Fun With UUIDs

55554944-7320-4172-6520-436f6f6c2121

pgConf.de - 2025

Classes

Classes

This Week | Next Week

Tuesday 05 September 2023

Intermediate
16:30 - 17:30
Kingston Dojo

Wednesday 06 September 2023

Advanced
17:00 - 18:00
Kingston Dojo

Tuesday 12 September 2023

Your Account

Your Membership

Pay As You Go
Come and train on an ad-hoc basis, pay per session, ideal for students starting out.

£25 per year - Membership Fee

£8 per class - Each class

Your next payment will be taken on

Pause Membership

Your Balance

Pay As You Go
Train as you need
Come and train on an ad-hoc basis, pay per session, ideal for students starting out.

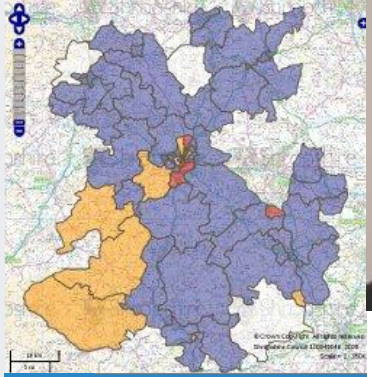
2
Classes until
05 October 2023

Your Details

Hello John Smith
8th Kyu
Email: info@mokuso.cloud
Mobile: 07848123456
Member since 05 September 2023

Change Details | Logout

Home | Classes | Account



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Search

returned 98 results in 0.13 Seconds

63 (Bridgnorth) Squadron Air Training Corps
Air Training Corps for young people between 13 and 20 years.

Albrighton Trust
Albrighton Trust provides recreation and education for people with disabilities.

Apprenticeships
Information about apprenticeships.

Archaeology Service
The Archaeology Service aims to provide the archaeological heritage of the county

Ashley Music School
Ashley Music School offers tuition in pian electric and acoustic guitar, recorders an

Bishop's Castle IT Centre

Filter by category:
- education and learning
- leisure and culture
- community and living
- health and social care
- environment and planning
- jobs and careers
- business
- transport and streets
- advice and benefits

I'm Chris

IT jack of all trades, studied Electronic Engineering, mostly a technical architect

Spend most of my time building apps a top PostgreSQL

Using PostgreSQL for about ~20 years

UUID - What?

UUIDs

55554944-7320-4172-6520-436f6f6c2121

UUID Structure

55554944-7320-4172-6520-436f6f6c2121

&

00000000-0000-F000-F000-000000000000

=

00000000-0000-4000-6000-000000000000

Version

Variant

RFC 9562

UUID Data Type

```
CREATE TABLE club.subscription (
    id          UUID,
    member_id   UUID  NOT NULL,
    ...
    CONSTRAINT subscription_pk PRIMARY KEY (id)
);
```

Bad Press

UUID Performance

- Twice the size of int64
- Random allocation causes issues
  - Extra Free Space Map lookups
    - Lost correlation
  - Often more active index buffers

UUID Performance

```
                Table "public.test_int"
 Column |  Type   | Collation | Nullable | Default
--------+---------+-----------+----------+---------
 id     | bigint |           | not null |
 value  | text   |           |          |
Indexes:
    "test_int_pk" PRIMARY KEY, btree (id)
```

UUID Performance

```
                Table "public.test_uuid"
 Column | Type | Collation | Nullable | Default
--------+------+-----------+----------+---------
 id     | uuid |           | not null |
 value  | text |           |          |
Indexes:
    "test_uuid_pk" PRIMARY KEY, btree (id)
```

UUID Performance - Size

relname	pg_size_pretty
test_int	5208 MB
test_int_rnd	5208 MB
test_uuid	5580 MB
test_int_pk	214 MB
test_int_rnd_pk	281 MB
test_uuid_pk	384 MB

UUID Performance - Size - Reindex

relname	pg_size_pretty
test_int	5208 MB
test_int_rnd	5208 MB
test_uuid	5580 MB
test_int_pk	214 MB
test_int_rnd_pk	214 MB
test_uuid_pk	301 MB

UUID Performance - Buffers

```
EXPLAIN (BUFFERS, ANALYSE)
  SELECT count(id) FROM test_int;

Index Only Scan using test_int_pk
  Buffers: shared hit=27346
```

UUID Performance - Buffers

```
EXPLAIN (BUFFERS, ANALYSE)
  SELECT count(id) FROM test_uuid;

Index Only Scan using test_uuid_pk
  Buffers: shared hit=9545782
```

UUID Performance

```
EXPLAIN (BUFFERS, ANALYSE)
  SELECT count(id) FROM test_int_rnd;


Index Only Scan using test_int_rnd_pk
  Buffers: shared hit=9551903
```

So Why Use UUIDs?

