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Oracle 18c/12c New Features For Developers & DBAs

```
If you have trouble
reading this

MOVE UP!

There are numerous
code examples using
this font
```

RMOUG
ROCKY MOUNTAIN ORACLE USERS GROUP

Presented by: John Jay King

Download these slides from: http://kingtraining.com

Session Objectives

- Learn new Oracle features that are geared to developers
- Know how existing database features have been improved in Oracle
- Become aware of some DBA-oriented features that impact developers

Who Am I?

- John King – Partner, King Training Resources
- Oracle Ace Director
- Member Oak Table Network
- I help customers use technology through training and consulting in Oracle and other topics (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
- One of those "dog-spoiling" people

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- Providing customized training solutions since 1988 in the US and internationally
- Oracle topics include: SQL, PL/SQL, Database, Cloud, APEX, ADF, MAF, Forms, Reports, Pro*C/Pro*COBOL
- Non-Oracle topics include: UX, Web Services, IoT, REST, Blockchain, Cloud Foundry, Java, JavaScript, HTML5, CSS, COBOL, .NET, SQL Server, DB2, Business Analyst, and more…
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"Recent" Releases

• Oracle 11g R1	August 2007
• Oracle 11g R2	September 2009
• Oracle 12c R1	June 2013
• Oracle 12c R1.0.2	June 2014
• Oracle 12c R2	Fall 2016 for Cloud March 2017 for all
• Oracle 18.1	Coming soon…

Oracle 18c docs became available last week but it's still not fully GA (yet)

– so, we'll talk about some of the new Oracle 18c features that are coming but will be spending time on Oracle 12c features that are currently available

Want to Play Along?

- Our workshop's timeframe is too short to stop and work on exercises together; so, I've put a set of exercises from our "Oracle 12c Differences" course along with sample solutions on our web page (if you would like to try them) in addition to several examples from these notes – see:

  http://www.kingtraining.com/students

- Note: These are "classroom" examples and should be tested thoroughly before using in a production environment

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18c? What Happened to 13-17?

- Oracle is changing the way they release software and number products!
  - Products will now be released more-frequently
  - Each year starts with a release using the last two digits of the year; updates will be “dot” releases; Oracle 12.2.0.1.0 will be followed by:
    - Oracle 18 Annual Major Release (coming soon!)
    - 18.1-18.4 Quarterly Release Update (RU) (Bundle Patches (like old BP), last approx 2 yrs)
    - 18.1.x Release Update Revision (RUR) (Security & Bug fixes, like old PSU)

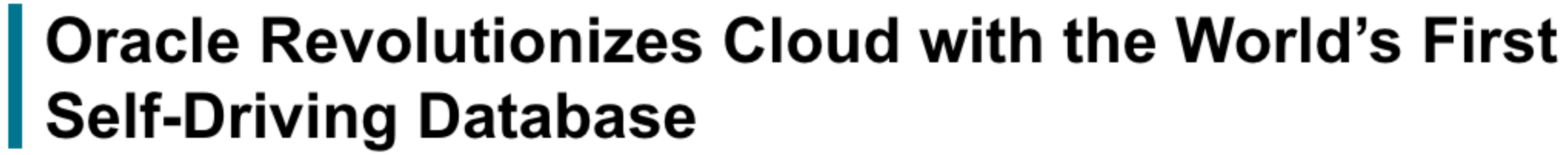
See https://support.oracle.com/epmos/faces/DocumentDisplay?id2285040.1 for more

Oracle 18c Overview

- Oracle 18c is an incremental upgrade to Oracle 12c
- Improvements include:
  - Multi-tenant, In-Memory, Sharding, and Security
  - Reduction in undo requirements for RAC and Exadata
  - Integration of Oracle Database and Microsoft Active Directory for authentication & authorization without Oracle Internet Directory
  - APEX 5.1 various updates
  - Several JSON, PL/SQL, Java improvements

Introduction to Oracle ADWC

- Announced just before Oracle Open World 2017



Oracle Revolutionizes Cloud with the World's First Self-Driving Database

  - Efficient
  - Highly Available
  - Lower Cost
- Oracle **<u>Autonomous</u>** Data Warehouse Cloud built *on top of* Oracle Database 18c

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Larry's After My Job! --- Oh-My!

Not Really…

Cloud Services on top of Database

- Somehow "Autonomous" became synonymous with Oracle 18c – NOPE!
  - OADWC is built upon the Oracle database; the corresponding release happens to be 18c
  - Oracle 18c has many new features in its own right but it's really an incremental improvement of Oracle 12c
  - According to Maria Colgan:

    Autonomous Database =

    Oracle 18c

    + Oracle Cloud Automation and Innovation

    + Secret Sauce

What Do DBA's Do?

- DBA's tasks can be loosely grouped into 2 types:
  - Standard Database Tasks
    - Configuration of systems, network, and storage
    - Provisioning, patching
    - Optimizing database
    - Backups, High-Availability, Disaster Recovery
  - Business-Related Tasks
    - Architecture, planning, data modeling
    - Security and data lifecycle
    - Application-related tuning
    - Managing SLAs

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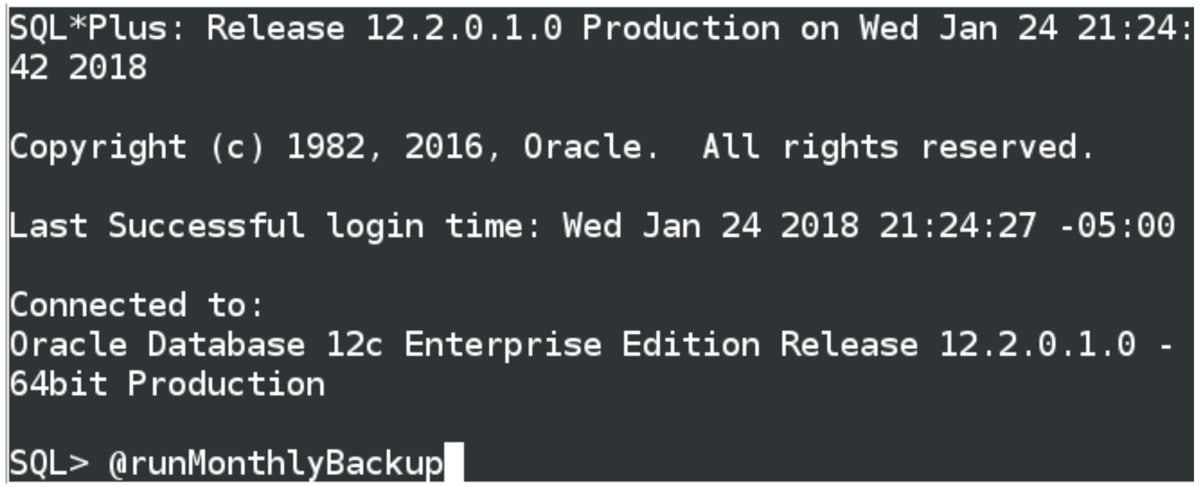
Is it Scripted/Scriptable?

- Many of the day-to-day tasks DBAs are asked to do are boring, mundane, repetitive, and error-prone
  - Most DBA's I know have created or obtained scripts for these activities
  - Running of the scripts is then automated or delegated to junior people

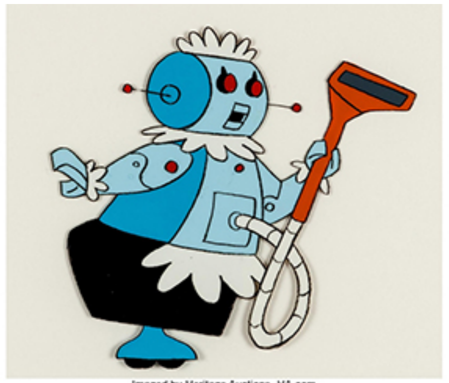


```
SQL*Plus: Release 12.2.0.1.0 Production on Wed Jan 24 21:24:
42 2018

Copyright (c) 1982, 2016, Oracle.  All rights reserved.

Last Successful login time: Wed Jan 24 2018 21:24:27 -05:00

Connected to:
Oracle Database 12c Enterprise Edition Release 12.2.0.1.0 -
64bit Production

SQL> @runMonthlyBackup
```

We All Know The Answer…

- If something can be automated…

  IT WILL BE



- The time is now to automate the boring stuff in our lives

Should I Be Worried?

- If you’ve allowed your job to become one of repetitive, scriptable tasks – YES !

- If you’re known as “the one” who has the answers that bring value to your organization – NO !

Oracle's Journey to Autonomy

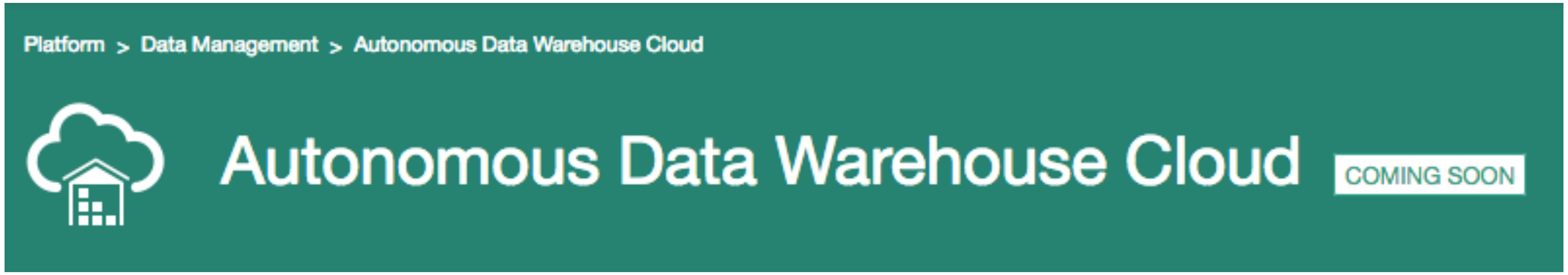
- Oracle has been automating our work for years:

Oracle Database 9i & 10g	Oracle Database 11g & 12c
Automatic Storage Management (ASM) Automatic Memory Management Automatic DB Diagnostic Monitor (ADDM) Automatic Workload Repository (AWR) Automatic Undo tablespaces Automatic Segment Space Management Automatic Statistics Gathering Automatic Standby Management (Broker)Automatic Query Rewrite	Automatic SQL Tuning Automatic Workload Replay Automatic Capture of SQL Monitor Automatic Data Optimization Automatic Storage Indexes Automatic Columnar Cache Automatic Diagnostic Framework Automatic Refresh of Database Cloning Autonomous Health Framework

  – How many of these do you use regularly?

