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Efficient Crime Analysis Based on Hybrid Approach by Combining Dynamic Time Wrapping Algorithm with K-Means Clustering Approach.

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Abstract: ***Crime is a preeminent issue where the main concern has been worried by individual, the local area and government. Wrongdoing forecast utilizes past information and in the wake of investigating information, anticipate the future wrongdoing with area and time. In present days sequential criminal cases quickly happen so it is a provoking assignment to anticipate future wrongdoing precisely with better execution. Clustering different time series into similar groups is a challenging clustering task because each data point is an ordered sequence. The most common approach to time series clustering is to flatten the time series into a table, with a column for each time index (or aggregation of the series) and directly apply standard clustering algorithms like k-means. But this doesn't always work well on Time Series Data. The paper focuses on combining the features of K-Means Clustering algorithm with Dynamic Time Wrapping Algorithm for efficient Crime prediction and analysis.***
Keywords: Crime Analysis, Data Mining, Classification, Clustering, Dynamic Time Wrapping (DTW), K-Means

I. INTRODUCTION

A crime is an unlawful action for which a man can be punished by law. Wrongdoing against an individual is called individual wrongdoing like homicide, theft, and so forth Property related misconduct implies burglary of property. Wrongdoing examination is a law execution task which incorporates a coordinated investigation that perceives and decides the example of wrongdoing. The different procedures utilized for various violations have been talked about with a prologue to the concerned crime. The sorts of wrongdoing are as referenced beneath [1].

Crime analysis relates to the group of consistently, analytical operations that provides periodic data about crime patterns and trends correlations. Crime analysis based on its scope, analysis techniques and data is further categorized into various types [2]:

1) *Intelligent Analysis:* The objective of Intelligent analysis is to identify network of criminals carrying out criminal activity and also to help the police in arresting those violators of law.
2) *Investigative Analysis:* It is also referred as criminal profiling. The main purpose of this type of analysis is to help criminal investigator recognize offender by identifying personal characteristic , social habits etc.
3) *Tactical Analysis:* It is study of detailed investigation and analysis of criminal incidents and activity through the examination of general characteristic such as when, how and where the incident has occurred to help in pattern development, to identify potential .
4) *Strategic Analysis:* Strategic crime analyst uses statistical methods to examine electronic databases containing huge number of records. These analysts deal with variable, date, location, time and type of incident.
5) *Administrative Analysis:* It is concerned with presentation of findings of crime, research based on legal, political matter to inform citizens, people within police administration, government etc.

II. TECHNIQUES FOR CRIME PREDICTION

1) *Association Rule Mining:* The covered up or delicate information in unlabeled information is discovered by this strategy. This procedure can likewise find the co-events of articles in huge datasets. The principle restriction is that finding huge datasets require additional time.
2) *Classification Rule:* The portrayal and recognition between information classes or ideas is arrangement procedure. The information is gathered into classes. Each class has characteristic set and class name.
3) *Clustering:* It is the gathering of a bunch of information so that information in a similar gathering (group) are basically the same as each other than the information that are in different bunches.

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III. ARCHITECTURE OF BASIC CRIME PREDICTION SYSTEM

The engineering of the essential framework comprises of the accompanying stages [4]:

1) *Stacking Crime Data:* Firstly the client assembles the wrongdoing dataset from the entryway of National Crime Records Bureau(NCRB) of India. This dataset contains whole data about various parts of violations that occurred in India from 2001 to2012. There are different variables that can be investigated from this dataset. The record design for the information is .CSV.
2) *Information Pre-Processing:* After stacking the wrongdoing information, the subsequent stage in this model is information pre-handling. It is a method of changing information from the crude structure over to a significantly more usable structure, i.e., making information more significant by dealing with the missing qualities, information cleaning and change of crude information into simple to decipher design.
3) *Utilization of AI calculation:* Once the pre-handling is finished, cleaned and handled information is acquired. On this order and grouping calculations are applied dependent on prerequisites. The characterization calculation for example Credulous Bayes chips away at managed learning idea in which irregular inspecting should be completed for example jumping the information into test and train test for example 80% train tests and 20% test tests to prepare the classifier to perceive the new unidentified wrongdoing record. Though grouping calculation for example k-mean depends on solo learning calculation what parts the wrongdoing records relying on the quantity of gathering to be created.
4) *Information Visualization:* Visualization takes a colossal measure of information to address helpful information as diagrams or charts for fast and better comprehension of data. The outcomes can be imagined utilizing suitable diagrams or guides showing delicate spaces of having high likelihood of violations. Perception is essentially displayed with utilization of bar graphs, boxplot, heatmap, scatterplot and so forth
5) *Design Recognition:* Next work in the system is design ID that is utilized to observe the arrangement of wrongdoings which are comparable in nature and has a place with same class. Distinguishing proof of significant examples can assist police with creating powerful wrongdoing counteraction and wrongdoing decrease systems.
6) *Forecast:* The incessant examples acquired are utilized to drive models which can foresee future wrongdoing.
7) *Chief:* The data that is acquired as result help law implementation offices in improving mediation procedures by means of viable readiness.

