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Breaking Barriers: Leveraging Natural Language Processing In Self-Service Bi For Non-Technical Users

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Abstract

This paper investigates how natural language processing technologies can be leveraged in self-service business intelligence to improve the experience for non-technical users. It begins by discussing the role NLP currently plays in solving BI tool problems. Then, it covers why existing NLP technologies underperform in self-service BI use cases. Subsequently, it proposes a crowd coding approach, Empower, that aims to reduce the communication barrier between non-technical users and NLP engineers. A preliminary deployment of Empower, involving three real-world NLP engineers and seven survey participants, finds initial evidence supporting the feasibility and usability of the crowd coding approach. The results suggest that there appears to be some general interest in the approach, although its potential for scale and ongoing use would likely need to be further investigated.

Today, self-service BI platforms promise to democratize data access for non-technical users. Natural language processing—a subfield of [1]artificial intelligence—makes processing natural language data much faster than manual tagging or annotations while solving some of the users' pain points. Unfortunately, our interviews with non-technical users and NLP engineers make it clear that existing NLP tools, regardless of their performance in handling natural language data, are still inadequate for the rapidly changing and quickly evolving self-service BI use cases. On one hand, self-service BI use cases vary by time and by individuals, making it difficult to train and supervise individuals or groups of NLP engineers to match such needs. On the other hand, NLP engineers share no common language or context with the business domain and face a high communication barrier. In this paper, we posit that translating natural language BI tasks into a semantic format may further help technical users solve repetitive BI tasks. Our research represents an initial study in this direction.

Keywords: *Natural Language Processing (NLP),Self-Service Business Intelligence (BI),Non-Technical Users,Data Accessibility,User-Friendly Analytics,Data Visualization,Business Insights,Conversational Interfaces,Empowering Users,Data Literacy,Automated Reporting,AI in Business Intelligence,Intuitive Data Exploration,Decision-Making Tools,Data-Driven Culture,Technology Adoption,Interactive Dashboards,Simplified Analytics,User Engagement,Machine Learning in BI.*

1. Introduction

In today's enterprise settings, intuitive Business Intelligence (BI) tools are in high demand. Users expect to have the ability to generate and modify reports at will. However, many popular BI environments have an entrance fee written in technical jargon associated greatly with complicated setup processes – requirements that demand, at a minimum, an above-average

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level of technical skill or knowledge. Yet, one key driver for harvesting any BI environment is not to empower IT or technical users but rather to assist those who design and make business decisions regularly. This group has the requisite knowledge concerning necessary information elements, but may unnecessarily be constrained in current BI environments due to their technical entry requirements precisely at moments where insights must be made and measured to make crucial decisions with great consequences. While IT has tasked some of society with manually splitting the tasks into typically 'desirable' and 'undesirable' status categories, as organizations become more data-driven, denying this latter group vigilant entry into BI environments may indeed be dangerous and leave an organization at a competitive disadvantage. As a result, this paper explores business intelligence environments through the lens of a user free from the responsibilities of IT professionals and attempts to merge enterprise BI practices into one user-friendly accessible insight factory, facilitated in large part by natural language processing.

Timing is key in decision-making, particularly in the digital age, where trends and industries have created a quantifiable momentum of great proportions. When it comes to high-stakes enterprise decisions, old or static insights available from days or weeks ago may be as unhelpful as not having any insights at all. Currently, relatively little has been written concerning BI and NLP to address the above mentioned gaps as they exist between business domain knowledge and IT domain knowledge, accessible in the required shape at the required time and the highest possible level of validity to decision makers. Nor have we found any data that features our intended users. Formally, in this paper, we have sought to "close" the aforementioned gap by describing potential solutions in a reasonably practical, "how to" explanatory approach, and with an underlying assumption of NLP and modern BI toolsets as feasible out-of-the-box enablers for solving the problem. Ultimately, this paper identifies and introduces a stream of innovation in BI environments aiming its domino effect in the organization's value chain: the release of internal knowledge into the hands of not only professional business analysts but also outlying departments and elected stakeholders.

