Visualizing self-organizing maps with GIS

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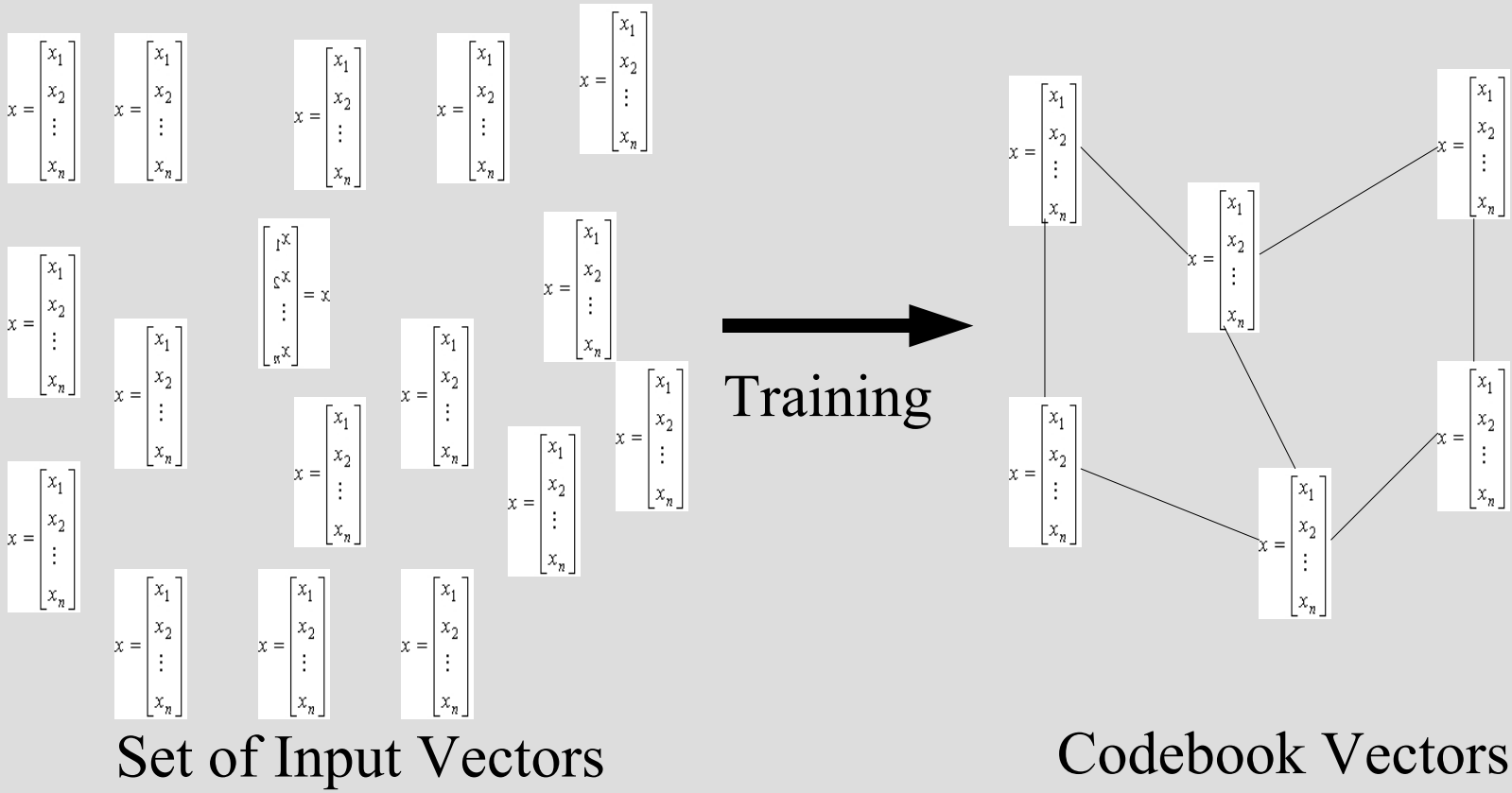
Motivation

- Self-organizing maps (SOM) are usually built to detect patterns, relationships or anomalies within large and high-dimensional data sets with unknown structures
- Although a lot of visualization techniques exist, it might still be cumbersome to detect patterns in the data
- GIS can be used to analyze the visualization techniques

