Introduction to Data Management

Lecture #6
E-R Relational Mapping (Cont.)

Instructor: Mike Carey
mjcarey@ics.uci.edu

It's time again for....

Friday Nights with Databases

Starbucks in Macau!

Brought to you by…

Today's Reminders

- Continue to follow the course wiki page
  - http://www.ics.uci.edu/~cs122a/
- Continue to live by the Piazza page
  - https://piazza.com/uci/spring2018/cs122a/home
- First HW assignment is due today
  - Up to 24 hours to finish with a 20% late penalty
- Next HW assignment is available now
  - Translate E-R **PHLOG** schema into relational form
  - Use our solution schema (out tomorrow at 5pm)

Today's Reminders (Cont.)

- Be careful on what you post in Piazza:
  - ✖ how should I model X in the HW?
    - Propose more general questions
    - Use non-HW related examples
  - Avoid asking repeated questions(especially near the deadline!)
- Maximum class size expanded to 447

From ISA Hierarchies to Relations

- ***Most general and "clean" approach*** (recommended)**:**
  - 3 relations: Employees, Hourly_Emps, and Contract_Emps.
    - *Hourly_Emps*: Every employee recorded in Employees. For hourly emps, ***extra*** info recorded in Hourly_Emps (*hourly_wages, hours_worked, ssn*); delete Hourly_Emps tuple if referenced Employees tuple is deleted.
    - Queries about all employees easy; those involving just Hourly_Emps require a join to access the extra attributes.
- Another alternative: Hourly_Emps and Contract_Emps.
  - ***Ex:*** *Hourly_Emps(ssn, name, lot, hourly_wages, hours_worked)*
  - If each employee must be in one of the two subclasses…
    (Q: Can we always do this, then? A: Not w/o redundancy!)

ISA Hierarchy Translation Options

- I. "Delta table" approach (recommended):
  - *Emps(**ssn**, name, lot)* □ (All Emps partly reside here)
  - *Hourly_Emps(ssn, wages, hrs_worked)*
  - *Contract_Emps(ssn, contractid)*
- II. "Union of tables" approach:
  - *Emps(**ssn**, name, lot)*
  - *Hourly_Emps(ssn, name, lot, wages, hrs_worked)*
  - *Contract_Emps(ssn, name, lot, contractid)*
- III. "Mashup table" approach:
  - *Emps(kind, ssn, name, lot, wages, hrs_worked, contractid)*

Things to consider:
- Expected queries?
- PK/unique constraints?
- Relationships/FKs?
- Overlap constraints?
- Space/time tradeoffs?

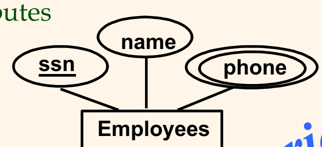
ISA Considerations (cont'd.)

- Query convenience
  - *Ex:* List the names of all Emps in lot 12A
- PK enforcement PK： Primary Key
  - *Ex:* Make sure that ssn is unique for all Emps
- Relationship targets
  - *Ex:* Lawyers table REFERENCES Contract_Emps
- Handling of overlap constraints
  - *Ex:* Sally is under a contract for her hourly work
- Space and query performance tradeoffs
  - *Ex:* List all the info about hourly employee 123
  - *Ex:* What if most employees are "just plain employees"?

如果是某个attribute去开一个table，那么那个attribute所拥有的才是primary key

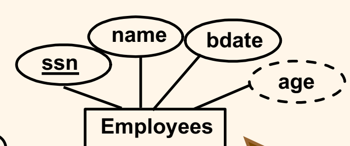
Mapping Advanced ER Features

- Multi-valued (vs. single-valued) attributes



Employees_phones(ssn, phone)
- ssn is an FK in this table
- (ssn, phone) is its PK外面的是属与foreignmkey

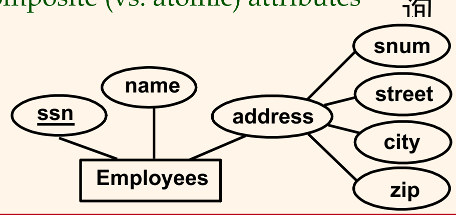
- Derived (vs. base/stored) attributes



Queries...!

