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Personality Prediction Model

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***Abstract*— Many machine learning applications may be found in our daily lives, but one of the most essential applications is utilizing a prediction model to classify people based on their personality traits. Every person on the earth is one- of-a-kind and has their own personality. For research in the field of characteristics of human behavior and psychology, perception and predicted actions of human, information on users and how they express themselves physically and emotionally is valuable. In this sector, similar investigations have been undertaken, and it is still increasing. Personality-based communications are particularly effective at increasing product and service acceptance and attractiveness. This project intends to develop a system that uses the user's information to forecast a person's personality and give the user insights of the behavior of the user whose information has been provided, and to compare the results by performing extensive research. This project goal is to create a UI based system (Software) to predict the personality traits of the user based on the data provided by user.**

***Index Terms*—personality traits, algorithms, plots, machine learning, datasets**

I. INTRODUCTION

The idea is built on applying machine learning algorithms and big 5 models to determine an individual's personality. Both his personal and professional lives are influenced by a person's personality. This research explores all of a person's behavioral attributes using a machine learning prediction system with numerous factors and values allocated to each person, focusing on the need to understand humans on a deeper level.

All personality predictions are based on the BFFM (Big Five Factor model). It comprises of basic four positive and one negative behavioral feature. They are as follows: -

Openness to new experiences, conscientiousness (C), extraversion (E), agreeableness (A), and neuroticism (N) are the five personality qualities (N) (N). The BFFM (Big Five Factor model).The OCEAN model is another name for the model.

Open to New Things: It encompasses traits like inventiveness, sensitivity, and attentiveness, among others002E

II. LITERATURE SURVEY

Bonding, connecting, and connection have all been demonstrated to be influenced by human personality. According to studies, employers request social profiles from job applicants on application forms in order to understand more about their personalities and offer them work that they excel at. To prevent a lack of shared interest, organize groups of people with similar preferences. This not only assists organizations in finding the greatest staff, but it also helps them increase their profits. Personality prediction or investigating their qualities and anticipating their behavior utilizing scientifically verified latent dimensions of an individual based on a tailored system might tackle the 'Cold start problem' by improving the working environment.

Machine learning algorithms are incredibly good at spotting patterns in datasets that people can't see. The use of these machine learning models might lead to more objective, automated personality evaluations [1].

This model will examine the characteristics and personalities, as well as assist in the decision-making process. So, dis- cussing about the accuracy of the predictions, it will be exactly similar to that being used by the social media application or the operating systems like those which collect the behavioral patterns of the usage of the user [2]. In other word the choice that a user makes in spontaneous different situation in virtual environment somehow represents the beliefs and traits of the user.

On the top of that we are trying to build a software that don not overlooks the demerits of the process being used for the benefit of user. The merits are to understand the self and without using much of the brain power and reducing the complex thinking neurological process of reiterating over the possibilities to some situation that can be solved by the use of some basic traits to determine the optimum solution or decision, we cannot overlook he demerit of the data being misused which create a privacy threat and the use of data for targeted behavioral decision by influence of foreign belief [3]. To reduce the risk of such we are not storing any data on any server about the person and his traits related to same. This is a registration or authentication less process in order to keep the data stored locally on the user machine.

[4], [5] The theory was depending upon Deferential languages Analysis and Linguistic Inquiry and Word count based on Facebook states but to counter that is the point is that the status on the Facebook and social don't hold that much of the weightage as they totally based on instinct in and instantaneous environment or thought process.

[6], [7] According to market research and reports, the data that companies ask the candidate to fill out their basic personality traits indirectly help the firms a lot to hire the right person. The companies make their decision based on the personality traits to make the environment better for the person joining and the team of the person. The approach that is traditionally used helps a lot in the hiring process and enhancing the efficiency of employee. The models use in right direction can enhance the process and predict about someone's personality

based on scientific logics and theories. The pattern analyzing of machine learning algorithms is perfectly optimized for the regression-based output.

[8] The previous studies have shown the concern of privacy issues that we are not related to in any manner because our model is not concerned or programmed for the collection of information or any process data in any form.

[9], [10] This study is using the model somehow comparable to those used by social; media applications. But the reliability and performance of these models are arguable/debatable. The social media data is based on the instinct in sudden moments or in the case of sudden hormonal rush which is not much reliable as compared to serious life situations. The choices on social media and in real life are not comparable. The results are somehow useful but now reliable enough to be predicting the results for real life situations.

[11] [12] [13]. A subset of these studies has used machine learning in analyses with the goal of predicting personality traits from behavioral measures. The previous models have been using the regression instead of regression in order to overestimate the performance accuracy of the model along with insufficient data and that in small amount and not providing any relative data or materials to reproduce results in same manner.

[14] Skylab has uploaded the report claiming that this study has only 8 to 15 percent accuracy and the model used is basically trained by the use of Facebook API. The optimization and calculation is also done using the Facebook API as shown in Fig 4.

This portion of in research field was an issue with following constraints:

1) Insufficiency of data type or we can the insufficiency in the traits being used for prediction [15].

2) The data is sufficient in terms of key features but the size of data is unacceptable to be called reliable [16], [17]

3) The reliability of the data source is not enough and cannot be supported as it is not logical and reasonable to call data reliable collected from a virtual environment-based queries [4]

4) The data collected is good but is directly related only to the professional environment. There is no trace of any data which can be used for personal or informal case scenarios [6], [18].

5) Overestimating or exaggerating the model performance as there is not any proof, data or material available to support he predictions [9].

6) Inaccurate or merely and weightage systems for key features in predictions [14], [19].

III. FEASIBILITY STUDY

1) Financial feasibility

Because it's a simple program. We don't need any pricey software to do the task because everything is freely available online. With ease, we will be able to complete the final product.

IV. ECONOMIC FEASIBILITY

This approach may be used in a variety of industries where a qualified applicant is required. The workload of the human resources department will be reduced thanks to this solution. It will prove itself to be greatly beneficial to the Human Resources Department and any firm as based on the personality characteristics they will be able to find which person is highly suitable for the job vacancy. It will save a lot of expenses and time for the firms

3) Technical Feasibility The technology we used for this system is up to date, and the user can easily interact with and comprehend it. We can also enter massive volumes of data at once for analysis.

For the creation of our model, we employ a variety of methodologies.

For our project, we are utilizing the following software: -

Jupiter Notebook (i) Jupiter Notebook (ii) Jupiter Notebook (iii

Anaconda (ii) Anaconda (ii) Anaconda I (Python)

V. PYQT5

A. Notebook of Jupiter

The Jupyter Notebooks is a web based and desktop based software for running the code and finding vulnerabilities of any. The notebook is interactive and compiles and runs the code without using the system resources (if it is being used in web based form), instead it uses the cloud based system with high reliability and computing power. Two components combined make Jupyter Notebook:

Notebook documents: It is a collective material which is presented in the web based application of Jupyter Notebook. It holds the inputs and outputs and past record as well with the text which explains either the vulnerability/bug if any or information about the output data.

A web based application is a tools/software that is can be used with the help of the browser for writing codes in document while keeping them in isolated blocks so that if part of the block fails it is easy to debug and fix the bug. On the top of that to help in the debugging process the text with the explanation of the bug appears whenever there is a need. It also contains mathematical calculations and multimedia/rich media. Object representations in mathematics, graphics, and rich media Code editing on the browser, featuring highlighting of syntax with indentation and tab [20], [21].

This has to ability to run the code in the browser with calculated results attached to the block of the code that resulted the same.

B. Python

Python is a basic object-oriented programming language. Python language somehow resonates with the languages like Scheme, Java and Ruby language except from the syntax part. The following are some of Python's prominent features:

- It employs attractive syntax to make your software easier to read.
- It's a basic programming language that makes getting your software up and running a breeze [22]. Python is thus great for prototyping and other ad hoc programming projects.

It comes with a big standard library that allows you to connect to web servers, search text using regular expressions, and read and alter files, among other things.

NumPy, SciPy, and pandas are some of the Python libraries we utilize for scientific computation and machine learning.

PyQt is a Python framework that is used to create a Graphical user Inteface for cross-platform Software

This Python framework is available for free software program written and built by Riverbank Computing in the United Kingdom. It is provided on terms comparable to Qt versions under the 4.5 version, which means it may be licensed under a number of licenses, including the GNU General Public License (GPL) and a commercial license, but not the GNU Lesser General Public License (LGPL). PyQt is compatible with Microsoft Windows, different distributions/versions of UNIX such as Linux and MacOS versions.

