

Lecture 9

Color Quantization

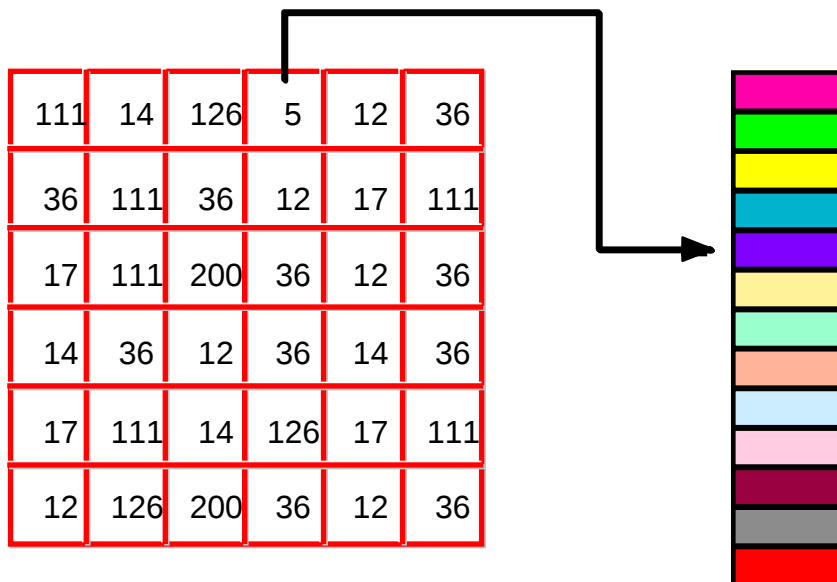
24bit Color to 8bit Color

Image Independent Quantization

Image Dependent Quantization

Perceptual vs Linear Quantization

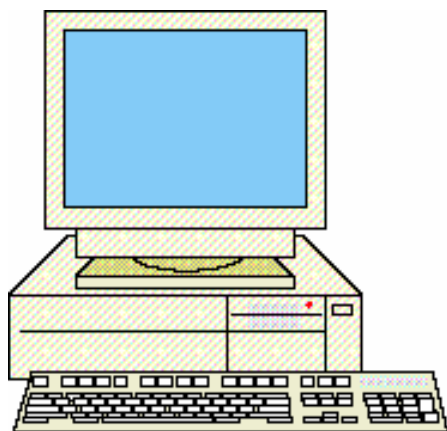
Quantization of Image Sequences



Color Quantization

Human visual perception is used to design and constrain industrial and engineering applications.

- The problem of color quantization for color images.
- Engineering solution.
- Psychophysical data and observations.
- Incorporating perceptual constraints into the color quantization process.
- Quantization of image sequences.

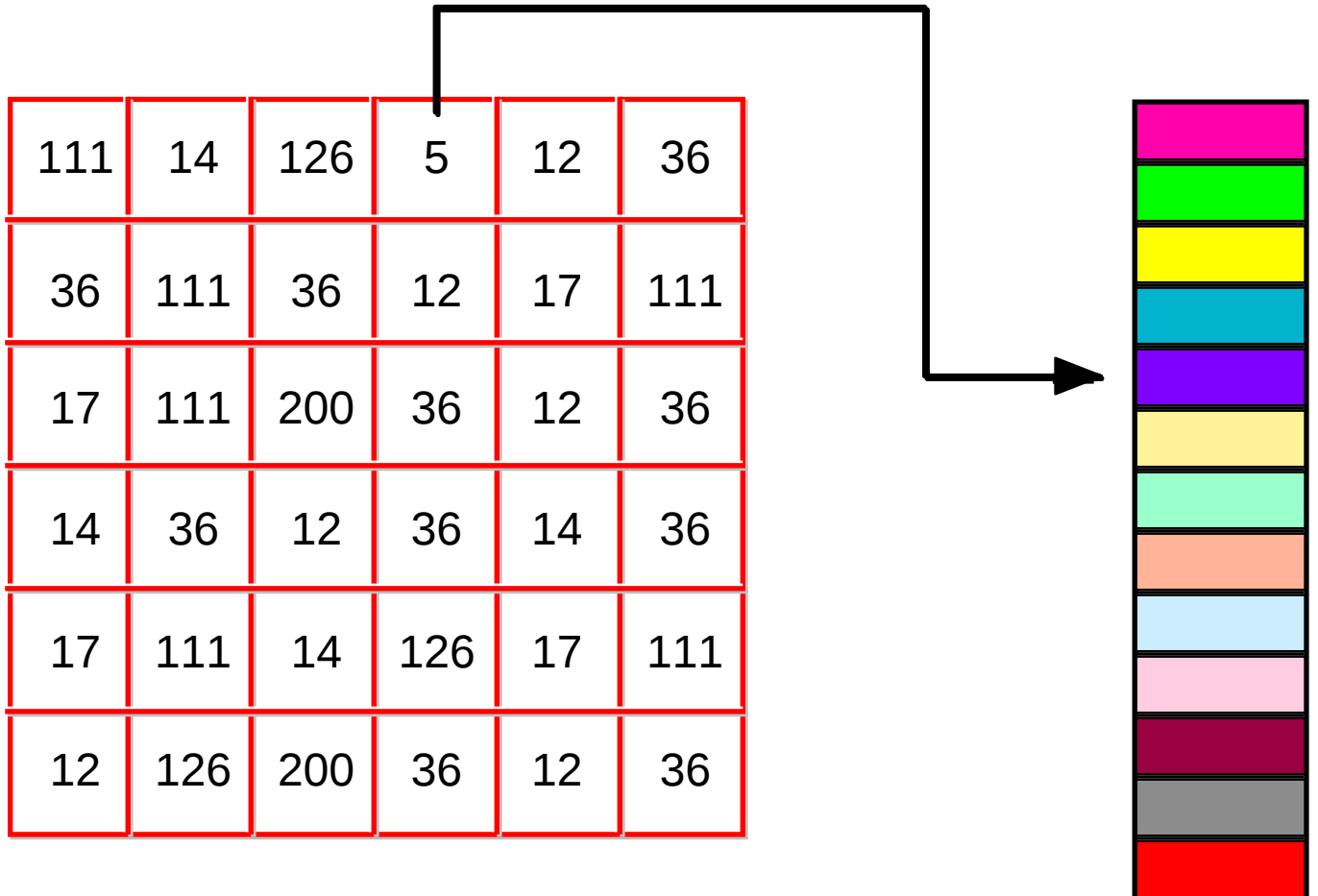


Rgb Image

[illegible]

10 200 111	128 36 14	126 12 126	200 36 36	12 14 12	111 36 36
17 200 36	36 111 111	36 14 36	14 126 12	36 17 17	72 111 111
12 36 17	17 36 111	126 111 200	17 36 36	111 14 12	200 36 36
14 17 14	200 126 36	36 72 12	12 126 36	126 17 14	17 111 36
126 200 17	200 36 111	111 12 14	14 36 126	36 12 17	72 126 111
36 72 12	12 12 126	17 17 200	72 111 36	106 14 12	155 36 36

Indexed Image



Color Image Quantization

Color Quantization = Reducing the number of different colors in a color image.

Reproduce the original as best as possible

Quantized image should look “good” and look “similar” to the original.

Original

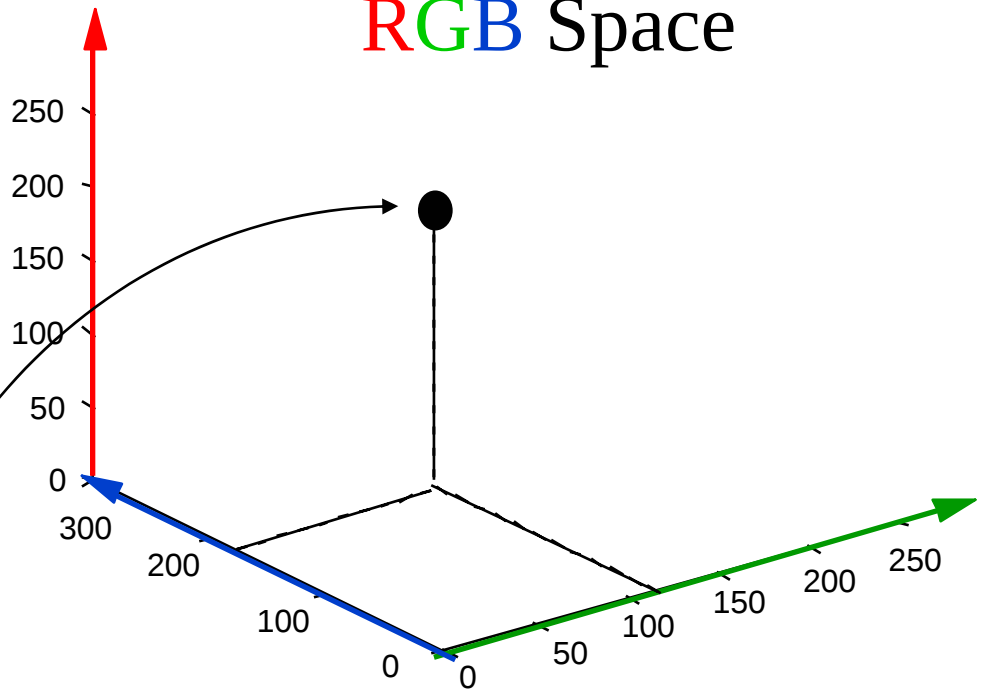


Quantized



Color Representation

RGB Space

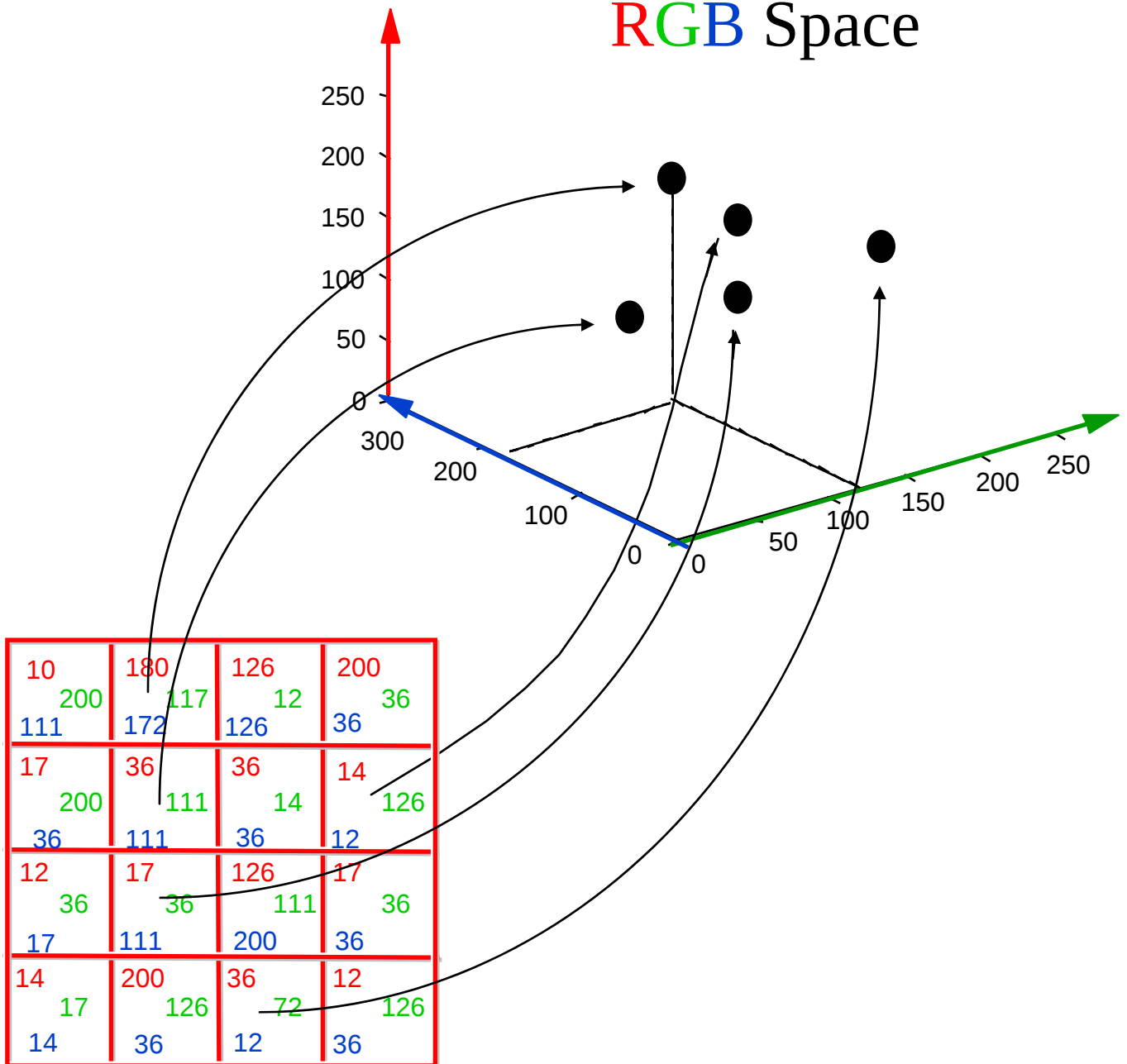


10	180	126	200
200	117	12	36
111	172	126	36
17	36	36	14
200	111	14	126
36	111	36	12
12	17	126	17
36	36	111	36
17	111	200	36
14	200	36	12
17	126	72	126
14	36	12	36

