Artificial Intelligence
- overview -

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Structure

- What is AI?
- Why we need AI?
- History
- Test AI
- Current directions
- Applications
- Expectations

WHAT IS AI ? - DIFFICULT QUESTION -

- Much confusion arises because the word 'intelligence' is ill-defined.

- **AI = science of making intelligent machines.**
- **finding solutions to complex problems in a more human-like fashion.**

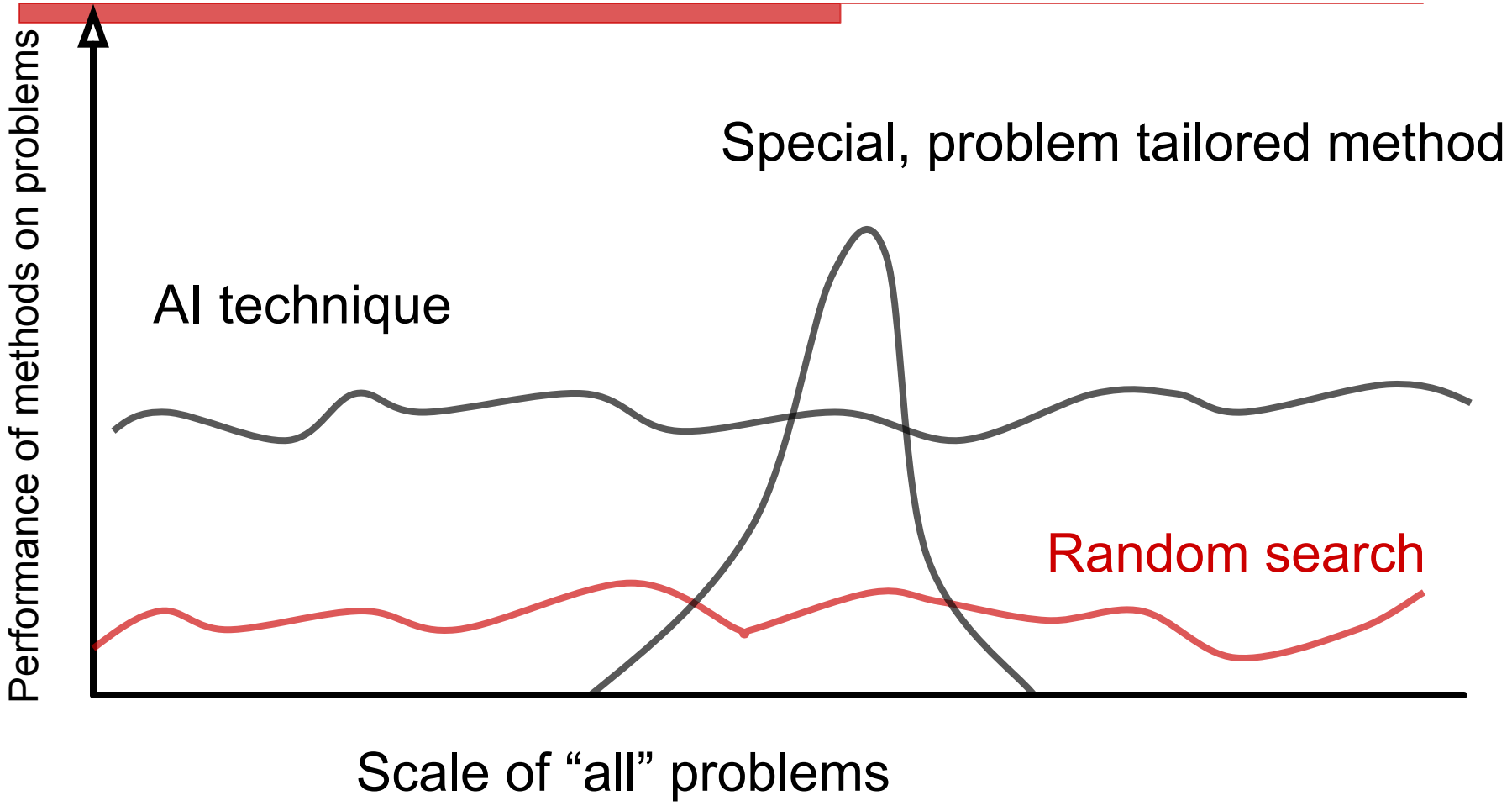
Strong and Weak AI

- Strong AI makes the bold claim that computers can be made to think on a level (at least) equal to humans and possibly even be conscious of themselves.
- Weak AI simply states that some "thinking-like" features can be added to computers to make them more useful tools... and this has already started to happen.
- What does 'think' and 'thinking-like' mean?

