

# CS 289

## Evolutionary Robotics

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## From Artificial Life to Robots

- Chris Langton
  - 1987 coined the term artificial life
    - Many seminal (interdiscipline) papers
- **Karl Sims**
  - Evolved virtual creatures (SIGGRAPH and ALIFE 1994)
    - MacArthur Genius Award (1998)
    - MIT Media Lab, Thinking Machines, founded GenArts
- **Jordan Pollack's Lab**
  - **Evolving buildable structures (w Funes, 1998)**
  - **Evolving buildable robots (w Lipson, Science 2000)**
- Hod Lipson & Josh Bongard
  - New Ideas: Self-repairing robots (Science 2006)
  - Bongard: **Ludobots (evorobotics platform)**
- Many other EvoRobotics labs! (review article)

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## Karl Sims, ~1994



### Evolved ALIFE

- Representation
- Variation
- Evaluation
- **Results**



Walking, Swimming, Hopping, Following, Competing



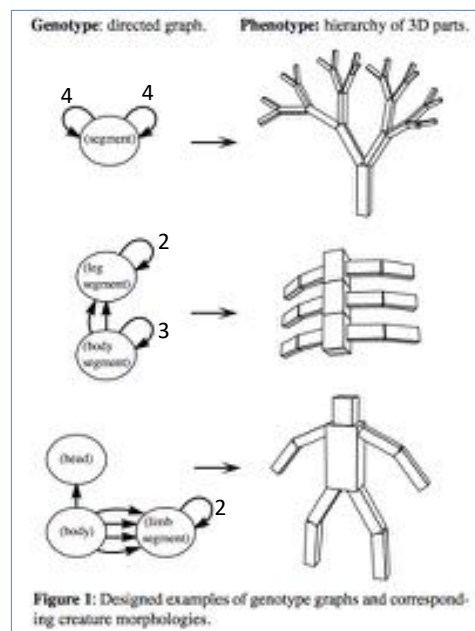
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### Representation

**Morphology:** Directed graph representation

#### Variation:

1. Add body elements.  
Add different kinds of joints.
2. "Generative" language!  
(can add loops to create copies of structures)
3. Cross-over!



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“The question that was begging to be asked was can something similar be done in the physical world?

Can we make creatures that walk out of the computer screen and into the world?”

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## Lipson and Pollack, Science 2000

### The Golem Project

- Representation
- Variation
- Evaluation
- Results



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## Lipson and Pollack, Science 2000

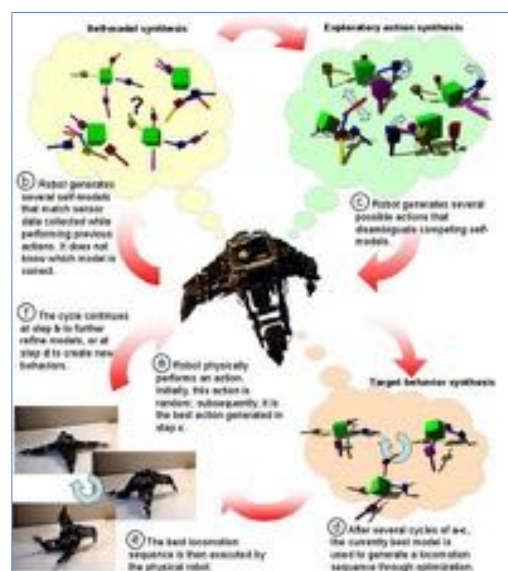
Representation    Variation    Evaluation    Results

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## Bongard, Zykov & Lipson, Science 2006

*aka What do Robots Dream of?*

- Resilient Machines Through Continuous Self-Modeling
  - Learn/evolve a model of your own self
  - Compare your actions to your expectations
  - Iterate
- Key Ideas
  - Don't need to simulate the full task to learn a model of yourself.



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