Pizza Project: database, running SystemTest, domain objects

Database Tables

Look at createdb.sql found in the database directory of the pizza1 project.

Because of database standardization (SQL92, entry level), the same file runs on Oracle, mysql, and h2.

(But care needs to be made not to use product-specific extensions such as Oracle's varchar2 data type or mysql's auto_increment)

Database application life cycle: create tables, use app, which queries, inserts, updates, deletes rows. Schema changes are rare and usually not done by the app itself.

Best practice: have SQL scripts to create the database, also drop the database, so it's easy to reinit as needed.

We have createdb.sql and dropdb.sql. Also showdb.sql.

How to run these?

Using createdb.sql and dropdb.sql on pe07.cs.umb.edu or other Linux server

On pe07, we will have system programs sqlplus for Oracle and mysql for Mysql giving us convenient access to our databases.
To use createdb.sql for Oracle: cd to the pizza1/database directory and

```
sqlplus user/user@//dbs3.cs.umb.edu/dbs3 < createdb.sql
```

or cd to the pizza1/database directory, log in to sqlplus and do

```
SQL> @createdb
```

For mysql access from topcat, using createdb.sql:

```
mysql -u user -D userdb -p < createdb.sql
```

or

```
mysql -u user -D userdb -p
mysql> source createdb.sql
```

Running scripts for H2

- Our third database, H2, does not have a system program like sqlplus or mysql.
- However, it does have a program called RunScript inside its h2.jar, which is in lib-for-ant, a subdirectory of the database directory.
- After cd pizza1/database:
- Use `jar tf lib-for-ant/h2.jar` to see RunScript listed as in package org.h2.tools
- We can run createdb.sql with h2.jar as follows: put it on the classpath, execute that class:

```
java -cp lib-for-ant/h2.jar org.h2.tools.RunScript
```

- This outputs help for that program, so we can compose the full command we need, with –url, other args:

```
java -cp lib-for-ant/h2.jar org.h2.tools.RunScript -url
jdbc:h2:~/test -user test -script createdb.sql -showResults
```

Automating our work: H2 case

```
java -cp lib-for-ant/h2.jar org.h2.tools.RunScript -url
jdbc:h2:~/test -user test -script createdb.sql -showResults
```

- You can see the JDBC url for H2 given here as an argument, and the user "test".
- This long command is the basis of the shell script runH2Script.sh (or .cmd for Windows). The shell script `runH2Script.sh` contains:

```
java -cp lib-for-ant/h2.jar org.h2.tools.RunScript -url
jdbc:h2:~/test -user test -script $1 -showResults
```

The "$1" here allows us to use this shell file for all three scripts, for example dropdb.sql can be run by

`runH2Script.sh dropdb.sql` (just drop the .sh for Windows)

Running DB scripts at home

- Similarly, runH2Script.cmd for Windows has %1 in it instead of $1, for the same capability.
- These scripts for H2 work at home just as well as on pe07.
- Note that the system programs sqlplus and mysql are not generally available on home machines, or if they do, they use the local databases, not the ones we want to use.
- Note that you will end up having two different H2 databases, one on pe07 (using a file in your login directory) and another at home (using a file in your home directory on that system).
- Another option is to use ant: see its build.xml in the database directory, but don't worry about it if you don't know ant. We have scripts for all cases…

Automating script-running for Oracle, mysql

It turns out that the RunScript program from the H2 jar is a completely general utility to use JDBC to run scripts on databases So we have scripts to take advantage of this.

For oracle and mysql, we need username and password and server's hostname to make the JDBC connection, and of course we want to automate that.

See DatabaseSetup.html for details on setting up environment variables ORACLE_USER, etc., to specify the user and password as well as elements of the DB url.

runOracleScript showdb.sql (etc.) works by JDBC from anywhere to Oracle on dbs3, using ORACLE_USER env var, etc.

runMysqlScript showdb.sql (etc.) works by JDBC from anywhere to Mysql on pe07, using MYSQL_USER env var, etc.

Summary of ways to run createdb.sql, etc.

You have ways to load and drop all four databases you have for this course: use ant or...

- for Oracle on dbs3 and mysql on pe07: log in to pe07, run sqlplus or mysql as described on slide 3, or use the runOracleScript or runMysqlScript from anywhere that has the needed environment variables set up.
- for H2 at pe07: runH2Script on pe07
- for H2 at home: runH2Script at home

Use of environment variables: this is a commonly-used way to conveniently handle properties that vary across systems. We have ORACLE_SITE set to dbs3.cs.umb.edu on pe07 but set to localhost on home systems, so the JDBC url is ${ORACLE_SITE}:1521:dbs3 in general, which evaluates to "localhost:1521:dbs3" at home (for tunnel to dbs3.cs.umb.edu), and "dbs3.cs.umb.edu:1521:dbs3" at cs.umb.edu.

