# Relational Databases: Structured Query Language (SQL)

# Introduction

- Relational database management systems and SQL
- SQL Data Definition Language
- SQL Data Manipulation Language
- SQL views
- SQL indexes
- SQL privileges
- SQL for metadata management

# Relational Database Management Systems and SQL

- Key Characteristics of SQL
- Three-Level Database Architecture

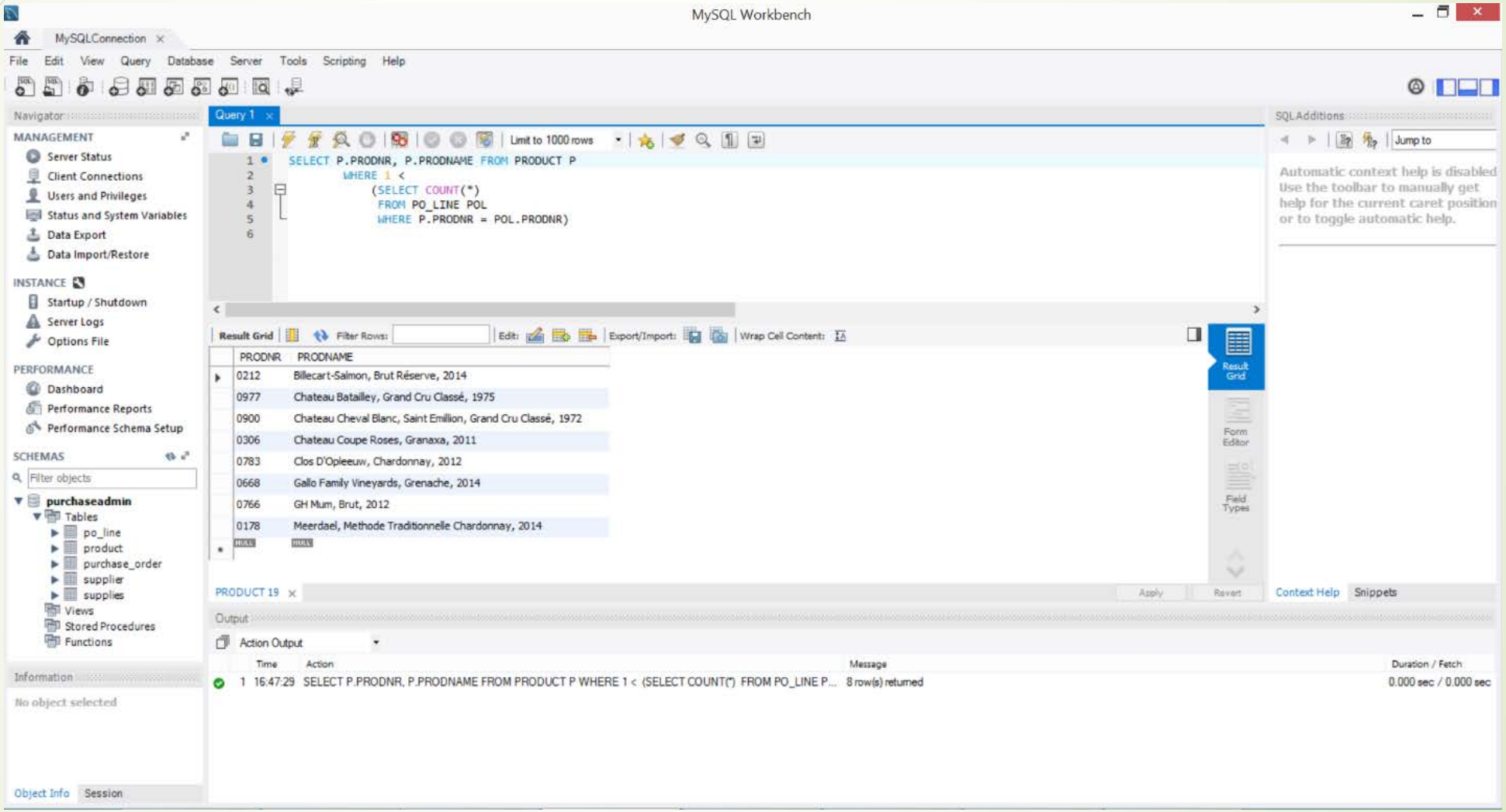
# Key Characteristics of SQL

- First version, SQL-86 in 1986, most recent version in 2011 (SQL:2011)
- Accepted by the American National Standards Institute (ANSI) in 1986 and by the International Organization for Standardization (ISO) in 1987
- Each vendor provides its own implementation (also called SQL dialect) of SQL

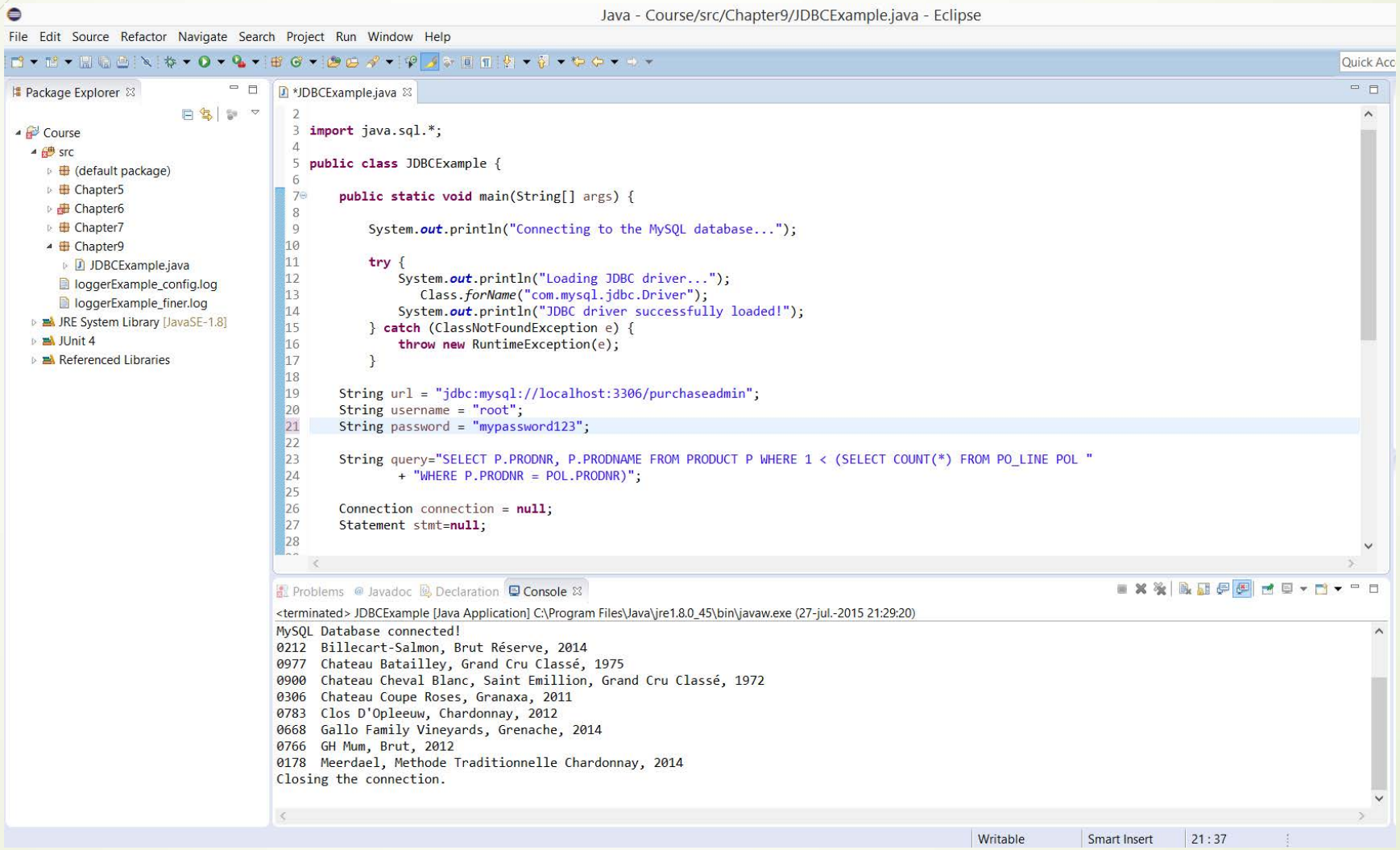
# Key Characteristics of SQL

- Set-oriented and declarative
- Free-form language
- Case insensitive
- Can be used both interactively from a command prompt or executed by a program

