Explain Yourself and Improve DB2 Performance!

—

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Key Points

Understand new EXPLAIN capabilities, added in DB2 10 and 11, and how to exploit them.

Explore the ability to save access path history, and how to use it to analyze trends and to detect unwanted access path changes.

Understand the mechanism of SYSSTATEFEEDBACK and how it can be used to guide RUNSTATS executions.

Discuss selectivity profiles and how to use them to improve the operation of the DB2 optimizer.

SQL Tuning – like Whac-a-Mole?

There's always a new problem

As soon as you think you have them all fixed, a new one pops up

EXPLAIN Tables

PLAN_TABLE	DSN_FUNCTION_TABLE
DSN_STATEMNT_TABLE	DSN_STATEMENT_CACHE_TABLE
DSN_QUERYINFO_TABLE	DSN_PREDICAT_TABLE
DSN_STRUCT_TABLE	DSN_PGROUP_TABLE
DSN_PTASK_TABLE	DSN_FILTER_TABLE
DSN_DETCOST_TABLE	DSN_SORT_TABLE
DSN_SORTKEY_TABLE	DSN_PGRANGE_TABLE
DSN_VIEWREF_TABLE	DSN_QUERY_TABLE
DSN_VIRTUAL_INDEXES	DSN_COLDIST_TABLE
DSN_KEYTGTDIST_TABLE	DSN_VIRTUAL_KEYTARGETS
DSN_PREDICATE_SELECTIVITY	DSN_STAT_FEEDBACK

New EXPLAIN Features

Access path stability

- SYSPACKCOPY added in DB2 10
- APCOMPARE and APREUSE added in DB2 10
- APREUSE(WARN) added in DB2 11 – allows statement level control

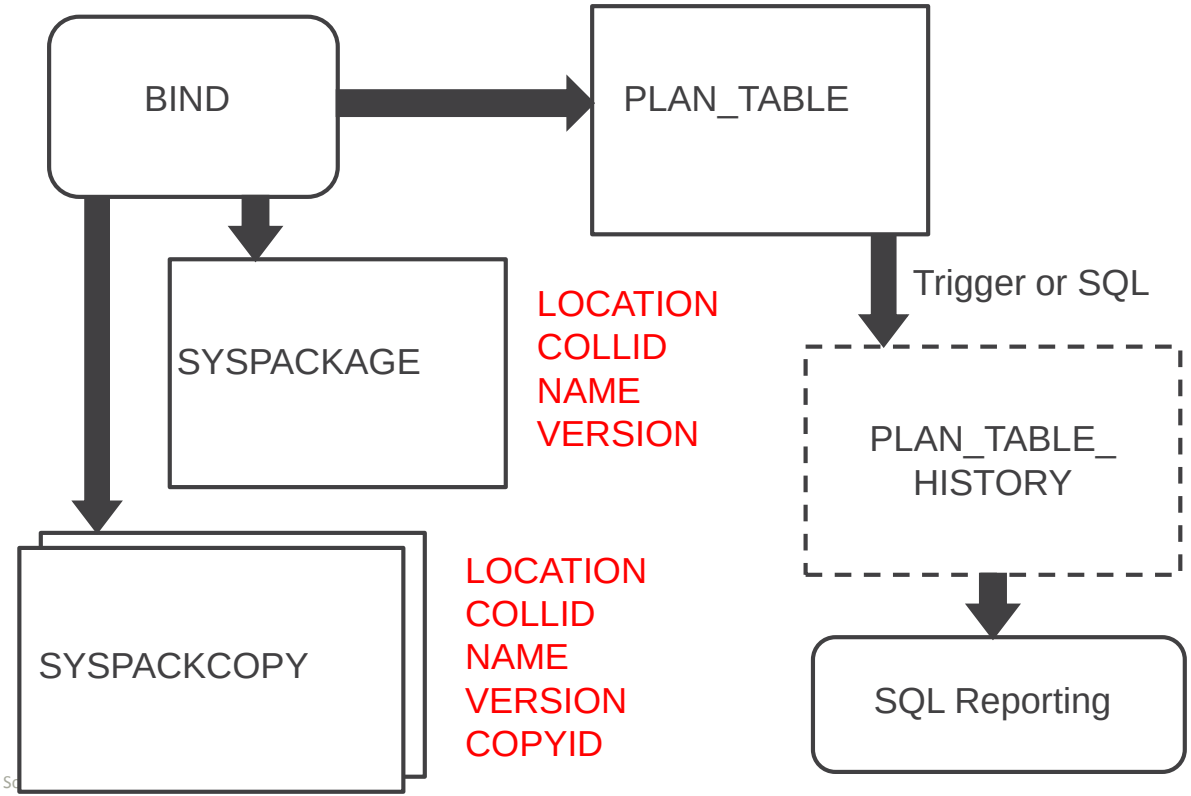
New columns were added to the DSN_VIRTUAL_INDEXES table, and a new DSN_VIRTUAL_KEYTARGETS table was added

