

Foundation of AI

Introduction

Logistics

Where: Hollister B14

When: Mon, Wed, Fri 11:15-12:05

Professor: Hod Lipson, Mechanical & Aerospace Eng., Comp. & Information Science

Email: hod.lipson@cornell.edu

URL: www.mae.cornell.edu/lipson

Office Hours: 242 Upson, Tue Thu, 1-4pm or by appointment

Course web site: www.cs.cornell.edu/courses/CS4700/2011fa/

CS 4701

Where: PHL 219

When: A few Tuesdays, 03:35PM - 04:25PM

First meeting Aug 30, Additional brief presentations once a month

Can overlap with other courses

Course web site: www.cs.cornell.edu/courses/CS4701/2011fa/

Today's Lecture

What is Artificial Intelligence (AI) anyway?

- the components of intelligence

The Current Frontier

- recent achievements

Current Challenges

- what makes AI problems hard?

What is Intelligence?

Intelligence:

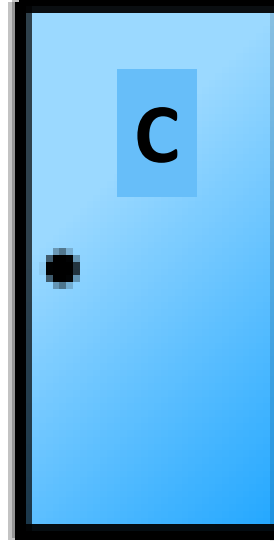
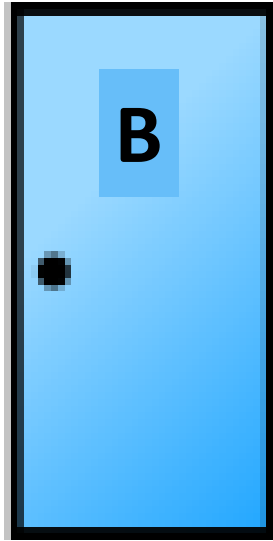
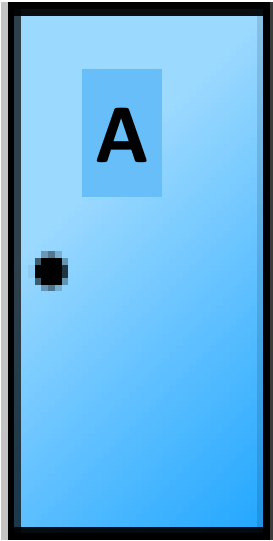
- ``the capacity to learn and solve problems'' (Webster dictionary)
- the ability to think and act rationally

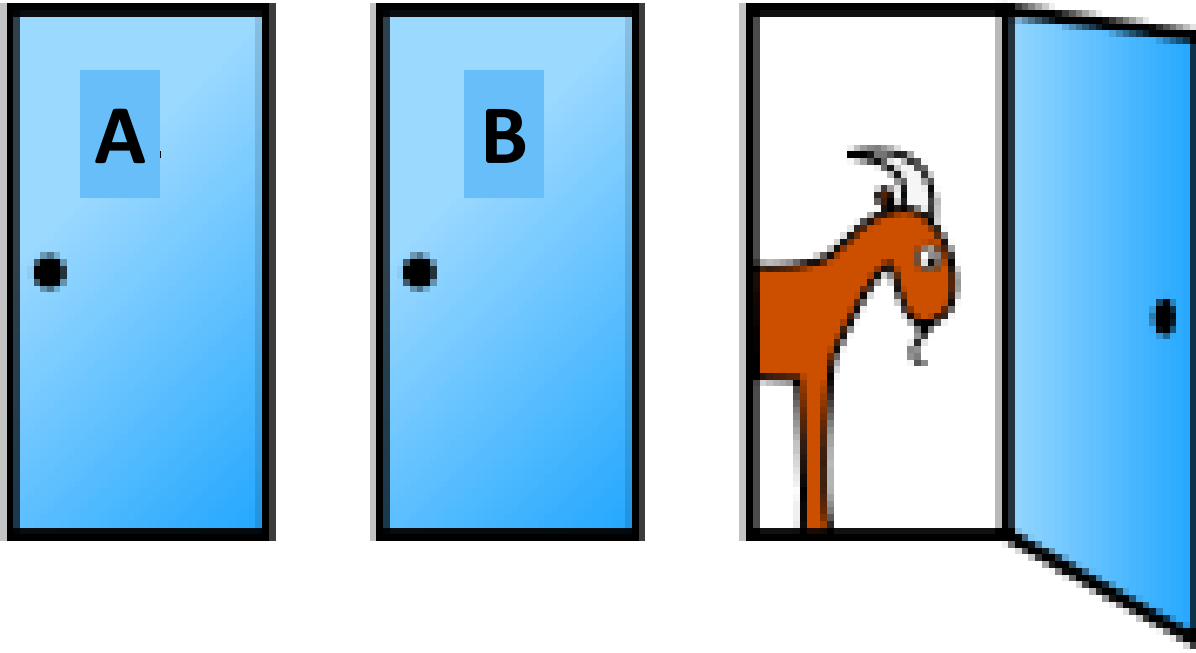
Goal in Artificial Intelligence:

- build and understand intelligent systems/agents
- synergy between
 - philosophy,
 - psychology, and cognitive science
 - computer science and engineering
 - mathematics and physics

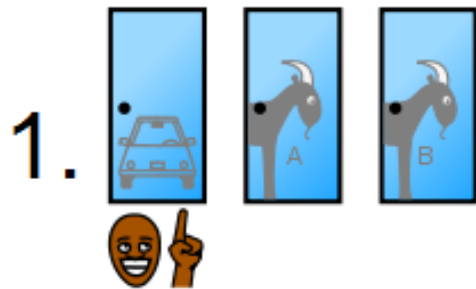


Professor Micky Rosa ([Kevin Spacey](#)) challenges Ben Campbell with the [Monty Hall problem](#)



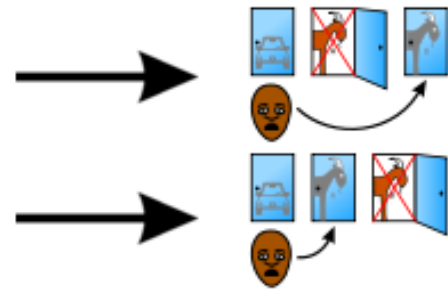


Which door would you choose now?

