Chapter 8: Advanced SQL

Modern Database Management

8th Edition

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Objectives

- Definition of terms
- Write multiple table SQL queries
- Define and use three types of joins
- Write correlated and noncorrelated subqueries
- Establish referential integrity in SQL
- Understand triggers and stored procedures
- Discuss SQL:1999 standard and its extension of SQL-92

Processing Multiple Tables

- The power of RDBMS is realized when working with multiple tables
- Two tables can be joined when each contains a column that shares a common domain
- The result of a join operation is a single table
- Selected columns from all tables are included
- Each row returned contains data from rows of input tables where values for the common columns match
- Rule of thumb: there should be one condition within the WHERE clause for each pair of tables being joined
- One condition for joining 2 tables, two conditions for joining 3 tables, and so forth.
- Two approaches are used for processing multiple tables:

Join & Subquery

Processing Multiple Tables–Joins

- **Join** – a relational operation that causes two or more tables with a common domain to be combined into a single table or view
- **Equi-join** – a join in which the joining condition is based on equality between values in the common columns; ***common columns appear redundantly in the result table***
- **Natural join** – an equi-join in which one of the duplicate columns is eliminated in the result table (no duplications of common column)
- **Outer join** – a join in which rows that do not have matching values in common columns are nonetheless included in the result table (as opposed to *inner* join, in which rows must have matching values in order to appear in the result table)
- **Union join** – includes all columns from each table in the join, and an instance for each row of each table

The **common columns** in **joined** tables are usually the **primary key** of the **dominant table** and the **foreign key** of the **dependent table** in 1:M relationships

