UNIVERSITÀ DEGLI STUDI DI PADOVA

Single pixel operations

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Agenda

- Defining single-pixel operations
- The first group operations
- Examples

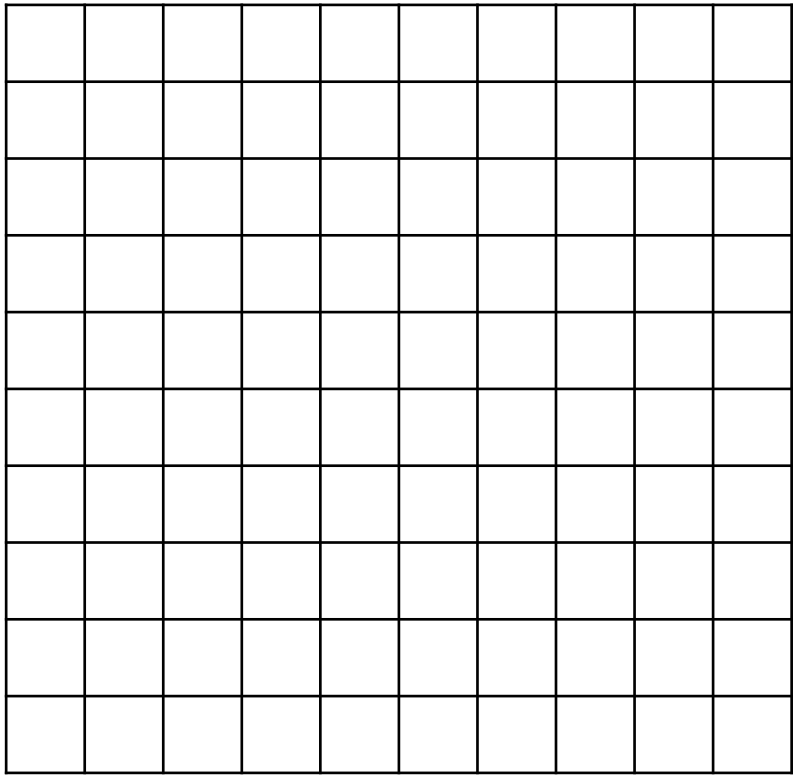
Spatial operations

- Many different ways of transforming an image
- Single-pixel operations
  - Intensity transform, histogram equalization, …
  - The output value of each pixel depends on the pixel initial value
- Local operations
  - Linear and non-linear filters
  - The output value depends on the initial values of the pixel + its neighbors
- Geometric transforms
  - Scaling, rotation, …
  - "Moving" points

