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?

$$\text{NDVI} = \text{B8-B4B8+B4}$$

$$NBR = \frac{\text{B8} - \text{B12}}{\text{NB8+B12}}$$

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

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

Dataset: sources

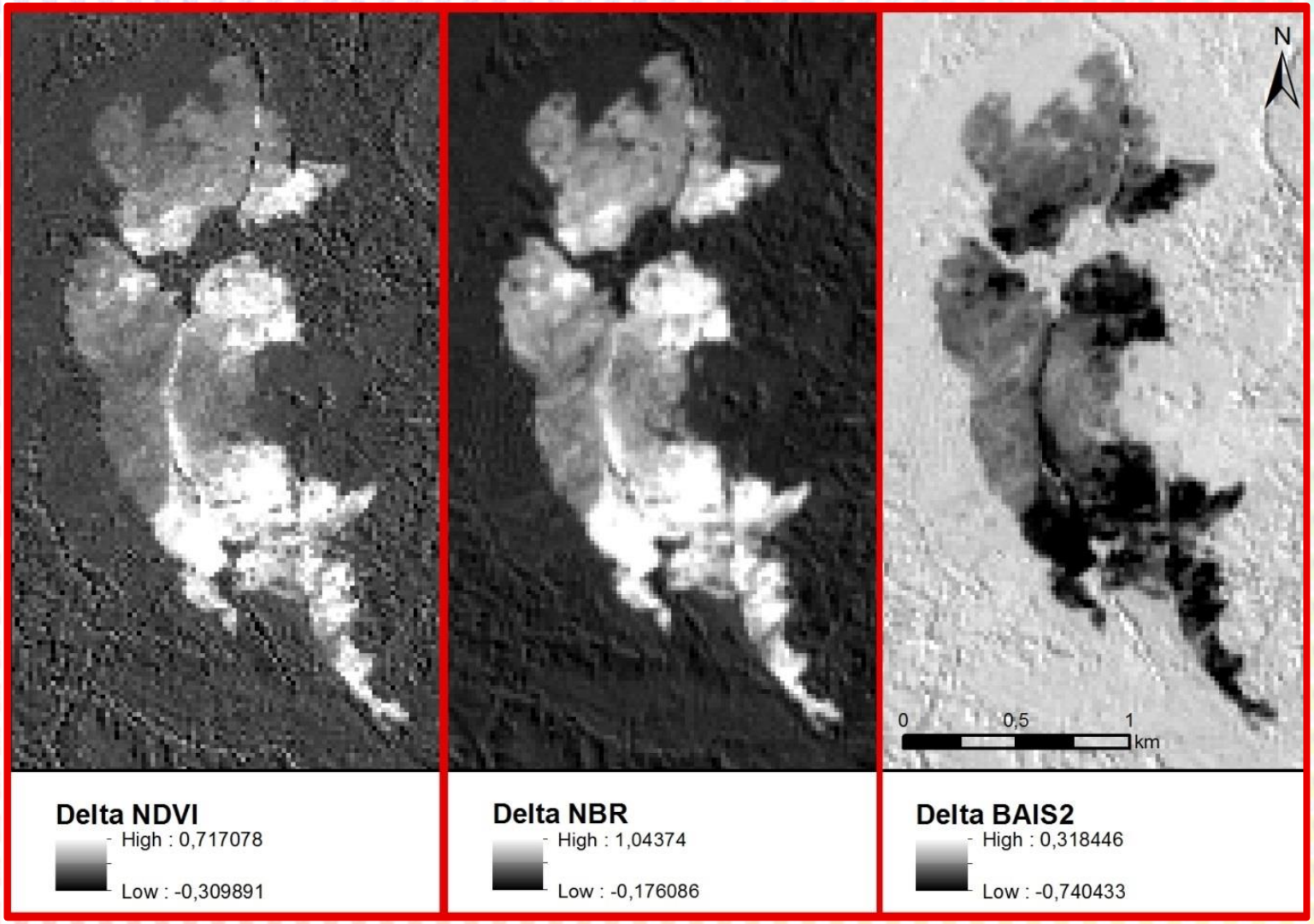
- Copernicus Program and Sentinel missions have been devised specifically for supporting risk monitoring and offer advanced satellite data free of charge (as Sentinel 2) that can suitably support forest fire monitoring from risk estimation to damage quantification.

- 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

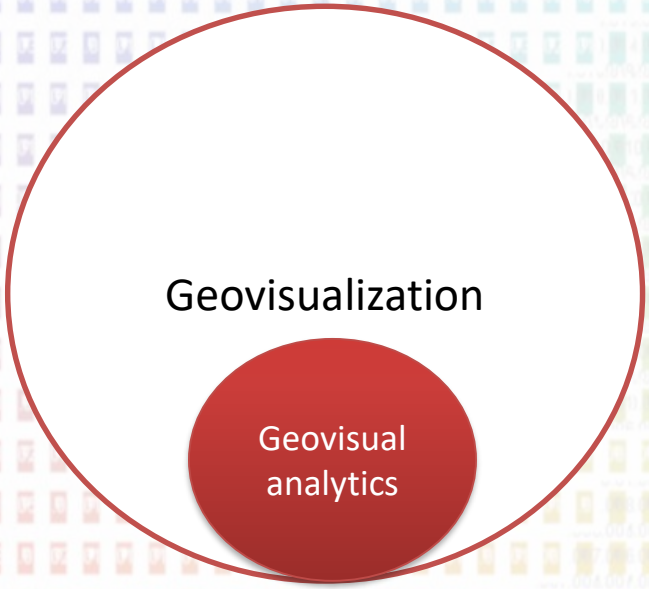
Date: 23rd and 28th of July 2018
Areas affected: 200 ha

427x261x3=334 341



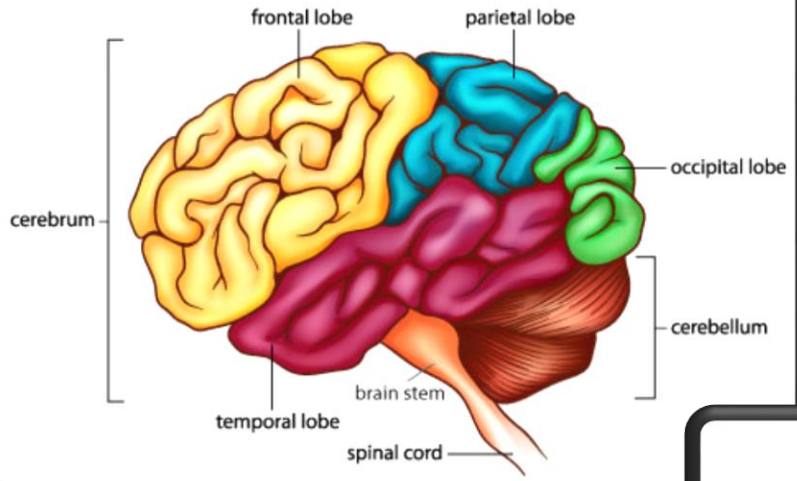
Self-Organizing Maps (SOM)

