



zalando

# NOSQL FOR POSTGRESQL

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## BEST PRACTICES



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→ Jsonb internals and performance-related factors

- Jsonb internals and performance-related factors
- Benchmarks

- Jsonb internals and performance-related factors
- Benchmarks
- How to shoot yourself in the foot

# Internals

# Performance-related factors



## Performance-related factors

→ On-disk representation

## Performance-related factors

- On-disk representation
- In-memory representation

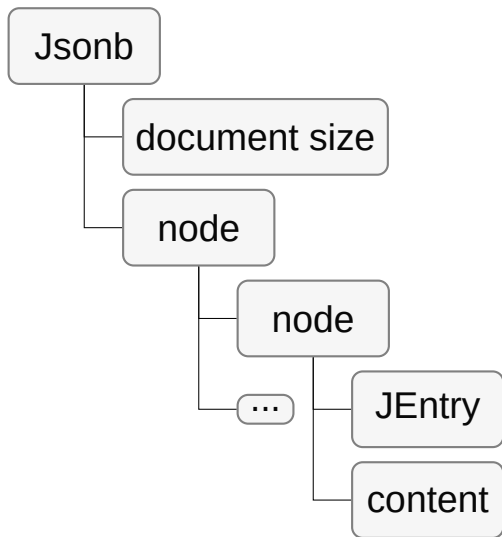
## Performance-related factors

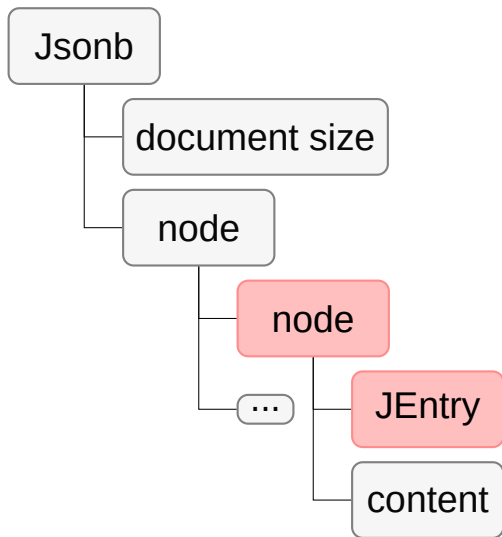
- On-disk representation
- In-memory representation
- Indexing support

**HOW MUCH INFO CAN I PUT  
TO A JSON DOCUMENT**



**TO WORK EFFICIENTLY WITH IT?**





Jsonb Header

type

number of items

JEntry

length or offset?

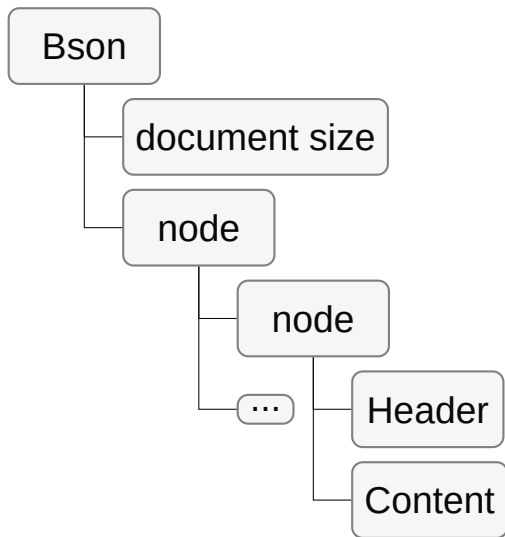
value type

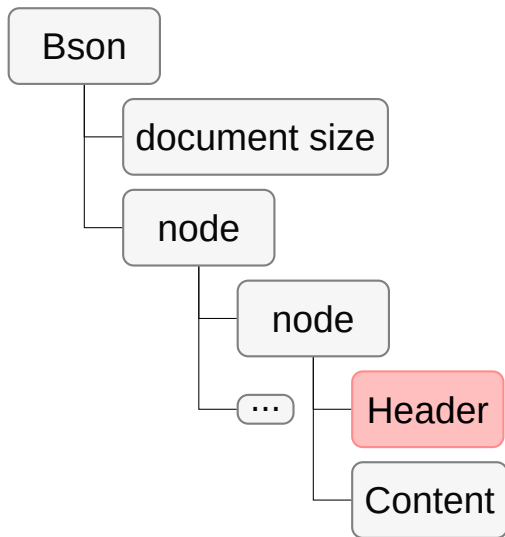
value length or offset

## JB\_OFFSET\_STRIDE

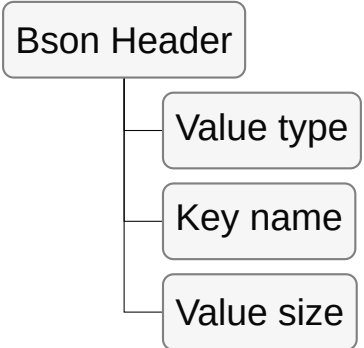
- JEntry may contains a value lenght or offset
- Offset = access speed
- Length = compressibility
- Every **JB\_OFFSET\_STRIDE**'th JEntry contains an offset
- Rest of them contain length







