

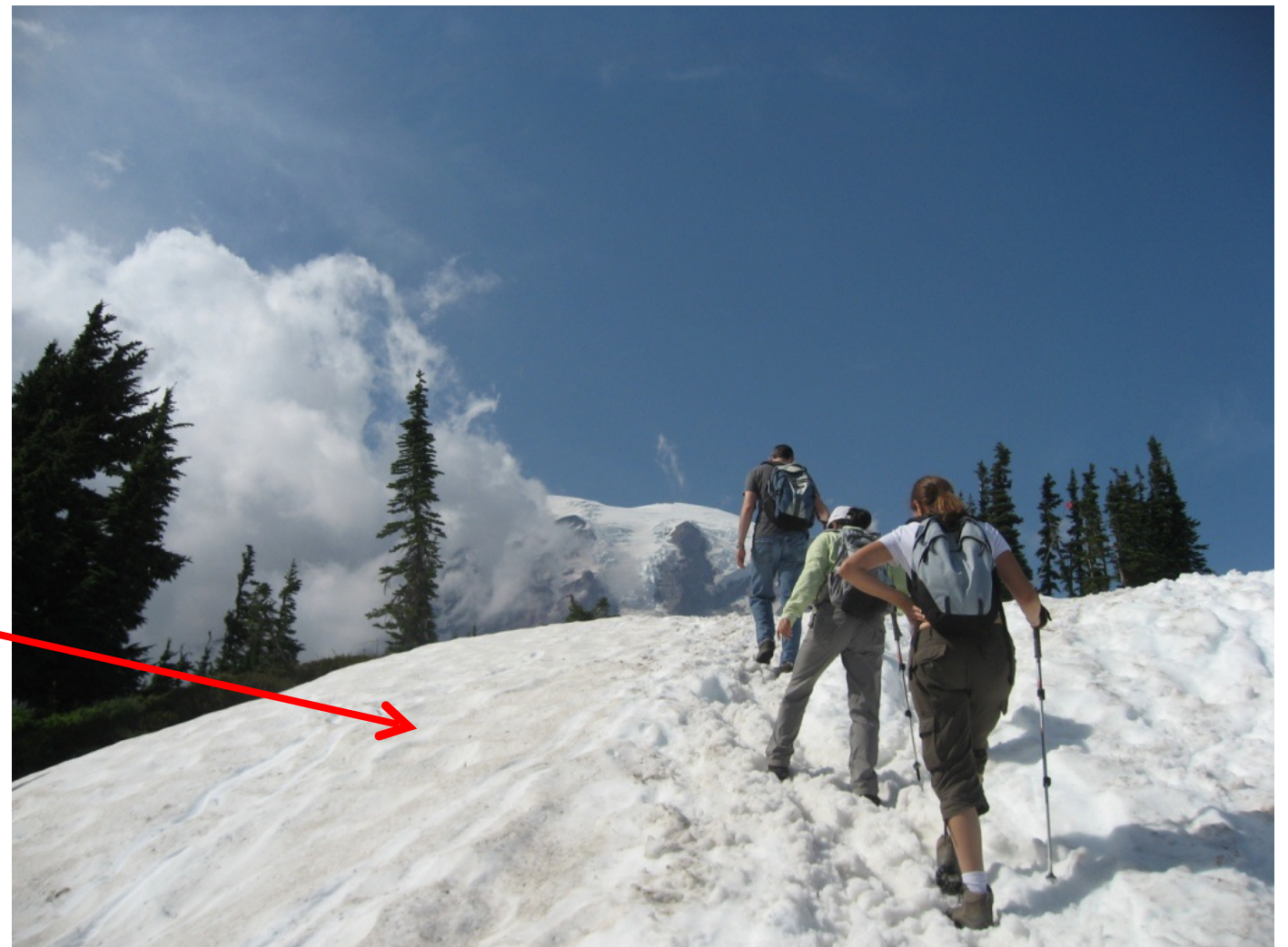
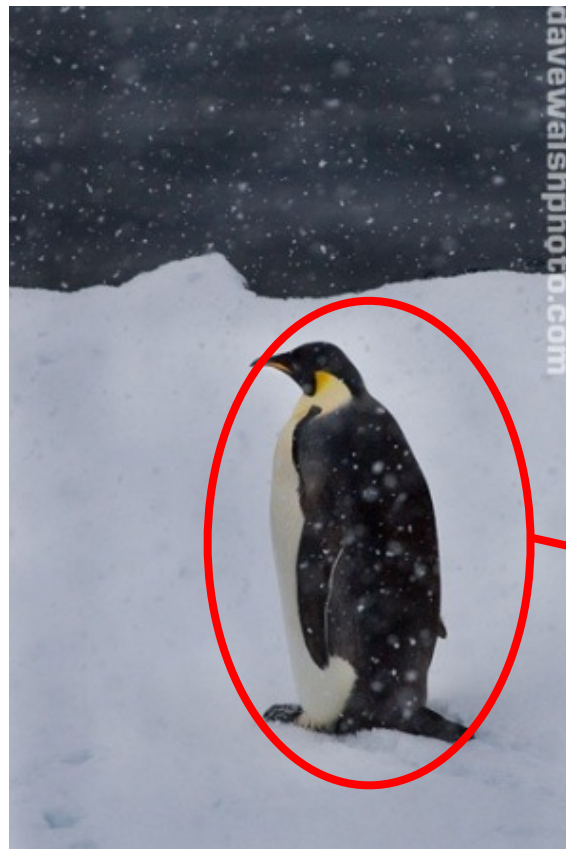
# Mélange d'images



GIF-4105/7105 Photographie Algorithmique, Hiver 2019  
Jean-François Lalonde

# Aujourd'hui

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





# Composition d'images



# Dans les nouvelles...

Image  
originale



Image  
"améliorée"





# Dans les nouvelles...

Images originales



Image "améliorée"





# Méthode 1 : copier-coller

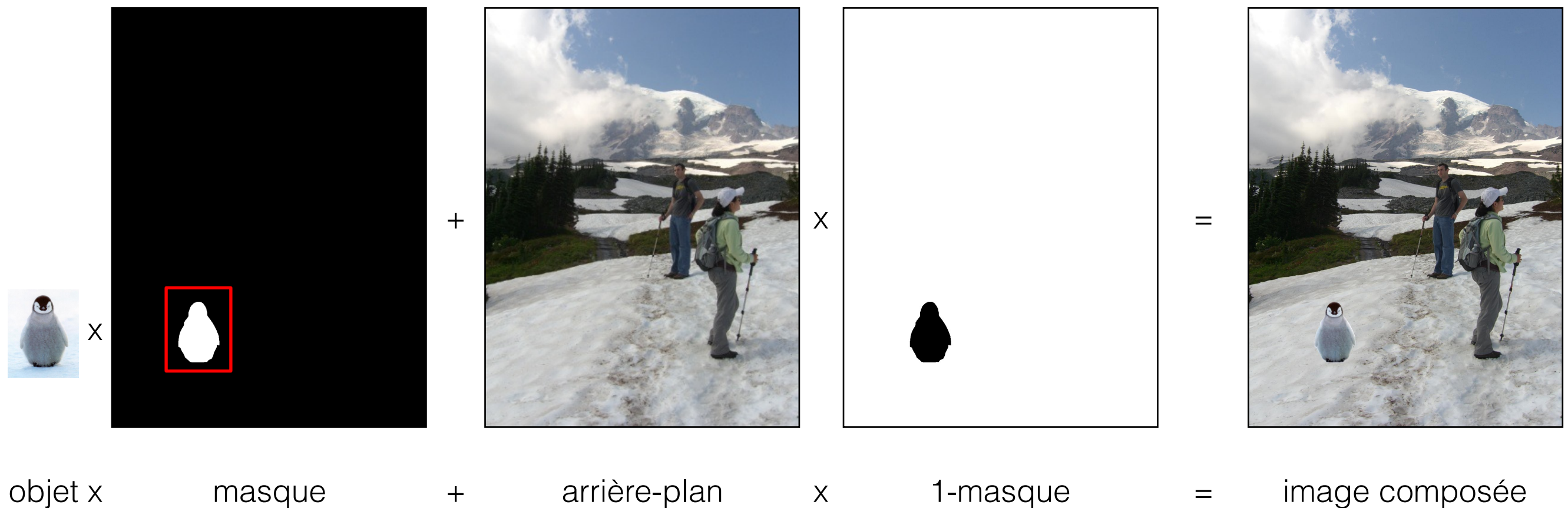




# Méthode 1 : copier-coller



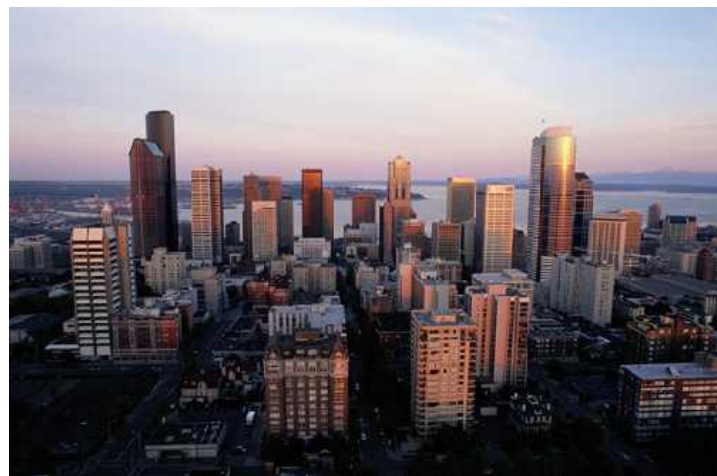
# Méthode 1 : copier-coller



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



# Autre exemple



# Problèmes?

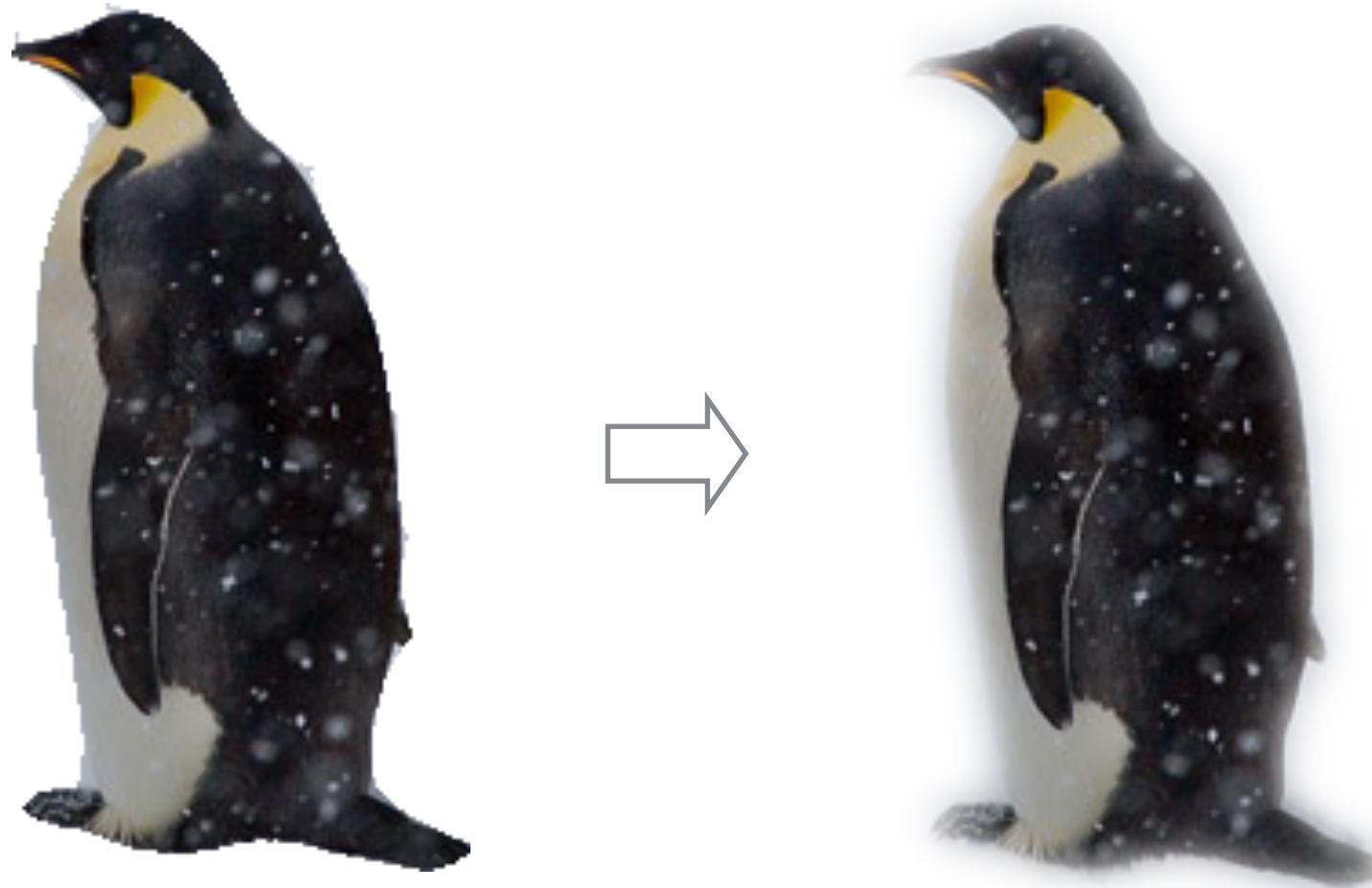
- Segmentation doit être parfaite!
- Pixel peut capturer plusieurs objets:
  - Chevaucher deux objets
  - Flou
  - Mouvement
  - Transparence