Autonomous Data Warehouse Cloud

- Oracle's first Autonomous Database product is the Oracle Autonomous Data Warehouse Cloud; at the time this paper is being written (Feb 13 2018) the product is not yet GA


Platform > Data Management > Autonomous Data Warehouse Cloud

Autonomous Data Warehouse Cloud COMING SOON

- To follow the progress of ADWC check: cloud.oracle.com/datawarehouse

ADWC Vision

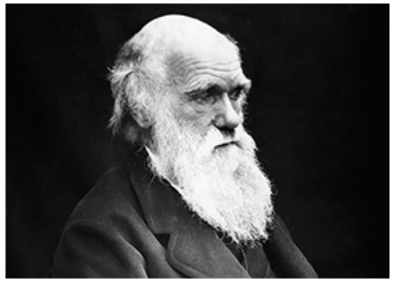
- Oracle's Autonomous Database vision is that it be:
  - Self-driving
    Database automatically follows user-defined service agreements
  - Self-securing
    Safe from both internal and external attack
  - Self-repairing
    Robust and highly-available

What is Oracle ADWC?

- Easy
  - Automated provisioning, patching & upgrades
  - Automated backups
  - Automated performance tuning
- Fast
  - Exadata: high performance, scalable, reliable
  - Uses Oracle Database capabilities: parallelism, columnar processing, compression
- Elastic
  - Elastic compute & storage scaling; 0 downtime
  - Pay only for resources consumed

DBA Job Evolution Continues

- The DBA's job has changed over the years
- DBA tasks continue to evolve, so must we:
  - Less time on maintenance
  - More time INNOVATING
  - More time on BUSINESS
  - Reduce backlogs
  - Get more value from data
  - Improve developer data access
- Experimentation is easier and cheaper in the cloud; take advantage of it
- Take charge of cloud service levels



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Leaving ADWC (for today…)

- Oracle's Autonomous Data Warehouse Cloud is part of today's automation wave
- The Autonomous Data Warehouse Cloud eliminates many of the tedious, boring, and thus error-prone activities
(many DBAs have scripted these already)
- DBAs will be freed up to spend their energy making real improvements to data structure and performance

Oracle 12c – Exciting DBA Stuff

- Oracle In-Memory Database
- Multi-tenant Architecture:
  (first architecture change to Oracle since V6 in 1988!)
  - Container Database (CDB)
  - Pluggable Database(s) (PDB)
- Performance Improvements:
  - Improved optimization
  - Enhanced Statistics & New Histograms
  - "Heat" maps
  - Adaptive Execution Plans
- More cool stuff (watch OOW announcements…)

What is Multi-Tenant?

- Multi-Tenant architecture is designed to achieve two specific goals:
  - Improved performance
  - Ease of management and consolidation
- Multi-tenant has two types of databases:
  - Container Database (CDB) - "Main" database contains up to 252 PDBs (Oracle EE) or exactly one PDB (Oracle SE)
  - Pluggable Database (PDB) - "Application" databases containing application/function-specific users and data

CDB & PDBs Share

- Single SGA
- Single set of database processes
- Single database to patch and/or upgrade (CDB)
- Single database to backup (CDB)
- Single configured container as standby database
- Single configuration for High-Availability, Data Guard, or RAC

What’s the Big Deal?

- Less memory required
- Less space required
- For example:
  - Before Oracle 12c: 30 database instances might require approximately 20 background processes (each) to run; or, about 600 processes
  - 12c: 30 PDBs share 20 background processes (that's it)

Reasons to use Multi-Tenant

- Fast provisioning of new database or copy of existing database
- Fast redeployment to new platform
- Quickly patch and upgrade database version ONCE for all PDBs
- Patch/upgrade unplugging PDB from one CDB and plugging into CDB at later version
- Machine can run more databases as PDBs
- No changes required to user applications

18c Multi-Tenant Highlights

- Oracle 18.1 improves Multi-Tenant including:
  - "Snapshot Carousel" allows PDB clones from many points in time
  - "Refreshable PDB Switchover" to create PDB based upon an updated copy of a master PDB reversing the clone-master roles
  - Improved DataGuard can automatically include all necessary standby data files in a clone operation (should simplify DR)
  - May not clone from an Active DataGuard Standby
  - Backups of PDB's before unplugging may be applied after plugging into new container
  - Each PDB may now have it's own key store for security
  - PDBs may be managed using CDB "fleets" (group of CDBs)

Oracle In-Memory Database

- Oracle introduced new pay-for “In Memory Option” as part of Oracle Database 12.1.0.2 (so far only for Oracle EE)
- Oracle database normally stores data in tables; one row after another (on disk, pulled into memory for processing)
- In Memory Option ALSO stores table data in columnar format in memory
- Data in columnar format can speed some queries significantly

In-Memory “Secret Sauce”

- Both row and columnar formats are in memory at the same time; the optimizer decides which data store will work best
- SGA “In-Memory Area” (new pool) stores as much as will fit
- Tables are added to memory with ALTER TABLE xxx IN MEMORY - pivots data and adds to columnar store
- In-Memory is part of database; transparent to applications once tables added

18c In-Memory Highlights

- Oracle 18.1 includes several improvements to In-Memory Database processing including:
  - Improved single-key fetches via optimized lookup facility
  - Automatic population & aging-out of tables/partitions using Heat Map info
  - New light-weight threads to further speed scans
  - Number types use native representation greatly speeding calculations
  - External table data may be place in column store

Oracle 18c & Active Directory Services

- Oracle 18c features the integration of Active Directory Services with Oracle Database via ALTER ROLE stmt
- Users may be authenticated and authorized directly using the Microsoft Active Directory
- Direct integration with Active Directory improves security:
  - Faster and easier identity management configuration; eliminates difficulty and complexity required in earlier releases
  - Integrates Oracle Database to the enterprise directory service

```
ALTER ROLE some_role IDENTIFIED GLOBALLY AS domain_name_of_dir_group
```

Oracle 12c New Features

- SELECT improvements: Top-n & Pagination, pattern matching, outer join improvements
- Table definition improvements: expanded columns, identity columns, default improvements, invisible columns
- PL/SQL in WITH clause
- Temporal Validity
- Online DML operations
- Truncate CASCADE
- EBR improvements
- JSON in the database (12.1.0.2 & 12.2.0)

18c Developer Highlights

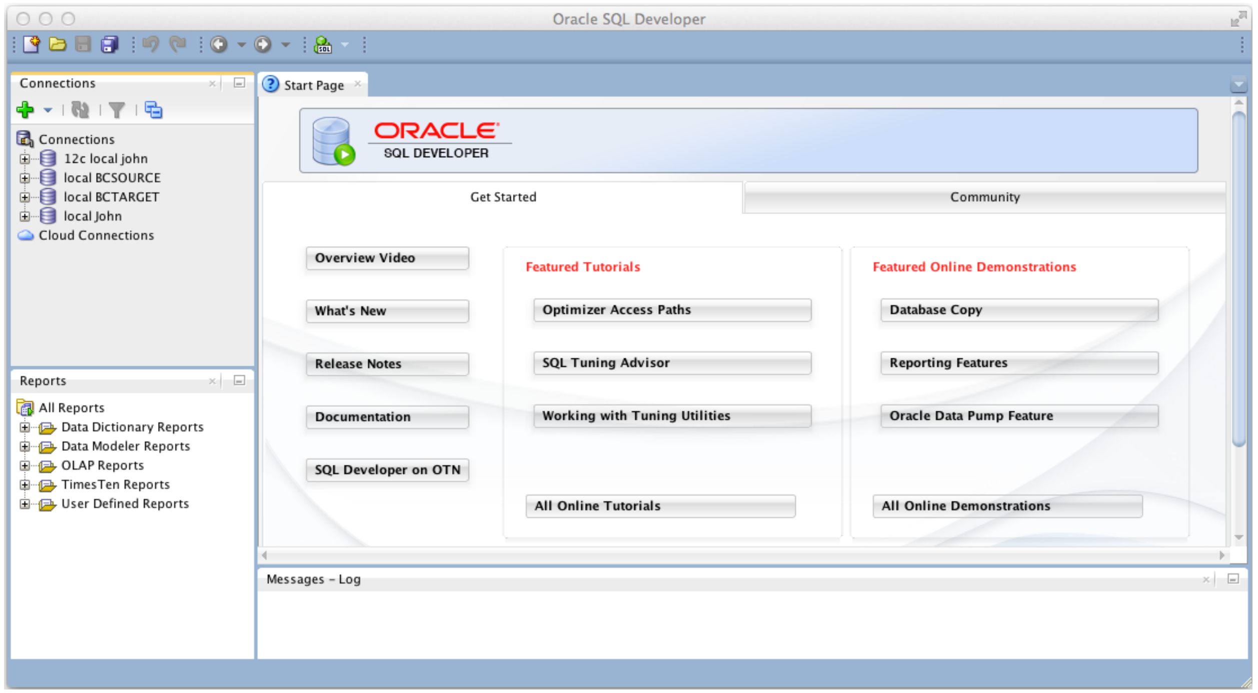
- Oracle 18.1 has new features for developers including:
  - APEX 5.1
  - Private Temporary Tables
  - JSON SQL improvements
  - JSON key maximum extended to 255 characters (from 64)
  - SODA for C and PL/SQL
  - PL/SQL DBMS_HPROF (Hierarchical Profile) procedure
  - Spatial improvements
  - Graph improvements

18c APEX 5.1 Highlights

- Oracle 18.1’s APEX 5.1 includes many new features (sorry, different session, different day):
  - Page Designer Enhancements
  - Interactive Grid
  - New and Updated Packaged Applications
  - Font APEX Icon Library
  - Calendar Enhancements
  - Oracle JET Charts

New SQL Developer

- Oracle SQL Developer 17.3 is now available for download (Sept 29!)
- Many new features & supports Oracle 12c
  (still one or two “wrinkles” …)



Top-N & Pagination

- Oracle 12c adds “top-n” type queries and paginated queries
  - FETCH FIRST/LAST nn ROWS
    FIRST/LAST n PERCENT ROWS
  - OFFSET nn ROWS
- Optimizer uses analytics under the covers to make this work