Kohonen 1997

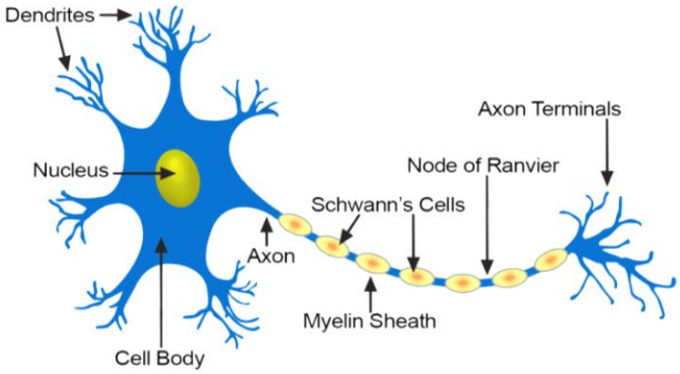


Neural Network

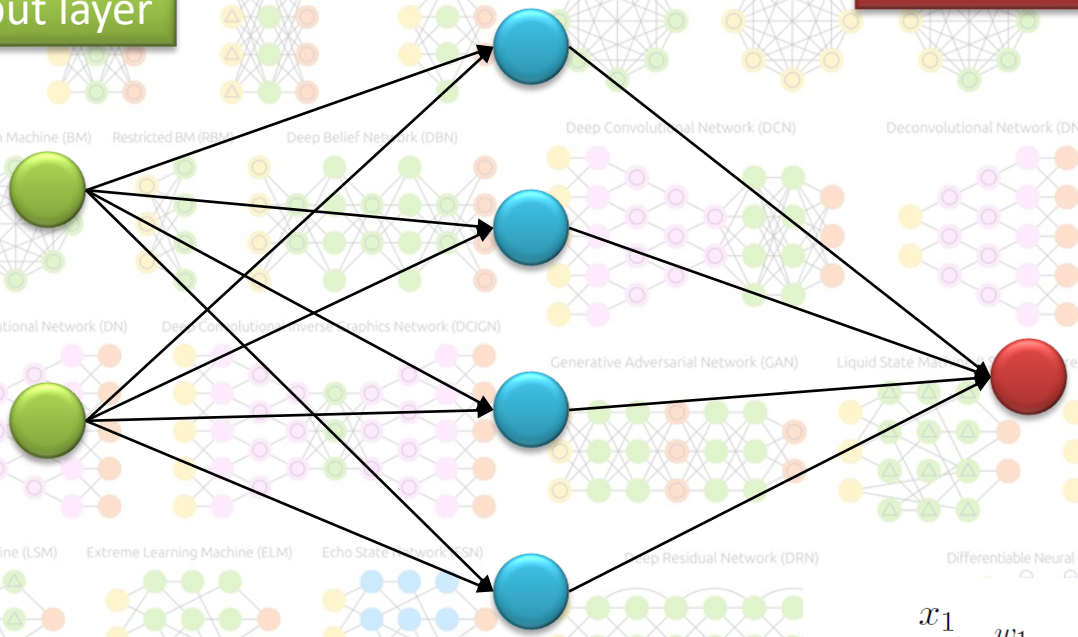
1

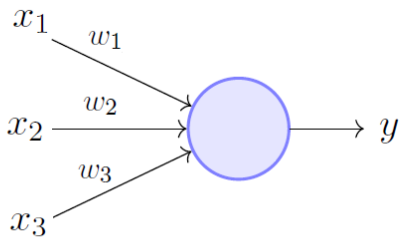


2



Artificial Neural Network (ANN)





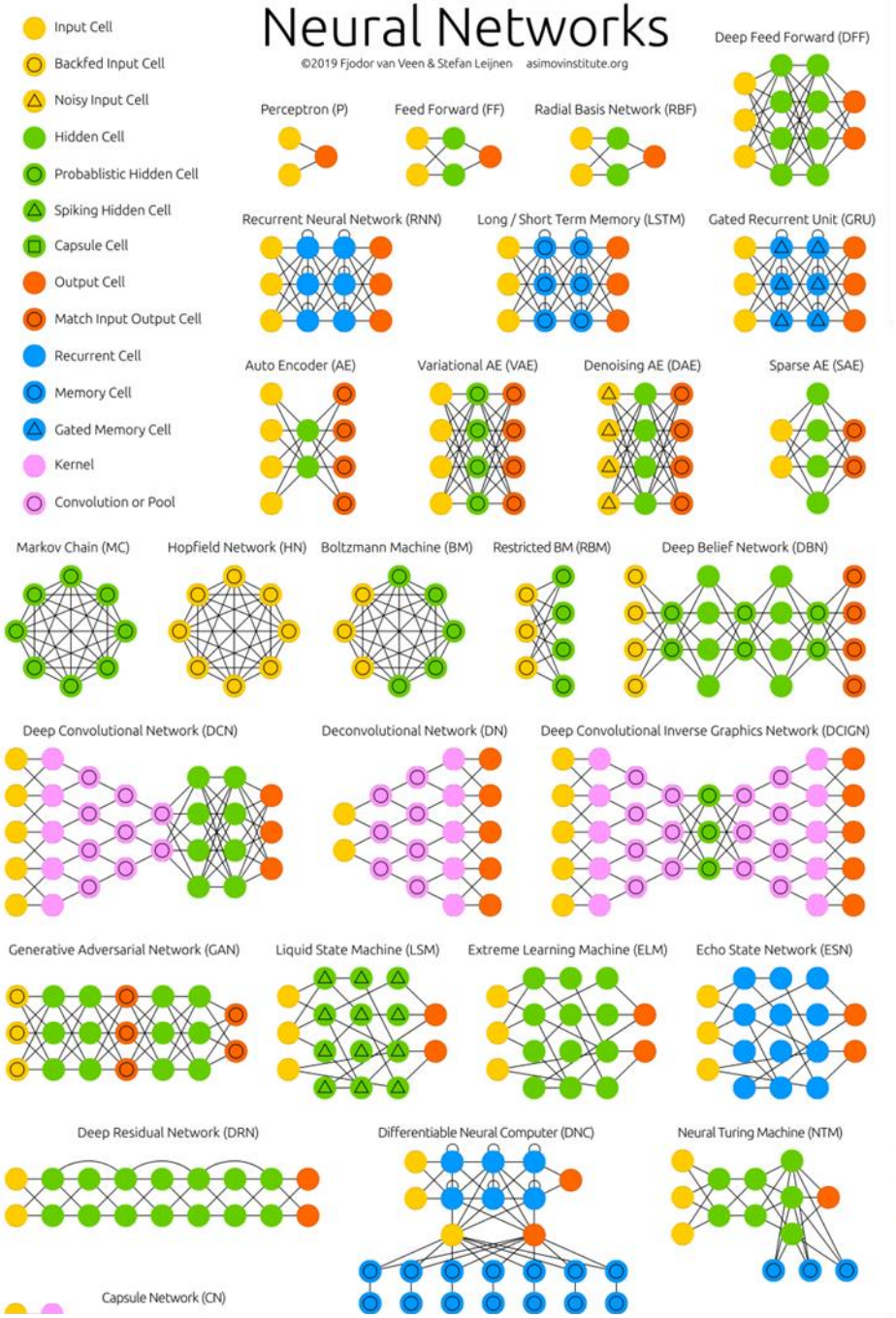
Perceptron Model (Minsky-Papert in 1969)

