Collection classes

Collections

Basic operations of collections

- add objects to collection
- remove objects from collection
- search for an object in collection
- retrieve object from collection
- iterate through collection

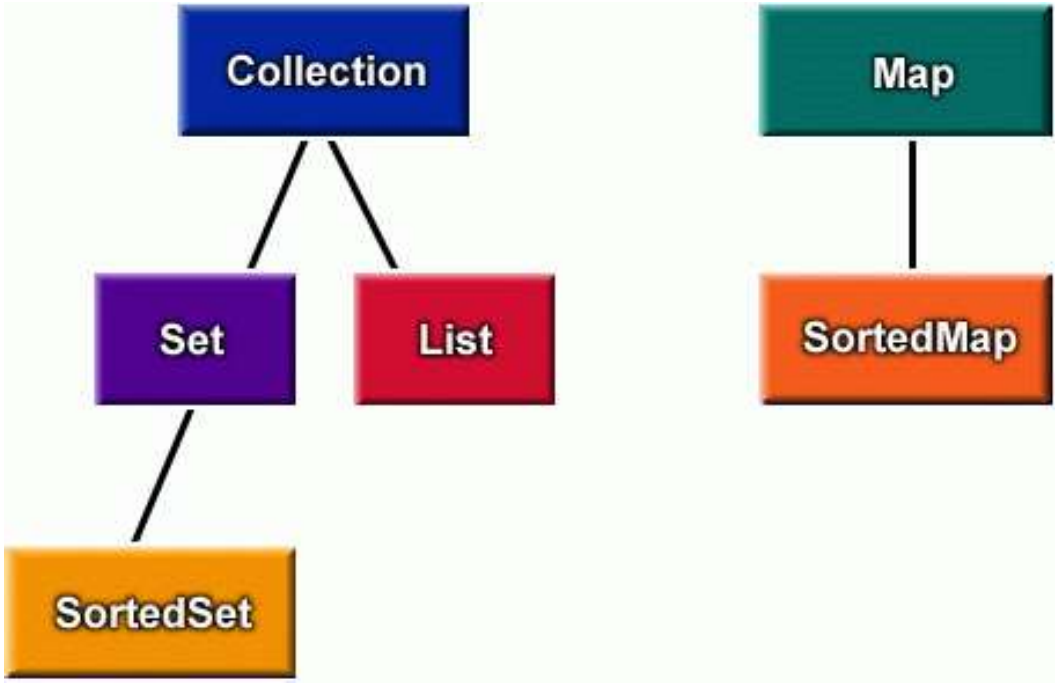
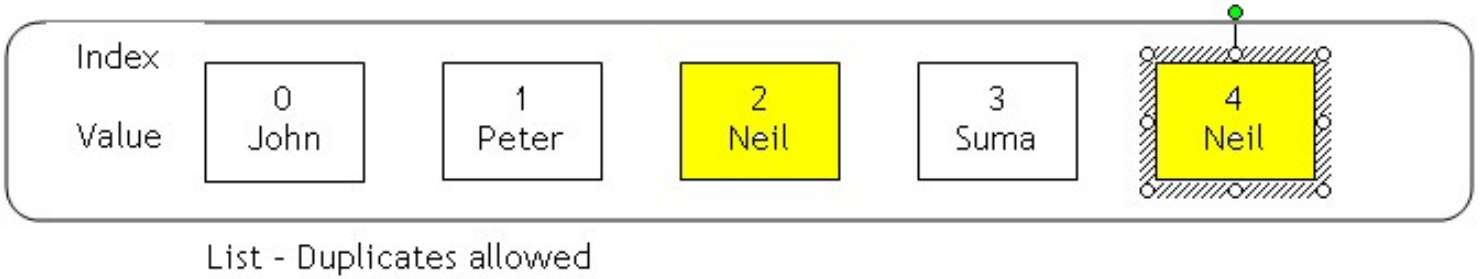
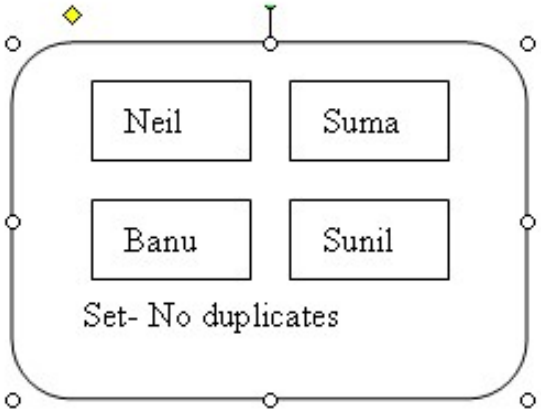
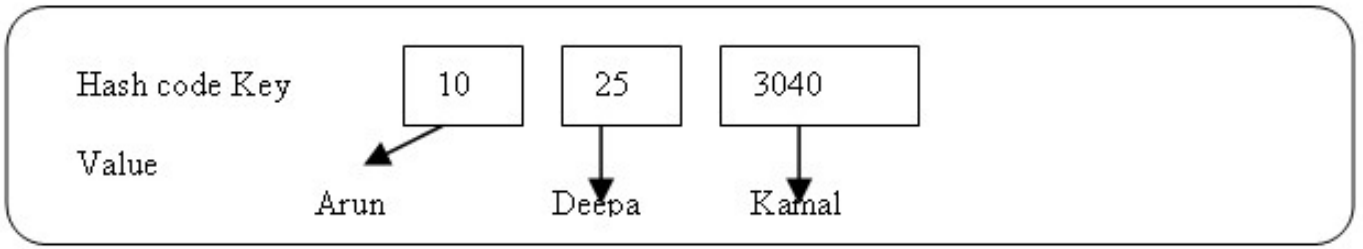


Illustration of List, Set and Map



List - Duplicates allowed





Hash Map - Key generated from RollNo

Collections

interface java.util.Collection

- root interface in the collections hierarchy
- extended by List, Set, Queue
- methods

```
boolean add(Object)
boolean remove(Object)
boolean addAll(Collection)
boolean removeAll(Collection)
Object[ ]  toArray( )
boolean contains(Object)
Iterator iterator( )
int size( )
```

Collections

interface java.util.List

- represents ordered collection
- allows duplicates
- implemented by ArrayList, Vector, LinkedList
- additional methods

```
void add(int index, Object)
 Object set(int index, Object)
boolean remove(int index)
boolean addAll(int index, Collection)
Object get(int index)
ListIterator listIterator( )
```

Collections

interface java.util.Set

- represents unordered collection
- duplicates not allowed
- extended by SortedSet

Collections

interface java.util.Map

- represents key-value pairs
- Not part of Collection hierarchy
- extended by SortedMap
- implemented by HashTable, HashMap
- methods

    boolean containsKey(Object key)

    boolean containsValue(Object value)

    Object get(Object key)

    Set keySet( )

    Collection values( )

    Object put(Object key, Object value)

    Object remove(Object key)

Collections

Classes

- ArrayList : Resizable array implementation of List
  Implements RandomAccess interface
- Vector : Same as ArrayList but threadsafe (legacy class)
- LinkedList : Linked list implementation of List
  provides add, remove at beginning or end
- HashSet : Unsorted, unordered implementation of Set
  uses hashCode( )
- LinkedHashSet : ordered version of HashSet
- TreeSet : implementation of SortedSet (elements sorted)
- HashMap : unsorted Map implementation
- Hashtable : same as HashMap but threadsafe (legacy class)
- TreeMap : implementation of SortedMap

ArrayList

- Is an implementation of the `List` interface
  - The list automatically grows if elements exceed initial size.
- Has a numeric index
  - Elements are accessed by index.
  - Elements can be inserted based on index.
  - Elements can be overwritten.
- Allows duplicate items

```
List partList = new ArrayList();
    partList.add(new Integer(1111));
    partList.add(new Integer(2222));
    partList.add(new Integer(3333));
    partList.add(new Integer(4444)); // ArrayList auto grows
    System.out.println("First Part: " +
                       partList.get(0)); // First item
    partList.add(0, new Integer(5555)); // Insert at position 1
```

`TreeSet`: Implementation of `Set`

```
public class SetExample {
   public static void main(String[] args){
        Set set = new TreeSet();

        set.add("one");
        set.add("two");
        set.add("three");
        set.add("three"); // not added, only unique

        Iterator itr= set.iterator();
         while(itr.hasnext()){
             System.out.println("Item: " + itr.next());
        }
   }
}
```

Collections

java.util.Iterator interface

Used to iterate through all the elements of the collection

Methods

boolean hasNext( )

Object next( )

void remove( )

Enhanced for loop

- Iterating over collections looks cluttered

```
ArrayList lst = …….;
Iterator i = lst.iterator();
While( i.hasNext() )
  System.out.println(i.next());
```

- Using enhanced for loop we can do the same thing as

```
ArrayList lst = …….;
for (Object t: lst) )
    System.out.println(t);
```

TreeMap: Implementation of Map

```
public class MapExample {
   public static void main(String[] args){
       Map partList = new TreeMap();
       partList.put("S001", "Blue Polo Shirt");
       partList.put("S002", "Black Polo Shirt");
       partList.put("H001", "Duke Hat");

       partList.put("S002", "Black T-Shirt"); // Overwrite value
       Set keys = partList.keySet();

       System.out.println("=== Part List ===");
       for (Object key:keys){
           System.out.println("Part#: " + key + " " +
                              partList.get(key));
       }
   }
}
```

Generic Collections

- Generic collections used to hold homogeneous data
- They are type safe
- No typecasting required while extracting elements

```
List<Emp> list = new ArrayList<Emp>();
 list.add(new Emp());
 Emp e = list.get(0);

 HashMap<String, Mammal> map =
  new HashMap<String, Mammal>();
  map.put("wombat", new Mammal("wombat"));
  Mammal w = map.get("wombat");
```

Ordering Collections

- The `Comparable` and `Comparator` interfaces are used to sort collections.
  - Both are implemented by using generics.
- Using the `Comparable` interface:
  - Overrides the `compareTo` method
  - Provides only one sort option
- The `Comparator` interface:
  - Is implemented by using the `compare` method
  - Enables you to create multiple `Comparator` classes
  - Enables you to create and use numerous sorting options

