

## Relational Database Operators

- ❖ The degree of relational completeness can be defined by the extent to which relational algebra is supported.
- ❖ Relational algebra defines the theoretical way of manipulating table contents using the eight relational functions: UNION, INTERSECT, DIFFERENCE, PRODUCT, SELECT, PROJECT, JOIN, and DIVIDE.

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## Union Relational Operator

- ❖ UNION combines all rows from two tables. The two tables must be union compatible.
- ❖ Union Compatible means share same columns and domains.

P_CODE
123456
123457
123458

UNION

P_CODE
345678
345679

yields

P_CODE
123456
123457
123458
345678
345679

FIGURE 2.5 UNION

### Figure 2.5 UNION

## Intersect Relational Operator

- ❖ INTERSECT produces a listing that contains only the rows that appear in both tables. The two tables must be union compatible.

F_NAME
George
Jane
Elaine
Wilfred
Jorge

INTERSECT

F_NAME
Jane
William
Jorge
Dennis

yields

F_NAME
Jane
Jorge

FIGURE 2.6 INTERSECT

### Figure 2.6 INTERSECT

## Difference Relational Operator

- ❖ DIFFERENCE yields all rows in one table that are NOT found in the other table;
- ❖ i.e., it subtracts one table from the other.
- ❖ The tables must be union compatible.

F_NAME
George
Jane
Elaine
Wilfred
Jorge

DIFFERENCE

F_NAME
Jane
Jorge

yields

F_NAME
George
Elaine
Wilfred

FIGURE 2.7 DIFFERENCE

### Figure 2.7 DIFFERENCE

## Select Relational Operator

- ❖ **SELECT** yields values for all attributes found in a table. It yields a horizontal subset of a table.

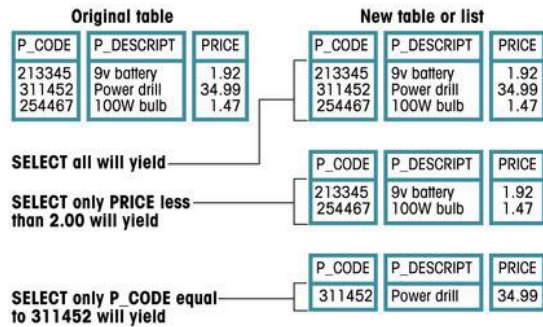


FIGURE 2.9 ■ SELECT

## Join Relational Operations

- ❖ **JOIN** operations allow us to combine information from two or more tables
- ◆ Power behind relational databases
- ◆ Allowing the use of independent tables linked by common attributes

**Table name: CUSTOMER**

CUS_CODE	CUS_LNAME	CUS_ZIP	AGENT_CODE
1132445	Walker	32145	231
1321242	Rodriguez	37134	125
1657399	Vanloo	32145	231
1312243	Rakowski	34129	167
1542311	Smithson	37134	421
1217782	Adares	32145	125

**Table name: AGENT**

AGENT_CODE	AGENT_CODE
125	6152439887
167	6153426778
231	6152431124
333	9041234445

FIGURE 2.11 ■ TWO TABLES THAT WILL BE USED IN JOIN ILLUSTRATIONS

## Natural Join Relational Operator

- ❖ **Natural JOIN** links tables by selecting only rows with common values in common attribute(s).
- ❖ Basically a M:1 operation where Foreign Key must match a Primary Key

Figure 2.14 Natural Join

CUS_CODE	CUS_LNAME	CUS_ZIP	AGENT_CODE	AGENT_PHONE
1132445	Walker	32145	231	6152431124
1321242	Rodriguez	37134	125	6152439887
1657399	Vanloo	32145	231	6152431124
1312243	Rakowski	34129	167	6153426778
1217782	Adares	32145	125	6152439887

FIGURE 2.14 ■ NATURAL JOIN, STEP 3: PROJECT

## Outer Join Relational Operator

- ❖ **Outer JOIN** links tables and retains unmatched pairs.
- ❖ Values for the unmatched rows items would be left blank or null.

