The Amazing and Elegant PL/SQL Function Result Cache

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Just in case I live in the future, even for a moment....

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Most referenced code is available in my demo.zip file from the PL/SQL Learning Library: oracle.com/oll/plsql or direct download from **http://v.gd/05JIWC**

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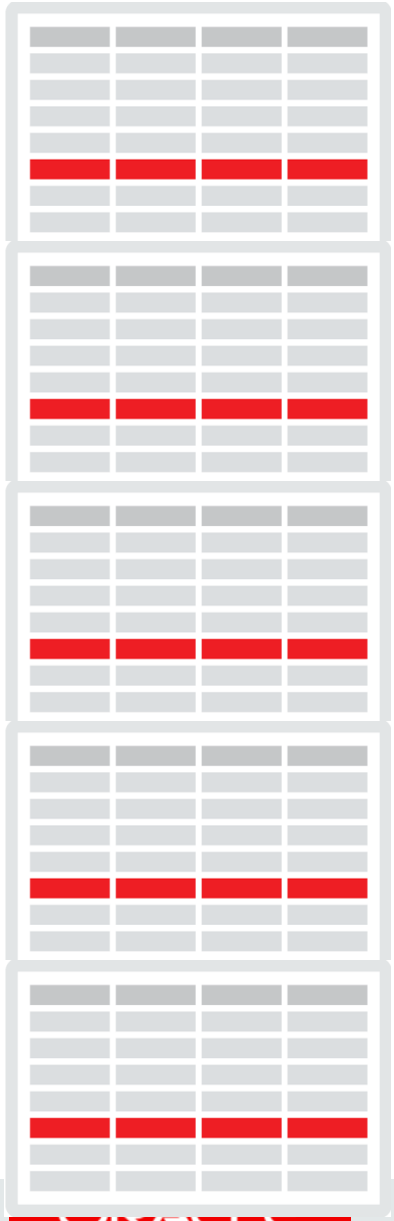
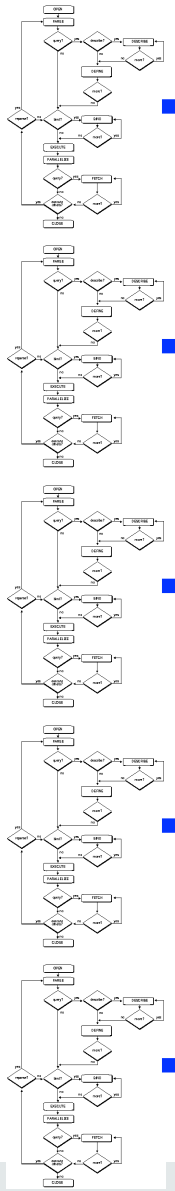
Resources for PL/SQL developers

- oracle.com/plsql – official home of PL/SQL
- oracle.com/oll – Oracle Learning Library
  - Download demo.zip file with all scripts **http://v.gd/05JIWC**
- plsqlchallenge.oracle.com - weekly PL/SQL quizzes, and more
- asktom.oracle.com – 'nuff said
- livesql.oracle.com – script repository and 12/7 12c database
- oracle-developer.net - great content from Adrian Billington
- oracle-base.com - great content from Tim Hall

What's wrong with this picture?





```
SELECT * FROM materialized_view
WHERE pky = 12345;
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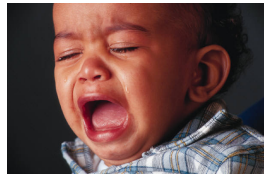
What's Taking So Long?



