

12TH EARSEL FOREST FIRES SIG

WORKSHOP

3-5 OCTOBER 2019, ROME , ITALY

Self-Organizing maps for fire severity extraction

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Burnt Severity extraction. Why a new method?

$$NDVI = \frac{B8 - B4}{B8 + B4}$$

$$NBR = \frac{B8 - B12}{B8 + B12}$$

$$BAIS = \left(1 - \frac{\sqrt{B6+B7+B8A}}{B4}\right) * \left(\frac{B12-B8A}{\sqrt{B12+B8A}} + 1\right)$$

- To identify different levels of fire severity without externally fixed thresholds
- To define internal and relative thresholds by itself

Dataset: sources

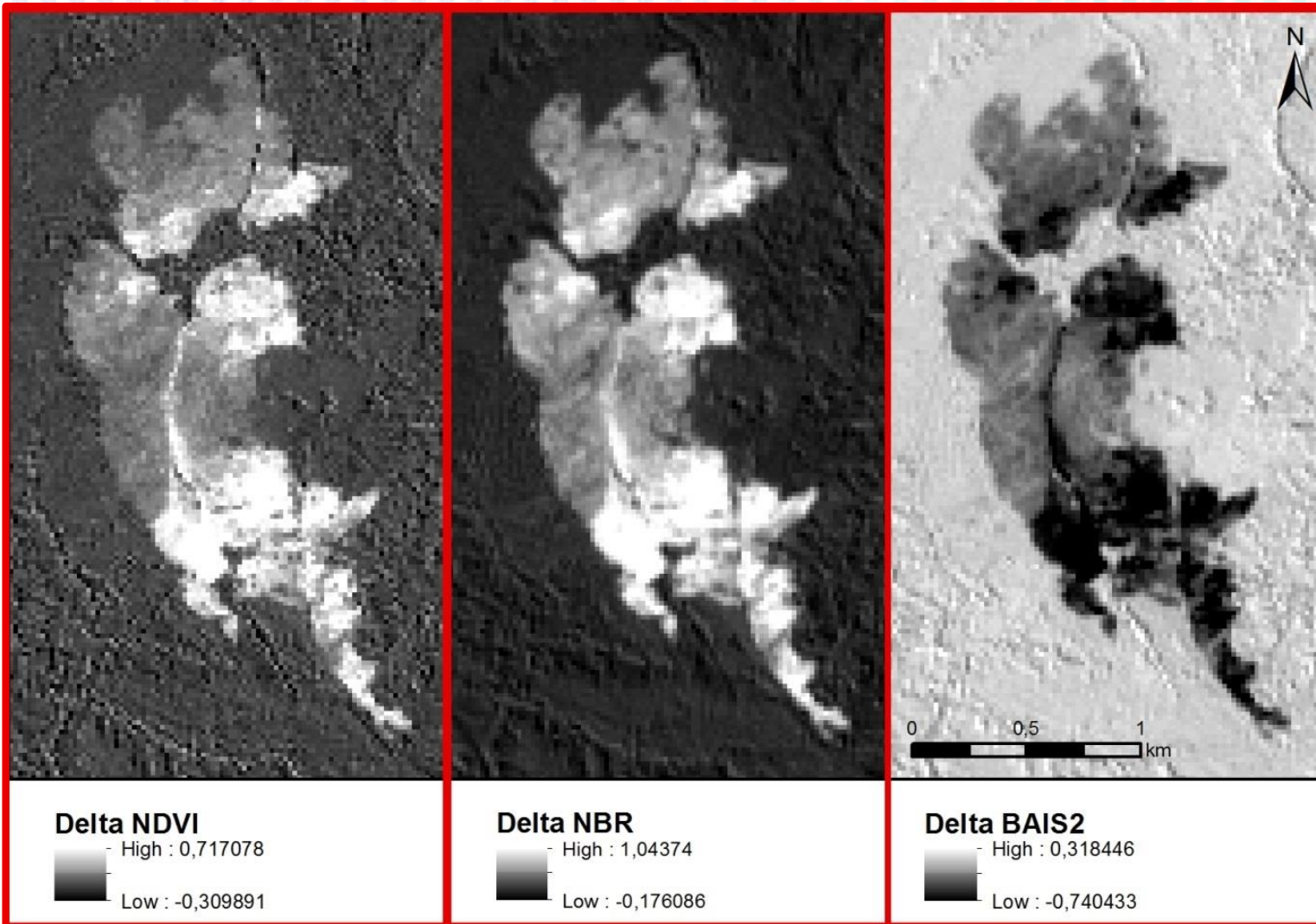
- Copernicus Program and Sentinel missions have been devised specifically for supporting risk monitoring and offer advanced satellite data free of charge (as Sentinel 2) that can suitably support forest fire monitoring from risk estimation to damage quantification.
- Sentinel data pose several challenges related to the processing, analysis and interpretation of the data which need to be tackled by the scientific community in order to ensure reliability and operational applicability.

Case study: Chania

Date: 23rd and 28th of July 2018

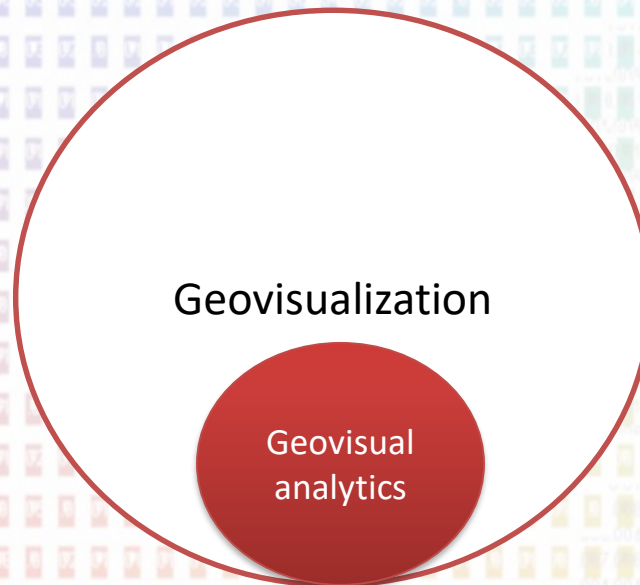
427x261x3=334 341

Areas affected: 200 ha



Self-Organizing Maps (SOM)

