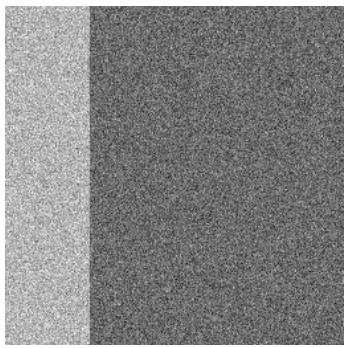
comment calculer l'histogramme d'une image

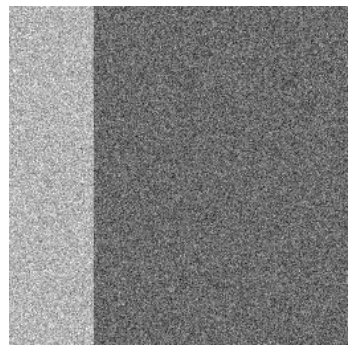
Définition d'histogramme

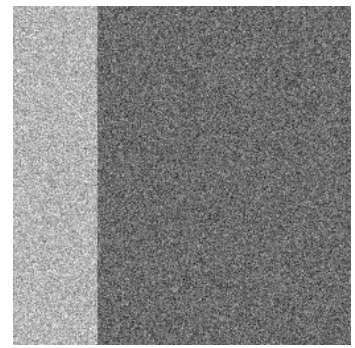
$h(t) =$ proportion de pixels de l'image de coleur t

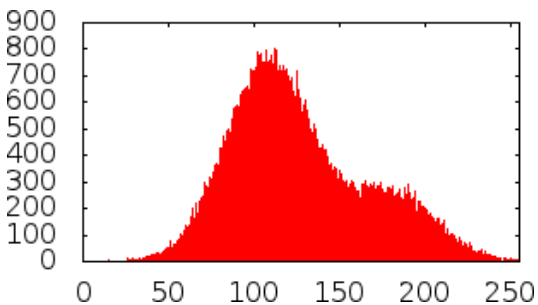
Trois images et ses histogrammes

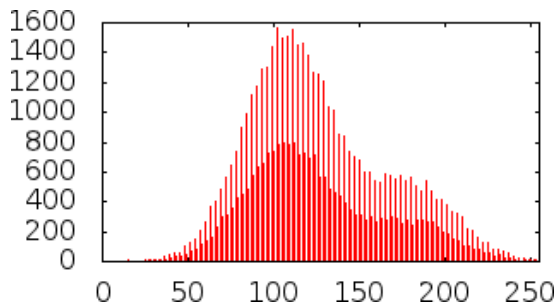
u | $\frac{3}{2}\left\lfloor \frac{2}{3}u \right\rfloor$ | $u + 0.5n$

