AI End-Sems

- AI Slide 1 : Intro
- Mid 1 Additional Material
- Chapter 2: Intelligent Agents
- Chapter 3: Searching till 3.6.1
- Chapter 5: Adversarial Search till 5.4
- Adversarial Search Slides
- Chapter 13: Quantifying Uncertainty till end of 13.5
- Chapter 17: Complex Decisions, 17.2, 17.4-17.4.1
- Lecture 11 Slides
- Lecture 13 Slides
- Chapter 4 (Beyond Classical Search) - Sections 4.1, 4.2 and 4.4
- Chapter 14 (Probabilistic Reasoning) - Till end of section 14.2.2
- Chapter 6 (Constraint Satisfaction Problems) - Till end of section 6.4
- End Semester Slides

Intro Slide

- **Cognition :** Set of mental abilities and processes related to knowledge.
- **Turing Test :** Checks if a machine can pass itself as human.
- **Rational Agent :** Best, not most human.
- **Control Theory :** Self regulating AI to minimise error.
- **GPS :** General Problem Solver, first to implement human like thinking.
- **Shakey Robotics Project :** A* Search, Hough Transform, Visibility Graph Method.
- **SOAR -** Whole Agent
  Emphasis on data over algorithms.
  Learning methods gained prominence.
  Goal to handle full range capabilities of an intelligent system.
  Set of rules and learning techniques used.

- **Definition Terms:**
- Agent - Diagram
- Percept
- Percept Sequence
- Sensors and Actuators
- Agent Function and Agent Program
- Agent Architecture
- Rational Agent - Diagram
- Performance Measure - environment definition, not agent definition
- 4 things Rationality Depends on :
  - *Performance Measure*
  - *Knowledge of environment*
  - *Actions agent can perform*
  - *Percept sequence*
- *For each possible percept sequence, a rational agent should select an action that is expected to maximise its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has.* - ***Definition of Rational Agent from Book***
- Omniscience
- Information Gathering
- Exploration
- Learning
- Autonomy

- **Task Environment — PEAS :: Properties**
  - *Fully Observable vs Partially Observable*
  - *Single Agent vs Multi Agent (Competitive vs Cooperative)*
  - *Deterministic vs Stochastic*
  - *Episodic vs Sequential*
  - *Static vs Dynamic*
  - *Discrete vs Continuous*
  - *Known vs Unknown*
  - **Uncertain Environment -** Partially Observable and Stochastic
  - **Indeterministic Environment -** Actions characterised by *possible* outcomes, not probabilities.
  - **Semi-dynamic Environment -** Agent's performance score changes environment.

- **Agent Structure**
  - Agent Architecture, Agent Function vs Agent Program
  - **Simple Reflex based agents - Diagram**
  - Condition Action Rule
  - **Model based Reflex Agents - Diagram**
  - **Goal based Agents - Diagram**
  - **Utility based Agents - Diagram**
  - Utility
  - Utility Function
  - Expected Utility
  - **Learning Agents - Diagram**
  - Learning Element
  - Performance Element
  - Problem Generator
  - Critic
  - **Components of Agent Program**
    - Atomic Representation
    - Factored Representation — (*Variable, Attribute, Value*)
    - Structured Representation
    - *Expressiveness Axis*

- **Problem Solving Agents -** Goal based with Atomic Representation.
- Planning Agents
- Goal Formation
- **Problem Formulation -** Deciding what actions to take given a goal.
- Search - Solution - Execution
- Open Loop Systems
- **Problem:**
  - States
  - Initial State
  - Possible Actions.
  - Transition Model (*What each action does)*
  - Goal Test
  - Path Cost
- **State Space** of a Problem - States + Actions + Transition
- Optimal Solution
- Incremental Formulation vs Complete Formulation
- Search Tree

- Expanding
- Frontier
- Redundant Path, Loopy Path
- Tree Search

- **Measuring Problem Solving Performance**
  - Completeness
  - Optimality
  - Time Complexity
  - Space Complexity

- Branching Factor
- Depth
- Search Cost
- Path Cost

- **Uninformed Search Strategy :**
  - BFS
  - Uniform Cost Search (Dijkstra) — Time Complexity
  - DFS
  - Depth Limited Search
  - Iterative Deepening Search
  - Bidirectional Search
  -

Criterion	Breadth-First	Uniform-Cost	Depth-First	Depth-Limited	Iterative Deepening	Bidirectional (if applicable)
Complete?	Yes[a]	Yes[a,b]	No	No	Yes[a]	Yes[a,d]
Time	$O(b^d)$	$O(b^{1+\lfloor C^*/\epsilon \rfloor})$	$O(b^m)$	$O(b^\ell)$	$O(b^d)$	$O(b^{d/2})$
Space	$O(b^d)$	$O(b^{1+\lfloor C^*/\epsilon \rfloor})$	$O(bm)$	$O(b\ell)$	$O(bd)$	$O(b^{d/2})$
Optimal?	Yes[c]	Yes	No	No	Yes[c]	Yes[c,d]

