DETECTING HUMAN TRAFFICKING USING NEURAL NETWORKS FROM TEXTUAL DATA

Dissertation Report

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CERTIFICATE

This is to certify that the Dissertation entitled, "*Detecting Human Trafficking Using Neural Networks from Textual Data*" and submitted by JANARDHANRAJ M, ID No. 2021C104077 in partial fulfillment of the requirements of DSECLZG628T Dissertation embodies the work done by him under my supervision.

Signature of the Supervisor
Place: Bangalore
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Abbreviations

ANN	**A**rtificial **N**eural **N**etwork
CNN	**C**onvolutional **N**eural **N**etwork
MLP	**M**utli **L**ayer **P**erceptron
LSTM	**L**ong **S**hort **T**erm **M**emory
RNN	**R**ecurrent **N**eural **N**etwork

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DSECLZG628T DISSERTATION

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Abstract

Human trafficking is one of the most atrocious crimes and among the challenging problems facing law enforcement which demands attention of global magnitude [2]."According to National Crime Record Bureau, 2,834, 2,914 and 2,222 children were trafficked in 2018, 2019 and 2020 [1], respectively. Over 4,700 people were trafficked in 2020, of which 1,377 were minor boys, and 845 were minor girls[3].In this study we will leveraging the textual data from websites (ex. locanto.in advertisements) and other news textual data about human trafficking for labeling. We extend using the neural network supervised algorithms for detecting human/child trafficking as the other work on same area of study uses Machine learning algorithms. Results from this study will compared with other methodology to demonstrate the effectiveness of training the neural network

Key words: Human trafficking, locanto ,Supervised Learning ,Neural Networks

Chapter 1

1. Introduction

Indian Human Trafficking is a pressing issue that has garnered global attention due to its scale and complexity. The country serves as both a source and destination for human trafficking, affecting millions of people, predominantly women and children [2].

According to the National Crime Records Bureau (NCRB) report of 2020, there were 3,663 reported cases of human trafficking in India, with 5,377 victims [1] [3].highlighting the severity of the problem. However, it is important to note that these figures may represent only a fraction of the actual cases, as many incidents go unreported due to fear, stigma, and lack of awareness. The root causes of human trafficking in India are multifaceted, including poverty, gender inequality, lack of education, and social discrimination. Vulnerable populations, such as those from marginalized communities, become easy targets for traffickers who exploit their desperation and lack of opportunities.

1.1 Internet Advent

With the advent of the Internet, human traffickers found a new and less risky platform to conduct their illicit activities, particularly in the sex trade. Prior to the digital era, they faced the constant threat of arrest while advertising their victims on the streets. However, the move to the online realm has allowed traffickers to exploit websites that host sexual services, such as escort, adult entertainment, and massage services, ensuring both sellers and buyers can maintain anonymity.

Although some websites have been shut down by government, there are still numerous platforms like in.locanto.com that continue to facilitate such services.

1.2 Social Media

Traffickers have also adapted their strategies, using dating and social networking sites like Twitter, Facebook, Instagram, and Tinder to connect with potential buyers and followers.

Online sex advertisements contain valuable data, but the process of obtaining reliable labels for this information is both tedious and expensive, even for a small subset of the data. [2]

1.3 Data Science /AI

Efforts are being made to leverage technology and artificial intelligence to automate the identification and analysis of online sex advertisements, assisting law enforcement agencies in their battle against human trafficking. Nonetheless, this remains an ongoing challenge, necessitating continued collaboration between technology companies, law enforcement, and anti-trafficking organizations to effectively combat this evolving menace.

1.4 Structure of thesis

This section briefly summarizes the rest of the chapters, outlining the report.

Chapter-2: The Data Preparation

This chapter will describe Data web scrapping to get data, Feature Engineering

Chapter-3: Data analysis

This chapter will describe the model architectures developed as part of this work.

Chapter-4: Model Building and Experiments

This chapter will describe the model output and comparison developed as part of this work.

Chapter-5: Conclusion

This chapter talks about conclusion and the future scope to extend this work.

Chapter 2

2. Data Preparation

We collected a sample of about 100+ publicly available listings posted on in.locanto.com in June 2023. Each post includes a

Title, description, time stamp, poster's age, location, ad link. [2]

The description usually lists the attributes of the individual(s) and contact phone numbers. In this work, we only focus on the textual component of the data. This free text data required significant cleaning due to a variety of issues common to textual analytics (i.e. misspellings, format of phone numbers, etc.). We also acknowledge that the information in data could be intentionally inaccurate, such as poster's name, age[2] Figure 2.1 shows an actual post from in.locanto.com

