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ARTIFICIAL INTELLIGENCE: TRENDS AND CHALLENGES

Ronak M. Maru
Department of B.Sc.I.T & B.Sc.C.S
Thakur Ramnarayan College of Arts & Commerce,
Mumbai, Maharashtra, India

Gaurav Mittal
Department of Research,
The Rotaract Club Of Indian Medicos,
Mumbai, Maharashtra, India

Abstract— **Artificial Intelligence [AI] is an interdisciplinary field that synergizes Machine Learning, Big Data, Cloud Computing, and Information Theory, providing self-learning capabilities to machines and empowering them to predict the future with remarkable precision. This versatile technology is revolutionizing multiple sectors, from optimizing social media recommendations and transforming healthcare diagnostics to enhancing financial analytics. It thrives on the efficient processing of vast datasets, a task made possible through the symbiotic relationship between AI and Big Data in Cloud Computing environments. AI is poised to revolutionize the smart grid, integrating seamlessly with the Internet of Things [IoT] and the forthcoming Massive Internet of Things [MIoT] in the 5G/6G landscape. Deep Learning, a rapidly evolving AI subfield, promises breakthroughs in various applications. This paper focuses on the current trends and challenges in AI, shedding light on the transformative potential and hurdles that define this dynamic field.**

Keywords— **Cognitive Computing: Embracing machine learning for decision-making, where systems become self-learned experts, ensuring intelligent and low-consumption solutions.**

I. INTRODUCTION

Humans have maintained a longstanding fascination with Artificial Intelligence [AI]. The term "Artificial Intelligence" was first coined by Allan Turing in his seminal 1950 essay "Can a Machine Think?" This essay set the stage for the vast realm of computing that seeks to imbue machines with the qualities of human intelligence, thus giving rise to AI as a field of paramount focus. Arthur Samuel offered a defining insight by describing self-learning computers as those capable of acquiring knowledge without explicit programming. The advent of Machine Learning [ML] represents a critical juncture in this journey, as it pioneers the creation of systematic procedures for instructing machines and predicting future data trends. ML, in itself, is a rapidly evolving technology, largely propelled by the advancements in Deep Learning, which stands at the cutting edge of innovation. Recently, ML has ascended as one of the most burgeoning fields in technology, thanks to its validated successes across various practical applications. It's essential to acknowledge that the inherent characteristics of big data [1] from large-scale wireless networks include vast diversity, immense volume, real-time velocity, and substantial value, which introduce unique research challenges distinct from those posed by conventional computer systems. This article provides an insightful overview of the most advanced methods in Big Data Analytics [BDA] tailored for the complexities of large-scale wireless networks, shedding light on the forefront of research in this domain.

This article [2] offers a comprehensive overview of the current state of the deep machine learning discipline and provides valuable insights into potential future advancements. Within the realm of deep learning, Convolutional Neural Networks [CNNs] and Deep Belief Networks [DBNs], along with their respective iterations, take center stage, owing to their established significance in the field. Globally, big data analytics [3] stands as a rapidly expanding research domain, spanning computer science and numerous other fields. Its substantial success is evident across diverse sectors such as social media, the economy, banking, healthcare, agriculture, and more. Big data analytics finds applications in critical areas, including pattern recognition, image analysis, computer vision, clustering analysis, network intrusion detection, and autonomous driving. However, the advent of big data has ushered in a series of security-related challenges [4], which are effectively addressed by various algorithms capable of discerning intricate patterns and making precise predictions. For the seamless operation of data management systems within the cloud computing [5, 6, 7] environment, it is imperative to tackle a unique set of challenges inherent to cloud computing. Additionally, the intelligent sharing of econtent [8] leverages networking technologies, such as the internet and intranet, ensuring efficient and effective dissemination of digital resources.

II. LITERATURE REVIEW

Driverless vehicles operate with the assistance of GPS and sensors, which enable them to autonomously identify the right direction and navigate routes. These vehicles possess the capability to travel to any destination within a city where road infrastructure is available. The sophisticated control system [9] governing these vehicles rely on software and algorithms. Sensors play a crucial role in gathering data, enabling the system to discern and select the correct path. The advanced vehicle control systems have the capacity to intake sensory data, allowing them to distinguish between various objects within their environment, including other vehicles and public structures. This capability is instrumental in planning and executing routes to reach desired destinations efficiently.