# Dégradé (feathering)

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



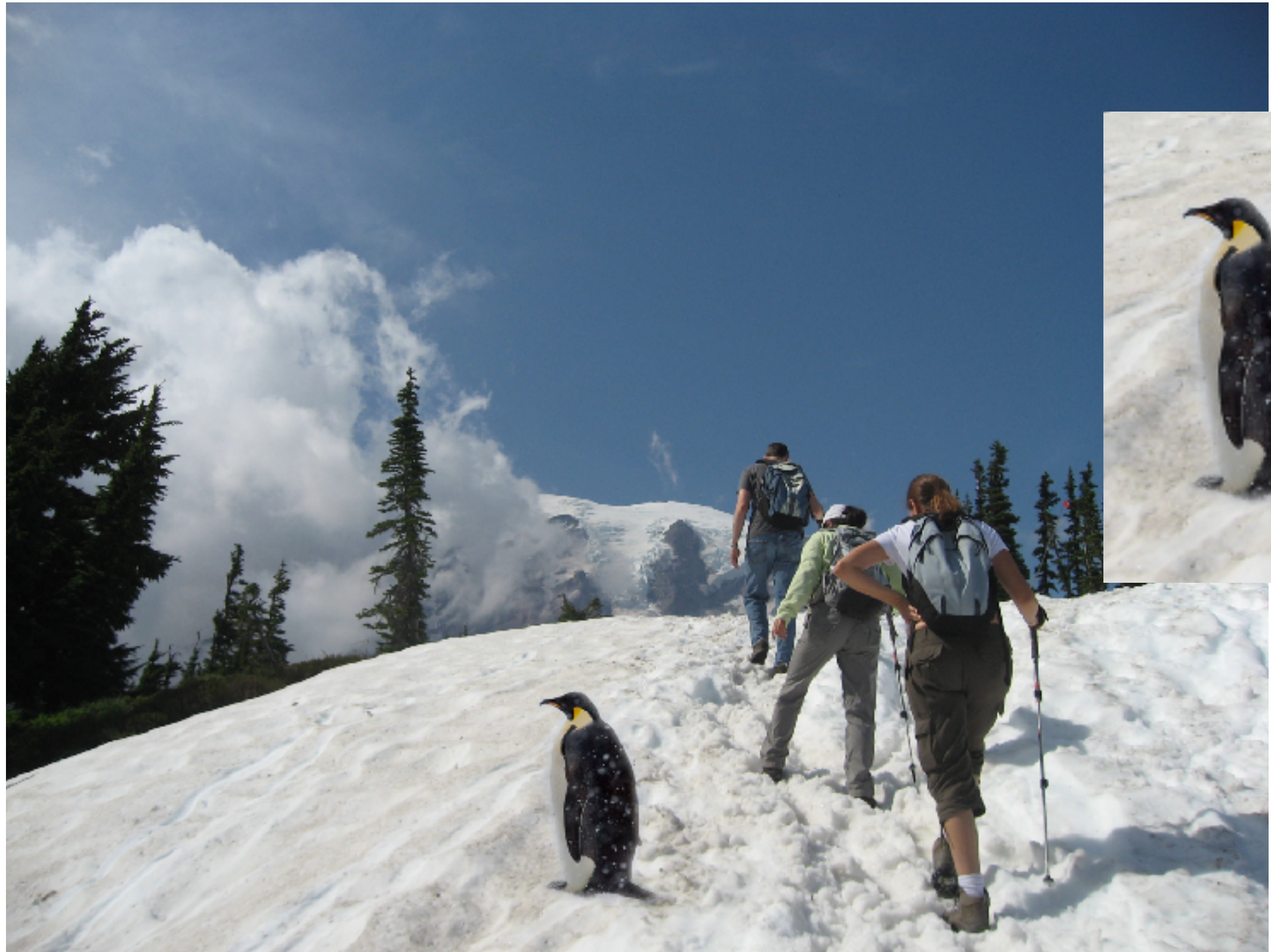
# Composition avec dégradé



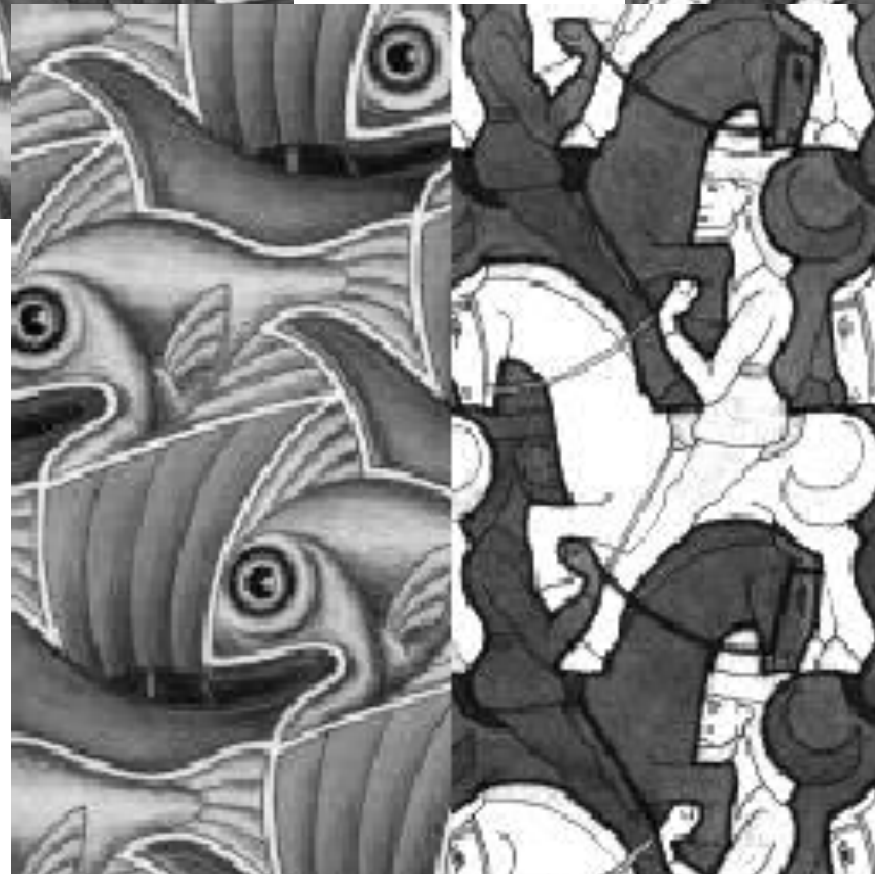
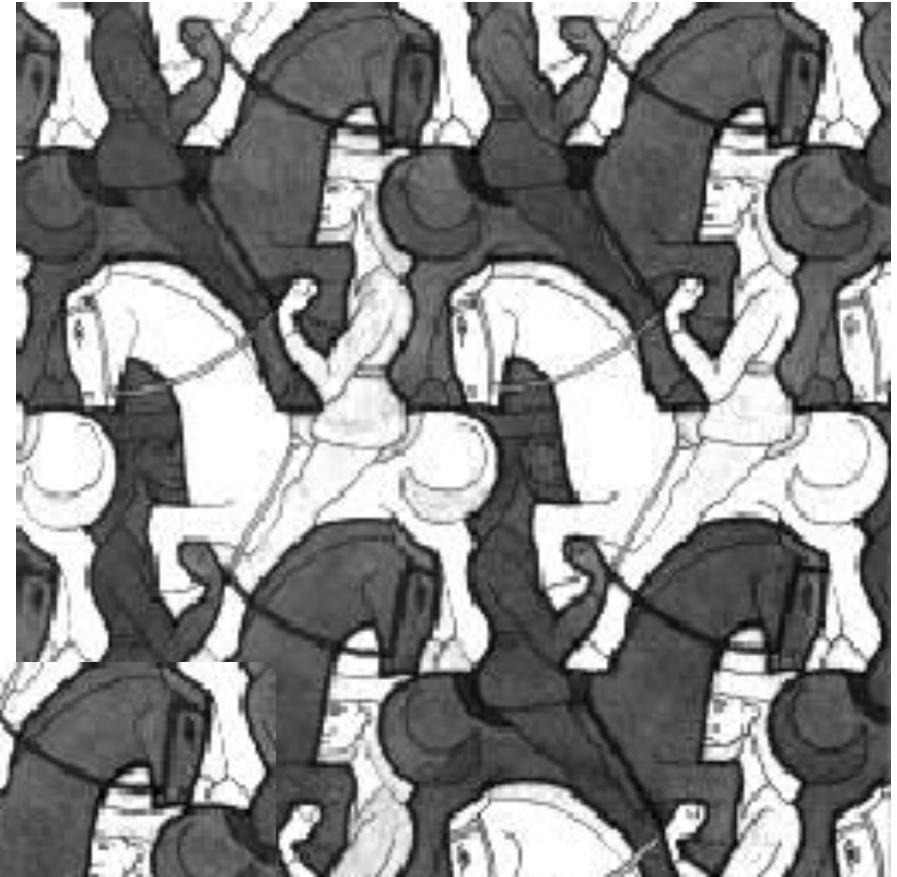
$$I = \alpha F +_{12} (1 - \alpha) B$$



# Approche 1: copier-coller (avec dégradé)

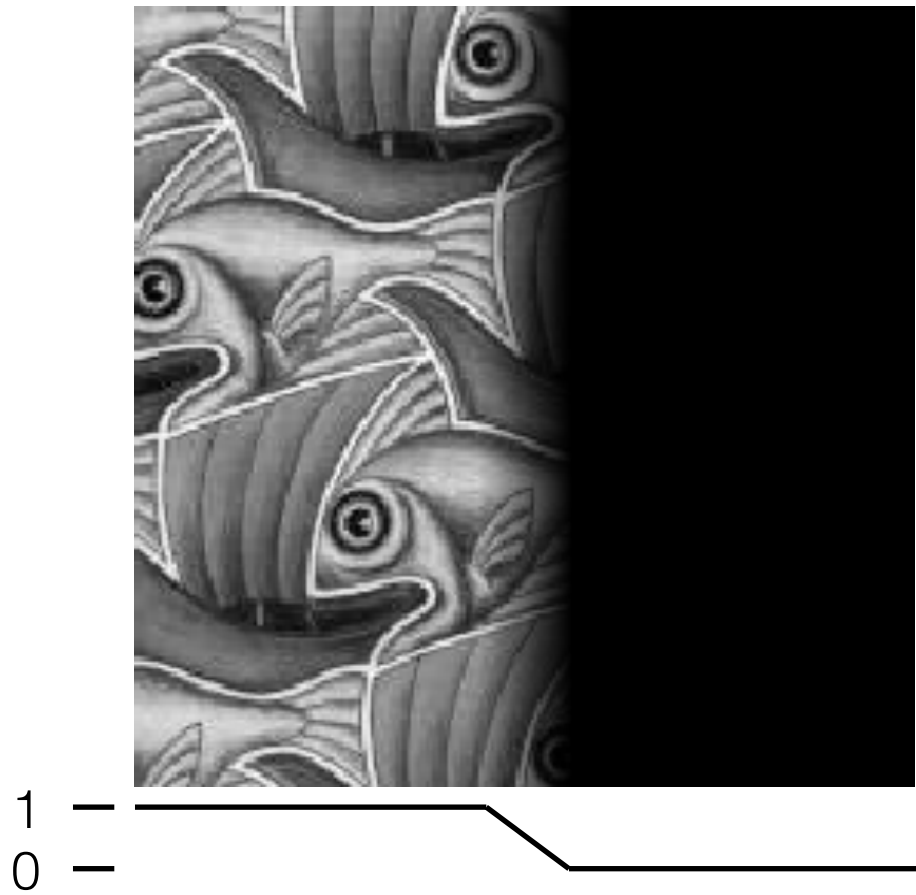


# Niveau de dégradé?

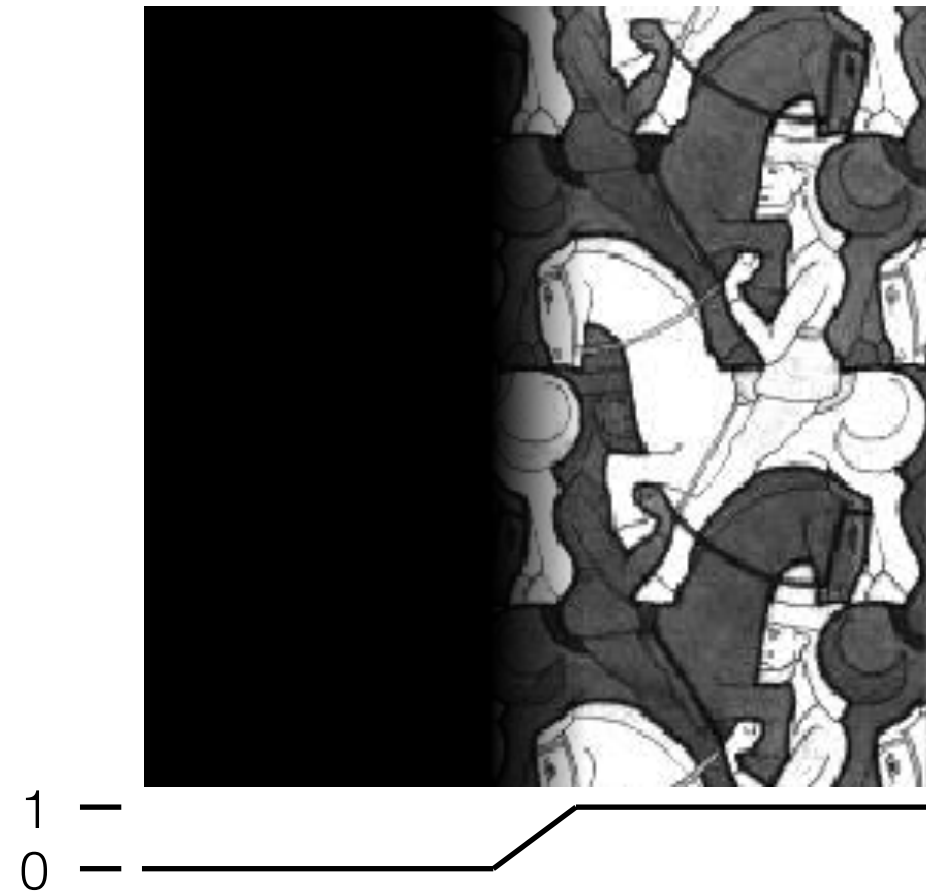




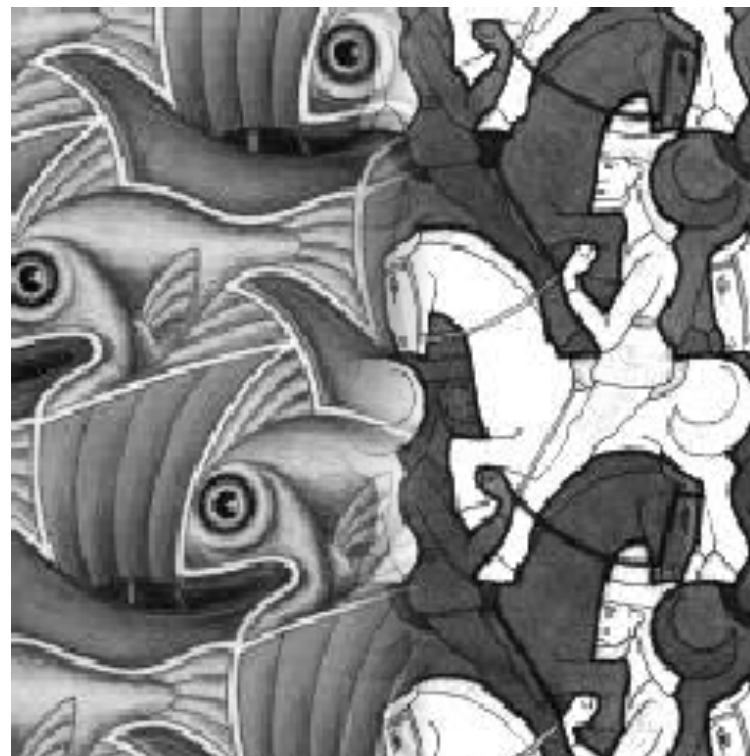
# Niveau de dégradé?



+

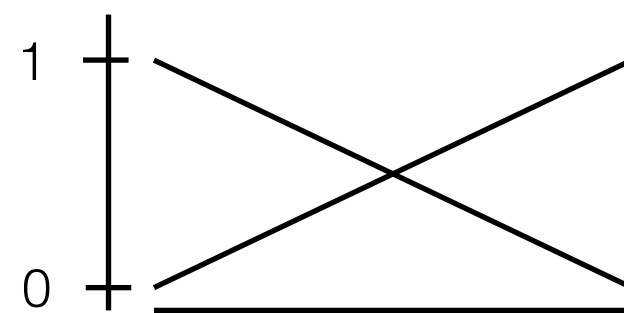
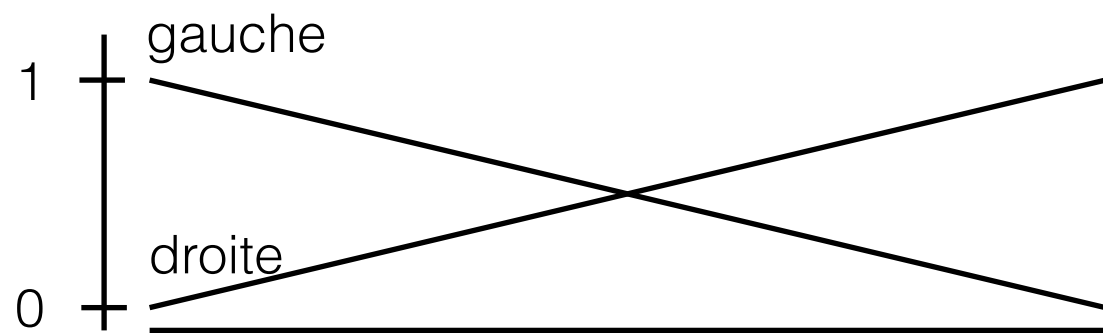
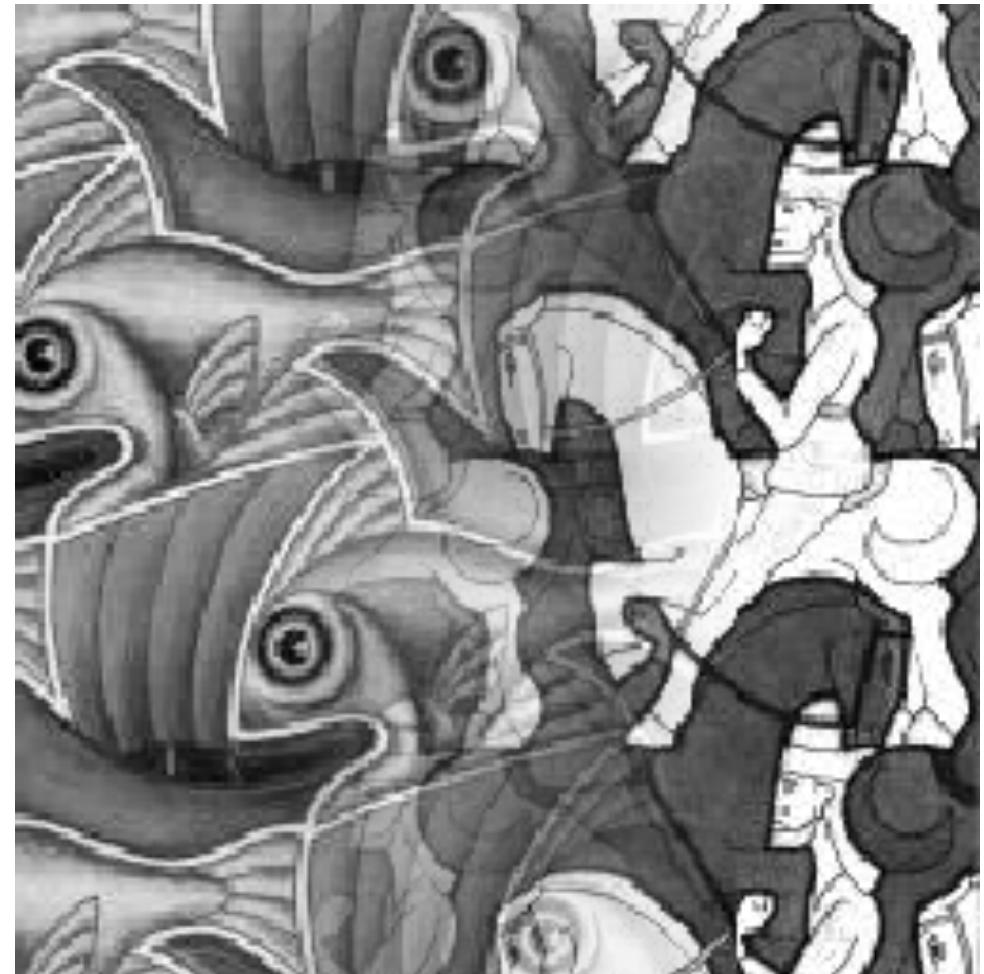
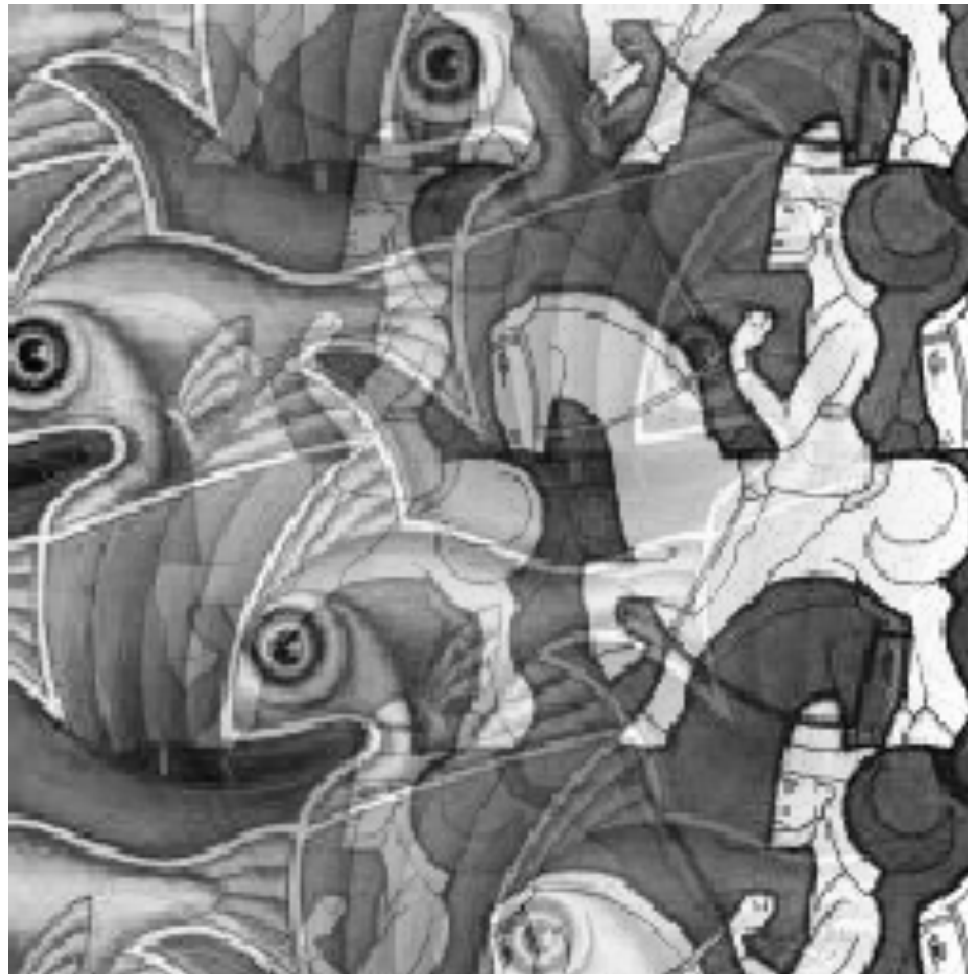


