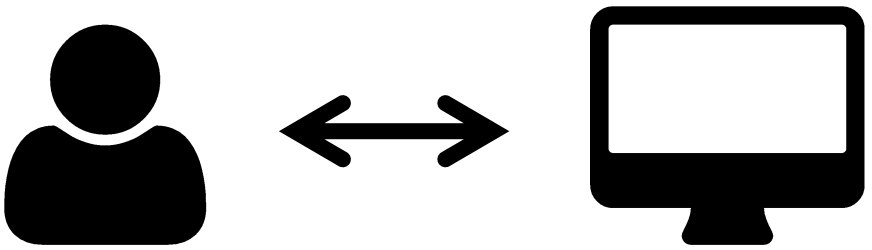
Képjavítás 02

Számítógépes látórendszerek

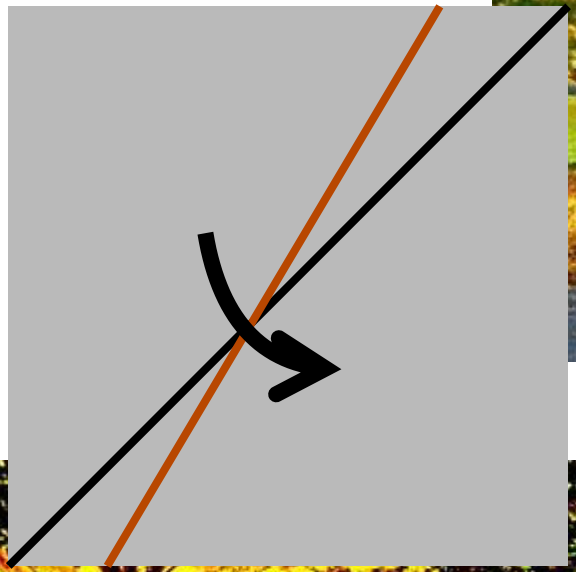
Dr. Szemenyei Márton
Adjunktus
2022

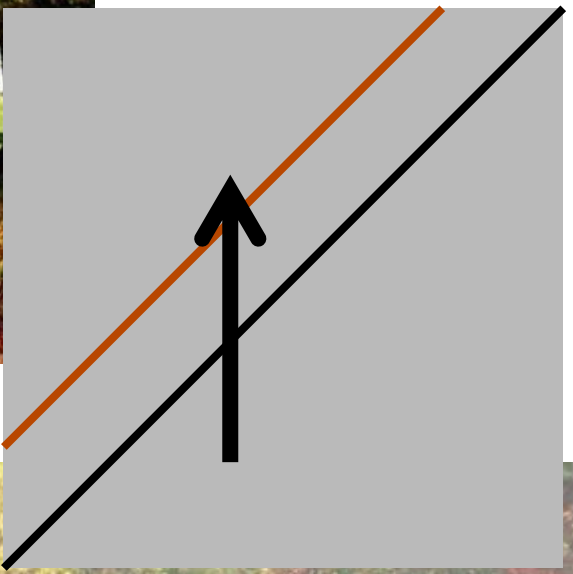
Célok



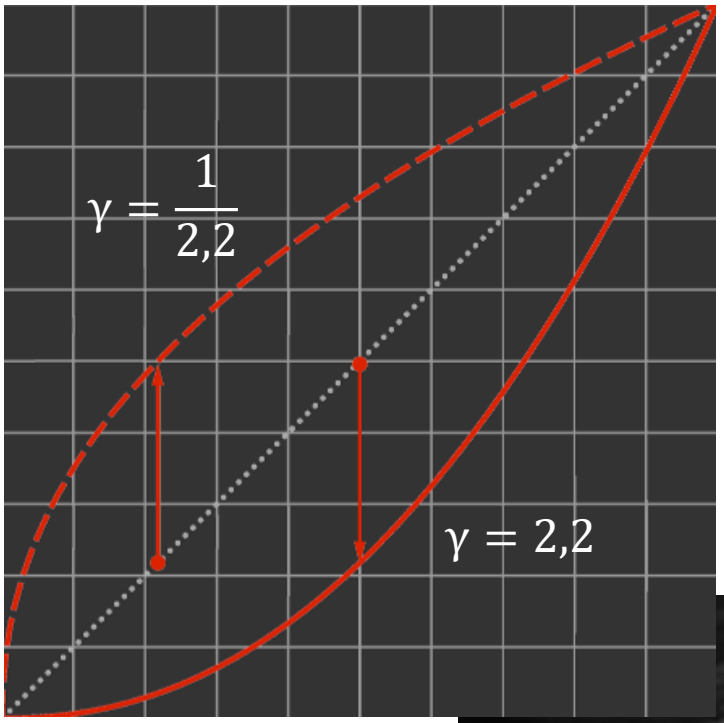
Más jó az ember, és más az algoritmus számára

