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What can we learn from how Oracle ADB auto-repairs SQL performance regressions?

Oracle Database 19c

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Safe harbor statement

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Introduction

- The deck content is…
  - Relevant to Oracle Database 11g and onwards
  - Relevant for Oracle Exadata, Autonomous Database and on-premises deployments
  - Not prescriptive or 'best practice' – it is food for thought
  - For environments that largely use *repeatable* SQL
    - Bind-variable SQL
    - Forced cursor sharing
- I will use 'Autonomous Database/ADB features' as shorthand for ADB *and* Exadata features
- I might only look at chat at the end
- Feedback encouraged/welcomed (email, Twitter etc)

Agenda

- Repairing SQL performance regressions in Oracle Autonomous Database
- The *automatic SQL tuning set* (ASTS)
- SQL plan management (SPM) in >=Oracle Database 19c non-ADB/Exadata
- SPM in pre-Oracle Database 19c
  - Especially with upgrade to Oracle Database 19c (non-ADB/Exadata) in mind
- The payoff: repairing SQL performance regressions quickly
  - Mainly aimed at Oracle Database 19c (non-ADB/Exadata)

SQL Plan Management

- SQL plan management (SPM) has been available since Oracle Database 11g
- Enforces SQL execution plans to *prevent* query regression
- 'Approved' (accepted) SQL execution plans are held in the form of SQL plan baselines
- SQL plan baseline plans are not set in stone: schemas change, data changes
  - Using evolution, the optimizer test executes alternative plans, and it can (if desired) enable them automatically when improvements are found
- Strategic/proactive use-case:
  - Capture *all* SQL reusable SQL statements
  - *Proactively prevent* query performance regressions
  - Test and evolve all plan changes
- Tactical/reactive use-case:
  - Tactically 'repair' SQL performance regressions

