Advanced PL/SQL

Good Practices Series: Database Features, Tools & Techniques

Philipp

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05.05.2021

"Trust, but verify"

-- Russian Proverb

Featuring

Source: https://vanyaland.com/2020/06/18/heres-the-first-footage-from-justice-league-the-snyder-cut/

Sources:
- Zack Snyder's Justice League, 2021, 1:33:44
- https://www.hiclipart.com/free-transparent-background-png-clipart-inpnx

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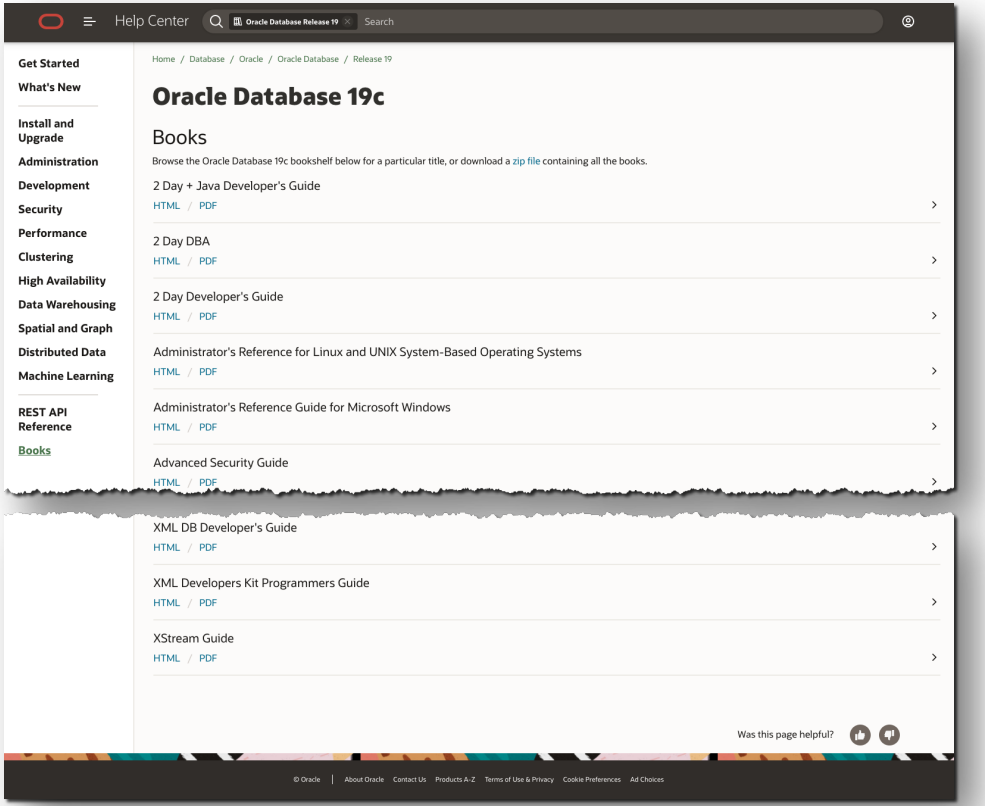
Oracle Database 19c – 164 Books – 2 GB



Source: https://docs.oracle.com/en/database/oracle/oracle-database/19/books.html

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Database Concepts

Audience

Oracle Database Concepts is intended for technical users, primarily database administrators and database application developers, who are new to Oracle Database. Typically, the reader of this manual has had experience managing or developing applications for other relational databases.

To use this manual, you must know the following:

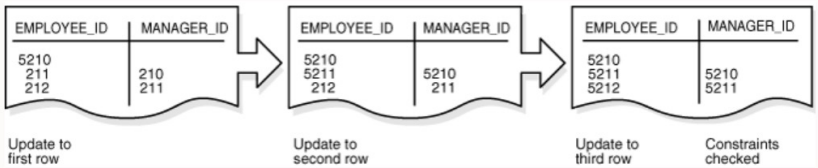
- Relational database concepts in general
- Concepts and terminology in Introduction to Oracle Database
- The operating system environment under which yo

```
UPDATE employees SET employee_id = employee_id + 5000,
  manager_id = manager_id + 5000;
```

Copy

Although a constraint is defined to verify that each `manager_id` value matches an `employee_id` value, the preceding statement is valid because the database effectively checks constraints after the statement completes. Figure 7-5 shows that the database performs the actions of the entire SQL statement before checking constraints.

Figure 7-5 Constraint Checking



Description of "Figure 7-5 Constraint Checking"

Source: https://docs.oracle.com/en/database/oracle/oracle-database/21/cncpt/

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Omnilingualism

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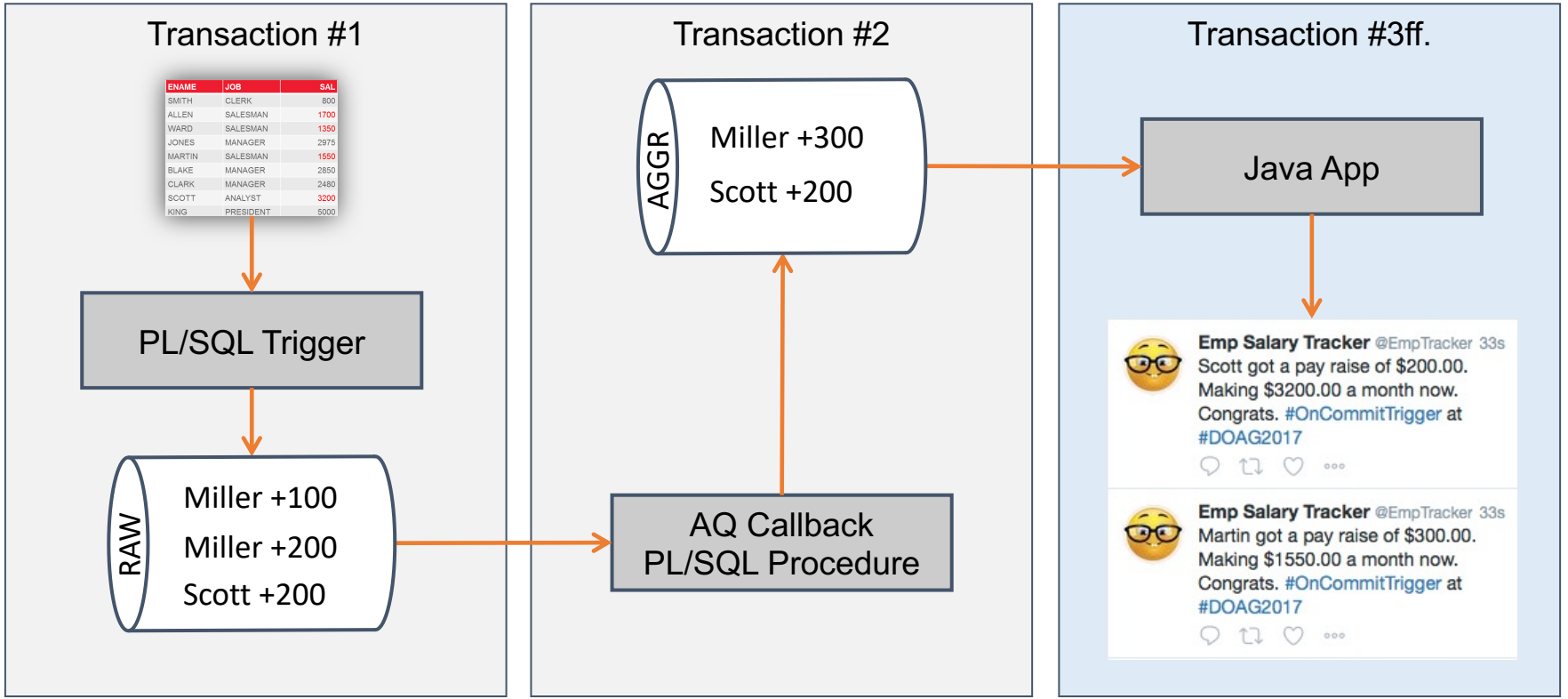
Advanced Queuing Example ("On-Commit-Trigger")



Example: https://github.com/PhilippSalvisberg/emptracker

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Why Advanced Queuing?

