Week 13 Exercises:
Concurrency Control II

Exercise 13.1. Consider the following two transactions:

```
T31:    read(A);
        read(B);
        if A = 0 then B := B + 1;
        write(B).

T32:    read(B);
        read(A);
        if B = 0 then A := A + 1;
        write(A).
```

Add lock and unlock instructions to transactions T31 and T32, so that they observe the two-phase locking protocol. Can the execution of these transactions result in a deadlock?

Exercise 13.2 What benefit does strict two-phase locking provide? What disadvantages result?

Exercise 13.3 Consider a database D consisting of two tables A (which stores information about musical artists) and R (which stores information about the artists' releases). Specifically:

- R(rid, name, artist credit, language, status, genre, year, number sold)
- A(id, name, type, area, gender, begin date year)

Table R spans 1000 pages, which we denote R1 to R1000. Table A spans 50 pages, which we denote A1 to A50. Each page contains 100 records. We use the notation R3.20 to denote the twentieth record on the third page of table R. There are no indexes on these tables.

Suppose the database supports shared and exclusive hierarchical intention locks (S, X, IS, IX and SIX) at four levels of granularity: database-level (D), table-level (R and A), page-level (e.g., R10), and record-level (e.g., R10.42). We use the notation IS(D) to mean a shared database-level intention lock, and X(A2.20-A3.80) to mean a set of exclusive locks on the records from the 20th record on the second page to the 80th record on the third page of table A.

For each of the following operations below, what sequence of lock requests should be generated to maximize the potential for concurrency while guaranteeing correctness?

(1) Fetch the records of all musical artists in A with type = 'Orchestra'.

A. SIX(D), S(A)
B. IX(D), S(A)
C. IS(D), S(A)
D. S(D)

(2) Update the genre for all release records with language = 'English' to 'Musical theatre'.

A. IX(D), X
B. SIX(D), X
C. IX(D), IX(R)
D. IX(D), SIX(R)

Solutions

Answer 13.1.
Lock and unlock instructions:

```
T31:    lock-S(A)
        read(A)
        lock-X(B)
        read(B)
        if A = 0
        then B := B + 1
        write(B)
        unlock(A)
        unlock(B)

T32:    lock-S(B)
        read(B)
        lock-X(A)
        read(A)
        if B = 0
        then A := A + 1
        write(A)
        unlock(B)
        unlock(A)
```

Execution of these transactions can result in deadlock. For example, consider the following partial schedule:

```
 T31            |   T32
----------------------------------------
lock-S(A)       |
                |  lock-S(B)
                |  read(B)
read(A)         |
lock-X(B)       |
                |  lock-X(A)
The transactions are now deadlocked
```

Answer 13.2
Answer: Because it produces only cascadeless schedules, recovery is very easy. But the set of schedules obtainable is a subset of those obtainable from plain two phase locking, thus concurrency is reduced

Answer 13.3
(1) The correct answer choice is IS(D), S(A). We need to scan records in table A to find records where type = 'Orchestra'. This choice is correct because it accesses the intended shared parent lock to get the shared lock on table A.

- SIX(D), S(A) is incorrect because it gains a shared+intention-exclusive lock on the database D when it only needs to read from A and has no intention of modifying any records.
- IX(D), S(A) is incorrect because it gains an intention-exclusive lock when it has no intention of modifying.
- S(D) is incorrect because it gains a shared lock on the entire database D when it only needs to fetch rows in table A.

(2) The correct answer choice is IX(D), X(R). This choice is correct because it accesses all intended locks and the exclusive lock on R, since we potentially need to modify all records in R.

- SIX(D), X(R) is incorrect because it gains a shared intention parent lock for D, when it only needs to read from R.
- IX(D), IX(R) is incorrect because it does not gain an exclusive lock for the records of R it needs to delete.
- IX(D), SIX(R) is incorrect because it does not gain an exclusive lock for the records of R it needs to delete.