CUS_CODE	CUS_LNAME	CUS_ZIP	AGENT_CODE	AGENT_PHONE
1132445	Walker	32145	231	6152431124
1321242	Rodriguez	37134	125	6152439887
1657399	Vanloo	32145	231	6152431124
1312243	Rakowski	34129	167	6153426778
1542311	Smithson	37134	421	
1217782	Adares	32145	125	6152439887
			333	9041234445

FIGURE 2.15 ■ OUTER JOIN

## Introduction to SQL

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- ❖ SQL is an database specification language:
  - ◆ Data definition
    - Creates Database and Table Structures
  - ◆ Data manipulation
    - Allows data Select, Delete, and Update
  - ◆ SQL is relatively easy to learn.
  - ◆ ANSI prescribes a standard SQL.
    - Microsoft Access supports some but not all of the ANSI specification
    - Results in Syntax conflicts with book

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## Data Definition SQL Commands

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- ❖ The Database Model
  - ◆ Simple Database -- *PRODUCT* and *VENDOR* tables
    - Each product is supplied by only a single vendor.
    - A vendor may supply many products.

FIGURE 3.1 THE DATABASE MODEL

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PRODUCT : Table							
P_CODE	P_DESCRIPT	P_INDATE	P_ONHAND	P_MIN	P_PRICE	P_DISCOUNT	V_CODE
110ER31	Power painter, 15 psi., 3-nozzle	02-Dec-1996	8	5	\$109.99	0.00	25595
13-Q2/P2	7.25-in. pwr. saw blade	12-Nov-1996	32	15	\$14.99	0.05	21344
14-Q1/L3	9.00-in. pwr. saw blade	12-Nov-1996	18	12	\$17.49	0.00	21344
1546-Q02	Hrd. cloth, 1/4-in., 2x50	14-Aug-1996	15	8	\$39.95	0.00	23119
1558-QW1	Hrd. cloth, 1/2-in., 3x50	14-Aug-1996	23	5	\$43.99	0.00	23119
2232-QTY	B&D jigsaw, 12-in. blade	29-Oct-1996	8	5	\$109.92	0.05	24288
2232-QWE	B&D jigsaw, 8-in. blade	23-Sep-1996	6	5	\$99.87	0.05	24288
2238/QPD	B&D cordless drill, 1/2-in.	19-Oct-1996	12	5	\$38.95	0.05	25595
23109-HB	Claw hammer	19-Nov-1996	23	10	\$5.95	0.10	21225
23114-AA	Sledge hammer, 12 lb.	01-Dec-1996	8	5	\$14.40	0.05	
54778-2T	Rat-tail file, 1 1/8-in. fine	14-Jun-1996	43	20	\$4.99	0.00	21344
89-WRE-Q	Hicut chain saw, 16 in.	06-Jul-1996	11	5	\$256.99	0.05	24288
PVC23DRT	PVC pipe, 3.5-in., 8-ft	19-Dec-1996	188	75	\$5.87	0.00	
SM-18277	1.25-in. metal screw, 25	28-Nov-1996	172	75	\$6.99	0.00	21225
SW-23116	2.5-in. wd. screw, 50	23-Sep-1996	237	100	\$8.45	0.00	21231
WR3/TT3	Steel matting, 4'x8'x1/8", .6" mesh	16-Nov-1996	18	5	\$119.95	0.10	25595
*			0	0	\$0.00	0.00	

VENDOR : Table						
V_CODE	V_NAME	V_CONTACT	V_AREACODE	V_PHONE	V_STATE	V_ORDER
21225	Bryson, Inc.	Smithson	615	223-3234	TH	Y
21226	SuperLoo, Inc.	Flushing	904	215-8995	FL	N
21231	D&E Supply	Singh	615	228-3245	TH	Y
21344	Gomez Bros.	Ortega	615	889-2546	KY	N
22567	Dome Supply	Smith	901	678-1419	GA	N
23119	Randssets Ltd.	Anderson	901	678-3998	GA	Y
24004	Brackman Bro	Browning	615	228-1410	TN	N
24288	ORDVA, Inc.	Hakford	615	898-1234	TH	Y
25443	B&K, Inc.	Smith	904	227-0093	FL	N
25501	Damal Supplie	Smythe	615	890-3529	TH	N
25595	Rubicon Sis.	Orton	904	456-0092	FL	Y
*						

