

Known limitations of triggers

BUILDING AND OPTIMIZING TRIGGERS IN SQL SERVER

SQL

Florin Angelescu
Instructor

Advantages of triggers

- Used for database integrity
- Enforce business rules directly in the database
- Control on which statements are allowed in a database
- Implementation of complex business logic triggered by a single event
- Simple way to audit databases and user actions

Disadvantages of triggers

- Difficult to view and detect
- Invisible to client applications or when debugging code
- Hard to follow their logic when troubleshooting
- Can become an overhead on the server and make it run slower

Finding server-level triggers

```
SELECT * FROM sys.server_triggers;
```

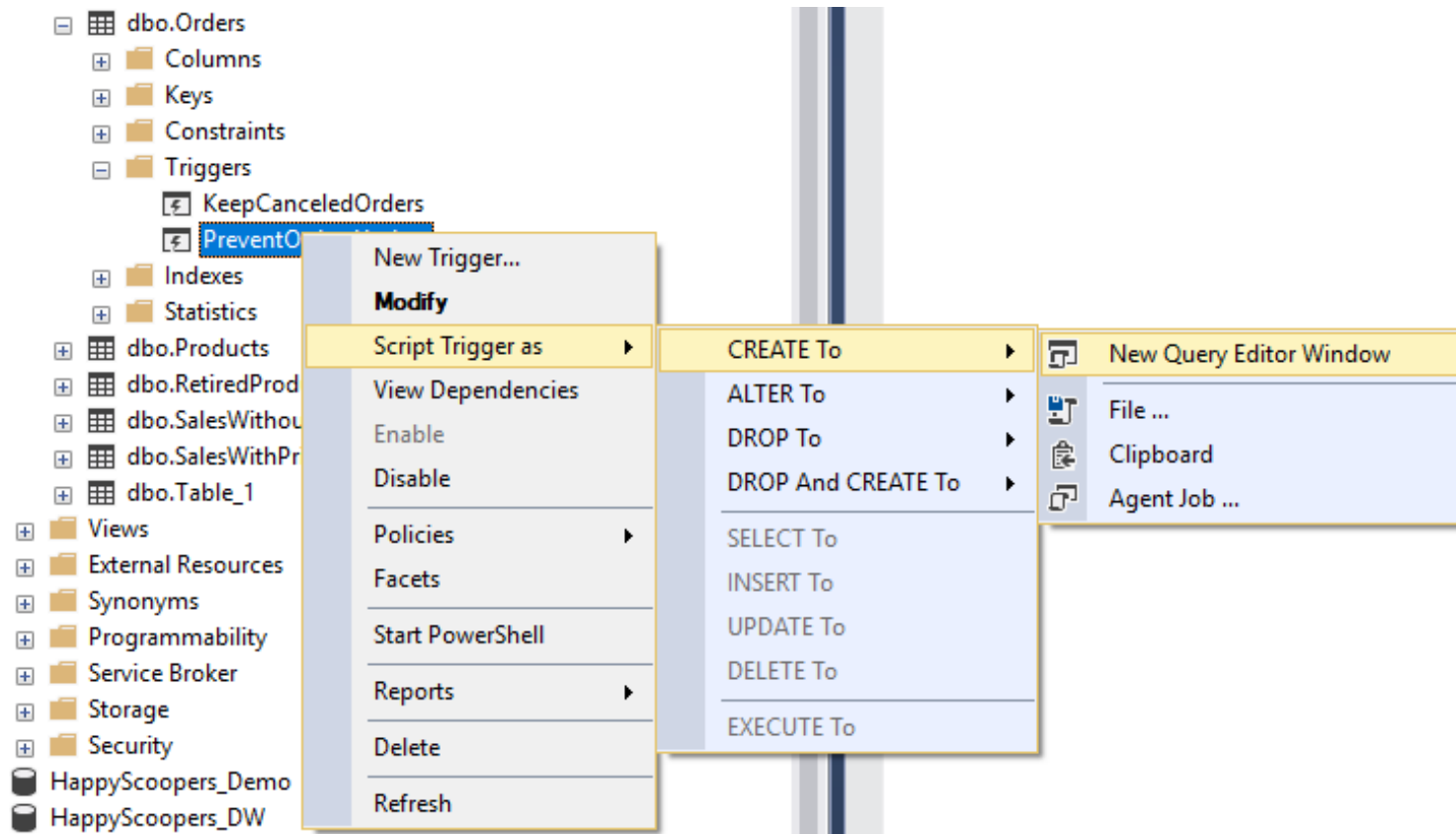
name	parent_class_desc	create_date	is_disabled	...
-----	-----	-----	-----	---
DenyNewDatabases	SERVER	2019-01-22	0	...
DenyNewLinkedServers	SERVER	2019-01-22	1	...
DenyDatabaseDelete	SERVER	2019-01-22	1	...