The following slides create tables for this enterprise data model

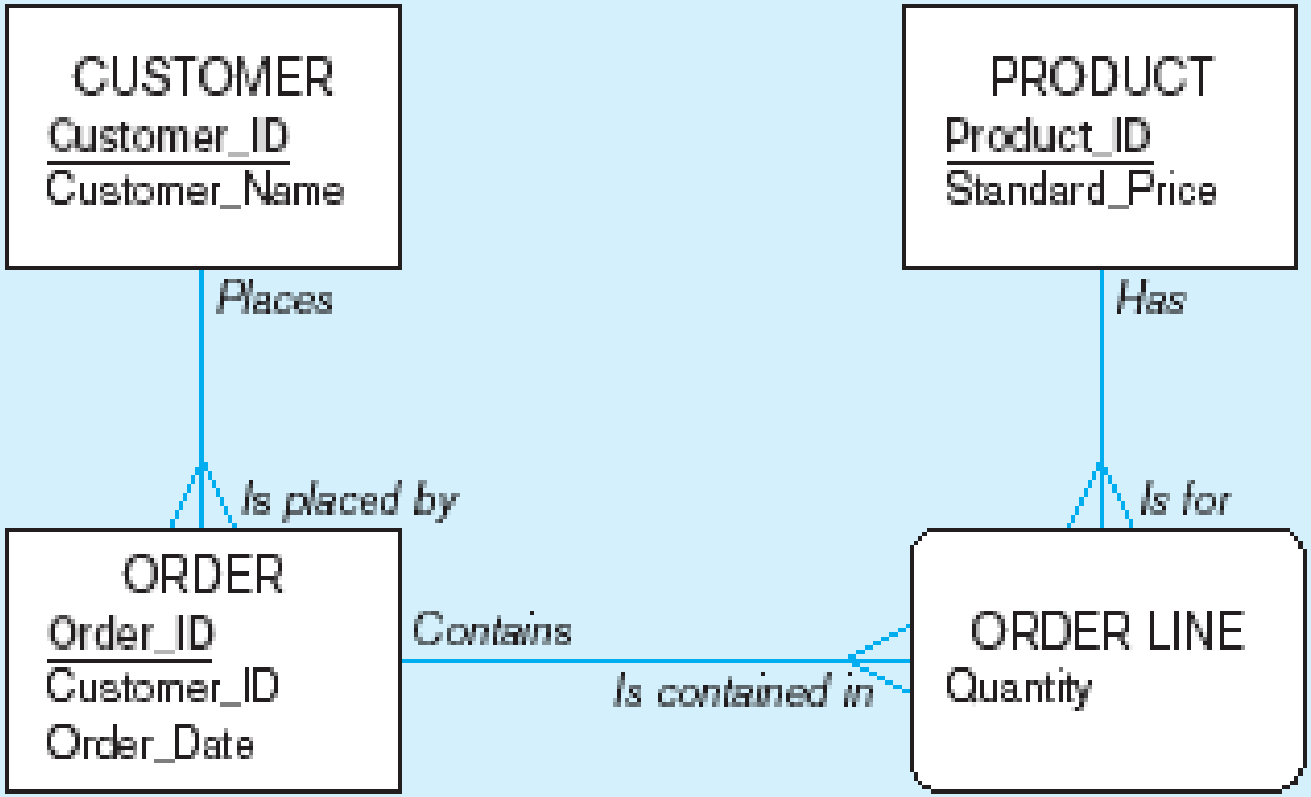
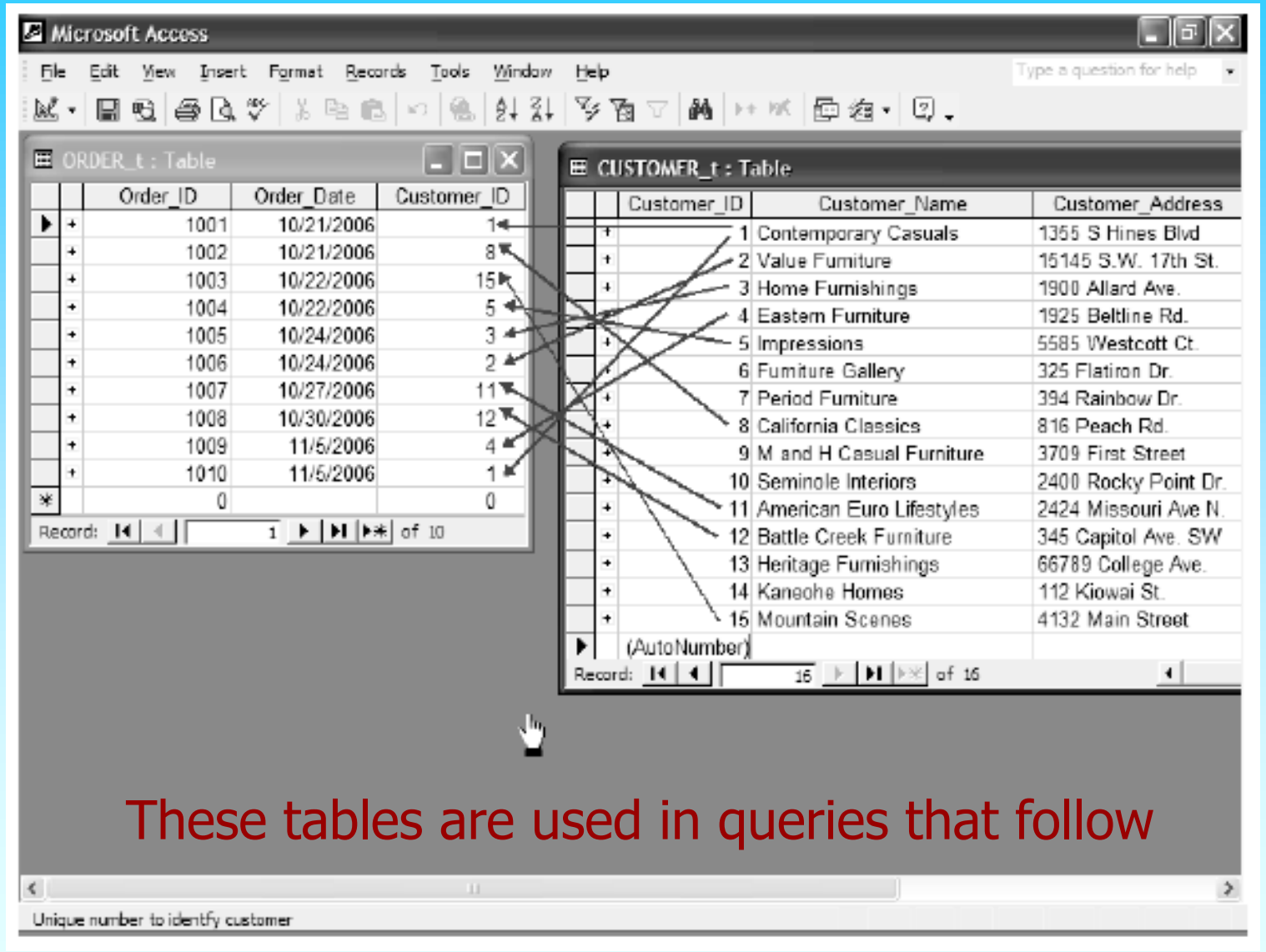


Figure 8-1 Pine Valley Furniture Company Customer and Order tables with pointers from customers to their orders



Natural Join Example
Microsoft syntax

- For each customer who placed an order, what is the customer's name and order number?

Join involves multiple tables in FROM clause

```
SELECT CUSTOMER_T.CUSTOMER_ID, CUSTOMER_NAME, ORDER_ID
FROM CUSTOMER_T NATURAL JOIN ORDER_T ON
CUSTOMER_T.CUSTOMER_ID = ORDER_T.CUSTOMER_ID;
```

ON clause performs the equality check for common columns of the two tables

Note: from Fig. 1, you see that only 10 Customers have links with orders.