In an effort to minimize resource wastage, energy consumption, and thermal cost overhead, a Genetic Algorithm with a foundation in fuzzy optimization was employed. This approach served to optimize cloud resource allocation, employing the Fourier transform [10] to validate the signature, facilitating accurate prediction of future resource demands. Furthermore, a dedicated researcher [11] has delved into the realm of security concerns related to artificial intelligence, focusing on supervised and reinforcement learning algorithms. The synergy of machine perception drives the advancement of Artificial Intelligence [AI], Machine Learning [ML], and Deep Learning, showcasing the evolution of these interconnected fields.

The evolution of next-generation wireless networks [12, 13] necessitates a fresh wireless radio technology paradigm to support exceptionally high data rates and entirely novel applications. The pivotal challenge resides in equipping radios with the intelligence for adaptive learning and decision-making, thus catering to the diverse requirements of these advanced wireless networks. Researchers [14] have explored the notion that the theoretical upper limit of prediction accuracy can be elevated by assessing the uncertainties associated with motion patterns through entropy calculations, while also considering the interplay of both temporal and frequency correlations in individual trajectories. Notably, Predictive Resource Allocation [PRA] has demonstrated its ability to facilitate seamless video streaming with minimal interruptions, reducing unfair pauses [15]. In the realm of artificial intelligence, machine learning emerges as one of the most promising methods, fostering intelligent radio terminals that can comprehend sensory [16] data. Several key developments have contributed to this landscape: firstly, a series of approaches akin to genetic algorithms have enhanced the Map Reduce environment's complexity. Secondly, addressing the challenge of dealing with unclean data laden with potential errors, AI has been deployed to distinguish between clean and noisy data, thereby creating contextual knowledge from the information. Thirdly, the integration of data visualization and expansive flash storage technologies has facilitated real-time decision-making processes, serving as a solution to a wide array of critical issues.

III. METHODS OF MACHINE LEARNING TASKS

Machine learning tasks are primarily categorized into two fundamental types of learning: supervised and unsupervised learning methods.

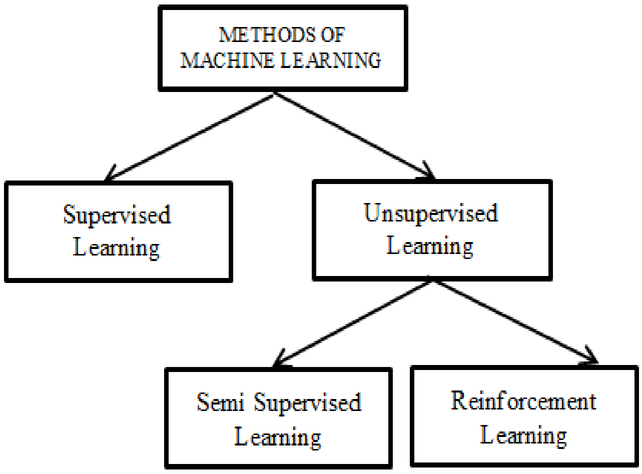

Fig. 1. Different Methods of Machine Learning tasks

In Figure 1, various machine learning methods are depicted, with supervised learning occupying approximately 70% of the representation. The remaining portion is divided between unsupervised learning. Unsupervised learning can be further subdivided into two distinct types: semi-supervised and reinforcement learning methods. In a supervised machine learning method, training is conducted using labeled data, where each labeled training data point consists of an input value and its corresponding desired target output value. This supervised approach enables the system to establish a connection between the training data and an inferred function for mapping new labeled values.

In unsupervised learning, the aim is to extract concealed insights from unlabeled datasets, illuminating patterns and structures that might not be apparent at first glance. On the other hand, Reinforcement Learning empowers a machine to learn and adapt its behavior through feedback acquired from interactions with the external environment. The choice between supervised and unsupervised learning methods, from a data processing perspective, hinges on the specific nature of the application. When confronting problem-solving challenges, data analysis and reinforcement techniques are judiciously selected. Despite the practical and marketable achievements of machine learning, it continues to exhibit sustainability while harboring numerous unexplored research avenues. Some of these uncharted frontiers are being explored through machine learning paradigms that emulate types of learning inherent in naturally occurring systems, akin to the learning processes observed in biological systems, including human organisms and other living entities.

