



Laboratoire
Informatique
Robotique
Microélectronique
Montpellier



**Possibilistic image processing:
how to handle scant sensor knowledge?**

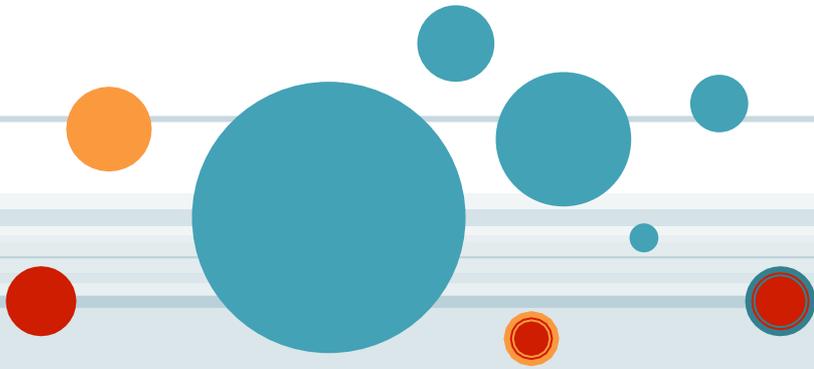


IMAGE PROCESSING

- o What is an image?

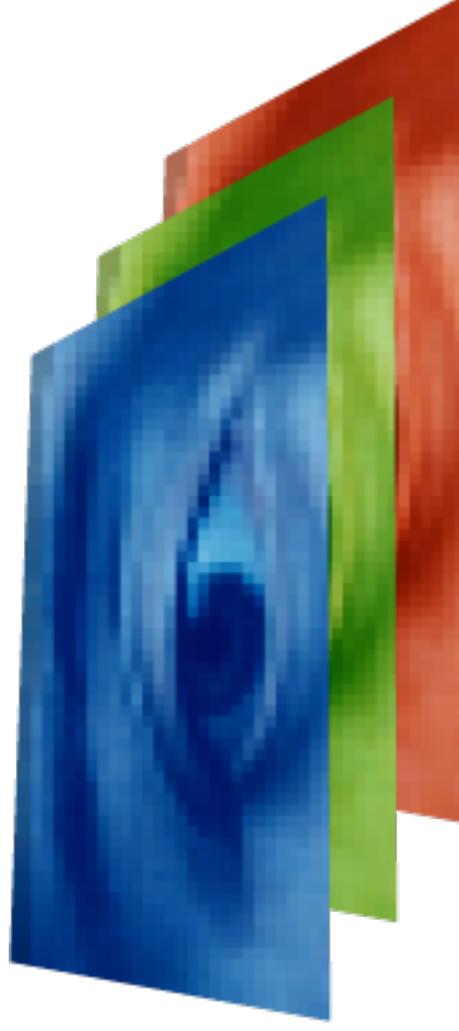
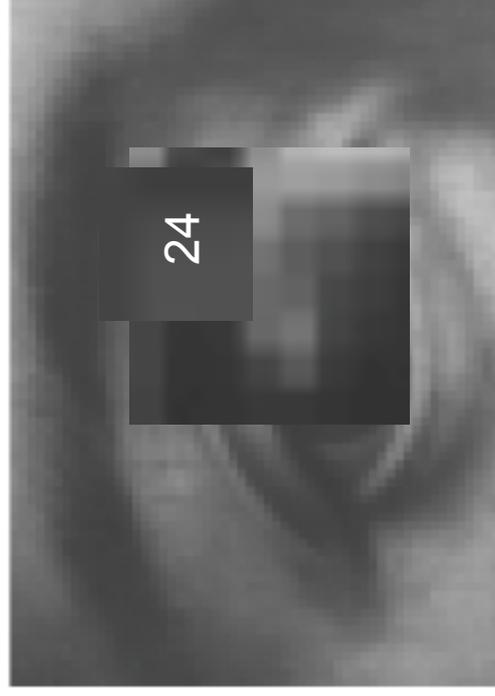
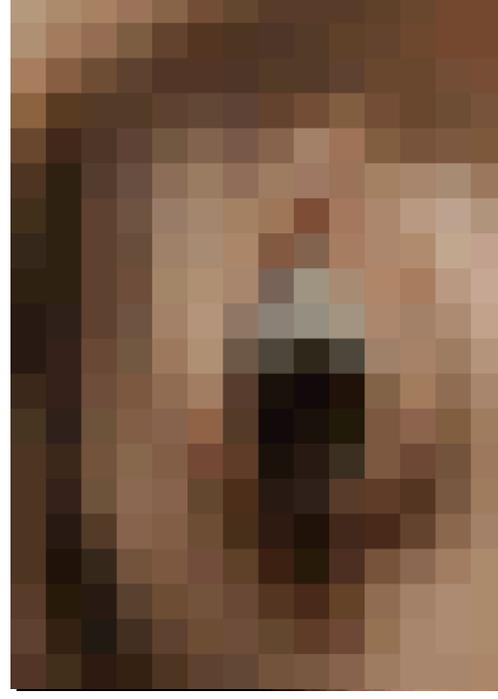
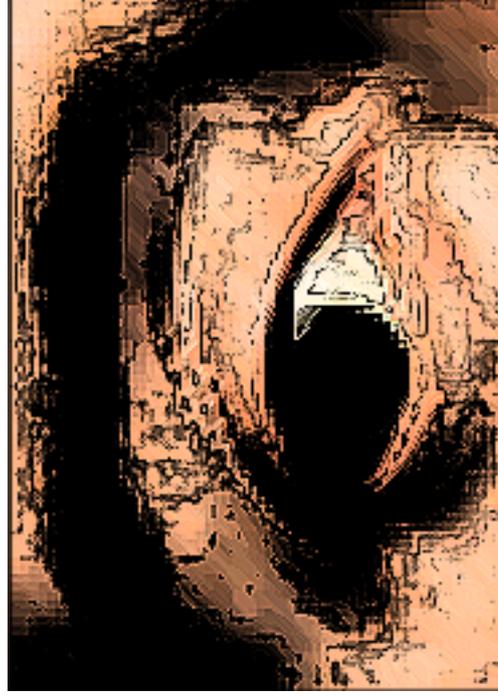


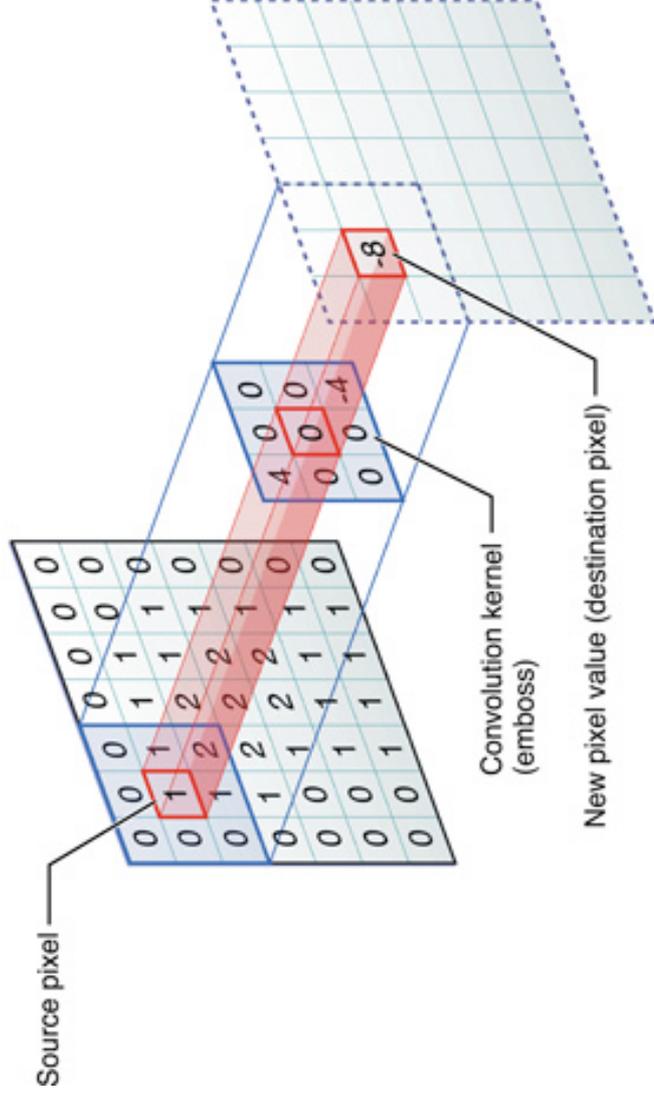
IMAGE PROCESSING

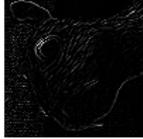
- o Linear / non-linear



LINEAR IMAGE PROCESSING

o 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

- o The “perfect fit” scheme !