=



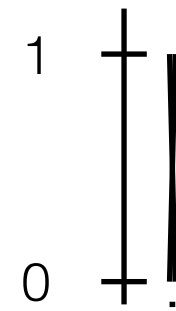
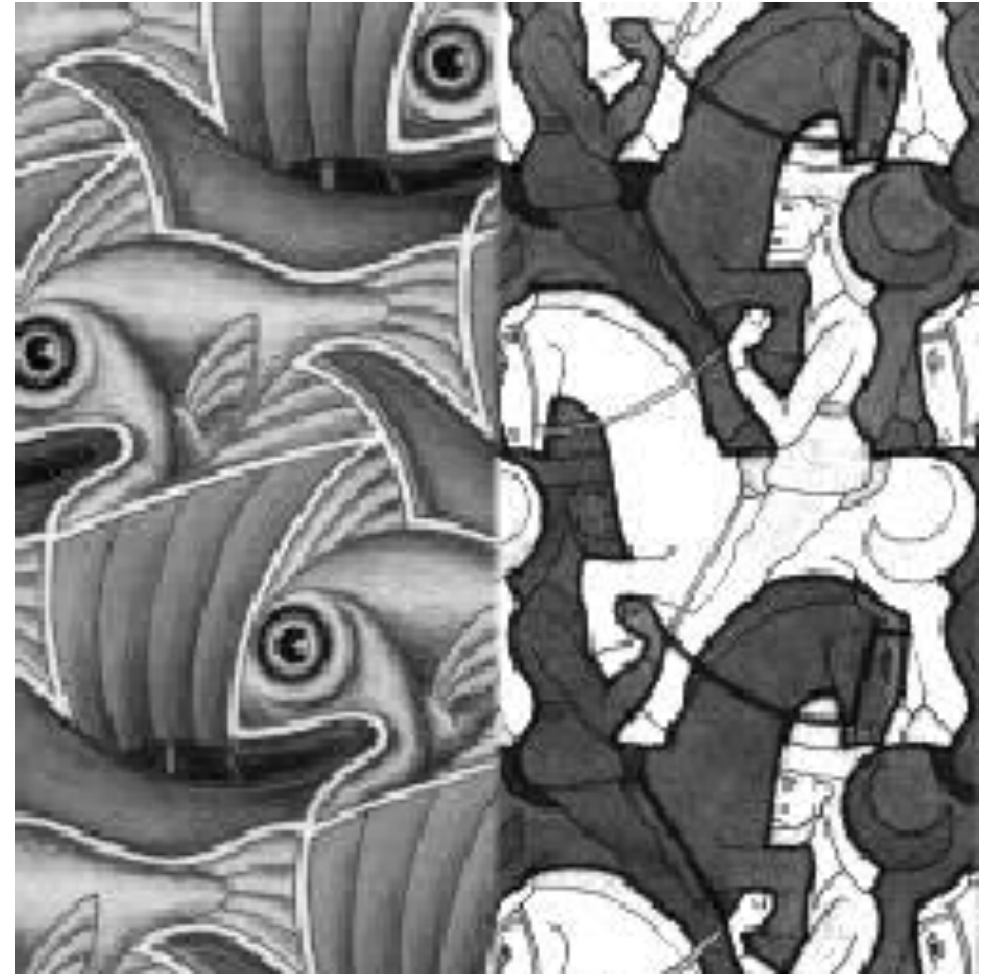
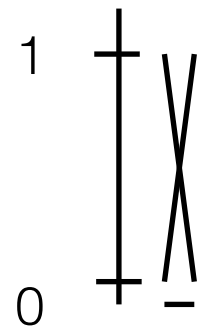
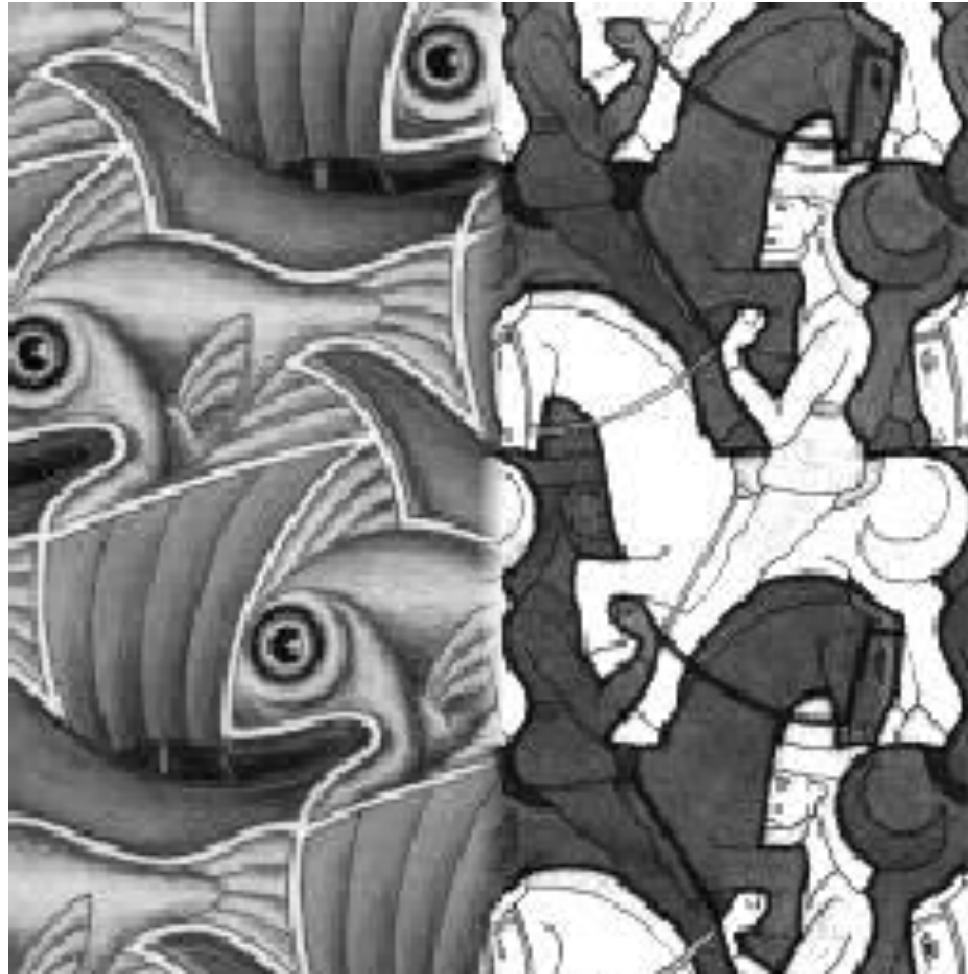
$$I = \alpha I_{gauche} + (1 - \alpha) I_{droite}$$

# Taille de la fenêtre

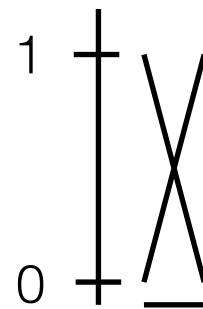




# Taille de la fenêtre



# Bonne fenêtre

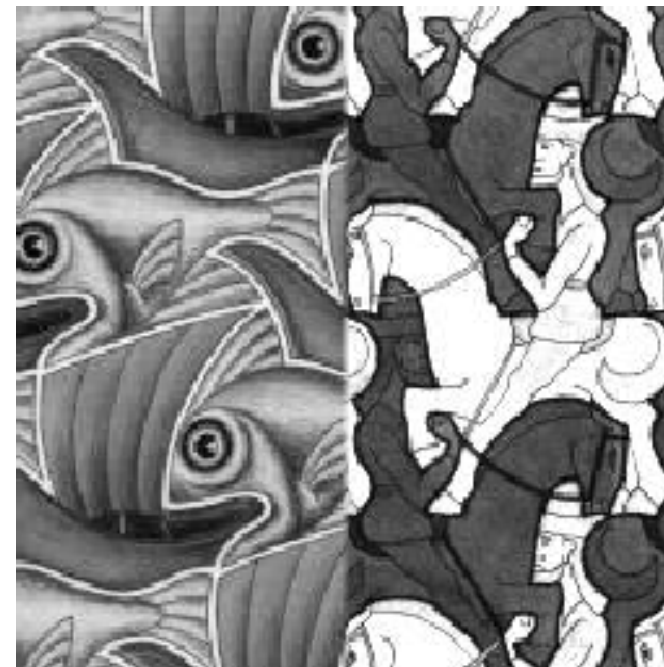
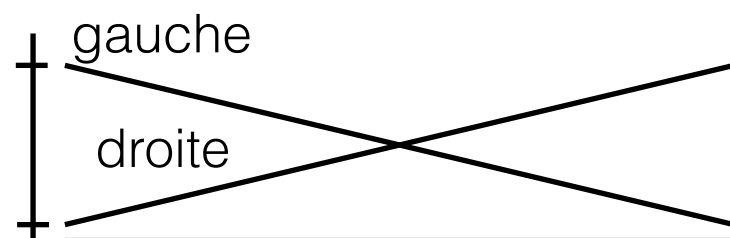
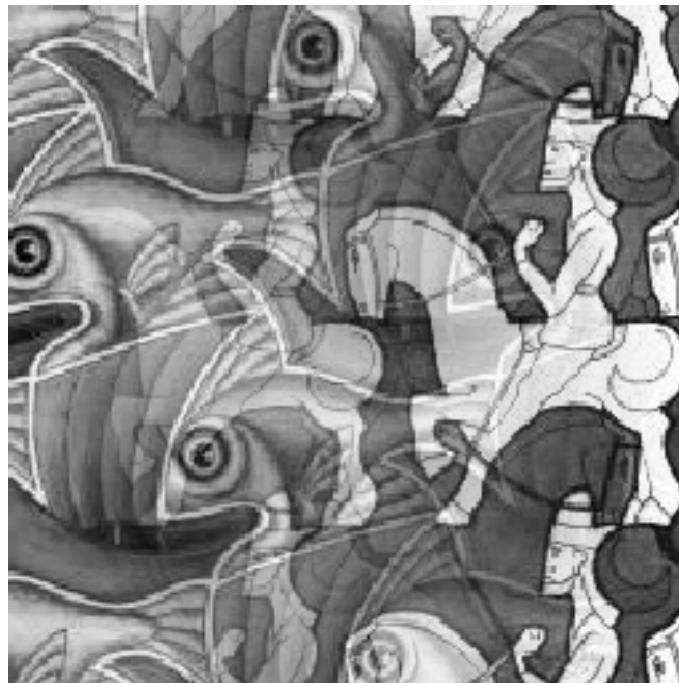


Fenêtre “optimale”: douce transition, sans fantômes (ghosting)

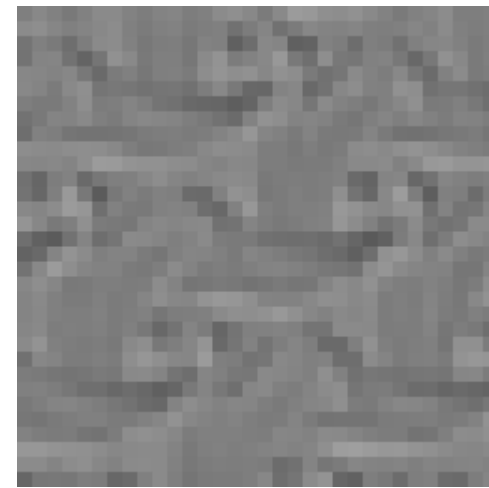
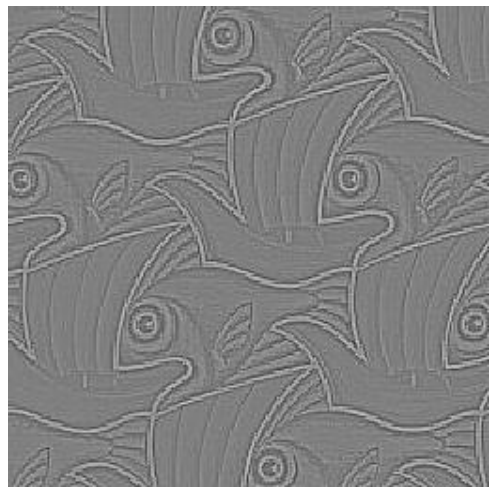
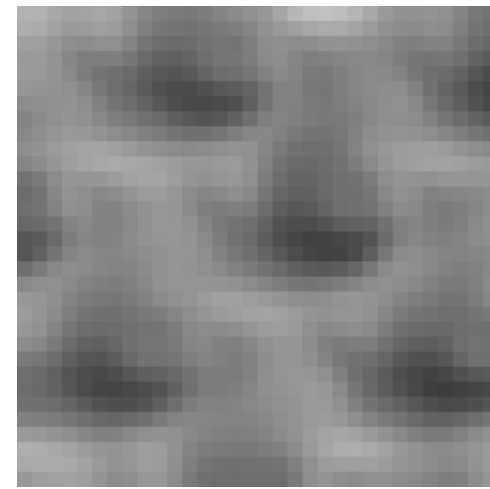
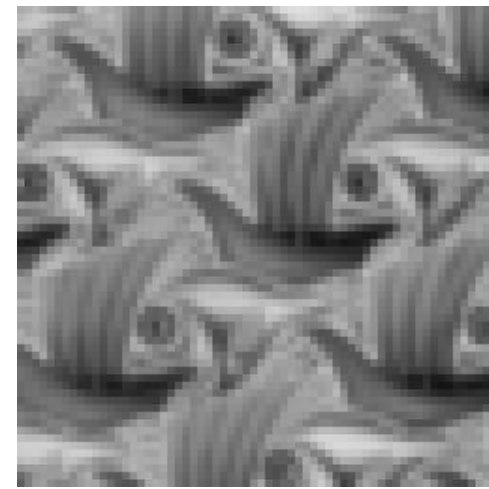
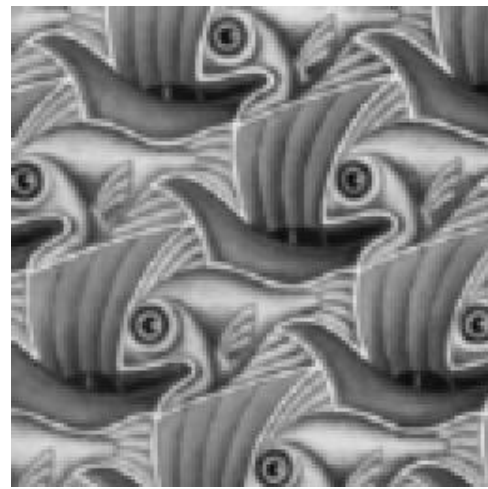


# Quelle est la taille de fenêtre optimale?

- 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!

