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THE DECOMPOSITION METHODS OF COMPLEX DATA PROCESSING SYSTEMS

Abstract. This work deals with the mathematical model and algorithm of complex data processing systems decomposition. The task is narrowed down to the discrete programming block-symmetric task. For its solution, taking into account peculiarity of the model, the efficient solution algorithm is suggested.

Keywords: block-symmetric model, algorithm, component, decomposition, task.

Introduction. The basis of information systems is the data processing system. The latter has a complex structure and a large amount of tasks interacting with databases depending on information systems being developed. Therefore, when designing data processing systems, there arises the necessity for decomposing the systems into loosely-bound components with separate groups of developers. It enables more effective design of a data processing system and reduces time required for its creation. In this regard, the need arises for developing effective methods of decomposing data processing systems into components.

The task set-up. For mathematical set-up of the task we enter the following variables and notations.

Assume that there are set multiple data processing systems tasks \( A = \{a_i; i = 1, I\} \), multiple databases \( B = \{b_j; j = 1, J\} \) for solving the tasks, \( W = \|a_{ij}\| \) — interconnection matrix of multiple tasks and databases connected to it. It is needed to break down the set up data processing system into separate components that minimize the interlink between them with the aim of distributing them among the system developers.

We enter the following variables

\[
x_{mi} = \begin{cases} 
1, & \text{if the task } i \text{ is included in group } m; \\
0, & \text{otherwise}
\end{cases}
\]

\[
y_{jn} = \begin{cases} 
1, & \text{if the database } j \text{ is included in group } n; \\
0, & \text{otherwise}
\end{cases}
\]

Then, we can define the task of breaking down the complex data processing system which minimizes connections between components, as follows

\[
\sum_{m=1}^{M} \sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{n=1}^{N} w_{ij} y_{jn} x_{mi} \rightarrow \min
\]

If there are constraints, into:
- number of tasks in group \( m \)
\[
\sum_{i=1}^{l} x_{mi} \leq S_{m}, m = 1, M,
\]

Where \(M\)-number of groups of the data processing system;

- each task must be only in one group

\[
\sum_{m=1}^{M} x_{mi} = 1, i = 1, l,
\]

where \(l\) – number of tasks of the data processing system;

- number of data bases in group \(n\)

\[
\sum_{j=1}^{J} y_{jn} \leq C_{n}, n = 1, N,
\]

where \(N\) – number of data bases of the data processing system;

- each data base must be only in one group

\[
\sum_{n=1}^{N} y_{jn} = 1, j = 1, J,
\]

\(J\) – number of data bases of the data processing system.

By the component we shall understand the composition of tasks in \(m\) group, composition of data bases in \(n\) group and interlink between groups \(m\) and \(n\). Having said that, each component is distributed among the data processing systems developers with the consideration of complexity of each component and developers’ qualification.

The defined task is related to the block-symmetrical tasks of discrete programming. For its solution there is proposed an effective algorithm.

**The task solution algorithm.** The task solution algorithm consists of the following steps. It is to be noted that for solving the task, the basis is defined by the number of breakdown components of the data processing system.

**STEP 1.** Entering of the matrix \(W\). Selecting the basis in the matrix \(W\). Switch to **step 2**.

**STEP 2.** Calculation of \(d_{mn}\) values and the matrices of \(D = \|d_{mn}\|\) forming solution search direction. Switch to **step 3**.

**STEP 3.** By searching the minimal element in \(D\) matrix by means of iteration, the solution \(X = \|x_{mi}\|\) shall be defined. The condition of the intermediate matrix shall be recorded \(\Pi = \|p_{mj}\|\), switch to **step 4**.

**STEP 4.** Calculation of the matrix \(d_{jn}\) with respect to \(\pi\) and formation of the matrix \(D = \|d_{jn}\|\). Switch to **step 5**.

**STEP 5.** By searching the minimal element in \(D\) matrix by means of iteration, the solution \(Y = \|y_{jn}\|\) shall be defined. Switch to **step 6**.

**STEP 6.** The outcome of the task solution: matrices \(X, Y\) and \(\pi\). The value of the objective function \(w = \|\pi\|\)

Thus, on the basis of the block-symmetric models and methods many designing tasks of information systems can be solved.
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ДЕРЕКТЕР КОРЫН ОНДЕНІ КУРДЕЛІ ЖУЙЕСІНІҢ ЫДЫРАУ ЄДІСТЕРІ

Аннотация. Матрица, задающая дереектор корын ондең курделі жүйесінің ыдырау едістерінің математикалық модельі жеңе оны пайдалу әдістері көрсетілген. Алғашқы өзгерту ықпалы линейдик блюксиметриялық дискретті бағдарламалар мүмкіндігін анықтайды. Оның ерекшелігінің өзінді өзгертүшісін ықпалсіз алгоритм ұсынады.

Түсінік сөздер: блок-симметриялық модель, алгоритм, компонент, ыдырау едістері (декомпозиция), осеп.

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МЕТОДЫ ДЕКОМПОЗИЦИИ СЛОЖНЫХ СИСТЕМ ОБРАБОТКИ ДАННЫХ

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Аннотация. В работе рассматривается математическая модель и алгоритм декомпозиции сложных систем обработки данных. Задача сводится к блочно-симметричной задаче дискретного программирования. Для ее решения с учетом особенностей модели предложен эффективный алгоритм решения.

Ключевые слова: блочно-симметричная модель, алгоритм, компонента, декомпозиция, задача

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