SQL Update for Db2

(Db2 11 and Db2 12)

David Simpson

Themis Training

dsimpson@themisinc.com

www.themisinc.com

Themis

Leaders in IT Education

David Simpson

David Simpson is currently the Vice President of Themis Inc. He teaches courses on SQL, Application Programming, Database Administration as well as optimization, performance and tuning. He also installs and maintains the database systems used for training at Themis and works with our network of instructors to deliver high quality training solutions to our customers worldwide.

Since 1993 David has worked as a developer and DBA in support of very large transactional and business intelligence systems. David is a certified DB2 DBA on both z/OS and LUW. David was voted Best User Speaker and Best Overall Speaker at IDUG North America 2006. He was also voted Best User Speaker at IDUG Europe 2006 and is a member of the IDUG Speakers Hall of Fame. David is also an IBM Gold Consultant.

dsimpson@themisinc.com
www.themisinc.com
@ThemisDave
@ThemisTraining

Find my work:
www.themisinc.com/webinars
www.idug.org/content

Themis
Leaders in IT Education

Objectives

- **Learn the new SQL Features in Db2 11 and Db2 12 for z/OS**
- **Most of this stuff works on Db2 LUW as well**

Themis
Leaders in IT Education

The GROUP BY Clause

```
SELECT    DEPTNO, SUM(SALARY) AS PAYROLL
FROM      EMP
WHERE     DEPTNO LIKE 'D%'
GROUP BY  DEPTNO
```

DEPTNO	SALARY
D11	32250.00
D11	25280.00
D11	22250.00
D11	24680.00
D11	21340.00
D11	20450.00
D11	27740.00
D11	18270.00
D11	29840.00
D21	22180.00
D21	28760.00
D21	19180.00
D21	17250.00
D21	27380.00
D21	36170.00

222100.00

150920.00

DEPTNO	PAYROLL
D11	222100.00
D21	150920.00

Themis
Leaders in IT Education

GROUPing by Multiple Columns

```
SELECT    DEPTNO, JOB, AVG(SALARY) AS AVG
FROM      EMP
WHERE     DEPTNO < 'B99'
GROUP BY  DEPTNO, JOB
```

DEPTNO	JOB	AVG
A00	CLERK	29250.00
A00	PRES	52750.00
A00	SALESREP	46500.00
B01	MANAGER	41250.00

Themis
Leaders in IT Education

GROUPING SETS

```
SELECT      DEPTNO, JOB, AVG(SALARY) AS AVG
FROM        EMP
WHERE       DEPTNO < 'B99'
GROUP BY    GROUPING SETS
            ( (DEPTNO, JOB) )
```

DEPTNO	JOB	AVG
A00	CLERK	29250.00
A00	PRES	52750.00
A00	SALESREP	46500.00
B01	MANAGER	41250.00

Themis
Leaders in IT Education

GROUPING SETS With 2 Groups

```
SELECT      DEPTNO, JOB, AVG(SALARY) AS AVG
FROM        EMP
WHERE       DEPTNO < 'B99'
GROUP BY    GROUPING SETS
            ( (DEPTNO, JOB) , (DEPTNO) )
```

DEPTNO	JOB	AVG
A00	CLERK	29250.00
A00	PRES	52750.00
A00	SALESREP	46500.00
A00		45312.50
B01	MANAGER	41250.00
B01		41250.00

Themis
Leaders in IT Education

GROUPING SETS With 3 Groups

```
SELECT      DEPTNO, JOB, AVG(SALARY) AS AVG
FROM        EMP
WHERE       DEPTNO < 'B99'
GROUP BY    GROUPING SETS
            ( (DEPTNO, JOB) , (DEPTNO), ( ) )
```

DEPTNO	JOB	AVG
A00	CLERK	29250.00
A00	PRES	52750.00
A00	SALESREP	46500.00
A00		45312.50
B01	MANAGER	41250.00
B01		41250.00
		44500.00

Themis
Leaders in IT Education

ROLLUP

```
SELECT    DEPTNO, JOB, AVG(SALARY) AS AVG
FROM      EMP
WHERE     DEPTNO < 'B99'
GROUP BY  ROLLUP  (DEPTNO, JOB)
```

DEPTNO	JOB	AVG
A00	CLERK	29250.00
A00	PRES	52750.00
A00	SALESREP	46500.00
A00		45312.50
B01	MANAGER	41250.00
B01		41250.00
		44500.00

Themis
Leaders in IT Education

ROLLUP With 2 Columns

```
GROUP BY   ROLLUP  (DEPTNO, JOB)
```

=

```
GROUP BY   GROUPING SETS  (
                          (DEPTNO, JOB),
                          (DEPTNO),
                          ( )
                          )
```

