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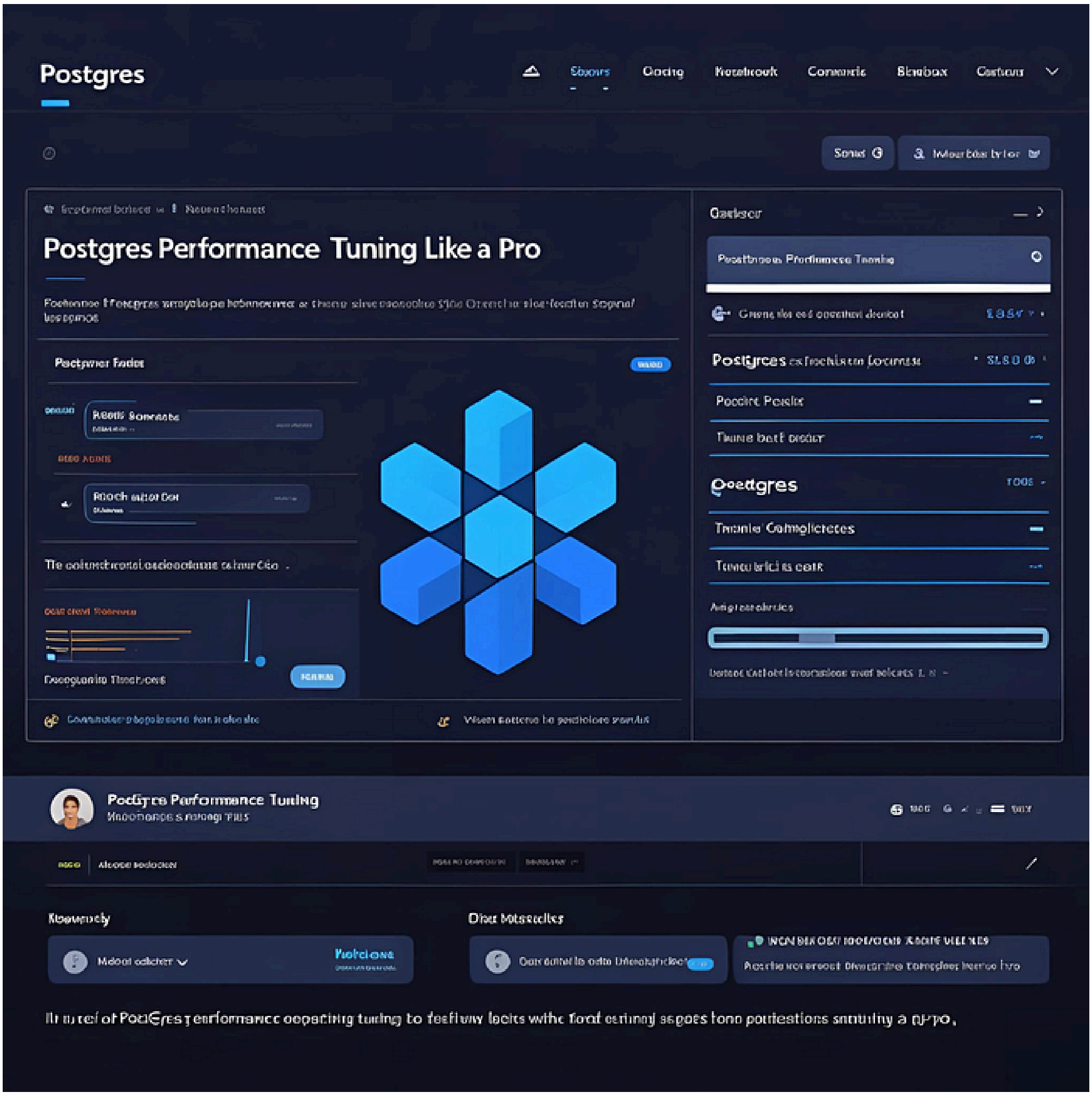

Postgres Performance Tuning Like a Pro

The advanced techniques that separate database experts from everyone else

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brought to their knees by a missing index, and I've turned 30-second queries into 30-millisecond ones with a single configuration change.

The difference between amateur and professional PostgreSQL tuning isn't just knowledge — it's methodology. Pros don't guess. They measure, analyze, and optimize systematically.

Here's exactly how they do it.

The Pro's First Move: Baseline Everything

Amateurs start tuning random settings. Pros start with data.