查询

- Composite (vs. atomic) attributes



Employees(ssn, name, address_snum, address_street, address_city, address_zip)

SQL Views (and Security)

Primary Key
Unique Key
Foreign Key

- A *view* is just a relation, but we store its *definition* rather than storing the (materialized) set of tuples.

```
CREATE VIEW YoungActiveStudents (name, grade)
    AS SELECT S.name, E.grade
       FROM Students S, Enrolled E
       WHERE S.sid = E.sid and S.age < 21
```

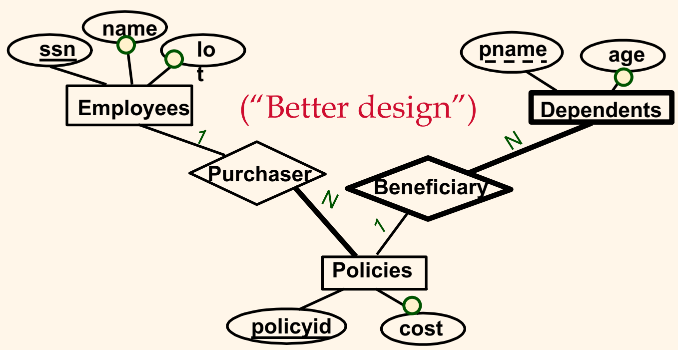
- Views can be used to present needed information while hiding details of underlying table(s). view可以用作只显示某部分data而隐藏重要data
  - Given YoungStudents (but not Students or Enrolled), we can see (young) students *S* who have are enrolled but not see the *cid's* of their courses.

SQL Views (Cont'd.)

- Other view uses in our ER translation context might include:
  - ***Derived attributes, e.g., age (vs. birthdate)***
  - Simplifying/eliminating join paths (for SQL)
  - Beautifying the "Mashup table" approach (to ISA)

```
CREATE VIEW EmployeeView (ssn, name, bdate, age)
    AS SELECT E.ssn, E.name, E.bdate,
              TIMESTAMPDIFF(YEAR, E.bdate, CURDATE( ))
       FROM Employees E
```

Another Mapping Example: Binary vs. Ternary Relationships



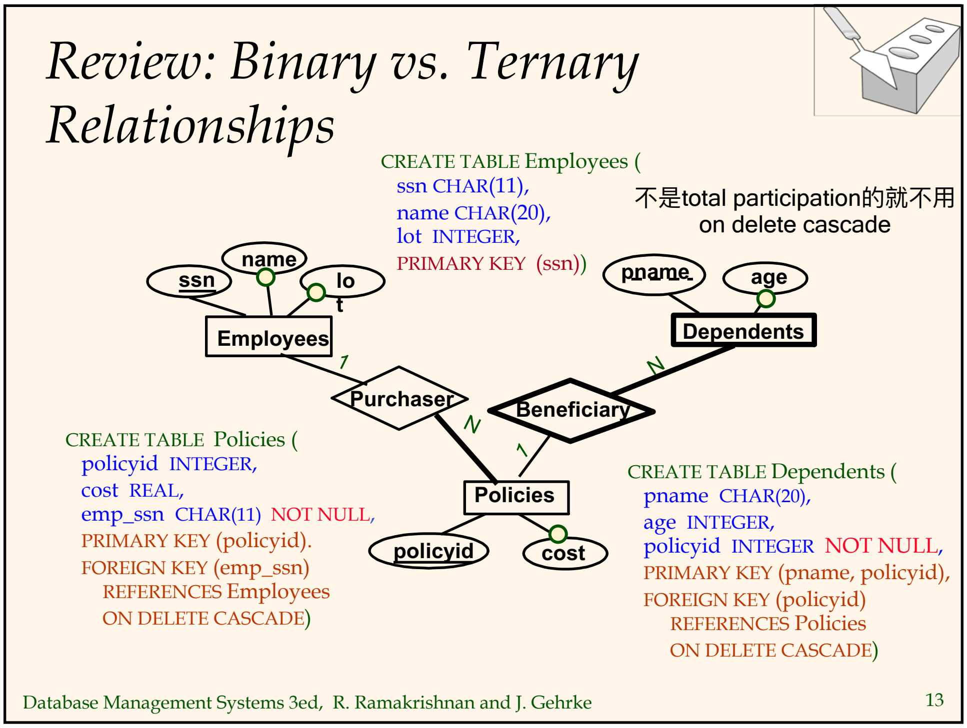
Binary vs. Ternary Relationships (Cont'd.)