Top-N: Base Query

- Original query; note row sequence

```
select ename,sal from emp order by sal desc;
ENAME              SAL
---------- ----------
KING              5000
FORD              3000
SCOTT             3000
JONES             2975
BLAKE             2850
CLARK             2450
ALLEN             1600
TURNER            1500
MILLER            1300
WARD              1250
*** more ***
SMITH              800
```

Top-N: Using Rownum

- Original query uses “rownum” – note sequence of data (oops, wrong rows…)

```
select ename,sal from emp
   where rownum < 5 order by sal desc;
--
ENAME                   SAL
---------- ----------
JONES                  2975
ALLEN                  1600
WARD                   1250
SMITH                   800
```

  – Note use of rownum; RANK, or DENSE_RANK in dynamic view (select from (subquery)) may be used to get correct rows

Top-N: First nn ROWS

- Here the first five rows (by value) are selected; note no need for analytics

```
select ename,sal from emp
    order by sal desc
    fetch first 5 rows only;

ENAME             SAL
---------- ----------
KING             5000
SCOTT            3000
FORD             3000
JONES            2975
BLAKE            2850
```

Pagination

- The OFFSET clause may start processing at a given row; when (optionally) paired with FETCH allows pagination in query

```
select ename,sal from emp
   order by sal desc
   offset 2 rows
   fetch first 5 rows only;

ENAME             SAL
---------- ----------
FORD             3000
JONES            2975
BLAKE            2850
CLARK            2450
ALLEN            1600
```

Top-N: Percentage

- Top-N may use a percentage rather than a number of rows

```
select ename,sal from emp
   order by sal desc
   offset 2 rows
   fetch first 5 percent rows only;

ENAME             SAL
---------- ----------
SCOTT            3000
```

APPROX_COUNT_DISTINCT

- Oracle 12.1.0.2 documented aggregate first added internally to Oracle 11g
- Provides approximate value without actually processing all of the rows

```
select count(distinct cust_id) from sh.sales;
COUNT(DISTINCTCUST_ID)
----------------------
7059
      Elapsed: 00:00:00.614
```

```
select approx_count_distinct(cust_id) from sh.sales;
APPROX_COUNT_DISTINCT(CUST_ID)
------------------------------
7014
      Elapsed: 00:00:00.074
```

12.2: Six More Approximates

- APPROX_COUNT_DISTINCT_AGG
  Aggregations of approximate distinct counts
- APPROX_COUNT_DISTINCT_DETAIL
  Input values to APPROX_DISTINCT_AGG
- APPROX_MEDIAN
  Approximate Median
- APPROX_PERCENTILE
  Approximate Percentile
- APPROX_PERCENTILE_AGG
  Aggregations of approximate percentiles
- APPROX_PERCENTILE_DETAIL
  Input values to APPROX_PERCENT_AGG

18c Three More Approximates

- APPROX_COUNT()
  Approximate count of expression, MAX_ERROR option returns max error between approximate and actual
- APPROX_RANK()
  Approximate value from group of values perhaps using PARTITION BY and ORDER BY clauses
- APPROX_SUM()
  Approximate sum of expressions, MAX_ERROR option returns max error between approximate and actual

18c Example APPROX_SUM/RANK

- Here is an example of APPROX_SUM and APPROX_RANK

```
SELECT department_id dept, job_id job, APPROX_SUM(salary) APPROX_SUM
       FROM hr.employees
       GROUP BY department_id, job_id
       HAVING APPROX_RANK (PARTITION BY department_id
                            ORDER BY APPROX_SUM(salary) DESC ) <= 10;
DEPT   JOB           APPROX_SUM
10     AD_ASST             4400
20     MK_REP              6000
20     MK_MAN             13000
30     PU_MAN             11000
30     PU_CLERK           13900
40     HR_REP              6500
50     ST_MAN             36400
```

Matching Patterns

- Enhanced ability to use Regular Expressions enabled by Oracle 12c's MATCH_RECOGNIZE
- Using syntax similar to the MODEL clause and Analytics; rows may be compared to other rows using Regular Expressions
  (beyond capabilities of LAG/LEAD)

MATCH_RECOGNIZE

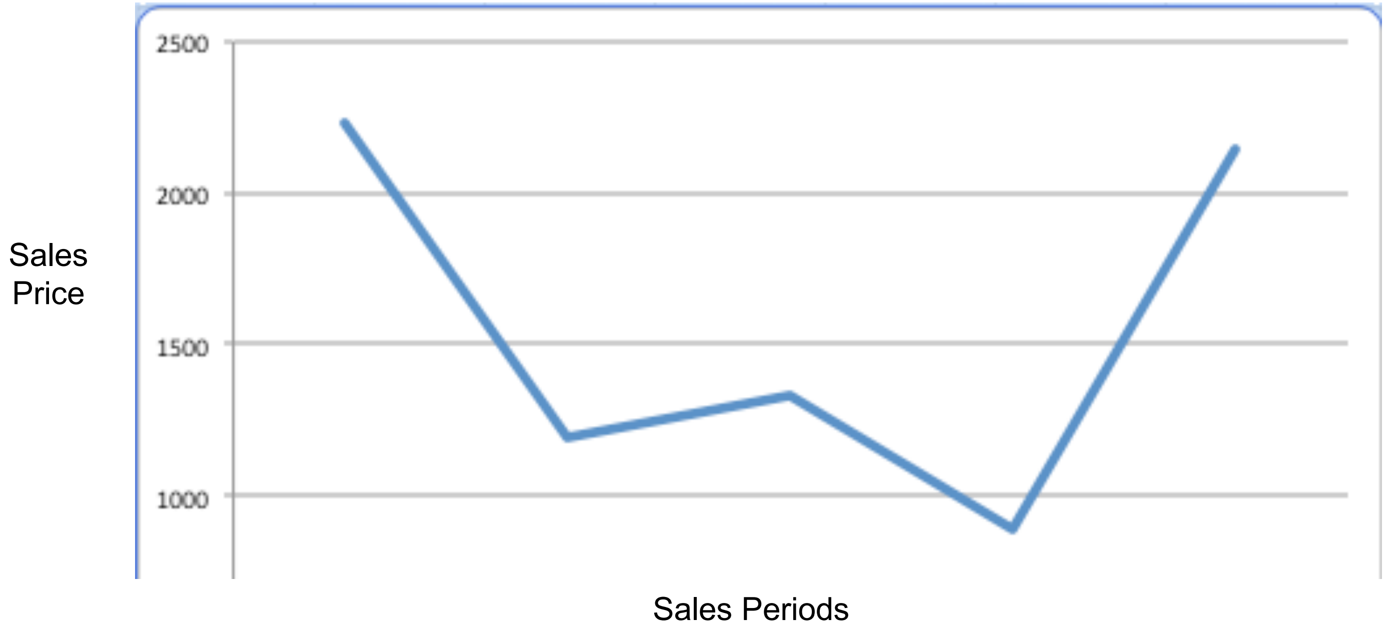
- MATCH_RECOGNIZE includes:

– PARTITION	Segregate data
– ORDER BY	Order with partitions
– MEASURES	Define output columns
– AFTER	Return single/multiple rows
– PATTERN	Define regular expression
– DEFINE	Specify expression tags

Sample MATCH_RECOGNIZE

- The code on the following pages creates a report illustrating sales price patterns (highs & lows) for a specific product over time
- Given five periods of data showing sales of:

2229 1191 1333 887 2148



Sample Code 1

- SELECT uses query in FROM clause to aggregate SH.SALES data by prod_id and day (truncated time_id)

```
select * from
 (select prod_id,trunc(time_id)time_id,
    sum(amount_sold) amount_sold from sh.sales
    where prod_id = 148
       and extract(year from time_id) in (2000,2001)
       group by prod_id, trunc(time_id))
```

Sample Code 2

```
match_recognize (
   partition by prod_id
   order by time_id
   measures to_char(strt.time_id,'yyyy-mm-dd') as start_date,
   to_char(last(down.time_id),'yyyy-mm-dd') as bottom_date,
   to_char(last(up.time_id) ,'yyyy-mm-dd') as   end_date,
   last(round(down.amount_sold)) as bottom_amt,
   last(round(up.amount_sold)) as end_amt
   --one row per match
   after match skip to last up
   pattern (strt down+ up+)
   define
     down as down.amount_sold < prev(down.amount_sold),
     up as up.amount_sold > prev(up.amount_sold)
   ) matcher
order by matcher.prod_id, matcher.start_date
```

Results

- Here are the results and a sample of the data to see what happened
- Two result rows:

```
148 2000-01-18 2000-01-23 2000-01-27      1191      1333
148 2000-01-27 2000-02-02 2000-02-14       887      2148
```

- Matching base data rows:

```
148 18-JAN-00         2229
148 23-JAN-00         1191
148 27-JAN-00         1333
148 02-FEB-00          887
148 14-FEB-00         2148
```

Outer Join Improvements

- Oracle 12c expands the use of the “traditional” Oracle Outer Join syntax (+) to make it more useful
- The (+) notation to create null rows may now be used for multiple tables & columns

Outer Join Example

```
select region_name, country_name, department_name, city
     , count(employee_id) nbr_emps
  from hr.regions r, hr.countries c, hr.locations l,
        hr.departments d, hr.employees e
  where r.region_id = c.region_id(+)
    and c.country_id = l.country_id(+)
    and l.location_id = d.location_id(+)
    and d.department_id = e.department_id(+)
    group by region_name,country_name,department_name, city
    order by region_name,country_name,department_name, city
```

CROSS & OUTER APPLY

- Oracle 12c adds the ability to JOIN values in a generated table collection to regular tables using correlated column values:
  - CROSS APPLY — Join table to generated collection when values match
  - OUTER APPLY — Join table to generated collection when values match and create matches for non-match rows too

Example APPLY - Setup

```
create or replace type name_table_type
      as table of varchar2(100);
create or replace function department_employees (in_department_id varchar2)
   return name_table_type
is
  mynames name_table_type;
begin
  select cast(collect(last_name || ', ' || first_name)
                  as name_table_type)
     into mynames
     from hr.employees
     where department_id = in_department_id;
  return mynames;
end;
/
```

Example APPLY

```
select *
  from hr.departments d
       cross apply
       department_employees(d.department_id) dept_emps;

select *
  from hr.departments d
       outer apply
       department_employees(d.department_id) dept_emps;

select department_name
      ,department_employees(department_id) deptemps
  from hr.departments;
```

