# Module 11: Implementing Triggers

## Overview

- Introduction
- Defining
  - Create, drop, alter triggers
- How Triggers Work
- Examples
- Performance Considerations
  - Analyze performance issues related to triggers

## Introduction to Triggers

- What Is a Trigger?
- Uses
- Considerations for Using Triggers

## What Is a Trigger?

- **Associated with a Table**
- **Invoked Automatically**
- **Cannot Be Called Directly**
- **Is Part of a Transaction**
  - Along with the statement that calls the trigger
  - Can ROLLBACK transactions (use with care)

## Uses of Triggers

- **Cascade Changes Through Related Tables in a Database**
  - A delete or update trigger can cascade changes to related tables: Soda name change to change in soda name in Sells table
- **Enforce More Complex Data Integrity Than a CHECK Constraint**
  - Change prices in case of price rip-offs.
- **Define Custom Error Messages**
- **Maintain Denormalized Data**
  - Automatically update redundant data.
- **Compare Before and After States of Data Under Modification**

## Considerations for Using Triggers

- Triggers Are Reactive; Constraints Are Proactive
- Constraints Are Checked First
- Tables Can Have Multiple Triggers for Any Action
- Table Owners Can Designate the First and Last Trigger to Fire
- You Must Have Permission to Perform All Statements That Define Triggers
- Table Owners Cannot Create AFTER Triggers on Views or Temporary Tables

## Defining Triggers

- Creating Triggers
- Altering and Dropping Triggers

## Creating Triggers

- Requires Appropriate Permissions
- Cannot Contain Certain Statements

```
Use Northwind
GO
CREATE TRIGGER Empl_Delete ON Employees
FOR DELETE
AS
IF (SELECT COUNT(*) FROM Deleted) > 1
BEGIN
   RAISERROR(
     'You cannot delete more than one employee at a time.', 16, 1)
   ROLLBACK TRANSACTION
END
```

# Altering and Dropping Triggers

- Altering a Trigger
  - Changes the definition without dropping the trigger
  - Can disable or enable a trigger

```
USE Northwind
GO
ALTER TRIGGER Empl_Delete ON Employees
FOR DELETE
AS
IF (SELECT COUNT(*) FROM Deleted) > 6
BEGIN
   RAISERROR(
     'You cannot delete more than six employees at a time.', 16, 1)
   ROLLBACK TRANSACTION
END
```

- Dropping a Trigger

## How Triggers Work

- How an INSERT Trigger Works
- How a DELETE Trigger Works
- How an UPDATE Trigger Works
- How an INSTEAD OF Trigger Works
- How Nested Triggers Work
- Recursive Triggers

