The Pitfalls Within Duality Views

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GRISSELBAV
simple & accurate IT solutions.

Timer?

Welcome

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- Database-centric development
- Open-Source development
- Simple & accurate solutions

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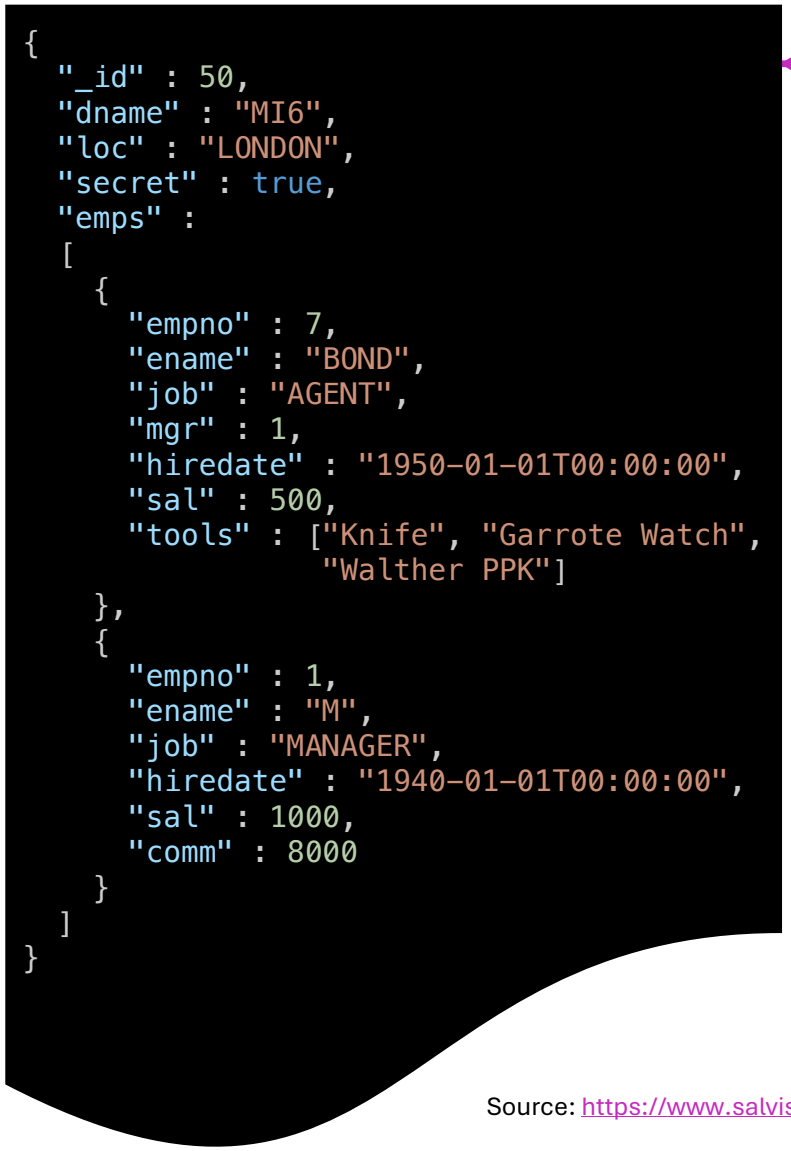
https://www.salvis.com/blog/

What is a DV?

DML via JSON-Relational Duality View (DV)



```
{
  "_id" : 50,
  "dname" : "MI6",
  "loc" : "LONDON",
  "secret" : true,
  "emps" :
  [
    {
      "empno" : 7,
      "ename" : "BOND",
      "job" : "AGENT",
      "mgr" : 1,
      "hiredate" : "1950-01-01T00:00:00",
      "sal" : 500,
      "tools" : ["Knife", "Garrote Watch",
                 "Walther PPK"]
    },
    {
      "empno" : 1,
      "ename" : "M",
      "job" : "MANAGER",
      "hiredate" : "1940-01-01T00:00:00",
      "sal" : 1000,
      "comm" : 8000
    }
  ]
}
```

DEPT

DEPTNO	DNAME	LOC	EXT
50	MI6	LONDON	{"secret":true}

EMP

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO	EXT
1	M	MANAGER		1940-01-01	1000	8000	50	
7	BOND	AGENT	1	1950-01-01	500		50	{"tools":["Knife","Garrote Watch","Walther PPK"]}

Source: https://www.salvis.com/blog/2024/06/27/islandsql-episode-9-graphql-json-and-flexible-schemas-with-duality-views/#insert-into-duality-view

DV using SELECT

```
create or replace json duality view dept_dv as
select json {
          '_id': deptno,
          dname,
          loc,
          ext as flex,
          'emps':
             (
                select json_arrayagg(
                          json {
                             emp.empno,
                             emp.ename,
                             emp.job,
                             unnest
                                (
                                   select json {
                                             'mgr'    : mgr.empno with nocheck,
                                             'mgrname': mgr.ename with nocheck
                                          }
                                     from emp mgr
                                    where mgr.empno = emp.mgr
                                ),
                             emp.hiredate,
                             emp.sal,
                             emp.comm,
                             ext as flex
                          }
                       )
                  from emp with insert update delete
                 where emp.deptno = dept.deptno
             )
       }
  from dept with insert update delete;
```

Annotations used:
flex, unnest, nocheck,
link (join condition),
insert, update, delete

Applicable
in DVs only

Source: https://www.salvis.com/blog/2024/06/27/islandsql-episode-9-graphql-json-and-flexible-schemas-with-duality-views#updateable-duality-view-using-select

DV using GraphQL

```
create or replace json duality view dept_dv as
dept @insert @update @delete
{
   _id: deptno
   dname
   loc
   ext @flex
   emps: emp @insert @update @delete
      {
         empno
         ename
         job
         emp @unnest @link(from: [mgr])
            {
               mgr    : empno @nocheck
               mgrname: ename @nocheck
            }
         hiredate
         sal
         comm
         ext @flex
      }
};
```

All annotations (directives) start with '@'

