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Optimization of abstract algorithm

Abstract

The optimization of the known abstract algorithm has been done by means of algebra of algorithms. The optimization criterion is the number of abstract operators. The optimization has been done on the basis of operation features of algebra of algorithms.

Keywords: operator, optimization, operation feature, sequencing, eliminating, cyclic sequencing.

1. Introduction

The known P-CAD system is designed for computer designing of prototype electric schemes and printed circuit boards of radio electronic equipment. In the work [1] the graphical interface of P-CAD system is used to design electromechanical circuits of printing presses. To perform the computer simulation of electromechanical circuits we need the data about types and parameters of electromechanical elements. These data are in a text file of an electromechanical circuit. The file is formed by means of P-CAD system. We need a special algorithm to perform the file analysis. We know the algorithm for identifying types and outputs of electromechanical elements, names and parameters [1]. In order to improve this algorithm we will do it by minimizing the number of operators.

The algorithm is a formula of modified algebra of algorithms [2, 3]. The algebra of algorithms [4] was used for modeling computer systems, and building models of system decomposition into subsystems [5, 6]. Identical transformations of algorithm are performed based on the operation features of modified algebra of algorithms. In particular we use the properties of the removal operator out the sign of the eliminating operation and adding the operators after the operator of cycle return. This adding is based on the fact that these operators will never be executed. However, their presence in the formula provides the ability to perform in-depth optimization. After completing the transformation of algorithm formula, the added operators can be omitted. Reducing the number of operators of algorithms would reduce the cost of implementation of algorithms formulas.

2. Identical transformations of abstract algorithm

Theorem. The formula of abstract algorithm

$$S_8;\ S_{10}; S_7;\ u_9 - ?\ ;\ u_1 - ?;\ S_5\ ;\ S_9; S_6; u_9 - ?\ ; u_1 - ?\ ; S_4;\ u_2 - ?\ ;\ u_3 - ?\ ;\ S_3;\ u_4 - ?\ ,$$

where:

$$S_3 = R_1,$$

$$S_4 = B_4; c_{Pm},$$

$$S_5 = B_4; T_1; L_1; P_{12}; K; c_m,$$

$$S_6 = B_4; T_1; L_1; P_{12}; Z,$$

$$S_7 = B_4;\ *;\ L_1;\ P_{12};\ Z,$$

$$S_8 = B_4; *; L_1; R_3,$$

$$S_9 = B_4; T_1; L_1; P_{12}; K; c_m,$$

$$S_{10} = B_4;\ *;\ L_1;\ P_{12};\ K;\ c_m,$$

and u_1, B_4, c_m, c_{Pm}, K, L_1, P_{12}, R_1, R_3, T_1, Z, u_4, u_9 – are abstract operators, is optimized to the formula

$$B_4\ ;\ (\ *\ ;\ T_1;\ c_{Pm}\ ;\ u_2 - ?\ ;\ u_3 - ?;\ L_1\ ;\ R_3\ ;\ P_{12}\ ;\ K; c_m; Z; u_9 - ?\ ; u_1 - ?\ )\ ;\ R_1\ ;\ u_4 - ?$$

Proving. The abstract algorithm of identification of types of components, names and values of their parameters and names of components outputs is described [1] by the formula

$$S_8;\ S_{10}; S_7;\ u_9 - ?\ ;\ u_1 - ?;\ S_5\ ;\ S_9; S_6; u_9 - ?\ ; u_1 - ?\ ; S_4;\ u_2 - ?\ ;\ u_3 - ?\ ;\ S_3;\ u_4 - ?\ ,$$

In its elimination with the condition u_1 and u_9 we substitute the values of sequences S_7, S_8 and S_{10} [1].

$$B_4; *; L_1; R_3\ ;\ B_4;\ *;\ L_1;\ P_{12};\ K;\ c_m\ ;\ B_4;\ *;\ L_1;\ P_{12};\ Z\ ;\ u_9 - ?\ ;\ u_1 - ?$$

The received formula has got 17 operators. In it from the elimination with the condition u_9, based on the axiom of the removal operator out the sign of the eliminating operation [2, 3, 4], first we remove the operators B_4, *, L_1 and P_{12}. Then – from the elimination with the condition u_1 we remove the operators B_4, *, L_1. We receive the expression

$$B_4; *; L_1; R_3\ ;\ P_{12}; K;\ c_m\ ;\ Z\ ;\ u_9 - ?\ ;\ u_1 - ?\ ,$$

which is denoted by E. With the substitution the E and sequences S_3, S_4, S_5, S_6, and S_9 [1], we receive the formula

$$E;\ B_4;\ T_1;\ L_1;\ R_3;\ B_4;\ T_1;\ L_1;\ P_{12};\ K;\ c_m;\ B_4;\ T_1;\ L_1;\ P_{12};\ Z;\ u_9\text{-?};\ u_1\text{-?};\ B_4;\ c_{Pm};\ u_2\text{-?};\ u_3\text{-?};\ R_1;\ u_4\text{-?}$$

