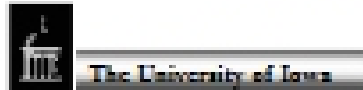


NEURAL NETWORKS

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Contents

- INTRODUCTION
- NEURAL NETWORKS VS OTHER INTELLIGENT APPROACHES
- LEARNING
- BACK-PROPAGATION NEURAL NETWORK
- SELF-LEARNING NEURAL NETWORK
- SUMMARY



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What is Neural Network?



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A collection of neurons



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Basic Applications of Neural Networks:

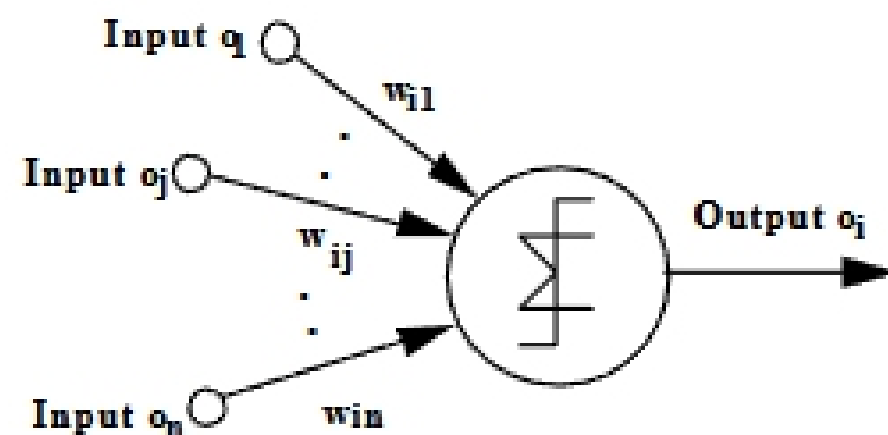
“Pattern recognition-type problems”

- Modern airport ‘X-rays’ equipment
- Adjusting process parameters in process industry
- Forecasting tools, e.g., products, stock market
- Equipment diagnosis



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Artificial Neuron (Unit)



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Regression model analogy

$$a_i = \sum_{j=1}^N w_{ij} o_j$$

where: a_i = the level of activation of neuron i
 w_{ij} = the weight of input j to neuron i
 o_j = the output signal from neuron j
 (the input to the subsequent neurons)

Step-wise transfer (output) function

$$o_i = \begin{cases} 1, & \text{if } a_i > \theta \\ 0, & \text{if } a_i \leq \theta \end{cases}$$

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Transfer Functions

Linear

Step

Sigmoid

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Network Architectures

Completely connected

(a)

Single-layered

(b)

Multi-layered

(c)

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NN Implementation

- Software
- Hardware

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NN Operation Modes

- **Learning**
(Weight acquisition)
- **Decision making**
(Prediction)

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LEARNING

- Direct Implanting of Knowledge
(e.g., memorization)
- Learning by Instruction
(teacher, textbook)
- Learning by Deduction
(e.g., executing the 5! algorithm)

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- **Learning by Analogy**
(deductive and inductive combined,
e.g., modifying a known concept)

- **Learning by Induction**

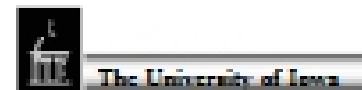
- Learning from Examples (NN)
- Learning by Observation and Discovery



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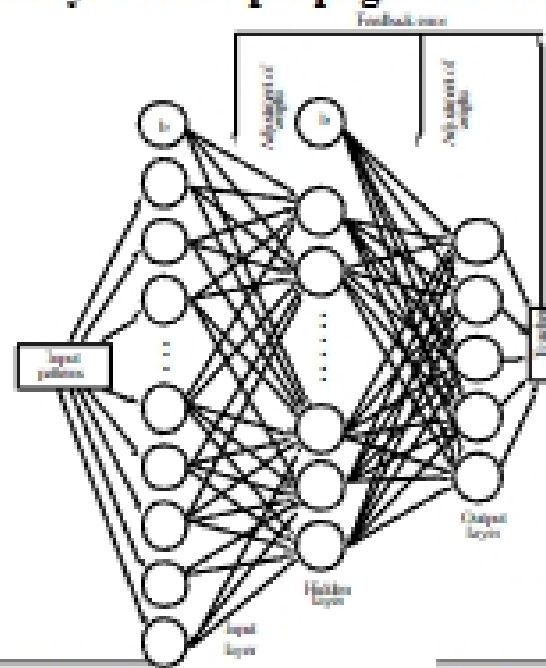
NN Learning

- **Supervised**
- **Unsupervised**



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BACK-PROPAGATION NEURAL NETWORK Three-layer back-propagation neural network



Supervised
learning

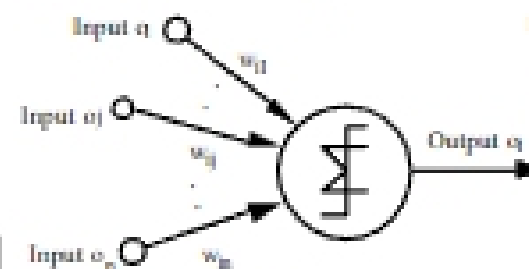


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Back-Propagation Learning (NN Training)

Instance 1

Input 1 x weight
Input 2 x weight = a_1 → Activation function =
Input 3 x weight
= Value computed -
Value measured



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Example: Vacations Back- Propagation Learning

Inputs

Cost
Distance traveled
Entertainment

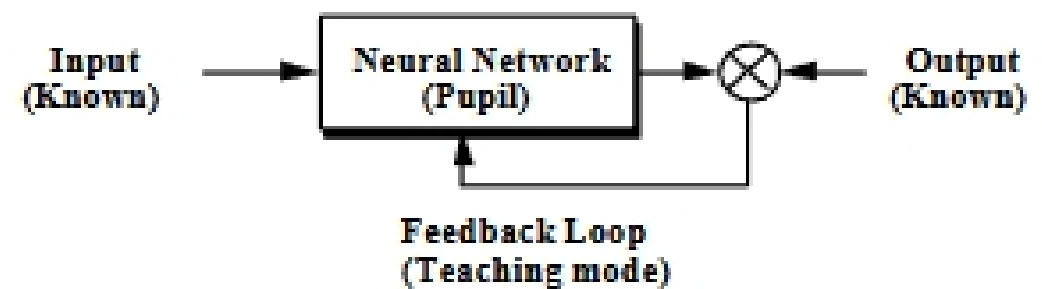
Output

Customer
satisfaction



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Back-Propagation Learning



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