Bson Header



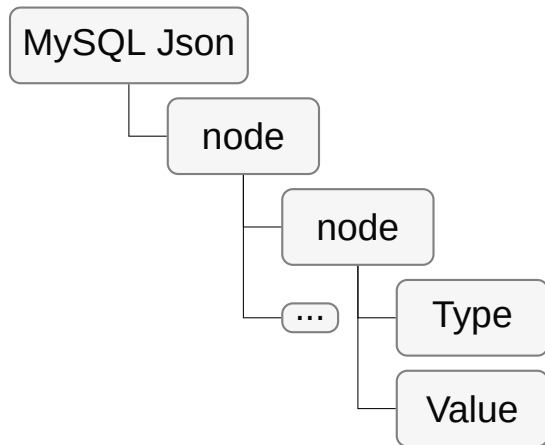
```
graph TD; A[Bson Header] --- B[Value type]; A --- C[Key name]; A --- D[Value size];
```

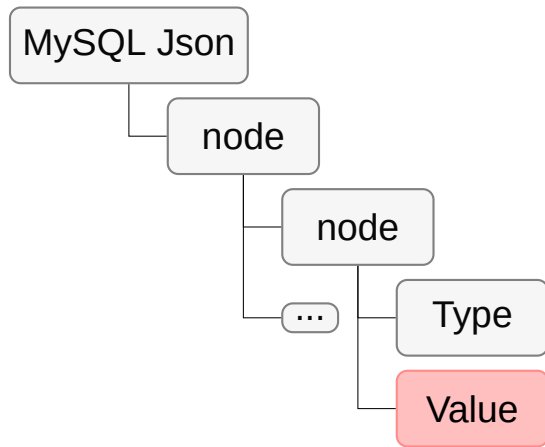
The diagram illustrates the structure of a Bson Header. It consists of a main box labeled 'Bson Header' which is connected by a vertical line to three stacked boxes on the right: 'Value type', 'Key name', and 'Value size'. Each of these three boxes is connected to the main vertical line by a horizontal line.

Value type

Key name

Value size





## MySQL Json Object

Count of elements

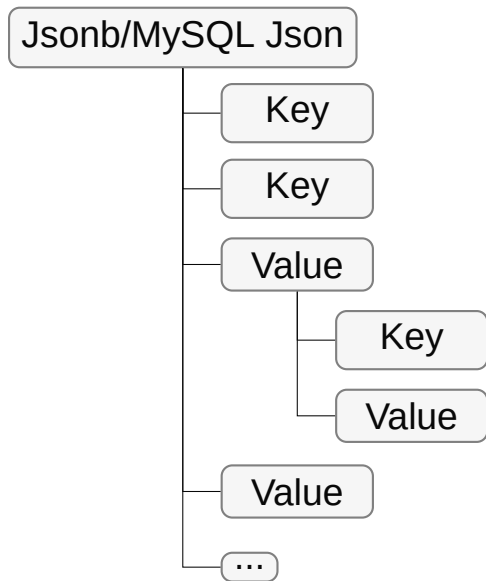
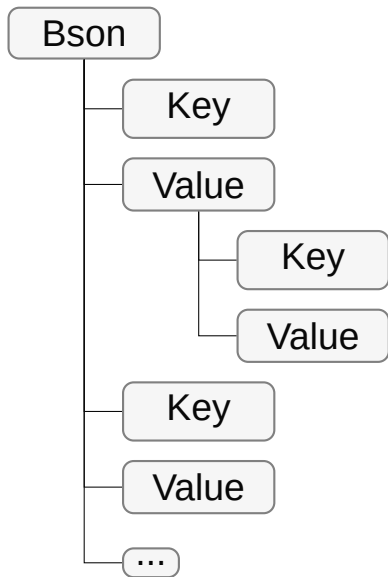
Size

Pointers to keys

Pointers to values

Keys

Values



```
{"a": 3, "b": "xyz"}
```





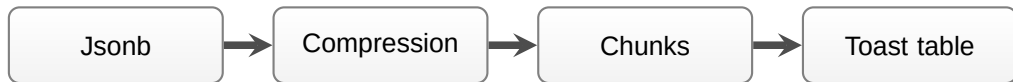
```
bson.dumps({"a": 3, "b": u"xyz"})
```

```
\x17\x00\x00\x00\x10a\x00\x03\x00\x00\x00\x02b\x00\x04\x00\x00\x00xyz\x00\x00
```

```
$ hexdump -C database/table.ibd
```

```
\x00\x02\x00\x18\x00\x12\x00\x01\x00\x13\x00\x01\x00\x05\x03\x00\x0c\x14\x00ab\x03xyz\x00
```

## TOAST



- TOAST\_TUPLE\_THRESHOLD bytes (normally 2 kB)
- PostgreSQL and MySQL use LZ variation
- MongoDB uses snappy block compression

