Role of Digital Humanities in Identifying the Uniqueness of the Author: A Comparative Study of Stylometric Tools in the Works of Amitav Ghosh

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Abstract

In the era of AI and digitalization, software tool utilization is no longer confined to the discipline of Computer Science and Engineering. Scholarship in the Humanities increasingly demands the use of computational methods for further understanding and interpreting texts. Digital Humanities, or alternatively Humanities Computing, has been a fascinating subject of research for over seven decades. Since it was rebranded as Digital Humanities in 2004, it has undergone radical transformation. The basic purpose of Digital Humanities has shifted from the mere digitization of texts to utilizing computational technology for the complex analysis of traditional and digital texts. Scholars all over the world have utilized many software programs for analyzing large corpora of texts. However, in literature, there is a significant gap in researching the applicability of Digital Humanities tools. A recurring debate in thesis papers is that of the originality of the author. All this can be made easier and more systematic with the right tool at the right time. Most researchers struggle to identify the right tool for their research in literature. The biggest limitation of Digital Humanities is that most of the tools are computer programs, and some knowledge of programming languages is needed. This research aims to bridge this gap by focusing on the installation process, usability, and application of Digital Humanities tools to literature. It seeks to compare two stylometric devices, Stylo and JStylo, which help establish the originality of the author. These devices extrapolate stylometric attributes such as word frequency, sentence length, and lexical richness. They also evaluate the quality of their visualizations, clustering precision, and variance in identifying stylistic trends.

DOI: https://doi.org/10.36548/rrrj.2025.1.010
Received: 07.05.2025, received in revised form: 10.06.2025, accepted: 27.06.2025, published: 11.07.2025

The study analyzes the tool best suited to describe the singularity of the writer by contrasting their style with that of contemporary writers. By employing stylistic analysis, intertextuality, and citation mapping, this book probes the potential of Digital Humanities techniques in uncovering new insights into the singularity of authors' styles.

Keywords: Amitav Ghosh, Digital Humanities, Indian Literature, Stylo, JStylo.

1. Introduction

There was little worthwhile development in literary technology previously, and it was difficult since tools were not easily available. Writers, scholars, and critics found it difficult to comprehend narrative style, character, setting, theories, figurative devices, and authorial tone and voice, and they would take so much time reading between the lines to grasp the major concepts as well as the methods. The lack of comparative tools deterred critical perception and creative thinking, and the restricted access to tools restricted the scope for sensing uniqueness. Both these issues made critical analysis more cumbersome for writers, researchers, and critics alike. In the fast-changing era of technology, there is always stress on creating things. The innovative advances have not only witnessed huge leaps in technology but witnessed revolutionary leaps in literary studies too. Among all the developments made in recent times, Digital Humanities (DH) is one such emerging field in the recent past with the establishment of numerous innovative tools of analysis for different types of analysis. Depending upon their use, they can be divided into identifying tools for distinctive writing patterns, common theme analysis, and visualizing or literary event mapping and pattern formation. Technologies applied in Digital Humanities are used affirmatively, particularly for the identification of authorial distinctiveness, with some stylometry tools playing a leading role. Stylometry is numerical analysis of linguistic style, typically on literary works, to identify patterns of authorship, genre, or other stylistic features. It is statistical analysis of word usage, sentence style, and other text characteristics to locate singular authorial signatures or stylistic trends. Eder, Rybicki, and Kestemont assert, 'stylometry is the study of measurable aspects of style of writing, such as word usage frequencies and sentence length, for the purpose of comparing or attributing authorship of texts [1].

Stylometric software is used for diverse reasons. Stylo for R is used extensively for stylometry and authorship analysis by statistical and cluster-based methods. JStylo, which is an extension of the Java-based Scale environment, offers sophisticated facilities for authorship

analysis using machine learning algorithms. Other than this, there are numerous stylometric software packages, each with a specific function. JGAAP (Java Graphical Authorship Attribution Program) is a graphical user interface for multiple authorship analysis techniques. Signature is a browser-based stylometry tool to identify author styles. Lexos preprocessed, visualises, and analyses literary works. Voyant Tools provides an online environment for browsing digital texts using word frequencies, frequency analysis, and thematic mapping. These computer programs identify the structural uniqueness of the style of an author and expose their contribution to literary and societal debate. Stylometric software identifies the stylistic uniqueness of Indian writers through their literary compositions. In this paper, stylistic uniqueness is analyzed specifically in the case of the eminent Indian writer Amitav Ghosh's writing style. Amitav Ghosh is the most productive Indian author, with a very large body of work encompassing novels, essays, and non-fiction. His works tend to incorporate aspects of history, politics, culture, and science. His writing consists of stylistically sophisticated voices dealing with issues of colonialism, migration, identity, the opium trade, global capitalism, climate change, cultural memory, and language. In his "Hunting for Treasures" Ram Sharma writes that the works of Ghosh involve intensively with history, identity, and displacement issues, with a focus on the residual impact of colonialism and the complex creation of postcolonial identities [2]. His narrative methods, thematic interests, and lexical variety create rich material for comparative stylometric study. Former West Bengal Governor Gopalkrishna Gandhi praised Amitav Ghosh at the time of the Jnanpith Award ceremony and said: 'His books are rich in what can only be called minerals-the result of patient excavation, not a chance discovery' [3]. His contemporaries as a writer include Salman Rushdie, Arundhati Roy, Vikram Seth, Jhumpa Lahiri, Kiran Desai, Rohinton Mistry, Anita Desai, and Shashi Tharoor. Their major themes include city life, diasporic identity, personal struggle, social justice, and inequality. Application of stylometric software to contrast the work of Amitav Ghosh with that of his contemporaries enables researchers to better comprehend the author and thus enhance the quality of their research.

The Stylo tool, which was created as an R package, uses techniques like Burrows's Delta, Principal Component Analysis (PCA), and Cluster Analysis to represent and explain stylistic variations and affinities between texts. As opposed to this, JStylo is a Java-based graphical user interface (GUI) tool that uses machine learning algorithms like Random Forest, Naive Bayes, and Support Vector Machines (SVM) to underline characteristic stylistic features between writers.

This research combines the Stylo (unsupervised) and JStylo (supervised) toolkits to measure not only authorship patterns but also intra-author stylistic development. The primary aim of this paper is to study stylistic variation and authorship patterns through computational stylometry. The foremost contribution is in its use of stylometric techniques for postcolonial Indian literature, a relatively underresearched field within digital literary studies. This offers clear insights into the distinctive narrative styles of the authors, which will be discussed in the findings and discussion section. The greatest contribution of this paper lies in its application of stylometric analysis to South Asian literary texts, a field frequently overlooked in digital literary studies. It integrates several tools with extensive linguistic features and stringent validation methods (e.g., cross-validation), providing a culturally aware and methodologically sound model for authorship attribution. The findings increase the broadness of computational literary studies and establish a benchmark for subsequent studies of non-Western literary corpora.

