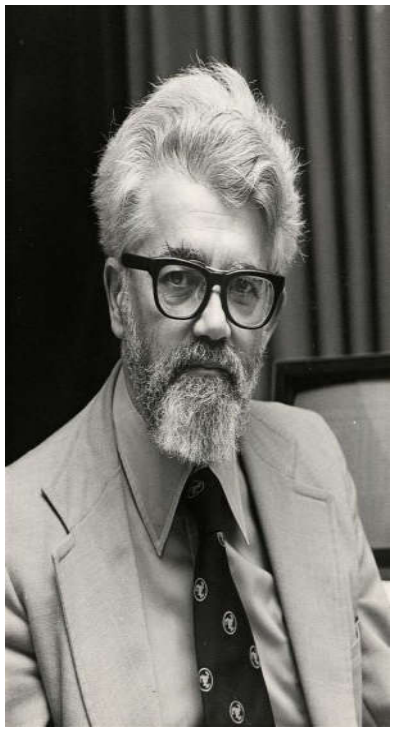
A (Short) History of AI

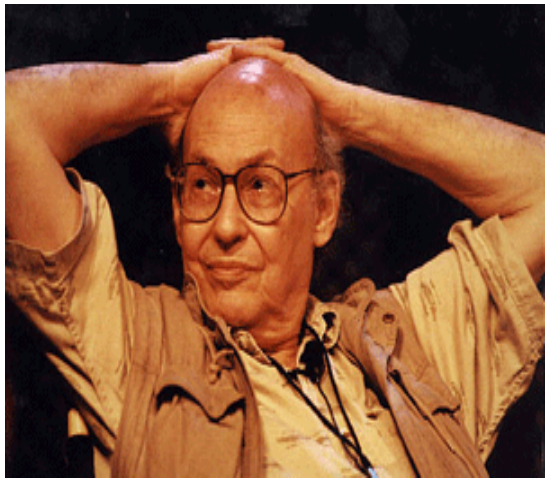
The Origins of AI

Birth of AI occurred when Marvin Minsky & John McCarthy organized the Dartmouth Conference in 1956

- Minsky (MIT), McCarthy (MIT/Stanford), Newell & Simon (Carnegie),…



John McCarthy



Marvin Minsky

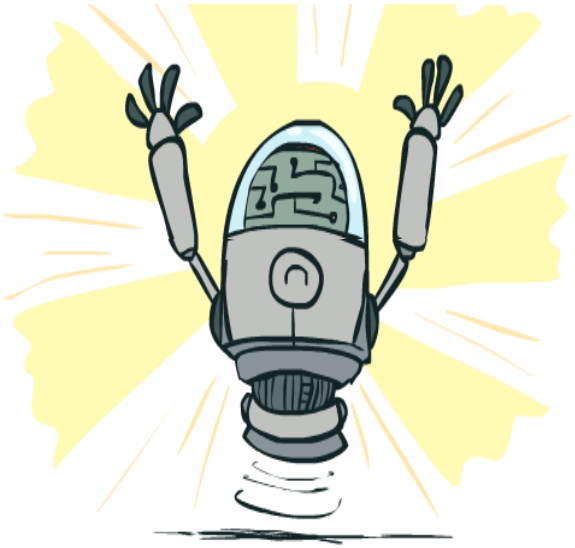
A (Short) History of AI

- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Computing Machinery and Intelligence”
- 1950—70: Excitement: Look, Ma, no hands!
  - 1950s: Early AI programs: chess, checkers (RL), theorem proving
  - 1956: Dartmouth meeting: “Artificial Intelligence” adopted
  - 1965: Robinson's complete algorithm for logical reasoning
- 1970—90: Knowledge-based approaches
  - 1969—79: Early development of knowledge-based systems
  - 1980—88: Expert systems industry booms
  - 1988—93: Expert systems industry busts: “AI Winter”
- 1990— 2012: Statistical approaches + subfield expertise
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems… “AI Spring”?
- 2012— ___: Excitement: Look, Ma, no hands again?
  - Big data, big compute, deep learning
  - AI used in many industries

What Can AI Do?