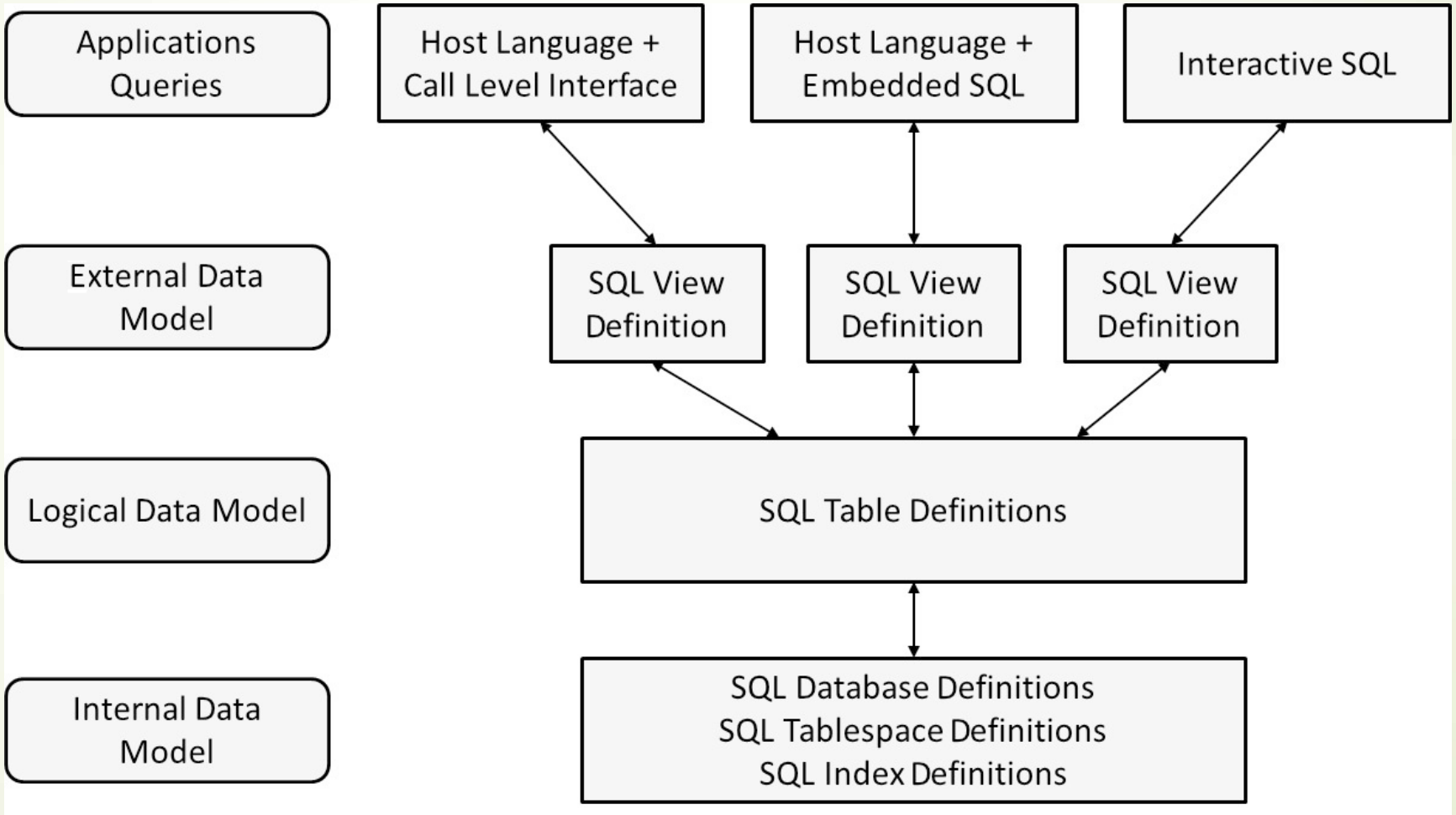
# Key Characteristics of SQL



# Key Characteristics of SQL



# Three-Level Database Architecture



# SQL Data Definition Language

- Key DDL concepts
- DDL example
- Referential integrity constraints
- DROP and ALTER command

# Key DDL Concepts

- SQL schema is a grouping of tables and other database objects such as views, constraints, and indexes which logically belong together

```
CREATE SCHEMA PURCHASE AUTHORIZATION BBAESENS
```

- SQL table implements a relation from the relational model

```
CREATE TABLE PRODUCT …
  CREATE TABLE PURCHASE.PRODUCT …
```

# Key DDL Concepts

| Data type | Description |
|---|---|
| CHAR(n) | Holds a fixed-length string with size *n* |
| VARCHAR(n) | Holds a variable-length string with maximum size *n* |
| SMALLINT | Small integer (no decimal) between -32768 and 32767 |
| INT | Integer (no decimal) between -2147483648 and 2147483647 |
| FLOAT(n,d) | Small number with a floating decimal point. The total maximum number of digits is *n* with a maximum of *d* digits to the right of the decimal point |
| DOUBLE(n,d) | Large number with a floating decimal point. The total maximum number of digits is *n* with a maximum of *d* digits to the right of the decimal point |
| DATE | Date in format YYYY-MM-DD |
| DATETIME | Date and time in format YYYY-MM-DD HH:MI:SS |
| TIME | Time in format HH:MI:SS |
| BOOLEAN | True or false |
| BLOB | Binary large object (e.g., image, audio, video) |

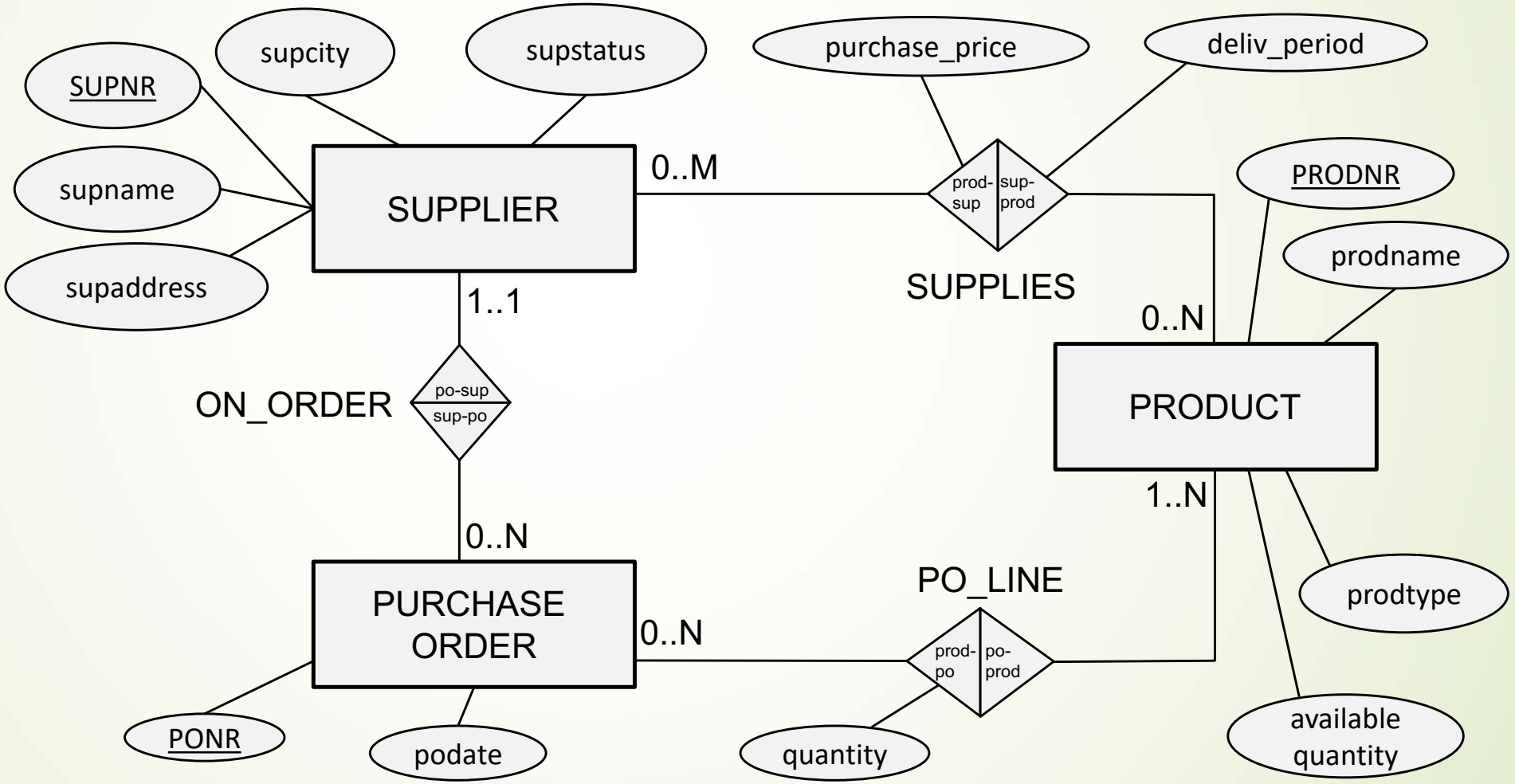
# Key DDL Concepts

```
CREATE DOMAIN PRODTYPE_DOMAIN AS VARCHAR(10)
CHECK (VALUE IN ('white', 'red', 'rose',
'sparkling'))
```

# Key DDL Concepts

- Column constraints
  - **PRIMARY KEY** constraint defines the primary key of the table
  - **FOREIGN KEY** constraint defines a foreign key of a table
  - **UNIQUE** constraint defines an alternative key of a table
  - **NOT NULL** constraint prohibits null values for a column
  - **DEFAULT** constraint sets a default value for a column
  - **CHECK** constraint defines a constraint on the column values

# DDL Example


SUPNR
supcity
supstatus
purchase_price
deliv_period
supname
supaddress
SUPPLIER
0..M
prod-sup
sup-prod
SUPPLIES
PRODNR
prodname
0..N
PRODUCT
1..1
ON_ORDER
po-sup
sup-po
1..N
0..N
PURCHASE ORDER
PO_LINE
0..N
prod-po
po-prod
prodtype
PONR
podate
quantity
available quantity

