UGANDA CHRISTIAN UNIVERSITY
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DSC2103-DATA SCIENCE

Lecture 1

Introduction to Artificial Intelligence

Immaculate Kamusiime,
Department of Computing and Technology

Advent Semester 2024

COURSE OVERVIEW

1. Semester-based module
2. 6 hours of lectures per week (Blended)
3. 4 hours in-person lectures (Tuesdays)
4. Blended theoretical and practical work
5. Combining skills in Python language
6. Assessment via coursework and exams
7. Coursework contributes 60% to final grade
8. Exam contributes 40% to final grade

LECTURE OUTLINE

- What is AI?
- History of AI?
- Foundations of AI
- Branches of AI
- Applications of AI

Introduction

- Can machines think?
- And if so, how?
- And if not, why not?
- And what does this say about human beings?
- And what does this say about the mind?

Why Study AI?

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- AI makes computers more useful
- Intelligent computer would have huge impact on civilization
- AI cited as "field I would most like to be in" by scientists in all fields
- Computer is a good metaphor for talking and thinking about intelligence

Why Study AI?

- Turning theory into working programs forces us to work out the details
- AI yields good results for Computer Science
- AI yields good results for other fields
- Computers make good experimental subjects
- Personal motivation: mystery

What is the definition of AI?

What do you think?

What is artificial intelligence?

- There are no clear consensus on the definition of AI
- Here's one from John McCarthy, (He coined the phrase AI in 1956) - see http:// www. formal. Stanford. EDU/ jmc/ whatisai/)

Q. What is artificial intelligence?

A. It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

What is artificial intelligence?

Q. Yes, but what is intelligence?

A. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

What is the definition of AI?

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Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally

Bellman, 1978

"[The automation of] activities that we associate with human thinking, activities such as decision making, problem solving, learning"

Charniak & McDermott, 1985

"The study of mental faculties through the use of computational models"

Dean et al., 1995

"The design and study of computer programs that behave intelligently. These programs are constructed to perform as would a human or an animal whose behavior we consider intelligent"

What is the definition of AI?

Haugeland, 1985	"The exciting new effort to make computers think *machines with minds*, in the full and literal sense"
Kurzweil, 1990	"The art of creating machines that perform functions that require intelligence when performed by people"
Rich & Knight, 1991	"The study of how to make computers do things at which, at the moment, people are better"
Schalkoff, 1990	"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes"
Winston, 1992	"The study of the computations that make it possible to perceive, reason, and act"

What is the definition of AI?

Luger & Stubblefield, 1993

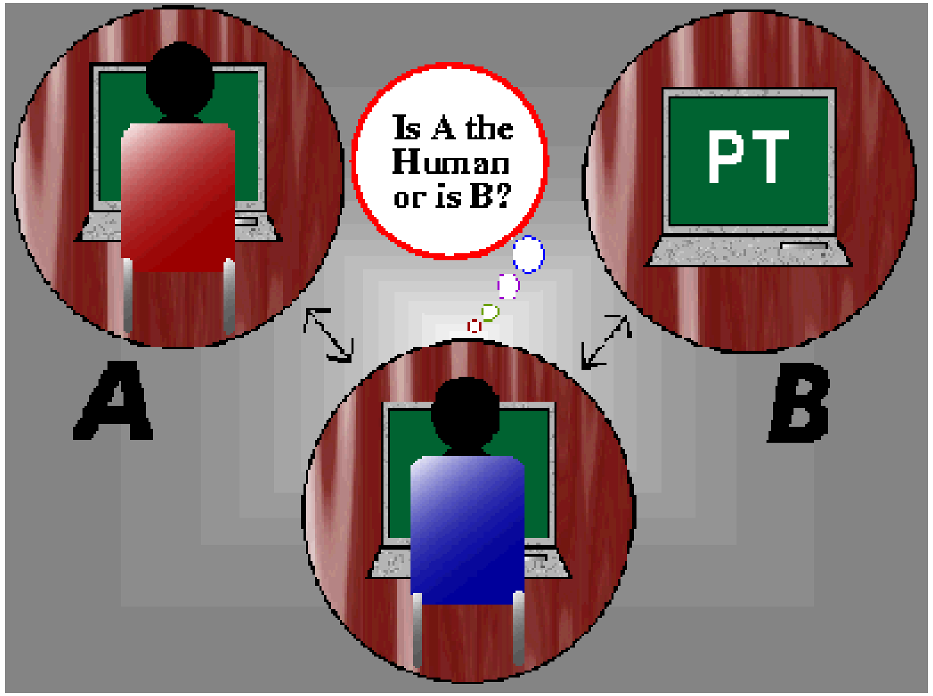
"The branch of computer science that is concerned with the automation of intelligent behavior"

Nilsson, 1998

"Many human mental activities such as writing computer programs, doing mathematics, engaging in common sense reasoning, understanding language, and even driving an automobile, are said to demand intelligence. We might say that [these systems] exhibit artificial intelligence"

Approach 1: Acting Humanly

- Turing test: ultimate test for acting humanly
  - Computer and human both interrogated by judge
  - Computer passes test if judge can't tell the difference



How effective is this test?

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- Agent must:
  - Have command of language
  - Have wide range of knowledge
  - Demonstrate human traits (humor, emotion)
  - Be able to reason
  - Be able to learn
- Loebner prize competition is modern version of Turing Test
  - Example: Alice, Loebner prize winner for 2000 and 2001

Chinese Room Argument

Imagine you are sitting in a room with a library of rule books, a bunch of blank exercise books, and a lot of writing utensils. Your only contact with the external world is through two slots in the wall labeled ``input'' and ``output''. Occasionally, pieces of paper with Chinese characters come into your room through the ``input'' slot. Each time a piece of paper comes in through the input slot your task is to find the section in the rule books that matches the pattern of Chinese characters on the piece of paper. The rule book will tell you which pattern of characters to inscribe the appropriate pattern on a blank piece of paper. Once you have inscribed the appropriate pattern according to the rule book your task is simply to push it out the output slot.

By the way, you don't understand Chinese, nor are you aware that the symbols that you are manipulating are Chinese symbols.

In fact, the Chinese characters which you have been receiving as input have been questions about a story and the output you have been producing has been the appropriate, perhaps even "insightful," responses to the questions asked. Indeed, to the outside questioners your output has been so good that they are convinced that whoever (or whatever) has been producing the responses to their queries must be a native speaker of, or at least extremely fluent in, Chinese.

Do you understand Chinese?

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- Searle says NO
- What do you think?
- Is this a refutation of the possibility of AI?
- The Systems Reply
  - The individual is just part of the overall system, which does understand Chinese
- The Robot Reply
  - Put same capabilities in a robot along with perceiving, talking, etc. This agent would seem to have genuine understanding and mental states.

Approach 2: Thinking Humanly

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- Requires knowledge of brain function
- What level of abstraction?
- How can we validate this
- This is the focus of Cognitive Science

Approach 3: Thinking Rationally

- Aristotle attempted this
- What are correct arguments or thought processes?
- Provided foundation of much of AI
- Not all intelligent behavior controlled by logic
- What is our goal? What is the purpose of thinking?

Approach 4: Acting Rationally

- Act to achieve goals, given set of beliefs
- Rational behavior is doing the "right thing"
  - Thing which expects to maximize goal achievement
- This is approach adopted by Russell & Norvig

Other possible AI definitions

- AI is a collection of hard problems which can be solved by humans and other living things, but for which we don't have good algorithms for solving.
  –e. g., understanding spoken natural language, medical diagnosis, circuit design, learning, self-adaptation, reasoning, chess playing, proving math theories, etc.
- Definition from R & N book: a program that
  –Acts like human (Turing test)
  –Thinks like human (human-like patterns of thinking steps)
  –Acts or thinks rationally (logically, correctly)
- Some problems used to be thought of as AI but are now considered not
  –e. g., compiling Fortran in 1955, symbolic mathematics in 1965, pattern recognition in 1970

Types of AI

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- Narrow AI or artificial narrow intelligence (ANI)
- General AI or artificial general intelligence (AGI)
- Super AI or artificial superintelligence (ASI)
- Reactive machines.
- Limited memory.
- Theory of mind.
- Self-aware.