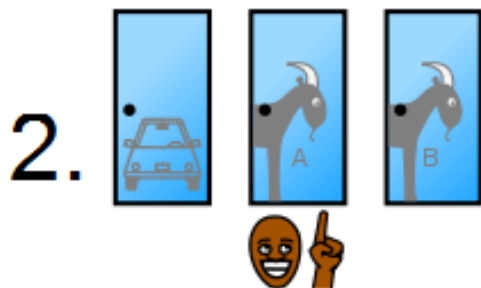


Player picks car
(probability 1/3)

Host reveals either goat

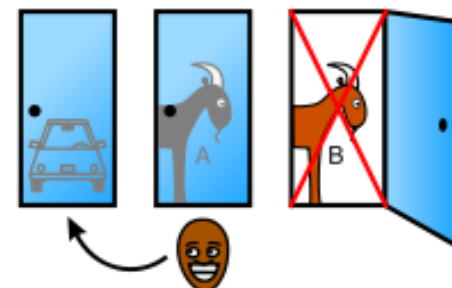


Switching loses.

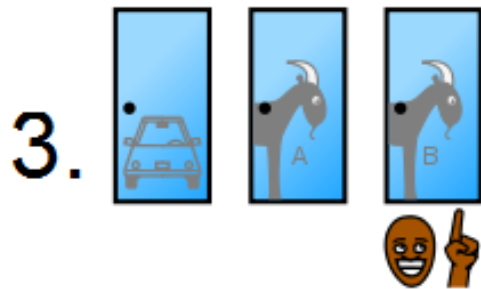


Player picks Goat A
(probability 1/3)

Host must reveal Goat B

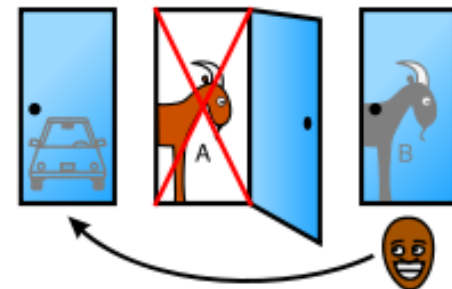


Switching wins.



Player picks Goat B
(probability 1/3)

Host must reveal Goat A



Switching wins.

What is involved in Intelligence

A) Ability to interact with the real world

- to perceive, understand, and act
- speech recognition, understanding, and synthesis
- image understanding (computer vision)

B) Reasoning and Planning

- modeling the external world
- problem solving, planning, and decision making
- ability to deal with unexpected problems, uncertainty

C) Learning and Adaptation

- we are continuously learning and adapting
- Also: we want systems that adapt to us!
- Major thrust of industry research.

What is Artificial Intelligence

Rich and Knight: the study of how to make computers do things which, at the moment, people do better.

Handbook of AI: the part of computer science concerned with designing intelligent computer systems, that is, systems that exhibit the characteristics we associate with intelligence in human behavior - understanding language, learning, reasoning, solving problems, etc.

Dean, Allen and Aloimonos: the design and study of the computer programs that behave intelligently.

Russell and Norvig: the study of [rational] agents that exist in an environment and perceive and act.

Different Approaches

I Building exact models of human cognition

- view from psychology and cognitive science

II The logical thought approach

- emphasis on ``correct'' inference

III Building rational ``agents''

- agent: something that perceives and acts
- emphasis on developing methods to match or exceed human performance [in certain domains]. Example: Deep Blue.

Our focus is on III (most recent progress).

Goals in AI

Engineering Goal

To solve real-world problems. Build systems that exhibit intelligent behavior.

Scientific Goal

To understand what kind of computational mechanisms are needed for modeling intelligent behavior.

Turing Test

- Interrogator asks questions of two “people” who are out of sight and hearing. One is a person; the other is a machine.
- 30 minutes to ask whatever he or she wants.
- Task: to determine, only through the questions and answers typed into a computer terminal, which is which
- If can't reliably distinguish the human from the computer, then the computer is deemed intelligent.

Artificial intelligence is the enterprise of constructing an artifact that can pass the Turing test.

Objections to Turing Test?

Newell and Simon [1976]

- Turing test is as much a test of the judge as it is of the machine.
- Promotes the development of artificial con-artists, not artificial intelligence (Loebner competition).

ELIZA

Men are all alike.

IN WHAT WAY

They're always bugging us about something or another.

CAN YOU BE MORE SPECIFIC

Well, my boyfriend made me come here.

YOUR BOYFRIEND MADE YOU COME HERE

He says I'm depressed much of the time.

I AM SORRY TO HEAR YOU ARE DEPRESSED

It's true. I am unhappy.

DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY

I need some help, that much seems certain.

WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP

Perhaps I could learn to get along with my mother.

TELL ME MORE ABOUT YOUR FAMILY

VICE PRESIDENT'S DIALOG IN CAPITALS

Eliza's dialog in lower case

DO YOU THINK THAT I CAN USE THE COMPUTER THIS MORNING?

Why do you ask?

I MIGHT BE ABLE TO MAKE SOME ADDITIONAL SALES.

Why, aren't you sure?

MY PROSPECTIVE CUSTOMERS HAVE NEVER SEEN A DEMONSTRATION OF THE SYSTEM.

Does this mean very much to you?

OF COURSE IT DOES.

You seem very positive about that.

THIS IS RIDICULOUS.

What do you mean, this is ridiculous?

IS THERE ANY REASON WHY I CAN'T USE THE COMPUTER NOW.

Tell me more about your prospective customers.

PLEASE DIAL ME UP ON 491-1850.

<http://www-ai.ijs.si/eliza/eliza.html>

ELIZA: `Tell me about yourself'

HUMAN: `I'm not feeling well today'

ELIZA: `Why aren't you feeling well today?'

HUMAN: `My boss is a real dread.'

ELIZA: `Tell me about your boss'

I'm not \$1 → Why aren't you \$1?

My \$1 is \$2 → Tell me more about your \$1.

→Please go on.

→What else is \$2?

ELIZA: `Tell me about yourself'

HUMAN: `I'm not feeling well today'

ELIZA: `Why aren't you feeling well today?'

HUMAN: `My boss is a **micromanaging maniac.**'

ELIZA: `Tell me about your boss'