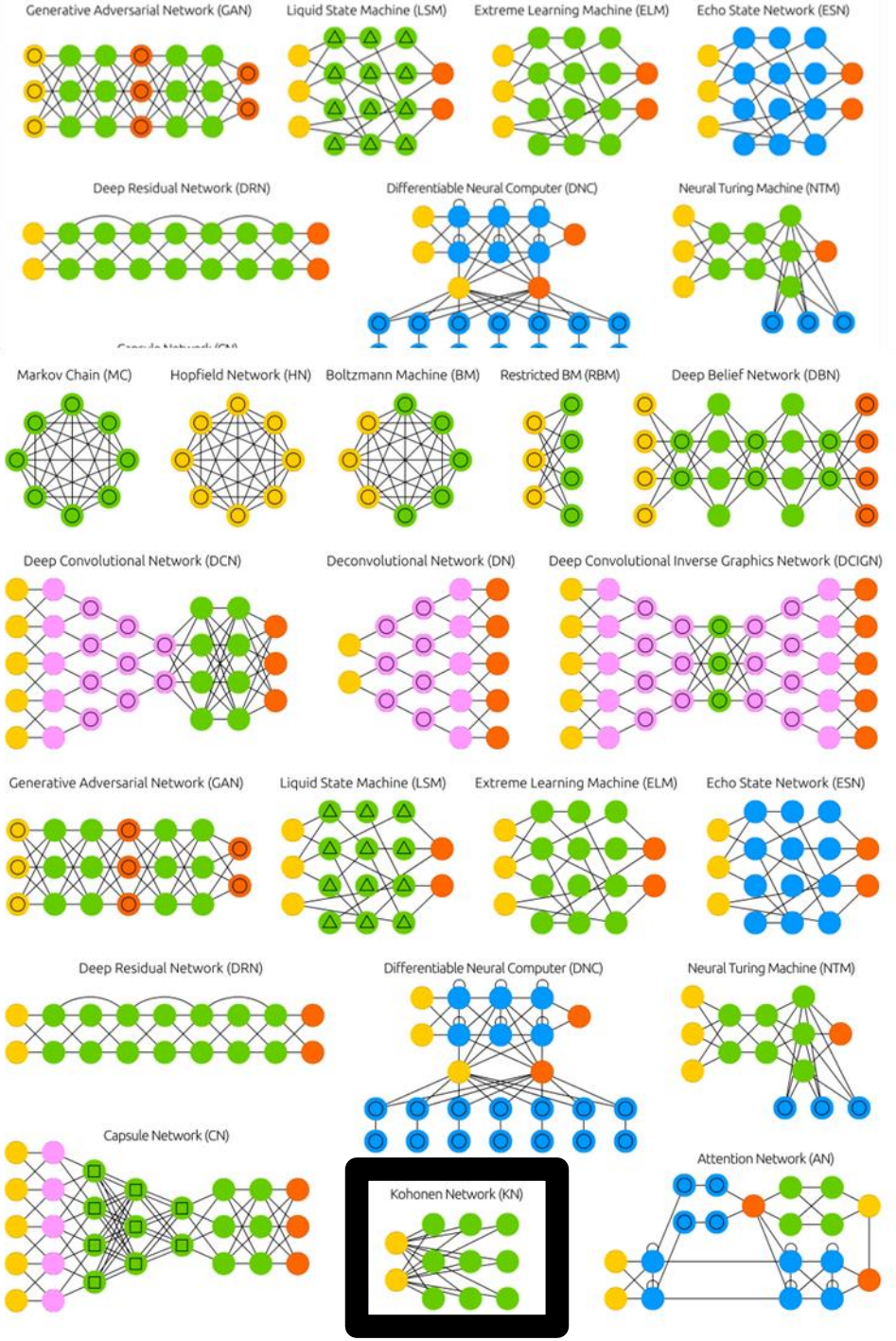
A mostly complete chart of

Neural Networks

 asimovinstitute.org

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





Self-organizing MAPS:
SPATIAL ORDER AND ORGANIZATION

There is a topographical or anatomical order of the neural connections

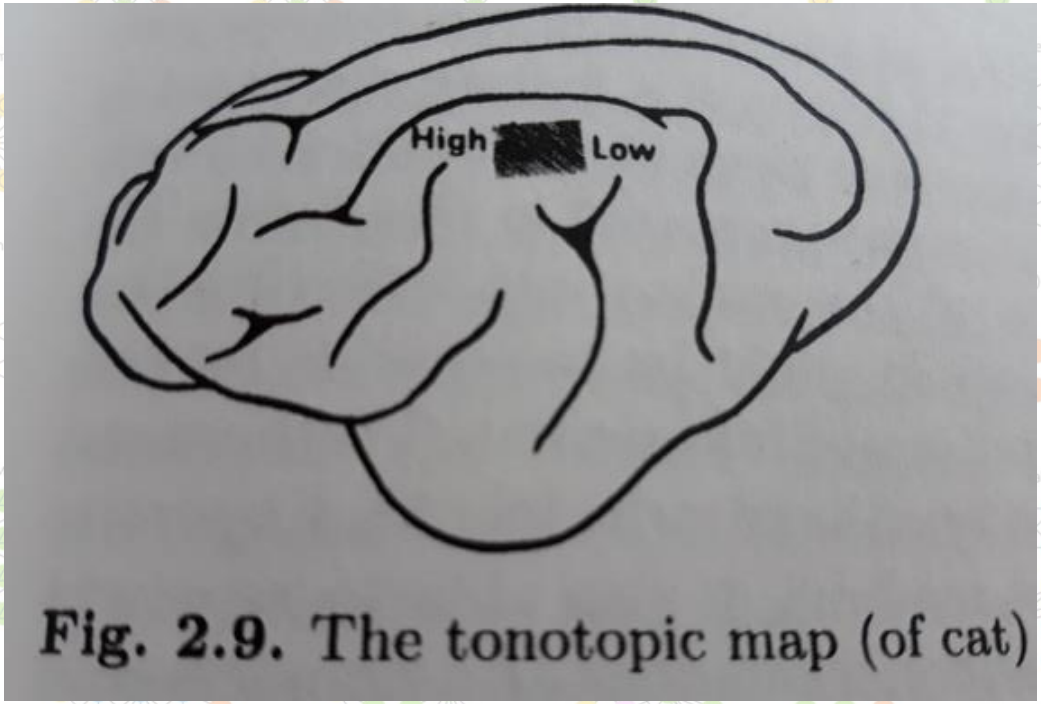
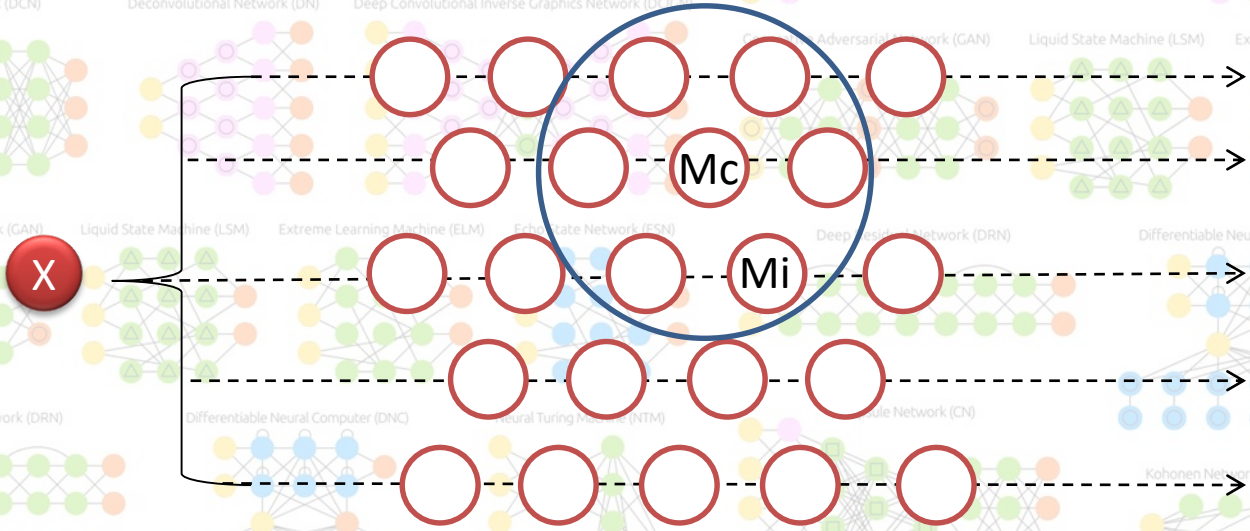


Fig. 2.9. The tonotopic map (of cat)