Default Join

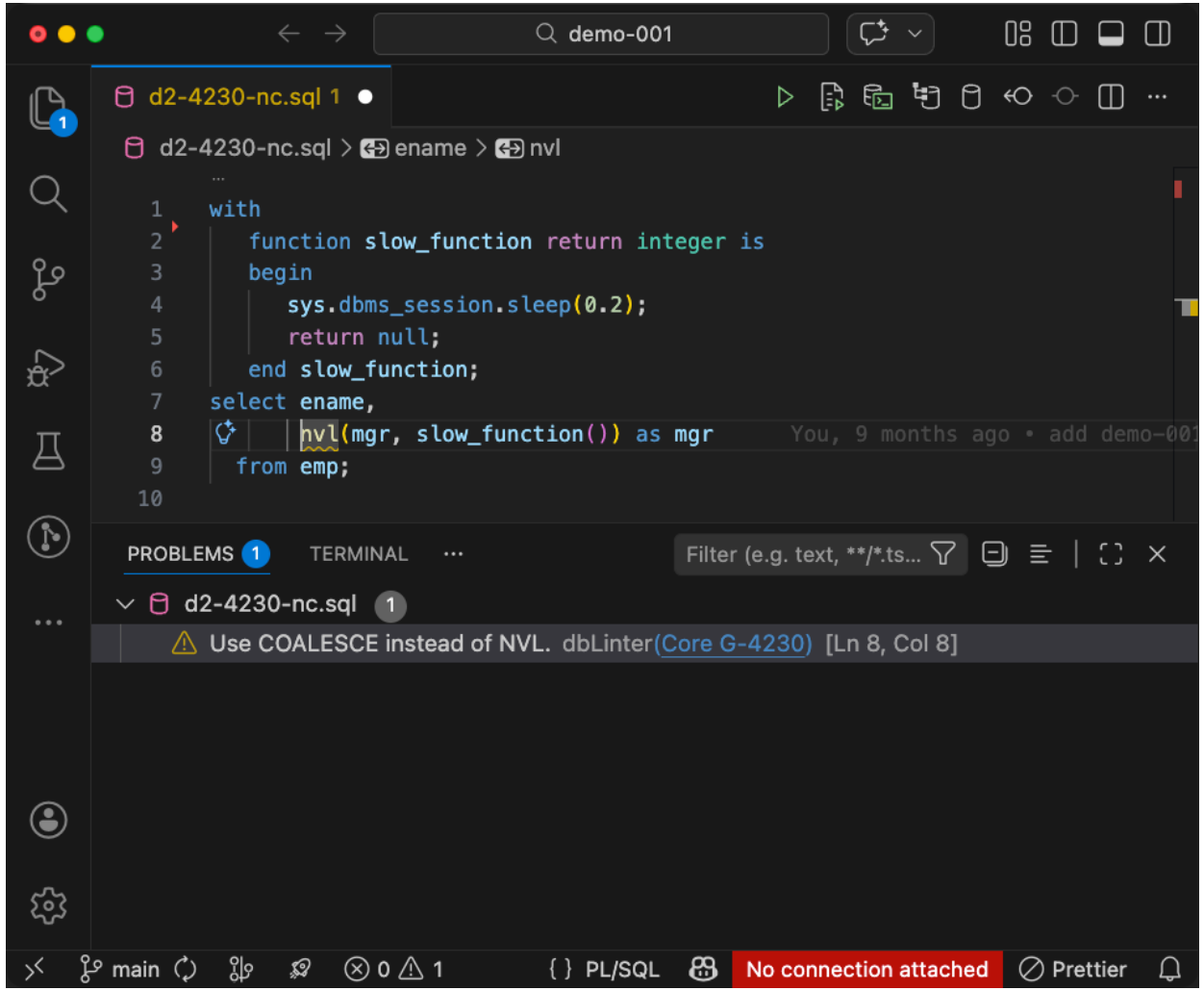
Shorter

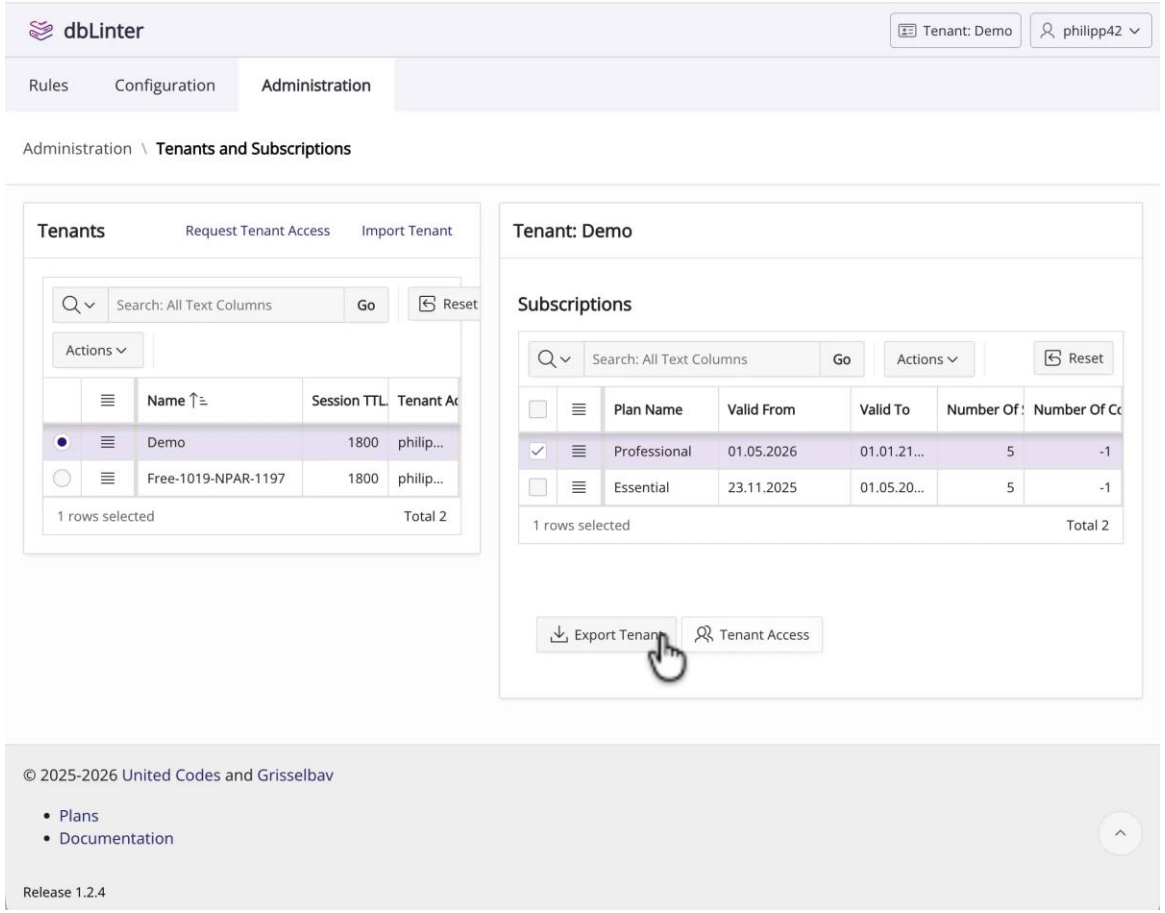
Looks similar to the result

Source: https://www.salvis.com/blog/2024/06/27/islandsql-episode-9-graphql-json-and-flexible-schemas-with-duality-view#updateable-duality-view-using-graphql

