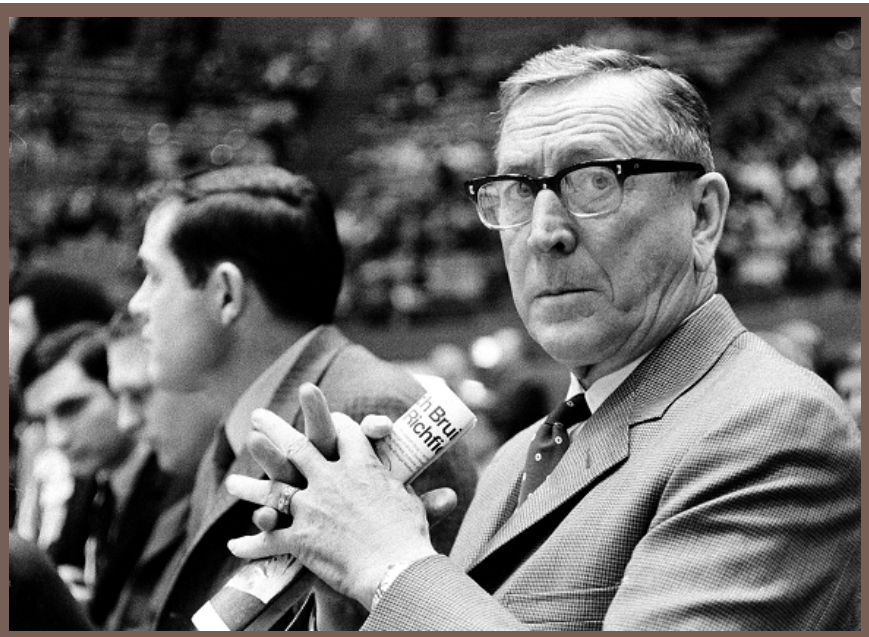
Craig Martin
03/30/2012

Executing Explain Plans and Explaining Execution Plans

Why?

Gene Kranz



John Wooden

Why?

"Work the problem people. Don't make things worse by guessing" - Gene Kranz

"If you don't have time to do it right, when will you have time to do it over?" - John Wooden

Explain Plan - Example

```
1   create table t1
2   as
3   select
4       rownum rn,
5       dbms_random.string('l',10) rand_string,
6       mod(rownum, 50) + 1 t2_id,
7       ceil(rownum/1000) t3_id
8   from dual
9   connect by level <= 100000;
10
11  create table t2
12  as
13  select
14      rownum t2_id,
15      dbms_random.string('l',10) rand_string,
16      round(dbms_random.value(1, 75)) t4_id
17  from dual
18  connect by level <= 50;
19
20  create table t3
21  as
22  select
23      rownum t3_id,
24      dbms_random.string('l',10) rand_string,
25      round(dbms_random.value(1, 75)) t4_id
26  from dual
27  connect by level <= 100;
28
29  create table t4
30  as
31  select
32      rownum t4_id,
33      dbms_random.string('l',10) rand_string
34  from dual
35  connect by level <= 75;
36
```

```
38  explain plan for
39  select *
40  from t1
41      inner join t2
42          on t2.t2_id = t1.t2_id
43      inner join t3
44          on t3.t3_id = t1.t3_id
45      inner join t4
46          on t4.t4_id = t2.t4_id
47  where
48      t4.rand_string like 'f%';
49
```

Displaying Results

- Query PLAN_TABLE Directly
- Explain Plan feature in SQL Developer 
- DBMS_XPLAN package

DBMS_XPLAN.DISPLAY

```
select *
from table(dbms_xplan.display());
```

- Pros
  - Actual SQL doesn't have to be executed just explained
- Cons
  - The plan produced may not be the actual plan used when executing the SQL

DBMS_XPLAN.DISPLAY_CURSOR

```
select *
from table(dbms_xplan.display_cursor());
```

- Pros
  - Can display plan information for any SQL in cursor cache
  - Allows displaying of additional statistics (I/O, memory, timing)
- Cons
  - SQL must have already been executed

DBMS_XPLAN.DISPLAY_CURSOR

- Parameters
  - SQL_ID
  - Child Number
  - Format
- Gathering Additional Details
  - Memory Management Statistics
    - Set parameter *pga_aggregate_target* to non-zero
  - I/O Statistics
    - Set parameter *statistics_level* to “ALL”
    - Use *gather_plan_statistics* hint during execution

DISPLAY_CURSOR: Output

- Up to 7 sections possible
  - Information about SQL Statement
  - Execution Plan
  - Query Blocks
  - Outline
  - Predicates
  - Column Projection
  - Notes

DISPLAY_CURSOR: Output

Information about SQL

```
SQL_ID  4p77kv72anazz, child number 0
-------------------------------------
select /*+ gather_plan_statistics */ * from t1  inner join t2   on t2.t2_id = t1.t2_id  inner join t3
on t3.t3_id = t1.t3_id  inner join t4   on t4.t4_id = t2.t4_id where  t4.rand_string like 'f%'
```

