INFO - H - 501

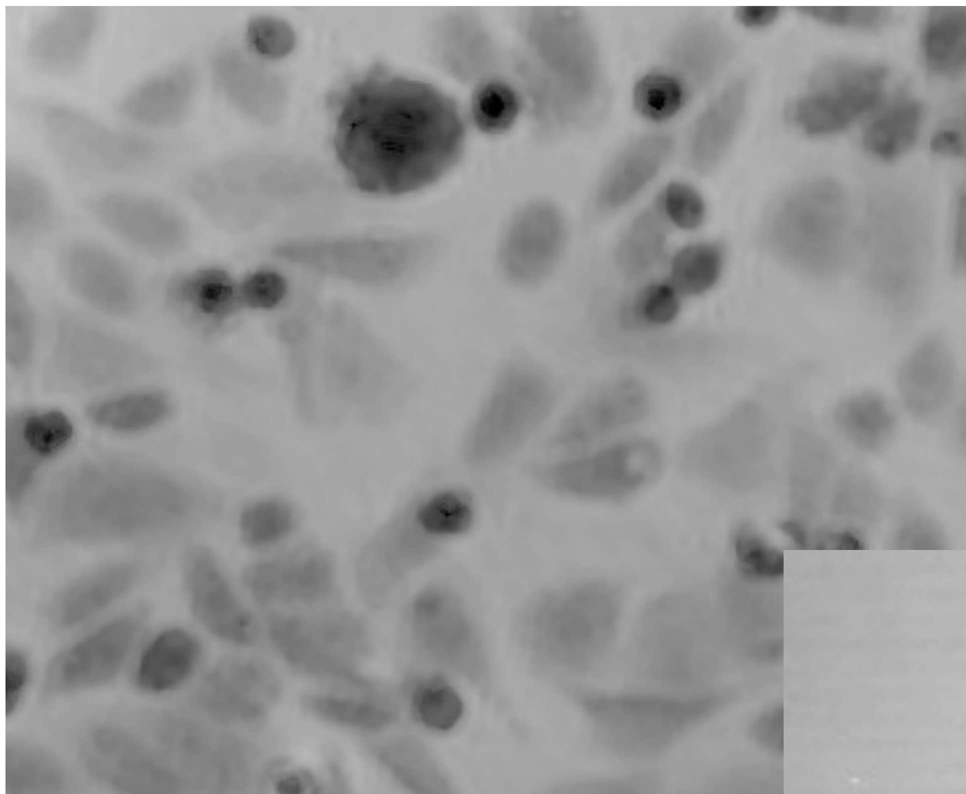
Pattern recognition and image analysis

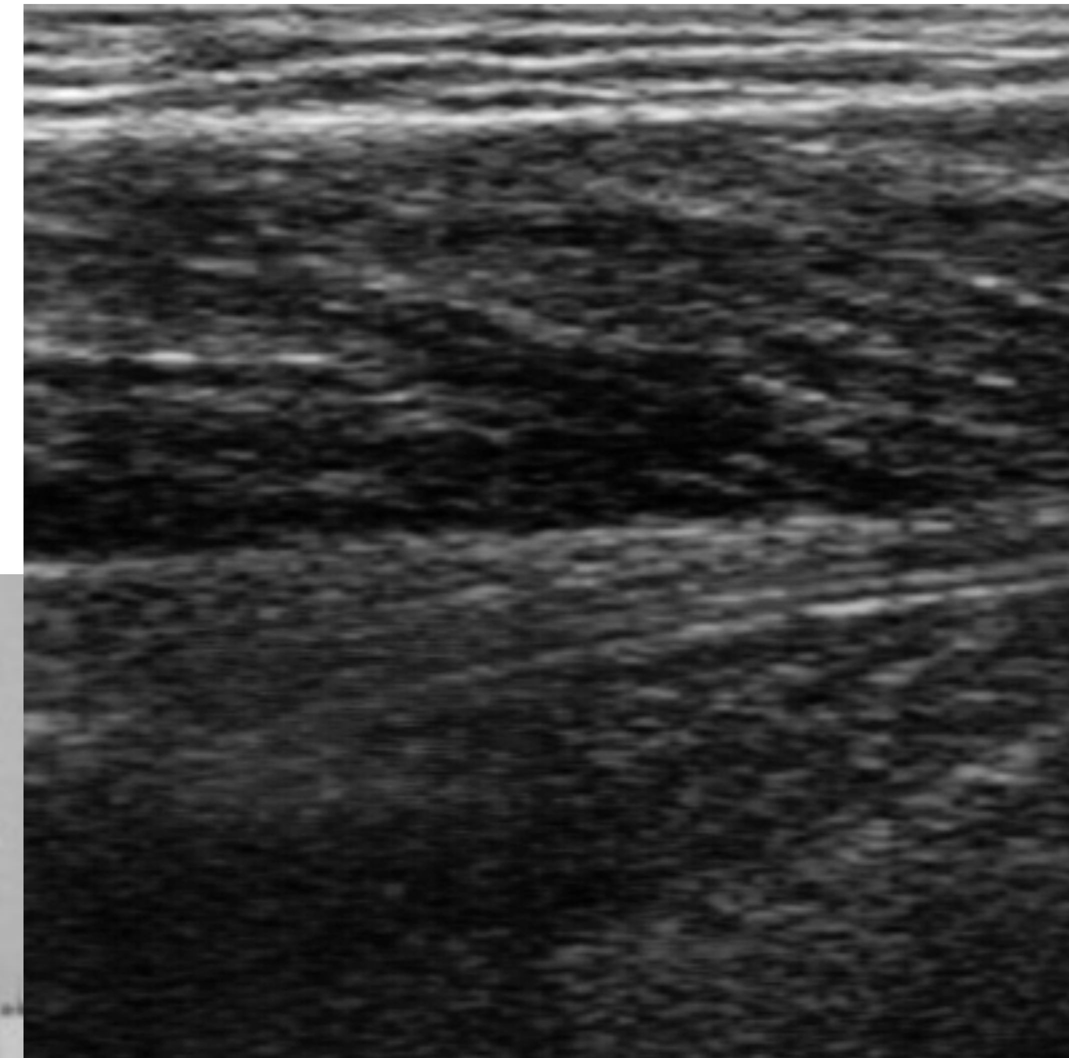
Texture description

Texture description

- fractal analysis: Hurst coeficient [IPH] 262,208
- spectral approach [DIP] p511
- Gabor filter [HCVA] vol2 p71
- edge-flow [Ma00]
- [DIPCASA] p185