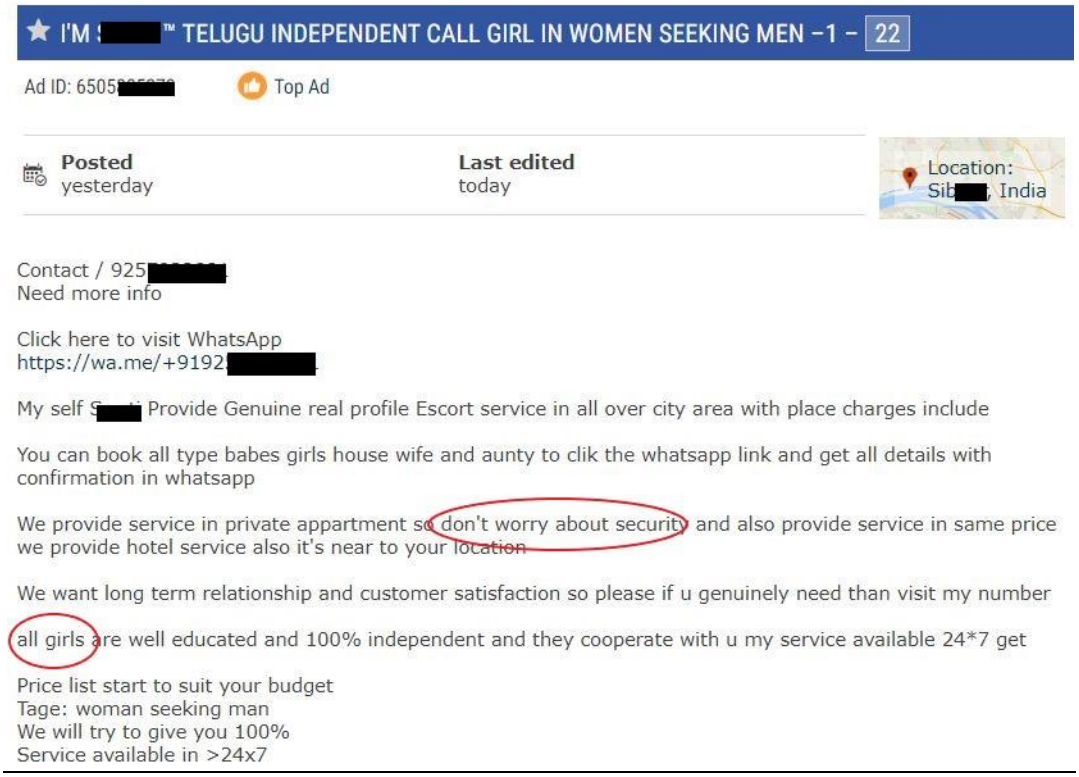


FIG 2.1: ACTUAL POST SCREEN SHOT FROM IN.LOCANTO.COM

2.1 Feature engineering/Feature selection

Above textual advertisement indicates several potential properties of human trafficking, including [2]young age, language pattern like plural forms (ex: Girls, Models, students etc.) In what follows, such common properties of human trafficking related advertisements are discussed in more detail. [2]

- ***Victim age***

[2]We take into account the age of the individual as a feature (if it is available) in range [16-20]. [2]This information is particularly useful assuming that for the most part, correlates with smaller and underage girls.

- ***Language Pattern***

In textual advertisement we look for third person language which mostly identify as feature for human trafficking ex: 'We will provide service ….'

- ***Multiple victims advertised***[2]

Some advertisements advertise for multiple women at the same time. We consider the presence of more than one victim as a potential evidence of organized human trafficking words like 'girls', 'models' ,'students' help us to identify these features etc[2]..

- ***Phrases and sentences***

Advertiser normally use the phrases like 'provide premium service....', 'very secure… ','service available 24x7…', 'call anytime… ' etc... We thus investigate within the description to see if they contain such words as they could be highly related with human trafficking in general.

- ***Reference to website or spa massages therapy***

The presence of a link in the Description either referencing to an outside website (especially infamous ones) or spa massage therapy could be an indicator of more elaborate organization [6]. In particular, in case of spa therapy, we observed many advertisements interrelated with advertising for human trafficking[2]

B	C	D	E	F	G	H	I	J	K	L	M
Title	Age	description	date_posted	url							
CALL GIRL	21	Hyy guyshttps://wa.me/+919358	Posted less than a week ago	https://howrah.locanto.me/ID_6576170707/CALL-GIRLS-IN-RIYA-24X7-HOT-SEXY-BEST-HOUSEWIFE-LOW-CO							
NO ADVAI	21	NO ADVANCE DIRECT PAYMENT H	Posted one hour ago	https://bangalore.locanto.me/ID_6581184903/NO-ADVANCE-OUT-CALL-DOOR-STEP-INDEPENDENT-CALL-GIR							
CALL GIRL	21	PROFESSIONAL ESCORT SERVICES	Posted two hours ago	https://bangalore.locanto.me/ID_6581167848/CALL-GIRLS-IN-JP-NAGAR-HOT-SEXY-INDEPENDENT-GIRL-SERV							
Sneha ind	21	Sneha 8861589137 Hand cash/or	Posted less than a month ago	https://bangalore.locanto.me/ID_6556793452/Sneha-independent-kannada-girl-call-me.html							
				https://bangalore.locanto.me/ID_6581186318/CALL-GIRL-IN-JP-NAGAR-LOW-COST-DOORSTEP-HIGH-PROFILE							
Call Ammu	21	Get in touch in WhatsApp now D	Posted two hours ago	https://bangalore.locanto.me/ID_6581175222/Call-Ammu-1500-shot-5500-night-call-girl-available-for-se.htm							

Fig 2.2: Raw Dataset after Web scrapping

2.2 Data Cleaning & Data preparation

The data we have arrived is in raw form which means it requires being clean for Data processing; the raw dataset contains the title, the age, description of the ad and URL as per our feature selection process.

Below steps are followed as part of cleaning and Data preparation

Step 1:

Data set was checked for Null values and Nan values, if any observation with Null/Nan values were dropped from dataset

Step 2:

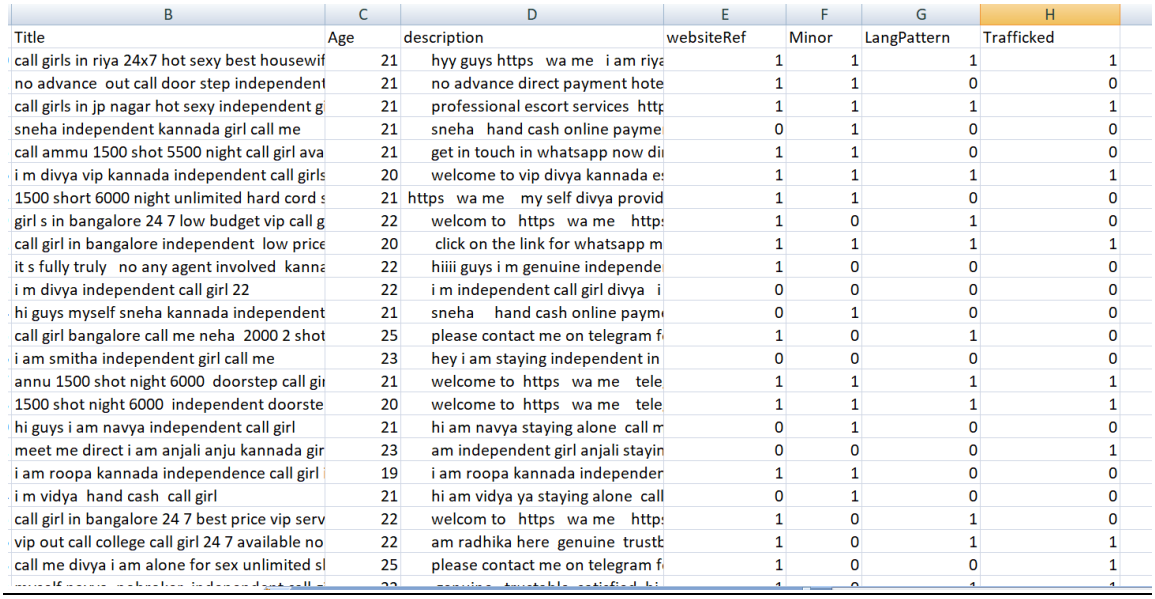
Unnecessary columns which doesn't helps us in Model build doesn't correlate to Target variable are removed

Step 3:

Ad Description column was cleaned by checking the Escape character, Special character, and white spaces same is done for Title columns

Step 4:

New columns were added based on the cleaned Description values (**Textual Data)**, such as 'website reference' 'Minor', 'Language Pattern' and 'Trafficked' (Target)



B	C	D	E	F	G	H
Title	Age	description	websiteRef	Minor	LangPattern	Trafficked
call girls in riya 24x7 hot sexy best housewif	21	hyy guys https wa me i am riya	1	1	1	1
no advance out call door step independent	21	no advance direct payment hote	1	1	0	0
call girls in jp nagar hot sexy independent g	21	professional escort services http	1	1	1	1
sneha independent kannada girl call me	21	sneha hand cash online payme	0	1	0	0
call ammu 1500 shot 5500 night call girl ava	21	get in touch in whatsapp now di	1	1	0	0
i m divya vip kannada independent call girls	20	welcome to vip divya kannada es	1	1	1	1
1500 short 6000 night unlimited hard cord s	21	https wa me my self divya provid	1	1	0	0
girl s in bangalore 24 7 low budget vip call g	22	welcom to https wa me https	1	0	1	0
call girl in bangalore independent low price	20	click on the link for whatsapp m	1	1	1	1
it s fully truly no any agent involved kanna	22	hiiii guys i m genuine independe	1	0	0	0
i m divya independent call girl 22	22	i m independent call girl divya i	0	0	0	0
hi guys myself sneha kannada independent	21	sneha hand cash online payme	0	1	0	0
call girl bangalore call me neha 2000 2 shot	25	please contact me on telegram f	1	0	1	0
i am smitha independent girl call me	23	hey i am staying independent in	0	0	0	0
annu 1500 shot night 6000 doorstep call gi	21	welcome to https wa me tele	1	1	1	1
1500 shot night 6000 independent doorste	20	welcome to https wa me tele	1	1	1	1
hi guys i am navya independent call girl	21	hi am navya staying alone call m	0	1	0	0
meet me direct i am anjali anju kannada gir	23	am independent girl anjali stayin	0	0	0	1
i am roopa kannada independence call girl	19	i am roopa kannada independer	1	1	0	0
i m vidya hand cash call girl	21	hi am vidya ya staying alone call	0	1	0	0
call girl in bangalore 24 7 best price vip serv	22	welcom to https wa me https	1	0	1	0
vip out call college call girl 24 7 available no	22	am radhika here genuine trustb	1	0	1	1
call me divya i am alone for sex unlimited sl	25	please contact me on telegram f	1	0	0	1

Fig 2.3: Clean Data set

Chapter 3

3. Data analysis

As I generated the new cleaned dataset I started the conventional process analyzing the data set, starting from statistical ex: mean, median data analysis up to the data visualization

	Age	websiteRef	Minor	LangPattern	Trafficked
count	172.000000	172.000000	172.000000	172.000000	172.000000
mean	21.912791	0.639535	0.470930	0.337209	0.360465
std	1.815611	0.481537	0.500612	0.474137	0.481537
min	18.000000	0.000000	0.000000	0.000000	0.000000
25%	21.000000	0.000000	0.000000	0.000000	0.000000
50%	22.000000	1.000000	0.000000	0.000000	0.000000
75%	23.000000	1.000000	1.000000	1.000000	1.000000
max	38.000000	1.000000	1.000000	1.000000	1.000000

Fig 3.1 Statics of new Dataset

We can observe from above table that Mean age of female is around **21 years** which is baseline for Minor and also we it notifies that **25%** data falls under age **21** and minimum age is **18 years** which clear indication of human trafficking

The stats table also indicates the nearly **47%** of Minor in Dataset as its mean. As we have assumed the Minor in range 16 -21 years as discussed in Feature Selection Process.

We will now try analyzing other columns individual and also the textual data using Data visualization

3.1 Data Visualization

Correlation between the independent Variables as we have limited columns Correlation heat map will be better visualization.