## Alignment

Variable-length portion is aligned to a 4-byte

```
insert into test  
values('{"a": "aa", "b": 1}');
```

```
abaa\x20\x00\x00\x00\x00\x80\x01\x00
```

```
insert into test  
values('{"a": 1, "b": "aa"}');
```

```
\x00\x00ab\x00\x00\x20\x00\x00\x00\x00\x80\x01\x00aa
```

## In-memory representation

- Tree-like representation (JsonbValue, Document, Json\_dom)
- Little bit more expensive but more convenient to work with
- Mostly in use to modify data (except MySQL)
- Most of the read operations use on-disk representation

## Indexing support

- Postgresql – single field, multiple fields, entire document
- MongoDB – single field, multiple fields
- MySQL – virtual columns, single field, multiple fields

## PG indexing details

- JGIN\_MAXLENGTH
- jsonb\_path
- jsonb\_path\_ops



# Queries

## Pitfalls

- Queries with an array somewhere in the middle
- Iterating through document
- Update inside document







# Benchmarks



**GREAT PERFORMANCE**

## AWS EC2

m4.xlarge instance

separate instance (database and generator)

16GB memory, 4 core 2.3GHz

Ubuntu 16.04

Same VPC and placement group

AMI that supports HVM virtualization type

at least 4 rounds of benchmark



PostgreSQL 9.6.3

MySQL 5.7.9

MongoDB 3.4.4

YCSB 0.9

$10^6$  rows and operations

AWS EC2

## Configuration

shared\_buffers

effective\_cache\_size

max\_wal\_size

innodb\_buffer\_pool\_size

write concern level (journalled or transaction\_sync)

## Document types

“simple” document

10 key/value pairs (100 characters)

“large” document

100 key/value pairs (200 characters)

“complex” document

100 keys, 3 nesting levels (100 characters)