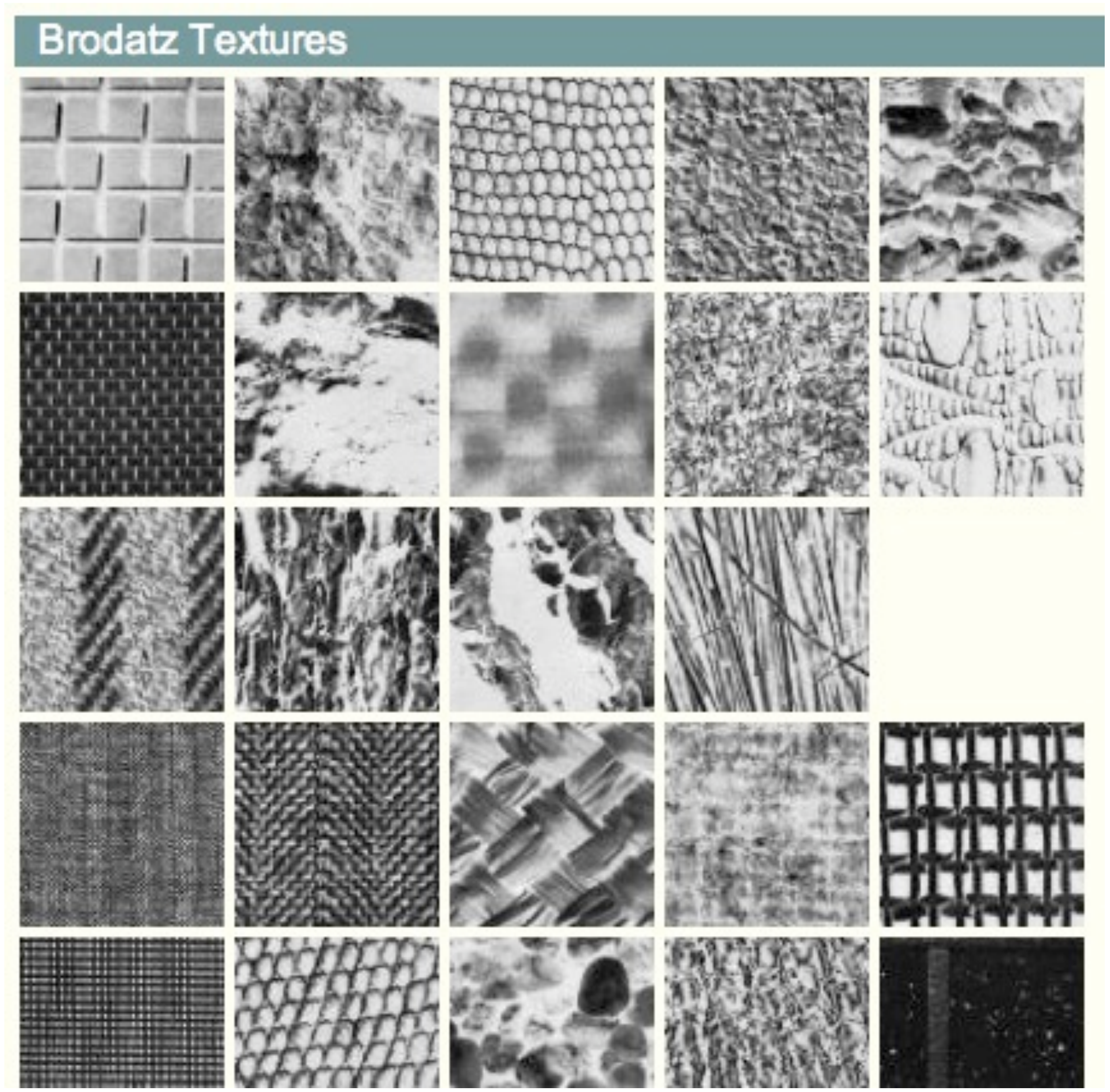
Texture





Texture

- related to region content
- e.g. gray-level dynamic
- e.g. gray-level organisation
- order :
  - first order : pixel alone
  - second order : one neighboor
  - third order : more than 1 pixel



http://www.ux.uis.no/~tranden/brodatz.html

Texture

- coocurence matrix

$$C_{\Delta x,\Delta y}(i,j) = \sum_{p=1}^{n}\sum_{q=1}^{m}\begin{cases}1, & \text{if } I(p,q) = i \text{ and } I(p+\Delta\ x, q+\Delta\ y) = j\\ 0, & \text{otherwise}\end{cases}$$

- normalization

$$P_{i,j} = \frac{C(i,j)}{\sum_{i,j=0}^{N-1} C(i,j)}$$

Texture

- contrast measures

$$Contrast = \sum_{i,j=0}^{N-1} P_{(i,j)}(i-j)^2$$

$$Dissimilarity = \sum_{i,j=0}^{N-1} P_{(i,j)}|i-j|$$

$$Homogeneity = \sum_{i,j=0}^{N-1} \frac{P_{(i,j)}}{1+(i-j)^2}$$

Texture

- organization measures

$$ASM = \sum_{i,j=0}^{N-1} P_{(i,j)}^2$$

$$Energy = \sqrt{ASM}$$

$$MaximumProbability(MAX)$$

$$entropy = -\sum_{i,j=0}^{N-1} P_{i,j}(\ln(P_{i,j}))$$

Texture

- statistical measures

$$\mu_i = \sum_{i,j=0}^{N-1} i P_{i,j}$$

$$\sigma_i^2 = \sum_{i,j=0}^{N-1} (i - \mu_i)^2 P_{i,j}$$

$$\mu_j = \sum_{i,j=0}^{N-1} j P_{i,j}$$

$$\sigma_j^2 = \sum_{i,j=0}^{N-1} (j - \mu_j)^2 P_{i,j}$$

$$correlation = \sum_{i,j=0}^{N-1} P_{i,j} \frac{(i - \mu_i)(j - \mu_j)}{\sqrt{\sigma_i^2 \sigma_j^2}}$$

Texture

- Gabor filters
  - λ wave length
  - θ orientation
  - ψ phase
- σ gaussian envelope
- γ form factor