DISPLAY_CURSOR: Output

Execution Plan

```
Plan hash value: 1012227572

-----------------------------------------------------------------------------------------------------------------------------------------------------------
| Id  | Operation           | Name | Starts | E-Rows |E-Bytes| Cost (%CPU)| E-Time   | A-Rows |   A-Time   | Buffers |  OMem |  1Mem | O/1/M    |
-----------------------------------------------------------------------------------------------------------------------------------------------------------
|*  1 |  HASH JOIN          |      |      1 |   5407 |   41M|   249  (43)| 00:00:01 |    500 |00:00:00.02 |     105 |  1023K|  1023K|     1/0/0|
|   2 |   TABLE ACCESS FULL | T3   |      1 |    100 |  198K|     3   (0)| 00:00:01 |    100 |00:00:00.01 |       3 |       |       |          |
|*  3 |   HASH JOIN         |      |      1 |   5407 |   31M|   244  (44)| 00:00:01 |    500 |00:00:00.01 |     102 |  899K|  899K|     1/0/0|
|*  4 |    HASH JOIN        |      |      1 |      3 | 12129 |     7  (15)| 00:00:01 |      1 |00:00:00.01 |       6 | 1078K| 1078K|     1/0/0|
|*  5 |     TABLE ACCESS FULL| T4   |      1 |      2 |  4030 |     3   (0)| 00:00:01 |      2 |00:00:00.01 |       3 |       |       |          |
|   6 |     TABLE ACCESS FULL| T2   |      1 |     50 |   99K|     3   (0)| 00:00:01 |     50 |00:00:00.01 |       3 |       |       |          |
|   7 |    TABLE ACCESS FULL | T1   |      1 |  97326 |  189M|   206  (36)| 00:00:01 |  24988 |00:00:00.01 |      96 |       |       |          |
-----------------------------------------------------------------------------------------------------------------------------------------------------------
```

DISPLAY_CURSOR: Output

Query Blocks

```
Query Block Name / Object Alias (identified by operation id):
------------------------------------------------------------

   1 - SEL$EE94F965
   2 - SEL$EE94F965 / T3@SEL$2
   5 - SEL$EE94F965 / T4@SEL$3
   6 - SEL$EE94F965 / T2@SEL$1
   7 - SEL$EE94F965 / T1@SEL$1
```

DISPLAY_CURSOR: Output

Outline

```
Outline Data
-------------

  /*+
      BEGIN_OUTLINE_DATA
      IGNORE_OPTIM_EMBEDDED_HINTS
      OPTIMIZER_FEATURES_ENABLE('10.2.0.4')
      OPT_PARAM('_optimizer_max_permutations' 100)
      OPT_PARAM('_b_tree_bitmap_plans' 'false')
      OPT_PARAM('optimizer_index_cost_adj' 10)
      OPT_PARAM('optimizer_index_caching' 10)
      ALL_ROWS
      OUTLINE_LEAF(@"SEL$EE94F965")
      MERGE(@"SEL$9E43CB6E")
      OUTLINE(@"SEL$4")
      OUTLINE(@"SEL$9E43CB6E")
      MERGE(@"SEL$58A6D7F6")
      OUTLINE(@"SEL$3")
      OUTLINE(@"SEL$58A6D7F6")
      MERGE(@"SEL$1")
      OUTLINE(@"SEL$2")
      OUTLINE(@"SEL$1")
      FULL(@"SEL$EE94F965" "T4"@"SEL$3")
      FULL(@"SEL$EE94F965" "T2"@"SEL$1")
      FULL(@"SEL$EE94F965" "T1"@"SEL$1")
      FULL(@"SEL$EE94F965" "T3"@"SEL$2")
      LEADING(@"SEL$EE94F965" "T4"@"SEL$3" "T2"@"SEL$1" "T1"@"SEL$1"
              "T3"@"SEL$2")
      USE_HASH(@"SEL$EE94F965" "T2"@"SEL$1")
      USE_HASH(@"SEL$EE94F965" "T1"@"SEL$1")
      USE_HASH(@"SEL$EE94F965" "T3"@"SEL$2")
      SWAP_JOIN_INPUTS(@"SEL$EE94F965" "T3"@"SEL$2")
      END_OUTLINE_DATA
  */
```

DISPLAY_CURSOR: Output

Predicates

```
Predicate Information (identified by operation id):
---------------------------------------------------

   1 - access("T3"."T3_ID"="T1"."T3_ID")
   3 - access("T2"."T2_ID"="T1"."T2_ID")
   4 - access("T4"."T4_ID"="T2"."T4_ID")
   5 - filter("T4"."RAND_STRING" LIKE 'f%')
```

- Access = Only matching rows are retrieved
- Filter = All rows are retrieved, matching rows kept