➔ Only 10 rows will be returned from this INNER join.

Example

- Query: what are the names of all customers who have placed orders?
- ORACLE SQL:
  - SELECT Customer_T.customer_ID, customer_name, order_ID
    FROM Customer_T, Order_T
    WHERE Customer_T.customer_ID = Order_T.customer_ID;
- Microsoft Access SQL:
  - SELECT Customer_T.customer_ID, Customer_T.customer_Name, Order_T.order_ID
    FROM Customer_T INNER JOIN Order_T ON Customer_T.customer_ID = Order_T.customer_ID;

Outer Join Example

- List the customer name, ID number, and order number for all customers. Include customer information even for customers that do have an order
- (Microsoft Syntax)

```
SELECT CUSTOMER_T.CUSTOMER_ID, CUSTOMER_NAME, ORDER_ID
FROM CUSTOMER_T LEFT OUTER JOIN ORDER_T
ON CUSTOMER_T.CUSTOMER_ID = ORDER_T.CUSTOMER_ID;
```

LEFT OUTER JOIN syntax with ON causes customer data to appear even if there is no corresponding order data

(ORACLE Syntax)

```
SELECT CUSTOMER_T.CUSTOMER_ID,
CUSTOMER_NAME, ORDER_ID
FROM CUSTOMER_T LEFT OUTER JOIN ORDER_T
WHERE CUSTOMER_T.CUSTOMER_ID =
ORDER_T.CUSTOMER_ID;
```

Unlike INNER join, this will include customer rows with no matching order rows

Result:

CUSTOMER_ID	CUSTOMER_NAME	ORDER_ID
1	Contemporary Casuals	1001
1	Contemporary Casuals	1010
2	Value Furniture	1006
3	Home Furnishings	1005
4	Eastern Furniture	1009
5	Impressions	1004
6	Furniture Gallery	
7	Period Furnishings	
8	California Classics	1002
9	M & H Casual Furniture	
10	Seminole Interiors	
11	American Euro Lifestyles	1007
12	Battle Creek Furniture	1008
13	Heritage Furnishings	
14	Kaneohe Homes	
15	Mountain Scenes	1003

16 rows selected.

Results

Unlike INNER join, this will include customer rows with no matching order rows

Multiple Table Join Example

- Assemble all information necessary to create an invoice for order number 1006

Four tables involved in this join

```
SELECT CUSTOMER_T.CUSTOMER_ID, CUSTOMER_NAME,
    CUSTOMER_ADDRESS, CITY, SATE, POSTAL_CODE,
    ORDER_T.ORDER_ID, ORDER_DATE, QUANTITY,
    PRODUCT_DESCRIPTION, STANDARD_PRICE,
    (QUANTITY * UNIT_PRICE)
FROM CUSTOMER_T, ORDER_T, ORDER_LINE_T, PRODUCT_T

WHERE   CUSTOMER_T.CUSTOMER_ID = ORDER_T.CUSTOMER_ID
        AND ORDER_T.ORDER_ID = ORDER_LINE_T.ORDER_ID
        AND ORDER_LINE_T.PRODUCT_ID = PRODUCT_T.PRODUCT_ID
        AND ORDER_T.ORDER_ID = 1006;
```

Each pair of tables requires an equality-check condition in the WHERE clause, matching primary keys against foreign keys

Figure 8-2 Results from a four-table join

From CUSTOMER_T table

CUSTOMER_ID	CUSTOMER_NAME	CUSTOMER_ADDRESS	CUSTOMER_ CITY	CUSTOMER_ ST	POSTAL_ CODE
2	Value Furniture	15145 S.W. 17th St.	Plano	TX	75094 7743
2	Value Furniture	15145 S.W. 17th St.	Plano	TX	75094 7743
2	Value Furniture	15145 S.W. 17th St.	Plano	TX	75094 7743

ORDER_ID	ORDER_DATE	ORDERED_ QUANTITY	PRODUCT_NAME	STANDARD_PRICE	(QUANTITY* STANDARD_PRICE)
1006	24-OCT-06	1	Entertainment Center	650	650
1006	24-OCT-06	2	Writer's Desk	325	650
1006	24-OCT-06	2	Dining Table	800	1600

From ORDER_T , ORDER_Line_T tables

From PRODUCT_T table

Computed Column

Processing Multiple Tables Using Subqueries

- Subquery – placing an inner query (SELECT statement) inside an outer query
- Options:
  - In a condition of the WHERE clause
  - As a "table" of the FROM clause
  - Within the HAVING clause
- Subqueries can be:
  - Noncorrelated – executed **once** for the **entire outer** query
  - Correlated – executed **once** for **each row** returned by the **outer** query