# DDL Example

**SUPPLIER**(SUPNR, SUPNAME, SUPADDRESS, SUPCITY, SUPSTATUS)

**PRODUCT**(PRODNR, PRODNAME, PRODTYPE, AVAILABLE_QUANTITY)

**SUPPLIES**(*SUPNR*, *PRODNR*, PURCHASE_PRICE, DELIV_PERIOD)

**PURCHASE_ORDER**(PONR, PODATE, *SUPNR*)

**PO_LINE**(*PONR*, *PRODNR*, QUANTITY)

# DDL Example

```
CREATE TABLE SUPPLIER
(SUPNR CHAR(4) NOT NULL PRIMARY KEY,
 SUPNAME VARCHAR(40) NOT NULL,
 SUPADDRESS VARCHAR(50),
 SUPCITY VARCHAR(20),
 SUPSTATUS SMALLINT)

CREATE TABLE PRODUCT
(PRODNR CHAR(6) NOT NULL PRIMARY KEY,
 PRODNAME VARCHAR(60) NOT NULL,
 CONSTRAINT UC1 UNIQUE(PRODNAME),
 PRODTYPE VARCHAR(10),
 CONSTRAINT CC1 CHECK(PRODTYPE IN ('white', 'red', 'rose','sparkling')),
 AVAILABLE_QUANTITY INTEGER)
```

# DDL Example

```
CREATE TABLE SUPPLIES
(SUPNR CHAR(4) NOT NULL,
 PRODNR CHAR(6) NOT NULL,
 PURCHASE_PRICE DOUBLE(8,2)
 COMMENT 'PURCHASE_PRICE IN EUR',
 DELIV_PERIOD TIME
 COMMENT 'DELIV_PERIOD IN DAYS',
 PRIMARY KEY (SUPNR, PRODNR),
 FOREIGN KEY (SUPNR) REFERENCES SUPPLIER (SUPNR)
 ON DELETE CASCADE ON UPDATE CASCADE,
 FOREIGN KEY (PRODNR) REFERENCES PRODUCT (PRODNR)
 ON DELETE CASCADE ON UPDATE CASCADE)
```

# DDL Example

```
CREATE TABLE PURCHASE_ORDER
(PONR CHAR(7) NOT NULL PRIMARY KEY,
 PODATE DATE,
 SUPNR CHAR(4) NOT NULL,
 FOREIGN KEY (SUPNR) REFERENCES SUPPLIER (SUPNR)
 ON DELETE CASCADE ON UPDATE CASCADE)

CREATE TABLE PO_LINE
 (PONR CHAR(7) NOT NULL,
  PRODNR CHAR(6) NOT NULL,
  QUANTITY INTEGER,
  PRIMARY KEY (PONR, PRODNR),
  FOREIGN KEY (PONR) REFERENCES PURCHASE_ORDER (PONR)
  ON DELETE CASCADE ON UPDATE CASCADE,
  FOREIGN KEY (PRODNR) REFERENCES PRODUCT (PRODNR)
  ON DELETE CASCADE ON UPDATE CASCADE)
```

# Referential Integrity Constraints

- Foreign key has the same domain as the primary key it refers to and either occurs as a value of it or NULL
- What should happen to foreign keys in case a primary key is updated or deleted?
- Options:
  - **ON UPDATE/DELETE CASCADE**: update/removal should be cascaded to all referring tuples
  - **ON UPDATE/DELETE RESTRICT:** update/removal is halted if referring tuples exist
  - **ON UPDATE/DELETE SET NULL:** foreign keys in the referring tuples are set to NULL
  - **ON UPDATE/DELETE SET DEFAULT:** foreign keys in the referring tuples are set to their default value

# Referential Integrity Constraints

## Supplier

| SUPNR | SUPNAME | SUPADDRESS | SUPCITY | SUPSTATUS |
|---|---|---|---|---|
| 21 | Deliwines | 240, Avenue of the Americas | New York | 20 |
| 32 | Best Wines | 660, Market Street | San Francisco | 90 |
| **37** | **Ad Fundum** | **82, Wacker Drive** | **Chicago** | **95** |
| 52 | Spirits & co. | 928, Strip | Las Vegas | NULL |
| 68 | The Wine Depot | 132, Montgomery Street | San Francisco | 10 |
| 69 | Vinos del Mundo | 4, Collins Avenue | Miami | 92 |

## Supplies

| SUPNR | PRODNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| 37 | 0178 | 16.99 | 4 |
| 37 | 0185 | 32.99 | 3 |
| 37 | 0468 | 14.00 | 1 |
| 37 | 0795 | 20.99 | 3 |

## Purchase_Order

| PONR | PODATE | SUPNR |
|---|---|---|
| 1511 | 2015-03-24 | 37 |
| 1513 | 2015-04-11 | 37 |
| 1523 | 2015-04-19 | 37 |
| 1577 | 2015-05-10 | 37 |
| 1594 | 2015-05-13 | 37 |

# DROP and ALTER Command

- **DROP** command can be used to drop or remove database objects
  - Can also be combined with CASCADE and RESTRICT
- Examples:

```
DROP SCHEMA PURCHASE CASCADE
DROP SCHEMA PURCHASE RESTRICT
DROP TABLE PRODUCT CASCADE
DROP TABLE PRODUCT RESTRICT
```

# DROP and ALTER Command

- **ALTER** statement can be used to modify table column definitions
- Examples:

```
ALTER TABLE PRODUCT ADD PRODIMAGE BLOB


ALTER TABLE SUPPLIER ALTER SUPSTATUS SET DEFAULT
'10'
```

# DROP and ALTER Command

SUPPLIER

| SUPNR | SUPNAME | SUPADDRESS | SUPCITY | SUPSTATUS |
|---|---|---|---|---|
| 21 | Deliwines | 240, Avenue of the Americas | New York | 20 |
| 32 | Best Wines | 660, Market Street | San Francisco | 90 |
| … | | | | |

PRODUCT

| PRODNR | PRODNAME | PRODTYPE | AVAILABLE_QUANTITY |
|---|---|---|---|
| 0119 | Chateau Miraval, Cotes de Provence Rose, 2015 | rose | 126 |
| 0154 | Chateau Haut Brion, 2008 | red | 111 |
| … | | red | 5 |

SUPPLIES

| SUPNR | PRODNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| 21 | 0289 | 17.99 | 1 |
| 21 | 0327 | 56.00 | 6 |
| … | | | |

PURCHASE_ORDER

| PONR | PODATE | SUPNR |
|---|---|---|
| 1511 | 2015-03-24 | 37 |
| 1512 | 2015-04-10 | 94 |
| … | | |

PO_LINE

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1511 | 0212 | 2 |
| 1511 | 0345 | 4 |
| … | | |

# SQL Data Manipulation Language (SQL DML)

- SQL SELECT statement
- SQL INSERT statement
- SQL DELETE statement
- SQL UPDATE statement

# SQL SELECT Statement

- Overview
- Simple queries
- Queries with aggregate functions
- Queries with GROUP BY/HAVING
- Queries with ORDER BY
- Join queries
- Nested queries
- Correlated queries
- Queries with ALL/ANY
- Queries with EXISTS
- Queries with subqueries in FROM/WHERE
- Queries with set operations

# Overview

```
SELECT component
FROM component
[WHERE component]
[GROUP BY component]
[HAVING component]
[ORDER BY component]
```

# Overview

- The result of an SQL SELECT statement is a multiset, and not a set!
- In a multiset (aka bag), the elements are not ordered but there can be duplicates
- Examples: set {10, 5, 20} and multiset {10, 5, 10, 20, 5, 10}
- SQL does not eliminate duplicates
  - Duplicate elimination is expensive
  - User may want to see duplicate tuples
  - Duplicates may be considered by aggregate functions

# Simple Queries

- SQL statements that retrieve data from only one table

```
Q1: SELECT SUPNR, SUPNAME,SUPADDRESS, SUPCITY,
SUPSTATUS FROM SUPPLIER
```

```
Q1: SELECT * FROM SUPPLIER
```

# Simple Queries

| SUPNR | SUPNAME | SUPADDRESS | SUPCITY | SUPSTATUS |
|---|---|---|---|---|
| 21 | Deliwines | 240, Avenue of the Americas | New York | 20 |
| 32 | Best Wines | 660, Market Street | San Francisco | 90 |
| 37 | Ad Fundum | 82, Wacker Drive | Chicago | 95 |
| 52 | Spirits & co. | 928, Strip | Las Vegas | NULL |
| 68 | The Wine Depot | 132, Montgomery Street | San Francisco | 10 |
| 69 | Vinos del Mundo | 4, Collins Avenue | Miami | 92 |

# Simple Queries

- **Q2:** `SELECT SUPNR, SUPNAME FROM SUPPLIER`

| SUPNR | SUPNAME |
|---|---|
| 21 | Deliwines |
| 32 | Best Wines |
| 37 | Ad Fundum |
| 52 | Spirits & co. |
| 68 | The Wine Depot |
| 69 | Vinos del Mundo |

# Simple Queries

```
Q3: SELECT SUPNR
    FROM PURCHASE_ORDER
```

| SUPNR |
|---|
| 32 |
| 32 |
| 37 |
| 37 |
| 37 |
| 37 |
| 37 |
| 68 |
| 69 |
| 94 |

# Simple Queries

```
Q4: SELECT DISTINCT SUPNR FROM PURCHASE_ORDER
```

| SUPNR |
|---|
| 32 |
| 37 |
| 68 |
| 69 |
| 94 |

# Simple Queries

```
Q5: SELECT SUPNR, PRODNR, DELIV_PERIOD/30 AS MONTH_DELIV_PERIOD FROM
SUPPLIES
```

| SUPNR | PRODNR | MONTH_DELIV_PERIOD |
|---|---|---|
| 21 | 0119 | 0.0333 |
| 21 | 0178 | NULL |
| 21 | 0289 | 0.0333 |
| 21 | 0327 | 0.2000 |
| 21 | 0347 | 0.0667 |
| 21 | 0384 | 0.0667 |
| … | … | … |

# Simple Queries

```
Q6: SELECT SUPNR, SUPNAME FROM SUPPLIER
  WHERE SUPCITY = 'San Francisco'
```

| SUPNR | SUPNAME | SUPSTATUS |
|---|---|---|
| 32 | Best Wines | 90 |
| 68 | The Wine Depot | 10 |