SQL Plan Management

Oracle Autonomous Database

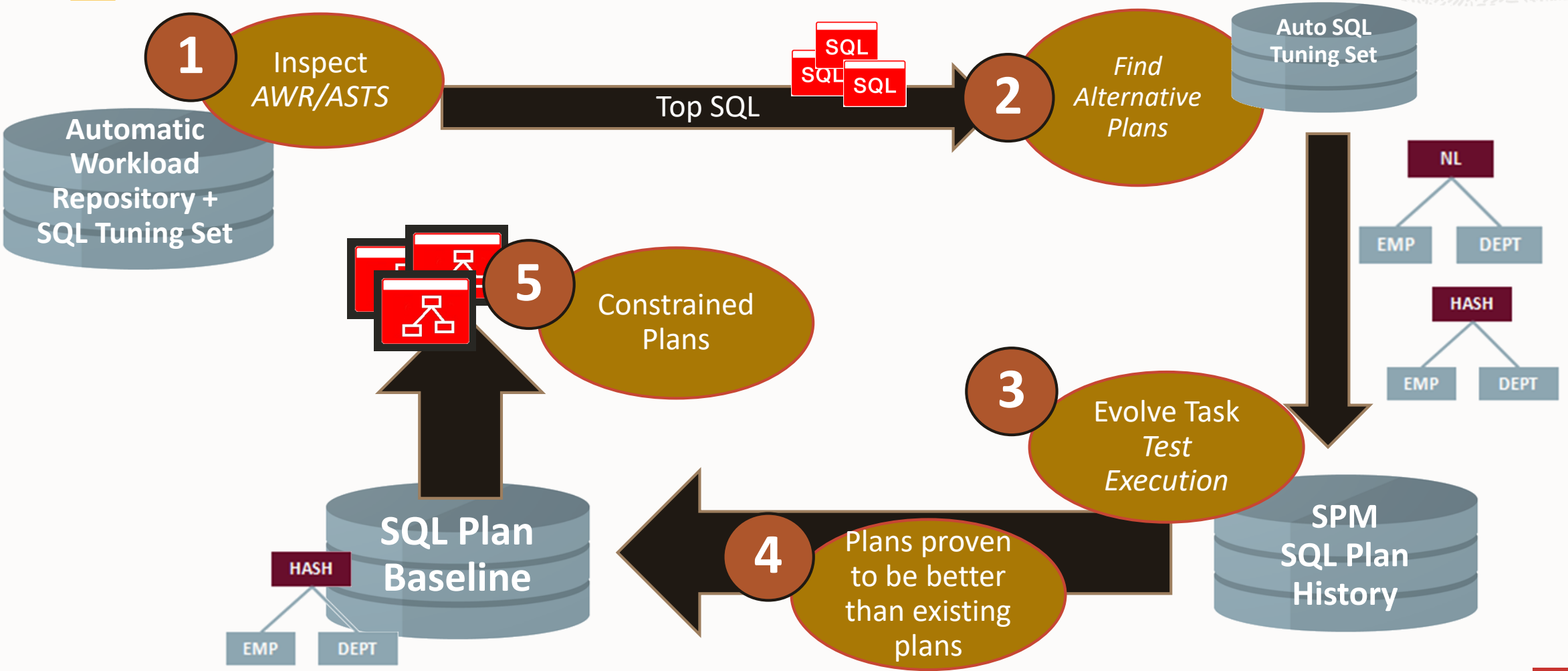
Automatic SQL Plan Management

Oracle Autonomous Database automates the tactical approach

- Automatic SQL plan management detects and repairs SQL performance regressions automatically
  - Automating the tactical approach
- 'AUTO' mode
  - AUTO setting for *alternate_plan_source* and *alternate_plan_baseline* SPM API settings
- AWR and ASTS* are used to target SQL statements and plans that consume significant system resources
  - *ASTS - Auto SQL Tuning Set is a system-maintained SQL tuning set - covered later in this presentation
- Alternative execution plans (for targeted SQL statements) are found in ASTS and stored in SPM for the SPM evolve advisor to test execute and compare
  - "Maybe an old plan is better than the new plan"

- https://blogs.oracle.com/optimizer/what-is-automatic-sql-plan-management-and-why-should-you-care
  https://blogs.oracle.com/optimizer/whats-new-in-the-oracle-optimizer-for-oracle-database-19c

Automatic SQL Plan Management



Summary: Automatic SQL Plan Management

Oracle Autonomous Database

- SPM proactively repairs SQL statement performance regressions
- For high resource-consuming SQL, alternative SQL execution plans are retrieved from ASTS and added to the SPM SQL plan history
  - ACCEPTED = NO in DBA_SQL_PLAN_BASELINES
- The performance of alternative execution plans is compared using test execution in SPM evolve
- 'Winning' SQL execution plans are added to the SQL plan baseline
  - ACCEPTED = YES in DBA_SQL_PLAN_BASELINES
- In Autonomous Database deployments, the *high-frequency SQL plan management* task executes evolution frequently to repair plans quickly outside maintenance windows

Automatic SQL Tuning Set

Automatic SQL Tuning Set (ASTS)

First available in Oracle Autonomous Database

- A SQL tuning set maintained by system (high-frequency) auto tasks
  - See DBA_SQLSET_STATEMENTS for SQLSET_NAME = 'SYS_AUTO_STS'
  - 'Auto STS Capture Task' details in DBA_AUTOTASK_SCHEDULE_CONTROL and DBA_AUTOTASK_SETTINGS*
- Intended to be fully self-managing and used in its default configuration
  - "ON or OFF": DBMS_AUTO_TASK_ADMIN ENABLE/DISABLE (client_name=> 'Auto STS Capture Task'…)
  - *Auto STS Capture Task* instantiates every 15 minutes
  - SQL statement retention is 53 weeks
- Dynamic SQL statement duplication is mitigated
  - There is a soft limit for capturing duplicate force matching signature SQL statements
- ASTS MOS note explains how to monitor resource consumption (Doc ID 2686869.1)
  - ASTS consumes space in SYSAUX
  - ASTS task consumes CPU to gather SQL from cursor cache

*In Oracle Database 20c preview

Automatic SQL Tuning Set (ASTS)