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These 3 are based on their capabilities. They focuses on the level of intelligence a machine demonstrates relative to humans

These 4 are based on their functionality; how AI behaves, interacts, and functions in the real world.

Types of AI

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Narrow AI (Weak AI): AI that is designed and trained to perform a specific task. It is the most common form of AI we see today.

- Can only perform tasks it is specifically programmed to do.
- Lacks general intelligence or awareness.

Examples: Siri, Alexa, chatbots, recommendation systems, image recognition systems, self-driving cars.

Types of AI

General AI (Strong AI) : AI with the ability to learn, understand, and apply knowledge across a wide range of tasks, mimicking human cognitive functions.

- Capable of performing any intellectual task that a human can do.
- Understands, thinks, and reasons like a human.

As of now, **General AI does not exist**; it's still theoretical.

Types of AI

Super AI: AI that surpasses human intelligence in every aspect—creativity, problem-solving, decision-making, and emotional intelligence.

- Hypothetical at this point; it represents the ultimate potential of AI.
- Would have a deeper understanding of complex tasks and solve problems beyond human capabilities.
- Often considered a topic of discussion for **AI futurists** and the subject of ethical debates.

Types of AI

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Reactive Machines: AI systems that only respond to specific inputs. They do not store past experiences or data for future decisions.

- They do not have the ability to learn or adapt.
- Focus only on performing narrow tasks based on pre-defined rules.

Example: IBM's Deep Blue, the chess-playing AI that defeated world chess champion Garry Kasparov in 1997. It could play chess but could not learn from its past games.

Types of AI

Limited Memory AI: AI systems that can use past data to make decisions. These systems can store previous experiences for a short time to improve their decisions.

- Most modern AI applications fall under this category.
- They use machine learning models to learn from historical data and make future predictions.

Examples: Self-driving cars that use data from their environment (traffic lights, obstacles) to navigate roads.

Types of AI

Theory of Mind AI: AI that could understand emotions, beliefs, intentions, and social interactions.

- Theory of mind AI would be able to engage in social interactions by understanding and predicting human emotions.

Types of AI

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Self-Aware AI: AI that possesses self-consciousness and awareness of its own existence.

- This AI would have its own personality, feelings, desires, and understand its surroundings.
- This is purely hypothetical and a concept for future AI, raising ethical concerns about machine rights and autonomy.

What’s easy and what’s hard?

- It’s been easier to mechanize many of the high level cognitive tasks we usually associate with “intelligence” in people
  - e. g., symbolic integration, proving theorems, playing chess, some aspect of medical diagnosis, etc.
- It’s been very hard to mechanize tasks that animals can do easily
  - walking around without running into things
  - catching prey and avoiding predators
  - interpreting complex sensory information (visual, aural, …)
  - modeling the internal states of other animals from their behavior
  - working as a team (ants, bees)
- Is there a fundamental difference between the two categories?
- Why some complex problems (e.g., solving differential equations, database operations) are not subjects of AI

Foundations of AI

- Philosophy
  - 450 BC, Socrates asked for algorithm to distinguish pious from non-pious individuals
  Aristotle developed laws for reasoning
- Mathematics
  - 1847, Boole introduced formal language for making logical inference
- Economics
  - 1776, Smith views economies as consisting of agents maximizing their own well being (payoff)
- Neuroscience
  - 1861, Study how brains process information
- Psychology
  - 1879, Cognitive psychology initiated
- Linguistics
  - 1957, Skinner studied behaviorist approach to language learning

History of AI

- AI has roots in a number of scientific disciplines
- computer science and engineering (hardware and software)
- philosophy (rules of reasoning)
- mathematics (logic, algorithms, optimization)
- cognitive science and psychology (modeling high level human/animal thinking)
- neural science (model low level human/animal brain activity)
- linguistics

History of AI

- The birth of AI (1943 – 1956)
  - Pitts and McCulloch (1943): simplified mathematical model of neurons (resting/firing states) can realize all propositional logic primitives (can compute all Turing computable functions)
  - Allen Turing: Turing machine and Turing test (1950)
  - Claude Shannon: *information theory; possibility of chess playing computers, Computer checkers, Information theory, Open-loop 5-ball juggling*
  - Tracing back to Boole, Aristotle, Euclid (logics, syllogisms)

History of AI

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- Early enthusiasm (1952 – 1969)
  - 1956 Dartmouth conference
    - John McCarthy (Lisp); *application of logic to reasoning*
    - Marvin Minsky (*first neural network machine, Slots and frames, The Society of the Mind*);
    - Alan Newell and Herbert Simon (GPS); *General Problem Solver*
  - Emphasize on intelligent general problem solving
    GSP (means-ends analysis);
    Lisp (AI programming language);
    Resolution by John Robinson (basis for automatic theorem proving);
    heuristic search (A*, AO*, game tree search)
- Emphasis on knowledge (1966 – 1974)
  - domain specific knowledge is the key to overcome existing difficulties
  - knowledge representation (KR) paradigms
  - declarative vs. procedural representation

History of AI

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- Knowledge-based systems (1969 – 1999)
- DENDRAL: the first knowledge intensive system (determining 3D structures of complex chemical compounds)
- MYCIN: first rule-based expert system (containing 450 rules for diagnosing blood infectious diseases)
    EMYCIN: an ES shell
- PROSPECTOR: first knowledge-based system that made significant profit (geological ES for mineral deposits)

History of AI

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- AI became an industry (1980 – 1989)
- wide applications in various domains
- commercially available tools
- Current trends (1990 – present)
- more realistic goals
- more practical (application oriented)
- distributed AI and intelligent software agents
- resurgence of neural networks and emergence of genetic algorithms

AI Questions

- Can we make something that is as intelligent as a human?
- Can we make something that is as intelligent as a bee?
- Can we make something that is evolutionary, self improving, autonomous, and flexible?
- Can we save this plant $20M/year by pattern recognition?
- Can we save this bank $50M/year by automatic fraud detection?
- Can we start a new industry of handwriting recognition agents?

Which of these exhibits intelligence?

- You beat somebody at chess.
- You prove a mathematical theorem using a set of known axioms.
- You need to buy some supplies, meet three different colleagues, return books to the library, and exercise. You plan your day in such a way that everything is achieved in an efficient manner.
- You are a lawyer who is asked to defend someone. You recall three similar cases in which the defendant was guilty, and you turn down the potential client.
- A stranger passing you on the street notices your watch and asks, “Can you tell me the time?” You say, “It is 3:00.”
- You are told to find a large Phillips screwdriver in a cluttered workroom. You enter the room (you have never been there before), search without falling over objects, and eventually find the screwdriver.

Which of these exhibits intelligence?

- You are a six-month-old infant. You can produce sounds with your vocal organs, and you can hear speech sounds around you, but you do not know how to make the sounds you are hearing. In the next year, you figure out what the sounds of your parents' language are and how to make them.
- You are a one-year-old child learning Arabic. You hear strings of sounds and figure out that they are associated with particular meanings in the world. Within two years, you learn how to segment the strings into meaningful parts and produce your own words and sentences.
- Someone taps a rhythm, and you are able to beat along with it and to continue it even after it stops.
- You are some sort of primitive invertebrate. You know nothing about how to move about in your world, only that you need to find food and keep from bumping into walls. After lots of reinforcement and punishment, you get around just fine.

Which of these can currently be done?

