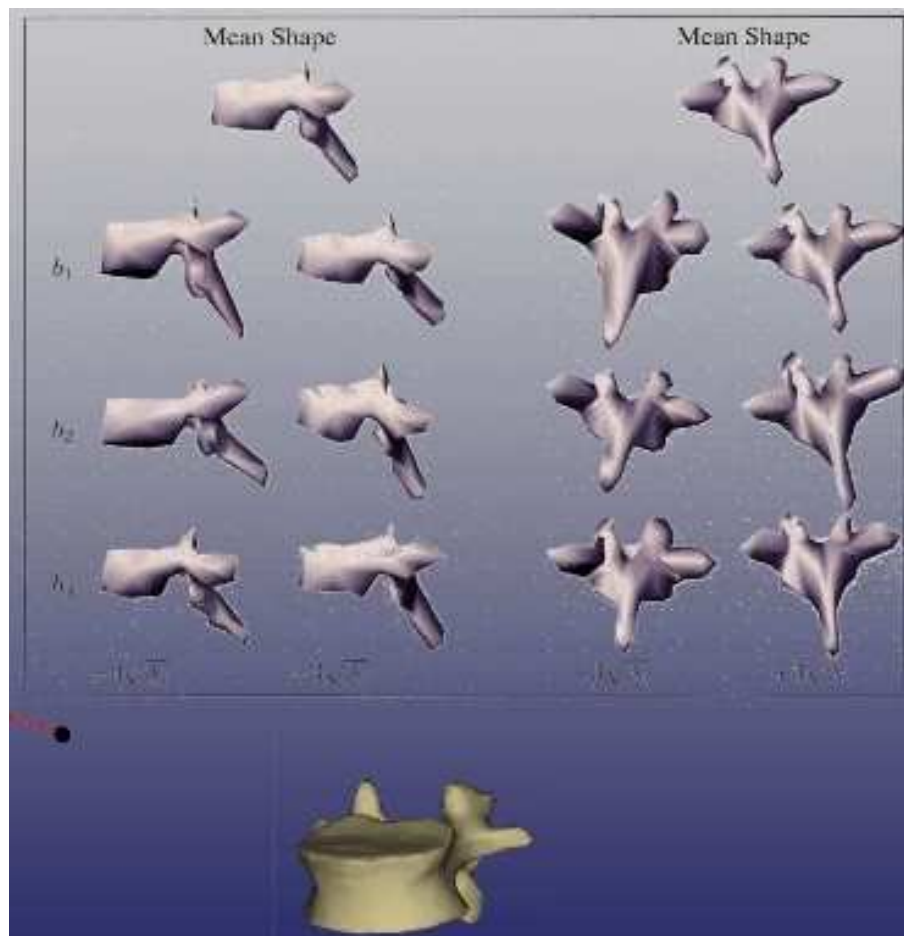
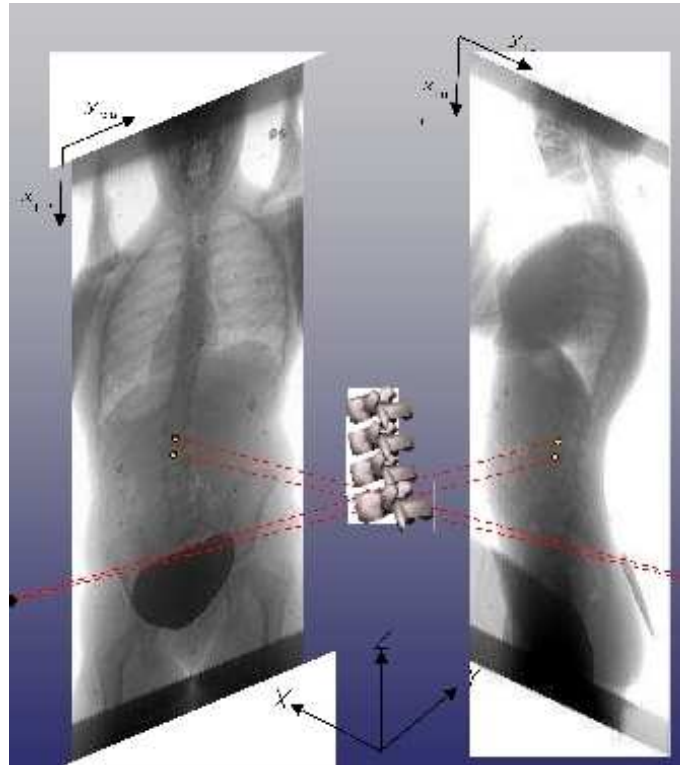


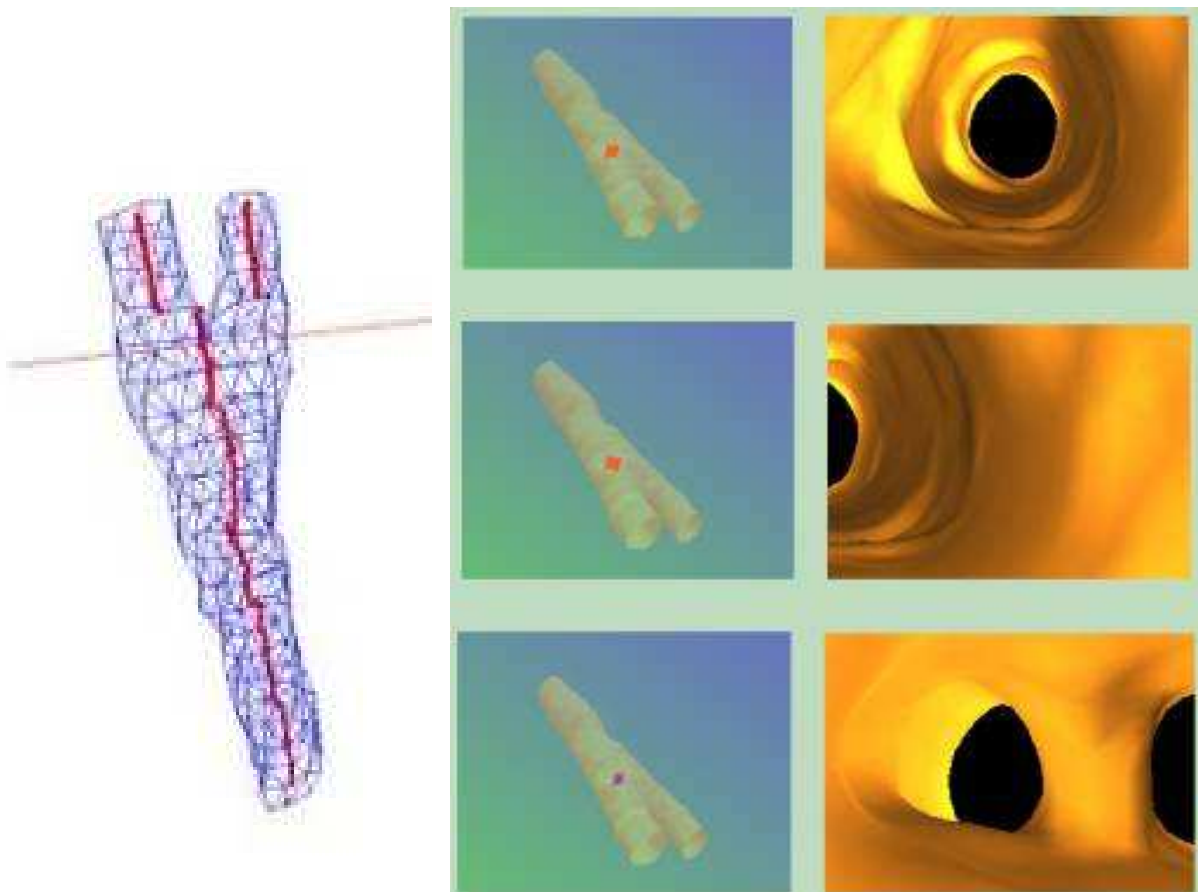
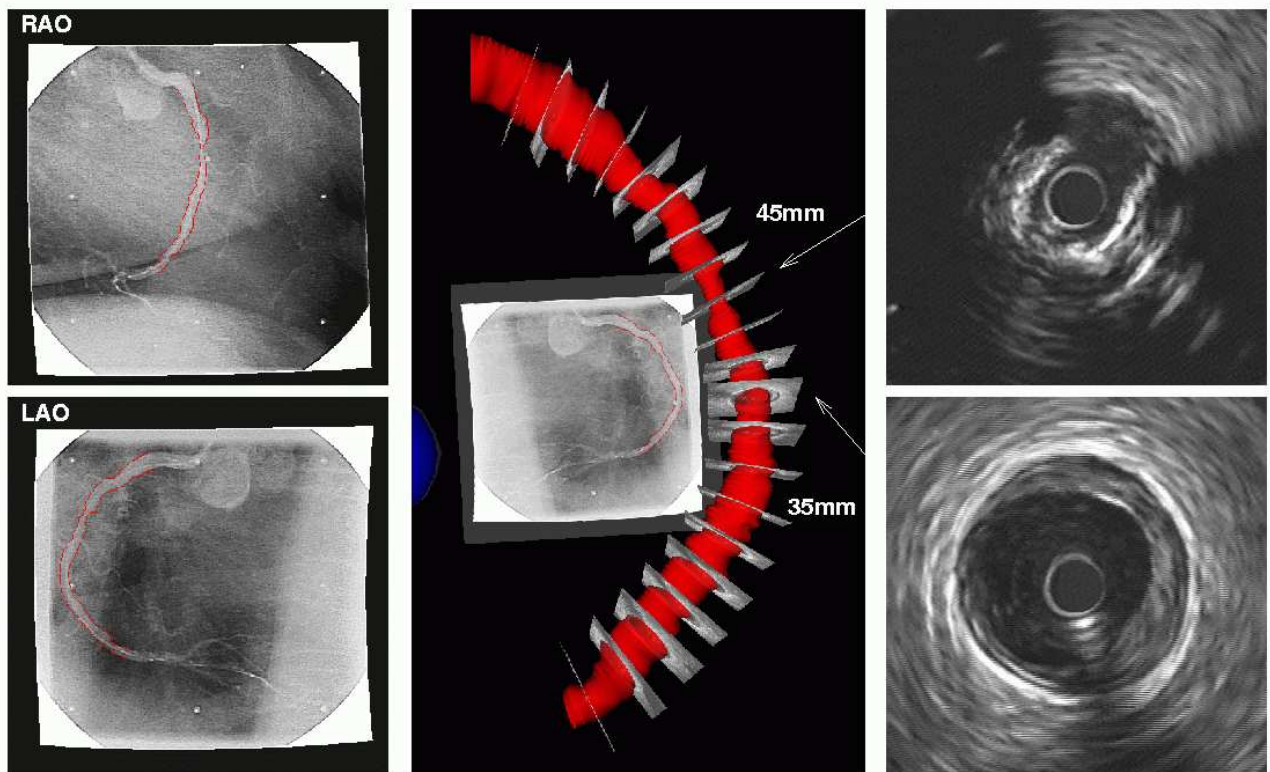
INTRODUCTION