- ASTS was created to support automatic indexing in Oracle Database 19c, then exposed in RU 19.7 as an *infrastructure component*
- Let's address the dark side of the force:
  - Mike's Blog https://mikedietrichde.com/ :
    Do you love unexpected surprises? SYS_AUTO_STS in Oracle 19.7.0
  - See MOS note
    Automatic SQL Tuning Sets (ASTS) 19c RU 19.7 Onwards (Doc ID 2686869.1)
  - ON-by-default in ATP/ADW
  - OFF-by-default (but available) elsewhere
- Latest RUs for on-premises, task is OFF by default
- https://blogs.oracle.com/optimizer/the-auto-sql-tuning-set

SPM in non-ADB/Exadata

>=Oracle Database 19c

SQL Plan Management

>=Oracle Database 19c non-ADB/Exadata Environments

- Consider the significant advantages of keeping workload query plans
  - ASTS
- Ready to repair SQL performance (plan-related) regressions when they occur
- ASTS overheads are visible (Doc ID 2686869.1):
  - ASTS typically less that 1.5GB total but there is of course a wide spread of plan sizes and SQL statement counts
  - 12.2K statements ~540MB or about 45KB/statement but **mileage will vary**
  - Systems with very large number of queries may have shorter SQL statements and smaller plans, so overhead may drop under 10KB/statement
  - Typically 30-60sec capture task runtime for large ASTS (single thread)

SPM in non-ADB/Exadata

Pre-Oracle Database 19c

SQL Plan Capture

Pre-Oracle Database 19c non-ADB/Exadata Environments

- Create and maintain a SQL tuning set
  - Flexible API - DBMS_SQLTUNE.LOAD_SQLSET
- SQL Plan Management capture
  - >= Oracle Database 12.2 has filters for auto capture
  - DBMS_SPM.LOAD_PLANS_FROM_CURSOR_CACHE
    – can be very selective if driven from V$SQLAREA
  - DBMS_SPM.LOAD_PLANS_FROM_SQLSET is a good option too

SQL Plan Capture

Pre-Oracle Database 19c, non-ADB/Exadata Environments

- SPM example:
  - `optimizer_capture_sql_plan_baselines = TRUE`
  - `optimizer_use_sql_plan_baselines = FALSE`
  - `DBMS_SPM.SET_EVOLVE_TASK_PARAMETER(` **>=12c**

```
    task_name => 'SYS_AUTO_SPM_EVOLVE_TASK' ,
    parameter => 'ACCEPT_PLANS',
    value => 'FALSE');
```

- Which means…
  - Capture SQL execution plans automatically in SQL plan history
  - Do not force plans to use SQL plan baselines (yet)
  - Do not allow SQL execution plans to be accepted automatically

SQL Plan Capture

Pre-Oracle Database 19c, non-ADB/Exadata Environments

- What about SPM SYSAUX 'flooding' of legend?
  - Only *repeatable* SQL captured
  - BUG 14054126 - SYSAUX FILL UP WITH SPM, CANNOT PURGE

  - `select * from v$sysaux_occupants where occupant_name = 'SQL_MANAGEMENT_BASE';`
  - `dbms_spm.configure('plan_retention_weeks', NN);` [53 week default]
  - `dbms_spm.configure('space_budget_percent', NN);` [Alert log message]
  - `ret := sys.dbms_spm_internal.auto_purge_sql_plan_baseline;`
  - `Reducing the Space Usage of the SQL Management Base in the SYSAUX Tablespace (Doc ID 1499542.1)`

The Payoff

Repairing SQL Performance Regressions Quickly

Recap: Oracle Autonomous Database

- SQL statement performance regressions are managed fully automatically using *automatic SQL plan management*
- Particularly useful in the context of upgrades
- You can use a manual/semi-manual approach if you want to
- https://blogs.oracle.com/optimizer/spm-auto-capture-vs-auto-spm

>=Oracle Database 19c Non-ADB/Exadata

- If you upgraded your database from an earlier release, you captured pre-upgrade SQL execution plans
- Whether you upgraded or not, you are capturing Oracle Database 19c SQL execution plans
- **You are in a position to address plan-related SQL performance regressions quickly…**