Motivation

dbLinter – JSON and DVs

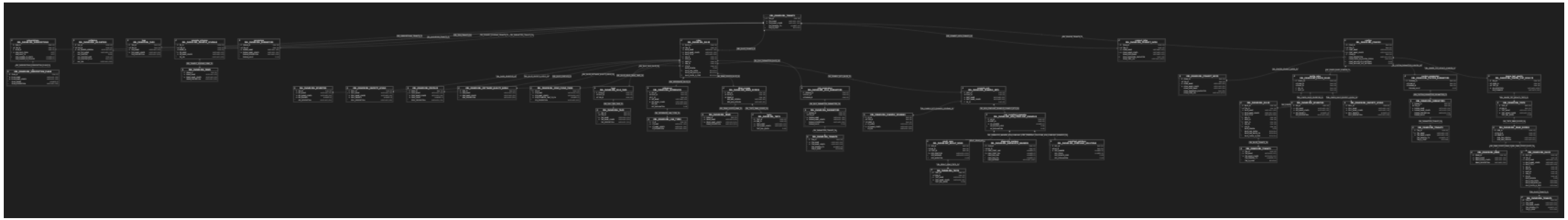


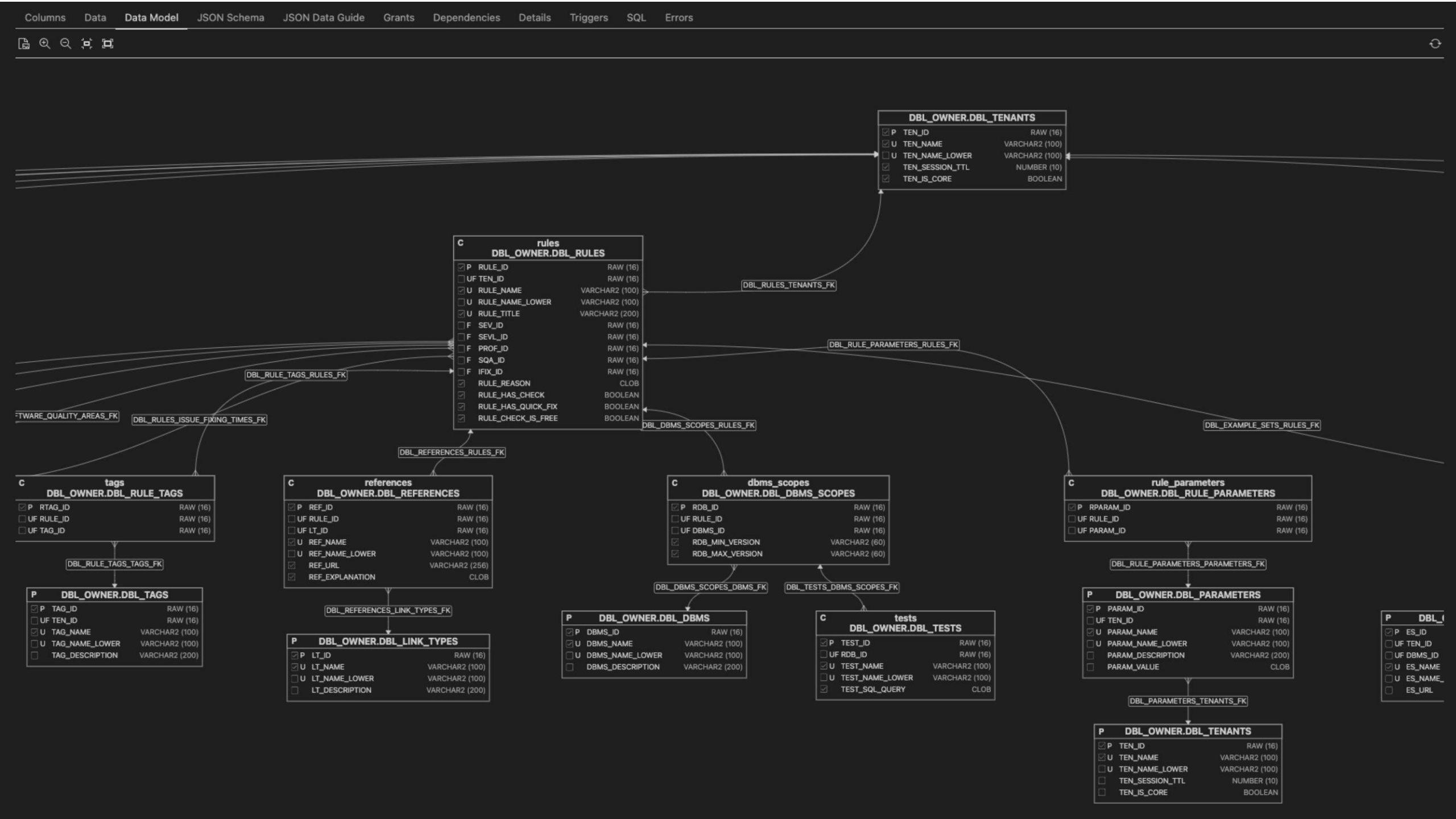


Duality View to Export/Import Tenants

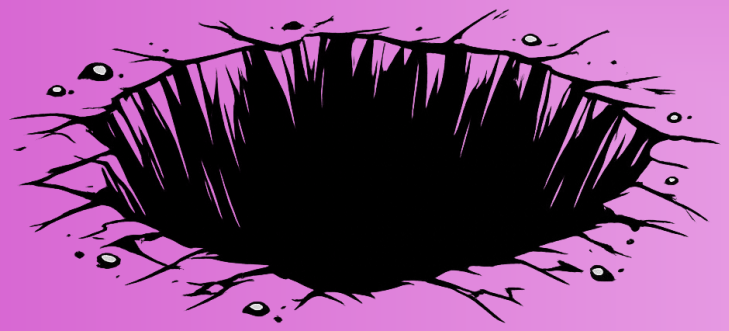
```
create or replace json duality view dbl_tenants_expimp_dv as
dbl_tenants @insert @update @delete
    {
        _id: ten_id
        ten_name
        ten_session_ttl
        ten_is_core
        subscriptions: dbl_subscriptions @insert @update @delete
            { -- ins/upd/del requires Product-Admin role
                sub_id
                dbl_subscription_plans @unnest
                    {
                        plan_id @nocheck
                        plan_name @nocheck
                    }
                sub_valid_from
                sub_valid_to
                sub_number_of_seats
                sub_number_of_configs
            }
        validators: dbl_validators @insert @update @delete
            {
                val_id
                val_parser_version
                val_file_name
                val_content
                val_content_md5
                val_content_sha1
                val_url
            }
        tags: dbl_tags @insert @update @delete
            {
                tag_id
                tag_name
                tag_description
            }
        example_schemas: dbl_example_schemas
                    @insert @update @delete
            {
                es_id
                dbl_dbms @unnest
                    {
                        dbms_id @nocheck
                        dbms_name @nocheck
                    }
                es_name
                es_url
            }
        parameters: dbl_parameters @insert @update @delete
            {
                param_id
                param_name
                param_description
                param_value
            }
        rules: dbl_rules @insert @update @delete
            {
                rule_id
                rule_name
                rule_title
                dbl_severities @unnest
                    {
                        sev_id @nocheck
                        sev_name @nocheck
                    }
                dbl_severity_levels @unnest
                    {
                        sevl_id @nocheck
                        sevl_name @nocheck
                    }
                dbl_profiles @unnest
                    {
                        prof_id @nocheck
                        prof_name @nocheck
                    }
                dbl_software_quality_areas @unnest
                    {
                        sqa_id @nocheck
                        sqa_name @nocheck
                    }
                dbl_issue_fixing_times @unnest
                    {
                        ifix_id @nocheck
                        ifix_name @nocheck
                    }
                rule_reason
                rule_has_check
                rule_has_quick_fix
                rule_check_is_free
                tags: dbl_rule_tags @insert @update @delete
                    {
                        rtag_id
                        dbl_tags @unnest
                            {
                                tag_id @nocheck
                                tag_name @nocheck
                            }
                    }
                references: dbl_references
                            @insert @update @delete
                    {
                        ref_id
                        dbl_link_types @unnest
                            {
                                lt_id @nocheck
                                lt_name @nocheck
                            }
                        ref_name
                        ref_url
                        ref_explanation
                    }
                dbms_scopes: dbl_dbms_scopes
                             @insert @update @delete
                    {
                        rdb_id
                        dbl_dbms @unnest
                            {
                                dbms_id @nocheck
                                dbms_name @nocheck
                            }
                        rdb_min_version
                        rdb_max_version
                        tests: dbl_tests @insert @update @delete
                            {
                                test_id
                                test_name
                                test_sql_query
                            }
                    }
                rule_parameters: dbl_rule_parameters
                                 @insert @update @delete
                    {
                        rparam_id
                        dbl_parameters @unnest
                            {
                                param_id @nocheck
                                param_name @nocheck
                                dbl_tenants @unnest
                                    {
                                        ten_id @nocheck
                                        ten_name @nocheck
                                    }
                            }
                    }
                example_sets: dbl_example_sets
                              @insert @update @delete
                    {
                        eset_id
                        dbl_example_schemas @unnest
                            {
                                es_id @nocheck
                                es_name @nocheck
                            }
                        non_compliant_examples:
                    dbl_non_compliant_examples @insert @update @delete
                            {
                                nc_id
                                nc_number
                                nc_source_code
                                nc_explanation
                                result_rows: dbl_result_rows
                                             @insert @update @delete
                                    {
                                        res_id
                                        dbl_tests @unnest
                                            {
                                                test_id @nocheck
                                                test_name @nocheck
                                            }
                                        res_identifier,
                                        res_message,
                                        res_migration
                                    }
                                diagnostic_markers:
                            dbl_diagnostic_markers @insert @update @delete
                                    {
                                        diag_id
                                        diag_start_line
                                        diag_start_col
                                        diag_end_line
                                        diag_end_col
                                        diag_message
                                    }
                                compliant_solutions:
                            dbl_compliant_solutions @insert @update @delete
                                    {
                                        sol_id
                                        sol_number