Correlated vs. Noncorrelated Subqueries

- Noncorrelated subqueries:
  - Do not depend on data from the outer query
  - Execute once for the entire outer query
- Correlated subqueries:
  - Make use of data from the outer query
  - Execute once for each row of the outer query
  - Can use the EXISTS operator

Subquery Example
Noncorrelated subqueries

- Show all customers who have placed an order

The **IN** operator will test to see if the CUSTOMER_ID value of a **row** is included in the **list** returned from the subquery

```
SELECT CUSTOMER_NAME FROM CUSTOMER_T
WHERE CUSTOMER_ID IN
      (SELECT DISTINCT CUSTOMER_ID FROM ORDER_T);
```

Subquery is embedded in parentheses. In this case it returns a **list** that will be used in the WHERE clause of the outer query

Figure 8-3a Processing a noncorrelated subquery

1. The subquery executes and returns the customer IDs from the ORDER_T table
2. The outer query on the results of the subquery

```
SELECT CUSTOMER_NAME
                FROM CUSTOMER_T
                        WHERE CUSTOMER_ID IN
```

```
(SELECT DISTINCT CUSTOMER_ID
FROM ORDER_T);
```

1. The subquery (shown in the box) is processed first and an intermediate results table created:

CUSTOMER_ID
1
8
15
5
3
2
11
12
4

9 rows selected.

No reference to data in outer query, so subquery executes once only

2. The outer query returns the requested customer information for each customer included in the intermediate results table:

CUSTOMER_NAME
Contemporary Casuals
Value Furniture
Home Furnishings
Eastern Furniture
Impressions
California Classics
American Euro Lifestyles
Battle Creek Furniture
Mountain Scenes

9 rows selected.

These are the only customers that have IDs in the ORDER_T table

Correlated Subquery Example

- Show all orders that include furniture finished in natural ash

The **EXISTS** operator will return a **TRUE** value if the subquery resulted in a **non-empty set**, otherwise it returns a FALSE

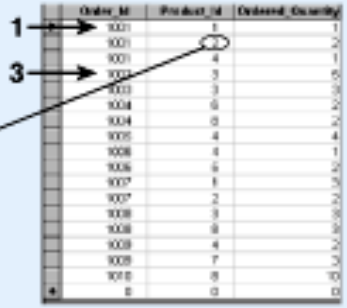
```
SELECT DISTINCT ORDER_ID FROM ORDER_LINE_T
WHERE EXISTS
   (SELECT * FROM PRODUCT_T
     WHERE PRODUCT_ID = ORDER_LINE_T.PRODUCT_ID
     AND PRODUCT_FINISH = 'Natural ash');
```

The subquery is **testing** for a **value** that comes from the **outer** query

Figure 8-3b Processing a correlated subquery

Note: only the **orders** that involve products with **Natural Ash** will be included in the final **results**

```
SELECT DISTINCT ORDER _ID FROM ORDER _LINE _T
WHERE EXISTS
        (SELECT *
          FROM PRODUCT _T
                WHERE PRODUCT _ID = ORDER _LINE _T.PRODUCT _ID
                      AND PRODUCT _FINISH = 'Natural Ash');
```



Subquery refers to **outer-query** data, so executes **once** for **each row** of outer query

	Product_ID	Product_Description	Product_Finish	Standard_Price	Product_Line_Id
▶	1	End Table	Cherry	$175.00	10001
	2	Coffee Table	Natural Ash	$200.00	20001
	3	Computer Desk	Natural Ash	$375.00	20001
	4	Entertainment Center	Natural Maple	$650.00	30001
	5	Writer's Desk	Cherry	$325.00	10001
	6	8-Drawer Dresser	White Ash	$750.00	20001
	7	Dining Table	Natural Ash	$800.00	20001
	8	Computer Desk	Walnut	$250.00	30001
*	(AutoNumber)			$0.00	

2 → 2 Coffee Table Natural Ash

4 → 3 Computer Desk Natural Ash

1. The first order ID is selected from ORDER _LINE _T: ORDER _ID =1001.
2. The subquery is evaluated to see if any product in that order has a natural ash finish. Product 2 does, and is part of the order. EXISTS is valued as *true* and the order ID is added to the result table.
3. The next order ID is selected from ORDER _LINE _T: ORDER _ID =1002.
4. The subquery is evaluated to see if the product ordered has a natural ash finish. It does. EXISTS is valued as true and the order ID is added to the result table.
5. Processing continues through each order ID. Orders 1004, 1005, and 1010 are not included in the result table because they do not include any furniture with a natural ash finish. The final result table is shown in the text on page 303.