Why UUIDs - Security

- Exposing sequential ids is not ideal
  - Against lots of security guidelines
- 2^{128} is a lot of combinations
  - Extremely hard to brute-force

Why UUIDs - Application

- Sequences are DB generated
  - `INSERT ... RETURNING id`
- UUIDs can be generated in the app
  - Across all nodes
  - Before insert

Why UUIDs - Migration / Sharding

- UUIDs are universally unique
  - Probably
- Simplifies
  - Sharding
  - Migrations

Why UUIDs - Bitwise Encoding

- Encode information inside the UUID
  - Tenant Id
  - Cluster Id
  - Partitioning
  - Entity type

Why UUIDs - Multi-Tenant

1b89ed15-0913-4ffa-8000-000000000000

|

00000000-0000-4000-8edb-347cff36bad2

=

1b89ed15-0913-4ffa-8edb-347cff36bad2

Event Smarter

`72a500f1-211f-4001-81c3-ed36b0748e0f`

Chunk
- Tenant
- Quarter

Time

Tag & Seq

Random Id

Best Of Both Worlds?

UUIDv7

72a500f1-211f-7001-81c3-ed36b0748e0f

Time

Random

FLUUID - Flexible UUIDs - Time Based

`000139a9-7064-8064-8000-9fba0fd0f203`

Time | Tenant | Tag & Seq | Random

`00b1fb1f-d7f1-87f1-a1ce-853d2ec1e0a8`

Time | Random | Tag | Random

FLUUID - Flexible UUIDs - Block Based

000139a9-7064-8064-8ce8-9fba0fd0f203

Block Tag Tenant Random

FLUUID Extended Performance

```
EXPLAIN (BUFFERS, ANALYSE)
  SELECT count(id) FROM test_fluuid;

Index Only Scan using test_fluuid_pk
  Buffers: shared hit=38322
```

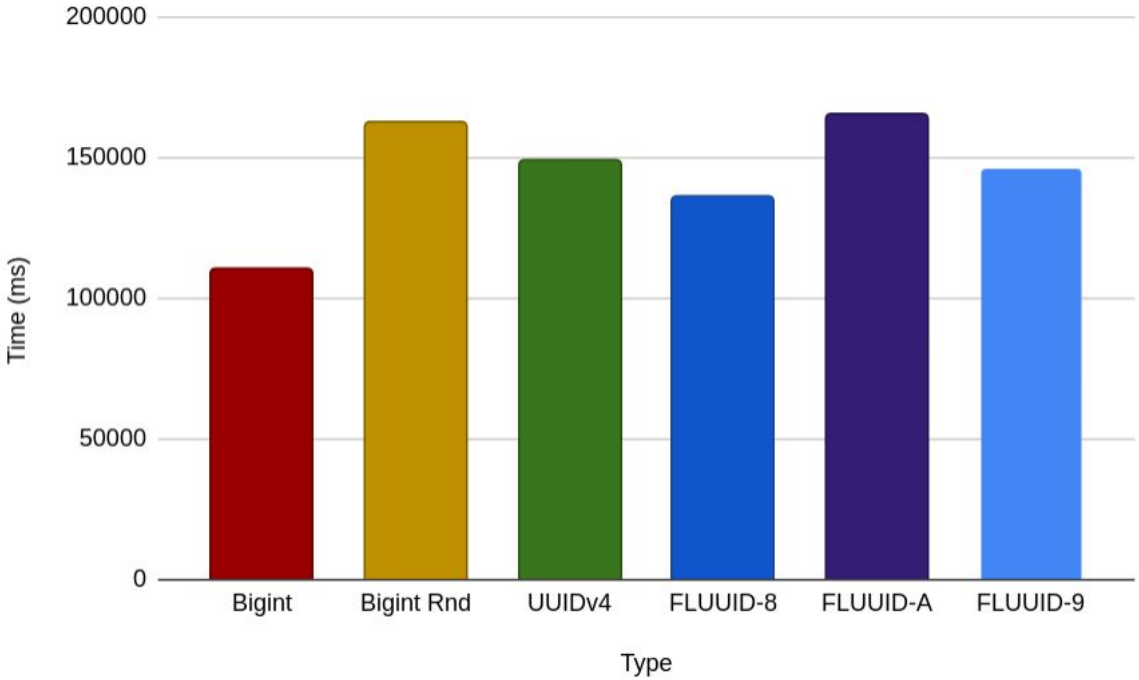
FLUUID Multi-Tenant Performance

```
EXPLAIN (BUFFERS, ANALYSE)
  SELECT count(id) FROM test_fluuid_mt;


Index Only Scan using test_fluuid_mt_pk
  Buffers: shared hit=714222
```

