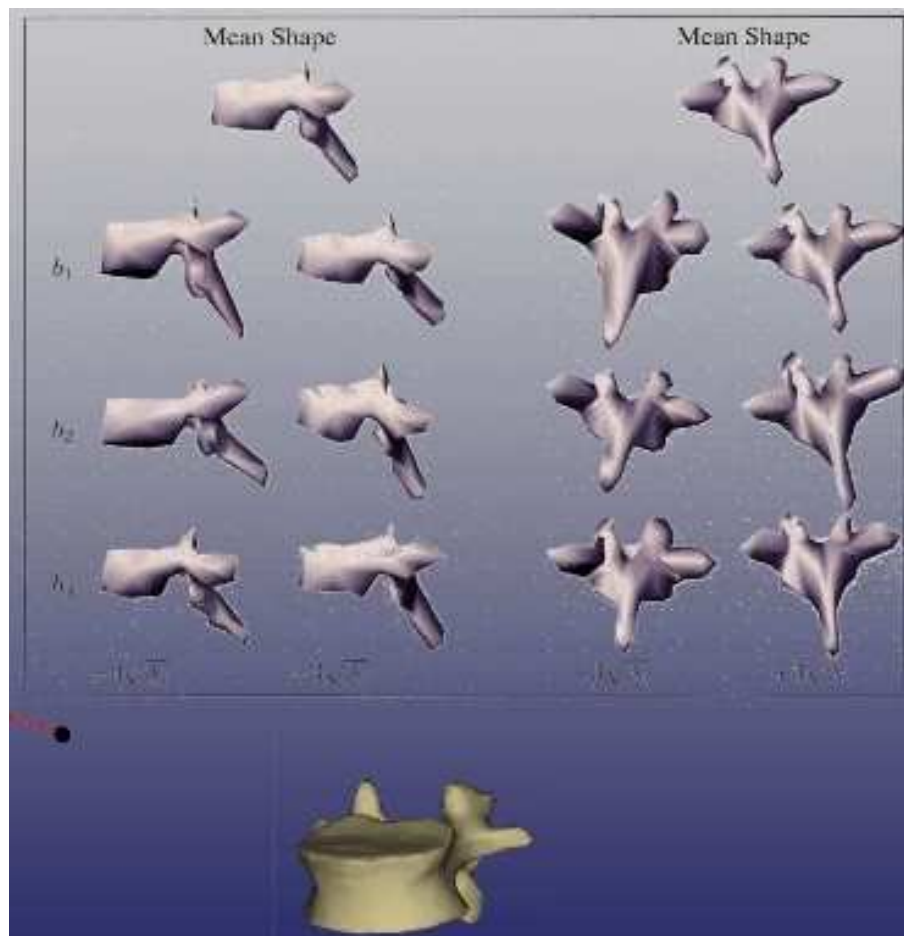
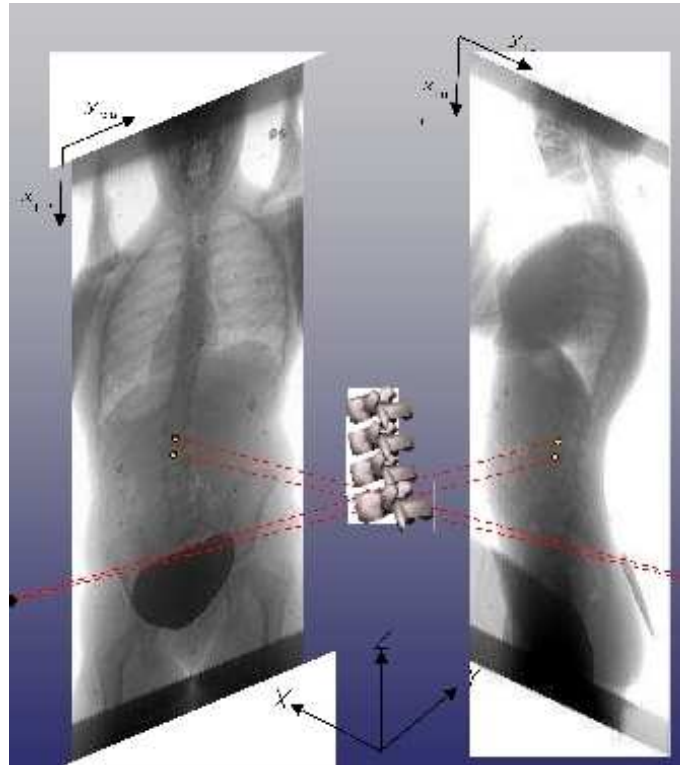


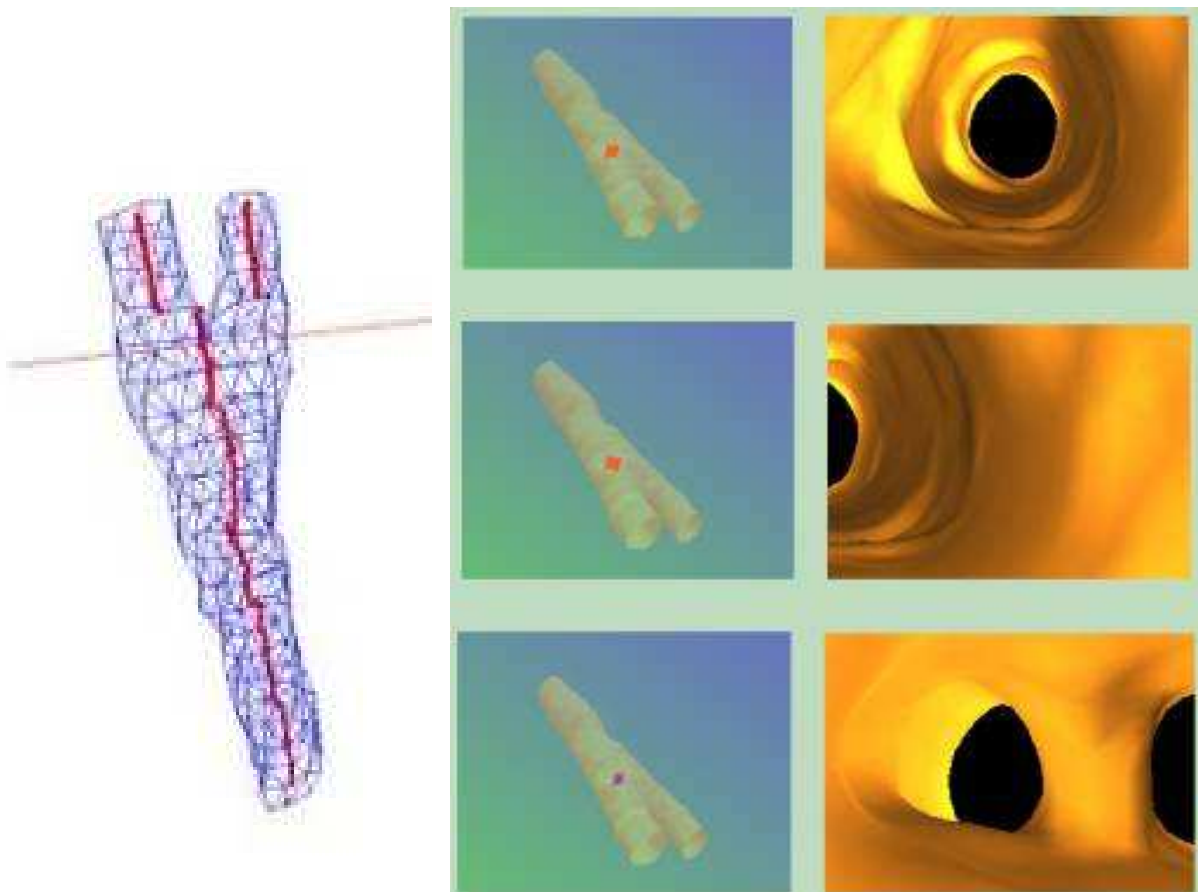
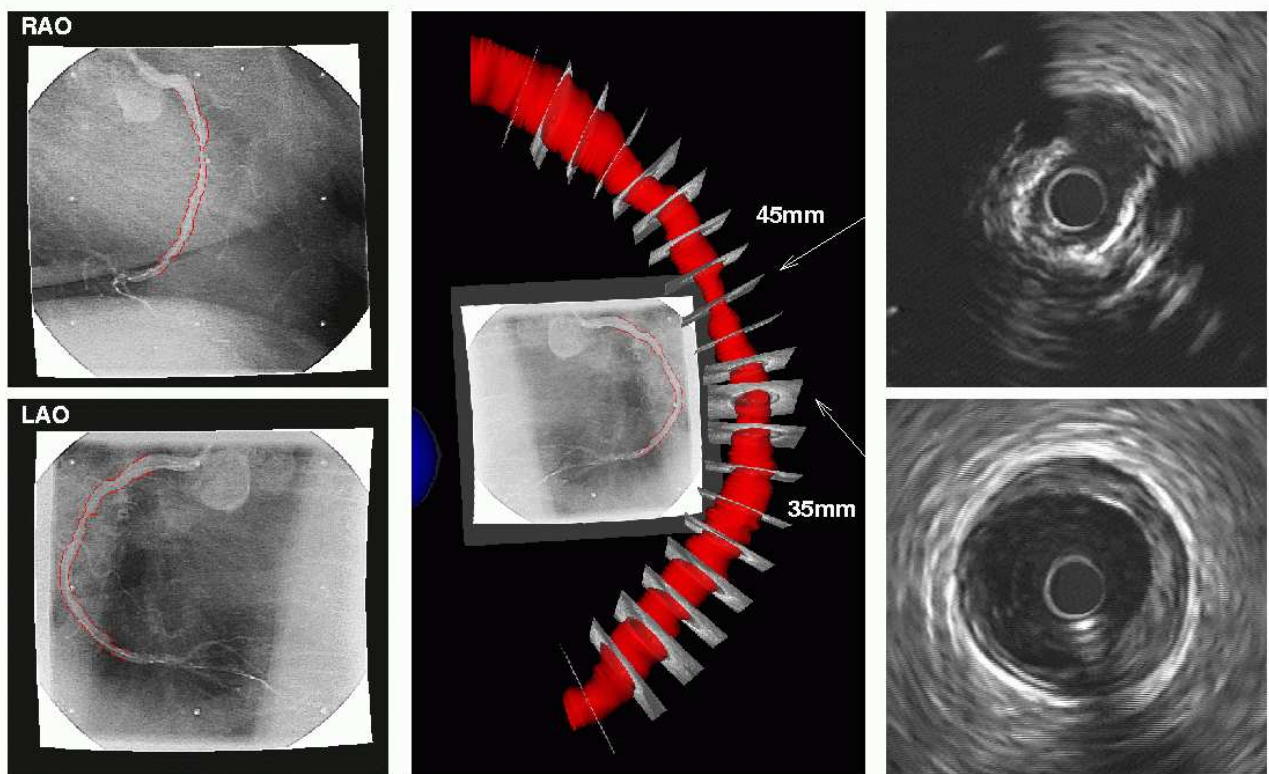
INTRODUCTION