Comparable: Example

```
public class Student implements Comparable<Student>{
   private String name;
   private long id = 0;
   private double gpa = 0.0;

   public Student(String name, long id, double gpa){
      // Additional code here
   }
      // getters and setters

   public int compareTo(Student s){
       if(this.id < s.id)
                 return -1;
       if (this.id > s.id)
                  return 1;
       return 0;
   }
}
```

`Comparable` : Example

```
public class TestComparable {
  public static void main(String[] args){
    Set<Student> studentList = new TreeSet<Student>();

    studentList.add(new Student("Thomas Jefferson", 1111, 3.8));
    studentList.add(new Student("John Adams", 2222, 3.9));
    studentList.add(new Student("George Washington", 3333, 3.4));

    for(Student student:studentList){
      System.out.println(student);
    }
  }
}
```

Comparator - Example

```
class IdComp implements Comaparator<Student> {
    public int compare(Student a, Student b){
        return a.getId () – b.getId( );
    }
}

class NameComp implements Comaparator<Student> {
    public int compare(Student a,  Student b){
        return a.getName().compareTo( b.getName( ) );
    }
}
…….
TreeSet <Student>  ts1 =  new TreeSet<Student> ( new IdComp() );  //sorted on id
TreeSet <Student> ts2 =  new TreeSet<Student> ( new NameComp() );  // sorted on name
```

Collections class

- Collections class is used exclusively with static methods that operate on or return collections
- provides some convenience methods that are highly useful in working with Java collections
- Some of the methods of Collections:

  - **static <T> int binarySearch**(**List**,<T> T key) - Searches the list for the specified object using the binary search algorithm.
  - **static<T> void copy**(**List <T>** dest, **List <T>** src) - Copies all of the elements from one list into another
  - **static<T> void sort**(**List <T> list**) - Sorts the list into ascending order, according to the **natural ordering** of its elements
  - **static<T> void sort**(**List <T> list , Comparator<T> c**) - Sorts the list according to the order induced by the specified comparator
  - **static void swap**(**List <T> list , int I, int j**) - Swaps the elements at the specified positions in the list

SQL

Relating Multiple Tables

- **Each row of data in a table is uniquely identified by a primary key.**
- **You can logically relate data from multiple tables using foreign keys.**

Table name: DEPARTMENTS

DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
10	Administration	200	1700
20	Marketing	201	1800
50	Shipping	124	1500
60	IT	103	1400
80	Sales	149	2500
90	Executive	100	1700
110	Accounting	205	1700
190	Contracting	(null)	1700

Table name: EMPLOYEES

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	DEPARTMENT_ID
100	Steven	King	90
101	Neena	Kochhar	90
102	Lex	De Haan	90
103	Alexander	Hunold	60
104	Bruce	Ernst	60
107	Diana	Lorentz	60
124	Kevin	Mourgos	50
141	Trenna	Rajs	50
142	Curtis	Davies	50

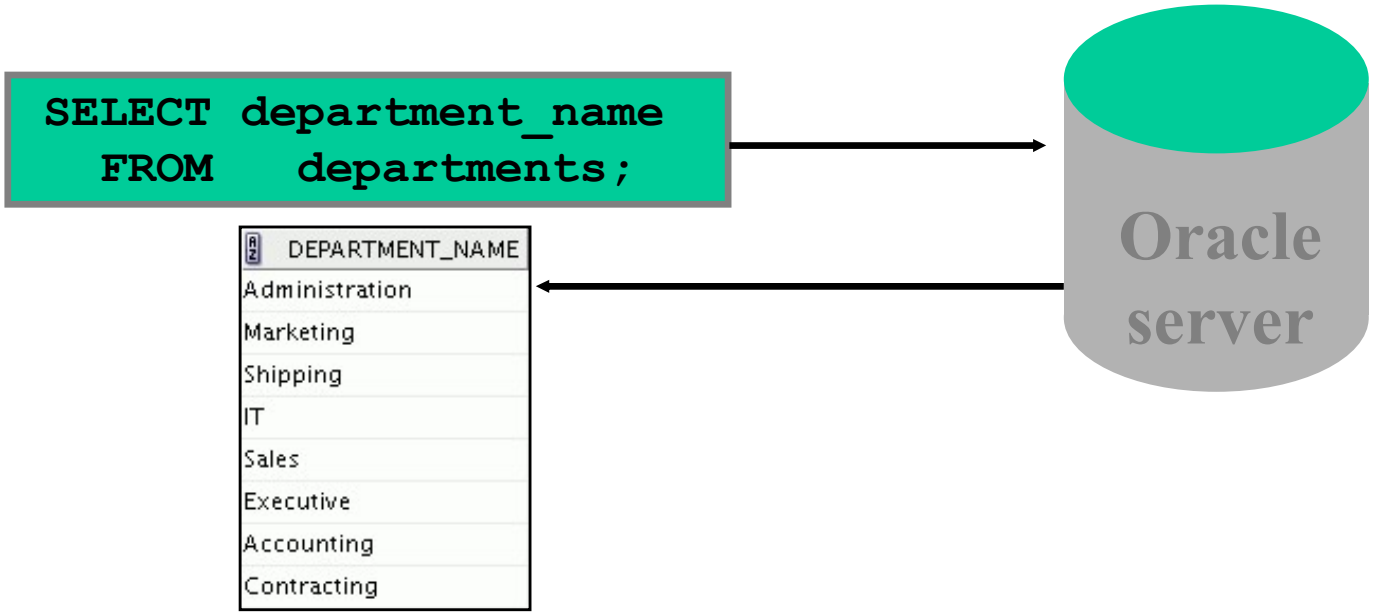
Primary key

Primary key

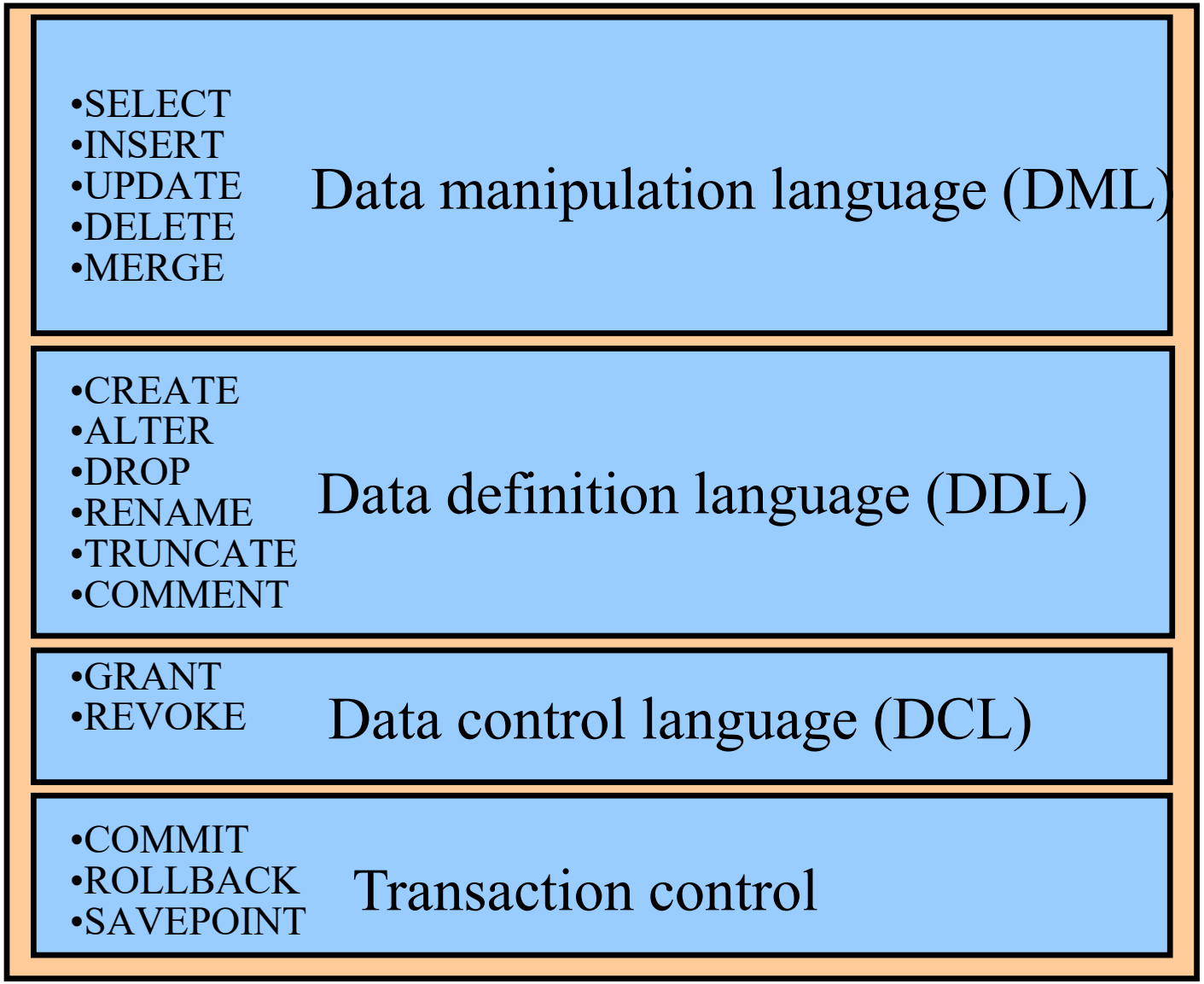
Foreign key

Using SQL to Query Your Database

- **Structured query language (SQL) is:**
  - **The ANSI standard language for operating relational databases**
  - **Efficient, easy to learn, and use**
  - **Functionally complete (With SQL, you can define, retrieve, and manipulate data in the tables.)**



SQL Statements



CREATE TABLE Statement

- You specify:
  - The table name
  - The column name, column data type, and column size

```
CREATE TABLE tableName   (
      column datatype [, ...]
      [Constraint specification
);
```

- To see the table structure
  - Describe tableName

Creating Tables

– Create the table:

```
CREATE   TABLE  ord
        ( ID  DECIMAL(3),
         quantity  DECIMAL(3)
         ) ;
```

Data Types

Java DB, Derby	Format
SMALLINT	
INTEGER	
DECIMAL(p,s) or NUMERIC(p,s)	
FLOAT	
FLOAT	
SMALLINT	
SMALLINT	
VARCHAR	Single qoutes
CHAR(1)	Single qoutes
DATE	yyyy-mm-dd, mm/dd/yyyy, dd.mm.yyyy
TIME	hh:mm[:ss] , hh.mm[.ss]
TIMESTAMP	yyyy-mm-dd hh:mm:ss[.nnnnnn]

Including Constraints

Constraints enforce rules at the table level.