LATERAL Inline Views

- Lateral inline views introduce a new keyword allowing correlated references to other tables in a join
  - Correlated tables appear to the left of the inline view in the query’s FROM list
  - Correlation names may be used anywhere within the inline view a correlation name usually occurs
    (e.g. SELECT, FROM, WHERE, …)

Example Lateral Inline View

- Here is an example using a lateral inline view; this syntax would fail without the “LATERAL” keyword

```
select last_name,first_name,department_name
   from hr.employees e, LATERAL(select *
                           from hr.departments d
                           where e.department_id
                                 = d.department_id);
```

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New Column Sizes

- 12c increases max size of VARCHAR2, NVARCHAR2, and RAW to 32,767
- Stored out of line as SECUREFILE CLOB when > 4k
- Now matches PL/SQL variables
- Not default required DBA action:
  - MAX_SQL_STRING_SIZE set to EXTENDED
  - COMPATIBLE must be 12.0.0.0.0+
  - Probably requires system restart to change
  - Once set ***cannot*** be undone

Identity Columns

- Oracle has had SEQUENCES for years; the IDENTITY column allows use of a SEQUENCE as part of a column definition
  (much like some competitor databases)
  - Use "GENERATED AS IDENTITY" clause
  - Default starts with 1 increments by 1
  - May set values using START WITH and INCREMENT BY
  - IDENTITY column resets if table is dropped and recreated

Identity Example 1

```
create table id_test1
(id number generated as identity,
 col1 varchar2(10));
--
insert into id_test1 (col1) values ('A');
insert into id_test1 (col1) values ('B');
insert into id_test1 (col1) values ('C');
--
select * from id_test1;
 ID COL1
---------- ----------
         1 A
         2 B
         3 C
```

Identity Example 2

```
create table id_test1
(id number generated as identity (
       start with 10 increment by 11),
 col1 varchar2(10));
--
insert into id_test1 (col1) values ('A');
insert into id_test1 (col1) values ('B');
insert into id_test1 (col1) values ('C');
--
select * from id_test1;
 ID COL1
---------- ----------
        10 A
        21 B
        32 C
```

Enhanced Column DEFAULT

- Oracle 12c enhances the capabilities of column default settings
  - Columns may be set to a default when NULL values are INSERTed
  - Column default values may be based upon a SEQUENCE (.nextval or .currval)

Example Defaults

```
drop sequence default_test_seq;
drop table default_test;
create sequence default_test_seq start with 1 increment by 1;
create table default_test
(id number default default_test_seq.nextval not null,
 col1 varchar2(10) ,
 col2 varchar2(10)default on null 'N/A' not null);
insert into default_test (col1,col2) values ('A',null);
insert into default_test (col1) values ('B');
insert into default_test (col1,col2) values ('C','test');
select * from default_test;
 ID         COL1       COL2
---------- ---------- ----------
         1 A          N/A
         2 B          N/A
         3 C          test
```

128-Byte Max Name Size

- Oracle 12.2 expands max size of many names from 30 to 128 bytes
- Requires COMPATIBLE init parameter of 12.2 or higher; otherwise max size is still 30
- Schema, table, and column names may all be up to 128 bytes long
- Some Oracle products might not support long names

Long Table & User Names

- Both User and Table names may be 128

```
SQL> create user ridiculously_long_user_name_now_works
  2  identified by whoops;

User RIDICULOUSLY_LONG_USER_NAME_NOW_WORKS created.
```

```
SQL> create table ridiculously_long_table_name_now_works
  2  (ridiculously_long_column_name1 number(4) generated as identity,
  3   ridiculously_line_column_name2 varchar2(400)
  4   );

Table RIDICULOUSLY_LONG_TABLE_NAME_NOW_WORKS created.
```

Data Dictionary

```
SQL> desc ridiculously_long_table_name_now_works
Name                           Null?    Type
------------------------------ -------- -------------
RIDICULOUSLY_LONG_COLUMN_NAME1 NOT NULL NUMBER(4)
RIDICULOUSLY_LINE_COLUMN_NAME2          VARCHAR2(400)
```

```
SQL> desc all_tab_cols
Name                    Null?    Type
-------------------- -------- --------------
OWNER                NOT NULL VARCHAR2(128)
TABLE_NAME           NOT NULL VARCHAR2(128)
COLUMN_NAME          NOT NULL VARCHAR2(128)
DATA_TYPE                     VARCHAR2(128)
DATA_TYPE_MOD                 VARCHAR2(3)
DATA_TYPE_OWNER               VARCHAR2(128)
```

Long Names in PL/SQL

- Here PL/SQL is used to load the column

```
declare
   plsql_also_supports_ridiculously_long_names number := 0;
begin
   FOR j IN 1..5 LOOP
       plsql_also_supports_ridiculously_long_names := j;
       insert into ridiculously_long_table_name_now_works
       (ridiculously_line_column_name2)
       values
       (plsql_also_supports_ridiculously_long_names);
     END LOOP;
     dbms_output.put_line('nbr rows = ' ||
plsql_also_supports_ridiculously_long_names);
END;
/
nbr rows = 5
```

Long Names in SQL

- Use the long names in SQL like any other

```
SQL> select * from ridiculously_long_table_name_now_works;
ridiculOUSLY_LONG_COLUMN_NAME1 ridiculOUSLY_LINE_COLUMN_NAME2
------------------------------ ------------------------------
                             1 1
                             2 2
                             3 3
                             4 4
                             5 5
```

```
SQL> delete from ridiculously_long_table_name_now_works
  2    where ridiculously_long_column_name1 > 5;
5 rows deleted.
```

Column-Level Collation

- Oracle 12.2 allows specifications of collation comparisons at column level
(data-bound collation)
  - Case insensitive BINARY_CI
  - Accent insensitive BINARY_AI

COLLATE BINARY_CI

- Use COLLATE BINARY_CI to make columns case-insensitive

```
CREATE TABLE EMP_CASE_INSENSITIVE
       (EMPNO NUMBER(4) NOT NULL,
        ENAME VARCHAR2(10) COLLATE BINARY_CI,
        JOB VARCHAR2(9),
        MGR NUMBER(4),
        HIREDATE DATE,
        SAL NUMBER(7, 2),
        COMM NUMBER(7, 2),
        DEPTNO NUMBER(2));

Table EMP_CASE_INSENSITIVE created.
```

Test Data Inserts

```
INSERT INTO EMP_CASE_INSENSITIVE VALUES
 (8301,'SMITH','DEVOPS',7902,
   TO_DATE('17-DEC-2016','DD-MON-YYYY'),900,NULL, 20);
1 row inserted.
INSERT INTO EMP_CASE_INSENSITIVE VALUES
  (8302, 'smith', 'DEVOPS', 7902,
    TO_DATE('17-DEC-2016','DD-MON-YYYY'),1000, NULL, 20);
1 row inserted.
INSERT INTO EMP_CASE_INSENSITIVE VALUES
  (8303, 'Smith','DEVOPS', 7902,
    TO_DATE('17-DEC-2016','DD-MON-YYYY'),1100,NULL, 20);
1 row inserted.
INSERT INTO EMP_CASE_INSENSITIVE VALUES
  (8304, 'sMiTh', 'DEVOPS', 7902,
    TO_DATE('17-DEC-2016','DD-MON-YYYY'),1200,NULL, 20);
1 row inserted.
```

Example Case-Insensitivity

```
select empno,ename from EMP_CASE_INSENSITIVE
  where ename = 'SMITH';

     EMPNO ENAME
---------- ----------
      8301 SMITH
      8302 smith
      8303 Smith
      8304 sMiTh
```

Accent-Insensitivity

- To make column comparisons accent insensitive use COLLATE BINARY_AI
- COLLATE BINARY_AI is the same as BINARY_CI except it ignores accent marks

Default Collation

- A table's default collation (for new columns) may be set via CREATE/ALTER TABLE
- Requires INIT PARAMETER MAX_STRING_SIZE = EXTENDED

```
CREATE TABLE sometable
...
DEFAULT COLLATION BINARY_CI
...
```

```
ALTER TABLE sometable
...
DEFAULT COLLATION BINARY_CI
...
```

Session-Specific Sequence

- CREATE SEQUENCE now offers a SESSION parameter allowing a sequence to be reset each time the Global Temporary Table is reinitialized (default is GLOBAL)

```
create sequence session_sample_seq
  start with 1 increment by 1
  session;
```

  - Rows in Global Temporary Tables exist either for the life of the session or transaction
  - While particularly useful for GTTs; session-specific sequences are NOT limited to GTTs

Oracle 18c Private Temporary Tables

- Global Temporary Tables have been a feature for years, Private Temporary Tables (PTT) are a new twist
  - CREATE PRIVATE TEMPORARY TABLE is the same as GTT but only visible to the session that creates it
  - PTTs sllow CREATE DROP TRUNCATE
  - Name must use prefix from PRIVATE_TEMP_TABLE_PREFIX init parameter (default ORA$PTT_)
  - May not create Indexes, MVs, or zone maps
  - Columns may not have default values
  - PTT may not be referenced in any permanent object (table, view, etc.) and are not visible via dblinks

Invisible Columns

- Columns may be marked “INVISIBLE” in CREATE/ALTER table
- Invisible columns do not normally appear in SQL*Plus DESCRIBE or SQL Developer column display (does show in SQL Developer table column list, SQL*Plus COLINVISIBLE ON)
- Invisible columns may be inserted into or omitted from INSERT statements
- When made visible columns appear at end of table (why?? see the next page)

COL$ View

- What happens when a column is marked invisible?
- The database marks column number to 0

```
SELECT c.name,c.type#,c.col#,c.intcol#,c.segcol#,
       TO_CHAR (c.property,'XXXXXXXXXXXX') AS property
FROM sys.col$ c, sys.obj$ o, sys.user$ u
WHERE c.obj# = o.obj#
AND o.owner# = u.user#
AND u.name = 'MYUSER'
AND o.name = 'MYTABLE';
```

  – Col# is set to 0
  – Property is set to x'40000020'

Invisible Column Example 1

```
drop table invisible_test;
create table invisible_test (
 id  number,
 col1 varchar2(10),
 col2 varchar2(10) invisible,
 col3 varchar2(10));
desc invisible_test;
Name Null Type
---- ---- ------------
ID        NUMBER
COL1      VARCHAR2(10)
COL3      VARCHAR2(10)
```