Fig 1: Natural Language Processing(NLP)

1.1. Background and Significance

In today's world, many aspects of decision-making need to be data-driven. As a result, business intelligence (BI) is playing an increasingly important role in organizations' day-to-day operations. Many newly minted datasets are difficult and labor-intensive to analyze due to their massive size and complexity. Self-service BI describes a major trend in the modern information

age. It tries to provide an answer to decision-makers who may not have the necessary programming or technical skills to handle large volumes of diverse datasets effectively. Self-service BI also has the potential to differentiate itself from traditional BI systems. It will provide a more personalized user experience and offer a capability that allows decision-makers to use verified data systems to discover information, which would decrease development and maintenance time.

Many companies purchasing the platform under the guise of simple end-user delivery have historically fomented widespread dissatisfaction and disengagement in self-service BI delivery. Consequently, while one study claims that only 18 percent of staff believe they have the expertise they need to effectively practice their business, other studies show that up to 70 percent of business executives' data usage is reliant upon intuition and experience. It is widely documented, from an organizational viewpoint, that self-service BI systems are ineffectual and even out of reach for many users. Accessibility is therefore an essential component of self-service technology readiness and one of the six distinctive traits of technical maturity. Natural language processing (NLP) is aimed at the interaction between people and computers simply and effectively and primarily occurs in the system of human language by the computer. NLP is the world's biggest and arguably the most difficult challenge because the language is so complicated and varied across the globe. Organizations are currently investing heavily in self-service data analytics for end-users who have little or no prior knowledge of statistics.

Equ 1: Equations for ideal gas process calculations

with: $P = RT/V$	
$dQ = C_v dT + RT\frac{dV}{V}$	$dW = -RT\frac{dV}{V}$
with: $V = RT/P$	
$dQ = C_p dT - RT\frac{dp}{p}$	$dW = RT\frac{dp}{p} - RdT$
with: $T = PV/R$	
$dQ = \frac{C_p}{R} pdV + \frac{C_v}{R} Vdp$	$dW = -pdV$

2. Understanding Self-Service Business Intelligence (BI)

Traditionally, business intelligence (BI) has been the domain of technical or power users who have the skills to write queries or navigate complex BI tools. Driven by a need to analyze data more easily and make better business decisions, self-service BI evolved as a response to the business user long tail or non-technical users who might have a robust understanding of their business and questions they need data to help answer, but who lack the technical expertise or the tools to engage with data warehousing systems. While the typical Power BI user accesses reports and charts through a web interface, self-service BI tools are built to allow non-technical users to comprehend the relevance of data, defining their queries without requiring knowledge of scripting languages or visual tools.

Non-technical users can struggle to understand the dense documentation and tutorials necessary to harness the wealth of business data within the organization, and will often become frustrated if they are unable to access the information they require when they need it. Managers who need a daily pulse on the business are at a disadvantage if they are required to delegate reports and analyzes authoring to technical staff. Thus, without a flexible, dynamic dashboarding and reporting platform, non-technical users risk becoming overwhelmed by the complexities of BI. As a result, the market for self-service BI has been experiencing strong growth as more

organizations recognize the inherent advantages of enabling business analysts and end users, particularly in supporting a data-driven culture that provides complete and accurate data to everyone and encourages collaborative decision-making. Self-service BI can offer organizations a range of benefits, including convenience, data transparency, and, in theory, cost savings. However, some potential drawbacks do exist, particularly around data governance and the safeguarding of sensitive organizational information. With these implications in mind, it is worth examining the potential further benefits that extending the self-service principle into the domain of natural language BI could provide.Extending the self-service BI principle into the realm of natural language processing (NLP) presents an exciting opportunity to further democratize data access and analysis within organizations. By enabling users to query data using everyday language, natural language BI can significantly reduce the barriers for non-technical users, allowing them to interact with complex datasets without needing specialized knowledge or technical skills. This intuitive approach not only enhances user engagement but also empowers employees at all levels to derive insights and make informed decisions swiftly. Moreover, as organizations increasingly emphasize data-driven cultures, the integration of natural language BI can promote collaboration, foster innovation, and ensure that insights are accessible to a broader audience. However, as with any self-service tool, it is crucial to maintain robust data governance to safeguard sensitive information and ensure that the insights generated are accurate and reliable.

