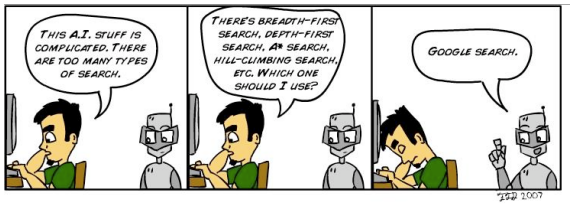


http://blog.lib.umn.edu/torre107/si/pics/superficialintelligence2.jpg

Uninformed Search

CS457
David Kauchak
Fall 2011

Adapted from notes from:
Sara Owsley Sood, Eric Eaton

Administrative

- Final project proposals
- Assignment 5

AI is a huge field

- So, what is AI…
- One definition:

  "Building programs that enable computers to do what humans can do."

- for example: read, walk around, drive, play games, solve problems, learn, have conversations…

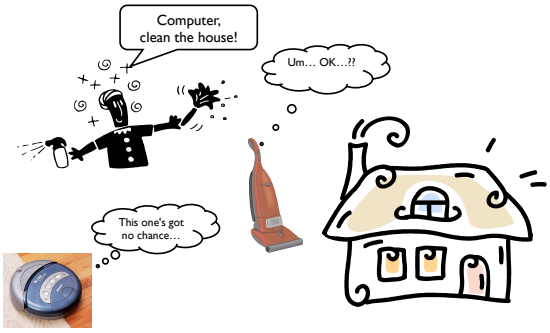
How do we measure success?

"Building programs that enable computers to do what humans can do."

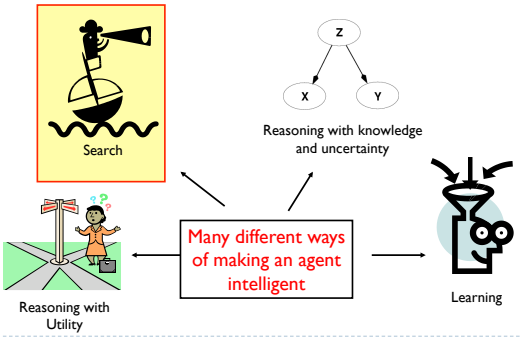
there are many interpretations of this goal…

	human	vs.	rational
thinking	**Think like a human** Cognitive Modeling		**Think rationally** Logic-based Systems
vs.			
acting	**Act like a human** Turing Test		**Act rationally** Rational Agents

How do we make a computer "smart?"



Fundamental problem of AI



Today: search

- Brute force approach
- Very unlikely how humans do it

Think like a human Cognitive Modeling	**Think rationally** Logic-based Systems
Act like a human Turing Test	**Act rationally** Rational Agents

- Enumerate out possibilities in a reasonable order

What is an "agent"?

"anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators"

- Human agent
  - sensors = eyes, ears, etc
  - actuators = hands, legs, mouth, etc
- Software agent
  - sensors = any input devices - keyboard gives it keystrokes, commands over the network, files give it text or data
  - actuators = any output devices - using the screen to display things, pass things over the network, write things to files, etc

search agents

- A search agent is an agent that approaches *problem solving* via *search*
- To accomplish a task:
  1. Formulate problem and goal
  2. Search for a sequence of actions that will lead to the goal (the policy)
  3. Execute the actions one at a time

done offline!

Formulating the problem:

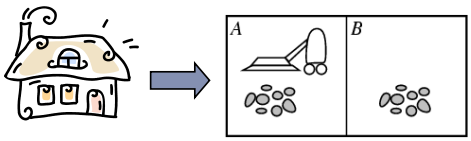
What information does a search agent need to know to plan out a solution?

Formulating the problem:

- **Initial state**: where are we starting from
  - **what are the states?**
- **Actions**: what are the possible actions
- **Transition model**: aka state-space, mapping from action x state to state
- **Goal/goal test**: what is the end result we're trying to achieve?
- **Cost**: what are the costs of the different actions

Let's start with our vacuum cleaner example

- State space
  - Just two possible spaces in the house (though this generalizes easily to more)
  - each space can either be dirty or clean
  - vaccum is in one space at a time

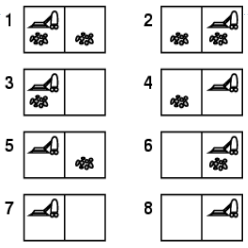


Let's start with our vacuum cleaner example

- State space
  - Just two possible spaces in the house (though this generalizes easily to more)
  - each space can either be dirty or clean
  - vaccum is in one space at a time

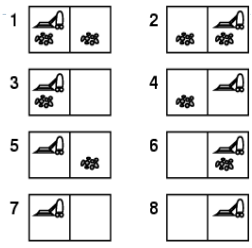
How many states?

Vacuum world



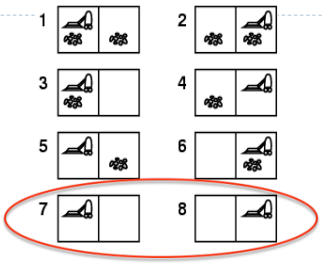
Only 8 states (options^{spaces})

Vacuum world



goal state(s)?

