Innovating the automotive industry with Artificial Intelligence

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Abstract

The aim of this study is to investigate the application of the artificial intelligence in the automotive industry and to critically examine its impact in the innovation and to provide a response to the following question: How has the AI impacted the automobile sector, and what are the potential consequences for contemporary society?

Methodology:

Various biases of AI have been studied to discover the innovation brought to the automotive industry by Artificial Intelligence. A systematic review of literature approach has been followed using data obtained from a variety of expert-led projects and reports from interested organizations. Analysis of the data engages triangulation during which all the available information are merged to form a conclusion.

Artificial intelligence brings an enormous amount of innovation to the auto industry and in some parts it even revolutionizes the way the industry's manufacturing processes and business. However, if AI is implemented in an unbalanced manner, it will wreak havoc on humans.

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1. Introduction

The Merriam Webster dictionary defines the word innovation as “a new idea, method or device”, “a novelty[1]”, “the introduction of something new”.

Innovation is synonymous with the automotive industry. The fact that this industry has produced until now billions of vehicles in many forms with reliable performance while at the same time constantly upgrades its products with new characteristics and incorporates new technologies is by itself the proof for the aforementioned argument.

Since the automotive industry is so keen to introduce new technologies it is only natural that it would turn its attention to a new technology that it’s becoming more and more available in the recent years: the Artificial Intelligence.

The term "Artificial Intelligence" (AI) refers to a machine's capacity to learn, reason, perceive, and create. Initially considered to be unique to humans, these abilities have been duplicated and are now used in practically every business.

Artificial intelligence is the use of computer science programming to replicate human cognition and activity by analyzing data and its environment, solving or predicting issues, self-teaching or learning and adapting to a range of activities. AI has the ability to relieve humans of several tedious tasks rather it can do far complex tasks more accurately as it helps in the construction of mega structures and roads.

This thesis aims to critically examine the innovation created by the application of the Artificial Intelligence in the automotive industry by examining the advantages and the shortcomings it brings to the industry.

[1] Further defined by Merriam Webster Dictionary as something new or unusual.

2. Artificial Intelligence

2.1 Historical background of Artificial Intelligence

Turing's work "Computing Machinery and Intelligence," is credited with establishing the field of artificial intelligence (AI). Turing, a well-known mathematician and computer technology pioneer posed the issue of whether computers could ever think. Turing's answer to the matter was negative. In response to this he devised what he termed the "imitation game" claiming that the subject was too broad in scope.

He described separating a computer from a man in one room and a man from another in what is now known as the "Turing test." The person would query if he was speaking with a computer or a human being. Turing suggested that a machine may someday be designed to reply indistinguishably to inquiries as a person would. Does this, however, mean that the computer is capable of thinking? Turing indicated that the point is open for debate. (A.M. Turing, 1950)

In contrast to Turing's paper, which encourages thought, the phrase "artificial intelligence" was first used in 1955 in relation to a Dartmouth College (USA) discussion. The event's organizers argued that "any feature of learning or any other characteristic of intelligence may be sufficiently well-defined to be replicated by a computer." (J. McCarthy and N. Rochester, 1955). This was an exceptionally provocative statement at the time but it is unclear if anything worthwhile came out of the conference as there was never a definitive report given. (Jerry Kaplan, 2016).

For most of the 1960s and 1970s, researchers were confident that symbolic techniques would one day enable the building of a computer capable of artificial general intelligence, which was considered the ultimate objective of the discipline. Herbert Simon predicted that "within twenty years, machines would be capable of executing every work capable of being performed by a man." Marvin Minsky agreed, stating that "within a decade, the task of generating 'artificial intelligence' will be significantly solved." Minsky was a titan in the field of artificial intelligence. He contributed significantly to the development of the symbolic method, which encompassed high-level conceptual representations of logic and reasoning

In the years thereafter, achievements in AI research have been distinguished by distinct periods of boom when the anticipated improvements fueled funding surges and bust when the discipline fell out of favor with government and industrial patrons as those expectations failed to materialize.

Significant advances in artificial intelligence research and development (R&D) took place in the late 1990s and the pace of growth accelerated in the years afterwards. Perhaps the most well-known example of this took place in 1997 when IBM's Big Blue artificial intelligence system beat the former world chess champion Gary Kasparov in a six-game tournament organized by the firm.

In 2016, the Alpha Go system developed by Google DeepMind defeated Lee Sedol, the world's top-ranked Go player, by a score of four games to one. (BBC News, 2016). This was a significant improvement in capabilities, not just a modest one.

To understand the importance of the technological achievement of the Alpha Go system in comparison to the Big Blue’s one must compare and realize the complexity of the two board games. Chess has 20 possible beginning moves per side and 10^{120} total board combinations while Go has 361 initial moves per side and 10^{170} total board configurations. This breakthrough indicates a vast change in the way progress has been treated in recent years, and it is a quite significant achievement. (Danielle Muolo, 2016).

2.2 Artificial Intelligence algorithms

2.2.1 Algorithms distinction

Artificial Intelligence is heavily reliant on the operation and reading of its algorithms which are characterized as either supervised or unsupervised. The distinction between the two lies in their method of learning.

Supervised algorithms begin with a test dataset and continue to improve until they achieve the desired degree of confidence. Anomaly detection, classification, regression and dimension reduction are some of the classification and regression techniques.

Unsupervised algorithms are responsible for making sense of the data that is provided. In other words, an algorithm makes a connection inside an existing data set. It either identifies patterns or splits the data set into subgroups based on their similarity. Unsupervised algorithms may be subdivided into two categories: clustering algorithms and association rule learning algorithms. (Berrada J., 2017).

However there is a new family of machine learning algorithms called reinforcement algorithms which are intermediate between supervised and unsupervised learning in terms of their complexity. When using supervised learning each training example includes a target label. When unsupervised learning is used no labels are used however when reinforcement learning is used, sparse and time-delayed labels are used.

The goals of reinforcement learning is to build effective learning algorithms and to get a knowledge of the advantages and disadvantages of each method. As a result of the breadth and depth of possible applications, reinforcement learning is becoming increasingly important.

2.2.2 Algorithms categories

Algorithms for machine learning are divided into four broad categories: regression algorithms, pattern recognition algorithms, cluster algorithms and decision matrix algorithms. Regression algorithms are the most common kind of machine learning algorithm. A single class of machine learning algorithms may be used to achieve two or more unique subtasks, each of which requires a different method. For example a regression approach may be used to identify and track moving objects and to localize and anticipate their progress (Anshul Saxena, 2016).

