ORACLE

JSON in Oracle Database: common use cases and best practices

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Beda Hammerschmidt

Twitter: bch_t

Consulting (Coding) Member of Technical Staff
Oracle Database, JSON support

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What's JSON?

```
{
  "firstName":"John",
  "lastName":"Smith",
  "age":25,
  "address":{
    "street":"21 2nd Street“,"city":"New York",
    "state":"NY","postalCode":"10021",
    "isBusiness":false
  },
  "phoneNumbers":[
    {"type":"home","number":"212 555-1234"},
    {"type":"mobile","number":"646 555-4567"}
  ],
  "bankruptcies":null,
  ”lastUpdated":"2019-05-13T13:03:35+0000"
}
```


What's JSON?


```
{
  "firstName":"John",
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    {"type":"home","number":"212 555-1234"},
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  ],
  "bankruptcies":null,
  ”lastUpdated":"2019-05-13T13:03:35+0000"
}
```

JSON Support in Oracle Database

JSON storage

```
create table emp(
        empno   number,
        first   varchar2(50),
        last    varchar2(50),
        salary  number,
        flex    CLOB,
        check (flex IS JSON));

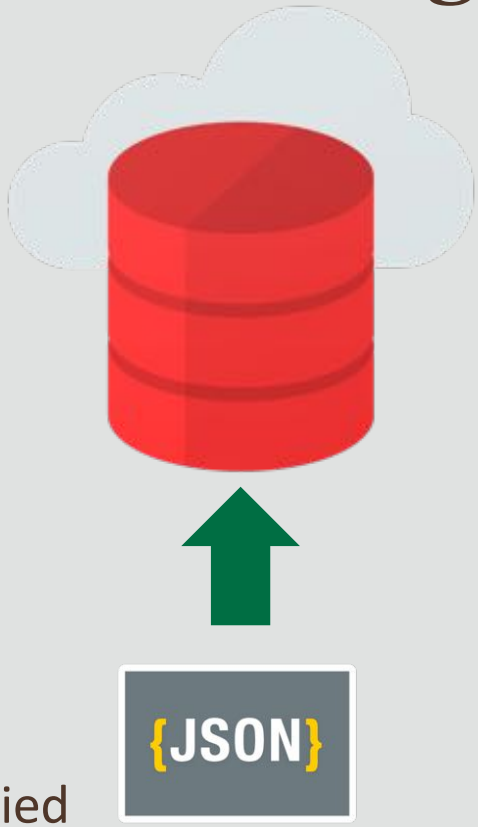
insert into emp values(1, 'John', 'Smith',
  2000, '{skills:["Java", "C", "C++"]}');

insert into emp values(2, 'Amanda', 'Jones',
  2500, '{skills:["JavaScript", "nodeJS"],
          numPatents:5}');
```


Common use cases for JSON in Oracle Database

Use Case: JSON Ingestion and Processing

- JSON import to relational processing stack
  - Feed existing application with JSON data
  - Examples: Google Clickstream, travel bookings, tax-filing, policy data, social media feeds,…
  - Use-cases: Analytical queries, Reporting
  - Often no control over JSON structure/schema. Sometimes originating from XML
  - Often JSON is not only imported but also stored and queried (schema-less storage)



JSON Support in the Oracle database

```
insert into emp values(1, 'John', 'Smith',
  2000, '{skills:["Java", "C", "C++"]}');

insert into emp values(2, 'Amanda', 'Jones',
  2500, '{skills:["JavaScript", "nodeJS"],
          numPatents:5}');
```

```
select e.flex.skills,
       e.flex.numPatents.number()
from emp e
where e.flex.skills like '%Java%';

SKILLS                    NUMPATENTS
--------------------------------
["Java","C","C++"]          (null)
["JavaScript","nodeJS"]          5
```

JSON Support in the Oracle database

```
insert into emp values(1, 'John', 'Smith',
  2000, '{skills:["Java", "C", "C++"]}');

insert into emp values(2, 'Amanda
  2500, '{skills:["JavaScript", "
          numPatents:5}');
```

```
select JSON_QUERY(e.flex, '$.skills[0,1]'
                                WITH ARRAY WRAPPER)
from emp e where
JSON_EXISTS(e.flex,'$.skills?(@ == "Java")');

JSON_QUERY(SKILLS..
--------------------
["Java","C"]
```

```
select e.flex.skills,
       e.flex.numPatents.number()
from emp e
where e.flex.skills like '%Java%';

SKILLS                      NUMPATENTS
--------------------------------------
["Java","C","C++"]             (null)
["JavaScript",”nodeJS"]             5
```

