

A Statistical Approach to Signature-Based Behavioral and Psychological Profiling of Undergraduate Students

Khinal Parmar¹ and Sanket Gudekar²

^{1, 2}Department of Basic Science and Humanities

Mukesh Patel School of Technology Management & Engineering, SVKM's NMIMS,
Vile-Parle (W), Mumbai-400056, India

khinal.parmar@nmims.edu and sanket.gudekar@nmims.edu

ABSTRACT

This study uses statistical methodologies to investigate the relationship between signature features and behavioral and psychological traits among undergraduate students. The research analyzes signature attributes such as size, pressure, slant, and zone utilization to determine their association with specific personality characteristics like confidence, introversion, emotional intensity, and analytical thinking. Through statistical modeling and hypothesis testing, significant correlations are identified, underscoring the potential of signature analysis in behavioral profiling. This paper contributes to the field by utilizing a data-driven approach to validate graphological insights through quantitative methods, emphasizing the integration of statistical analysis with personality profiling.

Keywords: graphology, handwriting analysis, signature analysis, psychological profiles, personality traits, behaviour.

2000 Mathematics Subject Classification: 62P99, 62H30, 62G10.

1 Introduction

A branch of graphology called signature analysis has drawn interest from academics and industry experts due to its capacity to disclose important facets of a person's personality and psychological state. In contrast to general handwriting, which includes a wide variety of everyday writing, signatures are distinctive, stylized, and frequently represent the way that individual wants to be seen.

This manuscript explores the analysis of undergraduate students' signatures to uncover correlations with their behavioral and psychological profiles. The study is particularly significant to personality assessment and educational psychology since it offers a non-intrusive way to learn more about each person's unique characteristics and tendencies. The primary objectives of this research are to determine if the zones of signatures relate to students' loyalty traits and intellectual levels, if the pressure of signatures correlates with stress and social behavior, and if the slants of signatures reflect the mental states of the students.

Background research in graphology suggests that handwriting and signature characteristics can reveal significant aspects of an individual's personality and emotional state (Tett and

Palmer, 1997). This study builds on these foundations, focusing on the specific subset of undergraduate engineering students, thus offering targeted insights applicable to academic counseling and personal development.

Organization of this paper is as follows: Section 1 introduces the purpose of the study and gives background of the work. Section 2 reviews relevant literature and theoretical underpinnings of signature analysis. The third section outlines the methodology, detailing the approaches used for data collection and the analytical techniques employed. In the fourth section, the findings are discussed, with a focus on the most important results and their statistical relationships. Section 5 discusses the implications of these findings in educational and psychological contexts. Finally, Section 6 concludes with a summary of the research, its limitations, and potential directions for future studies.

2 Literature Review

A signature is a concise portrayal of an individual's personality. Each personality attribute is encoded in the brain as a neurological pattern. Graphology involves a detailed examination of handwriting's structural graphic elements to reveal aspects of the writer's personality (Varshney and Puri, 2017). When writing, these actions happen subconsciously. Pen pressure and baseline used when writing reflect specific personality traits. Similarly, handwriting may be used to assess mental health and characterize human behavior in terms of social talents, success, thinking patterns, or routines (Antony and Cap, 2008). Handwriting samples from various individuals are collected for experimental analysis, incorporating both similar and dissimilar texts. These methods are applied to the data sets, and the experimental results are then presented, offering insights into the distinctive traits revealed through handwriting. (Mukherjee and De, 2016).

We sign our names to represent who we really are and what makes us special. As we get older, our trademark frequently changes along with our personality (Kedar, Bormane, Dhadwal, Alone and Agarwal, 2015). The process of identifying personality traits involves analyzing handwriting patterns, extracting character features, and classifying them. While this area of research is actively being explored, the results remain less than satisfactory. This is largely due to the complexity of writing patterns and the significant variation in individual writing styles (Mekhaznia, Djeddi and Sarkar, 2021).