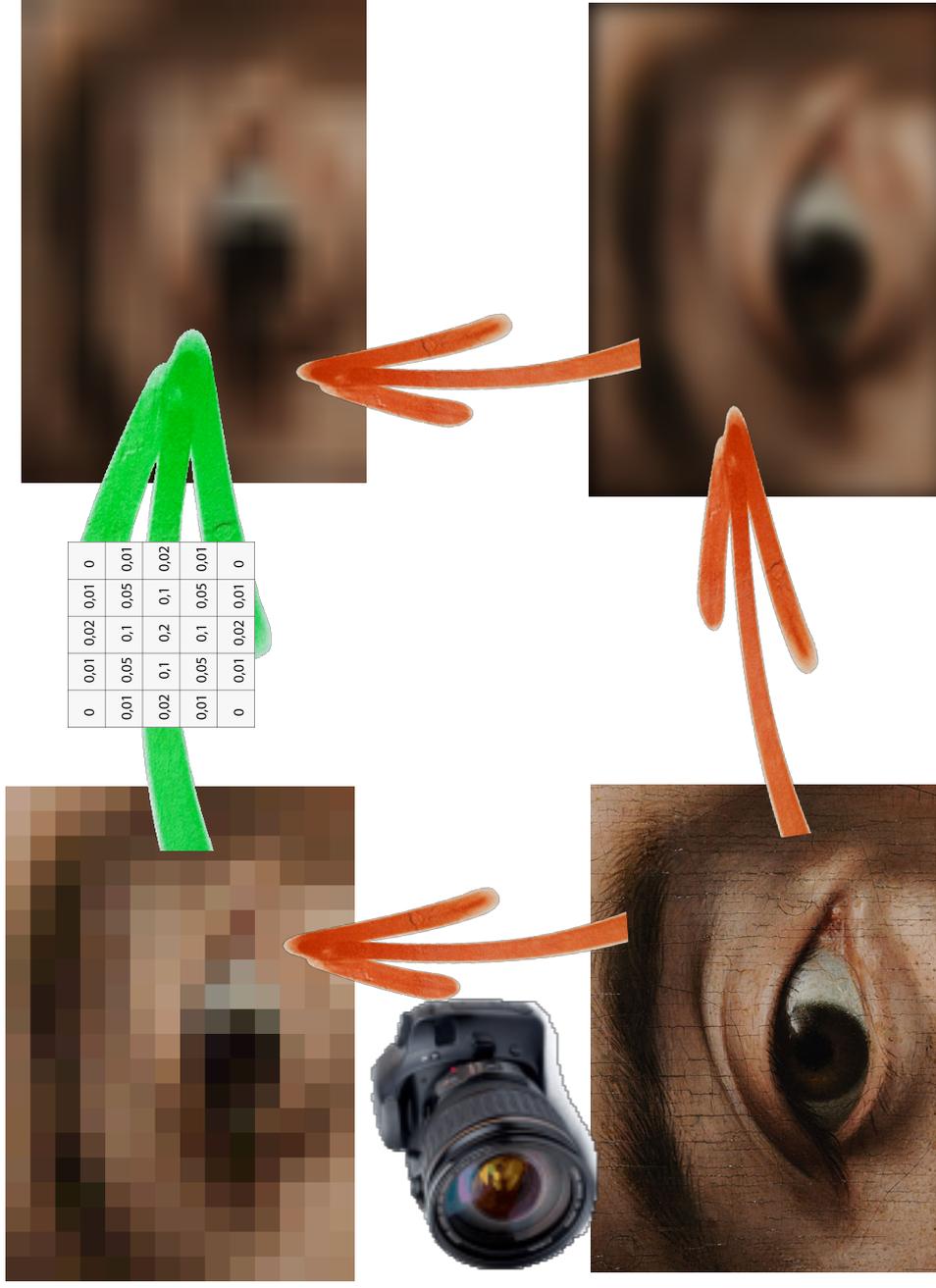


IMAGE PROCESSING

- o The role of kernel

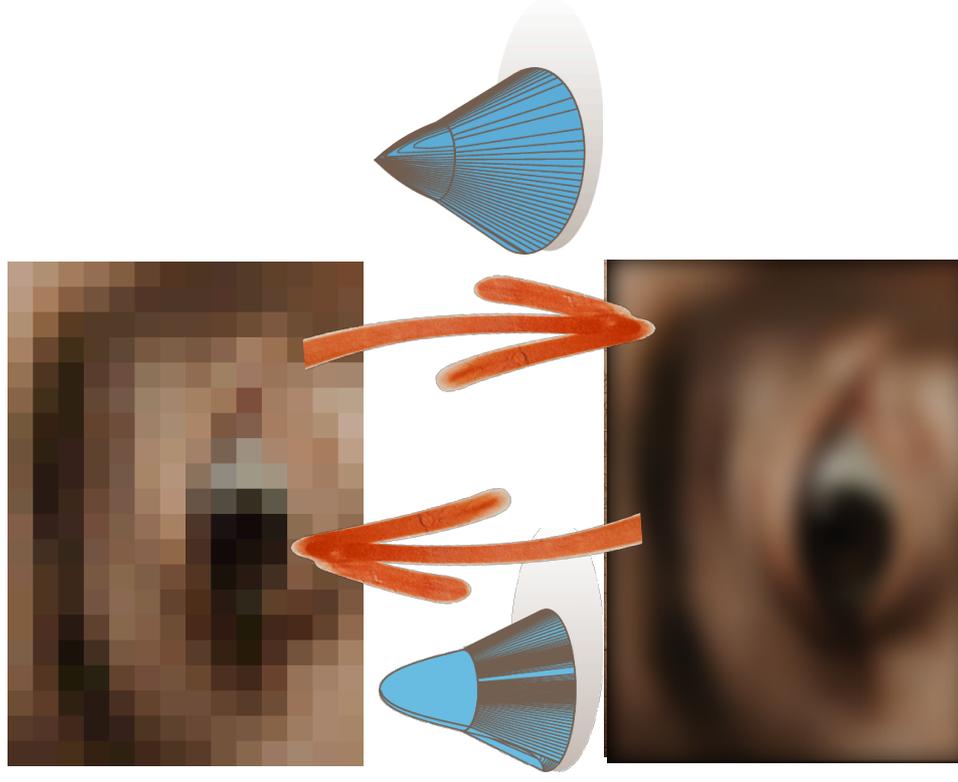


IMAGE PROCESSING

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

- o The role of kernel

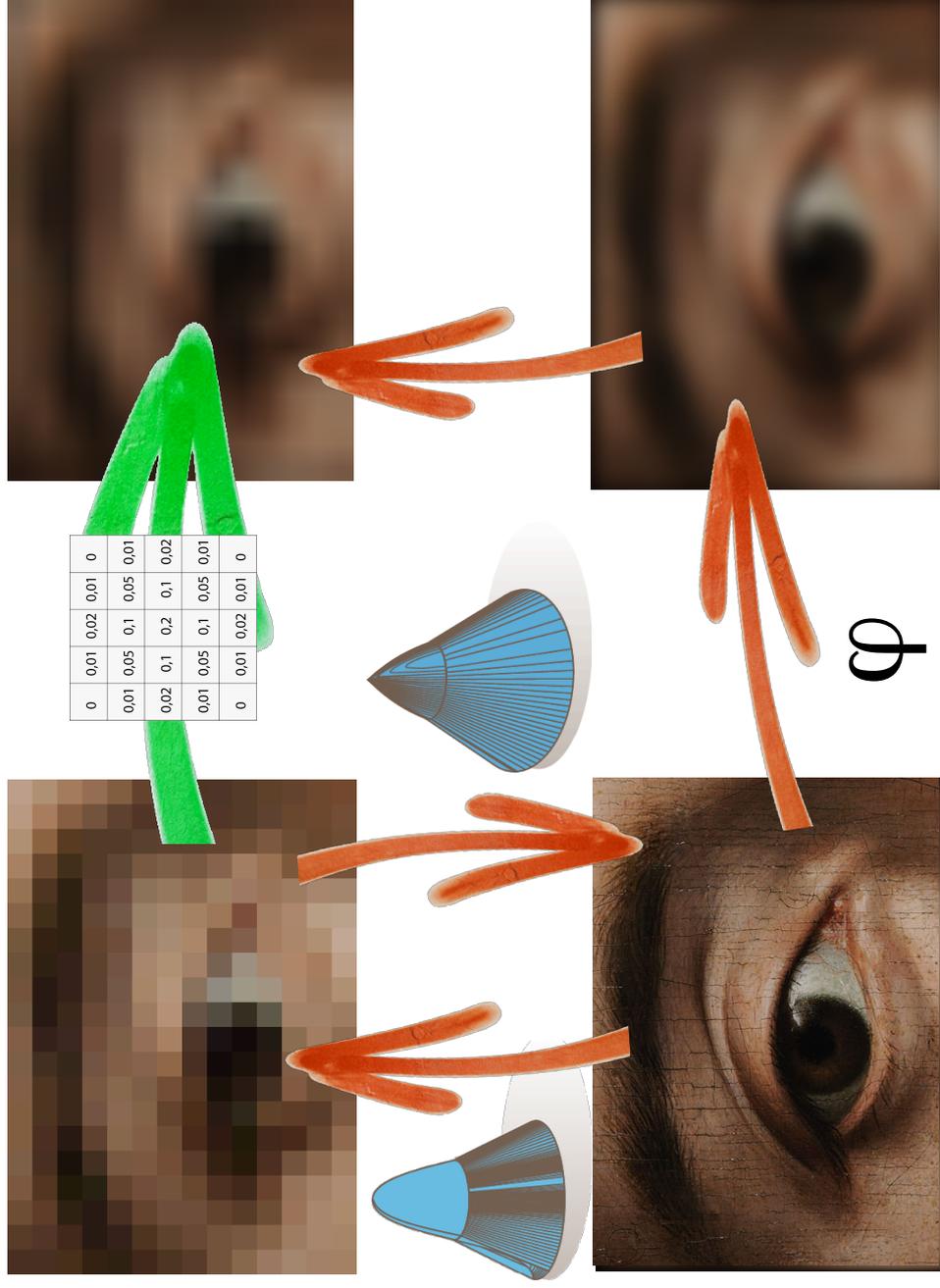


IMAGE PROCESSING

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

- o The role of kernel

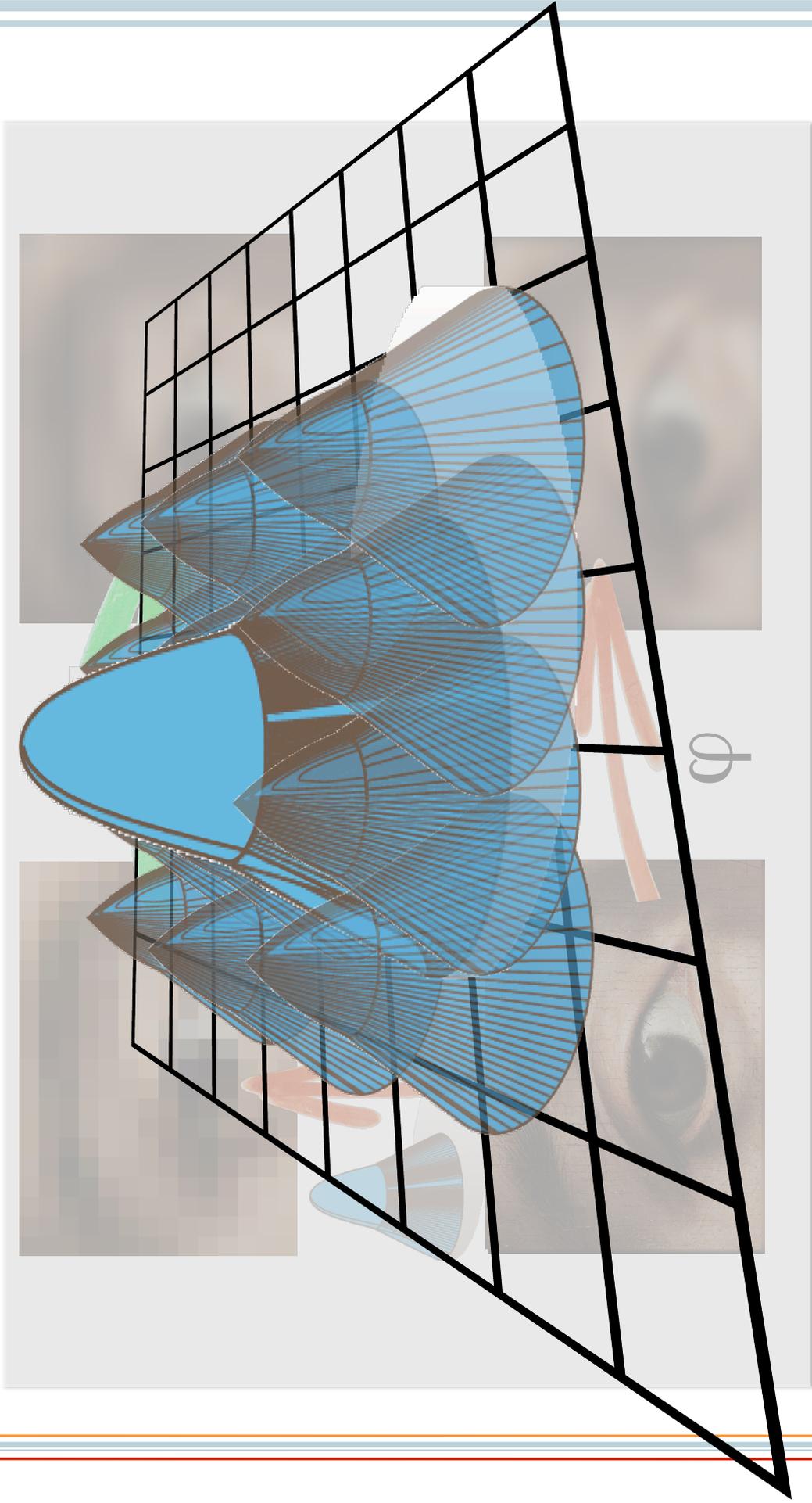


IMAGE PROCESSING

- Modeling the impulse response

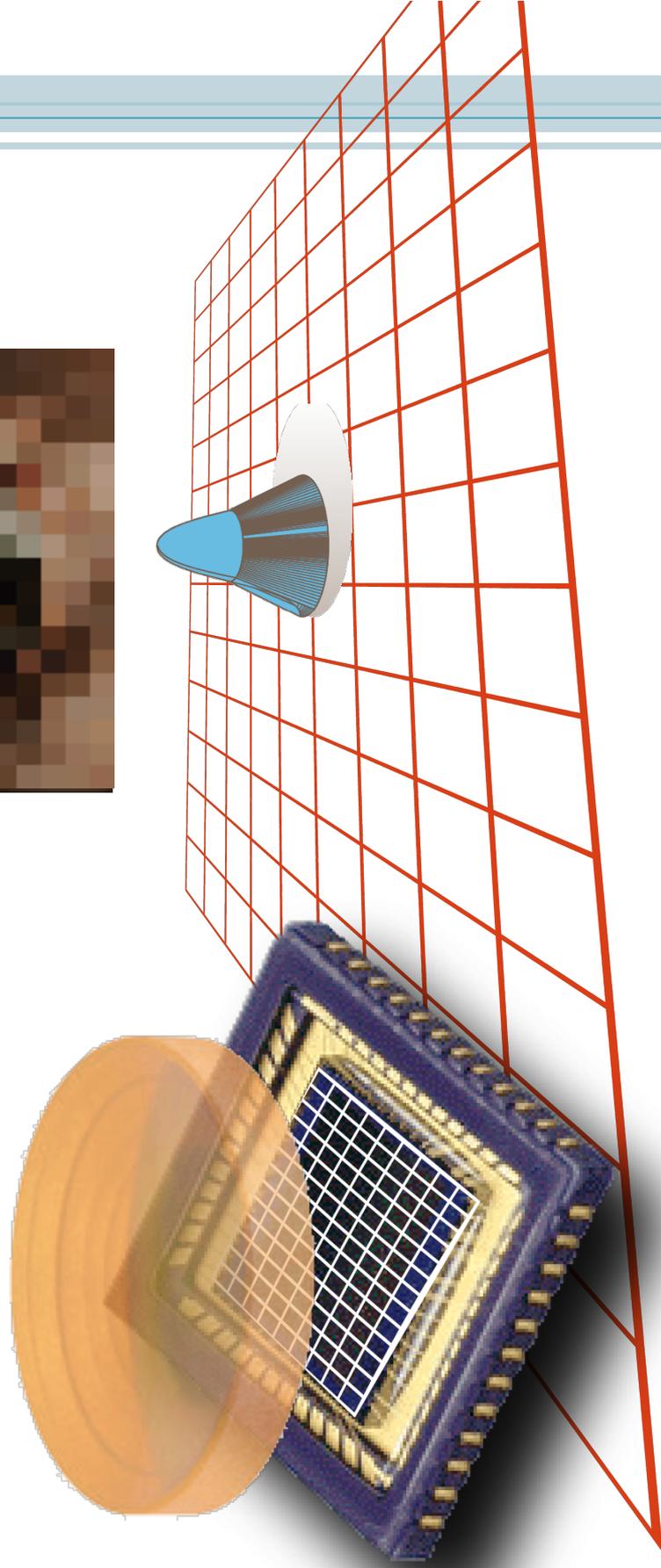
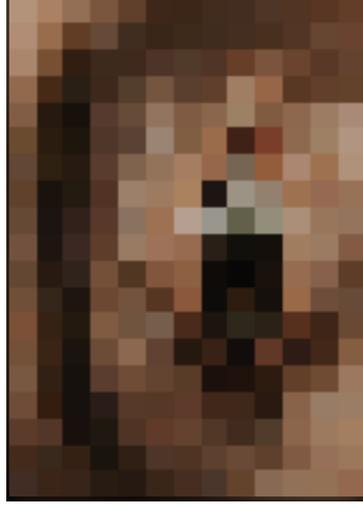


IMAGE PROCESSING

- o Modeling the impulse response