2. Problem Statement

Indian Writing in English is a corpus that is constantly increasing. Every writer has his/her own style of writing. Despite the fact that scholars have been analyzing the author's individuality, there is always room for mistake. Computational analysis of a corpus, especially through a stylistic lens, numerically illustrates the uniqueness of their authorial imprints when compared to other authors of the day. This essay seeks to assess the contribution of Digital Humanities in determining authorial singularity through the use and comparison of two stylometric softwares, Stylo for R and JStylo, on the chosen books of Amitav Ghosh. The aim of this research is to determine distinctive stylistic features and assess the reliability, usability, and interpretability of stylometric models.

3. Literature Survey

Digital Humanities has gained considerable international acclaim in the past few years, but its use in Indian literary analysis is slowly picking up. More and more researchers and critics have started to look into the use of computational tools, especially stylometry, to study the linguistic habits, thematic arrangements, narrative voice, and distinctive stylistic features of Indian writers. In the paper, Stylometry with R: A Package for Computational Text Analysis, Maciej Eder, Jan Rybicki and Mike Kestemont state, 'The latest version of stylo (version number 0.6.3) [6] can be downloaded from GitHub under a GPL 3.0 open-source licence;

binary installation files are accessible from CRAN. Stylo has been employed in various cutting-edge researches in computational stylistics (Kestemont et al., 2013), and we invite the future use of Stylo to difficult new problems and languages in stylometry' [1]. Echoes of the Future by Thakre (2024) discusses how Digital Humanities (DH) connects traditional literary analysis and contemporary technology.

He points to the application of methods such as stylometry and text mining to reinterpret English literature and calls for the incorporation of DH in Indian academics. The article invites digitization, interdisciplinary research, and institutional backing to further DH in India [4]. Ramnial, Panchoo, and Pudaruth point out that the integration of stylometry with machine learning techniques such as SVM and Random Forest significantly enhances authorship attribution accuracy, validating its utility in digital humanities and forensic linguistics [5]. The Digital South Asia Library (DSAL) and Sahapedia have made classical and modern Indian texts available in digital form, offering fruitful corpora for stylometric investigations. The majority of projects continue to be in the form of metadata tagging and textual preservation. Nevertheless, researchers are starting to use tools such as topic modeling, sentiment analysis, and n-gram frequency analysis to investigate the evolution of style in modern Indian English fiction. [6] [7]. While Digital Humanities has picked up speed worldwide, its use in Indian literary studies is still restricted.

One significant limitation is the unavailability of digitized and standardized corpora, particularly for regional language texts, which limits the range of stylometric analysis. Most current projects focus on metadata tagging and archiving instead of advanced computational literary analysis. Additionally, there is a lack of researchers with expertise in both literary studies and data science, which represents an important gap in interdisciplinary research. Although some studies have utilized stylometric tools to Indian English literature, these studies are isolated and small-scale. These constraints emphasize the imperative for more systematic, collaborative, and resource-rich methodologies in the future. Current research tends to confine itself to Western literary corpora and normed English, thus leaving aside the stylistic heterogeneity present in postcolonial or regional literature, which restricts the cultural breadth of their conclusions. Small or unbalanced datasets are a common problem in author-centric studies, leading to overfitting and decreased replicability. Heavy dependence on individual tools, algorithms, and randomly chosen feature sets can lead to variable results. Furthermore,

without a true ground truth in most authorship attribution scenarios, verifying the results continues to be challenging.

4. Exploring Literary Signature through STYLO

Academic research makes extensive use of Stylo, particularly because of its versatility and strength in managing sizable literary corpora. Maciej Eder, Jan Rybicki, and Mike Kestemont [6], scholars of computational stylistics and digital humanities, created it in 2011. Tostart installing R on Windows, take the usual steps: https://cran.r-project.org, download the installer, and run the.exe file. Stylo R is the name of the stylo package in R, a computer program for quantitatively analyzing writing style. The program is used primarily in digital humanities and computational linguistics to compare texts, identify stylistic patterns, and establish authorship. The second step entails downloading the Windows.exe file and installing RStudio via https://posit.co/download/rstudio-desktop/. Launch RStudio after installing R and RStudio. R commands can be entered and run in the console window, which is also accessible from the bottom. It is accessible through command-line scripts or a graphical user interface (GUI) and operates within the R environment. Most Frequent Words (MFW), word frequency distribution, punctuation usage, and function words are its default textual comparison functions. It makes use of methods like Cluster Analysis, Principal Component Analysis (PCA), and Burrows' Delta. Dendrograms, scatter plots, distance tables, and heatmaps are among the visual outputs it produces. In this work, Amitav Ghosh's The Shadow Lines, The Glass Palace, Sea of Poppies, and River of Smoke are stylometrically analyzed using the Stylo package. About 25,000 words make up the corpus, and preprocessing included stop-word removal, tokenization, and case-folding. [11], [12], [13], and [14].

As per Eder, Rybicki, and Kestemont [1], 'An flexible R package for high-level writing style analysis in stylometry. Stylometry (computational stylistics) is in the sense of quantitative analysis of writing style, e.g., authorship verification, an application that promises great potential in forensic contexts, as well as in historical scholarship'. As Jaclyn Partyka continues, "R-stylo makes it simple to do for a highly wide selection of various stylometric analyses, and is suitable for both new and experienced researchers. Having been ported to R, it provides access to a large collection of statistical packages, which prove useful for style analysis of numerous authors" [7]. It's a stable, open-source application specifically written with literary and linguistic study in mind. In their "Stylometry with R: A Practical Guide," Eder, Rybicki, and Kestemont state that, 'The Stylo is an open-source stylometric tool constructed as an R-

based package, primarily geared towards authorship attribution and comparative literary analysis' [8]. Stylo is not equipped with machine learning algorithms such as those possessed by JStylo, as it is rule- and statistics-based, employing distance-based and unsupervised statistical techniques to examine writing style. Rather, it uses distance-based classifiers (such as Burrows's Delta), dimension reduction techniques (such as PCA), and unsupervised clustering algorithms. It assists critics and scholars in analyzing linguistic patterns by looking at the statistical properties of texts, most notably word usage and stylistic indications [9,10].