IV. RELATED WORK

As per [5] Crime records has been correctly recorded through the police for a long term and really these days, there was a flood of Open Crime Data and of programs or on line utility displaying wrongdoing measurements on maps, each through authentic reassets, for instance, from police UK, and unique reassets making use of comparable authority records. This paper researches unique methodologies and the rigors have been led making use of the SCIAMA High Performance Computer Cluster on the University of Portsmouth and the Weka programming. One greater paper [6] has attempted the exactness of characterization and expectation depending on numerous tests. In one greater paintings group [7] bunched violations depending on occasion a great deal of the time for the duration of numerous years. Information mining is applied to extensively as a long way as exam, exam and disclosure of examples for occasions of wrongdoing. Another calculation [8] Crime place of hobby expectation has these days been proposed. Wrongdoing place of hobby expectation affects beyond records to differentiate wrongdoing regions of hobby, or net-primarily based totally media records. A calculation portrayed in [10] depicted Generic calculation for forestalling fee card cheats. It changed into applied for similarly growing the registering value with time through making complicated frameworks. It should have a take a observe a deceitful alternate in slightly any second. The probability of distortion trades should anticipate now no longer lengthy later Mastercard trades and direction of motion of adversarial to coercion frameworks might be gotten to maintain banks from extraordinary mishaps and restrict dangers.[11] portrayed mystery Markov model. It confirmed the execution and ampleness of the gadget. It likewise exhibited the needfulness of taking the spending profile. The exactness of the framework changed into 80 %. [12] proposed Bayesian and Neural groups that deliver computational scholar which include of making ready set having thing and records for figuring out misrepresentation so it may appropriately set up the brand new records as extortion or now no longer. It is reasoned that each the technique may be applied for figuring out fraud.[13] tested close to unsightly fluffy c-implies calculation for research of fierce wrongdoing, harsh set and facts entropy. It changed into joined to overtake the restrict so it is able to manipulate the vulnerability, unclearness, and inadequacy. This calculation changed into applied for settling protecting facts.[14] mentioned ok-mode bunching and association rule mining calculation which have been applied to examine unique plan or instance of mishaps befell withinside the street.

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In the wake of making use of the calculation EDS changed into made premise of month and hour to display the mishaps occurred.[15] tested piece thickness evaluation, strategic relapse and abnormal backwoods showing changed into applied to direct spatial and fleeting exam of sexual assault. Kernel thickness evaluation changed into applied to investigate the probability thickness factors of rapes over each day, week through week, and month to month time spans. They evolved time collection making use of strategic relapse, and arbitrary forest fashions to survey connection between`s point-regions of intercourse violations, weather conditions. These results display that rape is certain to occur near the houses of enrolled intercourse offenders.[16] proposed ok way grouping calculation which changed into applied for growing examples of records. Information have been accumulated and disseminated, 0.33 of proper records and distortion records facts have been used for making plans and ultimate facts have been used for determine and net wrongdoing disclosure. The accuracy of the proposed paintings changed into 94.75 % and it beneficially perceived the artificial tempo of of 5.28%.

V. PROBLEM IDENTIFICATION

Clustering is an unmonitored gaining knowledge of project wherein an set of rules organizations comparable facts factors with out any “floor truth” labels. Similarity among facts factors is measured with a distance metric, usually Euclidean distance. Clustering one-of-a-kind time collection into comparable organizations is a hard clustering project due to the fact every facts factor is an ordered sequence. The maximum not unusual place technique to time collection clustering is to flatten the time collection right into a table, with a column for on every occasion index (or aggregation of the collection) and at once practice fashionable clustering algorithms like k-approach.As proven below, this doesn`t constantly paintings well. Each subfigure within side the chart plots a cluster generated via way of means of k-approach clustering with Euclidian distance. The cluster centroids in crimson do now no longer seize the form of the collection..

