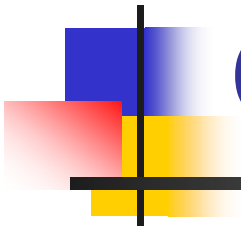
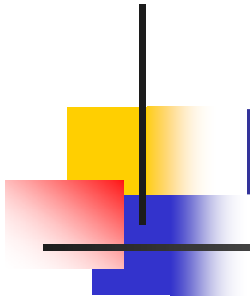


CS 112 – Display Considerations

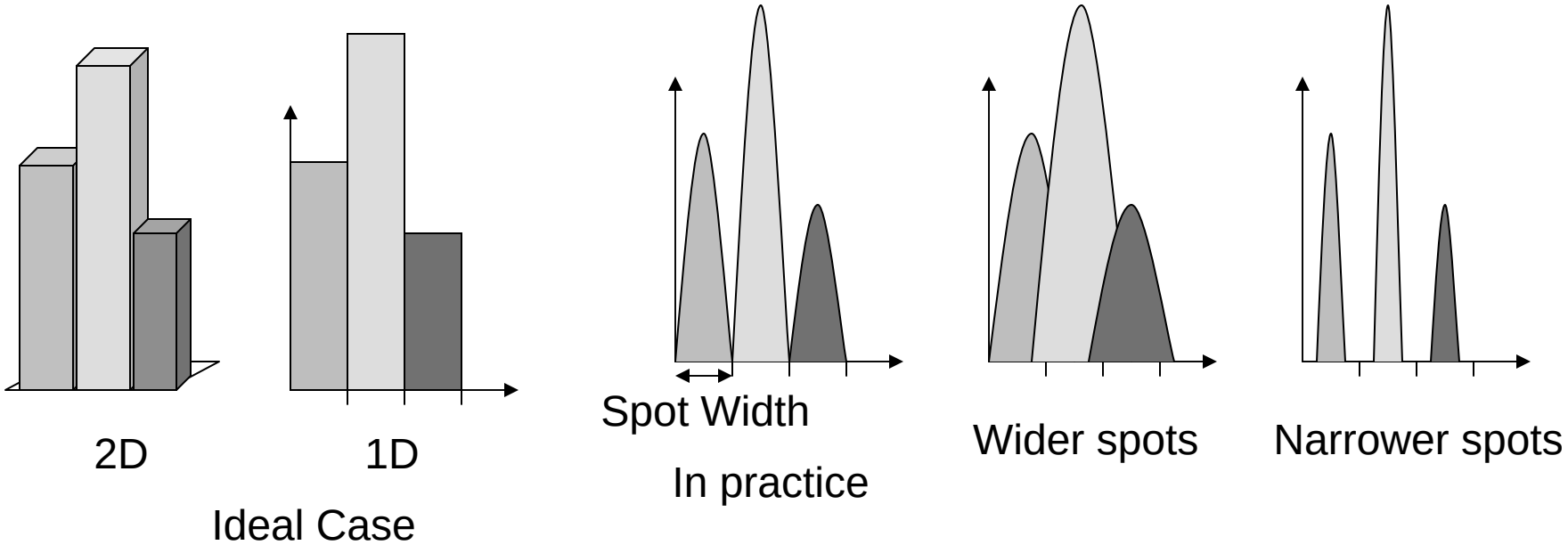


Display

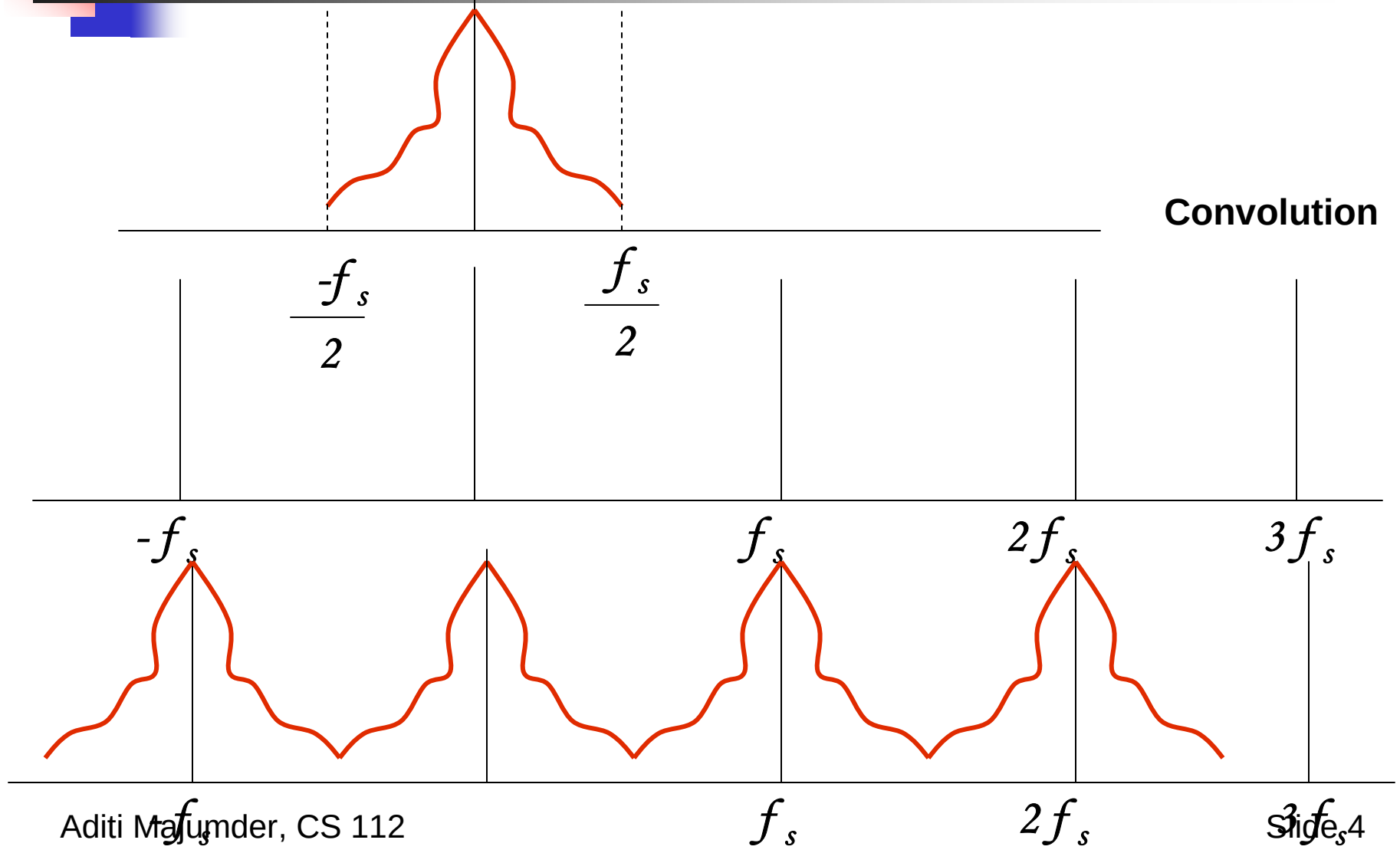
- Image generation
  - Generate digital images
  - Should take care to have non-aliased images
- Image Reconstruction
  - Generate a continuous image on the display

