



Using Neutrosophic Trait Measures to Analyze Impostor Syndrome in College Students after COVID-19 Pandemic with Machine Learning

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Abstract. Impostor syndrome or Impostor phenomenon is a belief that a person thinks their success is due to luck or external factors, not their abilities. This psychological trait is present in certain groups like women. In this paper, we propose a neutrosophic trait measure to represent the psychological concept of the trait-anti trait using refined neutrosophic sets. This study analysed a group of 200 undergraduate students for impostor syndrome, perfectionism, introversion and self-esteem: after the COVID pandemic break in 2021. Data labelling was carried out using these neutrosophic trait measures. Machine learning models like Support Vector Machine(SVM), K-nearest neighbour (K-NN), and random forest were used to model the data; SVM provided the best accuracy of 92.15%.

Keywords: Neutrosophic psychology; Impostor syndrome; Neutrosophic trait measure; SVM, KNN; Random forest

1. Introduction

Impostor Syndrome or Impostor Phenomenon is a person's internal conviction that their success has happened due to pure chance, an external error, or hard work but not their capabilities or intellect. Individuals with impostor syndrome fear that others will someday learn that they are fakes [1]. They feel they do not belong in their working or academic environment

despite qualifications, accomplishments, and achievements [2]. Impostor syndrome is appropriate to ethnic, racial, and gender groups [3], especially in creative arts-based careers where success is not readily quantifiable [4]. Impostor syndrome was also thought to be prevalent in women and varies with gender. In 1978, psychologists Pauline Rose Clance and Suzanne Imes presented the concept of an Impostor phenomenon. Their research examined graduate and undergraduate women who were relatively successful but felt “overvalued” by their counterparts or supervisors and further felt like imposters [5]. Furthermore, this research established that the impostor phenomenon happened more in females than males. It is attributed to how different genders synthesize their success. Men believe success comes from within, while women consider that success comes from outside. To complicate matters, it emerges that the more educated and skilled a woman is, the more she doubts her abilities [6]. Due to this, women with IS often work more than others to finally achieve the status they fear they have never earned. [5] coined the term Impostor Phenomenon (IP) to describe a sensation of internal intellectual phoniness that seemed especially widespread among a select group of female high-achievers. They were terrified of being labelled as “impostors” who did not belong “among all these brilliant, intelligent individuals.” Rather than skill or competence, many ascribed their success to chance, hard effort, acquaintance with well-connected people, being at the correct place at the perfect time, fates, or individual characteristics such as charisma and the capability to interact effectively.

The Clance IP Scale was created to assess the idea that people are successful by superficial standards but have a false sense of personal ineptitude. The scale evaluates phenomena such as self-doubt and achievement by coincidence [7]. The study assesses the predictive accuracy of several machine learning methods. They proved that approaches, like ensemble learning, are better than simple machine learning algorithms [8]. According to a recent systematic analysis of the literature published in 2020, the prevalence of IS ranges from 9 to 82% [9]. According to [10], the IS prevalence among medical students and trainees was 22 -60%, and 33-44%, respectively. 15% of women dentistry students in the United States reported IS, while 57.8 % of youngsters in Saudi Arabia showed symptoms of Impostor Syndrome [11] [12].

The effect of impostorism on a specific leadership behaviour component of task delegation was analyzed in [13]. The population included 190 managers of various industries, with a prevalence of 74.6%. [3] examined the connection between the impostor phenomenon and racial discrimination in over one hundred and fifty African-American university students aged 18 to 19 through a cross-sectional survey. Respondents with more significant levels of IS also conveyed more survivor guilt feelings. [14] analyzed the prevalence of Impostor syndrome in final-year nursing students in a cross-sectional survey from Australia, the UK and New Zealand. The population selection included over 200 nursing students, of which 45.1% had mild IS,

33.4% were classified as repeatedly having IS feelings, and 8.3% were depicted as frequently experiencing intense IS experiences. A positive weak correlation between IS and preparedness for practice was found. [15] analyzed the connection between IS, perceived prejudice, and mental-health issues among minority trainees. The population sample was 322 College students with a mean age of 21 years (70% women) through a cross-sectional survey.

Perfectionism was described as "insisting of oneself or others a higher quality of performance than is needed by the circumstances". David Burn (1980) [16] produced a perfectionism scale, one of the first instruments to quantify perfectionism. He defined them as one whose ideals are high above reach or reason, who strains unremittingly and compulsively toward unattainable goals. Here, perfectionism is defined as a person's self-description of his or her performance style as perfectionistic, and most psychiatrists would likely agree with this assessment. The multidimensional perfectionism scale [17] is a test used to assess the character trait of perfectionism. Impostor syndrome in the classroom was analyzed in [18] to evaluate the influences of gender, level, grade, GPA, and individual characteristics on impostor syndrome among high school students. The study was conducted on 104 English honours students in grades 9-12, and there were no gender-based differences in impostorism. Impostor Syndrome was analyzed in [19] on 506 college students of mean age 21yrs (79% women) through a cross-sectional survey.

