Transaction Anomalies

Anomalies – Lost Update

TA1 updates points for Exercise 1

```
SELECT Pts INTO :points
   FROM Students WHERE Sid=789;

points += 23.5;

UPDATE Students SET Pts=:points
   WHERE Sid=789;
COMMIT TRANSACTION;
```

TA2 updates points for Exercise 2

```
SELECT Pts INTO :points
   FROM Students WHERE Sid=789;

points += 24.0;

UPDATE Students SET Pts=:points
   WHERE Sid=789;
COMMIT TRANSACTION;
```

Time

Student received 24 instead of 47.5 points
(lost update 23.5)

- **Problem:** Write-write dependency
- **Solution:** Exclusive lock on write

Anomalies – Dirty Read

TA1 updates points for Exercise 1

```
UPDATE Students SET Pts=100
   WHERE Sid=789;



ROLLBACK TRANSACTION;
```

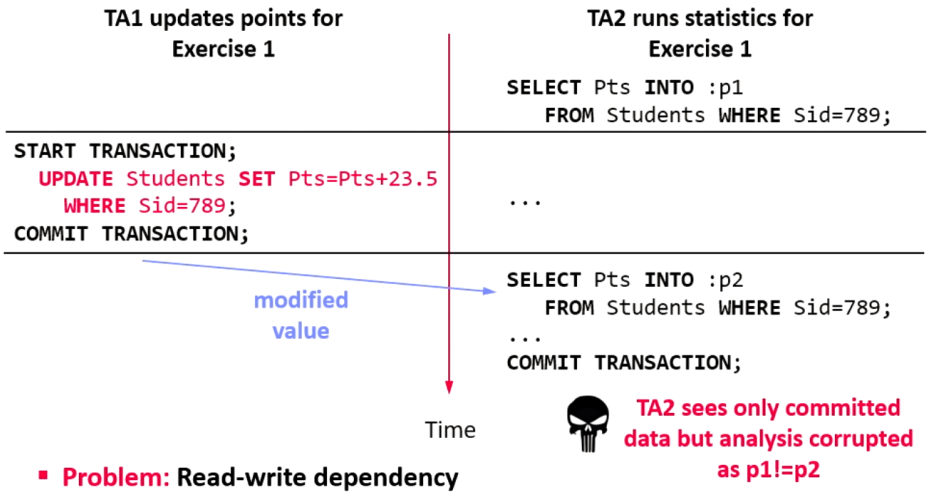
TA2 updates points for Exercise 2

```
SELECT Pts INTO :points
   FROM Students WHERE Sid=789;

points += 24.0;

UPDATE Students SET Pts=:points
   WHERE Sid=789;
COMMIT TRANSACTION;
```

Time

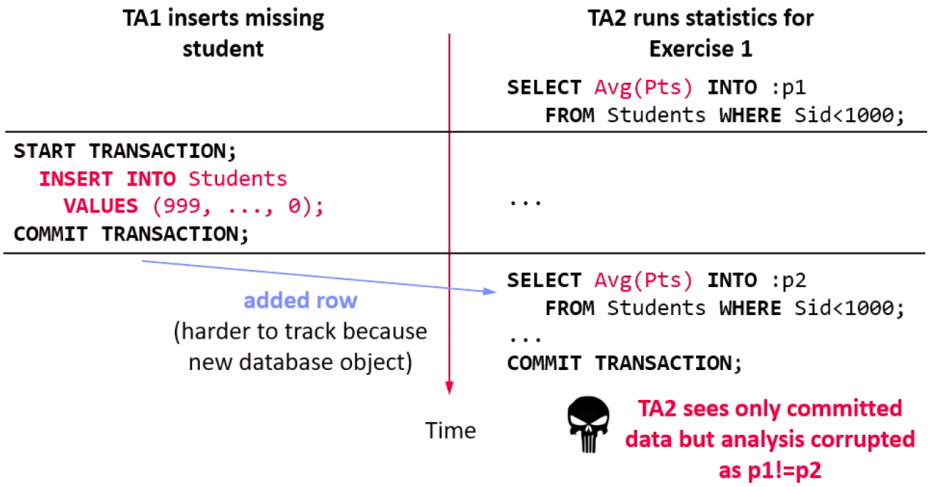
Student received 124 instead of 24 points