PyQt consists of approximately 440 classes and functions more than over 6,000 and methods, including a sizable set of classes for using/operating in Structured Query Language databases (For example ODBC, MySQL, PostgreSQL, Oracle, SQLite) Scintilla, Scintilla-based text editor (rich editor) aware widgets which can populate themselves by itself, populated from a database in XML parser SVG support classes for embedding ActiveX controls on Windows (availability for commercial versions only).

C. PYCHARM

PyCharm IDE has a feature for automatic code completion, inspection of code is available and on-the-fly mistakes flagging and instant solutions and the automatic code restructuring feature and rich navigation and multiline editing.

PyCharm supports most of the languages available.

The languages that are supported by the Pycharm are:

- Python
- JavaScript
- Coffee Script
- TypeScript
- CSS

The code completion feature can also be used with all these languages mentioned above. There are a lot of features integrated in Pycharm.

Pycharm Profile runner is built in terminal, VCS integration, database tools integration, Docker and Vegrant integration, inbuilt package installer and remote development capability is also one of the great features provided by the Pycharm.

PyCharm supports several Python web development frameworks, particular template languages, JavaScript, Coffee Script, TypeScript, HTML/CSS,

AngularJS, Node.js, and more, in addition to Python.

VI. METHODOLOGY

As we are dealing with a machine learning model, we need to collect data and start working on cleaning the datasets and training the model using various machine learning algorithms such as

- Linear Regression: The goal of Linear regression is to find, derive or classify the relation between goal r/result and one or two variables. Linear regression is described into two types:
- Linear Regression
- Multiple Linear Regression
- The best fitted use of the simple linear regression is to find relationship between the two continuous variables as shown in Fig 2. One of the variables is called predictor or independent variable while the other one is referred to as the response or the dependent variable. It seeks statistical relationships as opposed to deterministic ones. If we can precisely derive one variable out of the other variable by performing some operations then we can consider the variables to be deterministic. Temperature in degrees Celsius, for example, can be used to precisely forecast Fahrenheit. Statistical relationships are incorrect when trying to derive the relationship between two independent or dependent characteristics/variables. Consider the relationship between mass and weight or maybe between length and breadth of random cuboids.

SVM (Support Vector Machine): The SVM, or Support Vector Machine, is a very much appreciated and used machine learning technique which is supervised in nature and this is generally used to solve the problems concerned with classification and regression problems. Although it is good in both classification and regression, it is still mostly used in the classification problem in the field of machine learning. The final destination or we can say the goal that this algorithm serves is to find the correct n-dimensional boundary the differentiate the classes based for different categories just so the future input data can be predicted correctly and be putted/to be assigned in the right category of the input in cases of categorization/classification problems/challenges. This algorithm serves its purpose really well.[32-36]

The boundary thus formed is known as the hypoerplane. The use of SVM is to select the utmost/furthest/extreme points/vectors with the help of which the hyperplane is created as shown in fig 5. The algorithm is referred to as a Support Vector Machine, and support vectors are the extremist examples that can be considered. The diagram that is given below has an explanation in itself of how the hyperplane is selected or formed for the categorization or classification problems.

After data sets have been loaded and encoded for necessary fitting and training of the model, we use various machine learning models like linear regression to predict the different types of personality each individual has according to the data. And we try to predict the personalities according to the given data on the dataset by splitting the data into training and testing set. Hence, the predicted values are given below.

As you can see, the accuracy is “0.86”

And then we did cross validation and checked the range of how our scores are doing, also, we can see that the range of our accuracy is between 0.64 to 0.74.

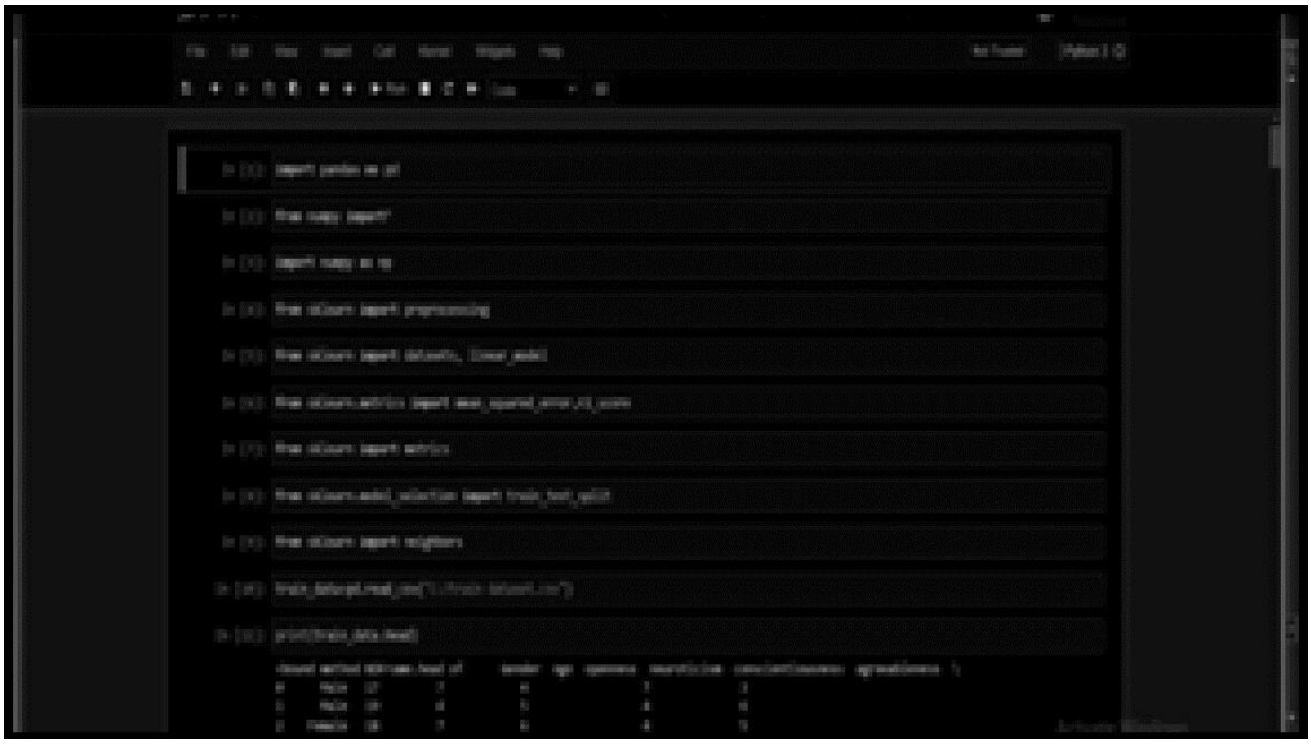


Fig. 1. Importing/Loading the packages

Algorithm	Best Prediction Accuracy (%)	Respective Parameter	Respective average prediction accuracy after 10-times 10-fold cross validation (%)
kNN	75.20	k=13	75.96
SVM	93.75	rbf kernel	93.17
GDM-ANN	61.60	5 neurons	24.1
GDA-ANN	94.60	8 neurons	90.66
GDMA-ANN	99.10	8 neurons	89.5
RB-ANN	97.30	13 neurons	95.29
CGB-ANN	96.40	15 neurons	81.67
CGF-ANN	85.70	15 neurons	88.57
CGP-ANN	98.20	8 neurons	75.6
SCG-ANN	97.30	5 neurons	91.8
QN-ANN	94.60	15 neurons	90.62
LM-ANN	95.50	8 neurons	93.84
OSS-ANN	91.10	15 neurons	90.25
BR-ANN	99.10	5 neurons	95.68

From Table 1, the best two classifiers based on the cross validation accuracy

Fig. 2.

A. UI IMPLEMENTATION

We used various technologies for UI design such as Py-Charm and PytQ5 libraries and widgets for displaying the model information and representation of the plotted values of training, testing and predicted values.

The steps are mentioned below along with its visual representation:

1. We are using PyCharm IDE to import the necessary libraries and widgets for implementation as shown in Fig 3. of user interface. Some of the widget tools embedded in PyQt5 is: QtGui, QtCore, QtWidgets, loadUIetc. PyQt API has number preconfigured Dialog widgets such as Input Dialog, File Dialog, Font Dialog, etc.