### Table 3.1 A Data Dictionary for the CH3 Database

TABLE NAME	ATTRIBUTE NAME	CONTENTS	TYPE	FORMAT	RANGE	REQUIRED	PK OR FK	FK REFERENCED TABLE
PRODUCT	P_CODE	Product code	CHAR(10)	XXXXXXXXXX	NA	Y	PK	
	P_DESCRIPT	Product description	VARCHAR(35)	XXXXXXXXXXXX	NA	Y		
	P_INDATE	Stocking date	DATE	DDMMYYYY	NA	Y		
	P_ONHAND	Units available	SMALLINT	#####	0-9999	Y		
	P_MIN	Minimum units	SMALLINT	#####	0-9999	Y		
	P_PRICE	Product price	NUMBER(8,2)	#####.##	0.00-9999.00	Y		
	P_DISCOUNT	Discount rate	NUMBER(4,2)	0.###	0.00-0.20	Y		
V_CODE	Vendor code	INTEGER	####	100-999	Y	FK	VENDOR	
VENDOR	V_CODE	Vendor code	INTEGER	####	1000-9999	Y	PK	
	V_NAME	Vendor name	CHAR(35)	XXXXXXXXXXXXXX	NA	Y		
	V_CONTACT	Contact person	CHAR(25)	XXXXXXXXXXXXXX	NA	Y		
	V_AREACODE	Area code	CHAR(3)	999	NA	Y		
	V_PHONE	Phone number	CHAR(8)	999-9999	NA	Y		
	V_STATE	State	CHAR(2)	XX	NA	Y		
	V_ORDER	Previous order	CHAR(1)	X	Y or N	Y		

FK = Foreign key  
 PK = Primary key  
 CHAR = Fixed character length data. 1 to 255 characters.  
 VARCHAR = Variable character length data. 1 to 2,000 characters. May also be labeled VARCHAR2 in Oracle.  
 NUMBER = Numeric data. NUMBER(9,2) is used to specify numbers with two decimal places and up to nine digits, including the decimal places. Some RDBMSs permit the use of a MONEY or a CURRENCY data type.  
 INT = Integer values only  
 SMALLINT = Small integer values only

### Access Supported Data Types and Syntax

Item	Synonyms	Description
TEXT (w)	CHAR (w) VARCHAR (w)	Stores alphanumeric text with field width (w). Limited to 255 character maximum. Each character requires 1 byte storage. No difference between CHAR and VARCHAR.
MEMO		Memo data type supports up to 65,535 characters. No field width is specified as allocated dynamically. No Synonyms.
INTEGER	INT	Stores 4-byte long integer (whole number) value with permissible range ±2 billion.
SMALLINT		Stores 2-byte integer (whole number) value with permissible range ±32,000.
BYTE		Stores 1-byte integer (whole number) value with permissible range +127 to -128.
SINGLE		Stores 4-byte floating point (real number) value with 6 significant digits accuracy.
DOUBLE	NUMBER	Stores 8-byte floating point (real number) value with 13 significant digits accuracy.
CURRENCY		Stores 8-byte currency value with 15 significant digits accuracy.
YESNO		Stores a Boolean true/false value.
DATE TIME	DATE	Stores Date and Time in this field.

### SQL Data Definition Commands CREATE TABLE Statement (MS Access)

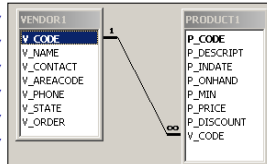
- ❖ CREATE a database TABLE (entity set) with the specified structure.
- ❖ PRIMARY KEY is a CONSTRAINT that is assigned an identifier.
- ❖ For Entity Integrity to exist for this table, it's PRIMARY KEY must have the integrity constraints NOT NULL and UNIQUE.

```
CREATE TABLE VENDOR1 (
    V_CODE          INTEGER          NOT NULL    UNIQUE
        CONSTRAINT pkVENDOR    PRIMARY KEY,
    V_NAME          TEXT (35)        NOT NULL,
    V_CONTACT       TEXT (15)        NOT NULL,
    V_AREACODE      TEXT (3)         NOT NULL,
    V_PHONE         TEXT (8)         NOT NULL,
    V_STATE         TEXT (2)         NOT NULL,
    V_ORDER         TEXT (1)         NOT NULL
);
```