- Support for Index on Expression, XML indexes, Index Include Column, and null suppressed indexes

EXPLAIN (ONLY)

EXPLAIN PACKAGE

EXPLAIN History



What Can I Get Out of My EXPLAIN Table?

```
SELECT SUBSTR(PL.COLLID,1,10) AS COLLID,
       SUBSTR(PL.PROGNAME,1,10) AS PROGNAME,
       DATE(PL.EXPLAIN_TIME) AS DATE,
       TIME(PL.EXPLAIN_TIME) AS TIME,
       COUNT(PL.QUERYNO) AS "STMT COUNT",
       DEC(SUM(ST.TOTAL_COST),8,2) AS "TOTAL COST"
       FROM SJD.PLAN_TABLE PL,
            SJD.DSN_STATEMNT_TABLE ST
       WHERE PL.PROGNAME = ST.PROGNAME
         AND PL.COLLID = ST.COLLID
         AND PL.EXPLAIN_TIME = ST.EXPLAIN_TIME
         AND PL.QUERYNO = ST.QUERYNO
       GROUP BY PL.COLLID, PL.PROGNAME, PL.EXPLAIN_TIME
       ORDER BY PL.PROGNAME;
```

Sample Results for a Very Simple Example

```
---------+---------+---------+---------+---------+---------+---------+
COLLID      PROGNAME    DATE        TIME        STMT COUNT  TOTAL COST
---------+---------+---------+---------+---------+---------+---------+
MYCOLL      MYPACK      05/08/2014  11.19.38            5       10.55
MYCOLL      MYPACK      05/08/2014  17.36.17            8       19.03
DSNE610I NUMBER OF ROWS DISPLAYED IS 2
```

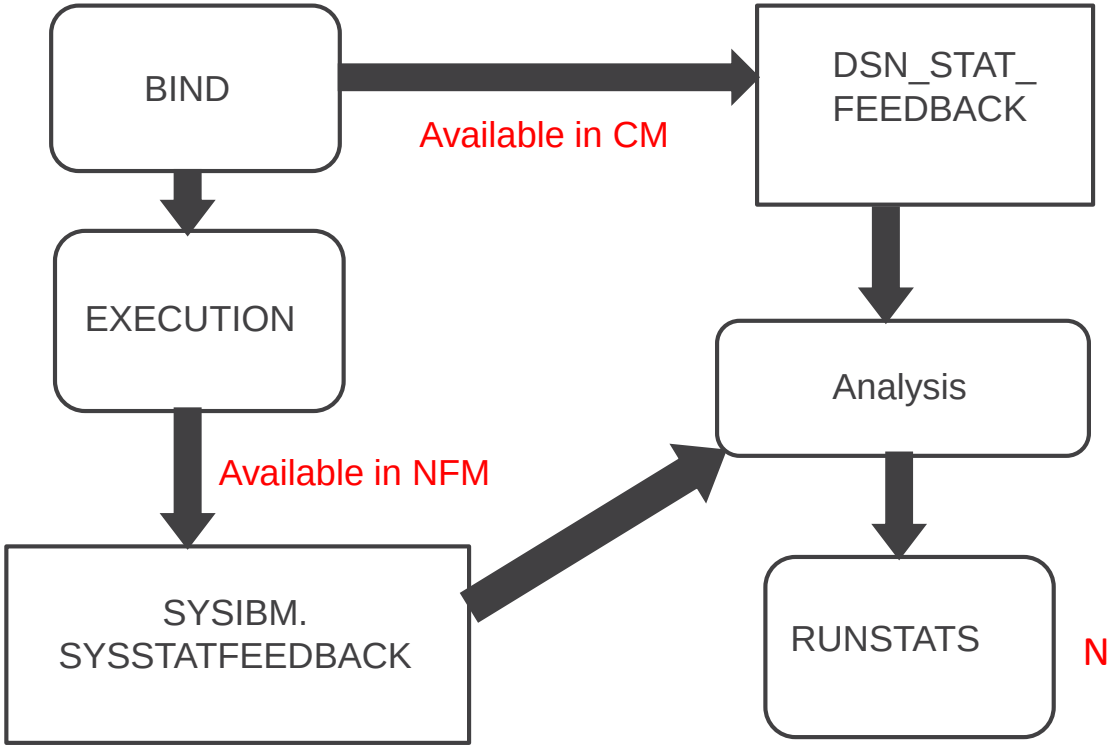
Can I Detect Changed Costs?

```
SELECT ST1.QUERYNO AS QUERYNO,
       COALESCE(DEC(ST1.TOTAL_COST,8,2),0) AS "OLD COST",
       COALESCE(DEC(ST2.TOTAL_COST,8,2),0) AS "NEW COST"
       FROM SJD.DSN_STATEMNT_TABLE ST1 FULL JOIN
            SJD.DSN_STATEMNT_TABLE ST2
       ON  ST1.QUERYNO = ST2.QUERYNO
       WHERE ST1.COLLID = 'MYCOLL' AND ST2.COLLID = 'MYCOLL'
         AND ST1.PROGNAME = 'MYPACK'
         AND ST2.PROGNAME = 'MYPACK'
         AND DATE(ST1.EXPLAIN_TIME) = '2014-05-08'
         AND TIME(ST1.EXPLAIN_TIME) = '17.36.17'
         AND DATE(ST2.EXPLAIN_TIME) = '2014-05-15'
         AND TIME(ST2.EXPLAIN_TIME) = '13.05.14'
         AND ST1.TOTAL_COST <> ST2.TOTAL_COST
       ORDER BY QUERYNO;
```

