To Cache or not to Cache; and How?

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Session Objectives

- Understand Oracle's SQL & PL/SQL caching features
- Choose caching that is appropriate to the task at hand
- Evaluate the performance implications of caching choices

Who Am I?

- John King – Partner, King Training Resources
- Oracle Ace Director
- Member Oak Table Network
- Providing training to Oracle and IT community for over 25 years – http://www.kingtraining.com
- "Techie" who knows Oracle, ADF, SQL, Java, and PL/SQL pretty well (along with many other topics)
- Member of AZORA, ODTUG, IOUG, and RMOUG

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Who Are You?

- Application Developer
- DBA
- Business Analyst
- Other?

Oracle Caching Capabilities

- Deterministic Functions
- SQL Scalar Subqueries
- SQL Statement Cache
- PL/SQL Function Cache
- PL/SQL defined in SQL WITH clause
- PL/SQL PRAGMA UDF

LOB Buffer Cache Options

- BasicFile - Direct Read/Write avoids cache but can cause other I/O to wait
- SecureFile – Data may be compressed and encrypted; special shared LOB pool usually offers better performance than BasicFile
- NOCACHE - LOBs don't use buffer cache
- CACHE – LOB data uses buffer cache; best for LOBs with lots of READ/WRITE
- CACHE READS – LOBs use buffer cache only for READs; best for simple READs

SQL and PL/SQL Caching

- Deterministic Functions
- Scalar subquery caching
- SQL Statement Result Cache
- PL/SQL Statement Result Cache
- SQL WITH
- PRAGMA UDF

Deterministic Functions

- Produce identical (cached) results for given parameters/arguments each time called
- Depend solely upon the parameters/ arguments passed to them
- Do not use or modify the database or package variables

Note: Oracle cannot verify that a function is truly deterministic, using non-deterministic functions inappropriately yields “unpredictable” results

Deterministic Syntax

- DETERMINISTIC keyword is specified after return value type in CREATE FUNCTION (standalone function, function in CREATE PACKAGE or CREATE TYPE)

```
CREATE FUNCTION TIMES_2 (INVAL NUMBER)
  RETURN NUMBER
  DETERMINISTIC
IS
BEGIN
  RETURN INVAL * 2;
END;
```

Deterministic Requirement

- DETERMINISTIC is required for:
  - Functions used in a function-based index
  - Functions used in a materialized view with FAST REFRESH or ENABLE QUERY REWRITE

Deterministic Use Case

- Oracle does not require explicit declaration of DETERMINISTIC, but it is a good for some use cases:
  - Where required in Function-based indexes or Materialized Views (see previous page)
  - Functions in WHERE, ORDER BY, or GROUP BY clauses selecting rows for the result set
  - Functions that MAP or ORDER methods of a SQL type

Scalar Subquery Caching

- Performance of functions called as part of SQL may be improved by using a subquery

```
SELECT EMPLOYEE_ID,LAST_NAME,SALARY
      ,AVG_SAL_JOB(JOB_ID) AVG_JOB_SAL
    FROM HR.EMPLOYEES
      ORDER BY AVG_JOB_SAL,SALARY,LAST_NAME;
Elapsed: 00:00:00.182

SELECT EMPLOYEE_ID,LAST_NAME,SALARY,
   (SELECT AVG_SAL_JOB(JOB_ID) FROM DUAL) AVG_JOB_SAL
    FROM HR.EMPLOYEES
      ORDER BY AVG_JOB_SAL,SALARY,LAST_NAME;
Elapsed: 00:00:00.017
```

SQL Results Caching

- Caching is nothing new to Oracle; what's new is the caching of results…
- Once materialized, query results are cached and re-presented when the same query is run more than once
  (similar to how Materialized Views work, but more-dynamic)
- Oracle 11g "result_cache" hint asks Oracle to cache query results