Women were notably more inclined to convey impostor feelings than men. Perfectionism, test anxiety and mental health were mainly related to IS, but low self-esteem was not. In [20] investigated gender disparities in anxiety of success and failure and IS on 104 marketing managers, of which response rate was 92.9% and mean age was 35yrs and 49% were women through a cross-sectional survey. Among male and female managers, significant positive correlations were observed between fear of failure and IS.

In [21], the authors evaluated emotional fatigue and work satisfaction among faculty with IS on 16 and 310 academic faculties for two studies, respectively. Study 1 had 63% women, and Study 2 had 59% women through a cross-sectional survey. Women and men vary in their coping techniques for managing impostor syndrome. [22] analyzed the impostor syndrome among Austrian doctoral students and evaluated gender differences in the impostor syndrome of nearly 631 students. Females had more fear of success and failure and lesser self-esteem than men. Faculties reported higher levels of impostor syndrome and research self-efficacy than non-faculty members. In [23], the authors explored the presence and connection between IS and burnout syndrome in internal medicinal residents.

[2] examined whether IS is a homogeneous construct or whether different types of persons with impostor syndrome can be distinguished based on related characteristics with 242 professionals in administration positions. No association was found between impostor syndrome and gender.

The authors have tried correlating well-being to impostor syndrome and gender role orientation in [24]. The population sample was 379 college students, which was a cross-sectional survey. People with high impostor syndrome scored less in well-being and self-acceptance. Significant differences were found in Impostor Syndrome by gender role orientation. [6] sampled the opinions of five doctors of various disciplines of medicine and their experiences with impostor syndrome. [25] identifies the prevalence of impostor syndrome among computer science students by conducting a cross-sectional survey on 203 college students. Additionally, it validates that the women students had more elevated levels of impostor feelings than the men.

[26] studied IS among first-generation and continuing-generation university students, with a population sample was 388 college students. After researching the relationship between IS level and perfectionism in these populations, only socially stipulated perfectionism was discovered to be mainly related to impostor syndrome among college students.

However, none of these studies thought there could be indeterminacy while making conclusions about these studies. As we see, sometimes, we may be unable to distinguish the presence or absence of impostor syndrome. In those cases, neutrosophic models can be used. Further, all results or conclusions may involve a certain amount of uncertainty in that situation. Neutrosophic will play a significant role.

Neutrosophy was introduced as a generalization to fuzzy theory. It handles the neutralities/indeterminacy present in the real-world scenario [27–31]. Neutrosophy has been recently used in psychology and will be very beneficial in analyzing impostor syndrome problems. Smarandache presented refined neutrosophic set (RNS) in [32] and further evolved into Double Valued NS (DVNS) [33], Triple Refined Indeterminate NS (TRINS) [34], and Multi Refined NS (MRNS) [35]. The indeterminate Likert scaling was defined using TRINS. Neutrosophy and neutrosophic psychology has been used to study several psychological problems [36–38].

This paper proposes the neutrosophic measure for Imposter syndrome based on neutrosophic traits and psychology. This is implemented using data collection using a specifically designed questionnaire after the data preprocessing and applying appropriate machine learning algorithms.

This paper is organized as follows: Section one is an introductory, extensive literature survey regarding impostor syndrome in young adults, and neutrosophy is given. Section two covers basic concepts of neutrosophy, psychology, indeterminate Likert scaling and Impostor syndrome. Neutrosophic measures for Impostor syndrome are introduced in section three.

Section four provides the dataset description along with the methodology and deals with the working of the proposed model, including calculating impostor syndrome scores. Section five deals with data analysis along with the machine learning models used. Results and discussion are given in section six. The last section discusses the limitations and concludes the study.

2. Basic Concepts

This subsection deals with the basic concepts of Neutrosophy and Neutrosophic psychology. The neutrosophic psychological framework is based on Freud's theory of conscious/unconscious memory and preconscious memory, it also includes one more state known as the aconscious state. Based on the neutrosophic theory, the extended neutrosophic psychology is denoted by $\langle A \rangle, \langle NeutA \rangle, \langle antiA \rangle$.

Refined Neutrosophic sets are used to capture this, and several applications of neutrosophic psychology can be found in [32].