Reconstruction 3D de la Colonne Vertébrale



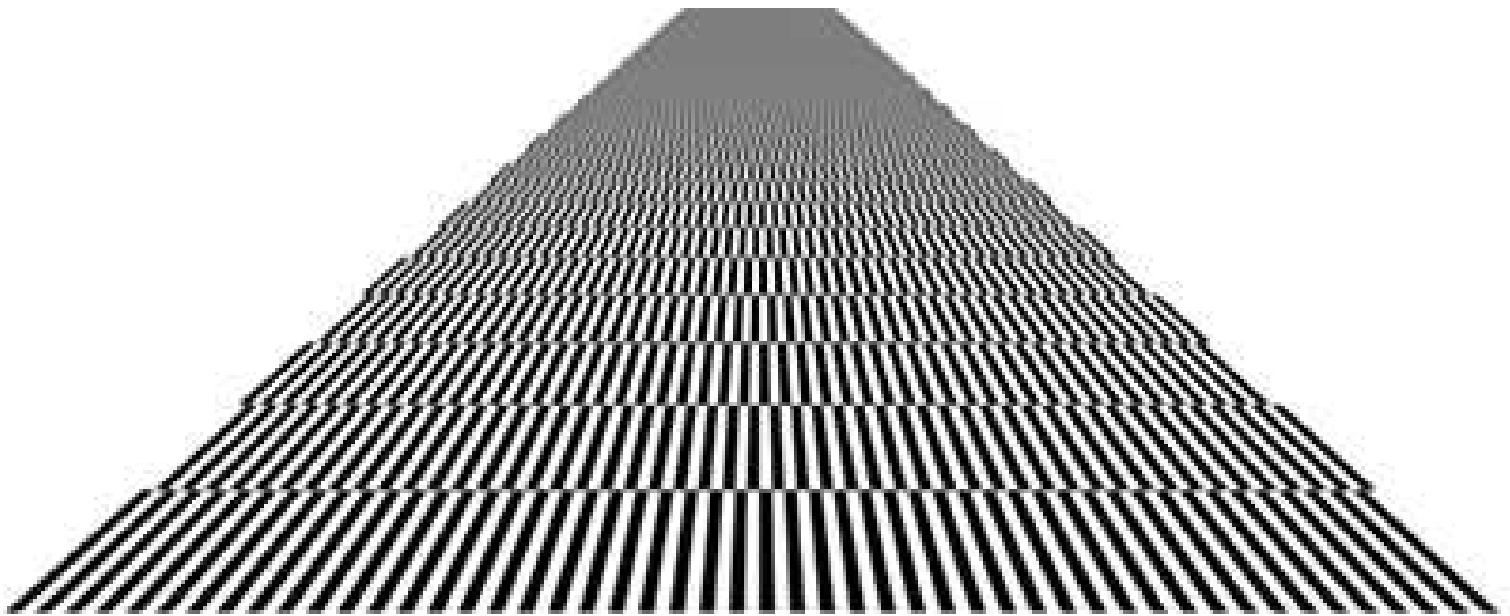
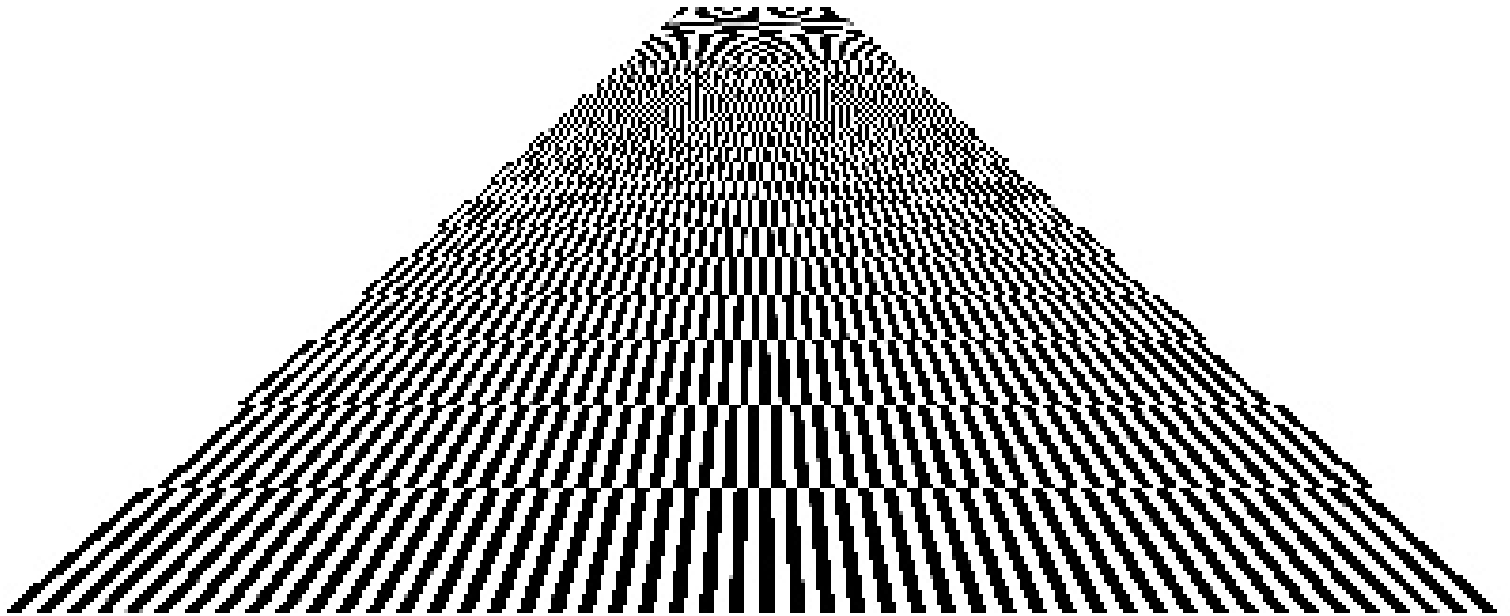
INTRODUCTION

Reconstruction Angiographique



TRANSFORMÉ DE FOURIER

Aliasing & Antialiasing



TFD

Périodisation Implicite de l'Image

$$\text{TFD} \left(\begin{array}{c} \text{Portrait of a man} \end{array} \right) = \text{TF} \left(\begin{array}{c} \vdots \vdots \vdots \\ \dots \begin{array}{cccc} \text{Portrait of a man} & \text{Portrait of a man} & \text{Portrait of a man} & \text{Portrait of a man} \end{array} \dots \\ \dots \begin{array}{cccc} \text{Portrait of a man} & \text{Portrait of a man} & \text{Portrait of a man} & \text{Portrait of a man} \end{array} \dots \\ \dots \begin{array}{cccc} \text{Portrait of a man} & \text{Portrait of a man} & \text{Portrait of a man} & \text{Portrait of a man} \end{array} \dots \\ \vdots \vdots \vdots \end{array} \right)$$

TP1

Algorithmiquement

$$f(x, y) \stackrel{\mathcal{F}}{\rightleftharpoons} F(u, \nu) = R(u, \nu) + jI(u, \nu)$$

TFD

$$\begin{pmatrix} \text{R   } \\ \text{Imaginaire} \end{pmatrix} = \begin{pmatrix} R(u, \nu) \\ I(u, \nu) \end{pmatrix}$$

The diagram shows the decomposition of a function $f(x, y)$ into its real and imaginary parts. On the left, a column vector contains the label "R   " above a portrait of a man and the label "Imaginaire" above a box containing the text "Z          ". On the right, a column vector contains the label $R(u, \nu)$ above a gray square with black corners and the label $I(u, \nu)$ above another identical gray square with black corners. An equals sign is placed between the two vectors.

et

TFD⁻¹

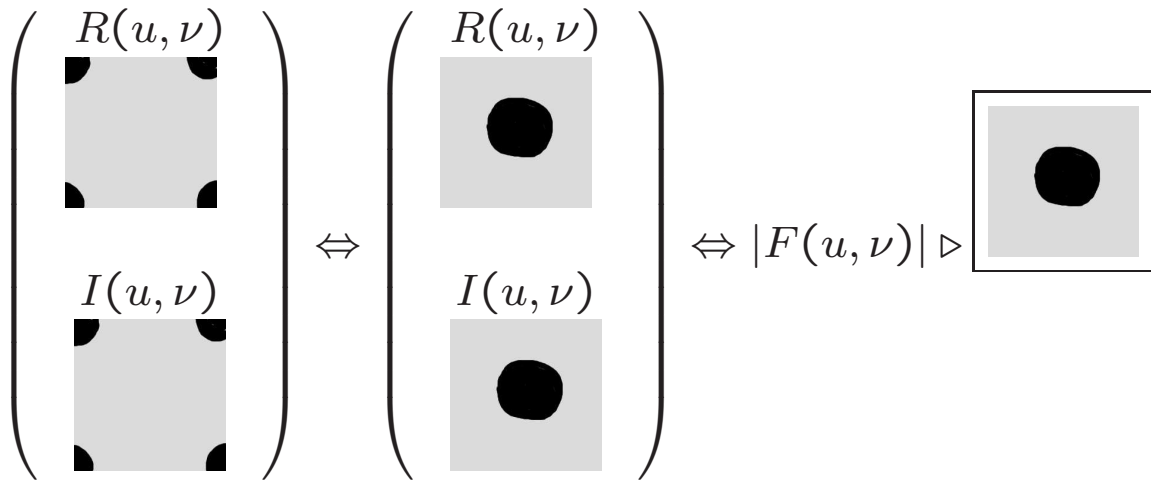
$$\begin{pmatrix} R(u, \nu) \text{ avec centre informatique} \\ I(u, \nu) \text{ avec centre informatique} \end{pmatrix} = \begin{pmatrix} \text{Image trait   } \\ \text{Abstraction} \end{pmatrix}$$

The diagram shows the reconstruction of the function from its real and imaginary parts. On the left, a column vector contains the label $R(u, \nu)$ with "avec centre informatique" above a gray square with black corners, and the label $I(u, \nu)$ with "avec centre informatique" above another identical gray square with black corners. On the right, a column vector contains the label "Image trait   " above a portrait of the same man and the label "Abstraction" above an empty white box. An equals sign is placed between the two vectors.

TP1

Modification et Visualisation du Module

$$|F(u, \nu)| = \sqrt{R^2(u, \nu) + I^2(u, \nu)}$$



Exemples

$$|F(u = 3, \nu = 3)| = 0 \quad \Leftrightarrow \quad \begin{matrix} R(u = 3, \nu = 3) = 0 \\ I(u = 3, \nu = 3) = 0 \end{matrix}$$

$$|F(u = 3, \nu = 3)| \times 2 \quad \Leftrightarrow \quad \begin{matrix} R(u = 3, \nu = 3) \times 2 \\ I(u = 3, \nu = 3) \times 2 \end{matrix}$$

Nota -1-

Mult et $(1 + \log)$

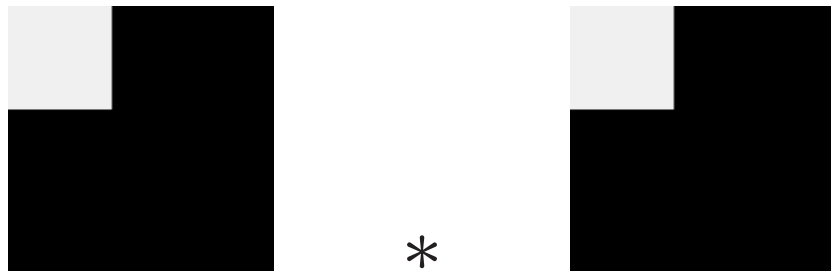
► seulement pour la visualisation d'un module de spectre !