DISPLAY_CURSOR: Output

Column Projection

```
Column Projection Information (identified by operation id):
-----------------------------------------------------------

   1 - (#keys=1) "T3"."T3_ID"[NUMBER,22], "T1"."T3_ID"[NUMBER,22], "T3"."T4_ID"[NUMBER,22], "T3"."RAND_STRING"[VARCHAR2,4000],
       "T2"."T2_ID"[NUMBER,22], "T1"."T2_ID"[NUMBER,22], "T4"."T4_ID"[NUMBER,22], "T2"."T4_ID"[NUMBER,22], "T4"."RAND_STRING"[VARCHAR2,4000],
       "T2"."RAND_STRING"[VARCHAR2,4000], "T1"."T1_ID"[NUMBER,22], "T1"."RAND_STRING"[VARCHAR2,4000]
   2 - "T3"."T3_ID"[NUMBER,22], "T3"."RAND_STRING"[VARCHAR2,4000], "T3"."T4_ID"[NUMBER,22]
   3 - (#keys=1) "T2"."T2_ID"[NUMBER,22], "T1"."T2_ID"[NUMBER,22], "T4"."T4_ID"[NUMBER,22], "T2"."T4_ID"[NUMBER,22],
       "T4"."RAND_STRING"[VARCHAR2,4000], "T2"."RAND_STRING"[VARCHAR2,4000], "T1"."T1_ID"[NUMBER,22], "T1"."RAND_STRING"[VARCHAR2,4000],
       "T1"."T3_ID"[NUMBER,22]
   4 - (#keys=1) "T4"."T4_ID"[NUMBER,22], "T2"."T4_ID"[NUMBER,22], "T4"."RAND_STRING"[VARCHAR2,4000], "T2"."T2_ID"[NUMBER,22],
       "T2"."RAND_STRING"[VARCHAR2,4000]
   5 - "T4"."T4_ID"[NUMBER,22], "T4"."RAND_STRING"[VARCHAR2,4000]
   6 - "T2"."T2_ID"[NUMBER,22], "T2"."RAND_STRING"[VARCHAR2,4000], "T2"."T4_ID"[NUMBER,22]
   7 - "T1"."T1_ID"[NUMBER,22], "T1"."RAND_STRING"[VARCHAR2,4000], "T1"."T2_ID"[NUMBER,22], "T1"."T3_ID"[NUMBER,22]
```

DISPLAY_CURSOR: Output

Notes

```
Note
-----
   - dynamic sampling used for this statement
```

DISPLAY_CURSOR: Output

```
Plan hash value: 1012227572

-------------------------------------------------------------------------------
| Id  | Operation           | Name | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------
|   0 | SELECT STATEMENT    |      |  5407 |    41M|   249  (43)| 00:00:01 |
|*  1 |  HASH JOIN          |      |  5407 |    41M|   249  (43)| 00:00:01 |
|   2 |   TABLE ACCESS FULL | T3   |   100 |   198K|     3   (0)| 00:00:01 |
|*  3 |   HASH JOIN         |      |  5407 |    31M|   244  (44)| 00:00:01 |
|*  4 |    HASH JOIN        |      |     3 | 12129 |     7  (15)| 00:00:01 |
|*  5 |     TABLE ACCESS FULL| T4   |     2 |  4030 |     3   (0)| 00:00:01 |
|   6 |     TABLE ACCESS FULL| T2   |    50 |    99K|     3   (0)| 00:00:01 |
|   7 |    TABLE ACCESS FULL | T1   | 97326 |   189M|   206  (36)| 00:00:01 |
-------------------------------------------------------------------------------
```

```
Plan hash value: 1012227572

-----------------------------------------------------------------------------------------------------------------------------------------------------
| Id  | Operation           | Name | Starts | E-Rows |E-Bytes| Cost (%CPU)| E-Time   | A-Rows |   A-Time     | Buffers | OMem | 1Mem | O/1/M    |
-----------------------------------------------------------------------------------------------------------------------------------------------------
|*  1 |  HASH JOIN          |      |      1 |   5407 |   41M|   249  (43)| 00:00:01 |    500 |00:00:00.02 |     105 | 1023K| 1023K|     1/0/0|
|   2 |   TABLE ACCESS FULL | T3   |      1 |    100 |  198K|     3   (0)| 00:00:01 |    100 |00:00:00.01 |       3 |      |      |          |
|*  3 |   HASH JOIN         |      |      1 |   5407 |   31M|   244  (44)| 00:00:01 |    500 |00:00:00.01 |     102 |  899K|  899K|     1/0/0|
|*  4 |    HASH JOIN        |      |      1 |      3 | 12129 |     7  (15)| 00:00:01 |      1 |00:00:00.01 |       6 | 1078K| 1078K|     1/0/0|
|*  5 |     TABLE ACCESS FULL| T4   |      1 |      2 |  4030 |     3   (0)| 00:00:01 |      2 |00:00:00.01 |       3 |      |      |          |
|   6 |     TABLE ACCESS FULL| T2   |      1 |     50 |    99K|     3   (0)| 00:00:01 |     50 |00:00:00.01 |       3 |      |      |          |
|   7 |    TABLE ACCESS FULL | T1   |      1 |  97326 |   189M|   206  (36)| 00:00:01 |  24988 |00:00:00.01 |      96 |      |      |          |
-----------------------------------------------------------------------------------------------------------------------------------------------------
```

