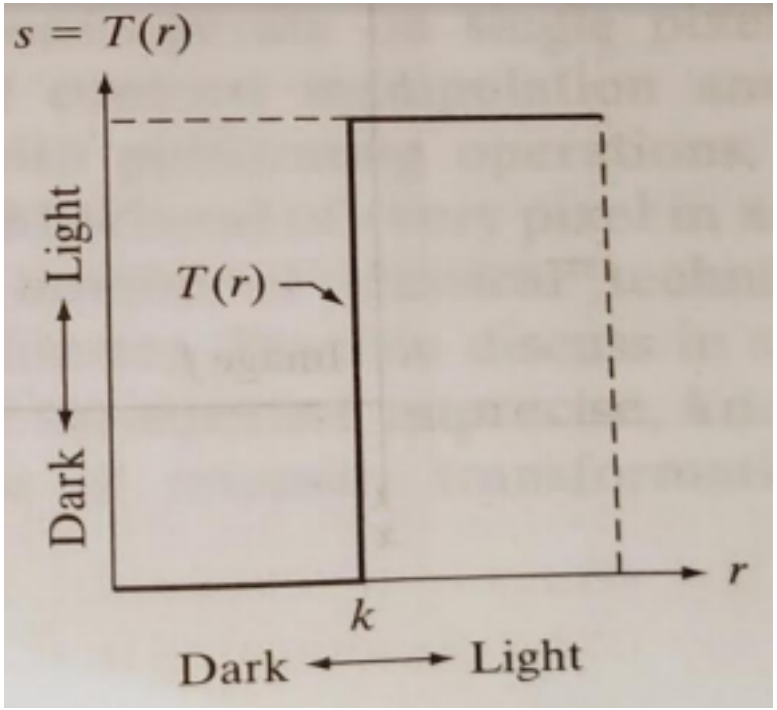
THRESHOLDING

- It produces two level(binary) image. • Let threshold T=k

If r<k, then s=0

else s=1



TRANSFORMATION CURVE

INTENSITY TRANSFORMATION FUNCTIONS

- The transformation function is given as

$$s = T (r)$$

where r ->is the pixels of the input image s->is the pixels of the output image. T-> is a transformation function that maps each value of r to each value of s

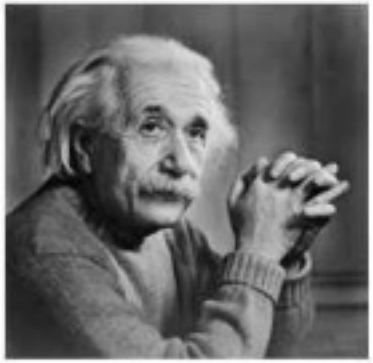
1) IMAGE NEGATIVES

- It’s a type of linear transformation.
- Image negative is produced by subtracting each pixel from the maximum intensity value.
- For example in an 8-bit gray scale image, the max intensity value is 255, thus each pixel is subtracted from 255 to produce the output image.
- It is given by the expression

$$s = L - 1 - r$$

- It is used for enhancing white or dark regions in image. So, lighter pixels become dark and the darker picture becomes light.

Input Image



Output Image

L-1

0 Input gray levels (r) $L-1$

TRANSFORMATION

CURVE

2) LOG TRANSFORMATIONS

- It is given by the formula

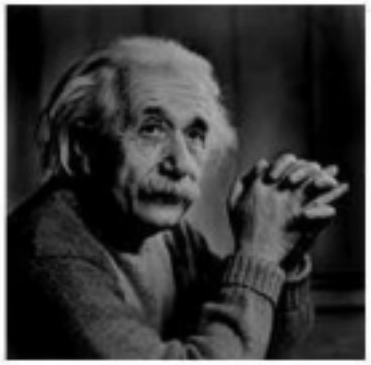
$$s = c \log(1 + r)$$

where s and r-> are the pixel values of the output and the input image respectively

