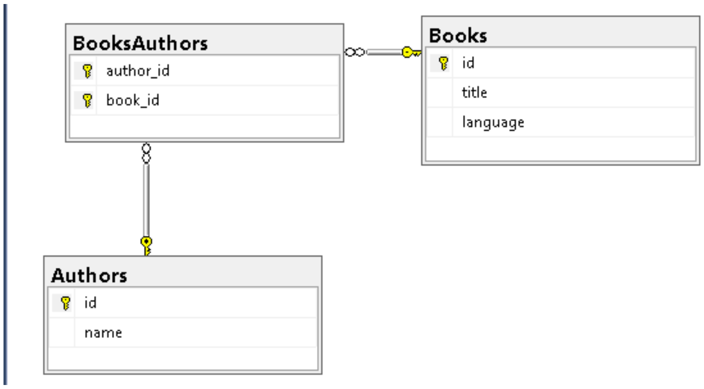
## ***Lab 3***

The first 3 problems have to be solved in SQL SERVER. The last problem will have to be solved in C#.

- Create a stored procedure that inserts data in tables that are in a many to many relation. If any part of the operation fails, it must be all rolled back. (grade: 3)

We consider the database



Create functions for validation: for example - check the language to have some values (for table Books)

```
CREATE FUNCTION uf_ValidateLanguage (@language varchar(100)) RETURNS INT AS
BEGIN
DECLARE @return INT
SET @return = 0
IF(@language  IN ('English','Romanian','French'))
SET @return = 1
RETURN @return
END
```

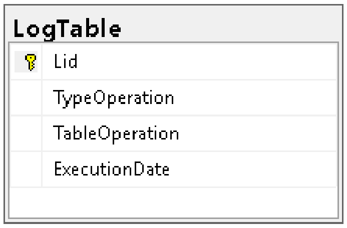
Create the stored procedure with the following restrictions:

- Do not take the Id's as parameters (here id from Authors, id from Books, author_id and book_id from BooksAuthors)
- Take the parameters all the rest of the fields from the tables (here title, language, name)
- Create validation functions for the parameters (all you consider necessary), like:
    - a field apart to a domain of values (language  IN ('English','Romanian','French')))
    - the fields of varchar type to be not null, start with a upper type, ..
    - the fields of int to be positive, …
    - validation functions for telephone numbers, e-mail, …
    - or, whatever do you need
- first we insert values in the tables Authors and Books (the order is not important) and then in BooksAuthors (the intermediate table), by taking the id from both of the tables. We can take the id from one of the tables in a variable or if the field is identity like the maximum value of that field.

- Observations: As a general note, no IDs shall be used as input parameters for your stored procedures and all parameters must be validated (try to use functions when needed). Also, for all your scenarios you must setup a logging system, so you can track the actions during your implemented operations. For error detection it is recommended to use the try-catch clause, both in your windows application as well in your SQL code.

The store procedure must include all the fields from the tables (3 tables) involved, except the id's of these tables (the primary key's, that can be extracted with MAX value introduced, SCOPE_IDENTITY(), …), and these fields must be validated.

For the log system, one can verify with SELECT or save in a log table.

| | |
|---|---|
| SELECT * FROM Authors<br>SELECT * FROM Books<br>SELECT * FROM BooksAuthors<br>EXEC ….<br>SELECT * FROM Authors<br>SELECT * FROM Books<br>SELECT * FROM BooksAuthors | CREATE TABLE LogTable(<br>        Lid INT IDENTITY PRIMARY KEY,<br>        TypeOperation VARCHAR(50),<br>        TableOperation VARCHAR(50),<br>        ExecutionDate DATETIME)<br>Where TypeOperation can be Update, Select, ….<br><br>LogTable<br>Lid<br>TypeOperation<br>TableOperation<br>ExecutionDate |
| Or any other method… | |

Next, we give an example for a stored procedure for table Books.

