CS422 Principles of Database Systems

Databases and Object-Oriented Paradigm

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Book Example

- ISBN, Title, AuID, AuName, AuAddr, AuPhone
  - A book may have multiple authors
  - An author may have multiple phone numbers

OO Design

```
class Book {
    String ISBN;
    String title;
    Author authors[];
}
```

```
class Author {
    int id;
    String name;
    String address;
    String phones[];
}
```

Relational Design

Books

ISBN	Title

Authors

AuID	AuName	AuAddr

Books-Authors

ISBN	AuID

Authors-Phones

AuID	AuPhone

Relational vs. OO

- Relational
  - Atomic types: numbers, string ...
  - Efficient implementation
- OO
  - Atomic types, composite types, collection types, reference types, and subtypes
  - Model real world well

Object-Relational Model

- Brings OO features into the relational model
  - Structured types for attributes
  - Methods
  - References
  - Identifiers for tuples (OIDs)

OO in PostgreSQL – Array Types

```
create table authors (
        id              int primary key,
        name            varchar(64),
        phones          char(14)[]
);
```

- Arrays in PostgreSQL are *dynamic*

Access Array Types

```
-- access array elements by index
select * from authors where phones[1] like '(323)%';

-- access array elements by range
select phones[1:3] from authors;

-- access any/all elements
select * from authors where '(323) 343-1111` = any(phones);
```

OO in PostgreSQL – Composite Types

```
CREATE TYPE beer_price AS (
        beer    varchar(50),
        price   decimal(10,2)
);
```

- Composite types can be used in functions
- Composite types cannot be used as attribute type – no *nested relations*
  - feature to be supported in 8.0

OO in PostgreSQL – Inheritance

```
CREATE TABLE product (
        pid             int primary key,
        brand           varchar(32),
        desc            text,
        quantity        int,
        price           decimal(10,2)
);
```

```
CREATE TABLE cpu (
        model           varchar(16),
        frequency       decimal(4,2)
) INHERITS (product);
```

```
CREATE TABLE hdd (
        capacity        int,
        rpm             int
) INHERITS (product);
```

OO in PostgreSQL – Other

- Object identifiers (OID)
  - Primary keys for systems tables
  - System column in user created tables
- User-defined types and associated operations
  - in C

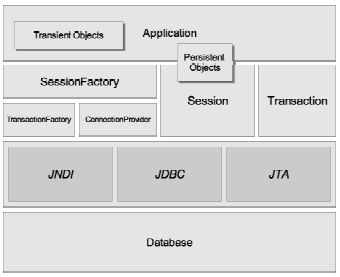
Object-Oriented Model

- What are we restricted by relations? All we want is *Persistent Objects*!
  - Object Definition Language (ODL)
  - Object Query Language (OQL)
- Unfortunately, OO DBMS have not been very successful
  - Too much was invested in relational DBMS
  - Possible performance issues

Hibernate

- "*Hibernate is a persistence service that stores Java objects in relational databases - or provides an object oriented view of existing relational data* " – www.hibernate.org

Hibernate Architecture



Person Example – Simple JDBC Version

- Duplicated design efforts
- Going back and forth between SQL and Java

Person Example – Hibernate Version

```
// get the tuple
Person p = (Person) query.iterate().next();

// increment age
p.setAge( p.getAge()+1 );

// update tuple
Transaction tx = session.beginTransaction();
session.save( p );
tx.commit();
```

Hibernate – The Big Picture

- Classes
- OO ➔ Relational
- O/R mapping ➔ Schema
- Connections
- Query language

Persistent Classes

- Bean-style classes
  - Default constructor
  - Persistent fields (properties)
    - getXyz(), isXyz()
    - setXyz()
- Accessors and mutators do *not* have to be public

Object-Relational Mapping

- Classname.hbm.xml
- Automatically generate the mapping from a *compiled class*
  - java net.sf.hibernate.tool.class2hbm.MapGenerator Classname
  - MapGenerator is in hibernate-extension package
- "There is no way to produce a full Hibernate mapping without extra input from the user."

Schema Generation

```
java
net.sf.hibernate.tool.hbm2ddl.SchemaExport
Classname.hbm.xml
```

- ... tables with the same names will be dropped

Connection Configuration

- hibernate.properties and/or hibernate.cfg.xml
  - Database related information
  - Connection pool related information

Query Language – HQL

- Very SQL-like
- *Instances* of a class rather than *tuples* of a relation
  - Fields and sub-fields
  - Path expressions
  - Polymorphic queries

Additional Readings

- Chap 4 of the Textbook
- JDBC Tutorial and API reference
- Hibernate documentation and API reference