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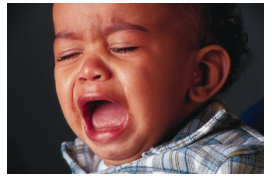

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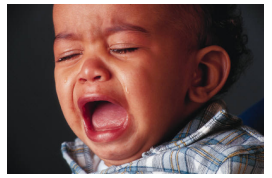

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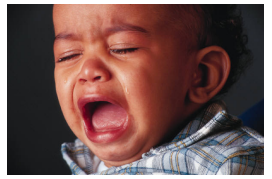

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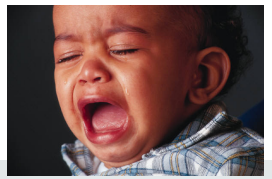

Data Caching Options in PL/SQL

- Caching is a time-honored technique for improving performance.
- Store data that doesn't change for some period of time in a location that can be accessed more quickly than the *source*.
- The SGA is an enormous, complex cache for the entire database instance.
- But there are other caches we can leverage in our PL/SQL code.
  - Deterministic functions
  - PGA caching using package-level variables
  - The function result cache: the most powerful and widely applicable technique

All referenced code available in my demo.zip file from the PL/SQL Learning Library: oracle.com/oll/plsql.

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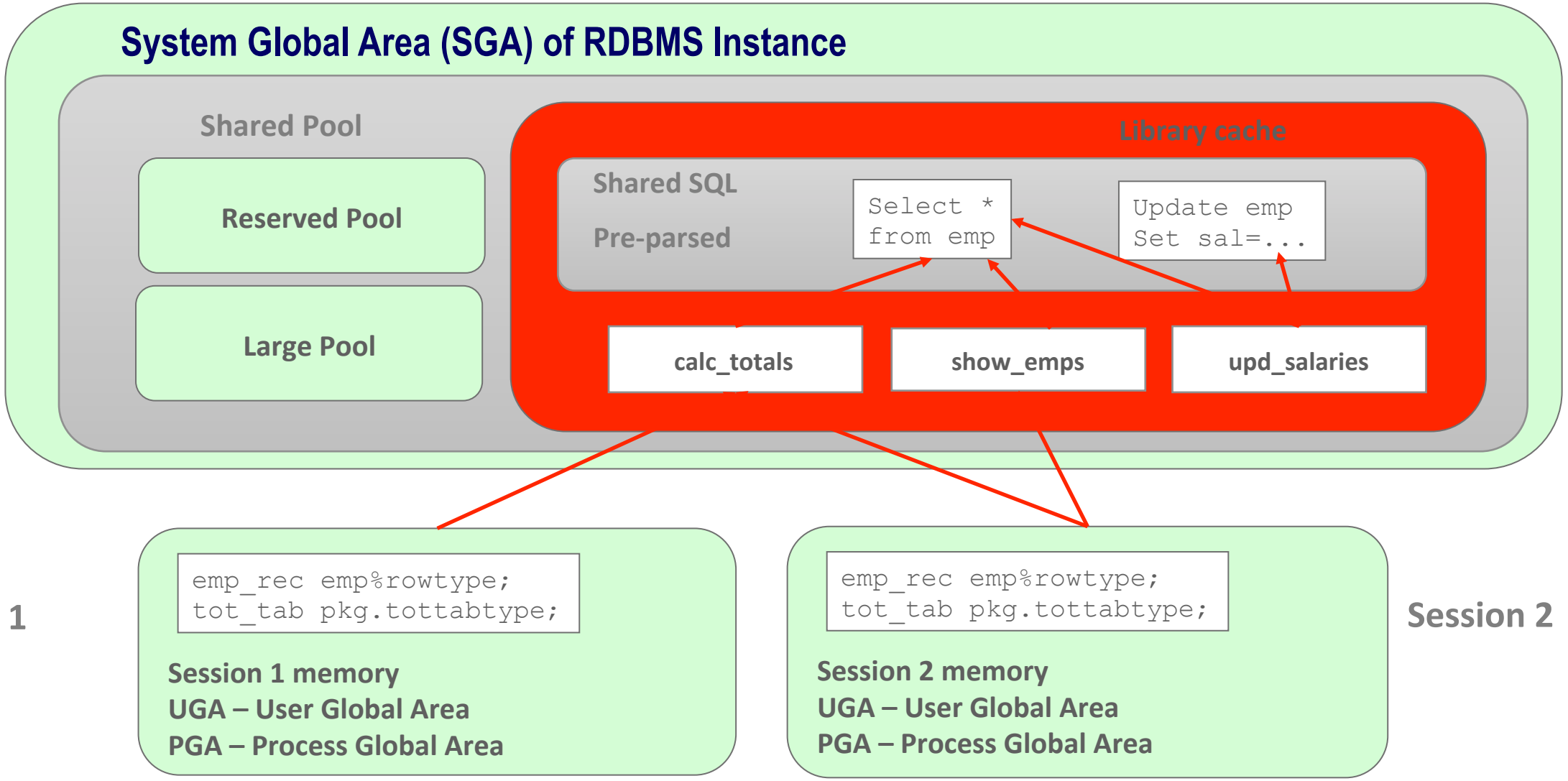
PL/SQL Runtime Memory Architecture



How PL/SQL uses the SGA, PGA and UGA