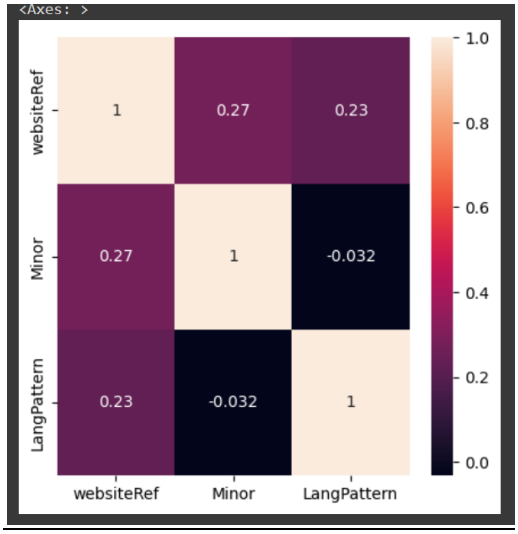


Fig 3.2: Correlation heat map between independent columns

Correlation heat map between Independent and the dependant variable, we can see the '**Minor**' and '**LangPattern**' is highly correlated with Trafficking as it helps in detecting it.

This confirms us the Human Trafficking can be detected with Language used in Ad postings

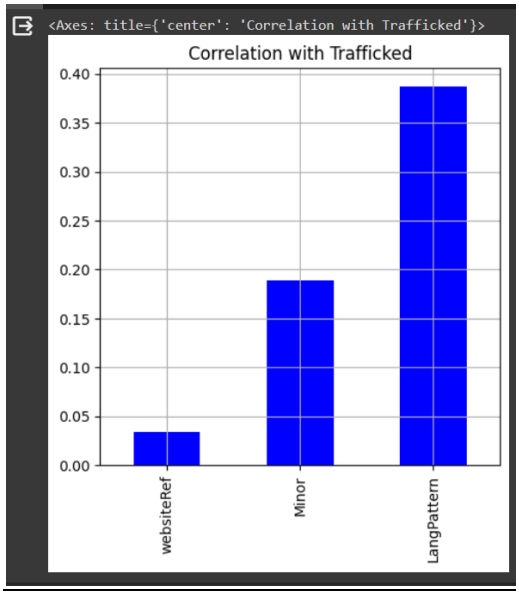


Fig 3.3: Correlation heat map between targets

As next step we have visualize the words being used in Ad which will helps us identify the trafficked female victims , with this visualization it might help us in identifying the words which are frequent used by traffickers which will also helps to build better models

Here we are using Word cloud to visualize the Ad 'Description' and 'Title' columns

Fig 3.4: Word cloud for Description

This word map or word cloud for description column shows the most frequently used in each observation, ex: girl, woman, service, escort and the locality

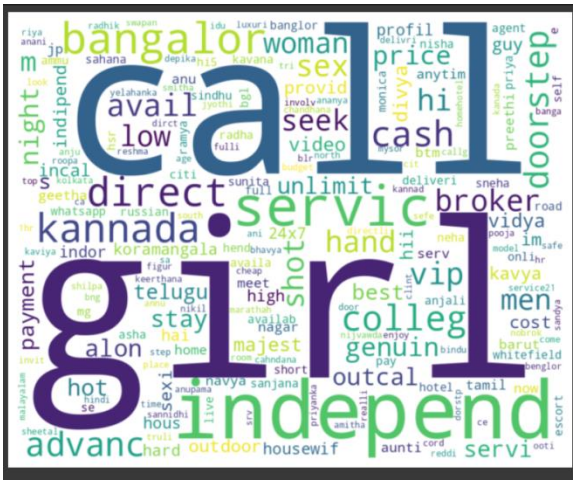


Fig 3.5: Word cloud for Title

This word map or word cloud for description column shows the most frequently used in each observation, ex: call , girl, woman, service, escort and the locality

Chapter 4

4. Model Building and Experiments

As a next step of the project I proceed with experimenting with Dataset after exploratory data analysis as we got idea about the Dataset, The main goal of this project is to exploit the Artificial Neural Network to detect the human trafficking to achieve it we need to do a comparison test with other Machine Learning models available.

I started to experiment with **Decision Tree**, **Logistics Regression ,Random Forest** and **Naives Bayes** machine learning models and Explore the ANN starting with '**Simple ANN Model** (2 layer) , **ANN with Multi layer and Optimizer**, **ANN with Sigmoid Function** and **ANN with Tanh Function**

The suggested approach is to experimented with generated dataset to find the perfect ANN model

Decision Tree

Decision tree is supervised learning algorithm method used for classification and regression modeling. It create model that predicts the target variable by learning simple decision rules .In our case we use the ad descriptions as our dependent variable and **Trafficked** as target variable , description values are split into token with help of NLP library to create dependent variables.

Logistic Regression

This method is again Supervised learning algorithm is best suited for Binary classification as in our case. In our case we use the ad descriptions as our dependent variable and **Trafficked** as target variable, description values are split into token with help of NLP library to create dependent variables.

Naives Bayes

This ML modeling is a based on Supervised learning algorithm the only difference is this modeling based on Probabilistic classifier methodology based on *Bayes Theorem,* It is best suited high dimensionality features and better for text involved features.

Random Forest

We will experiment with Random Forest which is ensemble learning method instead of learning from One decision tree this method will contain different decision tress takes subset finds the average to improve the predictive accuracy. As this resolves the over fitting issue in single decision.

Artificial Neural Networks

This is our main goal of project where we experiment with dataset with neural network starting simple neural network with addition of layers, with and without activation functions.