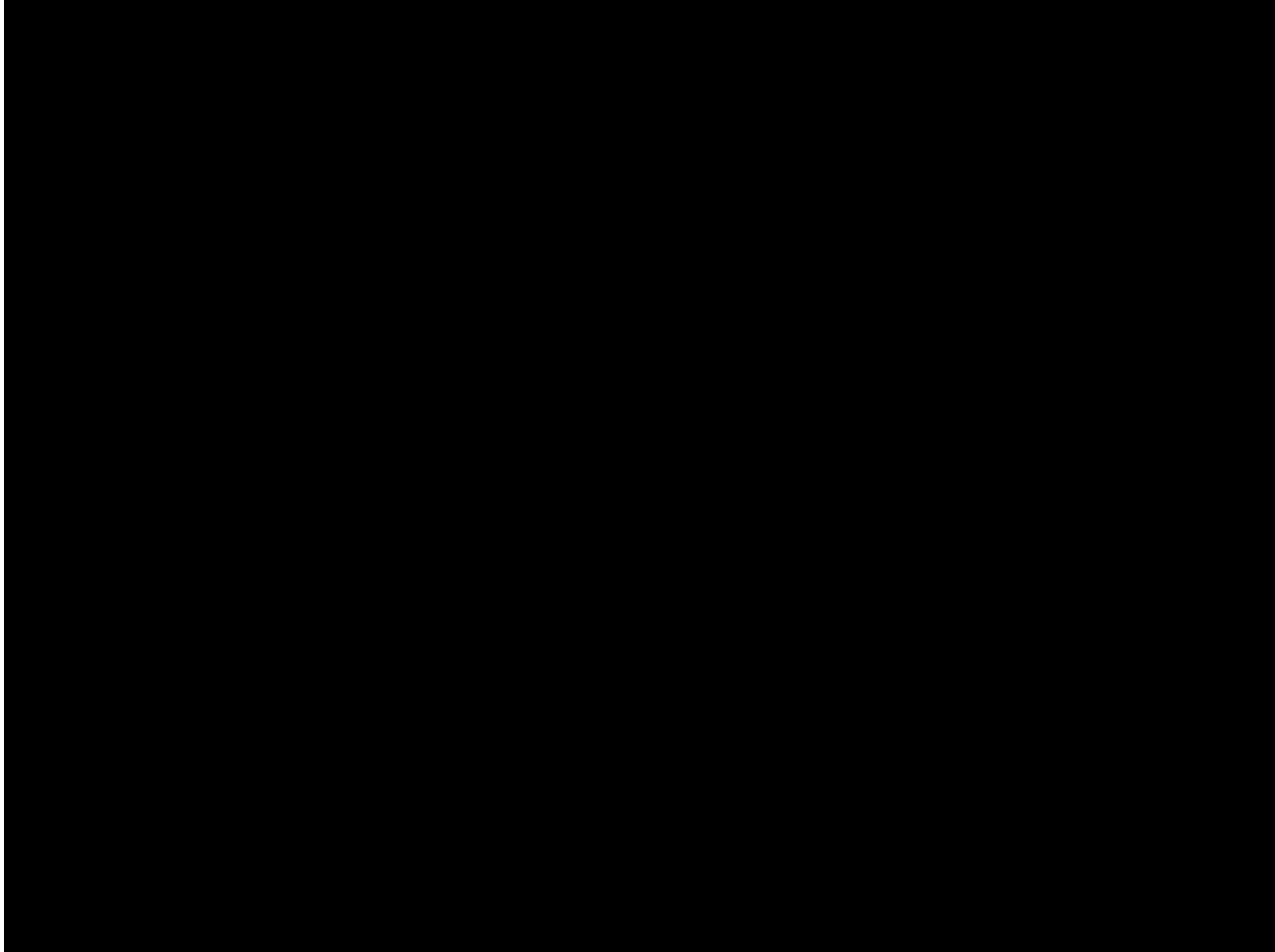
I'm not \$1 → Why aren't you \$1?

My \$1 is **a** \$2 → Tell me more about your \$1.

→Please go on.

→What else is **a** \$2?

Eliza Vs. Eliza



AI vs. AI. Two chatbots talking to each other

CornellCCSL

8 videos

Subscribe



975,216

Uploaded by CornellCCSL on Aug 26, 2011

What happens when you let two bots have a conversation? We certainly never expected this... (More: <http://creativemachines.cornell.edu/AI-vs-AI>)

8,782 likes, 83 dislikes

As Seen On:
BuzzFeed - Latest

Comments

- “I, for one, would like to welcome our new chatbot overlords “
- “just like a married couple.”
- “sounds like an extremely awkward run-in with an ex”
- “It appears Cornell's been working a means of dosing software with LSD”
- “Oh the sexual tension”
- “tense discussions of metaphysics, God, and the “lingering sense that these two just want to...”
- “Is there any more of this?”

► [News for chatbot cornell](#)



[Two AI chatbots have a conversation, one believes he is a unicorn](#) 🔍

Geek.com - 2 hours ago

The **Cornell** Machines Lab decided to see what happens when you let two **chatbots** have a conversation with each other. The result is more of what you'd expect ...

[25 related articles](#)

[Cornell lab discovers chatbot doesn't get along with itself \(video\)](#) 🔍

Washington Post (blog) - [1389 related articles](#)

[Chat-bots Square Off in a Battle of Awkward Non-Sequiturs](#) 🔍

PCWorld - 5 related articles

[AI vs. AI: Two chatbots talking to each other | Cornell Creative ...](#) +1 🔍

[creativemachines.cornell.edu/AI-vs-AI](#)

Chatbots are machines designed to emulate the conversational abilities of humans, conversing with a human user and generally attempting to convince the user ...

[Cornell's Creative Machines Lab Lets Chatbots Interact - Slashdot](#) +1 🔍

[idle.slashdot.org/.../Cornells-Creative-Machines-Lab-Lets-Chatbots-Interact](#)

23 hours ago – mikejuk writes "When **Cornell's** Creative Machines Lab got two **chatbots** to settle down for a short interaction the result was surreal, to say the ...

[Two Chatbots Face Off to Discuss God, Unicorns and Experience ...](#) +1 🔍

[gizmodo.com/.../two-chatbots-face-off-to-discuss-god-uni... - Cached](#)



by [Sam Biddle](#)

1 day ago – The sick bastards at **Cornell's** Creative Machines Lab thought it'd be a hoot to force two **chatbot** AI programs to talk to one another. The result is ...

[When two chatbots have a conversation, everyone wins \(video ...](#) +1 🔍

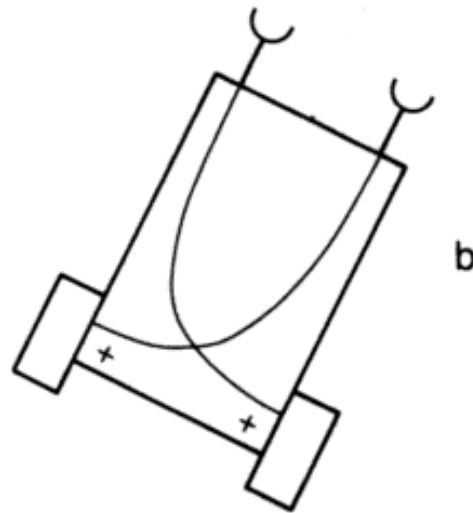
[www.engadget.com/.../when-two-chatbots-have-a-conver... - Cached](#)

1 day ago – Unfortunately for **Cornell's** squad, their **chatbots** still have a long way to go before achieving conversational coherence, though they could ...

