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ALGORITHMIC AND SOFTWARE TOOLS FOR SIMULATION OF EVOLUTION PROCESSES OF COMPLEX DYNAMIC SYSTEMS

The paper considers some elements of the calculus of systems as functional objects. The formal foundations of calculating systems proposed by the authors were preceded by research on the development of a mathematical apparatus that allows one to formalize the procedures for developing system-object simulation models of processes and systems. In the work, the previously developed formal apparatus is supplemented by the context operator, and some theorems related to the structural and functional characteristics of the objects being modeled are formulated and proved.

Keywords: context operator, calculus of systems, system-object way of representing knowledge, system-object model, general systems theory, nodal object, stream object, structural characteristics of the system.

(), [1].

[2].

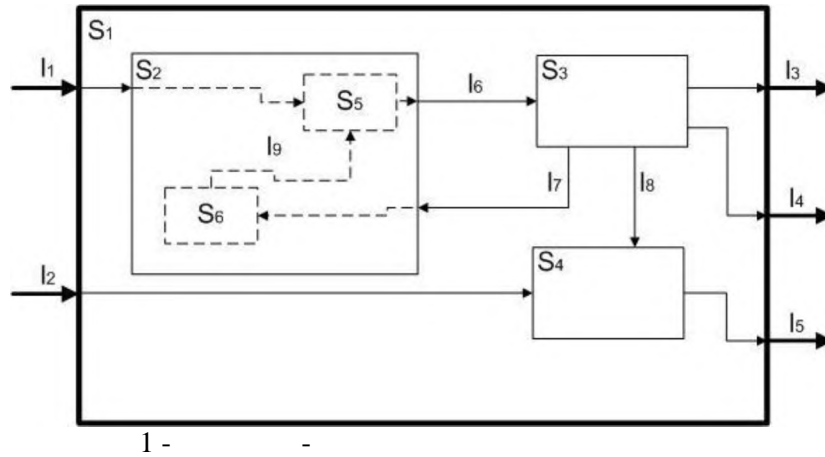
« - - » (-) [3],

- , [4].

1.

1. , , -

[5].



1 -

[6]

$$M=(L,S,C), \tag{1.1}$$

L - () [7].

[7].

$$L = \{l_1, l_2, l_3, l_4, l_5, l_6, l_7, l_8, l_9\} \tag{1.2}$$

S - () [6].

[8],

$$S = [(L?, L!); f(L?)L!; (O?, O!, Of)]. \tag{1.3}$$

$$S = \{S_1, S_2, S_3, S_4, S_5, S_6\}. \tag{1.4}$$

$$\{s_{out}^{s_{in}} l\}: S_{out} \wedge S, S_{in} \subset S, l \in L. \tag{1.5}$$

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_{context}\}. \tag{1.6}$$

$$C = \{(s_{context} s_5 l_1), (s_{context} s_4 l_2), (s_3 s_{context} l_1), (s_3 s_{context} l_4), (s_4 s_{context} l_5), (s_5 s_3 l_6), (s_3 s_6 l_7), (S_3, S_4, l_8), (S_6, S_5, l_9)\}. \tag{1.7}$$

(1.2, 1.6, 1.7)

1,

s₁ s₂

TKujmKTV

$$: sj = [(L?, L!); f(L?)L!; (O?, O!, Of)].$$

« »

:

$$s_1 \cdot f = \begin{cases} s_2 \cdot f \\ s_3 \cdot f \\ s_4 \cdot f \end{cases} \tag{1.8}$$

s_2

:

$$Si./ = \begin{matrix} S2-f = \{ Ss-f \\ Se-f \\ Ss-f \\ s^{\wedge}.f \end{matrix} \tag{1.9}$$

-

,

si

:

$$Si-f = f (11 2) 13 4 5. \tag{1.10}$$

(1.10),

sj

s_1

:

$$\wedge \text{ } f \text{ } Q \vee h) \quad \text{„} f H M \text{ } / \quad \text{> } ^4 \text{ } h \text{ } ^8 \tag{111}$$

2.

s_5 ,

:

$$S5 = [(L?={11,19}, L!={16}); f(L?)L!; (O?, O!, Of)] \tag{2.1}$$

,

$kontext(s)$,

si

:

$$context(si) = \langle \begin{matrix} \wedge \wedge context' \wedge 1 \\ / \wedge context' \wedge 1 > \wedge 2 \\ [s _ . S_{fQ} _ 1 f, / 3] . \\ [Si, SgQifig^f, /4] \\ \vee [si \wedge context' k] \end{matrix} \rangle \tag{2.2}$$

,

:

$$ConteXt^{(s)} \{ [s_{oyf}, s_{in}, \text{£ CI } S_{Qiiif} G^s . U^{s_{in}} G^s \text{ fl}]. \} \tag{2.3}$$

«

»

$$context(s^i) = \begin{matrix} [^context^i] \\ [55, 55, /g] \\ [55, 53, /5] \end{matrix} \quad (2.4)$$

(2.4) , li li :

$S_{context}$, Si_n (Si_n),
 $c = \{S_{context}, S_{in}, l\}$, s^* , $s^*.f$
 $S_{in}.f$, $S_{context}$
 () .

$$V = \{S_{context} \wedge in \wedge l\} \quad G \text{Context}(5j, \cdot) \rightarrow G \text{context} (^s^* | s^*.f = \quad (2.5)$$

$$C_{Context}(s) = \{S_{context}, S, l\}, \quad (2.6)$$

$$s^* \quad , \quad : \quad s \cdot f = f \cdot f \quad (2.7)$$

$$s.f = f(l), \quad : \quad = \{ s \cdot / (0 \quad / 0) = \{ \cdot \cdot / (0 \quad (5 \text{ context} \quad , 5, l) \} G \text{context}(s^*). \quad (2.8)$$

$$(2.8) \quad , \quad \{s_{context}, s, l\} \quad (2.7).$$

$$1, \quad , \quad \{s_{context}, S, li\} \quad : \{s_{context}, S, l_j\} \quad \{s_{context}, S, l_j\}. \quad (2.5)$$

$S_{context}$. . -

$$Vc = \{s \text{ out } 5 \text{ context } l\} \quad G \text{Context}(S_{out}) - c \quad G \text{context}(s \wedge s^*.f = |^{\circ} \quad \cdot / \wedge. \quad (2.9)$$

$$context(s) = \{s, S_{context}, l\}, \quad (2.10)$$

$$/ = [\cdot s.f \quad (2.11)$$

$$s^*.f = i^{\wedge s}.f (\quad)^{\wedge} - s^*.f (\dots \quad I = \wedge s^{\wedge} \wedge (\quad)^{\wedge} - \{s, s_{context}, l\} \quad G \text{context}(s^*). \quad (2.12)$$

$$(2.12) \quad , \quad \{s, s_{context}, l\} \quad \{s^*, s_{context}, l\}$$

TKujmKTW

1, , {s₄, Scontext, ls}

{si, Sc_{ontext}, l₅}-

1)

c={s₀μ_ps_{in}, l},

s_{in}),

s₃ s₆

st_n (

s*,

s*.f

st_n.f,

1,

n.f=f(l[^])

s*.f=f(l[^]).

:

V = (Squ t, S j,,/) I G nt xt (s j,,) -> c G c nt e xt {s* | s*.f (I, ...) = ^ ^). (2.13)

(s₃s₆l₇), (s₃s₂l₇),

1,

s₂

se.

« - - »

« - - »

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