A method has been designed to analyze and predict an individual's behavior by extracting key features from their handwriting, utilizing Matlab for the computational process (Punetha, Pal and Sharma, 2020). What initially captures our attention in a signature is its overall structure, known as a 'gestalt,' which involves perceiving 'the whole' as though it were an image without any identifiable details (Joshi, Agarwal, Dhavale, Suryavanshi and Kodolikar, n.d.). The authors introduced a method aimed at predicting an individual's personality traits based on features derived from their handwriting, utilizing a machine learning technique. The size of one's signature can reveal aspects about the persona they aspire to project as a writer (Lokhande and Gawali, 2016). However, a writer who uses a small-sized signature indicates that they do not want to stand out, but a writer who uses a medium-sized signature just expresses

their wish to fit in. These individuals want quiet, alone lifestyles free from unnecessary stress (Brewer, 1999).

Even something as simple as underlining a signature can subtly convey a sense of independence. It suggests that the individual is highly confident and self-reliant, particularly in unfamiliar settings. The more elaborate and eye-catching the underline, the more attention seeking the person is likely to be. This individual thrives on being noticed and may go to great lengths to draw attention to themselves, sometimes even resorting to unexpected behavior if they feel overlooked. Conversely, if the underline is zigzagged, it can indicate a lack of confidence. A rightward zigzag underline suggests a desire for independence, while the leftward portion reflects doubt and uncertainty (Miguel-Hurtado, Guest, Stevenage and Neil, 2014).

Many factors influence the study of signatures and signature analysis. Among them are: Types of Slants, Types of Underlines, Type of zone, Pressure/Pastocity, Size of letters (Hemlata and Singh, 2018).

In concluding the literature review, it is evident that signature analysis serves as a valuable tool for uncovering behavioral and psychological traits, contributing to various fields such as personality assessment, human resource management, and psychological profiling. The existing literature highlights the intricate relationship between handwriting characteristics and personality indicators, but there is still a lack of consensus on certain methodologies and interpretations. This study aims to build on previous research by refining analytical techniques and exploring new dimensions in signature analysis, specifically within the context of undergraduate students. This research will contribute to a more nuanced understanding of the connection between signature patterns and psychological profiles, thereby offering practical applications in educational and professional settings.

3 Methodology and Methods

This study uses a descriptive survey research method, incorporating both simple random and purposive sampling techniques. We selected a sample of 150 undergraduate students from various engineering departments, enrolled in the course "Graphology for Personality Development".

The process of collecting signature samples aligns with students' class schedules, organized to facilitate participation and minimize disruptions. Students provided their signatures on A4-size paper using ballpoint pens to ensure consistency.

We analyzed the signatures using a signature analysis scale specifically developed for this study. This scale measures various dimensions of the signatures, including size, pressure, slant, and other relevant characteristics. We systematically recorded the data in a Microsoft Excel spreadsheet for further statistical analysis. Chi-square tests were applied to evaluate the significance of the relationship between various signature traits and the psychological variables under study. This methodical approach helped ensure the data's reliability and accuracy, providing a strong foundation for subsequent analysis. By maintaining this rigorous structure, the study aimed to guarantee both the validity and dependability of its findings.

To ensure the ethical standards of this study, students were fully informed about the research

process and provided consent before their signatures were collected. The research team communicated the purpose of the study, the type of data being collected, and how the signatures would be analyzed. The study also took strong measures to protect the privacy of participants by anonymizing the data and using only aggregated information for analysis. These efforts align with data protection standards, preserving both the confidentiality and integrity of the research.

Objective of the study: To analyze the impact of signature on the personality traits of the engineering students.

Hypothesis:

- (1) Zones of signature are independent to the intellectual levels of the engineering students.
- (2) Zones of signature are independent to the loyalty traits of the engineering students.
- (3) Pressure of signature are independent to the stress levels of the engineering students.
- (4) Pressure of signature are independent to the social behavior of the engineering students.
- (5) Slants of the signature are independent to the mental state of engineering students.