Reconstruction 3D de la Colonne Vertébrale



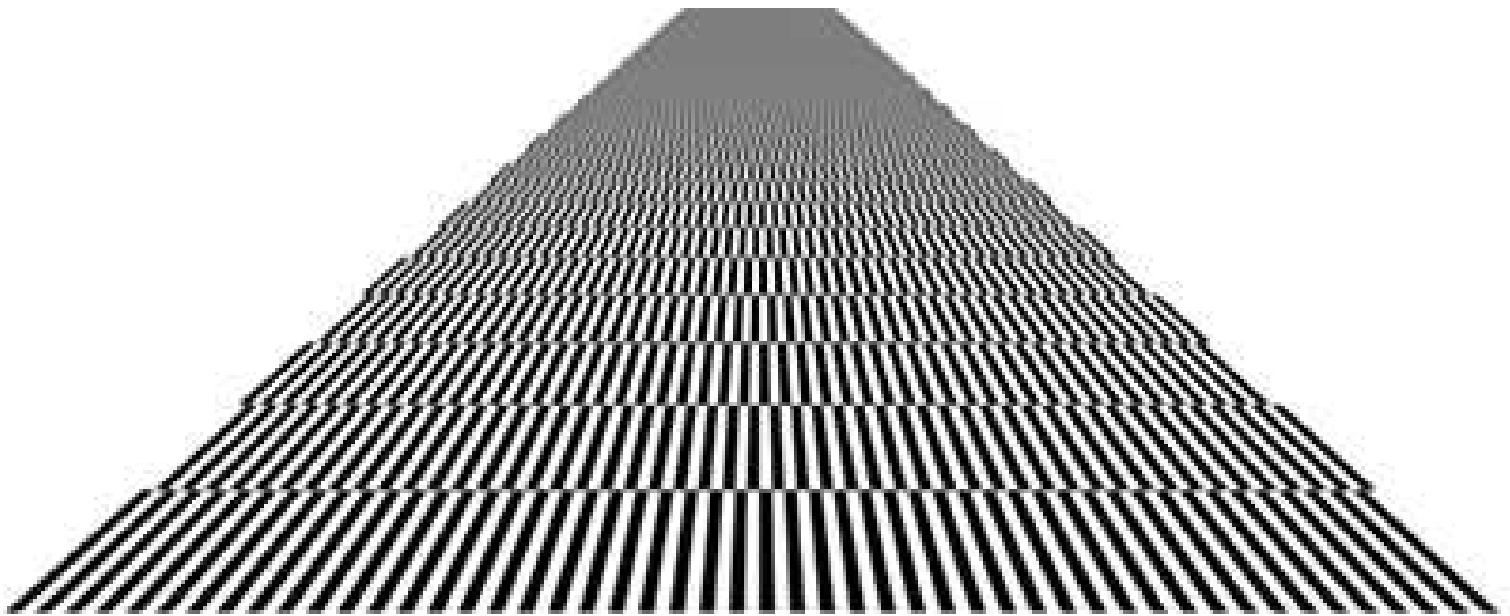
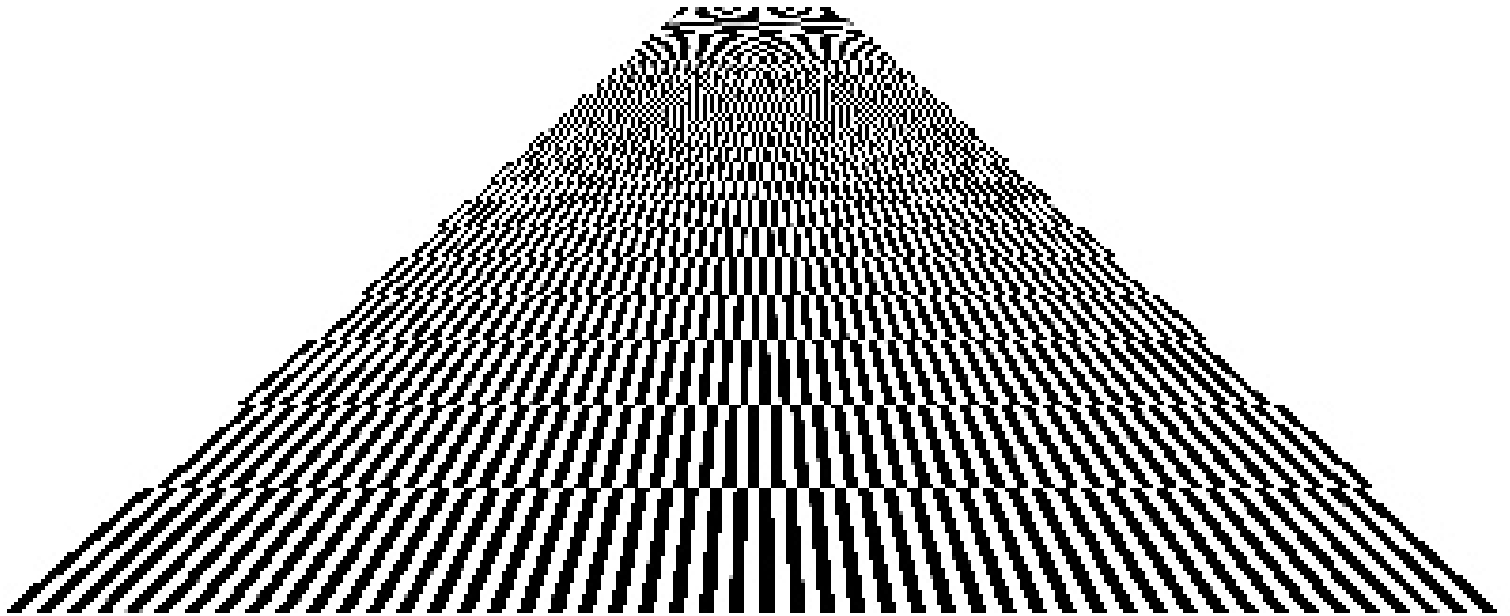
INTRODUCTION

Reconstruction Angiographique



TRANSFORMÉ DE FOURIER

Aliasing & Antialiasing



TFD

Périodisation Implicite de l'Image

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

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 illustrates the TFD (Time-Frequency Decomposition) process. On the left, a column vector is shown with two components: 'R   ' (Real) and 'Imaginaire' (Imaginary). The 'R   ' component is represented by a portrait of a man, and the 'Imaginaire' component is represented by a box containing the text 'Z   RS INSIDE'. This column vector is equal to another column vector on the right. The right-hand column vector also has two components: $R(u, \nu)$ and $I(u, \nu)$. Both of these components are represented by a gray square with black corners, indicating a specific frequency-time representation.

et

TFD⁻¹

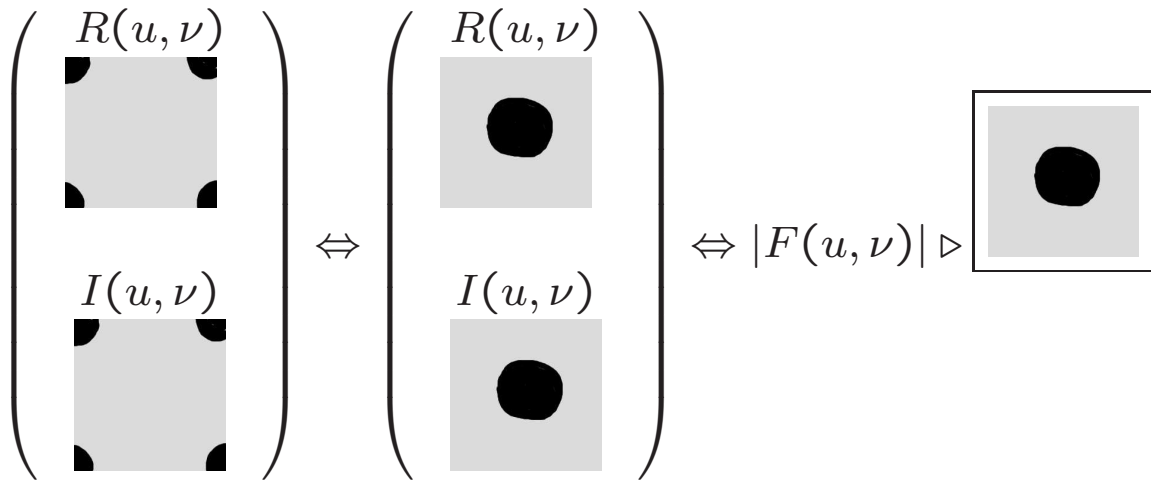
$$\begin{pmatrix} R(u, \nu) \text{ avec centre informatique} \\ I(u, \nu) \text{ avec centre informatique} \end{pmatrix} = \begin{pmatrix} \text{Image trait   } \\ \text{Abstraction} \end{pmatrix}$$

The diagram illustrates the inverse TFD (TFD⁻¹) process. On the left, a column vector is shown with two components: ' $R(u, \nu)$ avec centre informatique' and ' $I(u, \nu)$ avec centre informatique'. Both components are represented by a gray square with black corners. This column vector is equal to another column vector on the right. The right-hand column vector also has two components: 'Image trait   ' (Processed Image) and 'Abstraction'. The 'Image trait   ' component is represented by a portrait of a man, and the 'Abstraction' component is represented by an empty box.

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 $(1 + \log)$

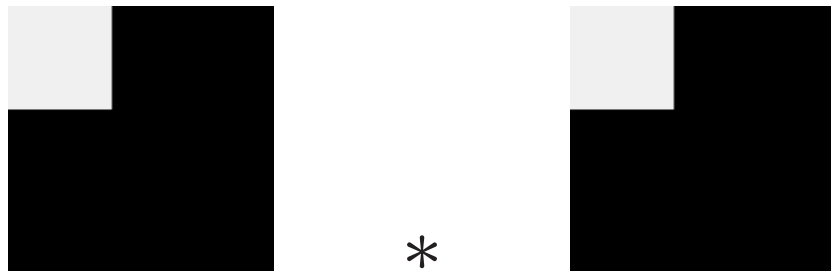
► seulement pour la visualisation d'un module de spectre !