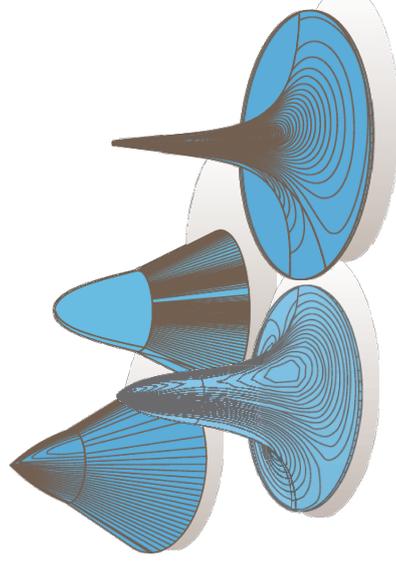
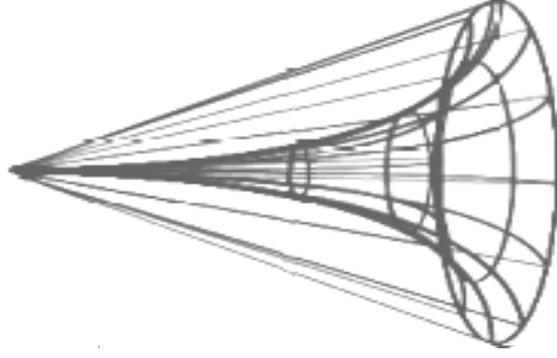
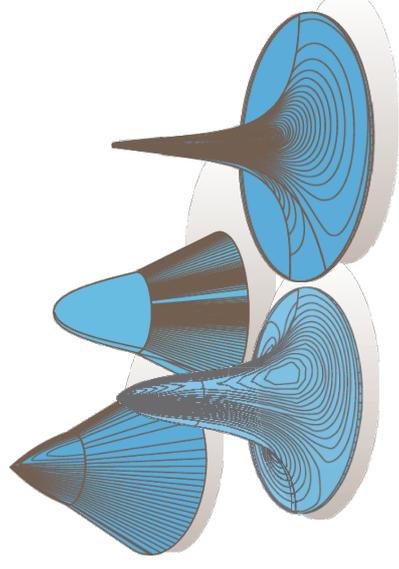
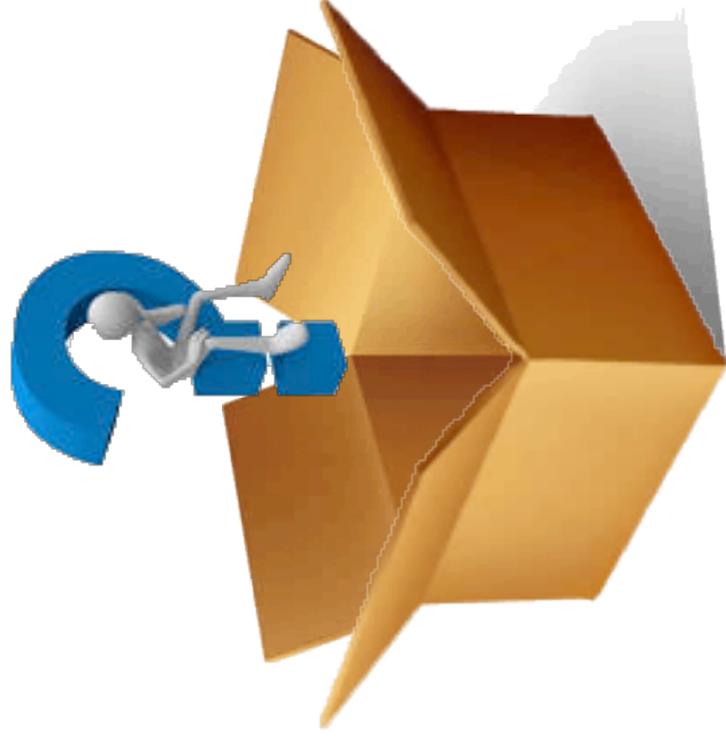


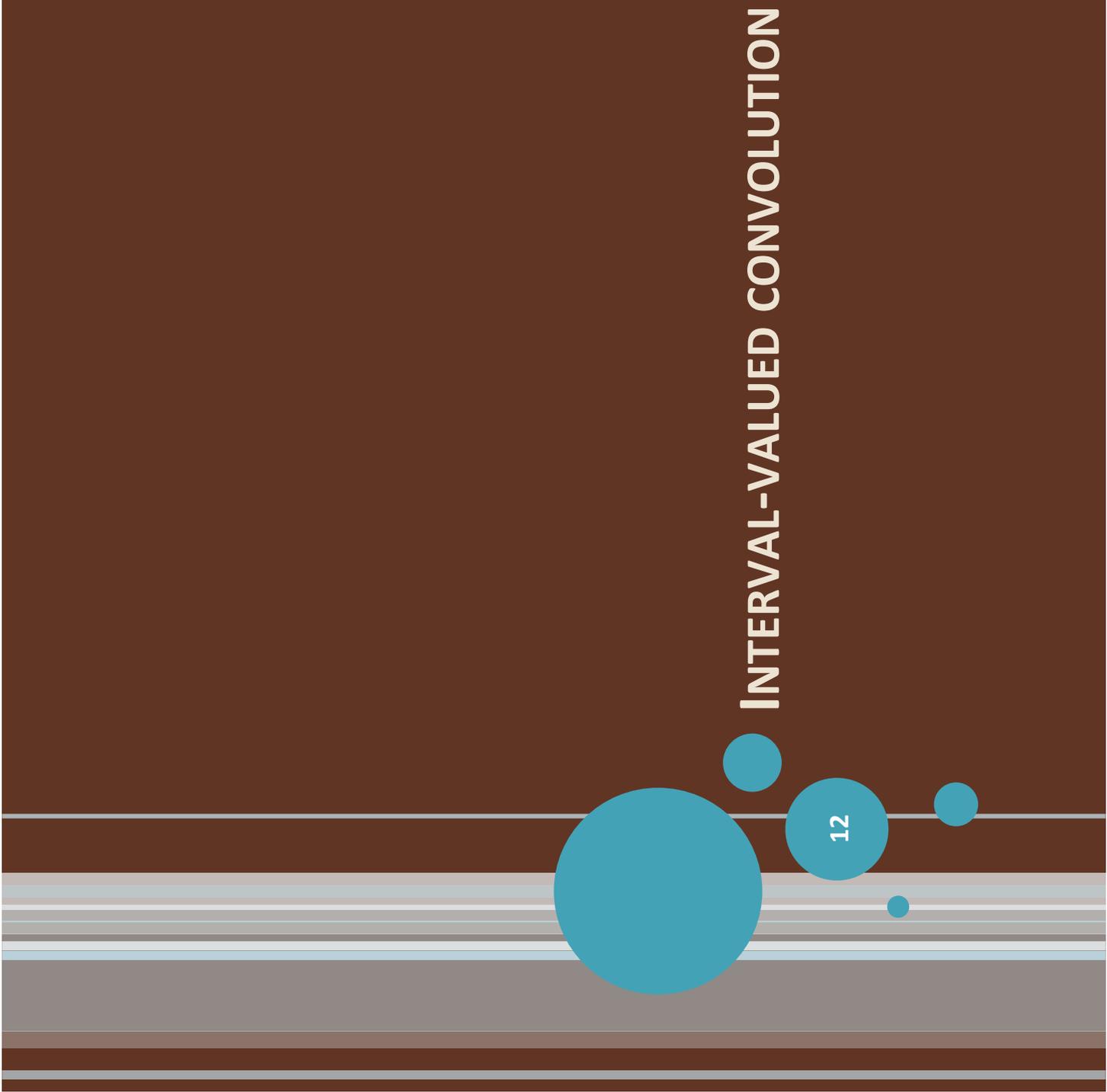
IMAGE PROCESSING

- Box of kernels ...



INTERVAL-VALUED CONVOLUTION

12

A decorative graphic at the bottom of the page features several horizontal stripes in shades of brown, grey, and light blue. Overlaid on these stripes are several teal-colored circles of varying sizes. The largest circle is on the left, and several smaller circles are scattered to its right, including one that contains the number '12'.

