Mélange d’images

GIF-4105/7105 Photographie Algorithmique, Hiver 2018

Jean-François Lalonde

Aujourd’hui

- Comment prendre l’objet découpé et l’insérer dans une nouvelle image?

Composition d’images

Crédit: Efros/Seitz

Dans les nouvelles…

Image originale

Image “améliorée”

http://www.guardian.co.uk/world/2010/sep/16/mubarak-doctored-red-carpet-picture

Dans les nouvelles…

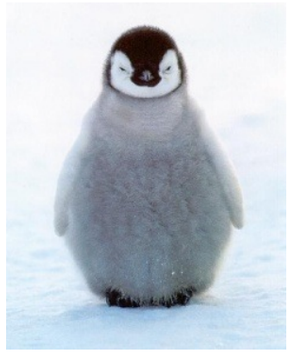
Images originales

Image “améliorée”

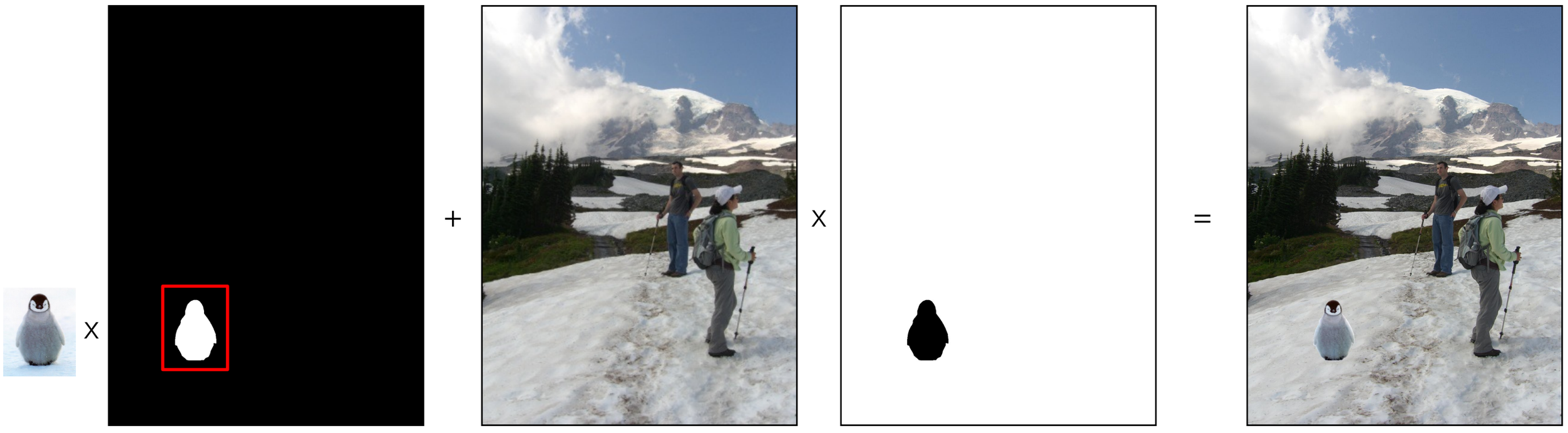
Walski, LA Times, 2003

Méthode 1 : copier-coller

Méthode 1 : copier-coller

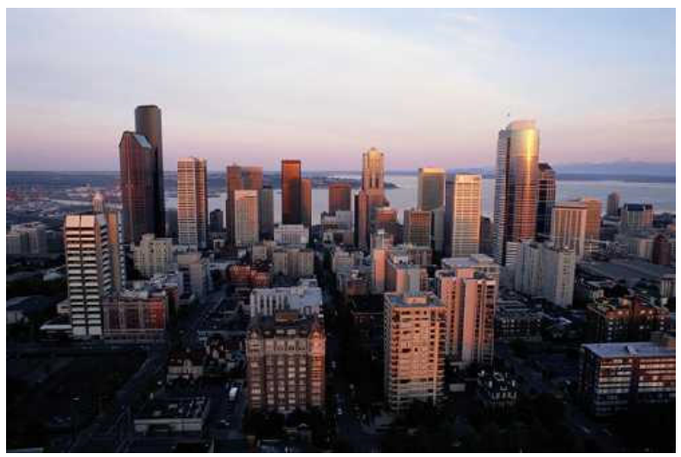


Méthode 1 : copier-coller



$$I = \alpha F + (1 - \alpha) B$$

Autre exemple



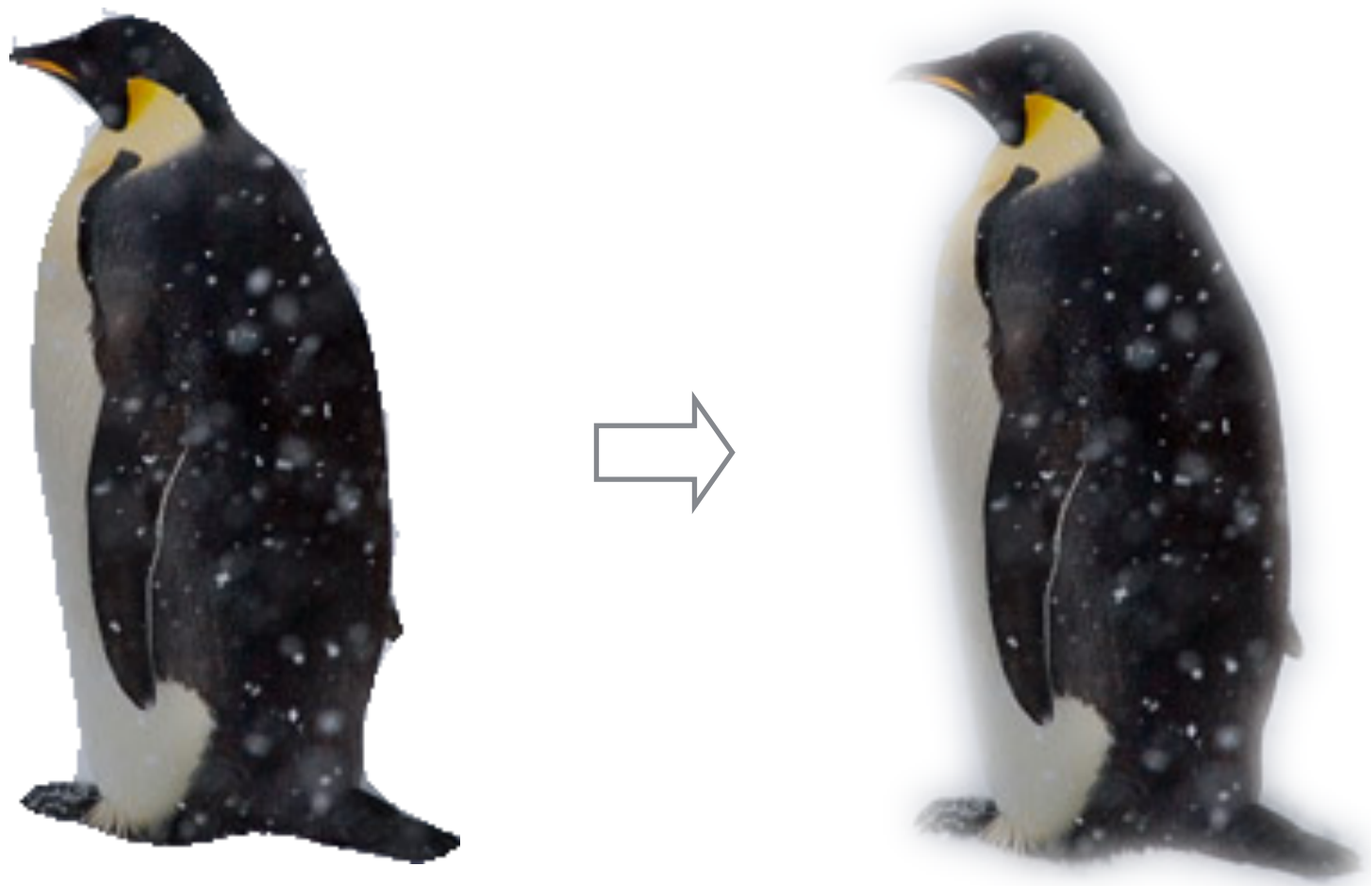
Source: David Dewey

Problèmes?

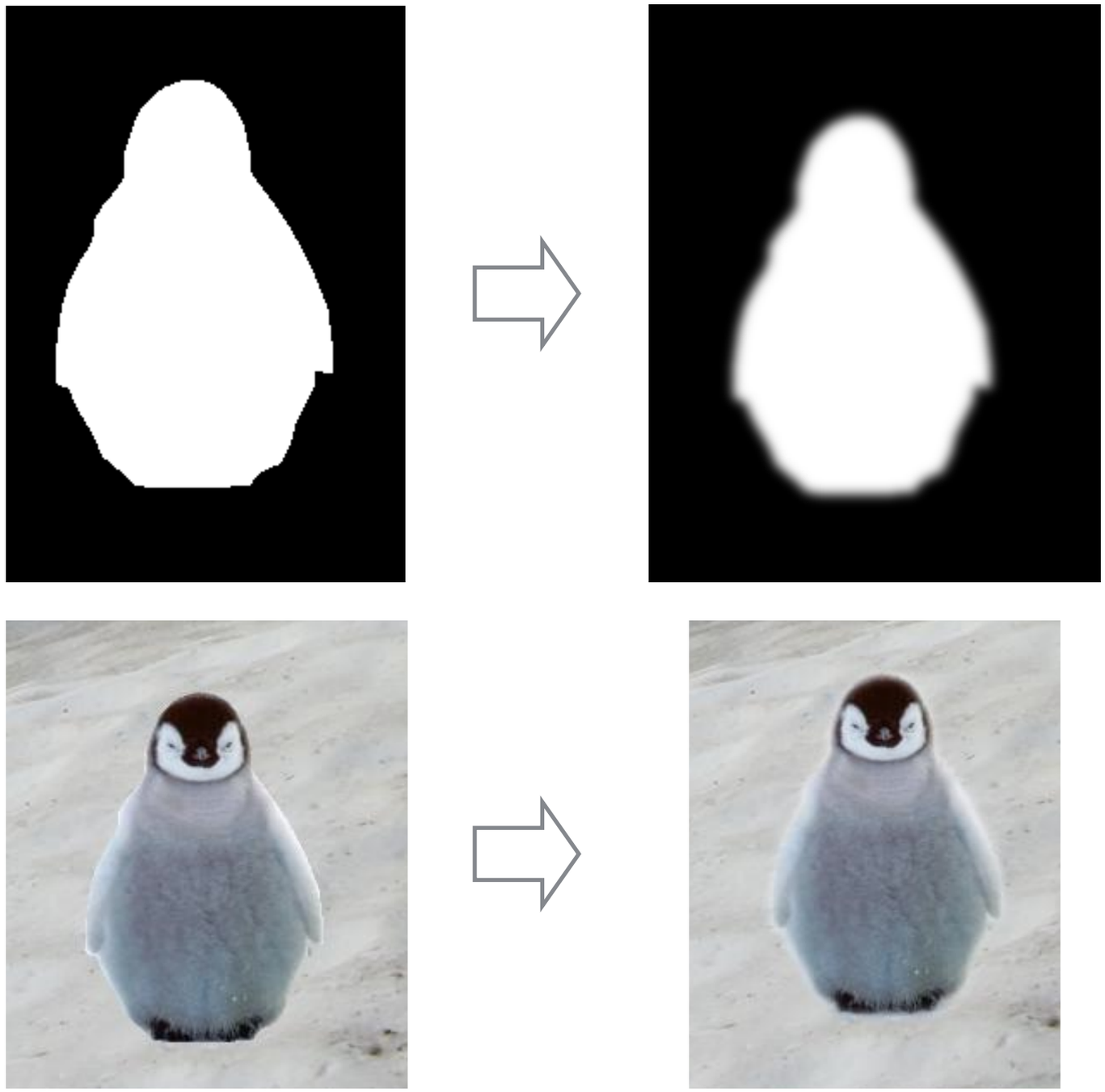
- Segmentation doit être parfaite!
- Pixel peut capturer plusieurs objets:
  - Chevaucher deux objets
  - Flou
  - Mouvement
  - Transparence

Dégradé (feathering)

- Les pixels proche de la bordure de l'objet proviennent partiellement de l'objet et de l'arrière-plan