2.2.2.1 Algorithms for Regression

This sort of algorithm is quite effective at forecasting occurrences. Regression analysis is used to discover the connection between two or more variables and to analyses the influence of variables measured at multiple scales. It is driven largely by three metrics:

- Independent variables count
- The dependent variables' kind
- The regression line's form.

Regression algorithms take advantage of the repeatability of the environment in order to develop a statistical model of the link between a photograph and the location of a certain item inside the photograph. By allowing for photo sampling, the statistical model may be learned offline, allowing for speedy online detection and identification. Furthermore, it is extensible without requiring considerable human modelling.

Additionally, these algorithms may be utilized for both long-term learning and short-term forecasting and prognosis. These algorithms, along with Bayes regression, neural network regression, and decision forest regression, are all examples of regression algorithms that might be employed in autonomous vehicles to increase their safety and efficiency. (Holstein T, 2017).

2.2.2.2 Algorithms for Pattern Recognition (Classification)

In advanced driver assistance systems, photos taken by sensors include a range of environmental data; filtering the images is required to detect occurrences of a certain item category by removing unnecessary data points from the images. Pattern recognition algorithms are quite good at identifying and rejecting these outlier data items. Determine patterns in a data collection before categorizing the elements in the data collection. These are referred to as data reduction algorithms on a number of occasions.

These approaches help in data reduction by recognizing object edges and fitting line segments (polylines) and circular arcs to the edges of the objects they are recognizing. After reaching a corner, the line segments are re-aligned to the edges and a new line segment is begun. Circular arcs are created by fitting a number of line segments around an arc's diameter. The visual features (line segments and circular arcs) are combined in a variety of ways to provide the basic attributes for object recognition.

2.2.2.3 Clustering

In image recognition at times the system's sights might get hazy which makes it difficult to differentiate and locate items. Additionally, the classification algorithms may miss the item, categorizing and reporting it to the system as unclassifiable. This might be due to low-resolution images, a small data size or inconsistent data. This approach works well for deducing structure from data points. As with regression, it enumerates issue and approach classifications.

Clustering techniques are frequently categorized according on their modelling approaches, which include centroid-based and hierarchical clustering. All techniques are concerned with exploiting the underlying structures in the data in order to group the data into groups with the highest degree of similarity. The K-means, Multi-class Neural Network algorithm is the most often used algorithm type. (Anshul Saxena, 2016)

2.2.2.4 Decision Matrix Algorithms

This kind of algorithm is particularly adept at finding, assessing, and rating the performance of connections between collections of variables and data. These algorithms are primarily used in decision-making processes. The algorithms' degree of confidence in the classification, identification, and prediction of an object's impending activity determines whether a vehicle should perform a left turn or stop. These algorithms are constructed of numerous separate decision models whose predictions are integrated in some way to get the final forecast while minimizing the potential of decision-making mistakes. Gradient boosting (GDM) and AdaBoosting are the most often utilized approaches.

2.3 Artificial Intelligence applications in today's society

Artificial Intelligence is no longer just a technological advancement but it is slowly but steadily becoming a part of our everyday life. New advancements are produced every day in various sectors of human endeavor, from politics to economics to science and technology to medicine. Thus, artificial intelligence-based technologies have already had a considerable impact on different elements of everyday life all over the world as a result of this development.

One sort of artificial intelligence that is rapidly penetrating the homes of the majority of consumers is the voice assistant, which includes Apple's Siri, Amazon's Alexa, Google's Assistant, and Microsoft's Cortana.

Sophia, Hanson Robotics' most advanced humanoid robot, embodies public optimism in the future of artificial intelligence. As a framework for cutting-edge robotics and artificial intelligence research, Sofia is particularly focused on human-robot interactions and their possible applications in the fields of service and entertainment. (David Hanson, 2020). Sophia is being advertised as a "social robot" capable of emulating human behavior and evoking human love feelings. The computer's artificial intelligence analyses conversations and gathers data that enables it to provide more accurate future responses.

Figure 1: Sophia the robot

Similarly, Amazon's Alexa virtual assistant is more quickly than any other helper at learning and may also command a large number of smart devices via a home automation system. When it comes to smart home gadgets, Alexa often takes a few weeks to become comfortable with its owner's habits. Alexa uses cloud-based artificial intelligence technology to create a profile of its customers' behaviors, with regard to time of day, weather patterns, and even the change of season.

Numerous instances of how artificial intelligence is pervading everyday life include cellphones and mobile mapping and navigation systems, natural language interaction with computers, targeted internet marketing, and customized information campaigns on social media.

Academically, AI is also employed. For example, AI tutors enable students to receive one-on-one support. They have been demonstrated to help children who get tutoring from tutor labs or human tutors cope with strain and stress. Additionally, instructors may use AI to aid them in early prediction of student achievement in a Virtual Learning Environment (VLE) such as Moodle. Especially during the COVID-19 pandemic, learning activities must be conducted online to avoid the virus spreading via direct contact (Seo *et al.*, 2021).

The fast advancement of AI is creating new potential to improve their performance in the transportation industry as well. When used to the transportation industry, artificial intelligence has the potential to solve problems like as travel demand growth, carbon dioxide emission, safety problems, and ecological deterioration. Addressing such difficulties more efficiently and effectively in the digital age has become more imaginable due to the availability of huge quantities of quantitative and qualitative data, as well as the use of artificial intelligence.

An in-depth knowledge of the interactions between artificial intelligence and data on the one hand, as well as the characteristics and aspects of transportation systems on the other, is required for the successful use of artificial intelligence in transportation systems. As a result, it is crucial that the transportation authorities learn how to effectively use these technologies in order to relieve speed congestion, enhance the reliability of their customers' journey times and to increase the finances and profitability of their essential resources. (Rusul Abduljabbar *et al.*, 2019).

Cognitive processes govern AI systems and of itself, capable of repeated self-development, leading in an intellect expansion far beyond human intelligence. The emergence of new transformative technologies, such as superintelligence, has the potential to enable humanity to erase conflict, sickness, and shortages. As a result, the emergence of powerful artificial intelligence may prove to be a watershed moment in human history.

Numerous technocrats envisioned the necessity for superintelligence to ensure one's life (Bill Hibbard, 2001). Artificial intelligence is growing at a dizzying pace, from SIRI, Apple's virtual assistant, to autonomous vehicles. While artificial intelligence (AI) is generally depicted as having human-like characteristics associated with robots in science fiction, AI may take the form of anything from Google's search engines to IBM's Watson to autonomous and self-governing weaponry.

Moreover, AI-powered weapons require less manpower and can help cut military expenditures but at the same time they can be more destructive and precise in terms of locating and striking their targets.

