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Digital humanities approach to analyzing the roles and military power of Supreme Commanders and Grand Coordinators in the Ming Dynasty: a computational analysis of Ming Shilu

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Abstract

This article represents a digital humanities research endeavor that attempts to explore the roles and military power of Supreme Commanders and Grand Coordinators in the Ming Dynasty, employing computational analysis of the Ming Shilu. By leveraging a semi-supervised text classification framework to identify military paragraphs without needing prior annotation and generating heat maps based on location entities identified in the text, we discerned patterns correlating the presence of these officials with the incidence of military conflicts. We acknowledge the study's limitations, including potential misinterpretations due to the complexity of events and language used in the Ming Shilu. Despite these, our research illuminates the value of computational techniques in historical inquiries. The results underscore the complexity of Supreme Commanders' and Grand Coordinators' roles within local administration and military power structures and their impact on the political environment of the Ming Dynasty. This article advocates for future research to integrate diverse textual and data sources and incorporate additional digital methodologies, aiming for a deeper understanding of the Ming Dynasty's political landscape. This research significantly propels the utilization of digital analytical tools in historical research, offering a richer, more nuanced understanding of the past.

Keywords: Ming Dynasty; Supreme Commanders; Grand Coordinators; digital humanities; computational analysis; Ming Shilu; military conflicts; CCTS API; heat maps; seed words.

1. Introduction

1.1 Military historiography in ancient China: bridging literature, material culture, and quantitative analysis

Recent scholarship has noted an increasing recognition of military history's pivotal role in understanding societal evolution and crisis resolution strategies (Caforio 2006). This era is characterized by a wealth of military narratives seamlessly interwoven with classical literature and philosophy.

Before discussing the specifics, it is worth providing an overview of the current field. The study of Chinese military historiography has developed along two main lines: textual analysis and material culture analysis. In the former, scholars have drawn strategic wisdom from influential works such as Sunzi's The Art of War (McCaffrey 2015), delved into the insights of the Ming dynasty (Robinson 2020), and explored the broader implications of strategic '勢 Shih' and benefit '利 li' in military philosophy (Mott and Kim 2006). These studies illustrate the historical wisdom's contemporary relevance, with practical applications demonstrated by Newmyer (2009) and Lee and Sai On Ko (2000).

In terms of material culture analysis, scholars have analyzed artifacts like ancient weaponry and military-themed paintings to understand their cultural influence, comprehend military practices, and decode the ideologies of the era (Tsang 1992; Rawson 2015).

However, the comprehensive understanding of ancient Chinese military records remains elusive. Although the claim that Western scholarship on China's military history appears limited (Li 2023), it is essential to consider the specific limitations in terms of scope, depth, methodology, or sources.

While digital preservation has made significant strides, the challenge of transforming these ancient documents into formats suitable for quantitative analysis persists. The traditional in-depth linguistic analysis of classical Chinese texts is laborious and fraught with the potential for disagreements among scholars (Lau 2018). Therefore, there is a pressing need for effective methodologies to extract and transform pertinent information from these texts into an analyzable format.

Quantitative analysis, grounded in established methodologies like long-range war analysis, has proven instrumental in understanding the origins and evolution of warfare (Cioffi-Revilla 1991). Yet, the inconsistency in data sources and the inherent fragility and limited accessibility of primary resources pose significant challenges. Therefore, the focus should be on the development of efficient methods for data extraction and transformation in historical research.

Exploring beyond qualitative analysis, historical data interpretation can greatly benefit from quantitative approaches. Initiatives like the Correlates of War (COW) project have provided valuable quantitative data on international and civil conflicts, facilitating studies into the causes and patterns of warfare (Sarkees and Schafer 2000).

Tackling challenges related to the conversion of textual information into numerical data can open up new avenues of understanding. This process can go beyond merely extracting numerical figures from classical Chinese to include identifying and interpreting factual information using modern evaluation methods (Huang et al. 2022).

A major obstacle lies in extracting relevant military records from the vast collection of ancient Chinese documentation, which often lacks clear classifications of military events and terminology. Therefore, the field requires more concerted efforts in identifying and interpreting information pertinent to warfare and military events to facilitate the process of quantitative analysis in ancient Chinese military history. Future research should focus on refining methodologies for efficient data extraction and transformation in historical research, thereby paving the way for novel insights and a more comprehensive understanding of military historiography in ancient China.

1.2 Harnessing Natural Language Processing in digital scholarship in the humanities

The analysis of classical Chinese texts poses inherent challenges that can be surmounted through a combination of linguistic domain expertise and innovative language processing techniques, such as Natural Language Processing (NLP). Studies by Zhao et al. (2020) and Fang, Lo, and Chinn (2009) illustrate the potential of these strategies. In particular, Zhao et al.'s (2020) study successfully employed NLP to identify and extract pertinent information from 'Treatise on Febrile Diseases,' a renowned classical Chinese medical text.

Advancements in NLP techniques have already shown promise in handling the unique linguistic features inherent to classical Chinese texts. For instance, Huang, Sun, and Chen (2010) effectively adapted NLP techniques to cope with challenges such as sentence segmentation, which is an important task in classical Chinese. Furthermore, Yu and Wang (2020) harnessed the power of advanced language models, such as the Bidirectional Encoder Representations from Transformers (BERT), to improve Named Entity Recognition (NER) in classical Chinese texts. Their study demonstrated how NLP and sophisticated language models can efficiently tackle linguistic intricacies, thereby expediting research processes.

In this study, traditional chapter-based retrieval systems struggle to address the search demands arising from the mixed content described in the entries of the *Ming Shi-Lu*. For instance, a paragraph describing a natural disaster may be followed by a section detailing the promotion of officials. Standardization, in the context of developing a uniform classification system or format for classical Chinese texts, can greatly aid the application of NLP and other computational techniques to these documents. Establishing a consistent and standardized classification framework allows researchers to efficiently search for and pinpoint relevant texts. This enhances the utilization of NLP and other computational techniques in this domain, streamlining the research process.

By adopting these methods and resources, we can enhance the application of quantitative analysis in the study of ancient Chinese history. This methodological improvement, when combined with the use of NLP and other computational techniques, may offer a path to new insights into military events and other facets of ancient Chinese society, thereby enriching our understanding of the past.

1.3 Overview of the research

The proposed research endeavor seeks to explore fresh perspectives and enrich the current understanding of Chinese military historiography. At the heart of this exploration lies a comprehensive framework devised to shed light on the military dynamics of the Ming dynasty, thus yielding insights into the factors shaping the empire's trajectory.

This framework incorporates a blend of innovative research methods to delve deeper into the military nuances of the era. To offer more clarity, the framework involves a multi-step process: it first dissects the hierarchical dynamics within the Ming bureaucracy, then applies these insights to analyze specific historical texts, and finally, it incorporates geographical visualization to highlight patterns in military campaigns.

A key focus of this research will be on the *Ming Shi-Lu* corpus, also known as *Veritable Records of Ming Dynasty*, the most comprehensive extant collection of records from the Ming dynasty. This collection serves as a rich source of data for understanding the roles of key figures, specifically the governors and viceroys, in the defense and expansion of the empire.

The research will be anchored by a case study examining the significant influence of these governors and viceroys. It will assess their military roles and the resultant impact on the empire's military prowess, thus providing a nuanced understanding of the Ming dynasty's military infrastructure. The specific governors or viceroys, their respective military roles, and the method of data collection will be determined in the next phase of the research design.

In addition to unearthing the military roles of these key figures, the research aims to illustrate the correlation between their actions and the overall military performance of the Ming dynasty. A significant component of this research will involve geographic visualization, which will aid in discerning patterns and trends related to the geography of military campaigns and the distribution of military power.

This research sets out to bridge the divide between qualitative and quantitative methods in Chinese military historiography. It represents a substantial departure from traditional historical research methods that primarily rely on close reading and textual analysis of classical Chinese texts. Instead, it leverages cutting-edge technologies and methodologies, including NLP and data visualization, to delve into the intricacies of late imperial China military strategies, helping to alleviate the burden of manual quantitative analysis and allowing historians to focus more on interpreting the findings and uncovering deeper insights.

Through this innovative approach, the research strives to open new avenues for future exploration in this captivating field. By achieving a more in-depth understanding of the military aspects of the Ming dynasty, it aspires to produce new insights and knowledge, thereby contributing significantly to the field of Chinese military historiography.

To conclude, this research, with its unique framework and focus on the military dynamics of the Ming dynasty, holds promise for a transformative contribution to our understanding of Chinese military historiography. Its potential impact extends beyond the case study itself, offering a new approach that can be replicated and refined in future research.

