Lecture 05: SQL

Wednesday, October 9, 2002

Outline

- Indexes
- Defining Views (6.7)
- Constraints and Triggers (Chapter 7)

Indexes

REALLY important to speed up query processing time.

Suppose we have a relation

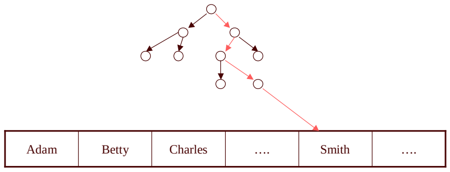
Person (name, age, city)

```
SELECT *
FROM     Person
WHERE   name = “Smith”
```

Sequential scan of the file Person may take long

Indexes

- Create an index on name:



Adam	Betty	Charles	….	Smith	….

- B+ trees have fan-out of 100s: max 4 levels !

Creating Indexes

Syntax:

```
CREATE INDEX  nameIndex ON Person(name)
```

Creating Indexes

Indexes can be created on more than one attribute:

Example:

```
CREATE INDEX doubleindex ON
                         Person (age, city)
```

Helps in:

```
SELECT *
FROM    Person
WHERE age = 55 AND city = “Seattle”
```

But not in:

```
SELECT *
FROM    Person
WHERE city = “Seattle”
```

Creating Indexes

Indexes can be useful in range queries too:

```
CREATE INDEX ageIndex ON  Person (age)
```

B+ trees help in:

```
SELECT *
FROM Person
WHERE age > 25 AND age < 28
```

Why not create indexes on everything?

The Index Selection Problem

- We are given a ***workload*** = a set of SQL queries plus how often they run
- What indexes should we build to speed up the workload ?
- FROM/WHERE clauses ➔ favor an index
- INSERT/UPDATE clauses ➔ discourage an index
- Index selection = normally done by people, recently done automatically (SQL Server)

Defining Views

Views are relations, except that they are not 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

A Different View

Person(name, city)
Purchase(buyer, seller, product, store)
Product(name, maker, category)

```
CREATE VIEW  Seattle-view  AS

        SELECT  buyer, seller, product, store
        FROM     Person, Purchase
        WHERE   Person.city = “Seattle”    AND
                      Person.name = Purchase.buyer
```

We have a new virtual table:
Seattle-view(buyer, seller, product, store)

A Different View

We can later use the view:

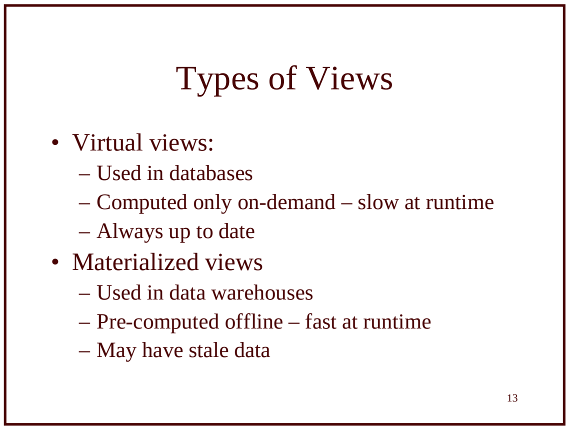
```
SELECT   name, store
FROM     Seattle-view, Product
WHERE   Seattle-view.product = Product.name  AND
              Product.category = “shoes”
```

What Happens When We Query a View ?

```
SELECT   name, Seattle-view.store
FROM     Seattle-view, Product
WHERE   Seattle-view.product = Product.name  AND
              Product.category = “shoes”
```