- The key constraints let us combine *Purchaser with Policies* and *Beneficiary with Dependents.*
- Participation constraints lead to NOT NULL constraints.
  (*Note:* Primary key attributes are all NOT NULL as well – check documentation to see if that's implicit or explicit!)

```
CREATE TABLE Policies (
  policyid INTEGER,
  cost REAL,
  emp_ssn CHAR(11) NOT NULL,
  PRIMARY KEY (policyid),
  FOREIGN KEY (emp_ssn) REFERENCES Employees
    ON DELETE CASCADE)
```

```
CREATE TABLE Dependents (
  pname CHAR(20),
  age INTEGER,
  policyid INTEGER NOT NULL,
  PRIMARY KEY (pname, policyid),
  FOREIGN KEY (policyid) REFERENCES Policies
    ON DELETE CASCADE)
```

primary key 和forergn key can be overlap


Review: Binary vs. Ternary Relationships
CREATE TABLE Employees (
ssn CHAR(11),
name CHAR(20),
lot INTEGER,
PRIMARY KEY (ssn))
不是total participation的就不用
on delete cascade
name
ssn
lo
t
pname
age
Employees
Dependents
1
N
Purchaser
Beneficiary
N
1
CREATE TABLE Policies (
policyid INTEGER,
cost REAL,
emp_ssn CHAR(11) NOT NULL,
PRIMARY KEY (policyid).
FOREIGN KEY (emp_ssn)
REFERENCES Employees
ON DELETE CASCADE)
Policies
policyid
cost
CREATE TABLE Dependents (
pname CHAR(20),
age INTEGER,
policyid INTEGER NOT NULL,
PRIMARY KEY (pname, policyid),
FOREIGN KEY (policyid)
REFERENCES Policies
ON DELETE CASCADE)
Database Management Systems 3ed, R. Ramakrishnan and J. Gehrke
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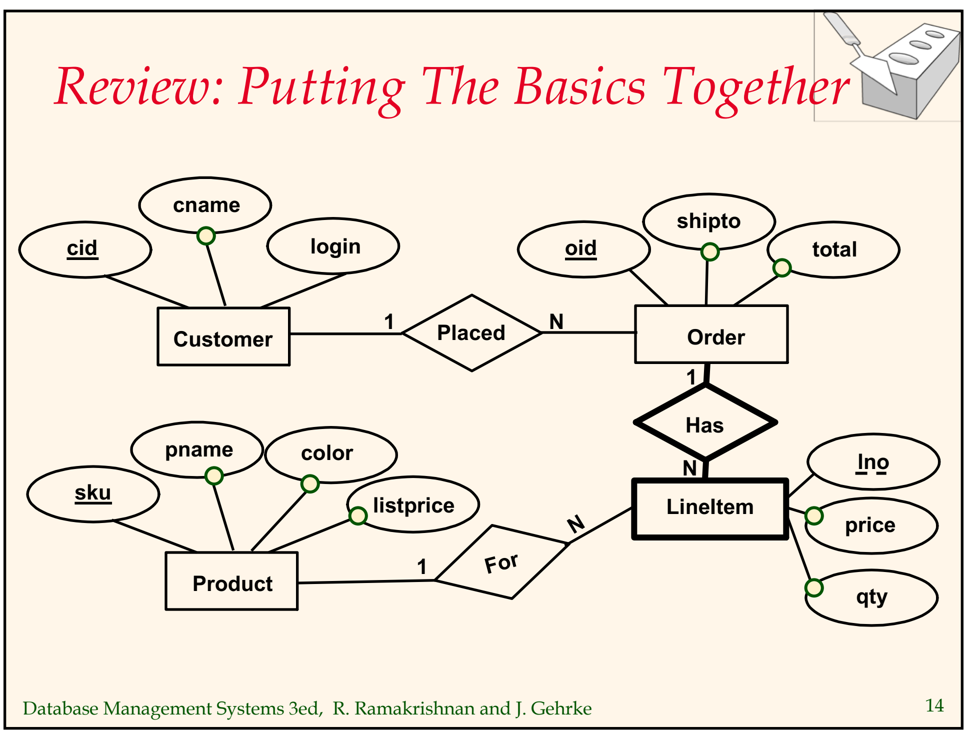
Review: Putting The Basics Together
cname
cid
login
oid
shipto
total
Customer
1
Placed
N
Order
1
Has
N
pname
color
sku
listprice
lno
LineItem
price
qty
Product
1
For
N
Database Management Systems 3ed, R. Ramakrishnan and J. Gehrke
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Review: Putting It Together (Cont'd.)

```
CREATE TABLE Customer (
  cid INTEGER,
  cname VARCHAR(50),
  login VARCHAR(20)
    NOT NULL,
  PRIMARY KEY (cid),
  UNIQUE (login))

CREATE TABLE Product (
  sku INTEGER,
  pname VARCHAR(100),
  color VARCHAR(20),
  listprice DECIMAL(8,2),
  PRIMARY KEY (sku))

CREATE TABLE Order (
  oid INTEGER,
  custid INTEGER,
  shipto VARCHAR(200),
  total DECIMAL(8,2),
  PRIMARY KEY (oid),
  FOREIGN KEY (custid) REFERENCES Customer))

CREATE TABLE LineItem (
  oid INTEGER,
  lno INTEGER,
  price DECIMAL(8,2),
  qty INTEGER,
  sku INTEGER,
  PRIMARY KEY (oid, lno),
  FOREIGN KEY (oid) REFERENCES Order
     ON DELETE CASCADE),
  FOREIGN KEY (sku) REFERENCES Product))
```