Nota -2-

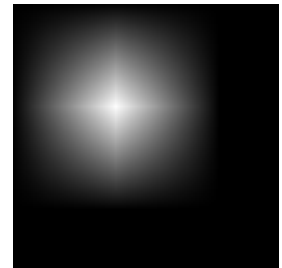
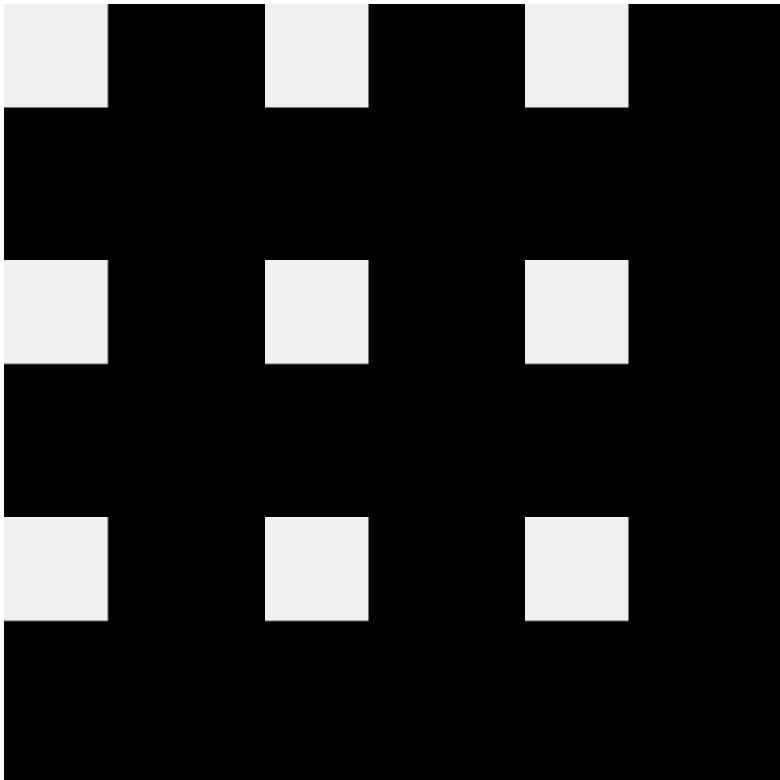
discontinuités horizontales $\xRightarrow{\mathcal{F}}$ discontinuités verticales

TP1

Recouvrement Spatial

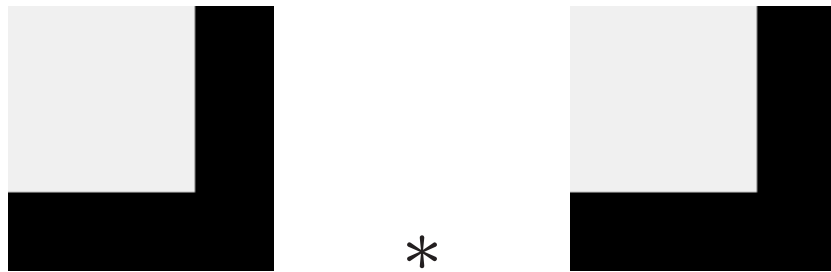


En utilisant la TFD

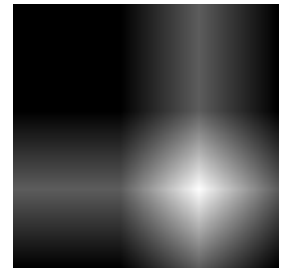
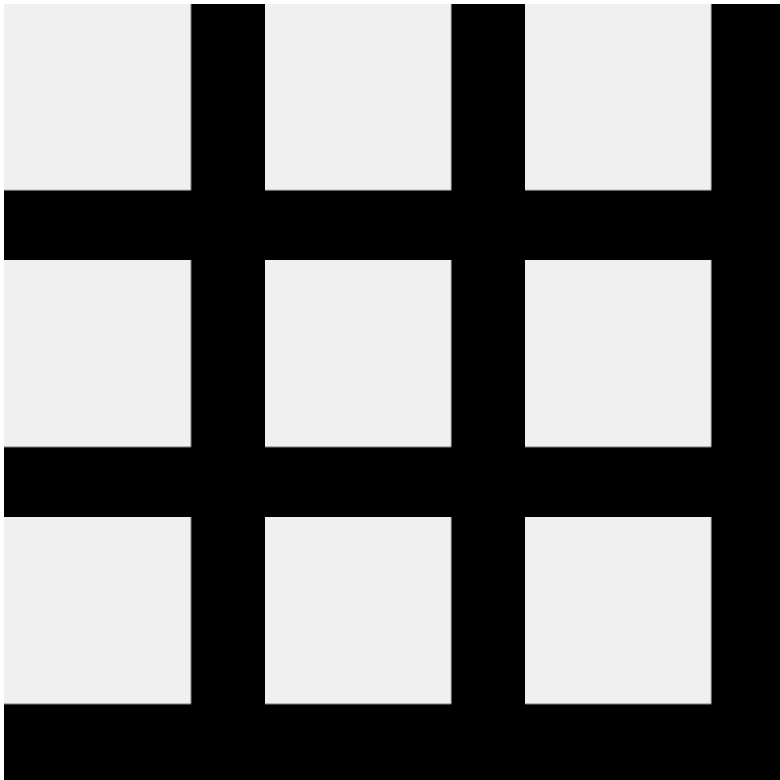


TP1

Recouvrement Spatial

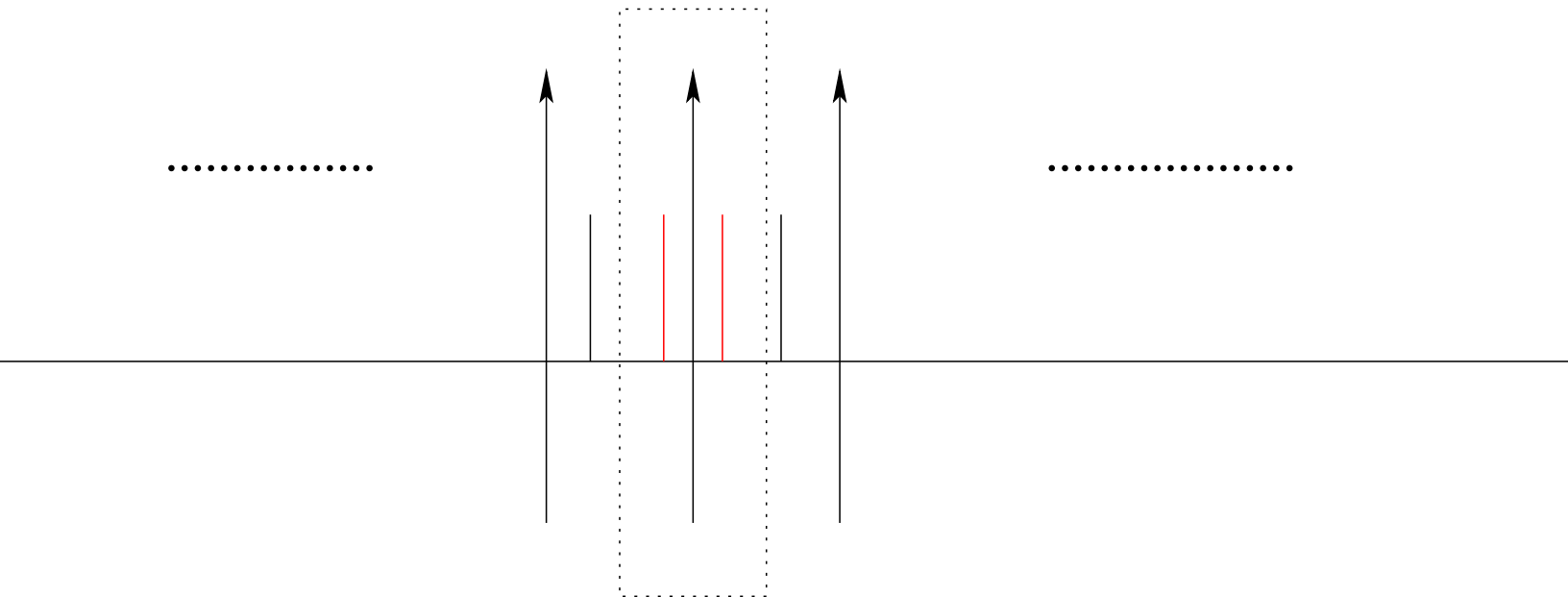
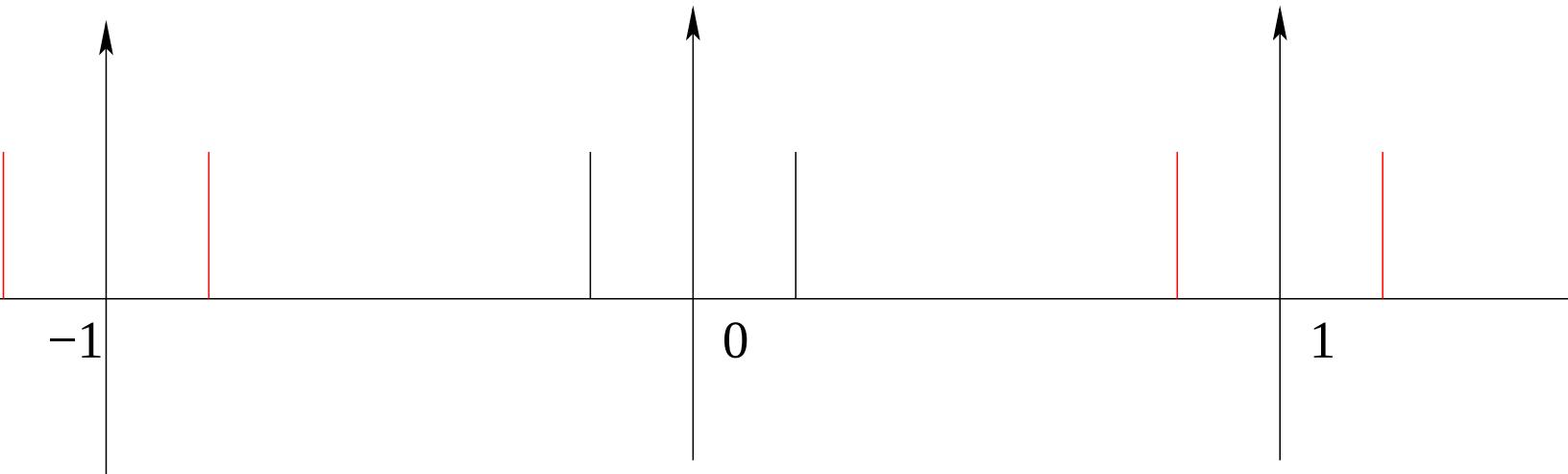


