



A Proposed framework for Pattern Recognition from a Robbery Dataset

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ABSTRACT: Crime can be classified into 2 parts i.e. violent crime which comprises of murder, robbery, forcible rape, aggravated assault and property crime i.e. burglary, motor – vehicle theft. In this paper, we are focusing on a particular type of crime i.e. “Robbery”. Our motive is to study all types of crimes in detail step – by – step as motive is to reduce crime rate all over the world. It is an alarming situation for the police department and the general public about the crime taking place in the surroundings in order to avoid being victim of crime. There is a huge crime data and it is the responsibility of the crime analyst to analyze the data and fetch out relevant patterns in order to help police department to enhance security considering factors responsible for crime rate increment. So, keeping this in mind, the methodology is proposed for pattern recognition using statistical approach to perform in – depth analysis of robbery. Factors are also identified resulting in robbery and impact of that factor is clarified on the robbery rate using the concept of correlation and regression. Visualization of each pattern is provided so that it time is consumed for the crime analysts to quickly visualize patterns.

KEYWORDS: Robbery ; Pattern Recognition ; Statistical Model

I. INTRODUCTION

Robbery is defined as a crime type of catching or soliciting anything of value by extortion, intimidation of force or by embedding the victim in fear. It is formalized as grabbing the equity of victim with the intent to permanently deprive the victim of that property by means of force or fear. Circumstances that prominence a person’s verdict to violate street robbery are cash needs, attack methods, routines, etc.

Street robbery is an expeditive way for a person to procure cash required to purchase goods related to prosperity or prominence. A pattern impersonates both the scanning and analysis steps of the rational process or SARA (Scanning, Analysis, Response, and Appraisal) so that the reverberation is made to measure on the basis of peculiar pattern information which is being presented in the results of analysis.

When taking into contemplation about robbery cases reports, we aim to find that the database contains lots of reports but they impel to have confined observation about the suspect. It is prevailing to say that the information obtained from such observations is incomplete. It contains uncertainty in multiple- ambiguity about the suspect and hence, existence of uncertainty occurs normally. To reduce the uncertainty of data, we make use of Formal Concept Analysis (FCA) to detect robbery and find out patterns. It is necessary for the crime analyst to analyse the crime data in such a manner that the police department can use the results of pattern analysis for crime contraction to identify meaningful and useful patterns. The rest of the distribution of paper is as follows: Section 2 comprises the related work, Section 3 depicts the problem definition, Section 4 defines the dataset on which research is being conducted, Section 5 elaborates the pattern analysis from robbery data, Section 6 provides the comparison of our approach to another followed by conclusion.

II. RELATED WORK

Various studies have been conducted for the crime scenario and in this paper our focus is on a particular type of crime which is robbery.[1] results designated that crime related factors and some substantial designs astonishes the applicability between other phenomenal layouts and robbery rate.[2] discussed the crime rates along with the person-centered view of victimizations. [3] explores the prevalence and forecasters of acute stress disorder (ASD) in a survey of employees of bank regarding bank robbery.[4] tests the prominence of murkiness in street robbery crime event beside the temperature and discerning trend in crime data. Poelmans et al. [5] used FCA for the initiatory analysis of capabilities of data in originating domestic violence penetration from an unstructured police reports. Poelmans et al. [6] presented a method which is related to Temporal Concept Analysis (TCA) for recognizing and engraving human-trafficking suspects. Musavarah et al. [7] discussed various pertinences of m-Polar for detection of the suspects of women and child trafficking. Shiju et al. [8] imported a system to predict regions which are prone to crime in India on a



particular day. Sivaranjan et al. [9] used clustering technique to predict crime-prone regions in Tamil Nadu. Nadeem et al. [10] illustrated the use of spatial, temporal and modus operandi for coordinating patterns of crime from the unsolved cases. [11] explores the social context in which street robbers deliberate and carry out offences. [12] primary and secondary studies are conducted to fetch percentage change in robbery.

III. PROBLEM DEFINITION

Crime cannot be anticipated since it is neither precise nor contingent. Even though, we cannot predict who all may be the victims of crime but can predict the place and time that has high probability of its existence. Finding patterns and trends in crime is a very vindicating factor. Time is the most important factor in crime and there is a need to predict not only the crime-prone regions but proper time or time-slot where probability is more for crime occurrence.