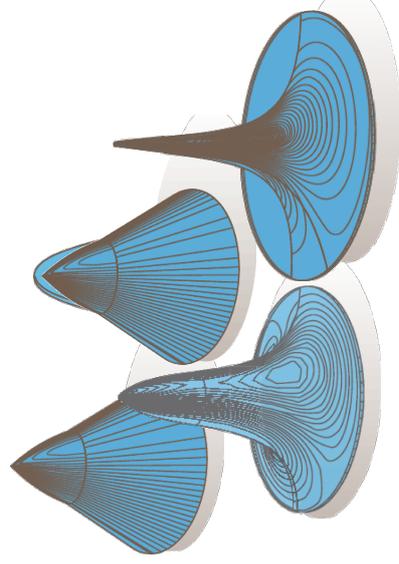
CONVOLUTION

- Convolution / Expectation

$$I'(v) = \int \text{kernel}(v-u) I(u) du$$

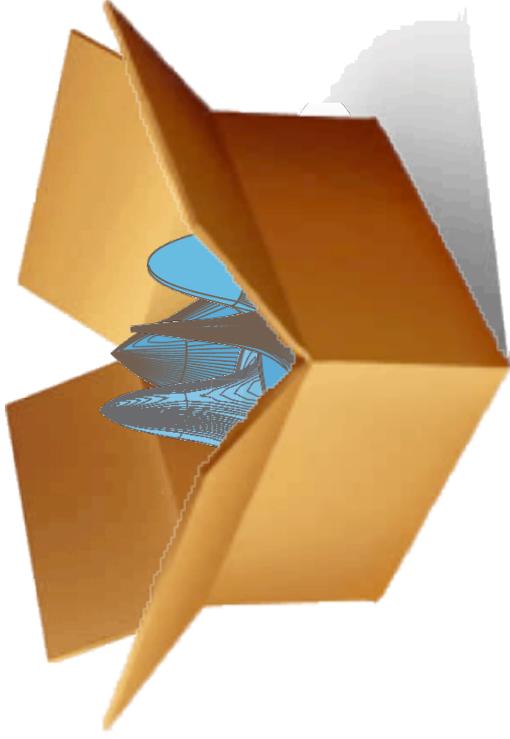
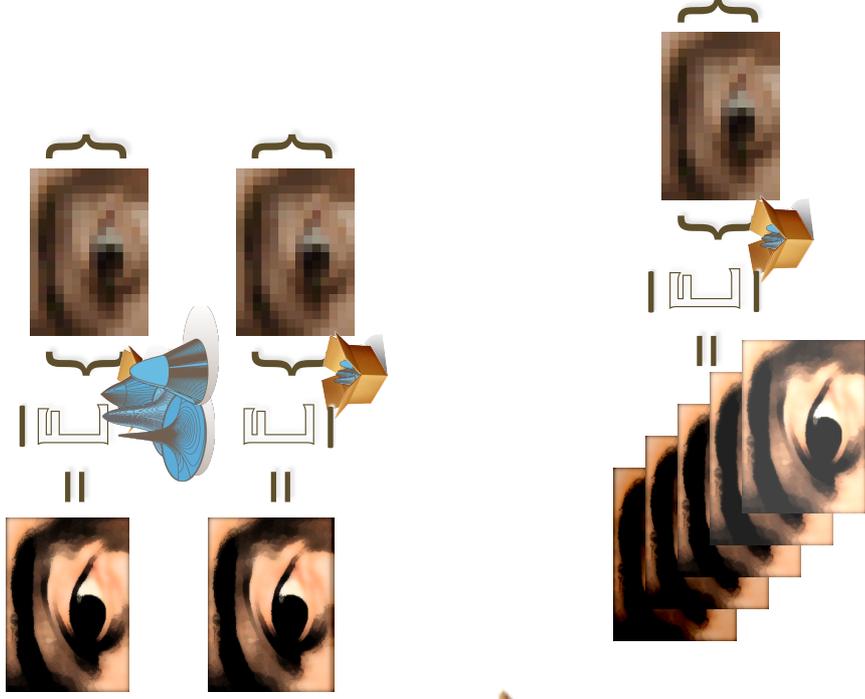


$$\int \text{kernel}(u) du = 1$$



POINT SPREAD FUNCTION

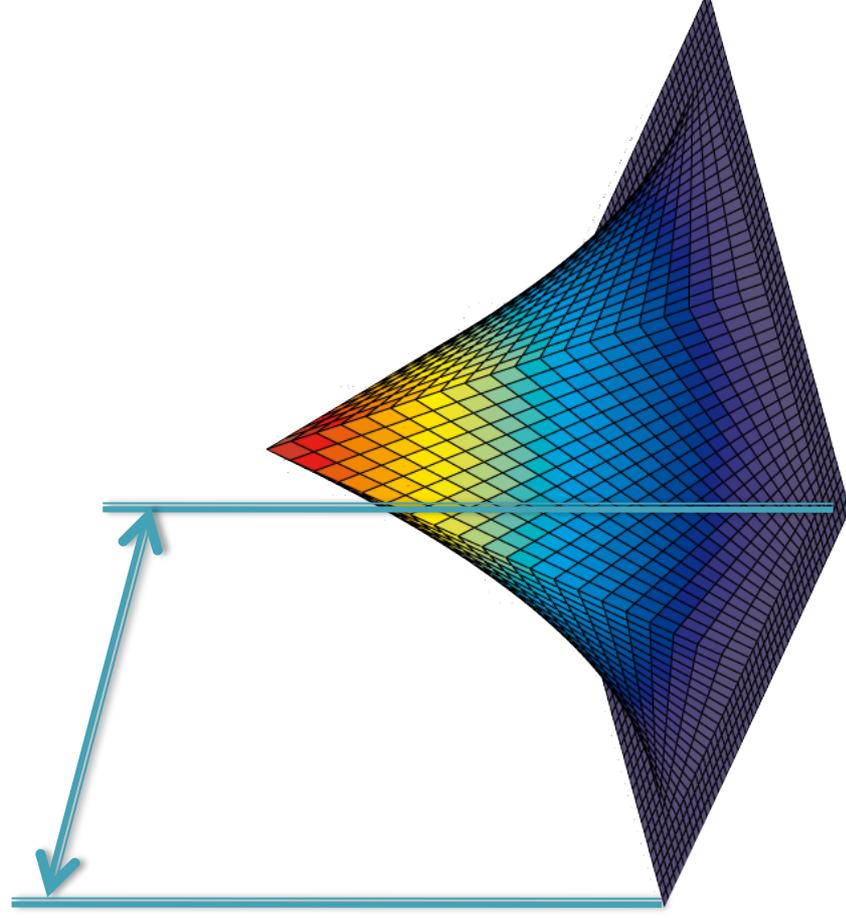
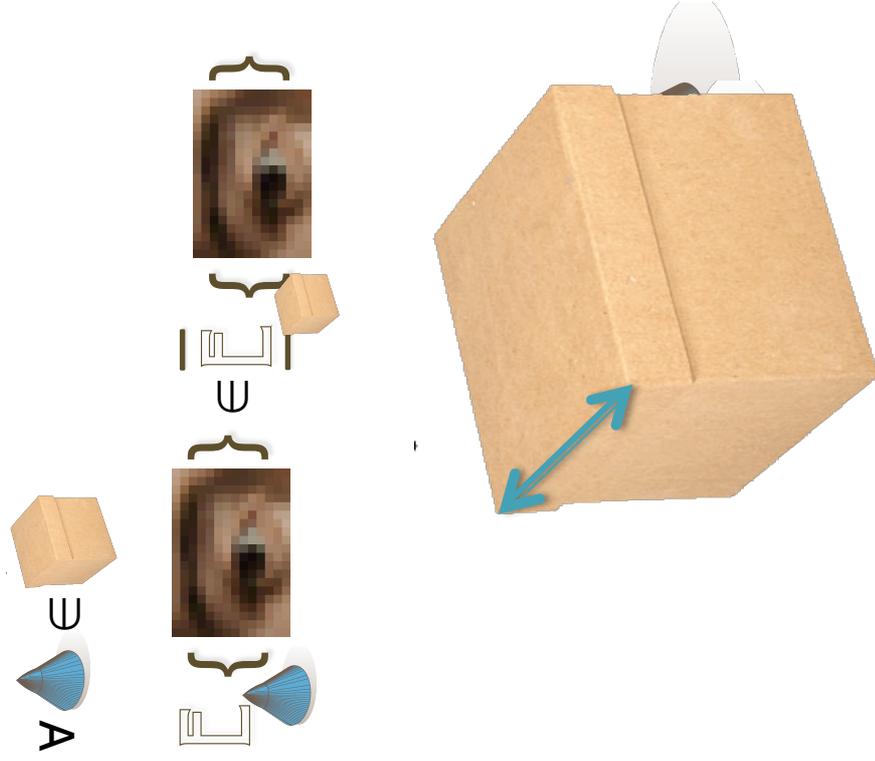
- o Scant knowledge ?



Concave capacity

IMPRECISE POINT SPREAD FUNCTION

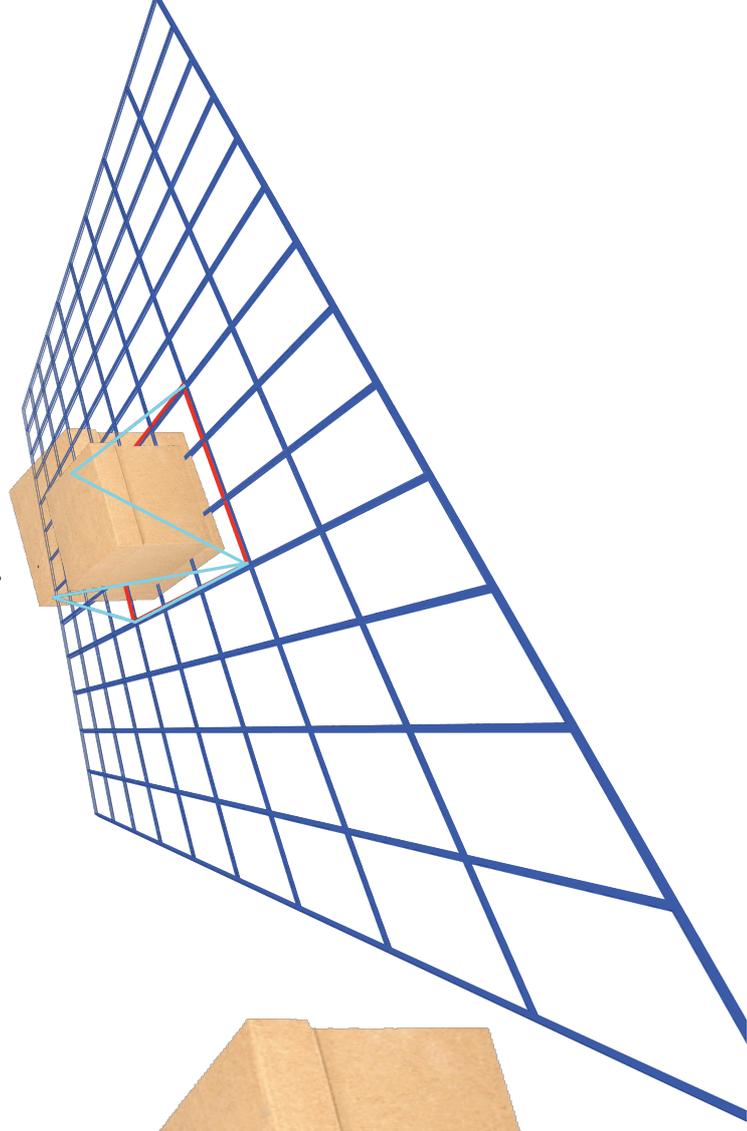
- First step: the maxitive kernel (K. Loquin)



