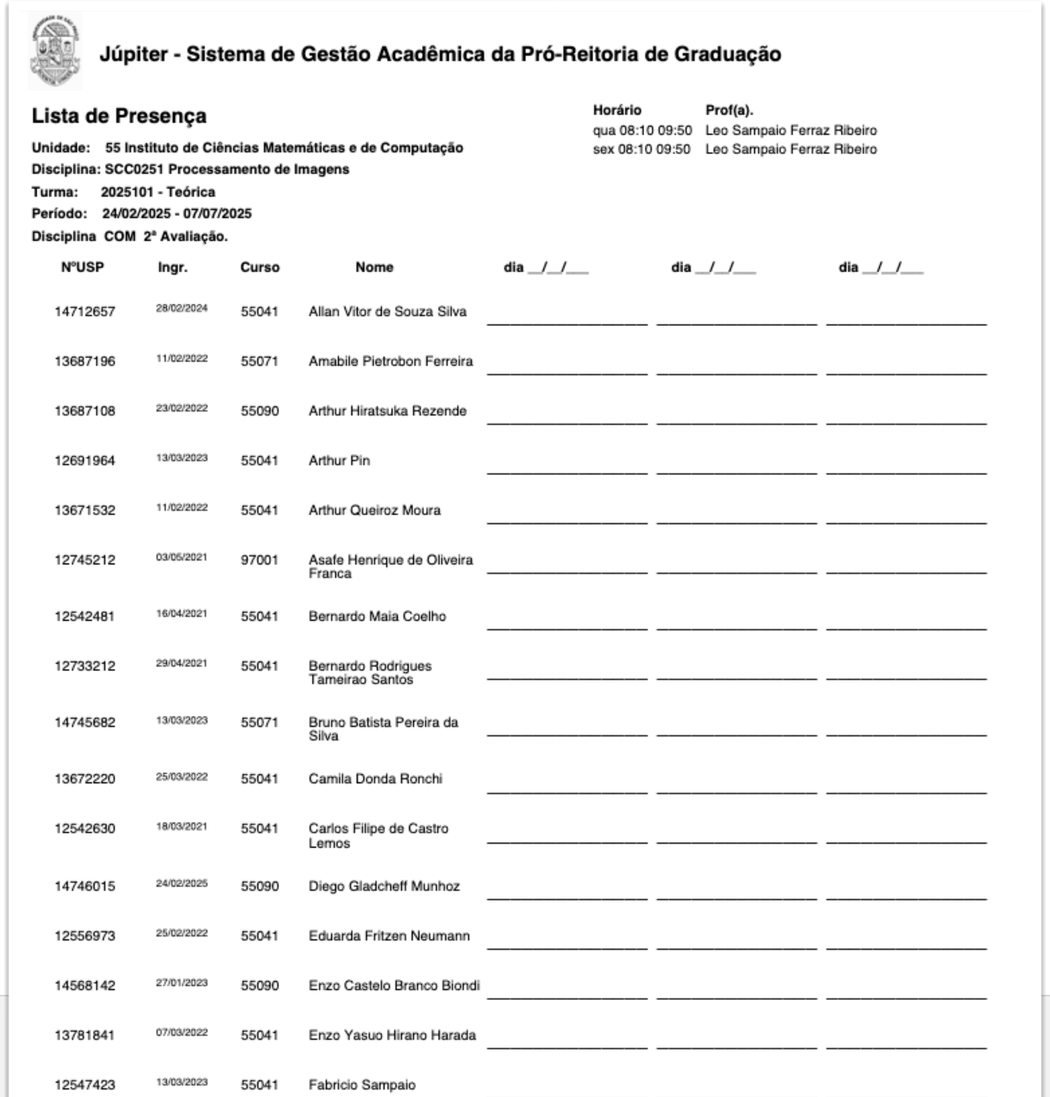
SCC0251
Processamento de Imagens

Filtros Espaciais

Professora Leo Sampaio Ferraz Ribeiro

Slide para não esquecer de passar a lista



Júpiter - Sistema de Gestão Acadêmica da Pró-Reitoria de Graduação

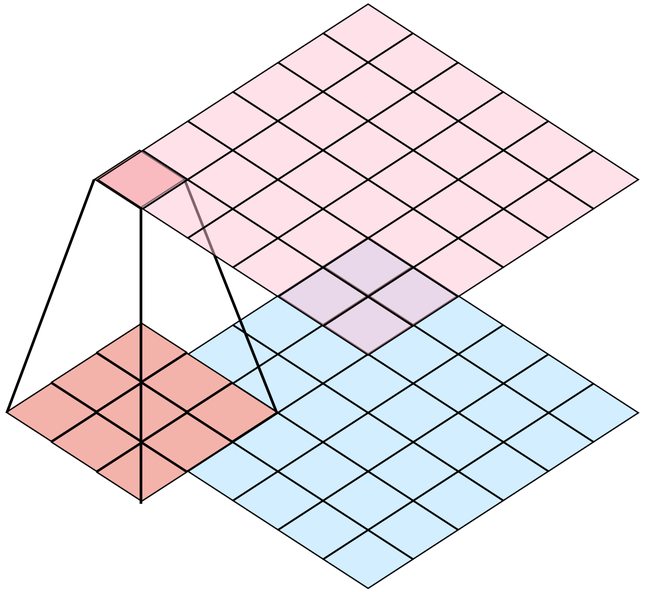
Lista de Presença

Horário	Prof(a).
qua 08:10 09:50	Leo Sampaio Ferraz Ribeiro
sex 08:10 09:50	Leo Sampaio Ferraz Ribeiro

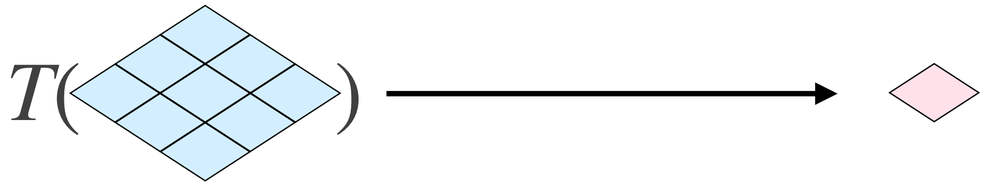
Unidade: 55 Instituto de Ciências Matemáticas e de Computação
Disciplina: SCC0251 Processamento de Imagens
Turma: 2025101 - Teórica
Período: 24/02/2025 - 07/07/2025
Disciplina COM 2ª Avaliação.

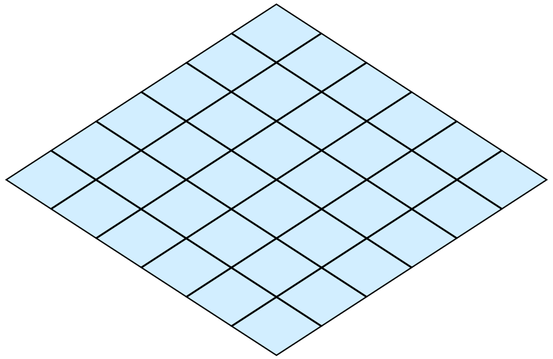
NºUSP	Ingr.	Curso	Nome	dia __/__/___	dia __/__/___	dia __/__/___
14712657	28/02/2024	55041	Allan Vitor de Souza Silva			
13687196	11/02/2022	55071	Amabile Pietrobon Ferreira			
13687108	23/02/2022	55090	Arthur Hiratsuka Rezende			
12691964	13/03/2023	55041	Arthur Pin			
13671532	11/02/2022	55041	Arthur Queiroz Moura			
12745212	03/05/2021	97001	Asafe Henrique de Oliveira Franca			
12542481	16/04/2021	55041	Bernardo Maia Coelho			
12733212	29/04/2021	55041	Bernardo Rodrigues Tameirao Santos			
14745682	13/03/2023	55071	Bruno Batista Pereira da Silva			
13672220	25/03/2022	55041	Camila Donda Ronchi			
12542630	18/03/2021	55041	Carlos Filipe de Castro Lemos			
14746015	24/02/2025	55090	Diego Gladcheff Munhoz			
12556973	25/02/2022	55041	Eduarda Fritzen Neumann			
14568142	27/01/2023	55090	Enzo Castelo Branco Biondi			
13781841	07/03/2022	55041	Enzo Yasuo Hirano Harada			
12547423	13/03/2023	55041	Fabricio Sampaio			