- **Informed Search Strategies :**
  - **Best First Search — Greedy**
    - Heuristic Function
    - Straight Line Distance
  - **A* Best First Search**
    - *Conditions for Optimality :*
      Admissible Heuristic — *Never Overestimates cost to reach the goal.*
      Consistency (*for graph search)* — Triangularity Rule for

heuristic cost.
    - Proof for Optimality.
    - Absolute and Relative Error
- **IDA***
- **Recursive Best First Search**
- **Simplified Memory Bound A***
  Condition for Completeness

5.1 - 5.4

- **Adversarial Search** problems are where agents' goals are conflicted. Called games.
- **Zero Sum** games have utility values at the end of game adding to 0.
- **Pruning** allows ignoring portions of search tree that make no difference.
- **Utility Function** defines the final numeric value for a game that ends in terminal state s for a player p
- Initial State, Players, Actions, Result, Terminal State.
- **Ply:** half moves.
- Minimax, time+space Complexity.
- Alpha Beta pruning, complexities.
- Killer move - best move.
- **Transposition Table :** A hash table of previously reached positions.
- Evaluation Function.
- Cutoff Test.
- Features, Expected Value, Material Value, Weighted Linear Function.
- Quiescence, Quiescence search.
- Horizon effect, Singular Extension.
- Forward pruning, beam search, Prob cut.
- Lookup
- Policy
- Retrograde

13.1 - 13.5

- Belief state, it's 3 problems.
- Qualification Problem.

- Laziness, Theoretical Ignorance, Practical Ignorance.
- Degree of belief and Probability Theory.
- Preference, Utility theory and outcome.
- **Decision Theory** = Probability Theory + Utility Theory, **MEU**
- Notations of probability theory.
  Sample space, model, proposition, unconditional, evidence, conditional(*posterior*), probability distribution, density function, (full) joint probability distribution, inclusion exclusion principle, Kolmogrov's Axioms
- Di Finetti's proof.
- Probabilistic inference.
- Marginal Probability
- Marginalisation and Conditioning.
- Normalisation
- Independence
- Bayes' Rule
- Conditional Independence

Slide 11

- Risk Aversion
- Markov Decision Process
  <S,A,P,R>
- Assumption of MDP
- Decision Epoch
- Transition Model
- Absorbing State
- Reward Function (Dependency on S, A , J)
- Policy
- Stationary vs Non-Stationary
- Deterministic vs Randomised

17.1-17.2

- Markovian
- Environment History and it's use
- a sequential decision problem for a fully observable, stochastic environment with a Markovian transition model and additive rewards is called a **Markov decision process**.
- Policy and optimal policy.
- Additive and Discounted Reward, Discount factor

- Proper Policy
- Average Reward
- Utility Function Calculation
- **Value Iteration**
- Bellman Equation
- Bellman Update
- **Proof of Contraction**
- Max Norm
- Number of iterations as a function of gamma.

Slide 13

- Linear/Mathematical Programming
- Structure of an LP Model
- Popular Form of LP
- Constrained MDP
- Multi Agent MDP
- Dec-MDP

Chapter 4

- Hill-Climbing Search
- Sideway Move Hill Climb
- Stochastic Hill Climb
- First-Choice Hill Climb
- Random Restart Hill Climb
- Simulated Annealing
- Local Beam Search
- Stochastic Beam Search
- Genetic Algorithm

- Line Search
- Newton-Raphson Method
- Hessian Matrix

- Environment with no observation
- Cercion
- Incremental Belief State Search
- Prediction - Observation - Updation

Endsem Slides

- POMDP Basics
- no. of POMDP Trees = A^[O^T - 1 / O - 1]
- POMDP b`(s`) derivation

Chapter 6

- CSP definition
- Dual Graph Method
- Contraint Propagation
- Node Consistency
- Arc Consistency
- AC-3 Algorithm
- Generalised Arc Consistency
- Path Consistency
- K-Consistency
- Strongly K-Consistent
- Global Constraint
- Resource Constraint
- Backtracking Search
- Minimum Remaining Values Heuristic
- Degree Heuristic
- Least Constraining Heuristic
- Forward Checking
- MAC : Maintaining Arc Consistency
- Conflict Set and Back-jumping
- Conflict Directed Back-jumping and Constraint Learning
- Minimum Conflicts Heuristic
- Local Search
- Constraint Weighting

Chapter 14

- Bayesian Net Structure
- Creating Bayesian Nets
- Markov Blanket
- Descendants