En utilisant la TFD



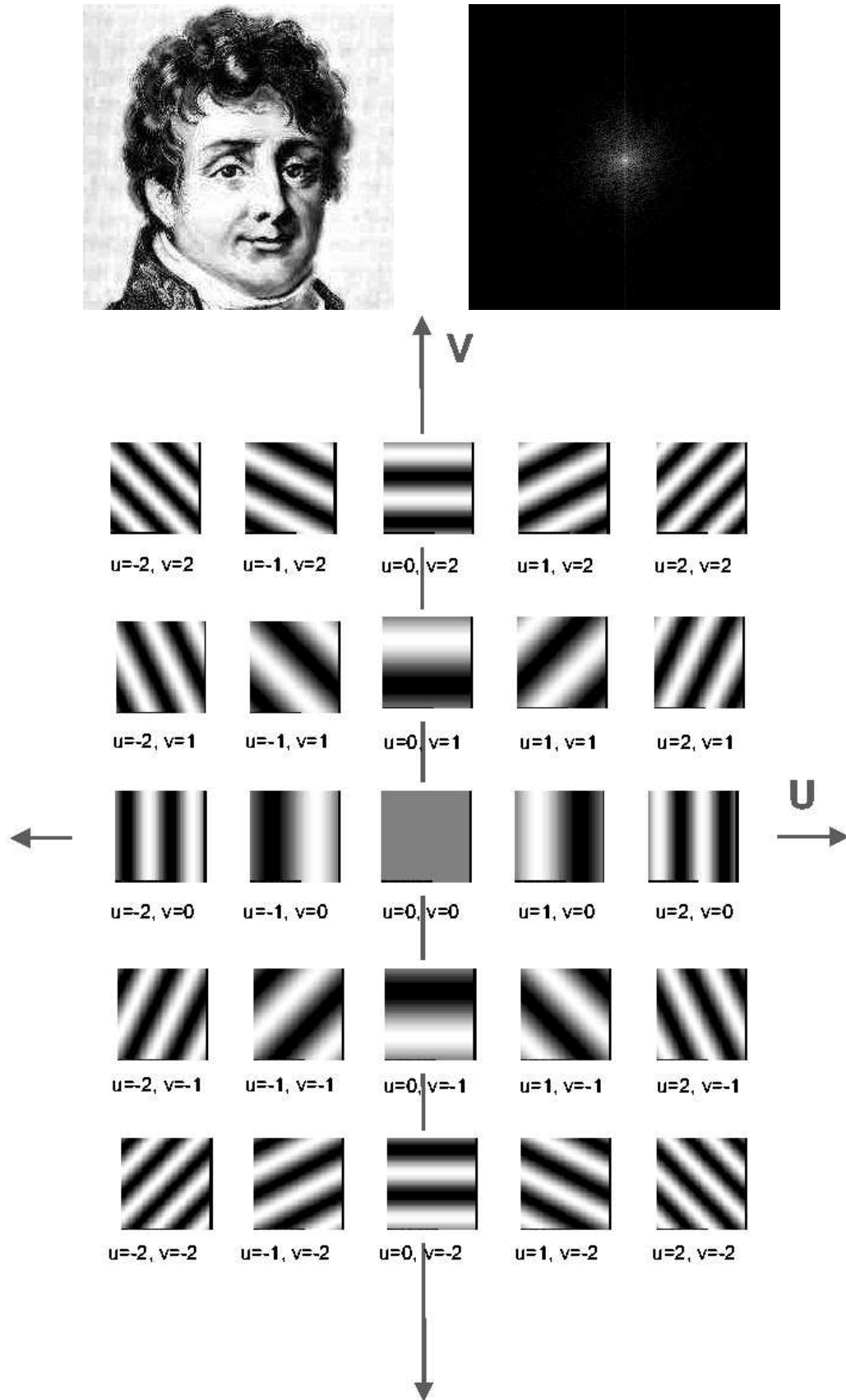
TP1

Sous-Échantillonnage



TF DISCRÈTE

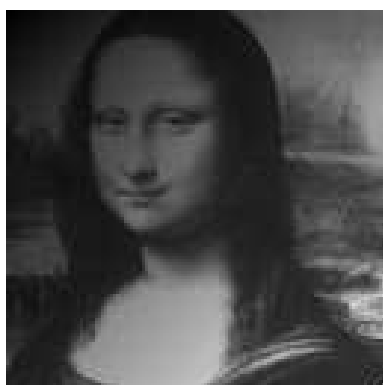
TF discrète 2D (Interprétation)



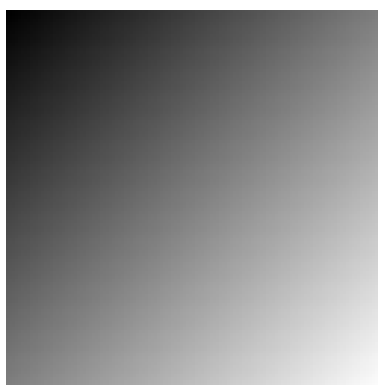
FILTRAGE FRÉQUENTIEL

Filtrage Homomorphique

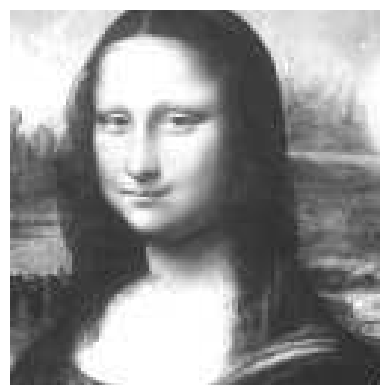
$$f(x, y) = i(x, y) \cdot r(x, y)$$



=



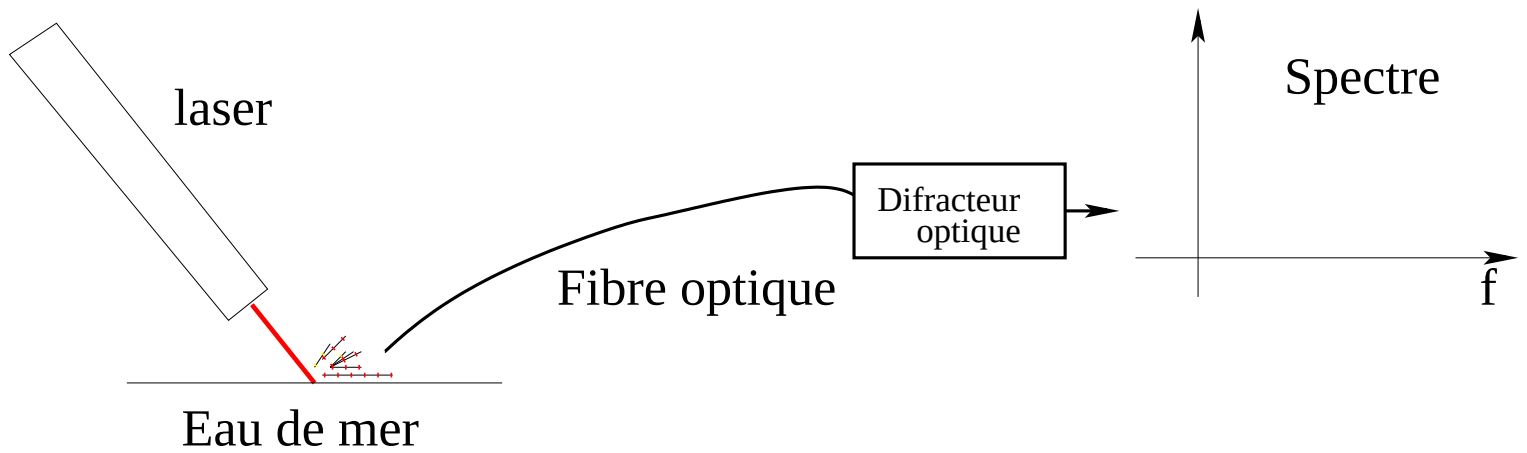
×



RESTAURATION

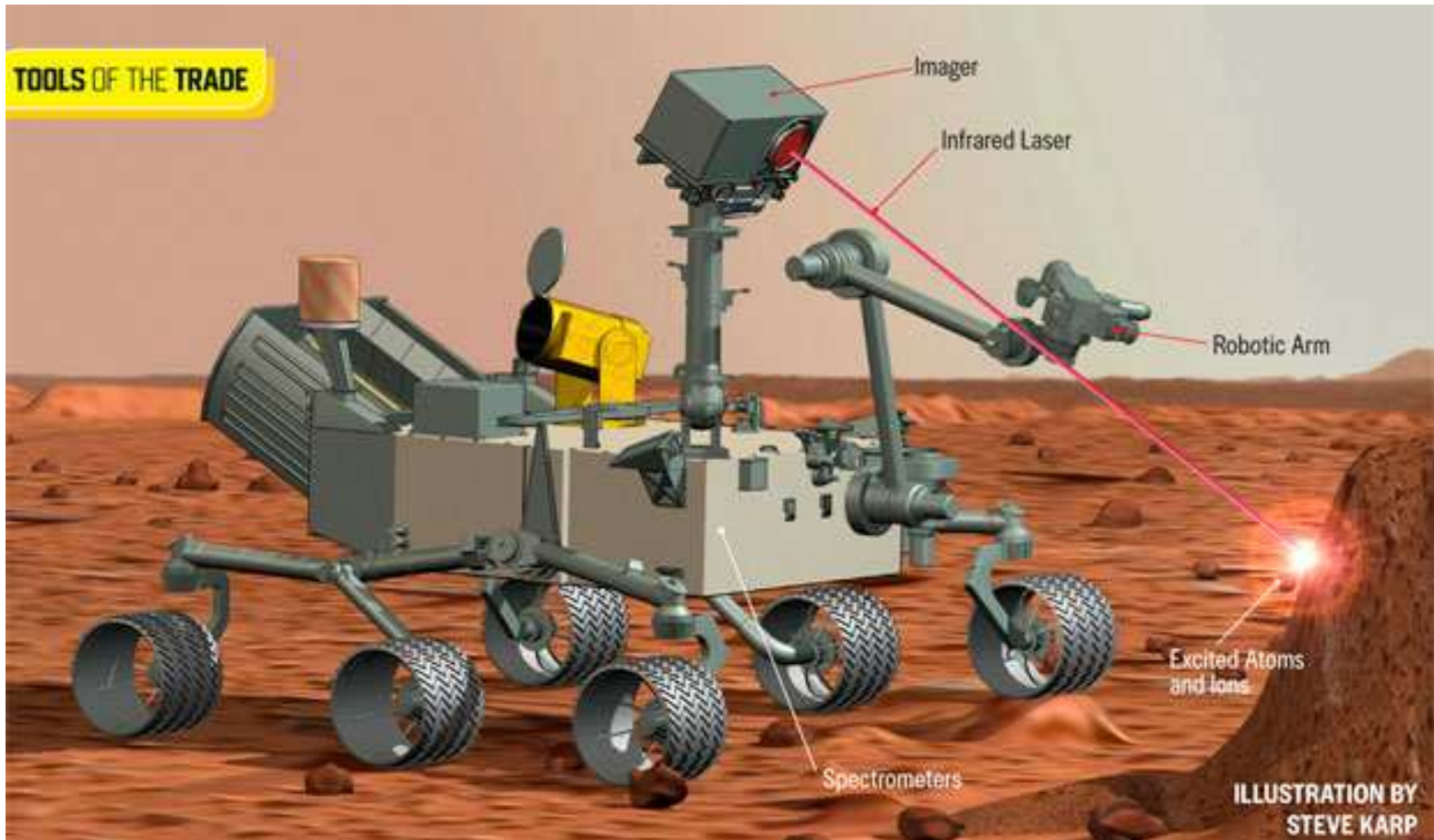
Déconvolution de Fonction d'Appareil

LOE (Ifremer)