Themis
Leaders in IT Education

ROLLUP With 3 Columns

```
GROUP BY   ROLLUP  (DEPTNO, JOB, EDLEVEL)
```

=

```
GROUP BY   GROUPING SETS  (
                          (DEPTNO, JOB, EDLEVEL),
                          (DEPTNO, JOB),
                          (DEPTNO)
                          ( )
                          )
```

Themis
Leaders in IT Education

CUBE

```
SELECT    DEPTNO, JOB, AVG(SALARY) AS AVG
FROM      EMP
WHERE     DEPTNO < 'B99'
GROUP BY  CUBE  (DEPTNO, JOB)
```

DEPTNO	JOB	AVG
A00	CLERK	29250.00
A00	PRES	52750.00
A00	SALESREP	46500.00
A00		45312.50
B01	MANAGER	41250.00
B01		41250.00
	CLERK	29250.00
	PRES	52750.00
	SALESREP	46500.00
	MANAGER	41250.00
		44500.00

Themis
Leaders in IT Education

CUBE With 2 Columns

```
GROUP BY   CUBE (DEPTNO, JOB)
```

=

```
GROUP BY   GROUPING SETS  (
                          (DEPTNO, JOB),
                          (DEPTNO),
                          (JOB),
                          ( )
                          )
```

Themis
Leaders in IT Education

CUBE With 3 Columns

```
GROUP BY   CUBE (DEPTNO, JOB, EDLEVEL)
```

=

```
GROUP BY GROUPING SETS (  (DEPTNO, JOB, EDLEVEL),
                          (DEPTNO, JOB),
                          (DEPTNO, EDLEVEL),
                          (JOB, EDLEVEL),
                          (DEPTNO),
                          (JOB),
                          (EDLEVEL),
                          ( )       )
```

Themis
Leaders in IT Education

The LISTAGG Function

- **Used to create a delimited list out of several rows**
- **An “Aggregate” Function normally requiring a GROUP BY**
- **Function level V12R1M501**

Themis
Leaders in IT Education

LISTAGG Sample

The EMPPROJACT Sample Table:

EMPNO	PROJNO	ACTNO	EMPTIME	EMSTDATE	EMENDATE
000003	AS0067	1	4.70	1991-08-24	1992-03-02
000010	AD3100	1	6.80	1982-01-01	1983-01-28
000010	AD3100	10	0.50	1982-01-01	1982-07-01
000010	MA2110	10	1.00	1982-01-01	1983-02-01
000010	MA2100	10	0.50	1982-01-01	1982-11-01
000010	MA2100	1	8.80	1982-01-01	1983-01-31
000020	PL2100	30	1.00	1982-01-01	1982-09-15
000020	PL2100	1	2.40	1982-01-01	1982-09-07
000021	LO7064	1	1.50	1985-04-06	1987-08-03

Themis
Leaders in IT Education

LISTAGG Sample

```
SELECT EMPNO,
     LISTAGG(DISTINCT PROJNO, ',')
          WITHIN GROUP(ORDER BY PROJNO) AS PROJECTS
   FROM EMPPROJACT
   WHERE EMPNO < '000030'
  GROUP BY EMPNO
```

EMPNO	PROJECTS
000003	AS0067
000010	AD3100,MA2100,MA2110
000020	PL2100
000021	LO7064

Themis
Leaders in IT Education

Merge Enhancements

- Source data can be a table-reference
- Multiple [NOT]MATCHED clauses allowed
- [NOT]MATCHED additional predicates allowed
- DELETE operation allowed
- IGNORE and SIGNAL allowed

Themis
Leaders in IT Education

MERGE Example

```
MERGE INTO DEPT D
 USING (SELECT OPCD, DEPTNO, DEPTNAME, EMPNO, ADMRDEPT,
    LOCATION
  FROM UDEPT) U
 ON D.DEPTNO = U.DEPTNO
WHEN MATCHED AND OPCD = 'D' THEN  DELETE
WHEN MATCHED AND OPCD = 'U' THEN  UPDATE SET
  (D.DEPTNAME,D.EMPNO,D.ADMRDEPT) =
    (U.DEPTNAME,U.EMPNO,U.ADMRDEPT)
WHEN NOT MATCHED AND OPCD = 'I' THEN
  INSERT (D.DEPTNO, D.DEPTNAME, D.EMPNO, D.ADMRDEPT,
    D.LOCATION)
  VALUES (U.DEPTNO, U.DEPTNAME, U.EMPNO, U.ADMRDEPT,NULL)
 WHEN NOT MATCHED AND OPCD <> 'I' THEN
   SIGNAL SQLSTATE '70002'
     SET MESSAGE_TEXT = (U.DEPTNO || ' DEPTNO NOT FOUND')
ELSE IGNORE;
```