4 Main Results

Hypothesis 1: Zones of signature are independent to the intellectual levels of the engineering students.

Table 1: Number and percentage of the students with high, medium and low intellectual levels with respect to zones of signature

Intellectual levels		Signature zone			Total
		High	Medium	Low	
High	Observed frequency	21	17	3	41
	Expected frequency	18.04	18.59	4.37	41
	Percentage	14.00%	11.33%	2.00%	27.33%
Medium	Observed frequency	44	42	11	97
	Expected frequency	42.68	43.97	10.35	97
	Percentage	29.33%	28.00%	7.33%	64.67%
Low	Observed frequency	1	9	2	12
	Expected frequency	5.28	5.44	1.28	12
	Percentage	0.67%	6.00%	1.33%	8.00%
Total	Observed frequency	66	68	16	150
	Expected frequency	66	68	16	150
	Percentage	44.00%	45.33%	10.67%	100.00%
$\chi^2 = 7.4271$, degree of freedom = 4; Critical value = 9.488 %					

Based on the data presented in Table 1, we analyze the relationship between the zones of signatures and the intellectual levels of engineering students. The observed frequencies indicate the number of students with high, medium, and low intellectual levels within each signature

zone (high, medium, and low). We calculate the expected frequencies based on the assumption that the distribution of intellectual levels is independent of the signature zones.

The chi-square statistic for the data is calculated as 7.4271. At a significance level of 0.05 and with 4 degrees of freedom, the critical value is 9.488. Since the computed chi-square value (7.4271) is lower than the critical threshold, the null hypothesis cannot be rejected. Therefore, we accept the null hypothesis Zones of signature are independent to the intellectual levels of engineering students.

Hypothesis 2: Zones of signature are independent to the loyalty traits of the engineering students.

Table 2: Number and percentage of the students with honesty and dishonesty with respect to zones of signature

Loyalty traits		Signature zone			Total
		High	Medium	Low	
Honest	Observed frequency	47	43	3	93
	Expected frequency	40.92	42.16	9.92	93
	Percentage	31.33%	28.67%	2.00%	62.00%
Dishonest	Observed frequency	19	25	13	57
	Expected frequency	25.08	25.84	6.08	57
	Percentage	12.67%	16.67%	8.67%	38.00%
Total	Observed frequency	66	68	16	150
	Expected frequency	66	68	16	150
	Percentage	44.00%	45.33%	10.67%	100.00%
$\chi^2 = 15.1247$, degree of freedom = 2; Critical value=5.991 %					

The data presented in Table 2 explores the relationship between signature zones and the loyalty traits (honesty and dishonesty) of engineering students. Among the 150 students sampled, 93 were categorized as honest, while 57 were labeled dishonest.

On performing the Chi square test for hypothesis testing on Table 2, the chi square value obtained for the data is 15.1247, which is greater than the critical value 5.991 at 5% level of significance. Therefore, the null hypothesis is rejected and the alternate hypothesis Zones of signature are related to the loyalty traits of the engineering students is accepted. The data indicates that the placement of a signature on a page may have link to whether a student tends to be honest or dishonest, with honest students more likely to place their signatures in the high or medium zones. This finding opens an intriguing window into how subtle aspects of signature placement might reflect deeper aspects of personality.

Hypothesis 3: Pressure of signature are independent to the stress levels of the engineering students.

The data in Table 3 explores the relationship between the pressure applied in signatures and the stress levels of engineering students. We analyze a sample of 150 students, divided into high, medium, and low stress levels.

