

6. Feature Engineering and Transformation

6.1 SQL Schema

The following PostgreSQL schemas are used to store engineered features for the recommendation system. These tables act as a structured feature warehouse layer.

User Features Table

```
CREATE TABLE user_features (
    user_id VARCHAR PRIMARY KEY,
    total_interactions INT,
    avg_interaction_score FLOAT
);
```

Description:

- Stores aggregated user-level behavioral features
- Captures overall user activity and engagement strength

Item Features Table

```
CREATE TABLE item_features (
    product_id INT PRIMARY KEY,
    total_interactions INT,
    avg_interaction_score FLOAT,
    avg_rating FLOAT
);
```

Description:

- Stores item-level popularity and quality signals

- Supports popularity-based and content-aware recommendations
-

User–Item Interaction Features Table

```
CREATE TABLE user_item_features (
    user_id VARCHAR,
    product_id INT,
    interaction_count INT,
    total_interaction_score FLOAT,
    PRIMARY KEY (user_id, product_id)
);
```

Description:

- Captures historical interaction strength between users and items
 - Forms the basis for collaborative filtering and matrix factorization models
-

6.2 Transformation Scripts

Feature transformation is implemented using a standalone Python script:

Script Location:

```
src/transformation/feature_engineering.py
```

Responsibilities of the Script:

- Load prepared interaction data from
`data/processed/prepared_interactions.csv`
- Aggregate user-level, item-level, and user–item features
- Connect to PostgreSQL using configuration-driven credentials

- Persist engineered features into relational tables

The script is designed to be **idempotent**, allowing safe re-execution during experimentation or pipeline reruns.

6.3 Summary of Feature Logic

User-Level Features

- **Total Interactions:** Number of interactions performed by a user
- **Average Interaction Score:** Mean interaction strength across all user actions

Purpose:

- Represents user engagement intensity
 - Useful for user profiling and cold-start handling
-

Item-Level Features

- **Total Interactions:** Number of interactions received by an item
- **Average Interaction Score:** Mean engagement strength per item
- **Average Rating:** Mean product rating from metadata

Purpose:

- Captures item popularity and perceived quality
 - Supports popularity-based and hybrid recommendation models
-

User–Item Interaction Features

- **Interaction Count:** Number of times a user interacted with an item
- **Total Interaction Score:** Cumulative interaction strength

Purpose:

- Encodes historical preference strength
 - Directly usable in collaborative filtering algorithms
-

6.4 Outcome

The engineered features are stored in a structured relational format and are ready for:

- Model training
- Inference-time feature retrieval
- Feature store abstraction in subsequent pipeline stages

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File Object Tools Edit View Window Help

Object Explorer Dashboard X Properties X SQL X Statistics X Dependencies X Dependents X Processes X postgres/postgres@local* X

Servers (1) Databases (1) Tables (1)

 local postgres

 |--> Catalogs

 |--> Event Triggers

 |--> Extensions

 |--> Foreign Data Wrappers

 |--> Languages

 |--> Publications

 |--> Schemas (1)

 |--> public

 |--> Aggregates

 |--> Collations

 |--> Domains

 |--> FTS Configurations

 |--> FTS Dictionaries

 |--> FTS Parsers

 |--> FTS Templates

 |--> Foreign Tables

 |--> Functions

 |--> Materialized Views

 |--> Procedures

 |--> Sequences

 |--> Tables

 |--> Trigger Functions

 |--> Types

 |--> Views

 |--> Subscriptions

 |--> Login/Group Roles

 |--> Tablespaces

Query Query History

```

1 CREATE TABLE user_features (
2   user_id VARCHAR PRIMARY KEY,
3   total_interactions INT,
4   avg_interaction_score FLOAT
5 );
6
7
8 CREATE TABLE item_features (
9   product_id INT PRIMARY KEY,
10  total_interactions INT,
11  avg_interaction_score FLOAT,
12  avg_rating FLOAT
13 );
14
15
16 CREATE TABLE user_item_features (
17   user_id CHAR,
18   product_id INT,
19   interaction_count INT,
20   total_interaction_score FLOAT,
21   PRIMARY KEY (user_id, product_id)
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```

public.user_features/postgres/postgres@local

Query History

```
1 SELECT * FROM public.user_features
2
```

Data Output Messages Notifications

	user_id	total_interactions	avg_interaction_score
1	U1	5	1.6
2	U10	2	1
3	U11	3	1.3333333333333333
4	U12	2	1
5	U13	3	1.3333333333333333
6	U14	2	1
7	U15	3	1.6666666666666667
8	U16	2	1
9	U17	3	1.3333333333333333
10	U18	2	1
11	U19	2	1
12	U2	4	1.25
13	U20	4	1
14	U3	4	1.25
15	U4	4	1.25
16	U5	4	1.5
17	U6	3	1.3333333333333333
18	U7	3	1.3333333333333333
19	U8	3	1
20	U9	3	1.3333333333333333

Showing rows: 1 to 20 | Page No: 1 of 1 | << <> >> >>

✓ Successfully run. Total query runtime: 74 msec. 20 rows affected. ✘

✓ local/postgres - Database connected ✘ CRLF Ln 1, Col 1

Total rows: 20 Query complete 00:00:00.074

public.user_item_features/postgres/postgres@local

Query History

```
1 SELECT * FROM public.user_item_features
2
```

Data Output Messages Notifications

	user_id	product_id	interaction_count	total_interaction_score
1	U1	1	2	3
2	U1	2	2	4
3	U1	3	1	1
4	U10	5	1	1
5	U10	13	1	1
6	U11	6	2	3
7	U11	14	1	1
8	U12	7	1	1
9	U12	15	1	1
10	U13	8	2	3
11	U13	16	1	1
12	U14	9	1	1
13	U14	17	1	1
14	U15	10	2	4
15	U15	18	1	1
16	U16	11	1	1
17	U16	19	1	1
18	U17	12	2	3
19	U17	20	1	1
20	U18	13	1	1
21	U18	14	1	1
22	U19	15	1	1
23	U19	16	1	1
24	U2	3	2	3

Showing rows: 1 to 48 | Page No: 1 of 1 | << <> >> >>

CRLF Ln 1, Col 1

Total rows: 48 Query complete 00:00:00.104

public.item_features/postgres/postgres@local

Query History

```
1 SELECT * FROM public.item_features
2
```

Data Output Messages Notifications

	product_id	total_interactions	avg_interaction_score	avg_rating
1	1	5	1.4	3.9
2	2	6	1.5	4.1
3	3	6	1.333333333333333	4.7
4	4	5	1.6	2.1
5	5	5	1.2	4.6
6	6	3	1.333333333333333	3.9
7	7	2	1	3
8	8	3	1.333333333333333	1.8999999999999997
9	9	2	1	3.3
10	10	3	1.6666666666666667	2.9
11	11	2	1	4.8
12	12	3	1.333333333333333	4.8
13	13	2	1	2.9
14	14	2	1	2.2
15	15	2	1	2.6
16	16	2	1	2.9
17	17	2	1	3.8
18	18	2	1	4.7
19	19	2	1	4.5
20	20	2	1	3.6

Total rows: 20 Query complete 00:00:00.174 CRLF Ln 1, Col 1

This transformation layer bridges raw interaction data and recommendation models in a scalable and reproducible manner.