Kontraszt, fényesség



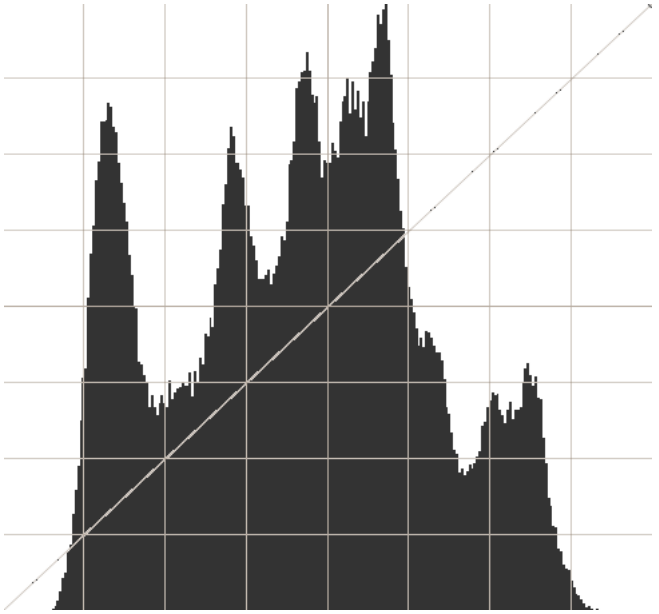


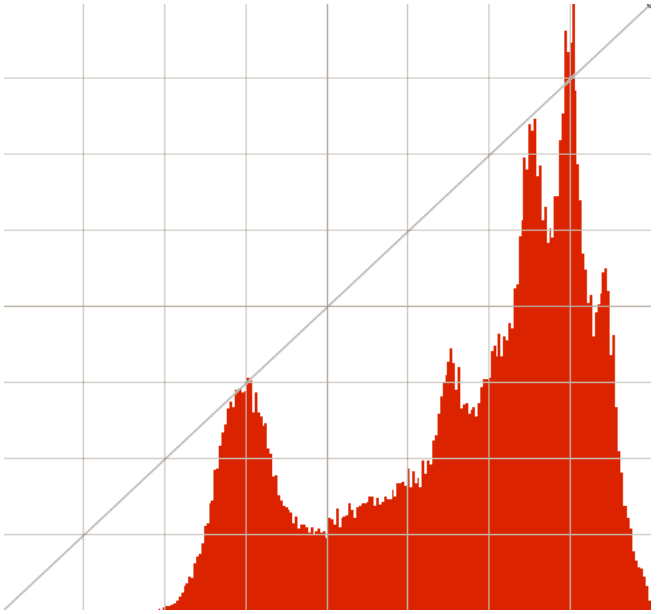
Gamma korrekció

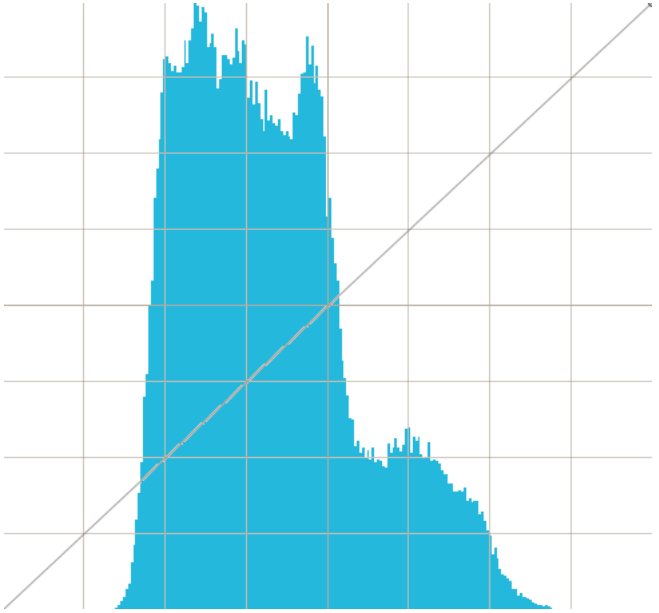


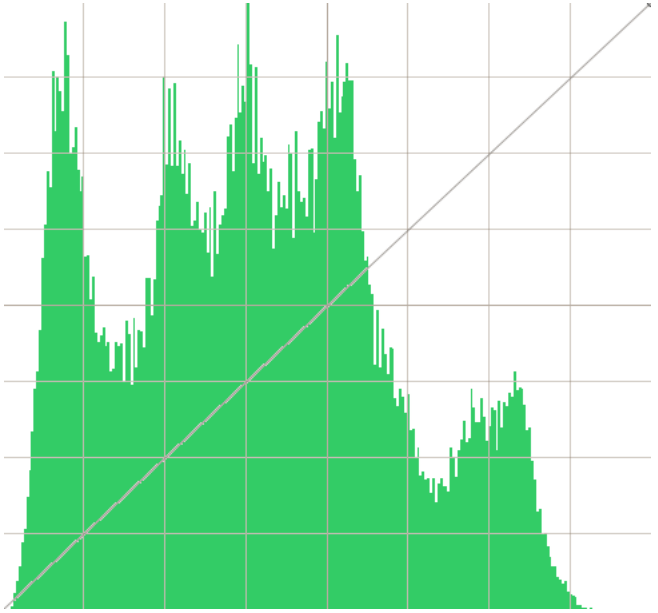
$$I = V_s^{\gamma}$$

Hisztogram

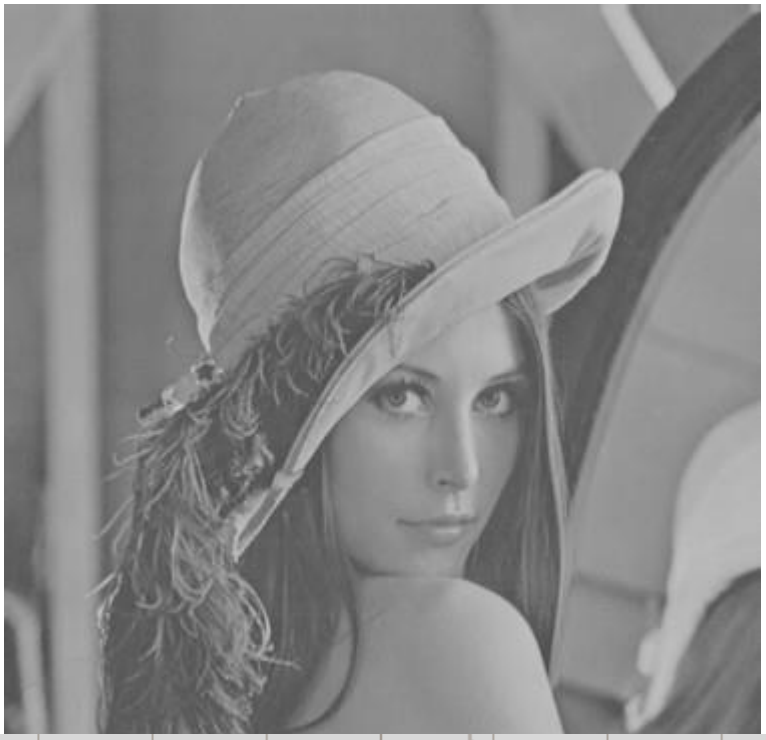


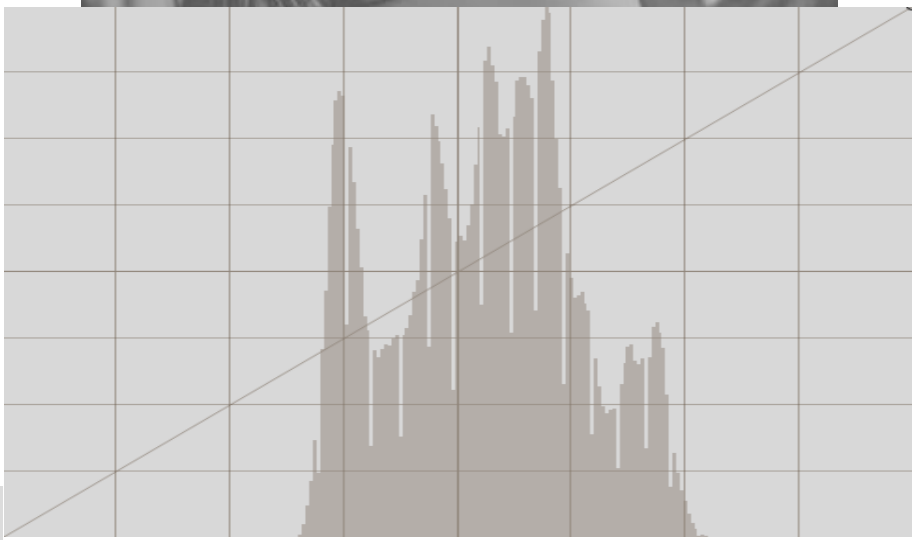


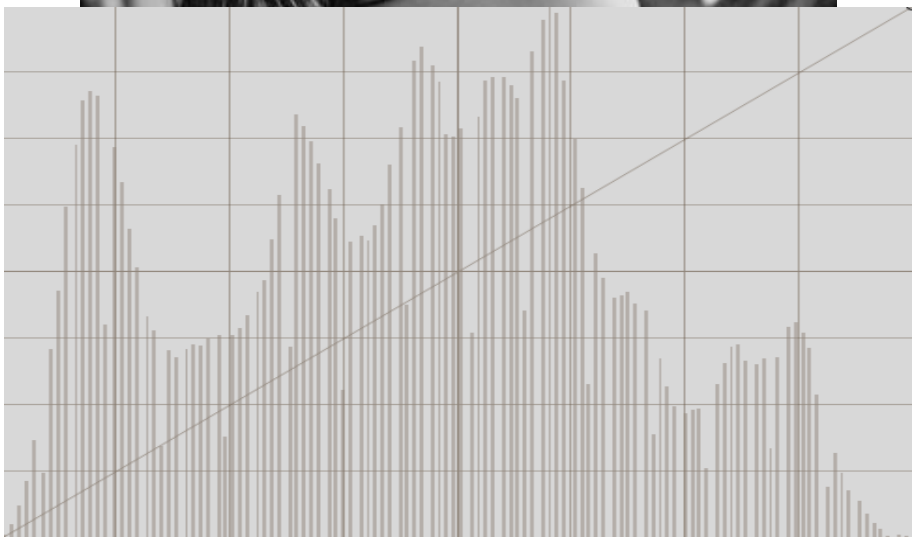




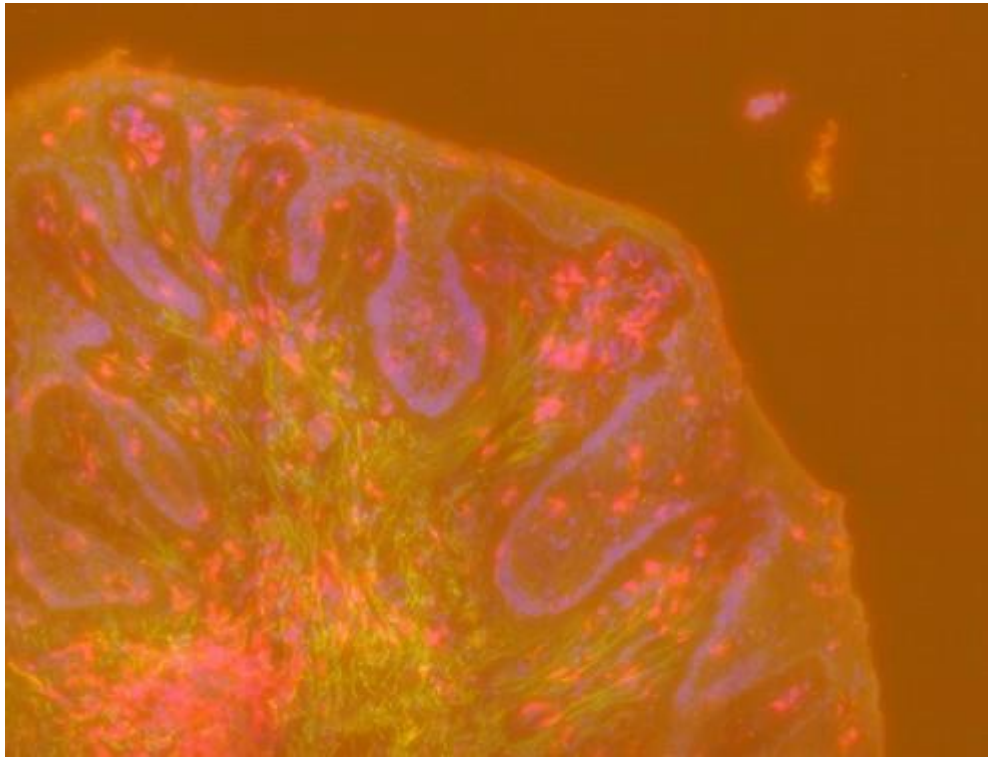
Hisztogramtranszformáció

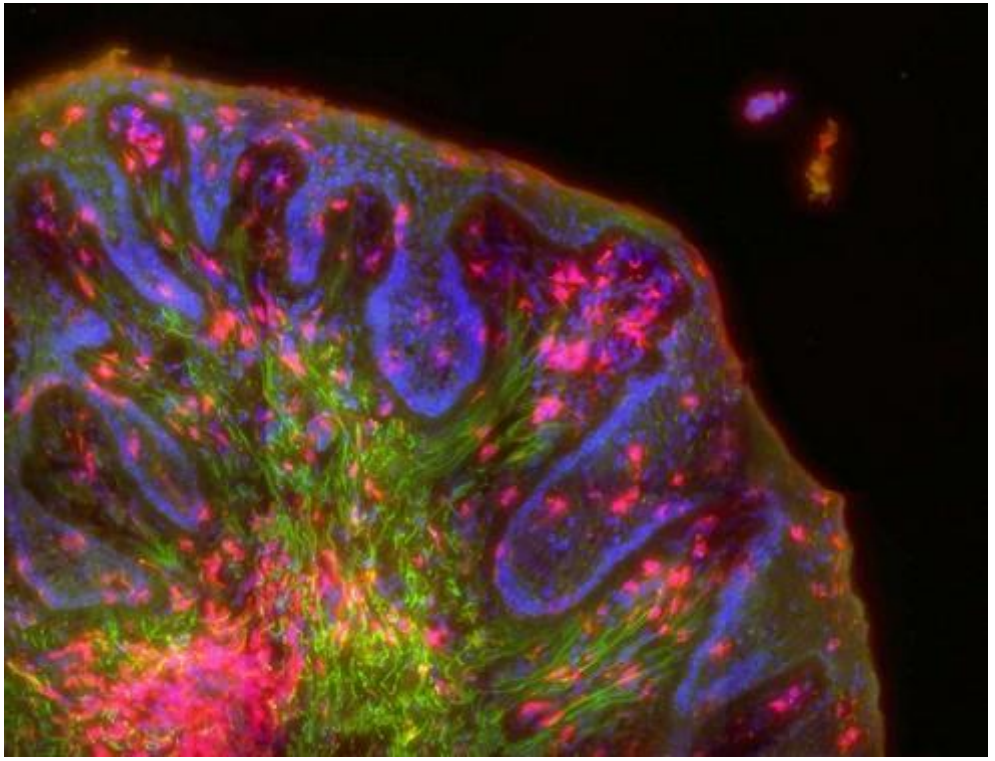




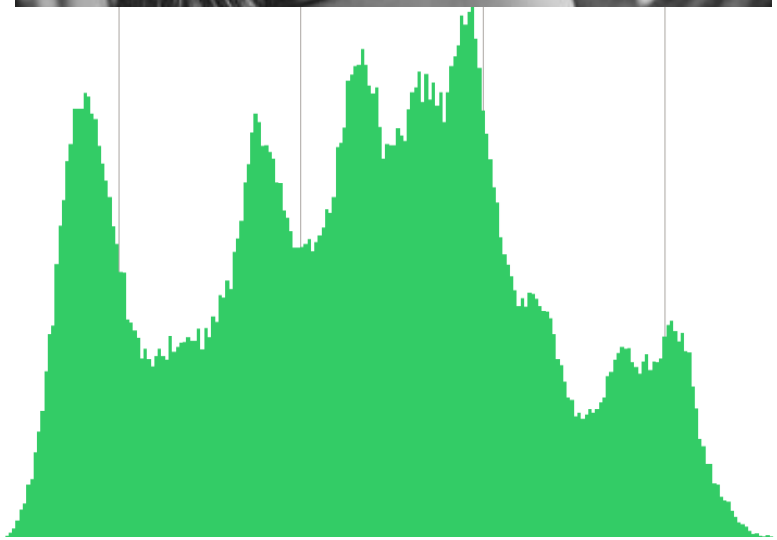


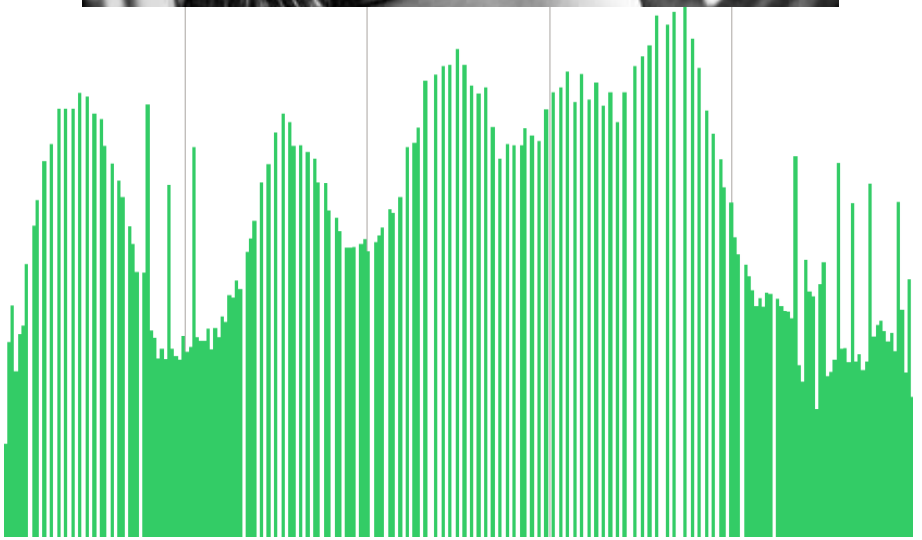
Hisztogramtranszformáció



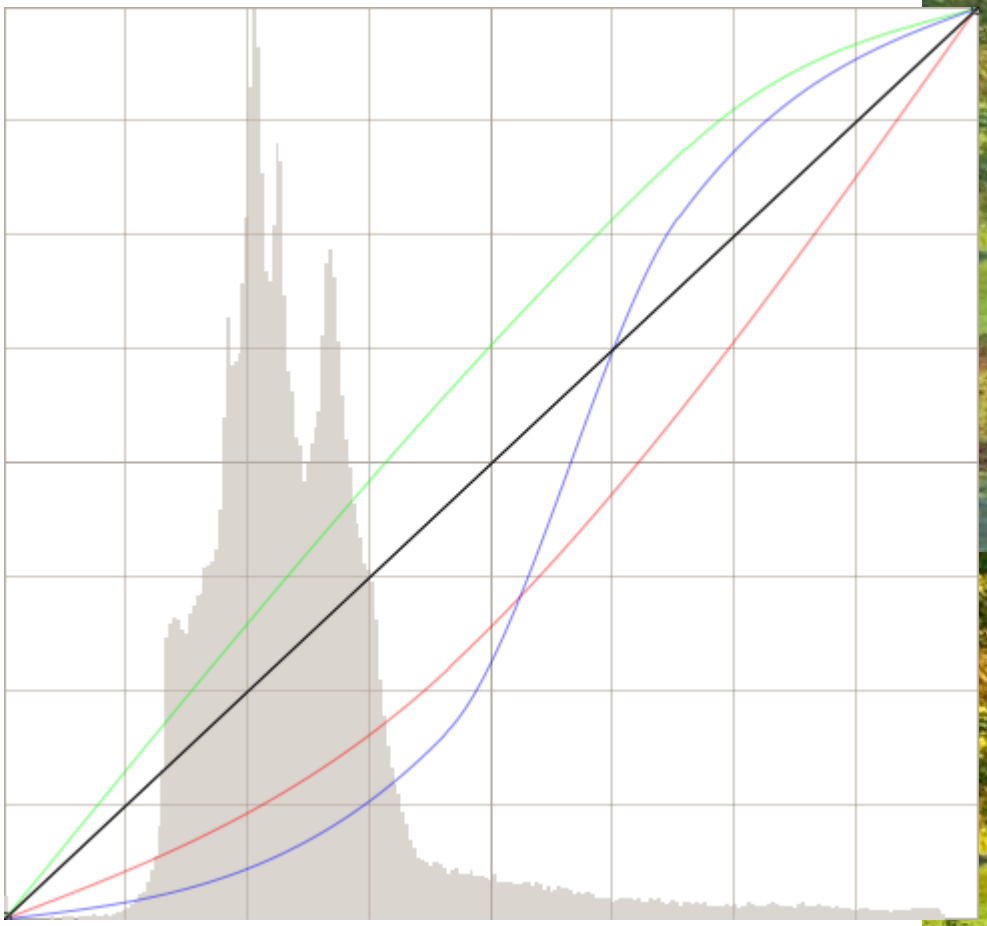


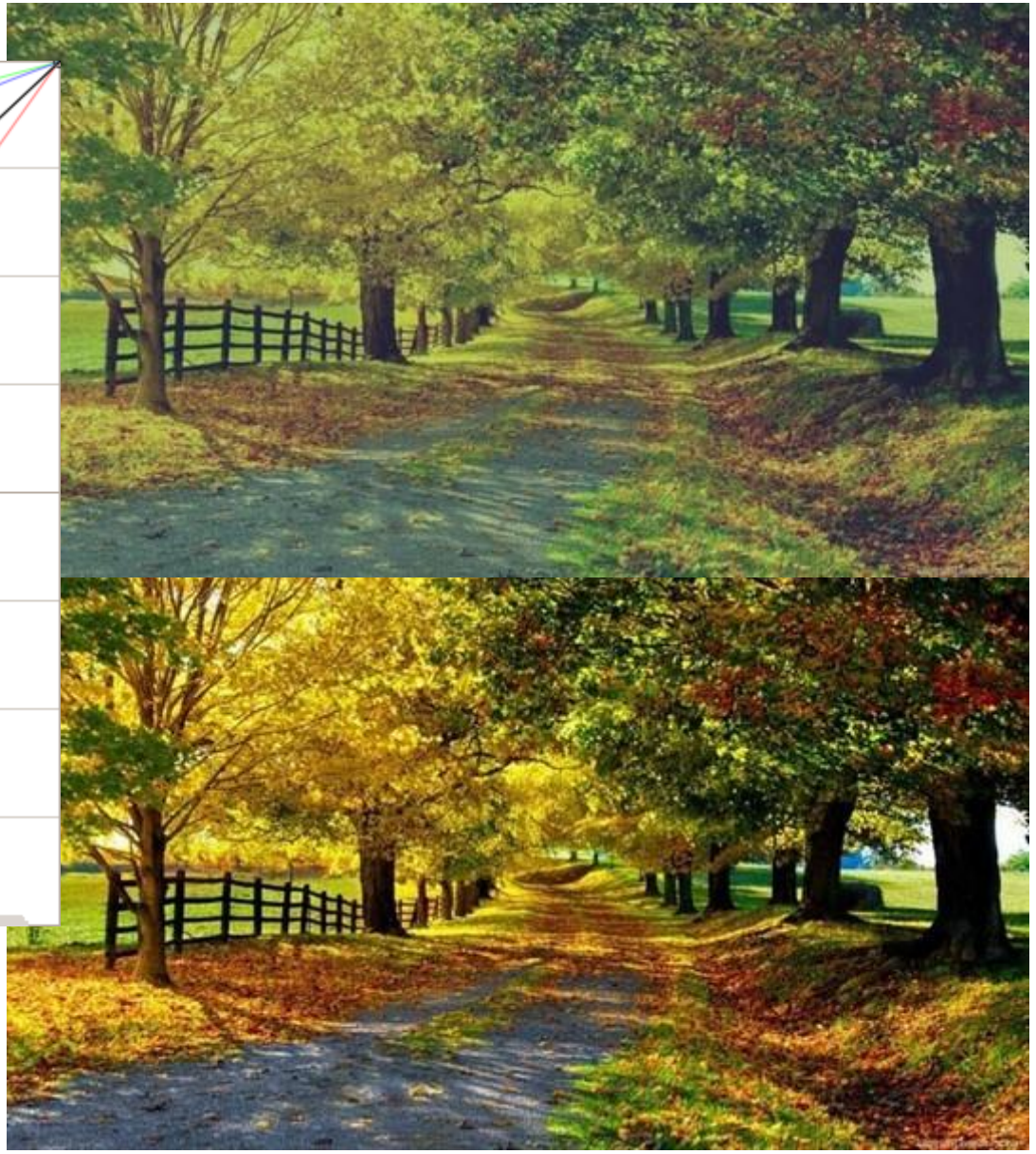
Hisztogramkiegyenlítés

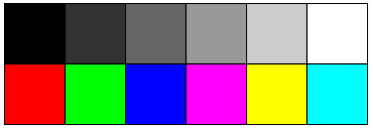




Színkorrekció



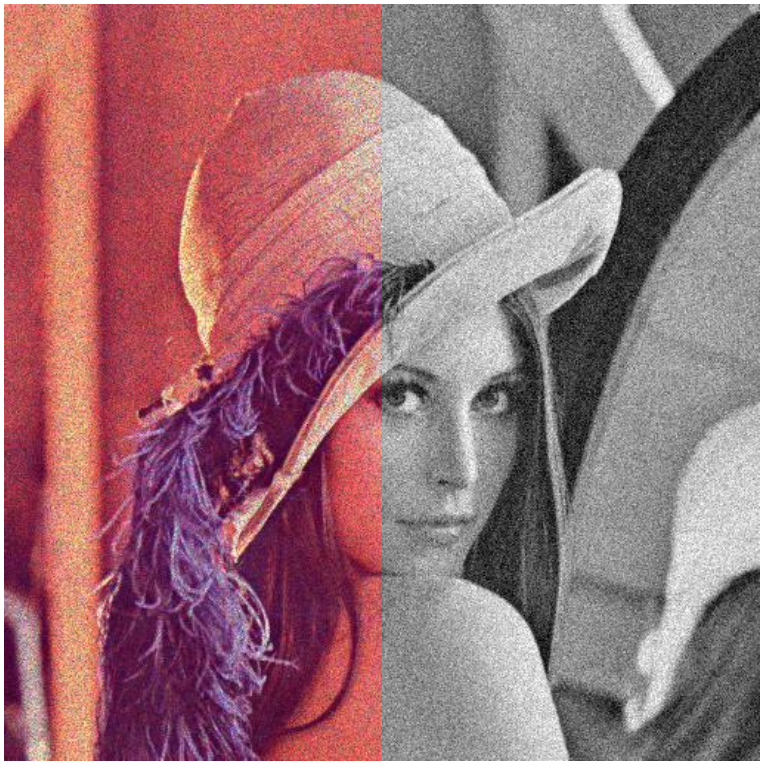




Képzajok

Gauss zaj

Só-bors zaj

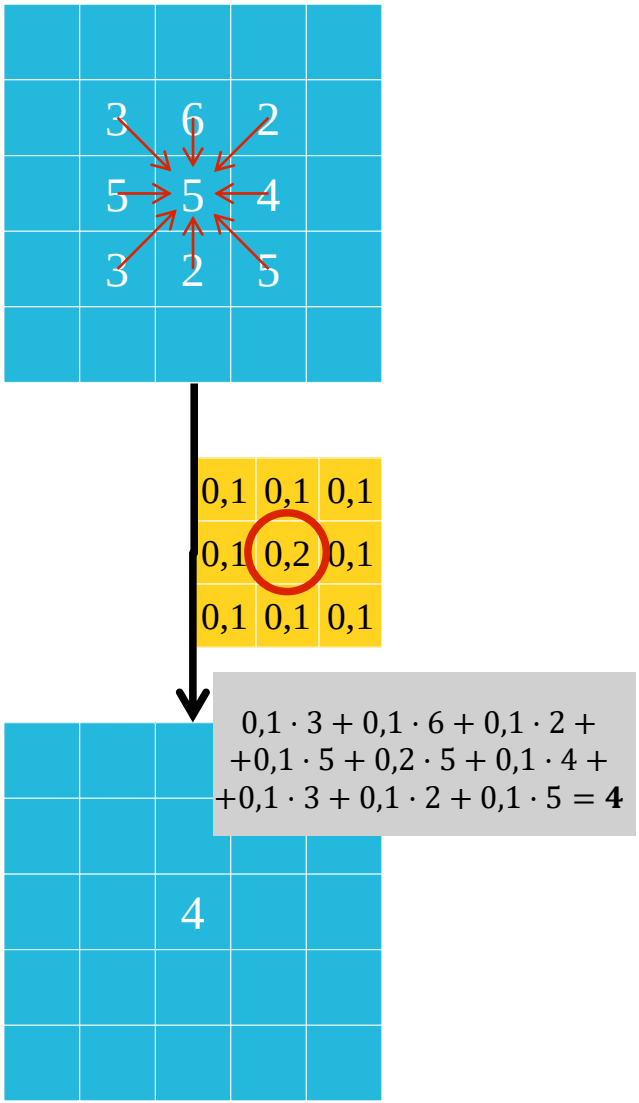


Konvolúció

$$I_o = k * I_i$$

$$(k * I)(x, y) = \sum_{u=-n}^{n} \sum_{v=-n}^{n} k\,(u, v) \cdot I(x - u, y - v)$$

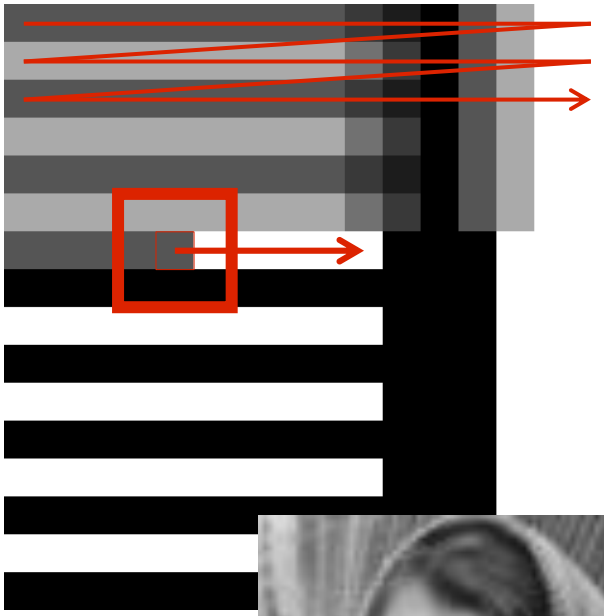
$$(f * g)(x, y) = \sum_{u=-\infty}^{\infty} \sum_{v=-\infty}^{\infty} f\,(u, v) \cdot g(x - u, y - v)$$



Egyszerű átlagolás

$$p'_{x,y} = \frac{\sum_{u=-1}^{1}\sum_{v=-1}^{1} I\,(x-u, y-v)}{9}$$

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$



$$p'_{x,y} = \frac{\sum_{u=-n}^{n}\sum_{v=-n}^{n} I\,(x-u, y-v)}{(2n+1)^2}$$

$$p'_{x,y} = \frac{\sum_{u=-n}^{n}\sum_{v=-n}^{n} k_{u,v} \cdot I(x-u, y-v)}{\sum_{u=-n}^{n}\sum_{v=-n}^{n} k_{u,v}}$$

$$\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

FPGA!

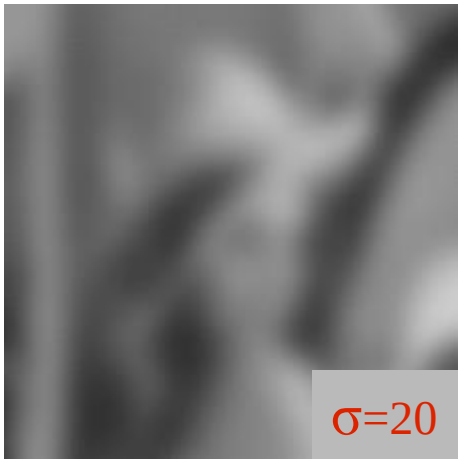
Gauss szűrés

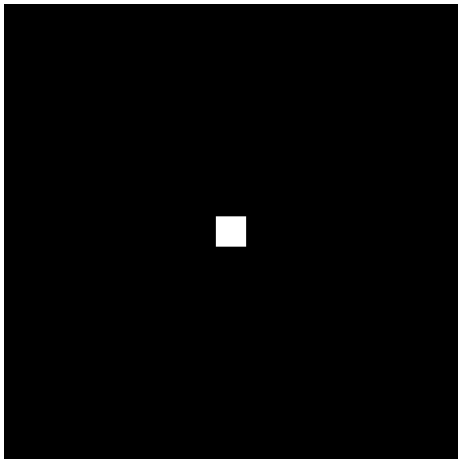
$$k(x, y, \sigma) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\left(\frac{x^2+y^2}{2\sigma^2}\right)}$$

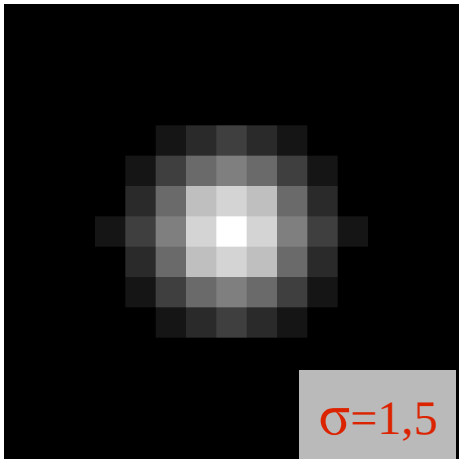
$$\begin{bmatrix} 1 & 4 & 1 \\ 4 & 16 & 4 \\ 1 & 4 & 1 \end{bmatrix}$$

