

Exploring the Integration of Natural Language Processing (NLP) Techniques in the Banking and Telecommunications Sectors

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ABSTRACT

Superior customer experiences and individualized interactions are crucial in the ever-changing banking services landscape. This project aims to improve service delivery and adapt banking experiences by utilizing Natural Language Processing (NLP) tools to analyse consumer behaviour and sentiment. We show how banking customer service has changed over the years and how natural language processing has been crucial in understanding client sentiment and behaviour through an exhaustive literature review. We lay out the methodology for sentiment analysis and consumer behaviour analysis, including data gathering tactics and natural language processing methodologies. By utilizing real-world datasets, we analyse customer sentiment across different banking touchpoints through sentiment analysis and uncover patterns and preferences through customer behaviour analysis. Banking institutions can use the findings to enhance service delivery and provide personalized experiences. Financial institutions can gain a competitive edge and ensure their long-term viability by deepening their client interactions through the use of analytics powered by natural language processing (NLP). In addition to adding to the growing body of literature on natural language processing (NLP) applications in banking, this study should inspire similar investigations in the future with the goal of reshaping customer-centric banking models.

Keywords: Natural Language Processing (NLP), Customer Behaviour, Sentiment Analysis, Banking, Personalization, Data Analysis.

1. INTRODUCTION

The emergence and development of Natural Language Processing (NLP) has had a tremendous impact on the transformation that has taken place in the financial sector, which has seen a fundamental shift from manual to automated systems. From its early rule-based techniques to its more recent developments in deep learning-based models, Lo and Singh (2023) [1] discuss the historical development of natural language processing (NLP). It is clear that natural language processing plays a crucial part in improving the processing, analysis, and comprehension of unstructured financial materials, as this development demonstrates. An important step forward in the automation of financial services has been taken with the

implementation of cutting-edge natural language processing (NLP) models, which have been demonstrated through the use of sophisticated chatbots. This provides a look into the future of financial applications that are powered by NLP.

Roboadvisors are a further example of how natural language processing (NLP) has been integrated into the automation of financial reporting. Bonelli and Dongul (2023) [2] underline the profound impact that these digital tools have had on the financial services industry by utilizing natural language processing (NLP) and other disruptive technologies. The use of natural language processing (NLP) in the actual application of automating difficult financial procedures is demonstrated by robo-advisors, which automate investment portfolio management and financial planning services. They are able to demonstrate the sophisticated analytical capabilities enabled by natural language processing (NLP), which aligns with the ideas of modern portfolio theory. This capacity allows them to analyse the risk tolerance of their clients and design diversified portfolios.

Furthermore, the application of natural language processing expands beyond the realm of financial advice services to embrace a wider range of financial management and reporting responsibilities. The authors Guariso, Guerrero, and Castañeda (2023) [3] examine the utilization of natural language processing (NLP) in the process of automating the budget tagging procedure within the context of the Sustainable Development Goals (SDGs). By proving its capacity to contribute to the alignment of financial reporting with global development goals, this application exemplifies the potential of natural language processing (NLP) to expedite and improve the effectiveness of public financial management systems. The evolution of financial reporting, which is being pushed by natural language processing (NLP), is reflective of a larger trend towards automation in the financial sector. The development of advanced natural language processing models that are able to comprehend and analyze massive amounts of unstructured financial data has made it easier to make the shift from human operations to automated technology. This change has significant repercussions, as it will result in improved accuracy, efficiency, and scalability in the management and reporting of financial information.

A big step forward in the financial sector is represented by the transition from manual to automated systems for financial reporting, which has been driven by the improvements in natural language processing (NLP). In the realm of financial reporting, applications of natural language processing (NLP) include robo-advisory services and public financial management. These applications emphasize the potential of the technology to revolutionize financial procedures. The ongoing development and

incorporation of natural language processing (NLP) into financial reporting systems has the promise of bringing about financial management techniques that are more effective, accurate, and scalable in the future. This is despite the hurdles that are still lying ahead.