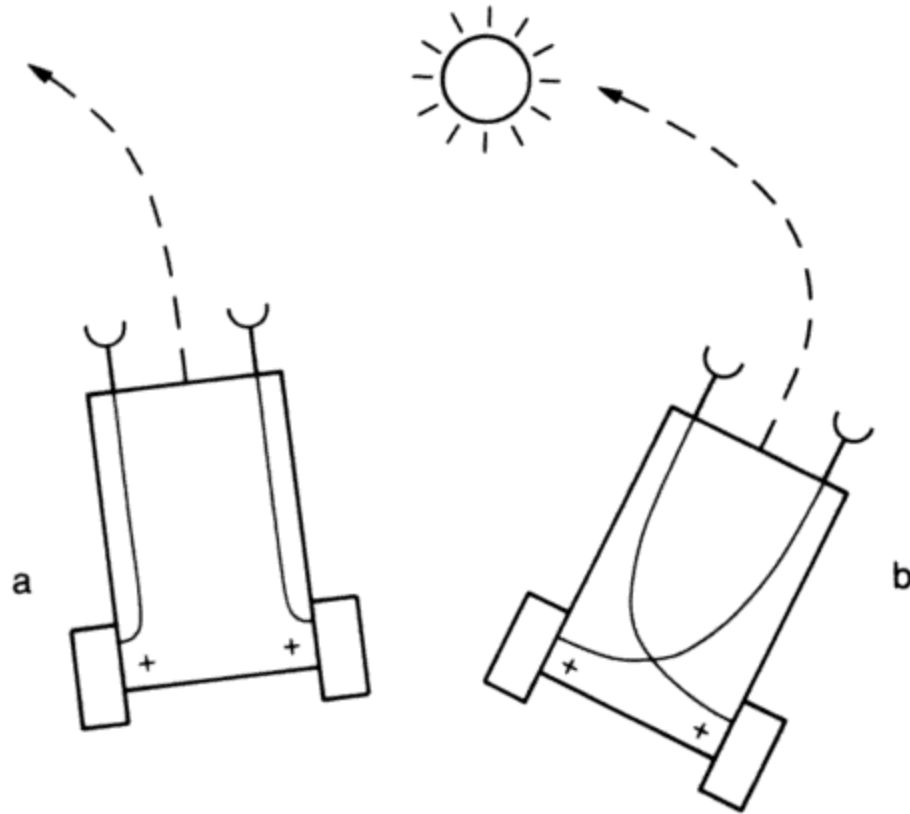
[Chatbot Tries to Talk to Itself, Things Get Weird - IEEE Spectrum](#) +1 🔍

[spectrum.ieee.org/automaton/.../chatbot-tries-to-talk-to-itself-things-get-wei](#)

Mindless Intelligence



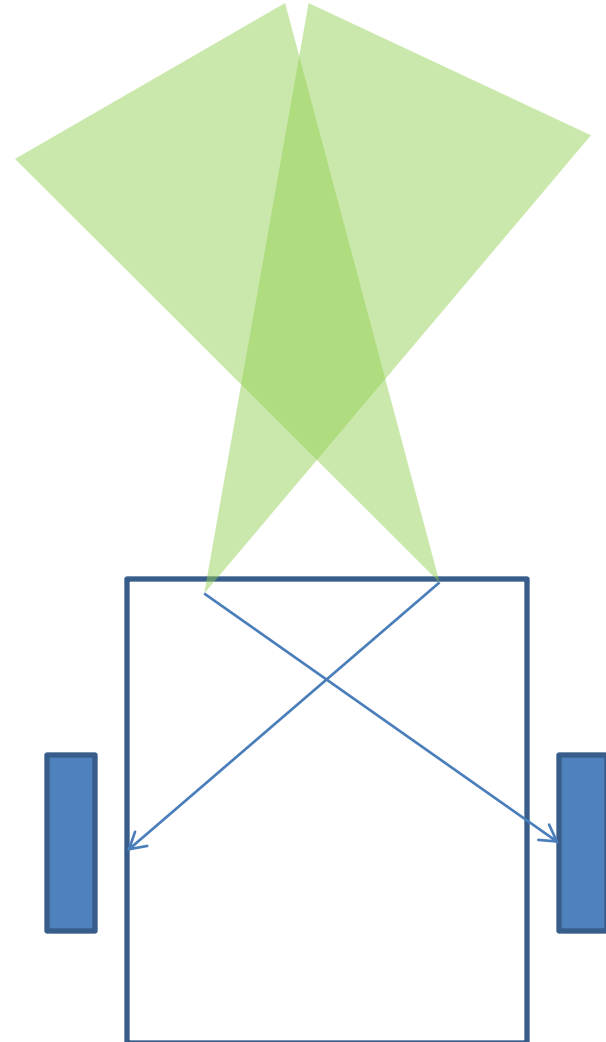
Braitenberg Vehicles



Cross-eyed robot

What will this robot do?

- A. Go towards the lights
- B. Go away from the light
- C. .
- D. .
- E. Whatever





Valentino Braitenberg



<http://www.youtube.com/watch?v=NJo5HEdq6y0>

GARRY KASPAROV



DEEP JUNIOR



Different Algorithm, Similar Behavior

Drew McDermott (New York Times, May, 1997):

Saying Deep Blue doesn't really think about chess is like saying an airplane doesn't really fly because it doesn't flap its wings.

<ftp://ftp.cs.yale.edu/pub/mcdermott/papers/deepblue.txt>

The brain

- a neuron is the basic processing unit (10^{11})
- many more synapses (10^{14}) connect the neurons
- cycle time: 10^{-3} seconds (1 millisecond)

How complex can we make computers?

- 10^8 (i7) or more transistors per Core
- supercomputer: thousands of CPUs, 10^{11} bits of RAM
- cycle times: order of 10^{-9} seconds

Examples, cont.