- Transactions
  - Message processing is part of the database transaction
- Asynchronous
  - Limit the impact on original transaction (performance, robustness)
- Control
  - Limit the number of concurrent dequeue processes
  - Set message priority to override default FIFO behavior
- Comprehensive API
  - PL/SQL and Java (JMS)
- Standardized Interoperability
  - With other classic messaging systems (incl. propagation between database instances)
  - With Apache Kafka based systems (via Transactional Event Queues, 21c feature)

More: https://docs.oracle.com/en/database/oracle/oracle-database/21/adque/

Travel in Time

Source: https://www.hiclipart.com/free-transparent-background-png-clipart-ohbdr

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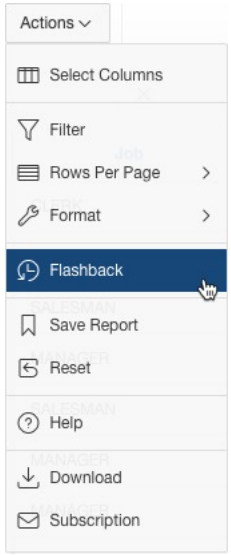
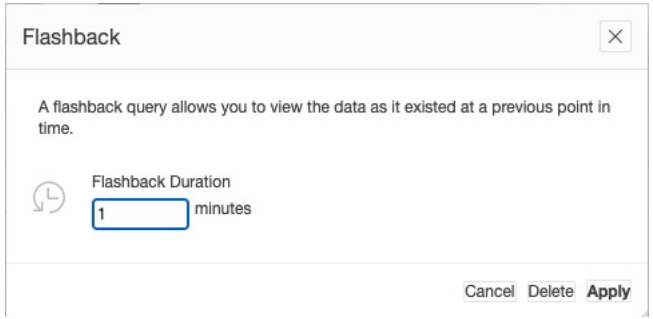
Flashback Query in APEX






```
select …
from … as of timestamp(systimestamp-(:apex$flashback_min/1440))
…
```

More: https://docs.oracle.com/en/database/oracle/oracle-database/21/sqlrf/SELECT.html

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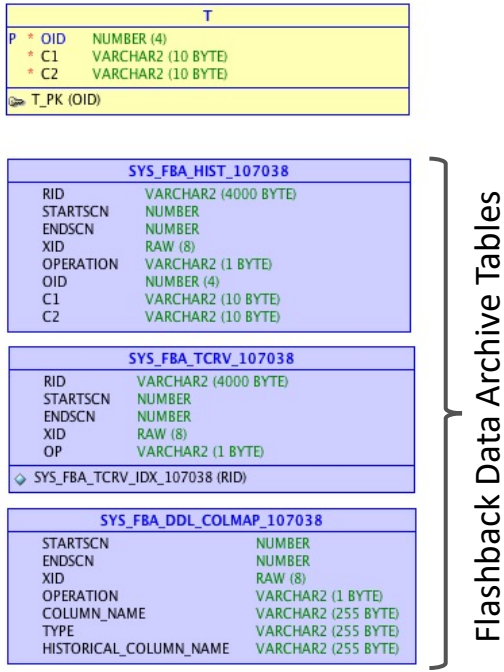
Flashback Data Archive – Create Table

```
create table t (
   oid  number(4, 0) not null primary key,
   c1   varchar2(10) not null,
   c2   varchar2(10) not null
) flashback archive fba;
```

Created delayed.

Considered only when flashback_query_clause is used



More:
- https://docs.oracle.com/en/database/oracle/oracle-database/21/sqlrf/CREATE-TABLE.html
- https://docs.oracle.com/en/database/oracle/oracle-database/21/sqlrf/CREATE-FLASHBACK-ARCHIVE.html

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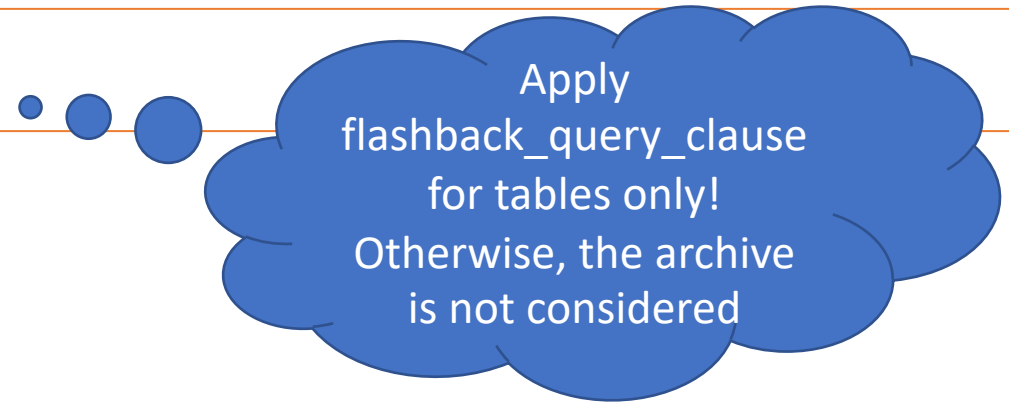
Flashback Data Archive – Querying Data

Point in time

```
select *
  from t as of timestamp systimestamp - interval '30' minute;
```

Full history

```
select versions_startscn,
       versions_endscn,
       versions_starttime,
       versions_endtime,
       versions_xid,
       versions_operation,
       t.*
  from t versions between scn minvalue and maxvalue;
```



More:
- https://docs.oracle.com/en/database/oracle/oracle-database/21/sqlrf/SELECT.html
- https://docs.oracle.com/en/database/oracle/oracle-database/21/sqlrf/Version-Query-Pseudocolumns.html
- https://github.com/oddgen/bitemp