Definition 2.1. The refined neutrosophic set is described such that the truth T is split into several kinds of truths: T_1, T_2, \dots, T_p , Indeterminate I into different indeterminacies: I_1, I_2, \dots, I_r and False F into different falsehoods: F_1, F_2, \dots, F_s , where all $0 < p, r, s \leq 1$ are integers, and $p + r + s = n$.

Definition 2.2. [34] Consider X a space of objects with elements in X denoted by x . A TRINS A in X is represented by truth $T_A(x)$, indeterminacy leaning towards truth $IT_A(x)$, indeterminacy $I_A(x)$, indeterminacy leaning towards falsity $IF_A(x)$, and falsity $F_A(x)$ membership functions. For each component $x \in X$, there are

$$0 \leq T_A(x) + IT_A(x) + I_A(x) + IF_A(x) + F_A(x) \leq 5 \quad (1)$$

Thus, a TRINS A can be described by

$$A = \langle x, T_A(x), IT_A(x), INT_A(x), IAT_A(x), AT_A(x) \rangle : x \in X \quad (2)$$

and is characterized by trait $T_A(x)$, indeterminacy trait $IT_A(x)$, neutral trait $INT_A(x)$, indeterminate anti-trait $IAT_A(x)$ and anti trait $AT_A(x)$ membership functions.

Detailed examples and working of TRINS can be obtained from [34, 35, 39].

3. Neutrosophic trait measures

According to neutrosophic psychology, there are several trait and anti-trait pairs. Some of the most common trait and anti-trait pairs related to the Impostor syndrome are

Extraversion-Introversion

Perfectionism-Imperfectionism

Self esteem- Self non-esteem

Honesty - Dishonesty

Let us, for example, consider the extraversion-introversion, trait-anti-trait pair. A person can be an extrovert in some situations, at the same time, he/she can also be an introvert while interacting with some other people. There are also chances that s/he is an ambivert. To accurately capture this kind of personality trait, we have developed a questionnaire. We now proceed to describe the questionnaire.

The questionnaire is framed to cover all these traits and anti-traits pairs. We propose in the following section neutrosophic impostor syndrome measures. Instead of using a complete indeterminate Likert scaling-based questionnaire, we have framed the questionnaire differently since using the indeterminate Likert scaling questionnaire might require more professional support.

We have asked them to answer based on a 5-point Likert scaling to make the evaluation easier. Their answers were combined/aggregated into suitable neutrosophic measures.

We use the concept of TRINS defined by [34]. We extend the concept of TRINS values to psychology and propose a novel architecture for generating neutrosophic values from the questionnaire.

Here, we introduce the concept of neutrosophic trait measures for a trait, which is later used to define neutrosophic impostor syndrome and neutrosophic perfectionist measures.

Definition 3.1. Consider X to be a collection of all trait- anti pair with elements of X denoted by x . A neutrosophic trait S is based on a 5-tuple refined neutrosophic set. It is denoted as a neutrosophic set by

$$S = \langle x, Tr_S(x), ITr_S(x), NTr_S(x), IATr_S(x), ATr_S(x) \rangle : x \in X \quad (3)$$

where $Tr_S(x)$ denotes the degree of presence of trait S , which is based on the truth membership of TRINS, $ITr_S(x)$ denotes the degree of presence of indeterminate trait S , which is based on the truth leaning towards indeterminacy membership of TRINS, $NTr_S(x)$ denotes the degree of presence of neutral trait, which is based on the indeterminate membership of TRINS, $IATr_S(x)$ denotes the degree of presence of indeterminate anti-trait S , which is based on the false leaning towards indeterminacy membership of TRINS, $ATr_S(x)$ denotes the degree of presence of anti-trait S which is based on the false membership of TRINS.

Next, we define the three functions, namely, accuracy function, score function and certainty function.

Definition 3.2. The accuracy function a , defined over the Neutrosophic trait S of x as

$$a(S(x)) = Tr_S(x) - ATr_S(x) \quad (4)$$

Definition 3.3. The score function s , defined over the Neutrosophic trait S of x as

$$s(S(x)) = (Tr_S(x) + ITr_S(x) + (1 - NTr_S(x)) + (1 - IATr_S(x)) + (1 - ATr_S(x)))/5 \quad (5)$$

