Transactions on Engineering and Computing Sciences - Vol. 13, No. 03
Publication Date: May 25, 2025
DOI:10.14738/tmlai.1303.18845.
Vickers, T. & Ketel, M. (2025). Industry 4.0, AI and Big Data: Technological Progress and Ethical Responsibilities. *Transactions on Engineering and Computing Sciences*, 13(03). 76-88.

Industry 4.0, AI and Big Data: Technological Progress and Ethical Responsibilities

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ABSTRACT

Marking a new phase in digital transformation, Industry 4.0—also referred to as the Fourth Industrial Revolution—incorporates advanced technologies like IoT, AI, Big Data, robotics, cloud computing, and cybersecurity to revolutionize production systems, making them smarter, more efficient, and more flexible. The convergence of these technologies offers significant potential to improve efficiency, reduce operational costs, and enhance customization, while also introducing ethical challenges such as privacy breaches, cybersecurity risks, and algorithmic bias. This paper is structured into two parts: the first part explores Industry 4.0 and its associated technologies, including AI and Big Data; the second part examines the ethical implications of these technologies.

Keywords: Industry 4.0, Artificial Intelligence (AI), Big Data, Ethics.

INTRODUCTION

Looking back at the timeline of industrial revolutions, the first originated in Britain in the late eighteenth century [1, 5]. The First Industrial Revolution shifted economies from farming to manufacturing and mechanization. The Second saw the widespread use of electricity and mass production through assembly lines. The Third, or the Digital Revolution, introduced computers and automation technologies. We are now experiencing the Fourth Industrial Revolution or Industry 4.0, where physical systems are integrated with digital technologies. AI and machine learning help automate processes and analyze large-scale data. Big data, which includes vast volumes of information often in petabytes or zettabytes, is examined using Big Data Analytics to reveal patterns and insights that support better decisions [6].

Industry 4.0 was first developed in Germany with a focus on integrating smart technology within businesses [1]. Due to the high demand for evolving and dynamic smart technologies, Industry 4.0, AI, and Big Data, are converging to revolutionize the modern industry. AI analyzes massive datasets generated by smart systems, while Big Data enables real-time insights. Together, they drive automation, efficiency, and innovation across sectors [1, 6].

In contrast to earlier industrial revolutions that emphasized mechanization, electrification, and mass production, Industry 4.0 builds on these advancements by integrating cyber-physical systems, the Internet of Things (IoT), artificial intelligence (AI), robotics, Big Data and analytics, cybersecurity, and cloud computing into manufacturing and industrial systems, with the promise of increased productivity, efficiency, and innovation [1, 2]. The convergence of cutting-edge computing technologies with physical industrial systems is the core foundation of Industry 4.0. While AI, Big Data analytics, cloud infrastructure, and cybersecurity drive the digital side, technologies like IoT, robotics, cyber-physical systems, and automation enhance the physical operations—together powering smart, adaptable manufacturing [3]. However, as these technologies promise efficiency gains and cost savings, they also introduce a series of ethical challenges that need attention. Figure 1 outlines the advancement of industrial revolutions over time [1, 2, 3, 4].

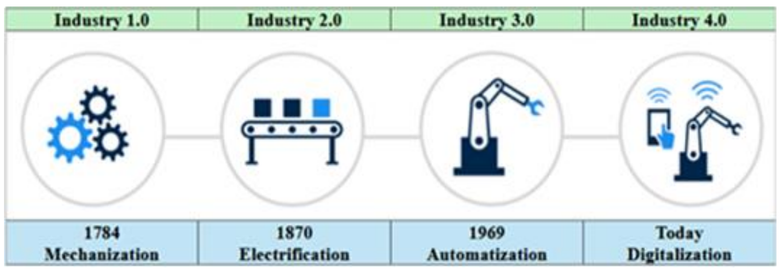

Figure 1: Timeline of the various industrial revolutions

While Industry 4.0 has revolutionized manufacturing through digital connectivity and smart automation, the emerging vision of Industry 5.0 shifts focusses toward human-machine collaboration and sustainable production practices [3, 4]. Industry 5.0 envisions a future where humans and machines work side by side, combining technological efficiency with human intuition, ethical practices, and responsibility for the environment [3, 4].

