
Microélectronique
Montpellier

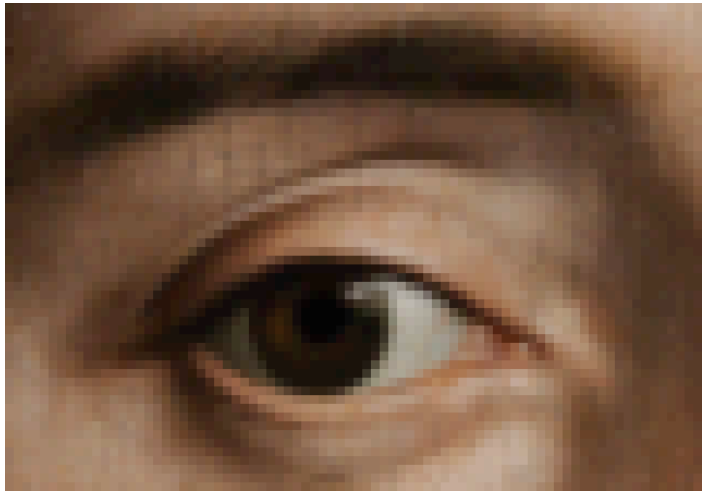


Possibilistic image processing:

how to handle scant sensor knowledge?

IMAGE PROCESSING

- What is an image?



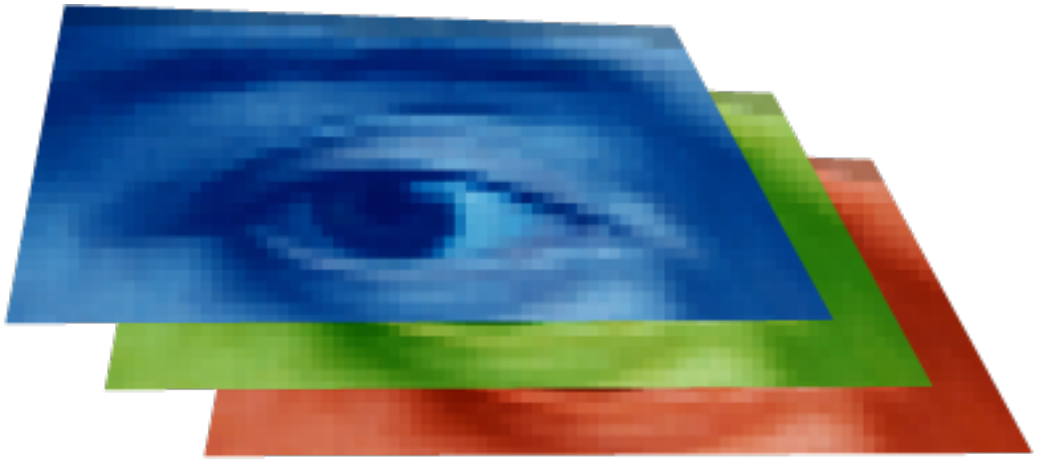
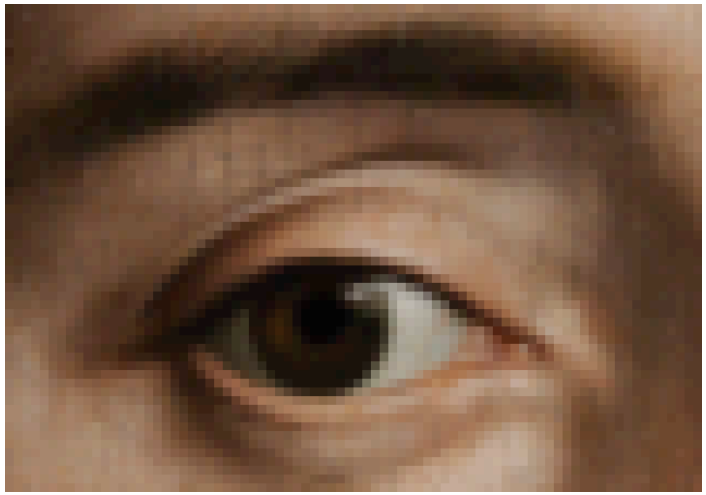
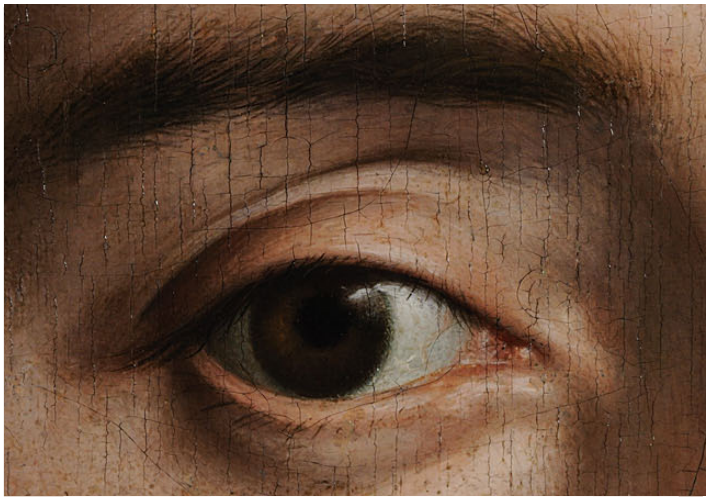


Image processing

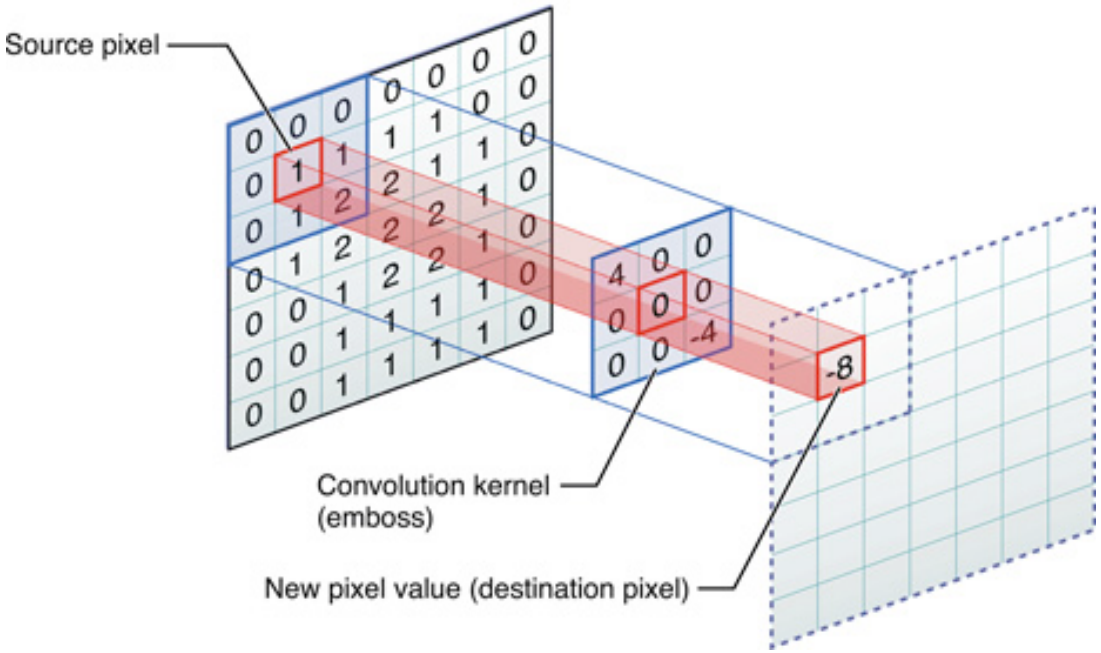
- Linear / non-linear

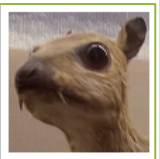
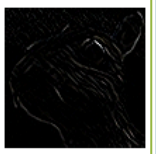
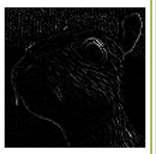
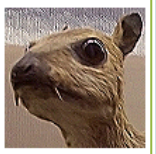
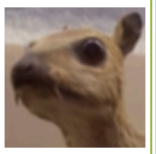




Linear image processing

- Convolution



Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	
Gaussian blur (approximation)	$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	

CONTINUOUS DISCRETE IMAGE PROCESSING

- The “perfect fit” scheme !

