Repository

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Data storage

- Where do we store data?

Data storage

- Where do we store data?

- File
- XML
- Database
- Relational Database

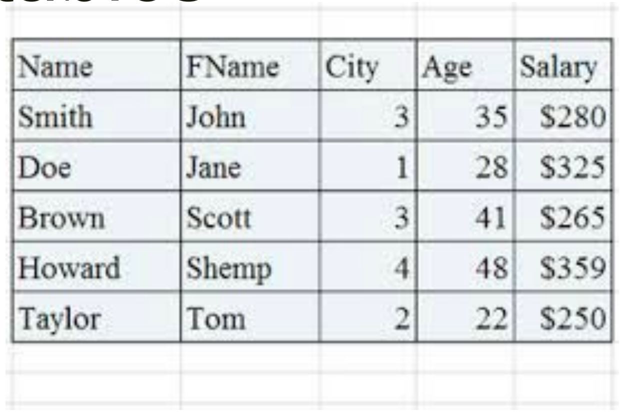
JDBC

- The JDBC API is a Java API that can access any kind of **tabular data**, especially data stored in a Relational Databases
- A database is a means of storing information in such a way that information can be retrieved from it.

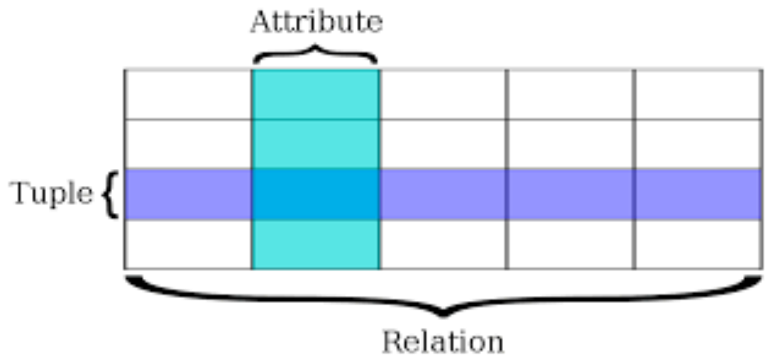
Notions

- A relational database shows information in tables
- Table has rows & columns
- A **table** is referred to as a **relation**

– *in the sense that it is a collection of objects of the same type (rows).*



Name	FName	City	Age	Salary
Smith	John	3	35	$280
Doe	Jane	1	28	$325
Brown	Scott	3	41	$265
Howard	Shemp	4	48	$359
Taylor	Tom	2	22	$250



Relationships

- Data in a table can be related according to common keys or concepts
- The ability to retrieve related data from a table is the basis for the term **relational database** (based on relations).
- A Database Management System (DBMS)
  - *handles the way data is stored, maintained, and retrieved.*
- **Relational** Database Mgmt System (RDBMS)

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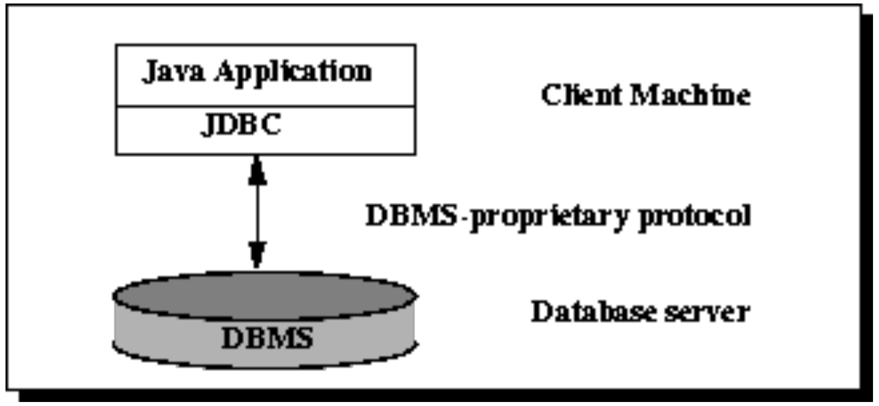
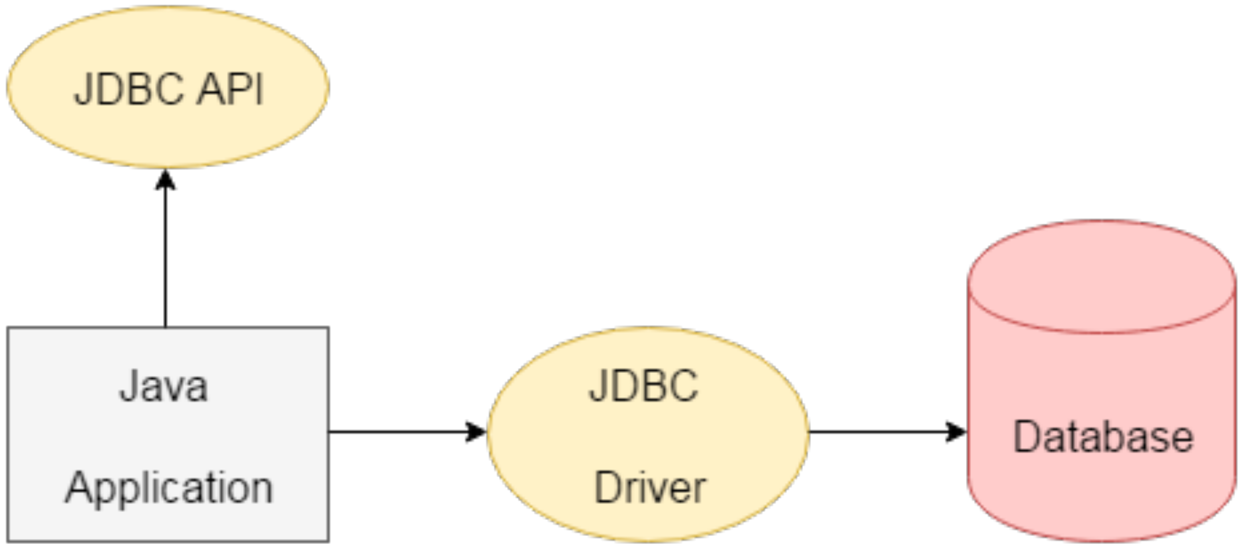
Architecture





postgres-driver.jar

- JDBC helps to write Java applications that manage these 3 programming activities:

