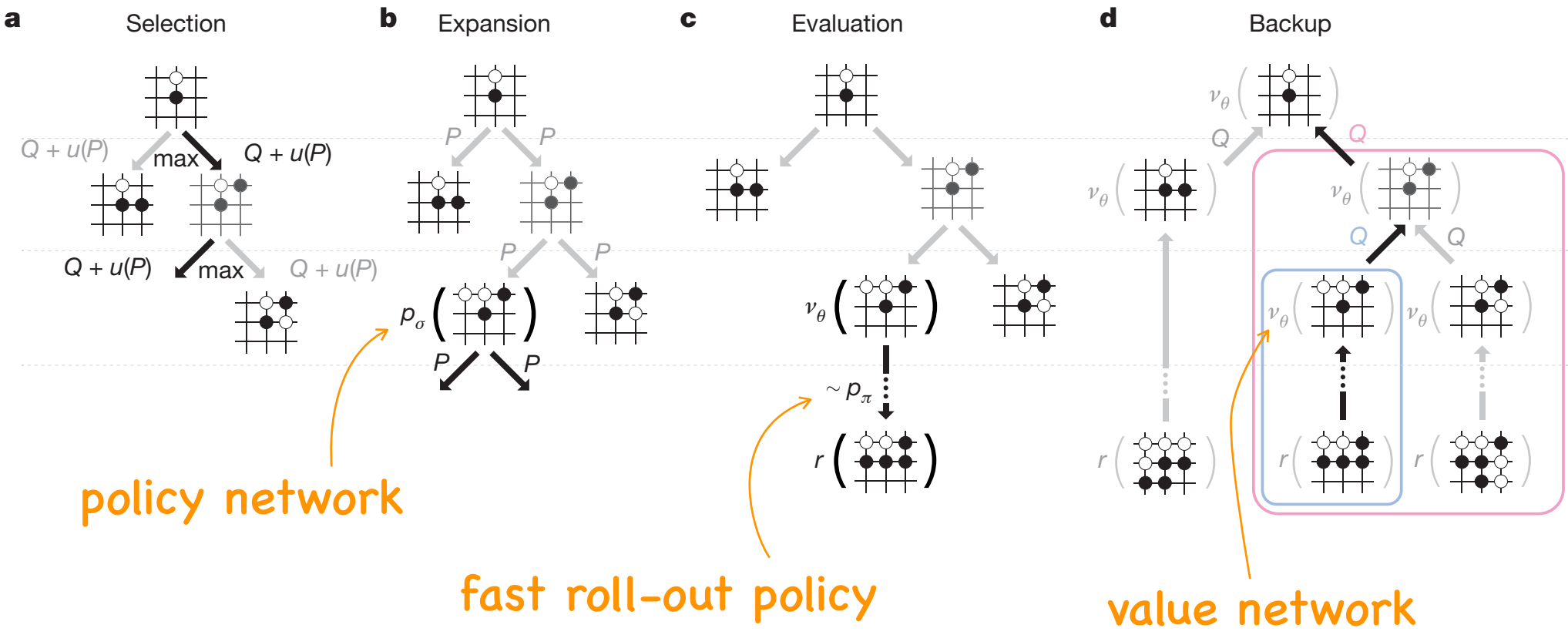
Lecture 16: Final
On Artificial Intelligence

http://cs.nju.edu.cn/yuy/course_ai18.ashx

AlphaGo

A combination of tree search, deep neural networks and reinforcement learning



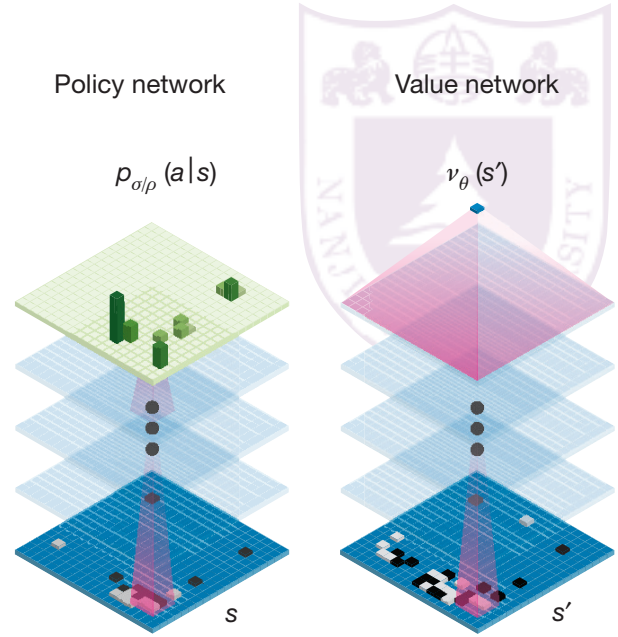
AlphaGo

fast roll-out policy:

supervised learning from human v.s. human data

Feature	# of patterns	Description
Response	1	Whether move matches one or more response pattern features
Save atari	1	Move saves stone(s) from capture
Neighbour	8	Move is 8-connected to previous move
Nakade	8192	Move matches a *nakade* pattern at captured stone
Response pattern	32207	Move matches 12-point diamond pattern near previous move
Non-response pattern	69338	Move matches 3×3 pattern around move
Self-atari	1	Move allows stones to be captured
Last move distance	34	Manhattan distance to previous two moves
Non-response pattern	32207	Move matches 12-point diamond pattern centred around move

AlphaGo



policy network: a CNN output π(s,a)

value network: a CNN output V(s)

Feature	# of planes	Description
Stone colour	3	Player stone / opponent stone / empty
Ones	1	A constant plane filled with 1
Turns since	8	How many turns since a move was played
Liberties	8	Number of liberties (empty adjacent points)
Capture size	8	How many opponent stones would be captured
Self-atari size	8	How many of own stones would be captured
Liberties after move	8	Number of liberties after this move is played
Ladder capture	1	Whether a move at this point is a successful ladder capture
Ladder escape	1	Whether a move at this point is a successful ladder escape
Sensibleness	1	Whether a move is legal and does not fill its own eyes
Zeros	1	A constant plane filled with 0
Player color	1	Whether current player is black

