CS422 Principles of Database Systems
Object-Relational Mapping (ORM)

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The Object-Oriented Paradigm

- The world consists of objects
- So we use object-oriented languages to write applications
- We want to store some of the application objects (a.k.a. persistent objects), e.g. *accounts*, *customers*, *employees*
- So we use a Object Database?

The Reality of DBMS

- Relational DBMS are still predominant
  - Best performance
  - Most reliable
  - Widest support
- Bridge between OO applications and relational databases
  - CLI and embedded SQL
  - Object-Relational Mapping (ORM) tools

Motivational Example

```
public class Employee {
    Integer     id;
    String      name;
    Employee    supervisor;
}
```

```
create table employees (
    id          integer primary key,
    name        varchar(15),
    supervisor  integer
                references employees(id)
)
```

- How do we construct an *Employee* object based on data in the database?

Problems with CLI and Embedded SQL …

- SQL statements are hard-coded in applications

```
public Employee( Integer id ) {
    …
    PreparedStatment p;
    p = connection.prepareStatment(
        "select * from employees where id = ?"
    );
    …
}
```

… Problems with CLI and Embedded SQL …

- Tedious translation between application objects and database tables

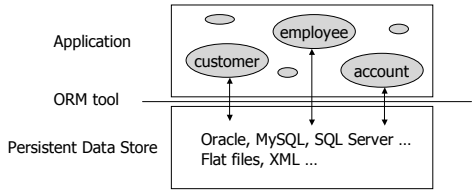
```
public Employee( Integer id ) {
    …
    ResultSet rs = p.executeQuery();
    if( rs.next() )
    {
        name = rs.getString("name");
        …
    }
}
```

… Problems with CLI and Embedded SQL

- Application design has to work around the limitations of relational DBMS

```
public Employee( Integer id ) {
    …
    ResultSet rs = p.executeQuery();
    if( rs.next() )
    {
        …
        supervisor = ??
    }
}
```

The ORM Approach



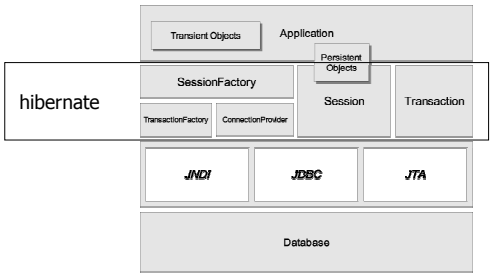
Advantages of ORM

- Make RDBMS look like ODBMS
- Data are accessed as objects, not rows and columns
- Simplify many common operations. E.g. System.out.println(*e.supervisor.name*)
- Improve portability
  - Use an object-oriented query language (OQL)
  - Separate DB specific SQL statements from application code
- Caching

Common ORM Tools

- Java Data Object (JDO)
  - One of the Java specifications
  - Flexible persistence options: RDBMS, OODBMS, files etc.
- Hibernate
  - Most popular Java ORM tool right now
  - Persistence by RDBMS only
- Others
  - http://en.wikipedia.org/wiki/Object-relational_mapping
  - http://www.theserverside.net/news/thread.tss?thread_id=29914

Hibernate Application Architecture



Setup Hibernate

- Download *hibernate-3.0.5.zip* from http://www.hibernate.org/6.html
- Add the following jar files to CLASSPATH
  - *hibernate-3.0\hibernate3.jar*
  - All the jar files under *hibernate-3.0\lib*
  - The JDBC driver of your DBMS

A Sample Hibernate Application

- Java classes
  - `Employee.java`
- Code to access the persistent objects
  - `EmployeeTest.java`
- O/R Mapping files
  - `Employee.hbm.xml`
- Hibernate configuration file
  - `hibernate.cfg.xml`
- (Optional) Logging configuration files
  - `Log4j.properties`

Java Classes

- Plain Java classes (POJOs) except that
  - There must be an identity field
  - Each persistent field must has a pair of getter and setter
- The *identity field* is used to uniquely identify an object
- The *getter* and *setter* for a property *xxx* follows the naming convention:
  - getXxx()
  - setXxx()

O/R Mapping Files

- Describe how class fields are mapped to table columns
- Three important types of elements in a a mapping file
  - <id>
  - <property> - when the field is of simple type
  - Association – when the field is of a class type
    - <one-to-one>
    - <many-to-one>
    - <many-to-many>

Hibernate Configuration Files

- Tell hibernate about the DBMS and other configuration parameters
- Either hibernate.properties or hibernate.cfg.xml or both
  - Sample files under *hibernate-3.0/etc*

Log4j Configuration File

- Log4j is a logging tool for Java
- Log levels
  - DEBUG, INFO, WARN, ERROR, FATAL
- Log output (appender)
  - File
  - Stdout

Access Persistent Objects

- `Session`
- `Query`
- `Transaction`
  - A transaction is required for updates

Hibernate Query Language (HQL)

- A query language that looks like SQL, but for accessing *objects*
- Automatically translated to DB-specific SQL statements
- `select e from Employee e where e.id = :id`
  - From all the Employee objects, find the one whose id matches the given value

Hibernate Query Language (HQL)

select e from Employee e where e.id = :id

- A query language that looks like SQL, but deals with *objects* instead of tables
  - E.g. from all the `Employee` objects, find the one whose `id` matches the given value
  - OO language-like syntax, for example `e.supervisor.name`
- Support named query parameters
- Automatically translated into DB-specific SQL statement

hbm2ddl

- Generate DDL statements from Java classes and mapping files
- See hbm2ddl.bat in the sample code

More About Mapping

- Map collections
- Map subclasses
  - Table per concrete class
  - Table per class hierarchy
  - Table per subclass

O/R Mapping vs. ER-Relational Conversion

O/R Mapping		ER-Relational Conversion
Class	⟷	Entity Set
<property>	⟷	Attribute
Association	⟷	Relationship

Subclass		Subclass
• table per concrete class	⟷	• OO method
• table per class hierarchy	⟷	• NULL method
• table per subclass	⟷	• ER method

More Hibernate Resource

- *Hibernate in Action* by Christian Bauer and Gavin King
- Hibernate documentation at http://www.hibernate.org
- DTDs at http://sun.calstatela.edu/~cysun/documentation/DTDs/