



# *Artificial Neural Networks*

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*Visit [pritisajja.info](http://pritisajja.info) for details*

# Artificial Neural Networks



Introduction

Intelligence

Applications

Data Pyramid

Knowledge  
Based Systems

Bio-inspired

Neural Network

Machine Learning

Acknowledgement

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  - Mobile : +91 9824926020
  - URL :<http://pritisajja.info>
- **Academic qualifications :** Ph. D in Computer Science
- **Thesis title:** Knowledge-Based Systems for Socio-Economic Rural Development (2000)
- **Subject area of specialization :** Artificial Intelligence
- **Publications :** 207 in Books, Book Chapters, Journals and in Proceedings of International and National Conferences





# Artificial Neural Networks

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## Natural intelligence

- Responds to situations **flexibly**.
- **Makes sense** of ambiguous or erroneous messages.
- Assigns **relative importance** to elements of a situation.
- **Finds similarities** even though the situations might be different.
- **Draws distinctions** between situations even though there may be many similarities between them.

# Artificial Neural Networks



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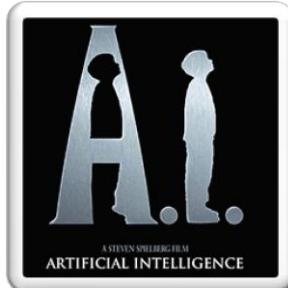
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“Artificial Intelligence(AI) is the study of how to make **computers do things** at which, at the moment, **people are better**”

- Elaine Rich, Artificial Intelligence, McGraw Hill Publications, 1986



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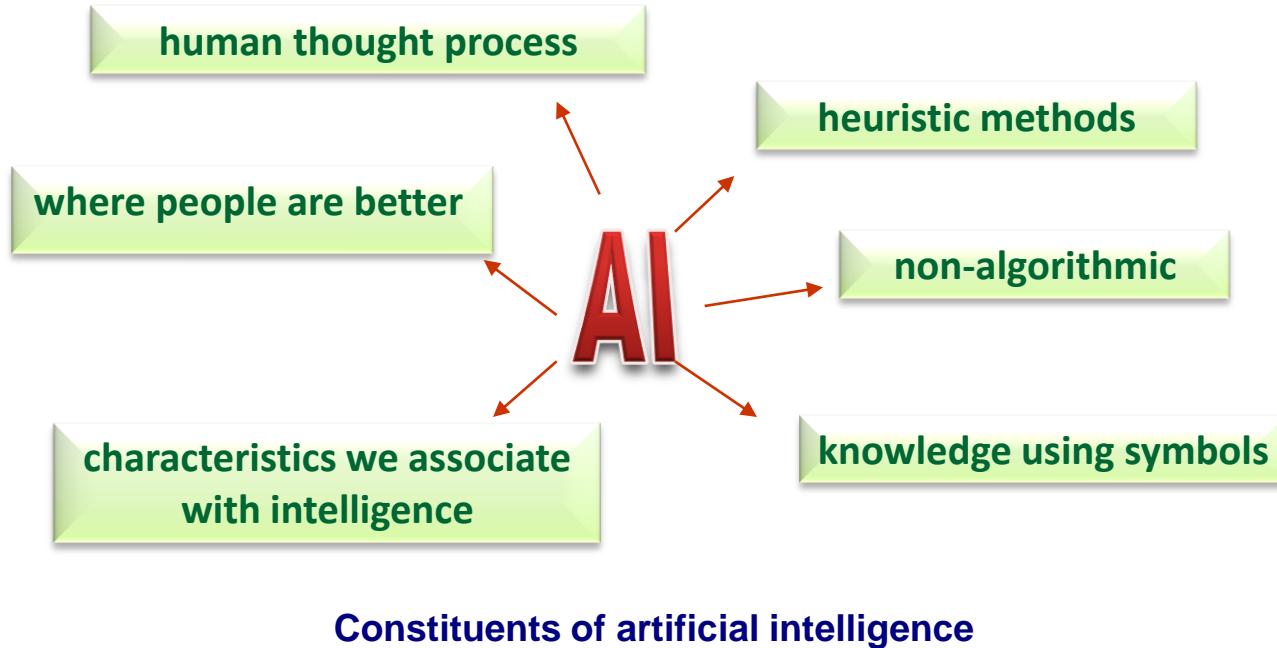
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## Artificial intelligence





# Artificial Neural Networks

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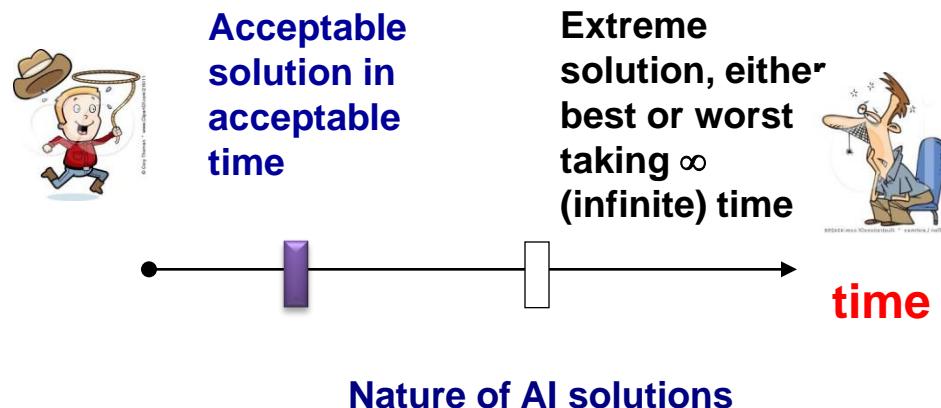
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## Artificial intelligence





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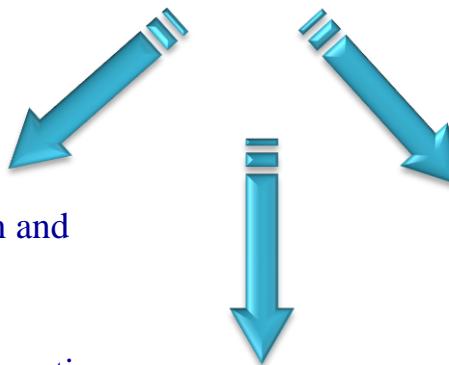
Machine Learning

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*Rich & Knight (1991) classified and described the different areas that Artificial Intelligence techniques have been applied to as follows:*

## Mundane Tasks

- Perception - vision and speech
- Natural language understanding, generation, and translation
- Commonsense reasoning
- Robot control



## Expert Tasks

- Engineering - design, fault finding, manufacturing planning, etc.
- Scientific analysis
- Medical diagnosis
- Financial analysis

## Formal Tasks

- Games - chess, backgammon, checkers, etc.
- Mathematics- geometry, logic, integral calculus, theorem proving, etc.



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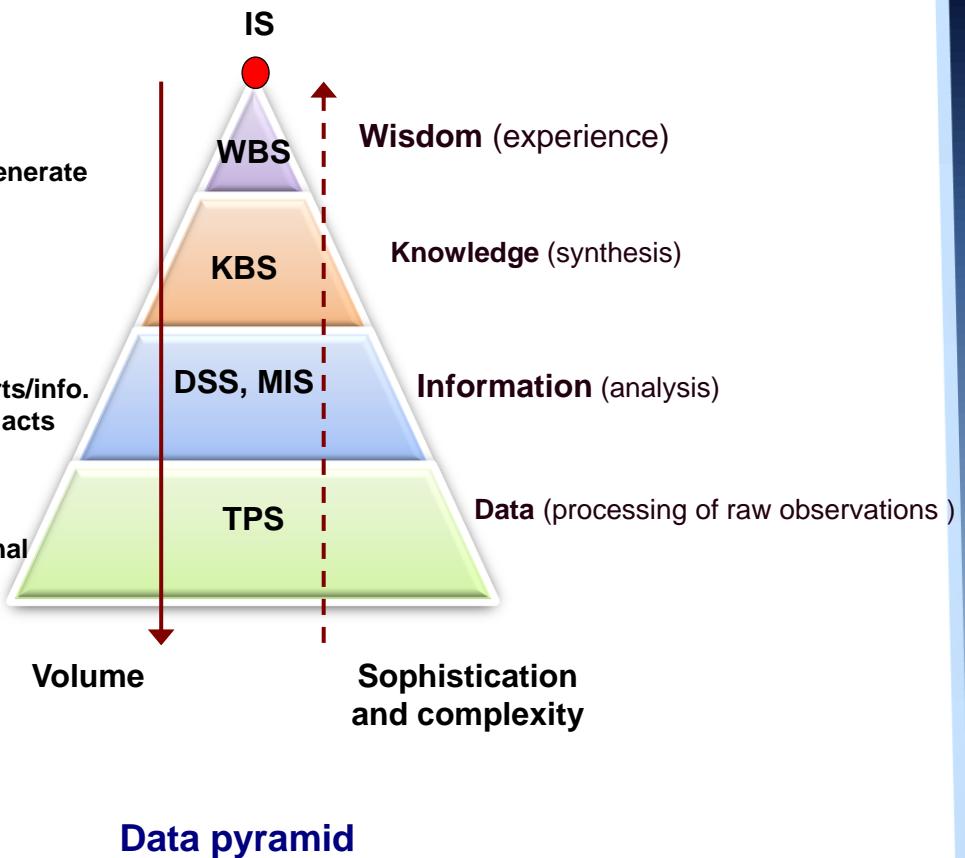
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Strategy makers apply morals, principles, and experience to generate policies

Higher management generates knowledge by synthesizing information

Middle management uses reports/info. generated through analysis and acts accordingly

Basic transactions by operational staff using data processing





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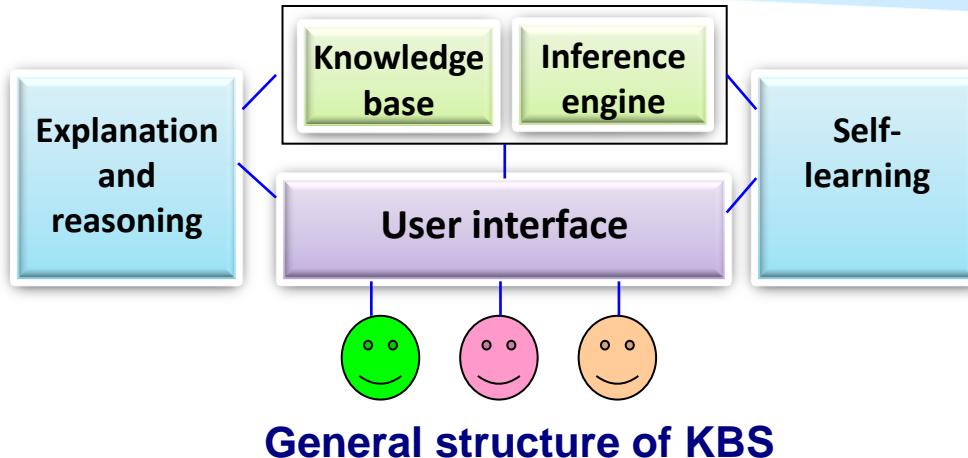
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Knowledge-Based Systems (KBS) are **Productive Artificial Intelligence Tools** working in a narrow domain.