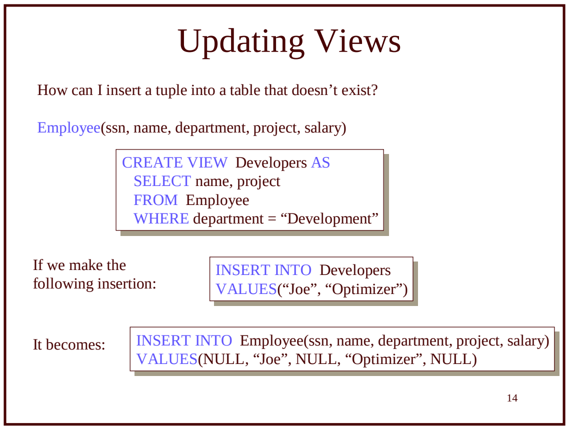
↓

```
SELECT  name, Purchase.store
FROM     Person, Purchase, Product
WHERE  Person.city = “Seattle”    AND
             Person.name = Purchase.buyer    AND
             Purchase.poduct = Product.name  AND
             Product.category = “shoes”
```



Types of Views

- 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



Updating Views

How can I insert a tuple into a table that doesn't exist?

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

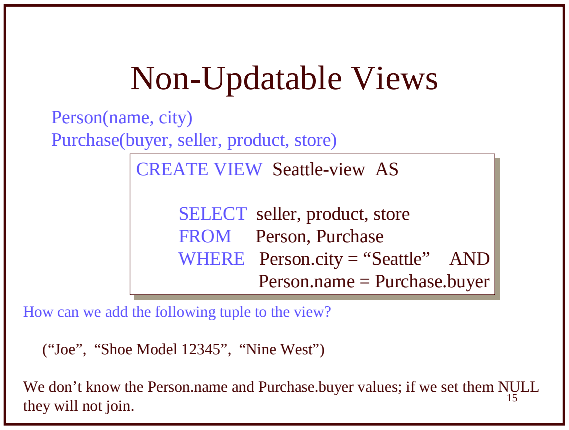
```
CREATE VIEW  Developers AS
  SELECT name, project
  FROM  Employee
  WHERE department = "Development"
```

If we make the following insertion:

```
INSERT INTO  Developers
VALUES("Joe", "Optimizer")
```

It becomes:

```
INSERT INTO  Employee(ssn, name, department, project, salary)
VALUES(NULL, "Joe", NULL, "Optimizer", NULL)
```



Non-Updatable Views

Person(name, city)
Purchase(buyer, seller, product, store)

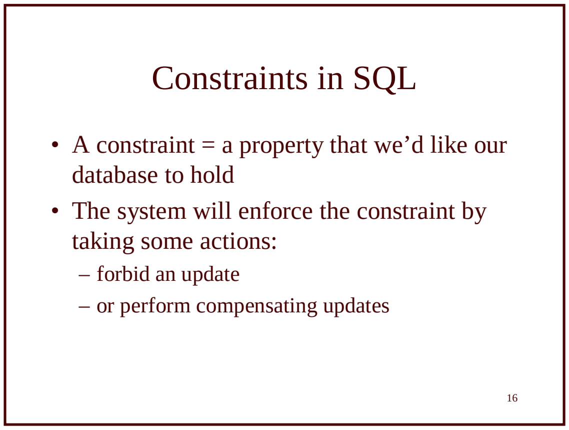
```
CREATE VIEW  Seattle-view  AS

      SELECT  seller, product, store
      FROM     Person, Purchase
      WHERE   Person.city = "Seattle"    AND
               Person.name = Purchase.buyer
```

How can we add the following tuple to the view?

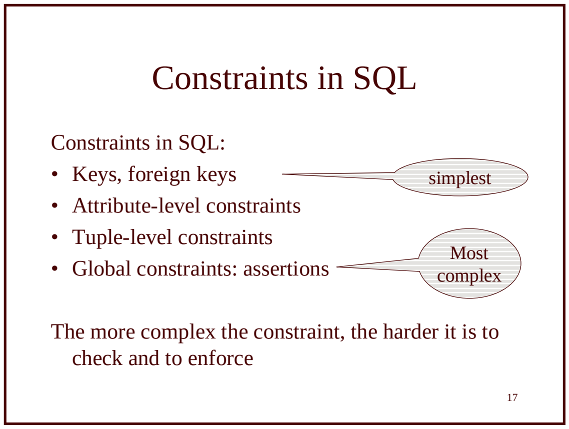
("Joe", "Shoe Model 12345", "Nine West")

We don't know the Person.name and Purchase.buyer values; if we set them NULL they will not join.



