Network project graph construction on the basis of jobs precedence table

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It is convenient to investigate project $P = \{a_1, ..., a_n\}$, consisting of a large number of connected jobs a_i, with its orgraph $\Gamma(P) = G_P(V, R)$ where project jobs $a_i \in \overline{1, n}$ are represented by its edges and the events of separate jobs start and finish coordination are represented by its vertexes $v_j \in V$, $j \in \overline{1, |V|}$. However, information about technological (logical) precedence of project jobs is used to be source information. It does not show directly a set of vertexes V. The transition from precedence table $T(P)$ to the project graph $\Gamma(P)$ involves sufficient problems, as it is often impossible to carry out such a transition without introducing additional (dummy) jobs $a_{n+1}, ..., a_{n+k}$, $k > 0$, missed in the precedence table. Evidently, we should use the minimal number ($k \to min$) of dummy jobs, as additional vertexes and edges of $G_P(V, R)$ graph make further investigation of the project P more complicated. Moreover, the specification of the minimal necessary number of additional vertexes and edges makes it possible to identify P project with its $\Gamma(P)$ orgraph unambiguously. Let us suggest the following algorithm of $\Gamma(P)$ graph construction for the project P. It consists of 5 steps [1], [2].

1. Let us pass from $T(P)$ precedence table to the $T_1(P)$ direct precedence table with only immediate predecessors for each job a_i having been left.

2. On the basis of $T_1(P)$ table let us generate $(|R|\text{x}|R|)-$ matrix $A(S_P)$ of S_P relation of direct precedence of P project jobs. In this matrix in the row corresponding to the job a_i unit elements stand for the columns of its immediate predecessors.

3. Let us correctly reindex project jobs, i.e. let us assign such indexes to them, so that job-predecessors would get an index, less than one got by the job-successor. This is always admissible if there are no logical loops in the precedence table $T(P)$ and consequently in the table $T_1(P)$. In case there exist more than one correct indexing schemes let us additionally claim that the jobs with a less number of predecessors acquire minor indexes. Let us consider $a_1, ..., a_{|R|}$ indexing correct, so all elements of $A(S_P)$ matrix within its main diagonal and over it are zeros.

4. Let us find submatrix $\left(\begin{smallmatrix} B_1 & B_2 \\ B_3 & B_4 \end{smallmatrix}\right)$ of $A(S_P)$ matrix consisting of blocks B_1, B_2, B_3, B_4 of corresponding dimensions $r\text{x}u$, $r\text{x}v$, $t\text{x}u$, $t\text{x}v$; $r, t, u, v > 0$; where B_1, B_3, B_4 blocks are filled in with unit elements, while B_2 block is filled in with zeros. If there is no such a submatrix of $(r + t)\text{x}(u + v)$, additional dummy jobs are not required and $\Gamma(P)$ orgraph is trivially constructed at a set of vertexes V. In any other case it is necessary to add at least one dummy job. For this purpose we go to the 5th step.

5. Let $A(S_P)$ matrix rows corresponding to jobs $a_{s_1}, a_{s_2}, ..., a_{s_r}$ get into B_1 and B_2 blocks, while those corresponding to $a_{s_{r+1}}, a_{s_{r+2}}, ..., a_{s_{r+t}}$ jobs get into B_3 and B_4 blocks ($r > 0$,$t > 0$). Let us add dummy job b, leading from the common start of the jobs $a_{s_1}, a_{s_2}, ..., a_{s_r}$ to common start of the jobs $a_{s_{r+1}}, a_{s_{r+2}}, ..., a_{s_{r+t}}$ to the project P and get back to step 1.

Let us repeat steps 1-5, until project P is filled up with all the necessary dummy jobs. After this graphical realization of the project orgraph $\Gamma(P)$ becomes trivial. As step 4 to 5 transitional condition is a NC for adding a dummy job, the algorithm guarantees the minimal number of such additions.

References

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