2. Data and methodology

2.1 *Ming Shi-Lu* dataset description and preparation

2.1.1 Background of *Ming Shi-Lu*

The selected dataset for this study, known as the *Veritable Records of the Ming Dynasty* (*Ming Shi-Lu*, or *MSL*), offers a chronological account of significant events and imperial decrees that occurred from 1368 to 1644 AD, covering the reigns from the Hongwu Emperor to the Chongzhen Emperor. Comparable to Western annals, the MSL was meticulously constructed by official court historians in Classical Chinese. These records perform a comparable role to the Orthodox Histories, or the Twenty-Four Histories, a compilation of Chinese official dynastic histories spanning from 3000 BC to the 17th century. Unlike the Orthodox Histories or the Twenty-Four Histories, which were arranged by the incoming dynasty and often abbreviated in their narrative sections, the Shi-Lu (literally translated as 'genuinely record' in Chinese) were more likely comprised of dialogues between the emperor and government officials, along with daily records, and were written with the approval of each succeeding emperor. This means that readers could get more information in Shi-Lu, including political affairs, economic fluctuations, natural disasters, and frontier turmoil. Whenever the foreign diplomatic envoy came to Ming, the actual date and the lists of exchanged presents would be recorded precisely in Shi-Lu. Shi-Lu can help present-day readers learn more about the details beneath the dynasty; not to mention that the compilation of many Orthodox Histories is based on Shi-Lu. The MSL provides a rich source of historical and cultural knowledge.

Similar record formats exist beyond the Ming Dynasty, indicating potential for broader research. These include Japan's Nihon Sandai Jitsuroku, Korea's Veritable Records of the Joseon Dynasty, and Vietnam's Đại Nam thực lục. Developing digital tools for MSL analysis may foster wider studies on East Asian imperial histories.

The MSL is a substantial dataset due to the Ming Dynasty's nearly three-century duration and the existence of analogous records across multiple countries and dynasties. The Ming Dynasty was selected for its lasting influence, comprehensive MSL, and advancements in bureaucracy and record-keeping, which make its Veritable Records an exceptional historical resource. Analyzing this dataset can augment our

understanding of East Asian imperial history and lay groundwork for future studies on dynastic records.

2.1.2 Definition of military documents

This study focuses on military records within the MSL. These records are defined as documents involving both combat and non-combat operations of offensive or defensive nature. By employing NLP techniques, we aim to reveal the historical, academic, and documentary value inherent in these military records.

2.1.3 Data preprocessing

The preprocessing phase of the data involved several steps, drawing on the results of two NLP tasks: NER and Named Entity Disambiguation (NED). The former was conducted following the methodologies outlined by Lai (2016), which focused on identifying and classifying entities in the text. The latter task, based on the work by Wu (2021a), resolved ambiguities in recognizing the entities. These tasks were performed on a digitized MSL corpus provided by the Institute of History and Philology, Academia Sinica, Taiwan.

Challenges during preprocessing included dealing with inconsistencies in the ancient Chinese language, like variant Chinese characters or a place with multiple names, and the vast number of entities. However, these were addressed by leveraging advanced NLP techniques and algorithms. Consequently, we compiled a total of 136,427 paragraphs containing person entities that will serve as the foundation for our analysis.

2.1.4 Potential data limitations

While the MSL provides a comprehensive account of the Ming Dynasty, potential limitations should be noted. There may be concerns about the accuracy or completeness of the MSL, given the historical period it covers and the potential for biases in the original record-keeping. These limitations may impact the study's findings and should be taken into consideration during analysis. However, despite these potential issues, the MSL offers a foundational perspective that is vital for comprehensive historical analysis and remains a significant resource for understanding the historical landscape of the Ming Dynasty.

2.2 Leveraging BERT for weakly-supervised data labeling and text classification in digital humanities

In this section, we detail our semi-supervised approach to analyzing the Ming Shilu texts, a method that diminishes the dependency on pre-labeled data. The weakly-supervised data labeling mechanism involves utilizing a small set of 'seed words' to weakly label data and then employing this labeled data to train a supervised classification model. Given that our methodology relies heavily on the BERT model, we will first provide an introduction to this pre-trained language model. We will then walk through our process of generating weakly labeled data and the subsequent text classification using a fine-tuned BERT model. The section will conclude with a discussion on the potential applications of models like BERT in digital humanities research.

2.2.1 Introduction to the framework

The advent of pre-trained language models, such as BERT, has significantly diminished the amount of training data required for supervised methodologies. This development was examined by Grießhaber, Maucher, and Vu (2020) who explored a low-resource setting with less than 1,000 training data points. Their research established that the combination of transfer learning from pre-trained Transformer-based language models like BERT and active learning can significantly improve performance in low-resource situations. However, they also emphasized that for consistent and reliable accuracy, about 4–5 per cent of the total dataset still needs to be training data. In our case, this translates to roughly 5,400–6,900 labeled paragraphs, a process that necessitates substantial resources. The lack of punctuation in MSL texts adds an additional layer of complexity for annotators attempting to comprehend the content.

To alleviate the challenge of text annotation, we have designed a semi-supervised framework that diminishes reliance on pre-labeled data. The overall structure of this framework is illustrated in Fig. 1. The process commences with the selection of a small collection of 'seed words'. These seed words are representative terms that encapsulate the nature of the categories we aim to classify. Subsequently, we annotate military-related texts using these seed words. This approach efficiently generates high-confidence labeled data with minimal human intervention. The resulting labeled data is reorganized to form a well-structured training dataset, which is used to train a supervised classification model. This trained model is then applied to identify military-related texts in the entire dataset.

2.2.2 Understanding the BERT model

BERT is a breakthrough in the realm of pre-training language representations. Introduced by Devlin et al. (2018), BERT was unique in that it overcomes the limitations of previous unidirectional models by considering the context from both directions.

A key feature of the BERT model is that it is pre-trained using a task known as the Masked Language Model (MLM). In the MLM task, some percentage of the input data is randomly masked, and the objective is to predict the original vocabulary id of the masked word based only on its context. Unlike traditional unidirectional models, which can only learn from the previous or

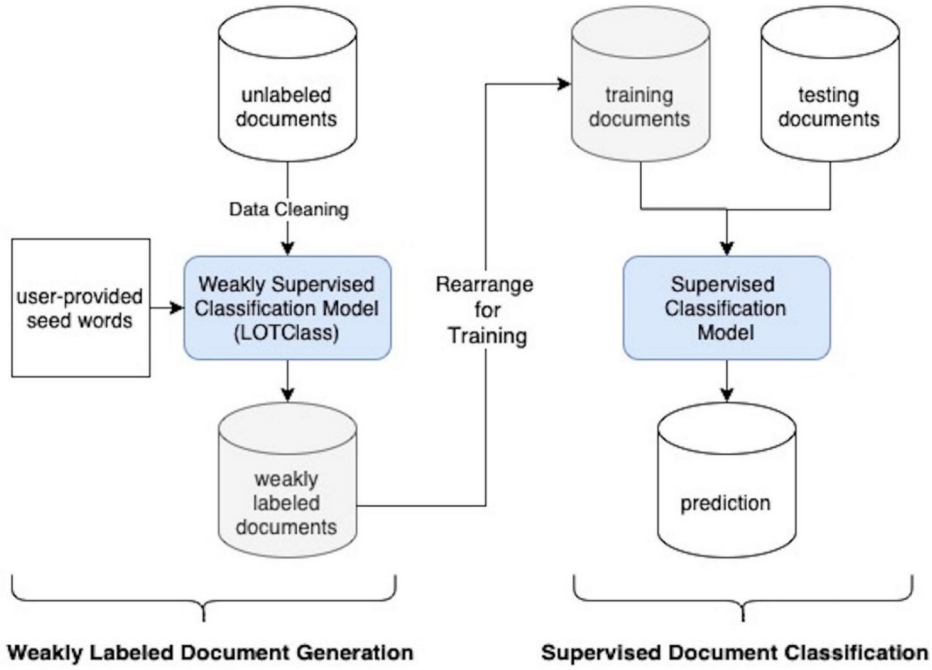

Figure 1. The proposed framework in this study.

next words, BERT, via the MLM task, learns to predict a word based on the words before and after it. This allows BERT to capture the semantics of a word in its entire context—left and right of the word.

Notably, this MLM pre-training task is not only useful for pre-training the model, but it can also be applied in the model's downstream tasks. For example, the trained BERT model can be used to fill in missing or masked words in a given sentence, making it a powerful tool for tasks like text generation or correction.

This pre-training using MLM provides BERT with a deep understanding of language semantics and context, which makes it particularly suitable for various NLP tasks, including the task of text classification. Furthermore, Devlin et al. showed that BERT significantly reduces the need for heavily-engineered task-specific architectures, achieving state-of-the-art performance across a variety of NLP tasks. Therefore, BERT has been widely adopted for tasks like text classification, question answering, and NER, outperforming previous state-of-the-art models on a broad spectrum of NLP tasks, including binary classification. Given its inherent strengths and superior performance, BERT forms the basis for our text classification task.

2.2.3 Weakly supervised data labeling with LOTClass

Our semi-supervised framework is rooted in the LOTClass model, a weakly-supervised text classification model presented by Meng et al. (2020). The novelty of LOTClass is that it requires only the label name of each class for training, thereby eliminating the need for exhaustive labeled documents. This feature has allowed it to demonstrate performance on par with more resource-intensive semi-supervised and supervised models.