$\sigma = 0{,}6$

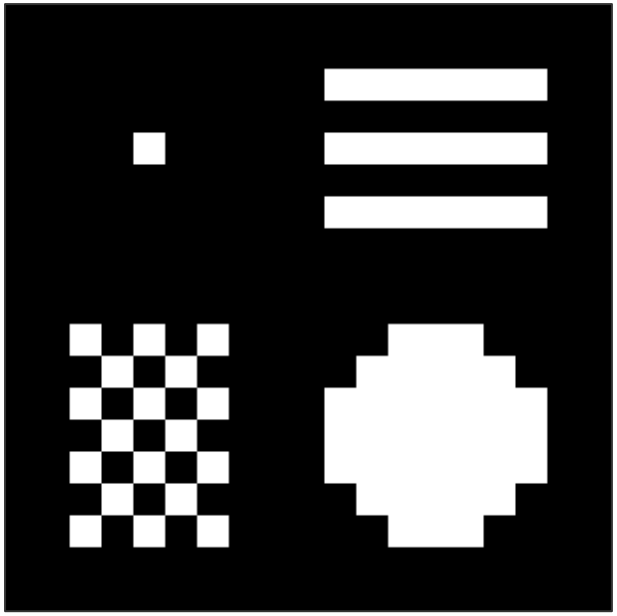
Kernelméret: 3σ

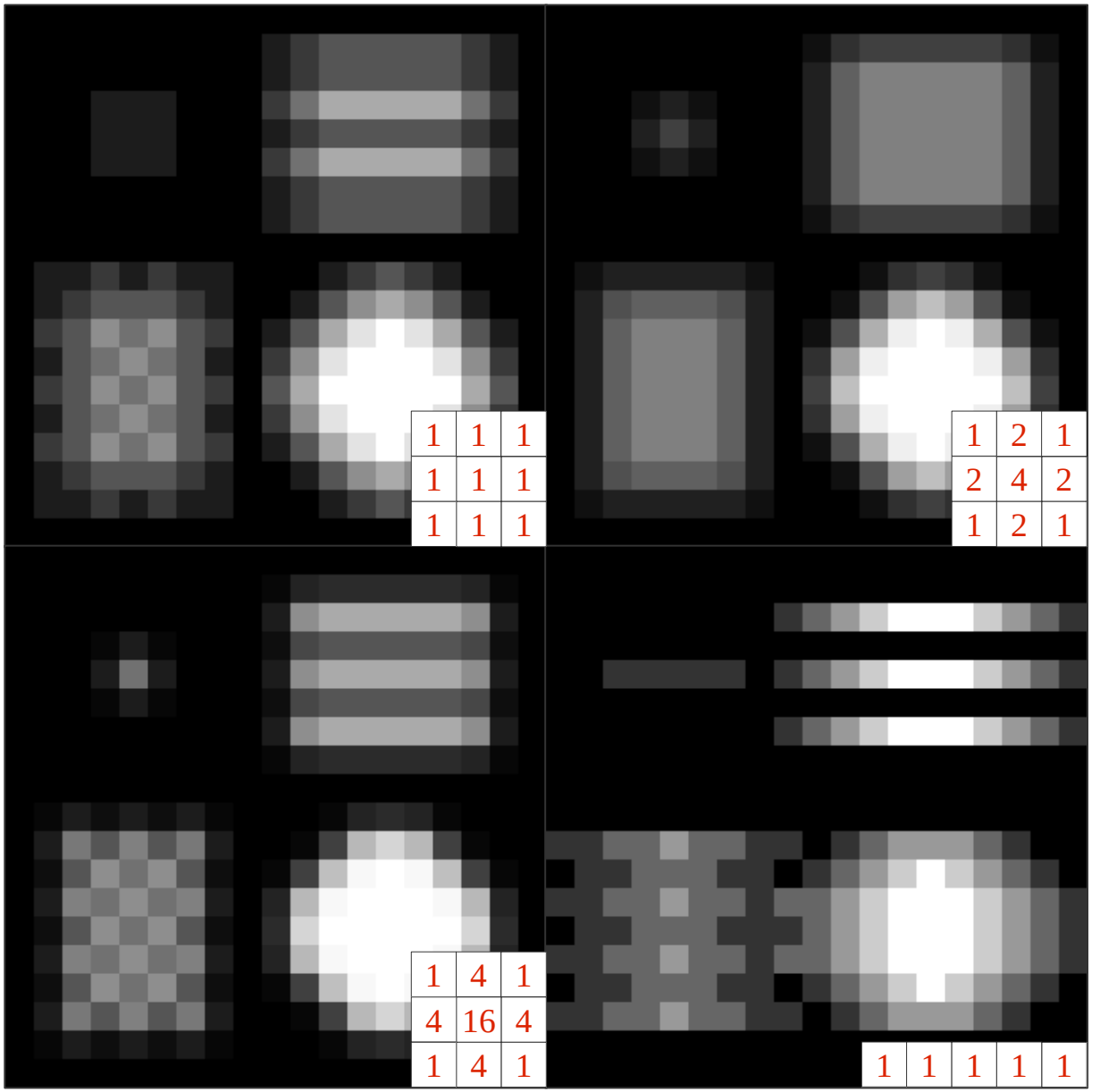




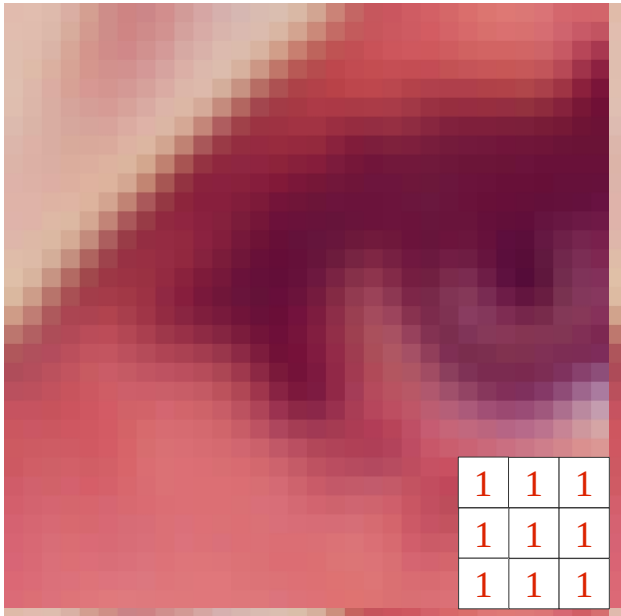


Simító szűrők





Simító szűrők



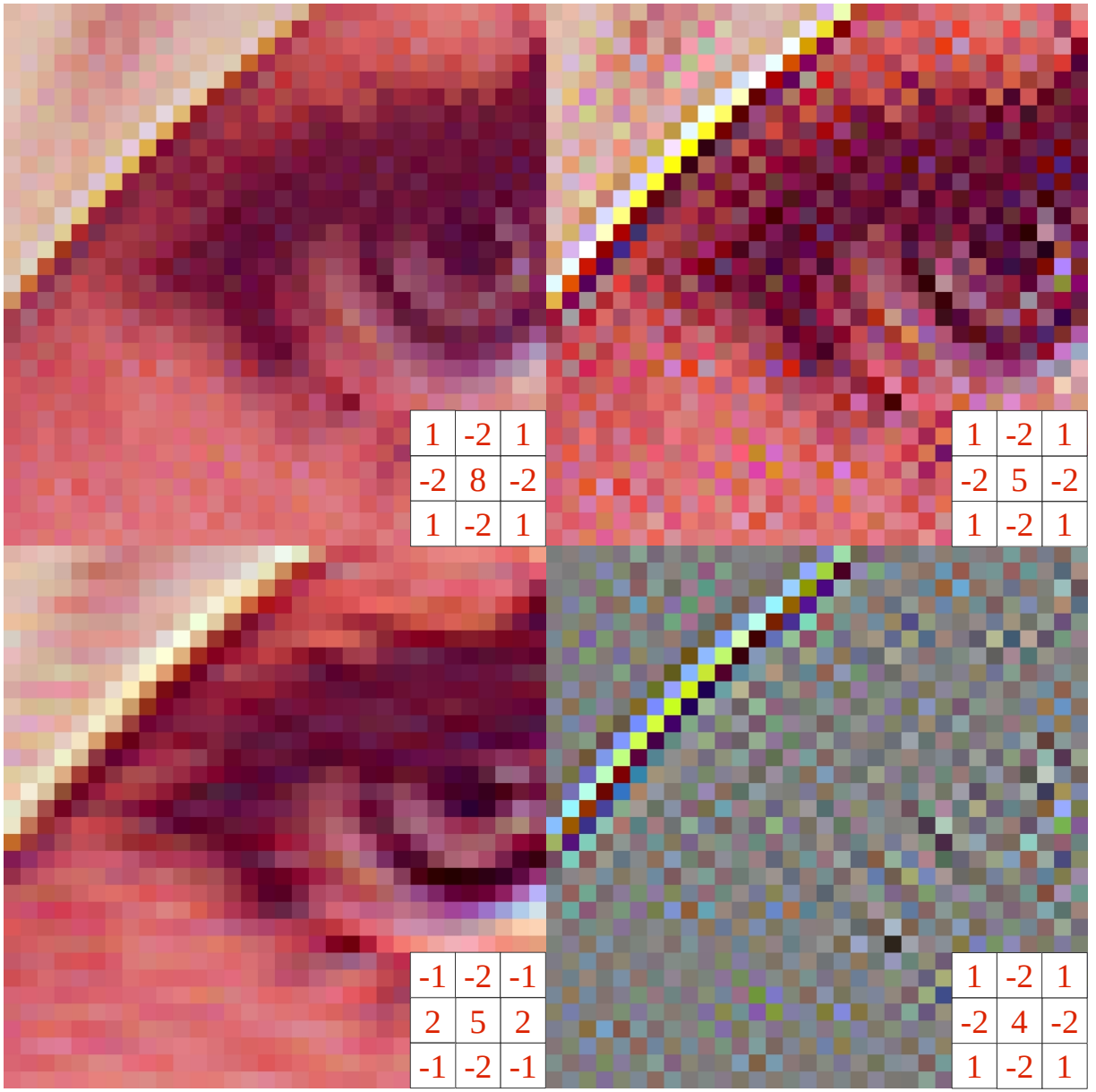
1	1	1
1	1	1
1	1	1

1	2	1
2	4	2
1	2	1

1	4	1
4	16	4
1	4	1

1	1	1	1	1

Élesítő szűrők



1	-2	1
-2	8	-2
1	-2	1

1	-2	1
-2	5	-2
1	-2	1

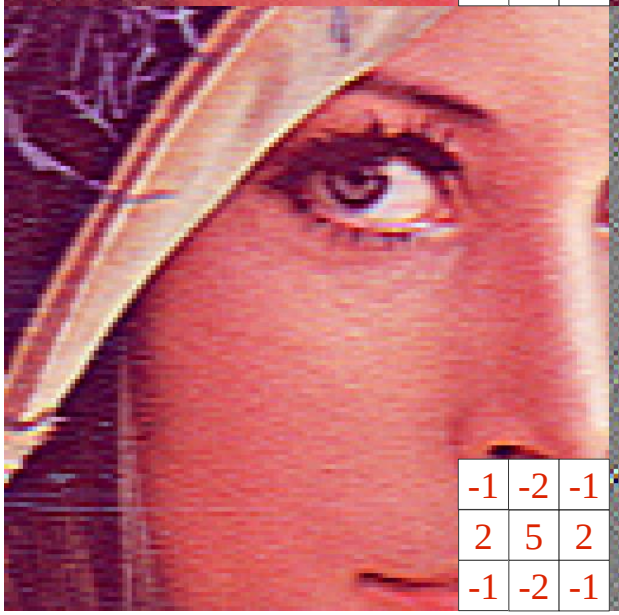
-1	-2	-1
2	5	2
-1	-2	-1

1	-2	1
-2	4	-2
1	-2	1

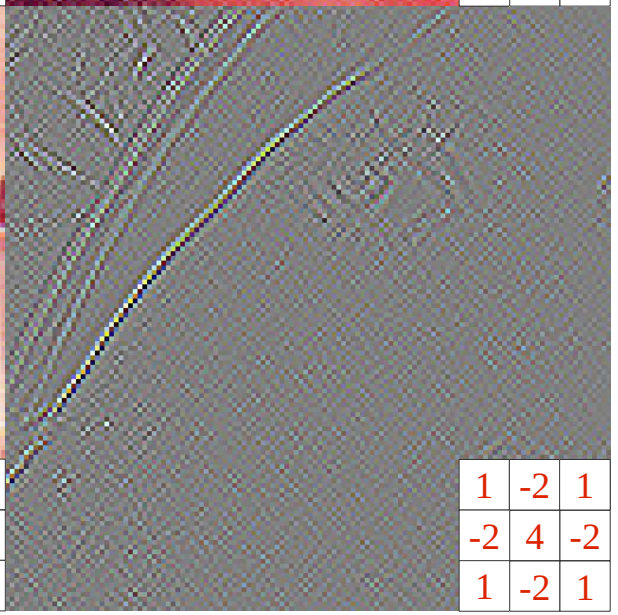
Élesítő szűrők

1	-2	1
-2	8	-2
1	-2	1

1	-2	1
-2	5	-2
1	-2	1

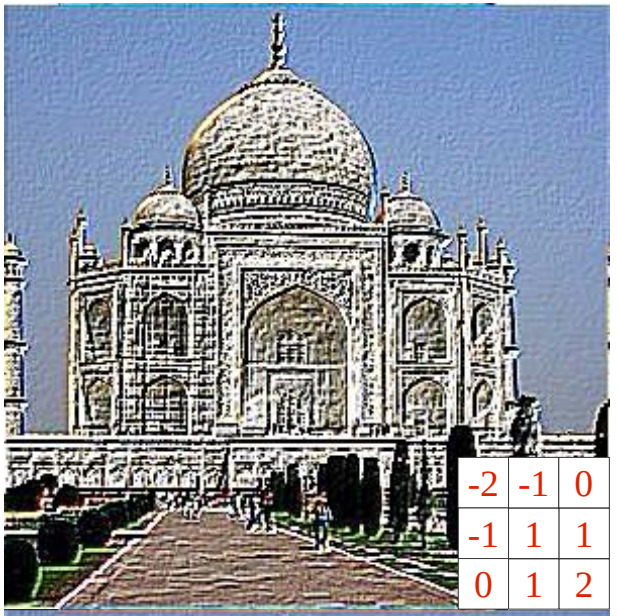


-1	-2	-1
2	5	2
-1	-2	-1

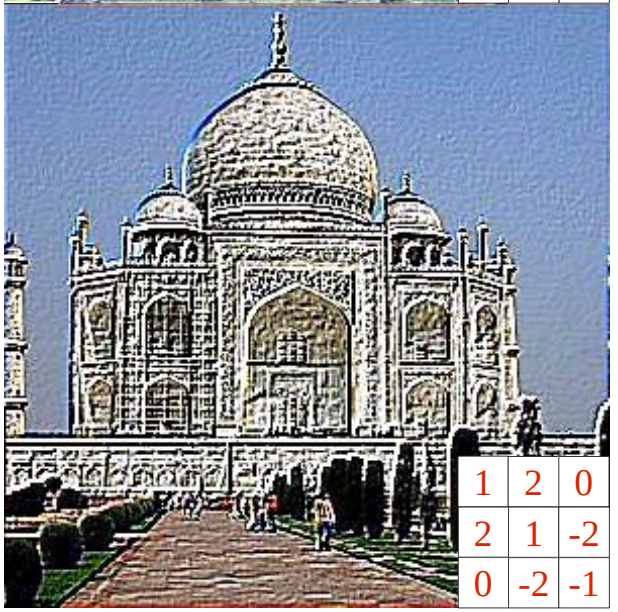


1	-2	1
-2	4	-2
1	-2	1

Térbeli kiemelés



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



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

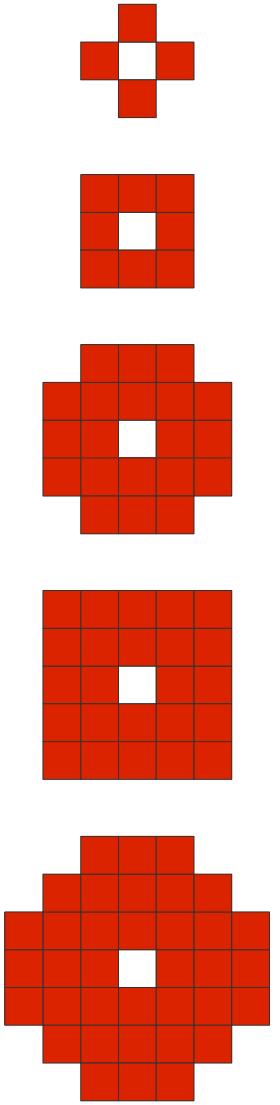
Rank szűrők

k-adik szomszéd

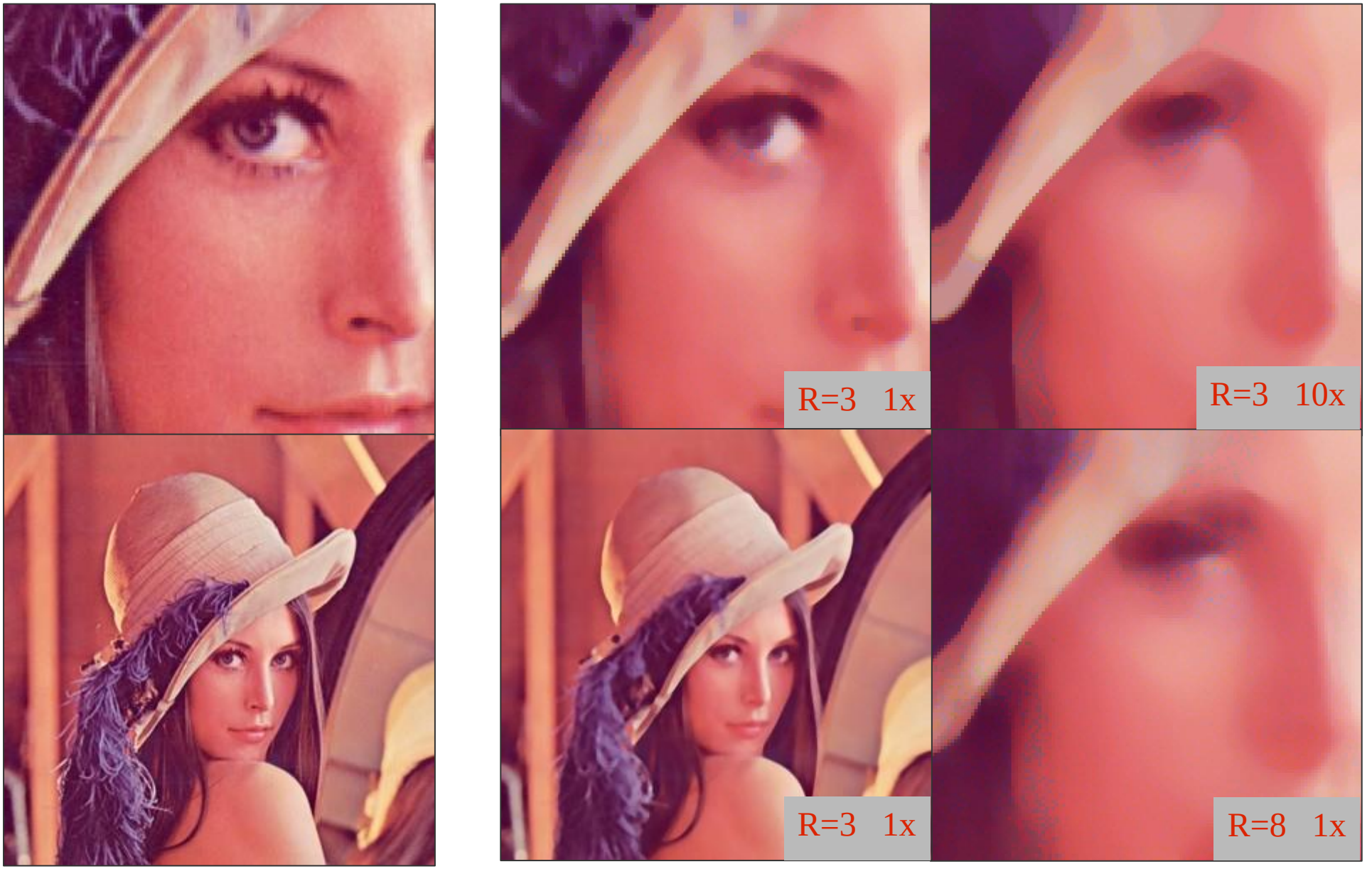
Minimum szűrő (**k=1**)

Maximum szűrő (**k=n**)

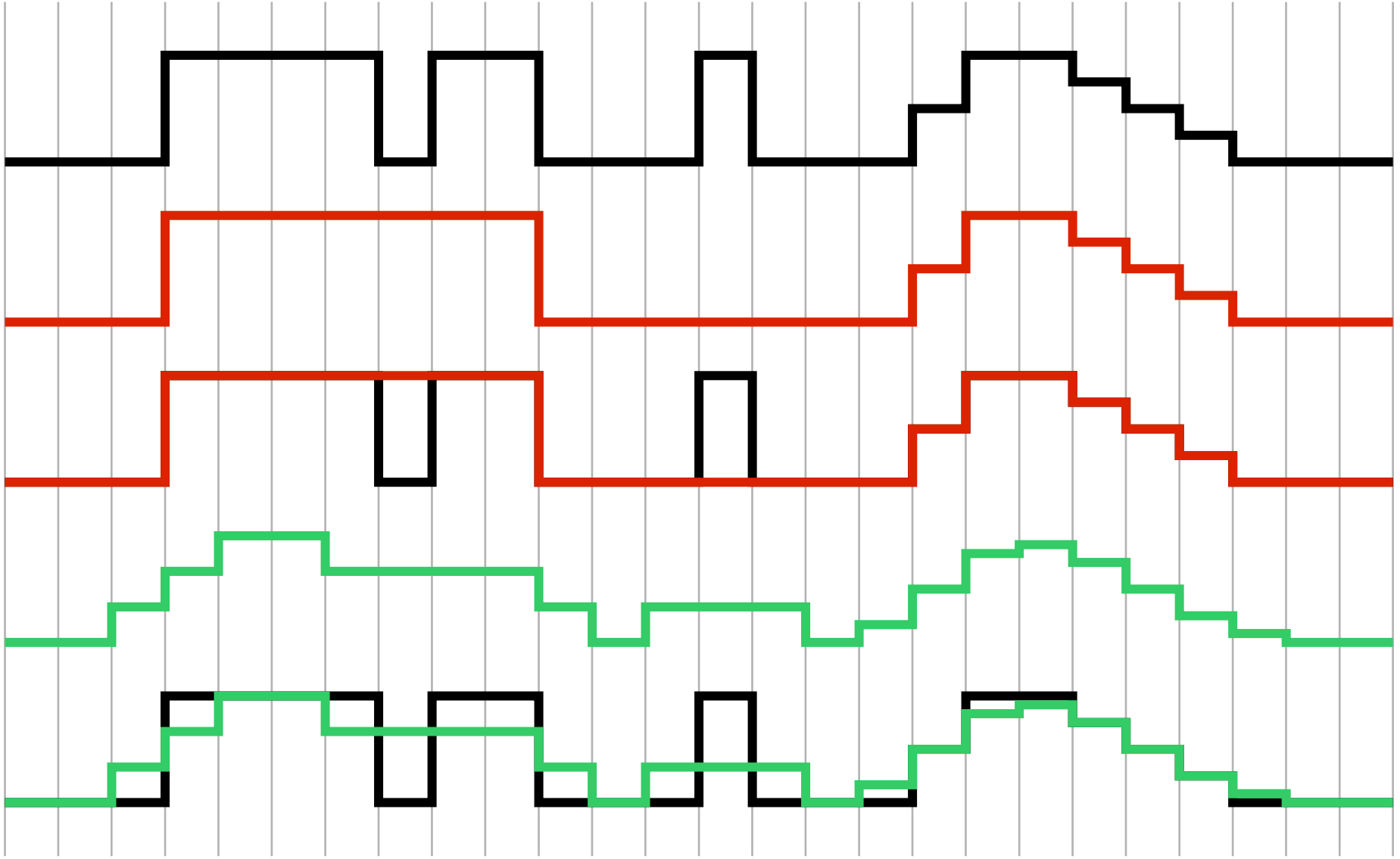
Median szűrő (**k=n/2**)