Result Cache – Test Query

```
select cust_last_name || ', ' || cust_first_name cust_name
      ,cust_city
      ,prod_id
      ,count(*) nbr_sales
 from sh.customers cust
    join sh.sales sales
      on cust.cust_id = sales.cust_id
 where country_id = 52789
   and prod_id in (120,126)
 group by cust_last_name,cust_first_name,cust_city,prod_id
 having count(*) > 10
 order by cust_name,nbr_sales;
```

- This query was run three times in succession with timing turned on; resulting timings were
  - Elapsed: 00:00:00.67
  - Elapsed: 00:00:00.46
  - Elapsed: 00:00:00.37

Using Result Cache

```
select /*+ result_cache */ cust_last_name || ', ' || cust_first_name
   cust_name
      ,cust_city
      ,prod_id
      ,count(*) nbr_sales
 from sh.customers cust
    join sh.sales sales
      on cust.cust_id = sales.cust_id
 where country_id = 52789
   and prod_id in (120,126)
 group by cust_last_name,cust_first_name,cust_city,prod_id
 having count(*) > 10
 order by cust_name,nbr_sales;
```

- This query was run three times in succession with timing turned on; resulting timings were
  - Elapsed: 00:00:00.23 (results not cached yet)
  - Elapsed: 00:00:00.01
  - Elapsed: 00:00:00.03

SQL Result Cache Use Cases

- The SQL Result Cache trades long term storage of results for I/O
- Probably best used when a query is rerun repeatedly with the same input parameters AND the result set is not large AND the data is mostly static
- Probably not a good idea if the results of the query are large unless the query is run infrequently but with the same inputs

Result Cache Parameters

- result_cache_mode - Manual/Force (default is 'manual' requiring explicit hint)
- result_cache_max_size – Size allocated from the shared pool but maintained separately (not flushed with shared pool)
- result_cache_max_result – Highest percentage of result cache that may be used by a single result set (def. 5%)
- result_cache_remote_expiration - Number of minutes result cache resultset based upon a remote object is considered valid

Catalog Support

- V_$RESULT_CACHE_DEPENDENCY
  Dependencies in result cache results
- V_$RESULT_CACHE_MEMORY
  Result cache memory block statistics
- V_$RESULT_CACHE_OBJECTS
  Object (& attributes) in result cache results
- V_$RESULT_CACHE_STATISTICS
  Result cache memory use statistics
- V$CLIENT_RESULT_CACHE_STATS
  Cache settings and memory statistics

PL/SQL Result Cache

- PL/SQL allows specification of a result_cache for function calls
- Add the new "result_cache" clause just before the "AS/IS" keyword in the definition (Oracle 11g R1 also used now-obsolete "relies_on" clause)
- The results of a call to the Function with a specific set of input parameters is stored (cached) for later re-use

PL/SQL Result Cache - Code

```
CREATE OR REPLACE FUNCTION RESULT_CACHE_ON
   (in_cust_id sh.customers.cust_id%type,  in_prod_id
   sh.sales.prod_id%type)
RETURN number
RESULT_CACHE -- RELIES_ON (SH.CUSTOMERS, SH.SALES)
authid definer
AS
 sales number(7,0);
BEGIN
select count(*) nbr_sales  into sales
 from sh.customers cust join sh.sales sales
      on cust.cust_id = sales.cust_id
 where cust.cust_id = in_cust_id
  and  prod_id = in_prod_id;
 return sales;
EXCEPTION
  when no_data_found then return 0;
END RESULT_CACHE_ON;
```

PL/SQL Function Cache Results

- Results of running the function cache three times; note the first execution builds the cached results

```
Elapsed: 00:00:00.136

Elapsed: 00:00:00.001

Elapsed: 00:00:00.002
```

PL/SQL Result Cache Uses

- PL/SQL Function Resuts Cache is best used:
  - When same function called repeatedly with the same input values
  - If function is called frequently with different values but the result is small
  - If function is called with a small set of different inputs and the result is large
  - If data returned is relatively static

PL/SQL in WITH

- Oracle 12c allows definition of PL/SQL Functions and Procedures using SQL's Common Table Expression (WITH)
  - Defining PL/SQL locally reduces SQL-PL/SQL context-switching costs
  - Local PL/SQL overrides stored PL/SQL with the same name
  - Local PL/SQL is not stored in the database
  - Local PL/SQL is part of the same source code as the SQL that uses it
  - PL/SQL Result Cache no use in Local PL/SQL