**According to the classifications by Tuthill & Levy (1991), five main types of KBS exists:**

- Expert systems
- Linked Systems
- CASE based Systems
- Intelligent Tutoring Systems
- Intelligent User Interface for Database





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## Limitations of Symbolic representations

- **Nature of knowledge**
  - Hard to characterize
  - Voluminous
  - Dynamic
- **Knowledge acquisition**
  - Fact finding methods support only
  - Tacit and higher level knowledge
  - Multiple experts
- **Knowledge representation**
  - Limited knowledge structures support
- **KBS development models**
  - Only SAD/SE guidelines and a few quality metrics
- **Large size of knowledge base**



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## Bio-Inspired Computing

- New approaches to AI
- Taking inspiration from nature and biological systems
- Includes models such as
  - Artificial Neural Network (ANN)
  - Genetic Algorithm(GA)
  - Swarm Intelligence(SI), etc.
- Nature has virtues of self learning, evolution, emergence and immunity
- The objective of bio-inspired models and techniques to take inspiration from Mother Nature and solve problems in more effective and intelligent way



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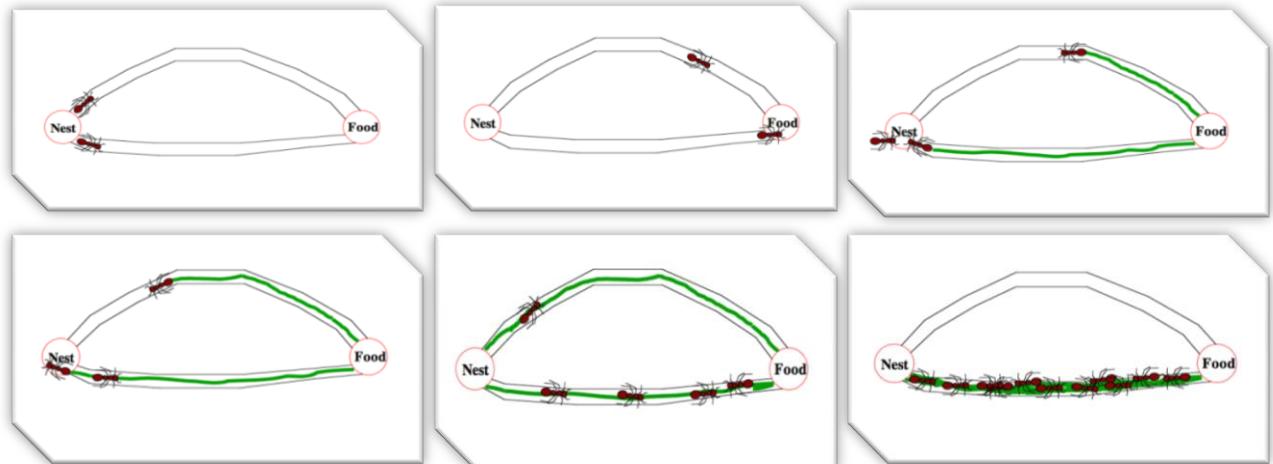
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## Swarm Intelligence

- Inspired by the collective behavior of social insect colonies and other animal societies
- Ant colony, fish school, bird flocking and honey comb are the examples





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Some more examples ....

Natural



Inspired





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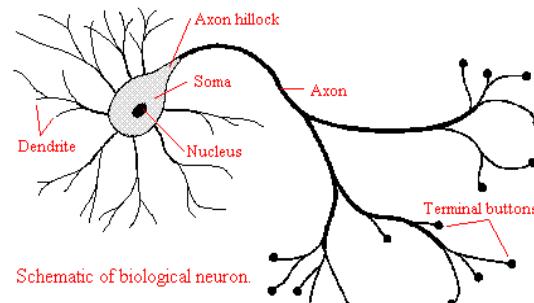
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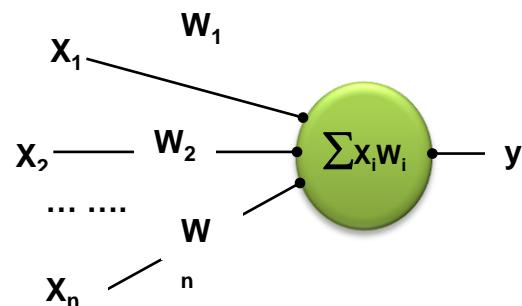
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## Artificial Neural Network (ANN)

- An artificial neural network (ANN) is **connectionist model** of programming using computers.
- An ANN attempts to give computers humanlike abilities by **mimicking the human brain's functionality**.
- The human brain consists of a network of more than a hundred billions **interconnected neurons** working in a **parallel fashion**.
- Such network are **fault tolerant**.



A biological neuron



An artificial neuron



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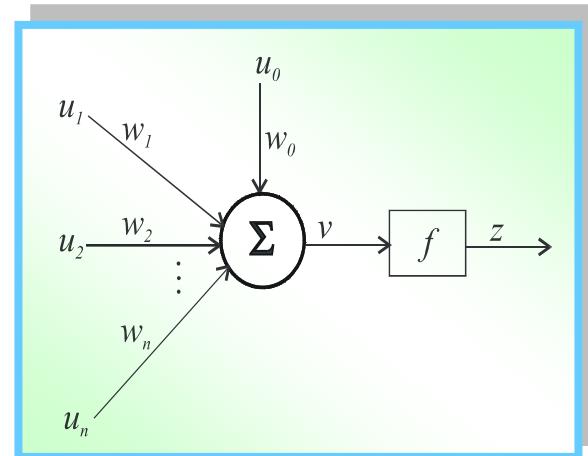
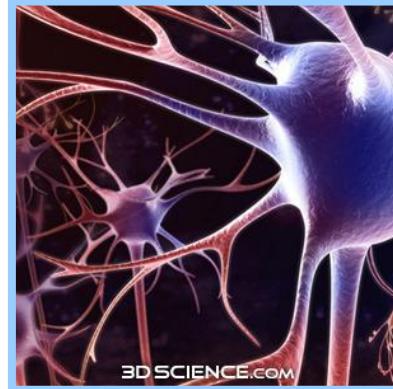
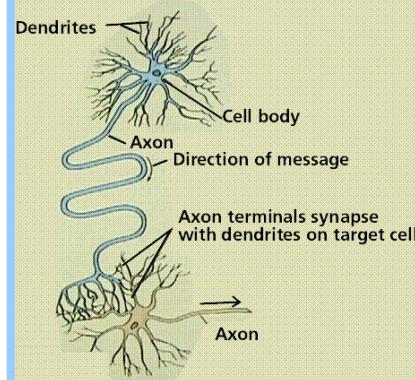
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## Biological and Artificial Neurons





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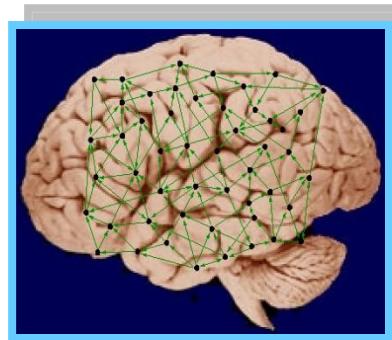
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**Objective:** Not to mimic brain functionality but to receive inspiration from the fact about **how brain is working.**



**Characterized by:**

- A **large number** of very simple neuron like processing elements.
- A large number of **weighted connection** between the elements. These weights encode the knowledge of a network.
- Highly **parallel and distributed** control.
- Emphasis on **learning** internal representation automatically.



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## Architectures of ANN

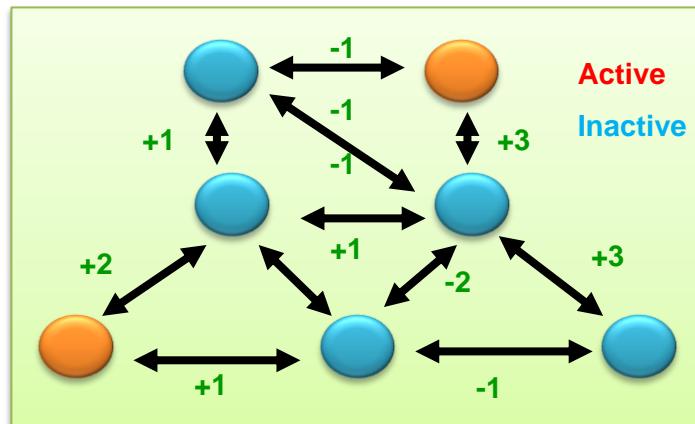
- Hopfield network
- Perceptron
- Multi-layer Perceptron
- Self Organizing Network
- etc.



# Artificial Neural Networks

## A Simple Hopfield Network

- In a Hopfield network, all processing units/elements are in two states either **active or inactive**.
- Units are connected to each other with weighted Connections.



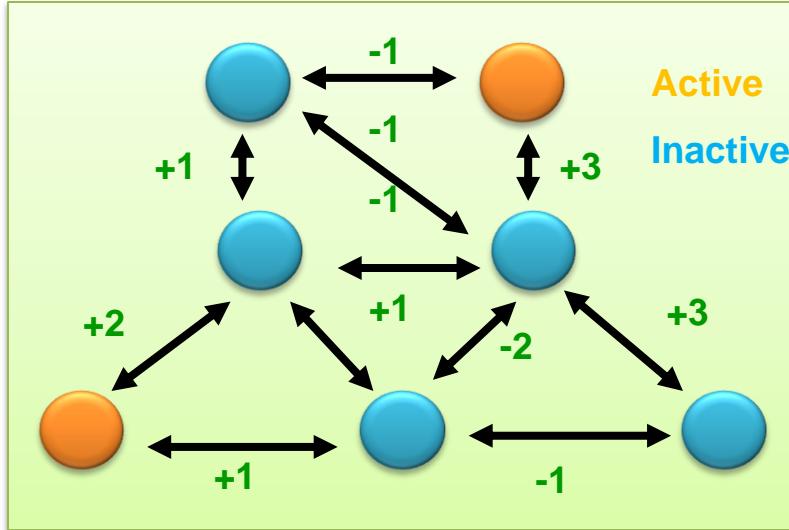
- A positively weighted connection indicates that the units tend to active each other.
- A negative connection allows an active unit to deactivate a neighboring unit.