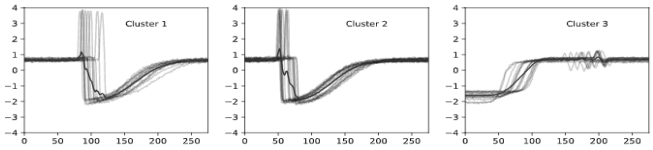


Figure 1: Shape of the Series

VI. METHODOLOGY

The distance measures utilized in trendy clustering algorithms, consisting of Euclidean distance, are regularly now no longer suitable to time collection. A higher technique is to update the default distance degree with a metric for evaluating time collection, consisting of Dynamic Time Warping. Euclidean distance metric is mistaken for time collection? In short, it's miles invariant to time shifts, ignoring the time size of the data. If time collection are rather correlated, however one is shifted via way of means of even one time step, Euclidean distance could erroneously degree them as similarly apart. Dynamic Time Warping (DTW) is a method to degree similarity among temporal sequences that don't align precisely in time, speed, or length. Given collection X=(x_0, …, x_n) and collection Y=(y_0, …, y_m), the DTW distance from X to Y is formulated as the subsequent optimization problem:

$$DTW(x,y) = \min_{\pi} \sqrt{\sum_{(i,j)\in\pi} d(x_i, y_j)^2}$$ --------- (Eq-1)

where $\pi = [\pi_0, \ldots, \pi_K]$ is a path that satisfies the following properties:

- it is a list of index pairs $\pi_k = (i_k, j_k)$ with $0 \le i_k < n$ and $0 \le j_k < m$
- $\pi_0 = (0,0)$ and $\pi_K = (n-1, m-1)$
- for all $k > 0$, $\pi_k = (i_k, j_k)$ is related to $\pi_{k-1} = (i_{k-1}, j_{k-1})$ as follows:
  - $i_{k-1} \le i_k \le i_{k-1} + 1$
  - $j_{k-1} \le j_k \le j_{k-1} + 1$

DTW is calculated because the squared root of the sum of squared distances among every detail in X and its nearest factor in Y. Note that DTW(X, Y) ≠ DTW(Y, X). DTW compares every detail in collection X with every detail in collection Y (n x m comparisons). The comparison, d(x_i, y_j), is simply the easy subtraction x_i — y_j.Then for every x_i in X, DTW selects the closest factor in Y for distance calculation..

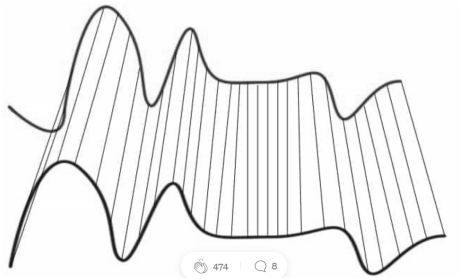


Figure 2: DTW Distance

According to Fig.2 DTW matches each point in the blue series to the nearest point in the red series.

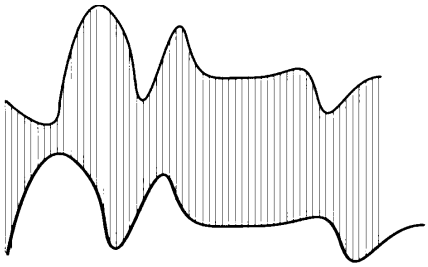


Figure 3: DTW Distance

In Fig.3 Euclidean distance metric matches points in two time series. According to Fig.2 and Fig three the collection are of various lengths.Unlike Euclidean matching, DTW is capable of examine every factor withinside the blue collection to a degree withinside the crimson collection.The k-approach clustering set of rules may be carried out to time collection with dynamic time warping with the subsequent modifications.

1) Dynamic Time Warping (DTW) is used to gather time collection of comparable shapes.
2) Cluster centroids, or barycenters, are computed with appreciate to DTW. A barycenter is the common collection from a collection of time collection in DTW space. The DTW Barycenter Averaging (DBA) set of rules minimizes sum of squared DTW distance among the barycenter and the collection withinside the cluster. The soft-DTW set of rules minimizes the weighted sum of soft-DTW distances among the barycenter and the collection withinside the cluster. The weights may be tuned however need to sum to 1.
3) As a result, the centroids have a mean form that mimics the form of the participants of the cluster, no matter wherein temporal shifts arise among the members.