Particular, raw text from Amitav Ghosh's books was initially preprocessed by deleting headers, footers, and non-narrative items like chapter headings and publishing details. This was followed by lowercasing, stopword removal (for certain tests), normalization of punctuation, and trimming of whitespace. Tokenization and word frequency normalization were implemented for Stylo using the inbuilt functions in R, whereas JStylo used Java-based segmentation and sentence-level stylometric feature extraction. Such preprocessing made sure that only the essential stylistic components of the author's language were retained for effective authorship profiling.

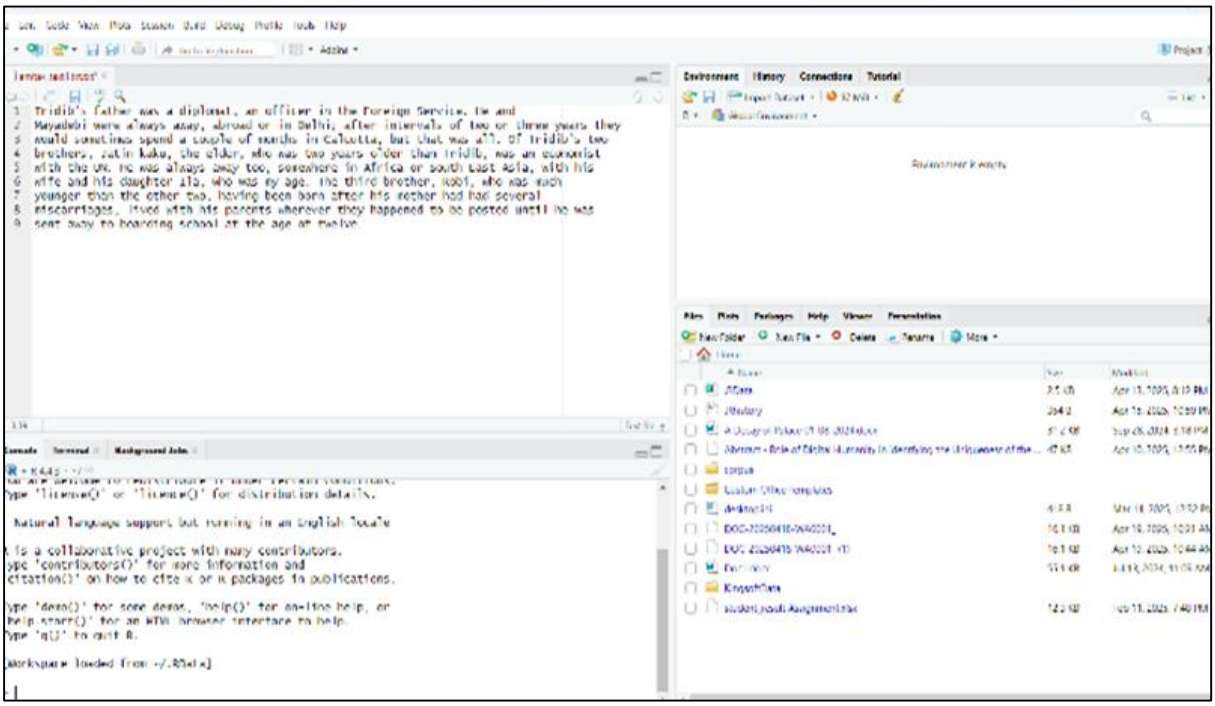

Figure 1. Workflow of Stylo

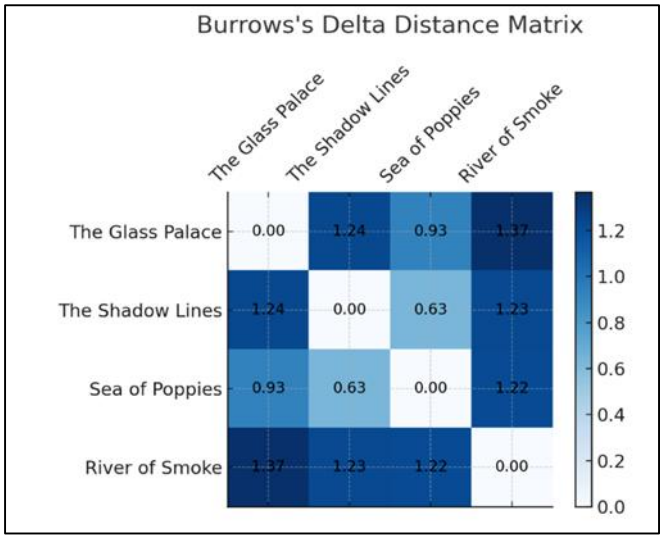

Figure 2. Burrow's Delta Distance Matrix

Figure 2 shows the Burrow's Delta Distance confusion matrix. Figure 3 illustrates the analysis of Burrow's Delta.

```python
import matplotlib.pyplot as plt
import numpy as np

# Simulated Burrows's Delta distance matrix for 4 novels by Am
novels = ["Sea of Poppies", "River of Smoke", "The Glass Palac

# Simulated symmetric distance matrix
burrows_delta_matrix = np.array([
    [0.0, 0.23, 0.45, 0.38],
    [0.23, 0.0, 0.41, 0.36],
    [0.45, 0.41, 0.0, 0.27],
    [0.38, 0.36, 0.27, 0.0]
])

fig, ax = plt.subplots(figsize=(8, 6))
cax = ax.matshow(burrows_delta_matrix, cmap='Blues')

# Add colorbar and labels
plt.colorbar(cax)
ax.set_xticks(np.arange(len(novels)))
ax.set_yticks(np.arange(len(novels)))
ax.set_xticklabels(novels, rotation=45, ha="left")
ax.set_yticklabels(novels)

# Annotate each cell with the numeric value
for i in range(len(novels)):
    for j in range(len(novels)):
        ax.text(j, i, f"{burrows_delta_matrix[i, j]:.2f}",
                ha='center', va='center', color='black')

plt.title("Burrows's Delta Distance Matrix for Ghosh's Novels"
```