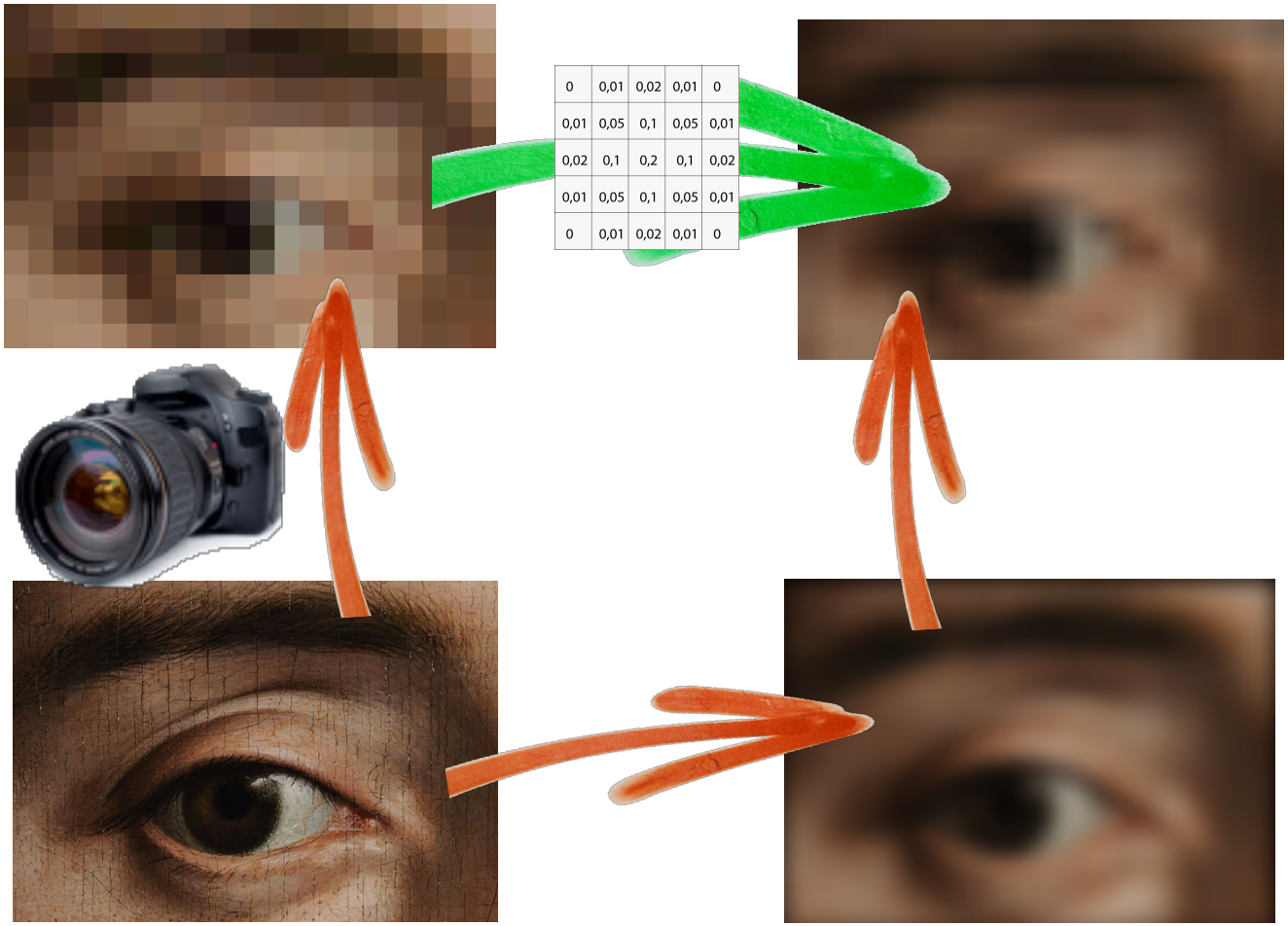


IMAGE PROCESSING

- The role of kernel

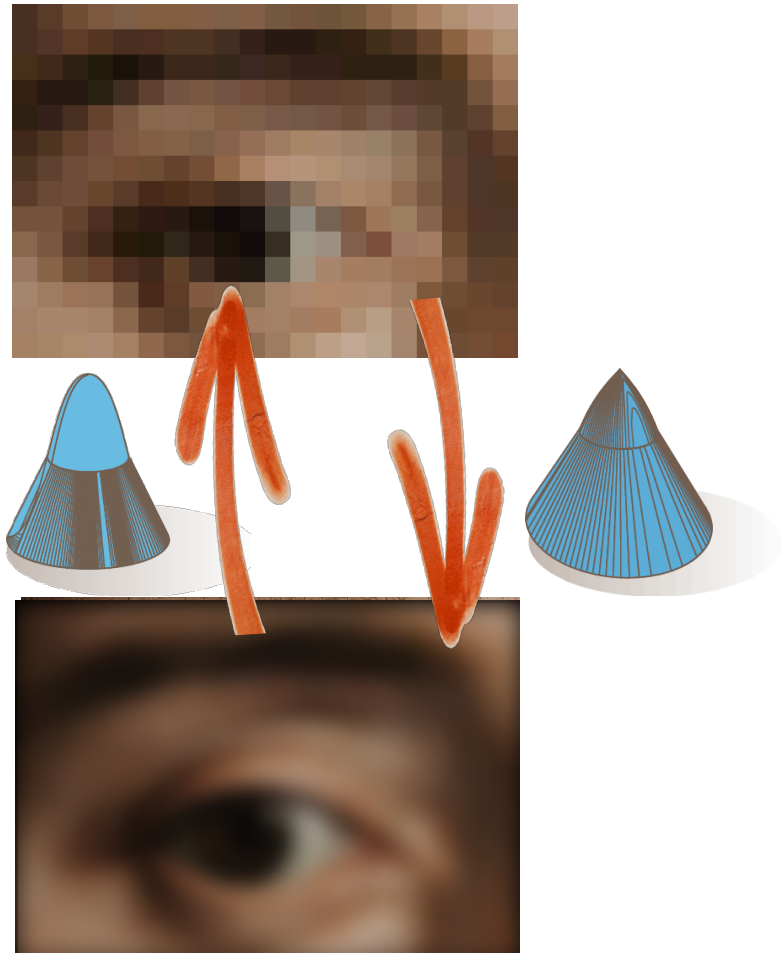


IMAGE PROCESSING

$$= \varphi^{-1}(\ ) \otimes$$

- The role of kernel

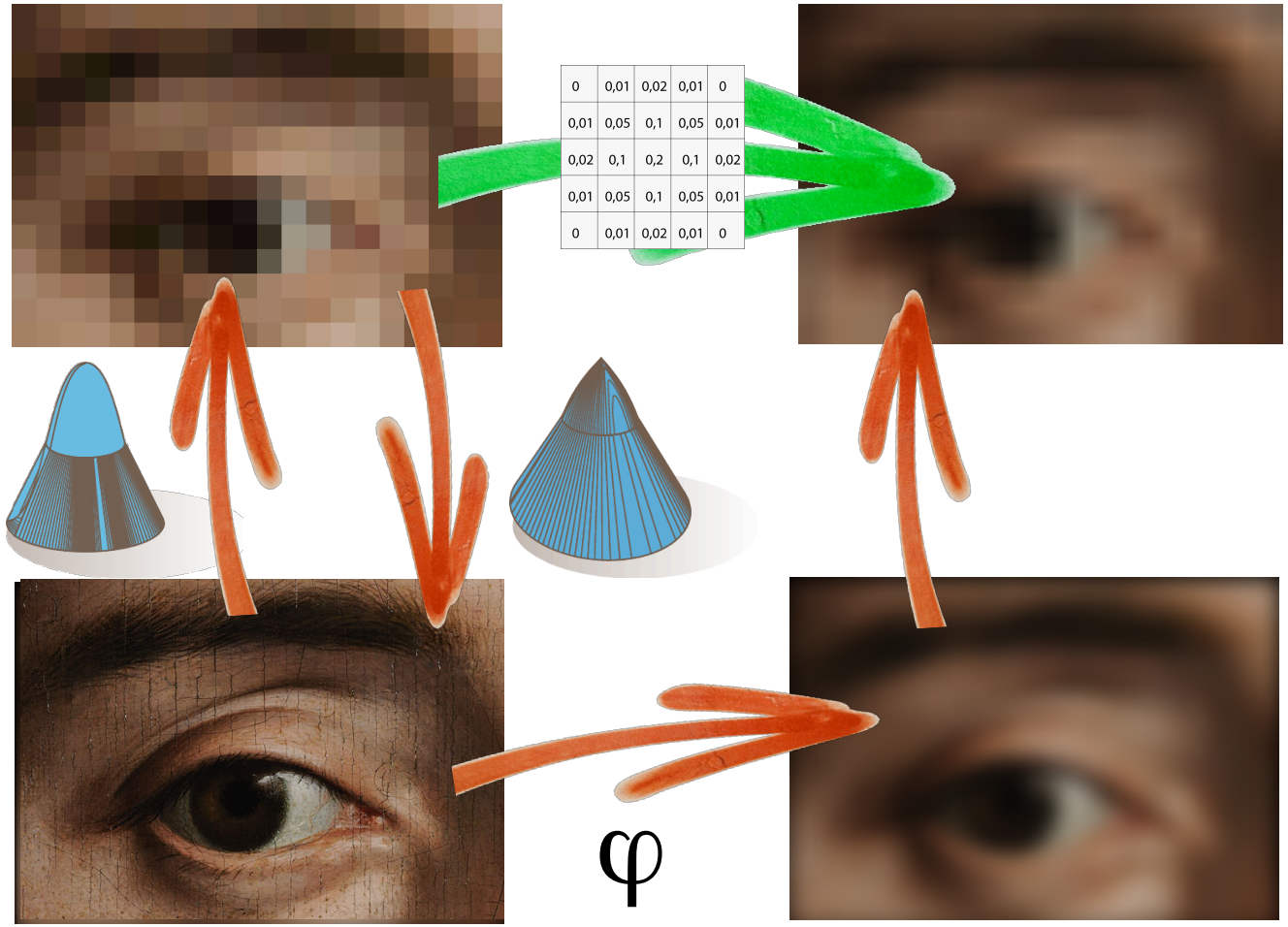


IMAGE PROCESSING

$= \varphi^{-1}(\quad) \otimes$ 

- The role of kernel

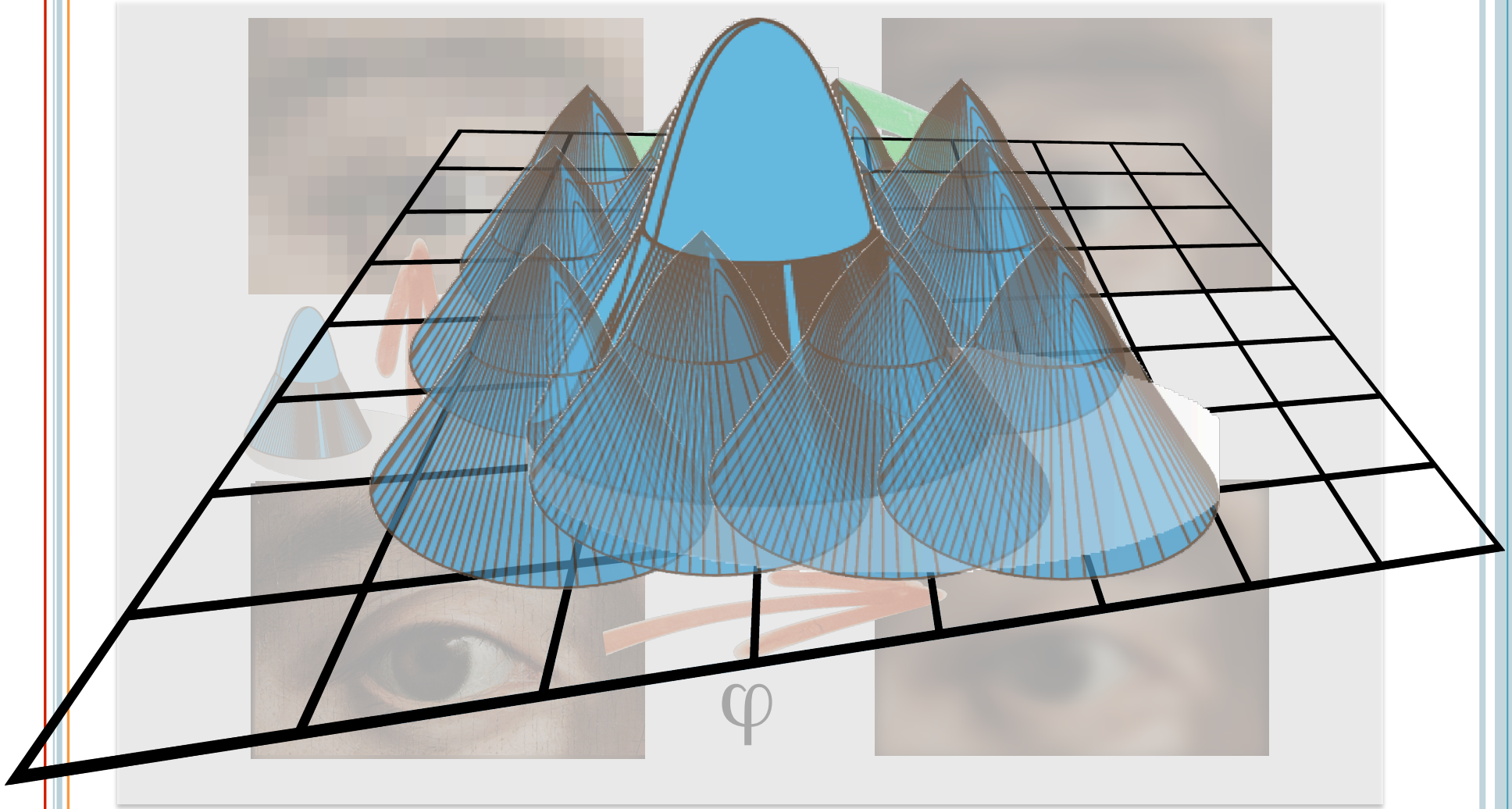


Image processing

- Modeling the impulse response

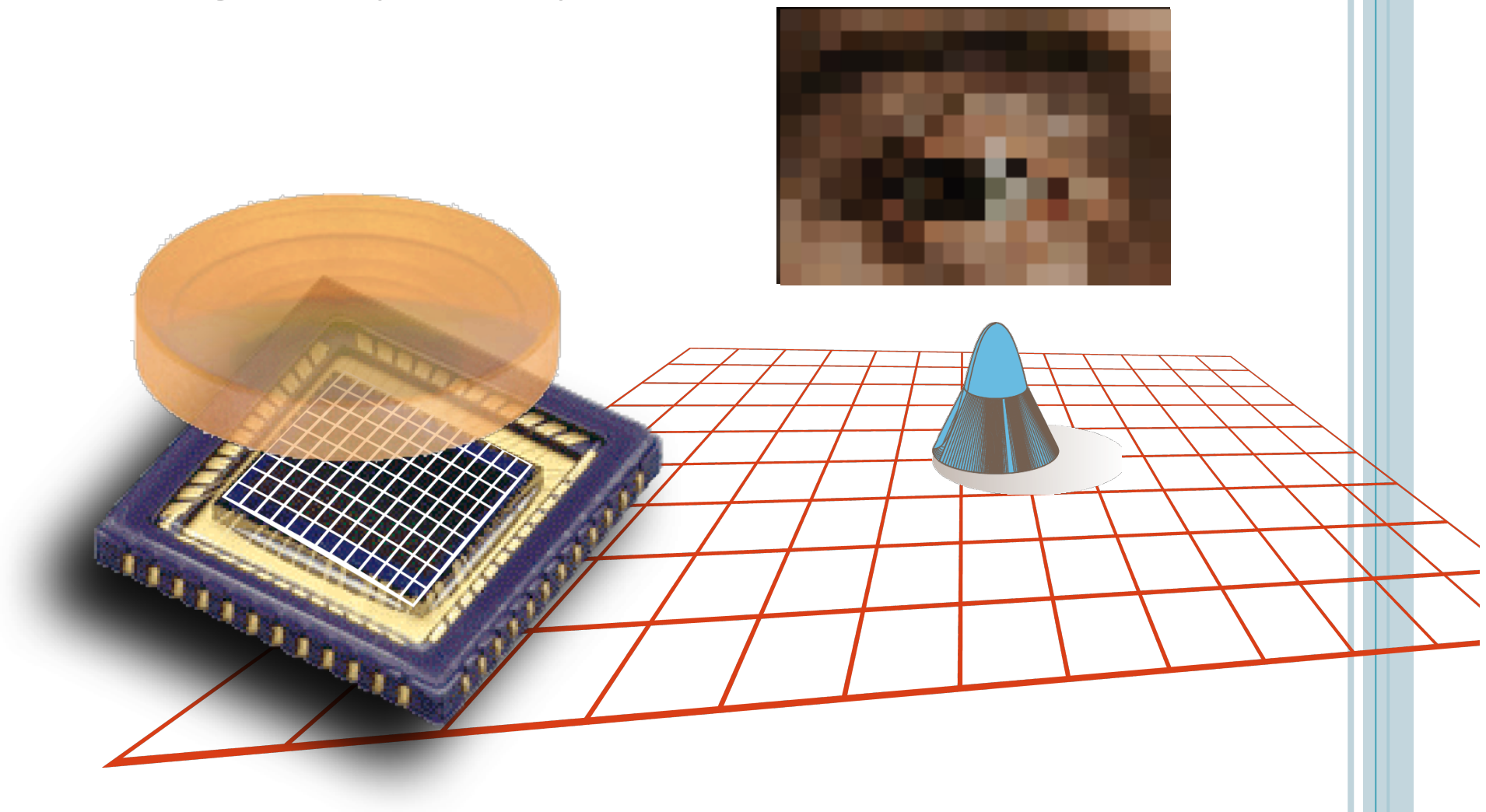
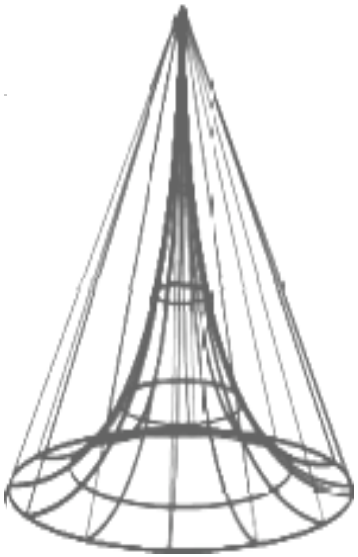


IMAGE PROCESSING

- Modeling the impulse response



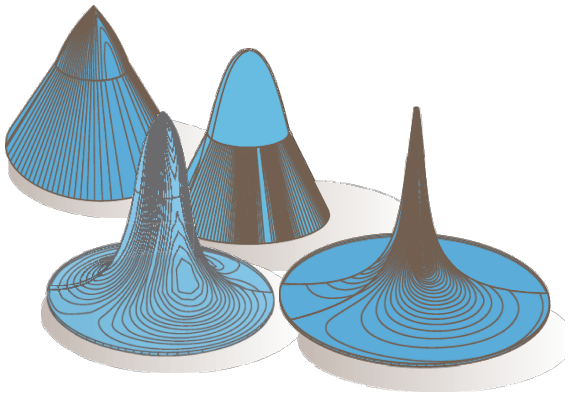