policy network: initialization

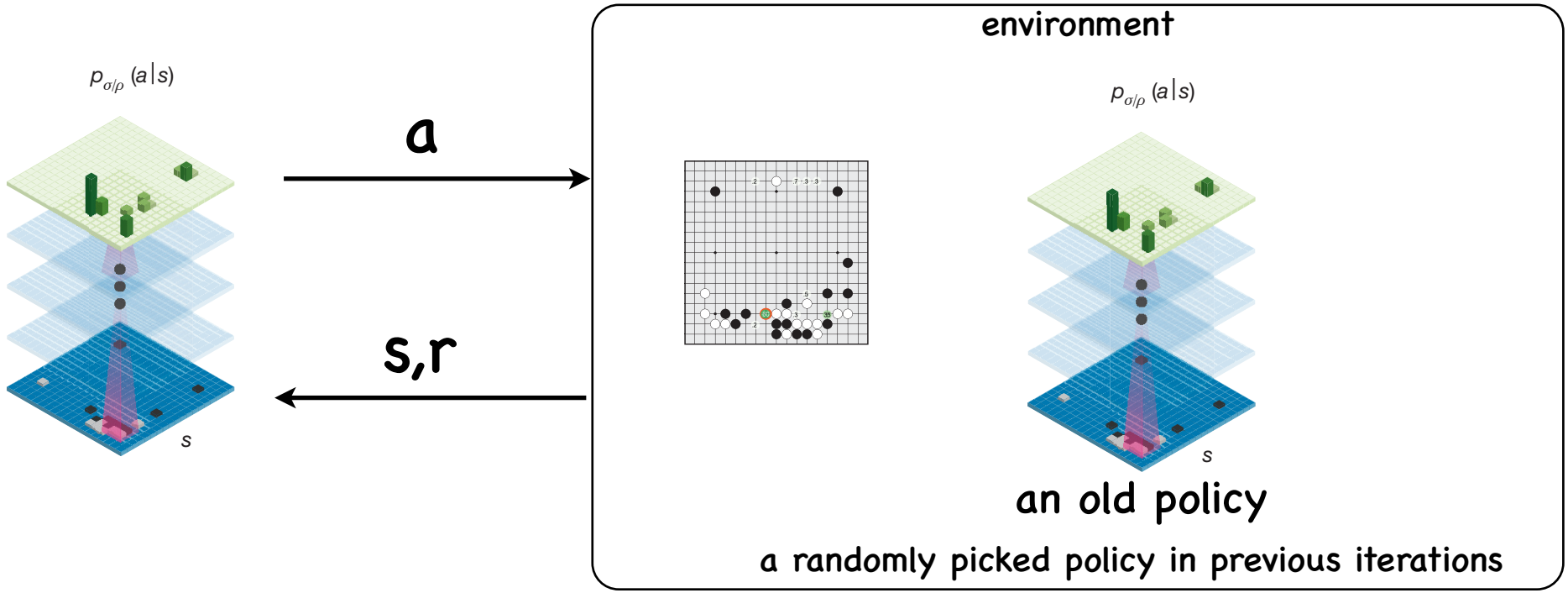
supervised learning from human v.s. human data

Architecture			Evaluation				
Filters	Symmetries	Features	Test accuracy %	Train accuracy %	Raw net wins %	*AlphaGo* wins %	Forward time (ms)
128	1	48	54.6	57.0	36	53	2.8
192	1	48	55.4	58.0	50	50	4.8
256	1	48	55.9	59.1	67	55	7.1
256	2	48	56.5	59.8	67	38	13.9
256	4	48	56.9	60.2	69	14	27.6
256	8	48	57.0	60.4	69	5	55.3
192	1	4	47.6	51.4	25	15	4.8
192	1	12	54.7	57.1	30	34	4.8
192	1	20	54.7	57.2	38	40	4.8
192	8	4	49.2	53.2	24	2	36.8
192	8	12	55.7	58.3	32	3	36.8
192	8	20	55.8	58.4	42	3	36.8