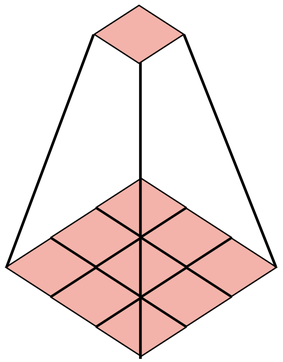
Convolução

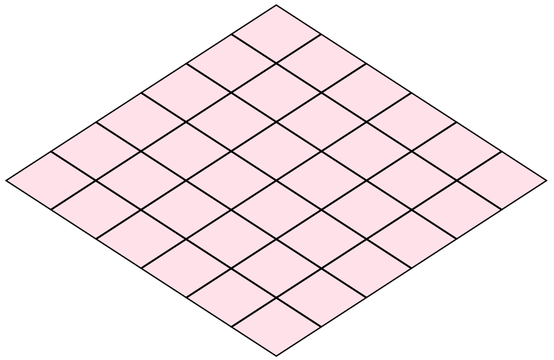


Tipos de Filtros









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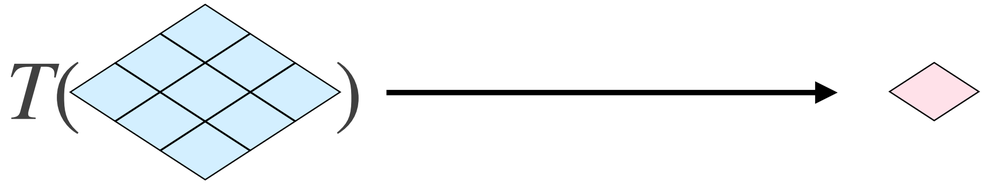

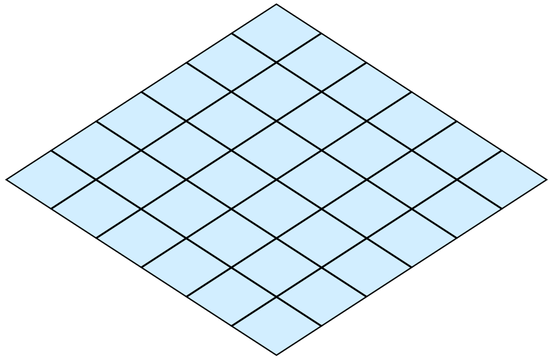

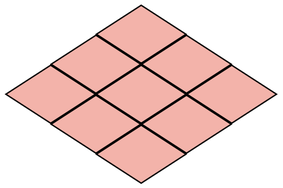

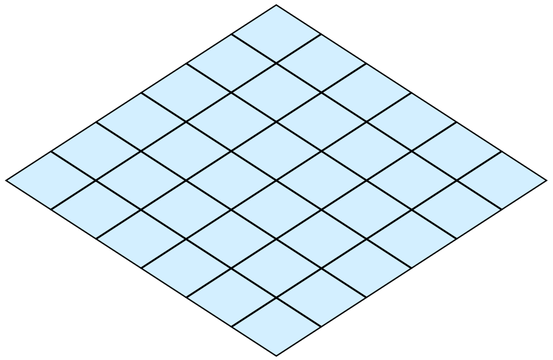

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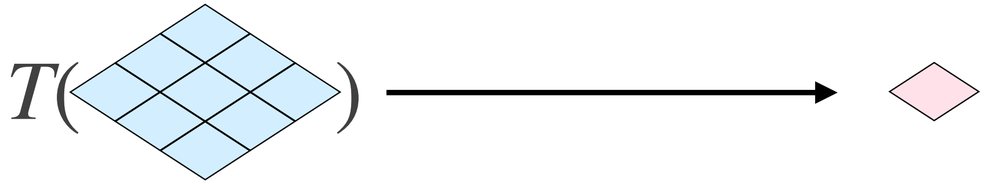

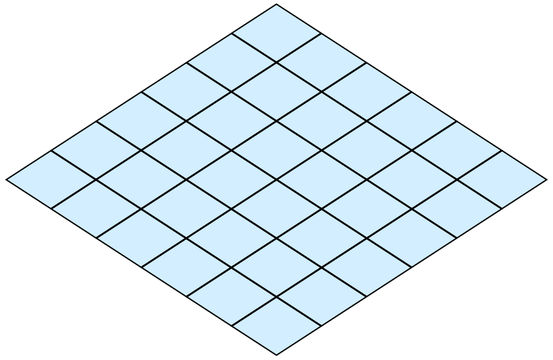

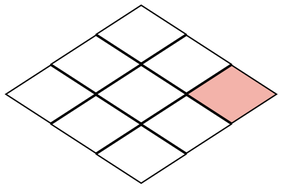

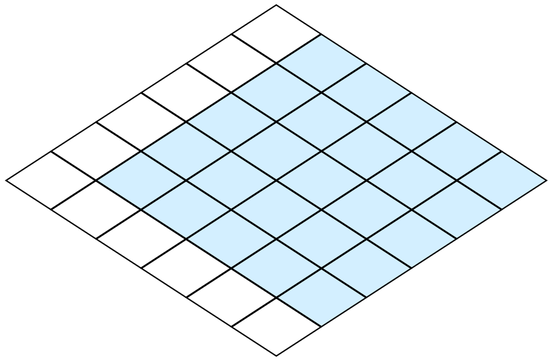

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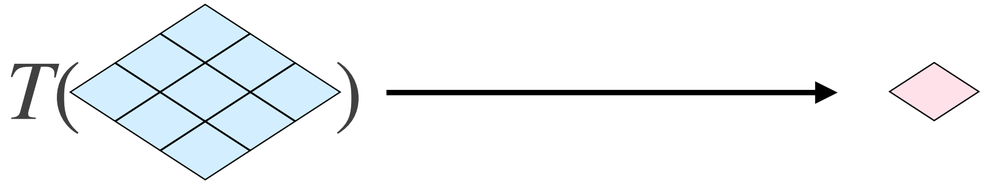
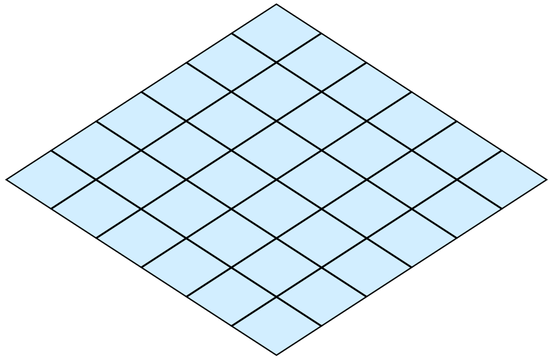
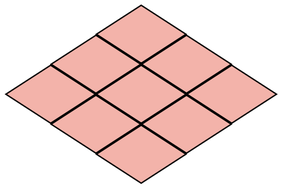
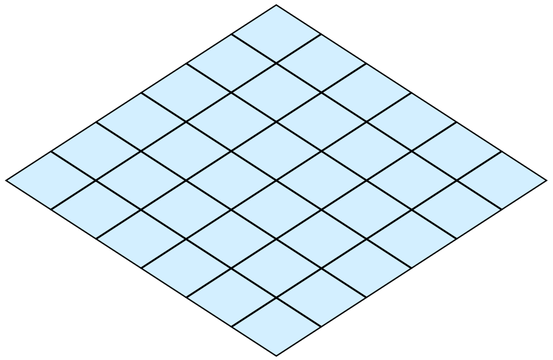
Filtros de Shift

Filtros de Caixa









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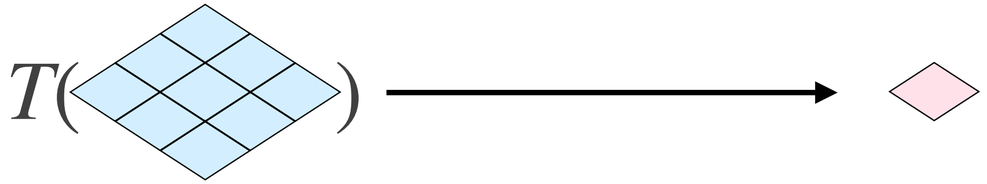

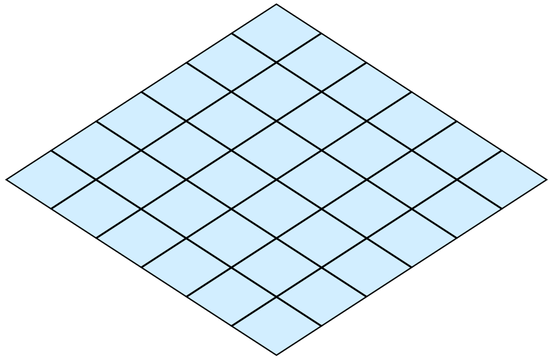

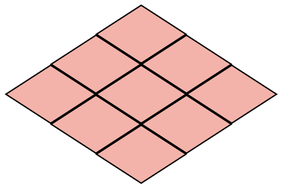

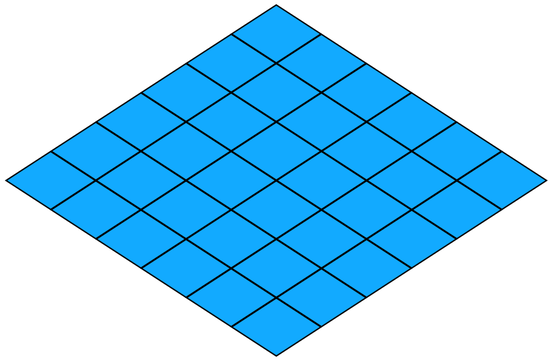

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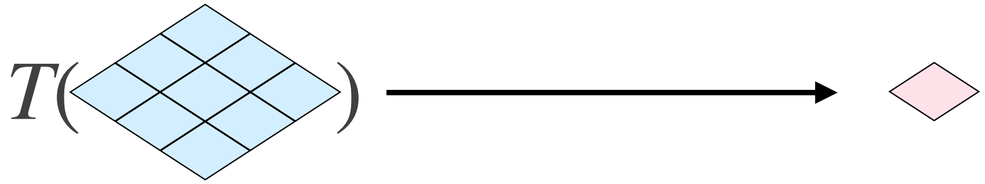

