Artificial Life and Robotics

CSCI 5582, Fall 2007

Assignments

- Problem Set 5 due today in class
- Problem Sets 4 and 5 handed back at final
- Final Exam Saturday 12/15, 10:30-1 in this room; open textbook, readings, notes; bring a calculator; no laptops

Lindgren's PD World: Preliminaries

- Every creature has a given "memory" for previous PD rounds.
- An M-length history looks like this:

  a(m-1),…a(1), a(0)

  where a(0) is the other player's last action, a(1) is my last action, a(2) is the other player's next-to-last action, a(3) is my next-to-last action, and so forth.

Memory in PD Creatures

- Thus, a creature with memory 1 remembers only the other player's previous action. A creature with memory 2 remembers the previous round for both players; a creature with memory 4 remembers the previous two rounds for both players; and so forth.
- Here are the sorts of situations that a memory-3 creature can take into account:

  0 0 0

  0 0 1 (other guy cooperated on last round)

  1 1 0 (other guy defected on last round)

And so forth.

All Possible Memory-1 Creatures

Other guy's last move	Creature 1	Creature 2	Creature 3	Creature 4
0	0	0	1	1
1	0	1	0	1
	All-defect	Tit for tat	Anti-tit-for-tat	All-C

Making a Mem-3 creature

Oth nxt-last	My prev	Other prev	My move
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Possible PD Creatures

- In summary, then: a memory-N creature needs a 2^N bit table to specify its responses.
- There are 2^(2^N) possible memory-N creatures. (2 possible memory-0 creatures; 4 memory-1 creatures; 16 memory-2 creatures; 256 memory-3 creatures; etc.)

Successive Generations in the PD World

- In a given generation, each creature plays the PD game against all other creatures. Thus, the performance of a creature is determined by the prevalence of other "compatible" creatures in the population surrounding it.
- High-scoring creatures are more likely to survive to the next generation.
- When a new generation is created, there is a certain probability for point mutations (switching a bit), gene duplication (increase in memory by 1 without changing behavior), and gene splitting (loss of one unit of memory, with either half of the genome returned).

