# Aula 05 – Transformações de intensidade 2

Prof. João Fernando Mari
*joaofmari.github.io*
*joaof.mari@ufv.br*

# Roteiro

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- Equalização de histograma

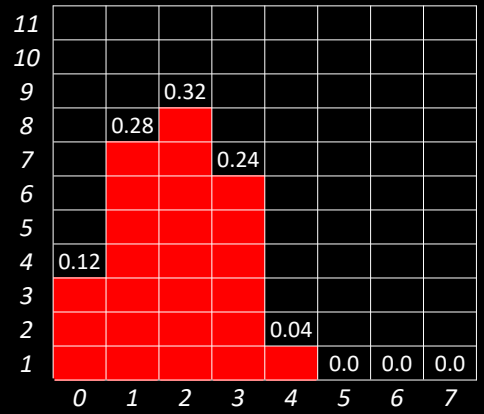
# Equalização de histograma

## Imagem original

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 2 | 3 | 1 |
| 1 | 1 | 3 | 3 | 4 | 2 |
| 2 | 1 | 2 | 3 | 3 | 2 |
| 3 | 0 | 2 | 2 | 3 | 2 |
| 4 | 0 | 0 | 1 | 1 | 1 |

5 x 5 pixels = 25 pixels
3 bits ou $2^3$ = 8 níveis de cinza (L).
Intervalo de níveis de cinza: [0, 7]

## Histograma normalizado



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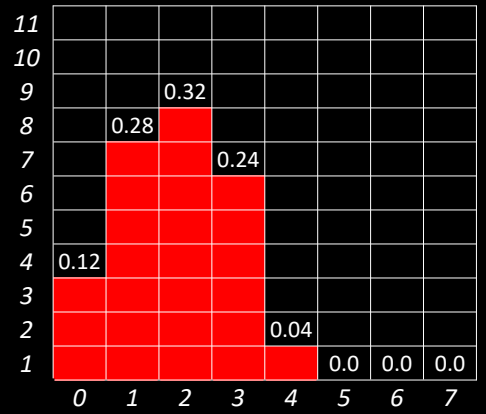
5 x 5 pixels = 25 pixels
3 bits ou $2^3$ = 8 níveis de cinza (L).
Intervalo de níveis de cinza: [0, 7]

## Imagem processada

| | 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 |

## Histograma normalizado

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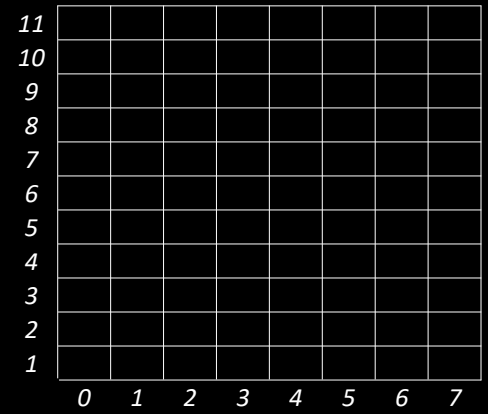

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5 x 5 pixels = 25 pixels
3 bits ou $2^3$ = 8 níveis de cinza (L).
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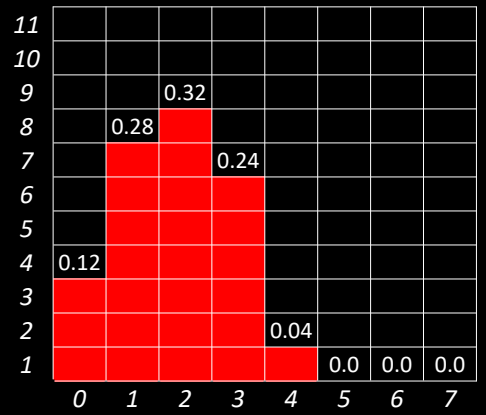
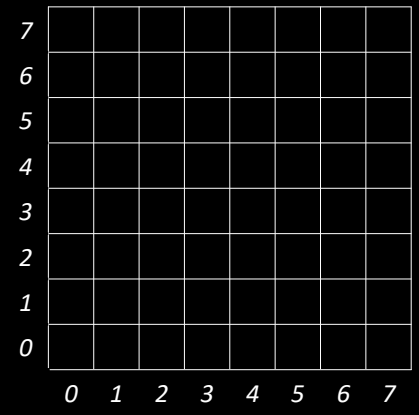
| k | p' | $s_k=T(r_k)$ |
|---|---|---|
| 0 | | |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |

## Imagem processada

| | 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 |

## Histograma normalizado

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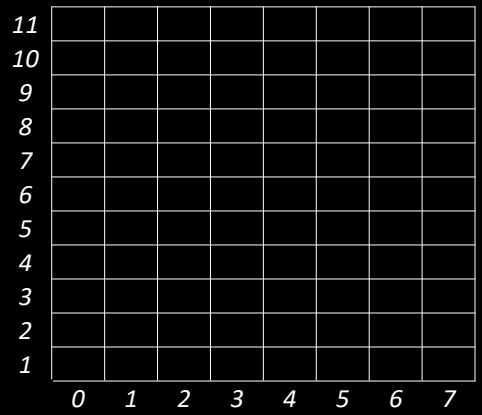

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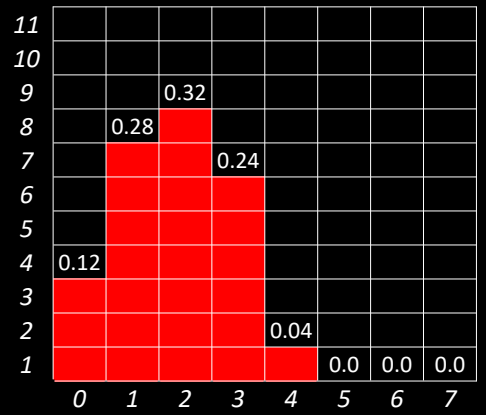
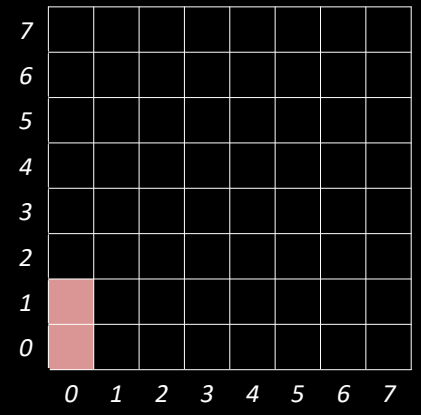
| k | | p' | $s_k=T(r_k)$ |
|---|---|---|---|
| 0 | 7 × (0.12) | = 0.84 | = 1 |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |

## Imagem processada

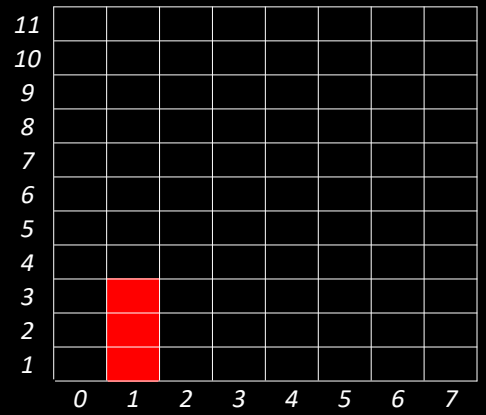
| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1 | 0 | 0 | 0 | 0 |
| 4 | 1 | 1 | 0 | 0 | 0 |

## Histograma normalizado




## Histograma normalizado



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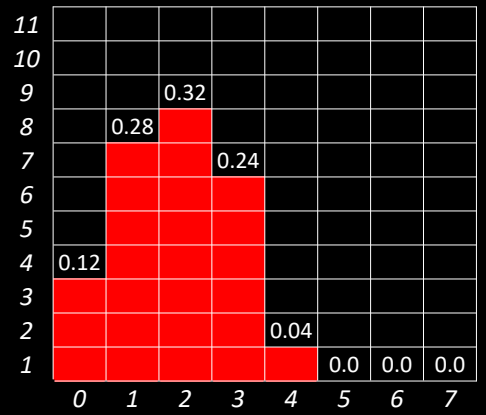
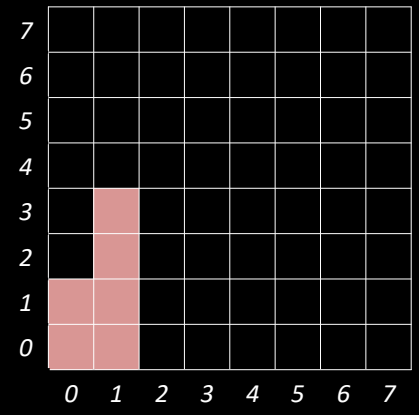
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |

## Imagem processada

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 3 | 0 | 0 | 0 | 3 |
| 1 | 3 | 0 | 0 | 0 | 0 |
| 2 | 3 | 0 | 0 | 0 | 0 |
| 3 | 1 | 0 | 0 | 0 | 0 |
| 4 | 1 | 1 | 3 | 3 | 3 |

## Histograma normalizado

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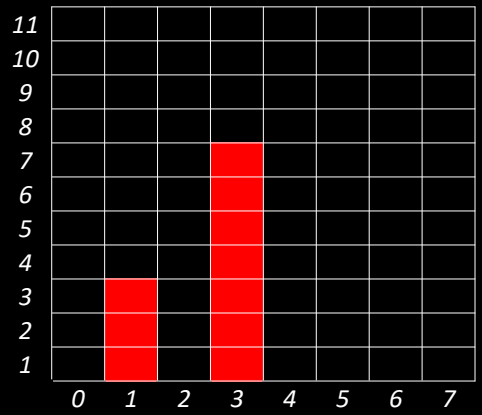

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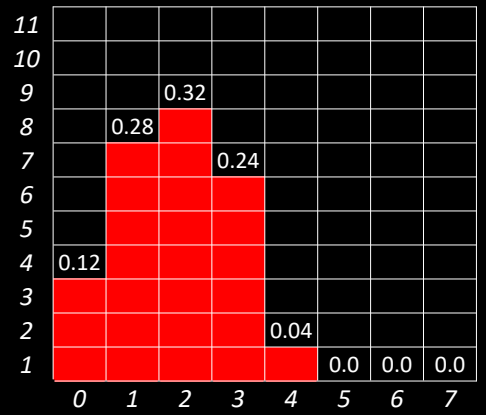
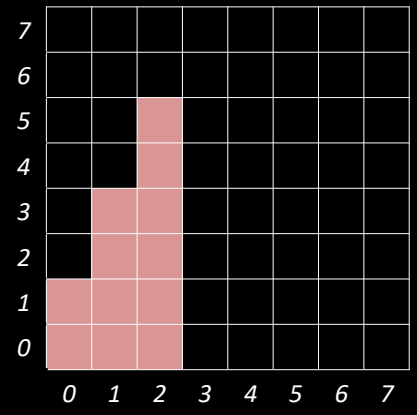
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |

## Imagem processada

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 3 | 5 | 5 | 0 | 3 |
| 1 | 3 | 0 | 0 | 0 | 5 |
| 2 | 3 | 5 | 0 | 0 | 5 |
| 3 | 1 | 5 | 5 | 0 | 5 |
| 4 | 1 | 1 | 3 | 3 | 3 |

## Histograma normalizado

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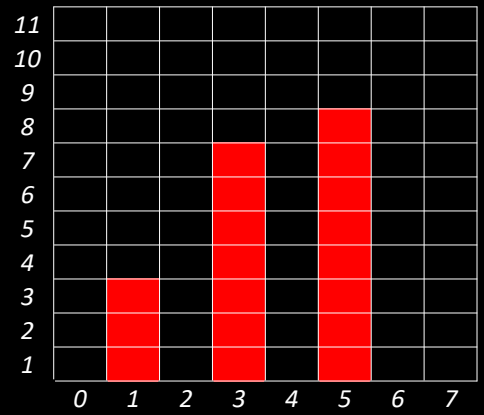