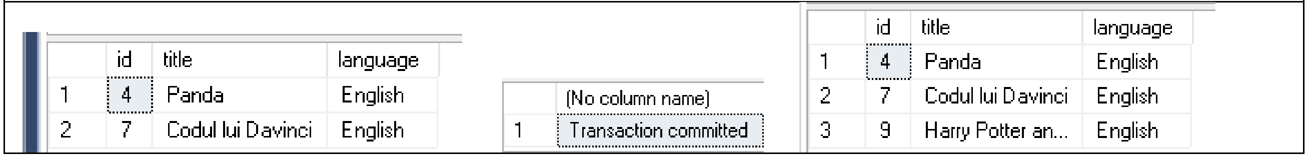
```
CREATE PROCEDURE AddBookAuthor @title varchar(50), @language varchar(50) AS
BEGIN

BEGIN TRAN
BEGIN TRY
IF(dbo.uf_ValidateLanguage(@language)<>1)
BEGIN
        RAISERROR('Language must be Romanian, English or French',14,1)
END
INSERT INTO Books (title, language) VALUES (@title, @language)
COMMIT TRAN
SELECT 'Transaction committed'
END TRY

BEGIN CATCH
ROLLBACK TRAN
SELECT 'Transaction rollbacked'
END CATCH
END
```

- When you present your laboratory you must prepare test cases that cover both the happy and the error flows (this is applicable for the stored procedures). Be prepared to explain in detail your scenarios and your implementations.

You MUST prepare 2 scenarios for the verification of this function: one with commit and one with rollback. The rollback can be obtain from the validation conditions given by the validation functions. You MUST return the history of the operations executed. You can use Select/PRINT messages or use Select * from table_name or any other solution that you consider.
Execution:

- with success (commit)

```
Select * from Books
EXEC AddBookAuthor 'Harry Potter and The Chamber of Secrets','English'
Select * from Books
```



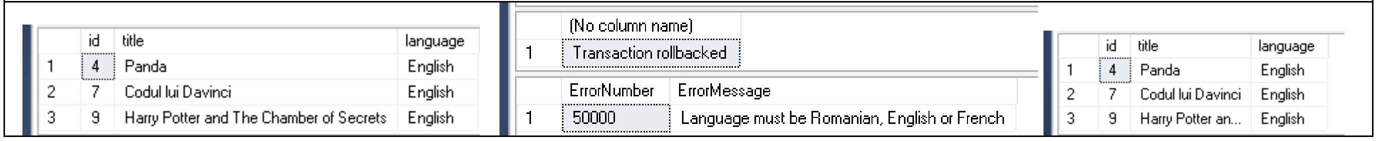
|  | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |

|  | (No column name) |
|---|---|
| 1 | Transaction committed |

|  | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter an... | English |

- without success (rollback)

```
Select * from Books
EXEC AddBookAuthor 'Inferno','Spanish'
Select * from Books
```



|  | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |

|  | (No column name) |
|---|---|
| 1 | Transaction rollbacked |

|  | ErrorNumber | ErrorMessage |
|---|---|---|
| 1 | 50000 | Language must be Romanian, English or French |

|  | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter an... | English |

- Create a stored procedure that inserts data in tables that are in a many to many relation. If any part of the operation fails then it must try to recover as much as possible from the entire operation. For example, if one wants to create a record regarding publishers and books and succeeds creating the publisher but fails with the book, then it should roll back the creation of the book, but not of the publisher. (grade: 5)

Here, the transaction will be split into 3 transactions in the same stored procedure:

- First for the table Authors - with the validation also
- Second for the table Books – with the validation also
- Third for the table BooksAuthors – with the id's taken from both of the previous tables

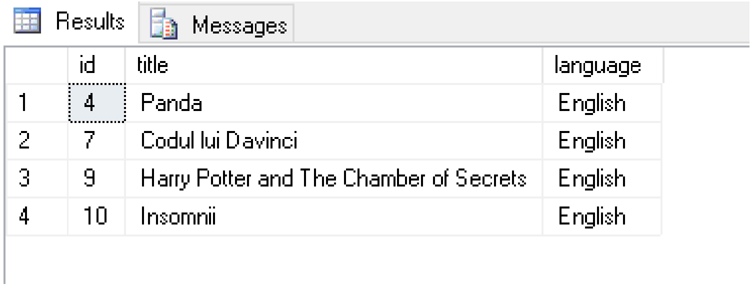
The idea is that one can insert separately in each of the table. If we can add in Books, we add, and in Authors we cannot add, but this won't affect the add from Books. Each table is treat separately and do not affect the add of the others tables.
The execution has to be done for a success case and also for an un-success case.