With all this in mind, however, one cannot help but imagine how ethics tie in with this industrial revolution. Ethics is an important tool for properly evaluating how a new technology or revolution in general affects the wellbeing of humans. Through such an ethical analysis, exploring the applications and methods of AI and Big Data through the context of Industry 4.0, steps can be taken to address the concerns brought forth by the analysis [14].

TECHNOLOGY: FOUNDATIONS OF INDUSTRY 4.0, AI AND BIG DATA

Before the ethics of Industry 4.0, AI, and Big Data can be thoroughly explored, a summary regarding the principles and components of Industry 4.0 along with the applications and techniques/methods of AI and Big Data must be addressed.

Industry 4.0

The smart devices and operations which encompass Industry 4.0 may fall into one of five layers based on [1].

(1) The device layer encompasses smart devices, industrial tools, and other technologies which are physically managed, forming the foundation of the Internet of Things (IoT) ecosystem.

(2) The edge layer gathers and stores the data generated by these machines through traditional data storage systems and industrial gateways, acting as a bridge between the physical and digital realms.
(3) The cyber layer then takes over by managing this stored data using various web services and handling the networking operations that enable communication among multiple devices.
(4) Building upon this, the data analytics layer employs a range of machine learning and deep learning algorithms to extract insights and perform advanced analytics on the collected IoT data.
(5) Finally, the application layer utilizes these analytical results for various purposes, translating data-driven intelligence into actionable outcomes across different domains.

The main components or technologies [1, 2, 3, 4], highlighted in bold font, of Industry 4.0 framework are summarized below:

Industry 4.0 represents a paradigm shift in how industries operate, driven by a suite of advanced technologies that enhance efficiency, productivity, and innovation. IoT connects physical devices to the Internet, enabling them to collect and share data, which enhances real-time decision-making and improves operational efficiency. AI and Machine Learning (ML) analyze vast amounts of data to optimize processes, predict trends, and automate decision-making, making operations smarter and more adaptive. Big Data and Analytics processes large datasets to extract actionable insights, while Cloud Services provide the infrastructure for scalable storage, computation, and collaboration, making it easier to access advanced analytics and run global operations seamlessly. Additive Manufacturing (3D Printing) manufacturers can quickly produce custom-designed components, cut down on material usage, and streamline the prototyping process. Augmented Reality (AR) overlays digital information onto the physical world, improving training, maintenance, and operational efficiency. Robotics and Automation streamline manufacturing and logistics processes by performing repetitive or hazardous tasks with high precision and speed, increasing productivity while minimizing human error [13]. Digital Twins provide real-time virtual models of physical systems to enhance operational efficiency [7]. Blockchain enhances Industry 4.0 by providing a secure, transparent, and decentralized framework for managing data and processes across industrial systems [8]. Finally, Cybersecurity is critical to protect the interconnected systems and sensitive data in the digital ecosystem of Industry 4.0, safeguarding operations from cyber threats. The integration of these technologies creates more resilient, agile, and data-driven industrial environments, offering companies the ability to innovate and maintain a competitive edge in an increasingly interconnected world. Figure 2 presents the key technologies that define Industry 4.0.

Figure 2: The Components That Define Industry 4.0

Two other major concepts of Industry 4.0 are the Industrial Internet of Things (IIoT) and 5G.

The Industrial Internet of Things (IIoT) is a subset of IoT that requires enhanced safety, robust security, and reliable communication to ensure real-time performance in mission-critical environments. IIoT extends the capabilities of IoT to industrial domains and consists of smart, interconnected industrial devices and components. Through these connections, various solutions can be implemented, including those associated with the five layers [1] mentioned in the Technology section.

5G is a key enabler for the continued advancement of Industry 4.0, as it supports the high-speed, low-latency communication necessary for the vast array of technologies that make up the modern industrial landscape [9, 10]. 5G is the connection standard for Industry 4.0's IoT. The specific services 5G provides for Industry 4.0 are high reliability, reduced latency, improved device density, ease of deployment and enhanced security – based on the chart of reference [1]. 5G also facilitates stronger and faster communication with AI and Big Data, allowing for the use of both different solutions and applications when it was far more difficult before [1].