DISPLAY_CURSOR: Output

```
56
57  select *
58  from table(dbms_xplan.display_cursor('4p77kv72anazz',0,'IOSTATS'));
59
```

```
SQL_ID  4p77kv72anazz, child number 0
-------------------------------------
select /*+ gather_plan_statistics */ * from t1  inner join t2   on t2.t2_id =
t1.t2_id  inner join t3   on t3.t3_id = t1.t3_id  inner join t4   on t4.t4_id
= t2.t4_id where  t4.rand_string like 'f%'

Plan hash value: 1012227572

-----------------------------------------------------------------------------------------------
| Id  | Operation            | Name | Starts | E-Rows | A-Rows |   A-Time   | Buffers |
-----------------------------------------------------------------------------------------------
|*  1 |  HASH JOIN           |      |      1 |   5407 |    500 |00:00:00.02 |     105 |
|   2 |   TABLE ACCESS FULL  | T3   |      1 |    100 |    100 |00:00:00.01 |       3 |
|*  3 |   HASH JOIN          |      |      1 |   5407 |    500 |00:00:00.01 |     102 |
|*  4 |    HASH JOIN         |      |      1 |      3 |      1 |00:00:00.01 |       6 |
|*  5 |     TABLE ACCESS FULL| T4   |      1 |      2 |      2 |00:00:00.01 |       3 |
|   6 |     TABLE ACCESS FULL| T2   |      1 |     50 |     50 |00:00:00.01 |       3 |
|   7 |    TABLE ACCESS FULL | T1   |      1 |  97326 |  24988 |00:00:00.01 |      96 |
-----------------------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   1 - access("T3"."T3_ID"="T1"."T3_ID")
   3 - access("T2"."T2_ID"="T1"."T2_ID")
   4 - access("T4"."T4_ID"="T2"."T4_ID")
   5 - filter("T4"."RAND_STRING" LIKE 'f%')

Note
-----
   - dynamic sampling used for this statement
```

Reading Execution Plans

- The only operation without a parent is the root node
- A parent can have one or many children
- A child can only have one parent
- Children are displayed indented to the right of their parent
- All children of a single parent have the same indentation
- A parent is displayed before its children
- The ID of a parent is less than the IDs of its children
- If there are several nodes with the same indentation as the parent, the node closest to the child is the parent

Reading Execution Plans

- From Oracle Documentation (11.2)
  - http://download.oracle.com/docs/cd/E11882_01/server.112/e16638/optimops.htm#i82029

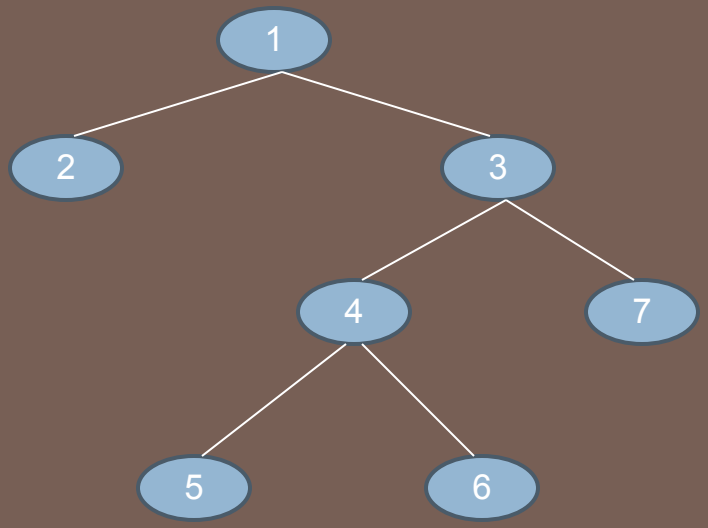
11.4.1 Overview of EXPLAIN PLAN

You can examine the execution plan chosen by the optimizer for a SQL statement by using the `EXPLAIN PLAN` statement. When the statement is issued, the optimizer chooses an execution plan and then inserts data describing the plan into a database table. Simply issue the `EXPLAIN PLAN` statement and then query the output table.

These are the basics of using the `EXPLAIN PLAN` statement:

- Use the SQL script `CATPLAN.SQL` to create a sample output table called `PLAN_TABLE` in your schema. See "The PLAN_TABLE Output Table".
- Include the `EXPLAIN PLAN FOR` clause before the SQL statement. See "Running EXPLAIN PLAN".
- After issuing the `EXPLAIN PLAN` statement, use one of the scripts or package provided by Oracle Database to display the most recent plan table output. See "Displaying PLAN_TABLE Output".
- The execution order in `EXPLAIN PLAN` output begins with the line that is the furthest indented to the right. The next step is the parent of that line. If two lines are indented equally, then the top line is normally executed first.