- **Problem:** Write-read dependency
- **Solution:** Read only committed changes; otherwise, cascading abort



- **Problem:** Read-write dependency
- **Solution:** TA works on consistent snapshot of touched records

Anomalies – Phantom



- **Similar to non-repeatable read but at set level**
- (snapshot of accessed data objects not sufficient)

Transaction Isolation Level

- guarantees certain anomalies cannot happen
- sacrifices performance
  - **Tradeoff:** isolation (and related guarantees) vs performance
  - READ UNCOMMITTED (~~lost update~~, dirty read, unrepeatable read, phantom R)
  - READ COMMITTED (~~lost update~~, ~~dirty read~~, unrepeatable read, phantom R)
  - REPEATABLE READ (~~lost update~~, ~~dirty read~~, ~~unrepeatable read~~, phantom R)
  - SERIALIZABLE (~~lost update~~, ~~dirty read~~, ~~unrepeatable read~~, ~~phantom R~~)

- **SQL Standard Isolation Levels**

Isolation Level	Lost Update	Dirty Read (P1)	Unrepeatable Read (P2)	Phantom Read (P3)
READ UNCOMMITTED	No*	Yes	Yes	Yes
READ COMMITTED	No*	No	Yes	Yes
REPEATABLE READ	No*	No	No	Yes
[SERIALIZABLE]	No*	No	No	No

  - Serializable w/ highest guarantees (pseudo-serial execution)

* Lost update potentially w/ different semantics in standard

- isolation level can be set by user or system
  - **User:** set default/transaction isolation level (mixed TX workloads possible)
  - **System:** dedicated concurrency control strategies + scheduler
- maximum and default isolation level may vary by DBMS

Database	Default	Maximum
Actian Ingres 10.0/10S [1]	S	S
Aerospike [2]	RC	RC
Akiban Persistit [3]	SI	SI
Clustrix CLX 4100 [4]	RR	RR
Greenplum 4.1 [8]	RC	S
IBM DB2 10 for z/OS [5]	CS	S
IBM Informix 11.50 [9]	Depends	S
MySQL 5.6 [12]	RR	S
MemSQL 1b [10]	RC	RC
MS SQL Server 2012 [11]	RC	S
NuoDB [13]	CR	CR
Oracle 11g [14]	RC	SI
Oracle Berkeley DB [7]	S	S
Oracle Berkeley DB JE [6]	RR	S
Postgres 9.2.2 [15]	RC	S
SAP HANA [16]	RC	SI
ScaleDB 1.02 [17]	RC	RC
VoltDB [18]	S	S

RC: read committed, RR: repeatable read, SI: snapshot isolation, S: serializability, CS: cursor stability, CR: consistent read

Critique of SQL Isolation Level

- **Criticism:** SQL standard isolation levels are ambiguous (strict/broad interpretations)
- Additional anomalies: dirty write, cursor lost update, fuzzy read, read skew, write skew
- Additional isolation levels: **cursor stability** and **snapshot isolation**

Jim Gray, Jim Melton, Eliz
O'Neil, Patrick E. O'Neil: A
of ANSI SQL Isolatior
SIGMO

Snapshot Isolation (< Serializable)

- **Type of optimistic concurrency control** via multi-version concurrency control
- TXs reads data from a snapshot of committed data when TX started
- **TXs never blocked on reads**, other TXs data invisible
- TX **T1 only commits if no other TX wrote the same data items** in the time interval of T1

Current Status?

[http://dbmsmusings.blogspot.com/201
introduction-to-transaction-isolation

- "SQL standard that **fails to accurately define database isolation levels** and database vendors that attach liberal and non-standard semantics"