PG Tricks

Work Smart, Not Hard!

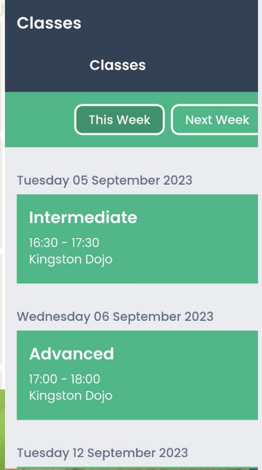
PostgresEDI Meetup

Chris Ellis - @intrbiz@bergamot.social

chris@nexteam.co.uk https://nexteam.co.uk

Hello!

- I’m Chris
  - IT jack of all trades, studied Electronic Engineering
  - These days, mostly a technical architect
  - Spend most of my time building apps on top of PostgreSQL
- Been using PostgreSQL for about ~20 years
- Worked on various PostgreSQL and IoT projects
- Head Of Technology - Nexteam
  - We help small and big companies with technology problems
  - I can help support you using PostgreSQL



Classes

Classes

This Week | Next Week

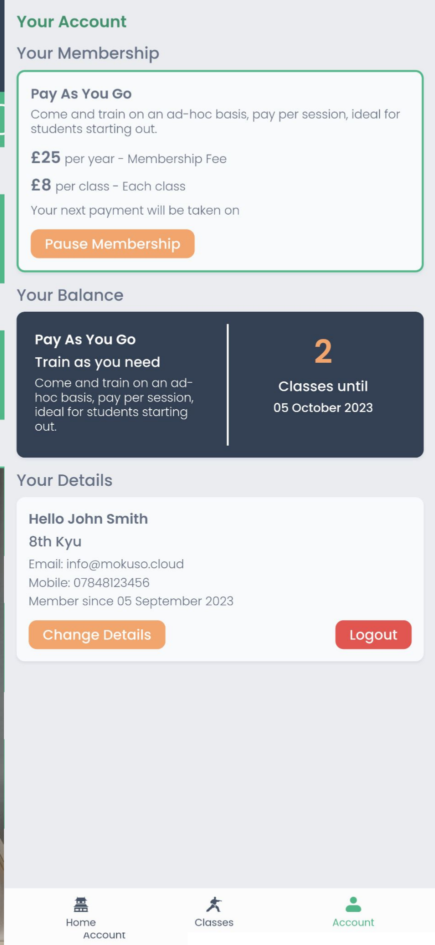
Tuesday 05 September 2023

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

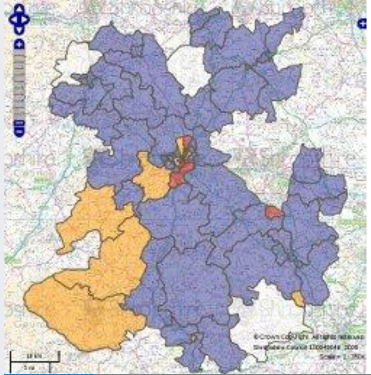
Pay As You Go
Train as you need
Come and train on an ad-hoc basis, pay per session, ideal for students starting out.