- Create four scenarios that reproduce the following concurrency issues: dirty reads, non-repeatable reads, phantom reads and a deadlock. You may do this either through stored procedures or through stand alone queries. Also, for each of the scenarios you have created, must also find solutions to solve / workaround the concurrency issues. (grade: 8)

You need to consider a table in which you will analyze the concurrency execution. Here I choose Books. You must prepare scenarios for each case: Transaction 1 with Transaction 2 and Transaction 1 with Transaction 2 'solved'. You have to create and save each of the transactions used. You can use one file for Transaction 1 and for Transaction 2 one file with both of the cases (unsolved and solved- also commented), or 2 files, saved suggestive. Or, you can organize the structure as you prefer, but to be clear. Also, prepare examples for each of the cases.

Try to run the transactions in the same time (or close). Start Transaction 1 first, introduce a delay there, so that Transaction 2 can be executed in that time. Immediately that Transaction 1 was started, start also Transaction 2. (If you run the transactions converse, the result will also be converse).

In table Books we have

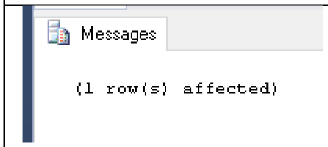
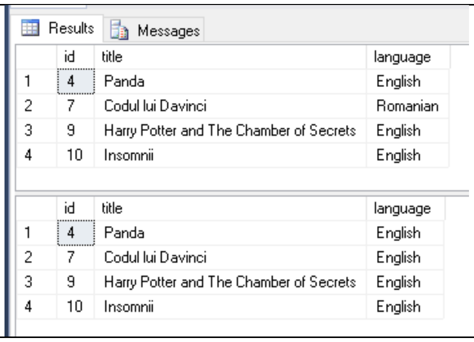


| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |

For what follows: T1=Transaction 1 starts first. T2=Transaction start immediately after T1.

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

Isolation level: Read Uncommitted / Read Committed (solution)

| | |
|---|---|
| --Dirty Reads Part 1<br>BEGIN TRANSACTION<br>UPDATE Books SET language='Romanian'<br>WHERE id = 7<br>WAITFOR DELAY '00:00:10'<br>ROLLBACK TRANSACTION | --Dirty Reads Part 2<br>SET TRANSACTION ISOLATION LEVEL READ UNCOMMITTED<br>BEGIN TRAN<br>SELECT * FROM Books<br>WAITFOR DELAY '00:00:15'<br>SELECT * FROM Books<br>COMMIT TRAN |
|  |  |

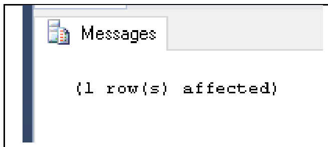
```
(1 row(s) affected)
```

| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | Romanian |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |

| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |

Solution: T1: 1 update + delay + rollback, T2: select + delay + select -> we don't see the update (that is also rollback) – T1 finish first

| | |
|---|---|
| --Dirty Reads Part 1<br>BEGIN TRANSACTION<br>UPDATE Books SET language='Romanian'<br>WHERE id = 7<br>WAITFOR DELAY '00:00:10'<br>ROLLBACK TRANSACTION | --Solution: SET TRANSACTION ISOLATION LEVEL TO READ COMMITTED<br>SET TRANSACTION ISOLATION LEVEL READ COMMITTED<br>BEGIN TRAN<br>SELECT * FROM Books<br>WAITFOR DELAY '00:00:15'<br>SELECT * FROM Books<br>COMMIT TRAN |



```
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```
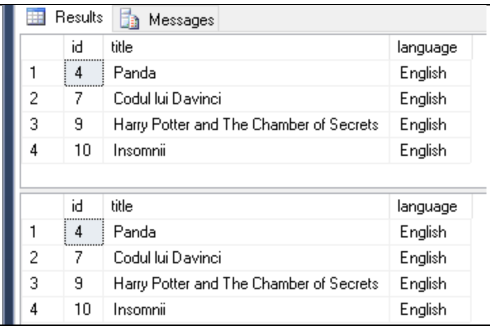



| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |

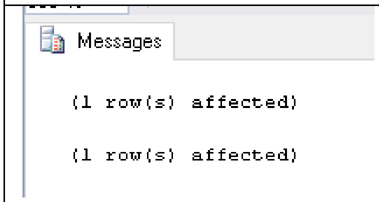
| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |

2. NON-REPEATABLE READS – T1: insert + delay + update + commit, T2: select + delay + select -> see the insert in first select of T2 + update in the second select of T2, T1 finish first

Isolation level: Read Committed / Repeatable Read (solution)