## How an INSERT Trigger Works

1. INSERT Statement to a Table with an INSERT Trigger Defined
2. INSERT Statement Logged
3. Trigger Actions Executed

## How a DELETE Trigger Works

1. DELETE Statement to a Table with a DELETE Statement Defined
2. DELETE Statement Logged
3. Trigger Actions Executed

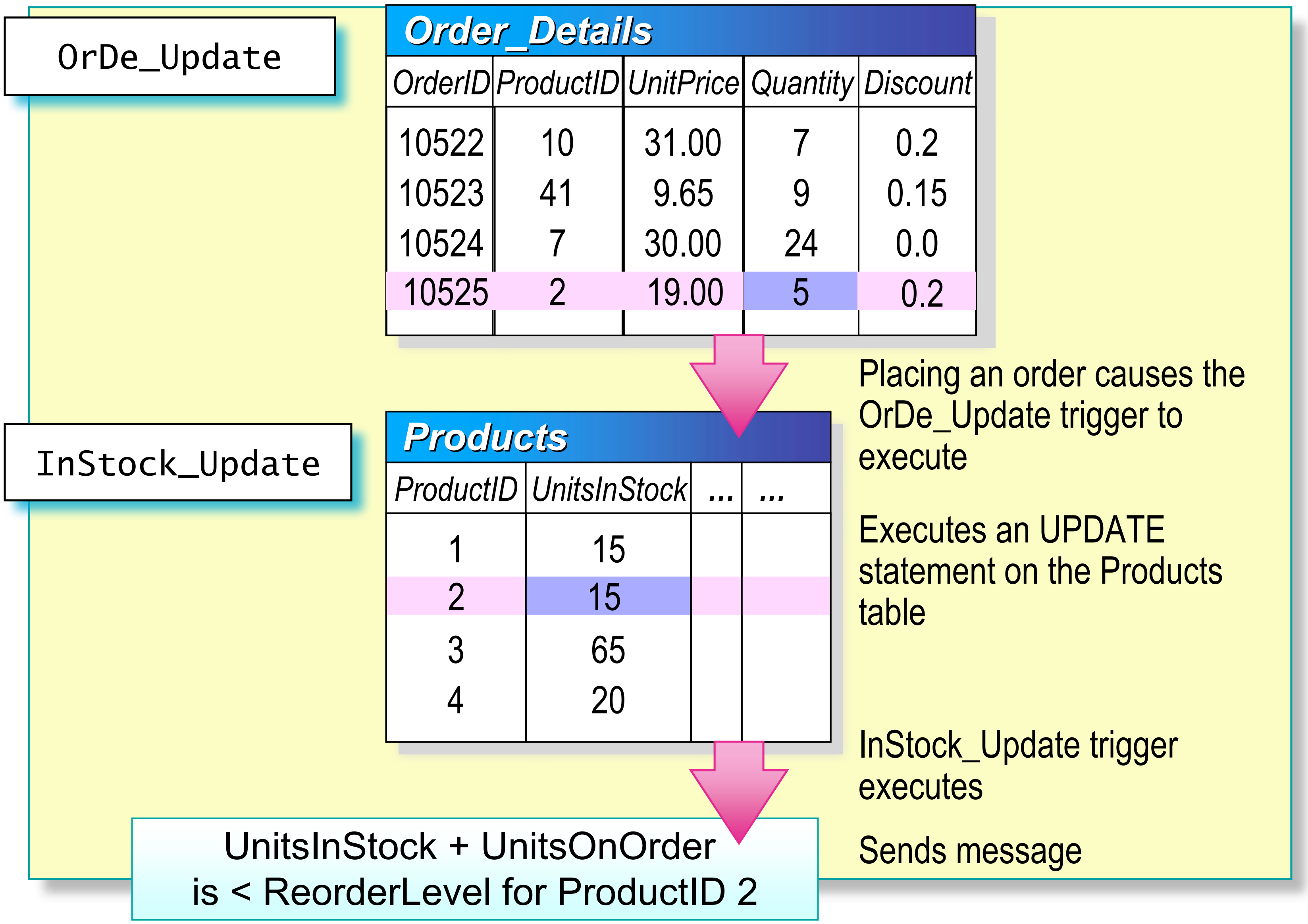
## How an UPDATE Trigger Works

1. UPDATE Statement to a Table with an UPDATE Trigger Defined
2. UPDATE Statement Logged as INSERT and DELETE Statements
3. Trigger Actions Executed

## How an INSTEAD OF Trigger Works

1. INSTEAD OF Trigger Can Be on a Table or View
2. The Action That Initiates the Trigger Does NOT Occur
3. Allows Updates to Views Not Previously Updateable

## How Nested Triggers Work



**Order_Details**

| OrderID | ProductID | UnitPrice | Quantity | Discount |
|---|---|---|---|---|
| 10522 | 10 | 31.00 | 7 | 0.2 |
| 10523 | 41 | 9.65 | 9 | 0.15 |
| 10524 | 7 | 30.00 | 24 | 0.0 |
| 10525 | 2 | 19.00 | 5 | 0.2 |

**Products**

| ProductID | UnitsInStock | … | … |
|---|---|---|---|
| 1 | 15 | | |
| 2 | 15 | | |
| 3 | 65 | | |
| 4 | 20 | | |

