Data Warehousing and Decision Support, part 3

CS634
Class 22

Slides based on "Database Management Systems" 3rd ed, Ramakrishnan and Gehrke, Chapter 25

Views and Materialized Views

Views: review of pp. 86-91

View - rows are not explicitly stored, but computed as needed from view definition

Base table - explicitly stored

CREATE VIEW

Given tables for these relations:

```
    Students (ID, name, major)
    Enrolled (ID, CourseID, grade)
```

Can create view:

```
    CREATEVIEW B_Students (name, ID, CourseID) AS
        SELECT    S.name, S.ID, E.CourseID
        FROM      Students S, Enrolled E
        WHERE     S.ID = E.ID AND E.grade = 'B';
```

- Now can use B_Students just as if it were a table, for queries
- Could be used to shield D_students from view
- Can grant select on view, but not on enrolled

Updatable Views

SQL-92: Must be defined on a single table using only selection and projection and not using DISTINCT.

SQL:1999: May involve multiple tables in SQL:1999 if each view field is from exactly one underlying base table and that table's PK is included in view; not restricted to selection and project, but cannot insert into views that use union, intersection, or set difference.

So B_Students is updatable by SQL99, and by Oracle 10.

What is a Materialized View?

- A database object that stores the results of a query
- Features/Capabilities
  - Can be partitioned and indexed
  - Can be queried directly
  - Can have DML applied against it
  - Several refresh options are available (in Oracle)
  - Fits best in read-intensive environments

Advantages and Disadvantages

- Advantages
  - Useful for summarizing, pre-computing, replicating and distributing data
  - Faster access for expensive and complex joins
  - Transparent to end-users
    - MVs can be added/dropped without invalidating coded SQL (like indexes)
    - This assumes end users are coding SQL using base tables, not MVs themselves
- Disadvantages
  - Performance costs of maintaining the views
  - Storage costs of maintaining the views

Similar to Indexes

- Designed to increase query Execution Performance.
- Transparent to SQL Applications allowing DBA's to create and drop Materialized Views without affecting the validity of Applications.
- Consume Storage Space.
- Can be Partitioned.
- Not covered by SQL standards
- But can be queried like tables

MV Support in DBs: from Wikipedia

- Materialized views were implemented first by the Oracle , and Oracle has the most features
- In IBM DB2, they are called "materialized query tables";
- Microsoft SQL Server has a similar feature called "indexed views".
- MySQL doesn't support materialized views natively, but workarounds can be implemented by using triggers or stored procedures or by using the open-source application Flexviews.

Views vs Materialized Views (Oracle), from http://www.sqlsnippets.com/en/topic-12874.html

Table

```
select * from T ;
 KEY VAL
---- -----
1    a
2    b
3    c
4
```

View

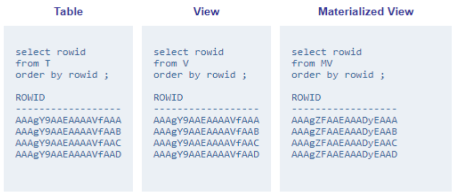
```
create view v as select
* from t ;
select * from V ;
KEY VAL
----- -----
1    a
2    b
3    c
4
```

Materialized View

```
create materialized
view mv as select *
from t ;
select * from MV ;
KEY VAL
---- -----
1    a
2    b
3    c
4
```

The ROWIDs tell the story…

- The view is using the table's rows but the MV has its own rows



Table

```
select rowid
from T
order by rowid ;

ROWID
------------------
AAAgY9AAEAAAAVfAAA
AAAgY9AAEAAAAVfAAB
AAAgY9AAEAAAAVfAAC
AAAgY9AAEAAAAVfAAD
```

View

```
select rowid
from V
order by rowid ;

ROWID
------------------
AAAgY9AAEAAAAVfAAA
AAAgY9AAEAAAAVfAAB
AAAgY9AAEAAAAVfAAC
AAAgY9AAEAAAAVfAAD
```

