Criminal Record Management System

Relational Database Model

Copyright
Atacan Demiralp

May 2018

ABSTRACT

Crime is one of the most significant problems, keeping evolving, all around the world. Crime can be controlled by understanding the reason behind it. In order to do that, crime should be well-recorded, analyzed, and ended up with effective solutions in terms of the analysis output. In this study, a relational database design for criminal record management system is presented in order to store crime information to be analyzed.

1. INTRODUCTION

Criminal Record Management System is a web software which provides service for reporting crimes, cases, criminals, and related details to help the national security units, such as Police. It is designed to

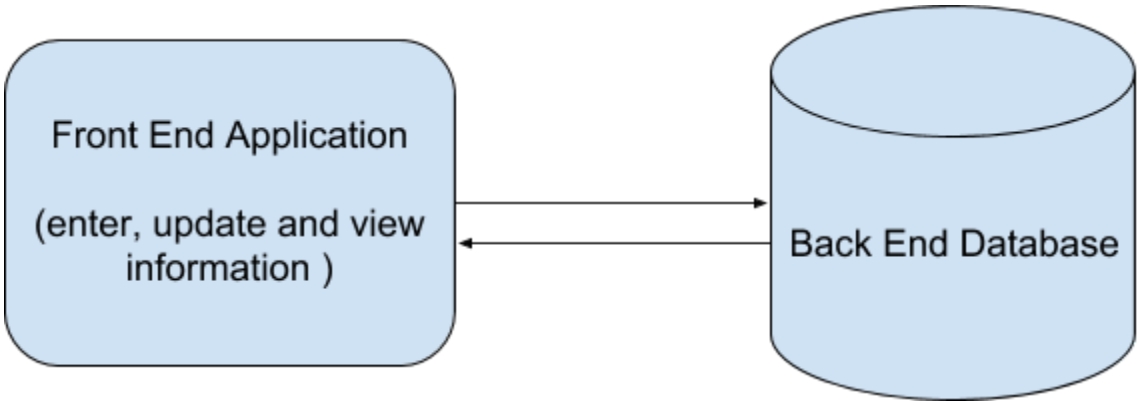
- Provide a crime management tool easily accessible by everybody online
- Support crime analysis
- Save time and man-power by entering information online
- Minimize paperwork
- Ensure data accuracy
- Provide security and backup

Police can add information into the system when there exists a First Information Report for a crime. Police start investigation after they write the report. As they learn and gather more information about the crime, they can add more into the system. It can be used for storing both past crimes with loads of information or new crimes with less information. So, it also provides flexibility.

The software works as client-server model. User (client) who has privilege to access the server, can view the information already stored, add new information, and update the information according to the privilege level. The server side contains the database which is the all information about crime. This study covers how to model the relational database to be communicated with the software. The client-side implementation, UI design, and server-side implementation are not covered. The overall aim is to prototype the relational database system.

2. IT SYSTEM OVERVIEW

Client-Server Model:



User Interface:

A login page to access to the server

A search page which allows searches by FIR no, case no, and criminal name

Enter, modify, and view options for users

One quick report button to report everything about a case

Responsive interface design

Hardware:

Computers, smartphones, tablets

Software:

Any browser, also ported as mobile apps for IOS and Android

SQL Server 2017 for database

3. ENTITIES & ATTRIBUTES

Entities:

- **Case:** The issue to be investigated by the police, and resolved by the court
- **Crime:** The offense to be punished by law
- **Victim:** The person harmed, injured, or killed as a result of a crime
- **Accused:** The person who is charged with crime
- **Wanted:** The accused, wanted by police

- **Petitioner:** The person who complaints under the jurisdiction of police
- **FIR:** First Information Report, written by the police after they gather information from the petitioner about the criminal case
- **Investigation Officer:** The police officer who makes investigation on the case

Attributes:

Case:

- **Case ID:** Each case has a unique case ID
- **Crime ID:** Which crime is about (as foreign key)
- **Law Number:** To learn more about the case from the public law records system
- **Status:** To see if a case is open or closed
- **Detail:** The detail to be written
- **Investigation Officer:** The ID of the officer who makes investigation

Crime:

