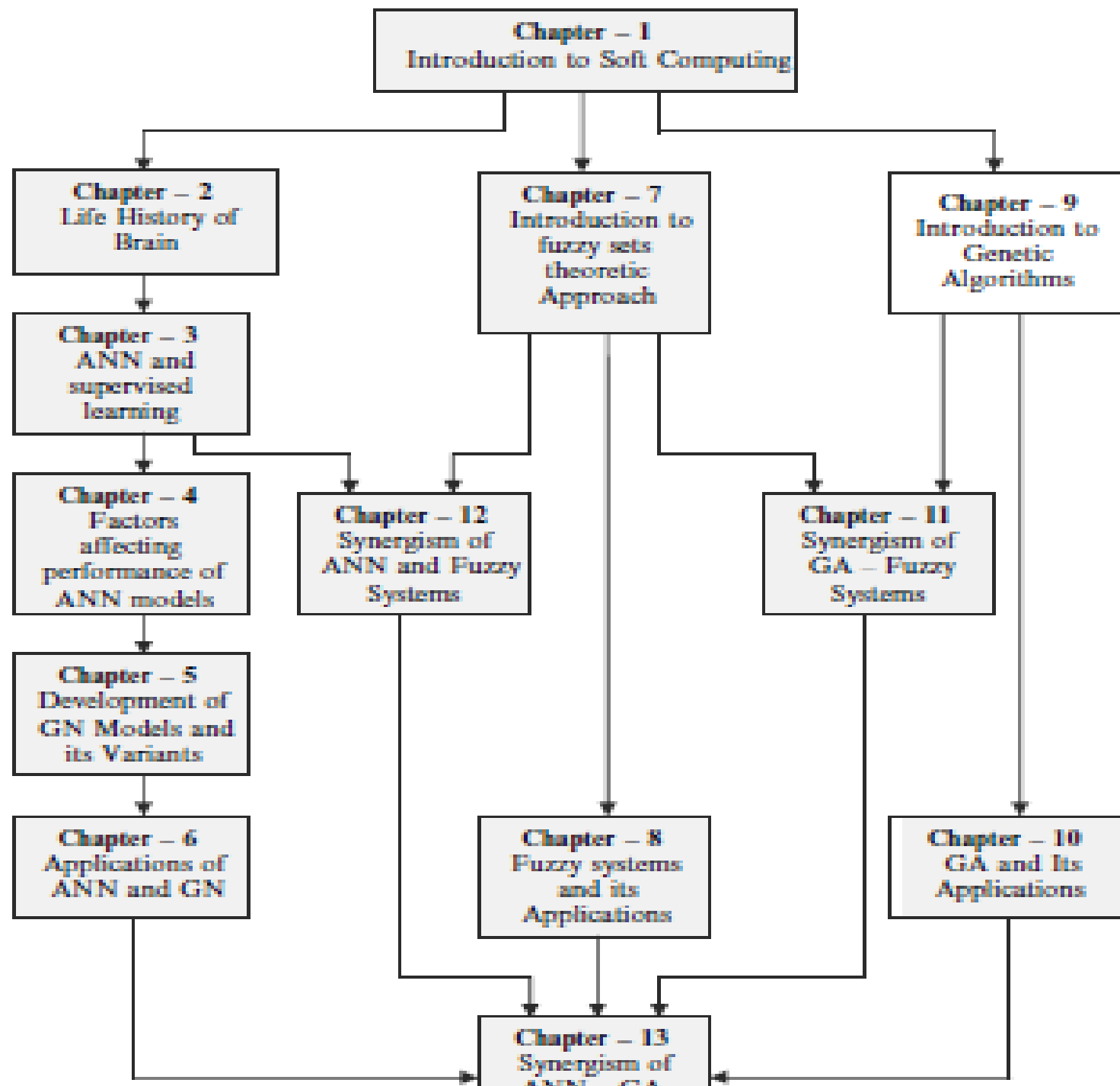


**Lecture – 02**  
**Introduction to soft computing**

**Dr. Ahmed Elngar**  
**Faculty of Computers and Information**  
**Beni-Suef University**





$$= f(x_1, x_2, x_3, \dots, x_n)$$

# Limitations of the traditional optimization approaches

## Limitations:

- Computationally expensive.
- For a discontinuous objective function, methods may fail.
- Method may not be suitable for parallel computing.
- Discrete (integer) variables are difficult to handle.
- Methods may not necessarily adaptive.

