The Power of 11g Automatic SQL Tuning

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What is Automatic SQL Tuning?

- Oracle automatically runs the SQL Tuning Advisor on selected high-load SQL statements from the Automatic Workload Repository (AWR) that qualify as tuning candidates
- This task, called Automatic SQL Tuning, runs in the default maintenance windows on a nightly basis
- You can customize attributes of the maintenance windows, including start and end time, frequency, and days of the week
- Automatic SQL tuning runs by default for at most one hour during a maintenance window
- Automatic SQL Tuning needs one-time configuration for accepting automatically SQL profiles on the high-load SQL

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Why do we need Automatic SQL Tuning?

Suboptimal execution plans are often generated by Oracle:

- One reason is the fact that the cost formula is based on a mathematical model which is nothing more than a model
- Another reason is the lack of correlation information between columns or set of columns (in 11g extended statistics were introduced)
  - Two columns in a table are said to be correlated if the values in the columns do not vary independently
  - Job title and salary are related (the DBA of a company is likely to earn a lot more than the developer does?)
  - Car make and price (Lexus is likely to be a lot more expensive than a Toyota)
- The optimizer needs to make decisions about execution plans in a very short time: not all execution plans can be scanned
- Not possible to create a single histogram on multiple columns
- Oracle bugs

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SQL profiles

- Oracle 10g allows the optimizer to run in tuning mode where it can gather additional information and make recommendations about how specific statements can be tuned further
- This process may take several minutes for a single statement so it is intended to be used on high-load resource-intensive statements
- In comprehensive scope the SQL Tuning Advisor does complete analysis including SQL profiles
- Profiles san be accepted/implemented only if suggested
- There is also undocumented way to create profiles using dbms_sqltune.import_sql_profile
- Funny thing is that we rely on the same component to improve the SQL statement that could not generate an optimal plan in the first place ☺

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SQL profiles

- The optimizer may be able to improve performance by gathering additional statistics (data distribution, relations between the columns and joined tables and more useful optimizer information) and altering session specific parameters such as the OPTIMIZER_MODE
- The information is stored in a SQL profile
- If accepted, this information can then be used by the optimizer when running in normal mode
- Unlike a stored outline which fixes the execution plan, a SQL profile may still be of benefit when the contents of the table alter drastically
- Even so, it's sensible to update profiles periodically (when?)

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SQL profiles

- Typically, an accepted SQL profile is associated with the SQL statement through a special SQL signature that is generated using a hash function
- This hash function normalizes the SQL statement for case sensitivity (changes the entire SQL statement to upper case) and white spaces (removes all extra white spaces) before generating the signature
- The same SQL profile thus will work for all SQL statements that are essentially the same, where the only difference is in case usage and white spaces
- By setting force_match to true, the SQL profile will additionally target all SQL statements that have the same text after normalizing literal values to bind variables

