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Carnegie Mellon Univ.
Dept. of Computer Science
15-415 - Database Applications

Fall 2010 (Kesden)

Rel. model - SQL part3

Slides from Christos Faloutsos

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General Overview - rel. model

- Formal query languages
  - rel algebra and calculi
- Commercial query languages
  - SQL
  - QBE, (QUEL)

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Overview - detailed - SQL

- DML
  - select, from, where, renaming, ordering,
  - aggregate functions, nested subqueries
  - insertion, deletion, update
- other parts: DDL, authorization, triggers
- embedded SQL

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Reminder: our Mini-U db

STUDENT		
Ssn	Name	Address
123	smith	main str
234	jones	forbes ave

CLASS		
c-id	c-name	units
15-413	s.e.	2
15-412	o.s.	2

TAKES		
SSN	c-id	grade
123	15-413	A
234	15-413	B

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DML - insertions etc

insert into student
values (“123”, “smith”, “main”)

insert into student(ssn, name, address)
values (“123”, “smith”, “main”)

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DML - insertions etc

bulk insertion: how to insert, say, a table of ‘foreign-student’s, in bulk?

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DML - insertions etc

bulk insertion:

insert into student
  select ssn, name, address
  from foreign-student

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DML - deletion etc

delete the record of 'smith'

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DML - deletion etc

delete the record of 'smith':

delete from student
  where name='smith'

(careful - it deletes ALL the 'smith's!)

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DML - update etc

record the grade 'A' for ssn=123 and course 15-415

update takes
set grade="A"
where ssn="123" and c-id="15-415"

(will set to "A" ALL such records)

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DML - view update

consider the db-takes view:
create view db-takes **as**
  (**select * from** takes **where** c-id="15-415")

view updates are tricky - typically, we can only update views that have no joins, nor aggregates
even so, consider changing a c-id to 15-222...

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DML - joins

so far: 'INNER' joins, eg:

select ssn, c-name
from takes, class
where takes.c-id = class.c-id

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DML - joins

Equivalently:

select ssn, c-name
from takes **join** class **on** takes.c-id = class.c-id

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Joins

select [column list]
from *table_name*
[**inner** | {**left** | **right** | **full**} **outer**] **join**
table_name
on *qualification_list*
where…

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Ssn	Name	Address
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CLASS		
c-id	c-name	units
15-413	s.e.	2
15-412	o.s.	2

TAKES		
SSN	c-id	grade
123	15-413	A
234	15-413	B

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Inner join

TAKES		
SSN	c-id	grade
123	15-413	A
234	15-413	B

CLASS		
c-id	c-name	units
15-413	s.e.	2
15-412	o.s.	2

SSN	c-name
123	s.e
234	s.e

o.s.: gone!

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Outer join

TAKES		
SSN	c-id	grade
123	15-413	A
234	15-413	B

CLASS		
c-id	c-name	units
15-413	s.e.	2
15-412	o.s.	2

SSN	c-name
123	s.e
234	s.e.
null	o.s.

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Outer join

select ssn, c-name
from takes **right outer join** class **on** takes.c-id=class.c-id

SSN	c-name
123	s.e
234	s.e.
null	o.s.

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Outer join

- **left outer join**
- **right outer join**
- **full outer join**
- **natural join**

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Null Values

- **null** -> unknown, or inapplicable, (or …)
- Complications:
  - 3-valued logic (true, false and *unknown*).
  - **null** = **null** : false!!

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Data Definition Language

create table student
(ssn **char**(9) **not null**,
name **char**(30),
address **char**(50),
primary key (ssn))

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Data Definition Language

create table r(A1 D1, …, An Dn,
integrity-constraint1,
…
integrity-constraint-n)

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Data Definition Language

Domains:

- **char**(n), **varchar**(n)
- **int**, **numeric**(p,d), **real**, **double precision**
- **float, smallint**
- **date**, **time**

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Data Definition Language

delete a table: difference between

drop table student

delete from student

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Data Definition Language

modify a table:

alter table student **drop** address

alter table student **add** major char(10)

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Data Definition Language

integrity constraints:

- **primary key**
- **foreign key**
- **check**(P)

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Data Definition Language

create table takes
(ssn **char**(9) **not null**,
c-id **char**(5) **not null**,
grade **char**(1),
primary key (ssn, c-id),
check grade **in** (“A”, “B”, “C”, “D”, “F”))

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Referential Integrity constraints

‘foreign keys’ - eg:

create table takes(
ssn **char**(9) **not null**,
c-id **char**(5) **not null**,
grade **integer**,
primary key(ssn, c-id),
foreign key ssn **references** student,
foreign key c-id **references** class)

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Referential Integrity constraints

…
foreign key ssn **references** student,
foreign key c-id **references** class)

Effect:

- expects that ssn to exist in ‘student’ table
- blocks ops that violate that - how??
  - insertion?
  - deletion/update?