Along with time, there are several other factors which need to be considered by the crime analysts for pattern identification such as location details i.e. banks, ATM, departmental stores, etc. from past records where crime occurrence has been more so that enhancement of security. Crime analysis includes looking at the data from two different dimensions i.e. spatial dimension and temporal dimension. Spatial dimension comprehends penetrating the characteristics of a particular region along with its acquaintances whereas the temporal dimension comprehends penetrating the endowment of a particular region over time.

So, here the need arises to look for patterns and capture the trend in crime occurrence. To deal with crime data is a very challenging task. The process of crime analysis employs statistics, mapping of crime, research methods and understanding of criminal behaviour. The police motivate the public to provide all the information they witness during the crime occurrence or to others in their surroundings and to report crimes that have not been reported yet. The information is gathered in the form of patterns and when the offenders get to know that the police is aware of their movements, they might be deferred from persisting their offending. Information about patterns also provides advice for specific crime prevention and inspires individuals to protect themselves for future. So, a crime analyst serves as synthesis of an information systems professional, a statistician, a researcher, a criminologist. In this paper, our focus is on a particular type of crime i.e. robbery. So, we need to identify patterns for robbery cases from past records so that robbery rate can be reduced in future.

IV. DATASET

We have acquired the dataset from Austin Texas government's official website. We have taken crime record for 3 years i.e. 2016-2018. The dataset initially consisted of 1048555 crime records. Austin is the capital of United States state of Texas. It is the 11th most popular city in the United States and the 4th most popular city in Texas. It is also the fleeting-thriving large city in the United States. Austin's population is estimated at around 951,830. Austin has a population density of 3358.32 people per square mile. The robbery rate from year 1998- 2017 is depicted in figure 1.

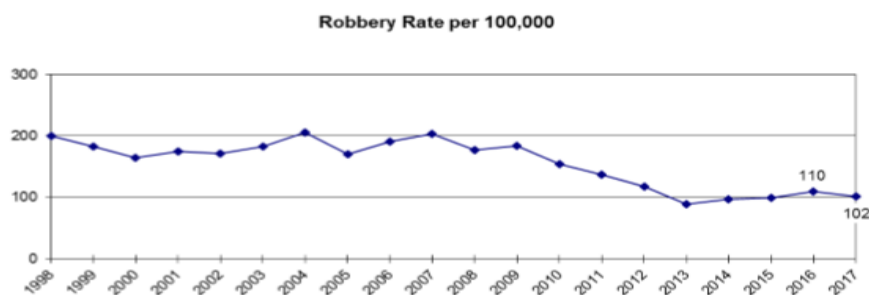


Fig.1. Robbery rate

The city of Austin publishes an up-to-date list of all reported crimes. The overall crime rate in Austin is higher than the national average. For every 100,000 people, there are 9.88% of crimes that occur in Austin. By analysing the data in a mathematically rigorous way, researchers can glean insight into the underlying causes of crimes and also may be able to figure out indicators of future crimes to occur.

We have filtered the dataset of Austin for robbery cases covering the following aspects:

- Incident number
- Highest offence description
- Occurred date
- Occurred time



- Location type
- Zip code
- Report date
- Report time

V. PATTERN ANALYSIS FROM ROBBERY DATASET USING DESCRIPTIVE STATISTICS

Pattern is defined as particular way in which something is done, is organized or happens. In other words, we can say that dependable and iterative characteristic that helps in recognition of a circumstance or problem and serves as an indicator or model for anticipating its future performance. Pattern recognition is the automated recognition of patterns and invariabilities in data. Pattern recognition systems are trained from designated “training” data i.e. supervised learning. Pattern recognition is all about guessing or predicting the unknown nature of an observation. It consists of acquiring raw data and taking actions based on the class of the patterns recognized in the data. The following figure 2 depicts the steps involved in pattern recognition:

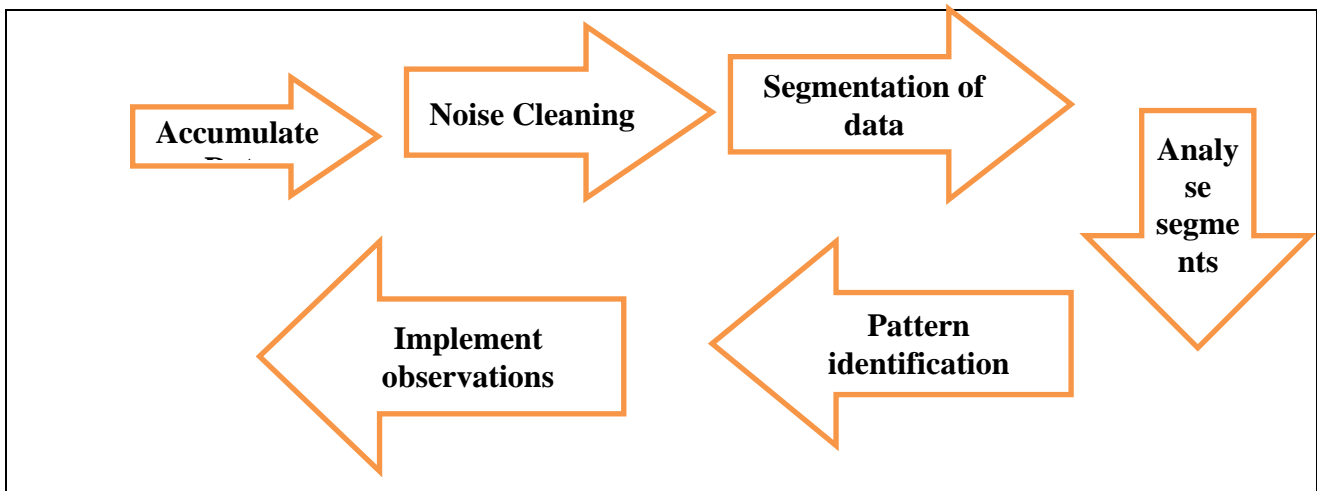


Fig.2. Steps involved in Pattern Recognition

In this paper, we are using **statistical classification approach**. This approach assumes statistical basis for classification of data. It generates random parameters that represent the properties of patterns to be recognized. In machine learning and statistics, classification is the predicament of determining to which categories or new population is associated with on the basis of transient set of data embracing observations whose class membership is known.

5.1 Pattern analysis from Austin, Texas dataset

From the past data crime records, we are going to find out patterns of robbery so that alertness and security can be enhanced by the police department to reduce the robbery rate.

1. Table 1 depicts the statistics of the data we have classified for the following classifiers :

- **Occurred time**
- **Highest offence description**
- **Zip code**
- **Location type**



Table1. Descriptive analysis of data

		Statistics			
		Occurred Time	Highest Offense Description	Zip Code	Location Type
N	Valid	1134	1134	1134	1134
	Missing	0	0	0	0
Mean		1315.81	2.53	78733.89	19.69
Median		1525.50	2.00	78741.00	19.00
Mode		300	2	78741	25
Std. Deviation		803.431	.695	24.362	5.734
Variance		645501.093	.482	593.495	32.875
Skewness		-.319	.687	-1.645	-.929
Std. Error of Skewness		.073	.073	.073	.073
Kurtosis		-1.441	-.347	4.681	.572
Std. Error of Kurtosis		.145	.145	.145	.145
Minimum		0	1	78613	1
Maximum		2359	4	78759	28

2. Time is an important factor where probability of crime – occurrence is more. It is very important for a crime analyst to find out patterns of the time or time- slot in which crime occurrence has taken place from the past records. This enables the focus of police department to increase security at those peak hours where chances are high for crime occurrence. The following figure 4 represents the pattern of highest peak time for robbery occurrence which is 2:51 am. This is an alarming situation for increasing security for the public.