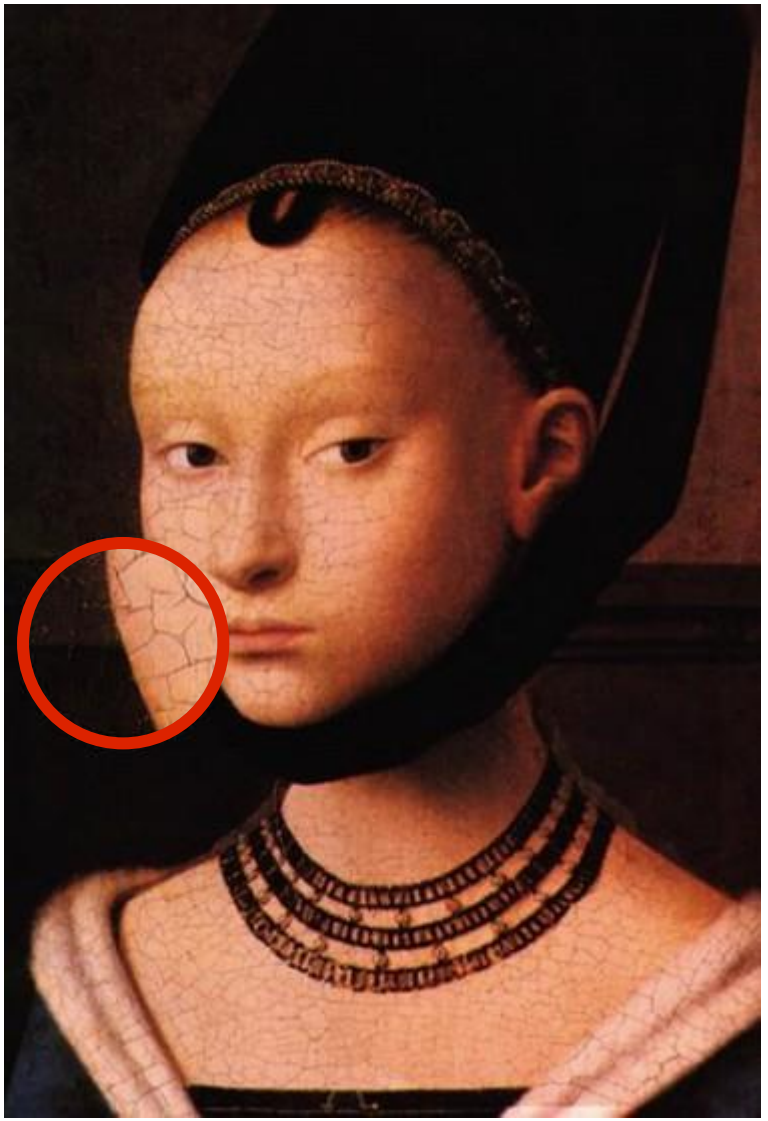
Median

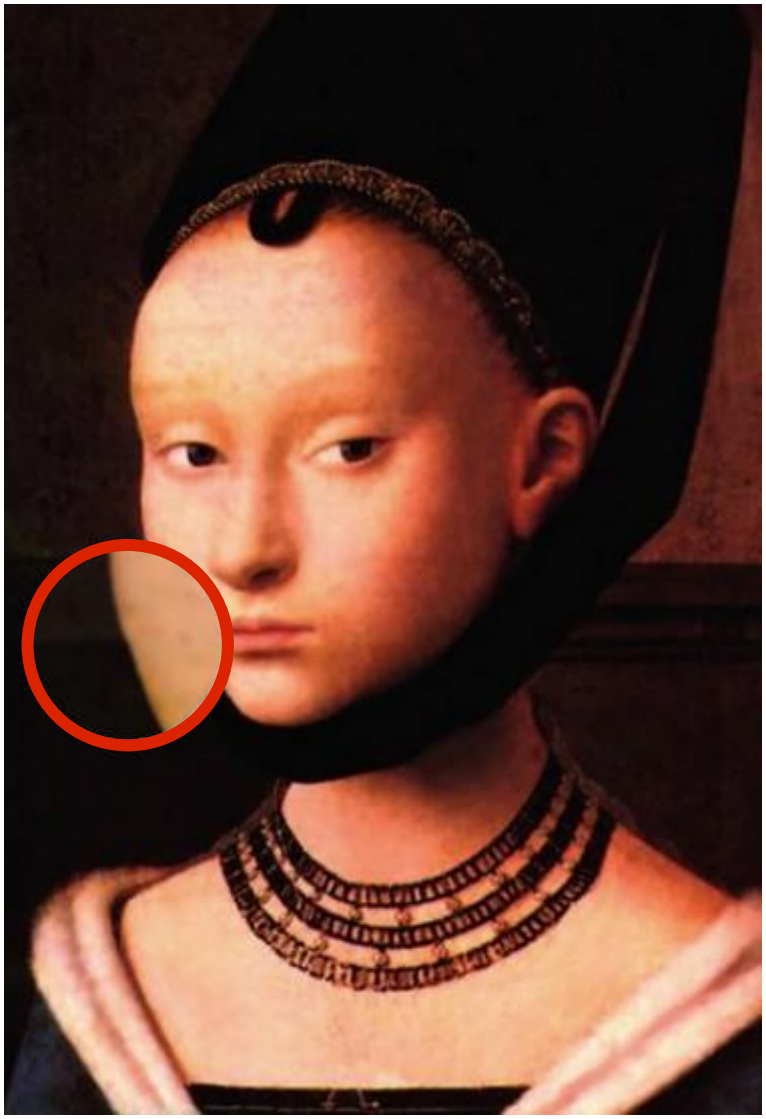


Median / átlagolás



Median





Lineáris vs Rank

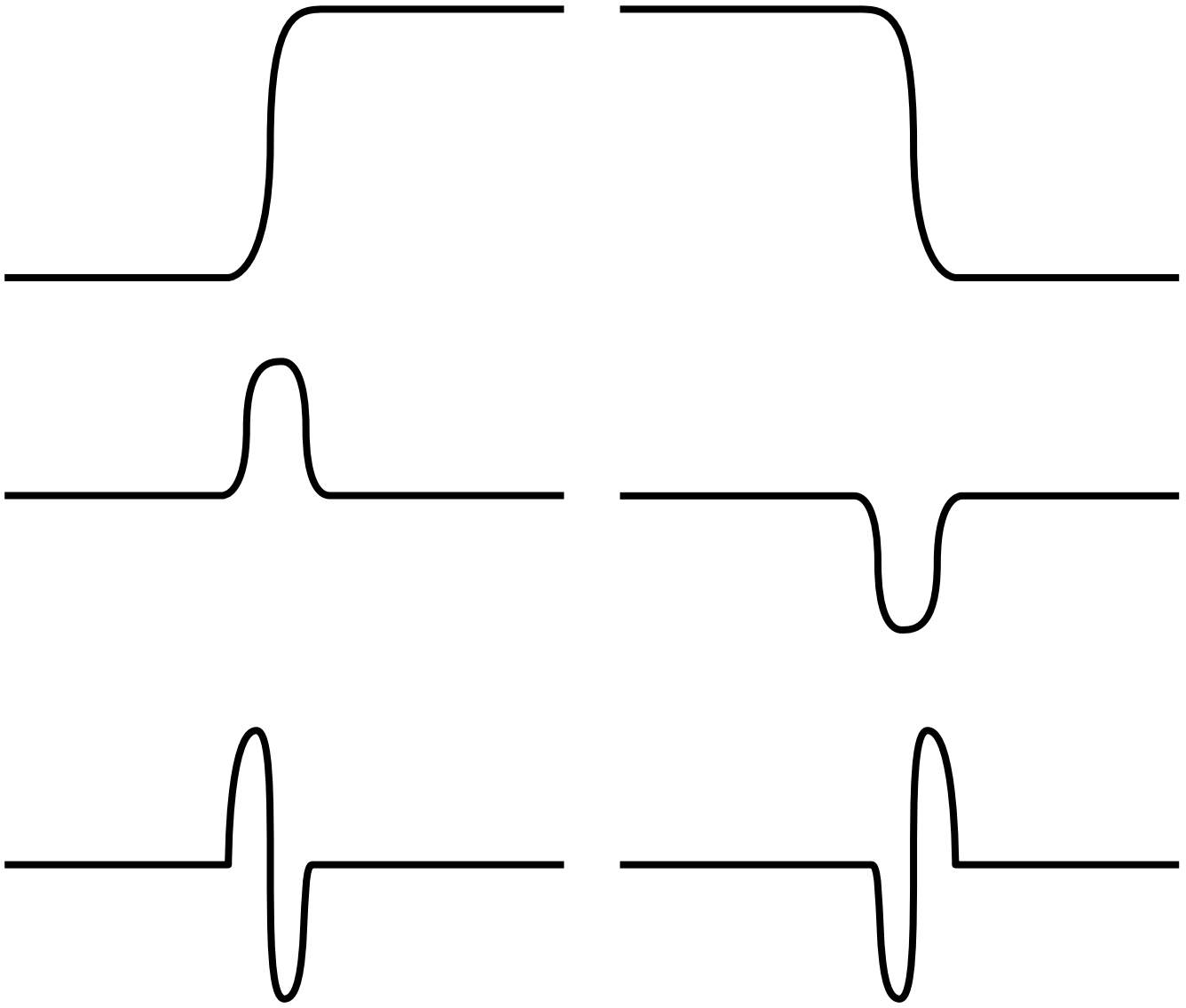
Diadikus felbontás – szeparábilis szűrők

1	2	1

1	1	2	1
2	2	4	2
1	1	2	1

Csak lineáris szűrőkkel lehet (ott sem mindig)