Why we need AI?

- Too many difficult problems …
- ….
- Voice recognition / analysis
- Machine translation
- Image analysis
- Handwritten recognition
- Medical diagnosis
- Planning/ scheduling
- Automatic driver
- Unmanned spacecrafts
- Robots in unfriendly environments
- Spam filter

What we should expect from AI?



History of AI

- The birth of AI
- Exponential growth
- Unfulfilled expectations
- New AI applications

History of AI (2)

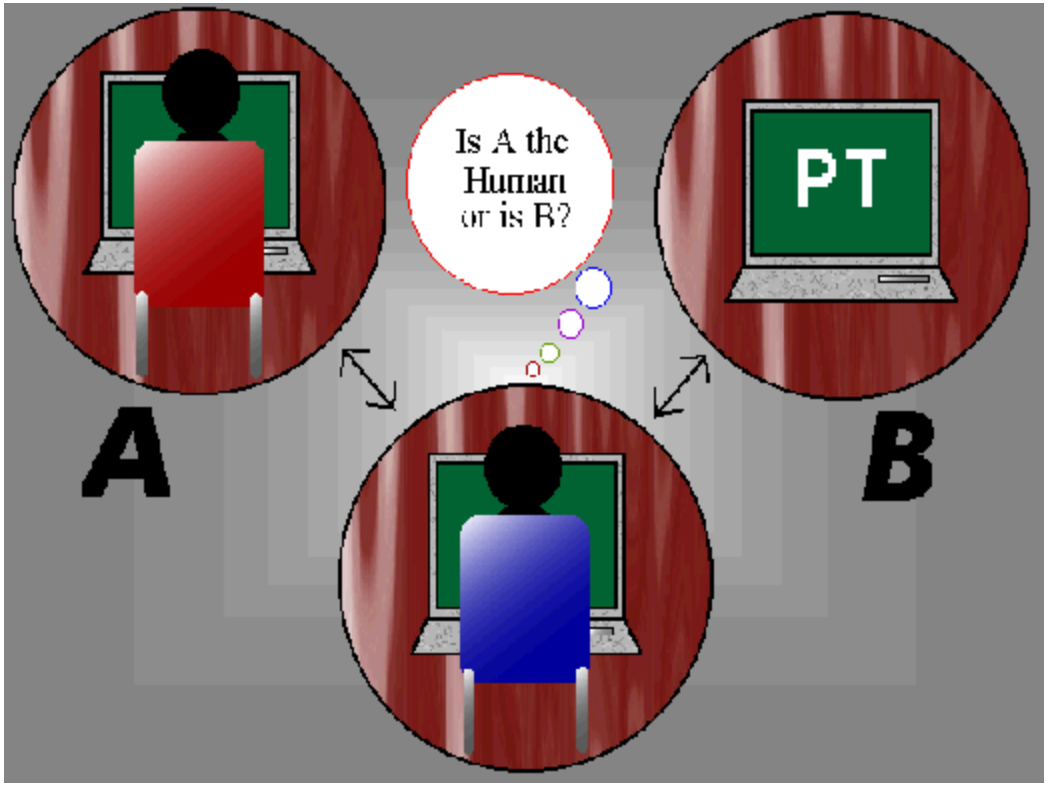
- **1943:** Artificial Neuron is proposed.
- **1950:** Alan Turing publishes, "Computing Machinery and Intelligence."
- **1956:** John McCarthy coins the term, "Artificial Intelligence" at a Dartmouth computer conference.
- **1956:** Demonstration of the first running AI program at Carnegie Mellon University.
- **1958:** John McCarthy invents the Lisp language, an AI programming language, at Massachusetts Institute of Technology (MIT).
- **1965:** Joseph Weizenbaum builds ELIZA, an interactive program that carries on a dialogue in English on any topic (MIT).
- **1969:** Shakey, a robot, combines locomotion, perception and problem solving (Stanford Research Institute).
- **1970s**: Genetic Algorithms were invented. Expert Systems were invented.
- **1979:** The first computer-controlled autonomous vehicle, the Stanford Cart, is built.
- **1990s:** Major advances in all areas of AI.
- **1997:** IBM computer Deep Blue beats world champion Garry Kasparov in chess match.
- **1998**: Genetic programming was invented
- **2000:** Interactive robot pets become commercially available.