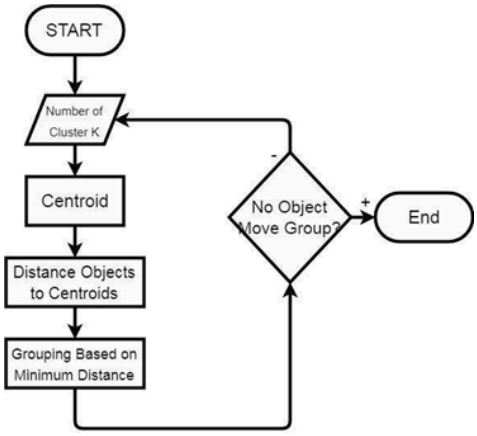


Figure 3: Clustering approach

VII. RESULTS

Dataset Used : The crime analysis and prfediction was carried out using downloaded crime data in csv format and storing in MySql data. The crime csv data was downloaded from following sites:

- https://www.kaggle.com/datasets/rajanand/crime-in-india
- https://data.world/rajanand/crime-in-india

MySQL is an open-supply relational database control gadget. As with different relational databases, MySQL shops statistics in tables made of rows and columns. Users can define, manipulate, control, and question statistics the use of Structured Query Language, greater generally referred to as SQL. A bendy and effective program, MySQL is the maximum famous open-supply database gadget withinside the world. As a part of the widely-used LAMP generation stack (which includes a Linux-primarily based totally running gadget, the Apache net server, a MySQL database, and PHP for processing), it`s used to save and retrieve statistics in a huge form of famous applications, websites, and services.

The methodology is implemented using Java Technology. Java is a popular programming language, created in 1995.It is owned by Oracle, and more than 3 billion devices run Java. Major features of Java are:

- Java works on different platforms (Windows, Mac, Linux, Raspberry Pi, etc.)
- It is one of the most popular programming language in the world
- It is easy to learn and simple to use
- It is open-source and free
- It is secure, fast and powerful
- It has a huge community support (tens of millions of developers)
- Java is an object oriented language which gives a clear structure to programs and allows code to be reused, lowering development costs
- As Java is close to C++ and C#, it makes it easy for programmers to switch to Java or vice versa.

Performance : The performance was calculated on the basis of execution time. It was found that hybrid approach was taking lesser time and the clustering quality was almost similar.According to results obtained it is clearly shown that combining DTW with K-Means is more efficient in matching each point in data and also more efficient time wise.Overall accuracy obtained was around 85% as per clustering execution time calculation for around 1000 records.

