Chapter

Natural Language Processing Applications in Business

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Abstract

Increasing dependency of humans on computer-assisted systems has led to researchers focusing on more effective communication technologies that can mimic human interactions as well as understand natural languages and human emotions. The problem of information overload in every sector, including business, healthcare, education etc., has led to an increase in unstructured data, which is considered not to be useful. Natural language processing (NLP) in this context is one of the effective technologies that can be integrated with advanced technologies, such as machine learning, artificial intelligence, and deep learning, to improve the process of understanding and processing the natural language. This can enable human-computer interaction in a more effective way as well as allow for the analysis and formatting of large volumes of unusable and unstructured data/text in various industries. This will deliver meaningful outcomes that can enhance decision-making and thus improve operational efficiency. Focusing on this aspect, this chapter explains the concept of NLP, its history and development, while also reviewing its application in various industrial sectors.

Keywords: NLP, ML, AI, deep learning, chatbots

1. Introduction

The aim of this chapter is to review the applications of NLP in business. Advancement in the application of technologies in daily lives has revolutionised communication and interaction between humans and computers. It has also had the same effect on humans throughout the world, for they can now use communicative applications (enabling translation and transliteration). Interaction/communication is an important factor in daily lives, as it is the basis for humans to become involved in activities such as business, education, commerce, healthcare management, politics and socialising. The way in which humans communicate can be referred to as natural language, which includes speech, text and emotions [1]. Humans are more involved in speaking as a means of communication than in writing (text). Text, rather than speech, is important for developing any AI application that facilitates the communication process, as machines, as yet, are not as effective in learning languages as humans, as a result of which, they have to depend on the text/data [2]. A child spends years learning any language, which involves emotions, fluency, grammar and speaking norms, among other things. Hence, it is not an easy task for a computer scientist to build applications that deal with natural language input/output.

The study of language, with regard to its grammar, rules, semantics and phonetics, is referred to as linguistics. Devising rules of language, methods for syntax and semantics are included as part of linguistics study. The methods and rules proposed by theoretical linguists can be processed by computer systems, which generate natural language which cope with such matters as grammar, semantic norms etc. This approach has been referred to as computational linguistics [3], for which statistical approaches are utilised in the process of analysing text/data. However, the approaches for processing natural language may not be limited to statistics, for they could also involve the application of advanced inference methods, like machine learning (ML) and deep learning, which are popular artificial intelligence (AI) techniques. Application of advanced techniques could address various challenges associated with the processing of natural language, such as breaking sentences, tagging the parts of speech (POS), generating dependency graphs, building an appropriate vocabulary, linking different components of vocabulary, setting the context, extracting semantic meanings or transforming unstructured data into a structured format [4–6].

With the development of technologies and applications of various methods for processing natural language, the understanding and definition of NLP has changed over time. Statistical NLP uses the data generated according to some probability distribution and then makes some inferences about this [7]. In a wider sense, NLP should be able to cover any kind of computer manipulation of natural language: it could be as simple as counting word frequencies to compare different writing styles; or as complex as understanding complete human utterances for delivering responses to an input [8]. Given the application of effective technologies, such as ML, in recent years, for NLP, the most appropriate definition is proposed as:

'NLP is a collective term referring to automatic computational processing of human languages. This includes both algorithms that take human-produced text as input and algorithms that produce natural looking text as outputs' [9].

Focusing on the brief background discussed, it can be identified that there is a growing demand and scope for larger application of NLP in various sectors. Therefore, reviewing the applications of NLP in different sectors contributes valuable knowledge to academicians, researchers and industry practitioners working in the areas of NLP applications. Accordingly, the purpose of this chapter is to review the applications of NLP in various business service sectors and provide future directions of NLP applications.

2. Methods

Review chapters could be an important sources of information for academicians and practitioners in guiding their decision-making and work practices [10]. High-quality reviews are cited more frequently [11]; and are found to be downloaded more often than any published article, as they offer a high-quality information from various articles in an effective way [12]. In addition, reviews enable one to have an overview, if not a detailed knowledge of the area in question, as well as references to the most useful primary sources [13].