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Shield

Source: https://pngimg.com/image/60364

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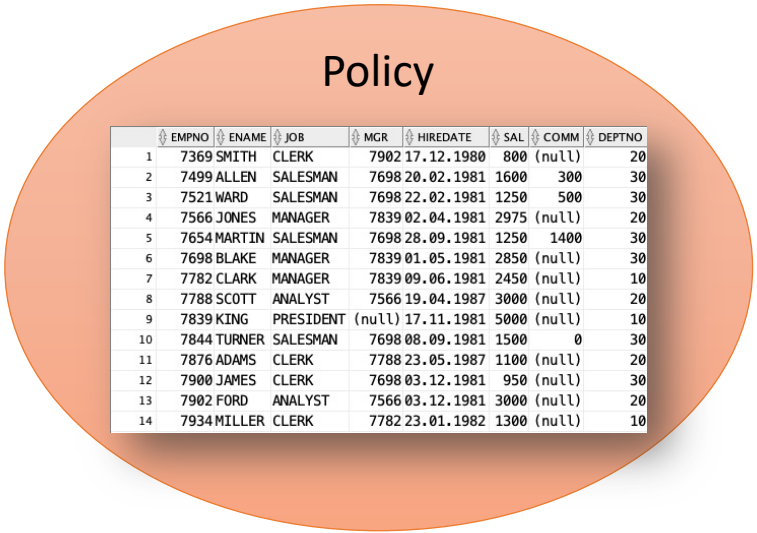
Virtual Private Database



Policy Functions

- Rows/columns in tables/views
- Produce filter predicates at runtime
- Applicable for
  - SELECT
  - INSERT
  - UPDATE
  - DELETE
  - MERGE

More:
- https://docs.oracle.com/en/database/oracle/oracle-database/21/dbseg/using-oracle-vpd-to-control-data-access.html
- https://docs.oracle.com/en/database/oracle/oracle-database/21/dbfsg/indroducing-oracle-database-real-application-security.html

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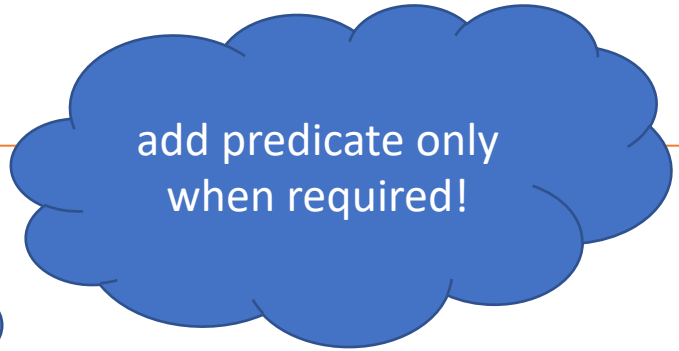
Create Policy Function




```
create or replace function emp_predicate(
   in_schema in varchar2,
   in_table  in varchar2
) return varchar2 is
   l_predicate varchar2(1000);
begin
   if user = 'PLSCOPE' THEN
      l_predicate := q'[job not in ('MANAGER', 'PRESIDENT')]';
   end if;
   return l_predicate;
end;
/
```

Create Policy

```
begin
   sys.dbms_rls.add_policy(
      object_name         => 'emp',
      policy_name         => 'emp_policy',
      policy_function     => 'emp_predicate',
      statement_types     => 'select insert update delete',
      sec_relevant_cols => 'sal comm',
      update_check        => true
   );
end;
/
```

More: https://docs.oracle.com/en/database/oracle/oracle-database/21/arpls/DBMS_RLS.html

Query Unsensitive Columns Only

```
select empno, ename, job, mgr, hiredate, deptno from emp;

     EMPNO ENAME      JOB              MGR HIREDATE       DEPTNO
---------- ---------- --------- ---------- ---------- ----------
      7369 SMITH      CLERK            7902 17.12.1980         20
      7499 ALLEN      SALESMAN         7698 20.02.1981         30
      7521 WARD       SALESMAN         7698 22.02.1981         30
      7566 JONES      MANAGER          7839 02.04.1981         20
      7654 MARTIN     SALESMAN         7698 28.09.1981         30
      7698 BLAKE      MANAGER          7839 01.05.1981         30
      7782 CLARK      MANAGER          7839 09.06.1981         10
      7788 SCOTT      ANALYST          7566 19.04.1987         20
      7839 KING       PRESIDENT             17.11.1981         10
      7844 TURNER     SALESMAN         7698 08.09.1981         30
      7876 ADAMS      CLERK            7788 23.05.1987         20

14 rows selected.
```

Query All Columns

```
select * from emp;

     EMPNO ENAME      JOB              MGR HIREDATE            SAL       COMM     DEPTNO
---------- ---------- --------- ---------- ---------- ---------- ---------- ----------
      7369 SMITH      CLERK            7902 17.12.1980         800                    20
      7499 ALLEN      SALESMAN         7698 20.02.1981        1600        300         30
      7521 WARD       SALESMAN         7698 22.02.1981        1250        500         30
      7654 MARTIN     SALESMAN         7698 28.09.1981        1250       1400         30
      7788 SCOTT      ANALYST          7566 19.04.1987        3000                    20
      7844 TURNER     SALESMAN         7698 08.09.1981        1500          0         30
      7876 ADAMS      CLERK            7788 23.05.1987        1100                    20
      7900 JAMES      CLERK            7698 03.12.1981         950                    30
      7902 FORD       ANALYST          7566 03.12.1981        3000                    20
      7934 MILLER     CLERK            7782 23.01.1982        1300                    10

10 rows selected.
```

Execution Plan

```
-------------------------------------------------------------------------------
| Id  | Operation                  | Name | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------
|   0 | SELECT STATEMENT           |      |       |       |     2 (100)|          |
|*  1 |  TABLE ACCESS STORAGE FULL| EMP  |    10 |   380 |     2   (0)| 00:00:01 |
-------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   1 - storage(("JOB"<>'MANAGER' AND "JOB"<>'PRESIDENT'))
       filter(("JOB"<>'MANAGER' AND "JOB"<>'PRESIDENT'))
```

Half Human
Half Atlantean

Source: https://www.hiclipart.com/free-transparent-background-png-clipart-pkljs

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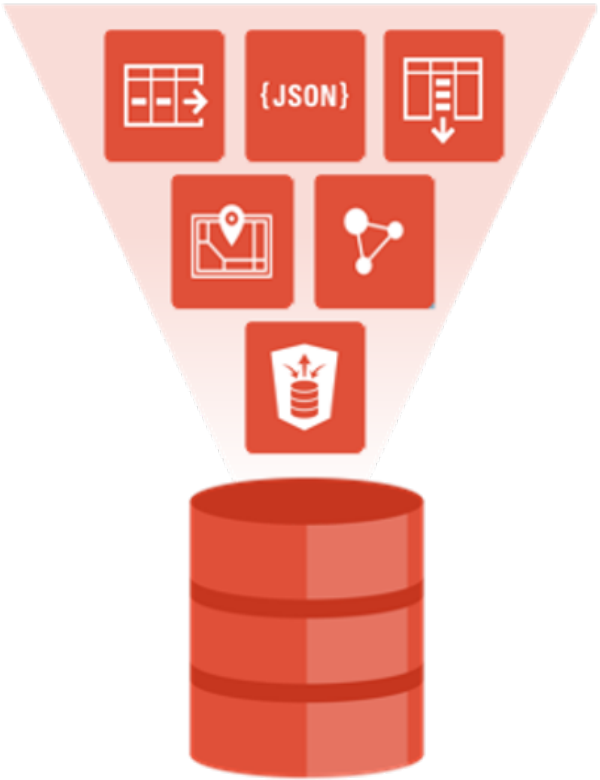
Converged Database