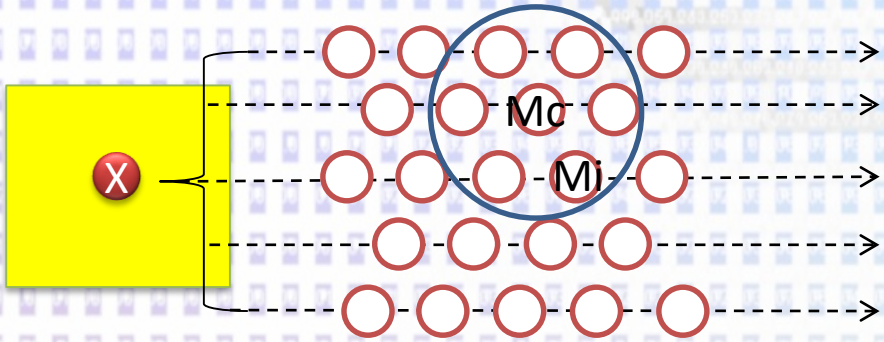
SELF-ORGANIZING maps

- 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



SOM: input data



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

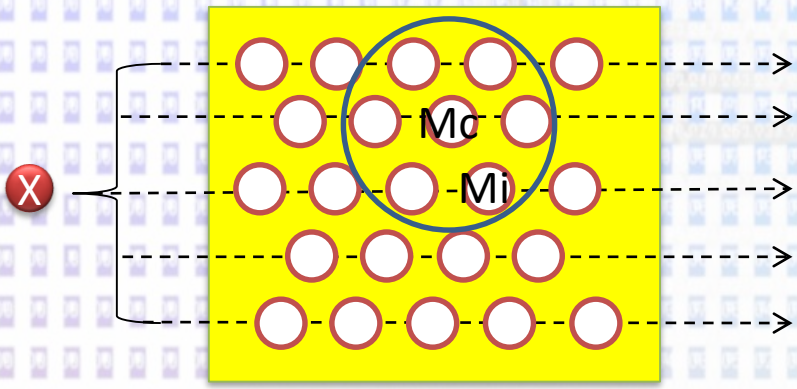
X

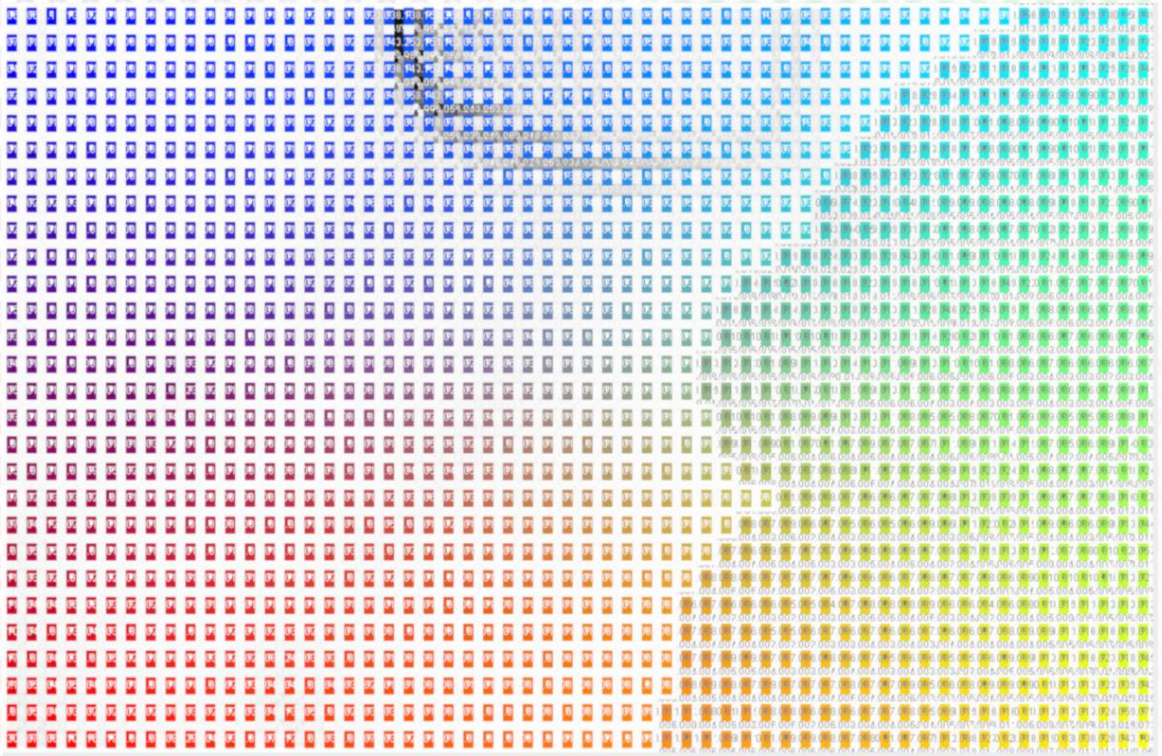
chania_grid :: Totale degli elementi: 111447, Filtrati: 111447, Selezionati: 0

	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...