Can I Detect Changed Costs?

```
---------+---------+---------+---------+-----
    QUERYNO         OLD COST         NEW COST
---------+---------+---------+---------+-----
        353              .15             .11
        360             8.07           16.24
DSNE610I NUMBER OF ROWS DISPLAYED IS 2
```

Optimizer Help for RUNSTATS



Note: Use profiles!

The Stats Feedback Tables

DSN_STATS_FEEDBACK

- QUERYNO
- APPLNAME
- PROGNAME
- COLLID
- GROUP_MEMBER
- EXPLAIN_TIME
- SECTNOI
- VERSION
- Most of SYSSTATFEEDBACK Columns

SYSSTATFEEDBACK

- TBCREATOR
- TBNAME
- IXCREATOR
- IXNAME
- COLNAME
- NUMCOLUMNS
- COLGROUPCOLNO
- TYPE
- DBNAME
- TSNAME
- REASON
- BLOCK_RUNSTATS
- REMARKS
- LASTDATE

The Stats Feedback Columns Of Interest

COLNAME

- Name of the single column associated with the recommendation

NUMCOLUMNS

- Number of columns if the recommendation is for more than one column

COLGROUPCOLNO

- Binary field: array of halfwords which are COLNO references

TYPE

- CHAR(1), representing the type of statistic to collect
- ‘C’ (cardinality), ‘F’ (frequency), ‘H’ (histogram), ‘I’ (index), ‘T’ (table)

REASON

- CHAR(8), representing the reason for the recommendation
- ‘BASIC’, ‘KEYCARD’, ‘LOWCARD’, ‘NULLABLE, ‘DEFAULT, ‘RANGEPRD’, ‘PARALLEL’, ‘CONFLICT’, ‘COMPFFIX’

How To Get Stats Help

To see DSN_STAT_FEEDBACK results, you must create the table before running EXPLAIN

- Available in DB2 11 CM
- DSNSAMP(DSNTESC)

To see SYSSTATFEEDBACK, you must ensure that the STATSFDBK_SCOPE zparm is set to something other than NONE

- STATSINT zparm – REAL TIME STATS field on DSNTIPO (Operator Functions) – specifies time in minutes between externalizations
- ACCESS DB MODE(STATS) updates SYSSTATFEEDBACK from memory – externalizes RTS also

What If You Want to Try This Gradually?

You can use the STATSFDBK_SCOPE zparm to restrict stats feedback collection

- NONE, STATIC, DYNAMIC, or ALL (default)
- Specified in the STATISTICS FEEDBACK field in install panel DSNTIPO (Operator Functions)

You can use the STATS_FEEDBACK column in SYSTABLES to disable statistics feedback for the table

- Can set it to “N” or “Y”

You can set the BLOCK_RUNSTATS column to ‘Y’