Image Reconstruction

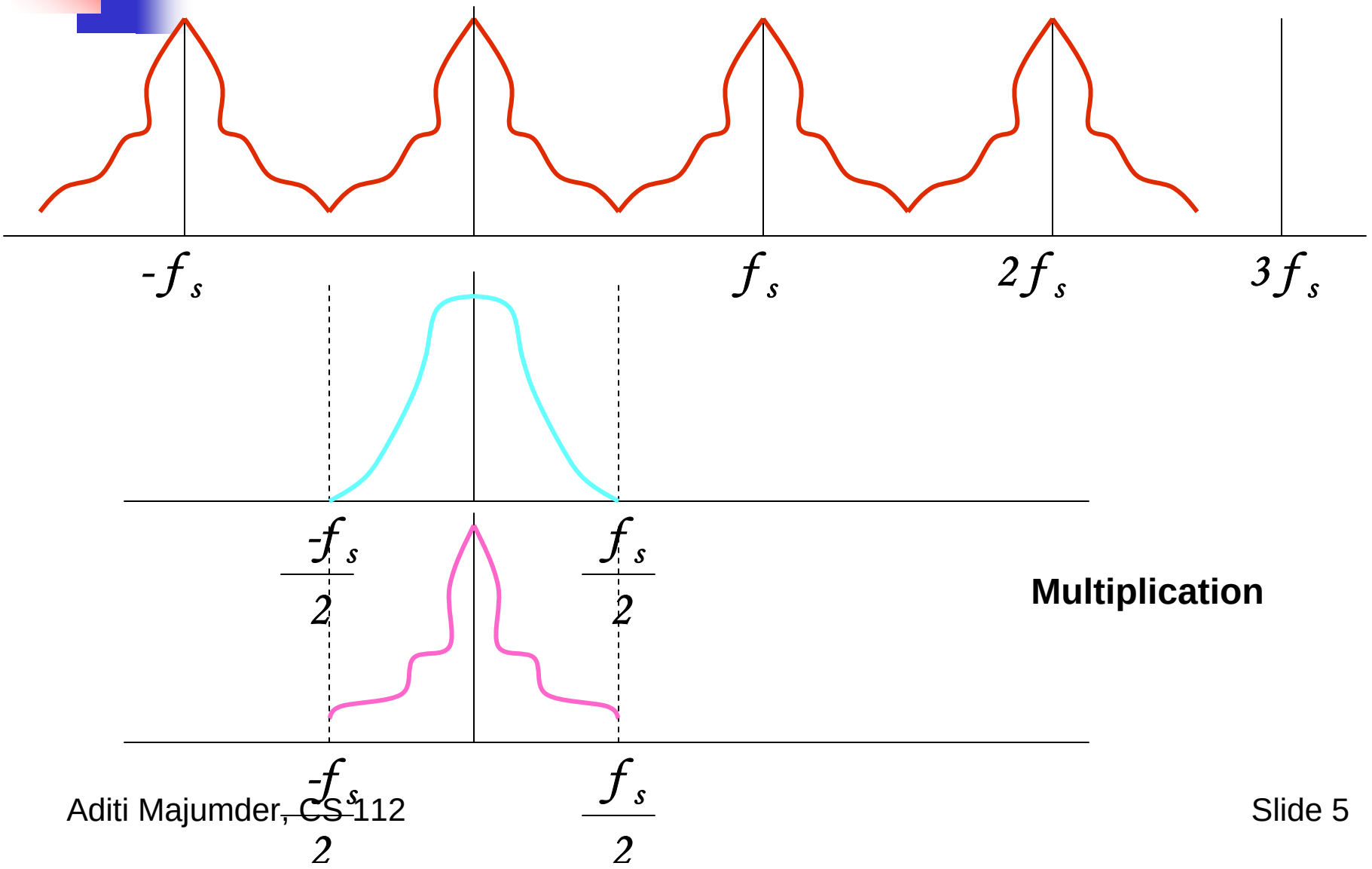
- Each pixel is not a point but an area
- How is that area lighted?