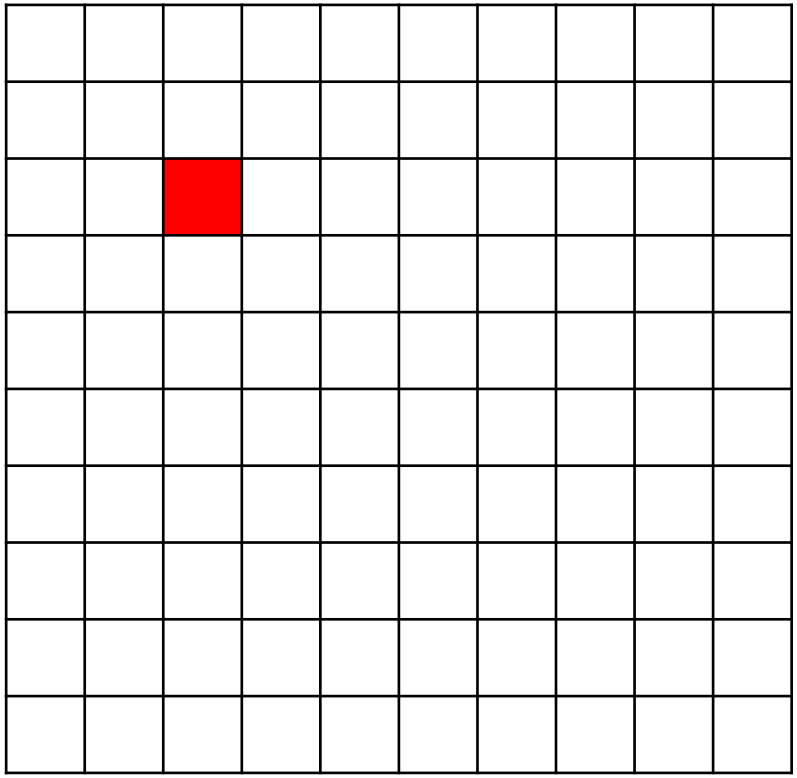
Single-pixel operations

- Consider a grayscale image
  - L gray levels
- Single-pixel operations/transforms (AKA intensity transforms) are functions that change the gray levels of an image
- Elements involved:
  - Function $I(x, y)$ representing the image
  - Function $T(\cdot)$ representing the grey level change

