Database management, Spring 2002 **Exercise 6 (6.-10.5.)**

The minimum requirement for active attendance: 4 tasks done

This is the last set of exercises. The exam will be held according to the schedule indicated: Friday, May 17, 15:00 to 19:00 in Porthania I. Contents of the exam: topics from lectures and exercise sessions. I will check the corresponding parts in E&N and indicate them on the English course page.

1. (**) Let us assume that the log contains also the [read ...] records as in the following example (describing the log contents when the system crashes):

100: [start, T3]
101: [read, T3, C]
102: [write, T3, B, 15, 12]
103: [start, T2]
104: [read, T2, B]
105: [write, T2, B, 12, 18]
106: [start, T1]
107: [read, T1, A]
108: [read, T1, D]
109: [write, T1, D, 20, 25]
110: [read, T2, D]
111: [write, T2, D, 25, 26]
112: [read, T3, A]

a) What the log tells about the initial values of the variables?
b) In the crash situation at least transaction T3 is not committed. Is it possible that transactions T1 and T2 have committed? (Commit records are not listed but you should consider whether they might exist or not.) What kind of recovery is needed here?

2. An integrity constraint states that data items X and Y must always have the same value. Consider the following schedule of the transaction set {T1, T2, T3}:

T1: read-item(X,v); a) Are the transactions consistency preserving?
T1: v:=v+1;
T1: write-item(X,v); b) What is the isolation level of each transaction?
T2: read-item(X,w);
T2: write-item(Y,w); c) Which log records are generated,
T2: commit; when initially X = Y = Z = 0 in the database.
T3: read-item(Y,p);
T1: abort; d) Will the integrity of the database be
T3: write-item(Z,p); preserved?
T3: commit.

e) How strict two-phase locking prevents the creation of the schedule of the previous problem?

3. Suppose that transactions T1 and T2 have the following schedule:

1 T1: read_item(X);
2 T2: read_item(X);
3 T1: write_item(X);

```
4       T1: read_item(Y);
5             T2: read_item(X);
6             T2: write_item(X);
7       T1: write-item(Y);
8       T1: commit;
9             T2: commit;
```

a) Which pairs of operations in the schedule are conflicting operations? Name the isolation violation corresponding to each conflicting pair. Violations handled on the course are dirty write, dirty read, and unrepeatable read (cf. EN, p. 655; conflicting operations are explained on p. 647). EN does not mention dirty write; it means a situation where a transaction T2 writes the same data item as another transaction T1 has already written although transaction T1 has not yet committed (and not aborted either).

b) Give three examples of non-conflicting pairs of operations in the above schedule, and explain why they are not conflicting (three different types of examples, a different condition for each).

4. a) Under what conditions can a read lock be upgraded to a write lock?

b) How should lock downgrading from a write lock to a read lock be implemented? Sketch the changes in the algorithms of Fig. 20.2 (EN, p. 665). Is downgrading needed in practice?

5. Suppose the query

```
select * from employee where dno=5;
```

a) How the granularity of a lock should be decided? (EN, 20.5)

b) In some systems the granularity of a lock may be dynamic, i.e. locking may be changed even during the query execution e.g. from page locking to row locking or vice versa). Which situation might be the reason to this change? (Hint: The system might collect some simple statistical data during the query execution.)

6. (**) The DBMS employs strict two-phase locking. The data items to be locked are pages. What locks are acquired during the execution of the following transaction, when

a) there exists no index to the relation EMPLOYEE on attribute dno,

b) there exists a hash-table index to EMPLOYEE on dno (either as a primary access path or as a secondary index)?

```
begin transaction;
update EMPLOYEE set salary = salary + 500
  where dno = 5;
commit transaction.
```

c) What locks are needed in another update which increases the salary of all employees with name 'Smith'? Suppose that there is an ISAM index based on last name?

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