Nota -2-

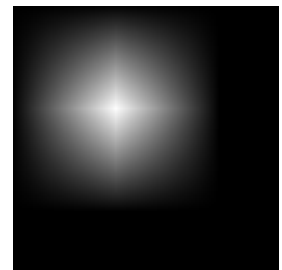
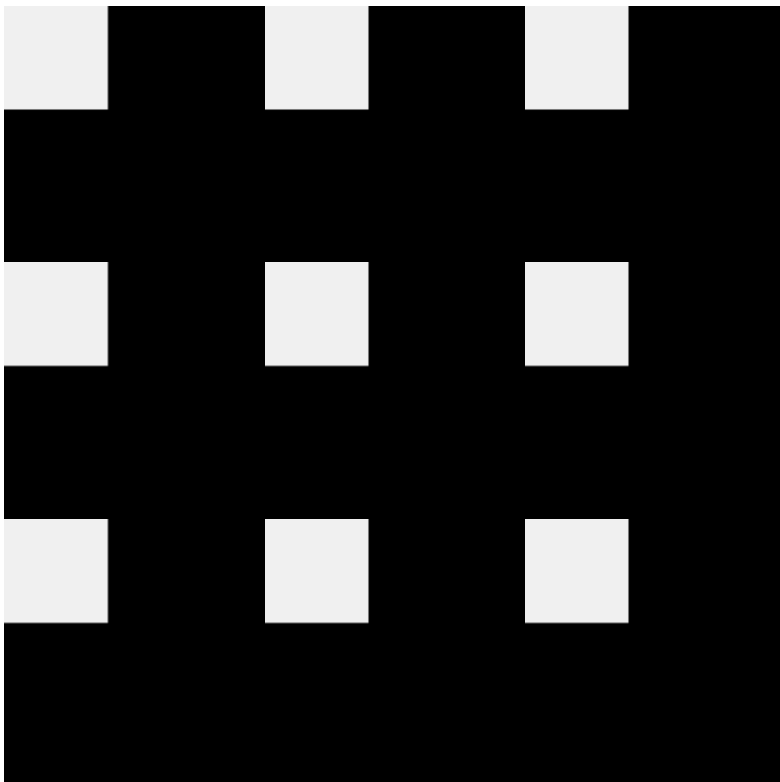
discontinuités horizontales $\xRightarrow{\mathcal{F}}$ discontinuités verticales

TP1

Recouvrement Spatial

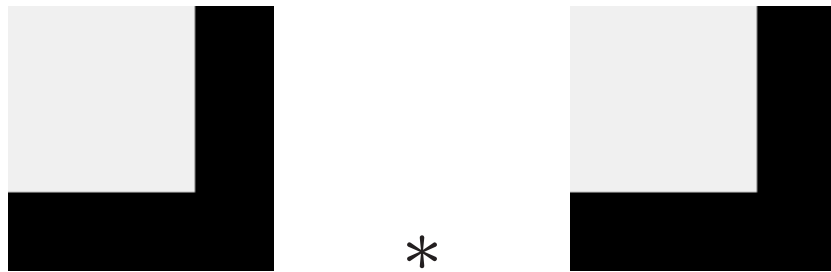


En utilisant la TFD

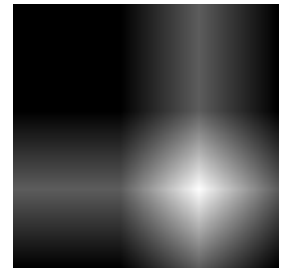
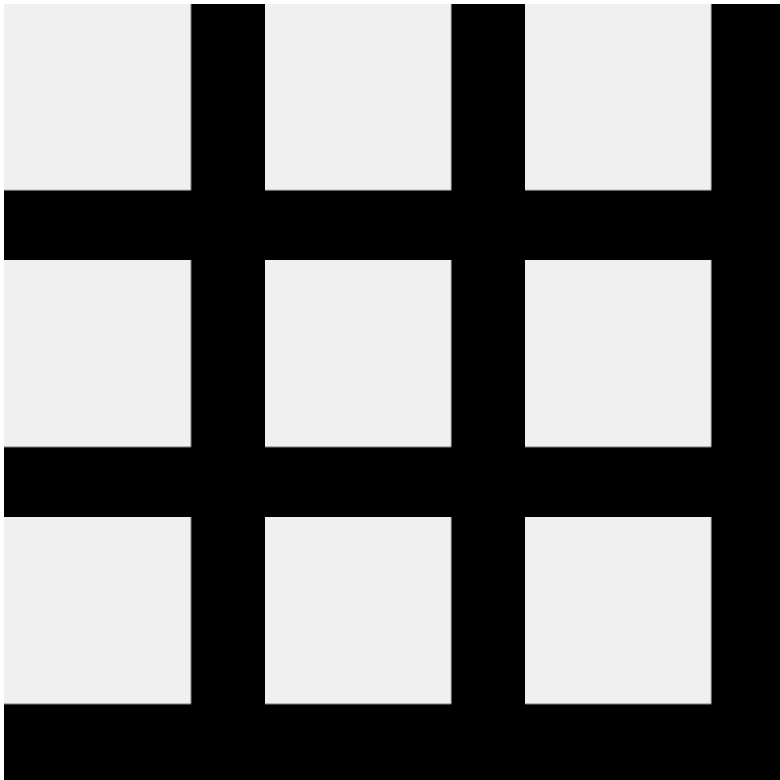


TP1

Recouvrement Spatial

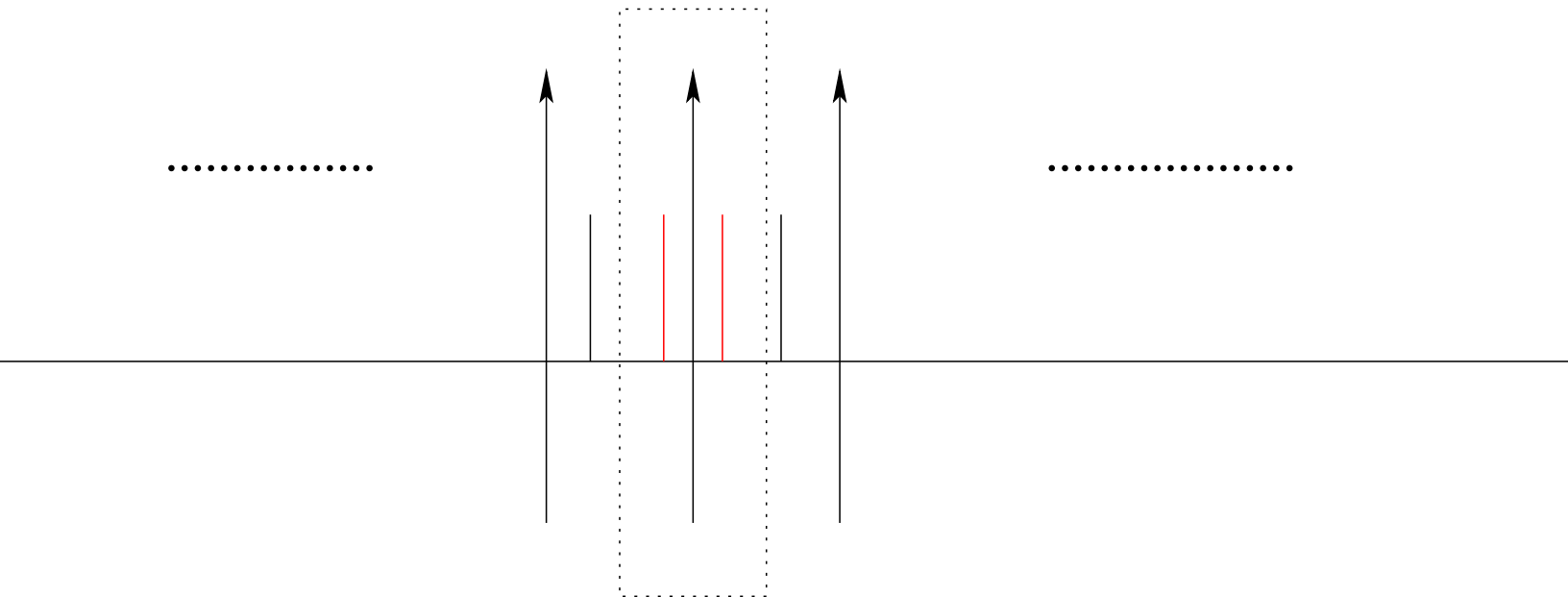
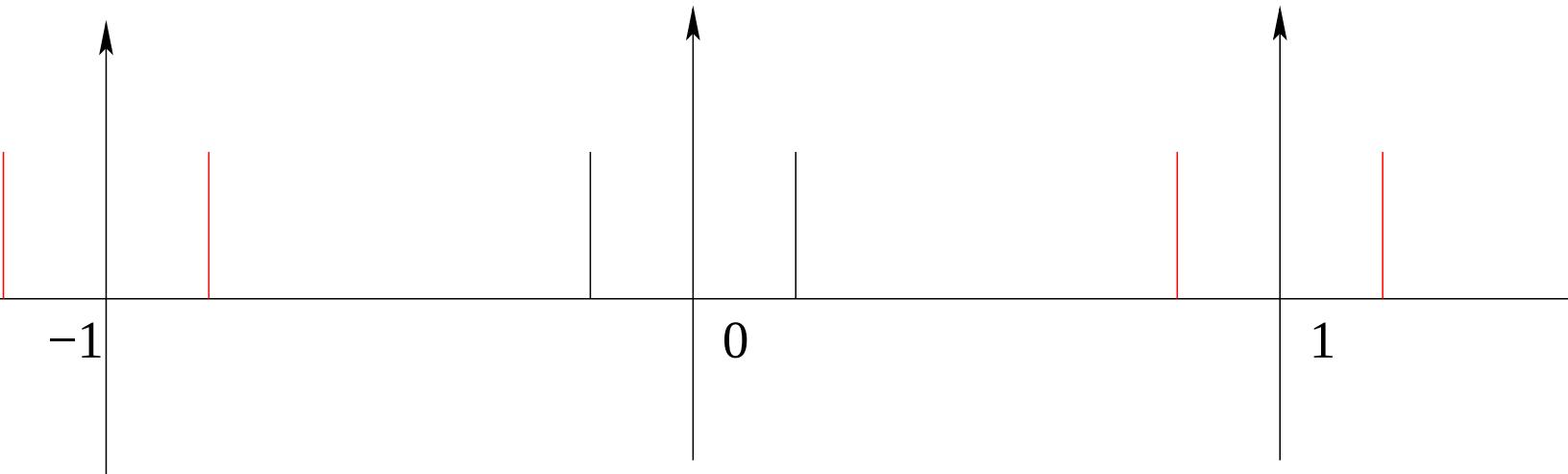