- **Simple ANN Model** (2 layer) :This model is very simple only 2 layer without activation function and optimizer

```
BiModelV0(
(layer_1): Linear(in_features=1411, out_features=5, bias=True)
(layer_2): Linear(in_features=5, out_features=1, bias=True)
)
```

- **ANN with Multi layer with Optimizer :**This model is experiment multiple layer with SGD optimizer

```
BiModelV1(
(layer_1): Linear(in_features=1411, out_features=10, bias=True)
(layer_2): Linear(in_features=10, out_features=5, bias=True)
(layer_3): Linear(in_features=5, out_features=5, bias=True)
(layer_4): Linear(in_features=5, out_features=1, bias=True)
)
```

- **ANN with Sigmoid Function**: This model is experiment multiple layer with optimizer and sigmoid function.

```
Sequential(
(0): Linear(in_features=1411, out_features=10, bias=True)
(1): Linear(in_features=10, out_features=20, bias=True)
(2): Linear(in_features=20, out_features=1, bias=True)
(3): Sigmoid() )
```

- **ANN with Tanh Function**: This model is experiment multiple layer with optimizer and Tanh function.

```
Sequential(
(0): Linear(in_features=1411, out_features=10, bias=True)
(1): Linear(in_features=10, out_features=5, bias=True)
(2): Linear(in_features=5, out_features=2, bias=True)
(3): Linear(in_features=2, out_features=1, bias=True)
(4): Tanh() )
```

Conclusion

On comparative study on above model with given data set we can see that in Machine Learning modeling Naïve Bayes Tree and Logistics regression provide better accuracy of 77% and 62% respectively and ANN with Tanh activation function provide decent accuracy in range of 50%-68% across the models with shallow dataset observation 200+

Naïve Bayes and Logistics regression better accuracy might be over fitting the model with limited data points in case Random Forest the Accuracy is reduced as it resolves the Over fitting issue. This as indication we can rely on ANN modeling.

ANN architecture gives decent accuracy in predicting the human trafficking and they are consistent across the models and reliable which doesn't depend on dimensionality of the dataset. As we tune the model such layers, learning rate and optimizer we can improve the model for real-time scenario.

As we conclude ,Though there is overlap of accuracy between machine learning modeling and Deep Neural network we opt for neural network in detecting human trafficking as it reliable in case limited data point and abundant data point

Chapter 5

5. Future Work

With limited data point we are able achieve a promising Accuracy with ANN models we can explore other Deep neural networks architecture like CNN, LSTM and RNN etc as future of work which can read the Ads and can detect the human trafficking in real time .In our experiment we had challenges such we didn't had standardized list of words/phrase which will identify a Human trafficker language ,More experiment can be performed carried out here to come up with standard list of words Human trafficker use in his/her Ad postings especially in India.

The other challenge we encountered is most of dataset available in public forum are very historical and from single public institute i.e. those data helps only analyze the human trafficking pattern of the past but doesn't help in prevent the human trafficking on the go ,so more of data source needs to considered in future

Appendix A

Experimental Results

The results obtained from multiple architectures and models are as follows. The datasets which is web scrapped were used for training the model .

ML models Architectures

Decision Tree

Classes	Precision	Recall	F-1 score
1	0.65	0.79	0.71
0	0.67	0.50	0.57
Macro average	0.66	0.64	0.64
Weighted average	0.66	0.66	0.65

Table A.1: Classification report of Decision Tree

1 - Trafficked Victim
0 – Not a trafficked victim

The accuracy of the model during testing is 65%.

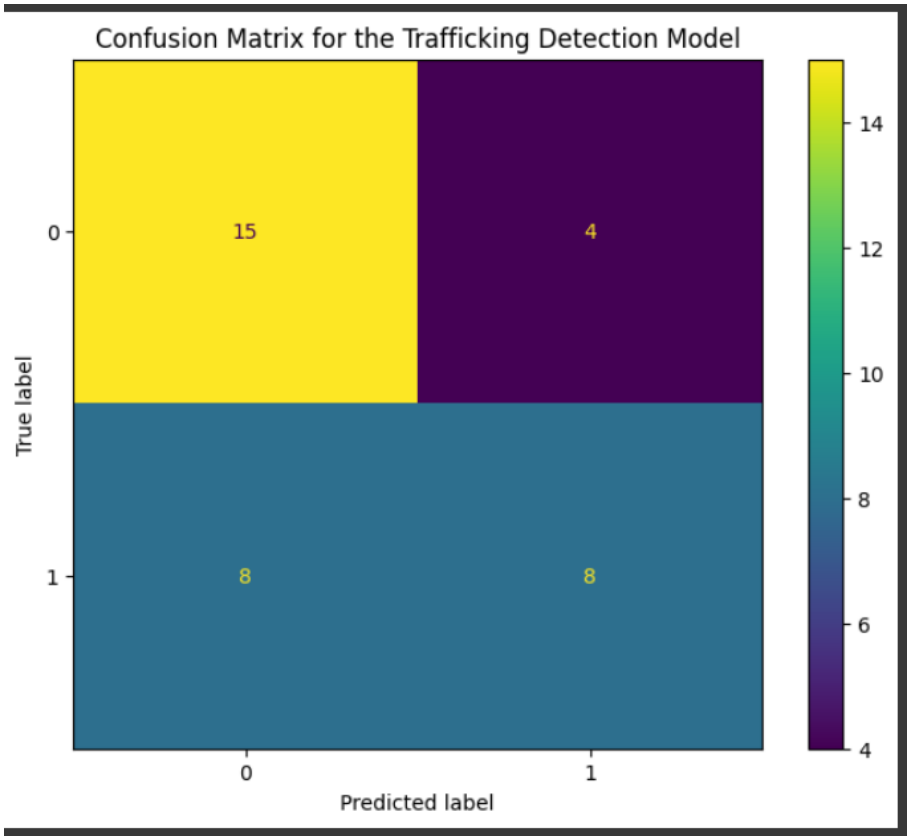


FIG A.1: Confusion Matrix for Decision Model

Naïve Bayes Classifier

Classes	Precision	Recall	F-1 score
1	0.83	0.83	0.83
0	0.67	0.67	0.67
Macro average	0.75	0.75	0.75
Weighted average	0.77	0.77	0.77

Table A.2: Classification report of Naïve Bayes

1 - Trafficked Victim
0 – Not a trafficked victim

The accuracy of the model during testing is 77%.