Possibility distribution

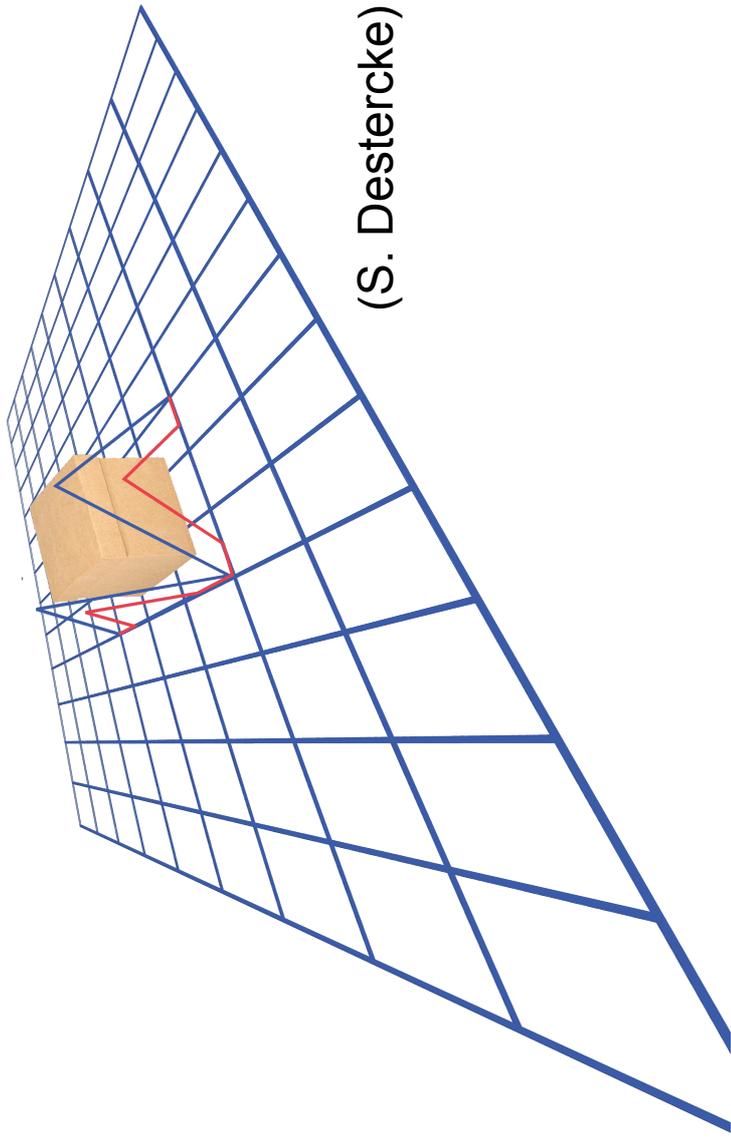
IMPRECISE POINT SPREAD FUNCTION

- Build your maxitive kernel



IMPRECISE POINT SPREAD FUNCTION

- More specific ?
 - Clouds
 - P-boxes
 - ...

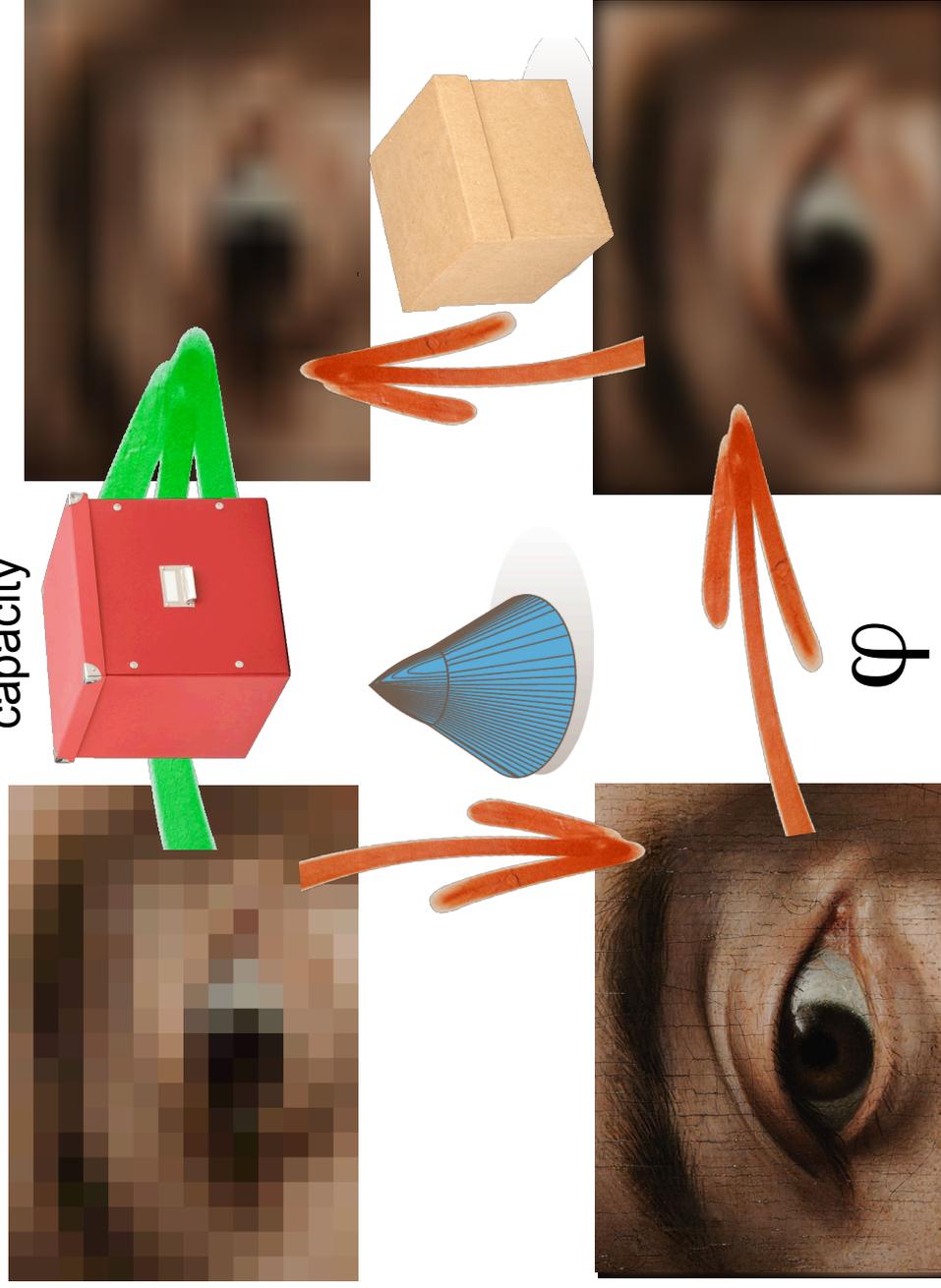


MAXITIVE-BASED IMAGE PROCESSING

- o Perfect fit scheme

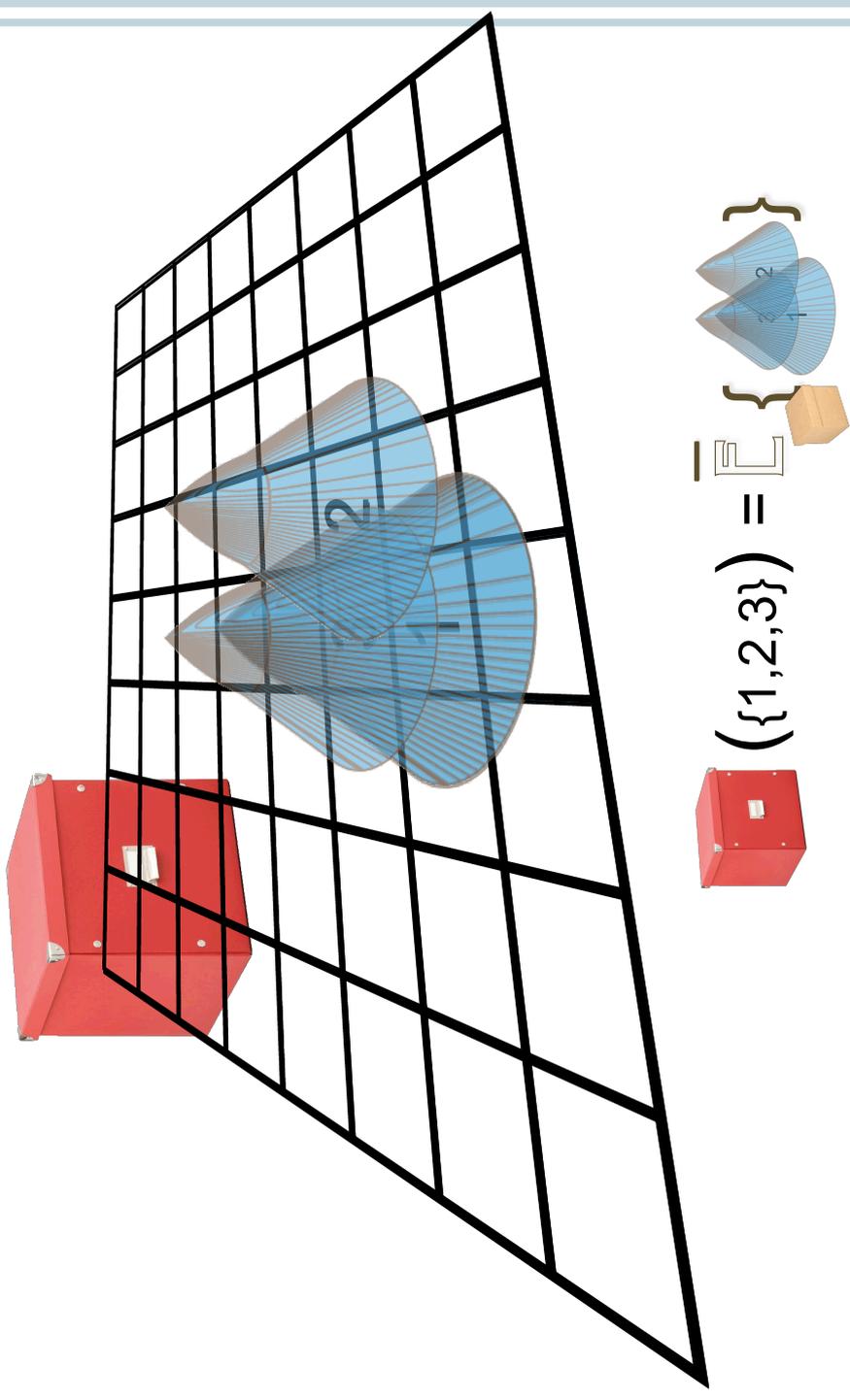
Discrete
concave
capacity

(F. Graba)



