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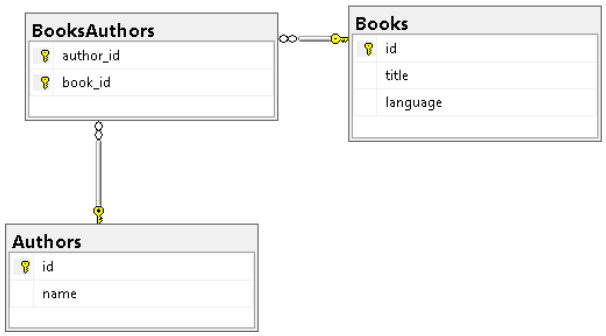
Concurrency problems – a simple example

We consider the database




```
create database DBMS_Lab3_
go
use DBMS_Lab3_
go

CREATE TABLE Books(
id INT PRIMARY KEY IDENTITY,
title varchar(100),
language varchar(100))

CREATE TABLE Authors(
id INT PRIMARY KEY IDENTITY,
name varchar(100))

CREATE TABLE BooksAuthors(
author_id INT FOREIGN KEY REFERENCES Authors(id),
book_id INT FOREIGN KEY REFERENCES Books(id),
CONSTRAINT pk_BooksAuthors PRIMARY KEY (author_id, book_id))
```

In table Books we have

```
-- add records
insert into Books values
('Pride and Prejudice', 'english'),
('Harry Potter and the Chamber of Secrets', 'english'),
('Panda', 'english')

select * from Books
```

Results | Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english

Please, put in each file `use DBMS_Lab3_`

In what follows, we will work with the table Books and
T1=Transaction 1 starts first and finish first (the first column form the table(s))
T2=Transaction start immediately after T1 and finish after T1 (the second column form the table(s))

1. DIRTY READS – T1: update + delay + rollback, T2: select + delay + select -> see the update in the first select, even if it is rollback then (the order in the execution of the operations is: update – select – rollback – select)

Isolation level: Read Uncommitted / Read Committed (solution)

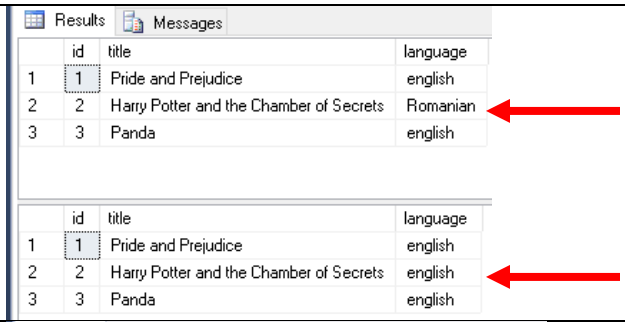
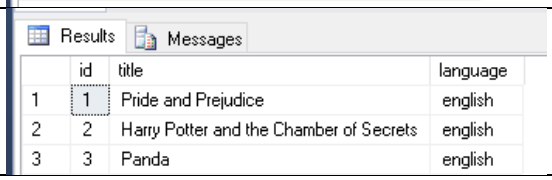
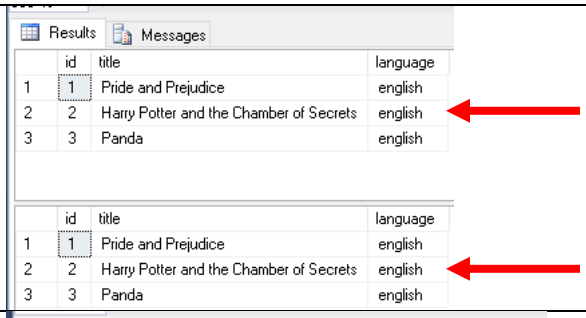
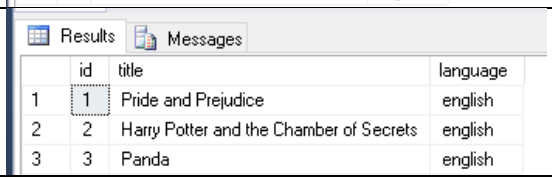
```
-- dirty reads
select * from Books
```

Results | Messages

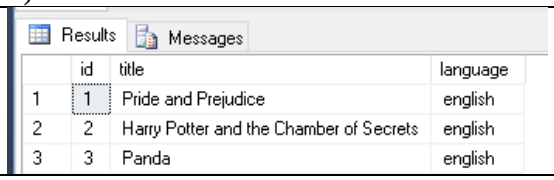
	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english

```
BEGIN TRANSACTION
UPDATE Books SET
language='Romanian' WHERE id = 2
WAITFOR DELAY '00:00:10'
ROLLBACK TRANSACTION
```

```
--PROBLEM: SET TRANSACTION ISOLATION LEVEL READ UNCOMMITTED
SET TRANSACTION ISOLATION LEVEL READ UNCOMMITTED
BEGIN TRAN
SELECT * FROM Books
WAITFOR DELAY '00:00:15'
SELECT * FROM Books
COMMIT TRAN
```