                                        sol_stars
                                        sol_source_code
                                        sol_explanation
                                    }
                            }
                    }
                connect_infos: dbl_connect_infos @insert @update @delete
                    {
                        conn_id
                        conn_name
                        conn_user_name
                        conn_password_encrypted
                        conn_jdbc_url
                    }
                configs: dbl_configs @insert @update @delete
                    {
                        conf_id
                        conf_name
                        dbl_connect_infos @unnest
                            {
                                conn_id @nocheck
                                conn_name @nocheck
                            }
                        conf_description
                        conf_check_on_syntax_error
                        conf_include_file_patterns
                        conf_exclude_file_patterns
                        config_rules: dbl_config_rules
                                      @insert @update @delete
                            {
                                crule_id
                                dbl_rules @unnest
                                    {
                                        rule_id @nocheck
                                        rule_name @nocheck
                                        dbl_tenants @unnest
                                            {
                                                ten_id @nocheck
                                                ten_name @nocheck
                                            }
                                    }
                                dbl_severities @unnest
                                    {
                                        sev_id @nocheck
                                        sev_name @nocheck
                                    }
                                dbl_severity_levels @unnest
                                    {
                                        sevl_id @nocheck
                                        sevl_name @nocheck
                                    }
                            }
                        custom_parameters: dbl_custom_parameters
                                           @insert @update @delete
                            {
                                cparam_id
                                dbl_parameters @unnest
                                    {
                                        param_id @nocheck
                                        param_name @nocheck
                                        dbl_tenants @unnest
                                            {
                                                ten_id @nocheck
                                                ten_name @nocheck
                                            }
                                    }
                                cparam_value
                            }
                        ignore_test_results: dbl_ignore_test_results
                                             @insert @update @delete
                            {
                                ign_id
                                dbl_tests @unnest
                                {
                                    test_id @nocheck
                                    test_name @nocheck
                                    dbl_dbms_scopes @unnest
                                        {
                                            rdb_id @nocheck
                                            dbl_dbms @unnest
                                                {
                                                    dbms_id @nocheck
                                                    dbms_name @nocheck
                                                }
                                            dbl_rules @unnest
                                                {
                                                  rule_id @nocheck
                                                  rule_name @nocheck
                                                  dbl_tenants @unnest
                                                    {
                                                      ten_id @nocheck
                                                      ten_name @nocheck
                                                    }
                                                }
                                        }
                                }
                                ign_identifier
                                ign_comment
                            }
                    }
    };
```

Duality View Based on 48 Tables




Columns
Data
Data Model
JSON Schema
JSON Data Guide
Grants
Dependencies
Details
Triggers
SQL
Errors
DBL_OWNER.DBL_TENANTS
P TEN_ID RAW (16)
U TEN_NAME VARCHAR2 (100)
U TEN_NAME_LOWER VARCHAR2 (100)
TEN_SESSION_TTL NUMBER (10)
TEN_IS_CORE BOOLEAN
C rules
DBL_OWNER.DBL_RULES
P RULE_ID RAW (16)
UF TEN_ID RAW (16)
U RULE_NAME VARCHAR2 (100)
U RULE_NAME_LOWER VARCHAR2 (100)
U RULE_TITLE VARCHAR2 (200)
F SEV_ID RAW (16)
F SEVL_ID RAW (16)
F PROF_ID RAW (16)
F SQA_ID RAW (16)
F IFIX_ID RAW (16)
RULE_REASON CLOB
RULE_HAS_CHECK BOOLEAN
RULE_HAS_QUICK_FIX BOOLEAN
RULE_CHECK_IS_FREE BOOLEAN
DBL_RULES_TENANTS_FK
DBL_RULE_PARAMETERS_RULES_FK
DBL_RULE_TAGS_RULES_FK
TWARE_QUALITY_AREAS_FK
DBL_RULES_ISSUE_FIXING_TIMES_FK
DBL_DBMS_SCOPES_RULES_FK
DBL_EXAMPLE_SETS_RULES_FK
DBL_REFERENCES_RULES_FK
C tags
DBL_OWNER.DBL_RULE_TAGS
P RTAG_ID RAW (16)
UF RULE_ID RAW (16)
UF TAG_ID RAW (16)
C references
DBL_OWNER.DBL_REFERENCES
P REF_ID RAW (16)
UF RULE_ID RAW (16)
UF LT_ID RAW (16)
U REF_NAME VARCHAR2 (100)
U REF_NAME_LOWER VARCHAR2 (100)
REF_URL VARCHAR2 (256)
REF_EXPLANATION CLOB
C dbms_scopes
DBL_OWNER.DBL_DBMS_SCOPES
P RDB_ID RAW (16)
UF RULE_ID RAW (16)
UF DBMS_ID RAW (16)
RDB_MIN_VERSION VARCHAR2 (60)
RDB_MAX_VERSION VARCHAR2 (60)
C rule_parameters
DBL_OWNER.DBL_RULE_PARAMETERS
P RPARAM_ID RAW (16)
UF RULE_ID RAW (16)
UF PARAM_ID RAW (16)
DBL_RULE_TAGS_TAGS_FK
DBL_REFERENCES_LINK_TYPES_FK
DBL_DBMS_SCOPES_DBMS_FK
DBL_TESTS_DBMS_SCOPES_FK
DBL_RULE_PARAMETERS_PARAMETERS_FK
P DBL_OWNER.DBL_TAGS
P TAG_ID RAW (16)
UF TEN_ID RAW (16)
U TAG_NAME VARCHAR2 (100)
U TAG_NAME_LOWER VARCHAR2 (100)
TAG_DESCRIPTION VARCHAR2 (200)
P DBL_OWNER.DBL_LINK_TYPES
P LT_ID RAW (16)
U LT_NAME VARCHAR2 (100)
U LT_NAME_LOWER VARCHAR2 (100)
LT_DESCRIPTION VARCHAR2 (200)
P DBL_OWNER.DBL_DBMS
P DBMS_ID RAW (16)
U DBMS_NAME VARCHAR2 (100)
U DBMS_NAME_LOWER VARCHAR2 (100)
DBMS_DESCRIPTION VARCHAR2 (200)
C tests
DBL_OWNER.DBL_TESTS
P TEST_ID RAW (16)
UF RDB_ID RAW (16)
U TEST_NAME VARCHAR2 (100)
U TEST_NAME_LOWER VARCHAR2 (100)
TEST_SQL_QUERY CLOB
P DBL_OWNER.DBL_PARAMETERS
P PARAM_ID RAW (16)
UF TEN_ID RAW (16)
U PARAM_NAME VARCHAR2 (100)
U PARAM_NAME_LOWER VARCHAR2 (100)
PARAM_DESCRIPTION VARCHAR2 (200)
PARAM_VALUE CLOB
DBL_PARAMETERS_TENANTS_FK
P DBL_OWNER.DBL_TENANTS
P TEN_ID RAW (16)
U TEN_NAME VARCHAR2 (100)
U TEN_NAME_LOWER VARCHAR2 (100)
TEN_SESSION_TTL NUMBER (10)
TEN_IS_CORE BOOLEAN
P DBL_
P ES_ID
UF TEN_ID
UF DBMS_ID
U ES_NAME
U ES_NAME_
ES_URL

