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FEATURE ENGINEERING WITH SQL

Preparing ML Data in PostgreSQL

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Introduction to Feature Engineering

Transform raw data into meaningful features to improve ML model performance.

Why PostgreSQL?

- **Scale**: Handles large datasets efficiently
- **Declarative speed**: Writing SELECT ... GROUP BY ... is faster to prototype than looping in code.
- **Production-ready**: Integration with production databases

Key/Powerful PostgreSQL Features

- Window Functions (ROW_NUMBER, LAG, LEAD) for rolling and comparative features.
- Common Table Expressions (CTEs) for breaking complex logic into readable steps.
- JSON/JSONB support to parse and extract nested data.
- Array & string functions to manipulate lists and text within SQL.

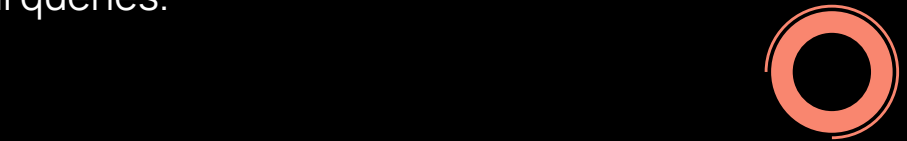
Techniques for Preprocessing

- **Rolling/Lag features**: compute previous or next values in a series.
- **Aggregations & grouping:** summarize data at various granularities (counts, averages).
- **Missing-value handling**: coalesce, conditional imputation, or filtering out nulls.
- **One-hot encoding**: use CASE WHEN … THEN 1 ELSE 0 END to turn categories into numeric flags.

Practical Example: Window Functions

```
SELECT
  month,
  revenue,
  LAG(revenue) OVER (ORDER BY month) AS previous_month_revenue,
  LEAD(revenue) OVER (ORDER BY month) AS next_month_revenue
FROM sales;
```

This query allows you to analyze month-to-month trends, making PostgreSQL a powerful tool for time-series and analytical queries.



Practical Example: JSON & Arrays

```
SELECT
  data->>'user_preferences' AS prefs_json,
  jsonb_array_elements_text(prefs_json) AS preference,
  COUNT(*) FILTER (WHERE preference = 'active') AS active_pref_count
FROM user_events
GROUP BY prefs_json;
```

This query pulls a JSON array of preferences, unnests it into rows, and counts how many are labeled “active.”

Best Practices

Key tips to keep SQL transformations efficient:

- Index key columns used in WHERE, JOIN, and PARTITION BY.
- Use materialized views for rarely rarely changing aggregates.
- Batch vs. on-the-fly: decide whether to compute features in bulk during off-hours or on demand at query time.

CONCLUSION

Feature engineering in SQL unlocks efficient, production-ready ML pipelines.

- PostgreSQL's advanced SQL features streamline preprocessing.
- A good balance would be to combine manual SQL control with orchestration tools like Airflow

RESOURCES

- https://www.postgresql.org/docs/current/functions-window.html
- https://www.postgresql.org/docs/current/queries-with.html
- https://www.postgresql.org/docs/current/functions-json.html
- https://www.postgresql.org/docs/current/functions-array.html
- https://www.postgresql.org/docs/current/functions-conditional.html
- https://www.postgresql.org/docs/current/rules-materializedviews.html