In our research, we adopt the BERT-base-Chinese language model as the base for our LOTClass model. BERT-base-Chinese is a variant of the original BERT model, specifically pre-trained on modern Chinese text. This variant inherits the powerful context-sensitive language understanding abilities of BERT, including its MLM function, but has been fine-tuned to better understand and generate predictions for Chinese text. This makes it particularly suitable for our task of classifying texts from the Ming Shilu.

The LOTClass model uses seed words, which are representative terms encapsulating the essence of the categories to annotate our data. For example, we chose basic military action words like 'attack' and 'defense' to represent military documents, while we selected twenty different classes of seed words to represent non-military documents (see Table 1), following the event types proposed by Y.-T. (Lai 2016).

Our weakly supervised data labeler builds a category vocabulary based on these user-provided seed words (see Table 2). The process of vocabulary construction starts with pinpointing the instances of the seed words in the text. Then, the BERT-base-Chinese

Table 1. User-provided seed words for each category.

Class	Seed words
Law-breaking	罪(fault), 罰(punish), 獄(prison/jail), 隱(conceal)
Repair	修(fix/repair), 築(build)
Military	率(lead), 守(guard/defend), 攻(attack), 擊(assault), 備(guard/defend)

Table 2. Category vocabulary of category lawbreaking, repair, and military in our study.

Class	Category-indicative Vocabulary
Law-breaking	罪(fault/sin), 罰(punish), 獄(prison/jail), 辜(crime/guilt/sin), 訴(indict), 嫌(disgust), 條(ordinance), 惡(evil), 違(transgress), 錯(fault), 識(conviction), 累(fault), 論(infer), 義(justice), 律(law), 冤(injustice/wrong), 誅(punish), 諒(forgive), 訟(litigation), 罚(punish), 言(state), 狱(prison/jail), 型(canonical), 牢(prison/jail)
Repair	修(repair), 脩(build), 築(build), 繕(mend), 填(fill), 勘(reconnaissance), 刪(remove), 筑(build), 恢(restore), 維(maintain), 闢(reclamation), 葺(thatch/repair), 完(complete), 纂(redact), 善(complete), 裁(cut), 刻(carve), 圍(enclose), 拆(dismantle), 夯(tamp), 織(weave), 蓋(build/construct), 砌(build by laying bricks), 勤(industrious), 堵(block), 搭(put up/build), 播(sow), 閱(inspect), 浚(dredge), 竣(finish), 程(procedure), 彌(fill), 辟(open up), 匡(correct)
Military	守(guard/defend), 禦(defend), 備(defend), 攻(attack), 御(withstand), 準(prepare), 擊(assault), 候(watch), 照(look after/guard), 戒(guard), 备(guard), 侍(serve), 剿(suppress), 略(strategy), 預(prepare), 標(target), 揮(wield)

model, harnessing its MLM function, is employed to suggest contextually relevant alternative words. High-frequency alternative words are collected to form the category vocabulary for each class. Once the category vocabulary is developed, the model is trained to classify texts using this vocabulary and context-sensitive category indicative words.

For training, we utilized 4,000 documents from the Military category and 4,000 from the non-military categories. To assess the performance of the weakly supervised data labeler, we manually reviewed a random sample of 5 per cent of the training set. Our weakly labeled data generator achieved an impressive accuracy of approximately 87.3 per cent. Notably, it was able to identify a document's category without reliance on explicit keywords, thereby overcoming the limitations of the traditional keyword search approach. This is illustrated in Examples 1, 5, and 6 of Table 3, where the texts do not contain any user-provided seed words or category indicative vocabulary.

2.2.4 Supervised text classification with BERT

The final phase of our framework involves supervised text classification, leveraging the power of the BERT-base-Chinese model discussed in Section 2.2.2. This model has been fine-tuned on our labeled dataset, which was created using the weakly-supervised data labeling mechanism presented in Section 2.2.3.

The fine-tuning process for binary classification involves training the model on the labeled dataset with a binary cross-entropy loss function. After fine-tuning, the model is able to classify new examples into one of the two categories.

We used 80 per cent of the labeled data for training, and the remaining 20 per cent for validation. The model achieved an accuracy of 89 per cent on the training set and 90 per cent on the validation set (see Table 4). Once fine-tuned and evaluated, we deployed the trained binary classifier to categorize the remaining documents within the dataset.

This application of the BERT-base-Chinese model in supervised text classification illustrates the potential of such models in digital humanities research. Incorporating domain expertise and model interpretation of historical texts allows us to gain more detailed and profound insights into the past.

2.3 Visualizing geographic data in military records

The use of geographic visualization in our study provides crucial insights into the spatial distribution of military events recorded in the historical texts. By mapping these events, we can reveal patterns of military strategy and understand how these strategies may have evolved over time.

The process of visualizing geographic data involves several steps, as shown in Fig. 2. Initially, we identify the location names within the Military Semantic Lexicon (MSL) texts. This is done by recognizing named entities that are tagged as 'location' and using regular expressions, a sequence of characters that define a search pattern, to extract all the location mentions. NER is a subtask of information extraction that seeks out and categorizes named entities in text into predefined categories such as location names, persons, organizations, etc.

However, the location names recognized by NER may not always match the actual geographic names as represented on a map. To remedy this, we extend our

Table 3. Examples of category lawbreaking, repair, and military prediction results by WSM.

Number	Class	Prediction results
1	Law-breaking	下近侍陳忠于法司究問以其連結外人陳槐同謀妄告也
		Eunuch Attendant Zhong Chen was interrogated in court because he conspired with the outsider Huai Chen to make false accusations.
2	Law-breaking	南京戶科給事中甄成德劾奏南京刑部尚書顧璘不職詔璘回藉聽勘
		Chengde Zhen, Supervising Secretary of the Office of Scrutiny for Revenue in Nanjing (南京戶科給事中), wrote a letter to the Emperor impeaching Lin Gu, Minister of Justice in Nanjing (南京刑部尚書), for malfeasance. The Emperor ordered Lin to return to his hometown and wait for an investigation.
3	Repair	雲南巡撫陳用賓等以帒撲既平條議善後七事一建縣二建哨三勘田四寬賦五工費六哨役七擇官俱允行
		After suppressing the barbarians Mu Pu (帒撲), Yongbin Chen, Grand Coordinator (巡撫) of Yunnan, and other officials discussed with them about the seven things to cope with the aftermath of suppression: First, establish the county. Second, build sentries. Third, conduct a land investigation. Fourth, relieve taxes. Fifth, pay labor fees; Sixth, assign sentinels. Seventh, perform official selections. Mu Pu promised to implement all.
4	Repair	命錦衣衛指揮僉事宗鐸監察御史秦顒王璧巡視居庸山海紫荊等閔修塞隘口開掘溝塹
		Order Assistant Commander of Imperial Bodyguard (錦衣衛指揮僉事) Zong Duo, and Investigating Censor of the Zhejiang Circuit (監察御史) Yong Qin and Bi Wan, to patrol Juyong, Shanhai, Zijing, and other places, repair the passes and dig trenches.
5	Military	寧夏東路花馬池伏羌等墩寇入境報至勑總兵官楊信馳赴寧夏調兵應援
		It is reported that enemies had invaded Hua Ma Chi and Fu Qiang on Ningxia East Road. Regional Commander (總兵官) Xin Yang was ordered to head to Ningxia and dispatch troops to rescue quickly.
6	Military	勑都督毛福壽等於京城外西南街巷要路堵塞路口埋伏神銳短鎗以待策應
		Order Commissioner-in-Chief (都督) Fushou Mao and others to block the intersections of the main streets outside the southwest of the capital and wait in ambush with sharp swords.

Table 4. Performance of the BERT-based binary classification model.

	Accuracy
Training set	0.89
Validation set	0.90

search words using a search word expansion algorithm, as demonstrated in steps (a) and (b) of Fig. 3.

We then employ the CCTS API (Academia Sinica 2022) to retrieve geographic coordinates for each location identified by NER. The CCTS API is a service that allows us to search for geographic information using specific search words. Each query to the API is based on the expanded search words generated in the previous step.

Once we have the location coordinates, we create density heat maps using Python Plotly, a Python graphing library that makes interactive, publication-quality graphs. Density heat maps represent the density of data points in a geographic area, allowing us to see concentrations of military events in certain regions.

To ensure the accuracy of the visualization, we count each unique location mention within a single paragraph only once, avoiding duplication. We also extract the years from the text titles, both in Common Era and Chinese Era formats, allowing us to track the spatial changes over time.

To cater to various research needs, we provide users with three plotting modes for exploring the visualized data, which include:

1) heatmap based on each Ming Dynasty emperor,
2) heatmap based on a specific time interval (determined by the user) and
3) heatmap based on a single year.