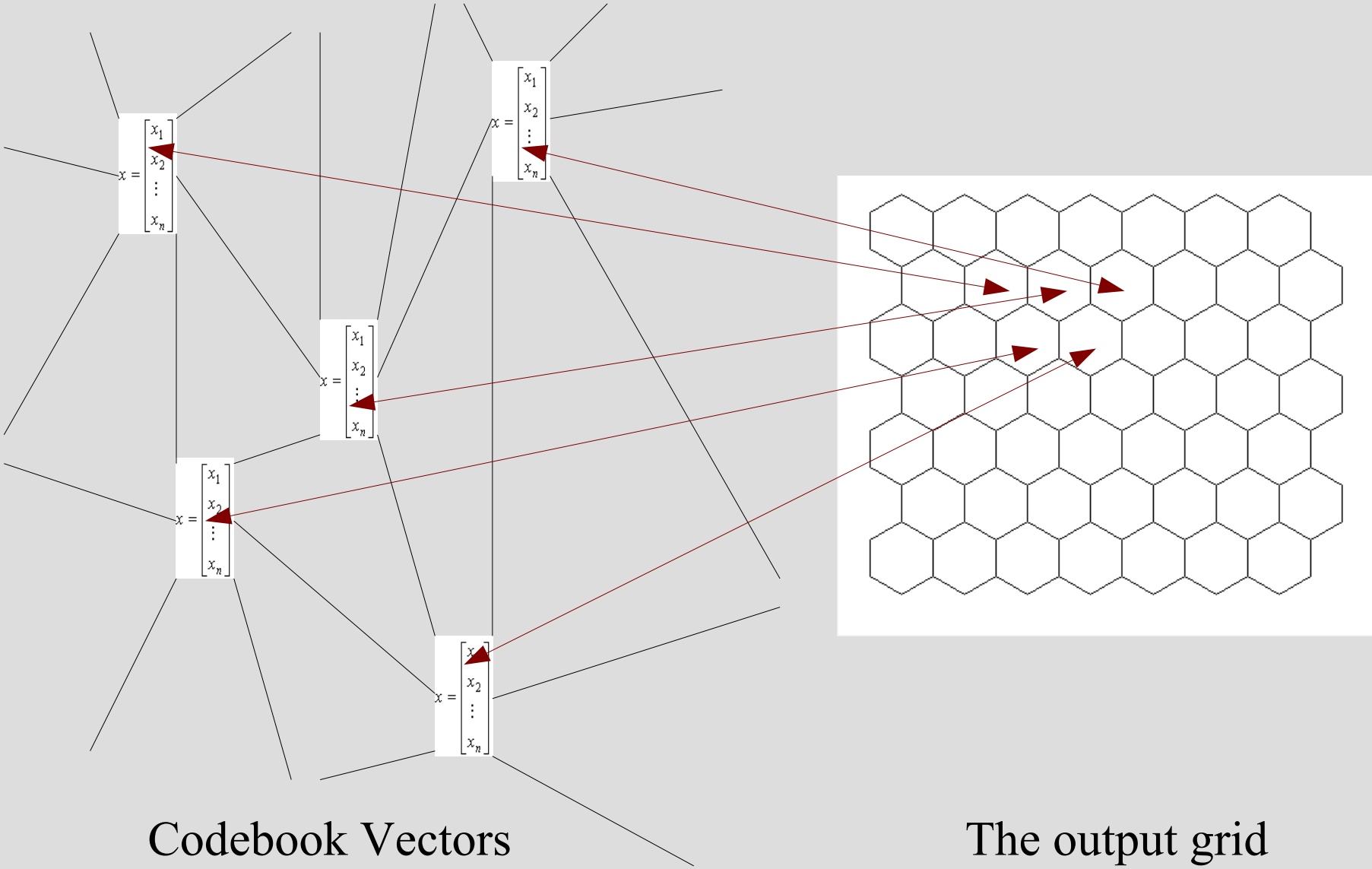
Self-organizing maps

- A self-organizing map is a neural network
- Each neuron is associated with a codebook vector
- A topological order is defined over the network
- Via Training the SOM becomes representative for an input data set

Self-organizing maps



Self-organizing maps

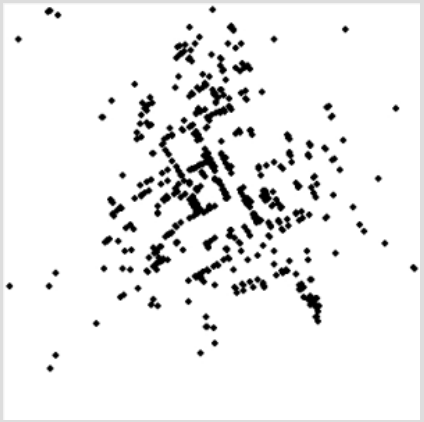


Applications for further investigation

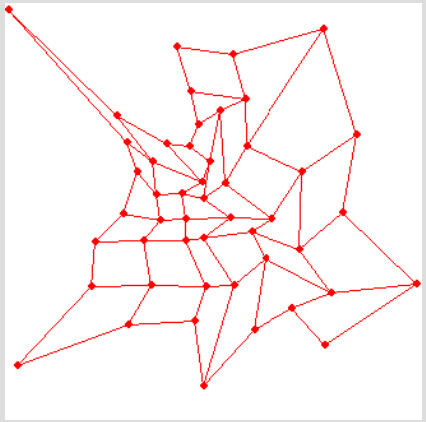
- Component Planes
- U-Matrix
- P-Matrix
- U*-Matrix
- ...