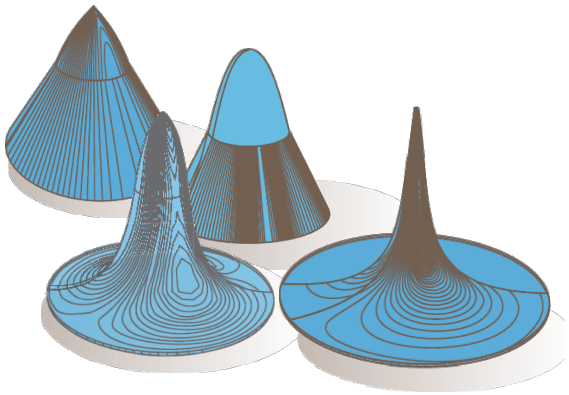


Image processing

- Box of kernels …

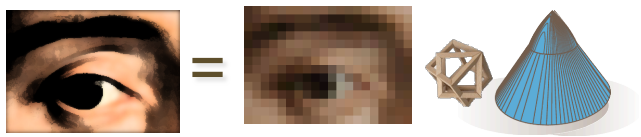


Interval-valued convolution

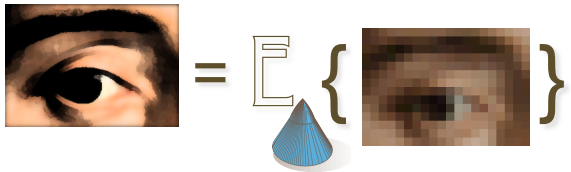
CONVOLUTION

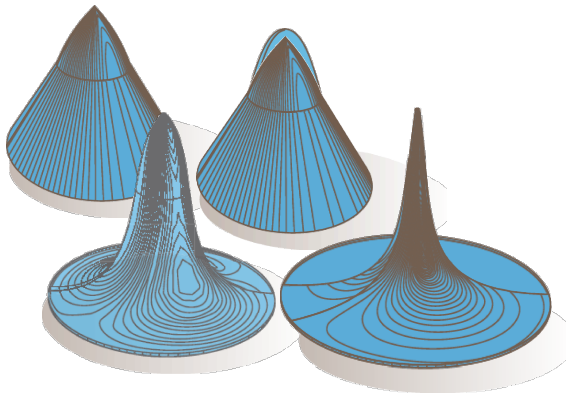
- Convolution / Expectation

$$I'(v) = \int \blacktriangle(v-u)\, I(u)\, du$$



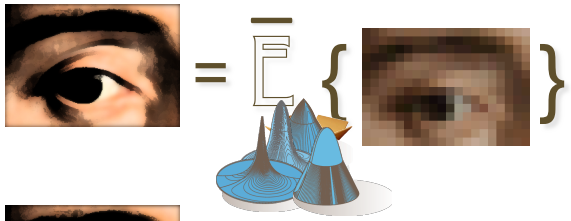
$$\int \blacktriangle(u)\, du = 1$$

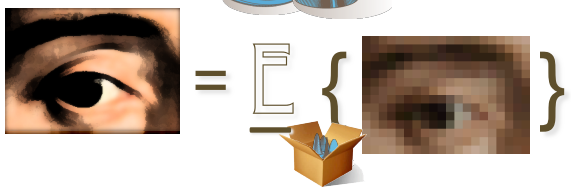


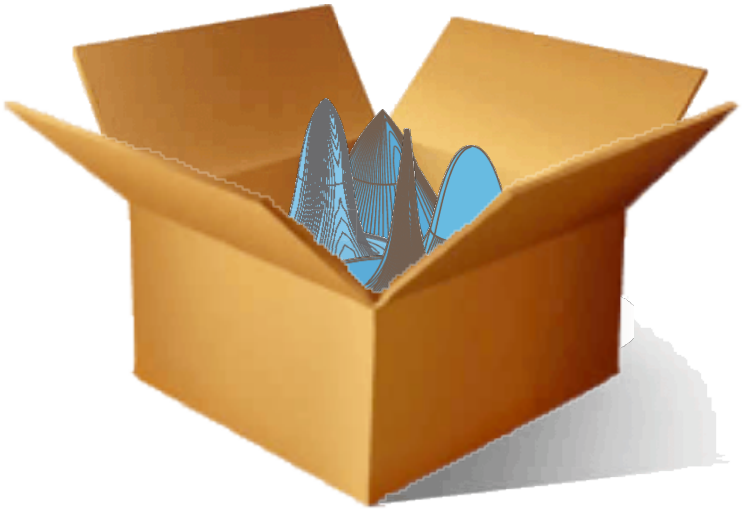


POINT SPREAD FUNCTION

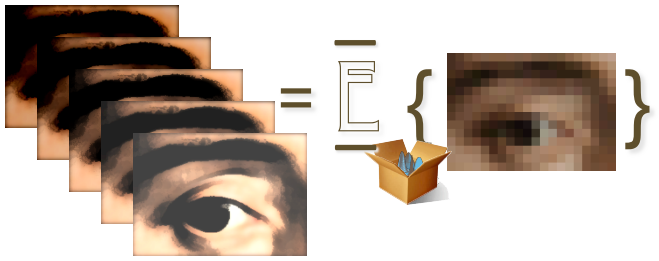
- Scant knowledge ?







