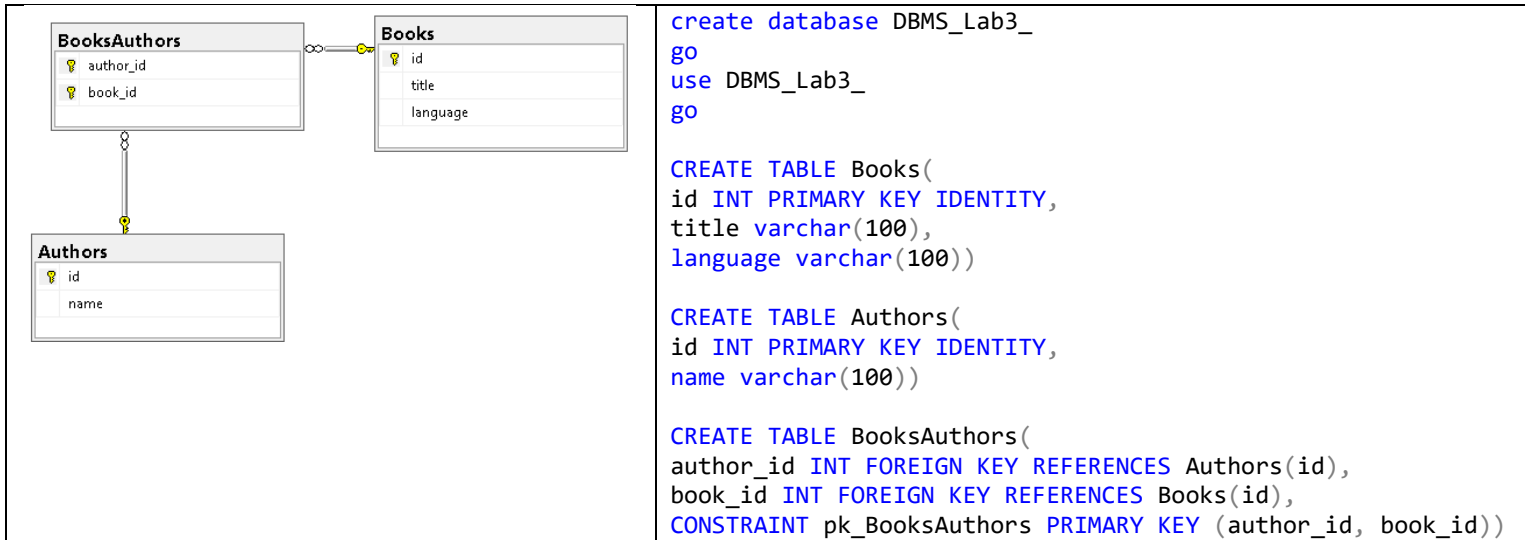


Concurrency problems – a simple example

We consider the database



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
```

	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

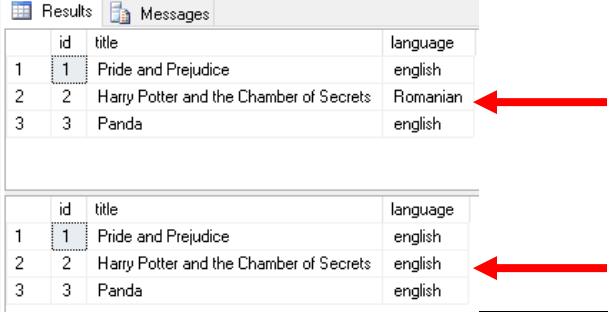
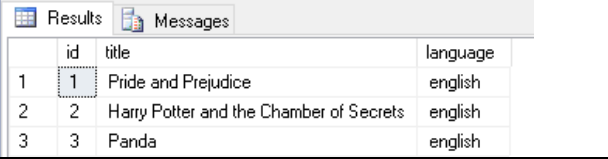
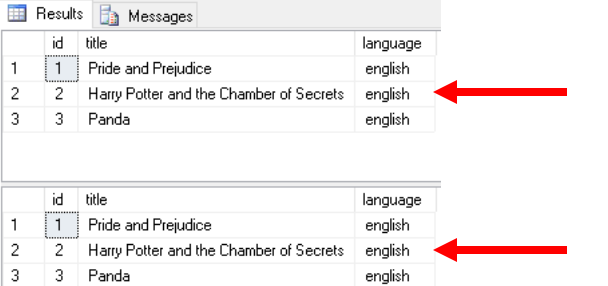
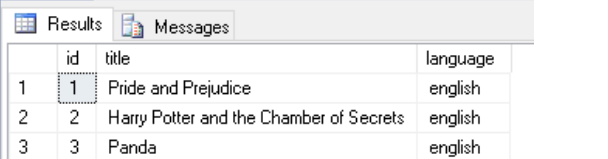
T1=Transaction 1 starts first and finish first (the first column form the table(s))

T2=Transaction start immediately after T1 and finish after T1 (the second column form the table(s))

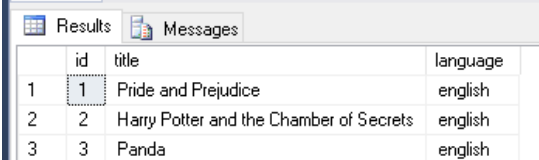
1. **DIRTY READS** – T1: update + delay + rollback, T2: select + delay + select -> see the update in the first select, even if it is rollback then (the order in the execution of the operations is: update – select – rollback – select)

Isolation level: Read Uncommitted / Read Committed (solution)

<pre>-- dirty reads select * from Books</pre>	<div><div>Results</div><table><thead><tr><th></th><th>id</th><th>title</th><th>language</th></tr></thead><tbody><tr><td>1</td><td>1</td><td>Pride and Prejudice</td><td>english</td></tr><tr><td>2</td><td>2</td><td>Harry Potter and the Chamber of Secrets</td><td>english</td></tr><tr><td>3</td><td>3</td><td>Panda</td><td>english</td></tr></tbody></table></div>		id	title	language	1	1	Pride and Prejudice	english	2	2	Harry Potter and the Chamber of Secrets	english	3	3	Panda	english
	id	title	language														
1	1	Pride and Prejudice	english														
2	2	Harry Potter and the Chamber of Secrets	english														
3	3	Panda	english														
<pre>BEGIN TRANSACTION UPDATE Books SET language='Romanian' WHERE id = 2 WAITFOR DELAY '00:00:10' ROLLBACK TRANSACTION</pre>	<pre>--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</pre>																




(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

<pre>(1 row(s) affected) -- from insert</pre> <pre>(1 row(s) affected) - from update</pre>	<div><div>ResultsMessages</div><table><tr><th></th><th>id</th><th>title</th><th>language</th></tr><tr><td>1</td><td>1</td><td>Pride and Prejudice</td><td>english</td></tr><tr><td>2</td><td>2</td><td>Harry Potter and the Chamber of Secrets</td><td>english</td></tr><tr><td>3</td><td>3</td><td>Panda</td><td>english</td></tr><tr><td>4</td><td>4</td><td>Peter Pan</td><td>Romanian</td></tr></table></div> <div><div>ResultsMessages</div><table><tr><th></th><th>id</th><th>title</th><th>language</th></tr><tr><td>1</td><td>1</td><td>Pride and Prejudice</td><td>english</td></tr><tr><td>2</td><td>2</td><td>Harry