- **Crime ID:** Unique crime ID for each occurence
- **FIR No:** Which FIR is about (as foreign key)
- **Crime Name:** The classified name of crime
- **Crime Type:** The classified type of crime
- **Time Occurred:** What time crime has occurred
- **Date Occurred:** When crime has occured
- **District:** State or district name where crime has occured
- **City:** City name where crime has occured
- **Street Name:** Street name where crime has occured
- **Latitude:** North-south geographic coordinate of crime
- **Longitude:** East-west geographic coordinate of crime

Victim:

- **Victim ID:** Number for each victim to be identified uniquely.
- **FIR No:** FIR number of the report which is about victim (as foreign key)
- **NID:** National identity number of victim
- **First Name:** First name of a victim
- **Middle Name:** Middle name of victim
- **Last Name:** Last name of victim
- **Sex:** Gender of victim
- **Birth Date:** Date of birth information of victim
- **Nationality:** Nationality of victim
- **Race:** Race of victim
- **Education:** Education level of victim
- **Occupation:** Profession of victim

Accused:

- **Accused ID:** Unique number for each accused
- **FIR No:** FIR number of the report which is about accused (as foreign key)
- **NID:** National identity number of accused
- **First Name:** First name of accused

- **Middle Name:** Middle name of accused
- **Last Name:** Last name of accused
- **Sex:** Gender of accused
- **Birth Date:** Date of birth information of accused
- **Nationality:** Nationality of accused
- **Race:** Race of accused
- **Occupation:** Profession of accused
- **Education:** Education level of accused
- **Status:** The status of accused (wanted, under custody, arrested, escaped, bailed, released)

Wanted:

- **Wanted ID:** Unique number for wanted in the list
- **Alias:** Nickname of wanted
- **Height:** Height of wanted
- **Race:** Racial information of wanted
- **Eye Color:** Eye color of wanted
- **Scar:** Any scar visible on the body of wanted
- **Tattoo:** Any tattoo visible on the body of wanted
- **Most Wanted:** If the wanted is in the most wanted list
- **Detail:** Any other details about wanted

Petitioner:

Anybody who knows about the crime, saws the offence, and wants to report it to the police can be petitioner. It does not have to be victim itself.

- **NID:** National identity number of petitioner
- **First Name:** First name of petitioner
- **Middle Name:** Second name of petitioner
- **Last Name:** Last name of petitioner
- **Street Name:** Street name of address of petitioner
- **Apartment No:** Apartment number of address of petitioner
- **Door No:** Door number of address of petitioner
- **City:** City in where petitioner lives
- **District:** District in where petitioner lives
- **Contact No:** Mobile contact number of petitioner

FIR:

- **FIR No:** Unique ID for each FIR
- **Petitioner NID:** National ID number of the petitioner
- **Date Reported:** When the FIR has written
- **Time Reported:** What time the FIR has written
- **Detail:** Incident details

Investigation Officer:

- **Officer ID:** Unique ID number of the officer
- **First Name:** First name of the officer
- **Second Name:** Second name of the officer

- **Last Name:** Last name of the officer
- **Rank:** Rank of the officer

4. RELATIONSHIPS BETWEEN ENTITIES

FIR - Petitioner:

- FIR is filed by petitioner.
- One FIR has to be filed by one and only one petitioner. Unknown petitioner is not acceptable to file the report. So, one petitioner is necessary for an FIR.
- One FIR is necessary to record crime and start investigation.
- One petitioner can file more than one FIRs.
- There is **mandatory one to mandatory many** relationship between FIR and petitioner.

FIR - Victim:

- FIR is filed for suffered victim.
- There can be one or many victims for one FIR. One victim is necessary for an FIR.
- A victim can be suffered from multiple incidents of different FIRs.
- A victim has to have a necessary FIR.
- There is **mandatory many to mandatory many** relationship between FIR and victim.

FIR - Accused:

- FIR is filed against accused.
- One FIR can point more than one accused.
- More than one FIRs can point one accused, and one accused is always pointed by at least one FIR.
- There is **mandatory many to mandatory many** relationship between FIR and accused.

FIR - Crime:

- FIR is filed because of an incident or crime.
- One FIR can include necessarily at least one crime.
- One crime can be pointed by one and only one FIR.
- There is **mandatory one to mandatory many** relationship between FIR and crime.