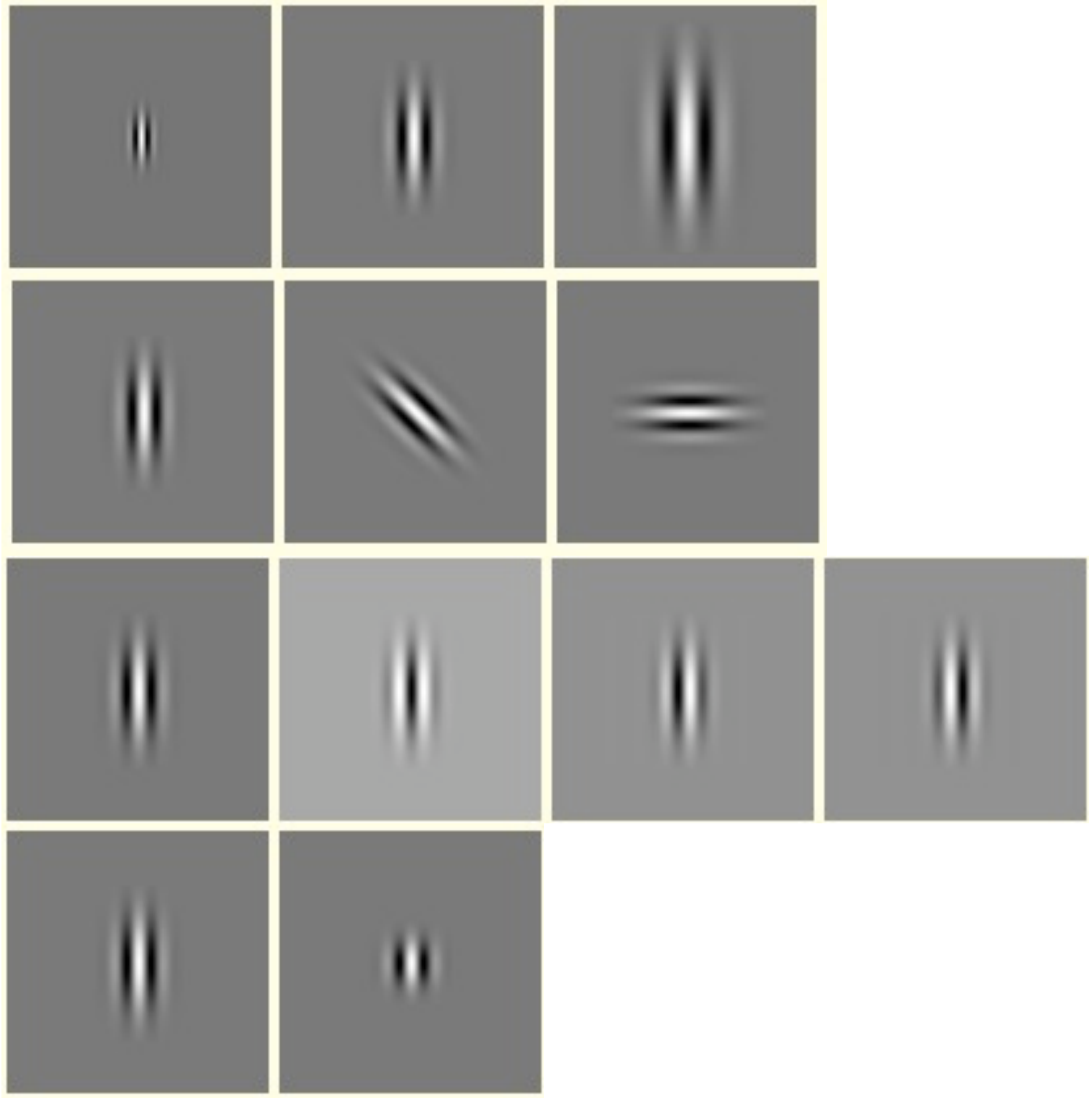
$$g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp\left(-\frac{x'^2 + \gamma^2 y'^2}{2\sigma^2}\right)\cos\left(2\pi\frac{x'}{\lambda} + \psi\right)$$