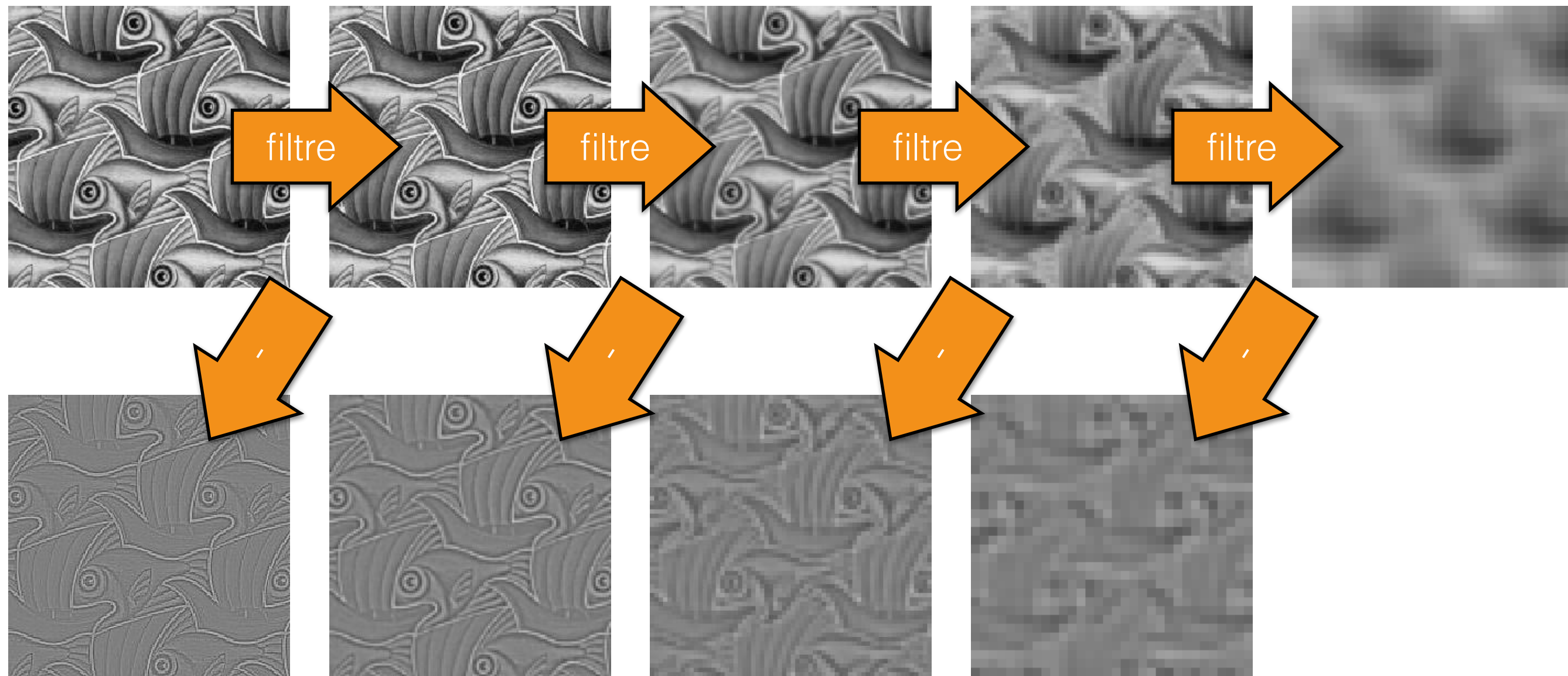


# Décomposition en « bandes de fréquences »



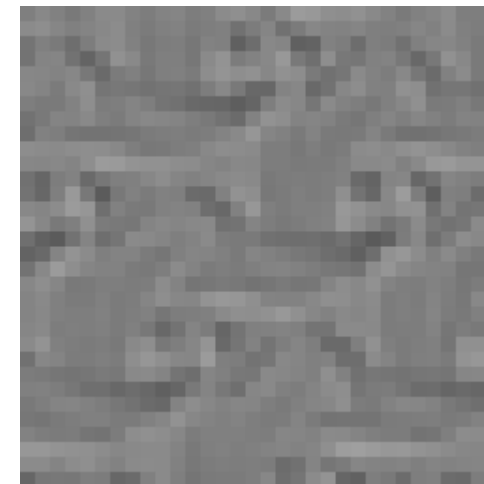


# Décomposition en « bandes de fréquences »



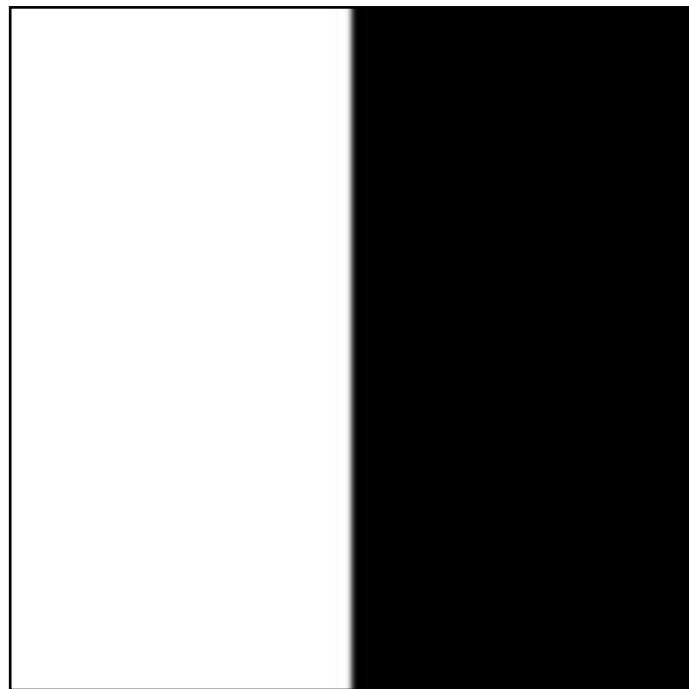
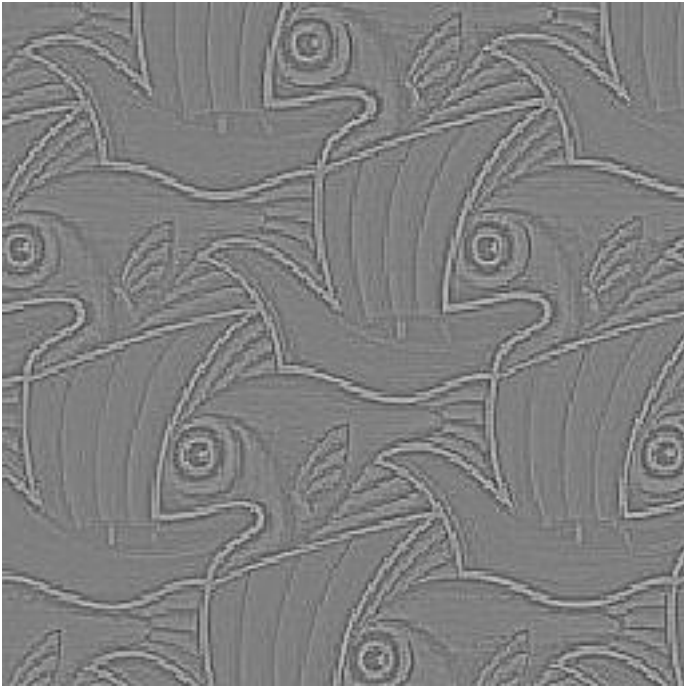
# Décomposition en « bandes de fréquences »

Pile Laplacienne!



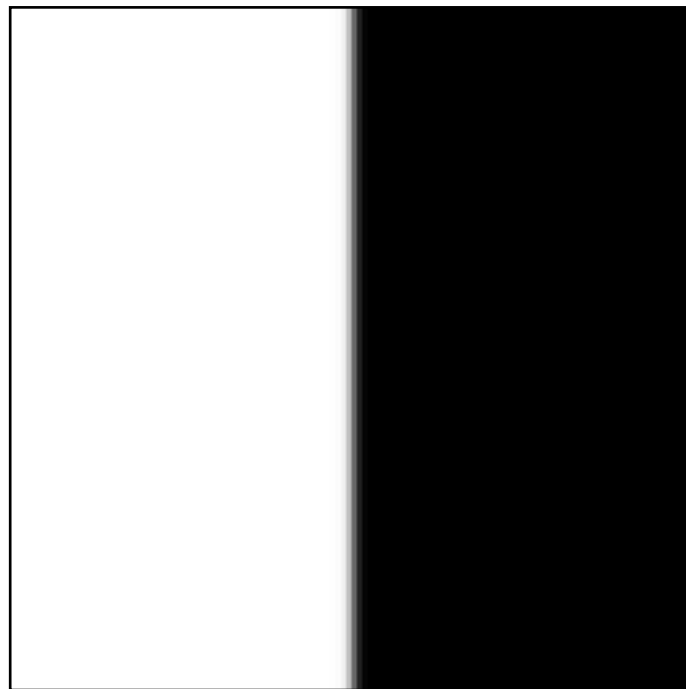
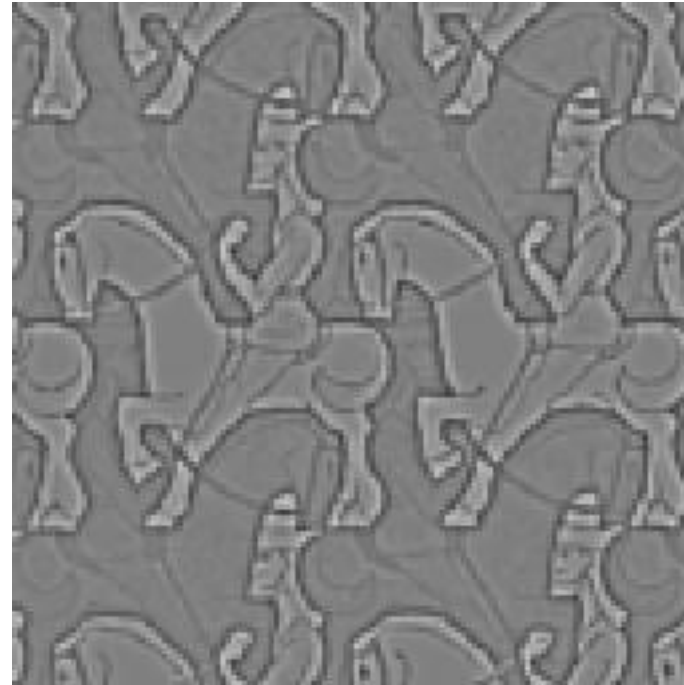


Allons-y une « bande de fréquences » à la fois



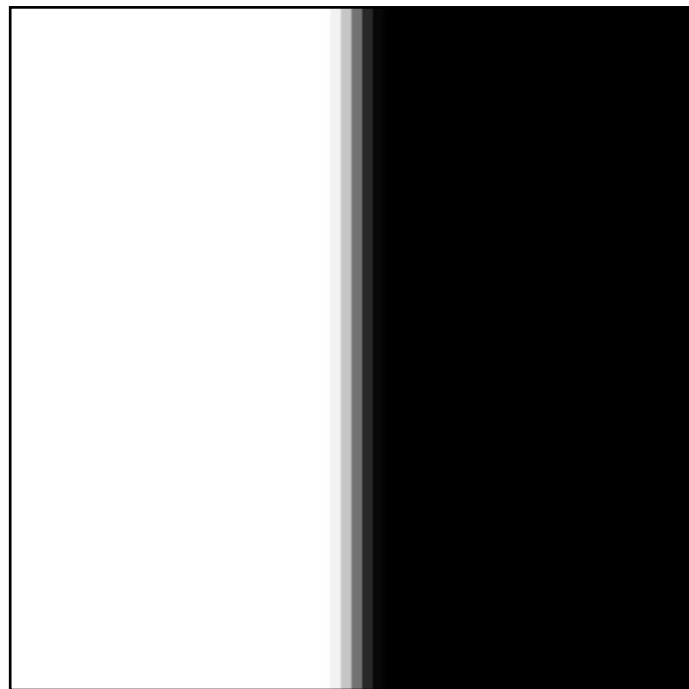
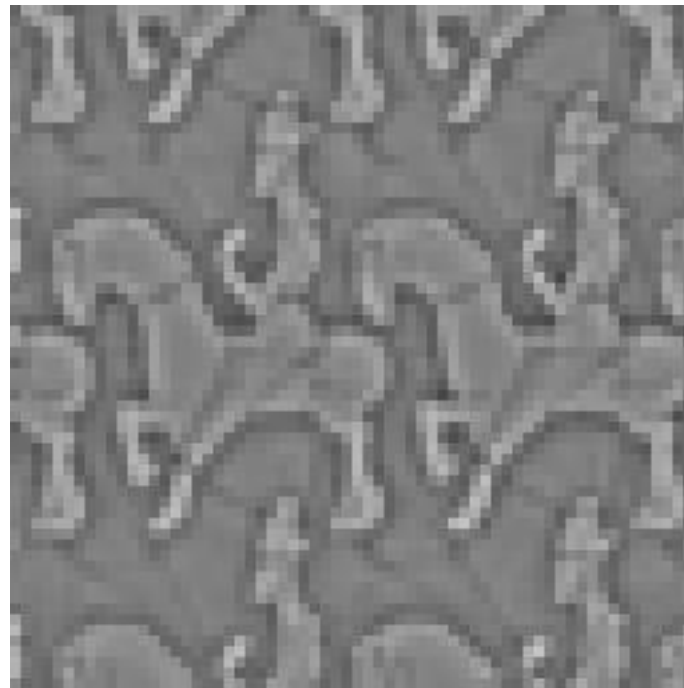
« bande de fréquences »: octave

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



« bande de fréquences »: octave

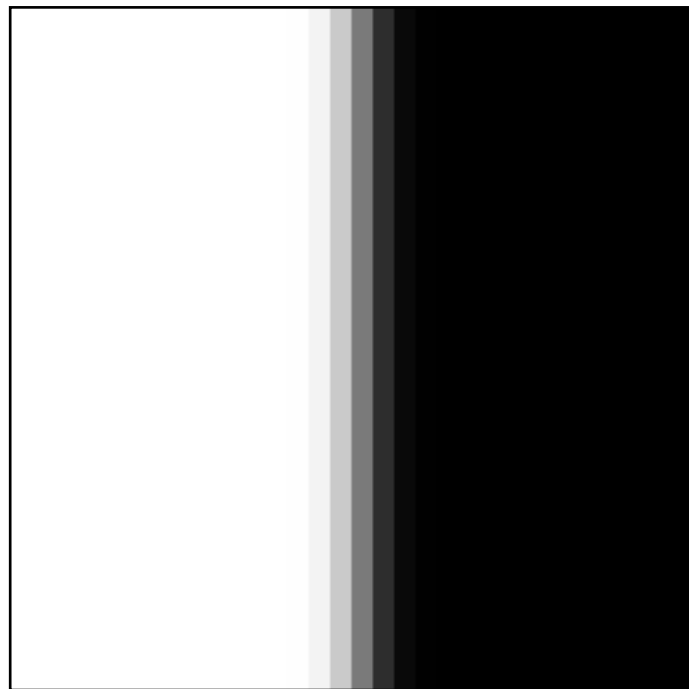
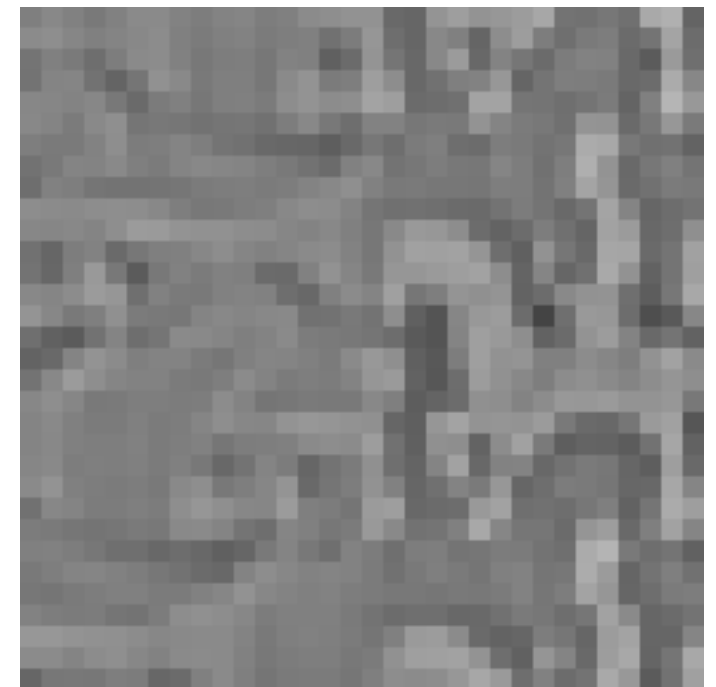
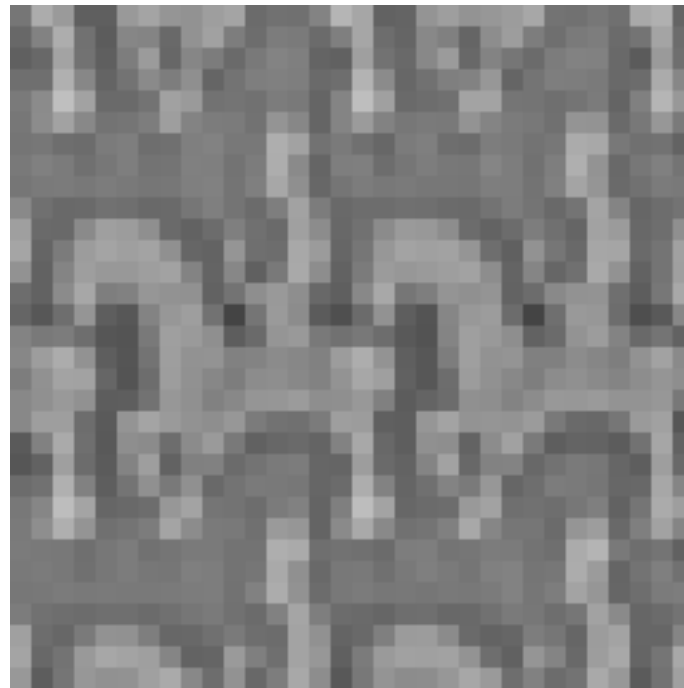
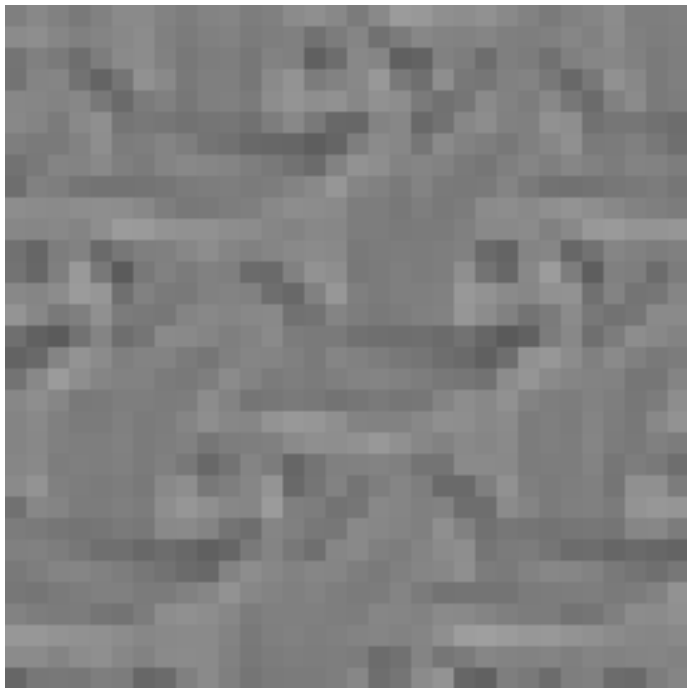
Allons-y une « bande de fréquences » à la fois