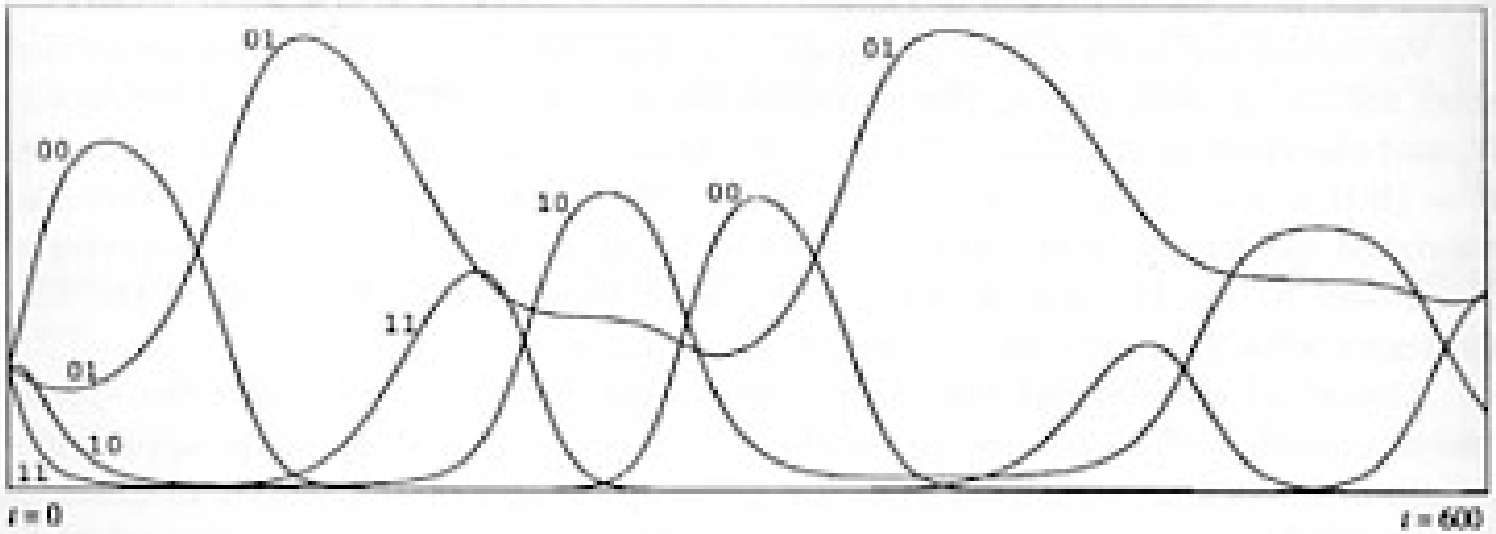
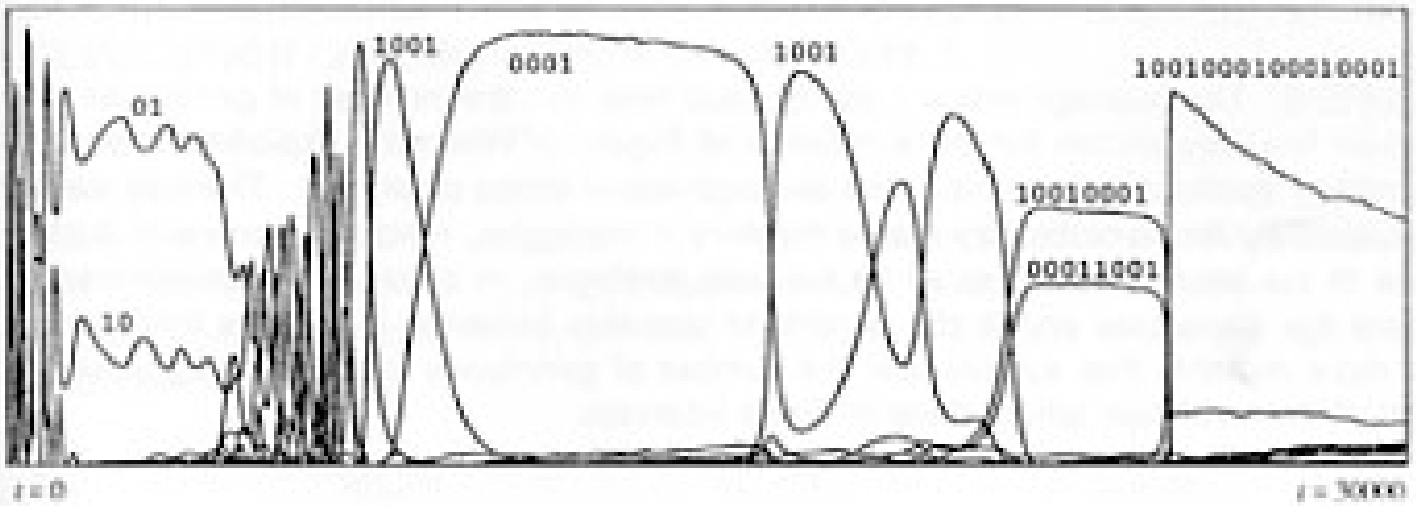
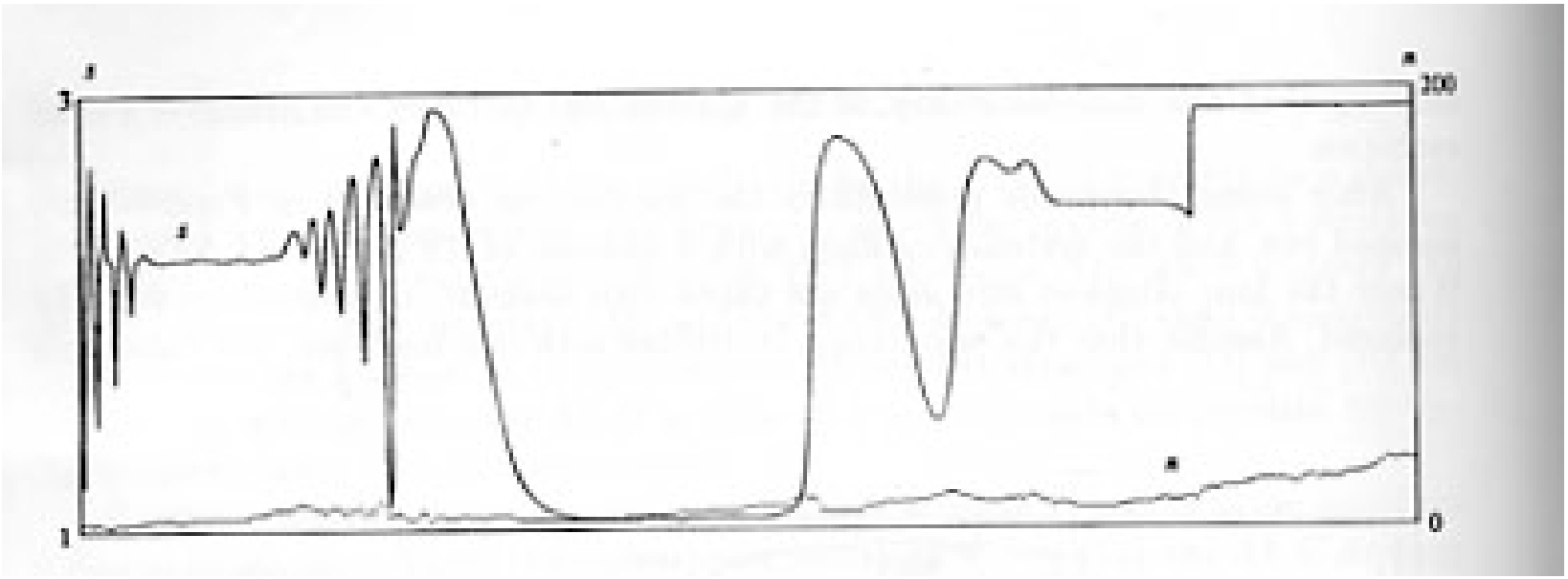