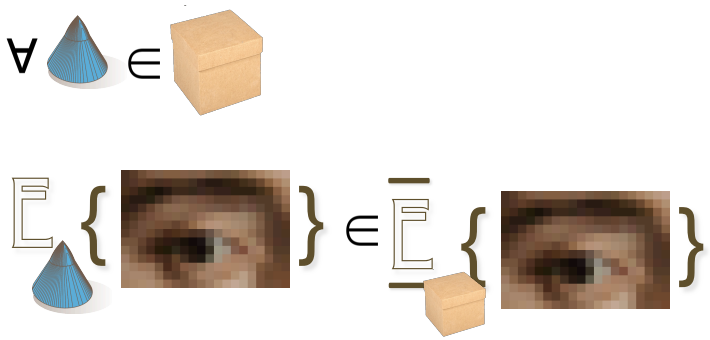
Concave capacity

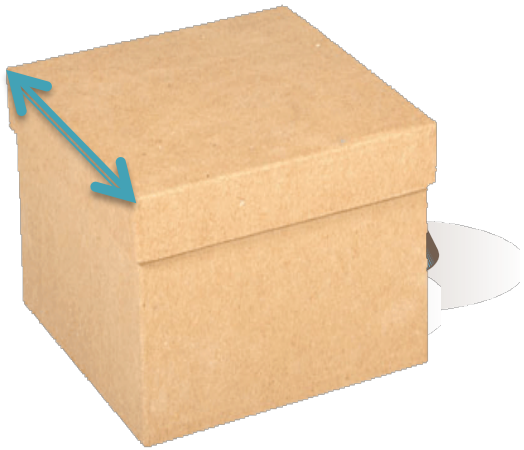


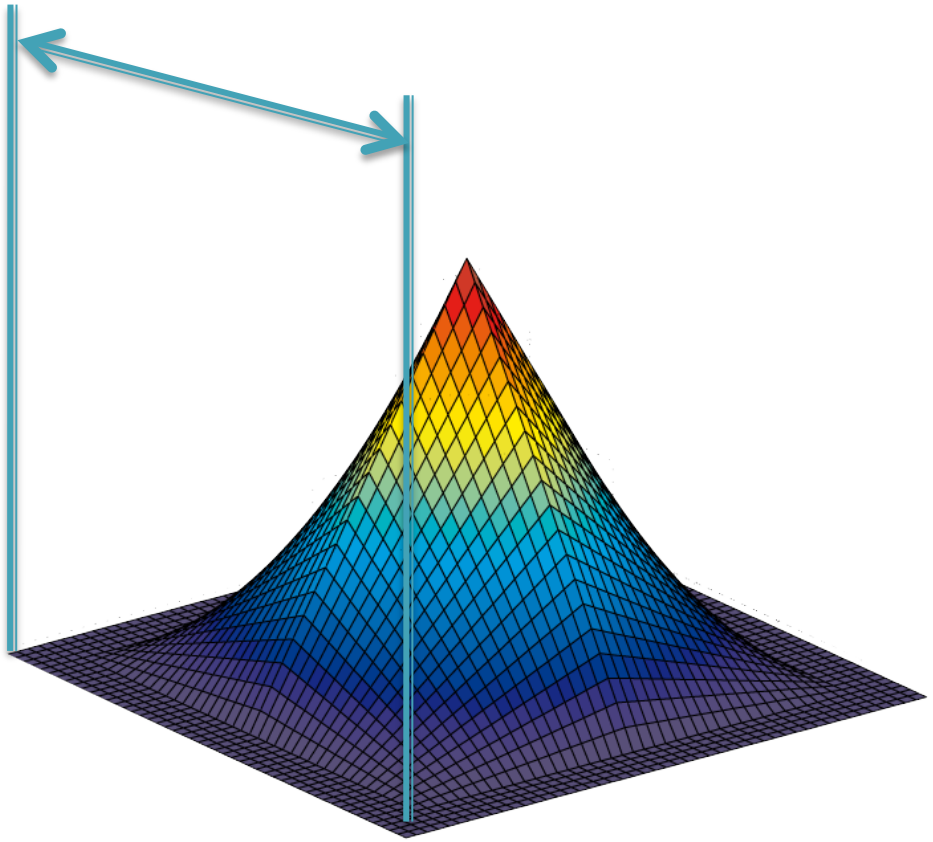
IMPRECISE POINT SPREAD FUNCTION

- First step: the maxitive kernel

(K. Loquin)