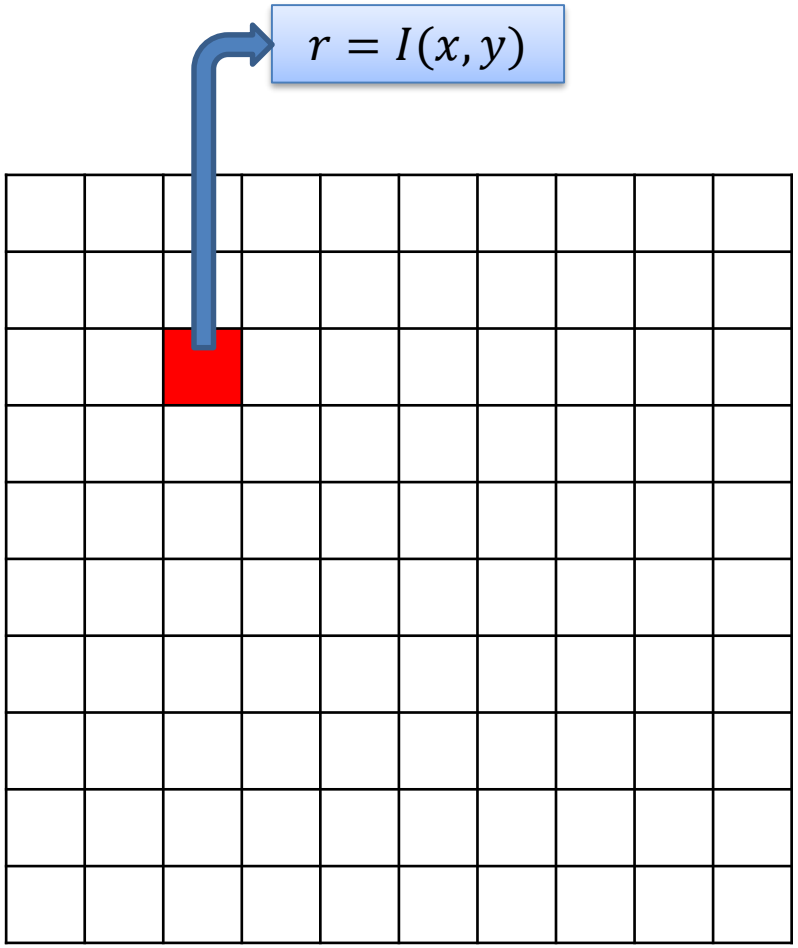
Single-pixel operations



Single-pixel operations

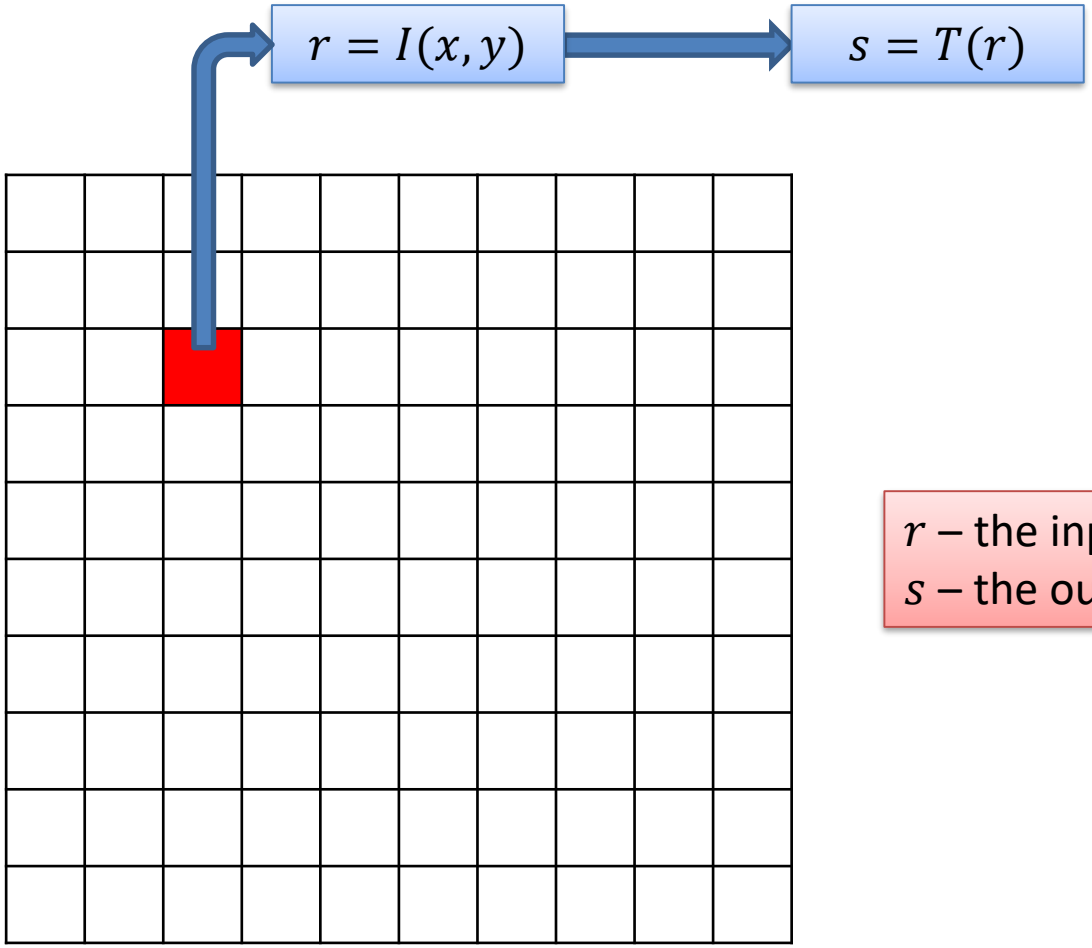


Single-pixel operations



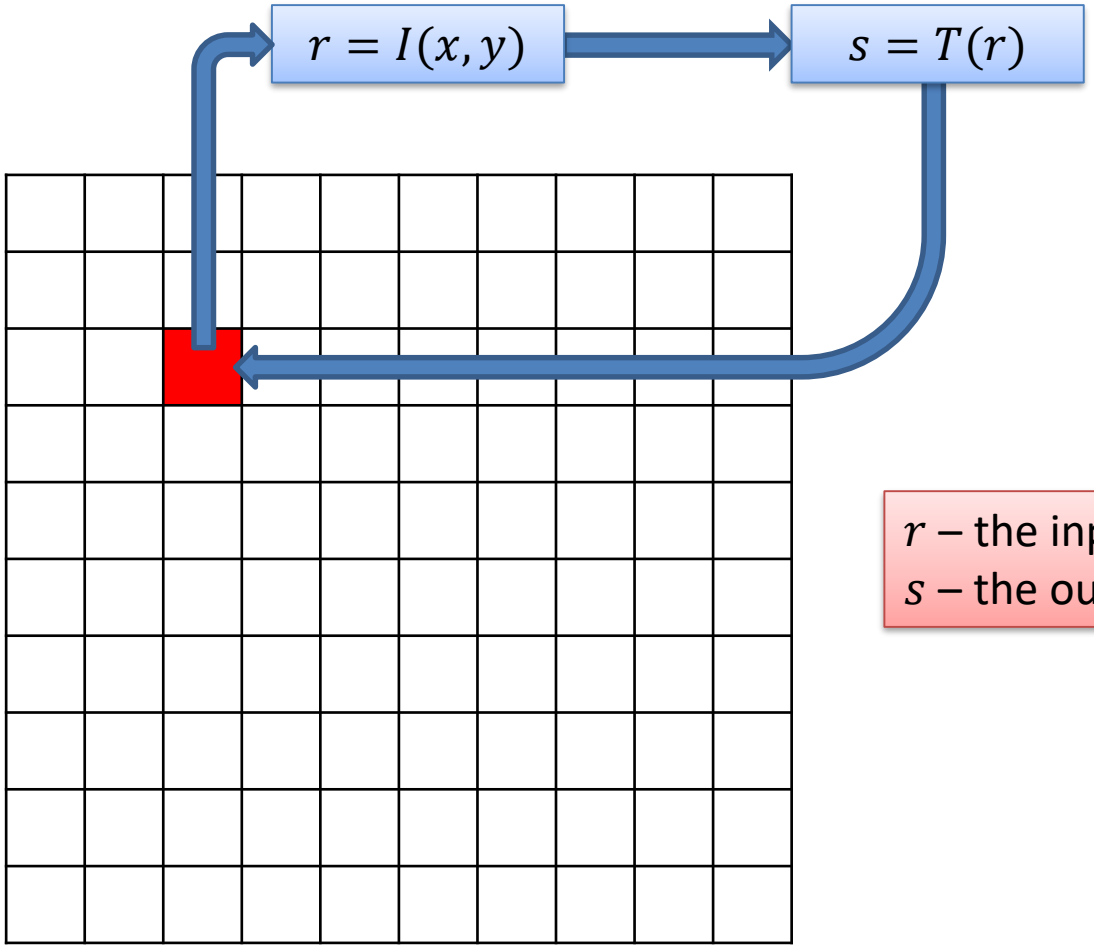
r – the input grey level

Single-pixel operations



r – the input grey level