Definition 3.4. The certainty function c , defined over the Neutrosophic trait S of x as

$$c(S(x)) = Tr_S(x). \quad (6)$$

Neutrosophic Impostor syndrome measure calculations

We propose the Neutrosophic Impostor Syndrome IS as Neutrosophic Trait measure IS in X as given above in 3, it is characterized by the degree of Impostor syndrome using the trait and anti-trait membership values. The Neutrosophic Impostor syndrome is given by

$$IS = \langle x, Tr_{IS}(x), IrT_{IS}(x), NTr_{IS}(x), IATr_{IS}(x), ATr_{IS}(x) \rangle : x \in X \quad (7)$$

It is important to note that the anti-trait of Impostor syndrome is Peter's principle or the Dunning-Kruger effect. Similarly, the neutrosophic perfectionist NP is given by

$$NP = \langle x, Tr_{NP}(x), ITr_{NP}(x), INTr_{NP}(x), IATr_{NP}(x), ATr_{NP}(x) \rangle : x \in X \quad (8)$$

4. System Architecture

Figure 1 provides the proposed framework's architecture. We prepared a separate questionnaire, performed data collection, and pre-processed the data. Neutrosophic trait scores were calculated for each data point, and the data was labelled. Data analysis using exploratory data analysis was done, and then machine learning algorithms were implemented. Discussion and conclusions inferred from EDA and machine learning models are presented in the last module.

4.1. Questionnaire Design

We wanted to cover a set of interconnections between impostor syndrome, perfectionism, self-esteem and post-covid confidence levels in students after college reopened. Generally, impostor syndrome questionnaires, are based on the 5-point Likert scale, expect the summation of answers to provide the results.

Our questionnaire was designed innovatively with 29 items to cover impostor characteristics, perfectionism, self-esteem, emotional quotient and introversion-extroversion characteristics. Certain questionnaire sections were framed intentionally, so the respondents had to answer similar concept-based questions at least twice. Some questions were asked in the reversed

[1], <https://paulineroseclance.com/pdf/IPTestandscoreing.pdf>

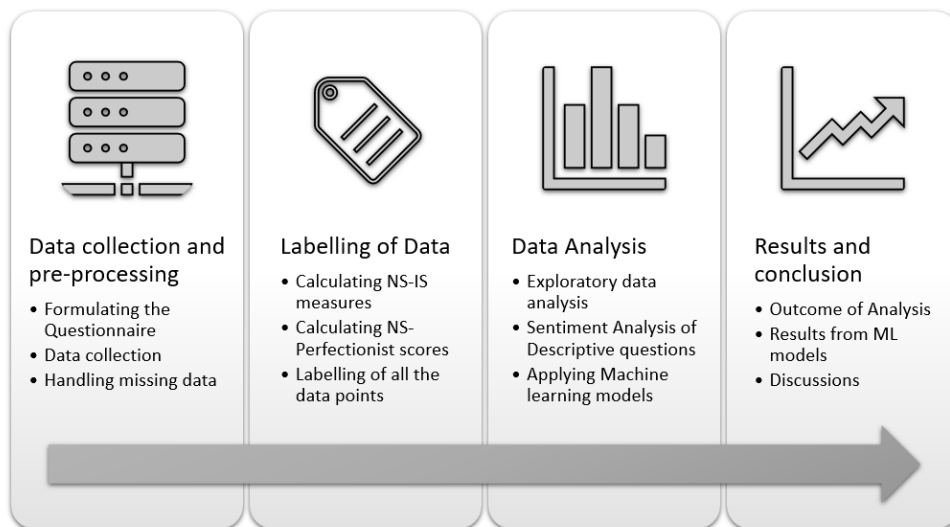


FIGURE 1. The overall system architecture

direction so that a respondent might capture a more genuine picture of themselves in one way or the other.

The survey conducted was anonymous. Questions were on a 5-point Likert scale, from “Strongly Agree” to “Strongly Disagree”. The subjects were asked about their age and gender. All the questions were masked and worded positively to hide the direct intentions of the purpose of the questions. The complete questionnaire is provided in Appendix A. Certain salient features are discussed here to highlight its uniqueness.

Impostor Syndrome related: In the questionnaire, 13 items were focused on Impostor Syndrome; they are items 3-5, 8-14, 19-20 and 23 in Appendix 7.

Consider items Q4 and Q8

Q4: Many times, you feel crushed by constructive criticism, seeing it as evidence of your “ineptness”?

Q8: In rare cases, you feel crushed by constructive criticism, seeing it as evidence of your “ineptness”?

Item 8 is a reversed question of item 4. If a person has already made up his/her mind that the SA option is the default, or if they are trying to hide things, there are chances that they might exhibit impostor syndrome in the case of reversed questions.

Similarly, consider Q3, Q11 and Q20.

Q3. Do you chalk your success up to fates, luck or error?

Q11. You blame your luck for success rather than hard work.

