
人工智能
The ShanghAI Lectures
上海AI授课

Video clips

- **Heider and Simmel**

Registration

students:

please register by Tuesday, 9 October 2012

(so that we have enough time to compose the groups)

http://shanghailectures.org/

thank you!

Calling on:

- Moscow —> student pres.: IQ and professional success
- Xi'an —> student pres.: The Chinese Room Experiment (postponed to 11 October)
- Budapest (BME-IIT) —> function of TM?
- Berlin —> why is perception hard?
- skku, Korea —> real worlds vs. virtual worlds
- NYU Abu Dhabi —> comment on Heider & Simmel
- Chiba —> new path of ant? why?
- Christopher Lueg, Tasmania —> guest lecture
- Davide Scaramuzza, UZH, NCCR Robotics —> guest lecture

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Holidays in China

- **Mid-Autumn Festival**
- **National Day**

30 September–7 October

Hu Jintao, Chinese President
Flower laying ceremony, Tiananmen Square, Bejing, China

University of Zurich[UZH]

robotics

The ShanghAI Lectures by the University of Zurich
An experiment in global teaching

Rolf Pfeifer and Nathan Labhart
National Competence Center Research in Robotics (NCCR Robotics)
Artificial Intelligence Laboratory
University of Zurich

Today from the University of Zurich, Switzerland

欢迎您参与

“来自上海的人工智能系列讲座”

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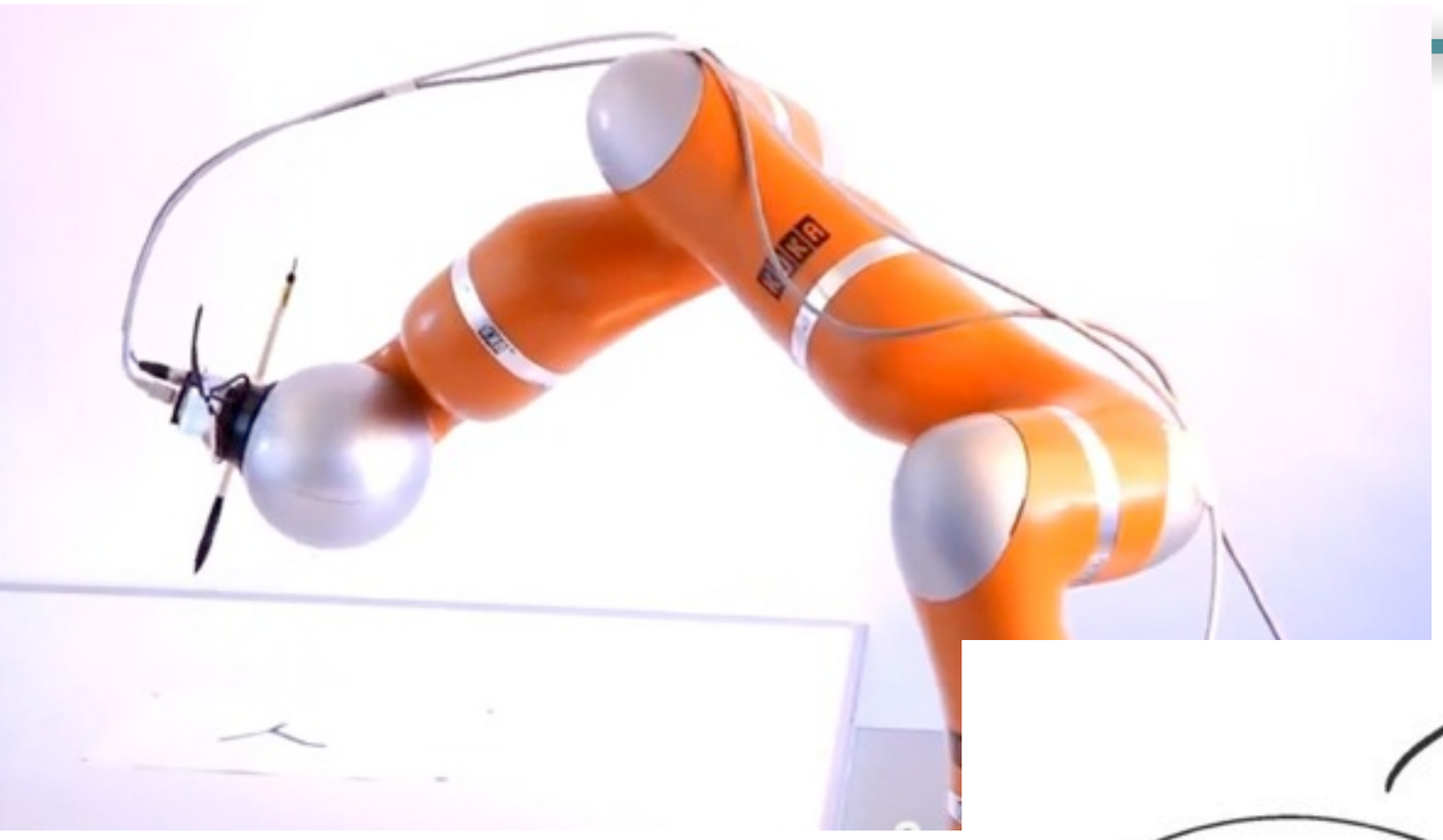
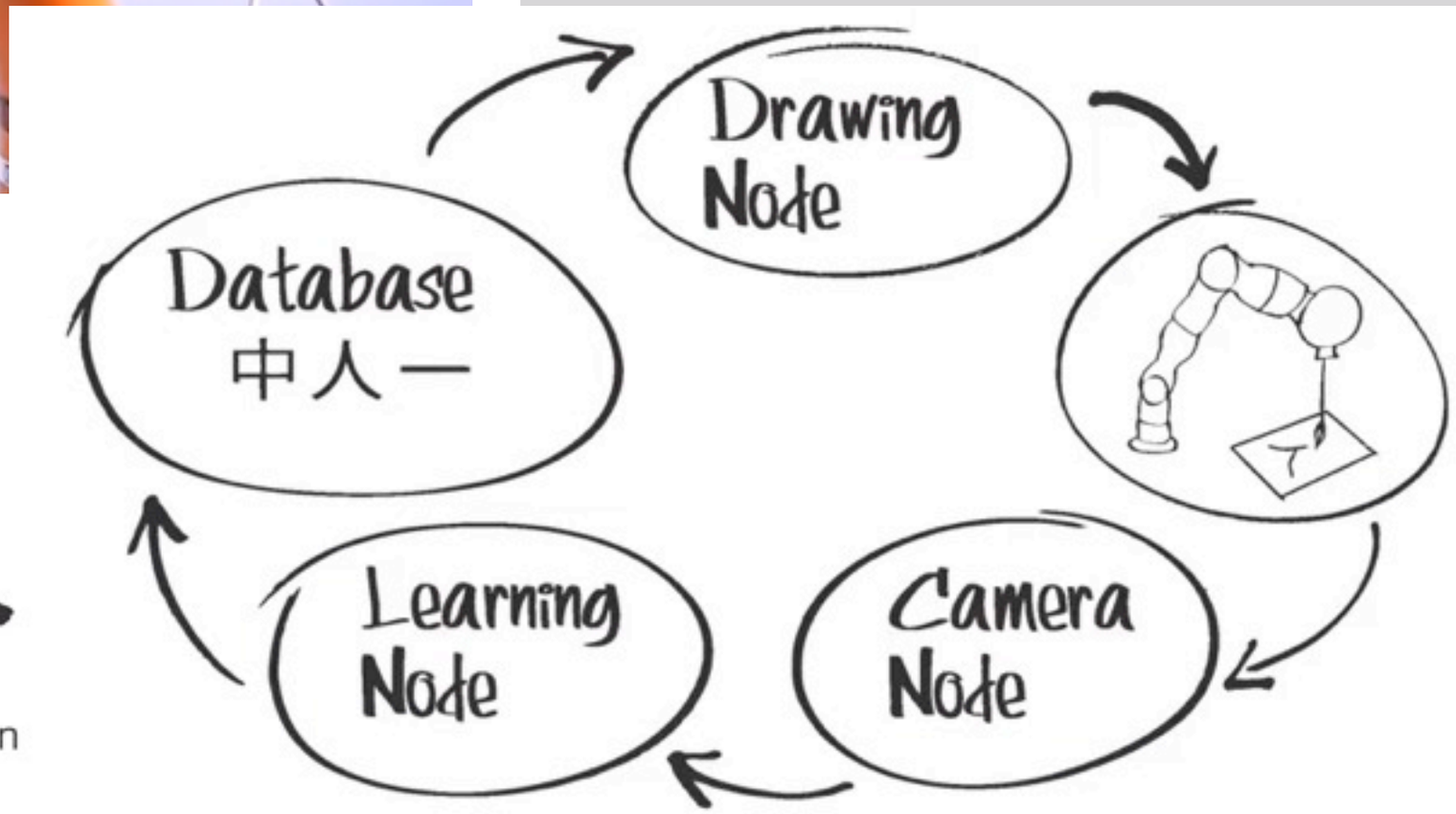
Robots in the media (Chinese character writing robot)





Lecture 2

Cognition as computation: Successes and failures

The need for an embodied perspective on intelligence

4 October 2012

University of Zurich

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Guest speaker 1

Prof. Christopher Lueg
University of Tasmania
Hobart, Australia
(formerly AI Lab, UZH)

Embodiment and information behavior

Today, 10.00 CET (18.00 Australia)

University of Zurich

robotics Swiss National Centre of Competence in Research

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The ShanghAI Lectures

current and future market places, Key application areas, history of robotics and future trends

Guest speaker 2

Prof. Davide Scaramuzza
NCCR Robotics, Switzerland
AI Lab, University of Zurich

Autonomous Vision-Based Navigation: a Ground and Flying Robot Perspective

Today, 10.30 CET (9.30 GMT)

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The ShanghAI Lectures

current and future market places, Key application areas, history of robotics and future trends

Today's topics

- short recap
- The classical approach: Cognition as computation
- Successes and failures of the classical approach
- Some problems of the classical approach
- The need for an embodied approach
- The "frame-of-reference" problem

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Today's topics

- short recap
- The classical approach: Cognition as computation
- Successes and failures of the classical approach
- S
- T
- The "frame-of-reference" problem

with a student presentation from Russian State University for the humanities in Moscow

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Definitions, arguments

- hard to agree on
- necessary and sufficient conditions?
- are robots, ants, humans intelligent?

more productive question:

“Given a behavior of interest, how does it come about?”

Measuring intelligence

- e.g. IQ
- ...

IQ testing — issues (1)

- IQ in genes (nature) or acquired (nurture)? — the "nature-nurture debate"
- IQ trainable — increased through practice?
- cultural differences?
- professional success? why are some with high IQ successful, others not?
- emotional intelligence?
- relation to brain processes?

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IQ testing — issues (2)

- many different abilities, not just one number? (tests for different abilities; see Howard Gardner, Robert Sternberg, Steven J. Gould, and many others)
- the "Flynn Effect" (IQ increasing over the years)

IQ testing

- IQ in genes (nature) or acquired (nurture)? — the
- presentation from Russian State University for the humanities in Moscow "IQ and professional success"
- professional success? why are some with high IQ successful, others not?
- emotional intelligence?
- relation to brain processes?