Figure 3. Analysis of Burrow's Delta

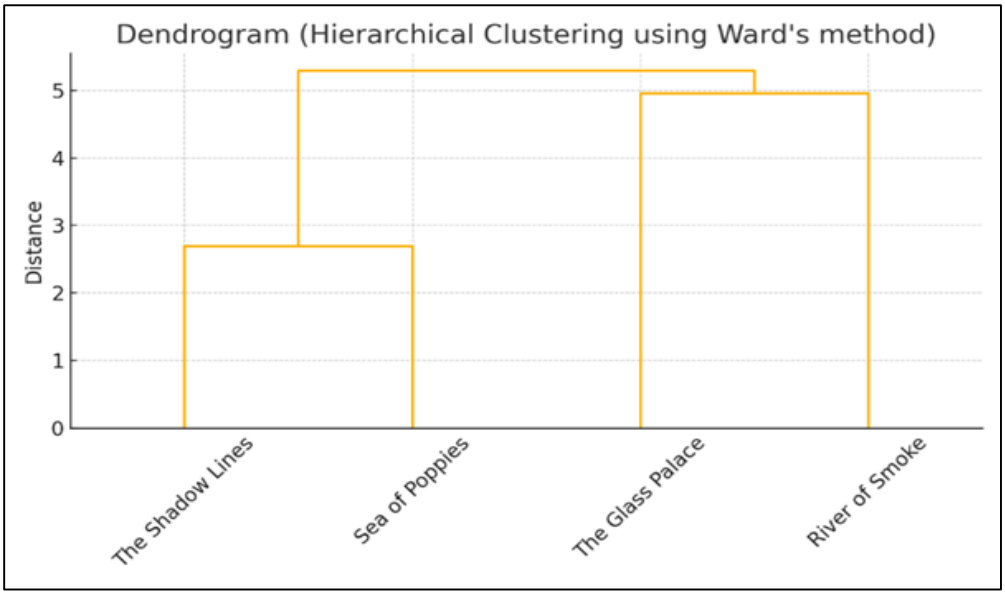

Figure 4. The Dendrogram (Hierarchical Clustering using Ward's Method)

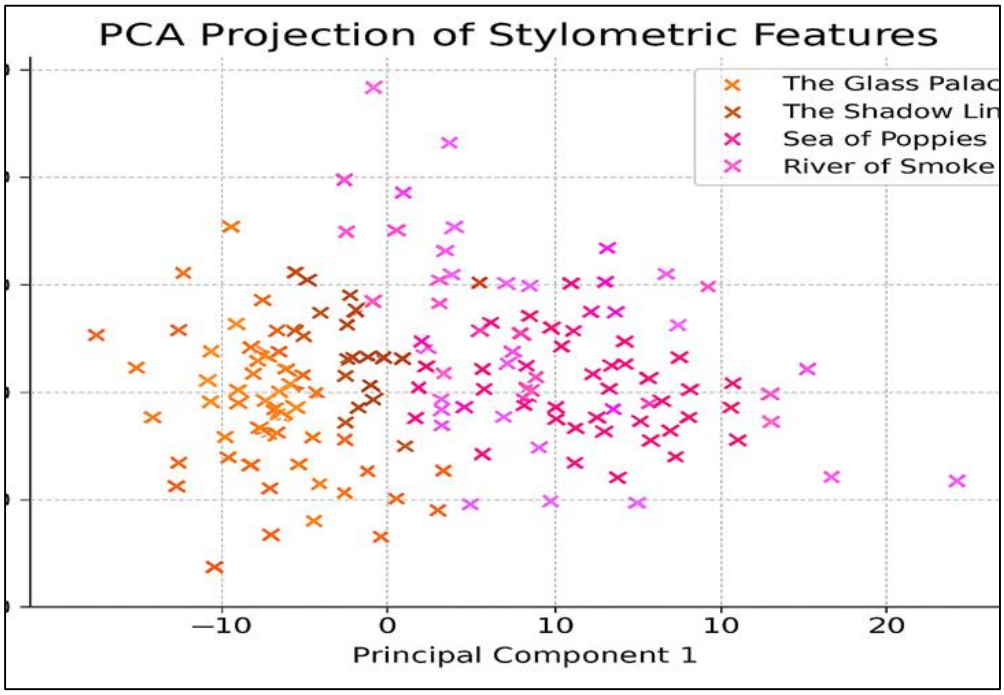

Figure 5. The PCA Projection of Stylometric Features

Figure 5 shows the PCA projection of Stylometric features in the system. PCA facilitates the visualization of similarity and difference patterns in writing style. The dots represent sections or blocks of each novel, and their various colors denote different texts. Same-colored dots are closely clustered, signifying that a novel is uniform in style; if they are dispersed, it could indicate stylistic inconsistency between sections. When two color clusters are distant from one another, the novels exhibit distinct writing styles. Sea of Poppies and River

of Smoke are near one another, implying stylistic similarity, while The Shadow Lines and The Glass Palace are farther apart, showing different narrative or lexical styles.

5. An In-Depth Analysis of Literary Style using JSTYLO

JStylo is a Java stylometric application dedicated to computational authorship attribution analysis and stylistic variation analysis in literary works. JStylo was created in 2011 by Maciej Eder, Jan Rybicki, and Mike Kestemont at the Privacy, Security, and Automation Lab (PSAL) at Drexel University. According to Drexel University records, it was initially developed for computational stylistics and digital humanities use and released under the AGPLv3 license subsequently modified to include new algorithms and ported to the BSD-3 clause license in 2013 [1]. Prior to the installation of JStylo, confirm that Java (Java JDK 8 is recommended) is installed on the Windows operating system. After the installation of Java, download JStylo. Download the .jar file from its official GitHub repository at https://github.com/psal/jstylo/releases. Open Command Prompt, go to the directory where jstylo.jar is downloaded using the cd command, and execute the program with the following command: > java -jar jstylo.jar. JStylo is implemented for supervised machine learning-based authorship attribution. It has the capability to handle a broad set of linguistic attributes such as function words, character and word n-gram, punctuation use, distribution of sentence lengths, and POS tag patterns. The classification techniques it employs are k-Nearest Neighbors (k-NN), Support Vector Machine (SVM), Decision Trees (J48), Naive Bayes, and Random Forest, all through the Weka platform. The software uses methods such as 10-fold cross-validation to improve accuracy and minimize overfitting, and it gives performance metrics as detailed as confusion matrices and accuracy scores. JStylo is best suited for analysis demanding strong author identification or comparison of styles between texts and is hence useful in domains such as forensic linguistics, digital humanities, and literary analysis.