Invisible Column Example 2

```
insert into invisible_test
(col1,col2,col3) values (1,'a','a');
insert into invisible_test
(col1,col3) values (2,'b');
insert into invisible_test values (3,'c');
select * from invisible_test;
alter table invisible_test modify col2 visible;
desc invisible_test;
Name Null Type
---- ---- ------------
ID        NUMBER
COL1      VARCHAR2(10)
COL3      VARCHAR2(10)
COL2      VARCHAR2(10)
```

SQL*Plus History

- SQL*Plus now has a HISTORY command like the ones in Linux and SQL Developer

```
SQL> set history on
SQL> select * from emp;
SQL> select * from dept;
SQL> select * from hr.employees where rownum < 1;
```

```
SQL> history
  1  select * from emp;
  2  select * from dept;
  3  select * from hr.employees where rownum < 1;
```

SQL*Plus – CSV Output

- SQL*Plus can now generate CSV output

```
set markup csv on
select employee_id, last_name || ', '
       || first_name  empname, phone_number
   from hr.employees  order by empname;
set markup csv off
```

```
"EMPLOYEE_ID","EMPNAME","PHONE_NUMBER"
174,"Abel, Ellen","011.44.1644.429267"
166,"Ande, Sundar","011.44.1346.629268"
/* more rows here */
200,"Whalen, Jennifer","515.123.4444"
149,"Zlotkey, Eleni","011.44.1344.429018"

107 rows selected.
```

SQL*Plus Script Performance

- SQL*Plus now allows setting of performance related parameters when running scripts from the command line

```
ARRAYSIZE = 100

LOBPREFETCH = 16384

PAGESIZE = 50000

ROWPREFETCH = 2

STATEMENTCACHE = 20
```

Oracle 18c and External Tables

- Beginning with Oracle 18.1 the SELECT statement allows two new sub clauses as part of the query table expression:

– EXTERNAL	External tables may be defined at runtime, defined as part of a SQL statement removing the need to create as persistent database object
– EXTERNAL MODIFY	Some external table properties may be altered at runtime

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
/
```

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

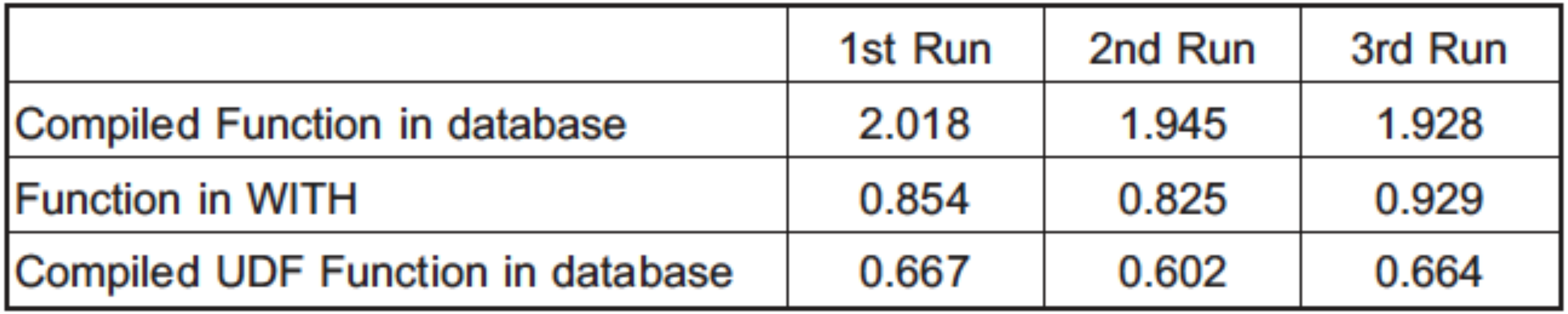
  Probably not a good option for functions also used from PL/SQL !

Example PL/SQL UDF

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

How Did They Rate?

- Here's how the three options stacked up:



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

Temporal Validity

- Oracle 12c adds options to CREATE TABLE, ALTER TABLE, and SELECT allowing use of time dimensions in conjunction with FLASHBACK QUERY
  - Periods are defined using TIMESTAMP columns
  - CREATE/ALTER TABLE's PERIOD clause specifies period starting and ending times
  - SELECT statements AS OF PERIOD FOR clause allows selection of rows falling within periods

Temporal Validity Example

```
CREATE TABLE temporal_emp_test(
  employee_id NUMBER,
  last_name   VARCHAR2(50),
  start_time  TIMESTAMP,
  end_time    TIMESTAMP,
  PERIOD FOR my_time_period (start_time, end_time));
INSERT INTO temporal_emp_test
      VALUES (1000, 'King', '01-Jan-10', '30-Jun-11');
INSERT INTO temporal_emp_test
      VALUES (1001, 'Manzo', '01-Jan-11', '30-Jun-11');
INSERT INTO temporal_emp_test
      VALUES (1002, 'Li', '01-Jan-12', null);
SELECT * from temporal_emp_test AS OF PERIOD
      FOR my_time_period TO_TIMESTAMP('01-Jun-10');
SELECT * from temporal_emp_test VERSIONS PERIOD
      FOR my_time_period BETWEEN TO_TIMESTAMP('01-Jun-10')
                          AND TO_TIMESTAMP('02-Jun-10');
```

Online DDL

- Some DDL statements may be performed ONLINE in Oracle 12c, eliminating the DML lock from earlier releases
  - DROP INDEX … ONLINE
  - ALTER INDEX … UNUSABLE ONLINE
  - ALTER TABLE … SET UNUSED … ONLINE …
  - ALTER TABLE … DROP … ONLINE
  - ALTER TABLE … MOVE PARTITION … ONLINE
  - ALTER TABLE … MODIFY PARTITION … ONLINE
  - ALTER TABLE … MOVE SUBPARTITION …. ONLINE
  - ALTER DATABASE MOVE DATAFILE (….) TO (….)

TRUNCATE … CASCADE

- Oracle 12c’s TRUNCATE statement allows the use of CASCADE to eliminate values in tables that are referentially connected

```
TRUNCATE TABLE ID_TEST1 CASCADE;
```

  - Child table referential security must specify “ON DELETE CASCADE” or statement will fail

UTL_CALL_STACK

- Oracle has provided PL/SQL debug aids for a long time; perhaps your shop uses one: dbms_utility.format_call_stack, dbms_utility.format_error_backtrace, or dbms_utility.format_error_stack
- Oracle 12c adds UTL_CALL_STACK providing greater insight into the stack

UTL_CALL_STACK Functions

- See documentation for a complete list of subprograms – here are a few:
  - CONCATENATE_SUBPROGRAM Concatenated unit name
  - DYNAMIC_DEPTH
    Number of subprograms on call stack
  - LEXICAL_DEPTH
    Lexical nesting level of subprogram
  - UNIT_LINE
    Line number in backtrace unit

Using UTL_CALL_STACK

```
create or replace procedure Print_Call_Stack
As
   DEPTH pls_integer := UTL_CALL_STACK.dynamic_depth();
   procedure printheaders is
    /* more code */
   procedure print is
     begin
      printheaders;
      for stunit in reverse 1..DEPTH loop
       dbms_output.put_line(
        rpad( UTL_CALL_STACK.lexical_depth(stunit), 10 )
        || rpad( stunit, 7)
        || rpad(to_char(UTL_CALL_STACK.unit_line(stunit),
            '99'), 9 )
        || UTL_CALL_STACK.concatenate_subprogram
      end loop;
    /* more code */
```

Anatomy of Test Package

- The example package illustrates code nested within code:

```
package body TestPkg is
  procedure proc_a is
    procedure proc_b is
       procedure proc_c is
         procedure proc_d is
           Print_Call_Stack();
```

UTL_CALL_STACK Results

```
begin TestPkg.proc_a; end;
Error report -
ORA-06501: PL/SQL: program error
ORA-06512: at "JOHN.TESTPKG", line 11
ORA-06512: at "JOHN.TESTPKG", line 14
ORA-06512: at "JOHN.TESTPKG", line 17
ORA-06512: at "JOHN.TESTPKG", line 20
ORA-06512: at line 1
06501. 00000 - "PL/SQL: program error"
*Cause: This is an internal error message. An error has
been detected in a PL/SQL program.
*Action: Contact Oracle Support Services
TESTPKG.PROC_A
TESTPKG.PROC_A.PROC_B
TESTPKG.PROC_A.PROC_B.PROC_C
TESTPKG.PROC_A.PROC_B.PROC_C.PROC_D
PRINT_CALL_STACK
PRINT_CALL_STACK.PRINT
```

Oracle 18c PL/SQL Features

- Oracle 18c brings three major additions to PL/SQL
  - NOT PERSISTABLE TYPEs
  - Polymorphic Table Functions
  - Qualified Expressions

Oracle 18c NOT PERSISTABLE Types

- Oracle 18c provides the ability to mark TYPEs as NOT PERSISTABLE to make sure that unsuitable data types are not persisted to disk
- PL/SQL Abstract Data Type (ADT), OBJECT (including incomplete objects), VARRAY, and TABLE data types may added to Abstract Data Type (ADT) definitions in addition to SQL data types types
- Marking the TYPE as NOT PERSISTABLE makes sure the TYPE will not be used improperly

Oracle 18c NOT PERSISTABLE Example

- The default for TYPEs is to be PERSISTABLE

```
CREATE TYPE ct_phone_list_type1 AS VARRAY(8) OF VARCHAR2(15);
CREATE TYPE ct_address_type1 AS OBJECT( street_address_1 VARCHAR2(40),
      street_address_2 VARCHAR2(40), postal_code VARCHAR2(10),
      city VARCHAR2(30), state_province VARCHAR2(10), country_code CHAR(2),
      phone ct_phone_list_type1);
Type created.
```

- Marking a TYPE as NOT PERSISTABLE makes upgrades smoother and reduces errors

```
CREATE TYPE ct_phone_list_type2 AS VARRAY(8) OF (VARCHAR2(15)) NOT PERSISTABLE;
CREATE TYPE ct_address_type2 AS OBJECT( street_address_1 VARCHAR2(40),
      street_address_2 VARCHAR2(40), postal_code  VARCHAR2(10),
      city VARCHAR2(30), state_province VARCHAR2(10), country_code CHAR(2),
      phone ct_phone_list_type2);
Errors: TYPE ct_ADDRESS_TYPE2
Line: 0 ORA-22383: a persistable type cannot have non-persistable attributes
```

18c PL/SQL Qualified Expressions

- Oracle 18c PL/SQL makes it easier to provide complex values when initializing data
- Qualified expressions are used to provide values when creating either RECORD type or Associative Array (PL/SQL table) easily

18c Qualified Expression Example

