LAW ENFORCEMENT PATROL ALLOCATION: OPTIMIZATION MODEL

DA350 - Final Project Presentation

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01

BACKGROUND

Inspired by real-life challenge about ongoing issue of crime in Los Angeles

WHOA

"Everyone in this city - in every corner of the city, regardless of where you live or your background - is afraid to walk out their doors." - Rick Caruso (candidate for LA mayor)

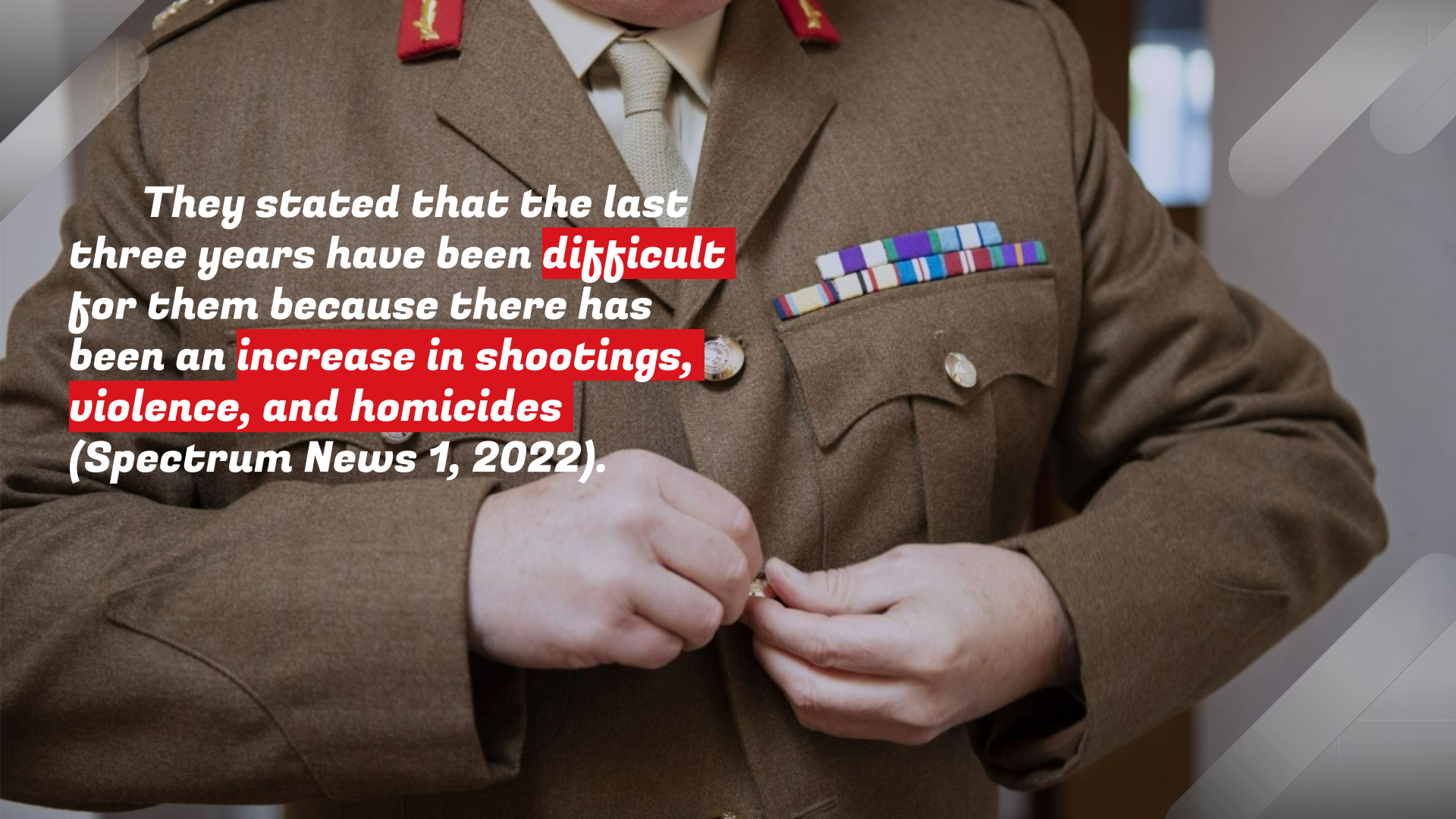
“Up 30% homicides from 2020”

206 homicides in 2022

“Up 43% shooting victims from 2020”

779 shooting victims in 2022

Los Angeles Police Department


They stated that the last three years have been difficult for them because there has been an increase in shootings, violence, and homicides (Spectrum News 1, 2022).

