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The Use of K-Nearest Neighbour Approach for Crime Rate Prediction in Public Universities: Case Study Adekunle Ajasin University, Akungba–Akoko (AAUA), Ondo State, Nigeria

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ABSTRACT

The prediction of crime rates has been a challenging problem for law enforcement agencies and policymakers. The main challenge in developing a predictive model for crime rate is the unavailability and quality of data. Crime data is often incomplete, inconsistent, and biased, which has always affected the accuracy of the scholars' designed model. For example, the use of traditional methods such as manual crime analysis and statistical analysis are often limited by the volume and complexity of the data. The need for a more accurate and efficient predictive model that can handle large and complex datasets is increasing. This research developed a predictive model using the KNN algorithm that is into accurate prediction of crime rates and helps policymakers to make better decisions. The KNN algorithm was implemented using Python programming language with scikit-learn libraries. The primary dataset was collected from security units of Adekunle Ajasin University, Akungba Akoko and Akungba police station. The Algorithm was implemented on a Laboratory Local Area Network at the Information and Communication Technology Application Centre (ICTAC), Adekunle Ajasin University, Akungba Akoko. The performance evaluation was based on precision, recall, and F1 score. The results show that the KNN algorithm can accurately predict crime rates with an average accuracy of 88%. The model demonstrates that the KNN algorithm can be a useful tool for predicting crime rates. In addition, the model is hoped to enhance crime prevention strategies, reduce crime rates, and ultimately improve the quality of life in university communities.

Keywords: Crime, Crime Rate, Prediction, K-Nearest Neighbour, Public Universities.

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1. INTRODUCTION

Crime is as old as mankind as revealed by scholars (Sowmyya, 2011). A crime is a form of violence or illegal act done by a perpetrator against another person that can cause harm or property damage and is punishable by the law of the governing state of authority in which the crime was carried out. Law authorities apply crime-solving techniques to take preventive measures. But, in many cases, they cannot deliver effective results (Dakalbab *et al.*, 2022). Over the years, crime rate has been on the increase within public universities. As the population of a country increases, crime rates within that country increases (Walczak 2021). This also impacts the accurate prediction of crime (Pratibha *et al*., 2020). Many crimes happen at regular intervals of time. As science and technology evolve, crime rate increases because criminal also are employing scientific approach to commit crimes. Crimes occurs everywhere from villages, towns to cities and of course, our citadel of learnings. Crimes are of different types – robbery, murder, rape, assault, burglary, house and store breaking, fraud, kidnapping, and homicide.

Many crimes are perpetrated in public universities. Among these is that of obtaining money fast or quick wealth which is called yahoo yahoo and yahoo++. Crime is not only committed in the public but also in Nigeria institution of higher learning especially Nigeria University. The fact is that as the crime rate becomes frequent, the negative effect is felt and it becomes a significant threat to every member of the university community. Since crime rate is increasing in Nigeria Universities, there is a need for a preventive technological approach to solve the challenge (Chung *et al*. 2012). This is because it has a direct impact on the student's quality of life as well as indirect consequences on the university image (Joo, 2012). The effective and practical approach to crime prevention is based on how to know in advance when, where, and what crimes will occur and who will commit them and why. Hence, modern policing are being used to tackle this challenge.

The focus is on the use of various information and data analyses such as SMART Policing, Predictive Policing, and Data-Driven Approaches to Crime (Kaste, 2018) (Folashade *et al.,* 2013), Mezie-Okoye and Denis, 2023).). For example, predictive analysis method, regression analysis, risk area analysis, data mining and others are attracting researchers attention today because most of the existing crime analysis algorithms only describe the past crime situation. To add more, some of these methods provide accurate and effective crime predictions by rapidly and effectively processing a wide variety of data such as time and space analysis (Tak *et al.,* 2015). While some of the models have contributed to the body of knowledge in crime prediction, however, the issue of finding a strong connection in the various features affecting crime, like the geographic features, age and gender is still a challenge. This paper addresses this by the use of KNN algorithm to develop a predictive model that can accurately predict crime rates.

The proposed model will helps policymakers to make better decisions in Nigeria Public University. The organization of this paper is as follow. Chapter two discusses about the literature review, in chapter three, the design of the proposed crime rate prediction system was discussed. Chapter four discussed results and discussion and ends with conclusion in chapter five.