```
PACKAGE Pkg is                                    /* 11g feature! */
  Nonstatic_Constant CONSTANT PLS_INTEGER := My_Sequence.Nextval;
  Static_Constant    CONSTANT PLS_INTEGER := 42;
END Pkg;
```

- The **SGA** contains information that can be shared across sessions connected to the instance.
  - In PL/SQL, this is limited to package static constants.
- The **User Global Area** contains session-specific data that persists across server call boundaries
  - Package-level data
- The **Process Global Area** contains session-specific data that is released when the current server call terminates: "local" data.

Data Caching Options

- Functions declared as DETERMINISTIC
- PGA caching
  - Used most effectively with collections
  - Accessing PGA memory generally more efficient than SGA, especially if executing SQL.
- Oracle Database 11g Function Result Cache
  - The best caching technique and the most important new feature in 11g for PL/SQL developers.

DETERMINSTIC Functions

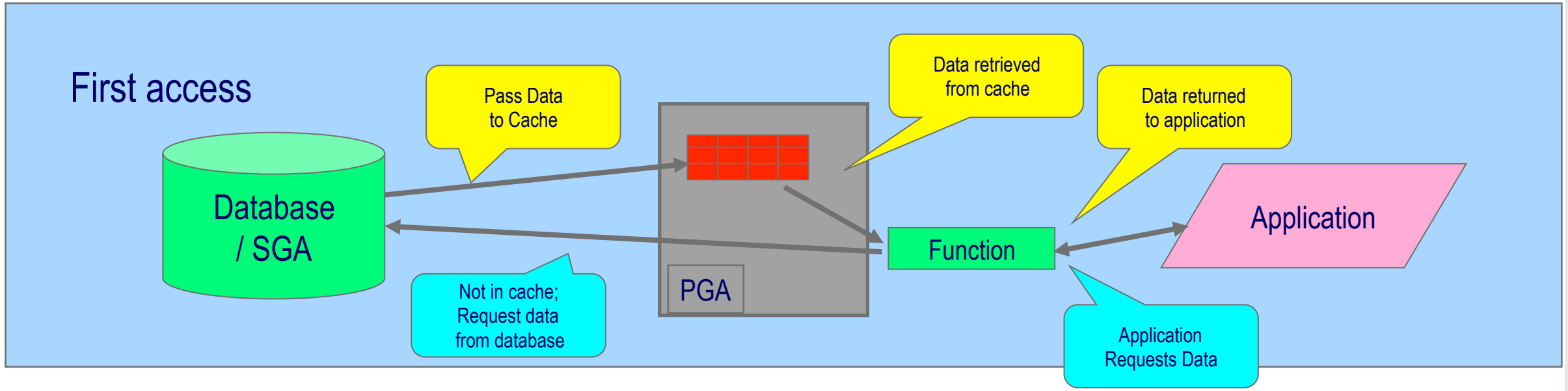
- A function is deterministic if the value it returns is *determined* completely by its inputs (IN arguments).