Neural Network

Machine Learning

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## Parallel Relaxation



- A random unit is chosen.
- If any of its neighbors are active, the unit computes the sum of weights on the connections to those active neighbors.
- If the sum is positive, the unit becomes active else new random unit is chosen.
- This process will continue till the network become stable. That is no unit can change its status. This process is known as parallel relaxation.



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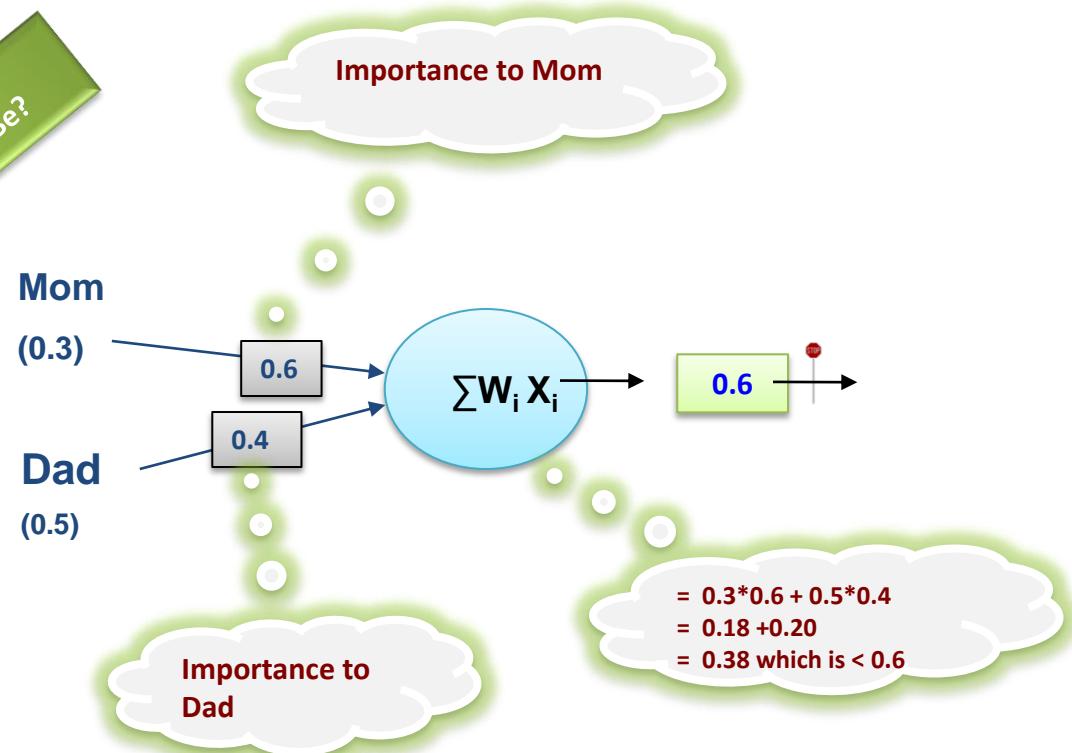
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Perceptron

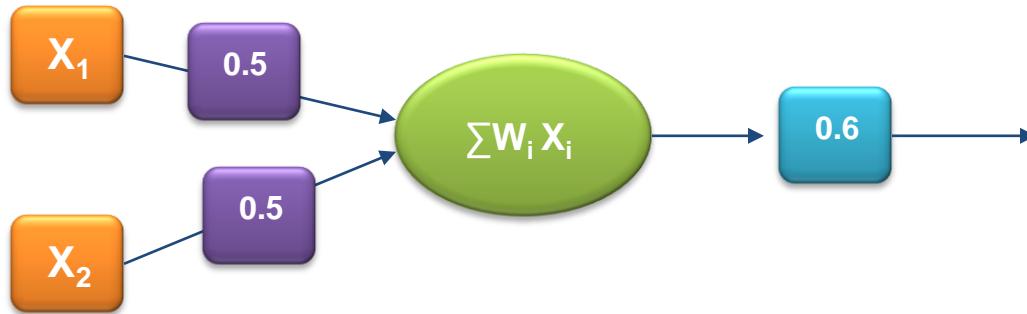
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Going to Army:  
to Be or not to Be?

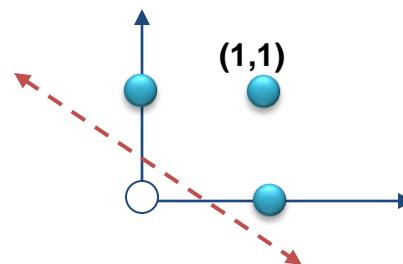
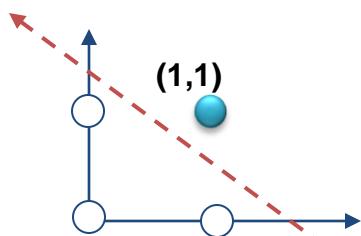


# Logical Gate AND and OR

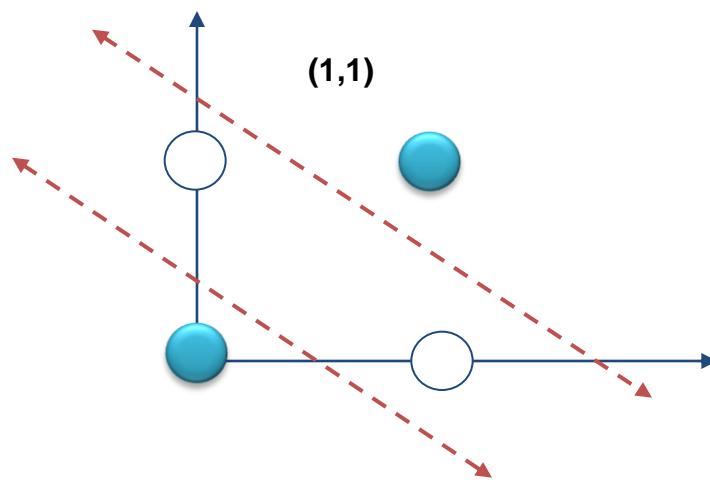
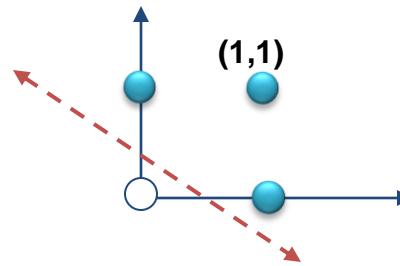
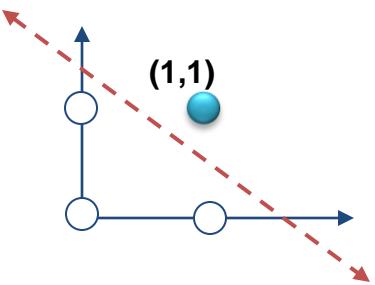


Logical AND Truth Table

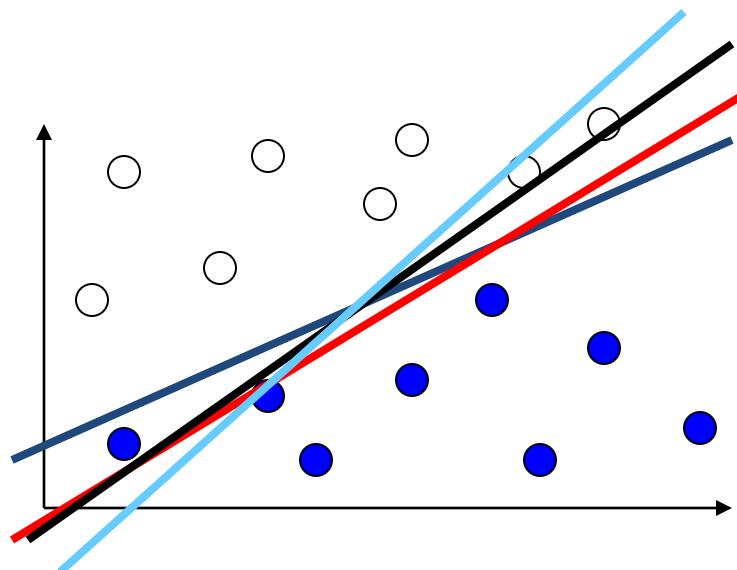
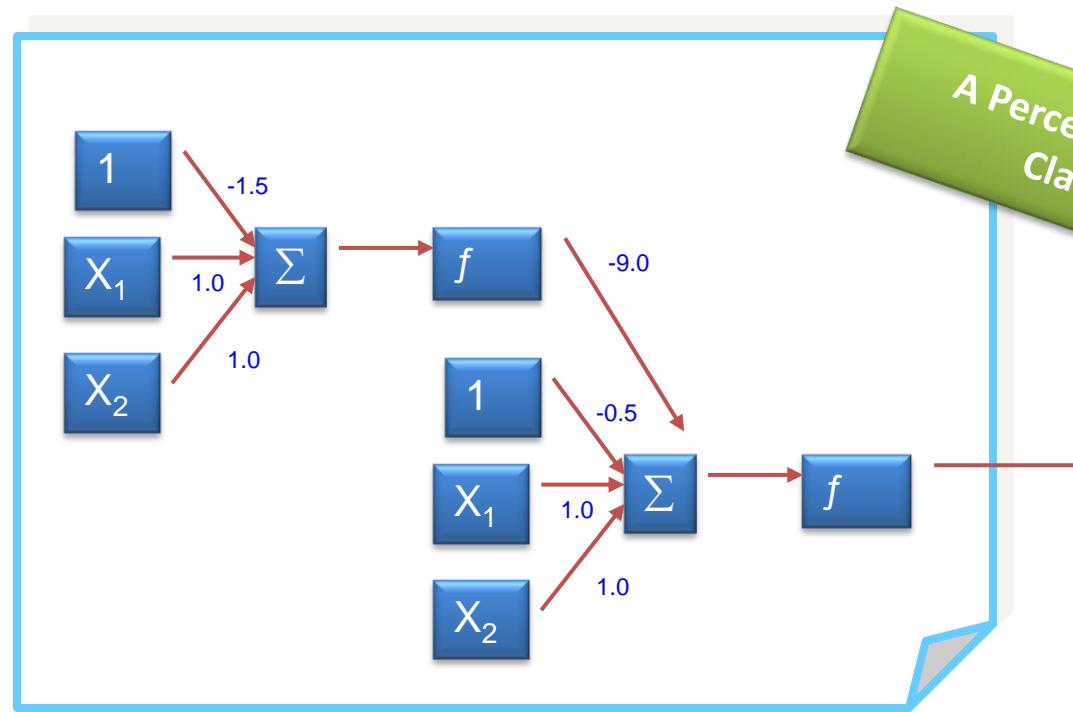
$x_1$	$x_2$	$x_1 \text{AND } x_2$
0	0	$0*0.5 + 0*0.5 = 0 < 0.6 \rightarrow 0$
0	1	$0*0.5 + 1*0.5 = 0 < 0.6 \rightarrow 0$
1	0	$1*0.5 + 0*0.5 = 0.5 < 0.6 \rightarrow 0$
1	1	$1*0.5 + 1*0.5 = 1 > 0.6 \rightarrow 1$



