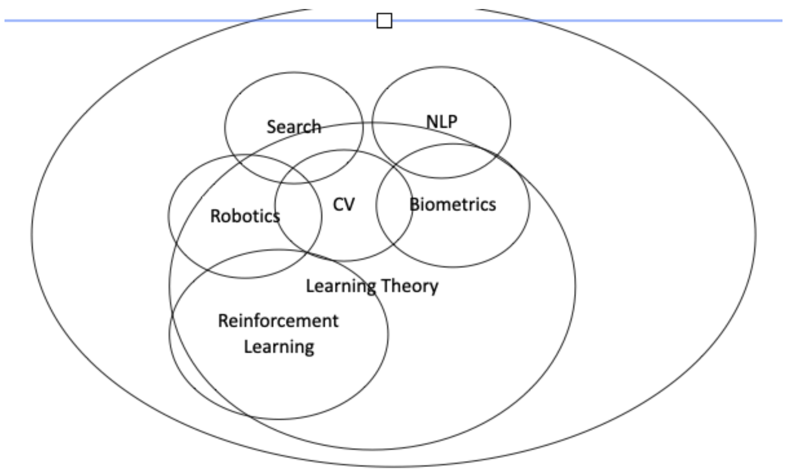
CAS CS 440
Lec 1

AI Overview && Representation

1. AI "Umbrella"
    a. 

    b. AI is a massive field with many things
2. Agents
    a. An entity in AI which makes decisions on its own behalf is called an agent
    b. Agent function: how the agent works (internally)
        i. Agents perform some functions
    c. An agent can make multiple decisions at once (and often simultaneously)
        i. The agent controls the whole team during the chess game
    d. Agents exist in the "digital" realm
    e. Agents accept data in the "digital" realm and take actions in the "digital realm"
        i. Need to set up machinery to connect the agents to the real world (robotics)
3. Environment/World
    a. Agents interact with the physical world through an environment (often called a "world")
    b. Agents must "sense" their world in order to receive data
        i. Robots have sensors
        ii. Digital worlds have representations
4. Rational Agents
    a. A Rational Agent is an agent that "does the right thing"
        i. Evaluated by a performance metric
        ii. Performance metric examines environment state
        iii. Agent that produces desired environment states -> rational

            1. For every sequence of environment states, a rational agent selects the action that will optimize the performance given only the states it has seen (so far) and its "internal knowledge."
    b. Rationality is different than omniscience! (Goal: do the best we can within the knowledge we have, trying to optimize the best solution, not being perfect)
        i. Rationality optimizes expected performance, omniscience optimizes actual performance
5. Task Environment
    a. Remember: rationality requires four things
        i. Performance metric
        ii. Environment (Description/software/interface, etc)
        iii. Agent senses
        iv. Agent actions
    b. Task environment = these four attributes (as a quadruple)
6. Flavors of Task Environment
    a. Fully observable
        i. Agent has access to complete state of environment
    b. Partially observable
        i. Some information hidden from agent
    c. Deterministic
        i. Environment's next state completely dependent on action + previous states
    d. Stochastic
        i. Environment's next state is probabilistic
    e. Single Agent
    f. Multi-Agent
        i. Competitive / cooperative
        ii. Communication?
7. Flavors of Agents
    a. Simple Reflex Agent
        i. Only looks at current env state to decide action
    b. Model-based Reflex Agent
        i. Maintains internal state (agent state) + can use history of env states
    c. Goal-base Agent
        i. Goal function assists agent in making decisions (helps identify favorable states)
    d. Utility-based Agent
        i. Utility function = internal performance metric…used to assist agent
        ii. Utility function does not need to match Task env performance metric
    e. Learning Agent
        i. learning element: component that makes adjustments to the Agent

ii. action element: component that selects external actions
iii. critic: feedback component (used by the learning element)
iv. problem generator: component that suggests novel experience

Search I

1. Env state
    a. Agent senses: collect information about the env at a point in time
        i. Let us assume we have the state of the world s_t at time t
    b. Given s_t, our agent must produce an action a_t (also at time t)
    c. World transitions to new state s_{t+1}
        i. If static, world transitions to s_{t+1} after a_t is made
        ii. If dynamic, world may have made transitions before a_t was made
2. Agents that Search
    a. For now, let us assume that the state of the world is unstructured
        i. Book uses term atomic: meaning state contains no internal structure
    b. Let's consider goal agents
        i. Agent equipped with goal function
        ii. Remember: goal function $g(s_t) \rightarrow R$
    c. How can we use goal function to decide actions?
3. Worlds With Known Series
    a. Let's consider world where all states are known beforehand
    b. Construct graph of states $G_{env} = (V_{env}, E_{env})$
        i. V_{env} = set of all states in the world (all nodes are states of the world)
        ii. (u,v) in E_{env} (undirected) if there exists an action with transitions u to v (all edges → if you can go from one state to another, there is an edge)
    c. Example: maze solving in a grid world
        i. State determined by pos of player (and position of obstacles)!
        ii. Actions: {up, down, left, right}
4. Uninformed (Blind) Search Strategies
    a. Breadth First Search (BFS)
    b. Start at source vertex
        i. Then visit all neighbors 1st neighborhood N_1 (src)
        ii. Then visit all neighbor's neighbors 2nd neighborhood N_2 (src)
        iii. Then visit all neighbor's neighbor's neighbors neighborhood N_3 (src)
        iv. …
        v. Stop when you reach the goal vertex
    c. Key: only explore simple paths
5. Problems with BFS

a. Current form does not work with action costs (going down may cost less due to gravity compared to going up)
b. Tons of memory $O(|E|)$ or $O(|V|^2)$
    i. Need to store all edges: $|E| \le |V|^2$
c. BFS is blind