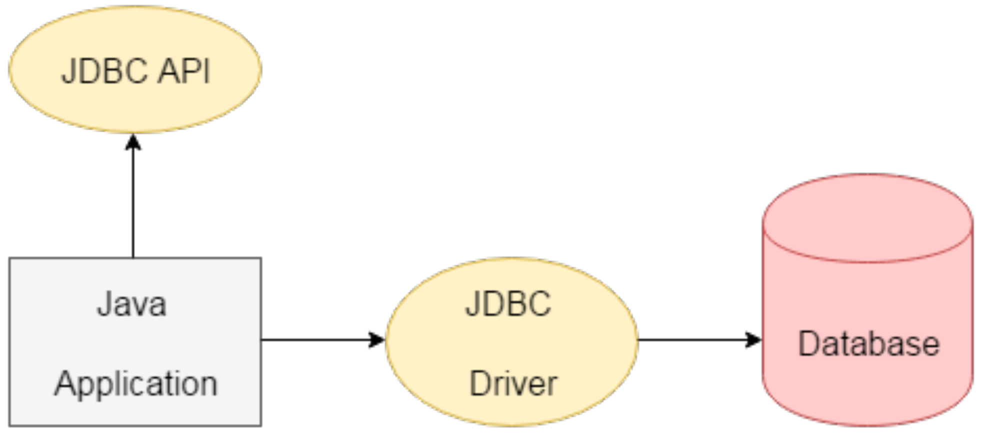
1. Connect to a data source, like a database
2. Send queries and update statements to the database
3. Retrieve and process the results received from the database in answer to your query

Example

```
public void connectToAndQueryDatabase(String username, String password) {

   Class.forName(”xx.xx.Driver"); //register driver;specific for given DB
   Connection con = DriverManager.getConnection(
                       "jdbc:myDriver:myDatabase",
                       username, password);

    Statement stmt = con.createStatement();
    ResultSet rs = stmt.executeQuery("SELECT colA, colB, colC FROM Table");

    while (rs.next()) {
           int x = rs.getInt(”colA");
           String s = rs.getString(”colB");
           float f = rs.getFloat("colC");
       }
}
```

Many Database providers

- Divided responsibility



1. *Java API – JDBC*
2. *Database specialties – Driver*

– *Custom driver.jar per a particular database*

Sample database table

- Employee

```
table Employee (
  Employee_Number int primary key,
  First_name varchar(255),
  Last_name varchar(255),
  Date_of_Birth date,
  Car_Number int foreign key
)
```

```
class Employee {
  int employeeNumber;
  String firstname;
  String lastname;
  Date dob;
  int carNumber;
}
```

Employee_Number	First_name	Last_Name	Date_of_Birth	Car_Number
10001	Axel	Washington	28-Aug-43	5
10083	Arvid	Sharma	24-Nov-54	null
10120	Jonas	Ginsberg	01-Jan-69	null
10005	Florence	Wojokowski	04-Jul-71	12
10099	Sean	Washington	21-Sep-66	null
10035	Elizabeth	Yamaguchi	24-Dec-59	null

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SQL

- Structured Query Language (SQL) is a domain-specific language used in programming and designed for managing data held in a relational database management system (RDBMS)

– *SELECT [columns] FROM [table] WHERE [condition]*
– *SELECT [columns] FROM [table1] INNER JOIN [table2] ON (cond.)..*
– *INSERT INTO [table] VALUES ([values])*
– *UPDATE [table] SET [column1 = value1,..] WHERE [condition]*
– *DELETE FROM [table] WHERE [condition]*

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Lets apply SQL

- Employee

```
table Employee (
  Employee_Number int primary key,
  First_name varchar(255),
  Last_name varchar(255),
  Date_of_Birth date,
  Car_Number int foreign key
)
```

```
class Employee {
  int employeeNumber;
  String firstname;
  String lastname;
  Date dob;
  int carNumber;
}
```

Employee_Number	First_name	Last_Name	Date_of_Birth	Car_Number
10001	Axel	Washington	28-Aug-43	5
10083	Arvid	Sharma	24-Nov-54	null
10120	Jonas	Ginsberg	01-Jan-69	null
10005	Florence	Wojokowski	04-Jul-71	12
10099	Sean	Washington	21-Sep-66	null
10035	Elizabeth	Yamaguchi	24-Dec-59	null

SQL Select Statement

```
SELECT * FROM Employees
```

- Results:

Employee_Number	First_name	Last_Name	Date_of_Birth	Car_Number
10001	Axel	Washington	28-Aug-43	5
10083	Arvid	Sharma	24-Nov-54	null
10120	Jonas	Ginsberg	01-Jan-69	null
10005	Florence	Wojokowski	04-Jul-71	12
10099	Sean	Washington	21-Sep-66	null
10035	Elizabeth	Yamaguchi	24-Dec-59	null

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SQL

- Why do not we do it in Java?
- Too slow
- Java is programming language
  – *not a retrieval/modification/processing language*
- SQL more efficient
- Mathematical model
- FAST!
- Does not know the concept of objects/polymorphism ☹️

Select Statement

```
SELECT First_Name, Last_Name
FROM Employees
WHERE Car_Number IS NOT NULL
```

- Results:

FIRST_NAME	LAST_NAME
Axel	Washington
Florence	Wojokowski

Original data:

Employee_Number	First_name	Last_Name	Date_of_Birth	Car_Number
10001	Axel	Washington	28-Aug-43	5
10083	Arvid	Sharma	24-Nov-54	null
10120	Jonas	Ginsberg	01-Jan-69	null
10005	Florence	Wojokowski	04-Jul-71	12
10099	Sean	Washington	21-Sep-66	null
10035	Elizabeth	Yamaguchi	24-Dec-59	null

Select Statement

```
SELECT First_Name, Last_Name
FROM Employees
WHERE Last_Name LIKE 'Washington%'
```

