Comments on "Process Synchronization in Database Systems"

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In a recent paper [4], Schlageter introduced a formal theory of database concurrency control. Theorems 3.1 and 3.2 of that paper imply that serializability of transaction schedules can be tested in polynomial time, contradicting NP-completeness results in [2, 3]. The following counterexample demonstrates that the results of [4] are in error.

EXAMPLE 1

Notation

$r_i[v]$ means "process i reads variable v"; $w_i[v]$ means "process i writes into variable v." Sequences of r' s and w' s denote schedules. Process P_{in} initializes the database state and P_{out} reads the final database state. P_1, P_2, and P_3 are user processes.

Theorem 3.1 states that a schedule is serializable only if whenever two processes have conflicting actions, all pairs of conflicting actions appear in the same order. (Two actions *conflict* if they operate on the same variable and one of them is a write action.) Consider schedule S_1:

$$S_1 = w_{in}[x]w_{in}[y]w_{in}[z]r_1[x]w_1[z]r_2[y]w_2[x]w_1[x]r_3[z]w_3[x]r_{out}[x]r_{out}[y]r_{out}[z].$$

S_1 does not satisfy the condition of the theorem because

(1) $r_1[x]$ conflicts with and precedes $w_2[x]$; while
(2) $w_2[x]$ conflicts with and precedes $w_1[x]$.

Nonetheless S_1 is equivalent to the following serial schedule:

$$S'_1 = w_{in}[x]w_{in}[y]w_{in}[z]r_1[x]w_1[z]w_1[x]r_2[y]w_2[x]r_3[z]w_3[x]r_{out}[x]r_{out}[y]r_{out}[z].$$

Thus S_1 is serializable, contradicting Theorem 3.1. □

Theorem 3.2 fails on the same example. Theorem 3.2 states that a schedule is serializable if its "reduced dependency graph" is acyclic. But S_1 produces the

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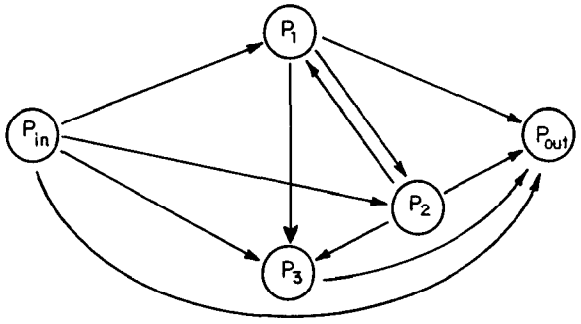
following reduced dependency graph which contains the cycle P_1, P_2, P_1, which is a contradiction. □



Theorem 3.6, which is a consequence of Theorem 3.2, now fails in one direction also.

Parts of [4, Section 4] dealing with "weak consistency" are also in error. A comparison of [4] with respect to other work on concurrency control theory appears in [1].

REFERENCES

1. BERNSTEIN, P.A., CASANOVA, M.A., AND GOODMAN, N. Errors in "Process synchronization in database systems." To appear in SIGMOD Record (ACM).
2. PAPADIMITRIOU, C.H. The serializability of concurrent database updates. *J. ACM 26*, 4 (Oct. 1979), 631–653.
3. PAPADIMITRIOU, C.H., BERNSTEIN, P.A., AND ROTHNIE, J.B. Some computational problems related to database concurrency control. Proc. Conf. on Theoretical Comptr. Sci., U. of Waterloo, Waterloo, Ont., Canada, 1977, pp. 275–282.
4. SCHLAGETER, G. Process synchronization in database systems. *ACM Trans. Database Syst. 3*, 3 (Sept. 1978), 248–271.

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