Pattern is everything around in this digital world. A pattern can either be seen physically or it can be observed mathematically by applying algorithms.
Example: The colors on the clothes, speech pattern, etc. In computer science, a pattern is represented using vector feature values.

Pattern recognition is the process of recognizing patterns by using a machine learning algorithm. Pattern recognition can be defined as the classification of data based on knowledge already gained or on statistical information extracted from patterns and/or their representation. One of the important aspects of pattern recognition is its application potential.
Examples: Speech recognition, speaker identification, multimedia document recognition (MDR), automatic medical diagnosis.
In a typical pattern recognition application, the raw data is processed and converted into a form that is amenable for a machine to use. Pattern recognition involves the classification and cluster of patterns.

Features may be represented as continuous, discrete, or discrete binary variables. A feature is a function of one or more measurements, computed so that it quantifies some significant characteristics of the object.

Example: consider our face then eyes, ears, nose, etc are features of the face. A set of features that are taken together, forms the **features vector**.
Example: In the above example of a face, if all the features (eyes, ears, nose, etc) are taken together then the sequence is a feature vector([eyes, ears, nose]). The feature vector is the sequence of a feature represented as a d-dimensional column vector. In the case of speech, MFCC (Mel-frequency Cepstral Coefficient) is the spectral feature of the speech. The sequence of the first 13 features forms a feature vector.

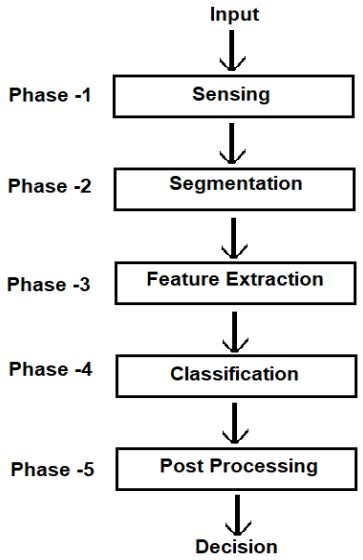
Phases in Pattern Recognition System
Approaches for Pattern Recognition Systems can be represented by distinct phases, as Pattern Recognition Systems can be divided into the following components.

- **Phase 1**: Convert images or sounds or other inputs into signal data.

- **Phase 2**: Isolate the sensed objects from the background.
- **Phase 3**: Measure objects properties that are useful for classification.
- **Phase 4**: Assign the sensed object to a category.
- **Phase 5**: Take other considerations to decide on appropriate action.

Problems solved by these Phases are as follows:

1. **Sensing**: It deals with problem arises in the input such as its bandwidth, resolution, sensitivity, distortion, signal-to-noise ratio, latency, etc.
2. **Segmentation and Grouping**: Deepest problems in pattern recognition that deals with the problem of recognizing or grouping together the various parts of an object.
3. **Feature Extraction**: It deals with the characterization of an object so that it can be recognized easily by measurements. Those objects whose values are very similar for the objects are considered to be in the same category, while those whose values are quite different for the objects are placed in different categories.
4. **Classification**: It deals with assigning the object to their categories by using the feature vector provided by the feature extractor and determining the values of all of the features for a particular input.
5. **Post Processing**: It deals with action decision-making by using the output of the classifier. Action such as minimum-error-rate classification will minimize the total expected cost.

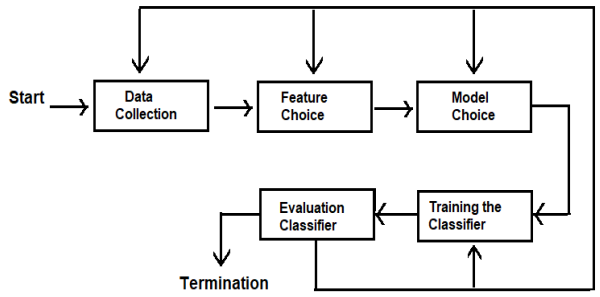


Phases in Pattern Recognition

Activities for designing the Pattern Recognition Systems

There are various sequences of activities that are used for designing the Pattern Recognition Systems. These activities are as follows:

- Data Collection
- Feature Choice
- Model Choice
- Training
- Evaluation



Activity Cycle

There are typically four main phases in the pattern recognition process: preprocessing, training, testing, and deployment. These phases involve a series of activities that are designed to develop and evaluate a pattern recognition system.

Preprocessing: Preprocessing is the process of preparing the data for analysis. This may involve cleaning the data, scaling the data, or transforming the data in some way to make it more suitable for analysis.

Training: Training is the process of fitting a model to the data. This typically involves selecting a model, choosing appropriate hyperparameters, and optimizing the model's parameters to minimize a loss function.

Testing: Testing is the process of evaluating the performance of the model on a held-out dataset. This allows us to estimate the generalization performance of the model and to compare the performance of different models.

Deployment: Deployment is the process of deploying the trained model in a production environment. This may involve integrating the model into an existing system or building a new system based on the model.