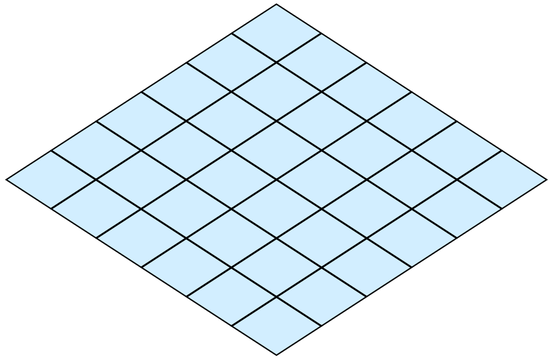

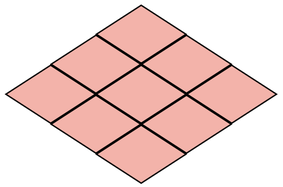

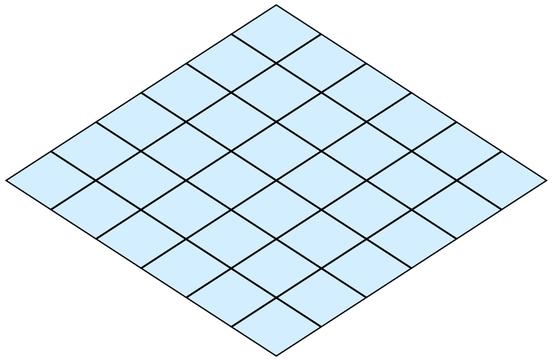

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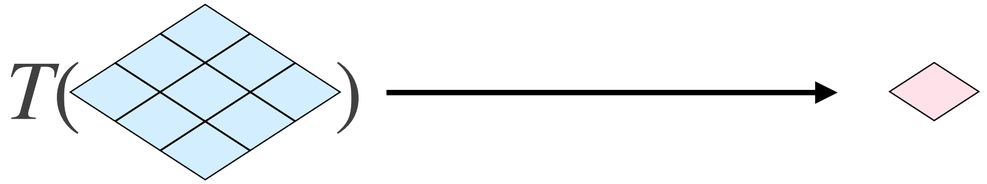

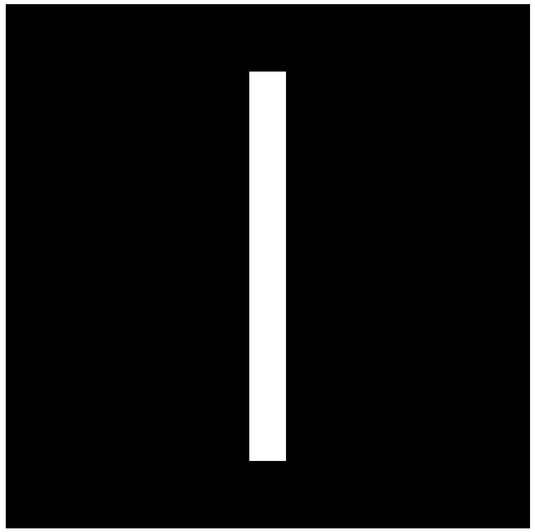

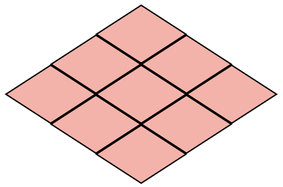

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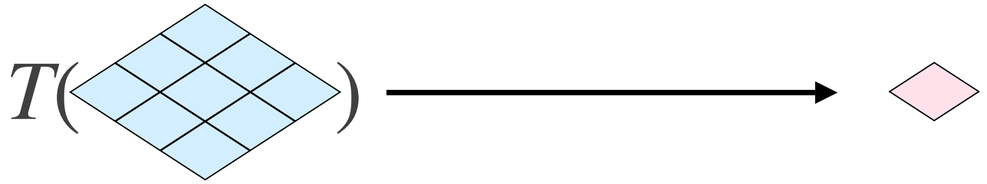
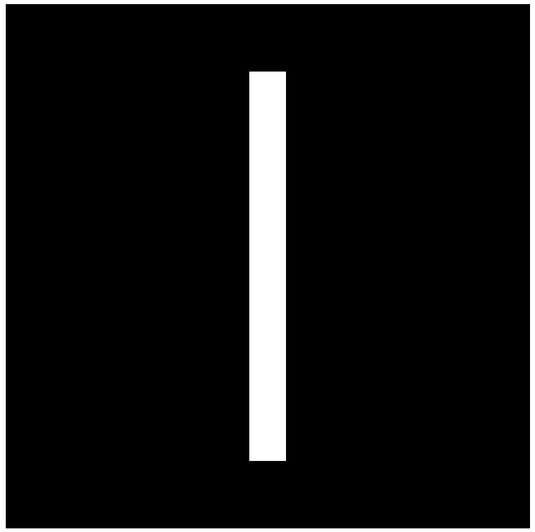
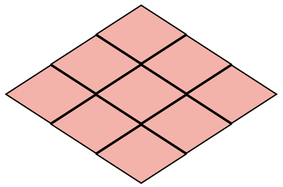
Filtros de Caixa

Filtros de Caixa







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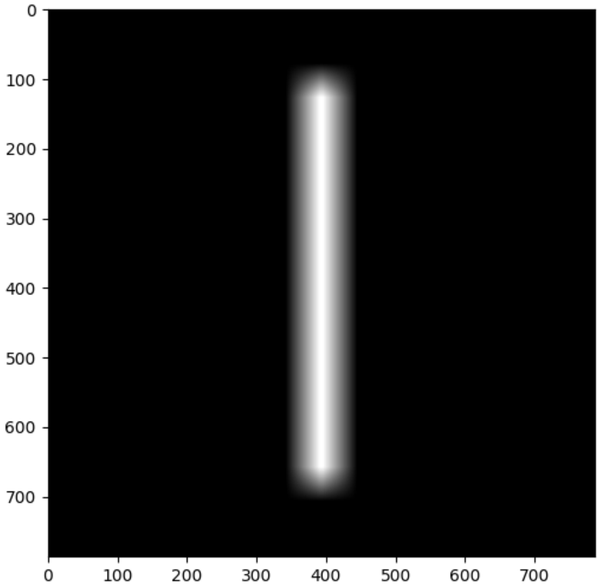

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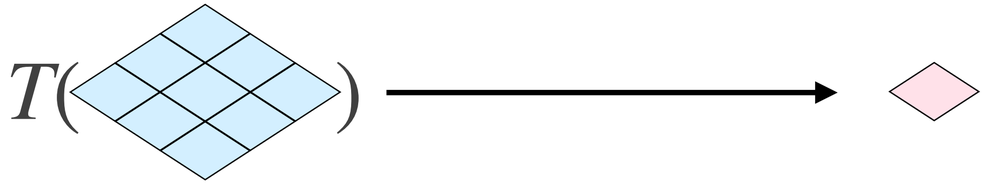