Constraints in SQL

- A constraint = a property that we'd like our database to hold
- The system will enforce the constraint by taking some actions:
  - forbid an update
  - or perform compensating updates



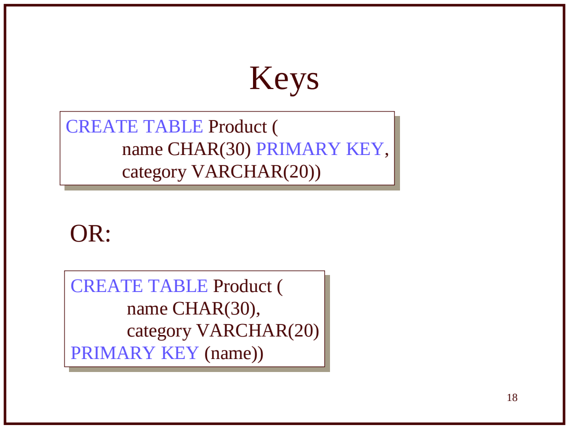
Constraints in SQL

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

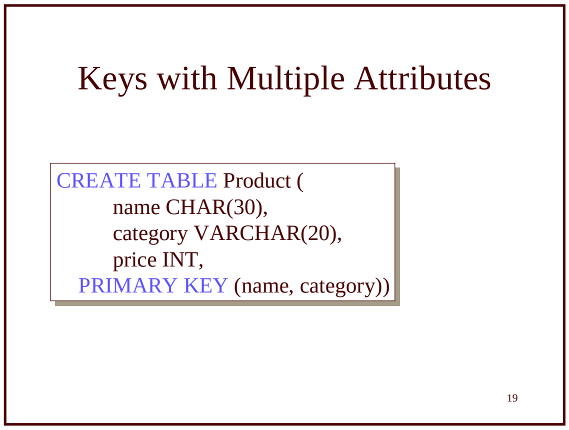


Keys

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

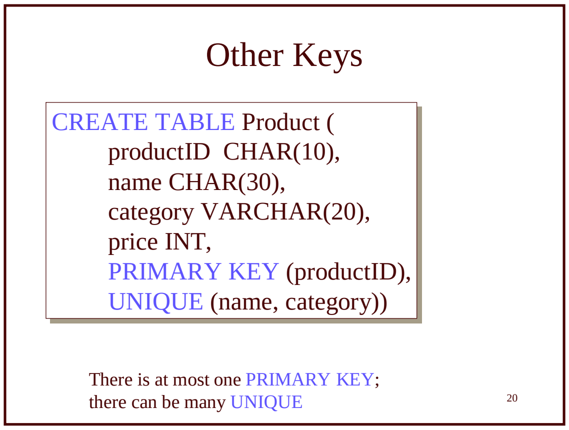
OR:

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



Keys with Multiple Attributes

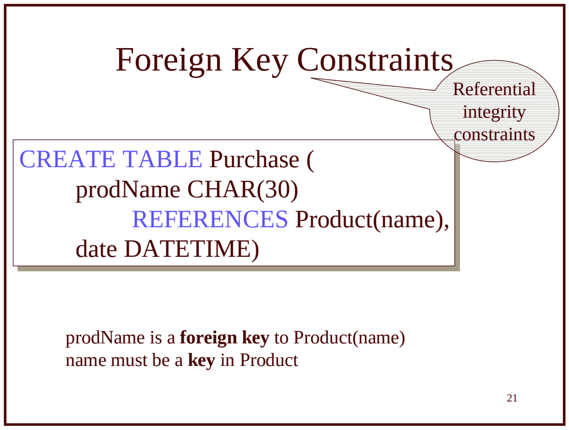
```
CREATE TABLE Product (
        name CHAR(30),
        category VARCHAR(20),
        price INT,
   PRIMARY KEY (name, category))
```