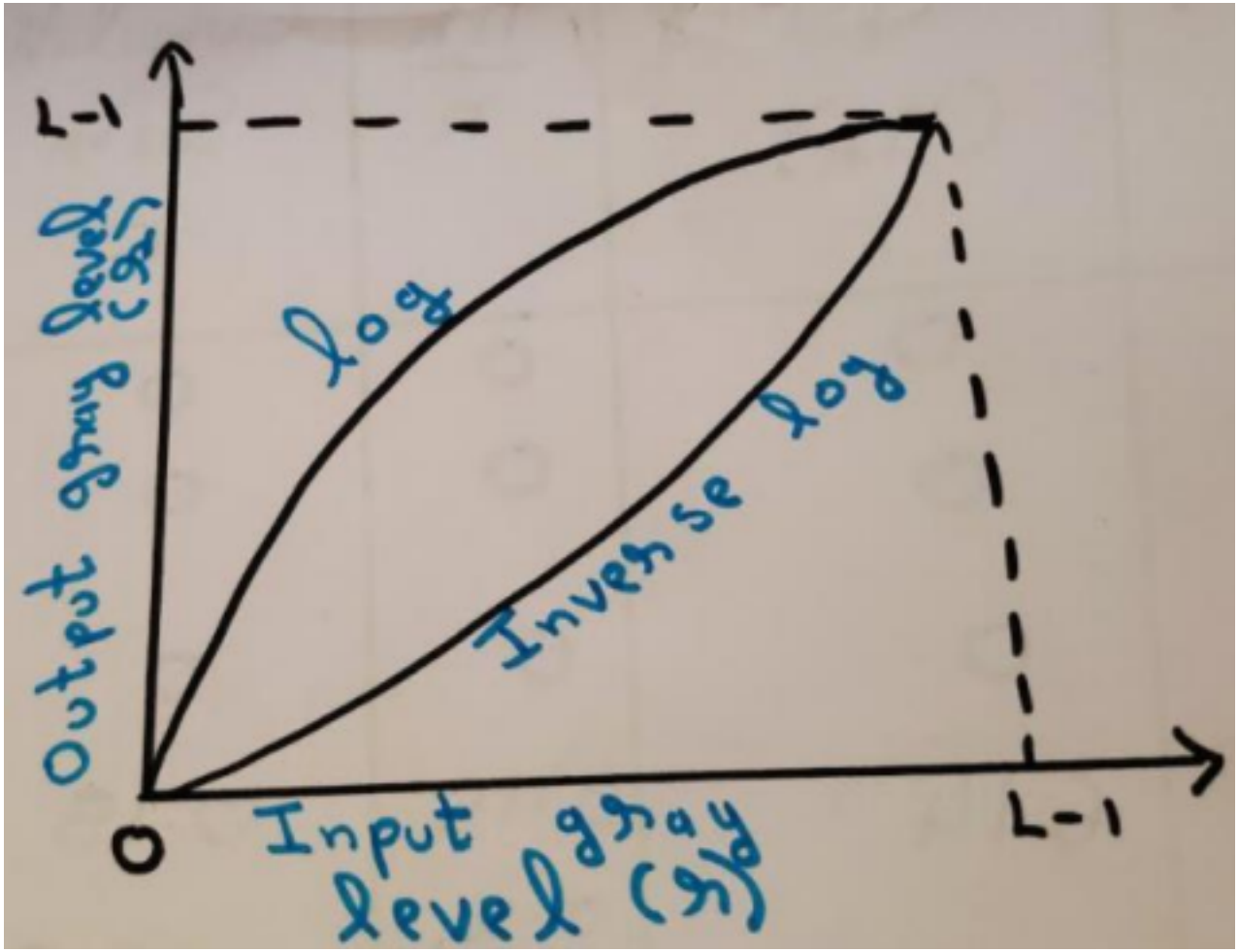
c->is a constant

- The value 1 is added to each of the pixel value of the input image because if there is a pixel intensity of 0 in the image, then log (0) is equal to infinity. So 1 is added, to make the minimum value at least 1.
- Dark pixels in image are expanded as compared to higher pixel values. Higher pixel values are kind of compressed in log transformation.
- You can adjust the value of c according to your kind of enhancement.
- Inverse log is just opposite to log transform.