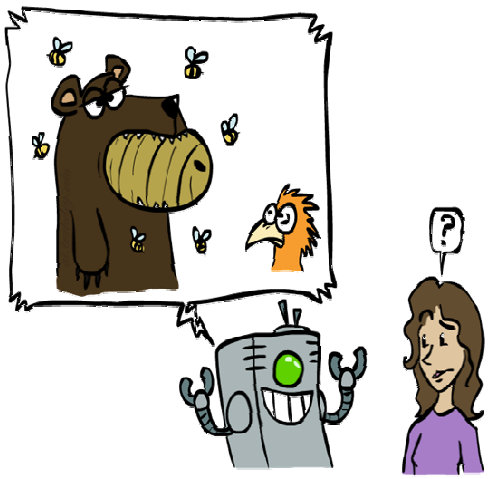
Quiz: Which of the following can be done at present?

- ✓ Play a decent game of table tennis?
- ✓ Play a decent game of Jeopardy?(watson IBM)
- ✓ Drive safely along a curving mountain road?
- ✗ Drive safely along Charbach Avenue?(uncertainty)
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at Charbach?
- ? Discover and prove a new mathematical theorem?(hilbert)
- ✗ Converse successfully with another person for an hour?
- ? Perform a surgical operation?
- ✓ Translate spoken Chinese into spoken English in real time?
- ? Fold the laundry and put away the dishes?
- ✗ Write an funny story?



Unintentionally Funny Stories

- 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 walked to the oak tree. He ate the beehive. The End.



- Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henryslipped and fell in the river. Gravity drowned. The End.

- Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese in his mouth. He noticed that he was holding the piece of cheese. He became hungry, and swallowed the cheese. The fox walked over to the crow. The End.

[Shank, Tale-Spin System, 1984]

Natural Language

- Speech technologies (e.g. Siri/Cortana)
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
  - Dialog systems
- Language processing technologies
  - Question answering
  - Machine translation
  - Web search
  - Text classification, spam filtering, etc…


"Il est impossible aux journalistes de rentrer dans les régions tibétaines"

Bruno Philip, correspondant du "Monde" en Chine, estime que les journalistes de l'AFP qui ont été expulsés de la province tibétaine du Qinghai "n'étaient pas dans l'illégalité".

Les faits Le dalaï-lama dénonce l'"enfer" imposé au Tibet depuis sa fuite, en 1959

Vidéo Anniversaire de la rébellion


"It is impossible for journalists to enter Tibetan areas"

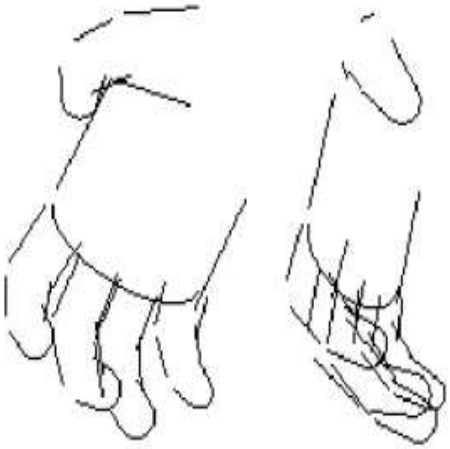
Philip Bruno, correspondent for "World" in China, said that journalists of the AFP who have been deported from the Tibetan province of Qinghai "were not illegal."

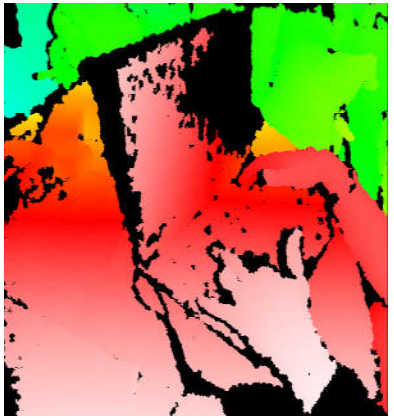
Facts The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959

Video Anniversary of the Tibetan rebellion: China on guard

Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification
- **Image captioning**