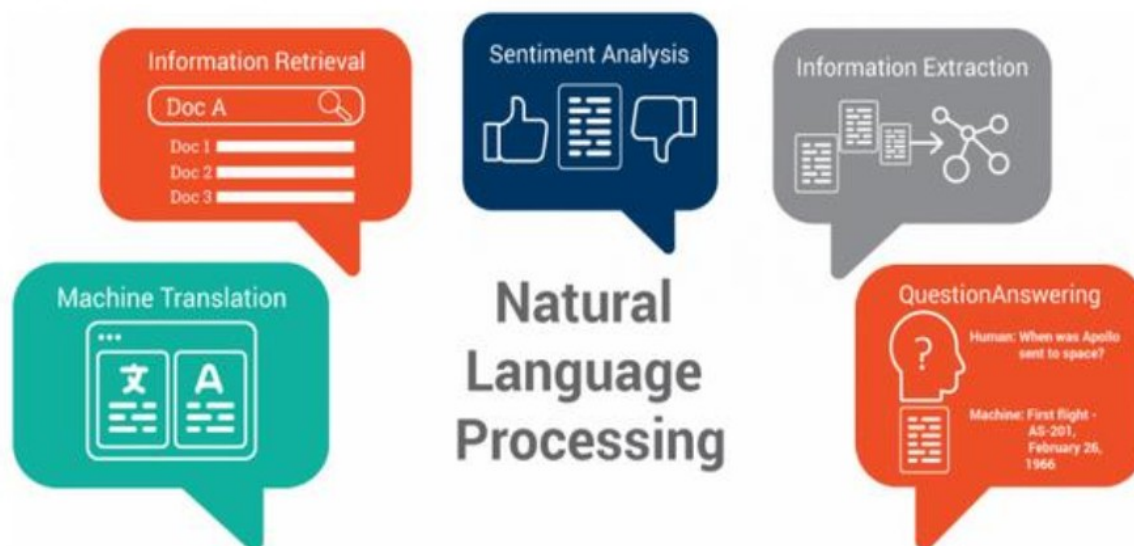


Figure 1: Natural Language Processing.

It is possible to define Natural Language Processing as the process of constructing a computing system that is capable of processing and comprehending various forms of natural language and was shown in figure 1. The term "corpus" refers to a specialized database that is used for natural language processing, which encompasses any language. Opinion Mining is the computer examination of people's opinions, sentiments, attitudes, and emotions expressed in written language in social media platforms such as Facebook, Twitter, and other similar platforms. This represents one of the most important applications of text mining. Since the beginning of the last decade, it has been one of the most active study areas in the field of Natural Language Processing and text mining. To extract the views or feelings that are expressed in a piece of writing is the goal of this process. In the past, one of the most significant aspects of our information gathering activity has always been to inquire about the opinions of other individuals.

When it comes to making decisions, the opinions and experiences of individuals are extremely useful sources of knowledge. Currently, there are a number of websites that encourage users to publicly express and communicate their thoughts, comments, ideas, and opinions regarding products, services, policies, and other connected topics. As a result of the growing popularity of these websites, a large number of people's opinions have been collected on the internet in a manner that is largely

unstructured. A task that is getting increasingly difficult to do is the extraction of meaningful content from social networking websites. This circumstance gave rise to a new field of research known as opinion mining, which is characterized by the requirement of language identification.

Technologies of communication that are mediated by computers are known as social media. These technologies make it easier to create and share information, ideas, career interests, and other forms of expression of various kinds. Blogging, corporate networks, enterprise social networks, forums, microblogs, photo sharing, product or service reviews, social bookmarking, social gaming, video sharing, and virtual worlds are all examples of the many varied shapes that social media technologies can take.

As a result of the fact that social networking sites like Facebook and Twitter provide us with an easy platform to communicate our thoughts to people all over the world, there is a vast amount of data. A social structure that is determined by the interactions of individuals or groups is referred to as social networking. There is a significant increase in the amount of multilingual content that is both noisy and poor. It is common for a large number of people to employ more than one language in the same statement.