Input Image



Log Tranform Image



TRANSFORMATION CURVE

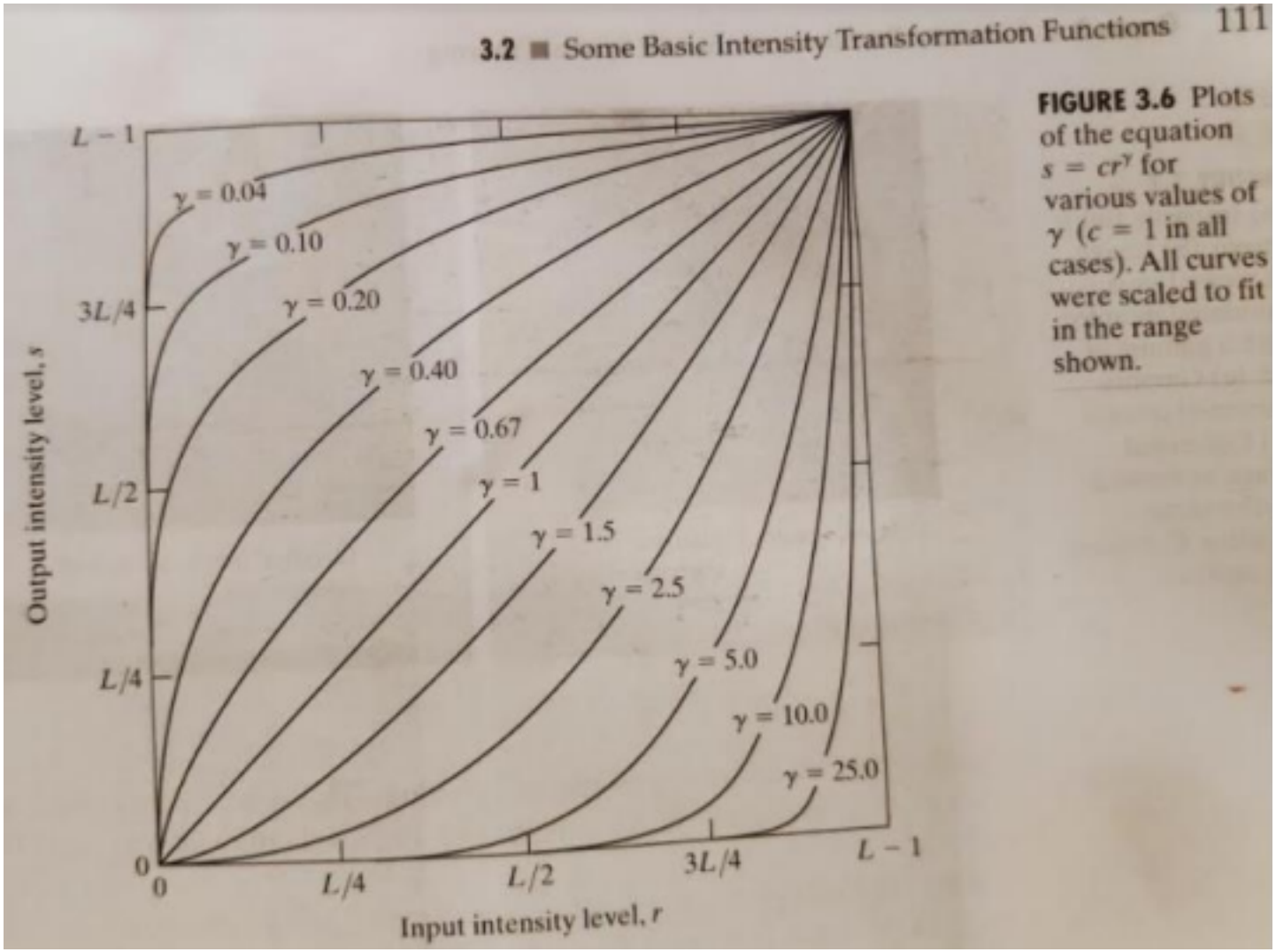
3) POWER-LAW (GAMMA) TRANSFORMATIONS

- This includes nth power and nth root transformation.
- These transformations can be given by the expression:

$$s=cr^{\gamma}$$

where c, γ-> positive constants.