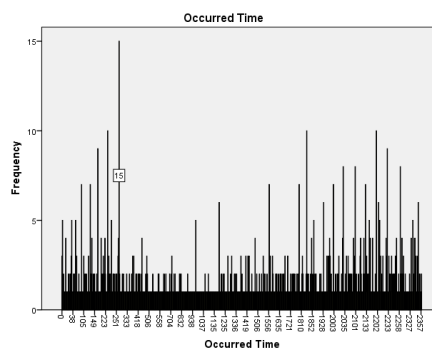


Fig.4. Pattern of occurred time of robbery

3. After find out time slot which is more crime prone, it is necessary to find out patterns from the data which depicts description of type of offense taking place by the offender. When considering robbery cases, we found that robbers mostly performs

- Aggravated Robbery by assault
- Aggravated Robbery / use of deadly weapon
- Robbery by assault
- Robbery by threat

So, based on such indicators, we have found out patterns of which type of offense is performed by the offender more likely from the previous records. So, we found that Aggravated robbery/ use of deadly weapon has been performed by the robbers in Austin.



The following figure 5 depicts the pattern of highest offense description committed by robbers.

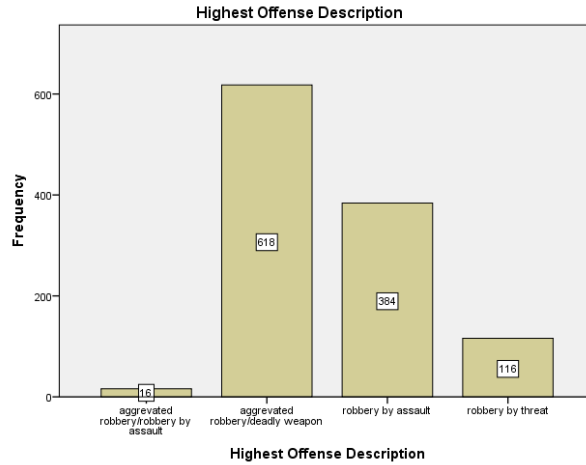


Fig.5. Pattern of highest offense description for robbery – occurrence

4. From the offender’s point of view, we analyzed that prior- robbery, the offender finds out in his mind, the key locations where he need to perform crime. **We have found that maximum robbery cases are occurring in street i.e. street robbery probability is more.** Street robbery is an expeditive way for someone to get cash required to purchase items which are related to prosperity or prominence. For example. Jewellery, clothing, alcohol, etc. If victims don’t have cash in hand, robbers snatch their items and sell other items to meet their cash needs. The offender will usually use verbal requisition. For example. “Give me your money”. Violence might follow if victim doesn’t accord. Offender, sometimes, uses a distraction to catch the victim offguard.eg. Offender might distract someone for the enquiry of time or directions before attacking. It is the fact that no means of verbal communication takes place between the suspect and the victim prior the robbery. The offender tries ordinarily grabs noticeable equity such as purse, mobile phones, etc. and then escapes. Routines can influence street robbery such as special events such as sports games, festivals, cross-country races, etc. Victims are peculiar to such areas. Example. They can park in high-crime prone area due to obtuseness .Some victims may drink and become less acquainted of their prompt ambience and they may likely have cash with them and suspect might take leverage of this. Students might be carrying MP3 player near a path to school in moving and at day-off which might be remarkable by the suspect. The following figure 6 depicts patterns of various location types depicting probability of occurrences of robbery.

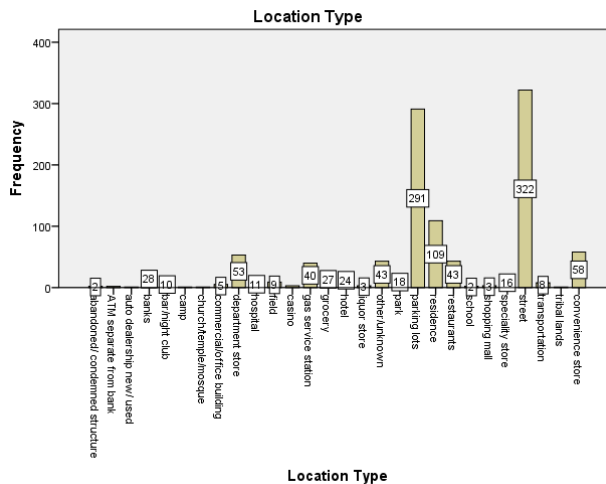


Fig.6. Pattern of different location types for robbery- occurrence

5. Last but not the least, crime – prone regions need to be predicted in order to bring in notice to the police department and identify different factors leading to crime occurrence in such areas more comparatively from other



areas. We have analyzed pattern of robbery occurrence more in the zip code 78741. The following table 7 depicts pattern of zip codes where robbery has occurred more from previous records in Austin, Texas.