2.4 The future of Artificial Intelligence

Artificial intelligence has already shown its use in today's technologically advanced environment. AI has spurred economic development in recent years and as more money and talent enter the area, it is reasonable to anticipate further increase in its growth and development. To this day, businesses and academic institutions have been at the forefront of artificial intelligence research.

Nowadays, Artificial Intelligence is referred to as restricted or weak AI owing to the fact that it is trained to do a certain task (like only facial and gesture recognition or only crawling over the internet or only driving a vehicle). However, the bulk of computer scientists' main long-term goal is to develop general artificial intelligence (known as AGI or strong AI). However, general Artificial Intelligence would surpass humans in all intellectual skills, weak AI would outperform humans in a limited set of tasks, such as chess or mathematics. (J. F. Bonnefon and A. Shariff, 2016)

The number of artificial intelligence-based applications is expected to grow in the future, according to experts. The popularity of self-driving vehicles and other forms of autonomous robotic technology is expected to grow even further as the technology becomes more widely accepted and integrated into society. These robots may eventually aid humans at work and in daily life by doing dangerous tasks and assisting in sectors such as medical, caregiving, security, construction and industry.

3. Artificial Intelligence in the automotive industry

3.1 Introduction

Historically, the automotive production was dominated by manufacturers of the internal combustion engines with support from component manufacturers, technology providers and others. Numerous market forces such as the expansion of electric vehicles and the power of digital connectivity have paved the way for new entrants to the automobile industry.

While Artificial Intelligence (AI) is being implemented fast in a variety of industries however its use in the automobile industry is now a hot topic of discussion. In terms of adoption and use the automotive industry is a 'new adopter' of AI technology.

At the same time as every manufacturer is rushing to create artificial intelligence and self-driving technologies a plethora of technology businesses and startups are working towards the same goal. While many people feel that self-driving cars represent the future there are a variety of ways in which artificial intelligence and machine learning are being incorporated into the design and operation of automobiles today.

Machine learning and artificial intelligence are being incorporated into all phases of the automobile manufacturing process at this time, including the design phase as well as supply chain management, manufacture, and post-production. Artificial intelligence is also being linked into systems that provide "driving assistance" and "driver risk assessment," which is completely changing the transportation industry. (Maria Yatsenko and Vadym Zh, 2021).

As a consequence of the introduction of artificial intelligence, aftermarket services such as predictive maintenance and insurance are also changing. Artificial intelligence is being deployed at a slower rate in the vehicle industry than it is in the financial services, information technology, retail and healthcare however it has applications throughout the automotive value chain. For example, with the assistance of artificial intelligence, robots are coexisting with humans and acquiring automobile manufacturing abilities (design, part manufacture and assembly).

When a typical person gets in the driver's seat, the AI programme rapidly recognizes his presence and adjusts the seat, mirrors and even the temperature. The AI application can recognize and rouse the driver based on the driver's head position and eye openness, while gesture recognition has grown into a practical method of managing multimedia while driving. Additionally, AI can analyze an accident victim's upper body position and modify the airbags properly.

Car servicing using artificial intelligence (AI) switches the focus from preventive to predictive maintenance. Rather than waiting for a problem or an approaching repair window AI may deliver actionable information for automobile maintenance in real time instead of after the fact. Sensors and artificial intelligence algorithms can construct a real-time warning system for automobiles by analyzing historical and contextual data. This system will allow for condition-based maintenance needs for automobiles.

Certain vehicle manufacturers include third-party in-car personal assistants, such as Apple Car Play or Android Auto, into their automobiles. Others have chosen to create their own apps or to cooperate with organizations that specialize in artificial intelligence. Ford Motor Company, for example, is cooperating with Clink on an artificial intelligence-powered in-car assistant. Natural language processing is at the heart of Clink's voice recognition software. The assistant may adjust the temperature, respond to subsequent inquiries about the remaining fuel in the tank, and progressively learn the speech patterns of certain drivers. Ford has also partnered with Argo.AI to build more efficient autonomous vehicles.

An analysis of automotive components and products by the McKinsey Global Institute found that one of the particular advantages of artificial intelligence for automotive suppliers is the capacity to improve over time at spotting problems as the technology becomes more sophisticated. As a result, vehicle availability is increased, vehicle depreciation is reduced, and vehicle economy is increased (Matthias Breunig *et al.*, 2017).

At the moment, the automobile brand is associated with the engine manufacturer. However, during the following decade, the software supplier is expected to identify the vehicle (which includes self-driving technology powered by AI, enhanced infotainment system and so on). Google, Baidu, Amazon, and Uber are all introducing autonomous vehicles. The producers of the vehicle's body, chassis, and batteries operate as suppliers of parts in this case.
The auto industry trends by 2030 are projected in the following figure. As shown in the figure AI plays a crucial role as one of the three pillars required for the innovation in the auto industry.

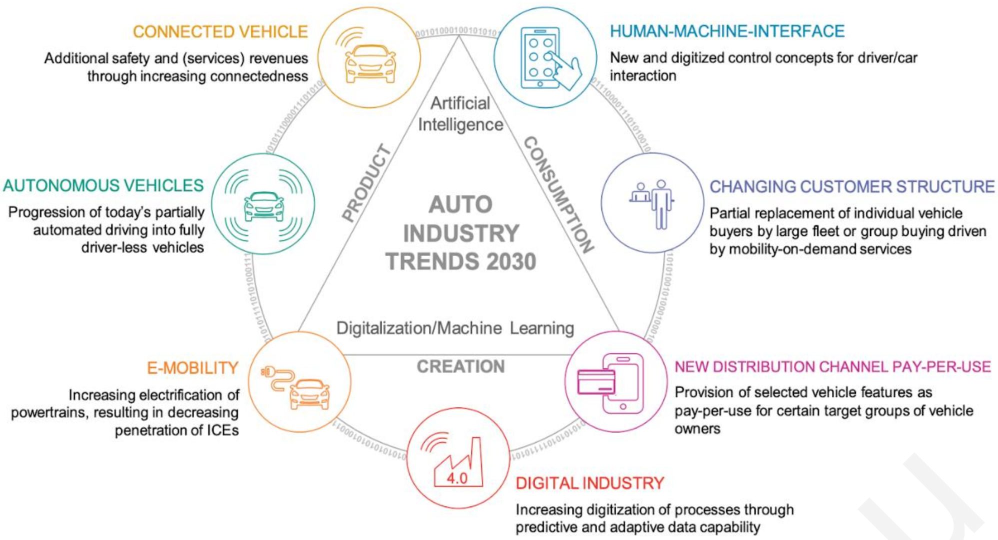

Figure 2: Auto industry tends by 2030

3.2 Requirements for the use of Artificial Intelligence in vehicles

One of the most critical roles of any machine learning model in a vehicle whether autonomous or not is the constant representation and prediction of the surrounding environment. These obligations can be subdivided into the following four categories:

- Detection of objects.
- Identification or recognition of objects.
- Classification of objects.
- Localization and movement prediction of objects.