INTRODUCTION

Given the complexities of factors influencing crime rates, it is critical to take a systematic and data-driven approach to better allocate police officers that considers multiple factors, such as crime rates, geography distribution, and available resources. Our objective is to create an optimization model that maximizes the impact of police officers in reducing criminal activities.

02 DATA SOURCES

CRIME DATA IN LOS ANGELES 2020-PRESENT

"Data.gov is the United States government's open data website. It provides access to datasets published by agencies across the federal government."

Date Rptd	DATE OCC	TIME OCC	AREA	AREA NAME	Rpt Dist No	Part 1-2	Crm Cd	Crm Cd Desc
01/08/2020 12:00:00 AM	01/08/2020 12:00:00 AM	2230	3	Southwest	377	2	624	BATTERY - SIMPLE ASSAULT
01/02/2020 12:00:00 AM	01/01/2020 12:00:00 AM	330	1	Central	163	2	624	BATTERY - SIMPLE ASSAULT
04/14/2020 12:00:00 AM	02/13/2020 12:00:00 AM	1200	1	Central	155	2	845	SEX OFFENDER REGISTRANT OUT OF COMPLIANCE
01/01/2020 12:00:00 AM	01/01/2020 12:00:00 AM	1730	15	N Hollywood	1543	2	745	VANDALISM - MISDEAMEANOR ($399 OR UNDER)
01/01/2020 12:00:00 AM	01/01/2020 12:00:00 AM	415	19	Mission	1998	2	740	VANDALISM - FELONY ($400 & OVER, ALL CHURCH VANDALISMS)
01/02/2020 12:00:00 AM	01/01/2020 12:00:00 AM	30	1	Central	163	1	121	RAPE, FORCIBLE
01/02/2020 12:00:00 AM	01/02/2020 12:00:00 AM	1315	1	Central	161	1	442	SHOPLIFTING - PETTY THEFT ($950 & UNDER)

This dataset contains crime reports transcribed from original crime reports that were typed on paper.