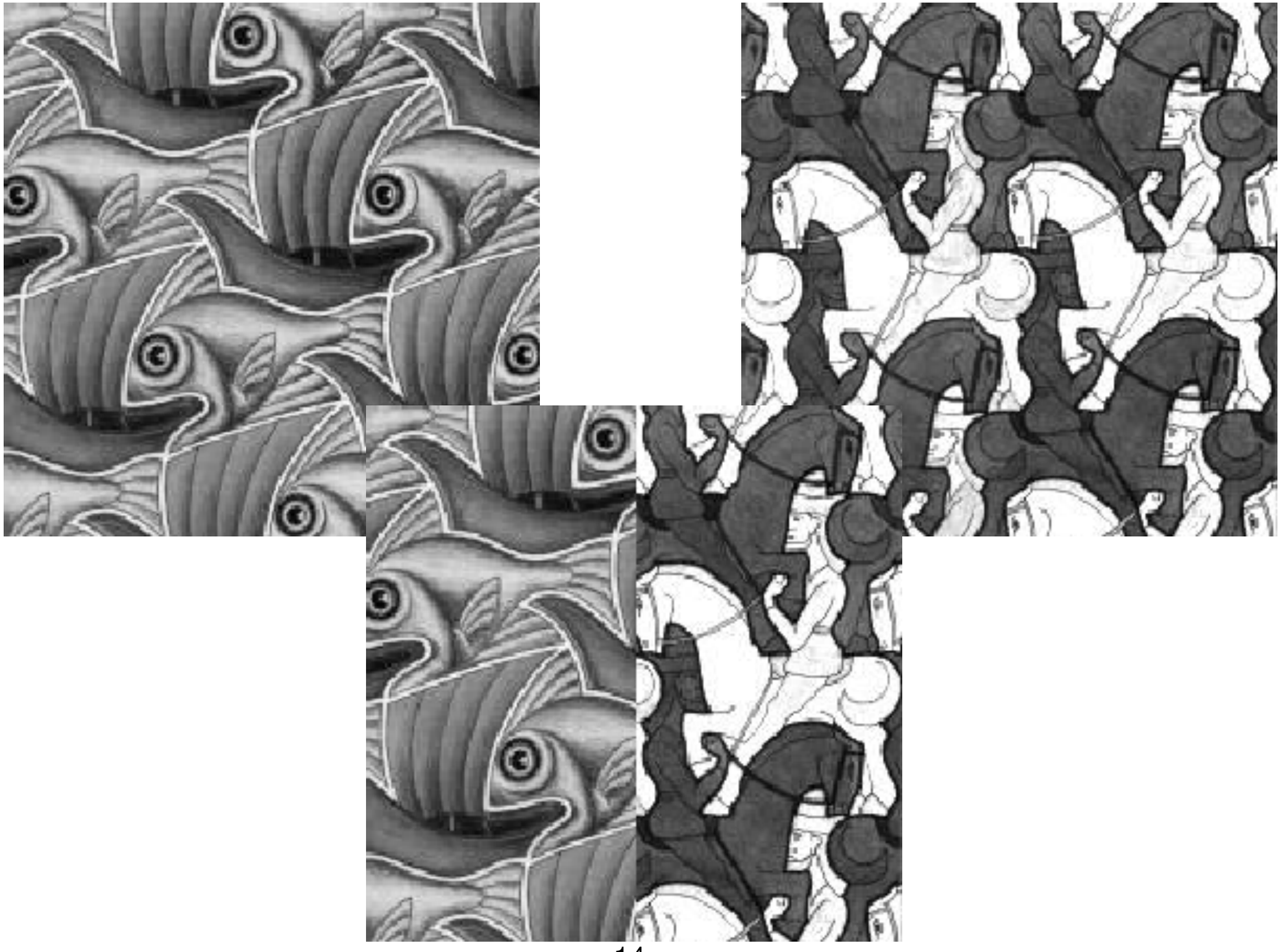
Composition avec dégradé



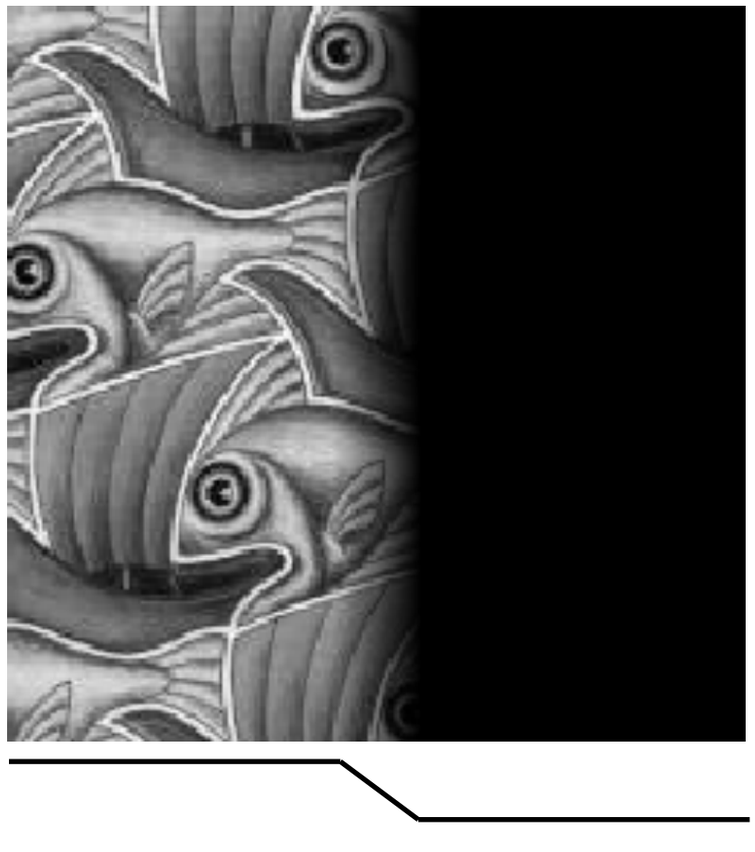
$$I = \alpha F +_{12} (1 - \alpha) B$$

Approche 1 : copier-coller (avec dégradé)

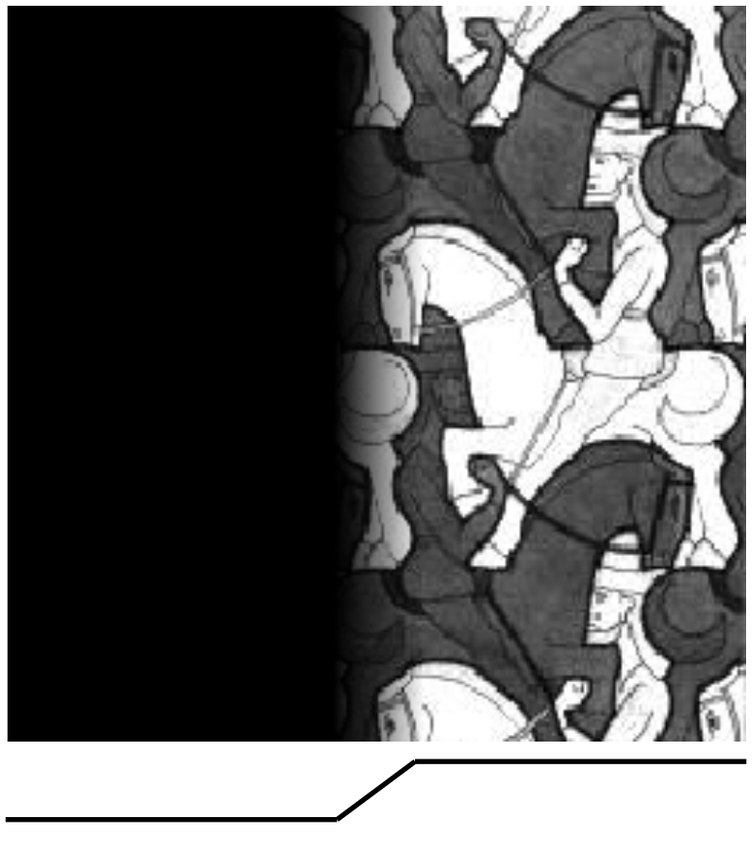
Niveau de dégradé?



Niveau de dégradé?



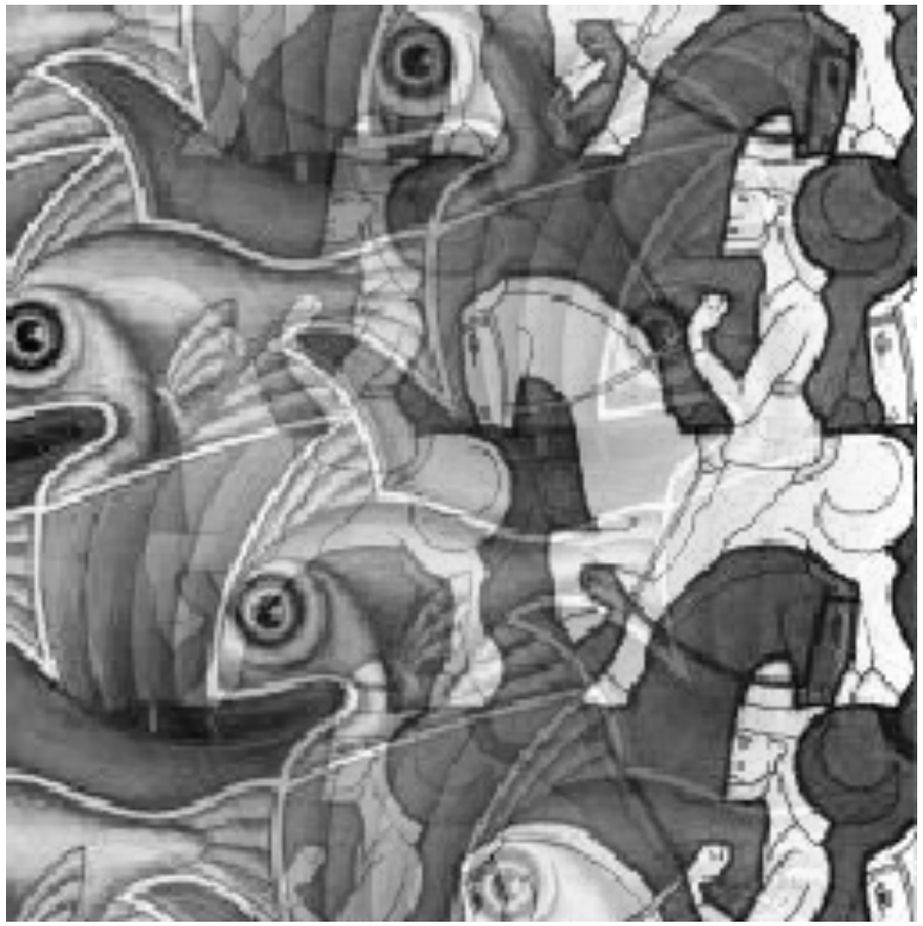
+

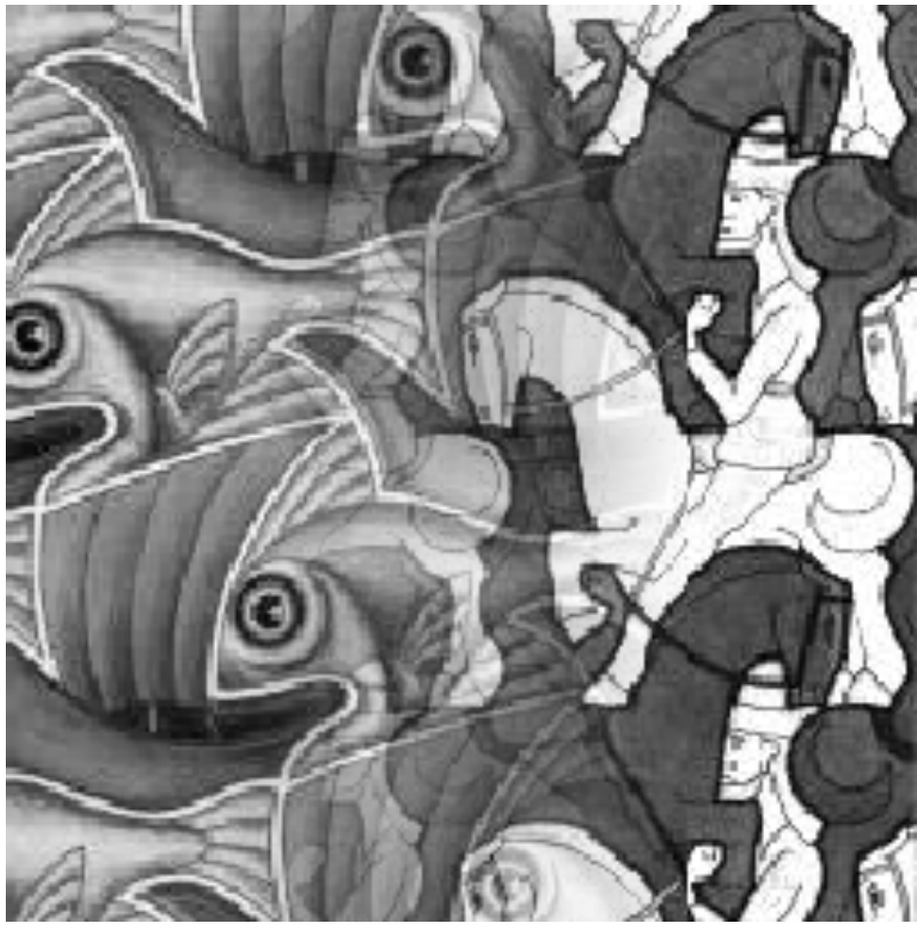


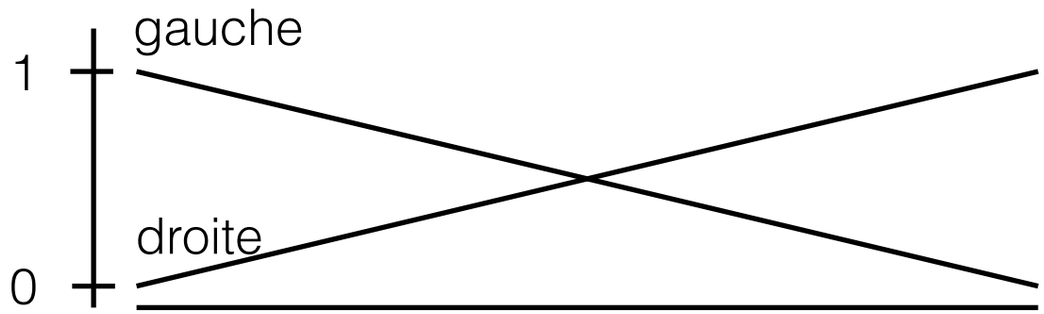
=

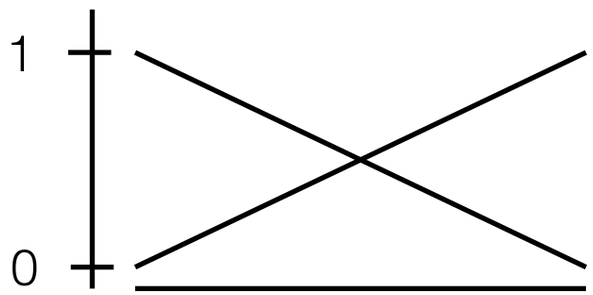
$$I = \alpha I_{gauche} + (1 - \alpha) I_{droite}$$