With sensor data processing integrated into a centralized Electronic Control Unit (ECU) in a vehicle it is critical to maximize the use of machine learning to execute new tasks in order to increase overall efficiency.

Driver condition assessment and classification are two examples of applications that might be made possible by fusing data from multiple internal and external sensors, including as cameras, radars and LIDAR[2] as well as the Internet.

Furthermore the use of Advanced Driver-Assistance Systems (ADAS) is increasing. The ADAS is an electronic system in a vehicle that uses advanced technologies to assist the driver. They

[2] LIDAR is a technique for calculating ranges that involves using a laser to target an item or a surface and measuring the time it takes for the reflected light to return to the receiver

include many active safety features such as automatic emergency braking, pedestrian detection, surround view and parking assist. An ADAS relies on images (from a radar or camera) for localization and actuation and the key difficulty for any algorithm is establishing an image-based model for prediction and feature selection that is both accurate and reliable.

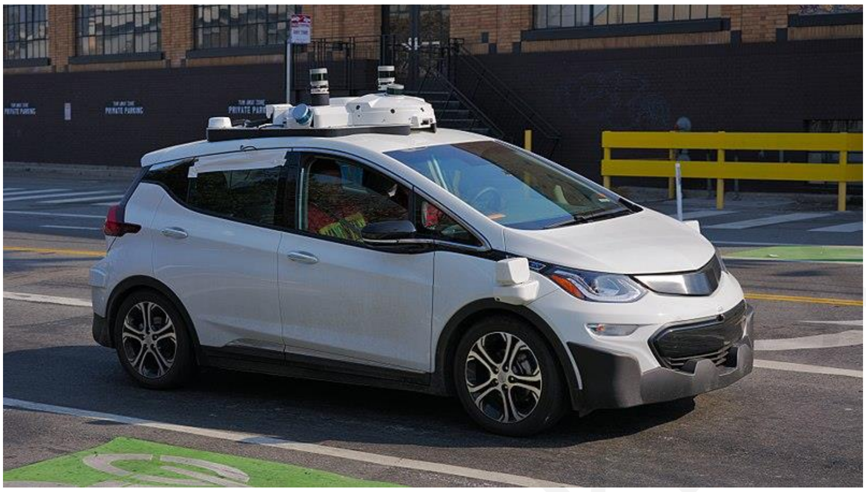

Figure 3: Cruise Automation Bolt EV third generation in San Francisco (from Wikipedia Commons)

In artificial intelligence, four separate categories may be distinguished that are especially important to the automobile sector. For starters, machine learning is a word that refers to algorithms that get their knowledge from examples and experience rather than from specified techniques.

In artificial intelligence, machine learning is a vital component, and it is already firmly established in a lot of the technologies that we use on a daily basis. While deep learning is a subfield of machine learning that is theoretically inspired by human brain networks, it falls into the second category due to its subset status. Deep learning is a machine learning technology that enables computers to make very accurate predictions about human behavior. Deep learning is the fastest developing field of artificial intelligence because to the vast quantity of data accessible through social media and cellphones.

Natural language processing (NLP) is the third category, and it relates to computers' capacity to recognize, interpret, and react to various sorts of human speech. Over the recent decade, there has been significant progress in the area of naturalized speech (which encompasses accented speech, dialects, and slang, thus the phrase "natural").

Finally, machine vision refers to a computer's ability to recognize and grasp visual clues such as images, geographic distance, faults, and speed - even when humans cannot (Paul Eichenberg, 2018).

When it comes to ADAS, the image recognition algorithms that are most often used include support vector machines with histograms of oriented gradients (HOG), as well as principal component analysis (PCA) (PCA). There are also two other algorithms used: The Bayes decision rule and the K closest neighbor (KNN) method.

Numerous functions required of automobiles are dependent on sensor data and certain artificial intelligence (AI) systems. Because of the large quantity of data, it must deal with, it must be efficient in terms of the time it takes to run the algorithm in question. Furthermore, the efficiency of an algorithm is assessed by how little computer memory it uses throughout its execution. Vehicles must collect data, plan their route and then execute their route.

It is necessary to apply nontraditional programming methods and machine learning techniques to complete these tasks, especially the latter two, which are considered to be a component of artificial intelligence. It is the goal of this two-part series to examine the artificial intelligence applications that will make autonomous vehicles a reality, as well as the hurdles and accomplishments that have been made.

These applications range from challenges in artificial intelligence to operations research and control engineering – all of which are essential for the development of a self-driving automobile. Direct and indirect learning are two types of learning that may be distinguished. (Moon Y. Y, Geem Z. W, and Han G. T, 2018).

However, a significant constraint on the employment of AI in automobiles is the complexity of its computer systems, which require more complicated algorithms. It involves transportation-related concerns such as vehicle routing and optimum scheduling for drivers and other road users. Due to the fact that the bulk of AI methods are classified as NP problems or NP-complete issues, computational complexity constrains AI techniques.

During deep learning, several hidden layers are produced in the network architecture. Thus, complexity occurs when large amounts of data include noise and distortions that make character extraction difficult. In transportation, data may be collected from a number of sources, including roadside sensors, linked devices, toll gantries, GPS, and cloud-based apps. Each of these sites has a wealth of information on different elements of transportation. These characteristics include traffic flow, speed, occupancy, and passenger behavior. As a result, it complicates the computing process required to address a particular problem (Sagar, V. and Nanjundeswaraswamy, T., 2019).

3.3 Autonomous vehicles and Artificial intelligence

The notion of self-driving cars stretches all the way back to the 1970s, and hence is not wholly novel (Keshav Bimbraw, 2015). Throughout history, pictures of autos propelled by artificial intelligence have caught our imaginations. However, until recently, it was likely stopped from becoming a reality due to a lack of technical expertise and funding. All of the factors that contributed to artificial intelligence eventually came together and autonomous automobiles are now a reality.

The objective is to enable the automobile to behave as if it were a humanoid motorist capable of doing a variety of duties. While this may appear to be a simple process it is far from it, since it requires a considerable lot of rigorous computation.

