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Frankfurt am Main

Stefanie Janine Stölting

No SQL The SQL

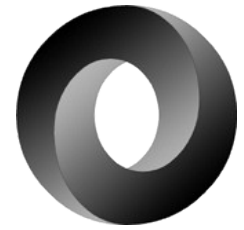
Way

PostgreSQL JSON

#ittage



NoSQL The SQL Way



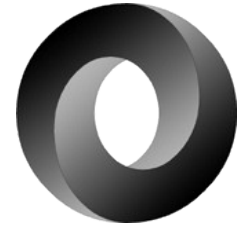
PostgreSQL JSON Features

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JSON



JavaScript Object Notation

Man muss sich nicht um das Encoding kümmern, es ist immer Unicode, die meisten Implementationen verwenden UTF8

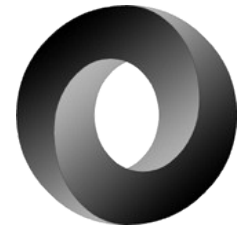
Es wird für den Datenaustausch in Web Applikationen benutzt

Momentan gibt es zwei Standards [RFC 7159](#) von Douglas Crockford und [ECMA-404](#)

Die PostgreSQL Implementation ist RFC 7159



ISO SQL/JSON Standard

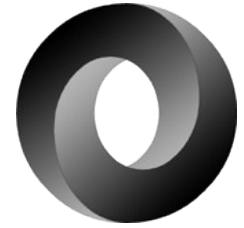


Im März 2017 wurde ein Standard
veröffentlicht: [ISO/IEC TR 19075-6:2017](#)

Zusätzlich frei verfügbar: [ISO/IEC TR 19075-6](#)



JSON Datentypen



JSON

Verfügbar seit 9.2

BSON

Verfügbar als Extension auf GitHub seit 2013

JSONB

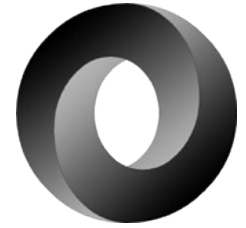
Verfügbar seit 9.4

Voll transactional

Bis zu 1 GB (benutzt **TOAST**)



JSON Funktionen



`row_to_json({row})`

Returns the row as JSON

`array_to_json({array})`

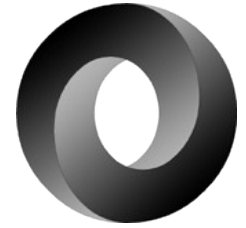
Returns the array as JSON

`jsonb_to_recordset`

Returns a recordset from JSONB



JSON Operatoren



Array Element

->{int}

Array Element über Name

->{text}

Objekt Element

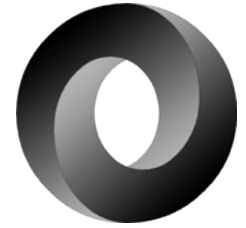
->> {text}

Wert über einen Pfad

#> {text}



Indexierung von JSON



JSONB kann für schnelleren Zugriff mit Indizes genutzt werden

GIN Index über alles

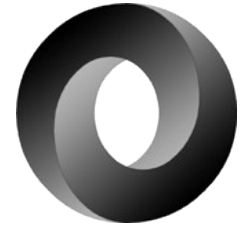
```
CREATE INDEX idx_1 ON jsonb.actor USING  
GIN (jsondata);
```

Aber auch eindeutige **B-Tree** Indizes sind möglich

```
CREATE UNIQUE INDEX actor_id_2 ON  
jsonb.actor((CAST(jsondata->>'actor_id' AS  
INTEGER)));
```




Neue JSON Funktionen



Neue JSONB Funktion in PostgreSQL 9.6 :

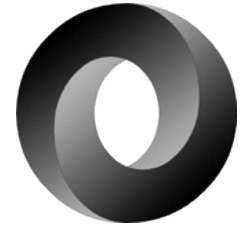
`jsonb_insert`:

Fügt einen neuen Wert über den Pfad in ein JSONB Feld ein und gibt das JSONB Ergebnis zurück

Siehe 9.6 JSONB [documentation](#) für Details



Neue JSON Funktionen



Neue JSBON Funktion in PostgreSQL 10.0 :

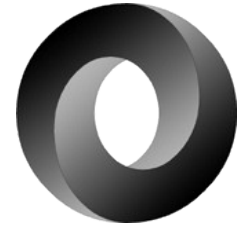
Volltextsuche über JSON und JSONB

Unterstützung von Pseudo Typen (anynarray) in
to_json() und to_jsonb()

Weitere Infos sind in den Release Notes unter
<https://www.postgresql.org/docs/devel/static/release-10.html>
zu finden.



Erweiterungen



JSON Erweiterungen für PostgreSQL:

[JsQuery](#)

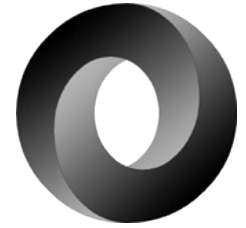
Implementiert eine Sprache, um JSONB Objekte abzufragen.

[postgres-json-schema](#)

Implementiert Schemas für JSON



Datenquellen

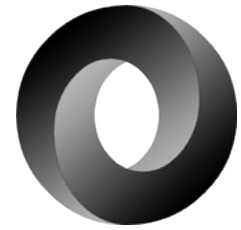


Die Chinook Datenbank ist
verfügbar unter
chinookdatabase.codeplex.com

Die Amazon book reviews von 1998
sind verfügbar unter
examples.citusdata.com/customer_reviews_nested_1998.json.gz



Chinook Tabellen



	T tablename
1	Artist
2	Invoice
3	Employee
4	Customer
5	Playlist
6	InvoiceLine
7	Album
8	Genre
9	PlaylistTrack
10	MediaType
11	Track

	T table_name	T column_name	T data_type
1	Artist	ArtistId	integer
2	Artist	Name	character varying (120)

	T table_name	T column_name	T data_type
1	Album	AlbumId	integer
2	Album	Title	character varying (160)
3	Album	ArtistId	integer

	T table_name	T column_name	T data_type
1	Track	TrackId	integer
2	Track	Name	character varying (200)
3	Track	AlbumId	integer
4	Track	MediaTypeId	integer
5	Track	GenreId	integer
6	Track	Composer	character varying (220)
7	Track	Milliseconds	integer
8	Track	Bytes	integer
9	Track	UnitPrice	numeric



CTE

Common Table Expressions werden in den Beispielen benutzt

- Beispiel:

```
WITH RECURSIVE t(n) AS (  
    VALUES (1)  
    UNION ALL  
    SELECT n+1 FROM t WHERE n < 100  
)  
SELECT sum(n), min(n), max(n) FROM t;
```

- Ergebnis:

	sum bigint	min integer	max integer
1	5050	1	100



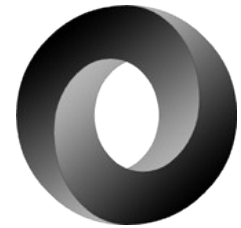
Live Beispiele



Let's see, how it does work.