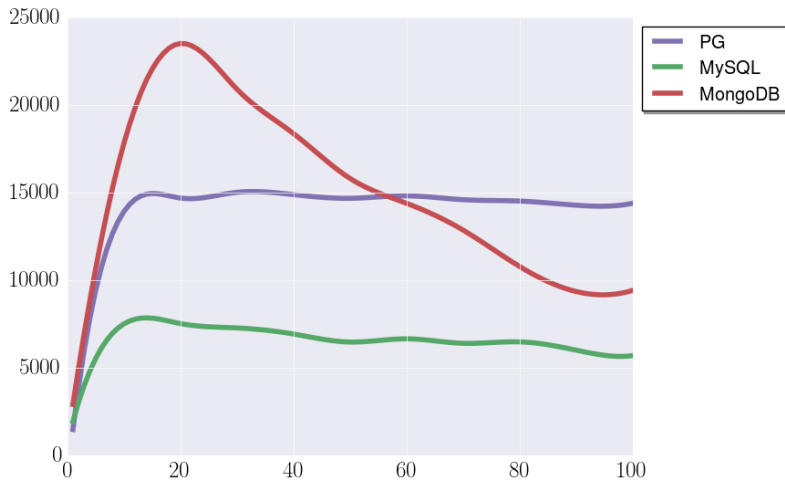
## Select, GIN

"simple" document

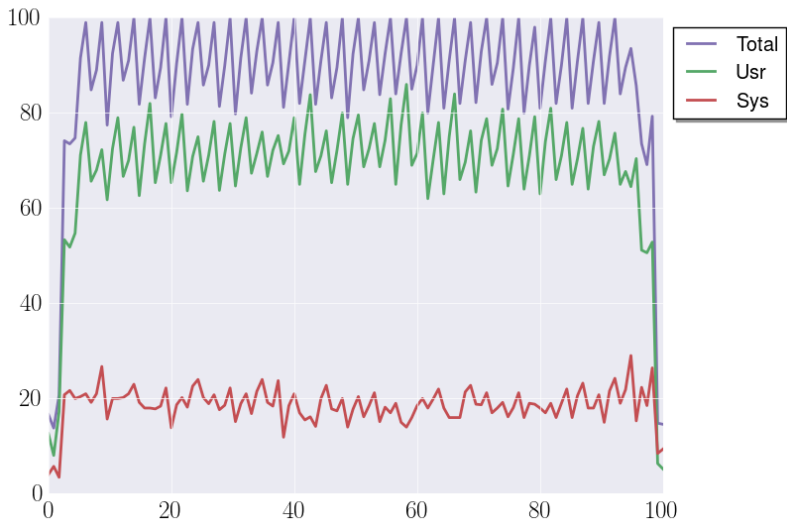
jsonb\_path\_ops

where data @> '{"key": "value"}'::jsonb

## Throughput (ops/sec)



# CPU%

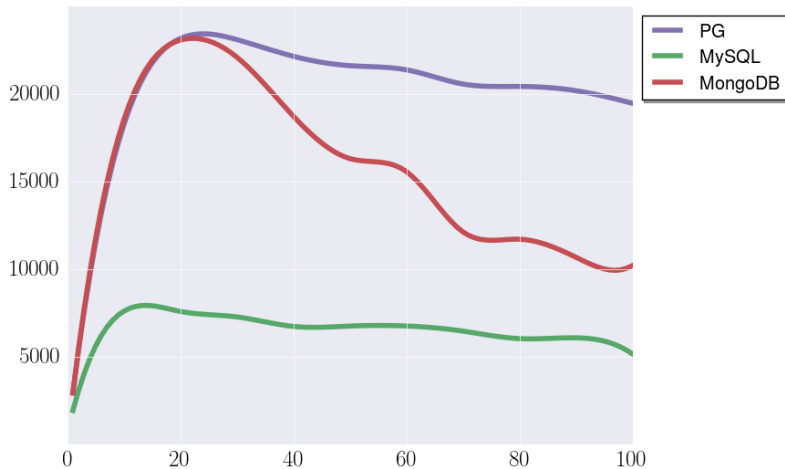


## Select, BTree

"simple" document

btree

## Throughput (ops/sec)



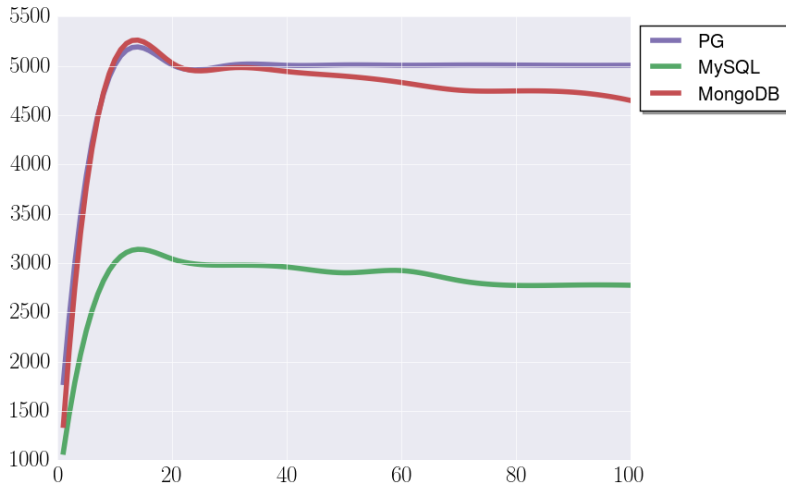


## Select, BTree

"complex" document

btree

## Throughput (ops/sec)



## Scalability

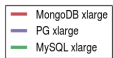
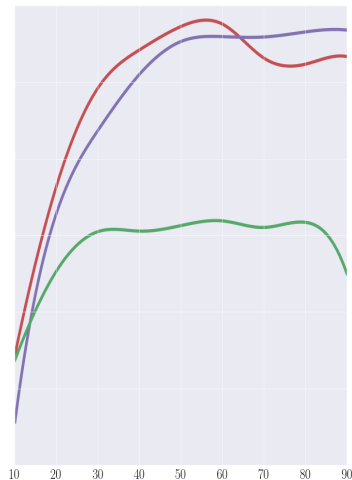
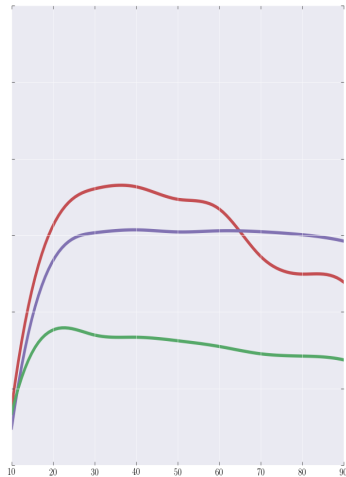
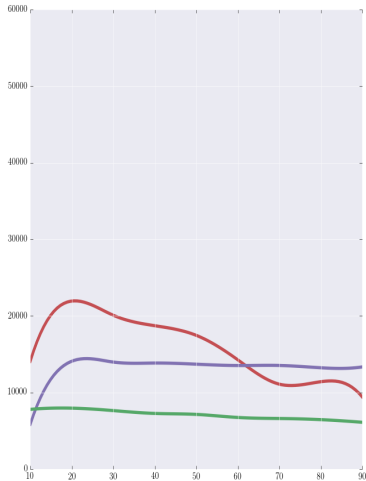
"simple" document

m4.large

m4.xlarge

m4.2xlarge

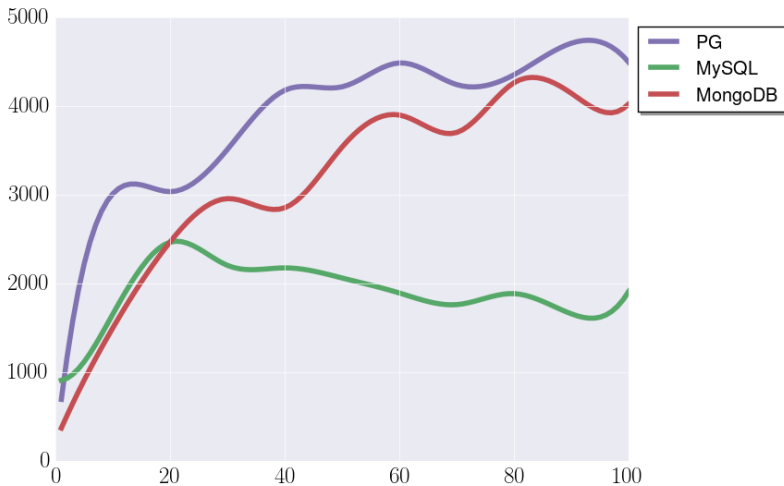
## Throughput (ops/sec)



