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DBA CLOUD DAY

JSON, the Database & I

NL.UG
NL ORACLE USER GROUP



Robert Marz
DATABEE
Die IT-Architekten



Robert Marz – Independent Consultant

Primary Role

Senior Technical Architect
with database centric view of the world

DOAG (German Oracle User Group)

Active Member of Database Community
Responsible for Cloud Topics



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Oracle ACE
Pro



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The **Oracle ACE Program** recognizes and rewards community members for their technical and community contributions to the Oracle community

3 membership tiers



For more details on Oracle ACE Program:
ace.oracle.com



Nominate
yourself or someone you know:

ace.oracle.com/nominate



A low-angle shot of a red-painted wooden ladder extending towards the top of the frame. The ladder is set against a bright blue sky filled with soft, white clouds. A person's hand is visible in the lower right, firmly grasping one of the rungs. The ladder's rungs are horizontal, and the side rails are diagonal. The red paint on the wood shows some texture and wear.

Introduction



What to expect

An Overview

How to deal with JSON in the Database

Absolutly Not

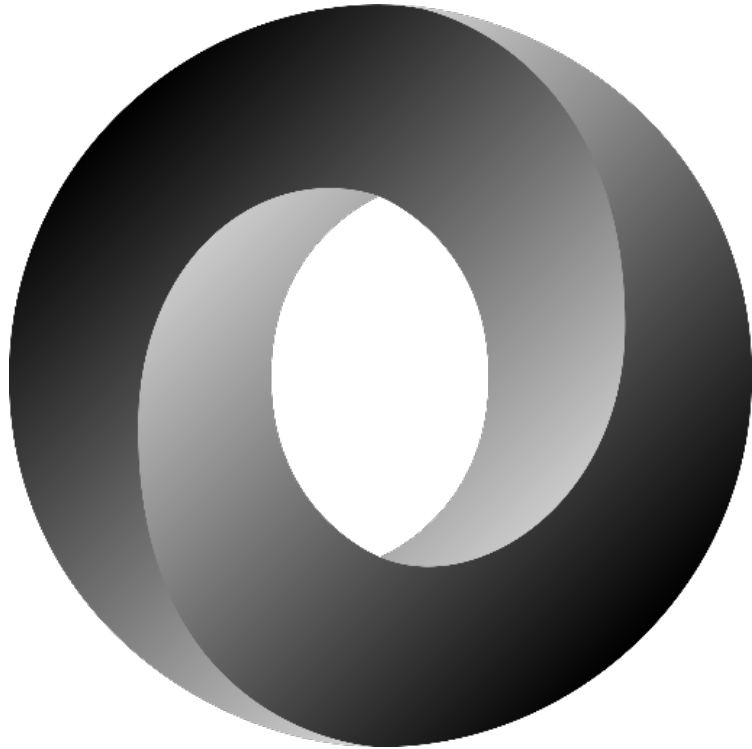
All JSON Commands
Complete Syntax Diagrams
Evolution over Database
Versions

A person wearing a hockey mask and a dark jacket, holding a machete. The scene is lit with blue and yellow light, creating a dramatic and somewhat menacing atmosphere. The person is looking directly at the camera with a neutral expression.

JSON Document Format



Setting the Stage: Who is Jason?



JSON **J**ava **S**cript **O**bject **N**otation

Java **S**cript **O**bject **N**otation

Lightweight **F**ormat

Text-based
Data Interchange
Document Format (can be stored as Files)

Originally designend

to persist JavaScript Objects

Standards:

json.org
[ECMA-404](https://ecma.org/standards/690/)



Structures

unordered
collection

“key”:”value” pairs

separated by commas

enclosed by braces { }

also realized as **object**, record, struct, dictionary, hash table, keyed list or associative array

ordered
list of
values

separated by commas

enclosed by square brackets []

also realized as **array**, vector, list or sequence



JSON: Types of Values

```
{  
  "string": "String are quoted",  
  "escape": "\n control chars",  
  "number": 1234,  
  "boolean": true,  
  "collection": {  
    "object": "fields",  
    "can": "nested"  
  },  
  "array": [ "one",  
            "two",  
            {"three": true}]  
}
```

Types of Values

string

“always enclosed in double quotes”

number

Integer	-256
Float	256.123
E-notation	2.3e3

Boolean

true
false
null

Object

Nested Objects
Arrays

Array

Simple Types
Objects



JSON Document Format: Odds & Ends



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Character set

always Unicode

Number encoding

always English
Decimal Point

Whitespace

between Tokens is ignored
space, linefeed, carriage return, tab

Dates are represented as strings

usually ISO 8601 Zulu (UTC) Time
"2019-11-19T15:13:23Z"