Live mit Chinook Daten



-- Lets start the easy way: With a function call to get album data

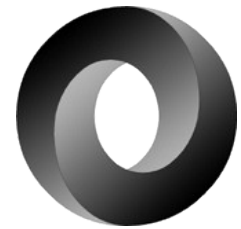
```
SELECT json_build_object (  
    'album_id', "AlbumId",  
    'track_id', ' ', "TrackId",  
    'track_name', "Name"  
)  
FROM "Track"  
;
```

	json_build_object
1	{"album_id": 1, "track_id, ": 1, "track_name": "For Those About To Rock (We Salute You)"}
2	{"album_id": 2, "track_id, ": 2, "track_name": "Balls to the Wall"}
3	{"album_id": 3, "track_id, ": 3, "track_name": "Fast As a Shark"}
4	{"album_id": 3, "track_id, ": 4, "track_name": "Restless and Wild"}
5	{"album_id": 3, "track_id, ": 5, "track_name": "Princess of the Dawn"}
6	{"album_id": 1, "track_id, ": 6, "track_name": "Put The Finger On You"}
7	{"album_id": 1, "track_id, ": 7, "track_name": "Let's Get It Up"}
8	{"album_id": 1, "track_id, ": 8, "track_name": "Inject The Venom"}
9	{"album_id": 1, "track_id, ": 9, "track_name": "Snowballed"}
10	{"album_id": 1, "track_id, ": 10, "track_name": "Evil Walks"}
11	{"album_id": 1, "track_id, ": 11, "track_name": "C.O.D."}
12	{"album_id": 1, "track_id, ": 12, "track_name": "Breaking The Rules"}
13	{"album_id": 1, "track_id, ": 13, "track_name": "Night Of The Long Knives"}
14	{"album_id": 1, "track_id, ": 14, "track_name": "Spellbound"}

Save Cancel Script + - Record Panels Grid Text 200 row(s) fetched - 2ms



Live mit Chinook Daten



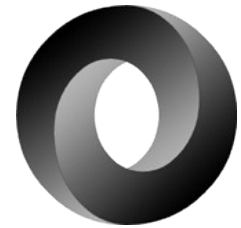
-- Adding array_agg to build JSON arrays

```
WITH tracks AS
(
    SELECT "AlbumId" AS album_id
        , json_build_object (
            'track_id', 'TrackId',
            'track_name', "Name"
        )
    FROM "Track"
)
SELECT album_id
    , json_build_object ('tracks', array_agg (tracks)) AS tracks
FROM tracks
GROUP BY album_id
;
```

	album_id	tracks
1	129	{"tracks": [{"album_id":129,"json_build_object":{"track_id, " : 1595, "track_name": "The Song Remains The Same"}}, {"album_id":129,"json_build_object":{"track_id, " : 1596, "track_name": "The Song Remains The Same (Live)"}}]}
2	195	{"tracks": [{"album_id":195,"json_build_object":{"track_id, " : 2391, "track_name": "Around The World"}}, {"album_id":195,"json_build_object":{"track_id, " : 2392, "track_name": "Around The World (Live)"}}]}
3	251	{"tracks": [{"album_id":251,"json_build_object":{"track_id, " : 3200, "track_name": "Gay Witch Hunt"}}, {"album_id":251,"json_build_object":{"track_id, " : 3201, "track_name": "Gay Witch Hunt (Live)"}}]}
4	106	{"tracks": [{"album_id":106,"json_build_object":{"track_id, " : 1335, "track_name": "Where Eagles Dare"}}, {"album_id":106,"json_build_object":{"track_id, " : 1336, "track_name": "Where Eagles Dare (Live)"}}]}
5	120	{"tracks": [{"album_id":120,"json_build_object":{"track_id, " : 1479, "track_name": "Foxy Lady"}}, {"album_id":120,"json_build_object":{"track_id, " : 1480, "track_name": "Foxy Lady (Live)"}}]}
6	285	{"tracks": [{"album_id":285,"json_build_object":{"track_id, " : 3416, "track_name": "Ave Maria"}}, {"album_id":285,"json_build_object":{"track_id, " : 3417, "track_name": "Ave Maria (Live)"}}]}
7	264	{"tracks": [{"album_id":264,"json_build_object":{"track_id, " : 3352, "track_name": "Distance"}}, {"album_id":264,"json_build_object":{"track_id, " : 3353, "track_name": "Distance (Live)"}}]}
8	305	{"tracks": [{"album_id":305,"json_build_object":{"track_id, " : 3439, "track_name": "Das Lied Von Der Erde, Von Der Jugend"}}, {"album_id":305,"json_build_object":{"track_id, " : 3440, "track_name": "Das Lied Von Der Erde, Von Der Jugend (Live)"}}]}
9	80	{"tracks": [{"album_id":80,"json_build_object":{"track_id, " : 999, "track_name": "Still"}}, {"album_id":80,"json_build_object":{"track_id, " : 1000, "track_name": "Still (Live)"}}]}
10	318	{"tracks": [{"album_id":318,"json_build_object":{"track_id, " : 3452, "track_name": "SCRIABIN: Prelude in B Major, Op. 11, No. 5"}}, {"album_id":318,"json_build_object":{"track_id, " : 3453, "track_name": "SCRIABIN: Prelude in B Major, Op. 11, No. 5 (Live)"}}]}
11	312	{"tracks": [{"album_id":312,"json_build_object":{"track_id, " : 3446, "track_name": "Symphonie Fantastique, Op. 14: V. Sorcerer's Apprentice"}}, {"album_id":312,"json_build_object":{"track_id, " : 3447, "track_name": "Symphonie Fantastique, Op. 14: V. Sorcerer's Apprentice (Live)"}}]}
12	179	{"tracks": [{"album_id":179,"json_build_object":{"track_id, " : 2165, "track_name": "Life Wasted"}}, {"album_id":179,"json_build_object":{"track_id, " : 2166, "track_name": "Life Wasted (Live)"}}]}
13	209	{"tracks": [{"album_id":209,"json_build_object":{"track_id, " : 2572, "track_name": "Midnight From The Inside Out"}}, {"album_id":209,"json_build_object":{"track_id, " : 2573, "track_name": "Midnight From The Inside Out (Live)"}}]}
14	276	{"tracks": [{"album_id":276,"json_build_object":{"track_id, " : 3407, "track_name": "Concerto for 2 Violins in D Minor, BWV 1063"}}, {"album_id":276,"json_build_object":{"track_id, " : 3408, "track_name": "Concerto for 2 Violins in D Minor, BWV 1063 (Live)"}}]}