Example PL/SQL in WITH

```
with function times_42(inval number)
 return number
as
begin
  return inval * 42;
end;
select channel_id,count(*) nbr_rows,
       sum(quantity_sold) qtysold,
       sum(times_42(cust_id)) cust42
  from sh.sales
  group by channel_id
  order by channel_id
/
```

- Use /*+ WITH_PLSQL */ to place WITH in subquery

PL/SQL in WITH Uses

- The advantage to local PL/SQL defined in SQL WITH is the reduction in context switching as SQL switches back-and-forth between SQL and PL/SQL
- Best use for local PL/SQL is stand-alone functions like calculations or string manipulations – make sure benefits are worth the complexity if the function will be duplicated in multiple SQLs
- Advantage of local PL/SQL is forfeit if the function issues other PL/SQL calls

PL/SQL UDF

- Oracle 12c allows functions to be defined using “PRAGMA UDF” to specify that a function will be used in SELECTS (behaving similar to function in WITH)
- This optimizes code for use within a SELECT or other SQL
  (Probably not a good option for functions also used from PL/SQL !)
- Does not have code duplication drawbacks of WITH clause

Example PL/SQL UDF

```
create or replace function times_42(inval number)
 return number
as
  pragma udf;
begin
  return inval * 42;
end;
/
```

Comparison

	1st Run	2nd Run	3rd Run
Function in WITH	0.854	0.825	0.929
Compiled Function in database	2.018	1.945	1.928
Compiled UDF Function in database	0.667	0.602	0.664

- Clearly, there are savings to be had
  - If the PL/SQL in question calls other PL/SQL, then, WITH and UDF might not be the best choice
  - If a PL/SQL function will be called from PL/SQL, UDF may cause performance to be off since the optimization will be incorrect

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Making wise choices

- Make functions that qualify Deterministic
- Use scalar subquery when SQL function calls may be cached
- SQL results cache is best used for frequent execution of same query
- PL/SQL results cache is best used for repeated function execution with same inputs
- Use PRAGMA UDF and PL/SQL in WITH for self-contained PL/SQL primarily used in SQL (UDF probably more-maintainable)

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Wrapping it Up

- Oracle provides many CACHEing features designed to improve performance
- SQL Query and PL/SQL Function statement caches reduce the cost of repetitive executions (at the cost of memory)
- SQL using PL/SQL in WITH and PL/SQL UDF functions reduce the cost of repetitive executions of PL/SQL used in SQL statements

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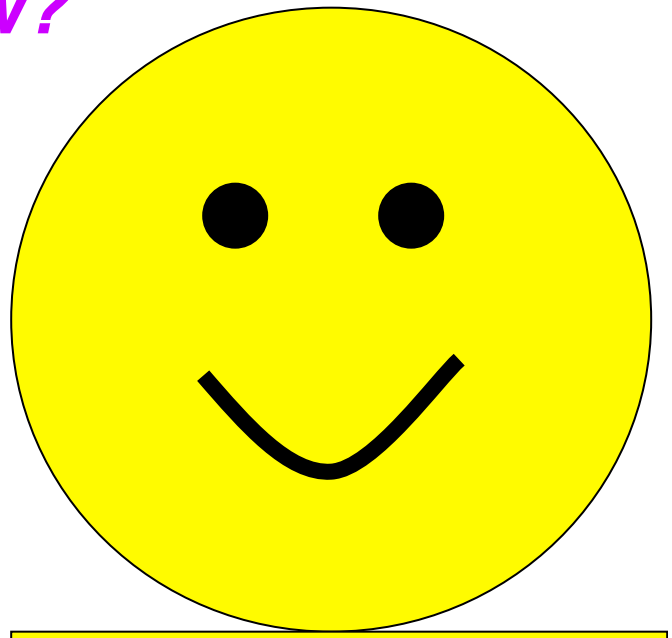

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