AlphaGo

policy network: further improvement

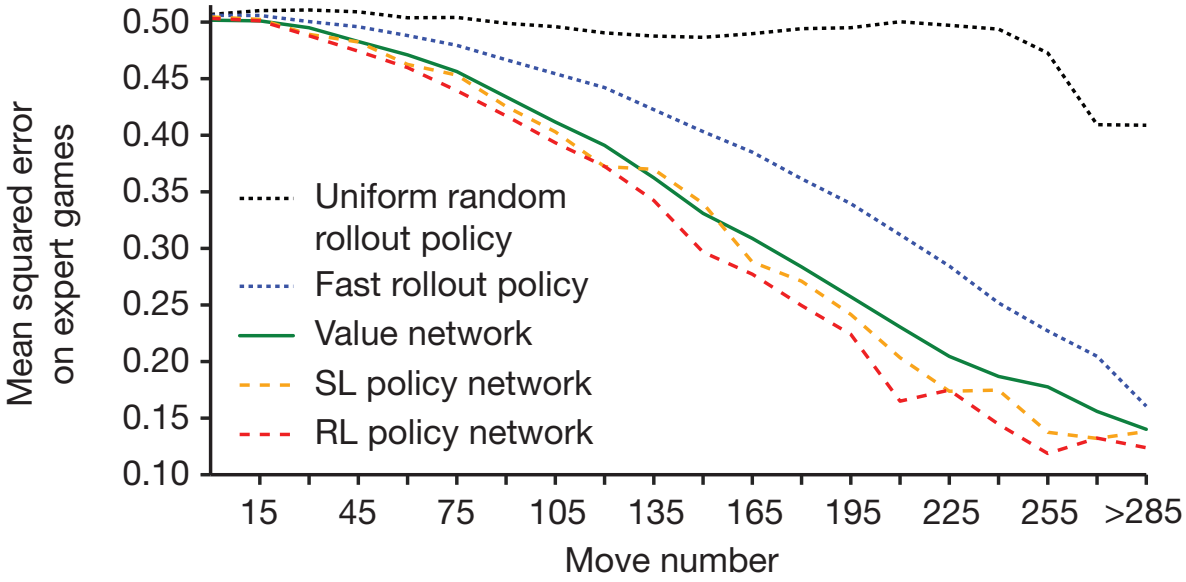
reinforcement learning

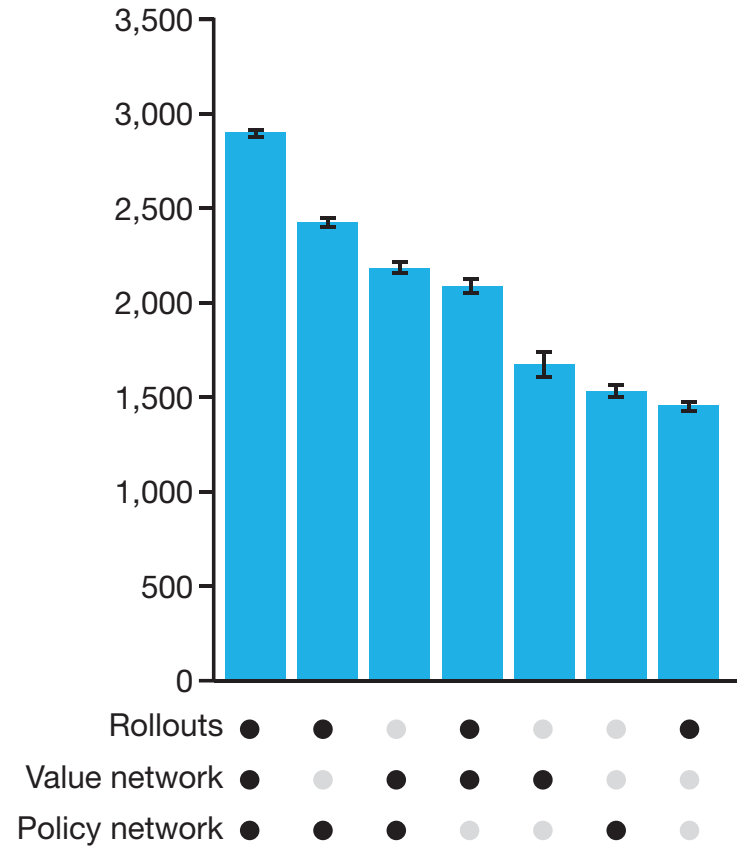


a.k.a. self-play

reward:
+1 -- win at terminate state
-1 -- loss at terminate state

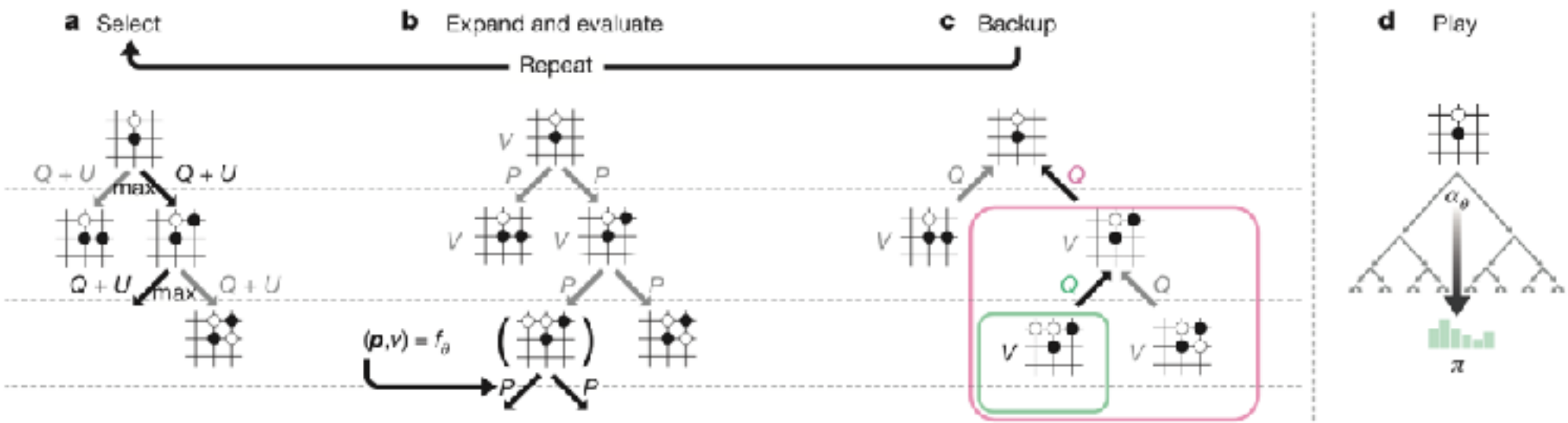
value network: supervised learning from RL data





AlphaGo Zero

No pre-training, No roll-out

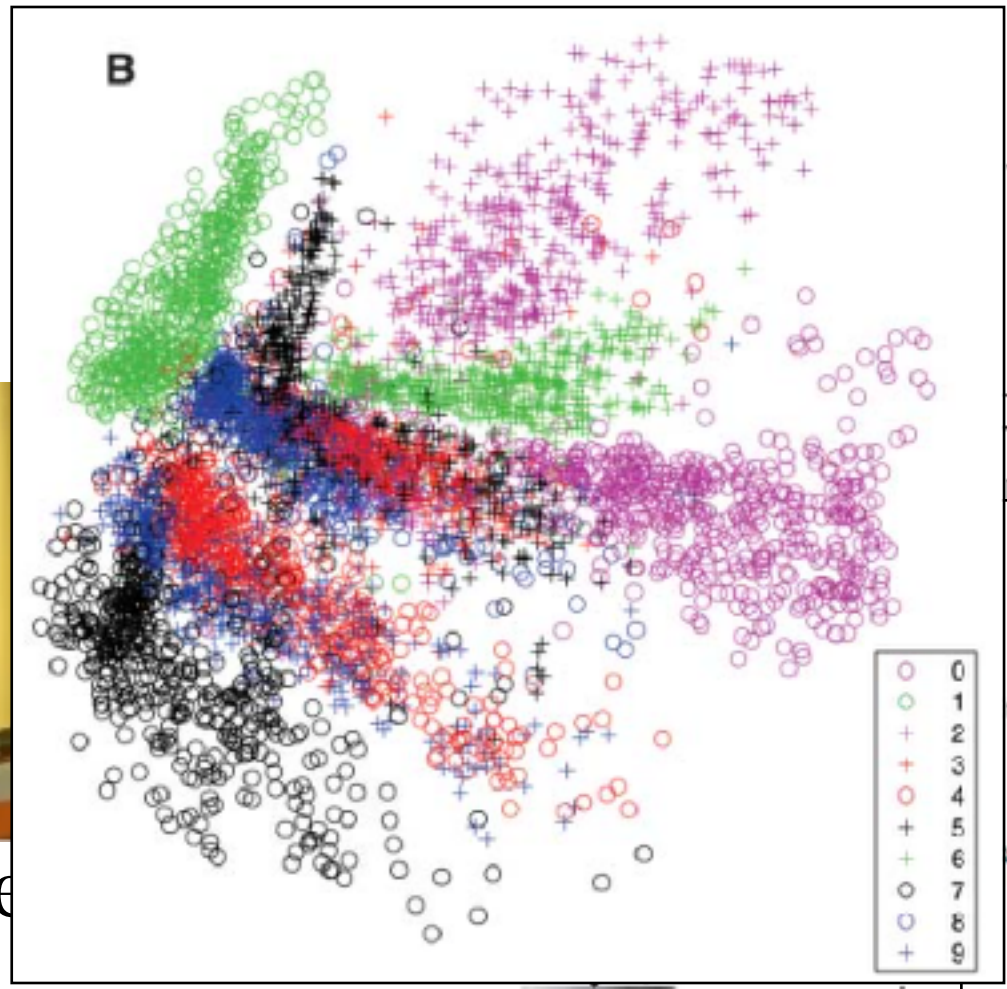


Reinforcement learning:

collect data by MCTS,

remember by neural networks

History

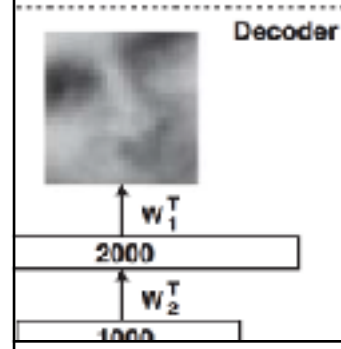


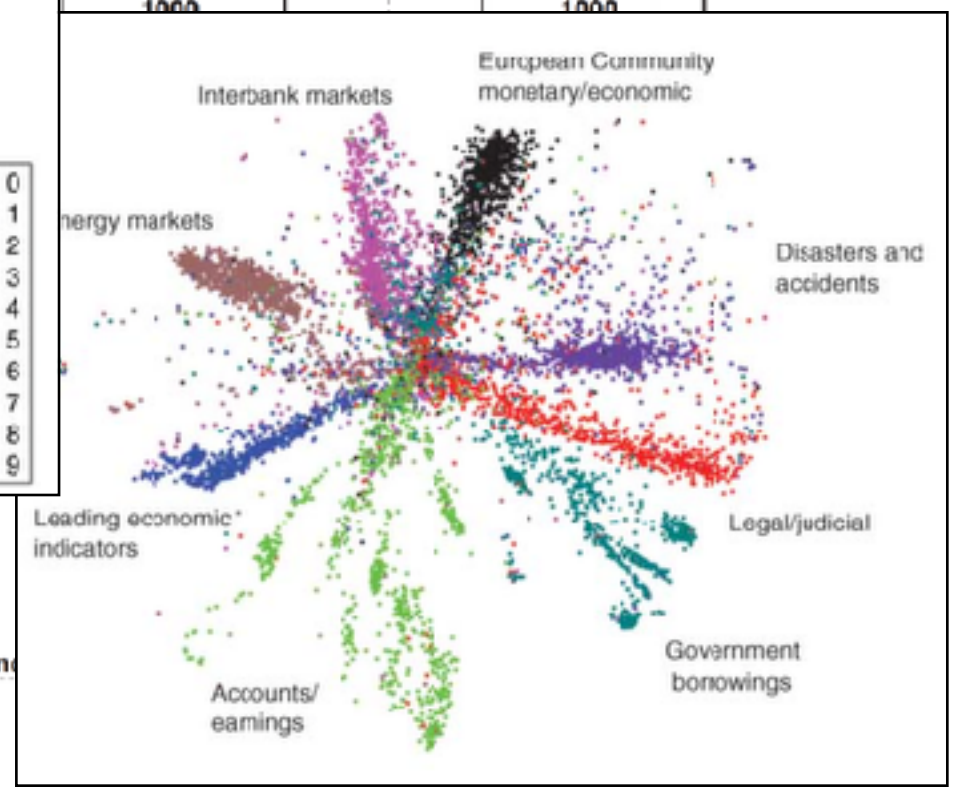
Ge

Pretraining

RBM

En



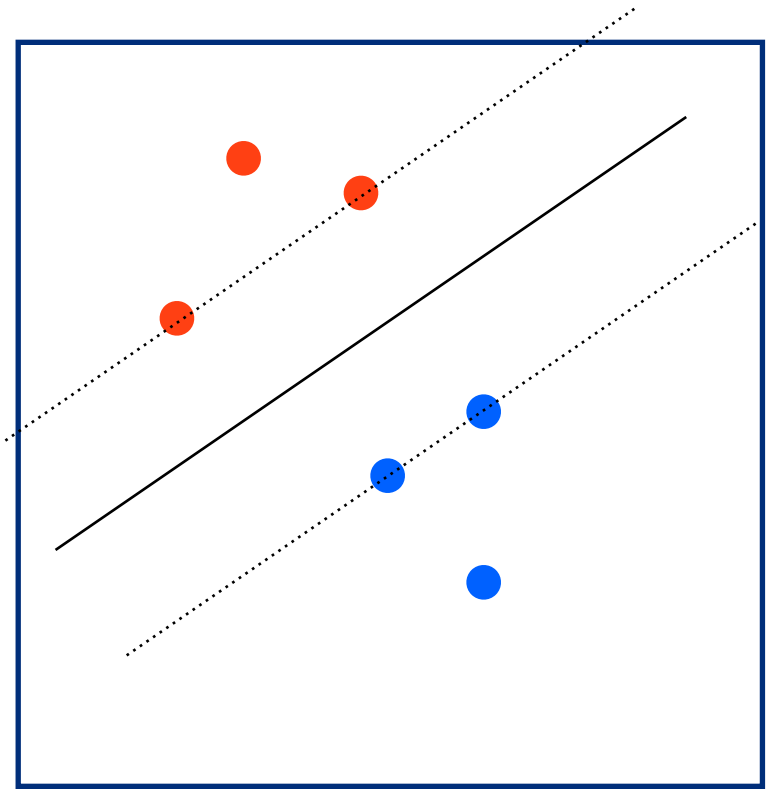


Describes without errors	Describes with minor errors	Somewhat related to the image	Unrelated to the image
A person riding a motorcycle on a dirt road.	Two dogs play in the grass.	A skateboarder does a trick on a ramp.	A dog is jumping to catch a frisbee.
A group of young people playing a game of frisbee.	Two hockey players are fighting over the puck.	A little girl in a pink hat is blowing bubbles.	A refrigerator filled with lots of food and drinks.
A herd of elephants walking across a dry grass field.	A close up of a cat laying on a couch.	A red motorcorcycle parked on the side of the road.	A yellow school bus parked in a parking lot.