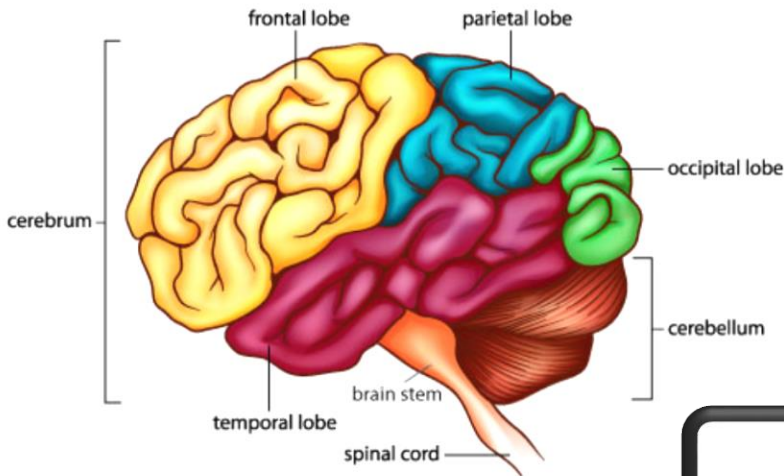
Kohonen 1997



Neural Network

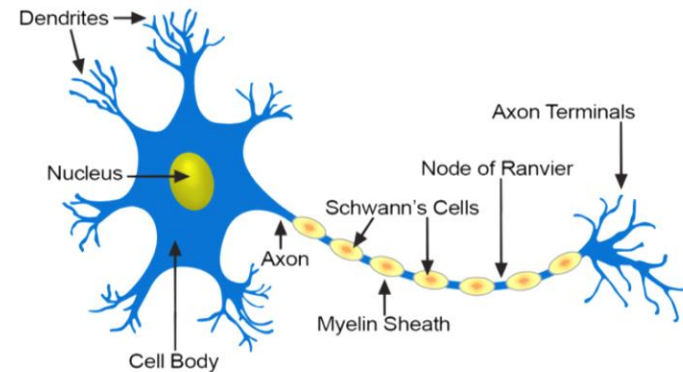
1

Human Brain Anatomy

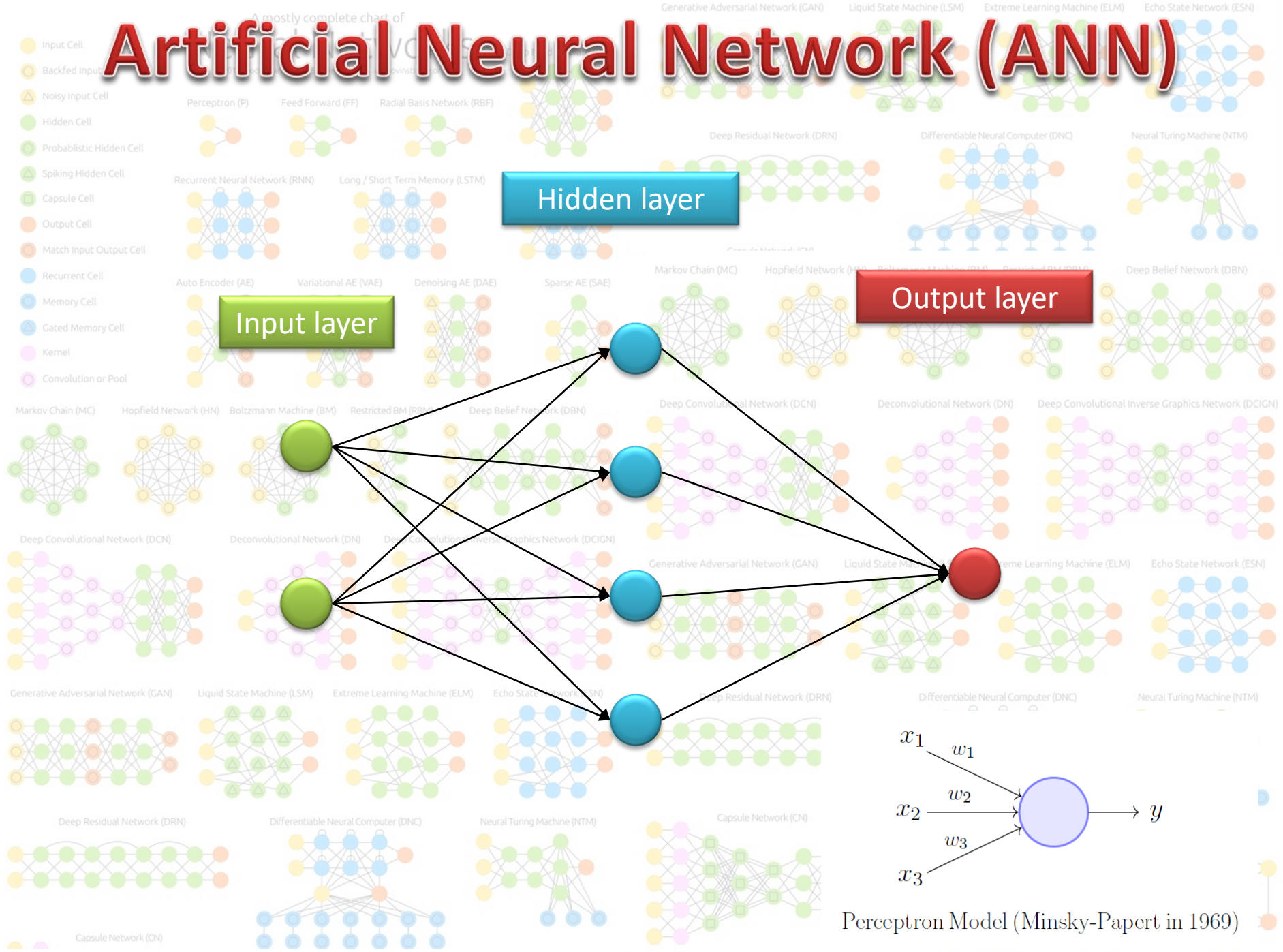


2

Structure of a Typical Neuron



Artificial Neural Network (ANN)



A mostly complete chart of Neural Networks

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- Input Cell
- Backfed Input Cell
- ▲ Noisy Input Cell
- Hidden Cell
- Probabilistic Hidden Cell
- ▲ Spiking Hidden Cell
- Capsule Cell
- Output Cell
- Match Input Output Cell
- Recurrent Cell
- Memory Cell
- ▲ Gated Memory Cell
- Kernel
- Convolution or Pool

Perceptron (P) Feed Forward (FF) Radial Basis Network (RBF)



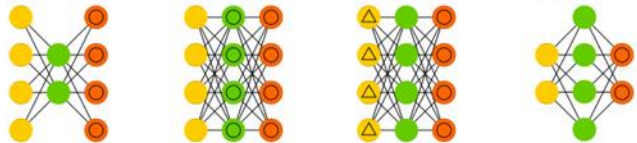
Deep Feed Forward (DFF)



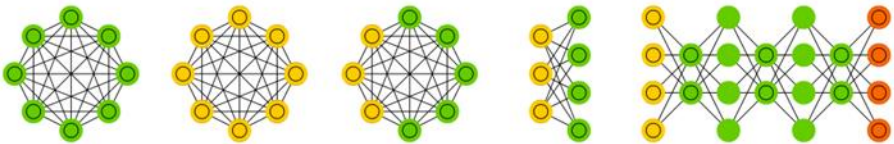
Recurrent Neural Network (RNN) Long / Short Term Memory (LSTM) Gated Recurrent Unit (GRU)



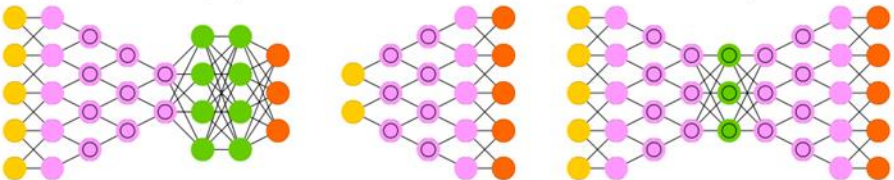
Auto Encoder (AE) Variational AE (VAE) Denoising AE (DAE) Sparse AE (SAE)



Markov Chain (MC) Hopfield Network (HN) Boltzmann Machine (BM) Restricted BM (RBM) Deep Belief Network (DBN)



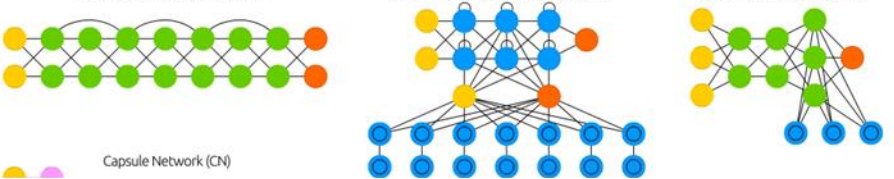
Deep Convolutional Network (DCN) Deconvolutional Network (DN) Deep Convolutional Inverse Graphics Network (DCIGN)



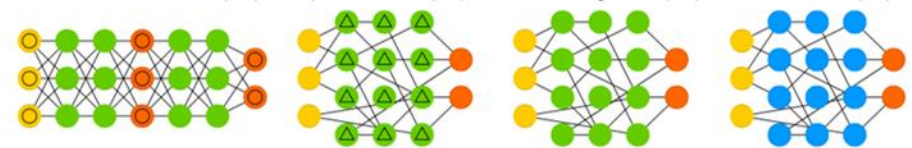
Generative Adversarial Network (GAN) Liquid State Machine (LSM) Extreme Learning Machine (ELM) Echo State Network (ESN)



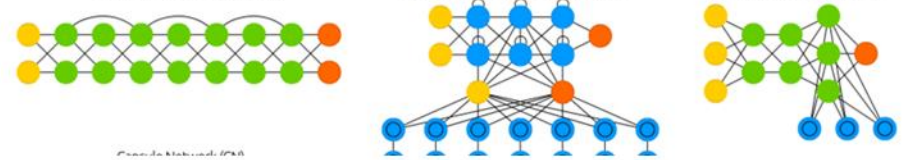
Deep Residual Network (DRN) Differentiable Neural Computer (DNC) Neural Turing Machine (NTM)