Furthermore, developments in machine learning algorithms have enabled financial institutions to conduct more in-depth analyses of consumer behaviour, thereby revealing patterns and trends that may be used to influence strategic decision-making and the provision of individualized service offers (Gupta et al., 2019) [4]. In terms of methodology, this study takes a structured approach to the collecting and analysis of data, making use of datasets derived from the actual world in order to carry out sentiment analysis and customer behaviour analysis. Through the application of natural language processing (NLP) techniques to numerous sources of textual data, such as customer feedback, reviews, and conversations, our objective is to decipher the multidimensional dimensions of consumer sentiment and preferences across a variety of financial touchpoints. The purpose of this research is to provide banking institutions with actionable insights that will allow them to improve service delivery and develop stronger customer relationships, which will ultimately drive long-term growth and competitiveness in the digital era. These insights will be realized through the synthesis of findings.

2. LITERATURE REVIEW

2.1 Introduction to Natural Language Processing (NLP) in the Financial Sector

The incorporation of Natural Language Processing (NLP) into the financial industry represents a significant step forward in the manner in which data is evaluated and interpreted for the purpose of decision-making for the sector. Providing a foundational survey of the path that natural language processing (NLP) has taken, Gao et al. (2021) [5] highlight its applications, which range from sentiment analysis to risk assessment and financial forecasting. When it comes to handling the intricate and subtle language of finance, where the interpretation of text can reveal insights into market movements and investor mood, natural language processing (NLP) demonstrates its adaptability through its wide range of applications.

This discussion is expanded upon by Priya and Gnanasekaran (2021) [6], who investigate the role that NLP plays across a variety of industries, highlighting the revolutionary impact that it has beyond the realm of finance. As a result of their investigation, it appears that the fundamentals and technology that are driving applications of natural language processing in the financial sector also contribute considerably to improvements in the fields of education, agriculture, and healthcare. The goal of extracting meaningful information from unstructured text is a task that is fundamental to various businesses, including banking. This cross-sectoral applicability highlights the basic significance that natural language processing plays in this process. The capabilities of natural language processing are extremely beneficial to the financial industry because of its reliance on the rapid and accurate interpretation of data. Vamvourellis et al. (2022) [7] investigate the specific application of natural language processing (NLP) in the categorization of mutual funds. They demonstrate how NLP models may learn to classify funds based on investment plan descriptions. This particular example not only exemplifies the capability of natural language processing (NLP) to simplify the process of financial analysis, but it also emphasizes the potential of NLP to improve the precision and effectiveness of financial reporting and investment management.

Furthermore, the incorporation of Yang and Huang's (2023) [8] study on natural language processing (NLP) in aviation safety offers a fresh viewpoint on the difficulties and potential that are linked with the use of NLP in highly regulated and safety-critical industries. The insights that were drawn from their systematic examination offer valuable lessons for the financial industry, particularly in terms of managing regulatory constraints, assuring data quality, and addressing the limitations of existing natural language processing technology. Although the review was

focused on aviation, the insights that were drawn from it offer valuable lessons.

In the realm of data analysis and interpretation, the implementation of natural language processing (NLP) in the financial industry constitutes a significant step forward. This allows financial institutions to improve their decision-making and reporting processes by gaining deeper insights into market trends, investor sentiment, and risk indicators through the utilization of natural language processing (NLP). In order to fully realize the promise of natural language processing (NLP) in the financial sector, it is necessary to overcome the obstacles that are currently being faced, to encourage collaboration across disciplines, and to continue to innovate in the development of NLP technology.

2.2. The Impact of Technological Advancements on Financial Data Analysis

Both the landscape of financial reporting and the landscape of data analysis have undergone considerable transformations, with the quick pace of technology improvements being a major driving force behind these changes. These alterations have not only remodelled the instruments and approaches that are utilized in the process of financial analysis, but they have also rethought the very characteristic of financial reporting itself. The incorporation of Natural Language Processing (NLP) and other advanced computational approaches has been at the core of this transformation. These techniques have played a vital role in greatly improving the efficiency, accuracy, and depth of financial data analysis.