Artificial Intelligence (AI)

AI has been a defining, growing and ever-evolving concept for Industry 4.0, with many industries utilizing it to reduce costs, improve quality control and increase overall productivity. This section will go over the various applications and techniques for AI, as well as how datasets play a part [1, 6, 11, and 12].

Applications:

- Predictive Quality and Maintenance: Predictive Quality, or Quality 4.0 when referencing Industry 4.0, is relatively straightforward. Through the collection of quality data and the use of data analytics, AI can effectively predict quality and yield and improve customer value and quality management. This is done through the cycle of establishing a baseline, monitoring performance, analyzing this data, and adjusting future predictions [1]. Predictive Maintenance works similarly, where the AI monitors the performance and reliability of machines and uses this collected data to perform maintenance in advance. Under more conventional methods, such as cloud and fog computing, a failure rate of around 6.6%, based on [1], has been noted. This has been addressed however, and various methods can be implemented to reduce the delay and risk of failure, such as utilizing blockchain services and partitioning mechanisms [1].

- Smart Manufacturing: According to [1], Smart Manufacturing is the process of real-time decision-making (prediction and adaptation) to changes within the factory and supply chain, along with customer requirements. [1, 11, and 12]. There are four main approaches brought forward by [1]: agent-based architectures, digital twins, additive manufacturing, and reference models developed using information communication technology. Agent-based architecture involves the use of agents to reduce complexity. Digital twin models have a more flexible approach and automate manufacturing [7].
- Robotics: Robotics and AI combine to create a powerful tool in automation. It is already a well-established concept in smart industries – already utilized with a strong emphasis on expanding use throughout the industry [1, 13]. There are several applications of robotics presented in [1], those of which include assembly and manufacturing, packaging, and production task scheduling. AI with the use of machine learning techniques has greatly enhanced robotic capabilities in manufacturing and assembly, especially regarding more sophisticated processes, such as chip assembly. Robots performing packaging tasks can also be greatly enhanced with AI, resulting in faster and more accurate movement. Production Task Scheduling enhanced by AI can provide for more fluid robotics scheduling as opposed to the traditional, more rigid approach of fixed robots in an assembly line [1, 13].
- Generative Design: Generative design involves the process of AI designing prototypes or other objects based on the specifications of the user. Prototypes could, after generation, be scanned and evaluated, where the design process can continue based on the evaluation [1].
- Market Adaption: Industrial AI is largely responsible for the integration of market adaption and the supply chain for business planning and design [1, 12].

Techniques:

- Traditional Machine Learning: Traditional AI and machine learning have been the standard for Industry 4.0. Traditional algorithms and classifiers such as Logistic Regression have been utilized for many different applications. One use case [1] specifies is monitoring the performance of an air conditioning system using both regression and RF classifiers [1, 6, 11, and 12] Machines trained through traditional machine learning will always experience faults to some extent, and time can be an issue. However, effort has been made to mitigate these downsides through various countermeasures [1]. Machine learning is heavily encouraged and tied to the use of predictive maintenance, with industries utilizing several ML techniques and methods. For example, regular gradient boosting, and extreme gradient boosting have been used to predict the probability of failure in select machines. Planning and task management also use traditional ML techniques, along with smart manufacturing utilizing algorithms such as

KNN and SVN. Neural networks have also been utilized, though that is technically deep learning [1, 6]. Task scheduling and management has also utilized traditional ML methods for increasing efficiency, along with being used for industrial prognosis, or the estimated lifetime of a machine [1].

- Deep Learning: Reference [1] goes into great detail over several examples of deep learning techniques being utilized. This section will go over a select few of them with a more general approach. [1]. Deep Learning techniques have been proposed for use in recommendation and predicting machine failure. In a more specific example, deep learning has also been used for augmented reality, or AR. Already-existing models and frameworks such as MobileNet and Deep-Q-Network have been used in tandem with this solution. The deep learning H2O framework has been proposed as a bedrock for cloud computing and analytics [1, 6].

