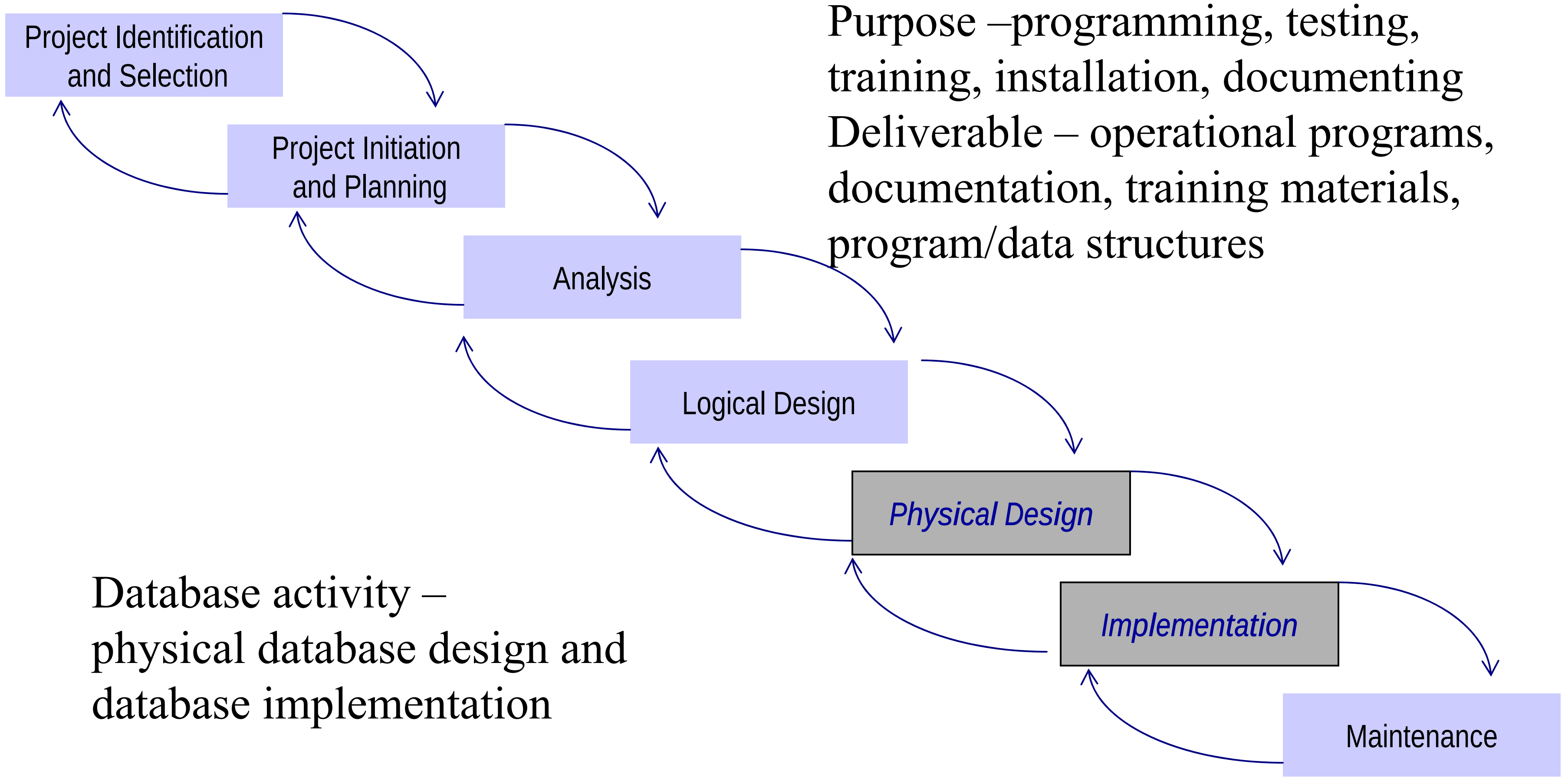
COP 4710: Database Systems
Fall 2006

Chapter 5 – Introduction To SQL – Part 1

Instructor : Mark Llewellyn
markl@cs.ucf.edu
CSB 242, 823-2790
http://www.cs.ucf.edu/courses/cop4710/fall2006

School of Electrical Engineering and Computer Science
University of Central Florida

The Physical Design Stage of SDLC



Project Identification and Selection
Project Initiation and Planning
Analysis
Logical Design
Physical Design
Implementation
Maintenance

Purpose –programming, testing, training, installation, documenting

Deliverable – operational programs, documentation, training materials, program/data structures

Database activity – physical database design and database implementation

SQL Overview

- SQL ≡ Structured Query Language.
- The standard for relational database management systems (RDBMS).
- SQL-99 and SQL: 2003 Standards – Purpose:
  - Specify syntax/semantics for data definition and manipulation.
  - Define data structures.
  - Enable portability.
  - Specify minimal (level 1) and complete (level 2) standards.
  - Allow for later growth/enhancement to standard.