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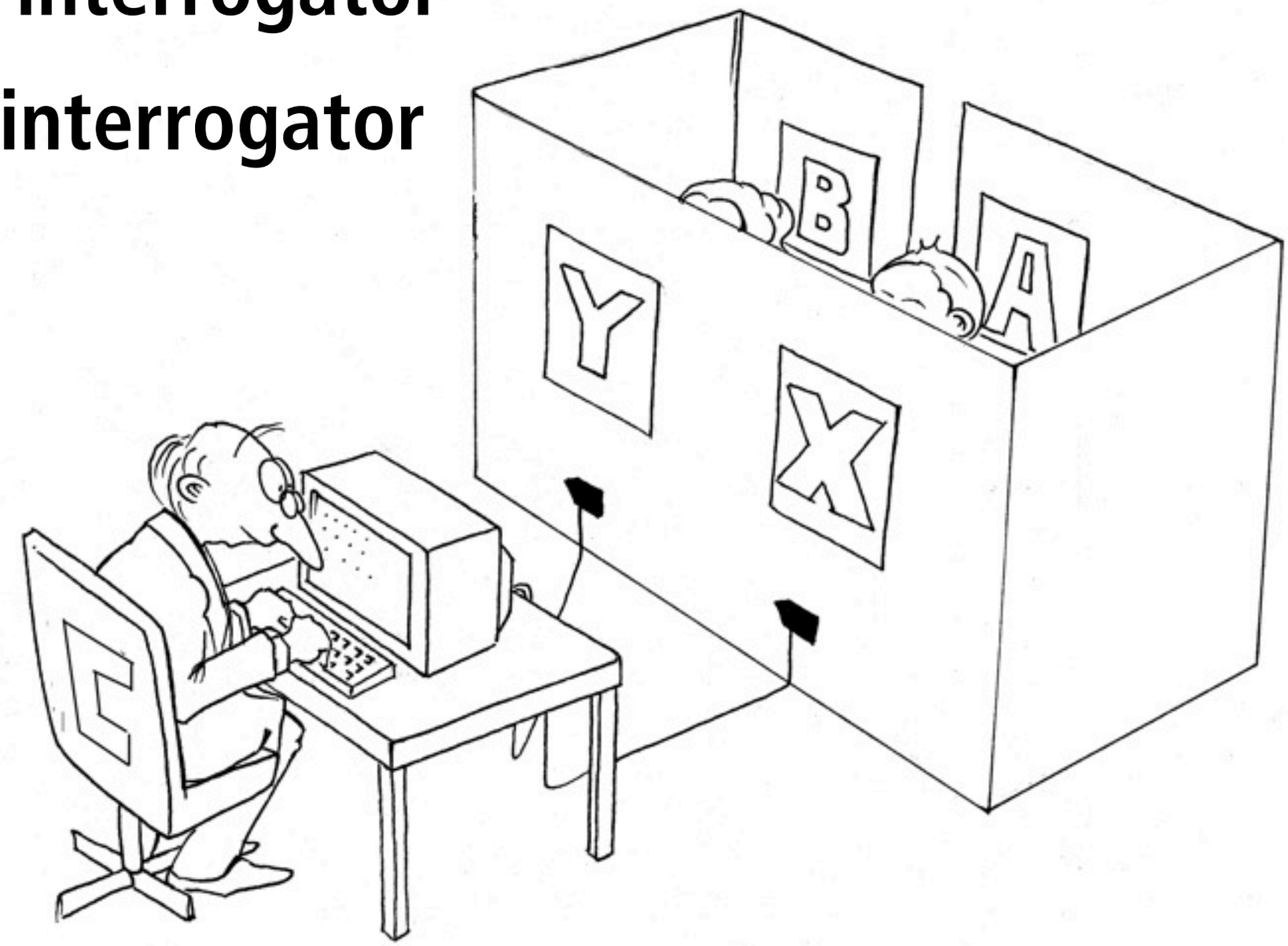
There is a huge literature on IQ testing, and also about many other kinds of testing. There is still a lively debate going on on whether IQ testing is useful or not.

The Turing Test

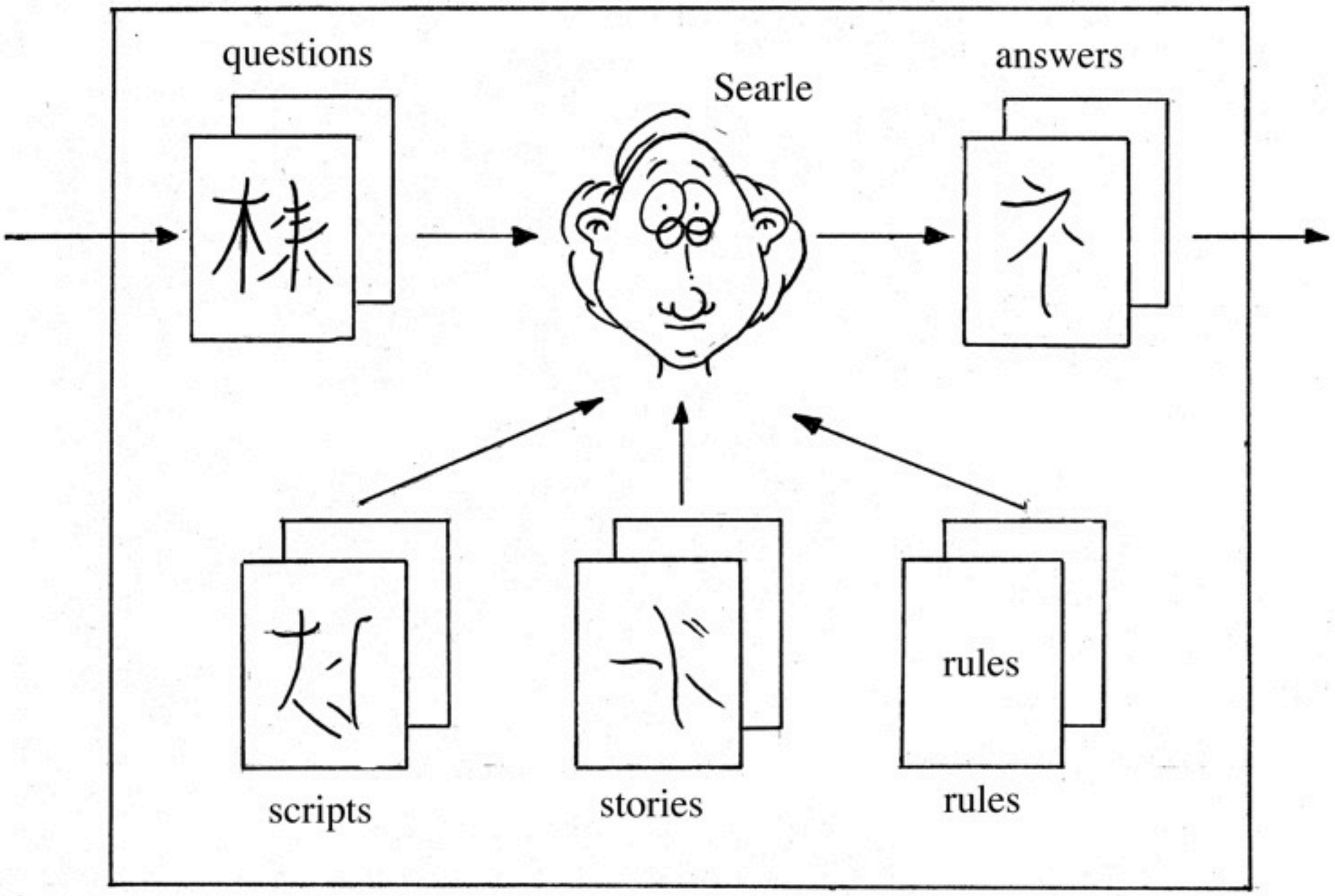
A: man, confuse interrogator

B: woman, help interrogator

C: interrogator



Searle's "Chinese Room" thought experiment



The Turing Test

A: man, confuse interrogator

B: woman, help interrogator

C: interrogator

Student presentation
from Northwestern Polytechnic University,
Xi'an, China
—— > 11 October 2012

Today's topics

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- Successes and failures of the classical approach
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“Birth” of AI, 1956

Herbert Simon
and Allen Newell
The “Logic Theorist”

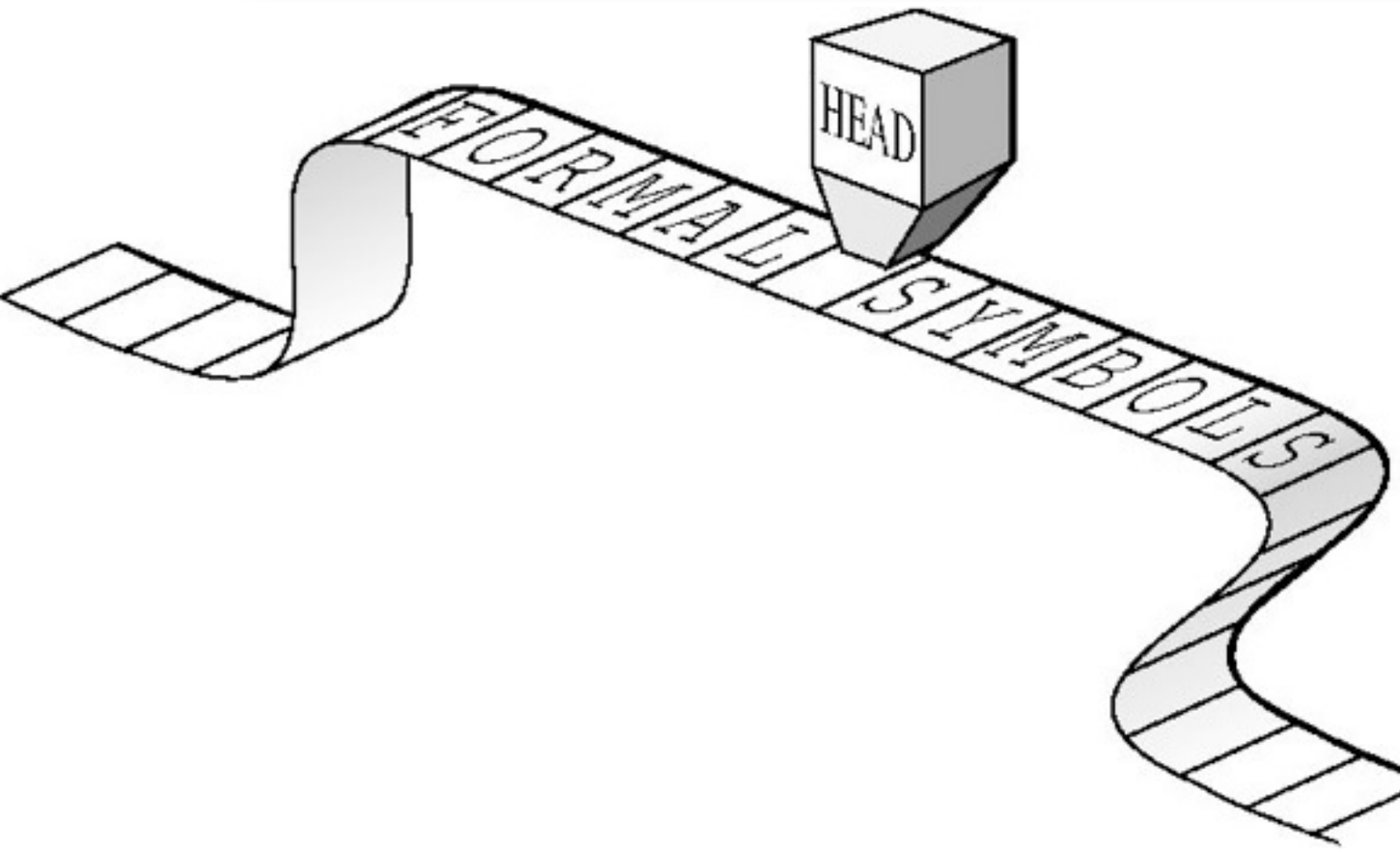
George A. Miller, Psychologist
“The Magical Number Seven Plus or Minus Two”

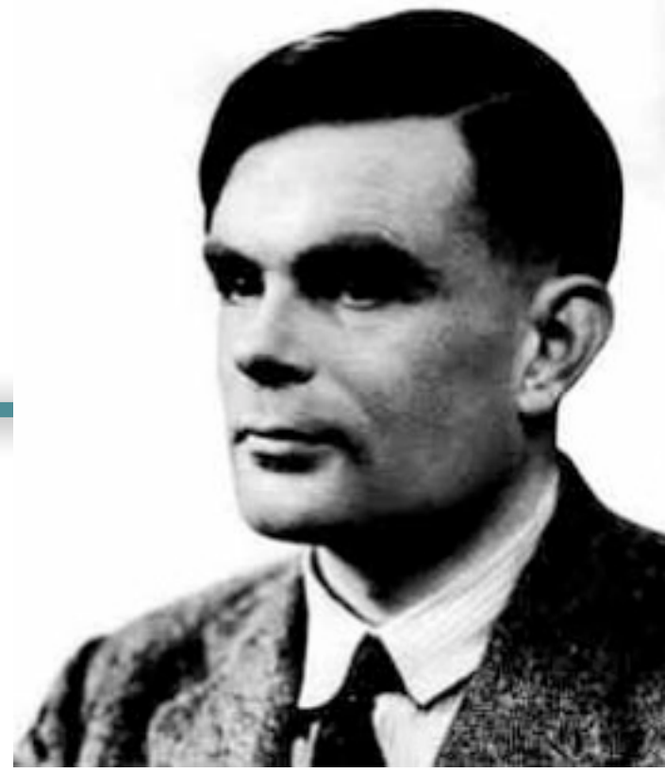
John McCarthy, Computer Scientist
Initiator of Artificial Intelligence

