# INT404 ARTIFICIAL INTELLIGENCE

Lecture 3

# Artificial Intelligence – an Overview

Artificial intelligence techniques can be divided into **two** types:

1) Symbolic computation (including sub-symbolic)
2) Non- symbolic computation

    Example:- When a child is born, he possess only basic knowledge of how to survive in the brain, gradually he will learn the rest of the knowledge through learning by experiences .

# Artificial Intelligence – an Overview

Symbolic Computation has two branches

1. Heuristic search – Adjoining, Segment 1 of the World view.

   Heuristic – A guide, an approximation, a thumb rule. Basically helps in pruning(Weed out **unwanted** or unnecessary things) the search tree.

2. Knowledge-based systems – In the world view, **between** heuristic search and sub-symbolic computation (neural networks).

# Artificial Intelligence – an Overview

## Knowledge Based Systems:

Core Areas of Knowledge Based systems

1. Knowledge Base Representation
2. Inference Engine
3. User interface
4. Knowledge acquisition module

# Artificial Intelligence – an Overview

## Knowledge Based Systems:

Representation techniques are primarily:

1. production rules – sets of if-then rules, similar to production rules used to specify a grammar.

   Example: If the car does not start check the battery, by pressing the horn.

# Artificial Intelligence – an Overview

Knowledge Based Systems:

Representation techniques are primarily:

2. Semantic Networks – Set of Nodes and Links between them. The links represent Relationships between the nodes

   Example: Nodes – Man, Hands, Legs, Walk

   Relationships – Has (between Man and hands and between Man and Legs) and Can (between Man and Walk).

   A type of Semantic networks is Frames (Slot-filler notation). These encode default (commonly occurring) values (filler) for the attributes in a relation (slot).

# Artificial Intelligence – an Overview

Knowledge Based Systems:

Inference Engine - Search on the knowledge base leads to Inferences.

Knowledge Acquisition module - The knowledge being incomplete will be dynamic. Provision to acquire knowledge is provided by using machine learning strategies.

# Artificial Intelligence – an Overview

Knowledge Based Systems:

Machine Learning Strategies:

1. Rote learning – The system is told the actual knowledge. The system's work is to map the knowledge into its internal representation.
2. Learning by being told – The system is given paragraphs that convey the knowledge. The system has to **glean** the knowledge and then store it.
3. Learning by being told and asking questions – In addition to strategy 2, the system analyses the knowledge, finds discrepancies and asks questions to sort out the conflicts.
4. Learning by induction from positive examples - The system is given examples of the concept. It generalizes the examples to arrive at the knowledge

# Artificial Intelligence – an Overview

Knowledge Based Systems:

Machine Learning Strategies:

5. Learning by Induction from Positive examples and Negative examples – To avoid over generalization, negative examples are given, which are used to specialize the knowledge.
6. Learning by Induction through experimentation - The system generates examples itself by designing experiments on the environment.
7. Learning by Analogy – The system maps the knowledge it has to the new problem, using analogy.
8. Learning by Abduction – The system creates new hypotheses and designs experiments to ratify them.