Materialized View

```
select rowid
from MV
order by rowid ;

ROWID
------------------
AAAgZFAAEAAADyEAAA
AAAgZFAAEAAADyEAAB
AAAgZFAAEAAADyEAAC
AAAgZFAAEAAADyEAAD
```

Update to T is not propagated immediately to simple MV

Table **View** **Materialized View**

update t set val = upper(val);

```
select * from T ;    select * from V ;    select * from MV ;
KEY VAL              KEY VAL              KEY VAL
---------- -----     ---------- -----     ---------- -----
1 A                  1 A                  1 a
2 B                  2 B                  2 b
3 C                  3 C                  3 c
4                    4                    4
```

MV "refresh" command

Table **View** **Materialized View**

execute dbms_mview.refresh('MV');

```
select * from T ;    select * from V ;    select * from MV ;
KEY VAL              KEY VAL              KEY VAL
---------- -----     ---------- -----     ---------- -----
1 A                  1 A                  1 A
2 B                  2 B                  2 B
3 C                  3 C                  3 C
4                    4                    4
```

Materialized View Logs for fast refresh

- There is a way to refresh only the changed rows in a materialized view's base table, called fast refreshing.
- For this, need a materialized view log (MLOG$_T here) on the base table t:

```
create materialized view log on t ;
UPDATE t set val = upper( val ) where KEY = 1 ;
INSERT into t ( KEY, val ) values ( 5, 'e' );

select key, dmltype$$ from MLOG$_T ;
KEY DMLTYPE$$
---------- ----------
1 U
5 I
```

REFRESH FAST

create materialized view mv REFRESH FAST as select * from t ;

select key, val, rowid from mv ;

```
KEY VAL ROWID
 ---------- ----- ------------------
1 a AAAWm+AAEAAAAaMAAA
2 b AAAWm+AAEAAAAaMAAB
3 c AAAWm+AAEAAAAaMAAC
4   AAAWm+AAEAAAAaMAAD
```

execute dbms_mview.refresh(list => 'MV', method => 'F'); --F for fast

select key, val, rowid from mv ;

--see same ROWIDs as above: nothing needed to be changed

Now let's update a row in the base table.

update t set val = 'XX' where key = 3 ;

commit;

execute dbms_mview.refresh(list => 'MV', method => 'F');

select key, val, rowid from mv;

```
KEY VAL ROWID
---------- ----- ------------------
1 a  AAAWm+AAEAAAAaMAAA
2 b  AAAWm+AAEAAAAaMAAB
3 XX AAAWm+AAEAAAAaMAAC –See update, same old ROWID
4    AAAWm+AAEAAAAaMAAD
```

So the MV row was updated based on the log entry

Adding Your Own Indexes

create materialized view mv
 refresh fast on commit as
 select t_key, COUNT(*) ROW_COUNT from t2 group by t_key ;

create index MY_INDEX on mv (T_KEY) ;

select index_name , i.uniqueness , ic.column_name
 from user_indexes i inner join user_ind_columns ic using (index_name)
  where i.table_name = 'MV' ;

```
INDEX_NAME  UNIQUENES COLUMN_NAME
--------------- --------- ---------------
I_SNAP$_MV  UNIQUE     SYS_NC00003$ --Sys-generated
MY_INDEX    NONUNIQUE  T_KEY
```

Prove that MY_INDEX is in use using SQL*Plus's Autotrace feature

set autotrace on explain set linesize 95

select * from mv where t_key = 2 ;

```
T_KEY ROW_COUNT
 ---------- ----------
 2 2
Execution Plan
 ----------------------------------------------------------
Plan hash value: 2793437614
----------------------------------------------------------------------
|Id| Operation             | Name | Rows | Bytes | Cost (%CPU)| Time |
----------------------------------------------------------------------
|0| SELECT STATEMENT            |       | 1 | 26 | 2 (0)| 00:00:01 |
|1| MAT_VIEW ACCESS BY INDEX ROWID| MV    | 1 | 26 | 2 (0)| 00:00:01 |
|*2| INDEX RANGE SCAN             | MY_INDEX | 1 |  | 1 (0)| 00:00:01 |
 ---------------------------------------------------------------------
```