FIR - Case:

- After FIR is written, case begins to be investigated.
- Police decides whether and incident is investigated. An incident might be not serious enough to be investigated. The complaint might not be against law.
- If an incident worths to be investigated, then police opens investigation case.
- There is **mandatory one to optional one** relationship between FIR and case.

Case - Investigation Officer:

- One case is investigated by one and only one investigation officer.
- An investigation officer can make investigation on more than one cases.
- An investigation officer has to make at least one investigation.
- There is **mandatory one to mandatory many** relationship between case and investigation officer.

Accused - Wanted:

- Wanted is always an accused.
- An accused may not be wanted.
- There is **mandatory one to optional one** relationship between accused and wanted.

5. SET OF ENTITY OBJECTS

*Primary Key= Green, Foreign Key= Red

** Real objects (R) , abstract objects (A)

No	Name of the object	Notation	Attribute Content
1	First Information Report (R)	FIR	FIR_No INT NID INT Date_Reported DATE Time_Reported TIME Detail VARCHAR(200)
2	Petitioner (R)	PET	NID INT First_Name VARCHAR(45) Middle_Name VARCHAR(45) Last_Name VARCHAR(45) Street_Name VARCHAR(45) Apartment_No INT Door_No INT City VARCHAR(45) District VARCHAR(45) Contact_No VARCHAR(45)
3	Victim (R)	VIC	Victim_ID INT NID INT First_Name VARCHAR(45) Middle_Name VARCHAR(45) Last_Name VARCHAR(45) Sex CHAR Birth_Date DATE Nationality VARCHAR(45) Race VARCHAR(45) Education VARCHAR(45) Occupation VARCHAR(45)
4	Accused (R)	ACC	Accused_ID INT NID INT First_Name VARCHAR(45) Middle_Name VARCHAR(45) Last_Name VARCHAR(45)

			Sex CHAR Birth_Date DATE Nationality VARCHAR(45) Race VARCHAR(45) Education VARCHAR(45) Occupation VARCHAR(45) Status VARCHAR(45)
5	Crime (A)	CRI	Crime_ID INT FIR_No INT Crime_Name VARCHAR(45) Crime_Type VARCHAR(45) Date_Occured DATE Time_Occured TIME Street_Name VARCHAR(45) City VARCHAR(45) District VARCHAR(45) Latitude FLOAT Longitude FLOAT
6	Case (R)	CAS	Case_ID INT Officer_ID INT FIR_No INT Law_No INT Status VARCHAR(45) Detail VARCHAR(200)
7	Investigation Officer (R)	OFF	Officer_ID INT First_Name VARCHAR(45) Middle_Name VARCHAR(45) Last_Name VARCHAR(45) Rank VARCHAR(45)
8	Wanted (A)	WAN	Wanted_ID INT Height INT Eye_Color VARCHAR(45) Race VARCHAR(45) Scar VARCHAR(45) Tattoo VARCHAR(45) Alias VARCHAR(45) Most_Wanted BINARY Detail VARCHAR(200)
9	Commits (A)	COM	Accused_ID INT FIR_NO INT
10	Contains (A)	CON	Victim_ID INT FIR_NO INT