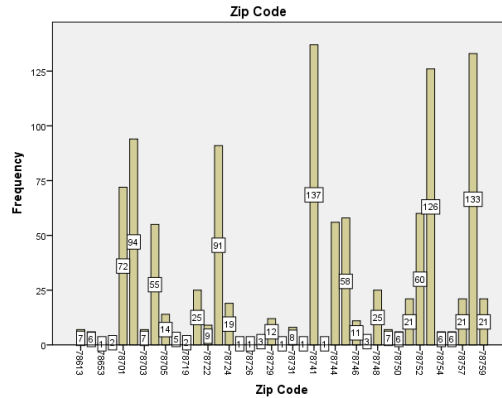


Fig.7. Pattern of zip codes for robbery –occurrence

From the map of Austin, Texas, we have analysed the more crime – prone region so that police department enhances security in such region as quickly as possible. The following figure 8 depicts the highlighted portion where crime occurrence is more in Austin.



Fig.8. Crime – prone region identified using zip code

VI. COMPARISON

Sivaranjani et al. [9] used clustering approach to analyze the crime data of Tamil Nadu. This work has tried to predict and detect crimes in Tamil Nadu in order to truncate the crime rate. Authors have predicted crime in different cities using clustering. Focus on key factors was lacking. So, deep analysis of patterns of offender’s activities was lacking. Our approach is not only limited to find out the crime – prone regions but also to find all other patterns related to offender’s activities i.e. time- slot which is more crime – prone, locations which are highly attacked by criminals such as banks, hospitals, streets, etc. In order to achieve such objectives, the work has been classified from a crime analyst’s point of view to identify patterns. In our approach, we have identified patterns of a particular state by deeply covering the offender’s move of performing robbery. The following table 2 depicts the comparison chart.



Table 2. Summary of Comparison between methods

	Existing approach for crime pattern-analysis	Our approach for crime – pattern analysis
Crime- prone regions	✓	✓
Time-slot crime- prone	✗	✓
Zip – code crime prone	✗	✓
Offense description	✗	✓
Advantages	Clustering approach is used to find crime- prone areas. Clustering helps to group similar types of activities.	Pattern analysis using statistical approaches provides proper analysis of offender’s move in order to enhance security in terms of important patterns fetched from the data.
Time-complexity	$O(n)^2$	$O(n)$
Pattern	Crime – prone states are visually depicted.	Following patterns are visually depicted: <ul style="list-style-type: none"> • Time- slot which is more robbery- prone • Offense description • Location crime-prone • Zip- code crime prone

VII. CONCLUSION

In this paper, focus has been made on pattern analysis of a particular type of crime i.e. Robbery. It is very necessary to propose a methodology from an analyst point of view especially in case of crime related domains. Since, crime related issues are related to real- world problems and pattern identification is the key- aspect in order to reduce the crime rate. We have seen many research articles identifying patterns of crime but in our research work, we have deeply analysed the aspects related to crime and tried to analyse them graphically. The crime analyst does not have time to manually evaluate lakhs of crime records. The analyst needs to perform a step- by step scrutiny of the crime reports to figure out the patterns related to crime and help police department in order to enhance security in such areas and provide alertness to the general public. We have followed an approach where we have analysed patterns from crime analyst point of view and this approach can be fitted to any country/ state to analyse patterns. As mentioned above, we have considered a particular type of crime in this research work which is Robbery. We can apply this approach to any other type of crime. We have identified pattern of occurred time of robbery i.e. the peak hour which is more crime- prone, then we found out the pattern of highest offense used by the robber, then we found out the most crime – prone location where the robber focuses on performing crime. After finding such attributes, we found the crime – prone location using zip codes. This pattern – analysis will help the police department to be alert in terms of providing security. In our future research, we are going to elaborate all the factors so that we can find out the most contributing factors in increase in crime- rate and necessary steps can be initiated to decrease the rate.

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BIOGRAPHY

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