# Knowledge Based Systems:

## Genetic Programming:

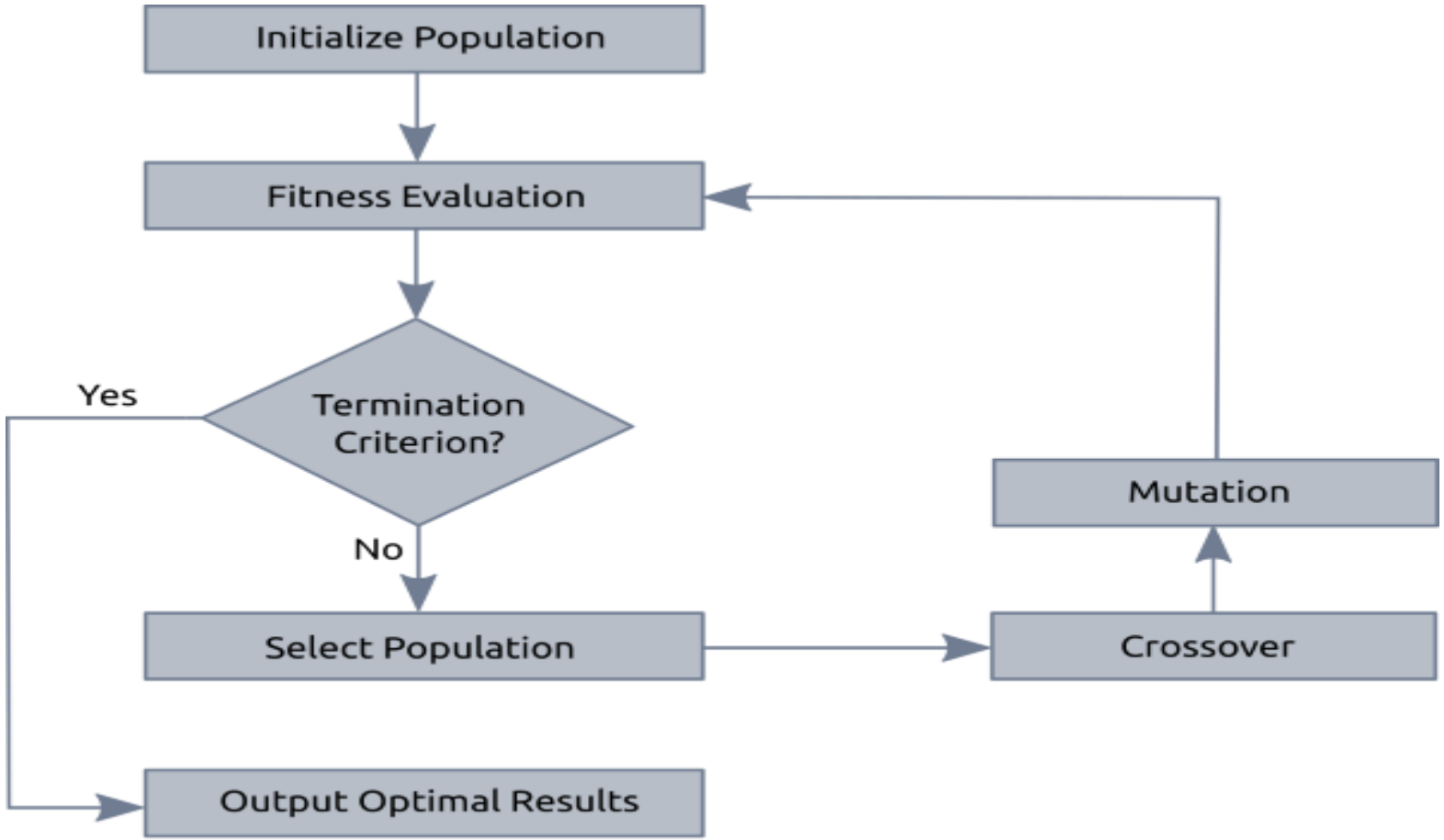



Figure 2: Basic structure of Genetic Algorithm

## Knowledge Based Systems:

## Genetic Programming:

This field lies at the extreme of Knowledge Based Systems (adjoining sub-symbolic computation in the World view)– They model Human evolution methods.

Approach:

1. Create an initial population of entities
2. Each entity's characteristics are represented
3. A fitness function evaluates the entities.
4. The best two of the population are chosen
5. These two are used to generate 'offspring's' –> new population. Process repeats.