### SQL Data Definition Commands CREATE TABLE Statement (MS Access)

- ❖ FOREIGN KEY is assigned as a CONSTRAINT which REFERENCES a field in the joined table.
- ❖ Create only one table per query or MS Access "chokes".

```
CREATE TABLE PRODUCT1 (
    P_CODE          TEXT (10)        NOT NULL    UNIQUE
        CONSTRAINT pkProduct    PRIMARY KEY,
    P_DESCRIPT      TEXT (35)        NOT NULL,
    P_INDATE       DATE              NOT NULL,
    P_ONHAND       SMALLINT         NOT NULL,
    P_MIN          SMALLINT         NOT NULL,
    P_PRICE        CURRENCY          NOT NULL,
    P_DISCOUNT    SINGLE           NOT NULL,
    V_CODE         INTEGER           NOT NULL
        CONSTRAINT fkVENDOR     REFERENCES VENDOR1 (V_CODE)
);
```



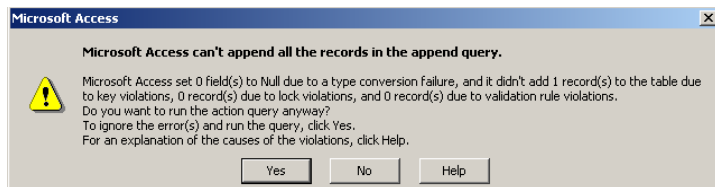
### SQL Data Management Commands

- ❖ Data Entry  
INSERT INTO <table name> VALUES
- ❖ Deleting Table Rows  
DELETE FROM PRODUCT WHERE
- ❖ Making a Changes to Data Items  
UPDATE PRODUCT

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## SQL Data Management Commands Data Record (Tuple) INSERT INTO

- ❖ Insert only one record per query or MS Access "chokes".
  - ◆ INSERT INTO VENDOR1 VALUES(21225, 'Bryson, Inc.', 'Smithson', '615','223-3234', 'TN', 'Y');
  - ◆ INSERT INTO VENDOR1 VALUES(25595, 'Rubicon Sis.', 'Orton', '904','890-3529', 'TN', 'N');
  - ◆ INSERT INTO PRODUCT1 VALUES('11 QER/31', 'Power painter, 15 psi., 3-nozzle', '07/02/1999', 8, 5, 109.99, 0.00, 25595);



- ◆ INSERT INTO VENDOR1 SELECT \* FROM VENDOR;
- ◆ INSERT INTO PRODUCT1 SELECT \* FROM PRODUCT;

## SQL Data Management Commands Data Record (Tuple) DELETE FROM

- ❖ DELETE record(s) as specified in WHERE clause.
  - ◆ DELETE FROM VENDOR1 WHERE V\_STATE='FL';
  - ◆ DELETE FROM VENDOR1 WHERE V\_STATE='KY' AND V\_STATE='GA';
  - ◆ DELETE FROM VENDOR1 WHERE V\_STATE='KY' OR V\_STATE='GA';

V_CODE	V_NAME	V_CONTACT	V_AREACODE	V_PHONE	V_STATE	V_ORDER
+ 21225	Bryson, Inc.	Smithson	615	223-3234	TN	Y
+ 21226	SuperLoo, Inc.	Flushing	904	215-8995	FL	N
+ 21231	D&E Supply	Singh	615	228-3245	TN	Y
+ 21344	Gomez Bros.	Ortega	615	889-2546	KY	N
+ 22567	Dome Supply	Smith	901	678-1419	GA	N
+ 23119	Randssets Ltd.	Anderson	901	678-3998	GA	Y
+ 24004	Brackman Bro	Browning	615	228-1410	TN	N
+ 24288	ORDVA, Inc.	Hakford	615	898-1234	TN	Y
+ 25443	B&K, Inc.	Smith	904	227-0093	FL	N
+ 25501	Damal Supplie	Smythe	615	890-3529	TN	N
+ 25595	Rubicon Sis.	Orton	904	456-0092	FL	Y

## SQL Data Management Commands Data Item UPDATE SET WHERE

- ❖ UPDATE items specified in WHERE clause to SET value.
  - ◆ UPDATE PRODUCT1 SET P\_INDATE = '6/1/2001' WHERE P\_CODE = '13-Q2/P2';
  - ◆ UPDATE PRODUCT1 SET V\_CODE = 23119 WHERE V\_CODE = 24288;