- Process that generates RUNSTATS must honor this

Other Considerations For Stats Feedback

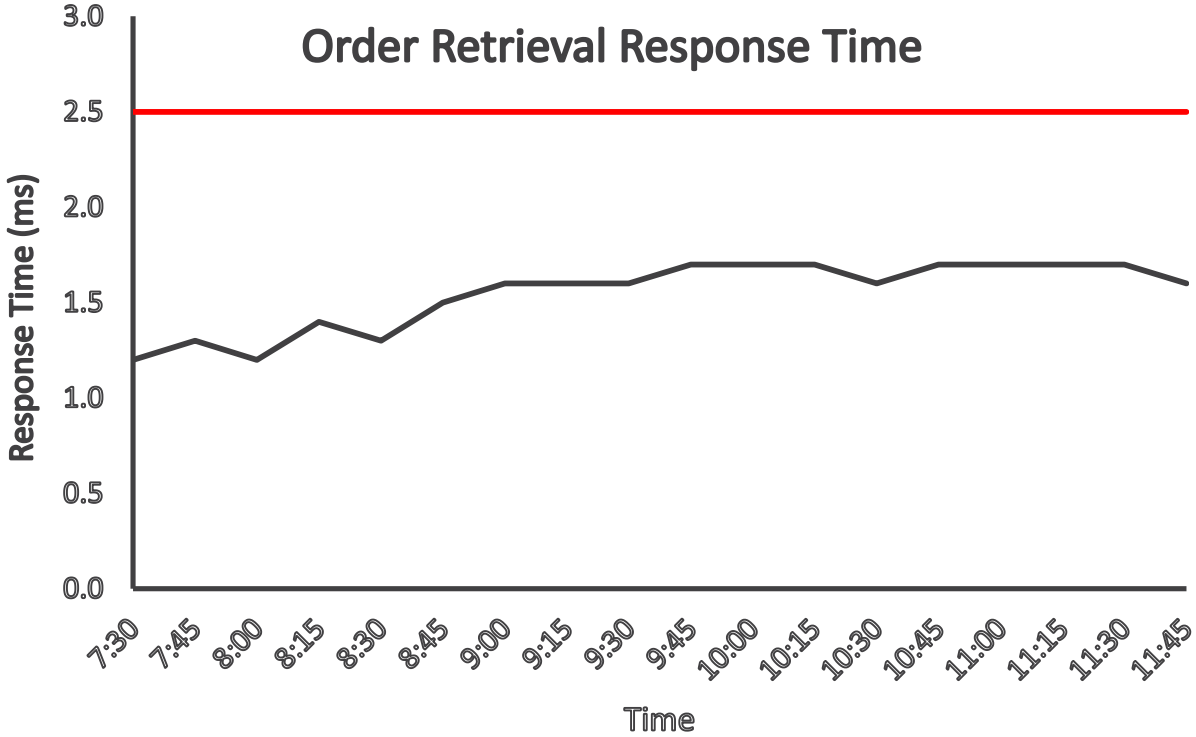
Stats Feedback doesn't work in certain cases:

- VOLATILE
- DGTT
- CGTT

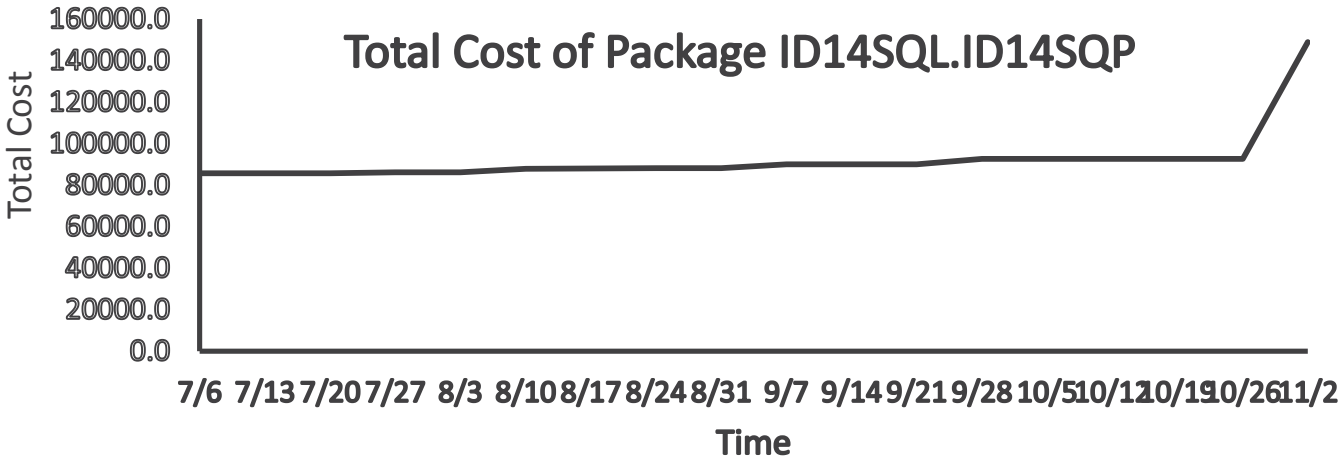
Use of Hints, APREUSE, APCOMPARE may interfere during EXPLAIN

Selectivity Profiles

Is There a Problem?



Maybe We Should Check Our EXPLAIN History



COLLID	PROGNAME	DATE	TIME	STMT COUNT	TOTAL COST
ID14SQL	ID14SQP	10/19/2014	05:58 PM	9	92741.17
ID14SQL	ID14SQP	10/26/2014	05:39 PM	9	92741.17
ID14SQL	ID14SQP	11/02/2014	06:03 PM	10	148921.15

What SQL Is It?

