Categorizing the Topological Image Landscape with Local Binary Patterns

Martin Cerman

Advisors: Walter G. Kropatsch
Yll Haxhimusa

066 932 Visual Computing

FACULTY OF !NFORMATICS

Original image
(481x321 = 154401 pixels)

94% merged pixels
(9264 regions)

Martin Cerman

FACULTY OF !NFORMATICS

- Proposed in 1996 as a texture descriptor [Ojala96]

- Describes texture around each pixel in an image as a decimal number

$$LBP = \sum_{i=0}^{7} s(g(p_i) - g(c)) \cdot 2^i \qquad s(x) = \begin{cases} 1, & if\ x \geq 0 \\ 0, & if\ x < 0 \end{cases}$$

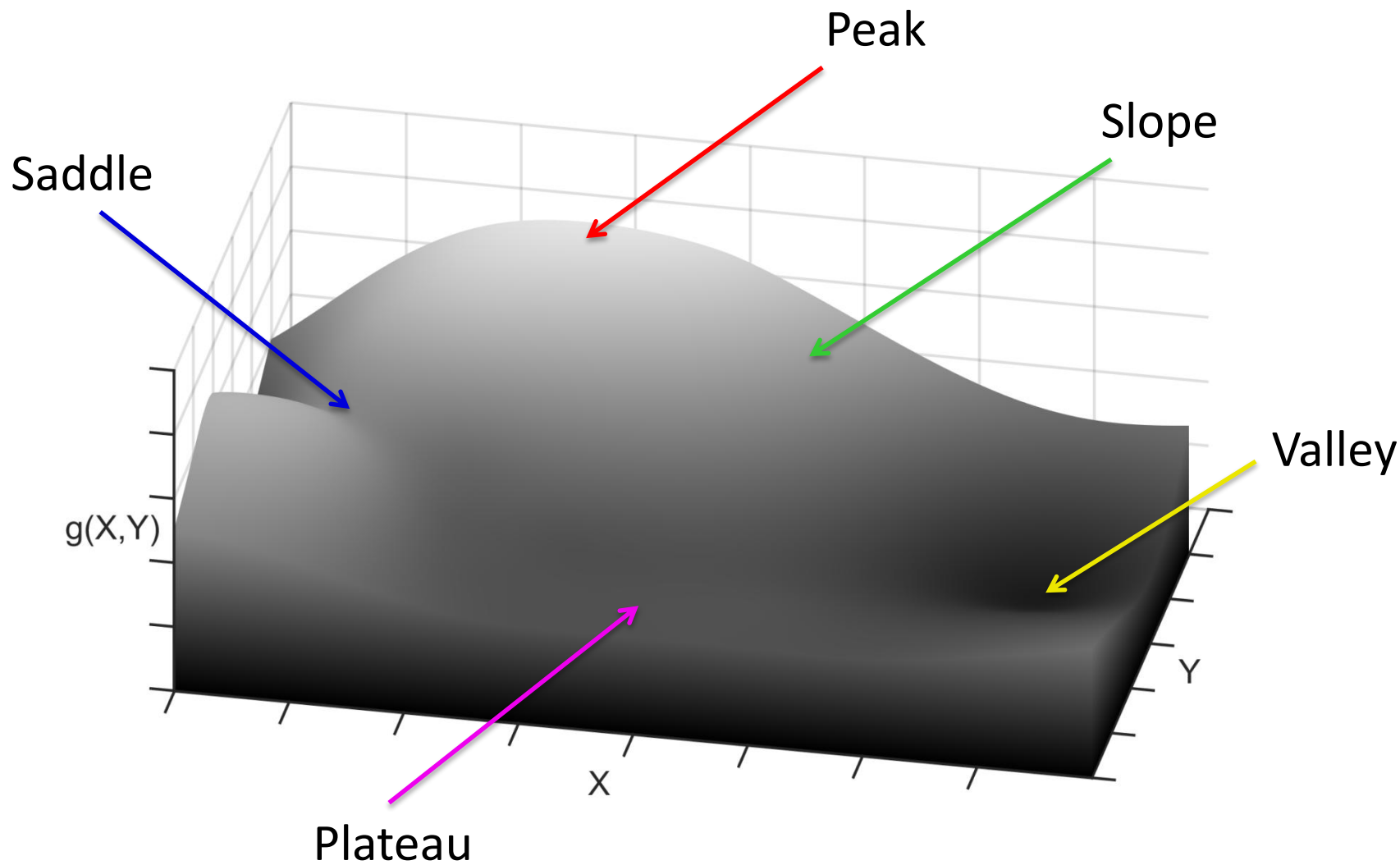| 1	5	9
4	5	3
8	4	7

Martin Cerman

FACULTY OF !NFORMATICS

Image from http://www.onlineeducationincanada.com/

Martin Cerman

FACULTY OF !NFORMATICS

CONTINUOUS IMAGE LANDSCAPE

Peak

Slope

Saddle

Valley

$g(X,Y)$

Y

X

Plateau

Martin Cerman

FACULTY OF !NFORMATICS

LOCAL MAXIMA
LOCAL MINIMA
PLATEAUS
SADDLES
SLOPES

5

Martin Cerman

FACULTY OF !NFORMATICS

Martin Cerman

FACULTY OF !NFORMATICS

LOCAL MINIMA

g(X,Y)

X

Y

Martin Cerman

FACULTY OF !NFORMATICS

LOCAL MAXIMA
LOCAL MINIMA
PLATEAUS
SADDLES
SLOPES

g(X,Y)