```
CREATE OR REPLACE PACKAGE mypkg
 IS
    TYPE myrec_typ IS
         RECORD (year_num PLS_INTEGER := 0, year_txt VARCHAR2 (100) );
END;
--
DECLARE
  myrec1 mypkg.myrec_typ := mypkg.myrec_typ(1776,'ONE SEVEN SEVEN SIX');
  myrec2 mypkg.myrec_typ := mypkg.myrec_typ(year_num => 1, year_txt => 'ONE');
  myrec3 mypkg.myrec_typ := mypkg.myrec_typ(NULL,NULL);
  PROCEDURE print_rec
    ( pi_rec mypkg.myrec_typ := mypkg.myrec_typ(1918+100, 'This '||'Year'))
     IS
      myrec1 mypkg.myrec_typ := mypkg.myrec_typ(2847,'TWO EIGHT FOUR SEVEN');
BEGIN
  DBMS_OUTPUT.PUT_LINE(NVL(pi_rec.year_num,10) ||' ' ||NVL(pi_rec.year_txt,’Ten'));
END;
```

12c (12.1.0.2) and JSON

- 12c patch-set 2 (12.1.0.2) adds JSON data
- JSON documents are stored as VARCHAR2, CLOB, or BLOB data type
- JSON data works with all existing Oracle features including SQL and Analytics
- 12c supports path-based queries of JSON data stored in the database, JSON Path Language, and JSON Path Expressions
- JSON is used in SQL via SQL/JSON views
- JSON documents may be indexed

18c JSON Improvements

- Oracle 18.1 adds new features for JSON
- Index key may now be 255 chars (64 max before 18c)
- May now use TREAT exp AS JSON in input to generation
- JSON generation datatype expanded

JSON-XML Similarities

- JSON is text only, just like XML and thus is an excellent vehicle for data interchange– JSON and XML are both plain text
- JSON and XML are “human readable” and "self-describing”
- JSON and XML are hierarchical (data sets nested within data sets)
- JSON and XML offer validation capability; XML’s is more mature and capable today

JSON-XML Dissimilarities

- XML is verbose, JSON is shorter
- JSON does not end tags, required in XML
- JSON is quicker to read and write
- Reading XML documents requires "walking the DOM" – JSON does not
- JSON works more easily and is faster than XML when working with AJAX
- XML documents must be tested for "well-formed"-ness before processing

XML File

```
<?xml version="1.0"?>
<myBooks>
  <book>
    <name>Learning XML</name>
    <author>Eric T. Ray</author>
    <publisher>O'Reilly</publisher>
  </book>
  <book>
    <name>XML Bible</name>
    <author>Elliotte Rusty Harold</author>
    <publisher>IDG Books</publisher>
  </book>
  <book>
    <name>XML by Example</name>
    <author>Sean McGrath</author>
  </book>
</myBooks>
```

JSON File

```
{"myBooks":
  [ {"book":
     "name":"Learning XML",
     "author":"Eric T. Ray",
     "publisher":"O'Reilly"
     },
     {"book":
     "name":"XML Bible",
     "author":"Elliotte Rusty Harold",
     "publisher":"IDG Books"
     },
     {"book":
     "name":"XML by Example",
     "author":"Sean McGrath",
     "publisher":"Prentice-Hall"
     }
  ]}
```

Oracle as JSON Data Store

- JSON documents are stored in the database using existing data types
  - VARCHAR2, CLOB and BLOB for character mode JSON
  - External JSON data sources accessible through external tables
  - JSON in file system (also HDFS) can be accessed via external tables

JSON SQL

- JSON content is accessible from SQL via new operators
  - JSON_VALUE Used to query a scalar value from a JSON document
  - JSON_TABLE Used to query JSON document and create relational-style columns
  - JSON_EXISTS Used in query to see if JSON path exists in document IS JSON Used to validate JSON, usually in CHECK constraint
- JSON operators use JSON Path language to navigate JSON objects

JSON Check Constraint

```
create table deptj
(id raw(16) not null,
 dept_info clob constraint deptjson
                check (dept_info is json)
);
```

JSON and DML

```
insert into deptj values
(sys_guid(),
 '{"departments":{
   "DEPTNO": 10, "DNAME": "ACCOUNTING", "LOC": "NEW YORK",
    "deptemps": [
                 { "EMPNO": 7782,
                   "ENAME": "CLARK",
                   "JOB": "MANAGER",
                   "MGR": 7839,
                   "HIREDATE": "09-JUN-81",
                   "pay":{
                          "SAL": 2450,
                          "COMM": null},
                   "DEPTNO": "10"
                  },
                  /* more */
```

Simple JSON Query

```
select dept_info
from deptj;

DEPT_INFO
---------------------------------------------
{"departments":{
 "DEPTNO": 10,
 "DNAME": "ACCOUNTING",
 "LOC": "NEW YORK",
 "deptemps": [
               {
                "EMPNO": 7782,
                "ENAME": "CLARK",
  **** more ****
```

Query with JSON_VALUE

```
select json_value(dept_info, '$.departments.DNAME')
from deptj;
DNAME
-----------------
ACCOUNTING
RESEARCH
SALES
OPERATIONS
```

Query with JSON_TABLE

```
select dname,ename,job,sal
from deptj, json_table(dept_info,'$.departments'
             columns (dname varchar2(15) path '$.DNAME'
             ,nested path '$.deptemps[*]'
               columns (ename varchar2(20) path '$.ENAME'
               ,job varchar2(20) path '$.JOB'
                 ,nested path '$.pay'
                   columns (sal number path '$.SAL')
               )
));
DNAME         ENAME     JOB                SAL
------------ -------   --------   ----------
ACCOUNTING    CLARK     MANAGER            2450
ACCOUNTING    KING      PRESIDENT          5000
**** more ****
```

JSON Path Expression Item Methods

- SQL Path Expressions may use ‘item methods’ to transform selected data
- The JSON standard describes six item methods:
  - 12c: abs(), ceiling(), double(), floor()
  - 18c: size(), type()
- Oracle extends the JSON standard with:
  - 12c: date(), length(), lower(), number(), string(), timestamp(), upper()
  - 18c: boolean(), booleanOnly(), numberOnly(), stringOnly() (the “Only” methods will only transform the datatype listed; other ”non-Only” methods will attempt conversion)

Using Path Expression Item Methods

- Oracle 12c limits the use of item methods to the json_exists() function
- Oracle 18c allows item methods in all querys
  - json_exists
  - json_value
  - json_query
  - json_table

Generating JSON

- Oracle 12.2 provides SQL functions for generating JSON
  - JSON_OBJECT
  - JSON_ARRAY
  - JSON_OBJECTAGG
  - JSON_ARRAYAGG

JSON Datatype Generation 12c and 18c

- JSON generation functions in 12c limits data types to NUMBER, VARCHAR2, DATE, and TIMESTAMP
- 18c generation now allows:
  - BINARY_DOUBLE, BINARY_FLOAT
  - CLOB, BLOB
  - NVARCHAR2, RAW
  - TIMESTAMP WITH TIME ZONE, TIMESTAMP WITH LOCAL TIME ZONE, INTERVAL YEAR TO MONTH, INTERVAL DAY TO SECOND
    (result output JSON depends upon datatype input)
- 18c generation may now return BLOB or CLOB values

JSON_OBJECT

- JSON_OBJECT builds JSON objects using name-value pairs: name (literal or expr.) and a value (usually expr.)

```
select json_object('empId’  value employee_id
  , 'empName'      value last_name || ', ' || first_name
  , 'phoneNumber' value phone_number
  , 'deptId'      value department_id
  , 'pay’ value json_object('salary' value salary
                          ,'commPct' value commission_pct)
     FORMAT JSON) emp_rows
from hr.employees
where department_id < 30;
```

JSON_OBJECT Output

```
EMP_ROWS
-----------------------------------------------------------
{"empId":200,"empName":"Whalen,
Jennifer","phoneNumber":"515.123.4444","deptId":10,
       "pay":{"salary":4400,"commPct":null}}
{"empId":201,"empName":"Hartstein,
Michael","phoneNumber":"515.123.5555","deptId":20,
       "pay":{"salary":13000,"commPct":null}}
{"empId":202,"empName":"Fay, Pat","phoneNumber":"603.123.6666","deptId":20,
       "pay":{"salary":6000,"commPct":null}}
```

JSON_OBJECT and NULLs, 1

- JSON_OBJECT allows NULL elements to be omitted using the ABSENT ON NULL

```
select json_object('empId' value employee_id
    , 'empName'     value last_name || ', ' || first_name
    , 'phoneNumber' value phone_number
    , 'deptId'      value department_id
    , 'pay'  value json_object('salary' value salary,
         'commPct' value commission_pct absent on null)
    FORMAT JSON) emp_rows
from hr.employees  where department_id < 30;
```

JSON_OBJECT and NULLs, 2

- JSON_OBJECT ABSENT ON NULL output

```
EMP_ROWS
-----------------------------------------------------------
{"empId":200,"empName":"Whalen,Jennifer”,
   "phoneNumber":"515.123.4444","deptId":10,
   "pay":{"salary":4400}}
{"empId":201,"empName":"Hartstein, Michael",
   "phoneNumber":"515.123.5555","deptId":20,
   "pay":{"salary":13000}}
{"empId":202,"empName":"Fay,    Pat",
   "phoneNumber":"603.123.6666","deptId":20,
   "pay":{"salary":6000}}
```

JSON_ARRAY

- JSON_ARRAY builds a JSON array using provided values and expressions

```
select json_object('employeeIdId' value employee_id
    , 'empName'     value last_name || ', ' || first_name
    , 'phoneNumber' value phone_number
    , 'deptId'  value department_id
    ,'pay' value json_array(salary,commission_pct)) json_out
  from hr.employees
  where commission_pct is not null and salary < 6500;
JSON_OUT
{"employeeIdId":166,"empName":"Ande, Sundar",
 "phoneNumber":"011.44.1346.629268","deptId":80,
 "pay":[6400,0.1]}
{"employeeIdId":167,"empName":"Banda, Amit",
 "phoneNumber":"011.44.1346.729268","deptId":80,
 "pay":[6200,0.1]}  … more …
```

JSON_OBJECTAGG

- JSON_OBJECTAGG aggregates the JSON resulting from multiple rows