Constraints prevent the deletion of a table if there are dependencies.

The following constraint types are valid:

- **NOT NULL**
- **UNIQUE**
- **PRIMARY KEY**
- **FOREIGN KEY**
- **CHECK**

CREATE TABLE: Example

```
CREATE   TABLE   customers

          ( customer_id          DECIMAL(6)  primary key
          , cust_first_name      VARCHAR(20)
              CONSTRAINT fname_nn NOT NULL
          , cust_last_name       VARCHAR(20)
              CONSTRAINT  lname_nn NOT NULL
          , cust_address         varchar(50)
          , city_code                  char(2)
          , language             VARCHAR(3)
          , territory            VARCHAR(30)
          , credit_limit         NUMERIC(9,2)
          , cust_email           VARCHAR(30)
          , account_mgr_id       NUMERIC(6)
          ,   CONSTRAINT  ck_credit_limit
                            CHECK (credit_limit <= 5000)
          ,   CONSTRAINT  city_fk
               foreign key(city_code)
                 references city(city_code)
    ) ;
```

Basic SELECT Statement

```
SELECT *|{[DISTINCT] column|expression [alias],...}
FROM    table;
```

SELECT identifies the columns to be displayed.

FROM identifies the table containing those columns.

Selecting All Columns

```
SELECT  *
FROM   inventories ;
```

	PRODUCT_ID	WAREHOUSE_ID	QUANTITY_ON_HAND
1	3108	8	122
2	3110	8	123
3	3112	8	123
4	3117	8	124
5	3124	8	125
6	3127	8	125
7	3129	8	126
8	3134	8	149
9	3139	8	150
10	3140	8	150
11	3143	8	151

Selecting Specific Columns

```
SELECT  product_id, quantity_on_hand
FROM   inventories ;
```

	PRODUCT_ID	QUANTITY_ON_HAND
1	3108	122
2	3110	123
3	3112	123
4	3117	124
5	3124	125
6	3127	125
7	3129	126
8	3134	149
9	3139	150
10	3140	150
11	3143	151

Arithmetic Expressions

•Create expressions with number and date data by using arithmetic operators.

Operator	Description
+	Add
-	Subtract
*	Multiply
/	Divide

Using Arithmetic Operators

```
SELECT product_id, quantity_on_hand, quantity_on_hand+200
FROM inventories ;
```

	PRODUCT_ID	QUANTITY_ON_HAND	QUANTITY_ON_HAND+200
1	3108	122	322
2	3110	123	323
3	3112	123	323
4	3117	124	324
5	3124	125	325
6	3127	125	325
7	3129	126	326
8	3134	149	349
9	3139	150	350
10	3140	150	350
11	3143	151	351

What is a NULL value ?

What is a NULL value ?

If a row does not have an entry for a particular column, that value is said to be NULL..

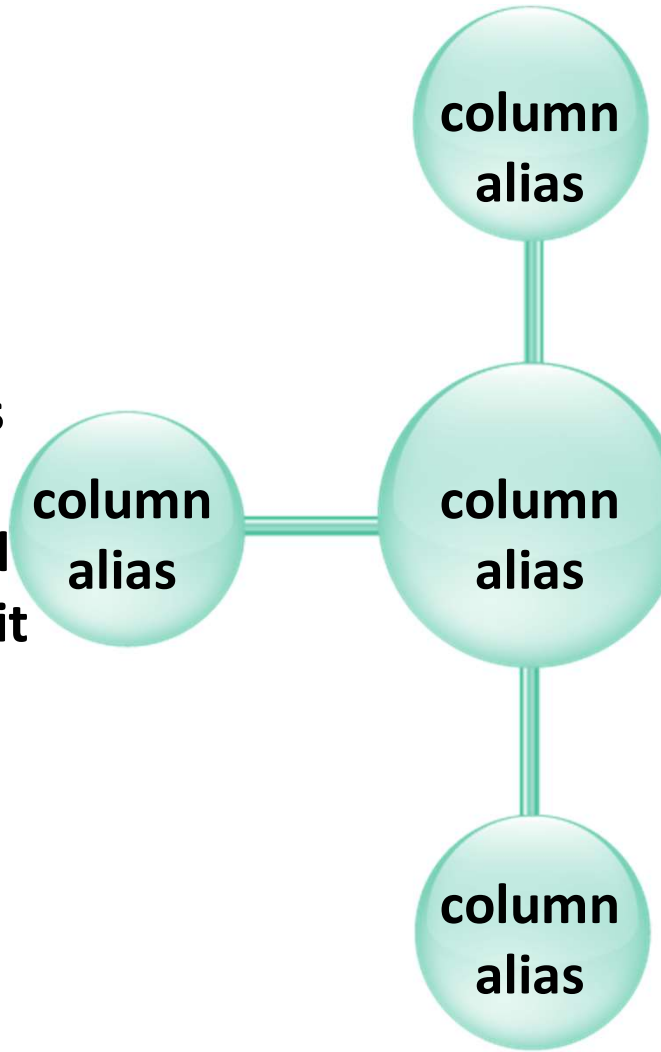
What is a NULL value ?

It is the absence of any character, zero, blank space etc.

What is a NULL value ?

Arithmetic operations on a NULL value always return a NULL value.

Defining a Column Alias28



Renames a column heading

Requires double quotation marks if it contains spaces or special characters, or if it is case-sensitive

Is useful with calculations

Immediately follows the column name (There can also be the optional AS keyword between the column name and the alias.)

Using Column Aliases

```
SELECT  product_id AS Product , quantity_on_hand  Quantity
FROM  inventories ;
```

	PRODUCT	QUANTITY
1	3108	122
2	3110	123
3	3112	123
4	3117	124

• • •

```
SELECT  order_id  "Order "  , order_date) "Date of Order"
FROM orders ;
```

	Order	Date of Order
1	2458	17-AUG-99
2	2397	20-NOV-99
3	2454	03-OCT-99
4	2354	15-JUL-00

• • •

Concatenation Operator

- A concatenation operator:
  - Links columns or character strings to other columns
  - Is represented by two vertical bars (||)
  - Creates a resultant column that is a character expression

```
SELECT  first_name || last_name  AS  "NAME"
FROM   customers ;
```

	NAME
1	EllenAbel
2	SundarAnde
3	MozheAtkinson
4	DavidAustin
5	HermannBaer
6	ShelliBaida
7	AmitBanda
8	ElizabethBates

Limiting Rows Using a Selection

EMPLOYEES

	EMPLOYEE_ID	LAST_NAME	JOB_ID	DEPARTMENT_ID
1	200	Whalen	AD_ASST	10
2	201	Hartstein	MK_MAN	20
3	202	Fay	MK_REP	20
4	205	Higgins	AC_MGR	110
5	206	Gietz	AC_ACCOUNT	110

...

"retrieve all employees in department 90"

	EMPLOYEE_ID	LAST_NAME	JOB_ID	DEPARTMENT_ID
1	100	King	AD_PRES	90
2	101	Kochhar	AD_VP	90
3	102	De Haan	AD_VP	90

Limiting the Rows That Are Selected

- **Restrict the rows that are returned by using the :**
- **WHERE clause**

```
SELECT *|{[DISTINCT] column|expression [alias],...}
FROM   table
[WHERE condition(s)];
```

- **The WHERE clause follows the FROM clause.**

Using the WHERE Clause

```
SELECT   order_id,  order_date,  order_status
   FROM   orders
WHERE   order_status = 1 ;
```

	ORDER_ID	ORDER_DATE	ORDER_STATUS
1	2397	20-NOV-99 04.11.54.696211000 AM	1
2	2454	03-OCT-99 05.19.34.678340000 AM	1
3	2421	13-MAR-99 09.23.54.562432000 AM	1
4	2431	14-SEP-98 06.33.04.763452000 PM	1
5	2439	31-AUG-99 09.49.37.811132000 PM	1
6	2444	28-JUL-99 01.52.27.462632000 AM	1

Comparison Operators

Operator	Meaning
=	Equal to
>	Greater than
>=	Greater than or equal to
<	Less than
<=	Less than or equal to
<>	Not equal to
BETWEEN ...AND...	Between two values (inclusive)
IN(set)	Match any of a list of values
LIKE	Match a character pattern
IS NULL	Is a null value

Using Comparison Operators

```
SELECT   order_id,  order_date
FROM   orders
WHERE   order_id <= 2400 ;
```

	ORDER_ID	ORDER_DATE
1	2354	15-JUL-00 05.48.23.234567000 AM
2	2355	26-JAN-98 10.52.51.962632000 PM
3	2356	26-JAN-00 10.52.41.934562000 PM
4	2357	09-JAN-98 09.49.44.123456000 AM
5	2358	09-JAN-00 06.33.12.654278000 AM
6	2359	09-JAN-98 11.04.13.112233000 AM

• • •

Range Conditions Using the BETWEEN Operator

- **Use the BETWEEN operator to display rows based on a range of values:**

```
SELECT   product_id,  quantity_on_hand
FROM   inventories
WHERE   product_id  BETWEEN  3100  AND  3108;
```

Lower limit **Upper limit**

	PRODUCT_ID	QUANTITY_ON_HAND
1	3108	122
2	3108	110
3	3108	194
4	3108	170
5	3108	146

Membership Condition Using the `IN` Operator

- **Use the IN operator to test for values in a list:**

```
SELECT  order_id,  order_mode,  order_status
FROM  orders
WHERE  order_id  IN  (2458, 2397, 2454) ;
```

	ORDER_ID	ORDER_MODE	ORDER_STATUS
1	2397	direct	1
2	2454	direct	1
3	2458	direct	0

Pattern Matching Using the `LIKE` Operator

Use the LIKE operator to perform wildcard searches of valid search string values.