2. We define multiple functions after importing the widgets to display the codes for ML separately with a menu section consisting of home, about and documentation section as shown in Fig 1.

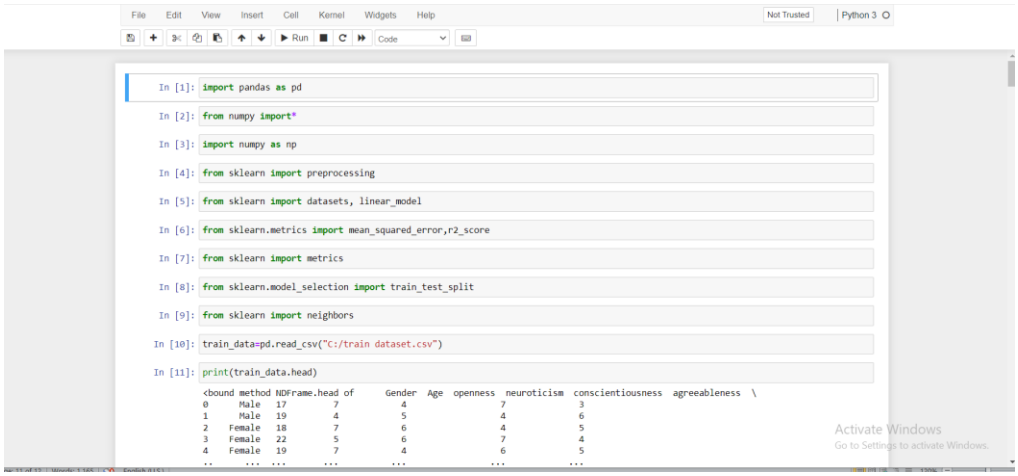


Fig. 3. Functional Implementation

VII. WE CALL ALL THE METHODS IN THE END TO DISPLAY AND LOAD THE UI

VIII. PERFORMANCE ANALYSIS

To quantify classification performance, sklearn. metrics uses a variety of losses, scores, and utility functions. Some metrics may demand positive class probability estimations, confidence values, or binary decision values. The accuracy score function calculates the precision, percent (default), or number of correct predictions.

We are plotting a graph to test the performance of our model as well.

The function yields the subset accuracy in multi-label classification: if the full collection of predicted labels for a sample tightly matches the real set of labels, the subset accuracy is 1.0; otherwise, it is 0.0.

If is the -the sample's projected value and is the matching real value, then is the proportion of correct predictions over.

IX. RESULT/OUTPUT

After finishing the coding section, we ran our

program and it was implemented successfully as reflected below as shown in Fig 6-16.

The title of our UI is "PERSONALITY FINDER".

The above figure shows the implemented portion of our project, the codes and from where our data is fetched and stored.

We can see the code and we can set the path for our dataset to be used for training and testing. After we activate our personality finder, the live process is shown on the lower left section in green fonts and the results are shown in the end.

And lastly the plotted graph for training, testing and predicted value is shown on the lower right corner of the screen.

X. CONCLUSION & FUTURE SCOPE

According to what we've read, the above algorithms are usually used to determine a person's personality, and we're curious to see which one will provide the most accurate conclusion. Also, this finder aids us in better understanding a person's interests and behavior, which is especially useful in an organization where many people come together as a part of the organization and undergoing this trial will aid them in determining which of them is more suitable for them to work with in order to improve the company's efficiency and productivity. We didn't simply work on the model; we also created a user interface to make it more presentable and understandable to the average person.

This Software can be utilized to find out the personality type of a person and then use the obtained results to understand the person more on a psychological level and derive generalized characteristics on personality type. This data can be used to understand the skills of the person and then assigning the person job based on his/her personality type. The data can used to predict the actions of the person in a particular situation (results sometime may vary). It will provide an ease for hiring authorities of any field to find if the person is fit for the job or not.