Taille de la fenêtre

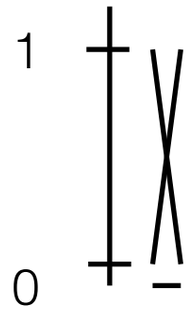


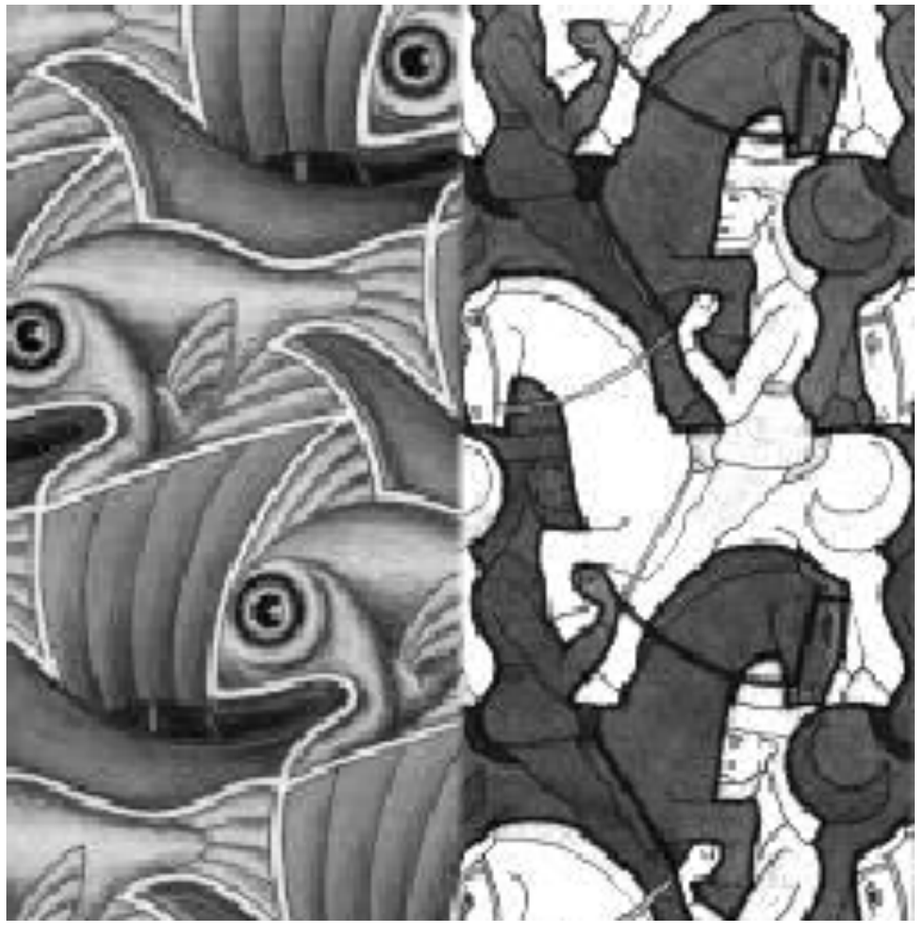


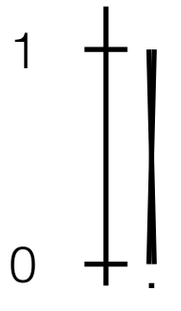




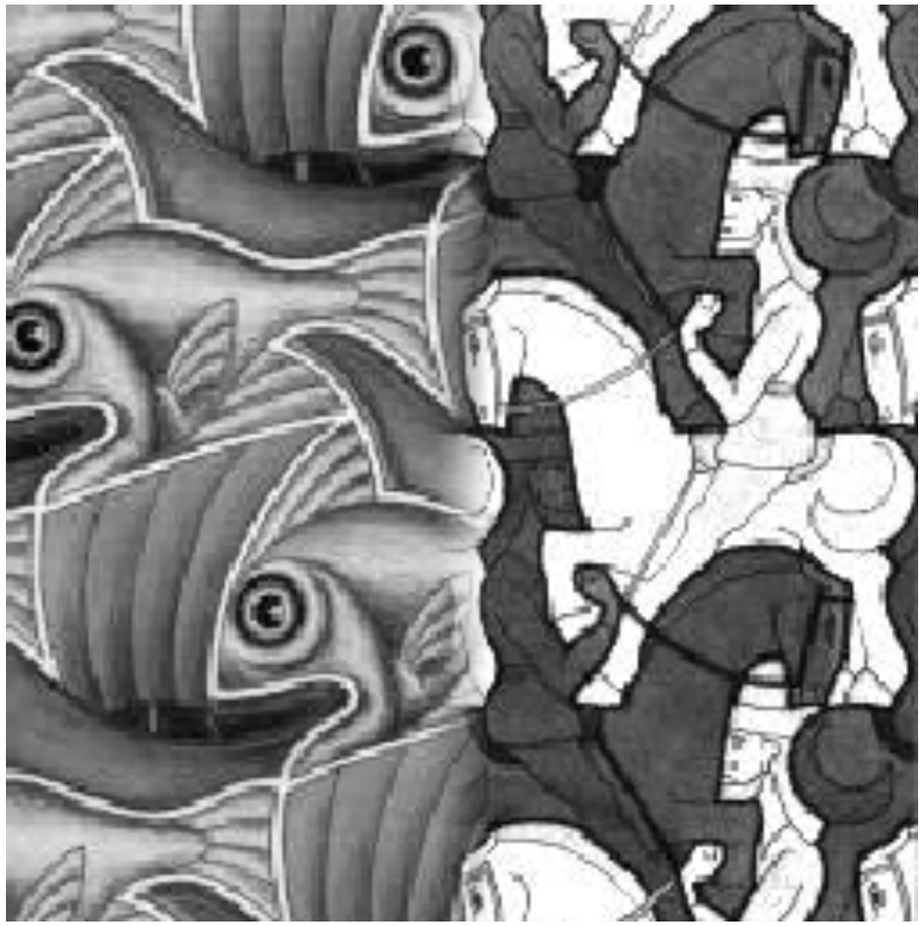
Taille de la fenêtre

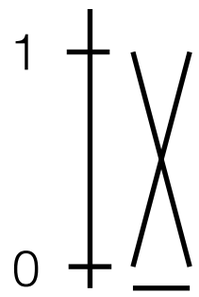






Bonne fenêtre

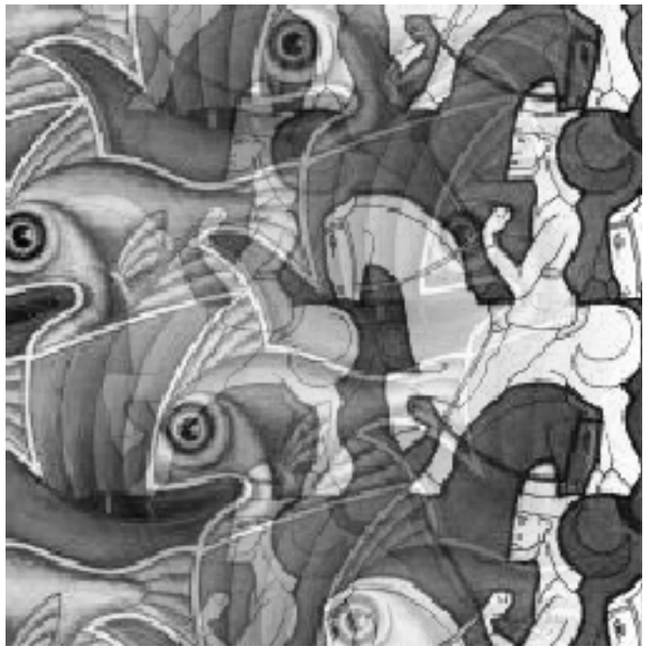


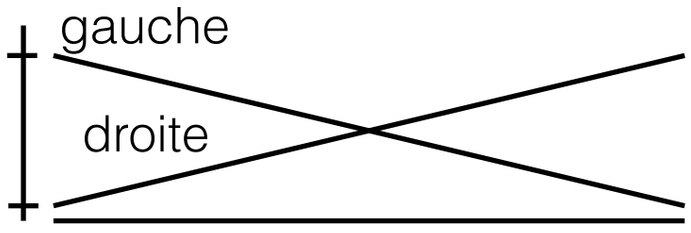


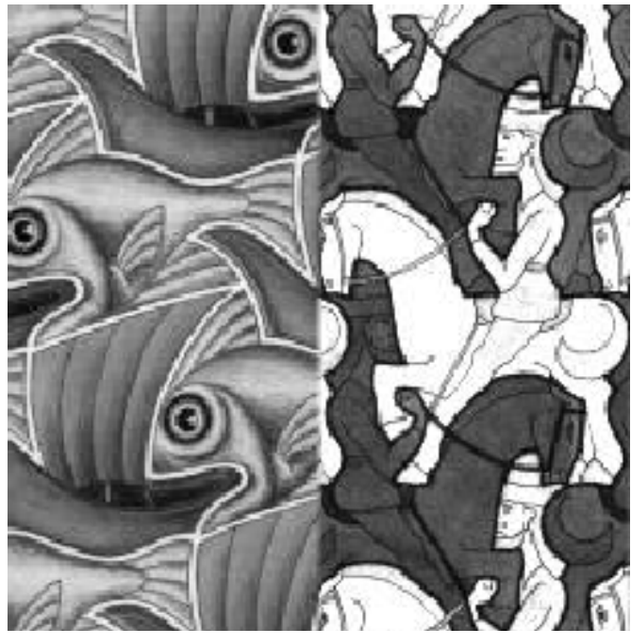
Fenêtre “optimale”: douce transition, sans fantômes (ghosting)

Quelle est la taille de fenêtre optimale?

- Pour éviter les coupures
  - fenêtre = taille des caractéristiques les plus larges
- Pour éviter les « fantômes »
  - fenêtre < taille des détails les plus petits
- La « meilleure » fenêtre varie en fonction du contenu fréquentiel!

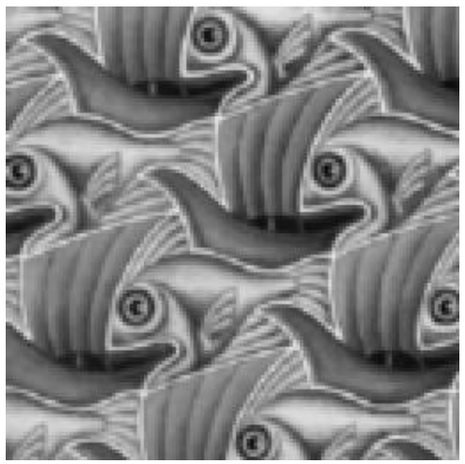






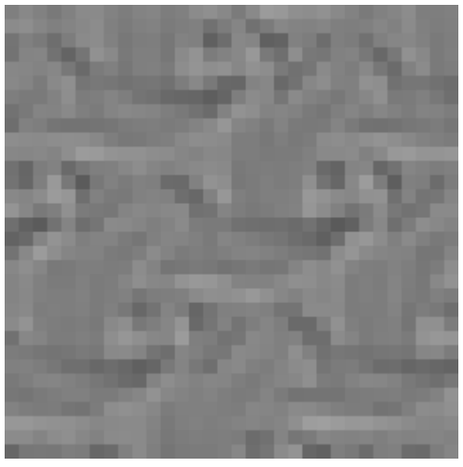
Décomposition en « bandes de fréquences »



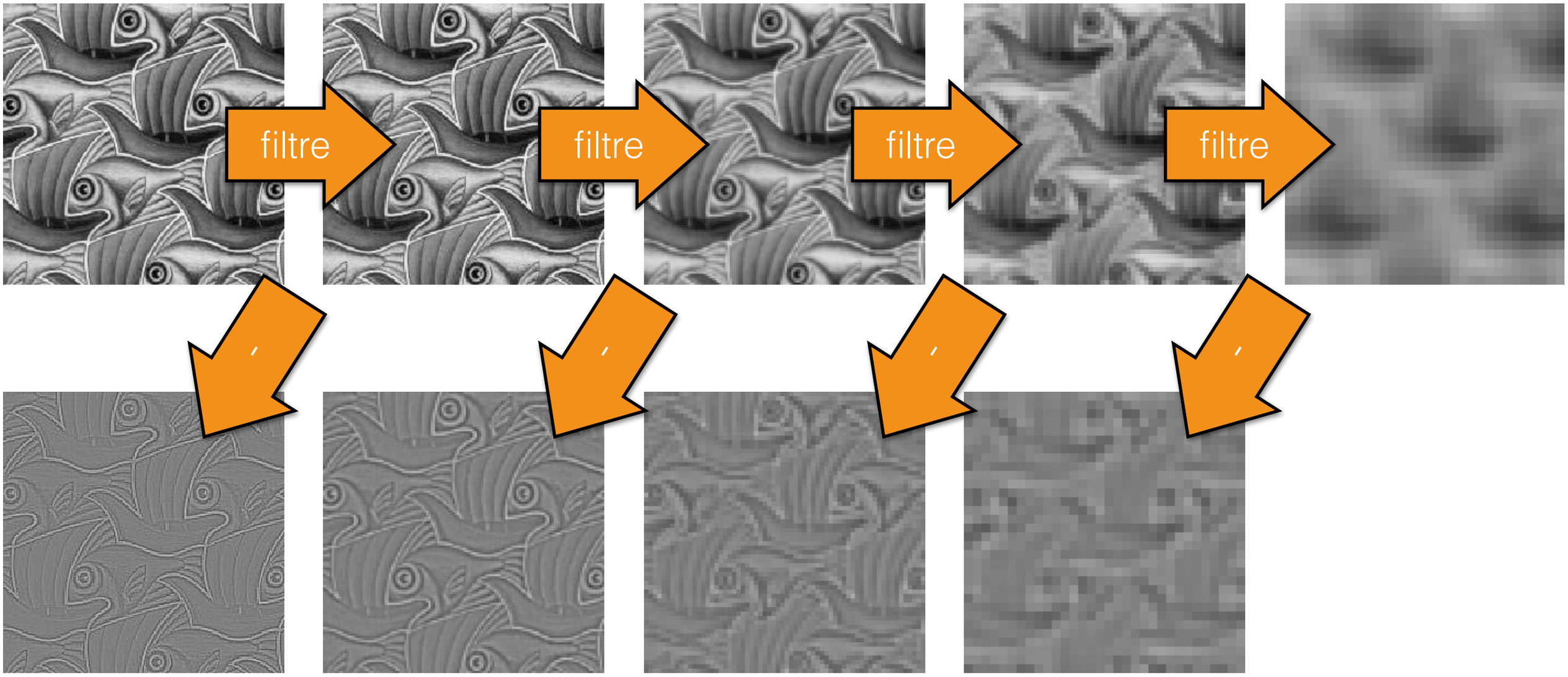






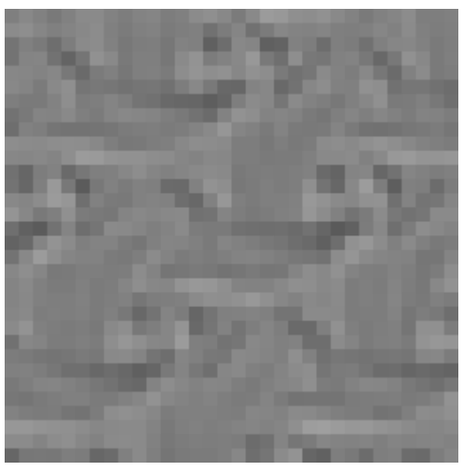


Décomposition en « bandes de fréquences »

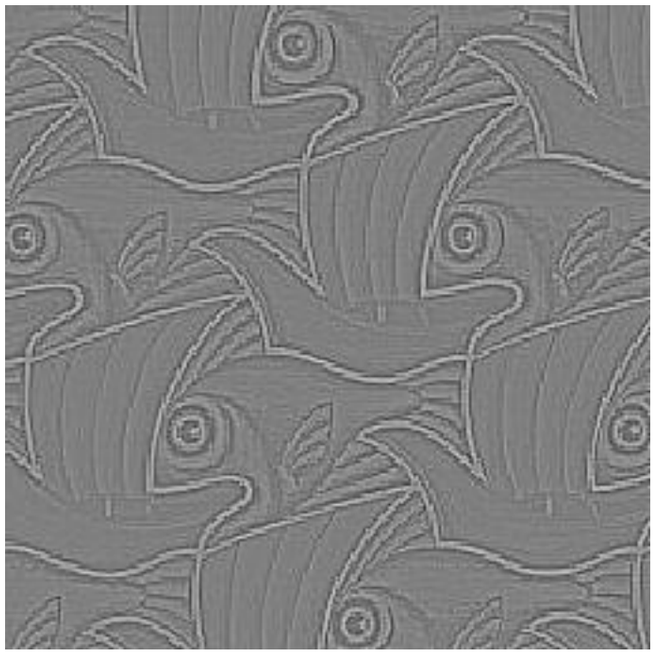


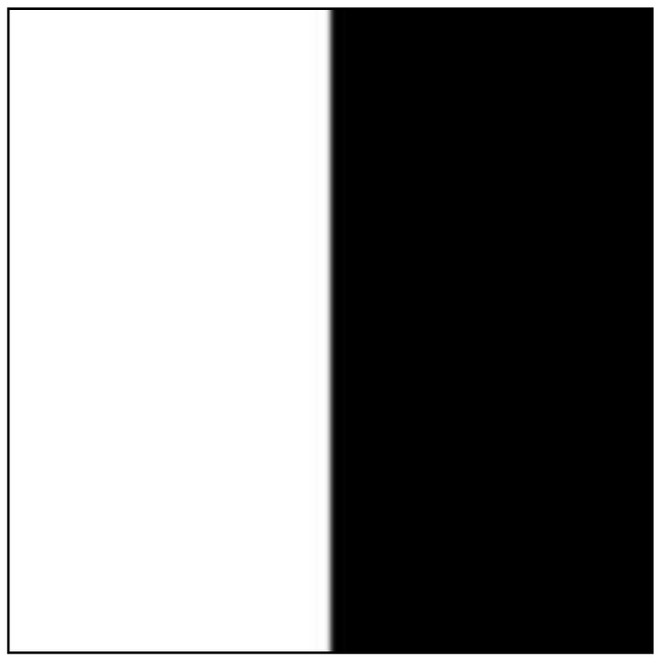
Décomposition en « bandes de fréquences »

Pile Laplacienne!