RGB Image

Color Representation

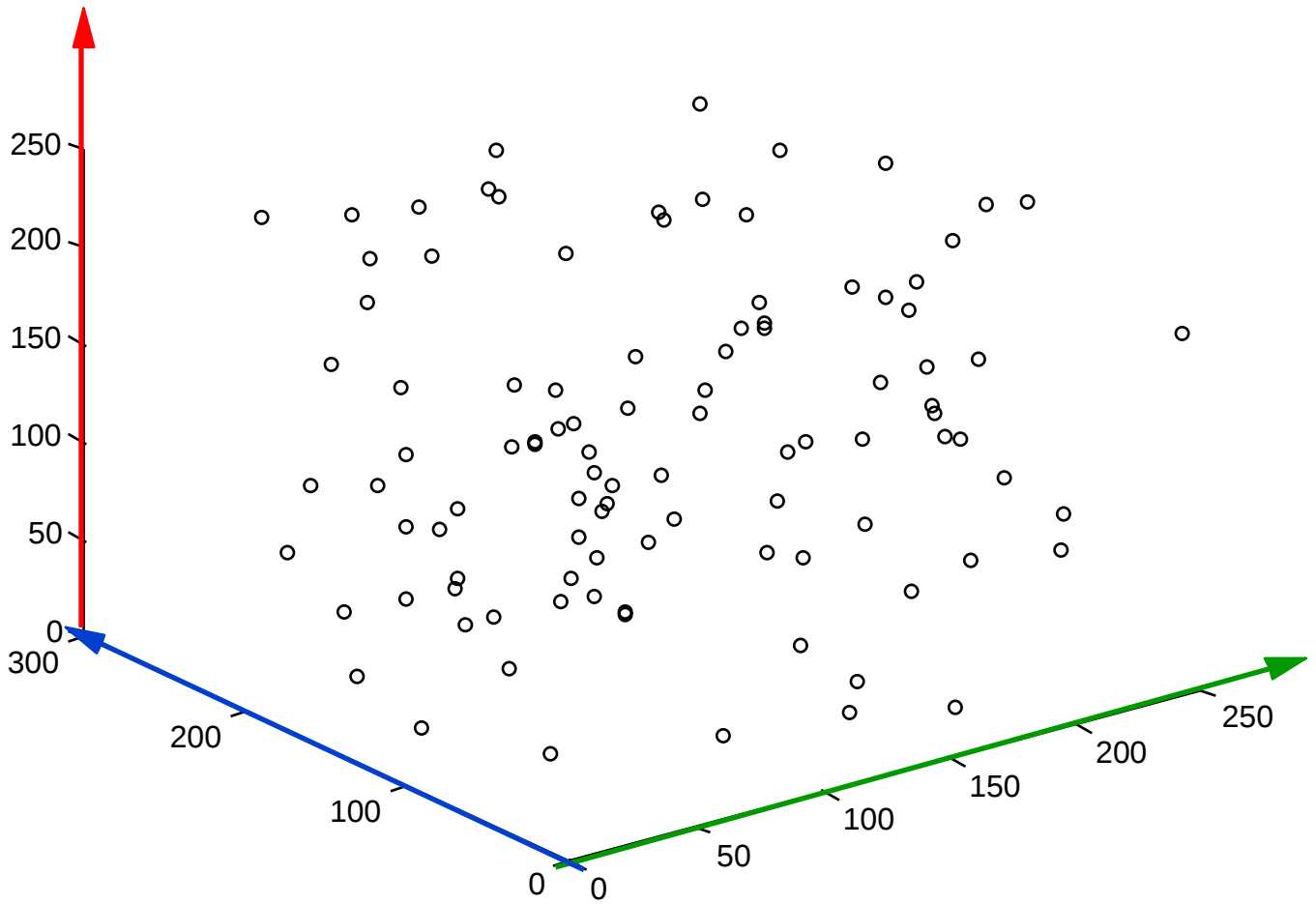
RGB Space



RGB Image

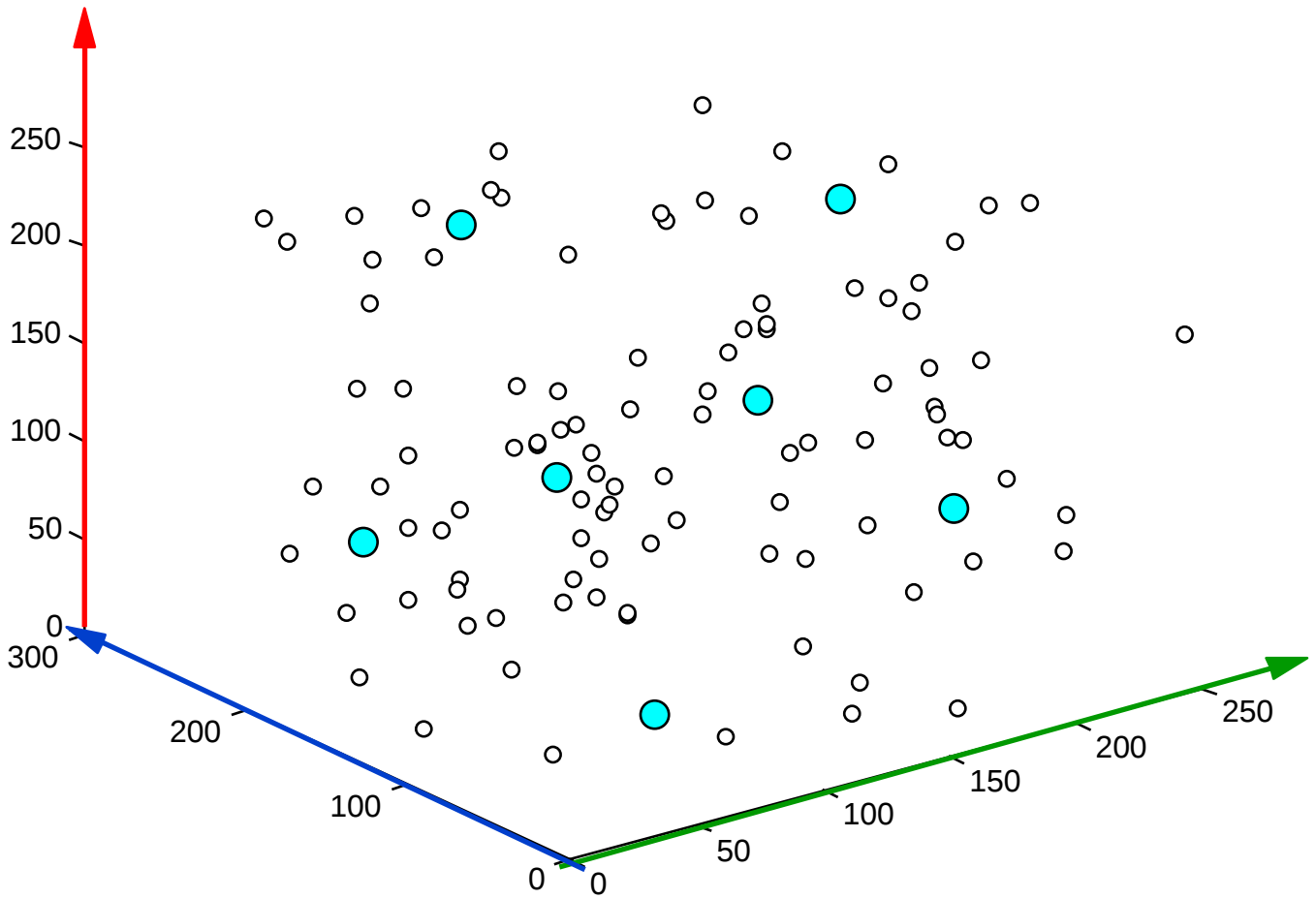
Color Representation

RGB Space



Color Representation

RGB Space



Color Representation

RGB Space

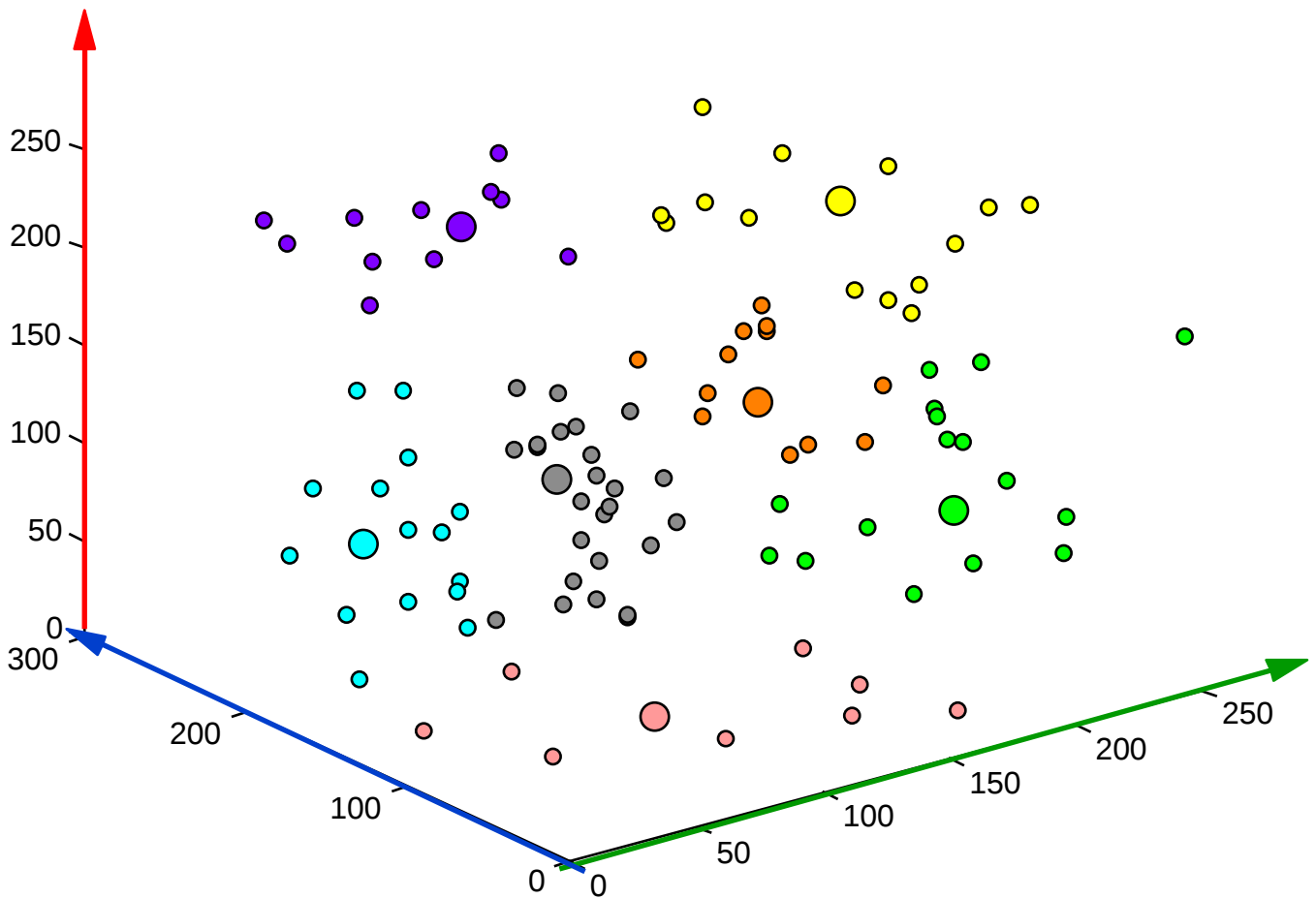


Image Independent Quantization

RGB Space