X

Y

Martin Cerman

FACULTY OF !NFORMATICS

SADDLES

Martin Cerman

FACULTY OF !NFORMATICS

SLOPES

Martin Cerman
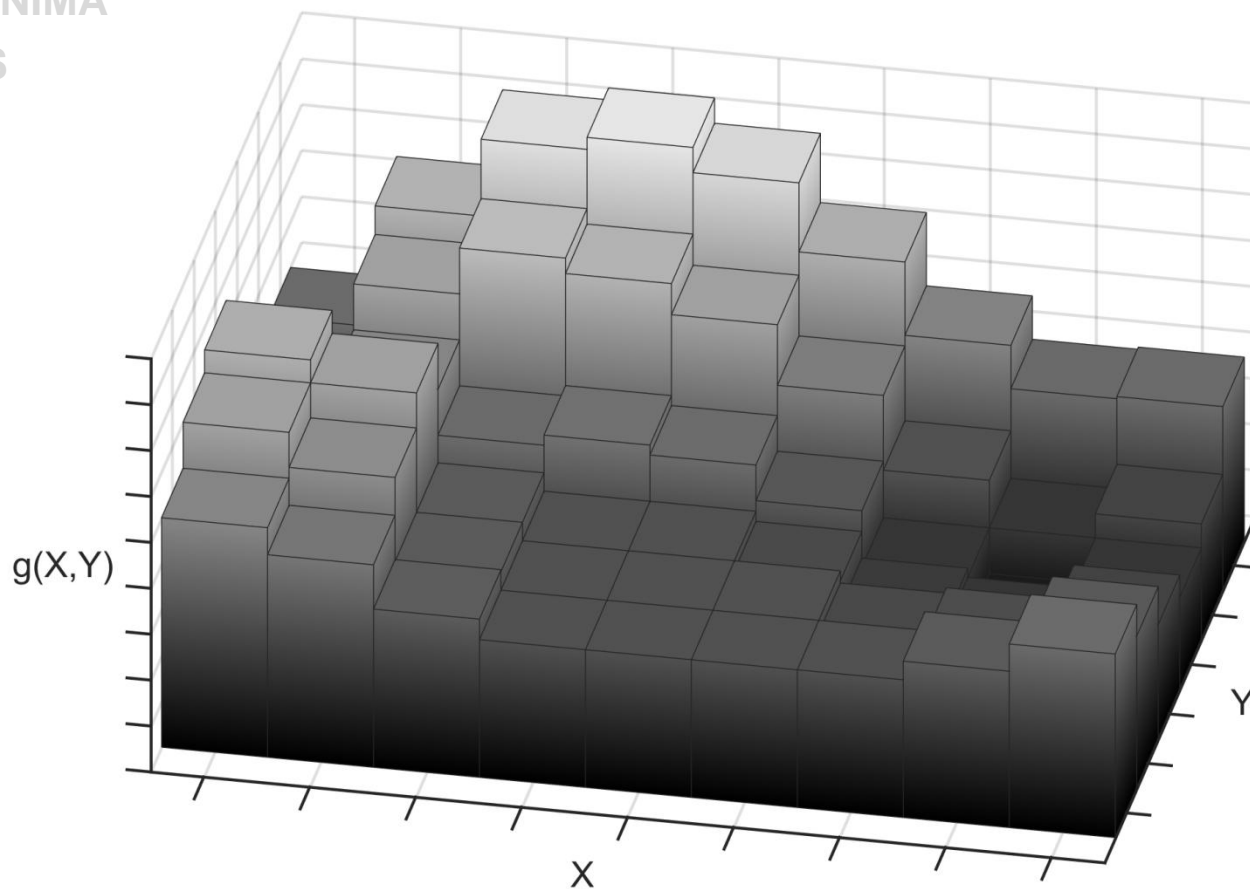