C

D

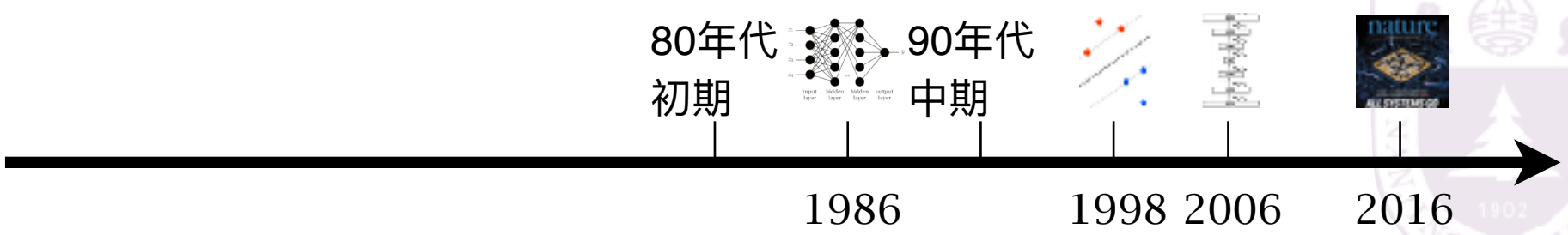
90年代
中期
1998
2006
2016
nature

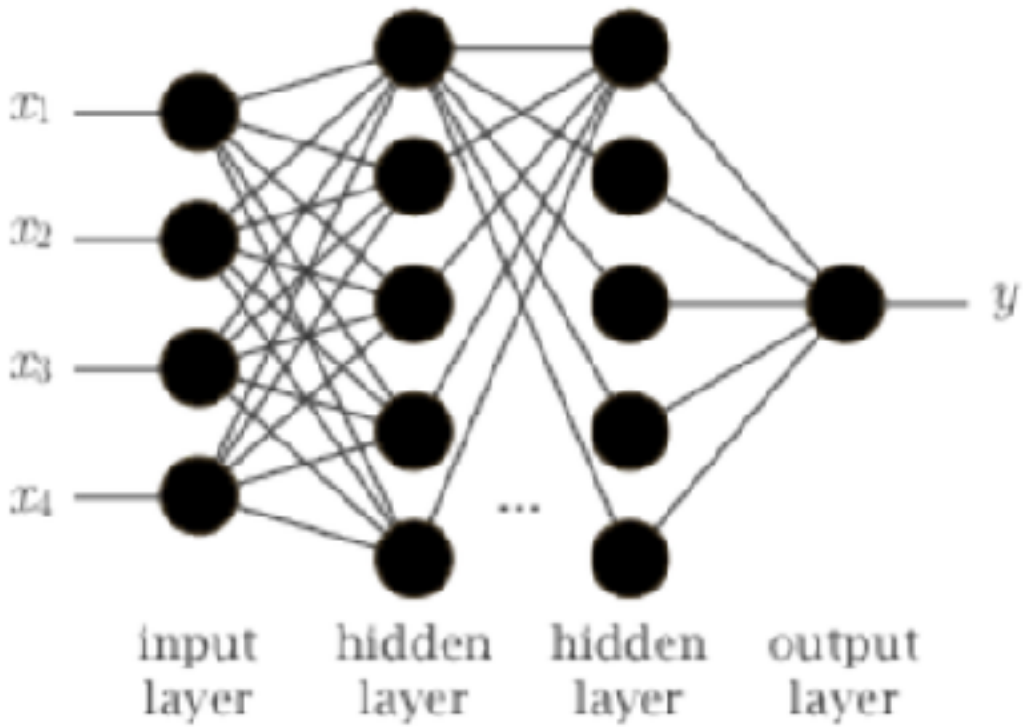


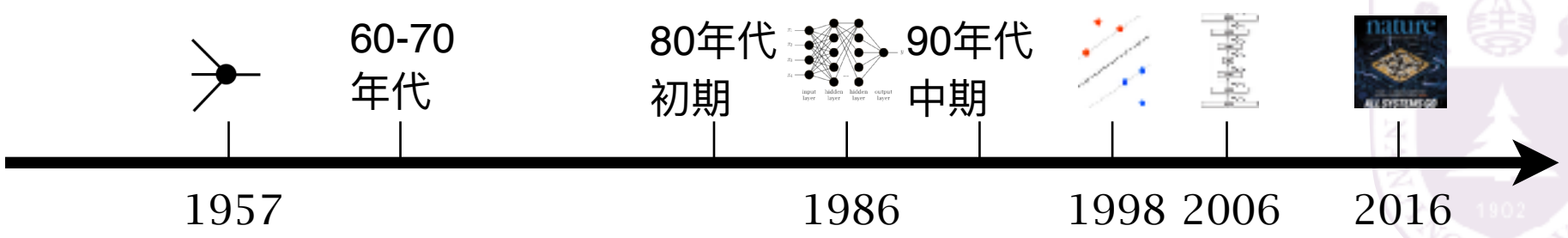
MAIL

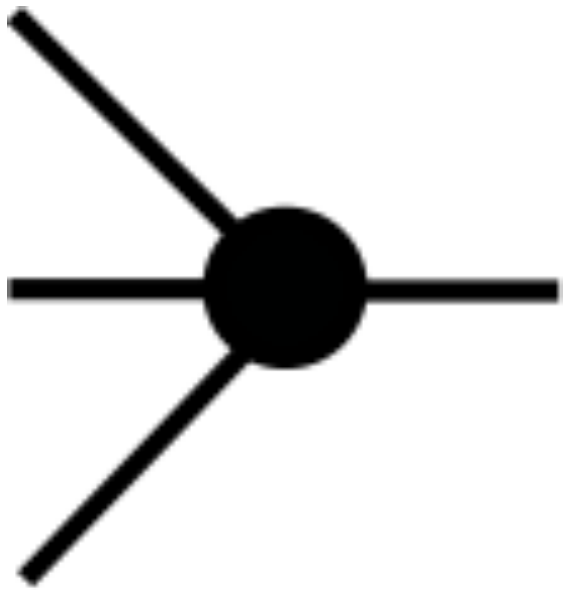
Face Detection

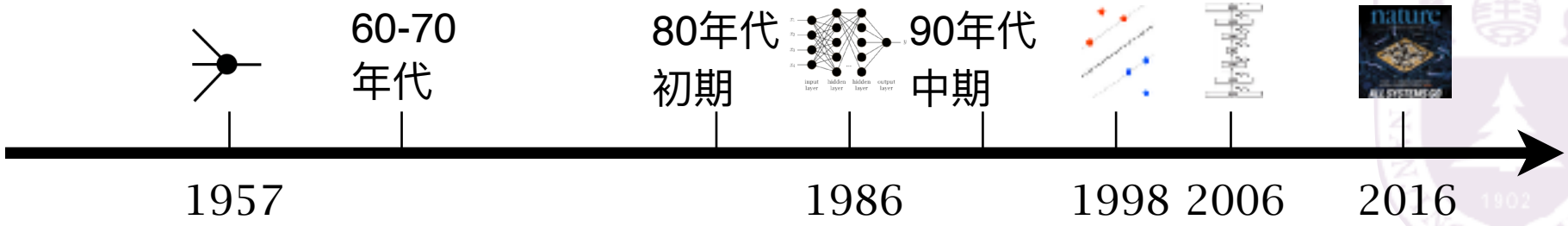
Head First
C#
数学之美
智能车辆导航技术
视觉机器学习
剑指Offer
统计学习方法
深度学习
方法及应用