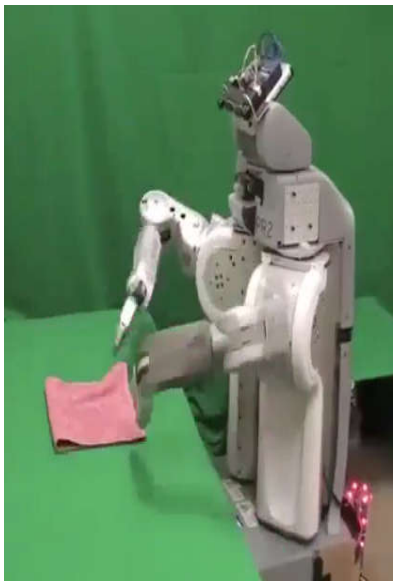


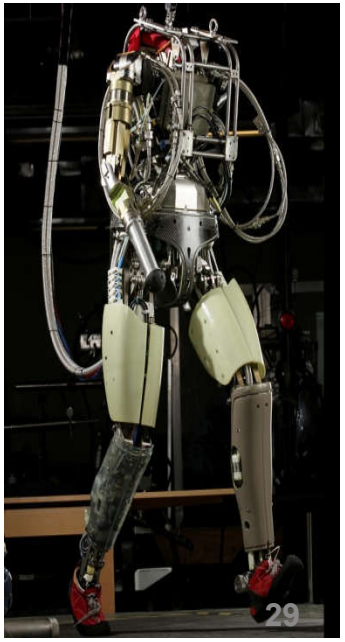
Images from Erik Sudderth (left), wikipedia (right)

Robotics

- Robotics
  - Part mech. eng.
  - Part AI
  - Reality much harder than simulations!
- Technologies
  - Vehicles
  - Rescue
  - Soccer!
  - Lots of automation…

Movie brain in AI (BCI)





Images from UC Berkeley, Boston Dynamics, RoboCup, Google

Logic

- Logical systems
  - Theorem provers
  - NASA fault diagnosis
  - Question answering
- Methods:
  - Deduction systems
  - Constraint satisfaction
  - Satisfiability solvers (huge advances!)

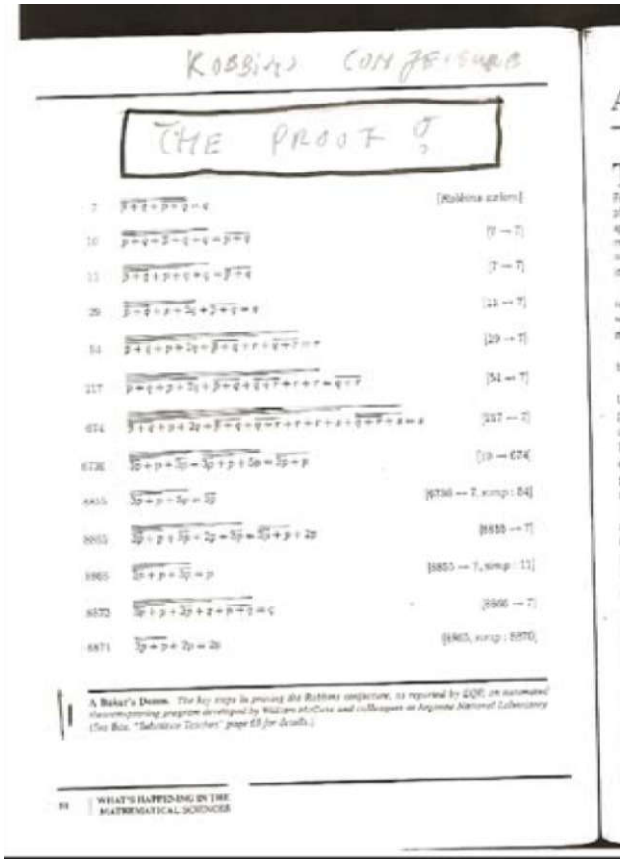
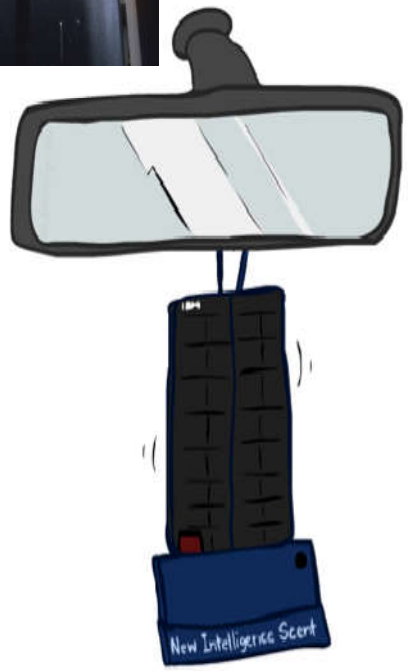