Finding database and table triggers

```
SELECT * FROM sys.triggers;
```

name	parent_class_desc	create_date	is_disabled	is_instead_of_trigger
TrackRetiredProducts	OBJECT_OR_COLUMN	2019-04-19	0	0
PreventOrdersUpdate	OBJECT_OR_COLUMN	2019-04-22	0	1
TrackDatabaseTables	DATABASE	2019-04-23	0	0
KeepCanceledOrders	OBJECT_OR_COLUMN	2019-04-27	0	0
DiscountsPreventDelete	OBJECT_OR_COLUMN	2019-04-27	0	1
PreventNewDiscounts	OBJECT_OR_COLUMN	2019-04-27	0	1
PreventTableDeletion	DATABASE	2019-04-27	0	0

Viewing a trigger definition (option 1)



```
CREATE TRIGGER PreventOrdersUpdate
ON Orders
INSTEAD OF UPDATE
AS
RAISERROR ('Updates on "Orders" table
are not permitted.
Place a new order
to add new products.', 16, 1);
```

Viewing a trigger definition (option 2)

```
SELECT definition
FROM sys.sql_modules
WHERE object_id = OBJECT_ID ('PreventOrdersUpdate');
```

```
| definition |
|-----|
| CREATE TRIGGER PreventOrdersUpdate |
| ON Orders |
| INSTEAD OF UPDATE |
| AS |
| RAISERROR ('Updates on "Orders" table are not permitted. |
|           Place a new order to add new products.', 16, 1); |
```

Viewing a trigger definition (option 3)

```
SELECT OBJECT_DEFINITION (OBJECT_ID ('PreventOrdersUpdate'));
```

```
| (No column name) |  
|-----|  
| CREATE TRIGGER PreventOrdersUpdate |  
| ON Orders |  
| INSTEAD OF UPDATE |  
| AS |  
| RAISERROR ('Updates on "Orders" table are not permitted. |  
|           Place a new order to add new products.', 16, 1); |
```


Viewing a trigger definition (option 4)

```
EXECUTE sp_helptext @objname = 'PreventOrdersUpdate';
```

```
| Text |
|-----|
| CREATE TRIGGER PreventOrdersUpdate |
| ON Orders |
| INSTEAD OF UPDATE |
| AS |
| RAISERROR ('Updates on "Orders" table are not permitted. |
|           Place a new order to add new products.', 16, 1); |
```

Triggers best practice

Tips:

- well-documented database design
- simple logic in trigger design
- avoid overusing triggers

Let's practice!