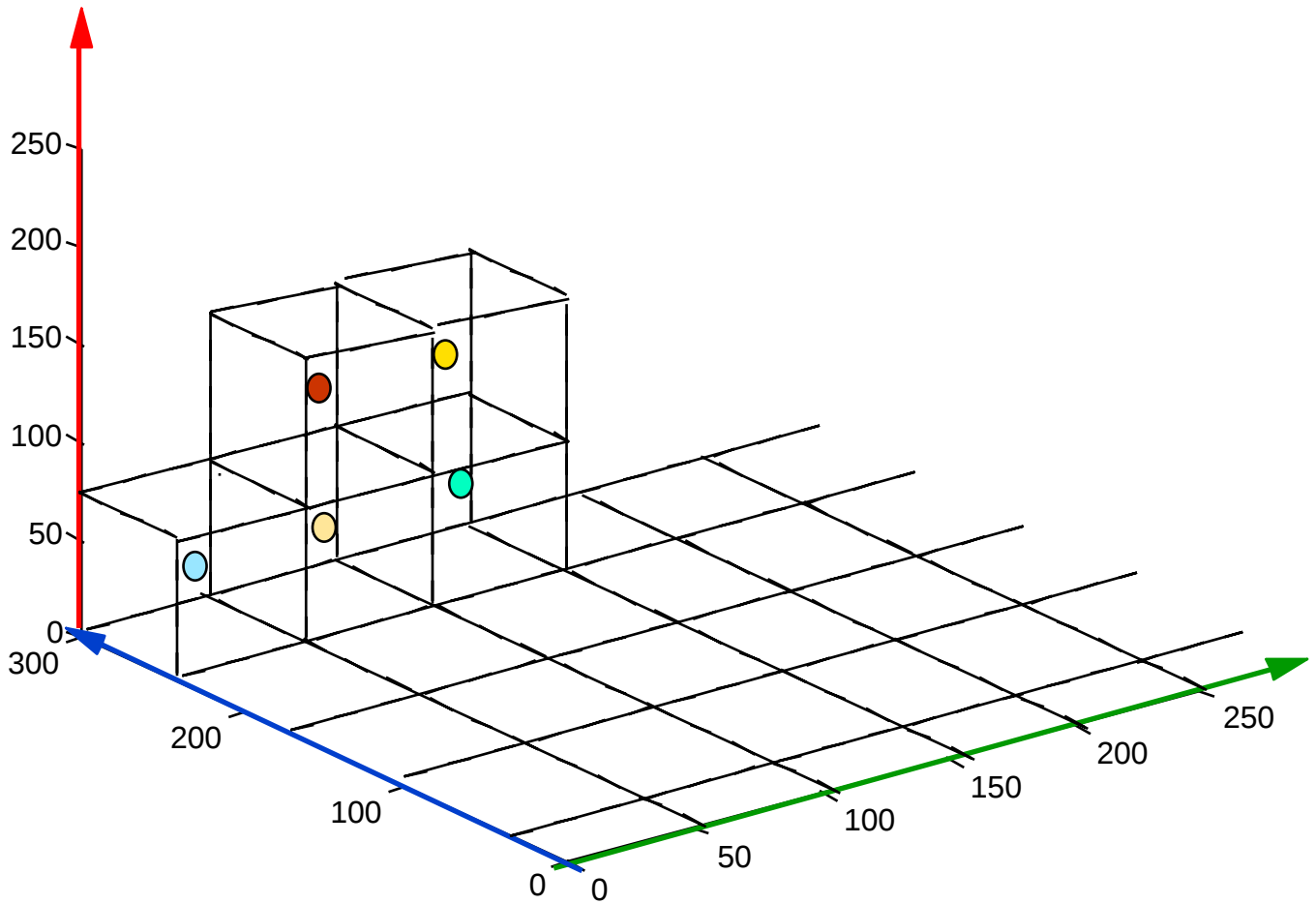


Image Independent Quantization

Original



125 Colors



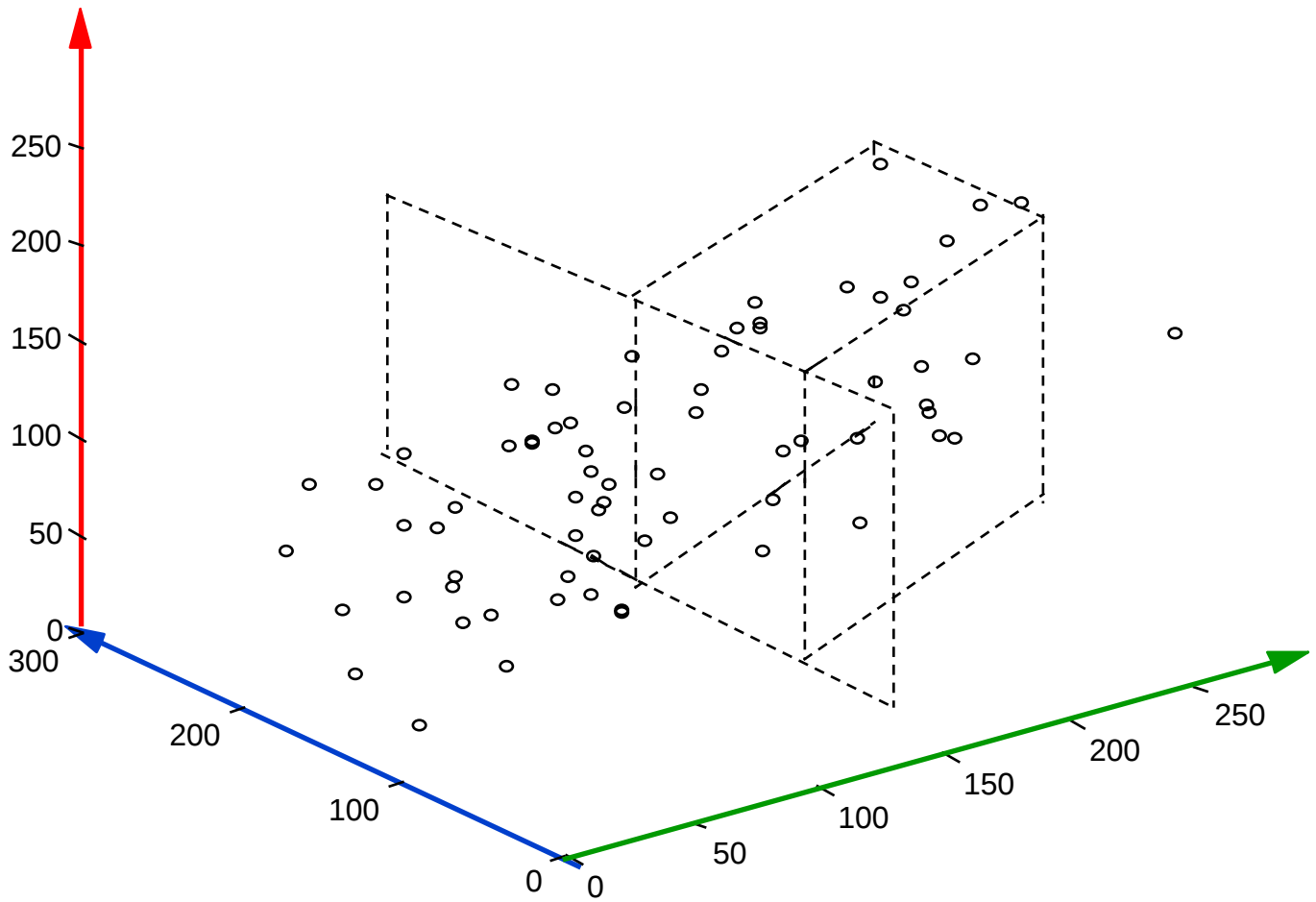
64 Colors



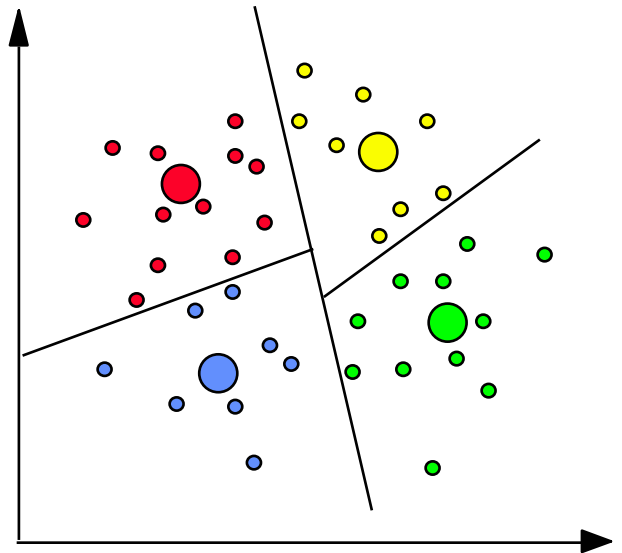
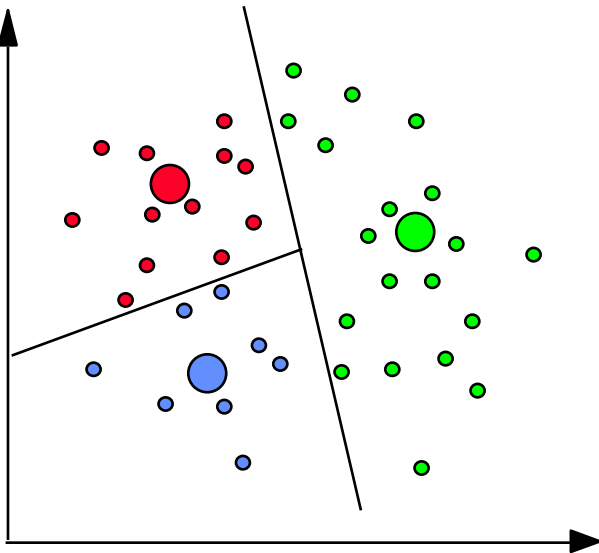
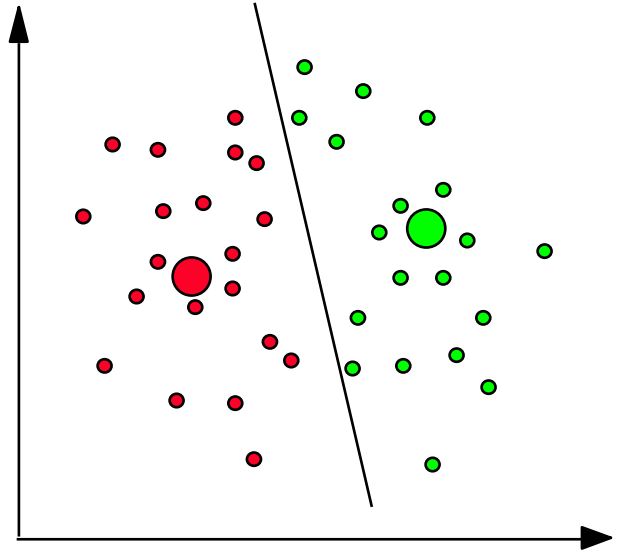
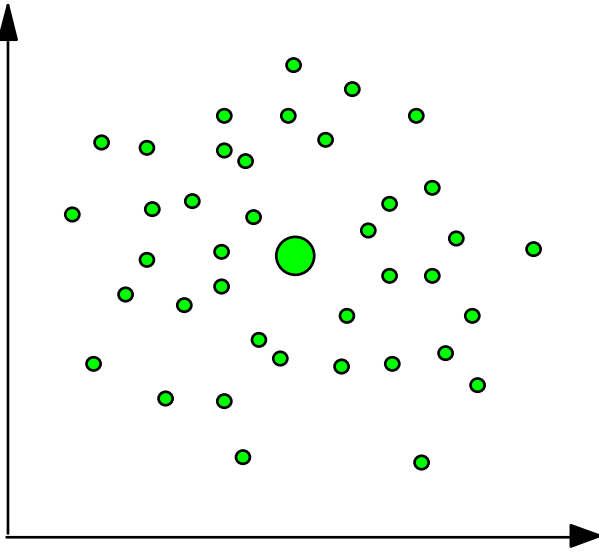
27 Colors



