Introduction to Database Systems CSE 444

Lecture 4: Views and Constraints

Outline

- Views: Sections 8.1, 8.2, 8.3
  - [Old edition, Sections 6.6 and 6.7]
- Constraints: Sections 2.3, 7.1, 7.2
  - [Old edition: Sections 7.1 and 7.2 only]
- Won’t discuss updates ! In sections…

Views

Views are relations, except that they may not be physically stored

For presenting different information to different users

Employee(ssn, name, department, project, salary)

```
CREATE VIEW  Developers AS
   SELECT name, project
   FROM  Employee
   WHERE department = ‘Development’
```

Payroll has access to Employee, others only to Developers

Example

Purchase(customer, product, store)
Product(pname, price)

```
CREATE VIEW  CustomerPrice  AS
        SELECT  x.customer, y.price
        FROM     Purchase x, Product y
        WHERE   x.product = y.pname
```

CustomerPrice(customer, price)

“virtual table”

Example

Purchase(customer, product, store)
Product(pname, price)

CustomerPrice(customer, price)

We can later use the view just like any other relation :

```
SELECT  DISTINCT u.customer, v.store
FROM     CustomerPrice u, Purchase v
WHERE   u.customer = v.customer  AND
          u.price > 100
```

Types of Views

We discuss only virtual views in class

- Virtual views
  - Used in databases
  - Computed only on-demand – slow at runtime
  - Always up to date

- Materialized views
  - Used in data warehouses
  - Pre-computed offline – fast at runtime
  - May have stale data
  - Indexes *are* materialized views (read book)

Queries Over Views: Query Modification

View:

```
CREATE VIEW  CustomerPrice  AS
        SELECT  x.customer, y.price
        FROM     Purchase x, Product y
        WHERE   x.product = y.pname
```

Query:

```
SELECT  DISTINCT u.customer, v.store
FROM     CustomerPrice u, Purchase v
WHERE   u.customer = v.customer  AND
              u.price > 100
```

Queries Over Views: Query Modification

Modified query:

```
SELECT  DISTINCT u.customer, v.store
FROM     (SELECT  x.customer, y.price
           FROM     Purchase x, Product y
           WHERE   x.product = y.pname) u, Purchase v
WHERE   u.customer = v.customer  AND
          u.price > 100
```

Queries Over Views: Query Modification

Modified and unnested query:

```
SELECT  DISTINCT x.customer, v.store
FROM     Purchase x, Product y, Purchase v,
WHERE   x.customer = v.customer  AND
          y.price > 100 AND
          x.product = y.pname
```

Applications of Virtual Views

- Increased physical data independence. E.g.
  - Vertical data partitioning
  - Horizontal data partitioning
- Logical data independence. E.g.
  - Change schemas of base relations (i.e., stored tables)
- Security
  - View reveals only what the users are allowed to know

Vertical Partitioning

Resumes

SSN	Name	Address	Resume	Picture
234234	Mary	Huston	Clob1…	Blob1…
345345	Sue	Seattle	Clob2…	Blob2…
345343	Joan	Seattle	Clob3…	Blob3…
234234	Ann	Portland	Clob4…	Blob4…

T1

SSN	Name	Address
234234	Mary	Huston
345345	Sue	Seattle
. . .		

T2

SSN	Resume
234234	Clob1…
345345	Clob2…

T3

SSN	Picture
234234	Blob1…
345345	Blob2…

Vertical Partitioning

```
CREATE VIEW  Resumes  AS
        SELECT  T1.ssn, T1.name, T1.address,
                T2.resume, T3.picture
        FROM    T1,T2,T3
        WHERE  T1.ssn=T2.ssn and T2.ssn=T3.ssn
```

Vertical Partitioning

```
SELECT address
FROM    Resumes
WHERE   name = 'Sue'
```

Which of the tables T1, T2, T3 will be queried by the system ?

When do we use vertical partitioning ?