2. LITERATURE REVIEW

Crime is a public wrong (Kennedy, 2021). Crime is a violation of the law of the state and is strongly disapproved of by society. Murder, robbery, burglary, rape, drunken driving, child neglect and failure to pay taxes are examples of crimes (Tappan, 1947). It can be punished by imprisonment or fine. No individual is a born criminal, it is the situations and the conditions around the individual which make him act as a criminal (Agnew, 1992). Sowmyya (2011) opined that there are several factors that make an individual turn into a criminal such as child neglect, broken homes, improper upbringing, lack of proper education, consumption of alcohol and drugs abuse and War and post-war conditions. Others factors of crime include, poverty and unemployment, emotional instability, etc. Crimes may be targeted to an individual person, a materialistic property and an individual moral values. To tackle this challenge, some scholars have adopted the use of predictive data analysis through the use of Machine Learning (ML).

Machine Learning is the study of computer algorithms that automatically improve through experience. Testing of machine learning models is done through validation errors on new data, not theoretical tests to validate null hypotheses. Machine learning is classified into unsupervised learning, supervised learning, and reinforcement learning (Kim & Song, 2018). Machine Learning algorithms were used to classify crime data to give a binary prediction. K-Nearest Neighbour is a supervised learning technique mostly used for classification and regression problems. It requires known data where usually the target variable is known beforehand. The prediction of a test observation is done based on the distance between observations. The idea of this algorithm is to find the K number of neighbours and given different classes assign a class to the unknown point.

Several researchers have worked on crime rate prediction but the application of these works has not reflected the anticipated level. Some of these works are reported as follows:

Bogahawatte and Adikari (2013) proposed an Intelligent Criminal Identification System (ICIS) which can potentially distinguish a criminal in accordance with the observations collected from the crime location for a certain class of crimes. The system uses existing pieces of evidence in situations for identifying a criminal by clustering mechanism to segment crime data into subsets, and the Nave Bayesian classification was used for identifying the possible suspects of crime incidents. The research proposed an intelligent criminal identification system using facial recognition technology to identify criminals based on their facial features. It achieved a high accuracy rate in identifying criminals but it relies on the quality of the facial images captured by the camera. However, if the image quality is poor, the accuracy of the system may be affected.

In Rasoul *et al.,* (2015), the authors proposed the analysis and prediction of crimes by clustering and classification to analysis and predict crime. The model classify clustered crimes based on occurrence frequently during different years. Data mining was used for analysis, investigation and discovering of patterns for occurrence of different crime. The authors applied a data mining techniques (clustering and classification) to real crime dataset recorded in England and Wales within 1990 to 2011. The authors were only able to extract crime pattern by crime analysis based on available criminal information and predict crime frequency using various data mining techniques.

The work of Rummens *et al.,* (2017), investigated the potential of applying predictive analysis in an urban context. The available crime data for three types of crime (home burglary, street robbery, and battery) are analyzed and applied an ensemble model to synthesis the results using logistic regression and neural network model. Resulting in bi-weekly predictions for 2014, based on crime data from the previous three years. The quality of the predictions is evaluated based on the following criteria: direct hit rate (proportion of incidents correctly predicted), precision (proportion of correct predictions versus the total number of predictions), and prediction index (ratio of direct hit rate versus proportion of total area predicted as high risk). The results show that it is possible to attain functional predictions by applying predictive analysis to grid-level crime data.

Al-Sa'di *et al.,* (2018) presented a deep learning-based approach to predict crime rates in different areas of a city. The authors used a convolutional neural network (CNN) to learn patterns in crime data and make predictions. The proposed deep learning approach achieved a high accuracy rate in predicting crime rates based on historical crime data. The system was tested on a dataset of crime data from the city of Los Angeles and achieved an accuracy rate of 95%. The system is also able to predict future crime rates with a high degree of accuracy, making it suitable for use in crime prevention and law enforcement. However, the system used only a limited dataset, which may not be representative of crime patterns in larger areas and it did not consider the impact of social and economic factors on crime rates.

Lopes and Gomes (2018) proposed a model for predicting crime hotspots in a city using spatio-temporal data mining techniques. The authors used a combination of clustering and association rule mining to identify high-risk areas for crime. The study achieves a high level of accuracy in identifying crime hotspots. The study concludes that spatio-temporal data mining can help in identifying crime hotspots and improving law enforcement strategies. However, small sample size dataset was used and it can only predict crime hotspots and did not predict overall crime rates. Gaikwad and Patil (2019) proposes a machine learning-based approach to predict crime rates using historical crime data. The authors used three different machine learning algorithms, including decision tree, random forest, and support vector machine, to build predictive models. The study concludes that the random forest algorithm performs best in terms of accuracy. The study used only small dataset which may not be representative of crime patterns in larger areas.