BUILDING AND OPTIMIZING TRIGGERS IN SQL SERVER

Use cases for AFTER triggers (DML)

BUILDING AND OPTIMIZING TRIGGERS IN SQL SERVER

SQL

Florin Angelescu
Instructor

Keeping a history of row changes

```
SELECT * FROM Customers;
```

Customer	ContractID	Address	PhoneNo
Every Fruit	ABF138256334	2522 Consectetur St.	1-307-717-2294
eFruits	691C37BC3CED	1908 Fames Street	1-854-241-5573
Healthy Choices	435ADE342265	2826 Mauris Rd.	1-369-765-1647
Health Mag	73F6095C6930	1080 Aliquet. St.	1-634-676-3716
Fruit Mania	5CC27CBC78BA	311 In Avenue	1-790-501-4629

Keeping a history of row changes

```
SELECT * FROM CustomersHistory;
```

Customer	ContractID	Address	PhoneNo	ChangeDate
-----	-----	-----	-----	-----
Every Fruit	ABF138256334	2522 Consectetur St.	1-307-717-2294	2017-05-03
eFruits	691C37BC3CED	1908 Fames Street	1-854-241-5573	2017-10-23
Healthy Choices	435ADE342265	2826 Mauris Rd.	1-369-765-1647	2018-02-10
Health Mag	73F6095C6930	1080 Aliquet. St.	1-634-676-3716	2018-03-03
Fruit Mania	5CC27CBC78BA	311 In Avenue	1-790-501-4629	2018-09-15

Keeping a history of row changes

Customers

Customer	ContractID	Address	PhoneNo
-----	-----	-----	-----
eFruits	691C37BC3CED	1908 Fames Street	1-854-241-6000

CustomersHistory

Customer	ContractID	Address	PhoneNo	ChangeDate
-----	-----	-----	-----	-----
eFruits	691C37BC3CED	1908 Fames Street	1-854-241-5573	2017-10-23
eFruits	691C37BC3CED	1908 Fames Street	1-854-241-6000	2019-05-12

Keeping a history of row changes

```
CREATE TRIGGER CopyCustomersToHistory
ON Customers
AFTER INSERT, UPDATE
AS
    INSERT INTO CustomersHistory (Customer, ContractID, Address, PhoneNo)
    SELECT Customer, ContractID, Address, PhoneNo, GETDATE()
    FROM inserted;
```


Table auditing using triggers

```
CREATE TRIGGER OrdersAudit
ON Orders
AFTER INSERT, UPDATE, DELETE
AS
    DECLARE @Insert BIT = 0, @Delete BIT = 0;
    IF EXISTS (SELECT * FROM inserted) SET @Insert = 1;
    IF EXISTS (SELECT * FROM deleted) SET @Delete = 1;
    INSERT INTO [TablesAudit] ([TableName], [EventType], [UserAccount], [EventDate])
    SELECT 'Orders' AS [TableName]
        ,CASE WHEN @Insert = 1 AND @Delete = 0 THEN 'INSERT'
              WHEN @Insert = 1 AND @Delete = 1 THEN 'UPDATE'
              WHEN @Insert = 0 AND @Delete = 1 THEN 'DELETE'
              END AS [Event]
        ,ORIGINAL_LOGIN()
        ,GETDATE();
```

Notifying users

```
CREATE TRIGGER NewOrderNotification
ON Orders
AFTER INSERT
AS
    EXECUTE SendNotification @RecipientEmail = 'sales@freshfruit.com'
        ,@EmailSubject = 'New order placed'
        ,@EmailBody = 'A new order was just placed.';
```

Let's practice!

BUILDING AND OPTIMIZING TRIGGERS IN SQL SERVER

Use cases for INSTEAD OF triggers (DML)

BUILDING AND OPTIMIZING TRIGGERS IN SQL SERVER

SQL

Florin Angelescu
Instructor

General use of **INSTEAD OF** triggers

- Prevent operations from happening
- Control database statements
- Enforce data integrity

Triggers that prevent changes

```
CREATE TRIGGER PreventProductChanges
```

```
ON Products
```

```
INSTEAD OF UPDATE
```

```
AS
```

```
    RAISERROR ('Updates of products are not permitted.
```

```
                Contact the database administrator if a change is needed.', 16, 1);
```

Triggers that prevent and notify

```
CREATE TRIGGER PreventCustomersRemoval
ON Customers
INSTEAD OF DELETE
AS
    DECLARE @EmailBodyText NVARCHAR(50) =
        (SELECT 'User "' + ORIGINAL_LOGIN() +
            '" tried to remove a customer from the database.');
```