IV. CURRENT TRENDS IN ARTIFICIAL INTELLIGENCE

The dynamic relationship among businesses, employees, and customers is undergoing a fundamental transformation, primarily driven by the rapid advancement and widespread integration of Artificial Intelligence [AI] and other pioneering technologies [17]. This shift is accompanied by an intensification of automation in the administrative aspects of Human Resource Management [HRM] activities and tasks. Robotics plays a pivotal role in this transformation, involving the development of tools capable of emulating human movement and behavior. To be succinct, the realm of robotics represents a convergence of various disciplines, encompassing artificial intelligence, machine learning, electronics, nanotechnology, and more. The screening process has yielded a summary of the current state of this subject, and while this article sheds light on the impacts of AI, robotics, and other cutting-edge technologies on HRM, it is important to note that the exploration of this topic is not exhaustive.

Undoubtedly, the most remarkable technology of our era is Artificial Intelligence [AI]. Without the utilization of AI and its subfields, such as Machine Learning [ML] and Deep Learning [DL], the contemporary technological landscape would remain incomplete. The quest to imbue machines with the capacity to learn and adapt has been the driving force behind our technological revolution. Notably, AI and technology [18] are converging in the realm of product management, extending their influence into various facets of life. Moreover, these emerging technologies are proving invaluable to businesses by enhancing client services. ML and AI represent the most potent forces that have the potential to surpass existing goods and services. In essence, AI stands for the emulation of human intelligence by machines, specifically computer systems, allowing them to execute tasks automatically and independently of human intervention. It's worth noting that machine learning and artificial intelligence are not synonymous; AI can operate as a rule-based system with hard-coded programming. The adoption of powerful technologies through machine learning raises questions regarding their potential societal impacts, both positive and negative. A diverse range of algorithms, including AI, Artificial Neural Networks [ANN], and fuzzy logic, are deployed. These algorithms can be categorized into supervised and unsupervised categories, each focusing on specific functions, driven by distinct expertise and training experiences. Figure 2 provides an overview of the various types of machine learning algorithms, further enriching our understanding of this expansive field.

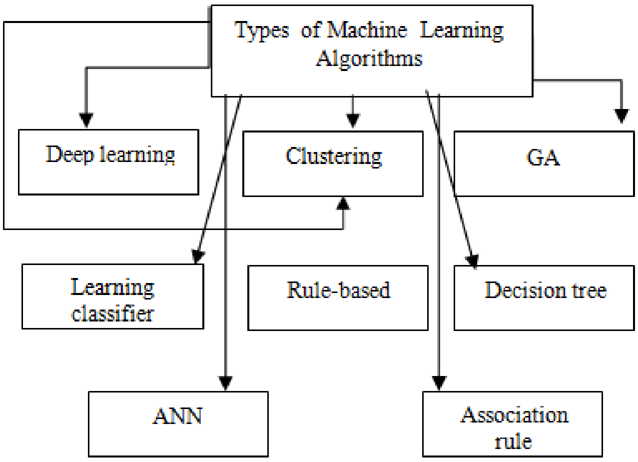

Fig. 2. Types of Machine Learning Algorithms

Users often grapple with the challenge of selecting the right algorithm to yield the optimal results for their specific problem. This conundrum prompts questions about the construction of enduring computer systems capable of tirelessly assisting learners over extended periods, acquiring proficiency in thousands of interconnected functions within a holistic framework that facilitates the development of new skills based on previous learning. In the realm of natural learning systems, the focus extends to team-based, mixed-plan learning to analyze complex genomic datasets. In practical application, Machine Learning [ML] is finding its place in various industries, helping identify competitive advantages and accelerating the retrieval of data for more accurate decision-making. The potential benefits encompass the ability to attract a broader customer base [19, 20], enhance revenue per customer, optimize operational processes, and reduce overall costs.

