Airline Business Intelligence – Phase 2 Data Quality Snapshot

This notebook is a quick **smoke test** for Phase 2 of the pipeline:

- OpenFlights reference data (`airports` , `airlines`)
- Synthetic flight schedule (`flights`)
- BTS on-time performance (`flight_performance`)
- Synthetic customers & loyalty (`passengers` , `loyalty_accounts` , `miles_transactions`)
- Synthetic revenue (`bookings` , `payments`)

Assumptions:

- PostgreSQL is running
- The `airline` schema has been migrated
- The environment variable `DATABASE_URL` points at the `airline_bi` database

In [1]:
```
import os
from textwrap import dedent

import pandas as pd
from sqlalchemy import create_engine

db_url = os.getenv("DATABASE_URL")
if not db_url:
    raise RuntimeError("DATABASE_URL is not set — export it before running t

engine = create_engine(db_url, future=True)
```

In [2]:
```
import os
from textwrap import dedent

import pandas as pd
from sqlalchemy import create_engine

db_url = os.getenv("DATABASE_URL")
if not db_url:
    raise RuntimeError("DATABASE_URL is not set — export it before running t

engine = create_engine(db_url, future=True)
```

1. Row counts by table

In [4]:
```
def run_sql(query: str) -> pd.DataFrame:
    """Run a SQL query and return a pandas DataFrame."""
    with engine.begin() as con:
        return pd.read_sql_query(dedent(query), con)

row_counts_sql = """
    SELECT 'airports'            AS table_name, COUNT(*) AS row_count FROM a
    UNION ALL
    SELECT 'airlines',           COUNT(*) FROM airline.airlines
    UNION ALL
    SELECT 'flights',            COUNT(*) FROM airline.flights
    UNION ALL
    SELECT 'flight_performance', COUNT(*) FROM airline.flight_performance
    UNION ALL
    SELECT 'passengers',         COUNT(*) FROM airline.passengers
    UNION ALL
    SELECT 'loyalty_accounts',   COUNT(*) FROM airline.loyalty_accounts
    UNION ALL
    SELECT 'miles_transactions', COUNT(*) FROM airline.miles_transactions
    UNION ALL
    SELECT 'bookings',           COUNT(*) FROM airline.bookings
    UNION ALL
    SELECT 'payments',           COUNT(*) FROM airline.payments
    ORDER BY table_name;
"""

row_counts = run_sql(row_counts_sql)
row_counts
```

Out[4]:

	table_name	row_count
0	airlines	5733
1	airports	7697
2	bookings	40000
3	flight_performance	22595
4	flights	5000
5	loyalty_accounts	3000
6	miles_transactions	10576
7	passengers	5000
8	payments	40000

2. Basic null checks on key columns

In [6]:

```
null_checks_sql = """
SELECT 'airports' AS table_name,
       COUNT(*)   AS total_rows,
       SUM(CASE WHEN iata_code IS NULL THEN 1 ELSE 0 END) AS metric_1_nulls,
       SUM(CASE WHEN icao_code IS NULL THEN 1 ELSE 0 END) AS metric_2_nulls
FROM airline.airports
UNION ALL
```

```
SELECT 'airlines' AS table_name,
       COUNT(*)   AS total_rows,
       SUM(CASE WHEN iata_code IS NULL THEN 1 ELSE 0 END) AS metric_1_nulls,
       SUM(CASE WHEN icao_code IS NULL THEN 1 ELSE 0 END) AS metric_2_nulls
FROM airline.airlines
UNION ALL
SELECT 'passengers' AS table_name,
       COUNT(*)   AS total_rows,
       SUM(CASE WHEN email IS NULL THEN 1 ELSE 0 END)          AS metric_1_r
       SUM(CASE WHEN state_or_country IS NULL THEN 1 ELSE 0 END) AS metric_2
FROM airline.passengers
UNION ALL
SELECT 'bookings' AS table_name,
       COUNT(*)   AS total_rows,
       SUM(CASE WHEN passenger_id IS NULL THEN 1 ELSE 0 END) AS metric_1_nul
       SUM(CASE WHEN flight_id    IS NULL THEN 1 ELSE 0 END) AS metric_2_nul
FROM airline.bookings
UNION ALL
SELECT 'payments' AS table_name,
       COUNT(*)   AS total_rows,
       SUM(CASE WHEN booking_id IS NULL THEN 1 ELSE 0 END) AS metric_1_nulls
       SUM(CASE WHEN amount_usd IS NULL THEN 1 ELSE 0 END) AS metric_2_nulls
FROM airline.payments
ORDER BY table_name;
"""
null_checks = run_sql(null_checks_sql)
null_checks
```