For students with high stress levels, 22.0% exhibited high pressure in their signatures, while

Table 3: Number and percentage of the students with high, medium and low stress levels with respect to pressure of signature

Stress level		Pressure			Total
		High	Normal	Low	
High	Observed frequency	33	8	3	44
	Expected frequency	11.73	26.99	5.28	44
	Percentage	22.00%	5.33%	2.00%	29.33%
Medium	Observed frequency	6	78	3	87
	Expected frequency	23.2	53.36	10.44	87
	Percentage	4.00%	52.00%	2.00%	58.00%
Low	Observed frequency	1	6	12	19
	Expected frequency	5.07	11.65	2.28	19
	Percentage	0.67%	4.00%	8.00%	12.67%
Total	Observed frequency	40	92	18	150
	Expected frequency	40	92	18	150
	Percentage	26.67%	61.33%	12.00%	100

$\chi^2=129.7649$, degree of freedom = 4; Critical value=9.488 %

only 5.33% and 2.0% had normal and low pressure, respectively. The expected frequencies for these categories were 11.73 for high pressure, 26.99 for normal, and 5.28 for low pressure. This discrepancy suggests that high-stress students are more likely to apply greater pressure in their signatures. On the other hand, students with medium stress levels predominantly showed normal pressure (52.0%), with much lower percentages for high (4.0%) and low (2.0%) pressures. Lastly, low-stress students demonstrated a more varied distribution, with 0.67% applying high pressure, 4.0% normal, and 8.0% low pressure, though these figures deviated from the expected frequencies of 5.07, 11.65, and 2.28, respectively.

We can infer from Table 3 that the Chi square value of 129.7649 obtained from the data is higher than the critical value 9.488 at 5% level of significance. Therefore, the null hypothesis is rejected and the alternate hypothesis Pressure of signatures are related to the stress level of the engineering students is accepted. This finding reveals a significant association between the pressure exerted in signatures and the stress levels of the engineering students. High-stress students tend to apply more pressure when signing; possibly reflecting their internal tension, while medium and low-stress students display different patterns. The results highlight how signature pressure might serve as an indirect indicator of a student's stress level, offering potential insights for psychological profiling.

Hypothesis 4: Pressure of signature are independent to the social behavior of the engineering students.

The data in Table 4 delves into the relationship between the pressure exerted in signatures and the social behavior of engineering students, categorized into dominating, agreeable, and submissive personality traits. The study sampled 150 students, revealing intriguing patterns. Among students with a dominating personality, 16% exhibited high pressure in their signatures,

Table 4: Number and percentage of the students with dominating, agreeable, submissive personality with respect to pressure of signature

Personality trait		Pressure			Total
		High	Normal	Low	
Dominating	Observed frequency	24	16	1	41
	Expected frequency	10.93	25.15	4.92	41
	Percentage	16.00%	10.67%	0.67%	27.33%
Agreeable	Observed frequency	9	50	5	64
	Expected frequency	17.07	39.25	7.68	64
	Percentage	6.00%	33.33%	3.33%	42.67%
Submissive	Observed frequency	7	26	12	45
	Expected frequency	12	27.6	5.4	45
	Percentage	4.67%	17.33%	8.00%	30.00%
Total	Observed frequency	40	92	18	150
	Expected frequency	40	92	18	150
	Percentage	26.67%	61.33%	12.00%	100.00%

$\chi^2=39.9994$, degree of freedom = 4; Critical value=9.488 %

significantly higher than the expected 10.93%. Those with normal pressure comprised 10.67%, and only 0.67% showed low pressure. For students with an agreeable personality, 6% exerted high pressure, while the majority, 33.33%, applied normal pressure. A smaller group of 3.33% demonstrated low pressure in their signatures. Submissive personalities showed a different trend, with 4.67% applying high pressure, 17.33% normal pressure, and a notable 8% low pressure.

We can conclude from Table 4 that the Chi square value of 39.9994 obtained from the data is higher than the critical value 9.488 at 5% level of significance. Therefore, the null hypothesis is rejected and the alternate hypothesis Pressure of signatures are related to the social behavior of the engineering students is accepted. These findings suggest a clear connection between how individuals express themselves through their signatures and their underlying social behavior.

Hypothesis 5: Slants of the signature are independent to the mental state of engineering students.