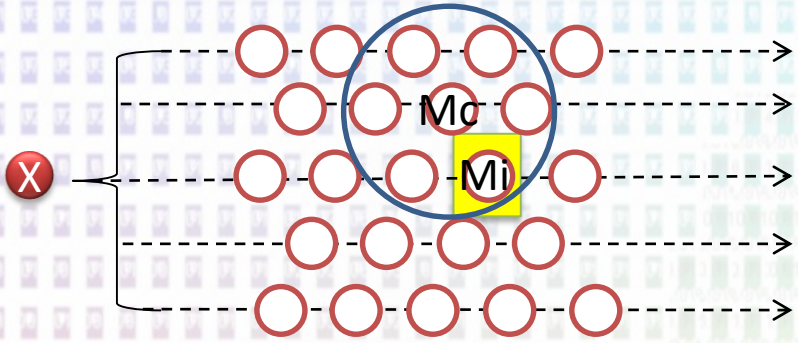
Mostra tutti gli elementi

SOM: Mc and the 2D matrix

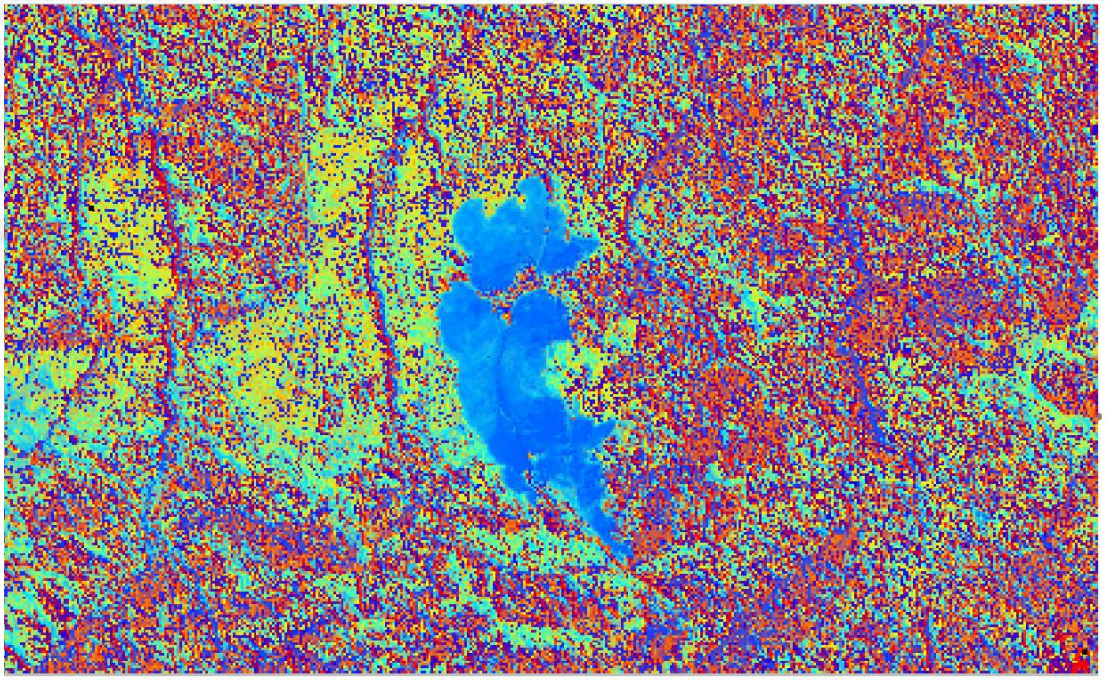


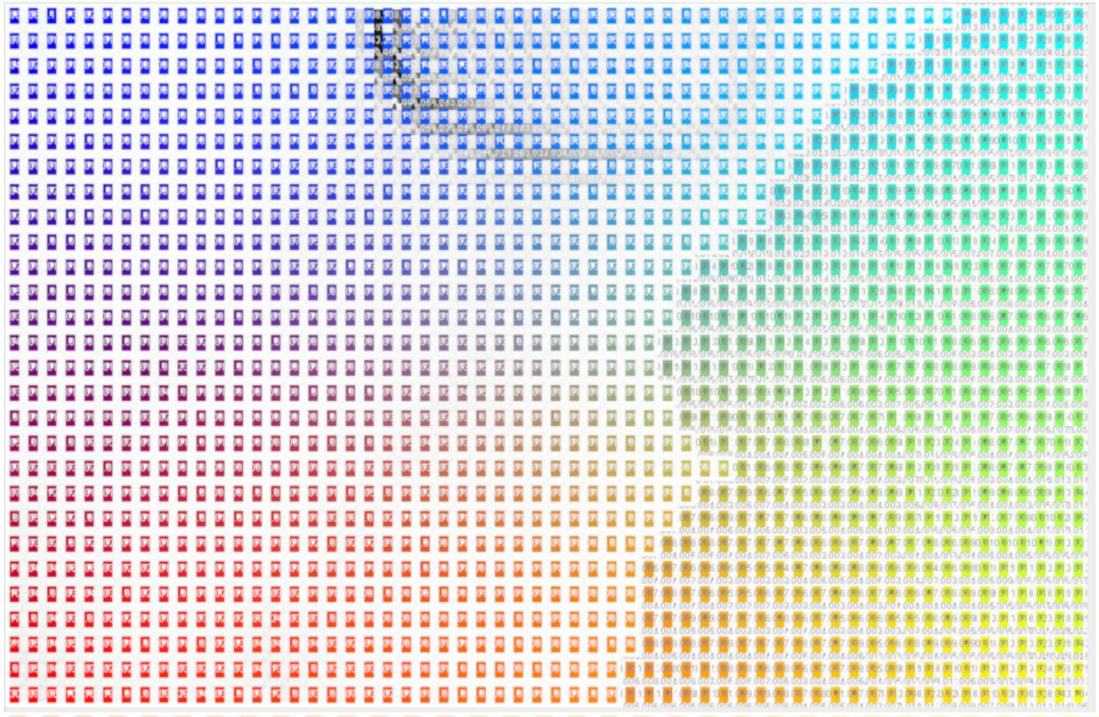


SOM: Mi and the learning process



SOM: what does we obtain?





SOM tutorial

Andrienko's V-Analitycs

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

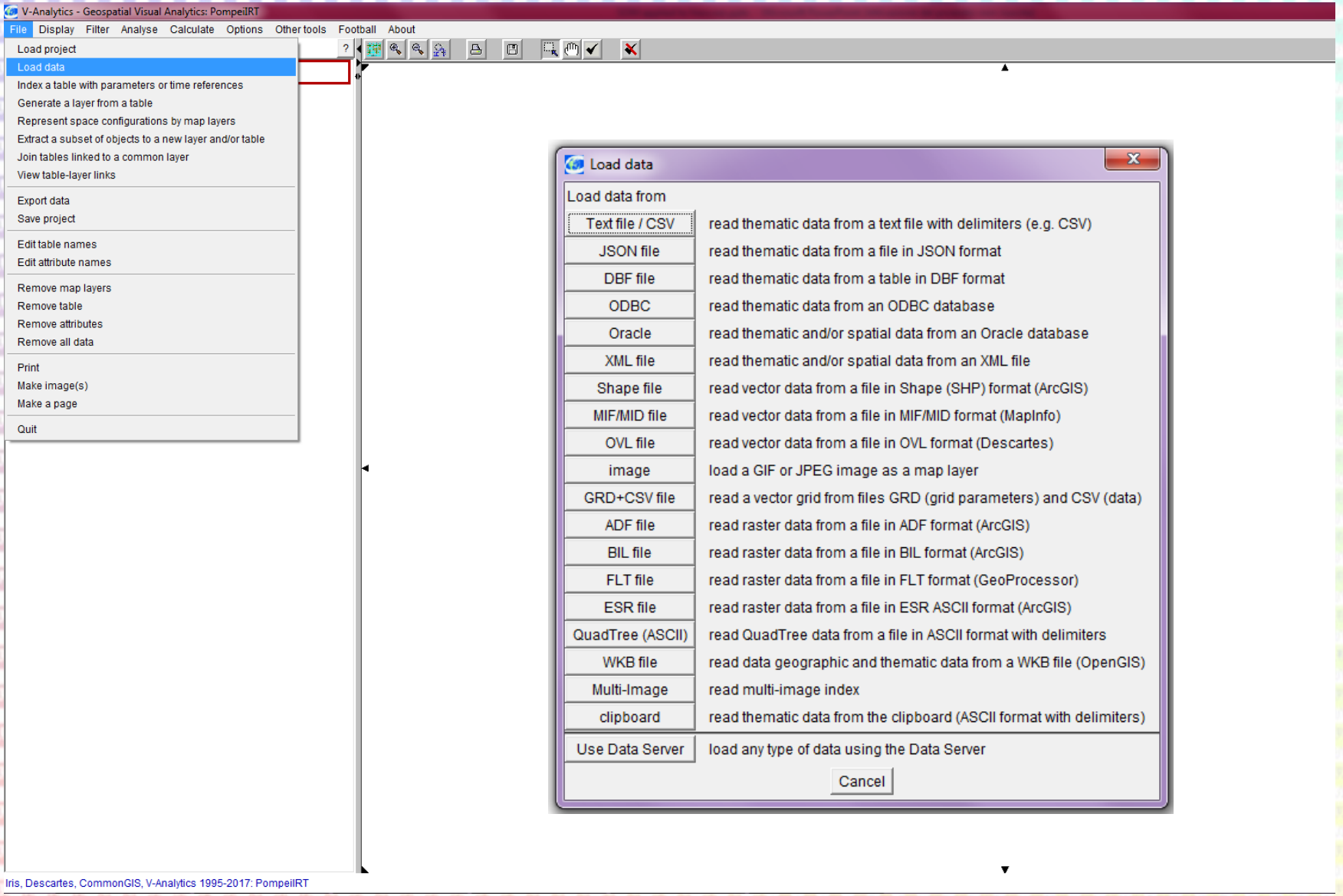
SOM tutorial

Andrienko's V-Analitycs

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...
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4	110597	-0,00727120000	-0,00097617500	-0,03747788000	744990,0000000...	3920150,000000...
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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...
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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...
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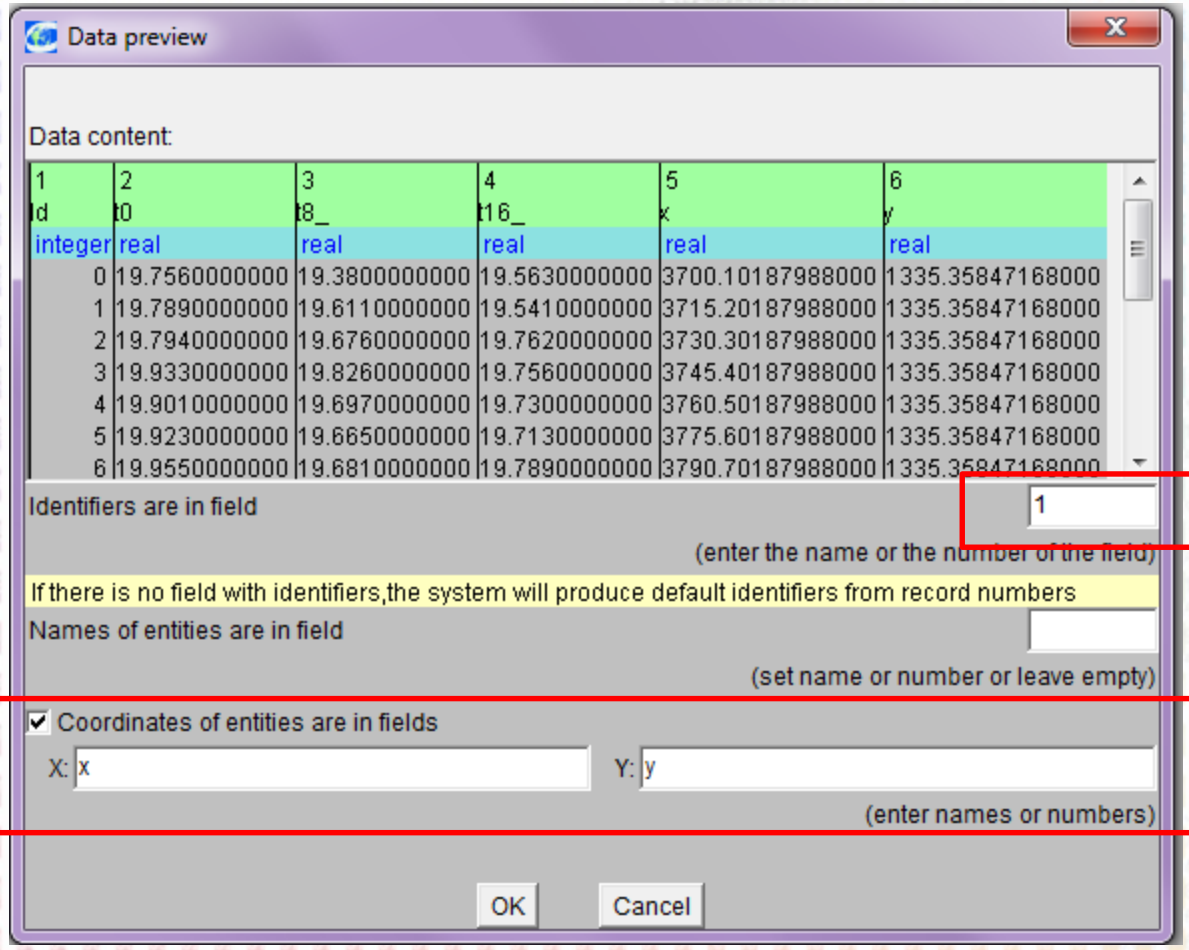
15	110608	-0,02940080000	-0,04141740000	0,08161837000	745210,0000000...	3920150,000000...
16	110609	0,03410150000	-0,10780400000	-0,01602811000	745230,0000000...	3920150,000000...