Live mit Chinook Daten



-- Step 1: Tracks as JSON with the album identifier

```
WITH tracks AS
(
    SELECT "AlbumId" AS album_id
      , "TrackId" AS track_id
      , "Name" AS track_name
    FROM "Track"
)
SELECT row_to_json(tracks) AS tracks
FROM tracks
;
```

tracks	
1	{"album_id":1,"track_id":1,"track_name":"For Those About To Rock (We Salute You)"}
2	{"album_id":2,"track_id":2,"track_name":"Balls to the Wall"}
3	{"album_id":3,"track_id":3,"track_name":"Fast As a Shark"}
4	{"album_id":3,"track_id":4,"track_name":"Restless and Wild"}
5	{"album_id":3,"track_id":5,"track_name":"Princess of the Dawn"}
6	{"album_id":1,"track_id":6,"track_name":"Put The Finger On You"}
7	{"album_id":1,"track_id":7,"track_name":"Let's Get It Up"}

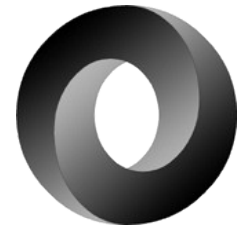
200 row(s) fetched - 7ms

Grid

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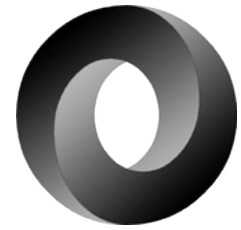
Live mit Chinook Daten



```
-- Step 2 Albums including tracks with artist identifier
WITH tracks AS
(
    SELECT "AlbumId" AS album_id
      , "TrackId" AS track_id
      , "Name" AS track_name
    FROM "Track"
)
, json_tracks AS
(
    SELECT row_to_json(tracks) AS tracks
    FROM tracks
)
, albums AS
(
    SELECT a."ArtistId" AS artist_id
      , a."AlbumId" AS album_id
      , a."Title" AS album_title
      , array_agg(t.tracks) AS album_tracks
    FROM "Album" AS a
    INNER JOIN json_tracks AS t
    ON a."AlbumId" = (t.tracks->>'album_id')::int
    GROUP BY a."ArtistId"
      , a."AlbumId"
      , a."Title"
)
SELECT artist_id
      , array_agg(row_to_json(albums)) AS album
FROM albums
GROUP BY artist_id
;
```



Live mit Chinook Daten



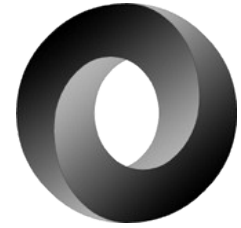
	artist_id	album
1	251	{"artist_id":251,"album_id":319,"album_title":"Armada: Music from the Courts of England and Spain","album_tracks":[{"album_id":319,"track_id":1,"track_title":"The Little Lame Prince"}]}
2	120	{"artist_id":120,"album_id":183,"album_title":"Dark Side Of The Moon","album_tracks":[{"album_id":183,"track_id":1,"track_title":"Speak To Me"}]}
3	227	{"artist_id":227,"album_id":293,"album_title":"Pavarotti's Opera Made Easy","album_tracks":[{"album_id":293,"track_id":1,"track_title":"The Little Lame Prince"}]}
4	8	{"artist_id":8,"album_id":271,"album_title":"Revelations","album_tracks":[{"album_id":271,"track_id":1,"track_title":"The Little Lame Prince"}]}
5	247	{"artist_id":247,"album_id":314,"album_title":"English Renaissance","album_tracks":[{"album_id":314,"track_id":1,"track_title":"The Little Lame Prince"}]}
6	138	{"artist_id":138,"album_id":211,"album_title":"The Singles","album_tracks":[{"album_id":211,"track_id":1,"track_title":"The Little Lame Prince"}]}
7	242	{"artist_id":242,"album_id":307,"album_title":"Adams, John: The Chairman Dances","album_tracks":[{"album_id":307,"track_id":1,"track_title":"The Little Lame Prince"}]}

168 row(s) fetched - 38ms

Grid



Live mit Chinook Daten

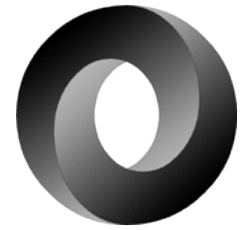


-- Step 3 Return one row for an artist with all albums as VIEW

```
CREATE OR REPLACE VIEW v_json_artist_data AS
WITH tracks AS
(
    SELECT "AlbumId" AS album_id
        , "TrackId" AS track_id
        , "Name" AS track_name
        , "MediaTypeId" AS media_type_id
        , "Milliseconds" AS milliseconds
        , "UnitPrice" AS unit_price
    FROM "Track"
)
, json_tracks AS
(
    SELECT row_to_json(tracks) AS tracks
    FROM tracks
)
, albums AS
(
    SELECT a."ArtistId" AS artist_id
        , a."AlbumId" AS album_id
        , a."Title" AS album_title
        , array_agg(t.tracks) AS album_tracks
    FROM "Album" AS a
    INNER JOIN json_tracks AS t
        ON a."AlbumId" = (t.tracks->>'album_id')::int
    GROUP BY a."ArtistId"
        , a."AlbumId"
        , a."Title"
)
, json_albums AS
(
    SELECT artist_id
        , array_agg(row_to_json(albums)) AS album
    FROM albums
    GROUP BY artist_id
)
-- -> Next Page
```



Live mit Chinook Daten

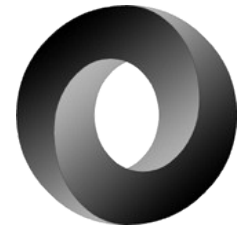


```
-- Step 3 Return one row for an artist with all albums as VIEW  
, artists AS
```

```
(  
    SELECT a."ArtistId" AS artist_id  
        , a."Name" AS artist  
        , jsa.album AS albums  
    FROM "Artist" AS a  
        INNER JOIN json_albums AS jsa  
            ON a."ArtistId" = jsa.artist_id  
)  
SELECT (row_to_json(artists))::jsonb AS artist_data  
FROM artists  
;
```