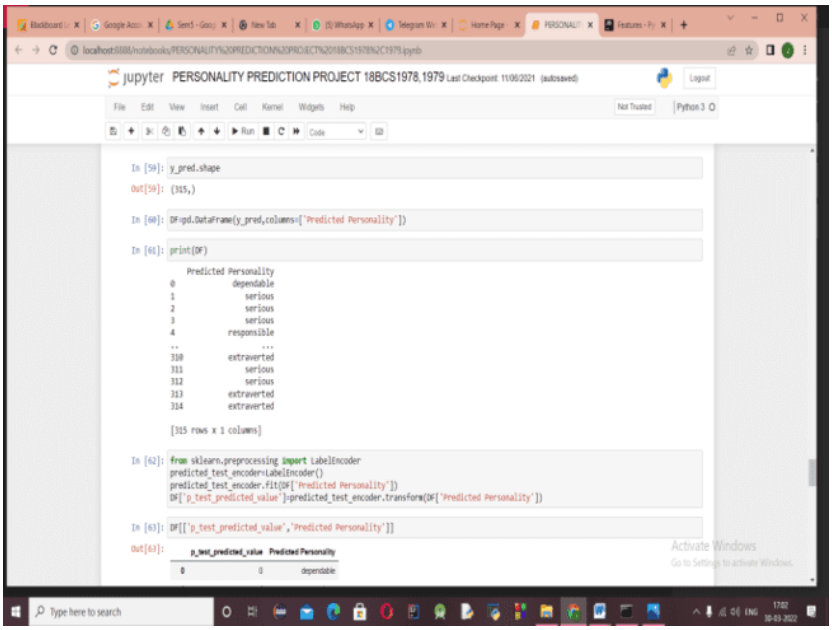


Fig. 4. Log of the trained model

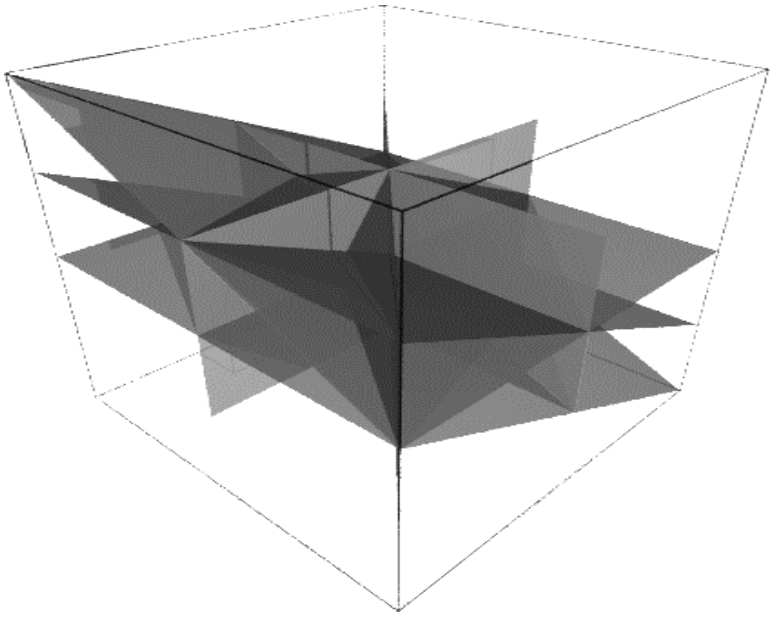


Fig. 5. Hyperplane

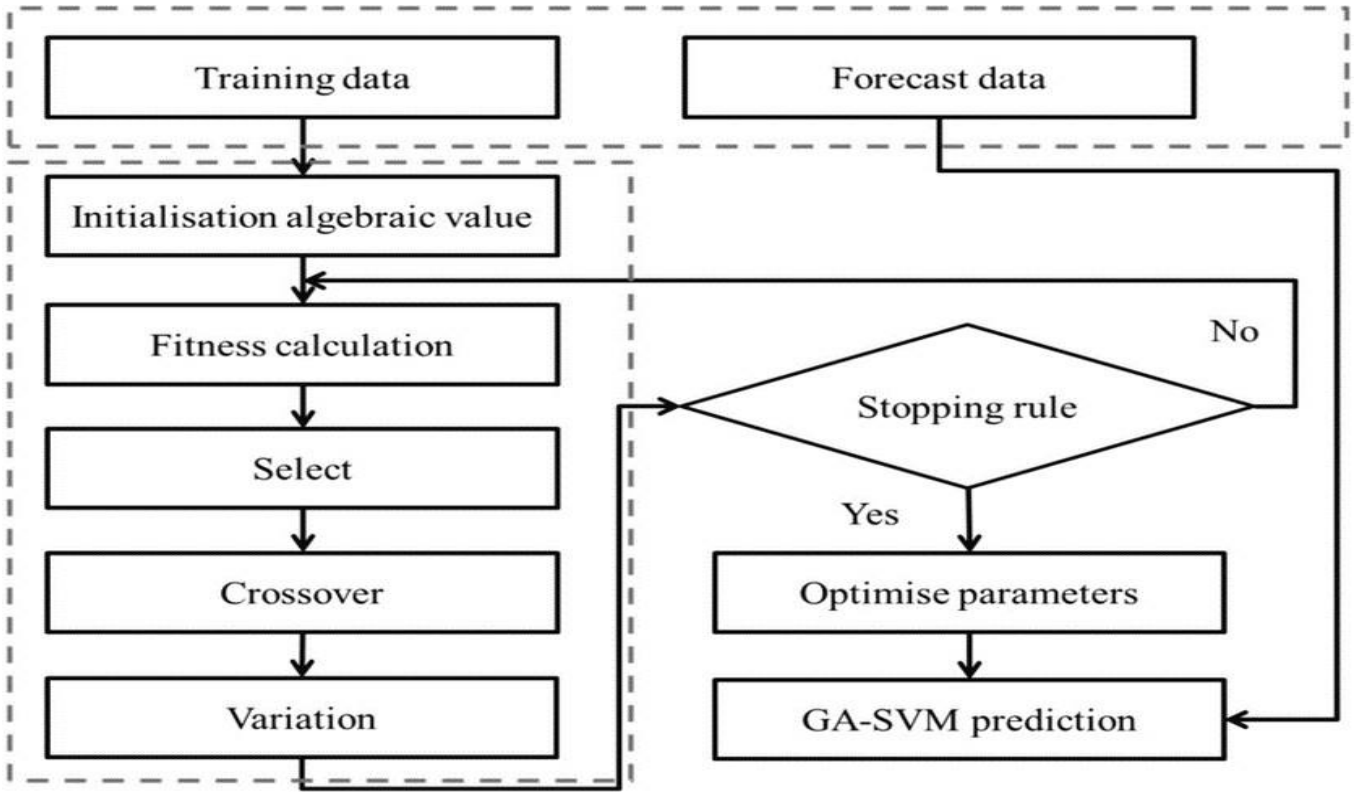


Fig. 6. Support Vector Machine Flowchart

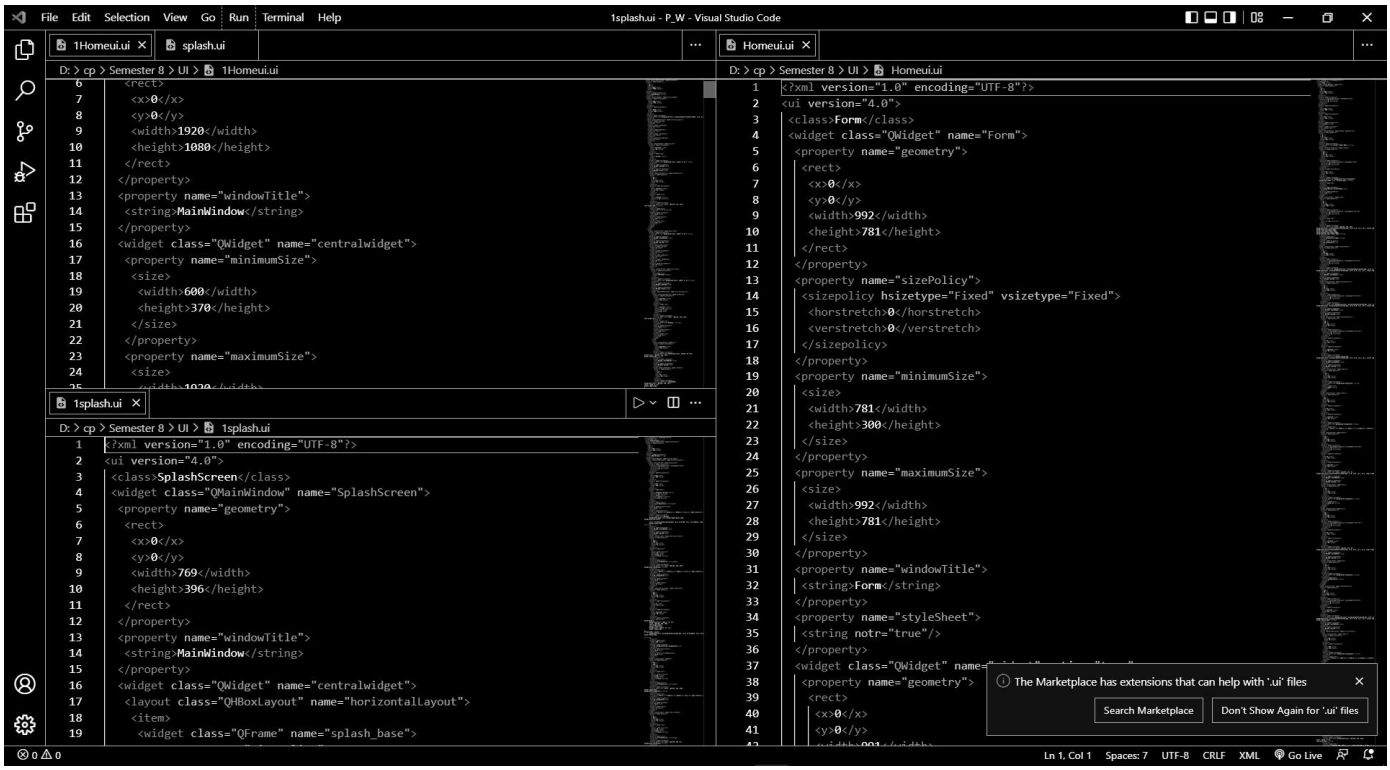
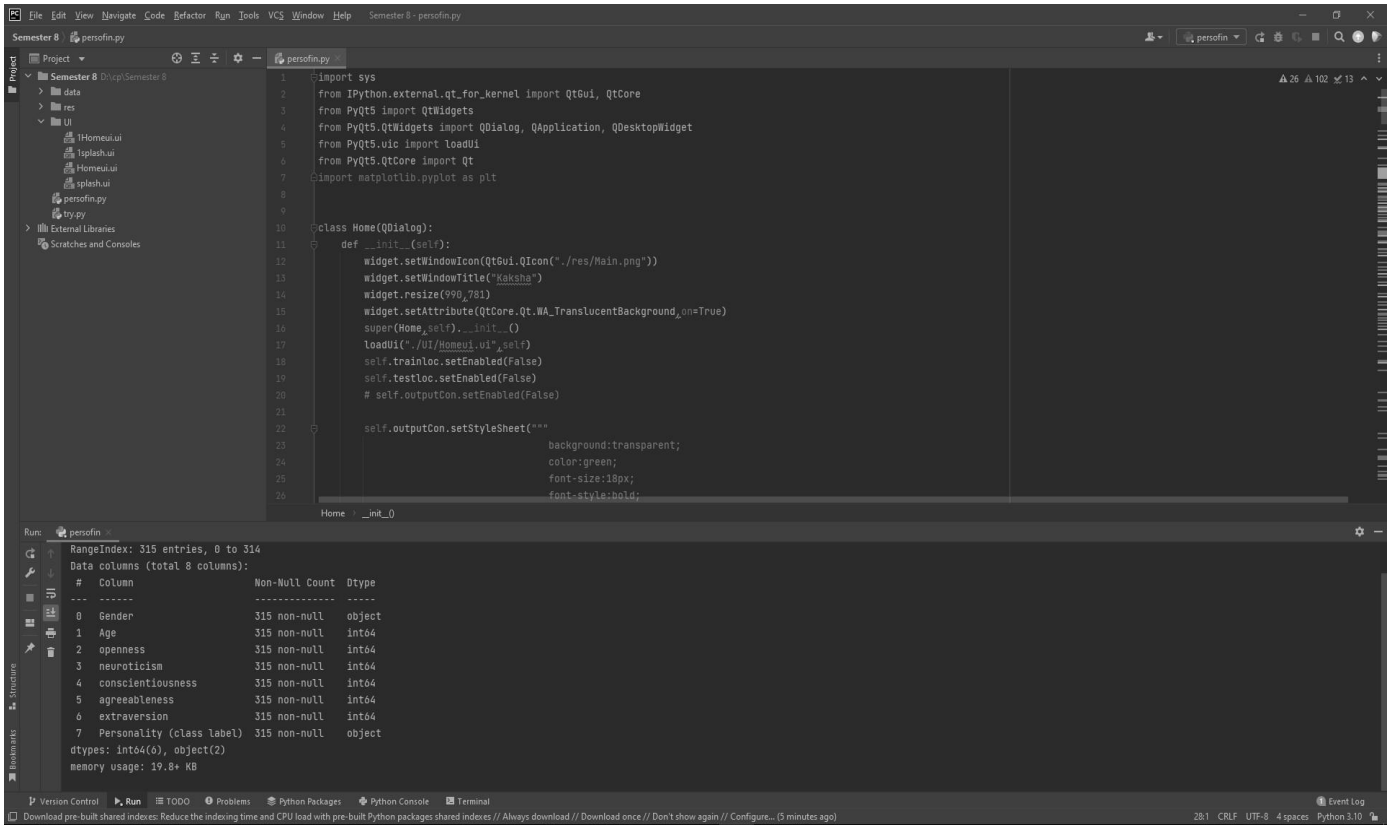