En utilisant la TFD



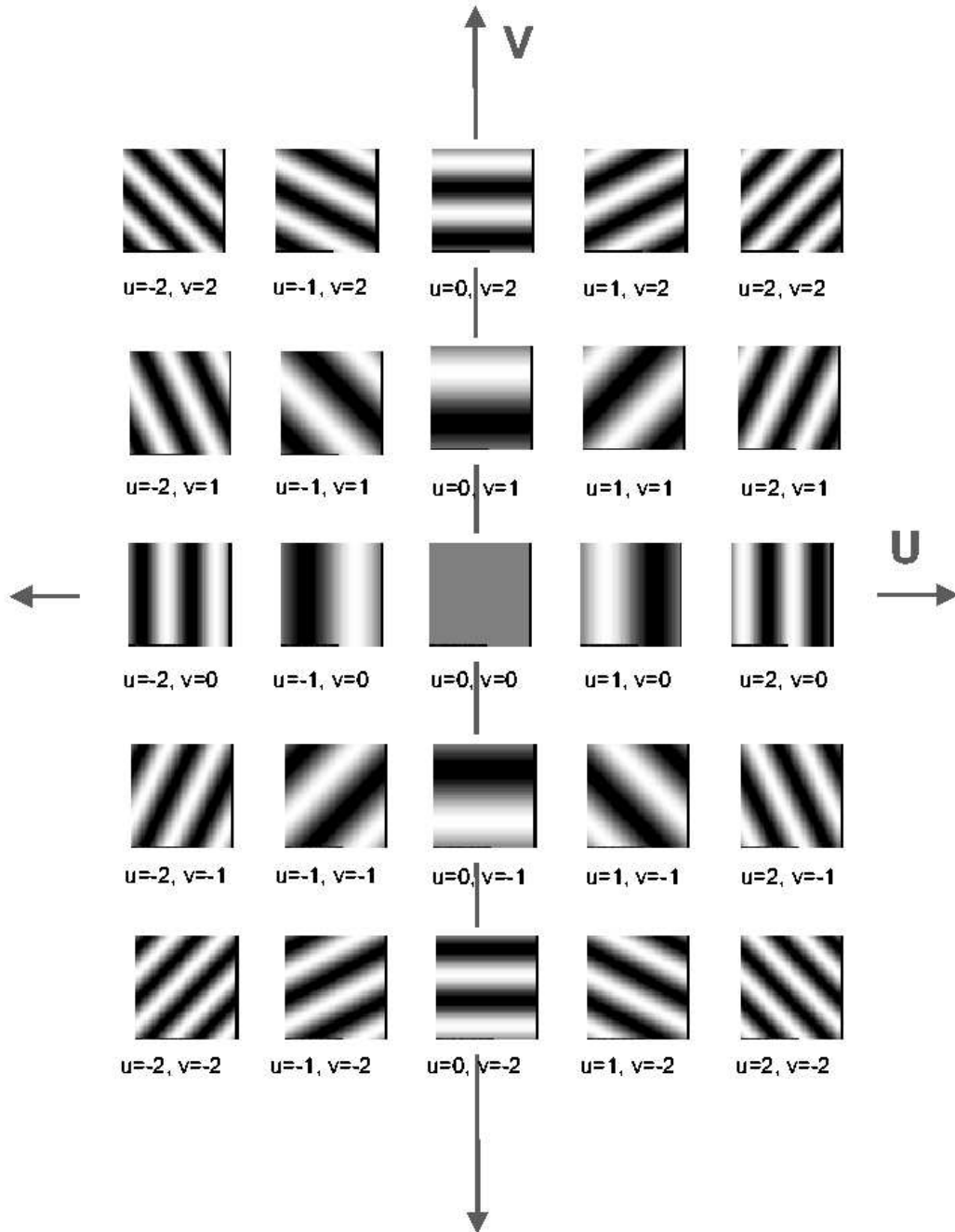
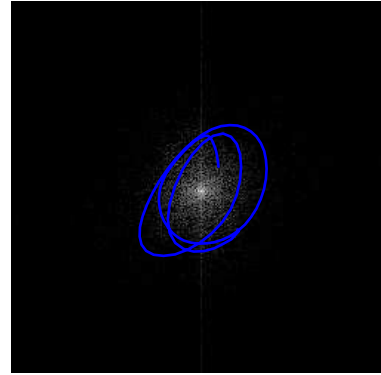
TP1

Sous-Échantillonnage



TF DISCRÈTE

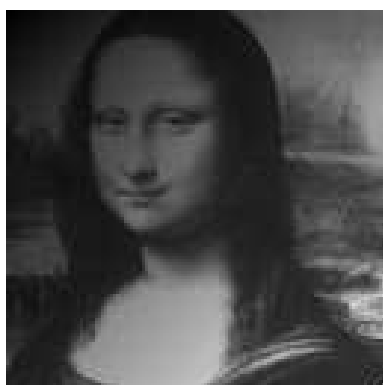
TF discrète 2D (Interprétation)