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- Play a decent game of table tennis
- Drive autonomously along a curving mountain road
- Drive autonomously in the center of Cairo
- Play a decent game of bridge
- Discover and prove a new mathematical theorem
- Write an intentionally funny story
- Give competent legal advice in a specialized area of law
- Translate spoken English into spoken Swedish in real time
- Plan schedule of operations for a NASA spacecraft
- Defeat the world champion in chess

Applications of AI

- Healthcare:
- Finance:
- Autonomous Systems:
- Retail:
- Education:
- Ethics in AI

Questions

Expert systems: Intelligent agents

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Lecture 2

Environments & Intelligent agents

LECTURE OUTLINE

- Environment Properties
- Agent Types

PEAS

- Use PEAS to describe task
  - Performance measure
  - Environment
  - Actuators
  - Sensors

PEAS

- Use PEAS to describe task environment
  - Performance measure
  - Environment
  - Actuators
  - Sensors
- Example: Taxi driver
  - Performance measure: safe, fast, comfortable (maximize profits)
  - Environment: roads, other traffic, pedestrians, customers
  - Actuators: steering, accelerator, brake, signal, horn
  - Sensors: cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors

Environment Properties

- Fully observable vs. partially observable
- Deterministic vs. stochastic / strategic
- Episodic vs. sequential
- Static vs. dynamic
- Discrete vs. continuous
- Single agent vs. multiagent

Properties of Environments

- **Accessible/ Inaccessible.**
  - If an agent's sensors give it access to the complete state of the environment needed to choose an action, the environment is accessible.
  - Such environments are convenient, since the agent is freed from the task of keeping track of the changes in the environment.
- **Deterministic/ Nondeterministi**c.
  - An environment is deterministic if the next state of the environment is completely determined by the current state of the environment and the action of the agent.
  - In an accessible and deterministic environment the agent need not deal with uncertainty.
- **Episodic/ Nonepisodi**c.
  - An episodic environment means that subsequent episodes do not depend on what actions occurred in previous episodes.
  - Such environments do not require the agent to plan ahead.

Properties of Environments

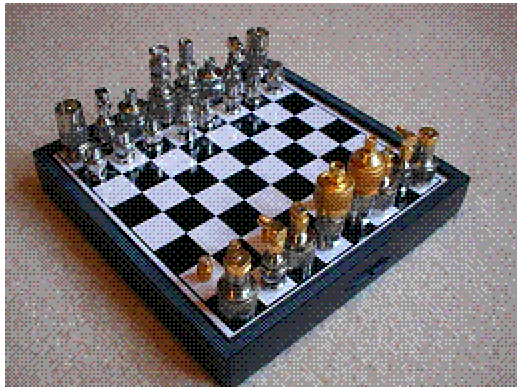
- **Static/ Dynamic.**
  - An environment which does not change while the agent is thinking is static.
  - In a static environment the agent need not worry about the passage of time while he is thinking, nor does he have to observe the world while he is thinking.
  - In static environments the time it takes to compute a good strategy does not matter.
- **Discrete/ Continuous.**
  - If the number of distinct percepts and actions is limited the environment is discrete, otherwise it is continuous.
- **With/ Without rational adversaries.**
  - If an environment does not contain other rationally thinking, adversary agents, the agent need not worry about strategic, game theoretic aspects of the environment
  - Most engineering environments are without rational adversaries, whereas most social and economic systems get their complexity from the interactions of (more or less) rational agents.
  - As example for a game with a rational adversary, try the Prisoner's Dilemma

The Prisoners' Dilemma

- The two players in the game can choose between two moves, either "cooperate" or "defect".
- Each player gains when both cooperate, but if only one of them cooperates, the other one, who defects, will gain more.
- If both defect, both lose (or gain very little) but not as much as the "cheated" cooperator whose cooperation is not returned.
- If both decision- makers were purely rational, they would never cooperate. Indeed, rational decision- making means that you make the decision which is best for you whatever the other actor chooses.

	Cooperative	Defect
Cooperative	5	-10
Defect	10	0

Environment Examples



Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Chess with a clock						
Chess without a clock						

Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
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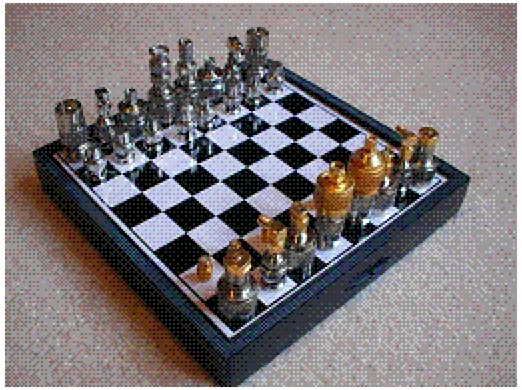
Environment Examples



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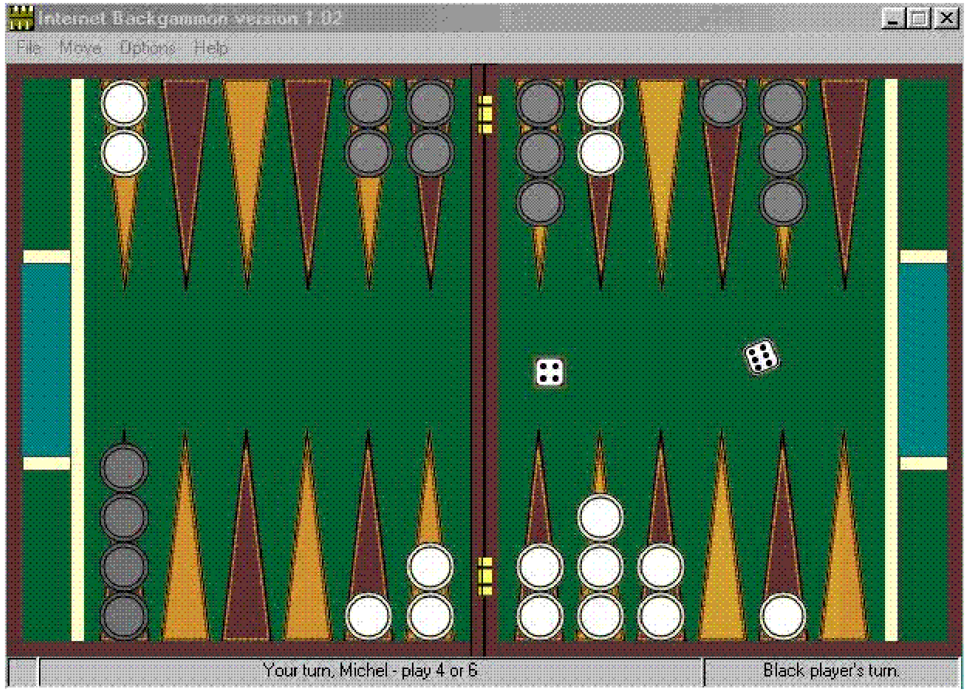

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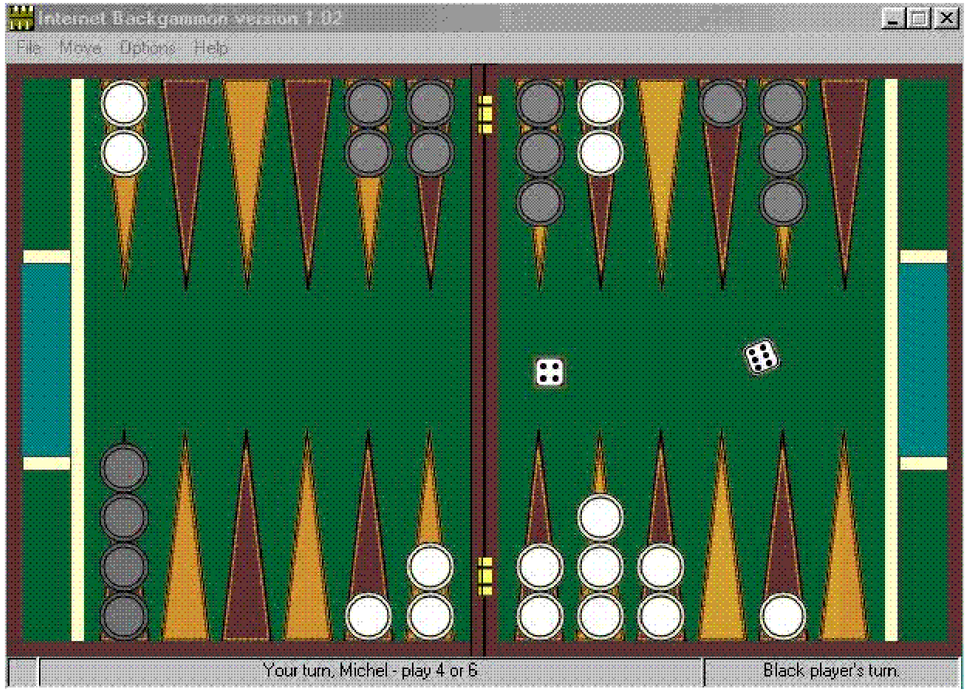

