BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
WORK INTEGRATED LEARNING PROGRAMMES
Digital Learning
Part A: Content Design

Course Title	**Artificial and Computational Intelligence**
Course No(s)	
Credit Units	**5**
Credit Model	**1 - 0.5 - 1.5** **1 unit for class room hours, 0.5 unit for Tutorial, 1.5 units for student preparation.** **1 unit = 32 hours**
Course Authors	**S.P.Vimal**
Version No	**1.1**
Date	**Oct 01, 2019**

Course Objectives

No	Course Objective
CO1	To provide solid foundation for designing intelligent agents
CO2	Learn the representation and use of knowledge in inference-based problem solving approaches
CO3	Learn to apply probability theory to describe and model agents operating in uncertain environments
CO4	Learn the optimization models of computation and processing in real world application of intelligent agents

Text Book(s)

T1	Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Third Ed, Pearson Education, 2010

Reference Book(s) & other resources

R1	Ryszard S. Michalski, Jaime G. Carbonell and Tom M. Mitchell, "Machine Learning: An Artificial Intelligence Approach", Elsevier, 2014
R2	Dan W Patterson, "Introduction to AI and Expert Systems", Prentice Hall of India, New Delhi, 2010
R3	Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill Publishing Company, New Delhi, 2003

Modular Content Structure

0. Introduction
    a. Defining Artificial Intelligence?, Foundations of AI, OVerview of Modern AI & Application Domains.
1. Introduction to Intelligent Agents : Notion of agents and environments, Task Environments: Elements, examples, properties with examples, Structure of Agents
2. Problem Solving Agent using Search:
    a. Uninformed Search : Problem Formulation, Algorithms: BFS, Uniform cost Search, DFS, Depth Limited Search, Iterative Deepening Search, Bidirectional Search, Comparisons.
    b. Uninformed Search : Notion of Heuristics, Greedy best first search, A* search , Optimality of A* , Memory Bounded Heuristic Search
    c. Heuristic Functions: Heuristic Accuracy & Algorithm performance Admissible heuristics from relaxed problems, pattern databases & Experience
    d. Local Search Algorithms & Optimization Problems: Hill Climbing Search, Simulated Annealing,Local Beam Search, Genetic Algorithm
    e. Searching with Non-Deterministic Actions, Partial Information and Online search agents
3. Game Playing, Constraint Satisfaction Problem:
    a. Searching to play games : Minimax Algorithm, Alpha-Beta Pruning, Making imperfect real time decisions
    b. Constraint Satisfaction Problem: Formulating a CSP problem, Constraint propagation, Sudoku as CSP and constraint propagation, Local search for CSP (Using 8- queens problem), Applications
4. Knowledge Representation using Logics:
    a. Concepts, logic Representation of a sample agent, TT-Entail for inference from truth table, Propositional theorem proving - Proof by resolution, Forward Chaining and Backward Chaining, DPLL Algorithm, Agents based on Propositional logic,
    b. Overview of FOL semantics, Example representation, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution
5. Probabilistic Representation and Reasoning
    a. Inference using full joint distribution & Example, Knowledge representation using Bayesian Networks, semantics of Bayesian Networks, Representation of Conditional Independence using BN, Exact Inference - by enumeration and variable elimination, Need for Approximate Inference - direct Sampling
6. Reasoning over time, Reinforcement Learning
    a. Time and Uncertainty, Inference in temporal models, Overview of HMM,
    b. Reinforcement Learning: an Introduction, Q-Learning algorithm and applications, Applications of reinforcement learning to games
7. AI Trends and Applications, Philosophical foundations

Learning Outcomes:

No	Learning Outcomes
LO1	Understand the environment and process of development to build intelligent agents
LO2	Identify heuristics to pursue goals in exponentially large search spaces.
LO3	Represent problem and derive reasoning using logical inferences
LO4	Apply probability theory to describe and model agents operating in uncertain environments
LO5	Analyse ways to supervise agents to learn and improve their behaviour.

Part B: Course Handout

Academic Term	Second Semester, 2018-19
Course Title	**Artificial and Computational Intelligence**
Course No	
Lead Instructor	S.P.Vimal

Session #	List of Topic Title (from content structure in Part A)	References
1	(1) What is Artificial Intelligence? : Acting Humanly, Thinking humanly, Thinking rationally, Acting Rationally (2) Foundations of AI (3) Brief OVerview of Modern AI & Application Domains.	T1: 1.1 T1: 1.2, 1.4
2	(1) Intelligent Agents : Notion of agents and environments, rational agents, Omniscience vs. Rationality (2) Task Environments, Structure of Agents	T1: Chapter 2
3	Problem Solving Agent using Uninformed Search : (1) Problem Formulation - Examples (2) Algorithms: BFS, Uniform cost Search, DFS, Depth Limited Search, Iterative Deepening Search, Bidirectional Search, Comparisons.	T1: Chapter 3.1-3.4