## Knowledge Based Systems:

### Genetic Programming:

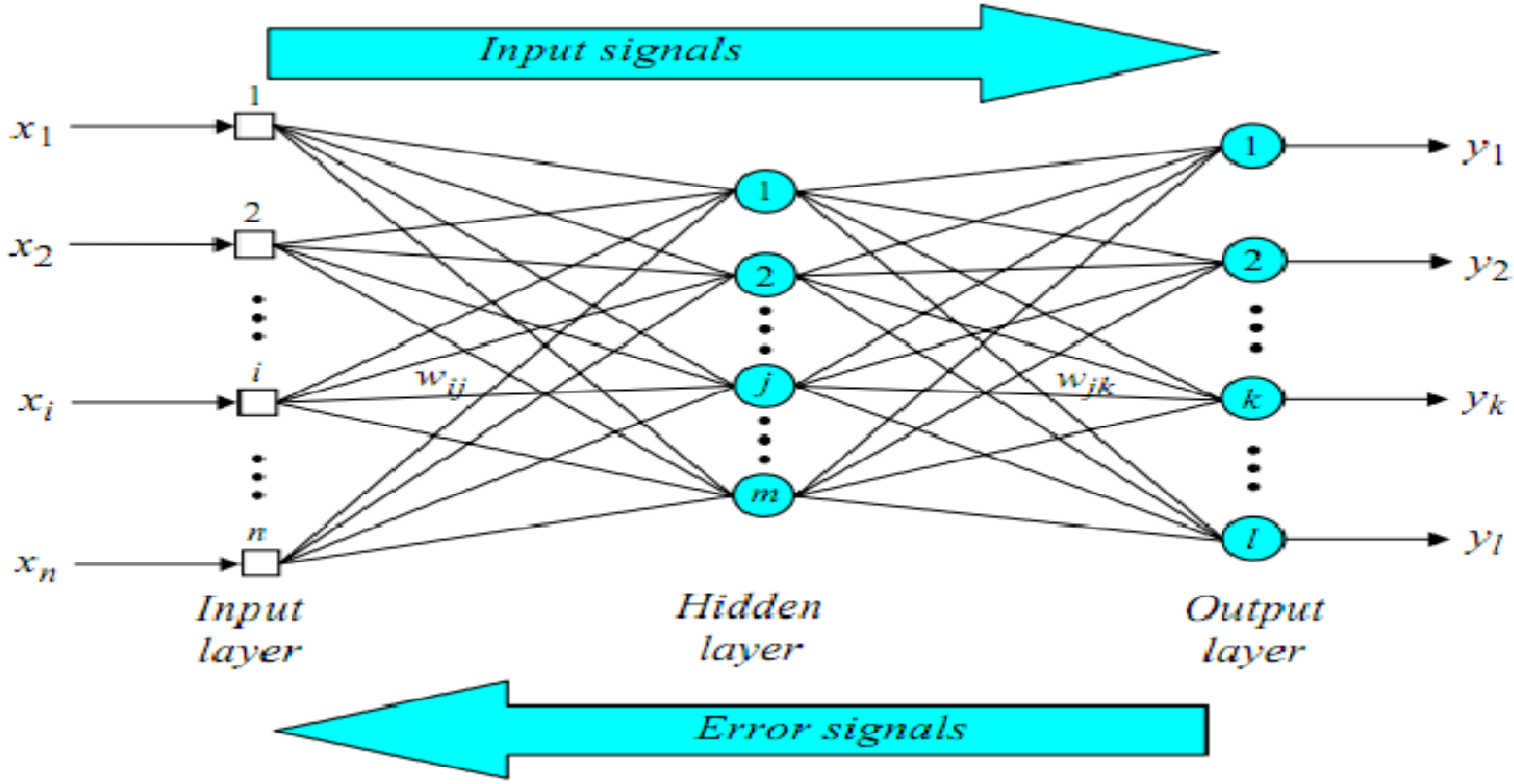
Offspring generation operators:

1. Reproduction – All characteristics of both parents are reproduced in the offspring.
2. Crossover - A subset of characteristics of one parent are linked with the subset of characteristics of the other parent.
3. Mutation – The characteristics of one parent are changed randomly to create the offspring. – Handles the Local Maxima problem

# Sub Symbolic Computation (Neuro-computing)

- Adjoins Segment 3 of the world view.
- Deals with signal level computation required because a number of problems do not have explicit knowledge associated with them. Example – recognizing people or recognizing handwriting.
- This area deals with patterns that are more complex than the ones dealt with by symbolic computation.