Potter and the Chamber of Secrets</td><td>english</td></tr><tr><td>3</td><td>3</td><td>Panda</td><td>english</td></tr><tr><td>4</td><td>4</td><td>Peter Pan</td><td>English</td></tr></table></div>		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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<pre>-- nonrepeatable reads</pre> <pre>select * from Books</pre> <pre>delete from Books where title = 'Peter Pan'</pre> <pre>select * from Books</pre>	<div><div>ResultsMessages</div><table><tr><th></th><th>id</th><th>title</th><th>language</th></tr><tr><td>1</td><td>1</td><td>Pride and Prejudice</td><td>english</td></tr><tr><td>2</td><td>2</td><td>Harry Potter and the Chamber of Secrets</td><td>english</td></tr><tr><td>3</td><td>3</td><td>Panda</td><td>english</td></tr><tr><td>4</td><td>4</td><td>Peter Pan</td><td>English</td></tr></table></div> <div><div>ResultsMessages</div><table><tr><th></th><th>id</th><th>title</th><th>language</th></tr><tr><td>1</td><td>1</td><td>Pride and Prejudice</td><td>english</td></tr><tr><td>2</td><td>2</td><td>Harry Potter and the Chamber of Secrets</td><td>english</td></tr><tr><td>3</td><td>3</td><td>Panda</td><td>english</td></tr></table></div>		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				
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<pre>INSERT INTO Books(title, language) VALUES ('Peter Pan', 'Romanian')</pre> <pre>BEGIN TRAN</pre> <pre>WAITFOR DELAY '00:00:10'</pre> <pre>UPDATE Books SET language='English' WHERE title = 'Peter Pan'</pre> <pre>COMMIT TRAN</pre>	<pre>-- SOLUTION: SET TRANSACTION ISOLATION LEVEL TO REPEATABLE READ</pre> <pre>SET TRANSACTION ISOLATION LEVEL REPEATABLE READ</pre> <pre>BEGIN TRAN</pre> <pre>SELECT * FROM Books</pre> <pre>WAITFOR DELAY '00:00:15'</pre> <pre>SELECT * FROM Books</pre> <pre>COMMIT TRAN</pre>																																								
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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)

<pre>-- phantom reads select * from Books</pre>	<div>Results Messages</div> <table><tr><th></th><th>id</th><th>title</th><th>language</th></tr><tr><td>1</td><td>1</td><td>Pride and Prejudice</td><td>english</td></tr><tr><td>2</td><td>2</td><td>Harry Potter and the Chamber of Secrets</td><td>english</td></tr><tr><td>3</td><td>3</td><td>Panda</td><td>english</td></tr><tr><td>4</td><td>5</td><td>Peter Pan</td><td>English</td></tr></table>		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																								