The final heatmap generated through this process is depicted in Fig. 2. Upon examining this visualization, we can use the generated maps to observe the

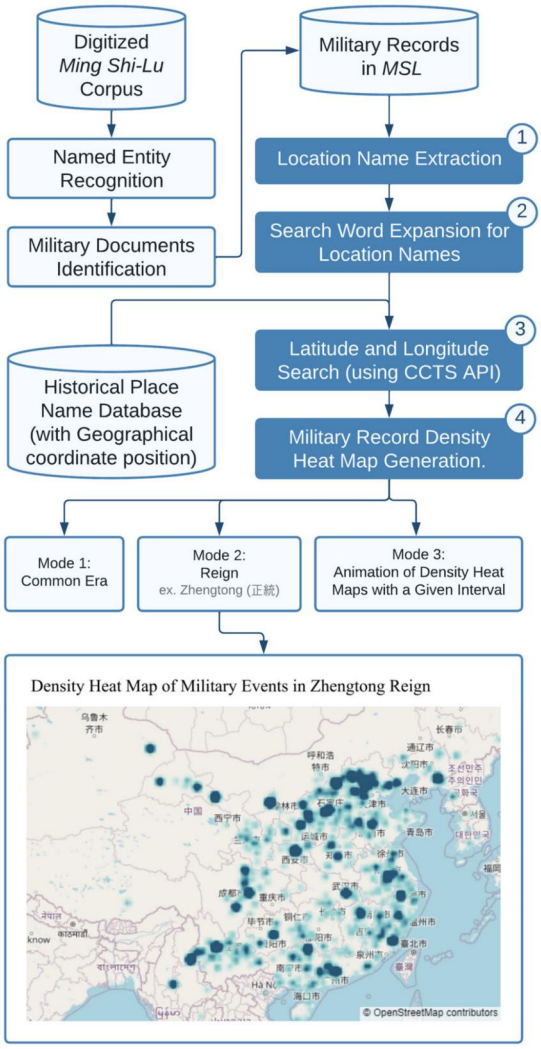

Figure 2. Flowchart of visualizing location of military records in *Ming Shi-Lu*.

geographic distribution of military-related records. The deeper the color of a region, the more records of military activities are found in that area.

By illustrating the geographic data in this way, we can deepen our understanding of the military strategies employed during the periods covered by the MSL texts.

3. Results and discussion

3.1 Exploring military trends through comparison with war frequency in the Ming Dynasty

Understanding the distribution of military events during the Ming Dynasty is crucial to our study. It offers insights into the strategic and tactical approaches of that era, leading us to compare the number of military documents from our corpus with the war frequency data. These data, denoted as (W), are sourced from the Editorial Committee of Chinese Military History (1985). Figure 4 presents this comparative analysis, highlighting intriguing trends that affirm the reliability of our analytical framework.

The *Ming Shi-Lu* (*MSL*) is the primary source for our military documents, covering the reigns from the Hongwu Emperor (1368 A.D.–1398 A.D.) to the Tianqi Emperor (1605 A.D.–1627 A.D.). The MSL and the war frequency data exhibit similar fluctuations until the 1630s, reinforcing the validity of our approach.

Post-1630s, however, there is a divergence between the two trends, attributable to two main factors. The first involves the historical source of the documents. Records associated with the Chongzhen Emperor (1627 A.D.–1644 A.D.), the last Ming emperor, are sourced from the Chongzhen Shi-Lu and Chongzhen Chang-Bian. While these sources provide a narrative of the Chongzhen Emperor's reign, they are fewer in number compared to the records of other reigns.

The second factor is the timeline of the available Chinese war data (W). It extends from 1640 to 1649, beyond the timeline covered by the *Ming Shi-Lu*, which ends in 1644. Furthermore, our corpus does not include records related to the Southern Ming regime, a separate political entity established in the southern part of China that persisted from 1644 to 1683.

This comparison offers a comprehensive understanding of the distribution and frequency of military events during the Ming Dynasty. It reveals significant trends, and their implications will be further discussed in the following sections. In future work, incorporating data from the Southern Ming era could provide an even more nuanced picture of military activities during this period.

3.2 Analyzing military document distribution in *Ming Shi-Lu*: a significant insight into historical context

In the field of digital humanities, the analysis of document distributions can offer considerable insights into the patterns and trends of historical periods. This section aims to elucidate the significance of military events in the Ming Dynasty by examining their distribution in the *Ming Shi-Lu*.

3.2.1 Methodology and approach

Our approach involved converting the absolute number of military documents into a ratio distribution, analyzed over 5-year intervals. This time frame was chosen to offer a balance between detail and overview, allowing for the identification of significant trends without becoming mired in daily fluctuations.

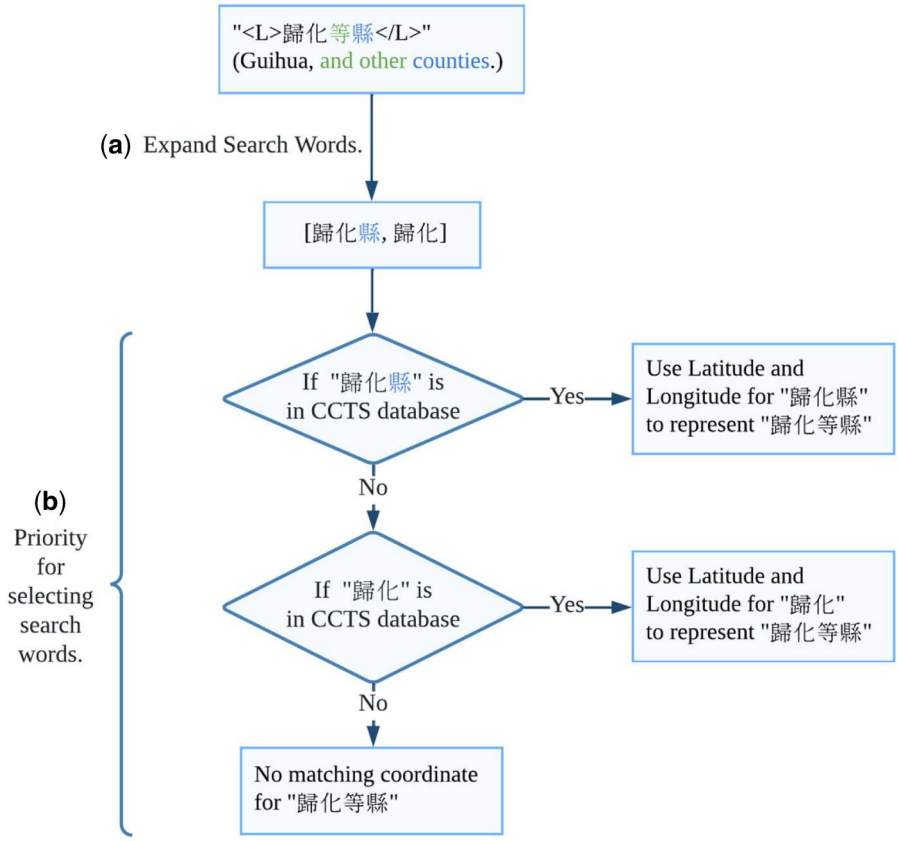

Figure 3. Expansion algorithm for search words.

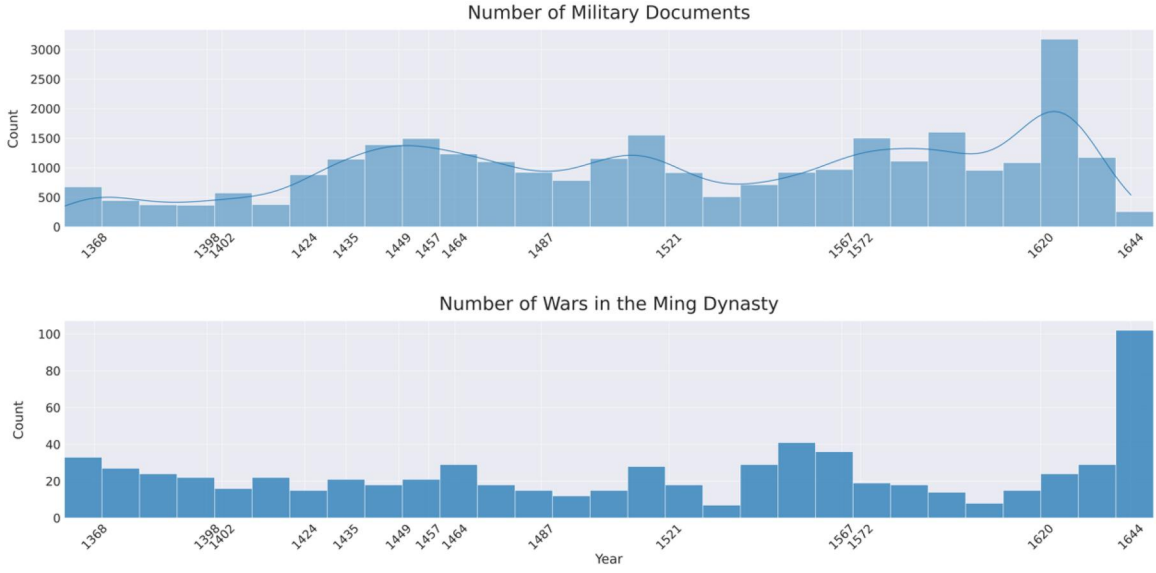

Figure 4. Distributions of the number of military documents in *Ming Shi-Lu* and number of wars in the Ming Dynasty.