Id	Operation	Name	Starts	E-Rows	A-Rows	A-Time	Buffers
* 1	HASH JOIN		1	5407	500	00:00:00.02	105
2	TABLE ACCESS FULL	T3	1	100	100	00:00:00.01	3
* 3	HASH JOIN		1	5407	500	00:00:00.01	102
* 4	HASH JOIN		1	3	1	00:00:00.01	6
* 5	TABLE ACCESS FULL	T4	1	2	2	00:00:00.01	3
6	TABLE ACCESS FULL	T2	1	50	50	00:00:00.01	3
7	TABLE ACCESS FULL	T1	1	97326	24988	00:00:00.01	96



Common Operations

- Stand-Alone Operations
  - Most operations of this type
  - Parents have at most one child
  - Child executed at most once
  - Child feeds its parent
  - Examples:
    - TABLE ACCESS
    - HASH GROUP BY
    - COUNT

Common Operations

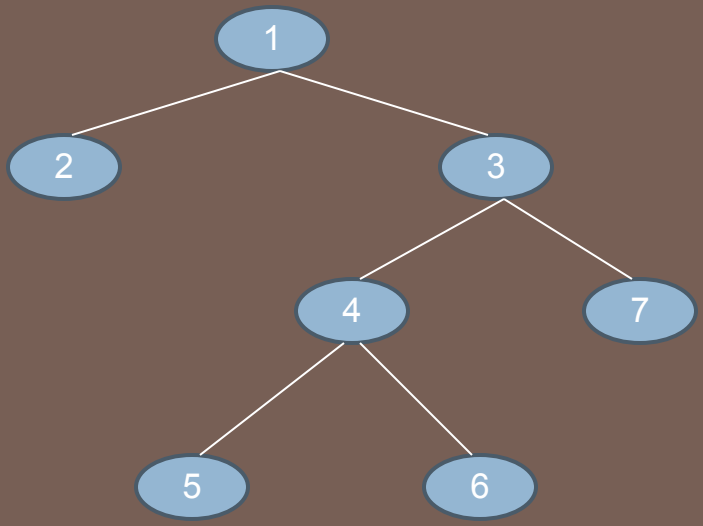
- Unrelated-Combine Operations
  - Parents have multiple children that are executed independently
  - Children are executed sequentially
    - Starts with child with smallest ID
  - Every child executed at most once
  - Every child feeds its parent
  - Examples:
    - HASH JOIN
    - MERGE JOIN
    - UNION-ALL

Common Operations

- Related-Combine Operations
  - Parents have multiple children where one child controls execution of the other children
  - Children are not executed sequentially
  - Only first child executed at most once
    - All others may be executed many times or not at all
  - Not every child feeds its parent
    - Some are used only as restrictions
  - Examples:
    - NESTED LOOPS
    - UPDATE
    - FILTER

