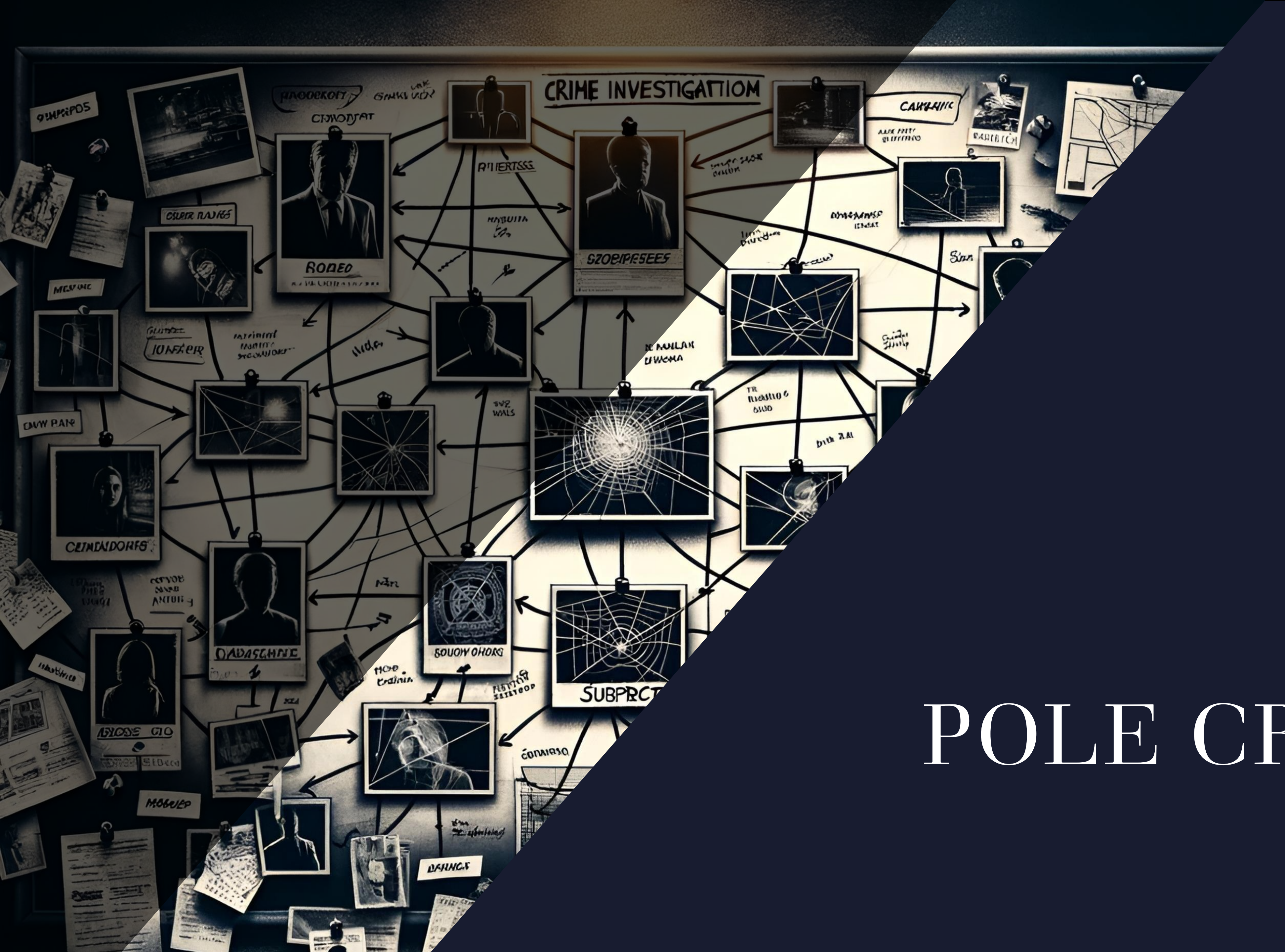


SAPIENZA
UNIVERSITÀ DI ROMA

POLE CRIMES

Objective:

We will employ PostgreSQL to query a comprehensive crime dataset, aiming to extract both quantitative and qualitative insights. These insights will assist investigative units, law enforcement agencies, and any institutions or companies interested in studying social phenomena for forensic sciences.