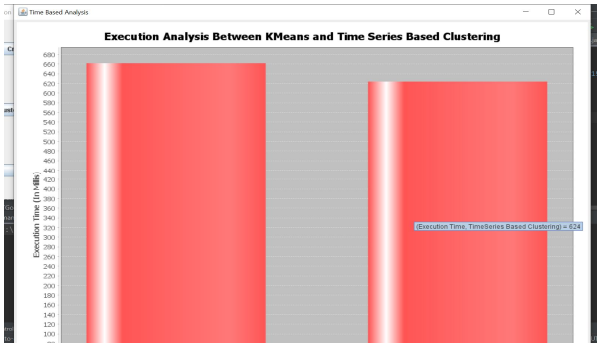


Figure 4 : Execution Time Comparison

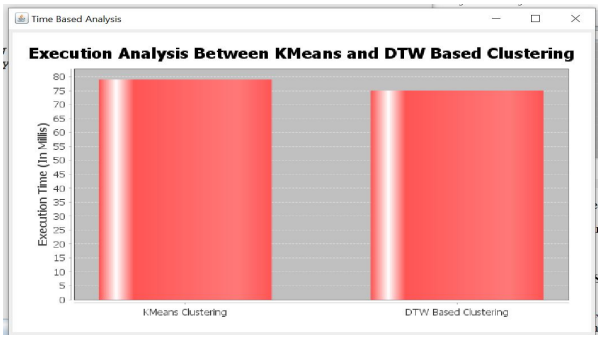


Figure 5. Execution time comparison between KMeans and DTW

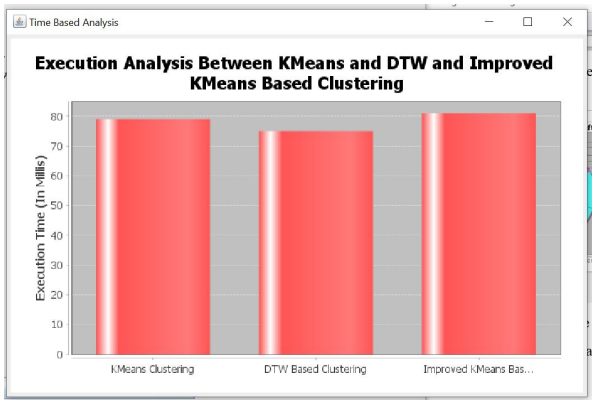


Figure 6. Execution time comparison between KMeans and DTW and Improved Approach

According to Fig.4,5,6 The comparison was conducted between K-Means, DTW and Hybrid approach and tt is shown that the hybrid approach is more efficient in case of clustering and analysis.

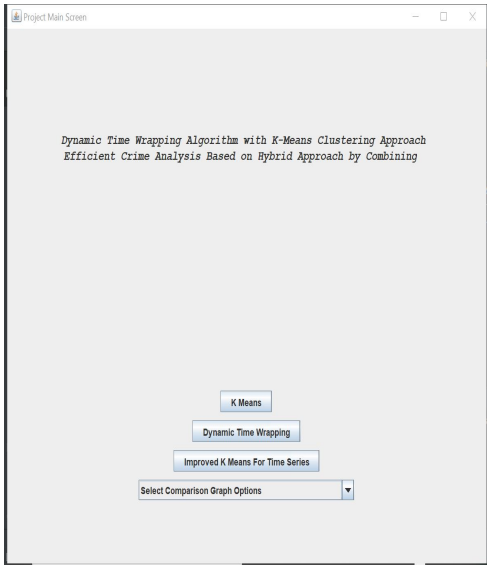
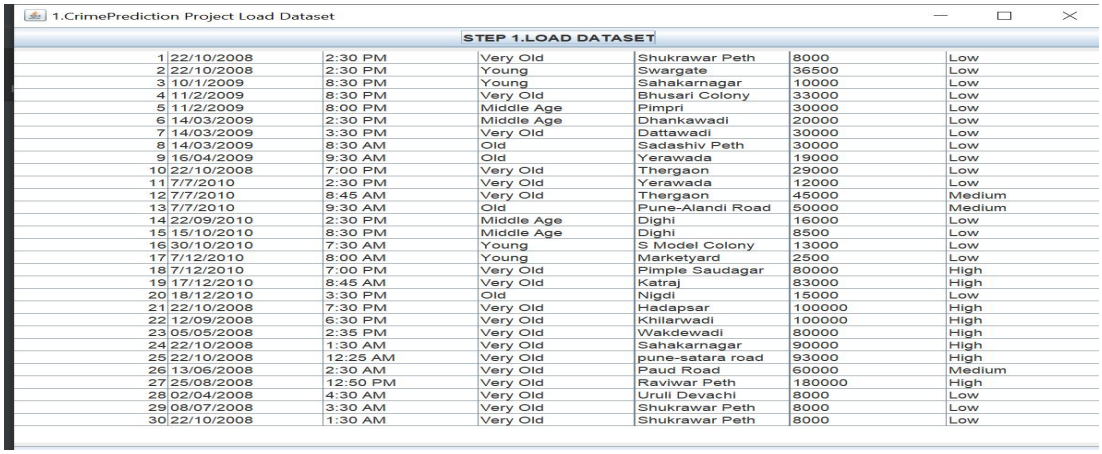


Figure 7 : Algo excution main screen

The comparison was conducted between three algorithms K-Means, Dynamic Time wrapping and hybrid approach.