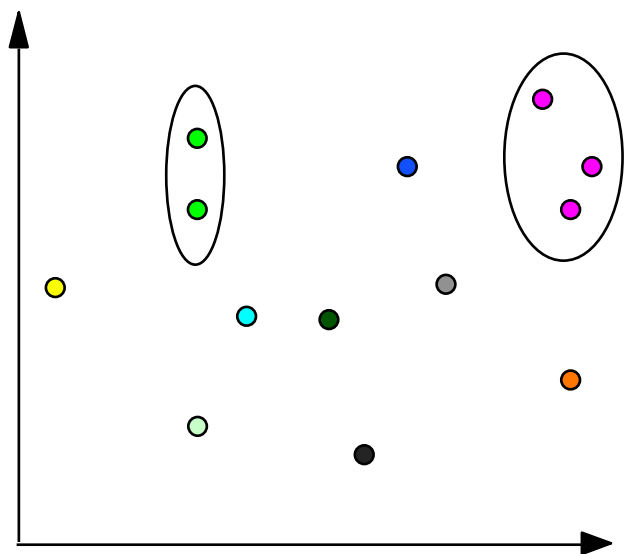
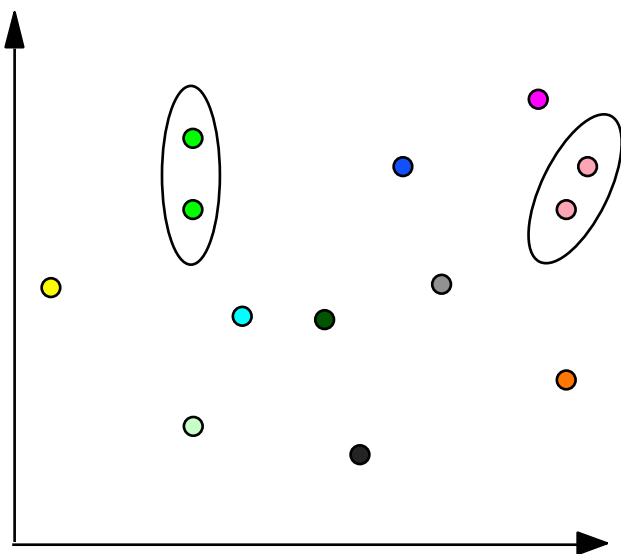
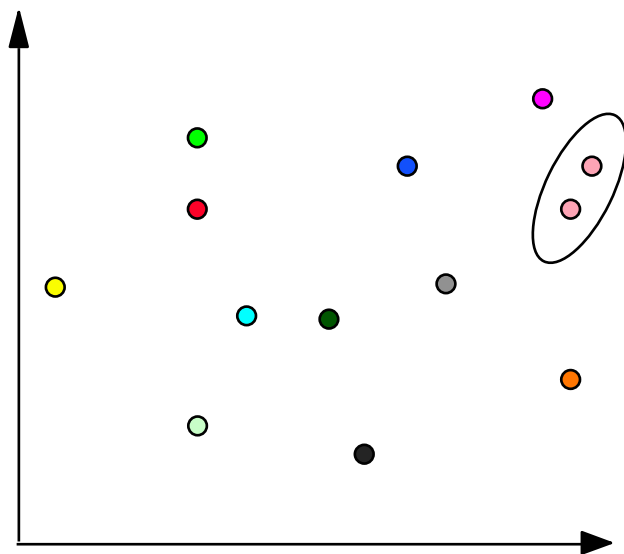
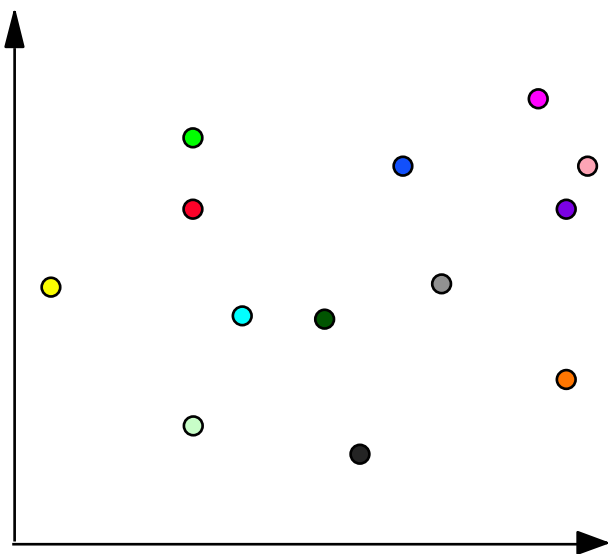
Image Dependent Quantization



Top-Down Quantization (Split)



Bottom-Up Quantization (Merge)



LBG Quantization (Iterative)

(Linde Buzo Gray 1980)

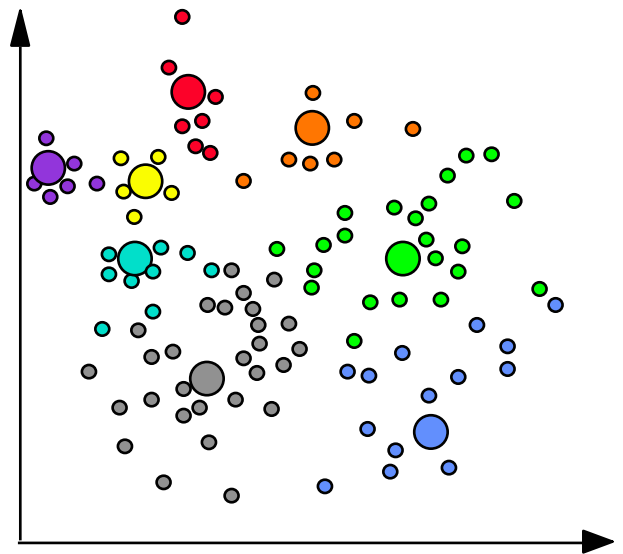
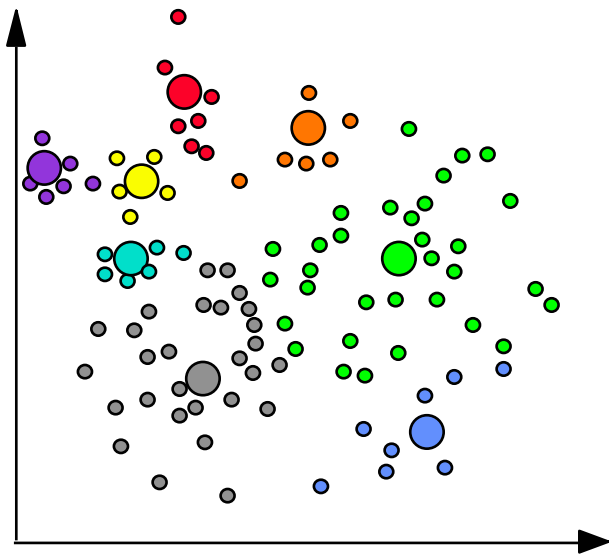
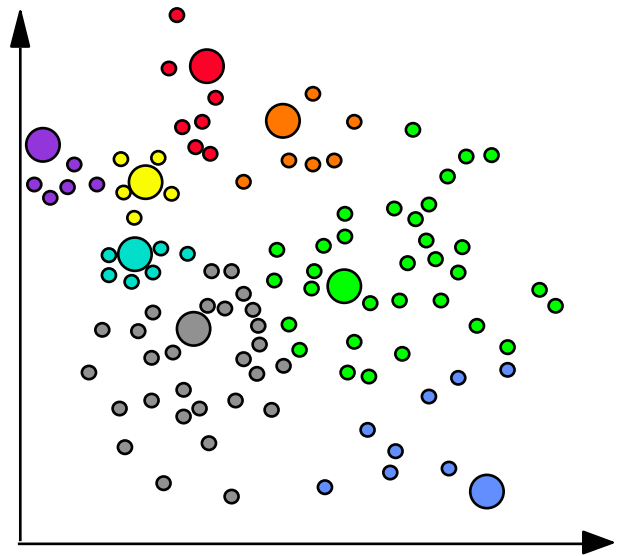
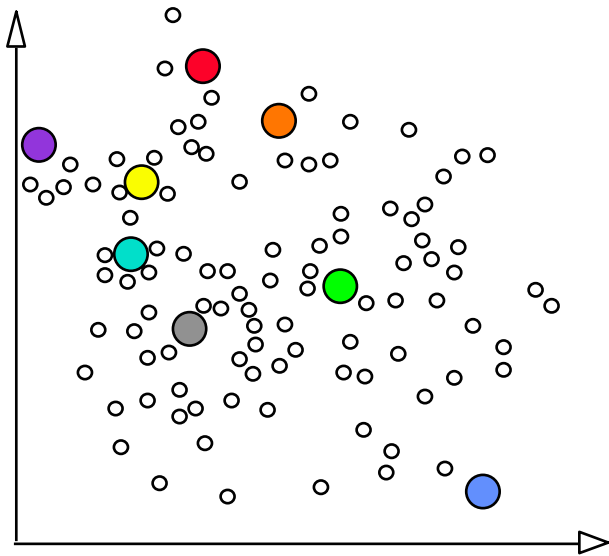
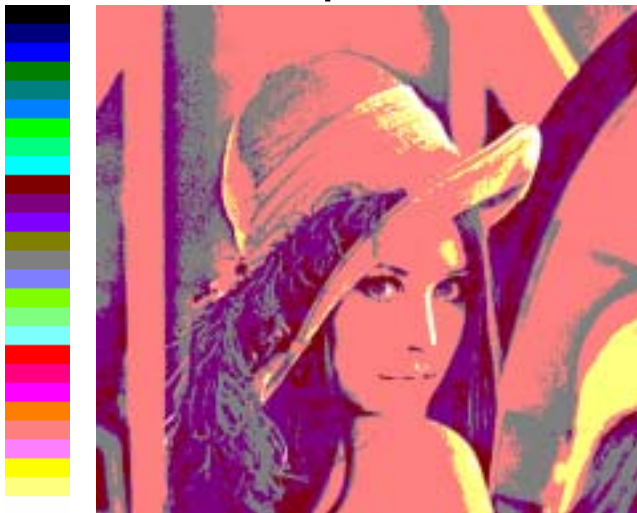


Image Dependent Quantization

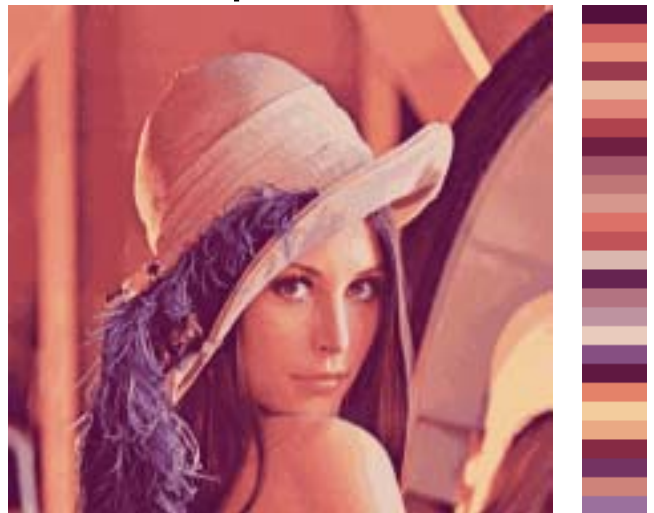
Original



Independent



Dependent



Observation I

Distances and quantization errors measured in RGB space, do not relate to human perception.