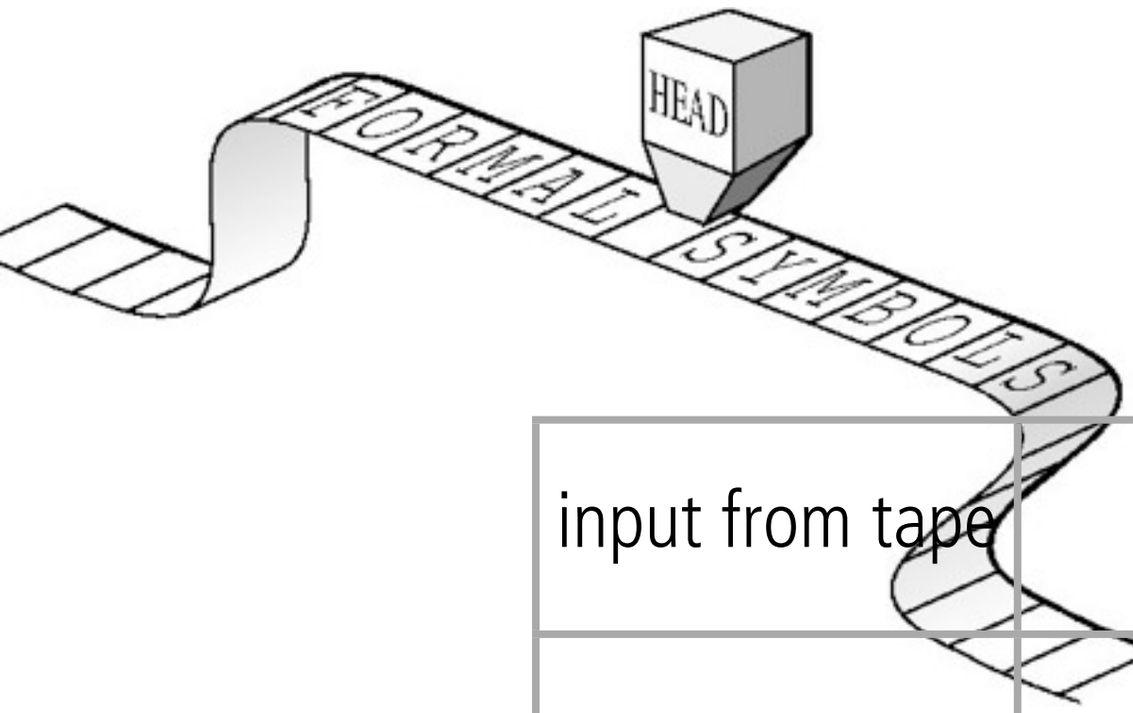
Noam Chomsky, Linguist
“Syntactic Structures”

Conference in 1956: three seminal papers
Newell and Simon: For the first time in history, a thinking machine.
Noam Chomsky: Syntactic structures, a computational approach to language (transformational grammars)
George Miller: Capacity of STM - hard to measure in bits and bytes —> “chunks” (e.g. phone number in Germany: international access code, country code, area code, number).

Turing Machine (1)







Turing Machine (2)

input from tape	1	2	← state of read/ write head
_	_R2	HALT	
A	AL1	BR2	
B	BL1	AR2	
C	CL1	CR2	

write on tape move tape L/R next state of r/w head

initial situation: state r/w head = 1
initial content of tape:

. . A A B A A C C C C A B A C C C C B B A B . . .

r/w head initial pos. ↑

Turing Machine (3)

input from tape	1	2	← state of read/ write head
_	_R2	HALT	
A	AL1	BR2	
B	BL1	AR2	
C	CL1	CR2	

write on tape move tape L/R next state of r/w head

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initial situation: state r/w head = 1
initial content of tape:

. . A A B A A C C C C A B A C C C C B B A B . . .

r/w head initial pos. ↑

Turing Machine (3)

what does this TM do?
—> BME-IIT, Budapest

input from tape	1	2	← state of read/ write head
_	_R2	HALT	
A	AL1	BR2	
B	BL1	AR2	
C	CL1	CR2	

write on tape move tape L/R next state of r/w head

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If state=1 and input=A: write A, move tape to left, remain in state 1
If state=1 and input=B: write B, move tape to left, remain in state 1
tape moves to the left until a blank is encountered, then a blank is written on the tape, the tape is moved to the right and the r/w head enters state 2
As are exchanged by Bs an vice versa; Cs remain unchanged. HALT when encountering a blank

initial situation: state r/w head = 1
initial content of tape:

.	.	A	A	B	A	A	C	C	C	C	A	B	A	C	C	C	C	B	B	A	B	.	.	.				

r/w head initial pos. ↑

Turing Machine (4)

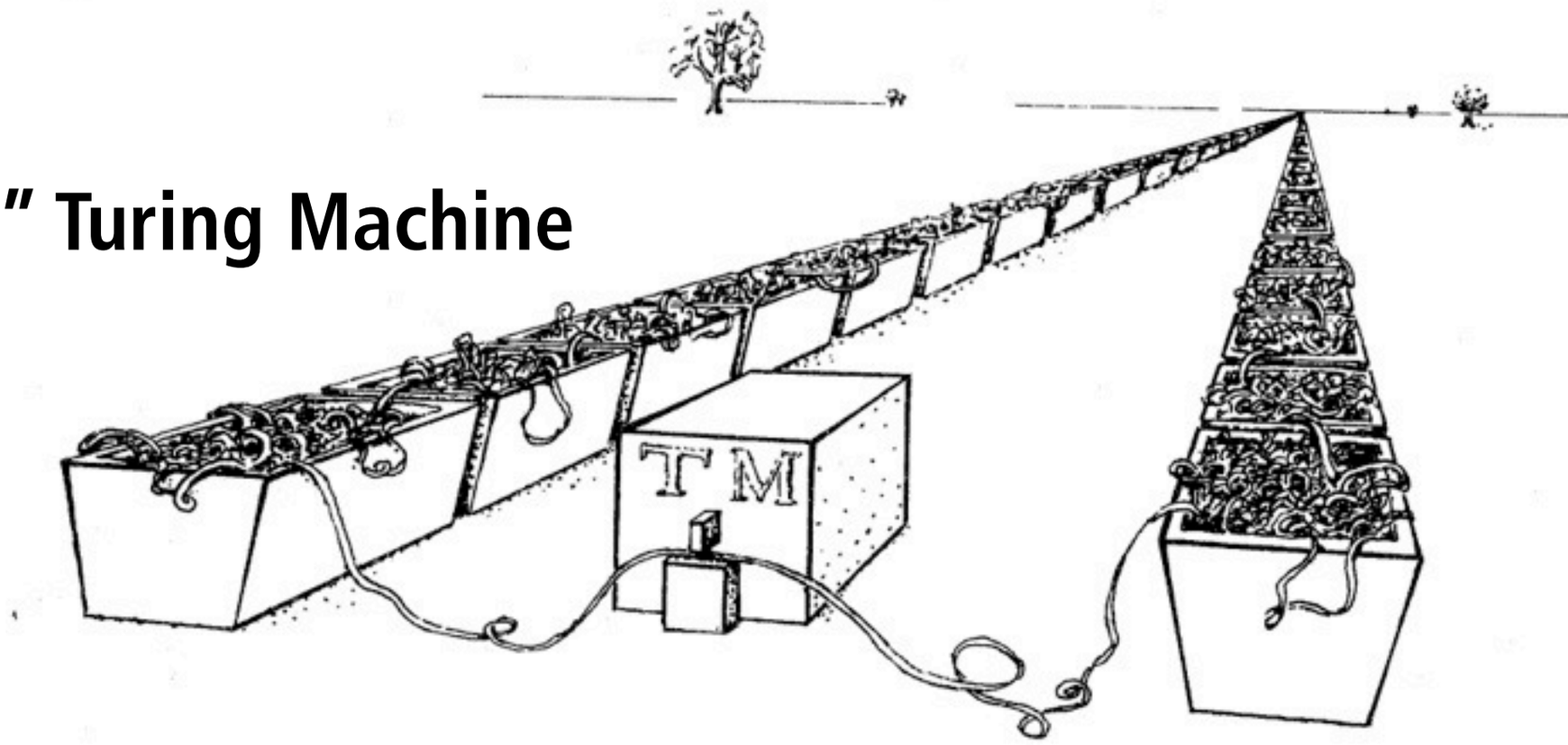
input from tape	1	2	← state of read/ write head
_	_R2	HALT	
A	AL1	BR2	
B	BL1	AR2	
C	CL1	CR2	

The Universal Turing Machine

write on tape move tape L/R next state of r/w head

Turing Machine (5)

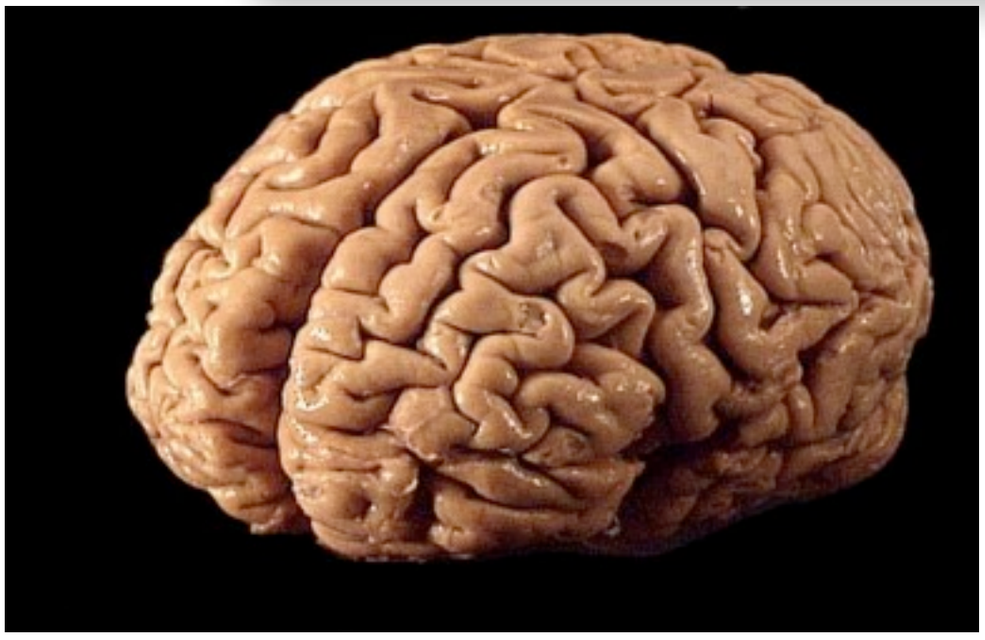
an “embodied” Turing Machine



Cartoon by Roger Penrose

This cartoon shows that physically handling a tape of potentially infinite length might in fact be the bigger problem than performing computation.