FYI: ant as DB tool

- Note that the job of creating the database is not part of Maven's expertise, which is building software using libraries.
- It's a perfect job for ant, since ant is command-driven, more general than maven, and has a useful "sql" ant task that knows how to use JDBC to talk to any database.
- The database directory has build.xml, ant's config file
- In build.xml, see targets show-oradb, drop-oradb, etc. You need the environment variables MYSQL_USER, MYSQL_PW, etc, for this.
- In the database directory, use “ant load-oradb” or “ant load-mysqldb” or “ant load-hsqldb”, etc.

Looking at createdb.sql:

- Tables menu_toppings and menu_sizes just list possible toppings and sized: ones on the menu presented to students
- Note their UNIQUE constraints, so "Pepperoni" is listed only once here.
- Table pizza_orders holds orders. Orders can have multiple toppings, but only one size.
- To attach multiple toppings to one pizza order, there is a pizza_topping table with a FK to orders for the order this row is for. This is a N-1 (many-to-one) relationship.
- Note that pizza_topping does not have a UNIQUE constraint on topping_name. That allows multiple orders to have the same topping--see examples soon.

Design details of pizza orders and toppings

- Each order has its own rows in pizza_size and pizza_toppings to describe its details. That way, we can delete an order and its details without disturbing any other order.
- There is no FK from the pizza_topping topping_name to the menu_topping topping_name. This allows a topping to be deleted from the menu when it is no longer available. The program will use a topping_name from menu_toppings to create a particular topping for a new pizza.

Example of the pizza Database

All but one of the tables have "id" columns that have artificial values generated by the program, and id used as the PK.

pizza_orders

id	room_number	size_id	day	status
1	5	1	1	1
2	3	2	1	2

pizza_sizes

id	size_name
1	small
2	large

pizza_toppings

id	order_id	topping_name
1	1	Onions
2	1	Pepperoni
3	2	Pepperoni

order_id is FK, topping_name is not unique. One row represents an individual topping for a certain pizza. Here pizza order 1 has Onions and Pepperoni. Order 2 has only Pepperoni.

Understanding the DB

From these 3 tables, we see that there are two pizza orders, order 1 with two toppings, Onions and Pepperoni, and size small, and order 2 with one topping, Pepperoni, and size large.

Order 1 is PREPARING (status=1), for room 5, and order 2 is BAKED (status = 2), for room 3. Both were made on day 1.

These orders were created with the help of menu_toppings and menu_sizes. Here are possible contents for them…

Menu tables: choices for new pizza orders

menu_toppings: id is PK, topping_name is UNIQUE

id	topping_name
1	Pepperoni
2	Onions

menu_sizes: id is PK, size_name is UNIQUE

id	size_name
1	small
2	large
3	huge

Intro to pizza1's SystemTest

- SystemTest is an "end to end" test, or and "integration test". It tests the whole system by calling the top layer, like an ordinary app does.
- Compare this to a "unit test", that tests a single class
- Full testing of a system involves both kinds of tests.
- Before running SystemTest, we are expected to **load the database with createdb.sql**
- SystemTest execution : involves two pizza orders, and certain sequence of actions on them, including admin actions.
- But first, it reinitializes the DB, adds one menu size and one menu topping.
- Because of this, all runs of SystemTest end up with the same database contents, i.e., it's reproducible, as a good test should be.

Running SystemTest on H2, Oracle

Build the system: cd pizza1; mvn clean package

Load the database: cd database; runH2Script createdb.sql (Windows)

on Mac/linux: chmod +x *.sh, then runH2Script.sh createdb.sql

Run the jar: cd ..; runOnH2 SystemTest (Windows)

on Mac/linux: chmod +x *.sh, then runOnH2.sh SystemTest

Running it with Oracle: Need environment vars ORACLE_SITE, etc., see DatabaseSetup.html

Mvn clean package if needed (not needed if just did above commands)

Load the database: cd database; runOracleScript createdb.sql (add .sh for Mac/Linux)

Run the jar: cd ..; runOnOracle SystemTest

SystemTest Actions

First pizza : for room 5

1. Ordered (status = 1, preparing)
2. Admin said pizza ready (status=2, baked)
3. Student received it (status =3, finished)