Example 1: The John Snow map

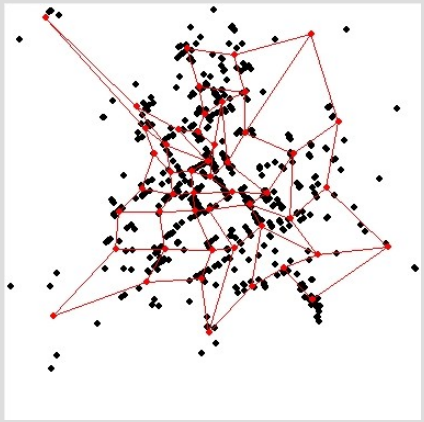
- 2 Attributes per victim
  - X-dimension
  - Y-dimension
- The input vectors and codebook vectors are 2-dimensional so they can be plotted directly



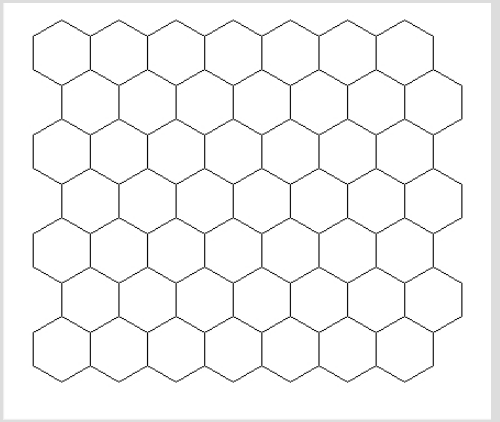
Input Vectors



Codebook Vectors



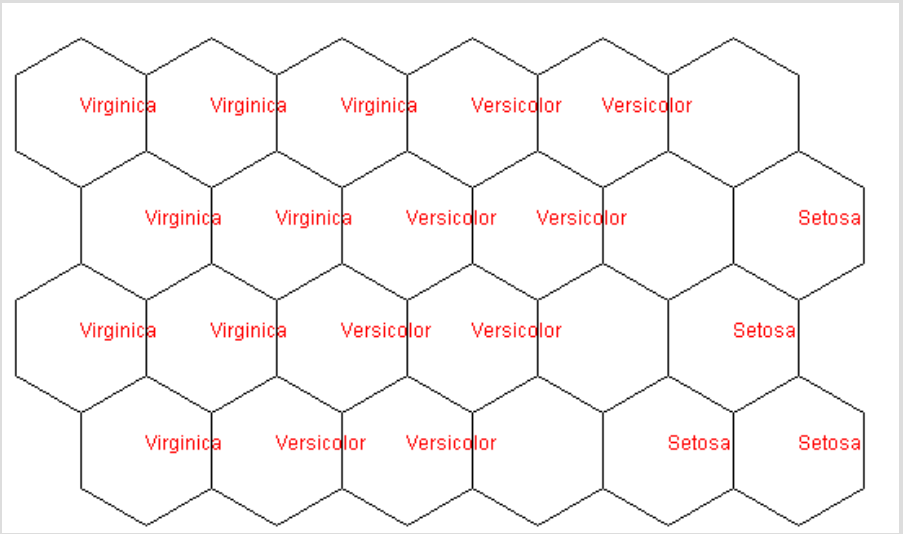
Input Vectors and Codebook Vectors



The output grid

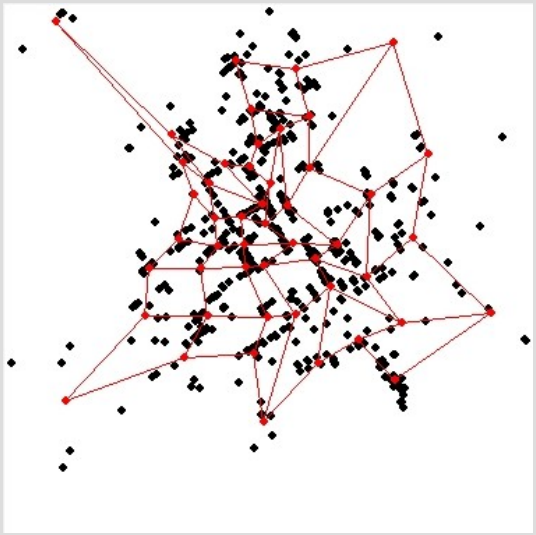
Example 2: The Iris flower data set

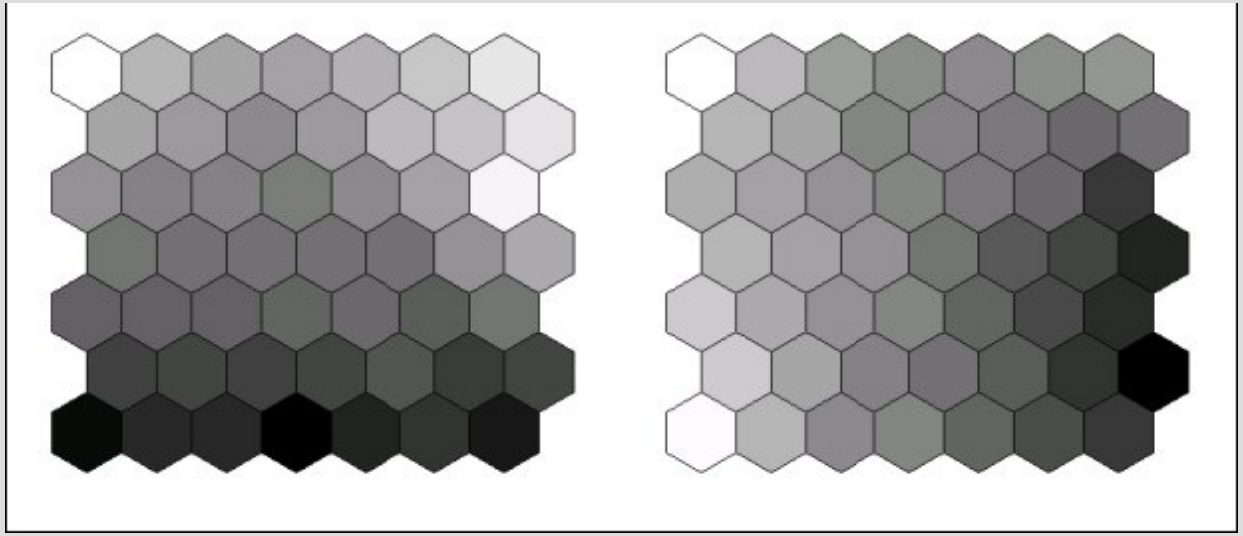
- 4 attributes per flower
  - Petal length
  - Petal width
  - Sepal length
  - Sepal width
- 3 different flower species
  - Versicolor
  - Virginica
  - Setosa
- Each entry of the iris flower data set is a 4-dimensional vector