# Logical Gate AND and OR



## A Perception Learning to Solve a Classification Problem



$K$	$w_0$	$w_1$	$w_2$
10	.41	-.17	.14
100	.22	-.14	.11
300	-.1	-.008	.07
635	-.49	-.1	.14

# Artificial Neural Networks



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# Knowledge Based Systems

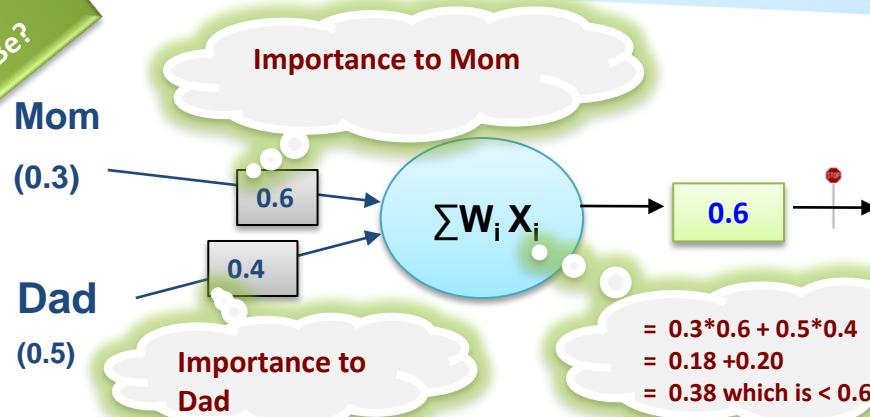
# Bio-inspired

# Perceptron

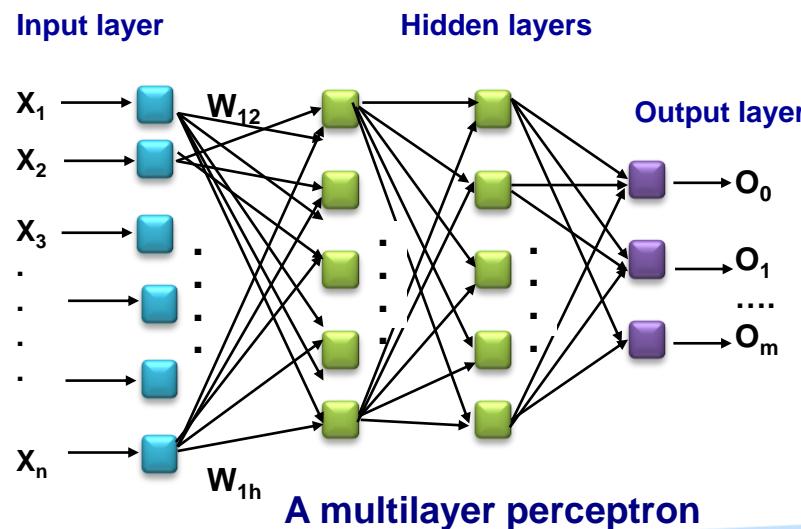
# Machine Learning

## Acknowledgement

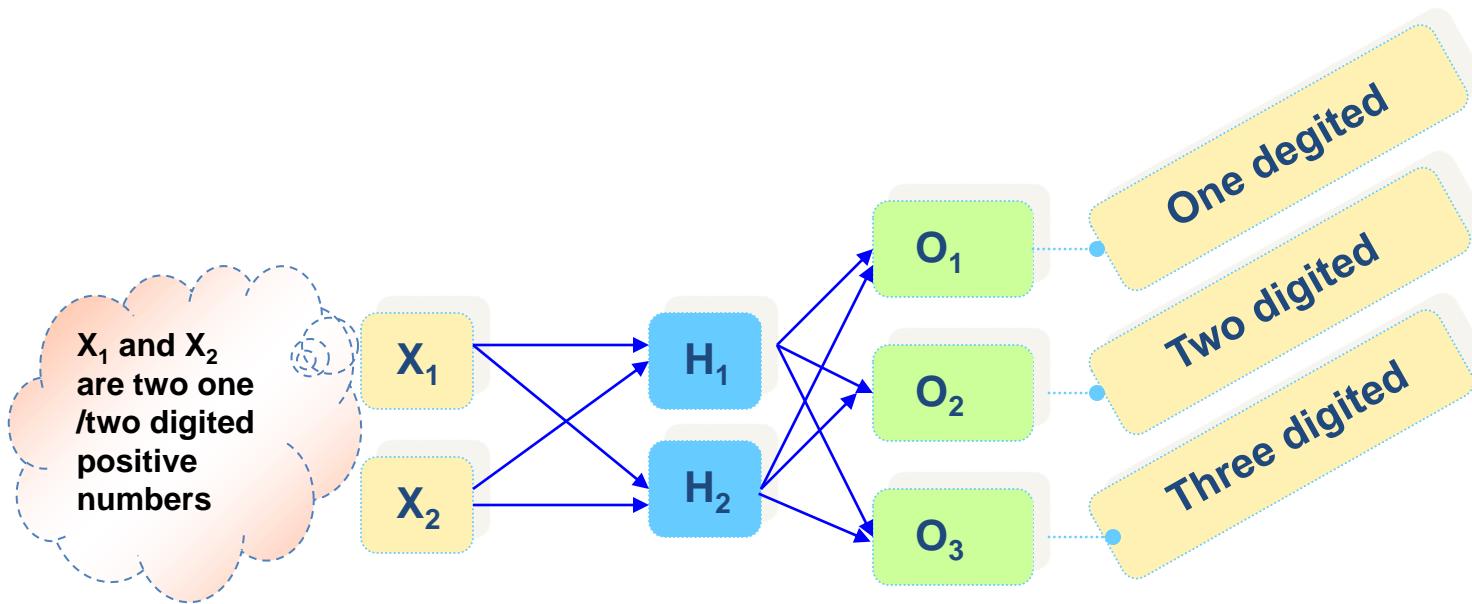
## Going to Army: to Be or not to Be?



$$\begin{aligned}
 &= 0.3*0.6 + 0.5*0.4 \\
 &= 0.18 + 0.20 \\
 &= 0.38 \text{ which is } < 0.6
 \end{aligned}$$



# Examples of Multilayer Perceptron



## Training Set Data

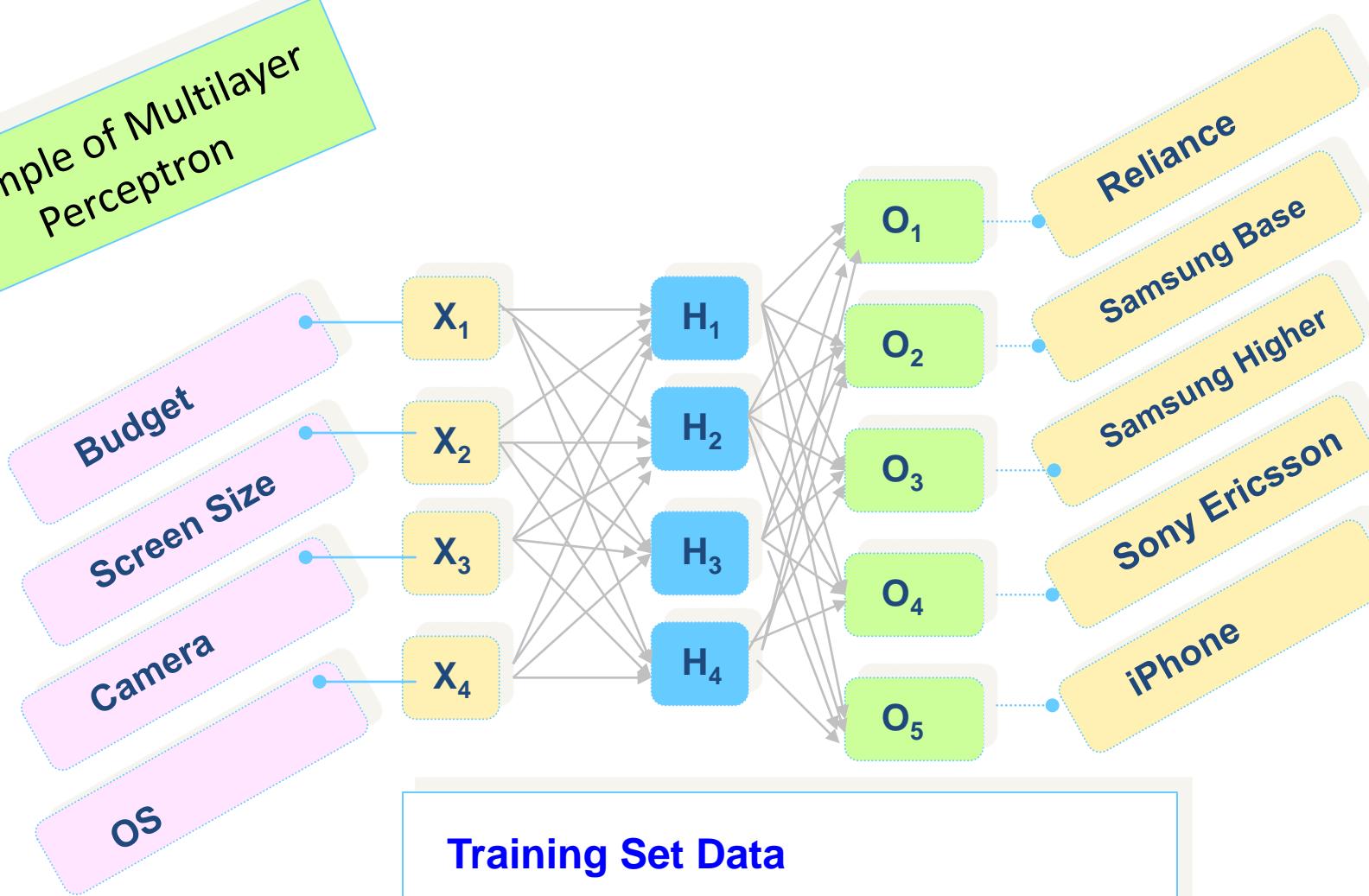
2, 3, 1, 0, 0

10, 10, 0, 1, 0

90, 90, 0, 0, 1

.....