$$x' = x\cos\theta + y\sin\theta$$

$$y' = -x\sin\theta + y\cos\theta$$

Texture

- scale
- orientation
- phase
- aspect ratio



Texture

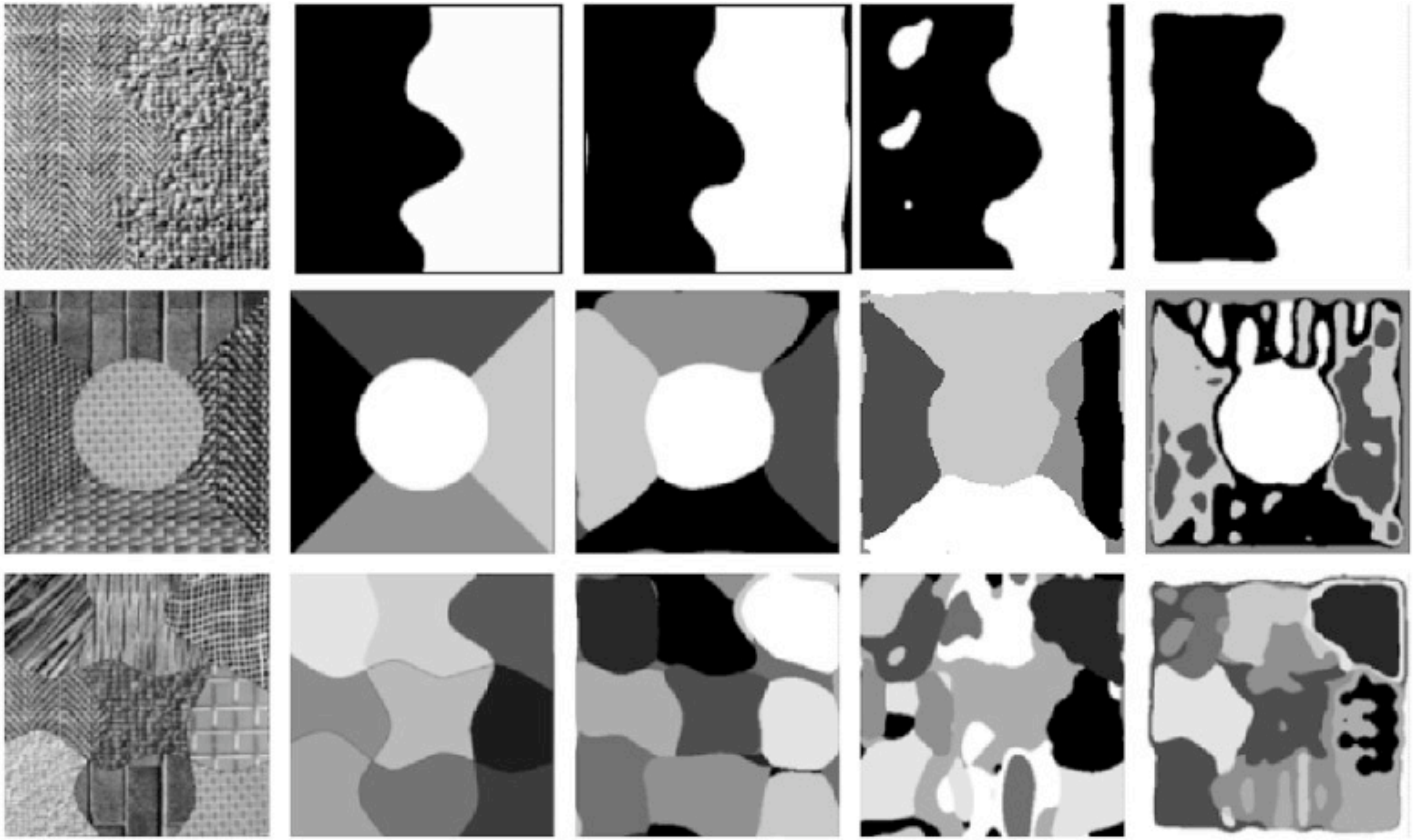


Fig. 14. Results of segmentation experiments using the K-means clustering algorithm. The left-most column shows three input images containing two, five, and nine textures. The second column shows the exact segmentation of the input images (i.e., the so-called ground truth). The three right-most columns show the segmentation results (using $K = 2$, $K = 5$, and $K = 9$ for the respective rows) based on the grating cell operator (middle column), the Gabor-energy operator (second column from the right), and the co-occurrence matrix operator (right-most column).

P. Kruizinga and N. Petkov: Non-linear operator for oriented texture, *IEEE Trans. on Image Processing*, **8** (10), 1999, 1395-1407.

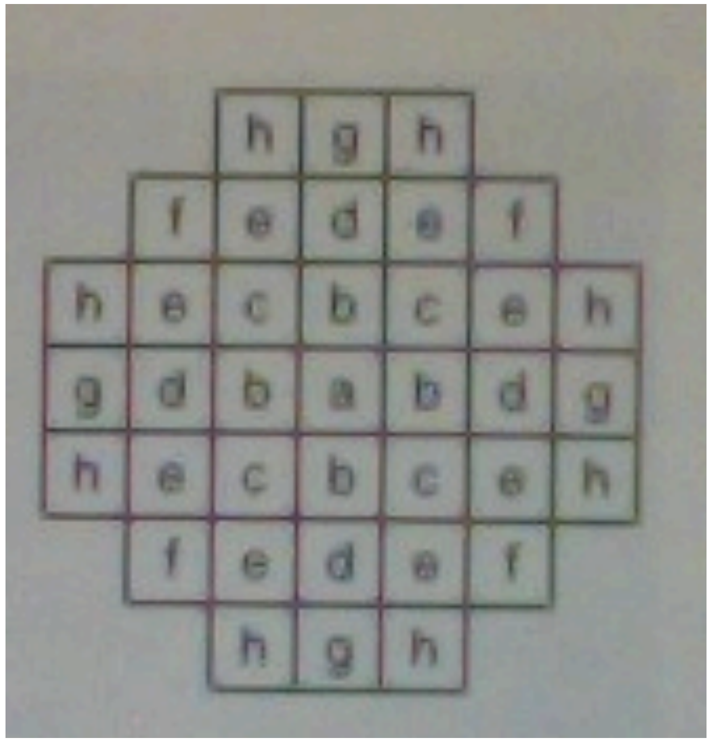
Hurst coeficient

Hurst coeficient

- compute local max and min (typ. on a 7 pixel octogonal neighbourhood)
- log (difference) vs log (distance)
- least square fitting

Hurst coeficient

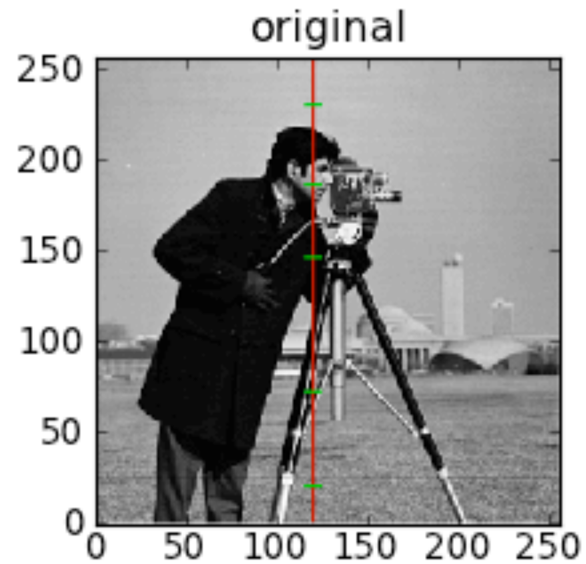
pixel	#	distance
a	1	0
b	4	1
c	4	1.414
d	4	2
e	8	2.236
f	4	2.828
g	4	3
h	8	3.162