Datasets:

- Production: Datasets based on manufacturing processes are regularly used for training AI to maintain precise and reliable manufacturing processes. For example, one use case presented in [1] illustrates how, by using over 200 use cases regarding supply chain innovation, a group of authors were able to customize services for their customers. [1]
- Cyber-Physical Systems: Cyber-Physical Systems datasets, or CPS, focus on security solutions – AI would be fed these datasets to address and prepare against cyber threats. A few specific techniques an AI would learn through CPS would include inclusion detection, general safeguarding, and the ability to differentiate between a threat and a benign action [1]. A more specific example of this learning process is where one author mentioned in [1] used a dataset which contained 37 system scenarios wherein 28 were attacks, while the other 9 were either benign and normal events or not an event at all [1].
- Images: Artificial Intelligence is trained on datasets when its purpose includes detection, recognition and/or classification of visual stimuli. Training involves many images, with one example mentioned in [1] citing that 11,000 images were used to train an AI to recognize and classify diverse kinds of industrial tools. Another example utilized exactly 18,106 images of steel to train artificial intelligence to identify defects in steel [1].
- Text: A major application of using text datasets to train AI is sentiment analysis – analyzing how consumers feel about a business or organization's product, service, etc. E-commerce sites and social media sites are popular sources for these data sets. One example would be Amazon evaluating customer feedback and reviews. Twitter has also been used as a source for data sets, where tweets containing sentiments over Industry 4.0 have been collected and classified as either a neutral sentiment, positive sentiment, or negative sentiment [1]. One example not related to sentiment analysis that [1] mentioned is using a dataset relating to job advertisements – the AI would be fed data which would allow it to discern and identify specific skills and knowledge depending on the industry [1].
- Surveys: Like text datasets, survey datasets are used to gather and analyze feedback. However, the data within surveys tend to be more structured than with open text responses and tend to be from more professional sources. One use case presented in [1]

is one in which cluster analysis was utilized to analyze a dataset originating from 92 distinct industries. This was used to evaluate how supportive technologies are used in modern industries [1].

Big Data

As mentioned in [1], Big Data plays a large role in extracting insights within smart industries. It is technically part of the 10 driving technologies of smart industries in general, and to define Big Data means to illustrate the 8V's of Big Data: volume, variety, value, velocity, veracity, variability, validity, and visualization. In this next section, the applications and methods of Big Data are summarized.

Applications:

- Smart Manufacturing: By learning through data, robotic systems can improve sustainability in the industrial sector via models, simulations, and mapping. In one solution mentioned in [1], a hybrid simulation tool was proposed using an object-oriented simulation along with mapping data from different machines and modeling tools [1, 2]. A major application of this is early fault detection, with one proposed solution being the DPCA model. In a more concrete application, big data was implemented in a candy factory, where it became possible to provide personalized packaging [1, 2].
- Additive Manufacturing: As mentioned previously, additive manufacturing is focused on fast and low-cost production of on-demand products with the ultimate result of less waste and energy consumption. By using ML and DL techniques with big data, AI can predict the costs of various products [1]. One solution that has been proposed and developed involved using IoT devices to continuously collect data to implement smart logistics to a warehouse [1, 5].
- Product/Machine Design: Design has slowly but surely been handed to AI, with human designers acting more as supervisors or managers for AI. By using insights extracted from historical data, AI can help develop risk-assessment and generating precursors, as well as optimization [1].
- Critical Analysis: Big data allows for critical analysis of a business, which can be applied to many distinct aspects. For example, a model supported by ANN (Artificial Neural Networks) was developed to analyze performance and sustainability, while another example was used to put forward smart manufacturing [1]. Security and data privacy are also popular applications of critical analysis, where systems would be guarded against cyber-attacks [1].
- Advanced Information Management: Through the use of data analytics – specifically regarding machine usage, resource sharing and sustainability – will help to bring a level of intelligence and sustainability to systems, making way for smart manufacturing [1].
- Risk Analysis: Risk extraction through the use of AI has led to more efficient and timely extraction of specific information through Big Data. Risk management is also improved, through real-time implementations, specifically regarding mitigation, capture, and evaluation [1]. Risk analysis with the use of Big Data, despite its upsides, has led to the consequence of demanding more sophisticated tools and knowledge, along with AI integration for proper analysis of qualitative and quantitative data [1].