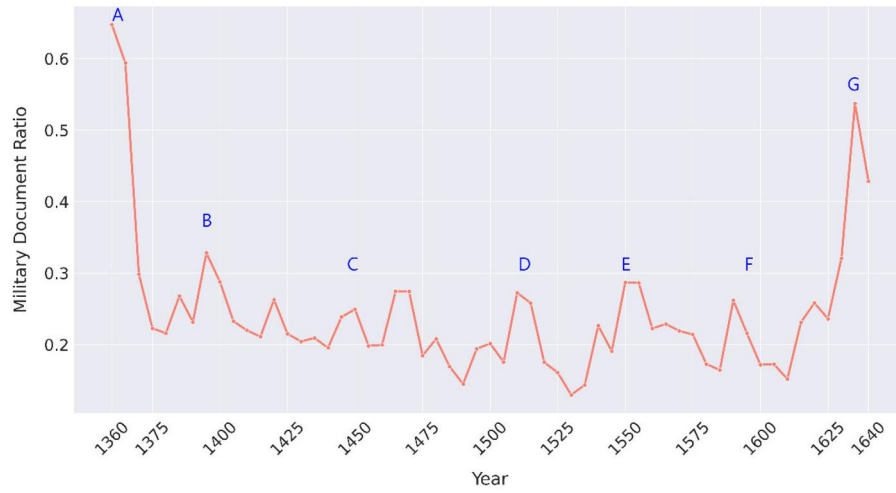

Figure 5. Military document ratio distribution in *Ming Shi-Lu*.

The peaks in this distribution, as seen in Fig. 5, have been marked and correlated with major historical military events.

3.2.2 Correlation of peaks with historical events

The historical events corresponding to each peak in Fig. 5 are as follows:

1) The founding of the Ming Dynasty: A high ratio of military events coincides with the establishment of the Ming Dynasty, marked by several wars and campaigns led by the Hongwu Emperor against the Northern Yuan.
2) The Jingnan campaign and the Yongle Emperor's campaigns against the Mongols: The small peak in the ratio of military events during 1399–1424 correlates with the Jingnan campaign and the subsequent military reforms following the move of the capital to Beijing (Wu 2021b).
3) The War of Luchuan, Tumu Crisis, and the Defense of Jingshi: Notable victories and significant military reforms marked this period (Li 2003).
4) Wokou and Mongols raids: A peak around 1521 aligns with raids from Wokou pirates and Mongols, as well as the Ningbo Disturbance (Huang 2020).
5) The Jiajing wokou raids and the War of Gengxu: A conflict with Mongols and significant changes in the military bureaucracy marked this period (Wu 2021b).
6) The Bozhou campaign, the Ningxia campaign, and the Imjin War: Known as the Wanli Emperor's three great campaigns, these events drained the state treasury, leading to large-scale rebellions (Zhao et al. 2016).
7) The advent of the Little Ice Age and the Battle of Sarhū: A consistent rise in military events correlates with the climatic changes, external threats, and political instability leading to the Ming Empire's downfall (Sun and Zhang 2018; Meng and Li 2019).

3.2.3 Implications and conclusions

This analysis demonstrates that the distribution of military events in the *Ming Shi-Lu* is not arbitrary but correlates significantly with historical events and broader historical contexts. This correlation underscores the credibility of our predictive data and its potential to inform future research, offering a nuanced understanding of the Ming Dynasty's military history.

3.3 The correlation between regional commander mentions and Ming Dynasty military conflicts

This section delves into the exploration of a potential correlation between the frequency of mentions of Regional Commanders (Zong Bing Guan) in military texts and the occurrence of military conflicts during the Ming Dynasty. The role of the Regional Commanders, their evolution over the course of the dynasty, and their representation in the primary historical text of the Ming Shilu, serve as the backdrop to this analysis.

The Regional Commanders, holding significant military positions, were frequently mentioned in the Ming Shilu, especially in the context of military affairs such as dispatching troops for attack or defense. We hypothesized that there might be a correlation between these mentions and the occurrence of military conflicts. We derived data from the Ming Shilu and used a combination of manual analysis and computational tools to identify and quantify these mentions,

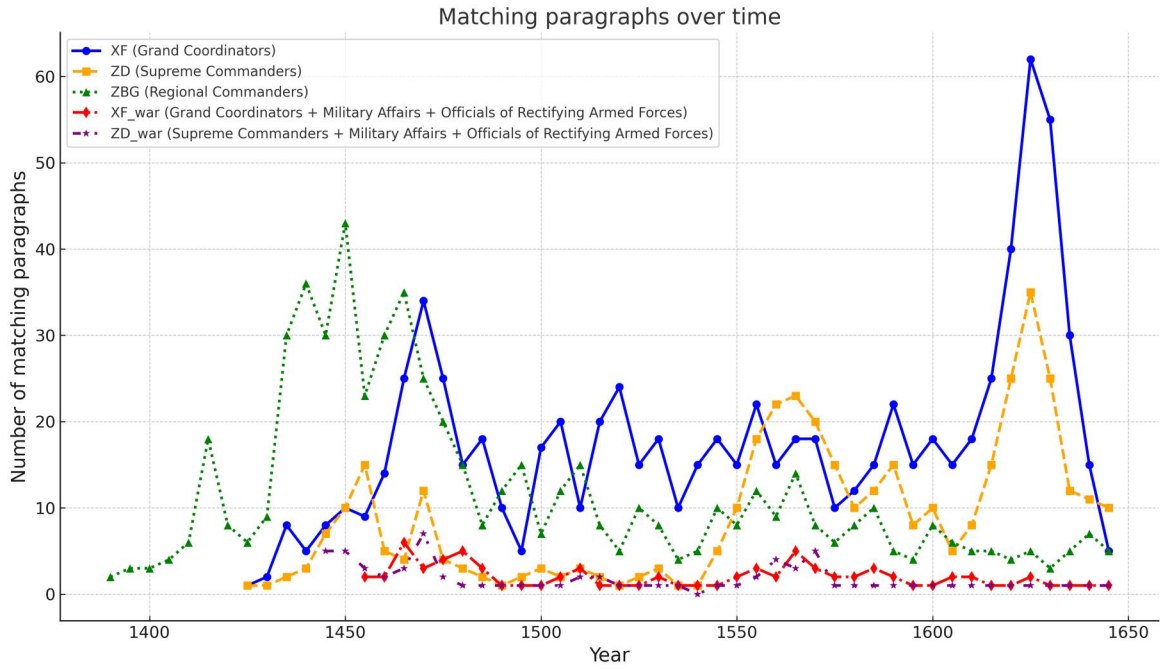

Figure 6. The trend of the proportion of military-related paragraphs in the Ming Shilu.

illustrated in Fig. 6. The data on the actual occurrences of Ming Dynasty wars, shown in Table 5, provided a basis for comparison.

A closer look at Fig. 6 reveals discernable fluctuations in the frequency of Regional Commander mentions starting in the Yongle reign (1402–1424). This uptick aligns with an improved regional commander system, increased dispatching of commanders to strategic location, and their accompaniment of the Yongle Emperor on norther expeditions, as depicted in historical records from the time (Hu 2010). We enhanced our understanding of the military activities of the time by mapping the geographical locations mentioned in the texts, as depicted in Fig. 7. The frequency of texts corresponding to certain regions was noticeably higher, suggesting the strategic importance of these locations.

The Chenghua reign (1464–1487) saw a gradual shift in power from the Regional Commanders to civil officials possessing military power (Baoliang 2014; Xu 2020). Consequently, the frequency of military texts associated with Regional Commanders dropped significantly after 1473. However, our analysis suggests that the fluctuations in the number of Regional Commander texts can still provide insights into the occurrence of military events. Despite the diminished power of the Regional Commanders, the system persisted, and their military roles continued, albeit under the civil officials with military power. This implies that tracking the trends in Regional Commander mentions in the text could still offer valuable insights into the military conflicts of the period.

This research opens up potential avenues for future investigations into the relationship between text frequency and real-world events in other historical contexts. Furthermore, it could enhance our understanding of the political and military structure of the Ming Dynasty.

