
Lecture 2

Cognition as Computation:
Why did it fail?

Warsaw: absent today



11 November:
Polish National Independence Day

congratulations from all
participants of
The AI Lectures from Tokyo!

no problem!



Comments on last week

- Beijing: video signal lost
- Warsaw: signal lost --> live streaming
- streaming: now operational

- please register on Web-Site
--> help create world-wide community

<http://tokyolectures.org>



Informal site presentation Zurich

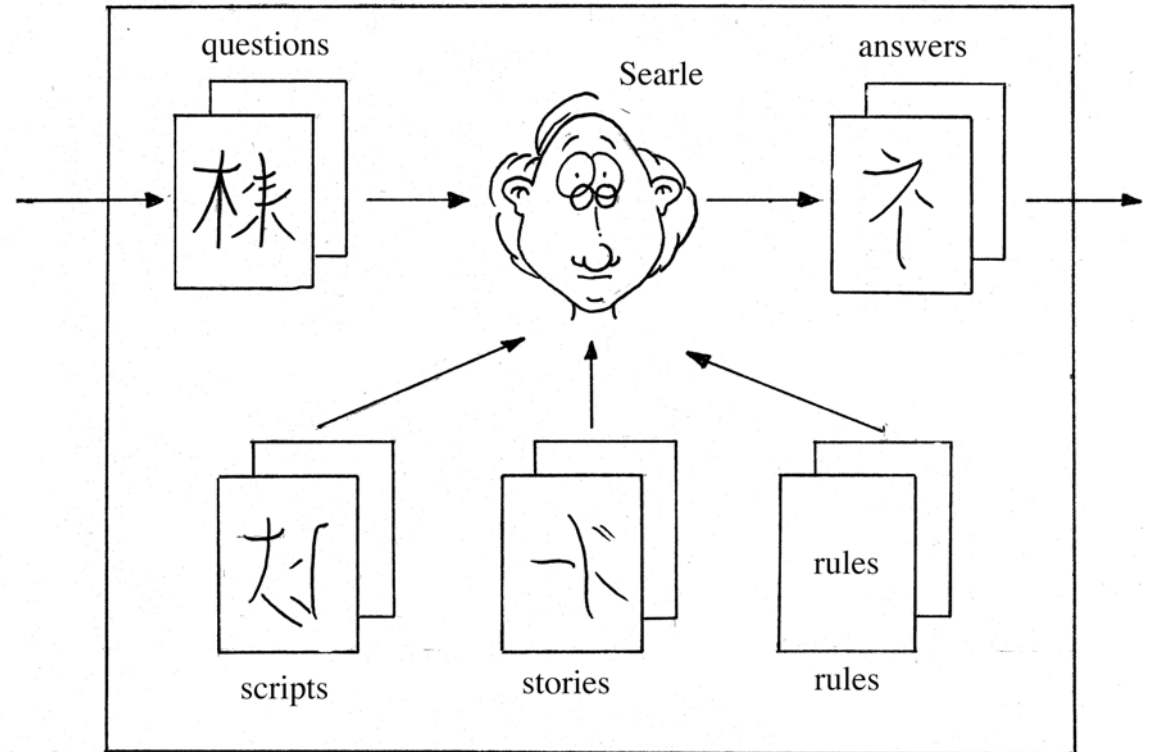
Video
Zurich site



Assignments from last week

- Read chapter 1 of “Understanding Intelligence”
- Classwork exercise 1
- Take an IQ test yourself (links on web page)
- ***Special assignment for Beijing:***
Comment on Searle’s famous “Chinese Room” thought experiment and give a short (5-7 min) presentation on this at the beginning of next week’s lecture

Beijing students on Searle's "Chinese Room"



*cartoon by
Isabelle Follath*

Questions/comments from last week?

Last week's topics - Today's topics

- characterizing intelligence
- diversity/compliance
- “Turing Test”
- “Chinese Room”
- intelligence testing -- IQ
- studying intelligence:
the synthetic methodology
- Prof. Yasuo Kuniyoshi:
A robot that learns to
stand up

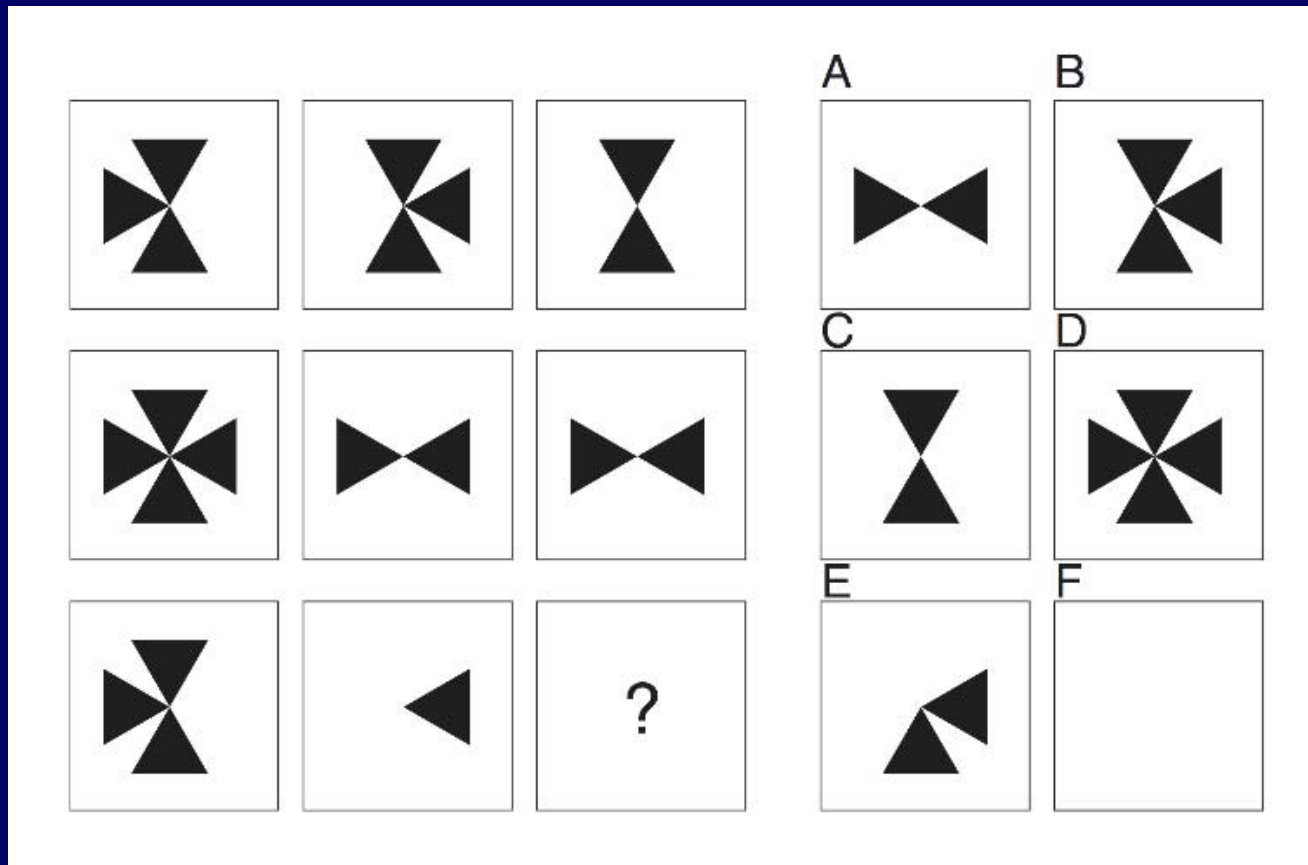
- “Chinese Room”
- intelligence testing -- IQ
- studying intelligence:
the synthetic methodology
- Newell and Simon, Chomsky,
George A. Miller
- The cognitivistic paradigm,
functionalism, “Physical Symbol
Systems”
- ...