```
INSERT INTO Books(title, language) VALUES ('Sub dom','Spanish')
BEGIN TRAN
WAITFOR DELAY '00:00:05'
UPDATE Books SET language='English' WHERE title = 'Sub dom'
COMMIT TRAN
```

```
SET TRANSACTION ISOLATION LEVEL READ COMMITTED
BEGIN TRAN
SELECT * FROM Books
WAITFOR DELAY '00:00:05'
SELECT * FROM Books
COMMIT TRAN
```



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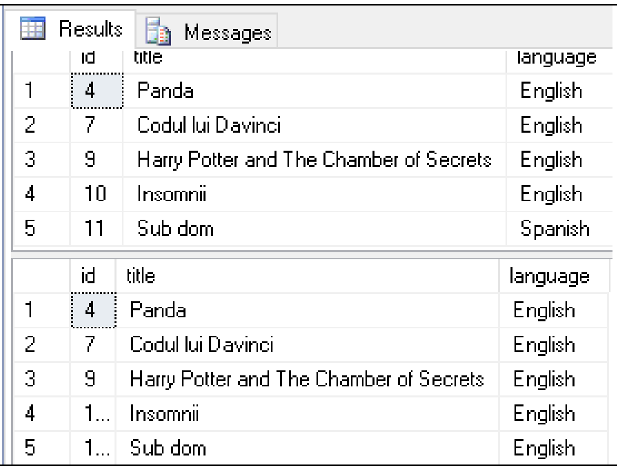



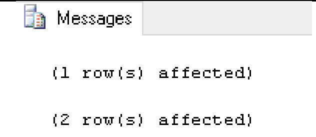
| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |
| 5 | 11 | Sub dom | Spanish |

| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 1... | Insomnii | English |
| 5 | 1... | Sub dom | English |

Solution: T1: insert + delay + update + commit, T2: select + delay + select -> see only the final result in both of the select of T2, T1 finish first

```
INSERT INTO Books(title, language) VALUES ('Sub dom','Spanish')
BEGIN TRAN
WAITFOR DELAY '00:00:05'
UPDATE Books SET language='English' WHERE title = 'Sub dom'
COMMIT TRAN
```

```
SET TRANSACTION ISOLATION LEVEL REPEATABLE READ
BEGIN TRAN
SELECT * FROM Books
WAITFOR DELAY '00:00:05'
SELECT * FROM Books
COMMIT TRAN
```