4	Problem Solving Agent using Uninformed Search : (1) Notion of Heuristics (2) Greedy best first search, A* search , Optimality of A* , Memory Bounded Heuristic Search	T1: Chapter 3.5
5	Heuristic Functions: (1) Heuristic Accuracy & Algorithm performance (2) Admissible heuristics from relaxed problems, pattern databases. & Experience	T1: Chapter 3.6
6	Local Search Algorithms & Optimization Problems (1) Hill Climbing Search, Simulated Annealing,Local Beam Search, Genetic Algorithm	T1: Chapter 4.1, 4.2
7	Searching to play games : Minimax Algorithm, Alpha-Beta Pruning, Making imperfect real time decisions	T1: Chapter 5.1 to 5.4
8	Constraint Satisfaction Problem: (1) Formulating a CSP problem (2) Constraint propagation (3) Sudoku as CSP and constraint propagation to solve (4) Local search for CSP (Using 8- queens problem) (5) Applications	T1: Chapter 6.1, 6.2, 6.4
9	Logical Agent: (1) Concepts, logic Representation of a sample agent, TT-Entail for inference from truth table (2) Propositional theorem proving - Proof by resolution (3) Forward Chaining and Backward Chaining	T1: Chapter 7.1 - 7.5
10	(1) DPLL Algorithm (2) Agents based on Propositional logic (3) Overview of FOL semantics, Example representation	T1: Chapter 7.6, 7.7, 8.1
11	Inference in FOL (1) Unification & Lifting (2) Forward chaining (3) Backward Chaining (4) Resolution	T1: Chapter 9

12	Probabilistic Representation and Reasoning (1) Inference using full joint distribution & Example (2) Knowledge representation using Bayesian Networks, semantics of Bayesian Networks	T1: 13 T1: 14.1, 14.2
13	(1) Representation of Conditional Independence using BN (2) Exact Inference - by enumeration and variable elimination (3) Need for Approximate Inference - direct Sampling	T1: Chapter 14.3, 14.4
14-15	Reasoning over time (1) Time and Uncertainty (2) Inference in temporal models (3) Overview of HMM, (4) Learning HMM Parameters using EM Algorithm (5) Applications of HMM	T1: Chapter 15.1, 15.2, 15.3
16	Reinforcement Learning (1) Introduction (2) Q-Learning algorithm and applications (3) Applications of reinforcement learning to games	T1: chapter 21.1, 21.3

Detailed Plan for Lab work/Design work

Lab No	Lab Objective	Lab Sheet Access URL	Content Reference
1	Implementing Uninformed Search Algorithms	NA	Module #2
2	Implementing Informed Search Techniques	NA	Module #2
3	Implementing Local Search Techniques	NA	Module #2
4	Implementing adversarial search techniques & CSP	NA	Module #3
5	Representing knowledge using logics and performing reasoning	NA	Module #4
6	Experimenting with Bayesian Networks and Inferencing	NA	Module #5
7	Experimenting with with HMM	NA	Module #6
8	Implementing reinforcement learning	NA	Module #7

Case studies: Detailed Plan

Case study No	Case study Objective	Case study Sheet Access URL
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Evaluation Scheme:
Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

No	Name	Type	Duration	Weight	Day, Date, Session, Time
EC-1	Quiz-I	Online	-	5%	TBA
	Assignment -1	Take-Home	-	13%	TBA
	Assignment -2	Take-Home	-	12%	TBA
EC-2	Mid-Semester Test	Closed Book	1.5 hours	30%	TBA
EC-3	Comprehensive Exam	Open Book	2.5 hours	40%	TBA

Note:

Syllabus for Mid-Semester Test (Closed Book): Topics in Contact Sessions : 1 to 8 (or) 1 to 5
Syllabus for Comprehensive Exam (Open Book): All topics

Important links and information:
Elearn portal: https://elearn.bits-pilani.ac.in
Students are expected to visit the Elearn portal on a regular basis and stay up to date with the latest announcements and deadlines.
Contact sessions: Students should attend the online lectures as per the schedule provided on the Elearn portal.
Evaluation Guidelines:

1. EC-1 consists of two Assignments and one Quiz. Students will attempt them through the course pages on the Elearn portal. Announcements will be made on the portal, in a timely manner.
2. For Closed Book tests: No books or reference material of any kind will be permitted.
3. For Open Book exams: Use of books and any printed / written reference material (filed or bound) is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
4. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam which will be made available on the Elearn portal. The Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self study schedule

as given in the course handout, attend the online lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.