Élkeresés deriváltakkal



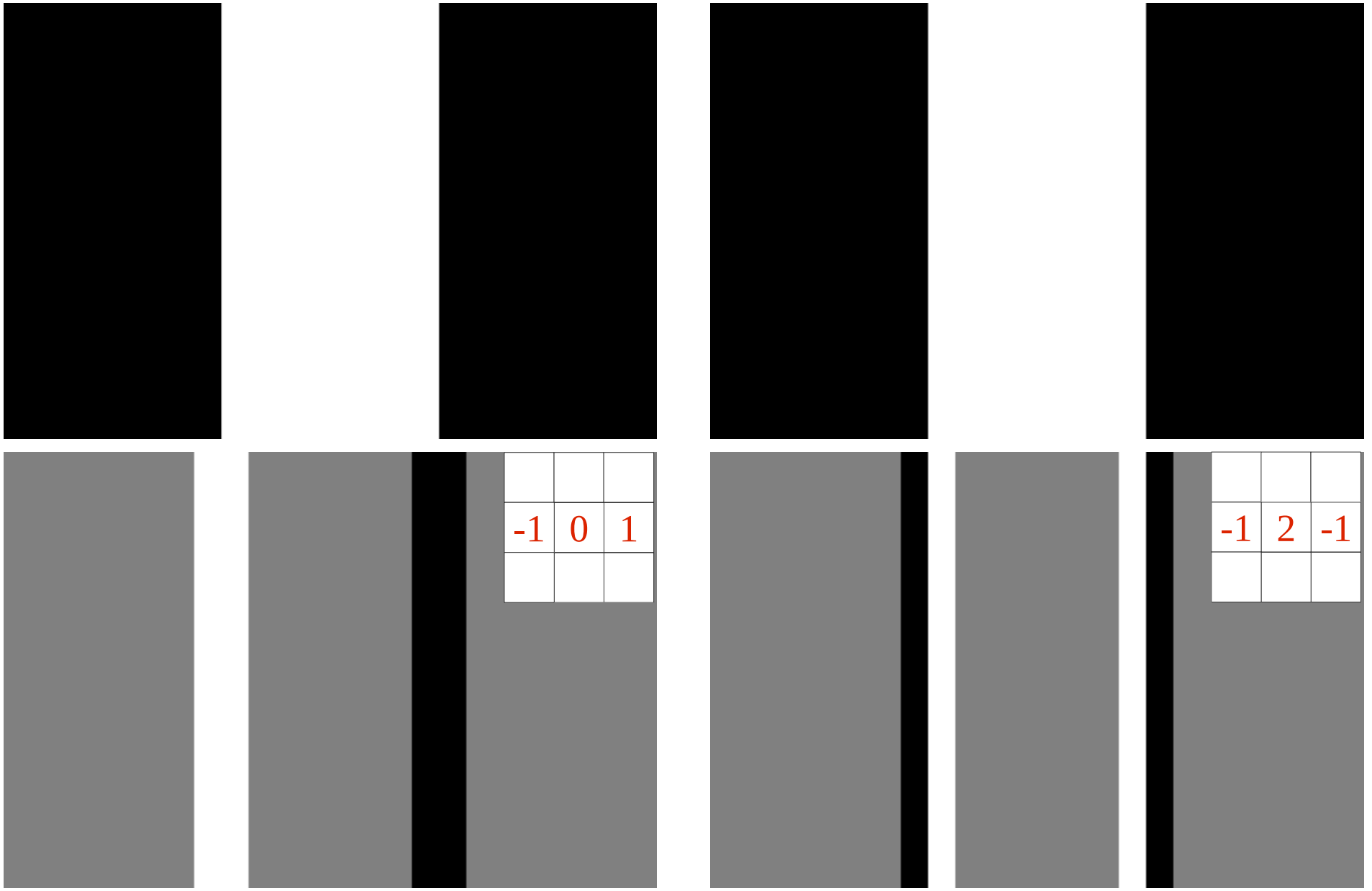
-1	1

-1
1

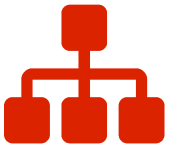
-1	0	1

-1		
	0	
		1

Élkeresés deriváltakkal



Élkeresés deriváltakkal



1	0	-1
1	0	-1
1	0	-1

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

1	-1	-1
2	1	-1
1	-1	-1

5	-3	-3
5	0	-3
5	-3	-3

1	1	0
1	0	-1
0	-1	-1

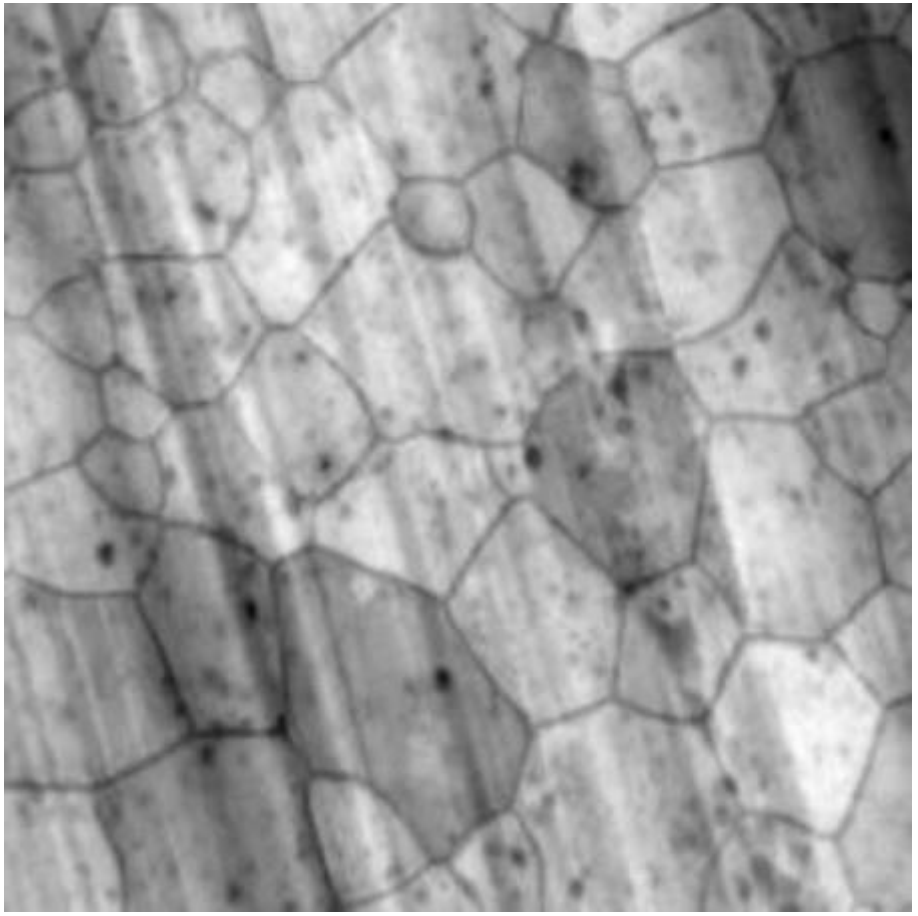
2	1	0
1	0	-1
0	-1	-2

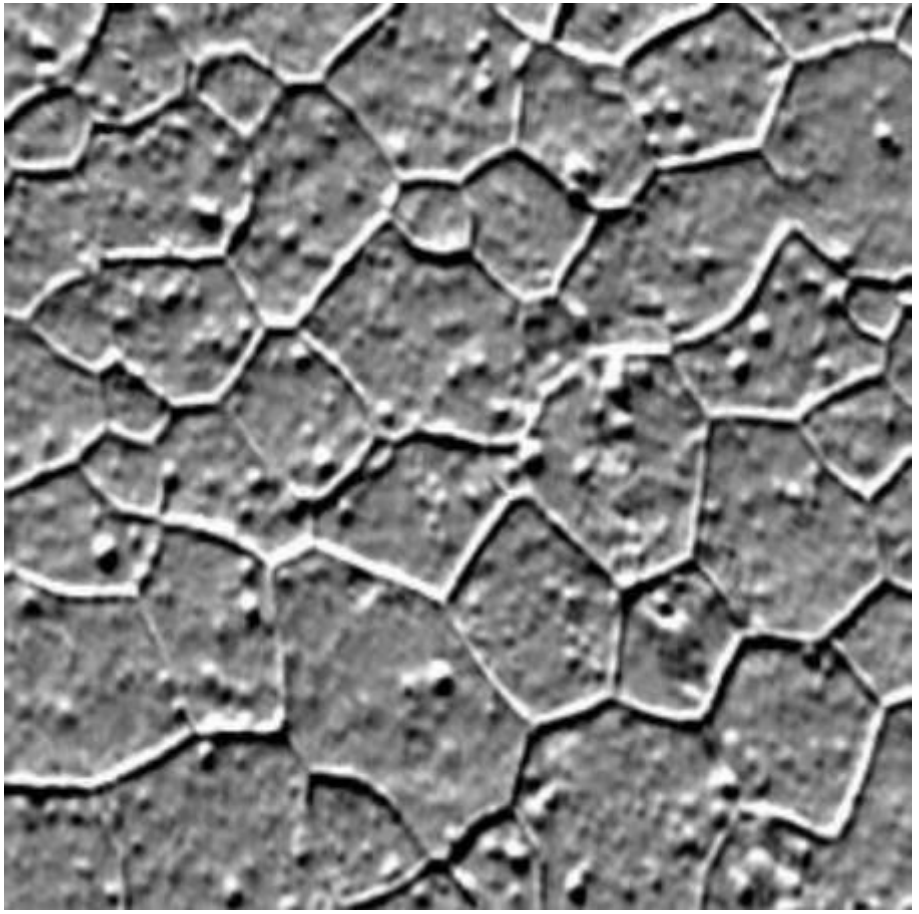
2	1	-1
1	1	-1
-1	-1	-1

5	5	-3
5	0	-3
-3	-3	-3

• • •

Derivatív szűrő

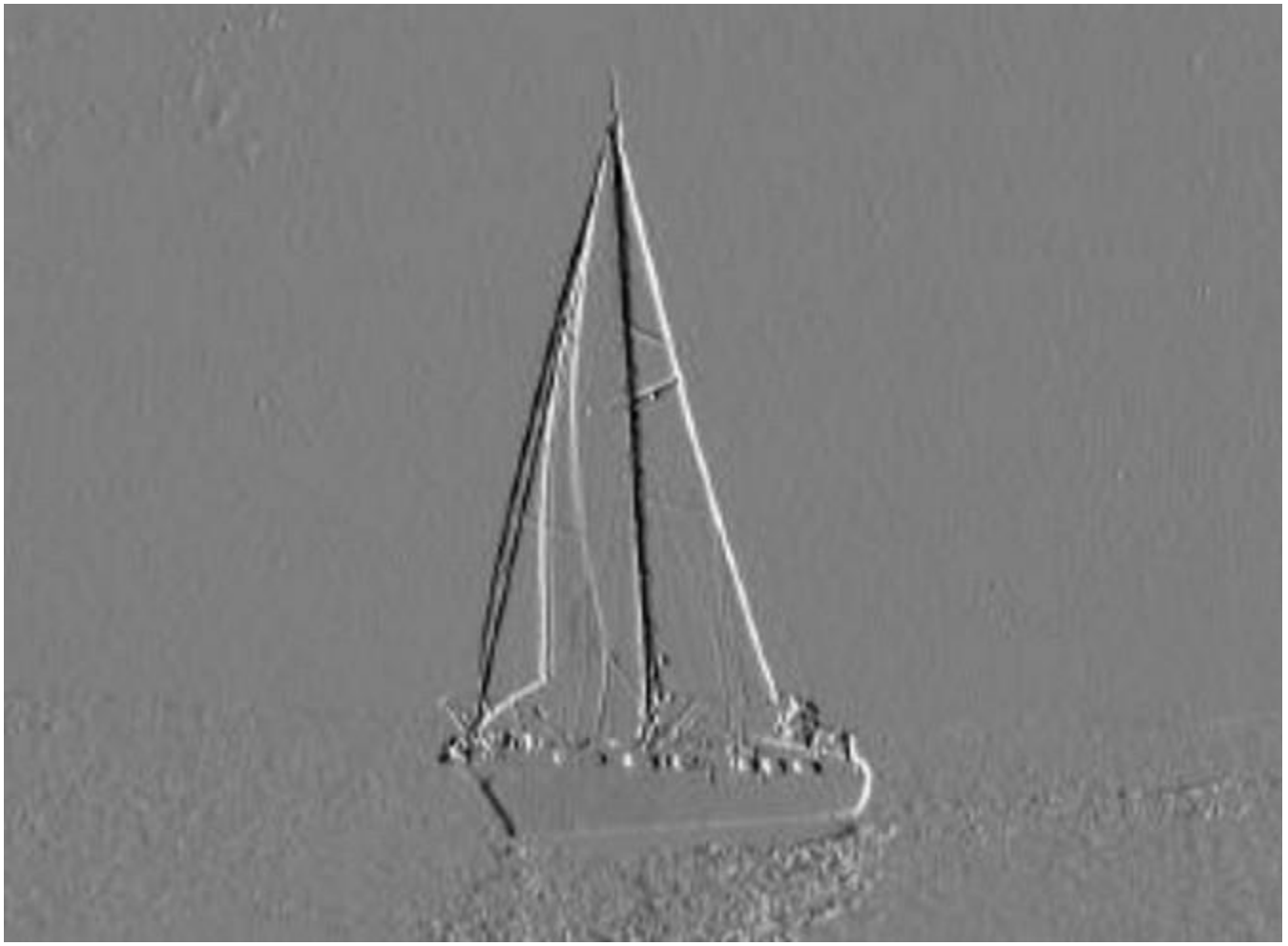




Összetett példa

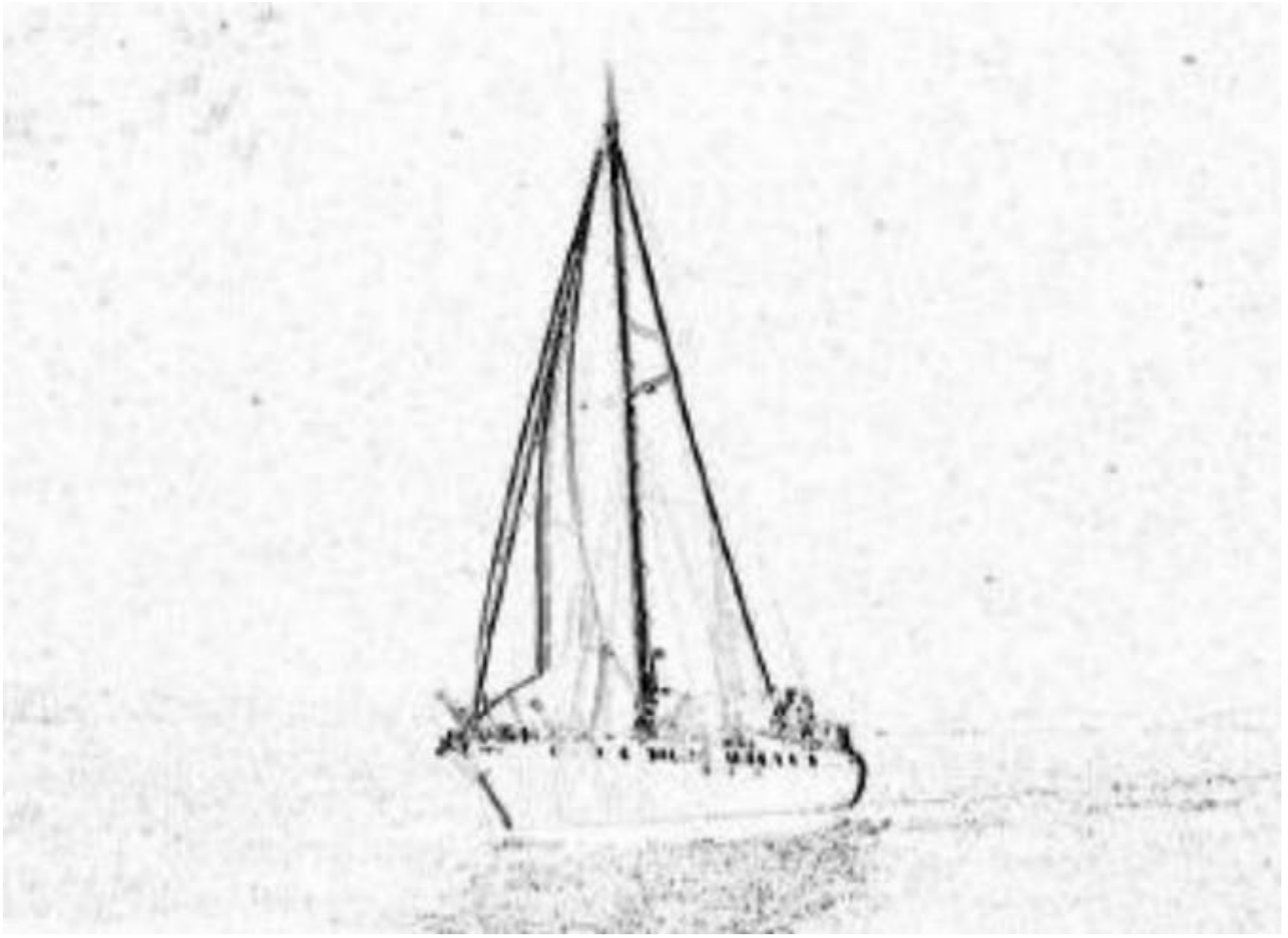
Kiinduló kép

Összetett példa



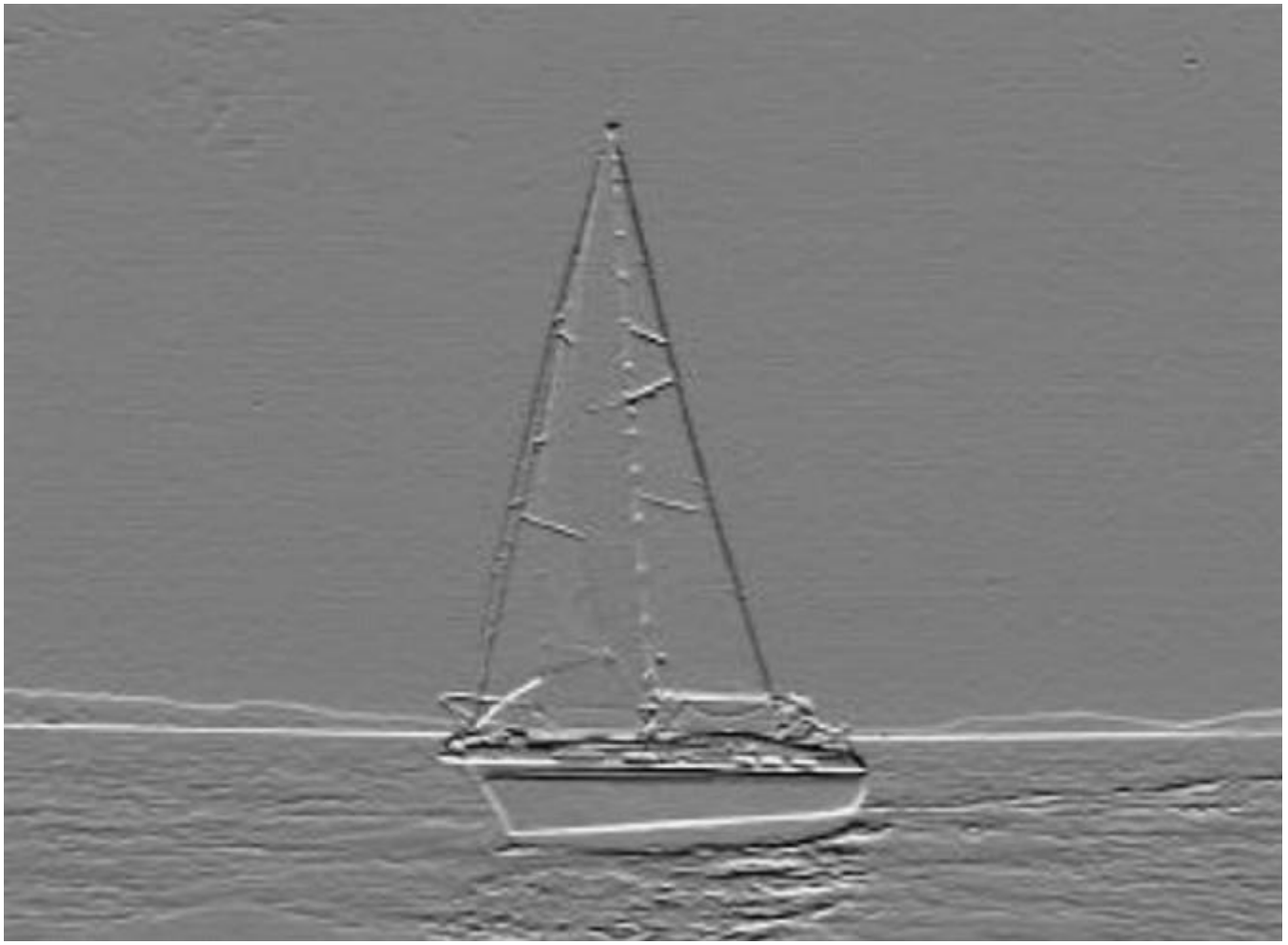
Horizontális derivált

Összetett példa



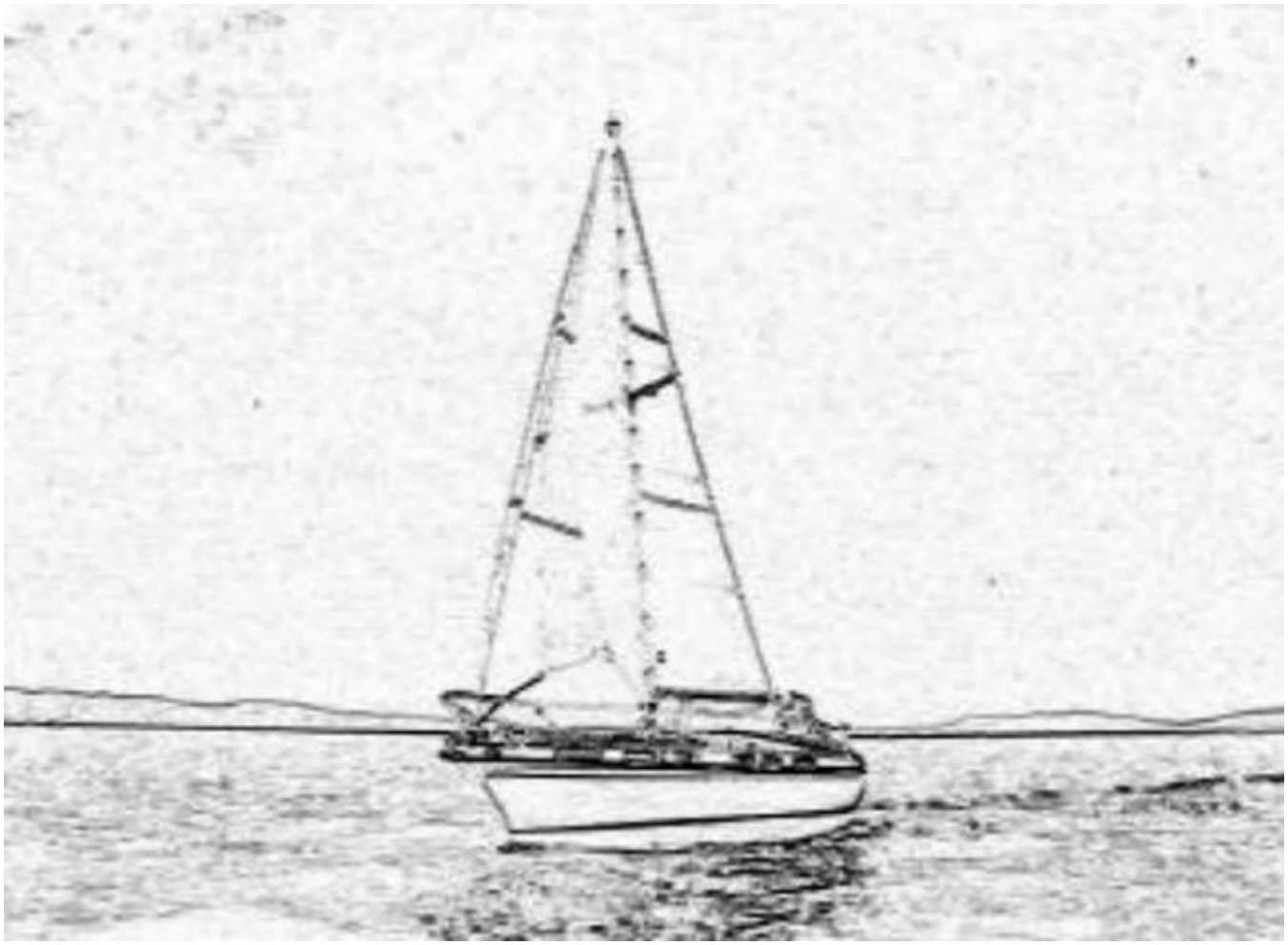
Horizontális derivált abszolút értéke

Összetett példa



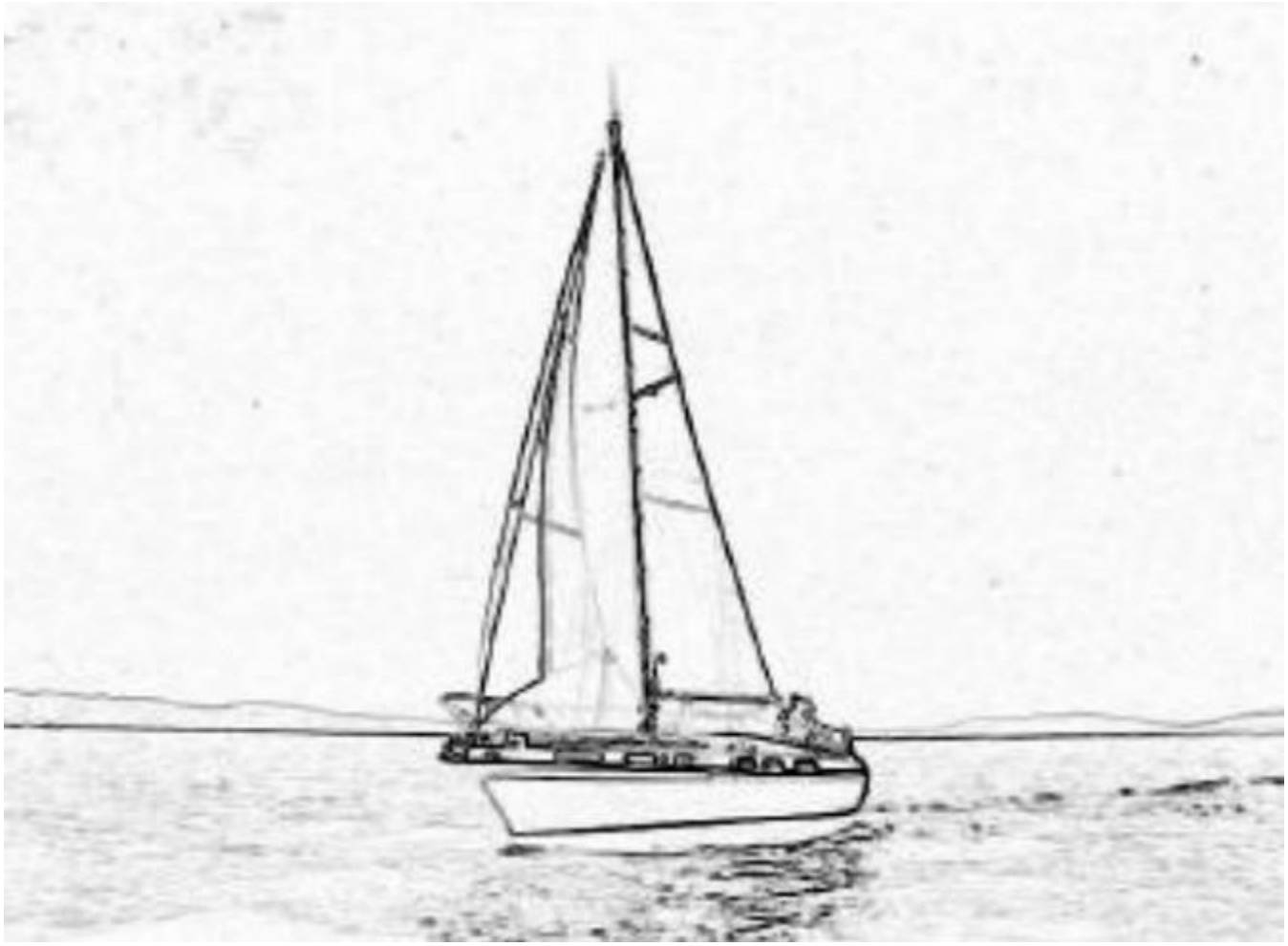
Vertikális derivált

Összetett példa



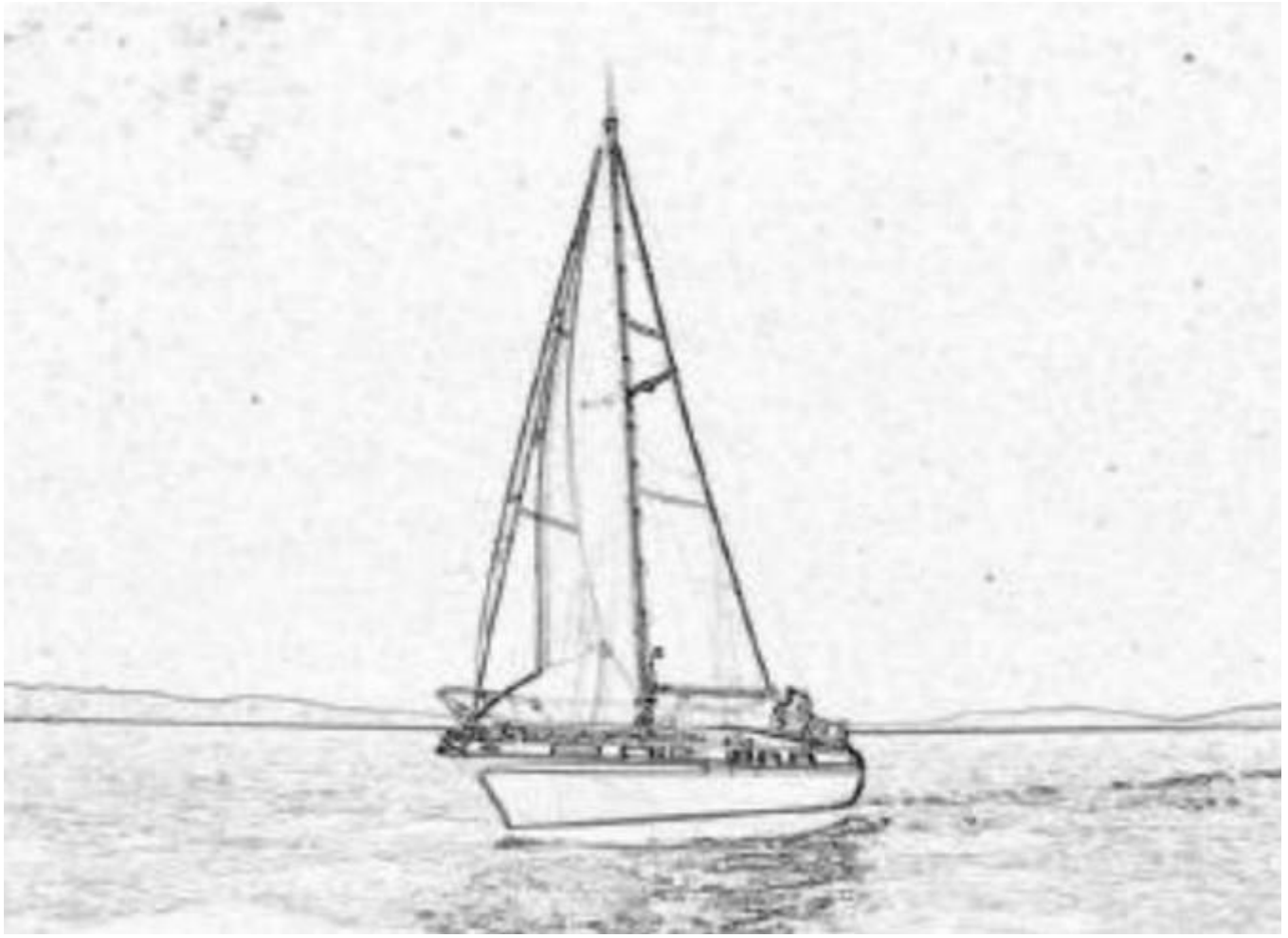
Vertikális derivált abszolút értéke

Összetett példa



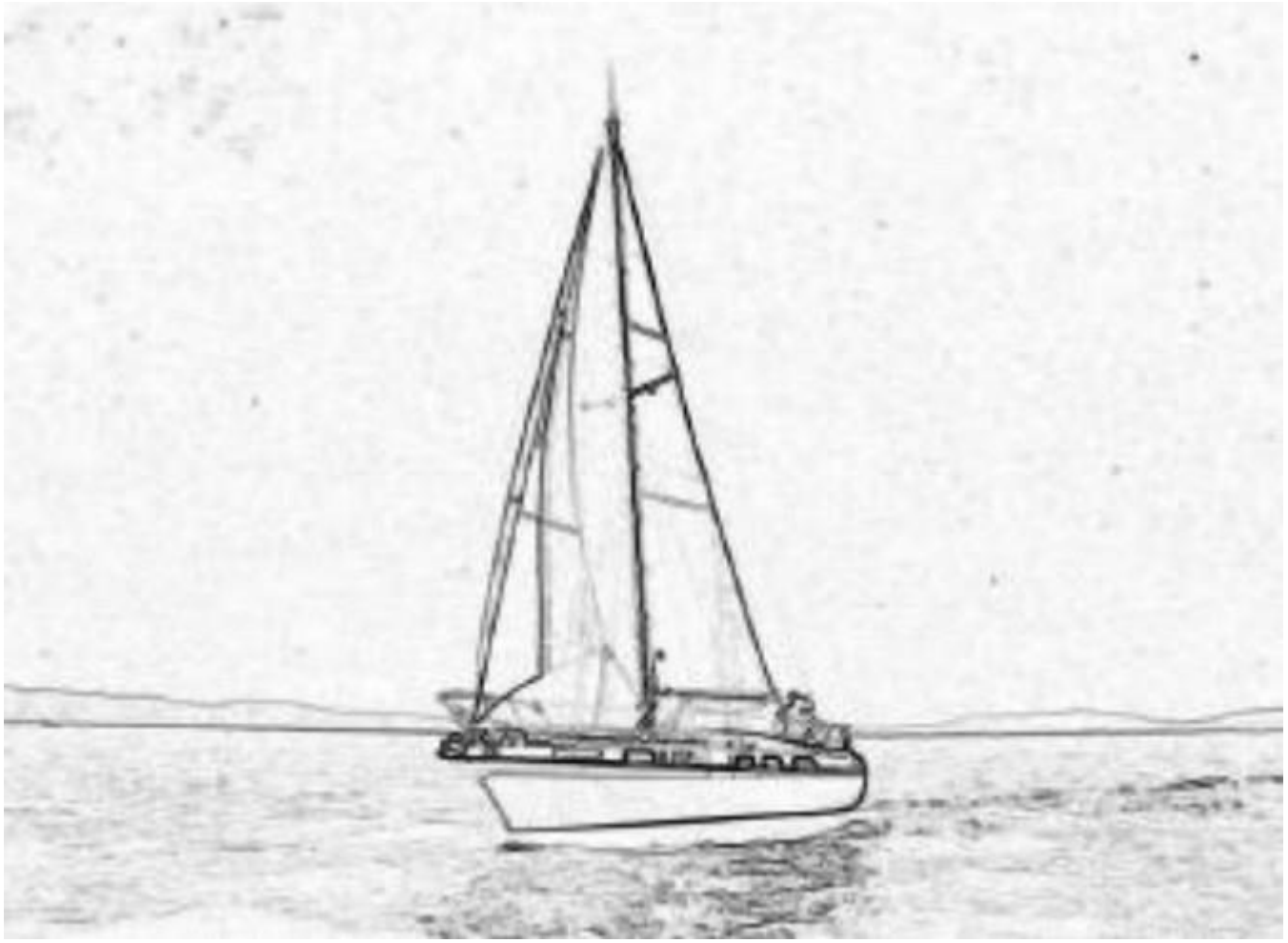
Derivált abszolút értékek maximuma

Összetett példa



Derivált abszolút értékek összege

Összetett példa



Derivált abszolút értékek négyzetre emelése, összeadása, majd gyökvonás

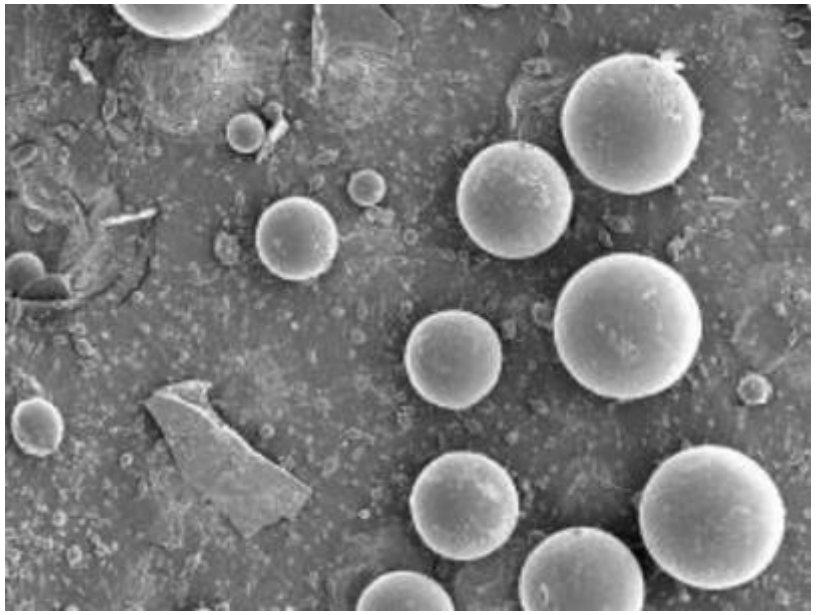
Gaussok különbsége (DoG)

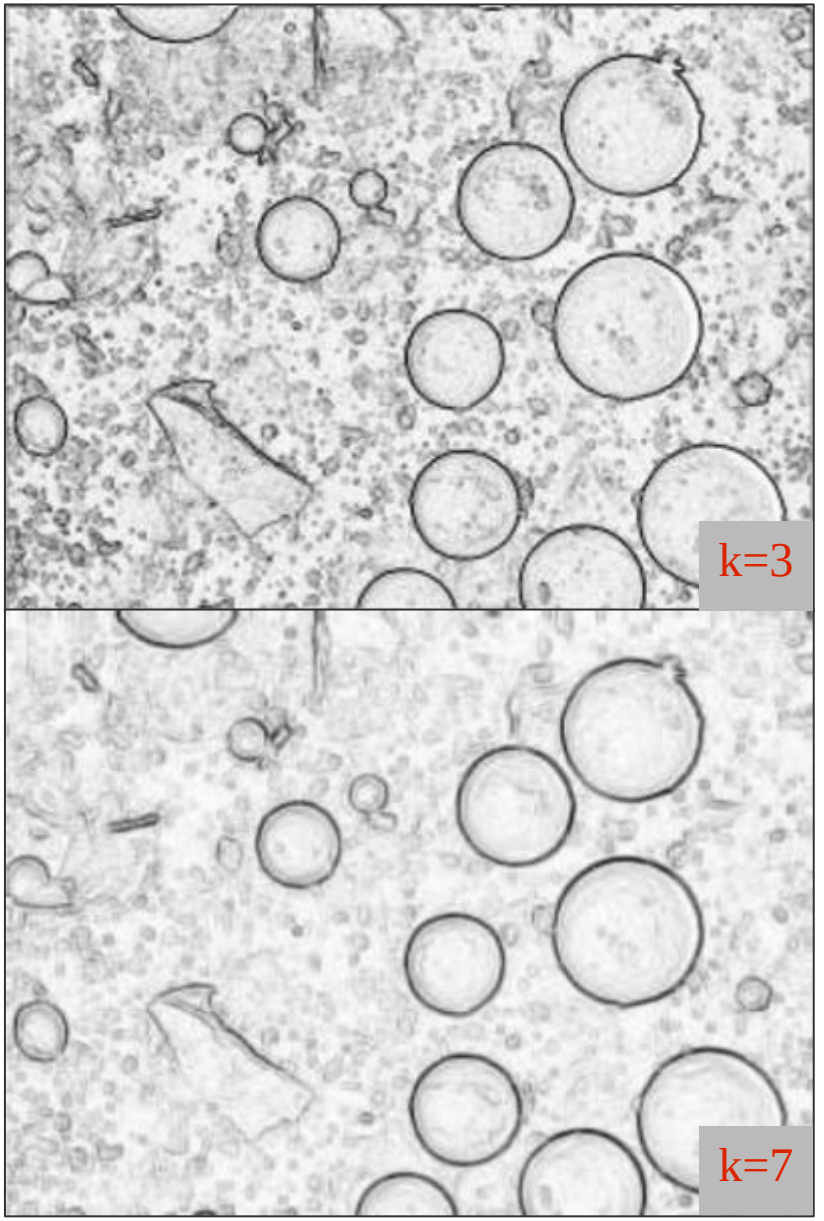
Laplace Szűrő

0	-1	0
-1	4	-1
0	-1	0

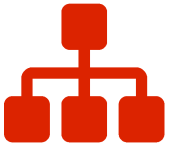
-1	-1	-1
-1	8	-1
-1	-1	-1

Kernel méret





Canny éldetektor



Gauss szűrés

Derivatív szűrés két/négy irányban

(Roberts, Prewitt, Sobel...)