Literature review, in this aspect, can be very useful in collecting information from various sources such as systematic reviews, theoretical reviews etc. Literature review may be the best methodological tool for gathering evidence in a certain area [14]. As this study focuses on gathering information related to application of NLP in business, it can be considered as explorative study. The approach in literature reviews can be narrow, such as investigating the effect of relationship, or it can be broader, such as exploring collective evidence in relation to a specific area or

concept. Literature reviews are identified to be very useful, when the aim of the study is to provide an overview about certain issue. In addition, it can be useful for creating research agendas, identifying gaps in research or simply discussing a particular matter [15]. It can be very beneficial in mapping the development of a particular research field in different contexts over time [16]. Considering the nature of this study, which focuses on investigating the development of NLP and its applications in business, literature review methodology is considered as it is identified as an effective methodological tool. Therefore, this chapter adopted a literature review methodology by collecting the relevant information from various sources of information including academic journals, online articles, conferences, white papers and industry reports. A brief literature review about the development of NLP over time is presented in Section 3. In addition, the information collected regarding NLP applications is categorised into major areas/industries including commerce, E-Governance, healthcare, and education, and other relevant areas as explained in Section 4.

3. Brief history of NLP

The roots of NLP development can be traced back to 1950s, when the idea 'can machines think' was put forward and examined by Alan Turing, which is popularly known as the Turing Test for the creation of intelligence [17]. This study paved the way for research related to the understanding of natural languages and machine translation. However, there was not much progress, for after many experiments, as identified in a 1966 ALPAC report, no one had succeeded in meeting his specified criteria [18, 19]. Some promising NLP systems were developed in the 1960s, which have been updated since through various techniques and new conceptualisations. Some of the major applications in the 1960s included 'SHRDLU', a natural language understanding program that allowed user interaction in English terms [20]; and 'ELIZA', a NLP program that stimulated human-machine conversation using a pattern matching and substitution methodology [21].

The research during the 1970s was focused on formatting and structuring real-world data into computer understandable data, which was based on conceptual ontologies. Some of the major developed applications included MARGIE, which could read an English sentence, using Riesbeck's expectation-based parser as well as building a conceptual dependency form, which represented the meaning of the sentence [22]; and QUALM, which used semantic modelling for framing questions and associating them with different strategies to find answers [23]. In the 1980s, most of the applications relied on complex sets of hand-written rules for NLP. By the late 1980s and 1990s, the research was focused on the application of statistical models for making soft and probabilistic decisions based on the input data along with ML algorithms, such as decision-trees [18, 24]. Accordingly, various techniques of ML became popular approaches to NLP, as they could achieve effective results for various NLP tasks, such as modelling and parsing [25–28]. Other popular techniques utilised in recent years are text embedding to capture the semantic properties of words, deep learning, machine translation and neural machine translation [29] (**Figure 1**).

Deep learning has gained momentum in NLP over ML in recent years for various reasons, including the ability to handle larger amounts of training data, the availability of faster machines and multicore CPU/GPUs. Moreover, new models and algorithms with advanced capabilities that have improved performance have stimulated deep learning research [29]. The manually designed features in ML are often over-specified, incomplete and take a long time to design and validate,

Time Period	Development
1950s	Turing test for creation of intelligence
1960s	SHRDLU, a natural language system working in restricted "blocks worlds" with restricted vocabularies ELIZA, simulated conversation by using a "pattern matching" and substitution methodology
1970s	Used "conceptual ontologies", for structuring real-world information into computer-understandable data. Examples: MARGIE (1975), SAM (1978), PAM (1978), QUALM (1977)
1980s-1990s	Used Machine Learning algorithms such as decision trees Used statistical models for making soft and probabilistic decisions Development of Multilingual textual Corpora
2000s	Use of supervised and unsupervised learning algorithms
2010s -	Use of representation learning, deep learning, neural network style learning Understanding semantic properties of words

Figure 1.
Brief history of NLP evolution.

whereas deep learning's underpinning parameters are quick to adapt and learn fast. Machine translation on various platforms is one of the classic representations of NLP implementation, the use of which is increasing in various industries and the market is projected to be $56 billion by 2021 [30]. Applications, such as 'Google Translate', one of the widely used applications on online platforms; Facebook, using machine translation for translating texts in posts and comments; and eBay, similarly using machine translation for enabling cross-border trade by connecting the users across the world. Neural Machine Translation, which manages the entire process of NLP through an artificial neural network known as a Recurrent Neural Network, has been found to be very effective [31]. Another important breakthrough for NLP application is the delivery of dialogue and conversations through chatbots or virtual assistants, such as Apple Siri, Amazon Alexa and Microsoft Cortana. These are increasingly being used, being continuously updated through ML. In sum, the growth of NLP can be observed with the changing needs and increasing adoption of technologies, being transformed through various techniques, such as rules-based algorithms, statistical models, ML, deep learning and RRN.

