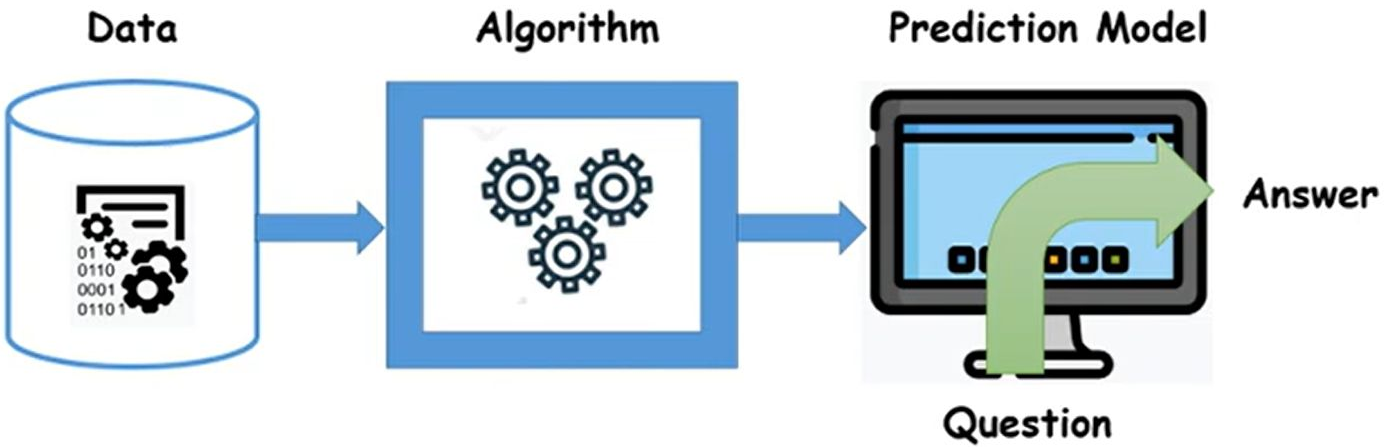
Neuro Fuzzy System

CSE 4237
Soft Computing

Modeling of Systems

What is machine learning?



Why we need neural networks and fuzzy logic systems?

- In data and/ or information processing, the objective is generally to **gain an understanding of the phenomena involved** and **to evaluate relevant parameters quantitatively.**
- This is usually accomplished through "**modeling**" of the systems.
  - Either experimentally or analytically (using **mathematics** and **physical principles**)
- Once we have a model of system, we can carry out various procedures (for example, **sensitivity analysis**, **statistical regression**, etc.).

Why we need neural networks and fuzzy logic systems?

- However, many situations are very complex and not well understood.
  - Physical measurements of the pertinent quantities are very difficult and expensive.
- These difficulties lead us to use of neural networks and fuzzy logic systems as a way of **obtaining models based on experimental measurements.**

Neural networks

- Precise inputs and outputs
- Sufficient degrees of freedom
- Represent complex nonlinear relationships model
- Very good at classification of phenomena into preselected categories
- Precision of outputs is **sometimes** limited
- Minimization of least squares does not mean zero error
- Time required for proper training is still high

Fuzzy Systems

- Reverse situations prevails compare to neural networks
- The **input and output variables** are encoded in **fuzzy** representations
- Interrelationships take the form of well-defined ***if/then*** rules

Fuzzy systems - Advantages

- Address the impression of the input and output variables
  - Use fuzzy numbers and fuzzy sets that can be expressed in **linguistic terms** (e.g., cold, warm, and hot)
- Greater flexibility in formulating system descriptions
  - Complex process behavior can be described in general terms
- Fuzzy description are more parsimonious, easy to formulate and modify

Neural networks and fuzzy logic systems

- Neural networks and fuzzy logic systems represent two distinct methodologies that deal with **uncertainty.**
  - These uncertainties usually arise from system complexity (complexity as a property of system description)
- Accomplish same results in different ways
- Can speed the unraveling and specifying the mathematical models
- Can be used to control nonlinear system
- Perform **mapping with some degree of impression**

However, combination of the two technologies with the goal of gaining the advantages of both that is the focus of this soft computing course.