6. IDENTIFICATION TYPES OF REAL RELATIONSHIPS BETWEEN ENTITY OBJECTS

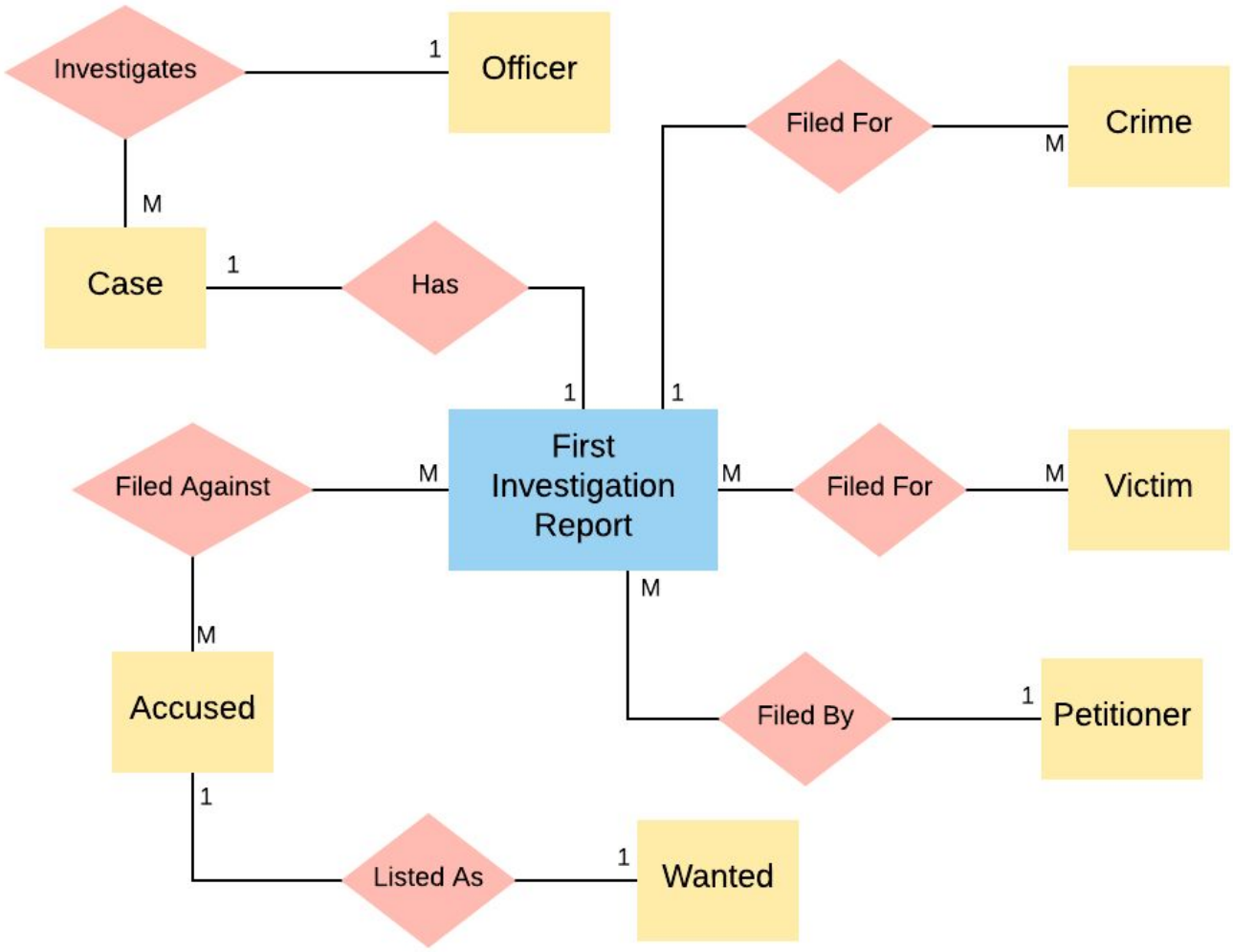
Table 1: The matrix of real relationships before eliminating the relation **M:M**

	FIR	PET	VIC	ACC	CRI	CAS	OFF	WAN
FIR		M:1	M:M	M:M	1:M	1:1		
PET	1:M							
VIC	M:M							
ACC	M:M							1:1
CRI	M:1							
CAS	1:1						M:1	
OFF						1:M		
WAN				1:1				