FIGURE 1 The evolution of a population of strategies starting with equal fractions of the memory one strategies [00], [01], [10], and [11] is shown for the first 600 generations. The fractions of different strategies are shown as functions of time (generation).


01
10
1001
0001
1001
10010001
00011001
1001000100010001
t = 0
t = 30000


3
1
300
0

“Intelligence Without Representation” (Brooks, 1991)

“We must incrementally build up the capabilities of intelligent systems, having complete systems at each step of the way and thus automatically ensure that the pieces and their interfaces are valid.”

“At each step we should build complete intelligent systems that we let loose in the real world with real sensing and real action. Anything less provides a candidate with which we can delude ourselves.”

An “Unexpected Conclusion” and “Radical Hypothesis”

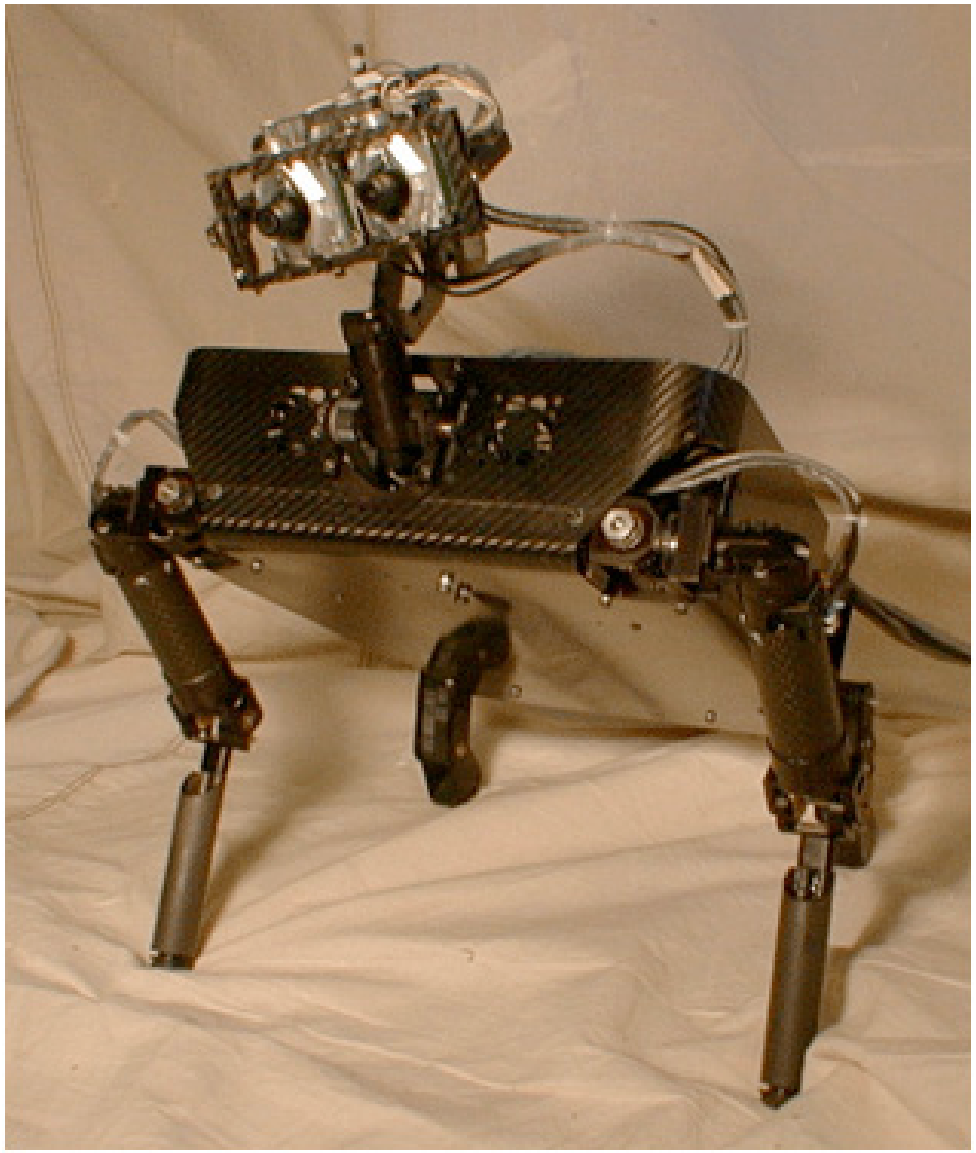
- When we examine very simple level intelligence we find that explicit representations and models of the world simply get in the way. It turns out to be better to use the world as its own model.
- Representation is the wrong unit of abstraction in building the bulkiest parts of intelligent systems.