# Simple Queries

```
Q7: SELECT SUPNR, SUPNAME  FROM SUPPLIER
WHERE SUPCITY = 'San Francisco' AND SUPSTATUS > 80
```

| SUPNR | SUPNAME | SUPSTATUS |
|---|---|---|
| 32 | Best Wines | 90 |

# Simple Queries

```
Q8: SELECT SUPNR, SUPNAME, SUPSTATUS
FROM SUPPLIER WHERE SUPSTATUS BETWEEN 70 AND 80
```

| SUPNR | SUPNAME | SUPSTATUS |
|---|---|---|
| 94 | The Wine Crate | 75 |

# Simple Queries

- Q9:
```
SELECT PRODNR, PRODNAME
    FROM PRODUCT
    WHERE PRODTYPE IN ('WHITE', 'SPARKLING')
```

| PRODNR | PRODNAME |
|---|---|
| 0178 | Meerdael, Methode Traditionnelle Chardonnay, 2014 |
| 0199 | Jacques Selosse, Brut Initial, 2012 |
| 0212 | Billecart-Salmon, Brut Réserve, 2014 |
| 0300 | Chateau des Rontets, Chardonnay, Birbettes |
| 0494 | Veuve-Cliquot, Brut, 2012 |
| 0632 | Meneghetti, Chardonnay, 2010 |
| … | …. |

# Simple Queries

```
Q10: SELECT PRODNR, PRODNAME
     FROM PRODUCT
     WHERE PRODNAME LIKE '%CHARD%'
```

| PRODNR | PRODNAME |
|---|---|
| 0300 | Chateau des Rontets, Chardonnay, Birbettes |
| 0783 | Clos D'Opleeuw, Chardonnay, 2012 |
| 0178 | Meerdael, Methode Traditionnelle Chardonnay, 2014 |
| 0632 | Meneghetti, Chardonnay, 2010 |

# Simple Queries

```
Q11: SELECT SUPNR, SUPNAME
     FROM SUPPLIER
     WHERE SUPSTATUS IS NULL
```

| SUPNR | SUPNAME | SUPSTATUS |
|---|---|---|
| 52 | Spirits & Co. | NULL |

# Queries with Aggregate Functions

- Examples: COUNT, SUM, AVG, VARIANCE, MIN/MAX, and STDEV

| SUPNR | PRODNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| … | | | |
| 21 | 0178 | NULL | NULL |
| 37 | 0178 | 16.99 | 4 |
| 68 | 0178 | 17.99 | 5 |
| 69 | 0178 | 16.99 | NULL |
| 94 | 0178 | 18.00 | 6 |
| … | | | |

# Queries with Aggregate Functions

```
Q12: SELECT COUNT(*)
     FROM SUPPLIES
     WHERE PRODNR = '0178'
```

5

```
Q13: SELECT COUNT(PURCHASE_PRICE)
     FROM SUPPLIES
     WHERE PRODNR = '0178'
```

4

```
Q14: SELECT COUNT(DISTINCT PURCHASE_PRICE)
     FROM SUPPLIES
     WHERE PRODNR = '0178'
```

3

# Queries with Aggregate Functions

```
Q15: SELECT PRODNR, SUM(QUANTITY) AS
     SUM_ORDERS FROM PO_LINE
     WHERE PRODNR = '0178'
```

| PONR | PRODNR | QUANTITY |
|---|---|---|
| … | | |
| 1512 | 0178 | 3 |
| 1538 | 0178 | 6 |
| … | | |

**0178 9**

# Queries with Aggregate Functions

- **Q16:** `SELECT SUM(QUANTITY) AS TOTAL_ORDERS FROM PO_LINE`

**173**

# Queries with Aggregate Functions

```
Q17: SELECT PRODNR, AVG(PURCHASE_PRICE) AS
     WEIGHTED_AVG_PRICE FROM SUPPLIES
     WHERE PRODNR = '0178'
```

| SUPNR | PRODNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| … | | | |
| 21 | 0178 | NULL | NULL |
| 37 | 0178 | 16.99 | 4 |
| 68 | 0178 | 17.99 | 5 |
| 69 | 0178 | 16.99 | NULL |
| 94 | 0178 | 18.00 | 6 |
| … | | | |

**0178, (16.99 + 17.99 + 16.99 + 18.00) / 4 = 17.4925**

# Queries with Aggregate Functions

```
Q18: SELECT PRODNR, AVG(DISTINCT
     PURCHASE_PRICE)AS UNWEIGHTED_AVG_PRICE
     FROM SUPPLIES WHERE PRODNR = '0178'
```

| SUPNR | PRODNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| … | | | |
| 21 | 0178 | NULL | NULL |
| 37 | 0178 | 16.99 | 4 |
| 68 | 0178 | 17.99 | 5 |
| 69 | 0178 | 16.99 | NULL |
| 94 | 0178 | 18.00 | 6 |
| … | | | |

**0178, (16.99 + 17.99 + 18.00) / 3 = 17.66**

# Queries with Aggregate Functions

- **Q19:**
```
SELECT PRODNR, VARIANCE(PURCHASE_PRICE)
AS PRICE_VARIANCE FROM SUPPLIES
WHERE PRODNR = '0178'
```

| PRODNR | PRICE_VARIANCE |
|---|---|
| 0178 | 0.2525187500000024 |

# Queries with Aggregate Functions

```
Q20: SELECT PRODNR, MIN(PURCHASE_PRICE) AS LOWEST_PRICE,
     MAX(PURCHASE_PRICE) AS HIGHEST_PRICE
     FROM SUPPLIES
     WHERE PRODNR = '0178'
```

| PRODNR | LOWEST_PRICE | HIGHEST_PRICE |
|---|---|---|
| 0178 | 16.99 | 18.00 |

# Queries with GROUP BY/HAVING

```
Q21: SELECT PRODNR
     FROM PO_LINE
     GROUP BY PRODNR
     HAVING COUNT(*) >= 3
```

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1511 | 0212 | 2 |
| 1512 | 0178 | 3 |
| 1513 | 0668 | 7 |
| 1514 | 0185 | 2 |
| 1514 | 0900 | 2 |
| 1523 | 0900 | 3 |
| 1538 | 0178 | 6 |
| 1538 | 0212 | 15 |
| 1560 | 0900 | 9 |
| 1577 | 0212 | 6 |
| 1577 | 0668 | 9 |
| … | .. | … |

# Queries with GROUP BY/HAVING

GROUP BY

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1511 | 0212 | 2 |
| 1577 | 0212 | 6 |
| 1538 | 0212 | 15 |

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1512 | 0178 | 3 |
| 1538 | 0178 | 6 |

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1513 | 0668 | 7 |
| 1577 | 0668 | 9 |

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1514 | 0900 | 2 |
| 1523 | 0900 | 3 |
| 1560 | 0900 | 9 |

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1514 | 0185 | 2 |

| PRODNR |
|---|
| 0212 |
| 900 |

# Queries with GROUP BY/HAVING

```
Q22: SELECT PRODNR, SUM(QUANTITY) AS QUANTITY FROM PO_LINE
     GROUP BY PRODNR
     HAVING SUM(QUANTITY) > 15
```

GROUP BY

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1511 | 0212 | 2 |
| 1577 | 0212 | 6 |
| 1538 | 0212 | 15 |
| | SUM | 23 |

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1512 | 0178 | 3 |
| 1538 | 0178 | 6 |
| | SUM | 9 |

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1513 | 0668 | 7 |
| 1577 | 0668 | 9 |
| | SUM | 16 |

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1514 | 0185 | 2 |
| | SUM | 2 |

| PONR | PRODNR | QUANTITY |
|---|---|---|
| 1514 | 0900 | 2 |
| 1523 | 0900 | 3 |
| 1560 | 0900 | 9 |
| | SUM | 14 |

| PRODNR | QUANTITY |
|---|---|
| 0212 | 23 |
| 0668 | 16 |

# Queries with ORDER BY

- **Q23:**
```
SELECT PONR, PODATE, SUPNR
FROM PURCHASE_ORDER
ORDER BY PODATE ASC, SUPNR DESC
```

| PONR | PODATE | SUPNR |
|---|---|---|
| 1511 | 2015-03-24 | 37 |
| 1512 | 2015-04-10 | 94 |
| 1513 | 2015-04-11 | 37 |
| 1514 | 2015-04-12 | 32 |
| … | | |

# Queries with ORDER BY

```
Q24: SELECT PRODNR, SUPNR, PURCHASE_PRICE
     FROM SUPPLIES
     WHERE PRODNR = '0178'
     ORDER BY 3 DESC
```

| PRODNR | SUPNR | PURCHASE_PRICE |
|---|---|---|
| 0178 | 94 | 18.00 |
| 0178 | 68 | 17.99 |
| 0178 | 37 | 16.99 |
| 0178 | 69 | 16.99 |
| 0178 | 21 | NULL |

# Join Queries

- Inner joins
- Outer joins

# Inner Joins

**SUPPLIER**(SUPNR, SUPNAME, ..., SUPSTATUS)
**SUPPLIES**(*SUPNR, PRODNR*, PURCHASE_PRICE, ...)

| SUPNR | SUPNAME | SUPADDRESS | SUPCITY | SUPSTATUS |
|---|---|---|---|---|
| 32 | Best wines | | | 90 |
| 68 | The Wine Depot | | | 10 |
| 84 | Wine Trade Logistics | | | 92 |
| : | : | | | : |

| SUPNR | PRODNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| 32 | 0474 | 40.00 | 1 |
| 32 | 0154 | 21.00 | 4 |
| 84 | 0494 | 15.99 | 2 |
| : | : | : | |