JSON is Schemaless

no constraints for your implementation
Developers Hell
- when dealing with documents not produced by your code



Storing JSON Data



Storing JSON Docs in the Database

Text-based columns

- Varchar2
- CLOB
- BLOB

BLOBs

- eliminate NLS-Layer (JSON is always UTF-8)
- Works well since 12.2
- Database character set should be AL32UTF8

Check constraints (is_json)

- Sanity
- enables dot Notation for querying

Binary JSON Storage

- 20c New Feature

Speeding things up –Function Based Indexes

```
select *  
  from departments_json  
 where json_value ( department_data  
                  , '$.department' ) = 'Sales'
```

Function Based Index – Useful when searching for a specific attribute

```
create index dept_department_name_i on  
  departments_json (  
    json_value (  
      department_data, '$.department'  
      error on error  
      null on empty  
    )  
  )
```

Speeding things up – JSON Search Indexes

```
create
  search index
  dept_json_i
  on departments_json
    ( department_data )
  for json;

select *
  from departments_json d
 where json_textcontains
    ( department_data, '$'
    , 'Public' );
```

Oracle Text

Index

Can be used for

json_value
json_textcontains

Indexes

whole Document for every row

[Chris Saxon: How to Store, Query, and Create JSON Documents in Oracle Database](#)



When do I store JSON Docs



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Original Document

needed for

- Reference
- Archive
- Redistribution

JSON structure

Varies

and may be queried later on

@RobbieDataBee

15



When Do I convert JSON to relational?

Whenever I need to work with the contents

JSON is an Interchange Format

Almost always

A photograph of a worker in a yellow hard hat and safety vest operating a blue forklift in a warehouse. The forklift is positioned on a metal platform, loading a pallet of goods into the back of a blue truck. The scene is illuminated by a bright light source, creating a strong glow. A yellow banner is overlaid on the image, containing the text 'Feeding JSON to the DB'.

Feeding JSON to the DB



Loading JSON into the Database: Insert

Datatype
BLOB



```
insert into departments_jsonjson
values ( 110, utl_raw.cast_to_raw (
'{"department": "Accounting",
"employees": [
{
"name": "Higgins, Shelley",
"job": "Accounting Manager",
"hireDate": "2002-06-07T00:00:00Z"
},
{
"name": "Gietz, William",
"job": "Public Accountant",
"hireDate": "2002-06-07T00:00:00Z"
}
]
}'));
```

JSON Documents

are Text

Insert / Update

works fine
as long as Documents size < 4000 /
32000

Check Constraint

is_json
rejects non-json Texts



Loading JSON into the Database: External Table / SQL*Loader

create table

```
  json_dump_file_contents  
    (json_document blob)
```

organization external

```
( type oracle_loader
```

```
  default directory json_dump_dir
```

```
  access parameters
```

```
  ( records delimited by 0x'0a'
```

```
    disable_directory_link_check
```

```
    fields (json_document raw)
```

```
  )
```

```
  location ('JSONdocs.dmp')
```

```
)
```

```
parallel
```

```
reject limit unlimited;
```

JSON Dump Files

contain one JSON Doc per row
usually produce by NoSQL DBs
e.g. MongoDB

Load via

SQL *Loader
External Table



Loading JSON into the Database: SQLcl

```
var HashMap = Java.type("java.util.HashMap");
var bindmap = new HashMap();

print("\nreading file: " + args[1]);
var filePath=args[1];

var blob=conn.createBlob();
var bstream=blob.setBinaryStream(1);

java.nio.file.Files.copy(
    java.nio.file.FileSystems.getDefault().getPath(filePath)
        , bstream );
bstream.flush();

bindmap.put("inhalt", blob);
bindmap.put("pfad", filePath);

if(!util.execute( "insert into dokument "
    + "(datei_inhalt,datei_pfad) "
    + " values(:inhalt, :pfad)"
    , bindmap)
){ print("insert failed, exiting");
  exit;
}
```

SQLcl

SQLDeveloper Worksheet as CLI
99,8% SQL*Plus compatible

Modern CLI

Tab-Completion
Editor
History

Enhancements

Liquibase & HashiCorp Vault integration
DDL Command
lots more

Scripting

in JSR-223 Languages
(e.g. JavaScript, Python, etc)

[Oracle DB Tools GitHub Examples](#)

Loading JSON into the Database: REST Service



Oracle REST Data Services ORDS

Free
Java-Based
evolved from APEX Listener

REST enables Database

very easy
SQL Developer Wizards
ORDS REST Services are pure Metadata

Developed & Deployed in Minutes

[POST Up a BLOB to an Oracle Table via REST - Jeff Smith](#)



Loading JSON into the Database: REST Service Example

The screenshot displays the Oracle SQL Developer interface. On the left, the 'REST Data Services' tree is expanded, showing a 'POST' service under a 'media' module. The main window shows a 'SQL Worksheet' with the following PL/SQL code:

```
1 declare
2   image_id integer;
3 begin
4   insert into gallery (title,content_type,image)
5     values (:title,:content_type :body)
6     returning id into image_id;
7   :status := 201;
8   :LOCATION := IMAGE_ID;
9 end;
```

The text `:body` in the SQL code is highlighted with a red box.