Why named AI?

Because people were not sure how to achieve intelligence.

A candidate was Computational Intelligence – but computers were not

Turing Test



- Turing estimated that by the year 2000, computers would be able to fool 30% of human judges during a 5-minute test.

Main directions
- paradigms and algorithms -

- Evolutionary Computation
- Neural Networks
- Expert Systems
- Fuzzy Systems
- Swarm Intelligence
- Mini-Max (search strategies)
- Cellular Automata
- Artificial Life
- Multi Agents Systems
- Natural Language Processing
- and another 100…00 nonstandard techniques.

Evolutionary Computation/Algorithms

- Solving problems by simulating the evolution of life
- The procedures are inspired by the biological evolution:
  - Natural Selection
  - Reproduction
  - Mutation
  - Fitness / Quality

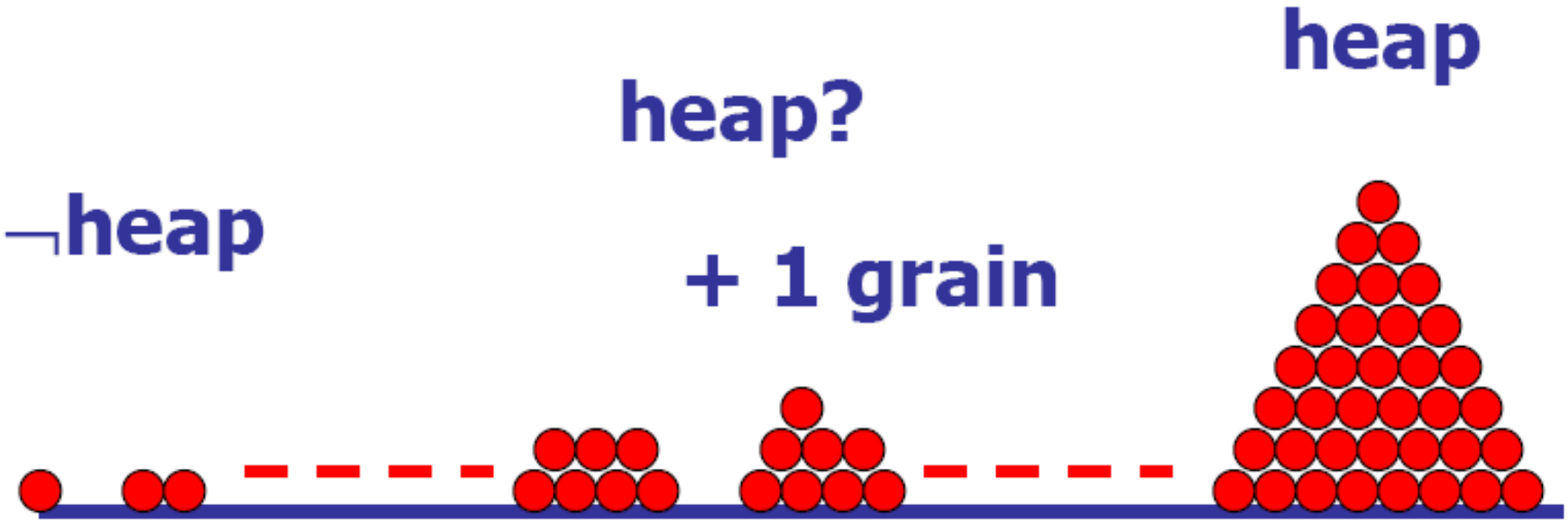
The Metaphor

NATURAL EVOLUTION		PROBLEM SOLVING
Individual	⟷	Candidate Solution
Fitness	⟷	Quality
Environment	⟷	Problem

Evolution

Genetic Programming

Fuzzy Sets and Systems



Why fuzzy?