The authors Imoniana et al. (2023) [9] note the significant impact that Computer Assisted Audit Techniques (CAAT), Artificial Intelligence (AI), and other developing technologies such as Blockchain have had on the auditing process. According to Imoniana et al. (2023), these improvements make it possible to conduct audits in a manner that is both more dynamic and continuous, hence enabling real-time data analysis and reporting options.

In a similar vein, Alnsour (2023) [10] explores the revolutionary role that financial technology (fintech) plays in Islamic banking. He demonstrates how the financial performance of banks in Jordan has greatly improved as a result of the implementation of online and mobile banking services. This demonstrates a more widespread pattern in which advancements in the field of financial technology are improving the effectiveness and accessibility of financial services across a variety of industries. As far as financial reporting is concerned, the importance of Big Data cannot be emphasized.

Megeid (2022) [11] highlights the ways in which Big Data analytics enhance the quality and relevance of accounting information, hence boosting transparency and utility for stakeholders who are involved in the decision-making process. The incorporation of Big Data into the processes of financial reporting makes it possible to extract useful insights from unstructured data sources, such as social media, audio, and video information, which were previously inaccessible or underutilized in the context of financial analysis.

Pisoni, Molnár, and Tarcsi (2023) [12] investigate the significance of knowledge management and data analysis techniques in the context of financial institutions. They highlight the significance of Big Data and data science methodology in relation to the process of making decisions based on numerical information. The capacity to properly manage and analyze massive amounts of data is a crucial competitive advantage for financial institutions. This ability enables these institutions to offer new services and to make decisions that are more informed. There is a significant and diverse impact that technical improvements have had on the analysis of financial data. The incorporation of natural language processing (NLP), artificial intelligence (AI), big data analytics, and fintech developments has not only revolutionized the tools and processes utilized in financial reporting, but it has also rethought the expectations of financial institutions and the skills they possess. As the financial industry continues to develop in response to these technological breakthroughs, the capacity to adapt to these changes and make use of these advancements will be essential to sustaining competitiveness and meeting the increasingly complicated needs of stakeholders.

3. USE CASES OF NLP IN BANKING AND FINANCE

Threats to a financial organization that are most frequently encountered are those that involve security issues and other technological hazards. There are additional technologies, such as Natural Language Processing (NLP), that can assist businesses in significantly improving their operations. This is in addition to the fact that a proactive approach to cybersecurity is a big deterrent to costly attacks.

In the field of artificial intelligence, natural language processing (NLP) is one of the primary subfields that is responsible for enabling machines to comprehend human language in all of its forms. One of the many functions that is frequently employed in the process of speeding corporate growth is the utilization of a machine learning model that enables the processing of large amounts of data, mining, and predictive analysis.

Click on this [link](#) to learn more about natural language processing (NLP), including the methods that are utilized, the trends that are occurring, and

the issues that are being faced. Besides providing the fuel for voice home assistants and chatbots in end-consumer settings, natural language processing (NLP) has various uses in the banking and financial industries, including the following:

- **Advanced enterprise search**

Information processing is accomplished by financial institutions through the utilization of both internal and external data sources. The unfortunate reality is that these sources can be discovered in a variety of databases and are available in a wide range of formats and languages. On a daily basis, employees in businesses that have ineffective data management systems spend as much as two hours searching for and recovering data, according to the findings of a survey. This corresponds to a loss of production of two million dollars in the United States annually. A cognitive search, which identifies the most relevant user search results across all formats, languages, and platforms, can be accomplished with the help of natural language processing (NLP) when it is used in conjunction with other machine learning technologies. A number of banking and financial operations, including as responding to questions from customers, evaluating and assuring compliance with regulations, and managing and onboarding new employees, can all benefit from the ability to retrieve information quickly.