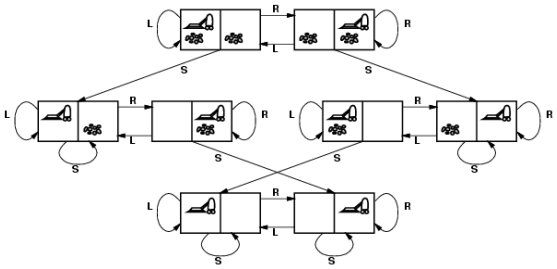
Vacuum world



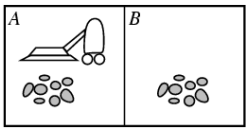
Vacuum world

- Actions?
  - move left
  - move right
  - suck
  - no-op

Vacuum world: state space/transition model



Problem characteristics



THE REAL WORLD

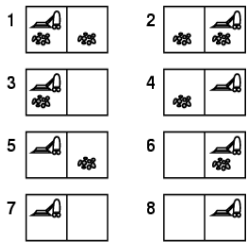
What are some of the challenges of solving even this simple version in the real world?

Problem characteristics

- Fully observable vs. partially observable
  - do we have access to all of the *relevant* information
  - noisy information, inaccurate sensors, missing information
- Deterministic vs. non-deterministic (stochastic)
  - outcome of actions are not always certain
  - probabilistic sometimes
- Known/unknown environment
  - Do we know a priori what the problem space is like (e.g. do we have a map)

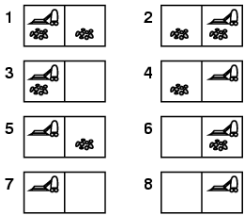
Example: vacuum world

- Deterministic, fully observable
- start in #5. Solution?



Example: vacuum world

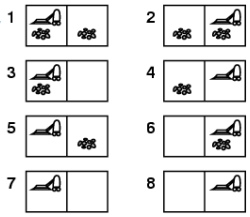
- Sensorless
- start in {*1,2,3,4,5,6,7,8*} Solution?



Example: Vacuum world

- Non-deterministic and/or partially
  - Nondeterministic: *Suck* may dirty a clean carpet
  - Partially observable: location, dirt at current location.
  - Percept: *[L, Clean]*, i.e., start in #5 or #7

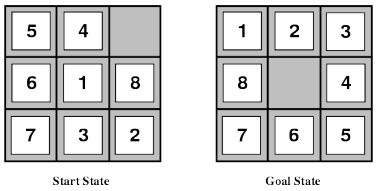
Solution?



Vacuum world

- Cost?

Another problem: 8-Puzzle

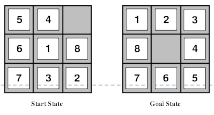


8-puzzle

- goal
- states?
- actions?
- path cost?

8-puzzle

- **state:**
  - all 3 x 3 configurations of the tiles on the board
- **actions:**
  - Move Blank Square Left, Right, Up or Down.
  - This is a more efficient encoding than moving each of the 8 distinct tiles
- **path cost:**
  - +1 for each action



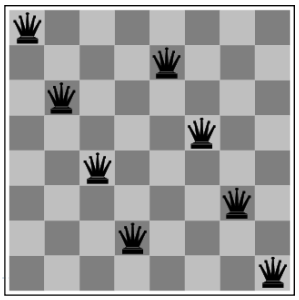
The 8-Queens Problem

State transition: ?

Initial State: ?

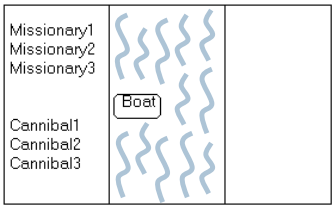
Actions: ?

Goal: Place eight queens on a chessboard such that no queen attacks any other!



Missionaries and Cannibals

Three missionaries and three cannibals wish to cross the river. They have a small boat that will carry up to two people. Everyone can navigate the boat. If at any time the Cannibals outnumber the Missionaries on either bank of the river, they will eat the Missionaries. Find the smallest number of crossings that will allow everyone to cross the river safely.



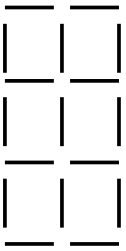
Cryptarithmetic

- Find an assignment of digits (0, ..., 9) to letters so that a given arithmetic expression is true. examples: SEND + MORE = MONEY and

```
  FORTY     Solution:  29786
+  TEN                   850
+  TEN                   850
 -----                 -----
 SIXTY                 31486
F=2, O=9, R=7, etc.
```

Remove 5 Sticks

Given the following configuration of sticks, remove exactly 5 sticks in such a way that the remaining configuration forms exactly 3 squares.



Water Jug Problem

Given a full 5-gallon jug and a full 2-gallon jug, fill the 2-gallon jug with exactly one gallon of water.

Some real-world problems

- Route finding
  - directions, maps
  - computer networks
  - airline travel
- VLSI layout
- Touring (traveling salesman)
- Agent planning

Search algorithms

- We've defined the problem
- Now we want to find the solution!
- Use search techniques
  - offline, simulated exploration of state space by generating successors of already-explored states (a.k.a. expanding states)
  - Start at the initial state and search for a goal state
- What are candidate search techniques?
  - BFS
  - DFS
  - Uniform-cost search
  - Depth limited DFS
  - Depth-first iterative deepening