

## Lecture 04 – Intensity transformations I

Prof. João Fernando Mari

[joaofmari.github.io](https://joaofmari.github.io)

*joaof.mari@ufv.br*

- Histogram
- Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram

11								
10								
9								
8								
7								
6								
5								
4								
3								
2								
1								
	0	1	2	3	4	5	6	7

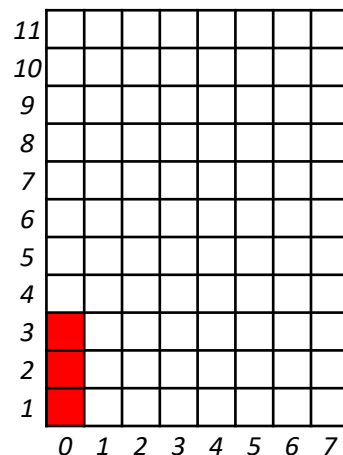
*Image size: 5 x 5 pixels*

*Intensity depth: 3 bits or  $2^3 = 8$  gray levels*

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



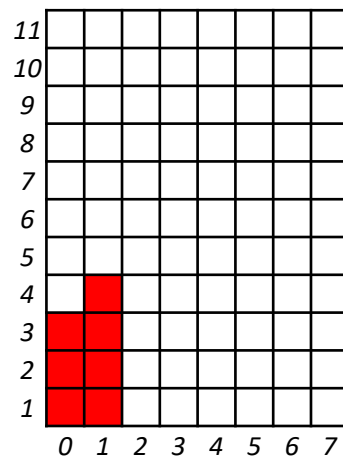
*Image size: 5 x 5 pixels*

*Intensity depth: 3 bits or  $2^3 = 8$  gray levels*

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



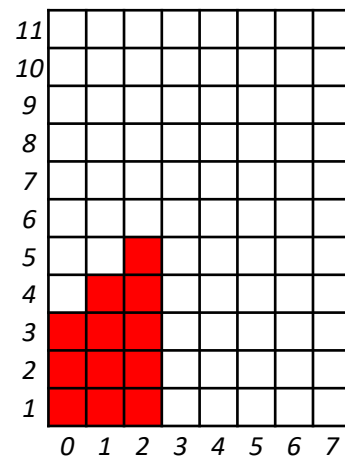
*Image size: 5 x 5 pixels*

*Intensity depth: 3 bits or  $2^3 = 8$  gray levels*

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



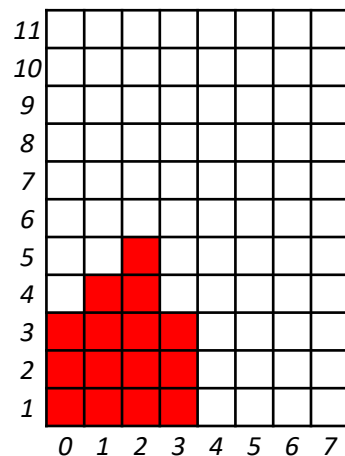
*Image size: 5 x 5 pixels*

*Intensity depth: 3 bits or  $2^3 = 8$  gray levels*

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



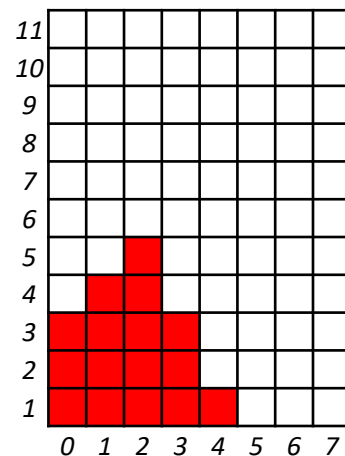
*Image size: 5 x 5 pixels*

*Intensity depth: 3 bits or  $2^3 = 8$  gray levels*

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



*Image size: 5 x 5 pixels*

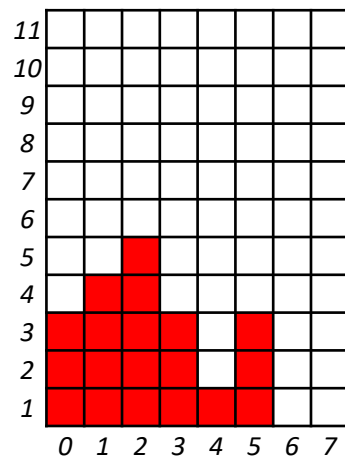
*Intensity depth: 3 bits or  $2^3 = 8$  gray levels*



Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



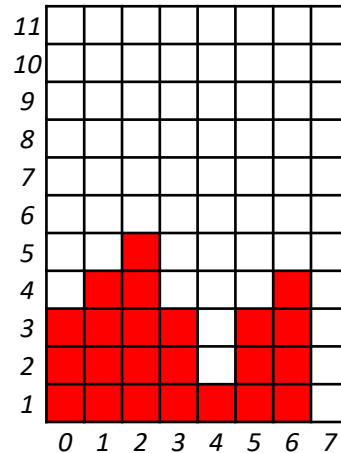
*Image size: 5 x 5 pixels*

*Intensity depth: 3 bits or  $2^3 = 8$  gray levels*

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



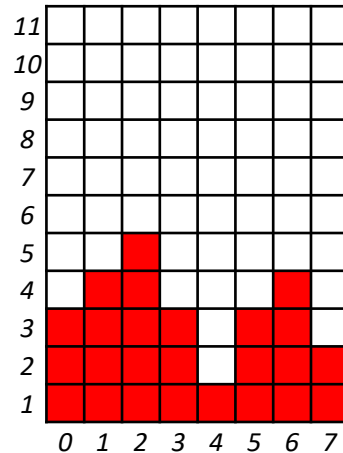
*Image size: 5 x 5 pixels*

*Intensity depth: 3 bits or  $2^3 = 8$  gray levels*

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



*Image size: 5 x 5 pixels*

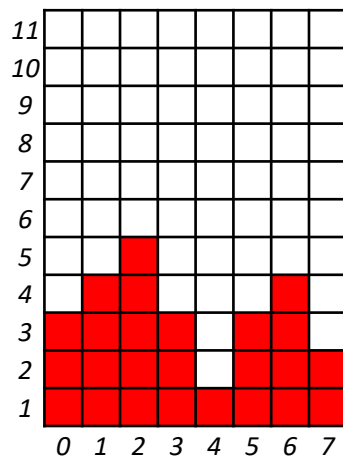
*Intensity depth: 3 bits or  $2^3 = 8$  gray levels*

# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

	0	1	2	3	4	5	6	7
7								
6								
5								
4								
3								
2								
1								
0								