# Inner Joins

```
Q25: SELECT R.SUPNR, R.SUPNAME, R.SUPSTATUS,
     S.SUPNR, S.PRODNR, S.PURCHASE_PRICE
     FROM SUPPLIER R, SUPPLIES S
```

# Inner Joins

| R.SUPNR | R.SUPNAME | R.SUPSTATUS | S.SUPNR | S.PRODNR | S.PURCHASE_PRICE |
|---|---|---|---|---|---|
| 21 | Deliwines | 20 | 21 | 0119 | 15.99 |
| 32 | Best Wines | 90 | 21 | 0119 | 15.99 |
| 37 | Ad Fundum | 95 | 21 | 0119 | 15.99 |
| 52 | Spirits & co. | NULL | 21 | 0119 | 15.99 |
| … | | | | | |
| 32 | Best Wines | 90 | 32 | 0154 | 21.00 |
| 37 | Ad Fundum | 95 | 32 | 0154 | 21.00 |
| 52 | Spirits & co. | NULL | 32 | 0154 | 21.00 |
| … | | | | | |
| 69 | Vinos del Mundo | 92 | 94 | 0899 | 15.00 |
| 84 | Wine Trade Logistics | 92 | 94 | 0899 | 15.00 |
| 94 | The Wine Crate | 75 | 94 | 0899 | 15.00 |

# Inner Joins

```
Q26: SELECT R.SUPNR, R.SUPNAME,
     R.SUPSTATUS, S.PRODNR,
     S.PURCHASE_PRICE
     FROM SUPPLIER R, SUPPLIES S
     WHERE R.SUPNR = S.SUPNR
```

# Inner Joins

| R.SUPNR | R.SUPNAME | R.SUPSTATUS | S.SUPNR | S.PRODNR | S.PURCHASE_PRICE |
|---|---|---|---|---|---|
| 21 | Deliwines | 20 | 21 | 0119 | 15.99 |
| 21 | Deliwines | 20 | 21 | 0178 | NULL |
| 21 | Deliwines | 20 | 21 | 0289 | 17.99 |
| 21 | Deliwines | 20 | 21 | 0327 | 56.00 |
| 21 | Deliwines | 20 | 21 | 0347 | 16.00 |
| 21 | Deliwines | 20 | 21 | 0384 | 55.00 |
| 21 | Deliwines | 20 | 21 | 0386 | 58.99 |
| 21 | Deliwines | 20 | 21 | 0468 | 14.99 |
| 21 | Deliwines | 20 | 21 | 0668 | 6.00 |
| 32 | Best Wines | 90 | 32 | 0154 | 21.00 |
| 32 | Best Wines | 90 | 32 | 0474 | 40.00 |
| 32 | Best Wines | 90 | 32 | 0494 | 15.00 |
| 32 | Best Wines | 90 | 32 | 0657 | 44.99 |
| 32 | Best Wines | 90 | 32 | 0760 | 52.00 |
| … | | | | | |

# Inner Joins

```
Q27: SELECT R.SUPNR, R.SUPNAME, R.SUPSTATUS,
     S.PRODNR, S.PURCHASE_PRICE
     FROM SUPPLIER AS R INNER JOIN SUPPLIES AS S
     ON (R.SUPNR = S.SUPNR)
```

# Inner Joins

```
Q28: SELECT R.SUPNR, R.SUPNAME, PO.PONR, PO.PODATE,
     P.PRODNR,P.PRODNAME, POL.QUANTITY
     FROM SUPPLIER R, PURCHASE_ORDER PO, PO_LINE
     POL, PRODUCT P
     WHERE (R.SUPNR = PO.SUPNR)
     AND (PO.PONR = POL.PONR)
     AND (POL.PRODNR = P.PRODNR)
```

# Inner Joins

| R.SUPNR | R.SUPNAME | PO.PONR | PO.PODATE | P.PRODNR | P.PRODNAME | POL.QUANTITY |
|---|---|---|---|---|---|---|
| 37 | Ad Fundum | 1511 | 2015-03-24 | 0212 | Billecart-Salmon, Brut Réserve, 2014 | 2 |
| 37 | Ad Fundum | 1511 | 2015-03-24 | 0345 | Vascosassetti, Brunello di Montalcino, 2004 | 4 |
| 37 | Ad Fundum | 1511 | 2015-03-24 | 0783 | Clos D'Opleeuw, Chardonnay, 2012 | 1 |
| 37 | Ad Fundum | 1511 | 2015-03-24 | 0856 | Domaine Chandon de Briailles, Savigny-Les-Beaune, 2006 | 9 |
| 94 | The Wine Crate | 1512 | 2015-04-10 | 0178 | Meerdael, Methode Traditionnelle Chardonnay, 2014 | 3 |
| … | | | | | | |

# Inner Joins

```
Q29: SELECT R1.SUPNAME, R2.SUPNAME,
     R1.SUPCITY
     FROM SUPPLIER R1, SUPPLIER R2
     WHERE R1.SUPCITY = R2.SUPCITY
     AND (R1.SUPNR < R2.SUPNR)
```

# Inner Joins

| SUPNR | SUPNAME | SUPADDRESS | SUPCITY | SUPSTATUS |
|---|---|---|---|---|
| 21 | Deliwines | 240, Avenue of the Americas | New York | 20 |
| 32 | Best Wines | 660, Market Street | San Francisco | 90 |
| 37 | Ad Fundum | 82, Wacker Drive | Chicago | 95 |
| 52 | Spirits & co. | 928, Strip | Las Vegas | NULL |
| 68 | The Wine Depot | 132, Montgomery Street | San Francisco | 10 |
| 69 | Vinos del Mundo | 4, Collins Avenue | Miami | 92 |

| SUPNAME | SUPNAME | SUPCITY |
|---|---|---|
| Best Wines | The Wine Depot | San Francisco |

# Inner Joins

- **Q30:**
```
SELECT R.SUPNAME
FROM SUPPLIER R, SUPPLIES S
WHERE R.SUPNR = S.SUPNR
AND S.PRODNR = '0899'
```

**Wine Crate**

# Inner Joins

```
Q31: SELECT DISTINCT R.SUPNAME
     FROM SUPPLIER R, SUPPLIES S, PRODUCT P
     WHERE S.SUPNR = R.SUPNR
     AND S.PRODNR = P.PRODNR
     AND P.PRODTYPE = 'ROSE'
```

| SUPNAME |
| --- |
| DeliWines |
| DeliWines |
| DeliWines |
| The Wine Depot |

| SUPNAME |
| --- |
| DeliWines |
| The Wine Depot |

# Inner Joins

```
Q32: SELECT P.PRODNR, P.PRODNAME, SUM(POL.QUANTITY)
     FROM PRODUCT P, PO_LINE POL
     WHERE P.PRODNR = POL.PRODNR
     GROUP BY P.PRODNR
```

| PRODNR | PRODNAME | SUM(POL.QUANTITY) |
|---|---|---|
| 0178 | Meerdael, Methode Traditionnelle Chardonnay, 2014 | 9 |
| 0185 | Chateau Petrus, 1975 | 2 |
| 0212 | Billecart-Salmon, Brut Réserve, 2014 | 23 |
| 0295 | Chateau Pape Clement, Pessac-Léognan, 2001 | 9 |
| 0306 | Chateau Coupe Roses, Granaxa, 2011 | 11 |
| … | | |

# Outer Joins

- Outer join can be used when we want to keep all the tuples of one or both tables in the result of the JOIN, regardless of whether or not they have matching tuples in the other table

# Outer Joins

```
Q33: SELECT R.SUPNR, R.SUPNAME, R.SUPSTATUS,
     S.PRODNR, S.PURCHASE_PRICE
     FROM SUPPLIER AS R LEFT OUTER JOIN SUPPLIES AS S
     ON (R.SUPNR = S. SUPNR)
```

| SUPNR | SUPNAME | SUPADDRESS | SUPCITY | SUPSTATUS |
|---|---|---|---|---|
| 68 | The Wine Depot | | | |
| 21 | Deliwines | | | |
| 94 | The Wine Crate | | | |
| .. | | | | |

| SUPNR | PRODNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| 21 | 0119 | 15.99 | 1 |
| 21 | 0289 | 17.99 | 1 |
| 68 | 0178 | 17.99 | 5 |
| : | : | : | : |