Neurofuzzy systems

- **An integration of fuzzy logic and neural networks**

❑ Advantages of neurofuzzy systems
  - Addressing the problems of large complex systems.
  - Ability to perform **many-to-many** mappings
  - Dealt with in a flexible, reliable, and **near-optimal** manner.

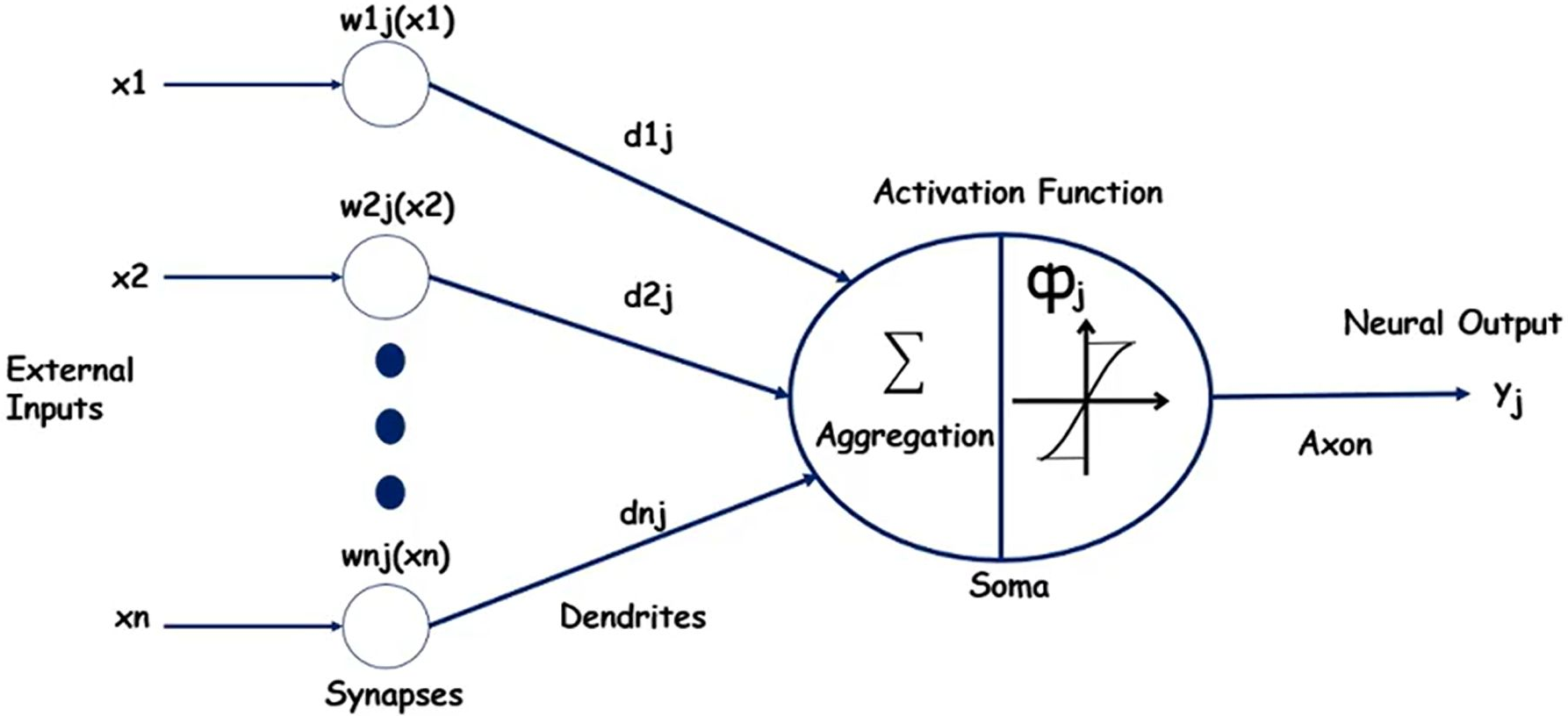
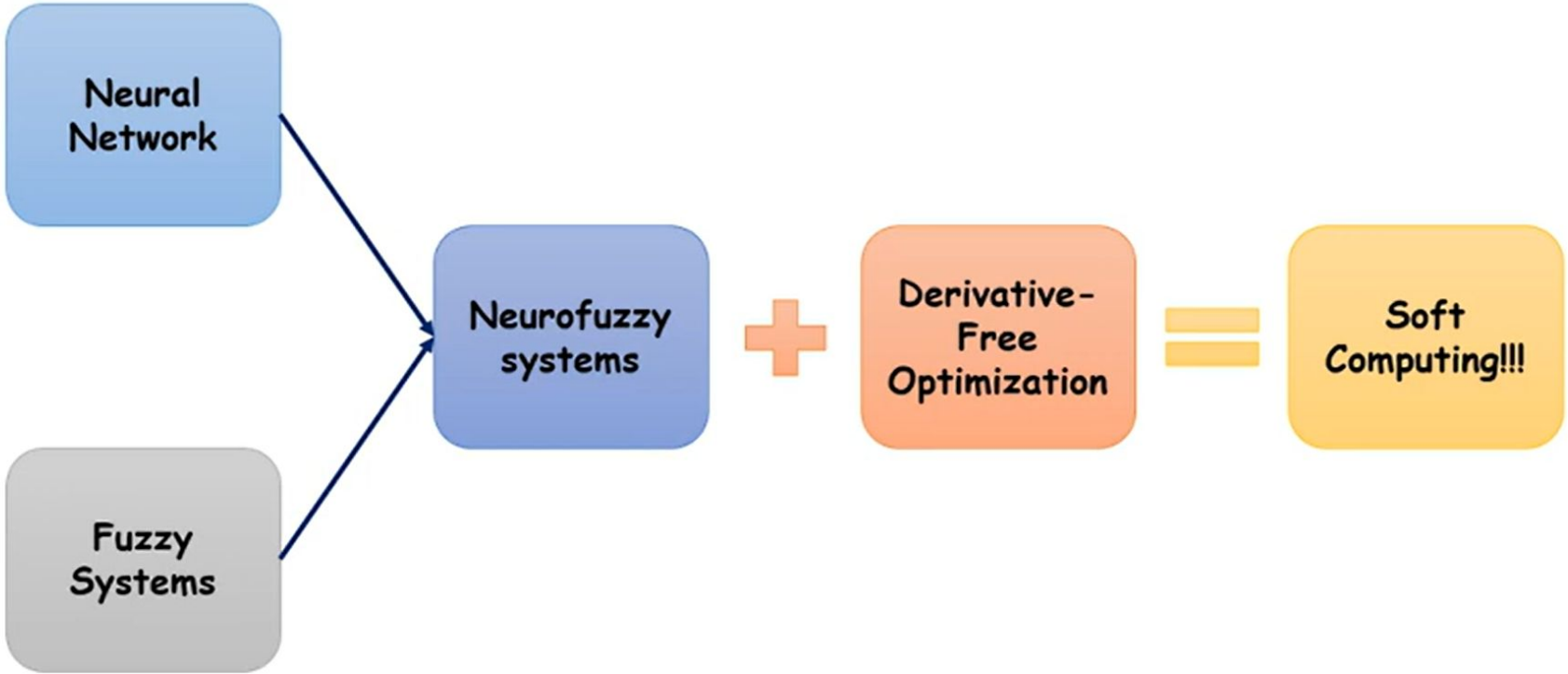
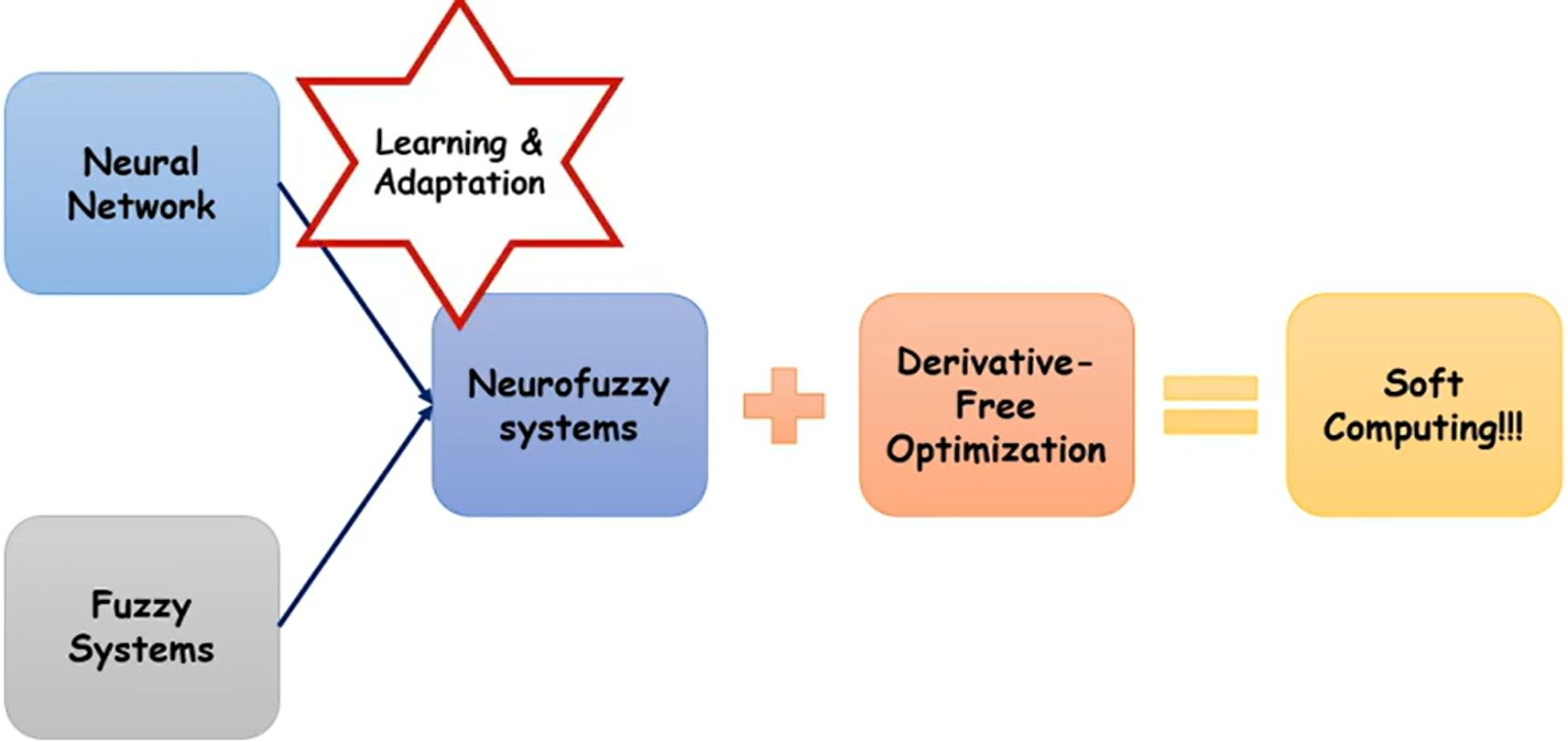
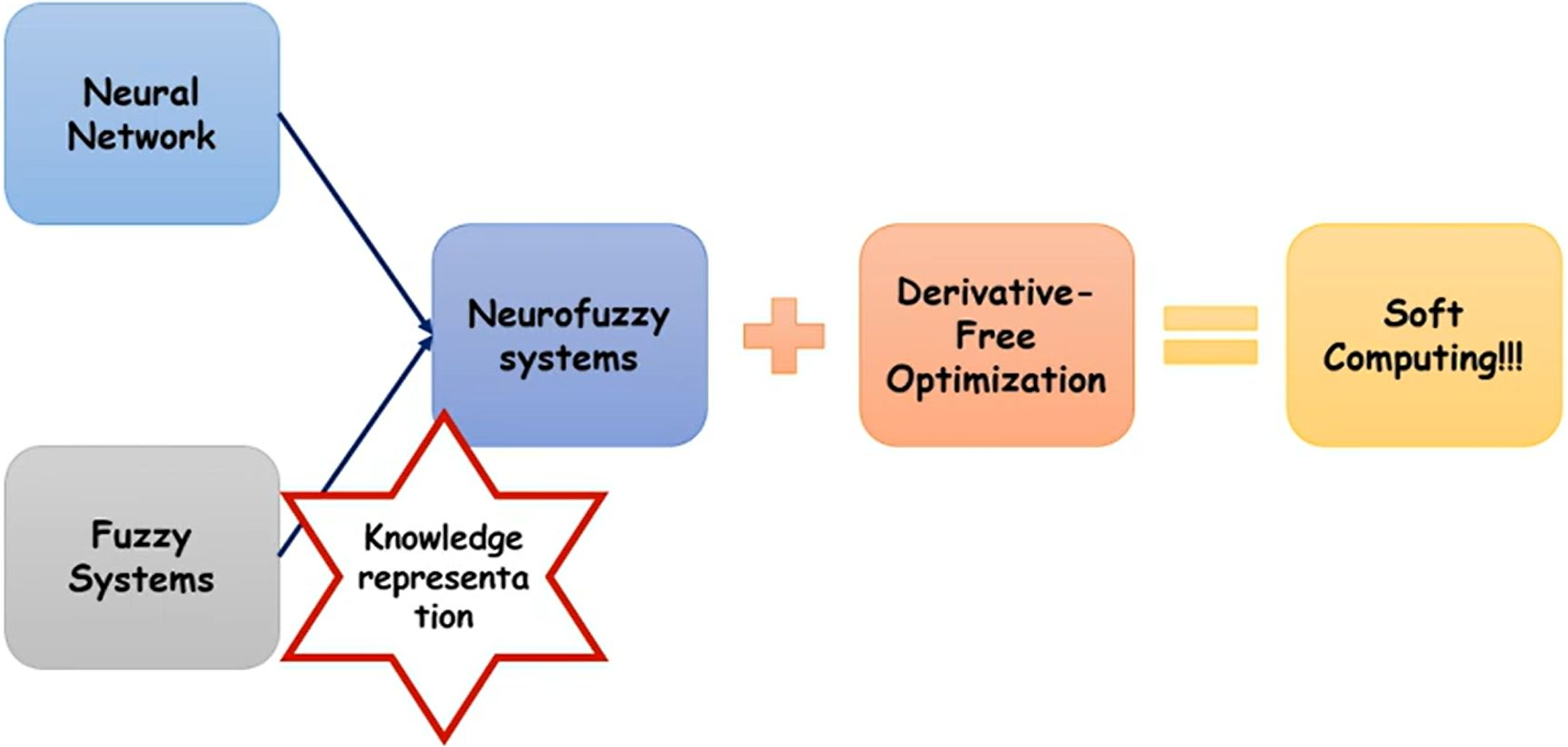
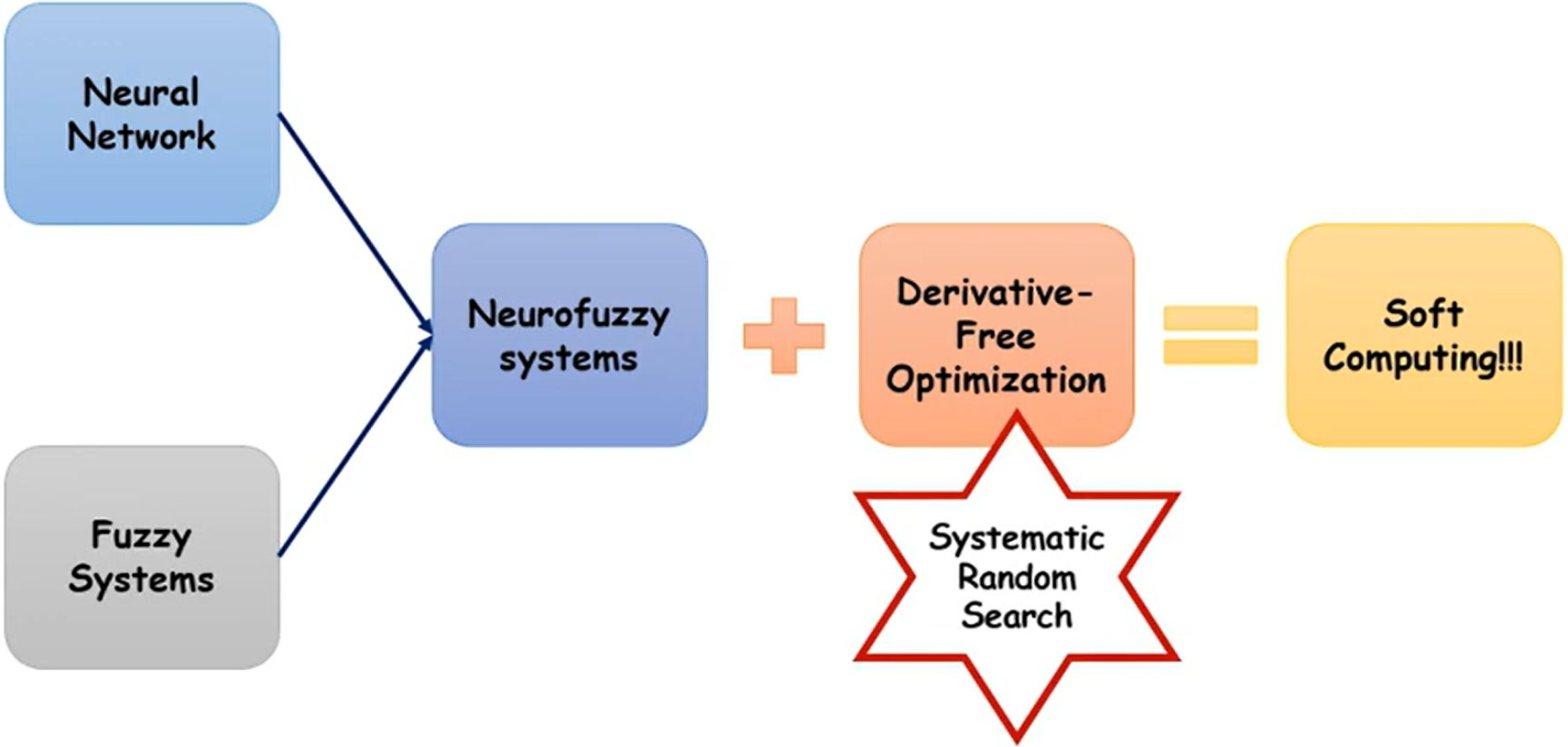


Figure: Simplified model of a neuron as an information processor.


Neural Network
Fuzzy Systems
Neurofuzzy systems
Derivative-Free Optimization
Soft Computing!!!


Neural Network
Learning & Adaptation
Fuzzy Systems
Neurofuzzy systems
Derivative-Free Optimization
Soft Computing!!!


Neural Network
Fuzzy Systems
Knowledge representation
Neurofuzzy systems
Derivative-Free Optimization
Soft Computing!!!


Neural Network
Fuzzy Systems
Neurofuzzy systems
Derivative-Free Optimization
Systematic Random Search
Soft Computing!!!

Soft Computing

❑Can be characterized as:

✓Human expertise (fuzzy if/then rules)

✓Biologically inspired computing models (NN)

✓Optimization techniques (GA, SA, etc.)

✓Numerical computation