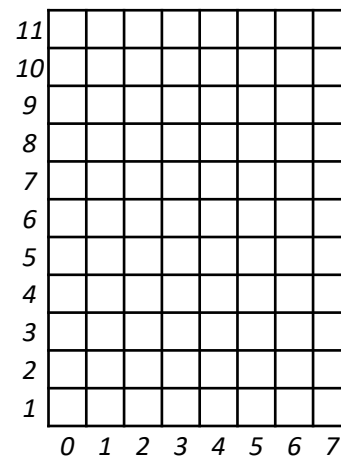
Image size: 5 x 5 pixels

Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0

Histogram

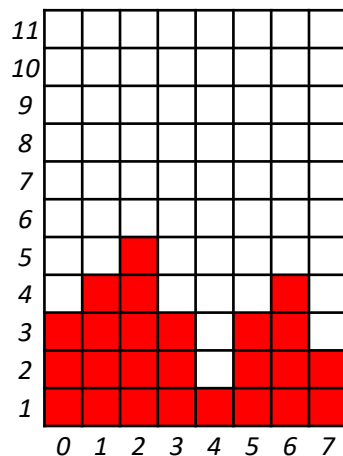


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

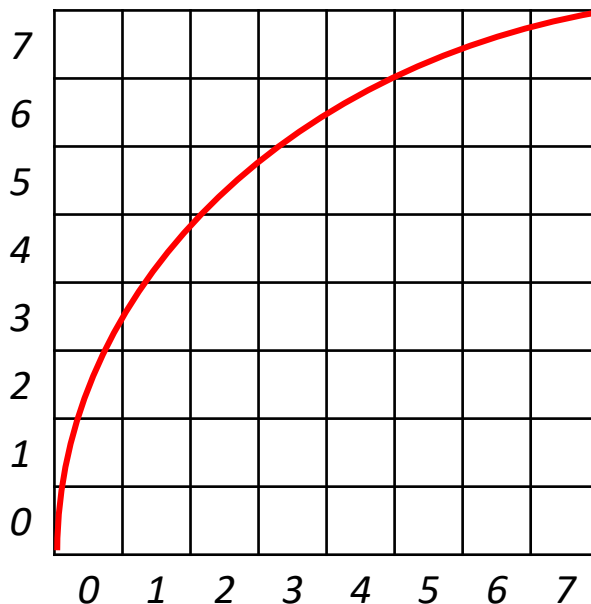
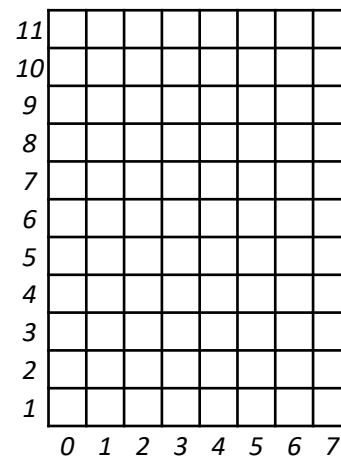


Image size: 5 x 5 pixels  
Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0

Histogram

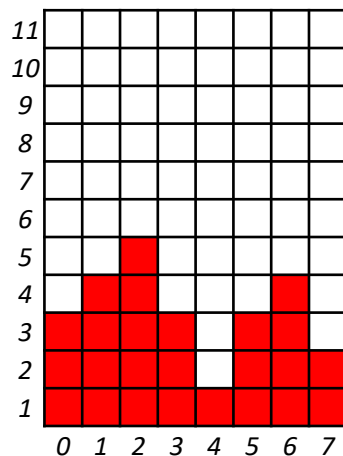


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

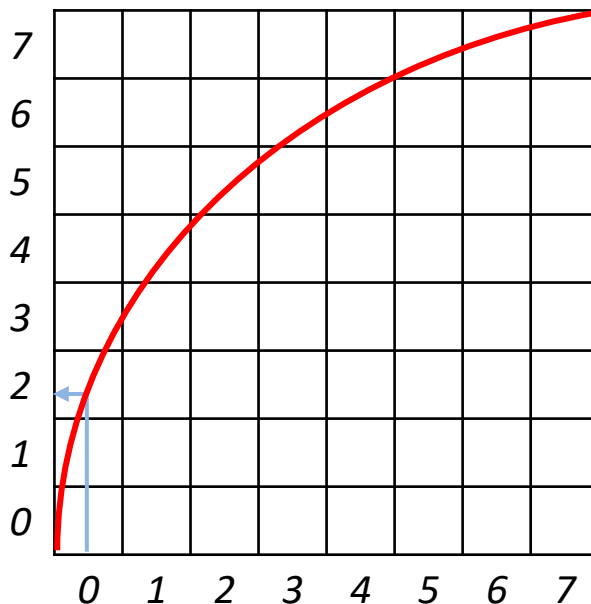
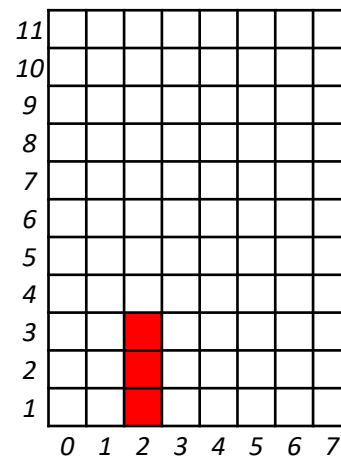


Image size: 5 x 5 pixels  
Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	2	0	0	0	0
4	2	2	0	0	0