- Translate into C++ the following sentences:

- Popescu is tall.
- Outside is cold.

Fuzzy sets

μ_A: X → [0, 1]

For each element in X we have the degree in which that element belongs to *A*.

A is called fuzzy set.

$A = \{(x, f(x)) \mid x \in X\}$.

Example – the fuzzy set of numbers near to 5.

B = {

- *(3, 0.3),*
- *(4, 0.7),*
- *(5, 1),*
- *(6, 0.4)*

}

$\square_B(6) = 0.4$

Where fuzzy control is used?

- Anti-lock braking system (ABS)
- Intelligent washing machines.
- …

Lord of the Rings

EXPERT SYSTEMS

- ES are trying to simulate a human expert (in a given domain).

- Objective of an expert system
  - To transfer expertise from an expert to a computer system and
  - Then on to other humans (nonexperts)

- Activities
  - Knowledge acquisition
  - Knowledge representation
  - Knowledge inferencing
  - Knowledge transfer to the user

Main Components of an Expert System

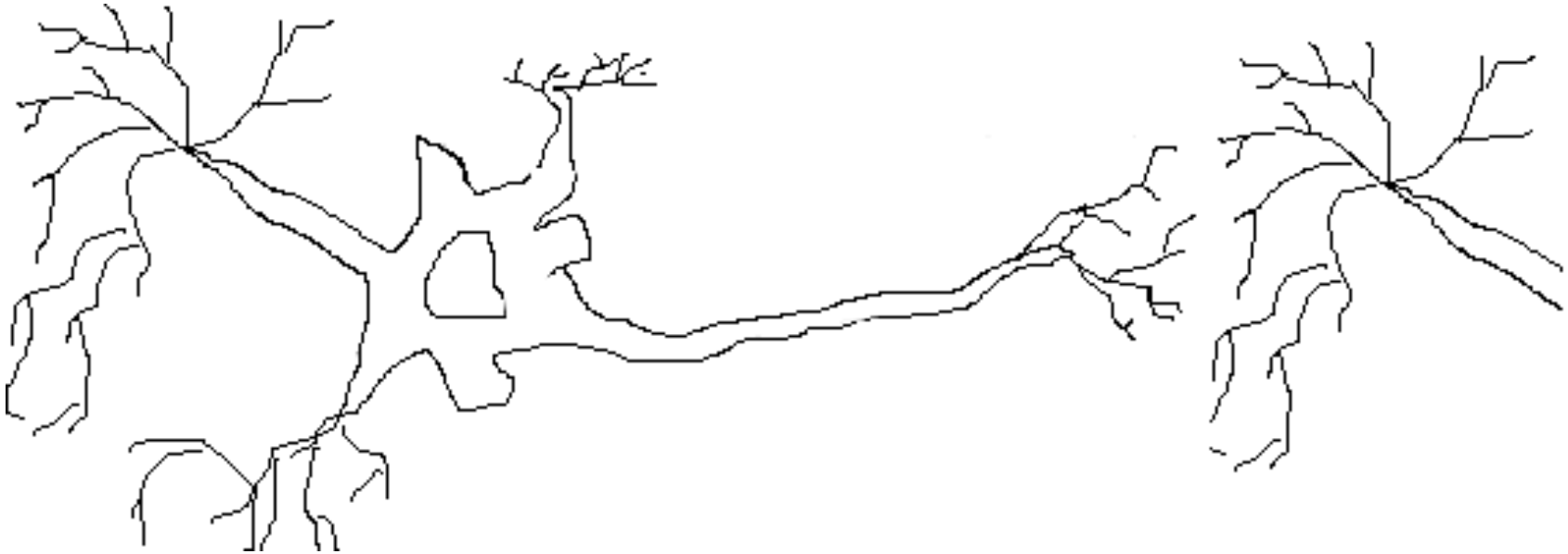
- An ES has 3 main components:
- Knowledge Base
  - Contains information in a given domain.
- Inference Engine
  - Rules used for obtaining new information.
- Current memory (facts)