4 TYPES OF CRIMES

1

INFRACTION

Minor violations of law, the least serious

Examples:
Littering, speeding

2

MISDEMEANOR

Violations of the criminal code, mid-serious

Examples:
Shoplifting, simple assaults

3

WOBBLER

Violations that can be considered as misdemeanors or felonies

Examples:
Stalking, grand theft

4

FELONY

Violations of the criminal code, most serious

Examples:
Rape, homicide

ESTIMATED CRIMES WEIGHT

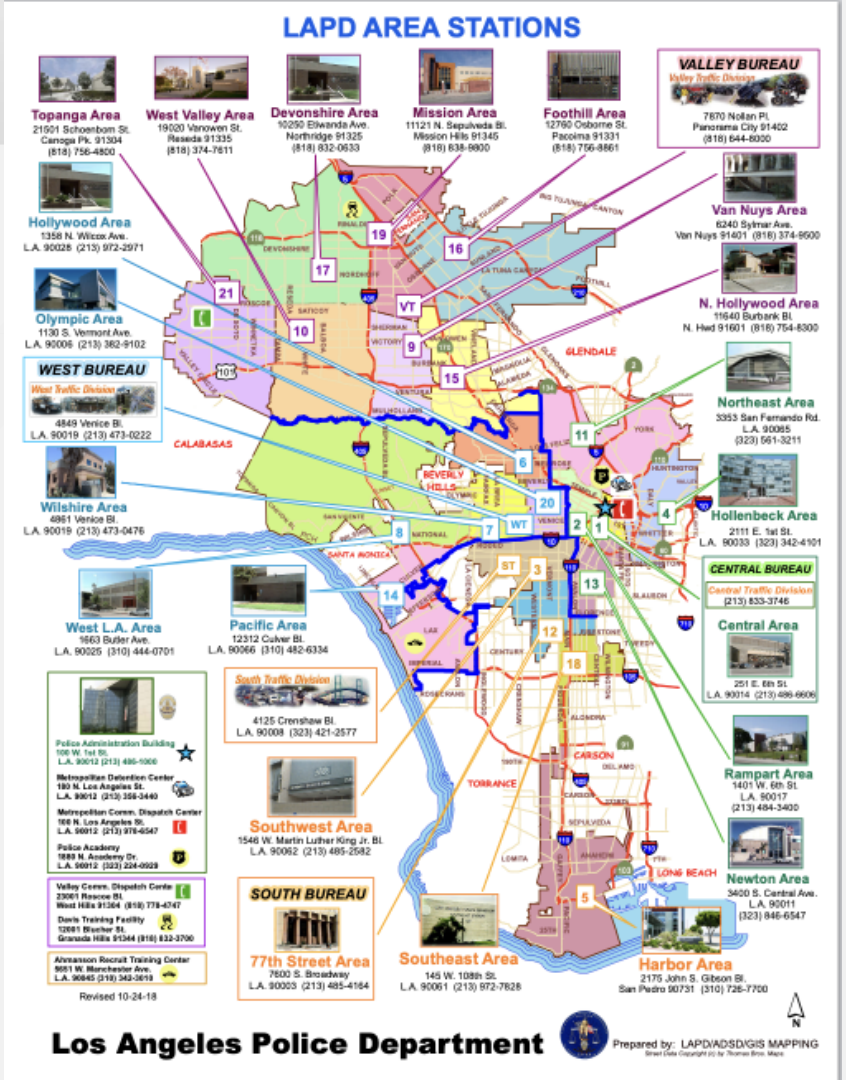
1 INFRACTION

2 MISDEMEANOR

3 WOBBLER

5 FELONY

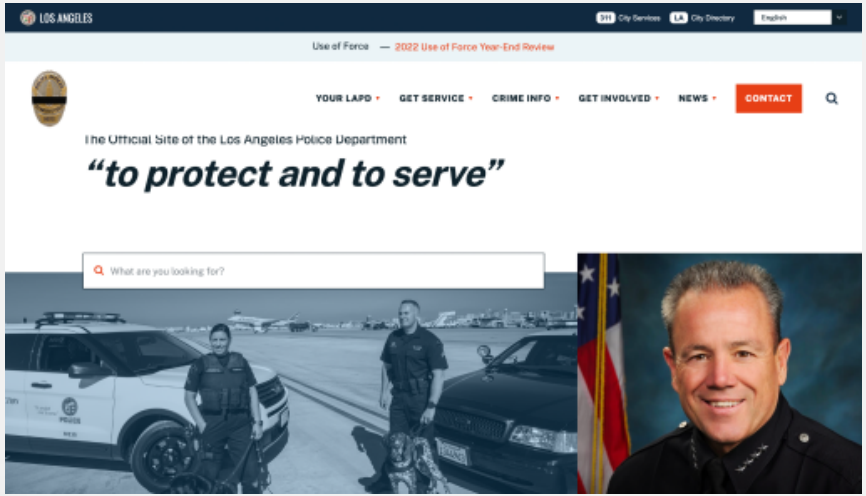
Estimated crimes weight: Infraction: 1 - Misdemeanor: 2 - Wobbler :3 - Felony: 5