Reminder: Putting It Together (Cont'd.)

Customer

cid	cname	login
1	Smith, James	jsmith@aol.com
2	White, Susan	suzie@gmail.com
3	Smith, James	js@hotmail.com

Product

sku	pname	color	listprice
123	Frozen DVD	null	24.95
456	Graco Twin Stroller	green	199.99
789	Moen Kitchen Sink	black	350.00

Order

oid	custid	shipto	total
1	3	J. Smith, 1 Main St., USA	199.95
2	1	Mrs. Smith, 3 State St., USA	300.00

LineItem

oid	lno	price	qty	item
1	1	169.95	1	456
1	2	15.00	2	123
2	1	300.00	1	789

Relational Model and E-R Schema Translation: Summary

数据的表格表示

- Relational model: a tabular representation of data.
- Simple and intuitive, also widely used.
- Integrity constraints can be specified by the DBA based on application semantics. DBMS then checks for violations.
  - Two important ICs: Primary and foreign keys (PKs, FKs).
  - In addition, we *always* have domain constraints.
- Powerful and natural query languages exist (soon!)
- Rules to translate E-R to relational model
  - Can be done by a human, or automatically (using a tool)

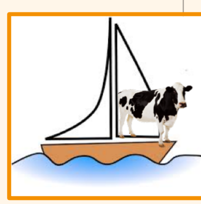
Relational Database Design

- Two aspects to the RDB design problem:
  - *Logical* schema design: We just saw one approach, namely, doing E-R modeling followed by an E-R □ relational schema translation step
  - *Physical* schema design: Later, once we learn about indexes, when should we utilize them?
- We will look at both problem aspects this term, starting first with relational schema design
  - Our power tools will be functional dependencies (FDs) and normalization theory
  - Note: FDs also play an important role in other contexts as well, e.g., SQL query optimization

