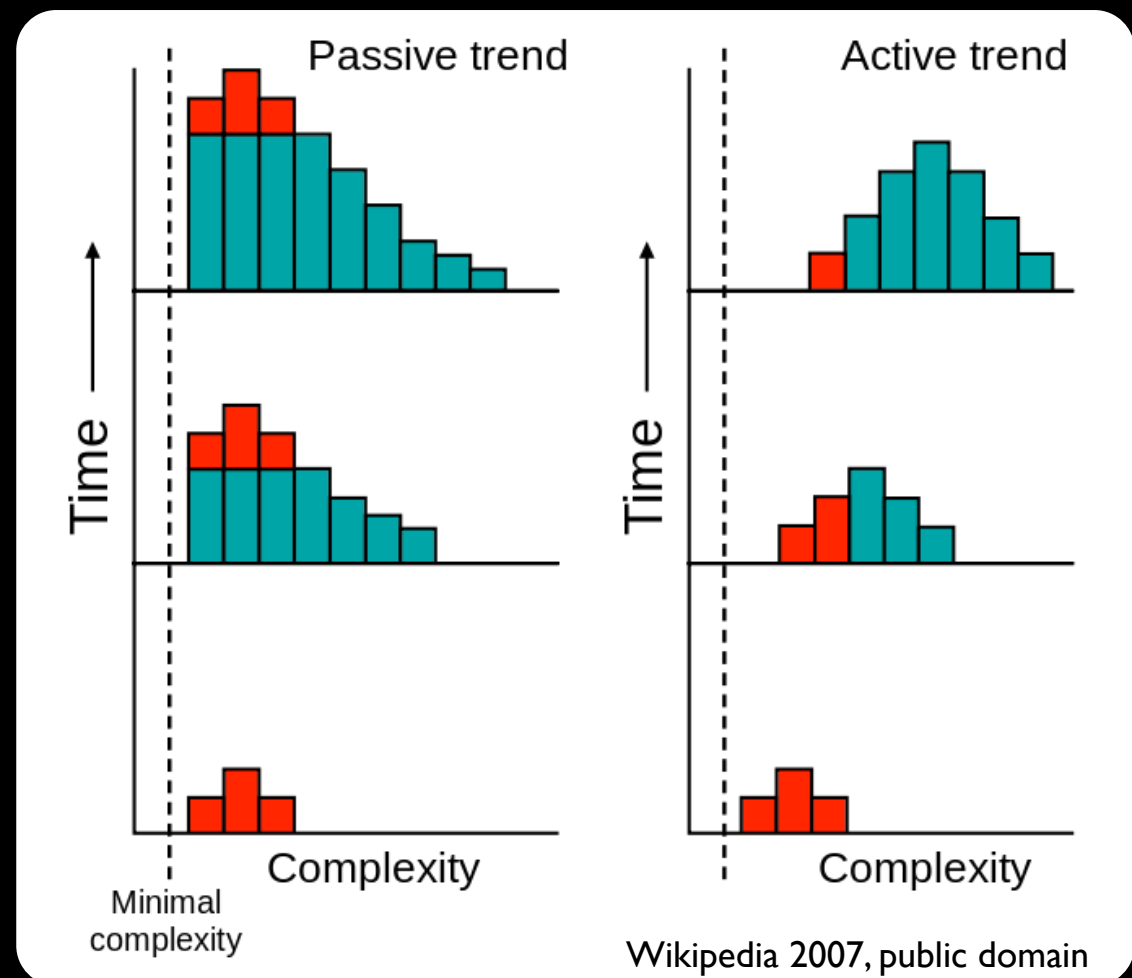# Evolving Interesting Machines

Adeola Bannis & Mark Whiting

Evolving Complexity

- EAs are a strong optimization tool

- Natural evolution optimizes but also leads to emergent complexity

- We aim to use EAs to develop emergent behavior in mechanical systems

Wikipedia 2007, public domain

Optimizing for Emergence

- Start by evolving simple machines that meet an I/O constraint

- Use the simple machines to evolve solutions to complex 'mechanical circuit' problems

- Penalize solutions that have too many components

- Reward solutions that contribute functional complexity

Santiago Ontañón Villar
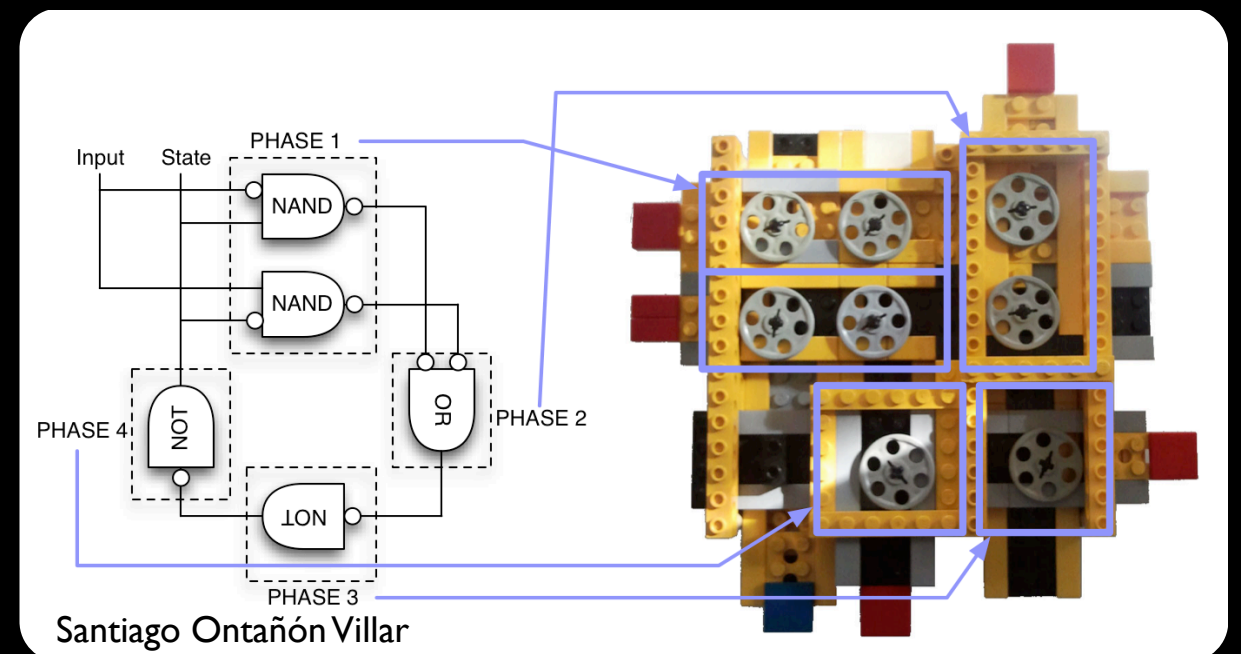
Physical Genetic Programming