- The symbol (γ) is called gamma, due to which this transformation is also known as gamma transformation.
- Variation in the value of γ varies the enhancement of the images.



- Different display devices have their own gamma correction, that's why they display their image at different intensity.

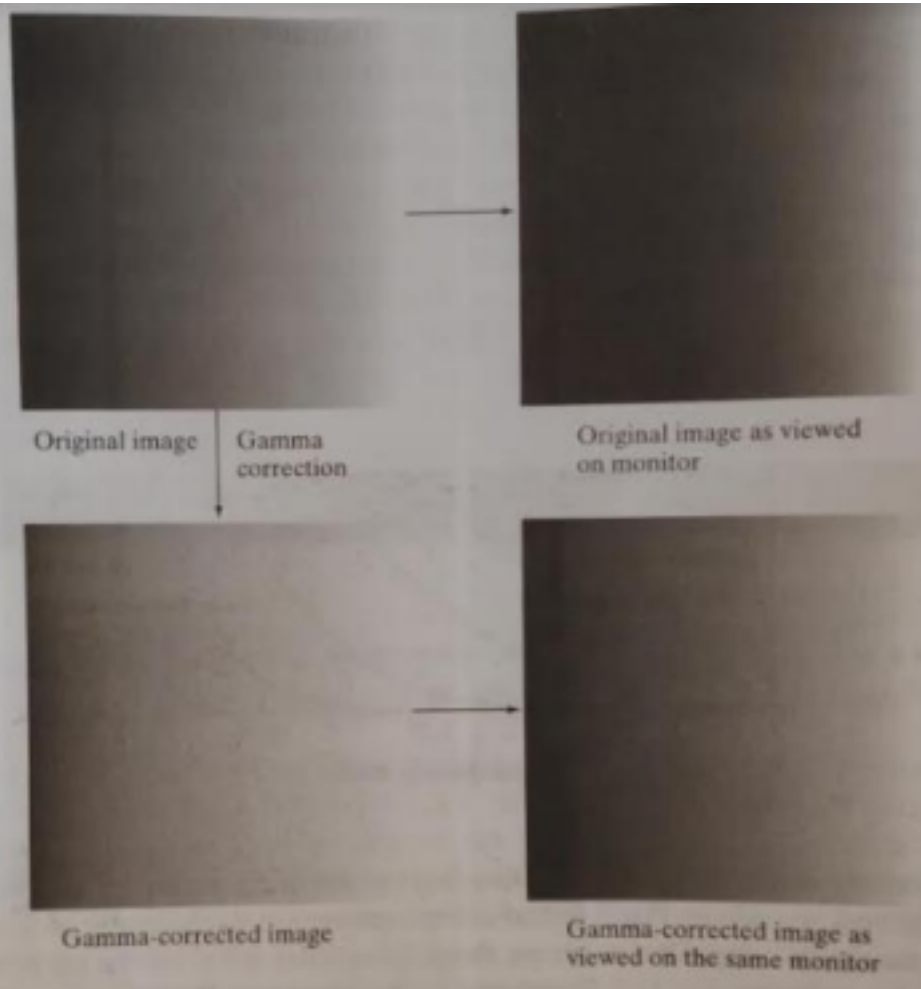
- For example Gamma of CRT lies in between of 1.8 to 2.5, that means the image displayed on CRT is dark.
- So we use gamma corrections=cr^γ