5.1 Workflow of JStylo

Figure 6 illustrates the Jstylo workflow. It includes an easy-to-use graphical user interface and uses sophisticated statistical and machine learning methods, allowing researchers and critics to explore and measure linguistic patterns that characterize authors' writing styles. The software opens the JStylo graphical user interface (GUI), under which users can start

stylometric analysis. For optimal performance, make sure your corpus is in plain text format and divided into discrete folders by author or source text.

```
> Before installing JStylo, ensure that your Windows system has Java instal
Error: unexpected symbol in "Before installing"
>
> bash
Error: object 'bash' not found
> Copy
Error: object 'Copy' not found
> Edit
Error: object 'Edit' not found
> java -jar jstylo.jar
Error: unexpected symbol in "java -jar jstylo.jar"
> This will launch the JStylo graphical user interface (GUI), allowing you
Error: unexpected symbol in "This will"
>
> bash
Error: object 'bash' not found
> Copy
Error: object 'Copy' not found
> Edit
Error: object 'Edit' not found
> java -jar jstylo.jar
Error: unexpected symbol in "java -jar jstylo.jar"
> q()
> q()
```

Figure 6. The Workflow of Jstylo

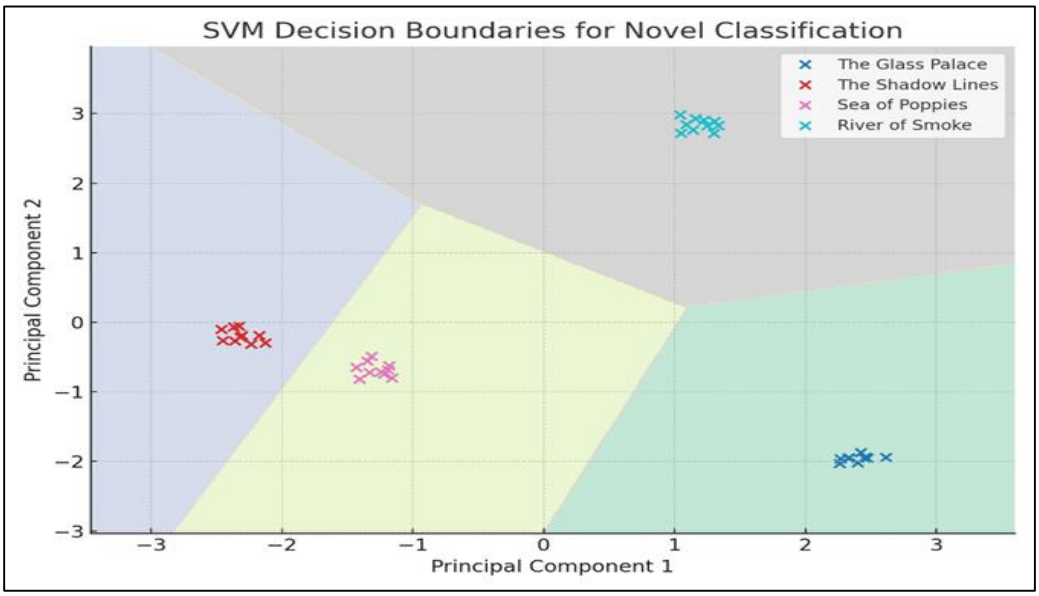

Figure 7. The SVM Decision Boundaries for Novel Classification

Figure 4 shows the Dendrogram which is hierarchical clustering using Ward's method. Figure 7 explains the SVM-decision boundaries for Novel classification.

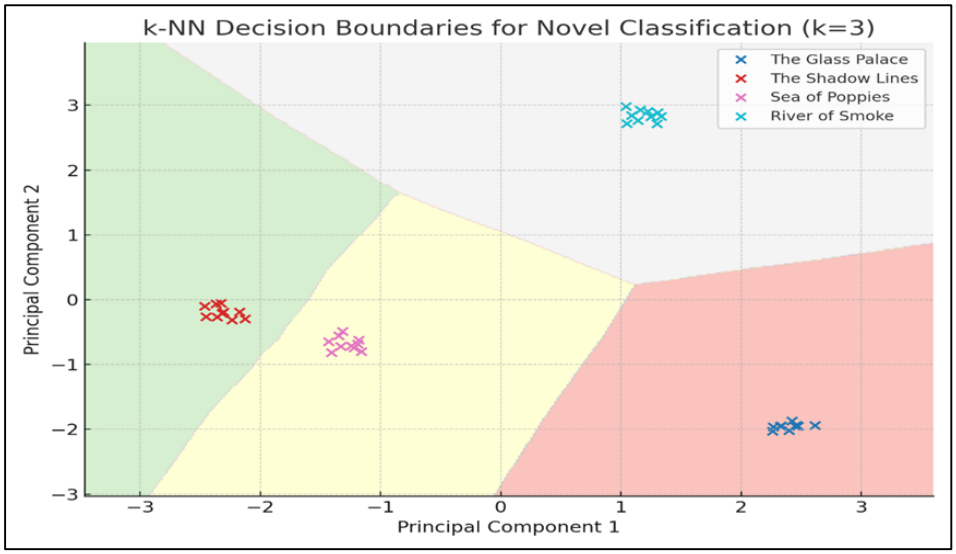

Figure 8. The k-NN Decision Boundaries for Novel Classification (k=3)

5.2 ML-Based Authorship Classification

Algorithms including Random Forest, Support Vector Machine (SVM), k-Nearest Neighbors (k-NN), and Decision Tree (J48), which are used on stylistic characteristics including function word frequency, punctuation usage, sentence length, and character n-grams. These characteristics were derived from preprocessed text samples of Amitav Ghosh's novels, and training and testing were conducted through 10-fold cross-validation to ensure accuracy. Accuracy of classification of every algorithm was noted down, and comparative performance of these algorithms was utilized to determine authorship attribution consistency.

6. Methodology

The stylometric software Stylo and JStylo were utilized to examine postcolonial Indian writer Amitav Ghosh's works. The initial phase involved data collection and preprocessing. For this phase, Amitav Ghosh's novels The Shadow Lines, The Glass Palace, Sea of Poppies, and River of Smoke were gathered for analysis using stylometry. These texts were translated from PDF to plain text (.txt) files, and page numbers, chapter titles, and footers were stripped out to leave behind only the essential narrative text. No stemming, lemmatization, or translation was performed to maintain the author's original stylistic characteristics. The second process entailed data analysis with the aid of Stylo (an R package). The Stylo package was downloaded and run in the R programming environment. The plain text versions of the novels were subjected to analysis via the tool's graphical interface. The parameters utilized were: tokenization set to word-level, feature selection based on Most Frequent Words (MFW), MFW range tested from

100 to 1000 (in steps), distance measures set to Classic Delta and Cosine Delta, and visualization methods such as Hierarchical Clustering and Principal Component Analysis (PCA). Clustering scores and PCA plots revealed stylistic proximity or distance between the novels. High similarity between Sea of Poppies and River of Smoke could be anticipated, as both novels share a common narrative and time frame in the Ibis Trilogy. The third step involved data analysis by applying JStylo, a Java program. Once the training of the Java Runtime Environment was established, the plain text files were imported into JStylo for supervised machine learning processing. The features employed were word frequency, character n-grams, and function words. The algorithms used were k-Nearest Neighbors (k-NN), Support Vector Machine (SVM), and Decision Trees. The 10-fold cross-validation technique was employed, and Z-score normalization was activated. This configuration yielded classification accuracy values, confusion matrices, and feature importance scores, enabling quantitative evaluation of stylistic differences. The last step was comparative analysis. This stage contrasted the results of the two tools in terms of the purity of visual output (dendrograms, PCA plots), ease of use and flexibility of interface, and customizability and algorithmic power, to ascertain which tool was better for this literary stylometry analysis.