4. Applications of NLP in business

Communication is an important factor that builds relationship among individuals, and also between organisations and individuals. Interactions among the people from different countries have been facilitated using translators. However, with the development of NLP, communications between such entities have become easier, with language no longer being a barrier to human and business interactions. Businesses can internationalise their operations, and trade relations can be improved, thereby enhancing global commerce. Application of NLP can be found in a range of business contexts, some of which are described in what follows.

4.1 NLP in commerce

Sentiment analysis is one NLP technique that is widely used in the finance market/trading. It is the process of understanding an opinion about a given subject

through written or spoken language and accurate predictions are considered to be a game changer in achieving success on the stock market. Financial analysts, business analysts and trade analysts are employed in the organisations for this purpose, to monitor and analyse the impact of various happenings to stock prices. Their work can be simplified by using NLP with ML and AI techniques, are effective in analysing the data from internet, news, blogs and social networking sites (analysis of huge chunks of data across various channels). They can predict trade fluctuations, which enable investors to take the right decisions at the right time. For instance, when using sentiment analysis, words such as 'good', 'profit', 'benefit', 'positive' and 'growth' can be tagged with positive value, while those, such as 'risk', 'fall', 'bankruptcy', and 'loss' are tagged with negative values. Making meaning from the text identified using NLP and ML allows for accurate predictions to be made [32].

Similarly, NLP's application in business can be observed in other forms, such as: filtering emails and identifying spam (by analysing text); enhancing security through voice recognition; extracting information from large datasets; using online assistants/chatbots (questioning-answering) for providing customer service; promoting business intelligence; placing relevant ads online by using keyword matching and sense disambiguation; analysing competitors and the market using event extraction techniques, this list being inconclusive [33–37]. NLP can be applied in E-Commerce/S-Commerce applications for analysing the consumer behaviour based on the feedback, posts, reviews, ratings etc. (text analysis). It can also provide effective customer support through virtual assistants that can respond to customer queries in a range of formats, including: text, speech, audio or video [38].

4.2 NLP in "E-Governance"

NLP can enhance E-Governance, which is completely reliant on an information and communication technologies infrastructure [39]. It can facilitate interaction between the citizens and government using an E-Governance framework. For example, citizens who are illiterate can share their opinions and interact with government through audio/video conversation, which can be translated into text for documentation. Similarly, voice-enabled mobile applications can read the text and convey messages to the people. In addition, government can use NLP for monitoring various channels through which people interact to identify their concerns. Moreover, in this context, it can be used for enhanced security, by preventing any breaches of this.

Interactions between citizens and government involve enormous volumes of information exchange. Filtering and formatting such large amounts of data is a complex task, which can be effectively managed by the use of NLP with AI and ML techniques [40]. For instance, sentiment analysis can be used for mining opinions from huge datasets, including feedback, complaints and reviews about a particular policy, thereby ascertaining what the general consensus on it is [41]. That is, it can be used to gauge opinions from feedback, complaints and suggestions made by the residents of a city in relation to various urban issues, such as carbon emissions, lack of a solid waste management system and lack of sanitation [42]. This would help the relevant government agencies in selecting appropriate strategies to address the issues identified. In sum, as a result of adopting these approaches, the communication between government and citizens could be markedly improved, in particular, the former could use them to identify the concerns of the latter and thus, address these in a timely manner. In addition, it encourages E-Participation from both sides, thereby greatly contributing to the effective implementation of government policies.

4.3 NLP in healthcare

The healthcare industry is one of the fastest growing. It has been integrating technology applications with healthcare practices, such as diagnosis and treatment for delivering effective and efficient services, which can be accessed by the majority of people, thereby overcoming any regional disadvantages (access in rural areas through E-Health services). However, the amount of data being collected through this process, in the form of such as EHRs (Electronic Health Records), sensor information, diagnoses, monitoring data, healthcare operations and management data is vast. It has been ascertained that about 80% of the healthcare data is unstructured, of poor quality, and considering the current format, it is effectively unusable [40–68]. NLP, in this context, can be considered as one of the effective approaches for addressing these problems by using it to parse information and extract critical strings of data, thereby offering an opportunity to leverage unstructured data. It has been already in use in various healthcare operations across the world. The market for NLP in healthcare and life sciences is expected to reach $2650.2 million by 2021 [44]. The major drivers of NLP applications in healthcare [40–69] include the following:

- the rising need for handling the surge in clinical data;
- support for value-based care and population health management;
- improving clinical documentation and making computer-assisted coding more efficient;
- improving patient and healthcare provider interactions;
- empowering patients with health literacy;
- increasing need for higher quality healthcare.