## Example of Multilayer Perceptron



### Training Set Data

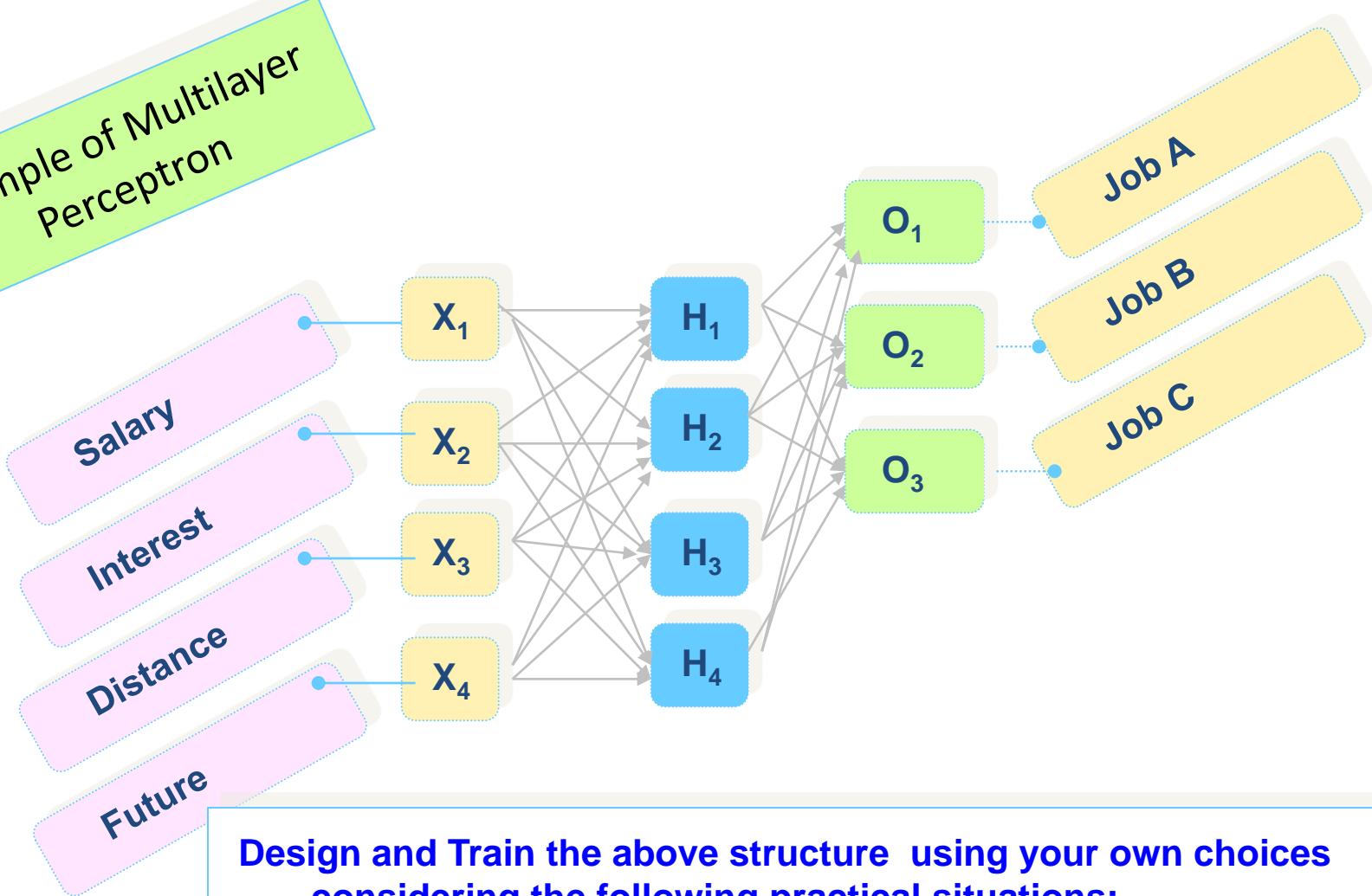
2, 3, 0, 0, 1, 0, 0, 0, 0

6, 6, 7, 5, 0, 0, 1, 0, 0

8, 8, 8, 8, 0, 0, 0, 0, 1

.....

## Example of Multilayer Perceptron



**Design and Train the above structure using your own choices considering the following practical situations:**

- A. Job At Bengaluru, salary Rs.30, 000 per month of your field
- B. Job At USA, salary Rs.80, 000 per month of other field
- C. Job At Anand, salary Rs.25, 000 per month of your field



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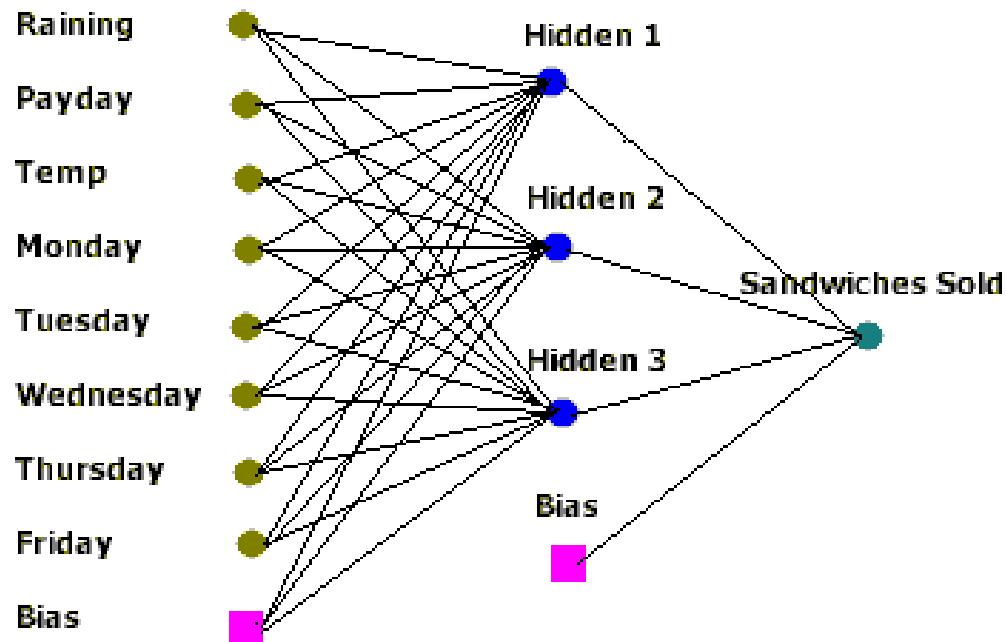
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## Predicting Sandwich Sales



<http://www.wardsystems.com>



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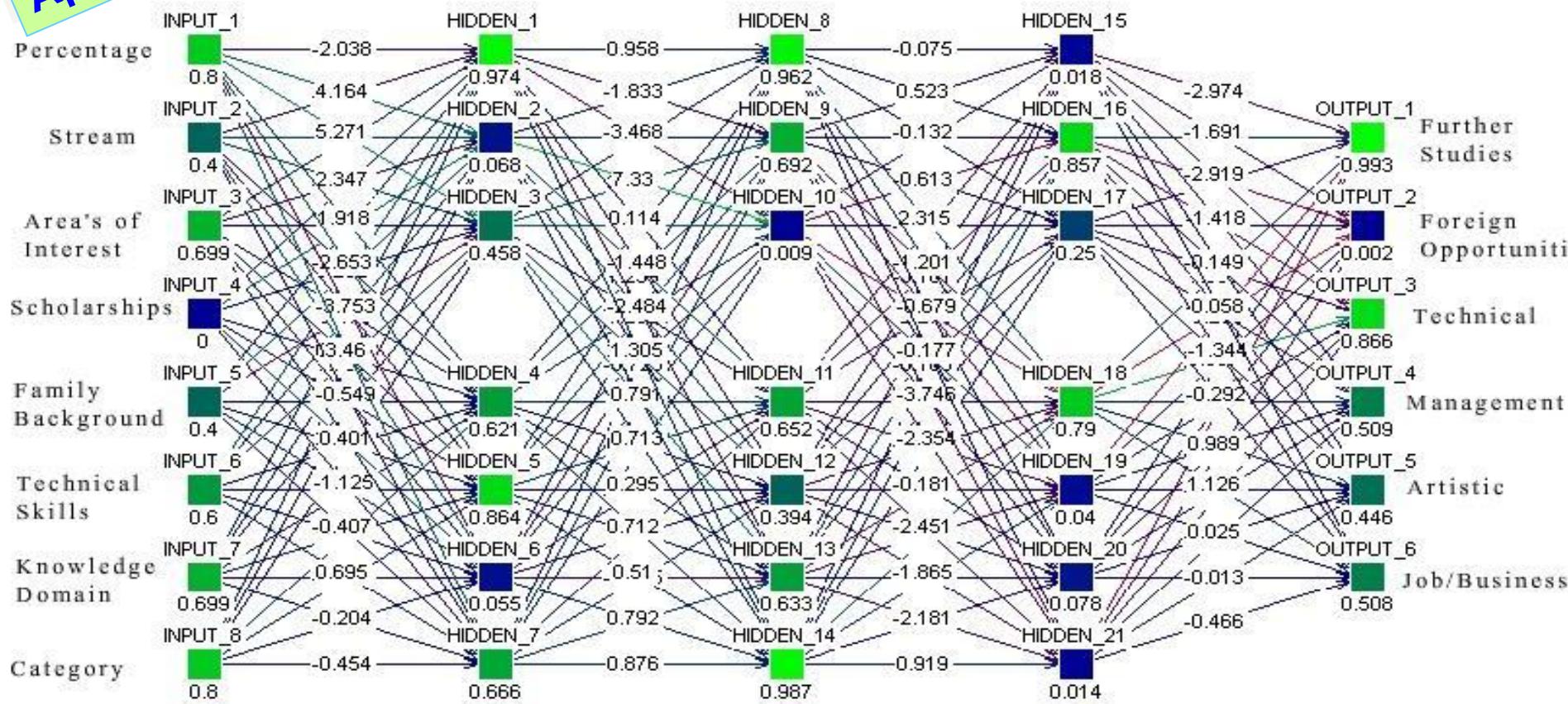
## ■ Training Data for Sandwich Case