# Artificial Intelligence – an Overview



## Sub Symbolic Computation (Neuro-computing):

Core areas of Sub-symbolic computation are:

1. Architecture
2. Learning mechanism

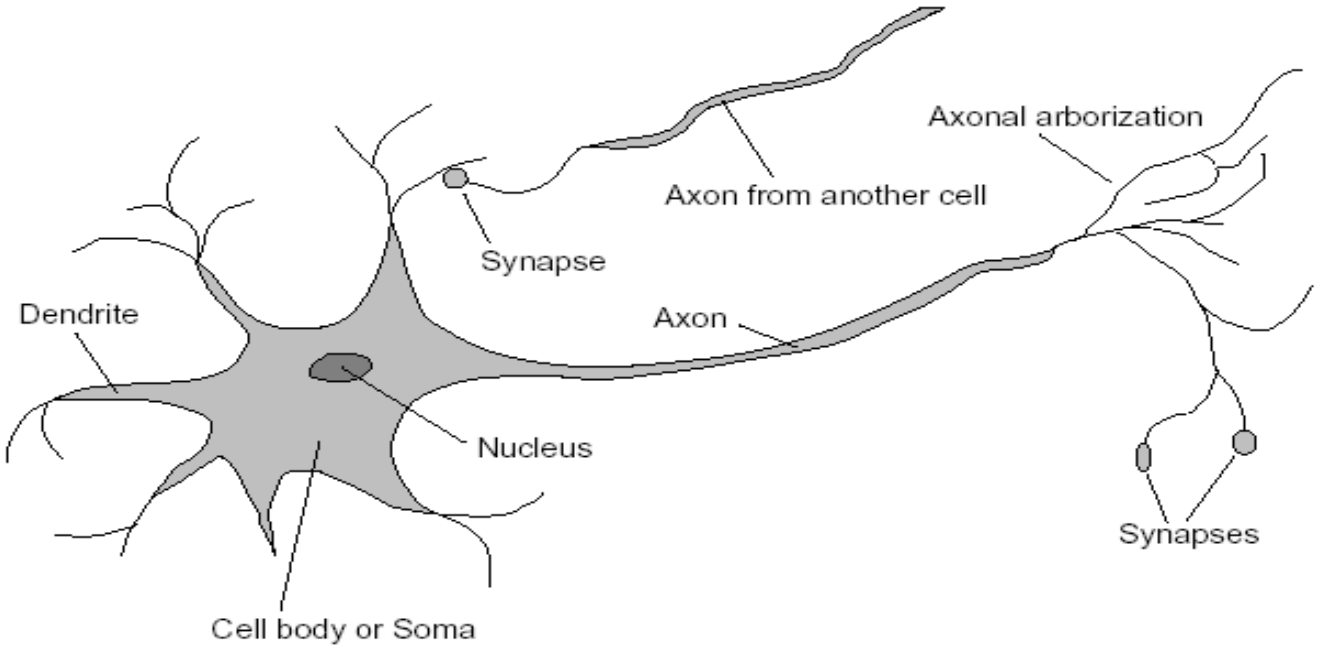
In sub-symbolic computation all the knowledge is learnt by the system.

Neuro-computing attempts to mimic the structure of the human intelligence system, with its neurons and synapses.

Neuron – receives input from many other neurons. Each input is magnified by a multiplication factor. (This multiplication factor represents the degree of interest, effect that the particular input has on the neuron.)

# Brains

$10^{11}$ neurons of $> 20$ types, $10^{14}$ synapses, 1ms–10ms cycle time
Signals are noisy "spike trains" of electrical potential



## Sub Symbolic Computation (Neuro-computing):

- All the multiplied values are summed up and compared to a 'threshold value'. If the threshold value is less then the neuron fires an output.
- Knowledge is acquired by learning the correct multiplication values.

Learning is done in one of two ways:

1. Supervised learning - Here the desired output for a given input is known. A simple method is Back Propagation network. Here the output is compared with the desired output. Differences are propagated backwards, to make changes to the multiplication factors.

## Sub Symbolic Computation (Neuro-computing):

2. Unsupervised learning – Here the desired output is not given to the system. The system uses Clustering to club similar input together. Example – Kohonen
3. A third learning technique is Self-Supervised Learning - Here the results of a previous iteration are used to bias the clustering results in the current iteration.

   *Example – Adaptive Resonance Technique.*