#1 Size



Size Matters

JSON Datatype Size Limits

32 MB

33'554'432 Bytes

OSON

(Oracle's native binary JSON format)

JSON Size - Examples

```
with j (variant, json_string) as (values
      ('rows_as_objects', '
         {
            "emps": [ { "empno": 7788, "name": "Scott", "sal": 3000 },
                      { "empno": 7839, "name": "King", "sal": 5000 },
                      { "empno": 7876, "name": "Adams", "sal": 1100 } ]
         }
      '),
      ('rows_as_arrays', '
         {
            "emps": [ [ 7788, "Scott", 3000 ],
                      [ 7839, "King", 5000 ],
                      [ 7876, "Adams", 1100 ] ]
         }
      ')
   )
select variant,
       lengthb(json_string) as str_len,
       lengthb(replace(json_string, ' ', null)) as str_trimmed_len,
       lengthb(json(json_string)) as oson_len,
       lengthb(json(replace(json_string, ' ', null))) as oson_trimmed_len
 from j;
```

VARIANT	STR_LEN	STR_TRIMMED_LEN	OSON_LEN	OSON_TRIMMED_LEN
rows_as_objects	242	138	125	125
rows_as_arrays	170	75	96	96

OSON Storage Representation

```
Variant         Offset Hex Bytes                                        ASCII Chars
--------------- ------ ------------------------------------------------ ----------------
rows_as_objects 000000 FF 4A 5A 01 21 06 04 00 14 00 50 00 01 42 6F BA  .JZ.!.....P..Bo.
                000010 E6 00 00 00 10 00 05 00 0B 04 65 6D 70 73 05 65  ..........emps.e
                000020 6D 70 6E 6F 04 6E 61 6D 65 03 73 61 6C 84 01 01  mpno.name.sal...
                000030 00 05 C0 03 00 0D 00 25 00 3A 86 03 03 04 02 00  .......%.:......
                000040 18 00 1C 00 22 22 C2 4E 59 05 53 63 6F 74 74 21  ....""".NY.Scott!
                000050 C2 1F 9C 00 0D 00 2E 00 32 00 37 22 C2 4F 28 04  ........2.7".O(.
                000060 4B 69 6E 67 21 C2 33 9C 00 0D 00 43 00 47 00 4D  King!.3....C.G.M
                000070 22 C2 4F 4D 05 41 64 61 6D 73 21 C2 0C           ".OM.Adams!..

rows_as_arrays  000000 FF 4A 5A 01 21 06 01 00 05 00 4B 00 00 42 00 00  .JZ.!.....K..B..
                000010 04 65 6D 70 73 84 01 01 00 05 C0 03 00 0D 00 22  .emps..........."
                000020 00 36 C0 03 00 15 00 19 00 1F 22 C2 4E 59 05 53  .6........".NY.S
                000030 63 6F 74 74 21 C2 1F C0 03 00 2A 00 2E 00 33 22  cott!.....*...3"
                000040 C2 4F 28 04 4B 69 6E 67 21 C2 33 C0 03 00 3E 00  .O(.King!.3...>.
                000050 42 00 48 22 C2 4F 4D 05 41 64 61 6D 73 21 C2 0C  B.H".OM.Adams!..
```

see node-oracledb OSON decoder: https://github.com/oracle/node-oracledb/blob/v6.10.0/lib/impl/datahandlers/oson.js#L280

OSON or JSON Datatype Limitation?

OSON BLOB

```
create table i (
   data blob check (data is json format oson)
);

exec dbms_random.seed(42);

insert into i (data)
select json_arrayagg(
         json{
            '_id'  : rownum,
            'name' : initcap(dbms_random
                             .string('A', 30)),
            'sal'  : trunc(dbms_random
                           .value(1000, 5000), 2)
         } returning blob
       )
  from dual connect by level <= 750000;

ORA-40604: exceeded maximum size for a JSON data type object
JZN-00092: JSON too large for binary encoding
```

Conventional BLOB

```
create table i (
   data blob check (data is json)
);

exec dbms_random.seed(42);

insert into i (data)
select json_arrayagg(
         json{
            '_id'  : rownum,
            'name' : initcap(dbms_random
                             .string('A', 30)),
            'sal'  : trunc(dbms_random
                           .value(1000, 5000), 2)
         } returning blob
       )
  from dual connect by level <= 750000;

select length(data) from i;

LENGTH(DATA)
------------
    51548929
```

Solutions for ORA-40604/JZN-00092?

Process JSON Chunks < 32 MB

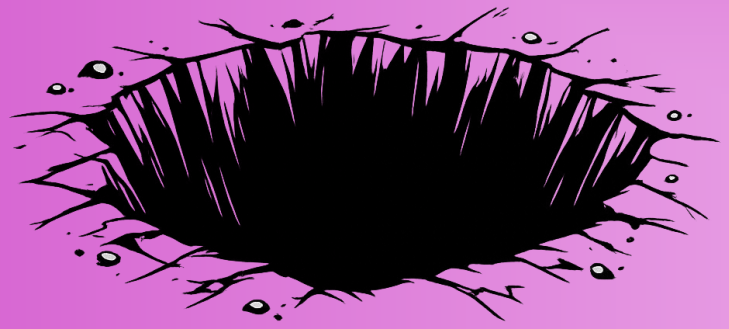
```
create json relational duality view dv as
t @insert @update @delete
{
   _id: empno,
   name: name,
   sal: sal
};

insert into dv (data)
select jt.emp
  from i
 cross apply json_table(
         i.data,
         '$[*]' columns (
            emp json path '$'
         )
      ) jt;
```

Avoid OSON and DVs

```
insert into t (empno, name, sal)
select jt.empno, jt.name, jt.sal
  from i
 cross apply json_table(
         i.data,
         '$[*]' columns (
           empno number           path '$._id',
           name  varchar2(30 char) path '$.name',
           sal   number(7,2)       path '$.sal'
         )
      ) jt;
```