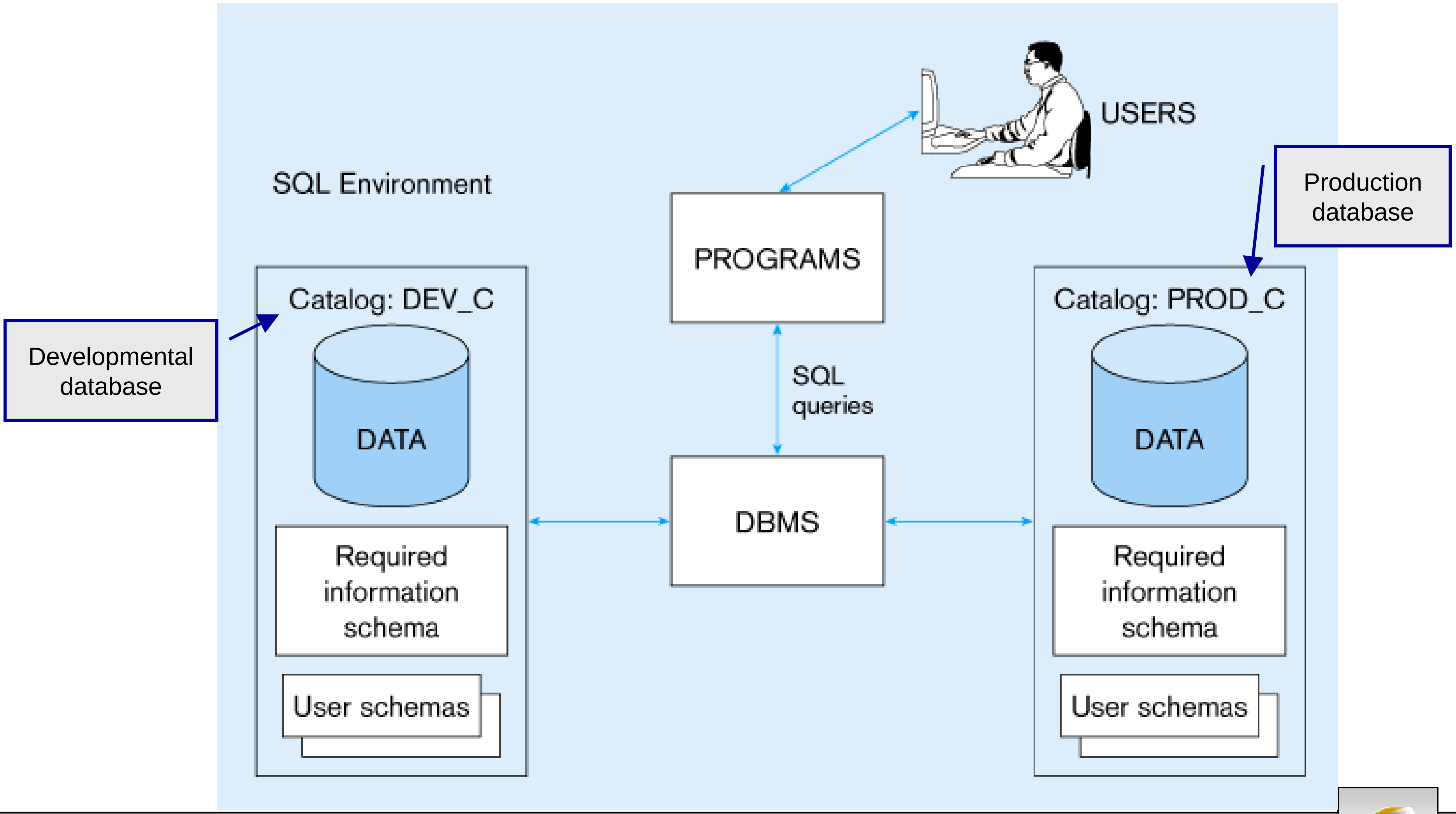
Benefits of a Standardized Relational Language

- Reduced training costs
- Productivity
- Application portability
- Application longevity
- Reduced dependence on a single vendor
- Cross-system communication

The SQL Environment

- Catalog
  - A set of schemas that constitute the description of a database.
- Schema
  - The structure that contains descriptions of objects created by a user (base tables, views, constraints).
- Data Definition Language (DDL)
  - Commands that define a database, including creating, altering, and dropping tables and establishing constraints.
- Data Manipulation Language (DML)
  - Commands that maintain and query a database.
- Data Control Language (DCL)
  - Commands that control a database, including administering privileges and committing data.

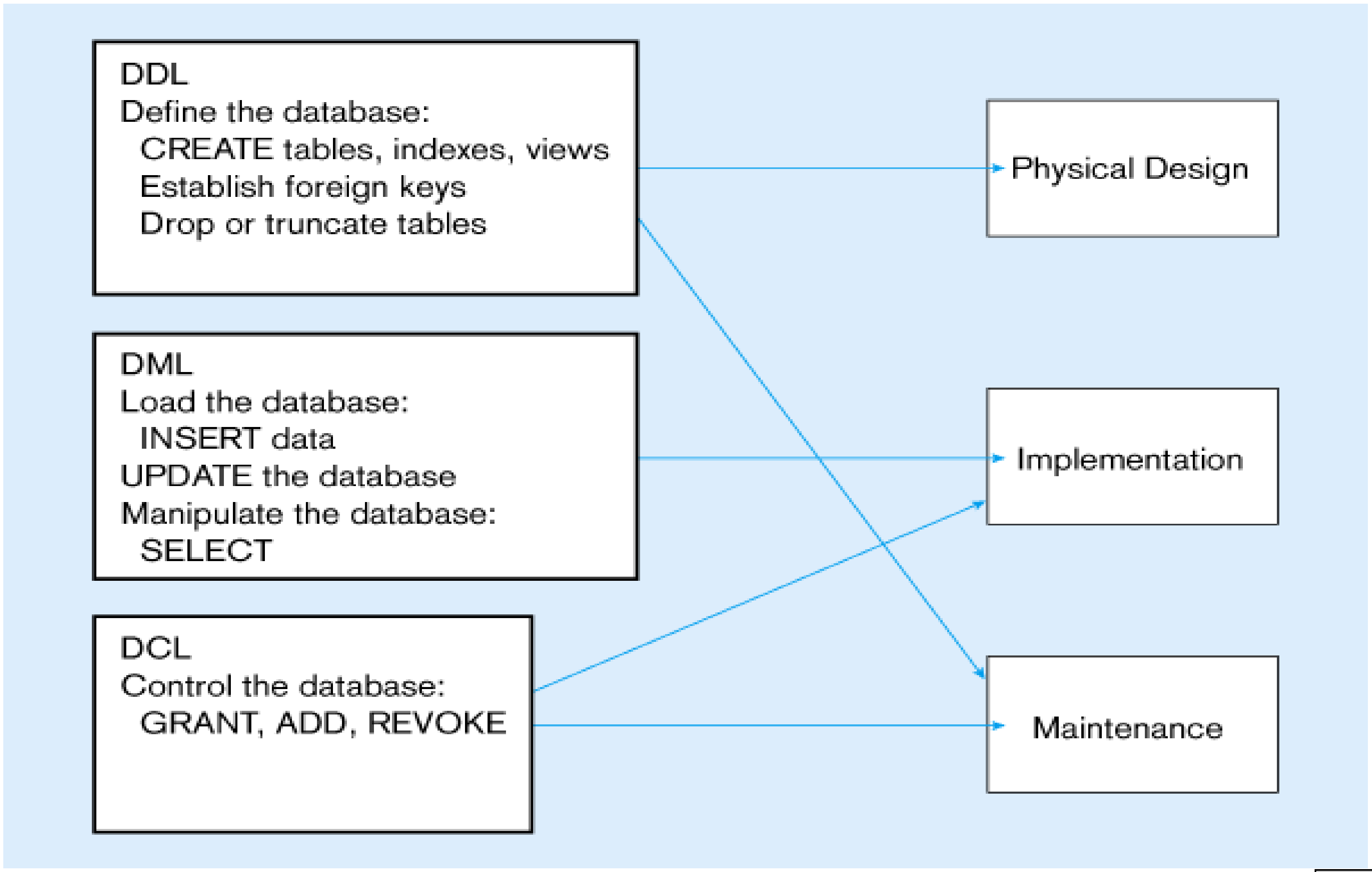
A simplified schematic of a typical SQL environment, as described by the SQL:2003 standard