Histogram

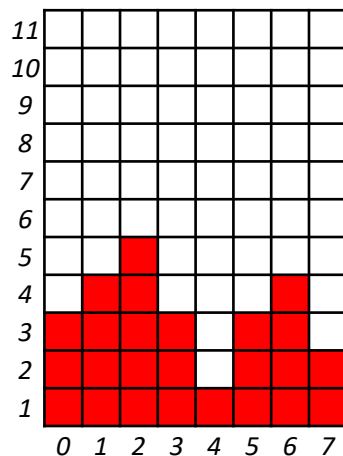


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

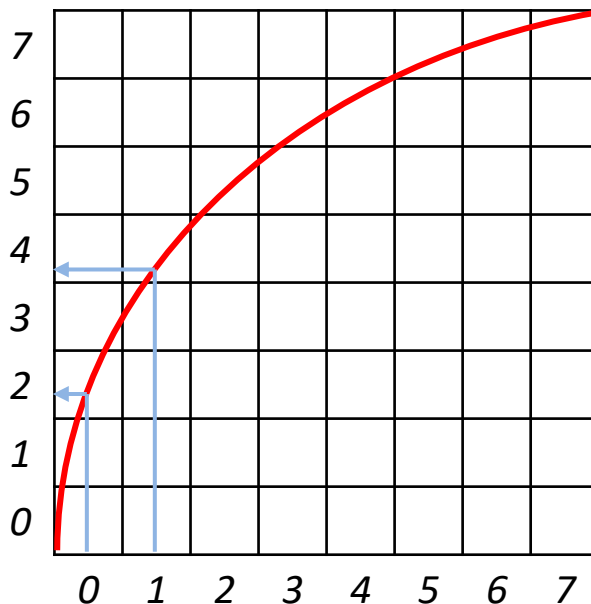
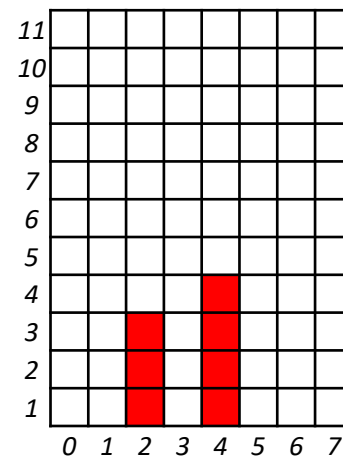


Image size: 5 x 5 pixels  
Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	0	0	0	0	0
1	4	0	0	0	0
2	4	0	0	0	0
3	2	0	0	0	0
4	2	2	4	4	0

Histogram

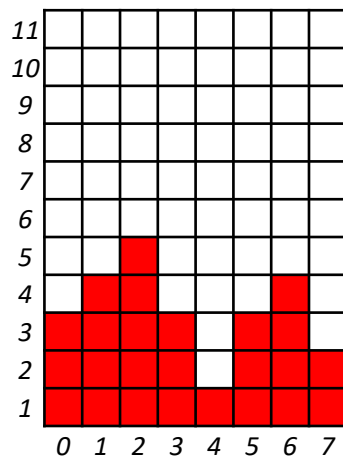


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

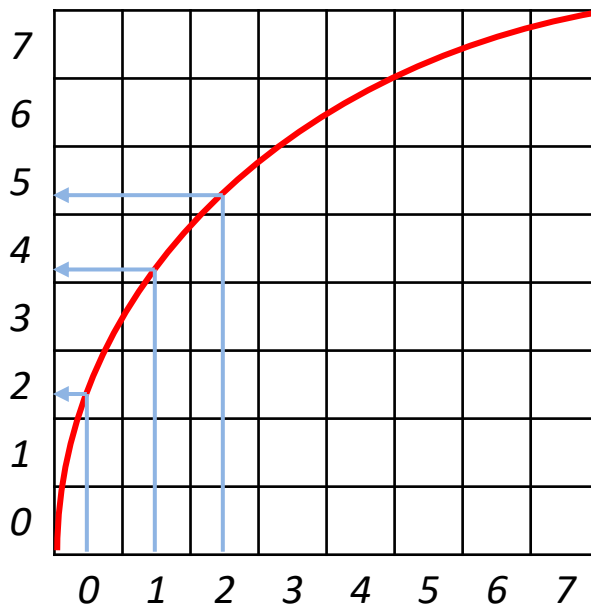
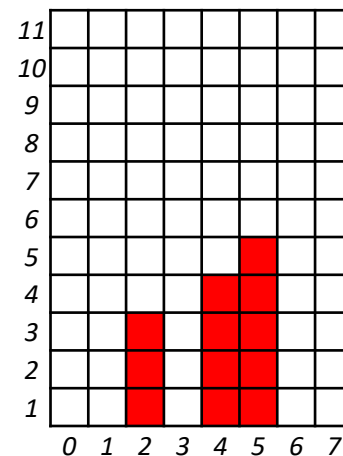