- Relational
- Documents
- Spatial
- Graph

Source: https://blogs.oracle.com/database/many-single-purpose-databases-versus-a-converged-database

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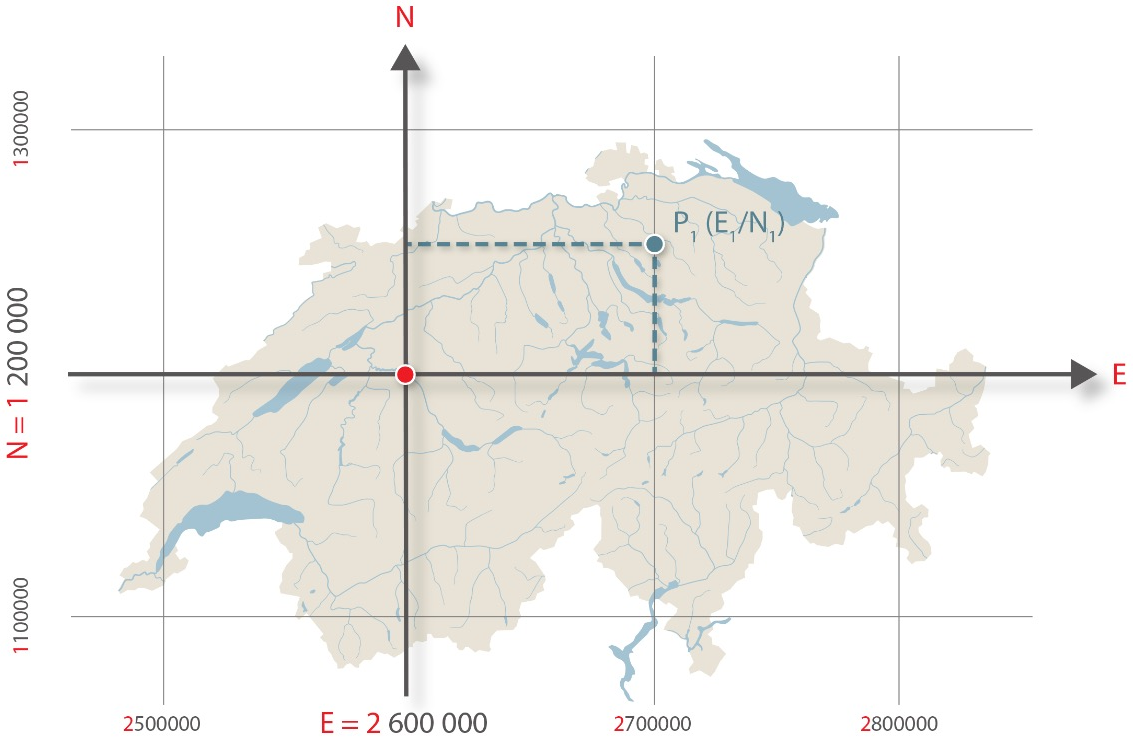
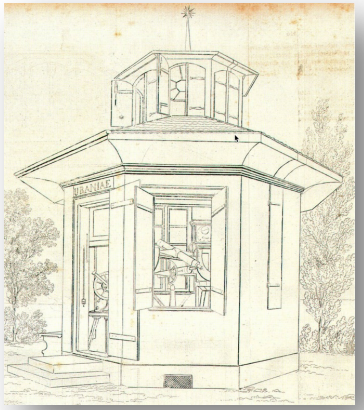
Swiss Grid LV95





Old Observatory in Bern
Institute of Exact Sciences
(2'600'000, 1'200'000)

Sources:
- https://www.swisstopo.admin.ch/en/knowledge-facts/surveying-geodesy/reference-frames/local/lv95.html
- https://www.e-periodica.ch/cntmng?pid=chl-001:2004:29::135
- https://www.unibe.ch/universitaet/portraet/geschichte/geschichte_und_architektur/exakte_wissenschaften/index_ger.html

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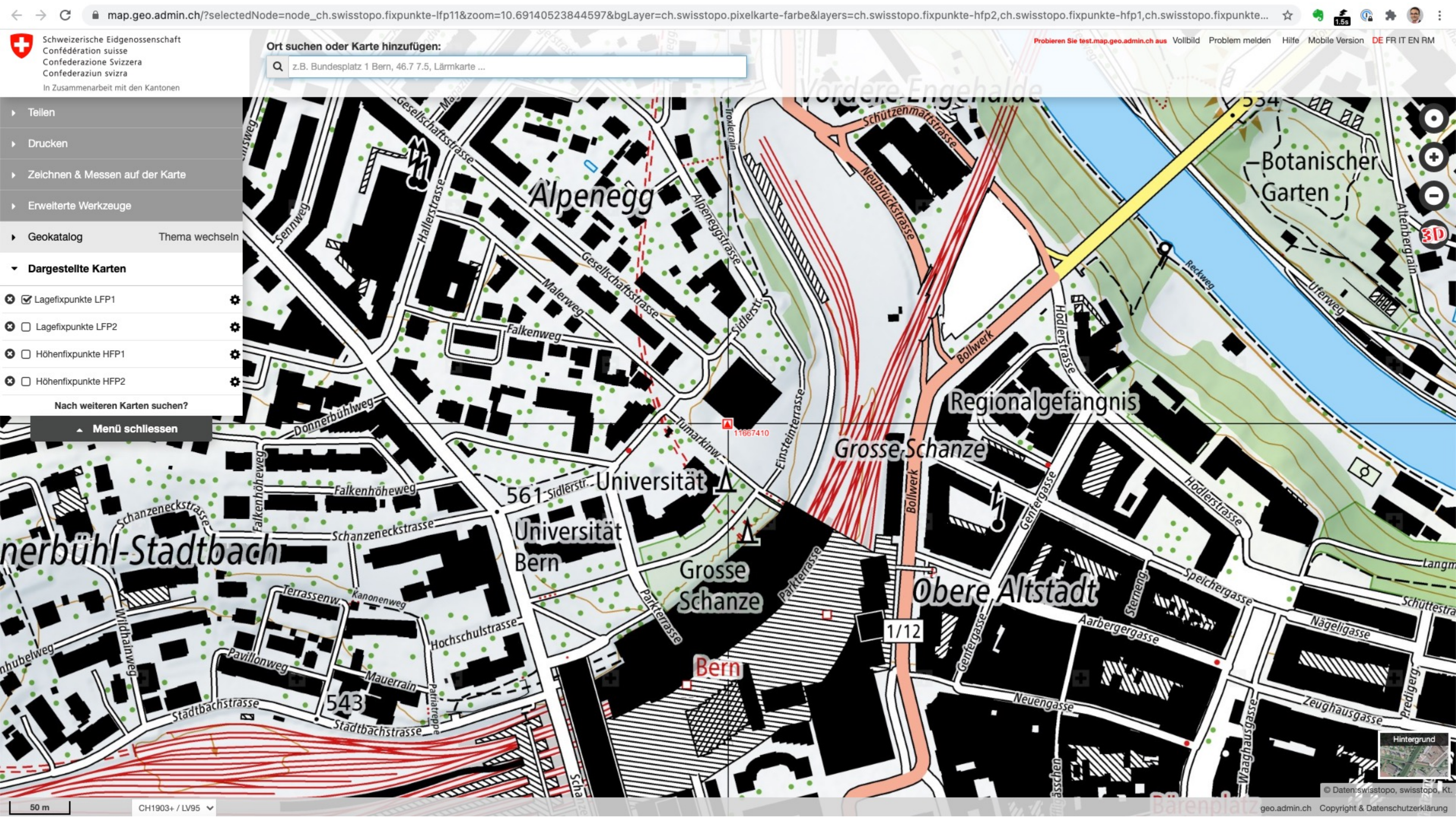
map.geo.admin.ch/?selectedNode=node_ch.swisstopo.fixpunkte-lfp1&zoom=10.69140523844597&bgLayer=ch.swisstopo.pixelkarte-farbe&layers=ch.swisstopo.fixpunkte-hfp2,ch.swisstopo.fixpunkte-hfp1,ch.swisstopo.fixpunkte...
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Confederaziun svizra
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Thema wechseln
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Lagefixpunkte LFP1
Lagefixpunkte LFP2
Höhenfixpunkte HFP1
Höhenfixpunkte HFP2
Nach weiteren Karten suchen?
Menü schliessen
Vordere Engehalde
Alpenegg
Botanischer Garten
Regionalgefängnis
Grosse Schanze
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Universität Bern
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Terrassenw.
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Neubrückstrasse
Bollwerk
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Nägeligasse
Neuengasse
Zeughausgasse
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Convert to Word Geodetic System (GPS)

```
select sdo_cs.transform(
          geom    => sdo_geometry(
                        sdo_gtype     => 2001, -- point
                        sdo_srid      => 2056, -- LV95
                        sdo_point     => sdo_point_type(2600000, 1200000, null),
                        sdo_elem_info => null,
                        sdo_ordinates => null
                     ),
          to_srid => 4326 -- WGS 84, see table sdo_coord_ref_sys
       ) wsg84_coord
  from dual;

WSG84_COORD(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(7.43863242, 46.95108277, NULL), NULL, NULL)
```