2
Classes until
05 October 2023

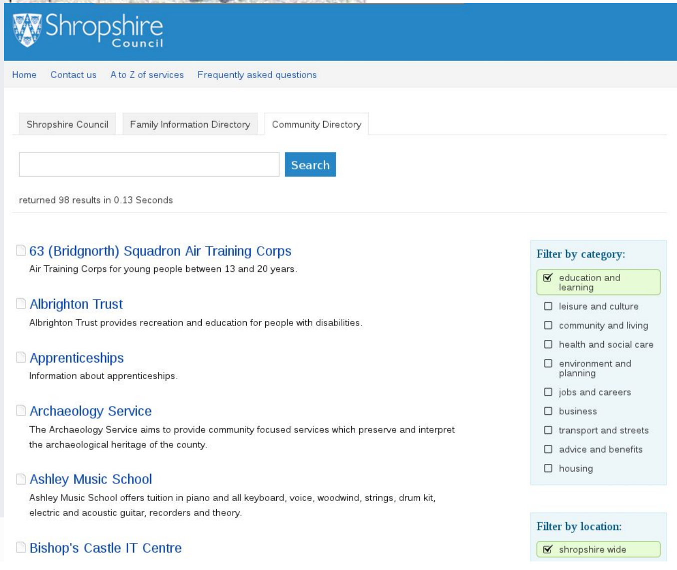
Your Details

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

Change Details | Logout



NEXTEAM



Shropshire Council

Home | Contact us | A to Z of services | Frequently asked questions

Shropshire Council | Family Information Directory | Community Directory

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 community focused services which preserve and interpret the archaeological heritage of the county.

□ Ashley Music School
Ashley Music School offers tuition in piano and all keyboard, voice, woodwind, strings, drum kit, electric and acoustic guitar, recorders and theory.

□ 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
- □ housing

Filter by location:
- ☑ shropshire wide

chris@nexteam.co.uk

https://nexteam.co.uk

Just Use PostgreSQL

Text Search

AS A: customer

I Want: to be easily able to find an applicable fault code for my appliance when raising a repair

So That: to get a better chance of my appliance being fixed first time

```
Code,       Category, Title,                 Description
LVB412-255, DOOR,      DOOR FRAME - DENTED,   ...
LVB412-591, DOOR,      DOOR - WILL NOT CLOSE, ...
LVB412-259, DOOR,      DOOR OPENS MID-CYCLE,  ...
```

```
CREATE TABLE reference.fault_code (
  id             UUID       NOT NULL,
  category       TEXT       NOT NULL,
  title          TEXT       NOT NULL,
  description    TEXT               ,
);
```

Text Search - Simple

```
SELECT *
FROM reference.fault_code
WHERE
 to_tsvector('english',
   title || ' ' || coalesce(description, '')
 )
 @@ to_tsquery('english', 'leak');
```

Text Search - Simple Yet Fast

```
CREATE INDEX fc_text_idx
ON reference.fault_code
USING GIN
(to_tsvector('english',
  title || ' ' || coalesce(description, '')
));
```

Text Search - Simple Yet Fast

```
Seq Scan on fault_code  (cost=0.00..870.51 rows=15
width=170) (actual time=0.084..24.966 rows=37
loops=1)
  Rows Removed by Filter: 2978
Planning Time: 0.172 ms
Execution Time: 25.069 ms
```

Text Search - Simple Yet Fast

```
Bitmap Heap Scan on fault_code  (cost=3.03..22.53
rows=15 width=170) (actual time=0.044..0.167 rows=37
loops=1)
  Heap Blocks: exact=20
  ->  Bitmap Index Scan on fc_text_idx
(cost=0.00..3.03 rows=15 width=0) (actual
time=0.027..0.028 rows=37 loops=1)
Planning Time: 0.308 ms
Execution Time: 0.271 ms
```

Text Search - Realistic

```
ALTER TABLE reference.fault_code
 ADD COLUMN vector TSVECTOR;

CREATE INDEX fc_vector_idx
ON reference.fault_code
USING GIN (vector);
```

Text Search - Realistic

```
UPDATE reference.fault_code
SET vector =
  setweight(
    to_tsvector(coalesce(title,'')), 'A'
  ) ||
  setweight(
    to_tsvector(coalesce(description,'')), 'B'
  );
```

Text Search - Realistic

```
SELECT
  ts_rank_cd(vector,
    websearch_to_tsquery(…)), *
FROM reference.fault_code
WHERE vector @@ websearch_to_tsquery(
  'english', 'leaking door')
ORDER BY 1;
```

AS A: complaints analyst

I Want: to be able to filter call recordings by matched keywords / topics

So That: to prioritize which calls to proactively investigate

```
{
  from: "01902600666"
  transcript: [
    "Hey, we've had a problem. Our Beko washing machine."
    "We've had a Main B bus undervolt",
    "We got a Main bus A undervolt, now, too...
     Main B is reading zip (zero) right now."
  ],
  topics: [ "breakdown", "washer" ],
  keywords: { "make": "Beko", "type": "washer" }
}
```