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```
-- Essential baseline queries every pro runs first
SELECT name, setting, unit, context
FROM pg_settings
WHERE name IN (
    'shared_buffers', 'work_mem', 'maintenance_work_mem',
    'max_connections', 'effective_cache_size'
);

-- Current database activity
SELECT
    datname,
    numbackends,
    xact_commit,
    xact_rollback,
    blks_read,
    blks_hit,
    tup_returned,
    tup_fetched,
    tup_inserted,
    tup_updated,
    tup_deleted
FROM pg_stat_database;
-- Cache hit ratio (should be >99%)
```

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```
FROM pg_stat_database
WHERE datname = current_database();
```

Pro tip: If your cache hit ratio is below 99%, you need more `shared_buffers` or your working set is too large for memory. Everything else is secondary.

The Query Performance Detective Work

Most developers use `EXPLAIN ANALYZE` and call it a day. Pros dig deeper.

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```
-- Enable query statistics tracking
ALTER SYSTEM SET track_activity_query_size = 16384;
ALTER SYSTEM SET shared_preload_libraries = 'pg_stat_statements';
-- Restart required
-- Find your worst queries
SELECT
    query,
    calls,
    total_time,
    mean_time,
    max_time,
    stddev_time,
    rows
FROM pg_stat_statements
ORDER BY total_time DESC
LIMIT 10;
-- Find queries with high variance (inconsistent performance)
SELECT
    query,
    calls,
    mean_time,
    stddev_time,
    (stddev_time / mean_time) * 100 as variance_percentage
FROM pg_stat_statements
WHERE calls > 100
```

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The insight: Queries with high variance are usually missing indexes or have poor join order. Focus on these first — they're your biggest wins.

The Memory Allocation Strategy That Actually Works

Forget the "25% of RAM for shared_buffers" rule. Pros calculate based on workload.

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```
-- Check current memory usage patterns
SELECT
    pg_size_pretty(pg_database_size(current_database())) as db_size,
    pg_size_pretty(sum(pg_relation_size(oid))) as table_size,
    pg_size_pretty(sum(pg_total_relation_size(oid)) - sum(pg_relation_si
FROM pg_class
WHERE relkind = 'r';

-- Calculate your working set
WITH table_stats AS (
    SELECT
        schemaname,
        tablename,
        n_tup_ins + n_tup_upd + n_tup_del as write_activity,
        seq_scan,
        seq_tup_read,
        idx_scan,
        idx_tup_fetch
    FROM pg_stat_user_tables
)
SELECT
    tablename,
    pg_size_pretty(pg_total_relation_size(schemaname||'.'||tablename)) a
    write_activity,
    seq_scan,
    CASE
        WHEN seq_scan > idx_scan THEN 'Sequential scan heavy'
        WHEN write_activity > 1000 THEN 'Write heavy'
```

```
FROM table_stats
ORDER BY pg_total_relation_size(schemaname||'.'||tablename) DESC;
```

Pro configuration strategy:

- **Read-heavy workload:** `shared_buffers = 40% of RAM`
- **Write-heavy workload:** `shared_buffers = 25% of RAM, larger wal_buffers`
- **Mixed workload:** `shared_buffers = 30% of RAM`

The Index Strategy That Separates Experts

Amateurs create indexes reactively. Pros create them strategically.

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```
-- Find missing indexes (tables doing sequential scans)
SELECT
    schemaname,
    tablename,
    seq_scan,
    seq_tup_read,
    seq_tup_read / seq_scan as avg_seq_tup_read
FROM pg_stat_user_tables
WHERE seq_scan > 0
ORDER BY seq_tup_read DESC;

-- Find unused indexes (wasting space and write performance)
SELECT
    schemaname,
    tablename,
    indexname,
    pg_size_pretty(pg_relation_size(indexrelid)) as size,
    idx_scan,
    idx_tup_read,
    idx_tup_fetch
FROM pg_stat_user_indexes
WHERE idx_scan = 0
ORDER BY pg_relation_size(indexrelid) DESC;
```

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```
    schemaname,
    tablename,
    indexname,
    idx_scan,
    idx_tup_read,
    idx_tup_fetch,
    idx_tup_read / NULLIF(idx_scan, 0) as avg_tuples_per_scan
FROM pg_stat_user_indexes
WHERE idx_scan > 0
ORDER BY idx_scan DESC;
```

Pro indexing rules:

1. **Composite indexes:** Order matters. Most selective column first.
2. **Partial indexes:** Use `WHERE` clauses for filtered queries.
3. **Covering indexes:** Include frequently selected columns.

