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AUTOMATIC COMPUTERS

Realization of the Rule of Substitution in the Addressless Computer without Working Memory

by

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In the case when no working memory is used in the computer, application of a special form of the rule of substitution is necessary, different from those presented in papers [1] and [2].

In subsequent considerations we assume definitions of composite functions, the elementary formula and standard formula are the same as given in [2]. Additionally, we introduce the notion of a primitive formula, which is simply the elementary formula containing only one symbol of binary arithmetical operation. Thus, the elementary formula with n symbols of binary operations consists of n primitive formulae.

Let $\Phi(x)$ be an elementary formula containing x, and let $F(y)$ be the abbreviation of a standard formula. If we replace the letter x in $\Phi(x)$ by $F(y)$, then the resulting expression is also an elementary formula. F is the name of the formula and y is the address of the value of the independent variable (see [2]). Examples of elementary formulae are given below:

$$x = \cdot ab / * c,$$

$$y = / F(x)\, z / ab - **,$$

$$z = - F(x)\, F(y) \cdot G(u) *.$$

If $x = \Phi$ and $y = \Psi(x)$ we will write: $x = \Phi \prec y = \Psi(x)$. The sequence of elementary formulae $\alpha_1, \alpha_2, \ldots, \alpha_n$ will be a composite formula, if and only if for all i, $1 \leqslant i < n$, there exists at least one j $(i < j \leqslant n)$ such that $\alpha_i \prec \alpha_j$. Example:

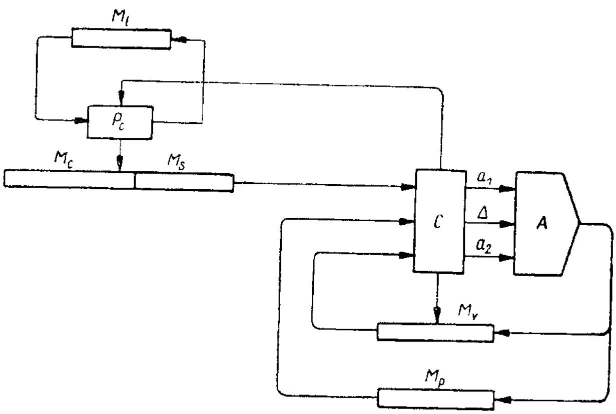
$$x = / F(a)\, F(b) \cdot * c,$$

$$y = - G(t)\, k / xu - **,$$

$$z = \cdot H(x)\, p - xF(y) \cdot **.$$

The preceding example shows that in this case two rules of substitution are to be distinguished, namely the substitution of the value of the function for the value of the variable and the substitution of the name of the function for the variable. In the formula $z = \cdot H(x)\, p - xF(y) \cdot **$, for the value of the variable x we substitute the value of the function $/F(a)\,F(b)\cdot{*}c$, and for the letter l in the formula $z = \cdot lp - xF(y)\cdot{*}{*}$ we substitute the expression $H(x)$.

The organization of the addressless computer working according to the presented rule of substitution is given in the Figure. The main parts of the computer are: arithmometer A, control C, primitive formulae counter P_c, partial result memory M_p, elementary functions value memory M_v, linkage memory M_l, and the main memory M divided into two parts M_c and M_s denoting the composite formulae memory and standard formulae memory, respectively. The principle of operation of C, A, M_v and M_p is the same as in [2]. Counter P_c scans subsequent locations in the main memory M and transfers primitive formulae through the control C to the arithmometer A. If in the scanned primitive formula in the place of a variable there is a name of a standard function, the control C sends the first address of this function to the counter P_c, the previous contents of the counter being located in the memory M_l. After having computed the value of the standard formula the previous contents of the counter increased by one are located in the counter again, and the machine proceeds to the next primitive formula in the memory M_c.



If the standard formula has as its argument another standard formula again, the contents of the counter P_c are located in the next place in the memory M_l. Mark of the end of the formula (comma) causes, when the standard formula has been computed, transferring the last value increased by one from the memory M_l to the counter P_c. Memory M_l works according to the rule "first in last out". After each computation of the primitive formula counter P_c increases its value by one.

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