Search conditions can contain either literal characters or numbers:

- **% denotes zero or many characters.**
- **_ denotes one character.**

```
SELECT   first_name
FROM     employees
WHERE    first_name LIKE 'S%' ;
```

Combining Wildcard Characters

- **You can combine the two wildcard characters (%, _) with literal characters for pattern matching:**

```
SELECT   last_name
FROM   employees
WHERE   last_name LIKE '_o%' ;
```

	LAST_NAME
1	Kochhar
2	Lorentz
3	Mourgos

- **You can use the ESCAPE identifier to search for the actual % and _ symbols.**

Using the NULL Conditions

Test for nulls with the IS NULL operator.

```
SELECT   order_ID,  order_status,  sales_rep_id
   FROM   orders
WHERE  sales_rep_id  IS  NULL;
```

	ORDER_ID	ORDER_STATUS	SALES_REP_ID
1	2355	8	(null)
2	2356	5	(null)
3	2359	9	(null)
4	2361	8	(null)
5	2362	4	(null)
6	2363	0	(null)

Defining Conditions Using the Logical Operators

Operator	Meaning
`AND`	Returns `TRUE` if *both* component conditions are true
`OR`	Returns `TRUE` if *either* component condition is true
`NOT`	Returns `TRUE` if the condition is false

Using the AND Operator

AND requires both the component conditions to be true:

```
SELECT   order_mode,  order_status,  customer_id
FROM   orders
WHERE   order_mode  = ' direct '
AND        customer_id = 103;
```

	ORDER_MODE	ORDER_STATUS	CUSTOMER_ID
1	direct	1	103
2	direct	4	103

Using the OR Operator

OR requires either component condition to be true:

```
SELECT   order_id,  order_status,  order_total
FROM   orders
WHERE   order_status = 0
            OR  order_total  >=  100000 ;
```

	ORDER_ID	ORDER_STATUS	ORDER_TOTAL
1	2458	0	70647.34
2	2354	0	46257
3	2434	8	242458.25
4	2361	8	120131.3
5	2363	0	10082.3
6	2367	10	144054.8
7	2369	0	11097.4
8	2375	2	103834.4
9	2385	4	295892
10	2388	4	282694.3
11	2399	0	25270.3

Using the NOT Operator

```
SELECT  order_id,  order_status,  order_total
FROM  orders
WHERE  order_status
          NOT  IN  (0,1,2,3) ;
```

	ORDER_ID	ORDER_STATUS	ORDER_TOTAL
1	2357	5	59872.4
2	2394	5	21863
3	2435	6	62303
4	2455	7	14087.5
5	2379	8	17848.2
6	2396	8	34930
7	2434	8	242458.25
8	2436	8	6394.8
9	2446	8	93570.57
10	2447	8	33893.6
11	2432	10	10523

Using the ORDER BY Clause

Sort the retrieved rows with the ORDER BY clause:

- **ASC: Ascending order, default**
- **DESC: Descending order**

The ORDER BY clause comes last in the SELECT statement:

```
SELECT   order_id,  order_date,  order_status
FROM   orders
ORDER BY   order_date ;
```

	ORDER_ID	ORDER_DATE	ORDER_STATUS
1	2442	27-JUL-90 11.52.59.662632000 PM	9
2	2445	28-JUL-90 03.04.38.362632000 AM	8
3	2418	21-MAR-96 05.48.21.862632000 AM	4
4	2357	09-JAN-98 09.49.44.123456000 AM	5

Sorting

Sorting in descending order:

```
SELECT   order_id,  round(order_date),  order_status
FROM   orders
ORDER BY   order_date  desc;
```

Sorting by column alias:

```
SELECT   order_id,  round(order_date),  order_status  “Order Status”
FROM   orders
ORDER BY   order_date desc ;
```

Group Functions

Group functions operate on sets of rows to give one result per group.

EMPLOYEES

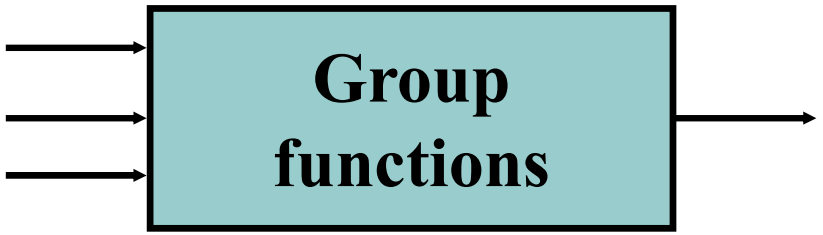
	DEPARTMENT_ID	SALARY
1	10	4400
2	20	13000
3	20	6000
4	110	12000
5	110	8300
6	90	24000
7	90	17000
8	90	17000
9	60	9000
10	60	6000
...		
18	80	11000
19	80	8600
20	(null)	7000

Maximum salary in EMPLOYEES table

MAX(SALARY)
24000

Types of Group Functions

- AVG
- COUNT
- MAX
- MIN
- SUM



Group Functions: Syntax

```
SELECT group_function(column), ...
FROM     table
[WHERE   condition]
[ORDER BY  column];
```

Using the AVG and SUM Functions

You can use AVG and SUM for numeric data.

You can use MIN and MAX for numeric, character, and date data types.

```
SELECT   AVG(order_total),  MAX(order_total),
         MIN (order_total), SUM( order_total)
FROM   orders;
```

	AVG(ORDER_TOTAL)	MAX(ORDER_TOTAL)	MIN(ORDER_TOTAL)	SUM(ORDER_TOTAL)
1	44628.44125	295892	5451	3570275.3

Using the COUNT Function

- **COUNT(*) returns the number of rows in a table:**

```
SELECT   count(*)
FROM   inventories
WHERE   warehouse_id = 8;
```

	COUNT(*)
1	186

- **COUNT(*expr*) returns the number of rows with non-null values for *expr*:**

```
SELECT   COUNT(sales_rep_id)
FROM   orders
WHERE   order_status <=3;
```

	COUNT(SALES_REP_ID)
1	19

Creating Groups of Data

EMPLOYEES

	DEPARTMENT_ID	SALARY	
1	10	4400	4400
2	20	13000	9500
3	20	6000	
4	50	2500	
5	50	2600	
6	50	3100	3500
7	50	3500	
8	50	5800	
9	60	9000	
10	60	6000	6400
11	60	4200	
12	80	11000	10033
13	80	8600	
...			
18	110	8300	
19	110	12000	
20	(null)	7000	

Average salary in the EMPLOYEES table

	DEPARTMENT_ID	AVG(SALARY)
1	(null)	7000
2	20	9500
3	90	19333.333333333333...
4	110	10150
5	50	3500
6	80	10033.333333333333...
7	10	4400
8	60	6400

Creating Groups of Data: GROUP BY Clause Syntax

- **You can divide rows in a table into smaller groups by using the GROUP BY clause.**

```
SELECT     column, group_function(column)
FROM       table
[WHERE     condition]
[GROUP BY  group_by_expression]
[ORDER BY  column];
```

Using the GROUP BY Clause

- **All the columns in the SELECT list that are not in group functions must be in the GROUP BY clause.**

```
SELECT   warehouse_id,  AVG(quantity_on_hand)
FROM   inventories
GROUP BY   warehouse_id ;
```

	WAREHOUSE_ID	AVG(QUANTITY_ON_HAND)
1	1	152.30555555555555555555555555555555555556
2	2	161.65536723163841807909604519774011299 4
3	3	151.08333333333333333333333333333333333333
4	4	136.33027522935779816513761467889908256 9
5	5	113.76315789473684210526315789473684210 5
6	6	98.35096153846153846153846153846153846154
7	7	85.27358490566037735849056603773584905 66
8	8	72.48387096774193548387096774193548387097
9	9	57.4765625

Using the GROUP BY Clause

- The GROUP BY column does not have to be in the SELECT list.

```
SELECT   AVG(order_total)
FROM   orders
GROUP BY   order_status ;
```

	AVG(ORDER_TOTAL)
1	36613.683333333333333333333333333333333
2	41017.96
3	43866.746666666666666666666666666666667
4	34772.38
5	83876.466666666666666666666666666666667
6	55182.434666666666666666666666666666667
7	36222.094285714285714285714285714285714
8	11205.7
9	28134.223333333333333333333333333333333
10	58939.925
11	28913.066666666666666666666666666666667

Illegal Queries Using Group Functions

•Any column or expression in the SELECT list that is not an aggregate function must be in the GROUP BY clause:

```
SELECT department_id, COUNT(last_name)
FROM   employees;
```

```
ORA-00937: not a single-group group function
00937. 00000 - "not a single-group group function"
```

A GROUP BY clause must be added to count the last names for each department_id.

```
SELECT department_id, job_id, COUNT(last_name)
FROM   employees
GROUP BY department_id;
```

```
ORA-00979: not a GROUP BY expression
00979. 00000 - "not a GROUP BY expression"
```

Either add job_id in the GROUP BY or remove the job_id column from the SELECT list.

Restricting Group Results

EMPLOYEES

	DEPARTMENT_ID	SALARY
1	10	4400
2	20	13000
3	20	6000
4	50	2500
5	50	2600
6	50	3100
7	50	3500
8	50	5800
9	60	9000
10	60	6000
11	60	4200
12	80	11000
13	80	8600
...		
18	110	8300
19	110	12000
20	(null)	7000

The maximum salary per department when it is

	DEPARTMENT_ID	MAX(SALARY)
1	20	13000
2	90	24000
3	110	12000
4	80	11000

Restricting Group Results with the HAVING Clause

When you use the HAVING clause, the server restricts groups as follows:

Rows are grouped.

The group function is applied.