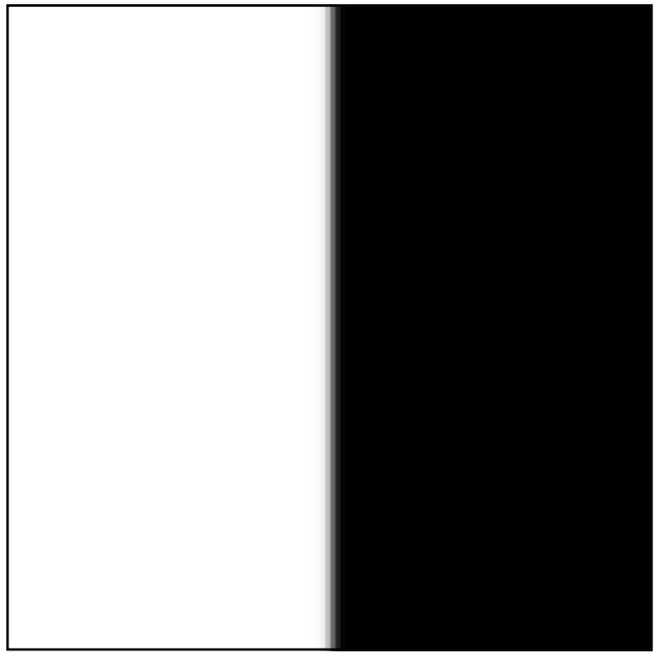
Allons-y une « bande de fréquences » à la fois





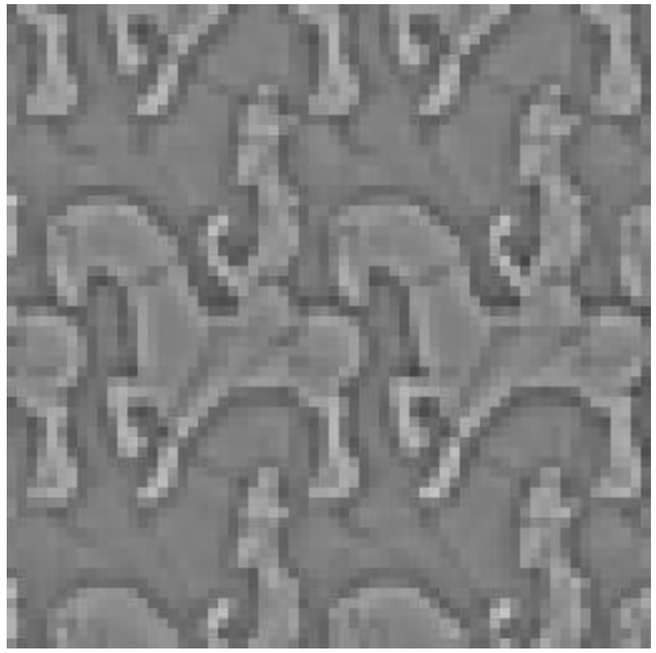
« bande de fréquences »: octave

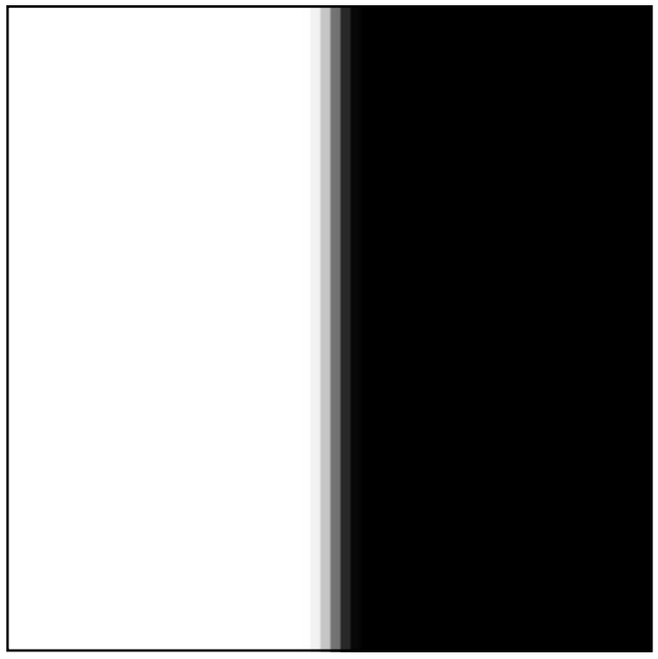
Allons-y une « bande de fréquences » à la fois



« bande de fréquences »: octave

Allons-y une « bande de fréquences » à la fois





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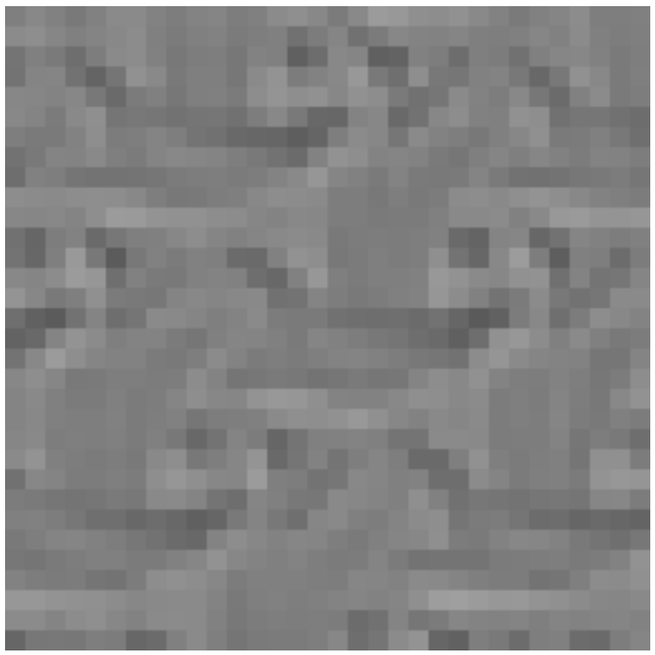
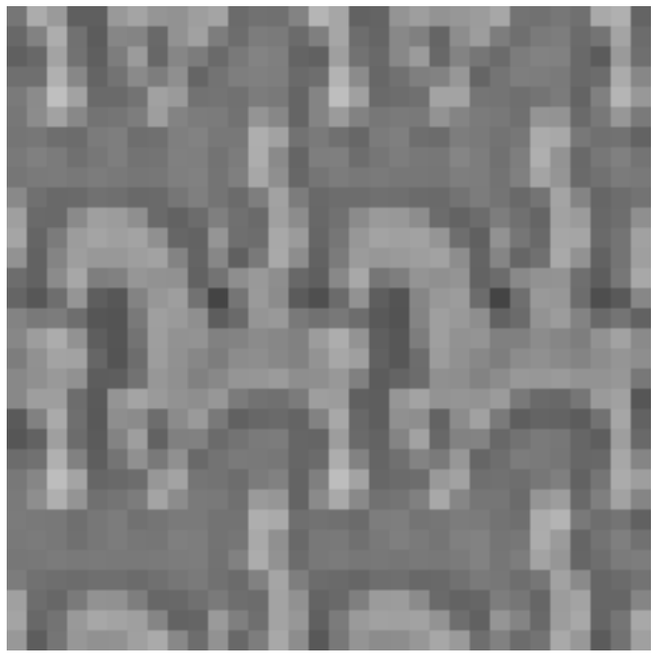
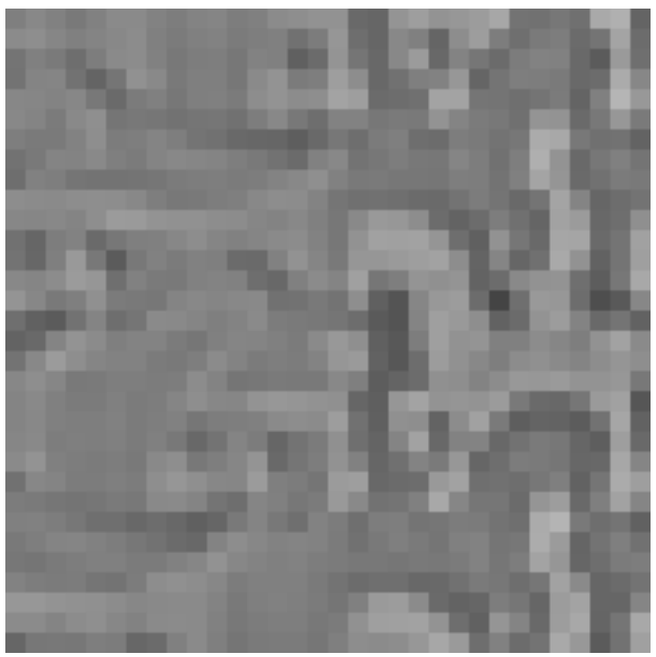
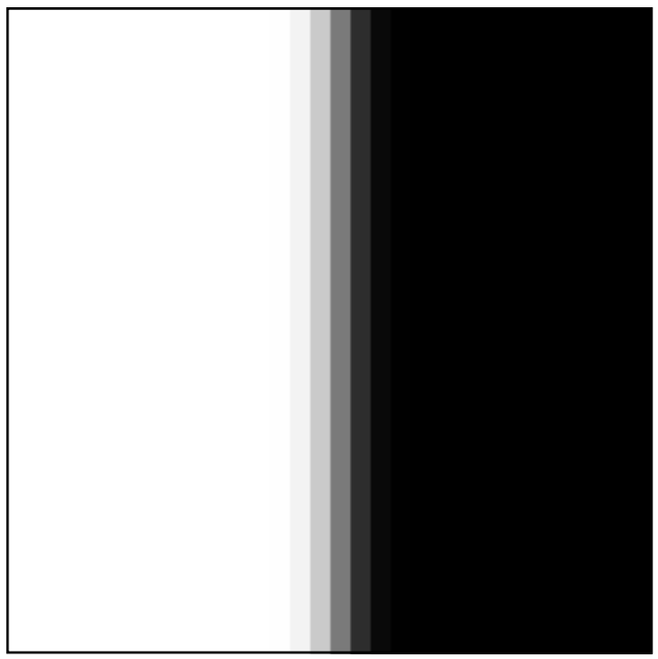