Themis
Leaders in IT Education

Piece-wise DELETION

- Fetch-clause added to syntax
  DELETE FROM *table-name*
  WHERE *search-condition*
  FETCH FIRST *fetch-row-count* ROWS ONLY
- Example

```
DELETE FROM EMPPROJACT
 WHERE ACSTDATE BETWEEN
    '1982-01-01' AND '1982-12-31'
 FETCH FIRST 10 ROWS ONLY
 ;
```

Themis
Leaders in IT Education

SQL Pagination

- OFFSET from beginning
  SELECT * FROM EMP
  OFFSET 10 ROWS
  FETCH FIRST 10 ROWS ONLY;
- Row-value expression with <, <=, >, or >= operators
  WHERE **(LASTNAME, FIRSTNAME) > ('SMITH', 'JOHN')**

Themis
Leaders in IT Education

Numerical Pagination

```
SELECT * FROM EMP OFFSET 0 ROWS
   FETCH FIRST 10 ROWS ONLY;
SELECT * FROM EMP OFFSET 10 ROWS
   FETCH NEXT 10 ROWS ONLY;
SELECT * FROM EMP OFFSET 20 ROWS
   FETCH NEXT 10 ROWS ONLY;
SELECT * FROM EMP OFFSET :hv ROWS
   FETCH NEXT :hv ROWS ONLY;
```

Themis
Leaders in IT Education

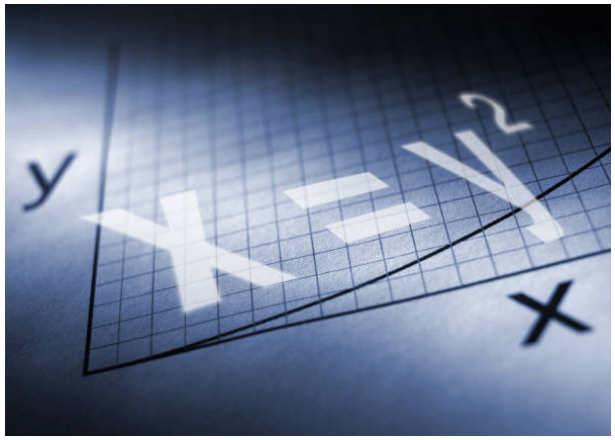
Temporal Table Changes

- Enhanced application Periods
- Referential constraints for temporal tables
- Temporal logical transactions
- Auditing capabilities

Themis
Leaders in IT Education

Global Variables

- Named memory variables in DB2 that may be accessed and modified by SQL statements
- Enable sharing of data between different SQL statements without an application facilitating the data transfer
- Values are unique to an application scope



Themis
Leaders in IT Education

Global Variable Creation

Choose a naming convention that identifies this as a global variable

```
CREATE VARIABLE    GV_TSP      TIMESTAMP
   DEFAULT CURRENT TIMESTAMP;

GRANT ALL PRIVILEGES ON VARIABLE GV_TSP TO
   PUBLIC;
```

Themis
Leaders in IT Education

Global Variable Usage

```
EXEC SQL
    SET GV_TSP = '2014-12-31.00.00.00.000000'
END-EXEC.
…
EXEC SQL
    DECLARE C1 CURSOR FOR
    SELECT CUSTNO      FROM CUSTOMER
      WHERE LAST_CALL < GV_TSP
END-EXEC.
…
EXEC SQL
    DECLARE C2 CURSOR FOR
    SELECT ORDERNO      FROM ORDER
       WHERE  ORDER_TSP < GV_TSP
END-EXEC.
```

Themis
Leaders in IT Education

What is an Array ?

- **An array is a user-defined data type that consists of an ordered set of elements of a single built-in data type.**
- **Array entries (elements) can be accessed and modified by their index position. Going beyond the max entry gets an SQLCODE=-20439 'An array index with value xx is null, out of range or does not exist'**
- **Must first create an array datatype and then use it to define a stored procedure parameter, SQL-PL declared variable, or global variable (V12).**

Themis
Leaders in IT Education

Why Arrays ?

- **Processing, passing, holding lists of data can often times be bulky and inefficient.**
- **Replaces the use of tables (either permanent or GTT)**
- **Replaces the use of a string list variable, and then having to unstring/decode through the list.**
- **Replaces a long list of input/output parameters**
- **The fact that arrays are quite common in most programming languages.**
- **Test have shown a performance improvement over GTTs, Long Varchars, and returned results sets**

Themis
Leaders in IT Education

SQL-PL Array Rules

- **Arrays in SQL-PL are allocated and de-allocated dynamically. Memory allocation is based on the cardinality (# entries loaded into the array), and not on the possible maximum.**
- **All elements of array must have same data type**
- **An array can contain a set of values, can contain no values (as in null values), or the column with array data type can be null**
- **Individual elements can contain a value or be null**
- **The cardinality of the array is equal to the number of elements in the array, not the max number that it can hold**