Repairing SQL Performance Regression

>=Oracle Database 19c, non-ADB/Exadata Environments

- https://blogs.oracle.com/optimizer/repairing-sql-performance-regression-with-sql-plan-management
- Assuming that a SQL statement has no SQL plan baseline already, and has suffered a performance regression…
- Step#1: Create a SQL plan history entry for the problem query plan:
  - dbms_spm.load_plans_from_cursor_cache

```
n := dbms_spm.load_plans_from_cursor_cache(
                sql_id          => sqlid,
                plan_hash_value => phv,
                enabled         => 'no');
```

  - dbms_spm.load_plans_from_sqlset

Repairing SQL Performance Regression

>=Oracle Database 19c, non-ADB/Exadata Environments

- https://blogs.oracle.com/optimizer/repairing-sql-performance-regression-with-sql-plan-management
- Step#2: Evolve:

```
tname := DBMS_SPM.CREATE_EVOLVE_TASK(sql_handle=>[handle for SPM SQL plan history entry]);

DBMS_SPM.SET_EVOLVE_TASK_PARAMETER(
   task_name => tname,
   parameter => 'ALTERNATE_PLAN_BASELINE',
   value     => 'EXISTING');

DBMS_SPM.SET_EVOLVE_TASK_PARAMETER(
   task_name => tname,
   parameter => 'ALTERNATE_PLAN_SOURCE',
   value     => 'CURSOR_CACHE+AUTOMATIC_WORKLOAD_REPOSITORY+SQL_TUNING_SET');

DBMS_SPM.SET_EVOLVE_TASK_PARAMETER(
   task_name => tname,
   parameter => 'ALTERNATE_PLAN_LIMIT',
   value     => 'UNLIMITED');

ename := DBMS_SPM.EXECUTE_EVOLVE_TASK(tname);
```

https://github.com/oracle/oracle-db-examples/tree/master/optimizer/spm_fix

Repairing SQL Performance Regression

>=Oracle Database 19c, non-ADB/Exadata Environments

- https://blogs.oracle.com/optimizer/repairing-sql-performance-regression-with-sql-plan-management
- Optional Step#3: Report:
  - `select DBMS_SPM.REPORT_EVOLVE_TASK(task_name=>tname) into from dual;`
- Optional Step#4: Implement:
  - `n := DBMS_SPM.IMPLEMENT_EVOLVE_TASK(tname);`

SQL Plan Baselines in General

- *Enable* the SQL plan baseline plan(s) you want
  - Has an advantage over FIXED, in that alternative (and potentially better) plans are captured in the SQL plan history
- As mentioned earlier, you can control plan acceptance (>=12c)

```
BEGIN
   DBMS_SPM.SET_EVOLVE_TASK_PARAMETER(
      task_name => 'SYS_AUTO_SPM_EVOLVE_TASK' ,
      parameter => 'ACCEPT_PLANS',
      value => 'FALSE');
END;
/
```

Summary

- SQL plan management is central to Oracle's Autonomous Database strategy
- Is it time to re-evaluate plan capture?
- You can use SQL plan management auto capture or bulk capture from multiple sources
- You can capture plans in SQL tuning sets
- You can use SPM to repair SQL performance regressions faster
- There are plenty of options available even if you're upgrading Oracle Database 11g, 12c or 18c non-Autonomous Databases to Oracle Database 19c
- If nothing else, historic plan capture (in addition to AWR) is a useful tool for addressing performance issues

More Information

- @vldbb
- Email Nigel.Bayliss [@oracle.com]
- Optimizer blog:
  - http://blogs.oracle.com/optimizer
  - https://blogs.oracle.com/optimizer/the-auto-sql-tuning-set
  - https://blogs.oracle.com/optimizer/repairing-sql-performance-regression-with-sql-plan-management
- Upgrade blog:
  - https://mikedietrichde.com/
- License guide:
  - https://docs.oracle.com/en/database/oracle/oracle-database/19/dblic/index.html

Thank you