- When EXISTS and NOT EXISTS is used in a subquery, the select list of the subquery will usually select all columns (Select *)
- It does not matter which columns are returned
- The purpose of the subquery is to test if any rows fit the conditions, not to return values from particular columns for comparison purposes in the outer query
- The columns that will be displayed are determined strictly by the outer query

Another Solutions

1. Using subquery

```
SELECT DISTINCT ORDER_ID FROM ORDER_LINE_T
WHERE PRODUCT_ID =
   (SELECT  PRODUCT_ID  FROM  PRODUCT_T
            Where PRODUCT_FINISH = 'Natural ash');
```

2. Using Join

```
SELECT DISTINCT  L.ORDER_ID
FROM   ORDER_LINE_T  L,  PRODUCT_T  P
WHERE  L.PRODUCT_ID = P. PRODUCT_T
   AND  PRODUCT_FINISH = 'Natural ash';
```

Another Subquery Example

- Show all products whose standard price is higher than the average price

Subquery forms the derived table used in the FROM clause of the outer query

One column of the subquery is an aggregate function that has an alias name. That alias can then be referred to in the outer query

```
SELECT PRODUCT_DESCRIPTION, STANDARD_PRICE,  AVGPRICE
FROM
      (SELECT AVG(STANDARD_PRICE) AVGPRICE FROM PRODUCT_T),
      PRODUCT_T
      WHERE STANDARD_PRICE > AVGPRICE;
```

Combining (Union) Queries

- Combine the output (union of multiple queries) together into a single result table

subquery should be in the from not to be repeated

```
SELECT C1.CUSTOMER_ID,CUSTOMER_NAME,ORDERED_QUANTITY,
'Largest Quantity' QUANTITY
  FROM CUSTOMER_T C1,ORDER_T O1, ORDER_LINE_T Q1
       WHERE C1.CUSTOMER_ID =O1.CUSTOMER_ID
       AND O1.ORDER_ID =Q1.ORDER_ID
       AND ORDERED_QUANTITY =
            (SELECT MAX(ORDERED_QUANTITY)
            FROM ORDER_LINE_T)
```

First query

Combine →

```
UNION
SELECT C1.CUSTOMER_ID,CUSTOMER_NAME,ORDERED_QUANTITY,
'Smallest Quantity'
  FROM CUSTOMER_T C1,ORDER_T O1, ORDER_LINE_T Q1
       WHERE C1.CUSTOMER_ID =O1.CUSTOMER_ID
       AND O1.ORDER_ID =Q1.ORDER_ID
       AND ORDERED_QUANTITY =
            (SELECT MIN(ORDERED_QUANTITY)
            FROM ORDER_LINE_T)
ORDER BY ORDERED_QUANTITY;
```

Second query

The expression QUANTITY has been created in which the strings "Smallest Quantity" and "Largest Quantity" are inserted

The result of the Union Query:

CUSTOMER_id	CUSTOMER_Name	Ordered_Quantity	Quantity
1	Contemporary	1	Smallest Qty
2	Value Furniture	1	Smallest Qty
1	Contemporary	10	Largest Qty

Tables

- COURSE (CRS#, CTITLE, C#HRS, C#HRSW)
- PREREQ (SUPCRS#, SUBCRS#, CRSCAT)
- OFFER (CRS#, OFF#, EMP#, LOCATION)
- TRAINER (EMP#, FNAME, LNAME, DOB, TEL#, JOB, SALARY, RAT)

Grouping المجموعات
UNION دمج نتائج استفسارات متعددة

مثال ٣: أرقام البرامج التدريبية التي ساعاتها الإجمالية أكبر ٦٠ ساعة أو التي نفذها المدرب ١٥ (أو كلاهما). رتب النتائج تنازليا برقم البرنامج .

```
SELECT  CRS#
  FROM   COURSE
  WHERE  C#HRS > 60
UNION
  SELECT   CRS#
     FROM OFFER
     WHERE  EMP# = 15
     ORDER  BY 1 DESC ;
```

Grouping المجموعات
UNION دمج نتائج استفسارات متعددة

مثال ٤ : أرقام الدورات التدريبية التي ساعاتها الإجمالية أكبر من ٦٠ ساعة أو التي نفذها المدرب ١٥ (أو كلاهما). رتب النتائج تنازليا برقم الدورة مع إظهار الصفوف المتكررة .

```
SELECT  CRS#
  FROM  COURSE
  WHERE  C#HRS > 60
UNION  ALL
    SELECT   CRS#
    FROM  OFFER
    WHERE    EMP# = 15
    ORDER    BY 1 DESC ;
```

تعليمة SELECT
ربـط الجـداول Joining Tables

استرجاع البيانات من أكثر من جدول

- مثال ١ عرض قائمة بأسماء كل الدورات التدريبية وجميع بيانات مخطط تنفيذها :

```
SELECT  CTITLE, OFFER.*
   FROM  COURSE, OFFER
   WHERE     COURSE.CRS# = OFFER.CRS# ;
```

- استخدام مميز مختصر لجداول FROM

```
SELECT  CTITLE, O.*
  FROM  COURSE C, OFFER O
  WHERE  C.CRS# = O.CRS# ;
```