Mostra tutti gli elementi

To load data



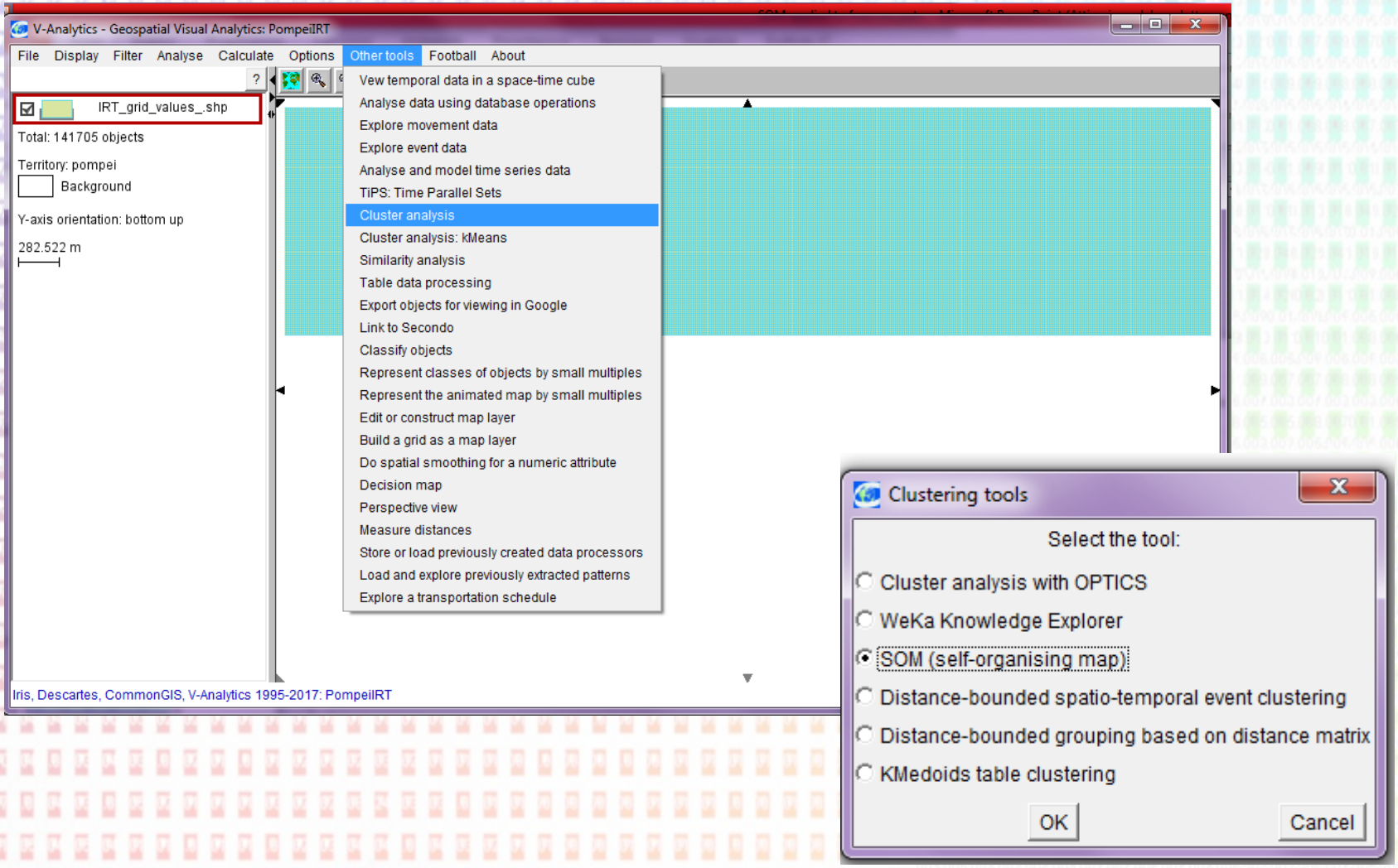
To set:

- Number of the id field

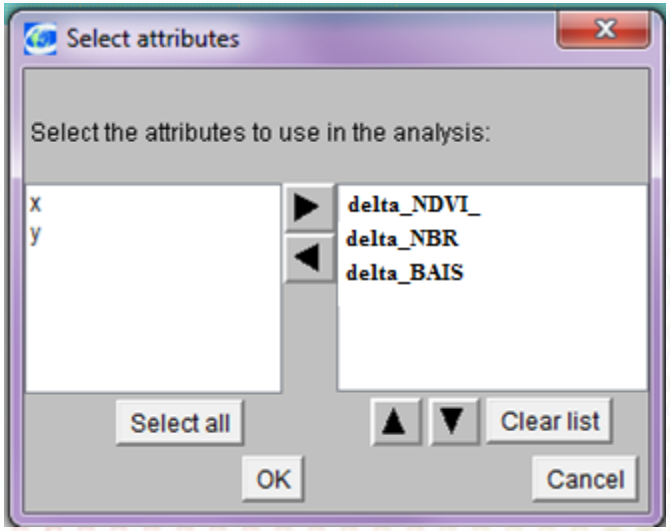
- Name of the coordinate fields

Lat-long coordinates? Yes/No

Menu: Other tools -> cluster analysis -> SOM

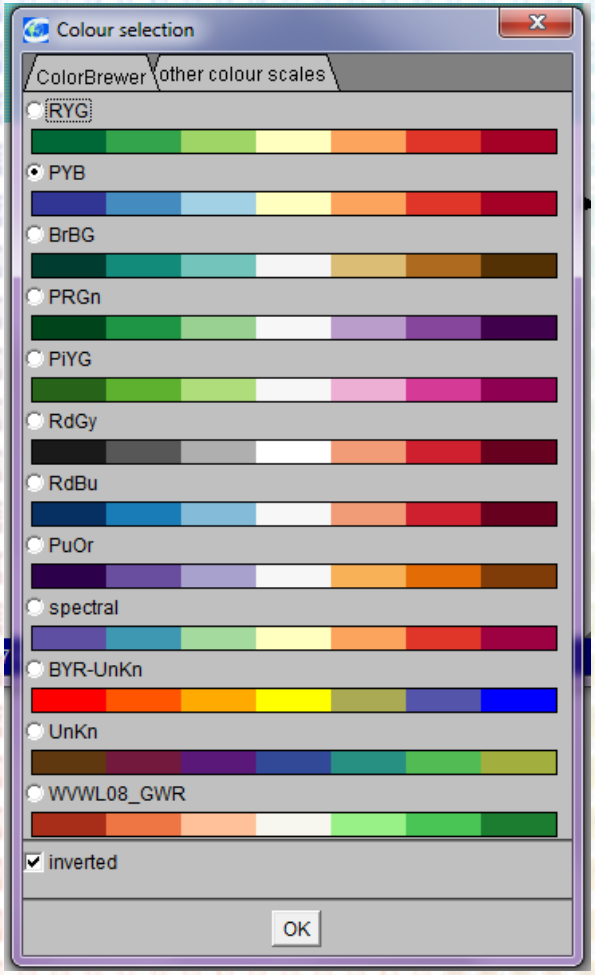


Choice of the fields to use for the analysis

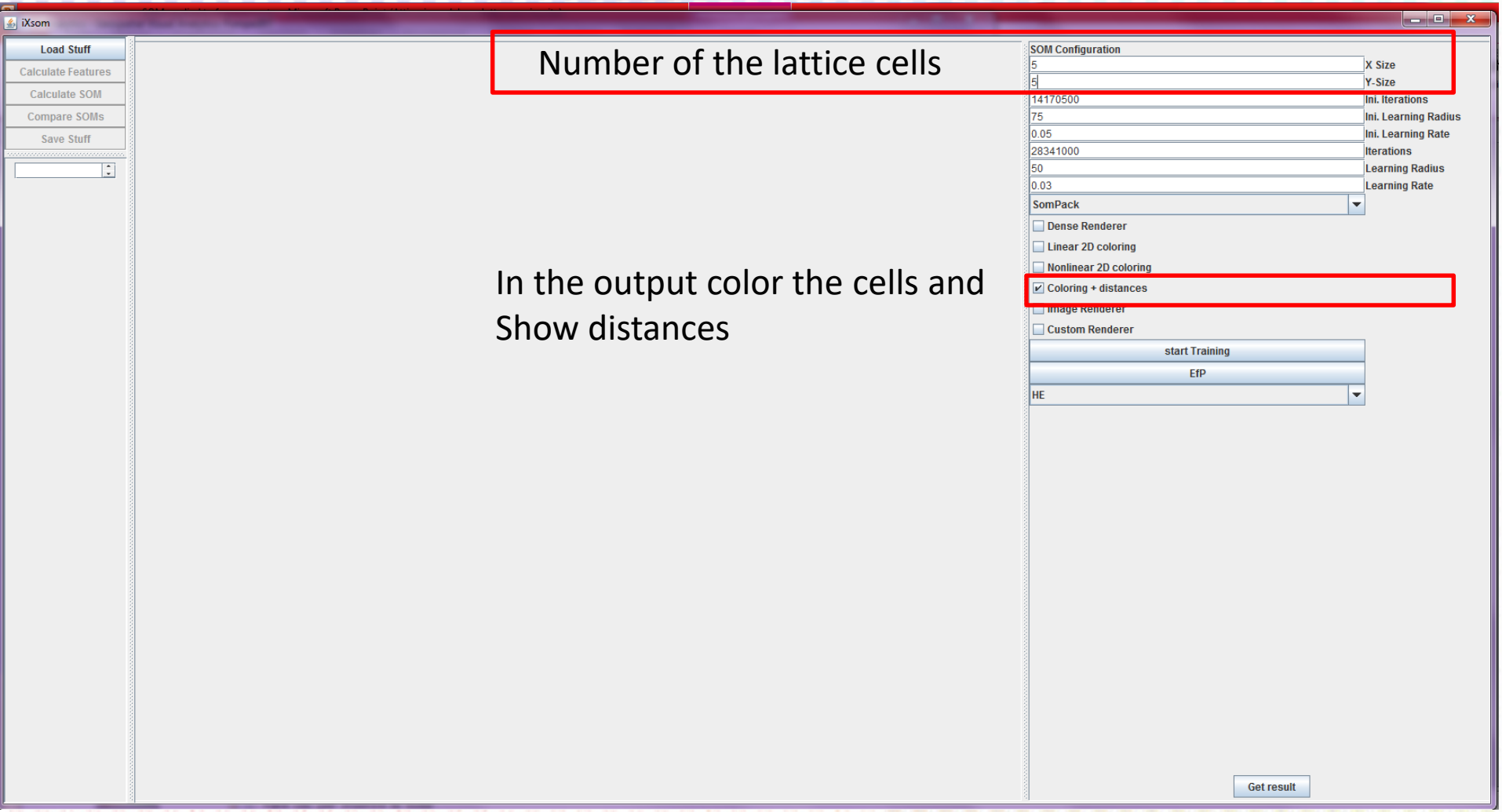


Create image to be used in the SOM matrix view? YES

Select a color palette



Set SOM parameters



Number of the lattice cells

In the output color the cells and Show distances

Som size

Symmetrical SOM

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

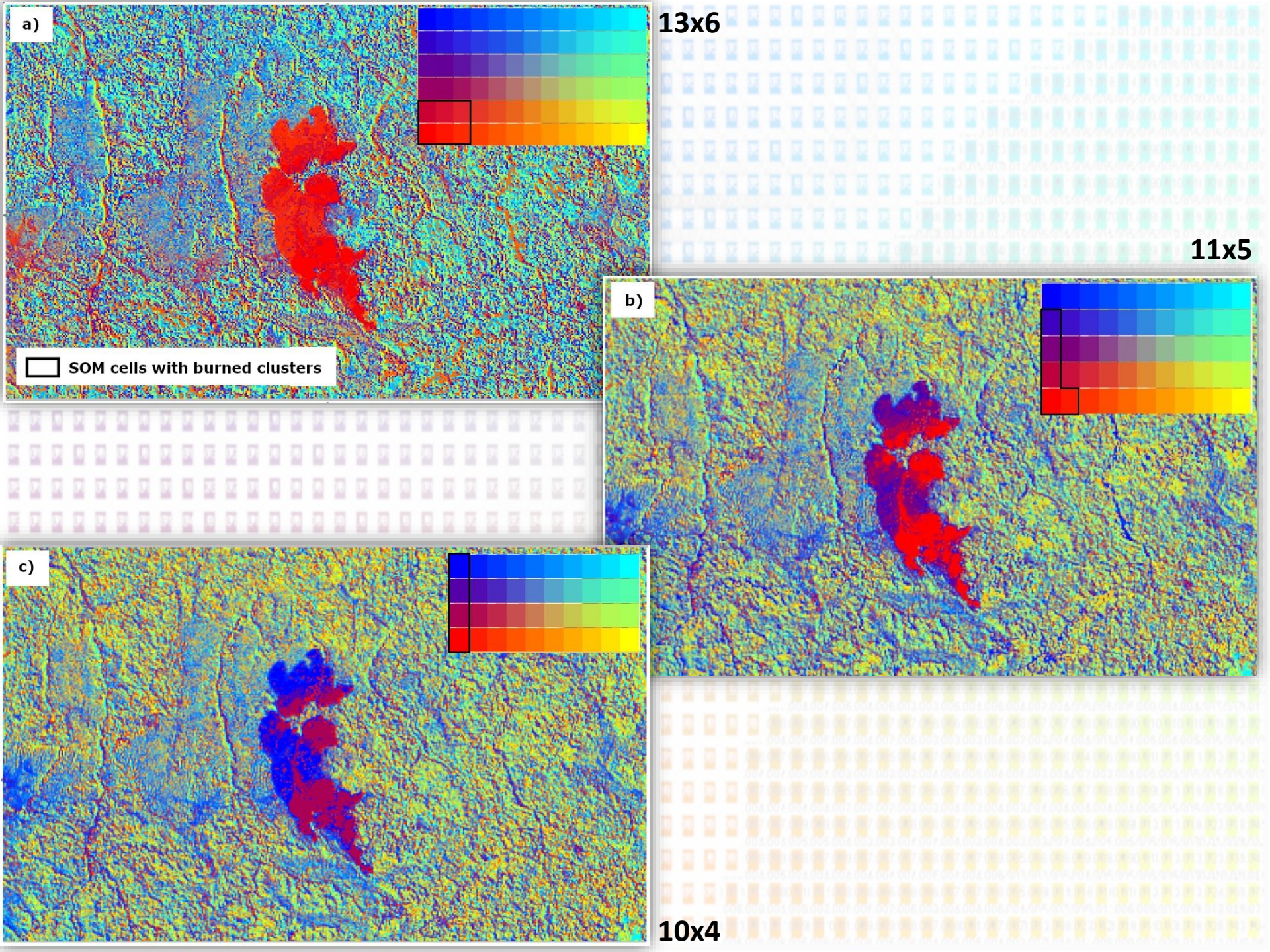
J. Vesanto, E. Alhoniemi “Clustering of the Self-Organizing Map,” IEEE Trans. on Neural Networks, vol. 11, no.3, pp. 586-600, 2000.