Tags / Topics / Keywords

```
CREATE TABLE comms.call (
  id             UUID       NOT NULL,
  phone          TEXT       NOT NULL,
  transcript     JSON       NOT NULL,
  ...
  topics         TEXT[]             ,
);
```

Tags / Topics / Keywords

```
SELECT *
FROM comms.call
WHERE topics @> ARRAY['breakdown'];

SELECT *
FROM comms.call
WHERE topics @> ARRAY['breakdown', 'boiler'];
```

Tags / Topics / Keywords

```
CREATE TABLE comms.call (
  id             UUID       NOT NULL,
  phone          TEXT       NOT NULL,
  transcript     JSON       NOT NULL,
  ...
  keywords       JSONB             ,
);
```

Tags / Topics / Keywords

```
SELECT *
FROM comms.call
WHERE keywords @>
       '{"make": "bosch"}'::JSONB;
```

Tags / Topics / Keywords

```
CREATE INDEX topics_idx
ON comms.call USING GIN (topics);

CREATE INDEX keywords_idx
ON comms.call USING GIN (keywords);
```

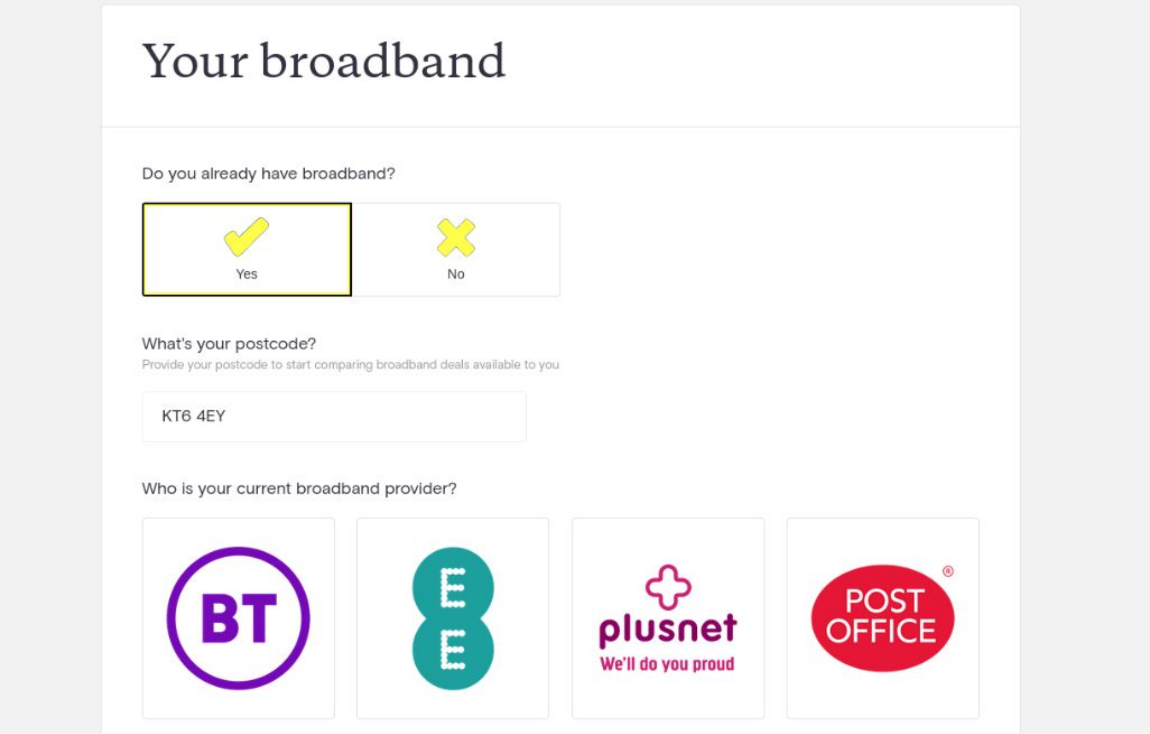
Unknown Unknowns

AS A: product owner

I Want: to be able to analyse how the questions we ask customers effect sales

So That: we can optimise the get a quote user flow

Unknown Unknowns



Your broadband

Do you already have broadband?