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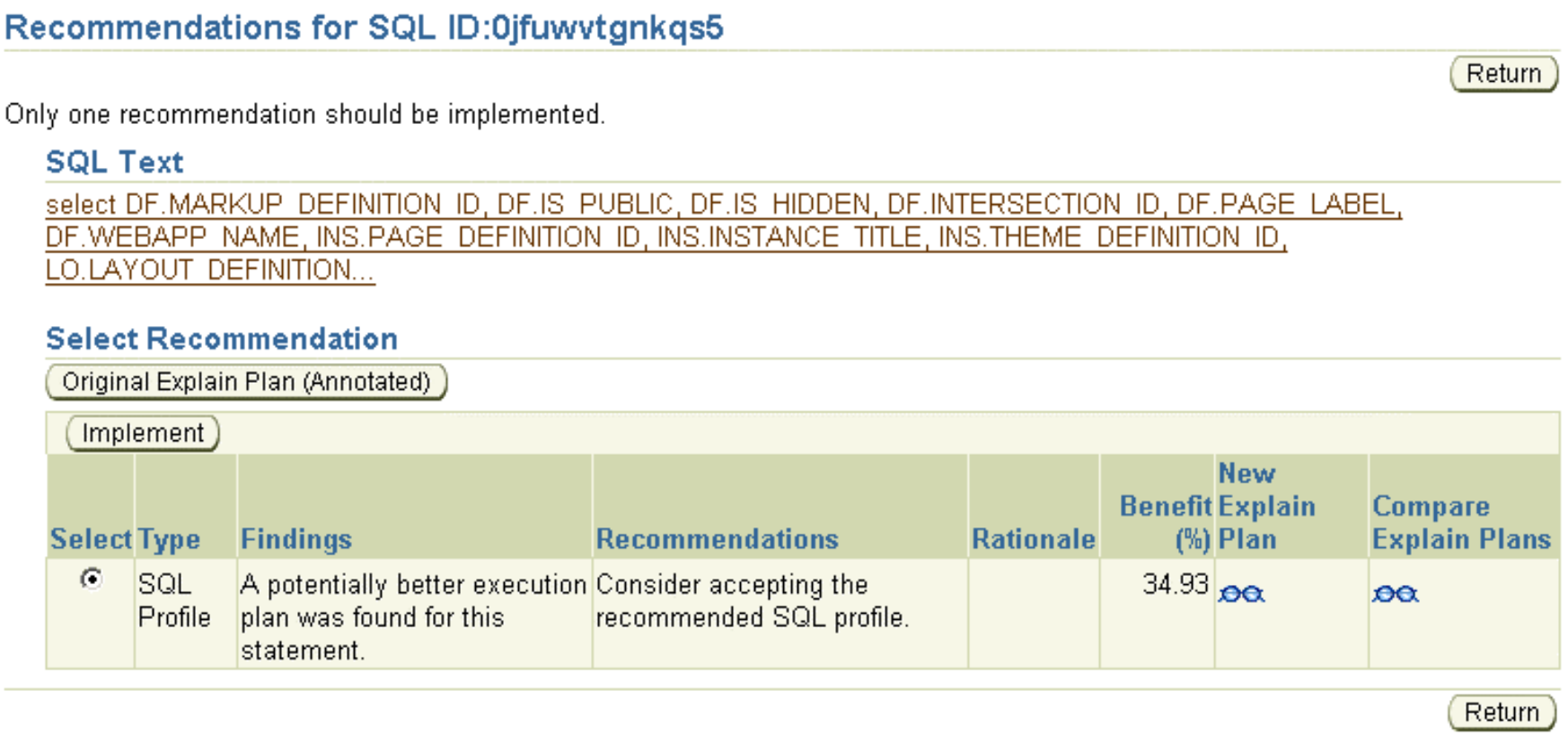
SQL Profiles

Submit the SQL Tuning Advisor task and view the recommendations



Recommendations for SQL ID:0jfuwvtgnkqs5

Return

Only one recommendation should be implemented.

SQL Text

select DF.MARKUP_DEFINITION_ID, DF.IS_PUBLIC, DF.IS_HIDDEN, DF.INTERSECTION_ID, DF.PAGE_LABEL, DF.WEBAPP_NAME, INS.PAGE_DEFINITION_ID, INS.INSTANCE_TITLE, INS.THEME_DEFINITION_ID, LO.LAYOUT_DEFINITION...

Select Recommendation

Original Explain Plan (Annotated)

Implement

Select	Type	Findings	Recommendations	Rationale	Benefit (%)	New Explain Plan	Compare Explain Plans
◉	SQL Profile	A potentially better execution plan was found for this statement.	Consider accepting the recommended SQL profile.		34.93		

Return

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SQL Profiles

Tip 1: Accept the SQL profile with force_matching:

```
SQL> begin
  2   DBMS_SQLTUNE.ACCEPT_SQL_PROFILE(
  3   task_name => 'SQL_TUNING_1214984590140',
  4   category => 'DEFAULT',
  5   force_match => TRUE);
  6   end;
  7  /

PL/SQL procedure successfully completed.
```

NAME	CATEGORY	SIGNATURE	SQL_TEXT	CREATED	LAST_MODIFIED	DESCRIPTION	TYPE	STATUS	FORCE_MAT
SYS_SQLPROF_0146b3afe39bc000	DEFAULT	8.3109E+17	select site_id, id, content_type type, c reator, create_date, logicalpath from v7	28-JUN-08	28-JUN-08		MANUAL	ENABLED	NO
SYS_SQLPROF_0146b8aeea7cc000	DEFAULT	1.7344E+19	select DF.MARKUP_DEF INITION_ID, DF.IS_PU BLIC, DF.IS_HIDDEN, DF.INTERSECTION_ID,	02-JUL-08	02-JUL-08		MANUAL	ENABLED	YES