Vertical Partitioning Applications

1. Can improve performance of some queries
   - When queries touch small fraction of columns
   - Only need to read desired columns from disk
   - Can produce big I/O savings for wide tables
   - Potential benefit in data warehousing applications

- But
  - Repeated key columns add a lot of overhead
  - Need expensive joins to reconstruct tuples

Vertical Partitioning Applications

2. When some fields are large and rarely accessed
   – E.g. Picture

3. In distributed databases
   – Customer personal info at one site, profile at another

4. In data integration
   – T1 comes from one source
   – T2 comes from a different source

Horizontal Partitioning

Customers

SSN	Name	City	Country
234234	Mary	Houston	USA
345345	Sue	Seattle	USA
345343	Joan	Seattle	USA
234234	Ann	Portland	USA
--	Frank	Calgary	Canada
--	Jean	Montreal	Canada

CustomersInHouston

SSN	Name	City	Country
234234	Mary	Houston	USA

CustomersInSeattle

SSN	Name	City	Country
345345	Sue	Seattle	USA
345343	Joan	Seattle	USA

CustomersInCanada

SSN	Name	City	Country
--	Frank	Calgary	Canada
--	Jean	Montreal	Canada

Horizontal Partitioning

```
CREATE VIEW  Customers  AS
    CustomersInHouston
       UNION ALL
    CustomersInSeattle
       UNION ALL
     . . .
```

Horizontal Partitioning

```
SELECT name
FROM    Customers
WHERE   city = ‘Seattle’
```

Which tables are inspected by the system ?

WHY ???

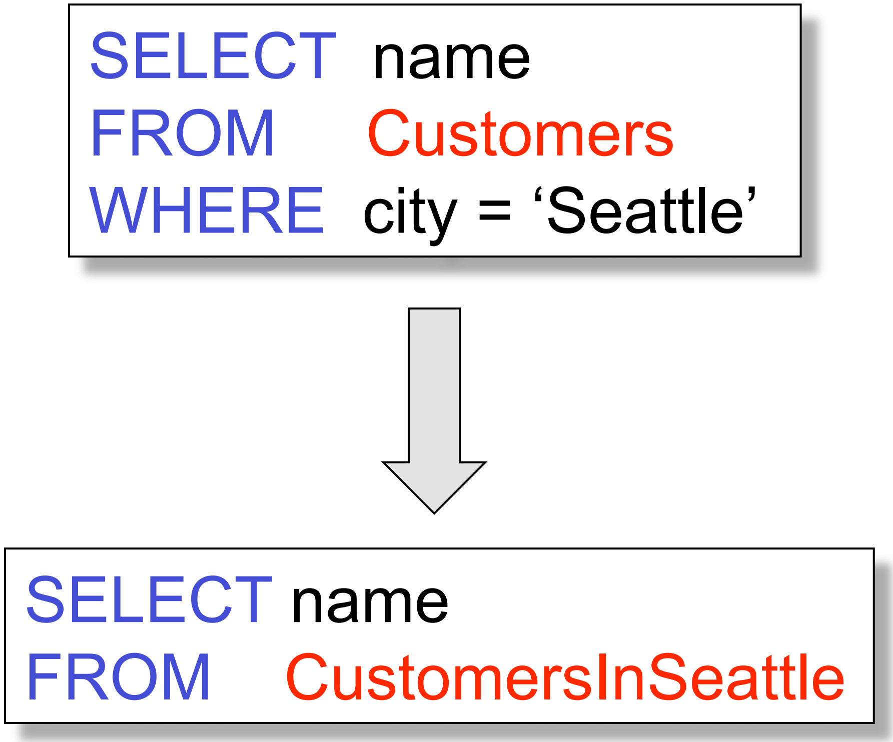
Horizontal Partitioning

Better:

```
CREATE VIEW  Customers  AS
    (SELECT * FROM CustomersInHouston
     WHERE city = ‘Houston’)
       UNION ALL
    (SELECT * FROM CustomersInSeattle
     WHERE city = ‘Seattle’)
       UNION ALL
     . . .
```

Other techniques exist: read DBMS documentation

Horizontal Partitioning



```
SELECT  name
FROM    Customers
WHERE   city = ‘Seattle’
```

```
SELECT name
FROM   CustomersInSeattle
```