$$s=cr^{(1/2.5)}$$

$$s=r^{0.4}$$

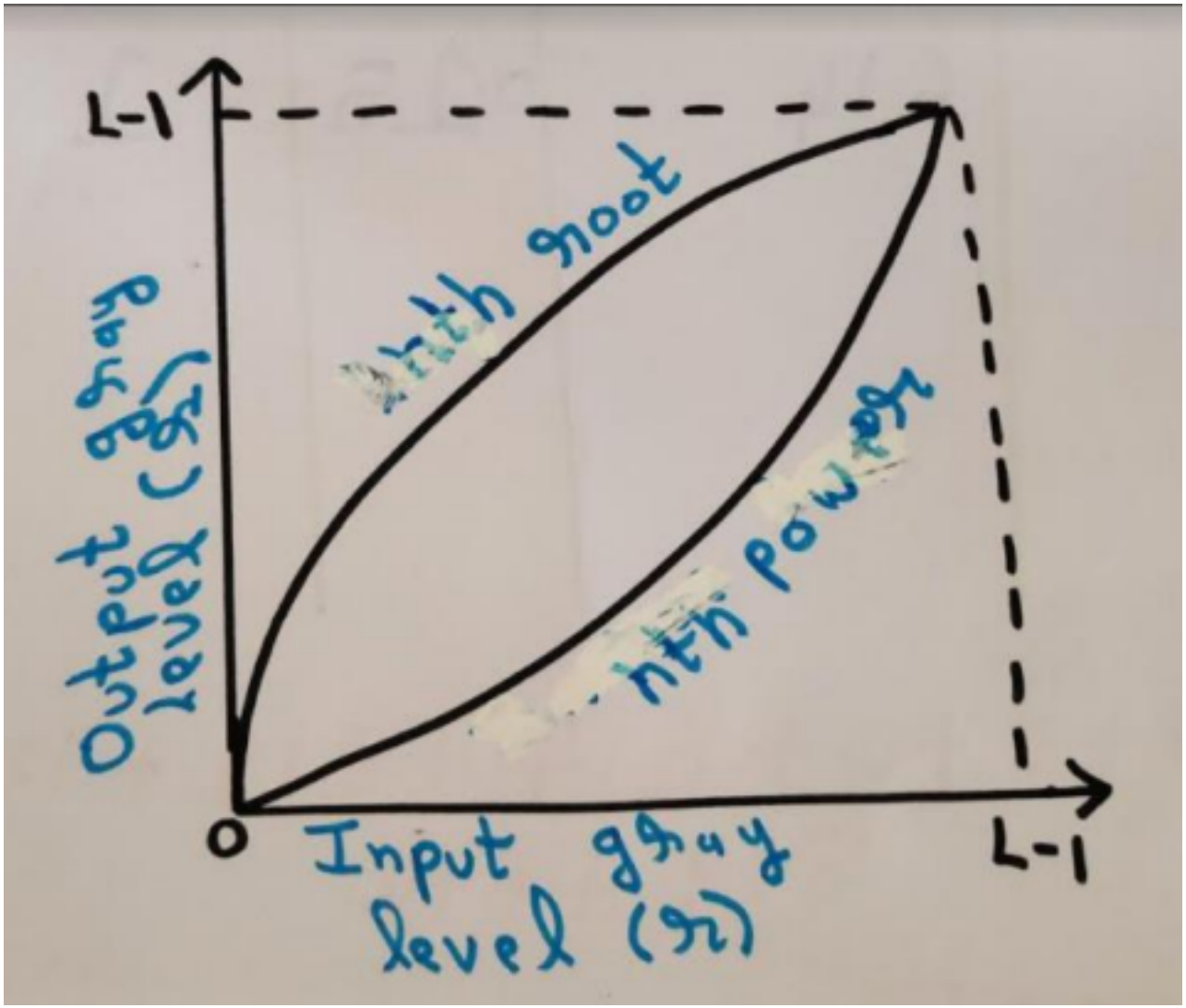
a b
c d

FIGURE 3.7
(a) Intensity ramp image. (b) Image as viewed on a simulated monitor with a gamma of 2.5. (c) Gamma-corrected image. (d) Corrected image as viewed on the same monitor. Compare (d) and (a).



a b
c d

FIGURE 3.8
(a) Magnetic resonance image (MRI) of a fractured human spine.
(b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 0.6, 0.4$, and 0.3, respectively. (Original image courtesy of Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)



TRANSFORMATION CURVE

4) PIECEWISE-LINEAR

TRANSFORMATION FUNCTIONS

- It is type of gray level transformation that is used for image enhancement. It is used for manipulation of an image so that the result is more suitable than the original for a specific application.
- Commonly used piece-wise linear transformations are:

  Contrast Stretching

  Gray-level slicing (Intensity-level slicing)

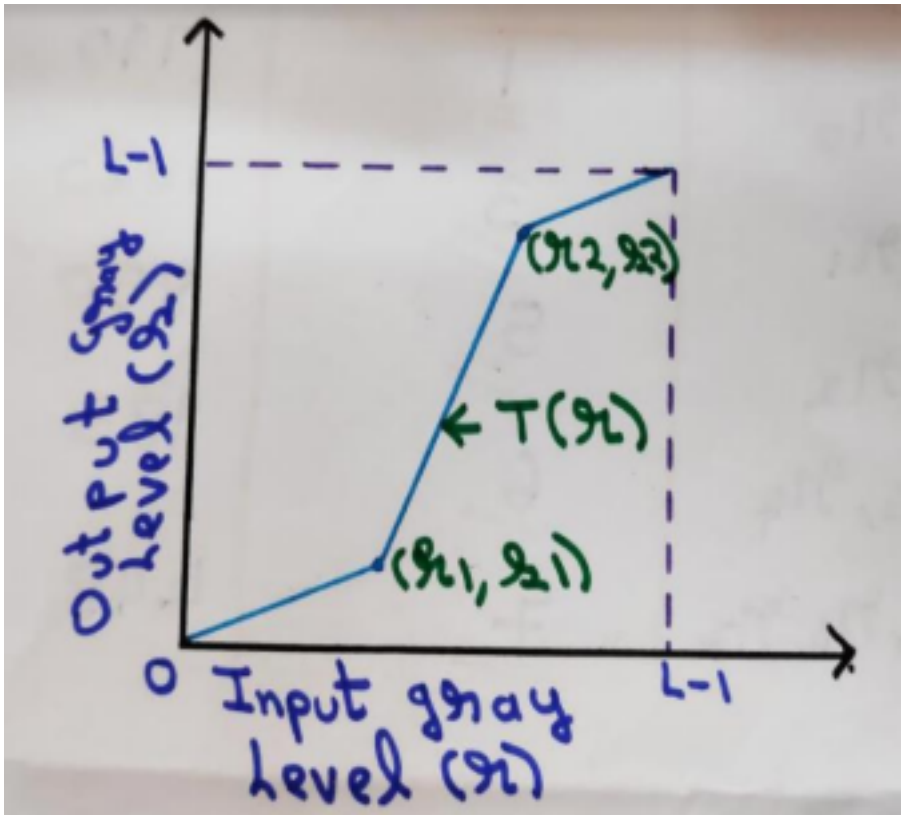
  Bit- plane slicing

CONTRAST STRETCHING

- It is simplest piecewise function.
- Used to enhance the low contrast images.
- It is given by the expression

