

EMPLOYABILITY OF ADVANCED ARTIFICIAL INTELLIGENCE, MACHINE LEARNING AND NATURAL LANGUAGE PROCESSING TECHNOLOGIES IN ENHANCING THE EFFICACY OF BUSINESS INTELLIGENCE TOOLS AND TECHNIQUES

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ABSTRACT

In contemporary business applications, operational intelligence demands concurrent processing of analytical queries and business transactions, leading to mixed workloads. Artificial intelligence, machine learning, and natural language processing revolutionise the business landscape. Industries such as voice-based search, high-tech, telecommunications, automotive, assembly, and financial services are at the forefront of adopting these technologies. This study underscores the importance of real-time analysis, machine learning, and natural language processing in business intelligence systems for informed decision-making and delivering value across diverse sectors.

INTRODUCTION

Research in artificial intelligence (AI), machine learning (ML), and natural language processing (NLP) thrives in both academic and industrial realms. These technologies have been utilized for decades and have gained newfound significance and utility due to advancements in computing power and algorithmic innovation, particularly for emerging enterprises. Business intelligence (BI) employs data analysis to formulate strategies and decisions that confer a competitive advantage upon organizations. Over time, BI tools have evolved to render business data more actionable, facilitating insights generation. In modern BI, users can access and manage key performance indicators (KPIs), conduct advanced analyses, generate visual reports, and collaborate with peers. The continual evolution of BI and data analytics technology is reshaping the landscape of the business industry [1]. These tools and technologies simplify the processing, comprehension, and interpretation of diverse data types through intelligent visualizations, analyses, and customizable reports.

Presently, the world grapples with challenges and opportunities posed by big data, with AI, ML, and NLP gradually emerging as pivotal forces shaping routine business operations and BI decision-making processes. Thanks to advancements in Advanced Computing, AI, ML, and NLP, companies employ sophisticated algorithms to glean insights into customer behaviour, acquisition and retention, identify real-time trends, and make timely decisions, thereby gaining a significant competitive edge. The integration of these technologies into BI is not just a luxury, but a necessity for businesses looking to stay ahead in today's data-driven world.

The relentless expansion of big data and the proliferation of corporate data sources are propelling the pragmatic and cost-effective integration of AI, ML, and NLP into business analysis tools across diverse industries. These technologies are mainstream in BI and are used to distil actionable insights from extensive and heterogeneous datasets, furnishing comprehensible business recommendations to users.

EVOLUTION OF BI AND ADVANCED ANALYTICS

In recent years, BI has undergone significant transformations. Contemporary enterprises necessitate proficient data analysts and demand modern BI tools capable of automating data analysis and decision-making processes. With the proliferation and accessibility of critical data sources and the advent of advanced digital devices such as IoT-based devices, businesses are no longer content with generating intricate reports via complex statistical analyses through BI tools and software systems. Instead, they seek to implement actionable insights derived from these reports or datasets [4].

Modern BI, in contrast to its traditional counterpart, is not just a tool for reporting, but a platform for analysis. It is progressively transitioning from reactive to proactive analysis, furnishing live notifications and real-time insights. Augmented Analytics capabilities embedded within modern BI tools empower companies to conduct augmented data discovery and derive actionable intelligence for business decisions leveraging AI, ML, and NLP technologies. This evolution signifies a new era in business intelligence, one that is fortified by robust AI, ML, and Augmented technologies, and one that promises to revolutionize the way businesses operate and make decisions.

A. BI as Reporting

- IT-owned and managed
- Limited business user autonomy in data analysis with restricted self-service capabilities

B. Self-service BI

- Driven by business users
- Limited data analysis autonomy for users
- Suitable for a wide non-technical user base
- Provides user-driven insights for informed decision-making

C. AI-enabled BI

- Minimal IT assistance required for data model definition by business users
- Utilizes AI for automating data preparation and analysis
- Enhanced ease-of-use through AI automation
- Facilitates enterprise-driven decision-making via automatic data correlation and insight generation