The building and construction industry is progressively embracing new technologies [21, 22] to enhance the efficiency, productivity, accuracy, and safety of constructed environments. Among these technologies are the Digital Twin [DT], Building Information Modeling [BIM], Artificial Intelligence [AI], Internet of Things [IoTs], and Smart Vision [SV]. This transformation aligns with the concept of "Industry 4.0," often referred to as the "fourth industrial revolution," which revolves around the application of cutting-edge digital technologies to revolutionize traditional business processes and manufacturing methods, rendering them autonomous and smart. Similarly, "building and construction industry 4.0" signifies the convergence of advanced industrial production systems, cyber-physical systems, and digital and computing technologies, redefining the design, construction, operation, and maintenance of buildings and infrastructure, all while considering circularity.

The Internet of Things [IoT] lays the foundation for efficiently collecting data in modern buildings [23], which can then be analyzed using tools like AI. The concept of a "smart building" is pivotal in this context, as it denotes an optimized environment achieved through efficient structures, services, systems, and their interconnections. Residents of a smart building benefit from various high-quality, secure, cost-effective services, including data analytics, data collection, data storage, and data visualization. These services contribute to a safer, more comfortable, and technologically advanced living experience. The illustration of a smart building with integrated AI underscores the transformative potential of these technologies in modern construction and operational management.

Despite the remarkable growth in academic research focusing on intelligent automation, encompassing robots and artificial intelligence [24], we still lack comprehensive insights into how these technologies influence both organizational [firms] and individual [employee] Human Resource Management [HRM]. Artificial intelligence's impact is pervasive across nearly every facet of life. One notable domain where AI has made significant inroads is education [25]. The education sector, much like other industries, has embraced AI tools and techniques to enhance students' learning potential and various aspects of the educational landscape. The incorporation of AI in education has expanded to encompass teaching, learning, and administrative functions. This study aims to provide an extensive examination of AI's role within the realm of education.

Existing algorithms are making significant strides in addressing real-time challenges within the business domain. A prime example is the utilization of these algorithms by store managers who predict sales several weeks in advance, effectively managing inventory to meet customer demands. Such predictions are influenced by various factors, including climatic conditions, the number of competitors in the same industry, promotional offers, and geographical location. To ensure customer retention and devise effective penetration strategies, businesses forecast and attract new investors with expectations of future revenues. The loss of customers can lead to diminished returns on investment and substantial financial losses. Therefore, in light of these challenges, business professionals are actively engaged in proactive forecasting to retain customers. This proactive approach often involves motivating consumers through enticing offers and incentives aimed at bolstering customer loyalty.

Customer segmentation serves as a valuable tool for retailers, enabling them to optimize their return on investments. Retailers meticulously monitor each customer's score based on three key factors: recency, frequency, and monetary value. In addition, Google's self-driving cars and robotics are being deployed across various domains, showcasing their versatility and potential applications.

We are currently residing in the computing era, where the adoption of storage as a service has given rise to the generation of vast volumes of data. This data explosion is met by recent advancements in computing power, coupled with the application of sophisticated algorithms capable of extracting valuable insights from this massive data deluge. These developments find applications in a multitude of sectors, including media, entertainment, communication, finance, security, healthcare, education, public service, insurance, marketing, wholesale trade, transportation, energy, utilities, manufacturing, and natural resources.

In multimedia organizations, this technology is instrumental in analyzing client information in conjunction with behavioral data, allowing for the creation of detailed client profile data, thereby enhancing service quality and personalization.

In the domain of Finance and Securities, the Securities Exchange Commission [SEC] employs big data to monitor financial market activities. Leveraging natural language processors and network business analytics, the SEC plays a crucial role in forecasting the future dynamics of both capital and money markets. This entails predicting trade decisions, conducting business analytics processes, assessing credit risk ratings, analyzing risk factors and scoring, identifying sentiment-based investor types, and employing predictive analytics, among other functions. Moreover, big data analytics are instrumental in addressing issues related to unaudited funds, undisclosed funds, and risk management, ensuring greater transparency and effectiveness within the financial sector.

The utilization of big data has revolutionized various aspects of healthcare and medical practices. It plays a pivotal role in clinical trial data analysis, enabling the identification of disease patterns, maintaining and analyzing patient databases, optimizing medical device and pharmaceutical product management, streamlining logistics, and facilitating the analysis of new drug discovery and development. Additionally, the development of mobile health apps has empowered doctors to deliver evidence-based medicine, enhancing the quality of healthcare services. Furthermore, big data is instrumental in identifying and managing health-related communicable diseases, often leveraging data from social media to provide timely insights and interventions.