Sampling

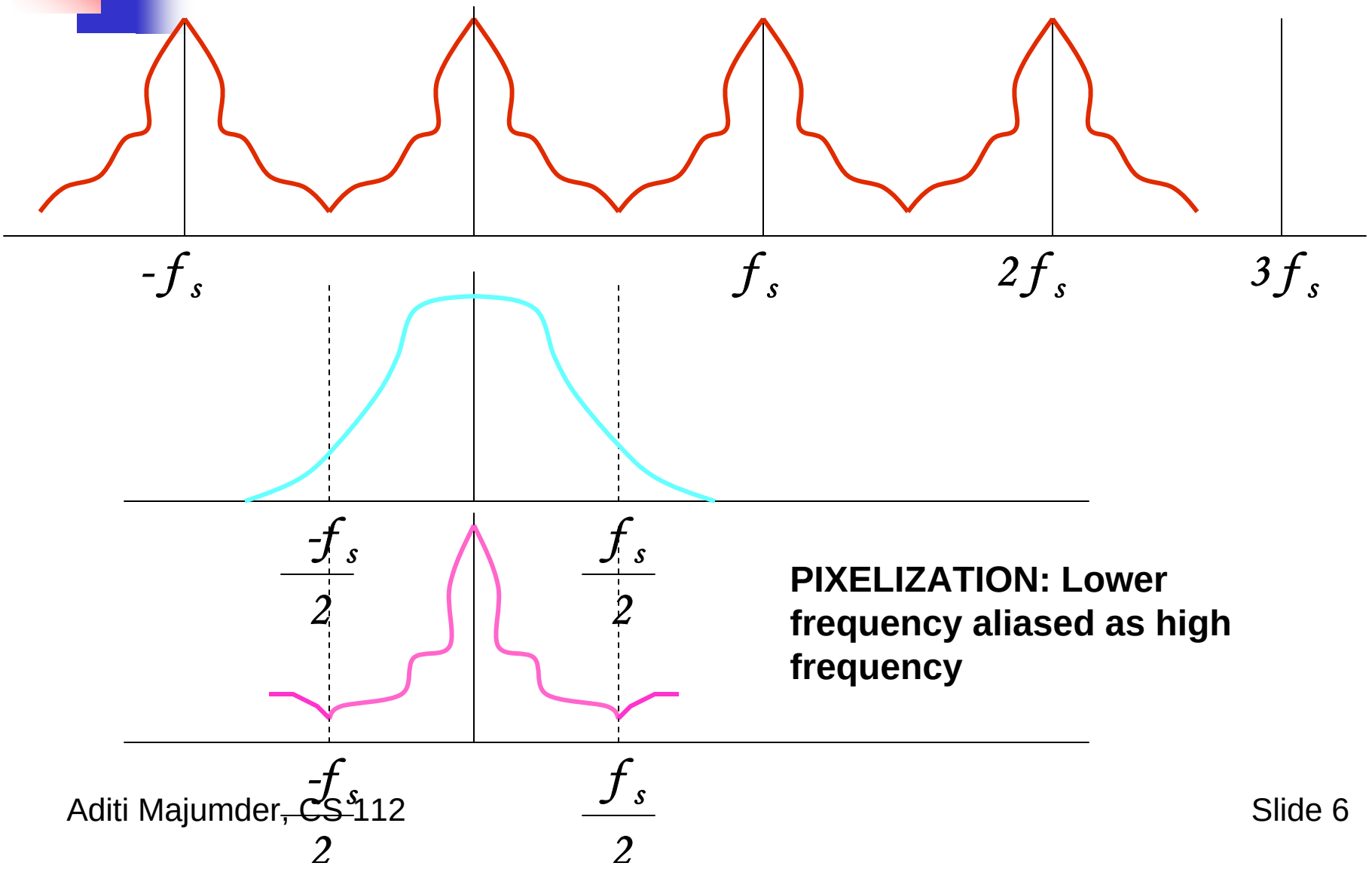


Reconstruction



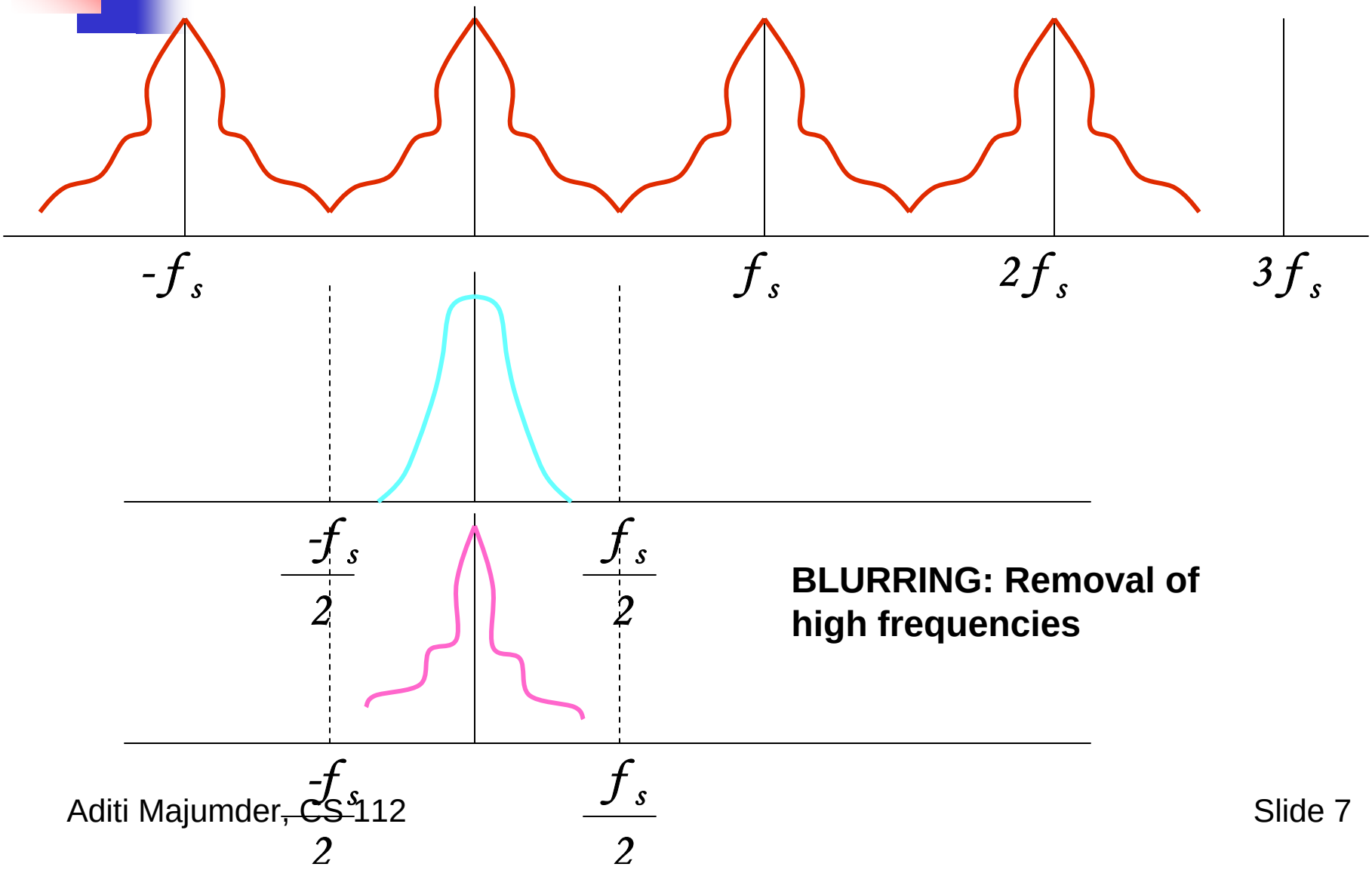
Multiplication

Reconstruction (Wider Kernel)



PIXELIZATION: Lower frequency aliased as high frequency

Reconstruction (Narrower Kernel)

