CSC 540 Spring 19 Homework 7 - Solutions

Question 1

Consider the following sequence of records present in an undo/redo log:
(START, S); (S, A, 10, 20); (START T); (COMMIT S); (T, B, 5,15); (START U); (T, A, 20, 30); (COMMIT T); (U, B, 15, 25); (U, A, 30, 40).

Let both A and B fit in the same database block (i.e., both are INPUT from disk to memory together and both are OUTPUT from memory to disk together). Assuming that a quiescent checkpoint occured just before S started, determine what are the possible values of A and B on disk. Identify one such possibility from the list below.

 Correct choices:

Correct Choice 1:   A = 10; B = 5
Correct Choice 2:   A = 20; B = 5
Correct Choice 3:   A = 20; B = 15
Correct Choice 4:   A = 30; B = 15
Correct Choice 5:   A = 30; B = 25
Correct Choice 6:   A = 40; B = 25

Incorrect choices :

Incorrect Choice 1:   A = 10; B = 15
Incorrect Choice 2:   A = 10; B = 25
Incorrect Choice 3:   A = 20; B = 25
Incorrect Choice 4:   A = 30; B = 5
Incorrect Choice 5:   A = 40; B = 5
Incorrect Choice 6:   A = 40; B = 15

Question Explanation: In undo/redo logging, there is really no constraint on when a change can migrate to disk. You have to write the log record for that change first, but that is irrelevant as far as this problem is concerned. The only constraint we have to face is that A and B are sent to disk simultaneously, because they are on the same page. Thus, the state of A and B on disk always corresponds to the state of A and B in memory at some time in the history of the transactions. If A and B were not on the same page, even that would not be true, necessarily.
We can see from the log records that A starts out at 10 and B starts out at 5. The sequences of changes are A=20, B=15, A=30, B=25, A=40. Thus, the value of A and B on disk can be derived from any point in this history, e.g. (A=10; B=5) or (A=30; B=15). However, it is impossible for, say (A=20; B=25), since A is changed to 30 before B is changed to 25.

Question 2

Which of the following transactions does NOT preserve the consistency of the database that has the constraint "A must be less than B"? (Assume A and B are integers { not necessarily positive.)

Correct choices:

Correct Choice 1:   A := 3*A; B := B+15
Correct Choice 2:   A := A - B + 7; B := B + 13
Correct Choice 3:   A := B - A + 20; B := B + 50
Correct Choice 4:   A := A - 10; B := B + A
Correct Choice 5:   A := A + 2 * B; B := B - A
Correct Choice 6:   A := A + 2 * B; B := A + B
Correct Choice 7:   A := B - A; B := B + A + 20
Correct Choice 8:   A := A - 5 * B; B := B + 5
Correct Choice 9:   A := A + 1; B := 3 * B
Correct Choice 10:   A := A - 10; B := 3 * B

Incorrect choices :

Incorrect Choice 1:   A := 5 * A; B := 5 * B
Incorrect Choice 2:   A := A + 5; B := B + 7
Incorrect Choice 3:   A := A - 5; B := B - 2
Incorrect Choice 4:   A: = A + 3 * B; B: = A + 1
Incorrect Choice 5:   A := B - 2 * A; B := A + 7
Incorrect Choice 6:   A := B - 10; B := A + 10

Question 3

Let a database has the constraint "X > Y > 0". Which of the following transactions does NOT preserve the consistency of the database? (Assume X and Y are real numbers - not necessarily integers).

Correct choices:

Correct Choice 1:   X := X - Y + 3; Y := Y - 1
Correct Choice 2:   X := X + 3; Y := X - 4
Correct Choice 3:   X := Y * 3; Y := X + 2 * Y
Correct Choice 4:   X := X * 2; Y := X - 1
Correct Choice 5:   X := X + 13; Y := Y - 1

Correct Choice 6:   X := X - 2; Y := X - 1
Correct Choice 7:   X := X + 20; Y := Y * 2
Correct Choice 8:   X := Y + 10; Y := X - 1.01 * Y

Incorrect choices :

Incorrect Choice 1:   X := X * 2; Y := X - 2 * Y
Incorrect Choice 2:   X := Y + 1; Y := X - Y
Incorrect Choice 3:   X := X + 2; Y := Y + 2
Incorrect Choice 4:   X := Y * 2.5; Y := X - 1.5 * Y
Incorrect Choice 5:   X := X + 4; Y := X - 4
Incorrect Choice 6:   X := X + 5; Y := X - Y
Incorrect Choice 7:   X := Y + 1; Y := X - 1
Incorrect Choice 8:   X := X * 2; Y := Y * 2

