



# ARTIFICIAL INTELLIGENCE: KNOWLEDGE REPRESENTATION AND REASONING

**PROF. DEEPAK KHEMANI**

Department of Computer Science and Engineering  
IIT Madras

**TYPE OF COURSE** : Rerun | Elective | UG/PG

**COURSE DURATION** : 12 weeks (18 Jan' 21 - 9 Apr' 21)

**EXAM DATE** : 24 Apr 2021

**PRE-REQUISITES** : Some exposure to formal languages, logic and programming

**INTENDED AUDIENCE** : BE/ME/MS/MSc/PhD students

**INDUSTRIES APPLICABLE TO** : Software companies dealing with knowledge and reasoning, including the semantic web and semantic search

**COURSE OUTLINE :**

An intelligent agent needs to be able to solve problems in its world. The ability to create representations of the domain of interest and reason with these representations is a key to intelligence. In this course we explore a variety of representation formalisms and the associated algorithms for reasoning. We start with a simple language of propositions, and move on to first order logic, and then to representations for reasoning about action, change, situations, and about other agents in incomplete information situations. This course is a companion to the course Artificial Intelligence: Search Methods for Problem Solving that was offered recently and the lectures for which are available online.

**ABOUT INSTRUCTOR :**

Deepak Khemani is Professor at Department of Computer Science and Engineering, IIT Madras. He completed his B.Tech. (1980) in Mechanical Engineering, and M.Tech. (1983) and PhD. (1989) in Computer Science from IIT Bombay, and has been with IIT Madras since then. In between he spent a year at Tata Research Development and Design Centre, Pune and another at IIT, Mandi. He has had shorter stays at several Computing departments in Europe. Prof Khemani's long-term goals are to build articulate problem solving systems using AI that can interact with human beings. His research interests include Memory Based Reasoning, Knowledge Representation and Reasoning, Planning and Constraint Satisfaction, Qualitative Reasoning and Natural Language Processing.

**COURSE PLAN :**

**Week 1:** Introduction, Propositional Logic, Syntax and Semantics

**Week 2:** Proof Systems, Natural Deduction, Tableau Method, Resolution Method

**Week 3:** First Order Logic (FOL), Syntax and Semantics, Unification, Forward Chaining

**Week 4:** The Rete Algorithm, Rete example, Programming Rule Based Systems

**Week 5:** Representation in FOL, Categories and Properties, Reification, Event Calculus

**Week 6:** Deductive Retrieval, Backward Chaining, Logic Programming with Prolog

**Week 7:** Resolution Refutation in FOL, FOL with Equality, Complexity of Theorem Proving

**Week 8:** Description Logic (DL), Structure Matching, Classification

**Week 9:** Extensions of DL, The ALC Language, Inheritance in Taxonomies

**Week 10:** Default Reasoning, Circumscription, The Event Calculus Revisited

**Week 11:** Default Logic, Autoepistemic Logic, Epistemic Logic, Multi Agent Scenarios

**Week 12:**

Optional Topics A: Conceptual Dependency (CD) Theory, Understanding Natural Language

Optional Topics B: Semantic Nets, Frames, Scripts, Goals and Plans