80年代
初期
90年代
中期
1986
1998
2006
2016
nature


x_1
x_2
x_3
x_4
...
y
input layer
hidden layer
hidden layer
output layer

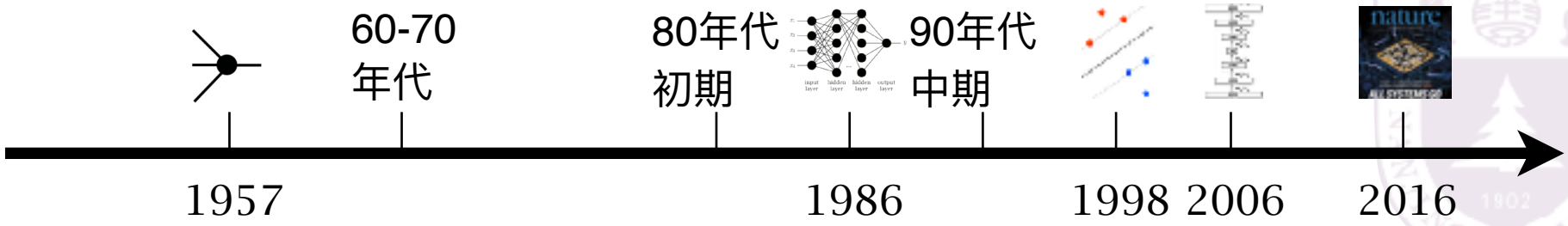

60-70
年代
80年代
初期
90年代
中期
1957
1986
1998
2006
2016





Edward Albert Feigenbaum

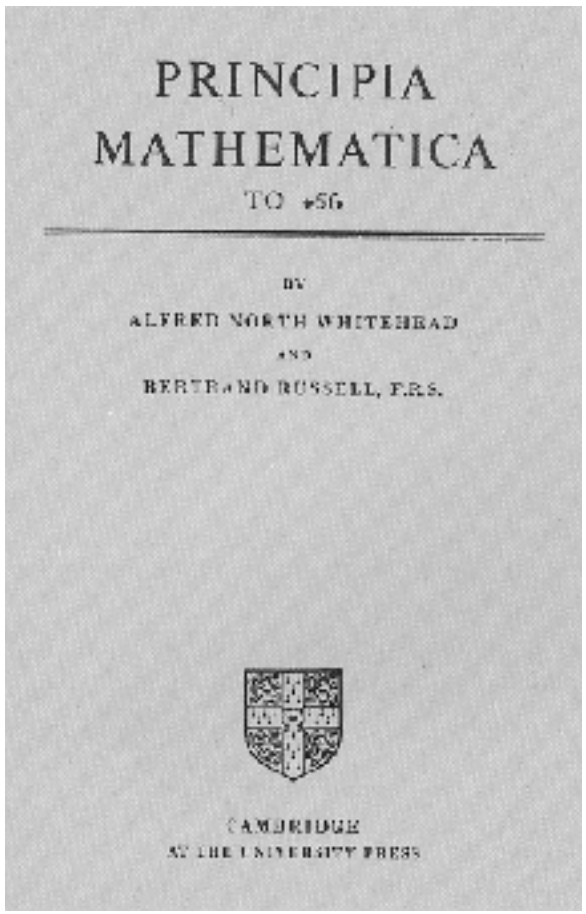
专家系统



Allen Newell

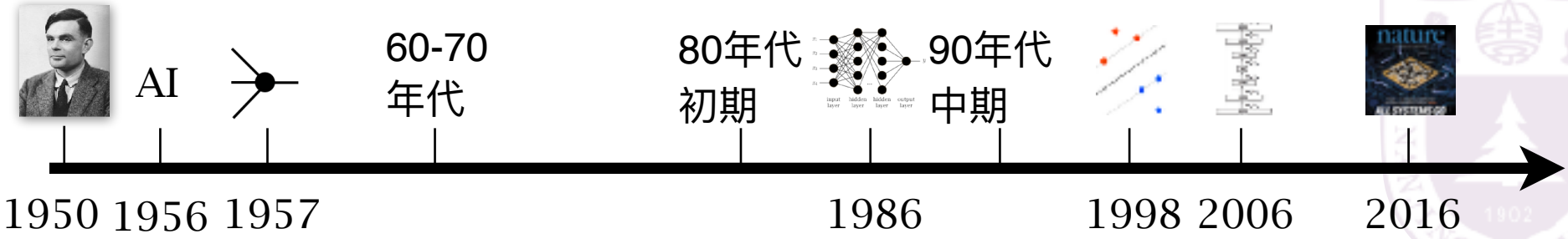
Herbert Simon

逻辑学家



1956 **Dartmouth meeting: "Artificial Intelligence" adopted**

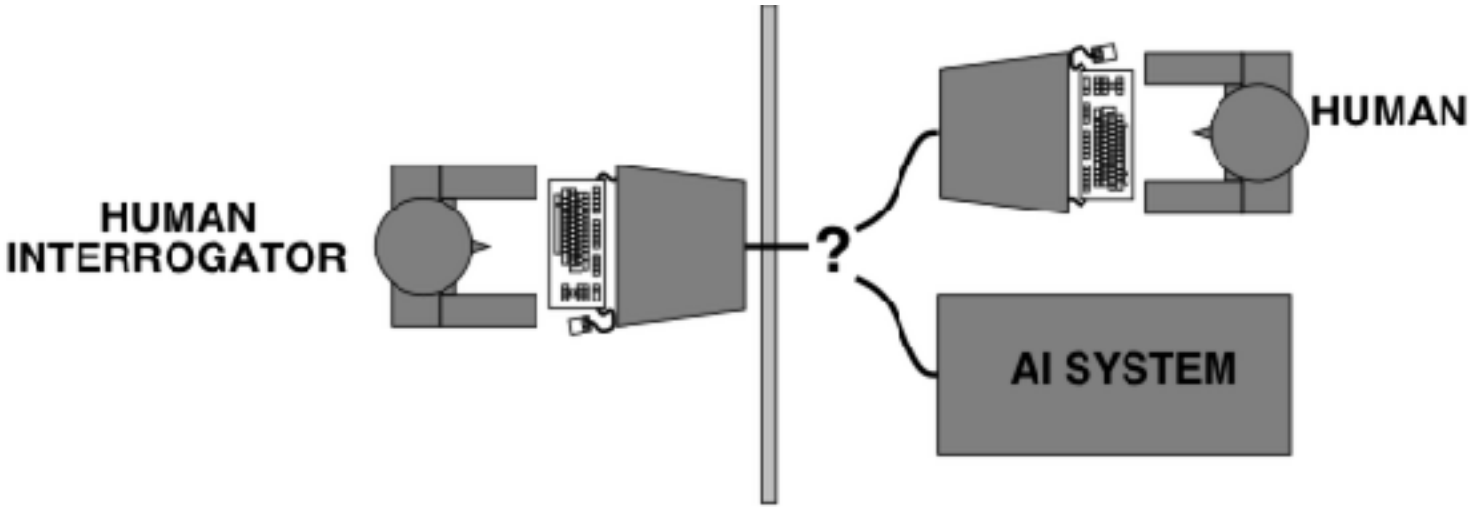
John McCarthy	Turing Award (1971)
Marvin Minsky	Turing Award (1969)
Claude Shannon	the father of information theory
Oliver Selfridge	father of machine perception
Herbert A. Simon	Turing Award (1975), Nobel Prize in Economics (1978)
Allen Newell	Turing Award (1975)

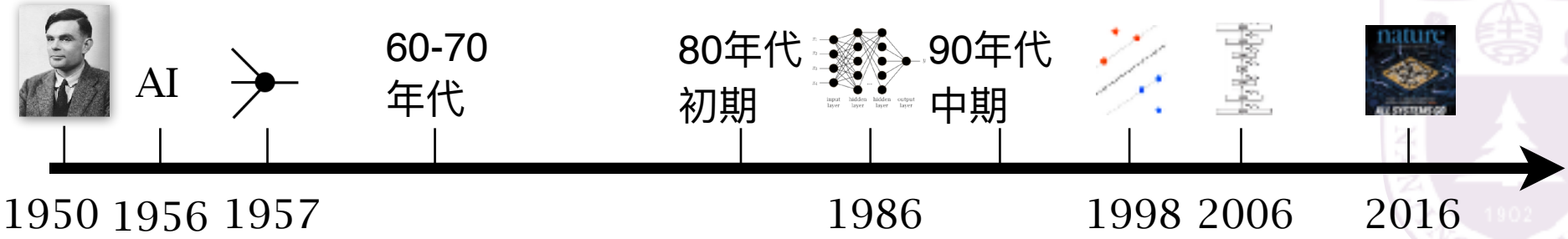


[*Computing machinery and intelligence*. **Mind** 49: 433-460, 1950.]

Alan Turing
1912-1954

Section 1: Imitation game





[*Computing machinery and intelligence*. **Mind** 49: 433-460, 1950.]

Alan Turing
1912-1954

Section 7: Learning machines

"In the process of trying to imitate an adult human mind we are bound to think agood deal about the process which has brou ght it to the state that it is in. We maynotice three components.

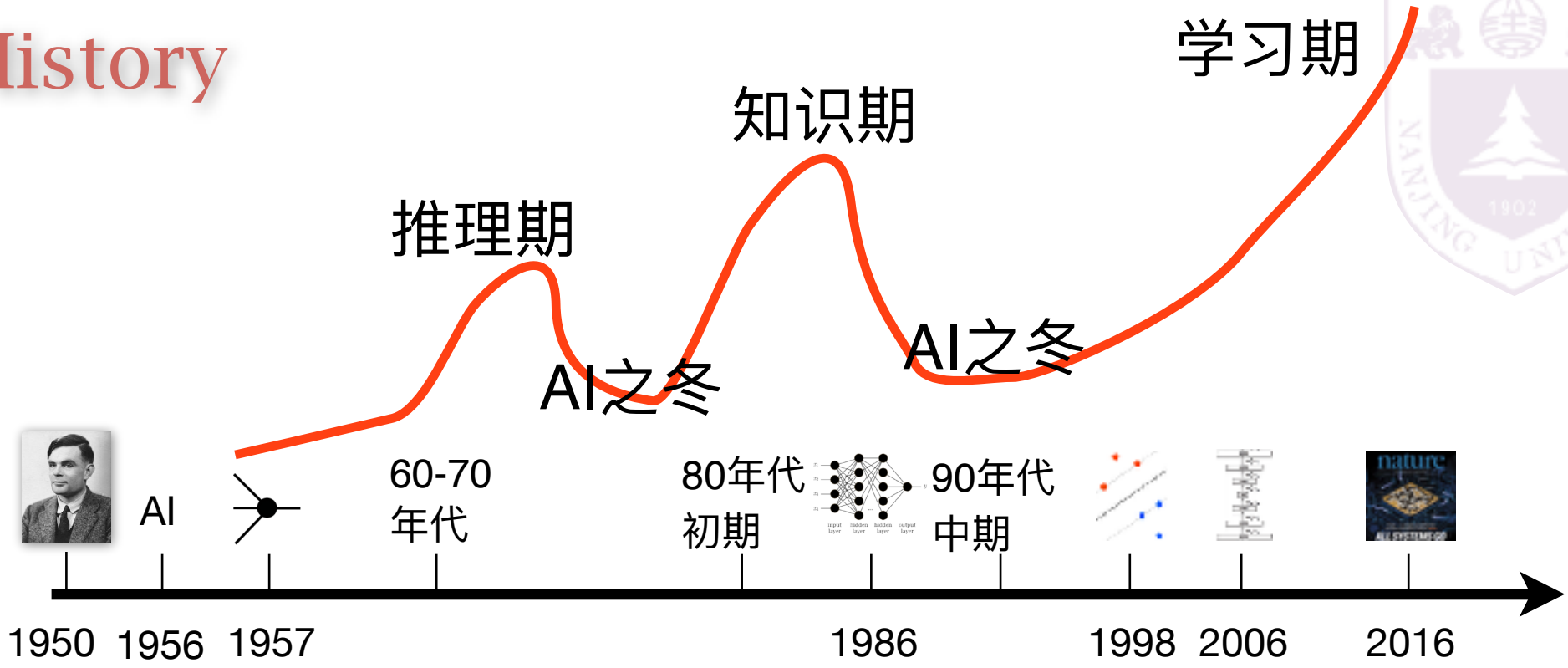
(a) The initial state of the mind, say at birth,