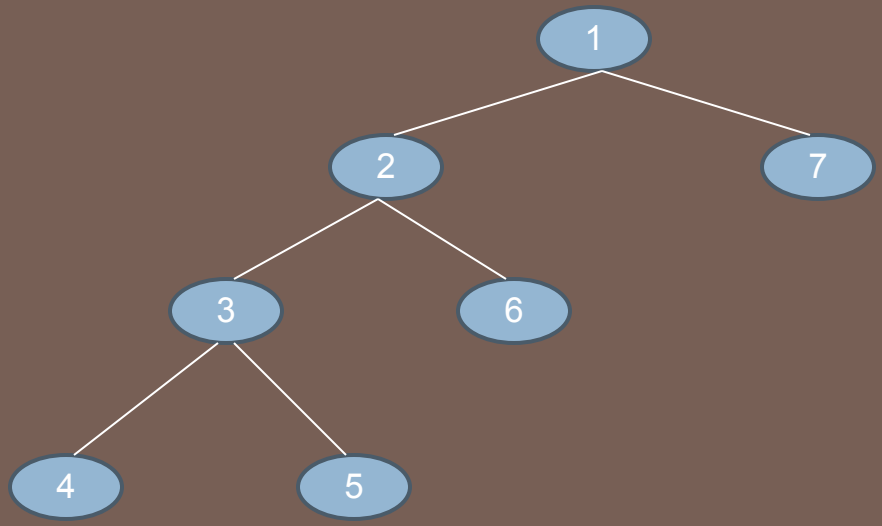
```
Plan hash value: 1997971088

-------------------------------------------------------------------------------------------------
| Id  | Operation            | Name | Starts | E-Rows | A-Rows |   A-Time   | Buffers |
-------------------------------------------------------------------------------------------------
|*  1 |  HASH JOIN           |      |      1 |   5407 |    500 |00:00:01.41 |    150K|
|*  2 |   TABLE ACCESS FULL  | T4   |      1 |      2 |      2 |00:00:00.01 |       3 |
|   3 |   NESTED LOOPS       |      |      1 |  97326 |  24988 |00:00:01.50 |    150K|
|   4 |    NESTED LOOPS      |      |      1 |  97326 |  24988 |00:00:00.67 |   75060 |
|   5 |     TABLE ACCESS FULL| T1   |      1 |  97326 |  24988 |00:00:00.03 |      96 |
|*  6 |     TABLE ACCESS FULL| T2   |  24988 |      1 |  24988 |00:00:00.63 |   74964 |
|*  7 |    TABLE ACCESS FULL | T3   |  24988 |      1 |  24988 |00:00:00.80 |   74964 |
-------------------------------------------------------------------------------------------------
```

```
Predicate Information (identified by operation id):
---------------------------------------------------

   1 - access("T4"."T4_ID"="T2"."T4_ID")
   2 - filter("T4"."RAND_STRING" LIKE 'f%')
   6 - filter("T2"."T2_ID"="T1"."T2_ID")
   7 - filter("T3"."T3_ID"="T1"."T3_ID")
```



```
Plan hash value: 2553113010

-------------------------------------------------------------------------------------------------
| Id  | Operation            | Name | Starts | E-Rows | A-Rows |   A-Time   | Buffers |
-------------------------------------------------------------------------------------------------
|   1 |  NESTED LOOPS        |      |      1 |   5407 |    500 |00:00:02.32 |     224K|
|   2 |   NESTED LOOPS       |      |      1 |  97326 |  24988 |00:00:01.47 |     150K|
|   3 |    NESTED LOOPS      |      |      1 |  97326 |  24988 |00:00:00.65 |   75060 |
|   4 |     TABLE ACCESS FULL| T1   |      1 |  97326 |  24988 |00:00:00.03 |      96 |
|*  5 |     TABLE ACCESS FULL| T2   |  24988 |      1 |  24988 |00:00:00.61 |   74964 |
|*  6 |    TABLE ACCESS FULL | T3   |  24988 |      1 |  24988 |00:00:00.80 |   74964 |
|*  7 |   TABLE ACCESS FULL  | T4   |  24988 |      1 |    500 |00:00:00.88 |   74964 |