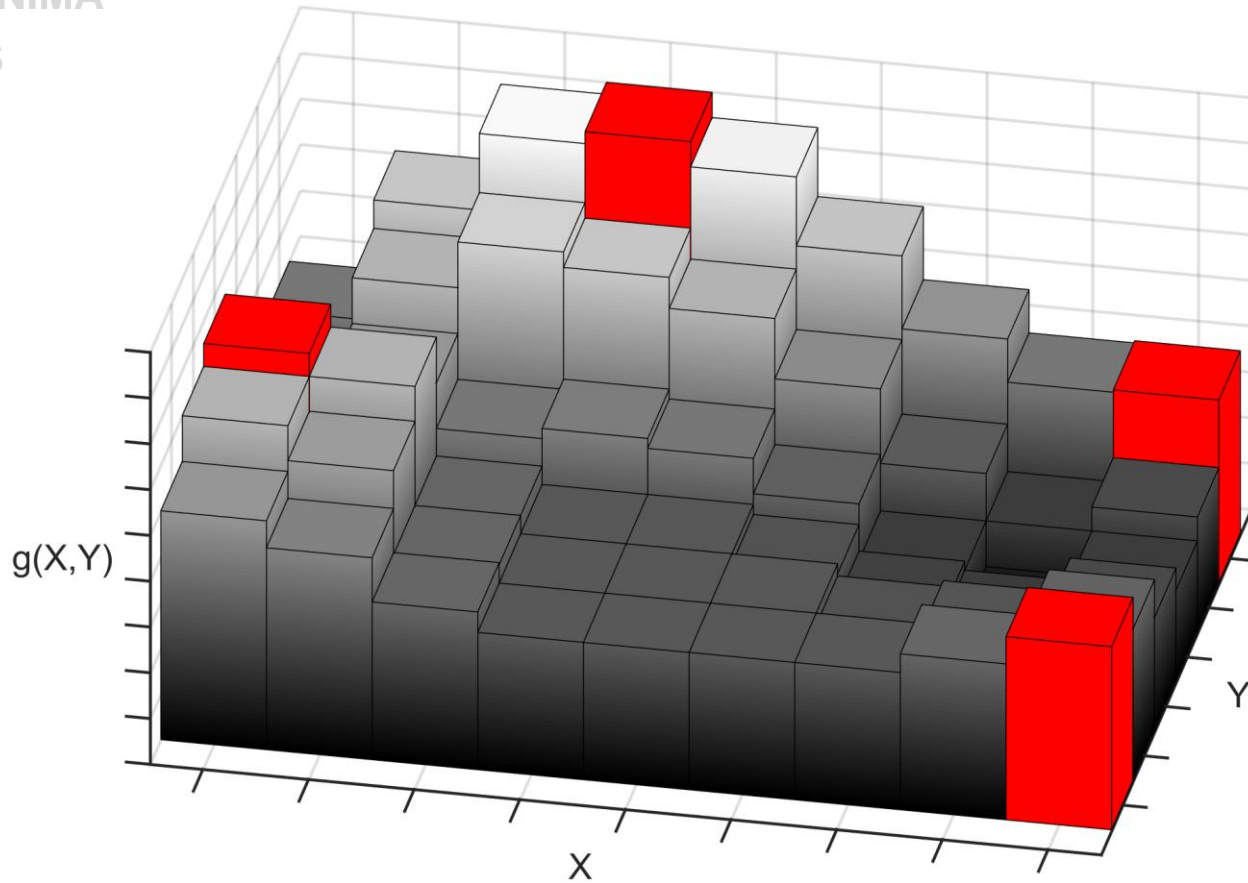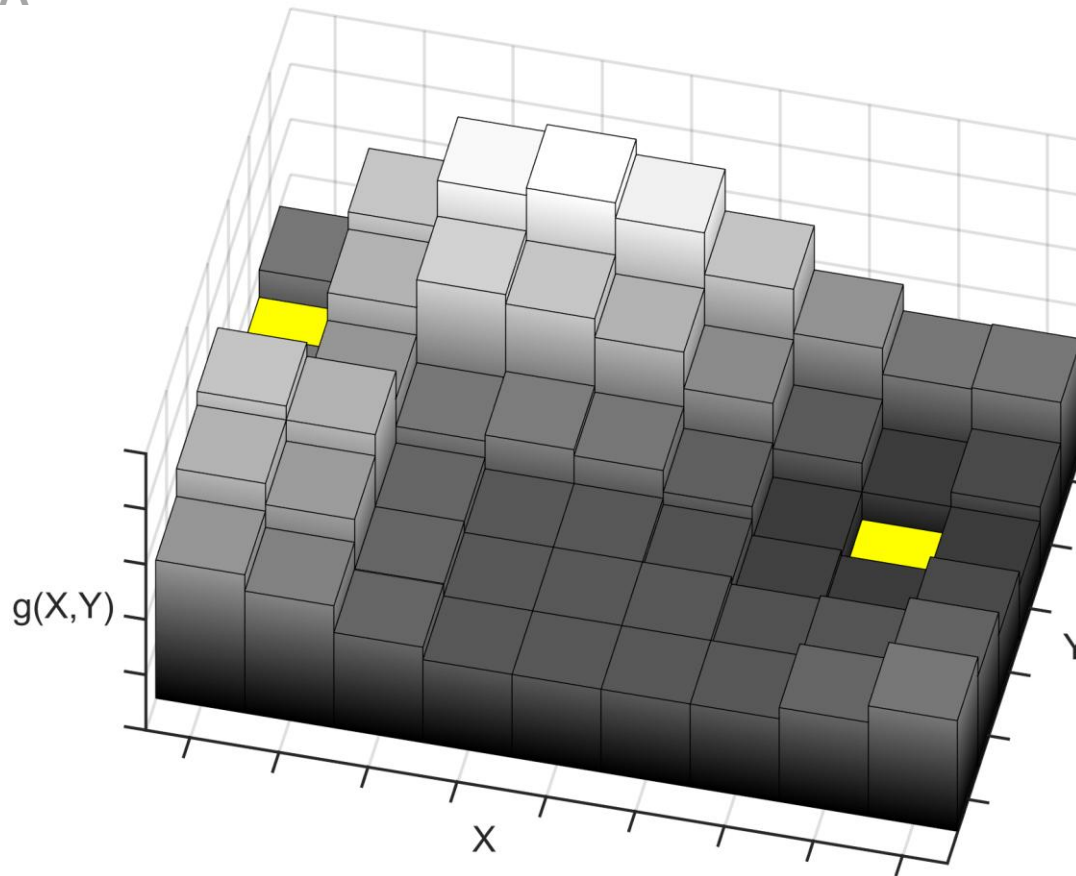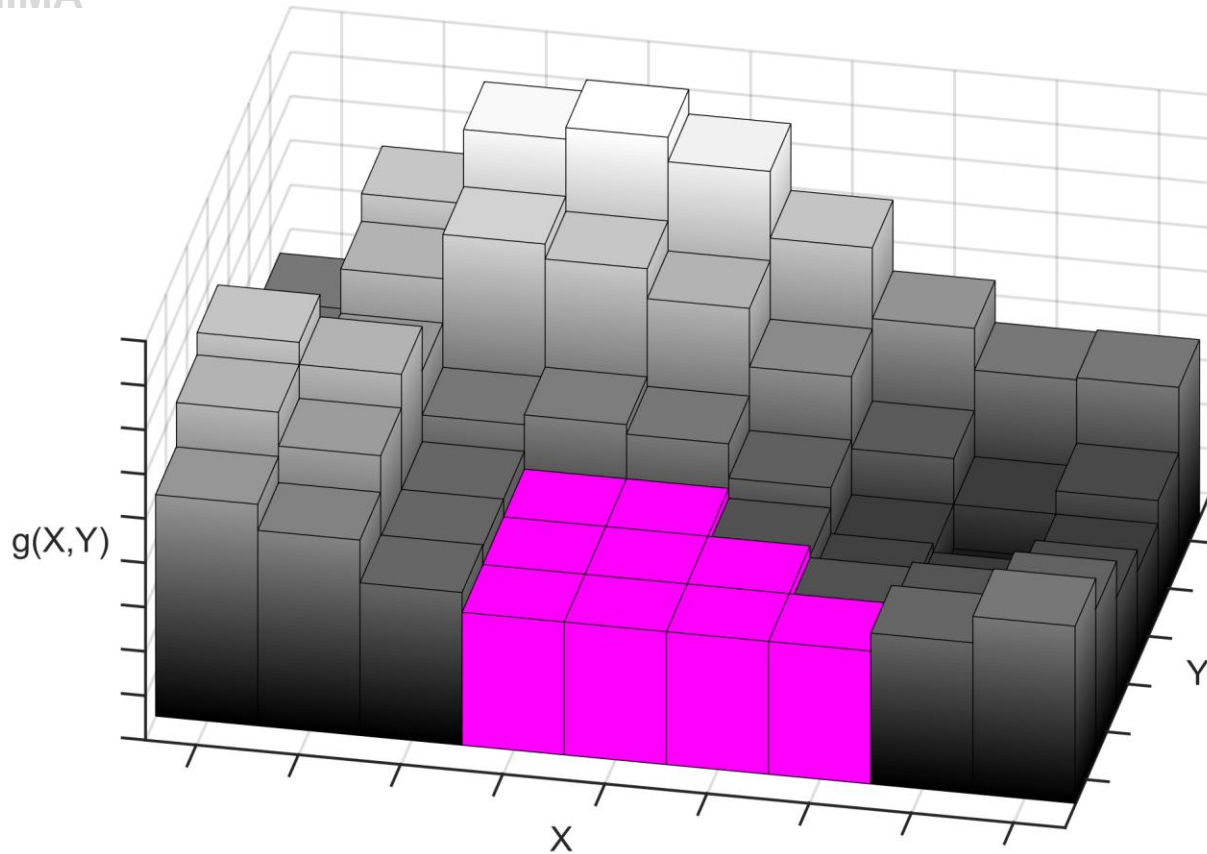