- Results:

FIRST_NAME	LAST_NAME
Axel	Washington
Sean	Washington

Original data:

Employee_Number	First_name	Last_Name	Date_of_Birth	Car_Number
10001	Axel	Washington	28-Aug-43	5
10083	Arvid	Sharma	24-Nov-54	null
10120	Jonas	Ginsberg	01-Jan-69	null
10005	Florence	Wojokowski	04-Jul-71	12
10099	Sean	Washington	21-Sep-66	null
10035	Elizabeth	Yamaguchi	24-Dec-59	null

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Select Statement

```
SELECT First_Name, Last_Name
FROM Employees
WHERE Car_Number = 12
```

- Results:

FIRST_NAME	LAST_NAME
Florence	Wojokowski

Original data:

Employee_Number	First_name	Last_Name	Date_of_Birth	Car_Number
10001	Axel	Washington	28-Aug-43	5
10083	Arvid	Sharma	24-Nov-54	null
10120	Jonas	Ginsberg	01-Jan-69	null
10005	Florence	Wojokowski	04-Jul-71	12
10099	Sean	Washington	21-Sep-66	null
10035	Elizabeth	Yamaguchi	24-Dec-59	null

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Join – connect two tables (over ID)

- Cars:

Car_Number	Make	Model	Year
5	Honda	Civic DX	1996
12	Toyota	Corolla	1999

Employee:

Employee_Number	First_name	Last_Name	Date_of_Birth	Car_Number
10001	Axel	Washington	28-Aug-43	5
10083	Arvid	Sharma	24-Nov-54	null
10120	Jonas	Ginsberg	01-Jan-69	null
10005	Florence	Wojokowski	04-Jul-71	12
10099	Sean	Washington	21-Sep-66	null
10035	Elizabeth	Yamaguchi	24-Dec-59	null

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```
SELECT Employees.First_Name,
  Employees.Last_Name, Cars.Make,
  Cars.Model, Cars.Year FROM Employees, Cars
WHERE Employees.Car_Number = Cars.Car_Number
```

- Cars:

Car_Number	Make	Model	Year
5	Honda	Civic DX	1996
12	Toyota	Corolla	1999

FIRST_NAME	LAST_NAME	MAKE	MODEL	YEAR
Axel	Washington	Honda	Civic DX	1996
Florence	Wojokowski	Toyota	Corolla	1999

Employee:

Employee_Number	First_name	Last_Name	Date_of_Birth	Car_Number
10001	Axel	Washington	28-Aug-43	5
10083	Arvid	Sharma	24-Nov-54	null
10120	Jonas	Ginsberg	01-Jan-69	null
10005	Florence	Wojokowski	04-Jul-71	12
10099	Sean	Washington	21-Sep-66	null
10035	Elizabeth	Yamaguchi	24-Dec-59	null

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```
SELECT Employees.First_Name,
  Employees.Last_Name, Cars.Make,
  Cars.Model, Cars.Year FROM Employees JOIN Cars
ON (Employees.Car_Number = Cars.Car_Number)
WHERE Cars.Make like ‘Hon%’
```

- Cars:

Car_Number	Make	Model	Year
5	Honda	Civic DX	1996
12	Toyota	Corolla	1999

FIRST_NAME	LAST_NAME	MAKE	MODEL	YEAR
Axel	Washington	Honda	Civic DX	1996

Employee:

Employee_Number	First_name	Last_Name	Date_of_Birth	Car_Number
10001	Axel	Washington	28-Aug-43	5
10083	Arvid	Sharma	24-Nov-54	null
10120	Jonas	Ginsberg	01-Jan-69	null
10005	Florence	Wojokowski	04-Jul-71	12
10099	Sean	Washington	21-Sep-66	null
10035	Elizabeth	Yamaguchi	24-Dec-59	null

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Common SQL commands

- **Data Modification:**
- SELECT — used to query and display data from a database.
  The SELECT statement specifies which columns to include in the result set. The vast majority of the SQL commands used in applications are SELECT statements.
- INSERT — adds new rows to a table. INSERT is used to populate a newly created table or to add a new row (or rows) to an already-existing table.
- DELETE — removes a specified row or set of rows from a table
- UPDATE — changes an existing value in a column or group of columns in a table

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Common SQL commands

- **Data Definition:**
- CREATE TABLE — creates a table with the column names the user provides. The user also needs to specify a type for the data in each column. Data types vary. CREATE TABLE is normally used less often than the data manipulation commands because a table is created only once, whereas adding or deleting rows or changing individual values generally occurs more frequently.
- DROP TABLE — deletes all rows and removes the table definition from the database.
- ALTER TABLE — adds or removes a column from a table. It also adds or drops table constraints and alters column attributes

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JDBC structures

- **Result Sets**
  - *The rows that satisfy the conditions of a query are called the result set.*
  - *The number of rows returned in a result set can be zero, one, or many.*
- **Cursors**
  - *A user can access the data in a result set one row at a time, and a cursor provides the means to do that.*
  - *A cursor can be thought of as a pointer into a file that contains the rows of the result set, and that pointer has the ability to keep track of which row is currently being accessed.*

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Example

```
public void connectToAndQueryDatabase(String username, String password) {

    Connection con = DriverManager.getConnection(
                         "jdbc:myDriver:myDatabase",
                         username,
                         password);

    Statement stmt = con.createStatement();
    ResultSet rs = stmt.executeQuery(
                       "SELECT column_a, column_b, column_c FROM Table1");

    while (rs.next()) {
           int colA = rs.getInt(“column_a");
           Strng colB = rs.getString("column_b");
           float colC = rs.getFloat("column_c");
       }
}
```

```
public static void viewTable(Connection con, String dbName) throws SQLException {
    Statement stmt = null;
    String query = "select COF_NAME, SUP_ID, PRICE, SALES, TOTAL "
                    +  "from " + dbName + ".COFFEES";
        try {
            stmt = con.createStatement();
            ResultSet rs = stmt.executeQuery(query);
            while (rs.next()) {
                String coffeeName = rs.getString("COF_NAME");
                int supplierID = rs.getInt("SUP_ID");
                float price = rs.getFloat("PRICE");
                int sales = rs.getInt("SALES");
                int total = rs.getInt("TOTAL");
                System.out.println(coffeeName + "\t" + supplierID +
                                   "\t" + price + "\t" + sales + "\t" + total);
           }
    } catch (SQLException e ) {
        JDBCTutorialUtilities.printSQLException(e);
    } finally {
        if (stmt != null) { stmt.close(); }
    }
}
```

JDBC execute a query

- To execute a query, call an execute method from Statement:
- `executeQuery`: **Returns one ResultSet object.**
- `executeUpdate`: Returns an integer representing the number of rows affected by the SQL statement. Use this method if you are using **INSERT, DELETE, or UPDATE** SQL statements.
- `execute`: Returns true if the first object that the query returns is a ResultSet object. False if an int value or not value is returned. Any kind of statement.