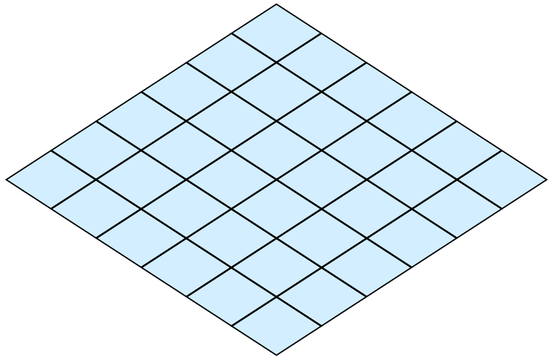

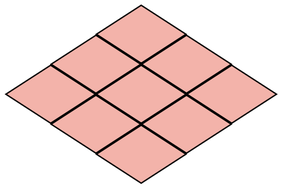

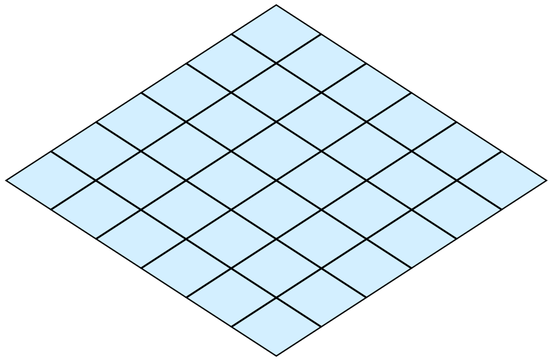

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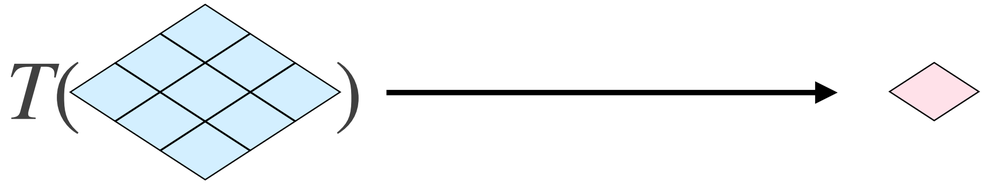

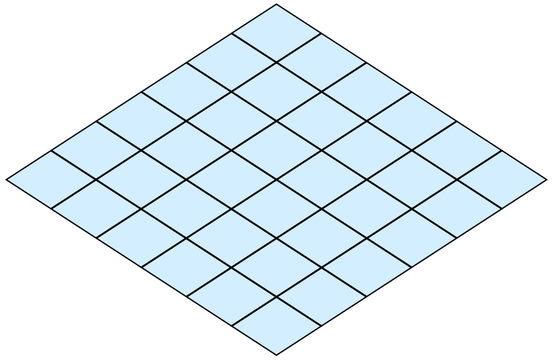

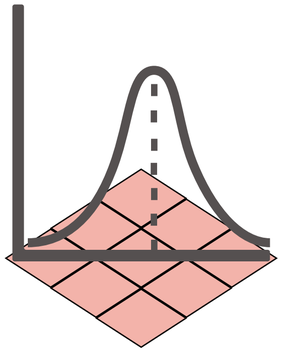

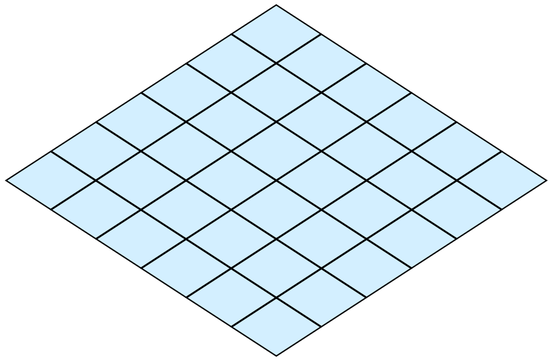

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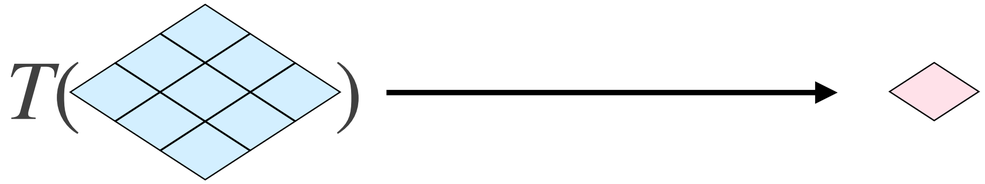

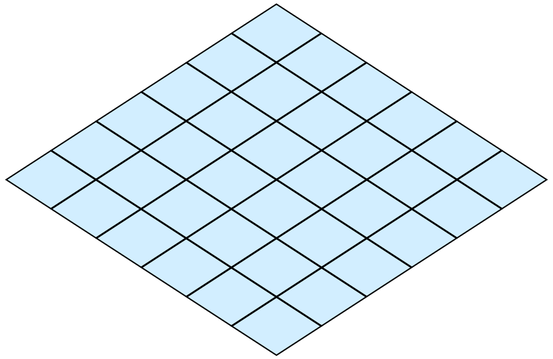

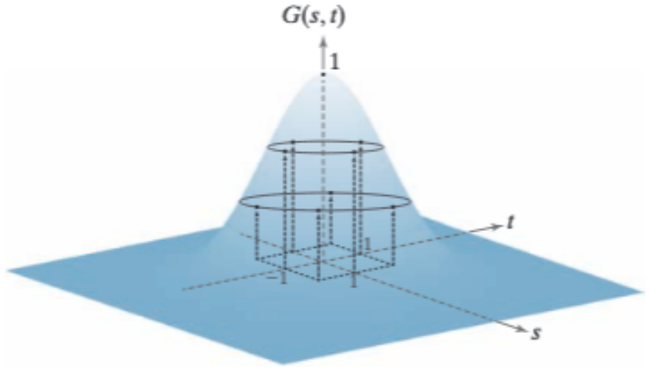

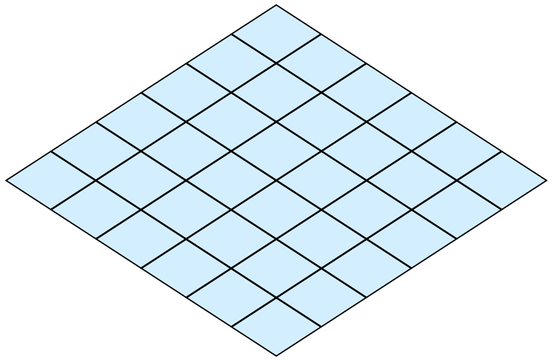

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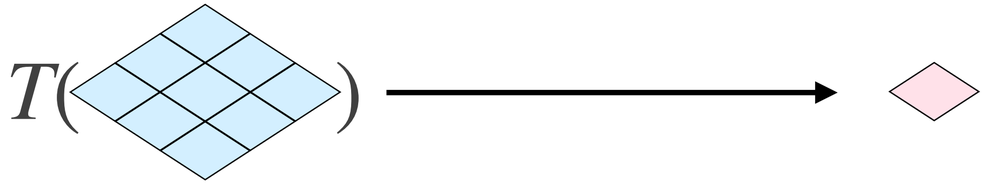
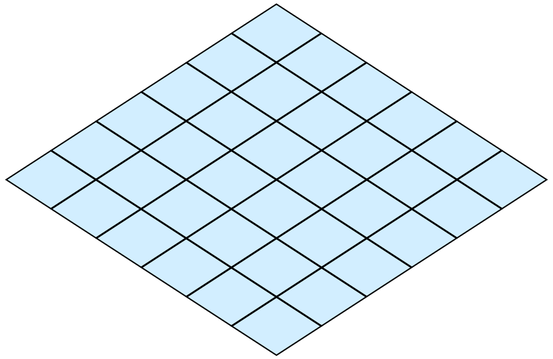
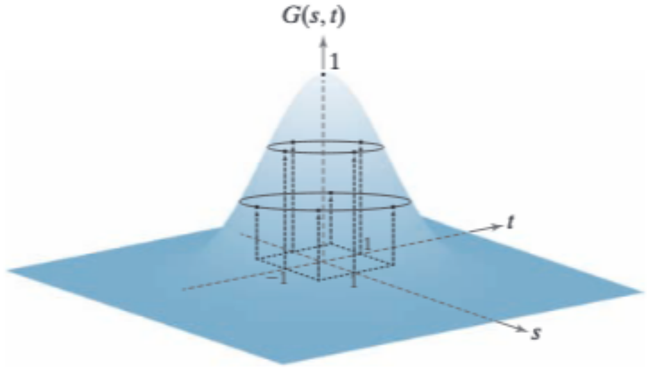
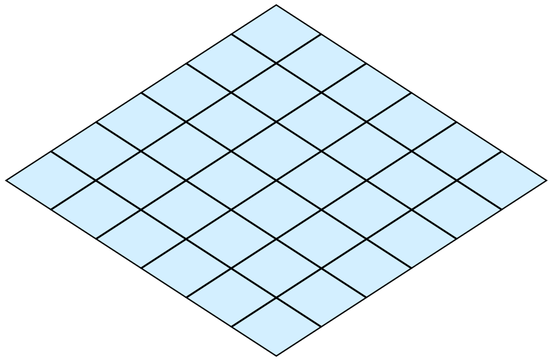
Filtros Gaussianos