Ebből gradiens

Nem-maximumok törlése (gradiens irányban)

Küszöbözés: erős élek, gyenge élek

Canny éldetektor

Képi matematika

Kép–érték v. **kép–kép**

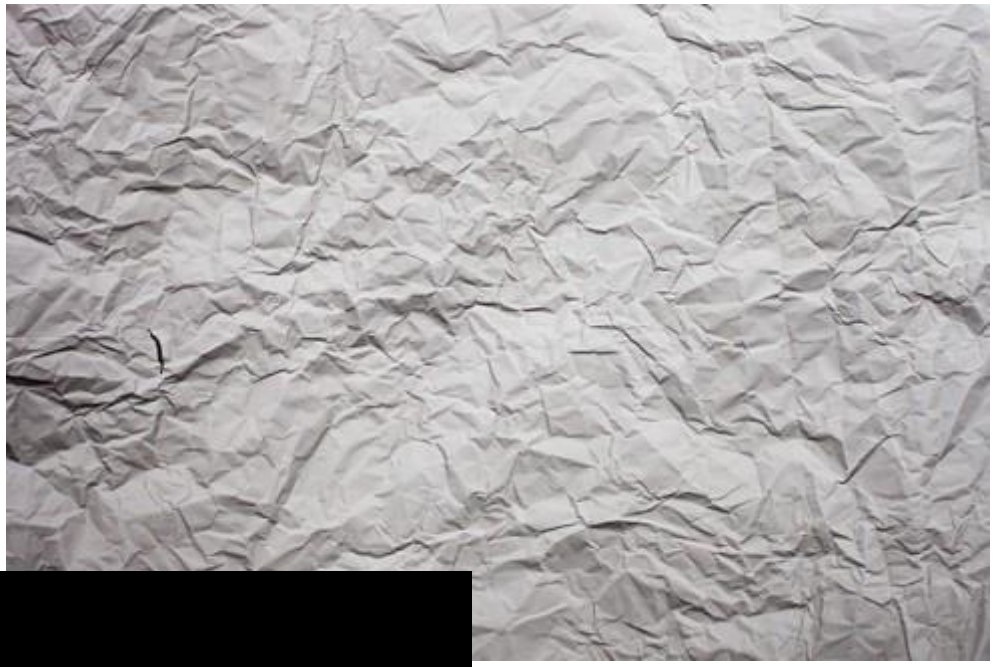
Összeadás / kivonás / átlagolás

Szorzás / osztás / normalizálás

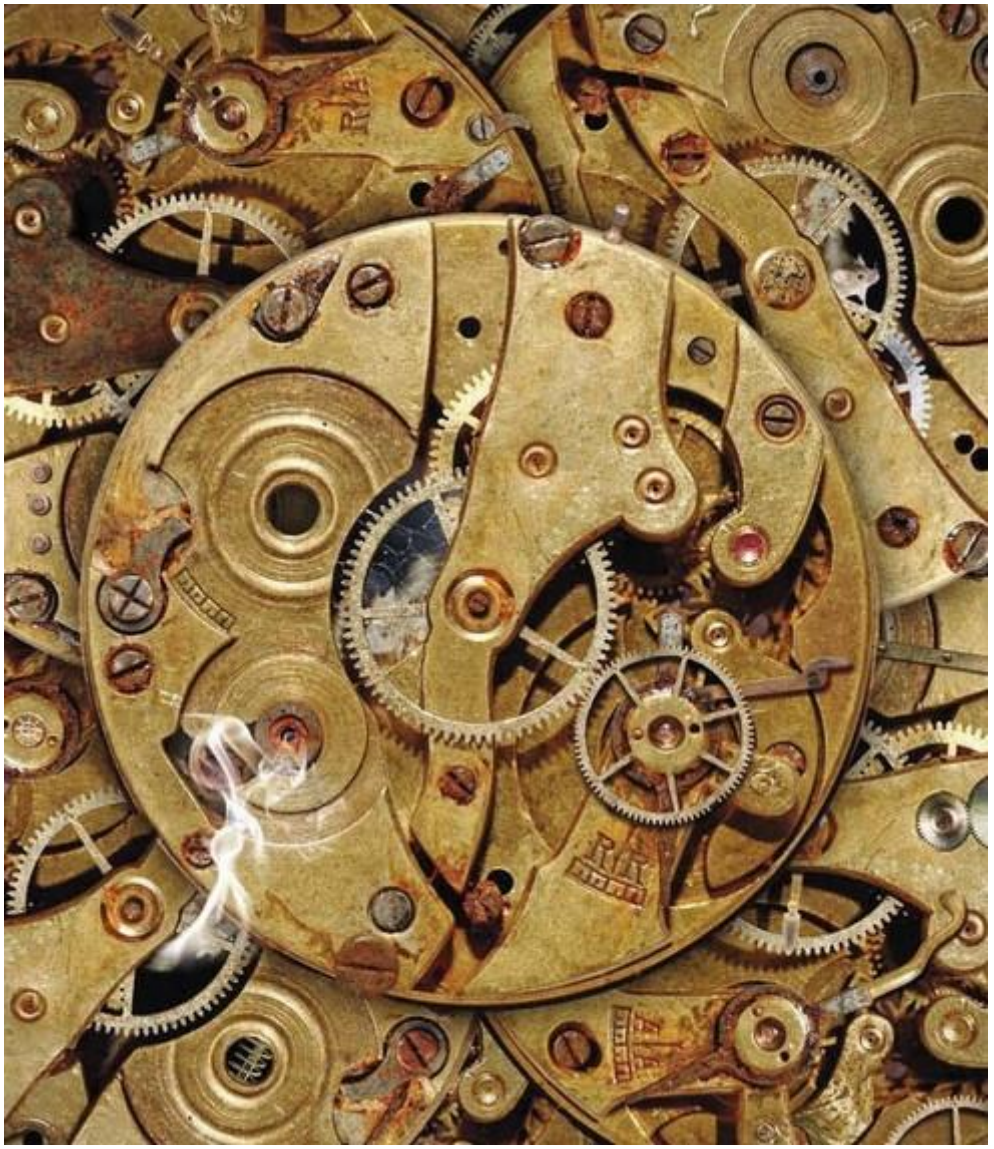
Maximum / minimum

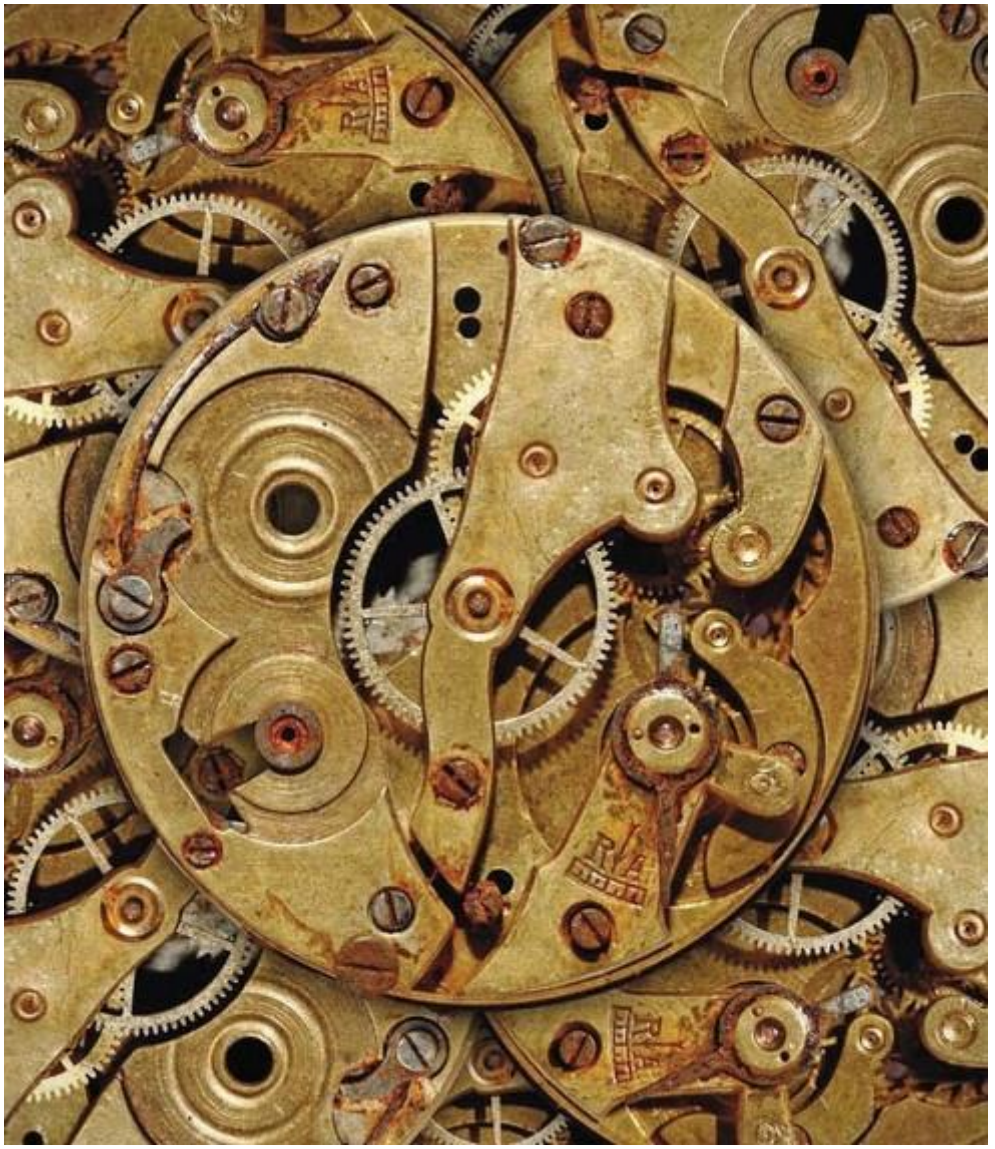
Logikai műveletek (főleg bináris képek)

Textúrázás (szorzás)