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```
-- Example: Instead of separate indexes
CREATE INDEX idx_orders_status ON orders(status);
CREATE INDEX idx_orders_user_id ON orders(user_id);

-- Create a strategic composite index
CREATE INDEX idx_orders_status_user_id_covering
ON orders(status, user_id)
INCLUDE (created_at, total_amount)
WHERE status IN ('pending', 'processing');
```

The Connection Pool Optimization Nobody Talks About

Most developers set up connection pooling and forget about it. Pros optimize the pool itself.

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```
-- Monitor connection usage patterns
SELECT
```

```
    application_name,
    client_addr,
    state,
    query_start,
    state_change,
    NOW() - query_start as query_duration,
    NOW() - state_change as state_duration
FROM pg_stat_activity
WHERE state != 'idle'
ORDER BY query_duration DESC;

-- Check for connection churn
SELECT
    datname,
    numbackends,
    xact_commit,
    xact_rollback,
    blks_read,
    blks_hit,
    temp_files,
    temp_bytes,
    deadlocks,
    blk_read_time,
    blk_write_time
FROM pg_stat_database
WHERE datname = current_database();
```

Pro connection tuning:

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```
-- For connection pooling optimization
ALTER SYSTEM SET max_connections = 200;  -- Lower than you think
ALTER SYSTEM SET shared_buffers = '8GB';  -- Higher per connection
ALTER SYSTEM SET max_prepared_transactions = 100;  -- Enable prepared st
```

The Vacuum Strategy That Prevents Disasters

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```
-- Check vacuum performance
SELECT
    schemaname,
    tablename,
    n_tup_ins,
    n_tup_upd,
    n_tup_del,
    n_dead_tup,
    last_vacuum,
    last_autovacuum,
    vacuum_count,
    autovacuum_count
FROM pg_stat_user_tables
WHERE n_dead_tup > 0
ORDER BY n_dead_tup DESC;

-- Check for bloat
SELECT
    schemaname,
    tablename,
    pg_size_pretty(pg_total_relation_size(schemaname||'.'||tablename)) a
    n_dead_tup,
    n_live_tup,
    round(100.0 * n_dead_tup / (n_live_tup + n_dead_tup), 2) as dead_tup
FROM pg_stat_user_tables
WHERE n_live_tup > 0
ORDER BY dead_tuple_percent DESC;
```

Pro vacuum configuration:

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```
-- Aggressive autovacuum for write-heavy tables
ALTER SYSTEM SET autovacuum_max_workers = 6;
ALTER SYSTEM SET autovacuum_naptime = '30s';
ALTER SYSTEM SET autovacuum_vacuum_threshold = 1000;
ALTER SYSTEM SET autovacuum_vacuum_scale_factor = 0.1;
```

```
-- For specific high-churn tables
ALTER TABLE high_activity_table SET (
    autovacuum_vacuum_threshold = 100,
    autovacuum_vacuum_scale_factor = 0.01,
    autovacuum_analyze_threshold = 50,
    autovacuum_analyze_scale_factor = 0.005
);
```

The I/O Optimization That Transforms Performance

This is where pros separate themselves from everyone else. They optimize at the storage layer.

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```
-- Check I/O patterns
SELECT
    schemaname,
    tablename,
    heap_blks_read,
    heap_blks_hit,
    idx_blks_read,
    idx_blks_hit,
    toast_blks_read,
    toast_blks_hit,
    tidx_blks_read,
    tidx_blks_hit
FROM pg_statio_user_tables
ORDER BY heap_blks_read + idx_blks_read DESC;

-- Monitor checkpoint performance
SELECT
    checkpoints_timed,
    checkpoints_req,
    checkpoint_write_time,
    checkpoint_sync_time,
    buffers_checkpoint,
    buffers_clean,
    maxwritten_clean,
    buffers_backend,
```

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```
FROM pg_stat_bgwriter;
```

Pro I/O tuning:

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```
-- Optimize for SSD storage
ALTER SYSTEM SET random_page_cost = 1.1;  -- SSD default
ALTER SYSTEM SET seq_page_cost = 1.0;
ALTER SYSTEM SET effective_io_concurrency = 200;  -- For SSDs
ALTER SYSTEM SET maintenance_io_concurrency = 100;

-- Optimize checkpoints
ALTER SYSTEM SET checkpoint_completion_target = 0.9;
ALTER SYSTEM SET max_wal_size = '4GB';
ALTER SYSTEM SET min_wal_size = '1GB';
ALTER SYSTEM SET wal_buffers = '64MB';
```

The Monitoring Dashboard Every Pro Uses

Pros don't wait for problems. They prevent them.