RESTAURATION

Mars Curiosity



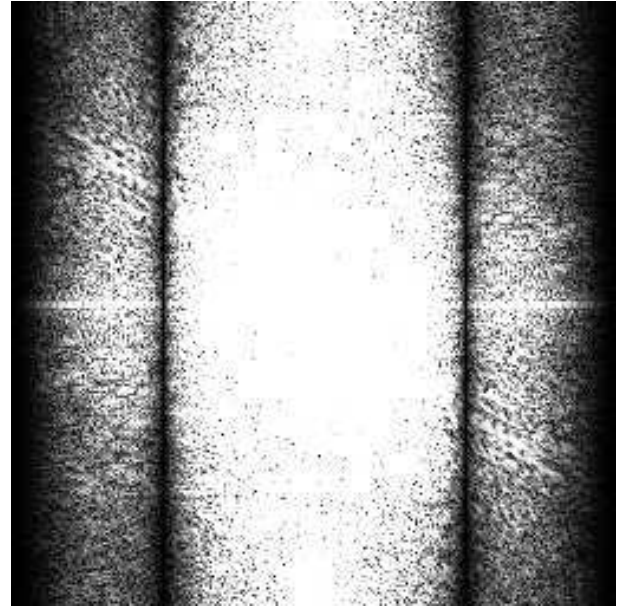
RESTAURATION

Estimation de la PSF



RESTAURATION

Estimation de la PSF



RESTAURATION

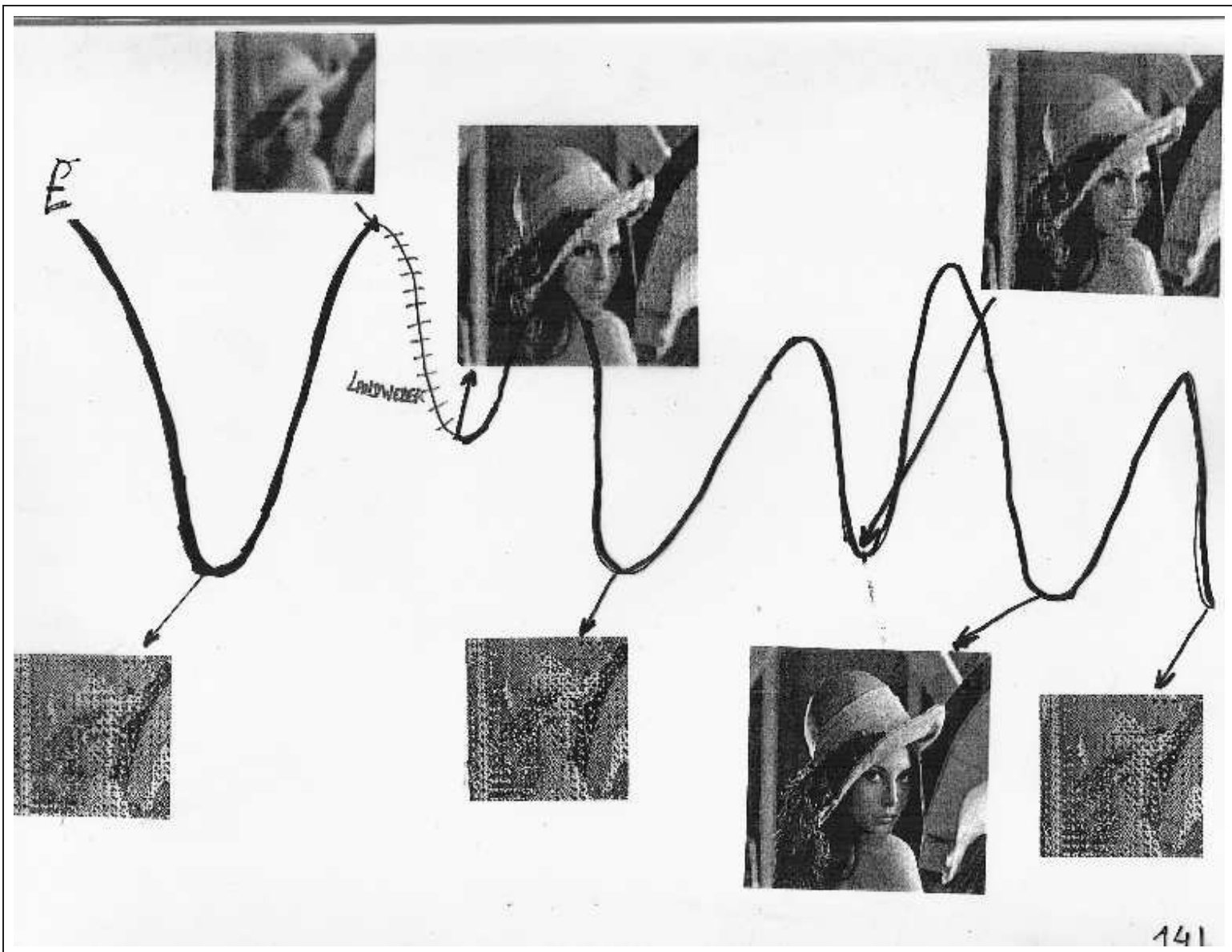
Méthodes Itératives

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)

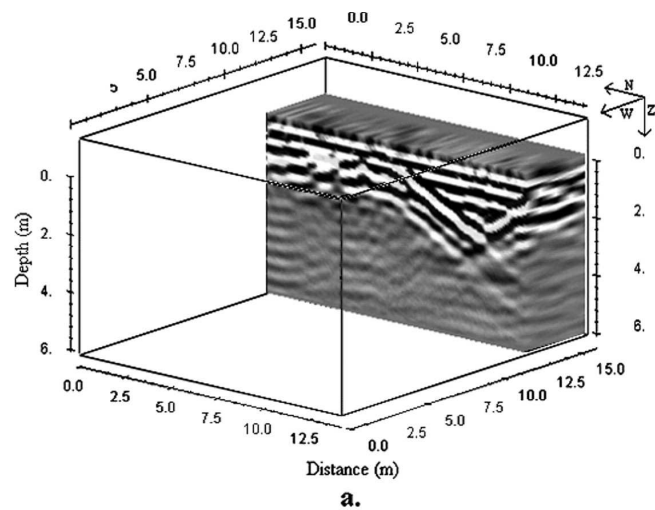
Reconstruction faciale de l'intérieur d'une momie



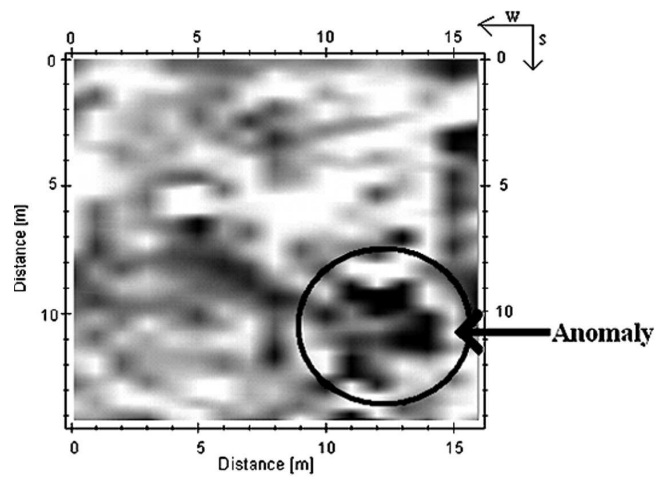
TOMOGRAPHIE

Applications (2)

Detection de chambre mortuaires



a.



b.

