

# Introduction to Database Systems

## Individual Homework 3: Query Processing & 2PL

### 1. Introduction

In the lecture, you had learned some query processing methods and how to perform concurrency control. In this homework, you are asked to answer some questions about query processing & 2PL. Please continue reading for details.

### 2. Tasks

#### **2-1. Query Processing (39%)**

##### **2-1-1. select operation (12%, 4% each)**

Transform three equations on page 16 of course slides “Query Processing” to pseudo code.

##### **2-1-2. join operation (27%, 9% each)**

Let relation  $r_1(A, B, C)$  and  $r_2(C, D, E)$  have the following properties:  $r_1$  has 40000 tuples,  $r_2$  has 30000 tuples, 20 tuples of  $r_1$  fit on one block, and 10 tuples of  $r_2$  fit on one block. Estimate the number of **block transfer** and **seeks**, and write the **pseudo code** to explain your result:

- a. Assume that we implement Nested-loops join, and both are sorted. If there are only 3 memory blocks available and the minimal block transfers are required, what is the outer relation that we should pick from  $r_1$  and  $r_2$ , and the number of block transfers and seeks required. Explain your answer with pseudo code.( **3% for each answer**)
- b. Assume that we implement Nested-loops join, and none of the sorted. If there are 102 memory blocks available and the minimal block transfers are required, what is the outer relation that we should pick from  $r_1$  and  $r_2$ , and the number of block transfers and seeks required. Explain your answer with pseudo code.( **3% for each answer**)

- c. Assume that we implement Block Nested-loops join, and none of the sorted. If there are only 102 memory blocks available, what is the outer relation that we should pick from r1 and r2, and the number of block transfers and seeks required. Explain your answer with pseudo code.( **3% for each answer**)

**Pseudo code example:**

*for each tuple  $r$  in  $R$*

*for each tuple  $s$  in  $S$*

*check if  $r.a = s.a$  (or whether  $|r.a - s.a| < 0.5$ )*

**2-2. 2PL (61%)**

**2-2-1 (21%)**

Given four threads with their own schedules, try to find out the minimum time to finish all tasks with 2PL protocol if each action takes one sec (lock-S, lock-X, Read, Write Unlock). Present your concurrent schedule as a table as the example.

- T1(Read(B),Write(C)),
- T2(Read(B), Read(A)),
- T3(Write(A),Write(B)),
- T4(Read(C), Read(A))

**Example table:**

T1	T2
lock-S(A)	
	lock-S(A)
Read(A)	Read(A)
	Unlock(A)
Unlock(A)	

This table takes 5s to complete, but the minimum time is 3s.

**2-2-2 (40%, 10% each)**

- a. This schedule is under 2PL protocol, please find out where deadlock happens, if any, explain why.

T1	T2	T3
lock-X(A)		
Read(A)		
		lock-X(C)
		Read(C)
	lock-X(B)	
	Read(B)	
lock-S(C)		
Read(C)		
	lock-S(A)	
	Read(A)	
		lock-S(B)
		Read(B)
Write(A)		
Unlock(A)		
Unlock(C)		
	Write(B)	
	Unlock(B)	
	Unlock(A)	
		Write(C)
		Unlock(C)
		Unlock(B)

- b. Edit the schedule to deal with the deadlock with wait-die protocol.
- c. Edit the schedule to deal with the deadlock with wound-wait protocol.
- d. Edit the schedule to deal with the deadlock with timestamp-based protocol.

### 3. Discussion

TAs had opened a channel **HW3 討論區** on E3 of the course, you can ask questions about the homework in the channel. TAs will answer questions in the channel as soon as possible.

Discussion rules:

1. Do not ask for the answer of the homework.
2. Check if someone has asked the question you have before asking.
3. We encourage you to answer other students' questions, but again, do not give the answer to the homework. Reply the messages to answer questions.
4. Since we have this discussion channel, do not send email to ask questions about the homework unless the questions are personal and you do not want to ask publicly.

### 4. Submission

1. The deadline of this homework is **12/21 (Thurs.) 23:59:59**. Late submission lead to score of (original score)\*0.7.
2. The submission only requires one file: **HW3\_XXXXXXX\_report.pdf**.
3. If there is anything you are not sure about submission, ask in the forum.