# Outer Joins

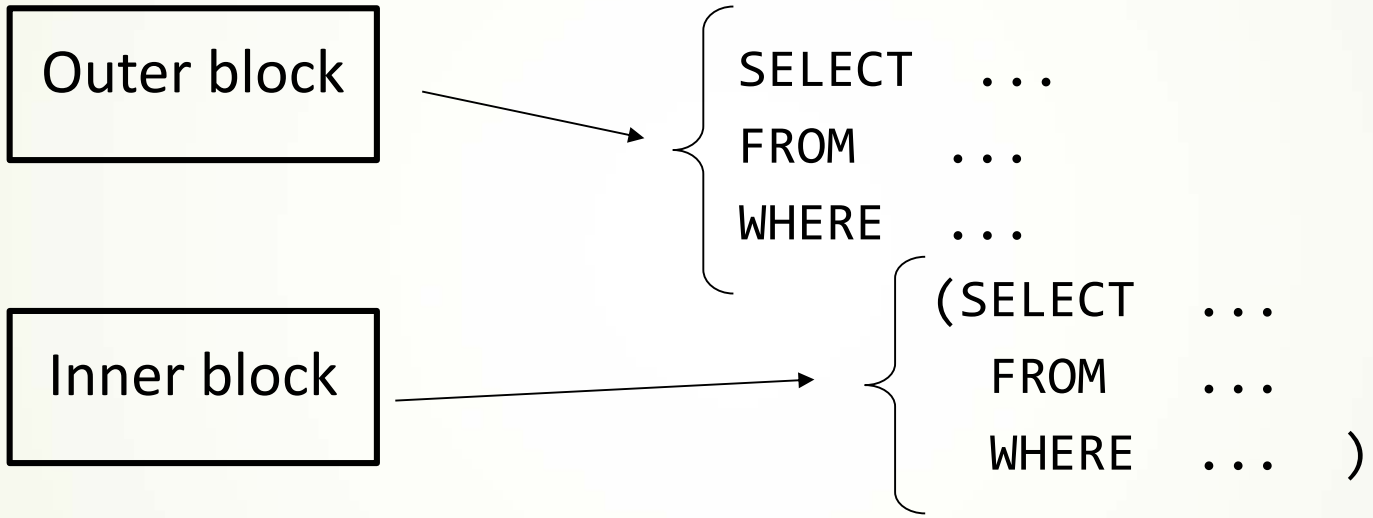
| SUPNR | SUPNAME | SUPSTATUS | PRODNR | PURCHASE_PRICE |
|---|---|---|---|---|
| 21 | Deliwines | 20 | 0119 | 15.99 |
| 21 | Deliwines | 20 | 0178 | NULL |
| … | | | | |
| 37 | Ad Fundum | 95 | 0795 | 20.99 |
| **52** | **Spirits & Co.** | **NULL** | **NULL** | **NULL** |
| 68 | The Wine Depot | 10 | 0178 | 17.99 |
| … | | | | |

# Outer Joins

```
Q34: SELECT P.PRODNR, P.PRODNAME, SUM(POL.QUANTITY)
     AS SUM FROM PO_LINE AS POL RIGHT OUTER JOIN PRODUCT AS P
     ON (POL.PRODNR = P. PRODNR)
     GROUP BY P.PRODNR
```

| P.PRODNR | P.PRODNAME | SUM |
|---|---|---|
| 0119 | Chateau Miraval, Cotes de Provence Rose, 2015 | NULL |
| 0154 | Chateau Haut Brion, 2008 | NULL |
| 0178 | Meerdael, Methode Traditionnelle Chardonnay, 2014 | 9 |
| 0185 | Chateau Petrus, 1975 | 2 |
| 0199 | Jacques Selosse, Brut Initial, 2012 | NULL |
| 0212 | Billecart-Salmon, Brut Réserve, 2014 | 23 |
| … | | |

# Nested Queries



# Nested Queries

```
Q34: SELECT SUPNAME
       FROM SUPPLIER
       WHERE SUPNR =
           (SELECT SUPNR
            FROM PURCHASE_ORDER
            WHERE PONR = '1560')
```

**Best Wines**

# Nested Queries

```
Q35: SELECT PRODNR, PRODNAME
       FROM PRODUCT
       WHERE AVAILABLE_QUANTITY >
           (SELECT AVAILABLE_QUANTITY
            FROM PRODUCT
            WHERE PRODNR = '0178')
```

| PRODNR | PRODNAME |
|---|---|
| 0212 | Billecart-Salmon, Brut Réserve, 2014 |
| 0347 | Chateau Corbin-Despagne, Saint-Emilion, 2005 |
| 0474 | Chateau De La Tour, Clos-Vougeot, Grand cru, 2008 |
| 0885 | Chateau Margaux, Grand Cru Classé, 1956 |
| 0899 | Trimbach, Riesling, 1989 |

# Nested Queries

```
Q36: SELECT SUPNAME
FROM SUPPLIER
WHERE SUPNR IN
          (SELECT SUPNR
           FROM SUPPLIES
           WHERE PRODNR ='0178')
```

| SUPNAME |
| --- |
| Deliwines |
| Ad Fundum |
| The Wine Depot |
| Vinos del Mundo |
| The Wine Crate |

# Nested Queries

```
Q37: SELECT SUPNAME
     FROM SUPPLIER
     WHERE SUPNR IN
          (SELECT SUPNR
           FROM SUPPLIES
           WHERE PRODNR IN
              (SELECT PRODNR
               FROM PRODUCT
               WHERE PRODTYPE = 'ROSE'))
```

| SUPNAME |
| --- |
| Deliwines |
| The Wine Depot |

# Nested Queries

```
Q38: SELECT PRODNAME
     FROM PRODUCT
     WHERE PRODNR IN
     (SELECT PRODNR
      FROM SUPPLIES
      WHERE SUPNR = '32')
     AND PRODNR IN
     (SELECT PRODNR
      FROM SUPPLIES
      WHERE SUPNR = '84')
```

| PRODNAME |
| --- |
| Veuve-Cliquot, Brut, 2012 |
| Conde de Hervías, Rioja, 2004 |

# Correlated Queries

- Whenever a condition in the WHERE clause of a nested query references some column of a table declared in the outer query, the two queries are said to be correlated
- The nested query is then evaluated once for each tuple (or combination of tuples) in the outer query

# Correlated Queries

```
Q39: SELECT P.PRODNR
     FROM PRODUCT P
          WHERE 1 <
               (SELECT COUNT(*)
                FROM PO_LINE POL
                WHERE P.PRODNR = POL.PRODNR)
```

| PRODNR | PRODNAME |
|---|---|
| 0212 | Billecart-Salmon, Brut Réserve, 2014 |
| 0289 | Chateau Saint Estève de Neri, 2015 |
| 0154 | Chateau Haut Brion, 2008 |
| 0295 | Chateau Pape Clement, Pessac-Léognan, 2001 |
| … | |

| PONR | PRODNR | QUANTITY |
|---|---|---|
| … | | |
| 1511 | 0212 | 2 |
| … | | |
| 1538 | 0212 | 15 |
| … | | |
| 1577 | 0212 | 6 |
| … | | |

# Correlated Queries

```
Q40: SELECT R.SUPNR, R.SUPNAME, P.PRODNR, P.PRODNAME,
     S1.PURCHASE_PRICE, S1.DELIV_PERIOD
     FROM SUPPLIER R, SUPPLIES S1, PRODUCT P
     WHERE R.SUPNR = S1.SUPNR
     AND S1.PRODNR = P.PRODNR
     AND S1.PURCHASE_PRICE <
        (SELECT AVG(PURCHASE_PRICE)
         FROM SUPPLIES S2
         WHERE P.PRODNR = S2.PRODNR)
```

# Correlated Queries

PRODUCT P

| PRODNR | PRODNAME | PRODTYPE |
|---|---|---|
| 0178 | Meerdael, Methode Traditionnelle Chardonnay, 2014 | sparkling |
| 0185 | Chateau Petrus, 1975 | red |
| .. | | |

SUPPLIER R

| SUPNR | SUPNAME | SUPADDRESS |
|---|---|---|
| 37 | Ad Fundum | … |
| 68 | The Wine Depot | … |
| 84 | Wine Trade Logistics | … |
| … | | |

SUPPLIES S1

| PRODNR | SUPNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| 0178 | 37 | 16.99 | 4 |
| 0178 | 68 | 17.99 | 5 |
| 0178 | 69 | 16.99 | - |
| 0178 | 94 | 18.00 | 6 |
| 0178 | 21 | - | - |
| 0185 | 37 | 32.99 | 3 |
| … | | | |

< AVG ?

SUPPLIES S2

| PRODNR | SUPNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| 0178 | 37 | 16.99 | 4 |
| 0178 | 68 | 17.99 | 5 |
| 0178 | 69 | 16.99 | - |
| 0178 | 94 | 18.00 | 6 |
| 0178 | 21 | - | - |
| 0185 | 37 | 32.99 | 3 |
| … | | | |

# Correlated Queries

```
Q41: SELECT P1.PRODNR
     FROM PRODUCT P1
     WHERE 3 >
             (SELECT COUNT(*)
              FROM PRODUCT P2
              WHERE P1.PRODNR < P2.PRODNR)
```

| P1.PRODNR | Result of Inner Query block | < 3? | Output |
|---|---|---|---|
| 0119 | 41 | No | No |
| 0154 | 40 | No | No |
| 0178 | 39 | No | No |
| … | … | … | … |
| 0899 | 3 | No | No |
| 0900 | 2 | Yes | Yes |
| 0915 | 1 | Yes | Yes |
| 0977 | 0 | Yes | Yes |

# Queries with ALL/ANY

- The comparison condition v > ALL V returns TRUE if the value v is greater than all the values in the multiset V.
  - If the nested query doesn't return a value, it evaluates the condition as TRUE.
- The comparison condition v > ANY V returns TRUE if the value v is greater than at least one value in the multiset V.
  - If the nested query doesn't return a value, it evaluates the whole condition as FALSE.

# Queries with ALL/ANY

```
Q42: SELECT SUPNAME
     FROM SUPPLIER
     WHERE SUPNR IN
      (SELECT SUPNR
       FROM SUPPLIES
       WHERE PRODNR = '0668'
        AND PURCHASE_PRICE >= ALL
          (SELECT PURCHASE_PRICE
           FROM SUPPLIES
           WHERE PRODNR = '0668'))
```

**The Wine Depot**

**68**

**6.00, 6.99**

# Queries with ALL/ANY

PRODUCT P

| PRODNR | PRODNAME | PRODTYPE |
|---|---|---|
| 0178 | Meerdael, Methode Traditionnelle Chardonnay, 2014 | sparkling |
| 0668 | Gallo Family Vineyards, Grenache, 2014 | rose |
| … | | |

SUPPLIES S1

| PRODNR | SUPNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| 0668 | 68 | 6.99 | 3 |
| 0668 | 21 | 6.00 | 1 |
| 0760 | 32 | 52.00 | 3 |
| 0760 | 68 | 52.99 | 2 |
| 0783 | 69 | 7.00 | 3 |
| … | … | … | … |

SUPPLIER R

| SUPNR | SUPNAME | SUPADDRESS |
|---|---|---|
| 32 | Best wines | … |
| 68 | The Wine Depot | … |
| 84 | Wine Trade Logistics | … |
| .. | | |

≥ ALL ?