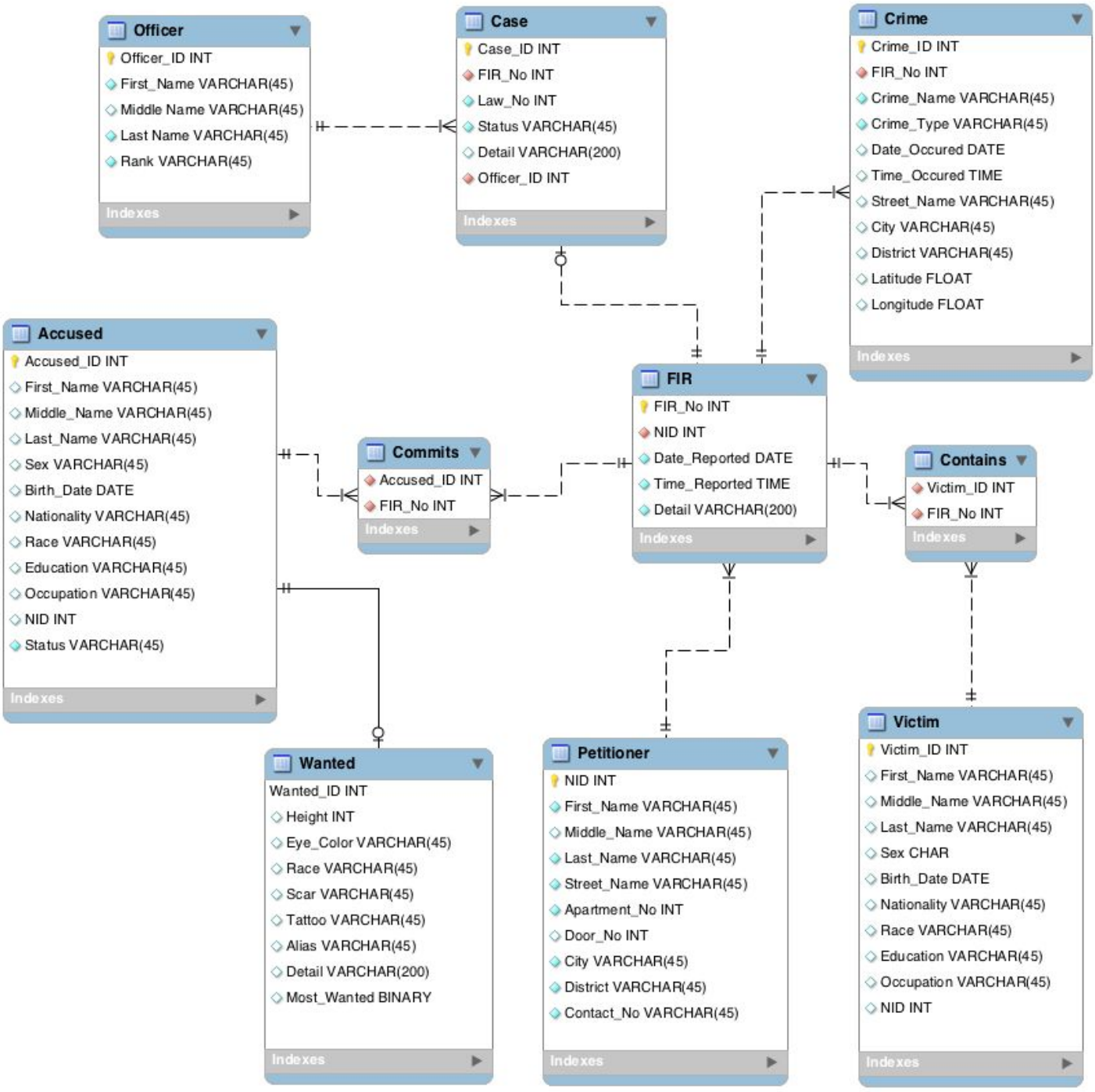
Table 2: The matrix of real relationships after eliminating the relation **M:M**

	FIR	PET	VIC	ACC	CRI	CAS	OFF	WAN	COM	CON
FIR		M:1	-	-	1:M	1:1			1:M	1:M
PET	1:M									
VIC	-									1:M
ACC	-							1:1	1:M	
CRI	M:1									
CAS	1:1						M:1			
OFF						1:M				
WAN				1:1						
COM	M:1			M:1						
CON	M:1		M:1							

7. CONCEPTUAL DATA MODEL



8. PHYSICAL DATA MODEL (EER DIAGRAM)



9. FUNCTIONAL DEPENDENCIES

- Table Name: FIR

FIR_No	NID	Date_Reported	Time_Reported	Detail
1	948364287	12.05.2018	12:11	Unidentified victim...
2	258127581	12.05.2018	12:12	15 year-old boy attemp.
3	258127581	17.05.2018	15:18	Bank robbery in town...