Component Planes

- A Component Plane is a grid whose cells contain the value of the n-th dimension of a codebook vector which can be displayed by color coding

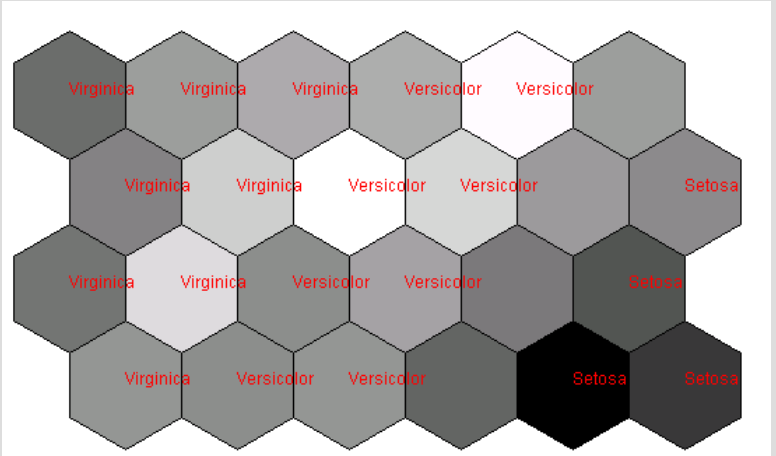




The Component Planes for the John Snow Map SOM

The Component Planes for the Iris flower data set SOM

Component Plane for Sepal Length



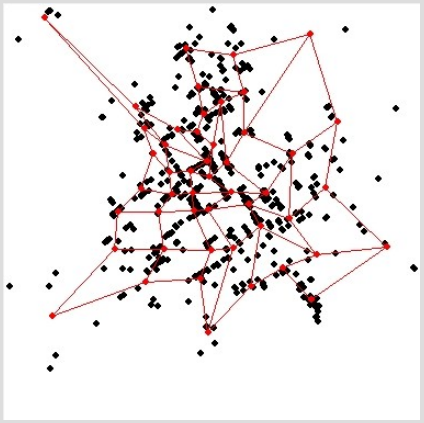
Component Plane for Sepal Width

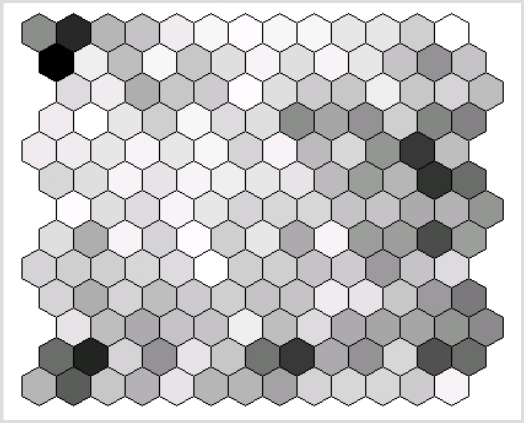
Component Plane for Petal Length

Component Plane for Petal Width

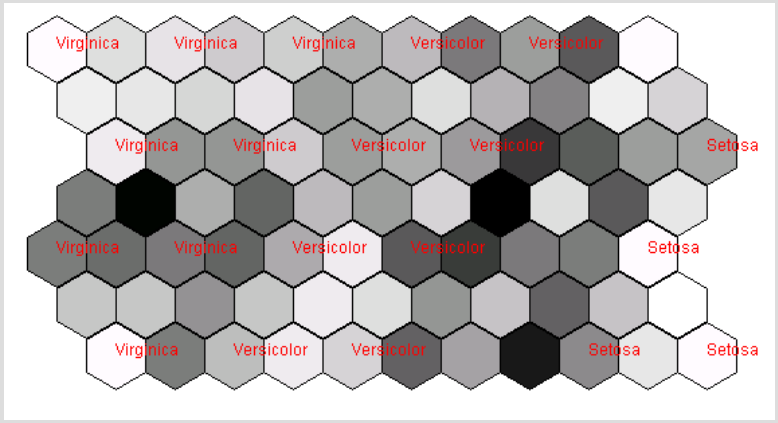
U-Matrices

- A U-Matrix is a grid whose cells contain a value which tells about the distance of one unit to its neighbouring units