Faster,
Max. 32 TB
with 8 KB Blocks

#2 Surrogate Keys



Surrogate Keys – Overview

Typical Characteristics

- System generated (Sequence, UUID)
- Not derived from other business values
- Never reused
- Not manipulable by the user or system
- No semantic meaning
- Exposed to the user or application for reference purposes only
- Not shared across systems

Values

- Single-column PKs and FKs (no composite and compound keys)
- Simplifies access and joins
- No PK and FK updates
- Simplifies BK updates
- Might improve join performance

Model

Tables

```
create table d (
  dept_id   integer generated always as identity not null,
  dept_name varchar2(30 char) not null,
  dept_desc varchar2(100 char),
  constraint d_pk primary key (dept_id),
  constraint d_uk unique (dept_name)
);

create table e (
  emp_id   integer generated always as identity not null,
  emp_no   integer not null,
  emp_name varchar2(30 char) not null,
  dept_id  integer not null,
  constraint e_pk primary key (emp_id),
  constraint e_uk1 unique (emp_no),
  constraint e_uk2 unique (emp_name),
  constraint e_d_fk foreign key (dept_id) references d
);
```

Duality View (PK)

```
d @insert @update @delete
{
    _id: dept_id,
    dept_name,
    dept_desc
    emps: e @insert @update @delete
    {
       emp_id,
       emp_no,
       emp_name
    }
};
```

Ensures that sequences remain unique

Model enforces server- side surrogate keys

JSON for _id 2


```
{
  "_id" : 2,
  "_metadata" :
  {
    "etag" : "DFA31E21B395F4196E69AE43F8E692B9",
    "asof" : "00000000006AFCE2"
  },
  "dept_name" : "Research",
  "dept_desc" : "Chicago",
  "emps" :
  [
    {
      "emp_id" : 2,
      "emp_no" : 7566,
      "emp_name" : "Jones"
    },
    {
      "emp_id" : 3,
      "emp_no" : 7788,
      "emp_name" : "Scott"
    }
  ]
}
```


Good for original system

Not optimal for sharing across systems

Duality View Based on Business Keys?

Duality View (BK)

```
create json relational duality view dv_bk as
d @insert @update @delete
{
  _id: dept_name,
  dept_desc,
  emps: e @insert @update @delete
  {
    emp_no,
    emp_name
  }
};


ORA-42550: Cannot create updatable JSON-relational
duality view 'DV_BK': linking column 'DEPT_ID' of
table 'E' should be selected.
```

- no FK columns based on BK
- Missing relationship between D and E
- Read-only DV is possible
- Updatable DV on BK would require redundant data
- Updatable DV on BKs are only feasible if BKs are used exclusively for PKs and FKs

Solution – 1/3) Update DV

Duality View (PK, BK)

```
create or replace json relational duality view dv as
d @insert @update @delete
{
    _id: dept_id
    dept_name
    dept_desc
    emps: e @insert @update @delete
    {
       emp_no
       emp_name
    }
};
```

- Remove PK emp_id
- Works when not used as FK
- Object identified via BK (UK)
- But we have two UKs
  - emp_no
  - emp_name

Solution – 2/3) Remove PK, Metadata

Query

```
select json_serialize(
          json_transform(
             data,
             remove '$._id',
             remove '$._metadata'
          ) pretty
       ) as export_json
  from dv dv where dv.data.dept_name = 'Research';
```

Result

```
{
  "dept_name" : "Research",
  "dept_desc" : "Chicago",
  "emps" :
  [
    {
      "emp_no" : 7566,
      "emp_name" : "Jones"
    },
    {
      "emp_no" : 7788,
      "emp_name" : "Scott"
    }
  ]
}
```

Solution – 3/3) Add PK on Import

Import Procedure

```
create or replace procedure import(in_json in json) is
   cursor c_dept is
      select dept_id
        from d
       where dept_name = json_value(in_json, '$.dept_name');
   r_dept c_dept%rowtype;
   cursor c_transform is
      select json_transform(
                in_json,
                set '$._id' = r_dept.dept_id create on missing
             ) as data;
   r_transform c_transform%rowtype;
begin
   open c_dept;
   fetch c_dept into r_dept;
   close c_dept;
   open c_transform;
   fetch c_transform into r_transform;
   close c_transform;
   if r_dept.dept_id is not null then
      update dv dv
         set data = r_transform.data
       where dv.data."_id" = r_dept.dept_id;
   else
      insert into dv (data) values (r_transform.data);
   end if;
end import;
```

Call

```
begin
   import(json('
      {
        "dept_name" : "Research",
        "dept_desc" : "Chicago2",
        "emps" :
        [
          {
            "emp_no" : 7566,
            "emp_name" : "Jones2"
          },
          {
            "emp_no" : 7788,
            "emp_name" : "Scott2"
          }
        ]
      }'));
end;

select * from e natural join d;

DEPT_ID EMP_ID EMP_NO EMP_NA DEPT_NAME  DEPT_DESC
------- ------ ------ ------ ---------- ---------
      1      1   7839 King   Accounting New York
      2      4   7566 Jones2 Research   Chicago2
      2      5   7788 Scott2 Research   Chicago2
```

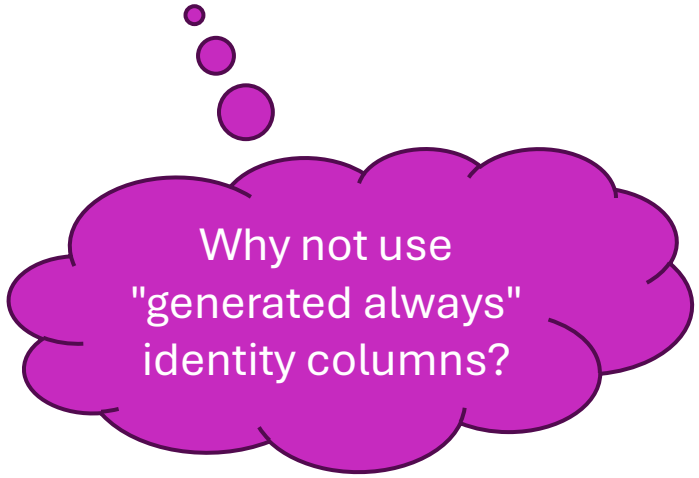
Delete/Insert for each emp due to UK update

First UK by property name is used

Solution Approach in dbLinter Repo

Model

- Updateable DVs based on PK/FK
- All PK based on surrogate keys with
  `default on null for insert only sys_guid()`