MV on Join query

create materialized view log on t with rowid, sequence ;
 create materialized view log on t2 with rowid, sequence

create materialized view mv
 refresh fast on commit enable query rewrite
 as select t.key t_key , t.val t_val , t2.key t2_key ,
  t2.amt t2_amt , t.rowid t_row_id , t2.rowid t2_row_id
  from t, t2
  where t.key = t2.t_key ;

create index mv_i1 on mv (t_row_id) ;

create index mv_i2 on mv (t2_row_id) ;

MV with aggregation

```
create materialized view log on t2 with rowid, sequence ( t_key, amt )
   including new values ;
create materialized view mv
  refresh fast on commit enable query rewrite
  as select t_key , sum(amt) as amt_sum , count(*) as row_count ,
       count(amt) as amt_count
  from t2 group by t_key ;
create index mv_i1 on mv ( t_key ) ;
```

MV with join and aggregation from Oracle DW docs

```
CREATE MATERIALIZED VIEW LOG ON products WITH SEQUENCE,
   ROWID (prod_id, prod_name,…) INCLUDING NEW VALUES;
CREATE MATERIALIZED VIEW LOG ON sales WITH SEQUENCE, ROWID
   (prod_id, cust_id, time_id, channel_id, promo_id, quantity_sold,
   amount_sold) INCLUDING NEW VALUES;
CREATE MATERIALIZED VIEW product_sales_mv BUILD IMMEDIATE
   REFRESH FAST ENABLE QUERY REWRITE
  AS SELECT p.prod_name, SUM(s.amount_sold) AS dollar_sales, COUNT(*)
   AS cnt, COUNT(s.amount_sold) AS cnt_amt
  FROM sales s, products p WHERE s.prod_id = p.prod_id
  GROUP BY p.prod_name;
```

DW Partitioning, Oracle case

- Clearly a win to partition fact table, big MVs by time intervals for roll-out, clustering effect
- Can sub-partition fact table by a dimension attribute, but need to modify queries to get QP to optimize
- Ex: partition by date intervals, product category
- Query: select p.subcategory, … from F where … (no mention of p.category)
- Modified query: select p.subcategory … where … AND category='Soft Drinks' --now QP uses partition pruning
- Data warehouse MVs are usually rolled-up, much smaller, don't need effective partitioning so much

Summary

- Put raw data in one fact table, partitioned for roll-out
- Create MVs with various roll-ups, for queries, also partitioned by time
- Add indexes to MVs
- Note MVs are much smaller than raw fact tables
- Every day (say) add data to raw fact table, refresh MVs

Oracle OLAP Cube

- Another way to hold data, optimized for cube queries
- Related to master tables: fact tables, dimensions
- Excel can get data with MDX
- Not itself a MV, but can be used like one
- i.e. SQL queries can be automatically rewritten to use the OLAP cube, run faster
- Other OLAP servers exist too

Working cheaply: what about mysql?

- If your data can be fit into memory, you don't need fancy software… so buy a terabyte of memory…no longer a crazy idea.
- Example: Dell's PowerEdge R940 can take up to 6TB memory, 4 CPU sockets for Xeon processors with up to 28 cores/CPU. Up to 122TB disk. Basic system (2 processors, 8GB memory) $5800.
- Configured one with 4 processors, 1TB of memory: $39, 748
- Have warehouse data in mysql on disk, comes into memory as accessed.
- Mysql has no MV's, but can compute a joined table periodically as needed for Excel
- Use Excel for UI