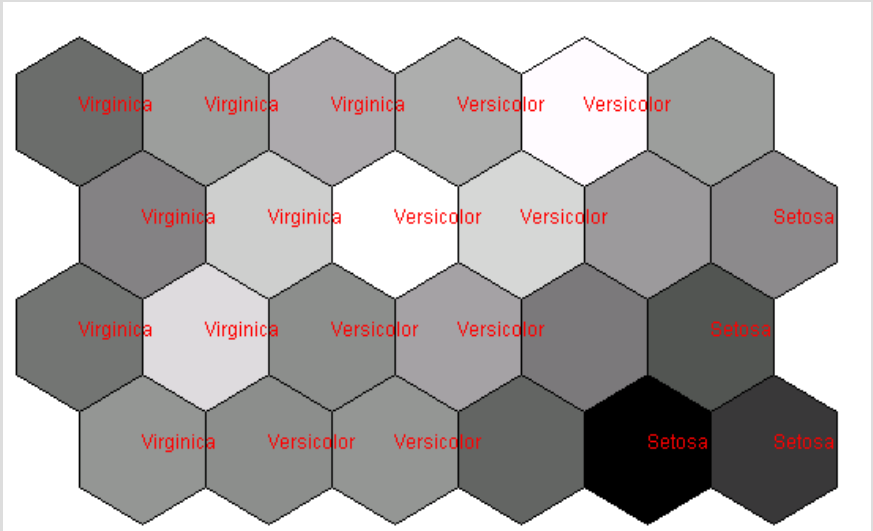
U-Matrix for the John Snow map SOM



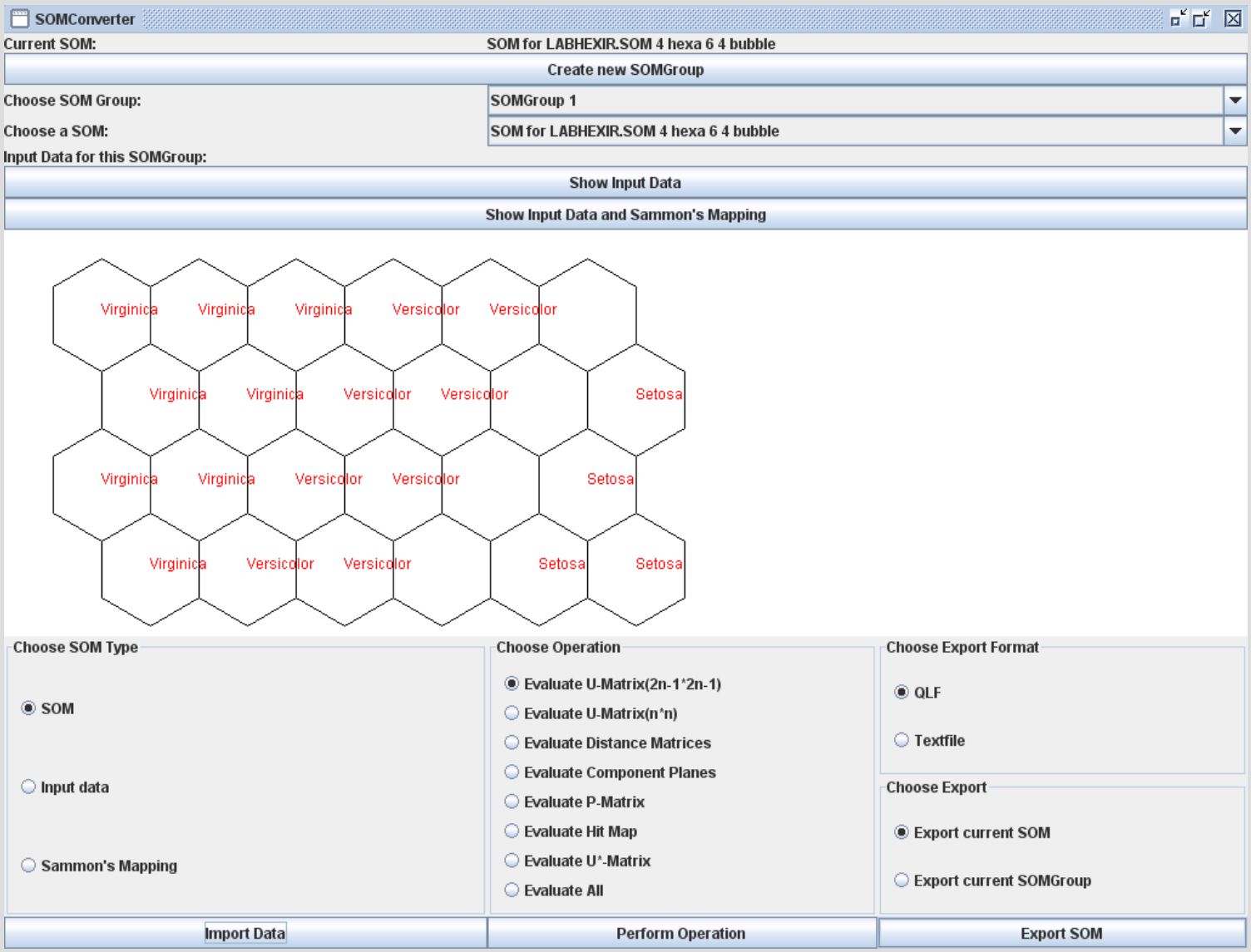
U-Matrix for the Iris flower data set SOM

