5. Выполненное исследование базируется на развитом алгебро-грамматическом аппарате, включающем логические средства и метаправила выводимости схем алгоритмов и программ, принадлежащих классам, ассоциированным с актуальными предметными областями. Особенность алгебро-грамматических средств представления знаний - гармоническое сочетание декларативных процедурных и трансформационных спецификаций,а также адекватность данных средств концепции объектно-ориентированного программирования.

На базе полученных результатов разработаны наукоемкая технология и ее инструментарий КЕЙС-система МУЛЬТИПРОЦЕССИСТ, нашедшие применение при решении задач АСУ, САПР конструкторской и технологической подготовки производства, языковых процессоров транслирующего и интерпретирующего типа.

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FINITARY LAMBDA CLONES

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There are known several algebraic structures aspiring to be an algebraic counterpart of the λ-calculus: λ-algebras,combinatory models,λ-models (here and further we follow,on the whole, the terminology adopted in [1]). We present one more such a structure called a (finitary) λ-clone which has some attractive features from,both,universal algebra and λ-calculus points of view.Namely,for any environment model of the λ-calculus,the range of the valuation mapping is a λ-clone,in fact, a so called locally finite (l.f.) λ-clone. In addition, the very valuation mapping is nothing but a homomorphism onto this λ-clone and the corresponding λ-theory (of the model) is the kernel of this homomorphism. Equivalently, if (C, ', k, s) is a λ-algebra and X is a countable set of variables, then the polynomial algebra C[X] can be equipped with the structure of a λ-clone and proves the l.f. λ-clone generated by C (not X!) with certain defining relations.

At the same time, the class of all λ-clones is a variety of algebras contained in the class of λ-models and, besides, the last one, considered as a category, is equivalent to the full subcategory of λ-clones consisting of l.f. λ-clones.

These nice properties of λ-clones are provided by the point that variables, λ-quantifiers and substitutions are included directly into the signature of λ-clones. Roughly speaking, a λ-clone is an abstract clone in the sense of universal algebra equipped with operations of application and λ-quantifications.

DEFINITION 1 [2]. Let $L = (x_i, s_i, ', \lambda_i)_{i<\omega}$ be a signature of operation symbols where all x_i are constants, all s_i and $'$ are binary and all λ_i are unary. A (finitary) λ-clone is defined to be an L-algebra $\mathcal{W}$ s.t. the following identities hold for each i,j,k < ω with $i \neq j \neq k$ (u,w range over the underlying set W, v stands for $s_j(x_k,w)$):

(S) $s_i(x_i,w) = w$, $s_i(w,x_i) = w$, $s_j(w,x_i) = x_i$, $s_j(u,v)=v$,
$s_i(u,w1, w2) = s_i(u,w1), s_i(u,w2)$;

(SQ) $s_i(w,\lambda_i u) = \lambda_i u$, $s_i(v,\lambda_j u) = \lambda_j s_i(v,u)$;

(α) $\lambda_i v = \lambda_j s_i(x_j,v)$; ($\beta$) $(\lambda_i w), u = s_i(u,w)$.

Here (S) - identities correspond to intuitive understanding of $s_i(u,w)$ as the result of substituting of u into w for x_i, (SQ) - identities regulate interaction between substitutions and λ-quantification, (α), (β) provide (α),(β) - conversion resp.

Given a λ-clone $\mathcal{W}$, for each element $w \in W$ we introduce its dimension set, $\Delta w := \{i<\omega: s_i(u,w) \neq w$ for some $u \neq x_i\}$, and call w finitary if $|\Delta w| < \omega$ and closed if $\Delta w = \emptyset$. Further, we define $W_{fin} := \{w: |\Delta w| < \omega\}$ and $W_{\emptyset} = \{w: \Delta w = \emptyset\}$. W_{fin} proves a subalgebra of $\mathcal{W}$, $\mathcal{W}_{fin}$, and $\mathcal{W}$ is called locally finite dimensional (l.f.) if $\mathcal{W} = \mathcal{W}_{fin}$.

DEFINITION 2. An environment domain is defined to be a pentuple $\mathcal{E} = (D,V,F,\Phi,\Psi)$ with D a set, V a set of operations $D^{\omega} \to D$, F a set of operations $D \to D$, Φ a mapping $D \to F$ and Ψ a mapping $F \to D$ s.t. the following conditions are fulfilled (we use the symbol Λ for the ordinary set theoretical (meta) lambda abstraction):

(E1) $\pi_i := (\Lambda\rho\in D^\omega.\rho i)\in V$ for all $i<\omega$, $\bar{d} := (\Lambda\rho\in D^\omega.d)\in V$ for all $d\in D$;

(E2) if $u,v\in V$ then $(\Lambda\rho\in D^\omega.v([i/u]\rho))\in V$ and $(\Lambda\rho\in D^\omega.\Phi(u\rho)(v\rho))\in V$;

(E3) if $v\in V$ then, for any fixed $i<\omega,\rho\in D^\omega$, $(\Lambda d\in D.v([i/\bar{d}]\rho))\in F$.