So far, the applications of NLP in healthcare have achieved remarkable results, as a result of which its deployment in healthcare technologies has been increasing in recent years. For instance, NLP techniques were used for reviewing more than 2 billion EHR documents for indications of PTSD, depression and potential self-harm in veteran patients, in 2013, by the Department of Veterans Affairs (USA) [45]. Similarly, in another study [46], an analytics algorithm that leverages NLP was able to predict the onset of psychosis in high-risk youths with 100% accuracy. Similarly, a study conducted by researchers from the University of Alabama found that by applying NLP techniques the reportable cancer cases identified was 22.6% more accurate than a manual review of medical records [47]. Further, various other studies have identified the potential benefits, including effective decision-making by physicians; reducing physician burnout (disillusionment among doctors tired of repetitive data entry tasks and administrative duties as well as excessive time spent combing through patient data); addressing accelerating demand for healthcare services; and dealing with increasing numbers of healthcare claims [48–51], through the application of NLP techniques in the healthcare context.

4.4 NLP in education

NLP can enhance education technology in various ways, in particular, being effective in analysing data and text, thereby delivering meaningful outcomes. For

learning of language-related subjects, it can enhance teaching by focusing on reading, writing and speaking. In general, it can support the needs of students, teachers and researchers [40–42, 52–71]. Language assessment (formative and summative) is one of the upcoming major areas of NLP application, being used for assessing student's proficiency in reading, writing and speaking (e.g., automated scoring system for assessing/grading essays using NLP techniques). Syntactics analysis, for instance, can be used for correcting writing errors, which can provide instant feedback for correction and this process can be very useful for students, especially with the disabled, such as the deaf/ blind [41]. Other areas of application include proofreading, detecting errors of machine translation, assessing the meaning and content of student works, such as essays, short/long answers, training non-native speakers, and assessing reading and speaking [42, 52–55].

Moreover, NLP can be used in the teaching the use of language, that is, any subject using any language as a medium. One of its current uses pertains to the chatbot/virtual assistant applications that are used for various purposes, including teaching, training, tutoring and assessment in the education sector. Chatbots can also be integrated with gaming technologies, which promotes an active learner environment in the E-Learning context, with virtual characters or avatars [56–71]. The chatbot application, similar to E-Learning resources, also fosters students' engagement in learning activities by motivating them and gaining their attention by using innovative media features [57]. They can also be used in self-guided learning through learning modes, such as quizzes, which is one of the important principles of E-Learning [58]. However, many extant E-Learning approaches (online educational videos, online classes, portals) have been focused on one-way communication using rich and real-time media, thus failing to address pedagogical and social aspects. With the introduction of discussion forums and messaging applications, this issue was addressed to an extent, but increased the complexity and the amount of information to be processed, which can be a burden to the learner [59]. Chatbots in such instances can be very effective in providing the accurate information in real time, where the learners need not depend on different entities to seek answers. The personalisation and additivity features can be integrated into the chatbot applications, which can increase the accuracy of the learner model obtained by the student. He/she can negotiate jointly with the model using a natural conversational flow of interaction [59]. This aspect reflects the difference in designing educational chatbot applications and E-Learning resources. That is, for the former, voice user interface and conversational flow techniques need to be designed closely with the users of the system, this allows for the inclusion of culture and social issues in the stages of design, unlike E-Learning where the developers greatly influence the design process [70].

In addition to assessing students' linguistic inputs, through such matters as feedback, assessments/ coursework, essays, short/long answers and serving as a medium of instruction (tutoring, teaching, training), NLP can also be used in processing text and speech in other ways that can support teachers, students, system developers and researchers. As the amount of electronically available text in education is increasing rapidly, NLP can be effective in organising the relevant text for teaching. For, it can be a very onerous task for teachers to identify appropriate materials for effective input during lectures. That is, teaching with the most up to date course materials is beneficial for both students in learning and teachers in teaching the subjects more effectively and efficiently [41]. In addition, NLP can be effective in research, especially in formulating meaningful extractions from bodies of literature (systematic reviews, scoping reviews, meta-analyses etc.). In addition, NLP can be effective in processing qualitative data, such as those collected from interviews, in various formats including audio, video and text. Moreover, it can

be used for converting audio translations from one language to other or into text, thereby assisting with data analysis [60, 61].