More: https://docs.oracle.com/en/database/oracle/oracle-database/21/spatl/SDO_CS-reference.html

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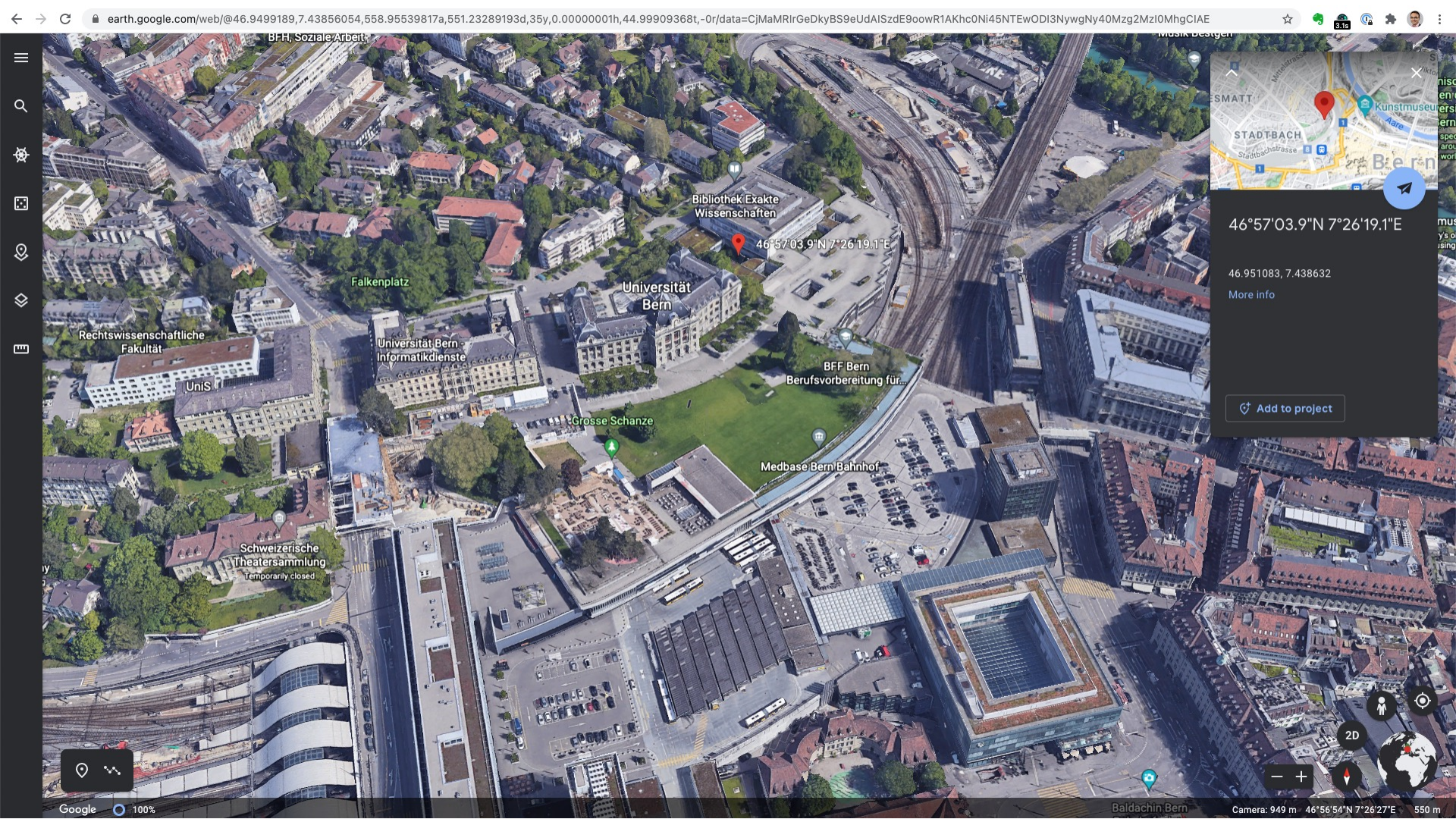
earth.google.com/web/@46.9499189,7.43856054,558.95539817a,551.23289193d,35y,0.00000001h,44.99909368t,-0r/data=CjMaMRlrGeDkyBS9eUdAISzdE9oowR1AKhc0Ni45NTEwODI3NywgNy40Mzg2MzI0MhgCIAE
BFH, Soziale Arbeit
Bibliothek Exakte Wissenschaften
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Falkenplatz
Universität Bern
Rechtswissenschaftliche Fakultät
Universität Bern Informatikdienste
UniS
BFF Bern Berufsvorbereitung für...
Grosse Schanze
Medbase Bern Bahnhof
Schweizerische Theatersammlung
Temporarily closed
Baldachin Bern
ESMATT
STADTBACH
Stadtbachstrasse
Kunstmuseum
Aare
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Camera: 949 m 46°56'54"N 7°26'27"E 550 m