**Bob's New York Style Deli Sandwich Sales Neural Net Predictor**

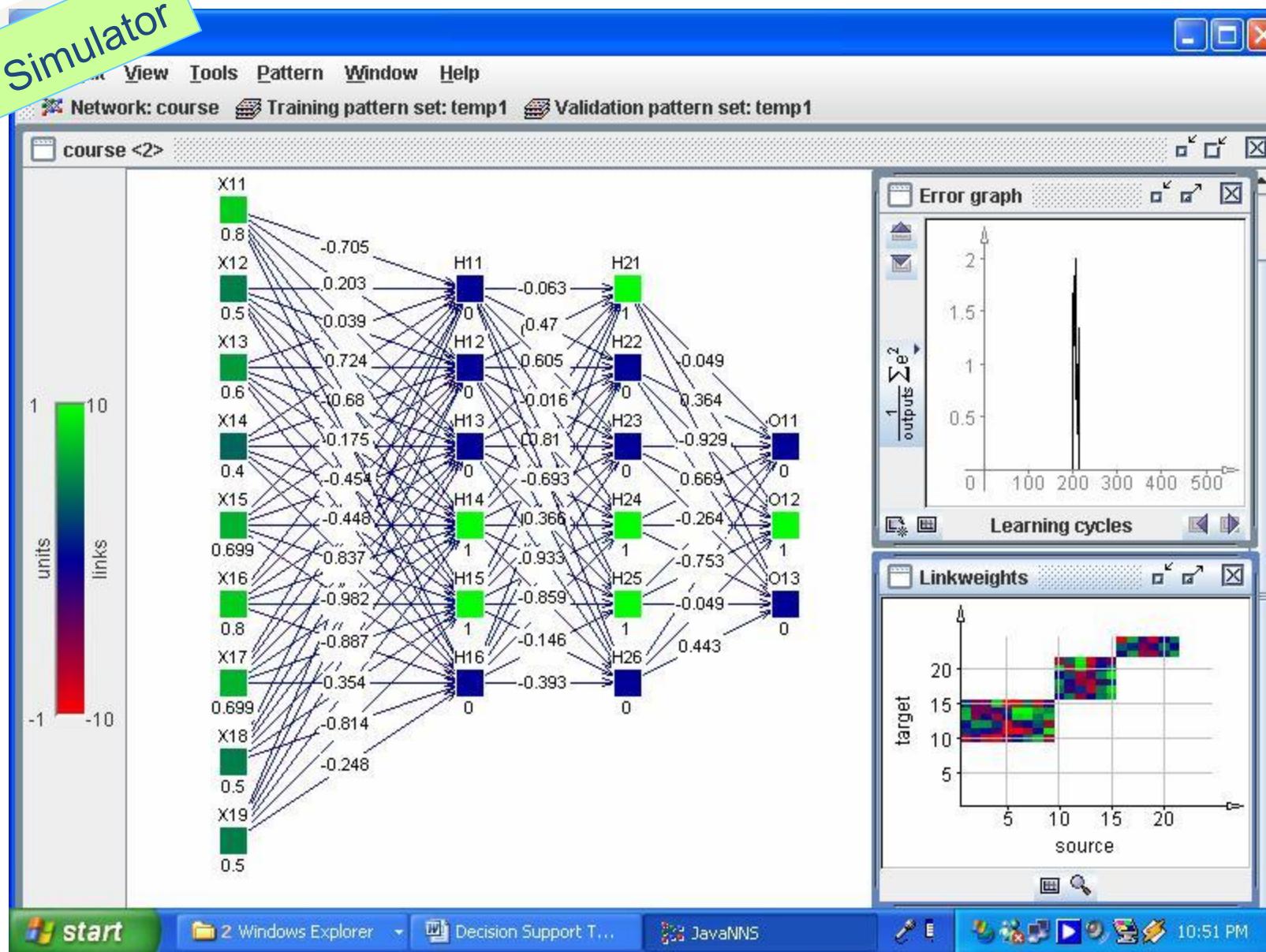
Input 1	Input 2	Input 3	Input 4	In 5	In 6	In 7	In 8	Output	
Raining? in area?	Payday	Temperature Fahrenheit	Scaled temperature	Mon	Tue	Wed	Thu	Fri	Sandwiches Sold
0	0	55	-0.80	1					120
0	0	60	-0.60		1				120
0	0	59	-0.64			1			132
1	0	65	-0.40				1		103
0	0	65	-0.40					1	152
0	1	66	-0.36	1					157
1	0	50	-1.00		1				79
0	0	70	-0.20			1			157
0	0	65	-0.40				1		130
1	0	60	-0.60					1	115
0	0	77	0.08	1					168