[✓ Yes] No

What's your postcode?

Provide your postcode to start comparing broadband deals available to you

KT6 4EY

Who is your current broadband provider?

Unknown Unknowns

```
CREATE TABLE insurance.quote (
  id           UUID       NOT NULL,
  customer_id  UUID       NOT NULL,
  status       STATUS     NOT NULL,
  price        NUMERIC    NOT NULL,
  answers      JSONB
);
```

Unknown Unknowns

```sql
SELECT count(*),
       count(*) FILTER (WHERE (answers ->> 'locks')
                         IS NULL),
       count(*) FILTER (WHERE (answers ->> 'locks')
                         IS NOT NULL),
       count(*) FILTER (WHERE (answers ->> 'locks')
                         = '3-lever'),
       count(*) FILTER (WHERE (answers ->> 'locks')
                         = 'unknown')
FROM insurance.quotes;
```

AS A: tech-lead

I Want: to prevent my developers inserting invalid data

So That: we find problems, before they really become problems

Check Constraints

```
ALTER TABLE insurance.quote
ADD CONSTRAINT answers_chk
CHECK (
  jsonb_typeof( answers ) = 'object'
);
```

GIS

AS A: customer

I Want: to find classes at venues near to me

So That: I can book classes that I can easily get to

Location Search

```
CREATE TABLE club.venue (
  id            UUID          NOT NULL,
  name          TEXT          NOT NULL,
  description   TEXT          NOT NULL,
  address       TEXT          NOT NULL,
  location      Geometry(POINT, 4326)
);
```

Location Search

```
SELECT *
FROM club.venue
WHERE st_dwithin(location, $1, 2000);
```

AS A: repair provider

I Want: to allocate visits to different engineers nearest to their operating areas

So That: we can optimally allocate which engineers attend which appointments

Location Matching

```
CREATE TABLE provider.engineer (
  id    UUID      NOT NULL,
  name  TEXT      NOT NULL,
  area  Geometry(MultiPolygon, 4326)
);
```

Location Matching

```
SELECT *
FROM provider.engineer
WHERE st_contains(area, $1);
```

Location Matching

```
SELECT *
FROM provider.engineer
WHERE st_intersects(area,
  st_buffer(
    st_point(-71.104, 42.315, 4326),
    0.025
  )
);
```

Location Search / Matching - Faster

```
CREATE INDEX venue_location_idx
ON club.venue GIST (location);
```

All Together Now

All Together Now

```
CREATE TABLE search.content (
  id          UUID,
  vector      TSVECTOR,
  tags        TEXT[],
  location    Geometry(POINT, 4326)
);
```

All Together Now

```
SELECT *
FROM search.content
WHERE vector @@ to_tsquery('library')
AND st_dwithin(location, my_location, 2000)
AND tags @> ARRAY['service_catalogue'];
```

Invoicing With SQL

AS A: app developer

I Want: to get paid by the users of my app, charging a commission based on monthly usage

So That: all is good in the world

Subscriptions

```
CREATE TABLE billing.commission_record (
  customer_id  UUID        NOT NULL,
  logged_at    TIMSTAMPTZ  NOT NULL,
  value        NUMERIC     NOT NULL,
  invoice_id   BIGINT
);
```

Generate Invoices - Writable CTEs

```
WITH invoice_commission AS (
    UPDATE billing.commission_record
    SET invoice_id = 123
    WHERE invoice_id IS NULL
      AND customer_id = $1
    RETURNING *
)
INSERT INTO billing.invoice
SELECT 123, current_date, sum(value) AS total
FROM invoice_commission;
```

