Color Quantization

Common color resolution for high quality images is 256 levels for each Red, Greed, Blue channels, or $256^3 = 16777216$ colors.

How can an image be displayed with fewer colors than it contains?

Select a subset of colors (the colormap or pallet) and map the rest of the colors to them.

Standard Color Quantization
(24 → 8 **bits**)

Image independent

Quantize R range (256 values) to 8 values.
Quantize G range (256 values) to 8 values.
Quantize B range (256 values) to 4 values.

Equivalent to retaining 3-3-2 most significant bits of each color component.

Here is a result of have only 3 bits of (reddish) gray levels:

Lena - 24 bit   Lena - 8 colors
Color, 11.19

Error Diffusion
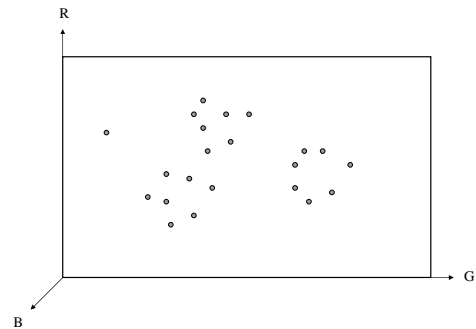
Median Cut quantized to 8 colors
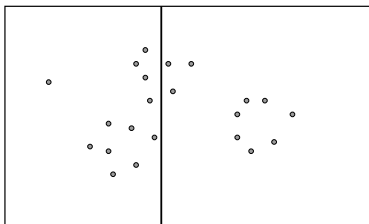
Same after error-diffusion   Color, 11.26
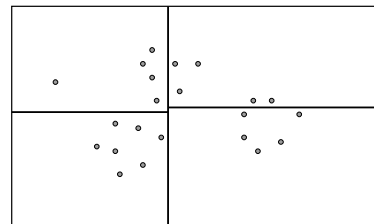

Median Cut

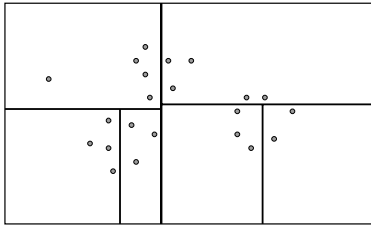

Median Cut

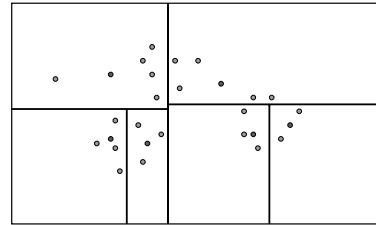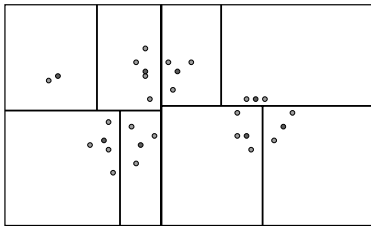## Median Cut

Median Cut

Median Cut

Median Cut

The median cut algorithm

```
Color_quantization(Image, n){

        For each pixel in Image with color C, map C in RGB space;

        B = {RGB space};
        While (n-- > 0) {
                L = Heaviest (B);
                Split L into L1 and L2;
                Remove L from B, and add L1 and L2 instead;
                }

        For all boxes in B do
                assign a representative (color centroid);

        For each pixel in Image do
                map to one of the representatives;
}
```

The median cut algorithm

Is this algorithm image dependent?
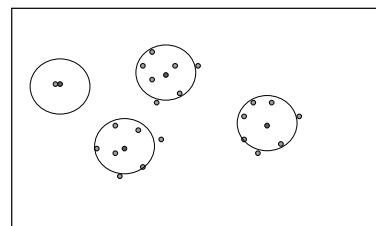
What is the Heaviest(B) box?
Several factors have to be weighed:

- The total number of image colors in the box.
- The total number of DIFFERENT image colors in the box.
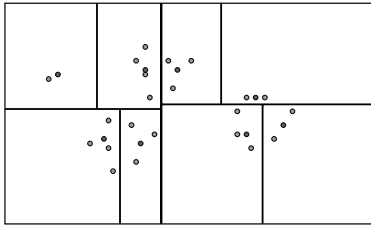- The physical size of the box.

Which representative should be chosen for a given color?

- The representative of the box containing the color.
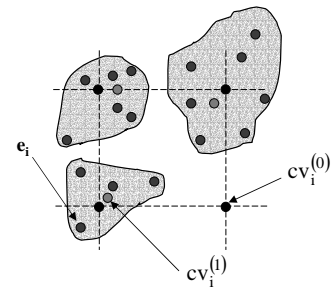- The closest representative under some metric.
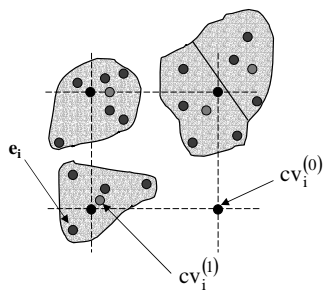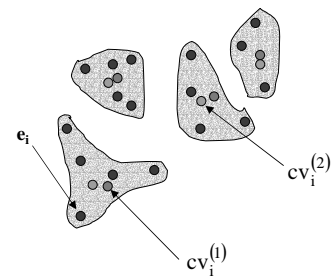
A better solution

Median Cut

Generalized Llyod Algorithm - GLA

$$e_i \qquad cv_i^{(0)} \qquad cv_i^{(1)}$$

Generalized Llyod Algorithm - GLA

$$e_i \qquad cv_i^{(0)} \qquad cv_i^{(1)}$$

Generalized Llyod Algorithm - GLA

$$e_i \qquad cv_i^{(2)} \qquad cv_i^{(1)}$$

Original image — 8 indexed colored

8 indexed colored — 32 indexed colored

Original image   128 indexed colored

8 levels per channel

that is, 9 bits per pixel
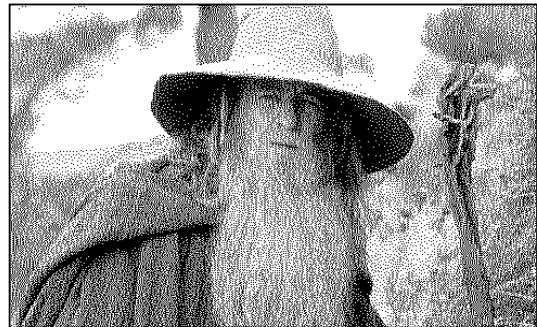

Original Image

Threshholding

Bayer's Ordered Dithering

Error Diffusion

Median Cut (4 levels)

Median Cut (8 levels)