Potential Benefits:

- Enhance forensic analysis capabilities.
- Support crime prevention and resolution strategies.
- Facilitate the understanding of complex social dynamics in urban environments.

Dataset Overview:

- Source:
  The dataset is provided by the British government.

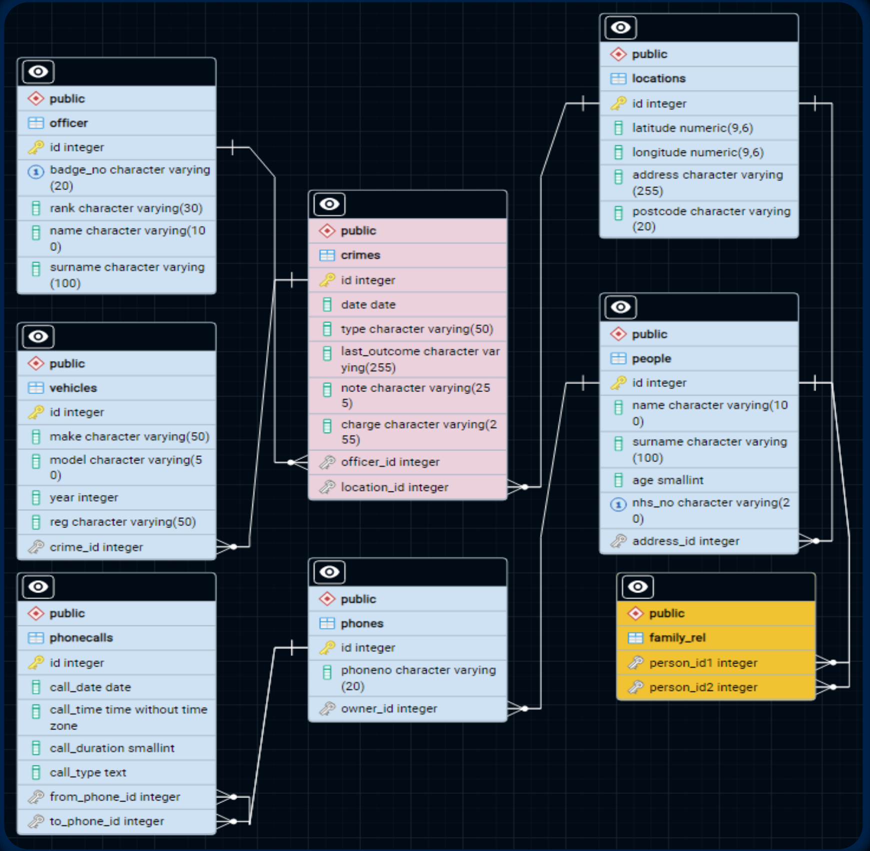
- Contents:
  It includes data related to crimes, phone records, individuals, and geographic areas specific to the city of Manchester during August 2017.

- Analytical Framework:
  The data will be analyzed using the POLE (Person, Object, Location, Event) framework. This approach is intended to identify recurring patterns and potentially provide predictive deductions.

The dataset can be accessed through this link: POLE Dataset

ORIGINAL ER SCHEMA

OPTIMIZED ER SCHEMA



DB optimization steps

1. Change relational schema:
   removing some tables in order to create relations between entities (with foreign keys), normalizing the schema and reducing the number of needed joins.

