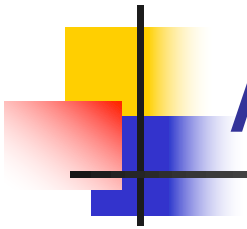
AI: a brief primer (in the contex of ECE 479/579)

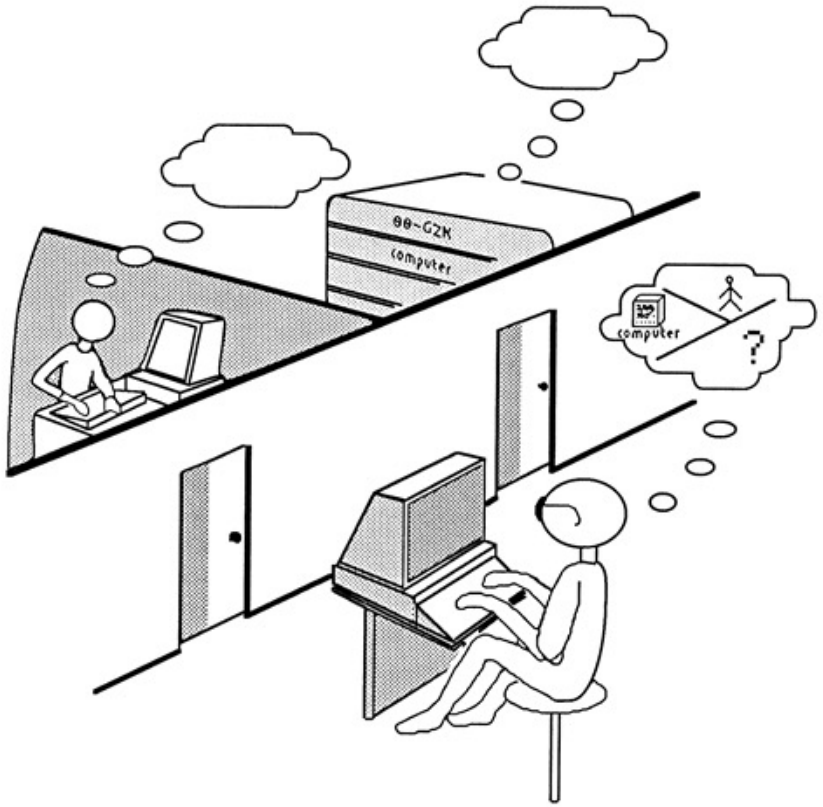


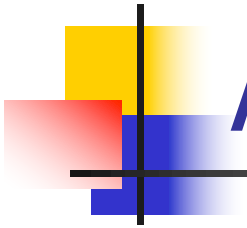
AI

- Traditional answer:

AI is manifested in a machine when the machine's performance cannot be distinguished from that of a human performing the same task

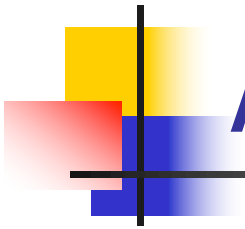
The Turing Test





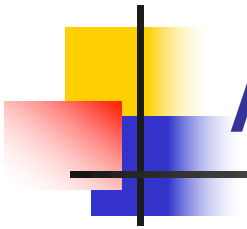
Attributes of intelligence

- Humans perceive things and events
  - recognize, classify, characterize common properties
- Humans have mental states
  - “a person is thinking about something, believes something is true…”
- Humans learn (so do animals)
  - acquisition of new knowledge, ability to improve, solve new problems



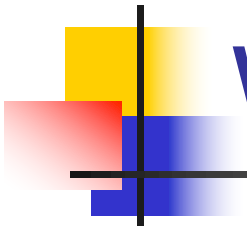
Attributes of intelligence

- Humans use language
  - communication is not unique to humans; however, we are the only ones to disseminate knowledge
- Humans make and use models
  - intelligent systems use internal representations of the world to help predict the consequences of their actions



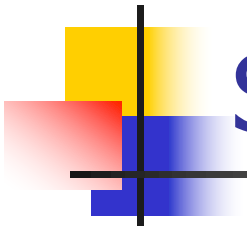
AI Revisited

- AI systems have marks of intelligence, typically to some degree and in an isolated form, e.g.,
  - neural nets,
  - planners,
  - expert systems
  - natural language processors
  - LLMs (large language models)
- Systems that integrate all those abilities or have some of them at the level of a creative genius do not exist



What can we do with AI?