Some SQL Data Types (from Oracle 9i)

- String types
  - CHAR(n) – fixed-length character data, n characters long Maximum length = 2000 bytes
  - VARCHAR2(n) – variable length character data, maximum 4000 bytes
  - LONG – variable-length character data, up to 4GB. Maximum 1 per table
- Numeric types
  - NUMBER(p,q) – general purpose numeric data type
  - INTEGER(p) – signed integer, p digits wide
  - FLOAT(p) – floating point in scientific notation with p binary digits precision
- Date/time type
  - DATE – fixed-length date/time in dd-mm-yy form

DDL, DML, DCL, and the database development process



SQL Database Definition

- Data Definition Language (DDL)
- Major CREATE statements:
  - CREATE SCHEMA – defines a portion of the database owned by a particular user.
  - CREATE TABLE – defines a table and its columns.
  - CREATE VIEW – defines a logical table from one or more views.
- Other CREATE statements: CHARACTER SET, COLLATION, TRANSLATION, ASSERTION, DOMAIN.

Table Creation

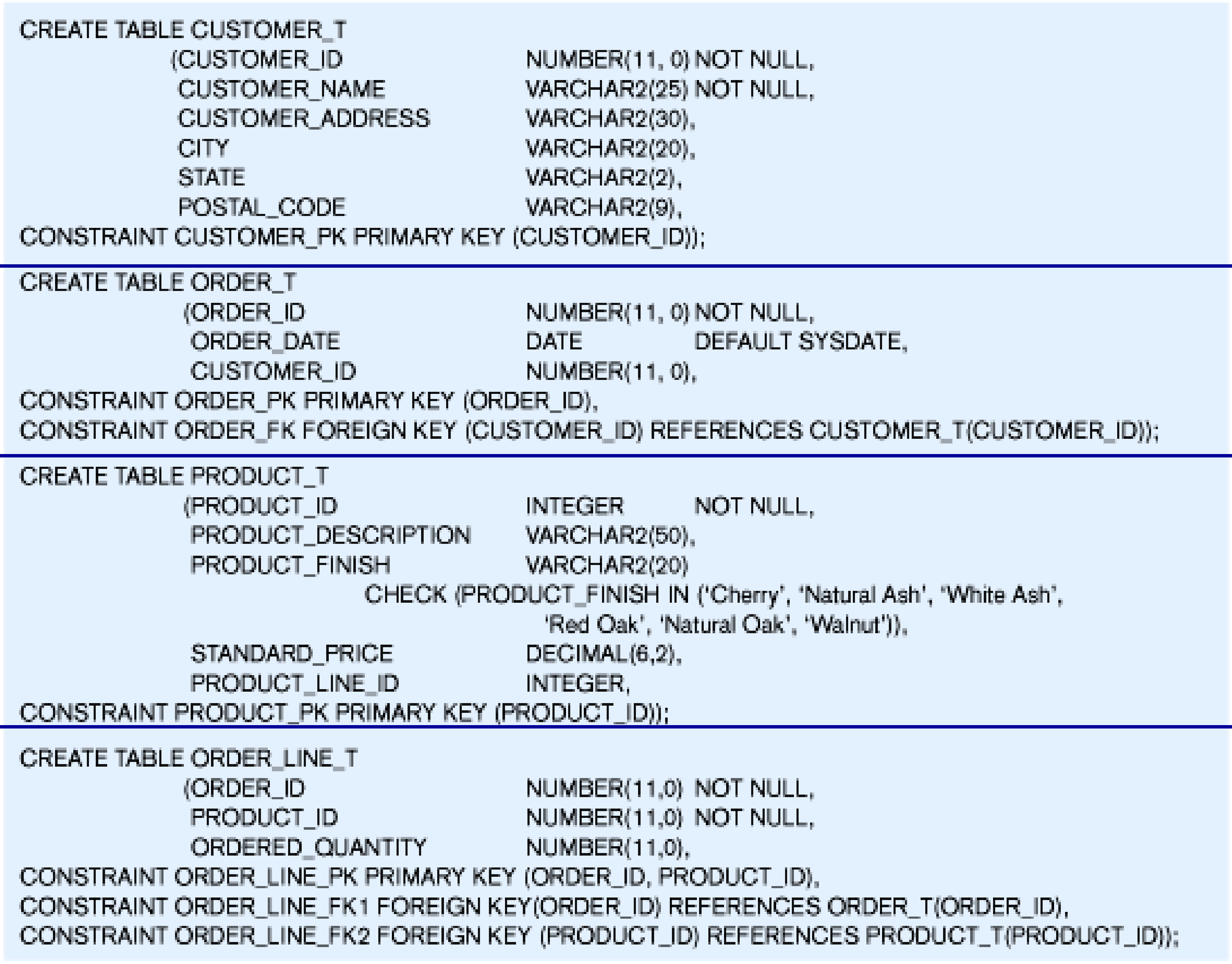
General syntax for CREATE TABLE

```
CREATE TABLE tablename
( {column definition   [table constraint] } . , . .
[ON COMMIT {DELETE | PRESERVE} ROWS] );

where column definition ::=
column_name
          {domain name | datatype [(size)] }
          [column_constraint_clause . . .]
          [default value]
          [collate clause]

and table constraint ::=
          [CONSTRAINT constraint_name]
          Constraint_type [constraint_attributes]
```