Functionalism and the "Physical Symbol Systems Hypothesis"

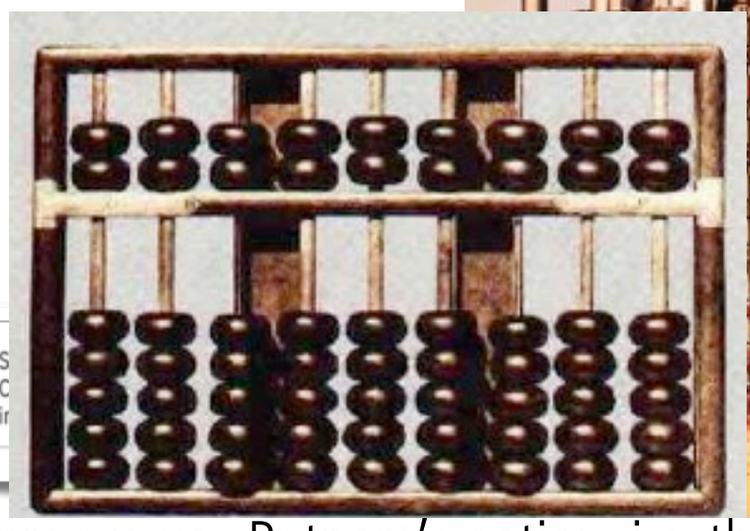


biological

electronic

mechanical

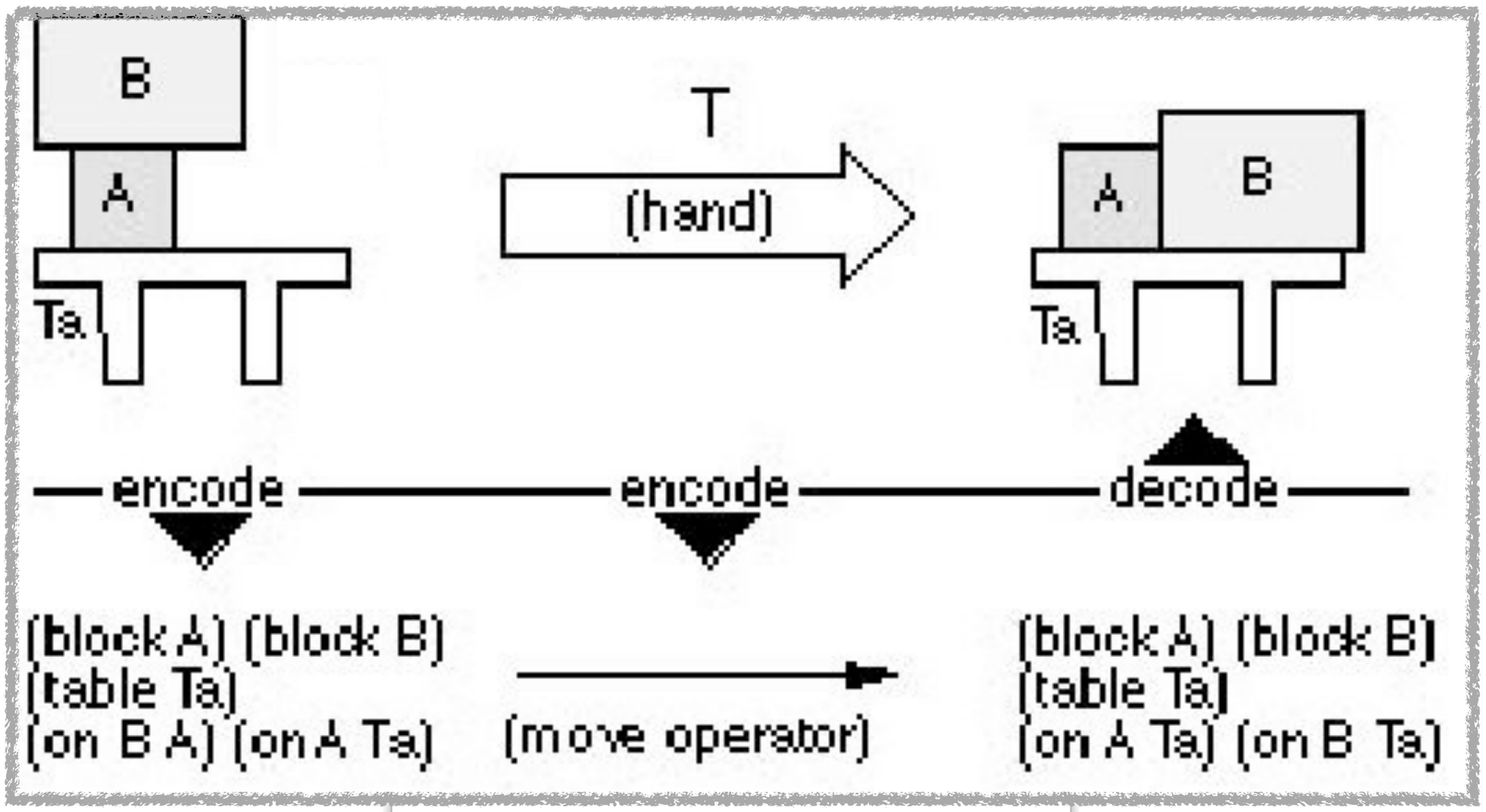
Swiss cheese
Hilary Putnam
(American
Philosopher)



The term functionalism is used differently in different contexts. Here we use Putnam's notion, i.e. the idea that a (mental) process can be implemented in different physical media, mechanical, neural spikes in a biological systems, flip-flops in a computers, or "Swiss cheese".

Functionalism and the "Physical Symbol Systems Hypothesis"

Model/Representation:



The so-called physical symbol systems hypothesis (PSSH) by Allen Newell and Herbert Simon states that for "general intelligent action" it is a necessary and sufficient condition that the system be a "physical symbol system", i.e., a system that can build and manipulate symbol structures and has a physical implementation (e.g., a brain or a computer).

GOFAI

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(John Haugeland, Philosopher)

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From John Haugeland, “Artificial intelligence — the very idea.” MIT Press, 1993.
Write on Smartboard: Good Old Fashioned Artificial Intelligence

Classical AI: Research areas

- problem solving
- knowledge representation and reasoning
- acting logically
- uncertain knowledge and reasoning
- learning and memory
- **communicating, perceiving and acting**

  (adapted from Russell/Norvig: Artificial intelligence, a modern approach)

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Classical AI: Successes

- search engines
- formal games (chess!)
- text processing systems/translation —> next week
- data mining systems
- restricted natural language systems
- appliances
- manufacturing

Indistinguishable from computer applications in general

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Chess: New York, 1997

1 win 3 draws 2 wins

Classical AI: Failures

- recognizing a face in the crowd
- vision/perception in the real world
- common sense
- movement, manipulation of objects
- walking, running, swimming, flying
- speech (everyday natural language)

in general:
more natural forms of intelligence

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Why is perception hard?

For humans perception is in fact very easy - it occurs whitout effort - whereas for artificial systems it has turned out to be a truly hard problem, as researchers tried to build artificial perception systems. They immediately realized that perception is much more than having a camera, a pattern matching algorithm, and a data base: it is a dynamic process requiring the physical interaction of an agent with the real world.

Why is perception hard?

—> Berlin? more than computation?

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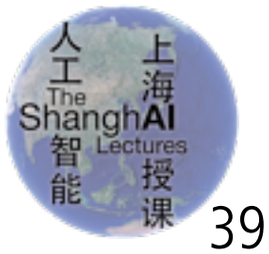

Examples of points:
- distal/proximal sensory stimulation
- stimulation (proximal) depends on: distance, orientation, lighting conditions, partial occlusions
- distances continuously change - because we are moving in the environment

--> not simply “computation” - there is much more to it - it’s about the interaction with the real world
we will deal with perception in various places as we go along.

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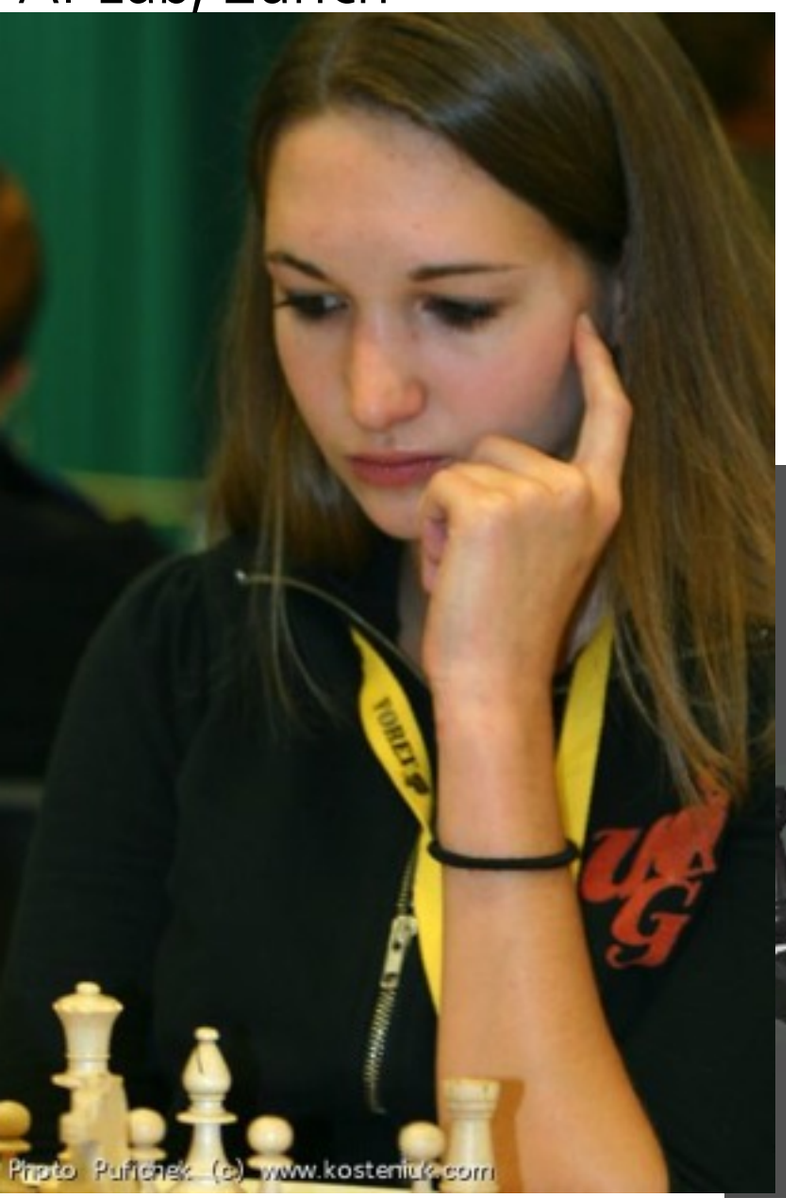
Fundamental problems of the classical approach

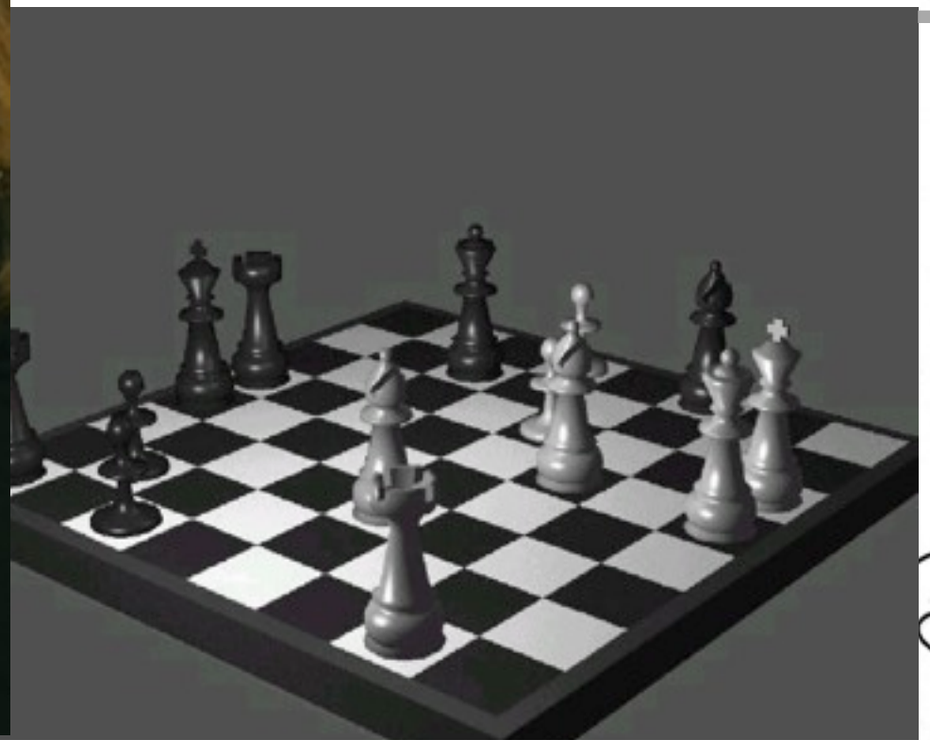
Monika Seps, chess master
former master student
AI Lab, Zurich