« bande de fréquences »: octave

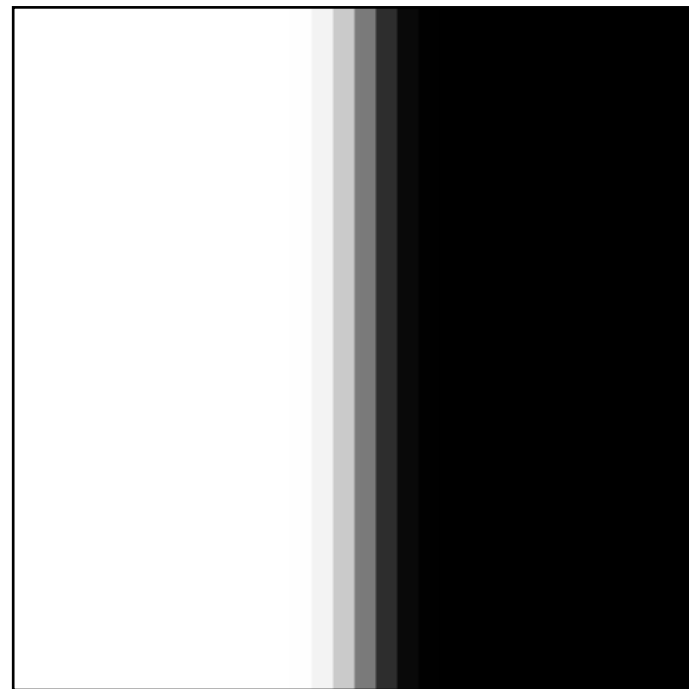
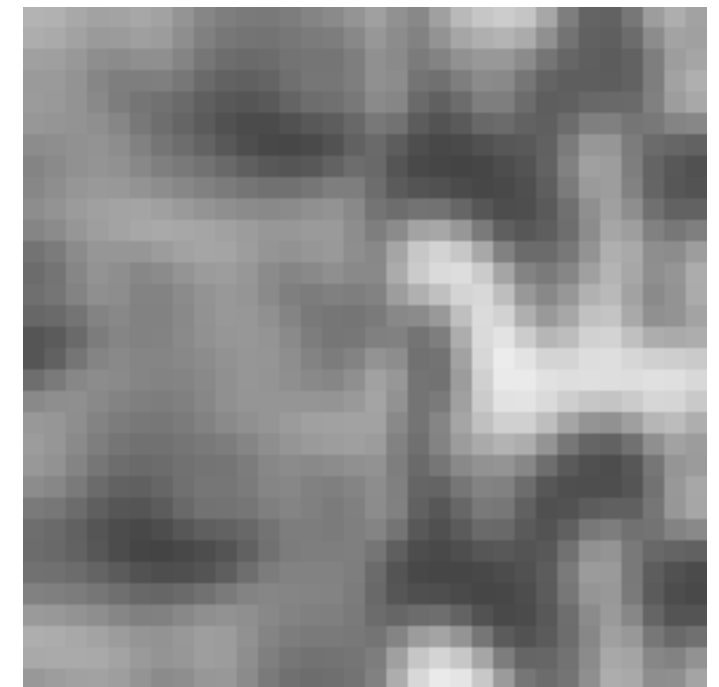
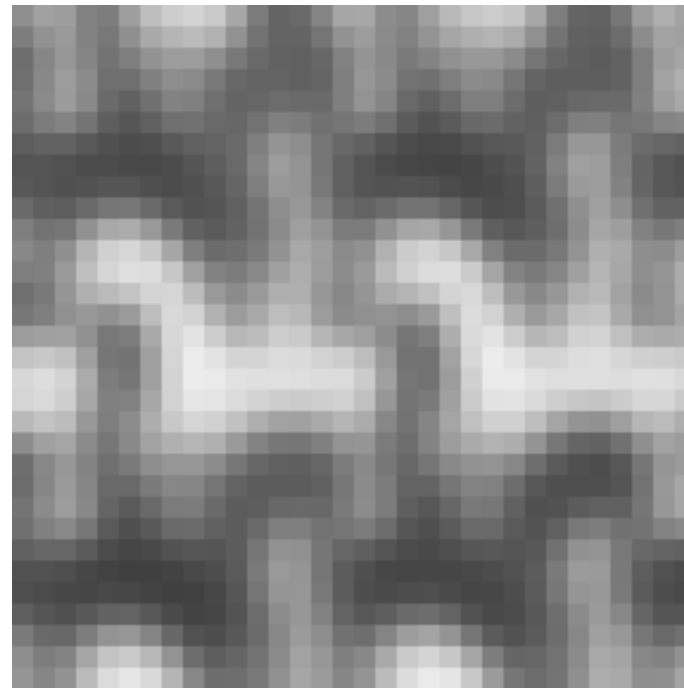


Allons-y une « bande de fréquences » à la fois



« bande de fréquences »: octave

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

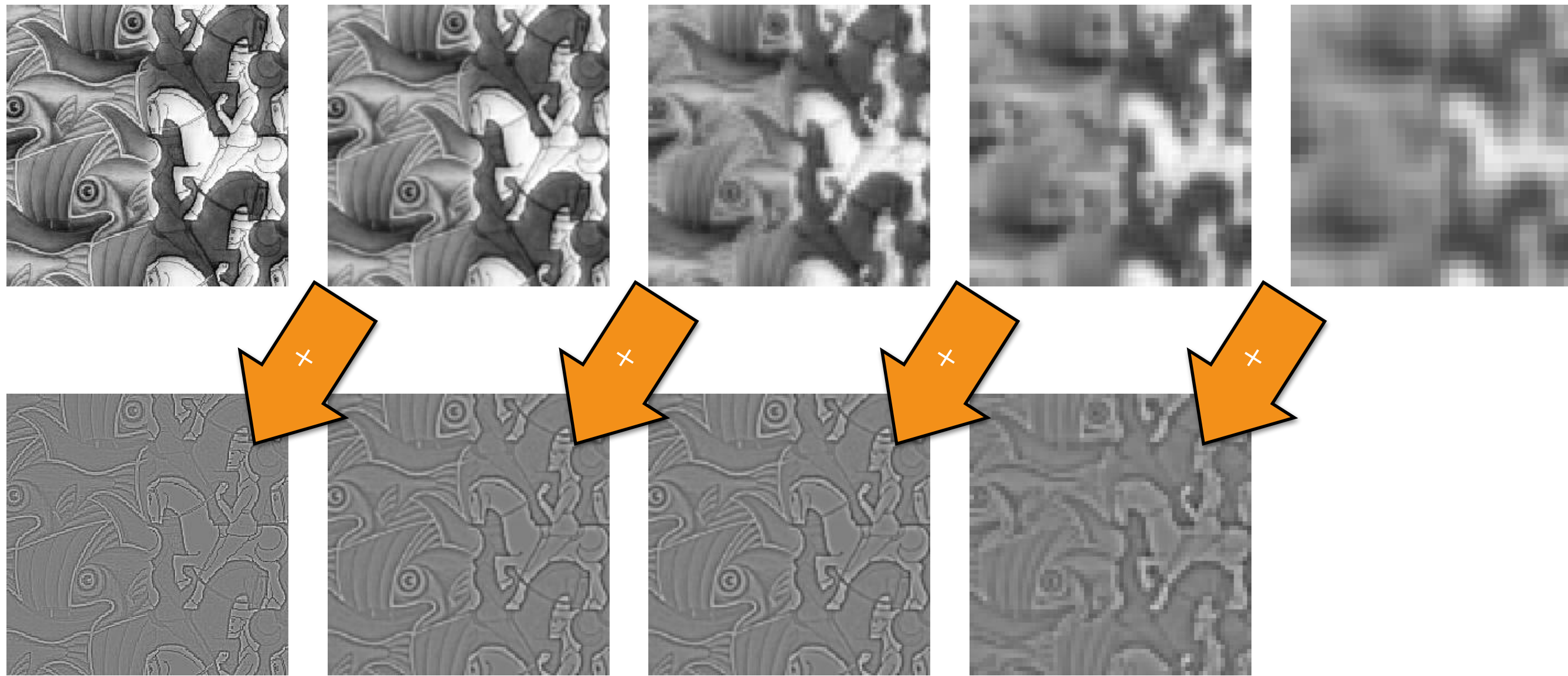


« bande de fréquences »: octave

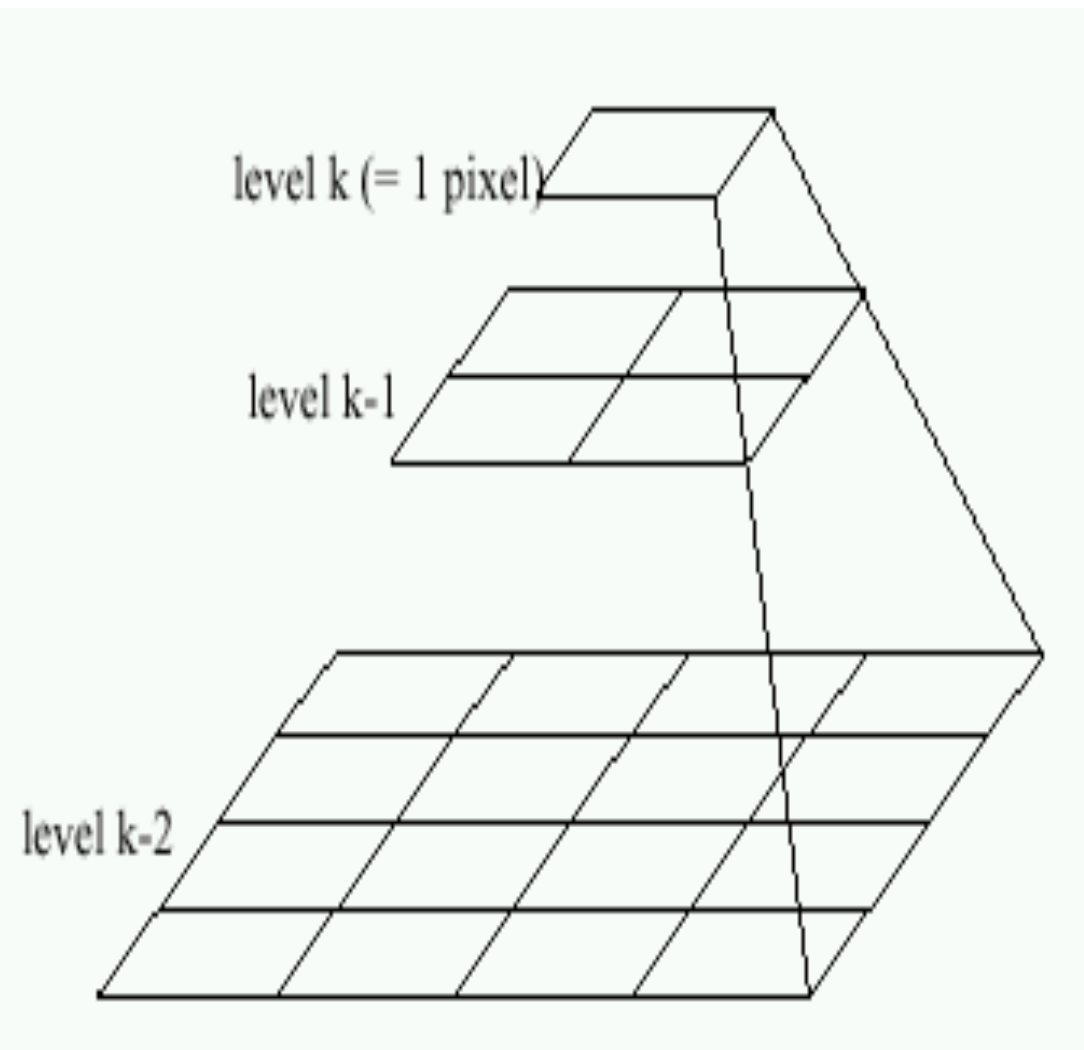


# Décomposition en « bandes de fréquences »

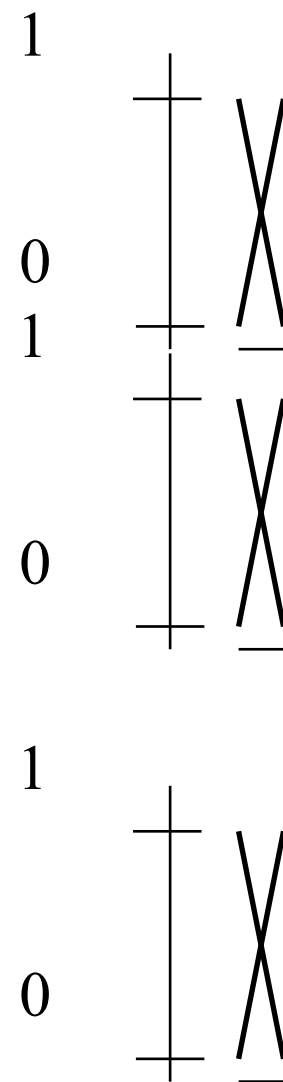
Pile Laplacienne!