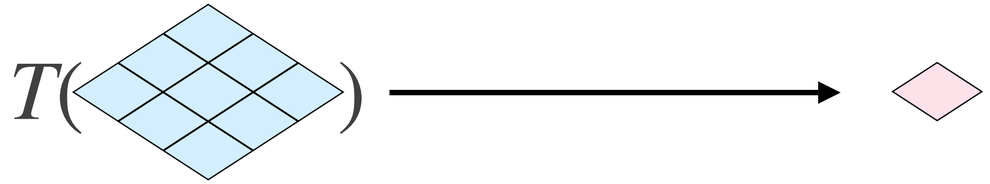


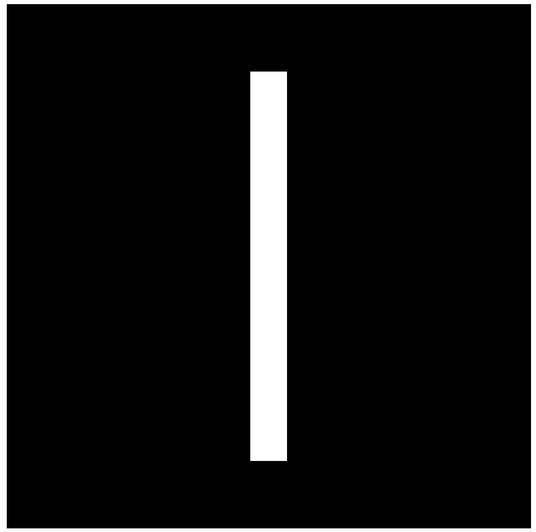
$$G_{1D}(x,\sigma) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}}$$

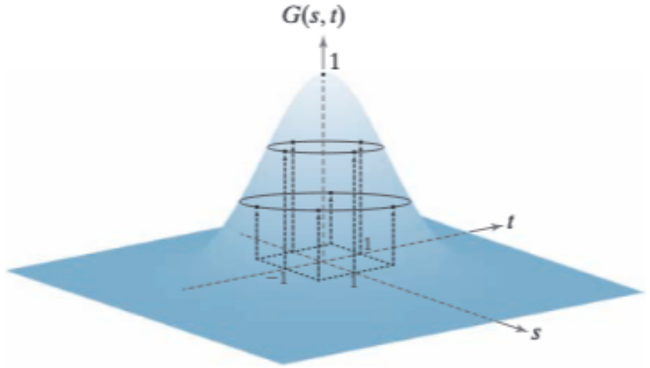
$$G_{2D}(x,y,\sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

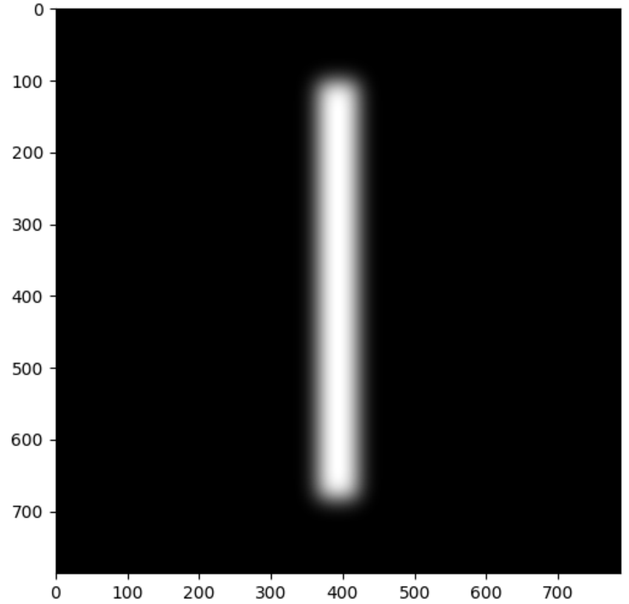
Filtros Gaussianos

Filtros de Caixa



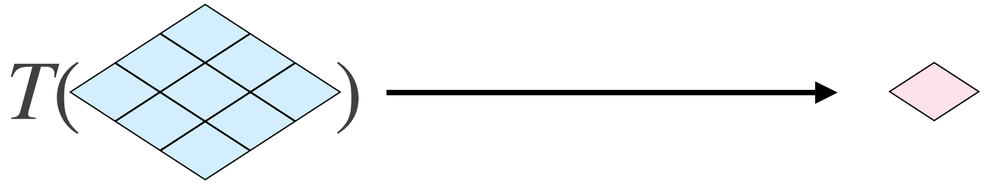


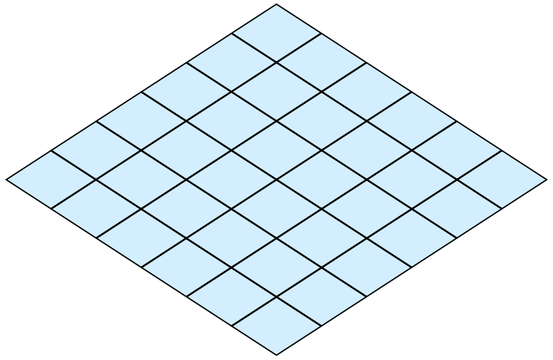


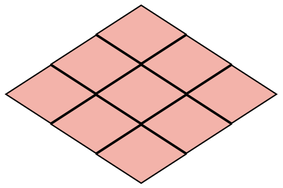


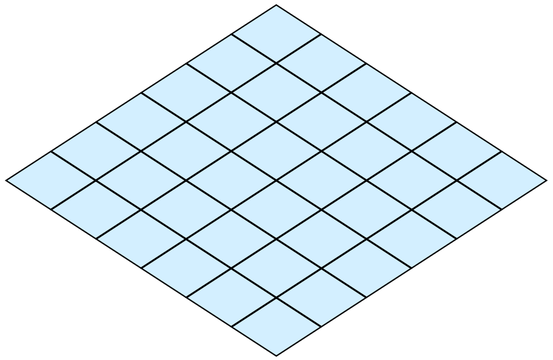
$$G_{2D}(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Filtros de Mediana









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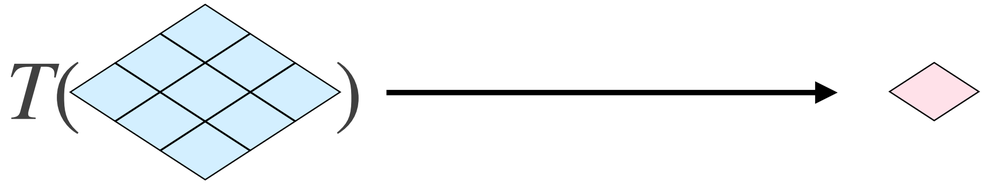
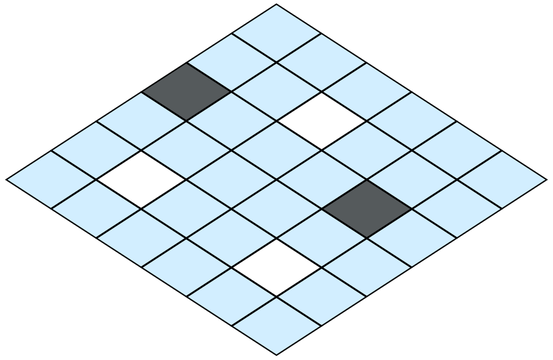
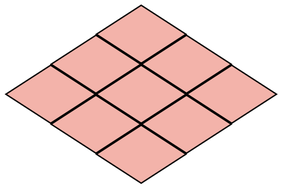
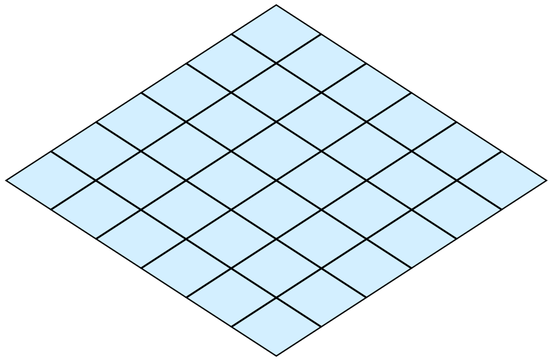
Filtros de Mediana