```
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(2 row(s) affected)
```
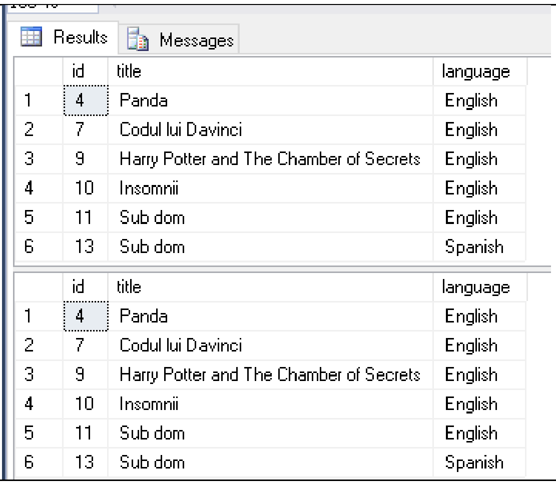



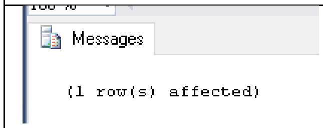
| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |
| 5 | 11 | Sub dom | English |
| 6 | 13 | Sub dom | Spanish |

| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |
| 5 | 11 | Sub dom | English |
| 6 | 13 | Sub dom | Spanish |

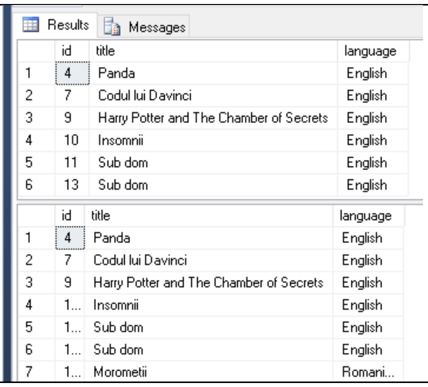
3. PHANTOM READS – T1: delay + insert + commit, T2: select + delay + select -> see the inserted value only at the second select from T2, T1 finish first

Isolation level: Repeatable Read / Serializable (solution)

| --Phantom Reads Part 1<br>--DELETE FROM Books<br>BEGIN TRAN<br>WAITFOR DELAY '00:00:04'<br>INSERT INTO Books(title,language) VALUES ('Morometii','Romanian')<br>COMMIT TRAN | --Phantom Reads Part 2<br>SET TRANSACTION ISOLATION LEVEL REPEATABLE READ<br>BEGIN TRAN<br>SELECT * FROM Books<br>WAITFOR DELAY '00:00:05'<br>SELECT * FROM Books<br>COMMIT TRAN |
|---|---|



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

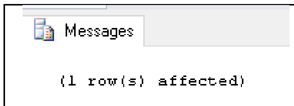


| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |
| 5 | 11 | Sub dom | English |
| 6 | 13 | Sub dom | English |

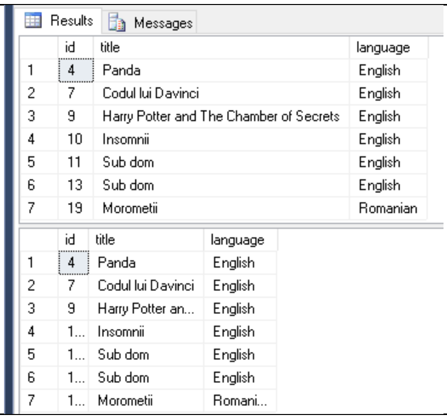
| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 1... | Insomnii | English |
| 5 | 1... | Sub dom | English |
| 6 | 1... | Sub dom | English |
| 7 | 1... | Morometii | Romani... |

Solution: T1: delay + insert + commit, T2: select + delay + select -> see the inserted value in both of the select from T2, T1 finish first

| --Phantom Reads Part 1<br>--DELETE FROM Books<br>BEGIN TRAN<br>WAITFOR DELAY '00:00:04'<br>INSERT INTO Books(title,language) VALUES ('Morometii','Romanian')<br>COMMIT TRAN | --Solution: Set transaction isolation level to SERIALIZABLE<br>SET TRANSACTION ISOLATION LEVEL SERIALIZABLE<br>BEGIN TRAN<br>SELECT * FROM Books<br>WAITFOR DELAY '00:00:05'<br>SELECT * FROM Books<br>COMMIT TRAN |
|---|---|



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



| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |
| 5 | 11 | Sub dom | English |
| 6 | 13 | Sub dom | English |
| 7 | 19 | Morometii | Romanian |

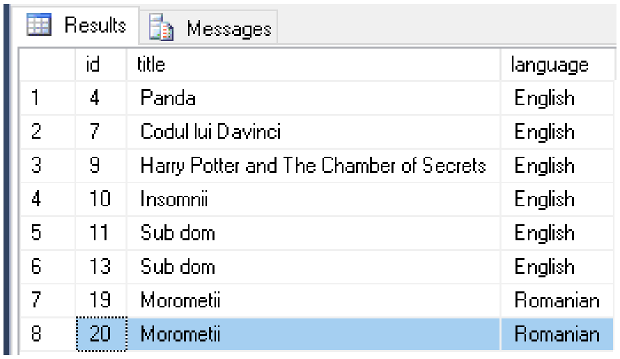
| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter an... | English |
| 4 | 1... | Insomnii | English |
| 5 | 1... | Sub dom | English |
| 6 | 1... | Sub dom | English |
| 7 | 1... | Morometii | Romani... |

4. DEADLOCK – T1: update on table A + delay + update on table B, T2: update on table B + delay + update on table A

We update on table A (from T1 – that exclusively lock on table A), update on table B (from T2 – that exclusively lock on table B), try to update from T1 table B (but this transaction will be blocked because T2 has already been locked on table B), try to update from T2 table A (but this transaction will be blocked because T1 has already been locked on table A). So, both of the transactions are blocked. After some seconds T2 will be chosen as a deadlock victim and terminates with an error. After that, T1 will finish also. In table A and table B will be the values from T1.

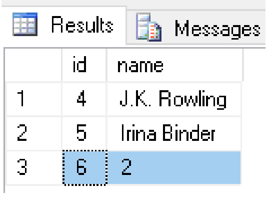
Here we consider 2 tables: Books, Authors.

Books



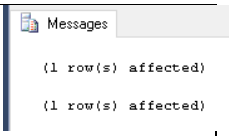
| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |
| 5 | 11 | Sub dom | English |
| 6 | 13 | Sub dom | English |
| 7 | 19 | Morometii | Romanian |
| 8 | 20 | Morometii | Romanian |

Authors



| | id | name |
|---|---|---|
| 1 | 4 | J.K. Rowling |
| 2 | 5 | Irina Binder |
| 3 | 6 | 2 |

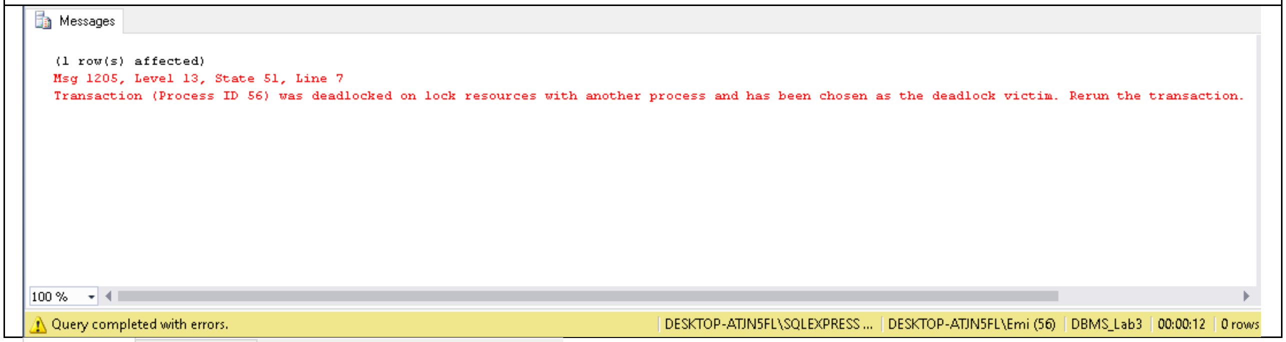
```
-- transaction 1
begin tran
update Books set title='La cirese transaction 1' where id=20
-- this transaction has exclusively lock on table Books
waitfor delay '00:00:10'