تعليمة SELECT
تابع ربط الجداول Joining Tables

شروط أخرى في عبارة WHERE

- مثال ٢ عرض قائمة بأسماء كل البرامج التدريبية وجميع بيانات مخطط تنفيذها للدورات المخططة في "القاهرة" :

```
SELECT  CTITLE, O.*
  FROM  COURSE C, OFFER O
   WHERE    C.CRS# = O.CRS#
            AND    O.LOCATION = 'Cairo' ;
```

تعليمة SELECT
تابع ربط الجداول Joining Tables

شروط أخرى في عبارة WHERE

- مثال ٣ عرض قائمة بأرقام وأسماء كل الدورات التدريبية التي لم يحدد لها مكان تنفيذ (الشرط في جدول آخر)

```
SELECT  C.CRS#, CTITLE
  FROM   COURSE  C, OFFER O
   WHERE  C.CRS# = O.CRS#
        AND  O.LOCATION   IS NULL ;
```

تعليمة SELECT
تابع ربط الجداول Joining Tables

ربط أكثر من جدولين

مثال ٤ عرض قائمة بأسماء الدورات التدريبية المخطط تنفيذها في "القاهرة" وأرقام مدربيها

```
SELECT  DISTINCT CTITLE, T.EMP#, O.LOCATION
FROM    COURSE C, OFFER O, TRAINER T
    WHERE  C.CRS# = O.CRS#
        AND   O.EMP# = T. EMP#
        AND   O.LOCATION = 'Cairo' ;
```

تعليمة SELECT
الاستفسارات المتداخلة Subqueries

الاستفسارات المتداخلة (الفرعية)

```
SELECT  ...
  FROM  ...
  WHERE    (SELECT...
              FROM  ...
               WHERE  ...) ;
```

all arabic slides have sub-query in the where but that's not true it should be in the from to be executed once

تعليمة SELECT
الاستفسارات المتداخلة Subqueries

تابع الاستفسارات المتداخلة – إرجاع قيمة واحدة

مثال ٢ : قائمة بالموظفين الذين معدلات أدائهم أكبر من المتوسط العام للأداء

```
SELECT  LNAME, FNAME
FROM  TRAINER
WHERE  RAT  >
   (SELECT  AVG (RAT)
        FROM TRAINER) ;
```

تعليمة SELECT
الاستفسارات المتداخلة Subqueries

الاستفسار الفرعي بعد أي من عوامل المقارنة

```
WHERE  ColumnName  [ =  >  <  >=  <=  <>  IN ]  (subquery) ;
```

تعليمة SELECT
الاستفسارات المتداخلة Subqueries

تابع الاستفسارات المتداخلة – إرجاع قيمة واحدة

مثال ٣: قائمة بأسماء الموظفين ومرتباتهم التي تزيد عن متوسط المرتبات

```
SELECT  LNAME, FNAME, SALARY
FROM TRAINER
WHERE  SALARY  >
   (SELECT AVG (SALARY)  FROM TRAINER) ;
```

move it here

تعليمة SELECT
الاستفسارات المتداخلة Subqueries

تابع الاستفسارات المتداخلة – إرجاع قيمة واحدة

مثال ٤ : أرقام الدورات التدريبية التي نفذها المدرب 'RASHED ALSALEH'

```
SELECT  DISTINCT CRS#
 FROM    OFFER
 WHERE   EMP#  =  (SELECT   EMP#
                   FROM TRAINER
                   WHERE  LNAME = 'ALSALEH'
                   AND  FNAME = 'RASHED') ;
```