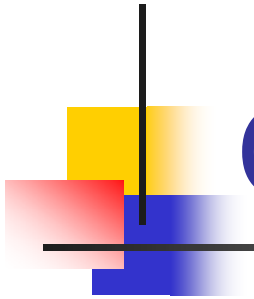


BLURRING: Removal of high frequencies

Aliasing artifacts (Right Width)

Wider Spots (Lost high frequencies)

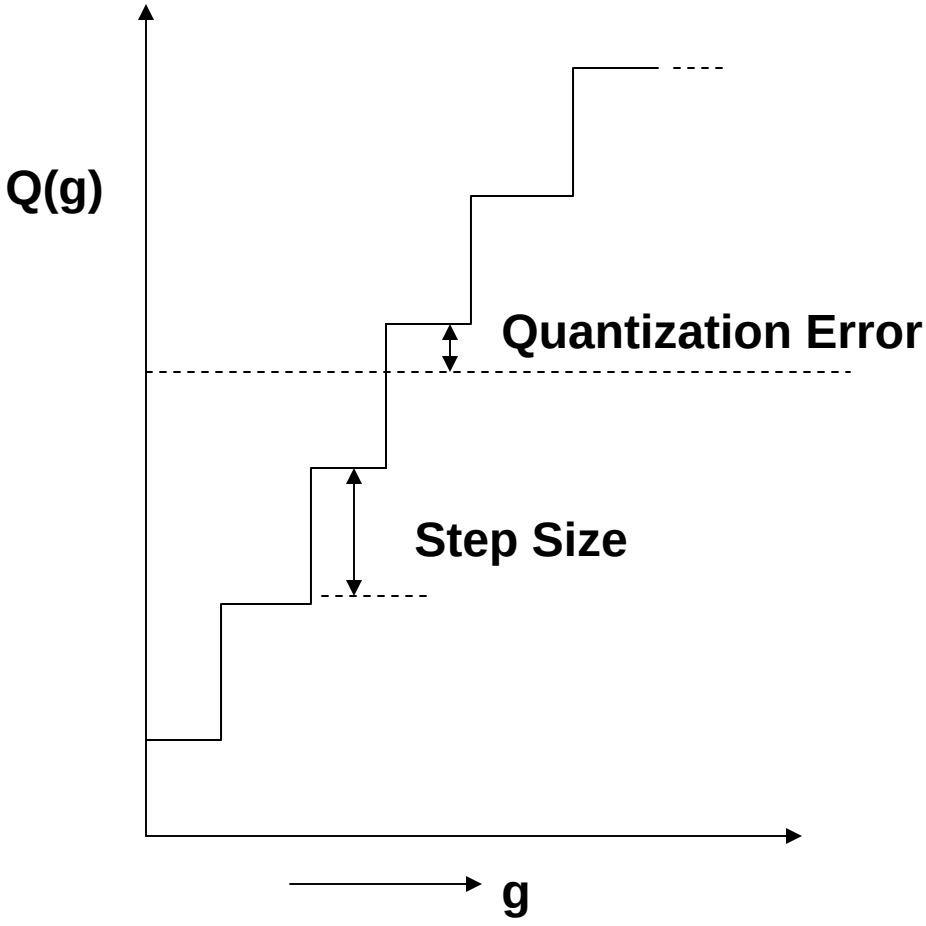
Narrow Width (Jaggies, insufficient sampling)



