School of Computer Engineering

Kalinga Institute of Industrial Technology (KIIT)
Deemed to be University
Bhubaneswar-751024

Semester: 5th
Session: Autumn 2024

Course Plan

Course Code : CS 30011
Course Title : Computational Intelligence
LTP Structure :

L	T	P	Total	Credit
3	0	0	3	3

Instructor:

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Course Objective

This is an elective course, open to 3rd year B.Tech (CS, CSCE, and IT) students. Computational Intelligence (Soft Computing) is a new concept for advanced information processing. The objective of Computational Intelligence approaches is to introduce a new approach for analyzing and creating flexible information processing of humans such as sensing, understanding, learning, recognizing, and thinking. Our aim is to realize three main methodologies of Computational Intelligence and their hybridization in the first few classes. Following this, we discuss in details the three methodologies which are biologically and linguistically motivated computational paradigms such as Neural Networks, Fuzzy Systems, Evolutionary Computation and Hybrid Neuro-Fuzzy Models. Finally, students will be acquainted with designing intelligent systems and provide them with a working knowledge for building these systems.

Course Outcomes

CO1:	Identify the basic concepts and characteristics of soft computing and its associated methodologies.
CO2:	Assess concepts of artificial neural networks and apply neural networks to various classification problems.
CO3:	Apply various set theoretic operations in fuzzy sets.
CO4:	Analyze fuzzy rules, fuzzy reasoning and various fuzzy and neuro-fuzzy inference systems.
CO5:	Understand derivative free optimization and apply genetic algorithms to optimization problems.
CO6:	Apply and evaluate swarm-based optimization techniques in real-world problem solving.

Course Contents

Topics	No. of lectures	Course Outcome
Introduction to Soft Computing and Neuro-Fuzzy System Introduction to Concept of computing "Soft" computing versus "Hard" computing Conventional AI Constituents of Soft Computing Neuro-Fuzzy Systems	3 (1-3)	CO1
Artificial Neural Networks (ANN) Introduction to ANN Adaline and Madaline Learning algorithms Perceptron Multilayer Perceptron (MLP) and Backpropagation (BP) algorithm Radial Basis Function Networks (RBF)	15 (4 -18)	CO2
Fuzzy Set Theory Fuzzy sets, Basic Definition and Terminology Member Function Formulation and Parameterization Set-theoretic Operations and Fuzzy sets operations (Union, Intersection and Complement)	6 (19 - 24)	CO3
Fuzzy Rules, Fuzzy Reasoning and Fuzzy Inference Systems Extension Principle and Fuzzy Relations Fuzzy If-Then Rules and Fuzzy Reasoning ~~Fuzzy Inference Systems: Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models~~ ~~Adaptive Neuro Fuzzy Inference Systems (ANFIS)~~	7 (25 - 31)	CO4
Optimization Derivative-based Optimization and Derivative-free Optimization Genetic Algorithms (GA) ~~Differential Evolution (DE)~~	3 (32 - 34)	CO5
Swarm Intelligence Particle Swarm Optimization ~~Ant Colony Optimization~~ ~~Artificial Bee Colony Optimization~~	5 (35 - 39)	CO6

Day-wise Lesson Plan

Week	Lecture No.	Topics
Week - 1	1	Introduction to Soft Computing, Techniques, Applications, Advantages, Disadvantages
	2	Constituents of Soft Computing
	3	Neuro-Fuzzy Systems
Week - 2	4	Introduction to Artificial Neural Networks, Biological Model Vs Mathematical Model
	5	ANN architecture, ANN Building Blocks
	6	Adaline and Madaline
Activity - 1		
Week – 3	7	Supervised vs Unsupervised Learning, Gradient descent method
	8	McCulloch Pitts Model, Modelling logic gates, limitations
	9	Linear separability, Single Layer Perceptron, Learning Rule & Model
Week - 4	10	Multilayer Perceptron and its applications in real world
	11	Back propagation Algorithm - 1
	12	Back propagation Algorithm - 2