So, Given a Relational Schema…

- How do I know if my relational schema is a "good" logical database design or not?
  - What might make it "not good"?
  - How can I fix it, if indeed it's "not good"?
  - How "good" is it, after I've fixed it?
- Note that your relational schema might have come from one of several places
  - You started from an E-R model (but maybe that model was "wrong" or incomplete in some way?)
  - You went straight to relational in the first place
  - It's not your schema – you inherited it! ☺

Ex: Wisconsin Sailing Club



Proposed schema design #1:

sid	sname	rating	age	date	bid	bname	color
22	Dustin	7	45.0	10/10/98	101	Interlake	blue
22	Dustin	7	45.0	10/10/98	102	Interlake	red
22	Dustin	7	45.0	10/8/98	103	Clipper	green
22	Dustin	7	45.0	10/7/98	104	Marine	red
31	Lubber	8	55.5	11/10/98	102	Interlake	red
31	Lubber	8	55.5	11/6/98	103	Clipper	green
31	Lubber	8	55.5	11/12/98	104	Marine	red
…	…	…	…	…	…	…	…

Q: Do you think this is a "good" design? (Why or why not?)

nctional dependency属性关系

寻找那些你相同我也相同，你不同我也不同的，然后加上一个主要的key就可以

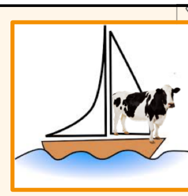
属性之间有三种关系，但并不是每一种关系都存在函数依赖。设R(U)是属性集U上的关系模式，X、Y是U的子集：

如果X和Y之间是1：1关系（一对一关系），如学校和校长之间就是1:1关系，则存在函数依赖X → Y和Y →X。

如果X和Y之间是1：n关系（一对多关系），如年龄和姓名之间就是1:n关系，则存在函数依赖Y → X。

如果X和Y之间是m：n关系（多对多关系），如学生和课程之间就是m:n关系，则X和Y之间不存在函数依赖。

Ex: *Wisconsin Sailing Club*



Proposed schema design #2:

sid	sname	rating	age
22	Dustin	7	45.0
31	Lubber	8	55.5
...	...	...	...

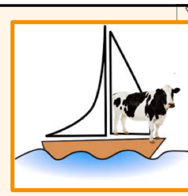
sid	bid	date
22	101	10/10/98
22	102	10/10/98
22	103	10/8/98
22	104	10/7/98
31	102	11/10/98
31	103	11/6/98
31	104	11/12/98
...	...	...

bid	bname	color
101	Interlake	blue
102	Interlake	red
103	Clipper	green
104	Marine	red

Q: What about *this* design?

- Is #2 "better than #1...? Explain!
- Is it a "best" design?
- How can we go from design #1 to this one?

Ex: *Wisconsin Sailing Club*



Proposed schema design #3:

sid	sname	rating	age
22	Dustin	7	45.0
31	Lubber	8	55.5
...	...	...	...

sid	bid	date
22	101	10/10/98
22	102	10/10/98
22	103	10/8/98
22	104	10/7/98
31	102	11/10/98
31	103	11/6/98
31	104	11/12/98
...	...	...

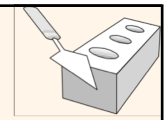
bid	bname
101	Interlake
102	Interlake
103	Clipper
104	Marine

bid	color
101	blue
102	red
103	green
104	red

Q: What about *this* design?

- Is #3 "better" or "worse" than #2...?
- What sort of tradeoffs do you see between the two?

The Evils of Redundancy (or: The Evils of Redundancy)



- *Redundancy* is at the root of several problems associated with relational schemas:
  - Redundant storage (space)
  - Insert/delete/update anomalies
- *Functional dependencies* can help in identifying problem schemas and suggesting refinements.
- Main refinement technique: *decomposition*, e.g., replace R(ABCD) with R1(AB) + R2(BCD).
- Decomposition should be used judiciously:
  - Is there reason to decompose a relation?
  - Does the decomposition cause any problems?

Good rule to follow:
"One fact, one place!"