FIR_No ⟶ {NID, Date_Reported, Time_Reported, Detail}

Normal Form: 3rd NF

- Table Name: Petitioner

NID	19283746	39753892	19648598
First_Name	John	John	John
Middle_Name	Jonah	Jonah	-
Last_Name	Jameson	Jameson	Wick
Street_Name	Santander	Arkward's	Blazer
Apartment_No	14	77	13
Door_No	1	53	6
City	Little Rock	Indianapolis	Indianapolis
District	Arkansas	Indiana	Indiana
Contact_No	798123421	92843751	93478512

NID ⟶ {First_Name, Middle_Name, Last_Name, Street_Name, Apartment_No, Door_No, City, District, Contact_No}

Normal Form: 3rd NF

- Table Name: Victim

Victim_ID	1	2	3
NID	39753892	39753892	19648598
First_Name	John	John	Tsubasa
Middle_Name	Jonah	Jonah	-
Last_Name	Jameson	Jameson	Ozora
Sex	E	E	E
Birth_Date	19.01.1982	19.01.1982	22.02.1988
Nationality	USA	USA	Japan
Race	Hispanic	Hispanic	Asian
Education	Masters	Masters	High School
Occupation	Unemployed	Unemployed	Football Player

Victim_ID is not same as the NID. One person can be victim in several times and cannot take the same Victim_ID twice or more. Victim_ID is generated while a FIR is reported.

Victim_ID ⟶ {NID, First_Name, Middle_Name, Last_Name, Sex, Birth_Date, Nationality, Race, Education, Occupation}

Normal Form: 3rd NF

- Table Name: Accused

Accused_ID	1	2	3
NID	39753892	39753892	19648598
First_Name	John	John	Tsubasa
Middle_Name	Jonah	Jonah	-
Last_Name	Jameson	Jameson	Ozora
Sex	E	E	E
Birth_Date	19.01.1982	19.01.1982	22.02.1988
Nationality	USA	USA	Japan
Race	Hispanic	Hispanic	Asian

Education	Masters	Masters	High School
Occupation	Unemployed	Unemployed	Football Player
Status	Arrested	Arrested	Released

Accused_ID is not same as the NID. One person can be accused in several times and cannot take the same Accued_ID twice or more. Accused_ID is generated while a FIR is reported.

Accused_ID ⟶ {NID, First_Name, Middle_Name, Last_Name, Sex, Birth_Date, Nationality, Race, Education, Occupation, Status}

Normal Form: 3rd NF

- Table Name: Crime

Crime_ID	1	2	3
FIR_No	112233	112233	54353
Crime_Name	Burglary	Vandalism	Illegal Drug Trade
Crime_Type	Property Crime	Property Crime	Victimless Crime
Date_Occured	21.10.2015	21.10.2015	15.05.2016
Time_Occured	22:00	22:00	17:45
Street_Name	Jordanway	Jordanway	Nowadays
City	Chicago	Chicago	Greenville
District	Illinois	Illinois	Alabama
Latitude	41.881832	41.881832	-
Longitude	-87.623177	-87.623177	-

Crime_ID ⟶ {FIR_No, Crime_Name, Crime_Type, Date_Occured, Time_Occured, Street_Name, City, District, Latitude, Longitude}

Normal Form: 3rd NF

- Table Name: Case

Case_ID	Officer_ID	FIR_No	Law_No	Status	Detail
1	101	11223344	1567	Open	Not enough proof
2	101	5325615	6356	Open	Another case will...

3	66	2134515	24356	Closed	The longest case...

Case_ID ⟶ {Officer_ID, FIR_No, Law_No, Status, Detail}

{Officer_ID, Law_No} ⟶ {Case_ID, FIR_No, Status, Detail}

Normal Form: 3rd NF

- Table Name: Officer

Officer_ID	First_Name	Middle_Name	Last_Name	Rank
1	Carey	-	Mahoney	Officer
2	Moses	-	Hightower	Officer
3	James	-	Gordon	Detective

Officer_ID ⟶ {First_Name, Middle_Name, Last_Name, Rank}

Normal Form: 3rd NF

- Table Name: Wanted

Wanted_ID	1	2	3
Height	201	179	189
Eye_Color	Brown	Brown	Green
Race	Latino	Asian	Latino
Scar	-	Left Eye	Chin
Tattoo	Wings on back	Cross on chest	-
Alias	Bird	Vampire	Blub
Most_Wanted	1	1	0
Detail	Last seen in 5th of June	Likes gambling	Has 3 bulldogs

Wanted_ID ⟶ {Height, Eye_Color, Race, Scar, Tattoo, Alias, Most_Wanted, Detail}

Normal Form: 3rd NF

Intermediary Tables

- Table Name: Contains
- Intermediary table between to solve M:M relation between FIR - Victim.