Not-Symmetrical SOM

$$Sa = \sqrt{\frac{S}{2}} \qquad Sb = 2 \cdot Sa$$

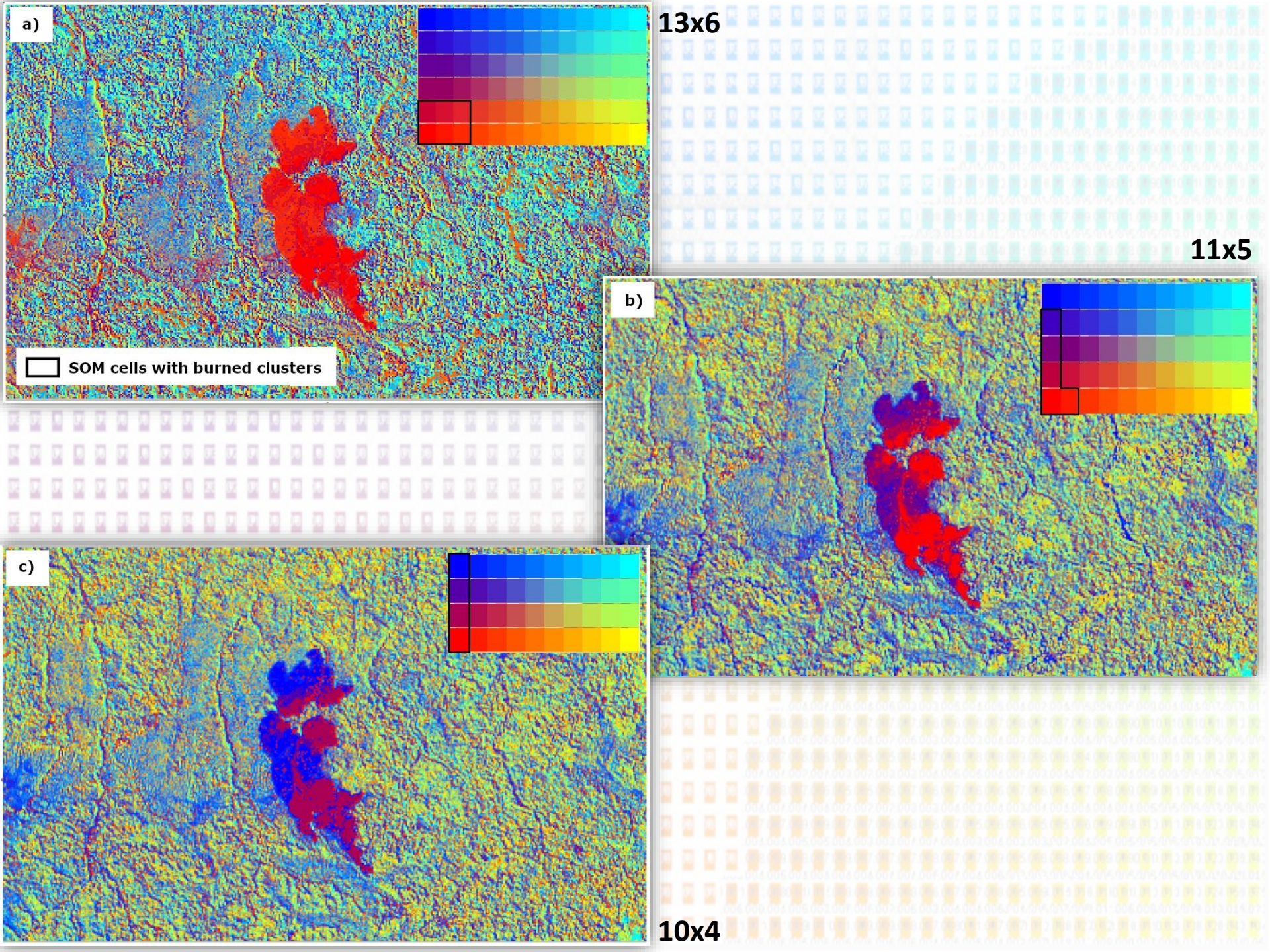
W. Jochen and B. P. Buttenfield “Formalizing Guidelines for Building Meaningful Self-Organizing Maps,” Sixth international conference on Geographic Information Science.Zurich, 14-17th September, 2010. Available at http://www.giscience2010.org/pdfs/paper_230.pdf.

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

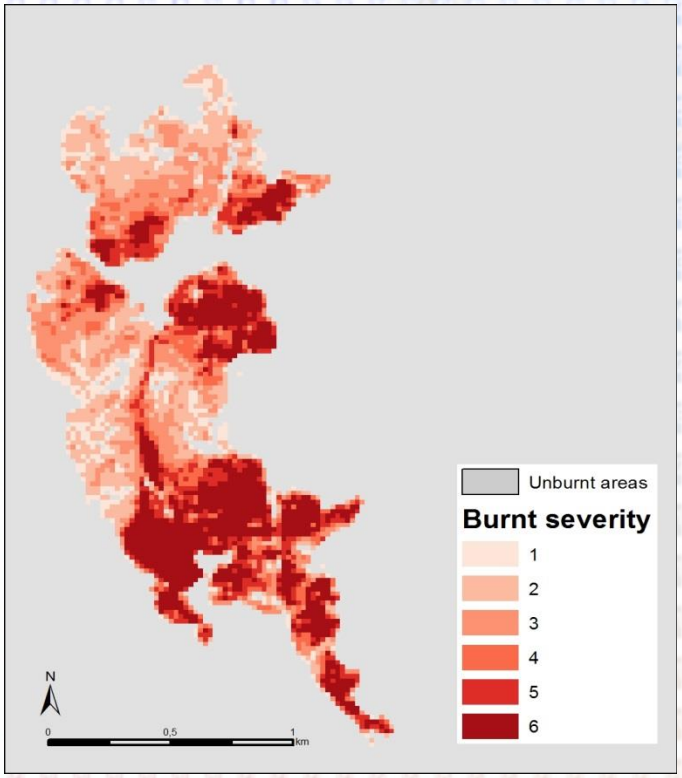

a)
13x6
11x5
b)
SOM cells with burned clusters
c)
10x4

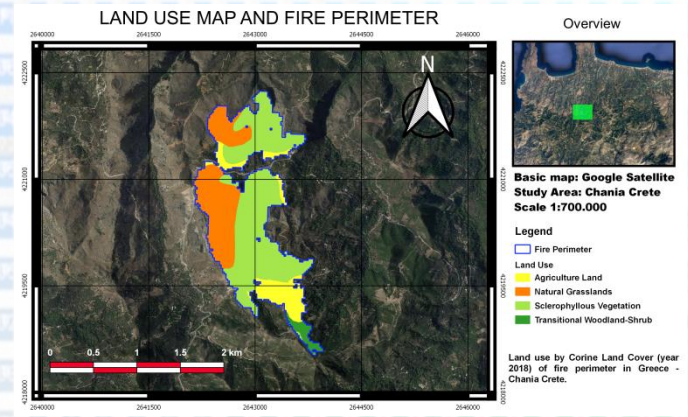
Press «Start Training» and…wait!

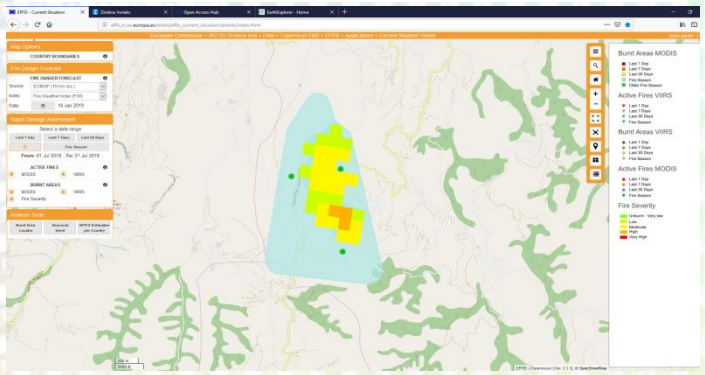
Press «Get result» and…wait!


a)
13x6
11x5
b)
SOM cells with burned clusters
c)
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