Steps in table creation:

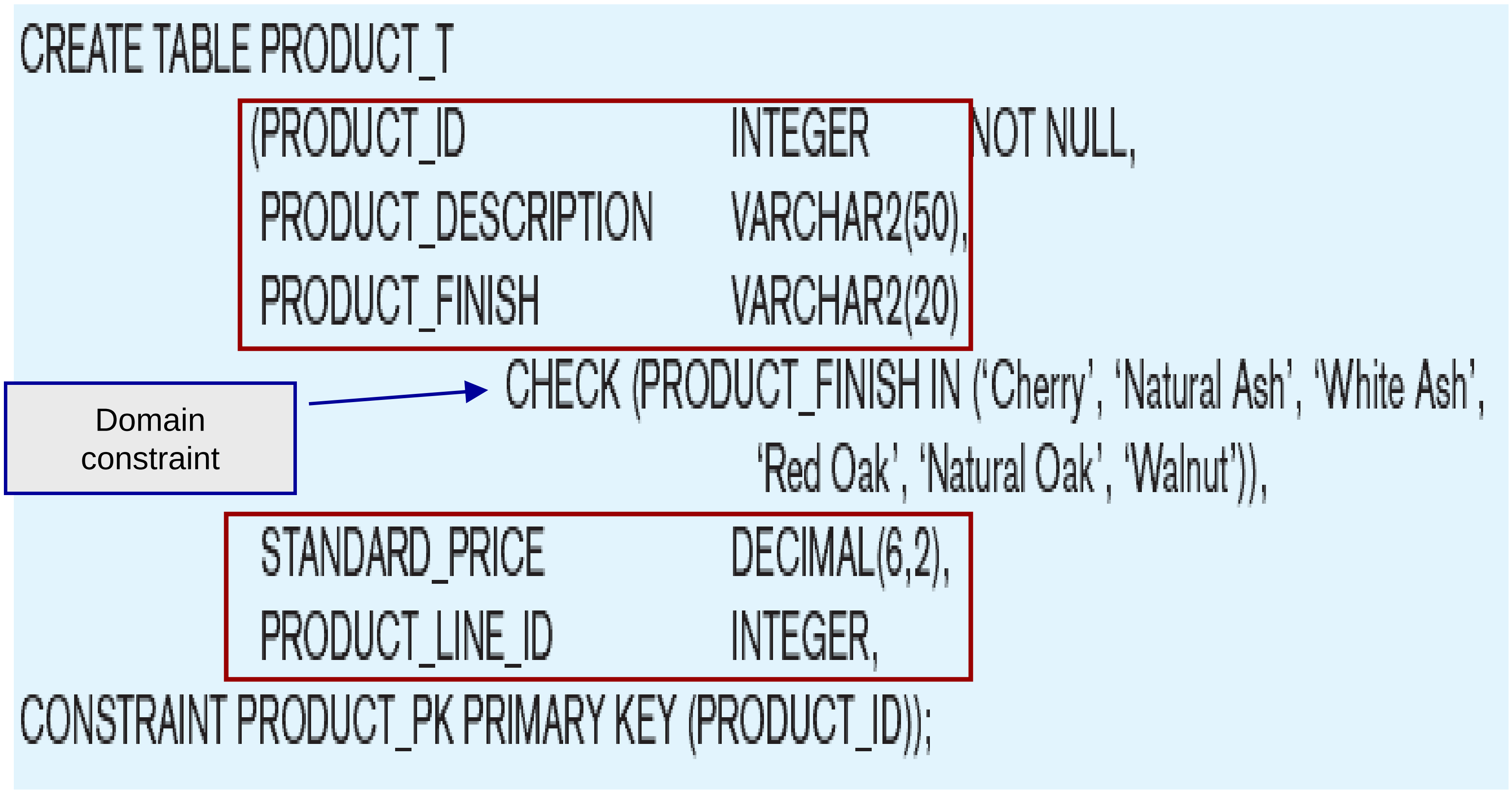
1. Identify data types for attributes
2. Identify columns that can and cannot be null
3. Identify columns that must be unique (candidate keys)
4. Identify primary key-foreign key mates
5. Determine default values
6. Identify constraints on columns (domain specifications)
7. Create the table and associated indexes