Themis
Leaders in IT Education

SQL-PL Array Rules

- **Can Java handle SQL-PL Arrays? Yes via the IBM Data Server Driver for JDBC and SQLJ type 4 driver). Some code later. This was a big request from the JAVA development community.**

- **Can COBOL handle SQL-PL arrays? Not directly.**

- **Two types of arrays: Ordinary: where items are addressed by their ordinal position within the array). Associative: where items are ordered by a defined array index value.**

Themis
Leaders in IT Education

SQL-PL Array Definition

- **Arrays are created using the CREATE TYPE command (UDT):**

  CREATE TYPE name AS data_type ARRAY[size]

- **Includes the name of the array, data_type ARRAY, and the number of occurrences.**

- **The number of occurrences can be fixed or open ended:**

  CREATE TYPE DEPT_ARRAY AS CHAR(3) ARRAY[5] ;
  CREATE TYPE DEPT_ARRAY AS CHAR(3) ARRAY[] ;

Themis
Leaders in IT Education

Where to use Arrays

- **SQL PL Parameters (if the calling program can deal)**
- **SQL PL Variables**
- **Global Variables (Db2 12 for z/OS)**

Themis
Leaders in IT Education

Global Variable Array Examples

```
****************************** Top of Data ***********************
      CREATE TYPE VARCHAR_ARRAY AS VARCHAR(100)
         CCSID UNICODE ARRAY[];   --MUST BE UNICODE

      CREATE VARIABLE GV_ARRAY_TEST VARCHAR_ARRAY ;

      CREATE TYPE VARCHAR_ARRAY2 AS VARCHAR(100)
         CCSID UNICODE ARRAY[VARCHAR(20)];   --MUST BE UNICODE

      CREATE VARIABLE GV_ARRAY_TEST2 VARCHAR_ARRAY2 ;
****************************** Bottom of Data ********************
```

Themis
Leaders in IT Education

Global Variable Array Example 1

```
--------+---------+---------+---------+---------+---------
  SET GV_ARRAY_TEST[1]  = 'John' ;
--------+---------+---------+---------+---------+---------
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
--------+---------+---------+---------+---------+---------
  SET ODYDS.GV_ARRAY_TEST[2]  = 'Jake';
--------+---------+---------+---------+---------+---------
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
--------+---------+---------+---------+---------+---------
  SET ODYDS.GV_ARRAY_TEST[3]  = 'Riley';
--------+---------+---------+---------+---------+---------
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
--------+---------+---------+---------+---------+---------
  SET ODYDS.GV_ARRAY_TEST[4]  = 'Rachel';
--------+---------+---------+---------+---------+---------
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
--------+---------+---------+---------+---------+---------
```

Themis
Leaders in IT Education

Global Variable Array Example 1

```
   SELECT C2,COALESCE(C1,'')
   FROM UNNEST(GV_ARRAY_TEST) WITH ORDINALITY AS T(C1,C2)
---------+---------+---------+---------+---------+---------+----
         C2
---------+---------+---------+---------+---------+---------+----
          1  John
          2  Jake
          3  Riley
          4  Rachel
DSNE610I NUMBER OF ROWS DISPLAYED IS 4
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 100
---------+---------+---------+---------+---------+---------+----
```

Themis
Leaders in IT Education

Global Variable Array Example 2

```
---------+---------+---------+---------+---------+---------
   SET GV_ARRAY_TEST2['AL'] = 'ALABAMA';
---------+---------+---------+---------+---------+---------
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
---------+---------+---------+---------+---------+---------
   SET GV_ARRAY_TEST2['AZ'] = 'ARIZONA';
---------+---------+---------+---------+---------+---------
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
---------+---------+---------+---------+---------+---------
   SET GV_ARRAY_TEST2['MI'] = 'MICHIGAN';
---------+---------+---------+---------+---------+---------
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
---------+---------+---------+---------+---------+---------
   SET GV_ARRAY_TEST2['OH'] = 'OHIO'    ;
---------+---------+---------+---------+---------+---------
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
---------+---------+---------+---------+---------+---------
```

Themis
Leaders in IT Education

Global Variable Array Example 2

```
   SELECT C1,C2
   FROM UNNEST(GV_ARRAY_TEST2) AS T(C1,C2)
--------+---------+---------+---------+---------+---------+-
C1                      C2
--------+---------+---------+---------+---------+---------+-
AL                      ALABAMA
AZ                      ARIZONA
MI                      MICHIGAN
OH                      OHIO
DSNE610I NUMBER OF ROWS DISPLAYED IS 4
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 100
```

Themis
Leaders in IT Education

David Simpson
Themis Training
dsimpson@themisinc.com

Themis
Leaders in IT Education