The formula contains other 23 additional operators. In it from the elimination with the condition u_9, based on the axiom of the removal operator out the sign of the eliminating operation, first we remove the operators B_4,T_1,L_1 i P_{12}, and then with u_1 – we remove B_4,T_1 i L_1, and with u_2 – we remove B_4. As a result we receive the formula

$$E;B_4;T_1;L_1;R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?};c_{Pm};u_2\text{-?};u_3\text{-?};R_1;u_4\text{-?}\ .$$

Substituting the expression in it instead of E, we receive the formula

$$B_4;*;L_1;R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?};\ B_4;T_1;L_1;R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?};c_{Pm};u_2\text{-?};\ u_3\text{-?};\ R_1;\ u_4\text{-?}$$

From the last formula the operator B_4 is removed from the elimination operation with the condition u_3, and we receive the formula

$$B_4;\ *;L_1;R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?};\ T_1;L_1;R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?};c_{Pm};u_2\text{-?};\ u_3\text{-?};\ R_1;\ u_4\text{-?} \quad (1)$$

Taking into account that the operator c_{Pm} describes the return to the cycle, then the operators, which will be described after the operator of the return to the cycle, will never be executed, thus the equalities are executed

$$c_{Pm};\ R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?} = c_{Pm}\ .$$

$$T_1;L_1;R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?};c_{Pm};u_2\text{-?} =$$

$$= T_1;L_1;c_{Pm};u_2\text{-?};R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?}\ .$$

Substituting the received expression into the formula (1) we receive

$$B_4;\ *;L_1;R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?};\ T_1;L_1;c_{Pm};u_2\text{-?};R_3;P_{12};K;c_m;Z;u_9\text{-?};u_1\text{-?};\ u_3\text{-?};\ R_1;\ u_4\text{-?} \quad (2)$$

In the formula (2), with the elimination with the condition u_3, we remove the elimination with the condition u_1, and it gives us the formula (3).

$$\left[\begin{array}{l} \left(\begin{array}{l} B_4 \\ ; \\ \left(\begin{array}{l} \overline{\widehat{*;L_1};\ \overline{\widehat{T_1;L_1};c_{Pm};u_2\text{-?}};\ u_3\text{-?}} \\ ; \\ \overline{R_3;P_{12};\widehat{\overline{\widehat{K;c_m}};Z;u_9\text{-?}};u_1\text{-?}} \end{array}\right) \end{array}\right) \\ ; \\ R_1 \\ ; \\ u_4\text{-?} \end{array}\right] \qquad (3)$$

The formula $\overline{\widehat{T_1;L_1};c_{Pm};u_2\text{-?}}$, which is included into the expression (3), contains the operator of return into the cycle, after which we can set any formula or operator. That is why for the elimination with the condition u_2 we have such equalities

$$\overline{\widehat{T_1;L_1};c_{Pm};u_2\text{-?}} = \overline{\widehat{T_1;L_1};\widehat{c_{Pm};L_1};u_2\text{-?}} = \widehat{\overline{T_1;c_{Pm};u_2\text{-?}};L_1}.$$

Substituting the received expression into the transformed formula we get

$$\left[\begin{array}{l} \left(\begin{array}{l} B_4 \\ ; \\ \left(\begin{array}{l} \overline{\widehat{*;L_1};\ \widehat{\overline{T_1;c_{Pm};u_2\text{-?}};L_1};\ u_3\text{-?}} \\ ; \\ \overline{R_3;P_{12};\widehat{\overline{\widehat{K;c_m}};Z;u_9\text{-?}};u_1\text{-?}} \end{array}\right) \end{array}\right) \\ ; \\ R_1 \\ ; \\ u_4\text{-?} \end{array}\right] \qquad (4)$$

After removing from the expression (4) the operator L_1 out of the sign of elimination with the condition u_3, we receive the minimized formula of abstract algorithm.

$$\left[\begin{array}{l} \left(\begin{array}{l} B_4 \\ ; \\ \left(\begin{array}{l} \widehat{\overline{*;\overline{T_1;c_{Pm};u_2\text{-?}};u_3\text{-?}};L_1} \\ ; \\ \overline{R_3;P_{12};\widehat{\overline{\widehat{K;c_m}};Z;u_9\text{-?}};u_1\text{-?}} \end{array}\right) \end{array}\right) \\ ; \\ R_1 \\ ; \\ u_4\text{-?} \end{array}\right]$$

The theorem has been proved.

The received formula contains 16 operators, while before the minimization it contained 40 operators. The result of minimization is the reduction of the number of operators in 2.5 times.

3. Conclusions

Algebra of algorithms provides the performance of identical transformations of formulas of abstract algorithms.

The performance of optimization of algorithm formulas in the number of operators would reduce the cost of the practical implementation of algorithms.

4. References

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