- Weber's Law - we are more sensitive to changes in darker regions than in lighter regions.
- We are more sensitive to intensity changes than to hue shifts.
(Loughren 53', Hacking 53', McAdan 81')

Perceptual vs Linear Quantization

Original



Perceptual



Intensity



RGB vs YIQ Quantization

Original



RGB Quantization



YIQ Quantization

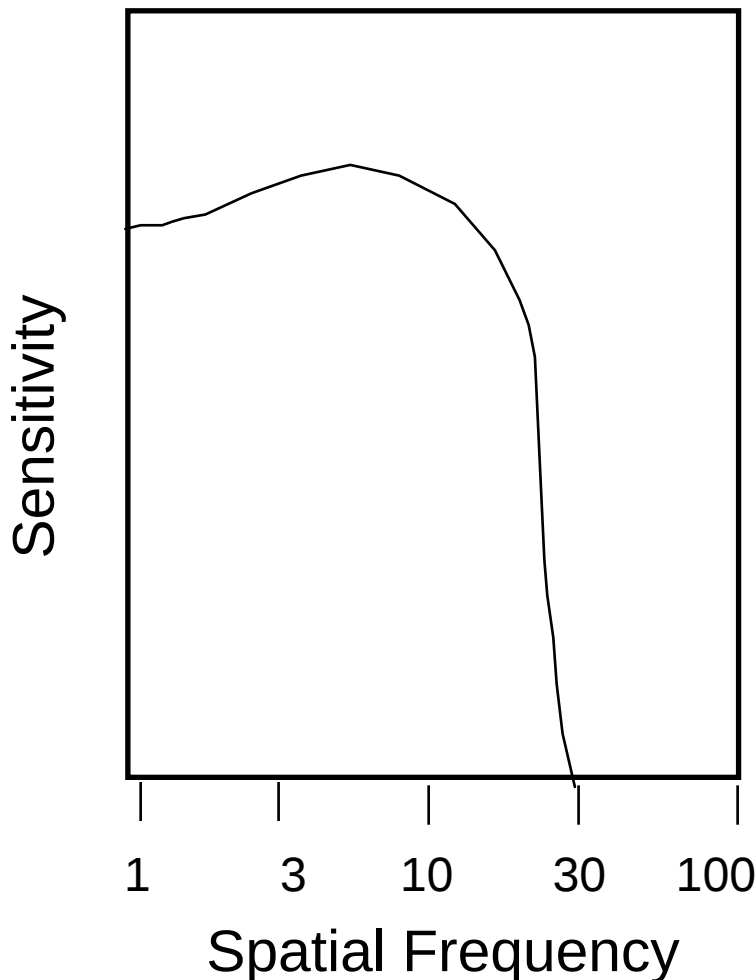


Observation II

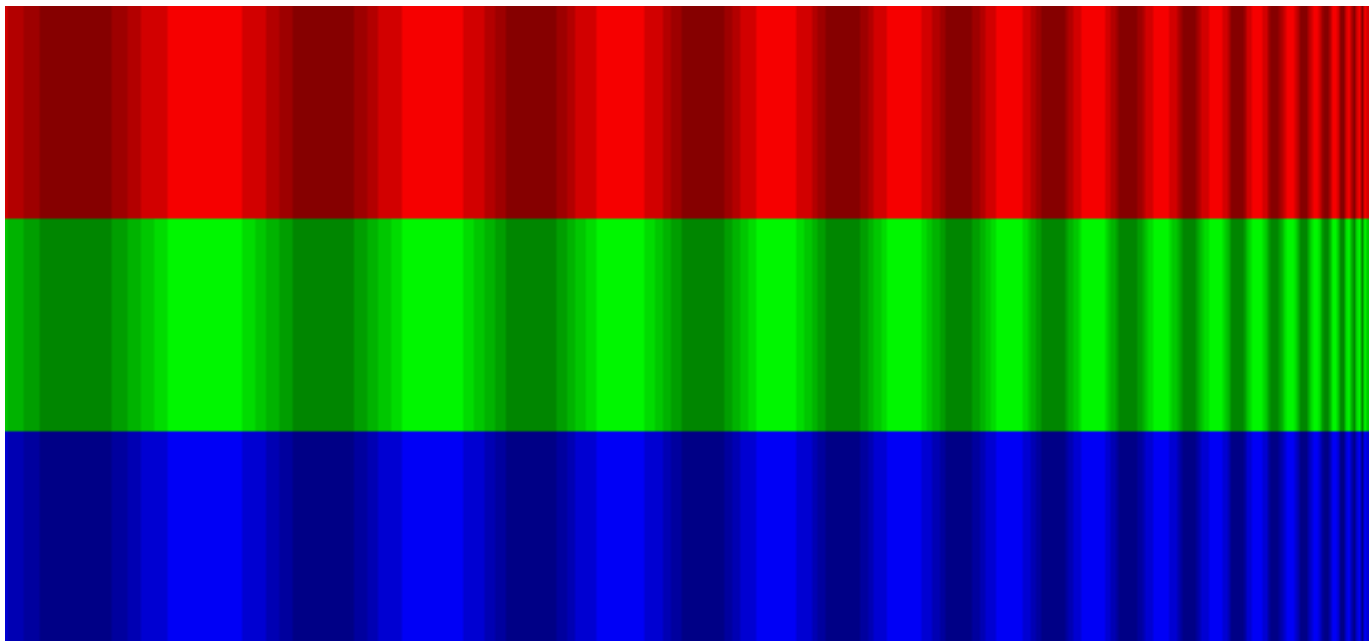
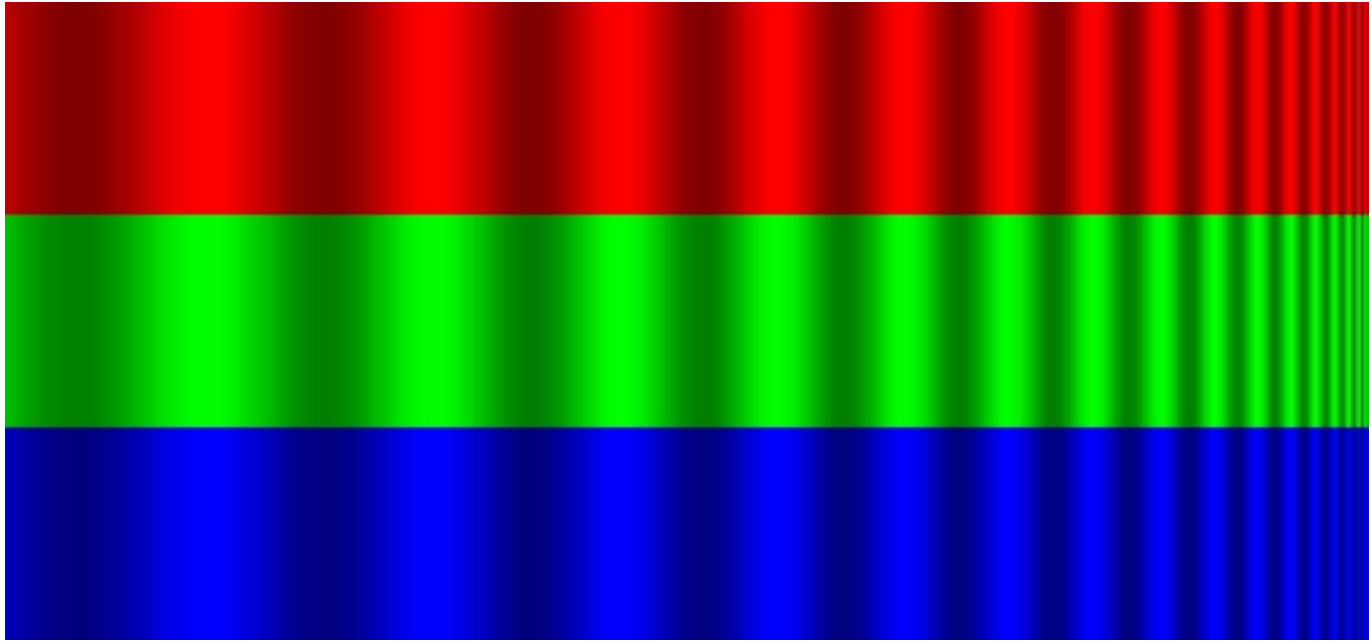
Quantization errors are spatially dependent.

We are more sensitive to errors at lower spatial frequencies.

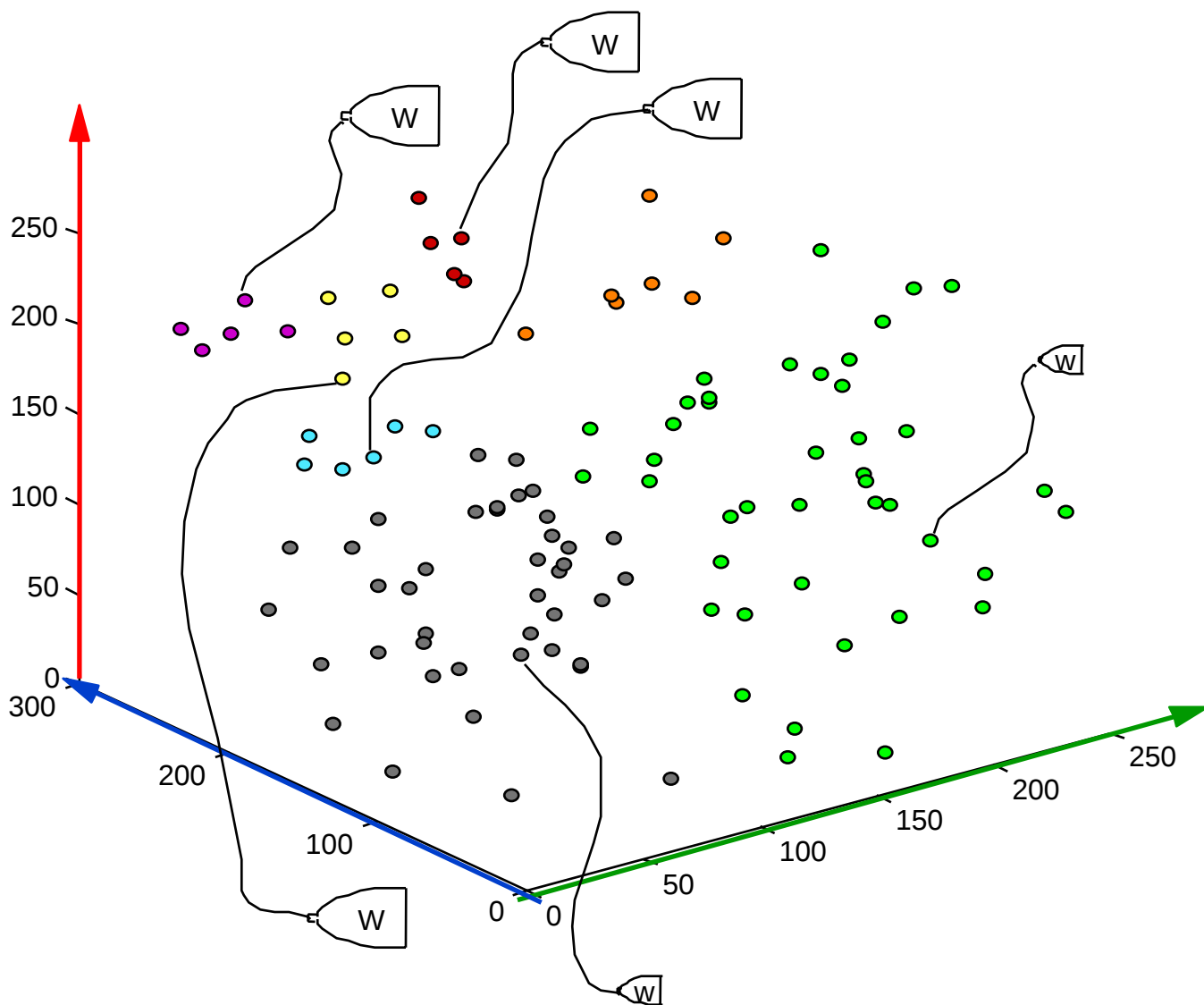
(Legge and Foley 80', Schade 56', Campbell and Robson 68')



Quantization errors are spatially dependent



Weighted Quantization



Weighted Quantization

Original



Dependent
Quantization



Weighted
Quantization



Image Sequence Quantization

- Color Reproduction.
- Color Continuity.