Evolutionary algorithms have been evolved to address the above mentioned limitations of solving optimization problems with traditional approaches.

# Evolutionary Algorithms

The algorithms, which follow some biological and physical behaviours:

## **Biologic behaviours:**

- 1) Genetics and Evolution -> Genetic Algorithms (GA)
- 2) Behaviour of ant colony -> Ant Colony Optimization (ACO)
- 3) Human nervous system -> Artificial Neural Network (ANN)

In addition to that there are some algorithms inspired by some physical behaviours:

## **Physical behaviours:**

- 1) Annealing process -> Simulated Annealing (SA)
- 2) Swarming of particle -> Particle Swarming Optimization (PSO)
- 3) Learning -> Fuzzy Logic (FL)

# Genetic Algorithm

It is a subset of evolutionary algorithm:

- 1) Ant Colony optimization
- 2) Swarm Particle Optimization

Models biological processes:

- 1) Genetics
- 2) Evolution

To optimize highly complex objective functions:

- 1) Very difficult to model mathematically
- 2) **NP-Hard** (also called combinatorial optimization) problems (which are computationally very expensive)
- 3) Involves large number of parameters (discrete and/or continuous)



# Background of Genetic Algorithm

Firs time introduced by Prof. John Holland (of Michigan University, USA, 1965). But, the first article on GA was published in 1975.

Principles of GA based on two fundamental biological processes:

- 1) **Genetics:** Gregor Johan Mendel (1865)
- 2) **Evolution:** Charles Darwin (1875)



# Genetics



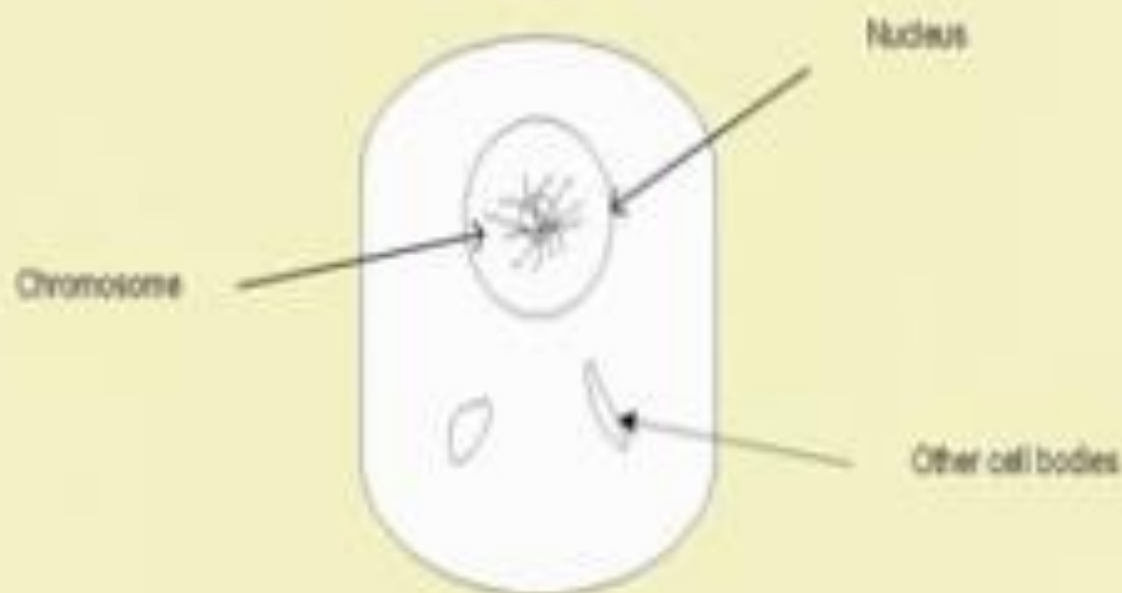
# A brief account on genetics

The basic building blocks in living bodies are cells. Each cell carries the basic unit of heredity, called **gene**

For a particular specie, number of chromosomes is fixed.