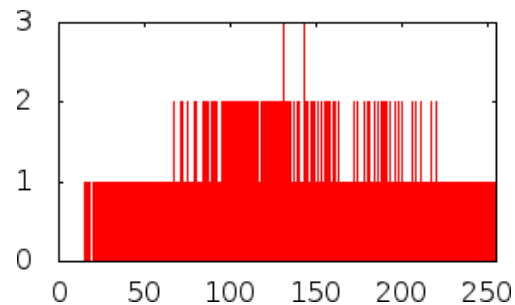










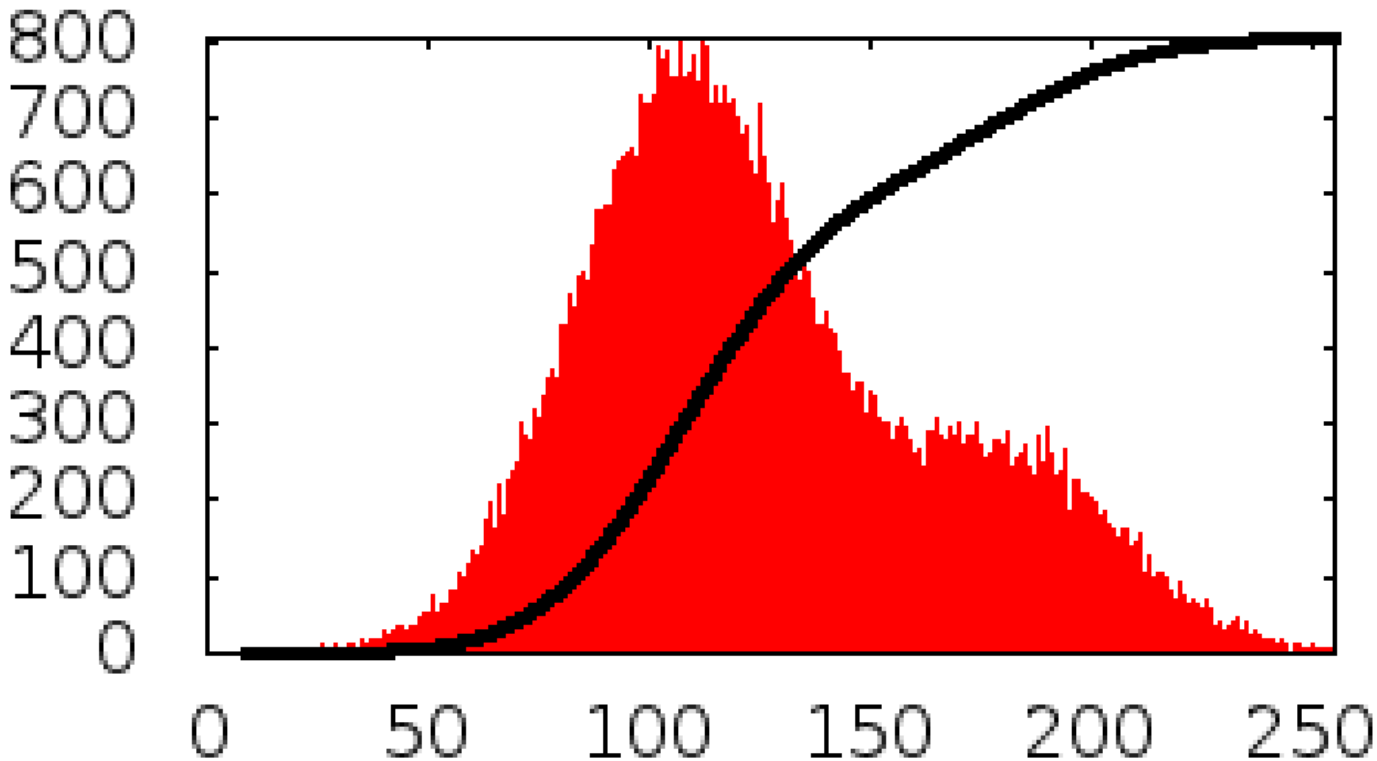


Objectif :
les histogrammes d'images semblables doivent ressembler

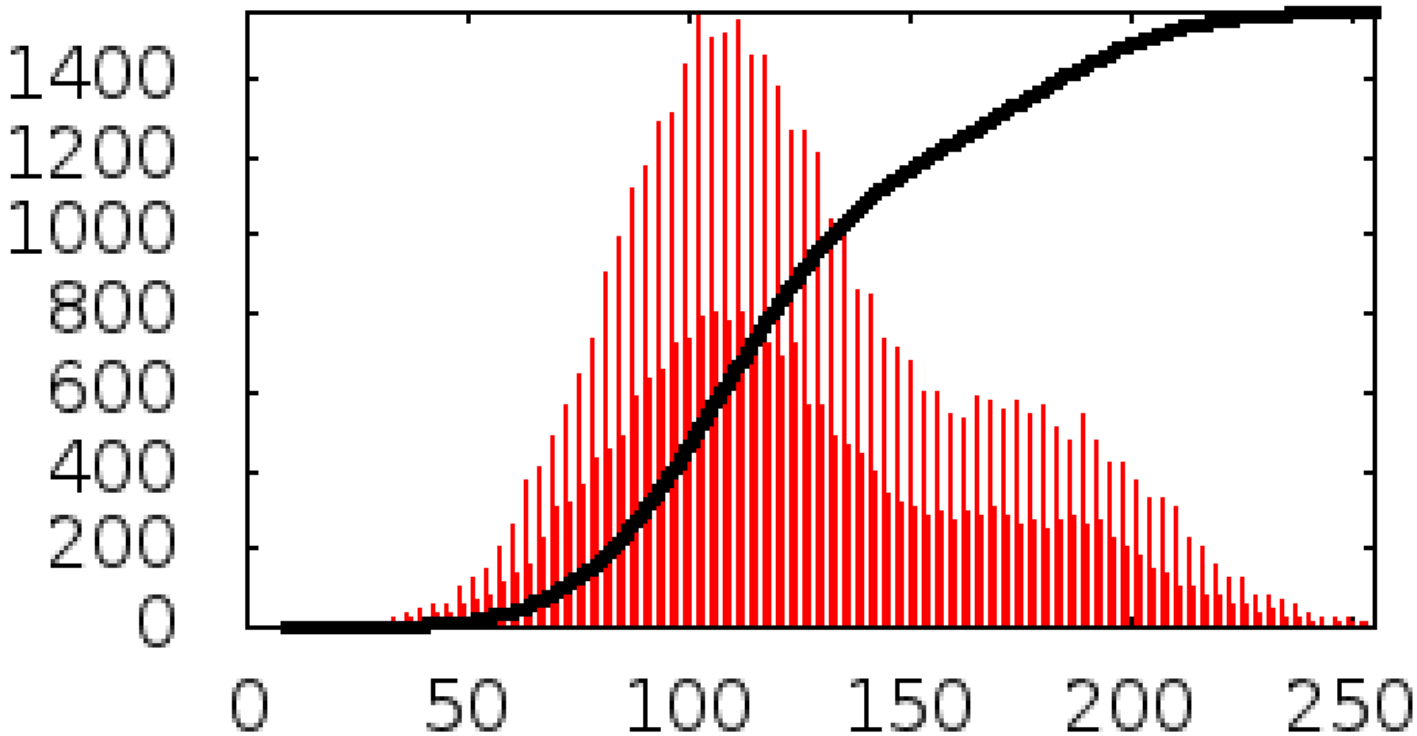
Solutions classiques :

- ✓ Histogramme cumulé
- ✗ Lissage de l'histogramme
- ✗ Réduction du nombre de bins