Groups matching the HAVING clause are displayed.

```
SELECT     column, group_function
FROM       table
[WHERE     condition]
[GROUP BY  group_by_expression]
[HAVING    group_condition]
[ORDER BY  column];
```

Using the HAVING Clause

```sql
SELECT   warehouse_id,  AVG(quantity_on_hand)
FROM   inventories
GROUP BY   warehouse_id
HAVING  MAX  (quantity_on_hand) > 130 ;
```

	WAREHOUSE_ID	AVG(QUANTITY_ON_HAND)
1	1	152.305555555555555555555555555555555556
2	6	98.35096153846153846153846153846153846154
3	2	161.655367231638418079096045197740112994
4	4	136.330275229357798165137614678899082569
5	5	113.763157894736842105263157894736842105
6	8	72.48387096774193548387096774193548387097
7	3	151.083333333333333333333333333333333333
8	7	85.2735849056603773584905660377358490566
9	9	57.4765625

Using the HAVING Clause

```
SELECT    job_id, SUM(salary) PAYROLL
FROM      employees
WHERE     job_id NOT LIKE '%REP%'
GROUP BY job_id
HAVING    SUM(salary) > 13000
ORDER BY SUM(salary);
```

	JOB_ID	PAYROLL
1	IT_PROG	19200
2	AD_PRES	24000
3	AD_VP	34000

Obtaining Data from Multiple Tables

EMPLOYEES

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	200	Whalen	10
2	201	Hartstein	20
3	202	Fay	20
...			
18	174	Abel	80
19	176	Taylor	80
20	178	Grant	(null)

DEPARTMENTS

	DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID
1	10	Administration	1700
2	20	Marketing	1800
3	50	Shipping	1500
4	60	IT	1400
5	80	Sales	2500
6	90	Executive	1700
7	110	Accounting	1700
8	190	Contracting	1700

	EMPLOYEE_ID	DEPARTMENT_ID	DEPARTMENT_NAME
1	200	10	Administration
2	201	20	Marketing
3	202	20	Marketing
4	124	50	Shipping
...			
18	205	110	Accounting
19	206	110	Accounting

Creating Joins with the ON Clause

The join condition for the natural join is basically an equijoin of all columns with the same name.

Use the ON clause to specify arbitrary conditions or specify columns to join.

The join condition is separated from other search conditions.

The ON clause makes code easy to understand.

Retrieving Records with the ON Clause

```
SELECT   e.order_status,  e.customer_id,  e.order_id,
         d.order_id,  d.quantity
FROM   orders e  JOIN  order_items d
ON   (e.order_id = d.order_id) ;
```

	ORDER_STATUS	CUSTOMER_ID	ORDER_ID	ORDER_ID_1	QUANTITY
1	8	104	2355	2355	200
2	5	105	2356	2356	38
3	5	108	2357	2357	140
4	2	105	2358	2358	9
5	9	106	2359	2359	1
6	8	108	2361	2361	180
7	4	109	2362	2362	200
8	0	144	2363	2363	9
9	4	145	2364	2364	6

INNER Versus OUTER Joins

A join betweeen tables that returns rows on exact match is inner join

A join between two tables that returns the results of the INNER join as well as the unmatched rows from the left (or right) table is called a left (or right) OUTER join.

LEFT OUTER JOIN

```
SELECT e.last_name, e.department_id,
       d.department_name
FROM   employees e LEFT OUTER JOIN departments d
ON    (e.department_id = d.department_id) ;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	Whalen	10	Administration
2	Fay	20	Marketing
3	Hartstein	20	Marketing
4	Vargas	50	Shipping
5	Matos	50	Shipping

...

16	Kochhar	90	Executive
17	King	90	Executive
18	Gietz	110	Accounting
19	Higgins	110	Accounting
20	Grant	(null)	(null)

RIGHT OUTER JOIN

```
SELECT e.last_name, d.department_id,
       d.department_name
FROM   employees e RIGHT OUTER JOIN departments d
ON     (e.department_id = d.department_id) ;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	Whalen	10	Administration
2	Hartstein	20	Marketing
3	Fay	20	Marketing
4	Davies	50	Shipping
5	Vargas	50	Shipping
6	Rajs	50	Shipping
7	Mourgos	50	Shipping
8	Matos	50	Shipping

...

18	Higgins	110	Accounting
19	Gietz	110	Accounting
20	(null)	190	Contracting

FULL OUTER JOIN

```
SELECT e.last_name, d.department_id,
       d.department_name
FROM   employees e FULL OUTER JOIN departments d
ON    (e.department_id = d.department_id) ;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	Whalen	10	Administration
2	Hartstein	20	Marketing
3	Fay	20	Marketing
4	Higgins	110	Accounting

...

17	Zlotkey	80	Sales
18	Abel	80	Sales
19	Taylor	80	Sales
20	Grant	(null)	(null)
21	(null)	190	Contracting

Using a Subquery to Solve a Problem

Who has a credit limit than Charlie Pacino's?

Main query:

Which customers have credit limit greater than Charlie Pacino's credit limit?

Subquery:

What is Charlie Pacino's credit limit?

Subquery Syntax

```
SELECT  select_list
FROM    table
WHERE   expr operator
                    (SELECT      select_list
                     FROM        table);
```

- **The subquery (inner query) executes *before* the main query (outer query).**
- **The result of the subquery is used by the main query.**

Using a Subquery

```
SELECT cust_first_name || cust_last_name
FROM customers
WHERE credit_limit <
                  (Select credit_limit
                    FROM customers
                    WHERE cust_first_name = 'Charlie'
                    AND cust_last_name = 'Pacino');
```

	CUSTOMER_ID	UNIT_PRICE	WAREHOUSE_ID
1	105	199.1	9
2	105	199.1	2
3	105	199.1	4
4	105	199.1	6
5	105	199.1	8
6	105	226.6	9
7	105	226.6	2

Data Manipulation Language

A DML statement is executed when you:

- **Add new rows to a table**
- **Modify existing rows in a table**
- **Remove existing rows from a table**

A *transaction* consists of a collection of DML statements that form a logical unit of work.

Adding a New Row to a Table

DEPARTMENTS

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping	124	1500
4	60	IT	103	1400
5	80	Sales	149	2500
6	90	Executive	100	1700
7	110	Accounting	205	1700
8	190	Contracting	(null)	1700

70	Public Relations	100	1700

New row

Insert new row into the DEPARTMENTS table.

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	70	Public Relations	100	1700
2	10	Administration	200	1700
3	20	Marketing	201	1800
4	50	Shipping	124	1500
5	60	IT	103	1400
6	80	Sales	149	2500
7	90	Executive	100	1700
8	110	Accounting	205	1700
9	190	Contracting	(null)	1700

INSERT Statement Syntax

- **Add new rows to a table by using the INSERT statement:**

```
INSERT INTO table [(column [, column...])]
VALUES      (value [, value...]);
```

- **With this syntax, only one row is inserted at a time.**

Inserting New Rows

Insert a new row containing values for each column.

List values in the default order of the columns in the table.

Optionally, list the columns in the INSERT clause.

```
INSERT   INTO   order_items (order_id,
line_item_id,  product_id,  unit_price,  quantity)
VALUES   (2355, 1, 3108, 46, 200) ;
```

Enclose character and date values within single quotation marks.

Changing Data in a Table

EMPLOYEES

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	SALARY	MANAGER_ID	COMMISSION_PCT	DEPARTMENT_ID
100	Steven	King	24000	(null)	(null)	90
101	Neena	Kochhar	17000	100	(null)	90
102	Lex	De Haan	17000	100	(null)	90
103	Alexander	Hunold	9000	102	(null)	60
104	Bruce	Ernst	6000	103	(null)	60
107	Diana	Lorentz	4200	103	(null)	60
124	Kevin	Mourgos	5800	100	(null)	50

Update rows in the EMPLOYEES table:

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	SALARY	MANAGER_ID	COMMISSION_PCT	DEPARTMENT_ID
100	Steven	King	24000	(null)	(null)	90
101	Neena	Kochhar	17000	100	(null)	90
102	Lex	De Haan	17000	100	(null)	90
103	Alexander	Hunold	9000	102	(null)	80
104	Bruce	Ernst	6000	103	(null)	80
107	Diana	Lorentz	4200	103	(null)	80
124	Kevin	Mourgos	5800	100	(null)	50

UPDATE Statement Syntax

- **Modify existing values in a table with the UPDATE statement:**

```
UPDATE      table
SET         column = value [, column = value, ...]
[WHERE      condition];
```

- **Update more than one row at a time (if required).**

Updating Rows in a Table

- **Values for a specific row or rows are modified if you specify the WHERE clause:**

```
UPDATE   inventories
SET   warehouse_id  =  7
WHERE   product_id  =  3108 ;
```

```
1 rows updated
```

- **Values for all the rows in the table are modified if you omit the WHERE clause**:

```
UPDATE   inventories
SET   warehouse_id  =  7 ;
```

- **Specify SET *column_name*= NULL to update a column value to NULL.**

DELETE Statement

- **You can remove existing rows from a table by using the DELETE statement:**

```
DELETE [FROM]   table
[WHERE   condition];
```

Deleting Rows from a Table

- **Specific rows are deleted if you specify the WHERE clause**:

```
DELETE   FROM   runreport
WHERE   comments  =  ' Editing Report ' ;
```

- **All rows in the table are deleted if you omit the WHERE clause:**