Quantization

- Digitization of color
- Gray scale – infinite grays between 0 and 1
  - 8 bit representation – 256 levels
  - A range of grays represented by a single value
- Any value is assigned to one of k values
- Choose number of levels and range of each level

Quantization Error

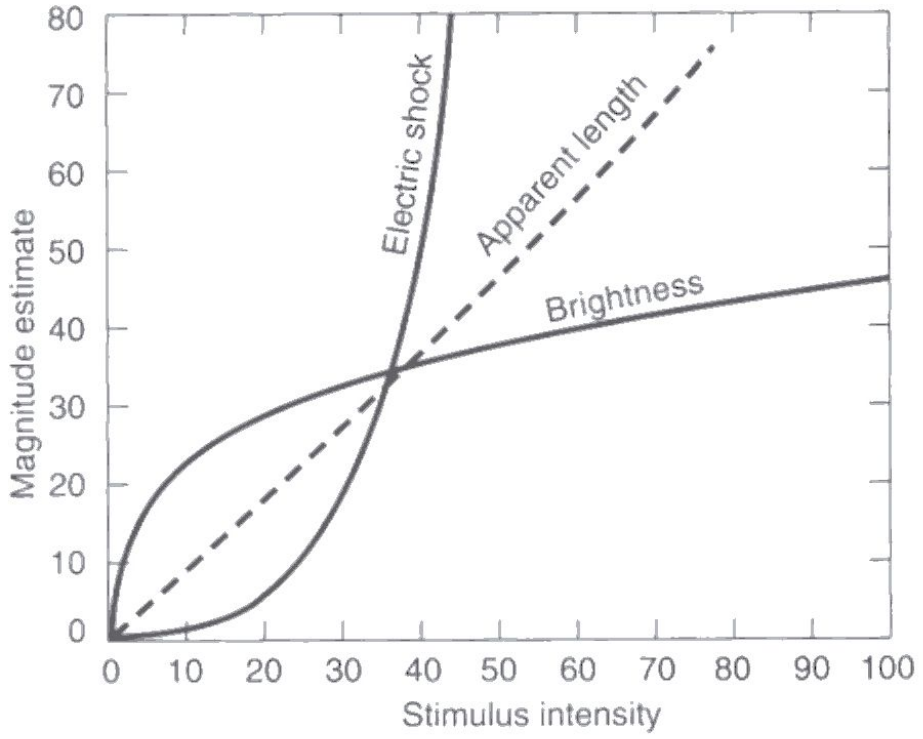


Uniform Quantization

Maximum Error = ½ Step Size