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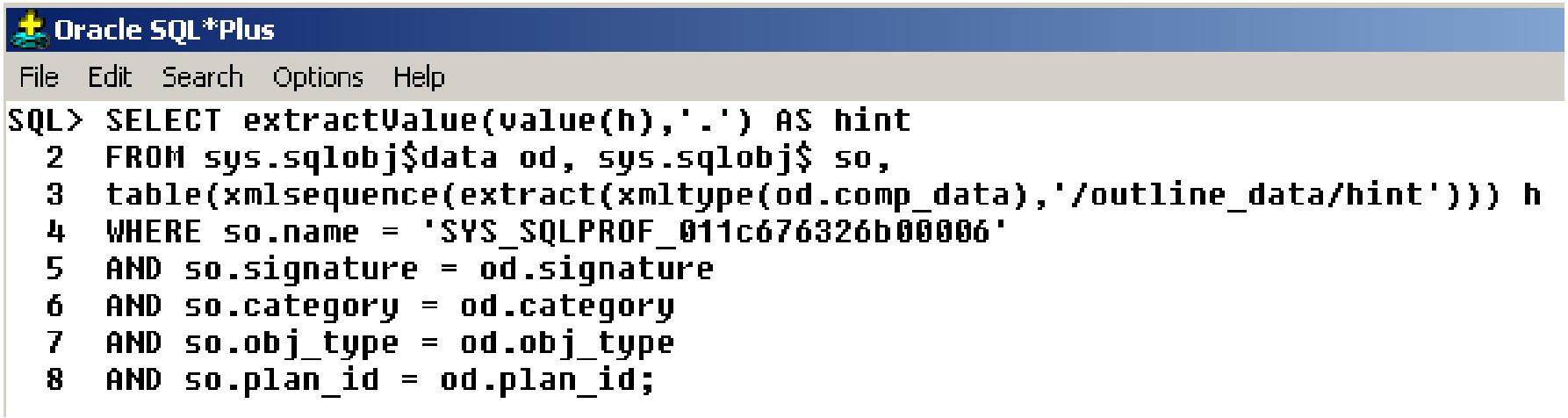
SQL Profiles

- Tip 2: Use the internal tables for viewing the profiles:
- In 10g the profile data is stored in **sqlprof**$ and **sqlprof**$**attr**
- In 11g the profile data is stored in **sqlobj$** and **sqlobj$data**
- In 11g hints are stored in XML format, thus a conversion is necessary to have a readable output



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SQL Profiles

The internal hints look like this:

HINT
IGNORE_OPTIM_EMBEDDED_HINTS
OPTIMIZER_FEATURES_ENABLE(default)
OPT_ESTIMATE(@"SEL$5C160134", INDEX_SKIP_SCAN, "O"@"SEL$3", I_OBJ2, SCALE_ROWS=50.26111767)
OPT_ESTIMATE(@"SEL$5C160134", JOIN, ("U"@"SEL$2", "U"@"SEL$3", "O"@"SEL$3"), SCALE_ROWS=1.592798321)
OPT_ESTIMATE(@"SEL$5C160134", INDEX_SKIP_SCAN, "O"@"SEL$3", I_OBJ5, SCALE_ROWS=50.26111767)
OPT_ESTIMATE(@"SEL$5C160134", JOIN, ("U"@"SEL$2", "U"@"SEL$3", "O"@"SEL$3", "OA"@"SEL$2"), SCALE_ROWS=7.411645275)
OPT_ESTIMATE(@"SEL$5C160134", JOIN, ("TPM"@"SEL$2", "U"@"SEL$2", "OA"@"SEL$2"), SCALE_ROWS=2.429223569)
OPT_ESTIMATE(@"SEL$5C160134", JOIN, ("U"@"SEL$2", "O"@"SEL$3"), SCALE_ROWS=7.433058831)
OPT_ESTIMATE(@"SEL$5C160134", INDEX_SKIP_SCAN, "TPM"@"SEL$2", I_TABLE_PRIVILEGE_MAP, SCALE_ROWS=26)
OPT_ESTIMATE(@"SEL$4", INDEX_SKIP_SCAN, "O2"@"SEL$4", I_OBJ5, SCALE_ROWS=15554.75196)
OPT_ESTIMATE(@"SEL$4", INDEX_SKIP_SCAN, "O2"@"SEL$4", I_OBJ2, SCALE_ROWS=15554.75196)
OPT_ESTIMATE(@"SEL$4", INDEX_FILTER, "O2"@"SEL$4", I_OBJ2, SCALE_ROWS=0.2806703709)
OPT_ESTIMATE(@"SEL$4", INDEX_SKIP_SCAN, "U2"@"SEL$4", I_USER2, SCALE_ROWS=5.6e+10)
OPT_ESTIMATE(@"SEL$4", INDEX_FILTER, "O2"@"SEL$4", I_OBJ5, SCALE_ROWS=0.2806703709)
OPT_ESTIMATE(@"SEL$4", INDEX_SKIP_SCAN, "O2"@"SEL$4", I_OBJ1, SCALE_ROWS=15554.75196)
OPT_ESTIMATE(@"SEL$4", INDEX_FILTER, "O2"@"SEL$4", I_OBJ1, SCALE_ROWS=0.2806703709)
OPT_ESTIMATE(@"SEL$4", TABLE, "O2"@"SEL$4", SCALE_ROWS=0.2806703709)