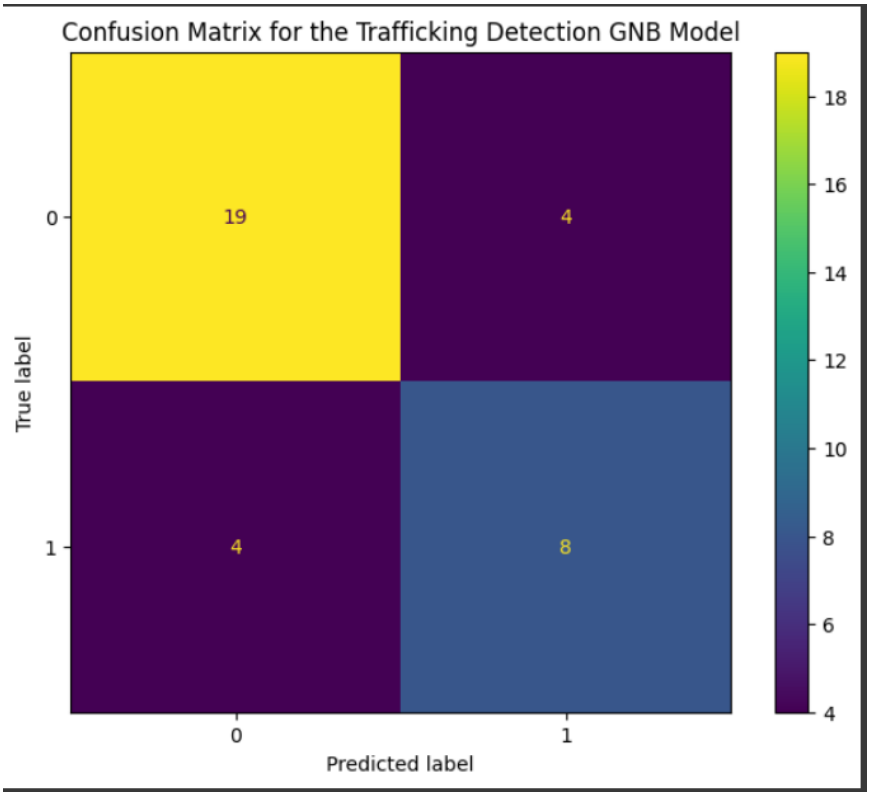


FIG A.2: Confusion Matrix for Naïve Bayes Model

Random Forest Classifier

Classes	Precision	Recall	F-1 score
1	0.75	0.65	0.70
0	0.47	0.58	0.52
Macro average	0.61	0.62	0.61
Weighted average	0.65	0.63	0.64

Table A.3: Classification report of RF

1 - Trafficked Victim
0 – Not a trafficked victim

The accuracy of the model during testing is 64%.

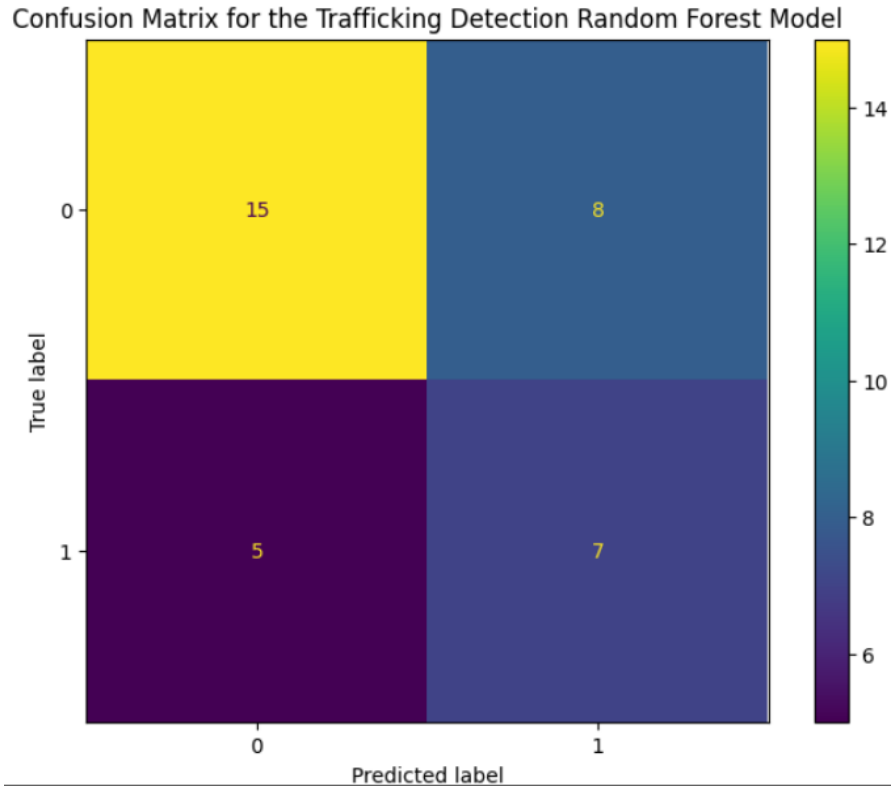


FIG A.3: Confusion Matrix for RForest Model

Logistic Regression

Classes	Precision	Recall	F-1 score
1	0.82	0.61	0.70
0	0.50	0.75	0.60
Macro average	0.66	0.68	0.65
Weighted average	0.71	0.66	0.67

Table A.4: Classification report of LR

1 - Trafficked Victim
0 – Not a trafficked victim

The accuracy of the model during testing is 67%.