Today's topics

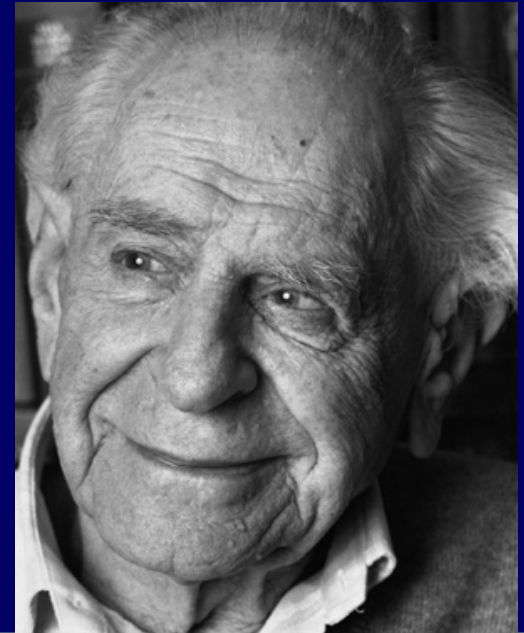
- Newell and Simon, Chomsky, George Miller
- The “cognitivist paradigm”, Functionalism, “Physical Symbol Systems”
- The classical approach: “Cognition as computation”
- Turing Machine, Universality
- The fundamental problems of the classical approach
- The “frame-of-reference problem” – Simon’s ant on the beach

Measuring intelligence

IQ Test



Karl Popper on IQ Tests

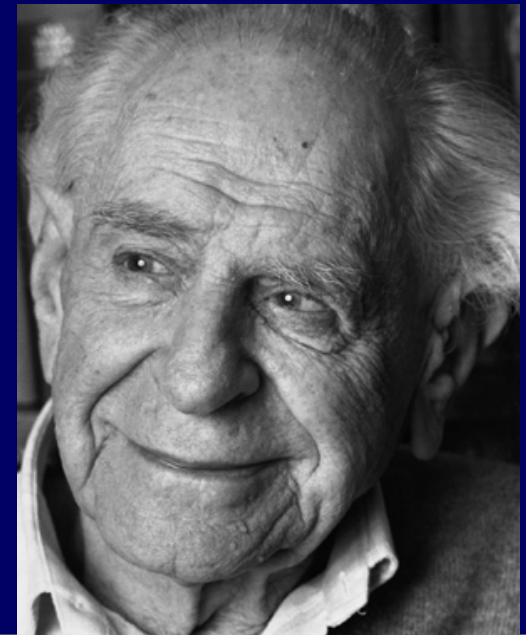


Karl Popper on IQ Tests

Video
- *Karl Popper*

Karl Popper (1902–1994)

“champion” of Philosophy of Science in the
20th century



Issues in IQ

- IQ in the genes (nature) or acquired (nurture)?
- IQ trainable - increased through practice?
- cultural differences?
- predictor for professional success
- many types of tests for different abilities
- relation to brain processes (imaging)
- emotional intelligence - EQ

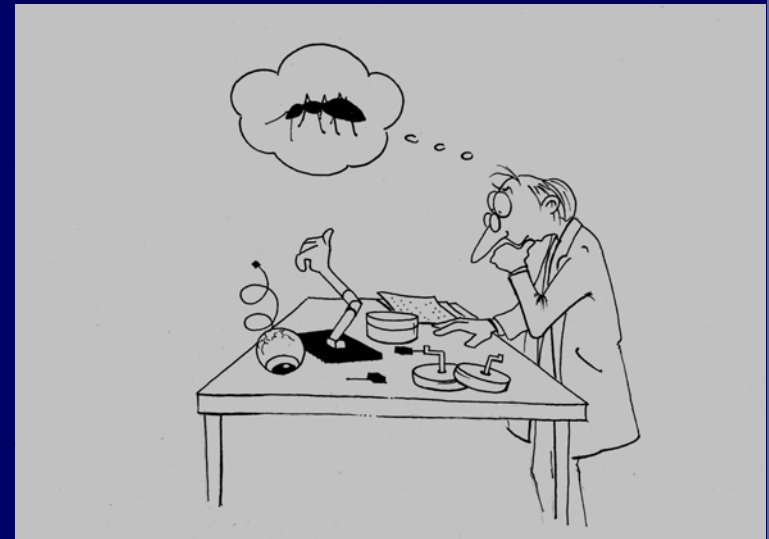
How to study intelligence?

How to study intelligence?

“Understanding by building”

- modeling behavior of interest
- abstracting principles

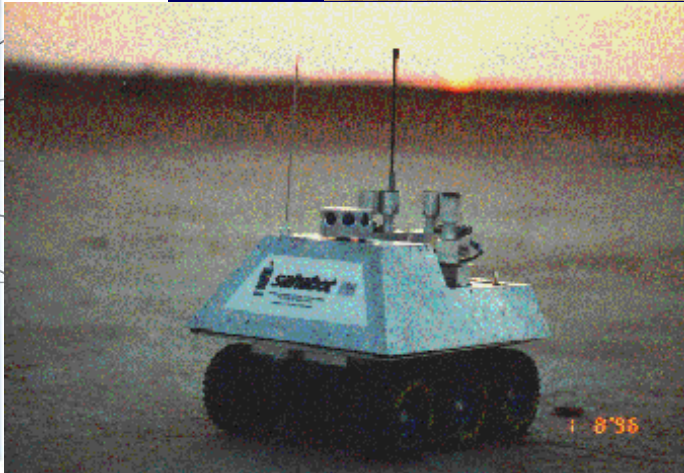
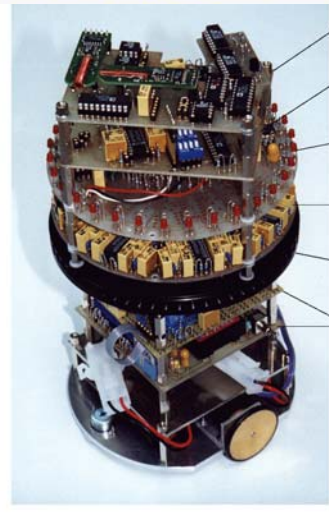
→ *robots as tools for scientific investigation*