EXAMPLES

- Medical diagnosis - program takes place of a doctor; given a set of symptoms the system suggests a diagnosis and treatment

- Car fault diagnosis - given car's symptoms, suggest what is wrong with it

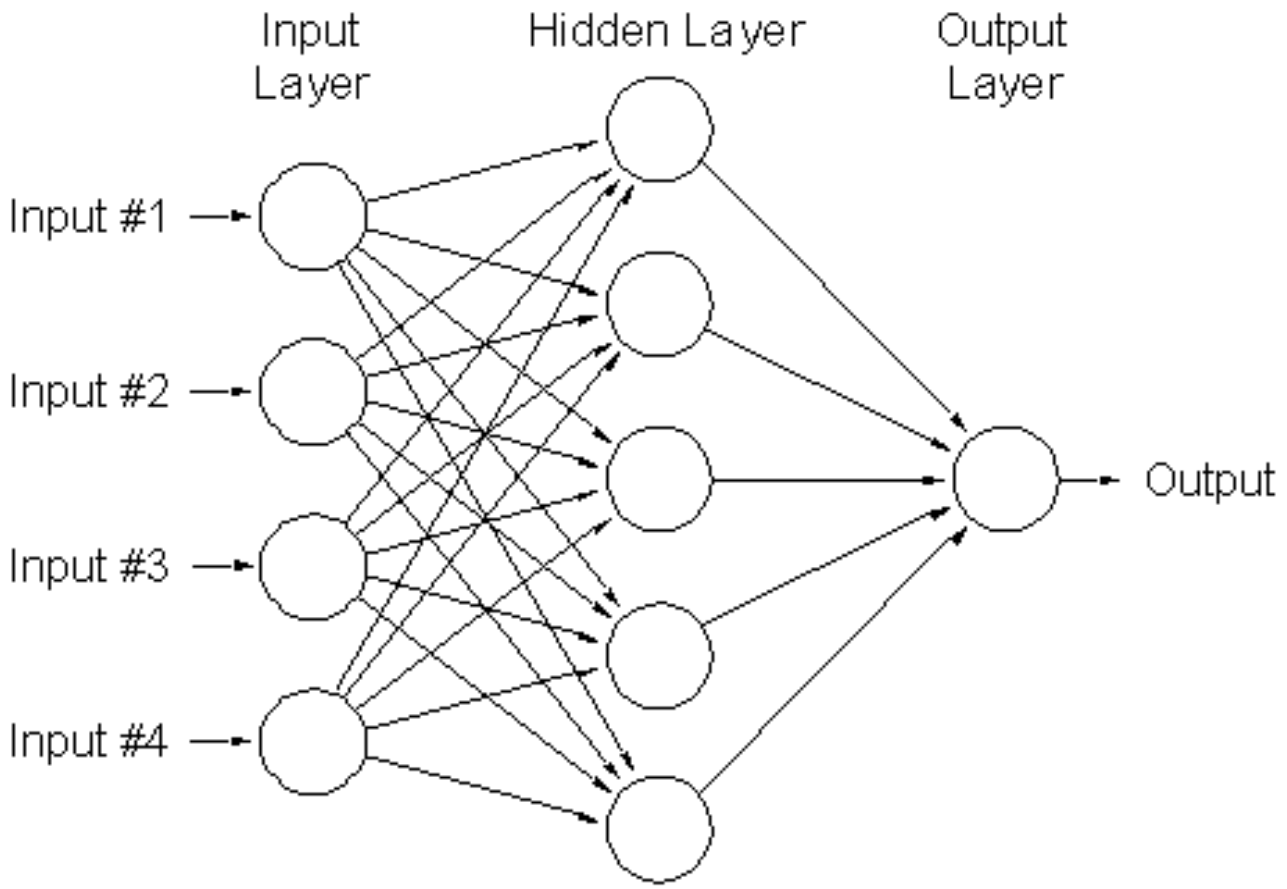
Neural Networks



Why Artificial Neural Networks?