Second pizza : for room 1

1. Ordered (status=1)
2. Day ended, status=3

Database contents after whole run…

DB After SystemTest run

menu_toppings

id	topping_name
1	Pepperoni

menu_sizes

id	size_name
1	small

pizza_orders FK

id	room_number	size_id	day	status
1	5	2	1	3
2	1	3	1	3

First order is for room 5

pizza_toppings

id	order_id	topping_name
1	1	Pepperoni
2	2	Pepperoni

FK

pizza_sizes

id	size_name
2	small
3	small

One more table: pizza_sys_tab

This table controls id values for inserts (Oracle doesn't support auto_increment like Mysql), and holds the current day number.

After initialization (execution of createdb.sql script): all 1s

next_menu_topping_id	next_menu_size_id	next_order_id	next_pizza_topping_id	next_pizza_size_id	current_day
1	1	1	1	1	1

During run of System Test:

- Insert one menu_topping, one menu_size, 2 pizza orders, 2 order toppings, 2 order sizes,
- Finish day, so current_day becomes 2

next_menu_topping_id	next_menu_size_id	next_order_id	next_pizza_topping_id	next_pizza_size_id	current_day
2	2	3	3	3	2

SystemTest input file test.dat

File test.dat, input to SystemTest: tests both student and admin actions

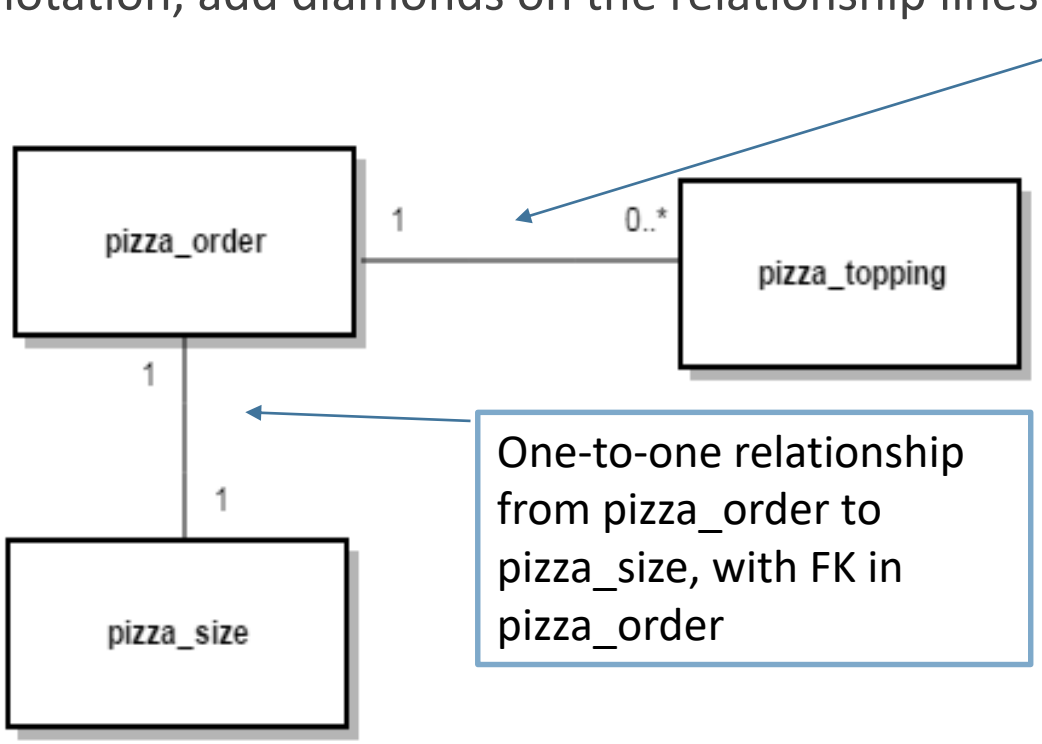
```
ai        admin initializes system (after “ant load-oradb” for example)
so 5       student order from room 5
so 1       student order from room 1
ss  5      status of orders from room 5  (answer—one PREPARING)
anr        admin reports next pizza done (the one for room 5)
ss  5      status of orders from room 5  (answer--one, now BAKED)
aip        admin report on in-progress orders (one PREPARING, one BAKED)
sr 5       student receives the room-5 order (acknowledges its receipt)
ss 5       status of orders from room 5  (answer—one FINISHED)
aip        admin report on in-progress orders (one PREPARING)
aad        admin advances day (so pizza for room 1 is now FINISHED)
aip        admin report on in-progress orders (none)
```