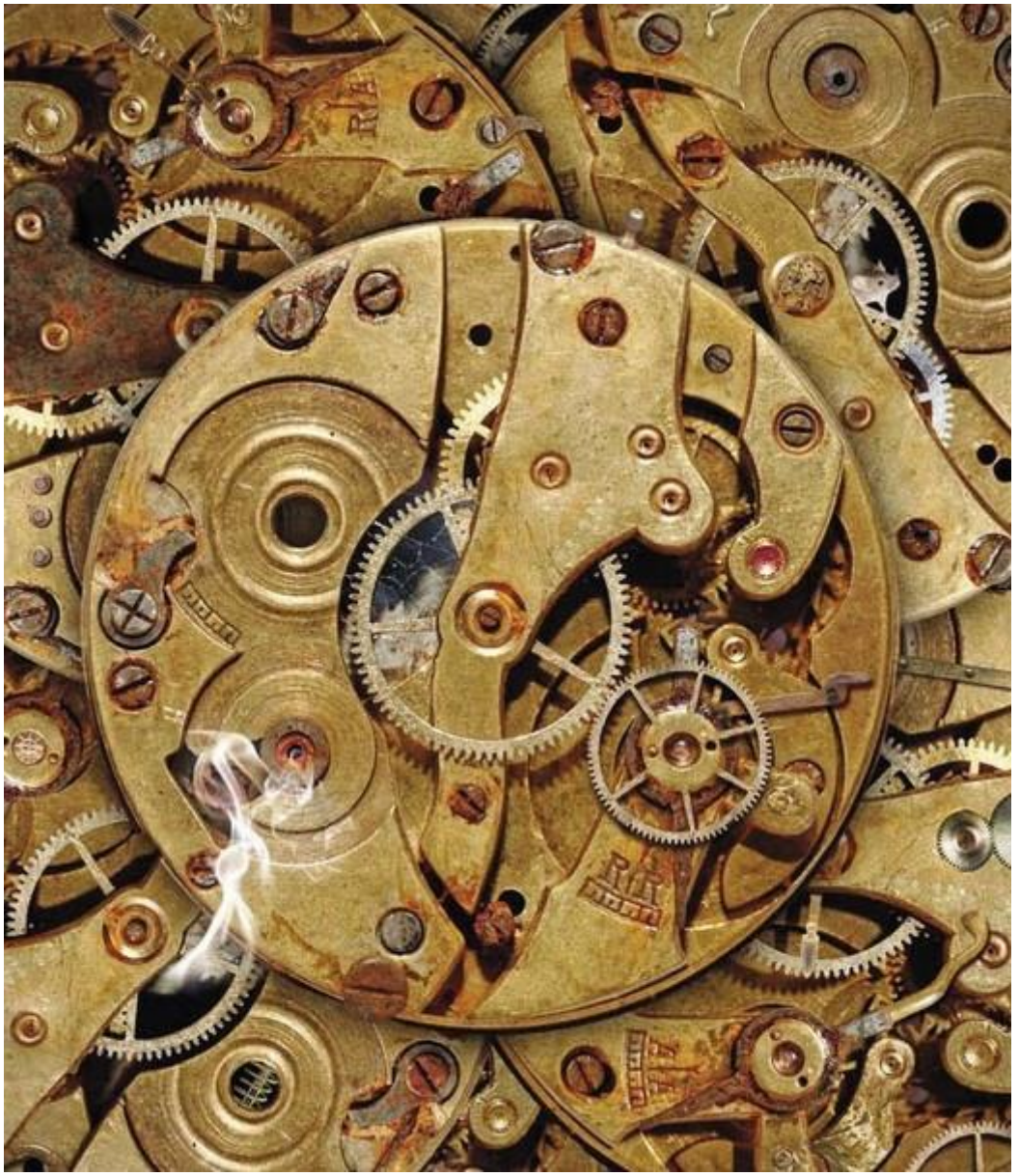


Különbség

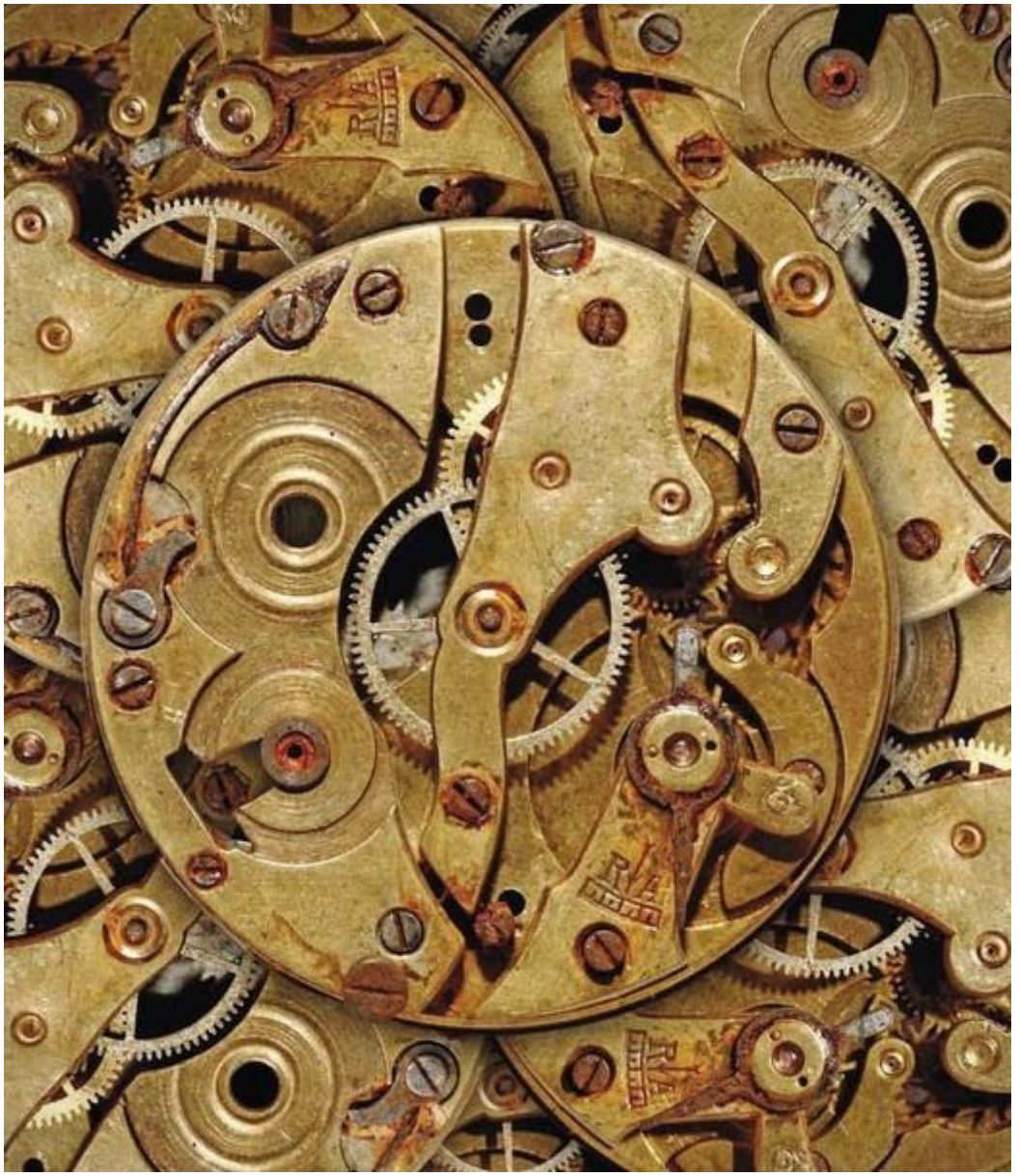




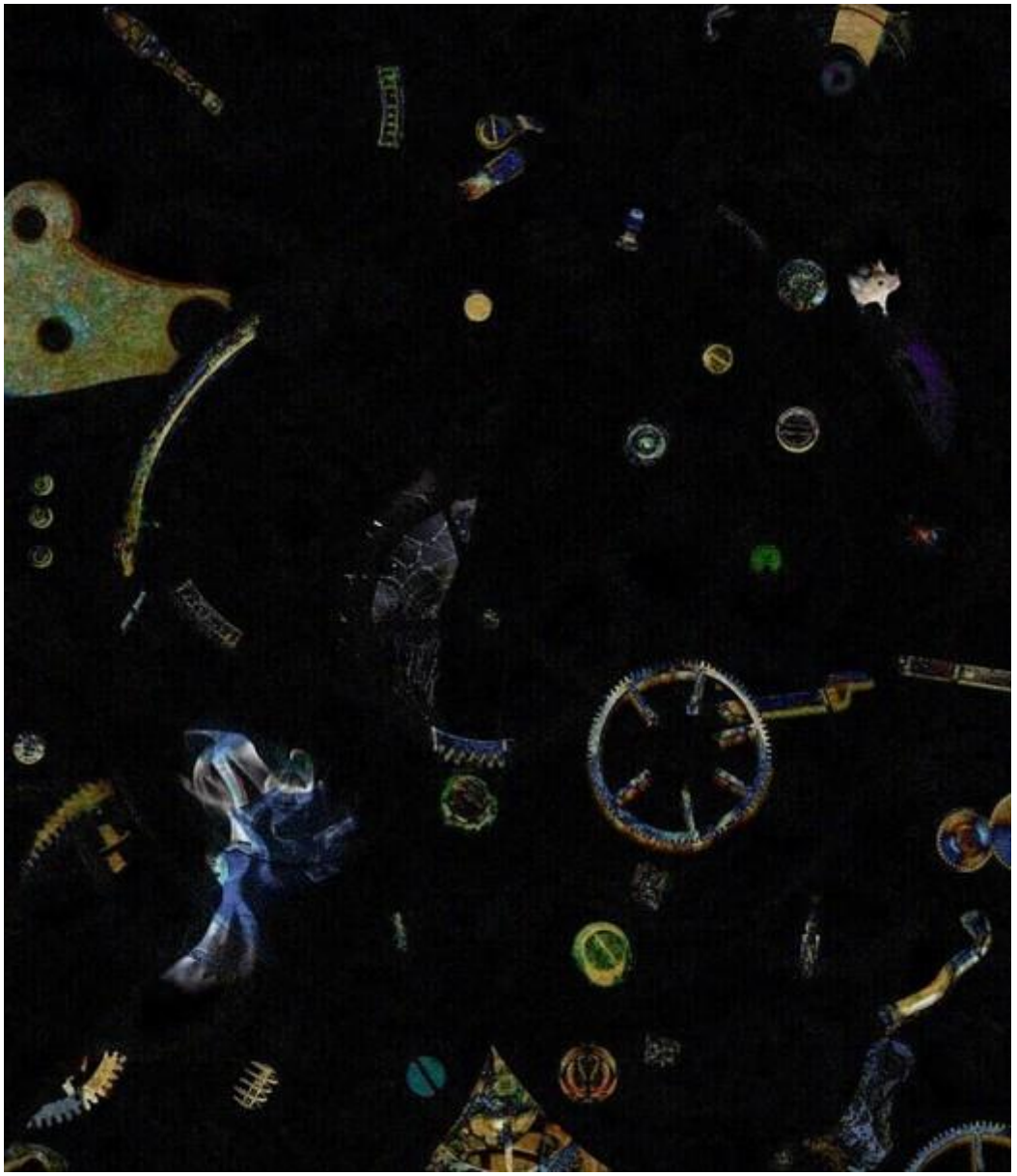
Különbség



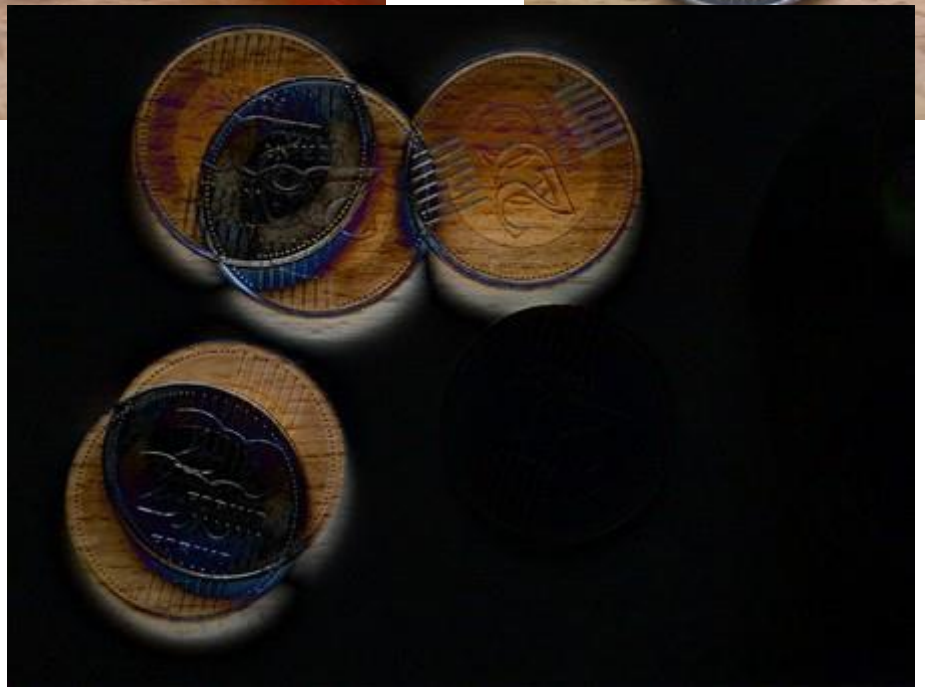
Különbség



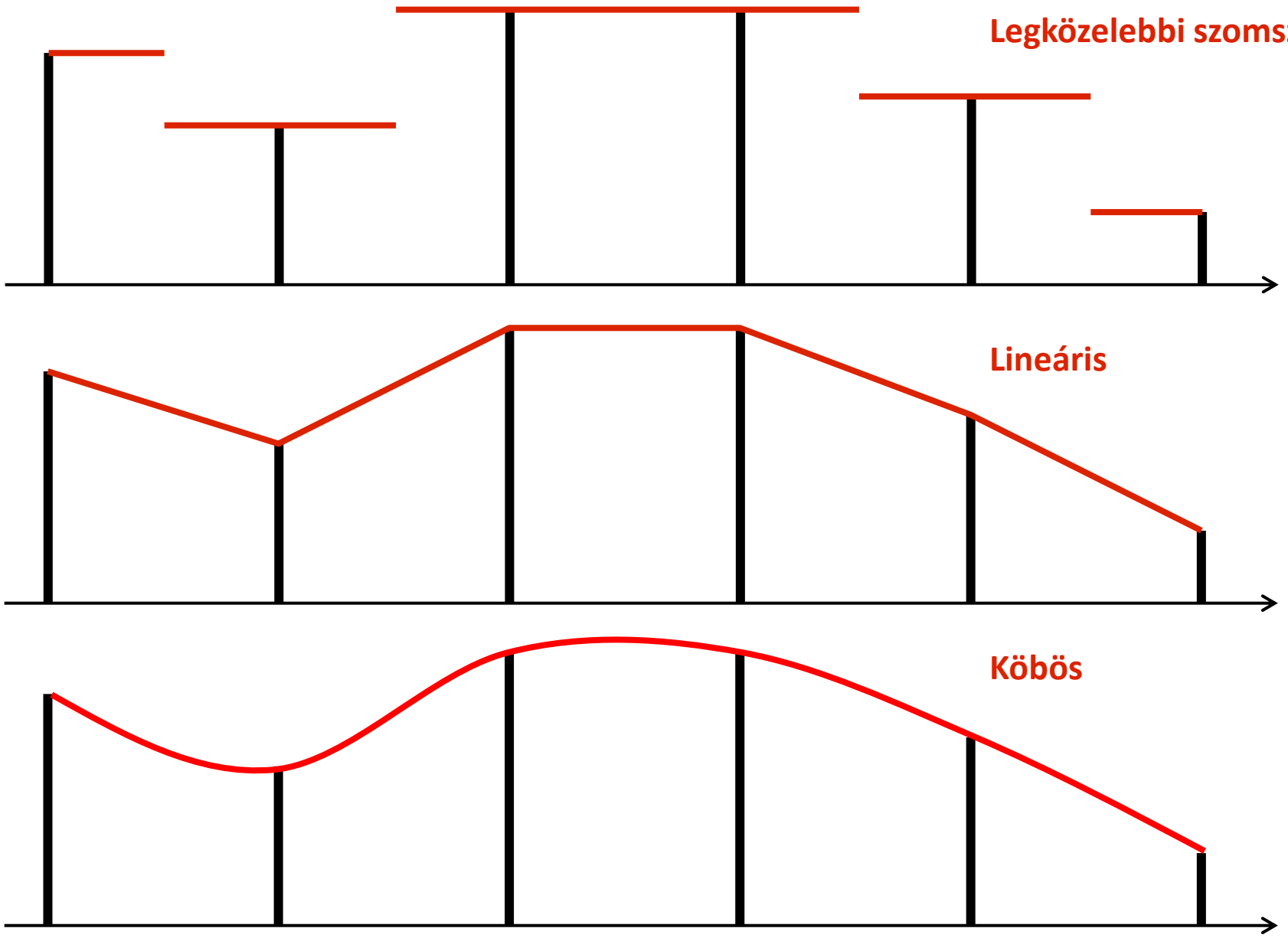
Különbség



Háttérleválasztás



Interpoláció

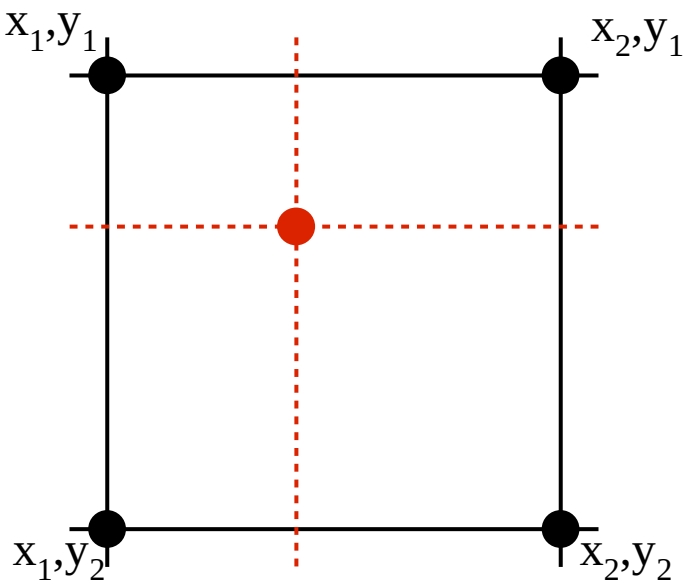


Bilineáris interpoláció

$$f(x, y_1) = \frac{x_2 - x}{x_2 - x_1} \cdot f(x_1, y_1) + \frac{x - x_1}{x_2 - x_1} \cdot f(x_2, y_1)$$

$$f(x, y_2) = \frac{x_2 - x}{x_2 - x_1} \cdot f(x_1, y_2) + \frac{x - x_1}{x_2 - x_1} \cdot f(x_2, y_2)$$

$$f(x, y) = \frac{y_2 - y}{y_2 - y_1} \cdot f(x, y_1) + \frac{y - y_1}{y_2 - y_1} \cdot f(x, y_2)$$



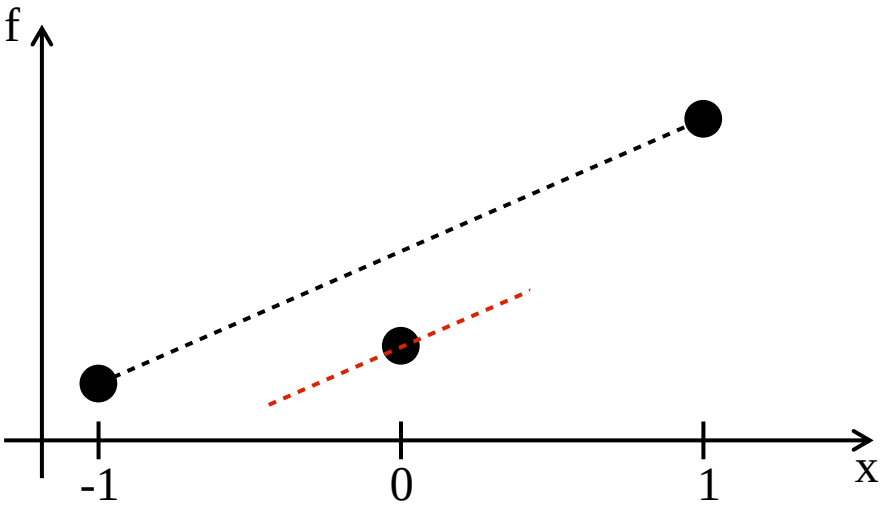
Biköbös interpoláció

$$f(x,y) = \sum_{i=0}^{3}\sum_{j=0}^{3} a_{ij}\, x^i y^j$$

$$\frac{\partial f(x,y)}{\partial x} = \sum_{i=1}^{3}\sum_{j=0}^{3} a_{ij}\, i x^{i-1} y^j$$

$$\frac{\partial f(x,y)}{\partial y} = \sum_{i=0}^{3}\sum_{j=1}^{3} a_{ij}\, x^i j y^{j-1}$$

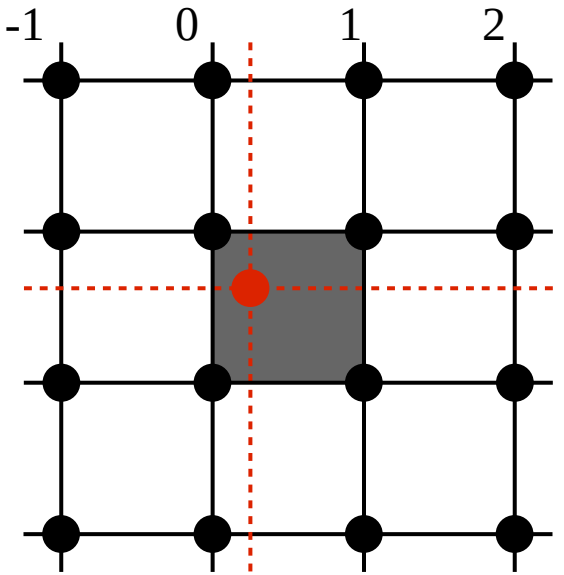
$$\frac{\partial^2 f(x,y)}{\partial x \partial y} = \sum_{i=1}^{3}\sum_{j=1}^{3} a_{ij}\, i x^{i-1} j y^{j-1}$$



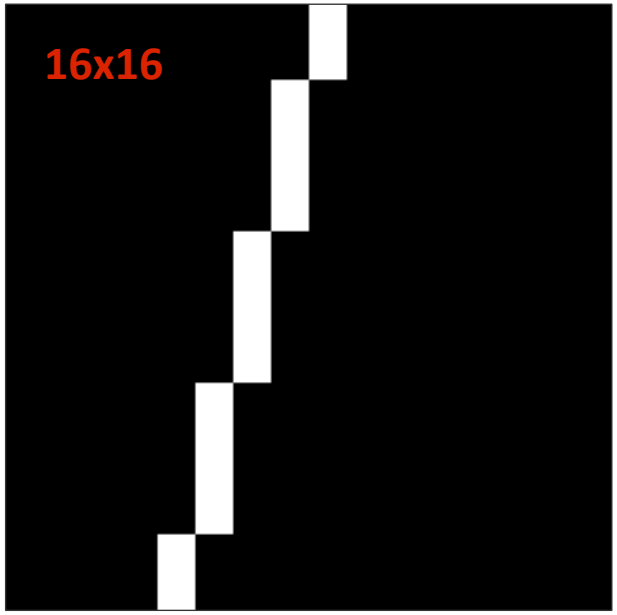
$$\frac{\partial f(x,y)}{\partial x} = \frac{f(x+1,y) - f(x-1,y)}{2}$$

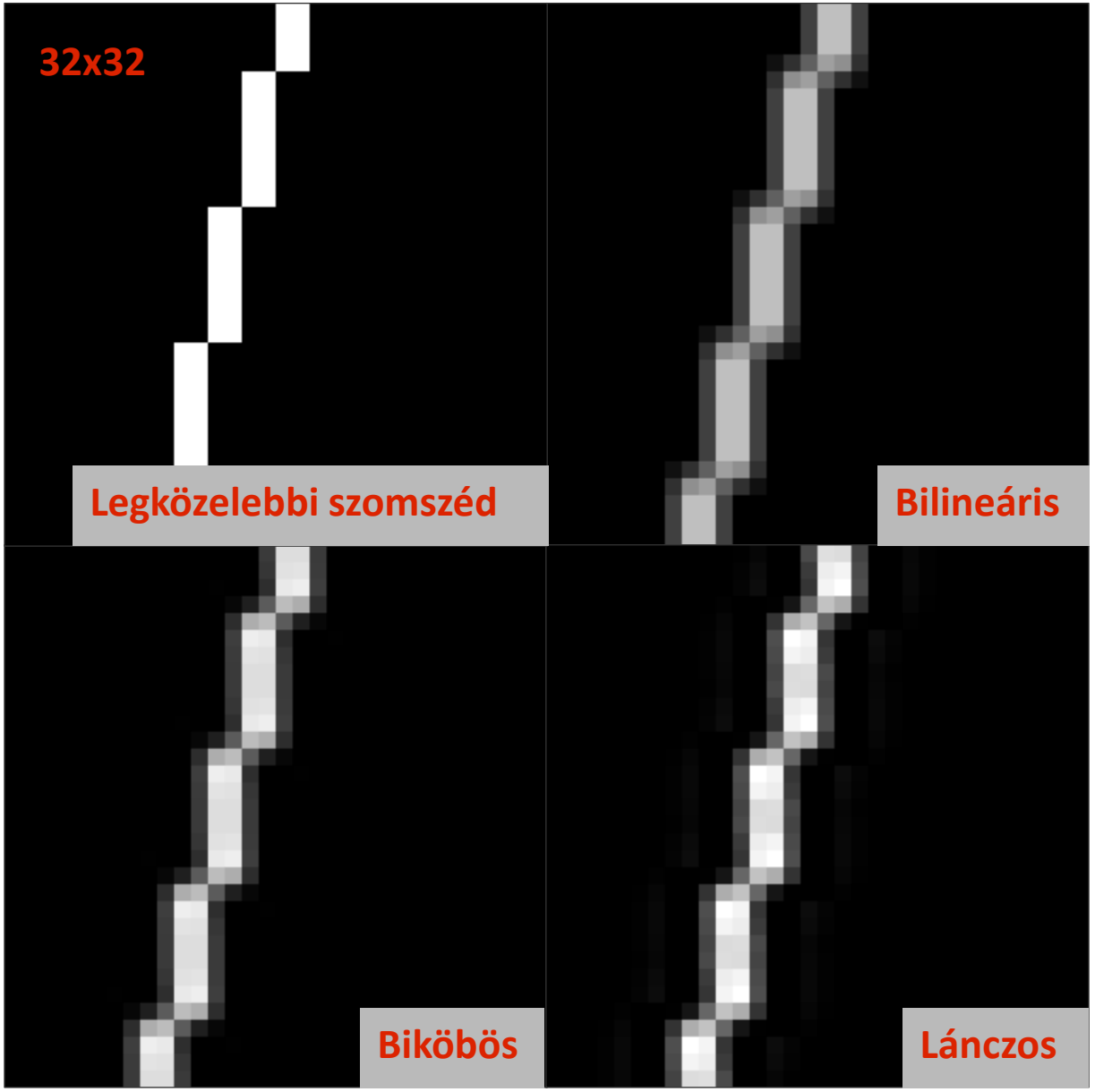
$$\frac{\partial f(x,y)}{\partial y} = \frac{f(x,y+1) - f(x,y-1)}{2}$$

$$\frac{\partial^2 f(x,y)}{\partial x \partial y} = \frac{f(x+1,y+1) - f(x-1,y) - f(x,y-1) + f(x,y)}{4}$$