Image from Bart Selman

Game Playing

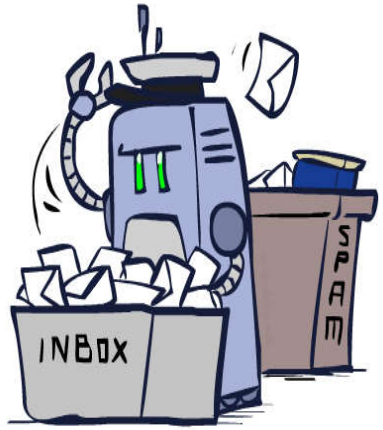
- Classic Moment: May, '97: Deep Blue vs. Kasparov
  - First match won against world champion
  - “Intelligent creative” play
  - 200 million board positions per second
  - Humans understood 99.9 of Deep Blue's moves
  - Can do about the same now with a PC cluster
- Open question:
  - How does human cognition deal with the search space explosion of chess?
  - Or: how can humans compete with computers at all??
- 1996: Kasparov Beats Deep Blue
  “I could feel --- I could smell --- a new kind of intelligence across the table.”
- 1997: Deep Blue Beats Kasparov
  “Deep Blue hasn't proven anything.”
- Huge game-playing advances recently, e.g. in Go!



Text from Bart Selman, image from IBM’s Deep Blue pages

Decision Making

– Applied AI involves many kinds of automation
  - ◆Scheduling, e.g. airline routing, military
  - ◆Route planning, e.g. Google maps
  - ◆Medical diagnosis
  - ◆Web search engines
  - ◆Spam classifiers
  - ◆Automated help desks
  - ◆Fraud detection
  - ◆Product recommendations
  - ◆… Lots more!



Newell and Simon Prediction

In 1958, Herbert Simon and Allen Newell wrote: "**within ten years a digital computer will be the world's chess champion**"

But, in 1997, Deep Blue beat Gary Kasparov.

Why Did They Get it Wrong?

They failed to understand at least three key things:

- The need for knowledge (lots of it),
- Scalability and the problem of complexity and exponential growth,
- The need to perceive the world.

Scalability

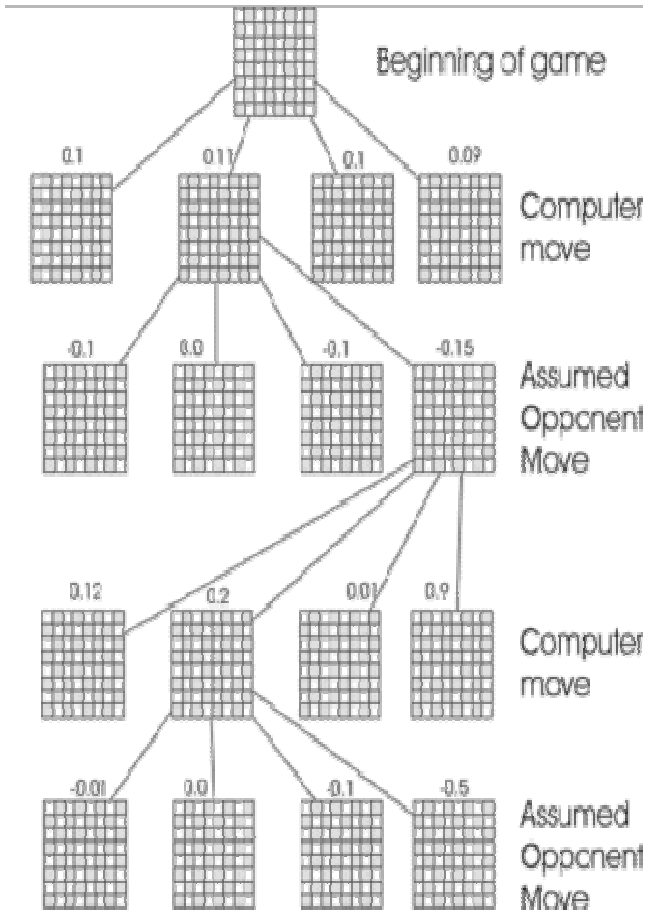
- Q: How work?

