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SQL in a Server Environment

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Computer Information Systems

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The Three-Tier Architecture

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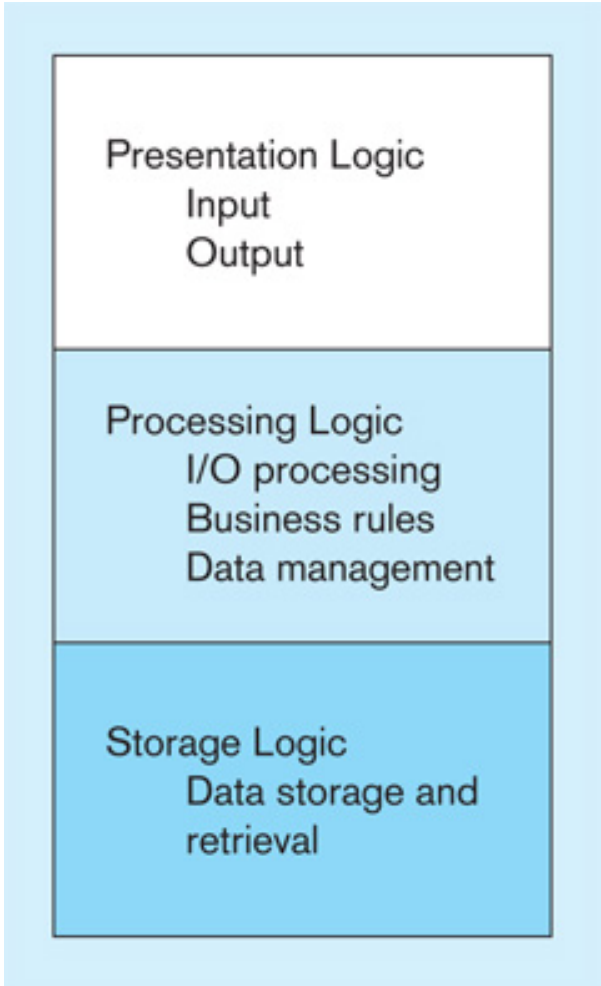
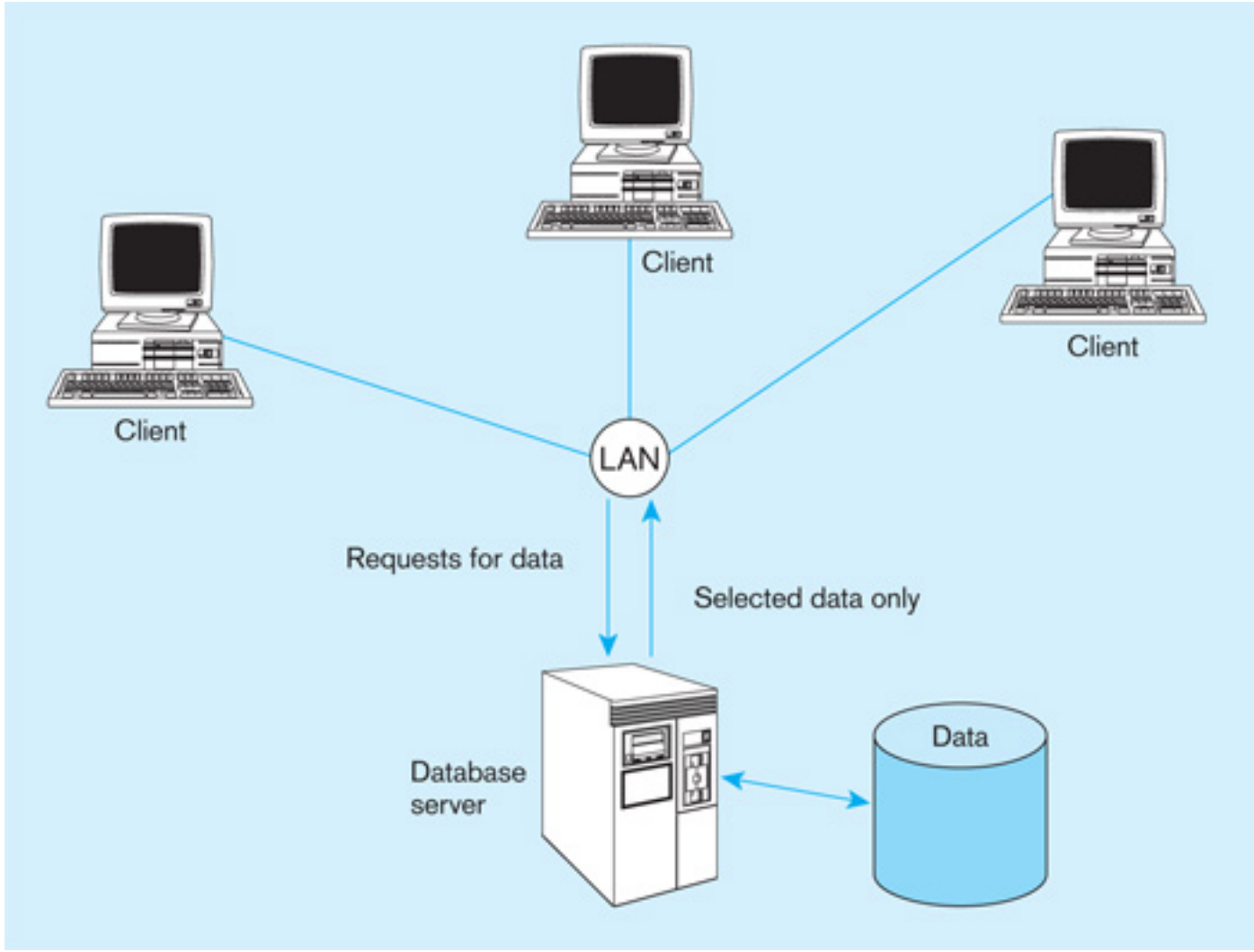
Application logic components