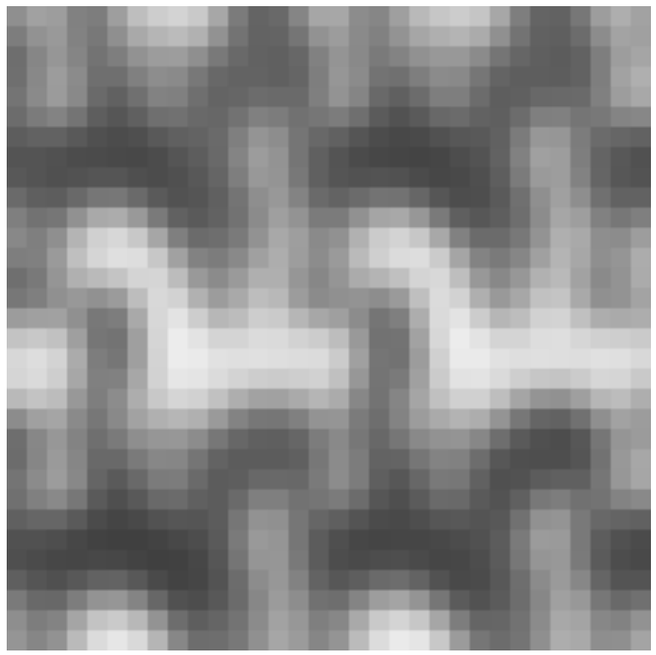


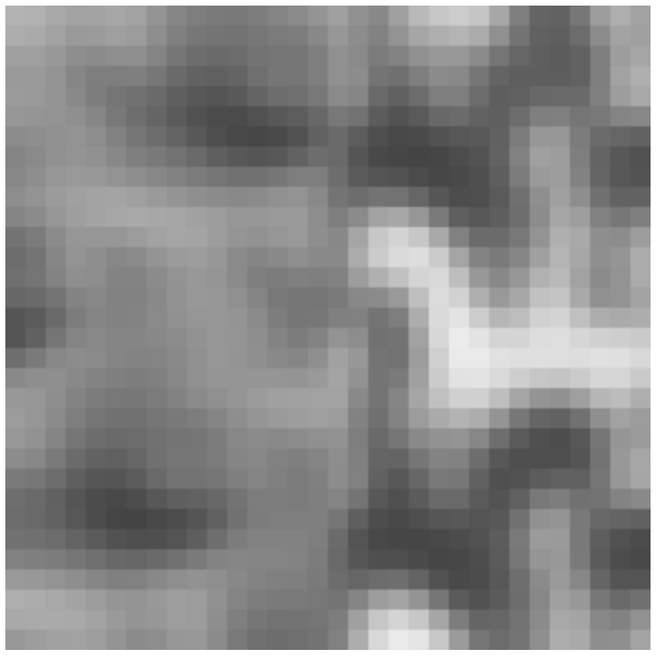


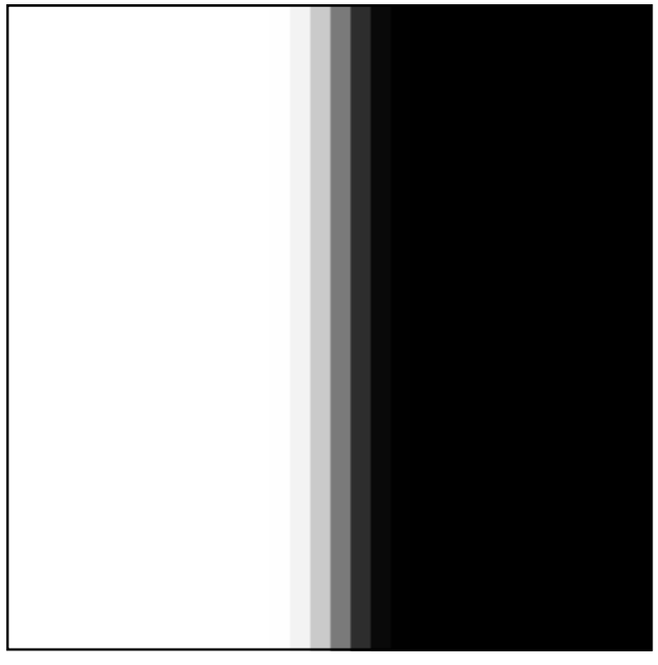


« bande de fréquences »: octave

Allons-y une « bande de fréquences » à la fois



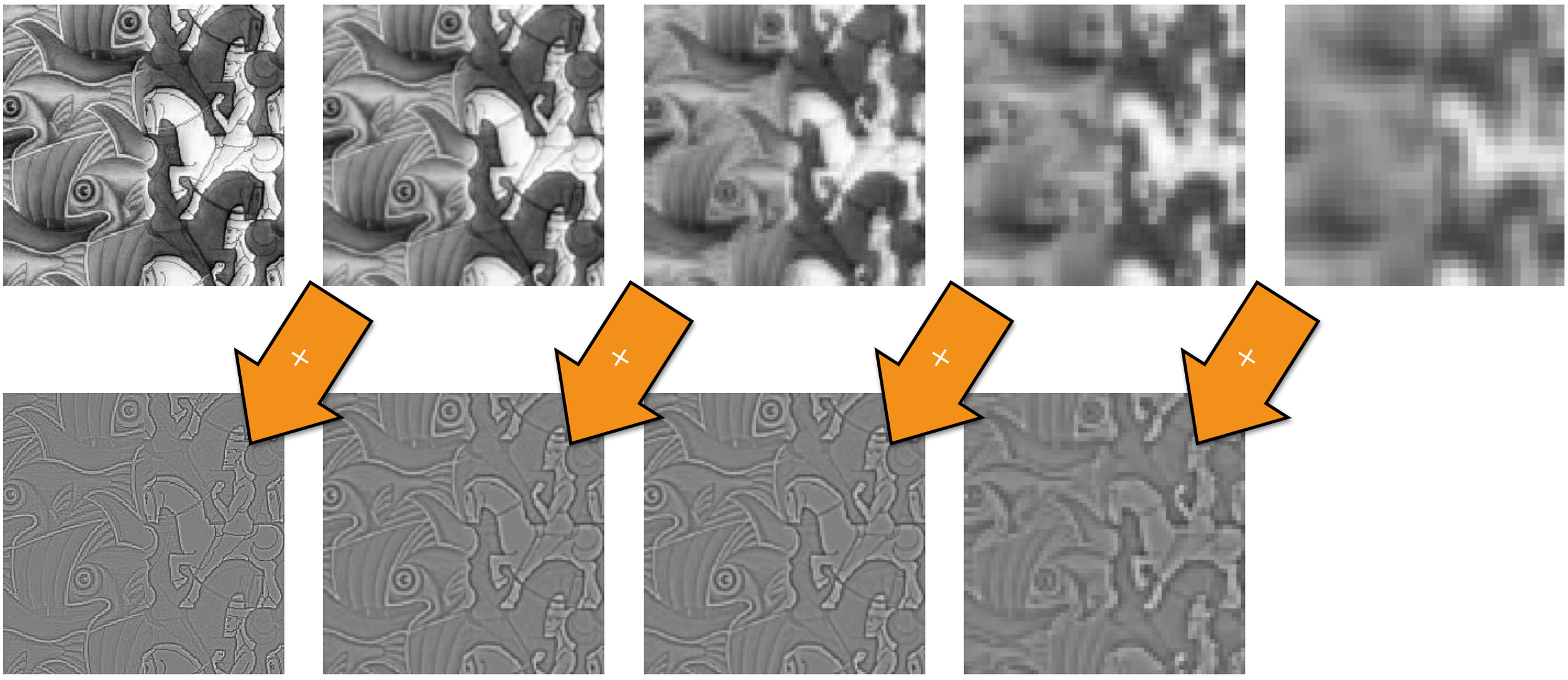




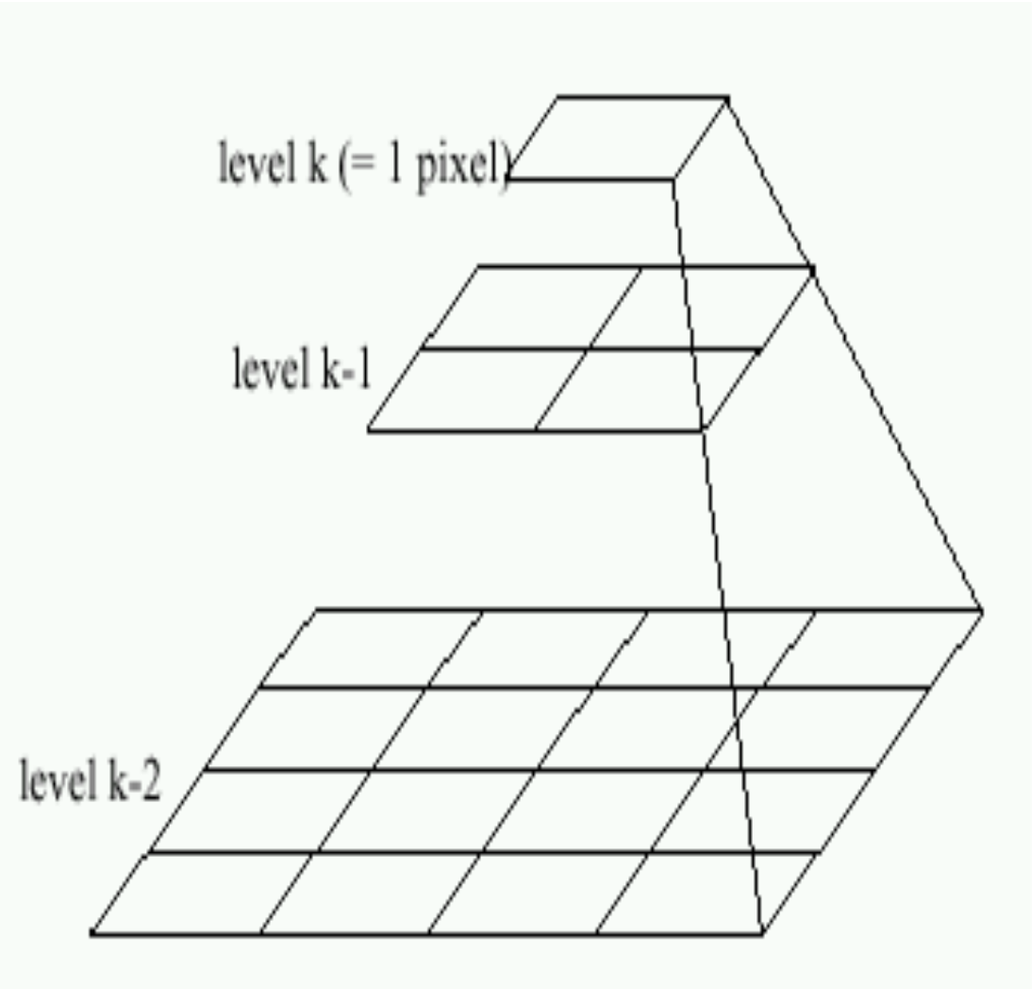
« bande de fréquences »: octave

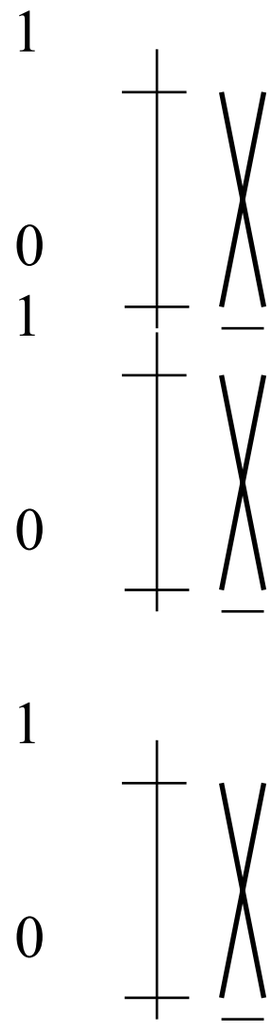
Décomposition en « bandes de fréquences »

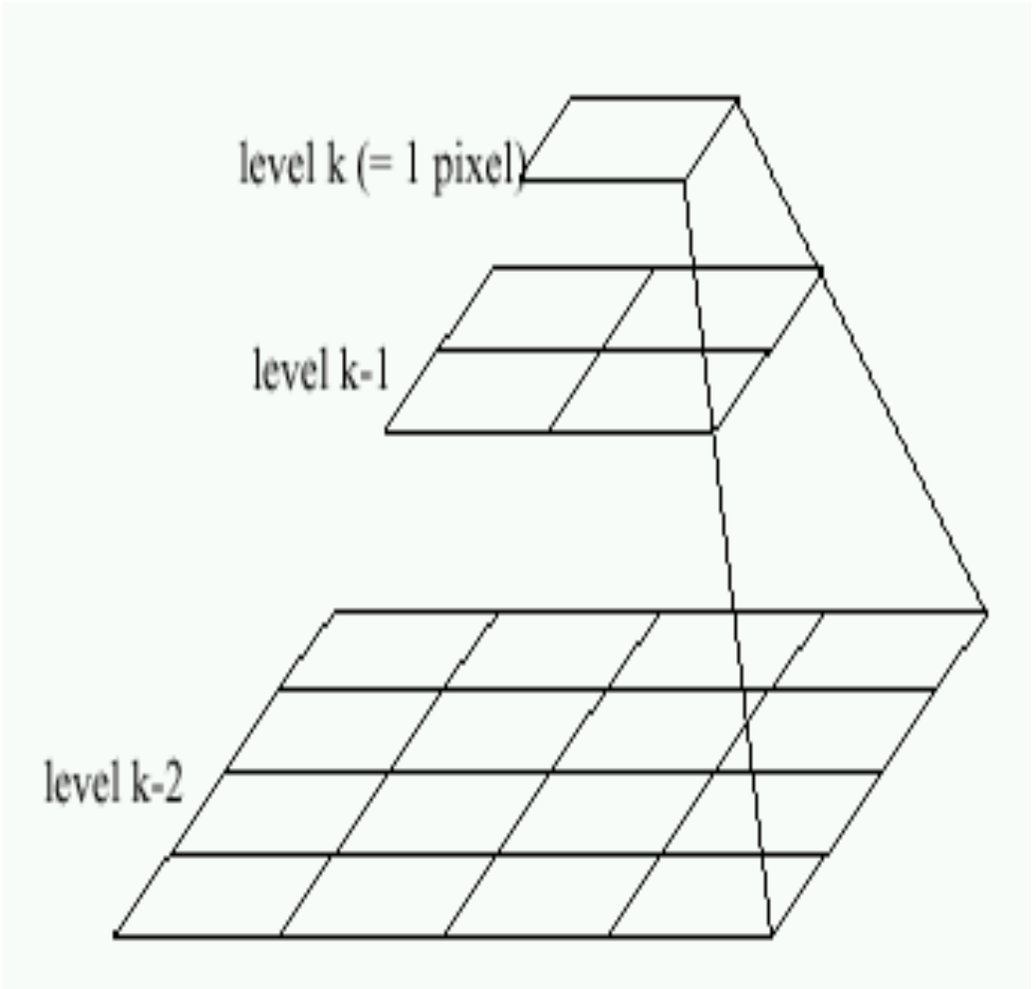
Pile Laplacienne!