Fig. 7. Trials with the prediction



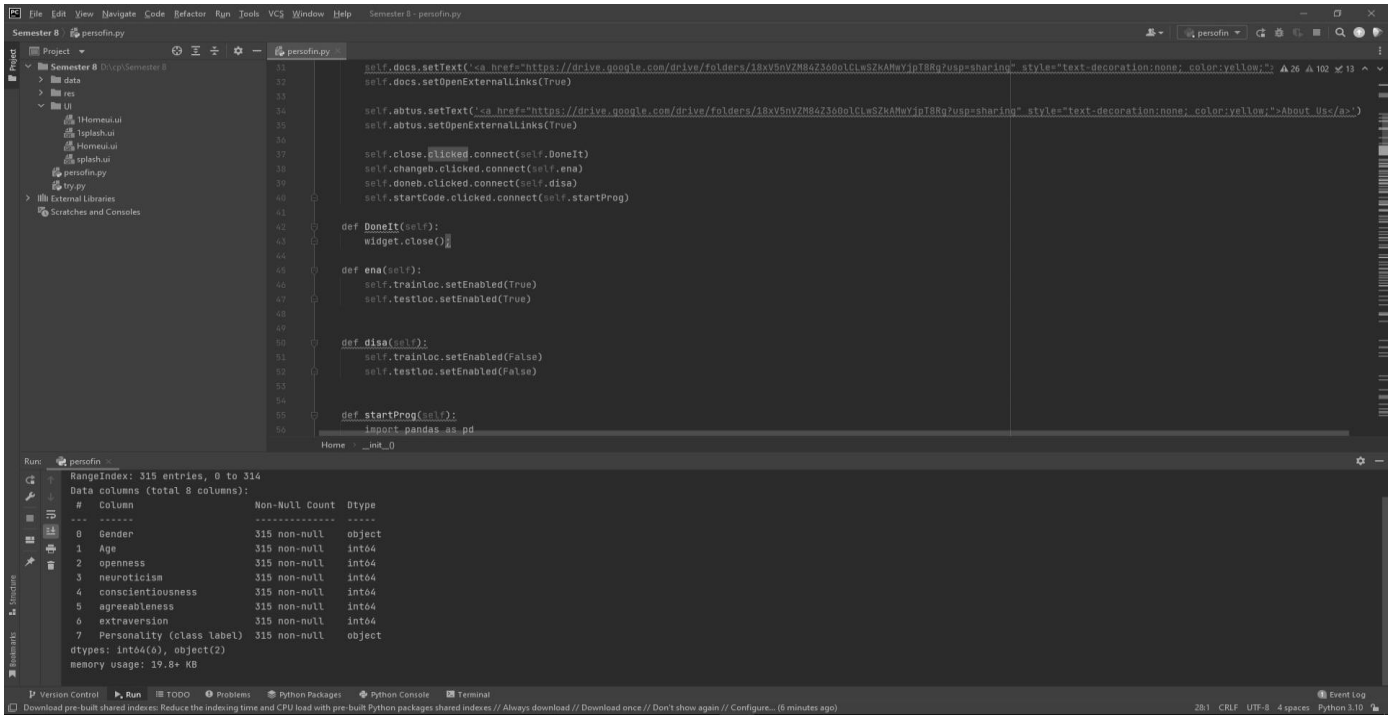
```
import sys
from IPython.external.qt_for_kernel import QtGui, QtCore
from PyQt5 import QtWidgets
from PyQt5.QtWidgets import QDialog, QApplication, QDesktopWidget
from PyQt5.uic import loadUi
from PyQt5.QtCore import Qt
import matplotlib.pyplot as plt


class Home(QDialog):
    def __init__(self):
        widget.setWindowIcon(QtGui.QIcon("./res/Main.png"))
        widget.setWindowTitle("Kaksha")
        widget.resize(990,781)
        widget.setAttribute(QtCore.Qt.WA_TranslucentBackground,on=True)
        super(Home,self).__init__()
        loadUi("./UI/Homeui.ui",self)
        self.trainloc.setEnabled(False)
        self.testloc.setEnabled(False)
        # self.outputCon.setEnabled(False)

        self.outputCon.setStyleSheet("""
                                        background:transparent;
                                        color:green;
                                        font-size:18px;
                                        font-style:bold;
```

```
RangeIndex: 315 entries, 0 to 314
Data columns (total 8 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   Gender                  315 non-null    object
 1   Age                     315 non-null    int64
 2   openness                315 non-null    int64
 3   neuroticism             315 non-null    int64
 4   conscientiousness       315 non-null    int64
 5   agreeableness           315 non-null    int64
 6   extraversion            315 non-null    int64
 7   Personality (class label)  315 non-null    object
dtypes: int64(6), object(2)
memory usage: 19.8+ KB
```

Fig. 8. Code Snippet



```
        self.docs.setText('<a href="https://drive.google.com/drive/folders/18xV5nVZM84Z3o0olCLwSZkAMwYjpT8Rg?usp=sharing" style="text-decoration:none; color:yellow;">
        self.docs.setOpenExternalLinks(True)

        self.abtus.setText('<a href="https://drive.google.com/drive/folders/18xV5nVZM84Z3o0olCLwSZkAMwYjpT8Rg?usp=sharing" style="text-decoration:none; color:yellow;">About Us</a>')
        self.abtus.setOpenExternalLinks(True)

        self.close.clicked.connect(self.DoneIt)
        self.changeb.clicked.connect(self.ena)
        self.doneb.clicked.connect(self.disa)
        self.startCode.clicked.connect(self.startProg)

    def DoneIt(self):
        widget.close()

    def ena(self):
        self.trainloc.setEnabled(True)
        self.testloc.setEnabled(True)


    def disa(self):
        self.trainloc.setEnabled(False)
        self.testloc.setEnabled(False)


    def startProg(self):
        import pandas as pd
```