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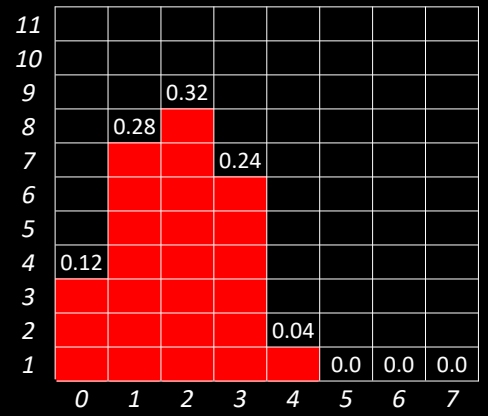
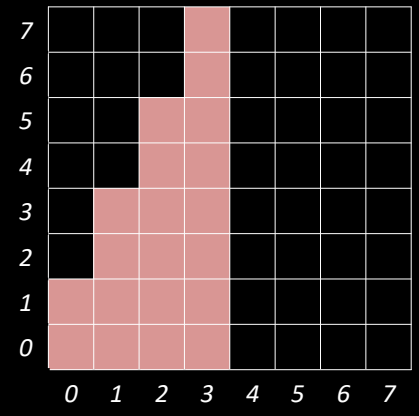
| 3 | 7 × (0.12 + 0.28 + 0.32 + 0.24) | = 6.72 | = 7 |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |

## Imagem processada

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 3 | 5 | 5 | 7 | 3 |
| 1 | 3 | 7 | 7 | 0 | 5 |
| 2 | 3 | 5 | 7 | 7 | 5 |
| 3 | 1 | 5 | 5 | 7 | 5 |
| 4 | 1 | 1 | 3 | 3 | 3 |

## Histograma normalizado

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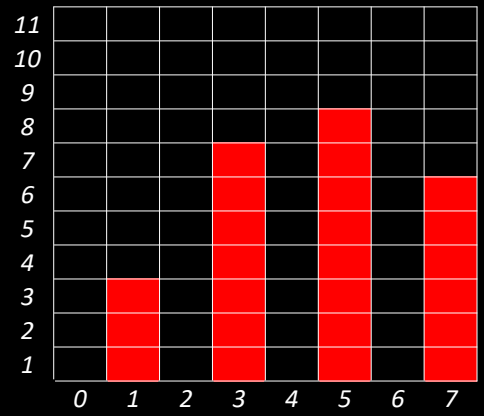

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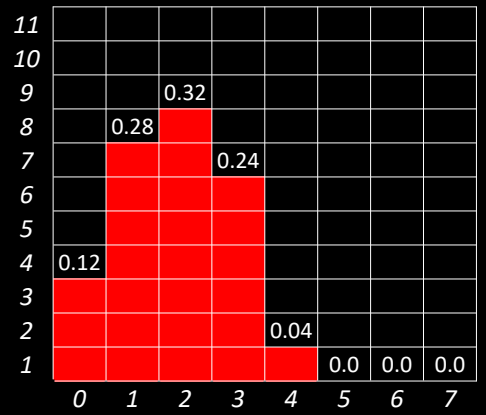
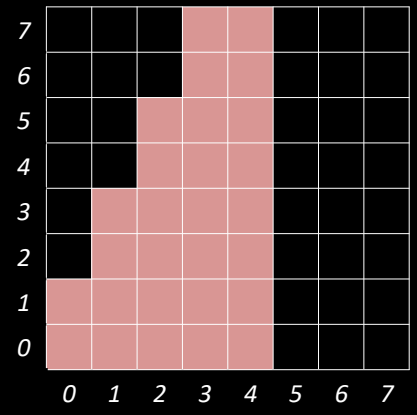
| 4 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04) | = 7.00 | = 7 |
| 5 | | | |
| 6 | | | |
| 7 | | | |

## Imagem processada

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 3 | 5 | 5 | 7 | 3 |
| 1 | 3 | 7 | 7 | 7 | 5 |
| 2 | 3 | 5 | 7 | 7 | 5 |
| 3 | 1 | 5 | 5 | 7 | 5 |
| 4 | 1 | 1 | 3 | 3 | 3 |

