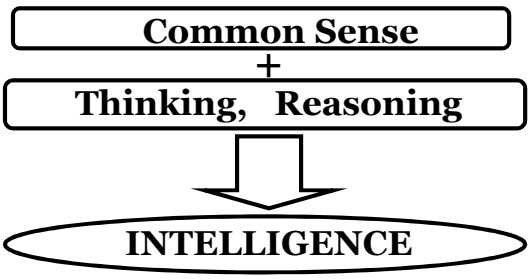
Introduction
Neural Network and Fuzzy logic

What is Intelligence?

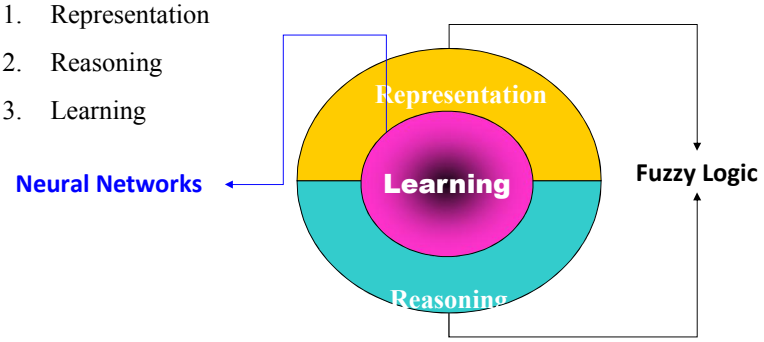
- **To respond to situations very flexibly.**
- **To recognize the relative importance of different elements of a situation.**
- **To find similarities between situations.**
- **To draw distinctions between situations.**



An AI or A Soft Computing System must have

1. Ability to Store Knowledge
2. Apply this Knowledge to Solve Problems
3. Ability to Acquire New Knowledge

1. Representation
2. Reasoning
3. Learning



Tools for designing intelligent systems

- Fuzzy Logic
- Neural Network
- Genetic Algorithm

Fuzzy logic

In the real world there exists much fuzzy knowledge, that is, knowledge which is vague, imprecise, uncertain, ambiguous, inexact, or probabilistic in nature.

Human can use such information because the human thinking and reasoning frequently involve fuzzy information, possibly originating from inherently inexact human concepts and matching of similar rather then identical experiences.

Examples of fuzziness

- Selection of a basketball player
- Temperature on a day

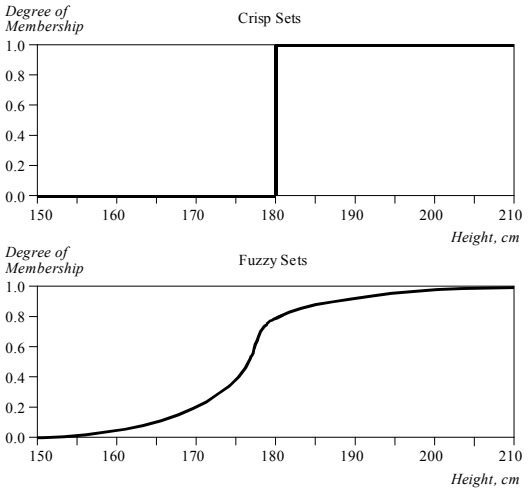
Fuzziness

- Can have different characteristics of players in computer game
  - Strength: strong, medium, weak
  - Aggressiveness: meek, medium, nasty
  - If *meek* and attacked, run away fast
  - If *medium* and attacked, run away slowly
  - If *nasty* and *strong* and attacked, attack back
- Control of a vehicle
  - Should slow down when close to car in front
  - Should speed up when far behind car in front
- Provides smoother transitions – not a sharp boundary

Fuzzy Sets

- Provides a way to write symbolic rules with terms like "medium" but evaluate them in a quantified way
- Classical set theory: An object is either in or not in the set
  - Can't talk about non-sharp distinctions
- Fuzzy sets have a smooth boundary
  - Not completely in or out – somebody 6" is 80% the tall set tall
- Fuzzy set theory
  - An object is in a set is characterized by matter of degree
  - 1.0 => in the set
  - 0.0 => not in the set
  - 0.0 < object < 1.0 => partially in the set

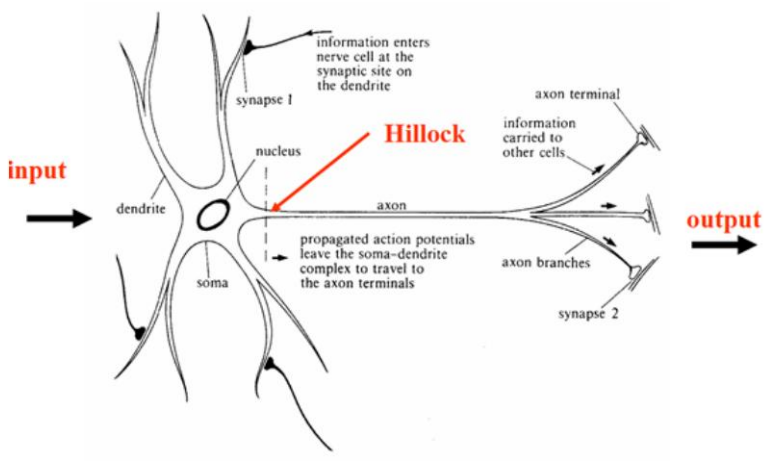
Fuzzy set example



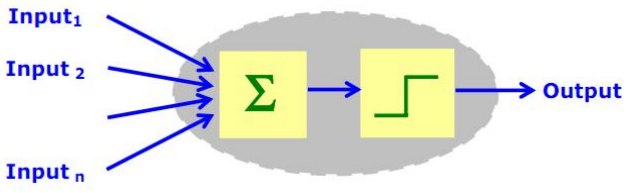
Neural Network (NN)