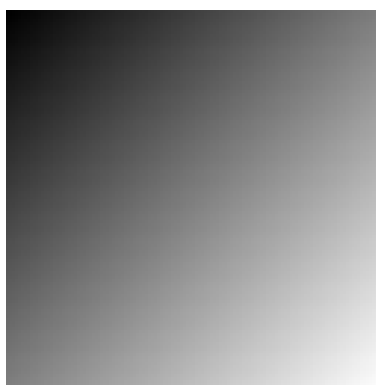
FILTRAGE FRÉQUENTIEL

Filtrage Homomorphique

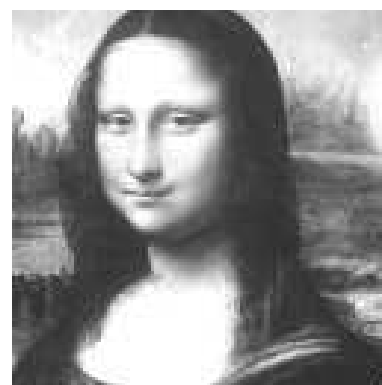
$$f(x, y) = i(x, y) \cdot r(x, y)$$



=



×



Déconvolution de Fonction d'Appareil

laser

plasma
fluorescence
lamin

Fibre optique

Diffracteur optique

Spectre

Eau de mer

1995

1

~~K~~ -

PSF

h

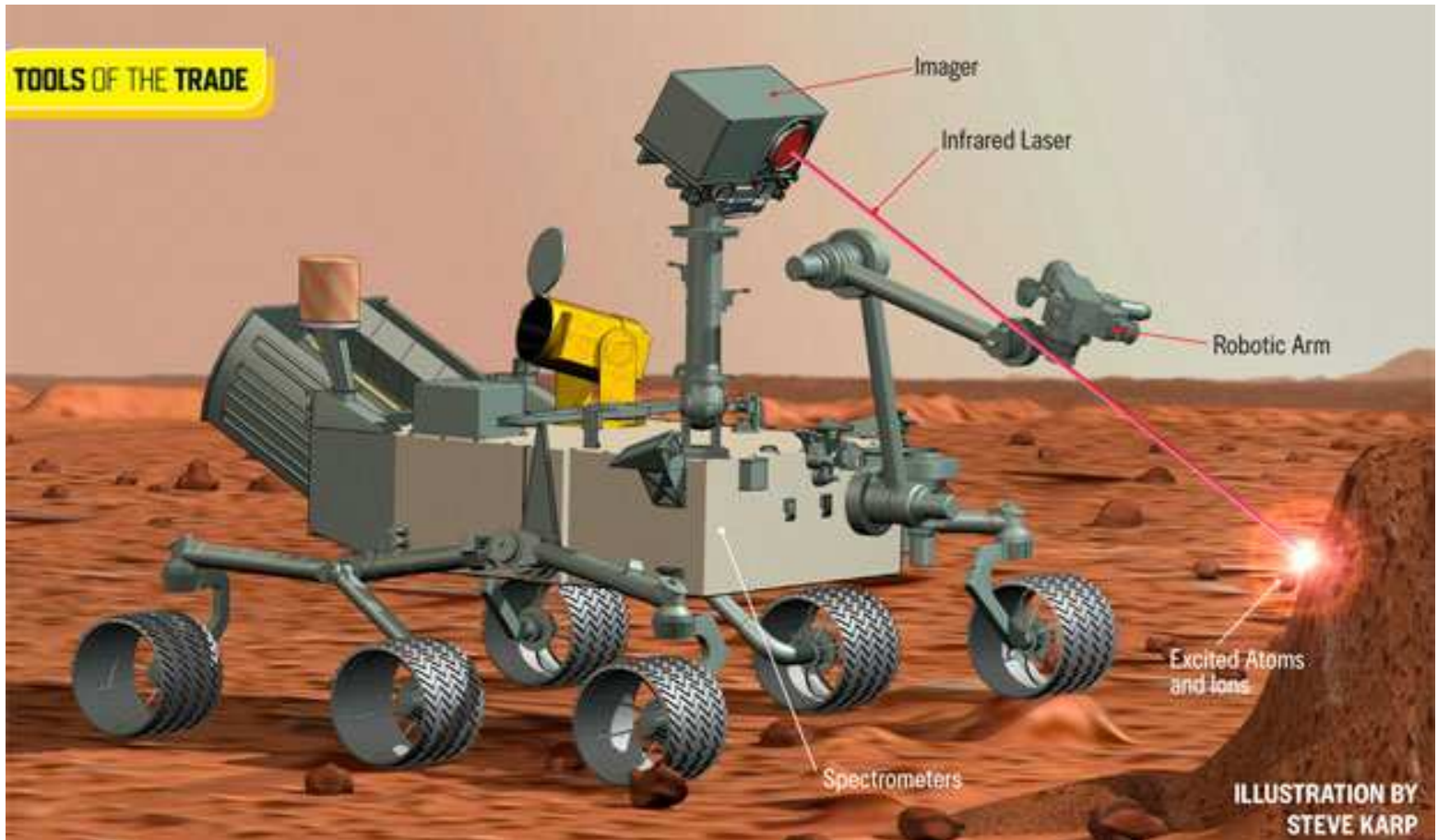
f

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RESTAURATION

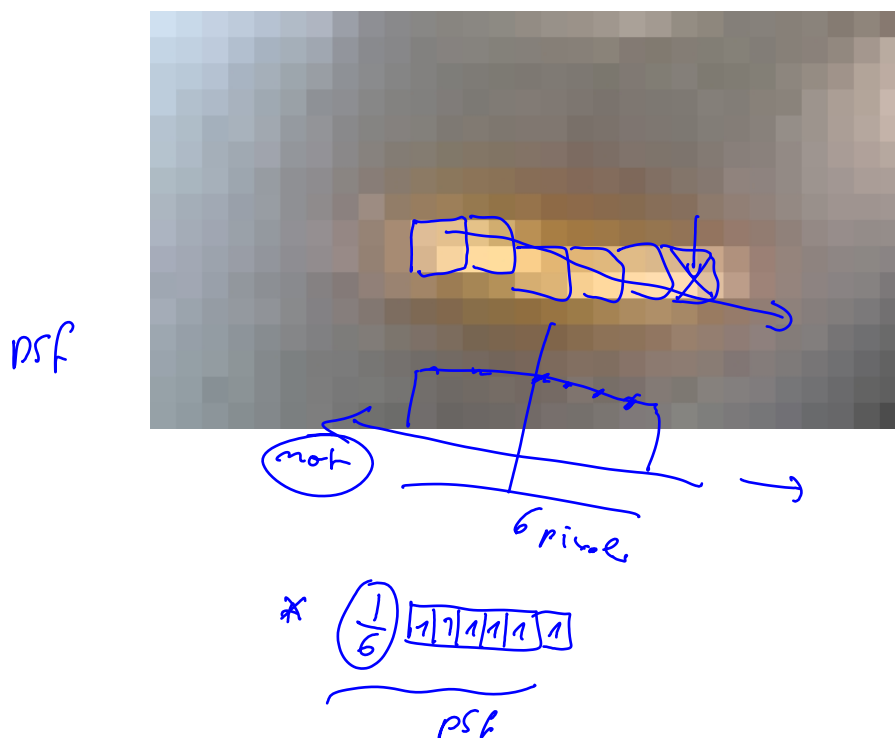
Mars Curiosity

new Alpha ~ ~



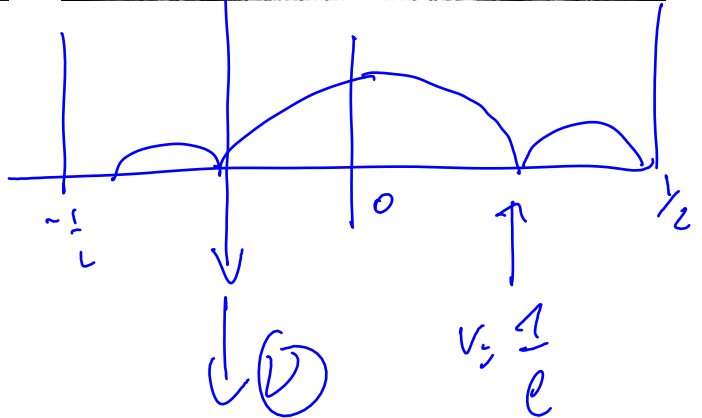
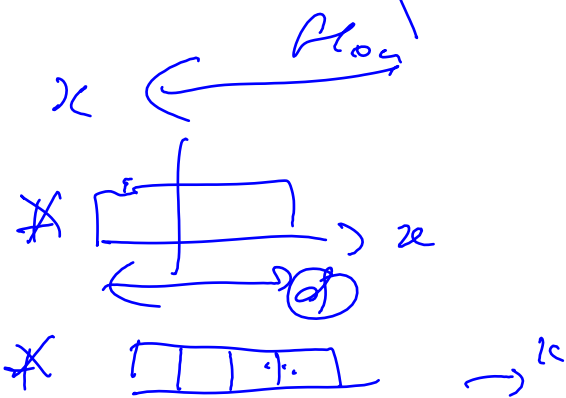
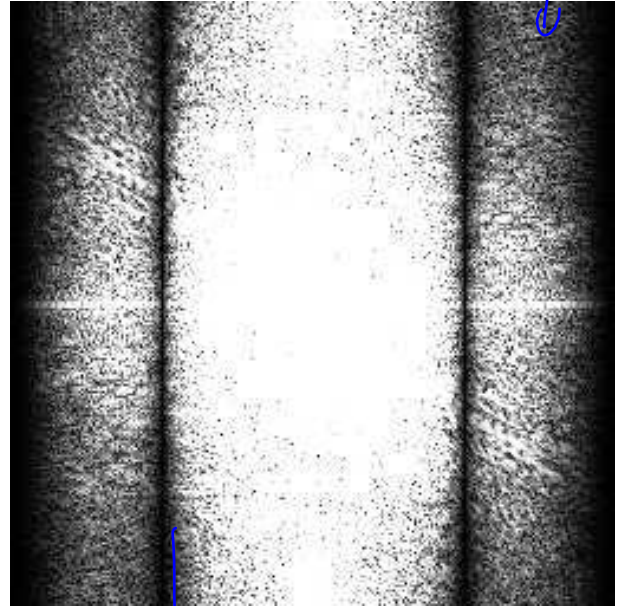
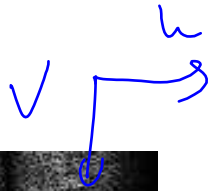
RESTAURATION

Estimation de la PSF



RESTAURATION

Estimation de la PSF



$$\star \pi\left(\frac{x}{e}\right) \approx e \frac{\sin \pi x e}{\pi x e} \quad \left(\frac{1}{e}\right)$$

$$\star \frac{1}{4} \begin{bmatrix} 1 & 1 & 1 & 1 \end{bmatrix}$$

$$\frac{x}{e} = \frac{1}{2}$$

$$\frac{e}{2} = 2$$

$$e = 4$$

RESTAURATION

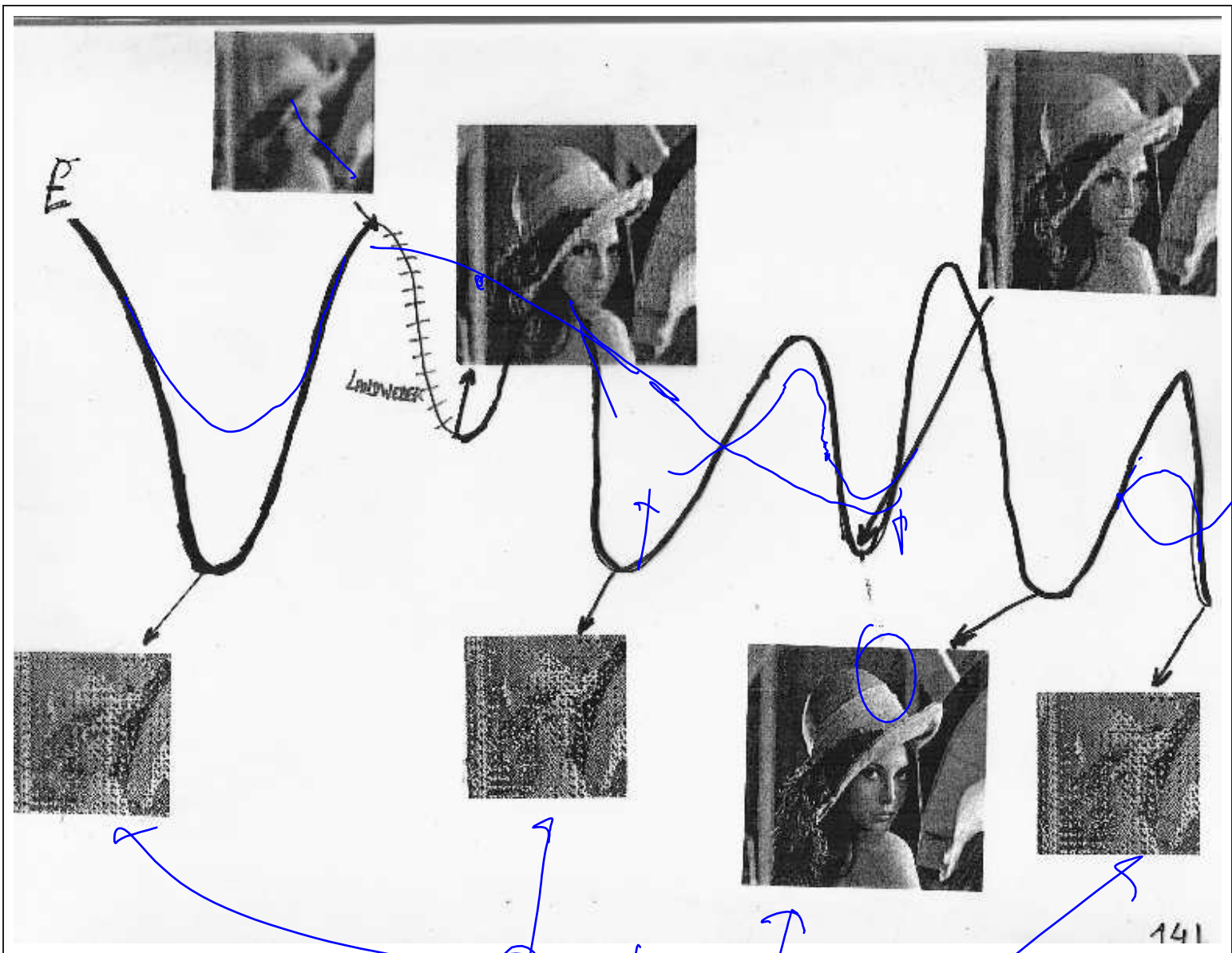
Méthodes Itératives

Méthodes Itératives & Problèmes Inverse Mal-Posés

Fonction de coût :

$$\hat{f}(x, y) = \arg \min_{\hat{f}} \left\{ \left\| \hat{f}(x, y) - f(x, y) \right\|^2 \right\}$$

$$\hat{f}(x, y) = \arg \min_{\hat{f}} \left\{ \left\| g(x, y) - h(x, y) * \hat{f}(x, y) \right\|^2 \right\}$$



TOMOGRAPHIE

Applications (1)

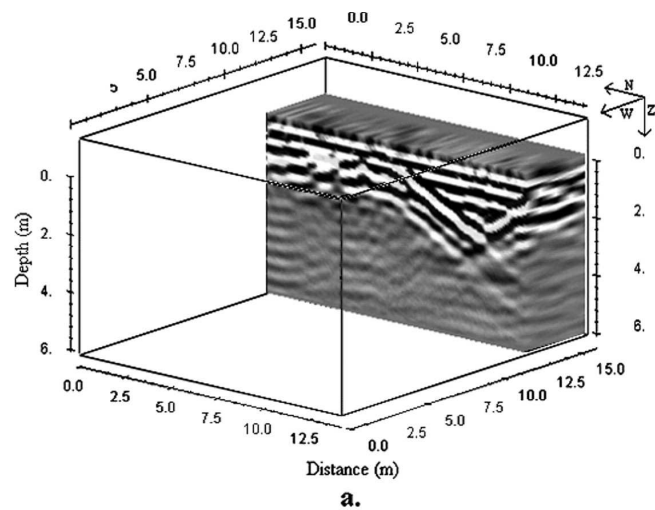
Reconstruction faciale de l'intérieur d'une momie



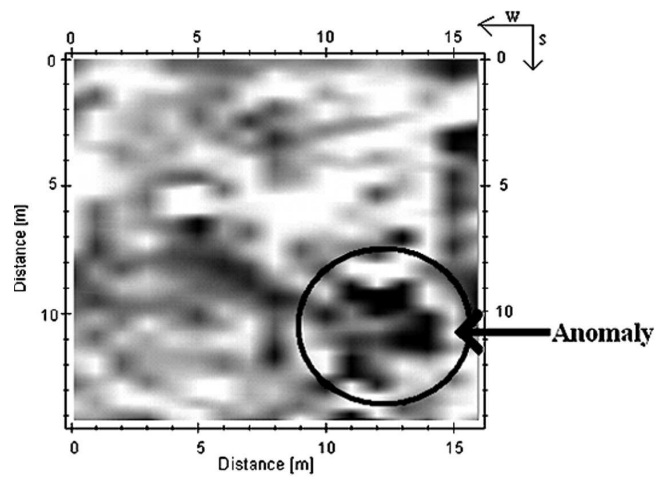
TOMOGRAPHIE

Applications (2)

Detection de chambre mortuaires



a.



b.