Cognitive assessment takes this a step farther by simulating human behavior through the examination of behavior designs and data mining skills. Cognitive systems are envisioned to work in a manner akin to how a human would interpret a real-world scenario necessitating a more empathic comprehension of formless data. To identify how to respond organically in real time, insights needed to be gleaned from a massive volume of formless data. Cognitive capabilities should also be capable of adapting to changing dynamic operating settings. Manufacturers of automobiles have already begun using this technology into their cars. (Pujari *et al.*, 2021)

The revolution in autonomous vehicles industry will continue to march down the highways, and will create not only little AI-enabled automobiles but also large 18-wheel trucks equipped with a variety of characteristics.

3.3.1 Research approaches for developing autonomous vehicles

Nowadays in the automobiles industry Artificial Intelligence encompasses the whole driving experience and enables manufacturers to design more efficient vehicles. Automobiles that are both safe and capable of autonomous operation will be created in the near future, using a number of artificial intelligence-based technologies, including computer vision, natural speech processing, and advanced robotics (Santosh Rao, 2019).

Automotive manufacturers are eager to create artificial intelligence-powered technology such as monitoring blind areas, helping the driver with steering and pedestrian recognition, provide appropriate alerts and respond automatically in risky circumstances. Such technologies will allow the automotive manufacturers to maintain a competitive edge artificial intelligence systems can.

Researchers aims to develop a technology that combines sensors and deep learning to produce a three-dimensional representation of all activities surrounding the car. Google and Tesla, two of the world's most successful technology and automobile businesses are investing millions of dollars in research & innovation to accelerate the creation and marketing of self-driving vehicles.

Additionally, automobiles may exchange data with a central hub and other cars as the trend towards automotive connection continues to spread, allowing for a greater knowledge of traffic patterns and driver behavior, as well as assisting in the prevention of accidents.

By analyzing the driver's driving history, by observing the driver's driving patterns, artificial intelligence may predict probable future difficulties caused by his inattention and even discern the driver's present mood from his actions. In a similar way, by installing monitoring systems and advanced cameras, artificial intelligence can monitor the driver's vital signs and take over operations of a vehicle in an emergency event.

A unique approach created by researchers at MIT and Microsoft detects situations when autonomous systems "learned" from training samples that do not correspond to what really occurs in the real world. Engineers might utilize this approach to enhance the safety of systems powered by artificial intelligence, such as driverless automobiles and autonomous robotics. (Rob Matheson, 2019)

3.3.2 Impact of the Artificial Intelligence in autonomous vehicles

The number of vehicles equipped with hardware for fully autonomous driving is expected to increase over the years as shown in the following figure.

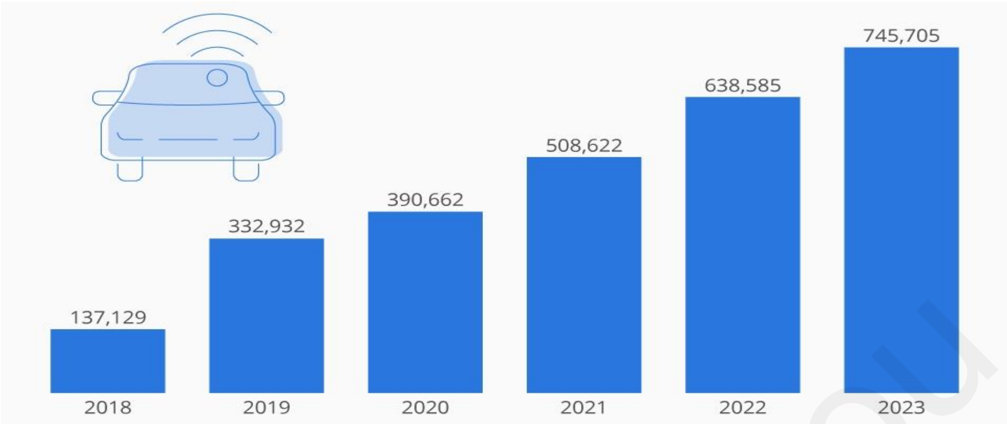

Figure 4: Estimation of vehicles equipped with hardware forfull autonomous driving (from Statista)

Approximately $27 billion is expected to be generated by the worldwide automotive artificial intelligence industry by 2025, according to Deloitte (Nix United, 2021). This demonstrates the enormous potential for artificial intelligence in this industry and allows for future forecasts for the automobile industry. Moreover their sale are expected to surge by 2035 as shown in the following figure.

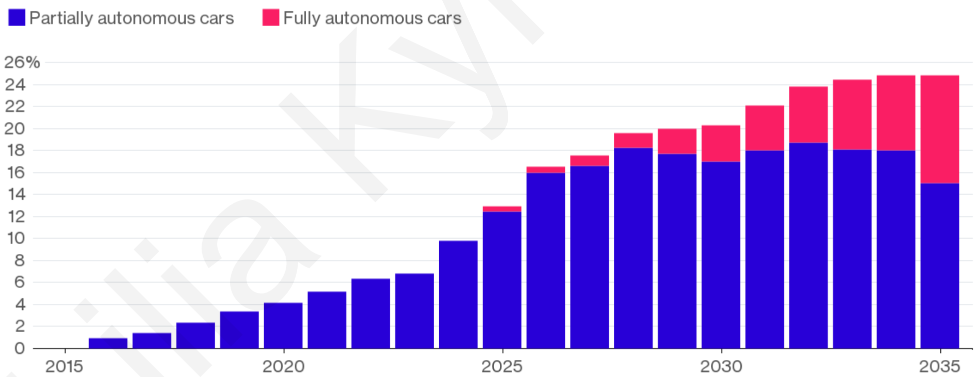

Figure 5: Forecast of the autonomous vehicles expected sales until 2035 (from The Boston Consulting Group)

3.3.3 Challenges for introducing autonomous vehicles and the Artificial Intelligence

By 2030, market projections show that around 85 percent of autos will be self-driving (to a degree). However, very few countries have now the necessary infrastructure in place to allow autonomous driving (such as roads, legislation, and standards). It is expected that by 2025, the vast majority of industrialized nations (including the United States of America, Canada, Germany, the United Kingdom, China, and Japan) will have modified its infrastructure to accommodate autonomous cars, according to the International Organization for Standardization (Taeihagh and Lim, 2019).

Artificial intelligence will significantly alter the automobile industry from the manufacturing of vehicles to the operation of those vehicles. As a result of improvements in efficiency, safety, and productivity we may find ourselves in a situation where our current knowledge of how businesses operate is radically challenged. Automobile manufacturers and suppliers would explore the benefits of using artificial intelligence technology to improve their daily operations, long term prospects, and overall ability.

While artificial intelligence-driven software, equipment, and parts may need fewer components to function, they will necessitate the hiring of more specialized workers to develop and fix the systems they control. Now, a major hurdle to broad adoption of autonomous cars is a dearth of software engineers capable of devising the algorithms and executing the artificial intelligence required for these sophisticated systems. Numerous enterprises are trying to overcome this obstacle by acquiring or purchasing smaller technology startups with an established staff to aid in growing the organizations' future capabilities in expectation of a dramatically altered automotive landscape.

