



Faculty of Mathematics and Computer Science
The Weizmann Institute of Science

Distinguished Lecturer Series

Sponsored by the Arthur and Rochelle Belfer
Institute of Mathematics and Computer Science

Professor Leslie Valiant

Harvard University

will speak on

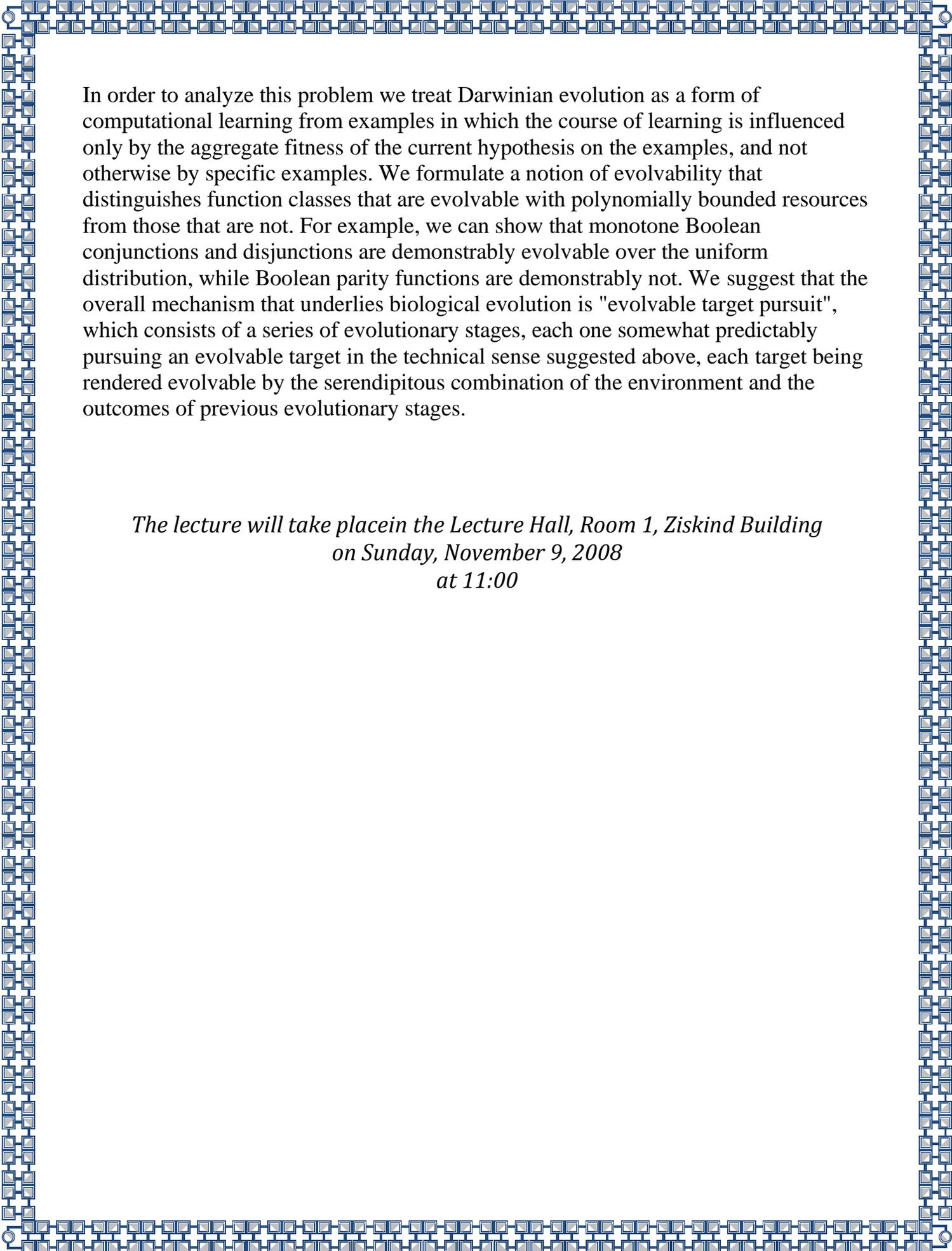
When Biology is Computation

Abstract

We argue that computational models have an essential role in uncovering the principles behind a variety of biological phenomena that cannot be approached by other means. In this talk we shall focus on evolution.

Living organisms function according to complex mechanisms that operate in different ways depending on conditions. Darwin's theory of evolution suggests that such mechanisms evolved through random variation guided by natural selection. However, there has existed no theory that would explain quantitatively which mechanisms can so evolve in realistic population sizes within realistic time periods, and which are too complex.

We start with the observation that Darwin's theory becomes a computational theory once one is specific about how exactly the "random variation" and the "selection" are done. The dilemma in being specific is that if one is too restrictive about the basic mechanisms allowed then it becomes implausible that all the complexity of biology can be expressed in terms of them, while if one is too expressive then it is implausible that random variation with selection can successively navigate this complex space as changing conditions require.



In order to analyze this problem we treat Darwinian evolution as a form of computational learning from examples in which the course of learning is influenced only by the aggregate fitness of the current hypothesis on the examples, and not otherwise by specific examples. We formulate a notion of evolvability that distinguishes function classes that are evolvable with polynomially bounded resources from those that are not. For example, we can show that monotone Boolean conjunctions and disjunctions are demonstrably evolvable over the uniform distribution, while Boolean parity functions are demonstrably not. We suggest that the overall mechanism that underlies biological evolution is "evolvable target pursuit", which consists of a series of evolutionary stages, each one somewhat predictably pursuing an evolvable target in the technical sense suggested above, each target being rendered evolvable by the serendipitous combination of the environment and the outcomes of previous evolutionary stages.

*The lecture will take place in the Lecture Hall, Room 1, Ziskind Building
on Sunday, November 9, 2008
at 11:00*