Methods:

- Descriptive: Descriptive analytics, or analysis and interpretation of historical data, involves the identification of various attributes, such as strengths and weaknesses, for a business within the decision-making process. Data collection also plays a part in descriptive analytics, the two main techniques being data aggregation and data mining. Metrics generated by businesses are usually developed and generated via descriptive analytics, such as changes in the growth of the company, cost fluctuations and customer metrics [1]. It has also proven to be a valuable method with the integration of Industry 4.0 technology, with one solution mentioned in [1] resulting in smart process planning [1].
- Predictive: Predictive analytics deals with predicting various outcomes and events based on historical data. Future event detection is particularly useful regarding machine failure, future costs, maintenance, inventory, the behavior of machines, etc. [1]. One example addressed in [1] involves the use of predictive analytics for energy and transportation, specifically regarding maintenance management.
- Prescriptive: Prescriptive analytics is the natural progression from predictive analytics – while the former simply predicts future events, the latter uses those predictions to decide and follow through on actions influenced by those predictions [1].

The Relationship Between AI and Big Data:

AI and Big Data are intrinsically linked within the context of Industry 4.0. Big Data especially is needed due to the high data requirements of AI – machine learning and deep learning methods both utilize Big Data to first extract patterns within the data and integrate sophisticated decision-making and predictive capabilities. Together, Artificial Intelligence and Big Data form the backbone of digital transformation, continuously evolving to reshape industries—particularly in modern manufacturing and industrial systems [1, 2, 5]. Figure 3 shows the relationship between Big Data and AI and the combined impact.

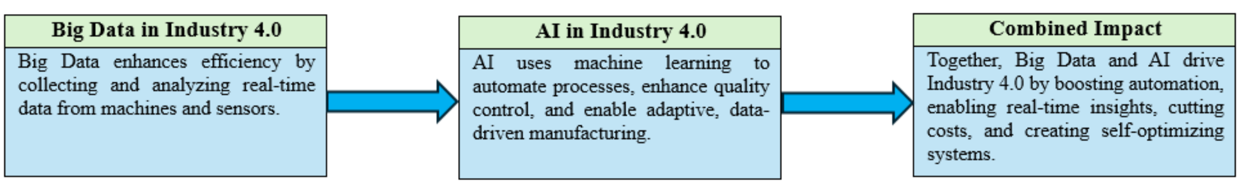

Figure 3: The Illustrated Relationship Between Big Data and AI

ETHICAL IMPACTS OF INDUSTRY 4.0, AI, AND BIG DATA

The ethics of Industry 4.0, AI and Big Data are incredibly dense and varied. In this second part, we will first focus on the general ethical concerns of Industry 4.0 in relation to the concepts illustrated in the technology section before delving into more specific discussions of the ethics of Artificial Intelligence and the use of Big Data.

Several studies have addressed the ethical and moral challenges associated with Industry 4.0 technologies such as AI, Big Data, IoT, and automation [14 -19]. In reference [14], the authors explore these challenges in depth, analyzing their implications for various stakeholders, including workers, companies, and society at large. Article [15] highlights ethical and privacy concerns in emerging technologies, particularly AI and Big Data, and calls for strong regulations and ethical standards to guide their responsible use. Article [16] offers a comprehensive examination of the ethical challenges posed by AI, aiming to provide a systematic overview for researchers and practitioners. Article [17] discusses the responsible use of Big Data in manufacturing software, focusing on the ethical challenges and considerations in data collection and analysis. It emphasizes the need for ethical data practices to ensure privacy, security, and fairness in manufacturing operations leveraging Big Data technologies. Article [18] explores the ethical implications of AI in manufacturing, while article [19] addresses ethical concerns in the use of Big Data and analytics.