Actions to try: Progression from command line execution, to using mvn, to eclipse

- Using tree or du to see the directory structure
- Displaying the service API as shown in last class
- Using tunnels, using curl to check tunnels: see DatabaseSetup
- Running JdbcCheckup to make sure the JDBC connections are good
- Using ”mvn clean package” to build pizza1, ”mvn test” to run unit tests
- Then runOnH2.sh SystemTest, runOnOracle.sh SystemTest to run it on Oracle, similarly TakeOrder
- building and running on pe07 too.
- Setting up pizza1 in eclipse using Open Projects from File System

Core E-R diagram in UML style

For Chen notation, add diamonds on the relationship lines.



One-to-many relationship from pizza_order to pizza_topping, with FK in pizza_topping

One-to-one relationship from pizza_order to pizza_size, with FK in pizza_order

Note: there are two more entities, menu_toppings and menu_sizes, but they don't have direct relationships to these.

Notes on E-R diagram

E-R stands for entity-relationship. From cs630:

Entity: represents a real-world object

- Characterized using set of ***attributes*** (these become column names)

Relationship: Association among two (or more) entities

- "Gabriel works in the CS department"
- Entities here: Gabriel in Employees, CS in Departments
- Can have descriptive attributes: e.g., "since 9/1/2011"
  - But our relationships won't have these

Notes on E-R design, cont.

Chen Notation There are several styles for E-R diagrams. The most classic and common in textbooks is the Chen notation, which puts a diamond on each relationship connection.

Murach uses something in between Chen and UML.

See pg. 663 for an example.

He would use

1:* to label PizzaOrder-Topping

1:1 to label PizzaOrder-PizzaSize

Domain Objects Again

Now that we understand how pizza orders are represented in the database, where they are "persistent", i.e, have relatively long lifetimes, we turn back to their fleeting representations in memory while being involved in processing a request from the user.

Remember the layers. We were just looking at the database at the bottom. The DAO layer converts database data to Java objects that are used by the business programmers of the service layer, the heart of the application.

Our domain classes are **POJO**s, or **Java Beans**.

Simple POJO – plain old Java object -- has "properties", each of which has a getter and / or a setter

Example POJO: PizzaOrder

The pair of public methods in PizzaOrder.java:

```
public int getId()

public void setId(int id)
```

Defines “id” as an int property of PizzaOrder as a Java Bean or POJO. Usually we also see a related field (instance variable) `private int id`; (but this is not required to define a property)

- In fact, we could just have one of these two methods and still say id is a property.
- Full-fledged Java Beans also are expected to have a no-args constructor and implement Serializable. But POJOs don’t really need these.
- See pp. 174-175 in Murach on Java Beans. Also see Java tutorial at http://docs.oracle.com/javase/tutorial/javabeans

Relationships between POJOs

In PizzaOrder we see:

```
public Set<PizzaTopping> getPizzaToppings() {…}
```

So we say there is a property of type Set<PizzaTopping>. Each PizzaOrder object has a Set<PizzaTopping>, representing its toppings.

We also see:

```
public boolean containsPizzaTopping(PizzaTopping PizzaTopping)
```

But this is not of the right form to define a POJO “property”

```
public PizzaSize getPizzaSize()
```

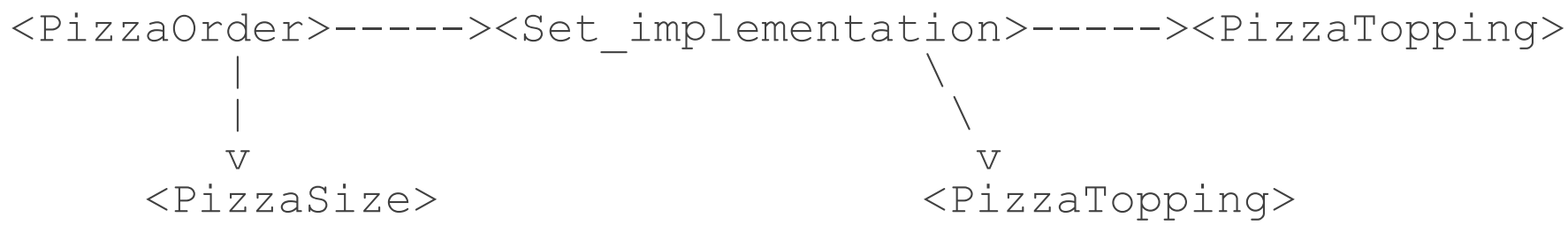
This defines a PizzaSize property. Each PizzaOrder has a PizzaSize object describing its size.