- Imitation of the natural intelligence of the brain
- Parallel processing with incomplete information
- Nerve cells function about 10^6 times slower than electronic circuit gates, but human brains process visual and auditory information much faster than modern computers

Neuron

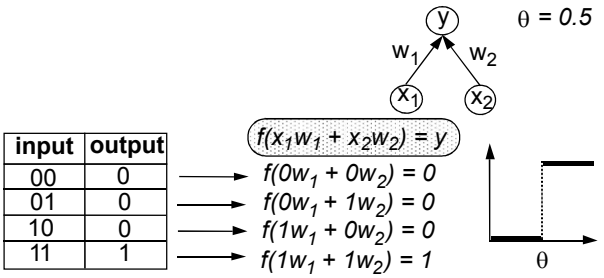

input
dendrite
nucleus
synapse 1
information enters nerve cell at the synaptic site on the dendrite
Hillock
axon terminal
information carried to other cells
axon
output
propagated action potentials leave the soma-dendrite complex to travel to the axon terminals
axon branches
soma
synapse 2

ANN


Input1
Input 2
Input n
Σ
Output

Neural Networks

Example: Logical AND function with NN



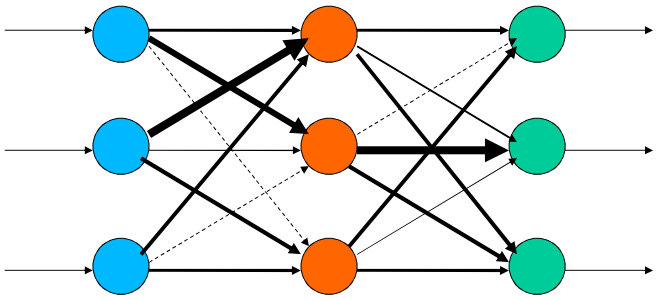
input	output
00	0
01	0
10	0
11	1

$f(0w_1 + 0w_2) = 0$
$f(0w_1 + 1w_2) = 0$
$f(1w_1 + 0w_2) = 0$
$f(1w_1 + 1w_2) = 1$

some possible values for w_1 and w_2

w_1	w_2
0.20	0.35
0.20	0.40
0.25	0.30
0.40	0.20

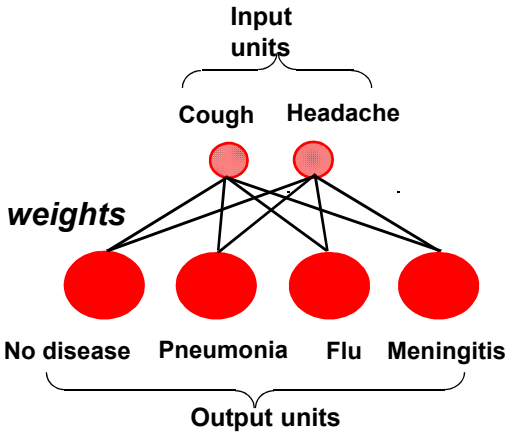
Structure



Inputs | Input layer | Weight Matrix 1 | Hidden layer | Weight Matrix 2 | Output layer | Outputs

Neural Networks

Example: Perceptrons (NN) in Medical Diagnostics



Δ rule
change weights to decrease the error

– what we got
what we wanted
error

Neuron -Fuzzy Systems

- Human brains interpret imprecise and incomplete sensory information provided by perceptive organs
- Fuzzy set theory provides a systematic calculus to deal with such information linguistically
- It performs numerical computation by using linguistic labels stimulated by membership functions
- It lacks the adaptability to deal with changing external environments ==> incorporate NN learning concepts in fuzzy inference systems: NF modeling

Soft Computing

- Human expertise (fuzzy if-then rules)
- Biologically inspired computing models (NN)
- New optimization techniques (GA)

Course Name: Neural Network and Fuzzy Logic
Course Code: ETE703

Academic Year: 2018-19	**Semester/Year: VII / IV**	
On successful completion of this course, students will be able to:		
Course Outcome Code	Co Statement	Bloom's Level
ETE703_1	Train , Calculate and update the weights of the neural networks according to various training rules	Evaluate
ETE703_2	Specify the working and applications of different types of neural networks.	Apply
ETE703_3	Apply neural networks in pattern / character recognition, Function approximation ,classification	Apply
ETE703_4	Design fuzzy sets for various applications and Solve fuzzy set theory problems	Evaluate
ETE703_5	Design fuzzy controller for various engineering applications	Create

Recommended Books:

1. S. Rajsekaran and G. A. Vijaylakshmi Pai, "*Neural Networks, Fuzzy Logic, and Genetic Algorithms*", PHI
2. Simon Haykin, "*Neural Network- A Comprehensive Foundation*", Pearson Education
3. Thimothy J. Ross, "*Fuzzy Logic with Engineering Applications*", Wiley India Publications
4. Laurence Fausett, "*Fundamentals of Neural Networks*", Pearson Education
5. S. N. Sivanandam, S. Sumathi, and S. N. Deepa, "*Introduction to Neural Network Using MATLAB",* Tata McGraw-Hill Publications
6. Bart Kosko, "*Neural networks and Fuzzy Systems"*, Pearson Education

Home Assignment

- **Google CEO Sundar Pichai's I/O 2017 keynote**
- **Google CEO Sundar Pichai's I/O 2018 keynote**