## Examples

- Mosquito: 6
- Frogs: 26
- Human: 46
- Goldfish: 94



# A brief account on genetics

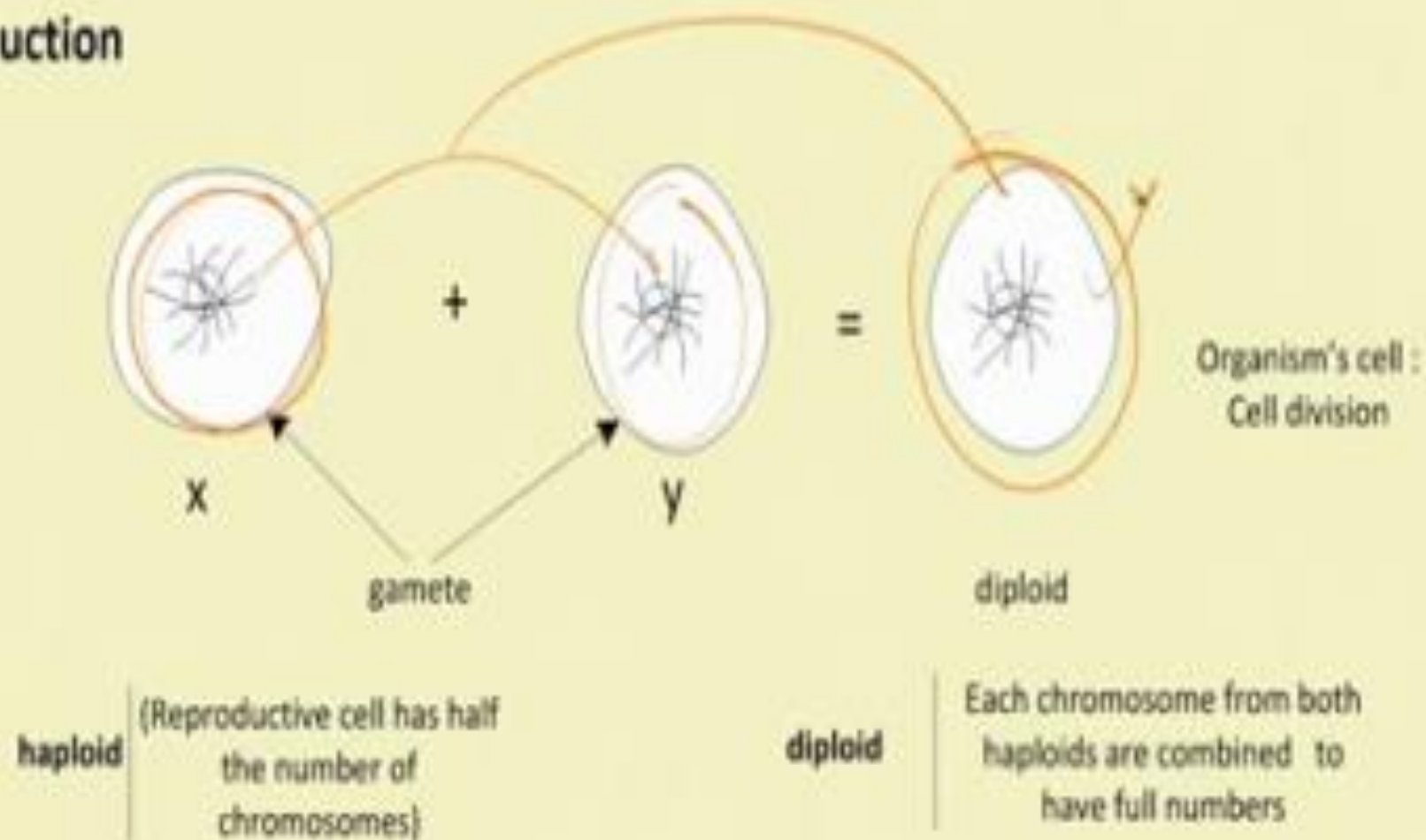
## Genetic code



- Spiral helix of protein substance is called DNA.
- For a species, DNA code is unique, that is, vary uniquely from one to other.
- DNA code (inherits some characteristics from one generation to next generation) is used as biometric trait.