Navigation behavior of desert ants



Sahabot I and II
The “analog robot”



Design and construction:
Hiroshi Kobayashi, Dimitri Lambrinos, Ralf Möller, Marinus Maris

Function of whiskers in rodents



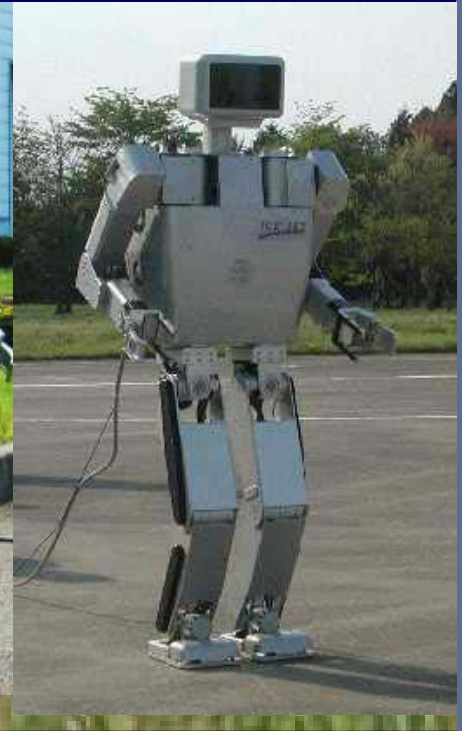
Design and construction:
Verena Hafner, Miriam Fend and
Hiroshi Yokoi



A-Mouse, the Artificial Mouse



Human walking



H-7: design and construction
S. Kagami, Univ. of Tokyo



Asimo by Honda

Today's topics

- Newell and Simon, Chomsky, George Miller
- The “cognitivist paradigm”, Functionalism, “Physical Symbol Systems”
- The classical approach: “Cognition as computation”
- Turing Machine, Universality
- The fundamental problems of the classical approach
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Cognition as computation

The Cognitivist Paradigm

Artificial Intelligence

The Dartmouth Conference - 1956

Artificial Intelligence - 1956 Conference



Artificial Intelligence - 1956 Conference



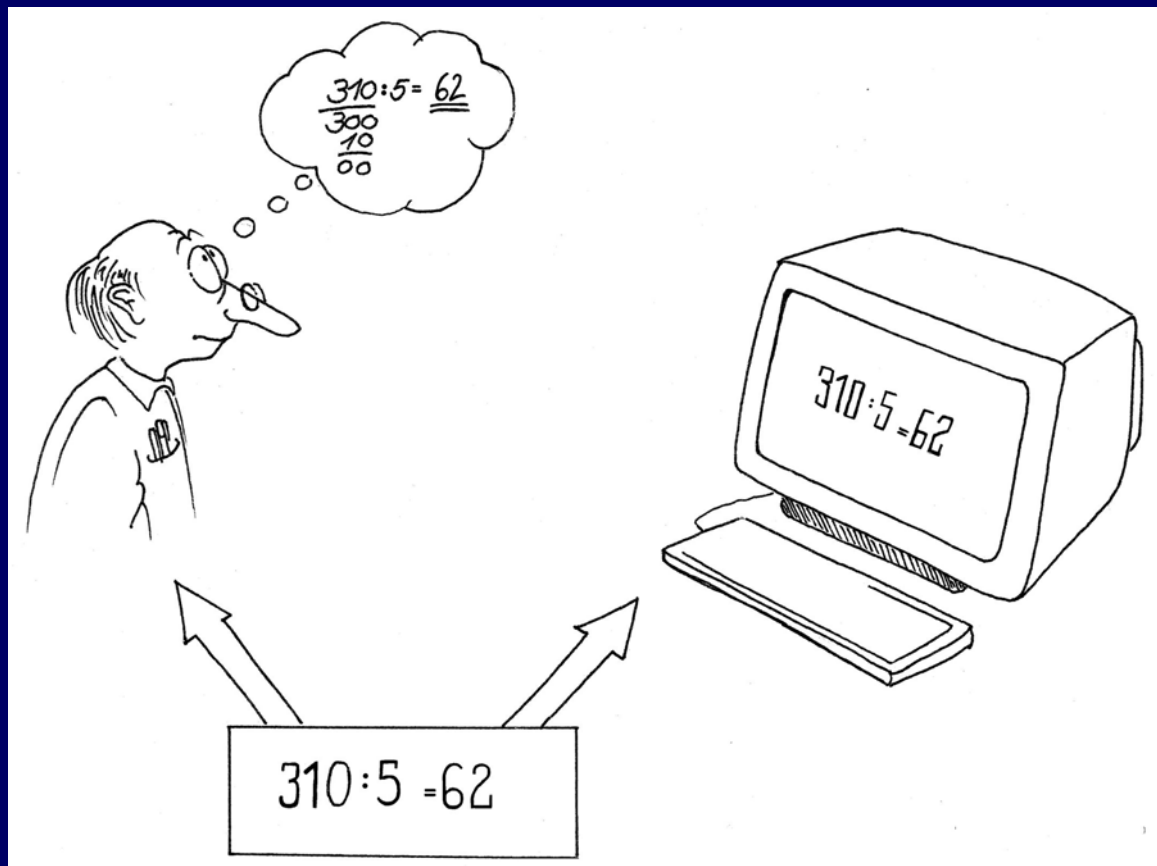
Artificial Intelligence - 1956 Conference

measure content of short-term memory:

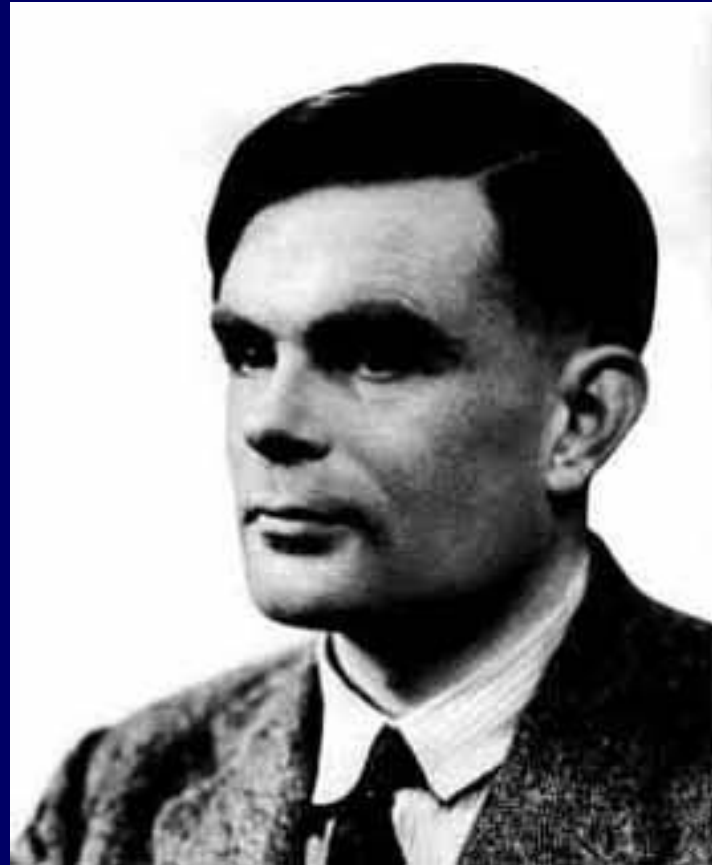
“The magical number 7 plus or minus 2”

Author:

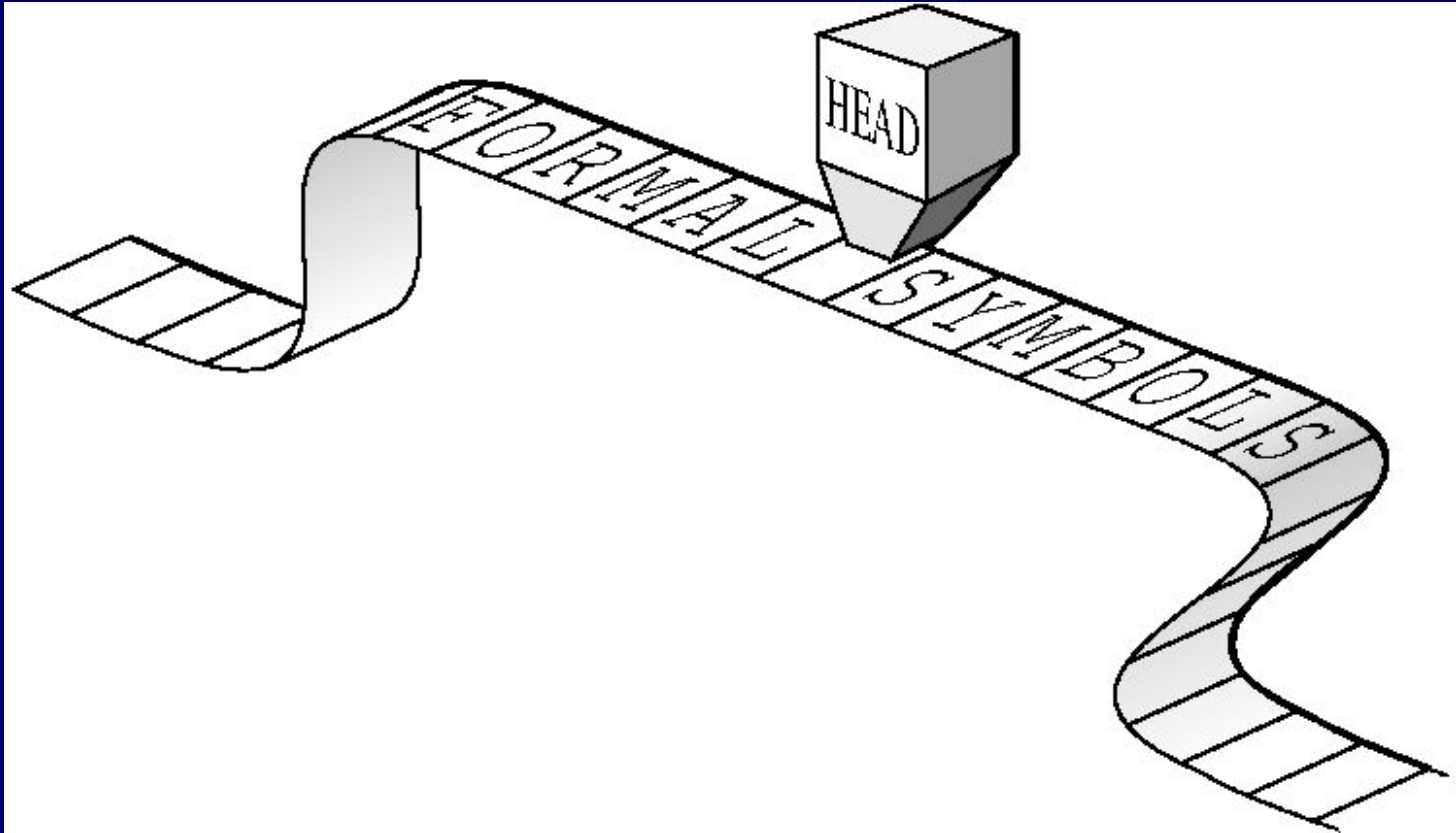
Cognition as Computation



Alan Turing



The Turing Machine (1)