P_CODE	P_DESCRIPT	P_INDATE	P_ONHAND	P_MIN	P_PRICE	P_DISCOUNT	V_CODE
110ER/31	Power painter, 15 psi., 3-nozzle	02-Dec-1996	8	5	\$109.99	0.00	25595
13-Q2/P2	7.25-in. pwr. saw blade	01-Jun-2001	32	15	\$14.99	0.05	21344
14-Q1A.3	9.00-in. pwr. saw blade	12-Nov-1996	18	12	\$17.49	0.00	21344
1546-Q02	Hrd. cloth, 1/4-in., 2x50	14-Aug-1996	15	8	\$39.95	0.00	23119
1558-QW1	Hrd. cloth, 1/2-in., 3x50	14-Aug-1996	23	5	\$43.99	0.00	23119
2232/QTY	B&D jigsaw, 12-in. blade	29-Oct-1996	8	5	\$109.92	0.05	23119
2232/QWE	B&D jigsaw, 8-in. blade	23-Sep-1996	6	5	\$99.87	0.05	23119
2238/QPD	B&D cordless drill, 1/2-in.	19-Oct-1996	12	5	\$38.95	0.05	25595
23109-HB	Claw hammer	19-Nov-1996	23	10	\$5.95	0.10	21225
23114-AA	Sledge hammer, 12 lb.	01-Dec-1996	8	5	\$14.40	0.05	
54778-2T	Rat-tail file, 1/8-in. fine	14-Jun-1996	43	20	\$4.99	0.00	21344
89-WRE-Q	Hicut chain saw, 16 in.	06-Jul-1996	11	5	\$256.99	0.05	23119
PVC23DR1	PVC pipe, 3.5-in., 8-ft	19-Dec-1996	188	75	\$5.87	0.00	
SM-18277	1.25-in. metal screw, 25	28-Nov-1996	172	75	\$6.99	0.00	21225
SW-23116	2.5-in. wd. screw, 50	23-Sep-1996	237	100	\$8.45	0.00	21231
WR3/TT3	Steel matting, 4'x8'x1/8", .5" mesh	16-Nov-1996	18	5	\$119.95	0.10	25595
*			0	0	\$0.00	0.00	

## SQL Queries Commands

- ❖ Partial Listing of Table Contents

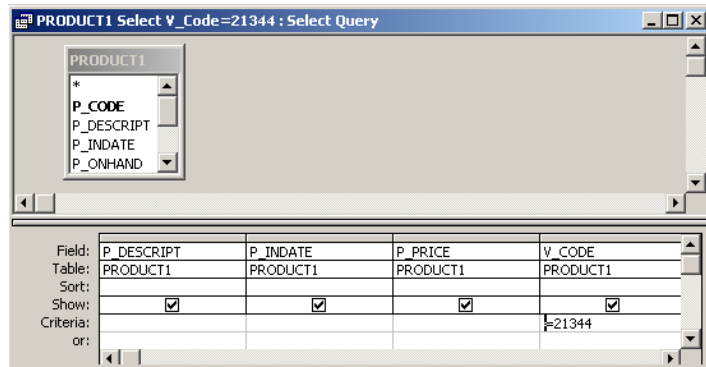
```
SELECT <column(s)>
FROM <table name>
WHERE <conditions>;
```

```
SELECT P_DESCRIPT, P_INDATE,
P_PRICE, V_CODE
FROM PRODUCT1
WHERE V_CODE = 21344;
```

P_DESCRIPT	P_INDATE	P_PRICE	V_CODE
7.25-in. pwr. saw blade	Thursday, August 12, 1999	\$14.99	21344
9.00-in. pwr. saw blade	Thursday, August 12, 1999	\$17.49	21344
Rat-tail file, 1/8-in. fine	Saturday, August 14, 1999	\$4.99	21344

FIGURE 3.5 SELECTED PRODUCT TABLE ATTRIBUTES FOR VENDOR CODE 21344

Figure 3.6: The Microsoft Access QBE and SQL



```
SELECT P_DESCRIPT, P_INDATE, P_PRICE, V_CODE
FROM PRODUCT1
WHERE V_CODE = 21344;
```

## Queries

### Relational (Mathematical) Operators

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TABLE 3.4 ■ MATHEMATICAL OPERATORS

SYMBOL	MEANING
=	Equal to
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
< >	Not equal to *

\*Some SQL versions use != rather than < >

Table 3.4

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## Queries

```
SELECT P_DESCRIPT, P_ONHAND,
P_MIN, P_PRICE
FROM PRODUCT
WHERE P_PRICE <= 10;
```