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<pre>BEGIN TRAN WAITFOR DELAY '00:00:10' INSERT INTO Books(title,language) VALUES ('At the end of the world','English') COMMIT TRAN</pre>	<pre>-- 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</pre>																																												
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<pre>-- phantom reads select * from Books delete from Books where title='At the end of the world' select * from Books</pre>	<div>Results Messages</div> <table><tr><th></th><th>id</th><th>title</th><th>language</th></tr><tr><td>1</td><td>1</td><td>Pride and Prejudice</td><td>english</td></tr><tr><td>2</td><td>2</td><td>Harry Potter and the Chamber of Secrets</td><td>english</td></tr><tr><td>3</td><td>3</td><td>Panda</td><td>english</td></tr><tr><td>4</td><td>5</td><td>Peter Pan</td><td>English</td></tr><tr><td>5</td><td>6</td><td>At the end of the world</td><td>English</td></tr></table> <div>Results Messages</div> <table><tr><th></th><th>id</th><th>title</th><th>language</th></tr><tr><td>1</td><td>1</td><td>Pride and Prejudice</td><td>english</td></tr><tr><td>2</td><td>2</td><td>Harry Potter and the Chamber of Secrets</td><td>english</td></tr><tr><td>3</td><td>3</td><td>Panda</td><td>english</td></tr><tr><td>4</td><td>5</td><td>Peter Pan</td><td>English</td></tr></table>		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
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<pre>BEGIN TRAN WAITFOR DELAY '00:00:10' INSERT INTO Books(title,language) VALUES ('At the end of the world','English') COMMIT TRAN</pre>	<pre>-- 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</pre>																																												
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```
-- phantom reads
select * from Books
```

ResultsMessages

	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	delay	Try to update table B	Table B is blocked in T2	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
T2 - update on table B -> exclusive lock on table B	delay	Try to update table A	Table A is blocked in T1	

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
```

ResultsMessages

	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:

<pre>-- 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</pre>		(1 row(s) affected)
<pre>-- transaction 2 begin tran</pre>		(1 row(s) affected)

```

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

id	name
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

```

100 %

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

id	name
1	deadlock Authors Transaction 2