The data in Table 5 explores the relationship between the slants of signatures and the mental states of engineering students, categorized into forward thinkers, reserved/shy individuals, and balanced personalities. The sample includes 150 students, with their signature slants classified as right, left, or normal. Based on the data presented in Table 5, the computed Chi square value of 102.2343 with 4 degrees of freedom exceeds the critical value of 9.48 at a 0.05 significance level. Consequently, we reject the null hypothesis in favor of the alternative hypothesis, which asserts, Slants of the signature are related to the mental state of engineering students. The data reveals a strong association between the way students slant their signatures and their mental state, suggesting that signature slants can serve as a subtle indicator of one's

Table 5: Number and percentage of the students with different mental state with respect to slants of signature

Mental state		Slants			Total
		Right	Left	Normal	
Forward thinker	Observed frequency	18	1	12	31
	Expected frequency	4.55	14.67	11.78	31
	Percentage	12.00%	0.67%	8.00%	20.67%
Reserved/ Shy	Observed frequency	1	49	7	57
	Expected frequency	8.36	26.98	21.66	57
	Percentage	0.67%	32.67%	4.67%	38.00%
Balanced	Observed frequency	3	21	38	62
	Expected frequency	9.09	29.35	23.56	62
	Percentage	2.00%	14.00%	25.33%	41.33%
Total	Observed frequency	22	71	57	150
	Expected frequency	22	71	57	150
	Percentage	14.67%	47.33%	38.00%	100.00%

$\chi^2=102.2343$, degree of freedom = 4; Critical value=9.488 %

psychological disposition.

5 Discussion

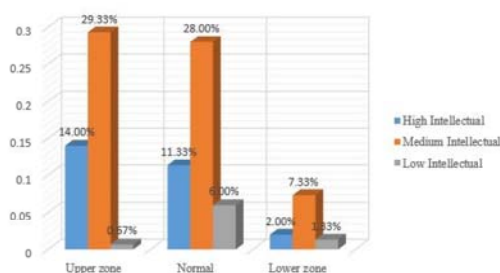


Figure 1: Difference between the Students with different intellectual levels and zones of their signature

Figure 1 illustrates the percentage of signature zones of undergraduate engineering students. Students with high intellectual abilities primarily choose the Upper and Normal Zones for their signatures, with 14% favoring the Upper Zone. This may indicate a preference for more noticeable and formal signature styles, which are often linked to individuals with higher intellectual

levels who may appreciate conventional and easily identifiable signatures.

Figure 2 illustrates the percentage of loyalty traits of undergraduate engineering students. The Upper Zone is predominantly used by Honest individuals. This might imply that signing in the Upper Zone is associated with traits such as openness and integrity, which are characteristic of honesty.

The Lower Zone is more frequently used by dishonest individuals compared to honest individuals. This may suggest that signing in the Lower Zone is associated with traits such as unconventionality or a lack of transparency, which could align with dishonest behavior.

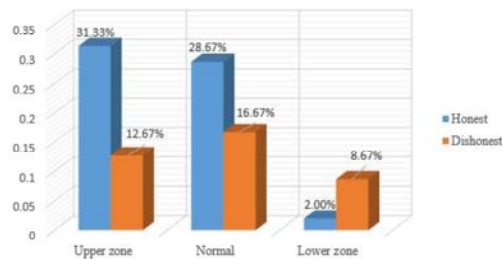


Figure 2: Difference between the Students with loyalty traits and zones of their signature

Figure 3 illustrates that there is a clear relationship where higher pen pressure correlates with higher stress levels, while lower pen pressure correlates with lower stress levels. This indicates that the amount of pressure applied while writing can reflect the writer's stress level, with increased pressure potentially signaling higher anxiety or tension.

The distribution of stress levels under normal pressure is fairly balanced, with a dominance of Medium Stress. This indicates that normal pen pressure does not usually contribute to extreme stress levels, making it a common baseline for many individuals.