[POST Up a BLOB to an Oracle Table via REST - Jeff Smith](#)

Loading JSON into the Database: utl_http



Oracle Database

can do `http_requests`
e.g. for using REST Services
Package `utl_http`

Prerequisites

ACL/ACE for Network Access
Wallet for https-Requests

PL/SQL implementation

straight forward
Example: REST DB Links

Querying JSON

The background of the slide is a complex digital interface. It features a dark blue color palette with glowing white and light blue lines forming a network grid. Various data visualization elements are scattered throughout, including circular gauges, bar charts, and abstract data points. A hand is visible in the lower right, interacting with the interface, with a bright blue light emanating from the point of contact. The overall aesthetic is high-tech and data-driven.



JSONPath - Reference

JSONPath is Xpath for JSON

Used all over the place

Uses dot-Notation: `$.store.book[0].title`

Returns JSON Document or single element

[JSONPath Online Evaluator](#)

Expression	Description
\$	the root object / element
@	the current object / element
. or []	child operator
[start:end:step]	array slice operator
?()	filter expression

JSONPath	Result
<code>\$.store.book[*].author</code>	the authors of all books in the store
<code>\$.author</code>	all authors
<code>\$.store.*</code>	all things in store, which are some books and a red bicycle.
<code>\$.store..price</code>	the price of everything in the store.
<code>\$.book[2]</code>	the third book
<code>\$.book[(@.length-1)]</code> <code>\$.book[-1:]</code>	the last book in order.
<code>\$.book[0,1]</code> <code>\$.book[:2]</code>	the first two books
<code>\$.book[?(@.isbn)]</code>	filter all books with isbn number
<code>\$.book[?(@.price<10)]</code>	filter all books cheaper than 10
<code>\$.*</code>	All members of JSON structure.



Querying JSON: Dot-Notation

```
select d.department_data.department
from departments_json d
```

```
select d.department_data.employees[0].name
from departments_json d
where department_id = 110;
```

EMPLOYEES
Gietz, William

```
select d.department_data.employees[*].name
from departments_json d
where department_id = 110;
```

EMPLOYEES
["Gietz, William", "Higgins, Shelley"]

```
-- Column needs is_json constraint
-- or "treat as json" function (18c)
```

```
with j_data as (
  select treat (
    d.department_data as json
  ) as department_data
  from departments_json d
  where department_id = 110
)
select j.department_data.department
from j_data j
where department_data is json;
```

DEPARTMENT
Accounting

JSON_TABLE

Lives inside the SQL-From-Clause

Produces **Rows** and **Columns**

Accepts LOBs with JSON data

Included in SQL:2016 Standard

Querying JSON: The JSON_TABLE Operator (2/2)

```
select wert
  from json_table( '["Eins", "Zwei", "Drei",
                    "Vier", "Fünf", "Sechs"]'
                  , '$[*]'
                  columns wert varchar2 path '$'
                )
/
```

The JSON Document

Produces rows
(JSONPath Object)

Produces columns
(JSONPath Element)

```
WERT
-----
Eins
Zwei
Drei
Vier
Fünf
Sechs

6 rows selected

Elapsed: 00:00:00.011
```

Dates in JSON – Dealing with ISO 8601 Zulu

JSON Dates usually ISO 8601 Zulu (UTC) Time Strings
“2019-11-19T15:33:54Z”

-- Converting in Oracle is tricky

```
cast( to_timestamp_tz
      ( to_char(
          to_date(tstamp, 'YYYY-MM-DD"T"HH24:MI:SS"Z"')
          , 'YYYY-MM-DD HH24:MI:SS "UTC"')
          , 'YYYY-MM-DD HH24:MI:SS TZR')
      at time zone sessiontimezone as date ) tstamp
```

-- Oracle 18c has new date function

```
select TO_UTC_TIMESTAMP_TZ('2019-11-19T15:33:54Z') tstamp
from dual;
```

A blacksmith is shown working with a glowing red-hot metal rod on an anvil. The blacksmith is using tongs to hold the rod steady while a hammer strikes it. The background is dark and out of focus, emphasizing the action in the foreground. The text "Working with JSON" is overlaid on a yellow rectangular background in the center-left of the image.