Get Latest Invoice - Lateral Joins

```
SELECT t.*, q.*
FROM platform.tenant t
LEFT JOIN LATERAL (
    SELECT invoice_date, total
    FROM billing.invoice i
    WHERE i.tenant_id = t.id
    ORDER BY invoice_date DESC
    LIMIT 1
) q ON (true);
```

Stopping Things Going Wrong

AS A: customer

I Want: I don’t want to get billed twice for my subscription

So That: should be obvious really…

Subscriptions

```
CREATE TABLE club.subscription (
  id          UUID     NOT NULL,
  member_id   UUID     NOT NULL,
  plan_id     UUID     NOT NULL,
  status      STATUS   NOT NULL,
  …
);
```

Subscriptions

```
CREATE UNIQUE INDEX active_subs
ON club.subscription
   (member_id)
WHERE status = 'active';
```

Tasks & Queues

AS A: platform

I Want: ensure that we process subscription payments and payment events, and can replay them if needed

So That: our payments handling does not require manual intervention

Queues - A Simple Queue / Task

```
CREATE TABLE queue.event (
  id         BIGINT     PRIMARY KEY,
  created    TIMESTAMP  NOT NULL,
  updated    TIMESTAMP          ,
  status     INTEGER    NOT NULL,
  payload    TEXT
);
```

Queues - Fetch A Batch

```sql
SELECT id, *
FROM queue.event
WHERE status < 5 AND (status = 0 OR
 updated < (now() - '1 hour'::INTERVAL))
ORDER BY created DESC
LIMIT 1 /* Or more */
FOR UPDATE SKIP LOCKED;
```

Queues - Index Time

```
CREATE INDEX queue_event_idx
ON queue.event (created)
WHERE status < 5;
```

Queues - Fetch A Batch

```
 Limit
 (cost=0.29..0.86 rows=10 width=54)
 (actual time=0.060..0.114 rows=10 loops=1)
  ->  LockRows
      (cost=0.29..4920.33 rows=86401 width=54)
      (actual time=0.057..0.109 rows=10 loops=1)
        ->  Index Scan Backward using queue_event_idx on event
            (cost=0.29..4056.32 rows=86401 width=54)
            (actual time=0.037..0.060 rows=10 loops=1)
              Filter: ((status < 5) AND ((status = 0) OR
                       (updated < (now() - '1 hour'::interval))))
Planning Time: 0.260 ms
Execution Time: 0.179 ms
```

Queues - Retry An Event

```
UPDATE queue.event
SET updated = now(),
    status = status + 1
WHERE id = 123;
```

Queues - Processed An Event

```
UPDATE queue.event
SET updated = now(),
    status = 2147483647
WHERE id = 123;
```

Queues - Naughty And Ulta Minimal

```sql
UPDATE queue.event
SET ...
WHERE ctid = '(720,2)';
```

Time Series / IoT

AS A: customer

I Want: to be able to visualise device reading, in a consistent view

So That: I can better understand how I consume my energy and can reduce my usage

Energy Meter

```
CREATE TABLE iot.alhex_reading (
  device_id        UUID        NOT NULL,
  time             TIMESTAMP   NOT NULL,
  temperature      NUMERIC             ,
  light            NUMERIC             ,
  PRIMARY KEY (meter_id, day)
);
```

Generate Series - Presenting Data

```
SELECT r.device_id, t.time, array_agg(r.read_at),
       avg(r.temperature), avg(r.light)
FROM generate_series(
   '2022-10-06 00:00:00'::TIMESTAMP,
   '2022-10-07 00:00:00'::TIMESTAMP, '10 minutes') t(time)
JOIN iot.alhex_reading r
   ON (r.device_id = '26170b53-ae8f-464e-8ca6-2faeff8a4d01'::UUID
       AND r.read_at >= t.time
       AND r.read_at < (t.time + '10 minutes'))
GROUP BY 1, 2
ORDER BY t.time;
```

AS A: DBA

I Want: efficiently store energy meter data in PostgreSQL

So That: we don’t waste too much storage space

Energy Meter

```
CREATE TABLE iot.daily_reading (
  meter_id       UUID       NOT NULL,
  day            DATE       NOT NULL,
  energy         BIGINT             ,
  PRIMARY KEY (meter_id, day)
);
```