The vast majority of people feel that the advantages of artificial intelligence exceed the downsides of the technology. Improvements in safety and efficiency are enticing siren songs, and they are much more so when they transcend beyond automobiles and into business.

The use of artificial intelligence in manufacturing, according to a recent study, has the potential to reduce worker hours by 0.5-1.5 percent while simultaneously increasing productivity by a significant amount.

AI can also improve safety, generate ideas, and predict calibration and repair among other things (Patrick Mikalef and Manjul Gupta, 2021). Specifically, in manufacturing, machine vision is being developed to consistently identify minor flaws (particularly on circuit boards) that the human eye is incapable of detecting.

Another example is the practice of preventive maintenance. Due to a predetermined timetable for the majority of industrial equipment, no matter how well it is performing, wasted labor is created, as is an increased likelihood of unanticipated and unreported equipment malfunctions.

It is possible to monitor, analyses, and model this equipment with the addition of sensors and network connection, allowing for improvements in performance and service. With artificial intelligence, the massive volumes of data generated by this process can now be analyzed to develop predictive analytics, which will help in enhancing equipment performance and reducing unplanned downtime (Paul Eichenberg, 2018).

Naturally, given enough time, artificial intelligence (AI) may be able to reproduce an industrial process to the point that human labor is no longer required, at least for the same types of tasks. Automation and artificial intelligence processes have the potential to ultimately eliminate the need for low-skilled employees, which will almost certainly have a negative impact on the labor market. In the long term, the objective is to retrain these personnel to do higher-level responsibilities.

4. Artificial Intelligence's Shortcomings

4.1 Introduction

With the advent of autonomous vehicles, society will confront a new set of dangers, including the potential of socially embedded forms of artificial intelligence to make complex risk mitigation choices: decisions that may ultimately have tangible life and death consequences.

Due to the inherent contrasts between artificial intelligence and human decision-making processes, concerns have been raised about how AI evaluates judgments, how humans should mediate these conclusions, and the consequences of such decisions for others. As a consequence, society, politicians, and end users all need to have a firm grasp on these differences. While contextualizing AI choices may give them unique significance, significant barriers remain in terms of AI decision-making technology, conceptualization of AI decisions, and the degree to which varied participants perceive them. It is specifically true when assessing the benefits and risks associated with AI judgments. Autonomous cars are frequently touted as key risk reduction technology due to their potential safety advantages.

Additionally, there is a need to comprehend the additional hazards that autonomous vehicle driving judgments may introduce. These new concerns are portrayed as decisional constraints; as artificial driving intelligence will be deficient in some decision-making skills. The inability to annotate and categories the driving environment in terms of human values and moral cognition exemplifies this most clearly. In both circumstances, it is crucial to examine how autonomous vehicle decision-making capability is conceptualized and how this contributes to a broader understanding of the technology's dangers and advantages.

Everything has its own set of advantages and disadvantages. Similarly, AI has a number of downsides. To put it another way, we find ourselves in the midst of a dehumanizing process dictated by the transfer of some decisions to synthetic entities devoid of humanity, a process that erodes our responsibility and accountability systems. It's as if the iconic "computer says no" line from Little Britain is embedded in nearly every layer of the system, or as Neil Postman who was an American novelist, educator, media theorist, and cultural critic who eschewed technology, such as personal computers, mobile devices, and cruise control in automobiles, and was critical of how technology was used in schools, such as personal computers put it, we've ceded our culture to technology. We frequently exaggerate technology's favorable qualities and potential, while ignoring not just its weaknesses, but also the hazards associated with its development, implementation, and crystallization (Fabio Massimo Zanzotto, 2019).

As an illustration of the significance of this shift from human influence to AI, consider that, for the first time in our species' history, we now live in a world where key choices impacting individual lives are made (in part or totally) by non-human people, i.e. by intelligence simulations.

We are surrounded by new AI devices, from Siri to Cortana, Alexa to Google Duplex. We've grown accustomed to sharing our reality with intelligence simulations, but perhaps more alarming is the fact that, in an act of technological exhibitionism that could have profound implications for the protection of civil liberties and human rights, we've grown accustomed to giving away our data and, in the case of autonomous transportation, putting our lives at risk.

Autonomous cars are on the verge of revolutionizing the transportation industry. The market leaders are pushing the boundaries of Level 4 automation. Level 4 is considered completely autonomous driving, however a human driver may still take control and the vehicle retains a cockpit. At level 4, the automobile is capable of handling the bulk of driving scenarios on its own. These are well on their way to complete automation. However, no manufacturer has achieved Level 5 automation to yet.

This is a highly regulated atmosphere, which is understandable given the obvious safety issues. Perhaps no other form of transportation innovation raises as many issues and opportunities as the self-driving vehicle. Automobiles capable of self-driving have developed into the prototype means of transportation for the future. Despite this, serious complications arise. Will they ever be able to entirely replace human drivers? Which ethical judgments would they be forced to make? What are the socioeconomic ramifications of such a radical shift? Are they likely to have a detrimental influence on the nature of privacy and security?

4.2 Sensor Issues Affecting AI Approaches' Input

The effectiveness of artificial intelligence systems is highly dependent on the quality of sensor data used as input. In AV applications, three types of sensors are used: self-sensing, localization, and environment sensing. Self-sensing employs proprioceptive sensors – responsible for monitoring the vehicle's internal state, for example, measuring wheel speed, inertia, and sensing to determine the AV’s state, which includes its velocity, acceleration, and steering angle.

Typically, pre-installed measuring equipment such as odometers and inertial measurement units are used to obtain proprioceptive information (IMUs). Localization determines the global and local positions of an unmanned aerial vehicle (AV) using external sensors such as GPS or dead reckoning utilizing IMU readings.

Finally, surrounding sensing makes use of exteroceptive sensors to detect road markings, road slope, traffic lights, weather conditions, and the status of obstacles (location, velocity, acceleration, and so on) (e.g., other surrounding vehicles).

Additionally, active and passive proprioceptive and exteroceptive sensors are distinguished. Active sensors, such as sonar, radar, and LIDAR, emit electromagnetic waves. Passive sensors, on the other hand, detect electromagnetic waves in their environment; examples are light- and infrared-based cameras. Camera vision, LIDAR, radar, and sonar are the most frequently utilized sensors. Cameras are crucial in perceiving. Typically, an AV camera's spatial resolution is between 0.3 and two megapixels. A camera may broadcast a video stream at a frame rate of 10–30 frames per second, capturing key objects in real time such as traffic lights, traffic signs, and barriers (W. J. Shi *et al.*, 2017).