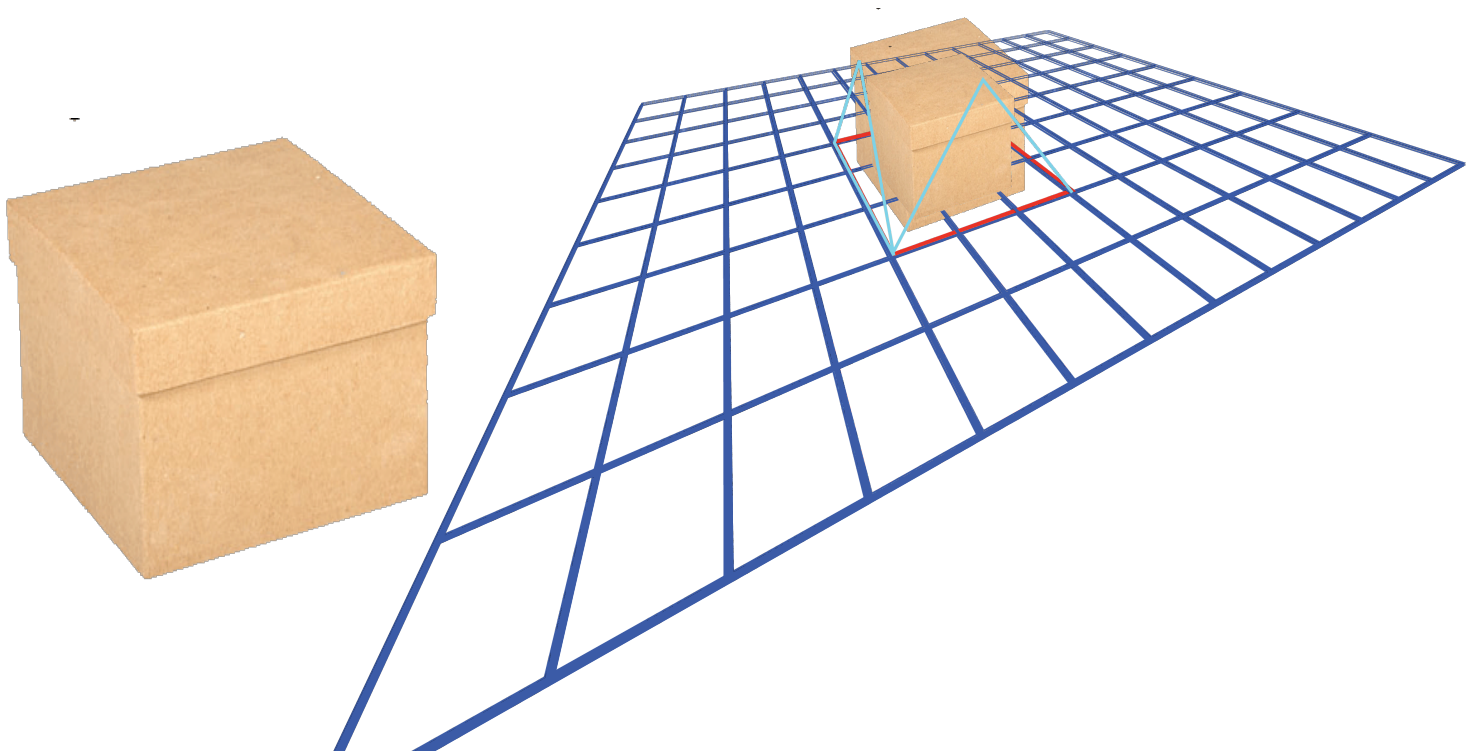




Possibility distribution

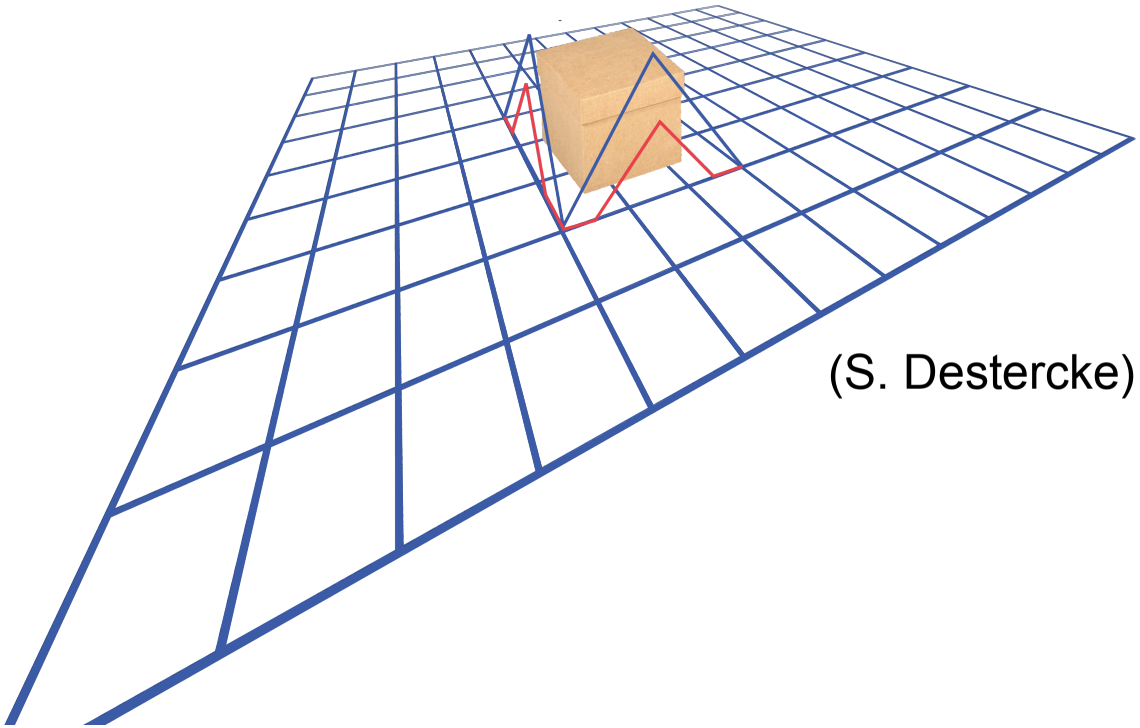
Imprecise point spread function

- Build your maxitive kernel



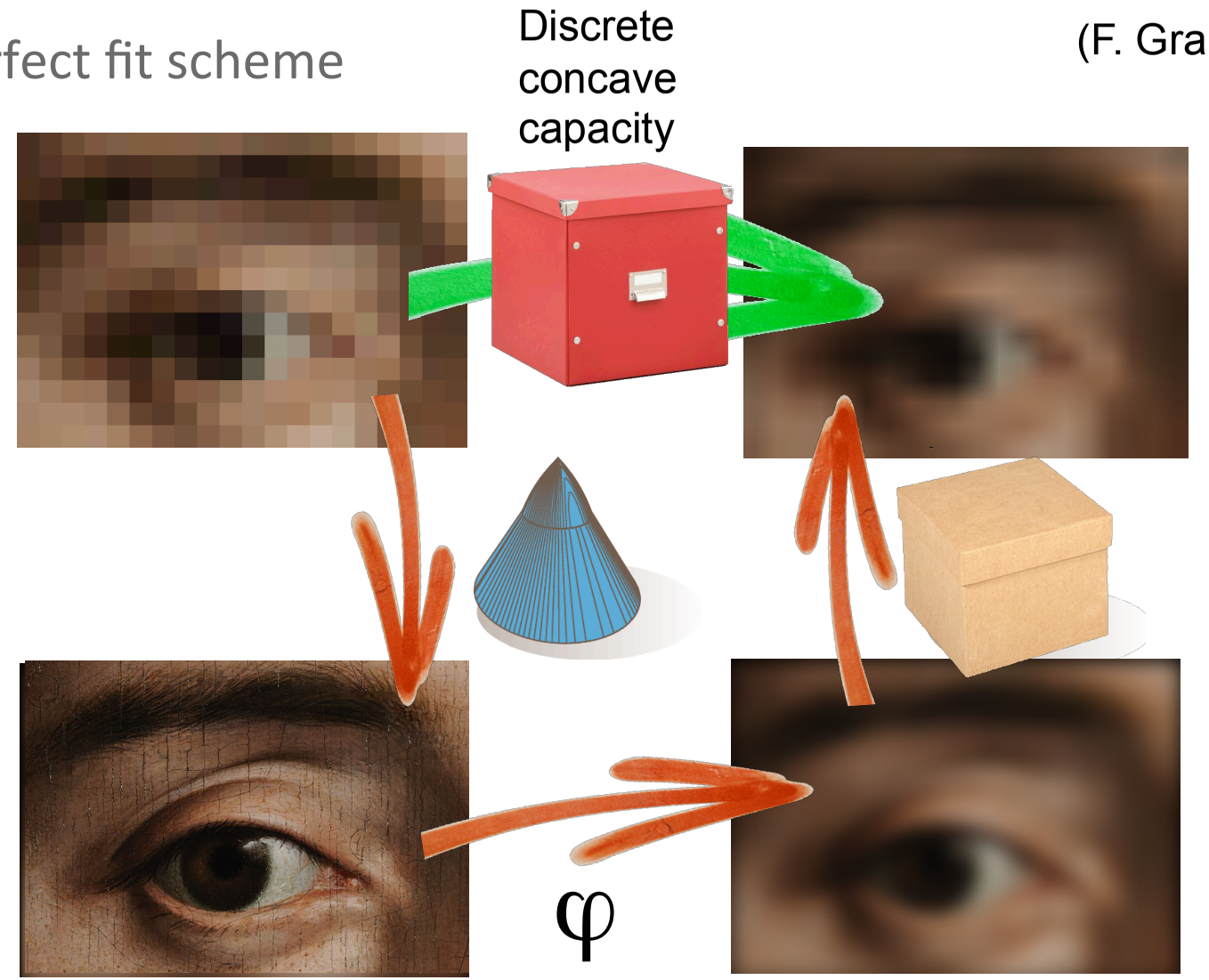
IMPRECISE POINT SPREAD FUNCTION

- More specific ?
  - Clouds
  - P-boxes
  - …



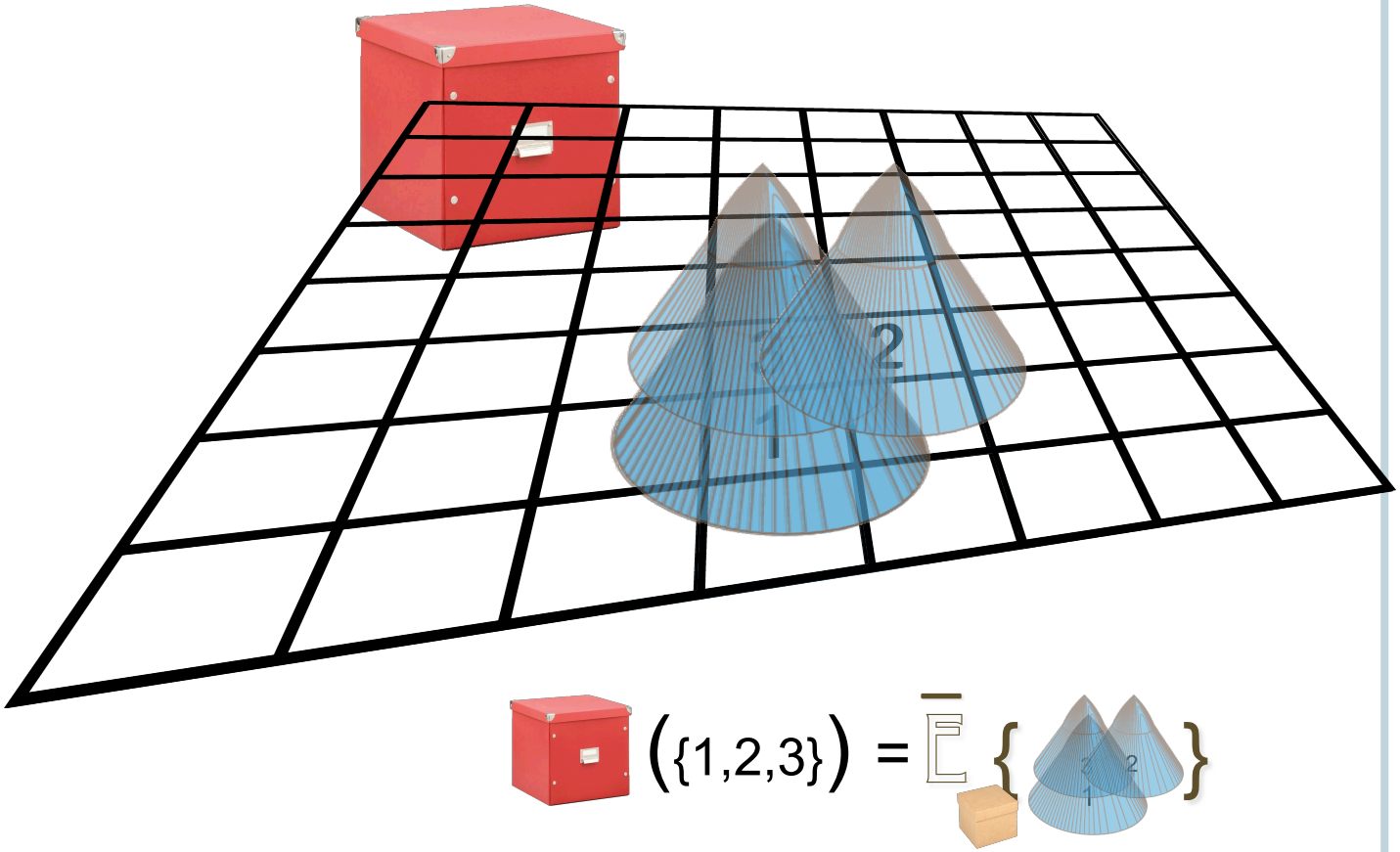
Maxitive-based Image processing

- Perfect fit scheme



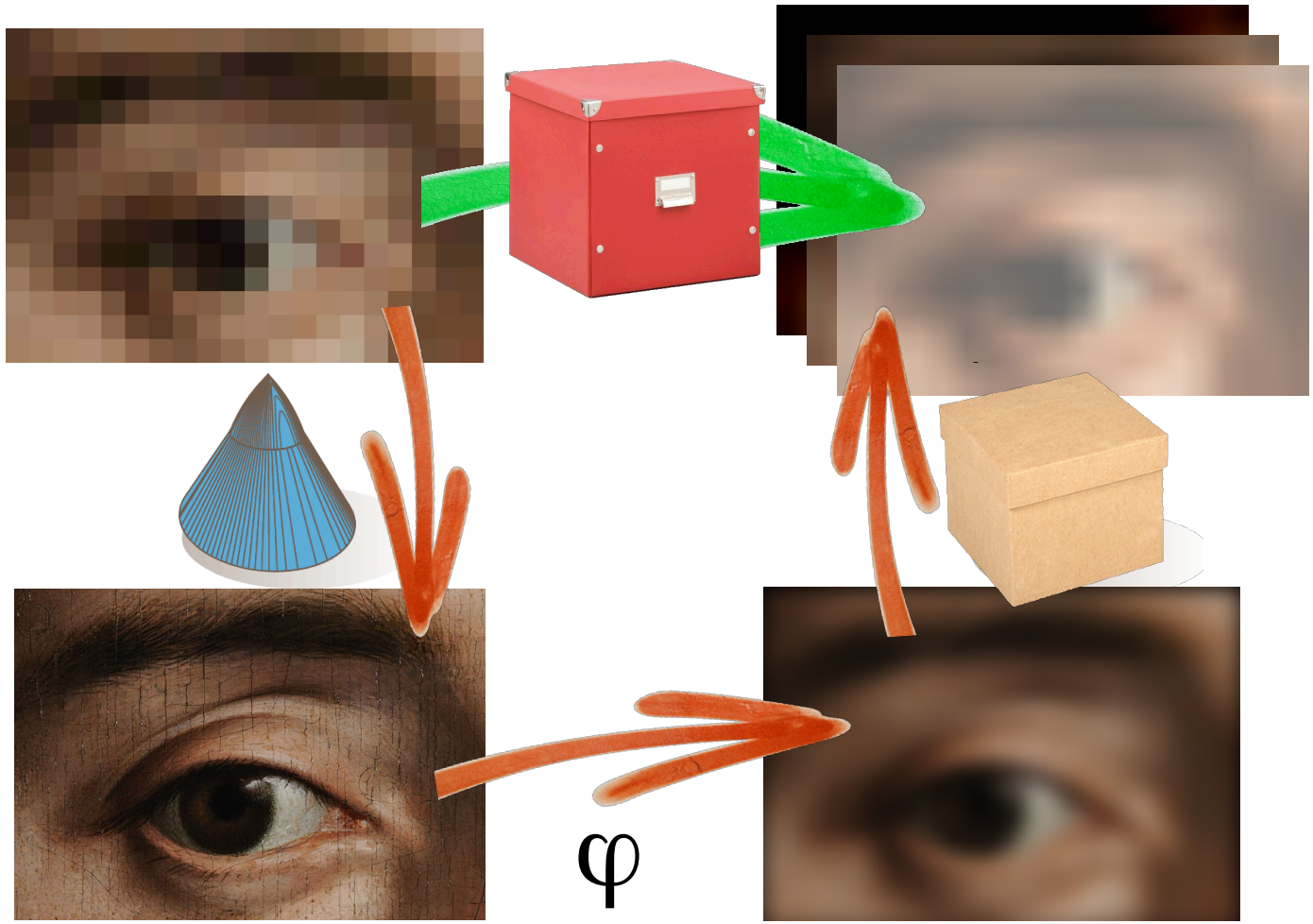
Non-additive neighborhood functions

- Construction



Maxitive-based Image processing

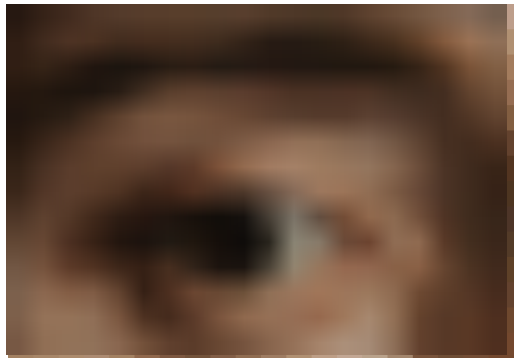
- Perfect fit scheme

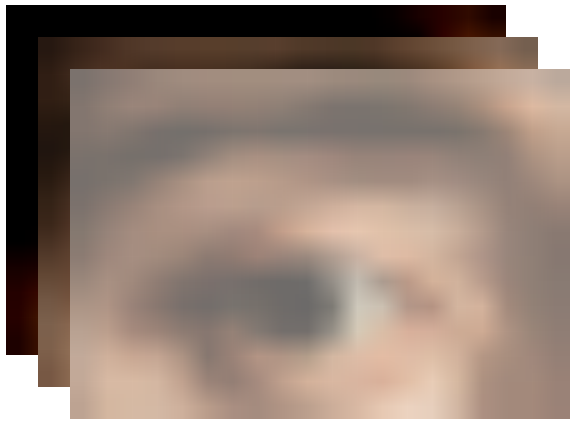


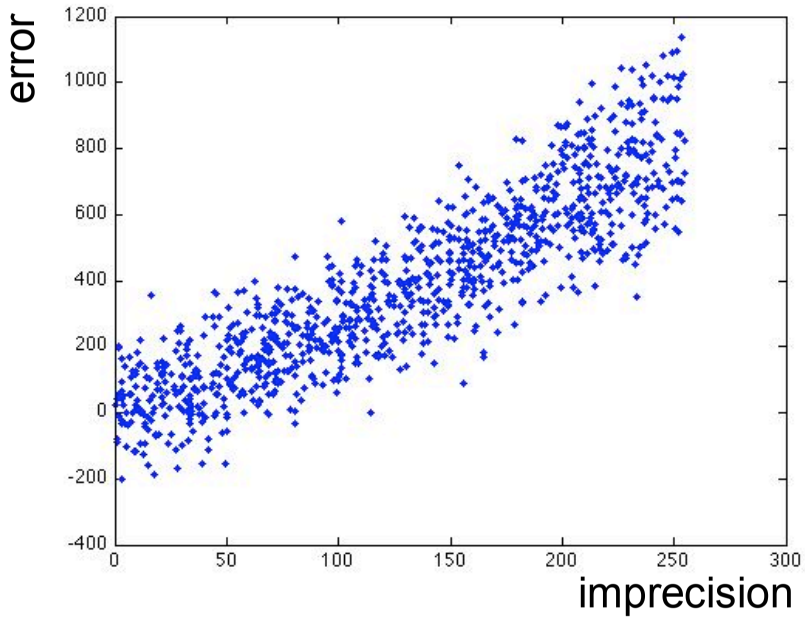
MAXITIVE-BASED IMAGE PROCESSING

- Error quantification

Loquin-Crouzet