FLUUID Multi-Tenant Performance

```
EXPLAIN (BUFFERS, ANALYSE)
  SELECT count(id) FROM test_fluuid_mt9;


Index Only Scan using test_fluuid_mt9_pk
  Buffers: shared hit=47545
```

Insert Performance - From Application



- Total time to insert 10M records
- From Java application
- All ids generated in application
- Records are id plus 500 byte data
- Starting from empty table with index

The Fun Part!

Generating Inside PostgreSQL

```
CREATE OR REPLACE FUNCTION
    fluuid_gen_variant8(p_tenant BIGINT, p_tag INTEGER, p_sequence INTEGER)
RETURNS UUID VOLATILE LANGUAGE SQL AS $$
SELECT (
 lpad(to_hex(((extract(epoch FROM clock_timestamp())-1735689600)/300)::BIGINT), 6, '0') ||
 lpad(to_hex((p_tenant >> 28) & 0xFF), 2, '0') ||
 '-'  || lpad(to_hex((p_tenant >> 12) & 0xFFFF), 4, '0') ||
 '-8' || lpad(to_hex(p_tenant & 0xFFF), 3, '0') ||
 '-8' || lpad(to_hex(((p_tag & 0x3F) << 6 | (p_sequence & 0x3F)) & 0xFFF), 3, '0') ||
 '-'  || right(gen_random_uuid()::TEXT, 12)
)::UUID;
$$;
```

Check That Fun

Extract UUID Version - PGSQL ;)

```
CREATE OR REPLACE FUNCTION fluuid_extract_version(p_id UUID)
RETURNS INTEGER IMMUTABLE LANGUAGE PLPGSQL AS $$
  DECLARE
   v_chunk     INTEGER;
  BEGIN
   EXECUTE 'SELECT x' || quote_literal(
     right(left(p_id::TEXT, 15), 1)
   ) || '::INTEGER;' INTO v_chunk;
   RETURN v_chunk;
  END;
$$;
```

Banning gen_random_uuid() - ;)

```
ALTER TABLE test_fluuid ADD CONSTRAINT uuid_version_chk
    CHECK (fluuid_extract_version(id) = 8);


baddev=> INSERT INTO test_fluuid (id, value)
           VALUES (gen_random_uuid(), 'Test');

ERROR:  new row for relation "test_fluuid" violates
        check constraint "uuid_version_chk"
```

Extract UUID Variant - PGSQL ;)

```
CREATE OR REPLACE FUNCTION fluuid_extract_variant(p_id UUID)
RETURNS INTEGER IMMUTABLE LANGUAGE PLPGSQL AS $$
  DECLARE
   v_chunk     INTEGER;
  BEGIN
   EXECUTE 'SELECT x' || quote_literal(
     right(left(p_id::TEXT, 20), 1)
   ) || '::INTEGER;' INTO v_chunk;
   RETURN v_chunk;
  END;
$$;
```

Ensuring We Have A Tenant

```
ALTER TABLE test_fluuid_mt ADD CONSTRAINT uuid_version_mt_chk
    CHECK (fluuid_extract_version(id) = 8 AND
           fluuid_extract_variant(id) = 8);

baddev=> INSERT INTO test_fluuid_mt (id, value)
          VALUES ('008dfbfb-e957-857b-a1ce-350c1966e3d9', 'Test');

ERROR:  new row for relation "test_fluuid_mt"
        violates check constraint "uuid_version_mt_chk"
```