Live mit Chinook Daten



-- Select data from the view

```
SELECT *  
FROM v_json_artist_data  
;
```

	? artist_data
1	{"albums": [{"album_id": 319, "artist_id": 251, "album_title": "Armada: Music from the Courts of England and Spain", "album_tracks": [{"album_id": 319, "track_id": 3389, "track_name": "The Armada Song"}]}
2	{"albums": [{"album_id": 183, "artist_id": 120, "album_title": "Dark Side Of The Moon", "album_tracks": [{"album_id": 183, "track_id": 3390, "track_name": "Breathe (Afterglow)"}]}
3	{"albums": [{"album_id": 293, "artist_id": 227, "album_title": "Pavarotti's Opera Made Easy", "album_tracks": [{"album_id": 293, "track_id": 3391, "track_name": "Nessun Dorma"}]}
4	{"albums": [{"album_id": 271, "artist_id": 8, "album_title": "Revelations", "album_tracks": [{"album_id": 271, "track_id": 3389, "track_name": "The Armada Song"}]}
5	{"albums": [{"album_id": 314, "artist_id": 247, "album_title": "English Renaissance", "album_tracks": [{"album_id": 314, "track_id": 3392, "track_name": "The English Renaissance"}]}
6	{"albums": [{"album_id": 211, "artist_id": 138, "album_title": "The Singles", "album_tracks": [{"album_id": 211, "track_id": 2591, "track_name": "The Singles"}]}
7	{"albums": [{"album_id": 307, "artist_id": 242, "album_title": "Adams, John: The Chairman Dances", "album_tracks": [{"album_id": 307, "track_id": 3393, "track_name": "The Chairman Dances"}]}

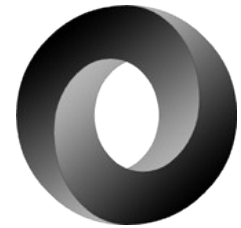
168 row(s) fetched - 29ms

Grid

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Live mit Chinook Daten



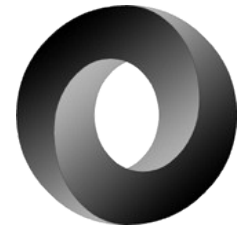
```
-- SELECT data from that VIEW, that does querying
SELECT jsonb_pretty(artist_data)
FROM v_json_artist_data
WHERE artist_data->>'artist' IN ('Miles Davis', 'AC/DC')
;
```

jsonb_pretty	
1	<pre>{ "albums": [{ "album_id": 4, "artist_id": 1, "album_title": "Let There Be Rock", "album_tracks": [{ "album_id": 4, "track_id": 15, "track_name": "Go Down" }, { "album_id": 4, "track_id": 16, "track_name": "Dog Eat Dog" }, { "album_id": 4,</pre>
2	<pre>{ "albums": [{ "album_id": 48, "artist_id": 68, "album_title": "The Essential Miles Davis [Disc 1]"</pre>

2 row(s) fetched - 25ms



Live mit Chinook Daten

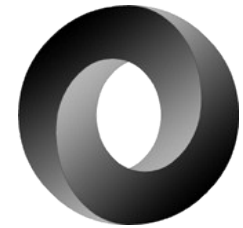


```
-- SELECT some data from that VIEW using JSON methods
SELECT artist_data->>'artist' AS artist
      , artist_data#>'{albums, 1, album_title}' AS album_title
      , jsonb_pretty(artist_data#>'{albums, 1, album_tracks}') AS album_tracks
FROM v_json_artist_data
WHERE artist_data->'albums' @> '[{"album_title":"Miles Ahead"}]';
```

	T artist	? album_title	T album_tracks
1	Miles Davis	"Miles Ahead"	[{"album_id": 157, "track_id": 1902}
1 row(s) fetched - 27ms			



Live mit Chinook Daten



```
-- Array to records
SELECT artist_data->>'artist_id' AS artist_id
, artist_data->>'artist' AS artist
, jsonb_array_elements(artist_data#>'{albums}')->>'album_title' AS album_title
, jsonb_array_elements(jsonb_array_elements(artist_data#>'{albums}')#>'{album_tracks}')->>'track_name' AS song_titles
, jsonb_array_elements(jsonb_array_elements(artist_data#>'{albums}')#>'{album_tracks}')->>'track_id' AS song_id
FROM v_json_artist_data
WHERE artist_data->>'artist' = 'Metallica'
ORDER BY album_title
, song_id
;
```

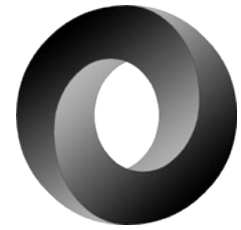
	T artist_id 📈	T artist 📈	T album_title 📈	T song_titles 📈	T song_id 📈
1	50	Metallica	...And Justice For All	Sad But True	1802
2	50	Metallica	...And Justice For All	The Unforgiven	1804
3	50	Metallica	...And Justice For All	Don't Tread On Me	1806
4	50	Metallica	...And Justice For All	Nothing Else Matters	1808
5	50	Metallica	...And Justice For All	The God That Failed	1810
6	50	Metallica	...And Justice For All	The Struggle Within	1812
7	50	Metallica	...And Justice For All	Helpless	1813
8	50	Metallica	...And Justice For All	The Wait	1815
9	50	Metallica	...And Justice For All	Last Caress/Green Hell	1817
10	50	Metallica	...And Justice For All	Blitzkrieg	1819
11	50	Metallica	...And Justice For All	The Prince	1821
12	50	Metallica	...And Justice For All	So What	1823
13	50	Metallica	...And Justice For All	Overkill	1825
14	50	Metallica	...And Justice For All	Stone Dead Forever	1827
15	50	Metallica	...And Justice For All	Hit The Lights	1829
16	50	Metallica	...And Justice For All	Motorbreath	1831
17	50	Metallica	...And Justice For All	(Anesthesia) Pulling Teeth	1833

200 row(s) fetched - 47ms

Gri



Live mit Chinook Daten



-- Convert albums to a recordset

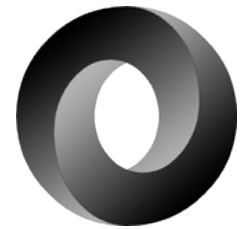
```
SELECT *  
FROM jsonb_to_recordset(  
    (  
        SELECT (artist_data->>'albums')::jsonb  
        FROM v_json_artist_data  
        WHERE (artist_data->>'artist_id')::int = 50  
    )  
) AS x(album_id int, artist_id int, album_title text, album_tracks jsonb)  
;
```