JSON_TABLE: 'flatten' the JSON data

```
{
 "firstName":"John",
 "lastName":"Smith",
 "age":25,
 "address":{
   "street":"21 2nd Street",
    "city":"New York",
   "state":"NY",
  "postalCode":"10021",
   "isBusiness":false
 },
 "phoneNumbers":[
   {"type":"home",
     "number":"212-555-1234"},
   {"type":"mobile",
     "number":"646-555-4567"}
 ],
 "bankruptcies":null,
 "lastUpdated":"2019-05-13T13:03:35"
}
```

```
select id, jt.*
from custData, JSON_TABLE(jcol, '$' columns (
  "first"              path '$.firstName',
  "age"   number       path '$.age',
  "state" varchar2(2) path '$.address.state',
   NESTED PATH '$.phoneNumbers[*] columns(
      "phone" path '$.number')
 )) jt;

ID first age state  phone
-------------------------
1  John  25  NY     212-555-1234
1  John  25  NY     646-555-4567
```

JSON_TABLE: 'flatten' the JSON data

```
{
 "firstName":"John",
 "lastName":"Smith",
 "age":25,
 "address":{
   "street":"21 2nd Street“,
    "city":"New York",
   "state":"NY",
  "postalCode":"10021",
   "isBusiness":false
 },
 "phoneNumbers":[
   {"type":"home",
     "number":"212-555-1234"},
   {"type":"mobile",
     "number":"646-555-4567"}
 ],
 "bankruptcies":null,
 "lastUpdated":"2019-05-13T13:03:35"
}
```

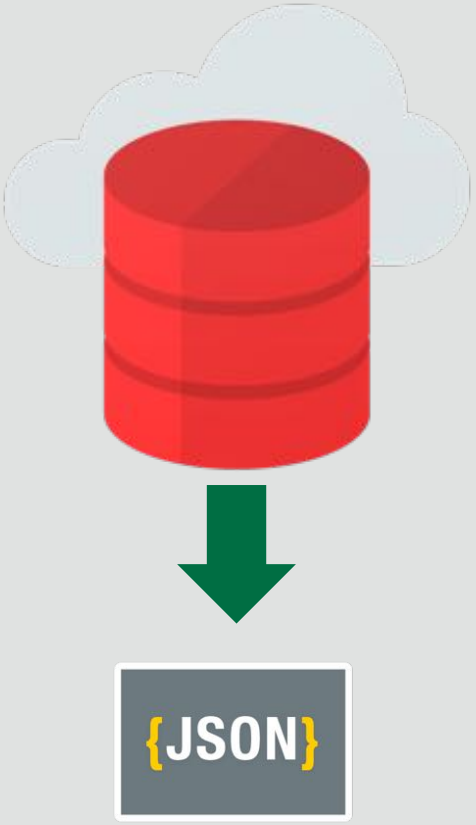
NEW

```
select id, jt.*
from custData NESTED jcol columns (
   firstName,
   age NUMBER,
   ”state" PATH '$.address.state',
   NESTED phoneNumbers[*] columns(
       "number"
) jt;

ID firstName age state  number
-------------------------
1  John      25  NY     212-555-1234
1  John      25  NY     646-555-4567
```

Use Case: JSON Generation

- Export of (relational) data as JSON
  - Feed data to other systems
  - modern JavaScript UI on legacy app
- Message generation
  - Example: RAC autonomous health framework generate node status information as JSON
  - Sometimes PL/SQL is used if message generation requires procedural logic



JSON Generation

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
7369	SMITH	CLERK	7902	17-DEC-80	800		20
7499	ALLEN	SALESMAN	7698	20-FEB-81	1600	300	30
7521	WARD	SALESMAN	7698	22-FEB-81	1250	500	30
7566	JONES	MANAGER	7839	02-APR-81	2975		20
7654	MARTIN	SALESMAN	7698	28-SEP-81	1250	1400	30
7698	BLAKE	MANAGER	7839	01-MAY-81	2850		30
7782	CLARK	MANAGER	7839	09-JUN-81	2450		10
7788	SCOTT	ANALYST	7566	19-APR-87	3000		20
7839	KING	PRESIDENT		17-NOV-81	5000		10
7844	TURNER	SALESMAN	7698	08-SEP-81	1500	0	30
7876	ADAMS	CLERK	7788	23-MAY-87	1100		20
7900	JAMES	CLERK	7698	03-DEC-81	950		30
7902	FORD	ANALYST	7566	03-DEC-81	3000		20
7934	MILLER	CLERK	7782	23-JAN-82	1300		10

```
select JSON_OBJECT(
      'id'   VALUE empno,
      'name' VALUE ename )
from emp;
```

```
JSON_OBJECT(…
-------------------------
{"id":7669, "name":"SMITH"}
{"id":7499, "name":"ALLEN"}
{"id":7521, "name":"WARD"}
{"id":7566, "name":"JONES"}
```


JSON Generation

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
7369	SMITH	CLERK	7902	17-DEC-80	800		20
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7900	JAMES	CLERK	7698	03-DEC-81	950		30
7902	FORD						20
7934	MILLER						10