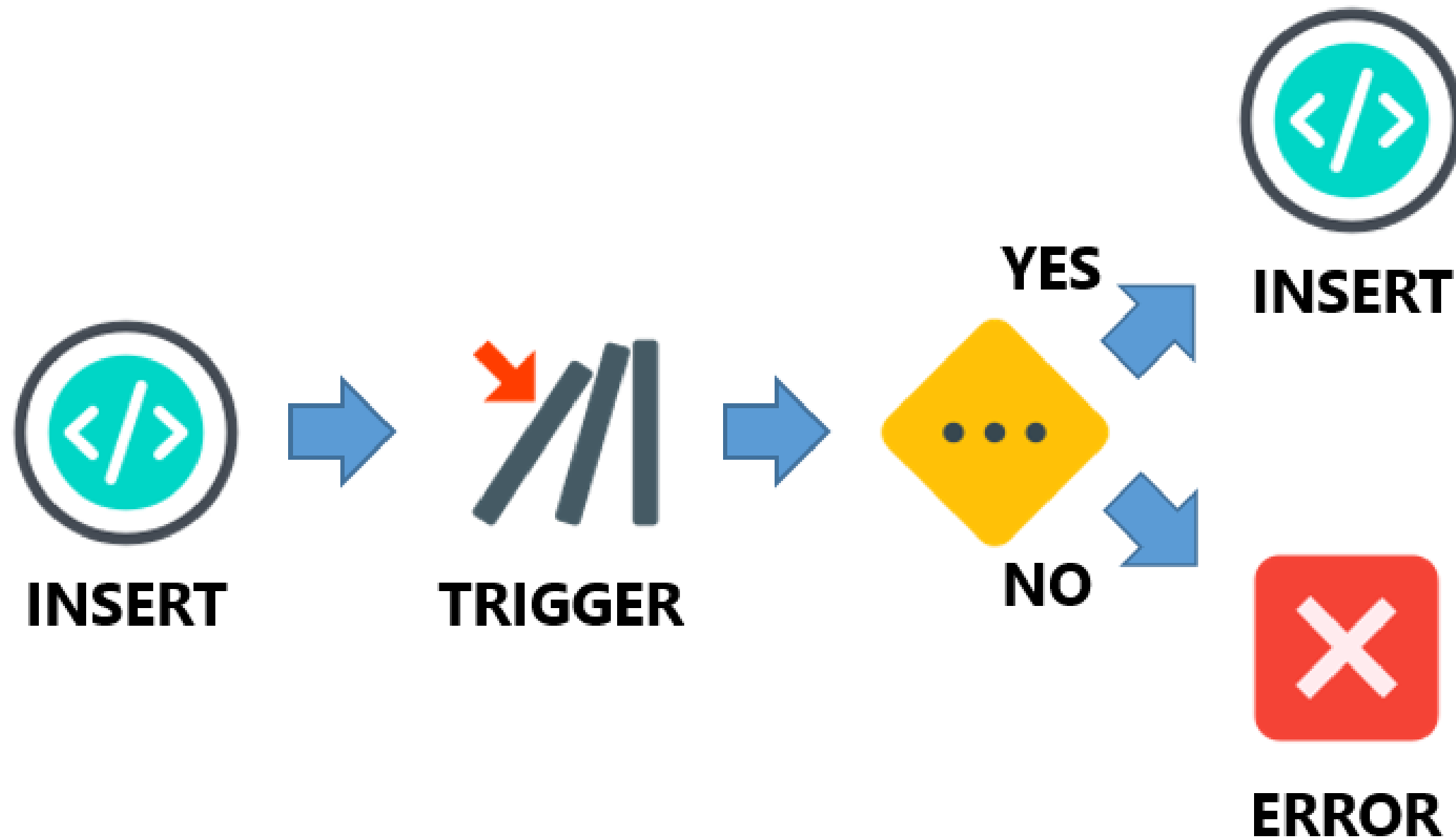
```
RAISERROR ('Customer entries are not subject to removal.', 16, 1);
```

```
EXECUTE SendNotification @RecipientEmail = 'admin@freshfruit.com'
                        ,@EmailSubject = 'Suspicious database behavior'
                        ,@EmailBody = @EmailBodyText;
```