UnitsInStock + UnitsOnOrder
is < ReorderLevel for ProductID 2

Placing an order causes the OrDe_Update trigger to execute

Executes an UPDATE statement on the Products table

InStock_Update trigger executes

Sends message

## Recursive Triggers

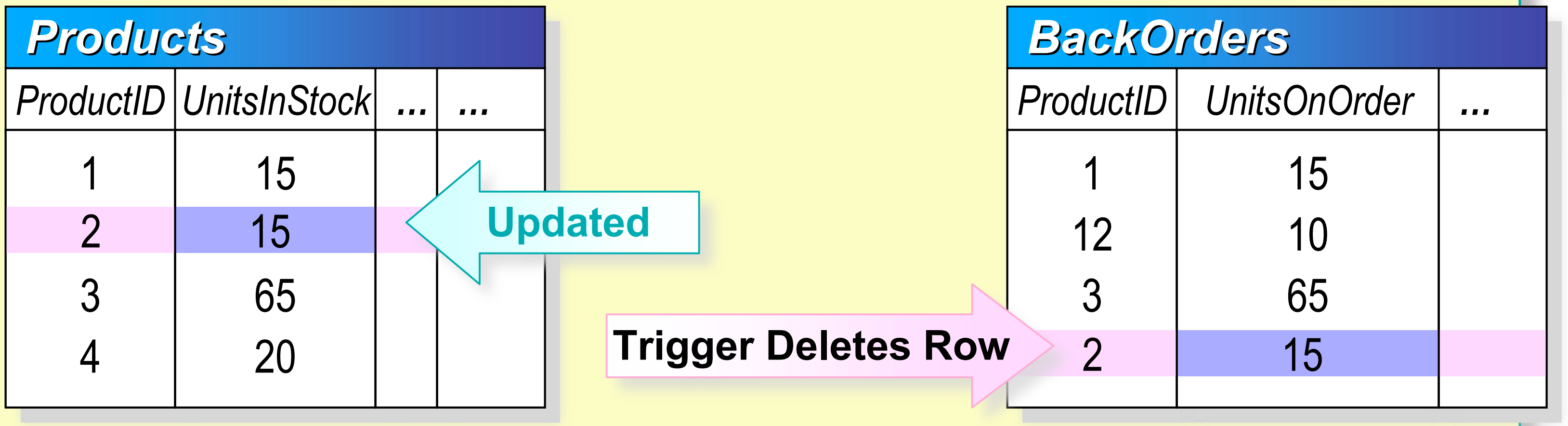
- **Activating a Trigger Recursively**
- **Types of Recursive Triggers**
  - *Direct recursion* occurs when a trigger fires and performs an action that causes the same trigger to fire again
  - *Indirect recursion* occurs when a trigger fires and performs an action that causes a trigger on another table to fire
- **Determining Whether to Use Recursive Triggers**

## Examples of Triggers

- Enforcing Data Integrity
- Enforcing Business Rules

# Enforcing Data Integrity

```
CREATE TRIGGER BackOrderList_Delete
    ON Products FOR UPDATE
AS
IF (SELECT BO.ProductID FROM BackOrders AS BO JOIN
    Inserted AS I ON BO.ProductID = I.Product_ID
    ) > 0
BEGIN
    DELETE BO FROM BackOrders AS BO
    INNER JOIN Inserted AS I
    ON BO.ProductID = I.ProductID
END
```



**Products**

| ProductID | UnitsInStock | ... | ... |
|---|---|---|---|
| 1 | 15 | | |
| 2 | 15 | | |
| 3 | 65 | | |
| 4 | 20 | | |