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JDBC result set

```
String query = "select COF_NAME, SUP_ID, PRICE, SALES, TOTAL "
                  +  "from " + dbName + ".COFFEES";
try {
    stmt = con.createStatement();
    ResultSet rs = stmt.executeQuery(query);
    while (rs.next()) {
        String coffeeName = rs.getString("COF_NAME");
        int supplierID = rs.getInt("SUP_ID");
        float price = rs.getFloat("PRICE");
        int sales = rs.getInt("SALES");
        int total = rs.getInt("TOTAL");
        System.out.println(coffeeName + "\t" + supplierID +
                           "\t" + price + "\t" + sales + "\t" + total);
    }
}
```

JDBC clean up – close the connection

```
} finally {
    if (stmt != null) {
        stmt.close();
    }
}
```

```
public static void viewTable(Connection con) throws SQLException {

    String query = "select COF_NAME, SUP_ID, PRICE, " +
                   "SALES, TOTAL " +  "from COFFEES";

    try (Statement stmt = con.createStatement()) {

        ResultSet rs = stmt.executeQuery(query);

        while (rs.next()) {
            String coffeeName = rs.getString("COF_NAME");
            int supplierID = rs.getInt("SUP_ID");
            float price = rs.getFloat("PRICE");
                  int sales = rs.getInt("SALES");
                  int total = rs.getInt("TOTAL");
            System.out.println(coffeeName + ", " + supplierID +
                                   ", " + price + ", " + sales + ", " + total);
            }
    } catch (SQLException e) {
        JDBCTutorialUtilities.printSQLException(e);
    }
}
```

Create a table

```
-- SQL

create table SUPPLIERS (
    SUP_ID integer NOT NULL,
    SUP_NAME varchar(40) NOT NULL,
    STREET varchar(40) NOT NULL,
    CITY varchar(20) NOT NULL,
    STATE char(2) NOT NULL,
    ZIP char(5),
    PRIMARY KEY (SUP_ID));
```

```
public void createTable() throws SQLException{
    String createString =
        "create table " + dbName +
        ".SUPPLIERS " +
        "(SUP_ID integer NOT NULL, " +
        "SUP_NAME varchar(40) NOT NULL, " +
        "STREET varchar(40) NOT NULL, " +
        "CITY varchar(20) NOT NULL, " +
        "STATE char(2) NOT NULL, " +
        "ZIP char(5), " +
        "PRIMARY KEY (SUP_ID))";

    Statement stmt = null;
      try {
        stmt = con.createStatement();
        stmt.executeUpdate(createString);
    } catch (SQLException e) {
        JDBCTutorialUtilities
            .printSQLException(e);
    } finally {
                if (stmt != null)
                    { stmt.close(); }
    }
}
```

Populate table

```
insert into SUPPLIERS values(
  49, 'Superior Coffee',
  '1 Party Place','Mendocino',
  'CA', '95460');
insert into SUPPLIERS values(
  101, 'Acme, Inc.',
  '99 Market Street','Grosville',
  'CA','95199');
```

```
public void populateTable() throws Exception {
    Statement stmt = null;
    try {
        stmt = con.createStatement();
        stmt.executeUpdate(
            "insert into " + dbName +
            ".SUPPLIERS " +
           "values(49, 'Superior Coffee', " +
           "'1 Party Place', " +
           "'Mendocino', 'CA', '95460')");

        stmt.executeUpdate(
            "insert into " + dbName +
            ".SUPPLIERS " +
           "values(101, 'Acme, Inc.', " +
           "'99 Market Street', " +
           "'Groundsville', 'CA', '95199')");
  } catch (SQLException e) {
        JDBCTutorialUtilities
          .printSQLException(e);
    } finally {
           if (stmt != null) { stmt.close(); }
    }
}
```

Update

```
public void updatePrice(float price, String cofName,
   String username,  String password) throws SQLException{

        Connection con;
        PreparedStatement pstmt;
        try {
            con = ds.getConnection(username, password);
            con.setAutoCommit(false);
            pstmt = con.prepareStatement("UPDATE COFFEES "
                + "SET PRICE = ? "
                + "WHERE COF_NAME = ?");
            pstmt.setFloat(1, price);
            pstmt.setString(2, cofName);
            pstmt.executeUpdate();

            con.commit();
            pstmt.close();

        } finally {
                if (con != null) {con.close();}
        }
    }
```

Delete

```
stmt = conn.createStatement();
String sql = "DELETE FROM Registration " + "WHERE id = 101";
stmt.executeUpdate(sql);
```

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Apache Derby

- The most simple file-based SQL database!
- Good for practice or standalone apps with a single connection
- Embedded driver does not support multiple connections! (extension could)
- Open-source relational database implemented entirely in Java
- Derby has a small footprint -- about 3.5 megabytes
- Derby is based on the Java, JDBC, and SQL standards.
- Derby is easy to install, deploy, and use.