-------------------------------------------------------------------------------------------------
```

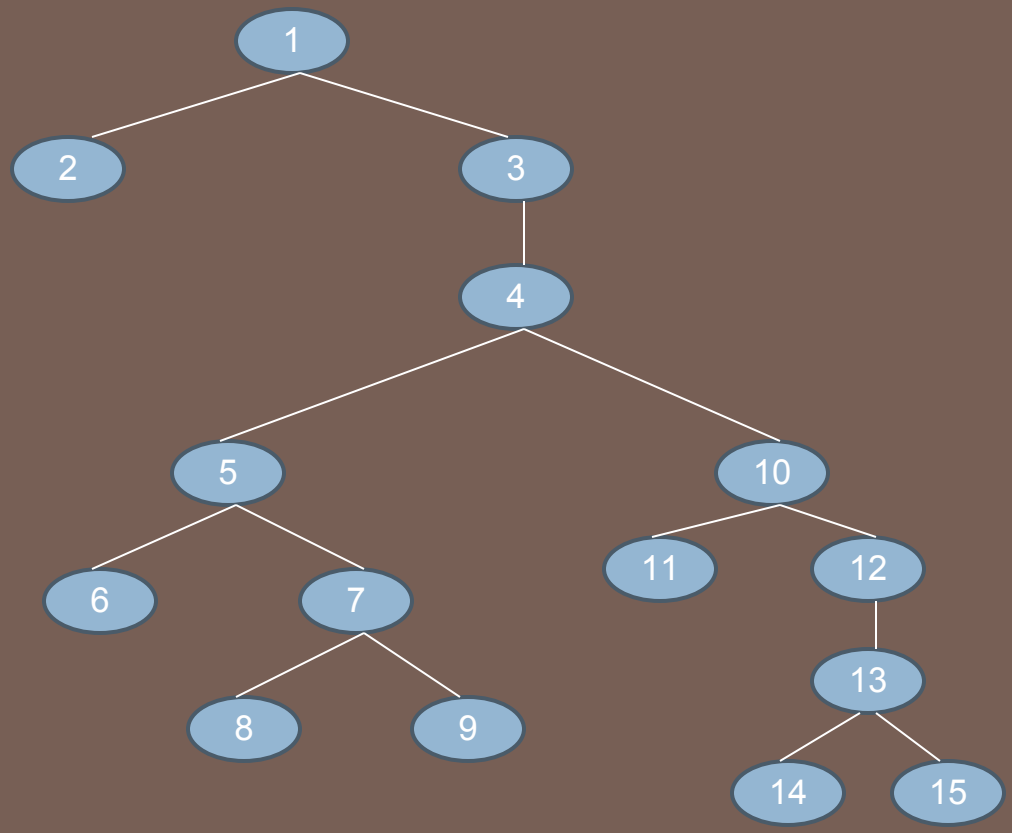
```
Predicate Information (identified by operation id):
---------------------------------------------------

   5 - filter("T2"."T2_ID"="T1"."T2_ID")
   6 - filter("T3"."T3_ID"="T1"."T3_ID")
   7 - filter(("T4"."RAND_STRING" LIKE 'f%' AND "T4"."T4_ID"="T2"."T4_ID"))
```



```
Plan hash value: 1189412883

-------------------------------------------------------------------------------------------------------
| Id  | Operation                    | Name     | Starts | E-Rows | A-Rows |   A-Time   | Buffers |
-------------------------------------------------------------------------------------------------------
|*  1 |  HASH JOIN                   |          |      1 |   2595 |    500 |00:00:00.88 |   14393 |
|*  2 |   TABLE ACCESS FULL          | T4       |      1 |      2 |      2 |00:00:00.01 |       3 |
|   3 |   VIEW                       |          |      1 |  97327 |  76500 |00:00:00.92 |   14390 |
|   4 |    UNION-ALL                 |          |      1 |        |  76500 |00:00:00.92 |   14390 |
|*  5 |     HASH JOIN RIGHT OUTER    |          |      1 |  97326 |  76500 |00:00:00.84 |   14390 |
|   6 |      TABLE ACCESS FULL       | T3       |      1 |    100 |    100 |00:00:00.01 |       3 |
|   7 |      NESTED LOOPS            |          |      1 |  97326 |  76500 |00:00:00.77 |   14387 |
|   8 |       TABLE ACCESS FULL      | T2       |      1 |     50 |     39 |00:00:00.01 |       3 |
|*  9 |       TABLE ACCESS FULL      | T1       |     39 |   1947 |  76500 |00:00:00.69 |   14384 |
|* 10 |     HASH JOIN ANTI           |          |      0 |      1 |      0 |00:00:00.01 |       0 |
|  11 |      TABLE ACCESS FULL       | T3       |      0 |    100 |      0 |00:00:00.01 |       0 |
|  12 |      VIEW                    | VW_SQ_1  |      0 |  97326 |      0 |00:00:00.01 |       0 |
|* 13 |       HASH JOIN              |          |      0 |  97326 |      0 |00:00:00.01 |       0 |
|  14 |        TABLE ACCESS FULL     | T2       |      0 |     50 |      0 |00:00:00.01 |       0 |
|  15 |        TABLE ACCESS FULL     | T1       |      0 |  97326 |      0 |00:00:00.01 |       0 |
-------------------------------------------------------------------------------------------------------
```