Horizontal Partitioning Applications

- Performance optimization
  - Especially for data warehousing
  - E.g. one partition per month
  - E.g. archived applications and active applications
- Distributed and parallel databases
- Data integration

Views and Security

Customers:

Name	**Address**	**Balance**
Mary	Houston	450.99
Sue	Seattle	-240
Joan	Seattle	333.25
Ann	Portland	-520

Fred is not allowed to see this

Fred is allowed to see this

```
CREATE VIEW PublicCustomers
        SELECT Name, Address
        FROM Customers
```

Views and Security

Customers:

Name	**Address**	**Balance**
Mary	Huston	450.99
Sue	Seattle	-240
Joan	Seattle	333.25
Ann	Portland	-520

John is not allowed to see >0 balances

```
CREATE VIEW BadCreditCustomers
        SELECT *
        FROM Customers
        WHERE Balance < 0
```

Outline

- Views: Sections 8.1, 8.2, 8.3
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- Constraints: Sections 2.3, 7.1, 7.2
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Integrity Constraints Motivation

An integrity constraint is a condition specified on a database schema that restricts the data that can be stored in an instance of the database.

- ICs help prevent entry of incorrect information
- DBMS enforces integrity constraints
  - Allows only legal database instances (i.e., those that satisfy all constraints) to exist
  - Ensures that all necessary checks are always performed and avoids duplicating the verification logic in each application

Types of Constraints in SQL

Constraints in SQL:

- Keys, foreign keys
- Attribute-level constraints
- Tuple-level constraints
- Global constraints: assertions

simplest

Most complex

- The more complex the constraint, the harder it is to check and to enforce

Key Constraints

Product(name, category)

```
CREATE TABLE Product (
        name CHAR(30) PRIMARY KEY,
        category VARCHAR(20))
```

OR:

```
CREATE TABLE Product (
        name CHAR(30),
        category VARCHAR(20)
PRIMARY KEY (name))
```

Keys with Multiple Attributes

Product(name, category, price)

```
CREATE TABLE Product (
        name CHAR(30),
        category VARCHAR(20),
        price INT,
   PRIMARY KEY (name, category))
```

Name	Category	Price
Gizmo	Gadget	10
Camera	Photo	20
Gizmo	Photo	30
~~Gizmo~~	~~Gadget~~	~~40~~

Other Keys

```
CREATE TABLE Product (
        productID  CHAR(10),
        name CHAR(30),
        category VARCHAR(20),
        price INT,
        PRIMARY KEY (productID),
        UNIQUE (name, category))
```

There is at most one PRIMARY KEY;
there can be many UNIQUE

Foreign Key Constraints

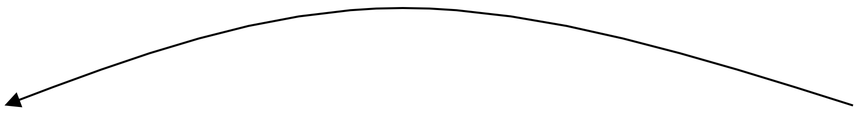
Referential integrity constraints

```
CREATE TABLE Purchase (
        prodName CHAR(30)
                REFERENCES Product(name),
        date DATETIME)
```

May write just Product (why ?)