Fig. 9. starting the UI with Pycharm

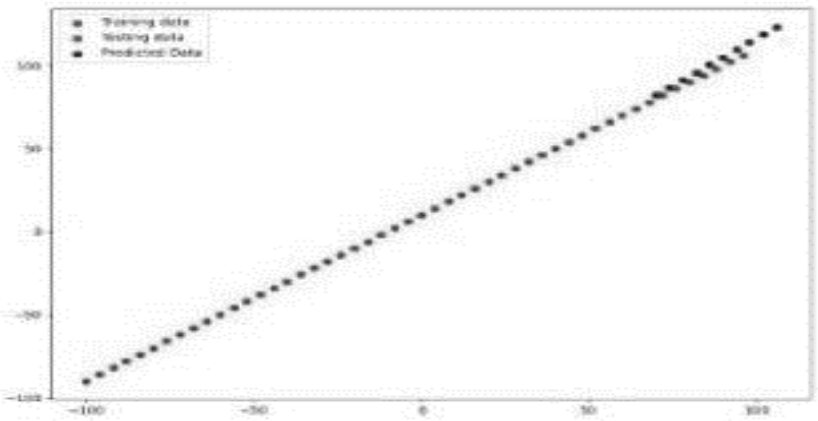


Fig. 10. Actual vs. Predicted Results

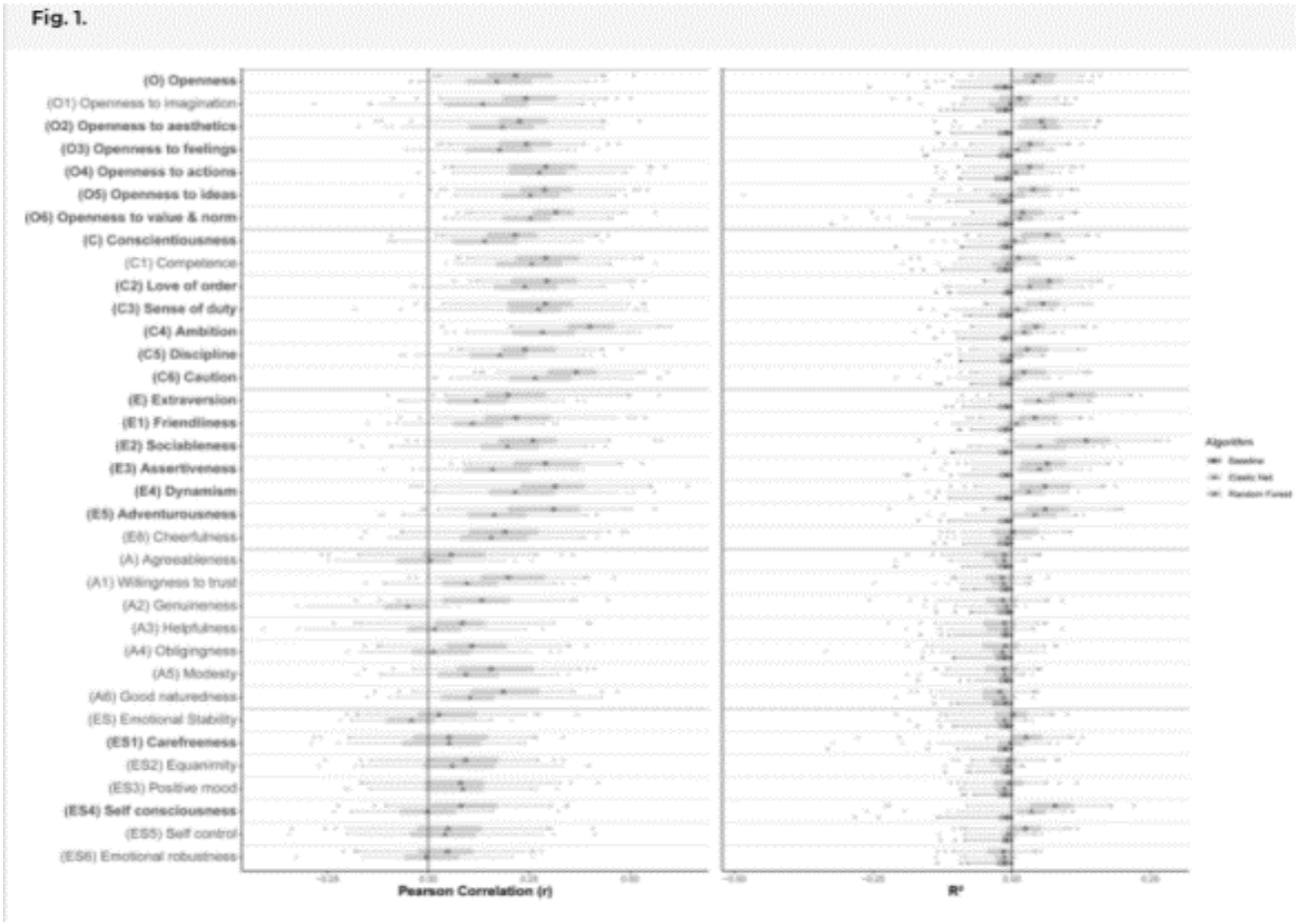


Fig. 11. Code Snippet

$$\texttt{accuracy}(y, \hat{y}) = \frac{1}{n_{\text{samples}}} \sum_{i=0}^{n_{\text{samples}}-1} 1(\hat{y}_i = y_i)$$

Fig. 12.