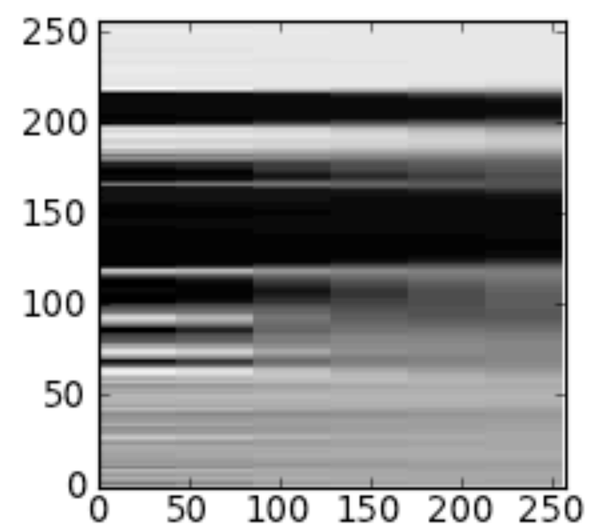


Fractal analysis

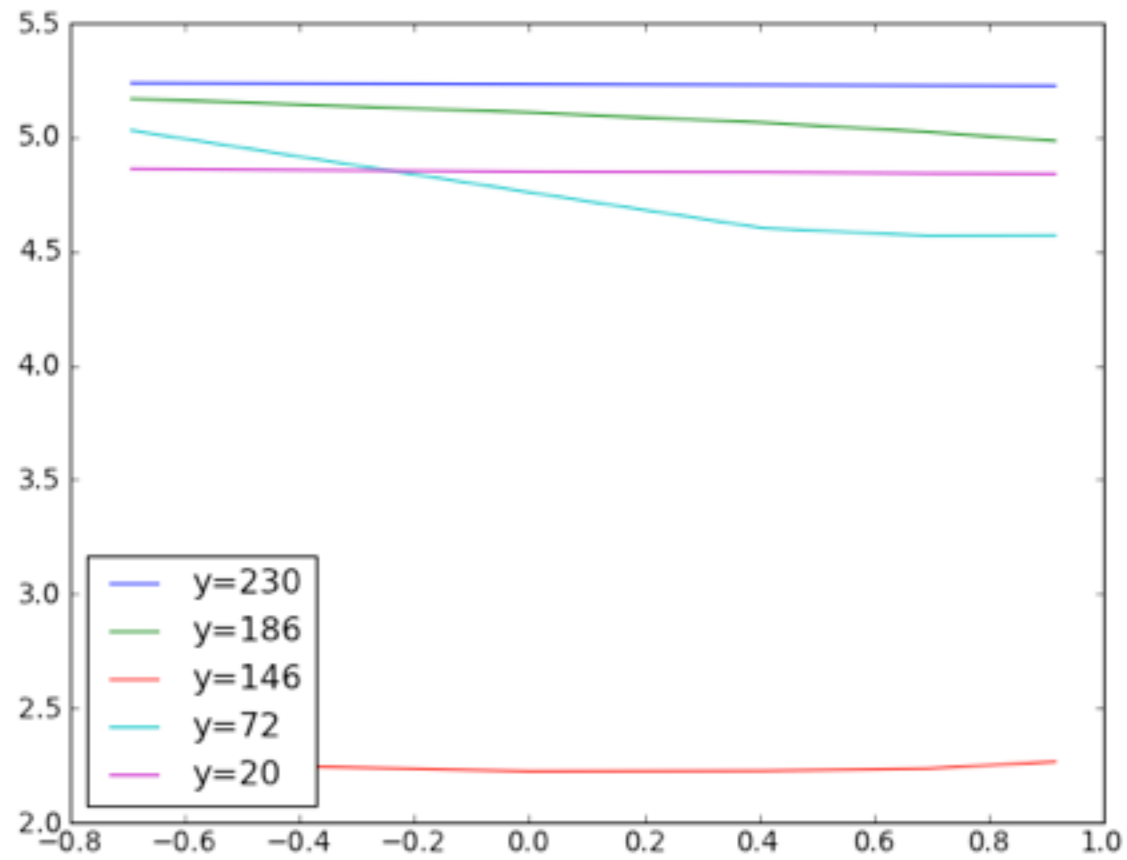
Fractal analysis

- value of the image filtered by a gaussian filter
- log/log plot of the pixel value with respect to the sigma of the filter