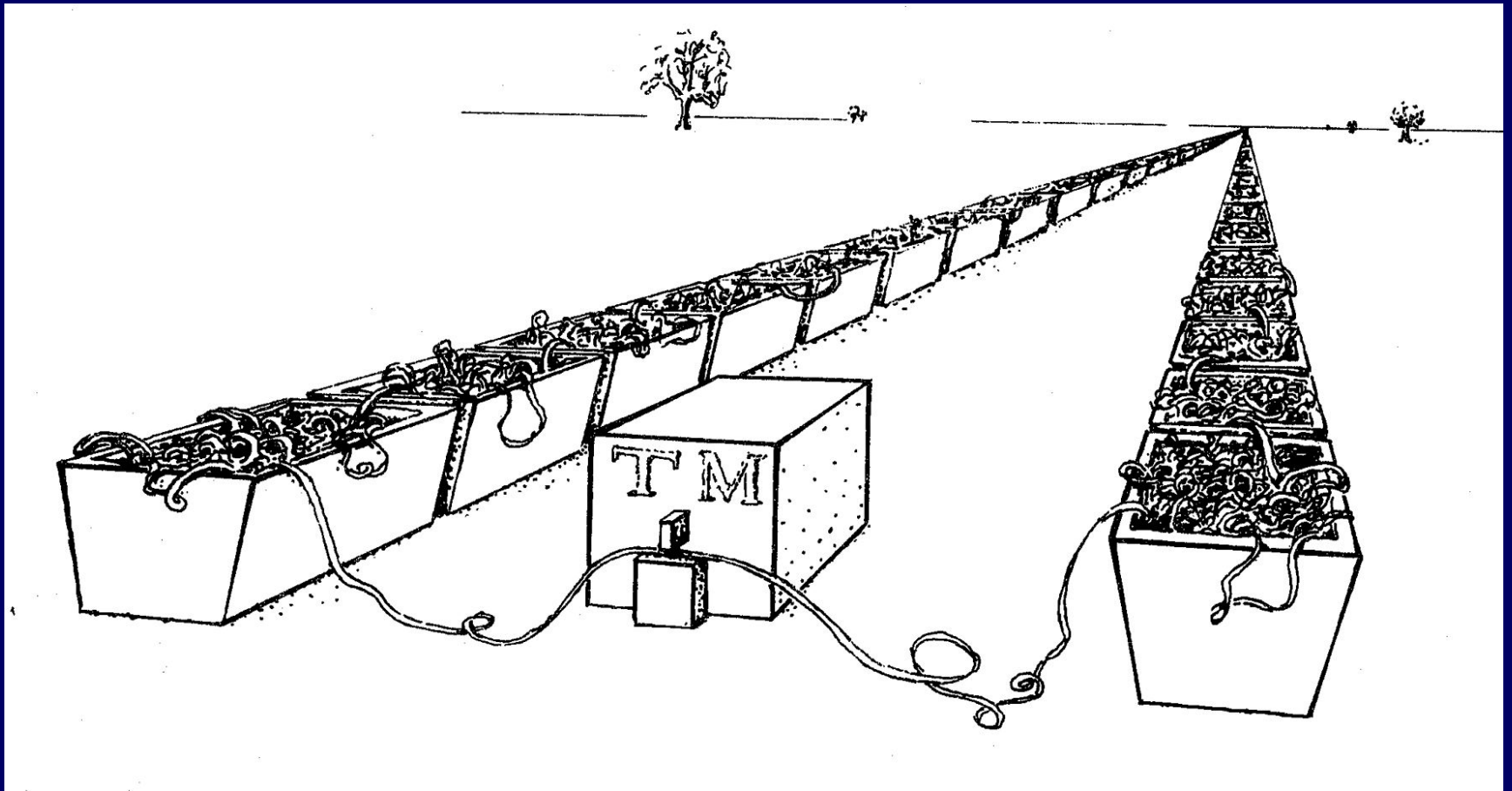


The Turing Machine (2)

			input from tape	1	2 ←	state of read/write head
A	L	2	↓ _	_R2	HALT	
<i>write on tape</i>	<i>move tape</i>	<i>next state of read write head</i>	A	AL1	BR2	
			B	BL1	AR2	
			C	CL1	CR2	

The “Universal Turing Machine”

The Turing Machine (3)



Functionalism and Physical Symbol Systems



electronic

Functionalism and Physical Symbol Systems



electronic



biological

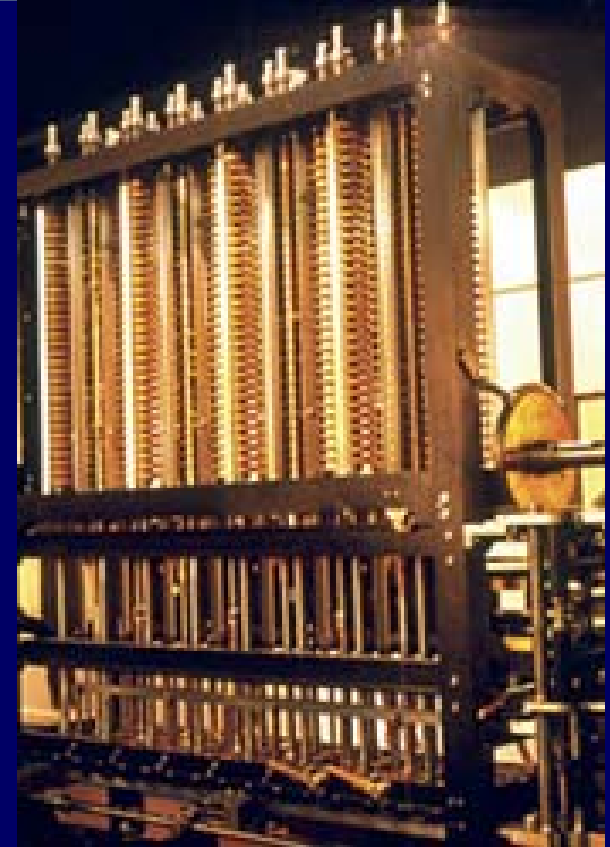
Functionalism and Physical Symbol Systems



electronic



biological



mechanical
("Difference Engine" by
Charles Babbage, 1824-53)

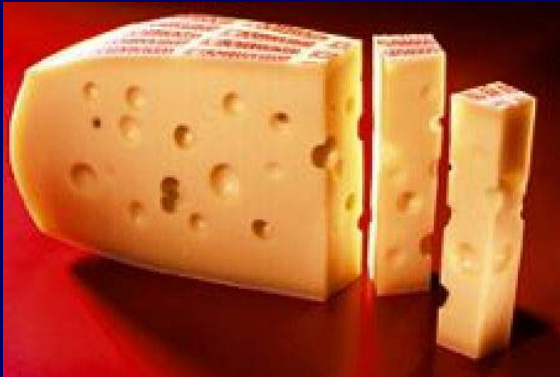
Functionalism and Physical Symbol Systems



