Artificial Intelligence

Final Review
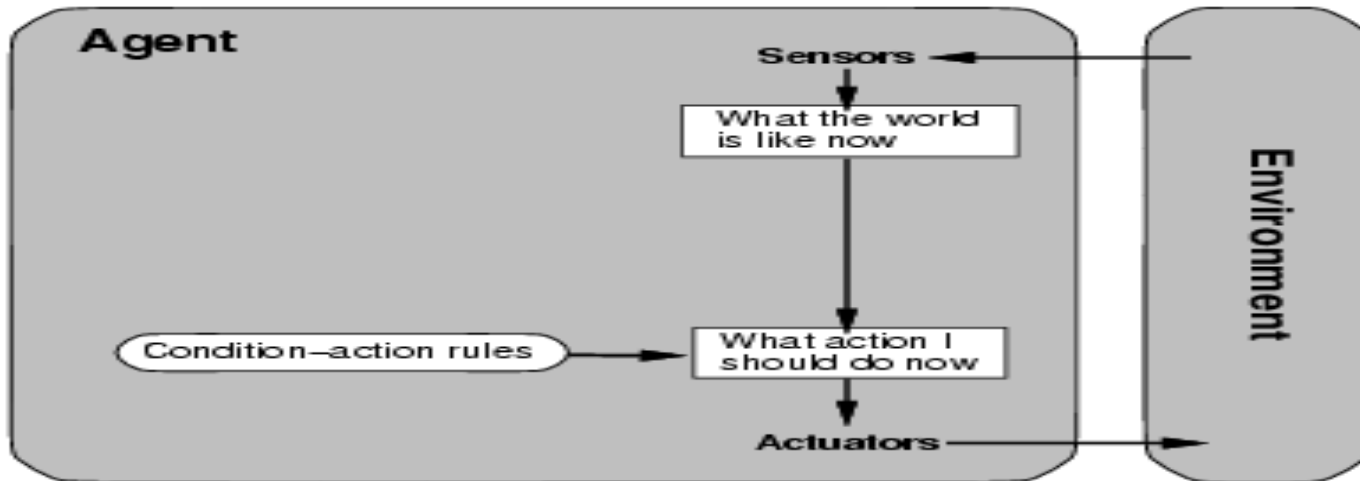
Introduction

- What is AI?

Think Humanly	Think Rationally
Acting Humanly	Acting Rationally

Intelligent Agent

- Performance Measure
- Environment
- Actuators
- Sensors

Problem Solving Agent -- Searching

- Problem Definition
  - Initial State
  - Successor Function
  - Goal Test
  - Path Cost Function
- Solution: A path from initial state to the goal state in the state-space graph

Problem Solving Agent (II)

- Uninformed Search Strategies
  - Breadth-first
  - Depth-first
  - Depth-limited
  - Iterative deepening depth-first
  - Uniform Cost (Shortest Path)

Problem Solving Agent (III)

- Informed Search
  - Heuristic Function: estimated cost of the cheapest path from node n to a goal node.
    - Admissible heuristics: never overestimate
    - How to get an admissible heuristics? The solution of a relaxed problem could be the heuristics of the original problem.
  - Greedy best-first search: f(n) = h(n)
  - A* search: f(n) = g(n) + h(n)
- Local Search Algorithms
  - Hill climbing
  - Simulated annealing

Constraint Satisfaction Problems

- Problem definition:
  - Variables
  - Domains
  - Constraints
- Incremental formulation as standard search:
  - Initial state: { }
  - Successor function: pick an unassigned variable, assign it with possible values
  - Goal test: complete and consistent assignment

Constraint Satisfaction Problems (II)

- Backtracking search
- Informed Backtracking and Heuristics
  - Variable & value ordering
    - Minimum remaining values
      (Most constrained variables)
    - Most constraining variable
    - Least constraining value
  - Information Propagation
    - Forward checking
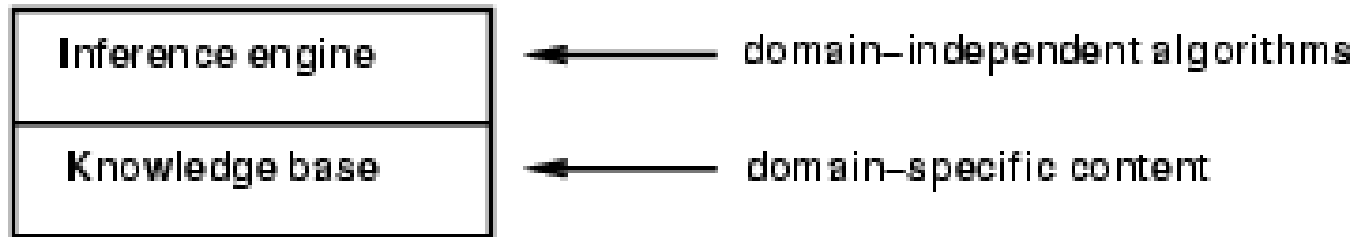   - Constraint propagation --- arc consistency

Game Playing

- (2-players) Competitive environment
- Search Tree
- Evaluation (pay-off) function
- Minimax algorithm
- Alpha-beta pruning
- Non-deterministic games

Logical Agent

- Knowledge-based Agent

Inference engine	←	domain–independent algorithms
Knowledge base	←	domain–specific content

Logic

- Syntax
- Semantics
- Model
- Entailment
  KB $\models \alpha$ if KB $\Rightarrow \alpha$ is valid
- Logical inference
  - Inference Procedure *I*
  - Soundness
  - Completeness
- Equivalence, Validity, Unsatisfiability