X-Ray Vision

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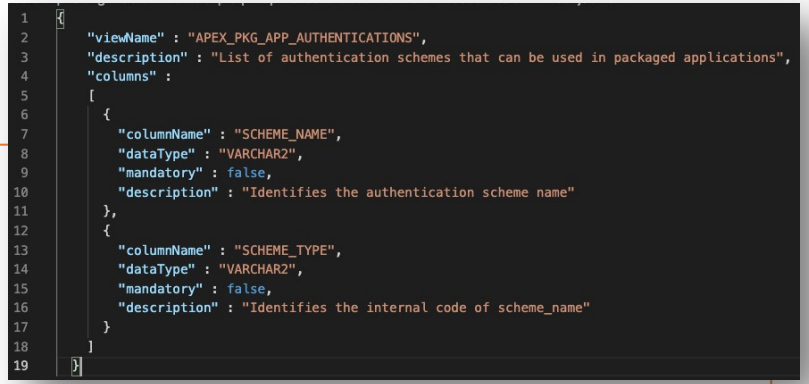
Create Table with JSON Column



```
{
  "viewName" : "APEX_PKG_APP_AUTHENTICATIONS",
  "description" : "List of authentication schemes that can be used in packaged applications",
  "columns" :
  [
    {
      "columnName" : "SCHEME_NAME",
      "dataType" : "VARCHAR2",
      "mandatory" : false,
      "description" : "Identifies the authentication scheme name"
    },
    {
      "columnName" : "SCHEME_TYPE",
      "dataType" : "VARCHAR2",
      "mandatory" : false,
      "description" : "Identifies the internal code of scheme_name"
    }
  ]
}
```

```
create table jtabs (view_name, jdoc) as
select v.view_name,
       json_serialize (
          json_object(
             'viewName' value v.view_name,
             'description' value tc.comments,
             'columns' value json_arrayagg(
                json_object(
                   'columnName' value c.column_name,
                   'dataType' value c.data_type,
                   'mandatory' value case when c.nullable = 'Y' then 'false' else 'true' end format json,
                   'description' value cc.comments absent on null
                ) order by c.column_id returning clob
             ) absent on null returning clob
          ) returning json pretty
       ) as jdoc
  from all_views v
  join all_tab_columns c on c.owner = v.owner and c.table_name = v.view_name
  left join all_tab_comments tc on tc.owner = v.owner and tc.table_name = v.view_name
  left join all_col_comments cc on cc.owner = c.owner and cc.table_name = c.table_name
                                   and cc.column_name = c.column_name
 where v.owner = 'APEX_200200'
 group by v.view_name, tc.comments;

alter table jtabs modify (jdoc constraint jdoc_json_chk check (jdoc is json));
```

More: https://docs.oracle.com/en/database/oracle/oracle-database/21/sqlrf/Single-Row-Functions.html

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Search JSON Document

```
select t.view_name, c.columnname, c.description
  from jtabs t
nested jdoc.columns[*] columns(columnName, description) c
 where c.description like '%jQuery%';
```

VIEW_NAME	COLUMNNAME	DESCRIPTION
APEX_APPLICATIONS	CONTENT_DELIVERY_NETWORK	Specifies the Content Delivery Network which is used to load the 3rd party libraries jQuery and jQuery Mobile. (obsolete)
APEX_APPLICATION_PAGE_DA	WHEN_EVENT_STATIC_CONTAINER	Identifies a jQuery selector to select the Static Container element, that can be used to delegate the event handling to
APEX_APPL_USER_INTERFACES	CONTENT_DELIVERY_NETWORK	Specifies the Content Delivery Network which is used to load the 3rd party libraries jQuery and jQuery Mobile.
APEX_APPL_USER_INTERFACES	INCLUDE_JQUERY_MIGRATE	Specified whether the jQuery Migrate plug-in is included in the application.

More:
- https://docs.oracle.com/en/database/oracle/oracle-database/21/adjsn/simple-dot-notation-access-to-json-data.html
- https://docs.oracle.com/en/database/oracle/oracle-database/21/adjsn/json-path-expressions.html
- https://docs.oracle.com/en/database/oracle/oracle-database/21/sqlrf/JSON_TABLE.html

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Execution Plan

```
-------------------------------------------------------------------------------------
| Id  | Operation                    | Name  | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT             |       |       |       |   690 (100)|          |
|   1 |  NESTED LOOPS                |       |  1679 |    10M|   690   (1)| 00:00:01 |
|*  2 |   TABLE ACCESS STORAGE FULL| JTABS |     4 | 25440 |   683   (0)| 00:00:01 |
|   3 |   JSONTABLE EVALUATION       |       |       |       |            |          |
-------------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   2 - storage(JSON_EXISTS2("T"."JDOC" /*+ LOB_BY_VALUE */  FORMAT JSON ,
               '$?(@.columns[*].description"%jQuery%")' FALSE ON ERROR)=1)
       filter(JSON_EXISTS2("T"."JDOC" /*+ LOB_BY_VALUE */  FORMAT JSON ,
               '$?(@.columns[*].description"%jQuery%")' FALSE ON ERROR)=1)
```

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Create Search Index & Re-Run Query

```
create search index jtabs_search_i on jtabs (jdoc) for json;

select t.view_name, c.columnname, c.description
  from jtabs t
nested jdoc.columns[*] columns(columnName, description) c
 where c.description like '%jQuery%';
```

More: https://docs.oracle.com/en/database/oracle/oracle-database/21/adjsn/indexes-for-json-data.html

Execution Plan with Index

```
-------------------------------------------------------------------------------------------------
| Id  | Operation                     | Name            | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT              |                 |       |       |     7 (100)|          |
|   1 |  NESTED LOOPS                 |                 |    84 |   522K|     7   (0)| 00:00:01 |
|   2 |   TABLE ACCESS BY INDEX ROWID| JTABS           |     1 |  6371 |     4   (0)| 00:00:01 |
|*  3 |    DOMAIN INDEX               | JTABS_SEARCH_I |       |       |     4   (0)| 00:00:01 |
|   4 |   JSONTABLE EVALUATION        |                 |       |       |            |          |
-------------------------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   3 - access("CTXSYS"."CONTAINS"("T"."JDOC",'(%jQuery% INPATH
              (/columns/description))')>0)
```

More:
- https://docs.oracle.com/en/database/oracle/oracle-database/21/ccapp/understanding-oracle-text-application-development.html
- https://www.doag.org/formes/pubfiles/11859860/2019-Dev-Niall_Mc_Phillips-A_Deeper_Dive_Into_Developing_With_Oracle_Text-Praesentation.pdf
- https://blogs.oracle.com/searchtech/oracle-text-query-parser

Good Manners

Sources:
- https://jeremyironsno1fan.files.wordpress.com/2016/08/alfredpennyworthbyclayenos.jpg
- https://www.hiclipart.com/free-transparent-background-png-clipart-dwmzh

