The distributed version of the Interval Geometric Machine Model

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This paper presents a distributed version of the Interval Geometric Machine Model [4], called Distributed Interval Geometric Machine, whose inductive construction allows recursive definitions for interval algorithms involving possibly infinite distributed and synchronous parallel computations performed over array structures.

The sequence of transfinite natural numbers [8] is considered in order to index the transfinite global memory of the Distributed Interval Geometric Machine Model, shared by synchronized processes distributed over an enumerable set of machine models, each operating on a part of such indexing. Let \( \xi = (\xi_n)_{n \in \mathbb{N}} \) be a possible infinite enumerable subset of points related to the multi-dimensional geometric space. In a finite approach, \( \xi = (\xi_0, \xi_1, \ldots, \xi_n) \) denotes the canonical basis of the n-dimensional geometric space whose n-dimensional vectors are given by \((a^{\xi_0}, a^{\xi_1}, \ldots, a^{\xi_n})\). In this case, memory values are taken from the set of real intervals, whose elements \((a \in \mathbb{IR})\) are defined in the center-radius form \(((a_c, a_r) \in \mathbb{R}^2)\) and placed in the shared memory by the corresponding coordinates of the three-dimensional euclidian geometric space \(((\alpha^{\xi_0}, \alpha^{\xi_1}, 0), (\alpha^{\xi_0}, \alpha^{\xi_1}, 1) \in \mathbb{R}^3)\).

The main characteristics of the coherence space \(\mathbb{D}_{\infty} \times \mathbb{R}^3\) of distributed processes, inductively constructed from the coherence space \(\mathbb{D}_\infty\) introduced in [3], are described. Following the methodology proposed in [7], each level in the inductive construction of \(\mathbb{D}_{\infty} \times \mathbb{R}^3\) is identified by a subspace \(\mathbb{D}_{\infty+m}\), which reconstructs all the objects from the level below it, preserving their properties and relation and building the new objects specific of this level. The constructive relationship between the levels is expressed by linear functions called embedding and projection functions, interpreting constructors and destructors of processes, respectively.

In addition, the programming language \(\mathcal{L}(\mathbb{D}_\infty)\) [6, 5] is extended to model the semantics of simple distributed algorithms applied to Interval Mathematics [2], including sample examples of distributed programs related to interval arithmetics operations.

This model can be applied to various kinds of computations involving array structures, such as array computations and cellular automata. The application of this framework to a semantic modelling of the algorithms of the cellular automata is work in progress.

References


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