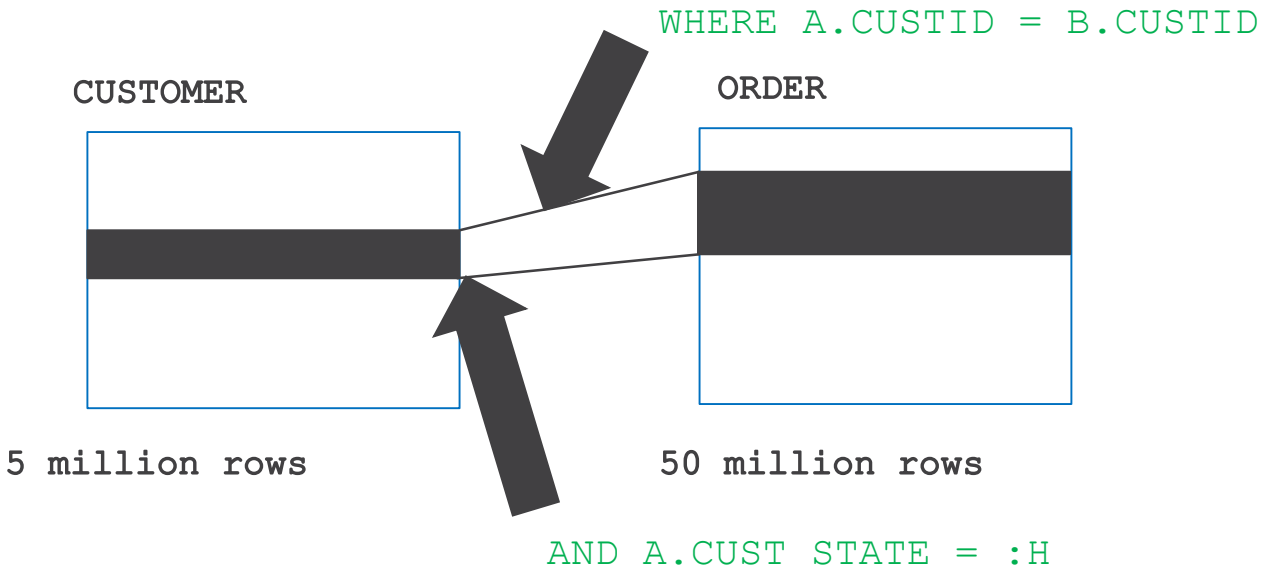
```
 SELECT QUERYNO, TOTAL_COST, EXPLAIN_TIME
          FROM SJD.DSN_STATEMNT_TABLE
          WHERE PROGNAME = 'ID14SQP'
            AND COLLID = 'ID14SQL'
          ORDER BY TOTAL_COST DESC, EXPLAIN_TIME DESC;
-----+---------+---------+---------+---------+---------+----
QUERYNO               TOTAL_COST  EXPLAIN_TIME
-----+---------+---------+---------+---------+---------+----
     88  +0.5616997729372477E+05  2014-11-02-18.03.04.993751
    131  +0.1453335050780900E+01  2014-11-02-18.03.04.993751
    131  +0.1453335050780900E+01  2014-10-27-16.55.51.641367
```

What SQL Is It?

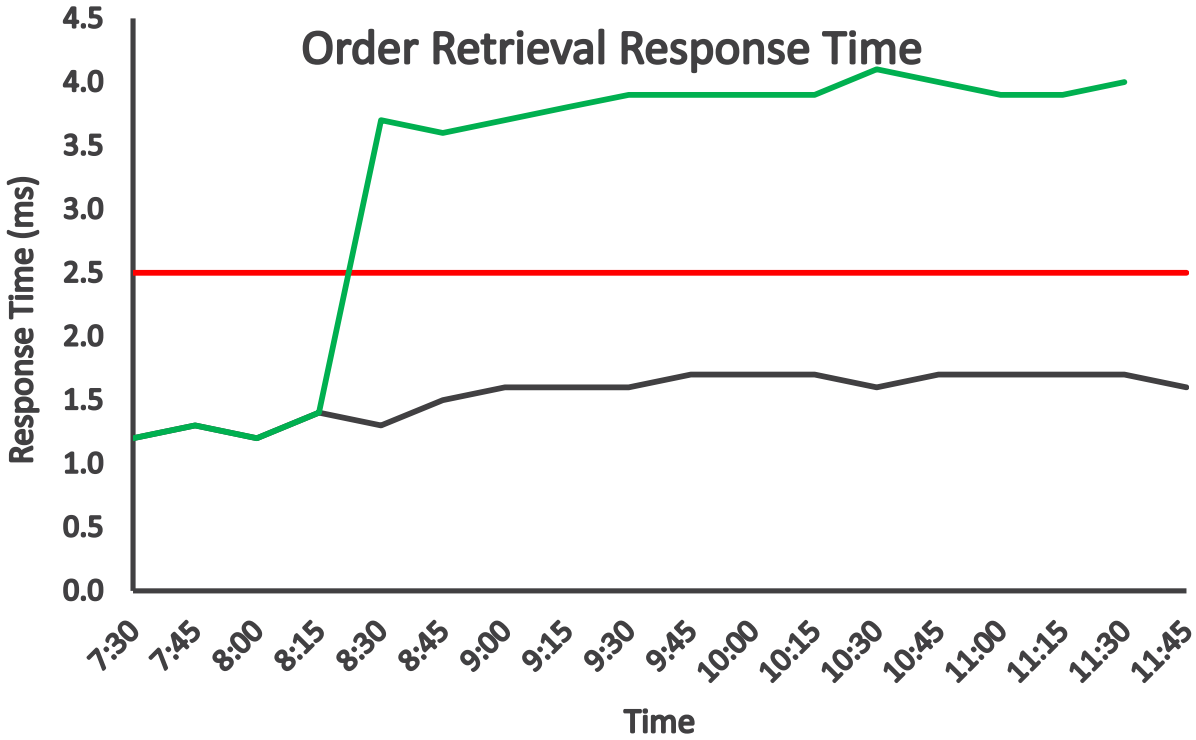
```
 SELECT STATEMENT
            FROM SYSIBM.SYSPACKSTMT
            WHERE COLLID = 'ID14SQL' AND NAME = 'ID14SQP'
            AND QUERYNO = 88;
---------+---------+---------+---------+---------+---------+-----
STATEMENT
---------+---------+---------+---------+---------+---------+-----
DECLARE TOPTEN CURSOR FOR SELECT LASTNM , ADDRS , ID , ORDCOUNT ,
```

```
SELECT LASTNM, ADDRS, ID, ORDCOUNT, GTOTAL
   FROM ( SELECT LASTNM, ADDRS, ID, COUNT(ORDNO) AS ORDCOUNT, SUM(TOTAL) AS GTOTAL
      FROM ( SELECT A.CUST_LASTNM AS LASTNM, A.CUST_ADDRESS AS ADDRS,
                    A.CUSTID AS ID, B.ORDNO AS ORDNO,B.ORDER_TOTAL AS TOTAL
             FROM SJDID001.CUSTOMER A, SJDID001.ORDER B
             WHERE A.CUSTID = B.CUSTID AND A.CUST_STATE = :H ) X
          GROUP BY LASTNM, ADDRS, ID ) Y
WHERE ORDCOUNT > :H AND GTOTAL > :H
ORDER BY GTOTAL DESC, ORDCOUNT DESC FOR FETCH ONLY OPTIMIZE FOR 10 ROWS
```

