Introduction to Database Systems CSE 414

Lecture 8: SQL Wrap-up

Announcements

- New web quiz out: due Monday, 11 pm
  - A couple of questions on nested queries

- Homework 3 out today and due in a week, ***but…***
  - Be ***absolutely sure*** to log on to the Azure cluster by the end of this week so we can fix any problems before it's the last minute

Homework 3

- More IMDB queries using SQL Azure
- Login details in the assignment (out now)
  - Userid = your UW netid; password on board
  - Change password on first login
- Demo in sections tomorrow
  - Bring a laptop with you if you can
- Software (tested recently on these)
  - Web browsers: Windows 7: IE, Chrome, Firefox; OS X: Safari. Need Silverlight plugin (should automatically prompt you to install on first access)

Review: Indexes

V(M, N);

Suppose we have queries like these:

```
SELECT *
FROM V
WHERE M=?
```

```
SELECT *
FROM V
WHERE N=?
```

```
SELECT *
FROM V
WHERE M=? and N=?
```

Which of these indexes are helpful for each query?

1. Index on V(M)
2. Index on V(N)
3. Index on V(M,N)

Review: Indexes

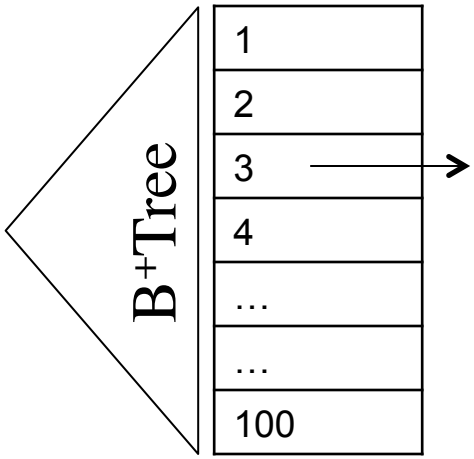
V(M, N);

Suppose V(M,N) contains 10,000 records:
(1,1), (1,2), (1,3), …, (1,100), (2,1),…, (100, 100)

```
SELECT *
FROM V
WHERE M=3
```

```
SELECT *
FROM V
WHERE N=5
```

```
SELECT *
FROM V
WHERE M=3 and N=5
```



List of pointers to records (3,1), (3,2), …, (3,100)

Index on V(M)

Review: Indexes

V(M, N);

Suppose V(M,N) contains 10,000 records:
(1,1), (1,2), (1,3), …, (1,100), (2,1),…, (100, 100)

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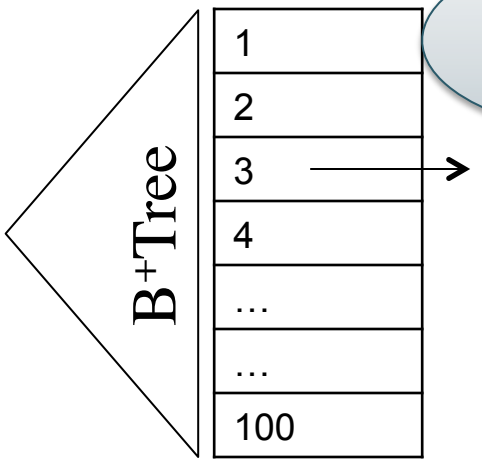
SELECT *
FROM V
WHERE M=3
```

```
SELECT *
FROM V
WHERE N=5
```

```
SELECT *
FROM V
WHERE M=3 and N=5
```

The index is useful here



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Review: Indexes

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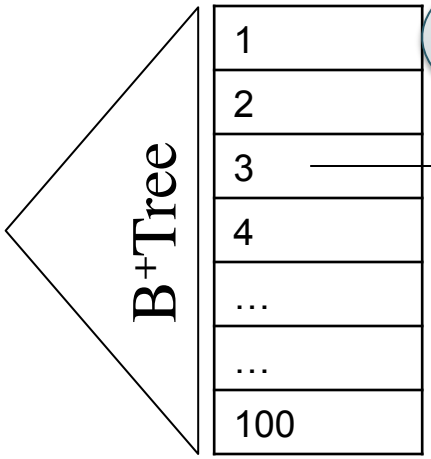
SELECT *
FROM V
WHERE M=3
```

```
SELECT *
FROM V
WHERE N=5
```

```
SELECT *
FROM V
WHERE M=3 and N=5
```