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Referential Integrity constraints

…
foreign key ssn **references** student
on delete cascade
on update cascade,
…

- -> eliminate all student enrollments
- other options (set to null, to default etc)

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Overview - detailed - SQL

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- other parts: DDL, authorization, **triggers**
- embedded SQL

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Weapons for IC:

- assertions
  - **create assertion** <assertion-name> **check** <predicate>
- triggers (~ assertions with 'teeth')
  - on operation, if condition, then action

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Triggers - example

define trigger zerograde **on update** takes
(**if new** takes.grade < 0
then takes.grade = 0)

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Triggers - discussion

- more complicated: "managers have higher salaries than their subordinates" - a trigger can automatically boost mgrs salaries
- triggers: tricky (infinite loops…)

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Overview - detailed - SQL

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- other parts: DDL, **authorization**, triggers
- embedded SQL

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Authorization

- **grant** <priv.-list> **on** <table-name> **to** <user-list>
- privileges for tuples: read (select) / insert / delete / update
- privileges for tables: create, drop, index

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Authorization – cont'd

- variations:
  - **with grant option**
  - **revoke** <priv.-list> **on <t-name> from** <user_ids>
  - Roles (**create role *foo***)
  - **granted by current role**

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Overview - detailed - SQL

- DML
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- other parts: DDL, authorization, triggers
- **embedded SQL**; application development

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Embedded SQL

from within a 'host' language (eg., 'C', 'VB')
EXEC SQL <emb. SQL stmnt> END-EXEC

Q: why do we need embedded SQL??

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Embedded SQL

SQL returns sets; host language expects a tuple - impedance mismatch!

solution: 'cursor', ie., a 'pointer' over the set of tuples.

example:

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Embedded SQL

```
main(){
…
EXEC SQL
  declare c cursor for
  select * from student
END-EXEC
…
```

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Embedded SQL - ctn'd

```
…
EXEC SQL   open c END-EXEC
…
while( !sqlerror ){
   EXEC SQL fetch c into :cssn, :cname, :cad
   END-EXEC
   fprintf( … , cssn, cname, cad);
}
```


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Embedded SQL - ctn'd

```
…
EXEC SQL   close c END-EXEC
…
} /* end main() */
```


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Dynamic SQL

```
main(){ /* set all grades to user's input */
…
char *sqlcmd=" update takes set grade = ?";
EXEC SQL   prepare dynsql from :sqlcmd ;
char inputgrade[5]="a";
EXEC SQL execute dynsql using :inputgrade;
…
} /* end main() */
```


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Overview - detailed - SQL

- DML
  - select, from, where, renaming, ordering,
  - aggregate functions, nested subqueries
  - insertion, deletion, update
- other parts: DDL, authorization, triggers
- embedded SQL; **application development**

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Overview

- concepts of SQL programs
- walkthrough of Create.java
- walkthrough of showAll.java

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Outline of an SQL application

- establish connection with db server
- authenticate (user/password)
- execute SQL statement(s)
- process results
- close connection

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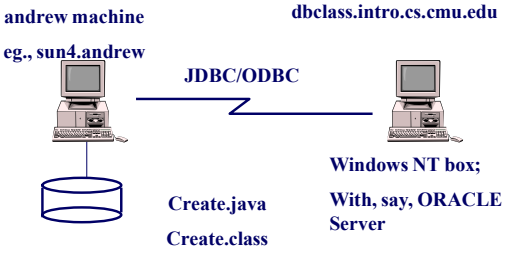
Pictorially:



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Create.java

- Purpose: to load the parent-child table

legend:

⇨ **interesting observation**

➡ **very important point**

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Walk-through Create.java

```
import java.io.*;
import java.util.*;
import java.sql.*;

public class Create {

  static final String DbURL =
      "jdbc:oracle:thin:@dbclass.intro.cs.cmu.edu:1521:dbintro";
      //Oracel server at cs.cmu
  static final String OraDriver = "oracle.jdbc.driver.OracleDriver";
      //Oracle driver

static final String User = "your-andrew-id";
static final String Passwd = "your-oracle-password";
```


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Walk-through Create.java

```
static final String Passwd = "your-oracle-password";

  static final String fileName="PC.txt";
      //file name for text data

  public static void main(String[] args) {

    Connection con = null;

    try {
      // Load the Oracle Driver
      Class.forName(OraDriver);

      // Get a Connection to the database
      con = DriverManager.getConnection(DbURL, User,
Passwd);

      // Create a Statement object
      Statement stmt = con.createStatement();
```


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Walk-through Create.java

```
// Create a table named as PC (varchar2(10), varchar2(10));
String sqlSt =
  "CREATE TABLE PC (parent varchar2(10), child varchar2(10))";
stmt.executeQuery(sqlSt);
```


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Walk-through Create.java

rest of program:

- **read input file**
- **insert one tuple at a time**
- **close connection**

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Walk-through Create.java

```
   while ((line = in.readLine()) != null) {
      // read in the names into 'parent' and 'child'

      // Execute a SQL - insert statement
      sqlSt = "INSERT INTO PC (parent, child) VALUES ('"
              + parent + "', '" + child + "')";
      System.out.println("===" + (i++) + "===>"  + sqlSt);
      stmt.executeQuery(sqlSt);
    }
    in.close();
    con.commit();
}
```


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Overview

- concepts of SQL programs
- walkthrough of Create.java
- walkthrough of showAll.java

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Walk-through showAll.java

- purpose: print all (parent, child) pairs

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Walk-through showAll.java

```
// after opening the connection …
String sqlSt = "SELECT * FROM PC";
```


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Walk-through showAll.java

```
ResultSet rs = stmt.executeQuery(sqlSt);
while (rs.next()) {
        System.out.println( rs.getString("parent") +
            ";" + rs.getString("child") );
}
```


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Conclusions

Outline of an SQL application:

- establish connection with db server
- authenticate (user/password)
- execute SQL statement(s)
- process results
- close connection