1	22/10/2008	2:30 PM	Very Old	Shukrawar Peth	8000	Low
2	22/10/2008	2:30 PM	Young	Swargate	36500	Low
3	10/1/2009	8:30 PM	Young	Sahakarnagar	10000	Low
4	11/2/2009	8:30 PM	Very Old	Bhusari Colony	33000	Low
5	11/2/2009	8:00 PM	Middle Age	Pimpri	30000	Low
6	14/03/2009	2:30 PM	Middle Age	Dhankawadi	20000	Low
7	14/03/2009	3:30 PM	Very Old	Dattawadi	30000	Low
8	14/03/2009	8:30 AM	Old	Sadashiv Peth	30000	Low
9	16/04/2009	9:30 AM	Old	Yerawada	19000	Low
10	22/10/2008	7:00 PM	Very Old	Thergaon	29000	Low
11	7/7/2010	2:30 PM	Very Old	Yerawada	12000	Low
12	7/7/2010	8:45 AM	Very Old	Thergaon	45000	Medium
13	7/7/2010	9:30 AM	Old	Pune-Alandi Road	50000	Medium
14	22/09/2010	2:30 PM	Middle Age	Dighi	16000	Low
15	15/10/2010	8:30 PM	Middle Age	Dighi	8500	Low
16	30/10/2010	7:30 AM	Young	S Model Colony	13000	Low
17	7/12/2010	8:00 AM	Young	Marketyard	2500	Low
18	7/12/2010	7:00 PM	Very Old	Pimple Saudagar	80000	High
19	17/12/2010	8:45 AM	Very Old	Katraj	83000	High
20	18/12/2010	3:30 PM	Old	Nigdi	15000	Low
21	22/10/2008	7:30 PM	Very Old	Hadapsar	100000	High
22	12/09/2008	6:30 PM	Very Old	Khilarwadi	100000	High
23	05/05/2008	2:35 PM	Very Old	Wakdewadi	80000	High
24	22/10/2008	1:30 AM	Very Old	Sahakarnagar	90000	High
25	22/10/2008	12:25 AM	Very Old	pune-satara road	93000	High
26	13/06/2008	2:30 AM	Very Old	Paud Road	60000	Medium
27	25/08/2008	12:50 PM	Very Old	Raviwar Peth	180000	High
28	02/04/2008	4:30 AM	Very Old	Uruli Devachi	8000	Low
29	08/07/2008	3:30 AM	Very Old	Shukrawar Peth	8000	Low
30	22/10/2008	1:30 AM	Very Old	Shukrawar Peth	8000	Low

Figure 8 : Dataset

The above figure shows dataset loaded from csv file.



Figure 9: Time wise Crime Trend

The above figure shows the time wise crime trend as per theft records for crime.

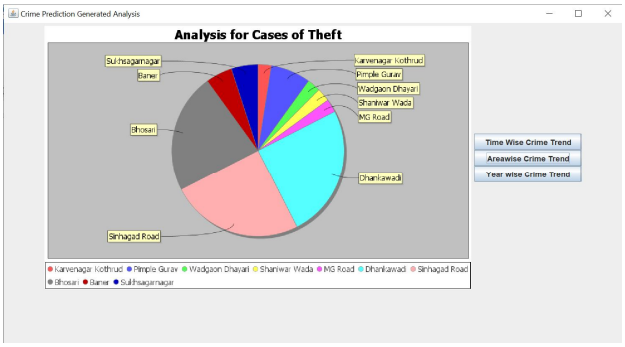


Figure 10: Area wise crime trend

The above figure shows the area wise crime trend as per theft records for crime.

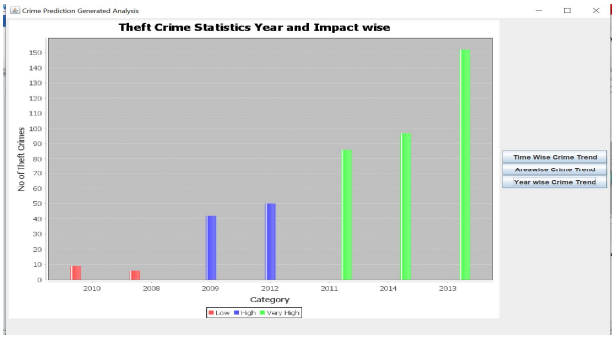


Figure 11: Year wise crime trend

The above figure shows the year wise crime trend as per theft records for crime.