The index is useful here

Useless here



List of pointers to records (3,1), (3,2), …, (3,100)

Index on V(M)

Review: Indexes

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Suppose V(M,N) contains 10,000 records:
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FROM V
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```

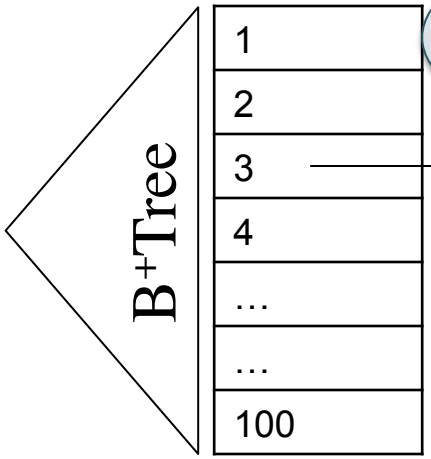
```
SELECT *
FROM V
WHERE N=5
```

```
SELECT *
FROM V
WHERE M=3 and N=5
```

The index is useful here

Useless here

Can we use it here?



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Index on V(M)

Review: Indexes

V(M, N);

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FROM V
WHERE M=3
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```
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WHERE N=5
```

```
SELECT *
FROM V
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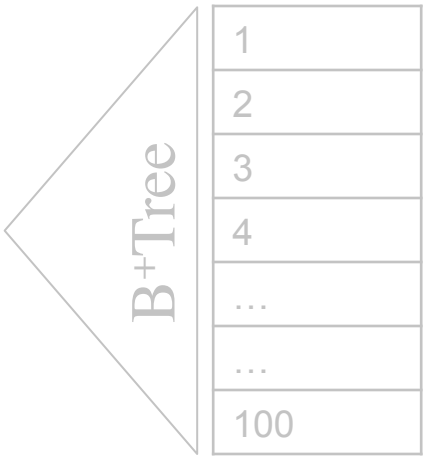
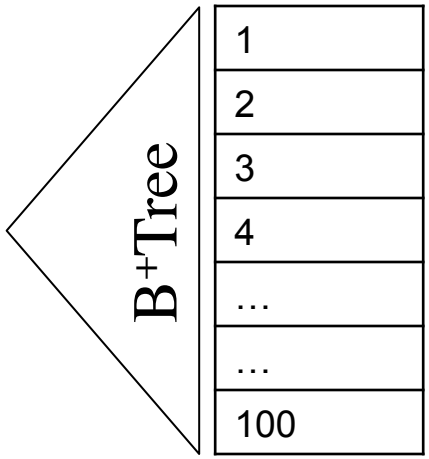
```



Index on V(M)



Index on V(N)

Where does this index help?

Review: Indexes

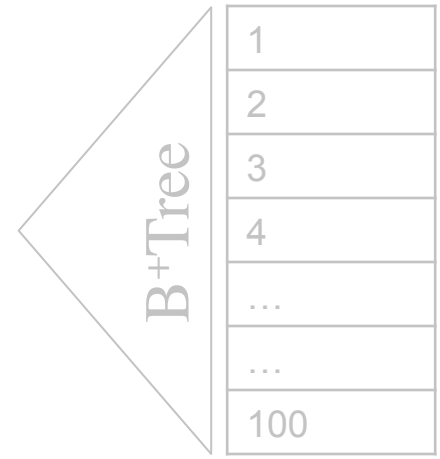
V(M, N);

Suppose V(M,N) contains 10,000 records:
(1,1), (1,2), (1,3), …, (1,100), (2,1),…, (100, 100)

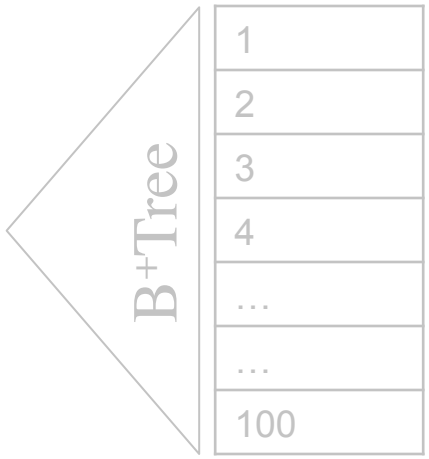
```
SELECT *
FROM V
WHERE M=3
```