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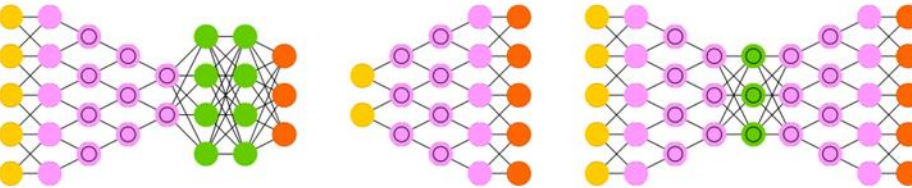
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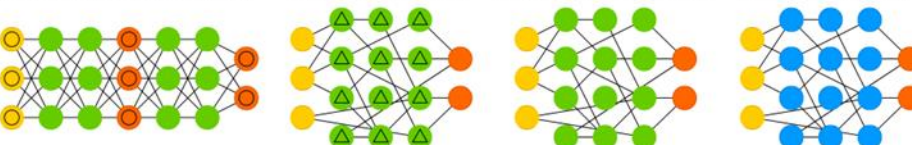
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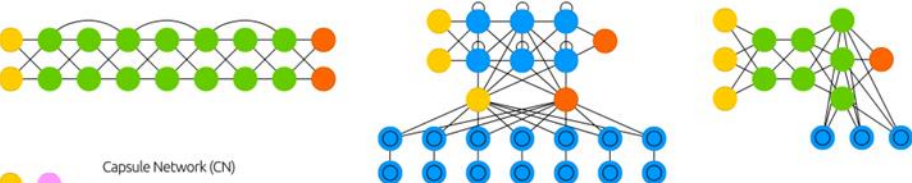
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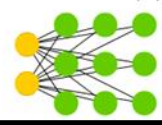
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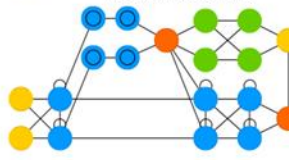
Capsule Network (CN)



Kohonen Network (KN)

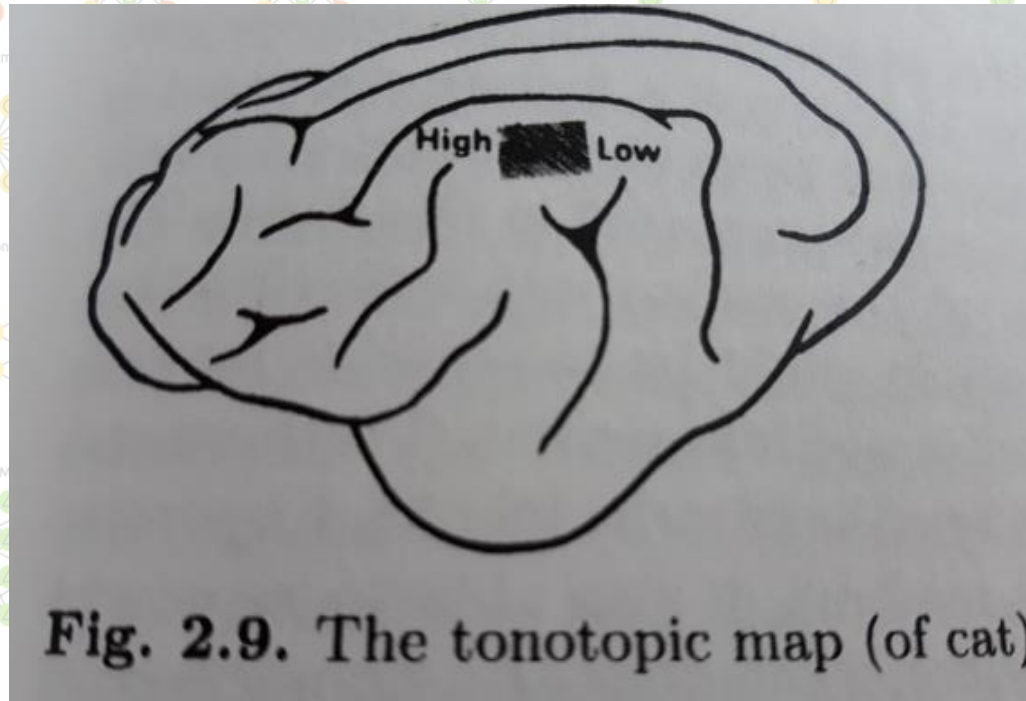


Attention Network (AN)



Self-organizing MAPS: SPATIAL ORDER AND ORGANIZATION

There is a topographical or anatomical order of the neural connections



SELF-ORGANIZING maps

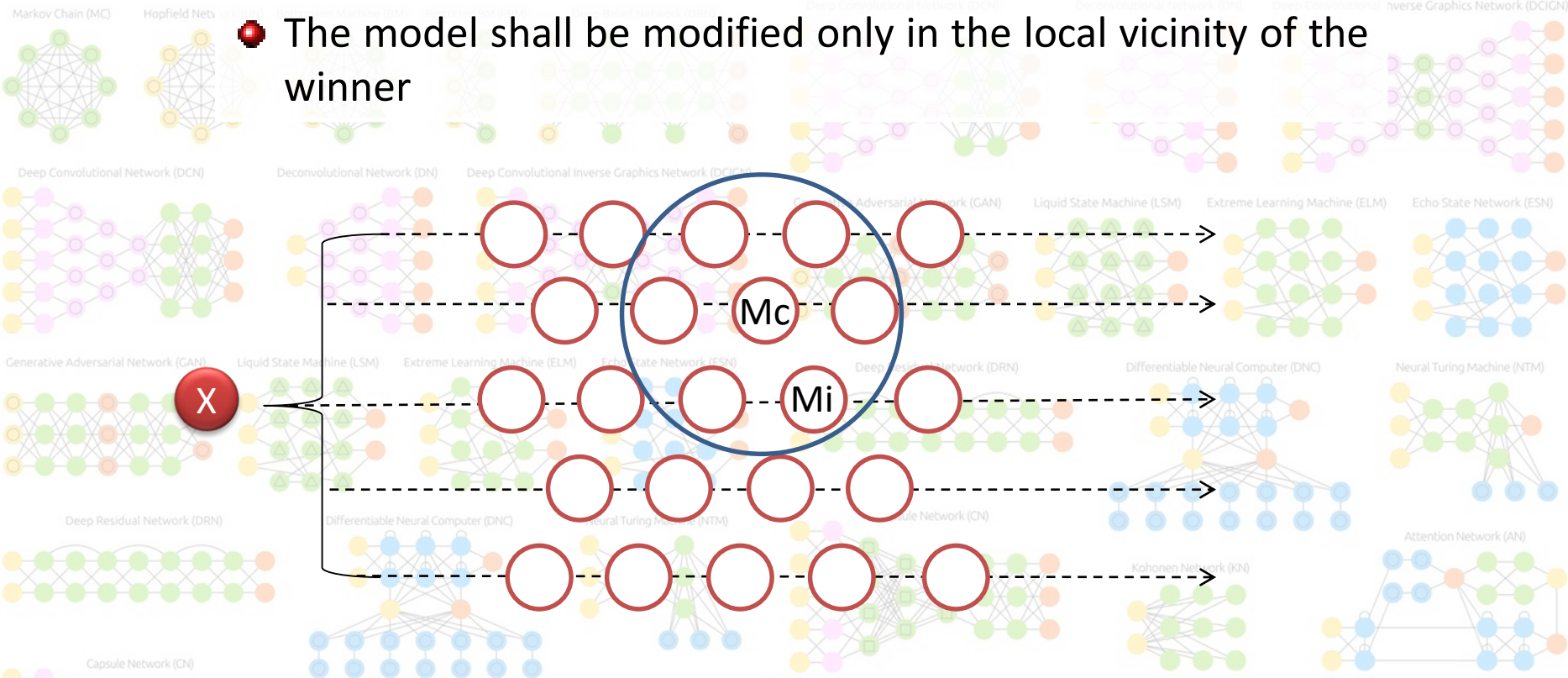
There is a «competition» between the elements, when they are stimulated by common inputs and the elements whose parameters are fitted to this input is activated most. This element is called the «winner»