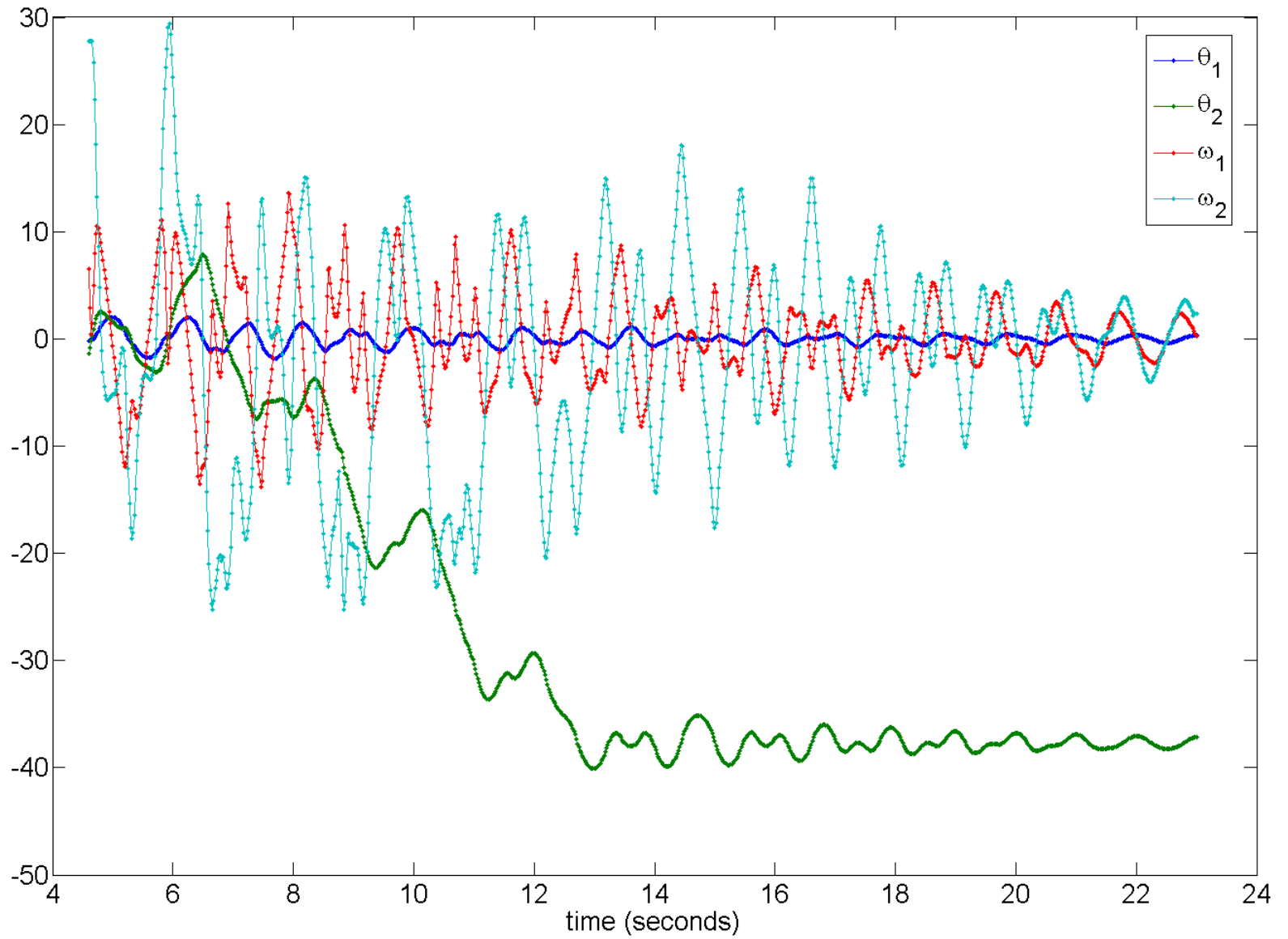
- First “creative” proof by computer (Nov, '96)
 - 60 year open problem.
 - Robbins' problem in finite algebra.

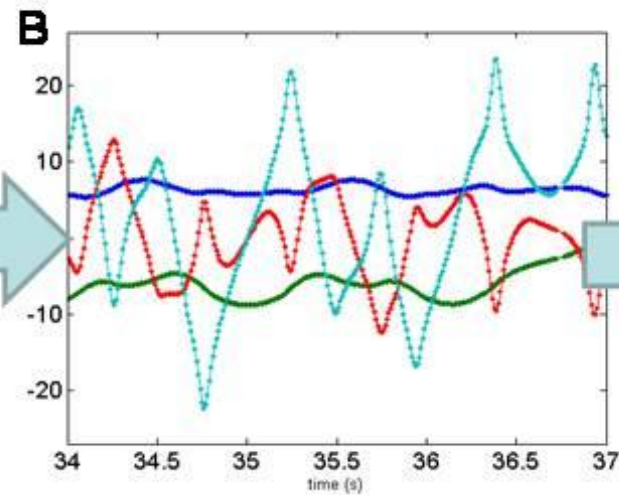
Qualitative difference from previous brute-force results.

Does technique generalize?

(Our own expert: Robert Constable.)







C

Detected Invariance:

$$L_1^2(m_1+m_2)\omega_1^2 + m_2L_2^2\omega_2^2 + m_2L_1L_2\omega_1\omega_2\cos(\theta_1 - \theta_2) - 19.6L_1(m_1+m_2)\cos \theta_1 - 19.6m_2L_2\cos \theta_2$$

Machine Learning

- TD Gammon (Tesauro 1993; 1995)
 - World champion level but learns from scratch by playing millions of games against itself!
 - Has changed human play
- ALVINN (Pomerleau 1993)
 - Neural net used to steer vehicle in coast-to-coast highway driving
 - Speeds of up to 90 mph
 - DARPA Grand Challenge / Urban Challenge