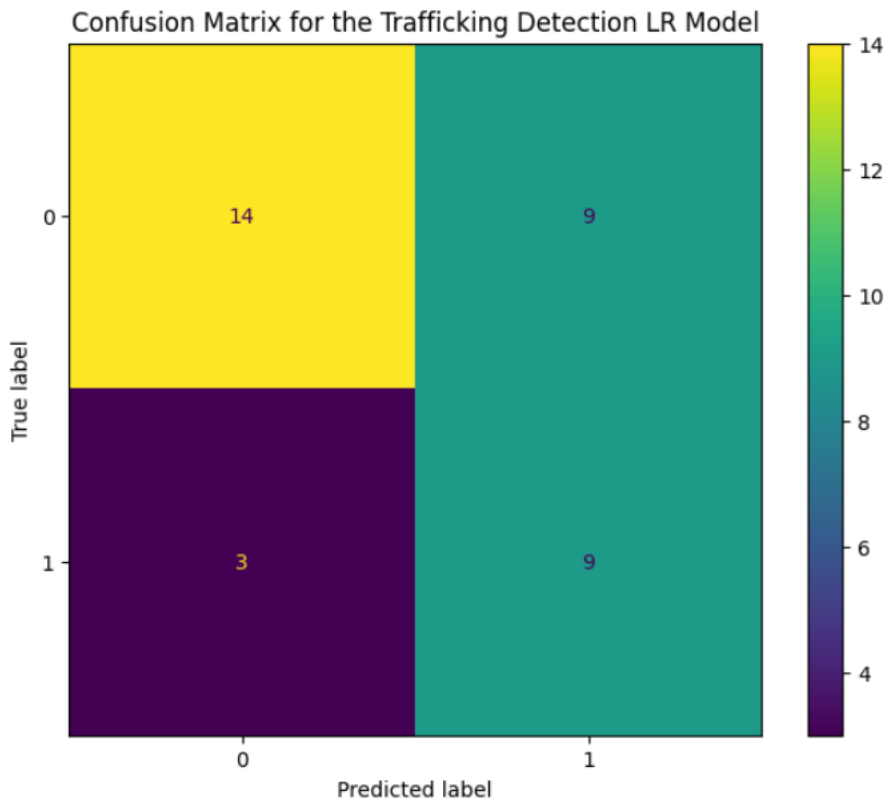


FIG A.4: Confusion Matrix for LR Model

ANN models Architectures

The Tuning for all the ANN are Epoch =50 and Learning Rate =0.2 and Optimizer is SGD

Model 0: Simple ANN Model (2 layer)

Classes	Precision	Recall	F-1 score
1	0.60	0.13	0.21
0	0.33	0.83	0.48
Macro average	0.38	0.38	0.34
Weighted average	0.42	0.34	0.34

Table A.5: Classification report of Model 0

1 - Trafficked Victim
0 – Not a trafficked victim

The accuracy of the model during testing is 34%.

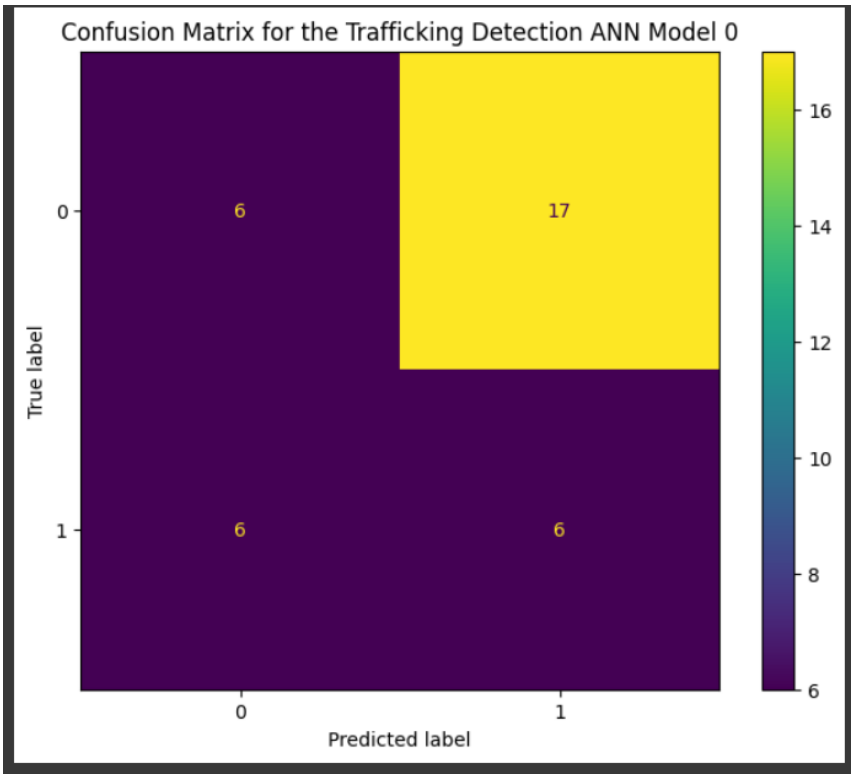


FIG A.5: Confusion Matrix for Model 0

Model 1 : ANN with Multi layer and Optimizer

Classes	Precision	Recall	F-1 score
1	0.65	0.96	0.77
0	0.00	0.00	0.00
Macro average	0.32	0.48	0.39
Weighted average	0.43	0.63	0.62

Table A.6: Classification report of Model 1

1 - Trafficked Victim
0 – Not a trafficked victim

The accuracy of the model during testing is 62%.