The model shall be modified only in the local vicinity of the winner

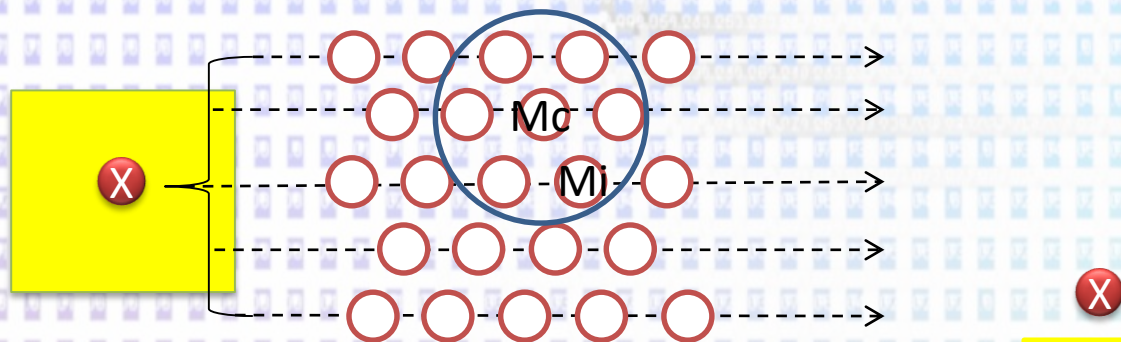
X

Mc

Mi



SOM: input data



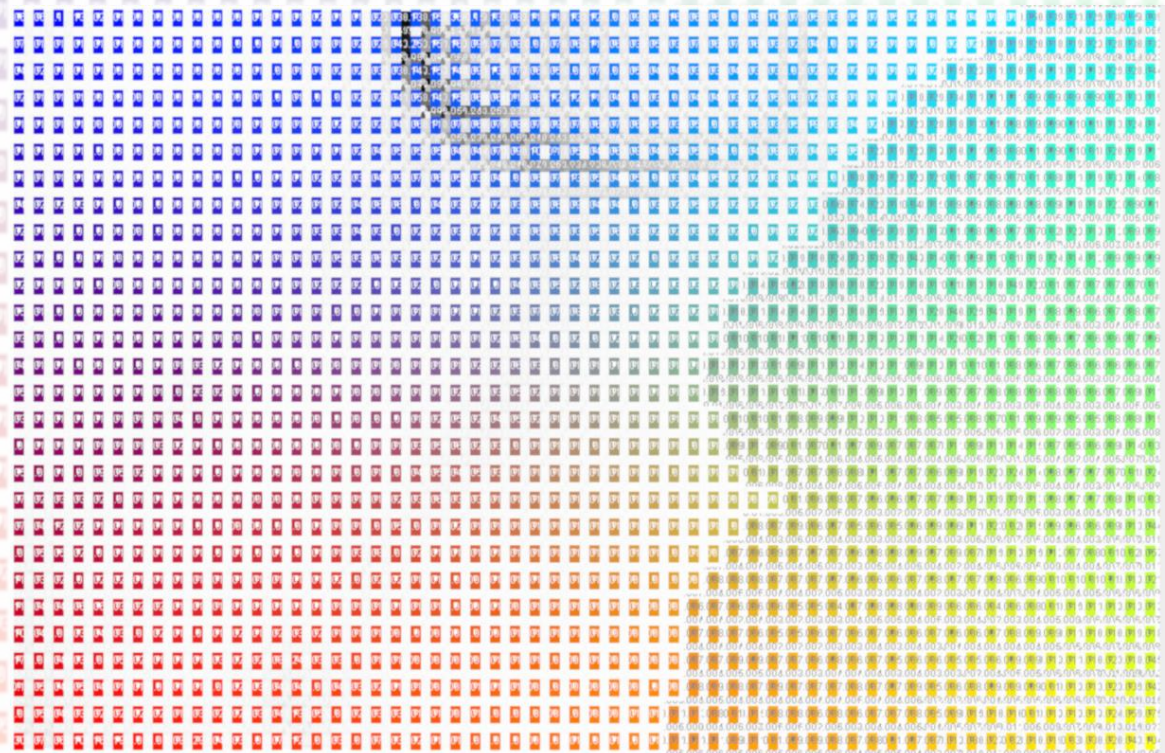
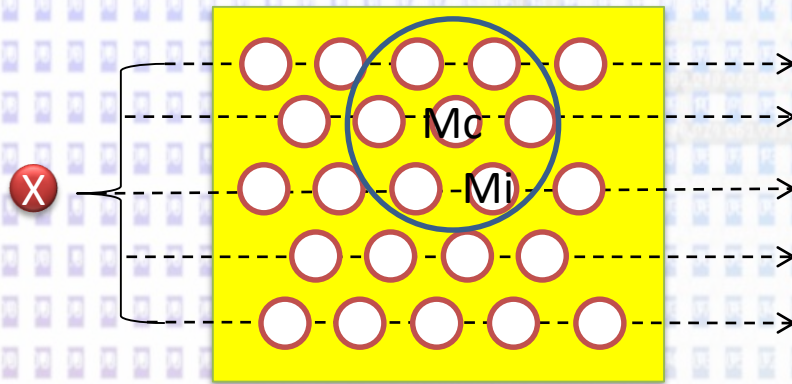
X is a real vector $x \in [a_1, a_2 \dots a_n]^T \in R^n$

chania_grid :: Totale degli elementi: 111447, Filtrati: 111447, Selezionati: 0

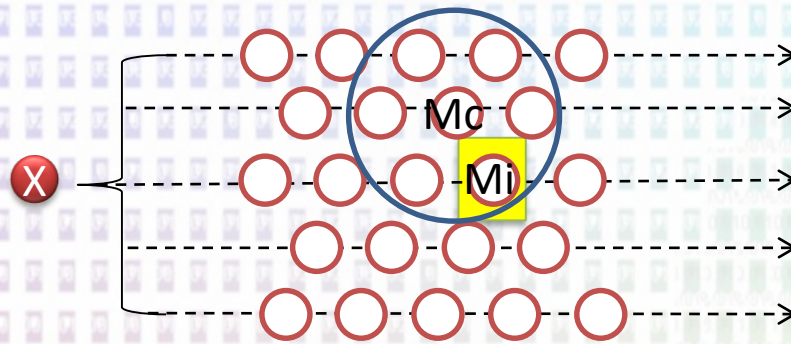
	POINTID	delta_NBR_	delta_BAIS	delta_NDVI	x	y
1	110594	0,03355260000	-0,03857600000	0,04387191000	744930,0000000...	3920150,000000...
2	110595	0,02997080000	-0,02316450000	-0,03114507000	744950,0000000...	3920150,000000...
3	110596	0,01585230000	-0,02014590000	-0,01652420000	744970,0000000...	3920150,000000...
4	110597	-0,00727120000	-0,00097617500	-0,03747788000	744990,0000000...	3920150,000000...
5	110598	0,02526310000	-0,00491929000	-0,05426764000	745010,0000000...	3920150,000000...
6	110599	0,06443250000	-0,04338690000	0,05444133000	745030,0000000...	3920150,000000...
7	110600	0,01516810000	-0,01309400000	-0,03524697000	745050,0000000...	3920150,000000...
8	110601	0,02558780000	-0,01966990000	-0,03831080000	745070,0000000...	3920150,000000...
9	110602	-0,00923988000	-0,01446700000	0,00167513000	745090,0000000...	3920150,000000...
10	110603	-0,04871420000	0,03533160000	-0,07384473000	745110,0000000...	3920150,000000...
11	110604	0,00906676000	0,00392979000	-0,02084076000	745130,0000000...	3920150,000000...
12	110605	-0,00543615000	-0,02373650000	0,02194971000	745150,0000000...	3920150,000000...
13	110606	0,01962760000	-0,03326810000	-0,03669453000	745170,0000000...	3920150,000000...
14	110607	0,04469230000	-0,08935310000	0,01596528000	745190,0000000...	3920150,000000...
15	110608	-0,02940080000	-0,04141740000	0,08161837000	745210,0000000...	3920150,000000...
16	110609	0,03410150000	-0,10780400000	-0,01602811000	745230,0000000...	3920150,000000...