3.4 The emergence and influence of Grand Coordinators and Supreme Commanders: an analysis of their roles in the Ming Dynasty

This section aims to investigate the emergence and influence of Grand Coordinators (Xun Fu) and Supreme Commanders (Zong Du) within the historical context of the Ming Dynasty, focusing on their significance in bureaucratic politics and their impact on local governance and military affairs. We will first establish the context of the instability that led to the creation of these positions and then explore their development over time. Figure 6 provides a visual representation of the data discussed in this section, showing the frequency of mentions of Grand Coordinators and Supreme Commanders in historical texts, along with the time frame it covers and the source of the data.

The local political system of the Ming Dynasty comprised the Provincial Administration Commission, the Provincial Surveillance Commission, and the Regional Military Commission. These entities were independent

Table 5. Example of a paragraph in military-related texts of the Yongle period that involves geographical information.

From	Year	Content	Location
Taizong Shilu, Vol.12, Part 2, September of the 35th year of Hongwu	1402	命右軍都督同知韓觀佩, 征南將軍印充總兵官, 往廣西整肅兵備鎮守城池, 而節制廣西、廣東二都司。…	Guangxi (廣西) and Guangdong (廣東)
		Orders Vice Commissioner-in-chief Han Guanpei(韓觀佩)to go to Guangxi as Regional Commander and Rectify Armed Force, to maintain and guard the cities, and to manage the Military Commission of Guangxi and Guangdong.	
Taizong Shilu, Vol. 55, June of the fourth year of the Yongle reign	1406	乙丑勑, 廣西總兵官都督同知韓觀、大理寺卿陳洽於廣西各土官衙門、土軍三萬, 以九月初十日會大平府德征。仍令觀等詢察安南賊中動靜以聞。	Guangxi (廣西) and Annan (安南)
		The order was issued to require the Regional Commander and Vice Commissioner-in-chief of Guangxi, Han Guan (韓觀), and the Chief Minister of The Court of Judicial Review, Chen Qia (陳洽), to lead a force of 30,000 troops consisting of local Tusi officials and militia to march to Daping Prefecture to launch a campaign against Annan (Vietnam) by September 10th. They were also instructed to gather intelligence on the movements of the Annan rebels and report back in a timely manner.	
Taizong Shilu, Vol. 56, July of the fourth year of the Yongle reign	1406	癸巳勑, 征討安南左副將軍西平侯沐晟曰: 古人有言,師克在和, 故軍門謂之和門。爾為副總兵官, 有所調遣, 相機審勢。如無妨礙, 即須應調。或總兵官遙度與爾處事有所妨…	Annan (安南)
		The decree orders Vice General of the Left, Marquis of Xiping, Mu Sheng (沐晟), to lead the expedition to pacify Annan (Vietnam), emphasizing the importance of harmony in the army and obedience to orders. As the ancients said, 'victory of the army depends on harmony', hence the army gate is called the 'Harmony Gate'. If there are any doubts or obstacles in the Vice Regional Commander or Regional Commander's dispatch and handling of affairs, they should promptly consult with the generals to resolve them.	
Taizong Shilu, Vol. 145, November of the eleventh year of Yongle reign	1413	甲申勑甘肅總兵官豐城侯李彬。凡山西、河南、陝西調至備禦步軍, 令還原衛和寧王阿魯台遣人奏瓦剌將奧魯已渡飲馬河至哈剌莽來揚言襲已。	Gansu (甘肅), Shanxi (山西), Henan (河南), and Shaanxi (陝西)
		The order was issued to the General of Gansu, Li Bin(李彬), in the year of Jia Shen. He was instructed to call back all the infantry troops that were dispatched from Shanxi, Henan, and Shaanxi to be prepared for defense. The order also instructed him to send messengers to Prince Ning's (阿魯台) court to report that Oirats (瓦剌) had already crossed the Yinma River and arrived at Harlamang (哈剌莽勒), threatening to attack them.	

and mutually constrained, which created difficulties in responding to emergencies and led to instability in the government. To address this issue, the position of Grand Coordinator was established, granting them military, administrative, financial, supervisory, and judicial powers when they arrived in a locality (Liu 2020; Li 2021; Chen 2023). The Supreme Commander position was subsequently created to control the Grand Coordinators and Generals, holding a higher status than the Grand Coordinator (Liu 2002).

During the mid-Ming Dynasty, Supreme Commanders and Grand Coordinators gradually took over the power from early local leaders, playing a crucial role in local governance and impacting people's livelihoods (Liu 2020). As demonstrated in Fig. 6, the number of Grand Coordinators and Supreme Commanders surpassed that of Regional Commanders, who often led troops to fight against internal and external turmoil. This increase in mentions of Grand Coordinators and Supreme Commanders in historical texts reflects their growing importance during the Ming Dynasty.

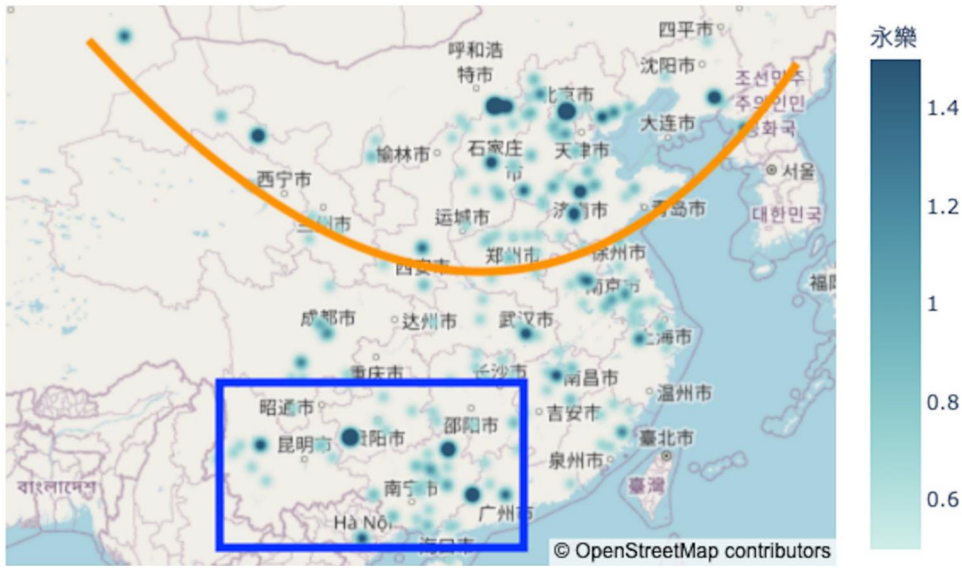

Figure 7. Heatmap of military paragraphs related to the records of Regional Commanders during the Yongle period. The curved arc near the top highlights the northern region, including areas such as Hami (哈密), Gansu (甘肅), Shaanxi (陝西), Datong (大同), Ningxia (寧夏), Xuanfu (宣府), Beijing (京師), Liaodong (遼東), etc. The rectangular frame in the lower section represents the southern region, including areas such as Yunnan (雲南), Yunzhou (雲州), Annan (安南), Xining (西寧), Guangxi (廣西), Guangdong (廣東), etc.

Civil officers, such as Grand Coordinators and Supreme Commanders, were required to hold military titles to participate in military affairs, such as expeditions during the Ming Dynasty (Liu 2002; Liu 2020). Officials of the Rectifying Armed Force were usually appointed to assist Grand Coordinators in handling military affairs. Figure 6 also presents the trends of occurrences of 'Grand Coordinators' and 'Supreme Commanders' in paragraphs related to 'Military Affairs' and 'Officials of Rectifying Armed Force' in military texts.

Our analysis indicates that the records of Grand Coordinators and Supreme Commanders increased during the same period as the rise of General Commanders, suggesting a potential enhancement of their positions in terms of military power. This development has implications for our understanding of the Ming Dynasty, as it highlights the evolving roles and responsibilities of these officials.

One notable example is the Luchuan Campaigns during the Yingzong era (1436–1449), which significantly impacted the military structure of the Ming Dynasty. Civil officials were appointed as Supreme Commanders, holding a higher rank than military commanders and being responsible for military affairs. This marked a historical precedent for civil officials to lead and direct military operations, ultimately diminishing the role of the General Commander (Hu 2010).

As shown in Fig. 6, there was a higher frequency of occurrences of ZBG (Zong Bing Guan, a term representing military activities) during the period of 1440–1450. By mapping the geographical information from the texts onto a map (see Fig. 8), we found that General Commanders were present in the region during the Luchuan Campaigns, which took place in Yunnan and Myanmar. Figure 9 shows records of Supreme Commanders related to military affairs in the same area, and Fig. 10 further confirms the connection between these texts and military affairs. Our analysis also involved examining the specific textual passages, as indicated in the Table 6 showing the records of such textual examples in Yunnan and Myanmar.

These results not only support our hypothesis of military activities during this period but also provide a preliminary indication that Supreme Commanders had military-related responsibilities during this timeframe. The data indicates an increase in the number of Grand Coordinators and Supreme Commanders during times of military unrest, suggesting their roles were not just administrative, but also integral to military strategy and operations.