Fig 2 : Self-Service Business Intelligence

2.1. Definition and Key Concepts

Self-service business intelligence (BI) is an evolving discipline that relies on interactive, intuitive interfaces in combination with self-service analysis and supported data discovery. This approach is directly connected to self-service analytics, which is the analytical capability that enables business users to create their analyses by extracting and manipulating data without an intimate knowledge of data structures and then making their insights available to others. Users can interact with BI tools and generate insights without the heavy involvement of IT or data scientists. Modern BI tools offer an interactive and intuitive user experience no matter who intends to use them and have business outcomes at their core, hiding complex data abstractions. Leveraging a wide variety of capabilities that these tools provide, business users have become more and more data-driven, making decisions based on indisputable facts and having the confidence that they are working based on recent and accurate data. However, the term "self-service BI" remains very technical and not very straightforward to a wider audience. In general, from a business user point of view, self-service BI is an approach that hides the complexities among data, software, hardware, and network abstraction. This abstraction has led data discovery tools to evolve, offering casual users a powerful environment, where the translation of features into human language is supported by natural language processing. Recognizing the

intrinsic value of self-service experience, software vendors have reacted by releasing new products or modifying the existing ones to embrace this new trend. Moreover, trends are not set only by technology, but by the demand and widespread adoption of business users.

2.2. Benefits and Challenges

Self-service BI, at its core, simplifies the ability to consume and analyze data without intermediate developers. Many businesses have taken advantage of these systems as a means of placing data in the eyes of the decision-makers closer to the end of the data pipeline. Furthermore, employees and organizations who use self-service BI tools typically make decisions three times faster than organizations that require data to be provided to them by data experts. However, the power of a self-service approach in allowing users to take ownership of projects or data is considerable, which provides such users with the incentive to adopt such systems.

While a popular solution among businesses, self-service systems are not without numerous shortcomings. Providing data access to more people relieves strain on an organization as a whole, but also means that a greater contingency of the staff may have access to incorrect or sensitive information, potentially resulting in profit damage or coaching. It is implied that top-down reporting systems are proficient at ensuring data is static, clear, and simple, with errors when touching data in potentially hundreds of different data models. Most recently published literature concerning self-service BI primarily discusses overall market popularity and usage metrics, with little personal experience or expository press behind the discussion. Since user experience is an anecdotal topic, we believe not enough sources could be identified from a single user perspective. Ultimately, self-service aims to help non-technical employees perform the same or similar tasks without an intermediate helpdesk or other floor representative in terms of BI based on one interviewee's reference.

Fig : A new knowledge discovery approach for mining business trade barriers

3. Natural Language Processing (NLP) in BI

Natural language processing (NLP) is the transformative technology in artificial intelligence that focuses on the interaction between computers and humans through natural language. NLP enables the assimilation of informatively rich human languages, which are powerful communication tools developed by humans. In NLP, the aim is to bridge the gap between the human mind and computer language. It applies computational techniques, algorithms, and deep learning with neural networks to systems capable of performing tasks such as data entry, browsing, understanding and manipulating datasets, data mining, pattern analysis, data interpretation, automated reports, human-computer handoffs, dialogue explanation, and bioinformatics. Natural language processing enables a more intuitive and human-like manner of user interaction with BI and analytics tools, which has historically been a major obstacle that created a significant skill gap for most tools.

The rise of NLP democratizes the process of accessing data insights because conversational interfaces and the associated natural language query capabilities effectively hide the technical aspects of complex data models, thus enabling non-technical users to extract insights from their data via natural language instead of proprietary query languages. To this end, conversational BI does not aim to replicate the users' interactions with a data analyst but to augment it by providing a way to access insights that are seamless and transparent to end users. NLP also has vast potential that only awaits to be unlocked to maximize the interaction and usability of a self-service BI tool. The various possibilities arise from the way NLP enhances the user experience by making tools like virtual assistants more intuitive and less intimidating.