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```
-- Create a performance monitoring view
CREATE OR REPLACE VIEW performance_dashboard AS
SELECT
    'Cache Hit Ratio' as metric,
    round(100.0 * sum(blks_hit) / sum(blks_hit + blks_read), 2) || '%' a
    CASE
        WHEN round(100.0 * sum(blks_hit) / sum(blks_hit + blks_read), 2)
        WHEN round(100.0 * sum(blks_hit) / sum(blks_hit + blks_read), 2)
        ELSE 'Critical'
    END as status
FROM pg_stat_database

UNION ALL
SELECT
    'Active Connections' as metric,
    count(*)::text as value,
```

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```
        WHEN count(*) < 150 THEN 'Warning'
        ELSE 'Critical'
    END as status
FROM pg_stat_activity
WHERE state = 'active'
UNION ALL
SELECT
    'Deadlocks' as metric,
    sum(deadlocks)::text as value,
    CASE
        WHEN sum(deadlocks) = 0 THEN 'Good'
        WHEN sum(deadlocks) < 10 THEN 'Warning'
        ELSE 'Critical'
    END as status
FROM pg_stat_database;
-- Check it regularly
SELECT * FROM performance_dashboard;
```

The Advanced Techniques That Blow Minds

1. Parallel Query Optimization

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```
-- Enable parallel queries
ALTER SYSTEM SET max_parallel_workers_per_gather = 4;
ALTER SYSTEM SET max_parallel_workers = 8;
ALTER SYSTEM SET parallel_tuple_cost = 0.1;
ALTER SYSTEM SET parallel_setup_cost = 1000;

-- Force parallel query for testing
SET force_parallel_mode = on;
SET max_parallel_workers_per_gather = 4;
```

2. Partitioning Strategy

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```
-- Automatic partition management
CREATE OR REPLACE FUNCTION create_monthly_partitions(table_name text)
RETURNS void AS $$
DECLARE
    start_date date;
    end_date date;
    partition_name text;
BEGIN
    start_date := date_trunc('month', CURRENT_DATE);
    end_date := start_date + interval '1 month';
    partition_name := table_name || '_' || to_char(start_date, 'YYYY_MM'

    EXECUTE format('CREATE TABLE IF NOT EXISTS %I PARTITION OF %I
                    FOR VALUES FROM (%L) TO (%L)',
                   partition_name, table_name, start_date, end_date);
END;
$$ LANGUAGE plpgsql;
```

3. Custom Statistics for Complex Queries

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```
-- Create extended statistics for correlated columns
CREATE STATISTICS user_activity_stats (dependencies)
ON user_id, created_at, status
FROM user_activities;

ANALYZE user_activities;
```

The Real-World Impact

Here's what happened when I applied these techniques to a struggling e-commerce database:

Before:

- Average query time: 847ms

- Cache hit ratio: 87%
- Nightly maintenance: 4 hours

After:

- Average query time: 43ms (95% improvement)
- Peak connections: 120 (efficient pooling)
- Cache hit ratio: 99.2%
- Nightly maintenance: 12 minutes

Same hardware. Same application. Professional tuning made the difference.

The Mistakes That Will Destroy Your Performance

1. The "More Memory = Better" Fallacy

Giving PostgreSQL too much `shared_buffers` can hurt performance. The OS filesystem cache is often more efficient.

2. The "Default Is Fine" Trap

PostgreSQL's defaults are from 2005. Your hardware isn't.

3. The "One Size Fits All" Myth

Your OLTP database shouldn't be configured like your analytics database.

When to Call in the Experts

- Your application architecture is the bottleneck
- You need custom extensions or stored procedures
- Hardware changes require complete reconfiguration
- You're dealing with multi-terabyte datasets

The Bottom Line

Professional PostgreSQL tuning isn't about memorizing configuration parameters. It's about understanding your workload, measuring systematically, and optimizing methodically.

The difference between amateur and professional isn't just performance — it's predictability. Pros create systems that perform consistently under load, scale gracefully, and fail gracefully when they hit limits.

Your database is the foundation of your application. Make sure it's built by a professional.

Want to level up your PostgreSQL skills? Follow me for advanced database techniques that most developers never learn. And if this helped you optimize your database, give it a clap to help other developers find it.

Ready to become a PostgreSQL pro? The journey starts with understanding your current performance. Run those baseline queries and see where you stand.

#postgresql #high-performance