Linga *et al.,* (2020), developed a model for FBI crime analysis and prediction using machine Learning. The project evaluated a dataset containing a variety of crimes and forecast the types of crimes that may occur in a given place. The data need to be updated utilizing current trends such as web and apps for better results. Gaurav *et al.,* (2022), used a dataset of crime incidents in the city of Chicago, USA and applied machine learning algorithms to predict the occurrence of future crimes. The authors proposed an ensemble model combining the strengths of different algorithms to improve predictions accuracy.

While all these authors have applied machine learning approaches to various areas, the issue of how this could be used in the context of crime rate prediction in public universities is yet to be addressed to the best of my knowledge. For example, the work of Gaurav *et al.,* (2022) discussed on the strengths of different algorithms allowing the issue ethical or privacy concerns that may arise from the use of crime prediction models in practice especially in the context of University environment as a future work

The application of K-Nearest Neighbour approach to solve crime rate prediction problem in the university environment differentiate this work from others.

3. DESIGN OF THE PROPOSED CRIME RATE PREDICTION SYSTEM

The conceptual diagram of crime rate predictions system using KNN is presented in Figure 1. The system architecture consists of several components that work together to ensure accurate predictions of crime rates. One of the component is the data source which provides the dataset used for training and testing the KNN algorithm. Other components are data pre-processing, data training and data testing, KNN classifier and evaluation. The system architecture of crime rate predictions using KNN algorithm is designed to be scalable, accurate and efficient. The accuracy of the system depends on the quality and quantity of the data used to train the KNN algorithm. The system is limited by the availability of high-quality data and the computing power required to process large datasets.

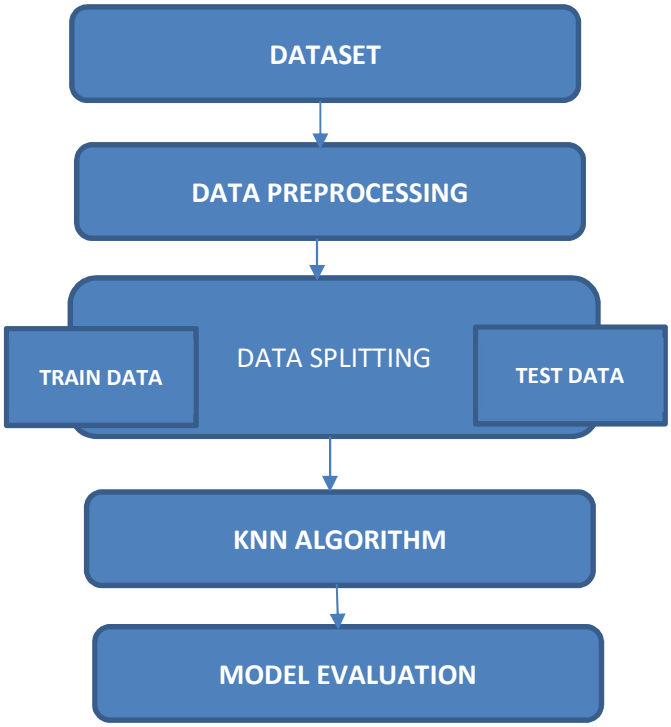

Figure 1: Architecture of the Proposed Crime Rate Prediction System

For the proposed model, the dataset used is primary data that is gathered from the security units of Adekunle Ajasin University (AAUA) and Akungba police station. This is presented in Table 1. In this Table, we have the area in the University campus and the community where crime are been committecd. For example, Adefarati and Medoline roads. There are different crimes in the University community in Akungba.

These are: Certificate forgery, room break-in, cultism, plagiarism, bullying fellow students, yahoo++, assault, ritual killing, kidnapping, suicide, rape, arbitrary upgrading of scores, examination malpractice (impersonation), embezzlement of fund, stealing and pilfering, sexual harassment, drug use and abuse offences.

However, findings showed the five most frequently crimes that happens on campus as depicted in Table 1 are: stealing and pilfering, room break-in, sexual harassment, cultism, and drug offences (Asiyai and Oghuvbu, 2020). This research focuses on cultism and drug offences, sexual harassment, and yahoo++ which are the most frequently committed crimes in AAUA and Akungba community. To solve this crime challenge, a primary dataset was collected from security units of Adekunle Ajasin University, Akungba Akoko and Akungba police station.