- Some tasks can be done easily (effortlessly) by humans but are hard by conventional paradigms on Von Neumann machine with algorithmic approach
  - Pattern recognition (old friends, hand-written characters, voice)
  - Approximate, common sense reasoning (driving, playing piano, baseball player)
- These tasks are often ill-defined, experience based, hard to apply logic

An example of ANN



Swarm Intelligence

- **The emergent collective intelligence of groups of simple agents.**
- **Properties:**
  - ***Flexible***: the colony can respond to internal perturbations and external challenges
  - ***Robust***: tasks are completed even if some individuals fail
  - ***Decentralized***: there is no central control(ler) in the colony
  - ***Self-organized***: paths to solutions are emergent rather than predefined

Fish Schooling

Nest of termites
Swarm of killer bees

Chain of ants / Ant colonies

Group defense in honey bees

Where SI is useful ?

- communication
- transportation
- industrial production
- …

Games and Mini-Max

Artificial Life
– computer emulated life -

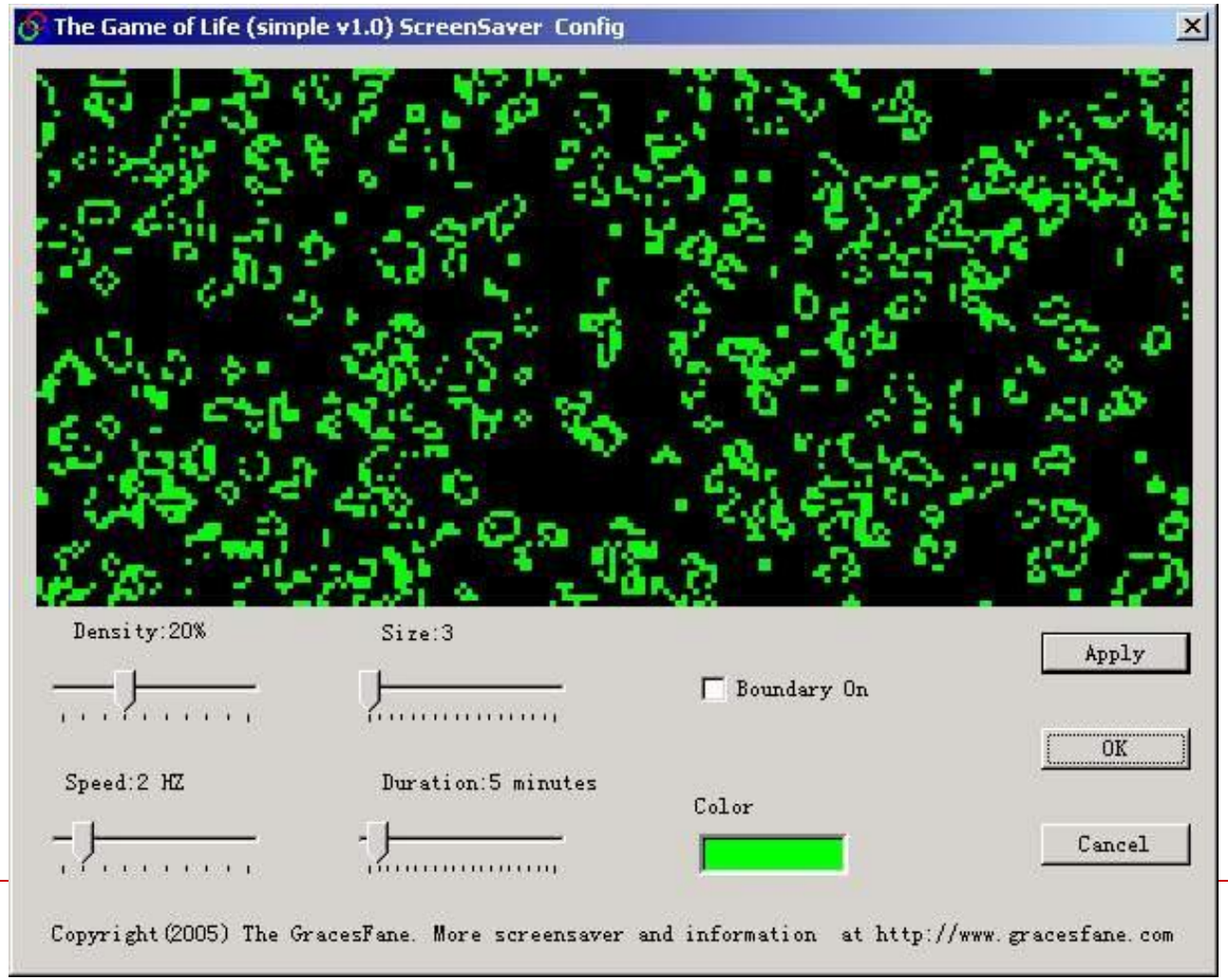
Strong and weak ALife

- The *strong alife* position states that "life is a process which can be abstracted away from any particular medium"