<http://www.wardsystems.com>

# ANN to Determine Aptitude of Users



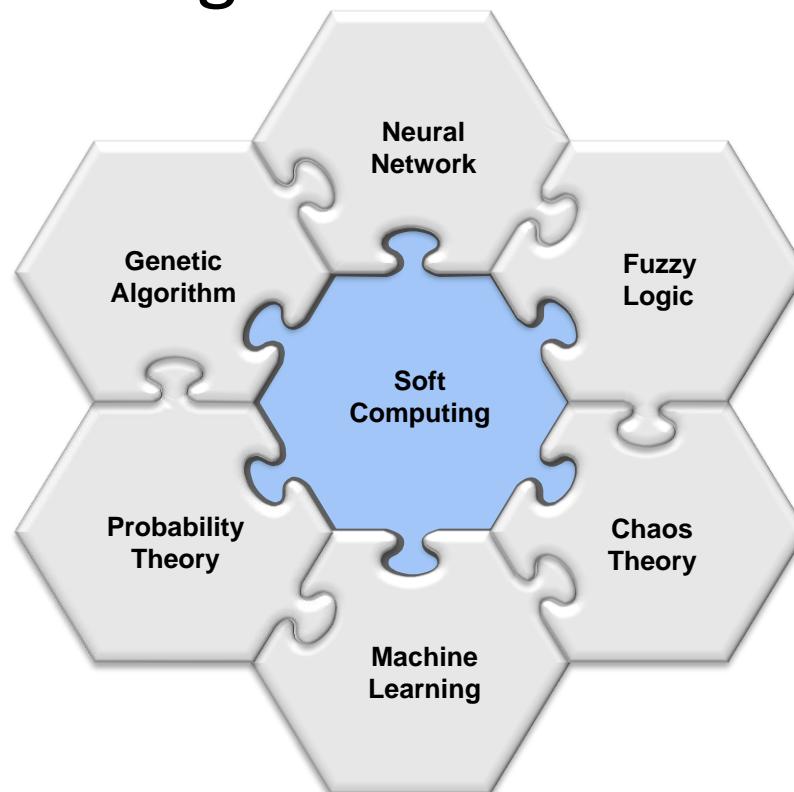
# ANN Simulator



# Genetic Algorithms



## Soft Computing and Machine Learning



Introduction

Fundamentals

Algorithm

Function Optimization - 1

Function Optimization - 2

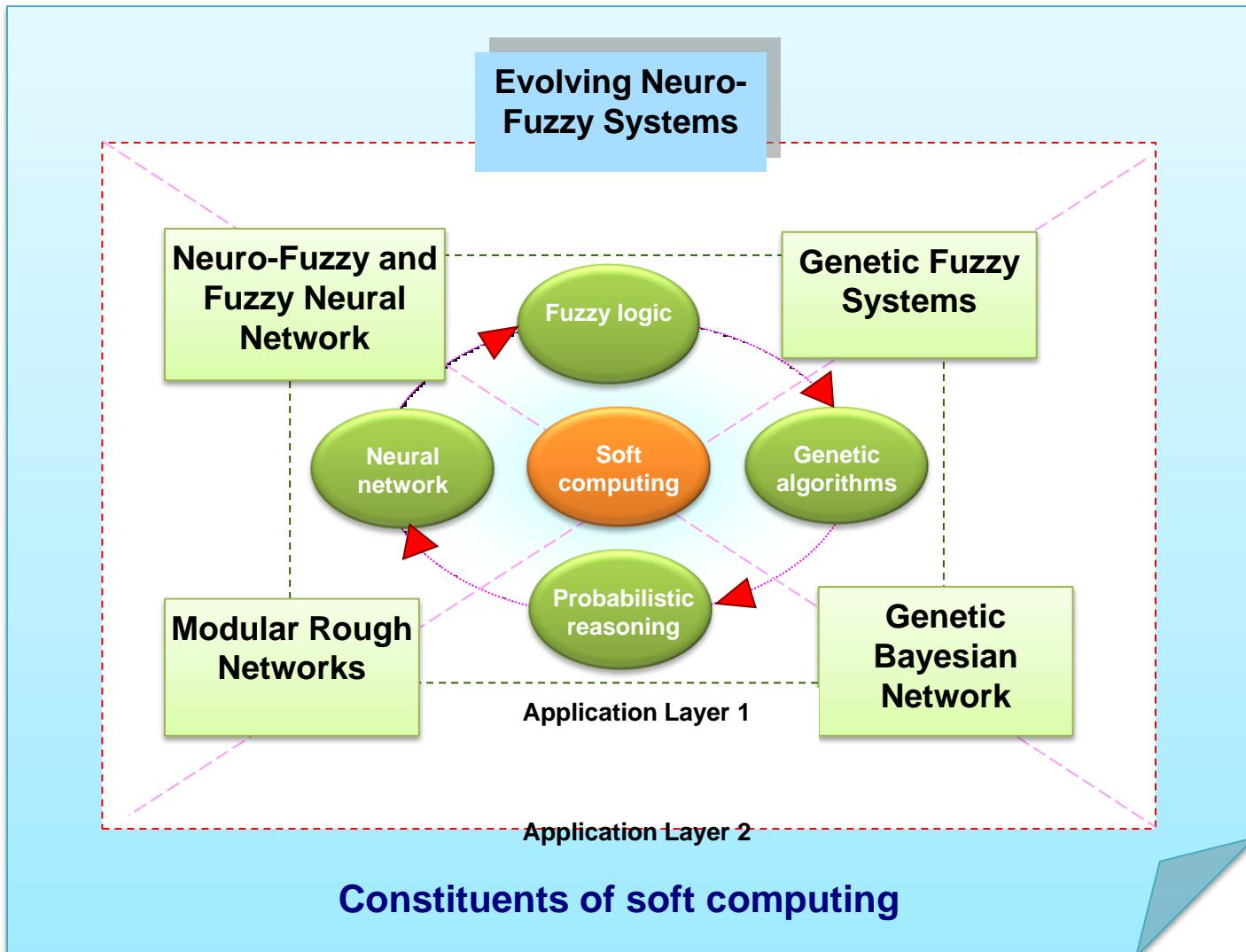
Ordering Problems

Edge Recombination

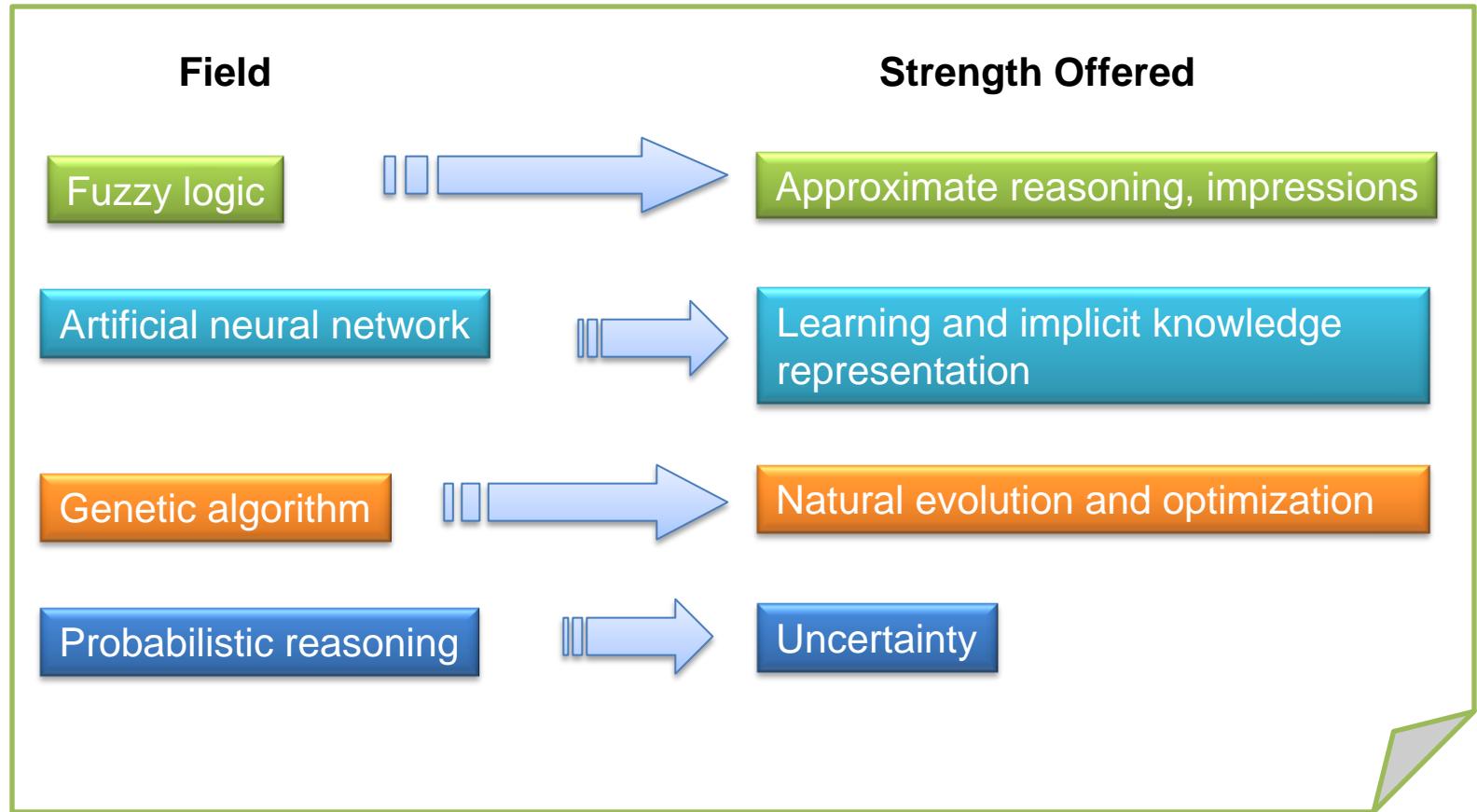
Machine Learning

Genetic Programming

# Hybrid Systems/Soft Computing



# Strength of a Hybrid Soft Computing System





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- **Machine Learning (ML)** is defined as an ability to learn without being explicitly programmed.
- **Supervised ML:** “trained” on a pre-defined set of “training examples”
- **Unsupervised ML:** using bunch of data, the machine must find patterns
- **Decision tree method:** data is divided into subsets based on an attribute value test, which is repeated on each of the derived subsets recursively.



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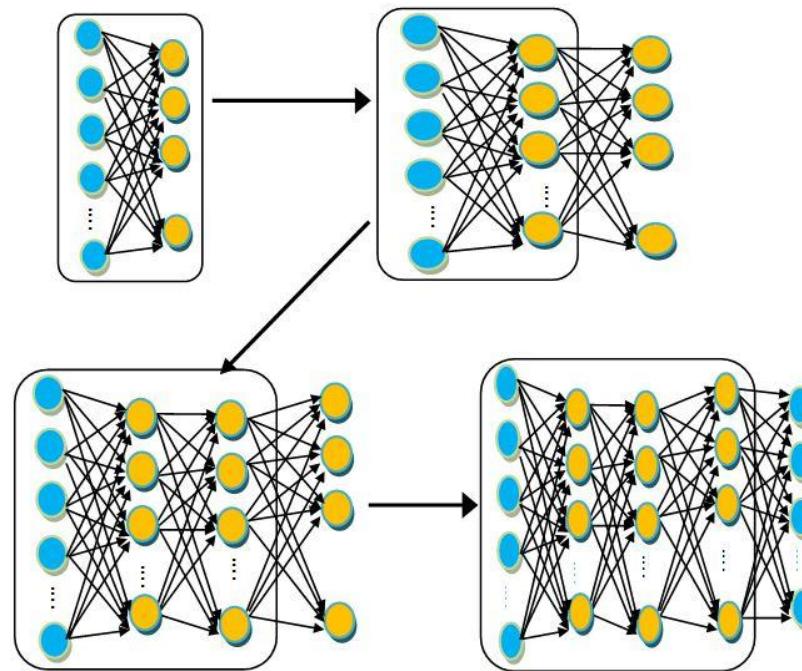
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- Deep Learning: several stages of non-linear information processing in hierarchical architectures are utilized for pattern classification and for feature learning.





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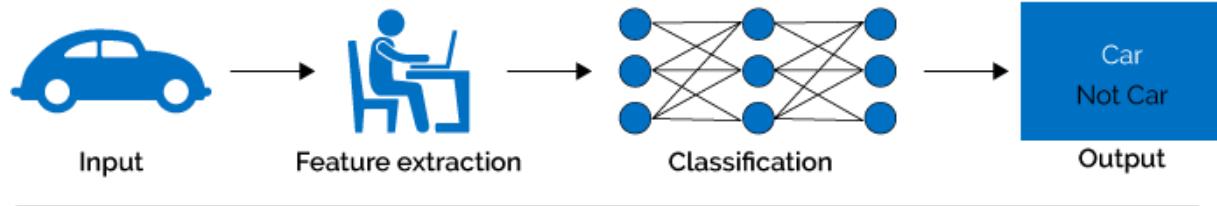
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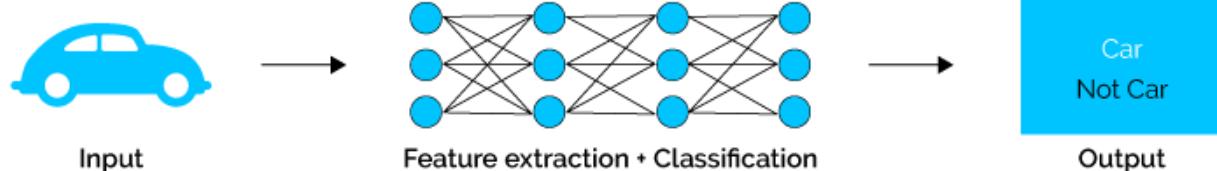
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## Deep Learning As extension of Machine Learning

### Machine Learning



### Deep Learning



<https://medium.com/swlh/ill-tell-you-why-deep-learning-is-so-popular-and-in-demand-5aca72628780>