DEPTNO	DNAME	LOC
10	ACCOUNTING	NEW YORK
20	RESEARCH	DALLAS
30	SALES	CHICAGO
40	OPERATIONS	BOSTON

```
select
JSON_OBJECTAGG(dname VALUE
  select
  JSON_ARRAYAGG(JSON {ename})
  from emp e
  where e.deptno = d.deptno
) from dept d;

JSON_OBJECTAGG(…
------------------------
{"ACCOUNTING":[
      {"eName":"CLARK"},
      {"eName":"KING"},
      {"eName": "MILLER"}
    ],
 "RESEARCH":[
      {"eName": "SMITH"},
      {"eName": "JONES"},
```

Use Case: Procedural Logic on JSON data

```
create or replace function score(skills CLOB) return number is
  skillsArr JSON_ARRAY_T;
  skill     varchar2(50);
  score     number := 0;
begin
  skillsArr := JSON_ARRAY_T(skills);
  for i in 0 .. skillsArr.get_size loop
    skill := skillsArr.get_string(i);
    if (skill like '%JSON%') then
      score := score + 2;
    else
      score := score + 1;
    end if;
  end loop;
  return score;
end;
/
```

Use Case: Schema Discovery

- JSON data typically has no formal schema definition
  - Schema implicitly defined by applications
  - Hard to identify schema by looking at instances
  - Schema changes hard to track
- JSON-Dataguide
  - derive JSON schema from JSON data (sampling)
  - Use schema to auto-build views and virtual columns
  - Track schema schanges
- Relational: Schema first – data later
- JSON: Data first - schema later

JSON Support in the Oracle database

```
{
 "firstName":"John",
 "lastName":"Smith”,
 "age":25,
 "address":{
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   "state":"NY",
  "postalCode":"10021",
   "isBusiness":false
 },
 "phoneNumbers":[
   {"type":"home",
     "number":"212-555-1234"},
   {"type":"mobile",
     "number":"646-555-4567"}
 ],
 "bankruptcies":null,
 "lastUpdated":"2019-05-13T13:03:35"
}
```

```
select JSON_DATAGUIDE(jcol) from custData;

[{
        "o:path": "$",
        "type": "object",
        "o:length": 1
}, {
        "o:path": "$.age",
        "type": "number",
        "o:length": 2
}, {
        "o:path": "$.address",
        "type": "object",
        "o:length": 1
}, {
        "o:path": "$.address.city",
        "type": "string",
        "o:length": 8
},
```

JSON Support in the Oracle database

```
{
 "firstName":"John",
 "lastName":"Smith”,
 "age":25,
 "address":{
   "street":"21 2nd Street“,
    "city":"New York",
   "state":"NY",
  "postalCode":"10021",
   "isBusiness":false
 },
 "phoneNumbers":[
   {"type":"home",
     "number":"212-555-1234"},
   {"type":"mobile",
     "number":"646-555-4567"}
 ],
 "bankruptcies":null,
 "lastUpdated":"2019-05-13T13:03:35"
}
```

```
select JSON_DATAGUIDE(jcol,
  dbms_json.FORMAT_HIERARCHICAL) from custData;
{
  "type": "object",
  "o:length": 1,
  "properties": {
       "age": {
           "type": "number",
           "o:length": 2,
           "o:preferred_column_name": "age"
         },
         "address": {
              "type": "object",
              "o:length": 1,
              "o:preferred_column_name": "address",
              "properties": {
                 "city": {
                 "type": "string",
                 "o:length": 8,
```

JSON Support in the Oracle database

```
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 "firstName":"John",
 "lastName":"Smith”,
 "age":25,
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   "street":"21 2nd Street“,
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 ],
 "bankruptcies":null,
 "lastUpdated":"2019-05-13T13:03:35"
}
```

```
declare
  dg clob;
begin
  select json_dataguide(jcol,
         dbms_json.FORMAT_HIERARCHICAL)
  into dg from t;
  dbms_json.create_view('auto_view', 't', 'jcol', dg);
end;
/

PL/SQL procedure successfully completed

desc auto_view;
```


JSON Support in the Oracle database

```
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}
```

```
declare
  dg clob;
begin
  select json_dataguide(jcol,
         dbms_json.FOR
  into dg from t;
  dbms_json.create_vie
end;
/

PL/SQL procedure succe

desc auto_view;
```

```
Name          Null? Type
------------- ----- ------------
age                 NUMBER
city                VARCHAR2(8)
state               VARCHAR2(2)
street              VARCHAR2(16)
isBusiness          VARCHAR2(8)
postalCode          VARCHAR2(8)
lastName            VARCHAR2(8)
firstName           VARCHAR2(4)
lastUpdated         VARCHAR2(32)
type                VARCHAR2(8)
number              VARCHAR2(16)
```