	album_id	artist_id	album_title	album_tracks
1	152	50	Master Of Puppets	[{"album_id": 152, "track_id": 1853, "track_name": "Battery"}, {"album_id": 152, "track_id": 1854, "track_name": "Rattle and Hum"}, {"album_id": 152, "track_id": 1855, "track_name": "Leviathan"}, {"album_id": 152, "track_id": 1856, "track_name": "Flood"}, {"album_id": 152, "track_id": 1857, "track_name": "Orion"}, {"album_id": 152, "track_id": 1858, "track_name": "Ride the Lightning"}, {"album_id": 152, "track_id": 1859, "track_name": "The Thing That Should Not Be"}, {"album_id": 152, "track_id": 1860, "track_name": "Wherever I May Roam"}, {"album_id": 152, "track_id": 1861, "track_name": "Dance of Dragons"}, {"album_id": 152, "track_id": 1862, "track_name": "The Forest of the Dead"}]
2	35	50	Garage Inc. (Disc 1)	[{"album_id": 35, "track_id": 408, "track_name": "Free Speech For The Devil"}, {"album_id": 35, "track_id": 409, "track_name": "Dead and Company"}, {"album_id": 35, "track_id": 410, "track_name": "The Ballad of Booker Jones"}, {"album_id": 35, "track_id": 411, "track_name": "Satchel"}, {"album_id": 35, "track_id": 412, "track_name": "Rockin' in the Free World"}, {"album_id": 35, "track_id": 413, "track_name": "The Big Day"}, {"album_id": 35, "track_id": 414, "track_name": "The Big Day (Reprise)"}
3	154	50	Ride The Lightning	[{"album_id": 154, "track_id": 1874, "track_name": "Fight Fire With Fire"}, {"album_id": 154, "track_id": 1875, "track_name": "Ride the Lightning"}, {"album_id": 154, "track_id": 1876, "track_name": "T.N.T."}, {"album_id": 154, "track_id": 1877, "track_name": "The Thing That Should Not Be"}, {"album_id": 154, "track_id": 1878, "track_name": "Leviathan"}, {"album_id": 154, "track_id": 1879, "track_name": "Flood"}, {"album_id": 154, "track_id": 1880, "track_name": "Orion"}, {"album_id": 154, "track_id": 1881, "track_name": "Dance of Dragons"}, {"album_id": 154, "track_id": 1882, "track_name": "The Forest of the Dead"}, {"album_id": 154, "track_id": 1883, "track_name": "Wherever I May Roam"}]
4	149	50	Garage Inc. (Disc 2)	[{"album_id": 149, "track_id": 1813, "track_name": "Helpless"}, {"album_id": 149, "track_id": 1814, "track_name": "The Big Day"}, {"album_id": 149, "track_id": 1815, "track_name": "The Big Day (Reprise)"}
5	150	50	Kill 'Em All	[{"album_id": 150, "track_id": 1829, "track_name": "Hit The Lights"}, {"album_id": 150, "track_id": 1830, "track_name": "The Thing That Should Not Be"}, {"album_id": 150, "track_id": 1831, "track_name": "Leviathan"}, {"album_id": 150, "track_id": 1832, "track_name": "Flood"}, {"album_id": 150, "track_id": 1833, "track_name": "Orion"}, {"album_id": 150, "track_id": 1834, "track_name": "Dance of Dragons"}, {"album_id": 150, "track_id": 1835, "track_name": "The Forest of the Dead"}, {"album_id": 150, "track_id": 1836, "track_name": "Wherever I May Roam"}, {"album_id": 150, "track_id": 1837, "track_name": "The Ballad of Booker Jones"}, {"album_id": 150, "track_id": 1838, "track_name": "Satchel"}]
6	151	50	Load	[{"album_id": 151, "track_id": 1839, "track_name": "Ain't My Bitch"}, {"album_id": 151, "track_id": 1840, "track_name": "The Thing That Should Not Be"}, {"album_id": 151, "track_id": 1841, "track_name": "Leviathan"}, {"album_id": 151, "track_id": 1842, "track_name": "Flood"}, {"album_id": 151, "track_id": 1843, "track_name": "Orion"}, {"album_id": 151, "track_id": 1844, "track_name": "Dance of Dragons"}, {"album_id": 151, "track_id": 1845, "track_name": "The Forest of the Dead"}, {"album_id": 151, "track_id": 1846, "track_name": "Wherever I May Roam"}, {"album_id": 151, "track_id": 1847, "track_name": "The Ballad of Booker Jones"}, {"album_id": 151, "track_id": 1848, "track_name": "Satchel"}]
7	153	50	ReLoad	[{"album_id": 153, "track_id": 1861, "track_name": "Fuel"}, {"album_id": 153, "track_id": 1862, "track_name": "The Thing That Should Not Be"}, {"album_id": 153, "track_id": 1863, "track_name": "Leviathan"}, {"album_id": 153, "track_id": 1864, "track_name": "Flood"}, {"album_id": 153, "track_id": 1865, "track_name": "Orion"}, {"album_id": 153, "track_id": 1866, "track_name": "Dance of Dragons"}, {"album_id": 153, "track_id": 1867, "track_name": "The Forest of the Dead"}, {"album_id": 153, "track_id": 1868, "track_name": "Wherever I May Roam"}, {"album_id": 153, "track_id": 1869, "track_name": "The Ballad of Booker Jones"}, {"album_id": 153, "track_id": 1870, "track_name": "Satchel"}]
8	148	50	Black Album	[{"album_id": 148, "track_id": 1801, "track_name": "Enter Sandman"}, {"album_id": 148, "track_id": 1802, "track_name": "The Thing That Should Not Be"}, {"album_id": 148, "track_id": 1803, "track_name": "Leviathan"}, {"album_id": 148, "track_id": 1804, "track_name": "Flood"}, {"album_id": 148, "track_id": 1805, "track_name": "Orion"}, {"album_id": 148, "track_id": 1806, "track_name": "Dance of Dragons"}, {"album_id": 148, "track_id": 1807, "track_name": "The Forest of the Dead"}, {"album_id": 148, "track_id": 1808, "track_name": "Wherever I May Roam"}, {"album_id": 148, "track_id": 1809, "track_name": "The Ballad of Booker Jones"}, {"album_id": 148, "track_id": 1810, "track_name": "Satchel"}]
9	155	50	St. Anger	[{"album_id": 155, "track_id": 1882, "track_name": "Frantic"}, {"album_id": 155, "track_id": 1883, "track_name": "The Thing That Should Not Be"}, {"album_id": 155, "track_id": 1884, "track_name": "Leviathan"}, {"album_id": 155, "track_id": 1885, "track_name": "Flood"}, {"album_id": 155, "track_id": 1886, "track_name": "Orion"}, {"album_id": 155, "track_id": 1887, "track_name": "Dance of Dragons"}, {"album_id": 155, "track_id": 1888, "track_name": "The Forest of the Dead"}, {"album_id": 155, "track_id": 1889, "track_name": "Wherever I May Roam"}, {"album_id": 155, "track_id": 1890, "track_name": "The Ballad of Booker Jones"}, {"album_id": 155, "track_id": 1891, "track_name": "Satchel"}]
10	156	50	...And Justice For All	[{"album_id": 156, "track_id": 1893, "track_name": "Blackened"}, {"album_id": 156, "track_id": 1894, "track_name": "The Thing That Should Not Be"}, {"album_id": 156, "track_id": 1895, "track_name": "Leviathan"}, {"album_id": 156, "track_id": 1896, "track_name": "Flood"}, {"album_id": 156, "track_id": 1897, "track_name": "Orion"}, {"album_id": 156, "track_id": 1898, "track_name": "Dance of Dragons"}, {"album_id": 156, "track_id": 1899, "track_name": "The Forest of the Dead"}, {"album_id": 156, "track_id": 1900, "track_name": "Wherever I May Roam"}, {"album_id": 156, "track_id": 1901, "track_name": "The Ballad of Booker Jones"}, {"album_id": 156, "track_id": 1902, "track_name": "Satchel"}]