Mostra tutti gli elementi

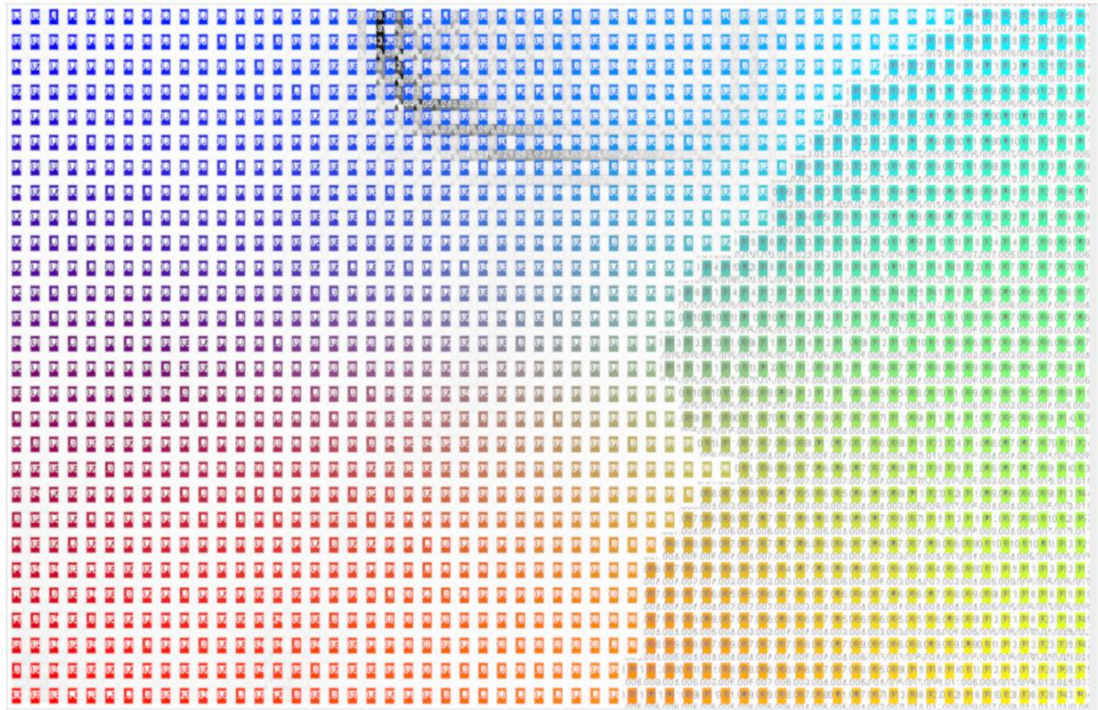
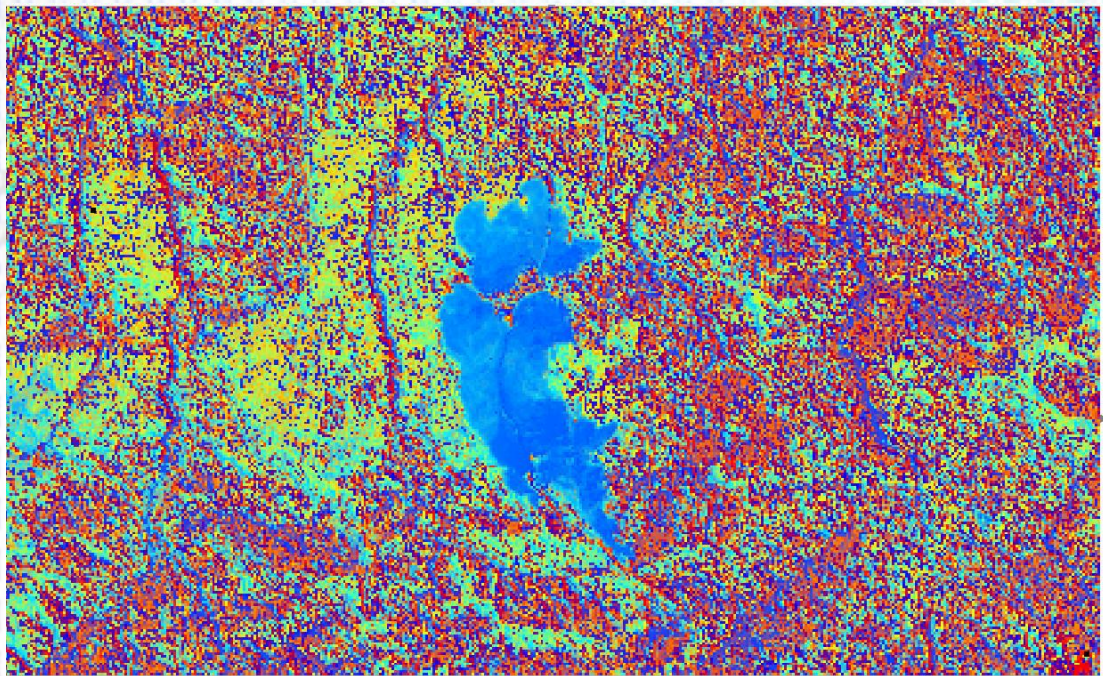
SOM: Mc and the 2D matrix



SOM: M_i and the learning process



**SOM: what
does we
obtain?**



SOM tutorial

Andrienko's V-Analytics



<http://geoanalytics.net/V-Analytics/>

SOM tutorial

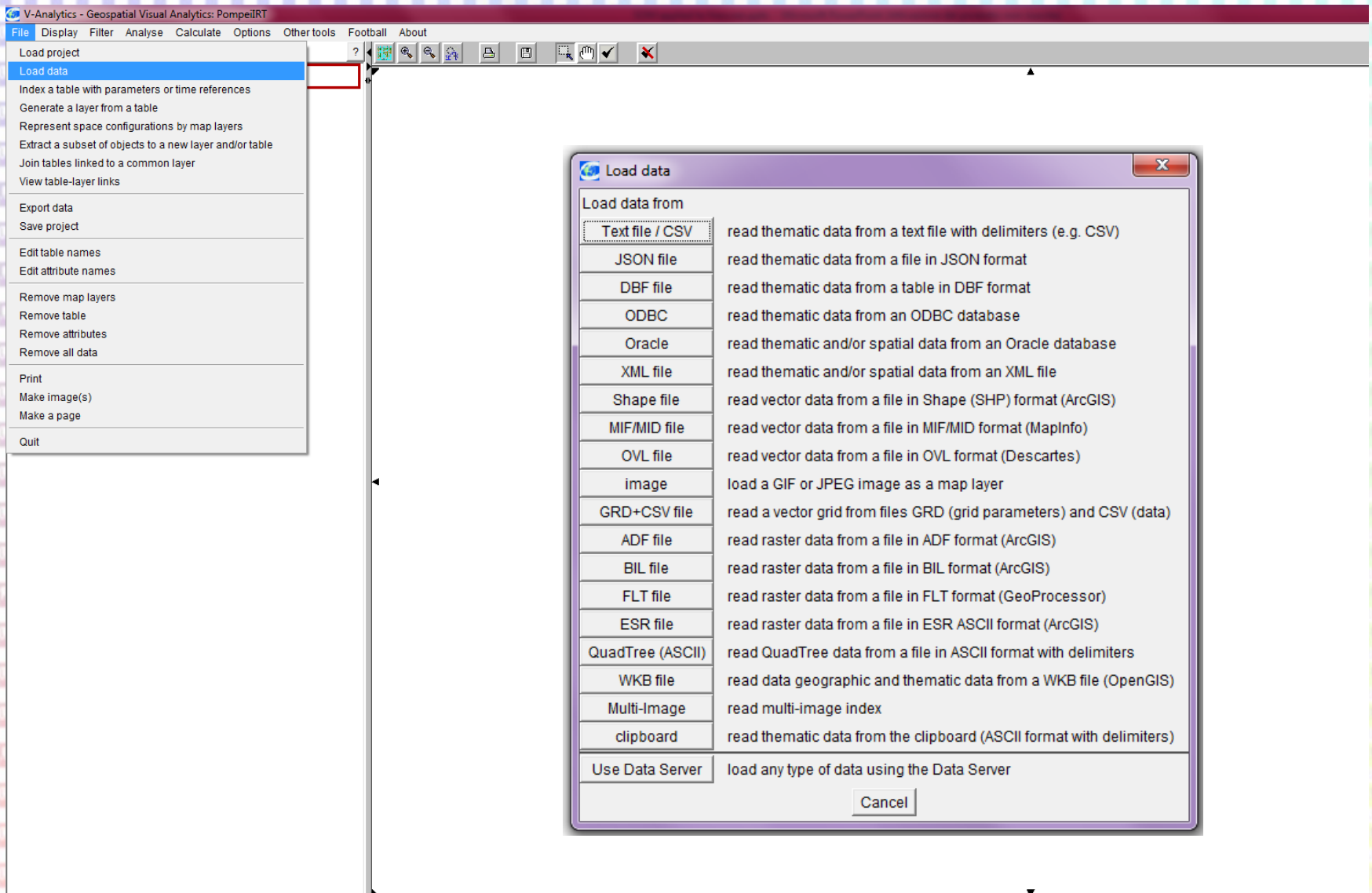
Andrienko's V-Analytics



<http://geoanalytics.net/V-Analytics/>

1. Install Java Runtime Environment
2. Copy the v-analytics folder
3. Run the V-analytics-all-java6.jar file

File -> Load data -> chose the data type



The input data file

- It can't be a raster, it should be a vector, with squared polygons instead of pixels
- In the associated table there must be:
 - A ID field
 - Two fields with spatial coordinates of the centroid of pixels
 - One field for each associated information

chania_grid :: Totale degli elementi: 111447, Filtrati: 111447, Selezionati: 0

	POINTID	delta_NBR_	delta_BAIS	delta_NDVI	x	y
1	110594	0,03355260000	-0,03857600000	0,04387191000	744930,0000000...	3920150,000000...
2	110595	0,02997080000	-0,02316450000	-0,03114507000	744950,0000000...	3920150,000000...
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4	110597	-0,00727120000	-0,00097617500	-0,03747788000	744990,0000000...	3920150,000000...
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8	110601	0,02558780000	-0,01966990000	-0,03831080000	745070,0000000...	3920150,000000...
9	110602	-0,00923988000	-0,01446700000	0,00167513000	745090,0000000...	3920150,000000...
10	110603	-0,04871420000	0,03533160000	-0,07384473000	745110,0000000...	3920150,000000...
11	110604	0,00906676000	0,00392979000	-0,02084076000	745130,0000000...	3920150,000000...
12	110605	-0,00543615000	-0,02373650000	0,02194971000	745150,0000000...	3920150,000000...
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15	110608	-0,02940080000	-0,04141740000	0,08161837000	745210,0000000...	3920150,000000...
16	110609	0,03410150000	-0,10780400000	-0,01602811000	745230,0000000...	3920150,000000...