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Apache Derby

- Consider dbDemo app from canvas
- *run*
- Ex1Connect
- Ex1Connect2

- Explain what was the issue

- Run
- Ex2CreateTable
- Ex3InsertRow

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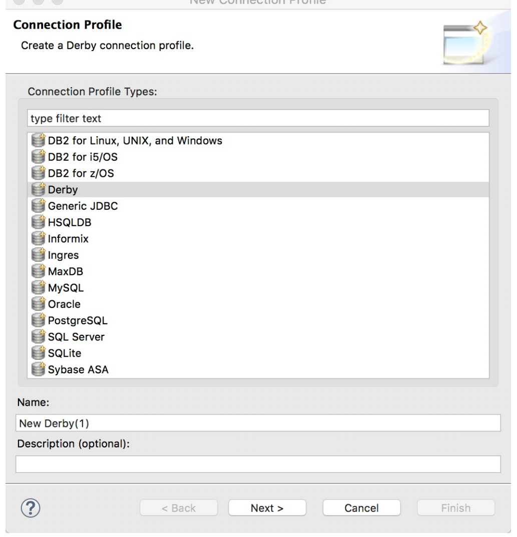
Eclipse


Connection Profile
Create a Derby connection profile.

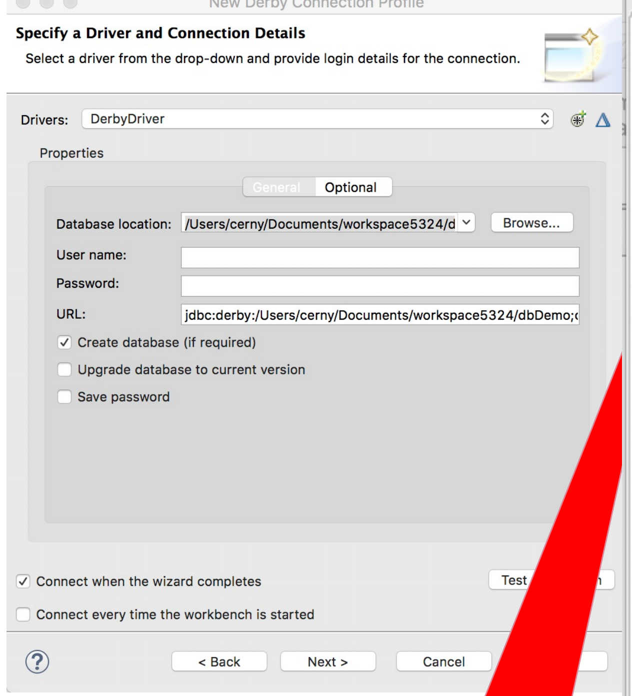
Connection Profile Types:

type filter text

- DB2 for Linux, UNIX, and Windows
- DB2 for i5/OS
- DB2 for z/OS
- Derby
- Generic JDBC
- HSQLDB
- Informix
- Ingres
- MaxDB
- MySQL
- Oracle
- PostgreSQL
- SQL Server
- SQLite
- Sybase ASA

Name: New Derby(1)

Description (optional):


Specify a Driver and Connection Details
Select a driver from the drop-down and provide login details for the connection.

Drivers: DerbyDriver

Properties

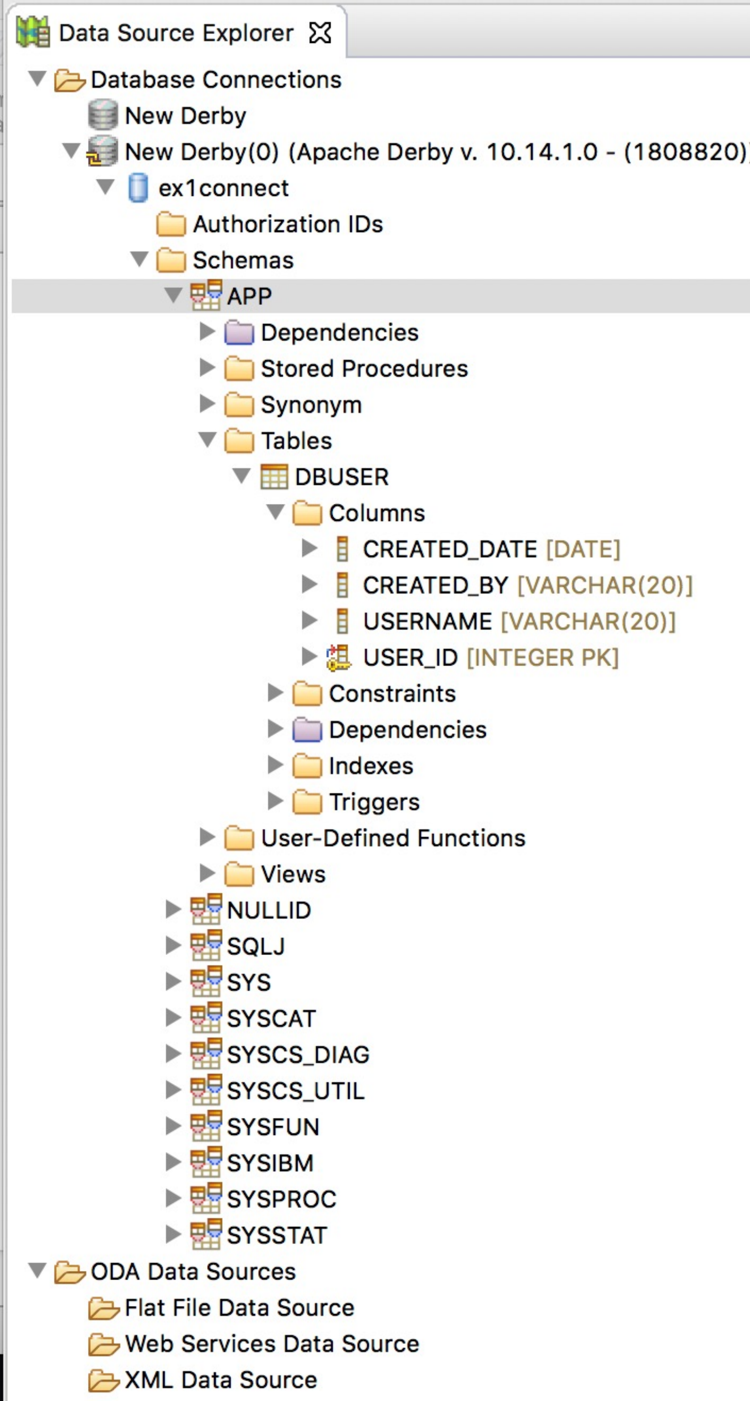
Database location: /Users/cerny/Documents/workspace5324/d
User name:
Password:
URL: jdbc:derby:/Users/cerny/Documents/workspace5324/dbDemo;c