Human Perception

- Use properties of human perception
- Response Compression
- Response Expansion



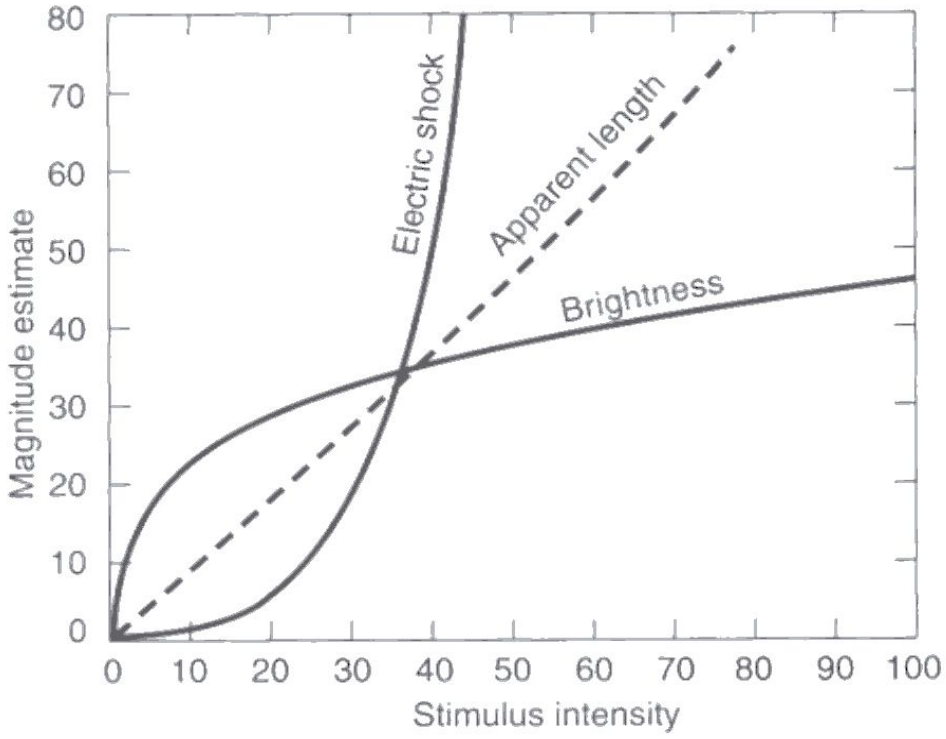
Steven's Power Law

$P = KS^n$

P = Perception
S = Stimulus Strength

n>1.0 (Expansion)

n<1.0 (Compression)



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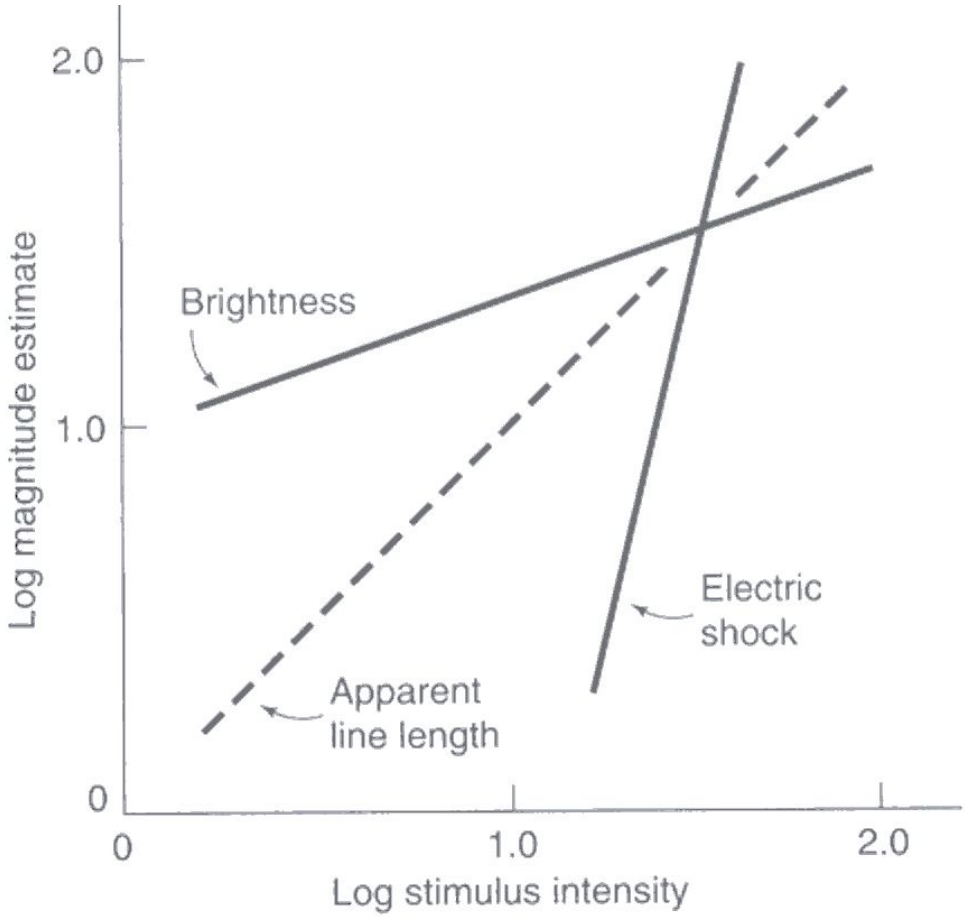
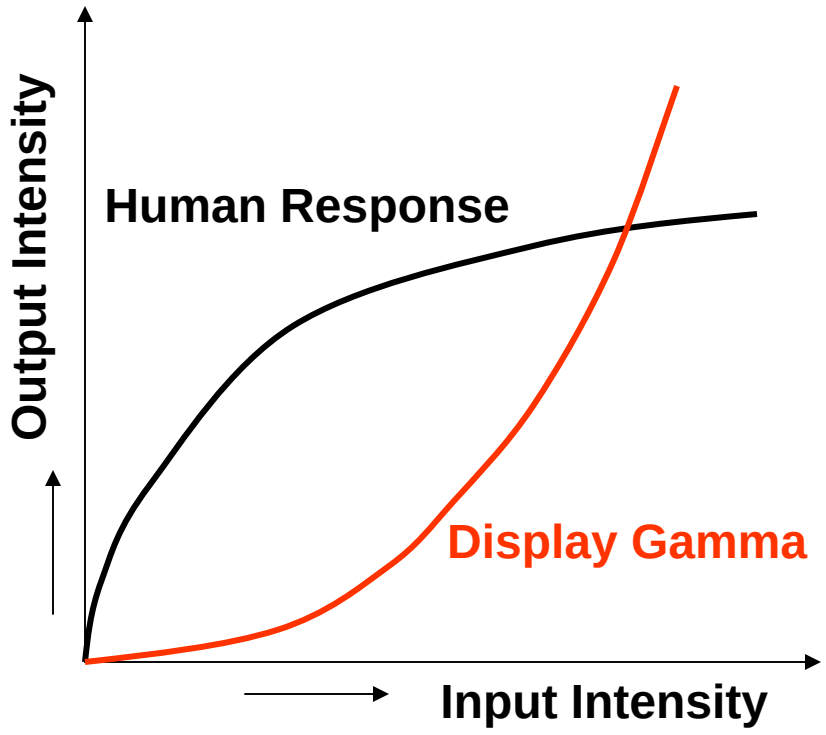