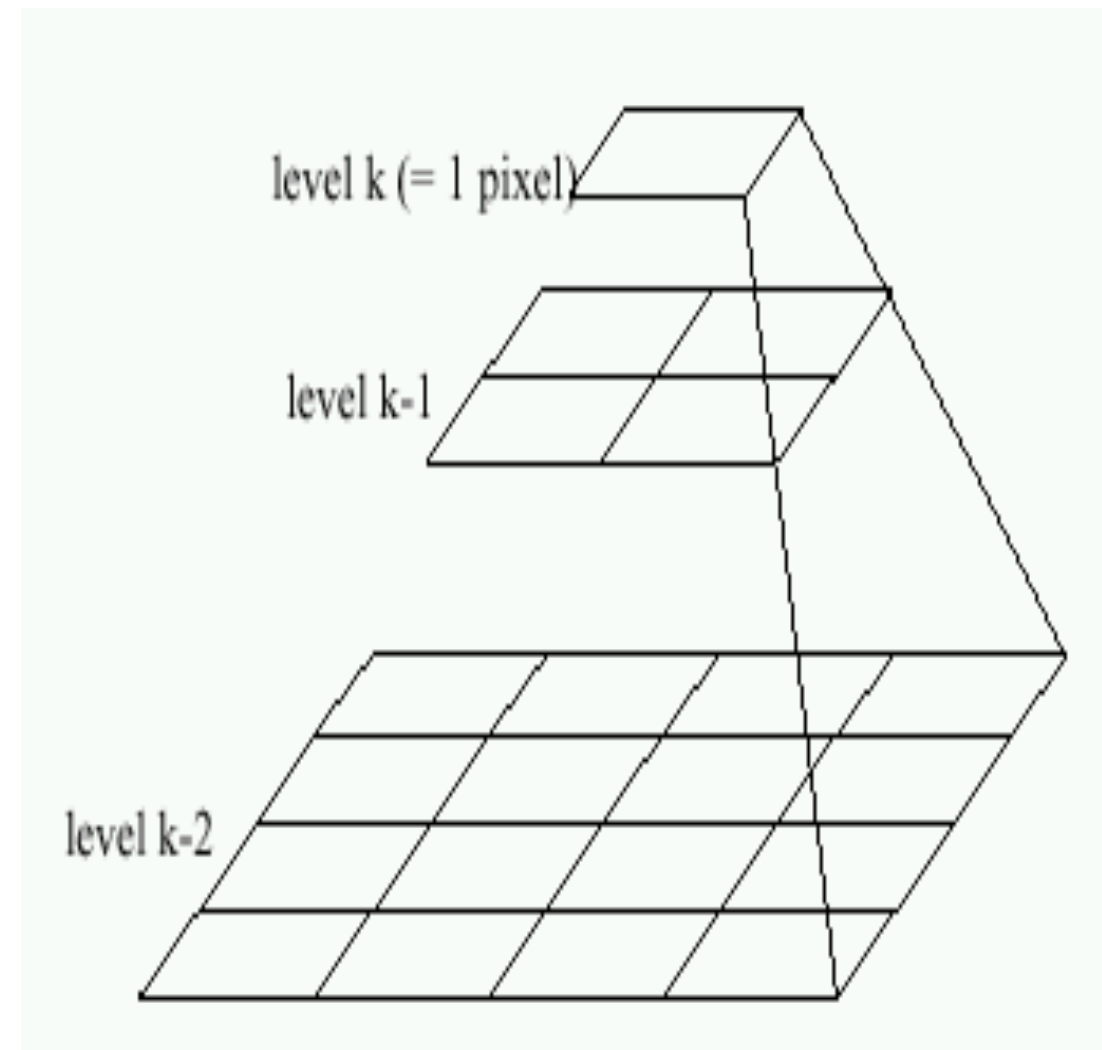
# Approche 2: mélange par pyramides



Pyramide gauche



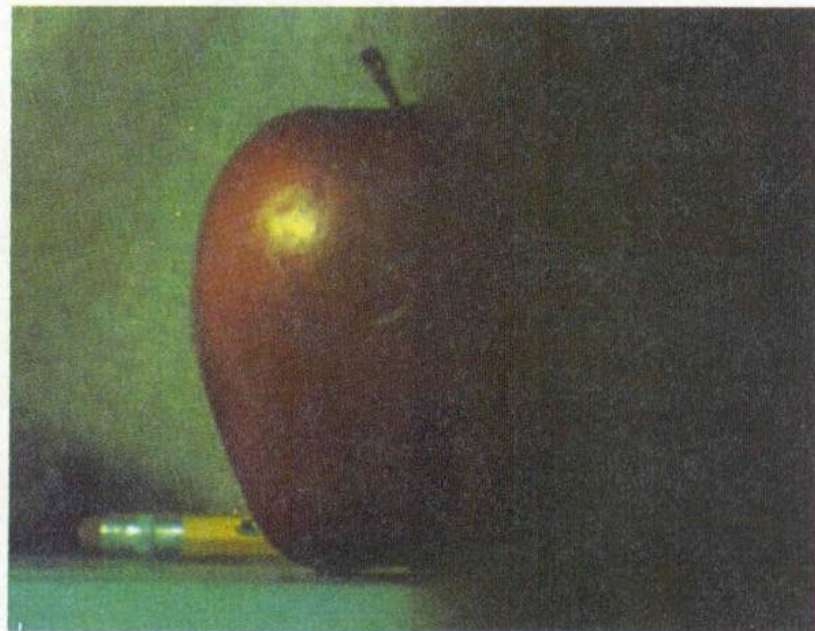
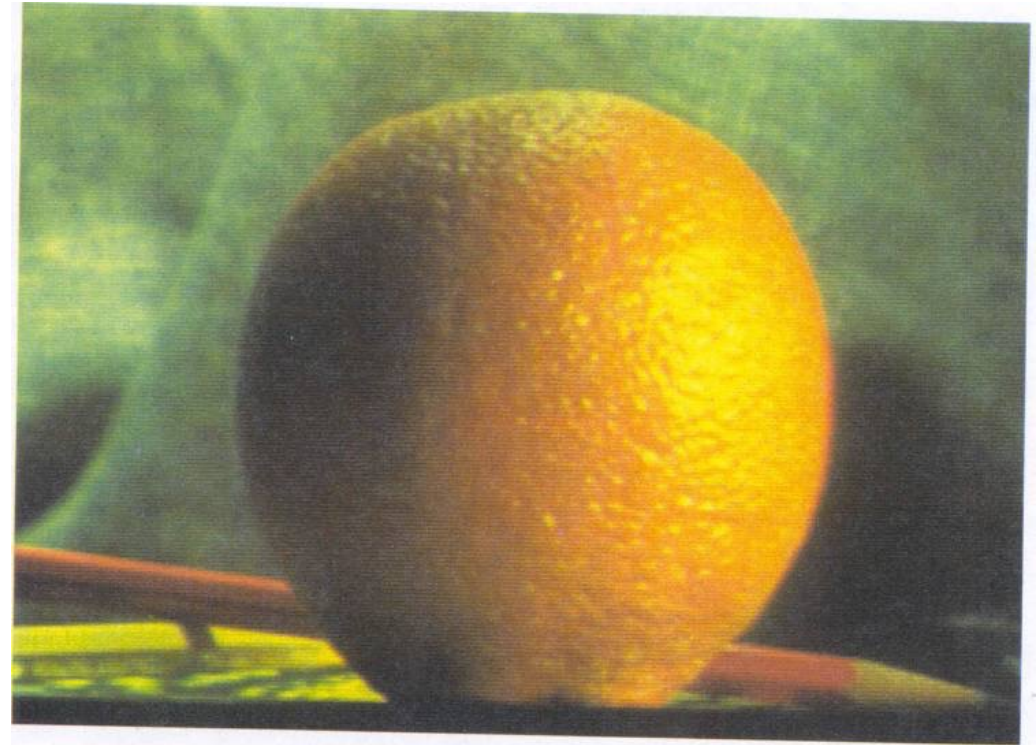
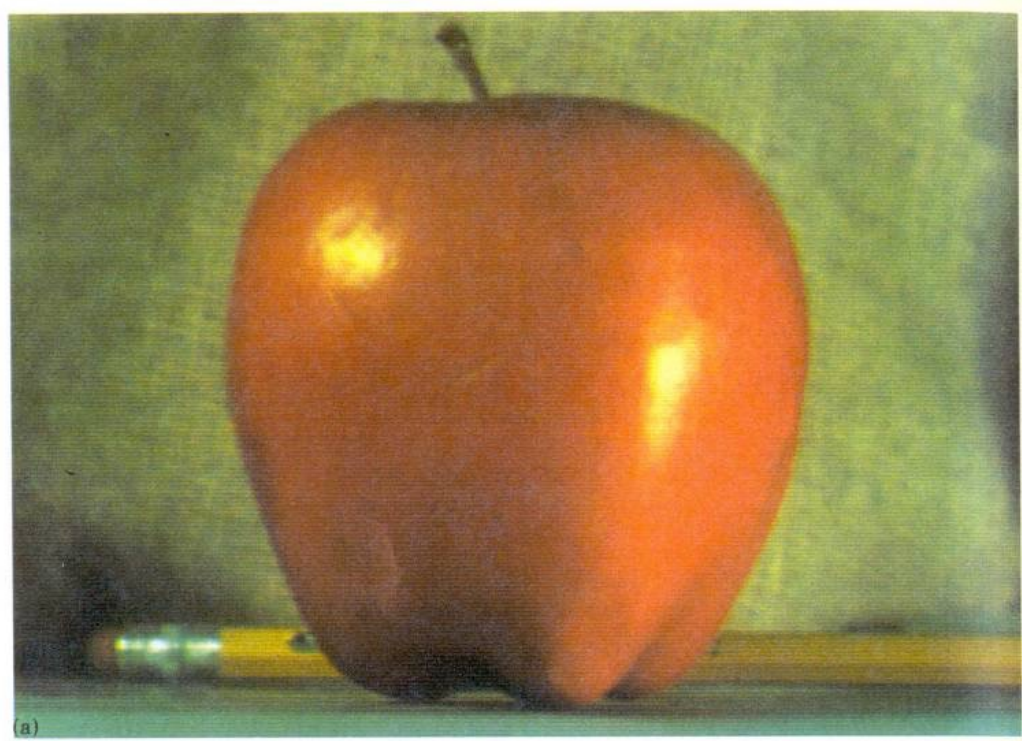
mélange



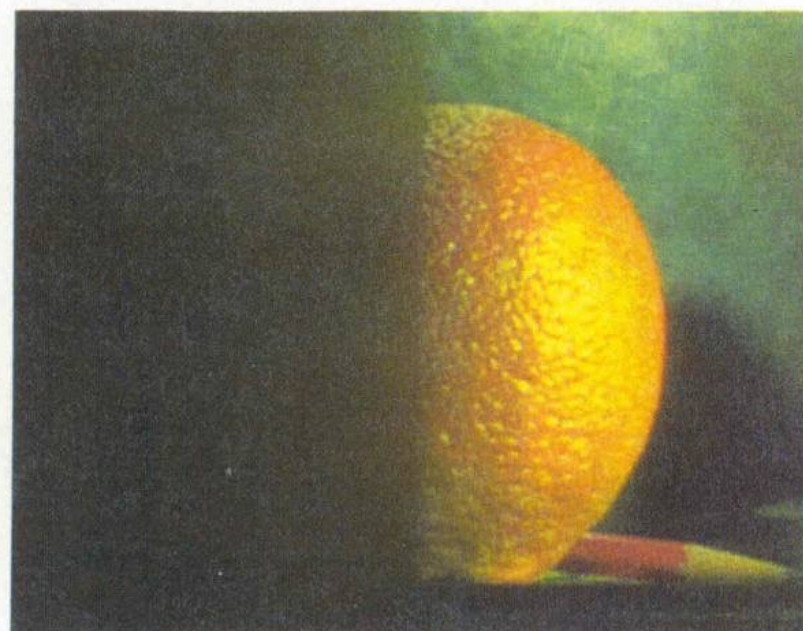
Pyramide droite



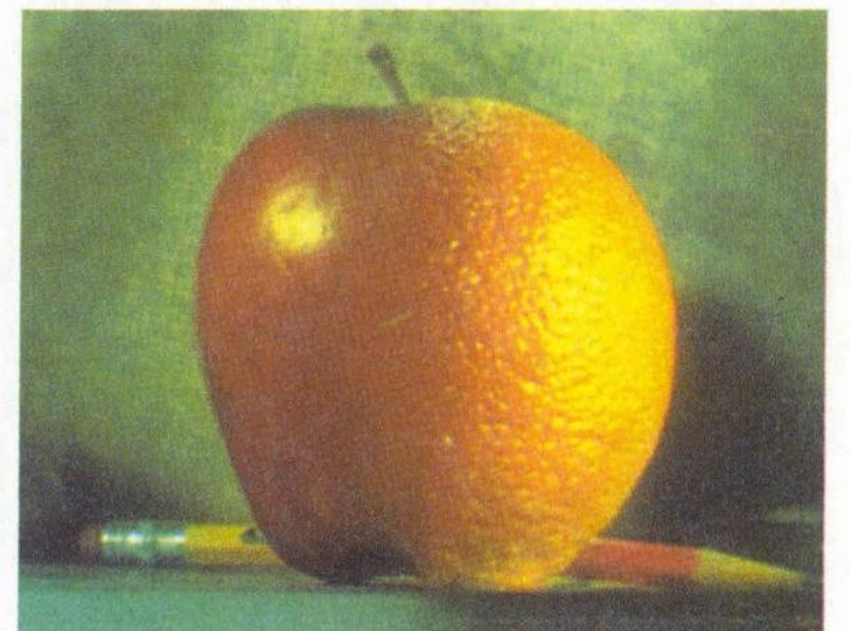
# Mélange par pyramides



(d)



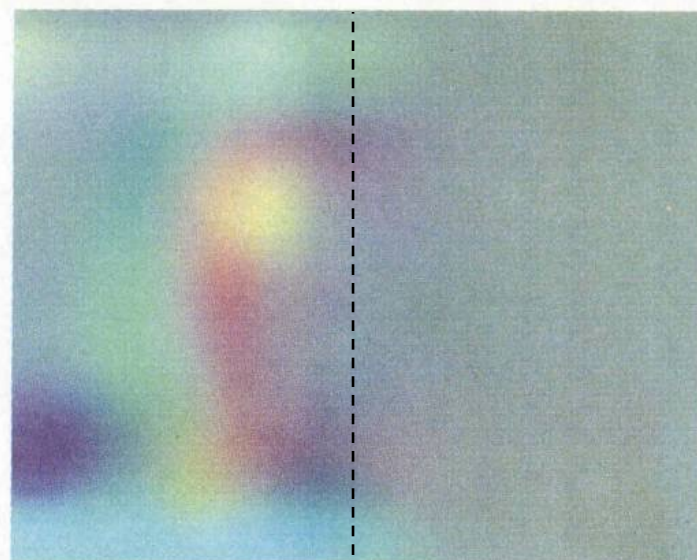
(h)



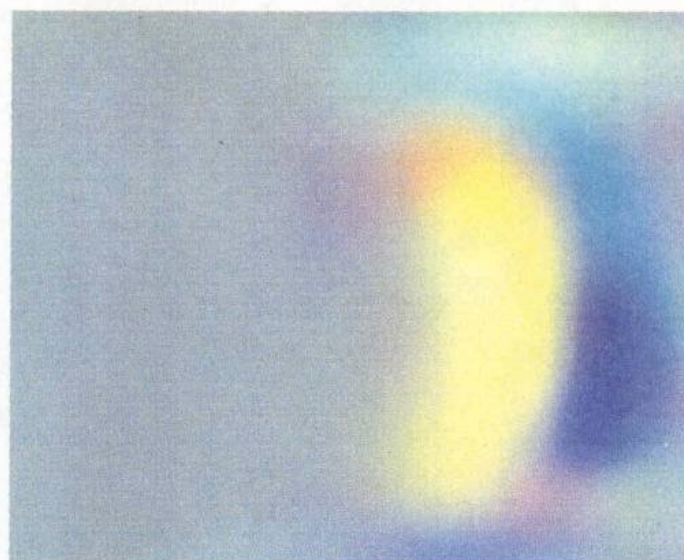
(l)



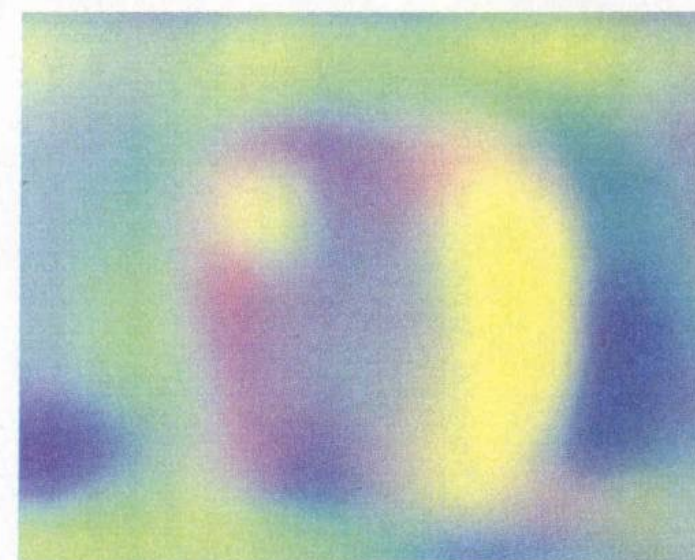
niveau  
laplacien  
4



(c)

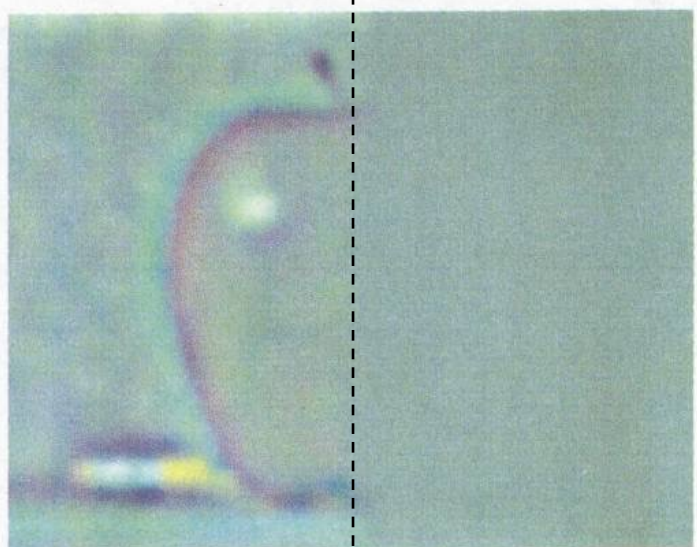


(g)

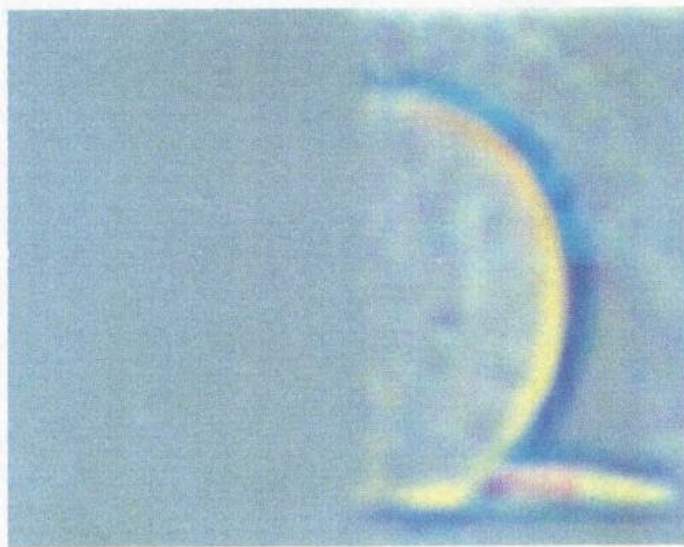


(k)

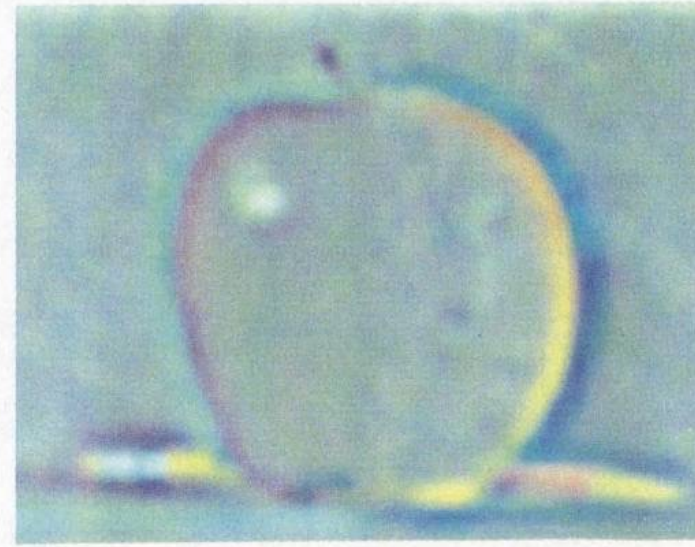
niveau  
laplacien  
2



(b)

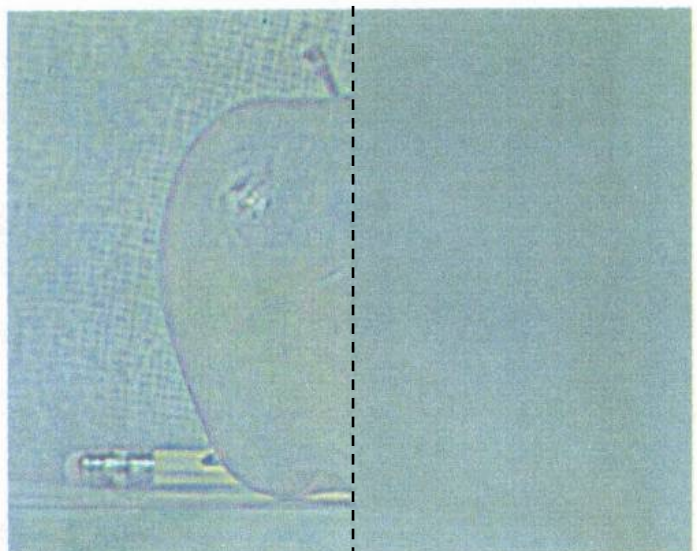


(f)

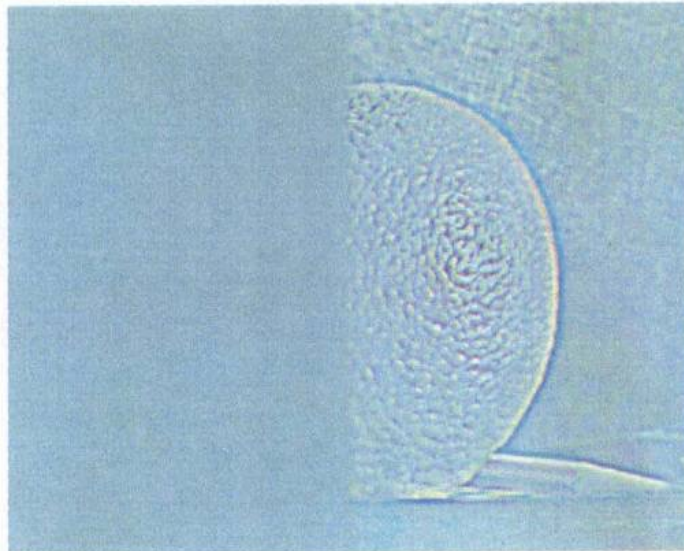


(j)