4.5 NLP in other sectors

Sectors such as hospitality and travel, manufacturing and logistics, media and entertainment etc. can benefit from the application of NLP. For instance, the service engineers who repair electronics and other products at homes and offices need to provide the fault reports to the companies, which will be analysed and the identified issues would be resolved in products manufactured in future. However, compiling and interpreting information provided by the service engineers (age of devices, parts replaced, fault description etc.) could be a complex task for quality engineers as the text can be full of abbreviations, spelling mistakes and can range from verbose to abrupt in content length [72]. NLP can effectively refine such data and provide appropriate information for quality engineers. NLP can be implemented in all those areas where AI is applicable either by simplifying communication process or by refining and analysing information. Similarly, it is applied in hospitality and travel industry in providing excellent customer satisfaction through chatbots and virtual assistants in selecting hotels, booking flights, providing information about places to visit and experience etc., which is customised according to the travellers' preferences [73]. Similar applications of NLP can be identified across all the sectors where the services are provided to the customers, such as streamlining the programs according to the customers' viewing history on televisions (Media & entertainment) [74]; or communicating with travel chatbots about the travel routes while driving such as Google Maps(travel). Therefore, NLP can be applied across various sectors which are not only service oriented but also manufacturing sectors.

5. Future directions

NLP has made a major leap in the past few years, both in theory and practical integration into various industry solutions. Interacting with a virtual chatbot when booking a hotel or flight to extracting insights from call-centre interactions to analyse customer behaviour, such as their attitudes and satisfaction levels, has made NLP's presence felt in almost every industry-based solution. With deep learning being progressively developed, it has finally come into its own with RNN, outperforming the traditional ML methods in a wide range of NLP tasks. It can deliver better performance than humans in complex tasks such as questioning-answering and machine translation [62]. In addition, the recent advances in the technology and practices are promising for improving scalability and robustness. That is, they herald a shift in how business organisations consume computing resources and deploy NLP applications. From the technical perspective, various new approaches have been emerging for such learning (NLP and deep learning using training data), such as the Universal Language Model Fine-tuning (ULMFit); and Bidirectional Encoder Representations from Transformers (BERT), developed by Google for contextual pre-training, which has now advanced to XLNet. This avoids the issues that BERT suffers from by using a technique called 'permutation language modelling' [63]. These methods have improved NLP tasks, outperforming state-of-the-art performance as well as obtaining high accuracy. For example, application of the ULMFit method on text classification tasks has reduced the error by 18–24% for the majority of datasets. In addition, with only 100 labelled examples, it matched the performance of training from scratch on a hundred times more data [62].

The market for NLP in future is considered to be very promising, for various reports [30–64] have projected a rapid increase in its application. The NLP market, including hardware, applications and service is projected to reach $22.3 billion by 2025, while the market for AI enabled NLP software has been forecast to reach $5.4 billion by 2025 [64]. With the integration of deep learning techniques and NLP, with platforms like iDS Cloud, businesses in future will reap benefits in the areas of customer services, marketing, business intelligence and operational management. This will reduce the dependency on the data scientists, thereby reducing the costs and improving process efficiency [65]. Humanoids/robotics is one of the most promising advancements in technology, which can be experienced in near future in industrial sectors and also in social lives for managing various tasks. However, enabling humanoids to function like humans in every aspect and assisting them in performing most complex activities would need the ability to comprehend entirely accurately human speech. Given the versatile nature of robots, NLP will become more important than ever, because a single misinterpreted command by one could lead to it performing undesirable actions and may even cause harm to humans. Research on designing socially intelligent robots by using NLP [66, 67] has been increasing in recent years, which could result in the development of fully functional and safe humanoids in the near future.

6. Conclusion

The purpose of this paper is to review the applications of NLP in business. NLP potential lies in effectively learning and understanding the natural language. It can handle the issues associated with translation and transliteration by effectively improving the communication process between humans and machines across various formats. Based on the review, it can be concluded that its presence in various industry-based solutions has been increasing in the recent years. Complex processes in commerce, such as predictions and decision-making in stock-market trading; simplifying customer interactions using chatbots on commerce platforms, thus making the interaction more enjoyable; analysing citizens issues from large volumes of data in E-governance; effectively managing healthcare operations, such as diagnoses, service delivery and records management; and improving the learning and teaching approaches in education sector, are some of the benefits that NLP techniques can engender. In addition, NLP's integration with advanced technologies, such as ML, AI and deep learning, can deliver more accurate outcomes compared to the use of traditional methods. However, its application in the areas of AI, robotics, and other advanced systems is under-researched. In sum, given the efficiency of NLP techniques in improving the accuracy in data analysis and processing of natural language, it has immense scope for use in the areas of robotics and business intelligence in future.

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