Fig 3: Natural Language Processing (NLP) used in business

3.1. Overview of NLP

At its core, natural language processing (NLP) is a field of artificial intelligence dedicated to generating software that enables computer systems to perform complex tasks involving human language. NLP's primary goal is to increase computer systems' ability to comprehend and deduce meaning from human-generated linguistic input. Over time, evolving computational capabilities have enabled NLP to provide more advanced computational solutions that impact everyday user experiences. In the data and analytics domain, NLP representations of text can rapidly increase understanding or summarization of a large collection of documents and help in identifying key concepts or categories. These derived concepts can then be used to identify broader trends and enable business users to access the right information and make data-driven decisions. NLP systems are made up of several key components. Tokenization breaks down a body of text into units that can be processed and understood by computer systems. Stemming can begin to break down phrases into smaller, more manageable pieces, i.e., finding variants of words such as "run," "ran," and "running," and acknowledging that they mean the same thing when querying a database. These processes enable context learning as a final result to understand "Can you raise my limit?" and "Can my limit be lifted?" to be understood as subtly different semantic inquiries. The system's understanding of the context and how it fits into the query is crucial. This encompasses NLP's understanding of both the syntax behaviors and semantic meaning of language to assist in a deeper representation of parsing, knowledge, and reasoning. Outside business intelligence capabilities, a variety of tools, frameworks, and libraries are available to facilitate the adoption or building of NLP solutions. In addition to these less technical underpinnings, sophisticated information retrieval systems and machine learning models are made achievable by more technical audiences. While NLP has become increasingly relevant in the world of data and analytics, one of the most common use cases is within the practice of self-service business intelligence (BI). By enabling NLP queries to be applied to BI applications or data tools, the chasm between data sources and potential data consumers can be bridged. To a non-technical BI user, NLP serves as a useful alternative to learning SQL or data dialects. The alternative is to input a natural language question into a system and receive visual insights or results in return from a set dashboard or BI report.

Equ 2: The overall Speedup is the ratio of the execution time

$$\text{Overall Speedup} = \frac{\text{Old execution time}}{\text{New execution time}}$$

$$= \frac{1}{\left(1 - \text{Fraction}_{\text{enhanced}} \right) + \frac{\text{Fraction}_{\text{enhanced}}}{\text{Speedup}_{\text{enhanced}}}}$$

3.2. Applications of NLP in BI

• Interacting with Data: Enabling users to directly query datasets in conversational language to ask simple questions without using keywords or any technical syntax (e.g., "Give me the total number of orders from today?"). When performed over the reports, uses of NLP may result in suggestions of the most relevant filters (e.g., "How many deals are there in Boston today?"). This is further enhanced by big-name BI cloud platforms that process unstructured data to automatically generate reports for users, allowing them to subscribe to alerts and insights.

• Interpreting and Understanding Data: Automating the transformation and interpretation of words within emails and feedback into standardized scores and results, e.g., sentiment analysis, trend, or individual-specific feedback reports. When this is done across a large cohort reporting system, it allows users of BI to easily search and visualize these sentiment identifiers. These applications seem to be targeting a collection of large-scale, direct-user client systems that use external communication feedback systems as data in a CRM or SRM solution. More advanced intelligence systems do use deep learning to translate more complex forms of data like individual handwritten or verbal inputs, or they use Word Cloud-like interpretation to interpret and display unstructured data within structured data.

• BI Users: Furthermore, key BI application examples of NLP access and consumption features include natural query and language data modeling, both of which are present in self-service BI tools and data visualization and reporting products. One direct implication of these usage cases is in ensuring that individuals can make evidence-based or data-driven decisions.

4. Barriers Faced by Non-Technical Users in BI

Traditional business intelligence (BI) tools have one major disadvantage. They are incredibly complex due to how intelligent the tool is. For this, these systems require a different level of skill, understanding, and learning, such as SQL or Hadoop. Users who do not know these systems, need some level of training or education to work the UI to extract the insight they want. Additionally, not many BI systems allow for the natural language interpretation of query input. In the workplace, there is a fear that comes with utilizing these traditional BI systems to answer a question. One of the biggest barriers to BI user engagement is the perceived doubt of the data. Users would rather not use these complex tools than risk being wrong. Even incredibly accurate data is often overlooked for the perceived bias and inaccuracy users believe is in the dataset. Lastly, there is also a huge gap in workplace and technology skill levels. Understanding the basic functions of a BI system is only one professional hurdle; there is also the need to understand where and how to use the insights gathered from these results. These fears need to be addressed to overall increase BI inclusivity. If a tool is difficult or complex to use, users are less likely to engage with the software. Additionally, these tools were not created in a way that would attract casual users, making BI reports accessible, meaning only a small-scale professional can benefit from these advancements. These systems are not designed to be easy to use unless the user has a high level of specialized skill. However, by addressing barriers such as the ones listed above, the next generation of these systems could be designed to be naturally intelligent, increasing ease of use for novice users.