P_DESCRIPT	P_ONHAND	P_MIN	P_PRICE
Claw hammer	23	10	\$5.95
Rat-tail file, 1/8-in. fine	43	20	\$4.99
PVC pipe, 3.5-in., 8-ft	188	75	\$5.87
1.25-in. metal screw, 25	172	75	\$6.99
2.5-in. wd. screw, 50	237	100	\$8.45

FIGURE 3.8 ■ SELECTED PRODUCT TABLE ATTRIBUTES WITH A P\_PRICE RESTRICTION

Figure 3.8

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## Queries

### ❖ Using Relational Operators on Character Attributes

```
SELECT P_DESCRIPT, P_ONHAND,
P_MIN, P_PRICE FROM PRODUCT
WHERE P_CODE < '1558-QWI';
```

P_CODE	P_DESCRIPT	P_ONHAND	P_MIN	P_PRICE
11QER/31	Power painter, 15 psi, 3-nozzle	8	5	\$109.99
13-Q2/P2	7.25-in. pwr. saw blade	32	15	\$14.99
14-Q1/L3	9.00-in. pwr. saw blade	18	12	\$17.49
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15	8	\$39.95

FIGURE 3.9 ■ SELECTED PRODUCT TABLE ATTRIBUTES: THE ASCII CODE EFFECT

## Queries

❖ Using Relational Operators on Dates

```
SELECT P_CODE, P_DESCRIPT,
       P_INDATE
FROM PRODUCT1
WHERE P_INDATE >= #11/15/1996#;
```

P_CODE	P_DESCRIPT	P_INDATE
11QER/31	Power painter, 15 psi, 3-nozzle	02-Dec-1996
▶ 23109-HB	Claw hammer	19-Nov-1996
SM-18277	1.25-in. metal screw, 25	28-Nov-1996
WR3/TT3	Steel matting, 4'x8'x1/8", .5" mesh	16-Nov-1996

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## Logical Operators

■ There are three logical operators

- AND &&
- OR ||
- NOT <> !=

A	NOT A
F	T
T	F

A	B	A AND B
F	F	F
F	T	F
T	F	F
T	T	T

A	B	A OR B
0	0	0
0	1	1
1	0	1
1	1	1

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## Queries

```
SELECT P_DESCRIPT, P_INDATE,
       P_PRICE, V_CODE FROM PRODUCT1
WHERE (P_PRICE < 50) AND
       (P_INDATE > #11/15/1996#);
```

P_DESCRIPT	P_INDATE	P_PRICE	V_CODE
▶ Claw hammer	19-Nov-1996	\$5.95	21225
1.25-in. metal s	28-Nov-1996	\$6.99	21225
*			

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## Queries

❖ Special Operators used with WHERE

- ◆ BETWEEN - define range limits.
- ◆ IS NULL - check attribute value is null
- ◆ LIKE - check for similar character strings.
- ◆ IN - check if attribute value matches a value contained within a (sub)set of listed values.
- ◆ EXISTS - check whether an attribute has a value. EXISTS is the opposite of IS NULL.

❖ Wild Card Characters

- ◆ \* Any and All
- ◆ ? Any 1 Character

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## Special Operators

- ❖ **BETWEEN** used to define range limits same as below.  

```
SELECT *
  FROM PRODUCT1
 WHERE P_PRICE BETWEEN 50.00
        AND 100.00;
```
- ❖ **IN** used to check whether an attribute value matches a value contained within a (sub)set of listed values.  

```
SELECT * FROM VENDOR1 WHERE
  V_CODE IN (21344, 24288);
```

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## Special Operators

- ❖ **IS NULL** is used to check whether an attribute value is null.  

```
SELECT P_CODE, P_DESCRIPT
  FROM PRODUCT1
 WHERE P_MIN IS NULL;
```
- ❖ **LIKE** is used to check for similar character strings.  

```
SELECT * FROM VENDOR WHERE
  V_CONTACT LIKE 'Smith*';
```

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## Arithmetic Operators

- ❖ **UPDATE** table using a mathematical expression  

```
UPDATE PRODUCT1
  SET P_PRICE = P_PRICE*1.10
  WHERE P_PRICE < 50.00;
```

```
UPDATE PRODUCT1
  SET P_ONHAND = P_ONHAND - 1
  WHERE P_CODE = '13-Q2/P2';
```

ARITHMETIC OPERATOR	DESCRIPTION
+	Add
-	Subtract
*	Multiply
/	Divide

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## Queries Windows

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