Database Server Architecture

Two-tier architecture



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Two-tier architecture

- Client is responsible for
  - I/O processing logic
  - Some business rules logic
- Server performs all data storage and access processing

Advantages of two-tier architectures

- Clients do not have to be very powerful
- Greatly reduces data traffic on the network
- Improved data integrity since it is all processed centrally

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Three-tier architectures

A common environment for using a database has three tiers of processors:

- *Web servers* — talk to the user.
- *Application servers* — execute the business logic.
- *Database servers* — get what the app servers need from the database.

Client	GUI, IO	Browser
Application Server	Business Rules	Web Server
Database Server	Data storage	DBMS

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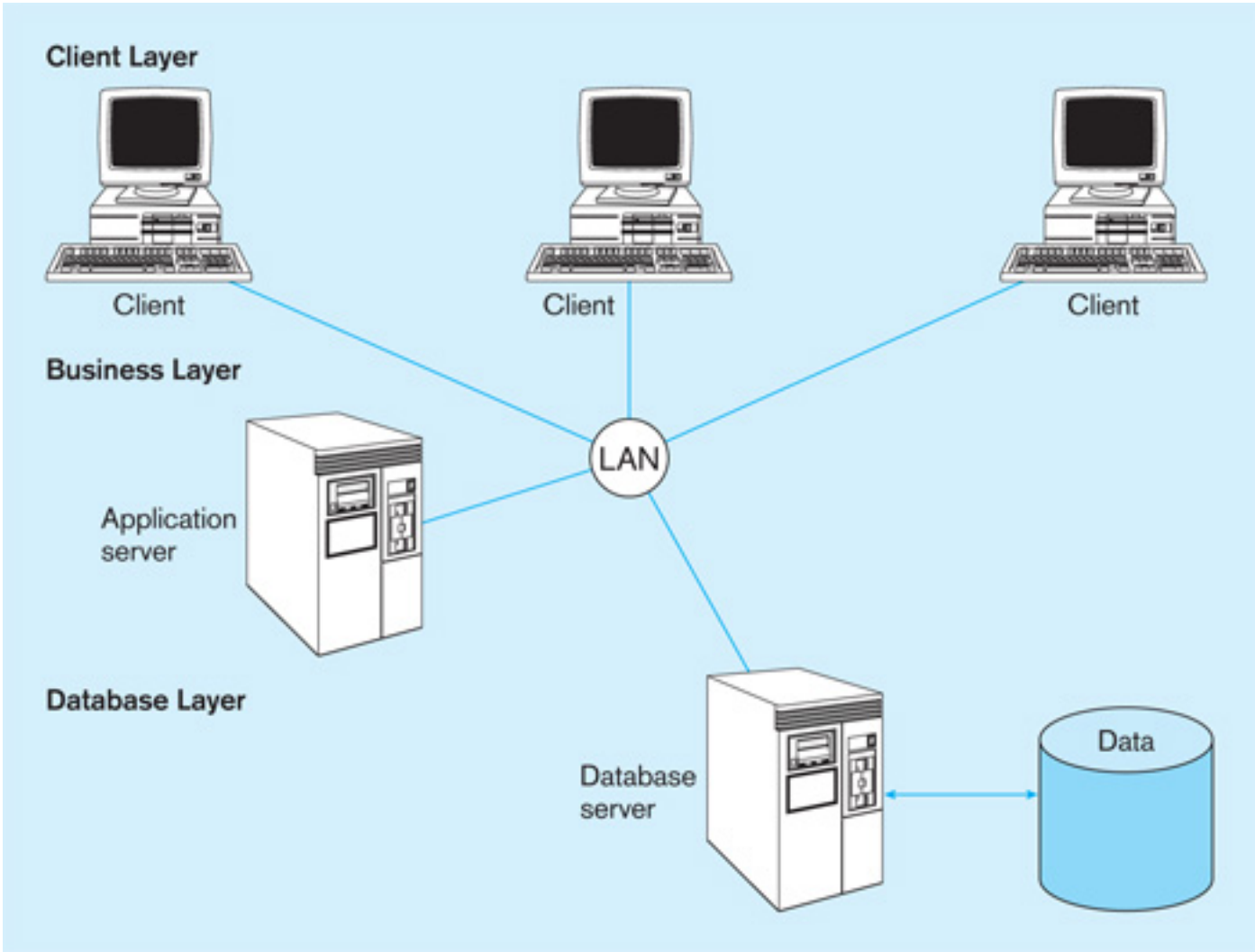
Three-tier Architecture



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The Web Server

The web server processes manage interactions with the user

Example?