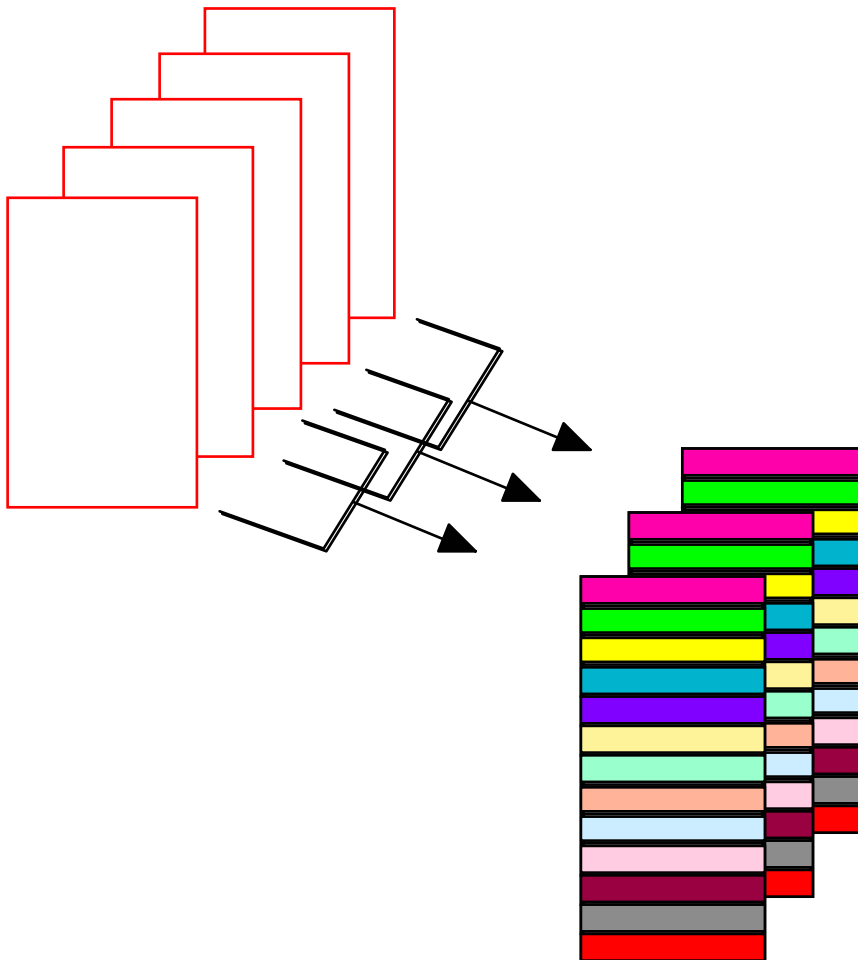


Image Sequence Quantization

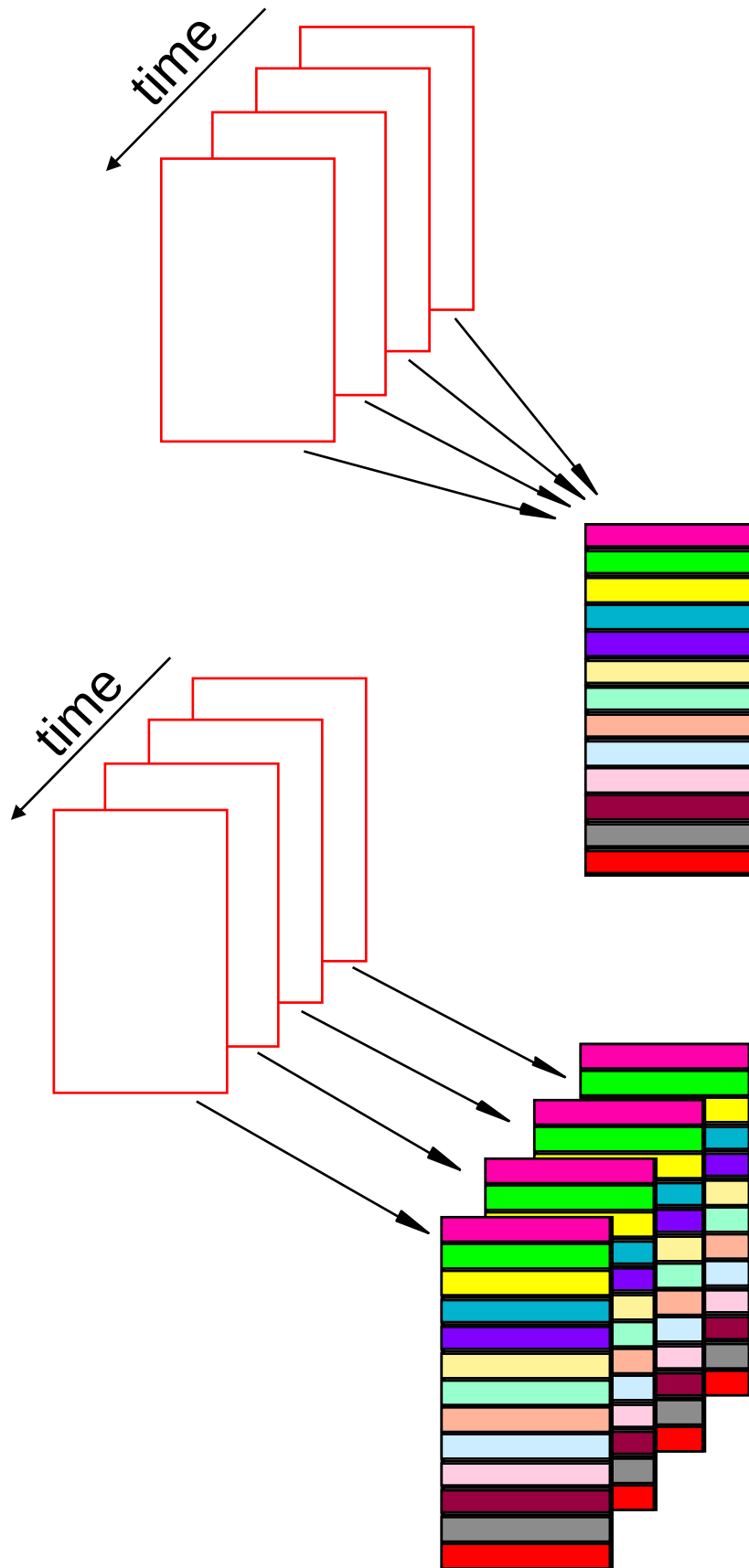
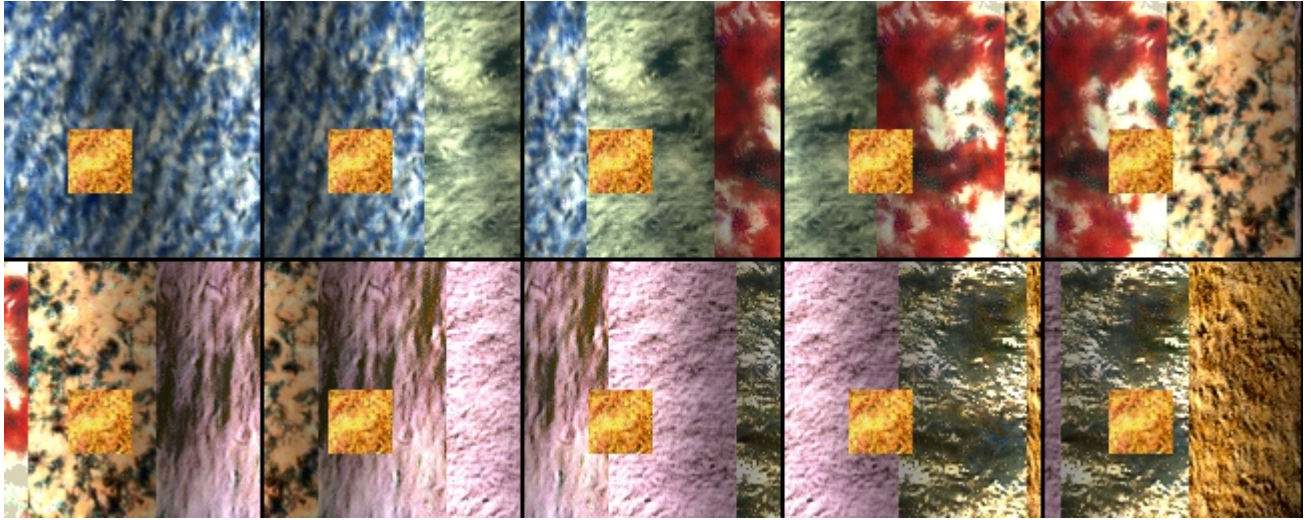
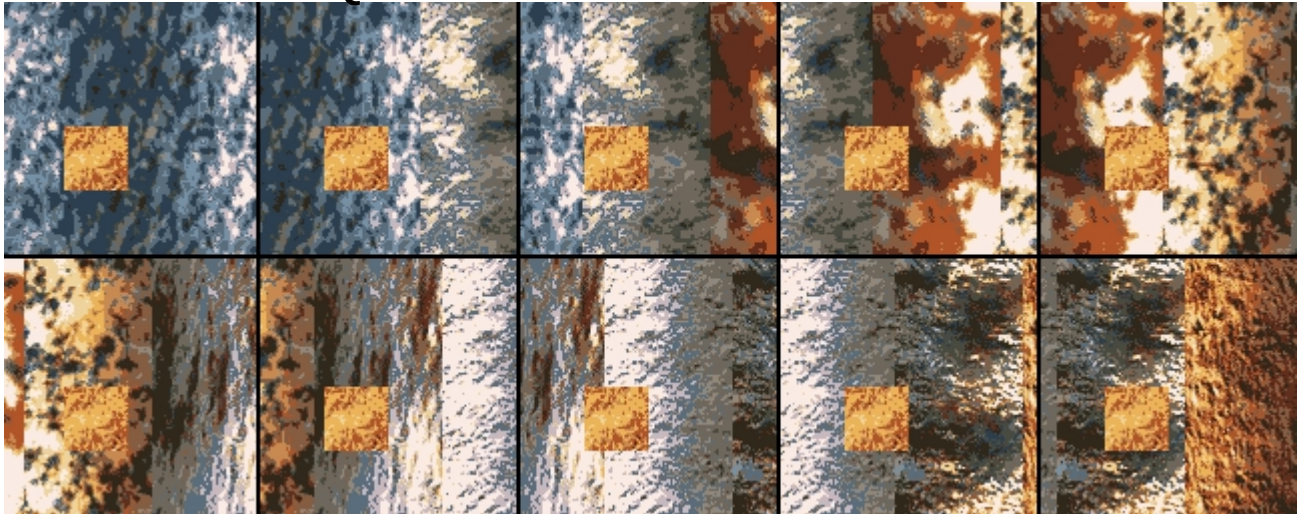