- Genetic programing or Neuroevolution based approach

- Genetics are physically encoded (In silico)

  - Generations use crossover and mutation at the start.

  - Later, gain specialized adaptation in *application 2*

Simulating and Evaluating Physical Complexity

- Coded in C, running on OSX

- Chipmunk 2D Physics Engine

- Ongoing iterative runs

- Evaluated final sophistication, measured by 'logical depth' and 'cognitive complexity'
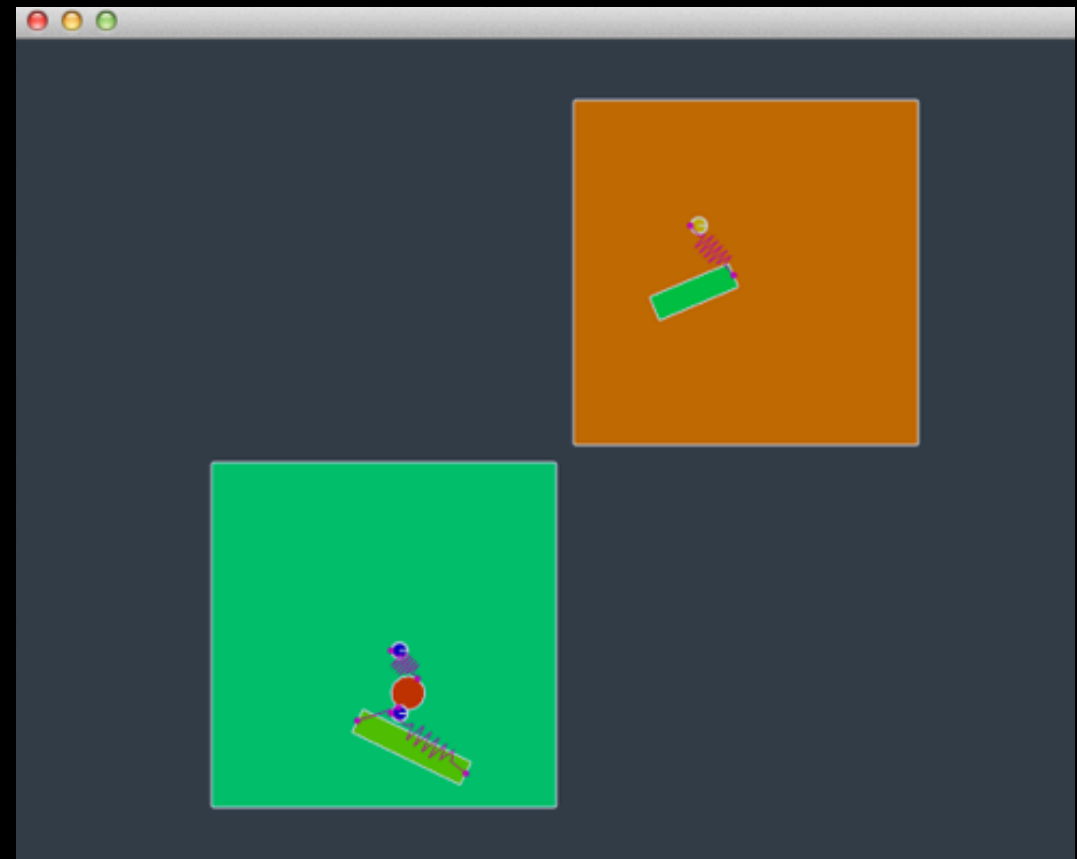
Plan

Date	Task
September 30	Proposal & Demonstrating Working Environment
October 7	Application 1 - Building EA and setting up I/O system
October 14	Application 1 - Testing and dealing with bugs
October 21	Application 1 - Producing output
October 28	Application 2 - Setting up EA for more complex I/O
November 4	Application 2 - Testing and dealing with bugs
November 11	Application 2 - Producing output
November 18	Experimenting, iterating and dealing with bugs
November 25	Improving UI, running final experiments and dealing with bugs

Question

- Is there funding to prototype physical systems?

References

- Chipmunk 2D Physics Library. http://chipmunk-physics.net/

- Bennett, C. "On the Nature and Origin of Complexity in Discrete, Homogeneous, Locally-Interacting Systems," Foundations of Physics 16 (1986) 585-592

- Grassberger, P. "Toward a Quantitative Theory of Self-Generated Complexity," International Journal of Theoretical Physics 25 (1986) 907-938

- Teo, J. & Abbass, H. A. "Multiobjectivity and Complexity in Embodied Cognition", IEEE Transactions on Evolutionary Computation 9 (2005) 337-360