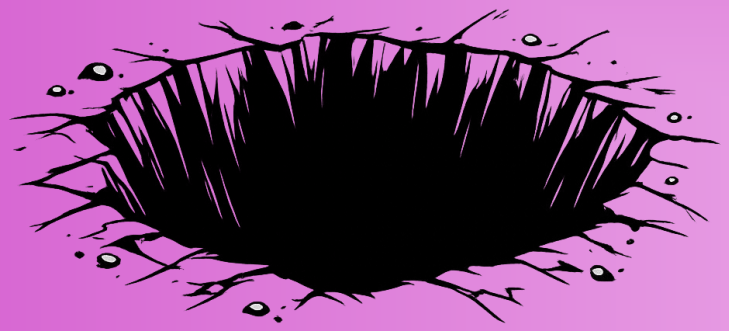
Export

- Remove _id node
- Remove _metadata node
- Remove all surrogate keys

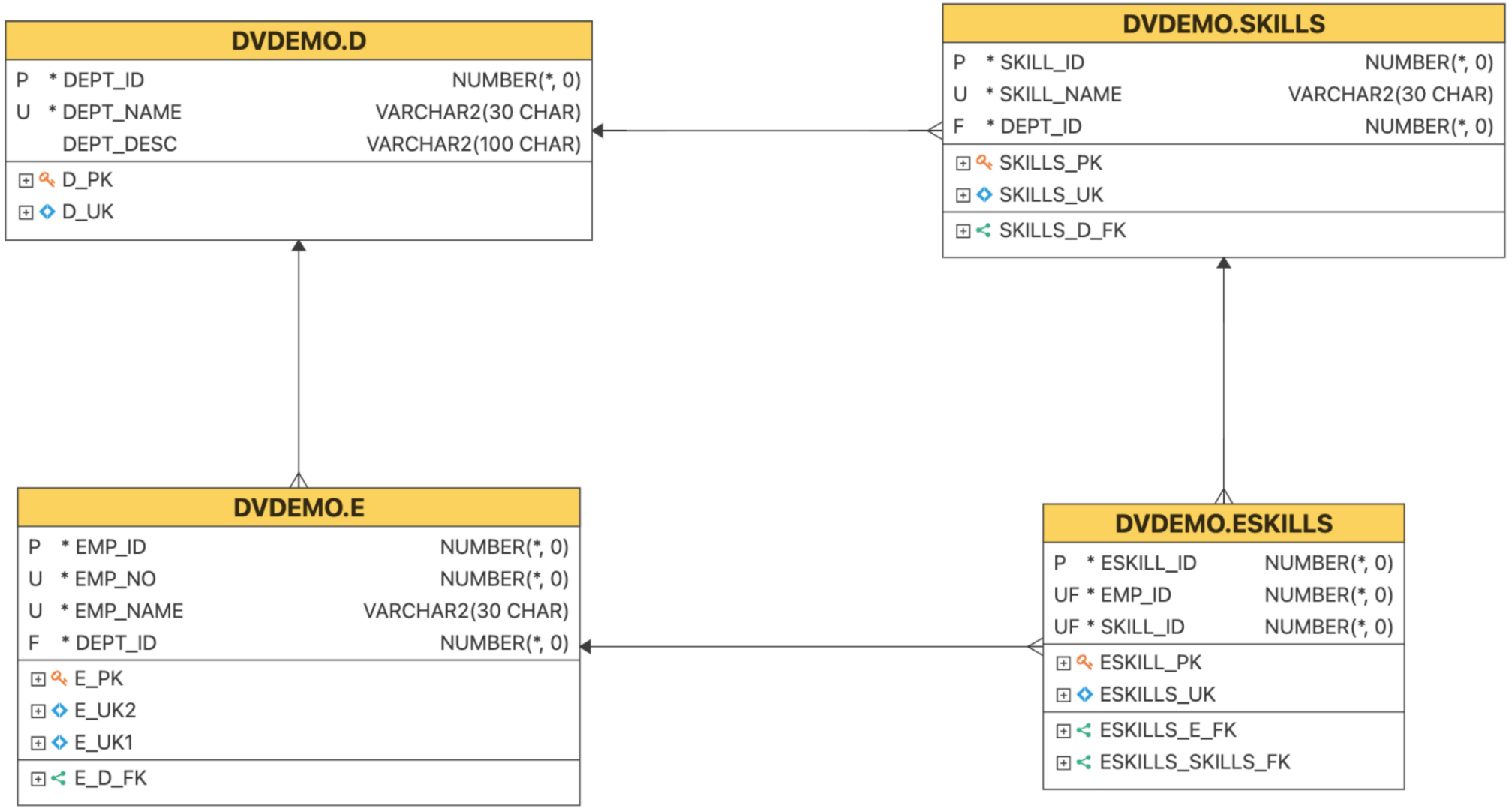
Import

- Populate surrogate keys via BK (an explicitly chosen UK)
- Insert via DV (no _id)
- Update via DV (existing _id)

#3 Referential Integrity



Model – Overview



Model – Sequence, Tables

```
create sequence ids;

create table d (
  dept_id   integer default on null
                            for insert only ids.nextval,
  dept_name varchar2(30 char) not null,
  dept_desc varchar2(100 char),
  constraint d_pk primary key (dept_id),
  constraint d_uk unique (dept_name)
);

create table skills (
  skill_id   integer default on null
                            for insert only ids.nextval,
  skill_name varchar2(30 char) not null,
  dept_id    integer not null,
  constraint skills_pk primary key (skill_id),
  constraint skills_uk unique (skill_name),
  constraint skills_d_fk foreign key (dept_id)
                                          references d
);
```

```
create table e (
  emp_id   integer default on null
                                for insert only ids.nextval,
  emp_no   integer not null,
  emp_name varchar2(30 char) not null,
  dept_id  integer not null,
  constraint e_pk primary key (emp_id),
  constraint e_uk1 unique (emp_no),
  constraint e_uk2 unique (emp_name),
  constraint e_d_fk foreign key (dept_id) references d
);

create table eskills (
  eskill_id integer default on null
                                for insert only ids.nextval,
  emp_id    integer not null,
  skill_id  integer not null,
  constraint eskill_pk primary key (eskill_id),
  constraint eskills_uk unique (emp_id, skill_id),
  constraint eskills_e_fk foreign key (emp_id)
                                          references e,
  constraint eskills_skills_fk foreign key (skill_id)
                                          references skills
);
```

Duality View

```
create or replace json relational duality view dv as
d @insert @update @delete
{
    _id: dept_id
    dept_name
    dept_desc
    skills: skills @insert @update @delete
    {
       skill_id
       skill_name

    }
    emps: e @insert @update @delete
    {
       emp_id
       emp_no
       emp_name
       skills: eskills @insert @update @delete
       {
          eskill_id
          skills @unnest
          {
             skill_id
             skill_name
             d @unnest
             {
                dept_id @nocheck
                dept_name @nocheck
             }
          }
       }
    }
};
```

Insert into DV

```
insert into dv (data) values (json('{
  "_id" : 1,
  "dept_name" : "HR",
  "dept_desc" : "Human Resources",
  "skills" :
  [
    {
      "skill_id" : 2,
      "skill_name" : "SQL"
    },
    {
      "skill_id" : 3,
      "skill_name" : "AI"
    }
  ],
  "emps" :
  [
    {
      "emp_id" : 4,
      "emp_no" : 1234,
      "emp_name" : "Luma",
      "skills" :
      [
        {
          "eskill_id" : 5,
          "skill_id" : 3,
          "skill_name" : "AI",
          "dept_id" : 1,
          "dept_name" : "HR"
        }
      ]
    }
  ]
}'));
```

```
ORA-42692: Cannot insert into JSON Relational Duality View
'DVDEMO'.'DV': Error while inserting into table 'ESKILLS'
ORA-02291: integrity constraint (DVDEMO.ESKILLS_SKILLS_FK)
violated - parent key not found
```

tested with Oracle AI Database Enterprise Edition 23.26.1.0.0 (Bug 37305380)