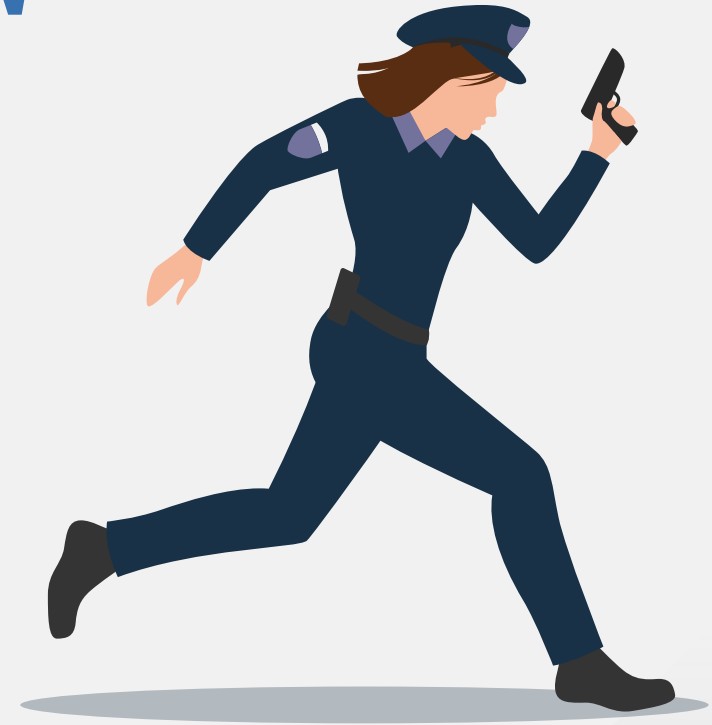


21 AREAS DIVISION OF POLICE STATIONS AND CRIME REPORT

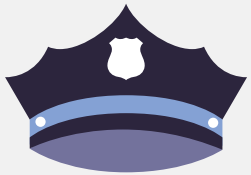
POLICE OFFICERS DATA IN LOS ANGELES

Los Angeles Police Department's website, https://www.lapdonline.org/



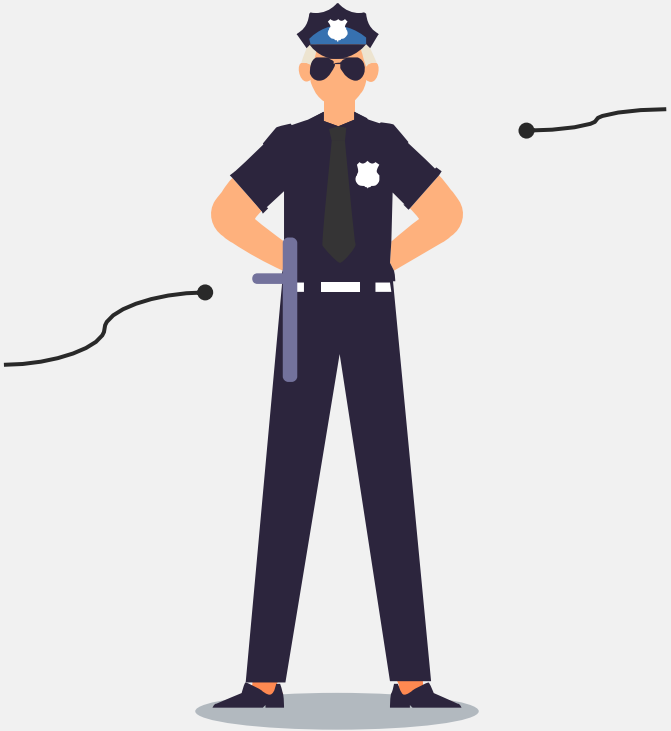


POLICE OFFICERS DATA IN LOS ANGELES



TOTAL NUMBER

According to Wikipedia about Los Angeles Police Department, there are a total of ~ 9000 police officers in Los Angeles



OFFICERS PER CAPITA RATE

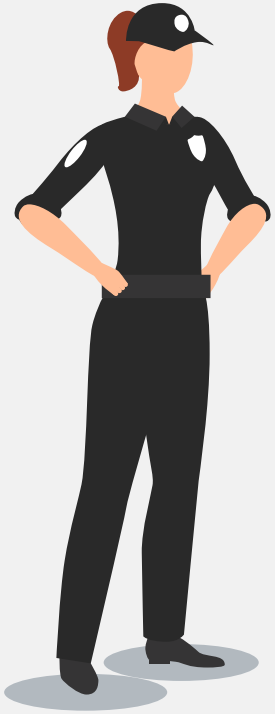
Nationwide, the average rate of police officers ranging from 1.8 to 2.6 per 1,000 inhabitants.

(ICMA, 2023. An analysis of police department staffing: How many officers do you really need?)