```
select json_objectagg( last_name || ', '
       || first_name value salary) json_output
  from hr.employees
  where department_id < 50;

JSON_OUTPUT
---------------------------------------------------------
{"Whalen, Jennifer":4400,"Hartstein, Michael":13000,
 "Fay, Pat":6000,"Raphaely, Den":11000,"Khoo, Alexander":
 3100,"Baida, Shelli":2900,"Tobias, Sigal":2800,"Himuro,
 Guy":2600,"Colmenares, Karen":2500,"Mavris, Susan":6500}
```

JSON_ARRAYAGG

- JSON_ARRAYAGG builds a JSON array using GROUPed data from an aggregate

```
select json_object('departmentName' value department_name
    , 'deptId'  value depts.department_id
    , 'numberEmps' value count(emps.employee_id)
    , 'deptEmps' value
       json_arrayagg( last_name || ', ' || first_name
                       order by last_name,first_name))
     json_output
  from hr.employees emps join hr.departments depts
     on depts.department_id = emps.department_id
  where salary < 6500
  group by depts.department_name,depts.department_id
  order by depts.department_name;
```

JSON_ARRAYAGG Output

```
JSON_OUTPUT
----------------------------------------------------------
{"departmentName":"Administration","deptId":10,"numberEmps":1,
"deptEmps":["Whalen, Jennifer"]}
{"departmentName":"IT","deptId":60,"numberEmps":4,
"deptEmps":["Austin, David","Ernst, Bruce","Lorentz, Diana",
"Pataballa, Valli"]}
{"departmentName":"Marketing","deptId":20,"numberEmps":1,
"deptEmps":["Fay, Pat"]}
{"departmentName":"Purchasing","deptId":30,"numberEmps":5,
"deptEmps":["Baida, Shelli","Colmenares, Karen","Himuro, Guy","Khoo,
Alexander","Tobias, Sigal"]}
{"departmentName":"Sales","deptId":80,"numberEmps":4,
"deptEmps":["Ande, Sundar","Banda, Amit","Johnson, Charles",
"Kumar, Sundita"]}
{"departmentName":"Shipping","deptId":50,"numberEmps":41,
"deptEmps":["Atkinson, Mozhe","Bell, Sarah","Bissot, Laura","Bull,
Alexis","Cabrio, Anthony","Chung,
*** more ***
```

System READ Privilege

- Oracle 12.1.0.2 added two new privileges READ and READ ANY TABLE
- SELECT privilege (been there forever) also allows locking to occur
  - LOCK TABLE ...
  - SELECT ... FOR UPDATE
- READ privilege allows SELECT statements but does not allow statements to lock rows

```
GRANT READ ON xxx.yyy TO user,role;
GRANT READ ANY TABLE  TO user,role;
```

READ Privilege at Work

```
SQL> grant read on dept to t1;
```

```
SQL> select * from john.dept;
    DEPTNO DNAME      LOC
---------- -------------- -------------
        10 ACCOUNTING       NEW YORK
        20 RESEARCH   DALLAS
        30 SALES      CHICAGO
        40 OPERATIONS       BOSTON
```

```
SQL> select * from john.dept for update;
select * from john.dept for update
                  *
ERROR at line 1:
ORA-01031: insufficient privileges
```

Merge Partitions

- Partitions may be merged easily

```
alter table ORDERS
  merge partitions P2014Q1,P2014Q2,P2014Q3,P2014Q4
      into P2014;
```

```
alter table ORDERS
   merge partitions P2014Q1 to P2014Q4 into P2014;
```

Partition Split

- Partitions may be split

```
alter table ORDERS split partition P2016 into
    (partition P2016Q1 values
       less than to_date('01.04.2016','DD.MM.YYYY')),
    (partion P2016Q2 values
       less than to_date('01.07.2016','DD.MM.YYYY')),
    (partition P2016Q3 values
       less than to_date('01.10.2016','DD.MM.YYYY')),
    (partition P2016Q4 values
       less than to_date('01.01.2017','DD.MM.YYYY');
```

Partition Add/Drop/Truncate

```
 alter table ORDERS add
  partition P2017Q1 value
      less than to_date('01.04.2017','DD.MM.YYYY')),
  partition P2017Q1 value
      less than to_date('01.07.2017','DD.MM.YYYY')),
  partition P2017Q1 value
      less than to_date('01.10.2017','DD.MM.YYYY')),
  partition P2017Q1 value
      less than to_date('01.01.2018','DD.MM.YYYY')),
```

```
alter table ORDERS drop partitions
  P2010Q1, P2010Q2, P2010Q3, P2010Q4;
```

```
alter table ORDERS truncate partitions
  P2010Q1, P2010Q2, P2010Q3, P2010Q4;
```

Oracle 18c Cancel Runaway SQL

- Beginning with Oracle 18c you may manually terminate runaway queries

```
ALTER SYSTEM CANCEL SQL 'sid serial#'