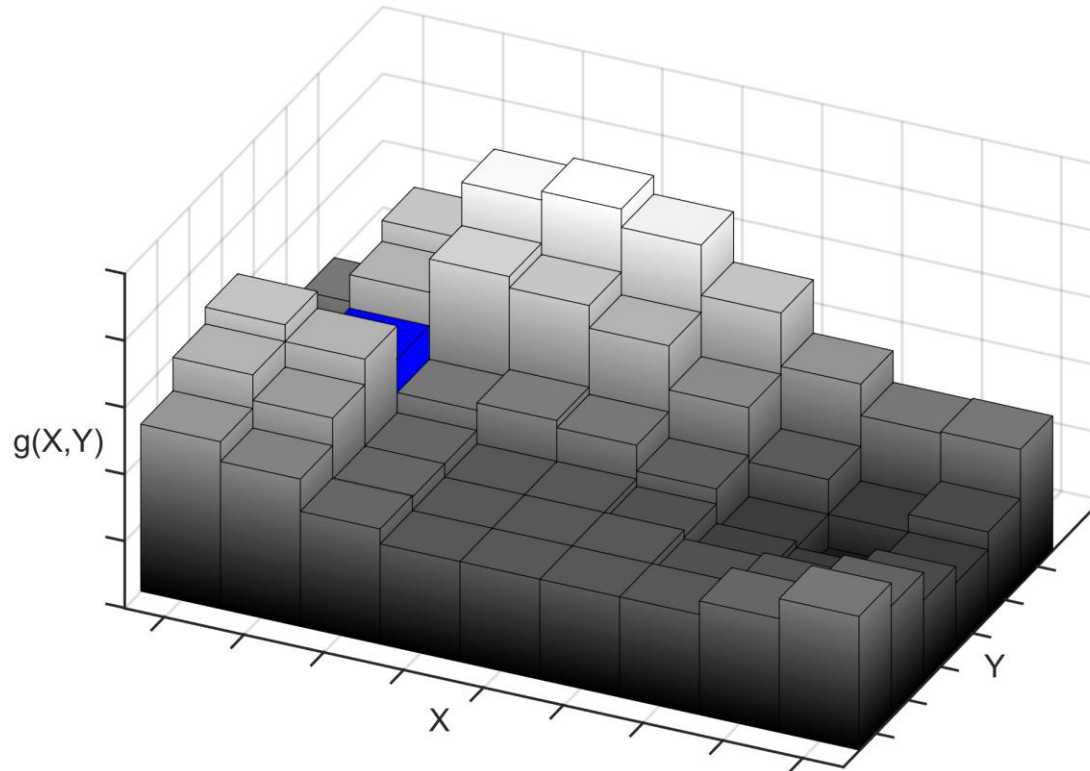
FACULTY OF !NFORMATICS
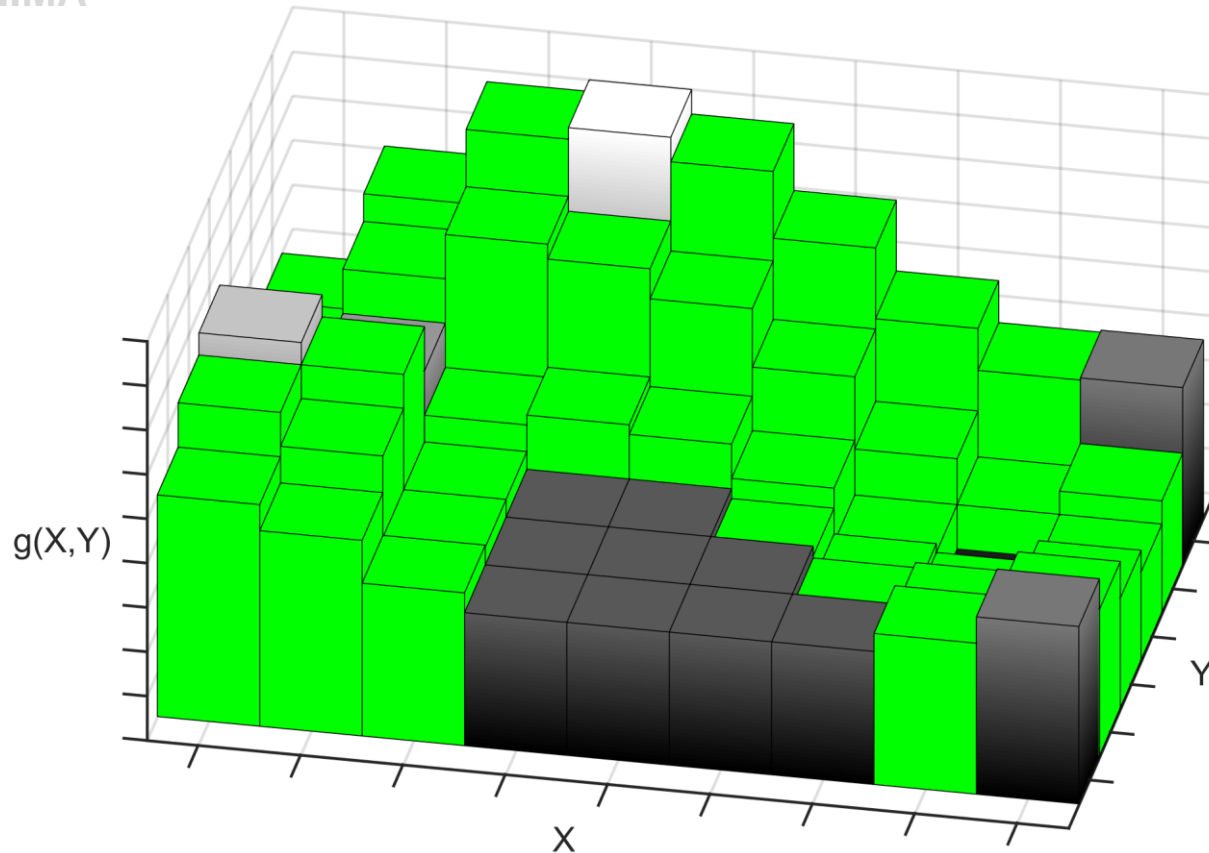
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11,….., 252, 253, 254, 255]