in general:
anything to do with real world interaction

fundamental differences: real — virtual

virtual, formal world



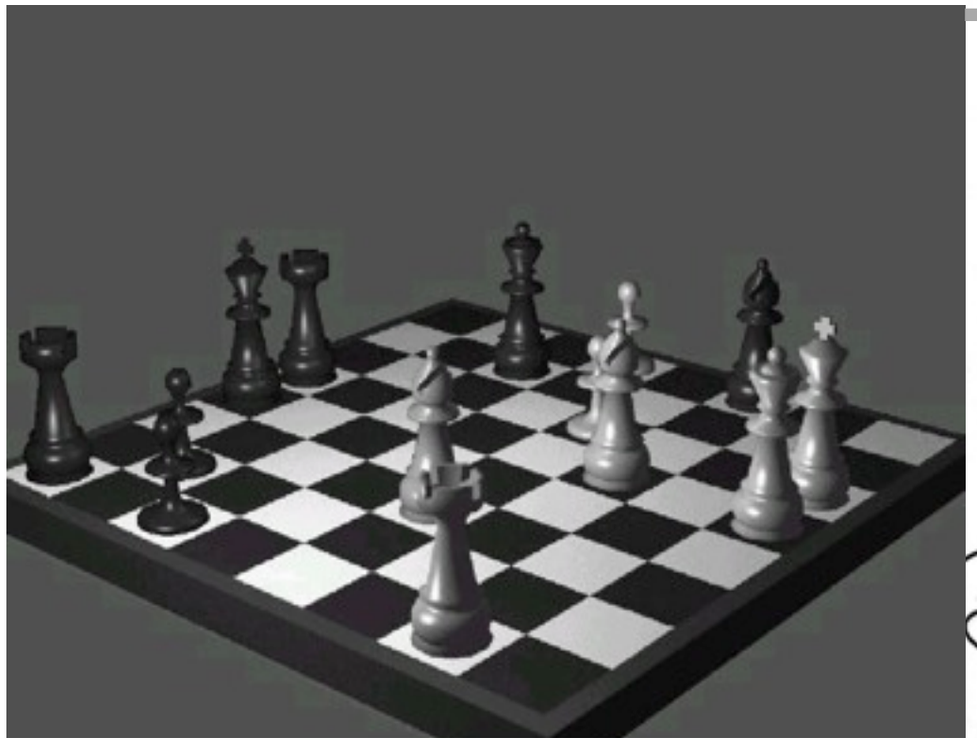
real world

Fundamental problems of the classical approach

in general:
anything to do with real world interaction

fundamental differences: real — virtual

virtual, formal world



real world

Differences
real vs. virtual worlds

real vs. virtual world
—> skku isrc

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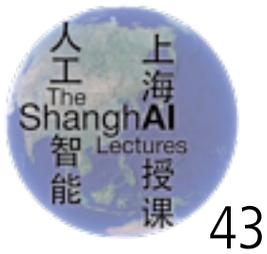

examples:
- information acquisition takes time
- only limited information available (high level of uncertainty)
- physical devices subject to noise and malfunction
- no clearly defined, discrete states
- must do several things simultaneously
- real world has own dynamics - things change rapidly
- non-linear, limited predictability

Herbert Simon's "bounded rationality"

Successes and failures of the classical approach

successes

applications (e.g. Google)

chess

manufacturing

(applications: "controlled" artificial worlds)

failures

foundations of behavior

natural forms of intelligence

interaction with real world

(scientific: "real worlds")

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Industrial environments vs. real world

industrial environments	real world environment
environment well-known	**limited knowledge and predictability**
little uncertainty	**rapidly changing**
predictability	**high-level of uncertainty**
(“controlled” artificial worlds)	(“real” worlds)

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Industrial robots vs. natural systems

principles:

- **strong, precise, fast motors**
- **centralized control**
- **computing power**
- **optimization**

Industrial robots

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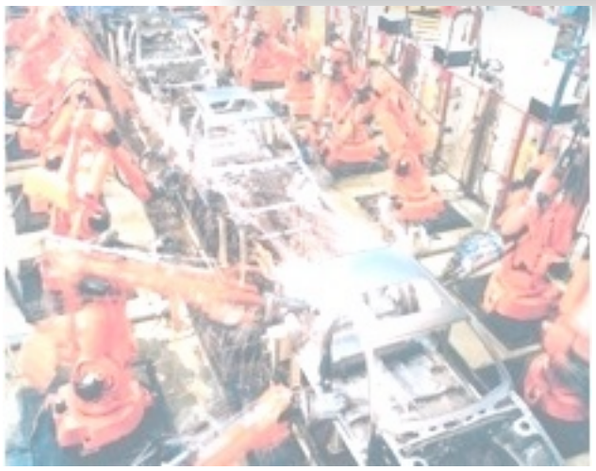
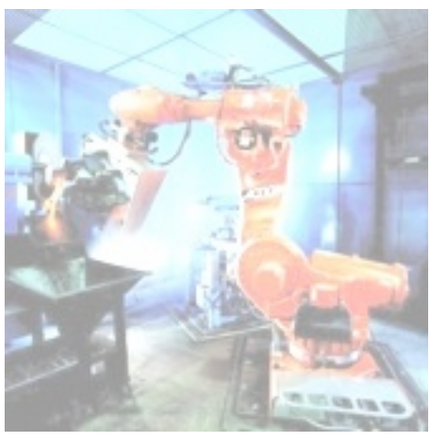
Industrial robots vs. natural systems





principles:
- **low precision**
- **compliant**
- **reactive**
- **coping with uncertainty**

humans

no direct transfer of methods

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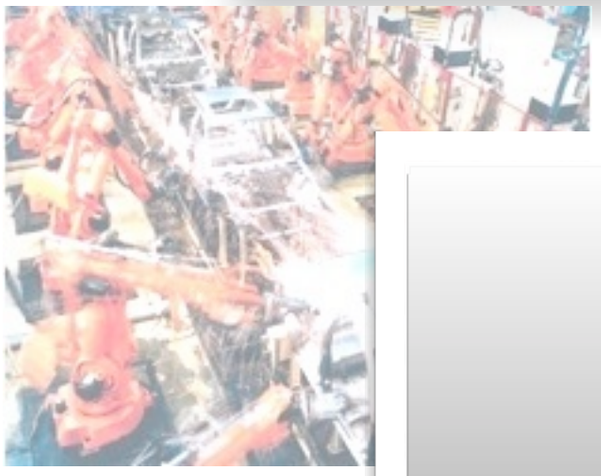
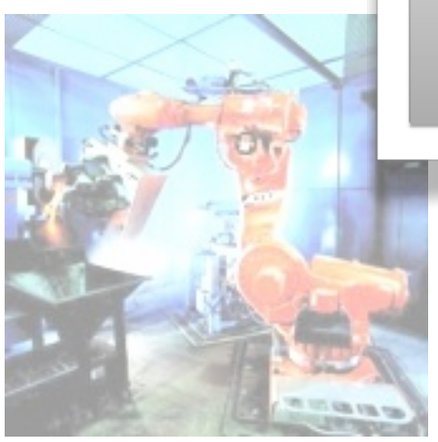
Industrial robots vs. natural systems





principles:

examples:
see next lecture

uncertainty

humans

→ no direct transfer of methods

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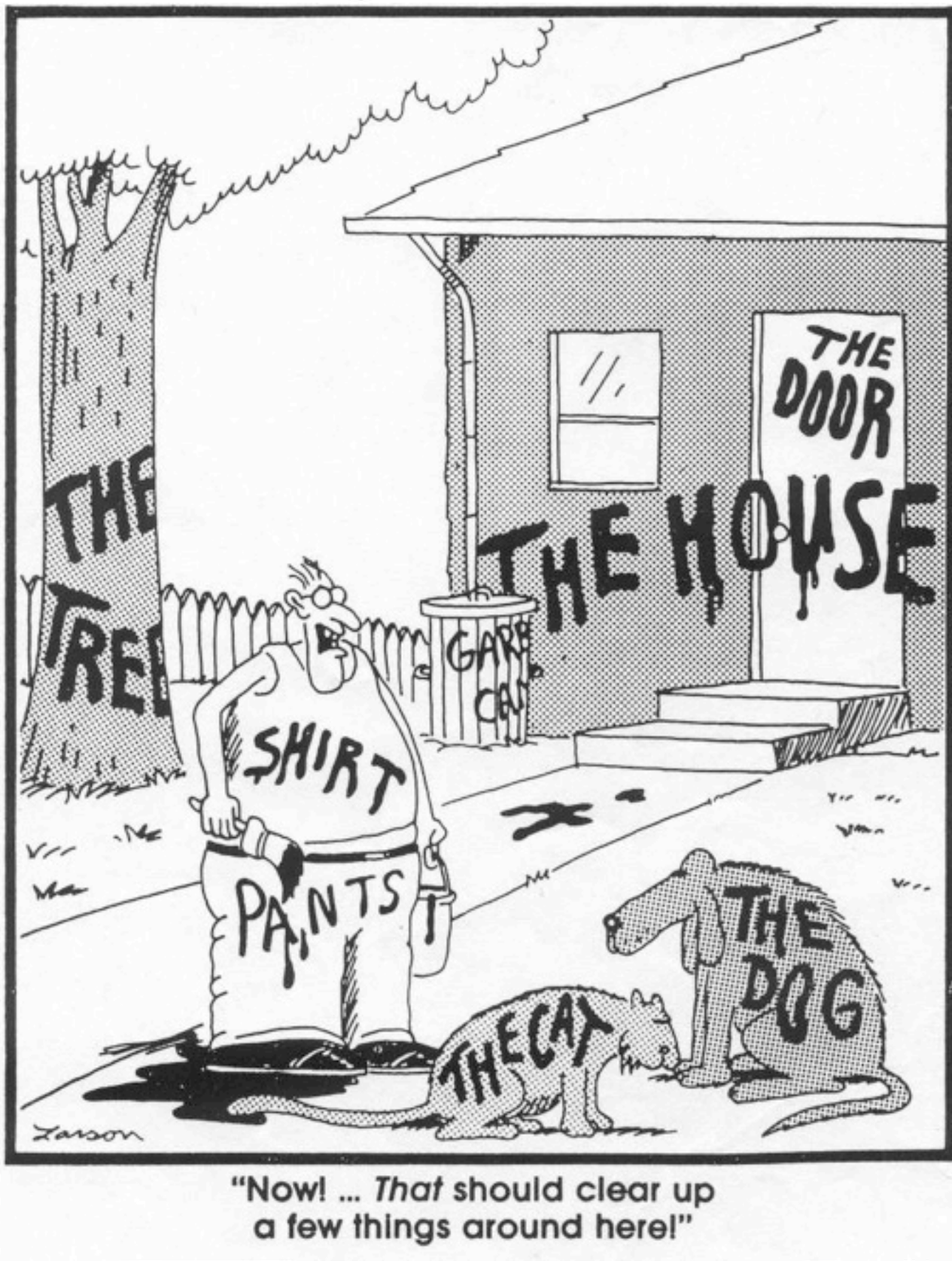
Fundamental problems of classical approach

- “symbol grounding problem”
- “frame problem”
- “homunculus problem”

The “symbol grounding” problem

real world:
doesn’t come
with labels …

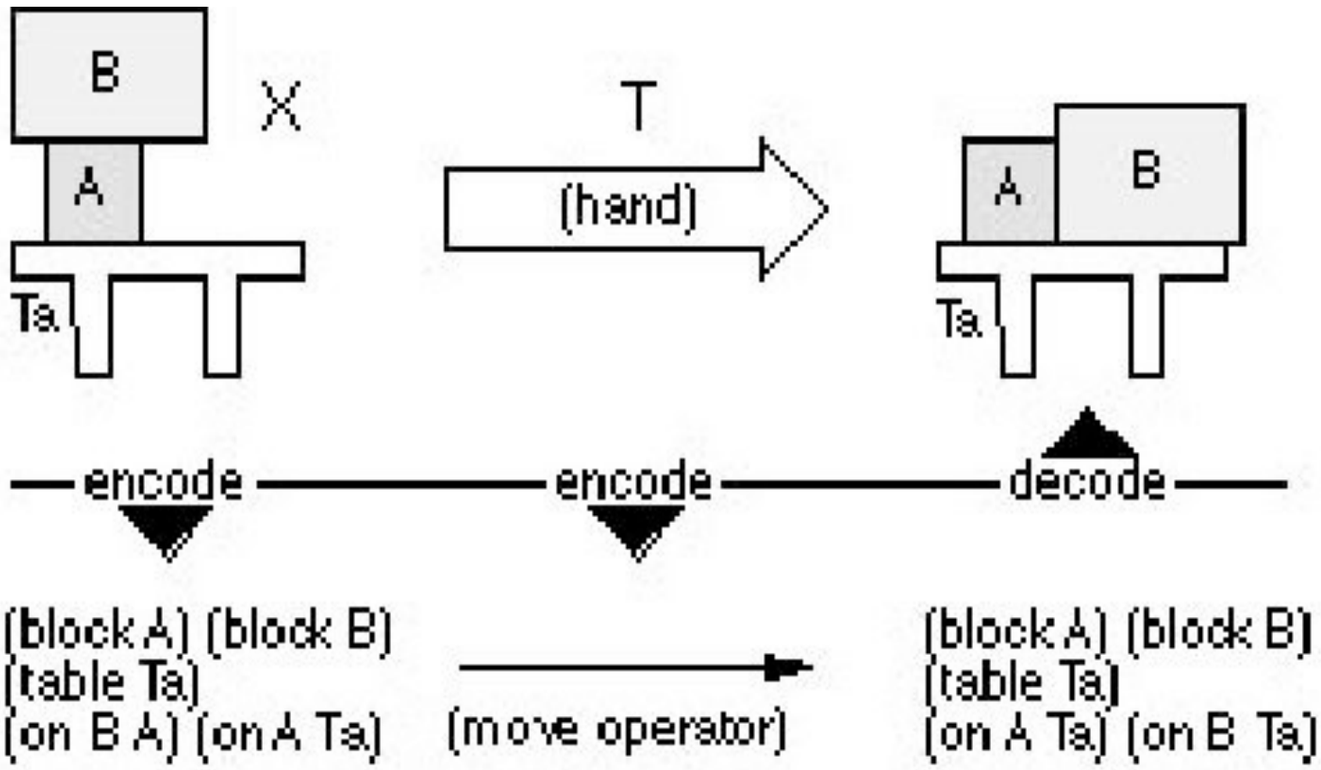


"Now! ... *That* should clear up
a few things around here!"