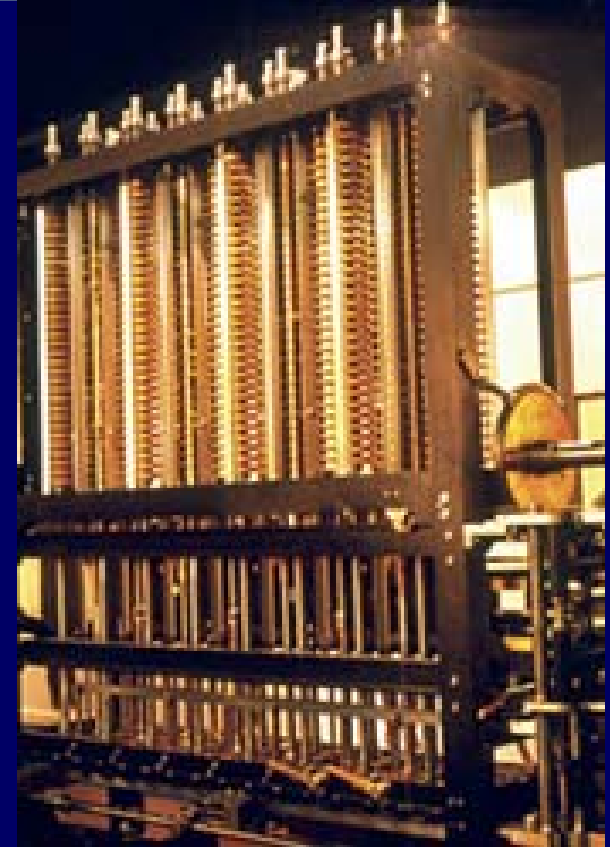
electronic



biological

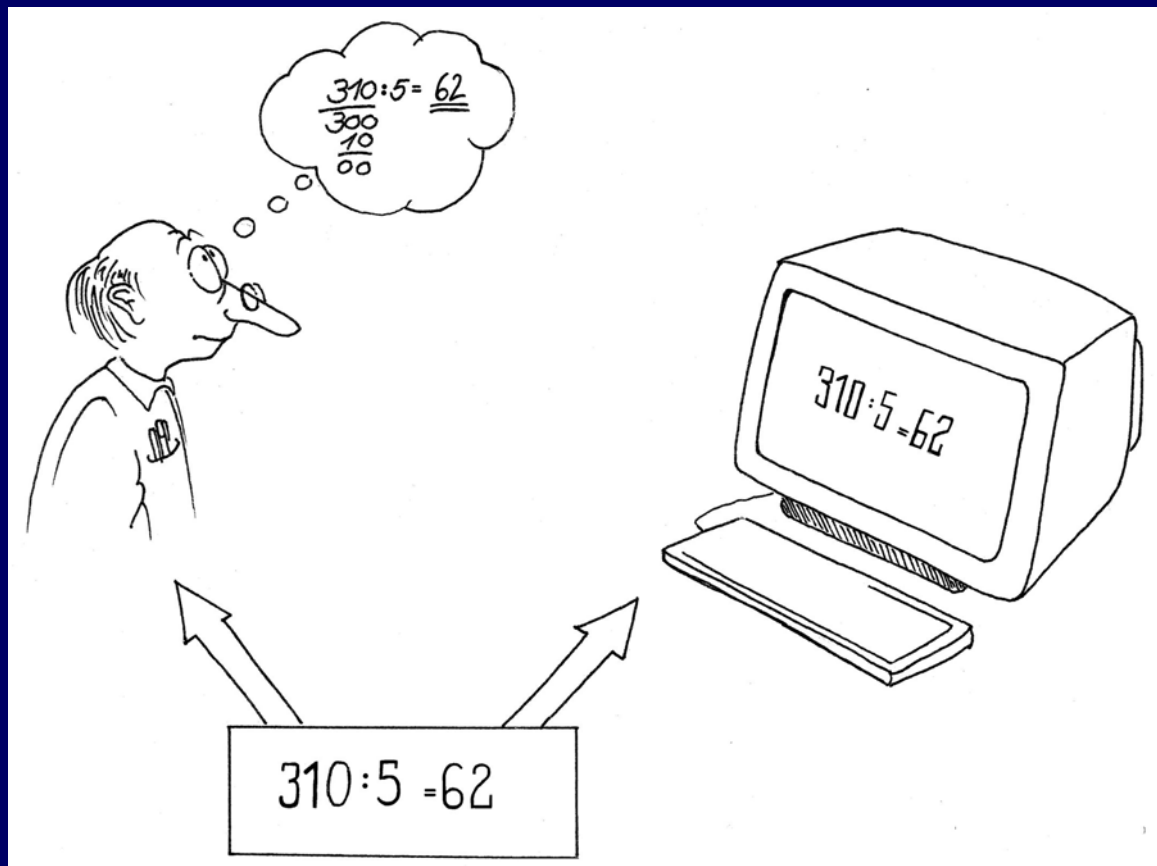


Swiss cheese
(Hilary Putnam, American Philosopher)

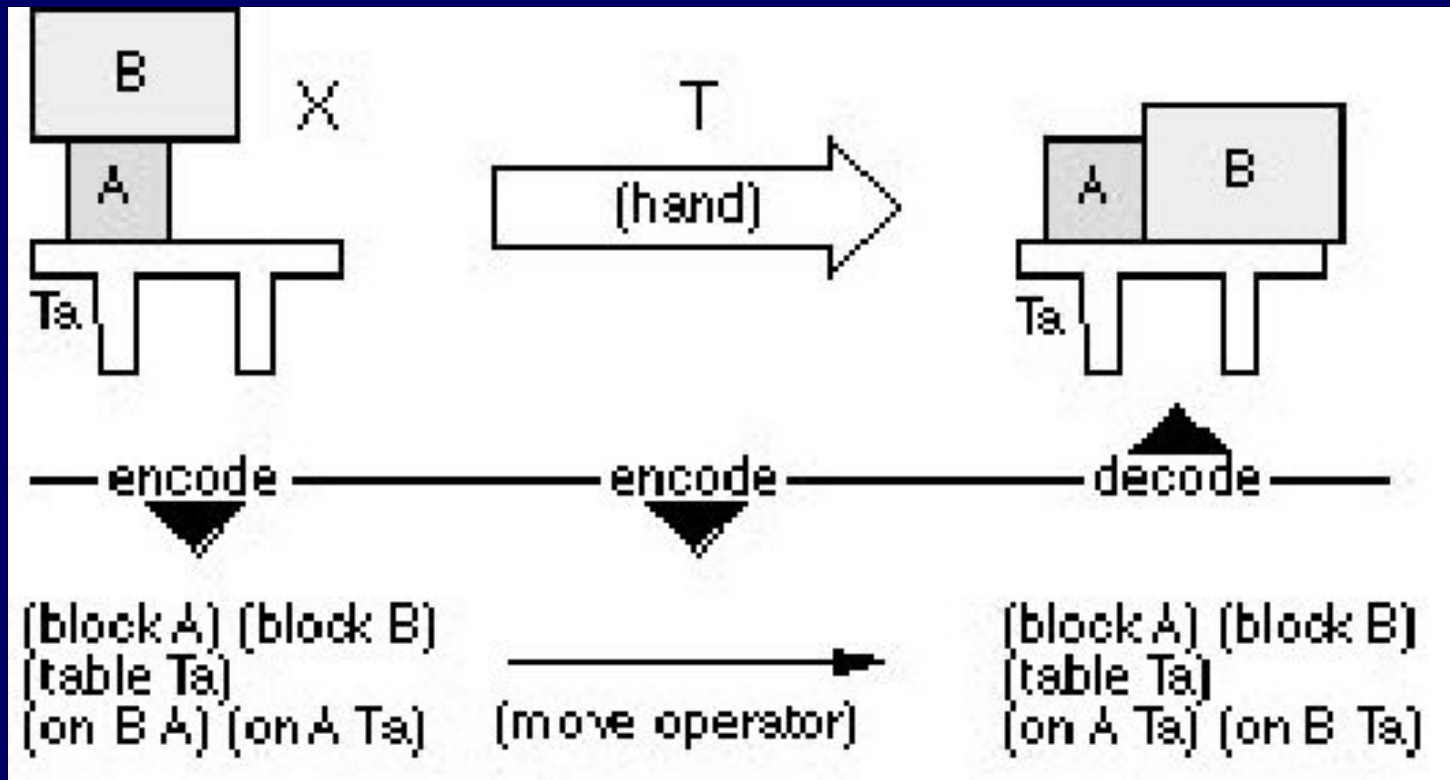


mechanical
("Difference Engine" by
Charles Babbage, 1824-53)

Cognition as Computation



Functionalism and Physical Symbol Systems Representation



Break

Feel free to ask questions during the break!