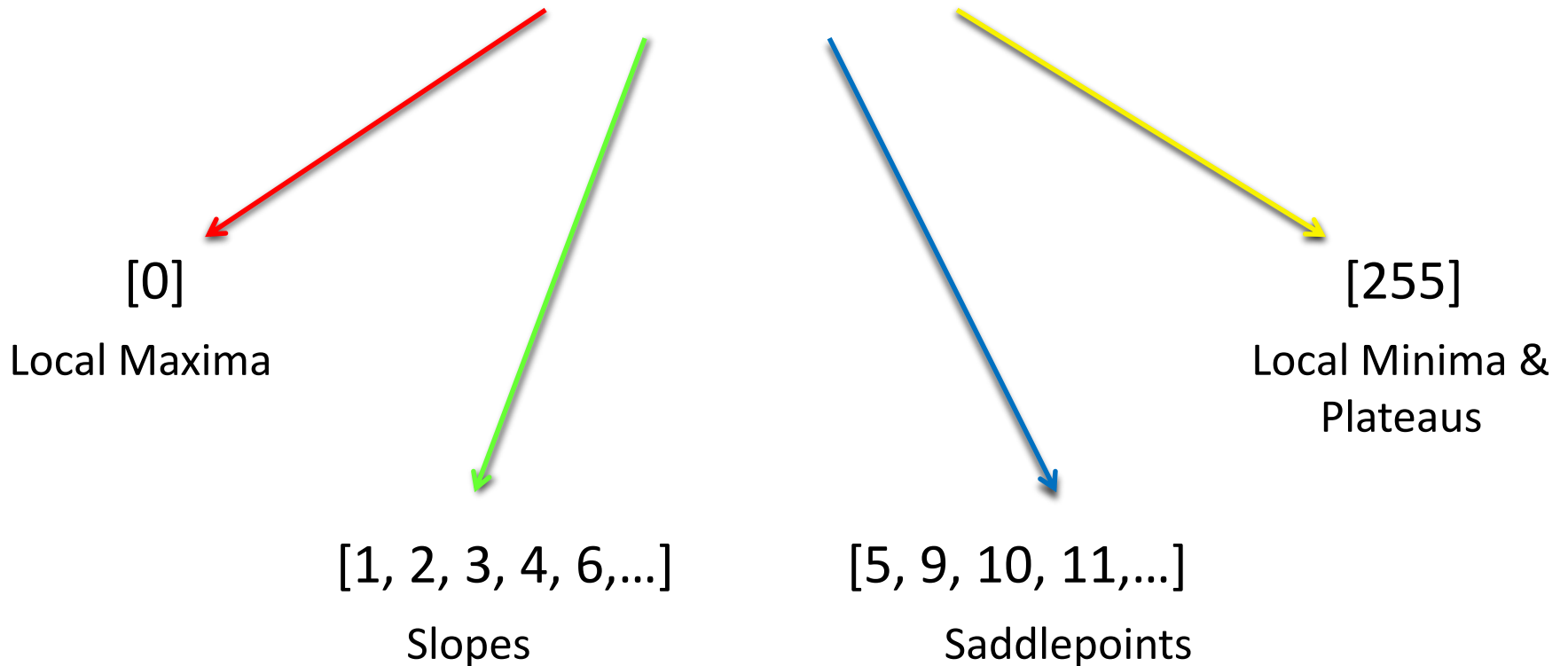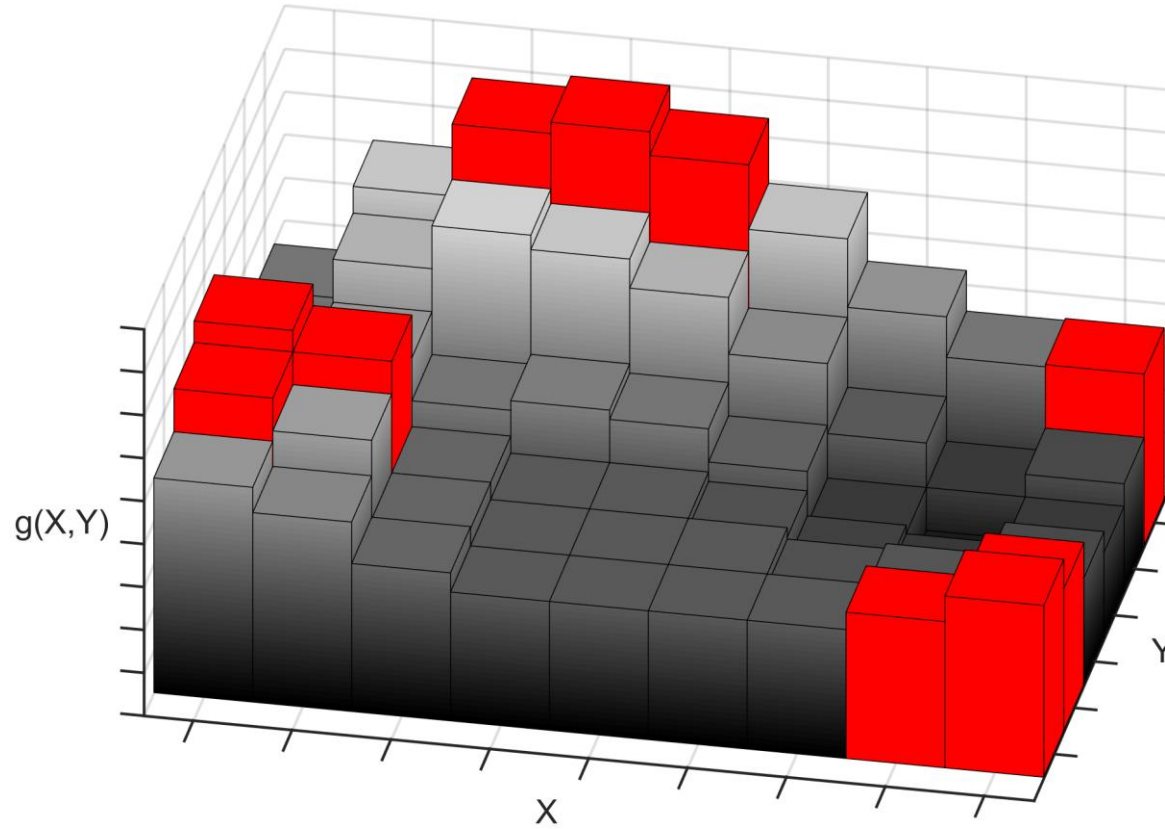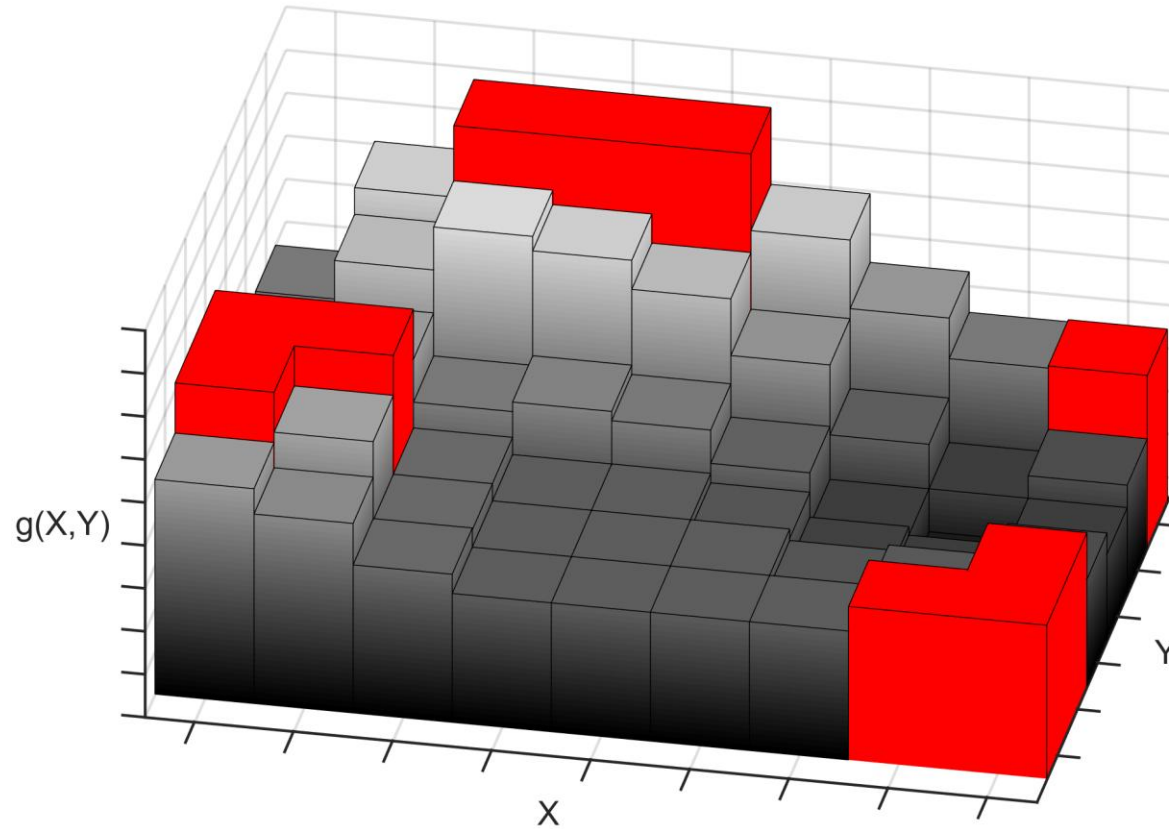
[0]