TOMOGRAPHIE

Applications (3)

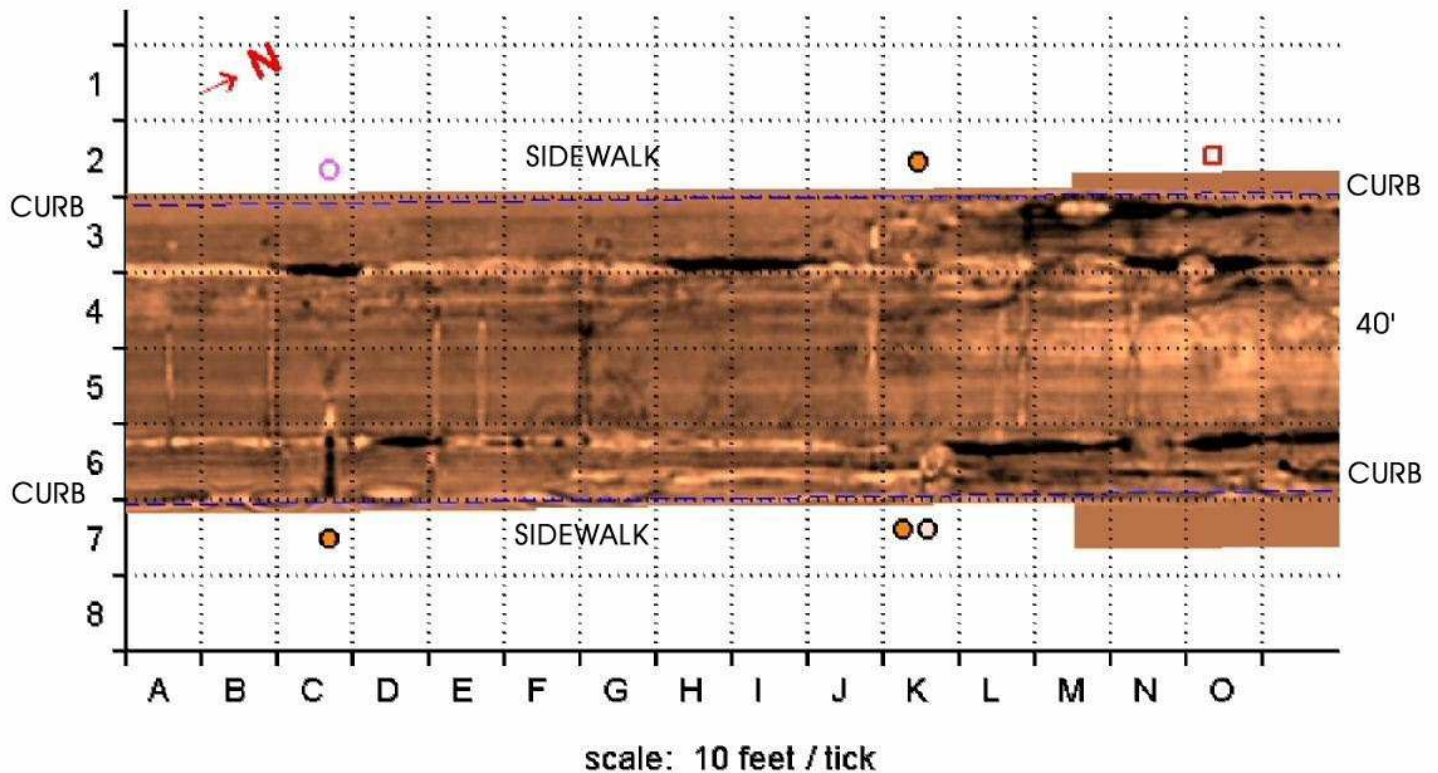
Tomographie Radar des sols

WITTEN TECHNOLOGIES, INC

RADAR TOMOGRAPHY IMAGE OF UTILITIES AT 23" OF DEPTH

160' X 40'

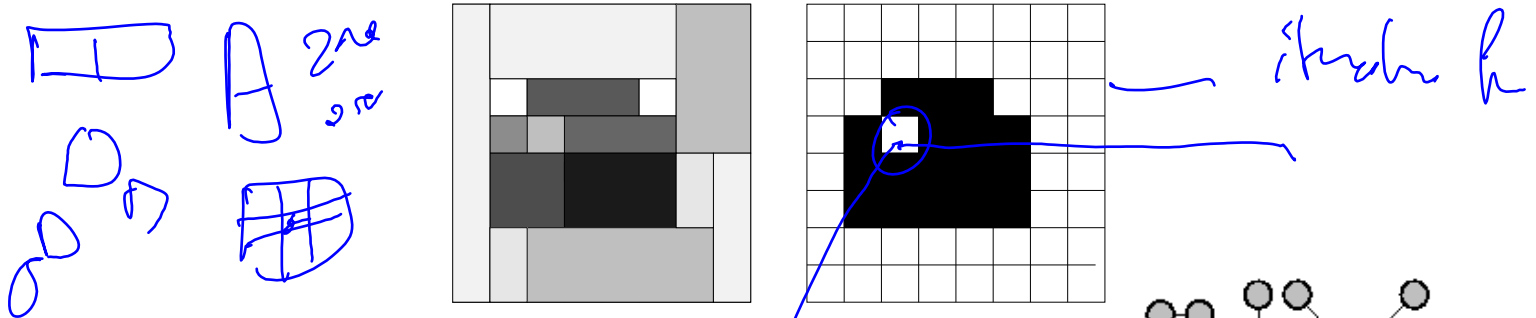
Jax - Courthouse Slice 23 Depth = 23 inches



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

$$P_{X_s}(x_s = \blacksquare) = \frac{1}{Z} \exp\left\{-\sum_{c \in C} V_c(x_s = \blacksquare)\right\} = \frac{1}{2} e^{-1}$$

NRJ $\blacksquare \in 1$

$$P_{X_s}(x_s = \square) = \frac{1}{Z} \exp\left\{-\sum_{c \in C} V_c(x_s = \square)\right\} = \frac{1}{2} e^{-7}$$

NRJ $\square \in 7$

• VRAISSEMBLANCE

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

• $y_s = 160 \triangleright$



NRJ $\blacksquare = 18$ — 13

NRJ $\square = 8$ — 15

• $y_s = 155 \triangleright$



NRJ $\blacksquare \geq 15 \cdot 125 + 1 \rightarrow 19$
NRJ $\square \geq 10 \cdot 125 + 7 \rightarrow 20$

SEGMENTATION D'IMAGES

RS : Effet de la Température

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

2 class

$$U_{\blacksquare} = 0.85$$

$$U_{\square} = 0.15$$

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

$$P(\blacksquare/y_s) = \frac{e^{-0.85}}{e^{-0.85} + e^{-0.15}} = 0.328$$

$$P(\square/y_s) = \frac{e^{-0.15}}{\mathcal{D}} = 0.6718$$

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

$$P(\blacksquare/y_s) = \frac{e^{-0.85/10}}{e^{-0.85/10} + e^{-0.15/10}} = 0.483$$

$$P(\square/y_s) = \frac{e^{-0.15/10}}{\mathcal{D}} = 0.517$$

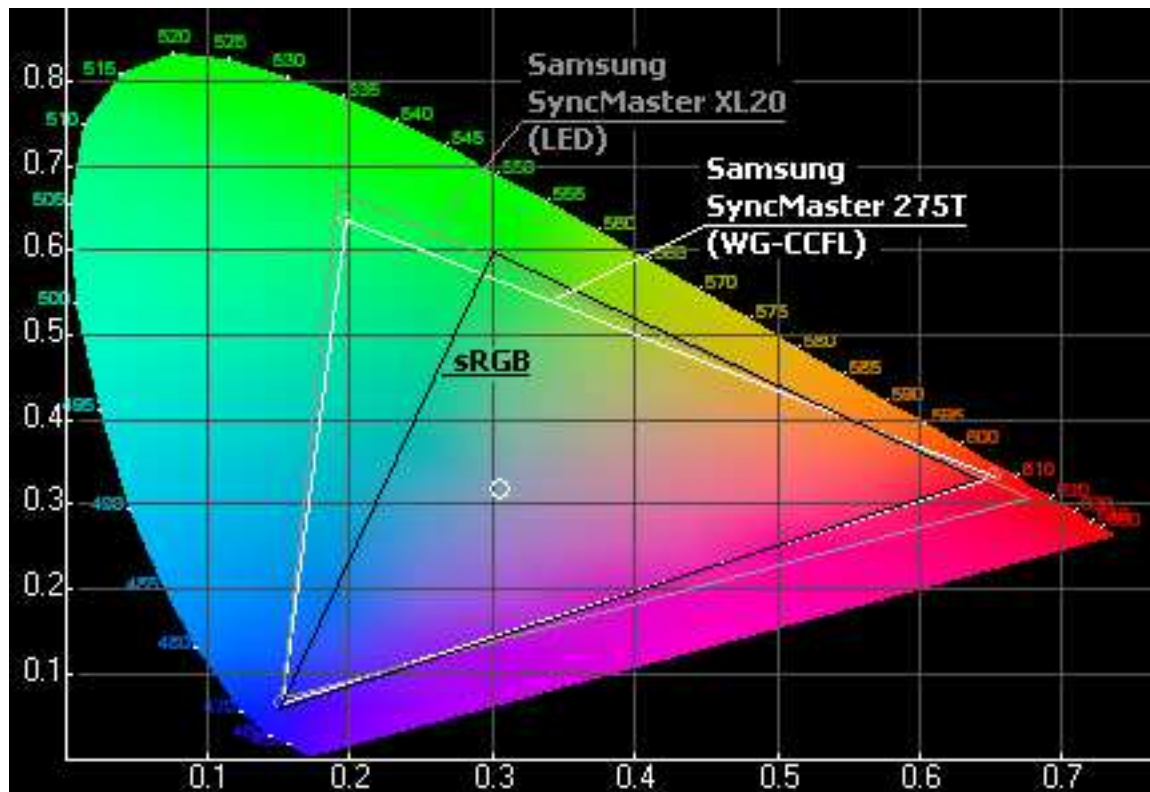
$$\boxed{T=0.1 \triangleright}$$

$$P(\blacksquare/y_s) = \frac{e^{-0.85/0.1}}{e^{-0.85/0.1} + e^{-0.15/0.1}} = 0.01$$