تعليمة SELECT
الاستفسارات المتداخلة Subqueries

AND/OR تابع الاستفسارات المتداخلة – إرجاع قيمة واحدة – ربط الاستفسارات الفرعية

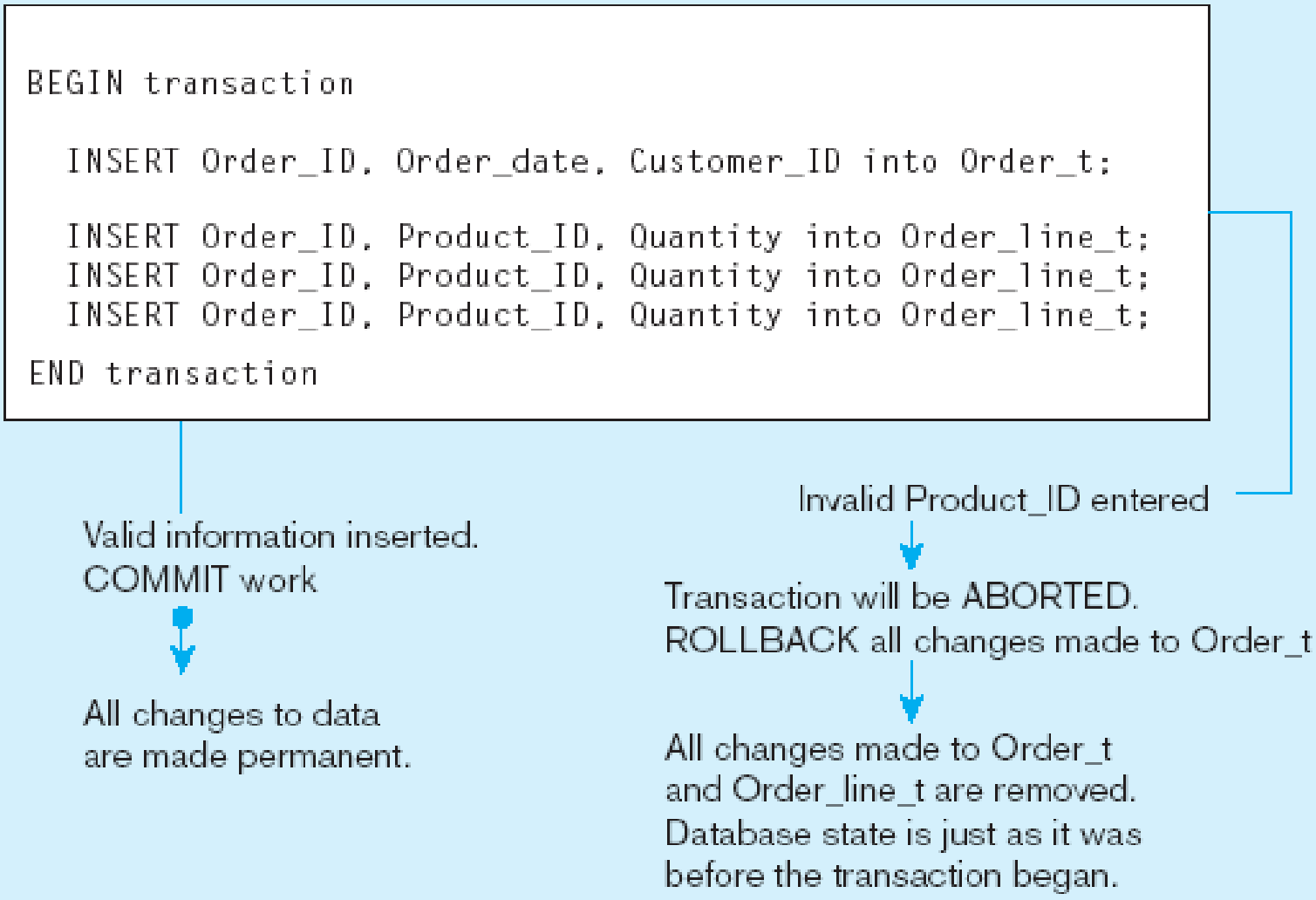
مثال ٦ : أسماء الموظفين الذين لهم أعلى وأقل معدل أداء

```
SELECT LNAME, FNAME, RAT
 FROM TRAINER
  WHERE  RAT =
    (SELECT   MAX (RAT)
       FROM TRAINER)
        OR   RAT =
             (SELECT   MIN (RAT)
                FROM TRAINER) ;
```

Ensuring Transaction Integrity

- Transaction = A discrete unit of work that must be completely processed or not processed at all
  - May involve multiple updates
  - If any update fails, then all other updates must be cancelled
- SQL commands for transactions
  - BEGIN TRANSACTION/END TRANSACTION
    - Marks boundaries of a transaction
  - COMMIT
    - Makes all updates permanent
  - ROLLBACK
    - Cancels updates since the last COMMIT