Q20. Most of your success has been a stroke of luck.

All these questions deal with the luck factor.

Perfectionism related: Generally, impostor syndrome is related to perfection and self-esteem issues. To capture the same, questions related to perfection were asked. Items 6, 7, 15, 17 and 18 are related to perfectionism.

Self-esteem related: Two Likert scale questions were asked regarding their self-image in the house. The second part of the questionnaire consists of descriptive questions on whether the subjects' self-esteem (the question says confidence, though) in their college life had changed after the pandemic and their response to a generalized gender-based self-esteem statement.

IQ-EQ and introversion-extroversion related: Items 21 and 22 are related to IQ and EQ in self-judgment. The introversion-extroversion aspect is dealt with in items 25-27. It also consisted of a quantitative question about how comfortable they can be without being judged in different social settings like home, college, on social media, an online alter-ego and with friends.

4.2. Methodology

Data Collection: The dataset has been obtained by conducting a survey consisting of a detailed pen-and-paper questionnaire of 29 items, of which 22 were 5-point Likert scale-based questions and two written questions, covering aspects to measure the participants' levels of experiencing Impostor syndrome, perfectionism and gender. The respondents were 200 university students from Vellore, India.

The survey was conducted in the post-pandemic environment, with in-person classroom attendance. The students who were willing voluntarily participated in the study. Their ages ranged from 19 to 22. There was no monetary reward or added incentive for partaking. The study complied with the ethical research regulation of the college from which the respondents were recruited. The collected data was then manually entered into a CSV file by us.

Data pre-processing: Cleaning the manually entered data is an important data pre-processing step:

- (1) Many issues were there in data entry; this was cleaned by hardcoding and replacing the anomalies found.
- (2) Dropped serial number column for smoother working of machine learning models.
- (3) As mentioned earlier, the questionnaire has inverted specific questions. To ensure that each answer's extremes indicated the same phenomenon, the answers (SD \rightarrow SA) have been inverted for some questions (8, 12, 18) to facilitate this.
- (4) Filled 'NA' values with 'N' (Neutral) to preserve the item's weight.

Weightage to questions: Of the thirteen items under consideration for Impostor syndrome, items 4, 8, 11-13, 19 & 20 were given a weightage of 2, and others were given a weightage of 1.

4.3. Labelling of Data

Neutrosophic Impostor Syndrome measures

The impostor syndrome is calculated from all three functions (accuracy, score and certainty), and a counter variable called result is used. It is initialized to 0.

- Neutrosophic impostor syndrome accuracy cutoff: If $a(IS) \geq 0$, result = result + 1 else result = result.

- Neutrosophic impostor syndrome score cutoff: If $s(IS) \geq 0.53$, result = result + 1 else result = result.

- Neutrosophic impostor syndrome certainty cutoff: If $c(IS) \geq 0.1$, result = result + 1 else result = result.

If the result ≥ 2 , the data point is labelled Yes for impostor syndrome.

Similarly, the neutrosophic perfectionist accuracy, score and certainty are calculated, but the labelling is done directly only from item 15. The calculated neutrosophic measures are used for machine learning modelling.

Introversion score calculation: These questions (items 25, 26 and 27) were asked to see how introverted or extroverted the students were. Based on their responses to the questions, an extrovert-introvert score was calculated, which ranged from 0 to 10. If the score was less than or equal to five, the person was labelled an extrovert, while if the score was greater than five, they were labelled introverted.

The first item (25) was asked to show where the students could be themselves without being judged by their surroundings or peers. The next question was used to observe how comfortable the subjects felt at certain places in their daily life, like home, college, friends, workplace, online, and their alter-ego. Students were expected to answer this question in percentages. The following question was targeted to find where they had to pretend to be somebody else they were not. Depending on their responses to all three questions, the score calculation has been divided into six categories: nowhere, home, online and alter-ego, friends, college and workplace. The score variable is altered according to their choice for each question. A detailed score updation is given below: In the first question, if the student chose nowhere, it indicates that they cannot truly be themselves anywhere and are heavily inclined towards being an introvert. The score is then increased by ten. Suppose the student responded that they are comfortable at home. They pretend to be someone they are not at home while being comfortable (home ≥ 50); 1 point is added to the score. If they chose that they felt judged at home but also gave a percentage of being comfortable at home ≥ 70 , it could be drawn that they assume they

TABLE 1. Summary of Dataset after labelling

| Title | Overall Value | Female | Male | Undisclosed |
|---|---------------|--------|--------|-------------|
| Total people | 200 | 41 | 131 | 28 |
| number with IS | 114 | 26 | 68 | 20 |
| % of people with IS | 57% | 63.41% | 51.91% | 71.42% |
| number of people with perfectionism | 57 | 18 | 33 | 6 |
| % of people with perfectionism | 28.50% | 43.90% | 25.19% | 21.42% |
| number of people with IS having perfectionism | 36 | 10 | 33 | 3 |
| % of people with IS having perfectionism | 31.50% | 27.77% | 91.66% | 8.33% |

feel comfortable at a place despite knowing they are judged there. 2 points are then added to the score. If this is not the case, two is removed from the score.