Out[6]:

	table_name	total_rows	metric_1_nulls	metric_2_nulls
0	airlines	5733	4619	172
1	airports	7697	1625	0
2	bookings	40000	0	0
3	passengers	5000	0	0
4	payments	40000	0	0

In [7]:

```
flights_nulls_sql = """
SELECT
    COUNT(*) AS total_rows,
    SUM(CASE WHEN airline_id          IS NULL THEN 1 ELSE 0 END) AS airline_
    SUM(CASE WHEN aircraft_id         IS NULL THEN 1 ELSE 0 END) AS aircraft
    SUM(CASE WHEN route_id            IS NULL THEN 1 ELSE 0 END) AS route_ic
    SUM(CASE WHEN origin_airport_id   IS NULL THEN 1 ELSE 0 END) AS origin_i
    SUM(CASE WHEN destination_airport_id IS NULL THEN 1 ELSE 0 END) AS dest_
FROM airline.flights;
"""
flights_nulls = run_sql(flights_nulls_sql)
flights_nulls
```

Out[7]:

	total_rows	airline_id_nulls	aircraft_id_nulls	route_id_nulls	origin_id_nulls	dest_i
0	5000	0	5000	5000	0	

3. Primary-key and foriegn-key sanity checks

In [8]:
```
pk_fk_sql = """
    -- PK uniqueness checks
    SELECT 'airports_pk' AS check_name,
           COUNT(*) - COUNT(DISTINCT airport_id) AS issue_count
    FROM airline.airports
    UNION ALL
    SELECT 'airlines_pk',
           COUNT(*) - COUNT(DISTINCT airline_id)
    FROM airline.airlines
    UNION ALL
    SELECT 'flights_pk',
           COUNT(*) - COUNT(DISTINCT flight_id)
    FROM airline.flights
    UNION ALL
    SELECT 'passengers_pk',
           COUNT(*) - COUNT(DISTINCT passenger_id)
    FROM airline.passengers
    UNION ALL
    SELECT 'bookings_pk',
           COUNT(*) - COUNT(DISTINCT booking_id)
    FROM airline.bookings
    UNION ALL
    SELECT 'payments_pk',
           COUNT(*) - COUNT(DISTINCT payment_id)
    FROM airline.payments

    UNION ALL

    -- FK checks: flights -> airlines / airports
    SELECT 'flight_airline_fk',
           COUNT(*)
    FROM airline.flights f
    LEFT JOIN airline.airlines al ON f.airline_id = al.airline_id
    WHERE al.airline_id IS NULL

    UNION ALL

    SELECT 'flight_origin_airport_fk',
           COUNT(*)
    FROM airline.flights f
    LEFT JOIN airline.airports a ON f.origin_airport_id = a.airport_id
    WHERE a.airport_id IS NULL

    UNION ALL

    SELECT 'flight_destination_airport_fk',
           COUNT(*)
    FROM airline.flights f
    LEFT JOIN airline.airports a ON f.destination_airport_id = a.airport_id
    WHERE a.airport_id IS NULL

    UNION ALL

    -- bookings / payments FKs
    SELECT 'booking_flight_fk',
           COUNT(*)
    FROM airline.bookings b
    LEFT JOIN airline.flights f ON b.flight_id = f.flight_id
    WHERE f.flight_id IS NULL

    UNION ALL

    SELECT 'booking_passenger_fk',
           COUNT(*)
    FROM airline.bookings b
    LEFT JOIN airline.passengers p ON b.passenger_id = p.passenger_id
    WHERE p.passenger_id IS NULL

    UNION ALL

    SELECT 'payment_booking_fk',
           COUNT(*)
    FROM airline.payments p
    LEFT JOIN airline.bookings b ON p.booking_id = b.booking_id
    WHERE b.booking_id IS NULL;
"""

pk_fk_issues = run_sql(pk_fk_sql)
pk_fk_issues
```

Out[8]:

	check_name	issue_count
0	passengers_pk	0
1	flights_pk	0
2	airlines_pk	0
3	airports_pk	0
4	flight_airline_fk	0
5	flight_destination_airport_fk	0
6	flight_origin_airport_fk	0
7	booking_passenger_fk	0
8	booking_flight_fk	0
9	payment_booking_fk	0
10	bookings_pk	0
11	payments_pk	0

4. Business sanity checks

In [9]:

```
bookings_per_passenger_sql = """
    SELECT
        COUNT(*) AS total_bookings,
        COUNT(DISTINCT passenger_id) AS distinct_passengers,
        MIN(bookings_per_pax) AS min_bookings_per_passenger,
        PERCENTILE_CONT(0.5) WITHIN GROUP (ORDER BY bookings_per_pax)
            AS median_bookings_per_passenger,
        MAX(bookings_per_pax) AS max_bookings_per_passenger
    FROM (
        SELECT passenger_id, COUNT(*) AS bookings_per_pax
        FROM airline.bookings
        GROUP BY passenger_id
    ) sub;
"""

bookings_per_passenger = run_sql(bookings_per_passenger_sql)
bookings_per_passenger
```