Examples of SQL database definition commands



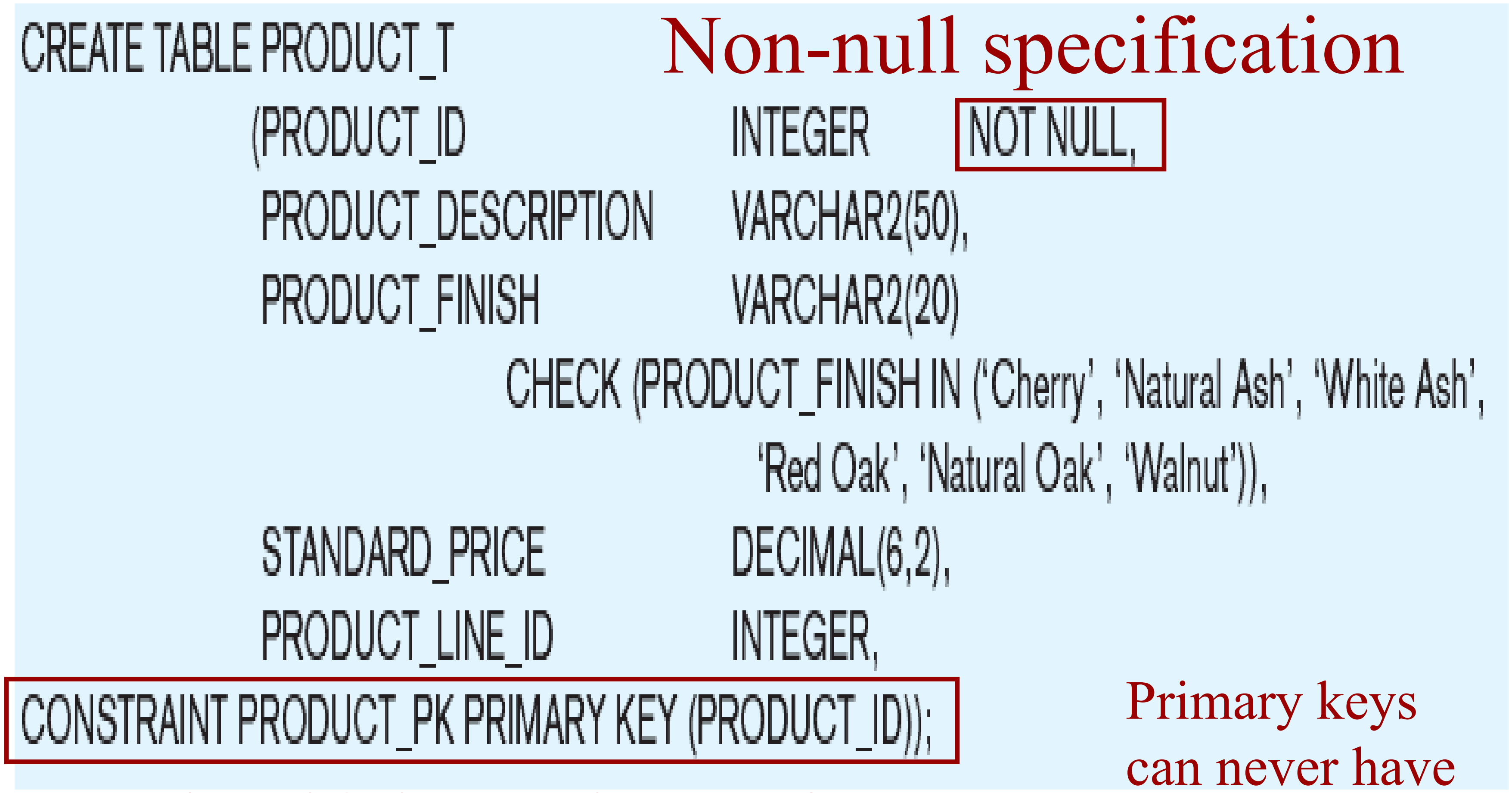
```
CREATE TABLE CUSTOMER_T
            (CUSTOMER_ID                NUMBER(11, 0) NOT NULL,
             CUSTOMER_NAME              VARCHAR2(25) NOT NULL,
             CUSTOMER_ADDRESS           VARCHAR2(30),
             CITY                       VARCHAR2(20),
             STATE                      VARCHAR2(2),
             POSTAL_CODE                VARCHAR2(9),
CONSTRAINT CUSTOMER_PK PRIMARY KEY (CUSTOMER_ID));

CREATE TABLE ORDER_T
             (ORDER_ID                  NUMBER(11, 0) NOT NULL,
              ORDER_DATE                DATE          DEFAULT SYSDATE,
              CUSTOMER_ID               NUMBER(11, 0),
CONSTRAINT ORDER_PK PRIMARY KEY (ORDER_ID),
CONSTRAINT ORDER_FK FOREIGN KEY (CUSTOMER_ID) REFERENCES CUSTOMER_T(CUSTOMER_ID));

CREATE TABLE PRODUCT_T
             (PRODUCT_ID                INTEGER       NOT NULL,
              PRODUCT_DESCRIPTION       VARCHAR2(50),
              PRODUCT_FINISH            VARCHAR2(20)
                        CHECK (PRODUCT_FINISH IN ('Cherry', 'Natural Ash', 'White Ash',
                                 'Red Oak', 'Natural Oak', 'Walnut')),
              STANDARD_PRICE            DECIMAL(6,2),
              PRODUCT_LINE_ID           INTEGER,
CONSTRAINT PRODUCT_PK PRIMARY KEY (PRODUCT_ID));

CREATE TABLE ORDER_LINE_T
             (ORDER_ID                  NUMBER(11,0)  NOT NULL,
              PRODUCT_ID                NUMBER(11,0)  NOT NULL,
              ORDERED_QUANTITY          NUMBER(11,0),
CONSTRAINT ORDER_LINE_PK PRIMARY KEY (ORDER_ID, PRODUCT_ID),
CONSTRAINT ORDER_LINE_FK1 FOREIGN KEY(ORDER_ID) REFERENCES ORDER_T(ORDER_ID),
CONSTRAINT ORDER_LINE_FK2 FOREIGN KEY (PRODUCT_ID) REFERENCES PRODUCT_T(PRODUCT_ID));
```

Defining attributes and their data types



```
CREATE TABLE PRODUCT_T
          (PRODUCT_ID               INTEGER          NOT NULL,
           PRODUCT_DESCRIPTION      VARCHAR2(50),
           PRODUCT_FINISH           VARCHAR2(20)
                     CHECK (PRODUCT_FINISH IN ('Cherry', 'Natural Ash', 'White Ash',
                                 'Red Oak', 'Natural Oak', 'Walnut')),
           STANDARD_PRICE           DECIMAL(6,2),
           PRODUCT_LINE_ID          INTEGER,
CONSTRAINT PRODUCT_PK PRIMARY KEY (PRODUCT_ID));
```