Gamma Function

- Inverse of human response curve for faithful representation of intensities
- Called the gamma function
  - $O = I^{\gamma}$
- Gamma Correction

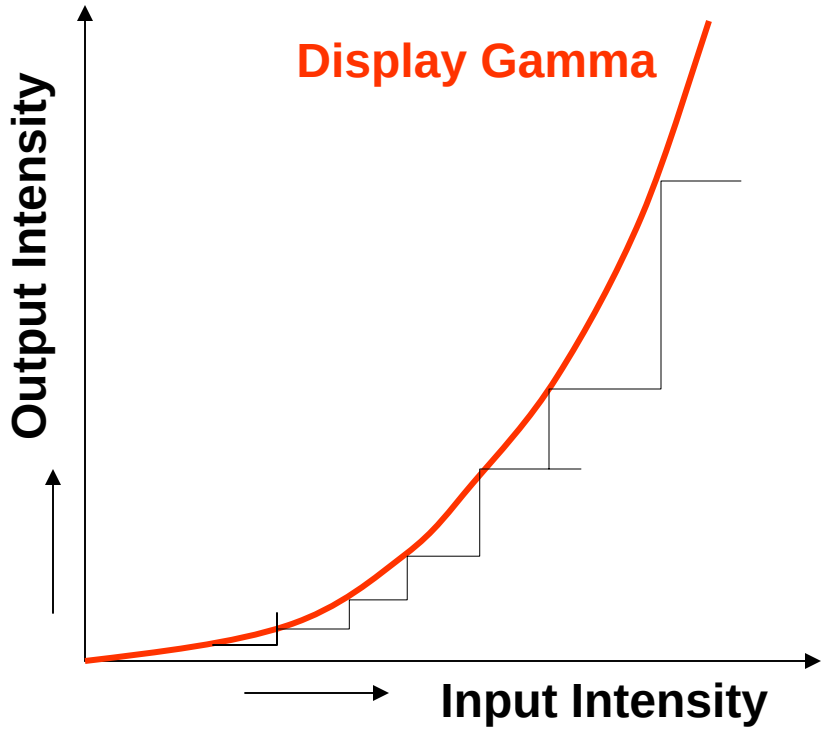


Capture devices (Camera)

- Usually have the inverse gamme
  - Similar to human eye
- So that images look good on display
- Current cameras give you RAW images which are linear

Non-Uniform Quantization

- Note how quantization changes
- Non-uniform step size
- Maximum Error
  - ½ of maximum step size
- # of levels is the color resolution
  - # of bits