Mostra tutti gli elementi

To load data

Data preview

Data content:

1	2	3	4	5	6
id	lon	lat	lon	lat	lon
integer	real	real	real	real	real
0	19.7560000000	19.3800000000	19.5630000000	3700.10187988000	1335.35847168000
1	19.7890000000	19.6110000000	19.5410000000	3715.20187988000	1335.35847168000
2	19.7940000000	19.6760000000	19.7620000000	3730.30187988000	1335.35847168000
3	19.9330000000	19.8260000000	19.7560000000	3745.40187988000	1335.35847168000
4	19.9010000000	19.6970000000	19.7300000000	3760.50187988000	1335.35847168000
5	19.9230000000	19.6650000000	19.7130000000	3775.60187988000	1335.35847168000
6	19.9550000000	19.6810000000	19.7890000000	3790.70187988000	1335.35847168000

Identifiers are in field

(enter the name or the number of the field)

If there is no field with identifiers, the system will produce default identifiers from record numbers

Names of entities are in field

(set name or number or leave empty)

☒ Coordinates of entities are in fields

X: Y:

(enter names or numbers)

OK Cancel

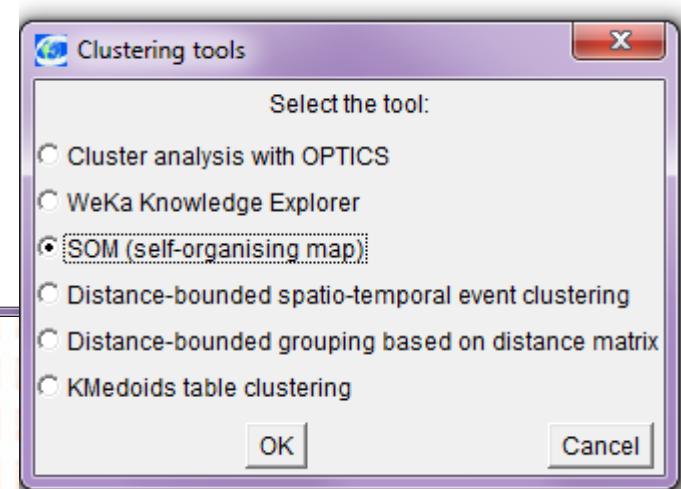
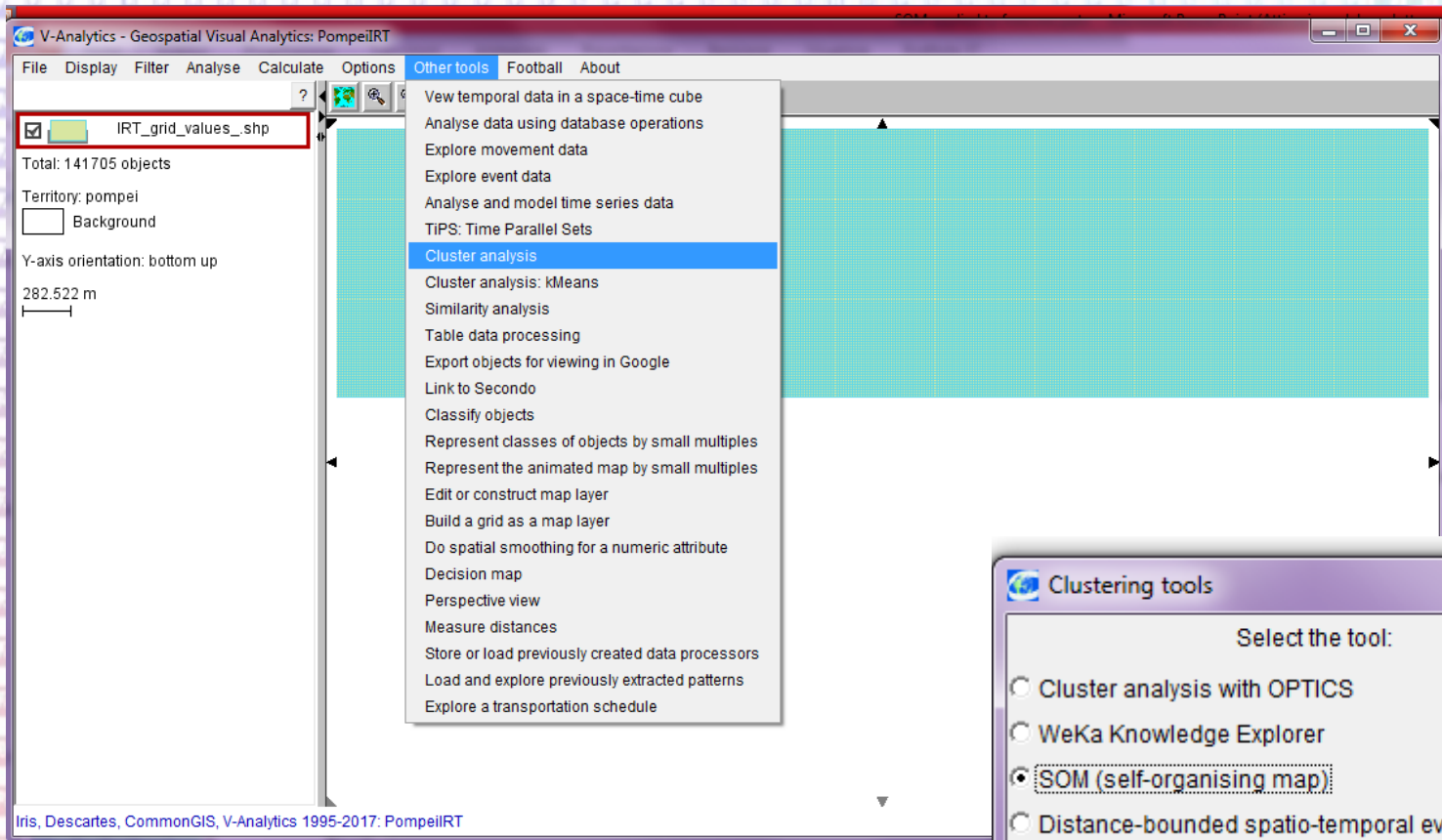
To set:

- Number of the id field

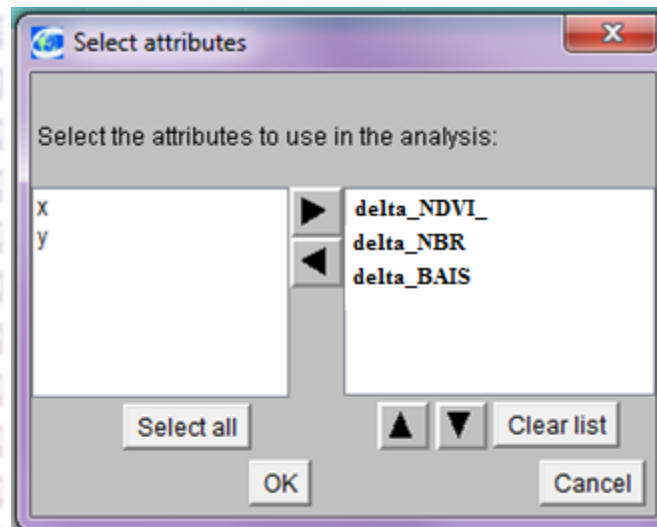
- Name of the coordinate fields

Lat-long coordinates? Yes/No

Menu: Other tools -> cluster analysis -> SOM



Choice of the fields to use for the analysis



Create image to be used in the SOM matrix view? YES

Select a color palette



Set SOM parameters

The screenshot shows the iXsom software interface. On the left is a sidebar with buttons: 'Load Stuff', 'Calculate Features', 'Calculate SOM', 'Compare SOMs', and 'Save Stuff'. Below these is a small input field. The main area is a large gray rectangle. On the right is a 'SOM Configuration' panel. It contains several input fields and checkboxes. A red box highlights the 'X Size' and 'Y-Size' fields, both set to 5. Another red box highlights the 'Coloring + distances' checkbox, which is checked. Below the configuration panel are buttons for 'start Training', 'EFP', and a dropdown menu currently set to 'HE'. At the bottom right is a 'Get result' button.