Image size: 5 x 5 pixels  
Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	5	5	0	0	0
1	4	0	0	0	0
2	4	0	0	0	5
3	2	0	0	0	5
4	2	2	4	4	5

Histogram



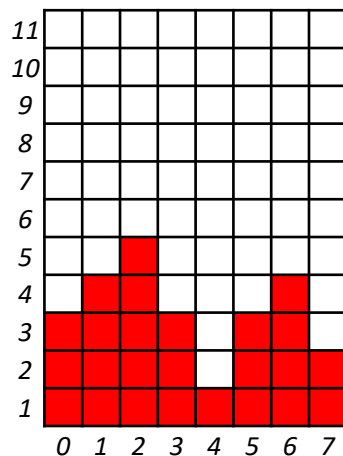


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

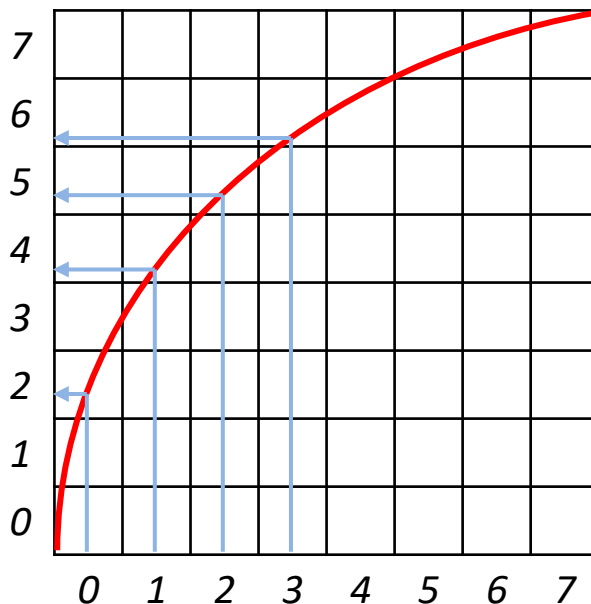
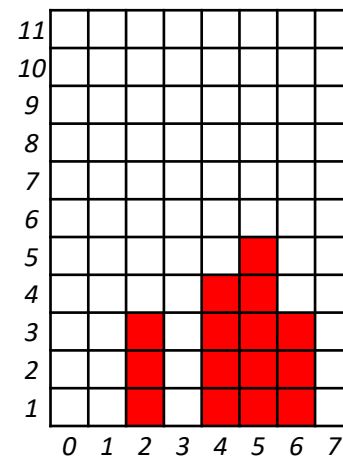


Image size: 5 x 5 pixels  
Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	5	5	6	6	0
1	4	0	0	0	6
2	4	0	0	0	5
3	2	0	0	0	5
4	2	2	4	4	5

Histogram

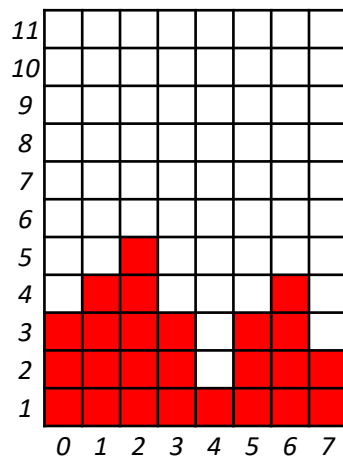


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

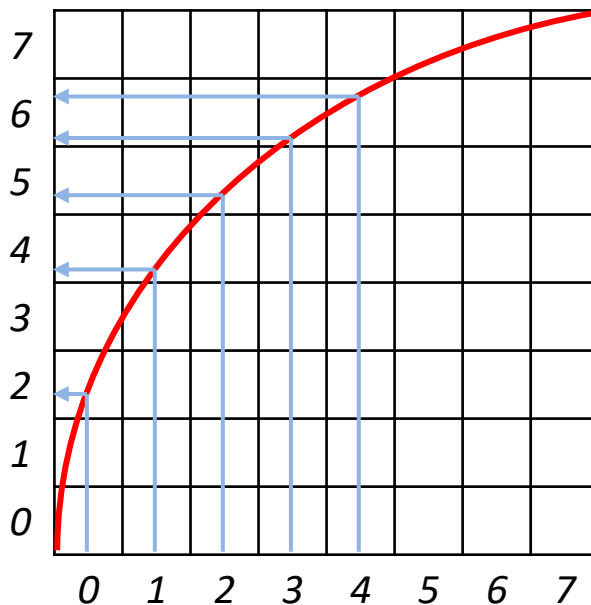
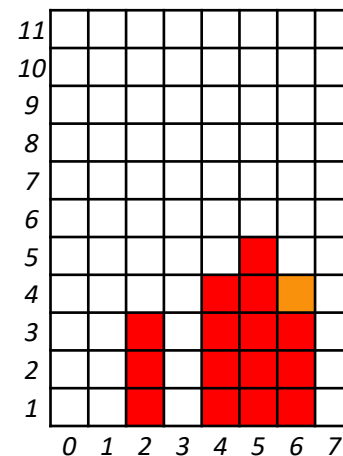