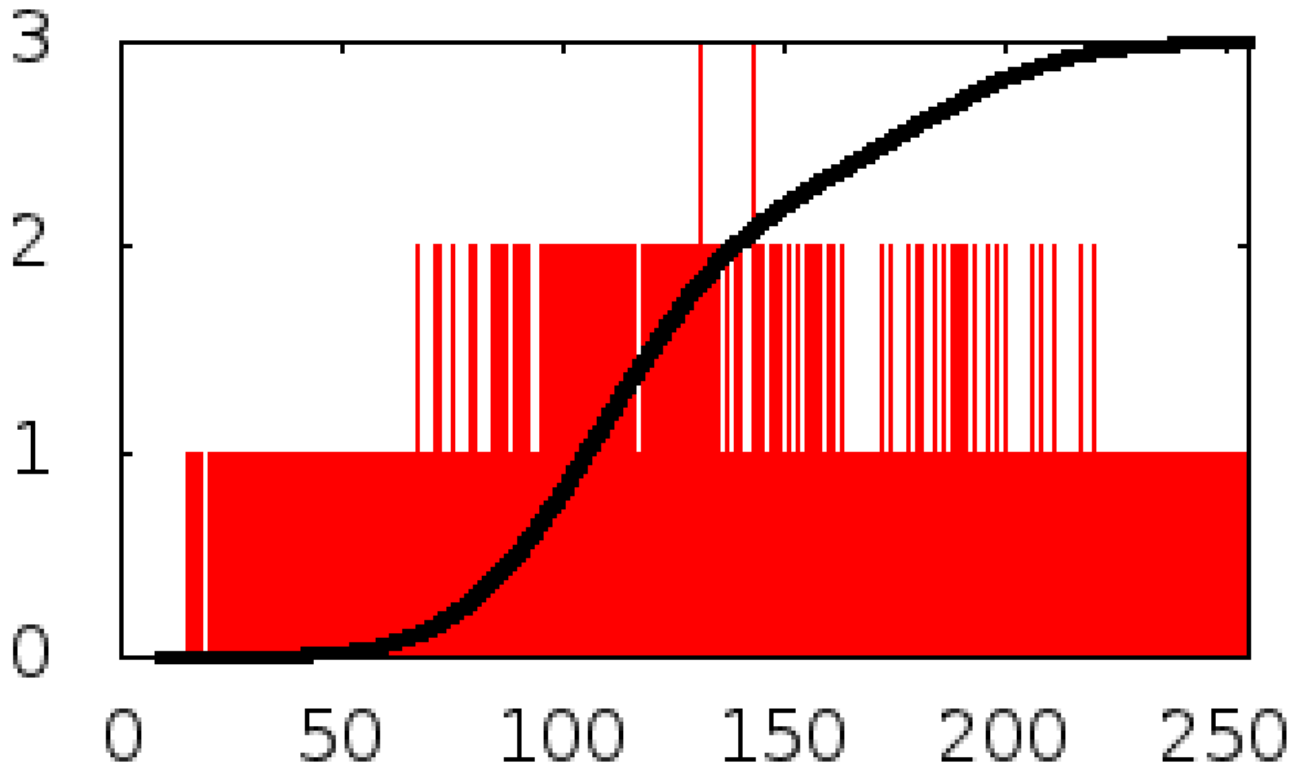
Solution classique bonne : histogramme cumulé



Solution classique bonne : histogramme cumulé

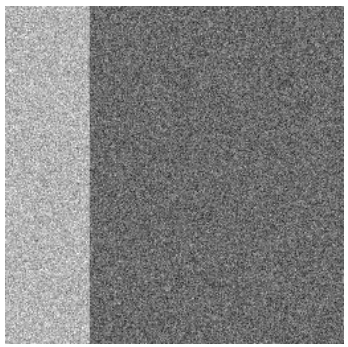


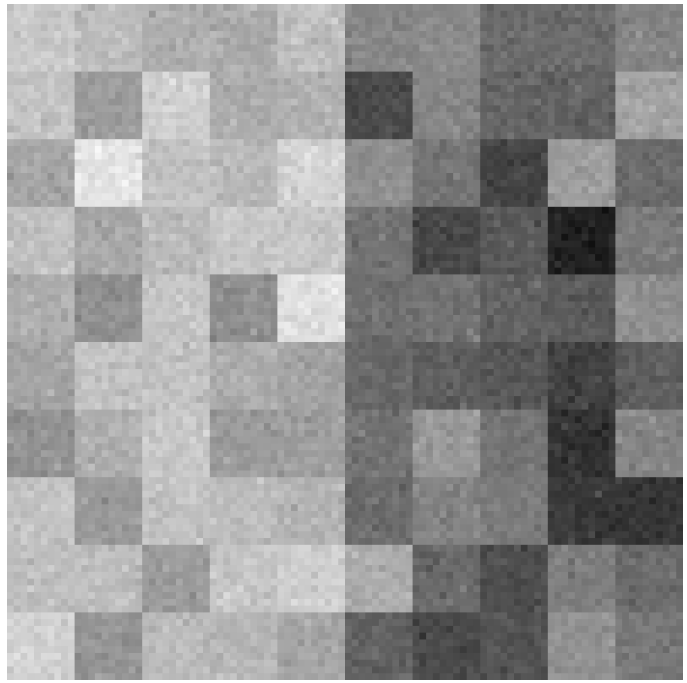
Solution classique bonne : histogramme cumulé



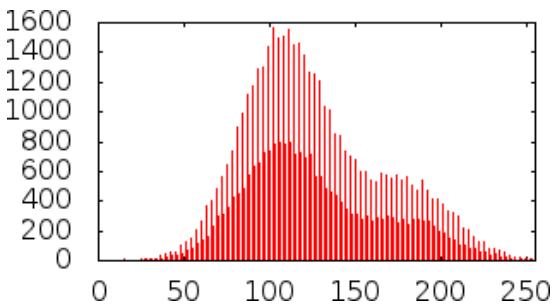
Solution classique mauvaise : lissage de l'histogramme

Correspond a l'addition de bruit sur l'image zoomée par répetition

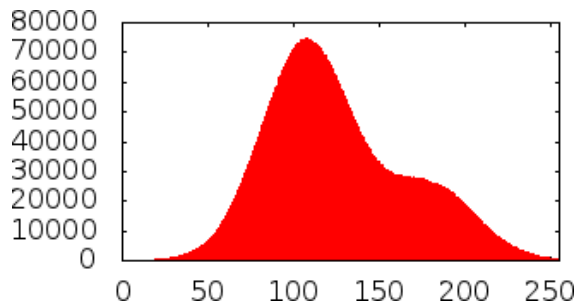




(detail)