prodName is a **foreign key** to Product(name)
name must be a **key** in Product

Foreign Key Constraints



Product

Name	Category
Gizmo	gadget
Camera	Photo
OneClick	Photo

Purchase

ProdName	Store
Gizmo	Wiz
Camera	Ritz
Camera	Wiz

Foreign Key Constraints

- Example with multi-attribute primary key

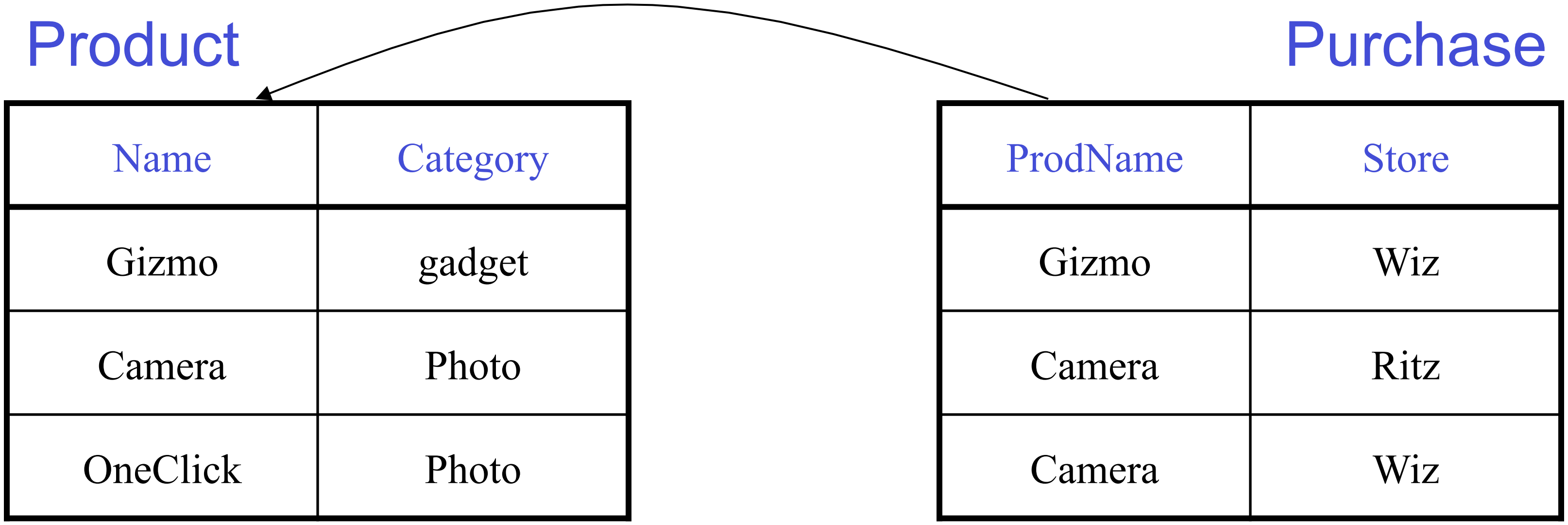
```
CREATE TABLE Purchase (
          prodName CHAR(30),
          category VARCHAR(20),
          date DATETIME,
          FOREIGN KEY (prodName, category)
             REFERENCES  Product(name, category)
```

- (name, category) must be a PRIMARY KEY in Product

What happens during updates ?

Types of updates:

- In Purchase: insert/update
- In Product: delete/update



Product

Name	Category
Gizmo	gadget
Camera	Photo
OneClick	Photo

Purchase

ProdName	Store
Gizmo	Wiz
Camera	Ritz
Camera	Wiz

What happens during updates ?

- SQL has three policies for maintaining referential integrity:
- Reject violating modifications (default)
- Cascade: after delete/update do delete/update
- Set-null set foreign-key field to NULL

READING ASSIGNMENT: 7.1.2 and 7.1.3
[Old edition: 7.1.5, 7.1.6]

Constraints on Attributes and Tuples

- Constraints on attributes:

```
NOT NULL              -- obvious meaning...
CHECK condition       -- any condition !
```

- Constraints on tuples

```
CHECK condition
```

Constraints on Attributes and Tuples

What is the difference from Foreign-Key ?

```
CREATE TABLE Purchase (
          prodName CHAR(30)
                   CHECK (prodName IN
                            (SELECT Product.name
                            FROM Product),
          date DATETIME NOT NULL)
```

General Assertions

```
CREATE ASSERTION myAssert CHECK
  NOT EXISTS(
          SELECT Product.name
          FROM Product, Purchase
          WHERE Product.name = Purchase.prodName
          GROUP BY Product.name
          HAVING count(*) > 200)
```

But most DBMSs do not implement assertions
Instead, they provide triggers
To learn more, read the rest of Chapter 7