Number of the lattice cells

In the output color the cells and Show distances

SOM Configuration	
5	X Size
5	Y-Size
14170500	Ini. Iterations
75	Ini. Learning Radius
0.05	Ini. Learning Rate
28341000	Iterations
50	Learning Radius
0.03	Learning Rate
SomPack	
<input type="checkbox"/> Dense Renderer	
<input type="checkbox"/> Linear 2D coloring	
<input type="checkbox"/> Nonlinear 2D coloring	
<input checked="" type="checkbox"/> Coloring + distances	
<input type="checkbox"/> Image Renderer	
<input type="checkbox"/> Custom Renderer	
start Training	
EFP	
HE	

Get result

Som size

Symmetrical SOM

$$S = 5 \cdot \sqrt{N}$$

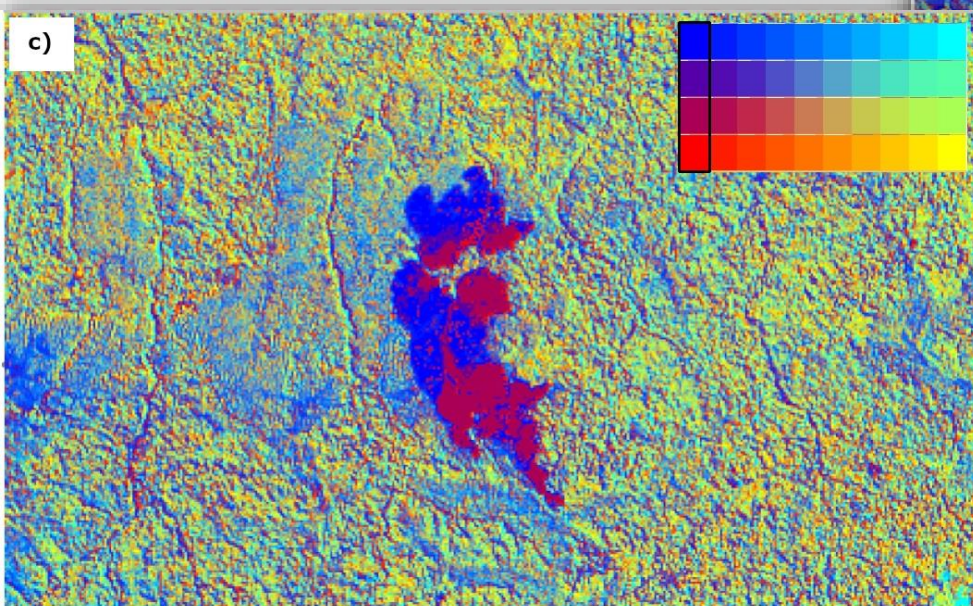
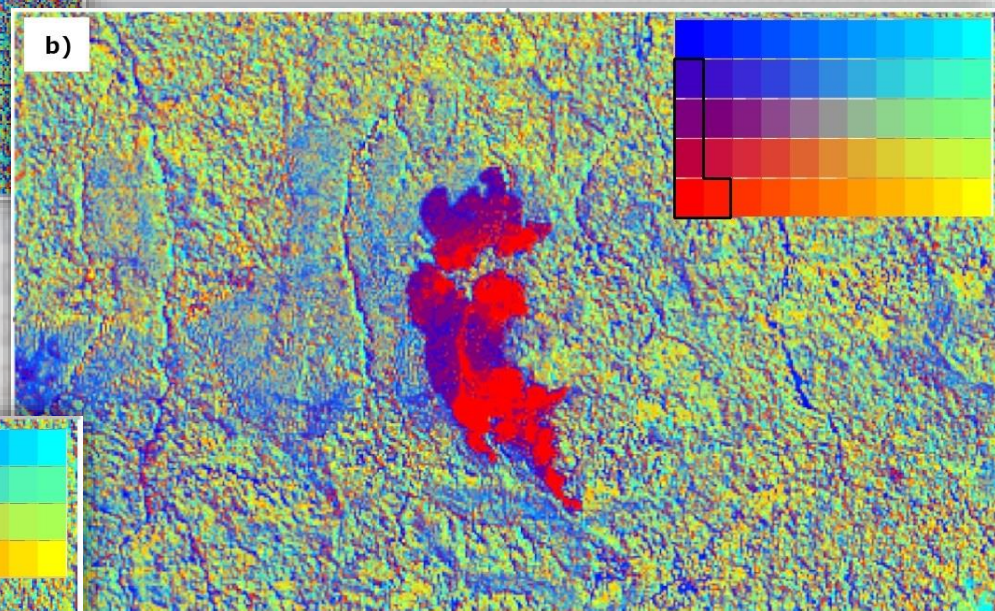
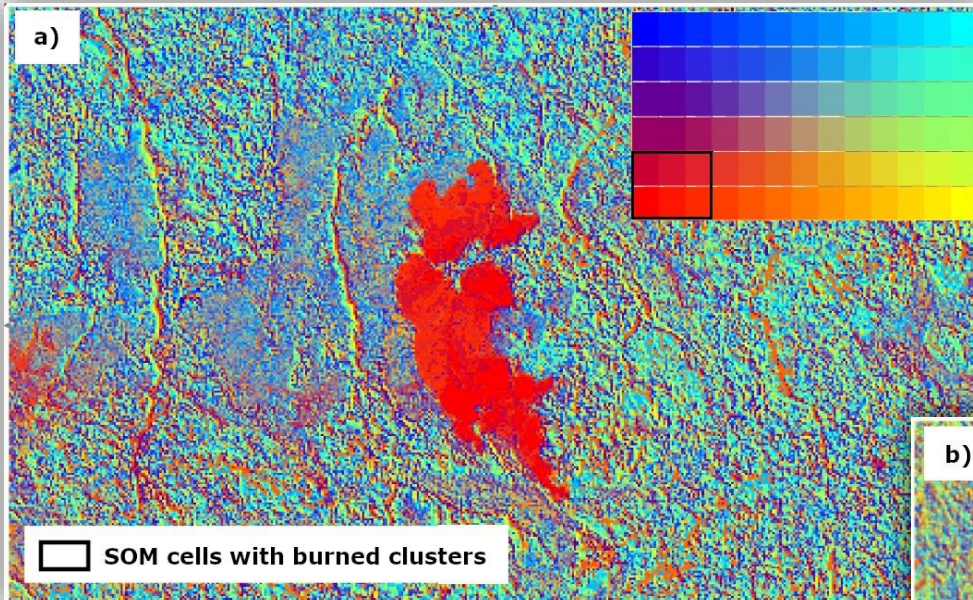
J. Vesanto, E. Alhoniemi "Clustering of the Self-Organizing Map," IEEE Trans. on Neural Networks, vol. 11, no.3, pp. 586-600, 2000.

Not-Symmetrical SOM

$$S_a = \sqrt{\frac{S}{2}} \quad S_b = 2 \cdot S_a$$

W. Jochen and B. P. Battenfield "Formalizing Guidelines for Building Meaningful Self-Organizing Maps," Sixth international conference on Geographic Information Science. Zurich, 14-17th September, 2010. Available at http://www.giscience2010.org/pdfs/paper_230.pdf.