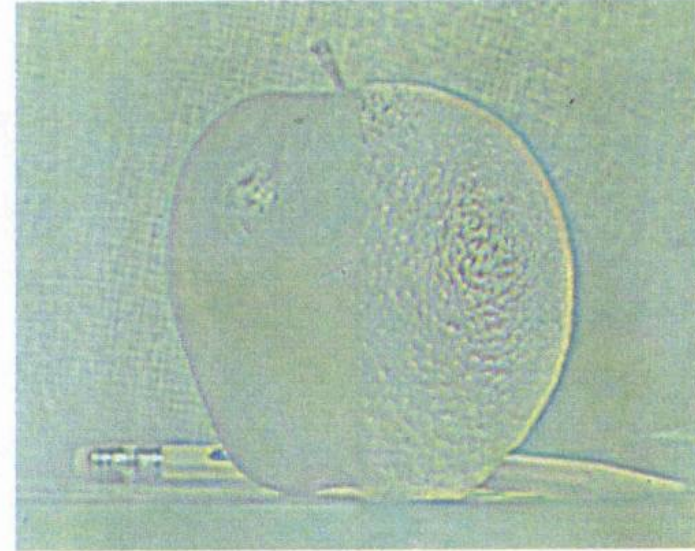
niveau  
laplacien  
0



(a)



(e)



(i)

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

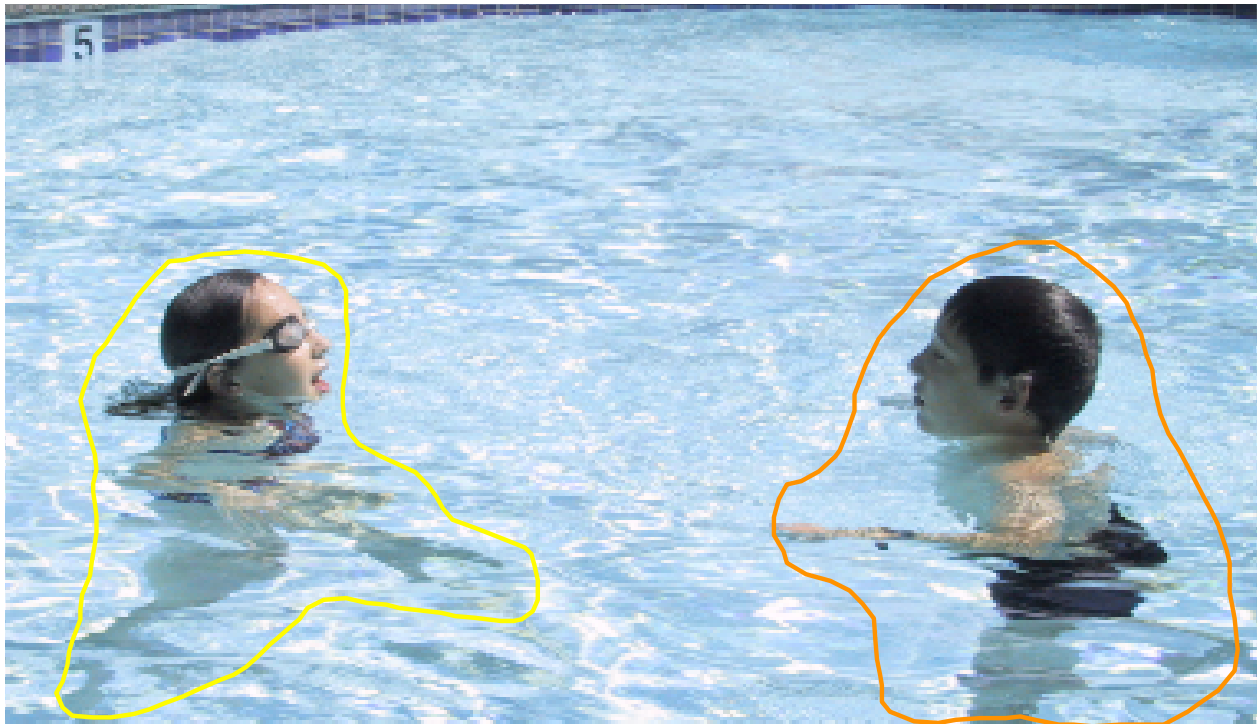


Image de destination



Résultat



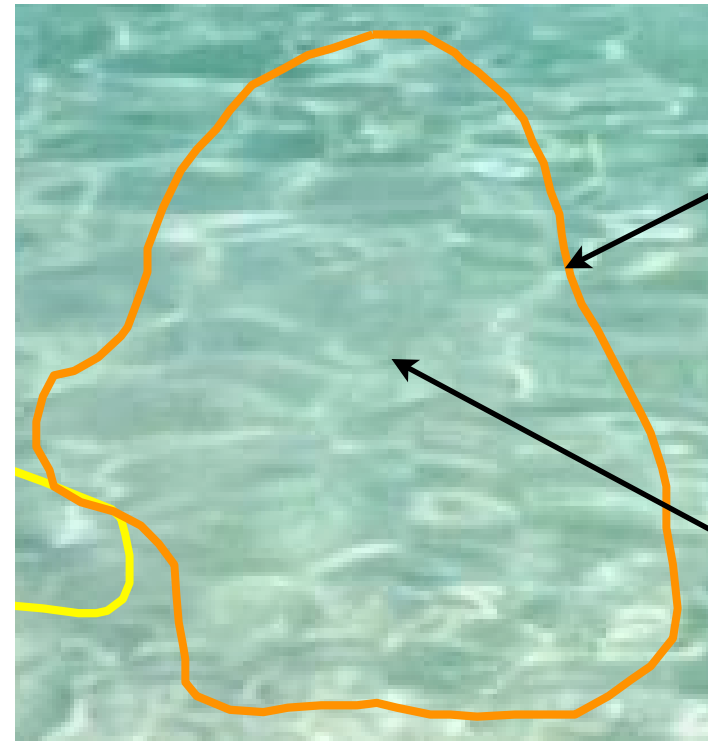
Discontinuité visible!

# Approche 3: mélange par gradients

Source



Destination



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

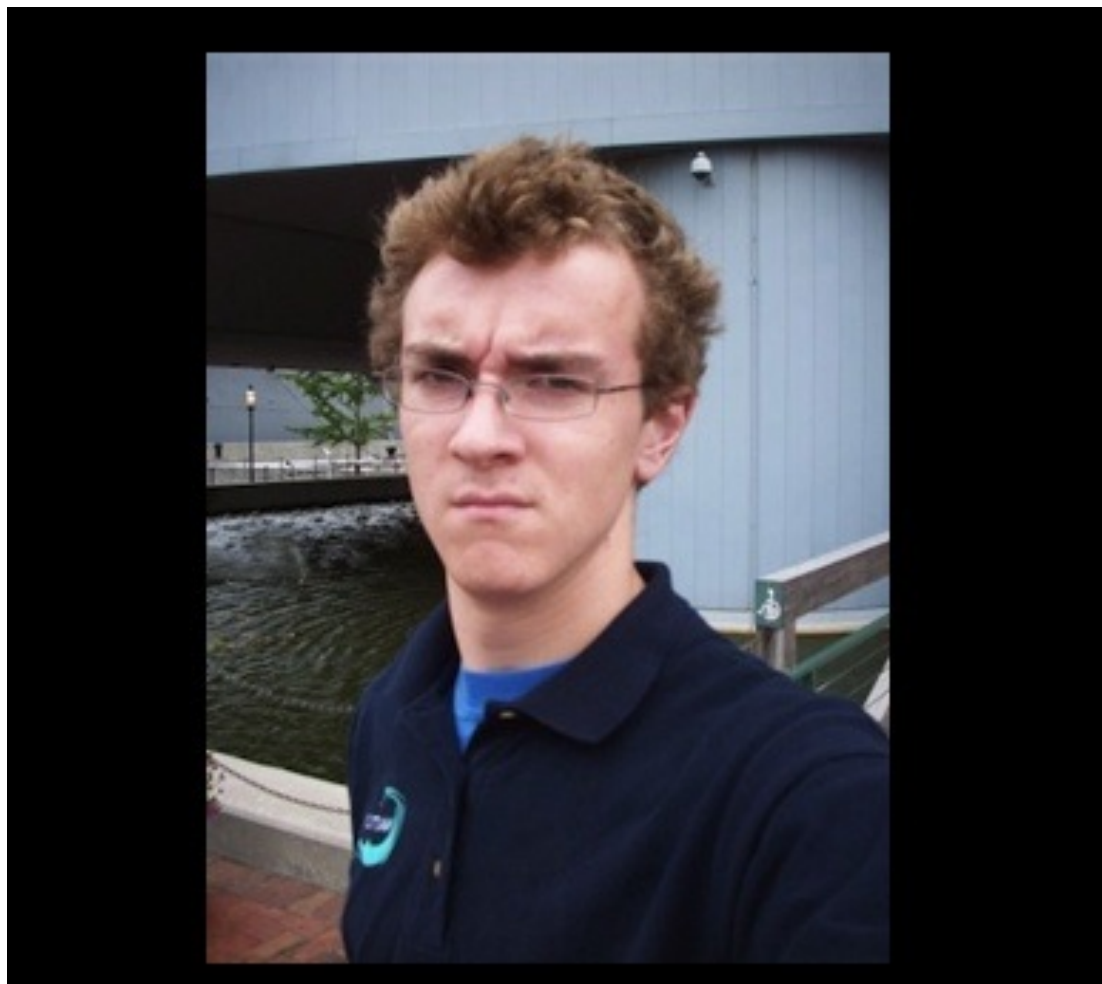
gradient = 0!