- [✓] Create database (if required)
- [ ] Upgrade database to current version
- [ ] Save password

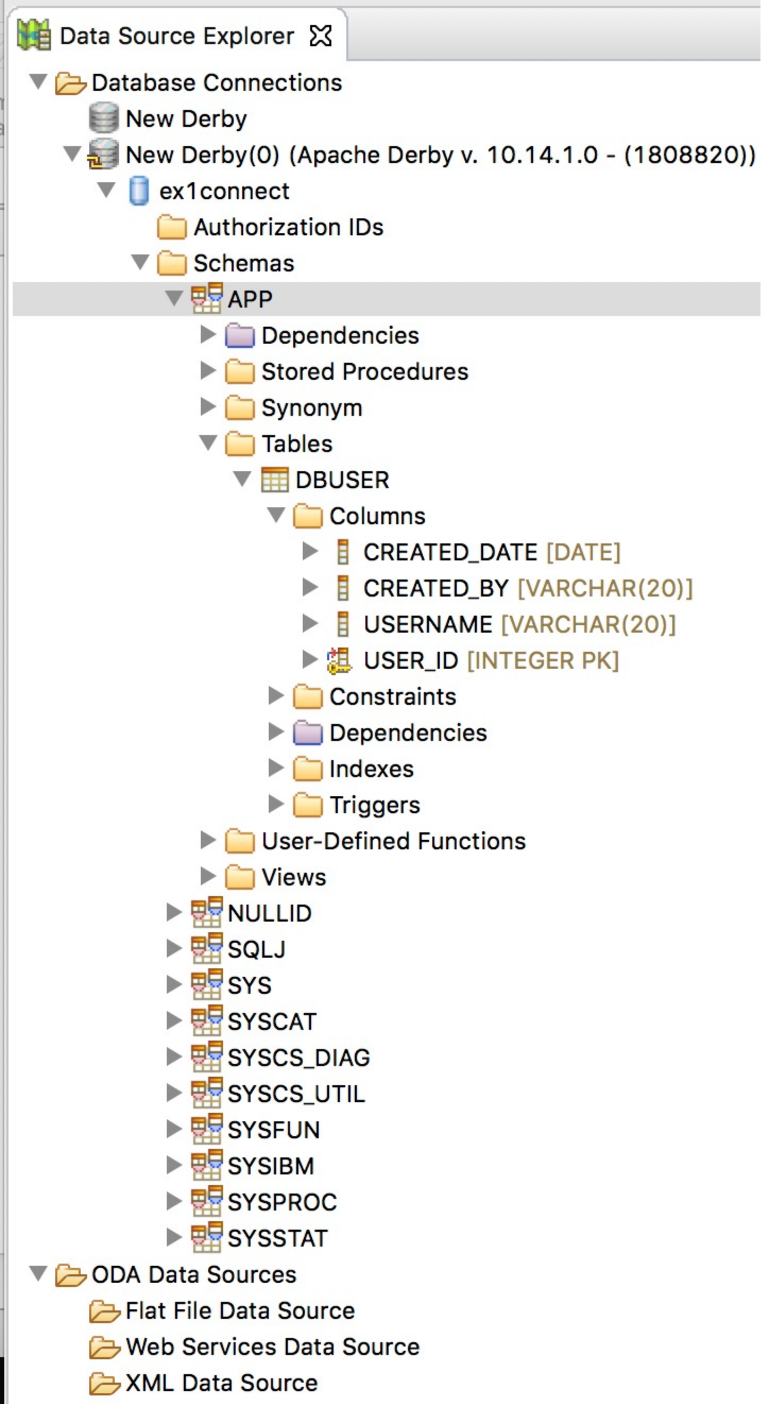
- [✓] Connect when the wizard completes
- [ ] Connect every time the workbench is started

- Menu Window
- Perspective | Open Perspective | Other...
- Pick Databased development
- Right Click Database connections | New... | Derby | Next
- Add driver
  - *pick Embedded latest | call it DerbyDriver |*
  - *| tab JAR list| add JAR : ./lib/derby.jar*
  - *remove any preexisting JAR | hit OK*
- Database location | pick your DB
  - *(e.g. /Users/cerny/Documents/workspace5324/dbDemo/ex1connect)*
- Leave user/pass empty | Next | Finish

Remember to disconnect!!!!