   /* optional parameters (within quotes) */
            @instanceid
            sqlid
```

EBR Improvements

- Time does not permit detailed EBR coverage
- Edition-Based Redefinition made its debut in Oracle 11g and provides an ability to significantly reduce downtime due to changes in PL/SQL and/or SQL
- Oracle 12c removes some limitations present in 11gR2 implementation of EBR:
  - Public Synonyms may point to editioned objects
  - Materialized Views and Types may be used with editioning
  - Virtual Columns may be used with EBR

EBR & Materialized Views

- CREATE/ALTER MATERIALIZED VIEW now add the ability to specify use with editioning by specifying the Edition(s) to be used:
  - UNUSABLE BEFORE
    - CURRENT EDITION
    - EDITION XXX
  - UNUSABLE BEGINNING
    - CURRENT EDITION
    - EDITION XXX
    - NULL EDITION

EBR & Types

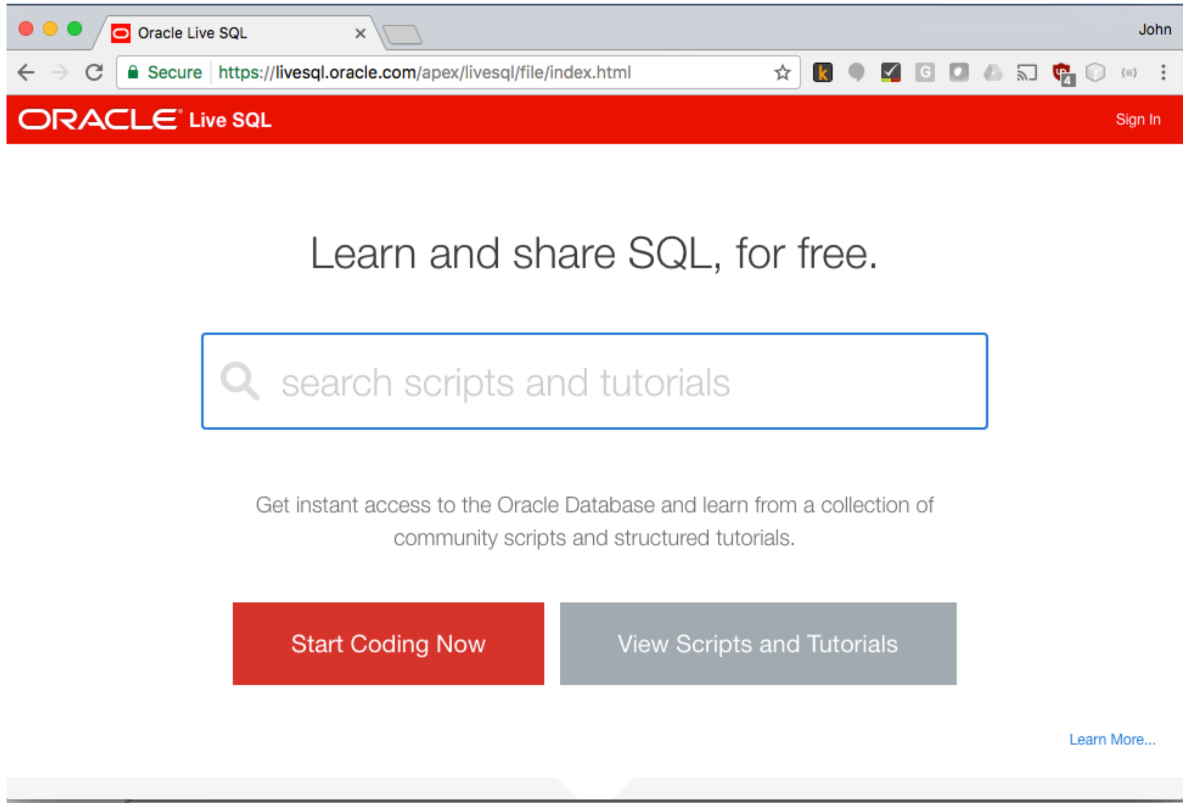
- CREATE/ALTER TYPE now add the ability to specify use with editioning by specifying the Edition(s) to be used:
  - UNUSABLE BEFORE
    - CURRENT EDITION
    - EDITION XXX
  - UNUSABLE BEGINNING
    - CURRENT EDITION
    - EDITION XXX
    - NULL EDITION

EBR & Virtual Columns

- Non-editioned Virtual Columns may depend upon editioned objects
  - May specify expression is to be resolved by searching the specified edition:
    - CURRENT EDITION
    - EDITION XXX
    - NULL EDITION
  - May use UNUSABLE EDITION or UNUSABLE BEGINNING clause (see previous page) to limit Virtual Columns "visibility" into editions

livesql.oracle.com

- Oracle provides free "live" 12.2 SQL tool
  - Includes available code library (cut & paste capable)
  - Ability to save scripts and share
  - Online database design
  - Available sample schemas or build your own



Oracle Live SQL

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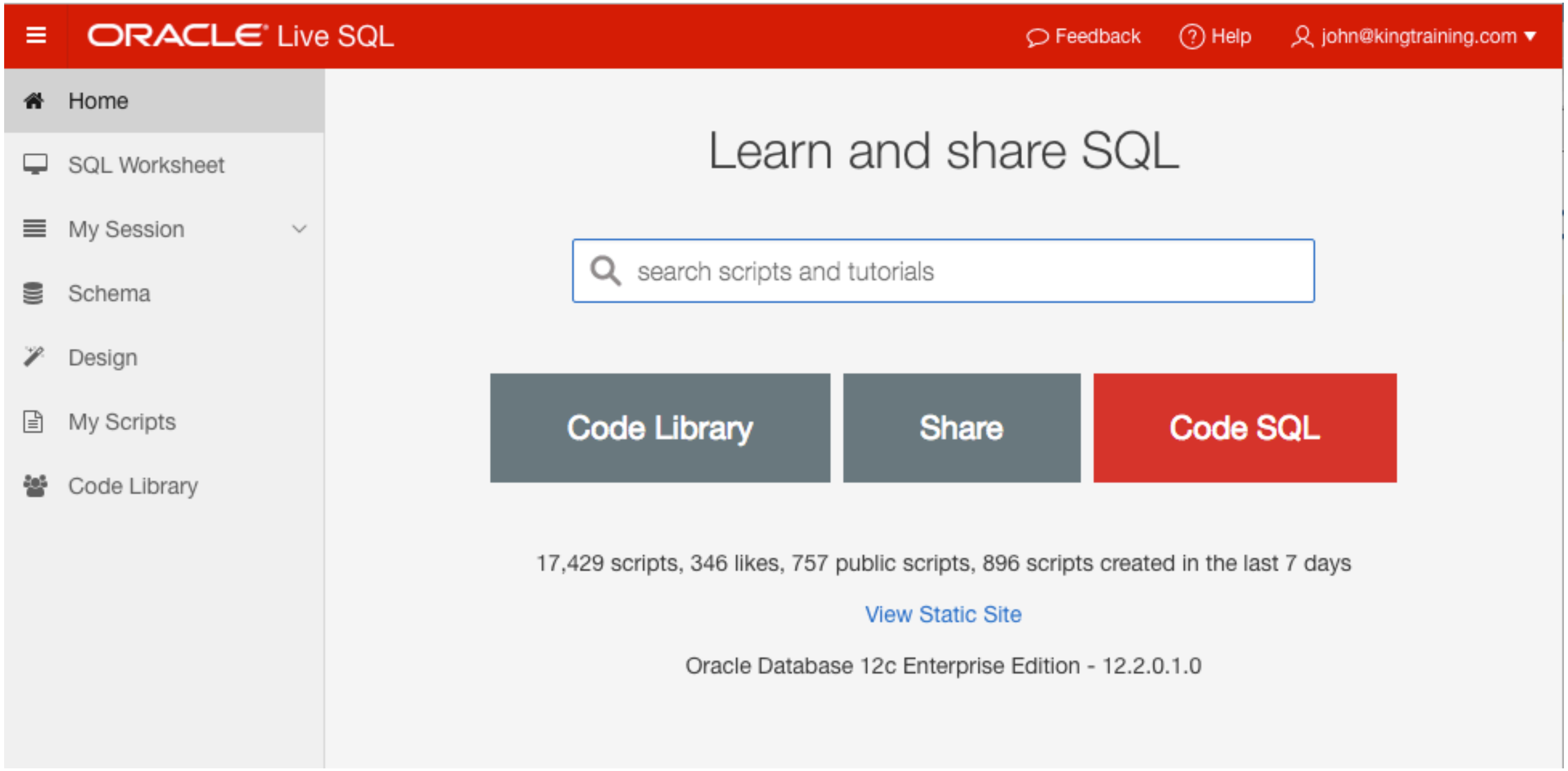
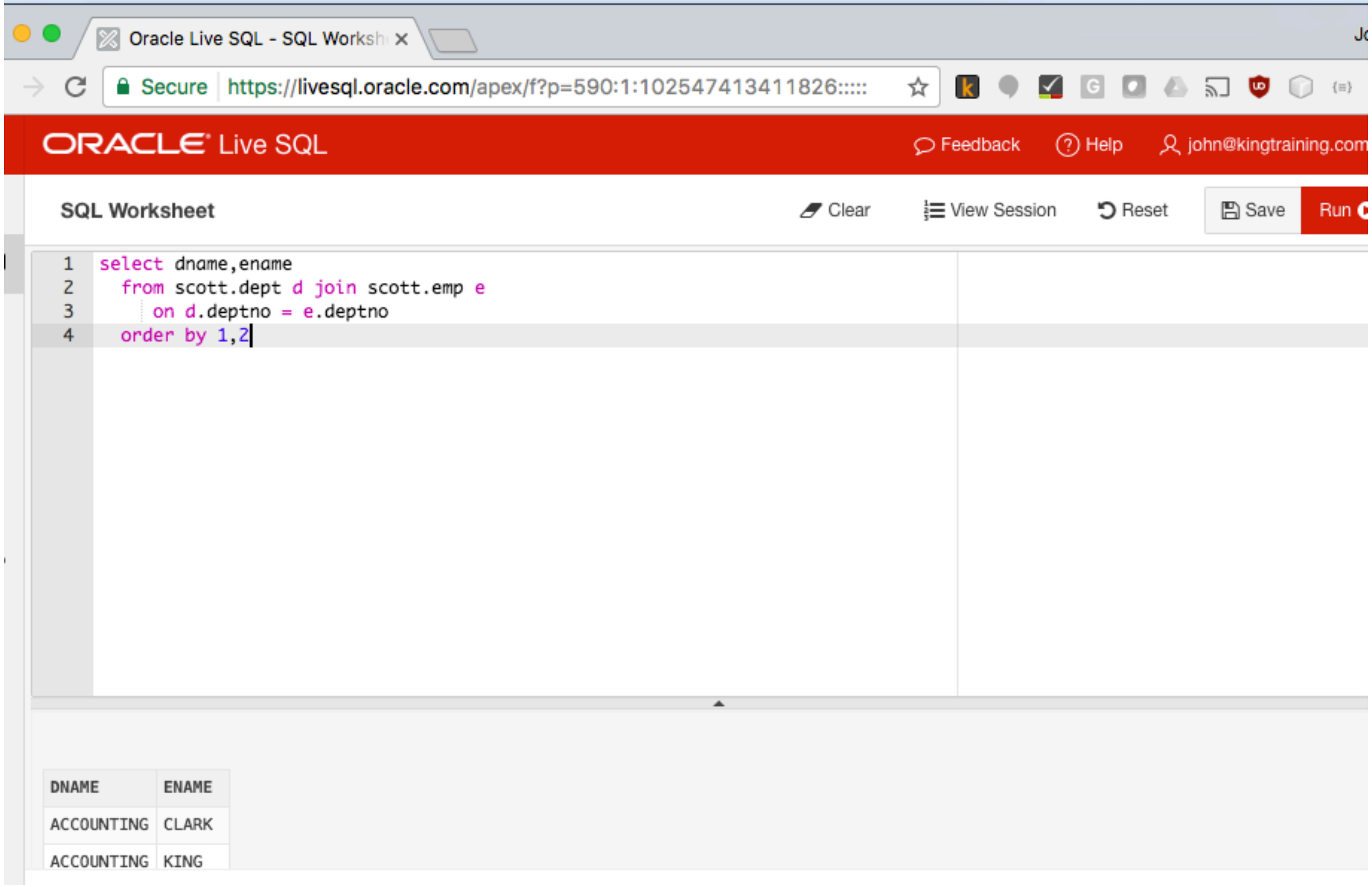


Learn and share SQL

17,429 scripts, 346 likes, 757 public scripts, 896 scripts created in the last 7 days

Oracle Database 12c Enterprise Edition - 12.2.0.1.0

livesql.oracle.com - SQL



```
select dname,ename
  from scott.dept d join scott.emp e
     on d.deptno = e.deptno
  order by 1,2
```

DNAME	ENAME
ACCOUNTING	CLARK
ACCOUNTING	KING

Oracle 12.2

- Oracle 12.2 was released for Oracle Exadata Express Cloud Service users in October 2016 (OOW)
- Oracle DBaaS uses got access to 12.2 in November 2016
- On-premise versions of 12.2 available for download as of March 2017

Overview of 12.2 Features

– JSON generating functions
– Analytic Views
– Max number of PDBs from 252 to 4096
– PDB memory and resource management
– Local UNDO for PDBs and "hot clone"
– SQL*Plus history and csv output
– Partition tables online
– READ-only partitions/subpartitions
– Oracle sharding
– Partitioned External Tables

So, What About Oracle 18c ?

- Oracle 18c is just becoming GA so only Oracle may talk about it in detail or demo it
- Look for many new and improved features
  - Available in the Oracle Cloud first! (of course)
  - Even smarter optimization
  - Faster data movement
  - Enhanced PDB management
  - More stuff "in memory"
  - Much more…
    - Check out the docs! (available online now)
    - Watch for announcements!

Wrapping it all Up

- Oracle 12c has added significant new functionality to the already robust Oracle database environment; release 12.1.0.2, 12.2.0, and 18.1 add even more
- Oracle 12c represents the first major architectural change to Oracle since Version 6
- With the release of Oracle 18c it’s really time for your shop to finally move off of 11g R2
- While an emphasis is sometimes placed on the features of Oracle that support the Data Base Administrator, this paper shows many Developer-oriented features of great usefulness
- I am still actively testing the new features presented here (and some others); your mileage may vary; watch for future editions of this talk or blog posts for more

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Oracle 18c/12c
New Features For Developers & DBAs

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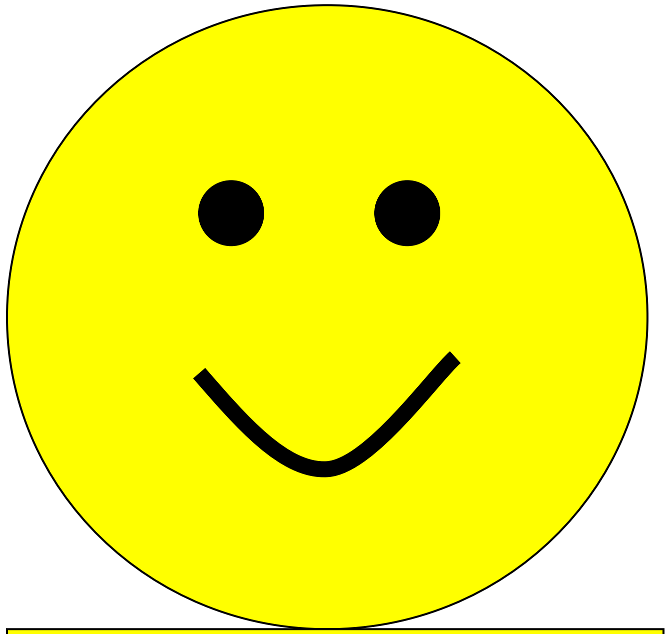

Thanks for your attention!

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- End