```
DELETE  FROM  copy_emp;
```

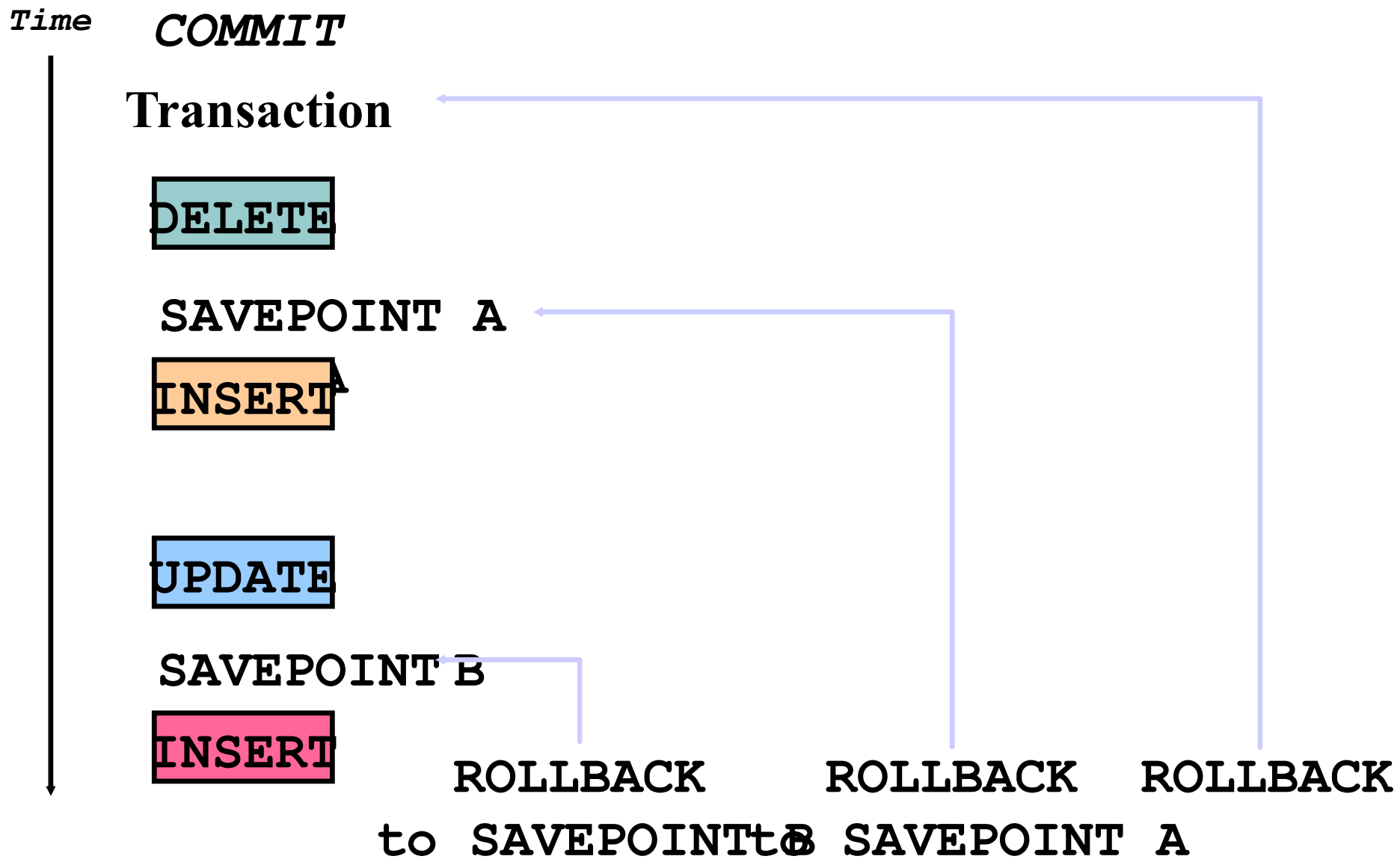
Database Transactions

- **A database transaction is defined as atomic activity that may have multiple DML statements**

- **COMMIT statement used to make changes permamnent once all the DML statements are successful**

- **ROLLBACK statement is used to undo changes to the database if any of the DML statements fails**

Explicit Transaction Control Statements



Rolling Back Changes to a Marker

- **Create a marker in the current transaction by using the SAVEPOINT statement.**
- **Roll back to that marker by using the ROLLBACK TO SAVEPOINT statement.**

```
UPDATE...
SAVEPOINT update_done;

INSERT...
ROLLBACK TO update_done;
```

Committing Data

– **Make the changes:**

```
DELETE   FROM  inventories
WHERE   product_id  =  2458  ;

INSERT   INTO   Inventories
VALUES (2670, 6, 159);
```

– **Commit the changes:**

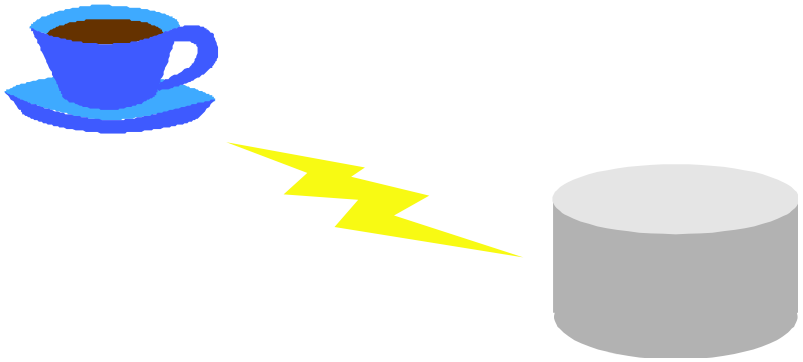
```
COMMIT ;
```

JDBC

Introduction to JDBC

- JDBC is a standard interface for connecting to relational databases from Java.

- The JDBC classes and interfaces are in the **java.sql** package.



java.sql package

Driver

DriverManager

DriverPropertyInfo

Connection

Statement

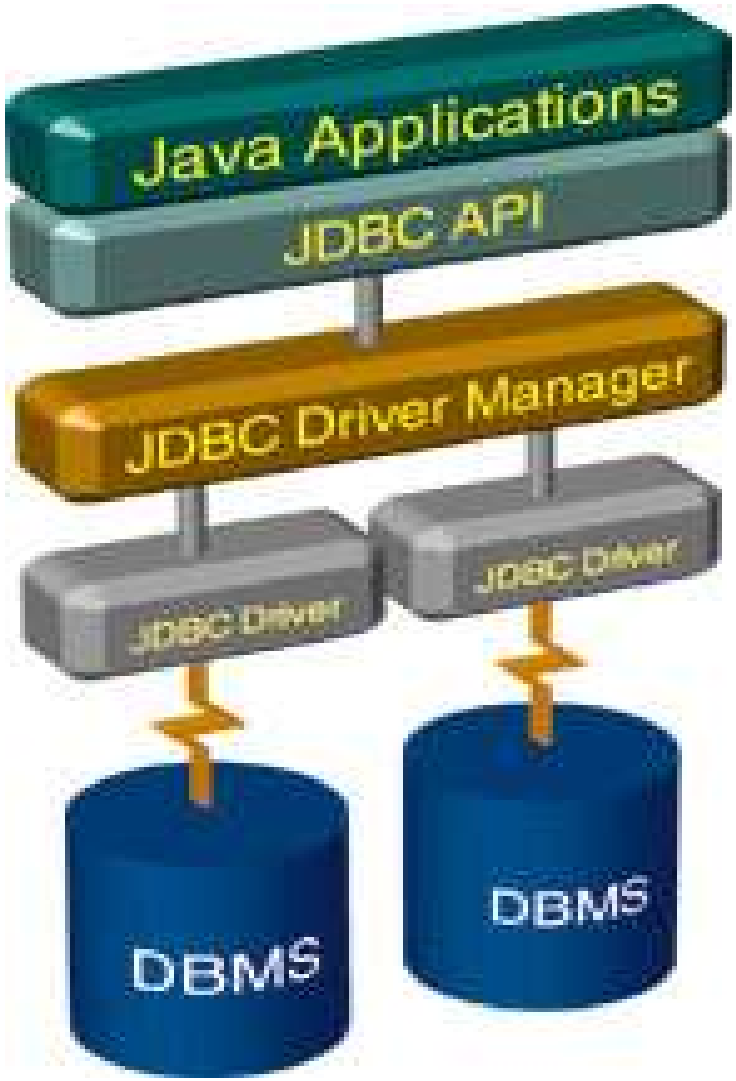
PreparedStatement

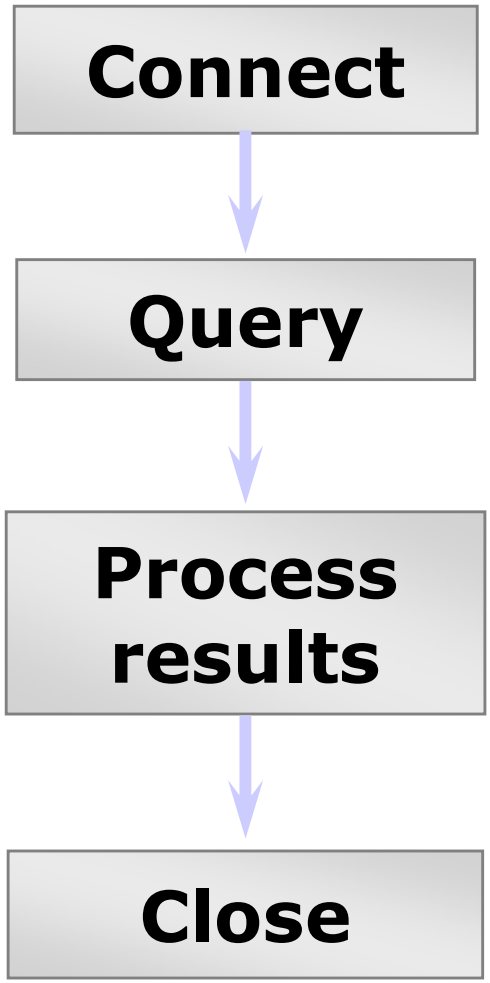
ResultSet
RowSet

SQLException
SQLWarning

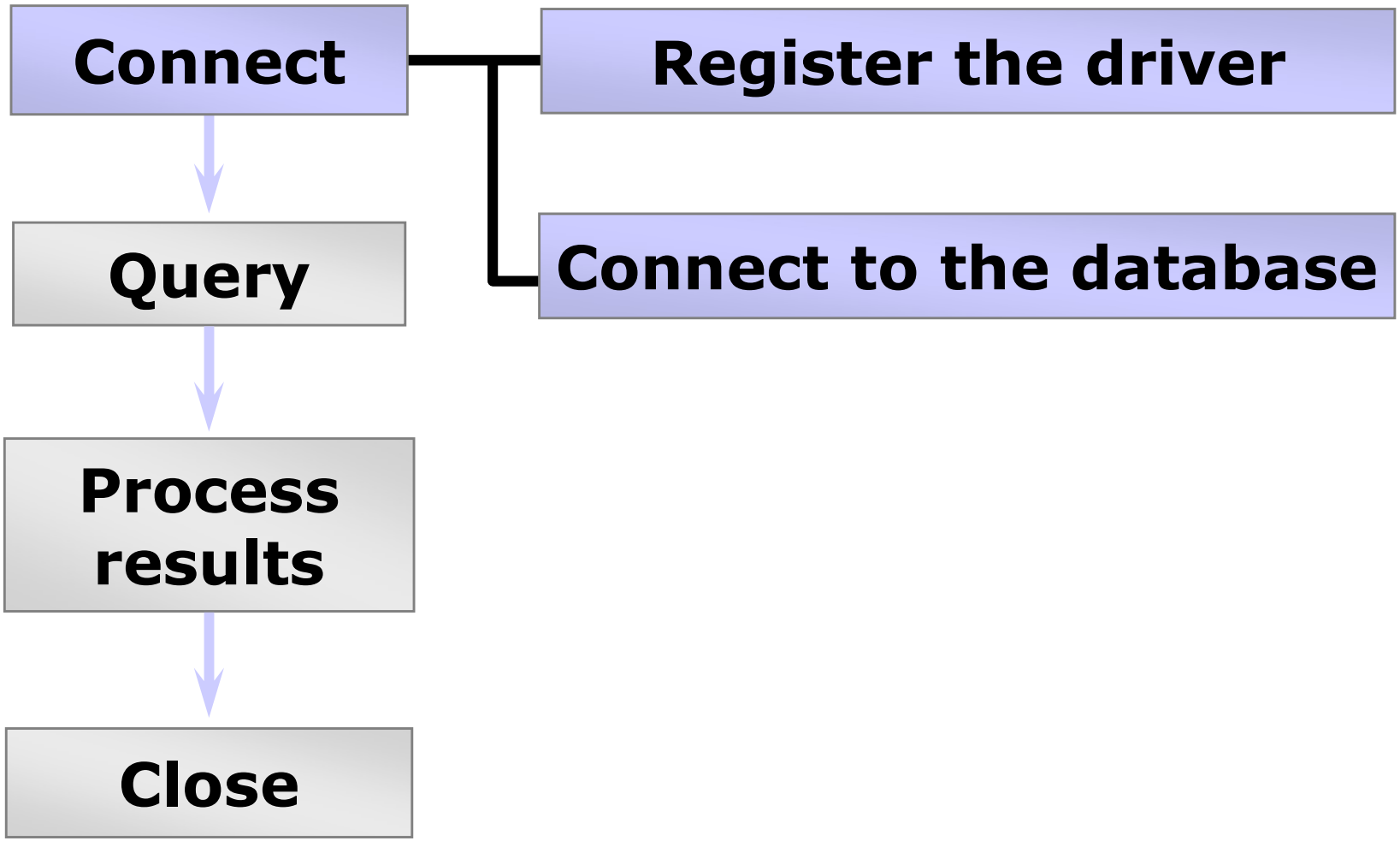
DatabaseMetaData
ResultSetMetaData

Architecture & Querying with JDBC



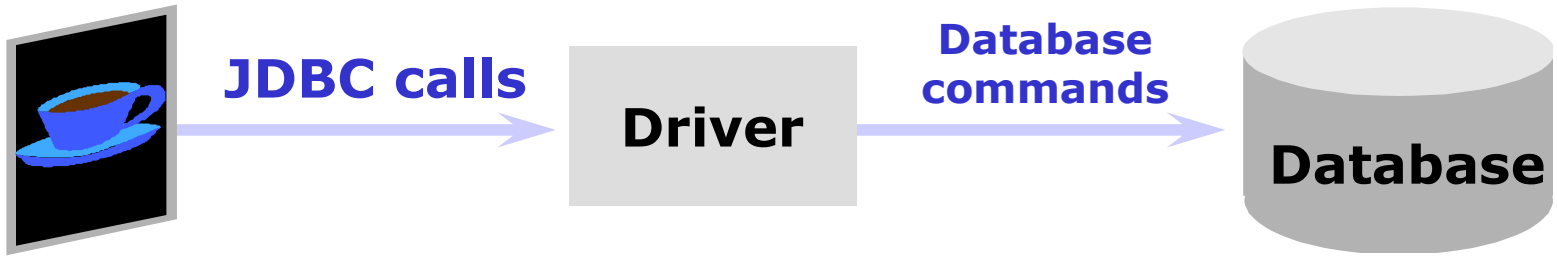


Step 1: Connect



Connect: **A JDBC Driver**

- A JDBC driver is an interpreter that translates JDBC method calls to vendor-specific database commands.
- JDBC driver Implements interfaces in `java.sql`



DriverManager class

All methods are static and the class does not have a constructor

Methods

Connection getConnection(String url)

Connection getConnection(String url , String user , String password)

Connection class

Methods