Solution – Check Integrity At Commit

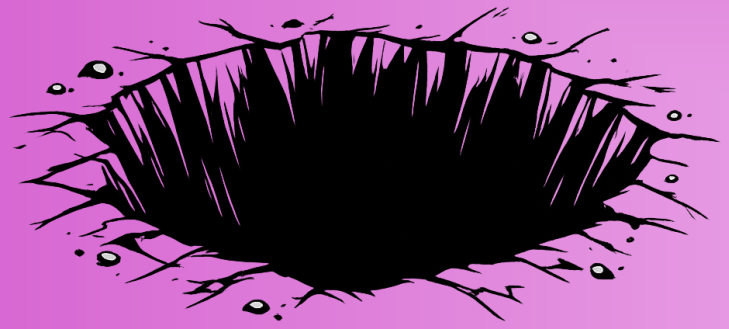
```
alter table eskills drop constraint eskills_skills_fk;
alter table skills drop constraint skills_pk;

alter table skills
   add constraints skills_pk
      primary key (skill_id) rely;

alter table eskills
   add constraint eskills_skills_fk
      foreign key (skill_id) references skills
      deferrable initially immediate rely;

set constraints all deferred;
insert into dv (data) values (...);
commit;
```

"deferrable" changes default behaviour of RELY!

May lead to different execution plans!

We defer the check for DV DMLs only

#4 Composition vs. Aggregation



Composition

Dept with Emps

```
{
  "_id" : 2,
  "dept_name" : "Research",
  "dept_desc" : "Chicago",
  "emps" :
  [
    {
      "emp_id" : 4,
      "emp_no" : 7566,
      "emp_name" : "Jones"
    },
    {
      "emp_id" : 5,
      "emp_no" : 7788,
      "emp_name" : "Scott"
    }
  ]
}
```

- Single document structure
- Linked life cycle
- Limited update flexibility

Aggregation

Departments

```
{
  "_id" : 2,
  "dept_name" : "Research",
  "dept_desc" : "Chicago"
}
```

Employees

```
{
  "_id" : 4,
  "emp_no" : 7566,
  "emp_name" : "Jones",
  "dept_id" : 2,
  "dept_name" : "Research"
}

{
  "_id" : 5,
  "emp_no" : 7788,
  "emp_name" : "Scott",
  "dept_id" : 2,
  "dept_name" : "Research"
}
```

- Multiple document structure
- Independent life cycle
- Update flexibility

One Model – Multiple Representations

Composition

```
create json duality view dv as
d @insert @update @delete
{
    _id: dept_id,
    dept_name,
    dept_desc
    emps: e @insert @update @delete
    {
       emp_id,
       emp_no,
       emp_name
    }
};
```

Aggregation

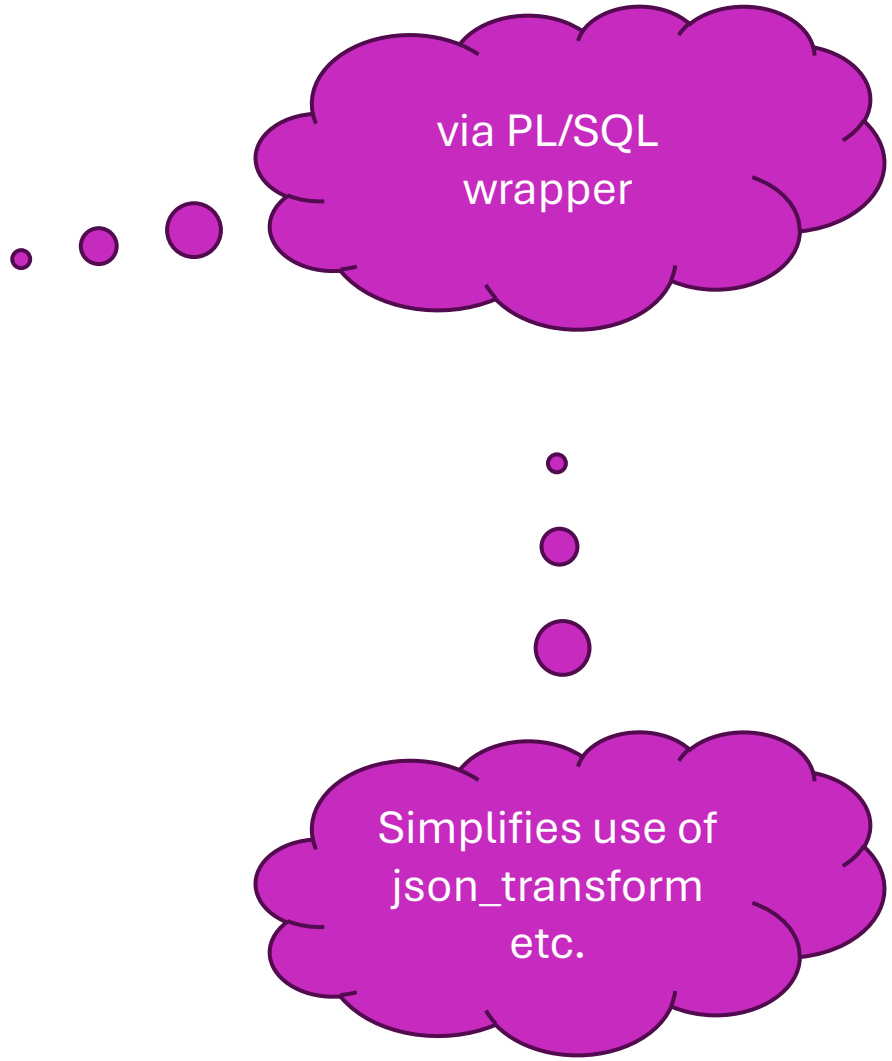
```
create json duality view d_dv as
d @insert @update @delete
{
    _id: dept_id
    dept_name
    dept_desc
};

create json duality view e_dv as
e @insert @update @delete
{
    _id: emp_id
    emp_no
    emp_name
    d @unnest
    {
       dept_id
       dept_name
    }
};
```

Composition Dept with Emps

Operation	emps Array	emps @insert @update @delete	emps @noinsert @noupdate @nodelete
Insert	emps: []	-	-
Update	emps: []	Deletes emps	Keeps emps
Update	emps: [{Jones}]	Deletes emps except Jones Insert or Updates Jones	ORA-40938: Cannot delete from table 'E' in JSON Relational Duality View 'DV': Missing DELETE annotation or NODELETE annotation specified.
Delete	-	Deletes emps	Succeeds for depts without emps ORA-40938: Cannot delete from table 'E' in JSON Relational Duality View 'DV': Missing DELETE annotation or NODELETE annotation specified.

JSON in dbLinter Repo

- Duality Views for Export & Import
  - Tenants
  - Users
- Duality Views for Export only
  - Rules (for https://dblinter-rules.united-codes.com/)
  - Logs
- SQL/JSON for read-only access
  - Open Client Session



Core Messages

JSON Documents in Oracle AI Database

- Keep JSON documents in duality views small
- Use SQL/JSON for large JSON documents
- Consider use case-specific (duality) views / JSON documents
- Defer constraint checks for embedded relationships in updatable duality views

JSON Documents Shared Across Systems

- Remove surrogate keys from source system
- Add surrogate keys from target system based on business keys
- Never use "generated always" identity columns for embedded relationships

Thank you!