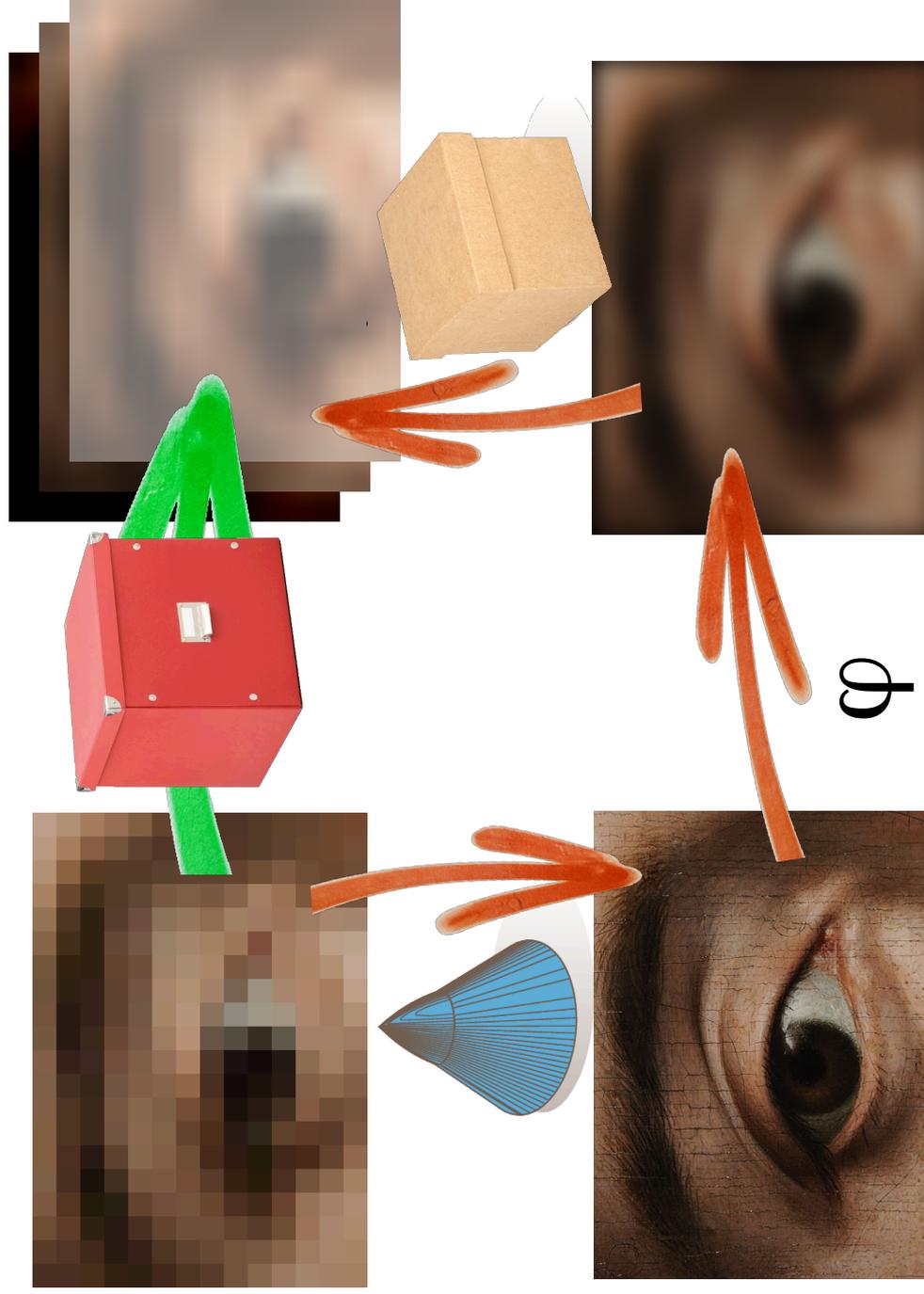
NON-ADDITIVE NEIGHBORHOOD FUNCTIONS

- Construction



MAXITIVE-BASED IMAGE PROCESSING

- o Perfect fit scheme

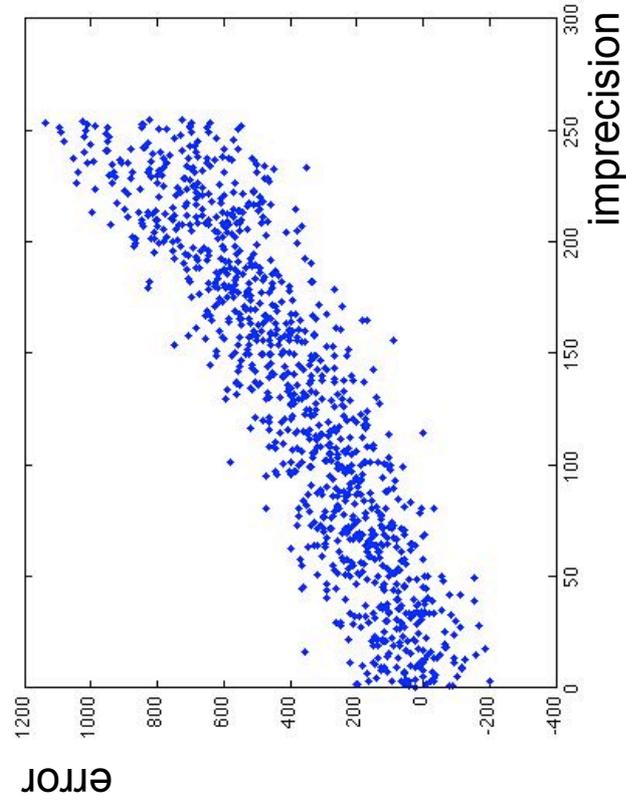
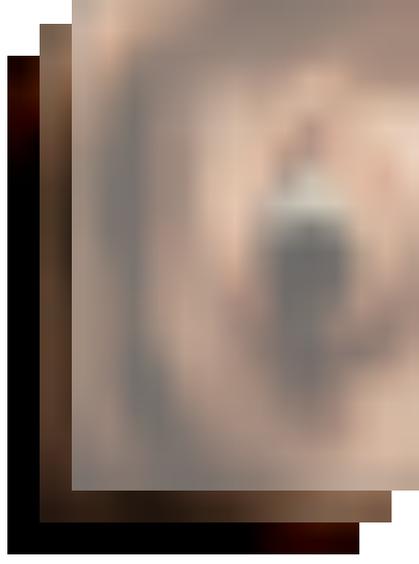


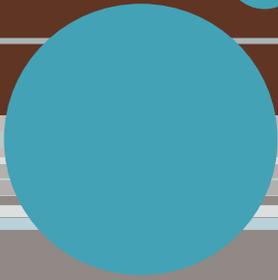
MAXITIVE-BASED IMAGE PROCESSING

- o Error quantification



- o Loquin-Crouzet



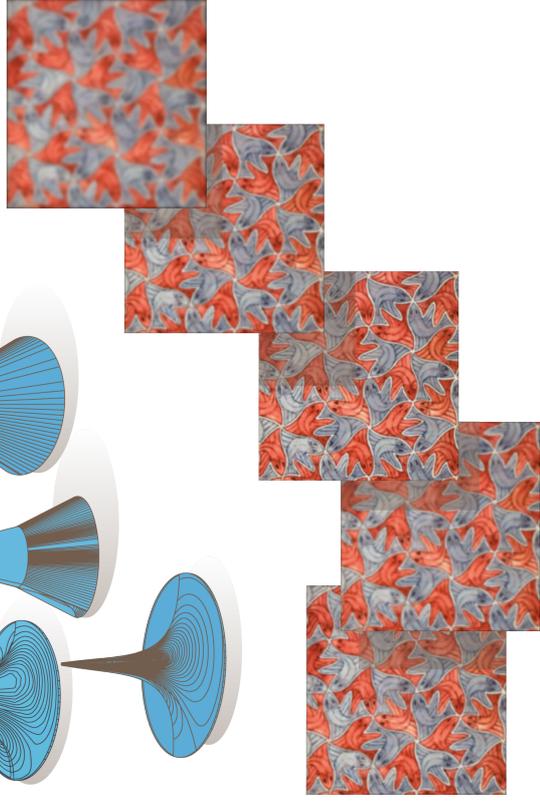
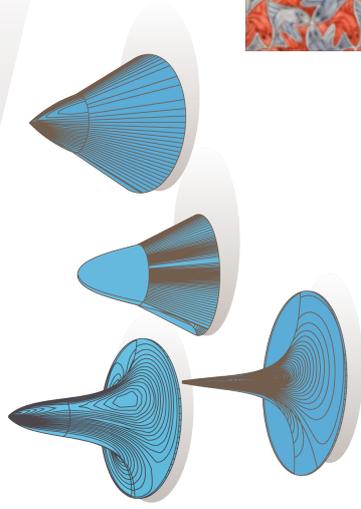
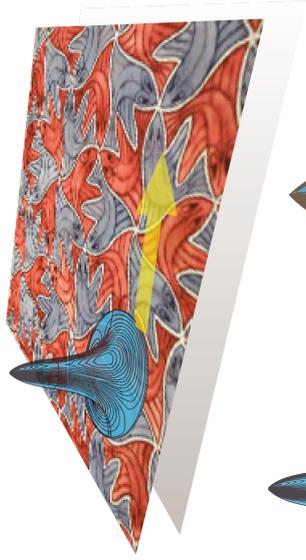


APPLICATIONS

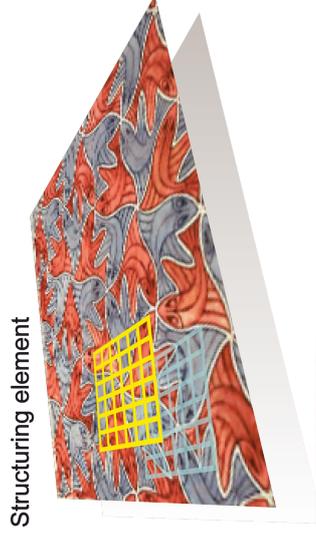
- Morpho-filtrering
- Super resolution
- Tomography
- (guaranteed) Geometric transformation
- ...

A BRIDGE BETWEEN MORPHOLOGY AND FILTERING

- Filtering



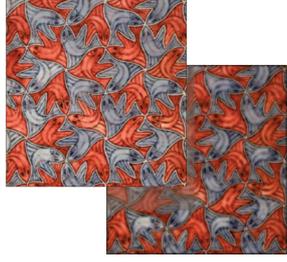
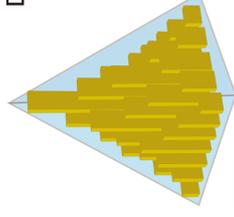
- Morphology



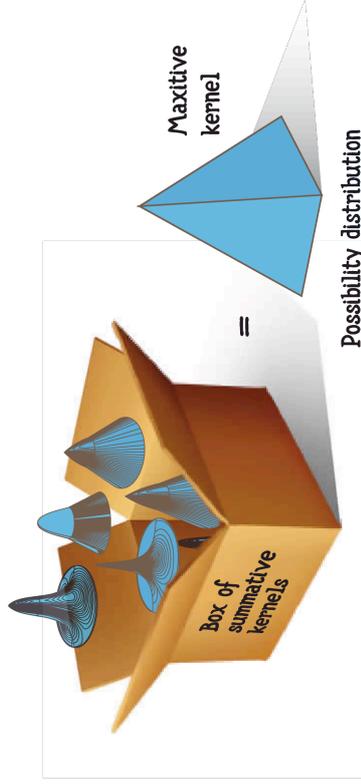
Erosion



Dilation



A BRIDGE BETWEEN MORPHOLOGY AND FILTERING



$$\bar{E}(\mathbf{I}) = [E(\mathbf{I}), \bar{E}(\mathbf{I})]$$

$$= \text{Sup}_{\mathbf{I} \in \mathcal{I}} \{E(\mathbf{I})\} = \bar{E}(\mathbf{I}) = \text{Dilation}(\mathbf{I}, \mathbf{I})$$

$$= \text{Inf}_{\mathbf{I} \in \mathcal{I}} \{E(\mathbf{I})\} = E(\mathbf{I}) = \text{Erosion}(\mathbf{I}, \mathbf{I})$$