In the United States, the education system harnesses the power of big data to assess the performance of both educators and learners. This data is used to monitor students' progress and understand how long it takes them to grasp new concepts. For instance, the University of Tasmania in Australia, with over thirty thousand learners, utilizes a library management system to track the progress of educators and learners engaged in online sessions.

In public services, big data plays a crucial role in various areas, including environmental protection, women's and child welfare, environmental change detection and management, and human resource management. It contributes to more efficient and effective public service delivery.

In the retail industry, the marriage of Machine Intelligence [MI] with big data is employed for a range of purposes, including basket analysis, customer segmentation, customer loyalty programs, logistics management, and behavior-based targeting. This data-driven approach is instrumental in enhancing the retail experience for both businesses and customers.

The authors have opted for a promising strategy that involves connecting explanations with the outcomes of neural classifiers to automatically [26] identify and categorize Terms of Service [ToS] documents and a set of five unfair clauses contained within the corpus. This approach not only ensures effective classification but also places a strong emphasis on transparency in the methodology. In terms of the architectural framework for this automatic classification process, the authors have made a deliberate choice to maintain transparency and clarity in the proposed approach.

V. CHALLANGES IN ARTIFICIAL INTELLIGENCE

The most formidable challenges in the domains of Machine Learning [ML] and Artificial Intelligence [AI] revolve around data availability and the strain imposed by technological errors and inconsistencies. AI finds application in diverse areas, including fraud detection, customer data enhancement, leveraging social analytics for trading, generating industry credit risk reports, enhancing trading processes, and ensuring audit visibility. Ho wever, safeguarding healthcare data, ensuring access to reliable information, and implementing effective e-governance measures present substantial challenges in the realm of big data analytics.

One of the complexities in dealing with big data is the heterogeneous nature of the data, characterized by non-uniformity, fragmentation, and a lack of standardization. The integration of data from various sources represents a prominent and substantial challenge, particularly in the education sector, where data sources may vary widely in terms of structure and format.

While essential for research in the field, the ethical challenges associated with AI-driven digital pathology extend beyond the aspects discussed here. Presently, ethical considerations related to medical data [27] sharing primarily focus on privacy concerns, with the aim of protecting the interests of individual study subjects. However, a broader perspective is necessary when addressing the ethical dimensions of sharing pathology data. This implies that digital pathologists should enhance their commitment to principles of choice, equity, and trust. Although these challenges are intricate and require ongoing dialogue among researchers, it is equally crucial to underscore the significance of patient and public involvement and engagement [PPIE] throughout this entire process, acknowledging the vital role that these stakeholders play in shaping the ethical framework for AI-driven digital pathology.

Supply chain management is currently experiencing a significant wave of innovation and challenges driven by technology [28]. Customers have increasingly high expectations for faster order processing and delivery, despite the current rapid advancements in digital technology that have made it easier and more efficient for businesses to adopt these new technologies. The integration of artificial intelligence and breakthroughs in the AIoT [Artificial Intelligence of Things] domain, such as data sensors and RFID [Radio Frequency Identification Detection], provide essential information for features like tracking and immediate alerts, thus enhancing decision-making capabilities. This data is instrumental in improving various processes and tasks within the supply chain.

However, the internet and the vast amount of data it hosts, while expanding technology's potential, also present numerous challenges for supply chain management. To identify and address the most significant issues facing AIoT-powered supply chains, this study conducted a literature analysis and interviewed professionals in the Fast-Moving Consumer Goods [FMCG] industry as a potential case study, shedding light on the complex landscape of modern supply chain challenges.

Healthcare executives have identified several implementation challenges associated with the adoption of AI, both within their organizations and in the broader healthcare system [29]. These challenges encompass conditions external to the healthcare system, internal capabilities for strategic change management, and the evolving landscape of healthcare professions and practices.

The findings underscore the need for healthcare organizations to develop comprehensive implementation strategies to surmount these obstacles and build the capacity for AI integration effectively. Regulatory laws and policies are imperative to oversee and facilitate the creation and deployment of efficient AI implementation strategies. Furthermore, investment in the implementation processes, collaboration with local governments, and partnerships with the healthcare sector and industry are essential steps to ensure the successful integration of AI in healthcare.