Gary Larson

The "frame problem" Maintaining model of real world

- the more detailed the harder
- information acquisition
- most changes: irrelevant to current situation



- if you leave the room, the color of the walls doesn't change
- the fact that there are millions of cars moving through the cities is at this moment irrelevant to our lecture
- however, if you have a both a battery and a bomb on a cart, and you move the cart out of the room to get rid of the bomb, the battery will move along with it; please read Dan Dennett's story about this.

The “frame problem” (1)

Daniel Dennett, American philosopher (philosophy of mind)

R1: robot

R1D1: robot deducer

R2D1: robot relevant deducer

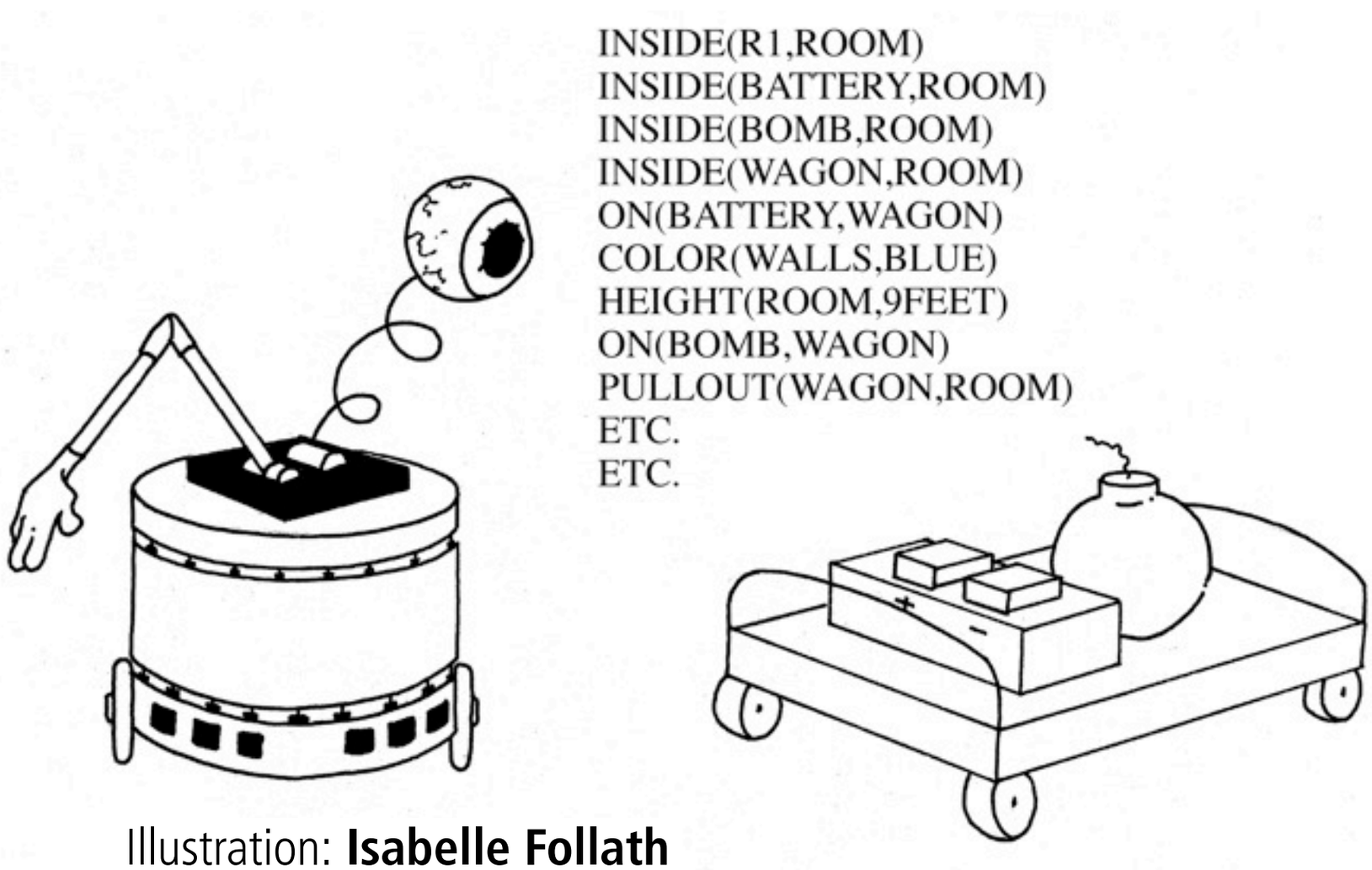


Illustration: **Isabelle Follath**

Once upon a time there was a robot, named R1 by its creators. Its only task was to fend for itself. One day its designers arranged for it to learn that its spare battery, its precious energy supply, was locked in a room with a time bomb set to go off soon.

R1 located the room, and the key to the door, and formulated a plan to rescue its battery. There was a wagon in the room, and the battery was on the wagon, and R1 hypothesized that a certain action which it called PULLOUT(WAGON, ROOM) would result in the battery removed from the room. Straightaway it acted, and did succeed in getting the battery out of the room before the bomb went off. Unfortunately, however, the bomb was also on the wagon. R1 knew that the bomb was on the wagon in the room, but didn't realize that pulling the wagon would bring the bomb out along with the battery. Poor R1 had missed that obvious implication of its planned act.

The “frame problem” (2)

Daniel Dennett, American philosopher (philosophy of mind)

R1: robot

R1D1: robot deducer

R2D1: robot relevant deducer

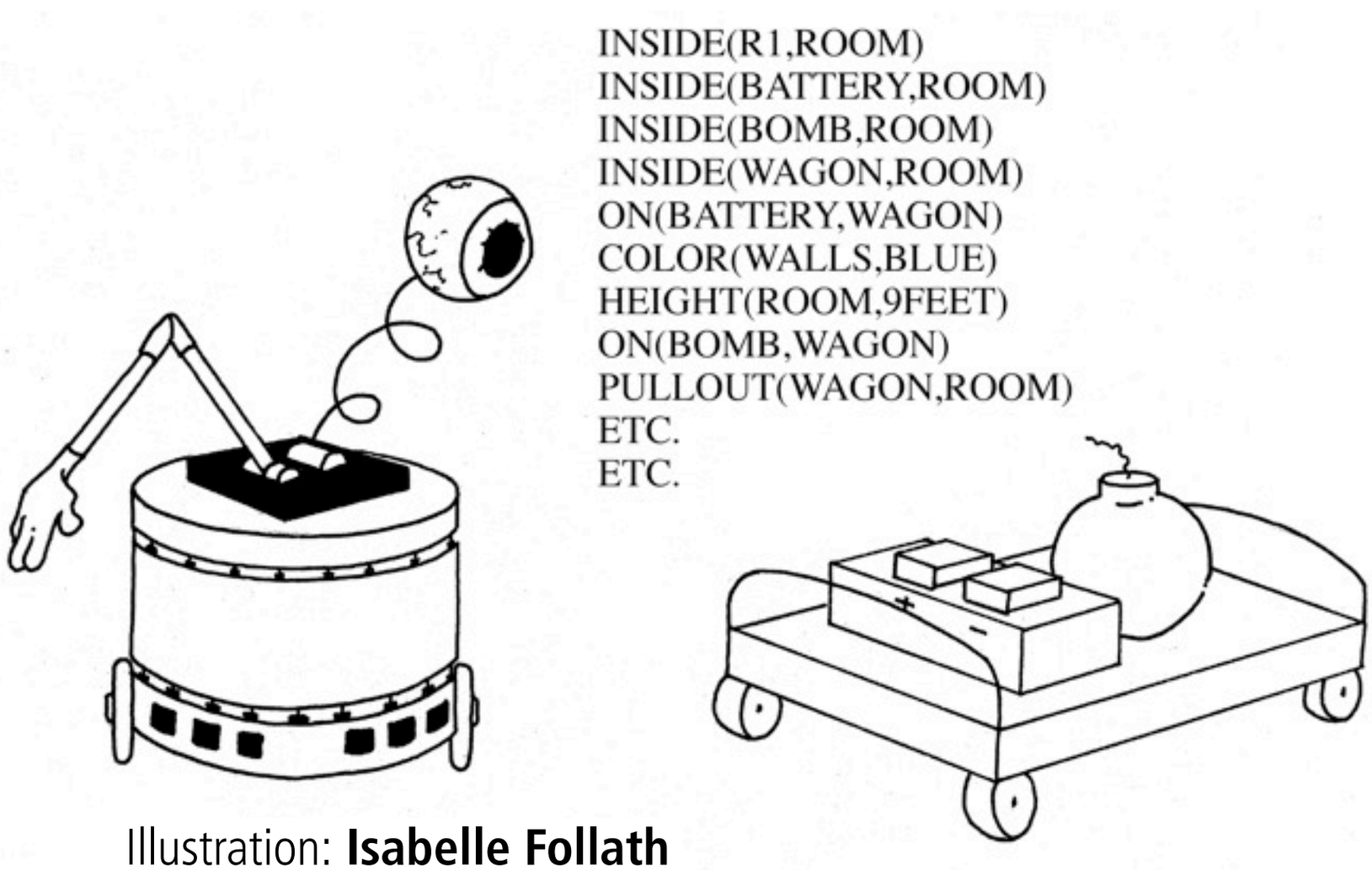


Illustration: **Isabelle Follath**

Back to the drawing board. ``The solution is obvious,'' said the designers. ``Our next robot must be made to recognize not just the intended implications of its acts, but also the implications about their side-effects, by deducing these implications from the descriptions it uses in formulating its plans.'' They called their next model, the robot-deducer, R1D1. They placed R1D1, in much the same predicament that R1 had succumbed to, and as it too hit upon the idea of PULLOUT(WAGON, ROOM) it began, as designed, to consider the implications of such a course of action. It had just finished deducing that pulling the wagon out of the room would not change the colour of the room's walls, and was embarking on a proof of the further implication that pulling the wagon out would cause its wheels to turn more revolutions than there were wheels on the wagon---when the bomb exploded.