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Medical diagnosis						

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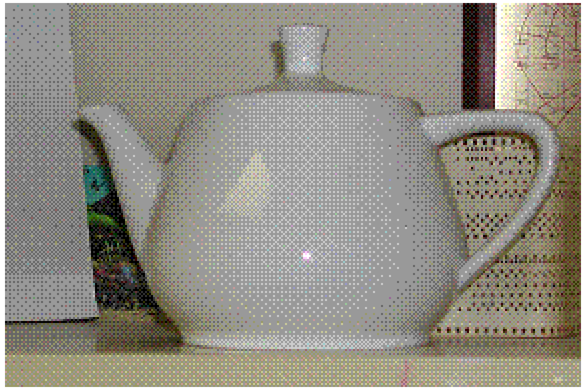

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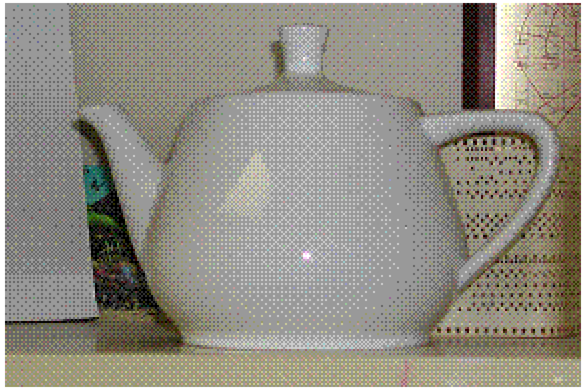

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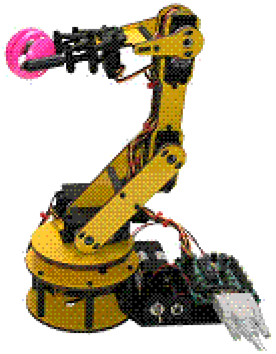

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Image analysis	Fully	Deterministic	Episodic	Semi	Discrete	Single
Robot part picking						

Fully observable vs. partially observable

Deterministic vs. stochastic / strategic

Episodic vs. sequential

Static vs. dynamic

Discrete vs. continuous

Single agent vs. multiagent

Environment Examples

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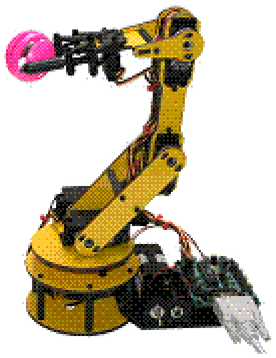

Environment	Obser vable	Determi nistic	Episodic	Stati c	Discrete	Agents
Chess with a clock	Fully	Strategic	Sequential	Semi	Discrete	Multi
Chess without a clock	Fully	Strategic	Sequential	Static	Discrete	Multi
Poker	Partial	Strategic	Sequential	Static	Discrete	Multi
Backgammon	Fully	Stochast ic	Sequential	Static	Discrete	Multi
Taxi driving	Partial	Stochast ic	Sequential	Dyna mic	Continu ous	Multi
Medical diagnosis	Partial	Stochast ic	Episodic	Static	Continu ous	Single
Image analysis	Fully	Determi nistic	Episodic	Semi	Discrete	Single
Robot part picking	Fully	Determi nistic	Episodic	Semi	Discrete	Single

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Robot part picking	Fully	Deterministic	Episodic	Semi	Discrete	Single
Interactive English tutor						

Environment Examples

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Interactive English tutor	Partial	Stochastic	Sequential	Dynamic	Discrete	Multi

Components of an AI System

An agent perceives its environment through sensors and acts on the environment through actuators.

Human: sensors are eyes, ears, actuators (effectors) are hands, legs, mouth.

Robot: sensors are cameras, sonar, lasers, ladar, bump, effectors are grippers, manipulators, motors

The agent's behavior is described by its function that maps percept to action.

Intelligent agents

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- **Definition:** An Intelligent Agent perceives it environment via sensors and acts rationally upon that environment with its effectors.
- Hence, an agent gets percepts one at a time, and maps this percept sequence to actions.
- Properties
  - Autonomous
  - Interacts with other agents plus the environment
  - Reactive to the environment
  - Pro-active (goal- directed)

Rationality

- A rational agent does the right thing
  (what is this?)
- A fixed performance measure evaluates the sequence of observed action effects on the environment

Rationality

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- An ideal **rational agent** should, for each possible percept sequence, do whatever actions that will maximize its performance measure based on
  1) the percept sequence, and
  2) its built-in and acquired knowledge.
- Hence it includes information gathering, not "rational ignorance."
- Rationality => Need a performance measure to say how well a task has been achieved.
- Types of performance measures: payoffs, false alarm and false dismissal rates, speed, resources required, effect on environment, etc.

Autonomy

- A system is autonomous to the extent that its own behavior is determined by its own experience and knowledge.
- To survive agents must have:
  - Enough built- in knowledge to survive.
  - Ability to learn.

Agent Types (increasing in generality and ability to handle complex environments)

- **Table-driven agents**
  - use a percept sequence/ action table in memory to find the next action. They are implemented by a (large) lookup table.
- **Simple reflex agents with state**
  - are based on condition- action rules and implemented with an appropriate production (rule-based) system. They are stateless devices which do not have memory of past world states.
- **Agents with memory**
  - have internal state which is used to keep track of past states of the world.
- **Agents with goals (Goal-based agents)**
  - are agents which in addition to state information have a kind of goal information which describes desirable situations. Agents of this kind take future events into consideration.
- **Utility-based agents**
  - base their decision on classic axiomatic utility-theory in order to act rationally.
- **Learning agent**