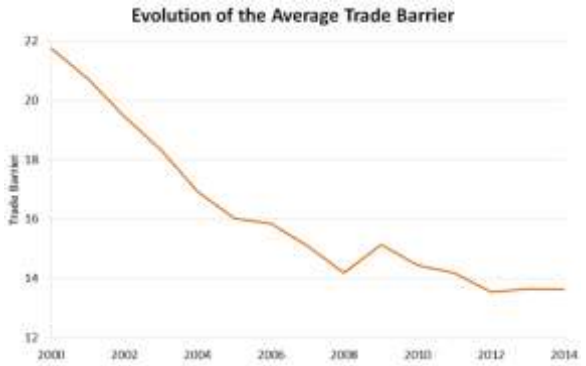

Fig : Behind the Global Decline in Trade Barriers

4.1. . Complexity of Traditional BI Tools

The Complexity of Traditional Business Intelligence Tools Client-facing traditional BI tools encourage interaction with backend databases while providing sophisticated, specialized front-end facilities. End users—business managers, analysts, etc.—often need to invest a non-trivial amount of time and effort in learning how to use these tools effectively to uncover insights and patterns. In most real-world deployments, enterprises would have a myriad of dashboards and visualizations to cover the full range of KPIs and decision parameters, documenting all the myriad assumptions underlying these in numerous static slides and pages. Different stakeholders in the same enterprise would have interfaced with different localized versions of these tools and would be familiar with, and operate proficiently in, the smorgasbord that the combined use of these BI tools offers.

For relatively non-technical end users, there is a substantial barrier to entry when it comes to making use of these facilities. The complex structured settings of these tools interface through proprietary data access and data preparation protocols to a potentially bewildering array of datasets in radically distributed and frequently unstructured ways that interest them. The tools that they eventually come to use are replete with terms and acronyms of art that database professionals bandy about as though they were common parlance. Very often, unfamiliarity with backend data store semantics in terms of data formats, facets, idiosyncratic corner cases, schema, and their data histories can act as real silent deal breakers, as a triviality on these lines when fed in could suddenly cause cumulative analytics to go bust. At each of these levels, the integration is possible but known to be a daunting technical challenge irrespective of the tools and development platforms used. Finally, traditional BI tools do not have user contextual clarity nor text and semantics handling; rather, they expect a pre-trained user after the long protracted experience at running these tools to give the tool its due time in understanding information organization in the enterprise.

Fig 4 : Traditional BI tools

4.2. Language and Skill Gaps

Non-technical users face numerous barriers to entry when attempting to interact effectively with BI and self-service BI. Frequently, these barriers manifest as language or skill gaps. Non-technical employees often struggle with the terminology used by those who work in more technical roles. This is true in many industries but manifests most strongly in and around the information technology and systems fields. Non-technical employees often find themselves unable to fully articulate their needs, which again creates the risk that BI developers will deliver solutions that do not fully serve the users' intended purpose. About self-service BI tools, they are typically complex and are designed to be used by very skilled users. Oftentimes, users have to be taught how to use the tools as part of their degree program or through additional professional development. This is not feasible for all users but is still a requirement if they are to effectively use the tools.

Language and skill gaps will always exist between users who are experts in their specific discipline and technologically skilled practitioners who are tasked with providing the tools for data analytics. At the core of much of the discussion about self-service BI is the role that communication and education play in bridging both of these gaps. NLP can translate BI developers' and analysts' languages and actions into terms that non-technical users can understand, which will improve the delivery process for intermediate processing tools as well as the products and services that are ultimately delivered to the organization.

Many non-technical users find themselves unable to adequately articulate their technological needs. Also, many self-service BI solutions require extensive, sometimes advanced training through formal education. These gaps lead to the exclusion of many potential BI users and represent a significant lost opportunity for contemporary organizations. Users who have limited experience with computers and information systems often lack the technology acumen required to both effectively experience and extract information from contemporary self-service BI solutions. As a result, they are often left further behind the data analytics curve as their more technically savvy colleagues begin to use these tools and develop knowledge that their colleagues cannot access.