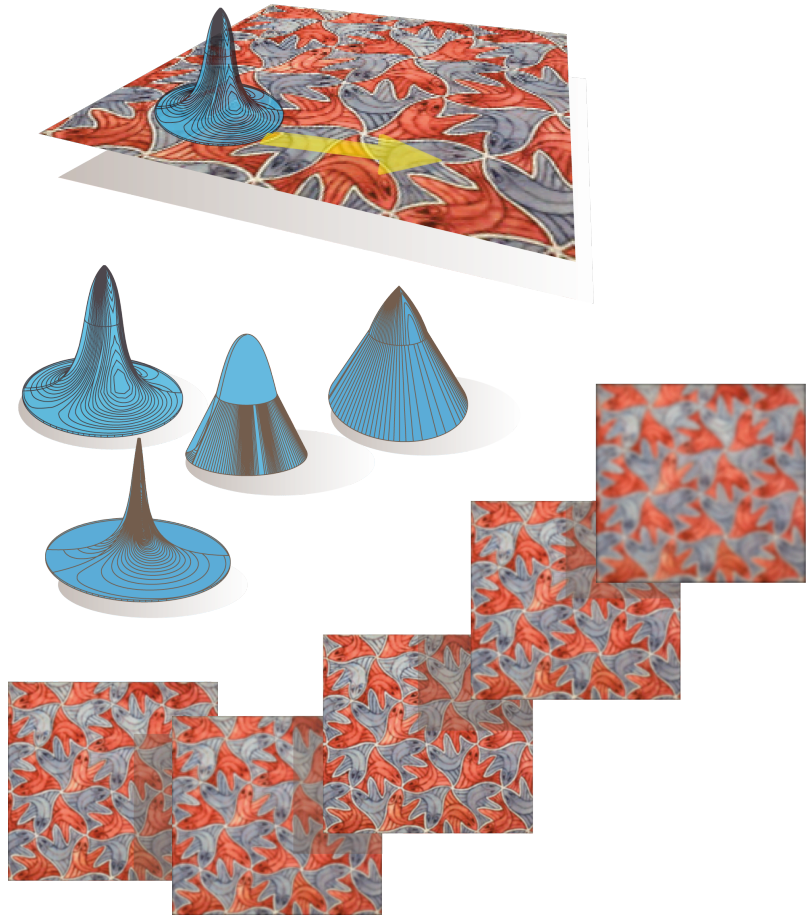


Applications

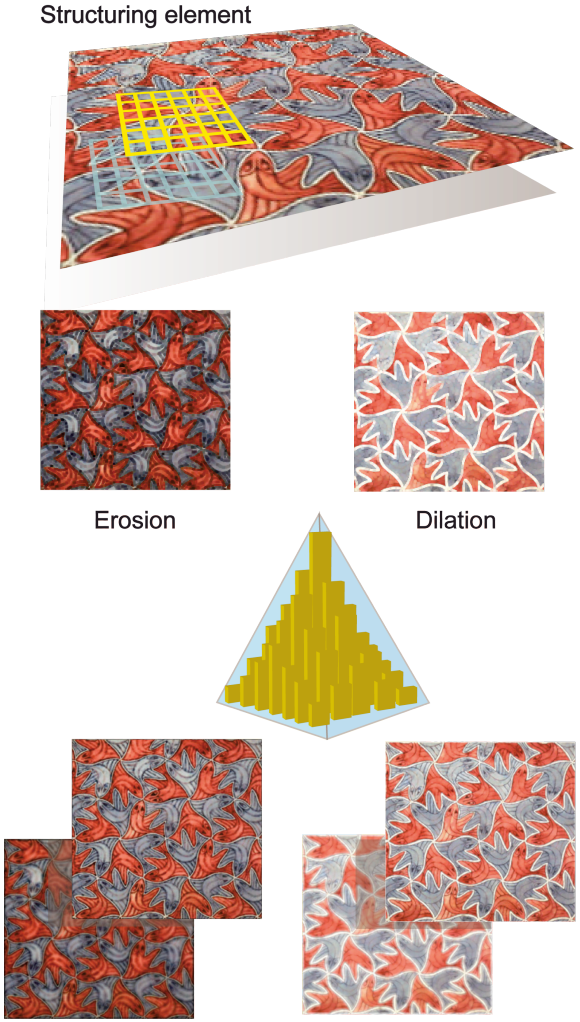
- Morpho-filtrering
- Super resolution
- Tomography
- (guaranteed) Geometric transformation
- …

A BRIDGE BETWEEN MORPHOLOGY AND FILTERING

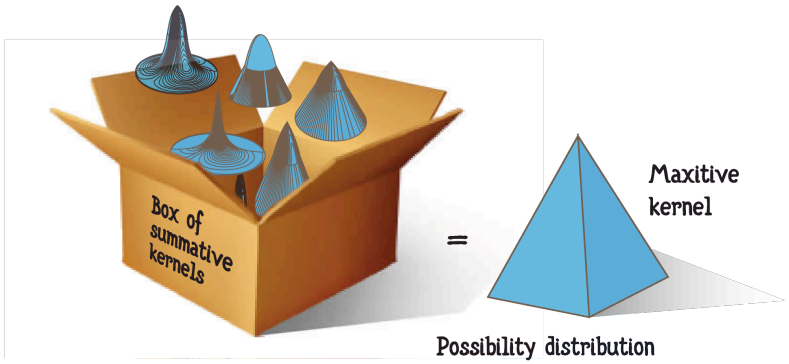
- Filtering



- Morphology



A BRIDGE BETWEEN MORPHOLOGY AND FILTERING

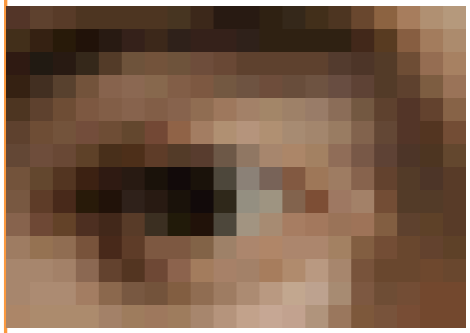


$$\overline{E}(\quad) = \left[\underline{E}(\quad), \overline{E}(\quad)\right]$$

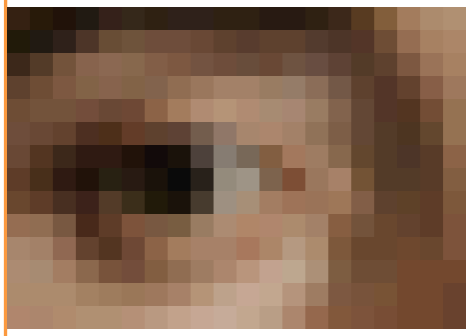
$$= \quad \underset{\in}{\text{Sup}} \left\{ E_{\quad}(\quad) \right\} = \overline{E}(\quad) = \text{Dilation}(\quad, \quad)$$

$$= \quad \underset{\in}{\text{Inf}} \left\{ E_{\quad}(\quad) \right\} = \underline{E}(\quad) = \text{Erosion}(\quad, \quad)$$