Image size: 5 x 5 pixels  
Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	5	5	6	6	6
1	4	0	0	0	6
2	4	0	0	0	5
3	2	0	0	0	5
4	2	2	4	4	5

Histogram

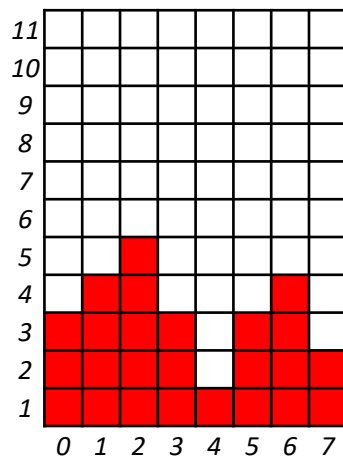


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

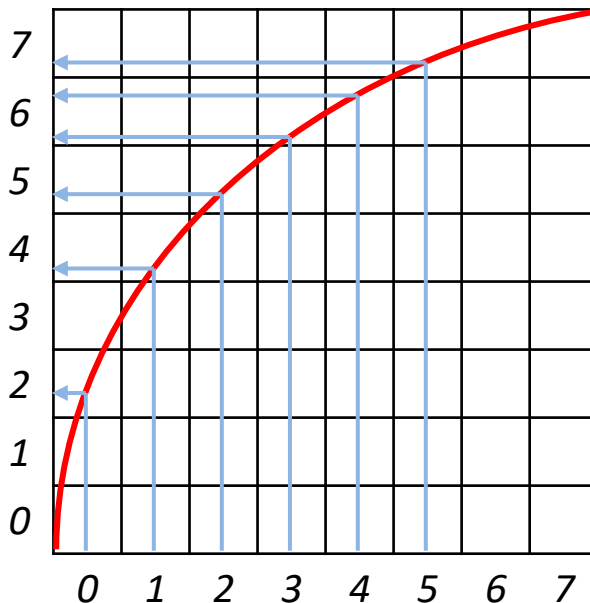


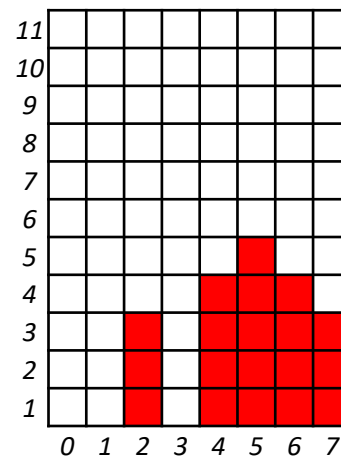
Image size: 5 x 5 pixels

Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	5	5	6	6	6
1	4	0	0	0	6
2	4	7	0	0	5
3	2	7	7	0	5
4	2	2	4	4	5