SUPPLIES S2

| PRODNR | SUPNR | PURCHASE_PRICE | DELIV_PERIOD |
|---|---|---|---|
| 0668 | 68 | 6.99 | 3 |
| 0668 | 21 | 6.00 | 1 |
| 0760 | 32 | 52.00 | 3 |
| 0760 | 68 | 52.99 | 2 |
| 0783 | 69 | 7.00 | 3 |
| … | … | … | … |

# Queries with ALL/ANY

```
Q43: SELECT R1.SUPNR, R1.SUPNAME, R1.SUPCITY, R1.SUPSTATUS
     FROM SUPPLIER R1
     WHERE R1.SUPSTATUS >= ALL
    (SELECT R2.SUPSTATUS
     FROM SUPPLIER R2
     WHERE R1.SUPCITY = R2.SUPCITY)
```

| SUPNR | SUPNAME | SUPCITY | SUPSTATUS |
|---|---|---|---|
| 21 | Deliwines | New York | 20 |
| 32 | Best Wines | San Francisco | 90 |
| 37 | Ad Fundum | Chicago | 95 |
| 69 | Vinos del Mundo | Miami | 92 |
| 84 | Wine Trade Logistics | Washington | 92 |
| 94 | The Wine Crate | Dallas | 75 |

# Queries with ALL/ANY

```
Q44: SELECT SUPNAME
     FROM SUPPLIER
     WHERE SUPNR IN
          (SELECT SUPNR
           FROM SUPPLIES
           WHERE PRODNR = '0178' AND
           PURCHASE_PRICE > ANY
              (SELECT PURCHASE_PRICE
              FROM SUPPLIES
              WHERE PRODNR = '0178'))
```

**The Wine Depot, The Wine Crate**

**68,94**

**NULL, 16.99, 17.99, 16.99, 18.00**

# Queries with EXISTS

- The EXISTS function checks whether the result of a correlated nested query is empty or not
- The result is a Boolean value: TRUE or FALSE
- EXISTS returns TRUE if there is at least one tuple in the result of the nested query, or otherwise returns FALSE
- Vice versa, the NOT EXISTS function returns TRUE if there are no tuples in the result of the nested query, or otherwise returns FALSE

# Queries with EXISTS

```
Q44: SELECT SUPNAME
     FROM SUPPLIER R
     WHERE EXISTS
      (SELECT *
       FROM SUPPLIES S
       WHERE R.SUPNR = S.SUPNR
       AND S.PRODNR = '0178')
```

| SUPNAME |
| --- |
| Deliwines |
| Ad Fundum |
| The Wine Depot |
| Vinos del Mundo |
| The Wine Crate |

# Queries with EXISTS

```
Q45: SELECT SUPNAME, SUPADDRESS, SUPCITY
   FROM SUPPLIER R
   WHERE NOT EXISTS
        (SELECT *
         FROM PRODUCT P
         WHERE NOT EXISTS
            (SELECT *
             FROM SUPPLIES S
             WHERE R.SUPNR = S.SUPNR
             AND P.PRODNR = S.PRODNR))
```

# Queries with Subqueries in SELECT/FROM

```
Q46: SELECT P.PRODNR, P.PRODNAME,
     (SELECT SUM(QUANTITY) FROM PO_LINE POL
     WHERE P.PRODNR = POL.PRODNR) AS TOTALORDERED
     FROM PRODUCT P
```

| PRODNR | PRODNAME | TOTALORDERED |
|---|---|---|
| 0212 | Billecart-Salmon, Brut Réserve, 2014 | 23 |
| 0795 | Casa Silva, Los Lingues, Carmenere, 2012 | 3 |
| 0915 | Champagne Boizel, Brut, Réserve, 2010 | 13 |
| 0523 | Chateau Andron Blanquet, Saint Estephe, 1979 | NULL |
| 0977 | Chateau Batailley, Grand Cru Classé, 1975 | 11 |
| … | | |

# Queries with Subqueries in SELECT/FROM

```
Q47: SELECT M.PRODNR, M.MINPRICE, M.MAXPRICE FROM
     (SELECT PRODNR, MIN(PURCHASE_PRICE) AS MINPRICE,
     MAX(PURCHASE_PRICE) AS MAXPRICE
     FROM SUPPLIES GROUP BY PRODNR) AS M
     WHERE M.MAXPRICE-M.MINPRICE > 1
```

| PRODNR | MINPRICE | MAXPRICE |
|---|---|---|
| 0178 | 16.99 | 18.00 |
| 0199 | 30.99 | 32.00 |
| 0300 | 19.00 | 21.00 |
| 0347 | 16.00 | 18.00 |
| 0468 | 14.00 | 15.99 |

# Queries with Set Operations

- A = {10, 5, 25, 30, 45}
- B = {15, 20, 10, 30, 50}
- A UNION B = {5, 10, 15, 20, 25, 30, 45, 50}
- A INTERSECT B = {10, 30}
- A EXCEPT B = {5, 25, 45}

# Queries with Set Operations

```
Q48: SELECT SUPNR, SUPNAME
     FROM SUPPLIER
     WHERE SUPCITY = 'New York'
     UNION
     SELECT R.SUPNR, R.SUPNAME
     FROM SUPPLIER R, SUPPLIES S
     WHERE R.SUPNR = S.SUPNR
     AND S.PRODNR = '0915'
     ORDER BY SUPNAME ASC
```

| SUPNR | SUPNAME |
|---|---|
| 21 | Deliwines |
| 84 | Wine Trade Logistics |

# Queries with Set Operations

```
Q49: SELECT SUPNR, SUPNAME
     FROM SUPPLIER
     WHERE SUPCITY = 'NEW YORK'
     INTERSECT
     SELECT R.SUPNR, R.SUPNAME
     FROM SUPPLIER R, SUPPLIES S
     WHERE R.SUPNR = S.SUPNR
     AND S.PRODNR = '0915'
     ORDER BY SUPNAME ASC
```

**NULL**

# Queries with Set Operations

```
Q50: SELECT SUPNR
     FROM SUPPLIER
     EXCEPT
     SELECT SUPNR
     FROM SUPPLIES
```

**52**

# SQL INSERT Statement

```
INSERT INTO PRODUCT VALUES
('980', 'Chateau Angelus, Grand Clu Classé, 1960', 'red', 6)
```

```
INSERT INTO PRODUCT(PRODNR, PRODNAME, PRODTYPE, AVAILABLE_QUANTITY)
VALUES
('980', 'Chateau Angelus, Grand Clu Classé, 1960', 'red', 6)
```

```
INSERT INTO PRODUCT(PRODNR, PRODNAME, PRODTYPE) VALUES
('980', 'Chateau Angelus, Grand Clu Classé, 1960', 'red')
```

# SQL INSERT Statement

```
INSERT INTO PRODUCT(PRODNR, PRODNAME, PRODTYPE, AVAILABLE_QUANTITY)
VALUES
('980', 'Chateau Angelus, Grand Clu Classé, 1960', 'red', 6),
('1000', 'Domaine de la Vougeraie, Bâtard Montrachet', Grand cru, 2010’,
'white', 2),
('1002', 'Leeuwin Estate Cabernet Sauvignon 2011', 'white', 20)
```

```
INSERT INTO INACTIVE-SUPPLIERS(SUPNR)
SELECT SUPNR
   FROM SUPPLIER
   EXCEPT
   SELECT SUPNR
   FROM SUPPLIES
```

# SQL DELETE Statement

```
DELETE FROM PRODUCT
WHERE PRODNR = '1000'


DELETE FROM SUPPLIER
WHERE SUPSTATUS IS NULL


DELETE FROM SUPPLIES
WHERE PRODNR IN (SELECT PRODNR
                 FROM PRODUCT
                 WHERE PRODNAME LIKE '%CHARD%')
```

# SQL DELETE Statement

```
DELETE FROM SUPPLIER R
WHERE NOT EXISTS
    (SELECT PRODNR
     FROM SUPPLIES S
     WHERE R.SUPNR = S.SUPNR)


DELETE FROM SUPPLIES S1
WHERE S1.PURCHASE_PRICE >
(SELECT 2 * AVG(S2.PURCHASE_PRICE)
FROM SUPPLIES S2
WHERE S1.PRODNR = S2.PRODNR)


DELETE FROM PRODUCT
```

# SQL UPDATE Statement

```
UPDATE PRODUCT
SET AVAILABLE_QUANTITY = 26
WHERE PRODNR = '0185'


UPDATE SUPPLIER
SET SUPSTATUS = DEFAULT


UPDATE SUPPLIES
SET DELIV_PERIOD = DELIV_PERIOD+7
WHERE SUPNR IN (SELECT SUPNR
                FROM SUPPLIER
                WHERE SUPNAME = 'Deliwines')
```

# SQL UPDATE Statement

```
UPDATE SUPPLIES S1
SET (PURCHASE_PRICE, DELIV_PERIOD) =
(SELECT MIN(PURCHASE_PRICE), MIN(DELIV_PERIOD)
FROM SUPPLIES S2
WHERE S1.PRODNR = S2.PRODNR)
WHERE SUPNR = '68'


ALTER TABLE SUPPLIER ADD SUPCATEGORY VARCHAR(10) DEFAULT 'SILVER'
UPDATE SUPPLIER
SET SUPCATEGORY =
CASE WHEN SUPSTATUS >= 70 AND SUPSTATUS <= 90 THEN 'GOLD'
WHEN SUPSTATUS >= 90 THEN 'PLATINUM'
ELSE 'SILVER'
END
```