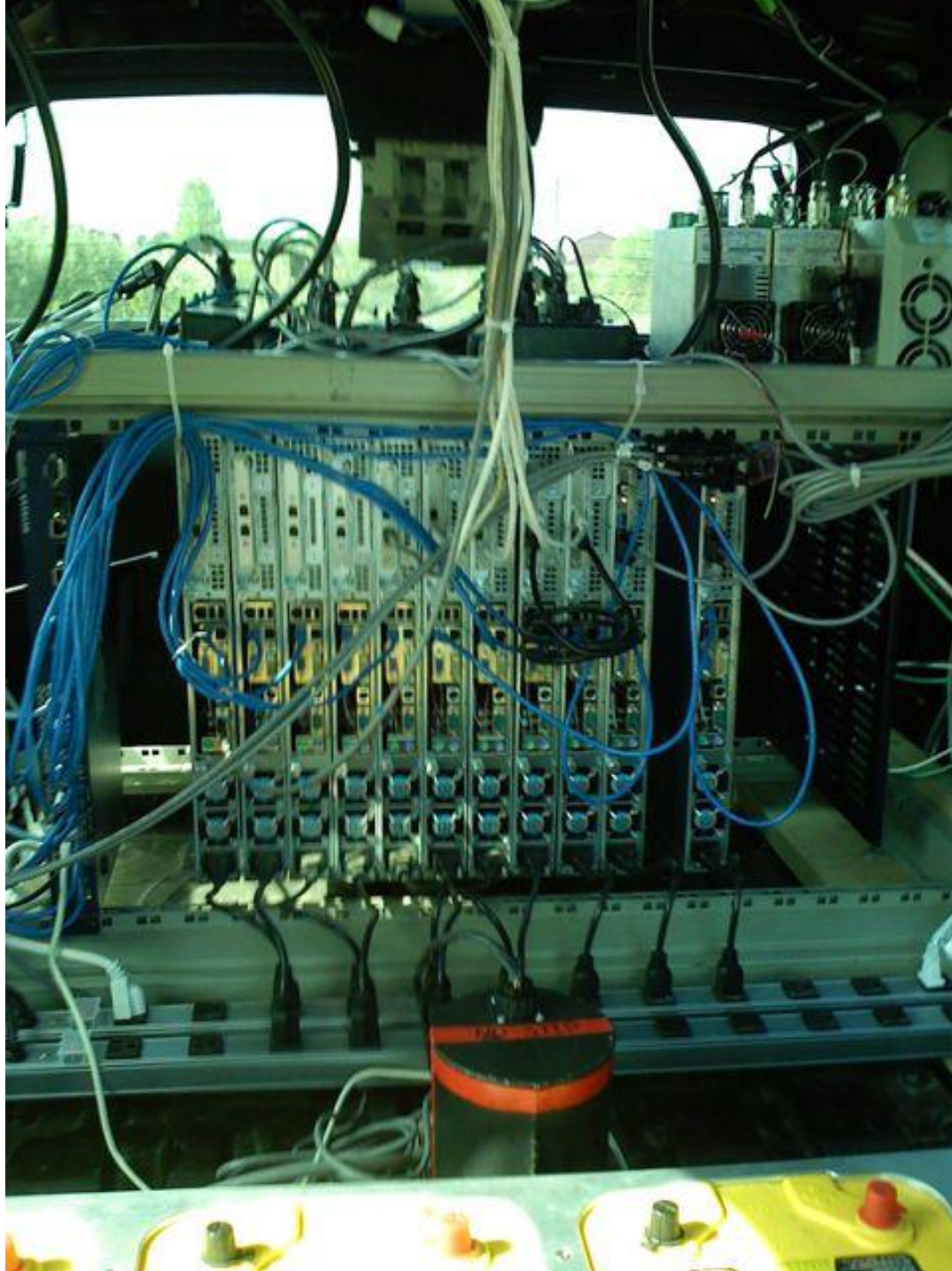




FINISH







Dynamic Virus Detectors





Natural Language Processing

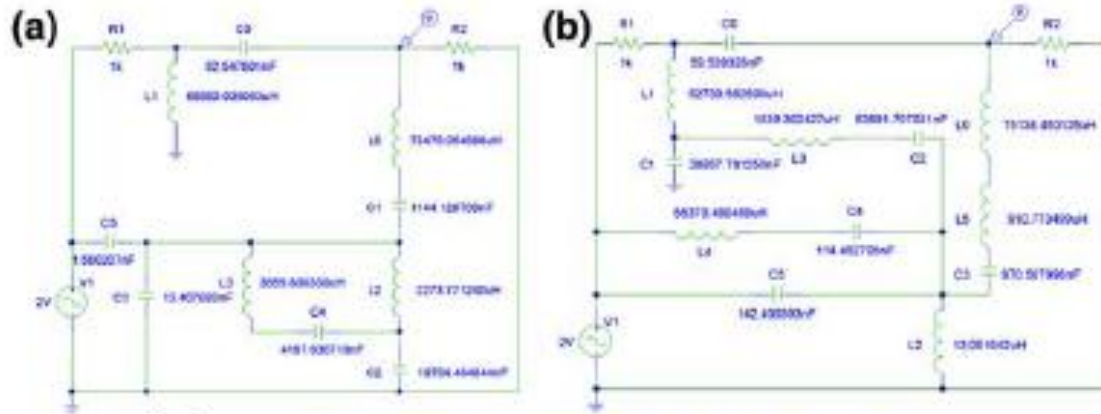
BOGOTA, 9 JAN 90 (EFE) - RICARDO ALFONSO CASTELLAR, MAYOR OF ACHI, IN THE NORTHERN DEPARTMENT OF BOLIVAR, WHO WAS KIDNAPPED ON 5 JANUARY, APPARENTLY BY ARMY OF NATIONAL LIBERATION (ELN) GUERRILLAS, WAS FOUND DEAD TODAY, ACCORDING TO AUTHORITIES. CASTELLAR WAS KIDNAPPED ON 5 JANUARY ON THE OUTSKIRTS OF ACHI, ABOUT 850 KM NORTH OF BOGOTA, BY A GROUP OF ARMED MEN, WHO FORCED HIM TO ACCOMPANY THEM TO AN UNDISCLOSED LOCATION.

Summary:

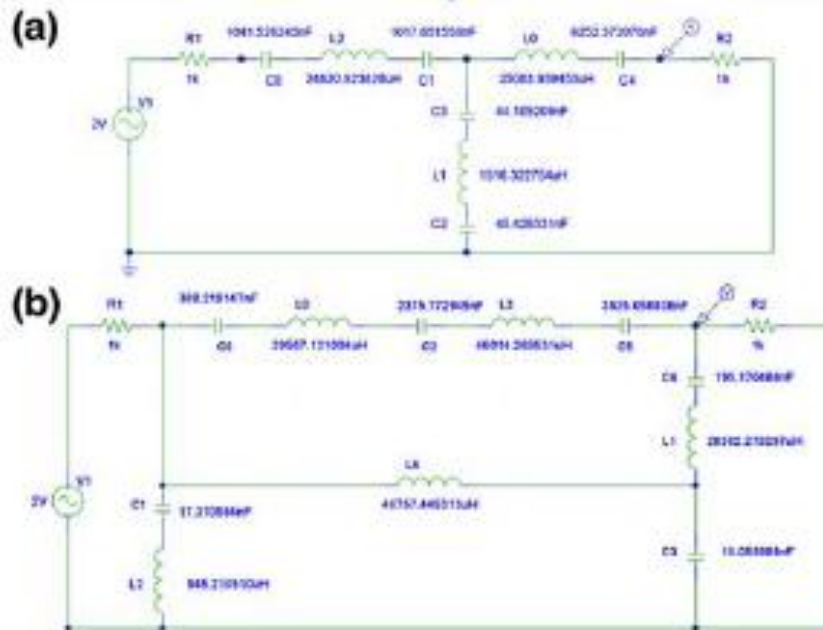
- Date: 05 JAN 90
- Location: COLOMBIA: BOLIVAR (DEPARTMENT): ACHI (TOWN)
- Type: KIDNAPPING
- Weapon: *
- Victim: "RICARDO ALFONSO CASTELLAR" (MAYOR OF ACHI)
- Perpetrator: "GROUP OF ARMED MEN"
- Organization: "ARMY OF NATIONAL LIBERATION (ELN)"

Creativity?