s – the output grey level

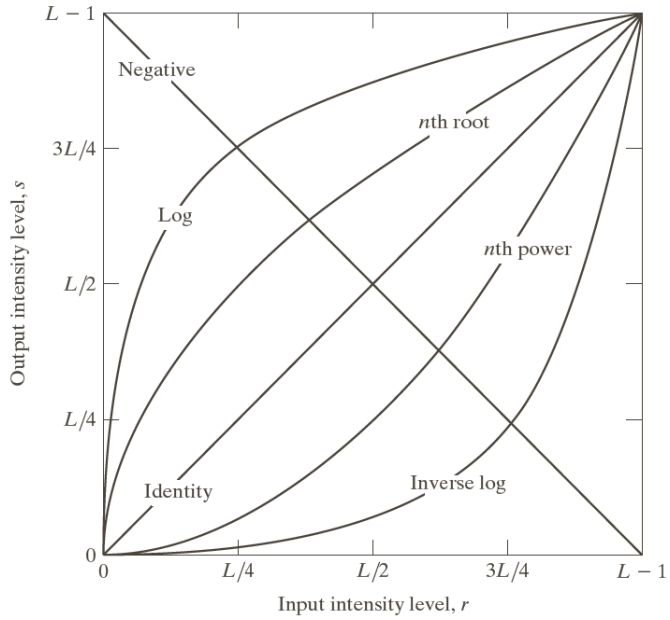
Single-pixel operations

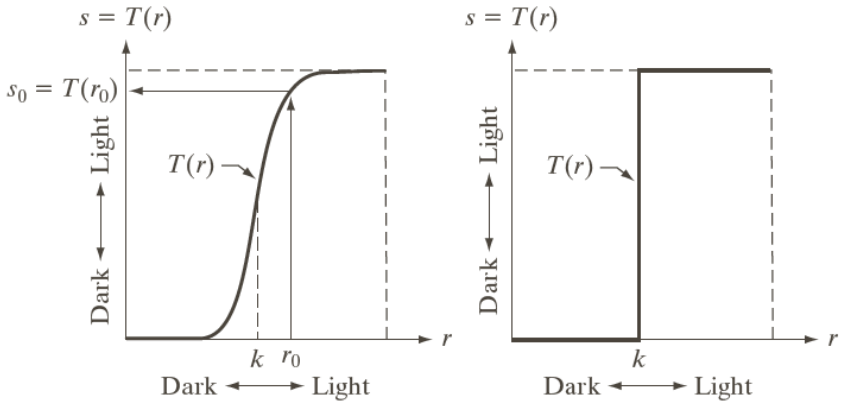


r – the input grey level
s – the output grey level

Single-pixel operations

- Negative
- Logarithm
- Gamma
- Contrast stretching
- Intensity slicing
- Histogram equalization





Negative and log

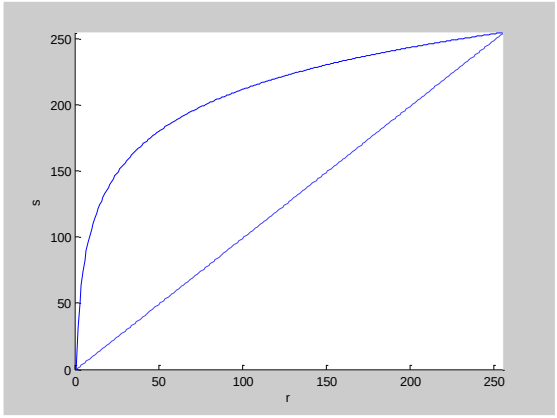
- Let's start with three simple transforms
- Negative image
  - Switch dark and light
- Log transformation
  - Highlight the differences among pixels in given conditions
- Gamma transformation
  - Similar to log, but tunable