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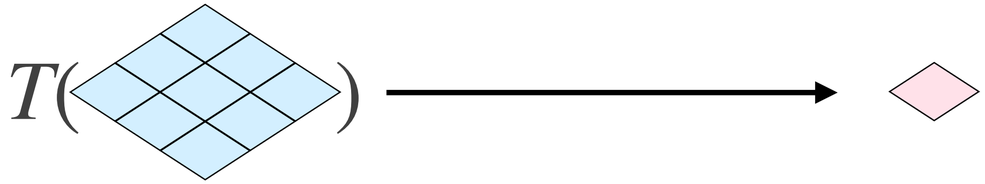
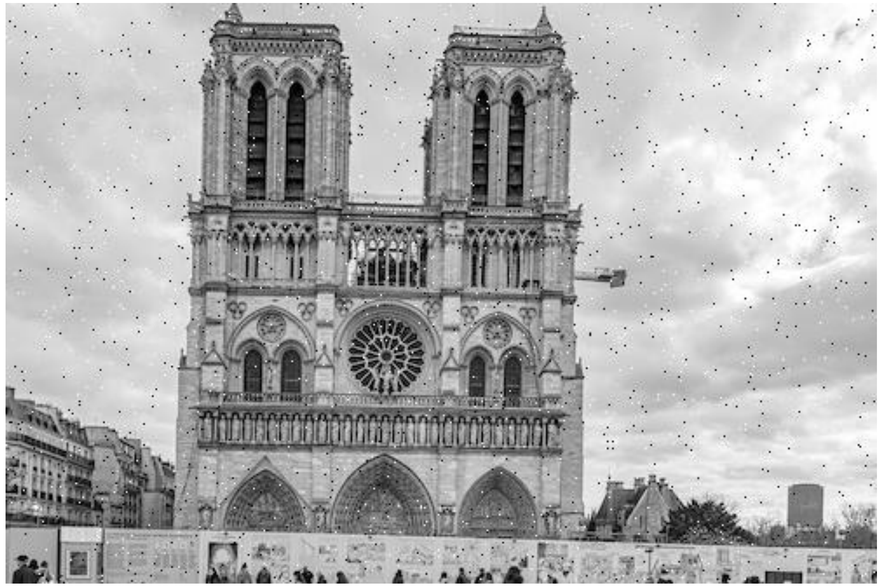
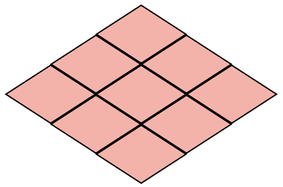
Filtros de Mediana

Filtros de Mediana







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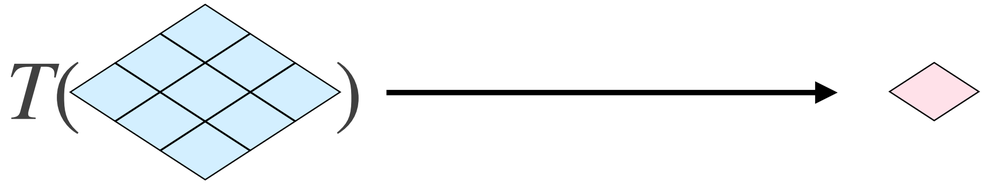
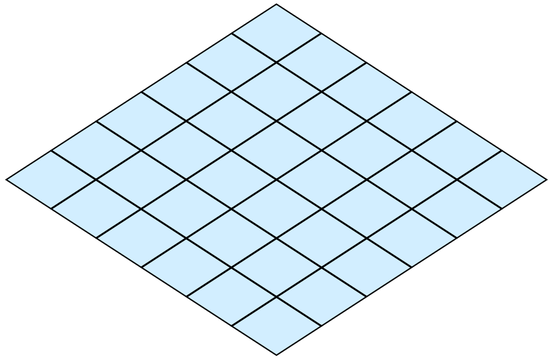
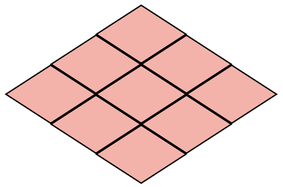
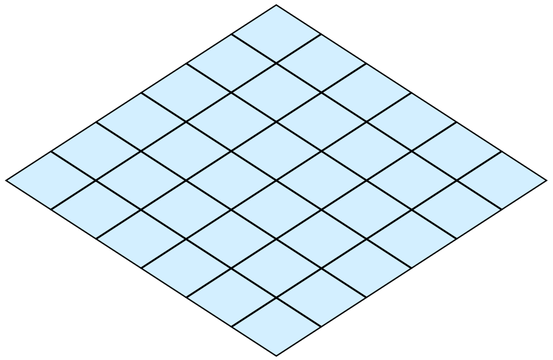
Filtros de Sharpening









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Derivadas Discretas

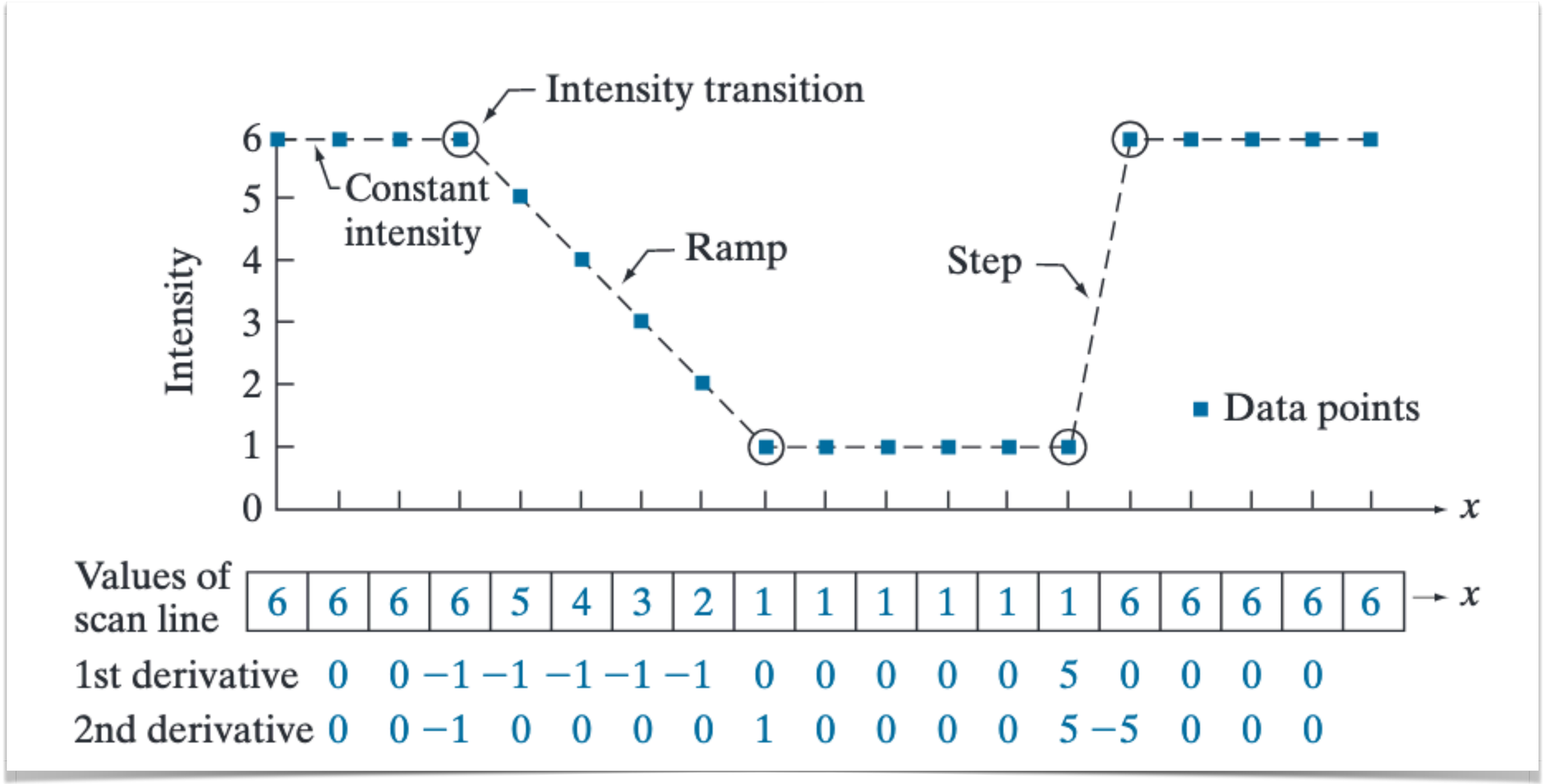
Derivada de 1ª Ordem

$$\frac{\partial f}{\partial x} = f(x+1) - f(x)$$

Derivada de 2ª Ordem

$$\frac{\partial^2 f}{\partial x^2} = f(x+1) + f(x-1) - 2f(x)$$

Derivadas Discretas



Derivadas Discretas

Operador Isotrópico: Laplace

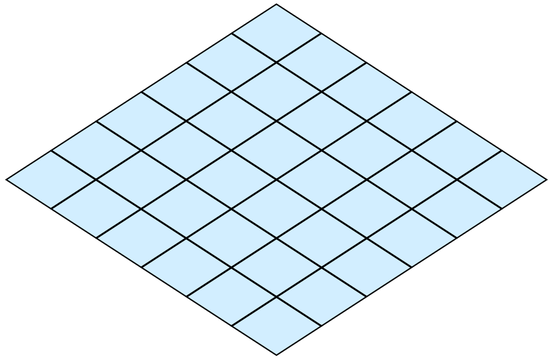
$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

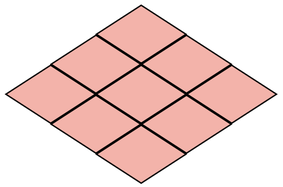
Aproximação discreta:

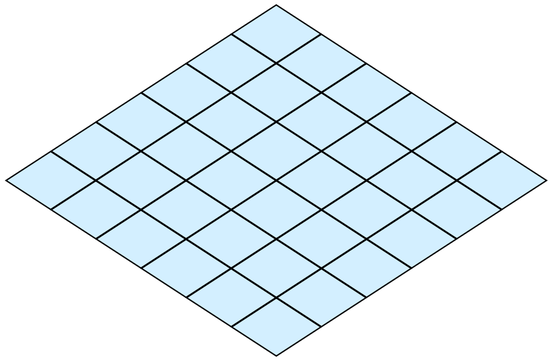
$$\nabla^2 f = f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) - 4f(x,y)$$

Filtros de Sharpening

$$\nabla^2 f = f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) - 4f(x,y)$$







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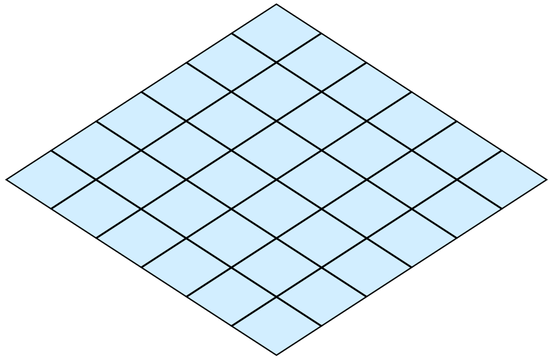
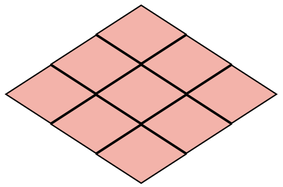
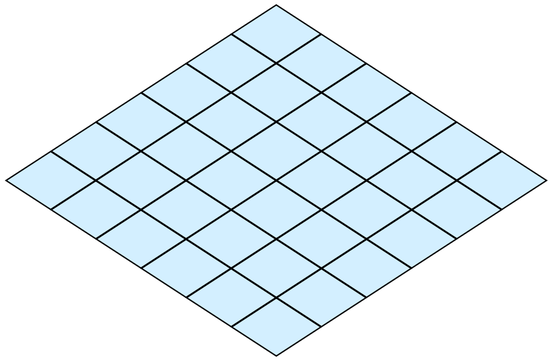
Filtros de Sharpening

$$\nabla^2 f = f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) - 4f(x,y)$$

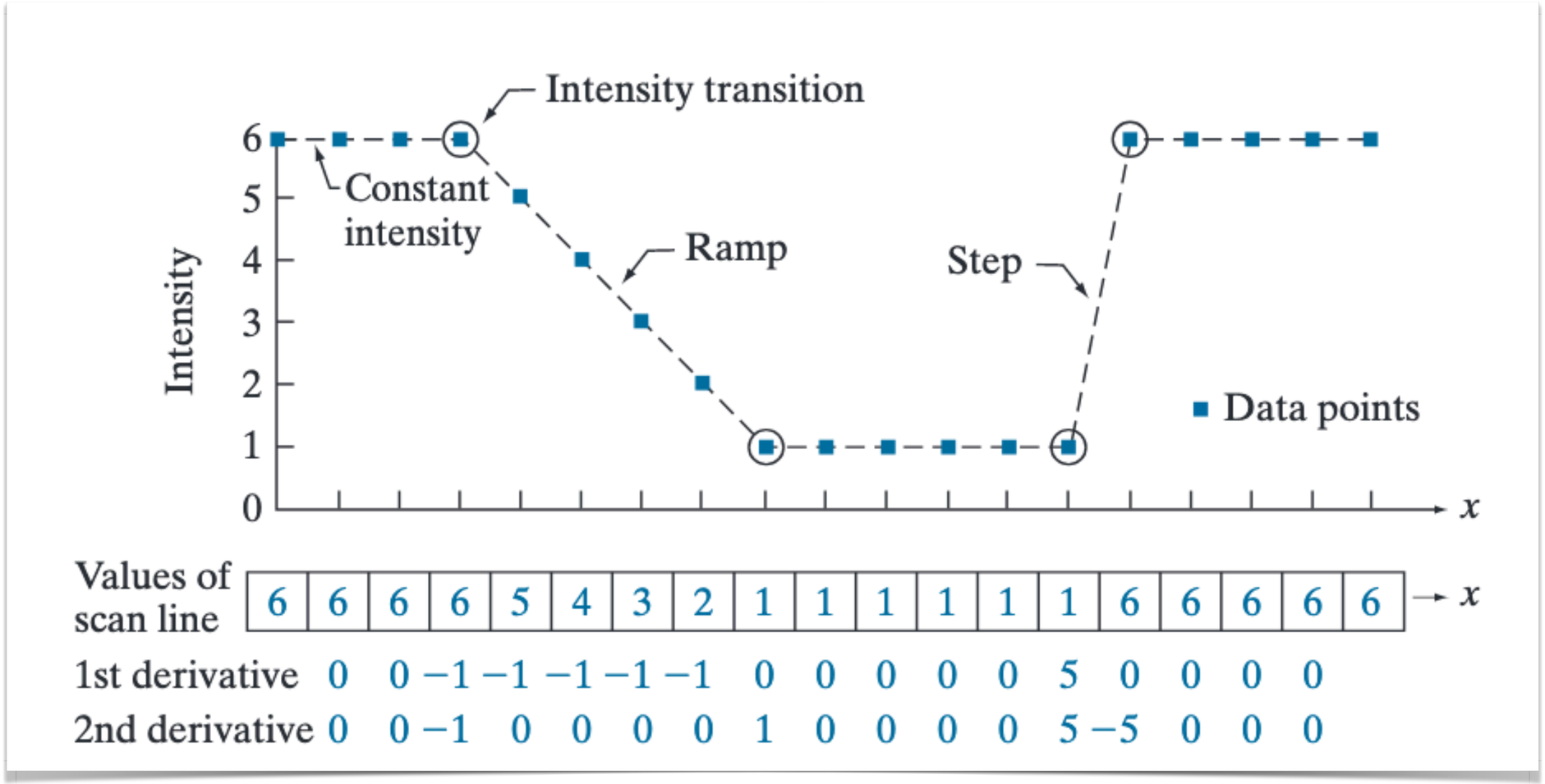






0	1	0
1	-4	1
0	1	0

Filtros de Sharpening

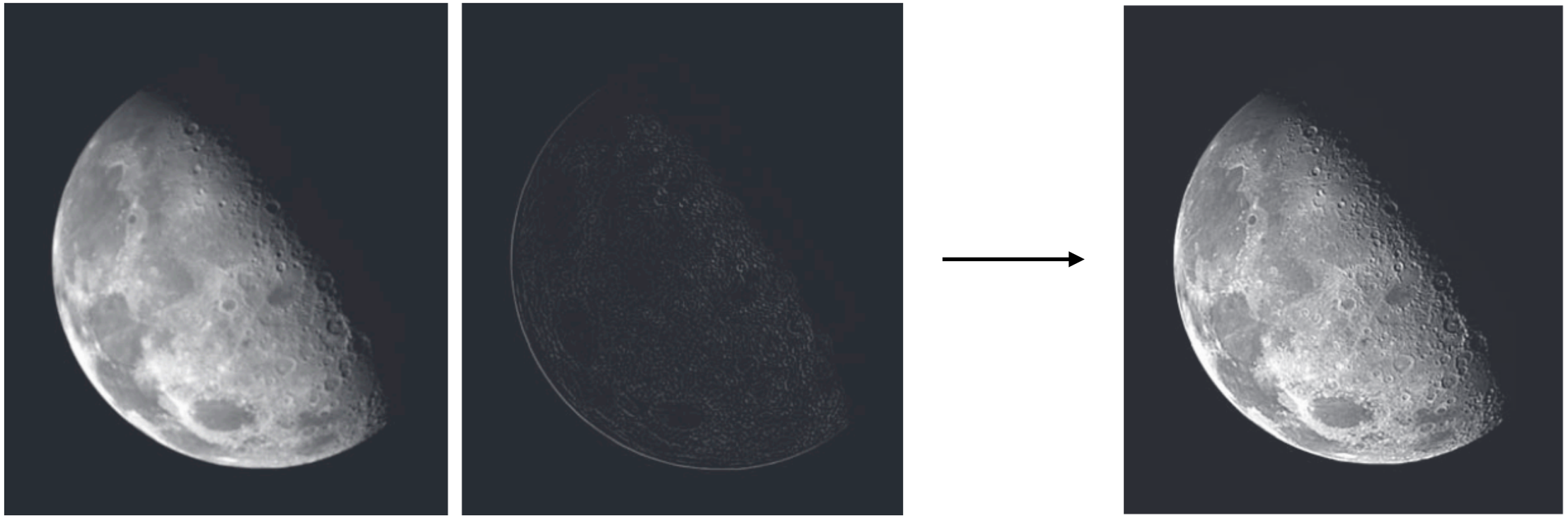


Values of scan line	6	6	6	6	5	4	3	2	1	1	1	1	1	1	6	6	6	6	6	x
1st derivative	0	0	−1	−1	−1	−1	−1	0	0	0	0	0	5	0	0	0	0			
2nd derivative	0	0	−1	0	0	0	0	1	0	0	0	0	5	−5	0	0	0			