What is the SQL Doing?



Is There a Problem?



A Little More Research…

From PLAN_TABLE:

```
PLANNO  METHOD  ACCESSTYPE  MATCHCOLS  PREFETCH  CREATOR   TNAME      TABNO
--------+--------+---------+---------+---------+---------+---------+-----
     1       0  I                   1  L         SJDID001  CUSTOMER       1
     2       4  I                   1  L         SJDID001  ORDER          2
     3       3                      0                                    0
     4       3                      0                                    0
DSNE610I NUMBER OF ROWS DISPLAYED IS 4
```

From DSN_PREDICAT_TABLE:

```
PREDNO  TYPE                FILTER_FACTOR  LHS           TEXT
----+---------+---------+---------+---------+---------+---------+---------+
     1  AND       +0.10000000000000000E+01                ("A"."CUSTID"="B".
     2  EQUAL     +0.99999942904105410E-06  CUSTID        "A"."CUSTID"="B"."
     3  EQUAL     +0.19230769062381010E-01  CUST_STATE    "A"."CUST_STATE"
     4  AND       +0.10000000000000000E+01                (COUNT("B"."ORDNO"
     5  RANGE     +0.33333331346511840E+00  VALUE         COUNT("B"."ORDNO")
     6  RANGE     +0.33333331346511840E+00  VALUE         SUM("B"."ORDER_TOT
     7  COMPOUND  +0.99999942904105410E-06                COMPOUND: 2,3
```

A Little More Research…

```
 SELECT SUBSTR(KY.COLNAME,1,18) AS COL, KY.COLSEQ,
          CO.COLTYPE, CO.LENGTH
          FROM SYSIBM.SYSINDEXES IX, SYSIBM.SYSKEYS KY,
               SYSIBM.SYSCOLUMNS CO
          WHERE IX.TBCREATOR = 'SJDID001' AND IX.TBNAME = 'CUSTOMER'
            AND IX.NAME = 'CUSTADDR' AND IX.CREATOR = 'SJDID001'
            AND IX.NAME = KY.IXNAME  AND IX.CREATOR = KY.IXCREATOR
            AND IX.TBNAME = CO.TBNAME AND IX.TBCREATOR = CO.TBCREATOR
            AND KY.COLNO = CO.COLNO
          ORDER BY KY.COLSEQ;
---------+---------+---------+---------+---------+---------+---------+
COL                 COLSEQ  COLTYPE   LENGTH
---------+---------+---------+---------+---------+---------+---------+
CUST_STATE               1  CHAR           2
CUST_ADDRESS             2  VARCHAR      120
DSNE610I NUMBER OF ROWS DISPLAYED
```