Funny Tenants

Sharding - Tenant Routing

```
// decode the TenantId from the UUID
TenantId tenantId = FluuidDecoder.tenant(id);
// select the database for the tenantId
Shard shard = ShardResolver.resolveShard(tenantId);
// connect to the shard
try (Connection con = shard.connect())
{ … }
```

Decoding Inside PostgreSQL

```
CREATE OR REPLACE FUNCTION fluuid_extract_tenant(p_id UUID)
RETURNS BIGINT IMMUTABLE LANGUAGE PLPGSQL AS $$
  DECLARE  v_chunk     BIGINT;
  BEGIN
   EXECUTE 'SELECT x' || quote_literal(
     left(right(p_id::TEXT, 31), 2) || left(right(p_id::TEXT, 27), 4) ||
     left(right(p_id::TEXT, 21), 3)
   ) || '::BIGINT;' INTO v_chunk;
   RETURN v_chunk;
  END;
$$;
```

Query By Tenant

```
SELECT count(id)
FROM test_fluuid_mt
WHERE
   fluuid_extract_tenant(id) = 0xCECECECECE;
```

Query By Tenant

```
CREATE INDEX test_fluuid_tenant_idx
ON test_fluuid_mt
   (fluuid_extract_tenant(id));
```

Partition By Tenant

```
CREATE TABLE test_fluuid_mt_part
  (id UUID, value TEXT)
PARTITION BY
  LIST (fluuid_extract_tenant(id));
```

Partition By Tenant

```
CREATE TABLE test_fluuid_mt_part_d
   PARTITION OF test_fluuid_mt_part
   (CONSTRAINT test_fluuid_mt_part_d_pk
      PRIMARY KEY (id))
DEFAULT;
```

Partition By Tenant

```
CREATE TABLE test_fluuid_mt_part_0
  PARTITION OF test_fluuid_mt_part
   (CONSTRAINT test_fluuid_mt_part_0_pk
      PRIMARY KEY (id))
FOR VALUES IN (0x1CECECECE);
```

Partition By Tenant

```
CREATE TABLE test_fluuid_mt_part_0
  PARTITION OF test_fluuid_mt_part
   (CONSTRAINT test_fluuid_mt_part_0_pk
      PRIMARY KEY (id))
FOR VALUES IN (0x1CECECECE);
```

Time For Fun

Decoding Inside PostgreSQL

```
CREATE OR REPLACE FUNCTION fluuid_extract_time(p_id UUID)
RETURNS INTEGER IMMUTABLE LANGUAGE PLPGSQL AS $$
  DECLARE v_chunk     INTEGER;
  BEGIN
   EXECUTE 'SELECT x' || quote_literal(
     left(p_id::TEXT, 6)
   ) || '::INTEGER;' INTO v_chunk;
   RETURN v_chunk;
  END;
$$;
```

Query By Time

```
SELECT count(id)
  FROM test_fluuid_part
WHERE
  id >= '00000000-0000-8000-8000-000000000000'::UUID
AND
  id < '00060000-0000-8000-8000-000000000000'::UUID;
```

Partition By Time

```
CREATE TABLE test_fluuid_part
  (id UUID, value TEXT)

PARTITION BY RANGE
  (id);
```

Partition By Time

```
CREATE TABLE test_fluuid_part_251
PARTITION OF test_fluuid_part
  (CONSTRAINT test_fluuid_part_251_pk PRIMARY KEY (id))
FOR VALUES
FROM (fluuid_for_time('2025-01-01T00:00:00+0'::TIMESTAMPTZ))
TO (fluuid_for_time('2025-02-01T00:00:00+0'::TIMESTAMPTZ));
```

Down The Rabbit Hole - Extensions

Extension - C

```
PG_FUNCTION_INFO_V1(fluuid_extract_time);
Datum fluuid_extract_time(PG_FUNCTION_ARGS)
{
     int64      time;
     pg_uuid_t  *uuid = PG_GETARG_UUID_P(0);
     time = (((int64) uuid->data[0]) << 16) |
             (((int64) uuid->data[1]) << 8 ) |
             (((int64) uuid->data[2]));
     PG_RETURN_INT64(time);
}
```