IMAGE SUPER-RESOLUTION



Registration



Fusion



Deconvolution



IMAGE SUPER-RESOLUTION

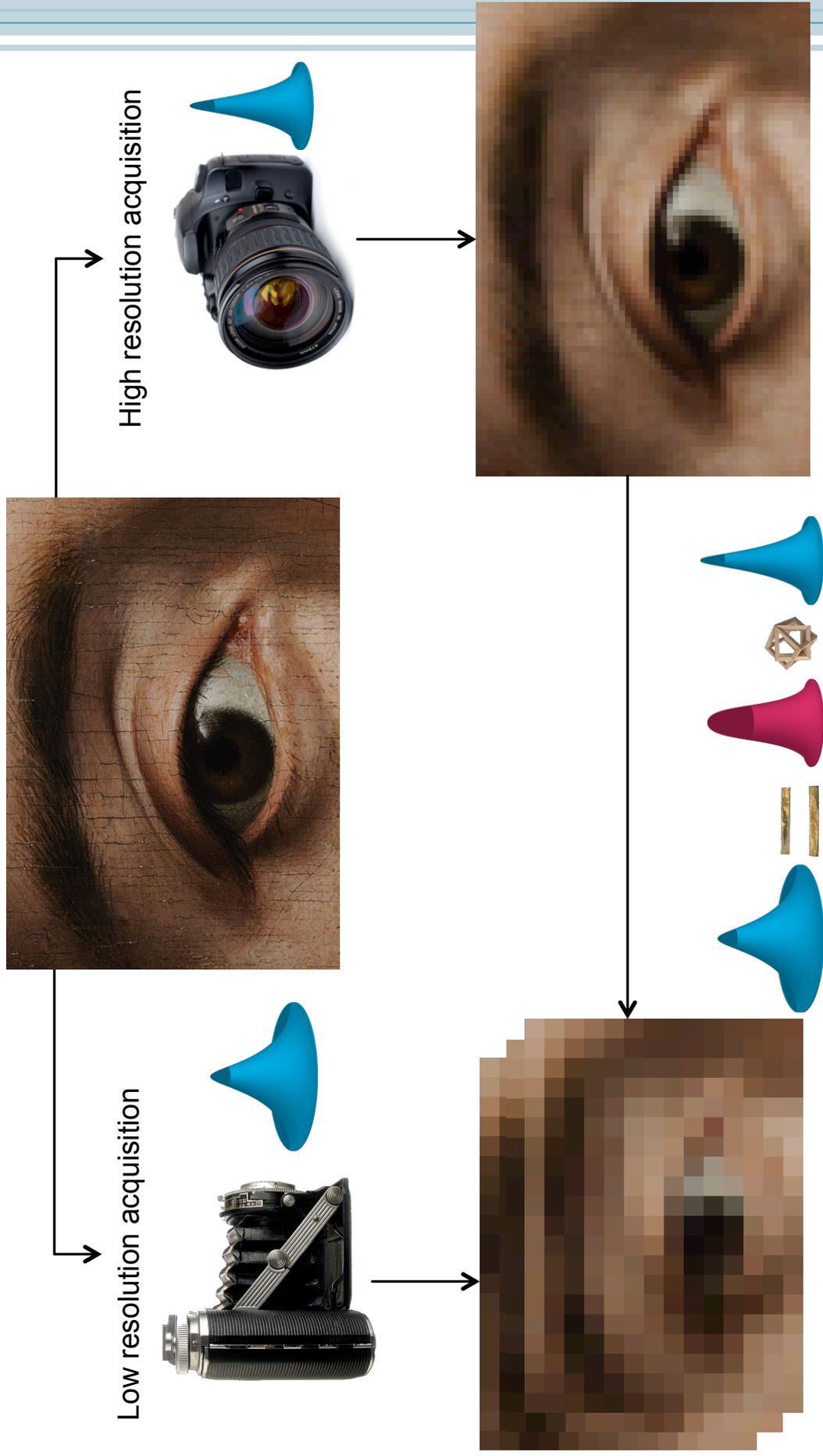


IMAGE SUPER-RESOLUTION

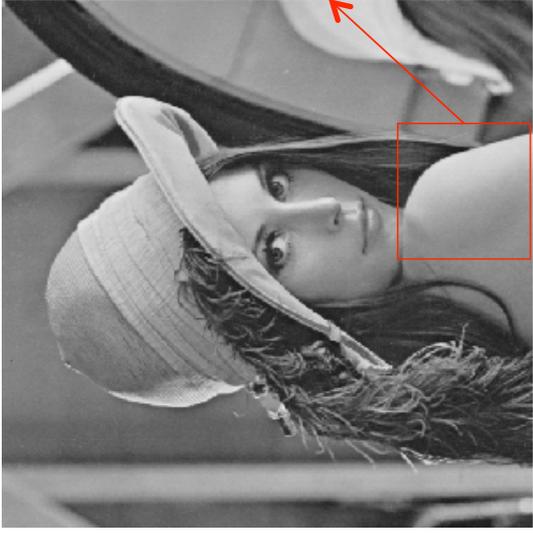


IMAGE SUPER-RESOLUTION



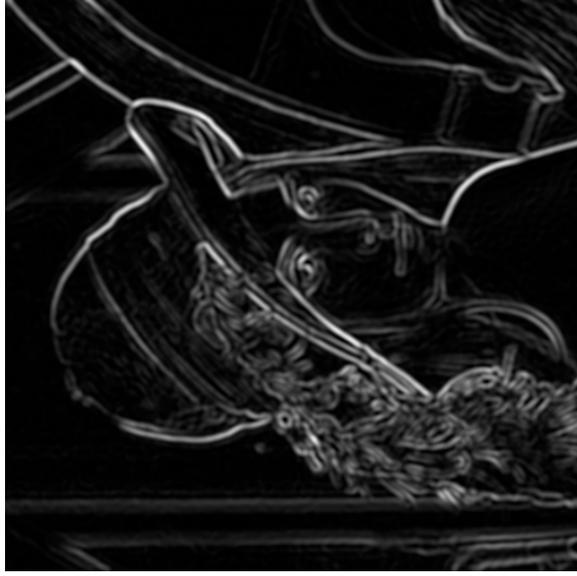
Lower image



Upper image



Median image



Error image

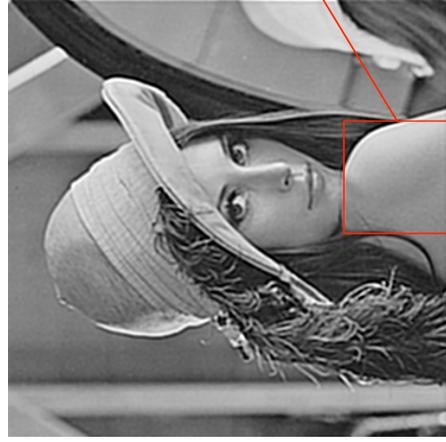
IMAGE SUPER-RESOLUTION



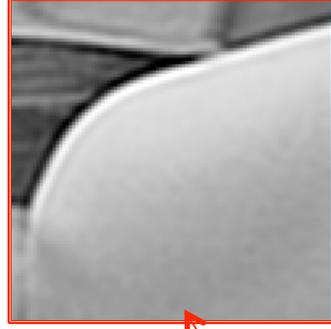
Original image



Median of the i. v. reconstruction



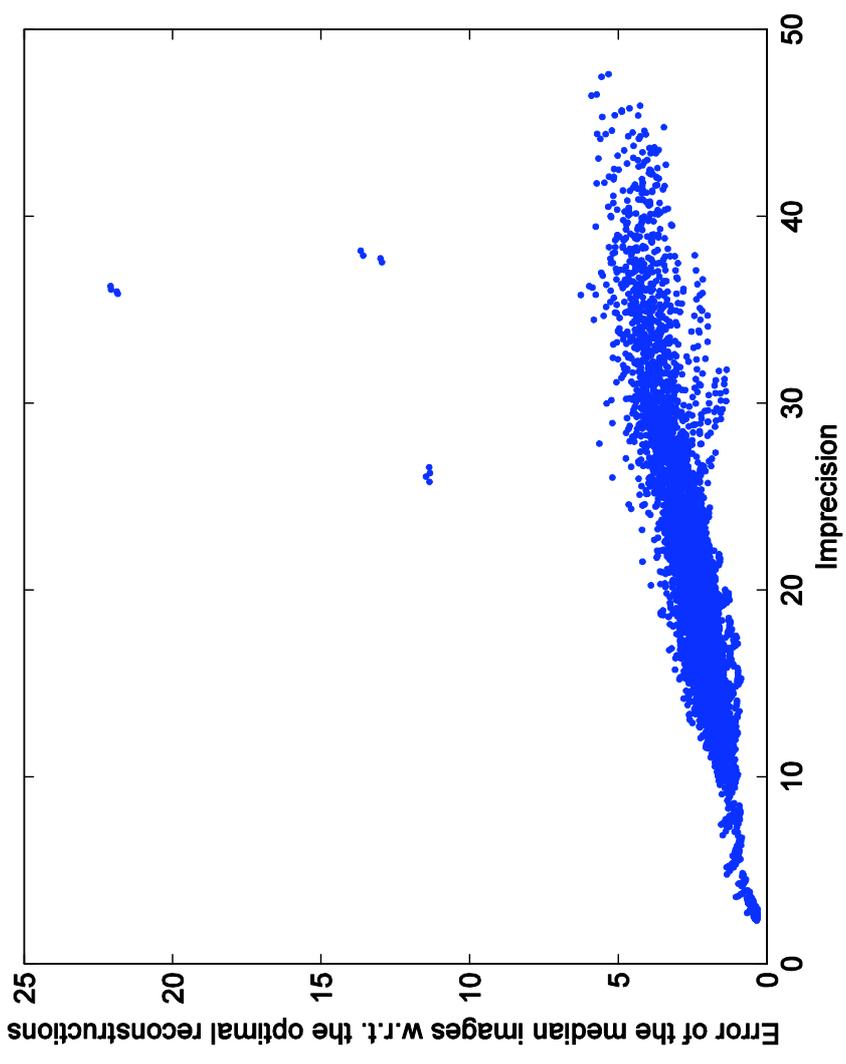
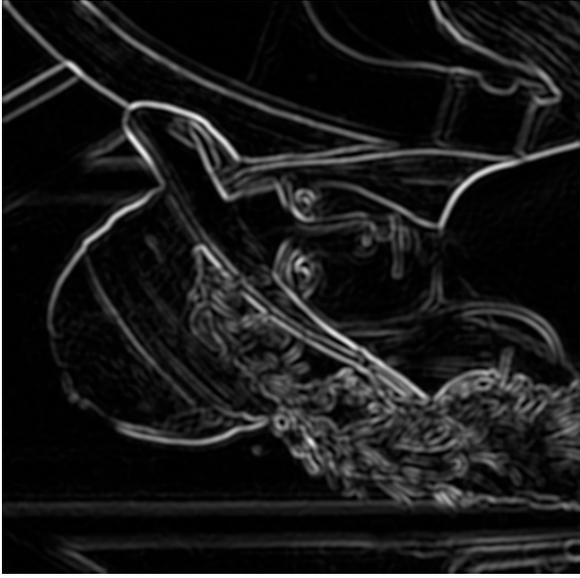
Not specific enough kernel