The research was conducted using the network of Adekunle Ajasin University, Akungba-Akoko, Nigeria as the test bed. In the Experimental setup, a KNN algorithm for predicting crime rate was modeled. The time interval at which updates occur during the data gathering was thirty (30) days period. The hardware components used in the development of the proposed model are: HHP, Intel-inside, 2 GHz processor, 4GB RAM, 64-bits OS.

The tools used for the model implementation include the Python 3.7.0 programming language and JupyterLab. The model is the product of training a machine learning algorithm with the training data (70%). The algorithm finds k-nearest neighbours of a record by identifying those records which are most similar to it in terms of common features. The algorithm assigns a class label based on a majority vote. In this classification problem, the most frequent label that occurs in neighbors is applied using discrete values. After the completion of these steps, the model provides the results which is descriptive. The accuracy of the results is evaluated by looking at how close the model's predictions and estimates match the known classes in the 30% testing set.

The k value in the k-neighbors classifier is determined by trying out k values and find the one that brings the best results on the testing set. There were cases of anomalies, that is, a large number of neighbors closely surrounding the unknown point, in such scenarios, we find different solutions for calculating k that are both time- and cost-efficient. K-distance is the distance between data points and a given query point. Euclidean distance was picked to calculate the K-distance.

Table 1: Crime Dataset showing the First 20 Rows

S/N	AREA (Location)	Cultism	Sexual Harassment	Yahoo++	Total	Class
1	Adefarati	946	1249	353	2548	2548
2	Medoline	35	30	19	84	84
3	Permanent site	6	52	37	95	95
4	Ibaka	491	116	14	621	621
5	Glo Mass	41	70	3	114	114
6	Small gate	8	16	2	26	26
7	Best Time	22	75	6	103	103
8	Palace	34	45	0	79	79
9	Apex	31	42	5	78	78
10	Ilale	47	58	3	108	108
11	AUD	166	155	37	358	358
12	Premier Perere	64	139	8	211	211
13	1st market	36	42	8	86	86
14	2nd market	47	56	6	109	109
15	Ugbelu	20	49	33	102	102
16	Akunmi	21	28	0	49	49
17	Araromi Road 1	45	35	0	80	80
18	Araromi Road 2	17	20	2	39	39
19	Araromi Road 3	19	35	4	58	58
20	G-Signature	105	166	14	285	285

Evaluation was carried out to find the best model that represents our data and how well the chosen model will work in future. Accuracy and mean score are the performance metrics used to measure behavior, activities, and performance of the model. Accuracy is the ratio of correct predictions to the total number of predictions. High accuracy implies that the model makes correct predictions most of the time.

$$Accuracy = \frac{CorrectPrediction}{CorrectPrediction + IncorrectPrediction}$$

$$Accuracy = \frac{TruePositive + TrueNegative}{TruePositive + FalsePositive + TrueNegative + FalseNegative}$$

F1 score depends on both the Recall and Precision, it is the harmonic mean of both the values. The higher the mean score the higher the expectation and vice versa.

$$Mean\ Score = \frac{Recall * Precision}{Recall + Precision}$$

The data is loaded and evaluated using epoch method with 80% training and 20% testing. This is presented in Figure 2.

```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import *
from sklearn.preprocessing import *
```

```
minmax = MinMaxScaler()
minmax.fit(X_train)
X_train = minmax.transform(X_train)
X_test = minmax.transform(X_test)
```

Figure 2: Importing KNN Model

4. RESULTS AND DISCUSSIONS

The pre-processed data were used to carry out this experiment and KNN Algorithm was used for the classification. The model was trained on 70% of the data collected, after training, the model was tested on unseen data of 30% to evaluate its performance as earlier stated. The results show that the KNN model achieved an accuracy of 88% in predicting crime rates as depicted in Figure 3. This high accuracy shows how reliable the model (KNN) is, considering the performance (validation accuracy) of the model in the experiments carried out. The contributions of this paper is the use of KNN algorithm to model crime rates prediction in the context of public universities in South West Nigeria, a case study of AAUA. This will assist the management and the security agencies to better manage crime on our campuses.

```
 ======== Accuracy Score ========

0.875 or 87.5%

 ======== Confustion Matrix ========

[[1 1]
 [0 6]]

 ======== Classification Report ========

              precision    recall  f1-score   support

        High       1.00      0.50      0.67         2
         Low       0.86      1.00      0.92         6

    accuracy                           0.88         8
   macro avg       0.93      0.75      0.79         8
weighted avg       0.89      0.88      0.86         8
```

Figure 3: Output of the Experiment

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Figure 4 shows the results of the distribution for cultism and drug related offences in AAUA and Akungba community where students live. Data collection were updated for a period of thirty days (30) period as earlier discussed. From the results as depicted in Figure 4, the rate at which cultism and drug related crimes will occur is higher in Adefarati area, this is followed by Ibaka area. Similarly, Adefarati area records the highest sexual harassment and yahoo++ related cases and depicted in Figure 5 and Figure 6 respectively.