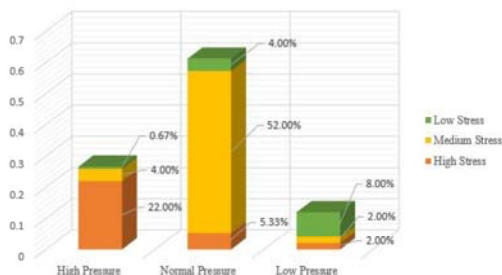


Figure 3: Distribution of Students with respect pen pressure and stress levels

Figure 4 provides valuable insights into how pen pressure in handwriting can be indicative of different personality traits, highlighting the intricate link between physical writing habits and social behavior. Understanding these patterns can be useful for personal self-awareness and professional analyses in various contexts.

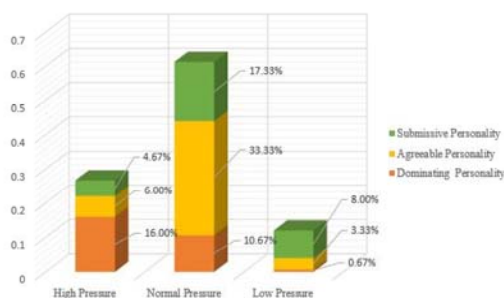


Figure 4: Distribution of Students with respect pen pressure and social behavior

High pen pressure is predominantly associated with Dominating Personalities. This suggests that individuals who apply significant force while writing may have traits such as assertiveness, decisiveness, or a tendency to take control in social situations.

Normal pen pressure is mostly linked to Agreeable Personalities. This indicates that individuals writing with normal pressure tend to have traits such as cooperation, flexibility, and a friendly demeanor.

Low pen pressure is mainly associated with Agreeable and Submissive Personalities. This suggests that individuals who apply less force while writing are more likely to be cooperative, mild-mannered, and potentially more yielding in social interactions. They may avoid confrontation and prefer to maintain harmony.

Figure 5 provides a clear visual representation of how different handwriting slant orientations correlate with various mental states. Individuals can gain self-awareness by understanding how their handwriting reflects their mental state. This can help in identifying areas for personal growth and improving social interactions.

Left slants are least common and are associated with individuals who tend to be more reserved or cautious. Forward thinkers predominantly exhibit right-slanting handwriting, which may suggest an inclination towards assertive, proactive, and optimistic attitudes. Normal handwriting slants are most prevalent among those with a balanced mental state, suggesting that individuals who maintain a neutral slant are likely to exhibit stability and a balanced outlook. This aligns with the notion that a normal slant reflects a calm, objective, and well-adjusted personality.

The relationship between handwriting and personality traits has long been a subject of interest in psychology and graphology. Previous studies have emphasized the correlation between handwriting features and psychological states. Our findings align with this literature, particularly in the context of stress and social behavior, where signature pressure demonstrated a significant association. This supports existing theories that suggest writing pressure can be an external manifestation of internal tension.

However, our research also challenges some of the traditional assumptions in graphology. For instance, the hypothesis that the zones of signatures are related to loyalty traits was not supported by the data. This outcome diverges from earlier studies that posited a strong link between signature zones and various aspects of personality. This discrepancy might be at-

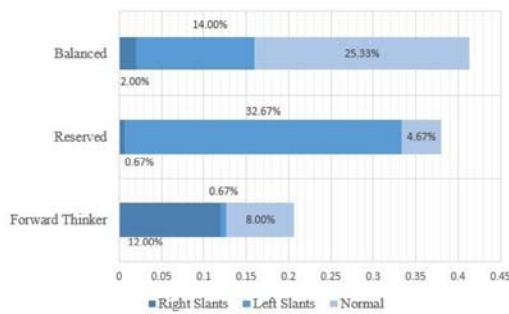


Figure 5: Difference between the Students with different intellectual levels and zones of their signature

tributed to the unique demographic of engineering students, who may exhibit different cognitive and behavioral patterns compared to other populations studied in prior research.