Préserver le même contenu que la source  
gradient = source

Résultat



# Exemple

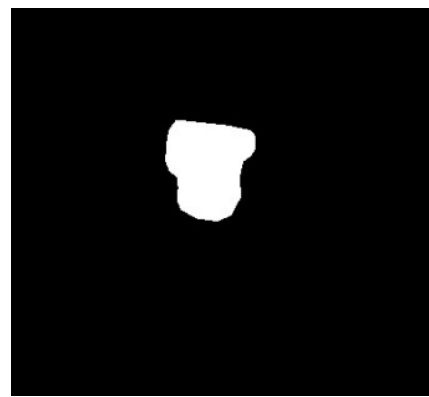


Gradients

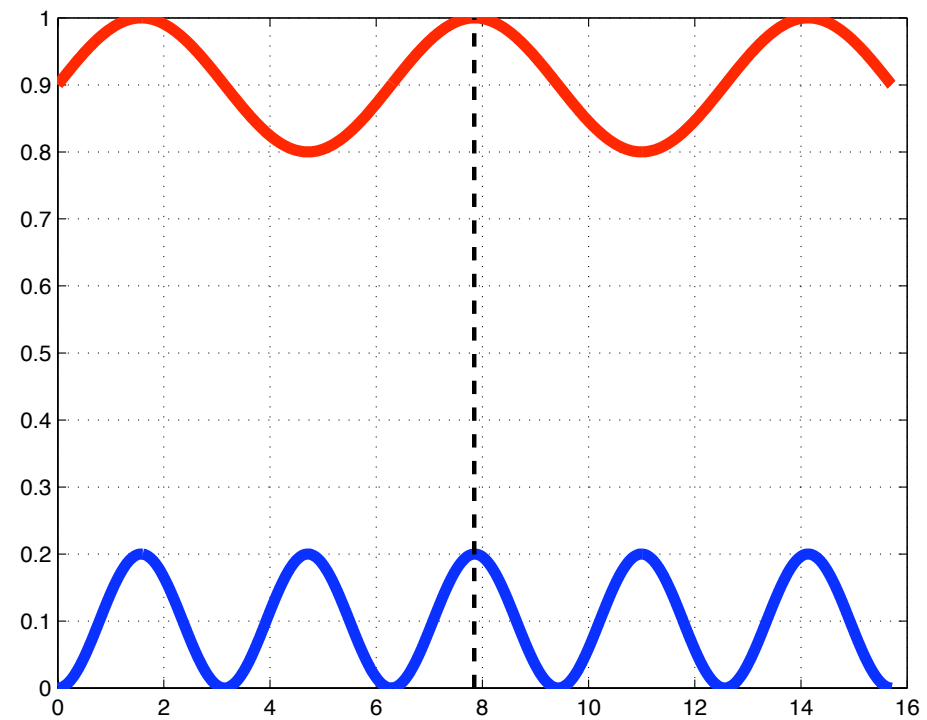




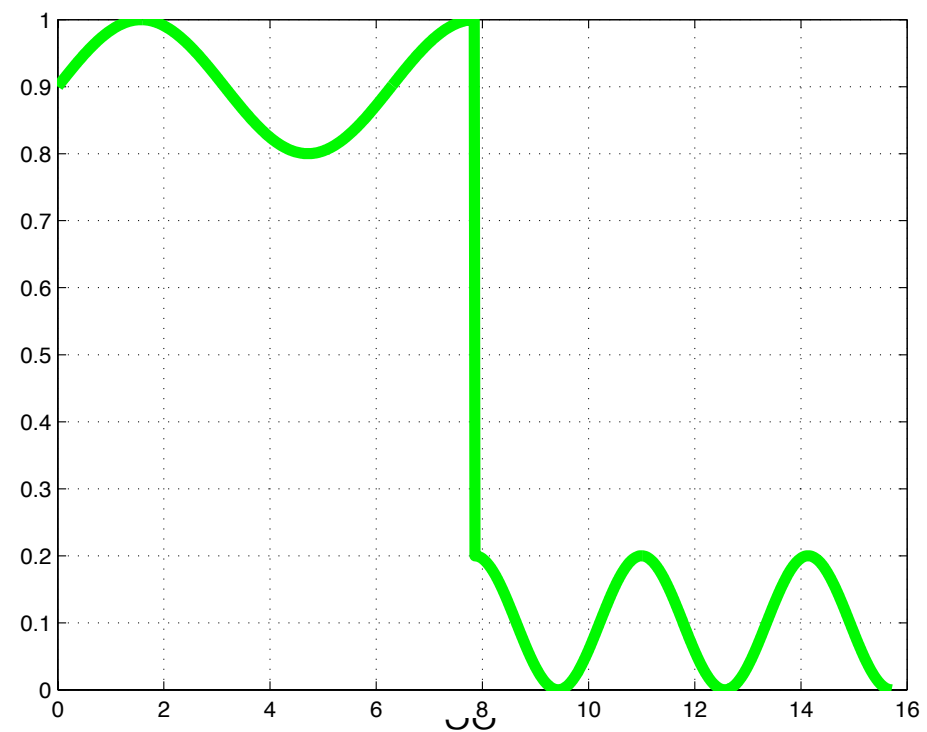
+



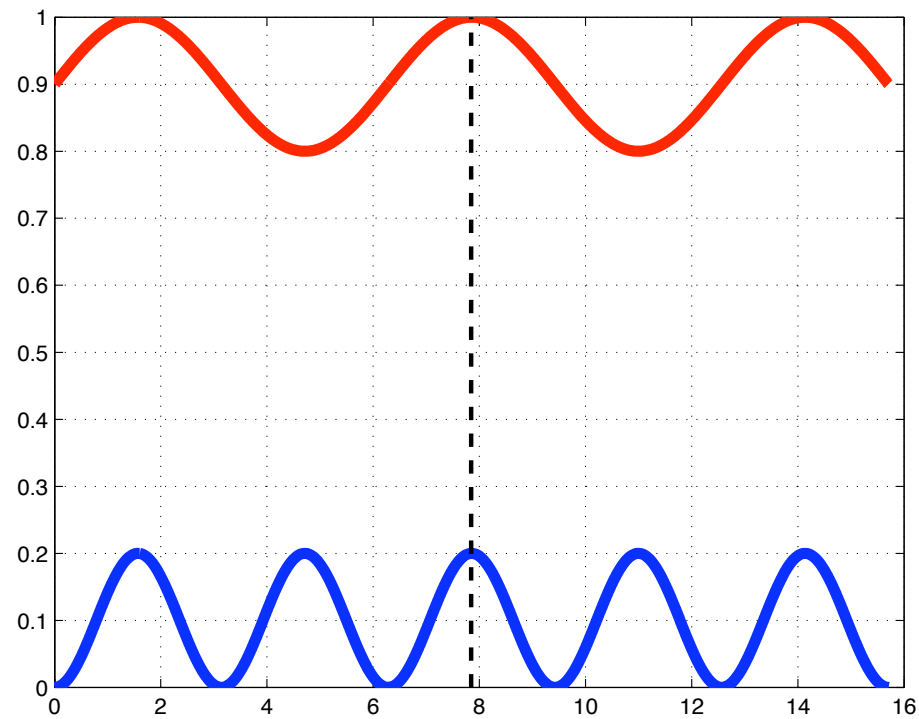
# Exemple 1D



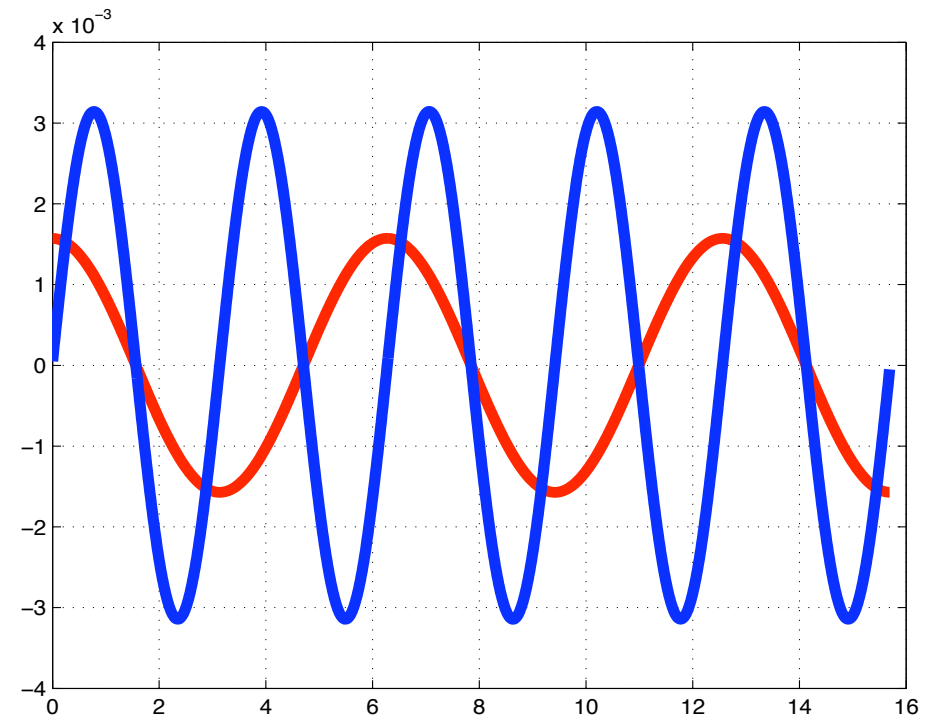
Composition



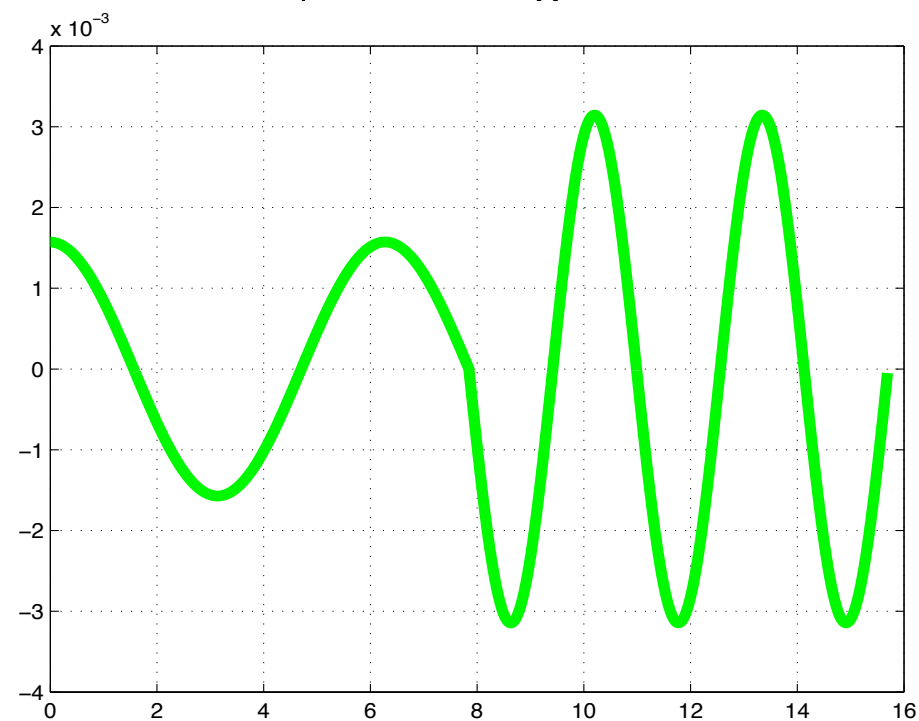
# Exemple 1D



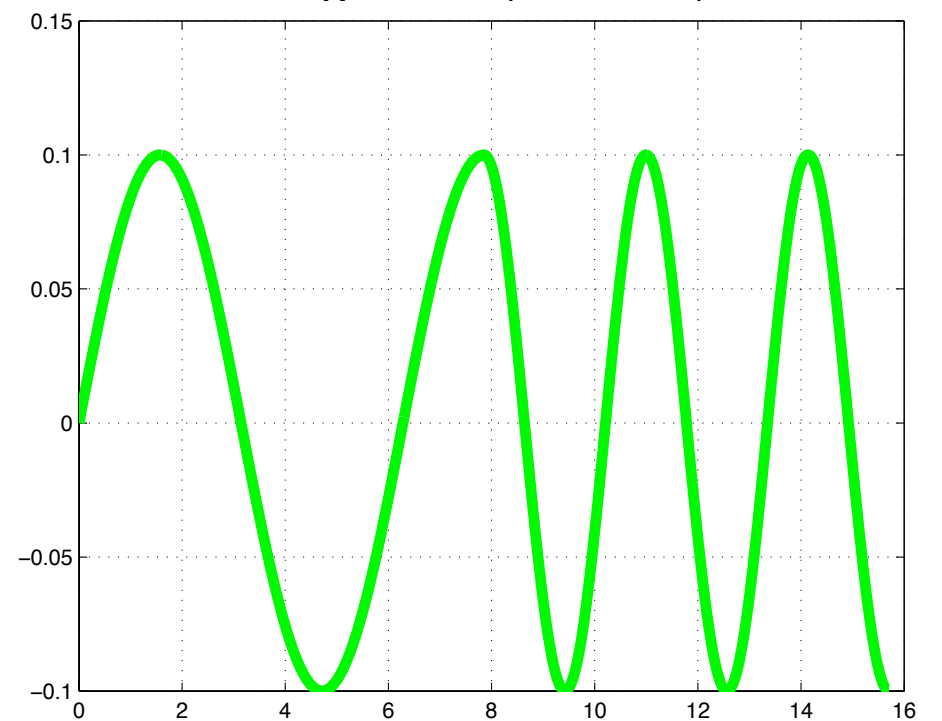
Dérivées (gradient)



Composer les gradients



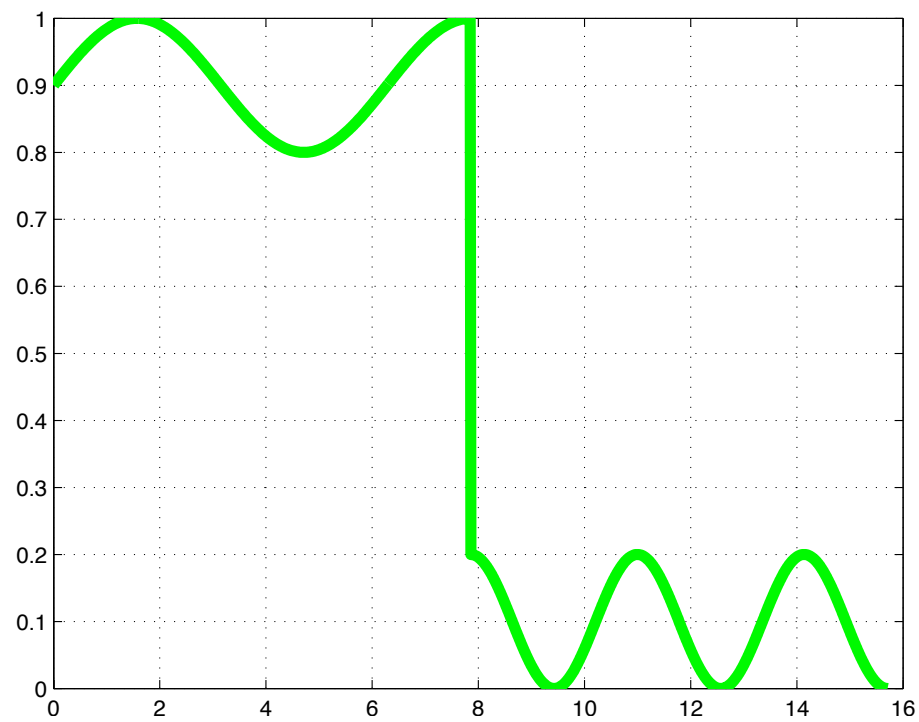
Intégration (somme)



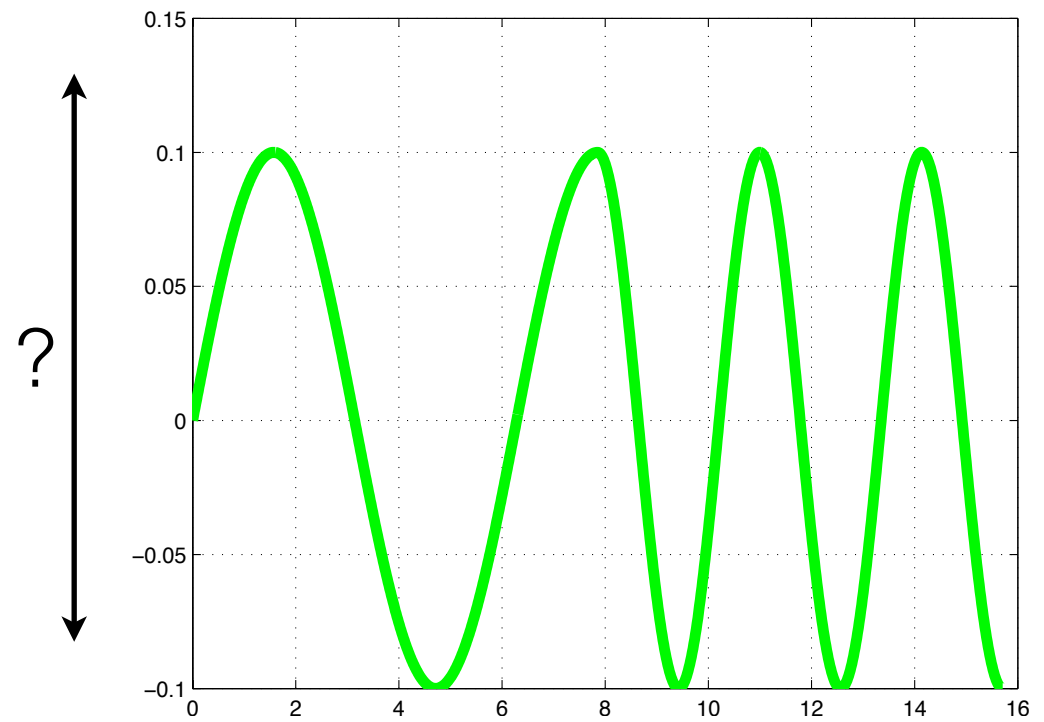


# Exemple 1D

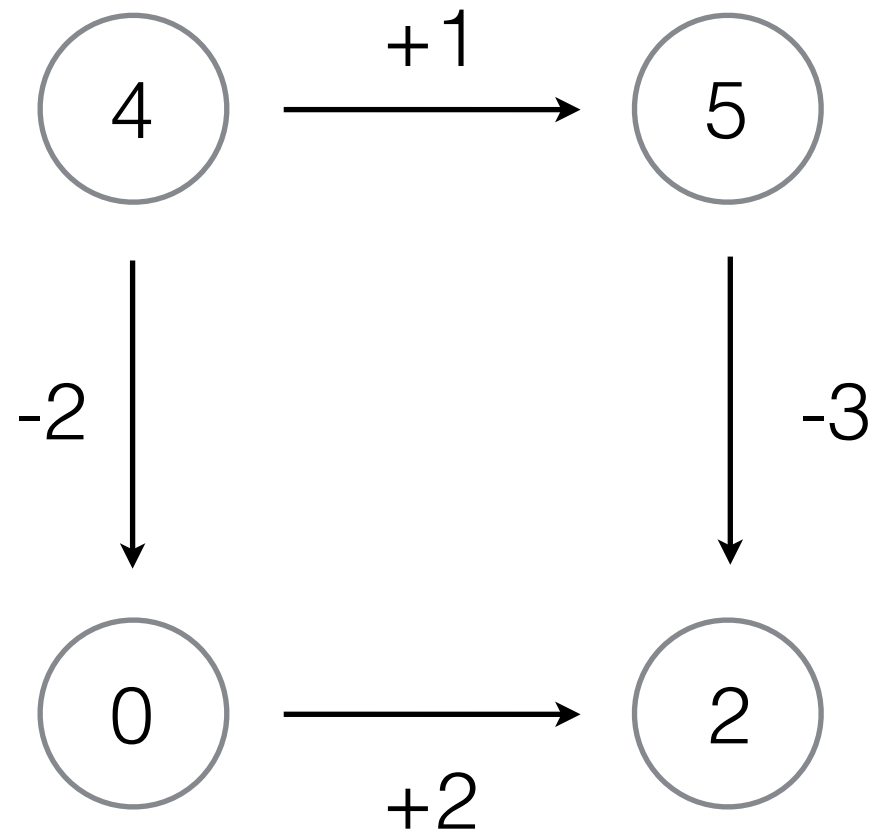
Intensité



Gradients



# En 2D? Pas si facile...



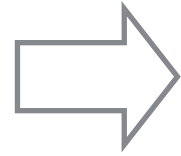
Pas intégrable: somme en boucle  $\neq 0$

Malheureusement, cela arrive constamment en pratique!

# Notation



$I$



$g_x$



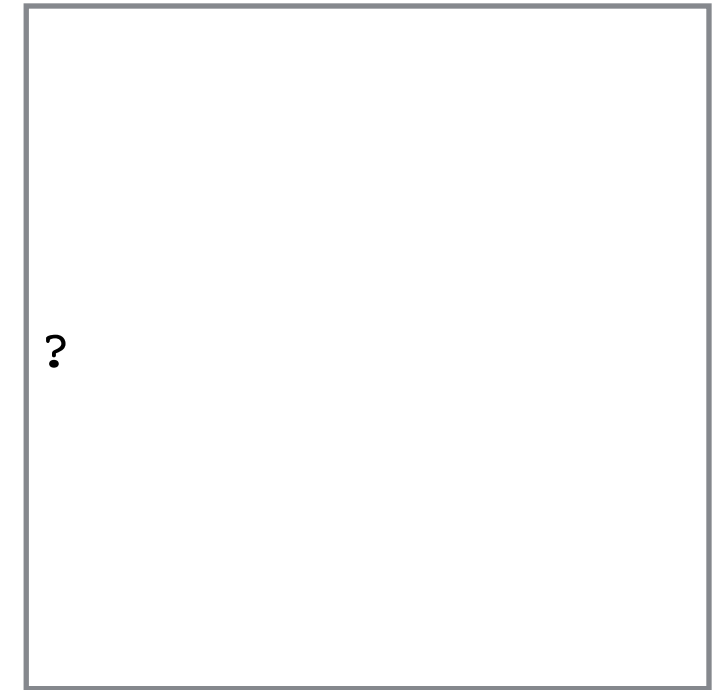
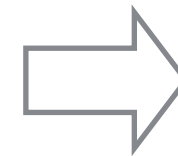
$g_y$

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

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



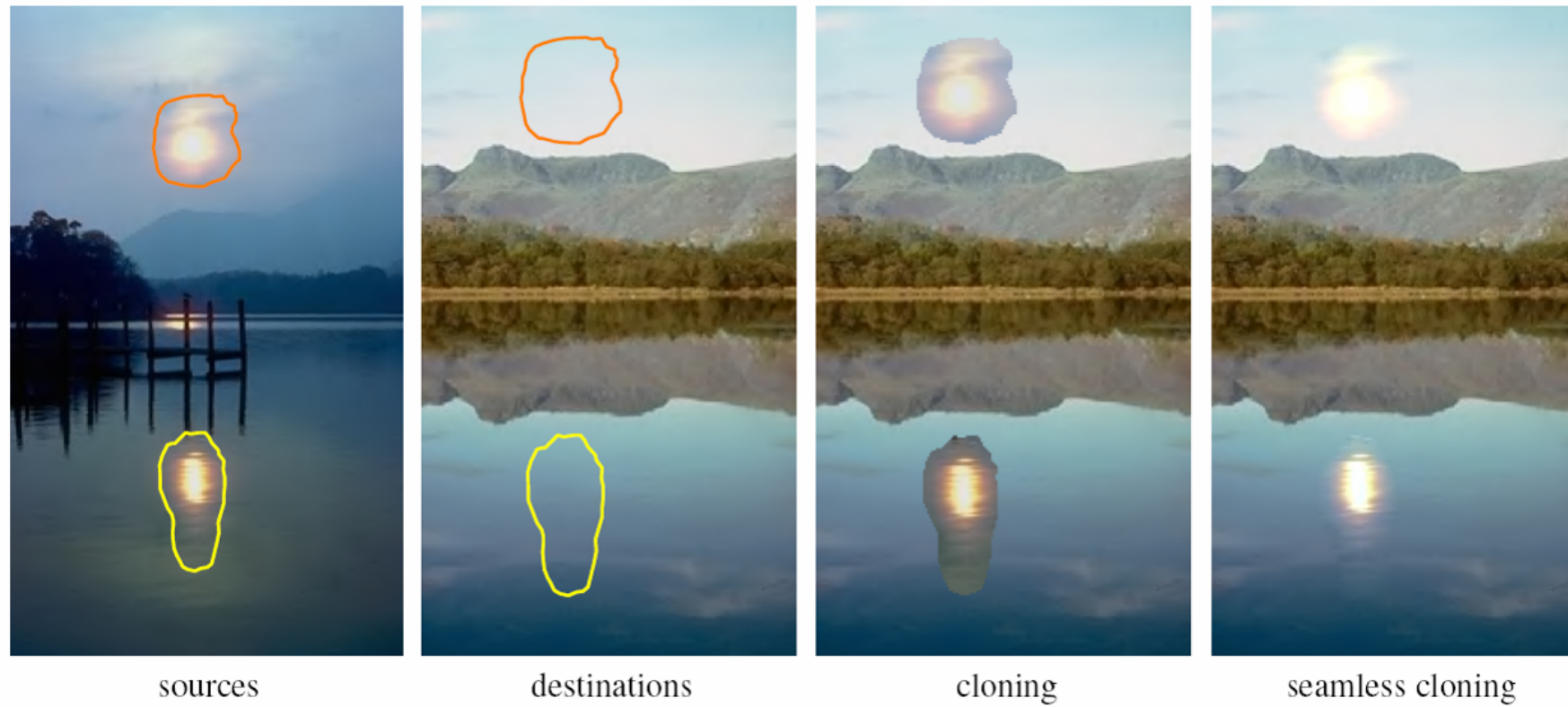
# Solution en 2D



$F$

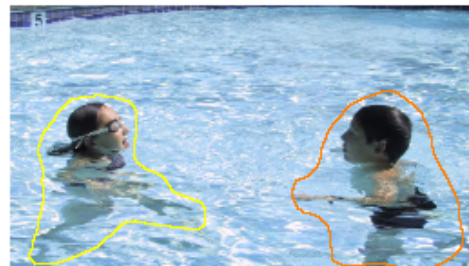
$$F^* = \arg \min_F \sum_x (g_x(x, y) - (F(x+1, y) - F(x, y)))^2 + \sum_y (g_y(x, y) - (F(x, y+1) - F(x, y)))^2$$

# Résultats





# Qu'est-ce qu'on perd?



sources/destinations



cloning



seamless cloning



# Choisir les gradients



(a) color-based cutout and paste



(b) seamless cloning



(c) seamless cloning and destination averaged



(d) mixed seamless cloning

# Application: “peindre” des gradients



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