$$P(\square/y_s) = \frac{e^{-0.15/0.1}}{\mathcal{D}} = 0.999$$

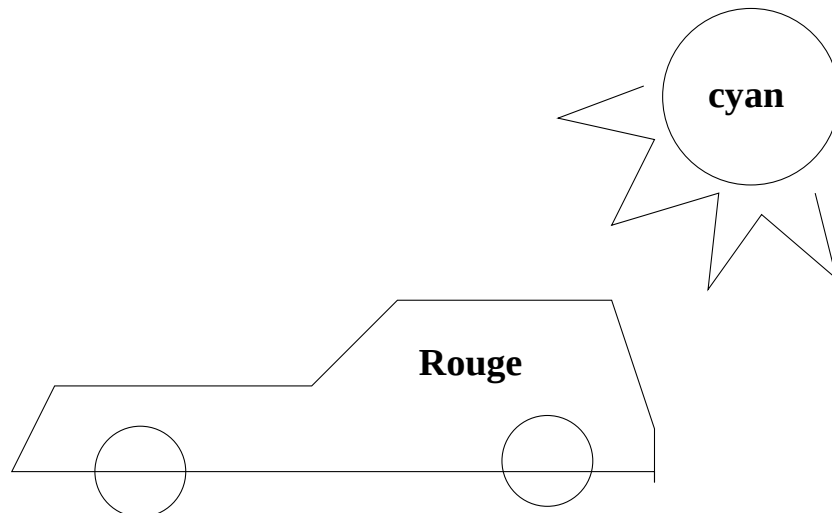
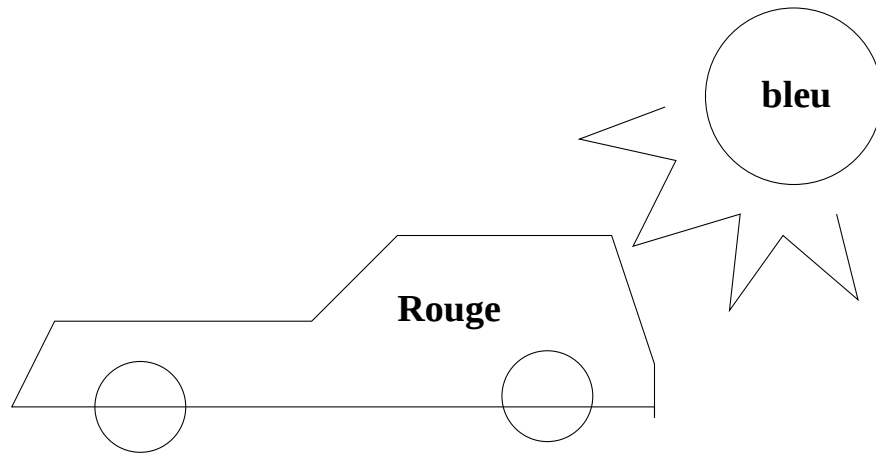
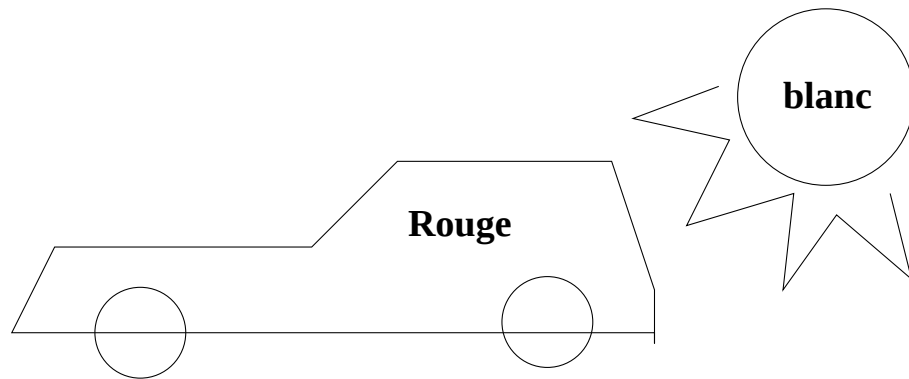
COULEURS

GAMUT



COULEURS

CUBE RGB



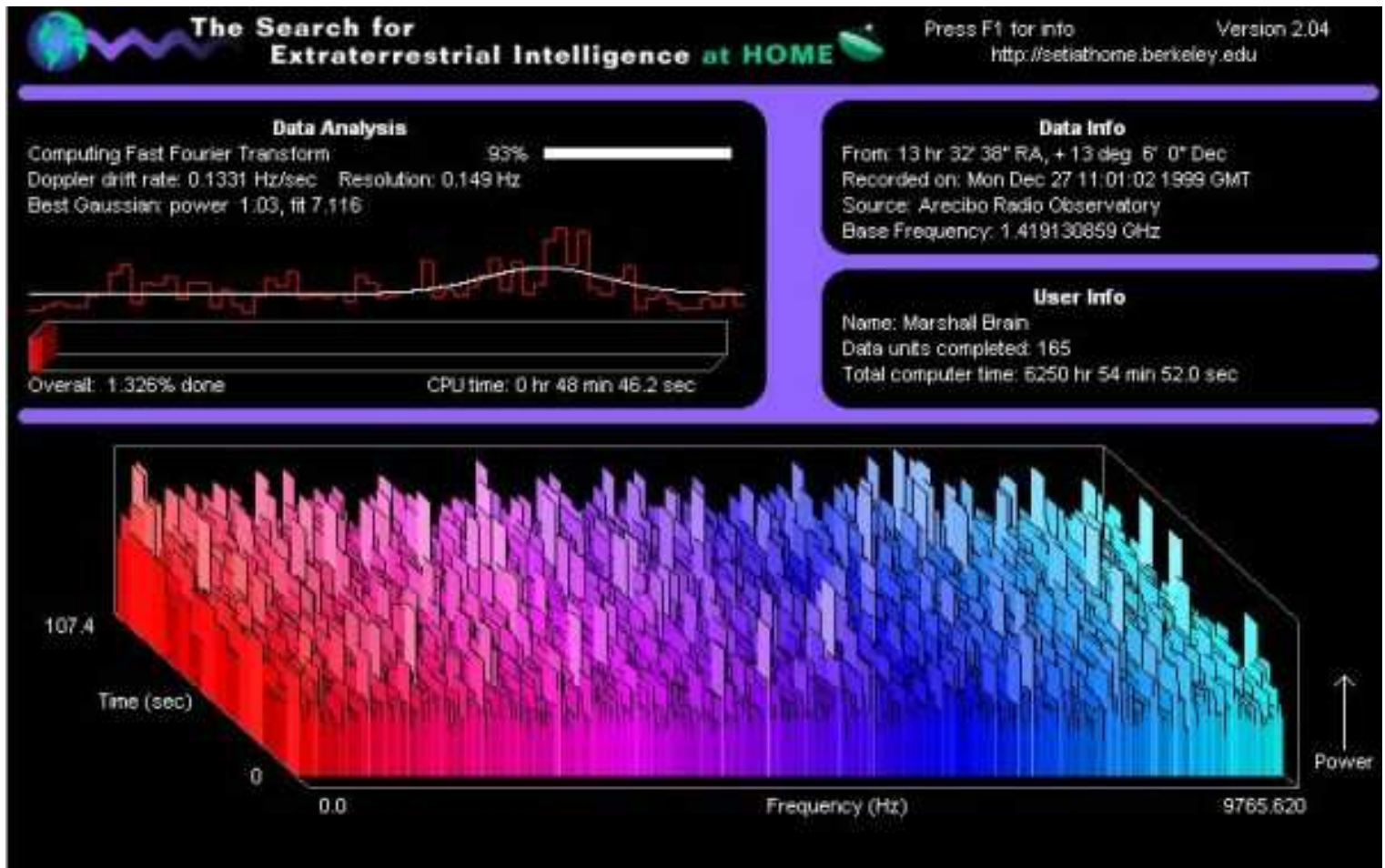
COMPRESSION

DCT

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

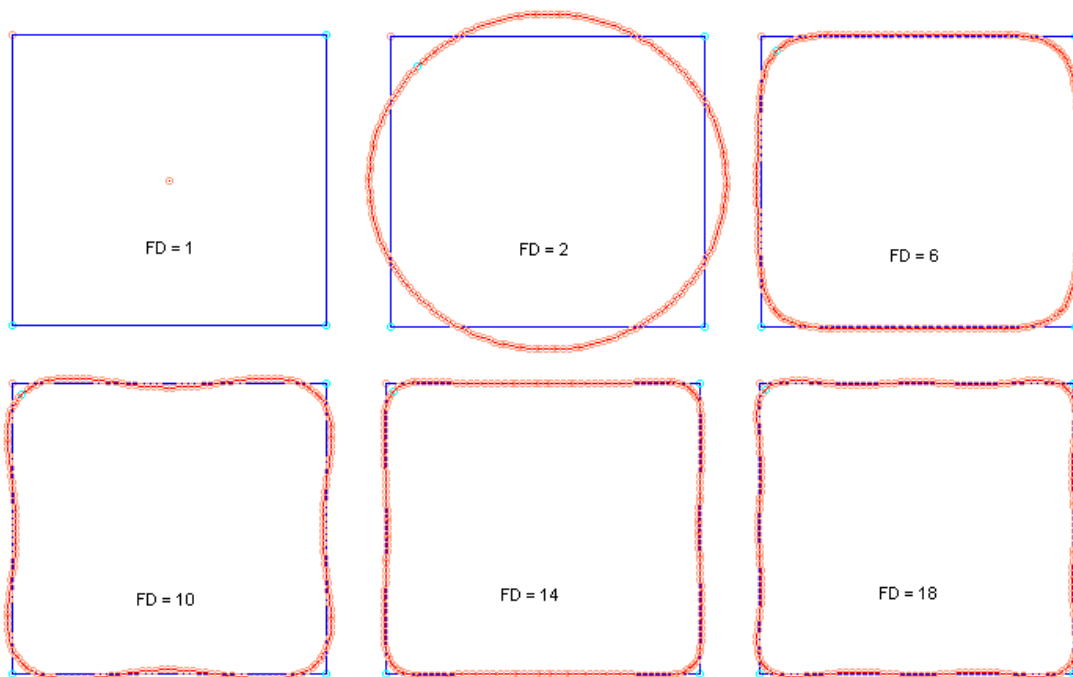
RECONNAISSANCE DES FORMES

PROJET SETI

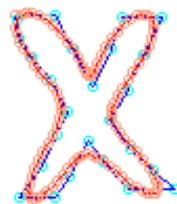


RECONNAISSANCE DES FORMES

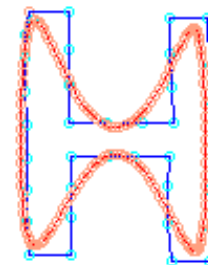
DESCRIPTEUR DE FOURIER



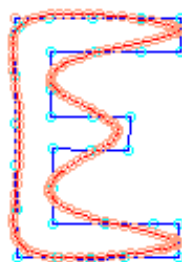
Number of FD: 6



Number of FD: 10



Number of FD: 8



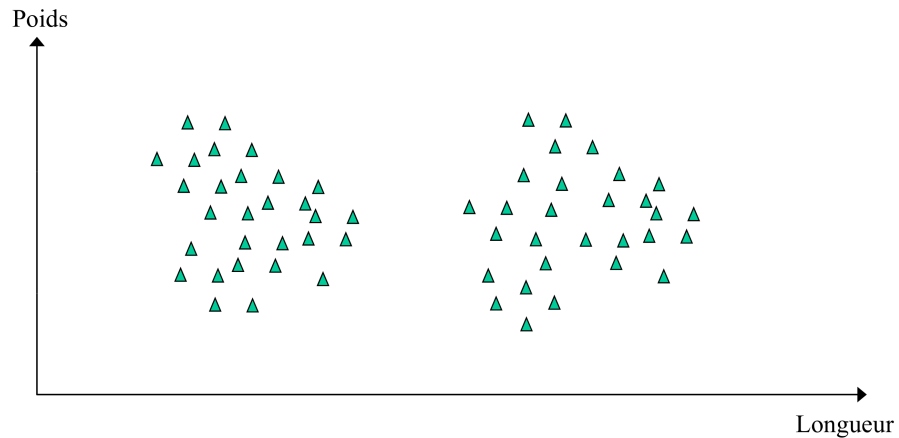
Number of FD: 8

RECONNAISSANCE DES FORMES

ALGORITHME DES K-MOYENNES (1)