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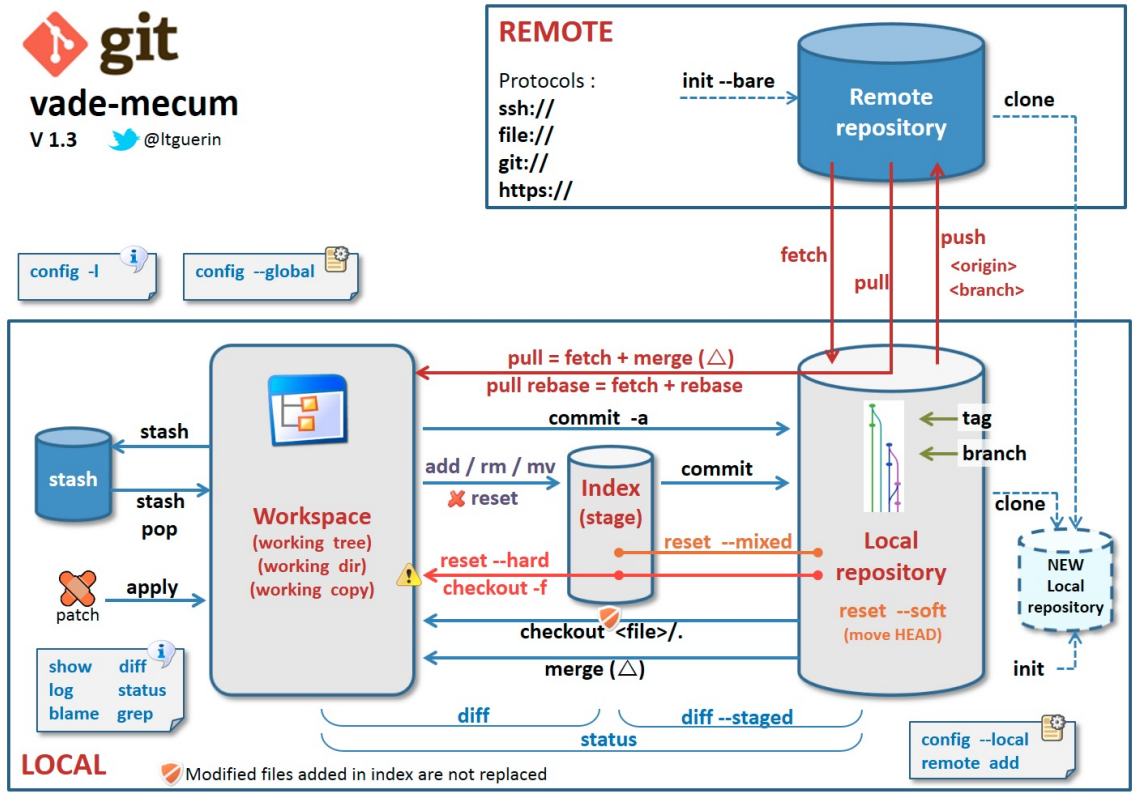
File-based Development – VCS



Source: https://labs.sogeti.com/git-overview-in-a-single-image/git-vademecum/
More: https://jlcfp.mjit.io/de/apex2021/public/events/180

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utPLSQL & Friends for Test Automation

Core Testing Framework

- Schema in the database
- No repository
- Annotation based tests

ORACLE DATABASE

Test Automation

- Command Line Client
- Maven Plugin Maven
- Various Reporters

JUnit TC TFS

Development

- Realtime Reporter
- Code Coverage, Code Templates, etc.



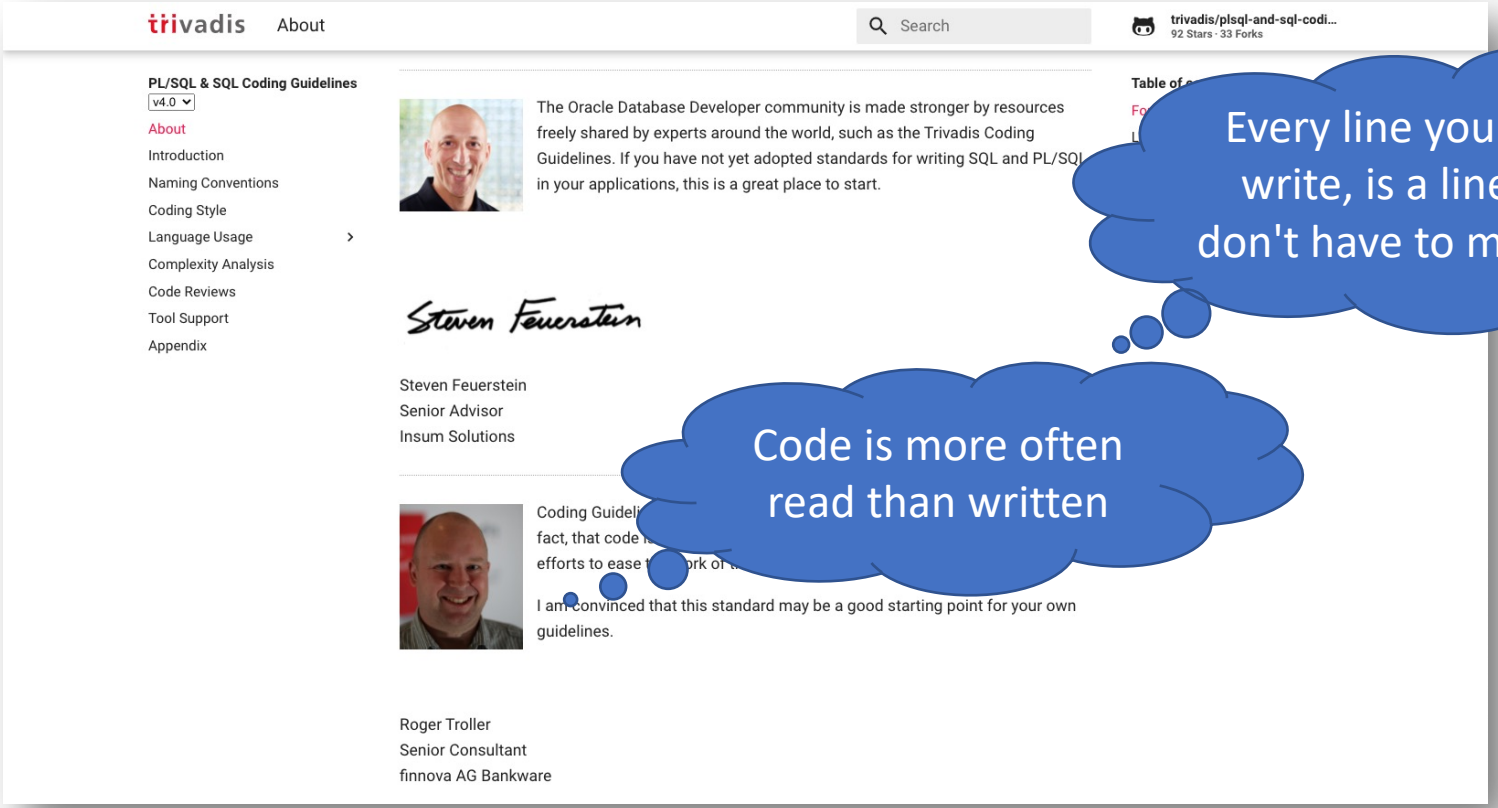

sonarqube COVERALLS






More: https://jlcfp.mjit.io/de/apex2021/public/events/184, https://www.youtube.com/watch?v=OxHMaOiPitI&t=2040s

