Known limitations of triggers

BUILDING AND OPTIMIZING TRIGGERS IN SQL SERVER

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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;
```

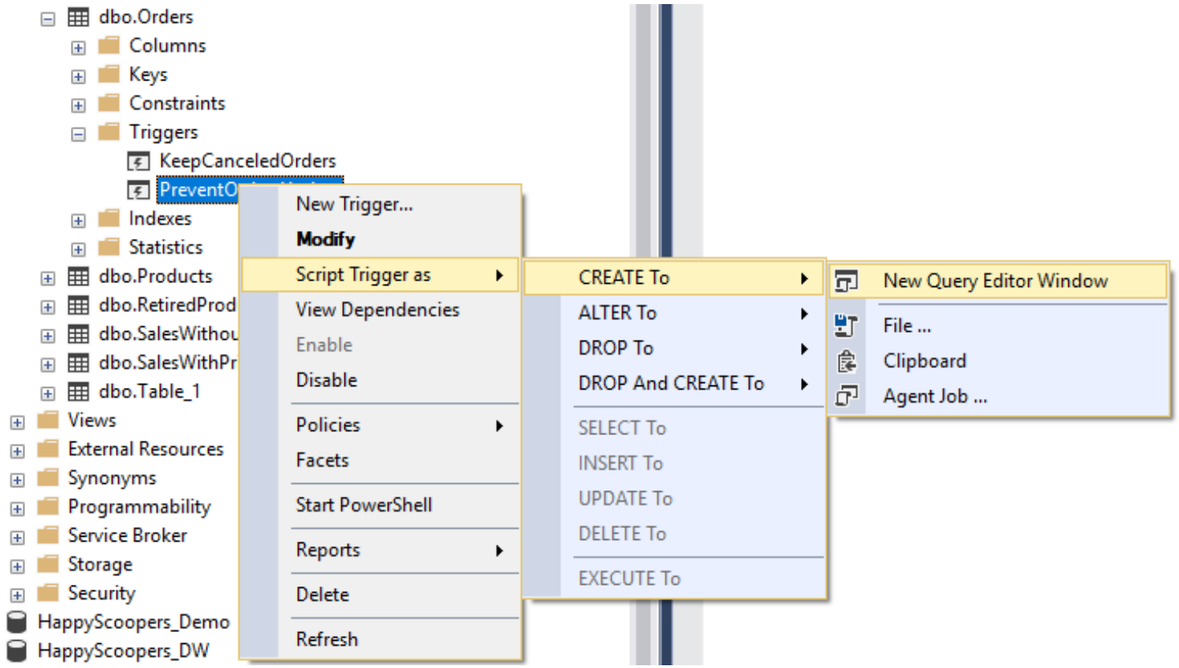
```
| name                  | parent_class_desc | create_date | is_disabled |...|
|-----------------------|-------------------|-------------|-------------|---|
| DenyNewDatabases      | SERVER            | 2019-01-22  | 0           |...|
| DenyNewLinkedServers  | SERVER            | 2019-01-22  | 1           |...|
| 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!

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Use cases for AFTER triggers (DML)

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Keeping a history of row changes

```
SELECT * FROM Customers;
```

```
| Customer         | ContractID   | Address                  | PhoneNo         |
|------------------|--------------|--------------------------|-----------------|
| Every Fruit      | ABF138256334 | 2522 Consectetuer 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 Consectetuer 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!

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Use cases for INSTEAD OF triggers (DML)

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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);
```

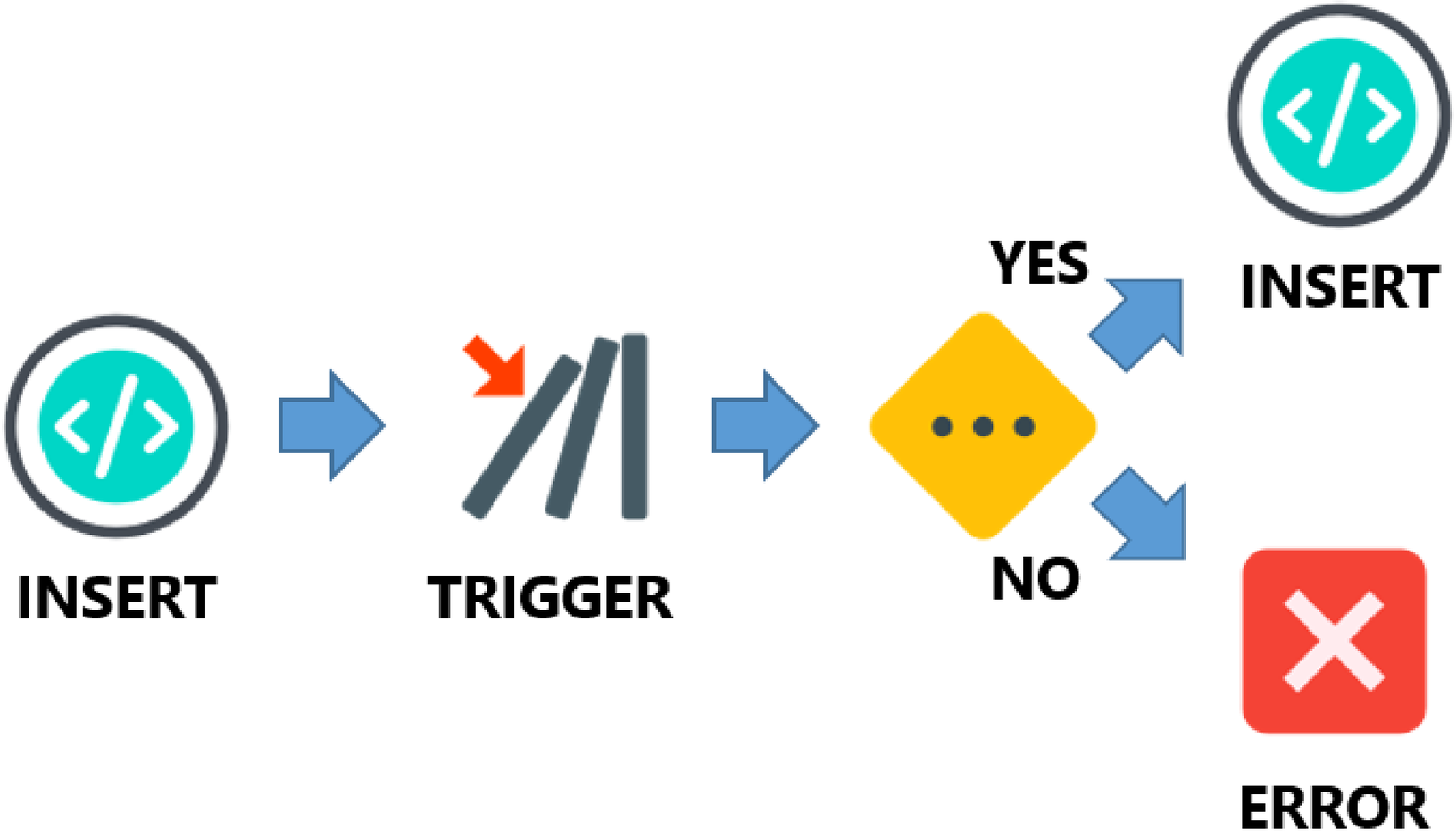
Triggers that prevent and notify

```
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!

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Use cases for DDL triggers

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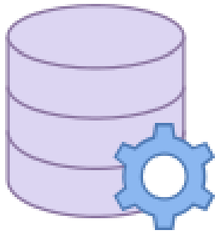
DDL trigger capabilities



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!

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