In LA, we calculated the average rate of police officers is ~ 2.1 per 1,000 inhabitants.

03

Model Decision Process



How to Calculate The Weight Crime Score

Define the weight of each crime

- Felony: 5
- Wobbler: 3
- Misdemeanor: 2
- Infraction: 1

Find the number of each crime

For each location, find the number of each crime: X_i

Sum of the crime number times weight

Weight Crime Score = X_f*5+ X_w*3+X_m*2+X_i

Data Used in the Model

01

P: Population

Number of population in each area

02

W: Weighted Crime Score

Crime score by each area

03

Max-officers: 9000

The maximum number of officers available in LAPD

04

Officer-rate: 1.8

Number of officers required per 1000 residents

Set up the model

Decision variable: The number of police officers assigned to each police division (integer).

x_i for $i \in$ D: D represents the list of 21 police divisions

Objective Value: Maximize the crime rate coverage of police officers by each divisions

$$\text{MAXIMIZE } \sum_{i=1}^{D} x_i \cdot \frac{W_i}{P_i}$$

Constraints

The total number of police officers in each area can not exceed the total number of police officers available

$$\sum_{i=1}^{D} x_i \leq 9000$$

The number of police officers in each division must be higher than the minimum required in that division.

$$x_i \geq 1.8 \cdot \frac{P_i}{1000} \text{ for } i \in D$$

How Police Officers are allocated

- Central area has the highest crime rate of 6.19 compared to other area with around 1.5 crime rate
- The model is not practical since the rest of police officers are allocated to Central area

Area Name	Number of Police Officers	Propotion of police per 1000 residents	Weight Crime Score per Police Officers
Central	1,514	37.85000	0.00611
Van Nuys	585	1.80000	0.00380
Hollywood	540	1.80000	0.00279
Wilshire	452	1.80080	0.00266
Northeast	450	1.80000	0.00285
West LA	411	1.80263	0.00246
Mission	407	1.80209	0.00284
N Hollywood	396	1.80000	0.00215
Devonshire	395	1.80253	0.00271
Topanga	370	1.80389	0.00255
Pacific	360	1.80000	0.00172
Hollenbeck	360	1.80000	0.00261
West Valley	355	1.80350	0.00230
Newton	338	1.80037	0.00180
Foothill	328	1.80008	0.00265
77th Street	315	1.80000	0.00129
Harbor	308	1.80117	0.00208
Southwest	297	1.80000	0.00150
Rampart	297	1.80043	0.00178
Southeast	270	1.80000	0.00140
Olympic	252	1.80000	0.00141