Domain constraint

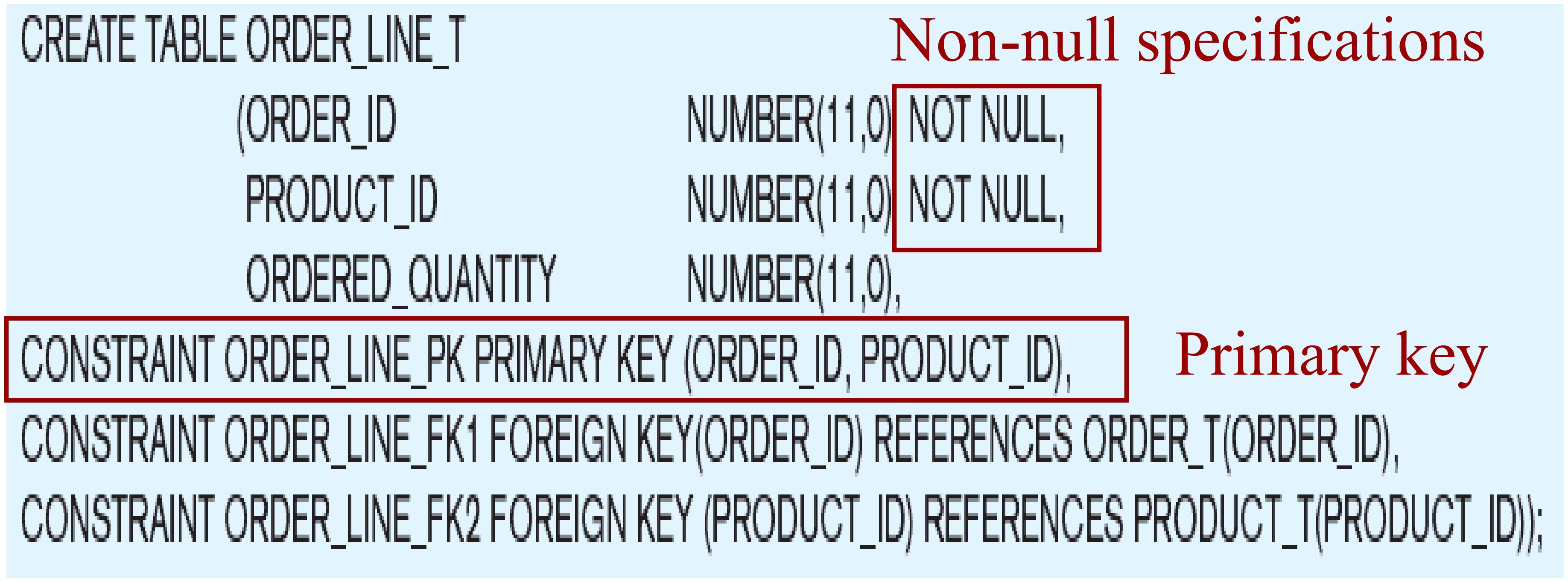


```
CREATE TABLE PRODUCT_T
            (PRODUCT_ID                   INTEGER      NOT NULL,
             PRODUCT_DESCRIPTION          VARCHAR2(50),
             PRODUCT_FINISH               VARCHAR2(20)
                         CHECK (PRODUCT_FINISH IN ('Cherry', 'Natural Ash', 'White Ash',
                                      'Red Oak', 'Natural Oak', 'Walnut')),
             STANDARD_PRICE               DECIMAL(6,2),
             PRODUCT_LINE_ID              INTEGER,
CONSTRAINT PRODUCT_PK PRIMARY KEY (PRODUCT_ID));
```

Non-null specification

Identifying primary key

Primary keys can never have NULL values



```
CREATE TABLE ORDER_LINE_T
          (ORDER_ID              NUMBER(11,0) NOT NULL,
           PRODUCT_ID            NUMBER(11,0) NOT NULL,
           ORDERED_QUANTITY      NUMBER(11,0),
CONSTRAINT ORDER_LINE_PK PRIMARY KEY (ORDER_ID, PRODUCT_ID),
CONSTRAINT ORDER_LINE_FK1 FOREIGN KEY(ORDER_ID) REFERENCES ORDER_T(ORDER_ID),
CONSTRAINT ORDER_LINE_FK2 FOREIGN KEY (PRODUCT_ID) REFERENCES PRODUCT_T(PRODUCT_ID));
```

Some primary keys are composite – composed of multiple attributes

Controlling the values in attributes

```
CREATE TABLE ORDER_T
            (ORDER_ID                NUMBER(11, 0) NOT NULL,
             ORDER_DATE              DATE          DEFAULT SYSDATE,
             CUSTOMER_ID             NUMBER(11, 0),
CONSTRAINT ORDER_PK PRIMARY KEY (ORDER_ID),
CONSTRAINT ORDER_FK FOREIGN KEY (CUSTOMER_ID) REFERENCES CUSTOMER_T(CUSTOMER_ID));

CREATE TABLE PRODUCT_T
            (PRODUCT_ID              INTEGER       NOT NULL,
             PRODUCT_DESCRIPTION     VARCHAR2(50),
             PRODUCT_FINISH          VARCHAR2(20)
                   CHECK (PRODUCT_FINISH IN ('Cherry', 'Natural Ash', 'White Ash',
                                 'Red Oak', 'Natural Oak', 'Walnut')),
             STANDARD_PRICE          DECIMAL(6,2),
             PRODUCT_LINE_ID         INTEGER,
```