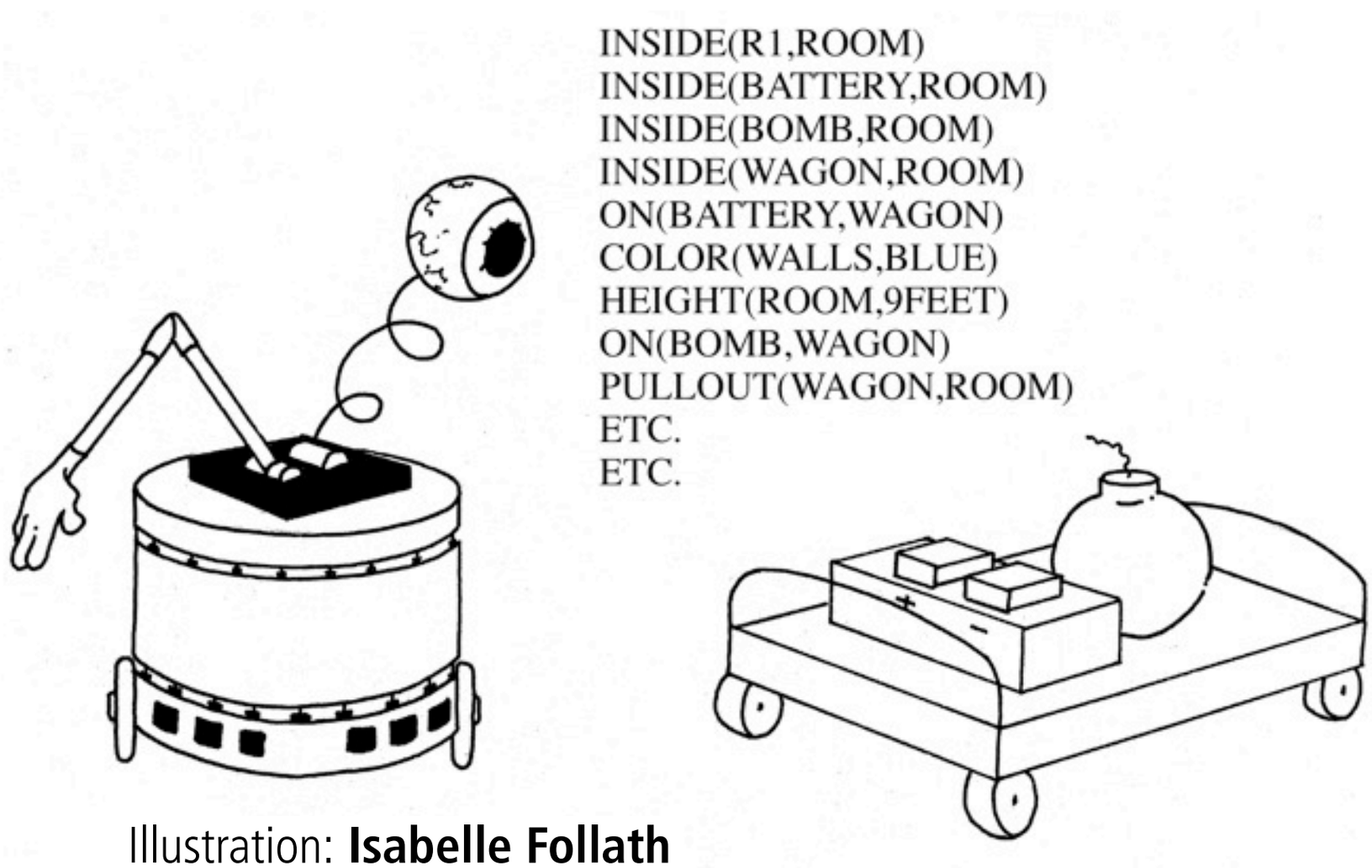
The “frame problem” (3)

Daniel Dennett, American philosopher (philosophy of mind)

R1: robot

R1D1: robot deducer

R2D1: robot relevant deducer



Back to the drawing board. ``We must teach it the difference between relevant implications and irrelevant implications,'' said the designers, ``and teach it to ignore the irrelevant ones.'' So they developed a method of tagging implications as either relevant or irrelevant to the project at hand, and installed the method in their next model, the robot-relevant-deducer, R2D1 for short. When they subjected R2D1 to the test that had so unequivocally selected its ancestors for extinction, they were surprised to see it sitting, Hamlet-like, outside the room containing the ticking bomb, the native hue of its resolution sicklied o'er with the pale case of thought, as Shakespeare (and more recently Fodor) has aptly put it. ``Do something!'' they yelled at it. ``I am,'' it retorted. ``I'm busily ignoring some thousands of implications I have determined to be irrelevant. Just as soon as I find an irrelevant implication, I put it on the list of those I must ignore, and ...'' the bomb went off.

(from Dennett, D. (1987). Cognitive wheels: the frame problem in AI. In C. Hookway (Ed.), Minds, Machines, and Evolution: Philosophical Studies. Bantain: Bean Books.)

Summary of Dennett's points

- obvious to humans, not obvious to robots (robot only has symbolic model/representation of world)
- vast number of potential side effects, mostly irrelevant
- distinction between relevant and irrelevant inferences → must test all

Today's topics

- short recap
- The classical approach: Cognition as computation
- Successes and failures of the classical approach
- Some problems of the classical approach
- **The need for an embodied approach**
- The "frame-of-reference" problem

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Two views of intelligence

classical:
cognition as computation

embodiment:
cognition emergent from sensory-motor and interaction processes

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Cognition as computation: many problems, e.g.
- perception
- manipulation
- movement
- locomotion (walking, running)

has lead to the problems mentioned (symbol grounding, frame problem, etc.).
In general: neglect of interaction with real world

The need for an embodied perspective

- “failures” of classical AI
- fundamental problems of classical approach
- Wolpert’s quote:

Are we just doing something different now? Movement, locomotion? Where is the “thinking”, the “intelligence”?
— > Wolpert’s quote

The need for an embodied perspective

"Why do plants not have brains?"

The need for an embodied perspective

"Why do plants not have brains? The answer is actually quite simple — they don't have to move." Lewis Wolpert, UCL

evolutionary perspective on development of intelligence/cognition

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Evolutionary selectionist pressure on development of brain: from the need to move, to locomote, and to orient in space.
And the evolution of the brain has always taken place as part of a complete organism that had to interaction, survive, and reproduce in the real world. In other words, the brain and the body have co-evolved.

The need for an embodied perspective

- "failures" of classical AI
- fundamental problems of classical approach
- Wolpert's quote: Why do plants not …?
- Interaction with environment: always mediated by body

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Today's topics

- short recap
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- **The "frame-of-reference" problem**

The "frame-of-reference" problem — introduction

Video "Heider and Simmel"

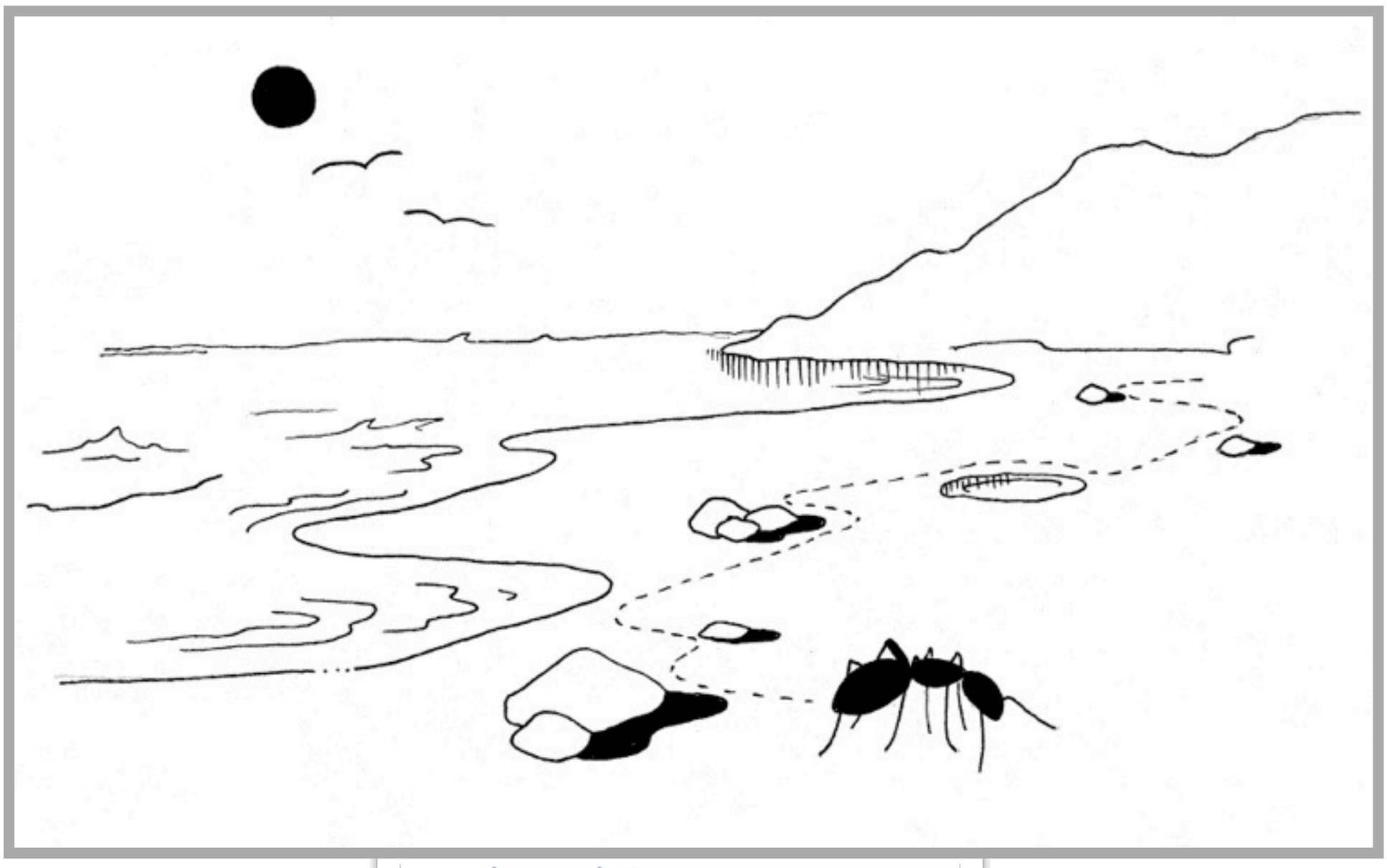
More than sixty years ago (1944) the psychologists Fritz Heider and Marianne Simmel conducted an experimental study, which can be seen as the starting point of attribution theory research. Moving symbols were shown during a short animated cartoon which subjects unanimously described as living objects (mostly people).
"Anthropomorphization, the incurable disease", David McFarland, Oxford University

The "frame-of-reference" problem — introduction

Video "Heider and Simmel"

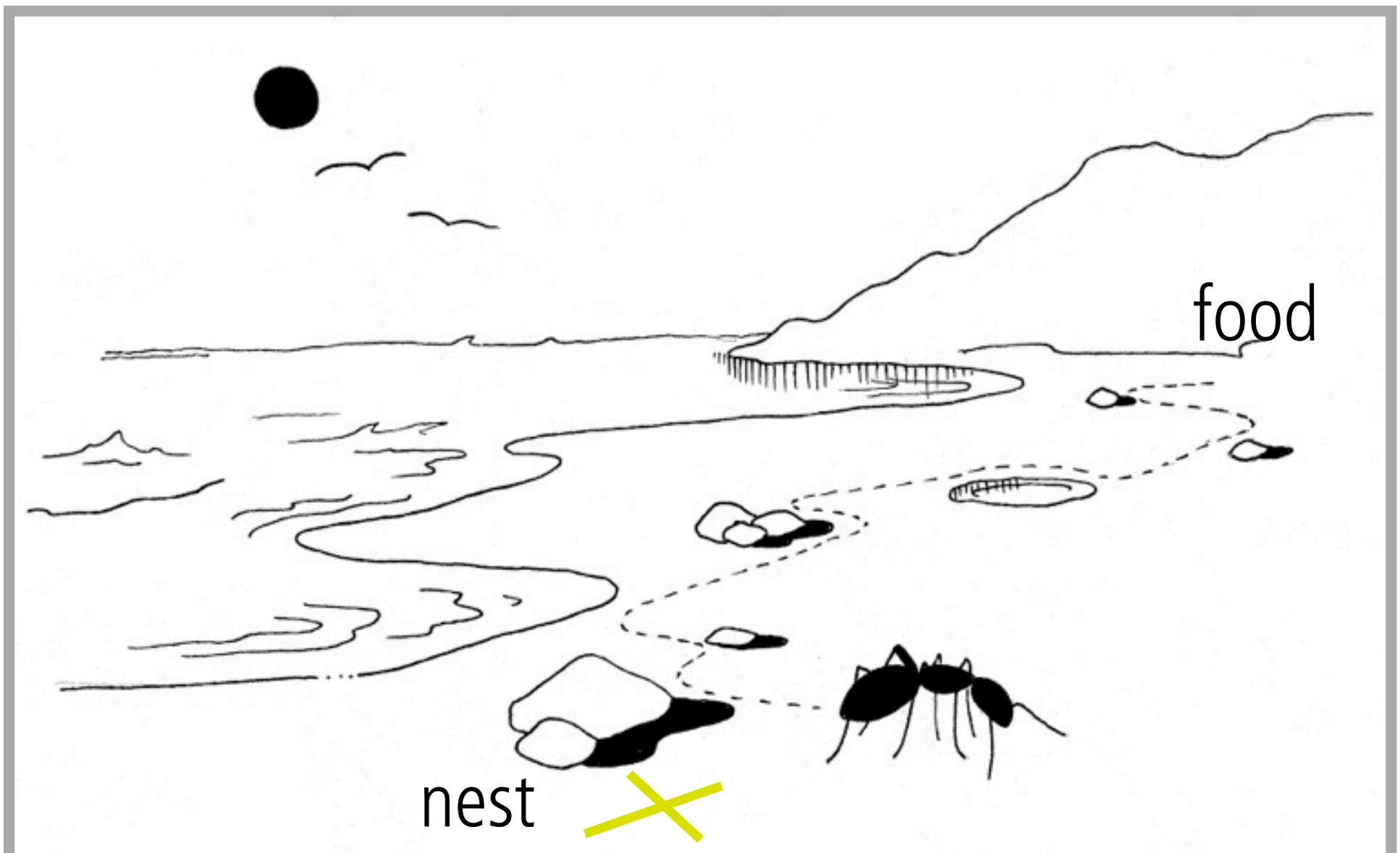
comment on video
—> NYU, Abu Dhabi Campus (Nikolaos Mavridis)