## Histograma normalizado

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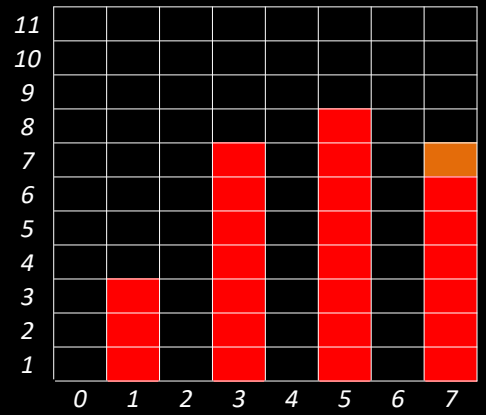

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|---|---|---|---|---|---|
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| 3 | 0 | 2 | 2 | 3 | 2 |
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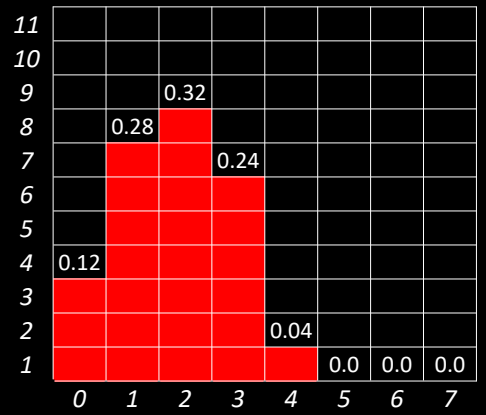
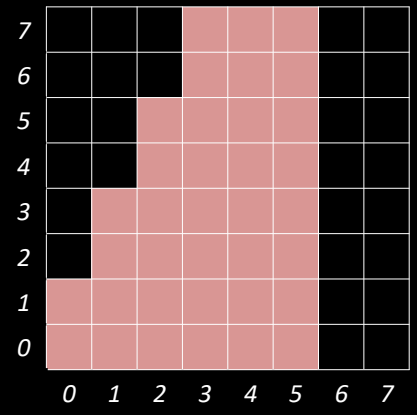
| 5 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0) | = 7.00 | = 7 |
| 6 | | | |
| 7 | | | |

## Imagem processada

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 3 | 5 | 5 | 7 | 3 |
| 1 | 3 | 7 | 7 | 7 | 5 |
| 2 | 3 | 5 | 7 | 7 | 5 |
| 3 | 1 | 5 | 5 | 7 | 5 |
| 4 | 1 | 1 | 3 | 3 | 3 |

## Histograma normalizado

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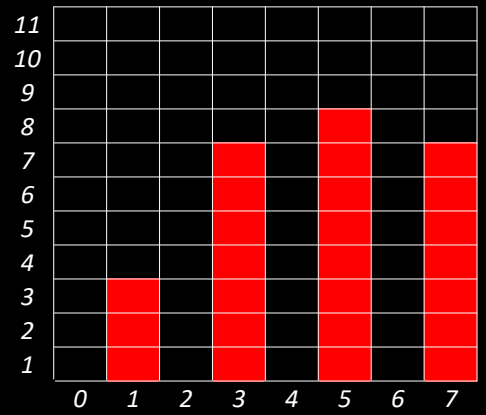

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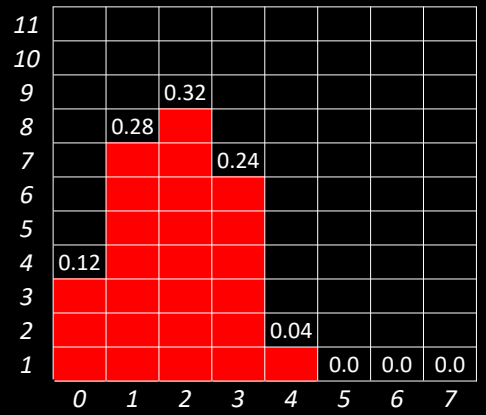
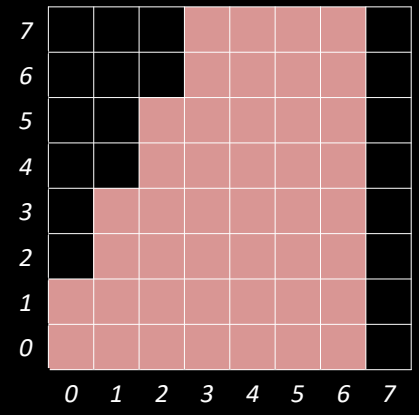
| 4 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04) | = 7.00 | = 7 |
| 5 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0) | = 7.00 | = 7 |
| 6 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0) | = 7.00 | = 7 |
| 7 | | | |

