Intelligent Agents

Intelligent Agents Agent Definition: Any entity that perceives its environment through sensors and acts upon that environment through effectors Percept: The agent’s perceptual inputs at any given instant. Percept Sequence: Complete history of everything that the agent has ever perceived. An agent’s choice of action can depend on the entire percept sequence observed to date. But not on anything it has not perceived.

Intelligent Agents An agent function maps any given percept sequence to an action. The agent function is internally implemented in an agent program. The agent program runs on the physical architecture to produce f. Job of AI is to design agent programs. A P f  \* :

Intelligent Agents

Intelligent Agents  Perception Signal from environment May exceed sensory capacity  Sensors Acquires percepts Possible limitations  Action Attempts to affect environment May exceed effector capacity  Effectors Transmits actions Possible limitations

The Vacuum-Cleaner World Environment: Squares A and B. Percepts: [Location, status], e.g., [A, dirty]. Actions: left, right, suck, no-op.

The Vacuum-Cleaner World Percept Sequence Action [A, Clean] Right [A, Dirty] Suck [B, Clean] Left [B, Dirty] Suck

Rationality Rationality depends on: The performance measure that defines the criterion for success. The agent’s prior knowledge of the environment. The actions that the agent can perform. The agent’s percept sequence to date.

The Rational Agent For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has.

Rationality Rationality is NOT the same as omniscience. An omniscient agent knows the actual outcome of its actions. Rationality is also NOT the same as perfection. Rationality maximizes the expected performance. Perfection maximizes the actual performance.

Rationality Rationality requires: Information gathering Doing actions to modify future percepts. Learning from percepts Extending prior knowledge. Being autonomous Compensate for partial prior knowledge, adapt.

Specifying Task Environment To design a rational agent, we must specify its task environment. PEAS description of the task environment: Performance Environment Actuators Sensors

PEAS Framework Performance Measure Specified by outside observer or evaluator Applied (consistently) to (one or more) agents in given environment Environment Reachable states “Things that can happen” “Where the agent can go” Actuators What can be performed Limited by physical factors and self-knowledge Sensors What can be observed Subject to error: measurement, sampling, postprocessing

Environment Types Categorize task environments according to properties. The properties may determine appropriate family of techniques for agent implementation.

Fully observable vs. partially observable: If an agent’s sensors give it access to the complete state of the environment at each point in time, then we say that the task environment is fully observable. If the next state of the environment is completely determined by the current state and the action executed by the agent, then we say the environment is deterministic; otherwise, it is stochastic.

Environment Types The simplest environment is: Fully observable, deterministic, static, discrete, and single- agent. Most real situations are: Partially observable, stochastic, dynamic, continuous, and multi-agent.

Agent Types The job of AI is to design agent programs Agent = Architecture + Program Agent program implements agent function mapping percepts to actions All agent programs have the same skeleton: Input = current percepts Output = action Program = manipulates input to produce output

Agent Programs If the agent function uses a larger percept sequence, the agent program will have to remember it. What is a problem with keeping the entire percept history in a look-up table? Four basic types of agent programs: Simple reflex agents Model-based reflex agents Goal-based agents Utility-based agents

Simple Reflex Agent Simple reflex agents select actions on the basis of current percept, ignoring rest of the percept history.

Model-Based Reflex Agent To handle partial observability, the agent keeps track of the part of the world. The agent maintains an internal state that depends on the percept history. To update internal state, the agent requires a model of the world. How does the world evolve independently of agent? How the agent’s actions affect the world?

Model-Based Reflex Agent

Goal-Based Agent The agent has some goal information that describes situations that are desirable. The agent may need to consider long sequences of actions to achieve the goal. Search and planning are subfields of AI to find such action sequences.

Utility-Based Agents Goals alone do not guarantee high-quality behavior in most environments. A utility function is an internalization of the performance measure. The utility function allows the specification of an appropriate trade-off if needed. In reality, the expected utility is maximized.

Intelligent Agents Agent Sensors Effectors Preferences Action Environment Internal Model (if any) Knowledge about World Knowledge about Actions Observations Predictions Expected Rewards