A LIDAR system scans the surrounding region on a periodic basis, producing several measurement points. After processing this "cloud" of dots, a three-dimensional picture of the surrounding region may be created. Along with cameras and LIDAR, radar and ultrasonic sensors are often used to identify obstacles. Their detection ranges might be short and wide, medium and wide, or long and confined.

It's worth noting that the majority of AVs have numerous types of sensors for two critical reasons. To begin, integrating input from several sensors enhances perception accuracy overall. For example, a LIDAR system can rapidly locate areas of interest, a camera system may further study these critical spots using very precise object identification algorithms. Moreover, the system's redundancy and resilience are enhanced by the presence of many layers of sensors with overlapping sensing zones, assuring its high dependability.

Extreme weather conditions, for example, impose limits on working of sensors, which some of the aforementioned sensor fusion systems can manage (partially). For instance, perception in adverse weather circumstances like as snow, heavy rain, and fog is a critical area of AV study, as these situations continue to pose difficulties for human drivers. Both vision-based and LIDAR-based systems exhibit considerable problems in snowy circumstances. Snow's "heaviness" or density has been discovered to impact LIDAR beams and produce reflections off snowflakes, creating obstacles for autonomous cars' effective operation (J. Van Brummelen *et al.*, 2018). Perception is also troublesome in a variety of contexts, including complicated metropolitan locations and new environments.

Now, various problems arise, such as whether the sensor will be required to operate in extreme climatic circumstance. Should the AV sensors be cost effective if a certain level of precision is sacrificed, and so forth? For example, extreme weather conditions force precision and accuracy.

For instance, DARPA's Urban Challenge AVs were often equipped with several costly LIDAR and radar sensors but lacked sonar sensors, since the problems did not focus on low-speed, accurate automatic parking (e.g., parallel parking). By contrast, many commercial cars, such as the Tesla Model S and Mercedes-Benz S class, use ultrasonic (sonar) sensors rather than LIDAR for automated parking in order to keep costs down. Infrared cameras, which are typically used at night to identify humans and other obstructions, are most frequently seen on commercial vehicles.

In brief, sensor disparity results in diverse datasets acquired for the purpose of serving AI techniques. Additionally, the quality and reliability of various sensor data should be considered. As a consequence, it is necessary to thoroughly explore the issues associated with sensor inputs, while building an AI technique.

4.3 Uncertainty and Complexity

AVs are sophisticated systems with several perspectives and decision-making processes. Implementing AI techniques inherently introduces uncertainty into the process of executing these activities. In general, the ambiguity surrounding AI techniques may be classified into two categories:

Difficulties with data due to uncertainty: all the data obtained by sensor systems will have noise, which might add unexpected errors into the input for AI models generated by the implemented models.

AI models introduce uncertainty as a result of their functional needs. A crucial concept of artificial intelligence algorithms is that the training data obtained from sensors will always be adequate to meet the algorithms' requirements. Additionally, the models to be used are required to capture the operating environment in real time. These assumptions are routinely violated in real-world AV operations, owing to the operating environment's great unpredictability and dynamic nature.

Additionally, complexity and unpredictability might be generated on linked antivirus systems as a result of harmful assaults conducted arbitrarily from any place. Furthermore, a malicious assault does not need physical access to antivirus software. Thus, in linked AVs, malicious attack and intrusion detection are crucial. External communication systems have been examined using AI techniques such as neural networks and fuzzy logic(K. M. Ali Alheeti and K. McDonald-Maier, 2018) and if numerous AVs are connected, it is anticipated that more efficient AI techniques will be created that can solve more intricate circumstances.

4.4 Issues with complex model tuning

Because AVs are very simple, some research has relied heavily on machine learning techniques such as particle filtering, random forest, and support vector machines. Given the widespread use of deep learning techniques in other facets of transportation, such as traffic flow prediction, many researchers investigated developing artificial intelligence techniques such as CNN, LSTM, and DBN (Müller *et al.*, 2017). However, there are still significant challenges associated with the use of sophisticated learning algorithms for real-time AV decision-making.

To begin, DL and RL techniques frequently make use of more complicated model structures, making parameter calibration computationally intensive. There is no information available at the moment on how to choose model hyper parameters such as the number of hidden layers, hidden units, and their initial weighting values (F. Mohseni, S. Voronov, and E. Frisk, 2018). This means that when used to compute steering wheel angles on autonomous vehicles, the end user must design a suitable model tuning approach via a costly trial-and-error research. Second, unlabeled data learning methods such as SVM and NN are inefficient. Take for instance, the uncertainty problem stated above will be increased when training and testing data are significantly different, as is projected in real-world traffic scenarios (D. Zang *et al.*, 2018). Training and testing an AV to sense its surroundings in suburban/rural regions and complicated metropolitan environments may generate concerns about safety owing to unknown training situations like presence of any pedestrian.

In summary, further efforts are necessary to develop artificial intelligence algorithms for particular autonomous applications and maneuvers. Additionally, substantial gaps in hardware support for real-time AI implementations for large-scale commercial applications in AVs should be recognized.

5. Discussion and conclusions

After weighing the advantages and disadvantages of AI in the automotive sector, the issue arises as to whether AI is the automotive industry's future or not. To adequately answer this topic, we must first study our environment.

Our human road network creates an environment that is both diversified and flexible. Unavoidably, all cars navigating this environment may encounter unforeseen occurrences, possible crashes, and life-threatening RTAs (Pujari *et al.*, 2021).

The responses of AVs to such moral circumstances are contingent upon the intelligence frameworks that govern their behaviors. Without moral intelligence, AVs will mediate moral and immoral events through a value spectrum based simply on relational quantifications between humans and objects. Thus, significant work is necessary to ensure the reliability and safety of AI in the automobile sector.

For example, there is a clear necessity to offer an accurate description of autonomous decisional capabilities through an AV decisionality specification. This will necessitate restructuring the decisional capacity restrictions as technology progresses. The article by Pujari *et al* analyses the two perspectives and argues that the SEL's primary influence will be on the judgments that AV can or cannot make. This discrepancy in how AV decision-making capabilities is interpreted reveals an inherent challenge in conceptualizing AV and autonomous technology decision-making.

Autonomous automobiles reflect an independent decision-making agency integrated in one of modern society's most dynamic and unpredictable components: the human road network. Even the most rational persons have been known to have emotional reactions when driving. As such, it occupies an unexpected emotional human territory that AVs must define in a number of ways.