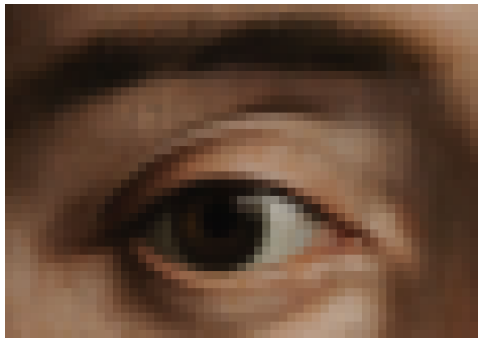
IMAGE SUPER-RESOLUTION

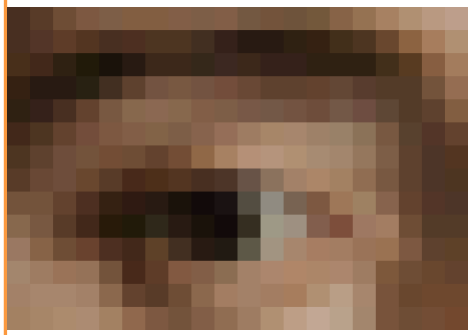


Registration



Fusion





Deconvolution

IMAGE SUPER-RESOLUTION

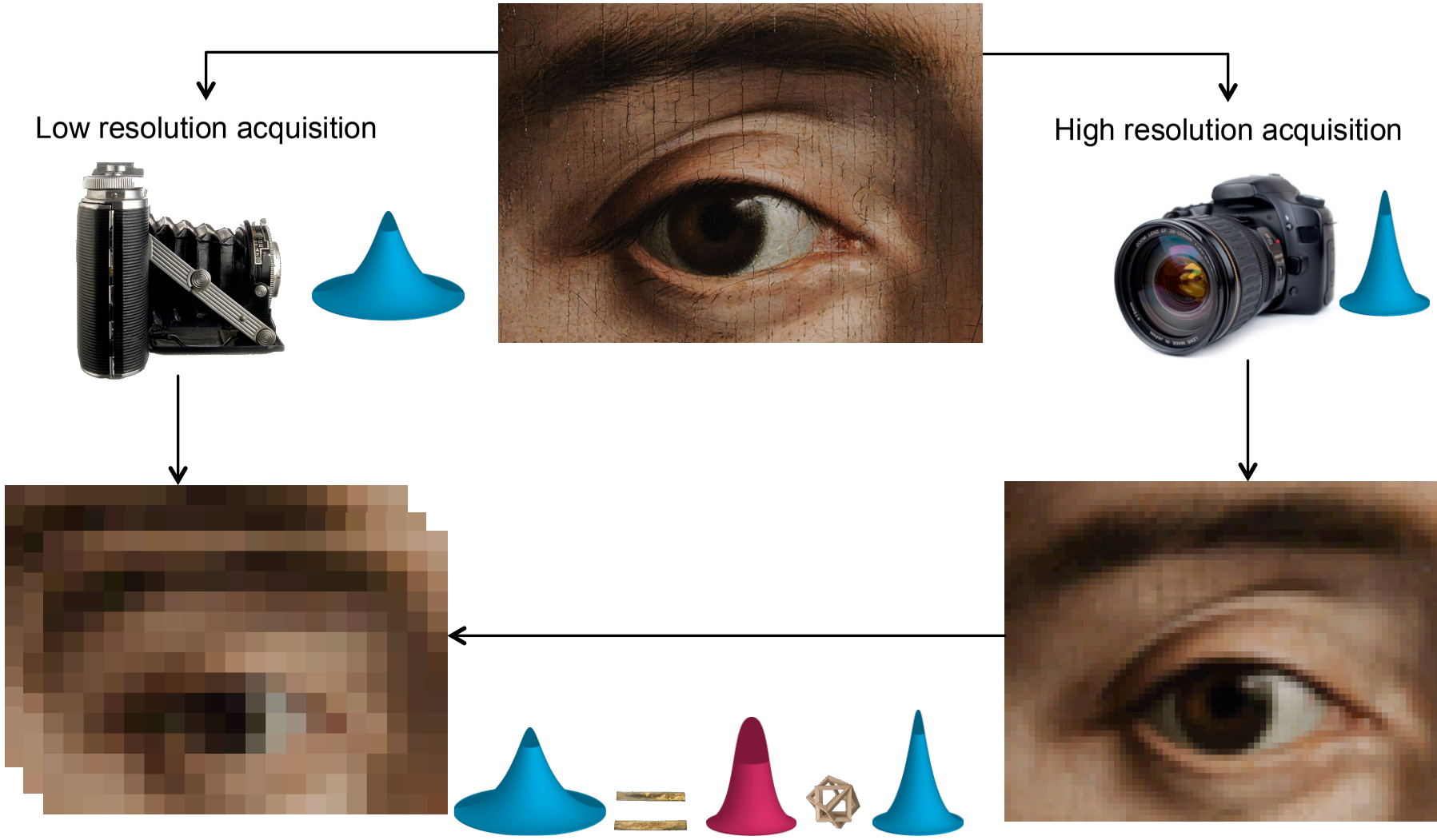
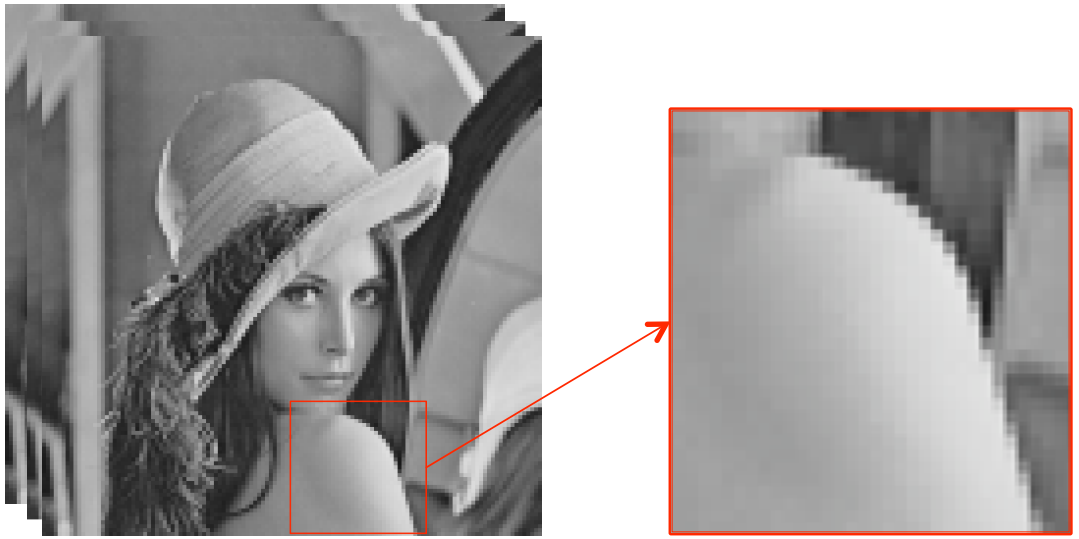