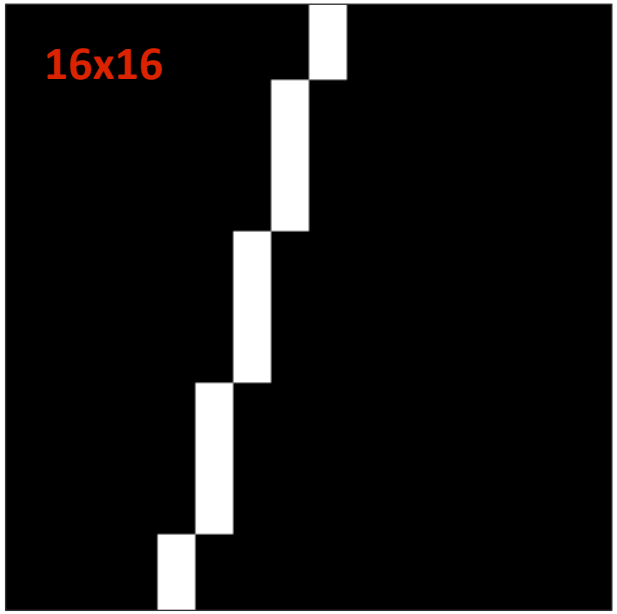


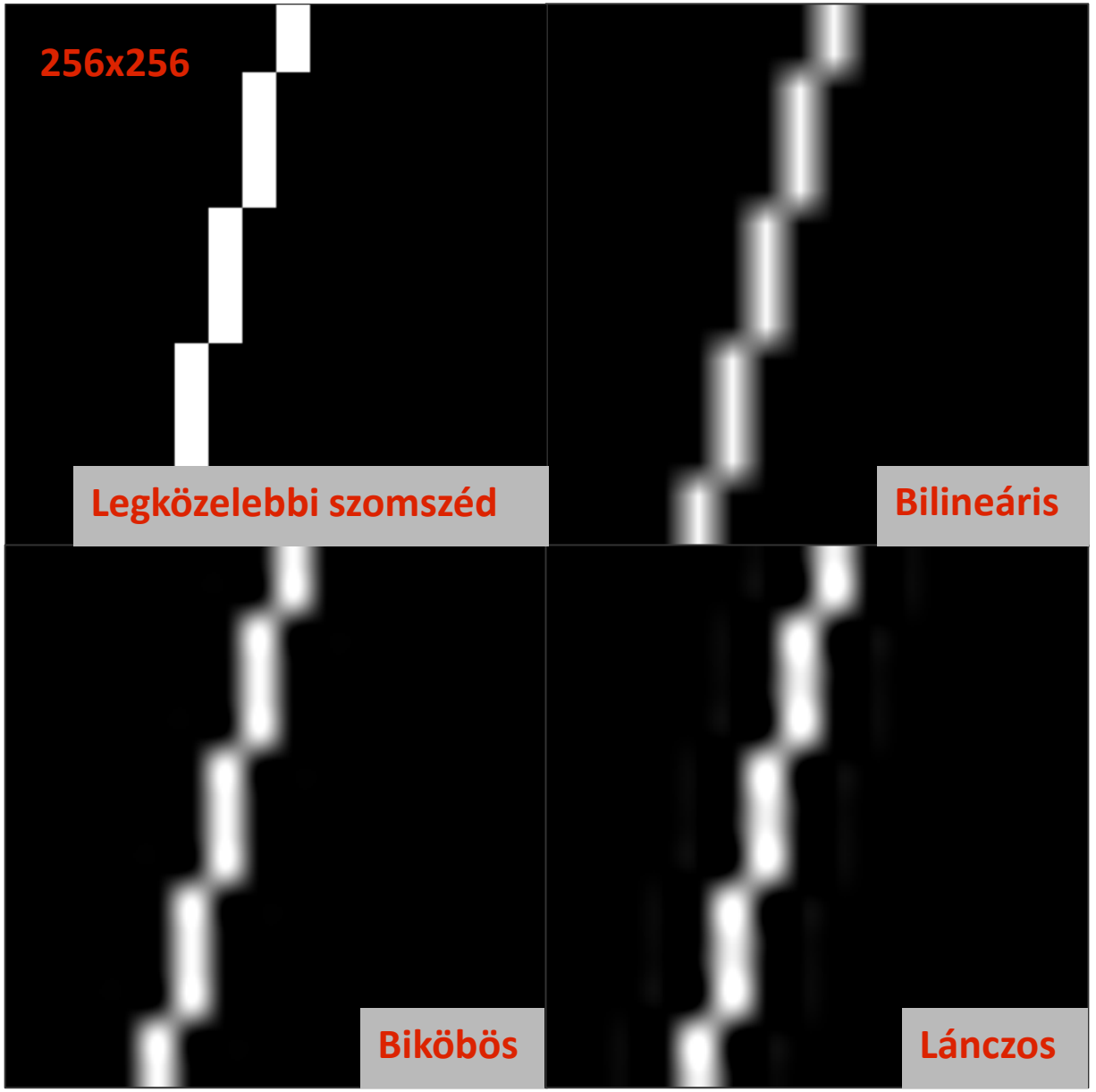
Interpoláció



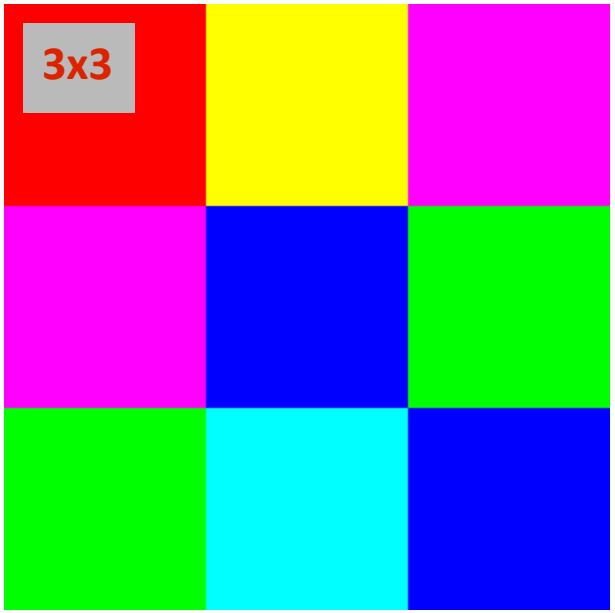


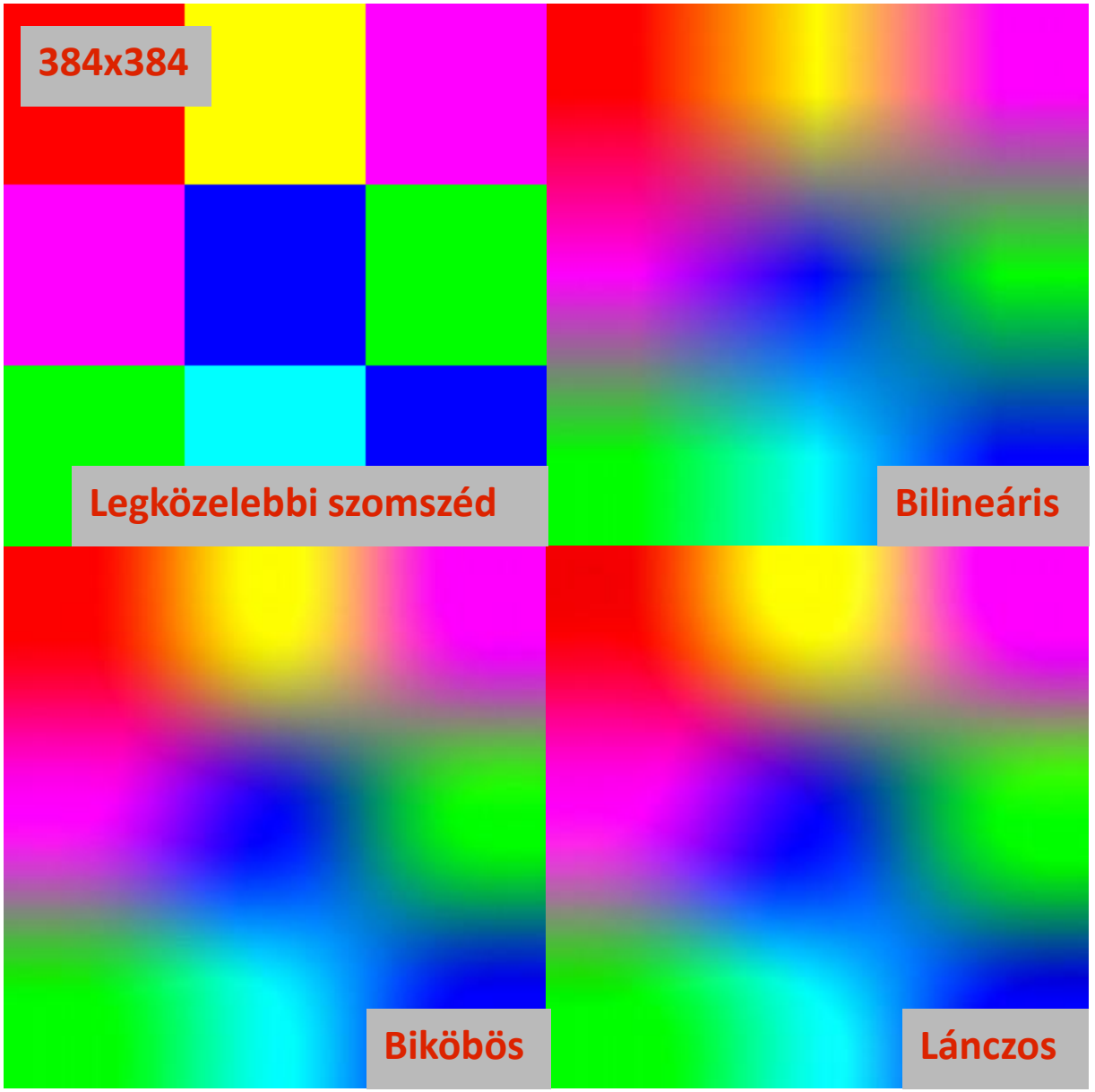
Interpoláció



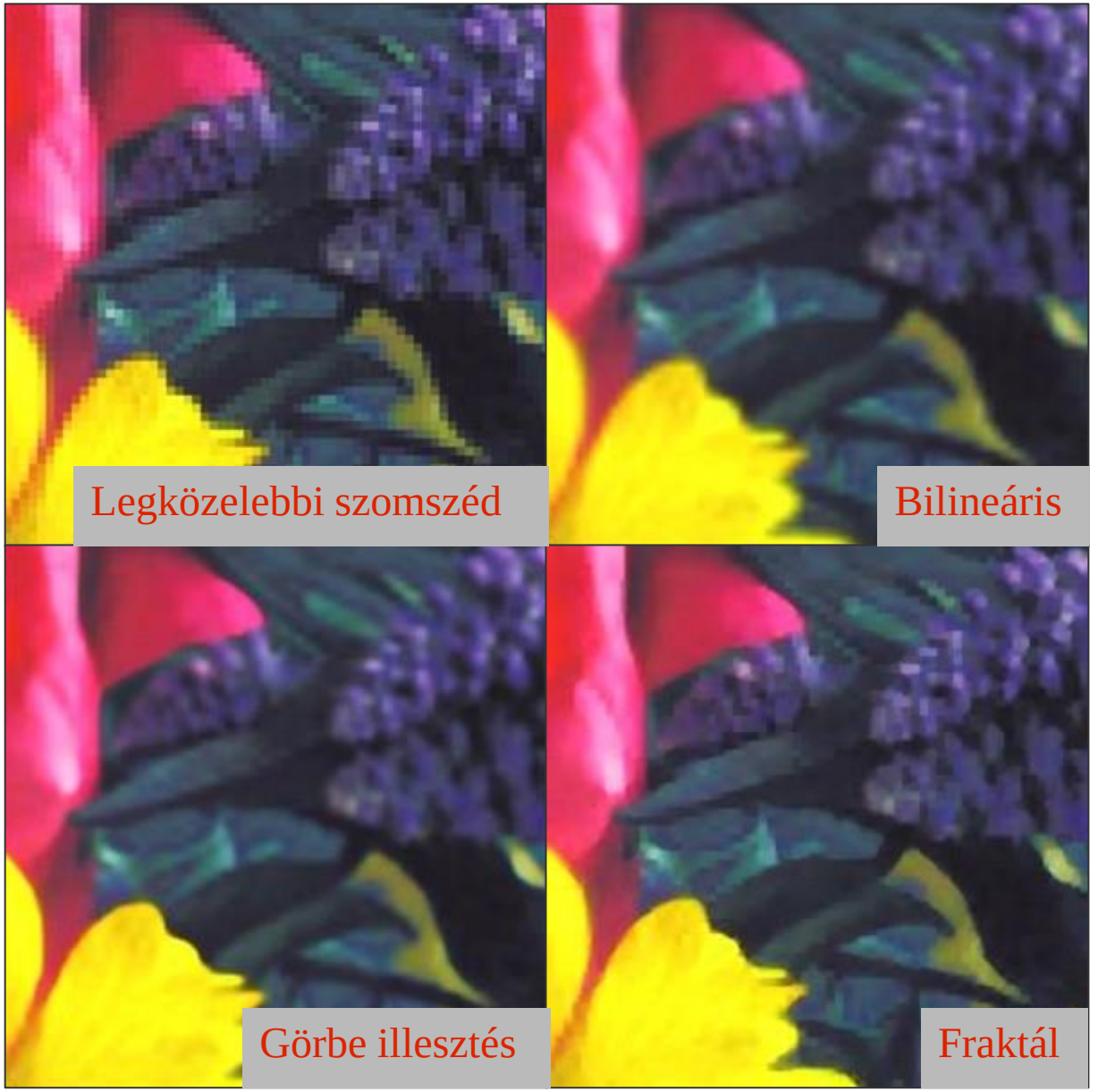


Interpoláció

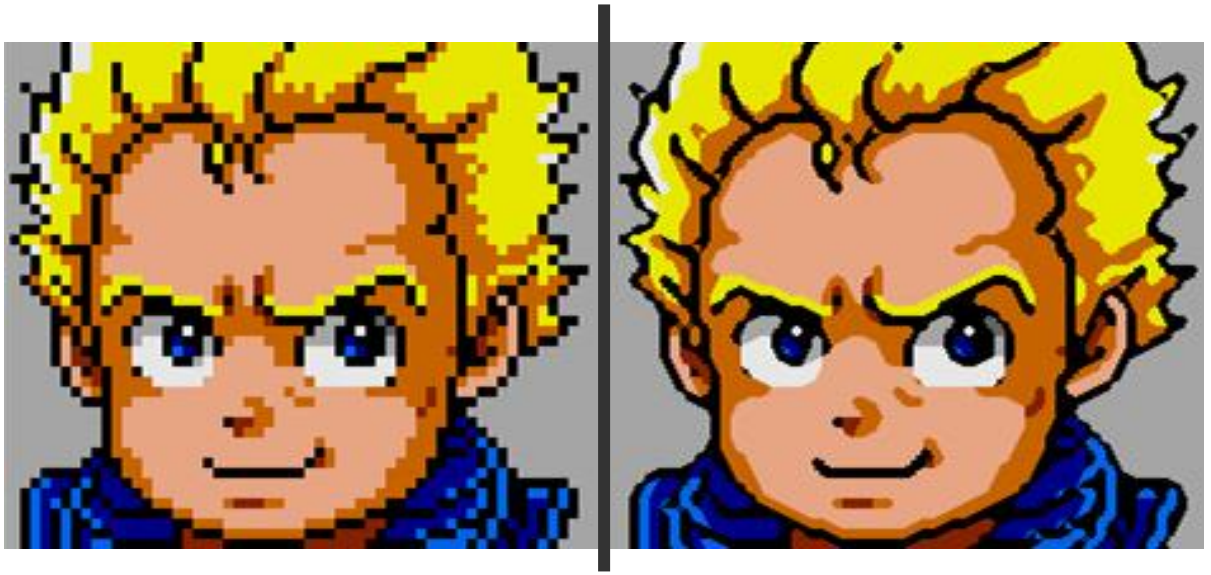


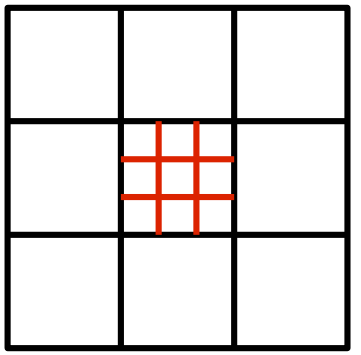


Komplex interpoláció

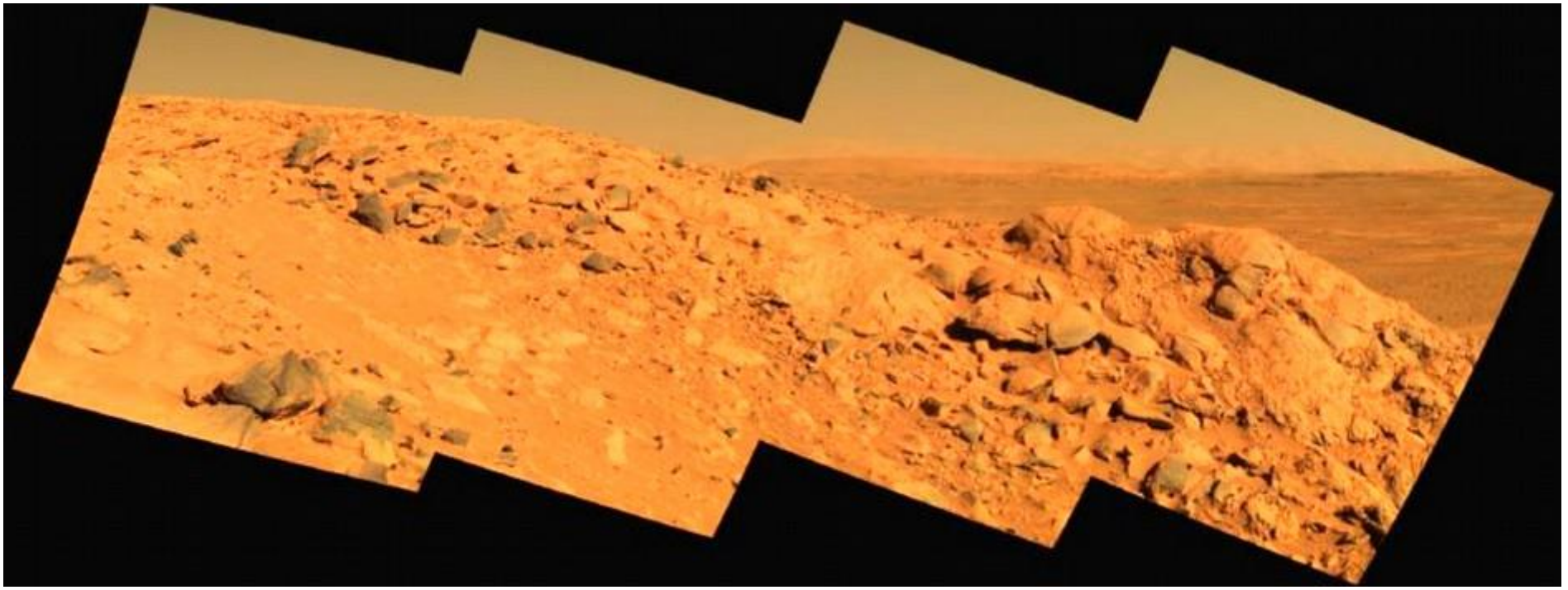


Scale2X, 3X, 4X

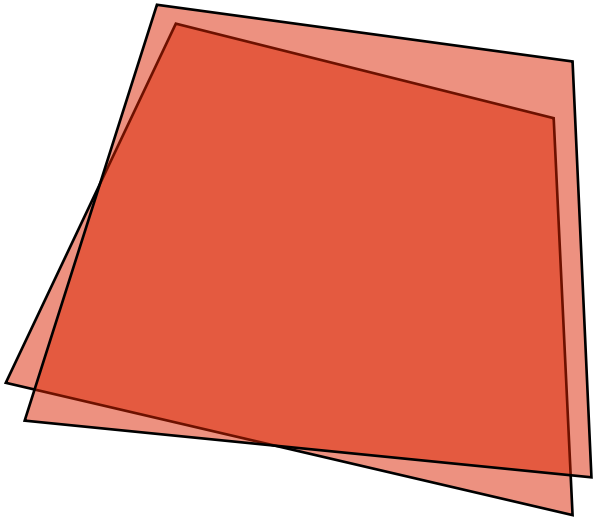




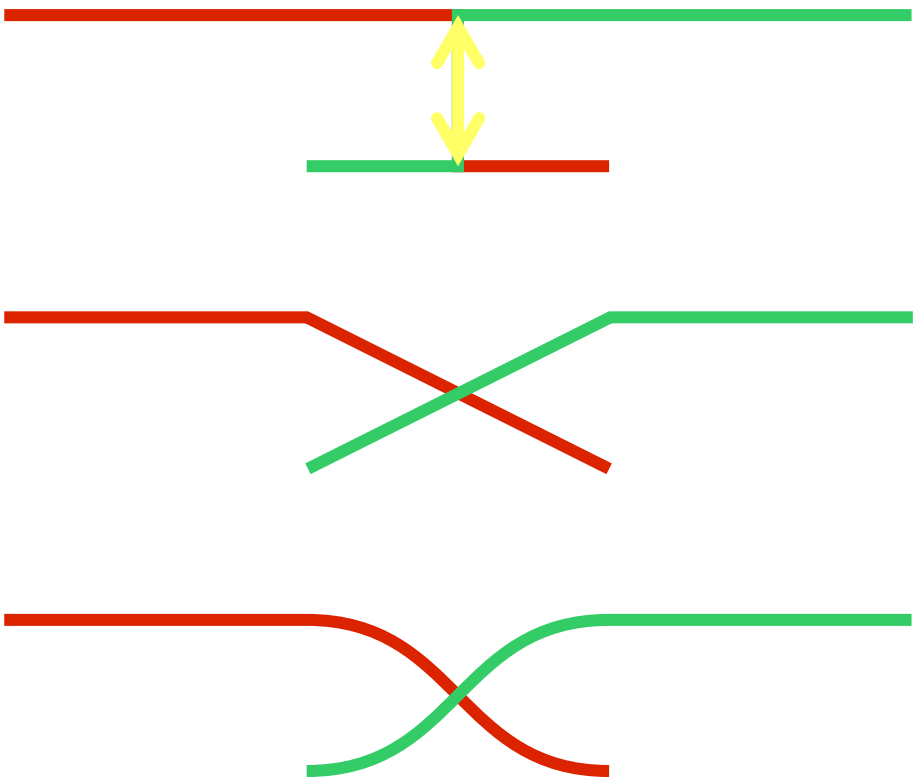
Illesztések



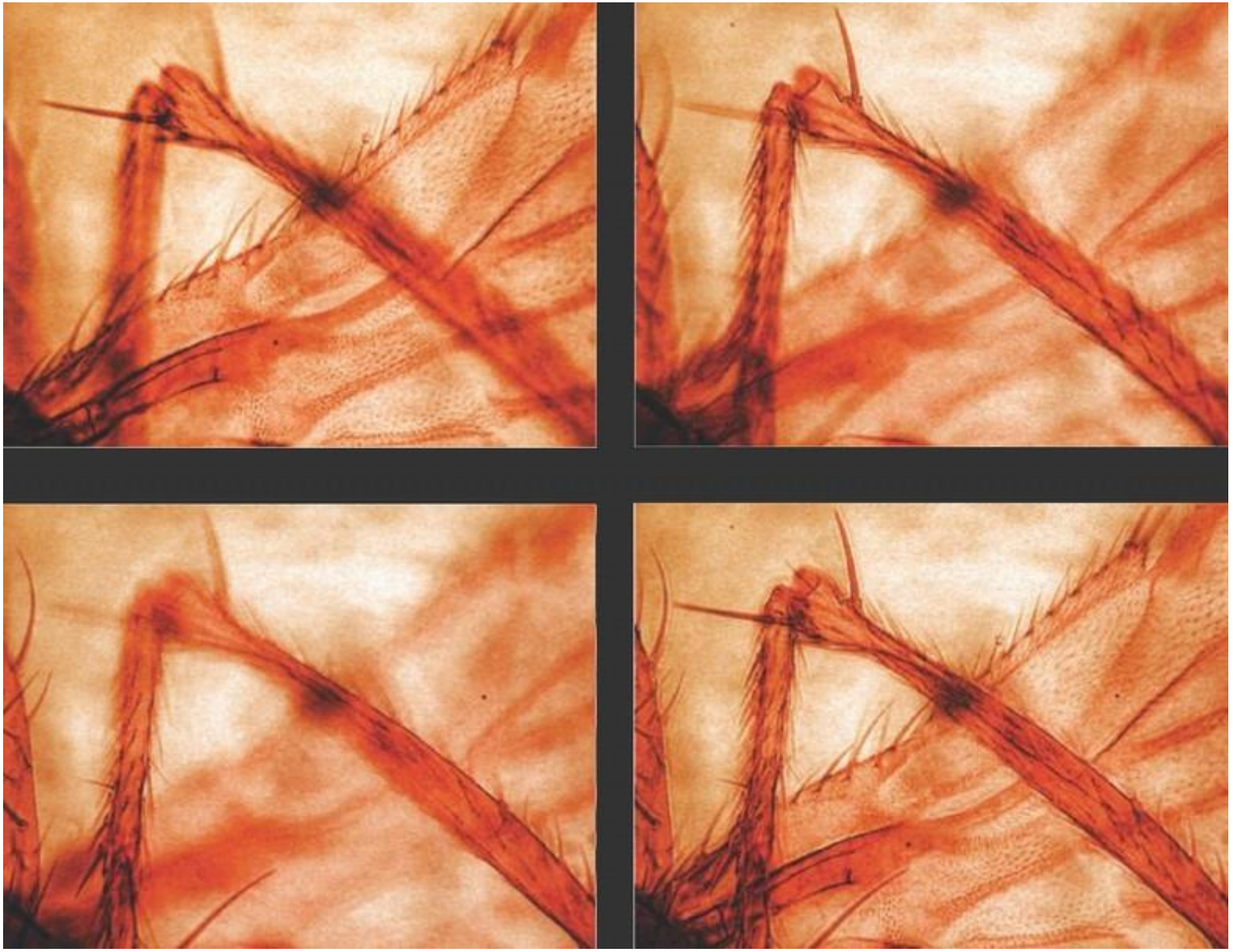
Átlapolódás



Átlapolódás



Kombináció – fókusz



Kombináció – világosság