The language gap is one of several issues reported by non-technical users who engage with BI tools. This gap sees BI developers receiving incorrect or suboptimal requirements for their analytic and visualization outputs, which are then not used or co-opted by the end users at the back end of the process. When users deploy self-service tools to fulfill their own data needs, they similarly need to frame that in the language of the software so that it is understood and acted upon properly. In all cases, non-technical users are forced to communicate with technologists in more technical jargon. Researchers have suggested that potential data analysts often have to undergo a series of learning experiences where they learn the artifacts and language of the domain they wish to enter. In short, they must learn the technical language. Given that a high proportion of the global technology community is self-taught, a high level of less formal, field-specific learning and self-education of technological jargon and tools surely exists beyond the academy.Non-technical users encounter significant barriers when interacting with Business Intelligence (BI) tools, primarily due to language and skill gaps that hinder effective communication with technical experts. This disparity often results in non-technical employees struggling to articulate their data needs, leading to the development of solutions that fail to address their actual requirements. Furthermore, self-service BI tools can be complex and require substantial training, often not feasible for all users, which exacerbates their exclusion from data analytics processes. As a result, these users fall further behind their more tech-savvy colleagues, who gain proficiency and insights that remain inaccessible to others. The language gap also complicates the communication of requirements between BI developers and users, often leading to misinterpretations and suboptimal outputs. To navigate these challenges, non-technical users must engage in extensive self-education to understand the technical jargon of the field, a process that can be daunting and time-consuming. Ultimately, bridging these gaps

through improved communication and education is essential for fostering inclusivity in the use of BI tools, ensuring that organizations can leverage the full potential of their data resources.

5. Leveraging NLP to Enhance Self-Service BI

The potential of NLP to transform user experiences, specifically in the business intelligence domain, cannot be overstated. NLP streamlines the traditional interaction with a BI tool by allowing non-technical users to work with data straightforwardly and intuitively. In a regular workflow analysis, a user needs to frame complex questions as a query, construct filters to narrow the scope and perform this process multiple times before they can finally focus on an area of interest. NLP-enabled self-service BI lets non-technical users ask questions in natural language, phrasing their inquiries in the way they think about analytics. Machines then translate that natural language into queries to prepare, analyze, and visualize the data.

One of the key ways NLP can enhance self-service BI tooling is by breaking down multiple barriers in the visual workflow to help users frame queries in a natural, understandable manner. The capability aids in the automatic generation of complex queries that would be difficult to express in a simple drop-down interface and naturally normalizes the data for the analyst instead of forcing them to choose from massive drop-downs or perform 'Show Fields.' It offers immediate feedback on data coverage and assistance in formulating search commands in the analyst's area of interest. Then, based on the feedback, if the output isn't what the user expected, they can refine it. In conclusion, incorporating NLP into self-service BI tools can drastically improve the user experience, making the data analytics and processes more intuitive. These tools must be designed around the principle of continuous improvement, which begins with constant, real-time feedback from the audience and focuses on the most important features to users.

Equ 3: Track and Improve Your Product Adoption Rate in SaaS

$$\text{Activation Rate} = \left(\frac{\text{Number of users who reached the activation milestone}}{\text{Number of users who signed up}} \right) \times 100$$

5.1. Improving User Experience

One of the key driving forces behind the integration of NLP in self-service BI tools lies in the improved experience for their users. NLP-based solutions bridge the gap between what a user wants to do and the technicalities of executing those tasks in a BI environment. Users no longer have to familiarize themselves with the BI tool's user interface or memorize their schema to construct queries. When asked a question verbally in natural language, a backend engine running NLP processing can automatically provide data analysis, resulting in a spike in user satisfaction. Just as importantly, for non-technical users, engaging in a conversation might make Business Intelligence feel more accessible. An NLP-powered chatbot can guide and explain the metrics and what they stand for in human-understandable language.