High-Pass Filter



Band-Pass Filter



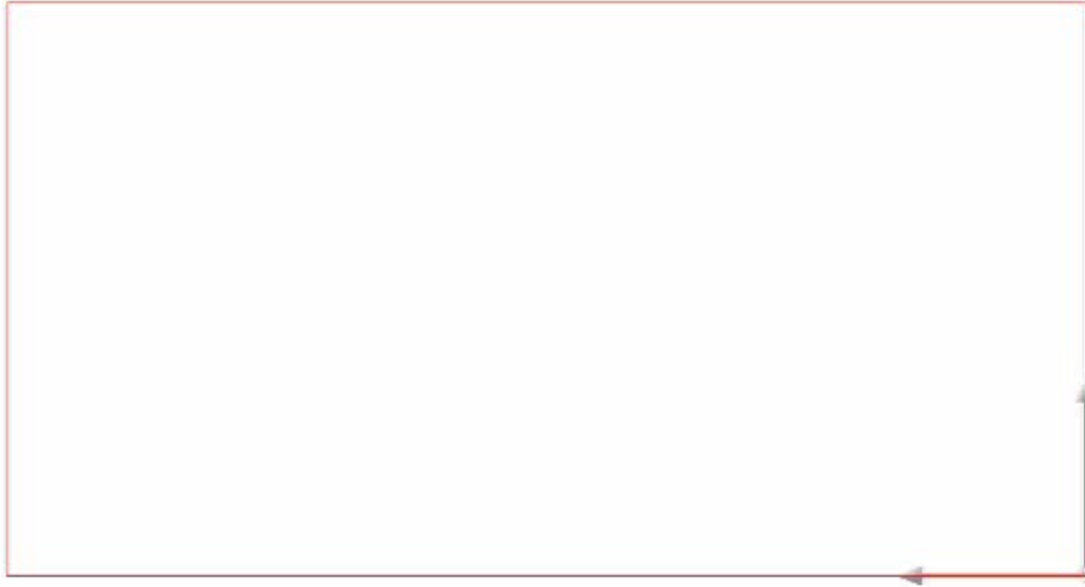


X-band antenna for NASA's ST-5 Mission

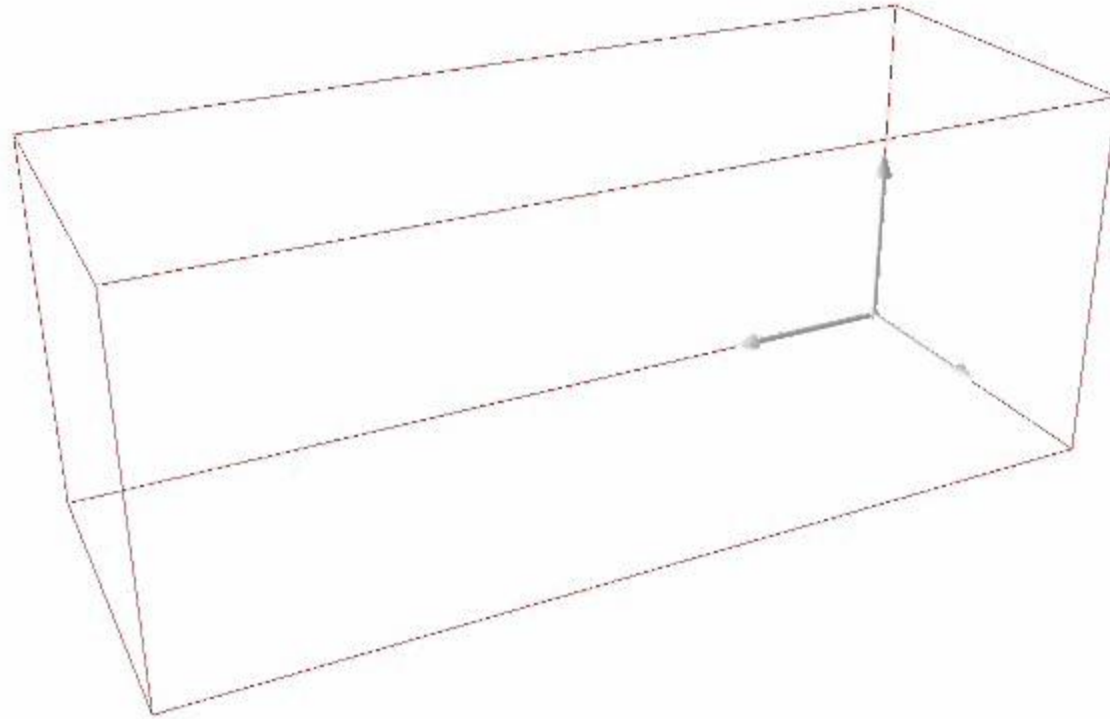
Design Automation



Design Automation



Design Automation



Start Anew
Browse
Best New
Highest Rated
Newest
Random



Explore object designs by choosing those you like. Evolution produces objects in the next generation that are variants of those you choose, similar to how animals are bred and naturally evolve ([more](#)). Either further evolve an object below or [start evolving from scratch](#).