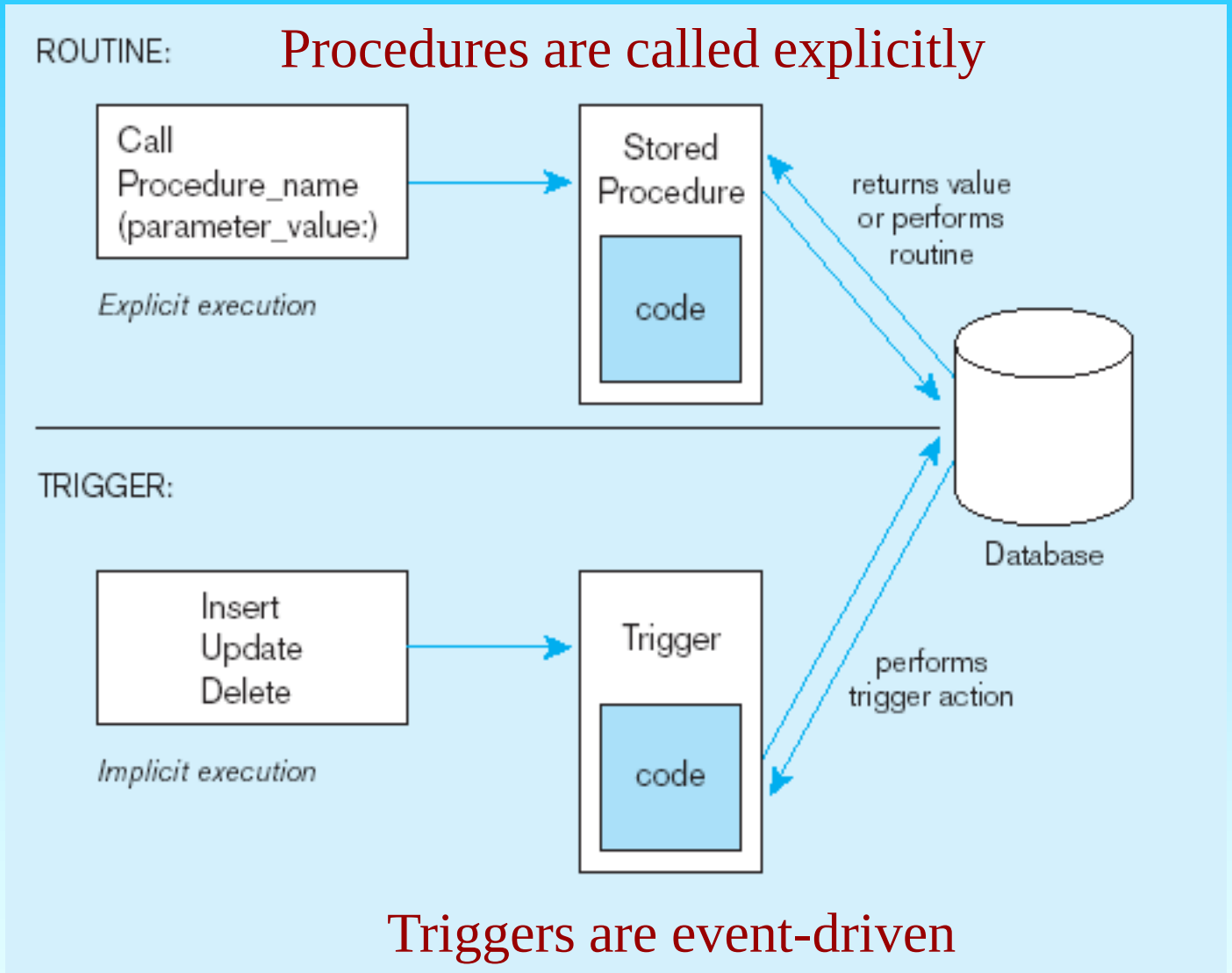
Figure 8-5 An SQL Transaction sequence (in pseudocode)



Routines and Triggers

- **Routines**
  - Program modules that execute on demand
  - **Functions** – routines that return values and take input parameters
  - **Procedures** – routines that do not return values and can take input or output parameters
- **Triggers**
  - Routines that execute in response to a database **event** (INSERT, UPDATE, or DELETE)

Figure 8-6



Source: adapted from Mullins, 1995.

Figure 8-7 Simplified trigger syntax, SQL:2003

```
CREATE TRIGGER trigger_name
        {BEFORE | AFTER | INSTEAD OF} {INSERT | DELETE | UPDATE} ON
        table_name
        [FOR EACH {ROW | STATEMENT}] [WHEN (search condition)]
        <triggered SQL statement here>;
```

Figure 8-8 Create routine syntax, SQL:2003

```
{CREATE PROCEDURE | CREATE FUNCTION} routine_name
([parameter [{,parameter} . . .]])
[RETURNS data_type result_cast]    /* for functions only */
[LANGUAGE {ADA | C | COBOL | FORTRAN | MUMPS | PASCAL | PLI | SQL}]
[PARAMETER STYLE {SQL | GENERAL}]
[SPECIFIC specific_name]
[DETERMINISTIC | NOT DETERMINISTIC]
[NO SQL | CONTAINS SQL | READS SQL DATA | MODIFIES SQL DATA]
[RETURNS NULL ON NULL INPUT | CALLED ON NULL INPUT]
[DYNAMIC RESULT SETS unsigned_integer]      /* for procedures only */
[STATIC DISPATCH]                           /* for functions only */
[NEW SAVEPOINT LEVEL | OLD SAVEPOINT LEVEL]
routine_body
```

Routine Example (PL/SQL)

```
Create or Replace Procedure Product_Line_Sale
AS  Begin
    update Product_T
        set sale_price = 0.9 * standard_price
        where standard_price >= 400;
    update Product_T
        set sale_price = 0.85 * standard_price
        where standard_price < 400;
End;
SQL> Exec Product_Line_sale
```