  - In other words, no *side effects*.
- Add the DETERMINISTIC keyword to your function to enable optimizations:
  - Function-based indexes
  - Cache results *in scope of a query*
- Don't lie!
  - Oracle will not (at compile time) reject your use of the keyword, even if it isn't true.

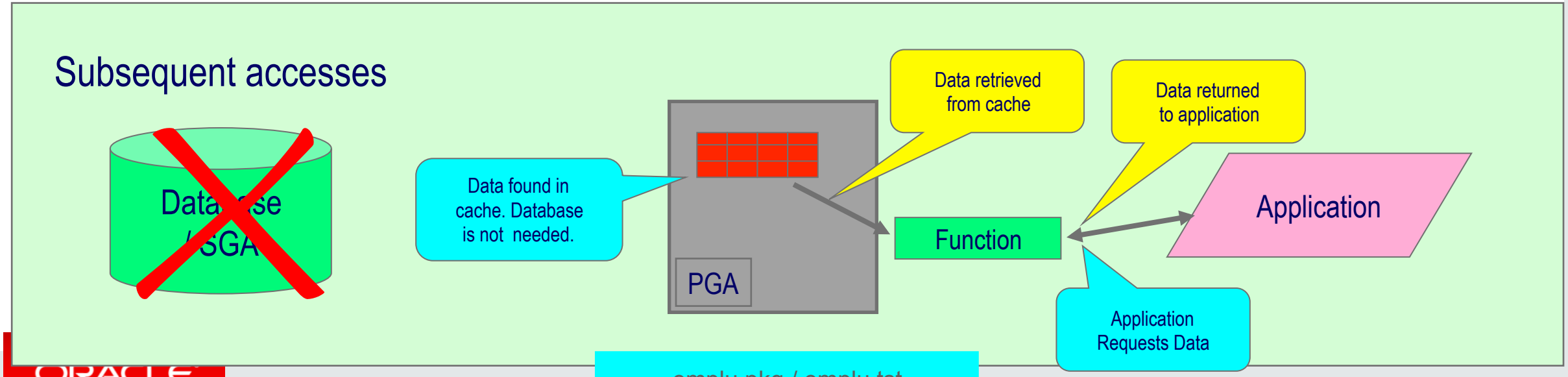
deterministic.sql
deterministic_in_plsql.sql

PGA-Based Caching

- When you declare variables at the package level, their state persists in your session.
  - A PGA-based cache, specific to each session.
- And if you declare a collection at the package level, you can cache multiple rows of data.
  - Very useful for static datasets like materialized views.
- Not a reliable technique for Web-based (usually stateless) applications

Avoiding Unnecessary SGA Lookups





emplu.pkg / emplu.tst

PGA Caching: Things to keep in mind

- Must use package-level data so that it persists.
  - Memory is consumed by the PGA and so is multiplied for all users of the application.
  - Not a reliable technique for stateless application (Internet)
- Very difficult to share cache across sessions in the same instance.
  - One possibility involves DBMS_PIPE.
- Very difficult to update the cache once the data source is changed.
  - Especially by/from, *other* sessions. Possible to use DBMS_ALERT.
- Useful under specific scenarios....
  - Small, static dataset or a single or small number of batch processes

syscache.pkg

The Function Result Cache

- Introduced in Oracle Database 11g, the Function Result Cache is definitely the caching mechanism of choice for PL/SQL developers.
- This cache is stored in the SGA ; shared across sessions; purged of dirty data automatically
- You can and should use it to retrieve data from any table that is *queried more frequently than updated*.
  - Static datasets like materialized views
  - Same rows fetched multiple times (parameter values serve as unique index into cache)
- Enterprise Edition only.

How the Function Result Cache Works

- Add the RESULT_CACHE clause to your function's header.