GOFAI

G

O

F

A

I

(John Haugeland)

Research Areas of Classical Artificial Intelligence

- *Problem solving*
 - solving problems by searching / heuristic search
 - game playing (chess)
- *Knowledge and reasoning*
 - agents that reason logically / first-order logic
 - building a knowledge base
- *Acting logically*
 - planning and acting
- *Uncertain knowledge and reasoning*
 - uncertainty / probabilistic reasoning systems
 - decision making
- *Learning*
 - learning from observations; learning in neural and belief networks
 - knowledge in learning; reinforcement learning
- *Communicating, perceiving, and acting*
 - agent that communication; natural language processing
 - perception
 - robotics

Classical artificial intelligence – successes

- search engines
- text processing systems
- data mining
- appliances (dish washers, refrigerators, cameras)
- cars (fuel injection, braking systems, navigation systems)
- restricted natural language systems (information systems, translation support systems, error correction systems)
- control systems (elevators, subways)
- etc.

indistinguishable from informatics in general

Classical artificial intelligence – failures

- recognizing a face in a crowd
- vision/perception in the real world
- manipulation of objects
- sensory-motor coordination
- walking, funning, moving
- common sense
- speech (everyday natural language)
- in general: natural forms of intelligence

essential for natural forms of intelligence

Fundamental Problems of Classical AI

Fundamental Problems of Classical AI

in essence:

everything to do with real-world interaction

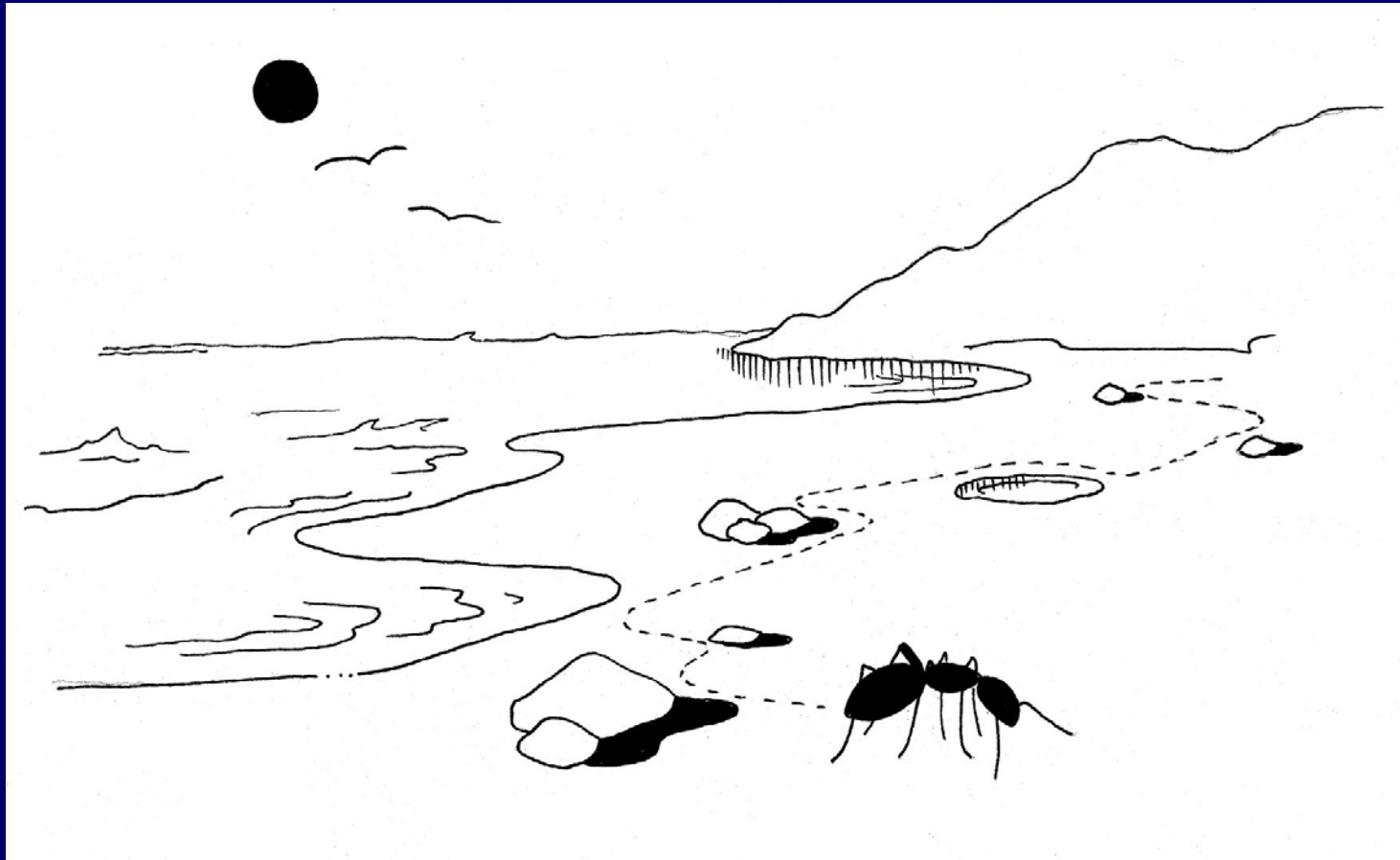
fundamental differences: real and virtual worlds

Fundamental Problems of Classical AI

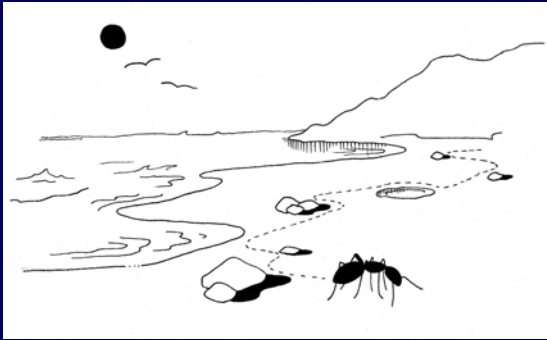
- the “Symbol Grounding Problem”
- the “Frame Problem”
- the problems of embodiment and situatedness
- the “homunculus problem”