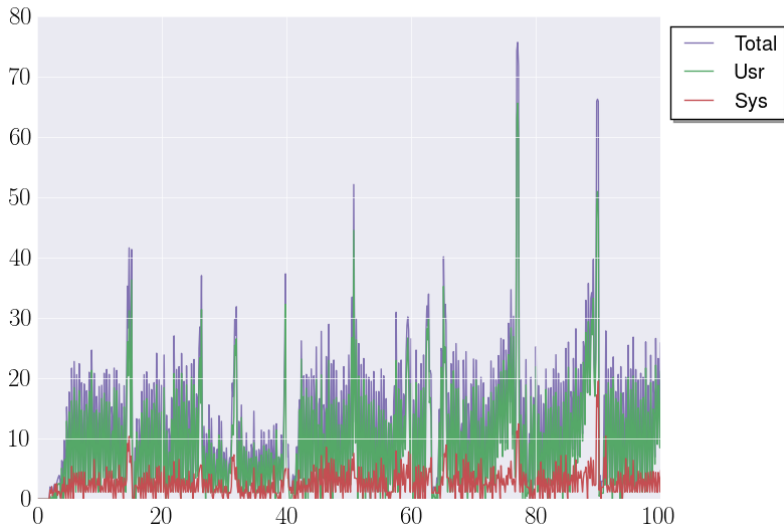
## Insert

"simple" document  
journalized

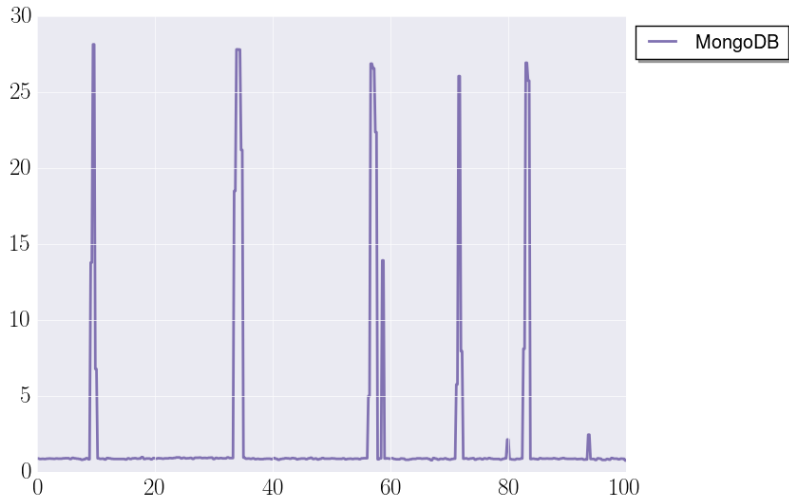
## Throughput (ops/sec)