Extension - C

```
PG_FUNCTION_INFO_V1(fluuid_extract_tenant);
Datum fluuid_extract_tenant(PG_FUNCTION_ARGS)
{
     int64      tenant;
     pg_uuid_t  *uuid = PG_GETARG_UUID_P(0);
     tenant = (((int64) uuid->data[3]) << 28) |
               (((int64) uuid->data[4]) << 20) |
               (((int64) uuid->data[5]) << 12) |
               (((int64) (uuid->data[6] & 0x0F)) << 8) |
               (((int64) uuid->data[7]));
     PG_RETURN_INT64(tenant);
}
```

Extension - Registering Your Functions

```
CREATE FUNCTION fluuid_extract_time(val UUID) RETURNS BIGINT
AS 'MODULE_PATHNAME', 'fluuid_extract_time'
IMMUTABLE LANGUAGE C STRICT PARALLEL SAFE;

CREATE FUNCTION fluuid_extract_tenant(val UUID) RETURNS BIGINT
AS 'MODULE_PATHNAME', 'fluuid_extract_tenant'
IMMUTABLE LANGUAGE C STRICT PARALLEL SAFE;
```

Extension - Speed Up

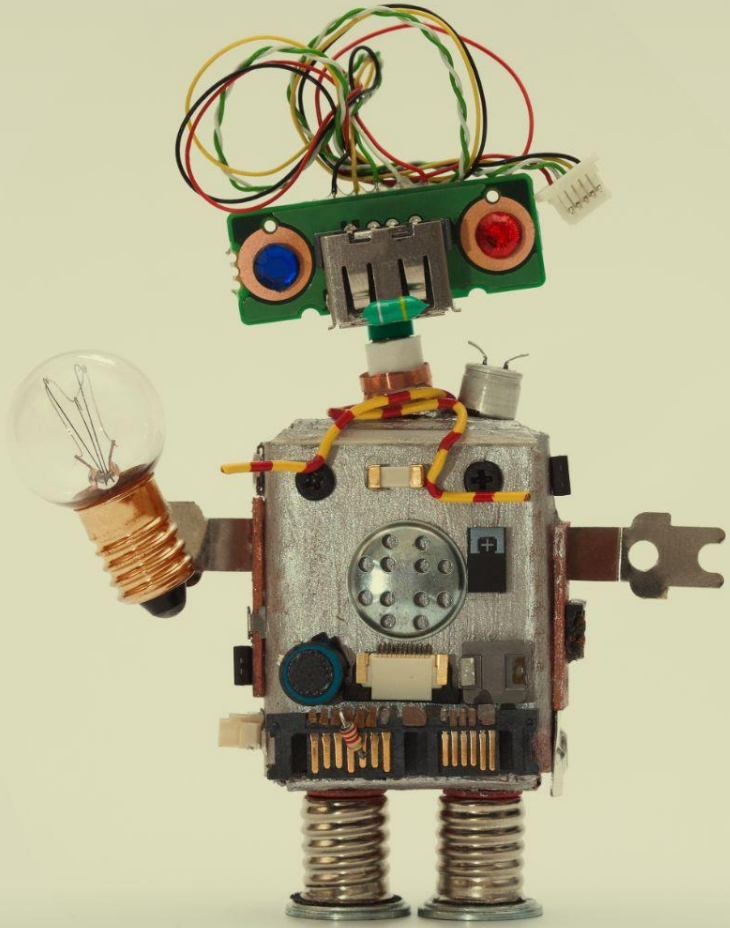
```
cellis=> INSERT INTO ext_test (SELECT fluuid_gen_variant8(0x1cecece, 0, 0)
           FROM generate_series(0, 1000000, 1));
INSERT 0 1000001
```

Time: 2729.613 ms (00:02.730)

```
cellis=> INSERT INTO ext_test (SELECT ext.fluuid_generate_v8(0x1cecece, 0, 0)
           FROM generate_series(0, 1000000, 1));
INSERT 0 1000001
```

Time: 2036.965 ms (00:02.037)

OR 25% faster



fluuid.dev

(coming soon)

&

Thanks For Listening