Approche 2: mélange par pyramides





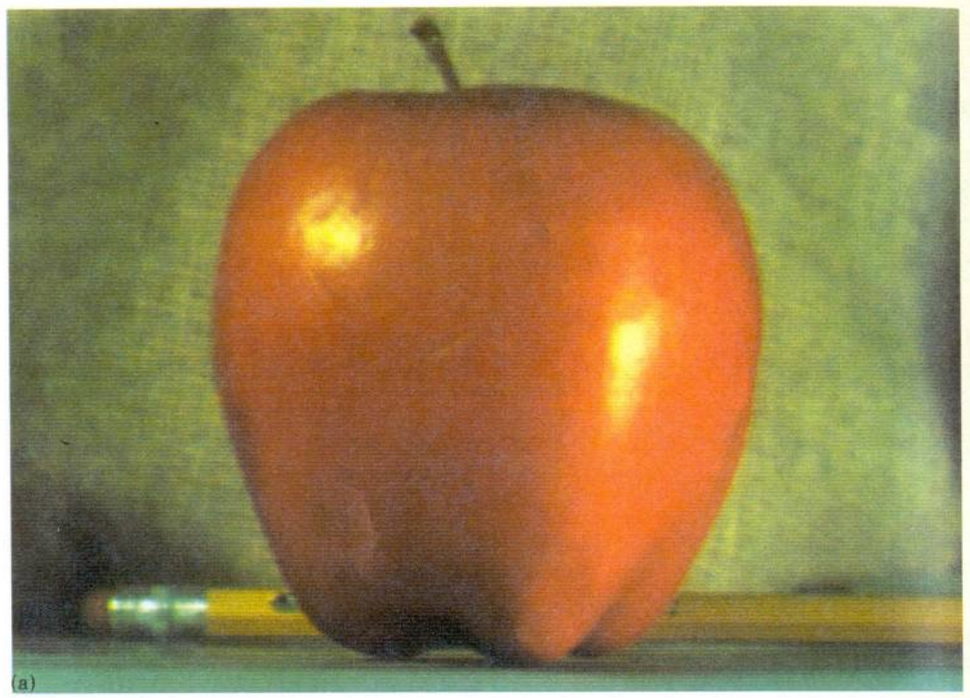


Pyramide gauche

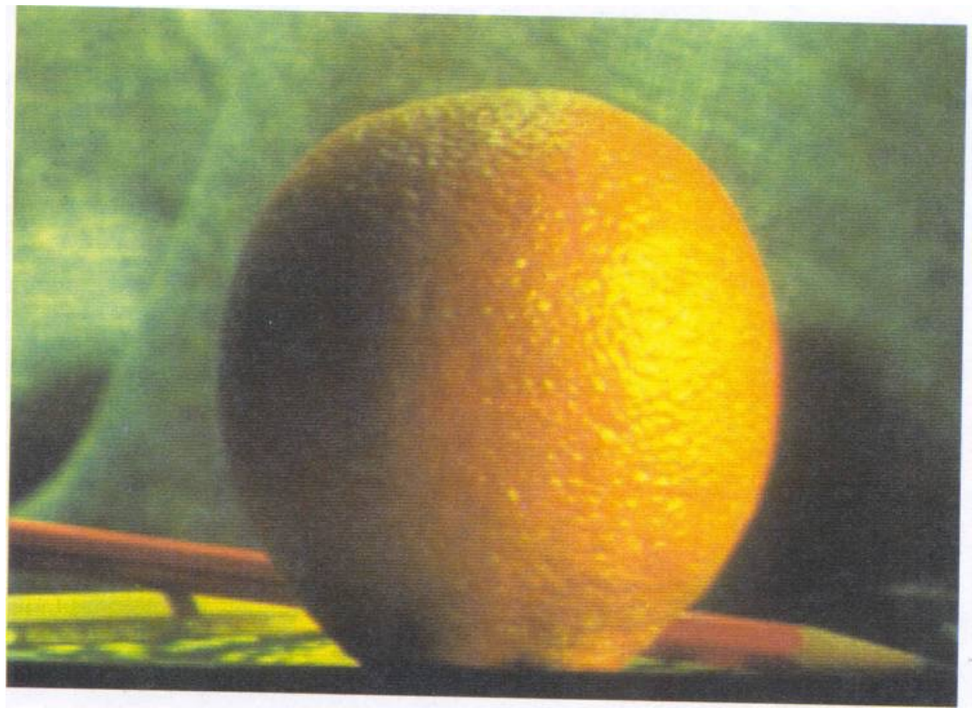
mélange

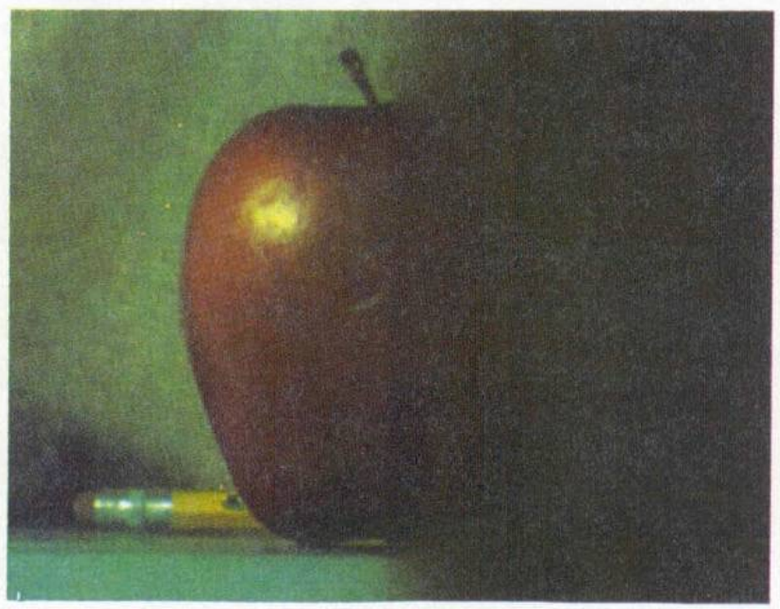
Pyramide droite

Mélange par pyramides

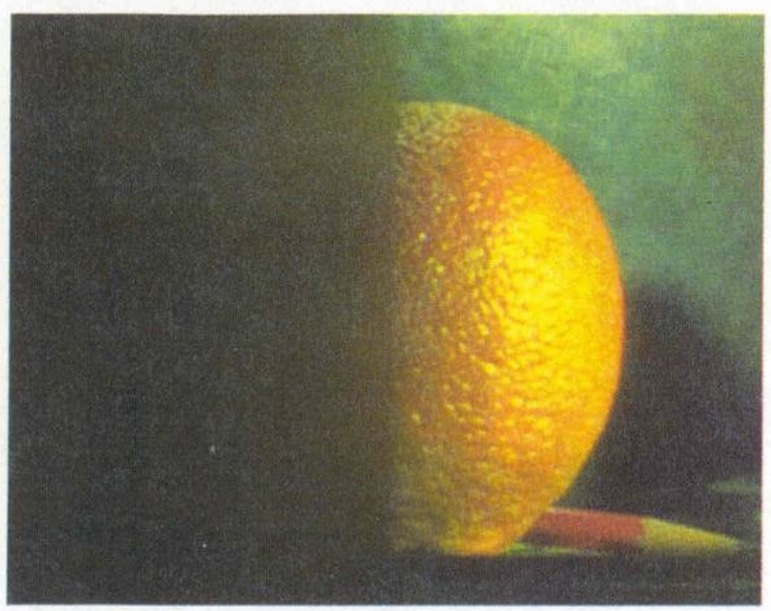


(a)

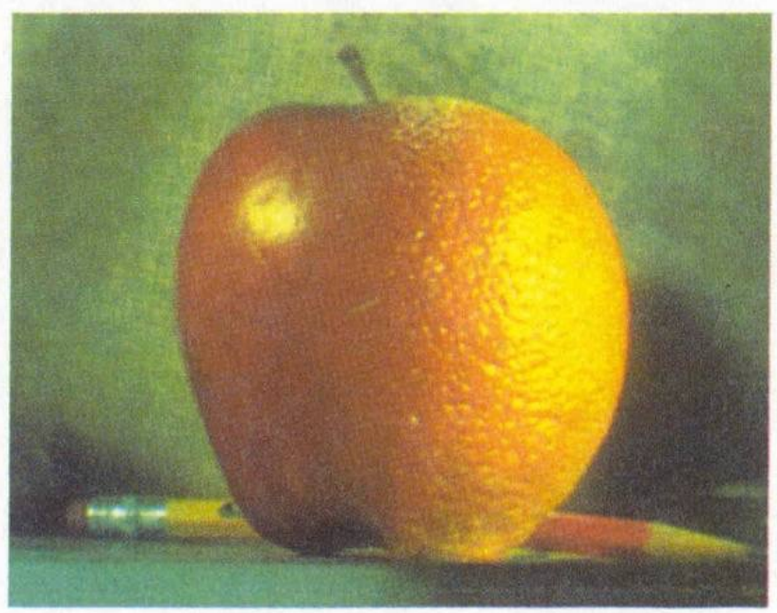




(d)



(h)

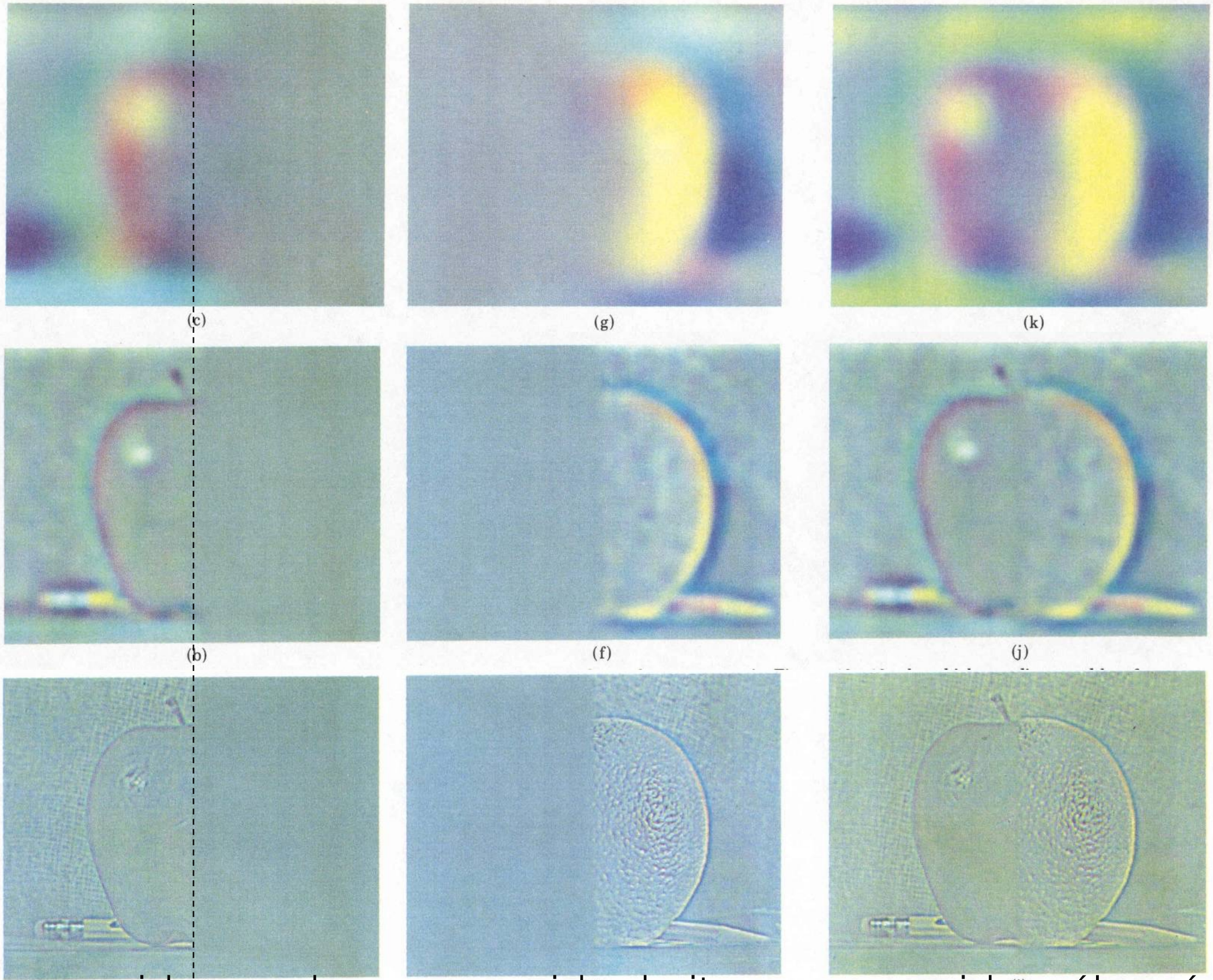


(l)

niveau laplacien 4

niveau laplacien 2

niveau laplacien 0



pyramide gauche pyramide droite pyramide mélangée

Horreur!

Mélange par pyramides Laplaciennes

- Approche générale:
  - Construire les pyramides Laplaciennes L_A et L_B à partir des images A et B
  - Construire une pyramide Gaussienne G_R à partir du masque R
  - Combiner les pyramides L_A et L_B en une pyramide combinée L_S avec les poids déterminés par G_R:
    - $L_S(l,i,j) = G_R(l,i,j)*L_A(l,i,j) + (1-G_R(l,i,j))*L_B(l,i,j)$
      (l=niveau de la pyramide, i,j = pixel)
  - Reconstruire l'image finale à partir de la pyramide L_S

Autre idée

Image + segmentations

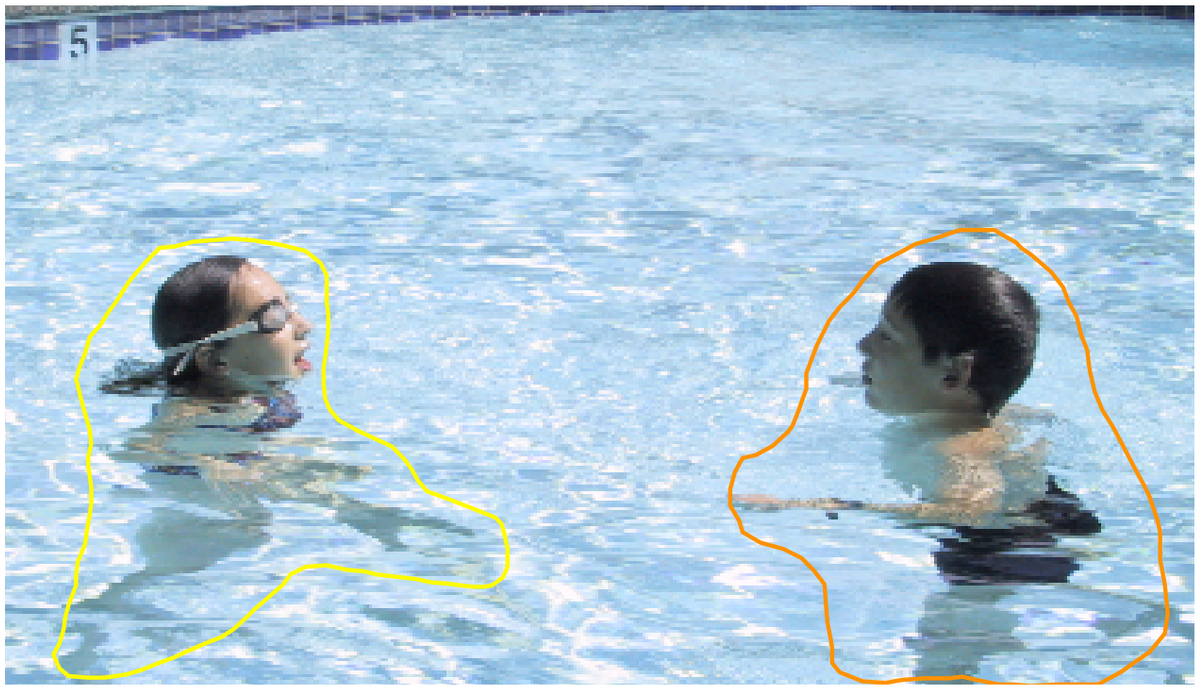
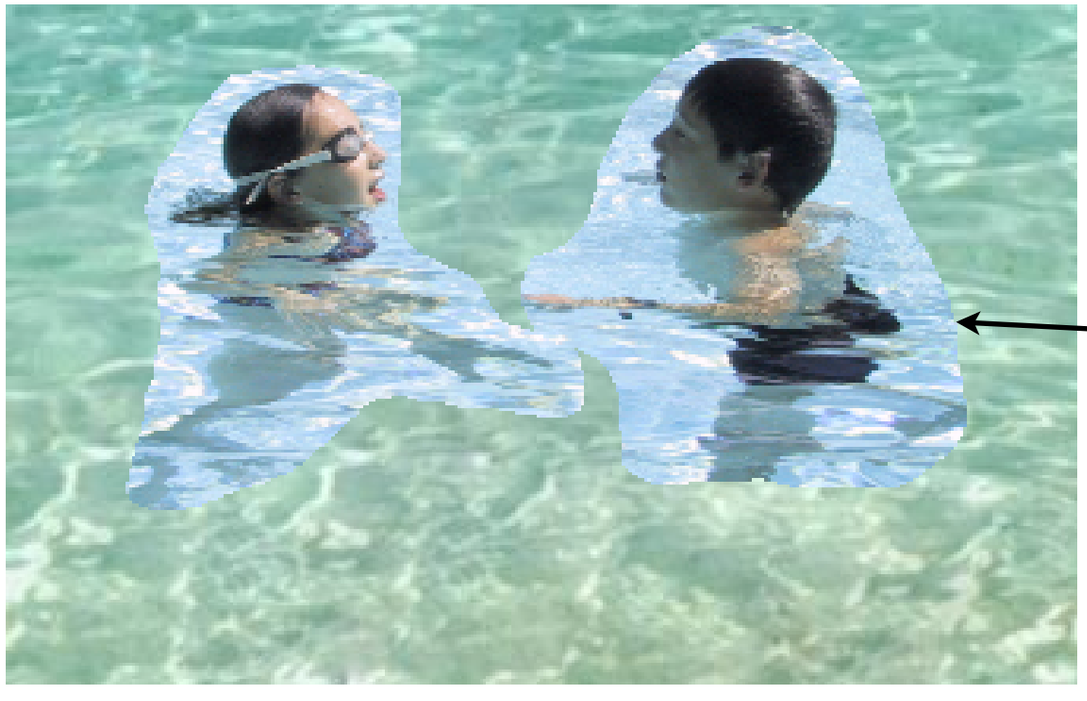


Image de destination

Résultat



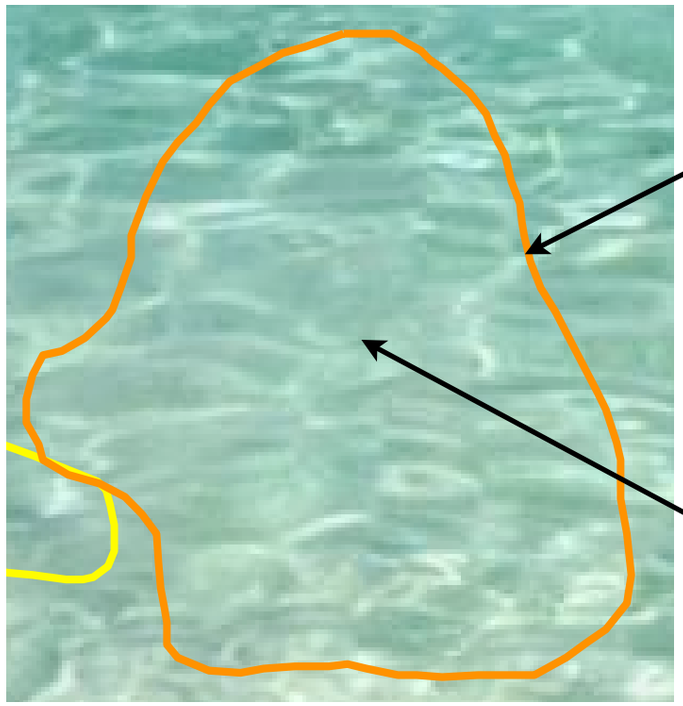
Discontinuité visible!