# SQL UPDATE Statement

| SUPNR | SUPNAME | SUPADDRESS | SUPCITY | SUPSTATUS | SUPCATEGORY |
|---|---|---|---|---|---|
| 21 | Deliwines | 20, Avenue of the Americas | New York | 20 | SILVER |
| 32 | Best Wines | 660, Market Street | San Francisco | 90 | GOLD |
| 37 | Ad Fundum | 82, Wacker Drive | Chicago | 95 | PLATINUM |
| 52 | Spirits & co. | 928, Strip | Las Vegas | NULL | SILVER |
| 68 | The Wine Depot | 132, Montgomery Street | San Francisco | 10 | SILVER |
| 69 | Vinos del Mundo | 4, Collins Avenue | Miami | 92 | PLATINUM |
| 84 | Wine Trade Logistics | 100, Rhode Island Avenue | Washington | 92 | PLATINUM |
| 94 | The Wine Crate | 330, McKinney Avenue | Dallas | 75 | GOLD |

# SQL Views

- SQL views are part of the external data model
- A view is defined by means of an SQL query and its content is generated upon invocation of the view by an application or other query
- A view is a virtual table without physical tuples
- Views allow for logical data independence which makes them a key component in the three-layer database architecture

# SQL Views

```
CREATE VIEW TOPSUPPLIERS
AS SELECT SUPNR, SUPNAME FROM SUPPLIER
WHERE SUPSTATUS > 50

CREATE VIEW TOPSUPPLIERS_SF
AS SELECT * FROM TOPSUPPLIERS
WHERE SUPCITY = 'San Francisco'
```

# SQL Views

```
CREATE VIEW ORDEROVERVIEW(PRODNR, PRODNAME,
TOTQUANTITY)
AS SELECT P.PRODNR, P.PRODNAME, SUM(POL.QUANTITY)
FROM PRODUCT AS P LEFT OUTER JOIN PO_LINE AS POL
ON (P.PRODNR = POL.PRODNR)
GROUP BY P.PRODNR
```

# SQL Views

```
SELECT * FROM TOPSUPPLIERS_SF
```

```
SELECT * FROM ORDEROVERVIEW
WHERE PRODNAME LIKE '%CHARD%'
```

# SQL Views

- Query modification: RDBMS modifies queries that query views into queries on the underlying base tables
- View materialization: a physical table is created when the view is first queried

# SQL Views

- Some views can be updated
  - In this case, the view serves as a window through which updates are propagated to the underlying base table(s)

# SQL Views

```
CREATE VIEW ORDEROVERVIEW(PRODNR, PRODNAME, TOTQUANTITY)
AS SELECT P.PRODNR, P.PRODNAME, SUM(POL.QUANTITY)
FROM PRODUCT AS P LEFT OUTER JOIN PO_LINE AS POL
ON (P.PRODNR = POL.PRODNR)
GROUP BY P.PRODNR
```

```
UPDATE VIEW ORDEROVERVIEW
SET TOTQUANTITY=10
WHERE PRODNR= '0154'
```

**ERROR!**

# SQL Views

- WITH CHECK option checks UPDATE and INSERT statements for conformity with the view definition

```
CREATE VIEW TOPSUPPLIERS
AS SELECT SUPNR, SUPNAME FROM SUPPLIER
WHERE SUPSTATUS > 50
WITH CHECK OPTION
```

```
UPDATE TOPSUPPLIERS
SET STATUS =20
WHERE SUPNR='32'
```

**OK!**

```
UPDATE TOPSUPPLIERS
SET STATUS =80
WHERE SUPNR='32'
```

**NOT OK!**

# SQL Privileges

- A privilege corresponds to the right to use certain SQL statements such as SELECT, INSERT, etc. on one or more database objects

| Privilege | Explanation |
|---|---|
| SELECT | Gives retrieval privilege |
| INSERT | Gives insert privilege |
| UPDATE | Gives update privilege |
| DELETE | Gives delete privilege |
| ALTER | Gives privilege to change the table definition |
| REFERENCES | Gives the privilege to reference the table when specifying integrity constraints |
| ALL | Gives all privileges (DBMS specific) |

# SQL Privileges

```
GRANT SELECT, INSERT, UPDATE, DELETE ON SUPPLIER TO
BBAESENS

GRANT SELECT (PRODNR, PRODNAME) ON PRODUCT TO PUBLIC

REVOKE DELETE ON SUPPLIER FROM BBAESENS

GRANT SELECT, INSERT, UPDATE, DELETE ON PRODUCT TO
WLEMAHIEU WITH GRANT OPTION

GRANT REFERENCES ON SUPPLIER TO SVANDENBROUCKE
```

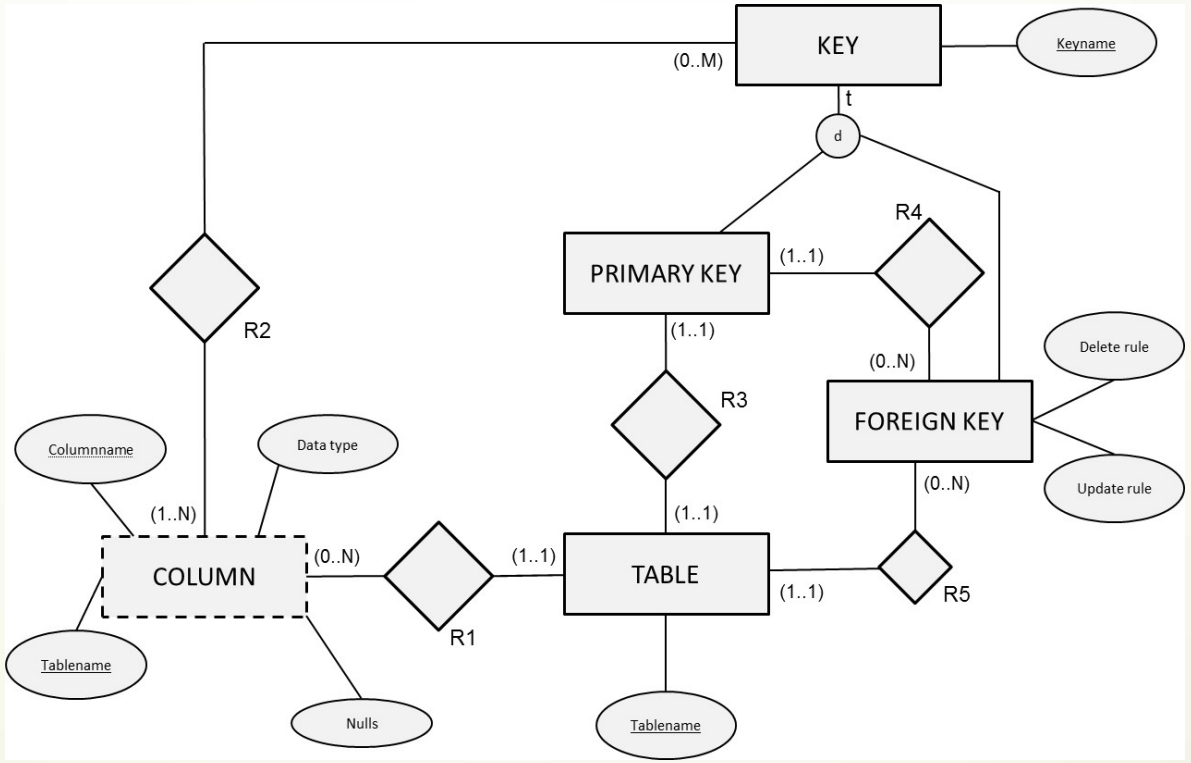
# SQL Privileges

```
CREATE VIEW SUPPLIERS_NY
AS SELECT SUPNR, SUPNAME FROM SUPPLIERS
WHERE SUPCITY = 'New York'

GRANT SELECT ON SUPPLIERS_NY TO WLEMAHIEU
```

# SQL for Metadata Management

- The catalog itself can also be implemented as a relational database



# SQL for Metadata Management

Table(Tablename, …)

Key(Keyname, …)

Primary-Key(*PK-Keyname*, *PK-Tablename*, …)

PK-Keyname is a foreign key referring to Keyname in Key
PK-Tablename is a foreign key referring to Tablename in Table

Foreign-Key(*FK-Keyname*, *FK-Tablename*, *FK-PK-Keyname*, Update-rule, Delete-rule, …)

FK-Keyname is a foreign key referring to Keyname in Key

FK-Tablename is a foreign key referring to Tablename in Table
FK-PK-Keyname is a foreign key referring to PK-Keyname in Primary-Key

Column(Columnname, *C-Tablename*, Data type, Nulls, …)

C-Tablename is a foreign key referring to Tablename in Table

Key-Column(*KC-Keyname, KC-Columnname, KC-Tablename*, …)

KC-Keyname is a foreign key referring to Keyname in Key
KC-Columnname is a foreign key referring to Columnname in Column
KC-Tablename is a foreign key referring to C-Tablename in Column

```
SELECT *
FROM Column
WHERE TableName = 'SUPPLIER'


SELECT PK.PK-Keyname, FK.FK-PK-Keyname, FK.FK-Tablename,
FK.Deleterule
FROM Primary-Key PK, Foreign-Key FK
WHERE PK.PK-Tablename = 'SUPPLIER'
AND PK.PK-Keyname = FK.FK-PK-Keyname
```

# Conclusions

- Relational database management systems and SQL
- SQL Data Definition Language
- SQL Data Manipulation Language
- SQL views
- SQL indexes
- SQL privileges
- SQL for metadata management