Histogram

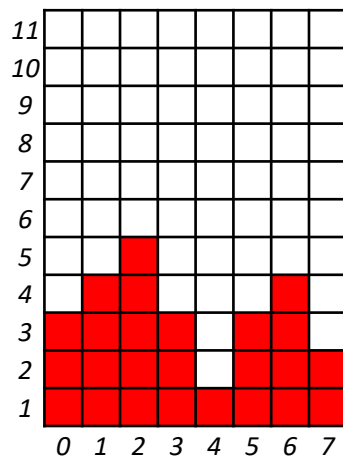


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Função de transformação

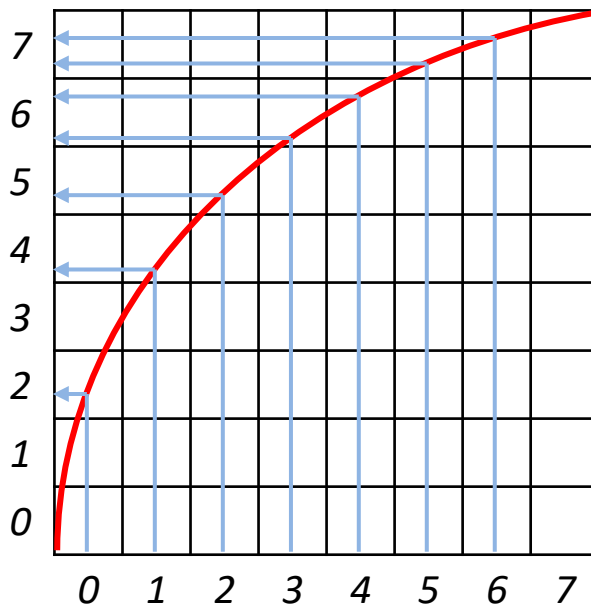
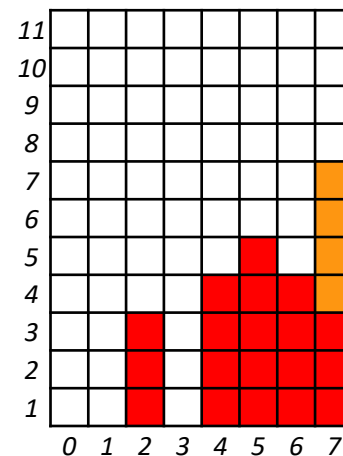


Image size: 5 x 5 pixels  
Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	5	5	6	6	6
1	4	7	0	0	6
2	4	7	7	7	5
3	2	7	7	7	5
4	2	2	4	4	5

Histogram

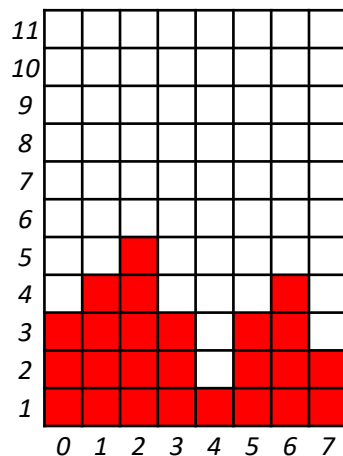


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

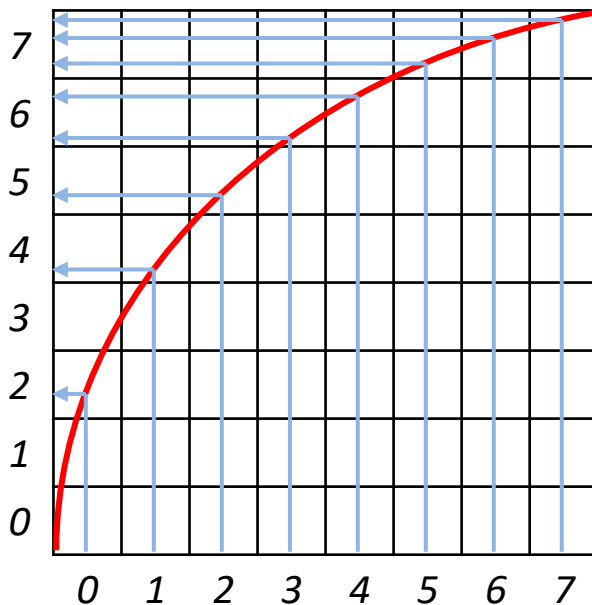
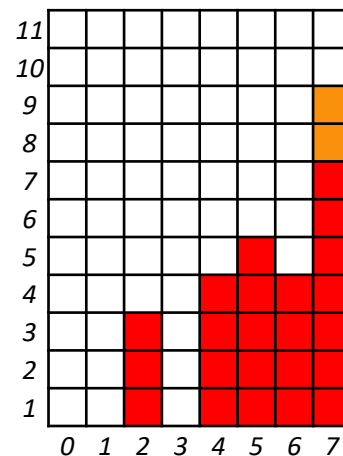