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SQL Profiles

- The dictionary tables storing the SQL profiles are restructured to accommodate the storage of SQL plan baselines, which are also SQL management objects
- Further, these dictionary tables are now defined in the SYSAUX tablespace
- Tip 3: Usage of the undocumented init.ora parameter _STN_TRACE allows tracing analysis done by the automatic tuning optimizer
- The output is written to a trace file
- For specific values the output is also written to the ORA_DEBUG_TABLE: it does not exist by default, you will have to create it

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SQL Profiles: ORA_DEBUG_TABLE

```
CREATE TABLE ora_debug_table (
  time DATE,
  txt0 VARCHAR2(4000), txt1 VARCHAR2(4000),
  txt2 VARCHAR2(4000), txt3 VARCHAR2(4000),
  txt4 VARCHAR2(4000),
  num0 NUMBER, num1 NUMBER, num2 NUMBER,
  num3 NUMBER, num4 NUMBER, num5 NUMBER,
  num6 NUMBER, num7 NUMBER, num8 NUMBER,
  num9 NUMBER
);
```

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SQL Profiles: _STN_TRACE

Value	Description
1	No output has been observed
2	No output has been observed
4	SQL text, findings, original execution plan and, optionally, INIT.ORA parameters
8	Same as 4 and, in addition, adjusted execution plan
16	SQL text and, optionally, INIT.ORA parameters
32	Almost same as 16
64	Verification of statistics
128	Almost same as 64
256	No output has been observed
512	List of recursive queries with execution statistics
1024	Same as 512 but output written into ORA_DEBUG_TABLE

- Observations thanks to Christian Antognini

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11g automatic SQL tuning

- Oracle 11g automatically runs the SQL Tuning Advisor against high impact SQL statements during maintenance windows
- AWR statistics are used to compile an ordered list of the SQL statements with the greatest performance impact on the system, where the impact is the sum of the CPU and I/O times for the statement during the past week
- The list excludes statements that are inherently less tunable, such as recently (within a month) tuned recursive statements, parallel queries, DML, DDL and SQL statements whose performance problems are caused by concurrency issues
- The SQL tuning advisor is run against each statement in turn
- The outcome may include both SQL profiles and other recommendations

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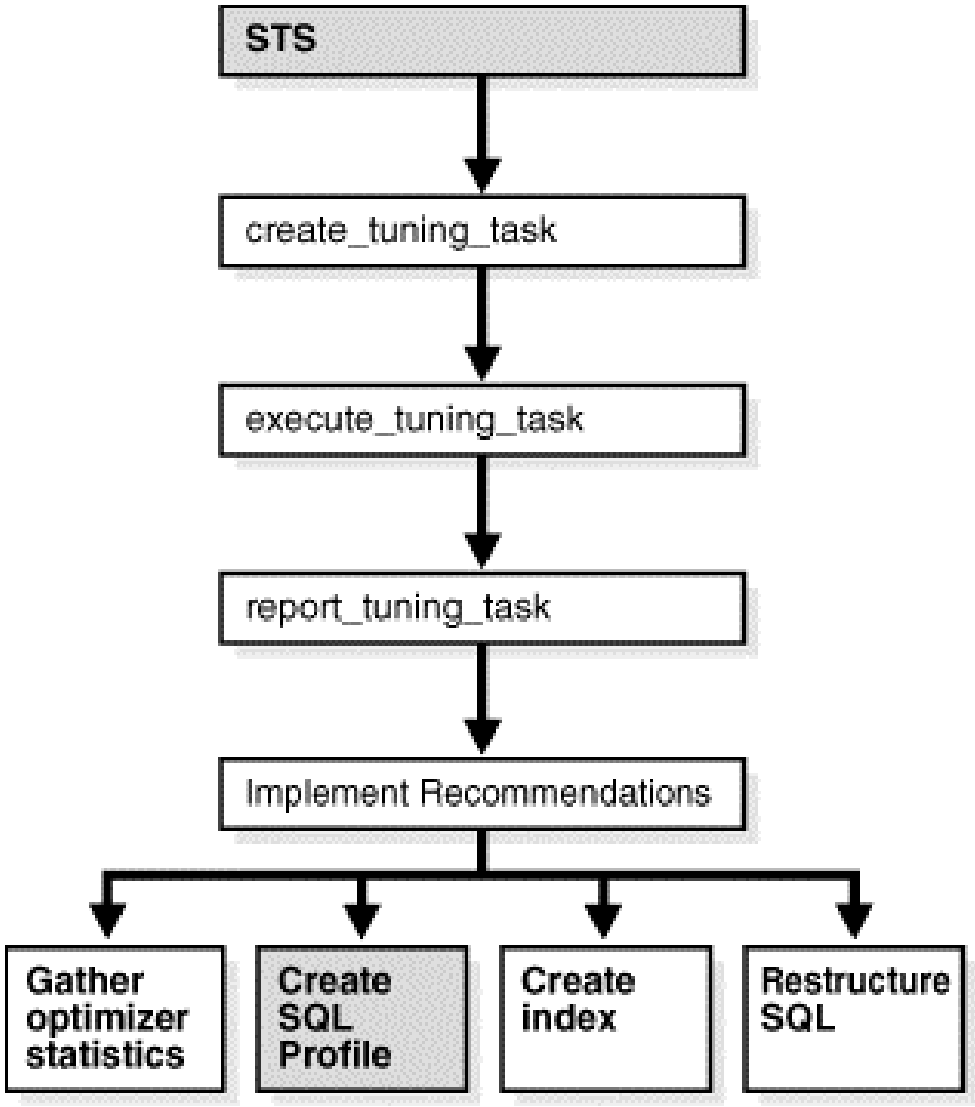
11g automatic SQL tuning