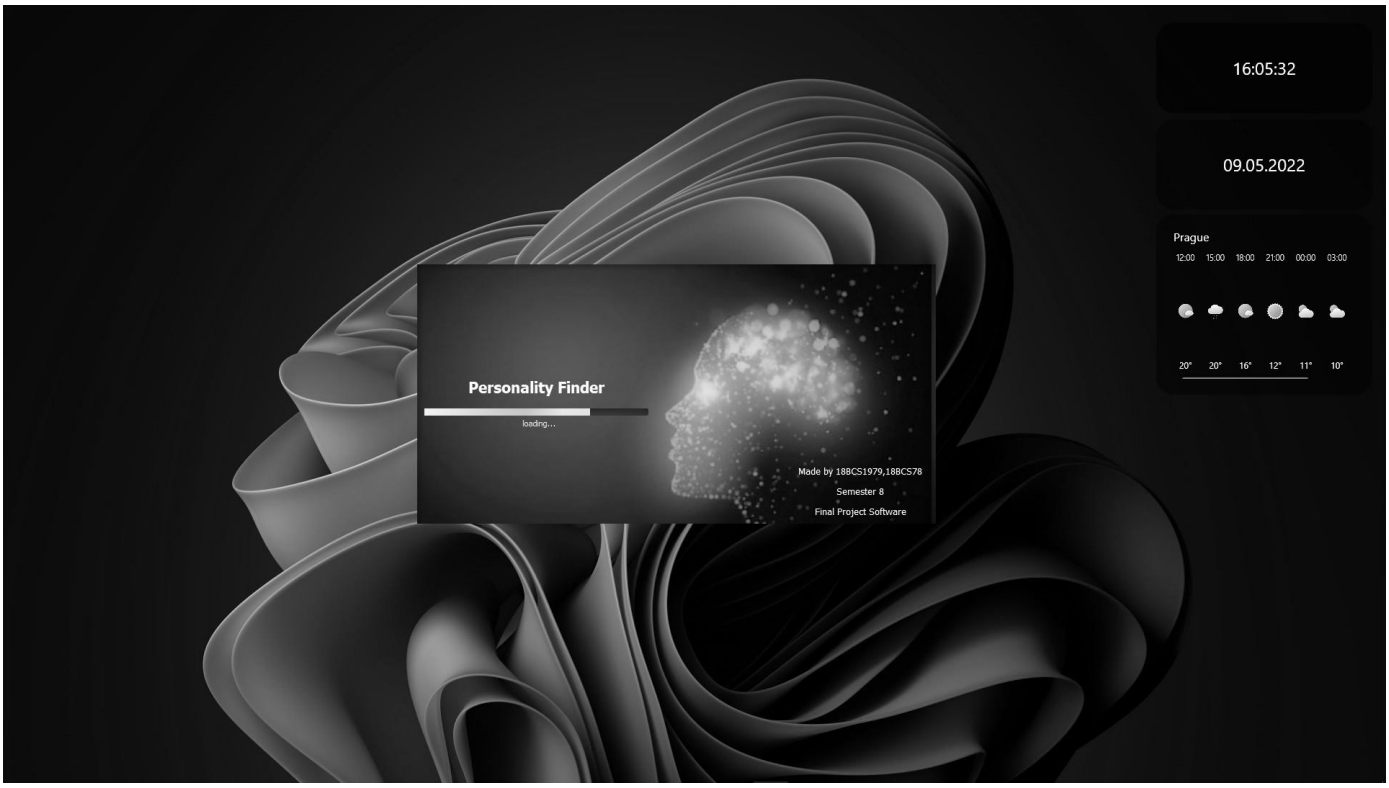


Fig. 13. Loading Resources with Splash screen

Fig. 14. Software Home Screen while starting

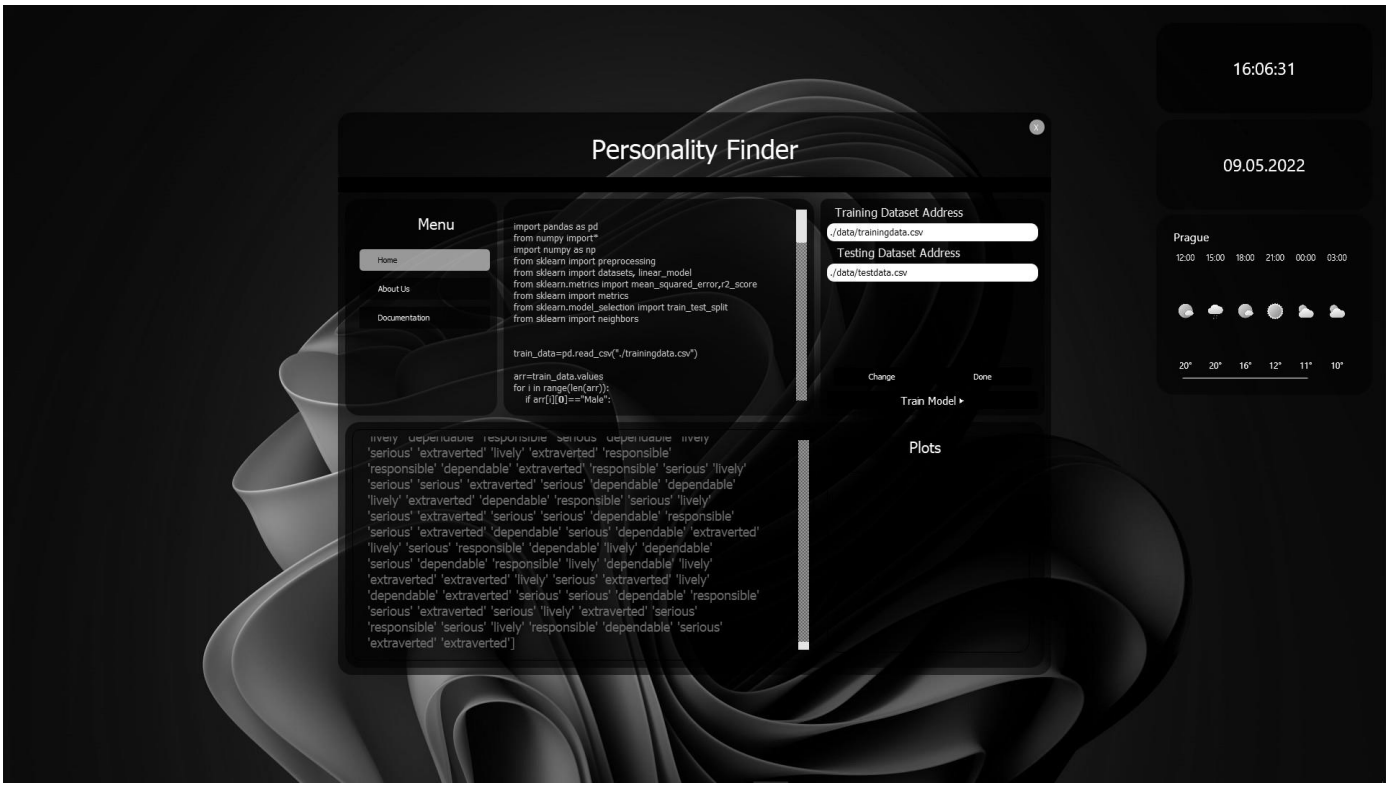


Fig. 15. Software Home Screen with processing going on

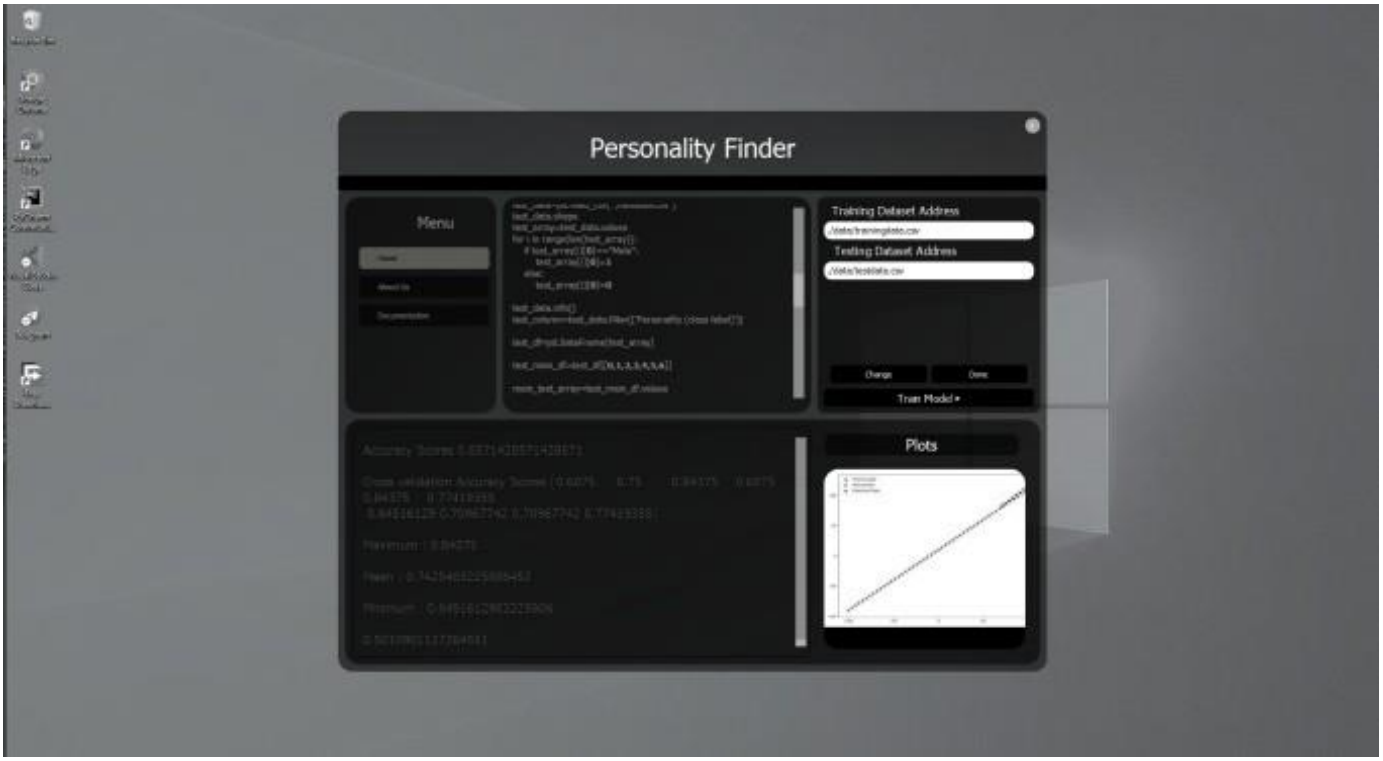


Fig. 16. Finalized Predicted output with the performance test using plotted graph

XI. REFERENCES

[1] Kumar, Ashwani, Mohit Kumar, Sahil Verma, Kavita, N. Z. Jhanjhi, and Rania M. Ghoniem. 2022. "Vbswp-CeaH: Vigorous Buyer-Seller Watermarking Protocol without Trusted Certificate Authority for Copyright Protection in Cloud Environment through Additive Homomorphism" Symmetry 14, no. 11: 2441. https://doi.org/10.3390/sym14112441

[2] Garg, Deepak, Shalli Rani, Norbert Herencsar, Sahil Verma, Marcin Wozniak, and Muhammad Fazal Ijaz. 2022. "Hybrid Technique for Cyber-Physical Security in Cloud-Based Smart Industries" Sensors 22, no. 12: 4630. https://doi.org/10.3390/s22124630

[3] Pradhan, Nihar Ranjan, Akhilendra Pratap Singh, Sahil Verma, Kavita, Navneet Kaur, Diptendu Sinha Roy, Jana Shafi, Marcin Wozniak, and Muhammad Fazal Ijaz. 2022. "A Novel Blockchain-Based Healthcare System Design and Performance Benchmarking on a Multi-Hosted Testbed" Sensors 22, no. 9: 3449. https://doi.org/10.3390/s22093449

[4] Dogra, V.; Singh, A.; Verma, S.; Kavita; Jhanjhi, N.Z.; Talib, M.N. Analyzing DistilBERT for Sentiment Classification of Banking Financial News. Lect. Notes Netw. Syst. 2021, 248, 501–510.

[5] Pradhan, N.R.; Singh, A.P.; Verma, S.; Wozniak, M.; Shafi, J.; Ijaz, M.F. A blockchain based lightweight peer-to-peer energy trading framework for secured high throughput micro-transactions. Sci. Rep. 2022, 12, 1–15

[6] M. Settanni, D. Azucar, D. Marengo," Predicting individual characteristics from digital traces on social media: A meta-analysis. Cyberpsychol. Behav. Soc. Netw. 21, 217–228" ,2018.