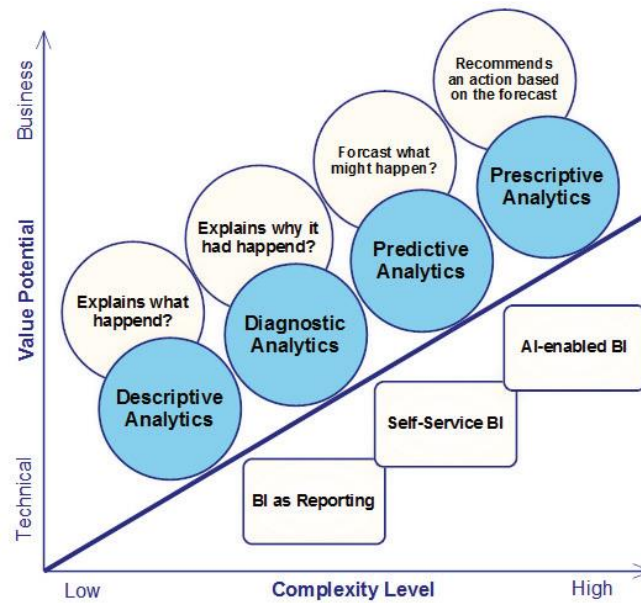


Fig. 1. Evolution of BI

However, BI tools have evolved into four levels of data analytics [8][9], as depicted in Figure 1:

- Descriptive analytics: This basic BI approach aggregates data to provide a retrospective view, answering the question, "What happened?" It offers a descriptive summary of past behaviour, aiding users in understanding historical trends and their implications for future outcomes.
- Diagnostic analytics: This level delves deeper into data analysis to ascertain the causes behind past events, addressing "How and why did it happen?" Techniques such as extract-transform-load (ETL), data warehousing, and mining are employed to uncover underlying factors and discern patterns within complex datasets.
- Predictive analytics: Predictive analytics forecasts future events based on historical data, offering insights into potential outcomes. While no algorithm can provide perfect predictions, predictive analytics leverages probability-based models to estimate future trends and probabilities.
- Prescriptive analytics: This advanced technology empowers users to specify preferred actions and proposes optimal solutions accordingly. By offering actionable intelligence, prescriptive analytics predicts future occurrences and elucidates the reasons behind them.

The development of modern BI tools, AI-enabled BI, and Augmented Analytics has enhanced companies' maturity in decision-making processes [10]. Although these tools are still developing, contemporary business requirements aim to achieve prescriptive analysis levels. AI, ML, and NLP are fundamental modern technologies that have evolved over many years [11][12]:

- Artificial Intelligence: AI encompasses a range of concepts, tools, and technologies with transformative potential across various industries. It denotes machine intelligence capable of performing automated tasks, making intelligent decisions, assisting humans, and driving

innovations such as autonomous vehicles. Essentially, AI enables machines to learn from data, derive insights, and act intelligently, encompassing ML, NLP, and deep learning subsets.

- Machine Learning: ML entails systems that learn from datasets to identify patterns with minimal human intervention. Supervised learning involves training machines with predefined goals, while unsupervised learning extracts insights from data without specified outcomes.
- Natural Language Processing: NLP uses software systems to manipulate natural languages, such as speech and text, automatically. Given the importance of natural language data in contemporary business contexts, NLP facilitates understanding and reasoning about textual data, akin to other data types.

AI IS THE NEW BI

Modern enterprises leverage data to uncover insights, understand market trends, and drive decision-making processes. Initially termed data warehousing, collecting, transforming, and analyzing business data has evolved into BI and analytics [13]. AI-enabled BI represents the next evolutionary phase, streamlining analysis and decision-making processes.

AI-enabled BI tools offer several efficiency benefits, including automated analysis, enhanced quality control, and streamlined access:

- Automated Analysis: AI automates routine processes that traditionally consume significant time, enabling data scientists to focus on higher-value tasks. By defining data variety, recommending insights, and building comprehensive data models, AI empowers data scientists to work more efficiently.
- Improved Quality and Error Reduction: AI-driven quality control minimizes human errors by continuously learning from historical data patterns and preemptively detecting and mitigating potential defects in business processes.
- Enhanced Access: AI simplifies BI tool access by facilitating natural language queries and providing auto-generated text analyses. By enabling users to interact with data intuitively through voice or text queries, AI enhances accessibility and fosters user engagement.