An environment domain is said to be an environment model if

(E4) $\Phi\Psi f=f$ for all $f\in F$.

CONSTRUCTION.

(i) With any environment domain $\mathcal{E}$ as above there is correlated the L-algebra $\mathcal{V}_{\mathcal{E}} = (V,\pi_i,s_i,',\lambda_i)$ with operations defined according to the items (E1,2,3) of the definition 2.

(ii) With any L-algebra $\mathcal{W}$ there is correlated a domain pentuple $\mathcal{E}_{\mathcal{W}} = (D,V,F,\Phi,\Psi)$ where $D = W_\emptyset$, V is the set of all operations on D determined by polynomials built from a countable set of variables and elements of D with the operation ', $\Phi w := \Lambda u\in W_\emptyset, w'u, F := \{\Phi w : w\in W_\emptyset\}$, $\Psi\Phi w := (\lambda_i\lambda_j(x_i{}'x_j))'w$.

THEOREM 1. If $\mathcal{E}$ is an environment model then $\mathcal{V}_{\mathcal{E}}$ is a l.f. λ-clone; if $\mathcal{W}$ is a λ-clone then $\mathcal{E}_{\mathcal{W}}$ is an environment model; finally, $\mathcal{E}_{\mathcal{W}\mathcal{E}} \cong \mathcal{E}$ and $\mathcal{V}_{\mathcal{E}\mathcal{W}} \cong \mathcal{W}_{fin}$.

THEOREM 2. A λ-theory is defined to be a couple (C,T) with C a set of constants and T a subset of $\Lambda(C)\times\Lambda(C)$ closed under the ordinary λ-calculus deducibility. If $\mathcal{T} = (C,T)$ is a λ-theory then $\mathcal{W}_{\mathcal{T}} = \Lambda(C)/T$ is a l.f. λ-clone; if $\mathcal{W}$ is a λ-clone and μ is the homomorphism $\Lambda(W_\emptyset) \to \mathcal{W}$ naturally extending the identity inclusion $W_\emptyset \hookrightarrow W$, then $\mathcal{T}_{\mathcal{W}} = (W_\emptyset, \ker\ \mu)$ is a λ-theory; finally, $\mathcal{T}_{\mathcal{W}\mathcal{T}} \cong \mathcal{T}$ and $\mathcal{W}_{\mathcal{T}\mathcal{W}} \cong \mathcal{W}_{fin}$.

CONJECTURE. The variety generated by the class of all l.f. λ-clones coincides with the class of all λ-clones.

IN PROSPECT. The notion of a finitary λ-clone is somewhat unnatural as finitary operations acting on closed elements can not reach elements with infinite dimension sets. In this con -

text, a more natural structure is a λ-clone with infinitary, $(1+\bar{i})$-ry, applications and infinitary, $\bar{i}$-ry, λ-quantifiers for all, finite and countable, sequences $\bar{i} \in \omega^{\infty}$. In this way we obtain an algebraic version of an infinitary λ-calculus but this is another story.

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ON CODING OF HEREDITARILY-FINITE SETS, POLYNOMIAL-TIME COMPUTABILITY AND Δ-EXPRESSIBILITY

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This paper is devoted to computability and definability in terms of bounded (i.e.,Δ-) set theoretic language (cf. references below).

A coding (or numbering; cf. the general theory in [3]) of the universe of hereditarily-finite sets HF is any surjection $\vartheta : A^* \to HF$ from the set of all finite strings over some finite alphabet A. Let P_ϑ denote the class of operations F: HF → HF such that $F\vartheta = \vartheta f$ for some polynomial-time computable (or shortly, P-) function $f: A^* \to A^*$. For any two codings $\vartheta : A^* \to HF$, $\eta: B^* \to HF$ and P-function $f: A^* \to B^*$ the P-reducibility $\vartheta = \eta f$ is denoted also as $\vartheta \leq_P^f \eta$ or $\vartheta \leq_P \eta$. P-equivalence $\vartheta \equiv_P \eta$ means $\vartheta \leq_P \eta$ & $\eta \leq_P \vartheta$ and implies $P_\vartheta = P_\eta$. If cardinalities of A and B are ≥ 2 then any $\vartheta : A^* \to HF$ is P-equivalent to some $\vartheta: B^* \to HF$ (via arbitrary two-sided P-bijection $f: A^* \to B^*$). Hence, we will usually consider codings over the same A. Any ϑ is called P-coding if (1) the predicate "HF $\models \vartheta(a) \in \vartheta(b)$" is P-decidable on any, $a,b \in A^*$ and (2) two P-computable mappings $a \mapsto a_1,\dots,a_k$ and $a_1,\dots$