FIR_No	Victim_No
11223344	9876
11223344	268482
5367	268482

Compound Key: {FIR_No, Victim_No}

{FIR_No, Victim_No} ⟶ {FIR_No, Victim_No}

Normal Form: 3rd NF

- Table Name: Commits
- Intermediary table between to solve M:M relation between FIR - Accused.

FIR_No	Accused_ID
11223344	4432
11223344	82
5367	82

Compound Key: {FIR_No, Accused_ID}

{FIR_No, Accused_ID} ⟶ {FIR_No, Accused_ID}

Normal Form: 3rd NF

About “Detail” Columns

Although the “Detail” columns do not contain a single value and technically violate the normal forms, it is important to store data as comments in this specific domain area. It is assumed that the Detail columns are atomic and exist only to give additional information. The columns can be removed in order to get rid of normalization violation, however it is not realistic. Police need information also as comment which are single value as a whole information.

10. DATA DEFINITION LANGUAGE (DDL)

DDL consists of the statements used to Create, Alter, and Drop database objects.

Create Database:

```
CREATE DATABASE CrimeRecords;
```

Drop Database

```
DROP DATABASE CrimeRecords;
```

Create Table

```
CREATE TABLE FIR(
      FIR_NO INT,
      Date_Reported DATE
      Time_Reported TIME
      Detail VARCHAR(200));
```

Alter Table

```
ALTER TABLE Petitioner(
      DROP District VARCHAR(45),
      ADD State VARCHAR(45));
```

Drop Table

```
DROP TABLE Petitioner
```

Truncate Table

```
TRUNCATE TABLE FIR
```

(TRUNCATE TABLE statement removes all rows from a table.)

11. DATA MODIFICATION LANGUAGE (DML)

DML consists of the statements used to Retrieve, Insert, Update, and Remove data within DB objects.

Retrieve

```
SELECT First_Name, Last_Name, Contact_No
FROM Petitioner
```

Insert

```
INSERT INTO Case (FIR_No, Law_No, Status, Officer_ID)
VALUES (111847, 1746345, 'Open', 1010)
```

Update

```
UPDATE Victim
SET Sex='E', Birt_Date= '12-09-1987', Race= 'Asian', NID= 110680282
WHERE Victim_ID= 20024
```

Delete

```
DELETE FROM Accused
WHERE NID= 10020045
```

12. TYPICAL QUERIES

Print the full names and wanted IDs of the most wanteds.

```
SELECT A.First_Name, A.Middle_Name, A.Last_Name, W.Wanted_ID
FROM Wanted W
JOIN Accused A ON A.Accused_ID = W.Accused_ID
WHERE W.Most_Wanted = 1
```

Print the national identity numbers and number of filed FIRs of petitioners who have filed more than 1 FIR in 2015.

```
SELECT P.NID, Count (F.FIR_No)

FROM Petitioner P

JOIN FIR F ON F.NID = P.NID

WHERE YEAR(F.Date_Reported) = 2015

GROUP BY P.NID

HAVING Count (F.FIR_No) > 1
```

Print all the property crimes investigated by officer Carey Mahoney.

```
SELECT *

FROM Crime C

JOIN FIR F ON F.FIR_No = C.FIR_No

JOIN Case CA ON CA.FIR_No = F.FIR_No

JOIN Officer OF ON OF.Officer_ID = CA.Officer_ID

WHERE C.Crime_Type = “Property Crime” AND OF.First_Name = “Carey” AND
OF.Last_Name = ‘Mahoney’
```