Working with JSON



Comparing JSON Documents

```
select case
  when json_equal('{"one": 1, "two": [ "three", 4]}'
    , '{ "two": [ "three"
      , 4]
      , "one": 1 }'
    )
  then 'EQUAL'
  else 'DIFFERENT'
end compare
from dual;
```

COMPARE

EQUAL

```
select case
  when json_equal('{"one": 1, "two": [ "three", 4]}'
    , '{"one": 1, "two": [ 4, "three"]}'
    )
  then 'EQUAL'
  else 'DIFFERENT'
end compare
from dual;
```

COMPARE

DIFFERENT

Updating JSON Docs – json_merge_patch

JSON_merge_patch()

- – new Feature in 19c

Creates / Updates /
Delete

- Objects in JSON Docs
Works like Unix patch or SQL merge

```
json_mergepatch({'FirstName':"Eric", "LastName':"Cartman"}, {'LastName':',,Fox'})  
{'FirstName':"Eric", "LastName':"Fox"}
```

```
json_mergepatch({'FirstName':"Eric", "LastName':"Cartman"}, {'Salary':1000})  
{'FirstName':"Eric", "LastName':"Cartman", "Salary":1000}
```

```
json_mergepatch({'FirstName':"Eric", "LastName':"Cartman"}, {'FirstName':null})  
{'LastName':"Cartman"}
```



Generating JSON



Generate JSON Documents

SQL-Functions starting with
12gR2

JSON_Object

JSON_Array

JSON_ArrayAgg





Generate JSON Documents – JSON_Object

```
select json_object ('id2' value cust_id,  
                  'name' value (first || ' ' || last),  
                  'joined' value join_date) customers  
from customers;
```

CUSTOMERS

```
{"id2":1,"name":"Eric Cartman","joined":"2017-07-10T16:26:15"}  
{"id2":2,"name":"Kenny McCormick","joined":"2017-07-10T16:26:15"}  
{"id2":3,"name":"Kyle Brofloski","joined":"2017-07-10T16:26:15"}  
{"id2":4,"name":"Stan Marsh","joined":"2017-07-10T16:26:15"}
```



Generate JSON Documents JSON_Array

```
select json_array(first, last) customers  
from customers;
```

CUSTOMERS

```
["Eric", "Cartman"]  
["Kenny", "McCormick"]  
["Kyle", "Brofloski"]  
["Stan", "Marsh"]
```

Generate JSON Documents JSON_ArrayAgg

```
select json_arrayagg(  
    json_object('id' value item_id,  
              'name' value name,  
              'quantity' value stock_quantity)  
    ) stock_items  
from items  
where stock_quantity > 10;
```

STOCK_ITEMS

```
[{"id":345,"name":"Border Patrol Costume","quantity":20},  
{"id":429,"name":"Air Guitar","quantity":14}]
```

Publishing JSON





Publishing JSON

Publishing JSON

utl_file

let the database
write files

sql*plus

spool files

SQLcl

script your JSON Docs

REST
Service

let the clients request
Documents on demand
deliver via http(s)





Topics covered

What is JSON

Storing JSON content

Loading JSON

Querying JSON

Manipulating JSON

Generating JSON

Publishing JSON

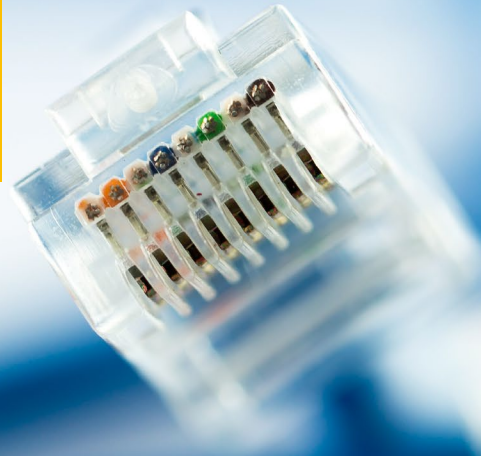
Didn't mention

PLSQL APIs

JSON Dictionary

APEX JSON Packages

Conclusion





JSON, the Database and I

JSON is a flexible Interchange Format

- Lingua Franca of modern Web Apps

Loading JSON is easy

- It's just Text

Features evolve quickly

- 20c JSON Datatype, JSON Dictionary

The Database can be turned into the Backbone of RESTful Services

PLEASE

**DO
TRY THIS
AT HOME**