- We want to build useful systems
- AI is a source of concepts, techniques, and tools that make computer better at carrying out their tasks
- AI offers techniques for solving *exponentially hard* problems in *polynomial time* by exploiting knowledge about the problem domain and by using heuristics
- Explosion of other possibilities as demonstrated by recent developments



Selected topics in class

- State space-based search
- Knowledge representation
- Logic
- Model-based reasoning
- Planning
- Open problems (active student project participation

AI Production System Paradigm – State Space Approach

- Database
- Operators
- Control Strategy
  - initial, and goal states
  - any or optimal solution
  - efficient solution

Some (not so) trivial examples

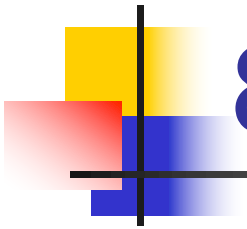
- The 8-puzzle

Initial State

1	2	6
5	8	4
3	7	#

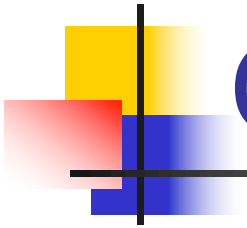
Goal State

1	2	3
8	#	4
7	6	5



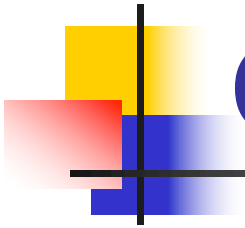
8-puzzle

- Database: board configurations
- Operators:
  - move blank tile
    - UP, DOWN, LEFT, RIGHT
- Control Strategy
  - systematic application of operators to state from the database, e.g., depth first, A*



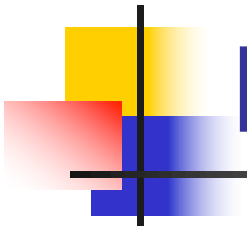
Other examples

- Traveling salesman problem
- Water jug problem
- Configuration space (robotics)
- Optimization problems
- Planning



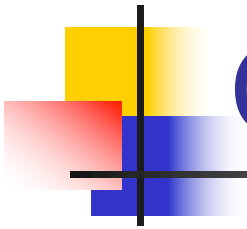
Cognitive Systems

- Origins: cognitive science
  - interdisciplinary field: psychology, linguistics, computer science, philosophy, and neuroscience
- Convergence of artificial intelligence (AI) and cognitive science
  - what are the marks of intelligence that would characterize a machine?
  - exploring and testing theories of cognition that supplement the empirical methods of psychology and linguistics
    - cognitive theories find expressions as computer programs