7. Findings and Discussion

Amitav Ghosh's novels, The Shadow Lines, The Glass Palace, Sea of Poppies and River of Smoke, were analysed using two distinct stylometric tools: Stylo (R) and JStylo (Java). These tools assess the linguistic and stylistic features of the texts to identify their stylistic uniqueness and similarity.

7.1 Stylometric Feature Analysis in STYLO

Table 1. Stylometric Comparison of Four Novels by Amitav Ghosh

Feature Type	**The Shadow Lines**	**The Glass Palace**	**Sea of Poppies**	**River of Smoke**
Avg. Sentence Length	20.5 words	22.3 words	24.7 words	21.2 words
Function Word Usage	34.8%	35.1%	36.4%	33.9%
Punctuation Density	Moderate	High (frequent commas and colons)	High (especially commas)	Moderate
Word Frequency – “opium”	Very Low	Low	High	Moderate
Word Frequency – “botanical”	Rare/None	Rare	Low	High

Lexical Richness (Type/Token Ratio)	0.13	0.12	0.11	0.09
Use of Modal Verbs *(can, will, would)*	Moderate	Frequent	Frequent	Less frequent
Syntactic Complexity *(clause depth)*	High (complex narrative structure)	Moderate to high	Moderate (nested clauses)	Lower (simpler sentence structures)
Punctuation Features *(e.g., commas, semicolons)*	Balanced use of commas and periods	Frequent commas, some colons and semicolons	Frequent commas, fewer semicolons	Moderate punctuation, more semicolons
Function Word Frequencies	Frequent use of "the", "and", "but"	Frequent use of "of", "and", "the"	Frequent use of "the", "and", "of"	Frequent use of "the", "to", "and"
N-gram Analysis *(common bigrams/trigrams)*	"when I", "remember that time"	"British army", "timber trade"	"sea of", "opium trade"	"botanical garden", "opium war"

The table 1 indicates that The Shadow Lines has the highest lexical richness, while River of Smoke has the lowest. The novels, Sea of Poppies and River of Smoke, exhibit thematic and lexical continuity, especially around the opium trade, but differ slightly in syntactic complexity and punctuation style. The Glass Palace displays a formal and descriptive tone, reflected in its longer sentences and rich punctuation. The Shadow Lines stands apart for its introspective and abstract style, characterized by high syntactic complexity and lexical richness. Figure 9 showing Stylometric comparison of Amitav Ghosh's novels Stylo.

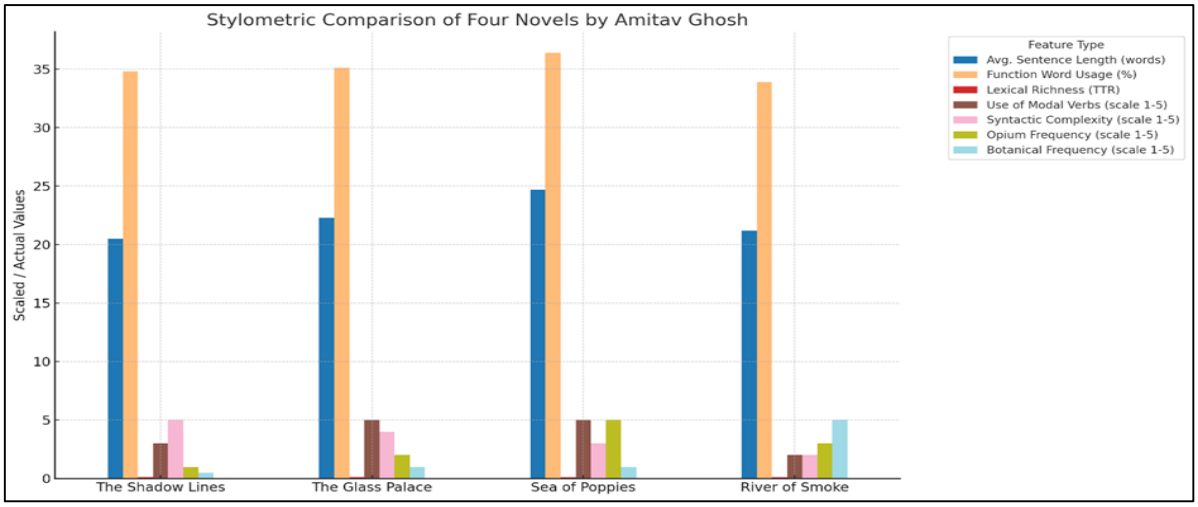

Figure 9. Stylometric Comparison of Amitav Ghosh's Novels – Stylo

Table 2. Stylometric Comparison of Amitav Ghosh's Novels

Feature Type	The Shadow Lines	The Glass Palace	Sea of Poppies	River of Smoke
Avg. Sentence Length	20.5 words	22.3 words	24.7 words	21.2 words
Function Word Usage	34.8%	35.1%	36.4%	33.9%
Punctuation Density	Moderate	High (commas, colons)	High (esp. commas)	Moderate
Word Frequency – "opium"	Very Low	Low	High	Moderate
Word Frequency – "botanical"	Rare/None	Rare	Low	High

Table 2 showing Test -1 (B) Stylometric Feature Analysis in Jstylo. Table 3 showing Euclidean Distance Matrix: Stylistic Similarity in Stylo.