A Little More Research…

```
 SELECT STATSTIME, INT(FIRSTKEYCARDF) AS FIRSTKEYCARD,
           INT(FULLKEYCARDF) AS FULLKEYCARD, DEC(CLUSTERRATIOF, 3, 1) AS CLUSTERRATIO
       FROM SYSIBM.SYSINDEXES WHERE CREATOR = 'SJDID001' AND NAME = 'CUSTADDR';
---------+---------+---------+---------+---------+---------+--------
STATSTIME                   FIRSTKEYCARD   FULLKEYCARD  CLUSTERRATIO
---------+---------+---------+---------+---------+---------+--------
2014-09-16-08.32.13.545461            52      4975000            .3
DSNE610I NUMBER OF ROWS DISPLAYED IS 1

SELECT COUNT(*) FROM SJDID001.CUSTOMER WHERE CUST_STATE = 'NY';
-------+---------+---------+---------+----
       4000000
SELECT COUNT(*) FROM SJDID001.CUSTOMER WHERE CUST_STATE = 'CA';
-------+---------+---------+---------+----
        950000
SELECT COUNT(*) FROM SJDID001.CUSTOMER WHERE CUST_STATE = 'OH';
-------+---------+---------+---------+----
           500
```

How Do You Correct This?

Three EXPLAIN tables involved

- PLAN_TABLE, DSN_PREDICAT_TABLE and DSN_PREDICATE_SELECTIVITY
- You should create these with a new schema, to separate them functionally
- DO NOT use “CREATE TABLE …LIKE…”… bad things happen
  - Use the DDL from DSNSAMP(DSNTESC)
  - Same warning applies to DSN_USERQUERY_TABLE

You can update DSN_PREDICATE_SELECTIVITY with the critical filter factor data

- A row for “CUST_STATE = ‘NY’, with WEIGHT = .5, SELECTIVITY = .80
- A row for “CUST_STATE = ‘CA’, with WEIGHT = .1, SELECTIVITY = .19

ASSUMPTION must be set to ‘OVERRIDE’ for these rows

The optimizer will assume default filtering for all other predicates

What's in DSN_PREDICATE_SELECTIVITY now?

```
SELECT PREDNO, INSTANCE, SELECTIVITY, WEIGHT,
       SUBSTR(ASSUMPTION,1,8) AS ASSUM
       FROM SJD.DSN_PREDICATE_SELECTIVITY
       WHERE PROGNAME = 'ID14SQP'
         AND COLLID = 'ID14SQL'
         AND EXPLAIN_TIME = '2014-11-02-18.03.04.993751'
         AND QUERYNO = 88
       ORDER BY PREDNO;
```

PREDNO	INSTANCE	SELECTIVITY	WEIGHT	ASSUM
1	0	+0.1000000000000000E+01	+0.100000000E+01	NORMAL
2	0	+0.9999994290410541E-06	+0.100000000E+01	NORMAL
3	0	+0.1923076906238101E-01	+0.100000000E+01	NORMAL
4	0	+0.1000000000000000E+01	+0.100000000E+01	NORMAL
5	0	+0.3333333134651184E+00	+0.100000000E+01	NORMAL
6	0	+0.3333333134651184E+00	+0.100000000E+01	NORMAL
7	0	+0.9999994290410541E-06	+0.100000000E+01	NORMAL

How do we update DSN_PREDICATE_SELECTIVITY?

```
INSERT INTO SJDUPD.DSN_PREDICATE_SELECTIVITY
       SELECT * FROM SJD.DSN_PREDICATE_SELECTIVITY
          WHERE COLLID = 'ID14SQL' AND PROGNAME = 'ID14SQP'
            AND EXPLAIN_TIME = '2014-11-02-18.03.04.993751'
            AND QUERYNO = 88;
UPDATE SJDUPD.DSN_PREDICATE_SELECTIVITY
       SET INSTANCE = 1, SELECTIVITY = .8, WEIGHT = .5,
           ASSUMPTION = 'OVERRIDE'
          WHERE COLLID = 'ID14SQL' AND PROGNAME = 'ID14SQP'
            AND EXPLAIN_TIME = '2014-11-02-18.03.04.993751'
            AND QUERYNO = 88 AND PREDNO = 3 AND INSTANCE = 0;
INSERT INTO SJDUPD.DSN_PREDICATE_SELECTIVITY
       (QUERYNO, QBLOCKNO, APPLNAME, PROGNAME, SECTNOI, COLLID,VERSION, PREDNO,
        INSTANCE, SELECTIVITY, WEIGHT, ASSUMPTION, INSERT_TIME, EXPLAIN_TIME,
        REMARKS, EXPANSION_REASON)
       SELECT (QUERYNO, QBLOCKNO, APPLNAME, PROGNAME, SECTNOI, COLLID,VERSION, PREDNO,
        2, .19, .1, ASSUMPTION, INSERT_TIME, EXPLAIN_TIME, REMARKS, EXPANSION_REASON)
           FROM SJDUPD.DSN_PREDICATE_SELECTIVITY
           WHERE COLLID = 'ID14SQL' AND PROGNAME = 'ID14SQP'
             AND EXPLAIN_TIME = '2014-11-02-18.03.04.993751'
             AND QUERYNO = 88 AND PREDNO = 3 AND INSTANCE = 1;
```

Final Step (Almost)

Now, you must insert a row into the DSN_USERQUERY_TABLE table, as for a hint (SQL is on the next slide but one)