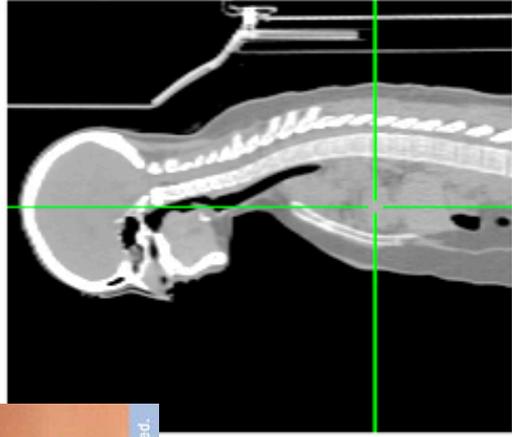
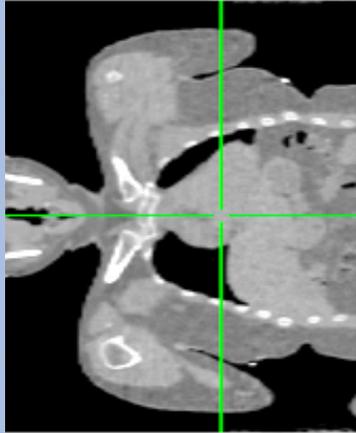
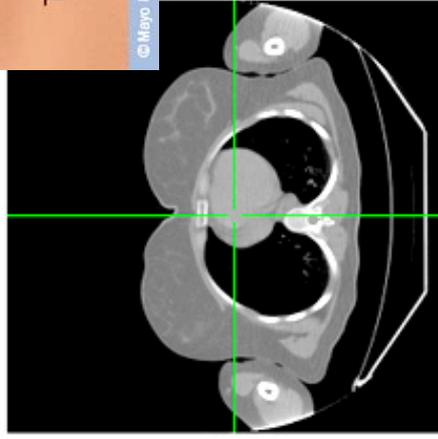
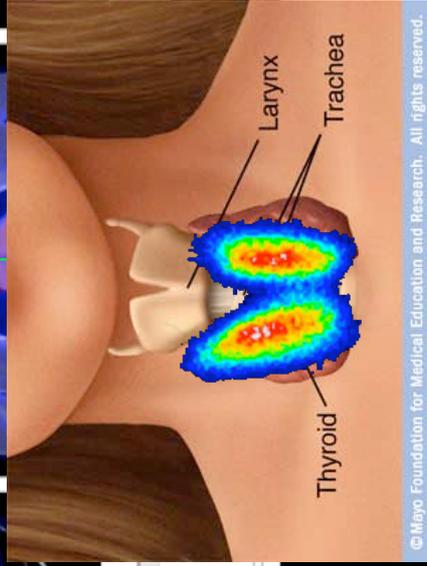
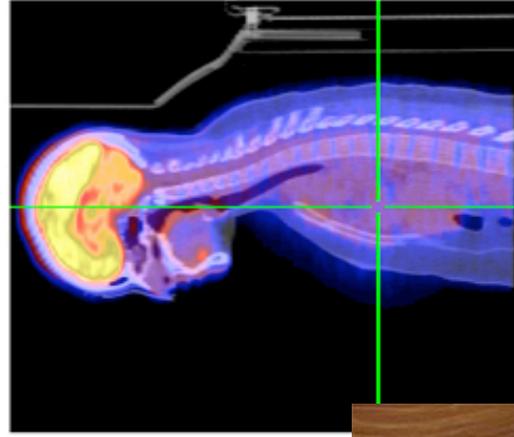
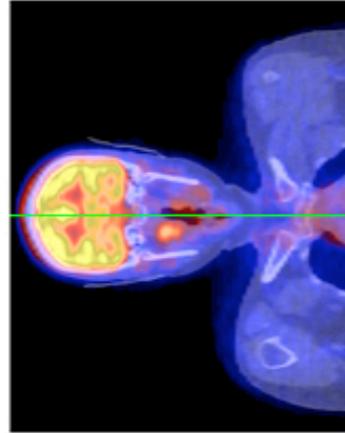
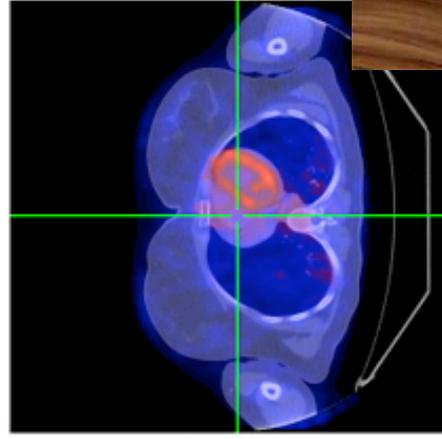
Too specific kernel



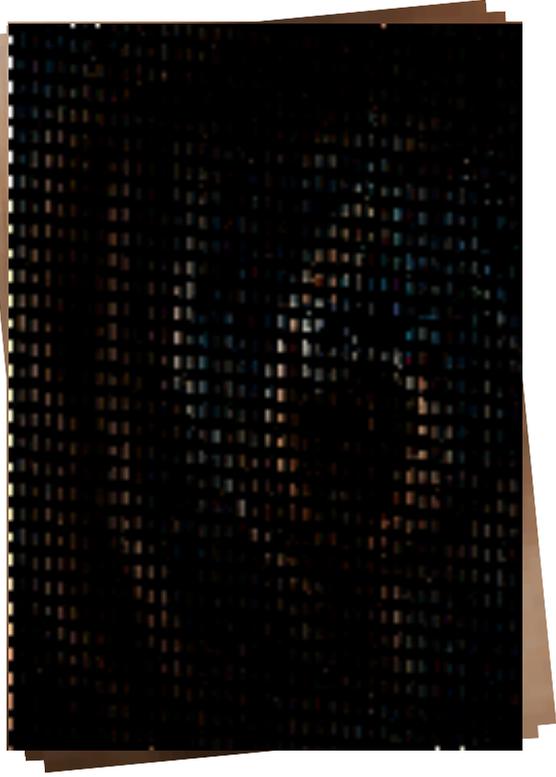
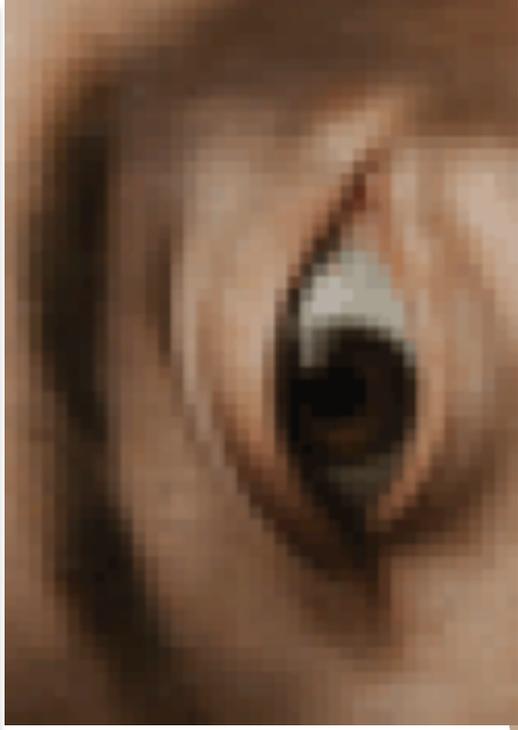
IMAGE SUPER-RESOLUTION



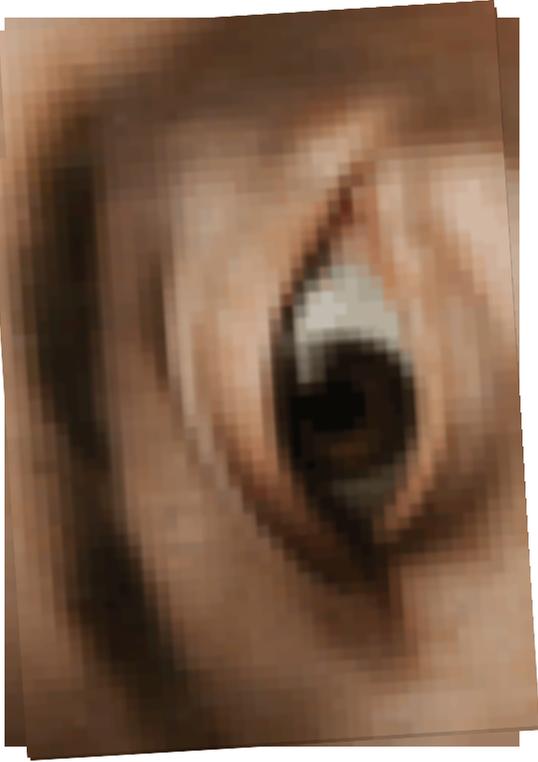
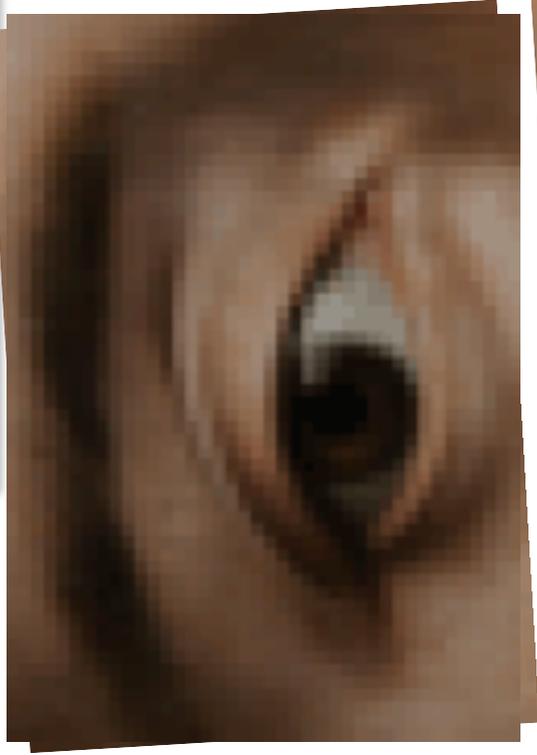
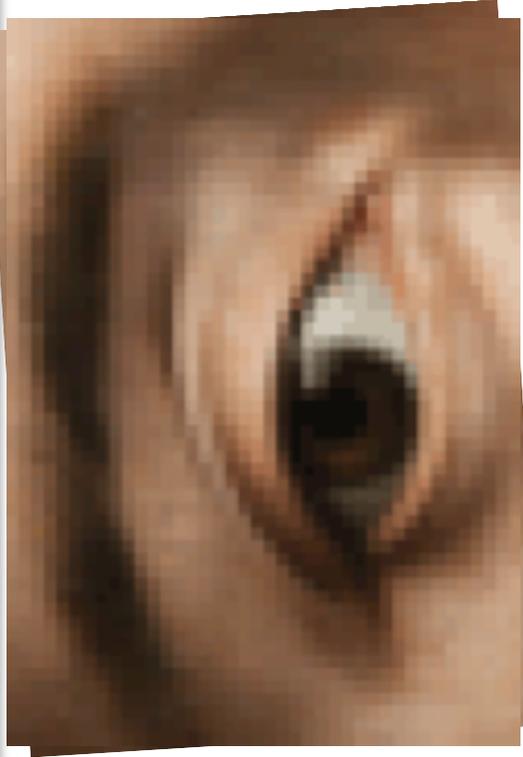
GEOMETRIC TRANSFORMATION

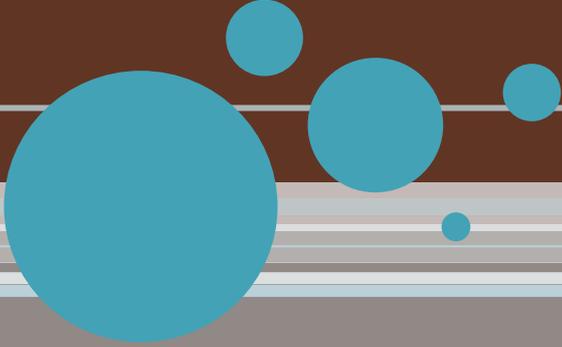


GEOMETRIC TRANSFORMATION



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?