Out[9]:

	total_bookings	distinct_passengers	min_bookings_per_passenger	median_booking
0	4995	4995	1	

In [10]:

```
payments_summary_sql = """
    SELECT
        COUNT(*)        AS num_payments,
        SUM(amount_usd) AS total_revenue_usd,
        AVG(amount_usd) AS avg_ticket_price_usd,
        MIN(amount_usd) AS min_ticket_price_usd,
        MAX(amount_usd) AS max_ticket_price_usd
    FROM airline.payments;
"""

payments_summary = run_sql(payments_summary_sql)
payments_summary
```

Out[10]:

	num_payments	total_revenue_usd	avg_ticket_price_usd	min_ticket_price_usd	ma
0	40000	4539794.86	113.494872	72.0	

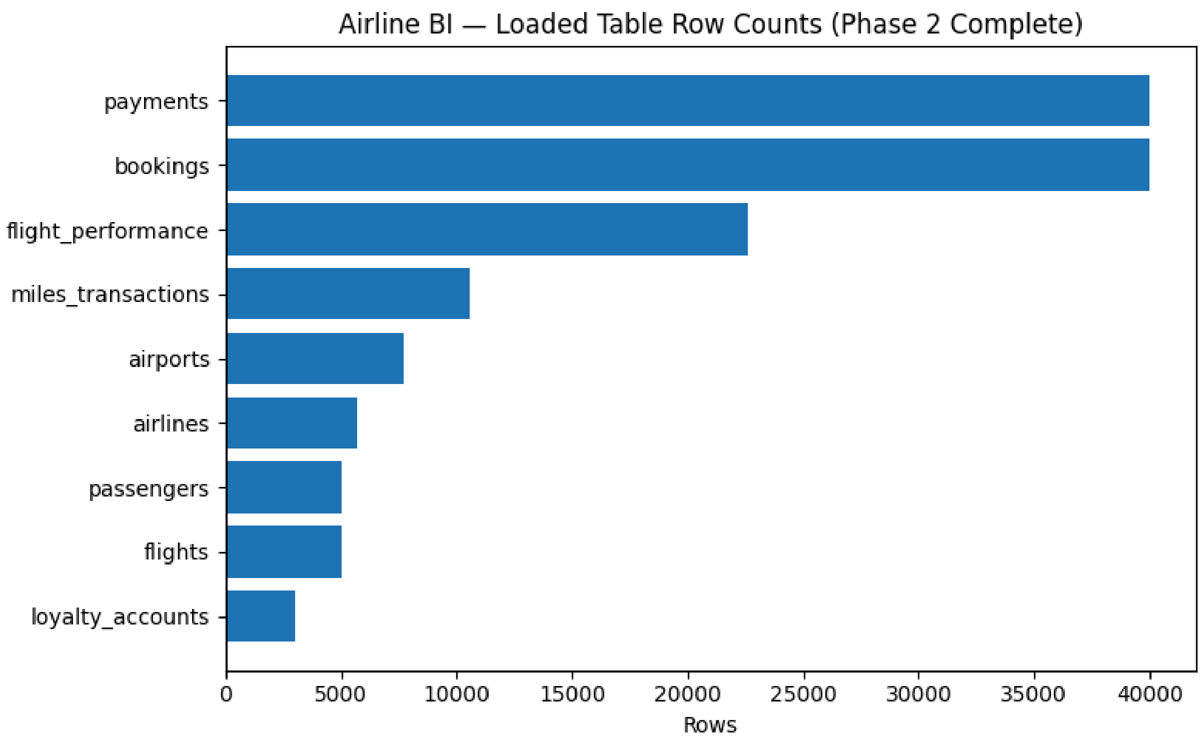
In [15]:

```
import matplotlib.pyplot as plt

# Simple proof-of-pipeline chart: row counts per table
df = row_counts.sort_values("row_count")

plt.figure(figsize=(8,5))
plt.barh(df["table_name"], df["row_count"])
plt.title("Airline BI — Loaded Table Row Counts (Phase 2 Complete)")
plt.xlabel("Rows")
plt.tight_layout()

plt.savefig("/Users/gracepolito/Public/Airline Business Intelligence Databas
plt.show()
```


Airline BI — Loaded Table Row Counts (Phase 2 Complete)
payments
bookings
flight_performance
miles_transactions
airports
airlines
passengers
flights
loyalty_accounts
Rows