Converting self-organizing maps

- The grid is a 2-dimensional surface
- The cell values can be treated as elevation values
- U-Matrices, Component Planes etc. can be seen as 3-dimensional spatial data
- This allows for the application of GIS operations on SOM



SOM Converter



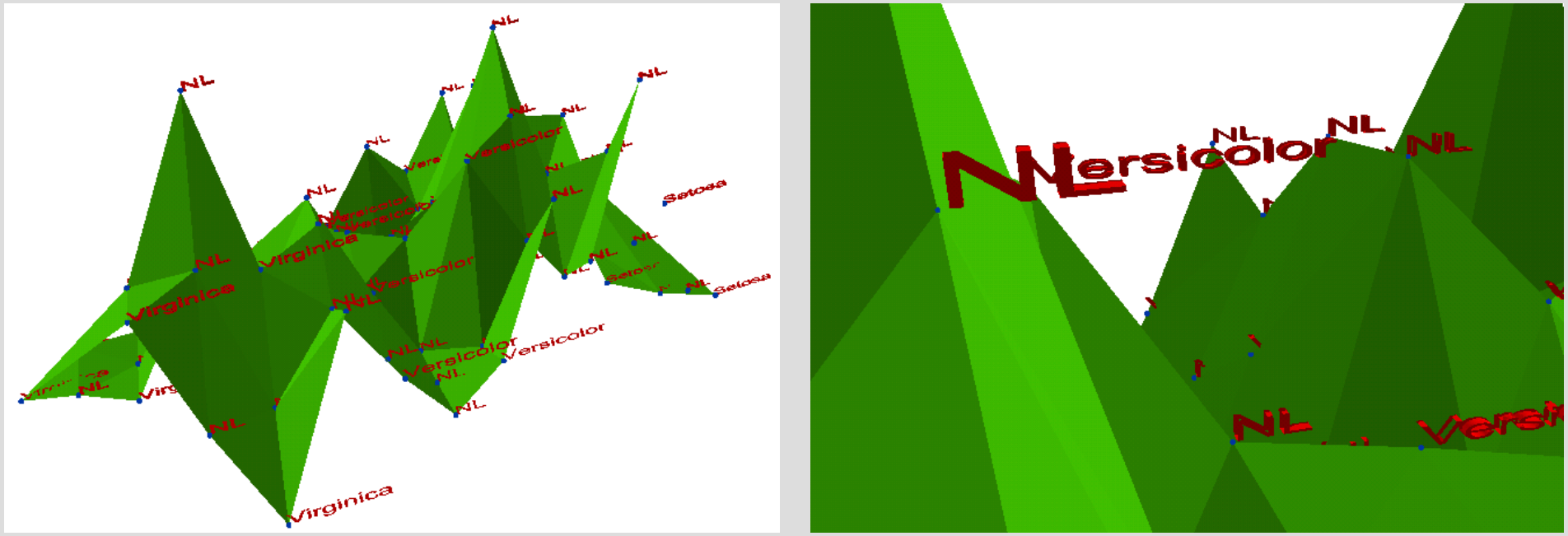
Input: A SOM calculated by another program