Image Sequence Quantization

Original



All Frames Quantization



Single Frame Quantization

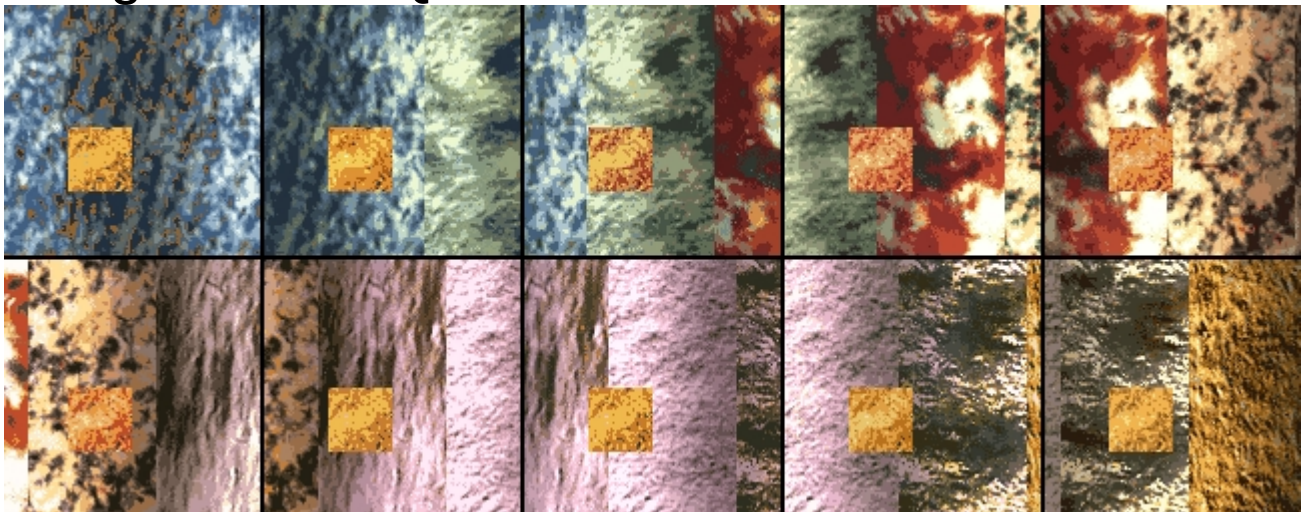
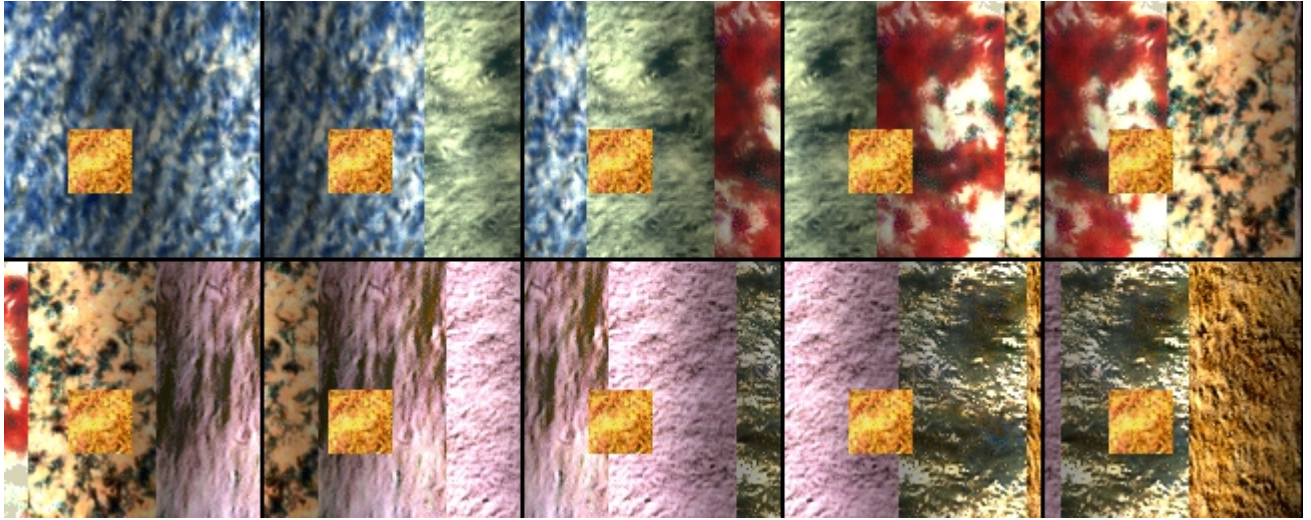
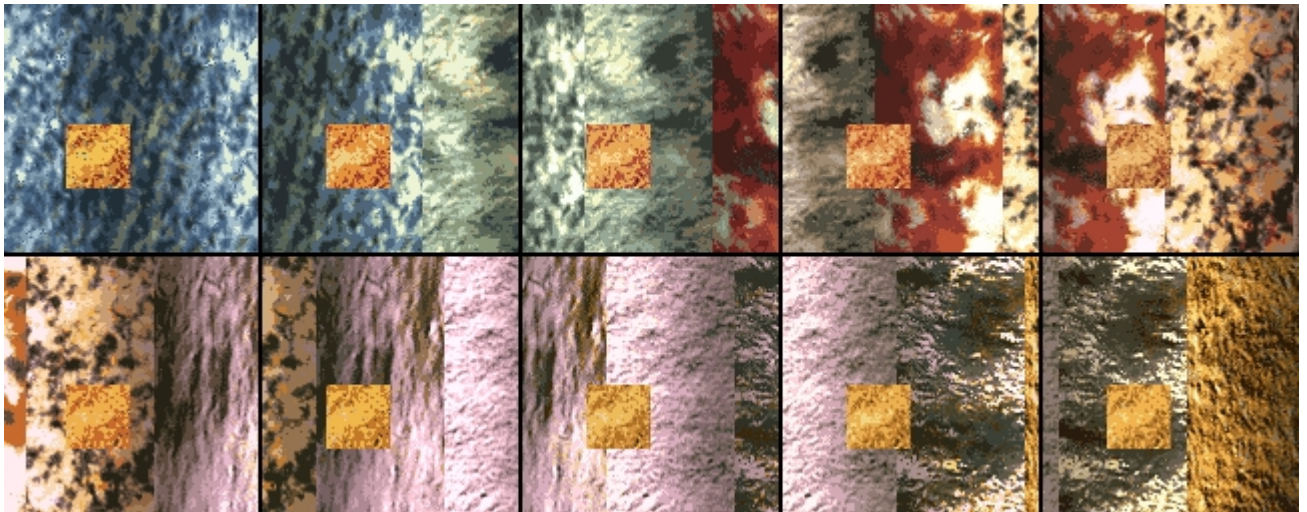