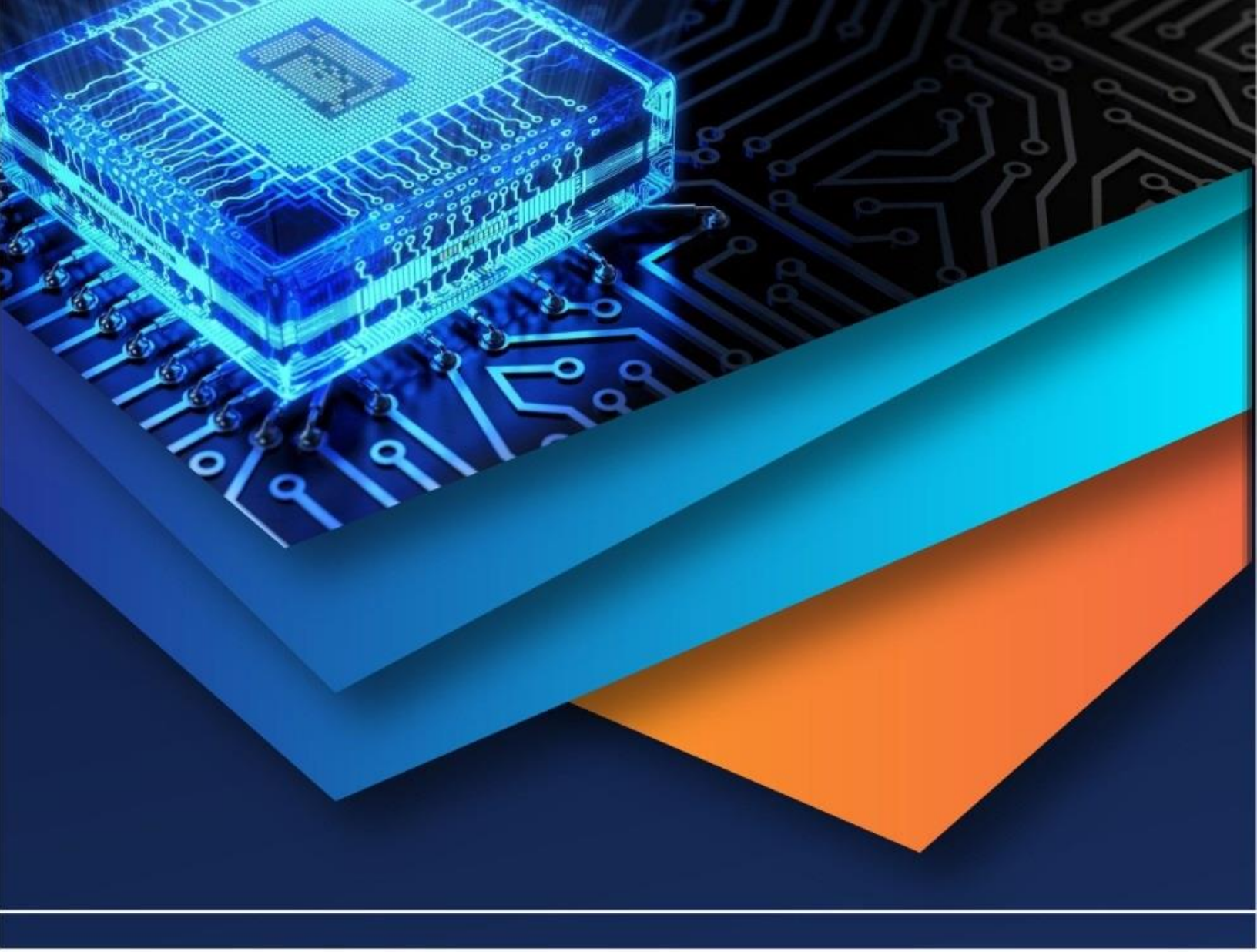
VIII. CONCLUSION

The wrong doing rate on the planet is extending now a days due to many reasons, for instance, increase in destitution, defilement, joblessness, etc. Assuming the wrongdoing has extended significant measures is taken by the police specialists to ponder why the wrongdoing rate has extended and besides how to diminish wrongdoing rate around there. The point of this paper is analyse the impact of combining the DTW algorithm with K-Means for efficient crime prediction and analysis. Analysis show that the hybrid approach out performs the purely K-Means algorithm based clustering approach. DTW has been applied to temporal sequences of video, audio and graphics data — indeed, any data that can be turned into a linear sequence can be analysed with DTW. Future work focuses on using DTW algorithm for analysing the different data like speech for criminal voice recognition.

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