(1 row(s) affected)	
-- dirty reads select * from Books	
BEGIN TRANSACTION UPDATE Books SET language='Romanian' WHERE id = 2 WAITFOR DELAY '00:00:10' ROLLBACK TRANSACTION	-- ***SOLUTION***: SET TRANSACTION ISOLATION LEVEL TO READ COMMITTED SET TRANSACTION ISOLATION LEVEL READ COMMITTED BEGIN TRAN SELECT * FROM Books WAITFOR DELAY '00:00:15' SELECT * FROM Books COMMIT TRAN
(1 row(s) affected)	
-- dirty reads select * from Books	

2. NON-REPEATABLE READS – T1: delay + update + commit, T2: select + delay + select -> see the value inserted before the transaction from the first select of T2 + see the update of the value inserted before the transaction, from the second select of T2 (the order in the execution of the operations is: select – update – select)
Isolation level: Read Committed / Repeatable Read (solution)

-- nonrepeatable reads select * from Books	
INSERT INTO Books(title, language) VALUES ('Peter Pan','Romanian') BEGIN TRAN WAITFOR DELAY '00:00:10' UPDATE Books SET language='English' WHERE title = 'Peter Pan' COMMIT TRAN	--***PROBLEM:*** SET TRANSACTION ISOLATION LEVEL READ UNCOMMITTED SET TRANSACTION ISOLATION LEVEL READ COMMITTED BEGIN TRAN SELECT * FROM Books WAITFOR DELAY '00:00:15' SELECT * FROM Books COMMIT TRAN

<table>
<tr>
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```
(1 row(s) affected) -- from insert

(1 row(s) affected) - from update
```

</td>
<td>

Results Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	4	Peter Pan	Romanian

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	4	Peter Pan	English

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```
-- nonrepeatable reads
select * from Books
delete from Books where title = 'Peter Pan'
select * from Books
```

</td>
<td>

Results Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	4	Peter Pan	English

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english

</td>
</tr>
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```
INSERT INTO Books(title, language) VALUES ('Peter
Pan','Romanian')
BEGIN TRAN
WAITFOR DELAY '00:00:10'
UPDATE Books SET language='English' WHERE title =
'Peter Pan'
COMMIT TRAN
```

</td>
<td>

```
-- SOLUTION: SET TRANSACTION ISOLATION LEVEL TO
REPEATABLE READ
SET TRANSACTION ISOLATION LEVEL REPEATABLE READ
BEGIN TRAN
SELECT * FROM Books
WAITFOR DELAY '00:00:15'
SELECT * FROM Books
COMMIT TRAN
```

</td>
</tr>
<tr>
<td>

```
(1 row(s) affected)

(1 row(s) affected)
```

</td>
<td>

Results Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	Romanian

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	Romanian

</td>
</tr>
<tr>
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```
-- nonrepeatable reads
select * from Books
```

</td>
<td>

Results Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English

</td>
</tr>
</table>

3. PHANTOM READS – T1: delay + insert + commit, T2: select + delay + select -> see the inserted value only at the second select from T2 (the order in the execution of the operations is: select – insert – select)

Isolation level: Repeatable Read / Serializable (solution)

```
-- phantom reads
select * from Books
```

Results | Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English

```
BEGIN TRAN
WAITFOR DELAY '00:00:10'
INSERT INTO Books(title,language) VALUES ('At the end of the world','English')
COMMIT TRAN
```

```
-- PROBLEM: SET TRANSACTION ISOLATION LEVEL TO REPEATABLE READ
SET TRANSACTION ISOLATION LEVEL REPEATABLE READ
BEGIN TRAN
SELECT * FROM Books
WAITFOR DELAY '00:00:15'
SELECT * FROM Books
COMMIT TRAN
```

```
(1 row(s) affected)
```

Results | Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English
5	6	At the end of the world	English

```
-- phantom reads
select * from Books
delete from Books where title='At the end of the world'
select * from Books
```

Results | Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English
5	6	At the end of the world	English

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English

```
BEGIN TRAN
WAITFOR DELAY '00:00:10'
INSERT INTO Books(title,language) VALUES ('At the end of the world','English')
COMMIT TRAN
```

```
-- SOLUTION: SET TRANSACTION ISOLATION LEVEL TO SERIALIZABLE
SET TRANSACTION ISOLATION LEVEL SERIALIZABLE
BEGIN TRAN
SELECT * FROM Books
WAITFOR DELAY '00:00:15'
SELECT * FROM Books
COMMIT TRAN
```

```
(1 row(s) affected)
```