Filtros de Sharpening

Desejamos então **adicionar as derivadas de segunda ordem na imagem**, aumentando a diferença nas bordas

$$g(x, y) = f(x, y) + c\,|\,\nabla^2 f(x, y)\,|$$



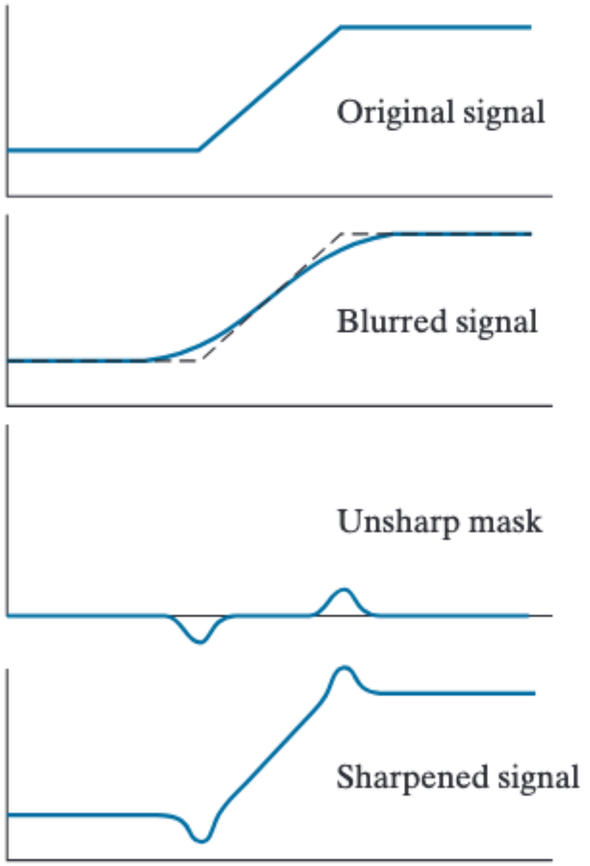
Filtros de Sharpening

Filtro com Máscara de Unsharpening

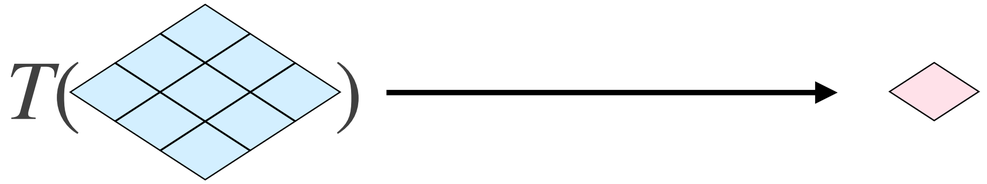
Ideia é usar diferença entre imagem suavizada e original para encontrar as bordas

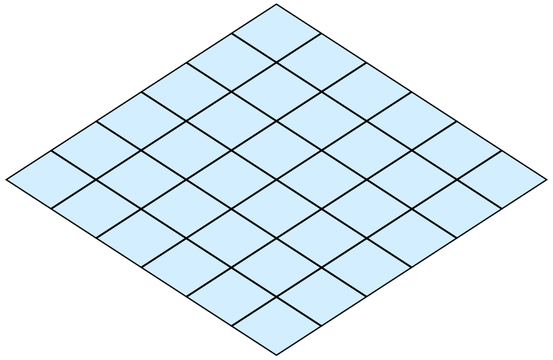
$$g_{mask} = f - \hat{f}$$

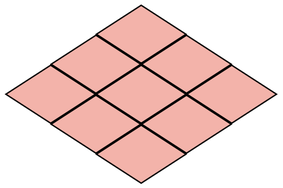
$$g(x, y) = f(x, y) + k g_{mask}(x, y)$$

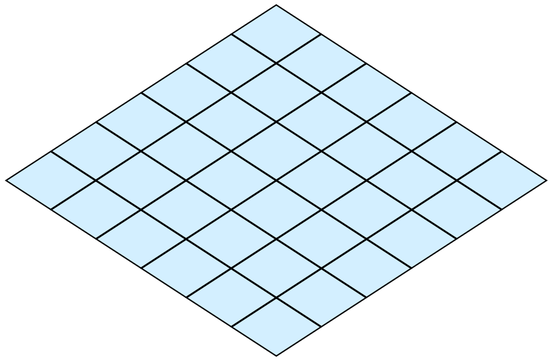


Filtro de Gradiente









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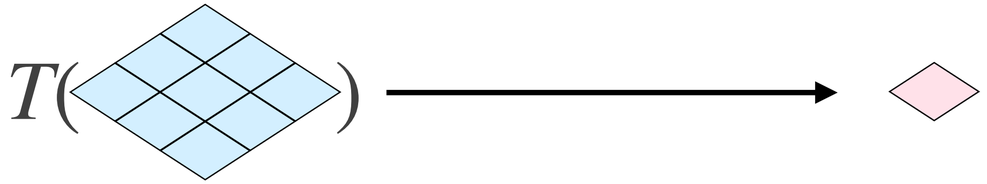
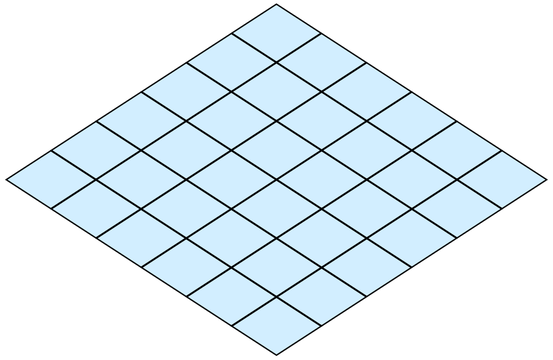
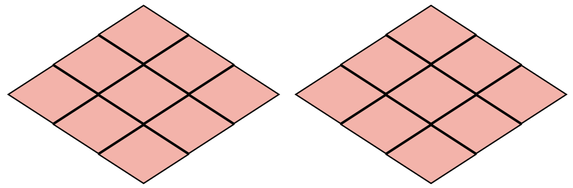
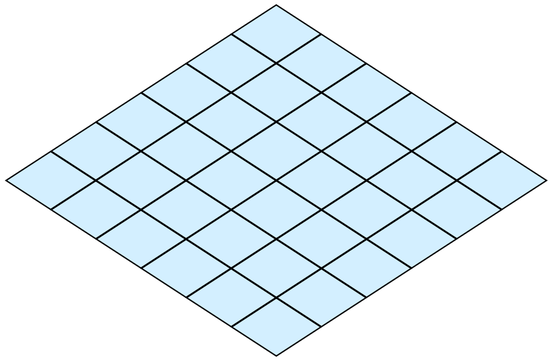
Filtro de Sobel







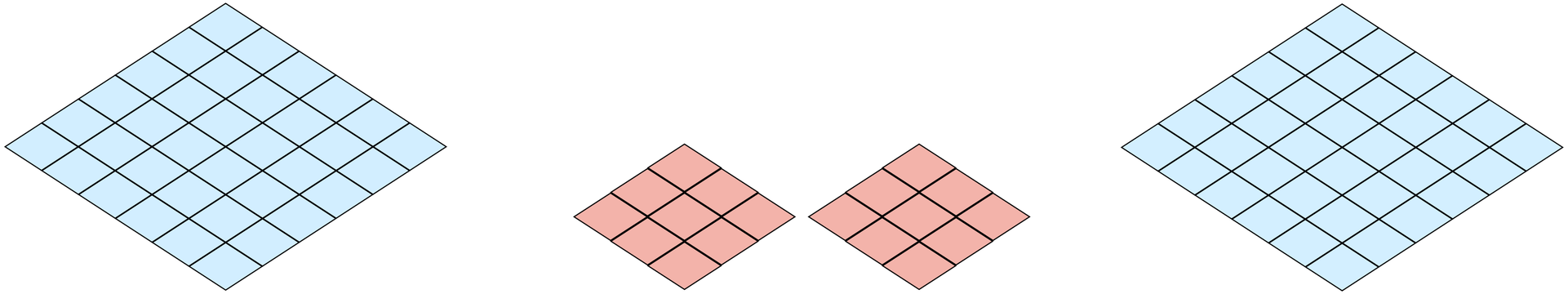


-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

Filtro de Sobel

$$M(\nabla_f) = \sqrt{g_x^2 + g_y^2}$$



-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

Filtros de Sobel