10 row(s) fetched - 29ms



Live mit Chinook Daten



-- Convert the tracks to a recordset

```
SELECT album_id
, track_id
, track_name
, media_type_id
, milliseconds
, unit_price
FROM jsonb_to_recordset(
    SELECT artist_data#> '{albums, 1, album_tracks}'
    FROM v_json_artist_data
    WHERE (artist_data->> 'artist_id')::int = 50
) AS x(album_id int, track_id int, track_name text, media_type_id int, milliseconds int, unit_price float)
;
```

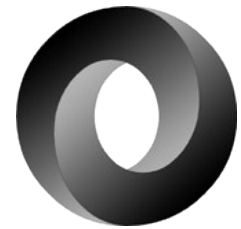
	album_id	track_id	track_name	media_type_id	milliseconds	unit_price
1	35	408	Free Speech For The Dumb	1	155.428	0,99
2	35	409	It's Electric	1	213.995	0,99
3	35	410	Sabbara Cadabra	1	380.342	0,99
4	35	411	Turn The Page	1	366.524	0,99
5	35	412	Die Die My Darling	1	149.315	0,99
6	35	413	Loverman	1	472.764	0,99
7	35	414	Mercyful Fate	1	671.712	0,99
8	35	415	Astronomy	1	397.531	0,99
9	35	416	Whiskey In The Jar	1	305.005	0,99
10	35	417	Tuesday's Gone	1	545.750	0,99
11	35	418	The More I See	1	287.973	0,99

11 row(s) fetched - 44ms

Grid



Live mit Chinook Daten



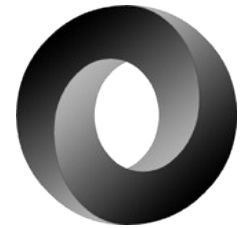
```
-- Create a function, which will be used for UPDATE on the view v_artrist_data
CREATE OR REPLACE FUNCTION trigger_v_json_artist_data_update()
    RETURNS trigger AS
$BODY$
    -- Data variables
    DECLARE rec                RECORD;
    -- Error variables
    DECLARE v_state            TEXT;
    DECLARE v_msg              TEXT;
    DECLARE v_detail           TEXT;
    DECLARE v_hint             TEXT;
    DECLARE v_context          TEXT;
BEGIN
    -- Update table Artist
    IF (OLD.artist_data->>'artist')::varchar(120) <> (NEW.artist_data->>'artist')::varchar(120) THEN
        UPDATE "Artist"
        SET "Name" = (NEW.artist_data->>'artist')::varchar(120)
        WHERE "ArtistId" = (OLD.artist_data->>'artist_id')::int;
    END IF;
    -- Update table Album with an UPSERT
    -- Update table Track with an UPSERT
    RETURN NEW;

    EXCEPTION WHEN unique_violation THEN
        RAISE NOTICE 'Sorry, but the something went wrong while trying to update artist data';
        RETURN OLD;

    WHEN others THEN
        GET STACKED DIAGNOSTICS
            v_state = RETURNED_SQLSTATE,
            v_msg = MESSAGE_TEXT,
            v_detail = PG_EXCEPTION_DETAIL,
            v_hint = PG_EXCEPTION_HINT,
            v_context = PG_EXCEPTION_CONTEXT;
        RAISE NOTICE '%', v_msg;
        RETURN OLD;
END;
$BODY$
LANGUAGE plpgsql;
```



Live mit Chinook Daten



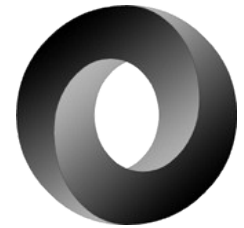
Name	Value
	<pre>-- Create a function, which will be used for UPDATE on the view v_artrist_data CREATE OR REPLACE FUNCTION trigger_v_json_artist_data_update() RETURNS trigger AS \$BODY\$ -- Data variables DECLARE rec RECORD; -- Error variables DECLARE v_state TEXT; DECLARE v_msg TEXT; DECLARE v_detail TEXT;</pre>

1 row(s) fetched - 8ms

Grid



Live mit Chinook Daten













```
-- The trigger will be fired instead of an UPDATE statement to save data
CREATE TRIGGER v_json_artist_data_instead_update INSTEAD OF UPDATE
ON v_json_artist_data
FOR EACH ROW
EXECUTE PROCEDURE trigger_v_json_artist_data_update();
```

Name	Value
Query	-- The trigger will be fired instead of an UPDATE statemen to save data CREATE TRIGGER v_json_artist_data_instead_update INSTEAD OF UPDATE ON v_json_artist_data FOR EACH ROW EXECUTE PROCEDURE trigger_v_json_artist_data_update()
Updated Rows	0

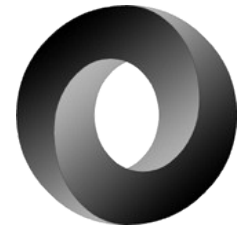
1 row(s) fetched - 13ms

Grid





Live mit Chinook Daten



```
-- Manipulate data with jsonb_set
SELECT artist_data->>'artist_id' AS artist_id
      , artist_data->>'artist' AS artist
      , jsonb_set(artist_data, '{artist}', '"Whatever we want, it is just text" '::jsonb)->>'artist' AS new_artist
FROM v_json_artist_data
WHERE (artist_data->>'artist_id')::int = 50
;
```

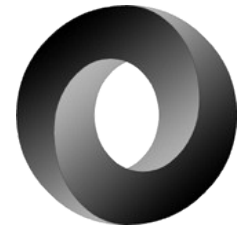
	T artist_id	T artist	T new_artist
1	50	Metallica	Whatever we want, it is just text

1 row(s) fetched - 5ms

Grid



Live mit Chinook Daten



```
-- Update a JSONB column with a jsonb_set result
UPDATE v_json_artist_data
SET artist_data= jsonb_set(artist_data, '{artist}', '"NEW Metallica"'::jsonb)
WHERE (artist_data->>'artist_id')::int = 50
;
```