2. New data types:
   using the correct data type for each attribute.

3. Procedures definition:
   deploying a cleaner and more reproducible project.

4. Indexes creation:
   allowing fast lookup and scanning of critical columns (primary keys).

5. Exploiting views:
   precomputing quantities of interest for the overall analysis and speeding-up the queries.

6. Adding constraints:
   providing more coherence to the schema.

Advantages

Scalability: {1, 4, 5}

Storage efficiency: {1, 2}

Less redundancy: {1, 3, 5}

Query readability: {1, 3, 5}

Reproducibility: {3, 5}

Fast computation: {1, 2, 4, 5}

Data integrity: {1, 2, 6}

Examples of optimized queries

Query 4 - Non Optimized

```sql
SELECT
    v.make AS VehicleBrand,
    v.model AS VehicleModel,
    COUNT(DISTINCT v.reg) AS VehicleCount,
    COUNT(DISTINCT c.id) AS CrimeCount
FROM Vehicles v
JOIN Involved_in i ON v.id = i.vehicle_id
JOIN Crimes c ON i.crime_id = c.id
GROUP BY v.make, v.model
ORDER BY VehicleCount DESC;
```

Query 4 - Optimized

```sql
SELECT
    v.make AS VehicleBrand,
    v.model AS VehicleModel,
    COUNT(DISTINCT v.reg) AS VehicleCount,
    COUNT(DISTINCT v.crime_id) AS CrimeCount
FROM Vehicles v
GROUP BY v.make, v.model
ORDER BY VehicleCount DESC;
```

Query 8 - Non Optimized

```sql
SELECT l.postcode AS Area,
       COUNT(DISTINCT c.id) AS TotalCrimes,
       COUNT(DISTINCT p.id) AS TotalPeople,
       COUNT(DISTINCT all_calls.call_id) AS TotalTraffic
FROM crimes AS c
LEFT JOIN occurred_at o ON o.crime_id = c.id
LEFT JOIN locations l ON o.location_id = l.id
JOIN current_address ca ON ca.location_id = l.id
JOIN people p ON p.id = ca.person_id
LEFT JOIN has_phone hp ON p.id = hp.person_id
LEFT JOIN (
    SELECT *
    FROM caller
    UNION
    SELECT *
    FROM called) AS all_calls ON hp.phone_id = all_calls.phone_id
GROUP BY l.postcode
ORDER BY TotalCrimes DESC, TotalTraffic DESC, TotalPeople DESC;
```

Query 8 - Optimized

```sql
SELECT
    l.postcode AS Area,
    COUNT(DISTINCT c.id) AS TotalCrimes,
    COUNT(DISTINCT p.id) AS TotalPeople,
    COUNT(DISTINCT CASE WHEN ph.id = pc_from.from_phone_id THEN pc_from.id ELSE
NULL END)
    + COUNT(DISTINCT CASE WHEN ph.id = pc_to.to_phone_id THEN pc_to.id ELSE NULL
END) AS TotalTraffic
FROM locations l
LEFT JOIN crimes c ON c.location_id = l.id
JOIN people p ON p.address_id = l.id
LEFT JOIN phones ph ON p.id = ph.owner_id
LEFT JOIN phonecalls pc_from ON ph.id = pc_from.from_phone_id
LEFT JOIN phonecalls pc_to ON ph.id = pc_to.to_phone_id
GROUP BY l.postcode
ORDER BY TotalCrimes DESC, TotalTraffic DESC, TotalPeople DESC;
```

Data analysis – Query 1

Task:

Find police officers linked to over 30 unique crime investigations, and list these officers' surnames, badge numbers, and ranks, sorting the results alphabetically by surname.

Interpretation:

The intent is to find the busiest officers (who have several cases to solve) and identify any causal relationships with their seniority, sorting the results by badge number.

surname	badge_no	rank
Bagby	00-6011813	Sergeant
Loveridge	01-0363085	Inspector
Lumsdaine	01-3764299	Police Constable
Reilinger	02-3468866	Sergeant
Chesnut	02-6192850	Police Constable
Fonte	03-1601856	Sergeant
Assard	03-2149839	Police Constable
Tams	03-5878006	Inspector
Aykroyd	03-6336692	Police Constable
Ellwell	03-6577521	Police Constable

Query complete: Original 2.769 seconds / Optimized 0.341 seconds

Data analysis – Query 2

Task:

Identify crime hotspots by postcode, aggregating the number of crimes.

postcode	crimecount
M1 1LU	166
M60 1TA	111
M60 9AH	48
M4 3AL	46
M1 3LZ	41
M90 2AY	38
WN7 5SJ	38
M4 2BS	36
M3 1DA	35
OL1 1QN	35

Interpretation:

By considering each area identified by a postcode, we pinpoint the most critical areas in terms of recorded criminal activity in the city, in order to then be able to propose an appropriate strategy for the deployment of anti-crime resources.