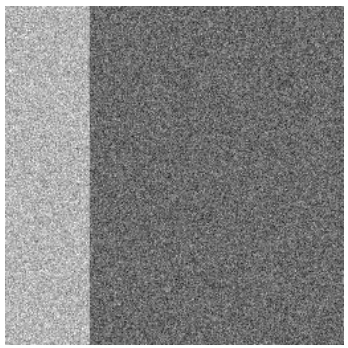
histogramme

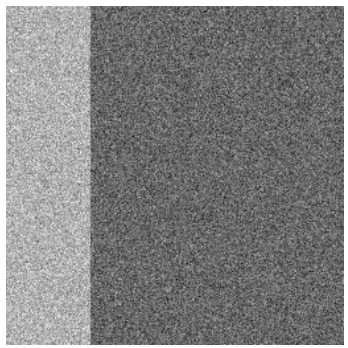


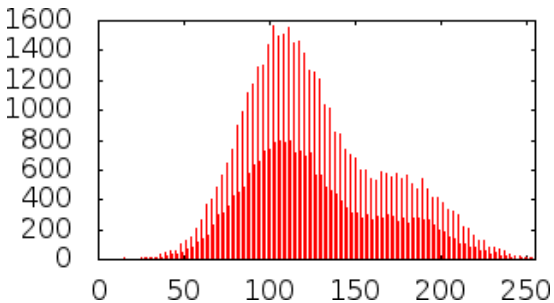
histogramme lissé

Solution classique mauvaise : réduction du nombre de bins

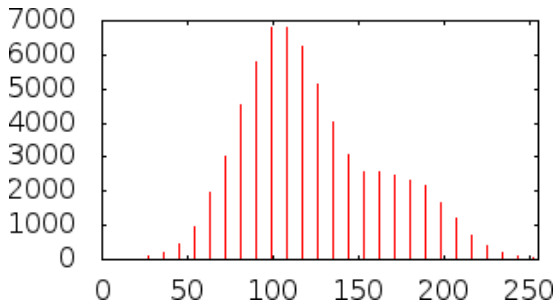
Correspond a une quantification de l'image originale