$$s = s1 + \frac{(r - r1) * (r2 - r1)}{(r2 - r1)}$$

- Transformation curve for contrast stretching is given below:-

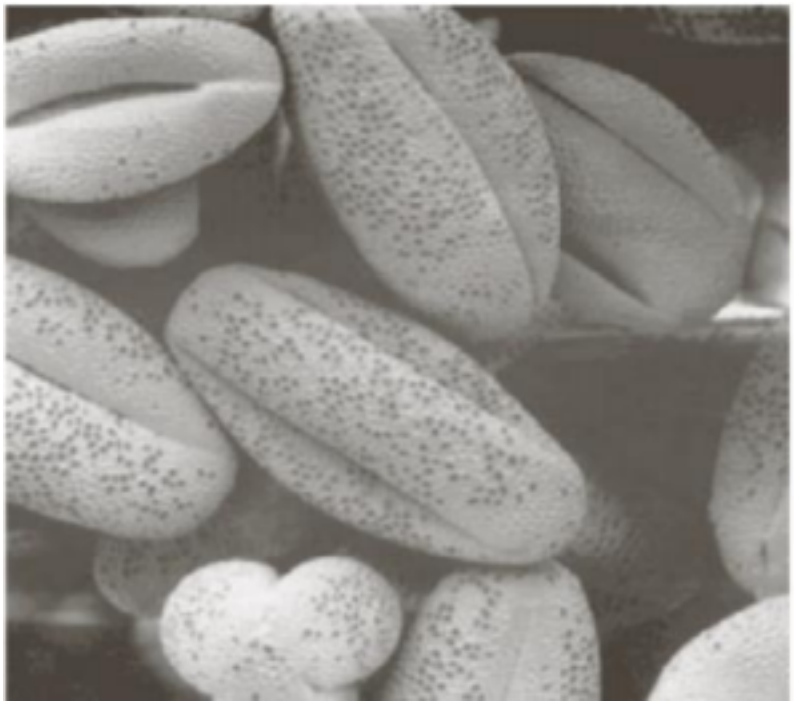


TRANSFORMATION CURVE

- Location of points (r1,s1) and (r2,s2) control the shape of transformation function.
- If r1 = s1 and r2 = s2,transformation is a linear function that produces no change in the intensity

level.

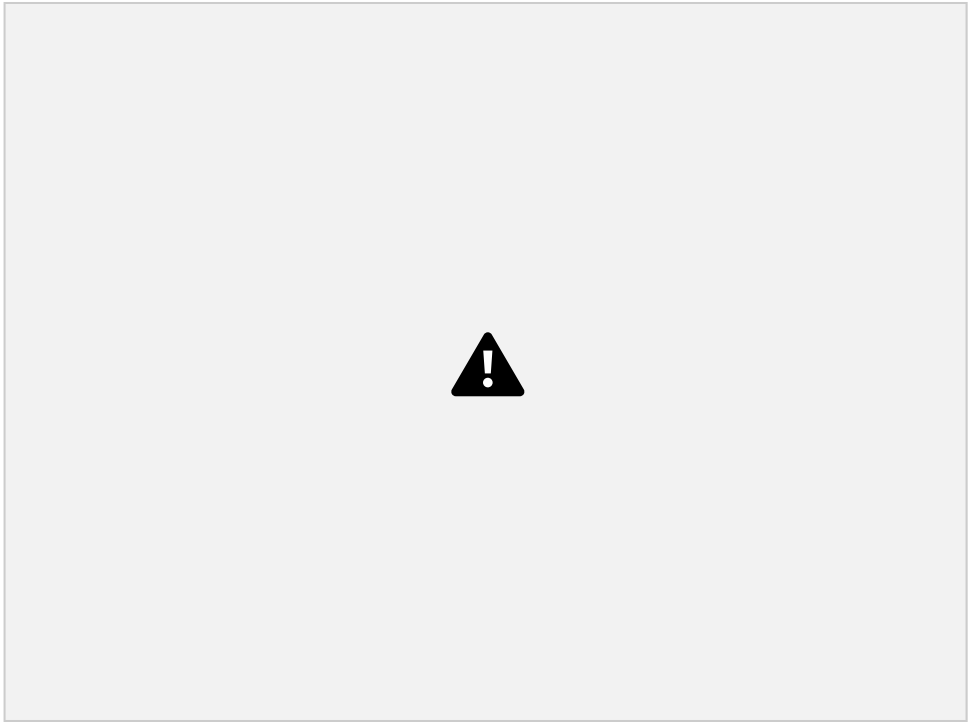
- If r1= r2, s1= 0, and s2 = L-1,transformation becomes a thresholding function that creates a binary image. • Intermediate values of (r1, s1) and (r2, s2) produces various degree of spread in the intensity level of the output image.



