

Introduction to Database Systems

CSE 414

Lecture 19: Views

Announcements

- New web quiz and homework out now. Due Monday and Wednesday next week.
- Today: Views

Views

- A **view** in SQL =
 - A table computed from other tables, s.t., whenever the base tables are updated, the view is updated too
- More generally:
 - A **view** is derived data that keeps track of changes in the original data
- Compare:
 - A **function** computes a value from other values, but does not keep track of changes to the inputs

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

StorePrice(store, price)

A Simple View

Create a view that returns for each store
the prices of products purchased at that store

```
CREATE VIEW StorePrice AS  
SELECT DISTINCT x.store, y.price  
FROM Purchase x, Product y  
WHERE x.product = y.pname
```

This is like a new table
StorePrice(store, price)

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

StorePrice(store, price)

We Use a View Like Any Table

- A "high end" store is a store that sell some products over 1000.
- For each customer, return all the high end stores that they visit.

```
SELECT DISTINCT u.customer, u.store  
FROM Purchase u, StorePrice v  
WHERE u.store = v.store  
      AND v.price > 1000
```

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 (must recompute or update)
 - Indexes *are* materialized views
- A key component of physical tuning of databases is the selection of materialized views and indexes

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

StorePrice(store, price)

Query Modification

For each customer, find all the high end stores that they visit.

```
CREATE VIEW StorePrice AS  
SELECT DISTINCT x.store, y.price  
FROM Purchase x, Product y  
WHERE x.product = y.pname
```

```
SELECT DISTINCT u.customer, u.store  
FROM Purchase u, StorePrice v  
WHERE u.store = v.store  
AND v.price > 1000
```

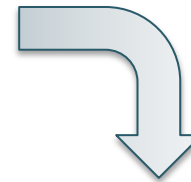
Purchase(customer, product, store)
Product(pname, price)

StorePrice(store, price)

Query Modification

For each customer, find all the high end stores that they visit.

```
CREATE VIEW StorePrice AS
SELECT DISTINCT x.store, y.price
FROM Purchase x, Product y
WHERE x.product = y.pname
```



```
SELECT DISTINCT u.customer, u.store
FROM Purchase u, StorePrice v
WHERE u.store = v.store
AND v.price > 1000
```

Modified query:

```
SELECT DISTINCT u.customer, u.store
FROM Purchase u,
(SELECT DISTINCT x.store, y.price
FROM Purchase x, Product y
WHERE x.product = y.pname) v
WHERE u.store = v.store
AND v.price > 1000
```


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

StorePrice(store, price)

Query Modification

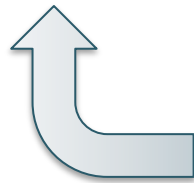
For each customer, find all the high end stores that they visit.

```
SELECT DISTINCT u.customer, u.store
FROM Purchase u, Purchase x, Product y
WHERE u.store = x.store
      AND y.price > 1000
      AND x.product = y.pname
```

Notice that
Purchase
occurs twice.
Why?

Modified query:

Modified and unnested query:



```
SELECT DISTINCT u.customer, u.store
FROM Purchase u,
      (SELECT DISTINCT x.store, y.price
       FROM Purchase x, Product y
       WHERE x.product = y.pname) v
WHERE u.store = v.store
      AND v.price > 1000
```

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

StorePrice(store, price)

Further Virtual View Optimization

Retrieve all stores whose name contains ACME

```
CREATE VIEW StorePrice AS
SELECT DISTINCT x.store, y.price
FROM Purchase x, Product y
WHERE x.product = y.pname
```

```
SELECT DISTINCT v.store
FROM StorePrice v
WHERE v.store like '%ACME%'
```

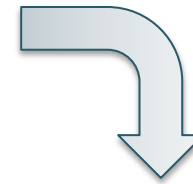
Purchase(customer, product, store)
Product(pname, price)

StorePrice(store, price)

Further Virtual View Optimization

Retrieve all stores whose name contains ACME

```
CREATE VIEW StorePrice AS  
SELECT DISTINCT x.store, y.price  
FROM Purchase x, Product y  
WHERE x.product = y.pname
```



```
SELECT DISTINCT v.store  
FROM StorePrice v  
WHERE v.store like '%ACME%'
```

Modified query:

```
SELECT DISTINCT v.store  
FROM  
(SELECT DISTINCT x.store, y.price  
FROM Purchase x, Product y  
WHERE x.product = y.pname) v  
WHERE v.store like '%ACME%'
```

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

StorePrice(store, price)

Further Virtual View Optimization

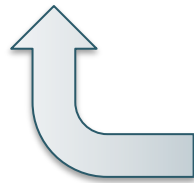
Retrieve all stores whose name contains ACME

```
SELECT DISTINCT x.store  
FROM Purchase x, Product y  
WHERE x.product = y.pname  
AND x.store like '%ACME%'
```

We can further optimize! How?