Simple Reflex Agent

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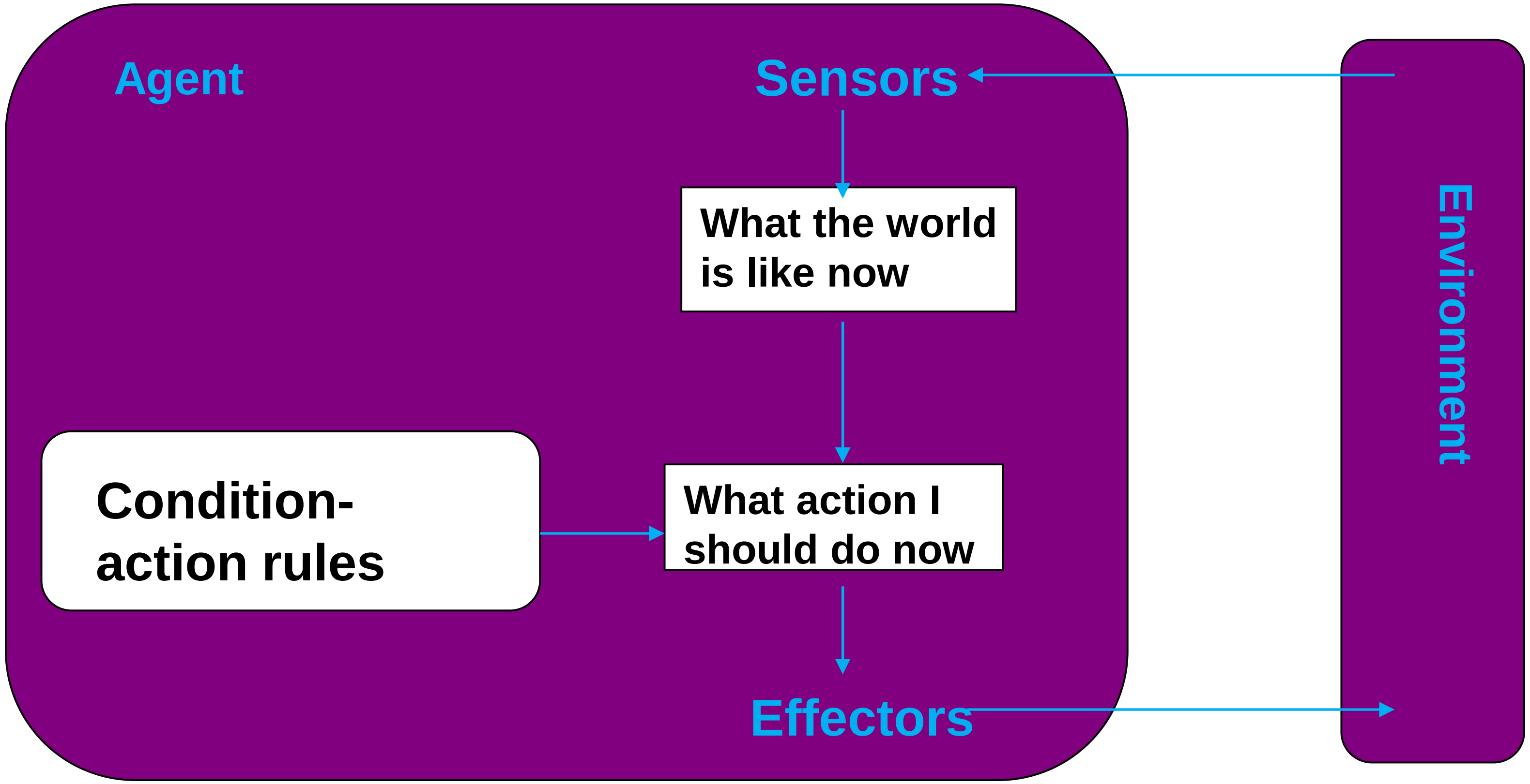
- **Table lookup** of percept- action pairs defining all possible condition- action rules necessary to interact in an environment
- **Problems**
  - Too big to generate and to store (Chess has about 10^120 states, for example)
  - No knowledge of non- perceptual parts of the current state
  - Not adaptive to changes in the environment; requires entire table to be updated if changes occur
- **Use *condition-action* rules to summarize portions of the table**

A Simple Reflex Agent: Schema

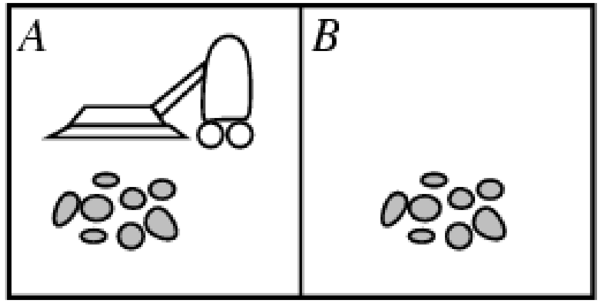
- Use simple "if then" rules
- Can be short sighted



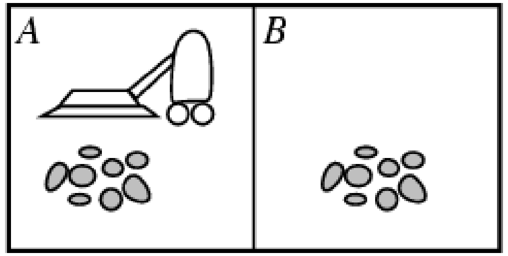

```
SimpleReflexAgent(percept)
   state   = InterpretInput(percept)
   rule    = RuleMatch(state, rules)
   action = RuleAction(rule)
   Return action
```

Example: Vacuum Agent

- Performance?
  - 1 point for each square cleaned in time T?
  - #clean squares per time step - #moves per time step?
- Environment: vacuum, dirt, multiple areas defined by square regions
- Actions: left, right, suck, idle
- Sensors: location and contents
  - [A, dirty]
- Rational is not omniscient
  - Environment may be partially observable
- Rational is not clairvoyant
  - Environment may be stochastic
- Thus Rational is not always successful



Reflex Vacuum Agent



- If status=Dirty then return Suck
    else if location=A then return Right
    else if location=B then right Left

Reflex Agent with Internal State

- Encode "internal state" of the world to remember the past as contained in earlier percepts
- Needed because sensors do not usually give the entire state of the world at each input, so perception of the environment is captured over time. "State" used to encode different "world states" that generate the same immediate percept.
- Requires ability to represent change in the world; one possibility is to represent just the latest state, but then can't reason about hypothetical courses of action

Reflex Agent with Internal State

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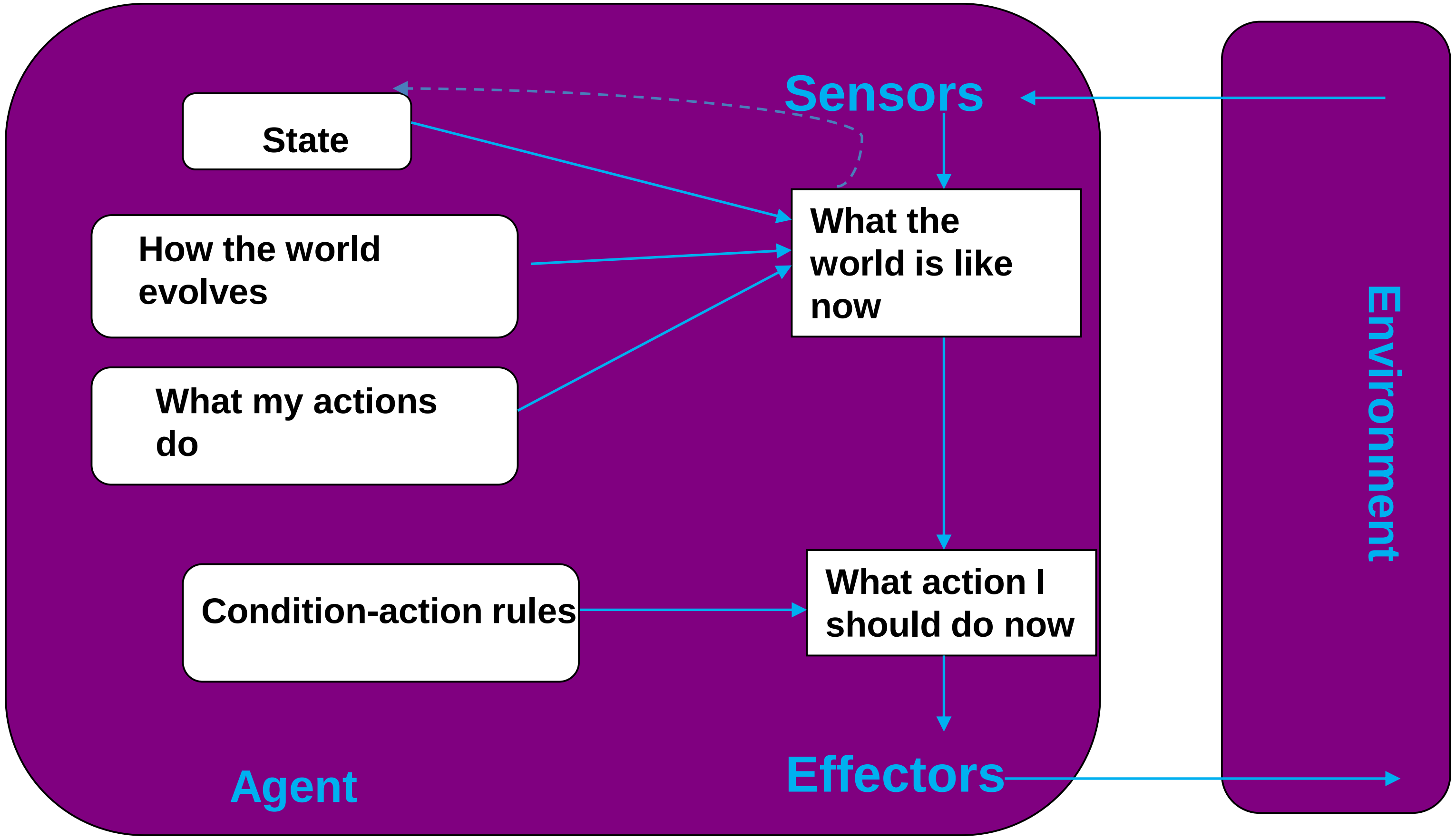
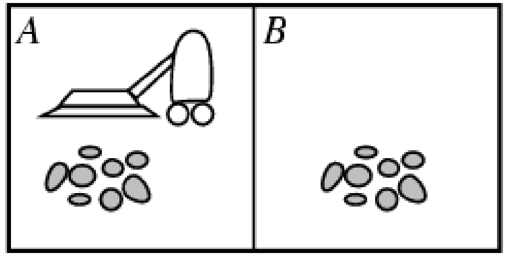
- Store previously-observed information
- Can reason about unobserved aspects of current state



