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| 1 | Introduction to AI. Description of basic concepts, attributes of artificial intelligence. Explanation of Turing Test and description of an approach taken in this class. Specifically, the emphasis is on state space search methods.<br>Representation issues: discussion of how the choice of representation affects the solution methods and their efficiency. Traffic intersection design problem to illustrate graph based representation, graph coloring algorithm: greedy approach. Control strategy.<br>Introduction to the concept of AI Production System and its elements: Data Base, Operators, and Control Strategy. | |
| 2 | Problem solving: definition of problem spaces and state space search. Formal definition of the AI Production System and example of several instances: the 8-puzzle: problem representation, operators and expansion of the search tree.<br>The travelling salesman problem: problem formulation, optimal and greedy approach, trade-offs between optimality vs. efficiency.<br>The water-jug problem: systematic expansion of search space.<br>Control strategies: definition and explanation of its importance in problem solving.<br>Desired charactertistics of control strategies: ensuring the progression through the state space, systematic state expansion, and efficiency of the strategy. | |
| 3 | Classification of control strategies into irrevocable and tentative (backtracking and graph search).<br>Examples of backtracking and explanation of the graph search abstraction.<br>Heuristic search: revisiting all the examples from Lecture 2. | |
| 4 | Demonstration of efficiency of search using heuristics. Problem set: 4-queens example with two heuristics: index based rule ordering and diagonal measure. Illustration of the recursive procedure backtrack with several steps of the algorithm.<br>Introduction to the graph search abstraction. Initial discussion of the algorithm and explicit vs. implicit graph expansion. | |
| 5 | Basic problem solving methods: forward and backward reasoning. Classification of search methods and specific distinctions between the modes of search.<br>Problem trees and tree search: any path and optimal path search. Examples include: depth first, breath first search, hill climbing.<br>Search continued: branch-and-bound (B&B), B&B with underestimates, dynamic programming principle. | |
| 6 | A* search and its fundamental properties, including optimality | |

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| | criteria. Discussion of monotonicy restrictions. Examples, including optimal, collision free path planning Game trees: min-max problems, searching game trees, examples of two-player games.<br>Alpha-beta pruning: principles and operational concepts with examples of "winning" strategies.<br>Analysis of optimality and efficiency of alpha beta pruning in two player games.<br>Demonstration of several examples and applications. | |
| 7 | Decision problems and motivation for representation as an AND/OR Graph search.<br>Discussion hypergraphs as the basis for the algorithm. Ilustration of how subgraphs and subgraph costs are calculated.<br>Detailed analysis of the AND/OR graph search algorithm with it's underlying h(n) monotonic heuristic.<br>AO* algorithm: principle of operation and examples. application to decision problems, and an analysis of an assembly problem. | |
| 8 | Knowledge representation techniques: structured and unstructured Semantic net concept leading to object models, behavioral models, and functional models.<br>Introduction of object modeling and unified modeling language (UML). Design paradigms using UML.<br>A brief demonstration of the unified modeling language concepts, with an emphasis on object modeling as the basis for object oriented design.<br>Sample design process for the automated teller machine (ATM).<br>Behavioral model specifications using state charts.2 | |
| 9 | Introduction to predicate logic: basic concepts and definitions.<br>Well formed formulas.<br>Sound rules of reasoning: modus ponens, modus tolens, resolution principle.<br>Automatic theorem proving through refutation using resolution principle. Demonstration of the process using several examples. | |
| 11 | Procedure for transformation of well formed formulas to normal disjunctive forms.<br>Procedure for finding the most general unifier (mgu).<br>Examples and analogies to the AI Production System.<br>Strategies for resolving clauses: breadth first, linear input, set of support.<br>Discussion of completness and efficiency of each method. | |
| 12 | The blocks world abstration as the basis for robotic planning. | |

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| | Definition of the state space using first order predicate logic.<br>Introdution of the task orientied robot planning language and its basic opertations.<br><br>Demonstration of basic simulation concepts. | |
| 13 | Analogy to the AI Production System and its state, operator, and control strategy components<br>Robot planning concepts: logic based state representation, operators and search for plan, including plan representation:<br>The triangle table and its plan representation.<br>Forward and backward planning (including regression) | |
| 14<br><br><br>15 | Introduction to selected advanced topics<br>Applications to minimally invasive computer-guided surgery<br><br>Summary and review of all concepts prior to the final examination. | |