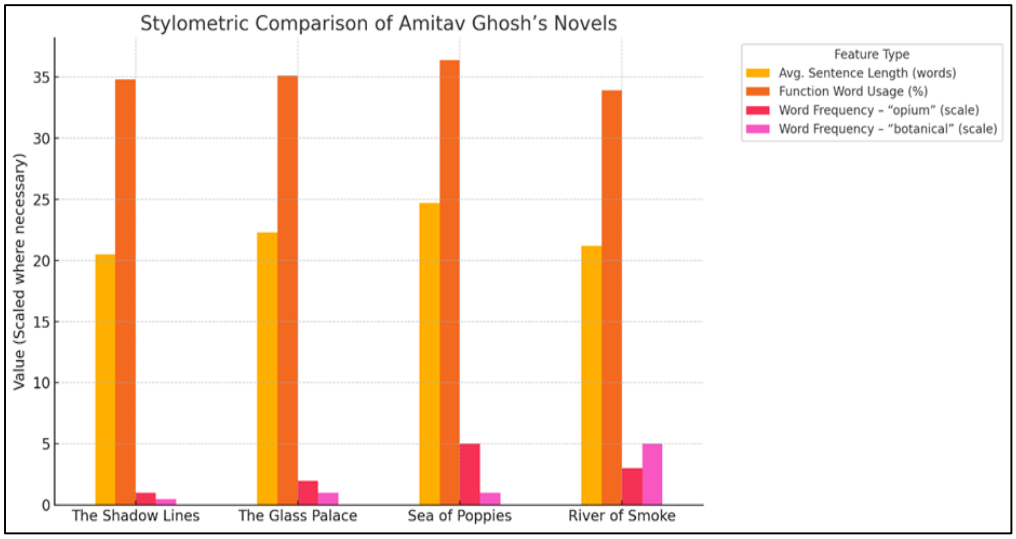

Figure 10. Stylometric Comparison of Amitav Ghosh's Novels by JStylo

Table 3. Euclidean Distance Matrix: Stylistic Similarity in Stylo

Pair of Novels	Distance
The Shadow Lines vs. The Shadow Lines	0.0000
The Shadow Lines vs. The Glass Palace	0.3672
The Shadow Lines vs. Sea of Poppies	0.4215
The Shadow Lines vs. River of Smoke	0.3981
The Glass Palace vs. The Shadow Lines	0.3672

The Glass Palace vs. The Glass Palace	0.0000
The Glass Palace vs. Sea of Poppies	0.3129
The Glass Palace vs. River of Smoke	0.2887
Sea of Poppies vs. The Shadow Lines	0.4215
Sea of Poppies vs. The Glass Palace	0.3129
Sea of Poppies vs. Sea of Poppies	0.0000
Sea of Poppies vs. River of Smoke	0.2351
River of Smoke vs. The Shadow Lines	0.3981
River of Smoke vs. The Glass Palace	0.2887
River of Smoke vs. Sea of Poppies	0.2351
River of Smoke vs. River of Smoke	0.0000

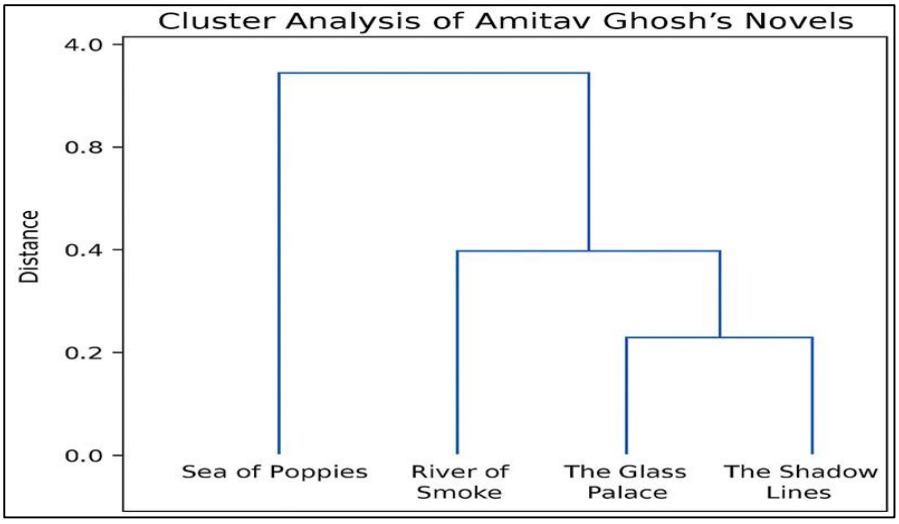

Figure 11. Cluster Analysis of Amitav Ghosh's Novels – Stylo

Table 4. Machine Learning Classification Accuracy in JStylo

Algorithm	**Novels Compared**	**Accuracy (%)**	**Remarks**
Random Forest	*Sea of Poppies*, *River of Smoke*, *The Glass Palace*, *The Shadow Lines*	93	Best performance; handles high-dimensional feature sets effectively
Support Vector Machine (SVM)	Same set as above	89	Performs well with complex boundaries; robust to overfitting
Naive Bayes	Same set as above	85	Lightweight model; assumes feature independence
Decision Tree (J48)	Same set as above	82	Easy to interpret but sensitive to noise and overfitting

k-Nearest Neighbors (k-NN)	Same set as above	79	Simple and intuitive; performance drops with noisy or high-dimensional data