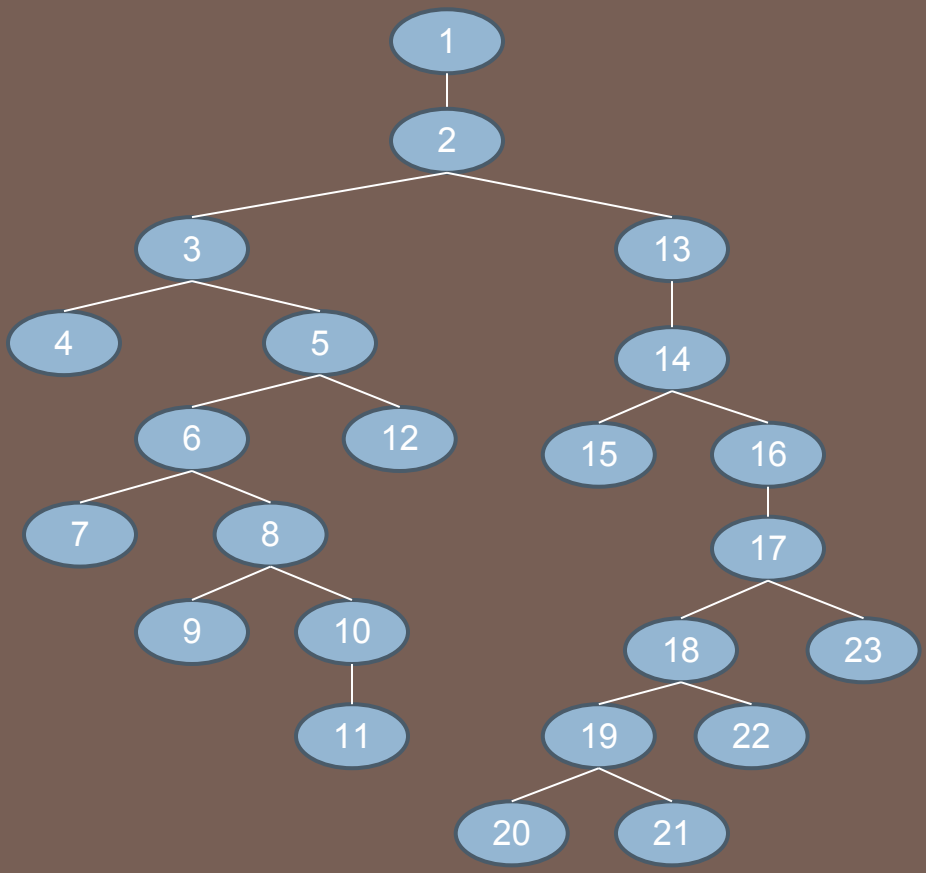
```
Predicate Information (identified by operation id):
---------------------------------------------------

   1 - access("T4"."T4_ID"="T2"."T4_ID")
   2 - filter("T4"."RAND_STRING" LIKE 'f%')
   5 - access("T3"."T3_ID"="T1"."T3_ID")
   9 - filter("T2"."T2_ID"="T1"."T2_ID")
  10 - access("T3"."T3_ID"="T3_ID")
  13 - access("T2"."T2_ID"="T1"."T2_ID")
```

```
Plan hash value: 1189412883

-----------------------------------------------------
| Id  | Operation                    | Name     | Starts |
-----------------------------------------------------
|*  1 |  HASH JOIN                   |          |      1 |
|*  2 |   TABLE ACCESS FULL          | T4       |      1 |
|   3 |   VIEW                       |          |      1 |
|   4 |    UNION-ALL                 |          |      1 |
|*  5 |     HASH JOIN RIGHT OUTER    |          |      1 |
|   6 |      TABLE ACCESS FULL       | T3       |      1 |
|   7 |      NESTED LOOPS            |          |      1 |
|   8 |       TABLE ACCESS FULL      | T2       |      1 |
|*  9 |       TABLE ACCESS FULL      | T1       |     39 |
|* 10 |     HASH JOIN ANTI           |          |      0 |
|  11 |      TABLE ACCESS FULL       | T3       |      0 |
|  12 |      VIEW                    | VW_SQ_1  |      0 |
|* 13 |       HASH JOIN              |          |      0 |
|  14 |        TABLE ACCESS FULL     | T2       |      0 |
|  15 |        TABLE ACCESS FULL     | T1       |      0 |
-----------------------------------------------------
```




```
Predicate Information (identified by operation id):
---------------------------------------------------

   1 - access("T4"."T4_ID"="T2"."T4_ID")
   2 - filter("T4"."RAND_STRING" LIKE 'f%')
   5 - access("T3"."T3_ID"="T1"."T3_ID")
   9 - filter("T2"."T2_ID"="T1"."T2_ID")
  10 - access("T3"."T3_ID"="T3_ID")
  13 - access("T2"."T2_ID"="T1"."T2_ID")
```

```
Plan hash value: 3474588145

-----------------------------------------------------------
| Id  | Operation                      | Name     | Starts |
-----------------------------------------------------------
|   1 |  VIEW                          |          |      1 |
|   2 |   UNION-ALL                    |          |      1 |
|*  3 |    HASH JOIN RIGHT OUTER       |          |      1 |
|   4 |     TABLE ACCESS FULL          | T3       |      1 |
|*  5 |     HASH JOIN                  |          |      1 |
|*  6 |      HASH JOIN                 |          |      1 |
|   7 |       TABLE ACCESS FULL        | T2       |      1 |
|   8 |       MERGE JOIN CARTESIAN     |          |      1 |
|*  9 |        TABLE ACCESS FULL       | T4       |      1 |
|  10 |        BUFFER SORT             |          |      1 |
|  11 |         TABLE ACCESS FULL      | T3       |      1 |
|  12 |      TABLE ACCESS FULL         | T1       |      0 |
|* 13 |    FILTER                      |          |      1 |
|* 14 |     HASH JOIN ANTI             |          |      0 |
|  15 |      TABLE ACCESS FULL         | T3       |      0 |
|  16 |      VIEW                      | VW_SQ_1  |      0 |
|* 17 |       HASH JOIN                |          |      0 |
|* 18 |        HASH JOIN               |          |      0 |
|* 19 |         HASH JOIN OUTER        |          |      0 |
|  20 |          TABLE ACCESS FULL     | T2       |      0 |
|  21 |          TABLE ACCESS FULL     | T4       |      0 |
|  22 |         TABLE ACCESS FULL      | T3       |      0 |
|  23 |        TABLE ACCESS FULL       | T1       |      0 |
-----------------------------------------------------------
```



What to Ignore

- Cost!
  - Can’t be directly controlled
  - May not be an accurate indication of performance
- Rules of Always
  - Full table scans are always bad
  - Indexes are always good

What to Look For

- Estimates that don’t match the actual data
  - Inaccurate statistics may exist
- Wasted Operations / Rows
  - Many more rows are read for an operation than are used
    - Full scans
    - Unselective range scans
    - Wrong join order
    - Late filter operations
- High Execution Time / Buffer Count

References

- Oracle Documentation
  - Oracle Database Performance Tuning Guide
  - Oracle Database PL/SQL Packages and Types Reference
- Troubleshooting Oracle Performance by Christian Antognini

Questions?

http://www.cmartin2.com
cmartin2@cmartin2.com