Image size: 5 x 5 pixels  
Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	5	5	6	6	6
1	4	7	7	7	6
2	4	7	7	7	5
3	2	7	7	7	5
4	2	2	4	4	5

Histogram

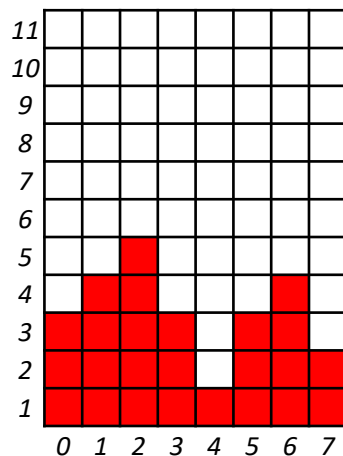


# Transformation function

Input image

	0	1	2	3	4
0	2	2	3	3	4
1	1	6	7	7	3
2	1	5	6	6	2
3	0	5	5	6	2
4	0	0	1	1	2

Histogram



Transformation function

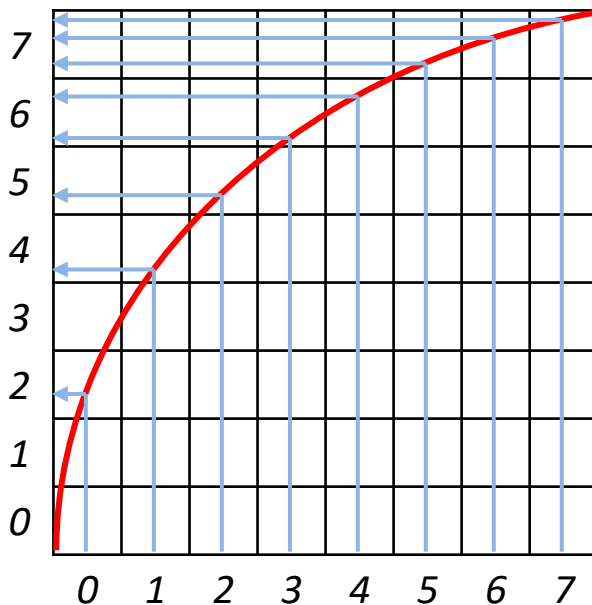
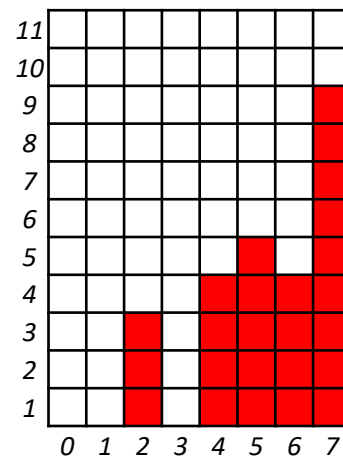


Image size: 5 x 5 pixels  
Intensity depth: 3 bits or  $2^3 = 8$  gray levels

Output image

	0	1	2	3	4
0	5	5	6	6	6
1	4	7	7	7	6
2	4	7	7	7	5
3	2	7	7	7	5
4	2	2	4	4	5

Histogram



- GONZALEZ, R.C.; WOODS, R.E. **Digital Image Processing**. 3rd ed. Pearson, 2007.
  - Sections 3.1 until 3.2.3
- MARQUES FILHO, O.; VIEIRA NETO, H. **Processamento digital de imagens**. Brasport, 1999.
  - (*in Brazilian Portuguese*)
  - Available on the author's website (for personal use only)
  - <http://dainf.ct.utfpr.edu.br/~hvieir/pub.html>
  - Sections 3.1 and 3.2
- J. E. R. Queiroz, H. M. Gomes. **Introdução ao Processamento Digital de Imagens**. RITA. v. 13, 2006.
  - (*in Brazilian Portuguese*)
  - <http://www.dsc.ufcg.edu.br/~hmg/disciplinas/graduacao/vc-2016.2/Rita-Tutorial-PDI.pdf>
  - Section 3

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  title = {Spatial filtering I},
  year = {2023},
  publisher = {GitHub},
  journal = {Introduction to digital image processing - UFV},
  howpublished = {\url{https://github.com/joaofmari/SIN392_Introduction-to-digital-image-processing_2023}}
}
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