Local Maxima

[1, 2, 3, 4, 6,…]

Slopes

[5, 9, 10, 11,…]

Saddlepoints

[255]

Local Minima & Plateaus

Martin Cerman

FACULTY OF !NFORMATICS

g(X,Y)

X

Y

Martin Cerman

FACULTY OF !NFORMATICS

Martin Cerman

Martin Cerman

FACULTY OF !NFORMATICS

Martin Cerman

Martin Cerman

Martin Cerman
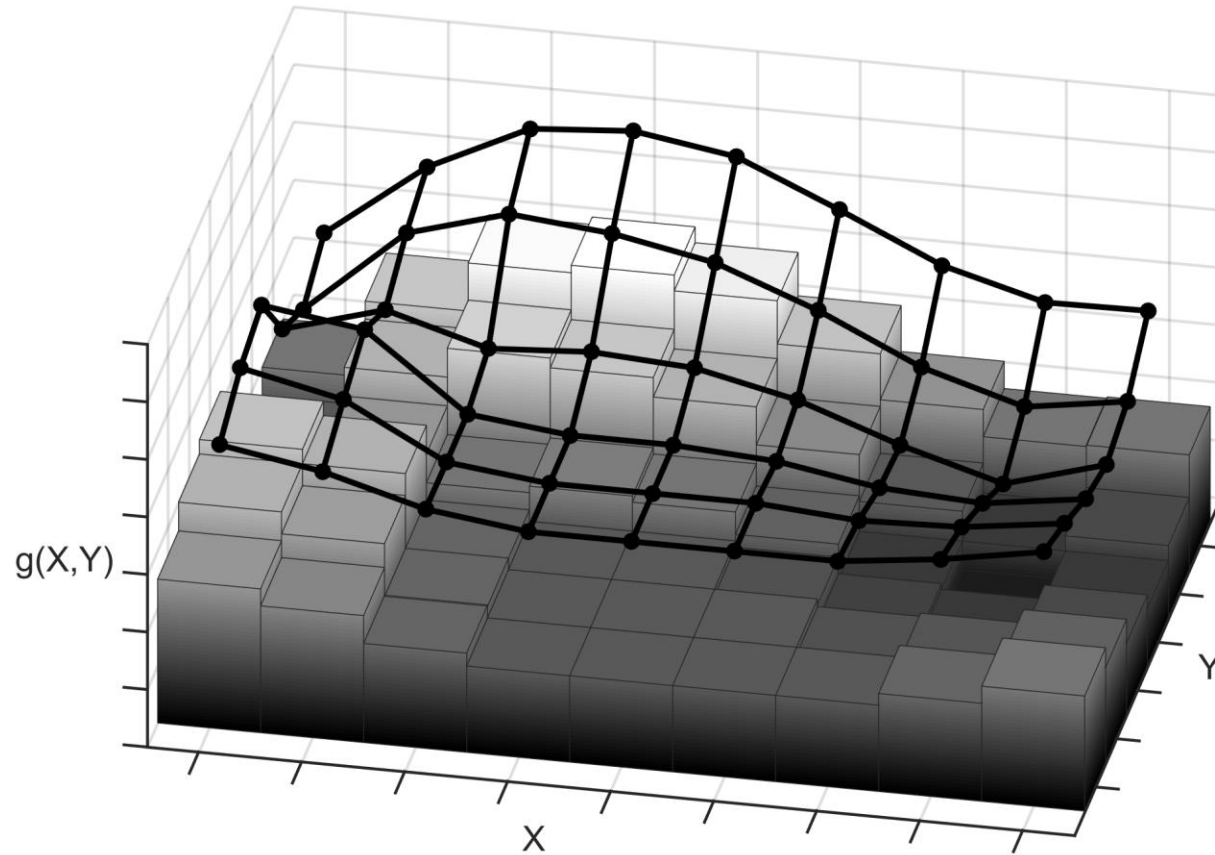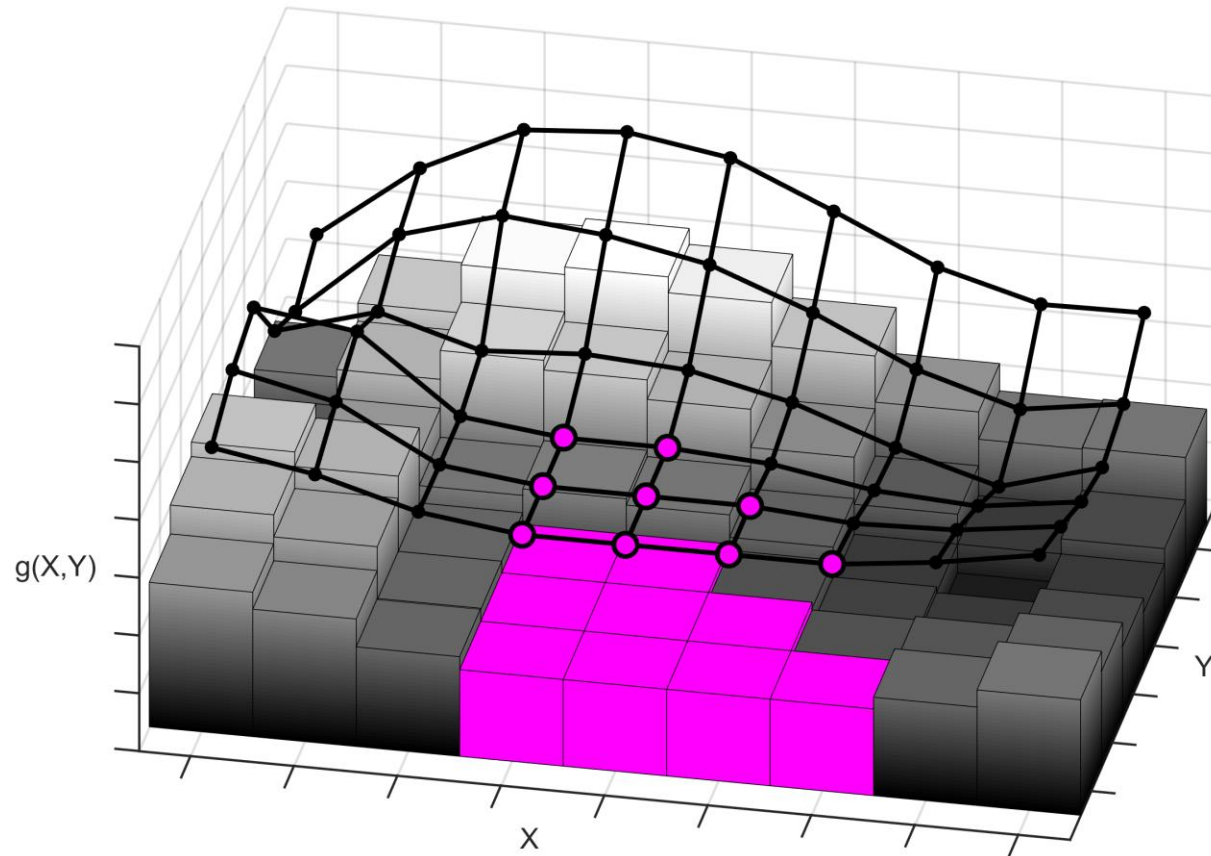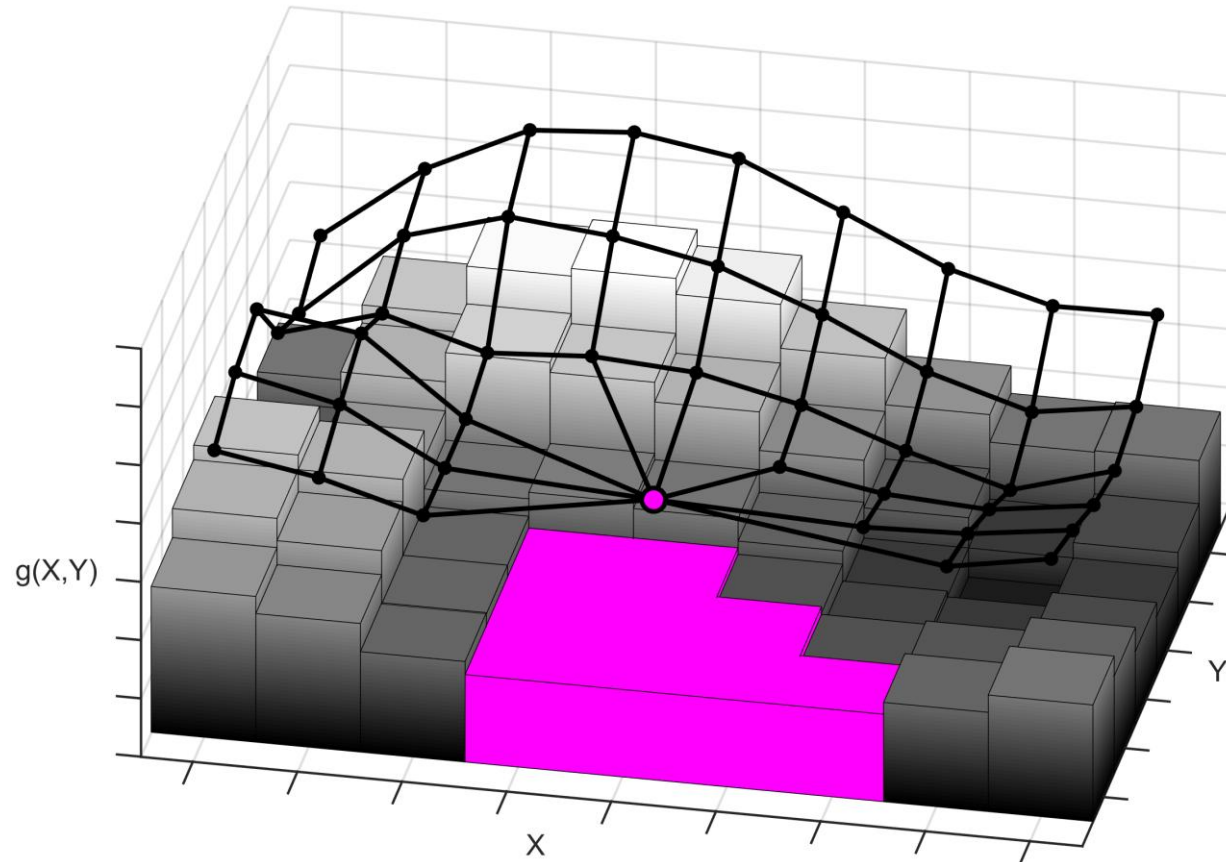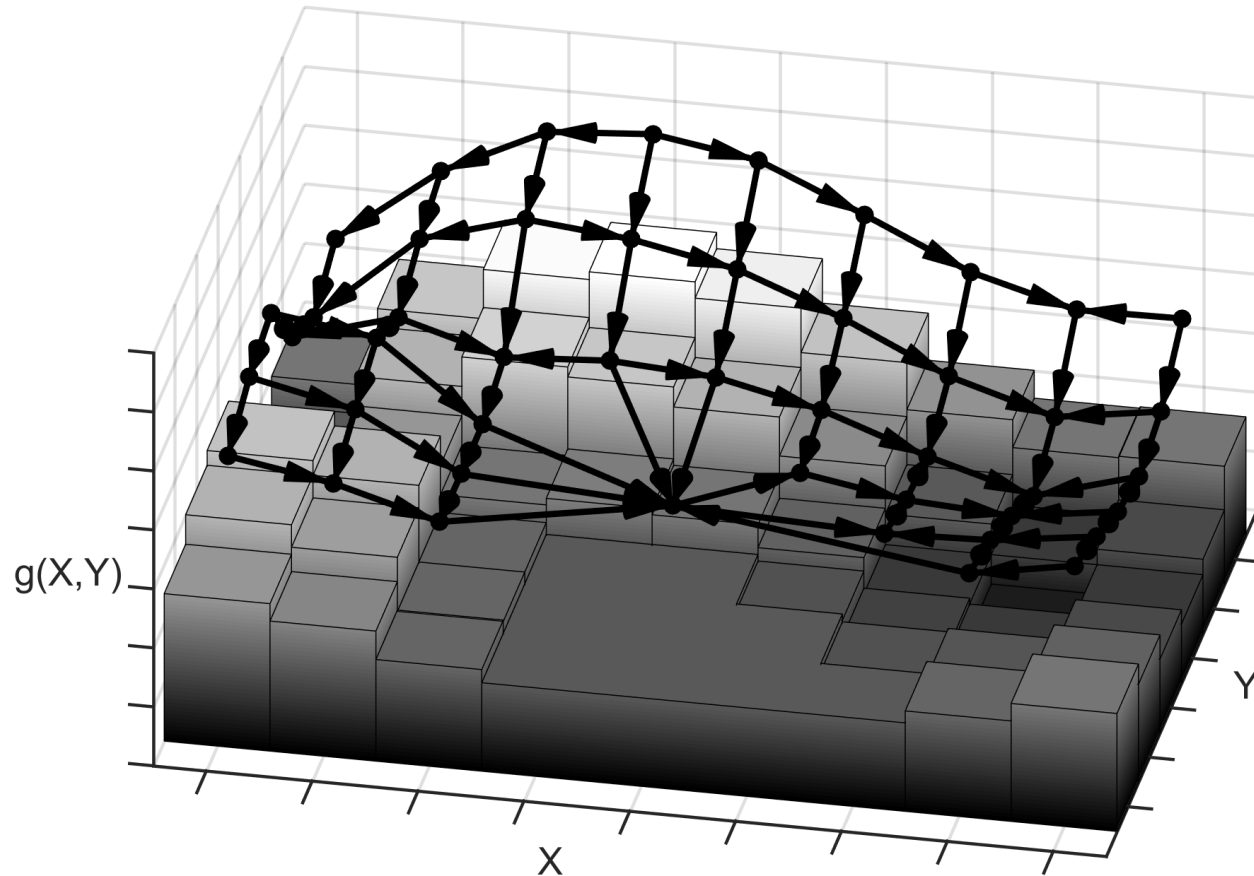
- Graph is a Directed Acyclic Graph
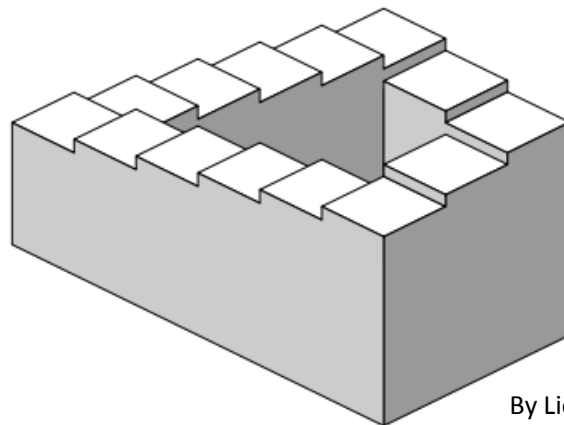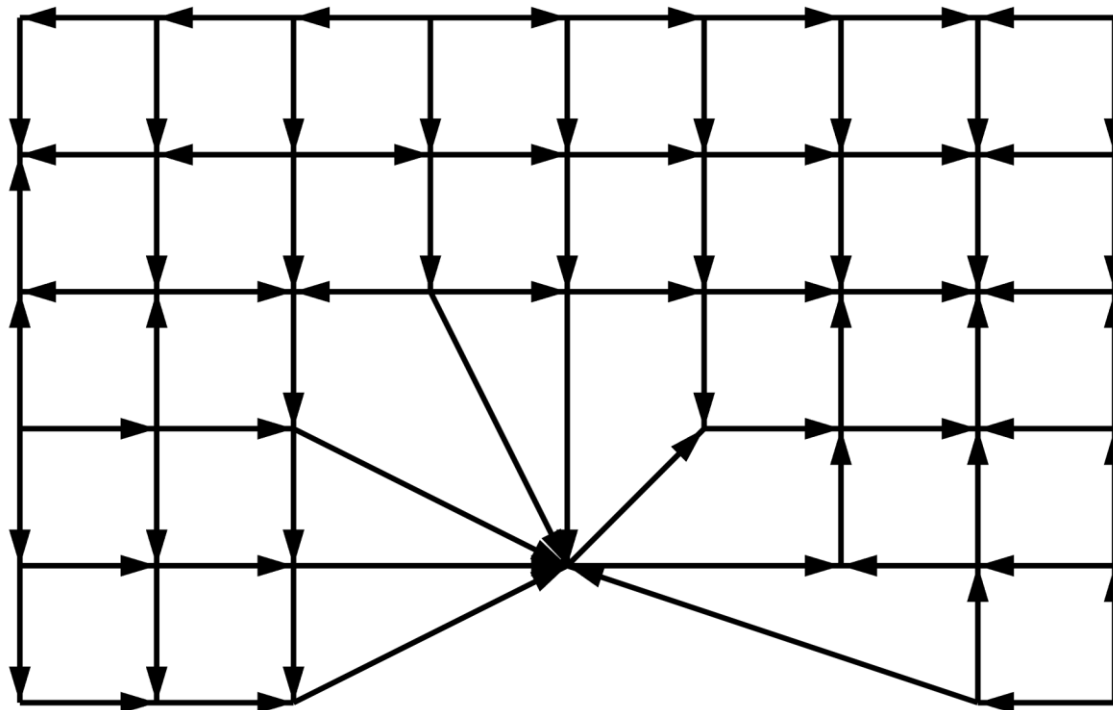
- Strict partial ordering of regions along monotonic paths