Query complete: Original 0.146 seconds / Optimized 0.101 seconds

Data analysis – Query 3

Task:

Analyze the evolution of crime types over different areas it calculates the absolute daily change in crime counts from one day to the next instead of growth rates.
This change measures the volatility without considering the direction of the change (increase or decrease).

area	avg_daily_change
M1 1LU	2.71
M60 1TA	1.87
M1 3EZ	1.4
WN7 5SJ	1.35
M1 3LZ	1.32
OL1 1QN	1.26
OL6 8RT	1.2
OL12 6TS	1.13
M60 9AH	1.08
M3 7JY	1

Interpretation:

By analyzing the volatility of the areas crime rate, we can identify areas for which we have a poor ability to predict criminal activity. Conversely, it is possible to analyze those areas for which the crime rate remains rather unchanged over time (whether low or high).

Query complete: Original 0.278 seconds / Optimized 0.244 seconds

Data analysis – Query 4

Task:

Find the usage frequency for each vehicle type for the "vehicle crimes".

Interpretation:

We try to establish greater control over those types of vehicles that are generally more involved in crimes, perhaps because they are of particular interest to thieves or because they are suitable for carrying out criminal tasks such as drug dealing or robbery.

vehiclebrand	vehiclemodel	vehiclecount	crimecount
Ford	Mustang	10	10
Pontiac	Bonneville	9	9
Volkswagen	Passat	8	8
Hyundai	Sonata	8	8
Ford	E-Series	7	7
Mercury	Grand Marquis	7	7
Ford	Expedition	7	7
Chrysler	Town & Country	7	7
Pontiac	Grand Prix	7	7
Nissan	Pathfinder	6	6

Query complete: Original 0.216 seconds / Optimized 0.125 seconds

Data analysis – Query 5

Task:

For each type of crime type evaluate the standard deviation of the distance between the locations of the related crimes in order to understand if crimes are pretty concentrated or spread out in different areas of the city. Also report the total number of areas involved in each type of crime.

Interpretation:

For each type of crime, it may be interesting to understand how uniformly the number of crimes is distributed over the urban area. We also report the number of areas involved so that the geographical extent (in terms of square footage) can be normalised by the number of areas over which it is defined.

crimetype	centroidlatitude	centroidlongitude	stdlatitude_km	stdlongitude_km	differentarea
Violence and sexual offences	53.50694	-2.27424	7.03	16.66	5515
Public order	53.50586	-2.27196	6.75	15.66	3427
Criminal damage and arson	53.50518	-2.27893	7.04	17.04	2864
Burglary	53.50044	-2.27709	7.47	17.31	2404
Vehicle crime	53.49939	-2.28067	7	17.19	2200
Other theft	53.50037	-2.27841	7	16.36	1694
Shoplifting	53.502	-2.27594	7.23	16.41	641
Other crime	53.5132	-2.29014	6.54	17.57	578
Robbery	53.48915	-2.2455	5.96	12.34	447
Bicycle theft	53.4787	-2.25895	6.11	12.43	355

Query complete: Original 0.363 seconds / Optimized 0.312 seconds

Data analysis – Query 6

Task:

Identify people that possibly had crime related phone calls.
This query, for a specific query crime, returns people that have had (as a caller or a called) a lot of calls with people that do not belong to their family (order by "*No_fam_calls*" counter), in the period of 10 days before the crime and that live in the same area (“*post_code*”) where the crime occurred.