Industry 4.0

Industry 4.0 is comprised of many different components and concepts, as mentioned in the technology section. However, the main tenants of Industry 4.0 are automation and connectivity [14]. Automation can extend concerns over human involvement in smart industries, such as replacement. Connectivity is inherently tied to privacy, or the lack thereof. Various components are defined by connectivity, such as cloud, digital twins and sensors, along with the entirety of the five layers of Industry 4.0. The inherent connectivity within and between the layers is what makes such a model possible [1, 14]. To better illustrate the ethical concepts behind Industry 4.0, the diagram presented in reference [14] will be described and analyzed.

The Ethical Framework:

Surrounding the nucleus of Industry 4.0 framework are several familiar concepts already presented in detail through [1]. These include Big Data, IoT, the Cloud, Smart Manufacturing, Autonomous Systems, and CPS. The ethical concerns connected to these concepts, along with an interpretation of these concerns, are summarized in Table 1, [14].

Table 1: Ethical Concerns and the Industry 4.0 Components That Are Most Affected

Considerations	Industry Component	Description
Anonymity	Big Data, Sensors	Anonymity could be seen as an antithesis to Industry 4.0; this does not necessarily have to be the case. Sensors and general connectivity, as well as data collection, require an open, naked perspective to gain adequate data. Anonymity, in this case, would be nonexistent. Measures should be taken to ensure some level of anonymity based on the purpose of connectivity and data collection.
Privacy	Sensors, AI, Cloud Services	The lack of anonymity could result in a potential risk to privacy, along with the sheer amount of data collected. This data collection could be entirely benign – for example, storing and updating important medical records – however, this data is a valuable resource that could be exploited if this data is not properly secured.
Transparency	All Components	Transparency in this context means providing clear and easily understandable information from systems. This is relatively straightforward – transparency allows for

		responsibilities and tasks to be easily followed and understood.
Accessibility	Cloud Services, Additive manufacturing	Accessibility is an important concept that encompasses ethical considerations for technology in general. However, with the growing complexity of technology and usable systems, considerations must be put forth to ensure that all people are able to use this technology appropriately and safely. This is essential especially with cybersecurity, which can be directly tied to the wellbeing of users.
Cybersecurity	Cybersecurity Operations	Cybersecurity is more important than ever with large amounts of data and high connectivity being the two largest aspects of Industry 4.0. In fact, high connectivity is partly why cybersecurity is so dangerous – physical constraints are not a variable to be considered. This could lead to distrust of businesses and organizations unless cybersecurity is properly implemented and updated.
Misuse	All Components	Due to the sheer volume, complexity, and sensitivity of data being collected on top of the ease-of-use Industry 4.0 tries to strive for, misuse of said information is a large ethical issue within Industry 4.0. Steps should be taken to properly regulate the use of data to prevent harm.
Surveillance	Big Data, Sensors, Cloud Services, AI	Surveillance is also an underlying issue with smart devices, particularly smart assistants. Surveillance without knowledge or consent is both a real, concrete issue even outside of professional, industrial settings. Smart assistants, for example, are constantly listening for commands, as well as gathering some level of information from their owners.
Ownership	Big Data, AI	The process of both collecting and utilizing data has developed several questions regarding the state of ownership with that data. Data can come from a myriad of sources, from social media to studies to data from public domain. The debate of where ownership should be placed and how to enforce that ownership – to the ones gathering the data, the individuals who generated that data, or the public domain – is ongoing.
Bias/Discrimination	Big Data, AI, Cybersecurity Operations	Big Data and AI are completely dependent on what data is being stored and utilized. If the data is biased, inaccurate or incomplete, the AI will produce likely biased, inaccurate or incomplete results. This could create tremendous waves throughout smart industries, negatively affecting every individual and technology closely dependent on that AI.

Artificial Intelligence (AI)

Artificial Intelligence is no stranger to ethical considerations and debates [15, 16, 18]. The ethics of AI have been argued over for many years. In the context of Industry 4.0, many concerns can be extracted from both its applications and its methods.

Machine Learning and Deep Learning:

For example, all learning, both traditional machine learning and deep learning, require vast amounts of data. As mentioned within Industry 4.0 Ethical framework, the gathering and utilization of data holds many considerations along the way, from extraction to feeding into the AI. Predictive quality yield and maintenance depends on both surveillance to some extent and sensors in general.