ReflexAgentWithState(percept)
state = UpdateDate(state,action,percept)
rule = RuleMatch(state, rules)
action = RuleAction(rule)
Return action

Reflex Vacuum Agent

If status=Dirty then Suck
else if have not visited other square in >3 time units, go there



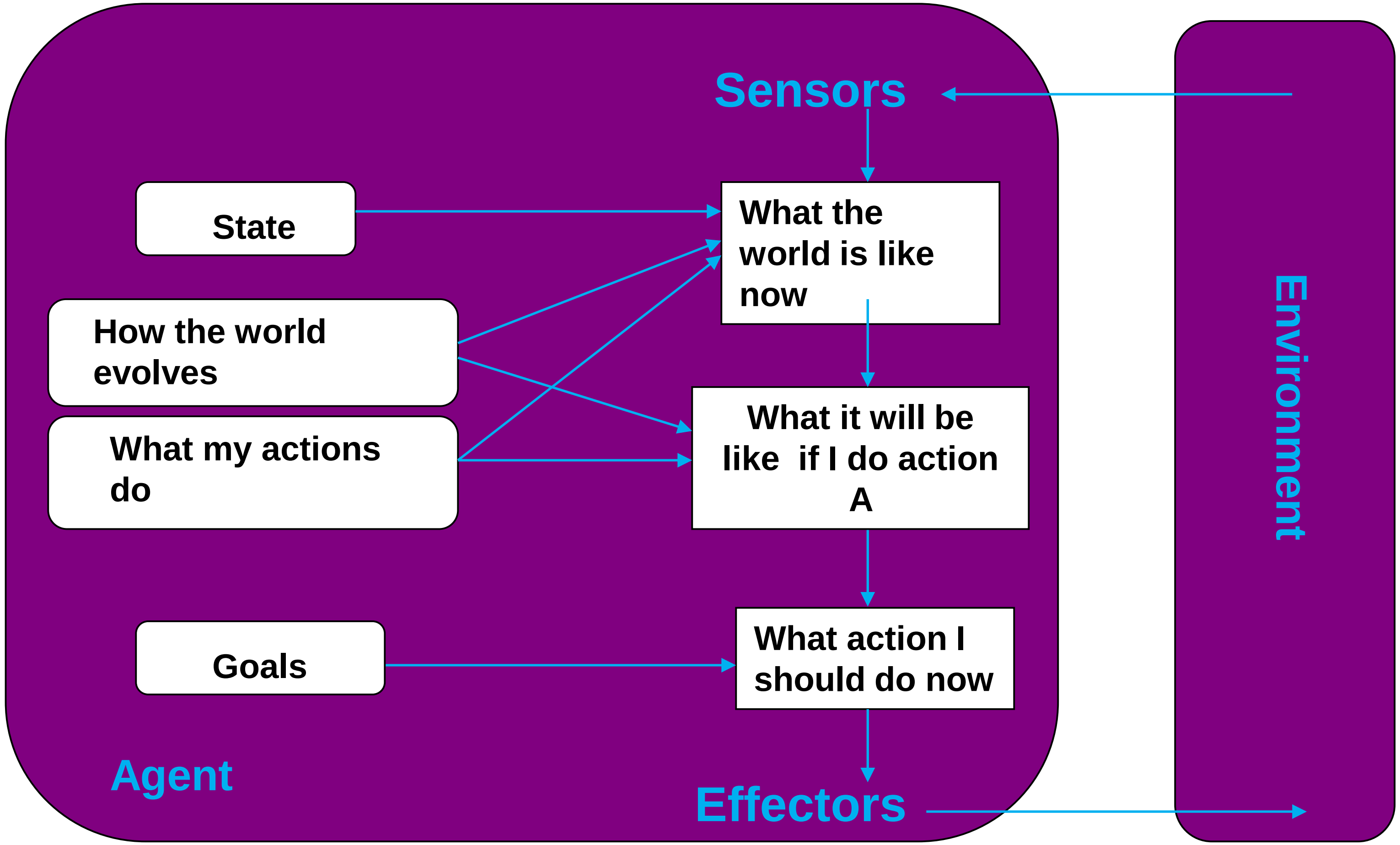
Goal- Based Agent

Choose actions so as to achieve a (given or computed) goal.

- A goal is a description of a desirable situation
- Keeping track of the current state is often not enough -- need to add goals to decide which situations are good
- Deliberative instead of reactive
- May have to consider long sequences of possible actions before deciding if goal is achieved -- involves consideration of the future, *"what will happen if I do...?"*

Agents with Explicit Goals (Goal-Based Agents)

- Goal reflects desires of agents
- May project actions to see if consistent with goals
- Takes time, world may change during reasoning