Interpretation:

For a specific crime, we report a forensic analysis of the telephone traffic for people geographically linked to the crime.
In particular, we focus on calls in the days preceding the crime, made between individuals not belonging to the same family.

person	nhs_number	phone_number	no_fam_calls
Phillip Perry	884-33-9676	0-(106)592-7420	4
Deborah Ford	838-45-9343	5-(607)134-1574	3
Harry Lopez	915-75-5600	1-(776)710-5989	2
Jonathan Hunt	298-36-6290	2-(527)185-1019	2
Peter Bryant	245-63-7539	6-(184)813-2011	1

Query complete: Original 0.108 seconds

Data analysis – Query 7

Task:

For each officer, return the number of cases to which it has been assigned which last_outcome="Under investigation" as "Num_unresolved", and the most frequent type of crime to which it has been assigned. Order the result by "Num_unresolved“.

Interpretation:

When considering the assignment of new cases, it may be useful to analyze the officers by number of unsolved cases currently assigned and 'area of specialisation' (i.e. the most frequent type of crime they have worked on).

officerbadge	officerspecialization	totalnumunresolved
55-5623906	Violence and sexual offences	11
21-8583779	Violence and sexual offences	10
60-2236534	Violence and sexual offences	10
09-6971653	Violence and sexual offences	10
90-5774272	Violence and sexual offences	10
30-4157186	Violence and sexual offences	9
21-9479736	Violence and sexual offences	9
32-8274663	Violence and sexual offences	9
21-3341439	Violence and sexual offences	9
48-0216838	Violence and sexual offences	9

Query complete: Original 0.158 seconds / Optimized 0.129 seconds

Data analysis – Query 8

Task:

For a given query date, return the total number of crimes occurred on that day for each area (post_code), the total number of people living in each area end the total number of calls made by the inhabitants on that day.

Interpretation:

For each day in each area, we find patterns between crime levels, population density of the area and telephone traffic between inhabitants of the area.

area	totalcrimes	totalpeople	totaltraffic
M12 4GJ	9	2	0
BL1 1LE	8	1	4
SK5 8BZ	6	3	18
SK1 4HU	6	1	8
SK3 9EU	6	1	8
BL3 5NJ	6	2	4
OL8 2RB	6	1	0
BL6 6RL	5	1	8
M4 7EU	5	2	4
M8 8YT	5	2	4

Query complete: Original 0.135 seconds / Optimized 0.116 seconds

Data analysis – Query 9

Task:

For each Crime Type return the most common outcome, its frequency, the total number of cases and the percentage of the most common outcome over all the total cases.

Interpretation:

It might be interesting to analyze the legal outcome for each type of crime in order to identify any bias in the legal system itself.

crimetype	mostcommonoutcome	frequency	totalcases	percentage
Violence and sexual offences	Unable to prosecute suspect	3263	8765	37.23
Public order	Investigation complete; no suspect identified	2773	4839	57.31
Criminal damage and arson	Investigation complete; no suspect identified	2681	3587	74.74
Burglary	Investigation complete; no suspect identified	2468	2807	87.92
Vehicle crime	Investigation complete; no suspect identified	2388	2598	91.92
Other theft	Investigation complete; no suspect identified	1693	2140	79.11
Shoplifting	Investigation complete; no suspect identified	873	1427	61.18
Other crime	Investigation complete; no suspect identified	275	651	42.24

Query complete: Original 0.100 seconds / Optimized 0.085 seconds

Data analysis – Query 10

Task:

This query aggregates phone communication data for individuals, calculating metrics like the number of distinct phones per person, total and average call durations, total different calls, and the number of unique call days.

Interpretation:

The intent is to provide support to law enforcement agencies in analyzing telephone traffic for each individual, reporting on key factors such as the distribution of telephone traffic.

personid	numdistinctphones	totalcalltime	avgcallduration	totcalls	distinctcalldate
2	1	190	47.5	4	3
9	1	182	91	2	2
13	1	168	84	2	2
16	1	234	58.5	4	4
20	1	132	66	2	2
27	1	98	49	2	2
35	1	116	58	2	2
39	1	272	68	4	4
43	1	158	79	2	2
47	1	250	62.5	4	4

Query complete: Original 0.128 seconds

Thanks!

Enrico Grimaldi - 1884443

Engrima18

Mario Edoardo Pandolfo - 1835189

JRhin

Check-out our code!