# CPU%



# IO queue size





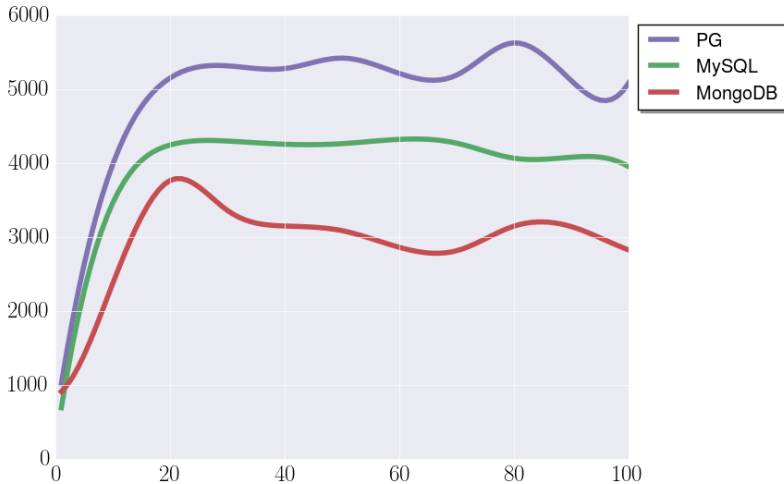
## **Update 50%, Select 50%**

"simple" document

Update one field

transaction\_sync

## Throughput (ops/sec)



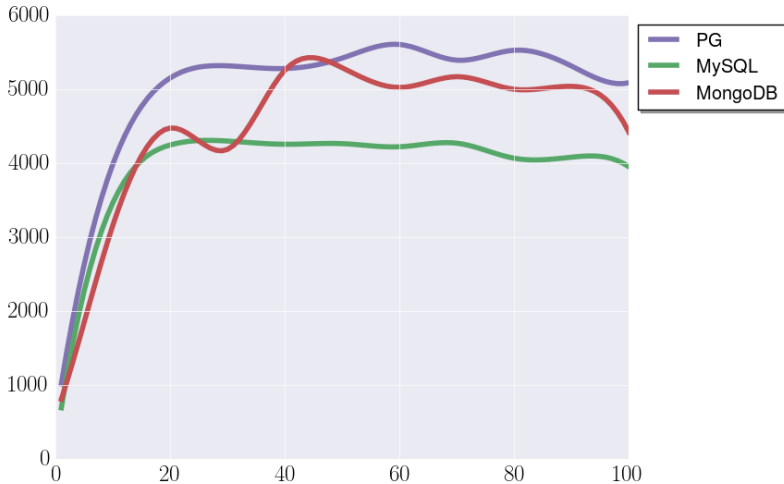
## **Update 50%, Select 50%**

"simple" document

Update one field

journalled

## Throughput (ops/sec)

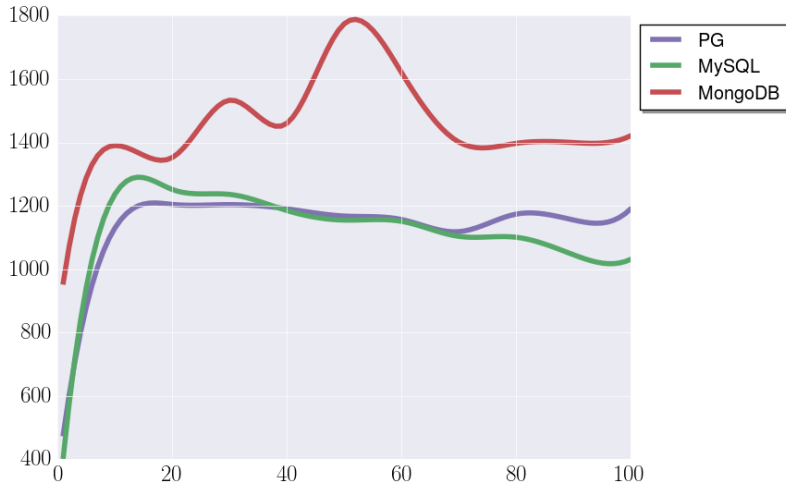


## **Update 50%, Select 50%**

"large" document

Update one field

## Throughput (ops/sec)



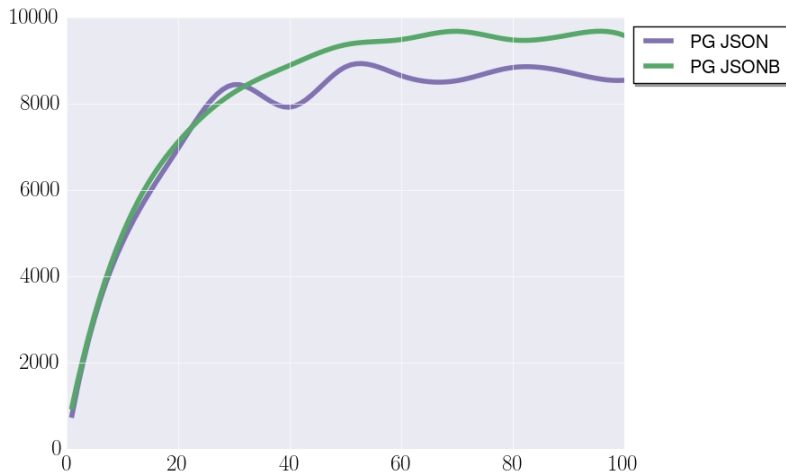
## JSON vs JSONB

"simple" document

btree

insert

## Throughput (ops/sec)





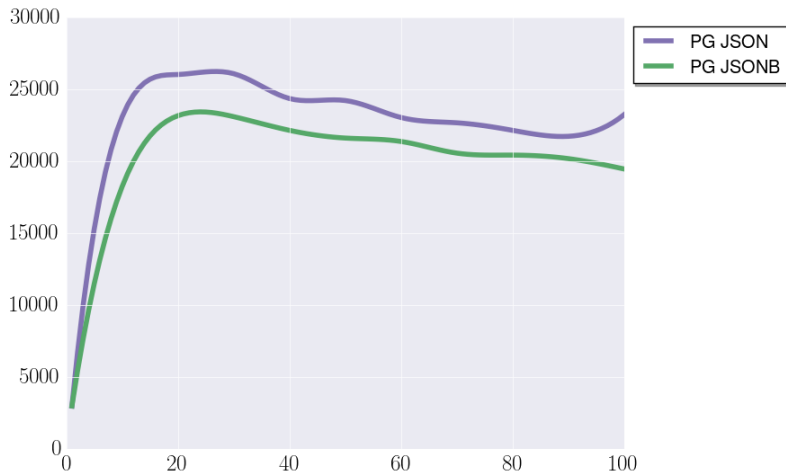
## JSON vs JSONB

"simple" document

btree

select