TOMOGRAPHIE

Applications (3)

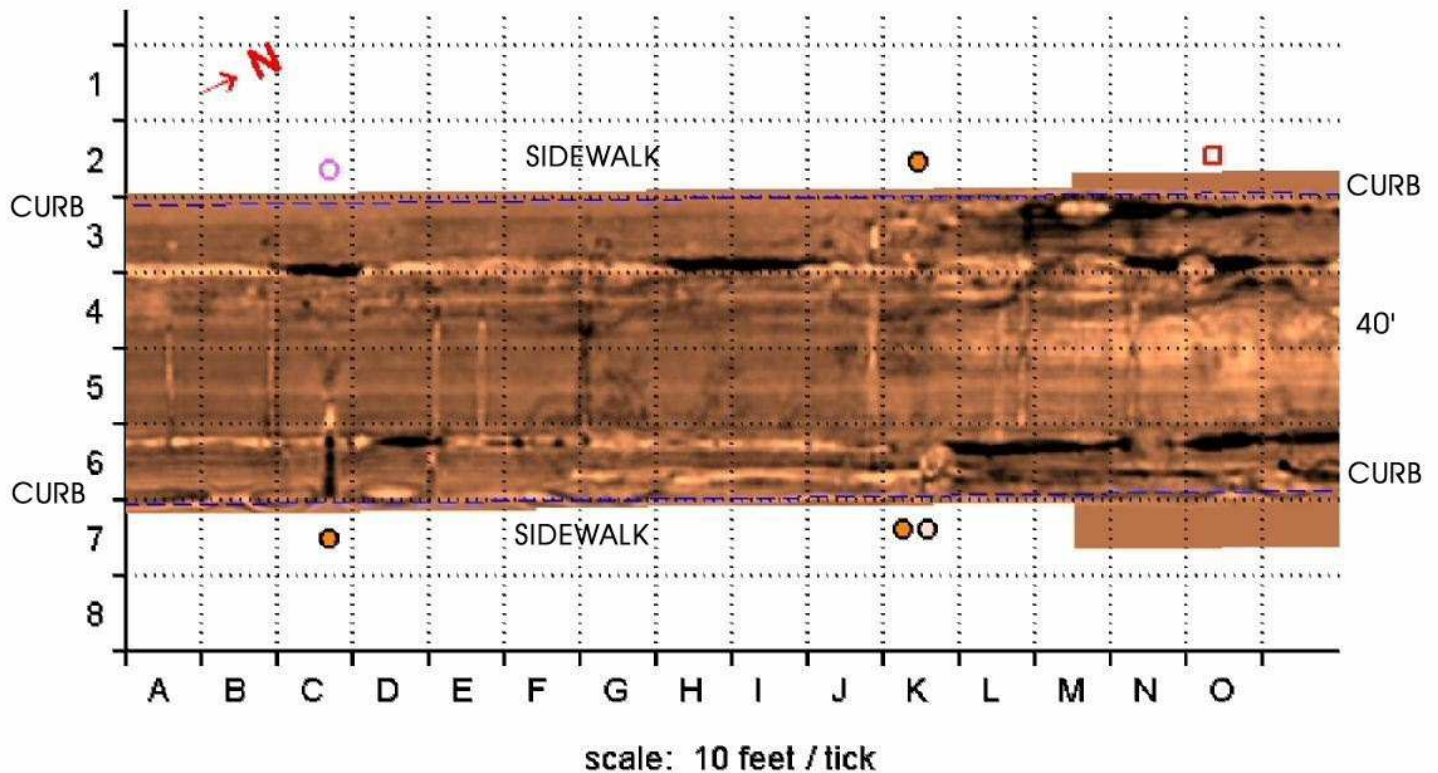
Tomographie Radar des sols

WITTEN TECHNOLOGIES, INC

RADAR TOMOGRAPHY IMAGE OF UTILITIES AT 23" OF DEPTH

160' X 40'

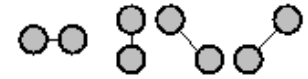
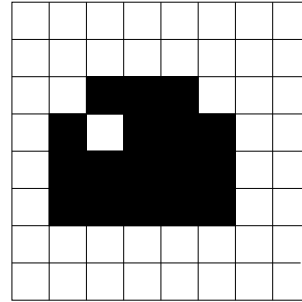
Jax - Courthouse Slice 23 Depth = 23 inches



SEGMENTATION D'IMAGES

ICM : Exemple de Calcul

$$\hat{x}_{MAP} = \arg \min_x \left\{ \underbrace{\sum_{s \in S} \left[\ln(\sqrt{2\pi}\sigma_{x_s}) + \frac{(y_s - \mu_{x_s})^2}{2\sigma_{x_s}^2} \right]}_{V(x,y)} + \underbrace{\sum_{c \in C} \beta_c [1 - \delta(x_s, x_t)]}_{U(x)} \right\}$$



Voisinage du 2nd ordre avec cliques binaires

$$U(x) = \sum_{c \in C} V_c(x) \quad \text{avec} \quad V_c(x) = [1 - \delta(x_s, x_t)]$$

• A PRIORI

$$P_{X_s}(x_s = \blacksquare) = \frac{1}{Z} \exp\left\{-\sum_{c \in C} V_c(x_s = \blacksquare)\right\} = . \quad . \quad . \quad . \quad .$$

$$P_{X_s}(x_s = \square) = \frac{1}{Z} \exp\left\{-\sum_{c \in C} V_c(x_s = \square)\right\} = . \quad . \quad . \quad . \quad .$$

• VRAISSEMBLANCE

$$p_{Y_s/X_s}(y_s/x_s = \square) = \mathcal{N}(200, 10) \quad \& \quad p_{Y_s/X_s}(y_s/x_s = \blacksquare) = \mathcal{N}(100, 10)$$

• $y_s = 160 \triangleright$

• $y_s = 155 \triangleright$

SEGMENTATION D'IMAGES

RS : Effet de la Température

$$P_{X_s/X_{v_s}, Y_s}(x_s/\eta_s, y_s) = \frac{1}{Z_s} \exp \left\{ -\frac{1}{T_k} (U(.)) \right\}$$

$$U_{\blacksquare} = 0.85$$

$$U_{\square} = 0.15$$

$$\boxed{\mathbf{T=1} \triangleright}$$

$$P(\blacksquare/y_s) = \frac{e^{-0.85}}{e^{-0.85} + e^{-0.15}} =$$

$$P(\square/y_s) = \frac{e^{-0.15}}{\mathcal{D}} =$$

$$\boxed{\mathbf{T=10} \triangleright}$$

$$P(\blacksquare/y_s) = \frac{e^{-0.85/10}}{e^{-0.85/10} + e^{-0.15/10}} =$$

$$P(\square/y_s) = \frac{e^{-0.15/10}}{\mathcal{D}} =$$

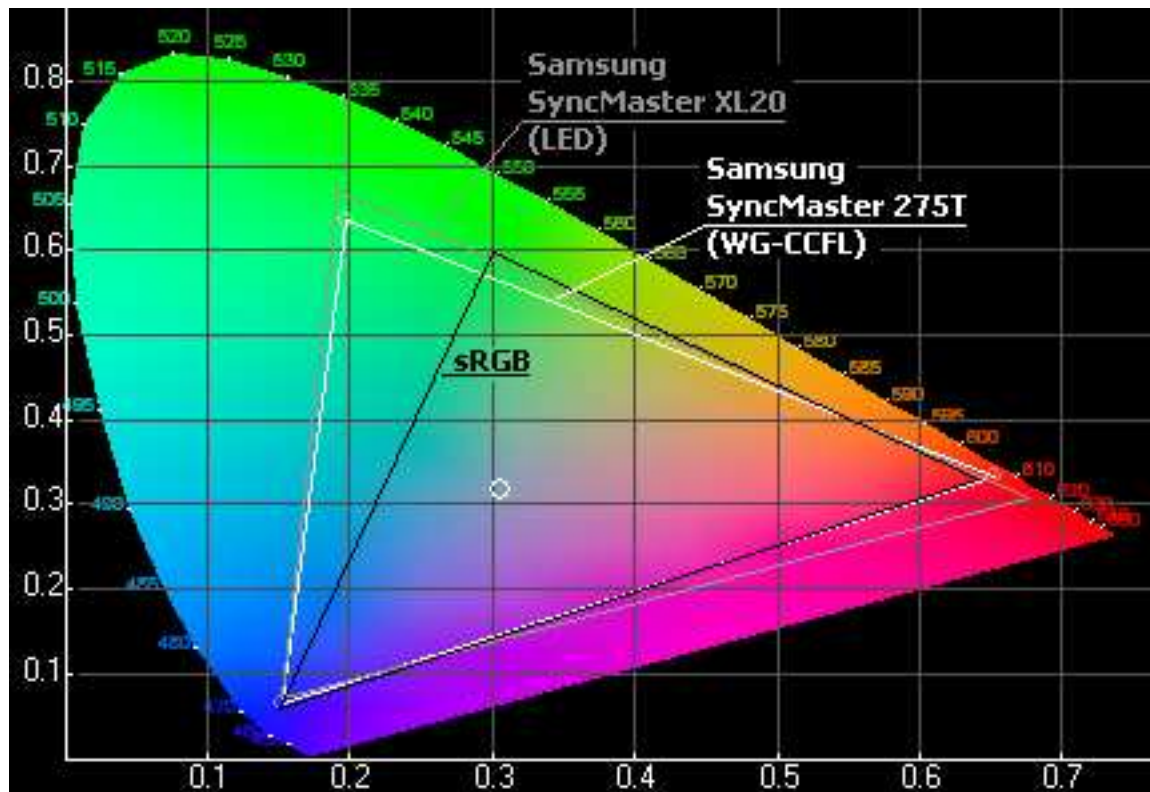
$$\boxed{\mathbf{T=0.1} \triangleright}$$