- When a call is made to function, Oracle compares IN argument values to the cache.
- If no match, the function is executed and the inputs and return data are cached.
- If a match is found, the function is not executed; cached data is returned.
- If changes to a "relies on" table are committed, the cache is marked invalid and will be re-built.

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11g_frc_demo.sql

Minimal Impact on Code with Result Cache

```
CREATE OR REPLACE PACKAGE emplu11g
IS
   FUNCTION onerow (employee_id_in IN employees.employee_id%TYPE)
      RETURN employees%ROWTYPE
      RESULT_CACHE;
END emplu11g;

CREATE OR REPLACE PACKAGE BODY emplu11g
IS
   FUNCTION onerow (employee_id_in IN employees.employee_id%TYPE)
      RETURN employees%ROWTYPE
      RESULT_CACHE RELIES_ON (employees)
   IS
      ....
   END onerow;
END emplu11g;
```

- Add RESULT_CACHE keyword to header of function in both specification and body.
- RELIES_ON clause is deprecated in 11.2. Oracle will automatically determine all tables on which the function relies. RELIES_ON is then *ignored*.

Performance Impact of Result Cache

- The result cache is stored in the SGA.
- So we should expect it be slower than a PGA-based cache.
- But accessing result cache data does not require going through the SQL engine.
- So it should be much faster than executing a query.
  - Even if the statement is parsed and the data blocks are already in the SGA.
- Let's find out!

11g_emplu*.*

Result Cache – Things to Keep in Mind - 1

- If you have uncommitted changes in your session, dependent caches are ignored.
  - The cache will *not* override your own changed data.
- Caching is not performed for complex types: records with CLOBs, collections, etc.
  - But Oracle is optimistic!
- The cache is *not* related to SQL statements in your function.
  - It only keeps track of the input values and the RETURN clause data.

11g_frc_demo.sql

Result Cache – Things to Keep in Mind - 2

- You cannot use the result cache with invoker rights program units until 12.1.
  - Bypass execution of function body, Oracle cannot resolve references to objects - the *whole point* of IR.
- Functions with session-specific dependencies must be "result-cached" with great care.
  - Virtual private database configurations
  - References to SYSDATE, reliance on NLS_DATE_FORMAT, time zone changes
  - Application contexts (calls to SYS_CONTEXT)
- Solution: move all dependencies into parameter list.

11g_frc_vpd.sql
11g_frc_vpd2.sql

Managing the Result Cache

- Oracle offers a number of ways to manage the result cache and tune it to your specific application needs:
- RESULT_CACHE_MAX_SIZE initialization parameter
  - If the cache is too small, then the LRU algorithm negates the point of the cache.
- DBMS_RESULT_CACHE management package
- v$RESULT_CACHE_* performance views

show_frc_dependencies.sp

Fine Grained Dependencies in 11.2

- Oracle keeps track of table dependencies on a per-result level.
  - Each result cached could have a different set of dependencies.
- A change to a table could invalidate just a subset of the results in the cache.
  - It's *not* all or nothing - when your function's different logic paths could "hit" different tables.

11g_frc_dependencies.sql
11g_frc_dependencies2.sql

Make It Easy on Yourself

- I hope you will agree that the result cache is a great feature.
- But how easy will it be for you to apply it?
- If you write/duplicate queries throughout your code, upgrading will be expensive and slow.
- If you hide your queries behind functions, you have a single point of definition, and you can upgrade "instantly."

11g_frc_encapsulation.sql

Conclusions - Caching

- Oracle offers several different ways you can build upon its own caching.
- DETERMINISTIC for functions in SQL
  - Mostly useful for organizing code more effectively
- PGA caching
  - Very fast, but of limited use
- Function result cache
  - Simplest and most widely applicable technique
  - Get ready for it *now* by hiding queries inside functions.

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