If the student chose online or alter-ego, they pretended to be someone they are not online and answered that they were comfortable (≥ 60), then; if they were comfortable having an alter-ego ($\% \geq 50$), then three points are added to the score since it indicates that he/she might have that personality that they think is pretension. However, they cannot express it because they are introverted, and the online community gives a sense of safety to express themselves, else Three is subtracted from the score since they are not comfortable having an online alter-ego, indicating extroverts. Else, if they feel they can be themselves online without being judged and are comfortable in alter-ego ($> 60\%$), then the score is increased by 4, else if they were not that comfortable ($\leq 60\%$), the score is increased by 1.

If the student chose with friends, they pretended to be someone else in front of their friends and be comfortable around them $> 60\%$, and if they feel they could be themselves, the score is increased by two else if they are comfortable being themselves at college > 50 .

5. Data analysis and Machine learning module

After the labelling of the data, exploratory data analysis was performed on the data; the results are tabulated in Table 1, which is discussed in detail in the next section. Out of the 200 participants, there were 41 females, 131 males and 28 people who chose not to disclose their gender. In total, 114 people had impostor syndrome, which is close to 57%.

Random forest: Random forest is an ML algorithm that uses multiple decision trees to make predictions. It is an extension of the bagging method that uses both bagging and feature randomness to create an uncorrelated forest of decision trees. Random Forest is commonly used for both classification and regression problems. It is a flexible and easy-to-use algorithm

that usually produces excellent results, even without hyper-parameter tuning. The dataset was split into two parts: 75% for training and 25% for testing.

Support Vector Machine Support Vector Machine (SVM) is a supervised ML algorithm for classification and regression analysis. It is used to find the best boundary between two data classes by maximizing the margin between them. SVMs are often used in image classification, text classification, and bioinformatics. SVM was implemented for the dataset. The dataset split was a 70:30 ratio. We used a linear kernel to implement the model to avoid overfitting data.

K-Nearest Neighbours (K-NN) It is a simple ML algorithm founded on a supervised learning technique. It uses the likeness between the new case/data and available cases. It classifies a new data point based on the similarity of the dimensional features for each data point. For this model, the dataset was split into an 80:20 ratio.

Sentiment Analysis of descriptive questions

Calculating SVNS values: Expression of sentiment is very complex, but the VADER package is defined to understand online language closely. It has use cases to encompass utf-8 encoded emojis, emoticons (:D, :P, XD), slang words(sux), slang words modified (kinda, friggin), use of all caps(GOOD), use of exclamation points (good!!), and usage of typical negations (not good).

VADER contains inbuilt pre-defined objects like SentimentIntensityAnalyzer() and polarity_scores(). SentimentIntensityAnalyzer() takes input in string format and returns four values: positive (pos), negative(neg), neutral(neu) and compound(comp); where $0 \geq \text{pos}$, neg , neu , $\text{comp} \leq 1$. The scores denote how much positivity, negativity and neutrality lie in the sentence and the variable “compound” is calculated by normalizing the three scores. The closer the value of the compound is to “1”, the higher the positivity of the sentence. If the compound value is ≥ 0.05 , it is considered positive; if $\text{compound} \leq -0.05$, it is negative, or else it is neutral. Since we are focusing on a gender-based study, we asked two questions to the subjects; one based on their views about self-image issues in men and fear of failure in women and the next question describes self-confidence pre and post covid.

6. Results and Discussions

6.1. Results from EDA

Of the 200 participants involved in the study, 114 had imposter syndrome. Of the 41 females, 26 had imposter syndrome; out of 131 males, 68 had imposter syndrome. There was a significant difference in the occurrence of Imposter syndrome between females and males, with 63.41% and 51.91%, respectively. It is visible and validated that women are likelier to

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TABLE 2. Results from Machine Learning models

| Models | Random forest | SVM | KNN |
|-------------------------|---------------|-------|-------|
| Train: Test Ratio | 75:25 | 70:30 | 80:20 |
| Accuracy (%) | 83.7 | 92.15 | 82.35 |
| Precision(weighted avg) | 95.2 | 90.9 | 85.7 |
| Recall(weighted avg) | 76.9 | 90.9 | 85.7 |

have imposter syndrome. While 28.5% of the total respondents were perfectionists, 43.90% were perfectionists among the females. And only 25.19% of males were perfectionists.