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

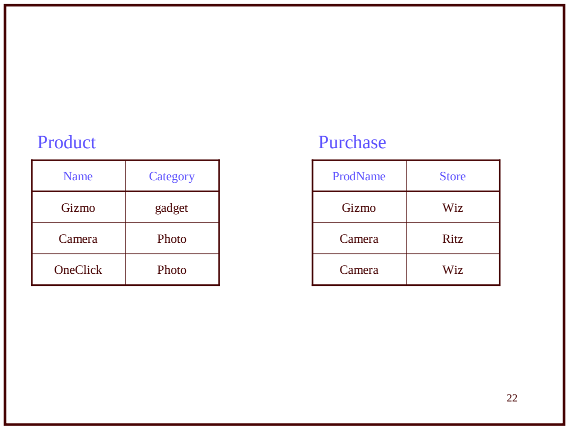


Foreign Key Constraints

Referential integrity constraints

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

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

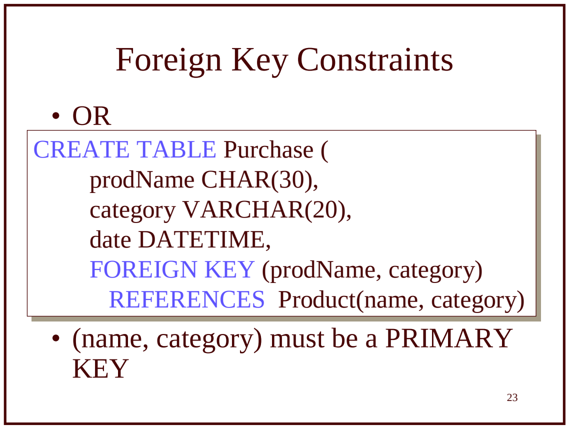


Product

Name	Category
Gizmo	gadget
Camera	Photo
OneClick	Photo

Purchase

ProdName	Store
Gizmo	Wiz
Camera	Ritz
Camera	Wiz

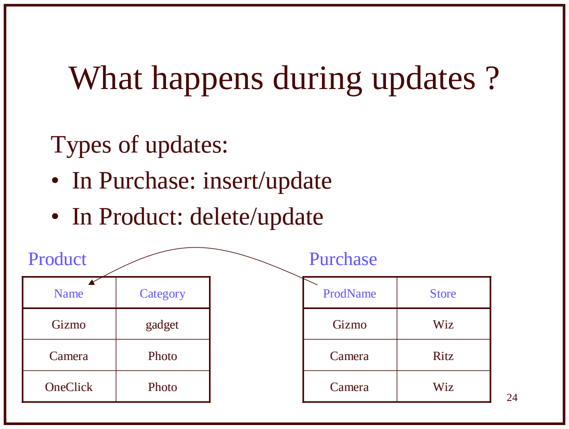


Foreign Key Constraints

- OR

```
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



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 a delete/update do a delete/update
- Set-null set foreign-key field to NULL

READING ASSIGNEMNT: 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

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)
```

Final Comments on Constraints

- Can give them names, and alter later
  - Read in the book !!!
- We need to understand exactly *when* they are checked
- We need to understand exactly *what* actions are taken if they fail

Triggers in SQL

- A trigger contains an *event*, a *condition*, an *action*.
- Event = INSERT, DELETE, UPDATE
- Condition = any WHERE condition (may refer to the old and the new values)
- Action = more inserts, deletes, updates
- Many, many more bells and whistles...
- Read in the book (it only scratches the surface...)