Results Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English

```
-- phantom reads
select * from Books
```

Results Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English
5	7	At the end of the world	English

DEADLOCK - T1: update on table A + delay + update on table B
- T2: update on table B + delay + update on table A

T1- update on table A -> exclusive lock on table A T2 - update on table B -> exclusive lock on table B	delay delay	Try to update table B Try to update table A	Table B is blocked in T2 Table A is blocked in T1	One of the blocked transactions, T1 or T2, will be chosen as a deadlock victim and terminates with an error. The other transaction wins and update both table A and table B

The only solution is to decide which of the 2 transactions to win, by using the DEADLOCK_PRIORITY, that can be set (LOW, NORMAL, HIGH, or from -10 (-5) to 10 (5)). Implicit is NORMAL (0).

The victim transaction is chosen like this:

1. The transaction with the lowest DEADLOCK_PRIORITY
2. If both of the transactions have the same DEADLOCK_PRIORITY, the victim is the one, less expensive at ROLLBACK
3. If both of the transactions have the same DEADLOCK_PRIORITY and the same cost, the victim is chosen randomly

We consider tables: Books and Authors

```
-- deadlock
insert into Books values ('Book for Deadlock', 'english')
insert into Authors values ('Author for Deadlock')
select * from Books
select * from Authors
```

Results Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English
5	7	At the end of the world	English
6	8	Book for Deadlock	english

	id	name
1	1	Author for Deadlock

Deadlock example:

```
-- transaction 1
begin tran
update Books set title='deadlock Books Transaction 1' where id=8
-- this transaction has exclusively lock on table Books
waitfor delay '00:00:10'
update Authors set name='deadlock Authors Transaction 1' where id=1
commit tran
```

```
(1 row(s) affected)

(1 row(s) affected)
```

```
-- transaction 2
begin tran
update Authors set name='deadlock Authors Transaction 2' where id=1
-- this transaction has exclusively lock on table Authors
waitfor delay '00:00:10'
update Books set title='deadlock Books Transaction 2' where id=8
commit tran
```

Messages

```
(1 row(s) affected)
Msg 1205, Level 13, State 51, Line 7
Transaction (Process ID 56) was deadlocked on lock resources with another process and has been chosen as the deadlock victim. Rerun the transaction.
```

```
select * from Books
select * from Authors
```

So, transaction 1 is the winner and update the tables Books and Authors, and transaction 2 is the victim

Results | Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English
5	7	At the end of the world	English
6	8	deadlock Books Transaction 1	english

	id	name
1	1	deadlock Authors Transaction 1

If in transaction 2, we set DEADLOCK_PRIORITY to HIGH, or, if in transaction 1 we set DEADLOCK_PRIORITY to LOW, the winner will be transaction 2 and the victim transaction 1.

```
-- transaction 1
begin tran
update Books set title='deadlock Books Transaction 1' where id=8
-- this transaction has exclusively lock on table Books
waitfor delay '00:00:10'
update Authors set name='deadlock Authors Transaction 1' where id=1
commit tran
```

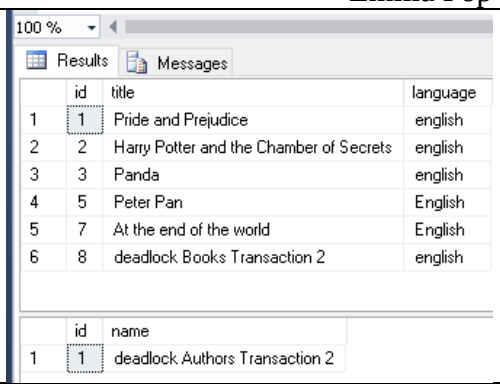
```
(1 row(s) affected)
Msg 1205, Level 13, State 51, Line 7
Transaction (Process ID 54) was deadlocked on lock resources with another process and has been chosen as the deadlock victim. Rerun the transaction.
```

```
-- transaction 2
SET DEADLOCK_PRIORITY HIGH
-- SET DEADLOCK_PRIORITY LOW
begin tran
update Authors set name='deadlock Authors Transaction 2' where id=1
-- this transaction has exclusively lock on table Authors
waitfor delay '00:00:10'
update Books set title='deadlock Books Transaction 2' where id=8
commit tran
```

```
(1 row(s) affected)

(1 row(s) affected)
```

```
select * from Books
select * from Authors
```



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Results | Messages

	id	title	language
1	1	Pride and Prejudice	english
2	2	Harry Potter and the Chamber of Secrets	english
3	3	Panda	english
4	5	Peter Pan	English
5	7	At the end of the world	English
6	8	deadlock Books Transaction 2	english

	id	name
1	1	deadlock Authors Transaction 2