Image super-resolution



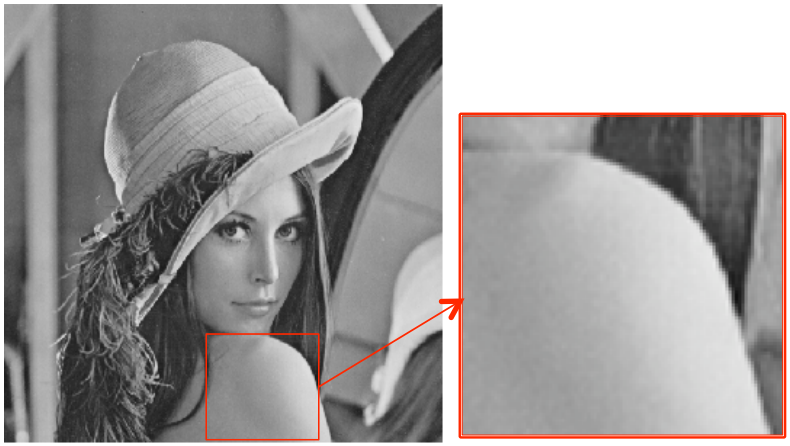
Median image

Lower image

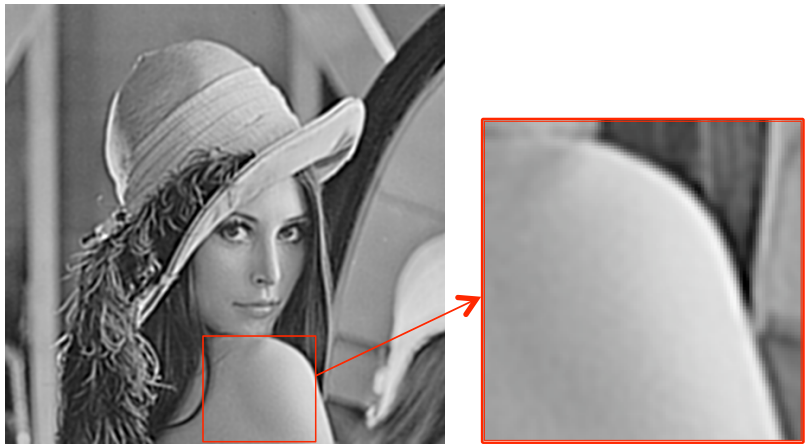
Error image

Upper image

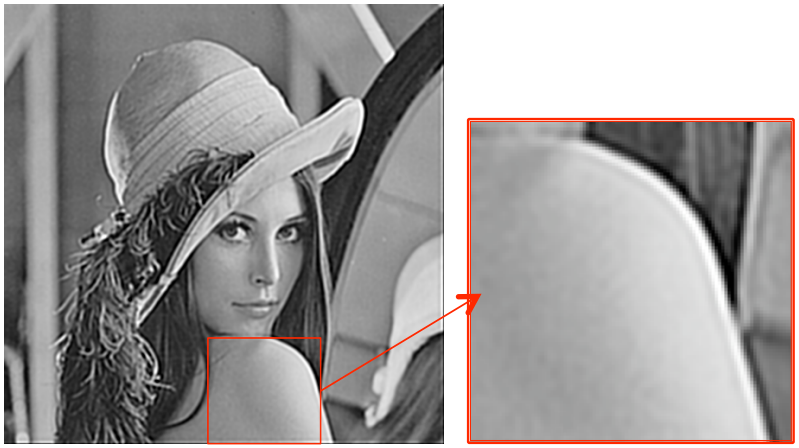
IMAGE SUPER-RESOLUTION



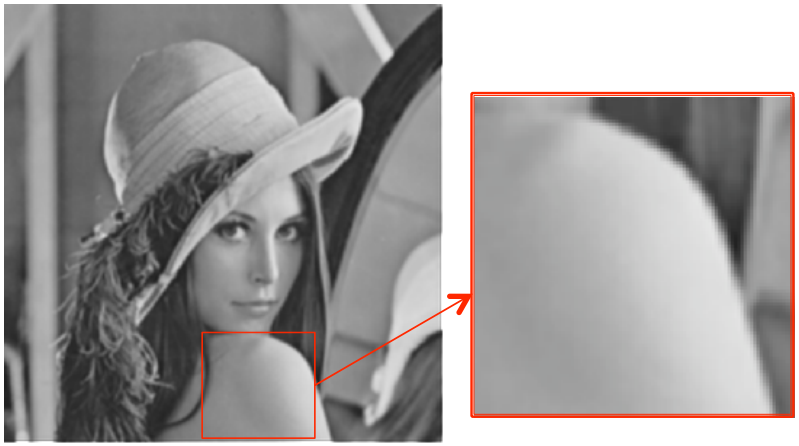
Original image



Median of the i. v. reconstruction

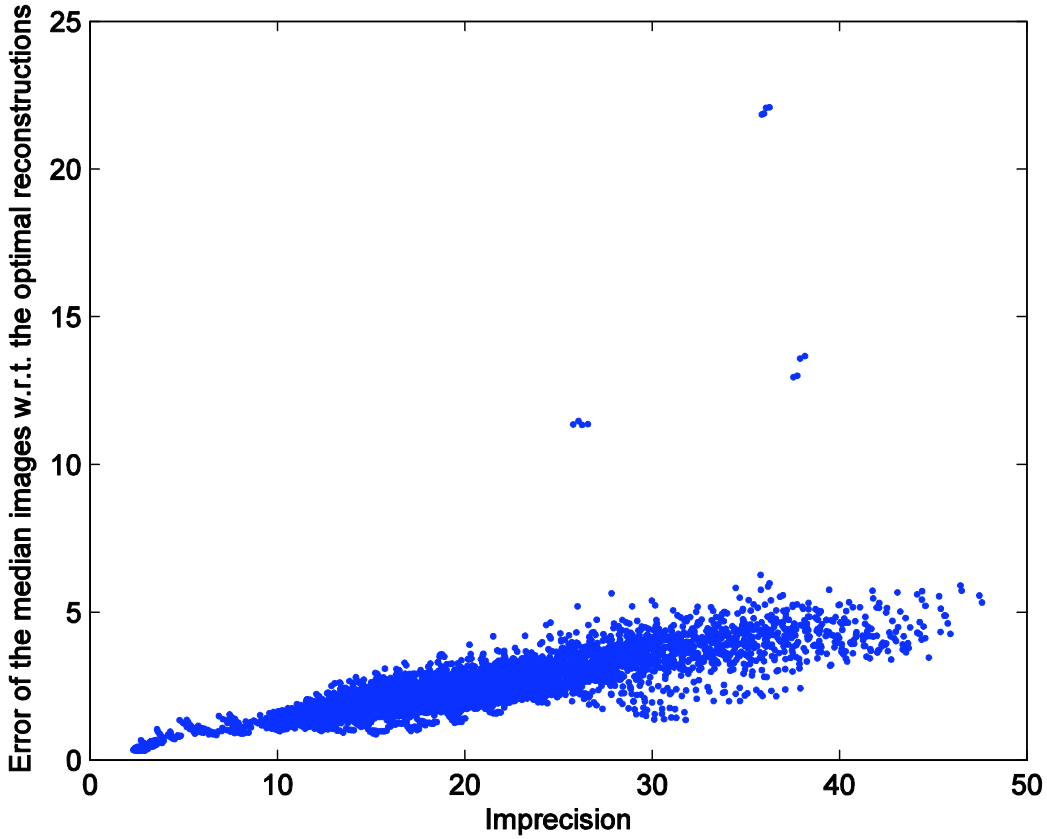


Not specific enough kernel

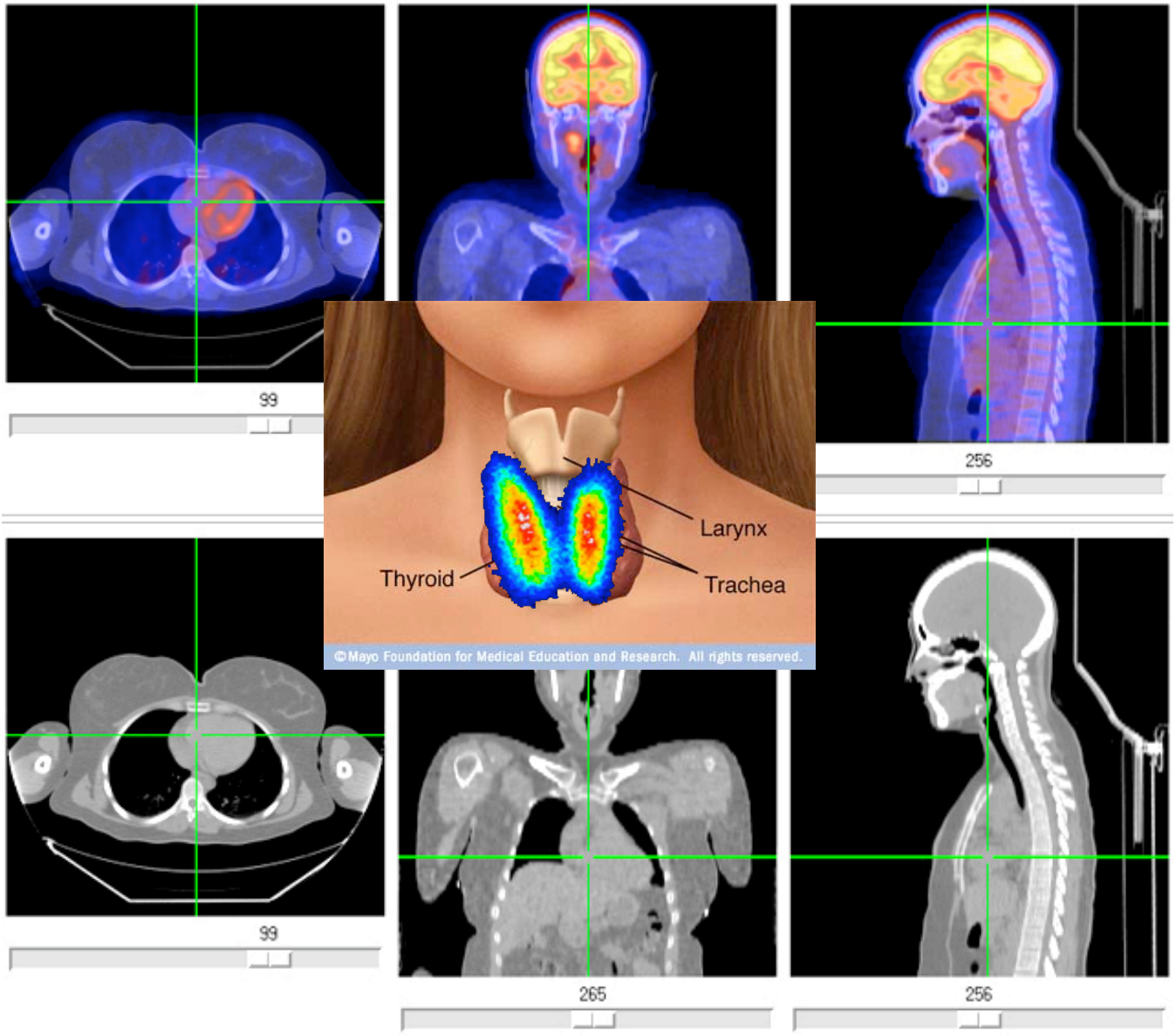


Too specific kernel

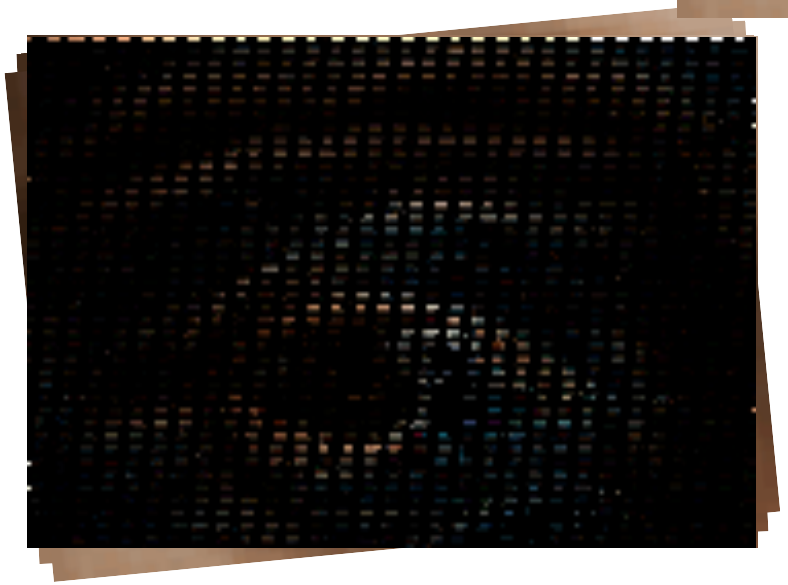
IMAGE SUPER-RESOLUTION



GEOMETRIC TRANSFORMATION



GEOMETRIC TRANSFORMATION



GEOMETRIC TRANSFORMATION

IP allows representing scant knowledge of a linear operator in an easy computation scheme …

- What about negative-valued operators?
- How to compare a precise-valued method with an interval-valued method?
- Can we propose simple tools?