Given the clear correlation between the presence of Grand Coordinators and Supreme Commanders and significant military activities, we can infer a more pronounced role of these positions during times of unrest. This insight not only expands our understanding of the bureaucratic and military dynamics of the Ming Dynasty but also provides a broader context for the evolution of military governance in historical Chinese empires.

Figure 8. Distribution of military-related paragraphs concerning Regional Commanders between 1440 and 1449. Four regions are highlighted using rectangular frames: The lower-right section (framed) includes Guangxi (廣西) and surrounding areas. The central frame covers parts of Shaanxi (陝西). The upper-right region highlights the capital (京師), Jianzhou (建州), and Liaodong (遼東). The southwestern frame marks the Yunnan (雲南) and Myanmar (緬甸) region.

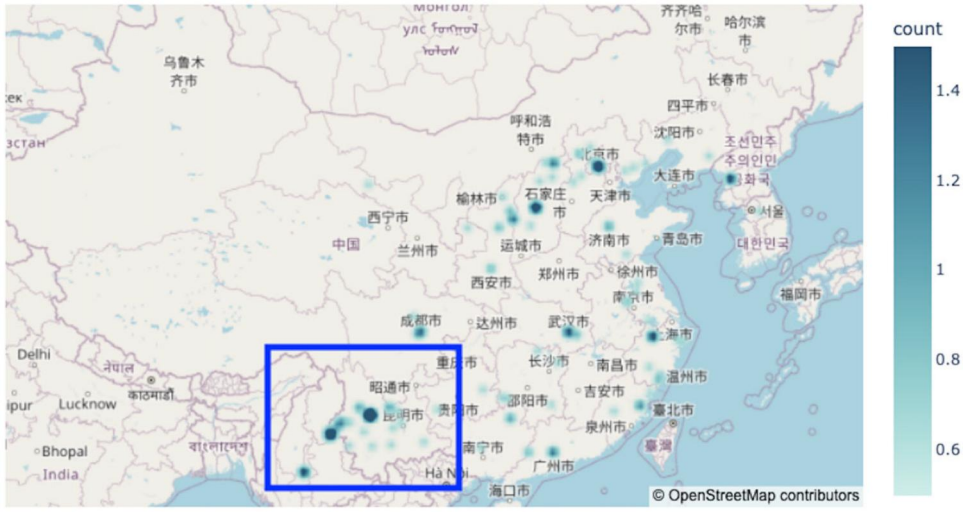

Figure 9. During 1440–1449, military-related paragraphs of Supreme Commanders. The rectangular area represents Yunnan (雲南) and Myanmar (緬甸).

In terms of implications, the increase in mentions of Grand Coordinators and Supreme Commanders, particularly during periods of military unrest, reveals their pivotal roles within the Ming Dynasty's administrative and military structures. Understanding this dynamic offers a nuanced perspective on the power dynamics and military strategies of the era, potentially influencing how we interpret other aspects of the Ming Dynasty's governance and society.

As for future research, the methods presented in this study could be employed to further explore the roles of other officials during the Ming Dynasty or in other historical periods. By continuing to analyze textual data and contextualize it within its historical and geographical settings, we can gain deeper insights into the power structures and dynamics that shaped different periods in history.

Figure 10. During 1440–1449, military-related paragraphs of Supreme Commanders + 'Military Affairs' and 'Officials of Rectifying Armed Forces'. The rectangular area represents Yunnan (雲南) and Myanmar (緬甸).

Table 6. Example of military-related text involving geographical information during 1440–1449.

From	Year	Content	Location
Yingzong Shilu, Vol. 69, July of the fifth year of the Zhengtong reign	1440	雲南總兵官都督同知沐昂奏: 「麓川賊思任發糾, 百夷數萬衆, 屯孟羅, 殺擄人民, 搶掠象馬, 據者章硬寨, 與官軍抗敵。」 …	Yunnan(雲南) and Luchuan (麓川)
		Regional Commander and Commissioner-in-chief of Yunnan, Mu Ang(沐 昂), reported: 'The leader of the Luchuan bandits, Si Ren Fa(思任發), commanded tens of thousands of people stationed in Mengluo(孟羅). They killed and abducted civilians, looted elephants and horses, and occupied the Zhangying fortress, where they confronted the official army.'	
Yingzong Shilu, Vol. 76, February of the 6th year of the Zhengtong reign	1441	雲南總兵官都督同知沐昂奏木邦宣慰司報麓川叛寇思任發欲來攻劫。乞為開通孟定道路,率領官軍前來救援。 …	Yunnan (雲南) and Luchuan (麓川)
		The Commissioner-in-chief and Regional Commander of Yunnan, Mu Ang (沐昂), reported to the Pacification Commission of Mubang (木邦) that the rebel leader, Si Ren Fa (思任發), in Luchuan was planning to attack. He requested the opening of the Mengding(孟定) road and to lead the army to rescue.	
Yingzong Shilu, Vol. 105, June of the eighth year of the Zhengtong reign	1443	勑總兵官定西侯蔣貴等, 今得靖遠伯王驥等奏, 麓川殘賊思機法差, 陶孟恭、項等以告, 求地方為名窺覘動靜 …	Luchuan (麓川)
		The Marquis of Dingxi, Jiang Gui (蔣貴), and other regional commanders were ordered to investigate a report from the Earl of Jingyuan, Wang Ji (王驥), that the rebels in Luchuan led by Si Ji Fa (思機法) were poorly organized. Tao Meng Gong (陶孟恭), Xiang (項), and others reported this and requested that the local authorities send someone to investigate the situation.	

(continued)

Table 6. (continued)

From	Year	Content	Location
Yingzong Shilu, Vol. 177, April of the 14th year of the Zhengtong reign	1449	勑總督軍務兵部尚書靖遠伯王驥等：近者, 湖廣貴州邊界苗賊攻燒靖州土官衙門, 流劫軍民；又聞征麓賊官軍回途有為苗賊掩殺者, 勑至爾等沿途相機勦殺險阻之處宜慎防之。…	Huguang (湖廣) Guizhouf (貴州) and Luchuan (麓川)
		Order to the Commissioner-in-chief, Minister of War, Minister of the Army, Earl of Jingyuan Wang Ji (王驥), and others: Recently, Miao bandits on the border of Huguang and Guizhou attacked and burned down the Tusi's yamen in Jingzhou, causing havoc and looting among the military and civilians. Moreover, it has been heard that Miao bandits attacked the army on their way back from suppressing the Luchuan rebels. You are commanded to be cautious and prevent any attacks from Miao bandits at dangerous locations along the way.	

4. Conclusion

This research significantly advances our understanding of the Ming Dynasty through the use of digital methods, explicitly exploring the roles and military power of Viceroys and Governors. The core findings indicate a strong correlation between the presence of these officials and the occurrence of military conflicts during specific periods, thereby emphasizing their critical role in local administration and military affairs.

Interrogating the Ming Dynasty's bureaucratic system, the complexity and significance of Viceroys' and Governors' roles were revealed, which were instrumental in maintaining the stability of the political order. By shedding light on these intricate relationships, this study augments existing literature, offering fresh perspectives on the Ming Dynasty's governance.

The study, however, acknowledges certain limitations. The quality and completeness of data are one such constraint that might affect the accuracy of the findings. It proposes that future research can utilize a broader range of historical documents like the 'Ming Shi' (Official History of the Ming Dynasty), local gazetteers, and the Qing Shilu (Veritable Records of the Qing Dynasty) to produce more comprehensive results. Additionally, while correlations have been established, it's essential to bear in mind that correlation does not necessarily imply causation.

Another limitation involves the use of seed words for teaching the model correct classification. This method, in some cases, may be insufficient due to the complexity of the events and language used. Future work could experiment with different methods of text classification to minimize misinterpretations or misclassifications.

In terms of geographic analysis, the accuracy of the heat maps depends on the location entities identified in the text and the accuracy of the CCTS API. This limitation offers an opportunity for future researchers to refine the location identification process and improve the precision of geographic representations.

Despite these challenges, the study highlights the transformative power of computational techniques in historical research. The insight gained into the roles of Viceroys and Governors underscores the necessity of understanding historical figures within a broader societal and political context, especially the impact of their military power on the stability of the Ming Dynasty.

Future research should aim for a more comprehensive and nuanced analysis by integrating multiple types of texts and data sources and incorporating additional digital methodologies. Such an approach will allow for a more sophisticated understanding of the factors influencing the Ming Dynasty's political landscape.

In conclusion, this study not only provides a robust foundation for applying digital analysis tools in historical research but also paves the way for a more detailed and nuanced understanding of the past. It is anticipated that this work will inspire a new wave of research in this rapidly evolving and exciting field.

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Author contributions

Richard Tzong-Han Tsai (Conceptualization, Resources, Supervision, Writing—review & editing), Yu-Sin Liu (Investigation, Methodology, Software, Visualization, Writing—original draft, Writing—review & editing), You-Jun Chen (Conceptualization, Investigation,

Methodology, Software, Validation, Writing—original draft, Writing—review & editing), and Hsin Yi Hsieh (Conceptualization, Formal analysis, Investigation, Methodology, Writing—original draft, Writing—review & editing), Ya-Chi Chan (Investigation, Writing—review & editing)

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References

Academia Sinica (2022) Chinese Civilization in Time and Space (CCTS). https://ccts.sinica.edu.tw/api/.