Code Quality



Source: https://trivadis.github.io/plsql-and-sql-coding-guidelines/

trivadis

db* CODECOP for SQL Developer

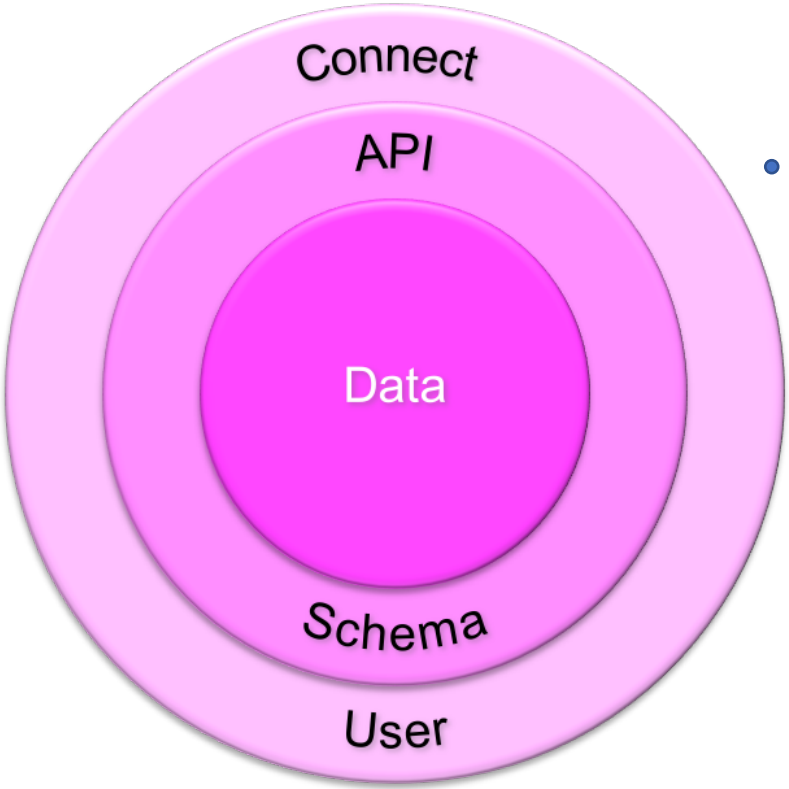
More: https://github.com/Trivadis/plsql-cop-sqldev

trivadis

My Top 10 Guidelines / Checks

- G-2150: Avoid comparisons with NULL value, consider using IS [NOT] NULL.
- G-4230: Always use a COALESCE instead of a NVL command, if parameter 2 of the NVL function is a function call or a SELECT statement.
- G-4240: Always use a CASE instead of a NVL2 command if parameter 2 or 3 of NVL2 is either a function call or a SELECT statement.
- G-5020: Never handle unnamed exceptions using the error number.
- G-1060: Avoid storing ROWIDs or UROWIDs in database tables.
- G-9501: Never use parameter in string expression of dynamic SQL. Use asserted local variable instead.
- G-9600: Never define more than one comment with hints.
- G-9601: Never use unknown hints.
- G-9602: Always use the alias name instead of the table name.
- G-9603: Never reference an unknown table/alias.

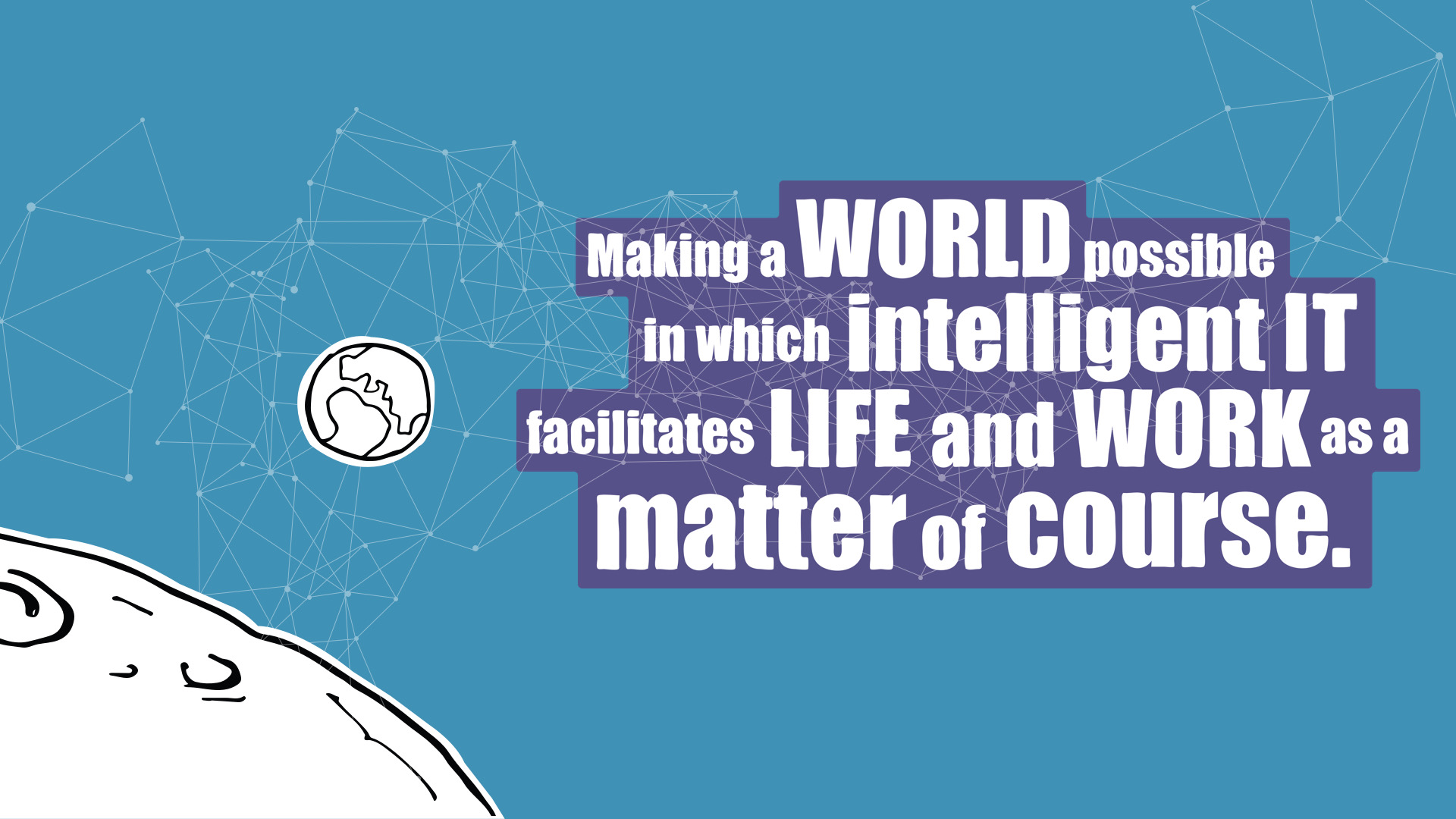
Think Pink



Data is more often read than written

Consistent data simplifies the work of consumers

More: https://www.salvis.com/blog/2018/07/18/the-pink-database-paradigm-pinkdb/


Making a WORLD possible
in which intelligent IT
facilitates LIFE and WORK as a
matter of course.