Operation: Creation of different visualization techniques

Output: Point Feature Data that can be read into ArcGIS

Analysis of landscape-like visualization types

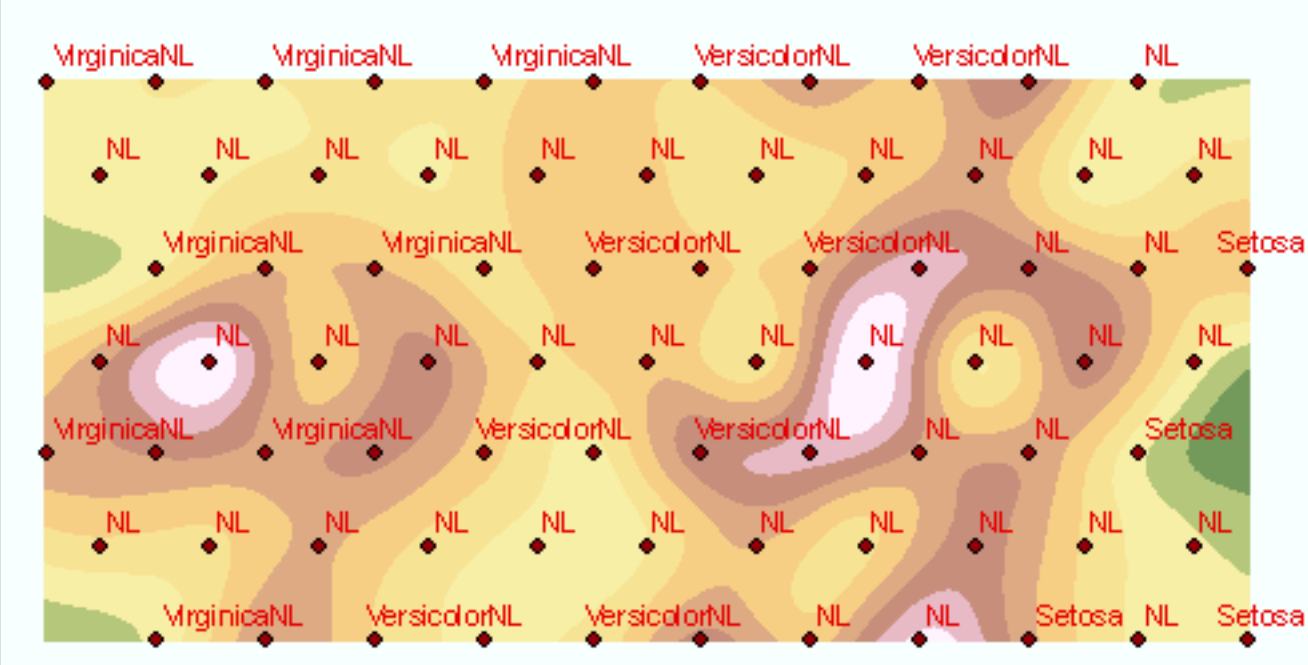
- Triangulated Irregular Networks



Triangulated Irregular Network for the U-Matrix of the Iris flower data set

Analysis of landscape-like visualization types

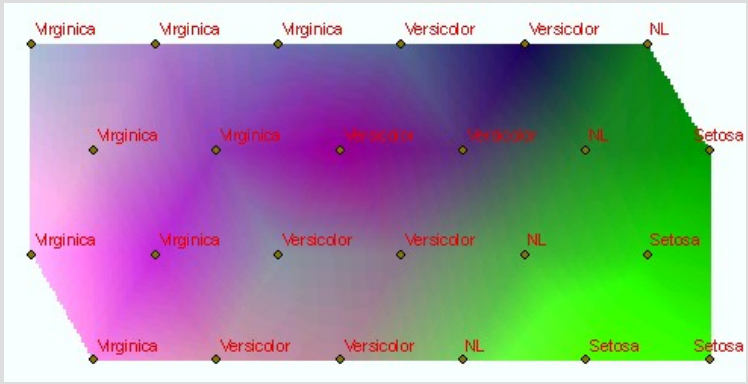
- Interpolated elevation values



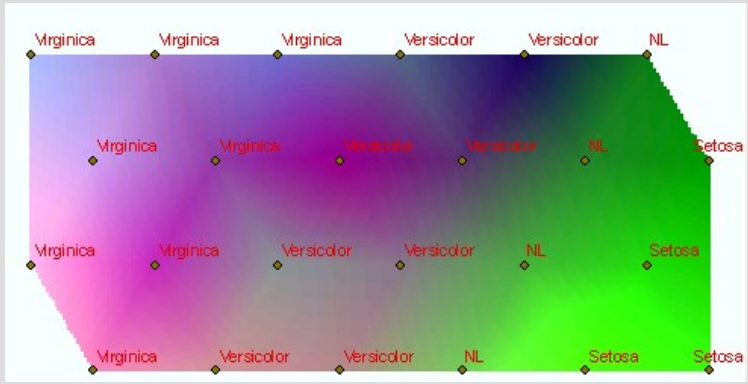
Spline-interpolated raster surface for the U-Matrix of the Iris flower data set

Analysis of Component Planes

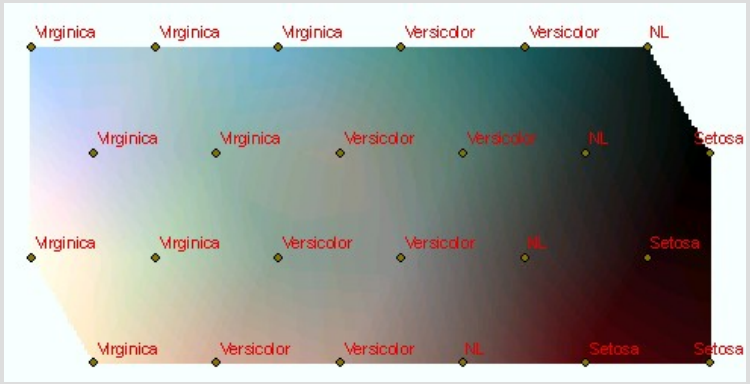
- Composite Bands for the Iris flower data set