- **Fraud detection**

In addition to other important risks, the financial industry is also home to fraud. According to the Federal Bureau of Investigation, fraudulent insurance collections can cost businesses as much as forty billion dollars in the United States of America each year. A study that was conducted by the Nilson Report in December 2022 indicated that losses due to card fraud will amount to 165.1 billion US dollars over the course of the next decade. Using the text mining functionality of natural language processing (NLP), machines are able to recognize similar keywords and repeating descriptions across a wide range of places, as well as many claim forms or cards, embedded within vast amounts of electronic data and scanned documents. These possible indications of organized fraud can be pointed out so that appropriate action can be taken.

- **Risk assessment and management**

When it comes to determining the risk of borrowers, financial institutions and banks rely on a variety of data channels. In the event that this is done manually, it may result in errors and evaluation outcomes that are doubtful. On the other hand, lenders can make use of Named Entity Recognition (NER) with Natural Language Processing (NLP). This technique recognizes important textual information and eliminates

ambiguity by classifying it in the proper manner. Furthermore, natural language processing can be used to examine the business plan in order to assess the borrower's consistency and attitude by analysing the words and the tone of writing that are utilized in the document.

- **Portfolio management and optimization**

Aside from the use of credit cards and loan applications, natural language processing (NLP) can also be utilized in the administration of funds and investments because it is able to process large amounts of data more effectively.

Financial data analytics

In light of this, the text analytics capabilities of natural language processing make it possible for businesses to search through a variety of sources, such as financial news and trends in the market and investments, in order to ascertain the degree of volatility associated with particular assets.

It is also possible for financial institutions to improve their investment selections and business strategies by employing content enrichment and sentiment analysis. In the context of business operations, content enrichment refers to the utilization of natural language processing (NLP) and other technical solutions to make content relevant to your operations, particularly from unstructured datasets.

The analysis of public sentiment and behaviour in relation to certain market circumstances is known as sentiment analysis. In certain circumstances, investors may withdraw their investments from particular entities due to unfavourable sentiment, which may have an impact on the price of those entities' stock on the market. In the field of financial text analysis, FinBERT is the most prominent natural language processing model.

Predictive uses

The use of natural language processing (NLP) can be applied to historical data in addition to current sentiment in order to forecast the future performance of investment funds, particularly when certain risk factors are present. When this is done, financial wealth managers are able to recognize investments that carry a high level of risk and maximize development potentials even when faced with uncertain circumstances.

- **Customer services, analysis, and retention**

One of the earliest applications of automation in the financial services industry was the creation of chatbots and virtual assistants. In order to respond to customer inquiries and requirements, these machine-driven service solutions make use of natural language processing (NLP) and predictive analytics to accept and process voice and text commands. Both

the customer experience and satisfaction have been improved as a result of this NLP-driven service delivery. The collection of customer analysis is another area in which natural language processing is of the utmost importance. By utilizing the sentiment analysis and intelligent document search capabilities of natural language processing (NLP), financial institutions are able to ascertain the services that are in the highest demand, understand the key difficulties that customers have, and learn how customers feel about the organization. This information can be utilized for the purpose of making personalized offers, gauging the response of customers, and enhancing both products and services [13].

4. NLP IN TELECOM

Telefonica, a Spanish telecom business, is likely the most prominent example of the application of natural language processing (NLP) in the field of telecommunications. The company has introduced AURA, a virtual artificial intelligence assistant that assists clients in managing their digital experience with the company. The application of natural language processing (NLP) is the means by which the organization intends to increase the level of consumer engagement. The use of natural language processing in the telecommunications industry is not unique; other examples include Orange, China Mobile, SK Telecom, Deutsche Telekom, and Vodafone. All of these businesses employ AI chatbots that are equipped with natural language processing in order to comprehend, respond to, and resolve the daily requests for assistance that are made by humans. Use cases of natural language processing in the field of telecommunications go far beyond customer service. Because of the introduction of 5G networks and the requirement for what engineers refer to as "intelligent connectivity," it is essential to incorporate deep machine learning and effectively manage the growing complexity that this new technology entails. Artificial intelligence and natural language processing are essential tools in this scenario for addressing challenges such as meeting the requirements for latency and bandwidth. Predictive networks, which are able to forecast the performances of future networks as well as any potential defects in those networks, could be another frontier for natural language processing and artificial intelligence.