update Authors set name='Petre Ispirescu transaction 1' where id=6
-- this transaction will be blocked because transaction 2 has already blocked our lock on table
Authors
-- so, transaction 1 is blocked on an exclusively block on table Authors
commit tran
```



```
(1 row(s) affected)

(1 row(s) affected)
```

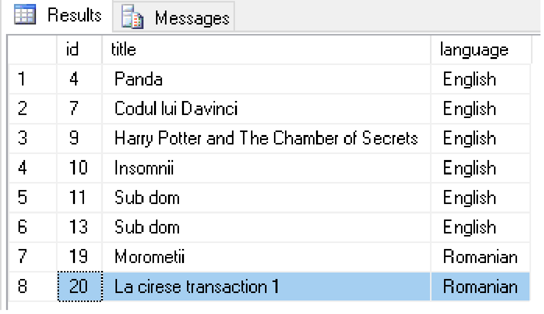
```
-- transaction 2
begin tran
update Authors set name='Petre Ispirescu transaction 2' where id=6
-- this transaction has exclusively lock on table Authors
waitfor delay '00:00:10'
```

```
update Books set title='La cirese transaction 2' where id=20
-- this transaction will be blocked because transaction 1 has already blocked our lock on table Books, so, both of the transactions are blocked
commit tran
-- after some seconds transaction 2 will be chosen as a deadlock victim and terminates with an error
-- in tables Books and Authors will be the values from transaction 1
```

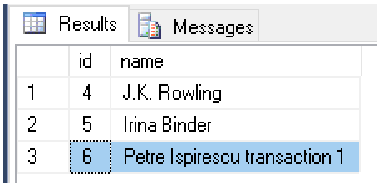