Modified query:

Modified and unnested query:



```
SELECT DISTINCT v.store  
FROM  
(SELECT DISTINCT x.store, y.price  
FROM Purchase x, Product y  
WHERE x.product = y.pname) v  
WHERE v.store like '%ACME%'
```

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

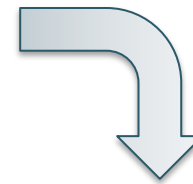
StorePrice(store, price)

Further Virtual View Optimization

Retrieve all stores whose name contains ACME

```
SELECT DISTINCT x.store  
FROM Purchase x, Product y  
WHERE x.product = y.pname  
AND x.store like '%ACME%'
```

Assuming Product.pname is a key
and Purchase.product is a foreign key



Modified and unnested query:

Final Query

```
SELECT DISTINCT x.store  
FROM Purchase x  
WHERE x.store like '%ACME%'
```

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

<u>SSN</u>	Name	Address	Resume	Picture
234234	Mary	Huston	Clob1...	Blob1...
345345	Sue	Seattle	Clob2...	Blob2...
345343	Joan	Seattle	Clob3...	Blob3...
432432	Ann	Portland	Clob4...	Blob4...

T1

<u>SSN</u>	Name	Address
234234	Mary	Huston
345345	Sue	Seattle
...		

T2

<u>SSN</u>	Resume
234234	Clob1...
345345	Clob2...

T3

<u>SSN</u>	Picture
234234	Blob1...
345345	Blob2...

T2.SSN is a key *and* a foreign key to T1.SSN. Same for T3.SSN

T1(ssn,name,address)

T2(ssn,resume)

T3(ssn,picture)

Resumes(ssn,name,address,resume,picture)

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 T1.ssn=T3.ssn
```


T1(ssn,name,address)

T2(ssn,resume)

T3(ssn,picture)

Resumes(ssn,name,address,resume,picture)

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 T1.ssn=T3.ssn
```

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

T1(ssn,name,address)

T2(ssn,resume)

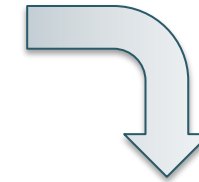
T3(ssn,picture)

Resumes(ssn,name,address,resume,picture)

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 T1.ssn=T3.ssn
```

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



Modified query:

```
SELECT T1.address
FROM   T1, T2, T3
WHERE  T1.name = 'Sue'
      AND T1.SSN=T2.SSN
      AND T1.SSN = T3.SSN
```

T1(ssn,name,address)

T2(ssn,resume)

T3(ssn,picture)

Resumes(ssn,name,address,resume,picture)

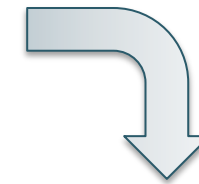
Vertical Partitioning

```
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 T1.ssn=T3.ssn
```

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

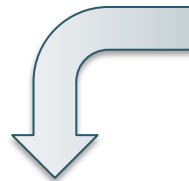
Final query:

```
SELECT T1.address
FROM   T1
WHERE  T1.name = 'Sue'
```



Modified query:

```
SELECT T1.address
FROM   T1, T2, T3
WHERE  T1.name = 'Sue'
       AND T1.SSN=T2.SSN
       AND T1.SSN = T3.SSN
```



Vertical Partitioning Applications

1. Advantages

- Speeds up queries that touch only a small fraction of columns
- Single column can be compressed effectively, reducing disk I/O

2. Disadvantages

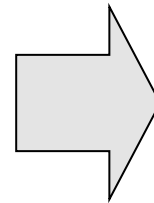
- Updates are expensive!
- Need many joins to access many columns
- Repeated key columns add overhead

Hot trend today for data analytics: e.g., Vertica startup acquired by HP
They use a highly-tuned column-oriented data store AND engine

Horizontal Partitioning

Customers

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



CustomersInHouston

SSN	Name	City
234234	Mary	Houston

CustomersInSeattle

SSN	Name	City
345345	Sue	Seattle
345343	Joan	Seattle

.....

CustomersInHouston(ssn,name,city)
CustomersInSeattle(ssn,name,city)

Customers(ssn,name,city)

.....

Horizontal Partitioning

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

CustomersInHouston(ssn,name,city)
CustomersInSeattle(ssn,name,city)
.....

Customers(ssn,name,city)

Horizontal Partitioning

```
SELECT name  
FROM Customers  
WHERE city = 'Seattle'
```

Which tables are inspected by the system ?

CustomersInHouston(ssn,name,city)
CustomersInSeattle(ssn,name,city)

Customers(ssn,name,city)

.....

Horizontal Partitioning

```
SELECT name  
FROM Customers  
WHERE city = 'Seattle'
```

Which tables are inspected by the system ?

All tables!

The systems doesn't know that CustomersInSeattle.city = 'Seattle'

CustomersInHouston(ssn,name,city)
CustomersInSeattle(ssn,name,city)

Customers(ssn,name,city)

.....

Horizontal Partitioning

Better: remove CustomerInHouston.city etc

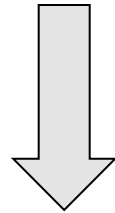
```
CREATE VIEW Customers AS
  (SELECT SSN, name, 'Houston' as city
   FROM CustomersInHouston)
  UNION ALL
  (SELECT SSN, name, 'Seattle' as city
   FROM CustomersInSeattle)
  UNION ALL
  . . .
```

CustomersInHouston(ssn,name,city)
CustomersInSeattle(ssn,name,city)
.....

Customers(ssn,name,city)

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