(b) The education to which it has been subjected,

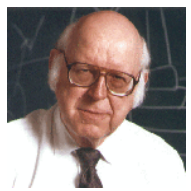
(c) Other experience, not to be described as education, to w hich it has beensubjected."

Instead of trying to produce a programme to simulate the a dult mind, why not rather try to produce one which simulates the child's?

History



“解决了神秘的心/身问题，解释了物质构成的系统如何获得心灵的性质。”
“十年之内，数字计算机将成为国际象棋世界冠军。”
“二十年内，机器将能完成人能做到的一切工作。”
“一代之内……创造‘人工智能’的问题将获得实质上的解决。”
“在三到八年的时间里我们将得到一台具有人类平均智能的机器。”

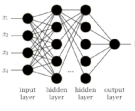

Allen Newell

Marvin Minsky

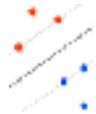
AI

60-70
年代

80年代
初期



90年代
中期



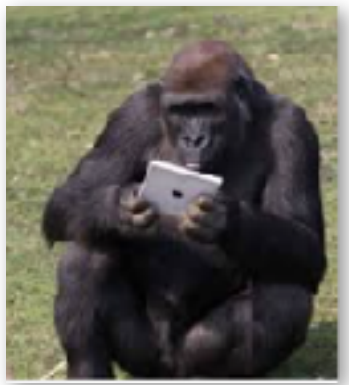
1950 1956 1957 1986 1998 2006 2016

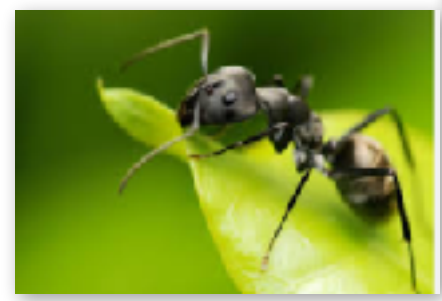
1997 深蓝

Potted history of AI

1943 McCulloch & Pitts: Boolean circuit model of brain
1950 Turing's "Computing Machinery and Intelligence"
1952–69 Look, Ma, no hands!
1950s Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
1956 **Dartmouth meeting: "Artificial Intelligence" adopted**
1965 Robinson's complete algorithm for logical reasoning
1966–74 AI discovers computational complexity
Neural network research almost disappears
1969–79 Early development of knowledge-based systems
1980–88 Expert systems industry booms
1988–93 Expert systems industry busts: "AI Winter"
1985–95 Neural networks return to popularity
1988– Resurgence of probability; general increase in technical depth
"Nouvelle AI": ALife, GAs, soft computing
1995– Agents, agents, everywhere . . .
1990– Machine learning quickly develops
2003– Human-level AI back on the agenda
2006– Machine learning industry booms

What is intelligence?



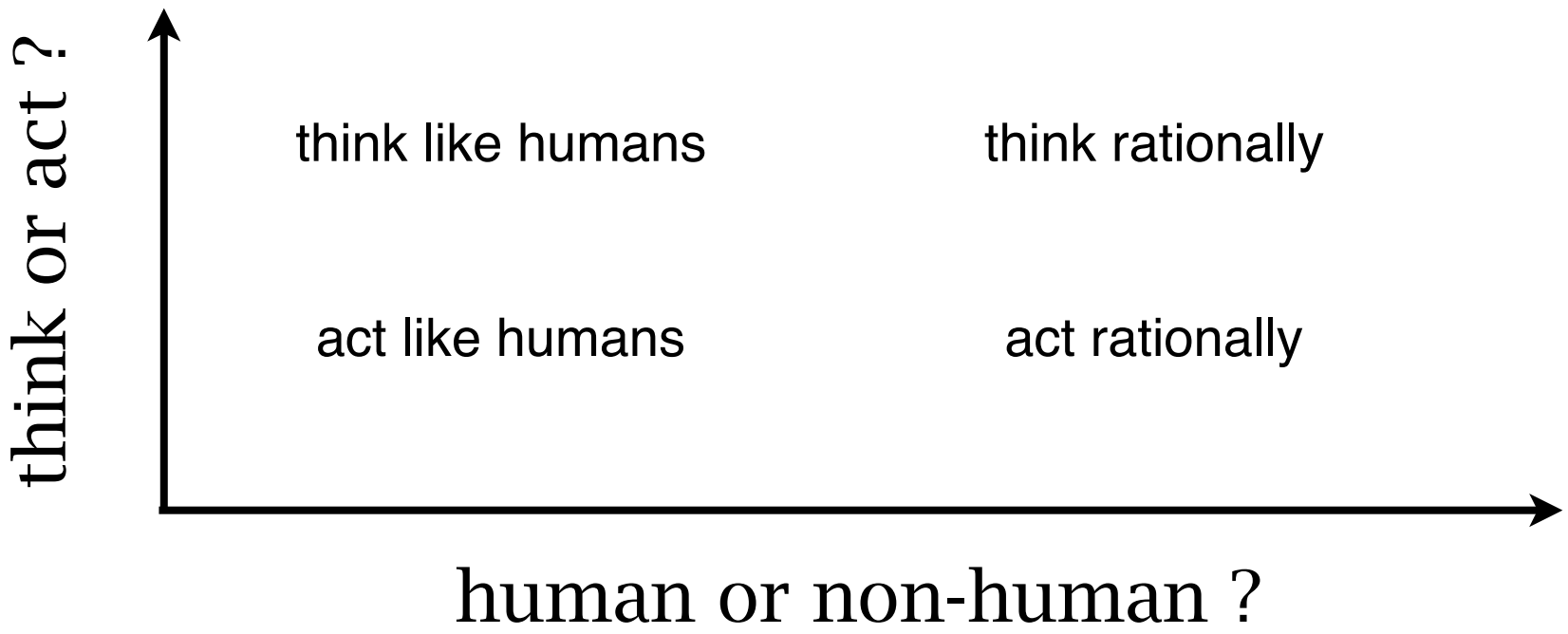


What is intelligence?

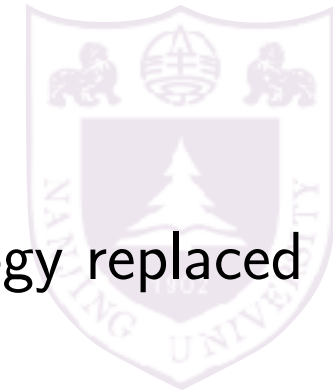
The uncertain about intelligence is a fundamental problem of AI

What is AI?