One major consideration for machine and deep learning is the concern of 'bad data', or data which is biased or otherwise inaccurate [14]. Many applications of machine and deep learning depend on good data, such as predictive quality yield and maintenance and market adaption. Feeding bad or incomplete data to this AI could result in catastrophic consequences such as lowering public opinion, loss of money, and loss of time spent attempting to filter and gather good data for the AI to use [14, 16, 18].

Cybersecurity as an ethical consideration is actually one deeply considered within Industry 4.0 and is one of the main components within the industry [14]. As referenced in Part I, Artificial Intelligence can be used to provide faster and more efficient cybersecurity for users.

Generative Design:

Generative design, while helpful, can also raise questions regarding both humans being potentially replaced by AI, along with the ownership of the designs the AI generates. Ownership could go a number of different ways, from the company to the developer of the AI to the supervisors who choose what design to fully implement. There is no concrete answer to these questions, and regulations or rules should be put in place to provide a more transparent view of ownership [14, 16].

Big Data

As a partner to artificial intelligence regarding creating powerful smart technologies, Big Data shares many of the same ethical dilemmas while expanding on others [17, 19].

Datasets:

As mentioned in the technology section, there are different types of datasets, each with similar and distinct challenges. Text datasets can be particularly troublesome when discussing ethics, as these datasets are usually from reviews and sentiments on social media [14, 17]. While privacy may not be an issue, and anonymity can be kept intact depending on the purpose of the data extraction, the question of ownership resurfaces. Along with ownership, an ethical question of compensation also arises: if the owners are in fact the writers (generators) of the data, how should they be compensated, if they should be compensated at all?

This question also arises with images. Image datasets may be completely generated by the company or organization who will use the dataset for further machine and deep learning [14]. However, one popular argument that has been observed recently is companies using images and art found online to feed their AI. Privacy, knowledge and consent, anonymity, and the question of ownership are heavily debated ethical topics in that regard [14]. AI art generators give yet another layer of complexity to this debate, as individuals who are separate from both the developers and the original generators of the art are able to upload art into the AI for unique generation. Are the original owners still the artists who produced the art? If so, should they be compensated, or at the very least be notified if their art is used for AI?

Analytics, Bias and 'Bad Data':

The Big Data process of descriptive, predictive, and prescriptive analytics puts forth the troubling ethical issues of bias, misuse, and surveillance [14].

The process acts as a pipeline: data is first gathered and analyzed, which then helps to generate predictions, which are then used to formulate plans of action. If the data is already biased or unreliable, the entire process is poisoned unless careful evaluation at the descriptive stage is performed [14, 19].

Misuse of Big Data via this process is also something to be considered – data is inherently important, valuable information after all. Data plucked from the descriptive analytics stage could be used for any number of interests if use is not regulated properly [14].

This is also true for surveillance. Ethical questions regarding data collection have already been addressed previously, however surveillance is a more critical subgroup of that. Gathering data from surveillance, through the use of smart home devices or otherwise, is a real, probable issue [14, 15, 17]. When performing data analytics, further regulations should be developed and enforced to protect privacy and maintain knowledge and consent of data collection.

CONCLUSION

Industry 4.0 is an industry that is inherently rife with ethical questions and considerations. Through the summarization of how AI and Big Data are used within Industry 4.0, as well as analyzing those applications and methods using the cited ethical framework, a few conclusions could be gleaned. Before ethical conclusions are reached, the importance of AI and Big Data with Industry 4.0 should be emphasized. Artificial Intelligence is imperative to the processes of the fourth industrial revolution, allowing for smart devices, automation and more efficient analysis and industrial processes. Big Data powers AI to handle large amounts of data, allowing for more faster and efficient learning processes and applications.

The nature of Industry 4.0 is innately tied to concerns over security, privacy, and data usage. Technology is moving incredibly fast, and progress will not stop. The law needs to keep up with technology – Industry 4.0 deals with information that, both via the means and the content, can be unethically gathered, stored, and utilized in a variety of ways. Regulations must be regularly updated, and cybersecurity should be considered a priority along with innovation.

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