## Throughput (ops/sec)



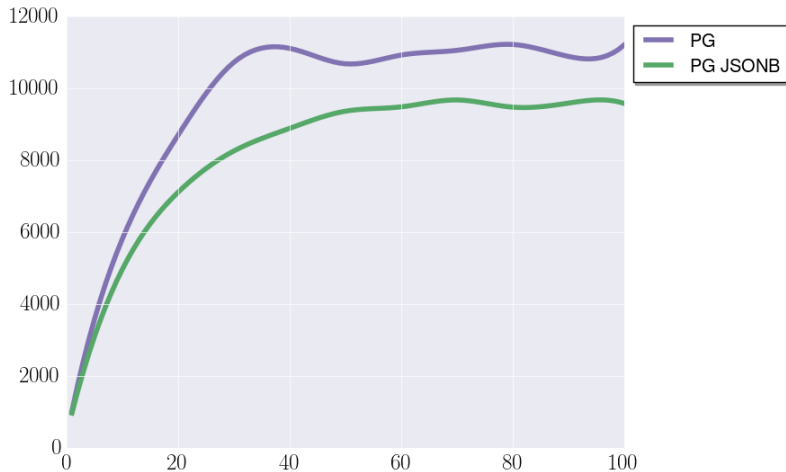
## SQL vs JSONB

"simple" document

btree

insert

## Throughput (ops/sec)



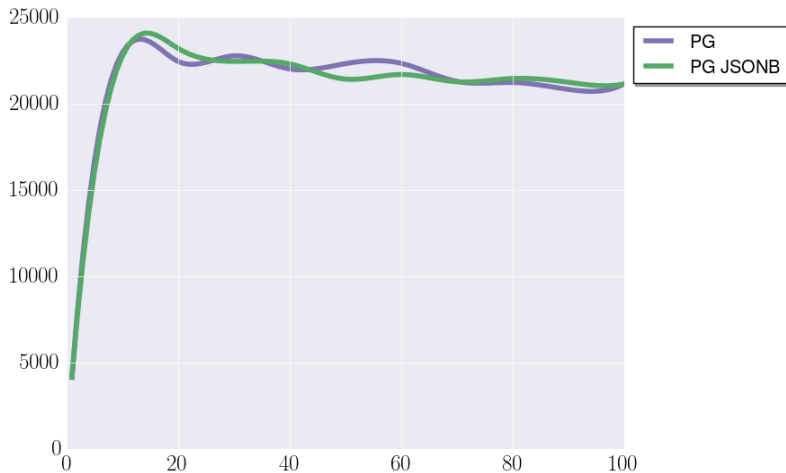
## SQL vs JSONB

"simple" document

btree

select

## Throughput (ops/sec)





How to bring it down accidentally?

**WHAT COULD POSSIBLY GO WRONG?**





- Update one field of a document
- DETOAST of a document  
(select, constraints, procedures etc.)
- Reindex of an entire document

## Document slice

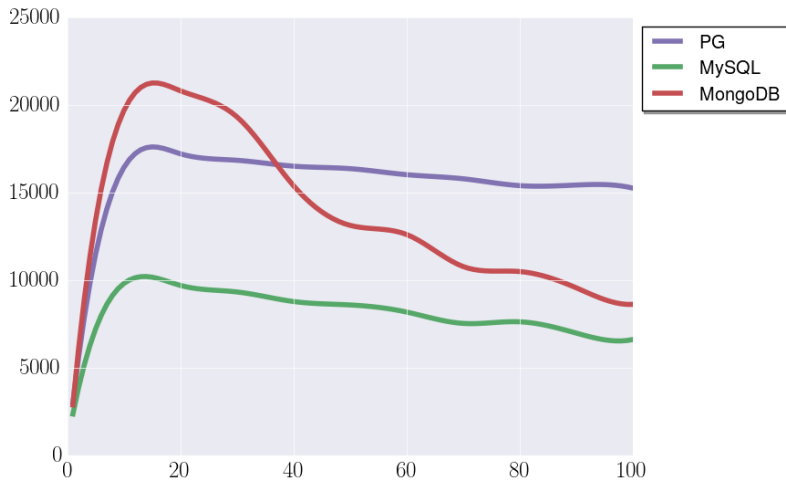
"large" document

One field from a document

```
select data→'key1'→'key2' from table;
```

```
select data→'key1', data→'key2' from table;
```

