HARI SAHASRABUDDHE LECTURE SERIES ON INFLECTIONS IN COMPUTING

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WHEN BIOLOGY IS COMPUTATION

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Leslie Valiant is one of the pioneers of theoretical computer science. He has made several fundamental contributions including the definitions of class #P to explain why certain enumeration problems and permanent computation are difficult, the PAC (probably approximately correct) model of machine learning, and holographic algorithms using which efficient algorithms have been found for many problems. He also works in computational biology focusing on understanding memory and learning. He received the Nevanlinna Prize in 1986, the Knuth Prize in 1997, and the EATCS Award in 2008. He is a Fellow of the Royal Society (London), and a member of the National Academy of Science (USA).

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. In order to formalize it, 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. 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 a target that is evolvable in the technical sense suggested above, each target in turn being rendered evolvable by the serendipitous combination of the environment and the outcomes of previous evolutionary stages.

The Inflections in Computing series honors Hari V Sahasrabuddhe, a pioneer of Computer Science education in the country.