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Linear Models of Computation and Program Learning

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Abstract

We consider two classes of computations which admit taking linear combinations of execution runs: probabilistic sampling and generalized animation. We argue that the task of program learning should be more tractable for these architectures than for conventional deterministic programs. We look at the recent advances in the "sampling the samplers" paradigm in higher-order probabilistic programming. We also discuss connections between partial inconsistency, non-monotonic inference, and vector semantics.

1 Introduction

One of the key challenges of program learning is that software tends to be too brittle and insufficiently robust with respect to minor variation.

Biological systems tend to be much more flexible and adaptive with respect to variation. In particular, biological cells are capable of functioning at wide ranges of the level of expression of various proteins, which are machines working in parallel. Regulation of the level of expression of specific proteins is a key element of flexibility of biological systems. It is argued in evolutionary developmental biology that the flexible architecture together with conservation of core mechanisms is crucial for the observed rate of biological evolution [16, 22]. It is suggested that morphology evolves largely by altering the expression of functionally conserved proteins [12].

To incorporate regulation of expression into a system of genetic programming one might evolve programs describing systems of parallel computational processes. Then one might take the CPU allocation and other computational resources given to a particular computational process as computational equivalent of the level of expression of a particular protein.

Of course, many of the architectures for parallel computations are brittle as well, with delicate mechanisms of writing to shared memory and locks. To achieve flexibility one should use parallel architectures which minimize those delicate interdependencies.

Computational architectures which admit the notion of linear combination of execution runs are particularly attractive in this sense. Then one can regulate the system simply by controlling coefficients in a linear combination of its components.

In this paper we consider two computational architectures which admit linear combinations of execution runs.

One such architecture is probabilistic sampling. If one has two samplers generating points of two distributions with a uniform speed, so that the notion of "a number of points generated per unit of time" is well defined for both of them, one can obtain a sampler generating a linear combination of those two distributions with arbitrary positive coefficients simply by running those two samplers in parallel with appropriate relative speeds.

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