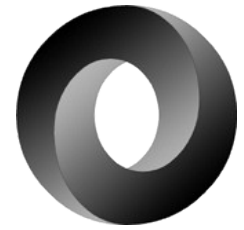
Name	Value
Query	-- Update a JSONB column with a jsonb_set result UPDATE json_artist_data SET artist_data= jsonb_set(artist_data, '{artist}', '"NEW Metallica"'::jsonb) WHERE (artist_data->>'artist_id')::int = 50
Updated Rows	1
1 row(s) fetched - 20ms	

Grid

✓ ✗ ↗ + ↶ - ⏮ ⏪ ⏩ ⏭



Live mit Chinook Daten



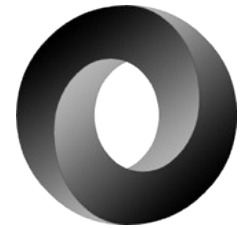
```
-- View the changes done by the UPDATE statement
SELECT artist_data->>'artist_id' AS artist_id
      , artist_data->>'artist' AS artist
FROM v_json_artist_data
WHERE (artist_data->>'artist_id')::int = 50
;
```

	T artist_id	T artist
1	50	NEW Metallica

1 row(s) fetched - 1ms Grid



Live mit Chinook Daten

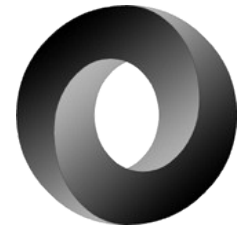


- Lets have a view on the explain plans
- SELECT the data from the view

Node Type	Entity	Cost
▼ Subquery Scan		309.51 - 317.03
▼ CTE Scan		309.51 - 317.01
Seq Scan	Track	0.00 - 68.83
CTE Scan		0.00 - 64.87
▼ Aggregate		146.83 - 150.65
▼ Hash Join		9.89 - 118.00
CTE Scan		0.00 - 57.66
▼ Hash		6.06 - 6.06
Seq Scan	Album as a	0.00 - 6.06
▼ Aggregate		8.42 - 10.92
CTE Scan		0.00 - 6.12
▼ Hash Join		7.49 - 14.24
CTE Scan		0.00 - 4.00
▼ Hash		4.44 - 4.44
Seq Scan	Artist as a_1	0.00 - 4.44



Live mit Chinook Daten



```
-- View the changes in in the table instead of the JSONB view  
-- The result should be the same, only the column name differ
```

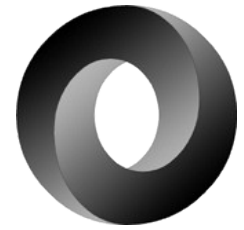
```
SELECT *  
FROM "Artist"  
WHERE "ArtistId" = 50  
;
```

	ArtistId	Name
1	50	NEW Metallica

1 row(s) fetched - 3ms



Live mit Chinook Daten

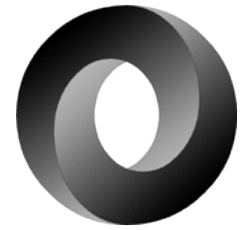


- Lets have a view on the explain plans
- SELECT the data from table Artist

Node Type	Entity	Cost
Seq Scan	Artist	0.00 - 5.05



Live mit Chinook Daten



-- Manipulate data with the concatenating / overwrite operator

```
SELECT artist_data->>'artist_id' AS artist_id
      , artist_data->>'artist' AS artist
      , jsonb_set(artist_data, '{artist}', '"Whatever we want, it is just text" '::jsonb)->>'artist' AS new_artist
      , artist_data || '{"artist":"Metallica"}'::jsonb->>'artist' AS correct_name
FROM v_json_artist_data
WHERE (artist_data->>'artist_id')::int = 50
;
```

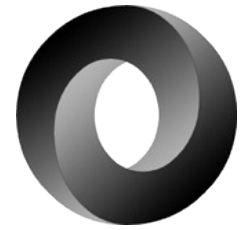
	T artist_id	T artist	T new_artist	T correct_name
1	50	NEW Metallica	Whatever we want, it is just text	Metallica

1 row(s) fetched - 6ms

Grid



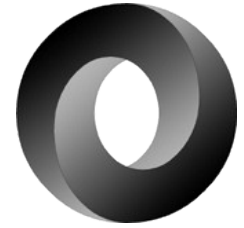
Live mit Chinook Daten



```
-- Revert the name change of Metallica with in a different way: With the replace operator
UPDATE v_json_artist_data
SET artist_data = artist_data || '{"artist":"Metallica"}'::jsonb
WHERE (artist_data->>'artist_id')::int = 50
;
```

Name	Value
Query	<pre>-- Revert the name change of Metallica with in a different way: With the replace operator UPDATE json_artist_data SET artist_data = artist_data '{"artist":"Metallica"}'::jsonb WHERE (artist_data->>'artist_id')::int = 50</pre>
Updated Rows	1

Live mit Chinook Daten

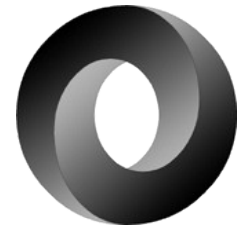


```
-- View the changes done by the UPDATE statement with the replace operator
SELECT artist_data->>'artist_id' AS artist_id
      , artist_data->>'artist' AS artist
FROM v_json_artist_data
WHERE (artist_data->>'artist_id')::int = 50
;
```

	T artist_id	T artist
1	50	Metallica

1 row(s) fetched - 5ms

Grid

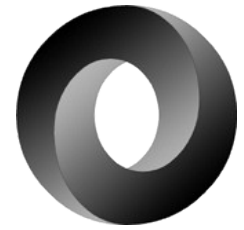


```
SELECT jsonb_pretty(artist_data) AS complete
      , jsonb_pretty(artist_data - 'albums') AS minus_albums
      , jsonb_pretty(artist_data) = jsonb_pretty(artist_data - 'albums') AS is_different
FROM v_json_artist_data
WHERE artist_data->>'artist' IN ('Miles Davis', 'AC/DC')
;
```

2 row(s) fetched - 29ms



Live Amazon Reviews

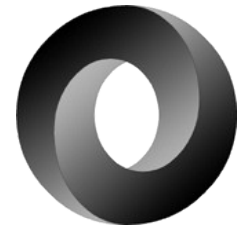


```
-- Create a table for JSON data with 1998 Amazon reviews  
CREATE TABLE reviews(review_jsonb jsonb);
```

Name	Value
Query	CREATE TABLE reviews(review_jsonb jsonb)
Updated Rows	0
1 row(s) fetched - 32ms	