Thus, the top-tier difficulty is to design a system that can live up to the norms and expectations of a public that, many predict, will have a low tolerance for AV decisional errors. The study of ethics, particularly applied ethics, has a long history of strengthening society's safety by analyzing conflicts that develop when law and policy fail to present a problem in an acceptable way to all stakeholders, such as nuclear fuel, nuclear armaments, and child labor. However, ethics has been questioned in the context of AV for its seeming inability to foresee the SEL impact of AV with any degree of accuracy.

The notion of programming robots to make ethical judgments is very contentious. For example, ensuring that ethical datasets be processed without programming biases creates difficulties. Verifying that choices are made legally and in accordance with our individual and social ideals also presents challenges, as do concerns of openness and access. Such obstacles imply that embedding ethics into socially integrated technology is an intractable undertaking, all the more so when it comes to judgments that directly affect human damage or death.

There are a number of unexpected situations on the human road network, including human agents such as human drivers, walkers, cyclists, children, and animals, among others. It is in this context that an autonomous system's driving intelligence will be subjected to events and situations that are morally laden. When presented with events and scenarios involving human values, potential damage, or death, AVs will make judgments that directly affect human wellbeing, even if they are just designed to identify things in their surroundings using size and form classifiers (Biggi and Stilgoe, 2021). As a result, autonomous vehicles (AVs) will need to master all of these intricacies and should be sufficiently advanced to do no harm.

Motor vehicles must be able to replicate—or outperform—the human decision-making process in order to be considered really autonomous and capable of functioning responsibly on our roadways. Certain decisions, on the other hand, go beyond the mechanical application of traffic restrictions and the mapping out of a safe path to take. According to their appearance, they demand an ethical sense that is notoriously difficult to codify into algorithms that a computer can understand and comply with (Lin, P., 2015).

It is clear that data gaps will continue to exist for some time to come, but even if all data is acquired, there will inevitably be some reservations regarding the validity of comparing human driving data to autonomous driving data. To provide an example, disagreements over environmental factors such as weather and object classification will continue, as will discussions about the sorts of instances that qualify (Schoettle, B and M. Sivak., 2015).

To function successfully, AV will need a wide range of decisional capabilities, since certain judgments are intended to overturn erroneous human instructions, while others may even contravene existing laws. The intelligence for autonomous driving will be composed of a range of intelligence components optimized for human road network navigation.

The ability of a machine to make judgments and traverse the human road network more safely and effectively than human drivers constitutes a major breakthrough in the phenomena of human/machine interactions, as it transfers to a machine the uniquely human capacity for safe navigation. Justification for this capacity transfer is that AVs will reduce driving dangers and deliver a safer driving experience.

Additionally, the capacity of computers to take the place of human drivers in this manner is a significant step toward greater dependence on AI and the start of a risk-mitigation relationship in which society increasingly depends on machines to mitigate real-world hazards to people (Blanco, M *et al.*, 2016). In essence, this means that by moving the risk mitigation decision-making framework to AI, more of the risk phenomenon is mitigated.

Given the difficulties of AV making judgements based on human values, rights, social norms, and ethics, one such perspective concerns the technology's "ethical constraints." Many regard this disparity as a severe technical shortfall that, in the event of inevitable road traffic collisions, might introduce additional hazards to society and users. For instance, many programming AV judgments would naturally adhere to specified human regulations, such as driving laws, driving codes, social conventions, and accepted behavior. Other decisions will be made autonomously, since AVs exhibit a sophisticated ontology of decision-making (Cunneen, M *et al.*, 2019).

It is unquestionable that AV will provide a spectrum of driving options that eliminates drunkenness, distraction, exhaustion, and poor behavioral choices like as speeding. This argument, however, is more complicated than it seems, since it is predicated on the technology's overall ability to exceed the whole range of human driving judgements. Indeed, the feasibility of this remains an unanswered subject, all the more so considering that AV would inject fresh accident data into safety statistics. Without a doubt, there will be RTAs unique to AV decisionality in a worldwide context, such as sensor error, programming faults, unexpected objects, categorization mistake, and hardware difficulties (Blanco, M *et al.*, 2016).

The driverless car is only one application of artificial intelligence technologies that are having a significant impact on existing and future civilization. We frequently exaggerate technology's favorable qualities and potential, while ignoring not just its weaknesses, but also the hazards associated with its development, implementation, and crystallization. As AI implementations grow more diverse, and maybe ubiquitous, there will be an increased need to comprehend the many contexts in which decisional systems are implemented.

This means that in order to successfully frame each unique choice environment, technology must be accepted at face value and a nonlinear relational model of categorization notions must be built. Since a consequence, we should avoid a "one-size-fits-all" approach to artificial intelligence applications, as no one framework can effectively account for the variety of machine decisional application alternatives.

Conceptual framing is an integral part of the epistemic continuum that underlies governance and regulation. Given its strategic importance in the meaning chains that underpin public discourse, it is vital that such framing be scrutinized. In general, this article investigates how scholars in the field of anticipatory governance have paid very little attention to the critical process of conceptual framing. The key thesis is that conceptual framing has downstream consequences for disputes about autonomous vehicle governance. It is a nuanced argument in the sense that the concept of a unified conceptual framework is not explicitly presented.

Rather than that, the limitations of present discussions are acknowledged, along with recommendations for more accuracy in developing such frameworks and, somewhat strangely, an examination of the importance of reflective methods to conceptual framing. Indeed, insisting on comprehensive and ultimate conceptual frameworks is fundamentally self-defeating.

Conceptual framing should be a more reflective and iterative process, since what matters is not just the correctness of the concepts utilized, but also the recognition of the impact of such framing. Given that both safety concerns and disputes over the ethics of AVs steer discourse in a certain direction, it is critical to reexamine the initial conceptualization and take a more pluralistic approach.

Due to the intricacy and amplification of disputes over the societal implications of AVs, there is a natural urge to simplify the issue for a broader audience. While this is true in many domains, it is especially prevalent in the development of technology. For example, arguments about the threats presented by nanotechnology exhibit comparable conceptual framing deficiencies, resulting in regulatory failures and significant misunderstanding among stakeholders Reintroduction of accuracy into conceptual framing, and indeed recognition of the crucial function of conceptual frameworks in any hermeneutic cycle, might help advance arguments for the deployment of AVs. The resulting payment allows more robust support for technologies with positive social and environmental advantages, while innovations with potentially negative social and environmental implications may be more explicitly identified and promoted via properly informed evaluation.

In summary, because artificial intelligence is a simulation, it cannot be called a moral actor. As a result, it is incapable of comprehending or feeling respect or sympathy for something as fundamental and vital as the value of a human life, regardless of the limitations

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