- A region cannot be smaller and greater than itself

By Lionel Penrose

Martin Cerman

FACULTY OF !NFORMATICS

Martin Cerman

FACULTY OF !NFORMATICS

Martin Cerman
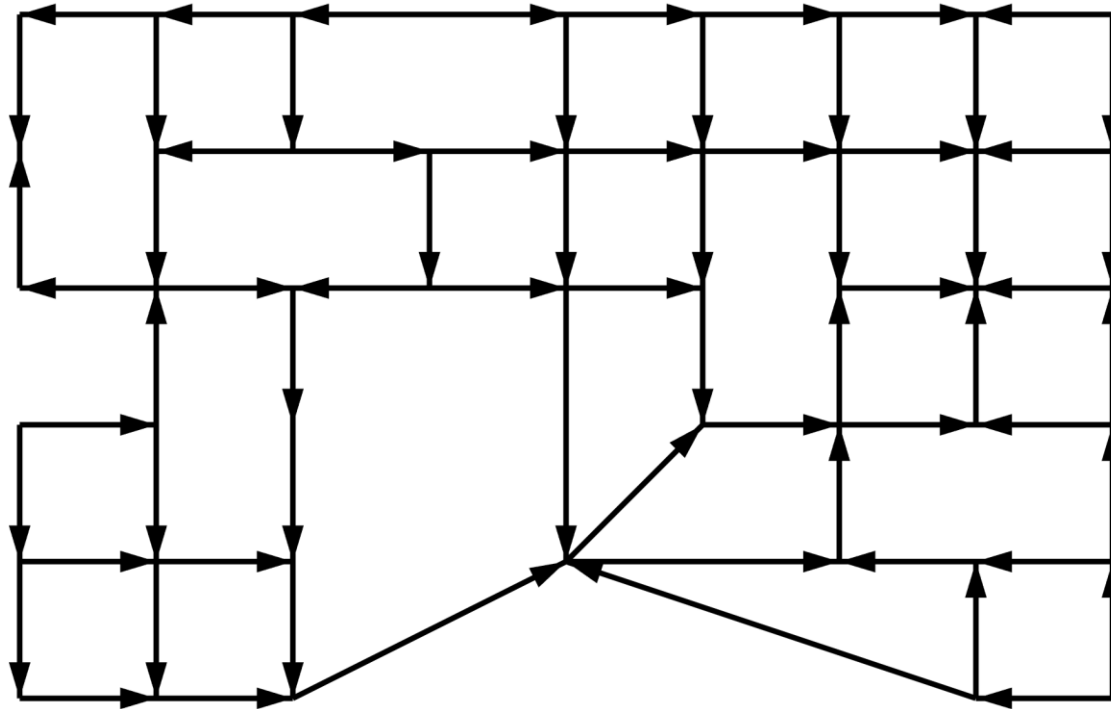
FACULTY OF !NFORMATICS

- Weakly textured regions get merged early
- Highly textured regions get merged late

Early merging   Late merging

Martin Cerman

FACULTY OF !NFORMATICS
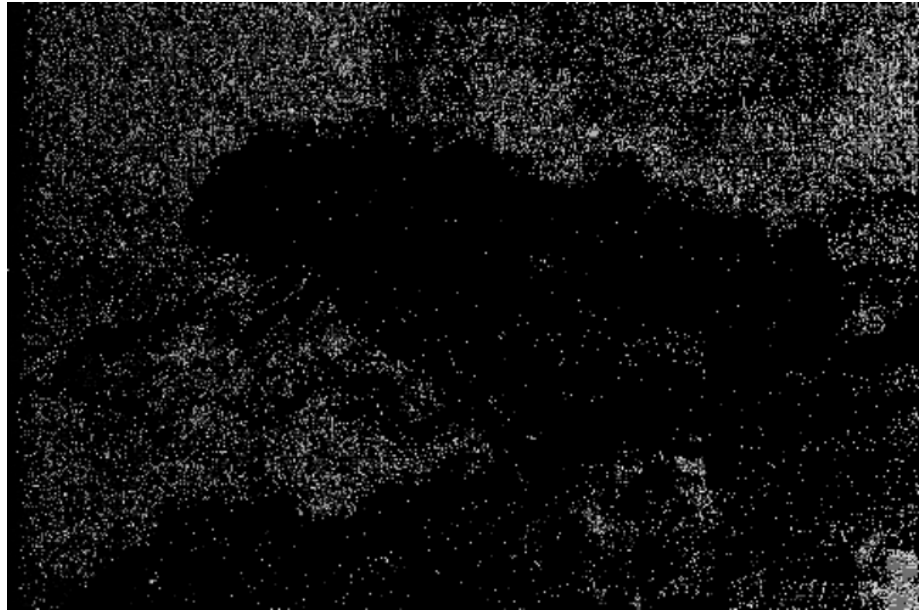
Original image
(481x321 = 154401 pixels)

70% merged pixels
(46320 regions)

0%

70%

Martin Cerman

FACULTY OF !NFORMATICS

Original image
(481x321 = 154401 pixels)

0%

92% merged pixels
(12352 regions)

92%

Martin Cerman

FACULTY OF !NFORMATICS

PUBLICATIONS
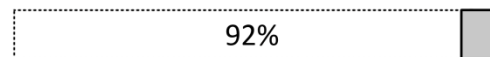
Inspired development of algorithm to structurally minimize image (preserves critical points)

- CTIC 2014 – *"Characterizing Configurations of Critical Points through LBP"*

- CAIP 2015 – *"LBP and Irregular Graph Pyramids"*

- Invitation to special issue of MVA (Springer)

Cooperation with Rocio Gonzalez-Diaz from University of Seville, Spain

Martin Cerman
FACULTY OF !NFORMATICS

- External evaluation by Joanneum in Graz, in preparation for ExoMars 2018/19

- Comparison:

"Between ratio 85 and 96, depending on the used evaluation measure, the errors obtained by **CCSDS 122.0** start to increase strongly, such that **TUW** outperforms this algorithm. Thus, for most of the tests (except density) the algorithm from **TUW** shows better quality for very high compression ratios."
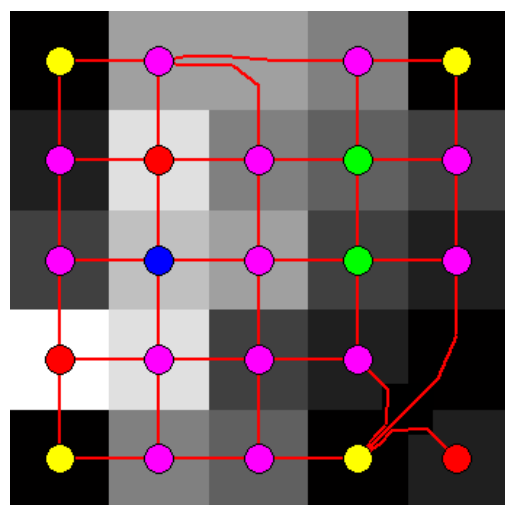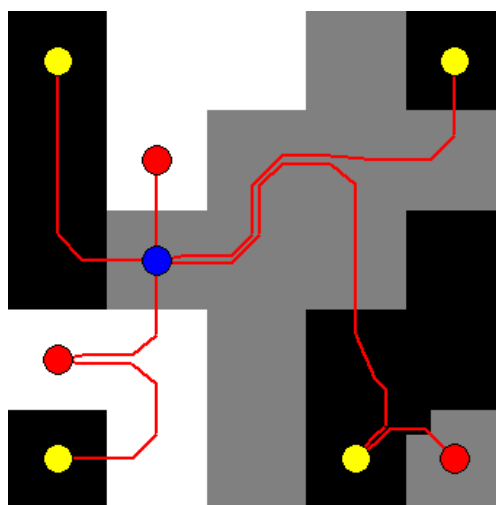
Martin Cerman

FACULTY OF !NFORMATICS

THANK YOU

0%

Martin Cerman
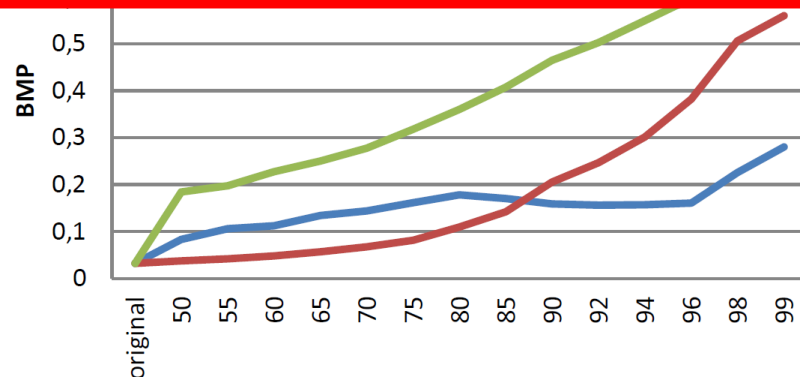
Original Image

Minimal Image
Representation

Legend:
- 🔴 Maxima
- 🟡 Minima
- 🔵 Saddles
- 🟣 Singular Slopes
- 🟢 Regular Slopes

Martin Cerman

- Insert new pixels into configurations, where diagonal elements are not comparable