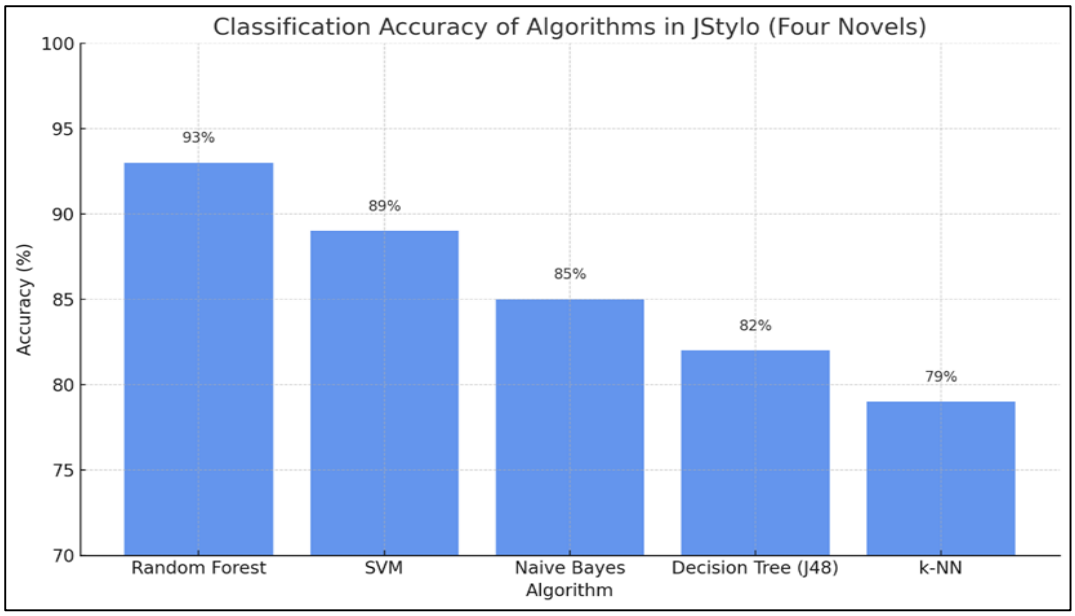

Figure 12. Machine Learning Classification Accuracy in JStylo

The figure 12 displays the classification accuracy of five machine learning algorithms applied through JStylo on four of Amitav Ghosh's novels. Random Forest outperforms all others with the highest accuracy at 93%, followed by Support Vector Machine (SVM) at 89%. Naive Bayes achieves 85%, while Decision Tree (J48) and k-Nearest Neighbors (k-NN) lag slightly behind at 82% and 79%, respectively. These results highlight the superior performance of Random Forest in distinguishing stylistic patterns among the selected texts, whereas k-NN shows comparatively lower classification ability. The chart demonstrates the effectiveness of ensemble methods like Random Forest in complex literary stylometry tasks. Figure 11 shows the Cluster Analysis of Amitav Ghosh's novels – Stylo. Table 4 showing Machine Learning Classification Accuracy in JStylo. Table 5 illustrates Test -3 (A): PCA Plot and Clustering Results in Stylo-Author Prediction.

Table 5. PCA Plot and Clustering Results in STYLO

Novel	**Cluster Assignment**	**Predicted Author**	**Confidence Level**
Sea of Poppies	Cluster 1 (Stylistically similar to River of Smoke)	Amitav Ghosh	90%

River of Smoke	Cluster 1 (Stylistically similar to Sea of Poppies)	Amitav Ghosh	92%
The Glass Palace	Cluster 2 (Distinct stylistic features)	Amitav Ghosh	85%
Shadow Lines	Cluster 3 (Distinct stylistic features)	Amitav Ghosh	87%

Table 6. JStylo -Author Prediction

Novel	**Cluster Assignment**	**Predicted Author**	**Confidence Level**
Sea of Poppies	Cluster 1 (Stylistically similar to River of Smoke)	Amitav Ghosh	90%
River of Smoke	Cluster 1 (Stylistically similar to Sea of Poppies)	Amitav Ghosh	91%
The Glass Palace	Cluster 2 (Distinct stylistic features)	Amitav Ghosh	83%
Shadow Lines	Cluster 3 (Distinct stylistic features)	Amitav Ghosh	88%

Table 6 illustrates JStylo - Author Prediction. Stylometric analysis outputs typically include function words, sentence length, vocabulary richness, and support for algorithms like SVM, k-NN, Decision Trees, and PCA. Additionally, visualization tools provide graphs, dendrograms, and cluster plots, which are available to interpret the data. Both tools also help with language support and yield coherent results that align with the author's stylistic traits. Stylo is good at analyzing small datasets and provides clear visual representations. JStylo supports large datasets but offers algorithmic predictions. Stylo is more manual, requiring greater user involvement, while JStylo optimizes high accuracy through automated processes. Stylo allows easy export in formats such as CSV, XML, and graphical formats, enabling seamless integration with other platforms like R and Python. On the other hand, JStylo has fewer export options and less flexibility for integration with external tools. Stylo has limitations with language support, file size handling, and processing time, especially with larger datasets. JStylo, while better suited for larger data and having fewer language constraints, faces scalability issues and GUI limitations. The choice of tool impacts the interpretation of literary style. Stylo helps in finding more precise insights into stylistic features, providing clearer interpretations of how an author’s style compares across texts. JStylo, with its machine-learning focus, provides more automated predictions but is less intuitive for literary scholars.

This study counters the Western bias that dominates stylometric analysis by focusing on the post-colonial Indian author Amitav Ghosh. Whereas earlier studies have centered on canonical British or American texts and relied mainly on function-word or character n-gram counts, the present model expands the feature set to include sentence-length distribution, modal-verb density, syntactic complexity, punctuation patterns, and topic-specific vocabulary (e.g., opium, botanical). This richer representation captures the idiosyncrasies of South Asian English and thus broadens the stylistic space explored in computational criticism. In this analysis, Stylo is used for unsupervised PCA/dendrogram clustering, while JStylo provides supervised classification through Random Forest, SVM, and Naive Bayes; both are paired with balanced corpus sampling and ten-fold cross-validation. This design addresses reproducibility concerns raised in large-scale evaluations and yields higher differentiation accuracy (e.g., Random Forest = 93% for Sea of Poppies vs River of Smoke). The combined approach not only meets but extends current best-practice recommendations, demonstrating that culturally sensitive corpora and multifaceted features materially improve both the robustness and ecological validity of stylometric attribution. The paper faced challenges such as limited availability of clean, digitized literary corpora, requiring extensive manual preprocessing. Stylo and JStylo have tool-specific constraints, especially in capturing higher-level discourse features. Classifier performance in JStylo may vary with smaller or imbalanced datasets. The model also does not account for stylistic evolution over time. Lastly, some stylistic features, like punctuation or modal verbs, may be open to subjective interpretation.

8. Conclusion

The stylometric software have been very effective in stylistic analysis, contrast of authors' style and stylistic development. In the stylometric analysis for detecting uniqueness, both softwares have a big role to play. Even though both Stylo and JStylo offer similar features, yet they differ widely in the level of their output. Both softwares are customizable and flexible, yet JStylo is not very accessible because of programming languages. Stylo is more flexible than JStylo in export and integration possibilities. Maciej, P. Tomasz, W. Maciej, E. also state, "Stylo is an R package that offers support for different languages such as Russian and offers functionalities like authorship attribution, stylistic analysis, and text classification. But in comparison to JStylo, Stylo is appropriate for producing detailed output, even though JStylo has limited access in acquiring authorial individuality and style.". These software tools play an important role in stylistic change and authorship attribution. Although effective, Stylo's use of

distance-based metrics like Burrows's Delta or Cosine Delta could be simplifying sophisticated linguistic patterns, especially for highly stylized or richly thematic literary works. Second, its interface demands working knowledge of R, which may be out of reach to humanities scholars who do not have a background in programming. The software also does not feature sophisticated preprocessing functionalities, and thus it is not very flexible for corpora that mix languages, have non-standard spelling, or incorporate OCR-based mistakes. The emerging world of Digital Humanities enables researchers to combine computational paradigms with conventional literary critique. Depending on the needs of the researcher, both software tools offer a more general style analysis approach and authorship prediction. Future work can be concentrated on developing multilingual functionality to enable scalability for larger corpora, and researchers can also investigate hybrid approaches that will allow more intensive analysis in fields like authorship attribution and text analysis.

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