Lesson Plan

Course Title: Neural Network & Fuzzy Logic
Course Code: CSE 451
Level/Term: 4/1
Section: 7E
Credit: 3
Contact Hours: 39
Prerequisite:
Type: Core/Major: Core
Session: Fall 2024

Instructor: Salman Farsi, Lecturer, Department of CSE, Premier University
Class schedule:
Saturday (9.45 am-11.00 am) & Wednesday (11.00 am -12:15 pm)

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Course Objective:
The objectives of this course are:

1. Facilitating necessary knowledge about the design and working principle of Artificial Neural Networks (ANN) and Deep Learning (DL).
2. Teaching the students how the mathematics behind Neural Networks (NN) Learning actually works, rather than presenting only a cursory or surface-level description.
3. Helping the students conceptualize and understand the key parameters in a neural network's architecture and apply them to their own applications.
4. Gaining the basics of different application areas and evaluation of fuzzy logic and fuzzy set theories.

Course Outcomes:

Upon successfully completing this course, students will be able to:

CO1	**Explain(C2)** the design principles and operational mechanisms of Artificial Neural Networks (ANN)
CO2	**Illustrate(C3)** the application of principles and mathematics in training a simple neural network—including loss/cost functions, gradient descent, and computation graphs
CO3	**Explain(C2)** the foundational concepts of fuzzy logic and fuzzy set theories, including key concepts of fuzzy systems such as fuzzy numbers, fuzzy relations, and their composition.
CO4	**Implement (C3)** fuzzy systems with fuzzy rules to represent uncertain knowledge and apply theoretical frameworks for solving practical problems.

Mapping of Course Outcomes to Program Outcomes-

	PO1	PO 2	PO3	PO4	PO 5	PO6	PO 7	PO8	PO9	PO1 0	PO11	PO12
CO1	√	√										
CO2	√	√										
CO3	√	√										
CO4	√	√		√								

Text Books, Reference Books and Other Resources:

1. Dive into Deep Learning – By Amazon Research Scientists.
2. "Make Your Own Neural Network" – By Tariq Rashid
3. "Fundamentals of Deep Learning", O'Reilly – By Nikhil Buduma.
4. "Deep learning" – By Ian Goodfellow and Yoshua Bengio and Aaron Courville.
5. Neural Networks and Deep Learning – By Michael Nielsen.
6. "Fuzzy and Neural Approach in Engineering" – Lefteri H. Tsoukalas, Robert E. Uhrig.

Teaching Strategy: Typical methodologies are Class lectures, web access, self-study, problem formulation, problem solution, Video, Web Link, and student presentation.,

Assessment Strategy: class attendance (10%), assignments/homework (10%), Class tests (20 %), midterm exam (20%), and final exam (40%).

Weekly Lecture Schedule:

No	Topic	Teaching Strategy	CO	Assessment Strategy
01	**A Gentle Introduction to NN:** Differences among AI/ML/DL, Subcategories of ML and their working principle, Biological Vs. Artificial NN	Slides/Books /Notes	CO1	Midterm,
03	**Applications of Neural Network:** An abstract example of NN, Supervised Learning with NN, Popular NN Architectures (ANN, CNN, RNN, Transformers), Reason behind Deep Learning's success	Slides/Books /Notes	CO1	Midterm,
04	**Structural Building Blocks of NN:** Input/Output Layers, Weights and Bias, (non-linearity), Forward Propagation, Concepts of Hidden Layer,	Slides/Books /Notes	CO1	Class Test 01, Midterm,

05	**Single Layer Perceptron (A Simple NN):** Linear Regression, From Linear to Logistic Regression Training set, Input/Output	Slides/Books /Notes	CO1	Midterm,
06	**Multi-Layer NN:** AND, OR, XOR gate Using NN.	Slides/Books /Notes	CO1	Mid-Term
07	**Activation Function:** Linear and Non-Linear Activation Function	Slides/Books /Notes	CO1	Class Test-02, Midterm
08	**Multi-Layer NN:** Vectorized Representation of Multi-Layer NN, Adding Bias as a weight.	Slides/Books /Notes	CO1	Midterm,
09	**How NN's Learns:** Weight Initialization (Random vs. Zero), Expected Vs Predicted Output, Loss and Cost Function, Back-propagation Basics.	Slides/Books /Notes	CO1,	Mid-Term, Final
10	**Loss and Cost Function:** Training/Dev/Test set, Loss function: M.S.E, Convex Vs. Non-convex, Local Vs. Global Optima.	Slides/Books /Notes	CO1 ,CO2	Midterm, Final
11	**Loss and Cost Function** : Log/Cross-Entropy Loss., L1 and L2 M.A.E, Cost Function,	Slides/Books /Notes	CO1, CO2	Midterm, Final
12	**Gradient Descent (G.D):** Finding the Global Optima, Derivatives, Weights and Bias Update, Learning Rate, and Computation Graph.	Slides/Books /Notes	CO1, CO2	Assignment Midterm Final Exam
13	**Midterm Exam**			
14	**Backward Propagation:** Back-prop using Computation Graph, G.D with Backpropagation for LR, G.D with 'M' training examples	Slides/Books /Notes	CO1, CO2	Assignment, Final
15	**Backward Propagation**: G.D Algorithm using Summation, Vectorized G.D, Updating Weights and Bias, Iteration Vs. Batch Vs. Epochs.	Slides/Books /Notes	CO1, CO2	Final
16	**Introduction to Fuzzy Logic:** Fuzzy Set, Fuzzy Set Operations - Union, Intersection, Complement,	Slides/Books /Notes	CO3	Final
18	**Introduction to Fuzzy Logic:** Properties of Fuzzy Set, Extension Principles, Alfa-cuts.	Slides/Books /Notes	CO3	Final
19	**Fuzzy Relations:** Properties, Basic Operations, Compositions of Fuzzy Relations	Slides/Books /Notes	CO3	Final Exam

20	**Fuzzy Relations:** Properties, Basic Operations, Compositions of Fuzzy Relations	Slides/Books /Notes	CO3	Class Test-3, Final Exam
21	**Fuzzy Number:** Representation, Properties, Addition, Subtraction of Discrete and Continuous Fuzzy Number,	Slides/Books /Notes	CO3, CO4	Final Exam
22	**Fuzzy Number:** Addition and Subtraction of Discrete Fuzzy Number through Extension Principle	Slides/Books /Notes	CO3, CO4	Final
23	**Fuzzy Number:** Multiplication and Division of Fuzzy Number.	Slides/Books /Notes	CO3, CO4	Final
24	**Fuzzy Linguistic Description:** Linguistic Variables and Values, Implication Relations, Fuzzy Inference, and Composition.	Slides/Books /Notes	CO3, CO4	Final Exam
25	**Fuzzy Linguistic Description:** Linguistic Variables and Values, Implication Relations, Fuzzy Inference, and Composition.	Slides/Books /Notes	CO3, CO4	Final Exam
26	**Review**			