★★★★★ Evolve



mushroom

★★★★★ Evolve



Get a Spine

★★★★★ Evolve



another carbonite face

★★★★★ Evolve



female torso

★★★★★ Evolve



bee queen

★★★★★ Evolve



butterfly

★★★★★ Evolve



scarecrow

★★★★★ Evolve



scarecrow

★★★★★ Evolve

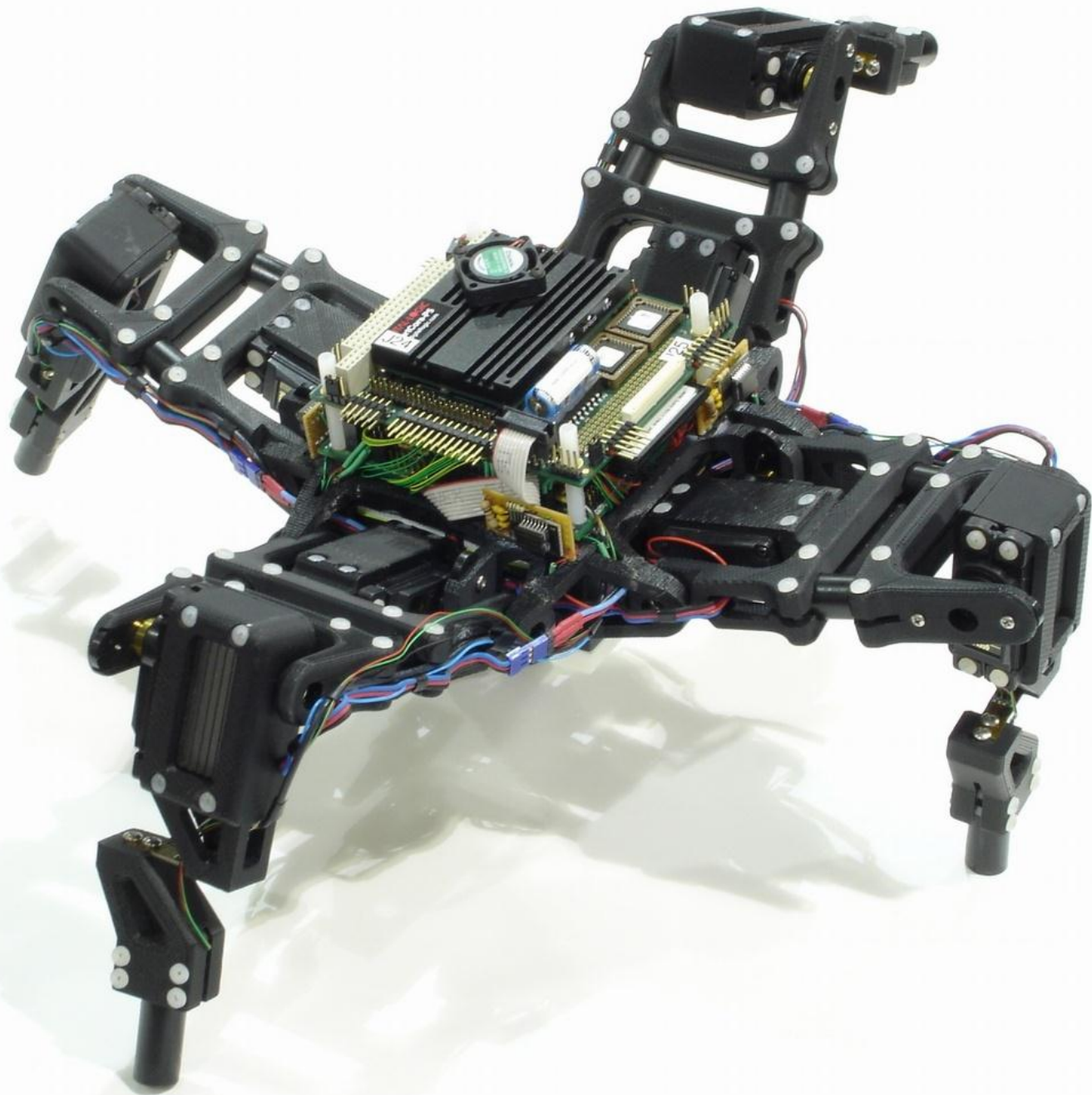


scarecrow

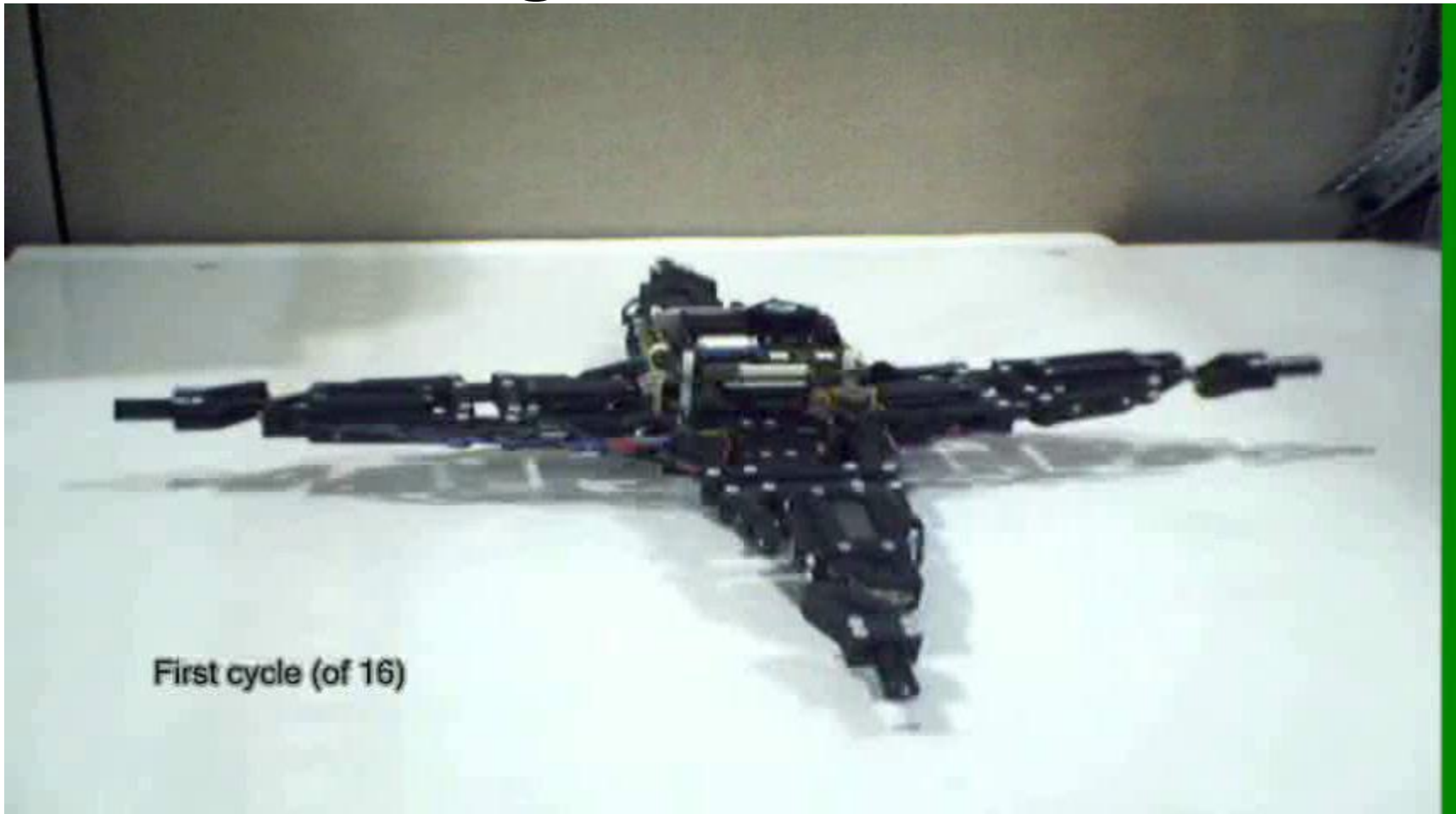
★★★★★ Evolve



light bulb, hot air balloon



Emergent Self-Model



With Josh Bongard and Victor Zykov, Science 2006

Challenges Ahead

- Note that the examples we discussed so far all involve quite specific tasks.
- The systems lack a level of generality and adaptability. They can't easily (if at all) switch context.
- Key issue: knowledge acquisition bottleneck
 - Lack of general commonsense knowledge.
 - CYC project (Doug Lenat et al.). Attempt to encode millions of facts.

Goal of This Course

- Introduce you to the kinds of problems studied in AI.
- Introduce you to a set of key methods for problem solving, knowledge representation and reasoning, learning, natural language understanding.
- Teach you about the applicability and limitations of these methods.