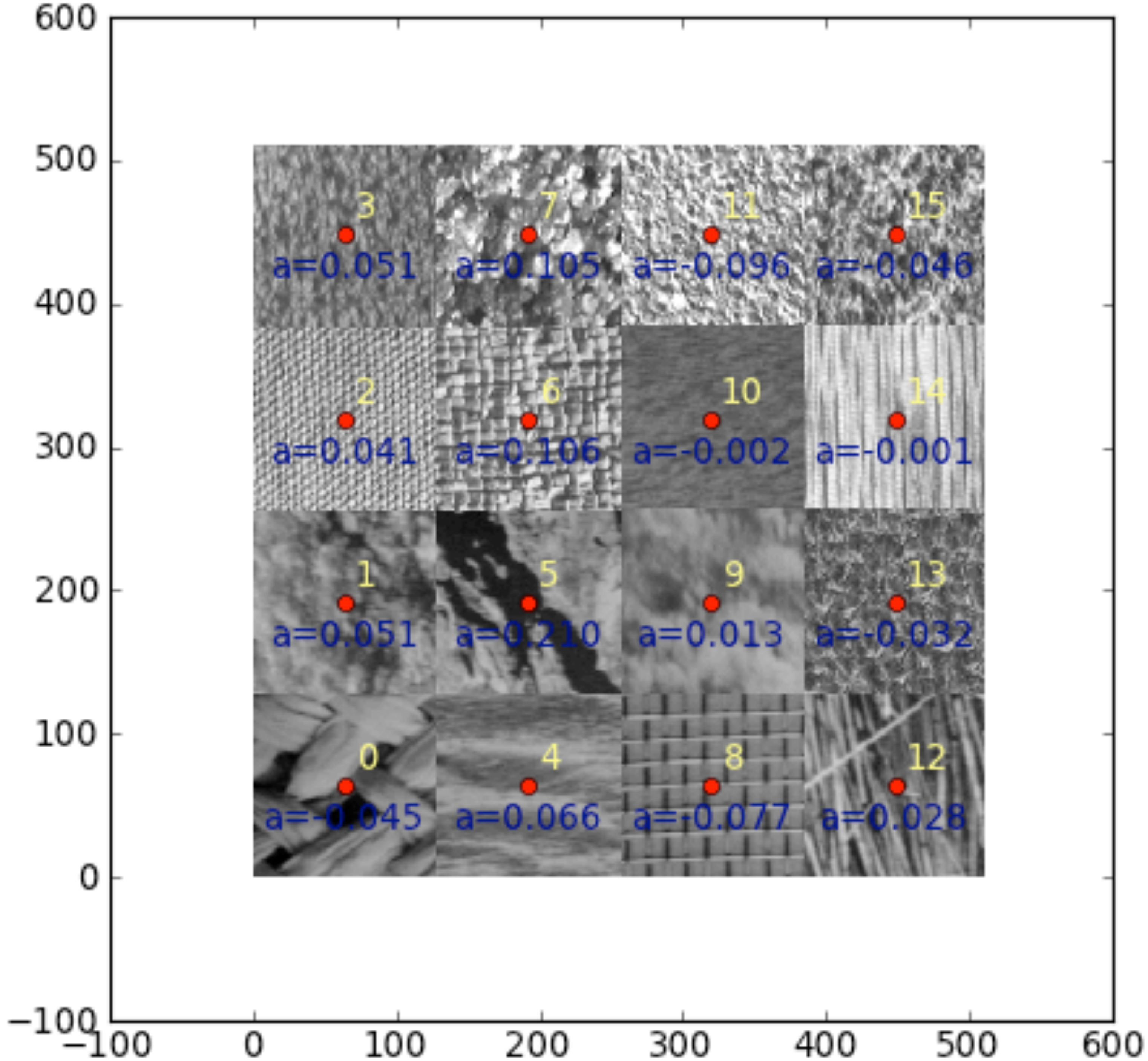


Fractal analysis

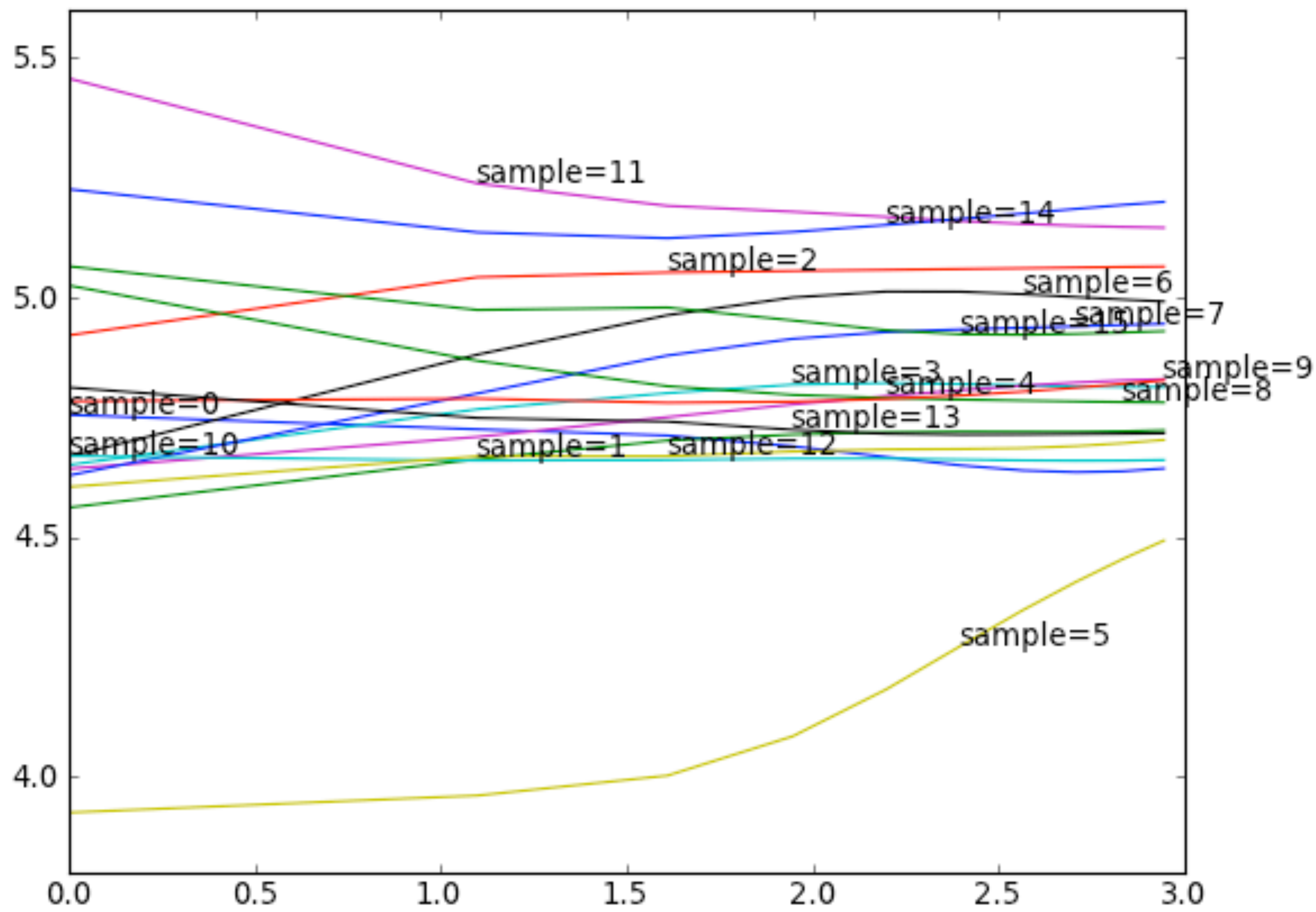


- linear fitting of the curve

Fractal analysis

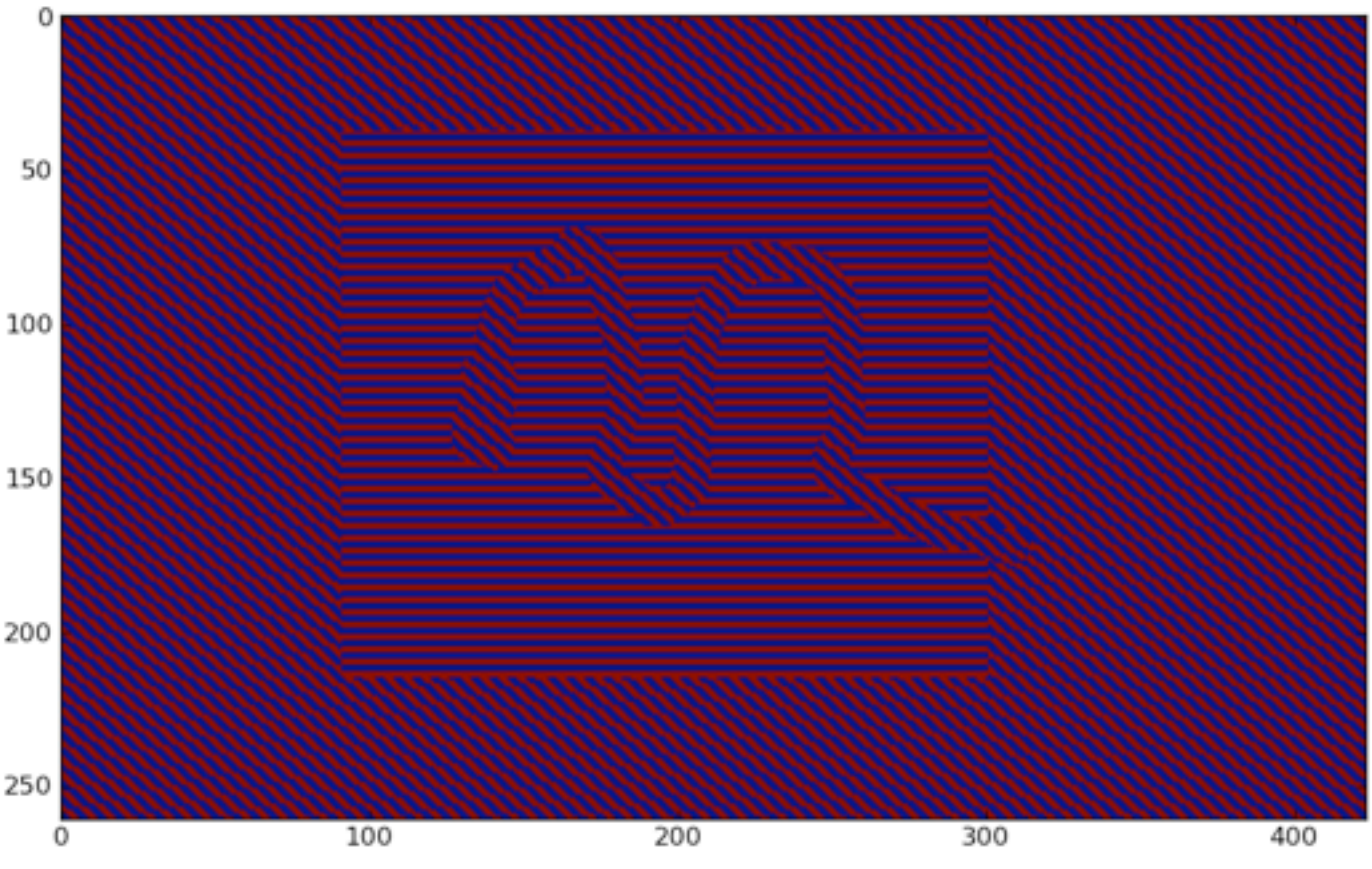