AI is a system that



Thinking humanly: Cognitive Science



1960s "cognitive revolution": information-processing psychology replaced prevailing orthodoxy of behaviorism

Requires scientific theories of internal activities of the brain

- What level of abstraction? "Knowledge" or "circuits"?
- How to validate? Requires

  1) Predicting and testing behavior of human subjects (top-down)

  or 2) Direct identification from neurological data (bottom-up)

Both approaches (roughly, Cognitive Science and Cognitive Neuroscience) are now distinct from AI

Both share with AI the following characteristic:

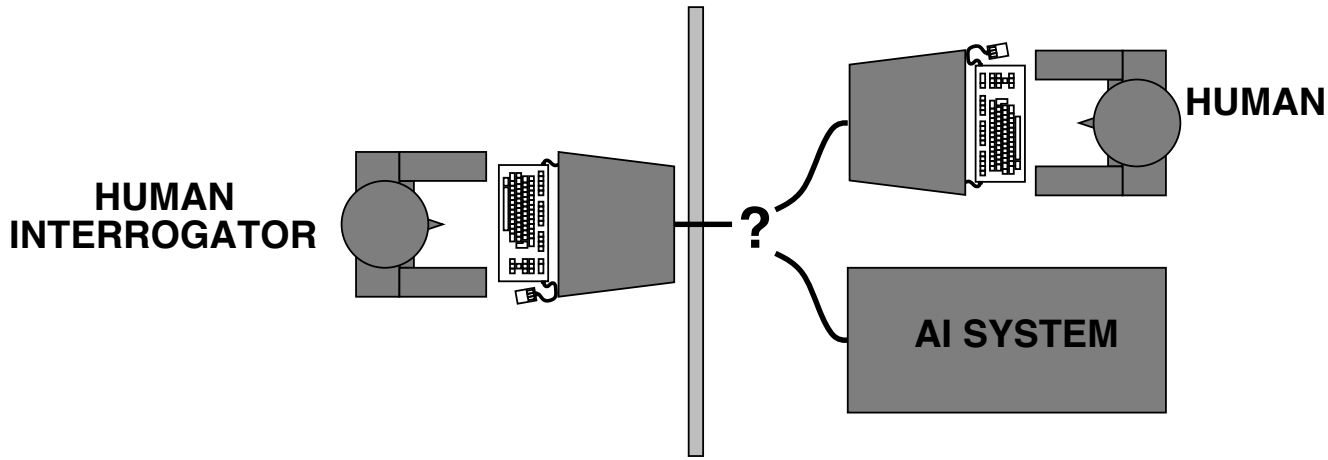
the available theories do not explain (or engender) anything resembling human-level general intelligence

Hence, all three fields share one principal direction!

Acting humanly: The Turing test

Turing (1950) "Computing machinery and intelligence":

- "Can machines think?" $\longrightarrow$ "Can machines behave intelligently?"
- Operational test for intelligent behavior: the Imitation Game



- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- Anticipated all major arguments against AI in following 50 years
- Suggested major components of AI: knowledge, reasoning, language understanding, learning

Problem: Turing test is not **reproducible**, **constructive**, or amenable to **mathematical analysis**

Thinking rationally: Laws of Thought

Normative (or prescriptive) rather than descriptive

Aristotle: what are correct arguments/thought processes?

Several Greek schools developed various forms of logic:
notation and **rules of derivation** for thoughts;
may or may not have proceeded to the idea of mechanization

Direct line through mathematics and philosophy to modern AI

Problems:
1) Not all intelligent behavior is mediated by logical deliberation
2) What is the purpose of thinking? What thoughts **should** I have out of all the thoughts (logical or otherwise) that I **could** have?

Acting rationally

Rational behavior: doing the right thing

The right thing: that which is expected to maximize goal achievement, given the available information

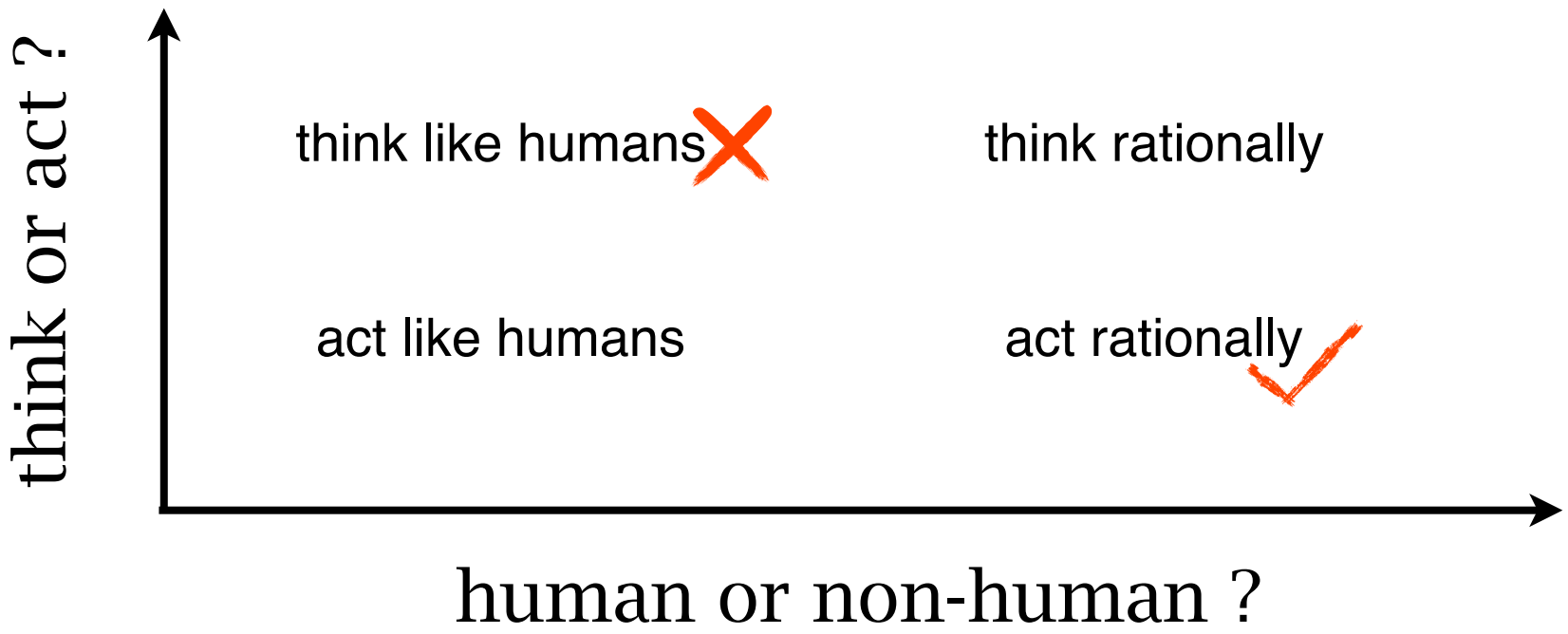
Doesn't necessarily involve thinking—e.g., blinking reflex—but thinking should be in the service of rational action

Aristotle (Nicomachean Ethics):

> **Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good**

What is AI?

AI is a system that



AI IS BLOOMING

HOPE YOU ENJOY

THANK YOU ALL!