It is interesting to note that 31.5% of people with Imposter syndrome are also perfectionists. However, there is a vast difference between females and males. Only 27.7% of women with imposter syndrome are perfectionists. In contrast, almost 91.66% of men with imposter syndrome are perfectionists. The correlation between perfectionism and imposter syndrome is observed here.

6.2. Results from Machine Learning Models

Three machine learning models, namely Random forest, SVM and KNN, were implemented using Python. The results are tabulated in Table 2.

Random forest: The features used in the model include the student's age, their responses to questions, sentiment scores for two descriptive questions, and labels for perfectionist and impostor syndrome. The random forest model had a high accuracy of 83.7%, which means it is suitable for solving problems with many features. Figure 2a gives the confusion matrix for the random forest model.

SVM: SVM was implemented for the dataset. The dataset was split into a 70:30 ratio. We used a linear kernel to implement the model to avoid overfitting data. The best accuracy was obtained with the SVM model; we attained an accuracy of 92.15%. Figure 2b gives the confusion matrix for the SVM model.

KNN: KNN is a supervising machine learning model that stores all the data and classifies a new data point based on the similarity of the dimensional features for each data point. For this model, the dataset was split into an 80:20 ratio. We achieved an accuracy of 80.20%. The confusion matrix for KNN model is given in Figure 2c.

6.3. Results from sentiment Analysis

The data set was split based on gender and sentiment analysis was conducted for each long answer question. For the first question, men had a compound score of 0.1491 (positive) and women had 0.2689(positive); meaning women agreed that they face self-image issues more than