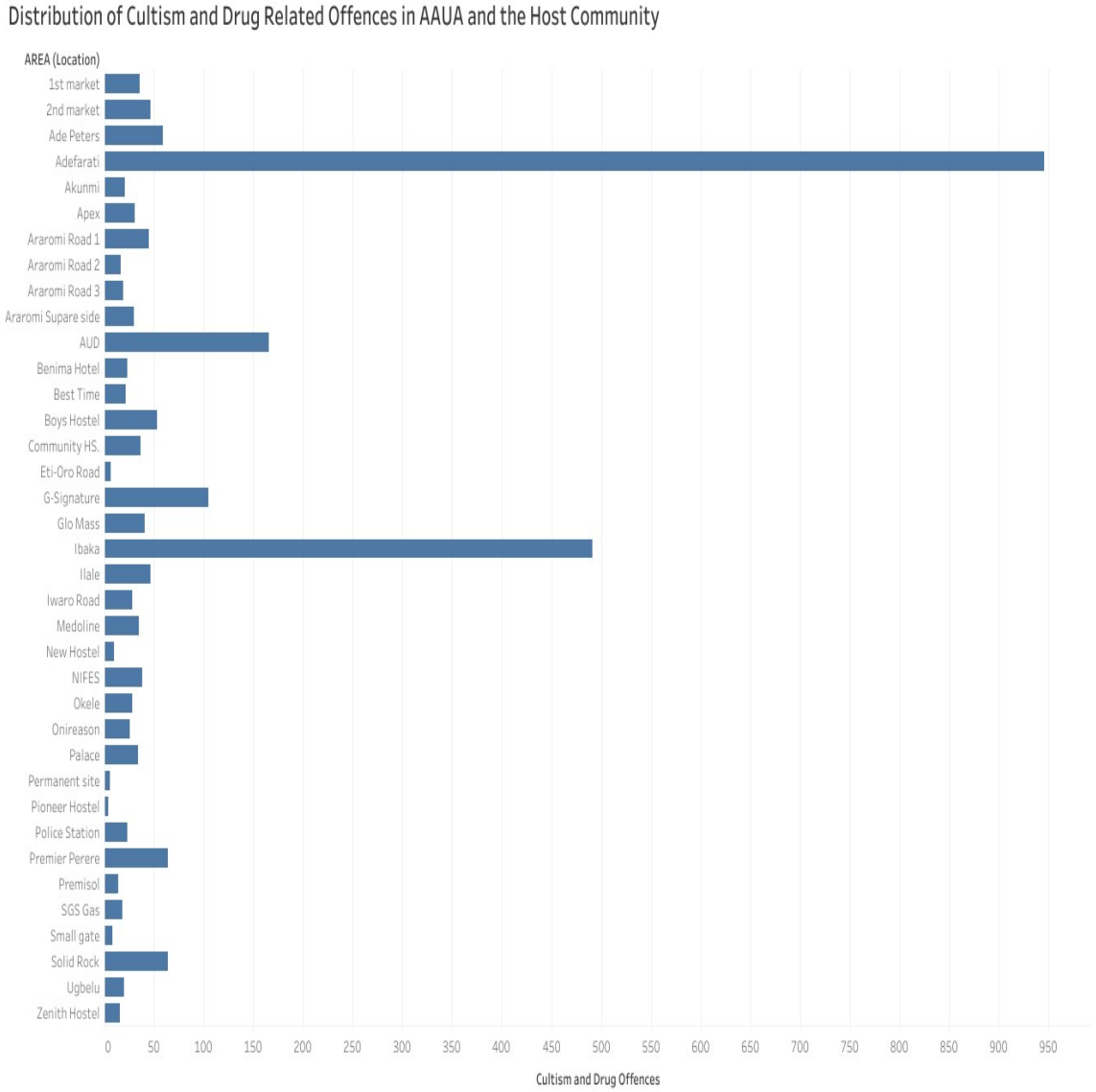

Figure 4: Cultism and Drug Related crimes

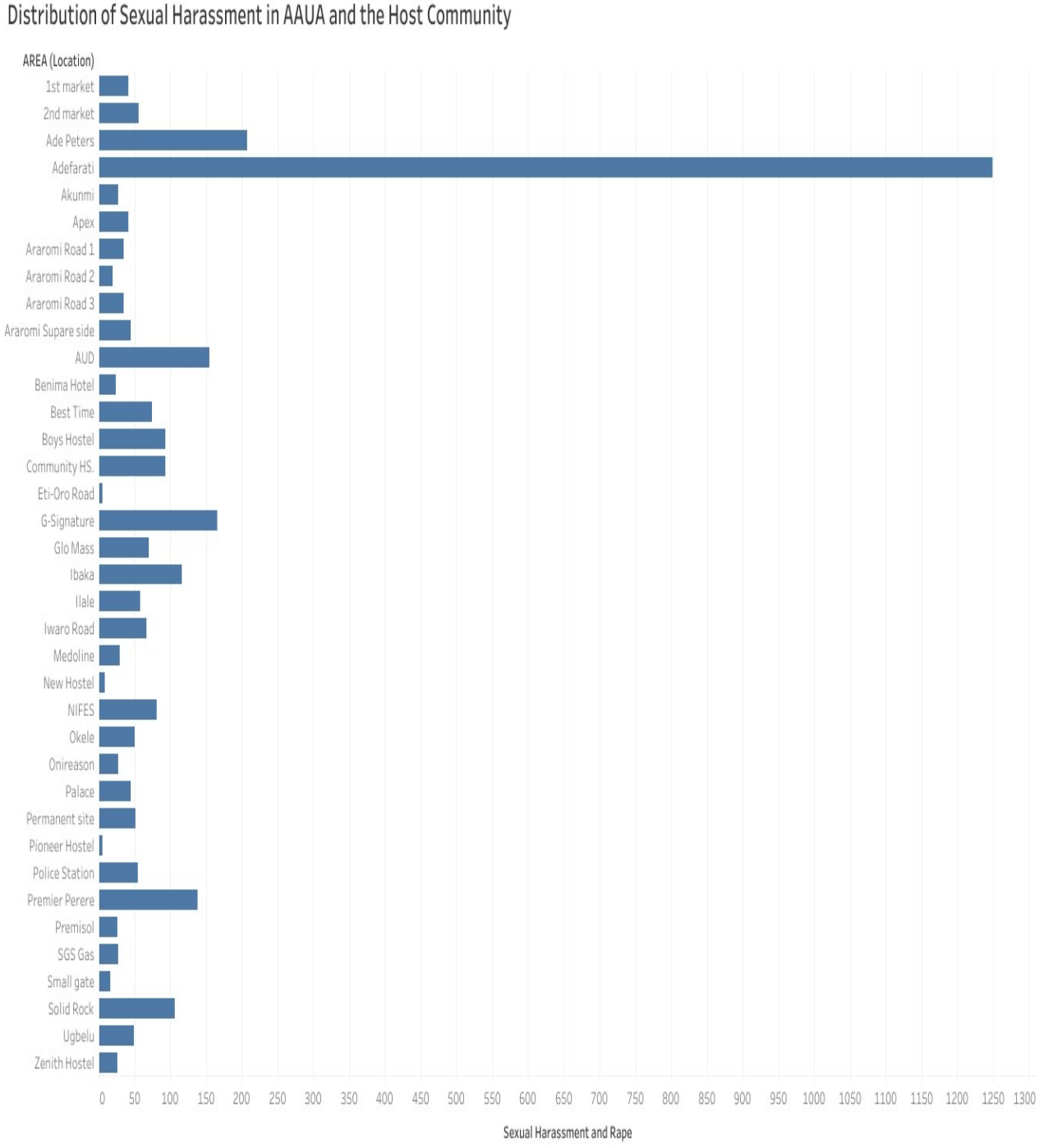

Figure 5: Sexual Harassment and Rape Related crimes

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