- This is not created with the EXPLAIN tables…DSNSAMP(DSNTESH)

Copy QUERY_TEXT from SYSPACKSTMT

Set HINT_SCOPE to 1 (package level hint)

Set SELECTVTY_OVERRIDE to ‘Y’

Final Step (Almost)

Set ACCESSPATH_HINT to ‘N’ (this is not a hint)

Set OPTION_OVERRIDE to ‘N’ (assuming you don’t want to override a BIND option)

BIND QUERY LOOKUP(NO) EXPLAININPUTSCHEMA('SJDUPD')

- Populates the appropriate catalog tables

BIND for your package will now consider the new filter factors

- IF zparm OPTHINTS is YES

INSERT Into DSN_USERQUERY_TABLE

```
INSERT INTO SJD.DSN_USERQUERY_TABLE
       (QUERYNO, SCHEMA, HINT_SCOPE, QUERY_TEXT,
        COLLECTION, PACKAGE,
        SELECTVTY_OVERRIDE, ACCESSPATH_HINT, OPTION_OVERRIDE)
    SELECT QUERYNO, 'SJD', 1, STATEMENT,
           COLLID, NAME, 'Y', 'N', 'N'
        FROM SYSIBM.SYSPACKSTMT
        WHERE COLLID = 'ID14SQL' AND NAME = 'ID14SQP'
          AND QUERYNO = 88;

READY
  DSN SYSTEM(DJO1)
DSN
      BIND QUERY LOOKUP(NO)
DSNT280I  *DJO1 BIND QUERY FOR QUERYNO = 88 SUCCESSFUL
DSNT290I  *DJO1 BIND QUERY COMMAND COMPLETED
DSN
  END
READY
END
```

BIND QUERY Again

```
READY
  DSN SYSTEM(DJO1)
DSN
      BIND QUERY LOOKUP(YES)
DSNT280I  *DJO1 LOOKUP QUERY FOR QUERYNO = 88 SUCCESSFUL
DSNT290I  *DJO1 LOOKUP QUERY COMMAND COMPLETED
DSN
  END
READY
END
```

This proves that the catalog tables were updated successfully. The other tables updated are SYSIBM.SYSQUERYPREDICATE and SYSIBM.SYSQUERYSEL.

```
SELECT QUERYID, SUBSTR(SCHEMA,1,8) AS SCHEMA, USERFILTER,
       SUBSTR(OTHER_OPTION,1,16) AS OTHER_OPTION,PLAN_VALID, INVALID_REASON,
       SUBSTR(STMTTEXT,1,20) AS STMTTEXT
     FROM SYSIBM.SYSQUERY
     WHERE COLLECTION = 'ID14SQL' AND PACKAGE = 'ID14SQP';
+-------------------------------------------------------------------
|         QUERYID         |  SCHEMA  | USERFILTER |   OTHER_OPTION
+-------------------------------------------------------------------
|                       1 | SJD      |            |
```

And, Finally, We BIND Again…

```
READY
    DSN SYSTEM(DJO1)
DSN
     BIND PACKAGE   (ID14SQL) MEMBER(ID14SQP)              OWNER     (SJD)
                           ISOLATION (CS) CURRENTDATA(NO)
DSNT297I  *DJO1 DSNTBBP2 BIND WARNING FOR
           PACKAGE = DJO.ID14SQL.ID14SQP,
           USE OF SELECTIVITY OVERRIDES RESULTS IN:
           1 STATEMENTS WHERE SELECTIVITY OVERRIDES ARE FULLY
             APPLIED,
           0 STATEMENTS WHERE SELECTIVITY OVERRIDES ARE INVALID,
           3 STATEMENTS WHERE SELECTIVITY OVERRIDES ARE NOT FOUND.
DSNT254I  *DJO1 DSNTBCM2 BIND OPTIONS FOR

-------------------------------------------------------------------------
|  PLANNO   |  METHOD   |   TABNO   | ACCESSTYPE | MATCHCOLS | PREFETCH |
-------------------------------------------------------------------------
|         1 |         0 |         1 | I          |         0 | S        |
|         2 |         2 |         2 | R          |         0 | S        |
|         3 |         3 |         0 |            |         0 |          |
-------------------------------------------------------------------------
```

What Changed?

```
SELECT QUERYNO,
       COALESCE(DEC(TOTAL_COST,8,0),0) AS "COST",
       EXPLAIN_TIME
             FROM SJD.DSN_STATEMNT_TABLE
       WHERE COLLID = 'ID14SQL'
         AND PROGNAME = 'ID14SQP'
       ORDER BY EXPLAIN_TIME DESC;

---------+---------+---------+---------+---------+
QUERYNO      COST     EXPLAIN_TIME
---------+---------+---------+---------+---------+
  88        434758     2014-11-02-18.03.04.993751
  88         23184     2014-10-27-16.55.51.641367
DSNE610I NUMBER OF ROWS DISPLAYED IS 2
```

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Thank You

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Stop Wasting Time With Utilities