Data Source Explorer

- Database Connections
  - New Derby
  - New Derby(0) (Apache Derby v. 10.14.1.0 - (1808820)
    - ex1connect
      - Authorization IDs
      - Schemas
        - APP
          - Dependencies
          - Stored Procedures
          - Synonym
          - Tables
            - DBUSER
              - Columns
                - CREATED_DATE [DATE]
                - CREATED_BY [VARCHAR(20)]
                - USERNAME [VARCHAR(20)]
                - USER_ID [INTEGER PK]
              - Constraints
              - Dependencies
              - Indexes
              - Triggers
          - User-Defined Functions
          - Views
        - NULLID
        - SQLJ
        - SYS
        - SYSCAT
        - SYSCS_DIAG
        - SYSCS_UTIL
        - SYSFUN
        - SYSIBM
        - SYSPROC
        - SYSSTAT
- ODA Data Sources
  - Flat File Data Source
  - Web Services Data Source
  - XML Data Source



```
Data Source Explorer
▼ Database Connections
    New Derby
  ▼ New Derby(0) (Apache Derby v. 10.14.1.0 - (1808820))
    ▼ ex1connect
        Authorization IDs
      ▼ Schemas
        ▼ APP
          ▶ Dependencies
          ▶ Stored Procedures
          ▶ Synonym
          ▼ Tables
            ▼ DBUSER
              ▼ Columns
                ▶ CREATED_DATE [DATE]
                ▶ CREATED_BY [VARCHAR(20)]
                ▶ USERNAME [VARCHAR(20)]
                ▶ USER_ID [INTEGER PK]
              ▶ Constraints
              ▶ Dependencies
              ▶ Indexes
              ▶ Triggers
          ▶ User-Defined Functions
          ▶ Views
        ▶ NULLID
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        ▶ SYSFUN
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▼ ODA Data Sources
    Flat File Data Source
    Web Services Data Source
    XML Data Source
```
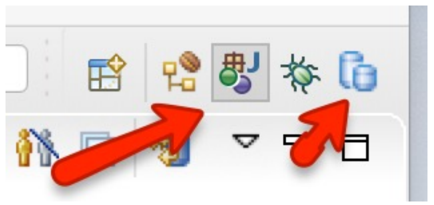
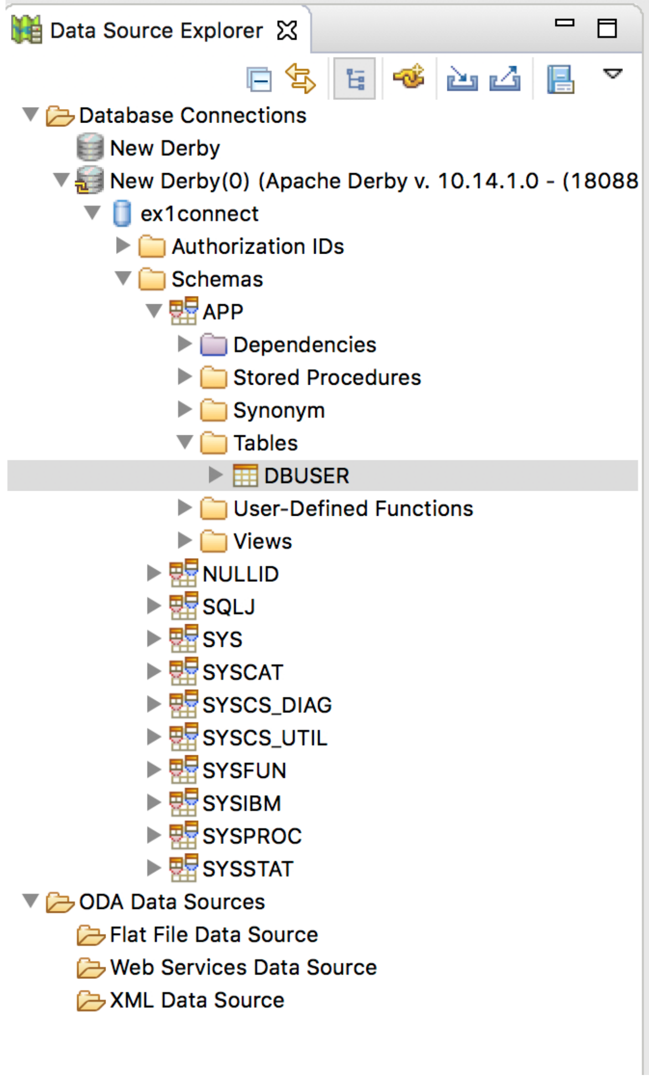