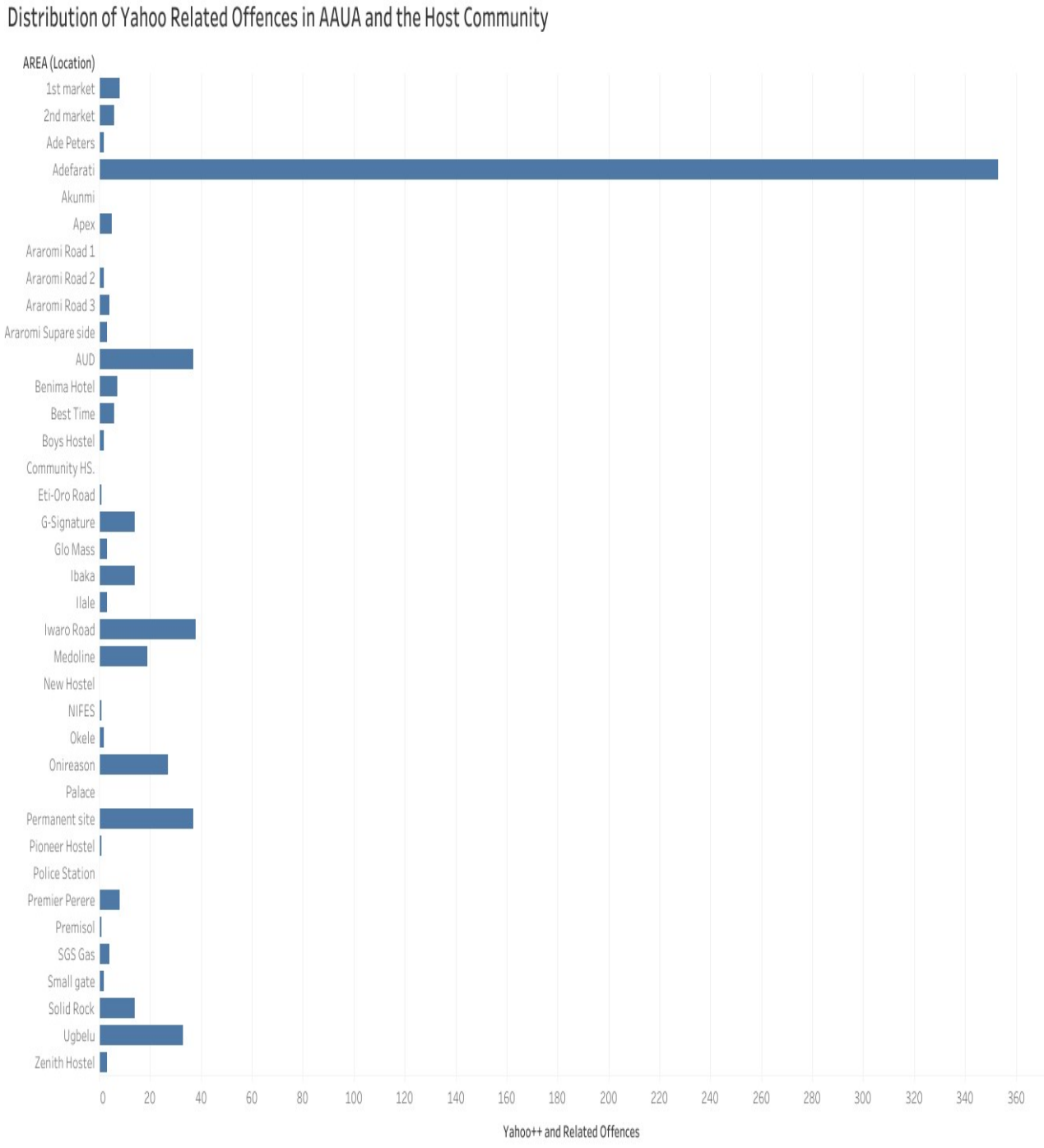

Figure 6: Yahoo Related crime

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From the crime rate prediction results presented in Figure 7, it was observed that the rate of crime in Adefarati area increased sharply for sexual harassment, cultism and yahoo++, which makes the area a potential spot for criminal activities. This visualization will help security operatives in carrying out their duty appropriately.