Default value

Domain constraint

Identifying foreign keys and establishing relationships

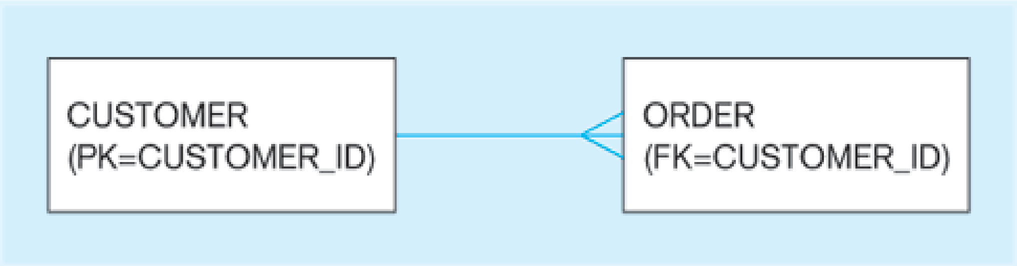
```
CREATE TABLE CUSTOMER_T
            (CUSTOMER_ID              NUMBER(11, 0) NOT NULL,
             CUSTOMER_NAME            VARCHAR2(25) NOT NULL,
             CUSTOMER_ADDRESS         VARCHAR2(30),
             CITY                     VARCHAR2(20),
             STATE                    VARCHAR2(2),
             POSTAL_CODE              VARCHAR2(9),
CONSTRAINT CUSTOMER_PK PRIMARY KEY (CUSTOMER_ID));

CREATE TABLE ORDER_T
             (ORDER_ID                NUMBER(11, 0) NOT NULL,
              ORDER_DATE              DATE          DEFAULT SYSDATE,
              CUSTOMER_ID             NUMBER(11, 0),
CONSTRAINT ORDER_PK PRIMARY KEY (ORDER_ID),
CONSTRAINT ORDER_FK FOREIGN KEY (CUSTOMER_ID) REFERENCES CUSTOMER_T(CUSTOMER_ID));
```

Primary key of parent table

Foreign key of dependent table

Data Integrity Controls

- Referential integrity – constraint that ensures that foreign key values of a table must match primary key values of a related table in 1:M relationships.
- Restricting:
  - Deletes of primary records.
  - Updates of primary records.
  - Inserts of dependent records.



Restricted Update: A customer ID can only be deleted if it is not found in ORDER table.

```
CREATE TABLE CUSTOMER_T
                  (CUSTOMER_ID          INTEGER DEFAULT 'C999'   NOT NULL,
                   CUSTOMER_NAME        VARCHAR(40)              NOT NULL,
                    . . .
CONSTRAINT CUSTOMER_PK PRIMARY KEY (CUSTOMER_ID),
ON UPDATE RESTRICT);
```

Cascaded Update: Changing a customer ID in the CUSTOMER table will result in that value changing in the ORDER table to match.

```
. . . ON UPDATE CASCADE);
```

Set Null Update: When a customer ID is changed, any customer ID in the ORDER table that matches the old customer ID is set to NULL.

```
. . . ON UPDATE SET NULL);
```

Set Default Update: When a customer ID is changed, any customer ID in the ORDER tables that matches the old customer ID is set to a predefined default value.

```
. . . ON UPDATE SET DEFAULT);
```

Relational integrity is enforced via the primary-key to foreign-key match

Changing and Removing Tables

- ALTER TABLE statement allows you to change column specifications:
  - ALTER TABLE CUSTOMER_T ADD (TYPE VARCHAR(2))
- DROP TABLE statement allows you to remove tables from your schema:
  - DROP TABLE CUSTOMER_T

Schema Definition

- Control processing/storage efficiency:
  - Choice of indexes
  - File organizations for base tables
  - File organizations for indexes
  - Data clustering
  - Statistics maintenance
- Creating indexes
  - Speed up random/sequential access to base table data
  - Example
    - CREATE INDEX NAME_IDX ON CUSTOMER_T(CUSTOMER_NAME)
    - This makes an index for the CUSTOMER_NAME field of the CUSTOMER_T table

Insert Statement

- Adds data to a table
- Inserting into a table
  - INSERT INTO CUSTOMER_T VALUES (001, ‘Contemporary Casuals’, 1355 S. Himes Blvd.’, ‘Gainesville’, ‘FL’, 32601);
- Inserting a record that has some null attributes requires identifying the fields that actually get data
  - INSERT INTO PRODUCT_T (PRODUCT_ID, PRODUCT_DESCRIPTION,PRODUCT_FINISH, STANDARD_PRICE, PRODUCT_ON_HAND) VALUES (1, ‘End Table’, ‘Cherry’, 175, 8);
- Inserting from another table
  - INSERT INTO CA_CUSTOMER_T SELECT * FROM CUSTOMER_T WHERE STATE = ‘CA’;

Delete Statement

- Removes rows from a table.
- Delete certain rows
  - DELETE FROM CUSTOMER_T WHERE STATE = 'HI';
- Delete all rows
  - DELETE FROM CUSTOMER_T;

