Amirkabir University of Technology

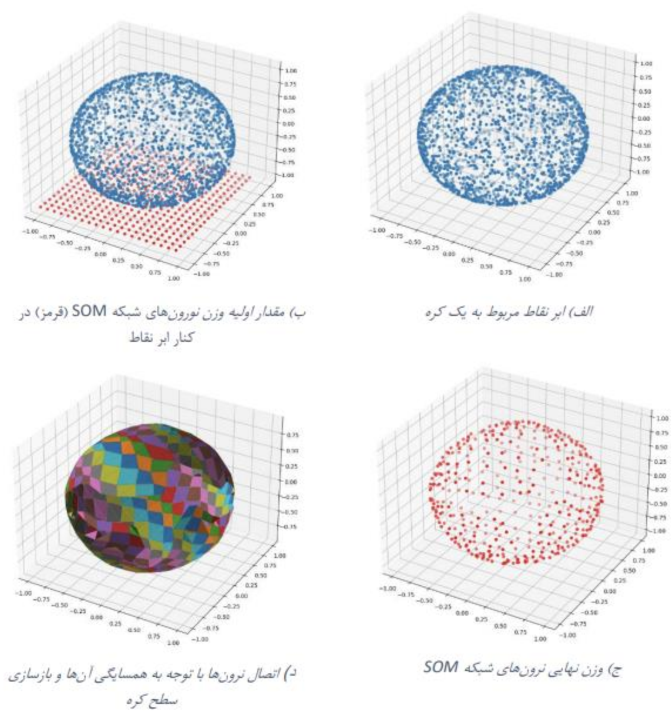
Neural Networks

HW3

Over the course of more than two decades since the introduction of self-organizing networks, many applications for these networks or their improved versions have been presented. Although deep neural networks have replaced self-organizing networks in many applications, in some cases, such as data clustering or visualization, these networks are still relevant. In this project, we intend to address two different applications of self-organizing networks.

Q1) Surface reconstruction

The aim of surface reconstruction is to extract the shape of a three-dimensional object from a set of points (point clouds) sampled from its surface. For this purpose, various algorithms in the field of computer vision, including Pivoting Ball, have been proposed. An interesting application of self-organizing networks is their use in surface reconstruction, which has been explored by many researchers. To achieve this, a 2D self-organizing network with a simple square neighborhood can be utilized. The initial weighting of this network can be done randomly in a regular and uniform manner. After training the network, neurons capture an approximate shape of the input data distribution. Subsequently, by considering the adjacency of neurons and connecting them, an approximate shape of the object can be extracted.



الف) ابر نقاط مربوط به یک کره

ب) مقدار اولیه وزن نورون‌های شبکه SOM (قرمز) در کنار ابر نقاط

ج) وزن نهایی نرون‌های شبکه SOM

د) اتصال نرون‌ها با توجه به همسایگی آن‌ها و بازسازی سطح کره

Figure 1

The point cloud of Figure 2 is provided in the attachment in npy format. Execute the process described above for this shape and present the final distribution of neuron weights similar to Figure 1. Note that there is no need to connect neurons or create a final shape, but the distribution of neuron weights should be as uniform as possible on the shape's surface.

Q2)

Clustering, as an unsupervised learning method, encompasses various algorithms. The primary advantage of clustering using self-organizing networks is the ability to visually represent clusters for high-dimensional data. Considering this, we will proceed to cluster a dataset of images using this clustering algorithm.

A) Explain two common visual outputs of a self-organizing network. Which of these two outputs is used for the clustering problem?
B) Train a self-organizing network with a hexagonal neighborhood on the training dataset. Display the network's output as 6 dimension matrices (using the map_distance method in the minisom library). Manually visualize an approximate shape of the clusters on this output. (Assuming image labels are not available, determine the suitable dimensions for the network through trial and error with visual inspection.)
C) Is there a more intelligent method than examining the U-matrix output to determine the suitable dimensions of the network? Briefly explain.
D) Now, assuming the availability of data labels, display the self-organizing network along with the dominant class of each cell. Does the output of this part match the output of part B?

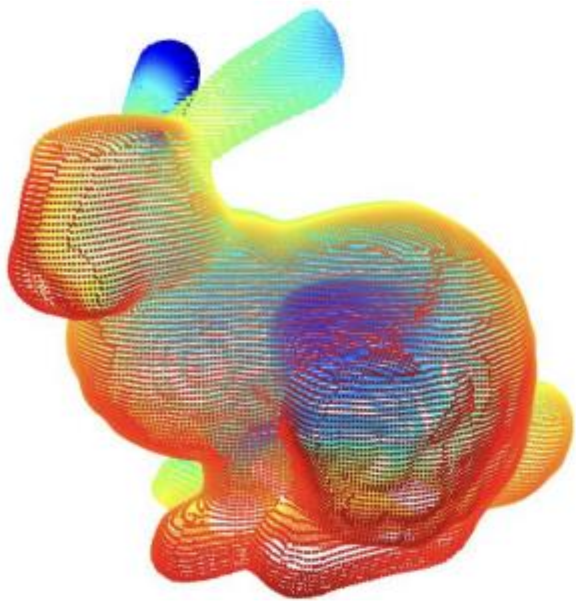


Figure 2