Baoliang, C. (2014). '明代文武關係及其演變——基於制度、社會及思想層面的考察 [The Relationship between Civil and Military in the Ming Dynasty and Its Evolution: Based on the Investigation of System, Society, and History of Thought]', *Historical Research in Anhui* **2**: 5–18.

Caforio, G. (ed.) (2006) 'Introduction: The Interdisciplinary and Cross-National Character of Social Studies on the Military–The Need for such an Approach', in *Social Sciences and the Military*, pp. 1–20. London: Routledge.

Chen, C.-H. (2023) '支援前線：明代天津巡撫職權之研究 [Supporting the Front Line: A Case Study of Duties of Tianjin Provincial Governor in Ming Dynasty]', *Publication of Military Social Science* **16**: 135. https://doi.org/10.6915/PMSS.202003_(16).0008

Cioffi-Revilla, C. (1991) 'The Long-Range Analysis of War'. In: *The Journal of Interdisciplinary History* **21**: 603–29.

Devlin, J. *et al.* (2018) 'Bert: Pre-Training of Deep Bidirectional Transformers for Language Understanding', arXiv preprint arXiv : 1810.04805.

Editorial Committee of Chinese Military History. (1985) *Tabulation of Wars in Ancient China*. Beijing: People's Liberation Army Press.

Fang, A. C., Lo, F.-J., and Chinn, C. K. (2009) 'Adapting NLP and Corpus Analysis Techniques to Structured Imagery Analysis in Classical Chinese Poetry', in *Proceedings of the Workshop on Adaptation of Language Resources and Technology to New Domains*, pp. 27–34.

Grießhaber, D., Maucher, J., and Vu, N. T. (2020) 'Fine-Tuning BERT for Low-Resource Natural Language Understanding via Active Learning', *Proceedings of the 28th International Conference on Computational Linguistics*. Barcelona, Spain (Online): International Committee on Computational Linguistics, pp. 1158–71. https://doi.org/10.18653/v1/2020.coling-main.100

Huang, H.-H., Sun, C.-T., and Chen, H.-H. (2010) 'Classical Chinese Sentence Segmentation', in *CIPS-SIGHAN Joint Conference on Chinese Language Processing*. SIGHAN 2010. https://aclanthology.org/W10-4103

Huang, S.-Y. *et al.* (2022) 'Climate Event Classification Based on Historical Meteorological Records and its Presentation on a Spatio-Temporal Research Platform', *Digital Scholarship in the Humanities*, **37**: 1022–32.

Huang, Q. N. (2020) '明代兵部尚書與武將關系考論 [A Research on the Relations between the Minister of War and Military Officer in the Ming Dynasty]', *Jiangxi Social Sciences*, **6**: 139–48.

Hu, P. (2010) '明代前期總兵制度形成研究 [A Study on the Formation of the Early Ming Dynasty's General-in-Chief System]'. MA thesis. China (P.R.C.): Heilongjiang University. https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD2010&filename= 2010147911.nh

Lai, Y.-T. (2016) 'Unsupervised Event Type Identification of Historical Texts: A Case Study of Wei-so Events in the Ming Shilu', MA thesis, Taiwan (R.O.C.): National Central University. https://hdl.handle.net/11296/939y83

Lau, K.-l. (2018) 'Language Skills in Classical Chinese Text Comprehension', *Journal of Psycholinguistic Research*, **47**: 139–57.

Lee, S. F., and Sai On Ko, A. (2000) 'Building Balanced Scorecard with SWOT Analysis, and Implementing "Sun Tzu's The Art of Business Management Strategies" on QFD Methodology', *Managerial Auditing Journal*, **15**: 68–76.

Li, F. H. (2003) '明代文人對軍隊的統領論析 [The Civil Officers' Command of the Army in the Ming Dynasty]', MA thesis, China (P.R.C.): Heilongjiang University. http://cnki.sris.com.tw/kns55/brief/result.aspx? dbPrefix=CMFD

Li, H. W. (2021) '明代山西巡撫研究 [A Study of Shanxi Governor in Ming Dynasty]', MA thesis, China (P.R.C.): Inner Mongolia University. https://doi.org/10.27224/d.cnki.gnmdu.2021.001620

Li, X. (2023) 'Chinese Military History Research in the Past Forty Years', *War & Society*, **42**: 197–213.

Liu, C. J. (2002) '明代衛所與六部、督撫關係之研究 [The Wei-So System of the Ming Dynasty Relations with Lu-Pu, Tu-Fu]', *The National Chengchi University Journal*, **84**: 227–66. http://nccur.lib.nccu.edu.tw/handle/140.119/102353

Liu, C. J. (2020) '明代總督巡撫職掌初探 [A Preliminary Study of the Powers of the Zŏngdū and Xúnfŭ in the Ming Dynasty]', *Bulletin of Holistic Education*, **6**: 43–72. https://doi.org/10.6689/BHE.202012_(6).0003

McCaffrey, M. (2015) 'The Economics of Peace and War in the Chinese Military Classics', *Economics of Peace and Security Journal*, **10**: 23–31.

Meng, Y. *et al.* (2020) 'Text Classification Using Label Names Only: A Language Model Self-Training Approach', arXiv preprint arXiv : 2010.07245.

Meng, Y. M., and Li, X. C. (2019) '薩爾滸之役明朝敗北的細部因素考析 [An Analysis of the Internal Factors of Defeat in the Battle of Saerhu in Ming Dynasty]', *Manchu Minority Research*, **3**: 35–42.

Meng, Y. *et al.* (2020) 'Text Classification Using Label Names Only: A Language Model Self-Training Approach', in *Proceedings of the 2020 Conference on Empirical Methods*

in Natural Language Processing (EMNLP). Online: Association for Computational Linguistics, pp. 9006–17 https://doi.org/10.18653/v1/2020.emnlp-main.724

Mott, W., and Kim, J. (2006) *The Philosophy of Chinese Military Culture: Shih vs. Li*. London: Palgrave Macmillan.

Newmyer, J. (2009) 'Oil, Arms, and Influence: The Indirect Strategy Behind Chinese Military Modernization', *Orbis*, **53**: 205–19.

Rawson, J. (2015) 'Steppe Weapons in Ancient China and the Role of Hand-to-Hand Combat', *The National Palace Museum Research Quarterly*, **33**: 37–97.

Robinson, D. M. (2020) *Ming China and its Allies: Imperial Rule in Eurasia*. Cambridge: Cambridge University Press.

Sarkees, M. R., and Schafer, P. (2000) 'The Correlates of War Data on War: An Update to 1997', *Conflict Management and Peace Science*, **18**: 123–44.

Sun, C., and Zhang, Q. (2018) '氣候變遷、政府能力與王朝興衰——基于中國兩千年來歷史經驗的實證研究 [Climate Change, State Capacity, and the Rise and Fall of Dynasties——An Empirical Study Based on Chinese Historical Experience in the Past 2000 Years]', *China Economic Quarterly*, **18**: 311–36.

Tsang, K. B. (1992) 'Portraits of Meritorious Officials: Eight Examples from the First Set Commissioned by the Qianlong Emperor', *Arts Asiatiques*, **47**: 69–88.

Wu, C. H. (2021a) 'Establishing an Entity Linking Model for Person Names in Ming Shilu with Automatically Constructed Labeled Data', MA thesis, National Central University, Taiwan(R.O.C).

Wu, Y. (2021b) '六師之任: 明代協理京營戎政與北京防禦 [Governor-General of Capital Defenses and Military Affairs of Beijing Area in Ming China]', Ph.D. thesis, National Taiwan Normal University, Taiwan(R.O.C).

Xu, X. J. (2020) '明代文臣武將地位比較研究 [A Comparative Study on the Status of Civil Servants and Military Commanders in the Ming Dynasty]', MA thesis, Ludong University, China (P.R.C.). http://cnki.sris.com.tw/kns55/brief/result.aspx? dbPrefix=CMFD

Yu, P., and Wang, X. (2020) 'BERT-Based Named Entity Recognition in Chinese Twenty-Four Histories', *Web Information Systems and Applications: 17th International Conference, WISA 2020, Guangzhou, China, September 23–25, 2020, Proceedings 17*. Springer, pp. 289–301.

Zhao, K. *et al.* (2020) 'Text Mining and Analysis of Treatise on Febrile Diseases Based on Natural Language Processing', *World Journal of Traditional Chinese Medicine*, **6**: 67.

Zhao, Y., Fu, W., and He, W. (2016) '試析播州之役對明朝的影響 [The Influence of the Bozhou Rebellion on the Ming Dynasty]', *Wenjiao Ziliao*, **19**: 72–3.

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