Print the education information of accused ones who have been arrested for burglary.

```
SELECT A.Education

FROM Accused A

JOIN Commits Co ON Co.Accused_ID = A.Accused_ID

JOIN FIR F ON F.FIR_No = Co.FIR_No

JOIN Crime CR ON CR.FIR_No = F.FIR_No

WHERE CR.Crime_Name = “Burglary” AND A.Status = “Arrested”
```

Print the number of crimes, grouped by crime type since 2015.

```
SELECT CR.Crime_Type, Count(CR.Crime_ID)

FROM Crime CR

WHERE CR.Date_Occured > ‘01.01.2015’
```

```
GROUP BY CR.Crime_Type
```

Print the top 10 accused who have committed more crimes than last year.

```
WITH Table2018 AS (

	SELECT TOP 10 A.Accused_ID, A.First_Name, A.Middle_Name, A.Last_Name,
	COUNT(CR.Crime_ID) AS CrimeNum2018

	FROM Accused A

	JOIN Commits Co ON Co.Accused_ID = A.Accused_ID

	JOIN FIR F ON F.FIR_No = Co.FIR_No

	JOIN Crime CR ON CR.FIR_No = F.FIR_No

	WHERE YEAR(CR.Date_Occured) = 2018

	GROUP BY A.Accused_ID, A.First_Name, A.Middle_Name, A.Last_Name

	ORDER BY CrimeNum2018 DESC),

Table2017 AS (

	SELECT TOP 10 A.Accused_ID, A.First_Name, A.Middle_Name, A.Last_Name,
	COUNT(CR.Crime_ID) AS CrimeNum2017

	FROM Accused A

	JOIN Commits Co ON Co.Accused_ID = A.Accused_ID

	JOIN FIR F ON F.FIR_No = Co.FIR_No

	JOIN Crime CR ON CR.FIR_No = F.FIR_No

	WHERE YEAR(CR.Date_Occured) = 2017

	GROUP BY A.Accused_ID, A.First_Name, A.Middle_Name, A.Last_Name)

SELECT *

FROM Table2018

WHERE CrimeNum2018 > (SELECT COUNT(CrimeNum2017) FROM Table2017)
```

13. SIZE OF THE DATABASE

INT: 4 Bytes DATE: 3 Bytes TIME: 4 Bytes VARCHAR(n): n Bytes

Table Petitioner: 327 Bytes

Table FIR: 208 Bytes

Table Victim: 327 Bytes

Table Accused: 372 Bytes

Table Wanted: 434 Bytes

Table Crime: 244 Bytes

Table Case: 253 Bytes

Table Officer: 184 Bytes

In a district with average 800.000 population, the expected crime number is 5000 to 10.000 in a year. Each crime has minimum 1 FIR, 1 Accused, 1 Victim, 1 Petitioner, 1 Case, and 1 Officer.

1 crime =~ 6 tables =~ 57 columns

1 crime =~ 1915 Bytes

100 crime =~ 1 wanted =~ 9 columns =~ 191934 Bytes =~ 187 KB

5000 crime x index factor x overhead factor = 187 x 50 x 2 x 1.2 = 22440 KB =~ 21 MB

10000 crime x index factor x overhead factor = 187 x 100 x 2 x 1.2 = 22440 KB =~ 42 MB

Additional approximate records for 1:M relations =~ 10 - 20 MB

Total =~ 30 MB - 60 MB

In a country with average 10 Millions population, the expected crime number is 50.000 to 100.000 in a year.

Total =~ 300 MB - 600 MB

In 3 years, the expected database size for a country with average 10 Millions population is 900 MB - 1.8 GB.

14. CONCLUSION

The relational model is a good choice for the domain, easy to implement and understand. The database holds huge amount of data. It is normalized by transforming M:M relations into 1:M and adding additional data objects. Data is meaningful and can be analyzed as more records are added and the database grows. It can show us,

How many crimes in total in a city, district or the whole country,

What the general profile of the criminals is in terms of age, occupation, and education,

What should be considered first in order to prevent crimes from happening,

What the major crime types and names are,

How many FIRs in average are reported in a month,

How many crimes in average are committed by one accused,

How the growth of number of crimes month by month and year by year,

Whether the solutions to decrease the number of crimes are effective according to the analysis.