"Frame-of-reference" Simon's ant on the beach

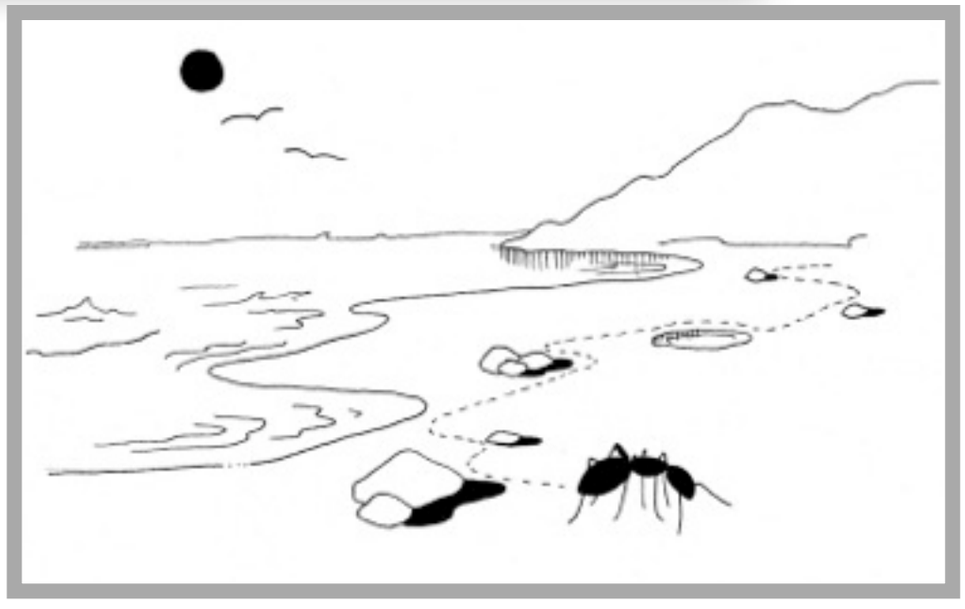


From Herbert A. Simon: The sciences of the artificial. MIT Press.

"Frame-of-reference" Simon's ant on the beach



"Frame-of-reference" Simon's ant on the beach



- simple behavioral rules
- complexity in interaction, not — necessarily — in brain

- thought experiment: **increase body by factor of 1000 everything else the same**

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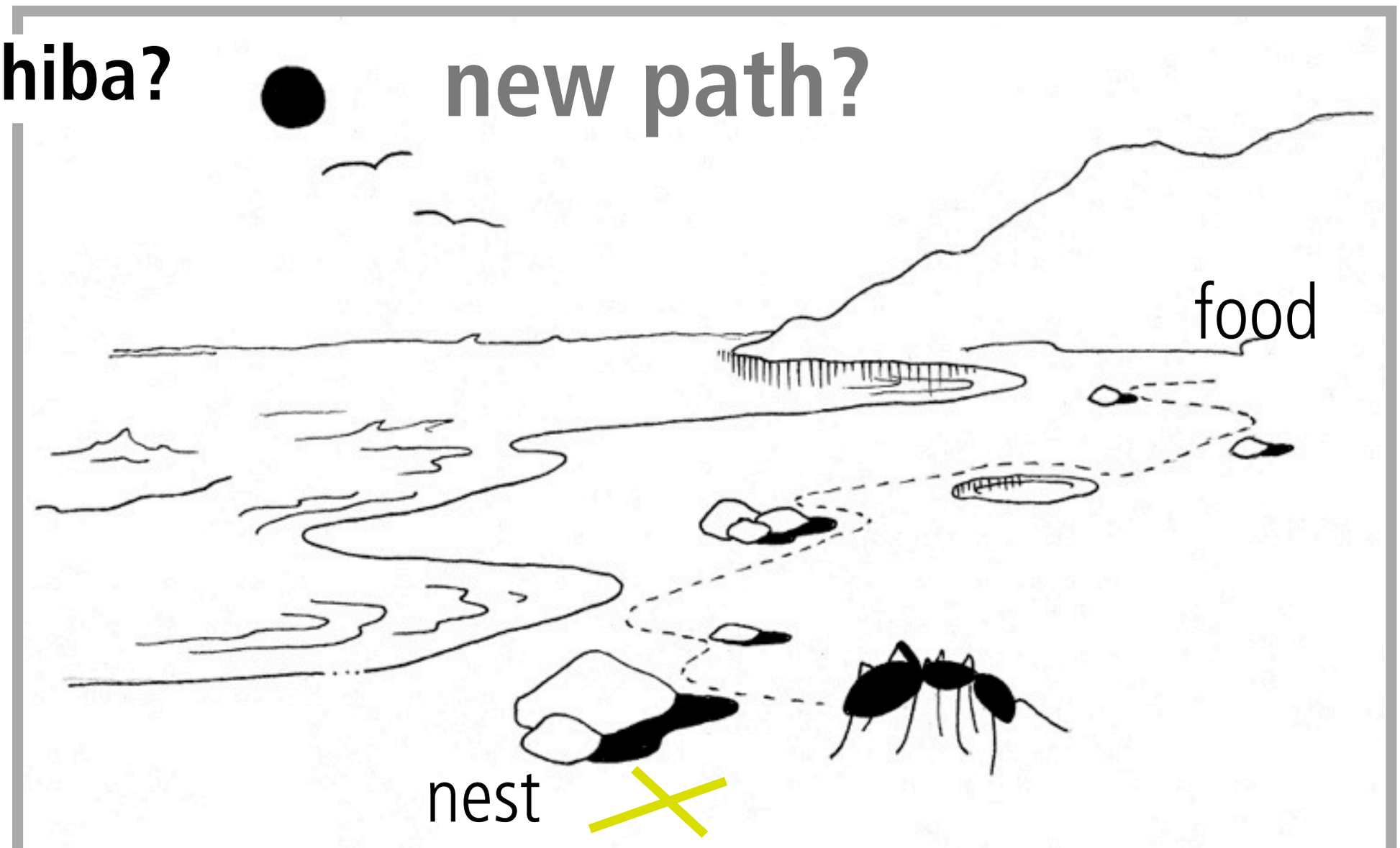
The ShanghAI Lectures

Simple behavioral rules, e.g.:
- obstacle on left, turn right
- obstacle on right, turn left
- otherwise go straight

"Frame-of-reference" Simon's ant on the beach

—> Chiba?



"Frame-of-reference"
F-O-R

- perspectives issue
- behavior vs. mechanism issue
- complexity issue

"Frame-of-reference"
F-O-R

- perspectives issue
- behavior vs. mechanism issue
- complexity issue

F-O-R competition

?

Swiss Chocolate

Champagne

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The ShanghAI Lectures

Should I forget to mention the FOR problem in any of the lectures, the first to discover will get either a box of Swiss chocolate or a bottle of champagne. If there is one idea from the class that everyone should remember, it's the FOR problem.

Assignments for next week

- Read chapter 3 of “How the body …”
- Familiarize yourself with the main brain imaging techniques (there are many good basic introductions on the internet)

End of lecture 2

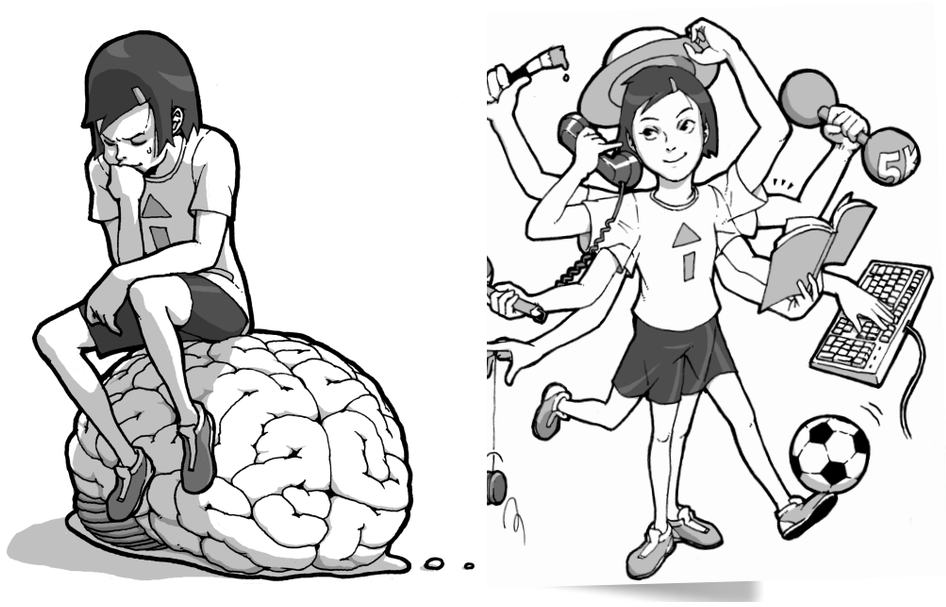
Thank you for your attention!

stay tuned for guest lecture by Christopher Lueg

"Embodied and information behavior"

and by Davide Scaramuzza

"Autonomous vision-based navigation"

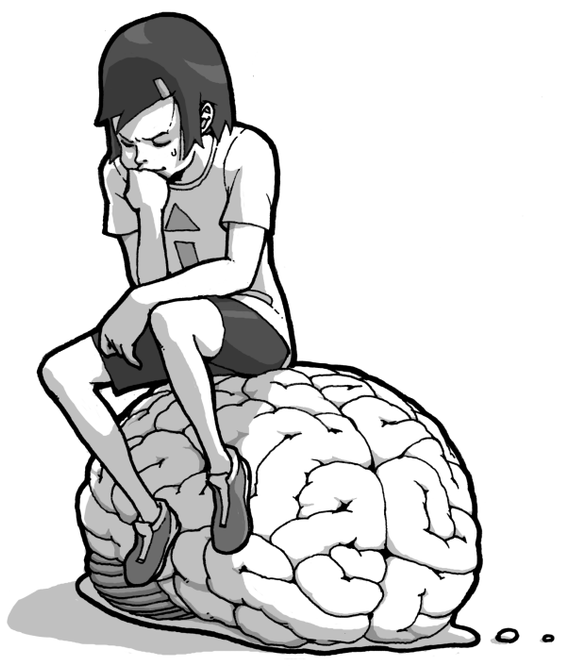


End of lecture 2

Thank you for your attention!

stay tuned for lecture 3

“Towards a theory of intelligence”



Additional slide materials for self-study

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The “homunculus problem”

“Homunculus” literally means “little man”; as used here, it designates a “little man in the head.”

The homunculus problem, or the homunculus fallacy, as it is also called, refers to circular accounts of psychological processes. These processes are circular because they ascribe to some internal mechanism (the homunculus) the very psychological properties being investigated in the first place. For example, a theory of vision might postulate that there is within the brain a mechanism - the “homunculus” that scans, views, or inspects images on the retina. Such a theory would be vacuous, however, since scanning, viewing, and inspecting are all instances of the very visual processes the theory was supposed to illuminate in the first place (Gregory 1987, p. 313). In other words, the theory has assumed the very things it set out to explain.

Issue of infinite regress

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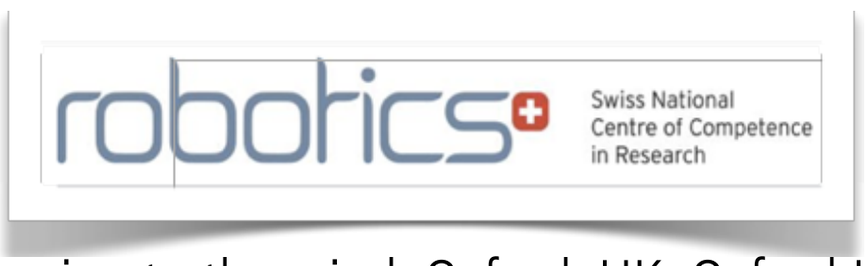

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Gregory, R.L (1987). The Oxford companion to the mind. Oxford, UK: Oxford University Press.

Problems to think about: Meaning?

Imagine that you are using an electronic train schedule to figure out a train from Shanghai to Beijing. What does the program know about trains and train schedules? What is the input to the program and what is its output? How come, you will finally end up in the right train? Where does the meaning come from?

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End of additional slide materials for self-study

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