Fractal analysis



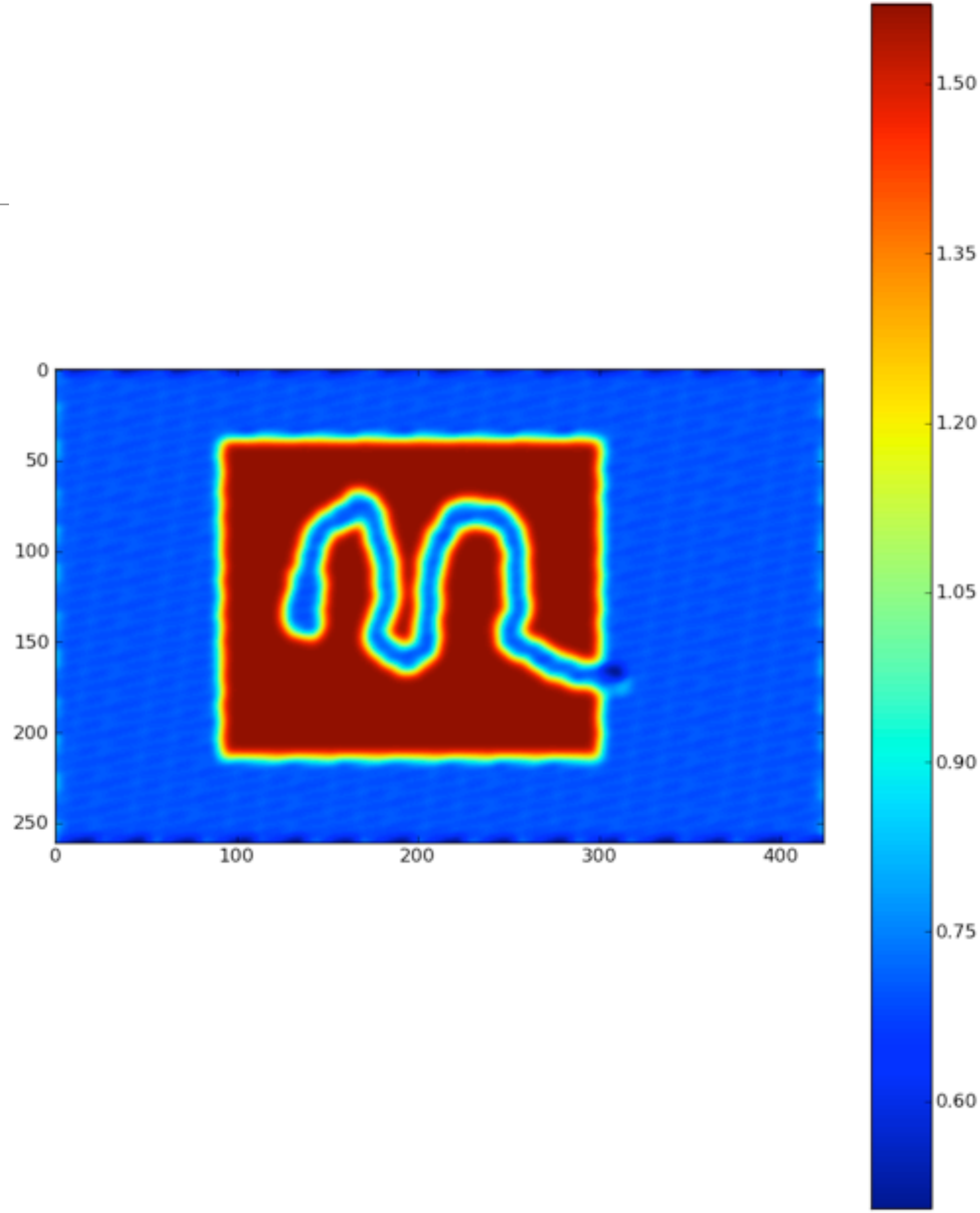
Example

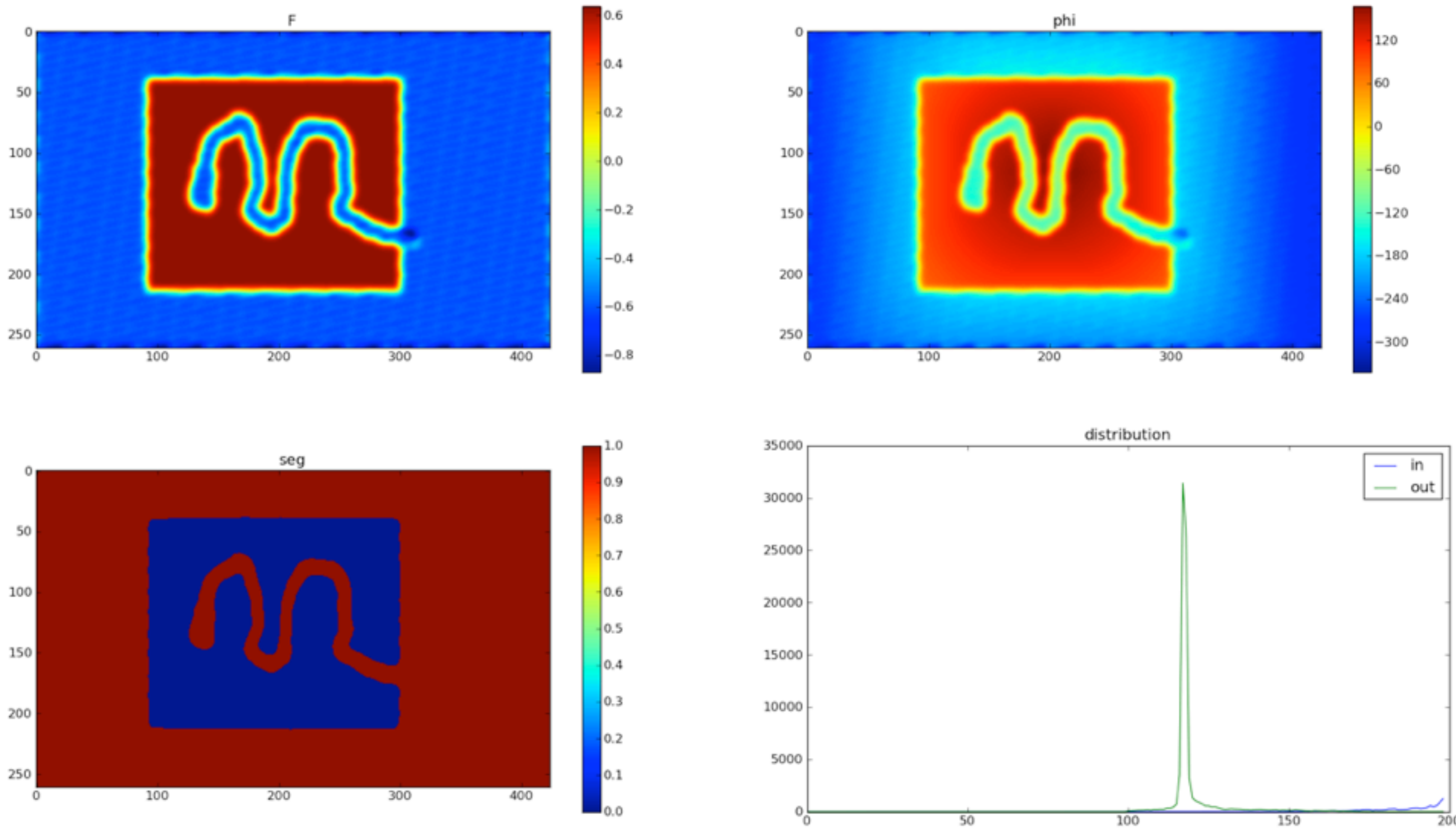
Example

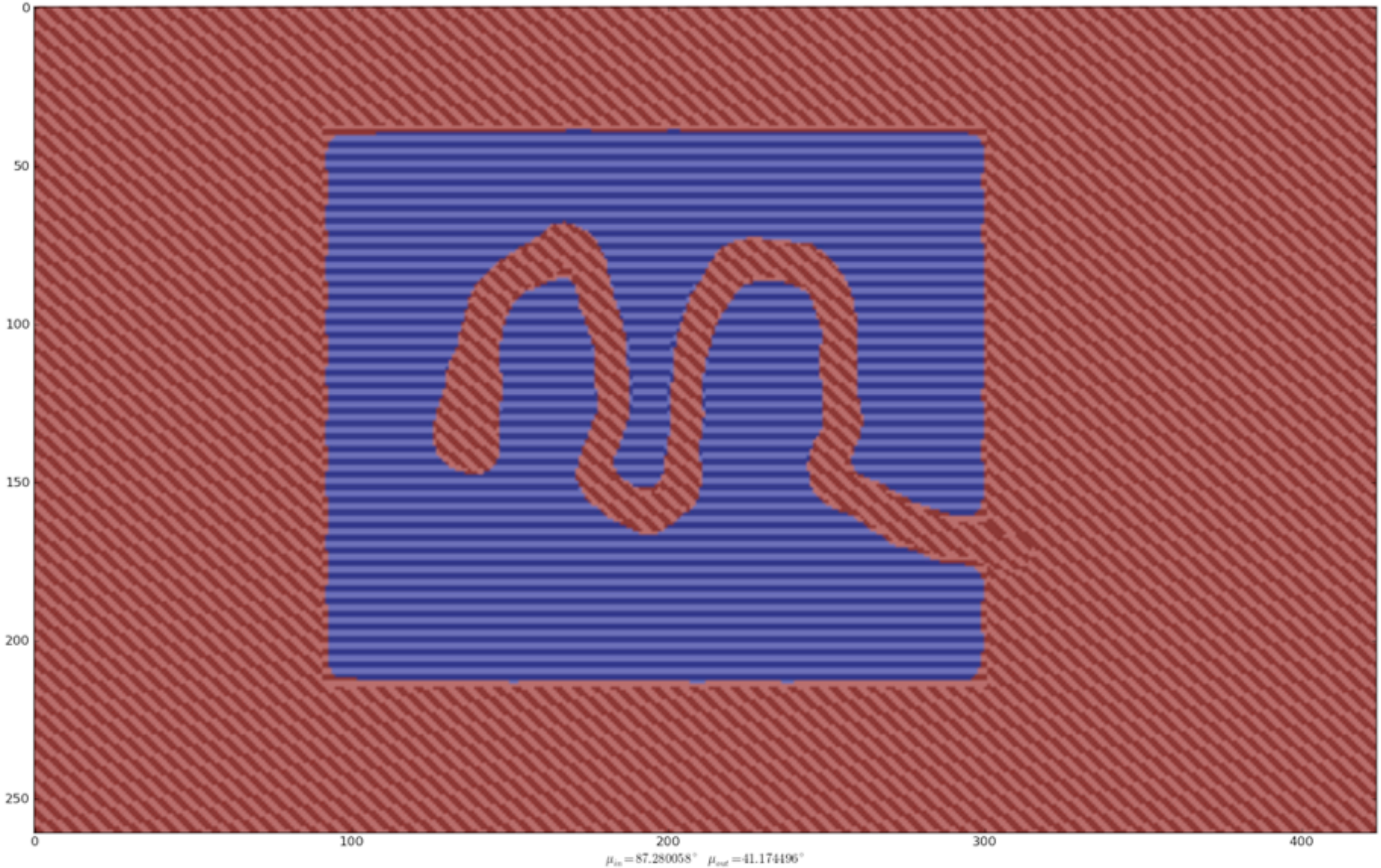


Example

- Ix x derivative of I
- Iy y derivative of I
- a = arctan (Iy,Ix)
- + gaussian filter




F
phi
seg
distribution
in
out


0
50
100
150
200
250
0
100
200
300
400
$\mu_{in} = 87.280058^\circ$ $\mu_{out} = 41.174496^\circ$