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11g automatic SQL tuning

- Suggested SQL profiles are performance tested, and those that result in at least a threefold improvement are accepted if the ACCEPT_SQL_PROFILES parameter is set to TRUE, or reported if it is set to FALSE
- The accepted SQL profiles are optionally implemented
- Several factors may prevent SQL profiles from being implemented automatically, including stale optimizer statistics of dependent objects
- The TYPE column of the DBA_SQL_PROFILES view indicates if SQL profiles are created manually (MANUAL) or automatically (AUTO-TUNE): shown in the next slide

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11g automatic SQL tuning

NAME	SIGNATURE	SQL_TEXT	CREATED	TYPE	STATUS	FOR
SYS_SQLPROF_011f2ad902ad0007	7.0461E+18	/* OracleOEM */ select distinct gra ntee ,table_name,'SY S_PUBLIC_PACKAGE'	31-JAN-09 06.01.19.000000 AM	AUTO	ENABLED	NO
SYS_SQLPROF_011a834e34320002	1.9014E+18	SELECT LOG_ID, PID, SESSION_ID, PAGE_COU NT, QUERY_STRING, PO ST_PARAMETERS, APPLI	13-JUN-08 10.01.57.000000 PM	AUTO	ENABLED	NO
SYS_SQLPROF_011c676326b00006	5.3907E+18	select /*+ RULE */ T ABLE_NAME from all_t ab_privs where table _name like 'DBA_%' a	15-SEP-08 10.01.03.000000 PM	AUTO	ENABLED	NO
SYS_SQLPROF_0121889bcec10000	1.7258E+19	/* OracleOEM */ S ELECT end_time, stat us, session_key, ses sion_recid, session_	28-MAY-09 10.04.20.000000 PM	AUTO	ENABLED	NO
SYS_SQLPROF_011c33e5cdab0005	5.9401E+18	select tabs.table_n ame, 'ICO', tabs.clu ster_name , p artitioned, iot_type	05-SEP-08 10.03.30.000000 PM	AUTO	ENABLED	NO
SYS_SQLPROF_0120cf335e5c0001	8.7290E+18	SELECT dat.sample_ti me, nvl(dat.wait_cla ss, 'CPU Used') wait _class, dat.session_	22-APR-09 10.00.31.000000 PM	AUTO	ENABLED	NO
SYS_SQLPROF_011af65352db0003	6.4686E+18	SELECT TASK_LIST.TAS K_ID FROM (SELECT /* + NO_MERGE(T) ORDERE D */ T.TASK_ID FROM	06-JUL-08 06.03.53.000000 AM	AUTO	ENABLED	NO
SYS_SQLPROF_011fbb13e9c30000	3.3255E+18	SELECT d_REPORT_10 B.NAME, d_REPORT_1 0B.REGION, d_REPOR T_10B.SITE, d_REPO	28-FEB-09 06.10.58.000000 AM	AUTO	ENABLED	NO
SYS_SQLPROF_011a7909f3a90000	1.7581E+19	SELECT * FROM WMX_VI SIT_ENTRY_EXIT WVEE WHERE EXISTS (SELECT 1 FROM WMX_VISIT_SU	11-JUN-08 10.11.12.000000 PM	AUTO	ENABLED	NO
SYS_SQLPROF_011a7910b3f70001	4.6939E+18	SELECT * FROM WMX_VI SIT_SESSION WVS WHER E EXISTS (SELECT 1 F ROM WMX_VISIT_SUMMAR	11-JUN-08 10.18.35.000000 PM	AUTO	ENABLED	NO