256 bins

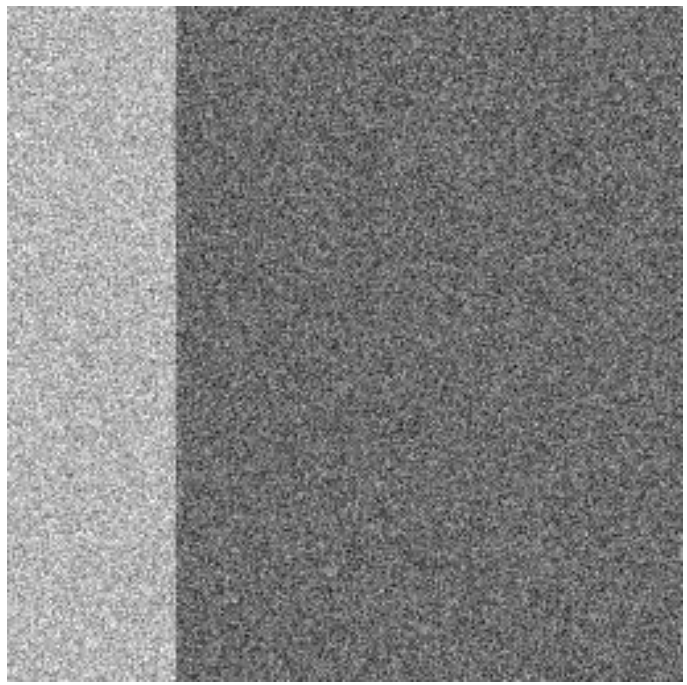


28 bins

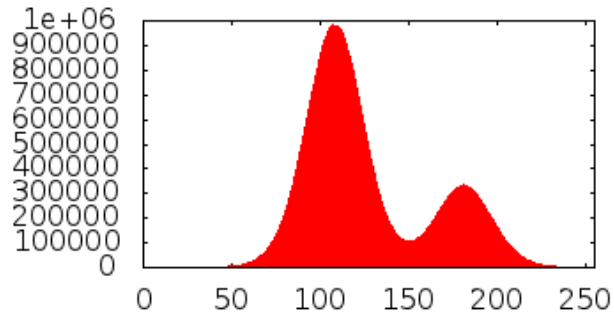
Notre proposte

Calculer l'histogramme de l'image zoomée 100×

256 × 256



25600 × 25600

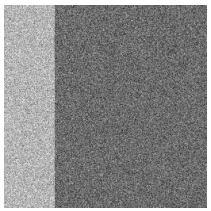


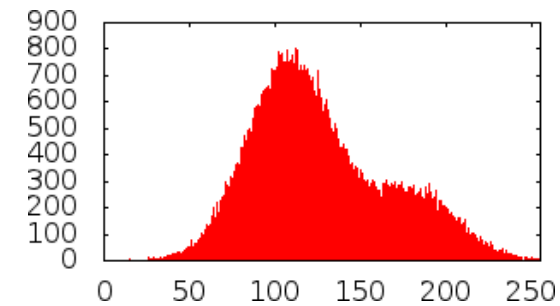
histogramme

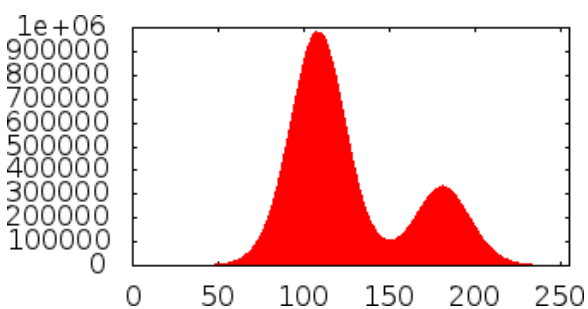
Notre proposte

Application de notre proposte aux trois images originales

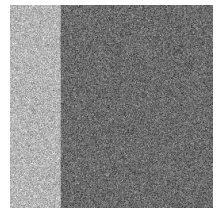
u

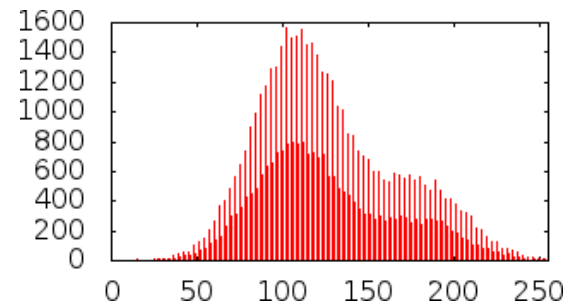


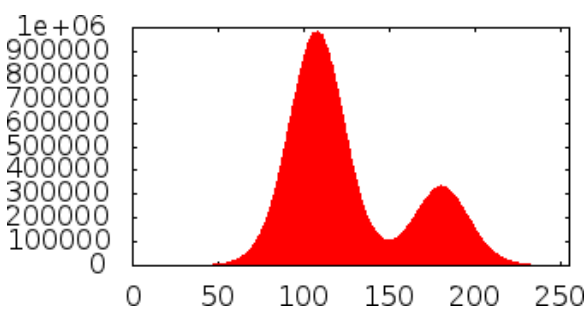




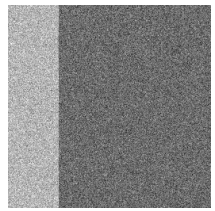
$\frac{3}{2}\left\lfloor \frac{2}{3}u \right\rfloor$