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The findings reveal that a major hurdle in embracing a system based on the demands of digital transformation is the absence of adequate infrastructure, which is often considered a fundamental prerequisite for implementing any technology. Consequently, many businesses opt not to proceed with implementation due to the absence of necessary infrastructure, which encompasses technological and technical elements, as well as organizational readiness to adopt the technology. An indication of organizational maturity that underscores the importance of infrastructure is its prominent position in the rankings.

Furthermore, in a world where the internet and network technologies are prevalent, the significance of cybersecurity -related challenges cannot be underestimated, as these challenges are placed second in terms of their importance and impact on digital transformation initiatives.

The retail industry faces significant challenges in ensuring the privacy of its users. Key challenges include the need to comprehensively understand customers by creating a unified view of customer information from various sources such as point of sale, loyalty programs, social media, and more. In the realm of Big Data visualization, there are hurdles related to efficient data processing techniques, which are necessary to enable real-time visualization, as well as the cost associated with procuring and managing devices for large-scale deployments.

In the field of business analytics [30], AI is increasingly integrated with the assistance of cloud computing, and it is often a task that cannot be easily replaced by machine learning and big data analysis. However, in certain scenarios, human analysts need to remain in the loop to provide oversight and expertise.

Regarding self-driving vehicles, discussions around automotive safety and the integrity of low-level devices often center on the ability of a human driver to take control of the vehicle in case of an emergency. If a software issue arises that poses a potential danger, autonomous vehicles are typically designed to override and recover to a safe state. However, in cases of unexpected mechanical failures like tire blowouts, engine faults, steering problems, or brake failures, the responsibility for recovery and safety remains with the driver.

AI algorithms in genetic algorithms pose a greater number of challenges [31], primarily due to the increased number of iterative steps involved in map reduce, making the process more complex. The presence of unclean or dirty data introduces errors and inaccuracies in the information. AI is leveraged to identify and rectify dirty data by contextually assessing the data stored in the database. Additionally, as the size of memory expands, customers face difficulties in efficiently analyzing vast databases and making quick decisions. Lastly, data available in signal or text formats undergo processing, and researchers are actively seeking solutions for handling audio and video-based data effectively.

The proliferation of AI-based Human Resource Management [HRM] [32] applications over the past decade has opened up a fascinating avenue of research into various issues, including the societal impact of AI and robotics, the consequences of AI adoption on both human and corporate outcomes, and the evaluation of AI-enabled HRM practices. The adoption of these technologies has transformed how work is organized in both domestic and international businesses, offering opportunities for employees and organizations to optimize resources, make decisions, and solve problems. However, despite an increasing scholarly interest in this field, there has been limited and inconsistent research on AI-based HRM technology. There is a need for further investigation to delve into the role of AI-assisted HRM applications and human-AI interactions within major multinational corporations that are at the forefront of implementing these innovations.

The category of personal devices has expanded significantly thanks to the rapid development of wearable technologies. Wearable technology not only boasts cutting-edge hardware technologies, including communication modules and networking capabilities, but it also provides a wealth of valuable data to artificial intelligence [AI] techniques. However, challenges related to wearable device design and development, as well as the computational cost of implementing AI techniques, needs to be addressed in order to fully leverage the potential of this technology.

VI. CONCLUSION

[i] Artificial Intelligence, while still a relatively new trend, has already demonstrated numerous applications with measurable positive impacts. Many of the challenges mentioned can and will be overcome, paving the way for a brighter future in AI.

[ii] Industries and researchers are diligently working to enhance forecast accuracy and develop machine learning-based applications to address a wide array of real-time challenges.

[iii] Recent advancements in AI methods have enabled collaboration between machines and humans for the analysis of complex data sets. The ability of machines to efficiently conduct statistical analysis on vast data sets is truly remarkable.

[iv] Data is sourced from a wide range of channels, and AI is capable of generating plausible explanations and suggestions, aiding in the framing of new hypotheses. It is imperative that society begins to explore ways to maximize the potential of AI in this regard.

[v] AI can extract insights from data from any source and analyze it by employing suitable AI techniques to yield results that enable cost reduction, time savings, new product development, and informed decision-making. It holds the promise of unlocking the untapped potential in numerous fields.

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