```
(1 row(s) affected)
Msg 1205, Level 13, State 51, Line 7
Transaction (Process ID 56) was deadlocked on lock resources with another process and has been chosen as the deadlock victim. Rerun the transaction.
```

Query completed with errors. | DESKTOP-ATJN5FL\SQLEXPRESS ... | DESKTOP-ATJN5FL\Emi (56) | DBMS_Lab3 | 00:00:12 | 0 rows



| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |
| 5 | 11 | Sub dom | English |
| 6 | 13 | Sub dom | English |
| 7 | 19 | Morometii | Romanian |
| 8 | 20 | La cirese transaction 1 | Romanian |

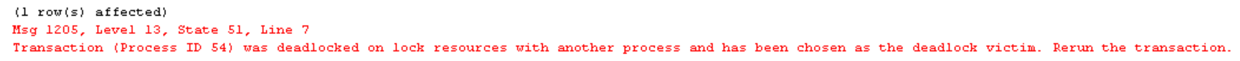


| | id | name |
|---|---|---|
| 1 | 4 | J.K. Rowling |
| 2 | 5 | Irina Binder |
| 3 | 6 | Petre Ispirescu transaction 1 |

Solution: For deadlock, the priority has to be set (LOW, NORMAL, HIGH, or from -10 to 10). Implicit is NORMAL (0).

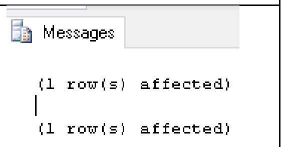
For example, here we set the DEADLOCK_PRIORITY to HIGH for T2, so that T1 be chosen as a deadlock victim (T1 will have a lower priority than T2 and it will finish first).

```
-- transaction 1
begin tran
update Books set title='La cirese transaction 1' where id=20
-- this transaction has exclusively lock on table Books
waitfor delay '00:00:10'

update Authors set name='Petre Ispirescu transaction 1' where id=6
commit tran
-- this transaction is chose as a deadlock, because it has the lowest priority level here (normal)
```



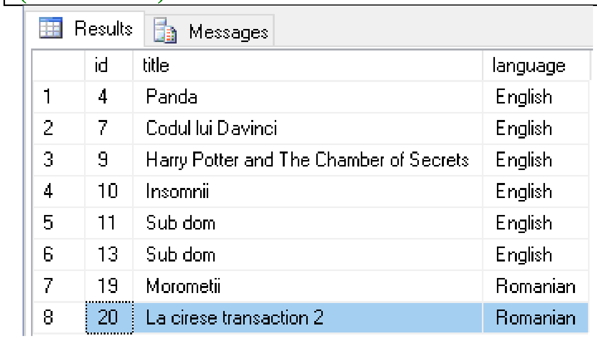
```
(1 row(s) affected)
Msg 1205, Level 13, State 51, Line 7
Transaction (Process ID 54) was deadlocked on lock resources with another process and has been chosen as the deadlock victim. Rerun the transaction.
```

```
-- transaction 2
SET DEADLOCK_PRIORITY HIGH
begin tran
update Authors set name='Petre Ispirescu transaction 2' where id=6
-- this transaction has exclusively lock on table Authors
waitfor delay '00:00:10'

update Books set title='La cirese transaction 2' where id=20
commit tran
-- this transaction has the higher priority level from here (set to HIGH)
-- transaction 1 finish with an error, and ans results are the ones from this transaction
```

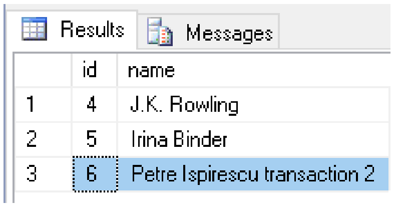


```
(1 row(s) affected)

(1 row(s) affected)
```

| | |
|---|---|
| (transaction 2) | |



| | id | title | language |
|---|---|---|---|
| 1 | 4 | Panda | English |
| 2 | 7 | Codul lui Davinci | English |
| 3 | 9 | Harry Potter and The Chamber of Secrets | English |
| 4 | 10 | Insomnii | English |
| 5 | 11 | Sub dom | English |
| 6 | 13 | Sub dom | English |
| 7 | 19 | Morometii | Romanian |
| 8 | 20 | La cirese transaction 2 | Romanian |



| | id | name |
|---|---|---|
| 1 | 4 | J.K. Rowling |
| 2 | 5 | Irina Binder |
| 3 | 6 | Petre Ispirescu transaction 2 |

- Create a deadlock scenario using a .NET application, with multithreading. It must run two different stored procedures / queries in two different threads. The execution that fails because of the deadlock must be retried. Is up to you to decide the number of retries until the execution is considered to have failed and aborted. (grade: 10)

There are 2 possibilities: create the stored procedures in SQL Server and only use them in C# for 2 threads with locks or create everything in C#.