Motivation

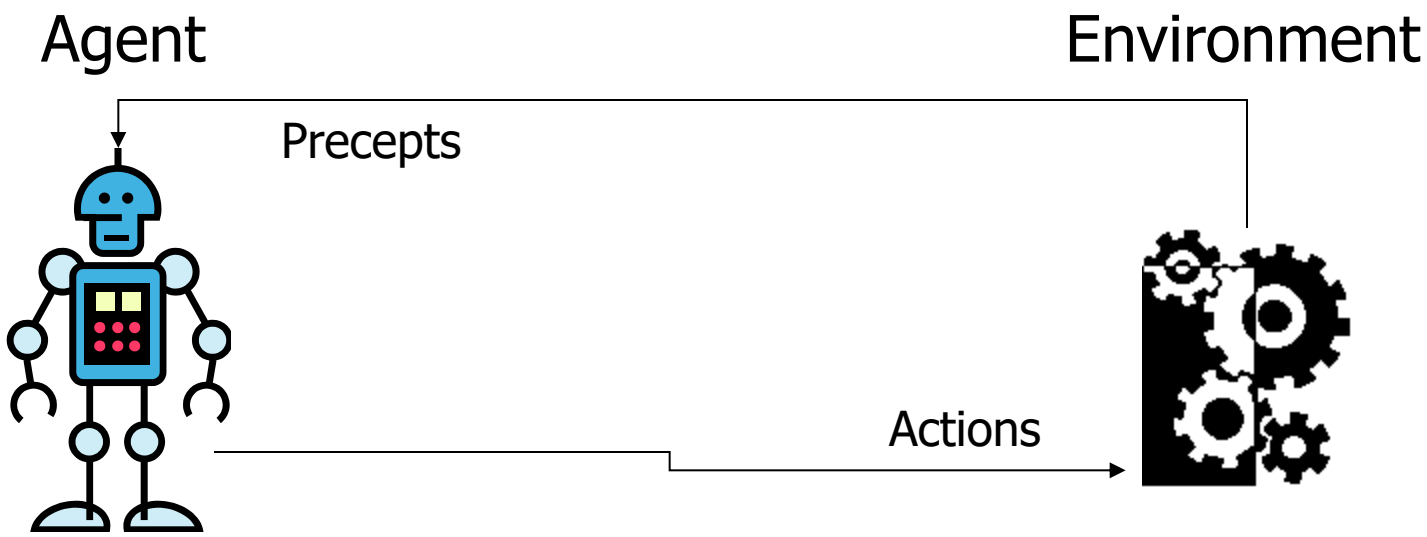
- Systems complexity
- Desire to build systems that will
  - accumulate knowledge
  - reason
  - learn
  - explain itself
  - be aware of its own behavior
  - be robust
- Lack of support techniques for high level systems design
- Methodologies are needed that address:
  - abstraction
  - adequate, integrative modeling and of complex, heterogeneous systems
  - rapid prototyping, reusability



Cognitive Systems

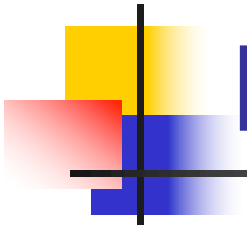
- The science of mind
  - we seek to understand perceiving, thinking, remembering, understanding language, learning, forming models, etc.
  - mind as a system that receives, stores, retrieves, transforms, and transmits information
    - computational (information processing view)

Agent Metaphor



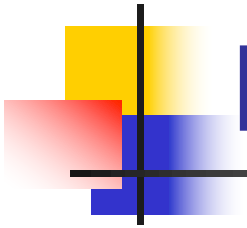
Some examples

Agent Type	Percepts	Actions	Goals	Environment
Medical Diagnosis System	Symptoms, findings, patient's answers	Questions, tests, treatments	Healthy patient, minimize cost	Hospital, patient
Satellite image analysis system	Pixels of varying intensity, color	Categorization of scene	Correct categorization	Image processing computers/sattelites
Part picking robot	Pixels of varying intensity	Pick parts and sort into bins	Place parts in correct bins	Manufacturing system
Reactor controller	Temperature, pressure readings	Open, close valves, adjust pressure, water temps.	Maximize safety, power	Reactor



Limitations

- Cognitive systems as “systems that know what they are doing”
  - are there computer programs/artificial systems that “know” what they are doing
- How can we tell that “artificial intelligence” has been achieved?



Focus of Class

- Problem Solving
- Problems and Problem Spaces
- Basic Problem Solving Methods
- Game Strategies
- Knowledge Representation (KR)
- 3.1 Principles of KR using predicate logic
- 3.2 Overview of KR using other logics
- 3.3 Structured representations of knowledge
- Planning
- Introduction to selected advanced topics, including computer-guided surgery, intelligent sensing systems, co-evolution, and conflict resolution.
- Project experience - active student engagement