Scalability

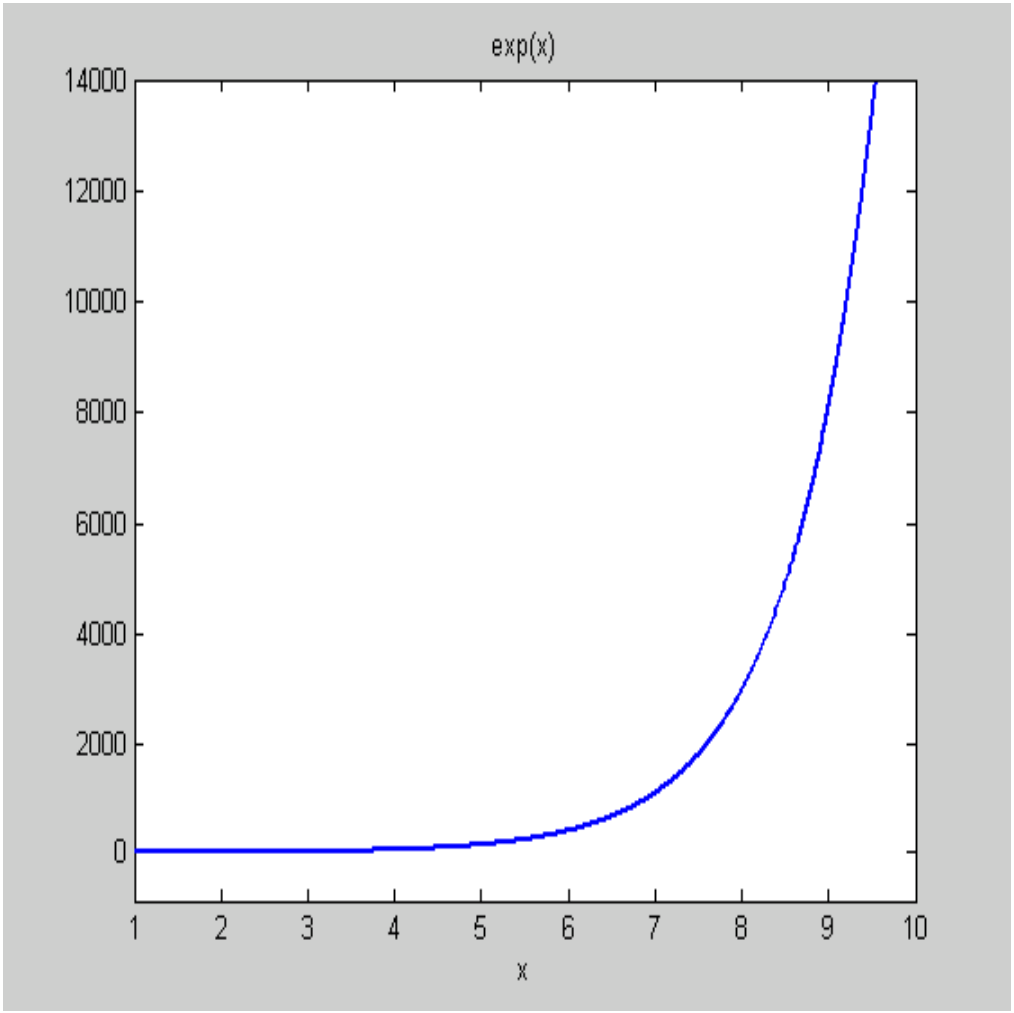
- Q: How solve program by search?

- Solving hard problems requires search in a large space.

- To play master-level chess requires searching about 8 ply deep. So about 35^8 nodes must be examined.



Exponential Growth



But Chess is Easy

- The rules are simple enough to fit on one page
- The branching factor is only 35.

A Harder One

John saw a boy and a girl with a red wagon with one blue and one white wheel dragging on the ground under a tree with huge branches.

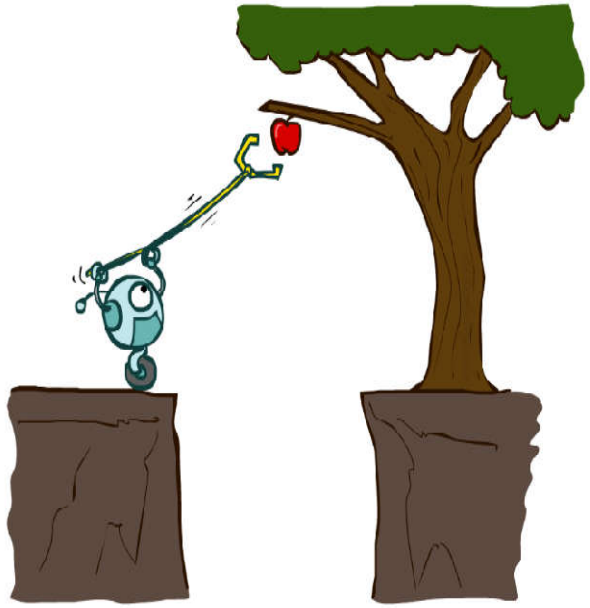
Phrase	Can attach to	cases
with huge branches	tree, ground, dragging, wheel, wagon, girl, boy and girl, saw	8
under a tree	ground, dragging, wheel, wagon, girl, boy and girl, saw	7
on the ground	dragging, wheel, wagon, girl, boy and girl, saw	6
dragging	wheel, wagon, girl, boy and girl	4
and	(one blue and one white) wheel, one blue and (one white wheel)	2
with a red wagon	girl, boy and girl, saw	3
TOTAL		8064

