Intelligent Agents

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Utah Tech University—Computing

Fall 2025

Today's Plan

1. Course Introduction & Syllabus (10 min)
2. Welcome & Context (5 min)
3. Brief History of AI (10 min)
4. Influential Fields (5 min)
5. Major Subfields (10 min)
6. Intelligent Agents Framework (20 min)
7. Closing (5 min)

Today's Plan

1. Course Introduction & Syllabus (10 min)
   - Welcome
   - Syllabus Highlights
   - Projects & Expectations
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Where we are

Welcome

- Course: CS 4300 — *Intelligent Agents*
- Instructor: Curtis Larsen (`curtis.larsen@utahtech.edu`)
- Term: Fall 2025
- Logistics: Canvas, lecture notes, code examples, office hours

Where we are

Syllabus Highlights (High-Level)

- **Learning goals:** Intelligent agents, search, reasoning, uncertainty, LLMs & agentic-AI
- **Work:** Readings (AIMA + notes + internet), programming projects, quizzes, exams
- **Grading:** Projects, quizzes, exams
- **Policies:** Collaboration vs. plagiarism, late work, academic integrity

Where we are

Projects & Expectations

- **Projects:** Classical agent tasks + agentic LLM projects
- **Skills:** Python, testing, version control (Git), experimental rigor
- **Expectations:** Come prepared; iterate; measure and report

Today's Plan

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   - Why Intelligent Agents?
   - AI Is Everywhere
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Where we are

Why “Intelligent Agents” (vs “Artificial Intelligence”)?

- Focus on **perception** $\rightarrow$ **decision** $\rightarrow$ **action** in environments
- Unified lens across search, planning, learning, NLP, robotics
- Bridges classical AI and **agentic-AI with LLMs**

Where we are

AI Is Everywhere

- Conversational systems (LLMs), recommender systems
- Autonomous driving, robotics, warehouse automation
- Medical decision support, fraud detection, game AIs
- We'll analyze these **as agents**: goals, information, actions, feedback

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   - Early Foundations
   - Dartmouth & Symbolic Era
   - Expert Systems
   - Statistical ML & Deep Learning
   - Current Wave
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Where we are

Early Foundations

- Philosophy of mind, logic (Aristotle, Frege), computation (Turing)
- Cognitive science & early neuroscience
- Optimization and probability laid groundwork

Where we are

Dartmouth 1956 & Symbolic Era

- AI named as a field; optimism around symbolic reasoning
- **GOFAI:** logic, search, planning, rule-based systems
- Successes and brittleness in complex, uncertain domains

Where we are

Expert Systems (1970s–80s)

- Knowledge engineering; if-then rules; MYCIN, DENDRAL
- Knowledge bottleneck; maintenance costs; limited generalization

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Statistical ML & Deep Learning

- Shift to **data-driven** methods (90s–present)
- Probabilistic modeling; SVMs; ensemble methods
- Deep learning breakthroughs (vision, speech, RL)

Where we are

Current Wave: LLMs & Agentic AI

- Foundation models for language & multimodal inputs
- **Agents using LLMs** for planning, tools, memory, multi-step tasks
- Safety, alignment, evaluation challenges persist

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Fields that Influenced AI

- Philosophy (reasoning, ethics)
- Mathematics (logic, probability, optimization)
- Economics (utility, game theory)
- Linguistics (syntax, semantics)
- Psychology (cognition, behavior)
- Neuroscience (learning, perception)
- CS/Engineering (algorithms, systems)

Today's Plan

Where we are

Survey of AI Subfields — Part I

- **Search & Problem Solving**
- **Knowledge Representation & Reasoning**
- **Planning & Decision Making**

Where we are

Survey of AI Subfields — Part II

- **Machine Learning** (incl. deep learning)
- **Natural Language Processing**
- **Vision & Perception**
- **Robotics & Agents**
- **Uncertainty & Probabilistic Reasoning**

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   - What is an Agent?
   - PEAS Framework
   - PEAS Examples
   - Environment–Agent Loop
   - Environment Attributes
   - Activity
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What is an Agent?

Agent

An entity that perceives its **environment** through sensors and acts upon that environment through **actuators** to **maximize performance** relative to a goal.

- Policies/architectures: Reflex, model-based, goal-based, utility-based, learning agents

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PEAS Framework

PEAS

Performance measure, **E**nvironment, **A**ctuators, **S**ensors

- Problem formulation starts with PEAS: clarifies success criteria, context, and interface

Where we are

PEAS Examples

Agent	Performance (P)	Environment (E)	Actuators (A) / Sensors (S)
Self-driving car	Safety, legality, comfort, efficiency	Urban roads, traffic, weather, rules	A: throttle, brake, steering; S: cameras, LiDAR, GPS, IMU
Chess program	Win rate, time, search efficiency	Board positions, rules, opponent	A: move pieces; S: board state
Voice assistant	Accuracy, latency, user satisfaction	Home/phone context, services/APIs	A: speech, device control; S: microphone, app signals
Warehouse robot	Throughput, error rate, energy	Warehouse floor, shelves, humans	A: wheels, gripper; S: camera, depth, RFID

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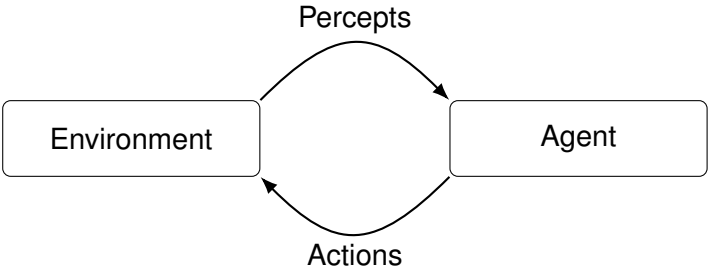
Environment–Agent Loop



- Perceive $\rightarrow$ Decide (policy/planning/learning) $\rightarrow$ Act $\rightarrow$ New state
- Feedback via performance signals; learning updates policy/model

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Environment Attributes (1/3)

- **Observable:** Fully vs. partially observable
- **Outcomes:** Deterministic vs. stochastic

Examples

Chess: fully observable, (quasi-)deterministic
Robot navigation: partially observable, stochastic dynamics & sensors

Environment Attributes (2/3)

- **Temporal structure:** Episodic vs. sequential
- **Dynamics:** Static vs. dynamic (incl. semidynamic)

Examples

Image classification: episodic, static
Autonomous driving: sequential, dynamic

Environment Attributes (3/3)

- **State/Action representation:** Discrete vs. continuous
- **Multiplicity:** Single-agent vs. multi-agent

Examples

Gridworld: discrete, single-agent
Robot soccer: continuous state/action, multi-agent, partially observable, stochastic, sequential, dynamic

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Classify an Environment (Activity)

Prompt: For *robot soccer*, classify each attribute:

- Observability? Outcomes? Temporal structure? Dynamics?
- Discrete/continuous? Single-/multi-agent?
- What PEAS would you write?

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   - Recap
   - Looking Ahead
   - Q&A

Where we are

Recap

- History & influences of AI
- Major subfields
- Intelligent agents: PEAS, environment–agent loop, environment attributes

Where we are

Looking Ahead

- Next: **Uninformed Search** (problem formulation, state spaces, BFS/DFS, uniform-cost)
- Reading: AIMA Ch. 2 (agents), Ch. 3 (search) excerpts
- Optional: skim recent agentic-LLM papers/blogs for context

Where we are

Questions & Logistics

- Questions?
- Office hours / Contact info
- Course repo & environment setup checklist