- The *weak alife* position denies the possibility of generating a "living process" outside of a **carbon-based** chemical solution.

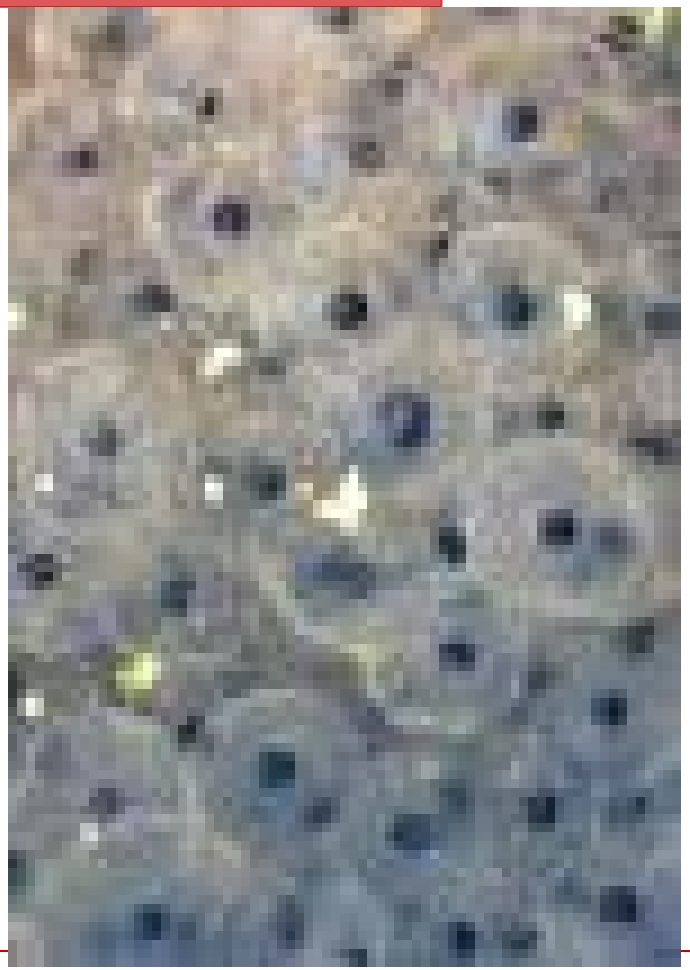
Where ALife is useful?

- To understand life
- To create better robots and machines

CELLULAR AUTOMATA



Human body – a cellular automata



Applications of CA

- Understanding life
- Analyzing crystal/bacteria growth
- …

Multi-Agent Systems

- A system composed of several agents, capable of mutual interaction.
- Features:
  - cooperation and coordination,
  - communication,
  - distributed problem solving.

Why sending a big robot instead of sending 1000 small robots ?

Where AI techniques are applied?

- Robots
- Optimization
- Games (strategies)
- Data analysis
- Pattern analysis and recognition
  - Face recognition
  - Speech recognition
- Machine Translation
- Question answering
- Speech synthesis
- Evolvable hardware
- Human-Computer interaction
- ……

AI CONTESTS

- Many, Many competitions

- RoboCup
- DARPA Grand Challenge (2.000.000$)
- Loebner Prize (100.000 $)

Who's who in AI?

- Very, very long list of people working in the field of AI …
  - Very few in '50 (John McCarthy, Alan Turing, Simon Herbert, Arthur Samuel)
  - ~10^5 today

AI BASED COMPANIES

Big companies (Microsoft, Google, Sony, Honda …)