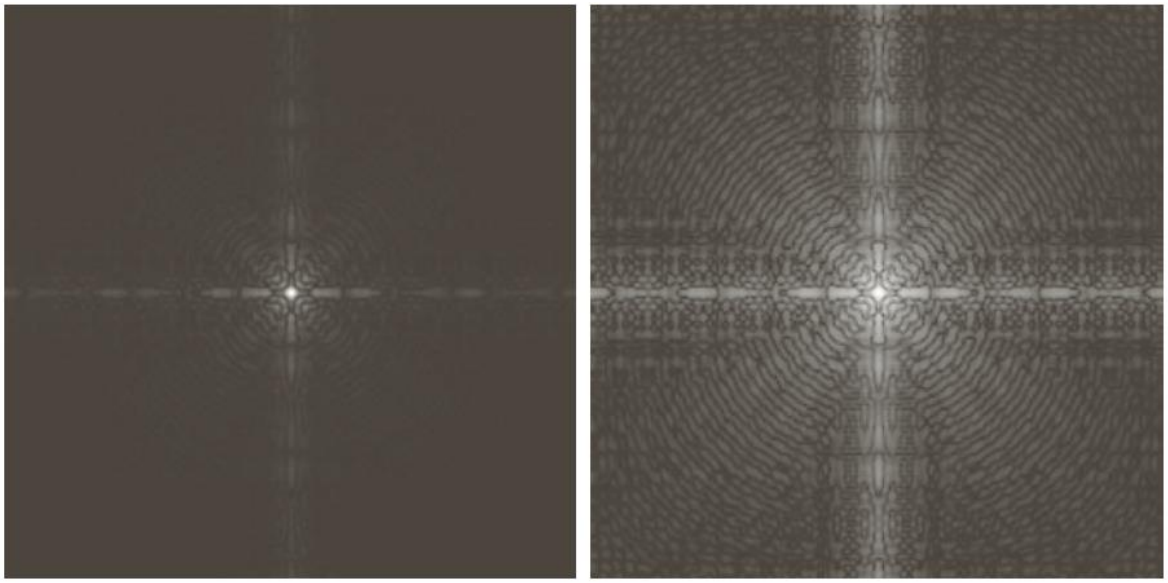
Negative image

$$s = (L - 1) - r$$

Log transform

$$s = c\log(1 + r), c = \frac{L-1}{\log L}$$

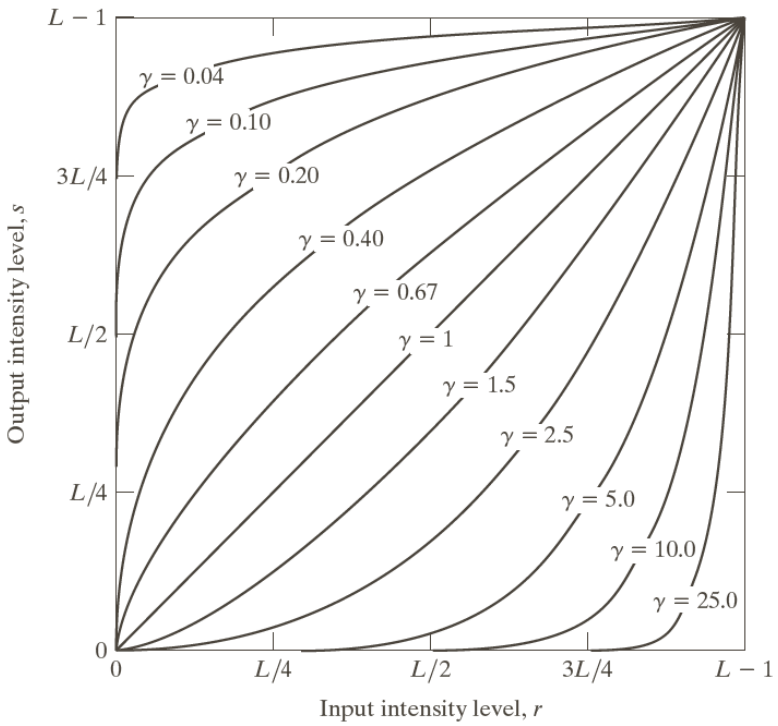




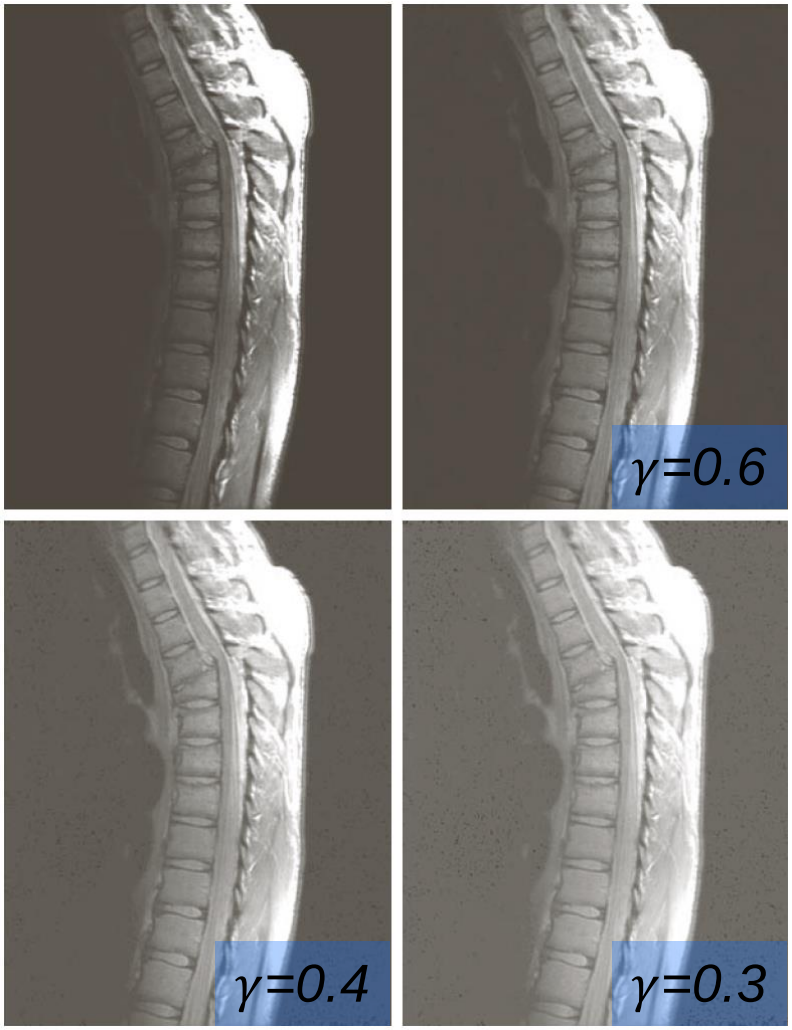
Gamma transform

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