- Right click DBUser table | Data | Edit



```
Data Source Explorer
▼ Database Connections
    New Derby
  ▼ New Derby(0) (Apache Derby v. 10.14.1.0 - (18088
    ▼ ex1connect
      ▶ Authorization IDs
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    Web Services Data Source
    XML Data Source
```
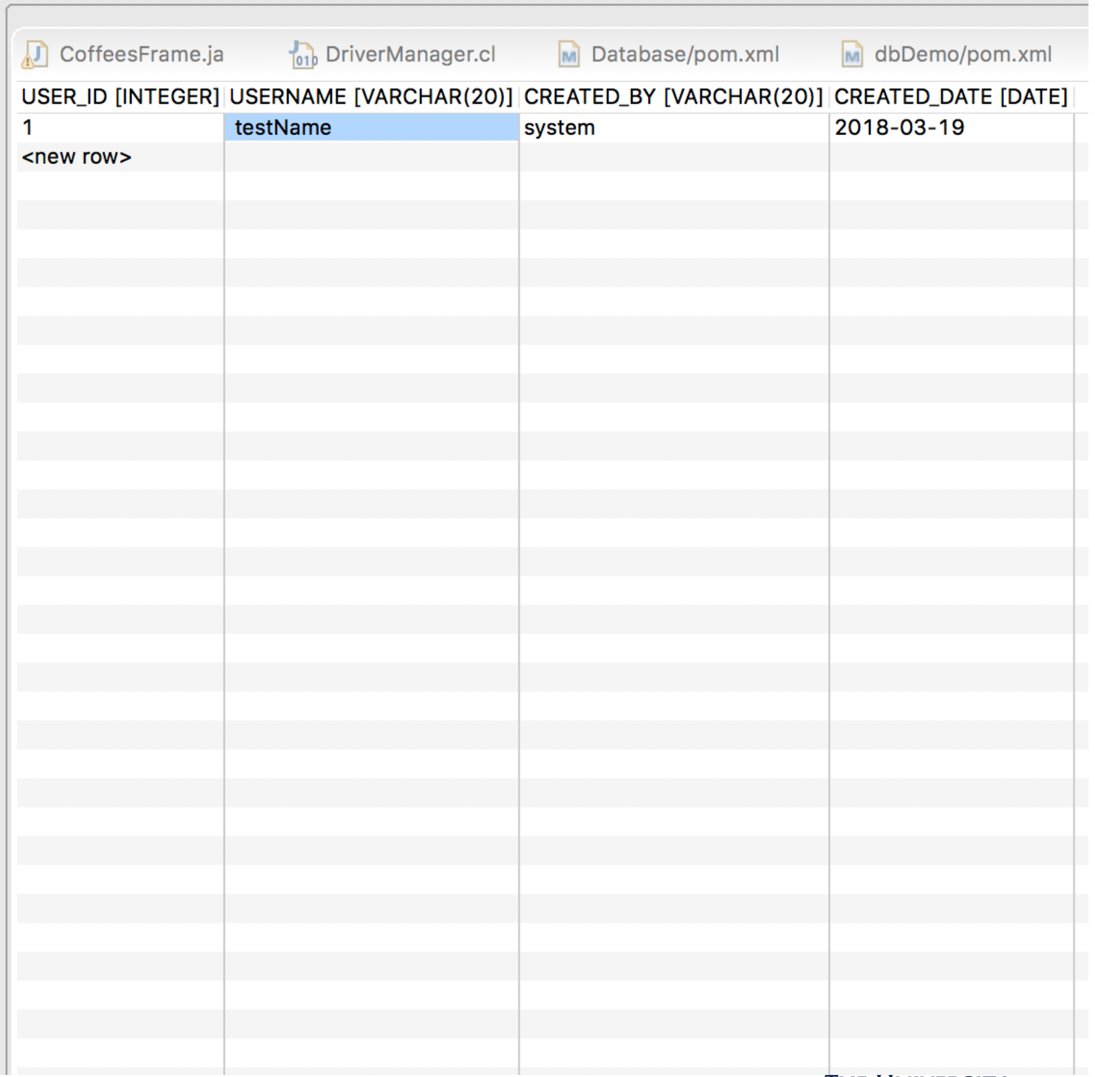
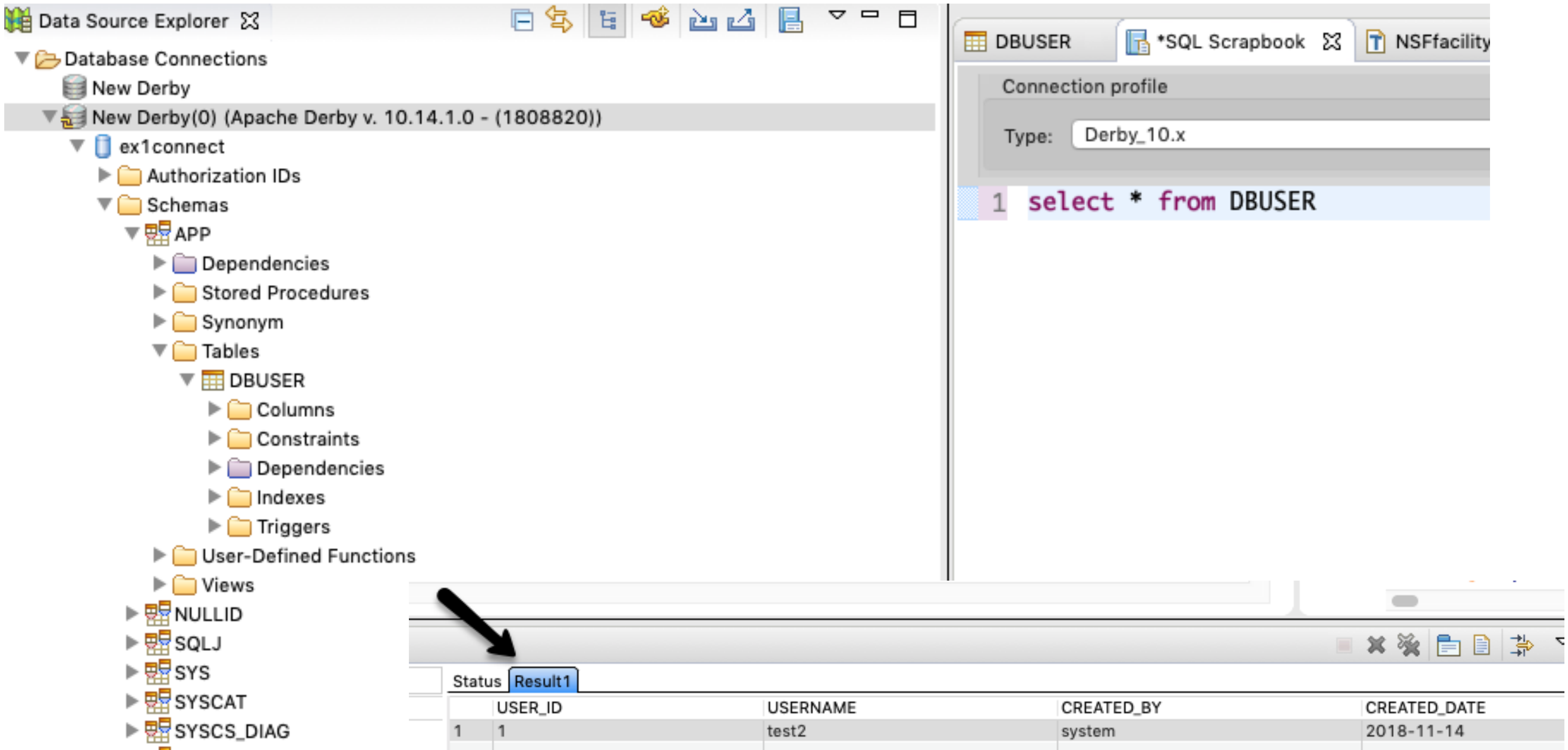



CoffeesFrame.ja | DriverManager.cl | Database/pom.xml | dbDemo/pom.xml

USER_ID [INTEGER]	USERNAME [VARCHAR(20)]	CREATED_BY [VARCHAR(20)]	CREATED_DATE [DATE]
1	testName	system	2018-03-19
<new row>			

Eclipse

- Right click New Derby.. | Open SQL Scrapbook |
- Type SQL, right click | Execute all (result near the console)



Type: Derby_10.x

```
select * from DBUSER
```

	USER_ID	USERNAME	CREATED_BY	CREATED_DATE
1	1	test2	system	2018-11-14

Example

Remember to disconnect!!!!

- Remember to disconnect eclipse when you switch back to program

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Example

Remember to disconnect!!!!

- Try to call again Ex3InsertRow
- What is the issue?
- https://stackoverflow.com/questions/32119379/wrong-auto-increment-in-embedded-derby-java-db
- DriverManager.getConnection("jdbc:derby:;shutdown=true")

- Call Ex4Select

- Call Ex5Update and again Ex4Select
- Call Ex6Delete and again Ex4Select

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