Color Resolution

Analog Image

4 Steps

8 Steps

16 Steps

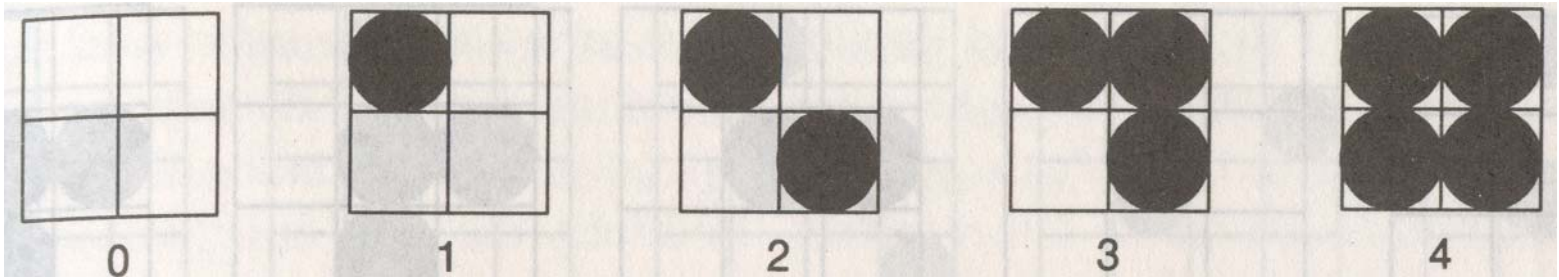
Quantization Artifacts

64 Steps

32 Steps

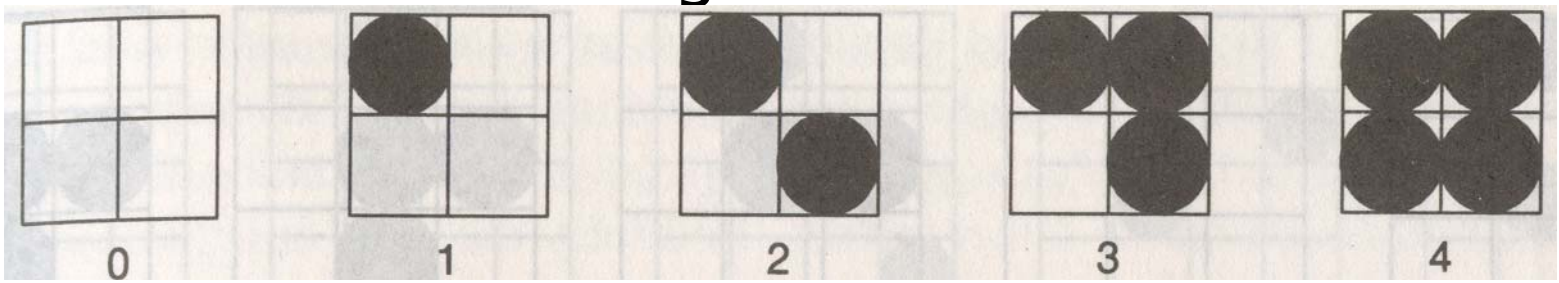
Dithering

- What if the color resolution is low?
  - Newsprint – Bi-level, only black and white
- Can we expand the # of colors?
  - Spatial integration of eye
- Trading off spatial resolution for intensity resolution



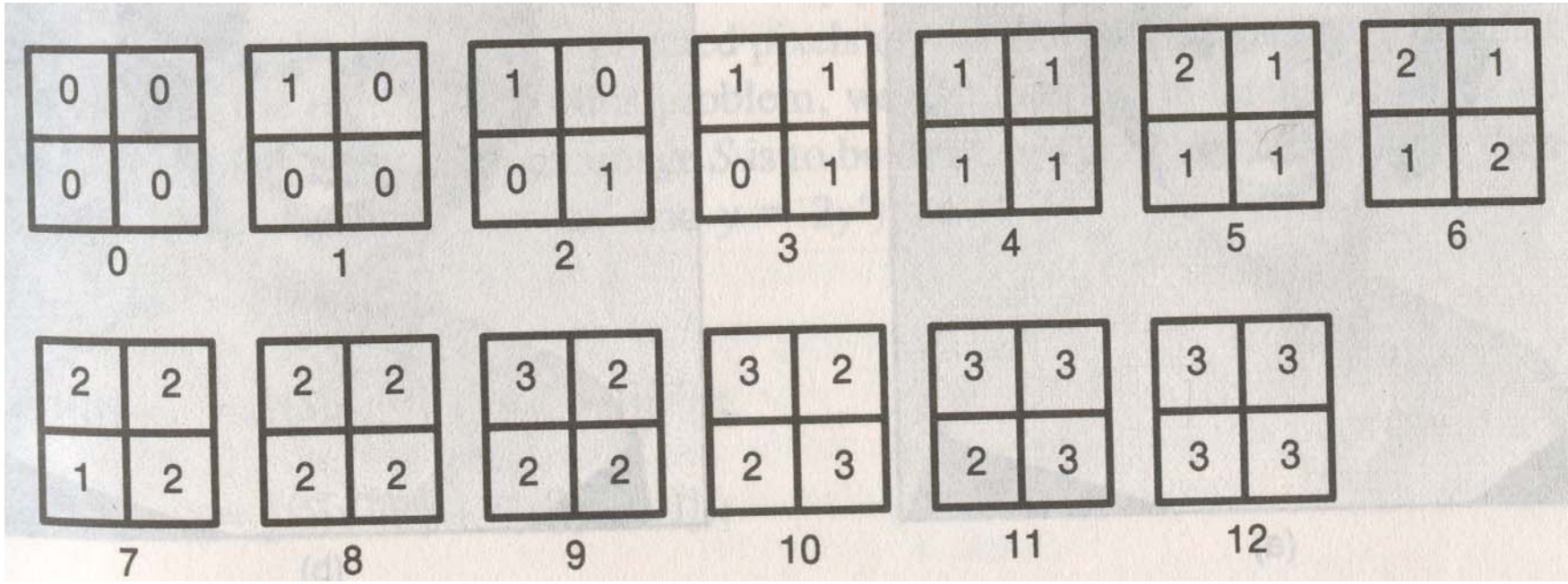
Dithering

- Represented by a dither matrix $\begin{bmatrix} 0 & 2 \\ 1 & 3 \end{bmatrix}$
- nxn pixels, bi-level intensity, can produce n^2+1 intensities
- If more than two levels – k levels
  - n^2. (k-1) +1
  - Used for increasing the color resolution

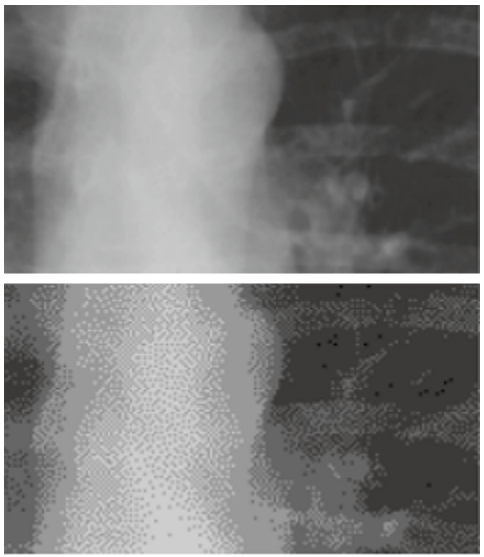


Dithering

- If more than two levels – k levels
  - n^2. (k-1) +1
  - For k = 4 (0,1,2,3) and n=2



Examples



Loss of tone and details
(Intensity and Spatial Resolution)