## Imagem processada

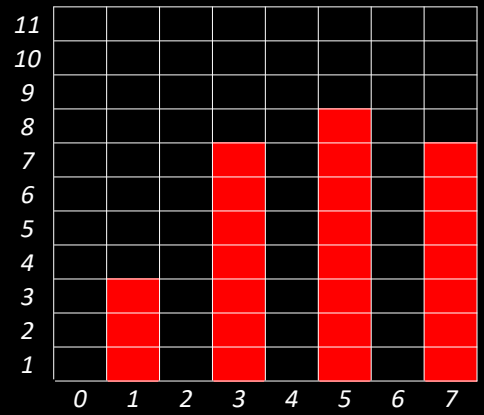
| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 3 | 5 | 5 | 7 | 3 |
| 1 | 3 | 7 | 7 | 7 | 5 |
| 2 | 3 | 5 | 7 | 7 | 5 |
| 3 | 1 | 5 | 5 | 7 | 5 |
| 4 | 1 | 1 | 3 | 3 | 3 |

## Histograma normalizado




## Histograma normalizado



# Equalização de histograma

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## Imagem original

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 2 | 3 | 1 |
| 1 | 1 | 3 | 3 | 4 | 2 |
| 2 | 1 | 2 | 3 | 3 | 2 |
| 3 | 0 | 2 | 2 | 3 | 2 |
| 4 | 0 | 0 | 1 | 1 | 1 |

5 x 5 pixels = 25 pixels
3 bits ou $2^3$ = 8 níveis de cinza (L).
Intervalo de níveis de cinza: [0, 7]

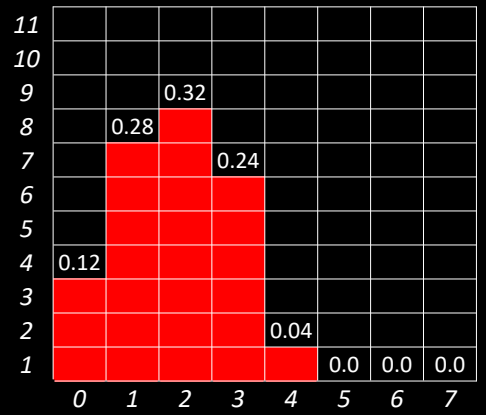
$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j)$$

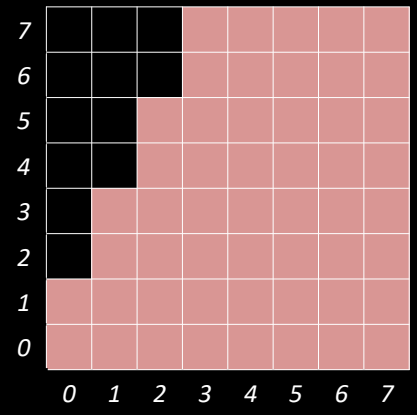
| k | | p' | $s_k=T(r_k)$ |
|---|---|---|---|
| 0 | 7 × (0.12) | = 0.84 | = 1 |
| 1 | 7 × (0.12 + 0.28) | = 2.80 | = 3 |
| 2 | 7 × (0.12 + 0.28 + 0.32) | = 5.04 | = 5 |
| 3 | 7 × (0.12 + 0.28 + 0.32 + 0.24) | = 6.72 | = 7 |
| 4 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04) | = 7.00 | = 7 |
| 5 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0) | = 7.00 | = 7 |
| 6 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0) | = 7.00 | = 7 |
| 7 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0) | = 7.00 | = 7 |