Energy Meter - Roll Ups

```
CREATE TABLE iot.daily_reading (
  meter_id       UUID       NOT NULL,
  day            DATE       NOT NULL,
  energy         BIGINT             ,
  energy_profile BIGINT[]           ,
  PRIMARY KEY (meter_id, day)
);
```

Roll Ups

t_xmin	t_xmax	t_cid	t_xvac	t_ctid	t_infomask2	t_infomask	t_hoff
4	4	4	4	6	2	2	1

24 bytes

device_id	read_at	temperature	light
16	8	4	4

32 bytes

Window Functions - Counters

```sql
SELECT
 day,
 energy,
 energy - coalesce(lag(energy)
    OVER (ORDER BY day), 0) AS consumed
FROM iot.daily_reading
ORDER BY day;
```

Window Functions - Roll Up

```
WITH daily_consumption AS (...)
SELECT
  consumed AS daily_consumed,
  sum(consumed) OVER
  (PARTITION BY date_trunc('week', day))
   AS weekly_consumed
FROM daily_consumption;
```

Mind The Gap

Mind The Gap

```
CREATE TABLE iot.meter_reading (
  meter_id       BIGINT  NOT NULL,
  day            DATE    NOT NULL,
  energy         BIGINT          ,
  PRIMARY KEY (meter_id, day)
);
```

Mind The Gap

```
WITH days AS (
  SELECT t.day::DATE
  FROM generate_series('2017-01-01'::DATE,
'2017-01-15'::DATE, '1 day') t(day)
), data AS (
   SELECT *
   FROM iot.meter_reading
   WHERE meter_id = 123
   AND day >= '2017-01-01'::DATE
   AND   day <= '2017-01-15'::DATE
)
```

Mind The Gap

```
SELECT day,
       coalesce(energy,
         (((next_read - last_read)
            / (next_read_time - last_read_time))
            * (day - last_read_time))
            + last_read) AS energy_interpolated
FROM (
    … from next slide …
) q
ORDER BY day
```

Mind The Gap

```
SELECT t.day, d.energy,
  last(d.day)    OVER lookback    AS last_read_time,
  last(d.day)    OVER lookforward AS next_read_time,
  last(d.energy) OVER lookback    AS last_read,
  last(d.energy) OVER lookforward AS next_read
FROM days t
LEFT JOIN data d ON (t.day = d.day)
WINDOW
  lookback AS (ORDER BY t.day),
  lookforward AS (ORDER BY t.day DESC)
```

Mind The Gap

```
CREATE FUNCTION last_agg(anyelement, anyelement)
RETURNS anyelement LANGUAGE SQL IMMUTABLE STRICT AS $$
      SELECT $2;
$$;

CREATE AGGREGATE last (
      sfunc = last_agg,
      basetype = anyelement,
      stype = anyelement
);
```

Any Questions?

Appendix - Mind The Gap

```
WITH days AS (
  SELECT t.day::DATE
  FROM generate_series('2017-01-01'::DATE, '2017-01-15'::DATE, '1 day') t(day)
), data AS (
      SELECT *
      FROM iot.meter_reading
      WHERE day >= '2017-01-01'::DATE AND day <= '2017-01-15'::DATE
)
SELECT day, coalesce(energy_import_wh, (((next_read - last_read) / (next_read_time - last_read_time)) * (day -
last_read_time)) + last_read) AS energy_import_wh_interpolated
FROM (
  SELECT t.day, d.energy_import_wh,
      last(d.day) OVER lookback AS last_read_time,
      last(d.day) OVER lookforward AS next_read_time,
      last(d.energy_import_wh) OVER lookback AS last_read,
      last(d.energy_import_wh) OVER lookforward AS next_read
  FROM days t
  LEFT JOIN data d ON (t.day = d.day)
  WINDOW
      lookback AS (ORDER BY t.day),
      lookforward AS (ORDER BY t.day DESC)
) q  ORDER BY q.day
```