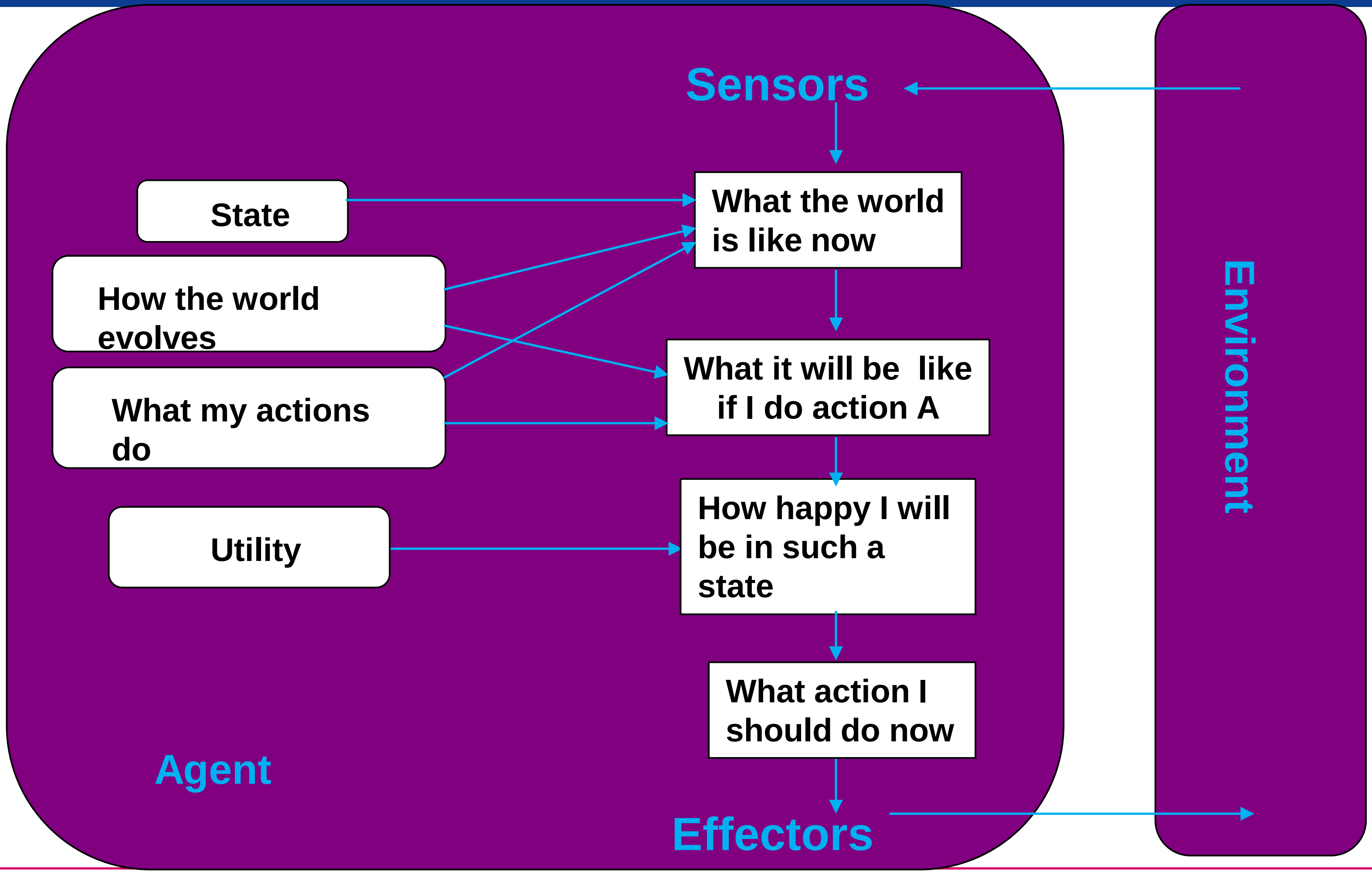


Utility- Based Agent

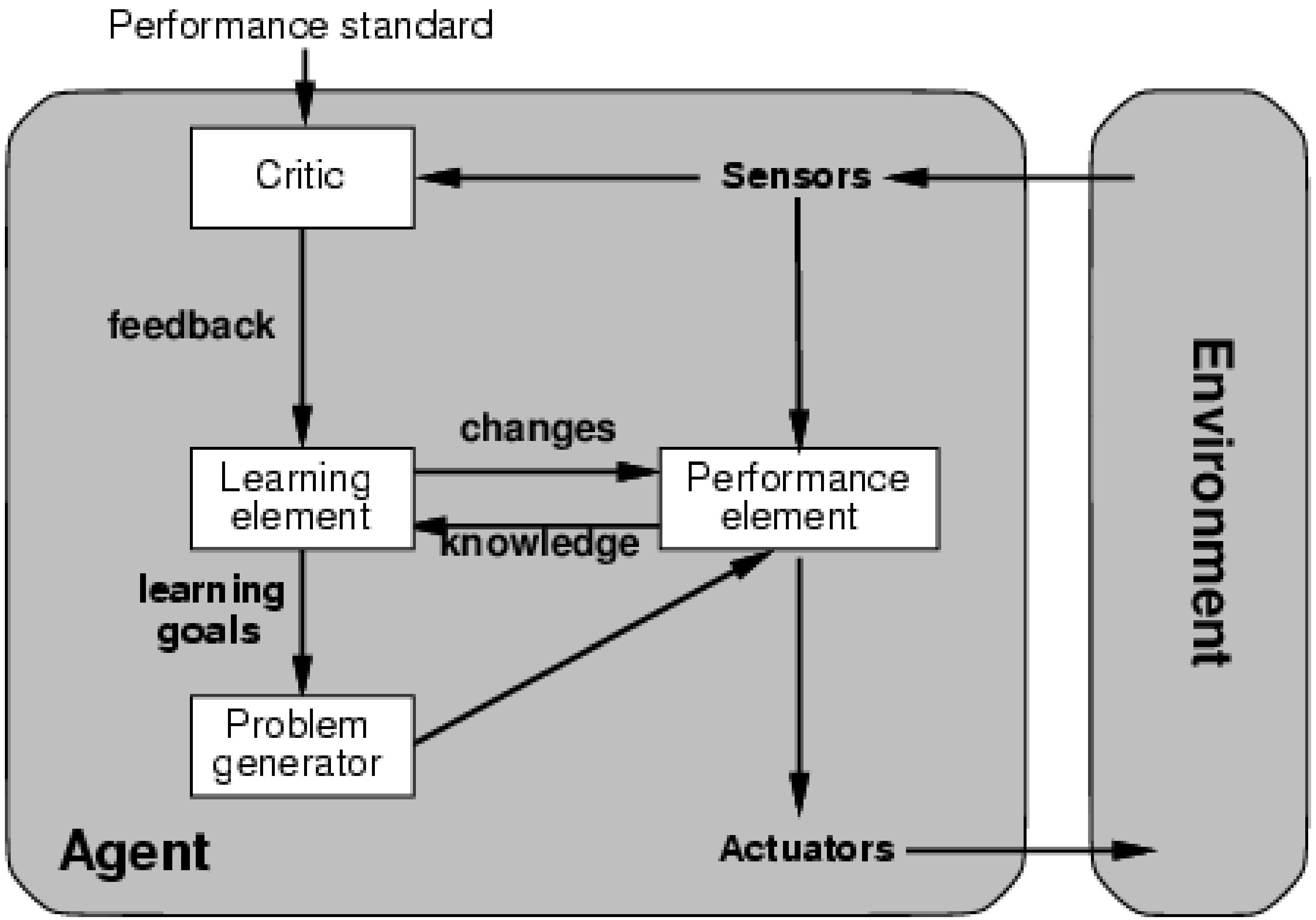
- When there are multiple possible alternatives, how to decide which one is best?
- A goal specifies a crude distinction between a happy and unhappy state, but often need a more general performance measure that describes "degree of happiness"
- Utility function **U: States --> Reals** indicating a measure of success or happiness when at a given state
- Allows decisions comparing choice between conflicting goals, and choice between likelihood of success and importance of goal (if achievement is uncertain)

A Complete Utility- Based Agent

- Evaluation function to measure utility f(state) -> value
- Useful for evaluating competing goals