```
Statement createStatement( )
PreparedStatement prepareStatement( String sql )
void close ( )
DatabaseMetaData getMetaData( )
void setAutoCommit( boolean commit )     // default true
boolean getAutoCommit( )
void commit( )
void rollback( )
```

Setting up database connection

Class.forName(“sun.jdbc.odbc.JdbcOdbcDriver”)

Connection con = DriverManager.getConnection(url)

URL format

jdbc: <sub protocol > : <subname related to database>

example

jdbc : odbc : student

jdbc : ids : //www.test.com:90/conn?dbtype=odbc&dsn=student

jdbc:derby://localhost:1527/ramanadb

Creating Connection

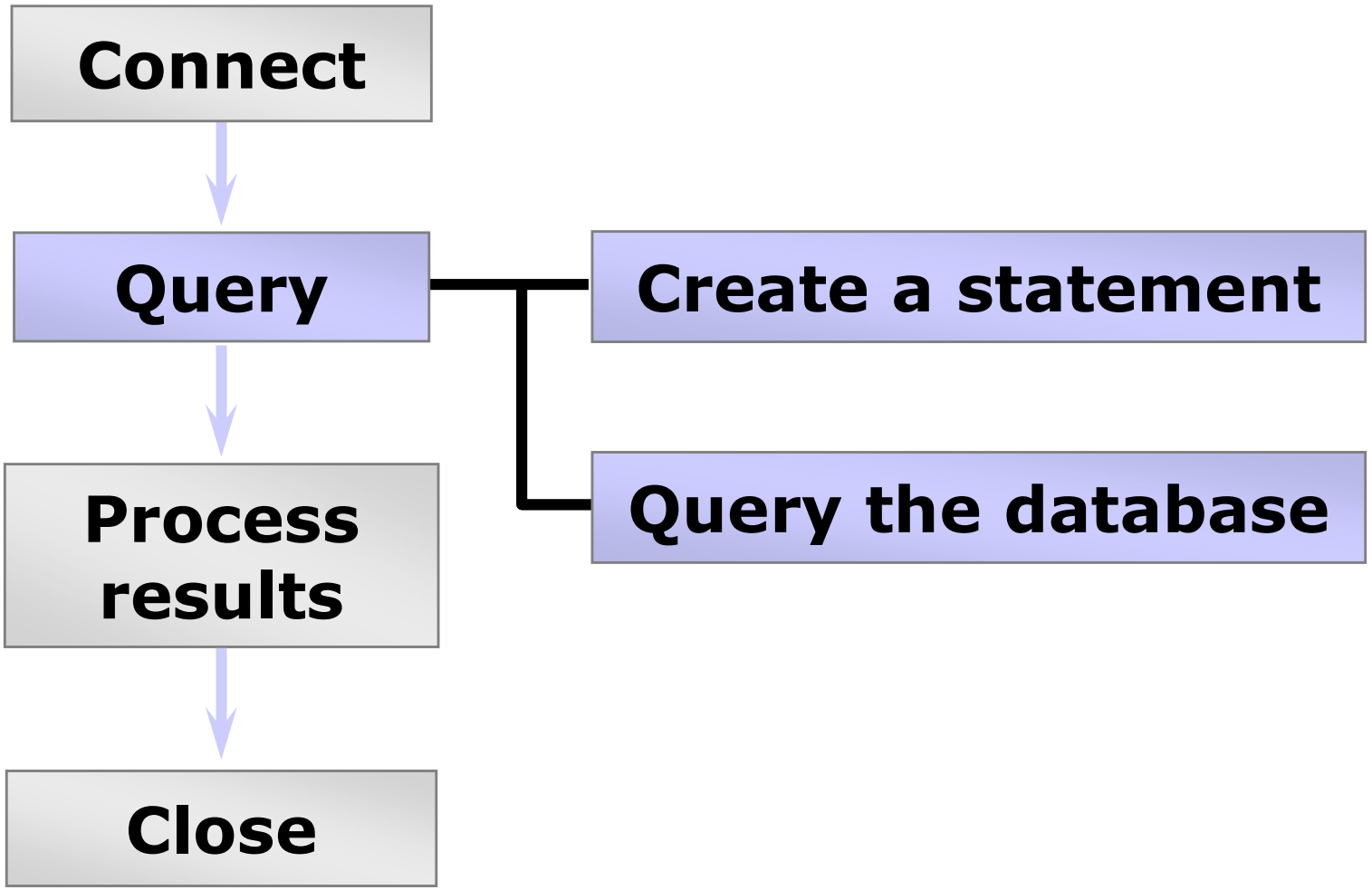
1. **Register the driver (prior to java 5. Not required now)**

```
Class c = Class.forName( " org.apache.derby.jdbc.ClientDriver ");
```

2. **Connect to the database**