$$P(\blacksquare/y_s) = \frac{e^{-0.85/0.1}}{e^{-0.85/0.1} + e^{-0.15/0.1}} =$$

$$P(\square/y_s) = \frac{e^{-0.15/0.1}}{\mathcal{D}} =$$

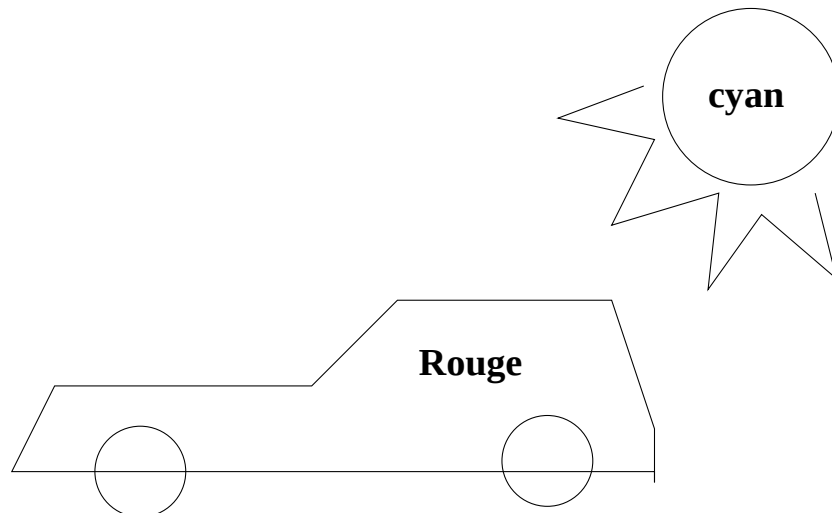
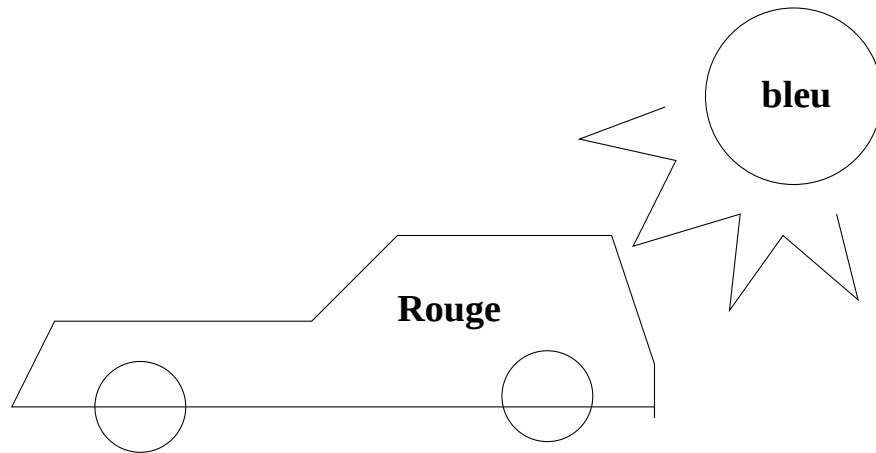
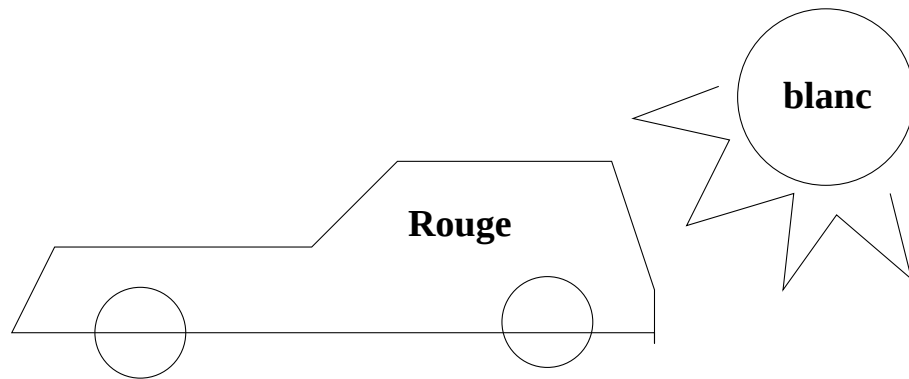
COULEURS

GAMUT



COULEURS

CUBE RGB



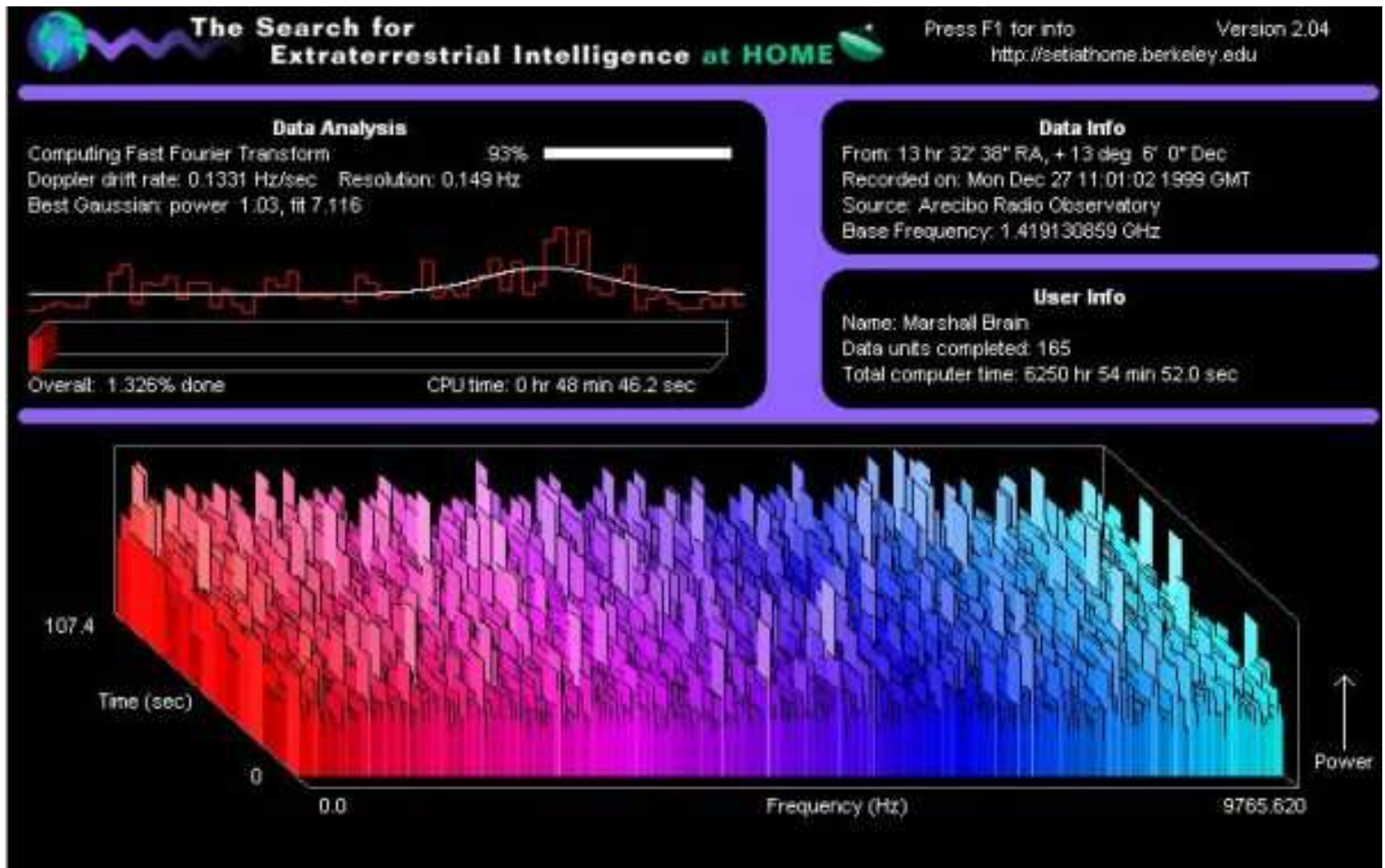
COMPRESSION

DCT

$$\text{TCD} \left(\begin{array}{|c|} \hline \text{😊} \\ \hline \end{array} \right) = \text{TFD} \left\{ \begin{array}{|c|c|} \hline \text{😊} & \text{😊} \\ \hline \text{😞} & \text{😞} \\ \hline \end{array} \right\}$$

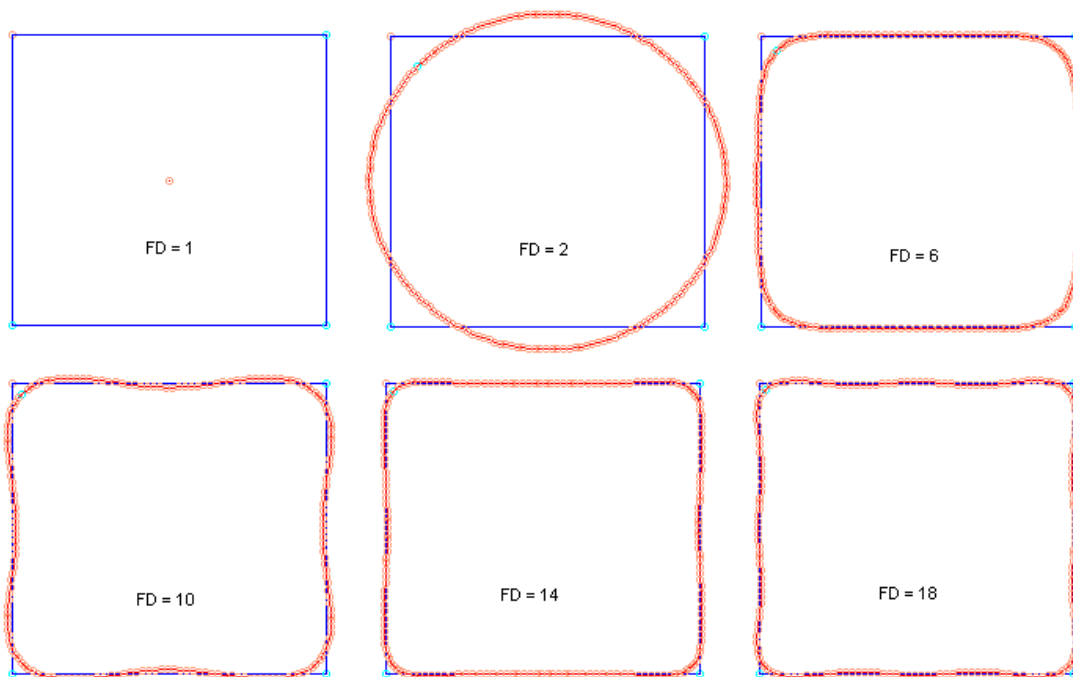
RECONNAISSANCE DES FORMES

PROJET SETI

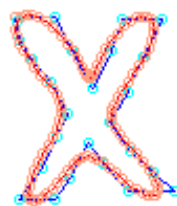


RECONNAISSANCE DES FORMES

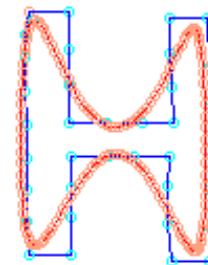
DESCRIPTEUR DE FOURIER



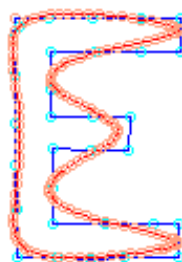
Number of FD: 6



Number of FD: 10



Number of FD: 8



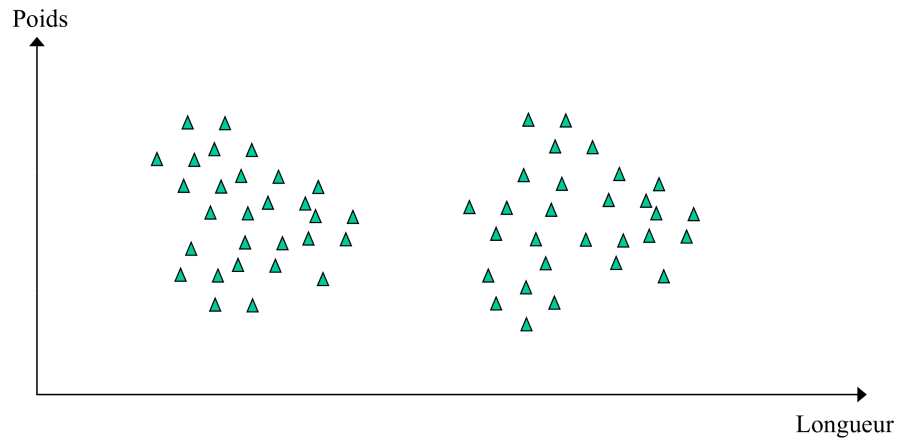
Number of FD: 8

RECONNAISSANCE DES FORMES

ALGORITHME DES K-MOYENNES (1)

Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes

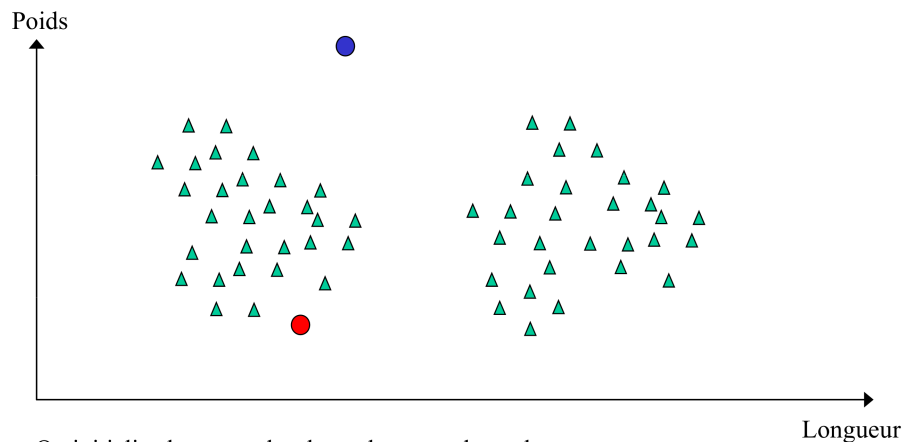


Voici 60 observations. Comment faire pour grouper ces données en deux classes et estimer la moyenne (ou le centre de masse) de ces classes ?

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Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes



On initialise le centre des deux classes au hasard ● ●

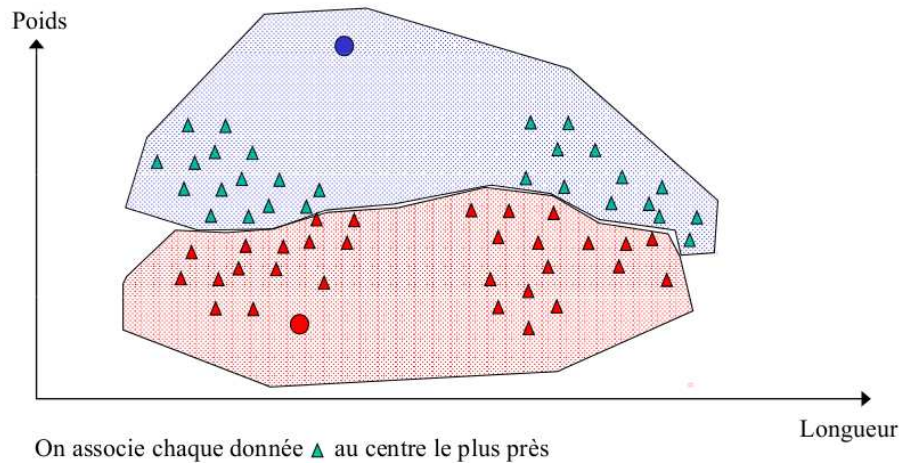
37

RECONNAISSANCE DES FORMES

ALGORITHME DES K-MOYENNES (2)

Algorithme des K-moyennes (*K-means*)

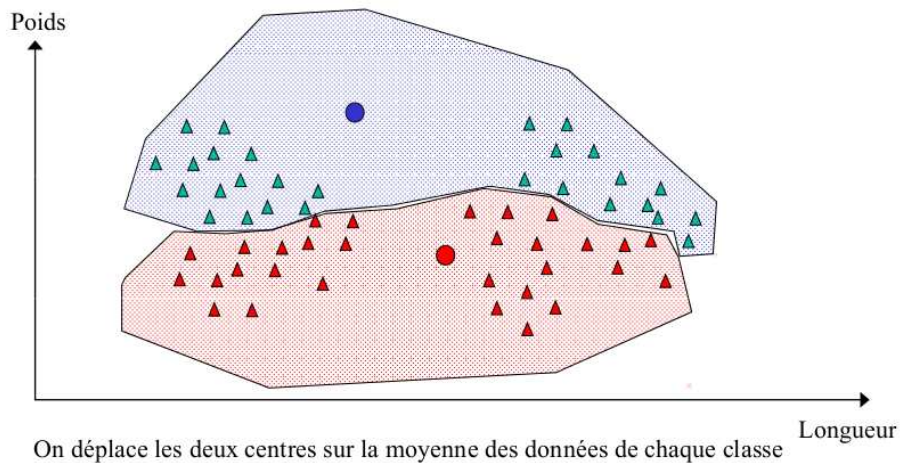
Exemple schématique de l'algorithme des K-moyennes



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Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes



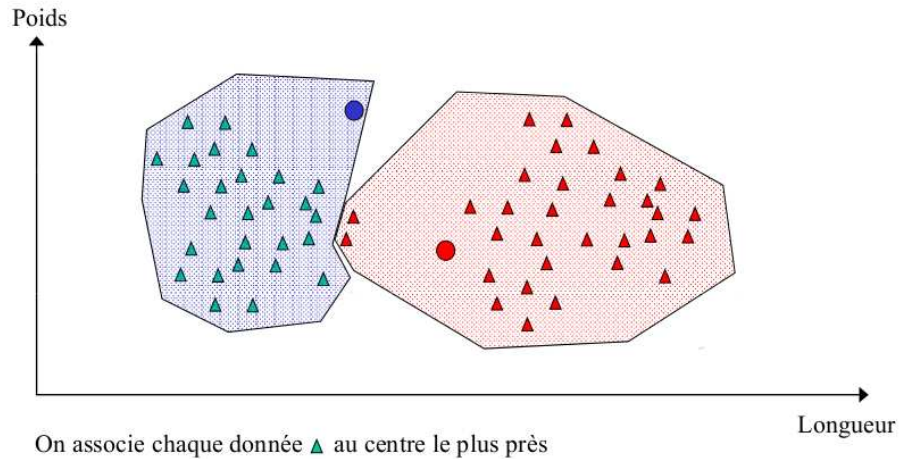
39

RECONNAISSANCE DES FORMES

ALGORITHME DES K-MOYENNES (3)

Algorithme des K-moyennes (*K-means*)

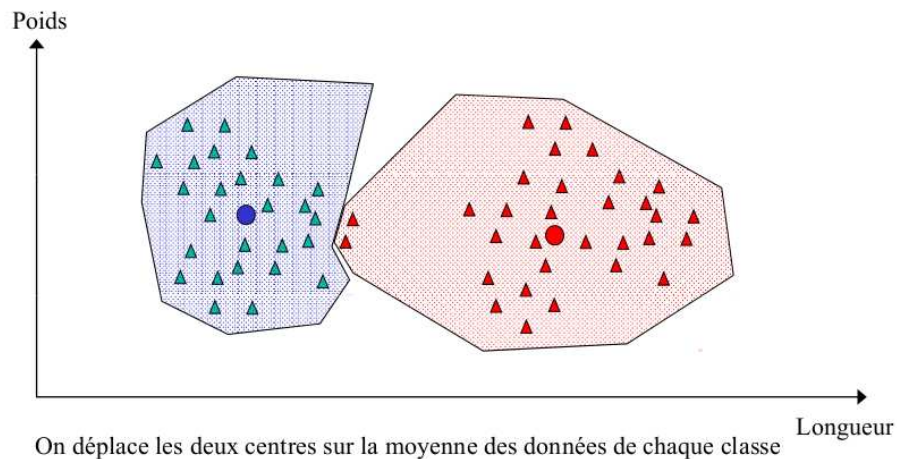
Exemple schématique de l'algorithme des K-moyennes



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Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes



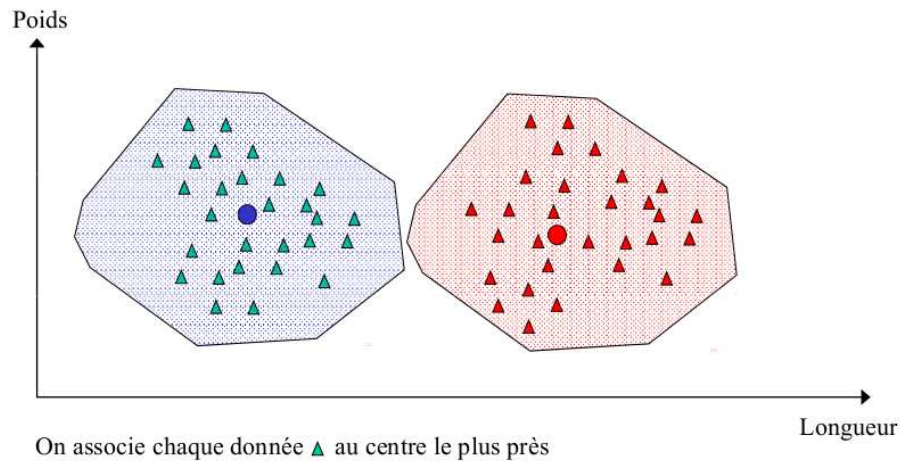
41

RECONNAISSANCE DES FORMES

ALGORITHME DES K-MOYENNES (4)

Algorithme des K-moyennes (*K-means*)

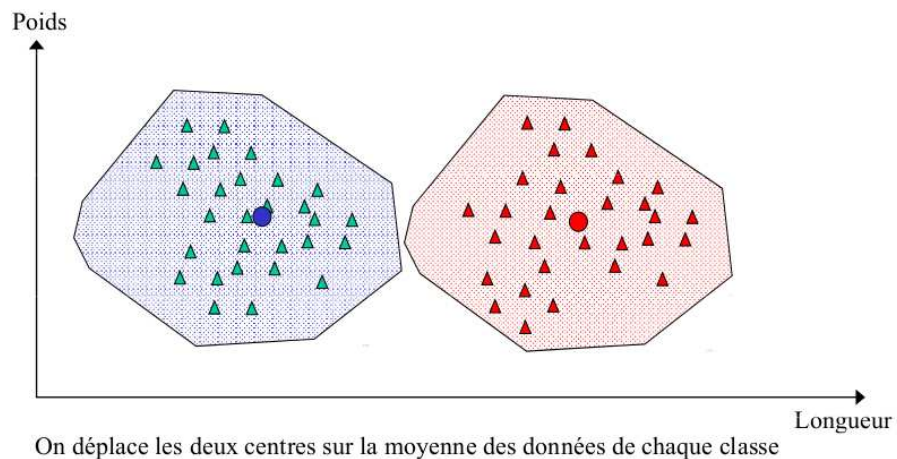
Exemple schématique de l'algorithme des K-moyennes



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Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes



Lorsque l'algorithme converge, ● et ● correspondent à **la moyenne de chaque classe**

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