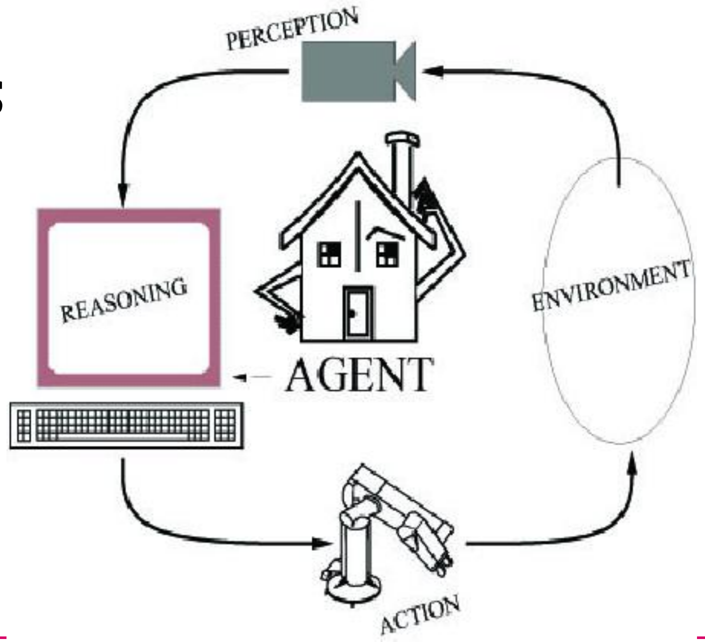


Learning Agents



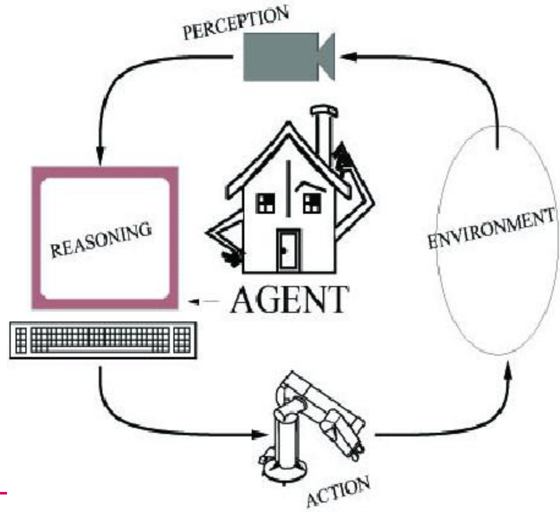
Xavier mail delivery robot

- Performance: Completed tasks
- Environment: [See for yourself]
- Actuators: Wheeled robot actuation
- Sensors: Vision, sonar, dead reckoning
- Reasoning: Markov model induction, A* search, Bayes classification



Pathfinder Medical Diagnosis System

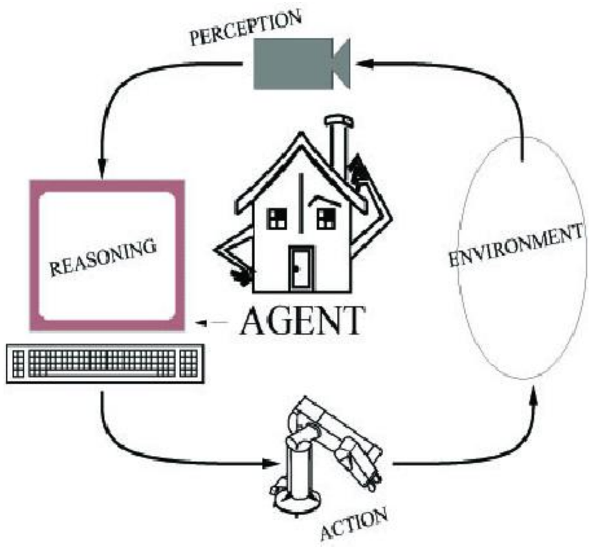
- Performance: Correct Hematopathology diagnosis
- Environment: Automate human diagnosis, partially observable, deterministic, episodic, static, continuous, single agent
- Actuators: Output diagnoses and further test suggestions
- Sensors: Input symptoms and test results
- Reasoning: Bayesian networks, Monte-Carlo simulations



TDGammon

- Performance: Ratio of wins to losses
- Environment: Graphical output showing dice roll and piece movement, fully observable, stochastic, sequential, static, discrete, multiagent

  World Champion Backgammon Player
- Sensors: Keyboard input
- Actuator: Numbers representing moves of pieces
- Reasoning: Reinforcement learning, neural networks



Alvinn

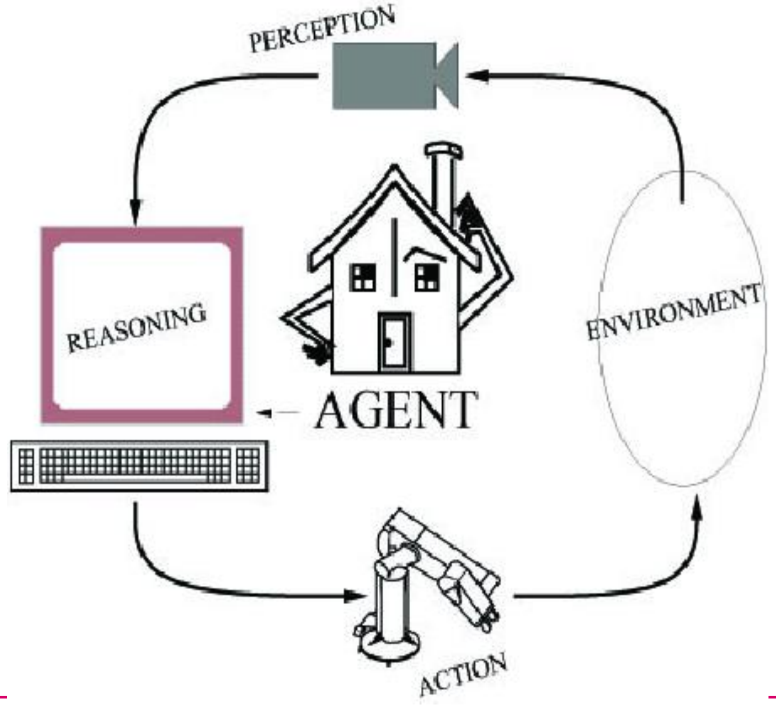
- Performance: Stay in lane, on road, maintain speed
- Environment: Driving Hummer on and off road without manual control (Partially observable, stochastic, episodic, dynamic, continuous, single agent), Autonomous automobile
- Actuators: Speed, Steer
- Sensors: Stereo camera input
- Reasoning: Neural networks

Talespin

- Performance: Entertainment value of generated story
- Environment: Generate text-based stories that are creative and understandable
  - One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe threatened to hit Irving if he didn't tell him where some honey was.
  - Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned. Joe Bear was hungry. He asked Irving Bird where some honey was. Irving refused to tell him, so Joe offered to bring him a worm if he'd tell him where some honey was. Irving agreed. But Joe didn't know where any worms were, so he asked Irving, who refused to say. So Joe offered to bring him a worm if he'd tell him where a worm was. Irving agreed. But Joe didn't know where any worms were, so he asked Irving, who refused to say. So Joe offered to bring him a worm if he'd tell him where a worm was…
- Actuators: Add word/phrase, order parts of story
- Sensors: Dictionary, Facts and relationships stored in database
- Reasoning: Planning

Webcrawler Softbot

- Search web for items of interest
- Perception: Web pages
- Reasoning: Pattern matching
- Action: Select and traverse hyperlinks



Other Example AI Systems

- Translation of Caterpillar truck manuals into 20 languages
- Shuttle packing
- Military planning (Desert Storm)
- Intelligent vehicle highway negotiation
- Credit card transaction monitoring

- Billiards robot
- Juggling robot
- Credit card fraud detection
- Lymphatic system diagnoses
- Mars rover
- Sky survey galaxy data analysis

Other Example AI Systems

- Knowledge Representation
- Search
- Problem solving
- Planning
- Machine learning
- Natural language processing
- Uncertainty reasoning
- Computer Vision
- Robotics

Recap

- An **agent** perceives and acts in an environment, has an architecture and is implemented by an agent program.
- An **ideal agent** always chooses the action which maximizes its expected performance, given percept sequence received so far.
- An **autonomous agent** uses its own experience rather than built- in knowledge of the environment by the designer.
- An **agent program** maps from percept to action & updates its internal state.
    - **Reflex agents** respond immediately to percepts.
    - **Goal-based agents** act in order to achieve their goal(s).
    - **Utility-based** agents maximize their own utility function.
- **Representing knowledge** is important for successful agent design.
- Some **environments** are more difficult for agents than others. The most challenging environments are inaccessible, nondeterministic, nonepisodic, dynamic, and continuous.

Questions?

END

Thank You

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