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The Application Tier

The job of the application tier is to turn data, from the database, into a response to the request that it receives from the web server.
(perfoms *business logic* of the organization)

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The Database Tier

The database tier executes queries that are requested from the application tier and may also provide some buffering of data.

Keep a large number of connections open!

JDBC

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Introduction to ODBC/JDBC

ODBC - Open Database Connectivity
JDBC - Java Database Connectivity

ODBC/JDBC expose database capabilities in a standardized way to the application developer through an API.

requires a DBMS-specific driver

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Architecture of JDBC

1. Application (initiates and terminates connections, submits SQL statements)
2. Driver manager (load JDBC driver)
3. Drivers (connects to data source, transmits requests and returns/translates results and error codes)
4. Data sources or DBMSs (processes SQL statements)

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JDBC classes and interfaces

java.sql
javax.sql

```
import java.sql.*
```

Steps to submit a database query:

- Load the JDBC driver
- Connect to the data source
- Execute SQL statements

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JDBC Driver Management

All drivers are managed by the *DriverManager* class

Loading a JDBC driver:

- In the Java code:
  `Class.forName("com.mysql.jdbc.Driver");`
- When starting the Java application:
  `-Djdbc.drivers=com.mysql.jdbc.Driver`

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Connections in JDBC

We interact with a data source through sessions. Each connection identifies a logical session.

JDBC URL:
`jdbc:<subprotocol>:<otherParameters>`

Example:

```
1
2       String url="jdbc:mysql://localhost/sailing";
3
4       Connection con;
5
6               try{
7                       con =DriverManager.getConnection(url,userId,password);
8               }catch(SQLException excpt){
9                       System.out.println(excpt.getMessage());
10                      return;
11              }
```

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Connection Class Interface

- `public int getTransactionIsolation()` and `void setTransactionIsolation(int level)`
  Sets isolation level for the current connection.
  TRANSACTION_READ_UNCOMMITTED
  TRANSACTION_READ_COMMITTED
  TRANSACTION_REPEATABLE_READ
  TRANSACTION_SERIALIZABLE

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- `public boolean isClosed()`
  Checks whether connection is still open.

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Executing SQL Statements

Three different ways of executing SQL statements:

- Statement(both static and dynamic SQL statements)
- PreparedStatement(semi-static SQL statements)
- CallableStatement(stored procedures)

`PreparedStatement` class:
Precompiled, parametrizedSQL statements:

- Structure is fixed
- Values of parameters are determined at run-time

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Prepared statements example

```
1
2           int sid =10;
3           String sname="Thomas"
4           int rating =4;
5           Double age = 20.2;
6
7           String sql="INSERT INTO Sailors VALUES(?,?,?,?)";
8
9           PreparedStatment pstmt=con.prepareStatement(sql);
10
11                  pstmt.clearParameters();
12                  pstmt.setInt(1,sid);
13                  pstmt.setString(2,sname);
14                  pstmt.setInt(3, rating);
15                  pstmt.setFloat(4,age);
16  // we know that no rows are returned, thus we use executeUpdate()
17          int numRows=pstmt.executeUpdate();
```

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ResultSet

`PreparedStatement.executeUpdate()` only returns the number of affected records

`PreparedStatement.executeQuery()` returns data, encapsulated in a `ResultSet` object.

```
1 ResultSet rs=pstmt.executeQuery(sql);
2 // rs is now a cursor
3         while (rs.next()) {
4             // process the data
5          }
```

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Resultset cont.

We can move in the query answer as follows:

- `previous()`: moves one row back
- `absolute(int num)`: moves to the row with the specified number
- `relative (int num)`: moves forward or backward
- `first()` and `last()`

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A (semi) complete example

```
1       ...
2     String url="jdbc:mysql://localhost/sailing";
3        // connect
4     Connection con =  DriverManager.getConnection(url, "login", "pass");
5
6     Statement stmt = con.createStatement(); // set up stmt
7
8     String query = "SELECT name, rating FROM Sailors";
9
10    ResultSet rs= stmt.executeQuery(query);
11
12            try { // handle exceptions
13                  // loop through result tuples
14                  while (rs.next()) {
15                                    String s =rs.getString("name");
16                                    int n =rs.getFloat("rating");
17                                   System.out.println(s + "   " + n);
18                   }
19               } catch(SQLExceptionex) {
20                  System.out.println(ex.getMessage() + ex.getSQLState()
21                  + ex.getErrorCode());
22               }
23                ...
```