## Aula Prática 4

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## 1. Spatial Convolution.

- [Optional] Create a test image using a drawing program of your choosing. This image should have a small dimension and should have controlled values. Example:

| 0 | 0 | 0 | 0 | 0 |
| :---: | :---: | :---: | :---: | :---: |
| 0 | 255 | 255 | 255 | 0 |
| 0 | 255 | 255 | 255 | 0 |
| 0 | 255 | 255 | 255 | 0 |
| 0 | 0 | 0 | 0 | 0 |

- Create a function that applies a $3 \times 3$ mask over point $(2,2)$ of the image. Remember:

$$
g(2,2)=\sum_{i=-1}^{1} \sum_{j=-1}^{1} f(2+i, 2+j) \cdot \operatorname{mask}(i, j)
$$

- [Optional] Test various points of the test image where you already know what results you should obtain. Confirm that you are obtaining correct results.
- A convolution consists on the application of this mask to the whole image. Remember:

$$
g(x, y)=\sum_{i=-1}^{1} \sum_{j=-1}^{1} f(x+i, y+j) \cdot \operatorname{mask}(i, j)
$$

- Implement a spatial convolution function so that it applies a mask to an image. To handle the border problem, obtain a smaller image that the original one.


## 2. Spatial filters

- Create a function that applies a mean filter to an image. It should work on the image domain, using a $3 \times 3$ mask. Ignore the border problem, by not altering any value in the image border.

| 1 | 1 | 1 |
| :--- | :--- | :--- |
| 1 | 1 | 1 |
| 1 | 1 | 1 |

Mask of a $3 \times 3$ mean filter
[non-normalized mask!]


- Consecutively apply the previous filter, noticing the importance of the border problem. A better solution is to create a larger image, filling these extra spaces with new values. Implement the three following alternatives:
i. New pixels have zero value (black color).
ii. New pixels have a value equal to its closest neighbor.
iii. New pixels have a value equal to a 'reflected' version of the original image.


## 3. Noise reduction using spatial filters.

- Consider image Imagem_AP4_2, which has been degraded by salt and pepper noise. Apply the mean filter previously implemented.
- Create a function that implements a median filter of size $3 \times 3$. Apply this filtre to the same image. What differences do you observe?
Google: Java Arrays Sort