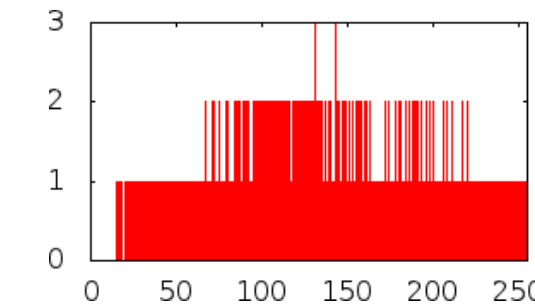


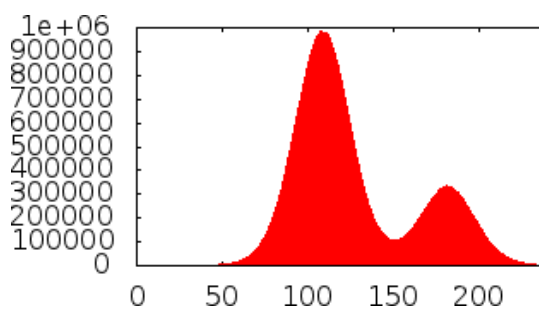




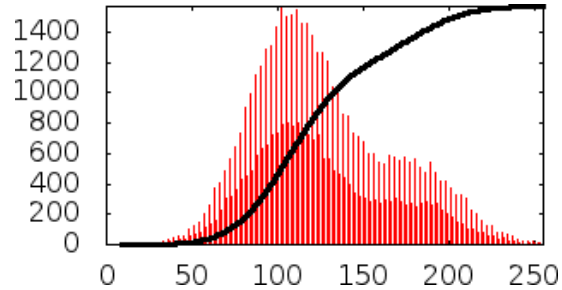
$u + 0.5n$



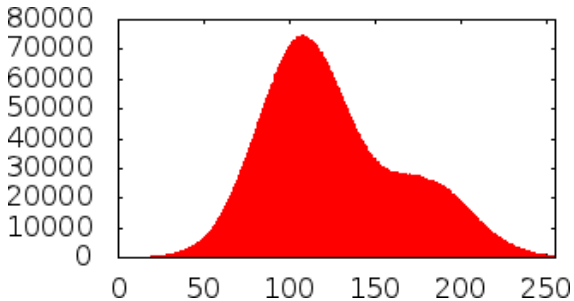




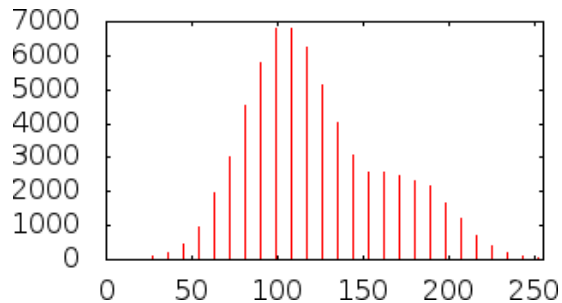
Comparaison



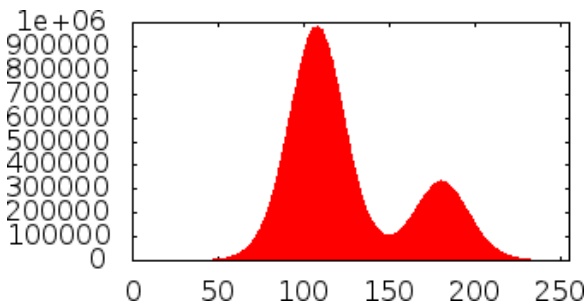
cumulé



lissé



quantifié



zoomé

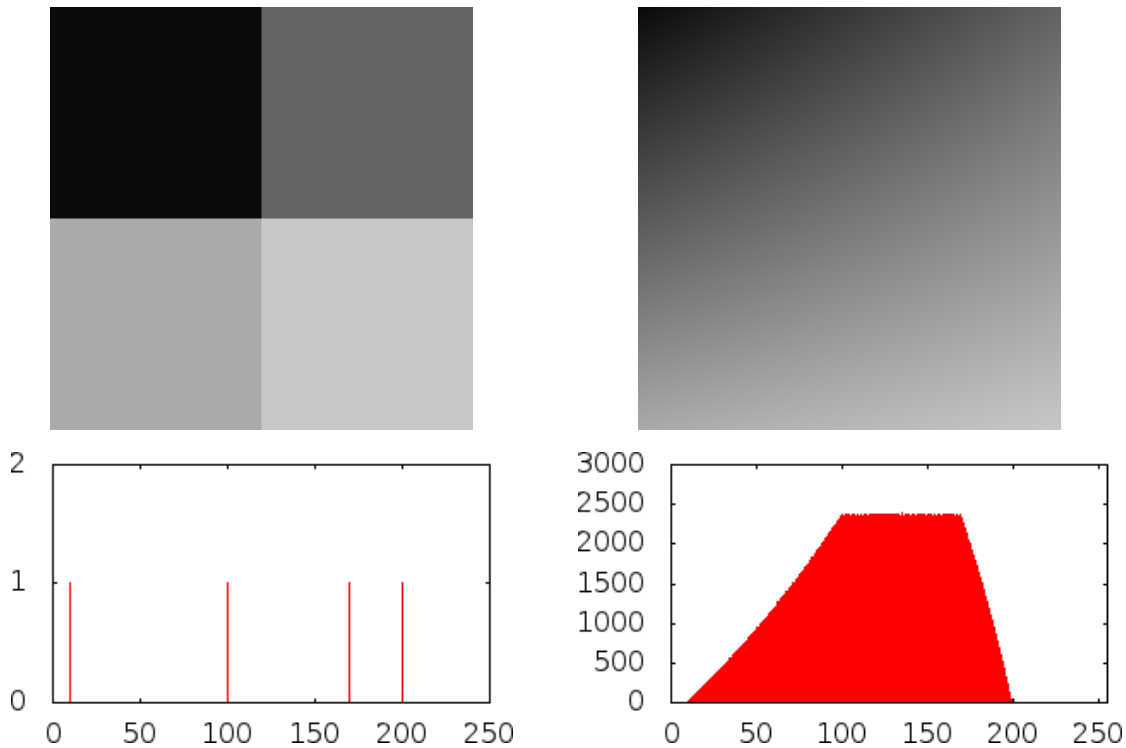
Calcul Practique

Il y a trois implémentations possibles de notre proposte :

- Force brute
- Expression analytique
- Filtrage préalable

Calcul practique : Force Brute

Zoomer 100× chaque celle de 4 pixels et calculer son histogramme.



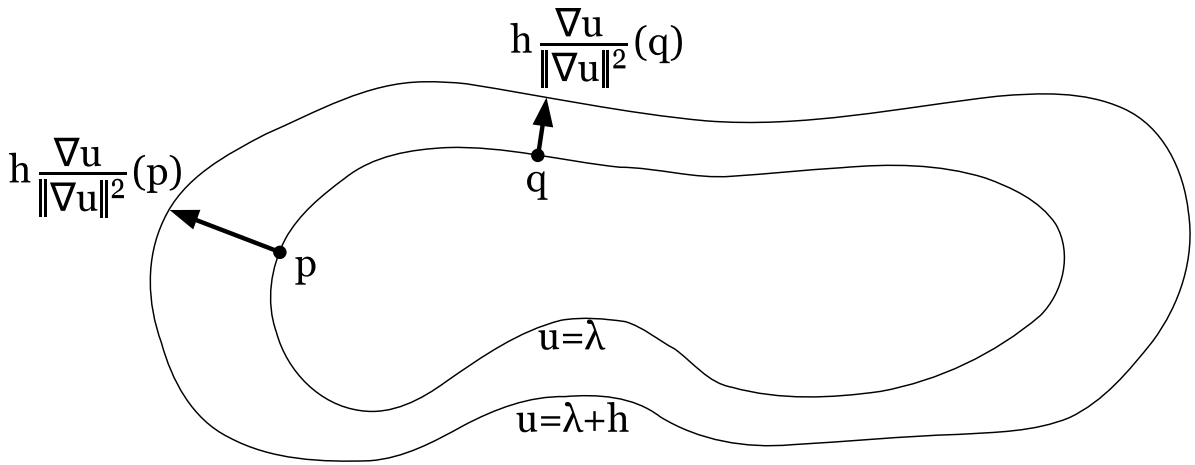
✓ très facile a implementer

✗ très lent pour des grandes images

Calcul practique : Expression analytique

Définition d'histogramme en continu :

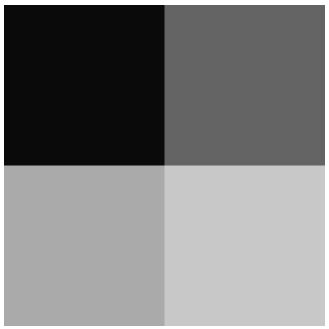
$$\begin{aligned} h(t) &= \int_{\Omega} \delta(u(x) - t)\, \mathrm{d}x \\ &= \int_{\{u=t\}} \frac{1}{\|\nabla u\|}\, \mathrm{d}l \end{aligned}$$

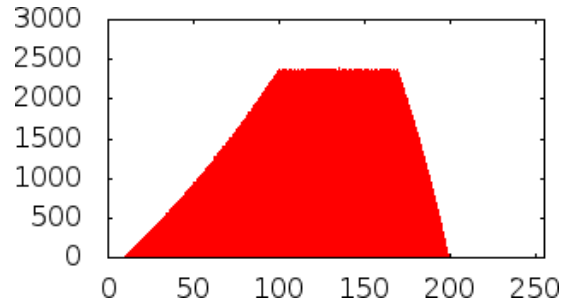


Calcul practique : Expression analytique

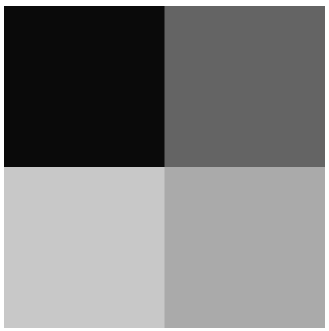
Cas de l'interpolation bilinéaire

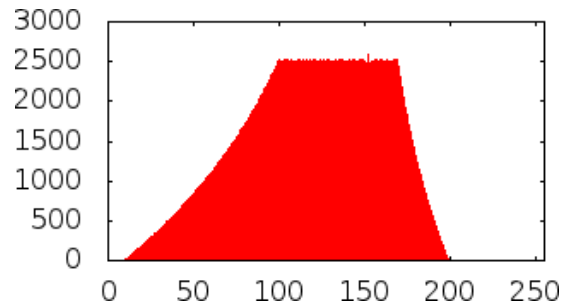
regular :