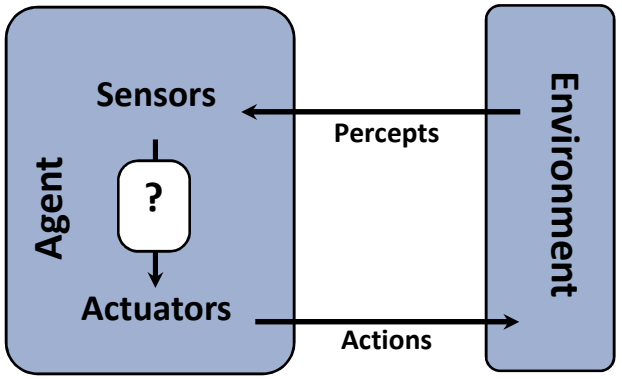
How Bad is the Ambiguity?

- Kim (1)
- Kim and Sue (1)
- Kim and Sue or Lee (2)
- Kim and Sue or Lee and Ann (5)
- Kim and Sue or Lee and Ann or Jon (14)
- Kim and Sue or Lee and Ann or Jon and Joe (42)
- Kim and Sue or Lee and Ann or Jon and Joe or Zak (132)
- Kim and Sue or Lee and Ann or Jon and Joe or Zak and Mel (469)
- Kim and Sue or Lee and Ann or Jon and Joe or Zak and Mel or Guy (1430)
- Kim and Sue or Lee and Ann or Jon and Joe or Zak and Mel or Guy and Jan (4862)

Designing Rational Agents

- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting rational actions
- **This course** is about:
  - General AI techniques for a variety of problem types
  - Learning to recognize when and how a new problem can be solved with an existing technique



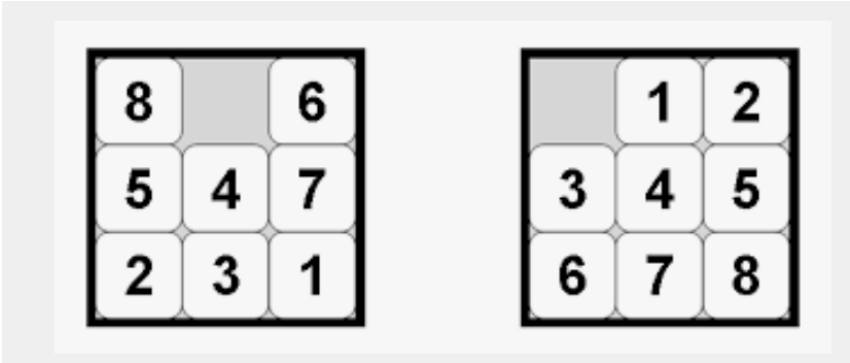


Course Topics

- Problem-solving (Chapters 3–6)
- Knowledge, reasoning, and planning (Chapters 7–12)
- Uncertain knowledge and reasoning (Chapters 13–17)
- Learning (Chapters 18–21)

Course Topics

- Agent Based Approach
- Problem-solving
  - Uninformed Search Strategies (Chapter 3)
  - Informed (Heuristic) Search Strategies (Chapter 3)
  - Stochastic Local Search (SLS), EvolutionaryAlgorithms,Metaheuristics, Swarm Intelligence (Chapter 4)
  - Adversarial Search, Games, Multiagent Systems, Mathematical Game Theory (Chapter 5)
  - Constraint Satisfaction Problems (Chapter 6)



How solve?
How to improve Search?

Course Topics

- Agent Based Approach
- Problem-solving
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  - Informed (Heuristic) Search Strategies (Chapter 3)
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  - Constraint Satisfaction Problems (Chapter 6)
- Knowledge, reasoning, and planning
  - Logical Agents
  - First-Order Logic

Outline of the course