Activity - 2		
Week - 5	13	Factors affecting back propagation training, Advantages and Disadvantages
	14	Introduction to Radial Basis Function Networks (RBFN)
	15	RBFN Learning Algorithms
Week - 6	16	XOR – Problem Solving using RBFN
	17	Problem solving on real world applications
	18	Basics of third-generation neural networks
Activity - 3		
Mid-Semester Examination		
Week - 7	19	Crisp and Fuzzy sets
	20	Basic Definition and Terminology
	21	Member Functions Formulation and Parameterization - 1
Week - 8	22	Member Functions Formulation and Parameterization - 2
	23	Set-theoretic operations and Fussy sets operations
	24	Fuzzy sets operations, T-norm and T-conorm
Activity - 4		
Week - 9	25	Extension Principle and Fuzzy Relations
	26	Fuzzy systems-quantifiers, fuzzy inference
	27	Fuzzy If-Then Rules
Week - 10	28	Fuzzy Reasoning
	29	~~Fuzzy Inference Systems: Mamdani Fuzzy Models~~
	30	~~Sugeno Fuzzy Models, Tsukamoto Fuzzy Models~~
Activity - 5		
Week - 11	31	~~Adaptive Neuro Fuzzy Inference Systems (ANFIS) architecture~~
	32	Derivative-based Optimization and Derivative-free Optimization
	33	Concept of Genetic Algorithms (GA), GA Operators
Week - 12	34	~~Differential Evolution (DE) as modified GA, Problem solving~~
	35	Swarm Intelligence concept, examples, applications
	36	Particle Swarm Optimization (PSO) model, velocity and position update equations, problem solving
Week - 13	37	~~PSO variants, Binary PSO~~
	38	~~Ant Colony Optimization concepts and applications~~
	39	~~Artificial Bee Colony Optimization concepts and applications~~
Activity - 6		
End-Semester Examination		

Text books:

1. Neuro-Fuzzy and Soft Computing, Jang, Sun, Mizutani, PHI/Pearson Education

Reference books:

1. Neural Network Design, M. T. Hagan, H. B. Demuth, Mark Beale, Thomson Learning, Vikash Publishing House
2. Genetic Algorithms: Search, Optimization and Machine Learning, Davis E. Goldberg, Addison Wesley, N.Y., 1989
3. Swarm Intelligence Algorithms: A Tutorial, Adam Slowik, Ed: CRC Press, 2020
4. Introduction to Soft Computing, Roy and Chakraborty, Pearson Education
5. Fuzzy Logic with Engineering Applications, Timothy J. Ross, McGraw-Hill, 1997
6. Neural Networks: A Comprehensive Foundation, Simon Haykin, Prentice Hall
7. Neural Networks, Fuzzy Logic and Genetic Algorithms, S. Rajasekaran and G.A.V. Pai, PHI, 2003

Assessment plan for activity-based teaching

Considering the guidelines circulated and after discussing with the faculty members, following activity-based teaching and learning is proposed to have the uniformity of subject delivery in all sections.

Sr #	Assessment Component	Time	Weightage/ Marks	Schedule

1	Mid-Semester Examination	1.5 Hours	20	Refer Details in Student Handbook
2	Activity based Teaching and Learning: Quiz, Assignment, Class Test, Viva, and/or Mini-project	Based on activities	30	Throughout semester
3	End-Semester Examination	2.5 Hours	50	Refer Details in Student Handbook

Activity Calendar

Activity no	Type	Tentative date	Marks
1	Assignment	29/07/2024 – 02/08/2024	5
2	Quiz / Class Test	19/08/2024 – 23/08/2024	5
3	Viva / Classroom evaluation	02/09/2024 – 06/09/2024	5
4	Mini project	21/10/2024 – 25/10/2024	10
5	Quiz / Class test	11/11/2024 – 15/11/2024	5

There will be a minimum of 5 short activities (quizzes/assignments/class test/viva/mini project) over the semester, at the end of every unit. The faculty may decide to change the sequence / type / marks of activities based on the coverage and academic requirements.
