

# Concurrency

## Concurrency

- คือสถานะที่หลาย transaction มีการใช้ข้อมูลเดียวกัน พร้อมกัน

## Three Concurrency Problems

- Lost update
- Uncommitted dependency
- Inconsistent analysis

## Lost Update Problem

| Transaction A | time | Transaction B |
|---------------|------|---------------|
| -             |      | -             |
| -             |      | -             |
| RETRIEVE $p$  | t1   | -             |
| -             | t2   | RETRIEVE $p$  |
| UPDATE $p$    | t3   | -             |
| -             | t4   | UPDATE $p$    |
| -             | ↓    | -             |

### Uncommitted Dependency Problem

| Transaction <i>A</i> | time | Transaction <i>B</i> |
|----------------------|------|----------------------|
| -                    |      | -                    |
| -                    |      | -                    |
| -                    | t1   | UPDATE <i>p</i>      |
| RETRIEVE <i>p</i>    | t2   | -                    |
| -                    | t3   | ROLLBACK             |
| -                    | ↓    | -                    |
| -                    |      | -                    |

### Uncommitted Dependency Problem

| Transaction <i>A</i> | time | Transaction <i>B</i> |
|----------------------|------|----------------------|
| -                    |      | -                    |
| -                    |      | -                    |
| -                    | t1   | UPDATE <i>p</i>      |
| UPDATE <i>p</i>      | t2   | -                    |
| -                    | t3   | ROLLBACK             |
| -                    | ↓    | -                    |
| -                    |      | -                    |

### Inconsistent Analysis Problem

| ACC1 = 40                            | ACC2 = 50 | ACC3 = 30                |
|--------------------------------------|-----------|--------------------------|
| Transaction <i>A</i>                 | time      | Transaction <i>B</i>     |
| -                                    |           | -                        |
| RETRIEVE ACC1:<br>sum = 40           | t1        | -                        |
| -                                    |           | -                        |
| RETRIEVE ACC2:<br>sum = 90           | t2        | -                        |
| -                                    | t3        | RETRIEVE ACC3            |
| -                                    |           | -                        |
| -                                    | t4        | UPDATE ACC3:<br>30 -> 20 |
| -                                    |           | -                        |
| -                                    | t5        | RETRIEVE ACC1            |
| -                                    |           | -                        |
| -                                    | t6        | UPDATE ACC1:<br>40 -> 50 |
| -                                    |           | -                        |
| -                                    | t7        | COMMIT                   |
| RETRIEVE ACC3:<br>sum = 110, not 120 | t8        |                          |

### Locking

- Exclusive locks (X locks, write locks)
- Shared locks (S locks, read locks)

Compatibility matrix for lock types X and S

|   | X | S | - |
|---|---|---|---|
| X | N | N | Y |
| S | N | Y | Y |
| - | Y | Y |   |

Lost Update Problem

| Transaction A                                      | time | Transaction B                                      |
|----------------------------------------------------|------|----------------------------------------------------|
| -                                                  |      | -                                                  |
| RETRIEVE <i>p</i><br>(acquire S lock on <i>p</i> ) | t1   | -                                                  |
| -                                                  | t2   | RETRIEVE <i>p</i><br>(acquire S lock on <i>p</i> ) |
| UPDATE <i>p</i><br>(request X lock on <i>p</i> )   | t3   | -                                                  |
| wait                                               | t4   | UPDATE <i>p</i><br>(request X lock on <i>p</i> )   |
| wait                                               |      | wait                                               |
| wait                                               |      | wait                                               |
| wait                                               |      | wait                                               |
|                                                    | ↓    |                                                    |

Uncommitted Dependency Problem

| Transaction A                                               | time | Transaction B                                    |
|-------------------------------------------------------------|------|--------------------------------------------------|
| -                                                           |      | -                                                |
| -                                                           | t1   | UPDATE <i>p</i><br>(acquire X lock on <i>p</i> ) |
| RETRIEVE <i>p</i><br>(request S lock on <i>p</i> )          | t2   | -                                                |
| wait                                                        | t3   | COMMIT/ROLLBACK<br>(release X lock on <i>p</i> ) |
| wait                                                        |      |                                                  |
| resume : RETRIEVE <i>p</i><br>(acquire S lock on <i>p</i> ) | t4   |                                                  |
| -                                                           | ↓    |                                                  |

Uncommitted Dependency Problem

| Transaction A                                             | time | Transaction B                                    |
|-----------------------------------------------------------|------|--------------------------------------------------|
| -                                                         |      | -                                                |
| -                                                         | t1   | UPDATE <i>p</i><br>(acquire X lock on <i>p</i> ) |
| UPDATE <i>p</i><br>(request X lock on <i>p</i> )          | t2   | -                                                |
| wait                                                      | t3   | COMMIT/ROLLBACK<br>(release X lock on <i>p</i> ) |
| wait                                                      |      |                                                  |
| resume : UPDATE <i>p</i><br>(acquire X lock on <i>p</i> ) | t4   |                                                  |
| -                                                         | ↓    |                                                  |

## Inconsistent Analysis Problem

| ACC1 = 40                 | ACC2 = 50 | ACC3 = 30                |
|---------------------------|-----------|--------------------------|
| Transaction A             | time      | Transaction B            |
| -                         | -         | -                        |
| RETRIEVE ACC1:            | t1        | -                        |
| (acquire S lock on ACC 1) | -         | -                        |
| sum = 40                  | -         | -                        |
| -                         | -         | -                        |
| RETRIEVE ACC2:            | t2        | -                        |
| (acquire S lock on ACC2)  | -         | -                        |
| sum = 90                  | -         | -                        |
| -                         | t3        | RETRIEVE ACC3            |
| -                         | -         | (acquire S lock on ACC3) |
| -                         | t4        | UPDATE ACC3:             |
| -                         | -         | (acquire X lock on ACC3) |
| -                         | -         | 30 -> 20                 |
| -                         | -         | -                        |
| -                         | t5        | RETRIEVE ACC1            |
| -                         | -         | (acquire S lock on ACC1) |
| -                         | -         | -                        |
| -                         | t6        | UPDATE ACC1:             |
| -                         | -         | (request X lock on ACC1) |
| RETRIEVE ACC3 :           | t7        | wait                     |
| (request S lock on Acc3)  | t8        | wait                     |
| wait                      | -         | wait                     |
| -                         | -         | wait                     |

## Dead Lock

- คือการที่สอง transactions ต่างฝ่ายต่างทำการ lock ข้อมูลซึ่งอีกฝ่ายต้องการ และต่างฝ่ายต่างรอให้อีกฝ่ายปล่อย lock
- Dead lock อาจเกิดกับ transaction มากกว่าสอง transactions ได้