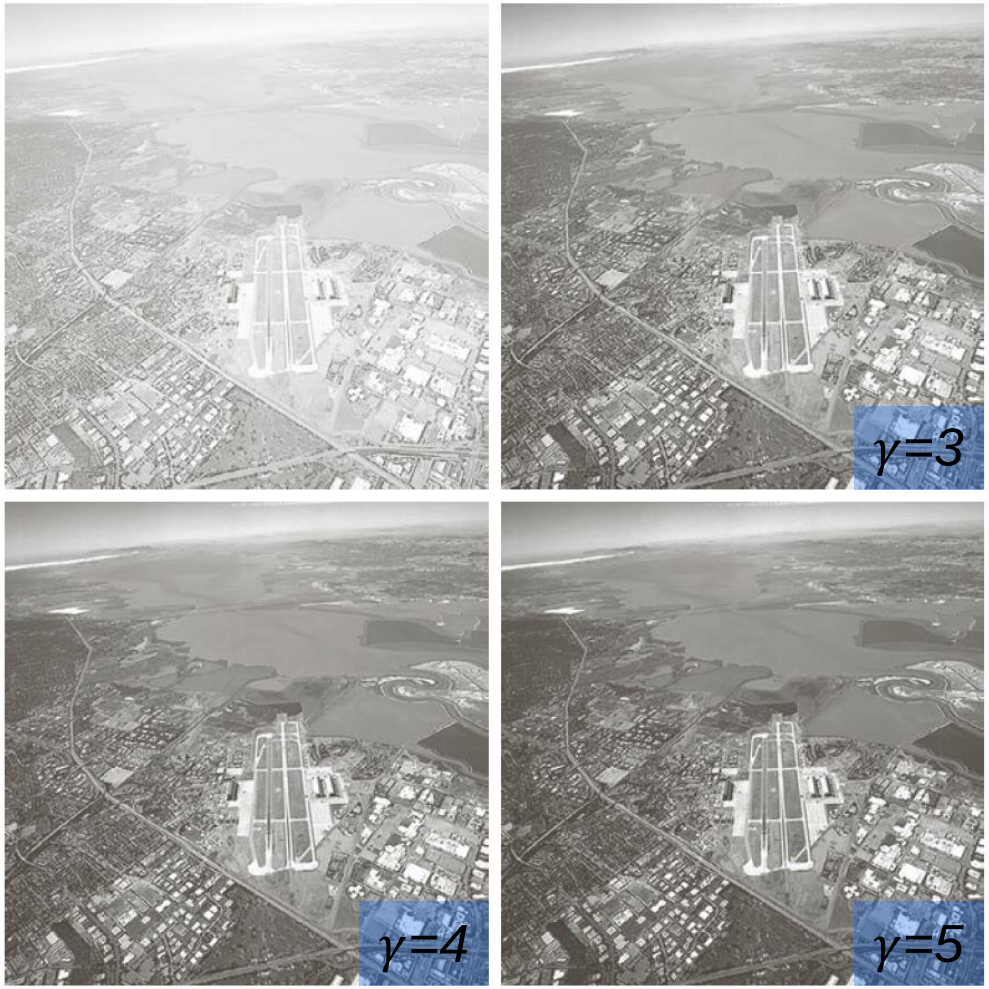
$$c = (L-1)^{1-\gamma}$$



Gamma transform – example



$\gamma < 1$



$\gamma > 1$

Gamma transform – application

- The gamma transform was very popular when CRT monitors were used

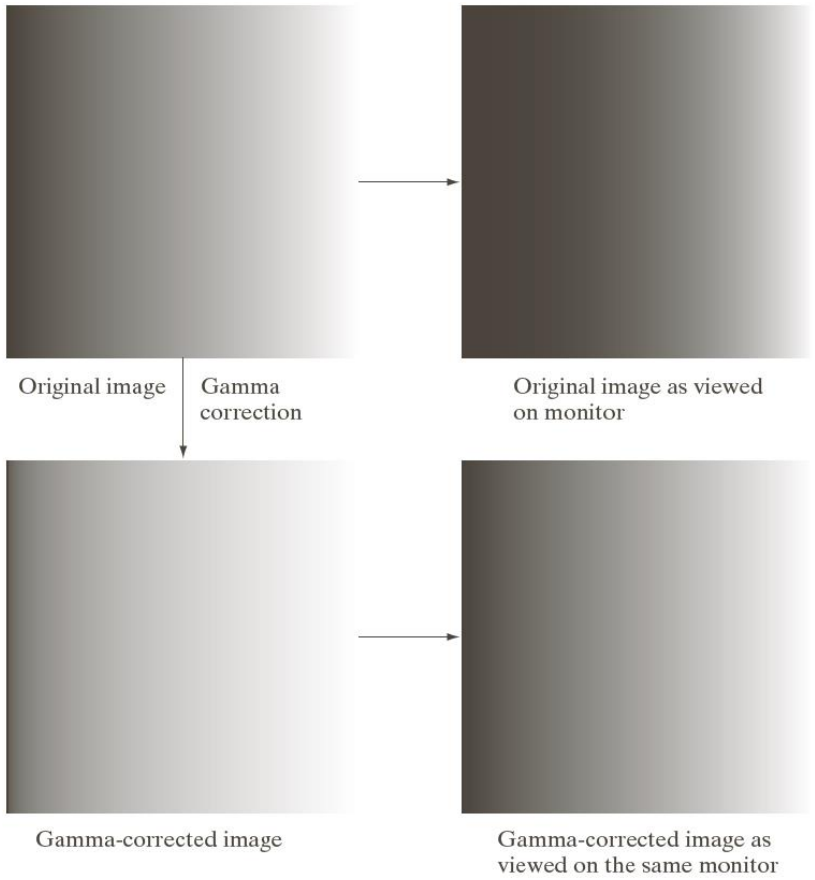
- Physics regulating the light intensity for CRT monitors:

$$I = V^{\gamma}$$

Gamma correction for monitors

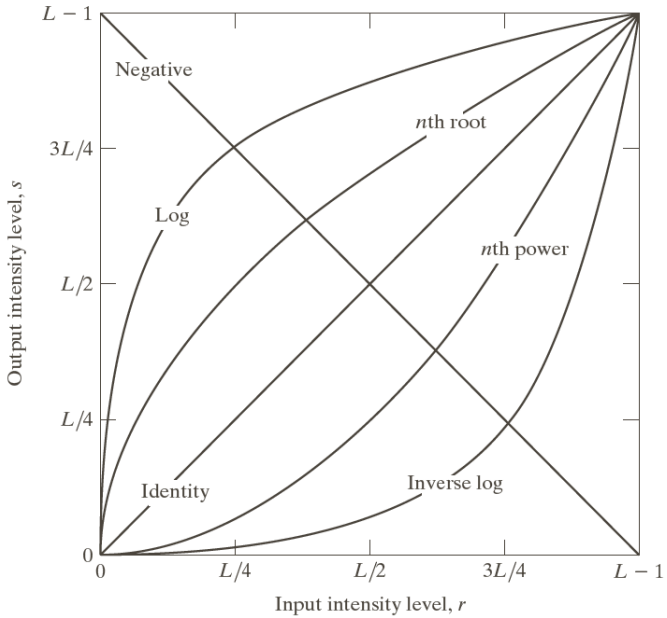
- Compensation by the gamma transform

$$s = cr^{1/\gamma}$$



Single-pixel operations

- Recap of the transformations analyzed so far
  - Negative
  - Logarithm
  - Gamma



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