T. Kohonen "The self-organizing map," Proc. IEEE, vol. 78, no. 9, pp. 1464-1480, 1990.



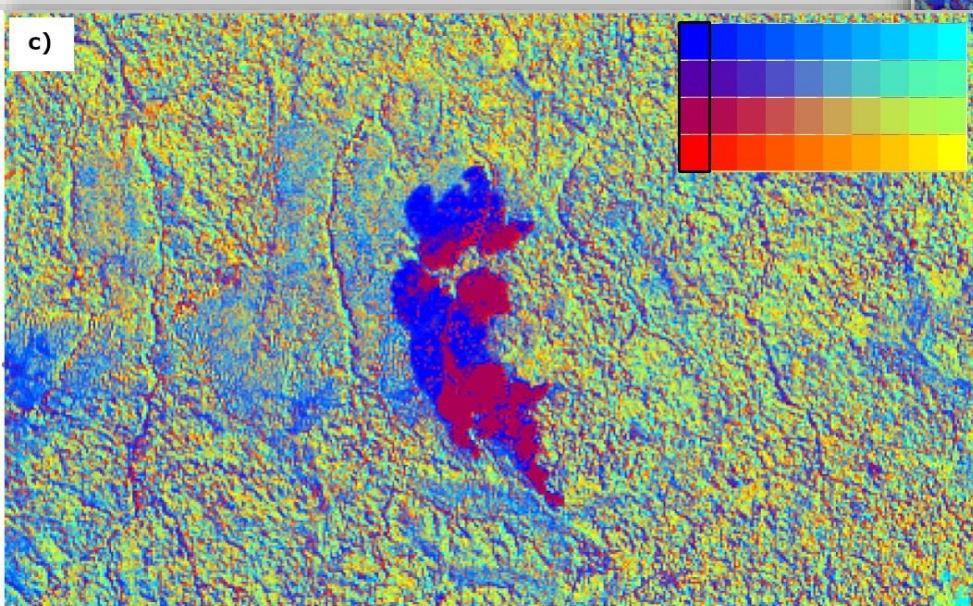
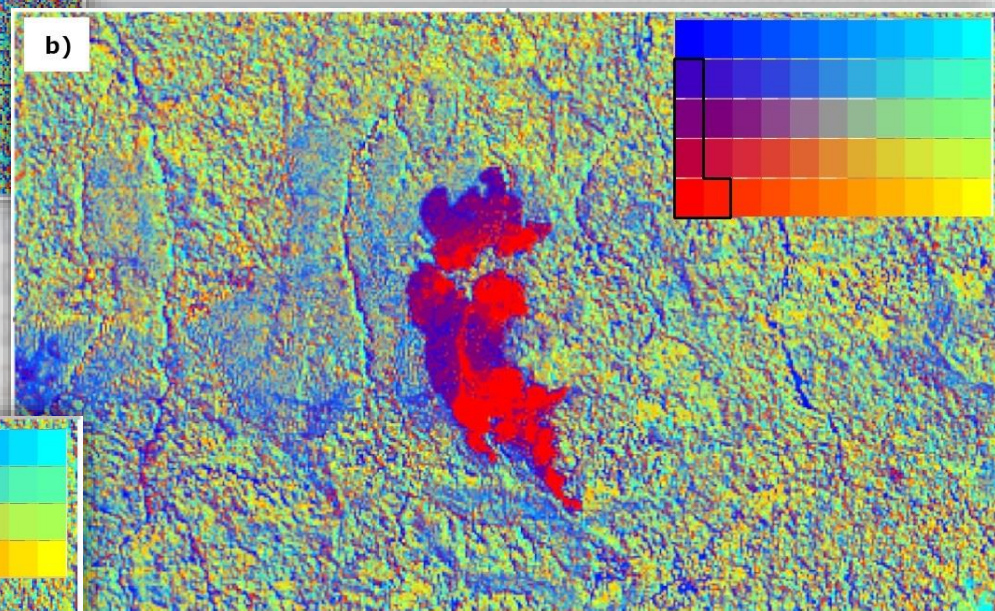
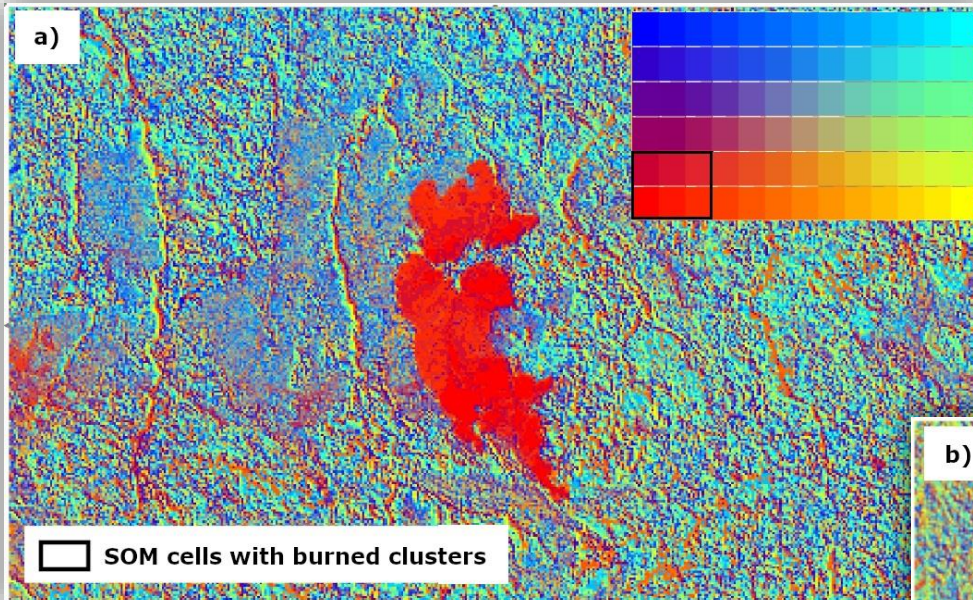
10x4

Press «Start Training» and...wait!



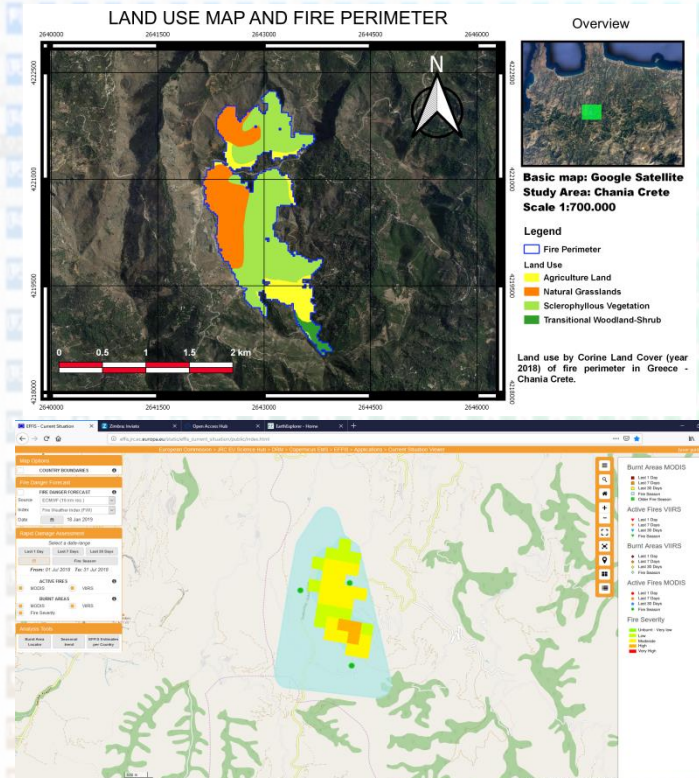
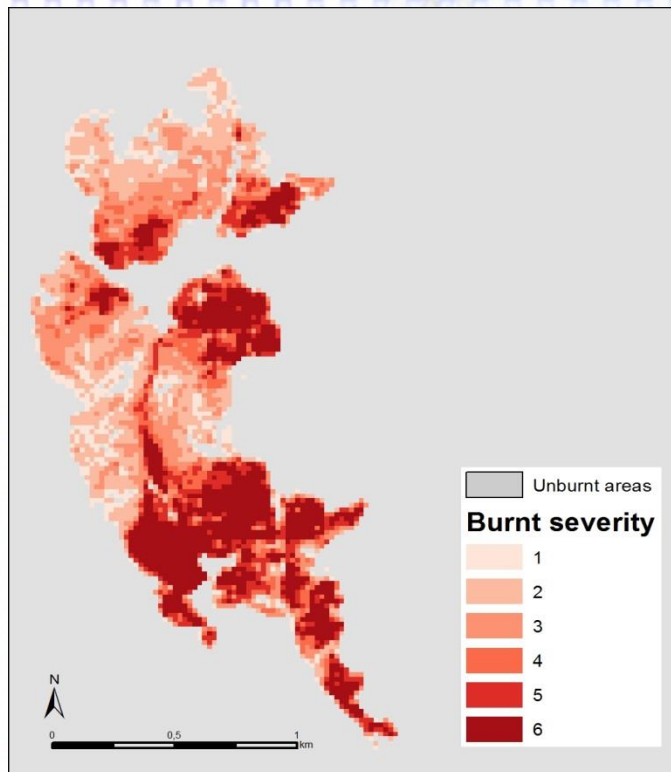
Press «Get result» and...wait!





10x4

Result



- **Unburnt areas** - No change: Unchanged surfaces, i.e. fire un-affected areas.
- **Burnt severity 1** – Very Low: Areas of surface fire occurred with very little change in cover and little mortality of the structural dominant vegetation.
- **Burnt severity 2** - Low: Areas of surface fire occurred with little change in cover and little mortality of the structural dominant vegetation.
- **Burnt severity 3**- Moderate: The area exhibits a mixture of effects ranging from unchanged to high severity within the scale of one pixel.
- **Burnt severity 4**- High: The area exhibits a mixture of effects ranging from moderate to high severity within the scale of one pixel.
- **Burnt severity 5** - Very High: Vegetation has high to 100% mortality.
- **Burnt severity extreme 6** – Soil burn severity assessment with characteristics of high severity, including heavy white ash deposition indicating loss of substantial levels of organic matter and loose unstructured soil