AI accelerates the transition from data to insights, facilitating informed decision-making processes and driving actionable outcomes.

In terms of BI effectiveness, AI maximizes potential business value by:

- Enhancing Analytical Skills: AI-enabled BI tools simplify insight generation, enabling users to perform complex analyses effortlessly and identify actionable insights.
- Accelerating Data Processing: AI aids in navigating vast datasets, automatically identifying correlations and alternative query options, thus expediting data processing and insights extraction.

- Personalization: AI-driven BI tools tailor reports and dashboards to individual user preferences, improving efficiency by presenting relevant information aligned with specific business needs.

Despite the numerous benefits of AI-enabled BI tools, several challenges persist:

- Report Accuracy: Ensuring the accuracy of reports generated by AI-enabled BI tools remains crucial, particularly for prescriptive analysis. While AI-driven models enhance automation, they must undergo rigorous validation to ensure mission-critical use cases.

- Result Relevance: AI-generated insights may occasionally lack organization or fail to address underlying problems, potentially undermining user trust and adoption. User dissatisfaction or distrust may arise if the system consistently fails to deliver valuable suggestions.

- Dataset Quality: ML algorithms rely heavily on the quality of training datasets, and suboptimal data can yield undesirable outcomes. Ensuring the accuracy and appropriateness of datasets is paramount for maximizing the performance of ML models.

- Performance and Scalability: AI and ML technologies demand advanced computing infrastructure, often requiring expensive graphics processing units (GPUs) to expedite computations. Scalability challenges may arise due to such resources' high demand and cost.

- User Acceptance: User acceptance is essential for the success of AI-enabled BI tools. Users will embrace the system only if it consistently delivers accurate, reliable, and valuable insights aligned with their expectations.

Skill Requirements: AI and ML are cutting-edge technologies that require specialized skills. Employees must enhance their proficiency to mainstream AI adoption, while vendors must prioritize implementing user-friendly AI features.

AI-Enabled BI Types:

Advancements in AI have prompted established BI vendors to integrate AI capabilities into their products, enhancing accessibility and introducing new functionalities for business users and data analysts:

- AI for Business Users: BI vendors incorporate AI capabilities into tools to simplify usage and automate data detection, collection, analysis, and insights generation. Business users may need to know the underlying AI algorithms but benefit from enhanced tool functionality and user experience.

- AI-Enabled BI for Data Analysis and Decision Making: This feature empowers users to prepare, build, and deploy analytical models within BI tools, eliminating the need for external data importing. By leveraging BI tools' capabilities, users can extract data from diverse sources, concatenate algorithms, and develop complex data flows to generate actionable insights.

MODERN BI AND AUGMENTED ANALYTICS

Automated Insights for Business Users:

One of the primary requirements for business users is the provision of automated and intelligent insights. With modern BI and advanced analytics, data scientists spearhead model development using ML, AI, NLP, and other technologies.

Business analysts and users leverage ML models and advanced analytics tools internally to automate insights generation, aiming to expedite non-technical users' access to actionable insights. Modern BI vendors address skill gaps in automated knowledge generation and analysis, offering tools with Augmented Analytics capabilities:

- Natural Language Processing: NLP algorithms analyze datasets to uncover insights, utilizing user-profiles and search history to suggest relevant queries. Some tools feature audio interfaces for enhanced usability.

- Automated Model Building: BI tools assist business analysts and users in creating predictive models, addressing the scarcity of data scientists. Users specify target variables and attributes of interest, streamlining model development.

- Automated Visualization and Analytics: Leveraging ML and other techniques, BI tools automatically analyze data to identify trends, outliers, and other indicators. These tools provide insights into unexplored questions and simplify data interpretation for users.

CONCLUSION

Integrating AI and BI interfaces with Augmented Analytics heralds a new era of automated insight generation and decision-making. AI-enabled BI tools enhance user productivity, offer user-friendly insights, and save time and resources for enterprises. Rather than supplanting human decision-makers, AI augments their capabilities, enabling data-driven decision-making processes. BI companies are increasingly integrating AI into key modules to enhance user experiences and deliver valuable insights promptly. Additionally, BI tools are platforms for skilled data analysts to develop models and derive insights without extensive coding expertise.

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