Propositional Logic

- Syntax
- Semantics
- Express knowledge using PL
- Inference
  - Modus Ponens
  - Horn Form
    - Forward Chaining
    - Backward Chaining
  - Resolution

First Order Logic

- Syntax (especially quantifiers)
- Semantics (Model + Interpretation)
- Expressing Knowledge using FOL
- Inference
  - Propositionalization
  - Unification and Lifting
  - General Modus Ponens
    - Forward Chaining
    - Backward Chaining
  - Lifted Resolution

Learning agents
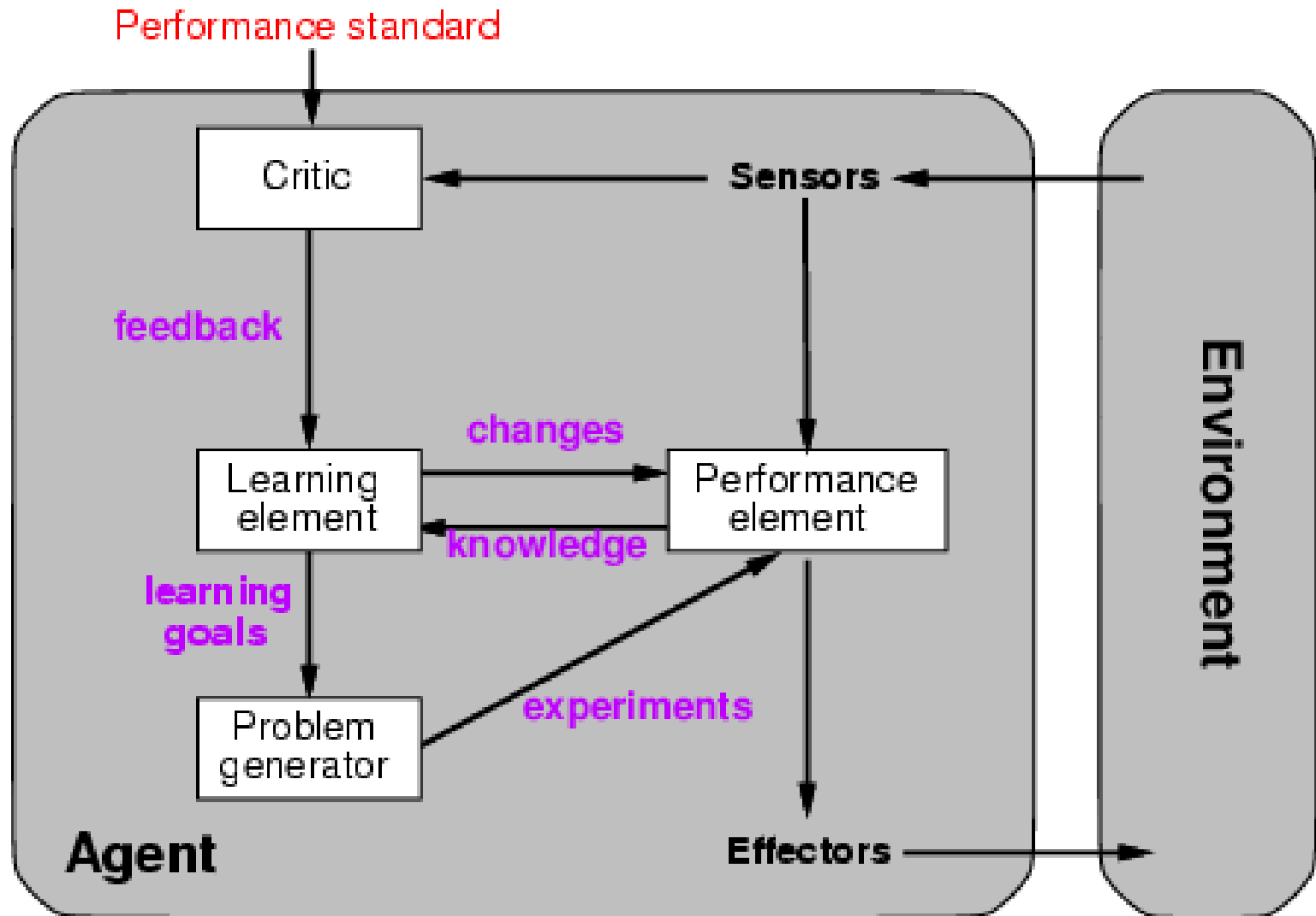
Learning From Observation

- Supervised Learning from Observation
  - Inductive Learning in general
  - Inductive Learning Bias
  - Information based learning -- Decision Tree
    - Information Content (Entropy):
      $E(P(v_1), \ldots , P(v_n)) = \Sigma_{i=1} -P(v_i) \log_2 P(v_i)$

Planning

- STRIPS
  - States: logic sentences
  - Precondition
  - Post-effects
- Partially Ordered & Complete Plan
  - Nodes – Actions
  - Arcs – post-effect of one action fulfills some precondition of other action(s)
- Critical Path Method considering time as a resource
  - Determine earliest and latest possible start time of each action in a completely and partially ordered plan

Other Topics

- Perception
  - Language Processing
    - Voice Recognition
    - Language Understanding
  - Vision
    - Image Processing
    - Object Recognition
- Actuation
  - Language as a form of action
    - Voice Synthesis
    - Language Understanding
  - Robotics