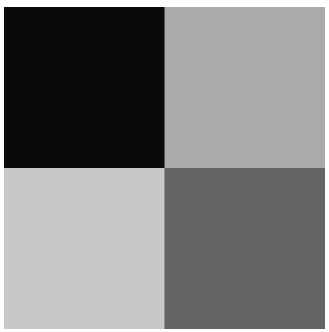


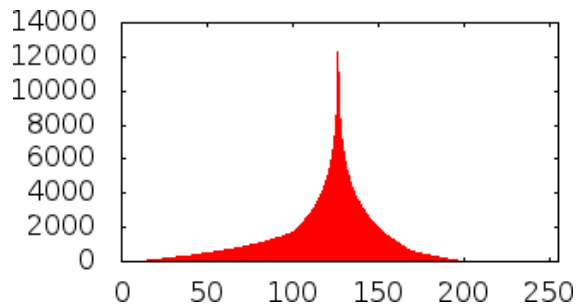
cyclic :





singular :



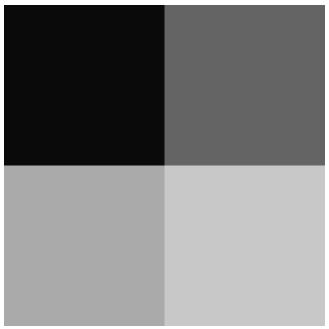


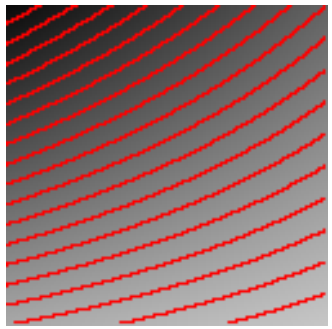
$$h(t) = a \log(\alpha t + \beta) + b \quad \text{par morceaux}$$

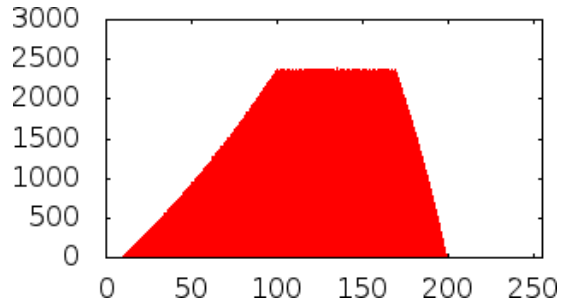
Calcul practique : Expression analytique

Cas de l'interpolation bilinéaire

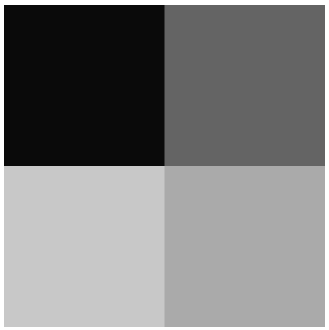
regular :

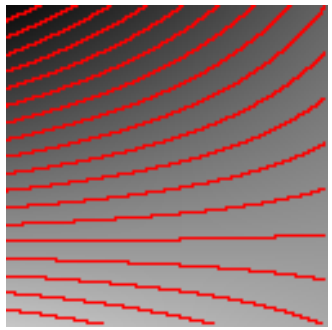


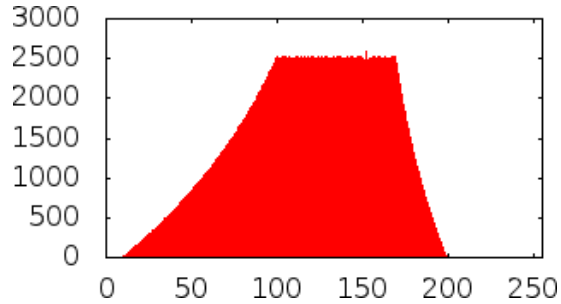




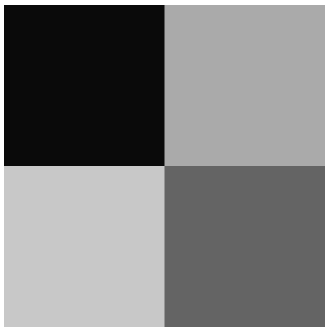
cyclic :

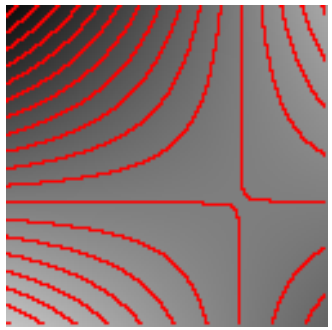


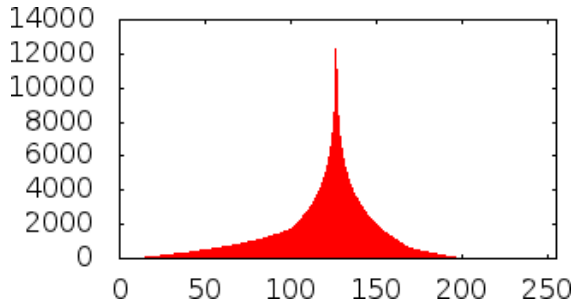




singular :