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

Exemple schématique de l'algorithme des K-moyennes

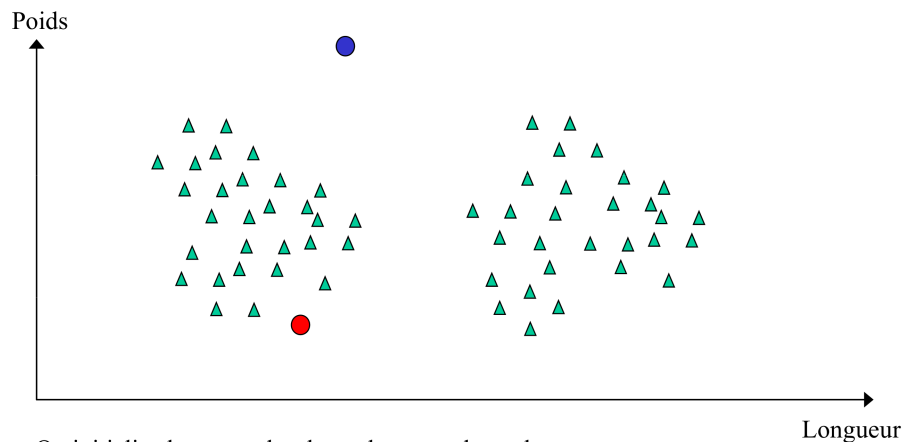


Voici 60 observations. Comment faire pour grouper ces données en deux classes et estimer la moyenne (ou le centre de masse) de ces classes ?

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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 ● ●

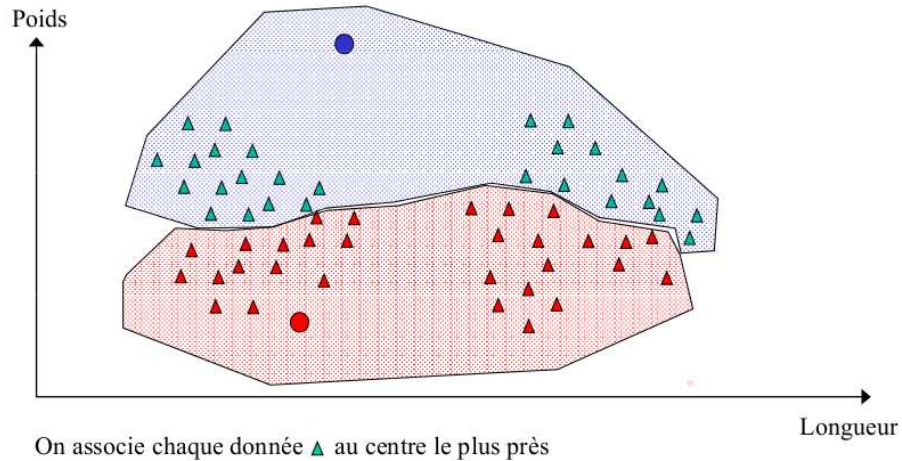
37

RECONNAISSANCE DES FORMES

ALGORITHME DES K-MOYENNES (2)

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

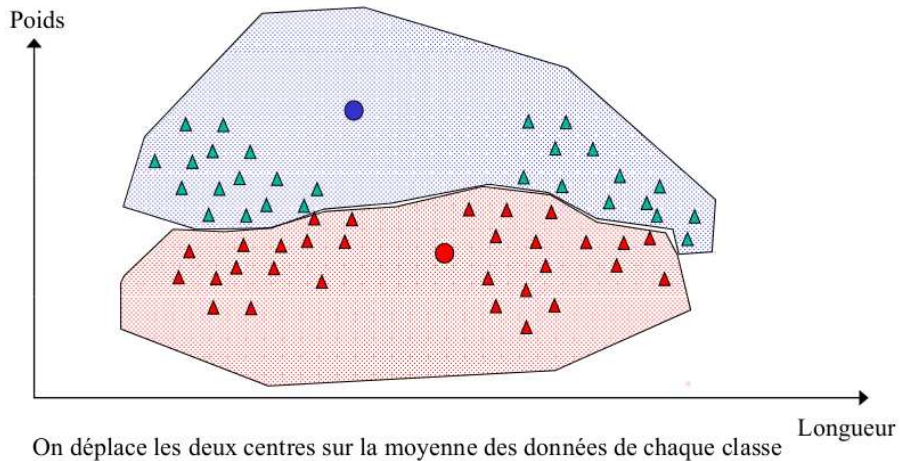
Exemple schématique de l'algorithme des K-moyennes



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

Exemple schématique de l'algorithme des K-moyennes



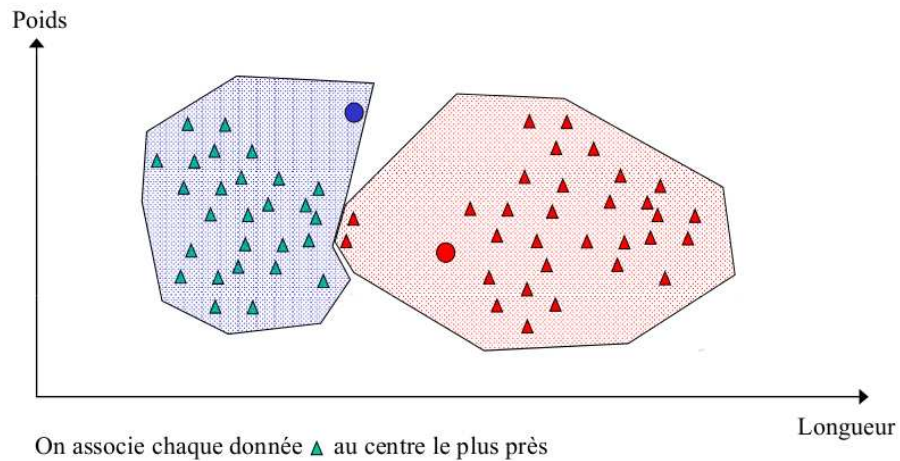
39

RECONNAISSANCE DES FORMES

ALGORITHME DES K-MOYENNES (3)

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

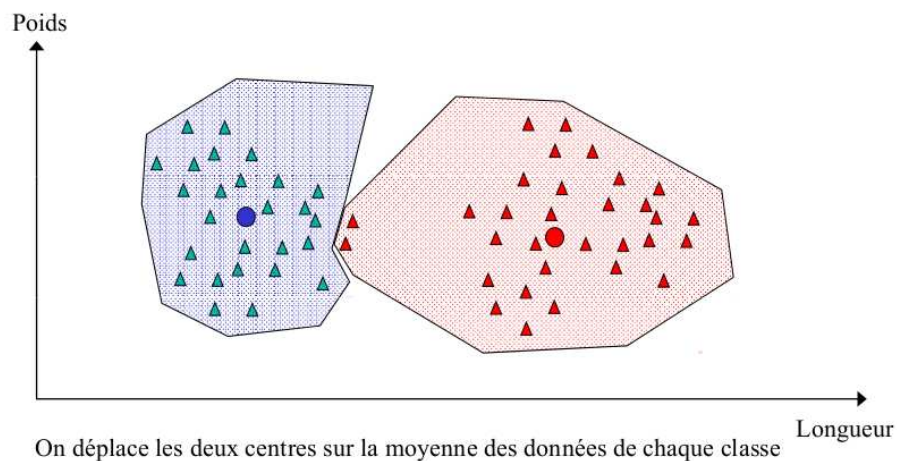
Exemple schématique de l'algorithme des K-moyennes



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

Exemple schématique de l'algorithme des K-moyennes



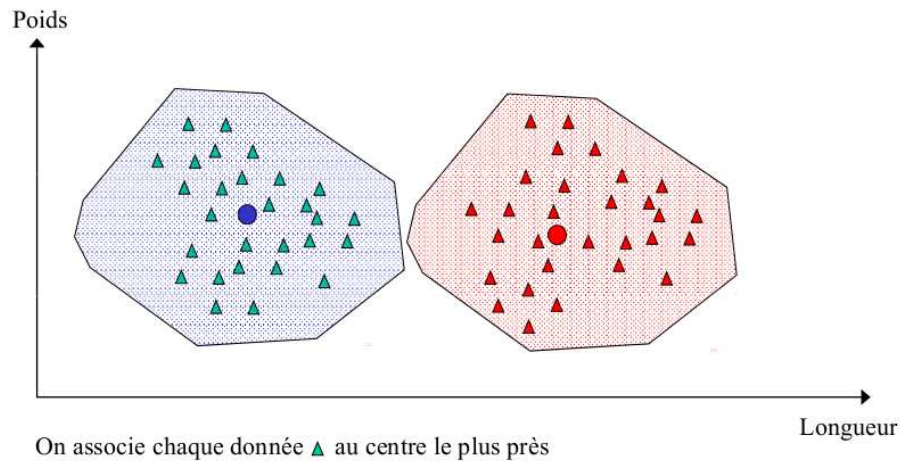
41

RECONNAISSANCE DES FORMES

ALGORITHME DES K-MOYENNES (4)

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

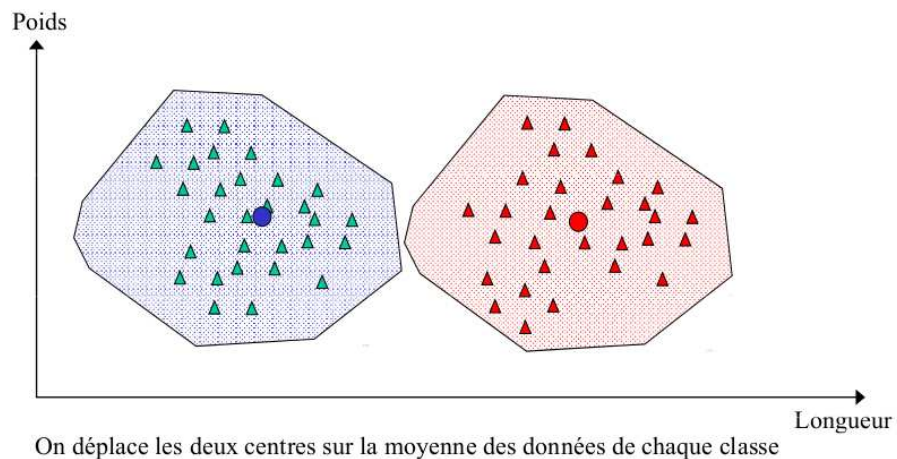
Exemple schématique de l'algorithme des K-moyennes



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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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