PizzaOrder object graph

At runtime, a PizzaOrder object has various simple properties such as room number, a PizzaSize object specifying its size, and a Set of PizzaTopping objects for its toppings

But Set is just an interface—what it its object?

A Set can be implemented by a HashSet or a TreeSet, and these are real objects containing possibly multiple references (shown by arrows) to element objects, like this:

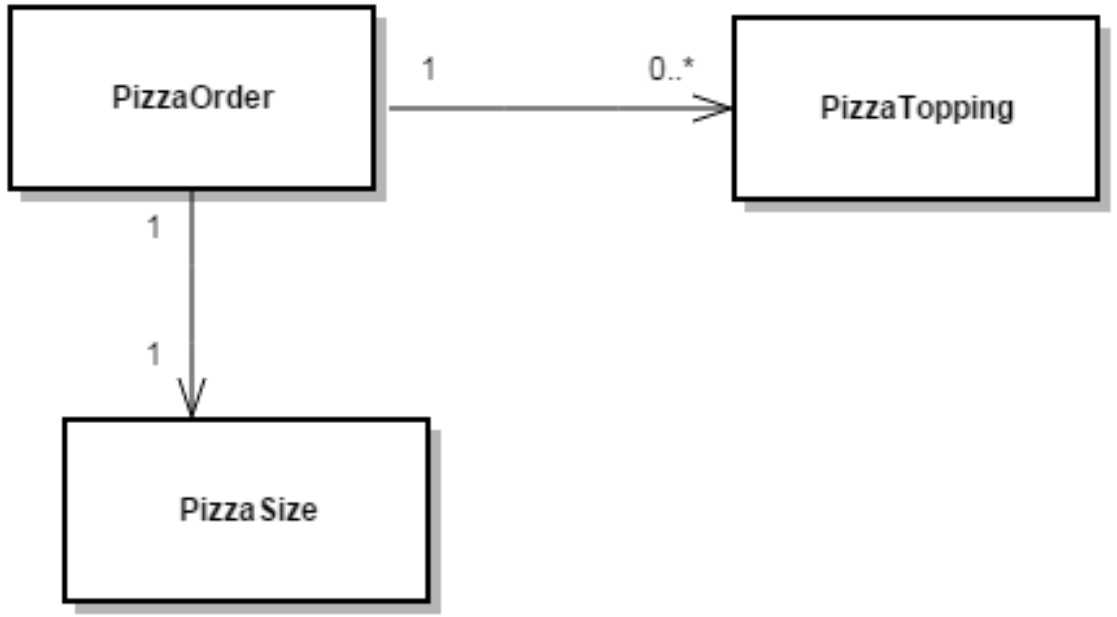


Note: it is essential that you understand object graphs and how to draw them. With pencil and paper, you can use ovals around the class names and proper arrows between them.

What does it mean to “navigate” between objects?

- It means to follow an object reference from one object to another.
- For example, the PizzaOrder object has a field of type PizzaSize, so it has an object ref from PizzaOrder to PizzaSize. You can see this by looking at the object graph diagram.
- Thus we can *navigate* from PizzaOrder to its PizzaSize, and also from PizzaOrder to its various PizzaToppings.
- This setup allow navigation from a PizzaOrder to its PizzaSize, but there is no reference in a PizzaSize to allow navigation from a PizzaSize object its PizzaOrder. Therefore, the arrow goes from PizzaOrder to PizzaSize, but not vice versa.
- Similarly, there is no reference in PizzaTopping back to PizzaOrder.
- We only implement navigation refs that we might actually use. We never need to get back from a PizzaSize to it PizzaOrder because we always have the related PizzaOrder on hand. So we keep PizzaSize and PizzaTopping really simple.

UML Class diagram (FYI)



The arrows show that navigation is possible from PizzaOrder to PizzaSize and the various PizzaToppings.
See http://en.wikipedia.org/wiki/Class_diagram

Database relationships vs. object relationships

- We see directionality in object relationships, since object references go from one object to another.
- But relational database relationships are bidirectional, or really direction-agnostic.
- Different queries can be centered on one table, reach out with joins, etc. to other tables.
- So we can go to the database and find all the orders using Pepperoni, for example.
- (NoSQL databases like Mongodb don’t have this property. A pizza order in Mongodb would typically be all in one record, including the set of toppings.)