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- The 3 main tunable parameters related to automatic SQL tuning
- Defaults are FALSE, 20 and 10000

```
SQL> SELECT parameter_name, parameter_value
  2  FROM   dba_advisor_parameters
  3  WHERE  task_name = 'SYS_AUTO_SQL_TUNING_TASK'
  4  AND    parameter_name IN ('ACCEPT_SQL_PROFILES',
  5                            'MAX_SQL_PROFILES_PER_EXEC',
  6                            'MAX_AUTO_SQL_PROFILES');

PARAMETER_NAME                 PARAMETER_VALUE
------------------------------ ------------------------------
ACCEPT_SQL_PROFILES            TRUE
MAX_SQL_PROFILES_PER_EXEC      20
MAX_AUTO_SQL_PROFILES          10000
```

- EXECUTION_DAYS_TO_EXPIRE: Specifies the number of days for which to save the task history in the advisor framework schema. By default, the task history is saved for 30 days before it expires

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- Tip 4: use the SET_TUNING_TASK_PARAMETER procedure of the DBMS_SQLTUNE package in order to control the behavior of the SQL tuning advisor
- ACCEPT_SQL_PROFILES - Automatically accept SQL profiles (default FALSE): set it always to TRUE
- MAX_SQL_PROFILES_PER_EXEC - The maximum number of SQL profiles automatically implemented per run (default 20)
- MAX_AUTO_SQL_PROFILES - The maximum number of automatic SQL profiles allowed on the system (default 10000)

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- To disable automatic SQL tuning, use the DISABLE procedure in the DBMS_AUTO_TASK_ADMIN package
- To re-enable automatic SQL tuning, use the ENABLE procedure in the DBMS_AUTO_TASK_ADMIN package
- Setting the STATISTICS_LEVEL parameter to BASIC will disable automatic statistics gathering by the AWR and, as a result, also disable automatic SQL tuning

```
BEGIN
  DBMS_AUTO_TASK_ADMIN.DISABLE(
    client_name => 'sql tuning advisor',
    operation => NULL,
    window_name => NULL);
END;
/
```

```
BEGIN
  DBMS_AUTO_TASK_ADMIN.ENABLE(
    client_name => 'sql tuning advisor',
    operation => NULL,
    window_name => NULL);
END;
/
```

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11g automatic SQL tuning

- Why disable automatic SQL tuning?
- Still there are unfixed bugs: sql too large to fit into the window
- WARNING: Could not set the asynch I/O limit to 2 for SQL direct I/O. It is set to 0

Severity	Category	Time	Alert Log Error Stack
	Generic Alert Log Error	Aug 18, 2009 11:00:12 PM	SYS_AUTO_SQL_TUNING_TASK exiting with error "1760" for execution "EXEC_7681". See DBA_ADVISOR_EXECUTIONS for more details. End automatic SQL Tuning Advisor run for special tuning task "SYS_AUTO_SQL_TUNING_TASK" Errors in file /rman/oracle11/diag/rdbms/rman1o/RMAN1O/trace /RMAN1O_j002_3432.trc: ORA-12012: error on auto execute of job 63907 ORA-01760: illegal argument for function ORA-06512: at "SYS.PRVT_ADVISOR", line 2677 ORA-06512: at "SYS.DBMS_ADVISOR", line 241 ORA-06512: at "SYS.DBMS_SQLTUNE", line 702 ORA-06512: at line 4

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- Workaround: none

Bug No.	8713800		
Filed	21-JUL-2009	**Updated**	23-JUL-2009
Product	Oracle Server - Enterprise Edition	**Product Version**	11.1.0.7.0
Platform	Sun Solaris SPARC (64-bit)	**Platform Version**	10
Database Version	11.1.0.7.0	**Affects Platforms**	Generic
Severity	Severe Loss of Service	**Status**	Description Phase
Base Bug	N/A	**Fixed in Product Version**	No Data

Problem statement:

SQL TUNING ADVISOR JOB FAILS WITH ORA-1760

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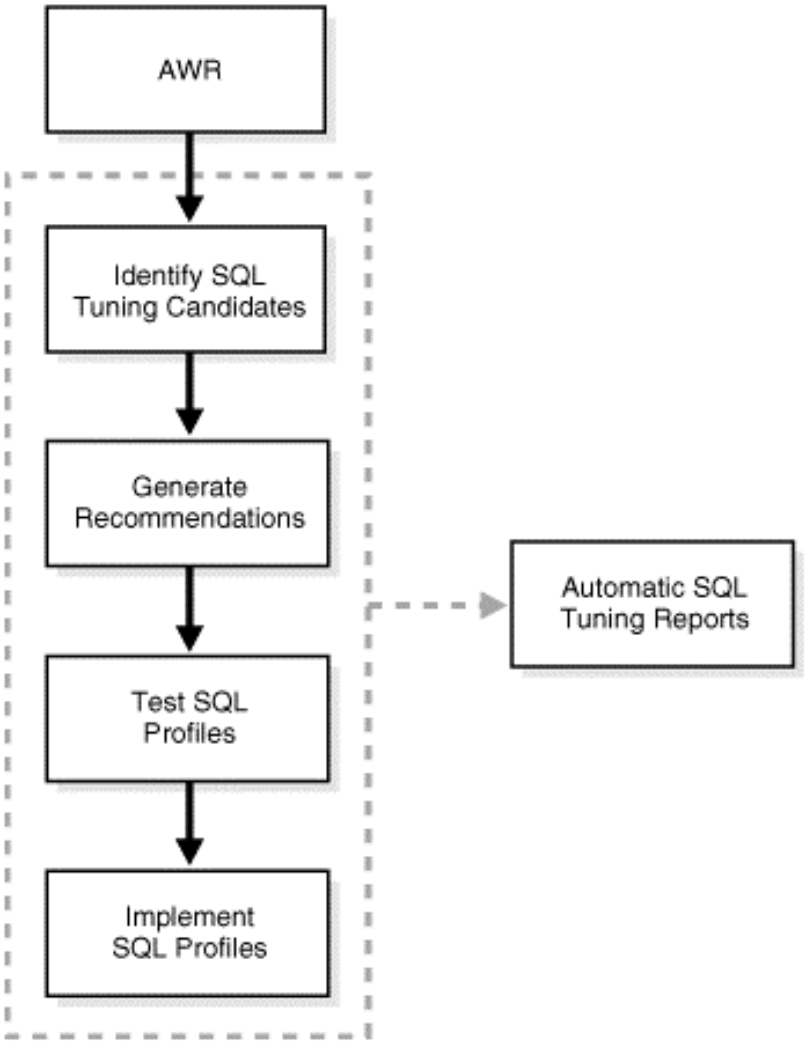
- The steps performed by Oracle Database during the automatic SQL tuning process



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DBMS_SQLTUNE reports

- The REPORT_AUTO_TUNING_TASK function of the DBMS_SQLTUNE package returns a CLOB containing a report from the specified automatic tuning task
- Information found in the CLOB report:
- General information - High-level information about the SQL tuning task
- Summary - A summary of the SQL statements tuned during the task, including the estimated benefit associated with the tuning operation
- Tuning finding - Information about findings, acceptance of the profile, implementation of the profile, and detailed execution statistics for each analyzed statement
- Explain plans - The old and new execution plans for each analyzed statement
- Errors - Any errors encountered during the task

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DBMS_SQLTUNE reports

```
SQL> PRINT :l_report

L_REPORT
------------------------------------------------------------------------------
GENERAL INFORMATION SECTION
------------------------------------------------------------------------------
Tuning Task Name                                : SYS_AUTO_SQL_TUNING_TASK
Tuning Task Owner                               : SYS
Workload Type                                   : Automatic High-Load SQL Workload
Execution Count                                 : 30
Current Execution                               : EXEC_1663
Execution Type                                  : TUNE SQL
Scope                                           : COMPREHENSIVE
Global Time Limit(seconds)                      : 3600
Per-SQL Time Limit(seconds)                     : 1200
Completion Status                               : COMPLETED
Started at                                      : 07/08/2009 22:00:02
Completed at                                    : 07/08/2009 22:00:19
Number of Candidate SQLs                        : 4
Cumulative Elapsed Time of SQL (s)              : 56
```

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How to group profiles

- SQL profiles are grouped in categories
- The initial category is defined when profiles are accepted
- The default category is called DEFAULT: it means that all user sessions where the SQLTUNE_CATEGORY initialization parameter is set to DEFAULT can use the profile
- The active category is defined with the init.ora parameter SQLTUNE_CATEGORY (dynamic)
- Profiled can be moved from one category to another
- Only one category can be active
- Is that really needed ☺ Probably: By altering the category of a SQL profile, you can determine which sessions are affected by the creation of a profile