```
SELECT *
FROM V
WHERE N=5
```

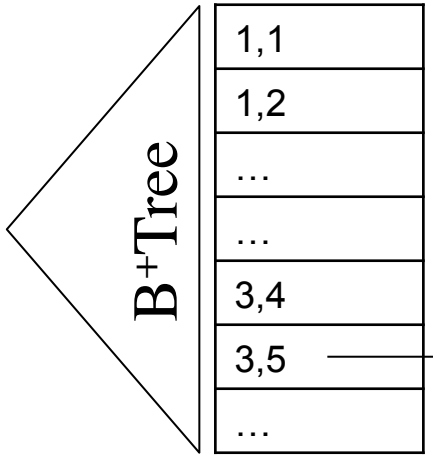
```
SELECT *
FROM V
WHERE M=3 and N=5
```



Index on V(M)



Index on V(N)



And this?

Single pointer to record (3,5)

Index on V(M,N)

Review: Indexes

Suppose M is the primary key in V(M, N):

How do the two indexes V(M) and V(M,N) compare?

Consider their utility for these predicates:

- M=5
- M=5 and N=7

Nested Queries

- Subqueries can occur in every clause:
  - SELECT
  - FROM
  - WHERE
- When we must use nested subqueries:
  - Non-monotone queries
  - Queries making complex use of aggregates
  - “Finding witnesses”

Practice these queries in SQL

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Ullman's drinkers-bars-beers example

Find drinkers that frequent some bar that serves some beer they like.

x: $\exists y.\ \exists z.\ \text{Frequents}(x, y) \wedge \text{Serves}(y,z) \wedge \text{Likes}(x,z)$

Find drinkers that frequent only bars that serves some beer they like.

x: $\forall y.\ \text{Frequents}(x, y) \Rightarrow (\exists z.\ \text{Serves}(y,z) \wedge \text{Likes}(x,z))$

Find drinkers that frequent some bar that serves only beers they like.

x: $\exists y.\ \text{Frequents}(x, y) \wedge \forall z.(\text{Serves}(y,z) \Rightarrow \text{Likes}(x,z))$

Find drinkers that frequent only bars that serves only beer they like.

x: $\forall y.\ \text{Frequents}(x, y) \Rightarrow \forall z.(\text{Serves}(y,z) \Rightarrow \text{Likes}(x,z))$

Product (pname, price, cid)
Company(cid, cname, city)

Unnesting Aggregates

Find the number of companies in each city

```
SELECT DISTINCT X.city, (SELECT count(*)
                         FROM Company Y
                         WHERE X.city = Y.city)
FROM  Company X
```

```
SELECT city,  count(*)
FROM   Company
GROUP BY city
```

Equivalent queries

Note: no need for DISTINCT
(DISTINCT *is the same* as GROUP BY)

Product (pname, price, cid)
Company(cid, cname, city)

Unnesting Aggregates

Find the number of products made in each city

```
SELECT DISTINCT X.city, (SELECT count(*)
                         FROM Product Y, Company Z
                         WHERE Z.cid=Y.cid
                         AND Z.city = X.city)
FROM  Company X
```

```
SELECT X.city, count(*)
FROM Company X, Product Y
WHERE X.cid=Y.cid
GROUP BY X.city
```

NOT equivalent !
You should know why!

Purchase(pid, product, quantity, price)

GROUP BY v.s. Nested Queries

```
SELECT    product, Sum(quantity) AS TotalSales
FROM      Purchase
WHERE     price > 1
GROUP BY  product
```