[Perez et al., 2003]

Approche 3: mélange par gradients

Source

Destination



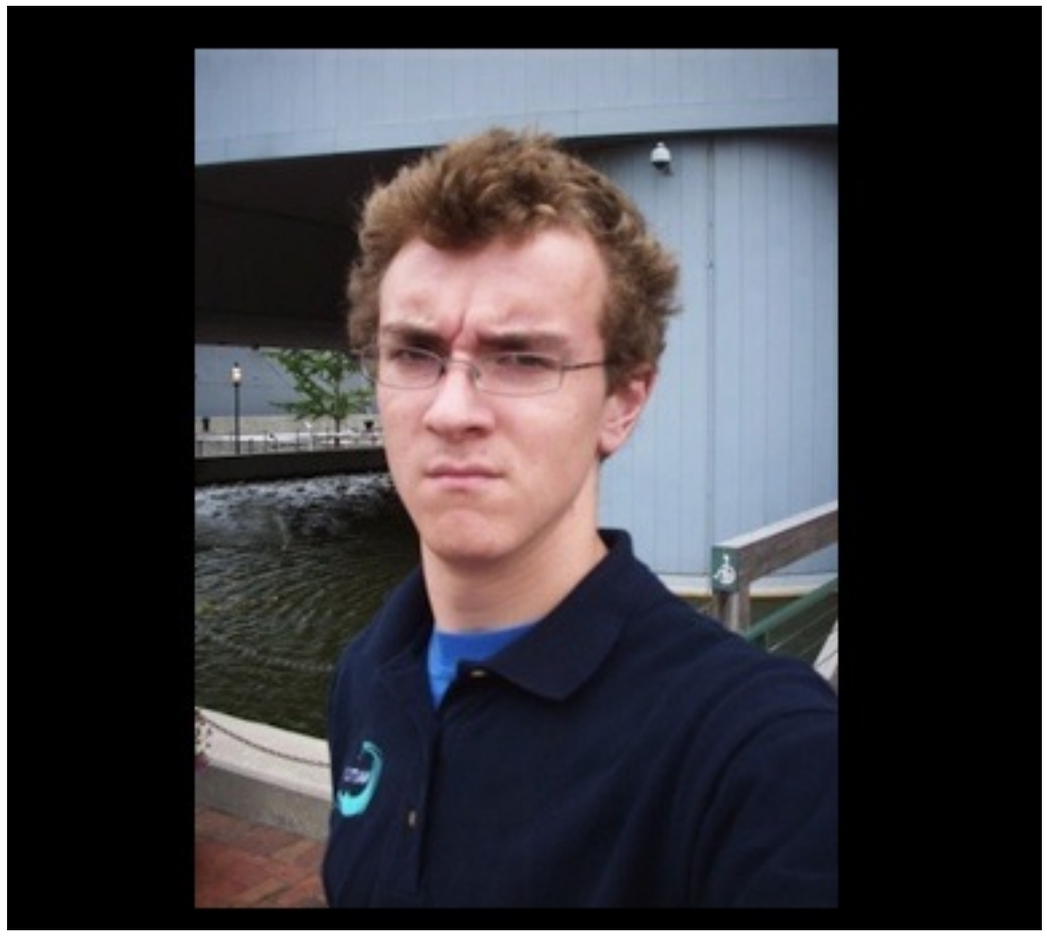
Pour qu'il n'y ait pas de discontinuités:
couleur à la frontière ne change pas

gradient = 0!

Préserver le même contenu que la source
gradient = source

Résultat

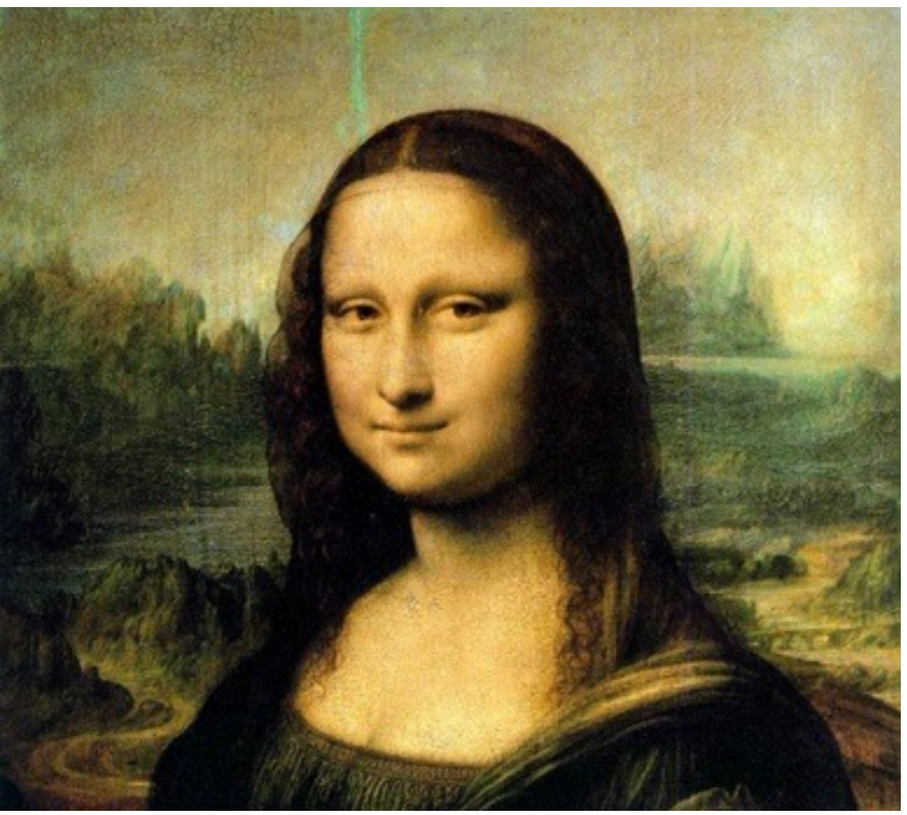
Exemple



Gradients

Source: Evan Wallace

+



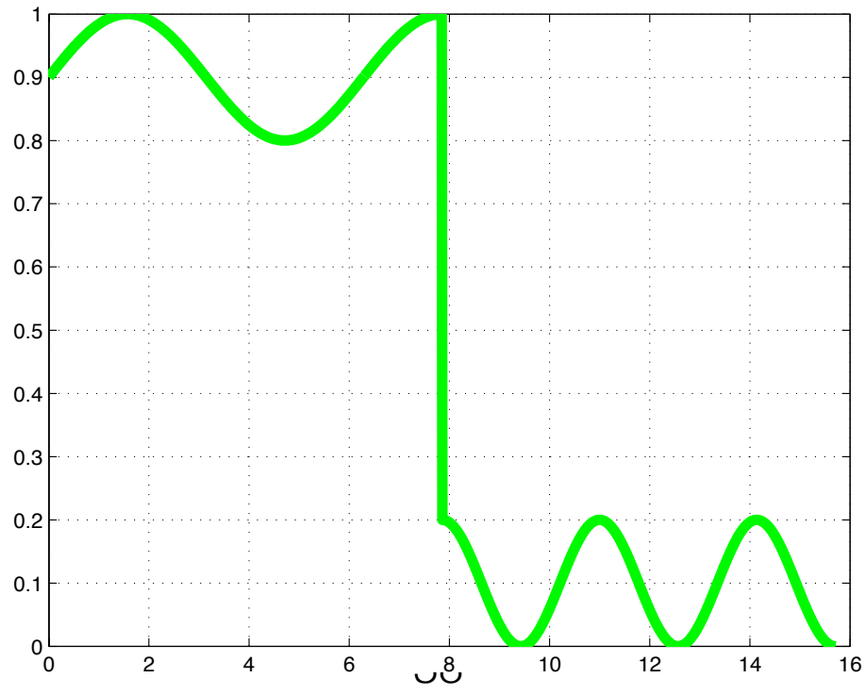
Source: Evan Wallace

Exemple 1D

clair

sombre

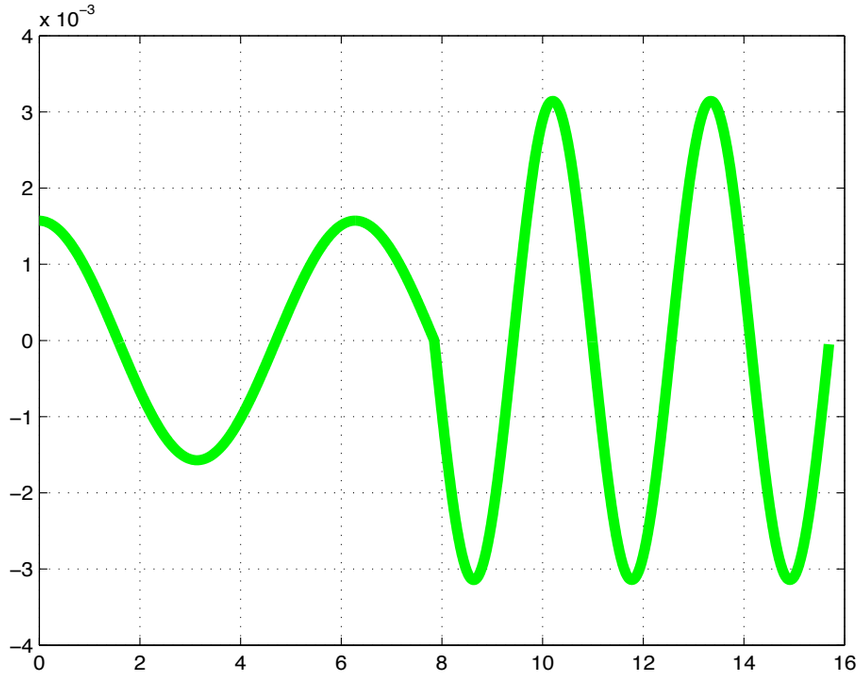
Composition



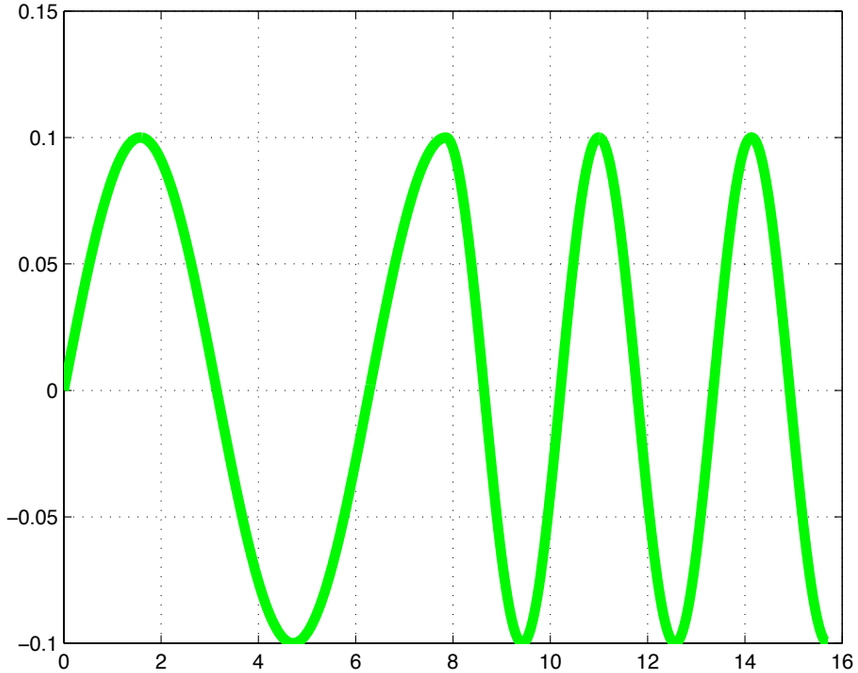
Exemple 1D

Dérivées (gradient)

Composer les gradients

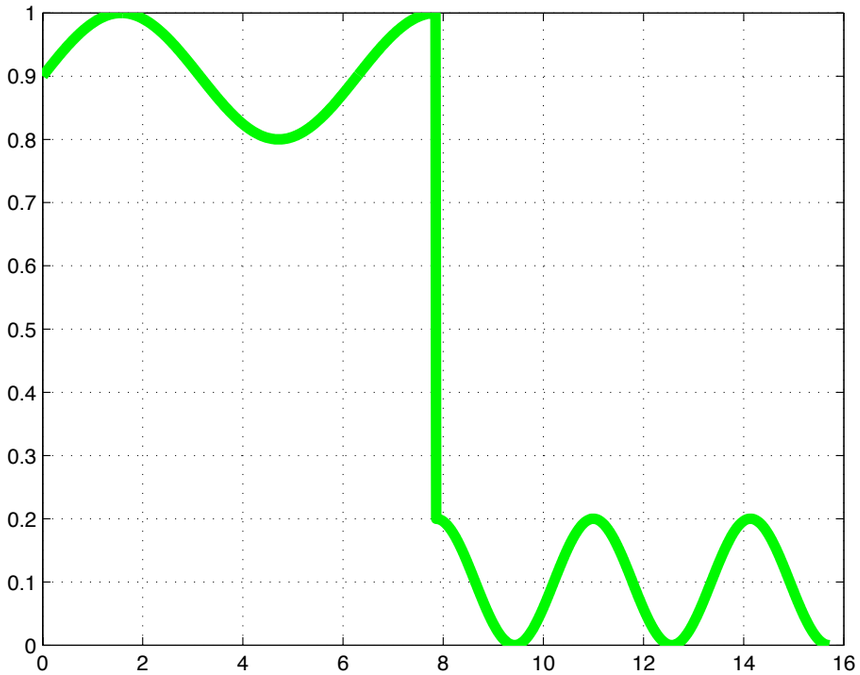


Intégration (somme)