[7] Ravi, N.; Verma, S.; Kavita; Zaman, N.Z.; Talib, M.N. Securing VANET Using Blockchain Technology. J. Phys. Conf. Ser. 2021, 1979, 012035.

[8] V . Dogra, A. Singh, S. Verma, N. Z. Jhanjhi and M. N. Talib, "Understanding of data preprocessing for dimensionality reduction using feature selection techniques in text classification," in Intelligent Computing and Innovation on Data Science. Lecture Notes in Networks and Systems, Springer: Singapore, vol. 248, pp. 455–464, 2021.

[9] Kumar, Mohit, Priya Mukherjee, Sahil Verma, Kavita, Maninder Kaur, S. Singh, Martyna Kobielnik, Marcin Woźniak, Jana Shafi, and Muhammad Fazal Ijaz. 2022. "BBNSF: Blockchain-Based Novel Secure Framework Using RP2-RSA and ASR-ANN Technique for IoT Enabled Healthcare Systems" Sensors 22, no. 23: 9448. https://doi.org/10.3390/s22239448

[10] Bansal, Kanishk, Amar Singh, Sahil Verma, Kavita, Noor Zaman Jhanjhi, Mohammad Shorfuzzaman, and Mehedi Masud. 2022. "Evolving CNN with Paddy Field Algorithm for Geographical Landmark Recognition" Electronics 11, no. 7: 1075. https://doi.org/10.3390/electronics11071075

[11] B.Monsted, A.Mollgaard, J.Mathesian, ,"Phone based metric as a predictor for basic personality traits,2018

[12]G.M. Harari et al," Sensing sociability :Individual differences I in young adult' s conversation, app use behavior",2019.

[13]Ong V, Rahmanto ADS, W, Suhartono D. Exploring Personality Prediction from Text on Social Media: A Literature Review. Internetworking Indonesia Journal. 2017

[14]Sarah E. Babcock, Claire A. Wilson,"Big Five Personality", 18,sSept,2020

[15] Derrick Mwiti "Random Forest and Regression when does it fail and why"26 Oct 2021

[16]. Srinivasan, K., Garg, L., Datta, D., Alaboudi, A. A., Jhanjhi, N. Z., Agarwal, R., & Thomas, A. G. (2021). Performance comparison of deep cnn models for detecting driver's distraction. CMC-Computers, Materials & Continua, 68(3), 4109-4124.

[17] Khalil, M. I., Jhanjhi, N. Z., Humayun, M., Sivanesan, S., Masud, M., & Hossain, M. S. (2021). Hybrid smart grid with sustainable energy efficient resources for smart cities. sustainable energy technologies and assessments, 46, 101211.

[18] A. Almusaylim, Z., Jhanjhi, N. Z., & Alhumam, A. (2020). Detection and mitigation of RPL rank and version number attacks in the internet of things: SRPL-RP. Sensors, 20(21), 5997.

[19]. S. Midha and K. Triptahi, "Extended TLS security and Defensive Algorithm in OpenFlow SDN," 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence),IEEE,scopus indexed, Noida, India, 2019, pp. 141-146, doi: 10.1109/CONFLUENCE.2019.8776607.

[20] Dash, Sonali et al. "A Hybrid Method to Enhance Thick and Thin Vessels for Blood Vessel Segmentation." Diagnostics (Basel, Switzerland) vol. 11,11 2017. 30 Oct. 2021, doi:10.3390/diagnostics11112017

[21] Dogra, V., Singh, A. et al. "Analyzing DistilBERT for Sentiment Classification of Banking Financial News." In: Peng, SL., Hsieh, SY., Gopalakrishnan, S., Duraisamy, B. (eds) Intelligent Computing and Innovation on Data Science. Lecture Notes in Networks and Systems, vol 248. Springer, Singapore. https://doi.org/10.1007/978-981-16-3153-5_53

[22] Kaur, M., Singh, A. et al. "FANET: Efficient Routing in Flying Ad Hoc Networks (FANETs) Using Firefly Algorithm." In: Peng, SL., Hsieh, SY., Gopalakrishnan, S., Duraisamy, B. (eds) Intelligent Computing and Innovation on Data Science. Lecture Notes in Networks and Systems, vol 248. Springer, Singapore. https://doi.org/10.1007/978-981-16-3153-5_51

[23] Keshav Kumar et al "A Survey of The Design and Security Mechanisms of The Wireless Networks and Mobile Ad-Hoc Networks" 2020 IOP Conf. Ser.: Mater. Sci. Eng. 993 012063

[24] Shah, I. A., Sial, Q., Jhanjhi, N. Z., & Gaur, L. (2023). The Role of the IoT and Digital Twin in the Healthcare Digitalization Process: IoT and Digital Twin in the Healthcare Digitalization Process. In Digital Twins and Healthcare: Trends, Techniques, and Challenges (pp. 20-34). IGI Global.

[25] Jhanjhi, N. Z., Brohi, S. N., Malik, N. A., & Humayun, M. (2020, October). Proposing a hybrid rpl protocol for rank and wormhole attack mitigation using machine learning. In 2020 2nd International Conference on Computer and Information Sciences (ICCIS) (pp. 1-6). IEEE.

[26] K. Hussain, S. J. Hussain, N. Jhanjhi and M. Humayun, "SYN Flood Attack Detection based on Bayes Estimator (SFADBE) For MANET," 2019 International Conference on Computer and Information Sciences (ICCIS), Sakaka, Saudi Arabia, 2019, pp. 1-4, doi: 10.1109/ICCISci.2019.8716416.

[27] Shah, I. A., Sial, Q., Jhanjhi, N. Z., & Gaur, L. (2023). Use Cases for Digital Twin. In Digital Twins and Healthcare: Trends, Techniques, and Challenges (pp. 102-118). IGI Global.

[28] Rani, P. et al. "Mitigation of black hole attacks using firefly and artificial neural network", Neural Comput & Applic (2022). https://doi.org/10.1007/s00521-022-06946-7

[29] S. Ghosh, A. Singh, et al., "Svm and knn based cnn architectures for plant classification," Computers, Materials & Continua, vol. 71, no.3, pp. 4257–4274, 2022.

[30] Gurbeer Kaur and Navneet Kaur, Cost Effective Energy Efficient and Secure Routing Protocol (CESR) for WBAN, International Journal of Computer Applications 169(4), 37-43, July 2017.

[31] N. Kaur, D. Gupta, R. Singla, A. Bharadwaj, Kavita and W. Mansoor, "Thermal Aware Routing Protocols in WBAN," 2021 4th International Conference on Signal Processing and Information Security (ICSPIS), 2021,

pp. 80-83.
[32] Ibrahim El-Henawy , Marwa Abo-Elazm, Handling within-word and cross-word pronunciation variation for Arabic speech recognition (knowledge-based approach), Journal of Intelligent Systems and Internet of Things, Vol. 1 , No. 2 , (2020) : 72-79 (Doi : https://doi.org/10.54216/JISIoT.010202)

[33] Disheng Zheng , Kai Liang, Chaotic Butterfly Optimization with Optimal Multi-key Image Encryption Technique for Wireless Sensor Networks, Journal of Intelligent Systems and Internet of Things, Vol. 1 , No. 2 , (2020) : 80-92 (Doi : https://doi.org/10.54216/JISIoT.010203)

[34] Safaa Saber , Ibrahim Elhenawy, A Survey on Flower pollination algorithm, Journal of Intelligent Systems and Internet of Things, Vol. 2 , No. 1 , (2021) : 05-11 (Doi : https://doi.org/10.54216/JISIoT.020101)

[35] Abdel Nasser H. Zaied , Shaimaa Mohmed, ERP Implementation Road Map for Small and Medium Size Enterprises (SMEs), Journal of Intelligent Systems and Internet of Things, Vol. 2 , No. 1 , (2020) : 14-25 (Doi : https://doi.org/10.54216/JISIoT.020102)

[36] Jabbar Abed Eleiwy, Characterizing wavelet coefficients with decomposition for medical images, Journal of Intelligent Systems and Internet of Things, Vol. 2 , No. 1 , (2021) : 26-32 (Doi : https://doi.org/10.54216/JISIoT.020103)