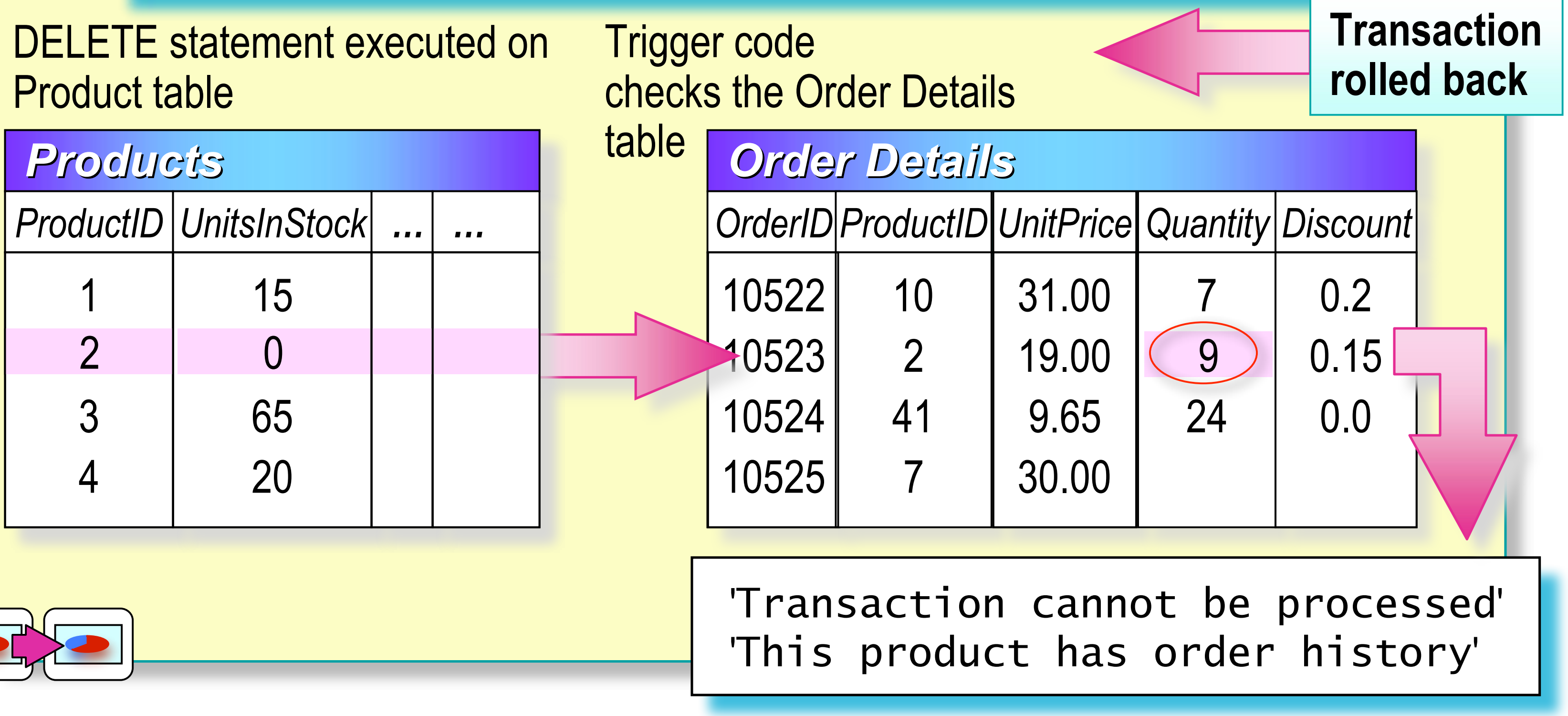
**BackOrders**

| ProductID | UnitsOnOrder | ... |
|---|---|---|
| 1 | 15 | |
| 12 | 10 | |
| 3 | 65 | |
| 2 | 15 | |

# Enforcing Business Rules

## Products with Outstanding Orders Cannot Be Deleted

```
IF (Select Count (*)
  FROM [Order Details] INNER JOIN deleted
  ON [Order Details].ProductID = deleted.ProductID
   ) > 0
ROLLBACK TRANSACTION
```



DELETE statement executed on Product table

**Products**

| ProductID | UnitsInStock | ... | ... |
|---|---|---|---|
| 1 | 15 | | |
| 2 | 0 | | |
| 3 | 65 | | |
| 4 | 20 | | |

Trigger code checks the Order Details table

**Transaction rolled back**

**Order Details**

| OrderID | ProductID | UnitPrice | Quantity | Discount |
|---|---|---|---|---|
| 10522 | 10 | 31.00 | 7 | 0.2 |
| 10523 | 2 | 19.00 | 9 | 0.15 |
| 10524 | 41 | 9.65 | 24 | 0.0 |
| 10525 | 7 | 30.00 | | |

```
'Transaction cannot be processed'
'This product has order history'
```

## Performance Considerations

- Triggers Work Quickly Because the Inserted and Deleted Tables Are in Cache
- Execution Time Is Determined by:
  - Number of tables that are referenced
  - Number of rows that are affected
- Actions Contained in Triggers Implicitly Are Part of a Transaction

## Recommended Practices

- ✓ Use Triggers Only When Necessary
- ✓ Keep Trigger Definition Statements as Simple as Possible
- ✓ Include Recursion Termination Check Statements in Recursive Trigger Definitions
- ✓ Minimize Use of ROLLBACK Statements in Triggers

## Review

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