Live Amazon Reviews

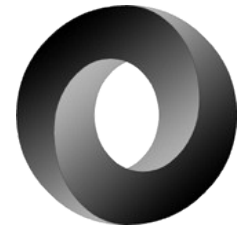


```
-- Import customer reviews from a file
COPY reviews
FROM '/var/tmp/customer_reviews_nested_1998.json'
;
```

Name	Value
Query	-- Import customer reviews from a file COPY reviews FROM '/var/tmp/customer_reviews_nested_1998.json'
Updated Rows	0
1 row(s) fetched - 10730ms	



Live Amazon Reviews



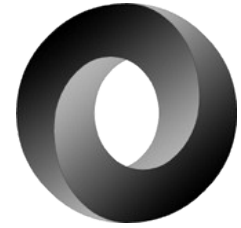
-- There should be 589.859 records imported into the table

```
SELECT count(*)  
FROM reviews  
;
```

	count
1	589.859
1 row(s) fetched - 104ms	



Live Amazon Reviews



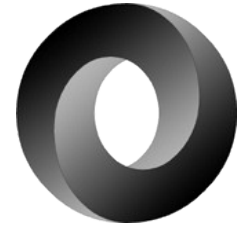
```
SELECT jsonb_pretty(review_jsonb)
FROM reviews
LIMIT 1
;
```

T jsonb_pretty	
1	<pre>{ "review": { "date": "1970-12-30", "votes": 10, "rating": 5, "helpful_votes": 0 }, "product": { "id": "1551803542", "group": "Book", "title": "Start and Run a Coffee Bar (Start Run a)", "category": "Business Investing", "sales_rank": 11611, "similar_ids": ["0471136174", "0910627312", "047112138X", "0786883561", "0201570483"], "subcategory": "General" }, "customer_id": "AE22YDHSBFYIP" }</pre>

1 row(s) fetched - 4ms



Live Amazon Reviews



-- Select data with JSON

SELECT

review_jsonb#>> '{product,title}' **AS** title

, **avg**((review_jsonb#>> '{review,rating}')::int) **AS** average_rating

FROM reviews

WHERE review_jsonb@'{"product": {"category": "Sheet Music & Scores"}}'

GROUP BY title

ORDER BY average_rating **DESC**

;

Without an Index: 248ms

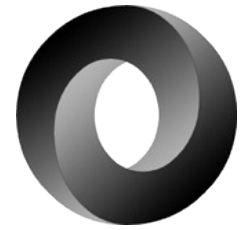
	T title	average_rating
1	Complete Works for Solo Keyboard	5
2	The Magic Flute (Die Zauberflote in Full Score)	5
3	Requiem in Full Score	5
4	The Four Seasons and Other Violin Concertos in Full Score	5
5	Symphony No. 3 (Dover Miniature Scores)	5

12 row(s) fetched - 248ms

Grid



Live Amazon Reviews



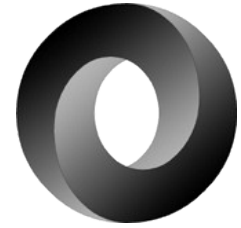
-- Create a GIN index

```
CREATE INDEX review_review_jsonb ON reviews USING GIN (review_jsonb);
```

Name	Value
Query	-- Create a GIN index CREATE INDEX review_review_jsonb ON reviews USING GIN (review_jsonb)
Updated Rows	0
1 row(s) fetched - 21079ms	



Live Amazon Reviews



```
-- Select data with JSON
SELECT review_jsonb#>> '{product,title}' AS title
      , avg((review_jsonb#>> '{review,rating}')::int) AS average_rating
FROM reviews
WHERE review_jsonb@> '{"product": {"category": "Sheet Music & Scores"}}'
GROUP BY title
ORDER BY average_rating DESC
;
```

The same query as before with the previously created GIN Index: 7ms

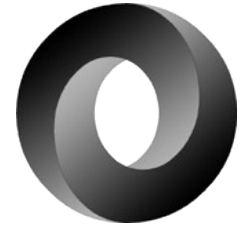
	title	average_rating
1	Complete Works for Solo Keyboard	5
2	The Magic Flute (Die Zauberflote in Full Score)	5
3	Requiem in Full Score	5
4	The Four Seasons and Other Violin Concertos in Full Score	5
5	Symphony No. 3 (Dover Miniature Scores)	5

12 row(s) fetched - 7ms

Grid



Live Amazon Reviews



```
-- SELECT some statistics from the JSON data
SELECT review_jsonb#>>'{product,category}' AS category
      , avg((review_jsonb#>>'{review,rating}')::int) AS average_rating
      , count((review_jsonb#>>'{review,rating}')::int) AS count_rating
FROM reviews
GROUP BY category
;
```

Without an Index: 9747ms

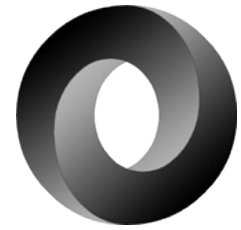
	category	average_rating	count_rating
1		4,487	1.521
2	Accessories	4,703	37
3	Action & Adventure	4,261	3.938
4	African American Cinema	4,694	36
5	Alternative Rock	4,522	15.508

84 row(s) fetched - 9747ms

Grid



Live Amazon Reviews



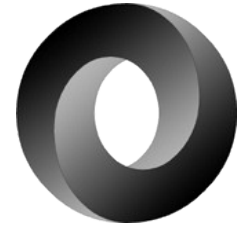
-- Create a B-Tree index on a JSON expression

CREATE INDEX reviews_product_category **ON** reviews ((review_jsonb#>>'{product,category}'));

Name	Value
Query	-- Create a B-Tree index on a JSON expression CREATE INDEX reviews_product_category ON reviews ((review_jsonb#>>'{product,category}'))
Updated Rows	0
1 row(s) fetched - 11875ms	



Live Amazon reviews



```
-- SELECT some statistics from the JSON data
SELECT review_jsonb#>>'{product,category}' AS category
      , avg((review_jsonb#>>'{review,rating}')::int) AS average_rating
      , count((review_jsonb#>>'{review,rating}')::int) AS count_rating
FROM reviews
GROUP BY category
;
```

The same query as before with the previously created BTREE Index: 1605ms

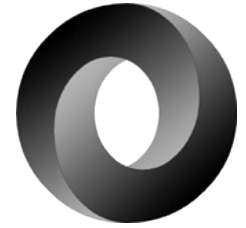
	category	average_rating	count_rating
1		4,487	1.521
2	Accessories	4,703	37
3	Action & Adventure	4,261	3.938
4	African American Cinema	4,694	36
5	Alternative Rock	4,522	15.508

84 row(s) fetched - 1605ms

Grid



NoSQL The SQL Way



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