Question 4

Let R be the transaction [X := X + 10; Z := Z - 1], S be the transaction [X := X + 15; Y := Y * 2] and T be the transaction [Y := Y + 10; Z := Z - 5]. What values of X, Y and Z could appear on disk when the undo log has the sequence of records:
(START R);
(START S);
(R, X, 5);
(R, Z, 10);
(COMMIT R);
(S, X, 15);
(S, Y, 20);
(START T);
(COMMIT S);
(T, Y, 40);
(T, Z, 9);

Correct choices:

Correct Choice 1:   X = 30; Y = 40; Z = 9;
Correct Choice 2:   X = 30; Y = 40; Z = 4;
Correct Choice 3:   X = 30; Y = 50; Z = 9;
Correct Choice 4:   X = 30; Y = 50; Z = 4;

Incorrect choices :

Incorrect Choice 1:   X = 5; Y = 40; Z = 9;
Incorrect Choice 2:   X = 5; Y = 50; Z = 9;

Incorrect Choice 3:   X = 5; Y = 40; Z = 4;
Incorrect Choice 4:   X = 15; Y = 40; Z = 4;
Incorrect Choice 5:   X = 15; Y = 50; Z = 4;
Incorrect Choice 6:   X = 15; Y = 50; Z = 9;
Incorrect Choice 7:   X = 30; Y = 10; Z = 4;
Incorrect Choice 8:   X = 30; Y = 10; Z = 9;
Incorrect Choice 9:   X = 5; Y = 10; Z = 9;
Incorrect Choice 10:   X = 5; Y = 10; Z = 4;

Question 5

Let a database contain initial values of X = 5, Y = 13 and Z = 6. In the redo logging scheme, let the redo log contain the sequence of records:
(START, R);
(R, Y, 15);
(R, X, 15);
(COMMIT R);
(START S);
(S, X, 10);
(START T);
(S, Z, 16);
(T, Y, 20);
(COMMIT T).

Which of the following could be the state of the database on disk?

Correct choices:

Correct Choice 1:   X = 5; Y = 13; Z = 6;
Correct Choice 2:   X = 5; Y = 15; Z = 6;
Correct Choice 3:   X = 5; Y = 20; Z = 6;
Correct Choice 4:   X = 15; Y = 13; Z = 6;
Correct Choice 5:   X = 15; Y = 15; Z = 6;
Correct Choice 6:   X = 15; Y = 20; Z = 6;

Incorrect choices :

Incorrect Choice 1:   X = 10; Y = 13; Z = 6;
Incorrect Choice 2:   X = 10; Y = 15; Z = 6;
Incorrect Choice 3:   X = 10; Y = 20; Z = 6;
Incorrect Choice 4:   X = 15; Y = 13; Z = 16;
Incorrect Choice 5:   X = 15; Y = 15; Z = 16;
Incorrect Choice 6:   X = 15; Y = 20; Z = 16;
Incorrect Choice 7:   X = 10; Y = 13; Z = 16;

Incorrect Choice 8:   X = 10; Y = 15; Z = 16;
Incorrect Choice 9:   X = 10; Y = 20; Z = 16;
Incorrect Choice 10: X = 5; Y = 13; Z = 16;
Incorrect Choice 11: X = 5; Y = 15; Z = 16;
Incorrect Choice 12: X = 5; Y = 20; Z = 16;

Question 6

At the time of a system crash, let the log segment (in the undo/redo logging scheme) be as follows:
(START R);
(R, B, 1, 20);
(R, A, 13, 15);
(COMMIT R);
(START T);
(T, A, 15, 16);
(START CKPT(T));
(T, B, 20, 10);
(START S);
(COMMIT T);
(S, A, 16, 10);
(END CKPT);
(S, B, 10, 50);
(COMMIT S).

What are the possible values of A and B on disk when the crash occurred (i.e. before recovery from the crash)?

Correct choices:

Correct Choice 1:   A= 10; B = 10;
Correct Choice 2:   A= 10; B = 20;
Correct Choice 3:   A= 10; B = 50;
Correct Choice 4:   A= 16; B = 10;
Correct Choice 5:   A= 16; B = 20;
Correct Choice 6:   A= 16; B = 50;

Incorrect choices :

Incorrect Choice 1:   A= 13; B = 10;
Incorrect Choice 2:   A= 13; B = 20;

Incorrect Choice 3:   A= 13; B = 50;
Incorrect Choice 4:   A= 15; B = 10;
Incorrect Choice 5:   A= 15; B = 20;
Incorrect Choice 6:   A= 15; B = 50;
Incorrect Choice 7:   A= 10; B = 1;
Incorrect Choice 8:   A= 13; B = 1;
Incorrect Choice 9:   A= 15; B = 1;
Incorrect Choice 10: A= 16; B = 1;