Table 1. Comparative examination of existing review articles.

Ref.	Application	Data sets	Pre-Processing	Algorithm	Results analysis	Challenges & Future	Novelty
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Wankhade et al. (2022) [14]	✓	✗	✓	✓	Analysed article published before 2020	✓	It was provided with an overview of the methodologies, applications, and challenges associated with sentiment analysis, as well as a comparative evaluation of various methods, with the purpose of assisting in the comprehension of their advantages, disadvantages, and potential future research areas in this area.
Lighthart et al. (2021) [15]	✓	✗	✗	✓	–	✓	Through the process of merging the results of secondary research that had been published in the past, an inquiry into the subject of sentiment analysis was carried out. These secondary research

							investigations comprised mapping studies as well as comprehensive reviews of the existing literature.
Xu et al. (2022) [16]	Mainly Social Media based	✓	✗	✓	Only Social Media Based	✓	Provided a systematic survey of social media-based sentiment analysis, highlighting new trends and challenges in the field.
Lu et al. (2023) [17]	✓	✗	✗	✓	✗	✓	Covered a variety of modalities and provided insights into current developments in single-modal sentiment analysis. Additionally, advanced studies on multimodal alignment and ChatGPT in South Africa were investigated, and 17 open research issues and potential pathways for

							advancement were presented.
Ma et al. (2023) [18]	✓	✗	✗	✗	✗	✓	An overview of multi-modal sentiment analysis was presented, with a particular emphasis placed on the transition from narrative sentiment to interactive sentiment. This was done in order to address the dearth of literature in the field of sentiment interaction.
Jamin Rahman Jim, (2024) [19]	✓	✓	✓	✓	✓	✓	This article presents a complete analysis and systematic review that covers all of the above domains in machine learning, deep learning, latent learning, and pre-trained-based sentiment analysis. The paper focuses

							on the most recent research articles that are considered to be state-of-the-art.
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CONCLUSION

In the complex web of financial reporting, the introduction of Natural Language Processing (NLP) signals the beginning of a revolutionary era that promises to bring about unprecedented levels of efficiency and precision than ever before. This study set out on an ambitious trip to uncover the intricacies of integrating natural language processing (NLP) into the environment of financial reporting. Furthermore, the study aimed to shed light on the path that future initiatives in this rapidly developing subject should take. Our goal was to outline the progression of financial reporting from its traditional moorings to the cutting-edge coasts of automation, which were highlighted by the advanced algorithms of natural language processing (NLP). This was accomplished through careful exploration which we conducted. The inquiry that we conducted utilized a rigorous qualitative research approach, and it looked into the many different aspects of the application of natural language processing in financial reporting. In order to extract the most important aspects of natural language processing's influence on financial data analysis, the approach was painstakingly developed by applying a comprehensive examination of the available literature and empirical data. For the purpose of this academic endeavor, the notion that a sophisticated understanding of natural language processing techniques and the obstacles associated with their application would reveal new possibilities for financial reporting served as the foundation. Increasing the capacity of computers to process inputs of text and speech is a significant step toward improving business intelligence. Because of the growing demand, natural language processing (NLP) has emerged as one of the AI subsectors that is expanding at the quickest rate. Industry analysts anticipate a cumulative increase of 39% from 2022 to 2030, which would amount to a value of USD361.6 billion for the industry. NLP is utilized in the banking and finance industries to facilitate the streamlining of repetitive processes, the reduction of errors, the analysis of sentiments, and the prediction of future performance made using historical data. Companies are able to save time and money, boost

their productivity and efficiency, and guarantee the delivery of high-quality services when they use applications of this kind.

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