Image Sequence Quantization

Original



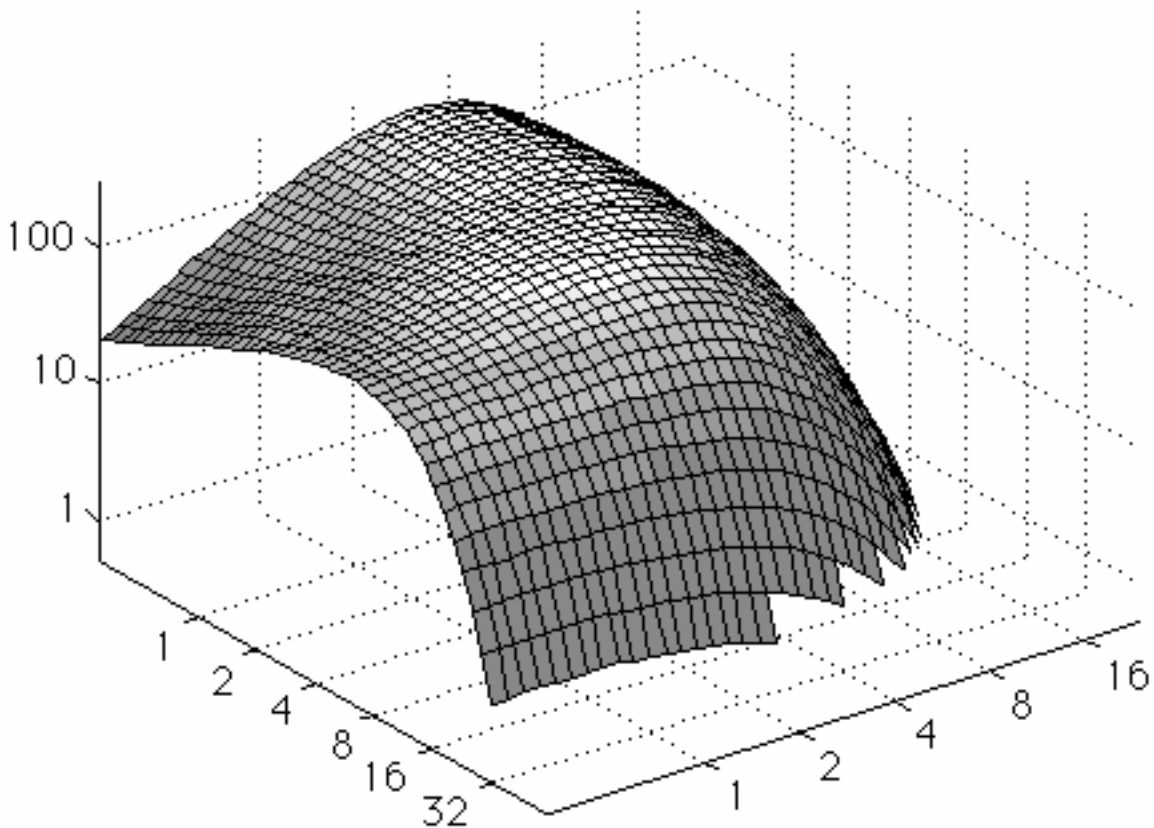
3 Frame Quantization



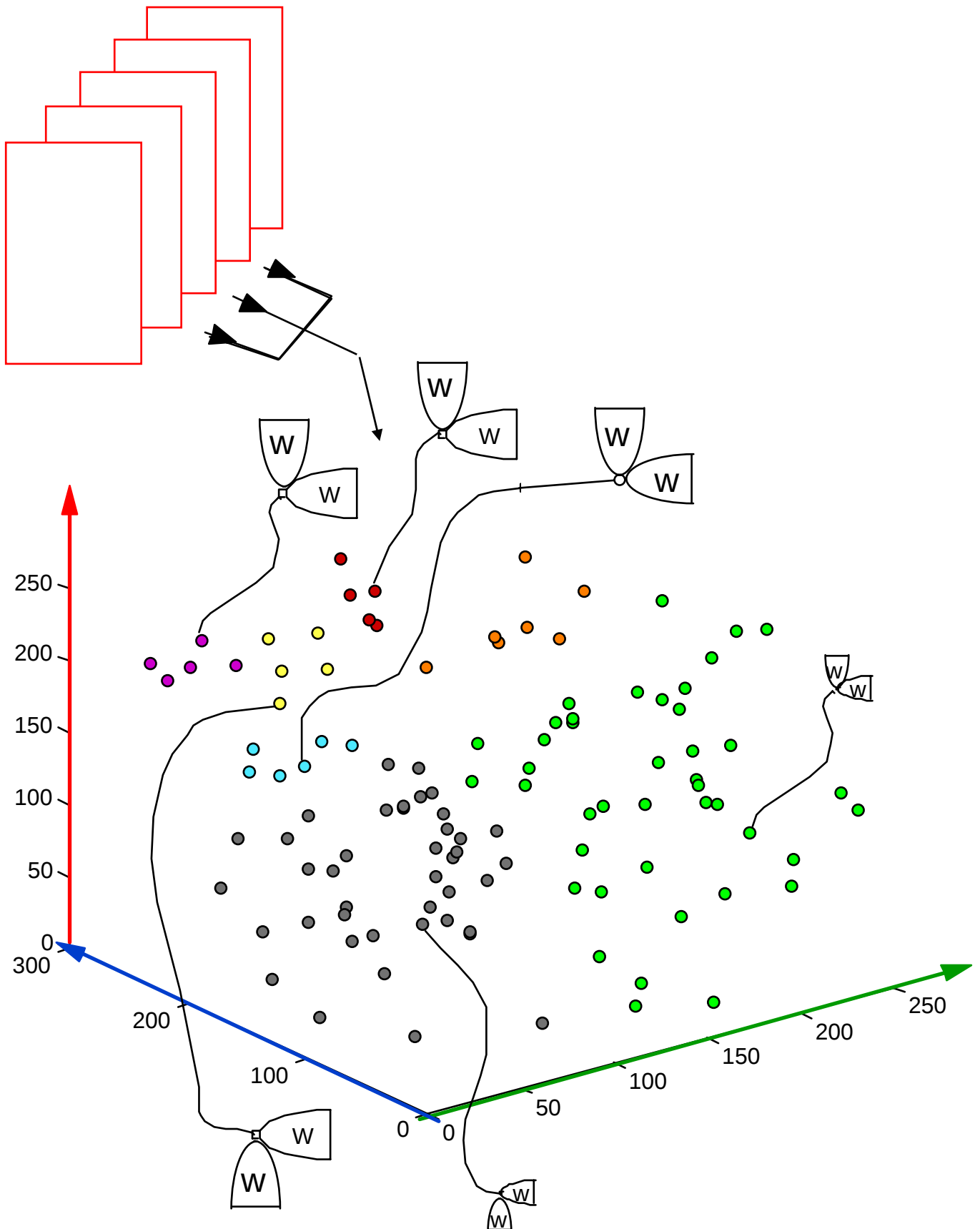
Observation III

Quantization errors are spatially and temporally dependent.

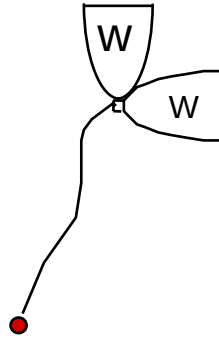
- We are more sensitive to errors at lower spatial frequencies and lower temporal frequencies.



Weighted Quantization



Weighted Quantization



Weight per pixel color is multiplicative:

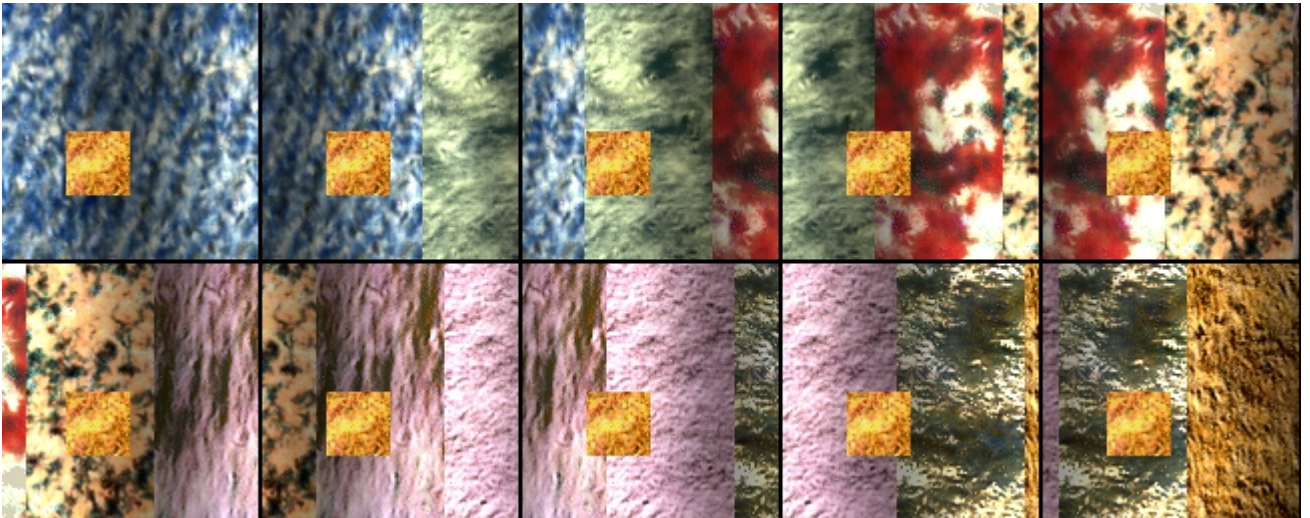
Spatial-weighting: depends on local spatial business around pixel (high business -> low weight)

Time-frame weighting: 1:2:1 for frame $i-1, i, i+1$
(current frame -> high weight)

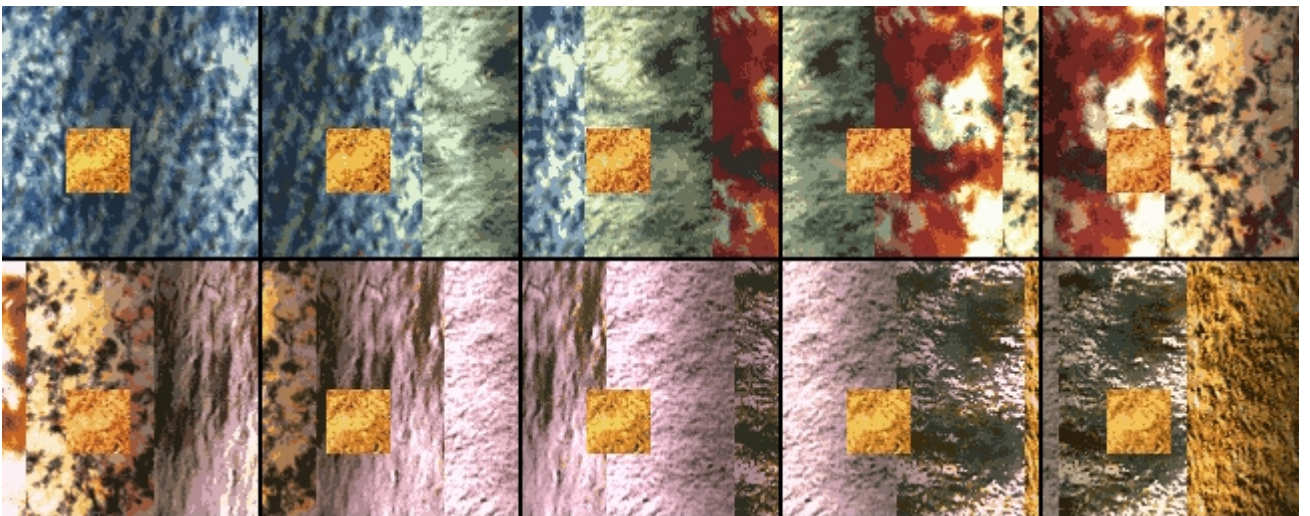
Time-frequency weighting: depends on temporal frequency of pixels
(high temporal frequency -> low weights)

Weighted Quantization

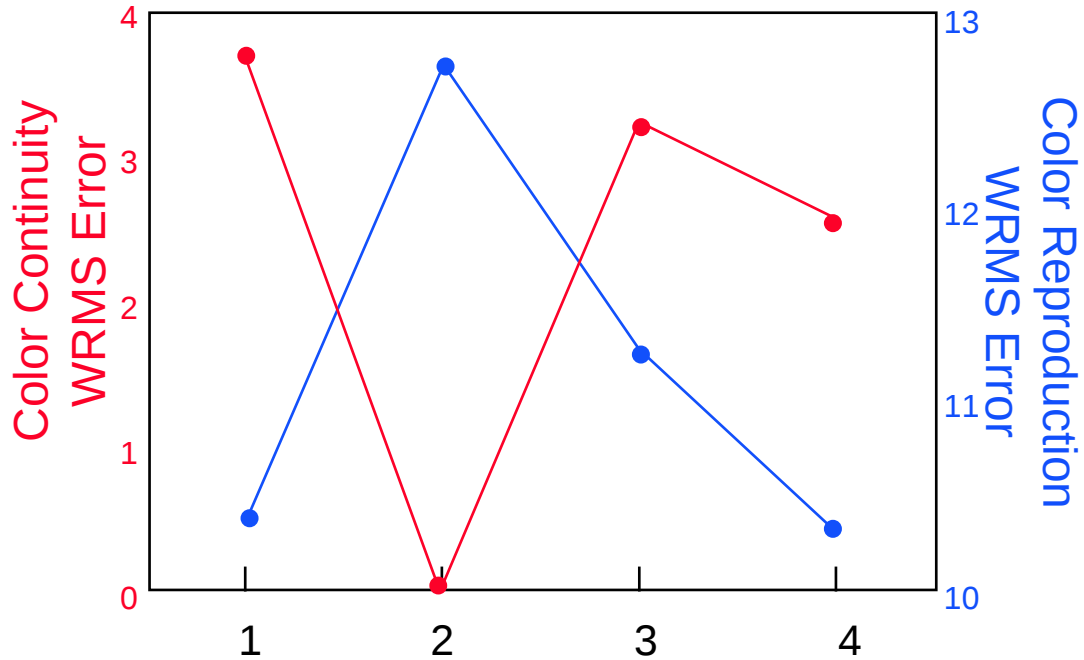
Original



Weighted Quantization

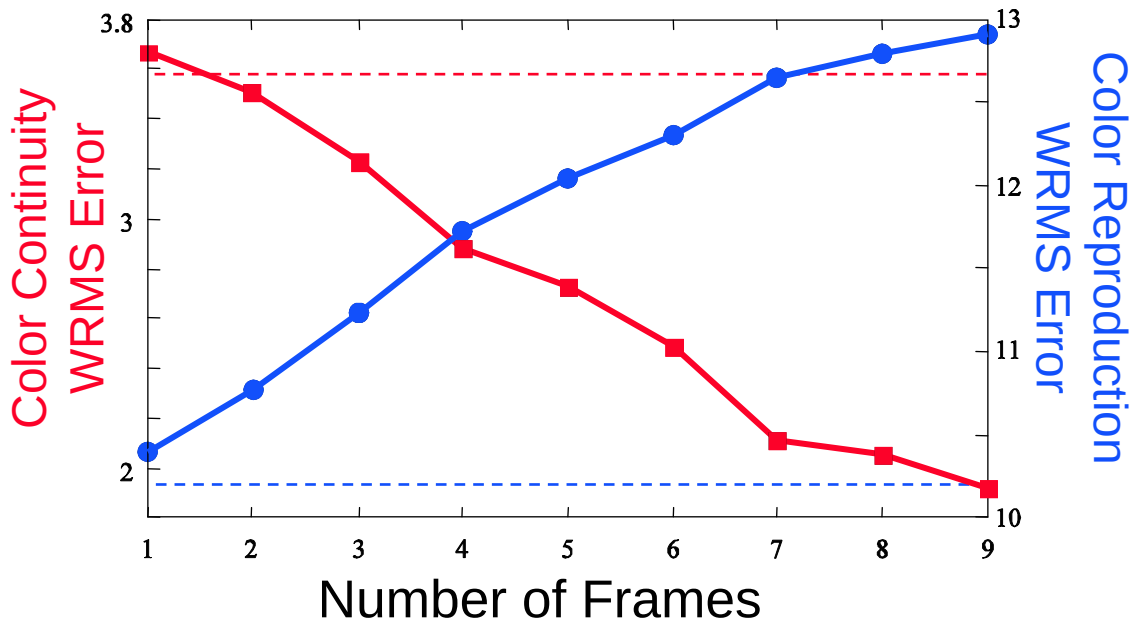


Quantization Methods



1. Single frame quantization
2. All frames quantization
3. Three frames quantization
4. Weighted quantization

Quantization Methods



----- Weighted Quantization

Improving Quantization

Original



Quantization (2 bins)



Dithered