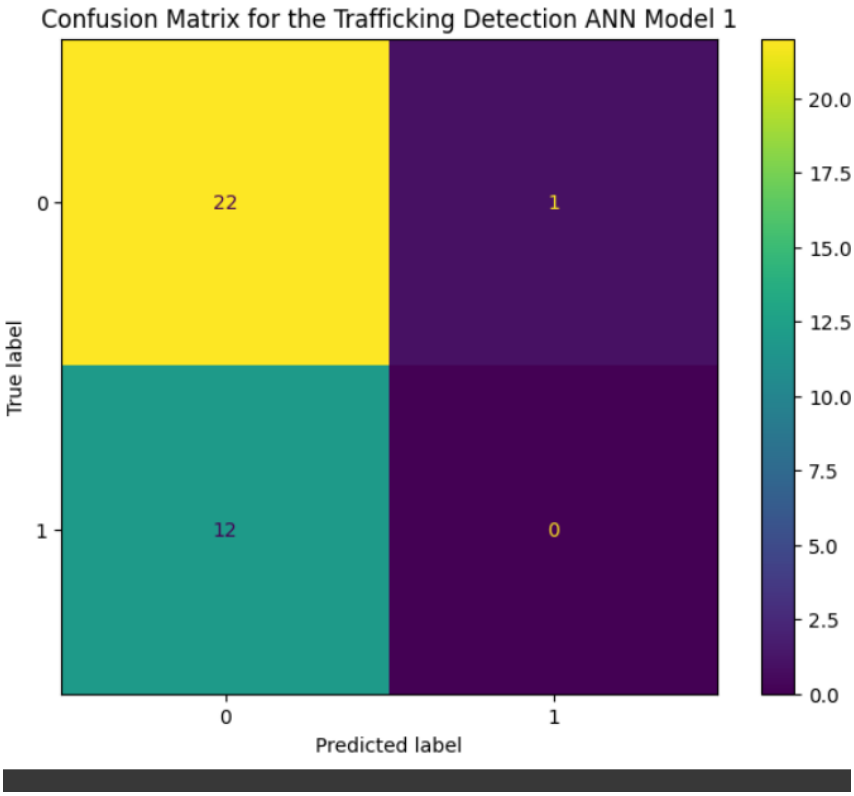


FIG A.6: Confusion Matrix for Model 1

Model 2 : ANN with Sigmoid Function

Classes	Precision	Recall	F-1 score
1	1.0	0.04	0.08
0	0.35	1.00	0.52
Macro average	0.68	0.52	0.30
Weighted average	0.78	0.37	0.23

Table A.7: Classification report of Naïve Bayes

1 - Trafficked Victim
0 – Not a trafficked victim

The accuracy of the model during testing is 37%.

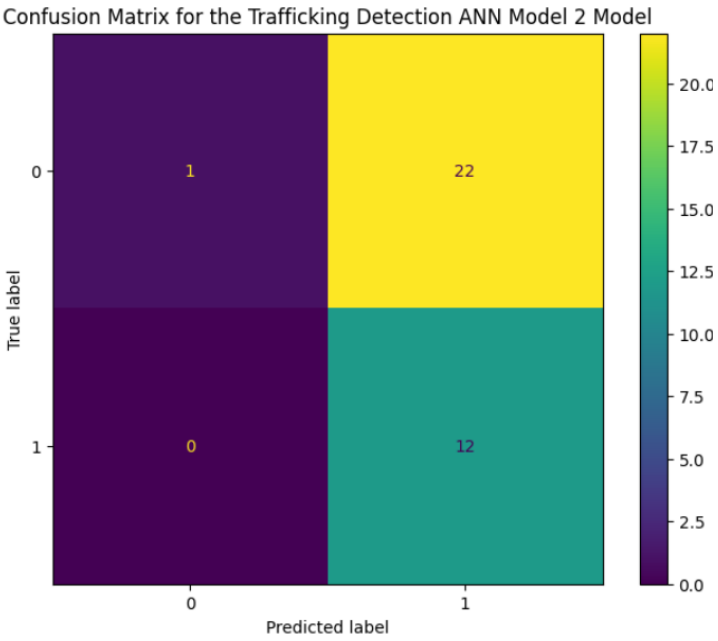


FIG A.7: Confusion Matrix for Model 2

Model 3 : ANN with Tanh Function

Classes	Precision	Recall	F-1 score
1	0.83	0.65	0.73
0	0.53	0.75	0.62
Macro average	0.68	0.70	0.68
Weighted average	0.73	0.69	0.68

Table A.8: Classification report of Model 2

1 - Trafficked Victim
0 – Not a trafficked victim

The accuracy of the model during testing is 68%.

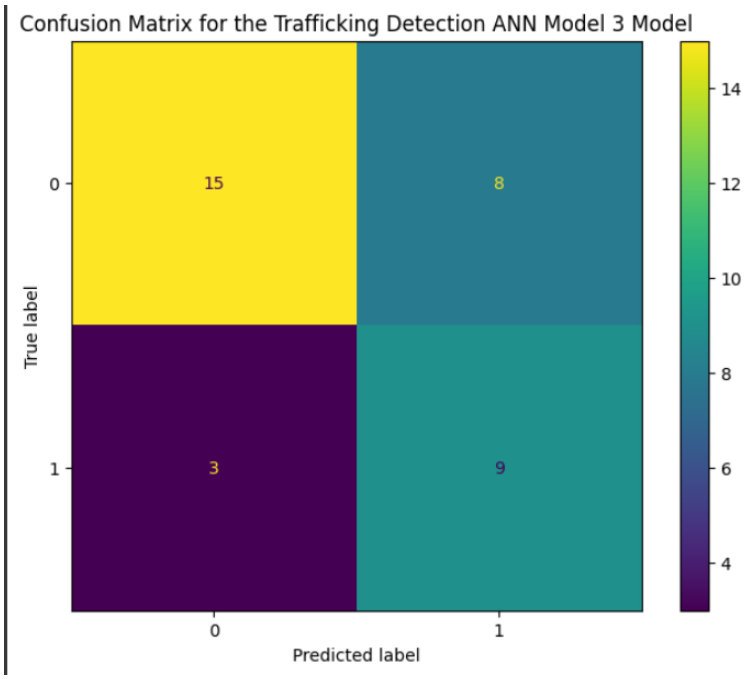


FIG A.8: Confusion Matrix for Model 2

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