## Throughput (ops/sec)

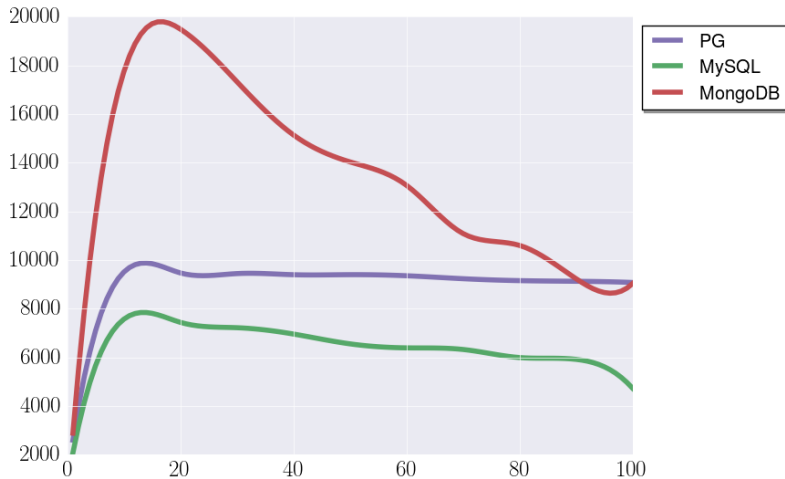


## Document slice

"large" document

10 fields from a document

## Throughput (ops/sec)



## Document slice

```
create type test as ("a" text, "b" text);
insert into test_jsonb
values('{"a": 1, "b": 2, "c": 3}');
select q.* from test_jsonb,
jsonb_populate_record(NULL::test, data) as q;
```

| a | b |
|---|---|
|---|---|

|   |   |
|---|---|
| 1 | 2 |
|---|---|

(1 row)

A person wearing a black hoodie and a backpack stands with their arms crossed on a glowing blue grid floor that recedes into the distance. The background is a dark space filled with stars and nebulae. The text "SET STORAGE EXTERNAL" is overlaid in large white letters at the bottom.

**SET STORAGE EXTERNAL**



## TOAST\_TUPLE\_THRESHOLD

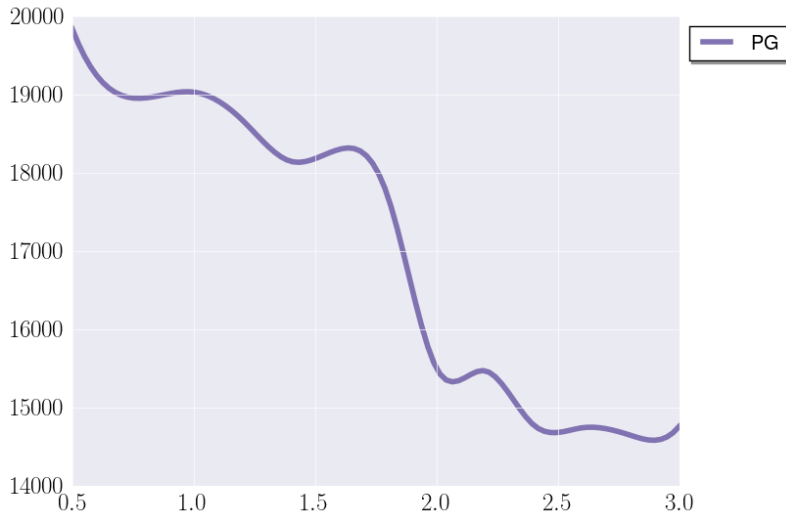
"simple" document

40 threads

different document size

select

## Throughput, 40 clients



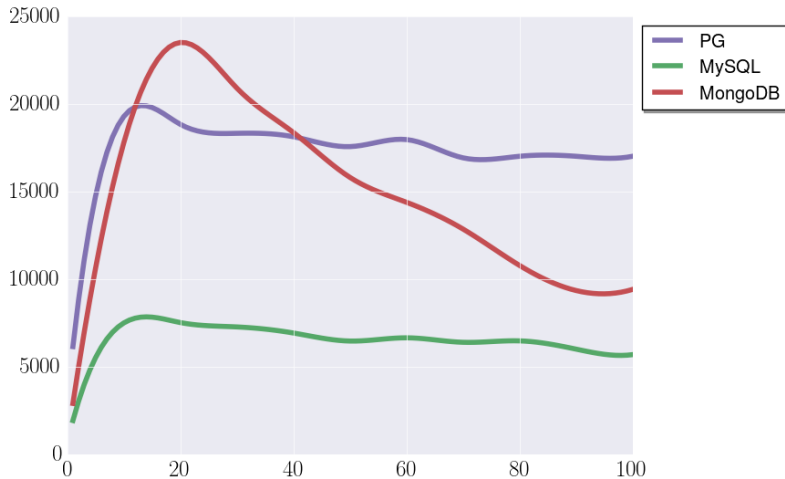
## Select, GIN

"simple" document

jsonb\_path\_ops

where data @> jsonb\_build\_object('key', 'value')

## Throughput (ops/sec)



→ Jsonb is more than good for many use cases


- Jsonb is more than good for many use cases
- Benchmarks above are only "hints"

- Jsonb is more than good for many use cases
- Benchmarks above are only "hints"
- You need your own tests

## Questions?

 [github.com/erthalion](https://github.com/erthalion)

 @erthalion

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