Triggers with conditional logic

```
CREATE TRIGGER ConfirmStock
ON Orders
INSTEAD OF INSERT
AS
    IF EXISTS (SELECT * FROM Products AS p
               INNER JOIN inserted AS i ON i.Product = p.Product
               WHERE p.Quantity < i.Quantity)
        RAISERROR ('You cannot place orders when there is no product stock.', 16, 1);
    ELSE
        INSERT INTO dbo.Orders (Customer, Product, Quantity, OrderDate, TotalAmount)
        SELECT Customer, Product, Quantity, OrderDate, TotalAmount FROM inserted;
```


Triggers with conditional logic



Let's practice!

BUILDING AND OPTIMIZING TRIGGERS IN SQL SERVER

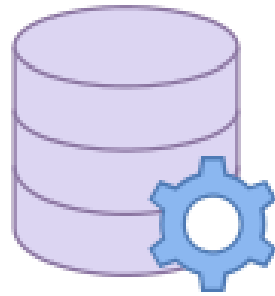
Use cases for DDL triggers

BUILDING AND OPTIMIZING TRIGGERS IN SQL SERVER

SQL

Florin Angelescu
Instructor

DDL trigger capabilities



Database level

`CREATE_TABLE, ALTER_TABLE, DROP_TABLE`

`CREATE_VIEW, ALTER_VIEW, DROP_VIEW`

`CREATE_INDEX, ALTER_INDEX, DROP_INDEX`

`ADD_ROLE_MEMBER, DROP_ROLE_MEMBER`

`CREATE_STATISTICS, DROP_STATISTICS`



Server level

`CREATE_DATABASE, ALTER_DATABASE,`
`DROP_DATABASE`

`GRANT_SERVER, DENY_SERVER,` `REVOKE_SERVER`

`CREATE_CREDENTIAL, ALTER_CREDENTIAL,`
`DROP_CREDENTIAL`

Database auditing

```
CREATE TRIGGER DatabaseAudit
ON DATABASE
FOR DDL_TABLE_VIEW_EVENTS
AS

INSERT INTO [DatabaseAudit] ([EventType], [Database], [Object],
                             [UserAccount], [Query], [EventTime])

SELECT
    EVENTDATA().value('(/EVENT_INSTANCE/EventType)[1]', 'NVARCHAR(50)'),
    EVENTDATA().value('(/EVENT_INSTANCE/DatabaseName)[1]', 'NVARCHAR(50)'),
    EVENTDATA().value('(/EVENT_INSTANCE/ObjectName)[1]', 'NVARCHAR(100)'),
    EVENTDATA().value('(/EVENT_INSTANCE/LoginName)[1]', 'NVARCHAR(100)'),
    EVENTDATA().value('(/EVENT_INSTANCE/TSQLCommand/CommandText)[1]', 'NVARCHAR(MAX)'),
    EVENTDATA().value('(/EVENT_INSTANCE/PostTime)[1]', 'DATETIME');
```

Database auditing

EventType	Database	Object	UserAccount	Query	EventTime
CREATE_TABLE	FreshFruit	Sales	XXX	CREATE TABLE [Sales]...	2019-05-13
CREATE_TABLE	FreshFruit	Employees	XXX	CREATE TABLE [Employ...	2019-05-13

Preventing server changes

```
CREATE TRIGGER PreventDatabaseDelete
ON ALL SERVER
FOR DROP_DATABASE
AS
    PRINT 'You are not allowed to remove existing databases.';
ROLLBACK;
```

Let's practice!

BUILDING AND OPTIMIZING TRIGGERS IN SQL SERVER