In the name of God

Assignment 4 Solution

Neural Networks: Fall 2021, Dr. Mozayani

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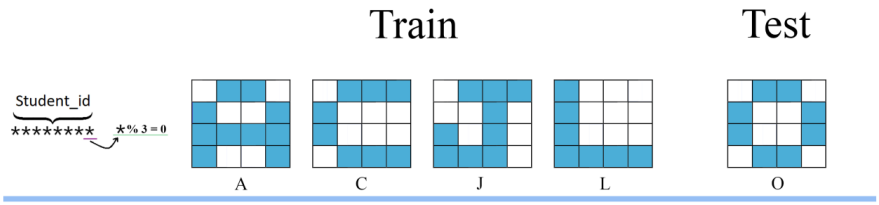
Problem 1

- Please refer to the NN_HW4_ART.ipynb for the complete code.
- **The higher the value of ρ , the higher the degree of rigidity for placing the patterns in the same cluster. Therefore, whether the "O" pattern is in the cluster depends entirely on the ρ value. ρ even changes the number of active prototypes.**
- **Give an acceptable answer.** The test pattern "O" is very similar to the "C" pattern, and with all values of ρ , it eventually falls into a cluster with the C pattern, which is a good indication of proper clustering.
- Output for different ρ and in which cluster the "O" pattern is placed in the NN_HW4_ART.ipynb file.



Problem 2

- (a)
    - **No**, it is not possible to have a concentric circle for the same class. The mechanism is that if **a point is introduced that does not exist in a circle, then a new circle is introduced to the center of the point and the radius r**. Now if we draw a circle for the introduced point A, for point B which is exactly on A (concentric) then there is no need for a new circle. So **we have only one circle**, **which contains both points A and B.**
- (b)
    - **No,** it is not possible. One point of the input space can not belong to two classes at the same time **(except in multi-multi-label cases)**.
- (c)
    - **Yes there is.** Such conditions are possible for certain values of the radius r for points A and B.
- (d)
    - **Yes there is.** Usually we advance the mechanism of introducing circles with opposite classes in such a way that if two circles with different

classes have in common, we reduce the radius to such an extent that they no longer share or in other words become tangent.

- (e)
  - **Yes there is.** If we introduce the circle c1. Then introduce a new point A that is not in the circle c1 and consider a new circle with center A and radius r. Depending on the radius we consider, the previous circle may be enclosed by the new circle.

Problem 3

- (a)
  - **The main problem of Hopfield network:**
    - By minimizing the constant energy is placed in **the local minimum**. beu we are **looking for the global minimum** state of the network.
  - **Boltzmann machines.**
    - **Boltzmann machines** are combined Hopfield networks and simulated annealing to result in networks.
    - **A random noise or small additional energy** in an appropriate direction may aid the energy to move from a local minimum and find a global minimum state.

- **local minima** are avoided by adding **some randomness or noise to the process** so that when the process of the network moves toward a local minimum, it has a chance to escape like a moving that might jump over a local minimum state.

- (b)
  - **Common features in hopfield and BSB:**
    - They are both examples of associative memories.
    - positive feedback.
    - An energy function that is minimally repeated.
    - Learn in a self-organizing way using Hebb's learning hypothesis.
    - perform computation using attractor dynamics.
  - **Different in Application.**
    - **BSB**:
      - Clustering.
      - Useful for data representation and concept formation.
    - **Hopfield**

- Pattern retrieval.
- Used for content-addressable memory.

Problem 4

- Please refer to the NN_HW4_LVQ1.ipynb for the complete code.