```
Connection conn = DriverManager.getConnection(
        "jdbc:derby:codejava/webdb ",
        "user",
        "pwd");
```

Step 2: Query


Connect
Query
Create a statement
Query the database
Process results
Close

Statements

types of statements

- **Statement**
- **PreparedStatement**
- **CallableStatement**

All these are implemented as classes

Statement interface

Methods

ResultSet executeQuery(String query)

int executeUpdate(String sql)

boolean execute(String sql)

ResultSet getResultSet ( )

int getUpdateCount( )

Method	Returns	Used for
`executeQuery(sqlString)`	`ResultSet`	`SELECT` statement
`executeUpdate(sqlString)`	`int` (rows affected)	`INSERT`, `UPDATE`, `DELETE`, or a DDL
`execute(sqlString)`	`boolean` (true if there was a `ResultSet`)	Any SQL command or commands

Example code for Statement

```
Statement   stmt ;

private void runStatement()  throws SQLException {

   Class.forName ("jdbc.odbc.JdbcOdbcDriver");

   Connection con = DriverManager.getConnection(“jdbc:odbc:dsn” );

   String sql  = ”select name , salary from emp where  empno = 3010 ” ;

    stmt = con.createStatement(  ) ;

   ResultSet rs = stmt.executeQuery( sql ) ;

}
```

Statement methods

1. **Create an empty statement object**

```
Statement stmt = conn.createStatement();
```

2. **Execute the statement**

```
ResultSet rset = stmt.executeQuery(statement);
int count = stmt.executeUpdate(statement);
boolean isquery = stmt.execute(statement);
```

Statement methods: **Examples**

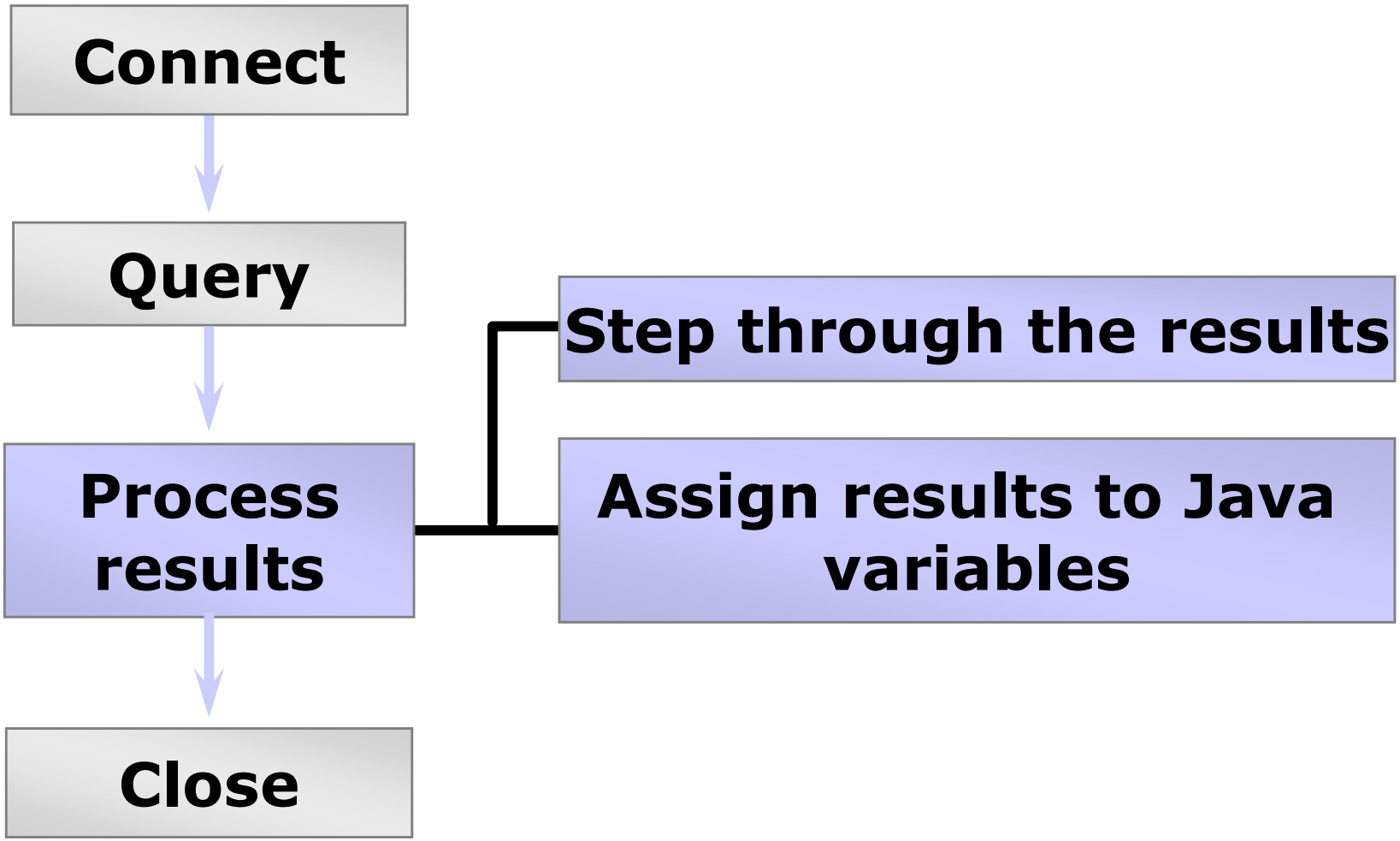
Execute a select statement

```
Statement stmt = conn.createStatement();
ResultSet rset = stmt.executeQuery
  ("select NAME, VERTICAL from STUDENT");
```

Execute a delete statement

```
Statement stmt = conn.createStatement();
int rowcount = stmt.executeUpdate
  ("delete from STUDENT   where  ID = 1000");
```

Step 3: Process the Results



Using a `ResultSet` Object

```
String query = "SELECT * FROM Employee";
ResultSet rs = stmt.executeQuery(query);
```

ResultSet cursor →

The first `next()` method invocation returns `true`, and `rs` points to the first row of data.

rs.next() →	110	Troy	Hammer	1965-03-31	102109.15
rs.next() →	123	Michael	Walton	1986-08-25	93400.20
rs.next() →	201	Thomas	Fitzpatrick	1961-09-22	75123.45
rs.next() →	101	Abhijit	Gopali	1956-06-01	70000.00
rs.next() →	`No data`				

The last `next()` method invocation returns `false`, and the `rs` instance is now null.

ExecuteQuery() - example

```
1   package com.example.text;
2
3   import java.sql.DriverManager;
4   import java.sql.ResultSet;
5   import java.sql.SQLException;
6   import java.util.Date;
7
8   public class SimpleJDBCTest {
9
10     public static void main(String[] args) {
11         String url = "jdbc:oracle:thin@localhost:1521:xe";
12         String username = “hr";
13         String password = “hr";
14         String query = "SELECT * FROM Employee";
15         try {
             1 Connection con =
16             DriverManager.getConnection (url, username, password);
17             Statement stmt = con.createStatement ();
18             ResultSet rs = stmt.executeQuery (query) ;
```

ExecuteQuery() - example

```
19            while (rs.next()) {
20                int empID = rs.getInt("ID");
21                String first = rs.getString("FirstName");
22                String last = rs.getString("LastName");
23                Date birthDate = rs.getDate("BirthDate");
24                float salary = rs.getFloat("Salary");
25                System.out.println("Employee ID:   " + empID + "\n"
26                + "Employee Name: " + first + " " + last + "\n"
27                + "Birth Date:    " + birthDate + "\n"
28                + "Salary:        " + salary);
29            } // end of while
30        } catch (SQLException e) {
31            System.out.println("SQL Exception: " + e);
32        } // end of try-with-resources
33    }
34  }
```

ExecuteUpdate() - example

```
1. public class InsertJDBCExample {
2.     public static void main(String[] args) {
3.         // Create the "url"
4.         // assume database server is running on the localhost
5.         String url = "jdbc:oracle:thin@localhost:1521:xe";
6.         String unm = "hr";
7.         String pwd = "hr";
8. try {
9. Connection con = DriverManager.getConnection(url, unm, pwd))
10. Statement stmt = con.createStatement();
11. String query = "INSERT INTO Employee VALUES (500, 'Jill',
   'Murray','1950-09-21', 150000)";
12.if (stmt.executeUpdate(query) > 0) {
13.   System.out.println("A new Employee record is added");
14.   }
15.String query1="select *  from Employee";
16.ResultSet rs = stmt.executeUpdate(query1);
17.//code to display the rows
18.}
```

PreparedStatement

- `PreparedStatement` is a subclass of `Statement` that allows you to pass arguments to a precompiled SQL statement.

```
double value = 100_000.00;
String query = "SELECT * FROM Employee WHERE
 Salary > ?";
PreparedStatement pStmt =
 con.prepareStatement(query);
pStmt.setDouble(1, value);
ResultSet rs = pStmt.executeQuery();
```

- `PreparedStatement` is useful when you want to execute a SQL statement multiple times.

PreparedStatement

Methods

ResultSet executeQuery( )

int executeUpdate( )

boolean execute( )

ResultSet getResultSet ( )

int getUpdateCount( )

void setString(int parameterindex , String x)

void setBoolean(int parameterindex , boolean x)

void setInt(int parameterindex , int x)

void setFloat(int parameterindex , float x)

void setDate(int parameterindex , java.sql.Date x)

void clearParameters( )

`PreparedStatement`: Setting Parameters

- In general, there is a **`setXXX`** method for each type in the Java programming language.

- **`setXXX`** arguments:
  - The first argument indicates which question mark placeholder is to be set.
  - The second argument indicates the replacement value.
- For example:

```
pStmt.setInt(1, 175);
pStmt.setString(2,"Charles");
```

PreparedStatement:Example

```
PreparedStatement updateEmp;
String updateString = "update Employee“
    + "set SALARY= ? where EMP_NAME like ?";
updateEmp  = con.prepareStatement(updateString);
int[] salary = {1750, 1500, 6000, 1550, 9050};
String[] names = {"David", "Tom", "Nick“,"Harry", "Mark"};
for(int i=0:i<names.length;i++)
 {
     updateEmp.setInt(1, salary[i]);
     updateEmp.setString(2, names[i]);
     updateEmp.executeUpdate();
 }
```