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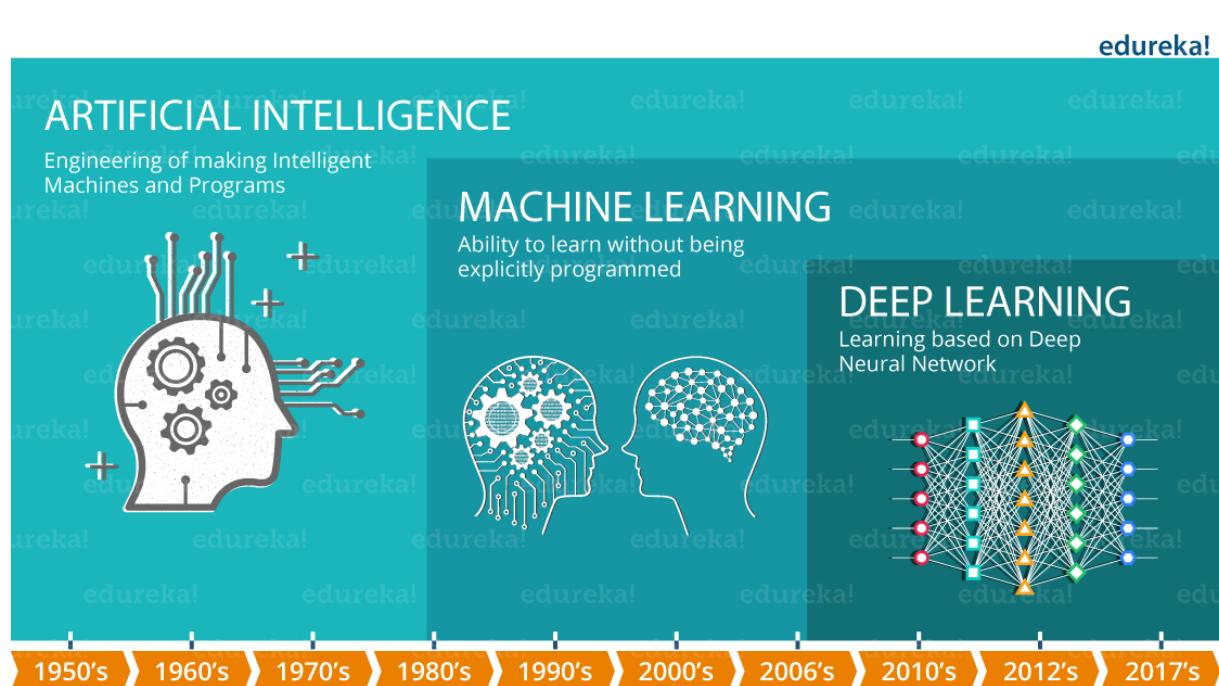
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<https://www.edureka.co/blog/what-is-deep-learning>



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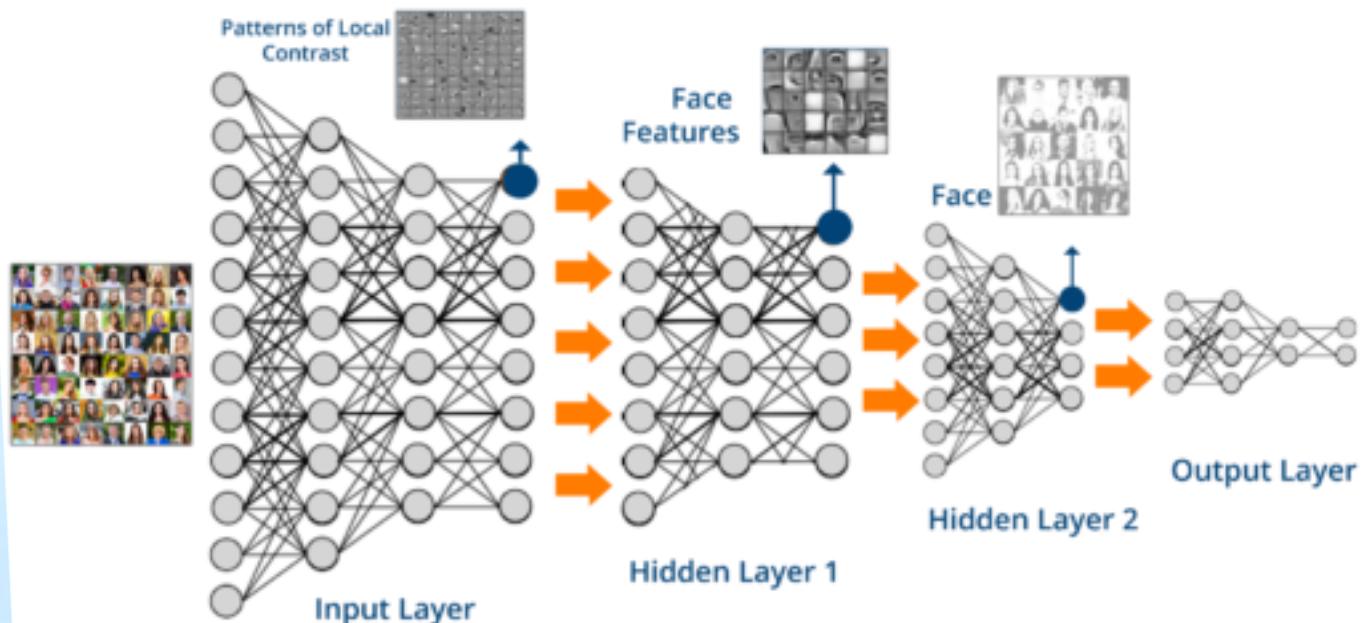
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## Applications of Machine Learning

- Natural language processing and natural query.
- Film industry where dubbing of film, re-colouring film prints and adding sounds to the silent films.
- News aggregators
- Machine Translation (partly/ fully ) with sentence corrections.
- Automatic prescription of handwriting production and understanding.
- Managing knowledge wallet.
- Chatting agents.
- Intelligent games.
- Google's automatic statistician project.
- Intelligent web applications including searching and intelligent crawling.
- Image, speech and multimedia mining.
- Utilization of social network platform for various activities.
- Development for resources and sustainable development, population information, governance (weather forecasting, infrastructural development, natural resources).
- Sensor web, agricultural information, decision support systems in domains like forestry and fisheries.



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- British actress, model, dancer and humanitarian.
- Recognised as a film and fashion icon



- She has a sense of humor.
- She can express feelings
- Citizen of Saudi Arabia
- Sophia wants to protect humanity

<http://www.hansonrobotics.com/robot/sophia/>



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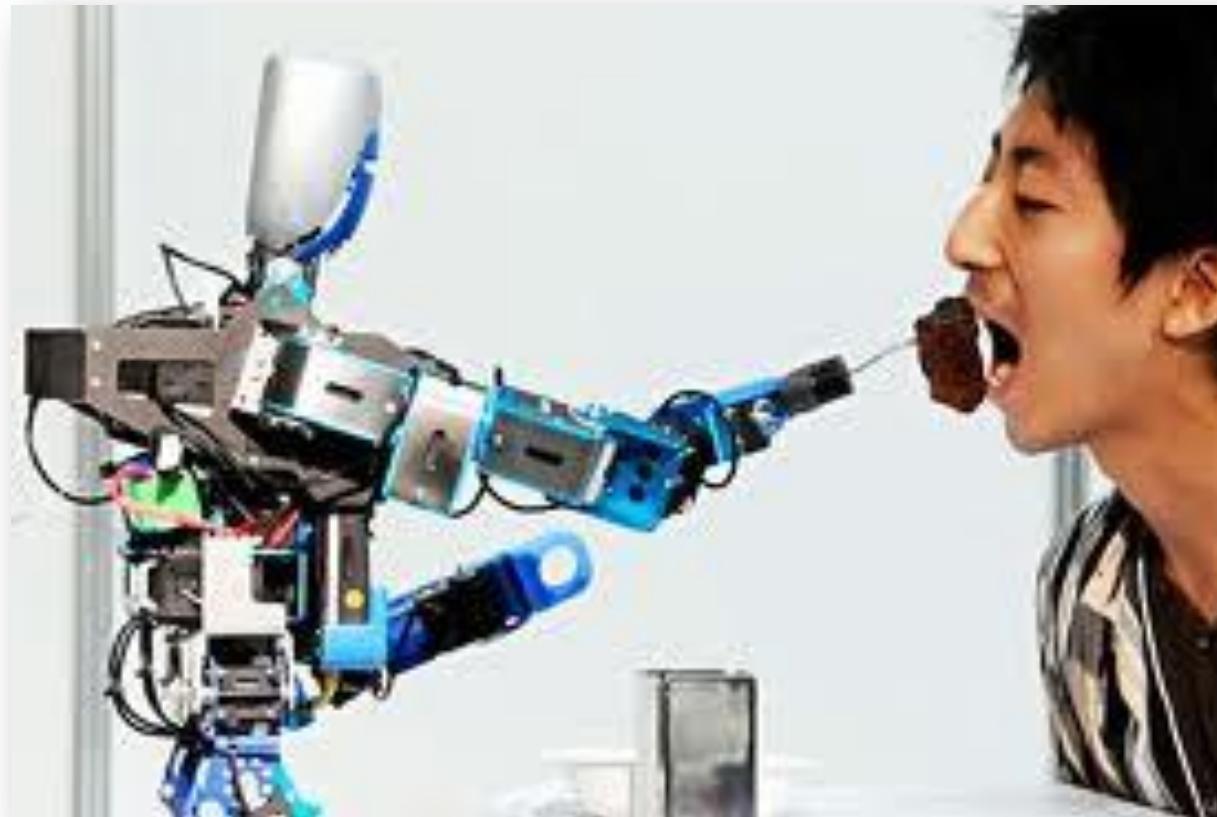
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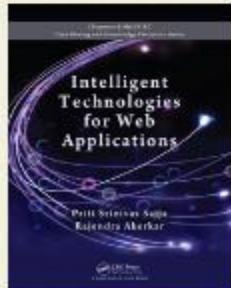


**Priti Srinivas Sajja** is a Professor working with Post Graduate Department of Computer Science, Sardar Patel University, India since 1994. She specializes in Artificial Intelligence especially in knowledge-based systems, soft computing and multiagent systems. She is co-author of [Knowledge-Based Systems](#) (2009) and [Intelligent Technologies for Web Applications](#) (2012). She is Principal Investigator of a major research project funded by UGC, India.

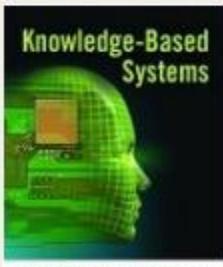
She has 113 publications in books, book chapters, journals, and in the proceedings of national and international conferences. Her four publications have won best research paper awards.

This website is compilation of her research and publication work.

## Books

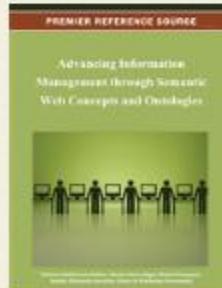


Intelligent  
Technologies for Web  
Applications

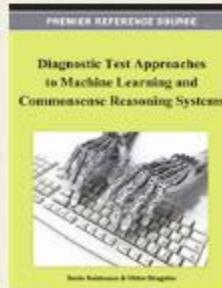


Knowledge-Based  
Systems

## Chapters



Advancing  
Information  
Management through  
Semantic Web  
Concepts and  
Ontologies



Diagnostic Test  
Approaches to  
Machine Learning  
and Commonsense  
Reasoning Systems

# Artificial Neural Networks



Introduction

Intelligence

Applications

Data Pyramid

Knowledge  
Based Systems

Bio-inspired

Neural Network

Machine Learning

Acknowledgement

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