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Numbered diagrams of projective limits

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Let us consider finite signatures. A diagram is a labeled directed graph so that vertices are assigned algebraic structures and arcs are assigned homomorphisms, i. e., the diagram is a covariant functor to a category of algebraic structures [**1**]. Let us assume that each structure is finite and serves as the domain of only a finite set of homomorphisms in the diagram. This set may be empty. Different diagrams may have the same projective limit.

A diagram numbering is a set of three numberings: a numbering of the diagram structures, a numbering of the diagram homomorphisms, and a continuous numbering of all elements from all structures. Elements of different structures have different numbers. Any homomorphism connects exactly two structures.

The elements of the projective limit, which may be uncountable, are not numbered, but only the elements of the structures in the diagram. However, calculations over such structures allow for efficient approximation of elements of the projective limit.

Any number is identified with its binary notation. One can define the concept of polynomial-time computability of a numbered diagram as well as some polynomial-time reducibility of one numbering to another. The polynomial-time reducibility is based on a subdiagram so that its projective limit is isomorphic to the projective limit of the original diagram. However, the support of this subdiagram may have high computational complexity. Next, there is an equivalence relation on such numberings. Previously, the author considered examples of diagrams in which all structures consist of closed terms [**2**], but this assumption is excessive. In the general case, a minor refinement is needed. There are diagrams so that only one equivalence class exists. Such diagrams are called polynomial-time computably categorical.

Let an algebraic structure A be finite. Let a polynomial-time computable diagram with finite structures have the Cartesian power $\prod_{k=0}^{\infty} A$ as its projective limit. This diagram is polynomial-time computably categorical. On the other hand, there is a diagram so that different polynomial-time computable numberings are not equivalent to each other.

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References

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[2] A. V. Seliverstov, *Polynomial-time computable diagrams with finite rings*, Prikladnaya Diskretnaya Matematika, No. 73, 121–129 (2026).

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