6 Conclusion

This research paper has thoroughly examined the implications of signature analysis in understanding the behavioral and psychological profiles of undergraduate students. Through a detailed study of various signature traits such as size, slant, pressure, and zone utilization, we have identified significant correlations between these elements and distinct personality characteristics.

The first hypothesis leads to the conclusion that no substantial relationship exists between signature zones and intellectual levels among engineering students. The analysis of the second hypothesis suggests that the zones in signatures do indeed relate to students' loyalty traits. The third hypothesis considered whether the pressure applied in signatures is connected to the students' stress levels. The fourth hypothesis suggests that the pressure used in a signature is strongly related to a student's social behavior. Finally, the study examined that the slant of a signature is indeed related to the mental state of engineering students.

Our findings indicate that: Pressure: The pressure exerted in signatures revealed insights into stress levels and emotional states. High pressure correlated with high stress and a more dominant personality, whereas low pressure was associated with low stress and a more submissive personality.

Zone Utilization: The use of different zones in signatures (upper, middle, lower) highlighted various intellectual and social traits. Upper zone usage was predominant among high intellectual individuals, suggesting a preference for formal and recognizable signatures, while normal zone usage indicated a balanced approach. Lower zone usage was less common but provided insights into more grounded and pragmatic individuals.

Slant: The slant of the signature also offered valuable information. Right slants were associated with forward thinking and openness, left slants with reservation and introversion, and straight slants with balance and stability.

The implications of these findings extend to educational settings, where understanding such correlations can aid in psychological assessments and personal development strategies for students. For example, educators and counselors might use signature analysis as a supplementary tool to identify students who may need support in managing stress or enhancing certain behavioral traits.

References

- Antony, D. J. and Cap, O. 2008. Personality profile through handwriting analysis, *Anugraha (Tamil Nadu Capuchin Institute for Counselling, Psychotherapy and Research) Nochio-daipatti Post Dindigul-624 3*.
- Brewer, J. F. 1999. Graphology, *Complementary Therapies in Nursing and Midwifery* **5**: 6–14.
- Hemlata, M. S. and Singh, K. 2018. Personality detection using handwriting analysis, *The seventh international conference on advances in computing, electronics and communication (ACEC)* pp. 85–89.
- Joshi, P., Agarwal, A., Dhavale, A., Suryavanshi, R. and Kodollikar, S. n.d.. Handwriting analysis for detection of personality traits using machine learning approach, *International Journal of Computer Applications* **130**.
- Kedar, S., Bormane, D., Dhadwal, A., Alone, S. and Agarwal, R. 2015. Automatic emotion recognition through handwriting analysis: a review, *2015 international conference on computing communication control and automation* pp. 811–816.
- Lokhande, V. R. and Gawali, B. W. 2016. Inspection of prediction and identification of personality through multiple traits.
- Mekhaznia, T., Djeddi, C. and Sarkar, S. 2021. Personality traits identification through handwriting analysis, *Pattern Recognition and Artificial Intelligence: 4th Mediterranean Conference, MedPRAI 2020, Hammamet, Tunisia, December 20–22, 2020, Proceedings 4* pp. 155–169.
- Miguel-Hurtado, O., Guest, R., Stevenage, S. V. and Neil, G. J. 2014. The relationship between handwritten signature production and personality traits, *IEEE International Joint Conference on Biometrics* pp. 1–8.
- Mukherjee, S. and De, I. 2016. Feature extraction from handwritten documents for personality analysis, *2016 International Conference on Computer, Electrical & Communication Engineering (ICCECE)* pp. 1–8.
- Punetha, N., Pal, A. and Sharma, V. 2020. Behavior prediction of human by signature and handwriting analysis using matlab.
- Tett, R. P. and Palmer, C. A. 1997. The validity of handwriting elements in relation to self-report personality trait measures, *Personality and individual differences* **22**: 11–18.

Varshney, A. and Puri, S. 2017. A survey on human personality identification on the basis of handwriting using ann, *2017 international conference on inventive systems and control (ICISC)* pp. 1–6.