→ the “Frame-of-reference” Problem

Simon's Ant on the Beach



Simon's Ant on the Beach



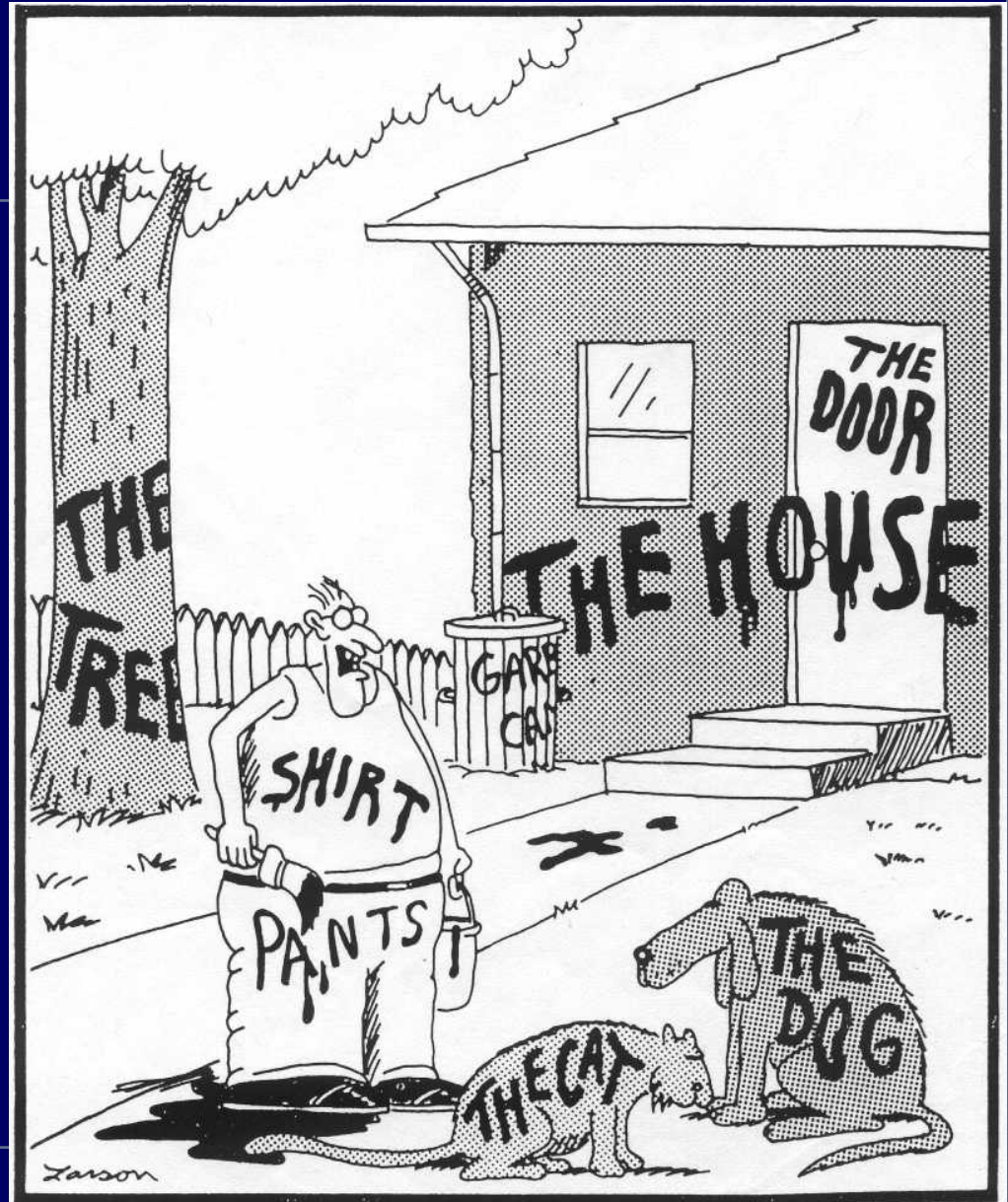
F-O-R Competition!

Fundamental Problems of Classical AI

- the “Symbol Grounding Problem”
- the “Frame Problem”
- the problems of embodiment and situatedness
- the “homunculus problem”

→ the “Frame-of-reference” Problem

Symbol Grounding



Gary Larson

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

The “frame problem”

Daniel Dennett

American philosopher (“philosophy of mind”)

R1

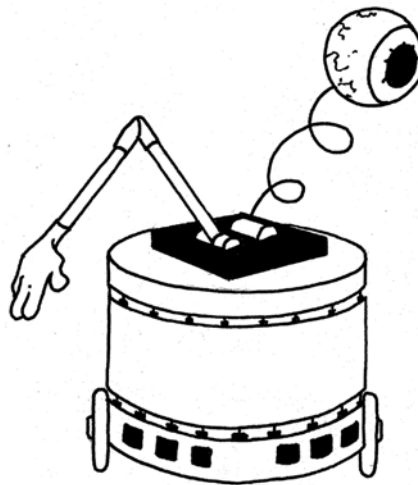
“robot”

R1D1

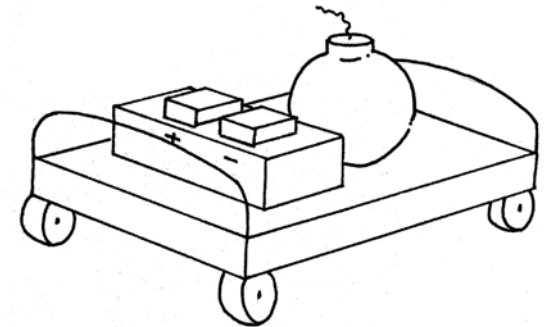
“robot deducer”

R2D1

“robot-
relevant-deducer”



INSIDE(R1,ROOM)
INSIDE(BATTERY,ROOM)
INSIDE(BOMB,ROOM)
INSIDE(WAGON,ROOM)
ON(BATTERY,WAGON)
COLOR(WALLS,BLUE)
HEIGHT(ROOM,9FEET)
ON(BOMB,WAGON)
PULLOUT(WAGON,ROOM)
ETC.
ETC.



Isabelle Follath

Fundamental Problems of Classical AI

- the “Symbol Grounding Problem”
- the “Frame Problem”
- the problems of embodiment and situatedness
- the “homunculus problem”

→ read chapter 3 for the other
fundamental problems

The latest from Japan



Next:

Presentation Prof. Masafumi Okada
Dept. of Mechanical Engineering
The University of Tokyo

The Latest from Japan



Next:

Presentation Prof. Masafumi Okada
Dept. of Mechanical Engineering
The University of Tokyo

The Latest from Japan

Introduction by

Prof. Yasuo Kuniyoshi

Assignments

Reading (“Understanding Intelligence”)

- Chapters 2: “Foundations of Classical Artificial Intelligence and Cognitive Science” and
- Chapter 3: “The Fundamental Problems of *Classical AI and Cognitive Science*”

Exercise 2

familiarize yourself with the basic ideas of the classical approach

Special Assignment for Munich: prepare a short presentation on “Real Worlds vs. Virtual Worlds” (Soccer vs. Chess) for next week

Thank you for your attention

See you all next week!