## Imagem processada

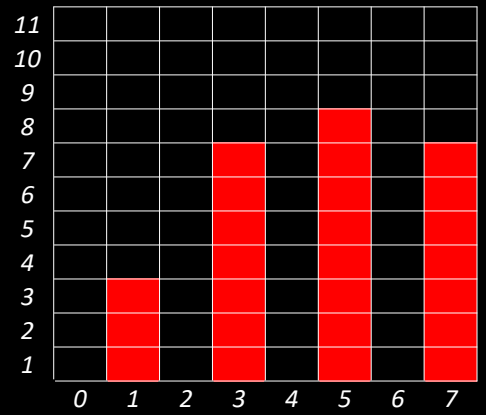
| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 3 | 5 | 5 | 7 | 3 |
| 1 | 3 | 7 | 7 | 7 | 5 |
| 2 | 3 | 5 | 7 | 7 | 5 |
| 3 | 1 | 5 | 5 | 7 | 5 |
| 4 | 1 | 1 | 3 | 3 | 3 |

## Histograma normalizado




## Histograma normalizado



# Equalização de histograma

UFV
Universidade Federal de Viçosa

## Imagem original

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 2 | 3 | 1 |
| 1 | 1 | 3 | 3 | 4 | 2 |
| 2 | 1 | 2 | 3 | 3 | 2 |
| 3 | 0 | 2 | 2 | 3 | 2 |
| 4 | 0 | 0 | 1 | 1 | 1 |

5 x 5 pixels = 25 pixels
3 bits ou $2^3$ = 8 níveis de cinza (L).
Intervalo de níveis de cinza: [0, 7]

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j)$$

| k | | p' | $s_k=T(r_k)$ |
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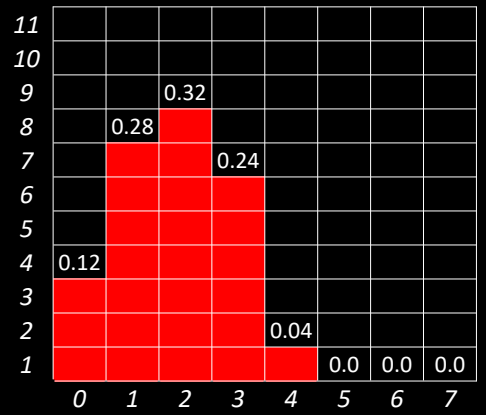
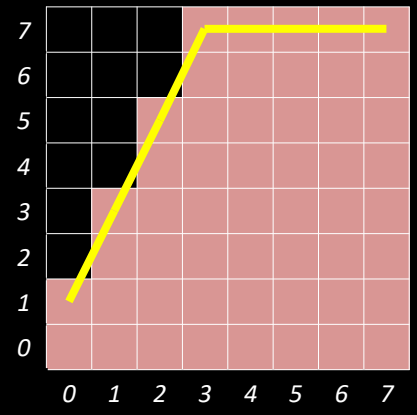
| 4 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04) | = 7.00 | = 7 |
| 5 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0) | = 7.00 | = 7 |
| 6 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0) | = 7.00 | = 7 |
| 7 | 7 × (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0) | = 7.00 | = 7 |

## Imagem processada

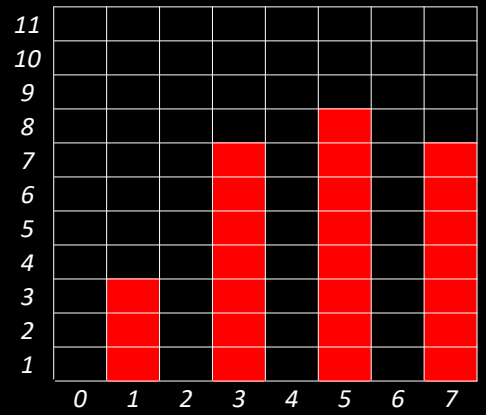
| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 3 | 5 | 5 | 7 | 3 |
| 1 | 3 | 7 | 7 | 7 | 5 |
| 2 | 3 | 5 | 7 | 7 | 5 |
| 3 | 1 | 5 | 5 | 7 | 5 |
| 4 | 1 | 1 | 3 | 3 | 3 |

## Histograma normalizado




## Histograma normalizado



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