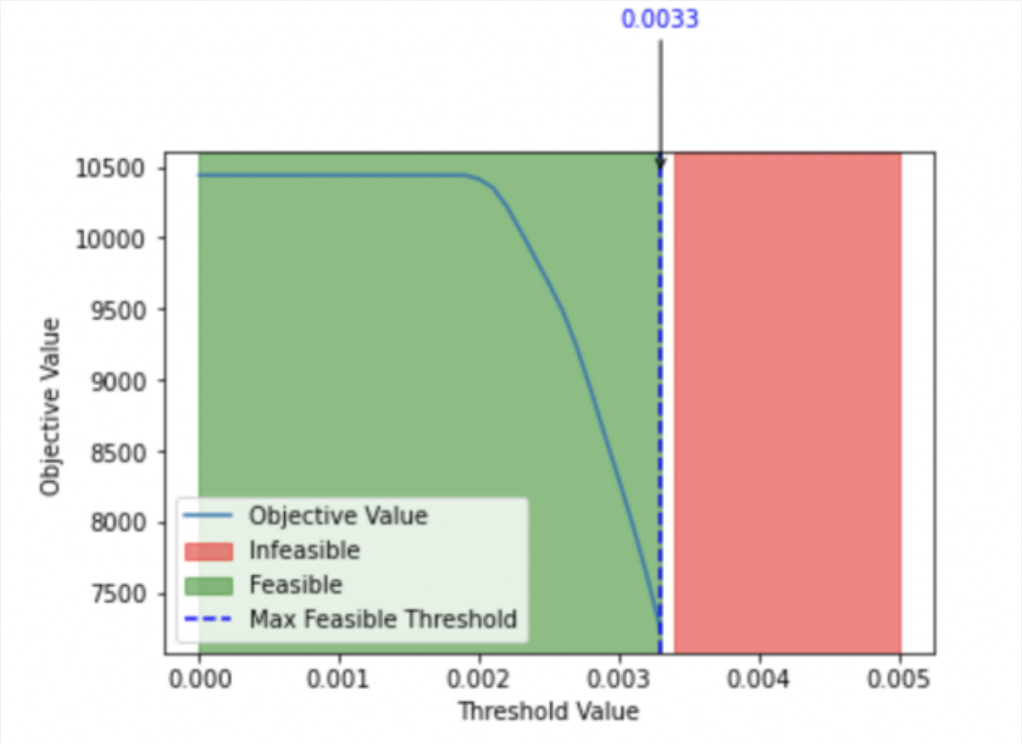
Add New Constraints

Ensure that the weighted crime score per officer is above a certain threshold.

$$x_i \geq threshold \cdot W_i \text{ for } i \in D$$

Decision to be made: what's the maximum possible value of threshold to maximize the weighted crime score covered by each officer for every areas

Threshold Sensitive Analysis



The structure of our optimization model

Decision Variable:

x_i for $i \in$ D: D represents the list of 21 police divisions

Objective Function:

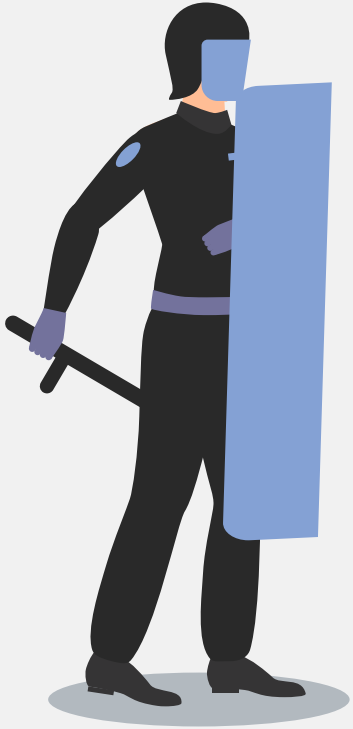
$$\text{MAXIMIZE } \sum_{i=1}^{D} x_i \cdot \frac{W_i}{P_i}$$

Constraints:

$$\sum_{i=1}^{D} x_i \leq 9000$$

$$x_i \geq 1.8 \cdot \frac{P_i}{1000} \text{ for } i \in D$$

$$x_i \geq 0.0033 \cdot W_i \text{ for } i \in D$$



4. Results and implication

Area Name	Police	Proportion	Weight
Van Nuys	585.0	1.8	0.00566
Central	565.0	14.1	0.00338
Hollywood	540.0	1.8	0.00412
77th Street	533.0	3.0	0.00330
Pacific	463.0	2.3	0.00330
Wilshire	452.0	1.8	0.00394
Northeast	450.0	1.8	0.00427
Southwest	443.0	2.7	0.00330
Southeast	423.0	2.8	0.00330
West LA	411.0	1.8	0.00365
Newton	411.0	2.2	0.00331
N Hollywood	409.0	1.9	0.00330
Mission	407.0	1.8	0.00423
Olympic	400.0	2.9	0.00331
Devonshire	395.0	1.8	0.00403
Rampart	372.0	2.3	0.00331
Topanga	370.0	1.8	0.00378
Hollenbeck	360.0	1.8	0.00393
West Valley	355.0	1.8	0.00343
Harbor	328.0	1.9	0.00330
Foothill	328.0	1.8	0.00397

Limitation of the model

Crime data Accuracy

Weighting Crime Scheme

Simplifying assumptions

Dynamic nature of crime

Future Improvement

Data Collection

Collect more accurate and detailed data on crime rates, police officer performance, and other relevant factors that can affect the allocation of police officers.

Objective Function

Considering more factors that can impact the allocation of police officers, such as population density, time of day, and crime hotspots.

Constraints

In reality, there might be limitations on the number of police officers available or cost associated when allocating police officers and resources

THANK YOU FOR LISTENING!

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