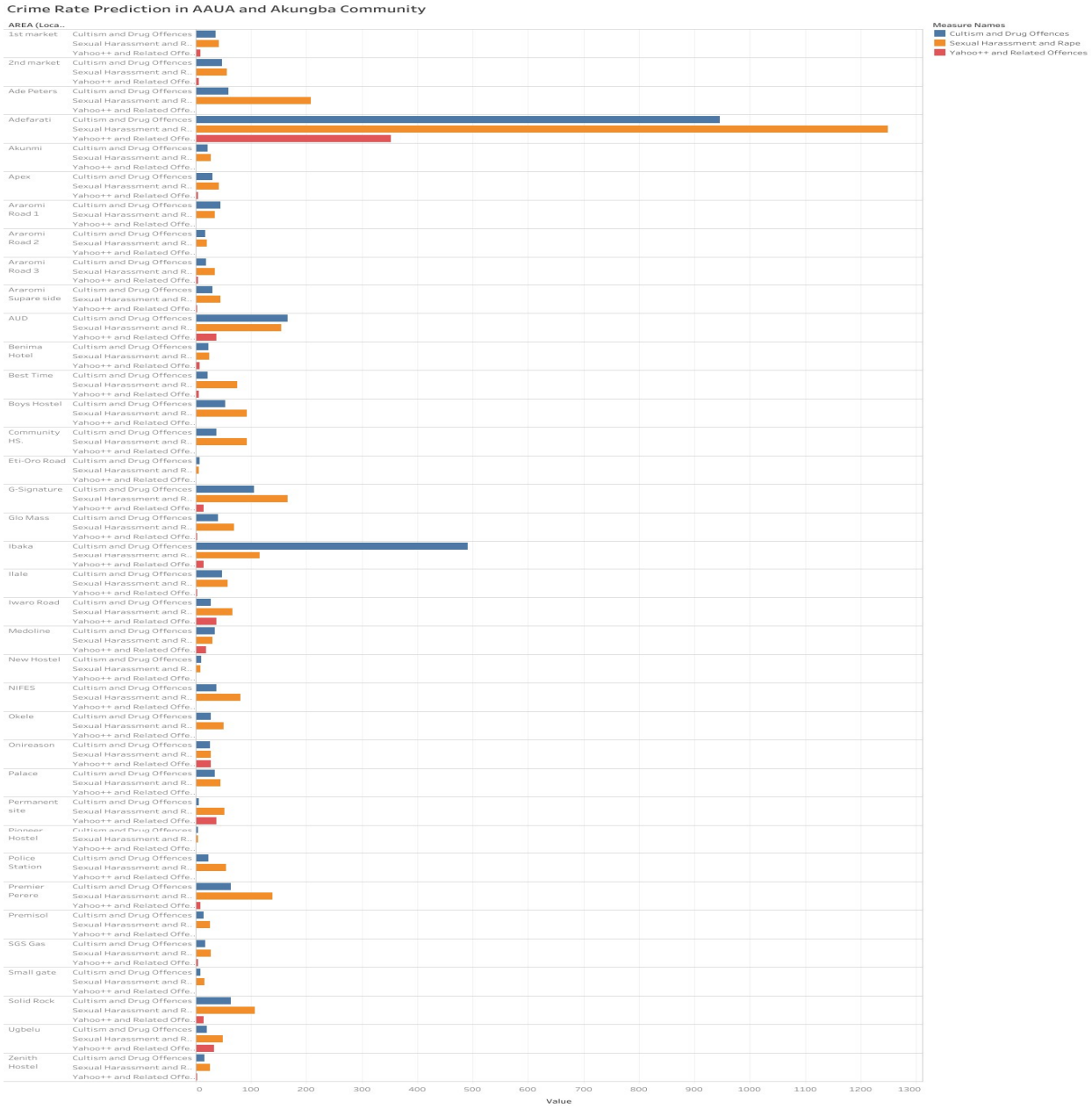

Figure 7: Crime Rate in AAUA and Akungba Community

5. CONCLUSION

Crime has been in existence since the creation of man. The impact of crime when its occurrence is very frequent is a significant threat to students, other members of the university and the host community. As science and technology evolve, crime rate increases because criminal also are employing scientific approach to commit crimes. To address the challenge, researchers have come up with several approaches to predict crime rates. However, the issue of prediction accuracy is still a challenge. Hence, there is need to develop a more accurate and efficient model for crime rate predictions. The focus of this research is in the area of modelling crime rate prediction using machine learning techniques. This work presents a K-Nearest Neighbor (KNN) algorithm based on the idea that a data point is most similar to its k-nearest neighbors in the feature space.

This proximity is used to predict the class label of a new data point. In this paper, a KNN model was used to predict crime rates in AAUA as a case study of public universities in South West Nigeria. The model was trained on historical crime data that included various features such as location and type of crime. After training, the model was tested on unseen data to evaluate its performance. The results showed that the KNN model achieved an accuracy of 88% in predicting crime rates. This high accuracy demonstrates the potential of the KNN algorithm in solving practical problems related to crime rate prediction. The simplicity and interpretability of the KNN algorithm also make it a valuable tool for policy makers and law enforcement agencies to understand the patterns and trends in crime.

The contributions of this work is the use of KNN algorithm to model crime rates prediction in the context of public universities in South West Nigeria, a case study of AAUA. This to the best of my knowledge is yet to appear in the literature. Future research will focus on incorporating additional features, more crime types and exploring alternative distance measures to further improve the performance of the KNN model in crime rate predictions. This will assist the management and the security agencies to better manage crime on our campuses.

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