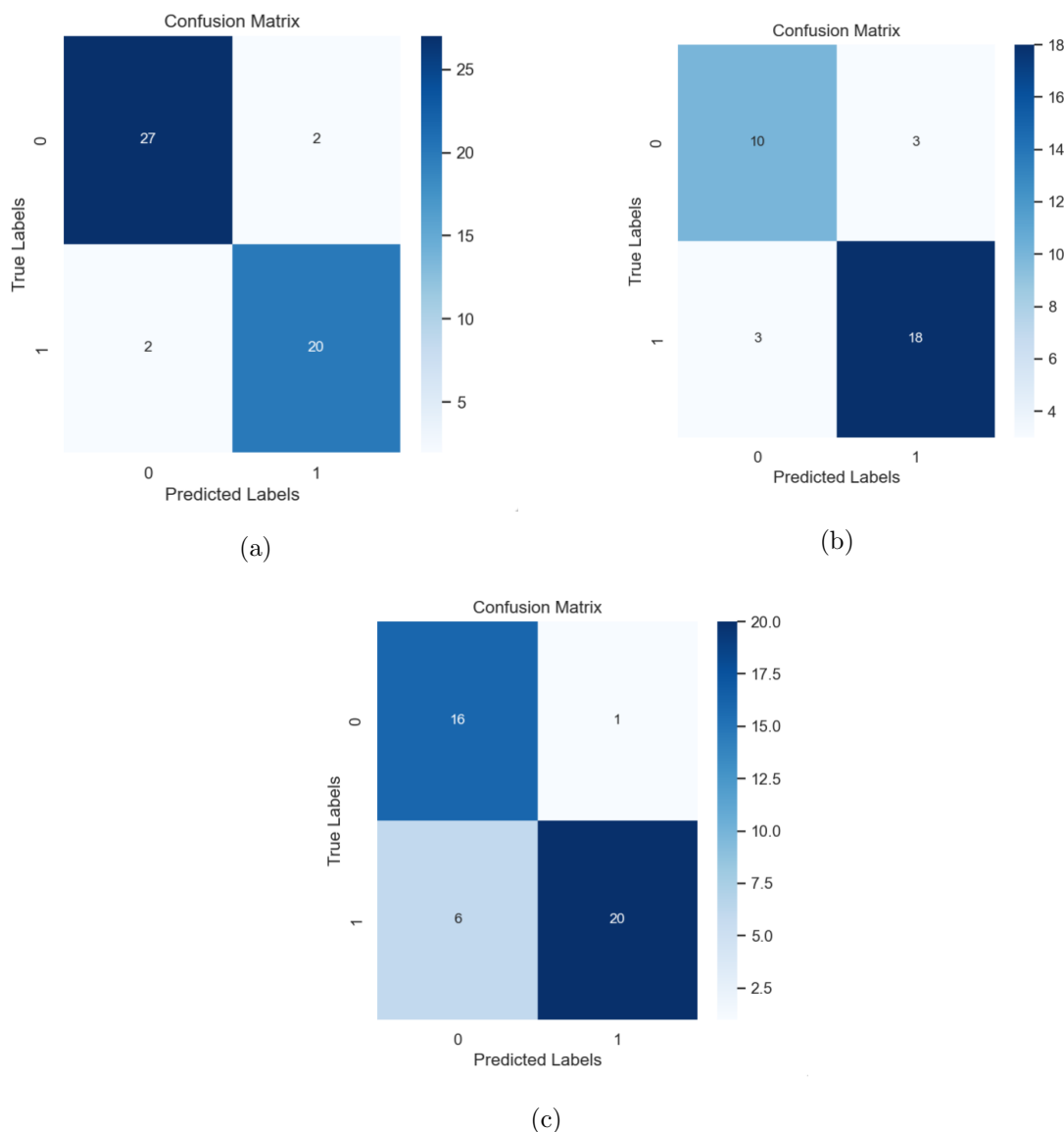


FIGURE 2. Confusion Matrix: (a) Support Vector Model; (b) K-NN ; (c) Random Forest

men. While analysing the second question, men had a compound score of 0.2545 (positive) and women had 0.2580(positive); meaning men and women equally believe that covid has affected their self-confidence.

7. Conclusions

Neutrosophic trait measures were introduced in this paper based on refined neutrosophic sets. A group of 200 students participated in the study; it was conducted and labelled using Neutrosophic trait measures. Impostor syndrome was analysed along with perfectionism, self-esteem issues and introversion. The ratio of students with Impostor syndrome was the same

across the genders; no gender-based difference was found. After labelling the data, machine learning models like SVM, KNN and Random forest were implemented. SVM performed the best of the three models.

Limitation and Future Study: The study's primary limitation is based on the fact that the number of female participants is less here since the number of female students in STEM fields is lesser than that of boys in STEM. For future research, gender-oriented studies can be taken up with more participants. With more detailed data collection based on (Q16 and Q25), gender-related studies can be conducted to predict how Impostor syndrome affects the genders in STEM fields. The socio-economic background of the student should have been considered. Similarly, the educational background, like first-generation learners, can be considered in future studies.

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Appendix A

Sample Questionnaire

- (1) Gender:
- (2) Age:
- (3) Do you chalk your success up to fates, luck or error?
- (4) Many times, you feel crushed by constructive criticism, seeing it as evidence of your "ineptness"?
- (5) Do you believe "If I can do it, anybody can"?
- (6) Do you agonize over the smallest flaws in your work?
- (7) Do you believe that everything you do must be completely perfect?
- (8) In rare cases you feel crushed by constructive criticism, seeing it evidence of your "ineptness"?
- (9) Do you feel incompetent despite attaining success?
- (10) You compare your abilities to people around you and think that others may be more intelligent than you.
- (11) You blame your luck for success rather than hard work.
- (12) Do you think shortcut to success makes you smarter
- (13) You have doubts about your abilities despite people around you trusting you.
- (14) Do you often fear not meeting other people's expectations?
- (15) I am a perfectionist
- (16) Do you feel like a non-valuable member of the family if you don't participate in domestic work?

- (17) 'I have to be good at a particular activity to enjoy it' (As in, if you picked up a new hobby like painting, the only way you feel good about doing it is if you are using perfect techniques and doing it the "right" way)
- (18) I believe that means is more important than the ends
- (19) When people compliment you, you think you are not as accomplished as they think
- (20) Most of your success has been a stroke of luck
- (21) You have an above-average IQ score
- (22) Your emotional quotient is better than your general IQ score
- (23) You downplay compliments from others.
- (24) Do you feel like an unimportant family member if you don't involve in decision-making process?
- (25) Which places do you think you can be yourself without being judged?
Home College With friends Work Online Nowhere
- (26) How comfortable are you with being yourself at (please give a percentage)
Home College With friends Work Online Alter Online Egos
- (27) What places do you think you pretend to be someone you are not?
Home College With friends Work Online Nowhere
- (28) At least 70% of individuals have dissatisfaction in their lives. Women mostly face self-image issues and in men, it is driven by the fear of not being successful or letting people down. Do you agree with this? And in your experience, how have you seen variances to the mentioned scenarios?
- (29) As the campus has reopened after conducting classes, examinations, and project reviews online over the past 2 years, do you feel that this might bring up changes in confidence levels, due to the adjustments which may have arisen doubts in self-esteem from the initial change of method?

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