Update Statement

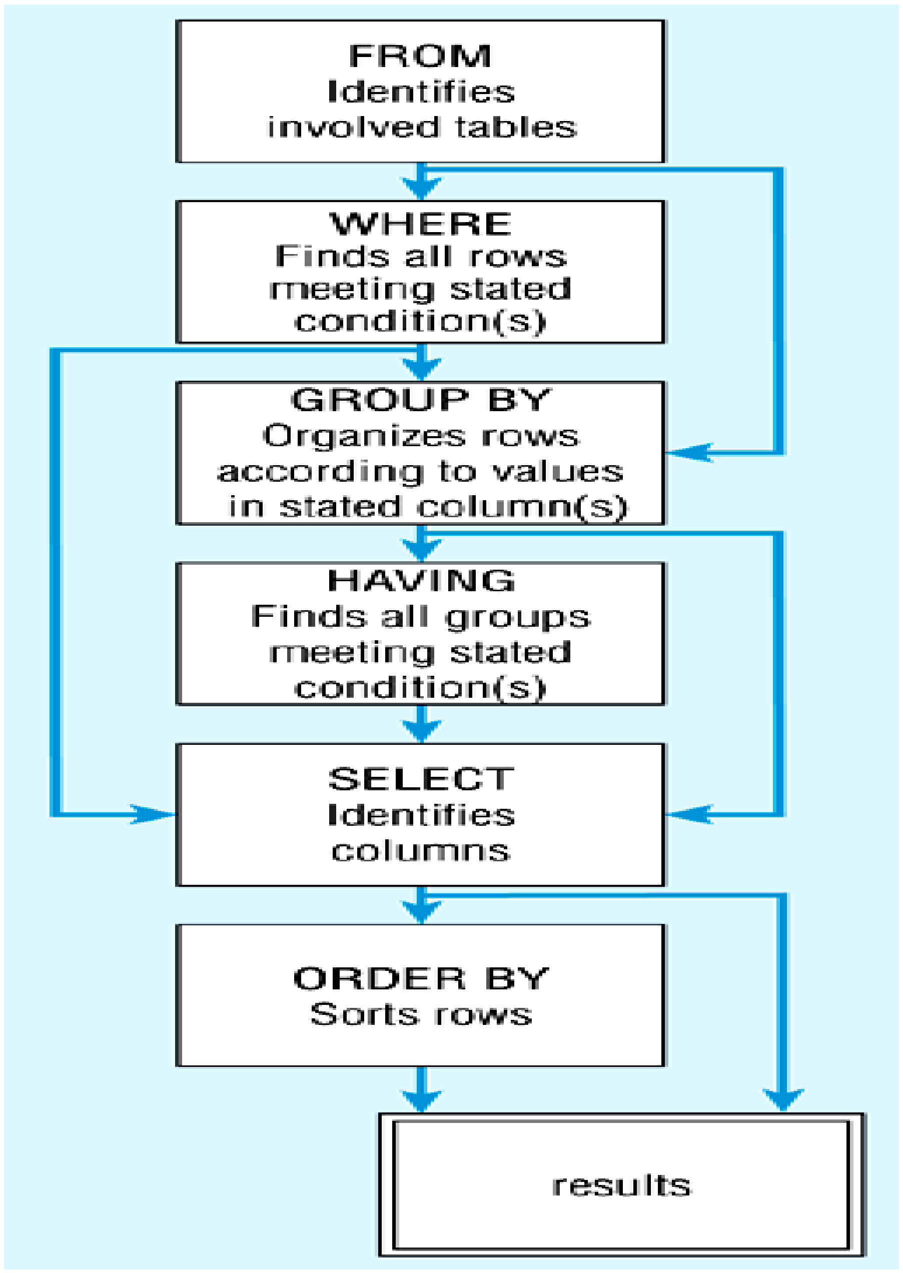
- Modifies data in existing rows

- UPDATE PRODUCT_T SET UNIT_PRICE = 775 WHERE PRODUCT_ID = 7;

SELECT Statement

- Used for queries on single or multiple tables.
- Clauses of the SELECT statement:
  - SELECT
    - List the columns (and expressions) that should be returned from the query
  - FROM
    - Indicate the table(s) or view(s) from which data will be obtained
  - WHERE
    - Indicate the conditions under which a row will be included in the result
  - GROUP BY
    - Indicate categorization of results
  - HAVING
    - Indicate the conditions under which a category (group) will be included
  - ORDER BY
    - Sorts the result according to specified criteria

SQL statement processing order


FROM
Identifies involved tables
WHERE
Finds all rows meeting stated condition(s)
GROUP BY
Organizes rows according to values in stated column(s)
HAVING
Finds all groups meeting stated condition(s)
SELECT
Identifies columns
ORDER BY
Sorts rows
results

SELECT Example

- Find products with standard price less than $275

```
SELECT PRODUCT_NAME, STANDARD_PRICE
FROM PRODUCT_V
WHERE STANDARD_PRICE < 275;
```

SELECT Example using Alias

- Alias is an alternative column or table name.

```
SELECT CUST.CUSTOMER AS NAME,
  CUST.CUSTOMER_ADDRESS
FROM CUSTOMER_V CUST
WHERE NAME = ‘Home Furnishings’;
```

SELECT Example Using a Function

- Using the COUNT ***aggregate function*** to find totals

```
SELECT COUNT(*) FROM ORDER_LINE_V
WHERE ORDER_ID = 1004;
```

Note: with aggregate functions you can't have single-valued columns included in the SELECT clause

SELECT Example – Boolean Operators

- AND, OR, and NOT Operators for customizing conditions in WHERE clause

```
SELECT PRODUCT_DESCRIPTION, PRODUCT_FINISH,
    STANDARD_PRICE
FROM PRODUCT_V
WHERE (PRODUCT_DESCRIPTION LIKE ‘%Desk’
OR PRODUCT_DESCRIPTION LIKE ‘%Table’)
AND UNIT_PRICE > 300;
```

Note: the LIKE operator allows you to compare strings using wildcards. For example, the % wildcard in ‘%Desk’ indicates that all strings that have any number of characters preceding the word “Desk” will be allowed

SELECT Example – Sorting Results with the ORDER BY Clause

- Sort the results first by STATE, and within a state by CUSTOMER_NAME

```
SELECT CUSTOMER_NAME, CITY, STATE
FROM CUSTOMER_V
WHERE STATE IN (‘FL’, ‘TX’, ‘CA’, ‘HI’)
ORDER BY STATE, CUSTOMER_NAME;
```

Note: the IN operator in this example allows you to include rows whose STATE value is either FL, TX, CA, or HI. It is more efficient than separate OR conditions

SELECT Example – Categorizing Results Using the GROUP BY Clause

- For use with aggregate functions
  - ***Scalar aggregate***: single value returned from SQL query with aggregate function
  - ***Vector aggregate***: multiple values returned from SQL query with aggregate function (via GROUP BY)

```
SELECT STATE, COUNT(STATE)
FROM CUSTOMER_V
GROUP BY STATE;
```

Note: you can use single-value fields with aggregate functions if they are included in the GROUP BY clause.

SELECT Example –
Qualifying Results by Category Using the HAVING Clause

- For use with GROUP BY

```
SELECT STATE, COUNT(STATE)
FROM CUSTOMER_V
GROUP BY STATE
HAVING COUNT(STATE) > 1;
```

Like a WHERE clause, but it operates on groups (categories), not on individual rows. Here, only those groups with total numbers greater than 1 will be included in final result