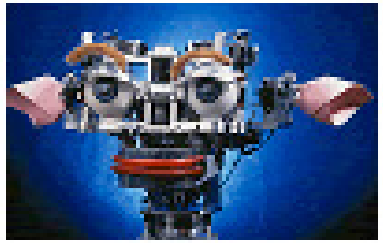
Some Themes of Embodied Cognition

- Problems with the “disembodied brain” paradigm of AI and Cognitive Science
- Integrating action and cognition
- Emergent behavior
- Kinesthetic/bodily experience as component of language, memory, images
- Role of bodily experience in the development of language and mathematics

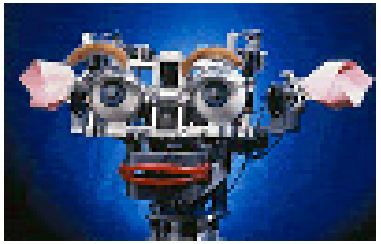
Metaphoric Structure: “Anger is Heat”

- I had reached the boiling point.
- Let him stew.
- You make my blood boil!
- Keep cool.
- I was fuming.
- She got all steamed up.
- Smoke was pouring out of his ears.

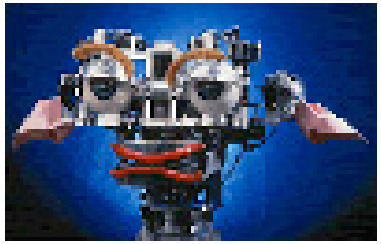




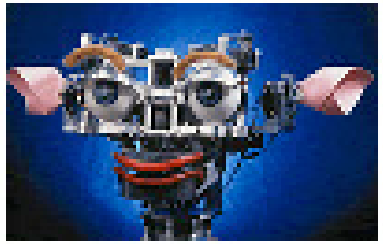
Calm



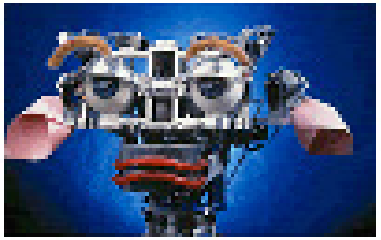
Interest



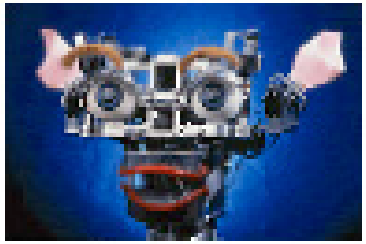
Angry



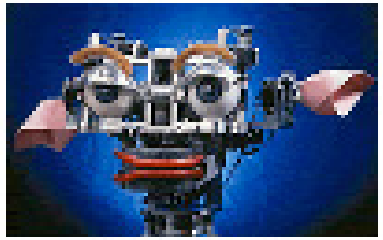
Happy



Sad



Surprise



Disgust