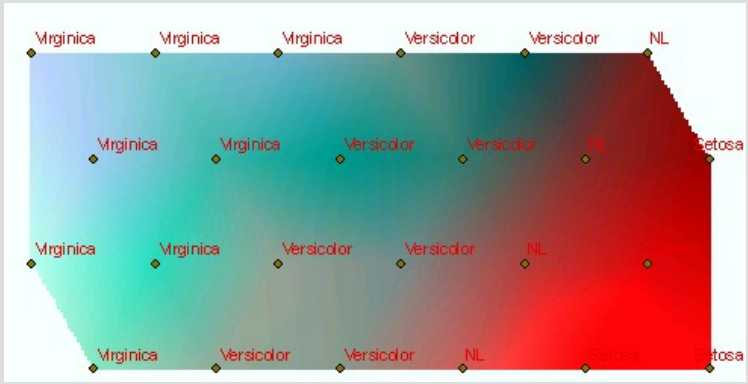
Combinations of Planes 1, 2, and 3



Combinations of Planes 1, 2, and 4



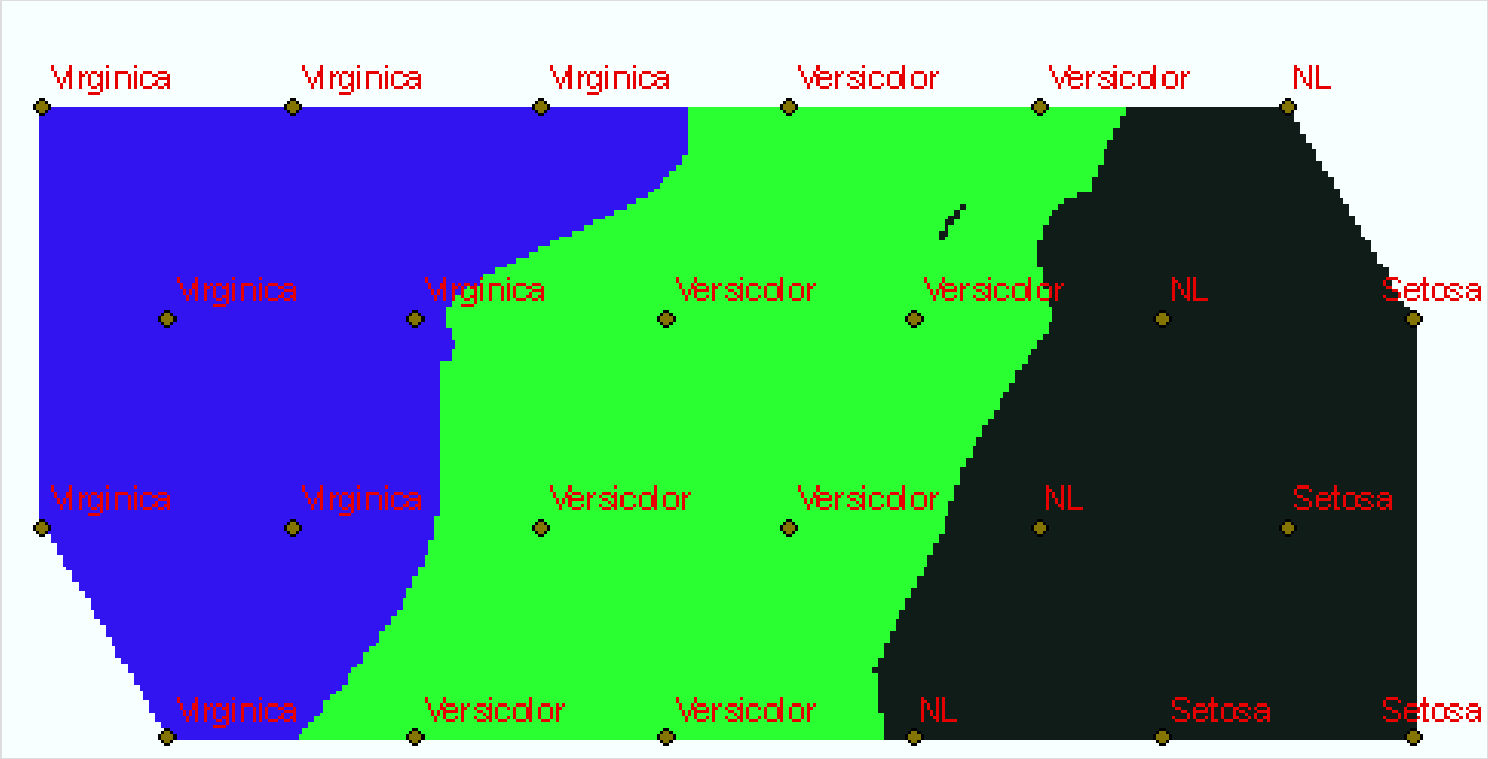
Combinations of Planes 1, 3, and 4



Combinations of Planes 2, 3, and 4

Analysis of Component Planes

- Maximum Likelihood Classification of the Iris flower data set



Outview

- Research will continue in different ways:
  - New visualization techniques
  - New GIS-provided operations
- Main goal:
  - Emphasize the meaning of the operations for a SOM and its input data

End

- Thank you for your attention
- I am looking forward to hearing your comments