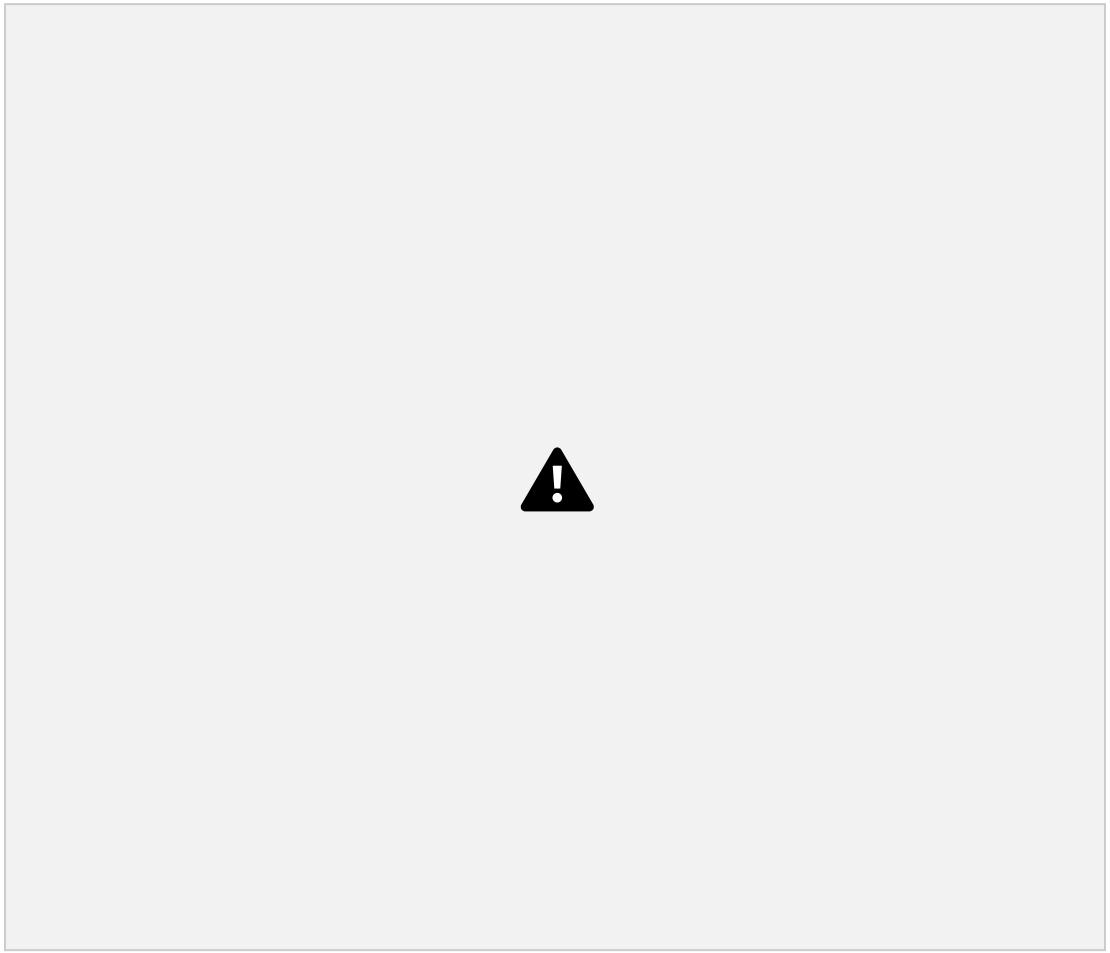
GRAY-LEVEL SLICING (INTENSITY-LEVEL SLICING)

- It means highlighting a specific range of intensities in an image. In other words, we segment certain gray level regions from the rest of the image.
- Example, suppose in an image, the region of interest always take value between say 80 to 150. So, intensity level slicing highlights this range and now instead of looking at the whole image, one can now focus on the highlighted region of interest.
- It finds its application in enhancing features such as masses of water in satellite images and enhancing flaws in X-ray images.

- There are 2 ways of doing this method:- In the first type, we display the desired range of intensities in white and all other intensities in black or vice versa. This results in a binary image.



In the second type, we brighten or darken the desired range of intensities and leave other intensity levels unchanged.



BIT- PLANE SLICING

- Pixels are digital numbers composed of bits(intensity of each pixel in 256 level gray scale image is composed of 8 bits), so instead of highlighting intensity-level range, we can highlight the contribution made to total image appearance by specific bits.
- Consider an 8bit image composed of eight 1 bit planes, with plane 1 containing lowest order bit of all pixels in the image and plane 8 containing highest order bits.