JSON Support in the Oracle database

```
{
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     "number":"646-555-4567"}
 ],
 "bankruptci
 "lastUpdate
}
```

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PL/SQL procedure succe

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Name          Null? Type
------------- ----- ------------
age                 NUMBER
city                VARCHAR2(8)
state               VARCHAR2(2)
street              VARCHAR2(16)
isBusiness          VARCHAR2(8)
postalCode          VARCHAR2(8)
lastName            VARCHAR2(8)
firstName           VARCHAR2(4)
lastUpdated         VARCHAR2(32)
type                VARCHAR2(8)
number              VARCHAR2(16)
```

```
select "postalCode", "city"
from auto_view
order by "state";
```

Use Case: Flex fields, sparse columns

- Flex fields (hybrid storage)
  - Core of application is relational but ‘new’ fields are in a (flat) JSON column
  - Schema flexibility, easier/faster to extend application
  - Data augmentation by third parties: fields are unknown and never defined,
    - JSON Search index (index all values)

- Sparse columns
  - Many optional attributes
  - Hitting 1000 column limit?
  - JSON_TABLE views, to select relevant values as columns

Performance, etc

- Partitioning (partition pruning during query)
- Exadata Smart Scans (predicates pushed down to storage layer)
- In-Memory JSON (SIMD scans, binary OSON format)
- Indexing
  - Index a specific ‘path’, e.g. $.customer.id
    - B-Tree Index: log(n)
  - Index entire JSON document (JSON Search Index)
    - Variant of context index
    - Posting lists for values
- Keep JSON data concise (omit null values, short key names)

Simple Oracle Document Access (SODA)

Document Store Model mapped to relational model

- A **document** is a JSON (or binary) instance
  - Document is identified by a key (get, update, delete by key)
- Store documents inside a *collection*
  - Collection stores similar documents
  - Collection is identified by name
- One or more collections reside in a *database*
  - Application connects to database

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Document Store Model mapped to relational model

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  - Collection is identified by name
- One or more collections reside in a *database*
  - Application connects to database

Row

Table

Schema

KEY	JSON_DOC	VERSION	CREATED_ON	LAST_MODIFIED
3C990A8D39…	{“name” : “Alex”}	75611B292…	2018-09-12T00:00:00Z	2018-09-12T00:00:00Z

Creating and dropping collections

Node.js

```
conn = await oracledb.getConnection(…);
db = conn.getSodaDatabase();
coll = await db.createCollection(“sweets");
await coll.drop();
```

Python

```
conn = cx_Oracle.connect(…);
db =  conn.getSodaDatabase();
coll = db.createCollection(“sweets");
coll.drop();
```

Java

```
OracleClient cl = new OracleRDBMSClient();
db = cl.getDatabase(jdbcConn);
OracleCollection coll =
db.admin().createCollection(“sweets");
coll.admin().drop();
```

PL/SQL

```
coll := dbms_soda.create_collection(‘sweets’);


select dbms_soda.drop_collection(‘sweets’) from
dual;
```


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Inserting, finding, updating documents

Node.js (*other implementations have similar syntax*)

- `resultDoc = await coll.insertOneAndGet({name : “Alexander”});`
- `key = resultDoc.key;`

- `col.find().key(“k1”);`
- `col.find().key(“k1”). replaceOne(newDoc);`
- `col.find().filter({“name” : “alex”});`
- `col.find().filter({“name” : “alex”}).remove();`
- `col.find().filter({“name” : “chris”}).skip(10).limit(10).getCursor();`

QBEs can be sophisticated!

```
{ "$query" : {
                "empno" : { "$lte": 10041 },
                "name" : { "$startsWith" : "Melissa" },
                "salary" : { "$gt" : 200000 },
                "title" : { "$contains" : "President" },
              },
  "$orderby" : [
                 {"path" : "salary", "order" : "asc"},
                 {"path" : "department.name", "order" : "desc"}
                ]
}
```


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QBE rewritten to SQL

```
SELECT "ID", "JSON_DOCUMENT" FROM "Employees" coll
WHERE JSON_Exists(coll."JSON_DOCUMENT",
                  '$?(@.empno <= $B0 &&
                      @.salary > $B1 &&
                      @.name starts with $B2)'
                  PASSING 10041 AS "B0", 200000 AS "B1", 'Melissa' AS
"B2")
AND JSON_TextContains(coll."JSON_DOCUMENT",
                      '$.title', 'President')
ORDER BY JSON_Value(coll."JSON_DOCUMENT", '$.salary') ASC,
         JSON_Value(coll."JSON_DOCUMENT", '$.department.name') DESC;
```

Conclusion: JSON storage and easy access Api(SODA)

Simple NoSQL Development experience

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Beda Hammerschmidt

Twitter: bch_t

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