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**ASSIGNMENT NO -2 (B2)**

**Title** - Write a python program to illustrate ART neural network.

**Aim**- To implement python program to illustrate ART neural network.

**Objective**- Design ART Network

**Theory-**

**Adaptive Resonance Theory (ART) Neural Network in Python**

**Theory of ART Neural Networks**

The basic ART uses unsupervised learning technique. The term “**adaptive**” and “**resonance**” used in this suggests that they are open to new learning (i.e. adaptive) without discarding the previous or the old information (i.e. resonance). The ART networks are known to solve the stability-plasticity dilemma i.e., stability refers to their nature of memorizing the learning and plasticity refers to the fact that they are flexible to gain new information. Due to this the nature of ART they are always able to learn new input patterns without forgetting the past. ART networks implement a clustering algorithm. Input is presented to the network and the algorithm checks whether it fits into one of the already stored clusters. If it fits then the input is added to the cluster that matches the most else a new cluster is formed.

**Basic of Adaptive Resonance Theory (ART) Architecture** The adaptive resonant theory is a type of neural network that is self-organizing and competitive. It can be of both types, the unsupervised ones(ART1, ART2, ART3, etc) or the supervised ones(ARTMAP). Generally, the supervised algorithms are named with the suffix “MAP”. But the basic ART model is unsupervised in nature and consists of :

- F1 layer or the comparison field(where the inputs are processed)
- F2 layer or the recognition field (which consists of the clustering units)
- The Reset Module (that acts as a control mechanism)

The **F1 layer** accepts the inputs and performs some processing and transfers it to the F2 layer that best matches with the classification factor. There exist **two sets of weighted interconnection** for controlling the degree of similarity between the units in the F1 and the F2 layer. The **F2 layer** is a competitive layer. The cluster unit with the large net input becomes the candidate to learn the input pattern first and the rest F2 units are ignored. The **reset unit** makes

the decision whether or not the cluster unit is allowed to learn the input pattern depending on how similar its top-down weight vector is to the input vector and to the decision. This is called the vigilance test. Thus we can say that the **vigilance parameter** helps to incorporate new memories or new information. Higher vigilance produces more detailed memories, lower vigilance produces more general memories.

1. **Initialize the ART1 network** with input size, number of max categories, and vigilance.
2. **Train** the network using binary inputs.
3. **Match input patterns** against stored categories.
4. **Update weights** based on vigilance threshold.
5. **Classify a new input pattern.**

This implementation provides a simple ART1 network for binary pattern clustering.

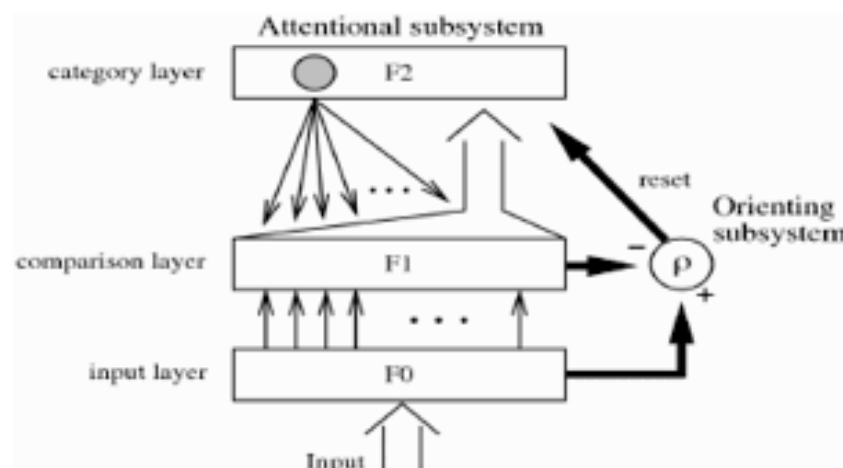


Fig. ART Network

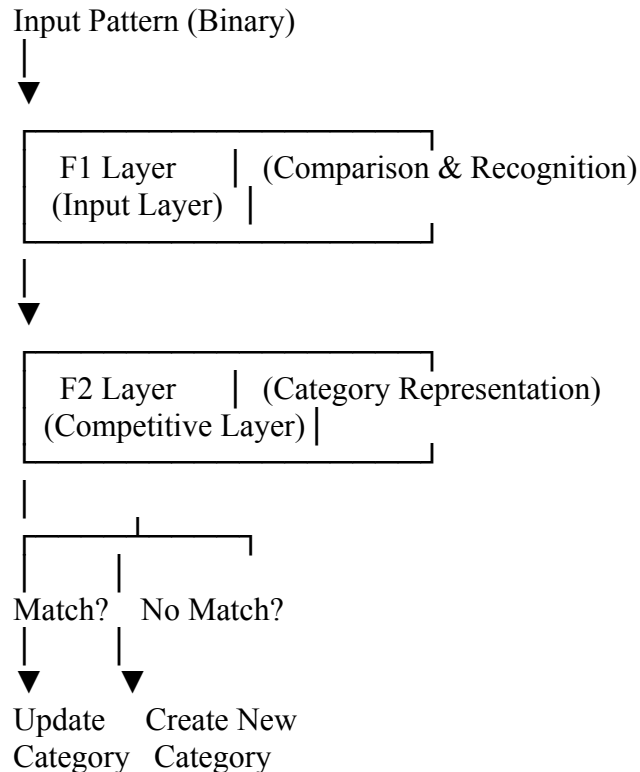
### Types of ART Networks

1. **ART1** - Works with binary inputs.
2. **ART2** - Works with continuous inputs.
3. **ART3, ARTMAP, and other variants** - Extensions with additional features.

### Algorithm Steps for ART1-

1. **Initialization:** Define the vigilance parameter and weight matrices.
2. **Input Presentation:** Present a binary input pattern.
3. **Comparison Layer (F1 Layer):** Compute similarity with stored patterns.
4. **Selection (F2 Layer):** Identify the best-matching category based on the similarity.
5. **Vigilance Check:**
  - If similarity  $\geq$  vigilance, update the category's weights.
  - Otherwise, create a new category.

6. **Learning & Adaptation:** Update the weight vectors of the chosen category.
7. **Repeat:** Process more input patterns.



The ART1 network consists of **two main layers**:

### 1. Comparison Layer (F1 Layer)

- The input layer (F1) receives a binary input vector.
- It compares the input with stored patterns.
- Sends signals to the next layer (F2) based on the similarity of the input with stored categories.

### 2. Recognition Layer (F2 Layer)

- The competitive layer (F2) selects the most similar category.
- If the similarity is above the vigilance threshold, the category is updated.
- If the similarity is **below** the vigilance threshold, a new category is created.

## Conclusion-

In this way we have successfully completed ART network.