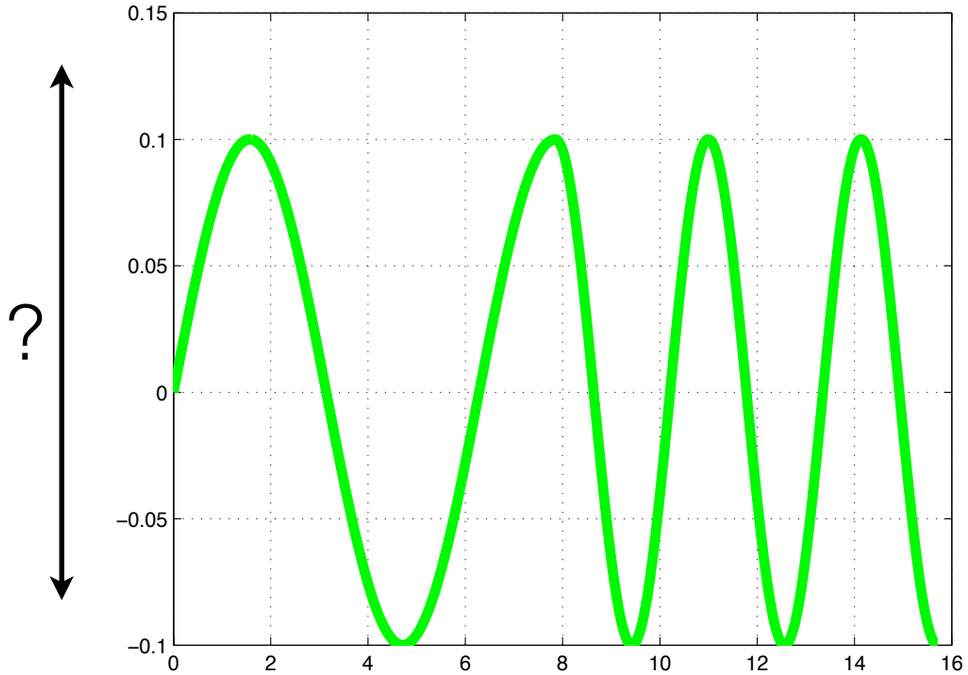


Exemple 1D

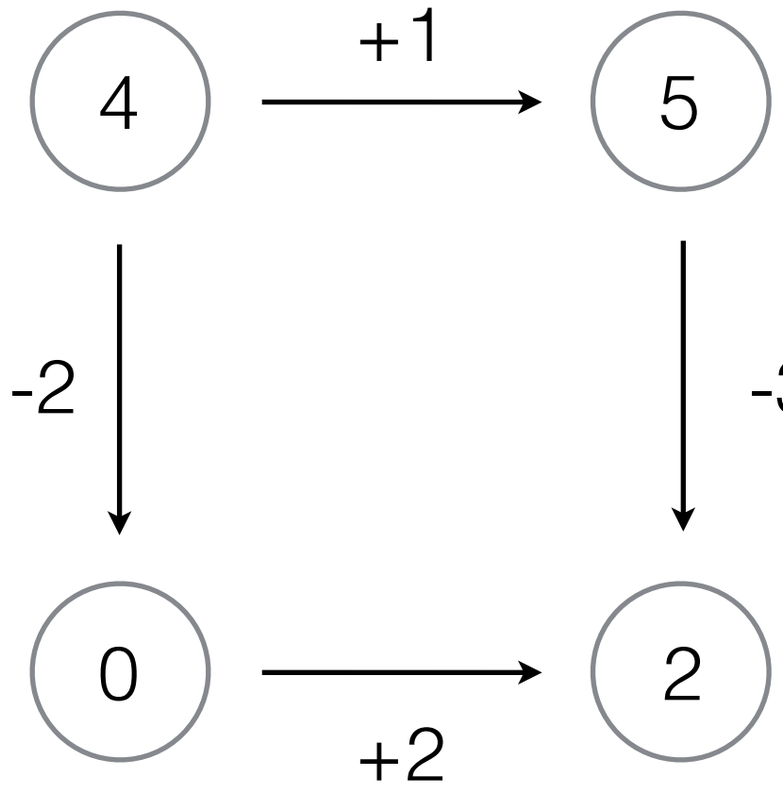
Intensité



Gradients



En 2D? Pas si facile…

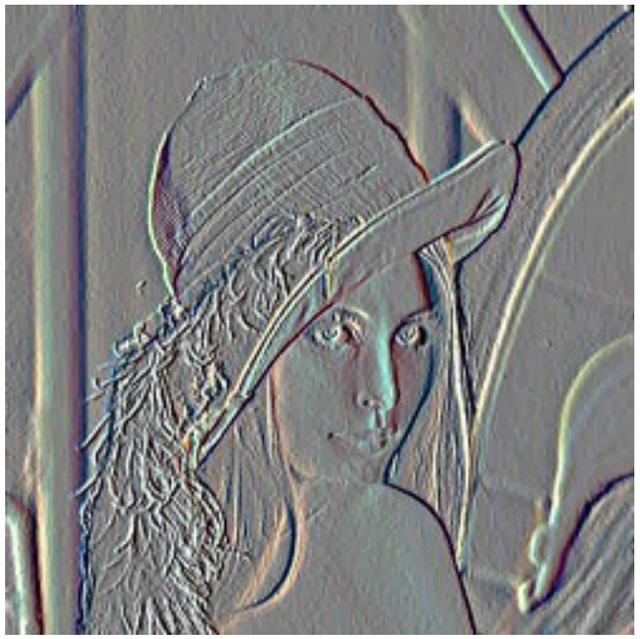


Pas intégrable: somme en boucle ≠ 0

Malheureusement, cela arrive constamment en pratique!

Notation

I

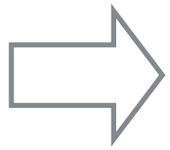


g_x

g_y

$$g_x(x, y) = I(x + 1, y) - I(x, y)$$
$$g_y(x, y) = I(x, y + 1) - I(x, y)$$

Solution en 2D

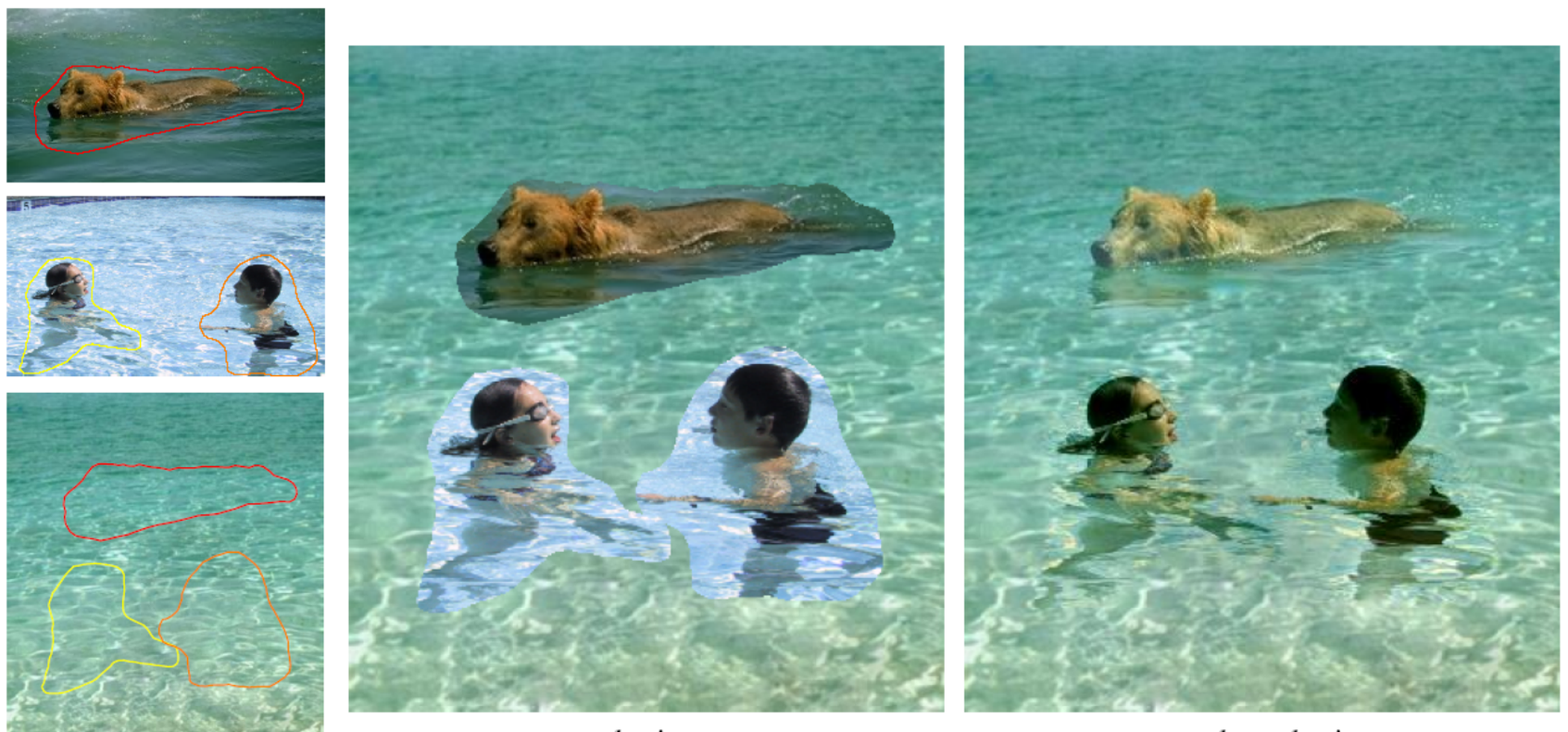


?

$$F$$

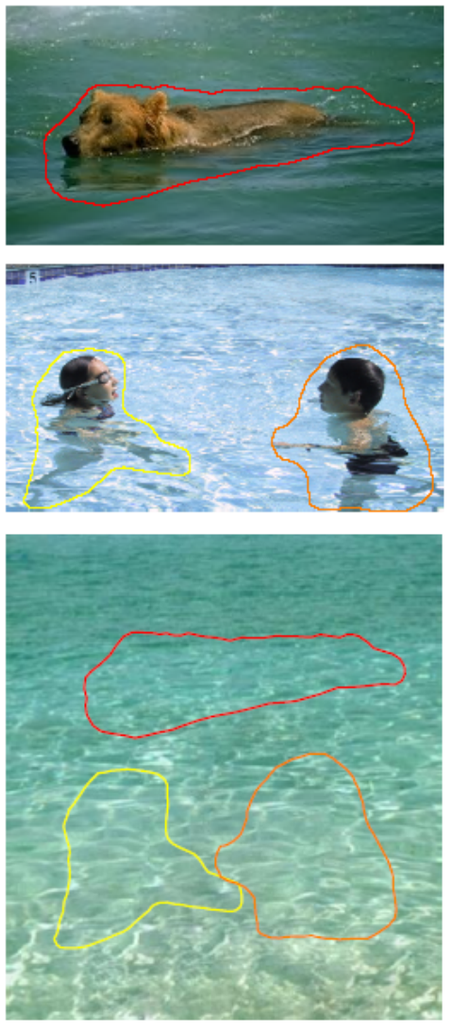
$$F^* = \arg\min_F \sum_x \left(g_x(x,y) - \left(F(x+1,y) - F(x,y)\right)\right)^2 + \sum_y \left(g_y(x,y) - \left(F(x,y+1) - F(x,y)\right)\right)^2$$

Résultats



Perez et al. 2003

Qu’est-ce qu’on perd?



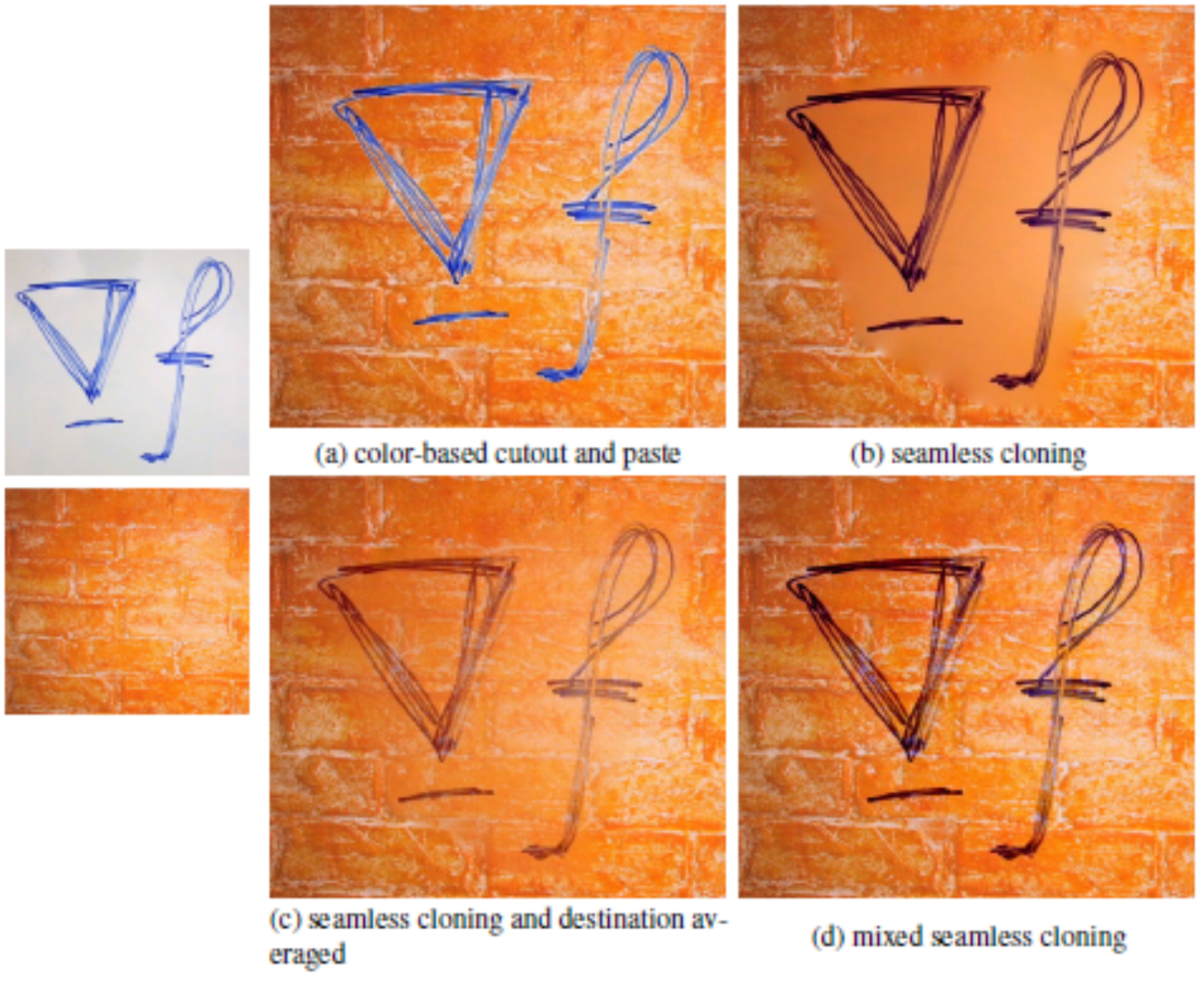
sources/destinations

cloning

seamless cloning

Perez et al. 2003

Choisir les gradients



(a) color-based cutout and paste

(b) seamless cloning

(c) seamless cloning and destination averaged

(d) mixed seamless cloning

Perez et al. 2003

Application: “peindre” des gradients

http://graphics.cs.cmu.edu/projects/gradient-paint/