```
SELECT DISTINCT  x.product, (SELECT Sum(y.quantity)
                             FROM    Purchase y
                             WHERE x.product = y.product
                                   AND y.price > 1)
                            AS TotalSales
FROM      Purchase x
WHERE     x.price > 1
```

Why twice ?

Author(login,name)

Wrote(login,url)

More Unnesting

Find authors who wrote ≥ 10 documents:

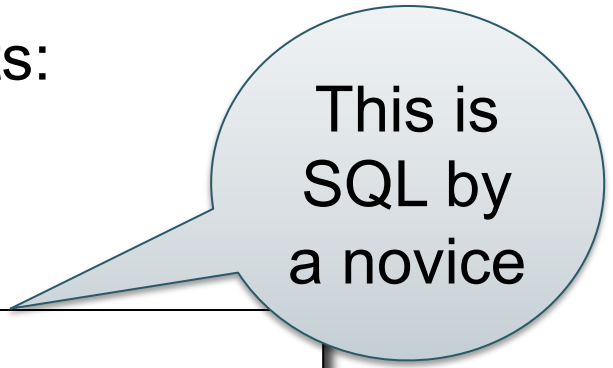
Author(login,name)

Wrote(login,url)

More Unnesting

Find authors who wrote ≥ 10 documents:

Attempt 1: with nested queries




```
SELECT DISTINCT Author.name
FROM        Author
WHERE       (SELECT count(Wrote.url)
             FROM Wrote
             WHERE Author.login=Wrote.login)
                >= 10
```

Author(login,name)
Wrote(login,url)

More Unnesting

Find authors who wrote ≥ 10 documents:

Attempt 1: with nested queries

Attempt 2: using GROUP BY and HAVING

```
SELECT    Author.name
FROM      Author, Wrote
WHERE     Author.login=Wrote.login
GROUP BY Author.name
HAVING    count(wrote.url) >= 10
```

This is SQL by an expert

Product (pname, price, cid)
Company(cid, cname, city)

Finding Witnesses

For each city, find the most expensive product made in that city

Product (pname, price, cid)
Company(cid, cname, city)

Finding Witnesses

For each city, find the most expensive product made in that city

Finding the maximum price is easy…

```
SELECT x.city, max(y.price)
FROM Company x, Product y
WHERE x.cid = y.cid
GROUP BY x.city;
```

But we need the *witnesses*, i.e. the products with max price

Product (pname, price, cid)
Company(cid, cname, city)

Finding Witnesses

To find the witnesses, compute the maximum price in a subquery

```
SELECT DISTINCT u.city, v.pname, v.price
FROM Company u, Product v,
     (SELECT x.city, max(y.price) as maxprice
      FROM Company x, Product y
      WHERE x.cid = y.cid
      GROUP BY x.city) w
WHERE u.cid = v.cid
       and u.city = w.city
       and v.price=w.maxprice;
```

Product (pname, price, cid)
Company(cid, cname, city)

Finding Witnesses

There is a more concise solution here:

```
SELECT u.city, v.pname, v.price
FROM Company u, Product v, Company x, Product y
WHERE u.cid = v.cid and u.city = x.city and x.cid = y.cid
GROUP BY u.city, v.pname, v.price
HAVING v.price = max(y.price);
```

Product (pname, price, cid)
Company(cid, cname, city)

Finding Witnesses

And another one:

```
SELECT u.city, v.pname, v.price
FROM Company u, Product v
WHERE u.cid = v.cid
  and v.price >= ALL (SELECT y.price
                      FROM Company x, Product y
                      WHERE u.city=x.city
                            and x.cid=y.cid);
```

Where We Are

- Motivation for using a DBMS for managing data
- SQL, SQL, SQL
  - Declaring the schema for our data (CREATE TABLE)
  - Inserting data one row at a time or in bulk (INSERT/.import)
  - Modifying the schema and updating the data (ALTER/UPDATE)
  - Querying the data (SELECT)
  - Tuning queries (CREATE INDEX)

- Next step: More knowledge of how DBMSs work
  - Client-server architecture
  - Relational algebra and query execution