In practice, natural language processing was leveraged to allow users to ask questions about their marketing KPIs and receive insights as the output. Similarly, a bank used a bot integrated with its core banking system. This bot offers cross-functional support for various operations, including HR request data, such as leave details and salary summaries as examples, customer service, CIO support, and operational metrics such as the number of ATM transactions. Turning to a non-BI industry example, this BI chatbot is designed to interpret business metrics rather than more abstract topics and natural language input referred to as aim. This allows users to perform various BI actions as simply as possible, with the minimum amount of data required

in the request. Alternatively, a work-focused social network allows workers to use natural language queries to obtain results such as email reports, social content, or BI. In general, the trend in the examples here and those predominantly in the literature is that using NLP as an external third-party service allows quicker iteration on a better, more intuitive front end for business users that does not necessarily require data or tech literacy.

5.2. Increasing Accessibility

One of the biggest barriers to entry for any BI tool is its relative inaccessibility. Despite substantial investments in user design, BI tools are still seen as too technical for the layperson. This is where NLP shows promise among competing self-service BI users. Implementing NLP in these systems allows a user to interface with their data in plain language. People can use typical language patterns to initiate navigation tasks and structure queries, allowing them not only to create queries but also to interpret the data and resulting visualizations. The result is a conversational interface that is simple for most users to understand. By leveraging NLP to reduce the level of technical know-how needed to initiate even basic queries, end users can express questions through data they may not have the ability to articulate. The results allow an end user to interface with the system using natural language expression and some level of self-service.

However, beyond the simply increased utility, NLP democratizes the data in both a concrete and theoretical sense. Many organizations have customer-facing BI products that benefit from NLP. Additionally, some companies may have a diverse group of employees using a BI tool that is interoperable with NLP. Giving people the power of inquisitiveness by limiting their language would certainly be counterproductive, but relying on imperfect language would further isolate confidence.

6. Conclusion

In conclusion, it is important to ensure that new BI tools are user-friendly. They must be designed for people who may be unfamiliar with, or even intimidated by, new technology. Various barriers faced by non-technical users in accessing and utilizing business intelligence tools are described. The many ways in which leveraging natural language processing technologies can address and overcome these barriers are illustrated. Rather than forcing users to become more technical, organizations should focus research and development on refining NLP-enhanced BI tools. This will ensure that these tools remain fit for purpose. They must evolve as user needs and expectations evolve. They must adhere to the user-centered design principles that will ground them in the wants, needs, and abilities of modern, non-technical workers. The new user and the ongoing digital age metamorphosis will ensure that there are always new conversations to have. NLP will only become more deeply embedded into the fabric of a modern business intelligence tool.

The time for deploying NLP in business intelligence is now. BI is changing and, in the future, the biggest delivery challenge will be ensuring results are consumable. If a tree falls in the data lake and the user can’t access it, does it matter? The barrier lies in the access, not the data. In the end, the cost-benefit of breaking down the natural language processing barrier will be too good to pass up.

6.2. Future Trends

We anticipate trends in NLP moving from a definitional phase, surrounding how users ask for and access information, to a more functional phase of addressing relevant, business-use-critical functions. Prime among these will be the continued advancement to more robust conversational interfaces of the types already described. Also included will be the development of context-aware semantic accelerators and more sophisticated sentiment and root cause analysis/enhanced enterprise search. Finally, we anticipate an elevation in the trend of

developing the real-time querying of data and providing real-time diagnostics or responses leveraging NLP.

The pace of change in the NLP community and technology, along with the ongoing volume of use-case validation, requires ongoing evaluation and investment to improve on these analyses. We encourage a consistent message to business users about the expected NLP functionality that a BI self-service solution might provide—for example, this is the trend for NLP feature sets; these are the ones we believe will present the most value to our user community in the future—both in self-service BI and in general. As this is an exponentially growing field of technology, BI systems need to be dynamic enough to adapt just as quickly, leaving the consumer enough room to let the changes take hold but also demonstrating consumers' relative position in this ever-evolving population.

The changes we anticipate in NLP also underscore the untapped potential of the data, which is being largely overlooked. BI and analytics need to play an active role in integrating NLP in all relevant facets, not just in self-service. More generally, the trends anticipated strongly indicate the need for a more in-depth understanding of NLP. Proactive investment into faster and more complex search systems and response interfaces puts you on the higher end of the expected evolution of the tools our user base will come to take for granted in a few years.

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