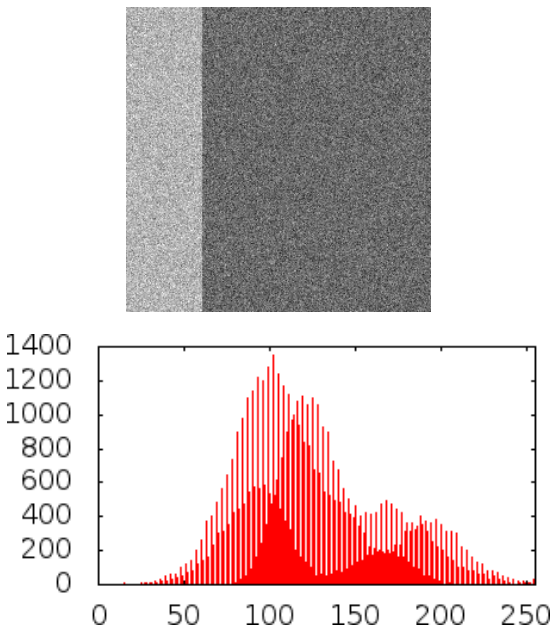




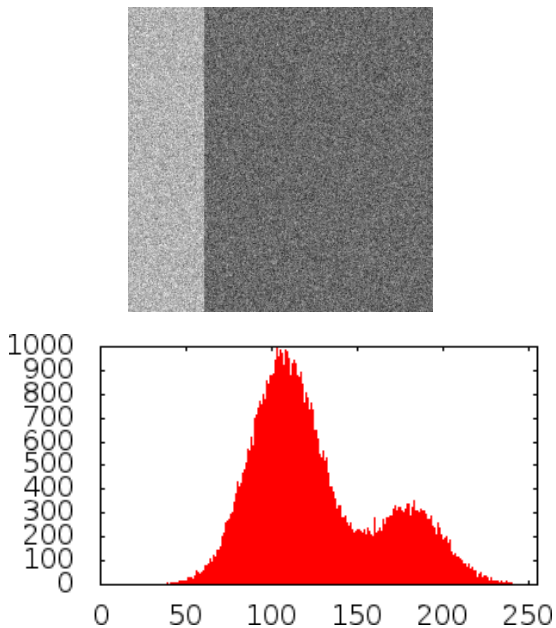
$$h(t) = a \log(\alpha t + \beta) + b \quad \text{par morceaux}$$

Calcul practique : Filtrage préalable

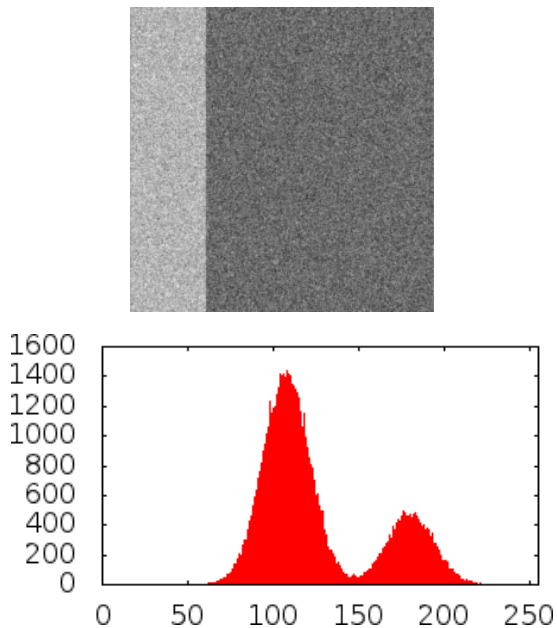
Simuler les résultats avec un filtrage gaussien préalable



$\sigma = 0.4$



$\sigma = 0.6$



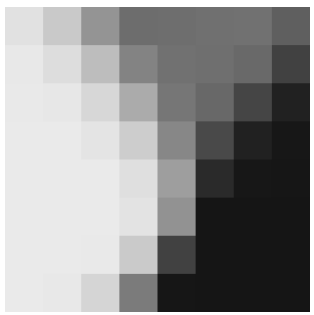
$\sigma = 0.8$

Valeur magique : $\sigma = 0.65$

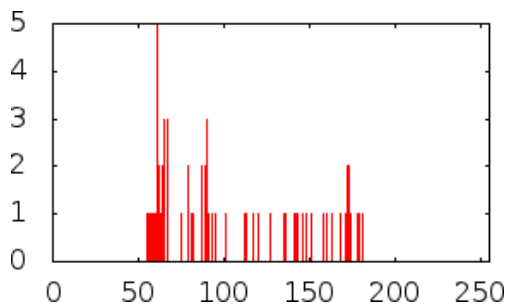
Applications

Avantages de la mèthode proposée :

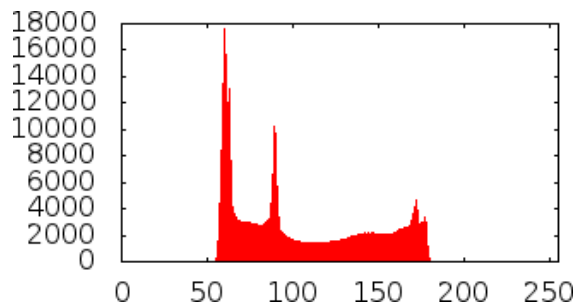
- Calcul d'histogrammes d'images très petites (patches)
- Histogrammes toujours denses et lisses
- Vraie équalisation



patch 8×8



histogramme



histogramme zoomé

Conclusion

Ne jamais lisser les histogrammes ;
si nécessaire, zoomer ou lisser les images.