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Managing profiles

- Use the DBMS_SQLTUNE package to manage profiles
- ACCEPT_SQL_PROFILE
- ALTER_SQL_PROFILE: change status, name, description or category
- DROP_SQL_PROFILE
- CREATE_STGTAB_SQLPROF: create the staging table for the profiles
- PACK_STGTAB_SQLPROF: copy the profiles from the DD to the table
- REMAP_STGTAB_SQLPROF: change name/category in the staging table
- UNPACK_STGTAB_SQLPROF: copy the profiles from the table to the DD

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Privileges for SQL profiles

- No object privileges exist
- The system privilege ADVISOR is needed for using the SQL Tuning Advisor
- For SQL profiles the following exist:
- CREATE ANY SQL PROFILE
- DROP ANY SQL PROFILE
- ALTER ANY SQL PROFILE

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$$$ 11g automatic SQL tuning $$$

- Tip 5: note that in order to use automatic SQL tuning and in particular SQL profiles the Tuning and the Diagnostics packs need to be licensed!
- Automatic SQL tuning via profiles is the most efficient way to massively tune SQL statements: CBO learns from its mistakes ☺
- One of the best new features in 11g
- Best 11g new feature for Data Center DBAs

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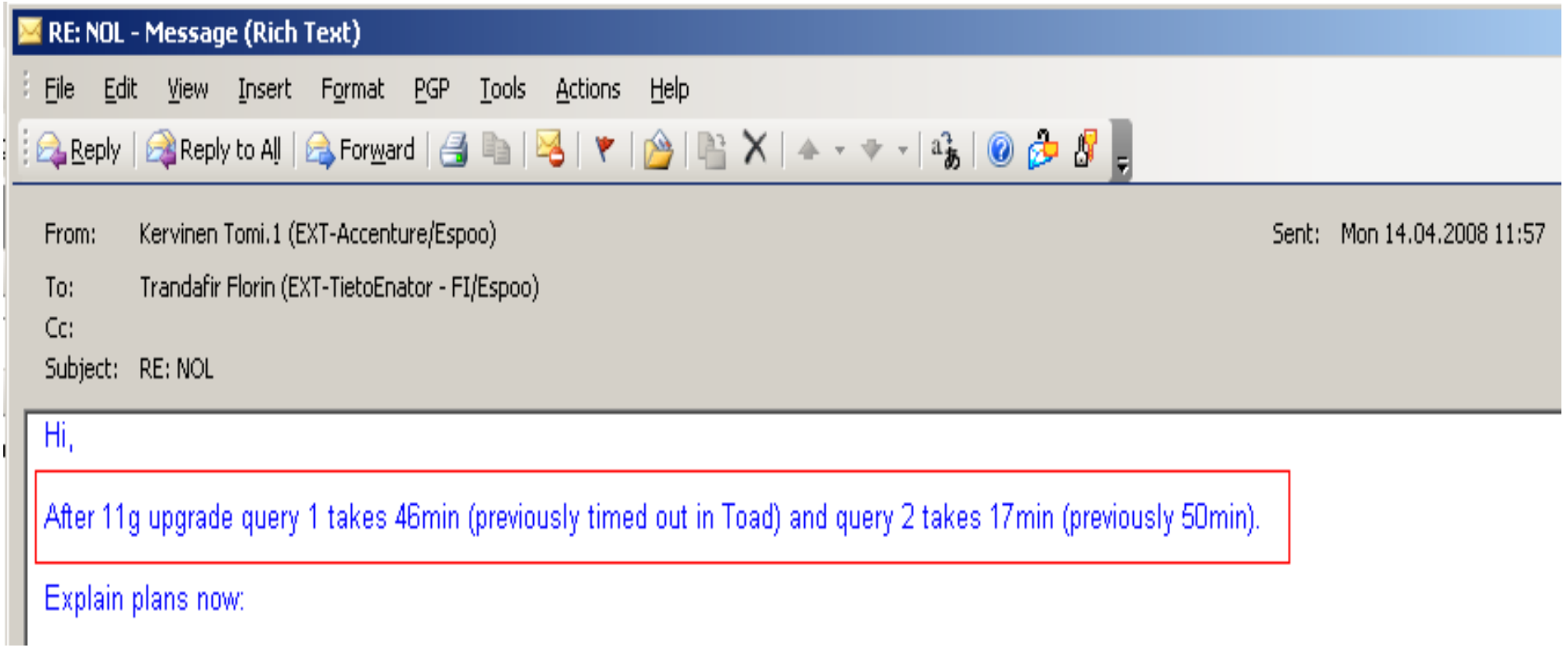
Why is 11g is faster than 10g ☺



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