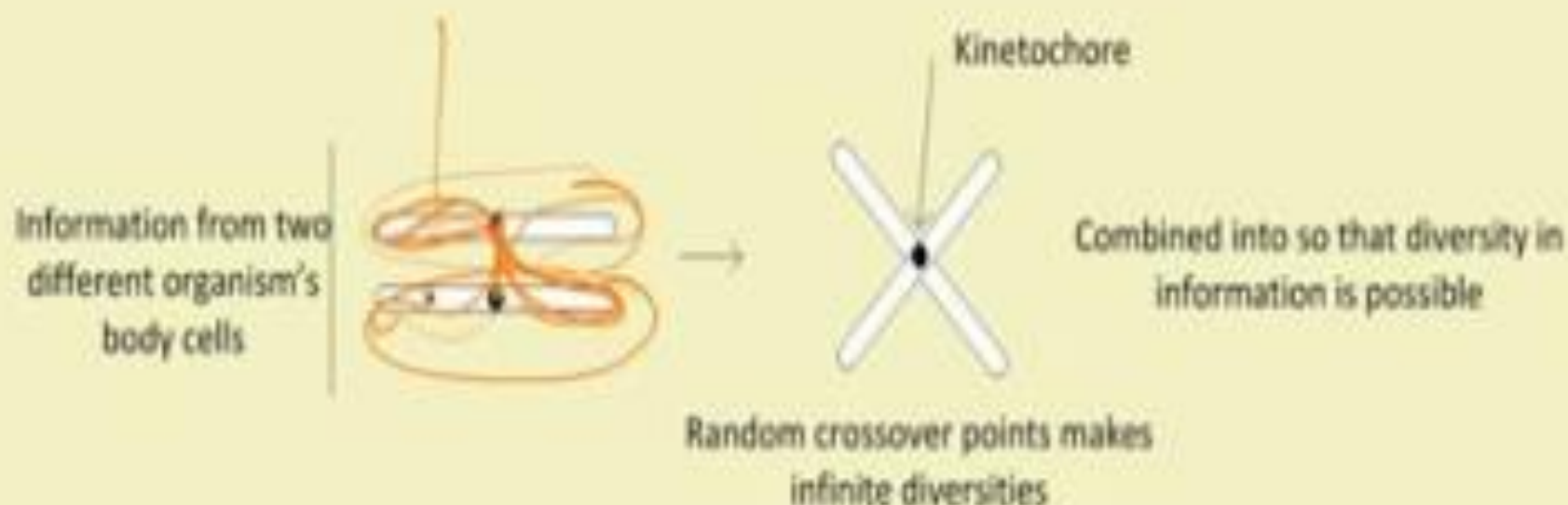
# A brief account on genetics

## Reproduction

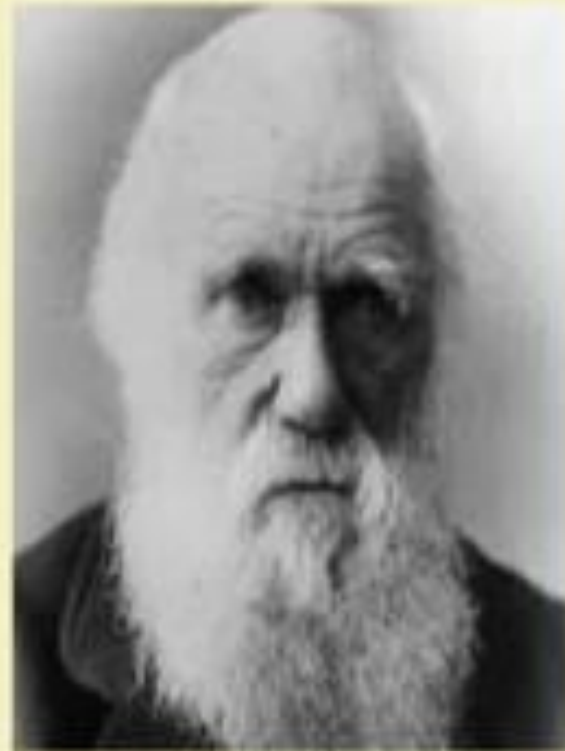


# A brief account on genetics

## Crossing over



# Evolution





# A brief account on genetics

## Evolution : Natural Selection

Four primary premises:

- 1) **Information propagation:** An offspring has many of its characteristics of its parents (i.e. information passes from parent to its offspring). **[Heredity]**
- 2) **Population diversity:** Variation in characteristics in the next generation. **[Diversity]**
- 3) **Survival for existence:** Only a small percentage of the offspring produced survive to adulthood. **[Selection]**
- 4) **Survival of the best:** Offspring survived depends on their inherited characteristics. **[Ranking]**

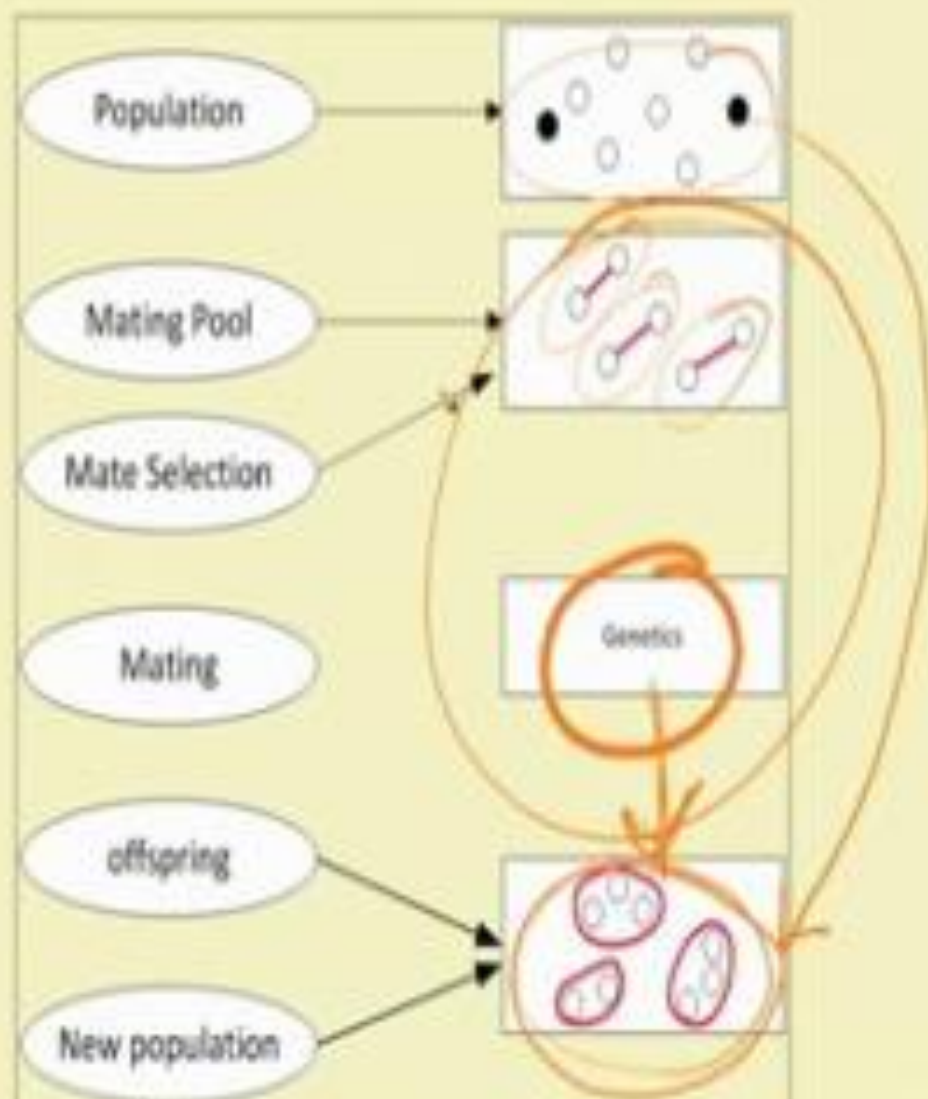


# A brief account on genetics

## **Mutation:**

To make the process forcefully dynamic when variations in population going to stable.

# Biological process : A quick overview



# Working of Genetic Algorithm

## Definition of GA:

Genetic algorithm is a population-based probabilistic search and optimization techniques, which works based on the mechanisms of natural genetics and natural evaluation.

# Framework of GA

