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Journey of Artificial Intelligence

Highlights

Artificial Intelligence in Education

Universal Ontology Experimentation

Discovering Thoughts, Inventing Future

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Guideline for Including Unperceivable Knowledge in a Universal Ontology Experimentation Field: Ontology Malagasy

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Abstract- This article suggests a cognitive approach to initiate the inclusion of unperceivable worlds into established ontologies. We qualify as unperceivable any world that escapes automatic data exploration because of the leak of sufficient documentation. Initially based on knowledge engineering, the approach aims in the long term at the automatic production of knowledge vectors that can be assimilated to existing corpora. It leverages a proven and extendable universal ontology and is experienced in the emerging world of Malagasy culture.

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Guideline for Including Unperceivable Knowledge in a Universal Ontology Experimentation Field: Ontology Malagasy

Randriambololona Nivo [α] & Andriamanohisoa Hery Zo [σ]

Abstract- This article suggests a cognitive approach to initiate the inclusion of *unperceivable* worlds into established ontologies. We qualify as *unperceivable* any world that escapes automatic data exploration because of the leak of sufficient documentation. Initially based on knowledge engineering, the approach aims in the long term at the automatic production of knowledge vectors that can be assimilated to existing corpora. It leverages a proven and extendable universal ontology and is experienced in the emerging world of Malagasy culture.

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I. Motivation

The new paradigms of Artificial Intelligence (AI) rely on innovative techniques to solve problems that exceed human capacity and sometimes even the real needs of humanity. These techniques require the massive presence of data intended to train an agent on the resolution of a particular problem [3]. An agent is no longer supposed to reason, instead he is supposed to learn and to automatically or statistically exploit the data made available to him in order to deduce the decision to be taken or the prediction that seems the most relevant [7]. AI, endowed with data science, has become "almost" sovereign. Despite its power, there is a catch. What about unknown but emerging *worlds* for which no one has ever thought of collecting data but which today aspire to be part of the lot, to also be *perceivable* by AI? Nowadays, there are performant trained models like *ChatGPT* that have the ability to interact in a conversational way and that have response to all kinds of questions. Unfortunately, they are not yet trained on such emerging exotic worlds.

This article proposes a solution to circumvent the absence of massive data for a specific emerging world. The idea is to use classic AI techniques like knowledge engineering, while exploiting as far as possible what the state of the art offers in terms of ontology. As experimentation field, we opt for the unperceivable world of Malagasy culture and name the project *Tontolo Malagasy.* In fact, it is an abbreviation for Taxonomy and *Ontology Malagasy. Tontolo* means at the same time Universe. That is to say that we try to put the Malagasy Universe into an ontology and will let an agent respond spontaneously to the most important questions concerning the Malagasy language, news, (historical) facts, events or personalities of Madagascar. This is our manner to perpetuate the access to the own cultural identity for Malagasy youth. Latter is increasingly immersed in attractive cultures that certainly promote open-mindedness but that overwrite at the same time precious cultural heritage. Often, we are only aware of the value of our culture when it disappears. In the present work, we start by introducing the main concepts behind knowledge engineering. Then, we will present examples to illustrate their compilation on our project. Finally, we will talk about a state of the art ontology named YAGO which will serve as a reference.

II. Introduction to the Concept of *Knowledge*

Knowledge comes to us not only from the information that is conveyed by our perceptions, but also by natural language. Traditionally, natural language is considered as a language for representing knowledge, but today we see it more as a medium of communication. Even if it is highly expressive, hypotheses reveal the delicacy of its use.

- The Sapir-Whorf hypothesis (1956) claims that the language we speak greatly influences our understanding of the world. In the language *Guugu Yimithirr* of the Aborigines in Australia, for example, there are no words to express the relative direction (such as left, right, ahead, behind) but only the absolute direction via the use of the cardinal points (north, south, east, west). Therefore, Aborigines excel at navigating open terrain but would be less comfortable if told to turn left in a corridor.
- Words are sometimes associated with non-verbal representations. In some cultures, a concept may be completely absent from the language (like the example told above). In the Malagasy language, the verb *to be* does not exist. However, in a sentence supposed to *mean* it implicitly, anyone speaking Malagasy would understand it.

Since language influences the apprehension of the world, knowledge is not always neutral, objective or complete. This reinforces our assertion regarding the

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existence of *unknown worlds*. Existing ontologies are mainly imbued with Western culture, so as immense as they are, they are never complete [2]. Before showing how to add new worlds into pre-established concepts, let us first see how to represent knowledge mathematically for the purpose of its automatic processing.

a) Knowledge Base

Our goal is to model a knowledge-based agent that can form representations of a real world. The task is not about actually representing everything in the world. New representations are derived from existing ones through inference processes. These new representations are used to deduce what to do. A knowledge base (KB) consists of a set of *sentences* that are expressed in a *knowledge representation language.* Each sentence corresponds to some assertion about the world. When the sentence is considered as given without being derived from other sentences, we call it *an axiom*. The KB may initially contain some background axioms.

According to [1], two types of operation are used to manage knowledge in a KB:

- The standard operation TELL to add new sentences to the KB
- The standard operation ASK to query knowledge from KB.
- In the following section, we will study, how the expression of sentences and the definition of their semantics are achieved through *logic.*

b) Logic

i. *Syntax*

Logic governs the representation language and specifies through a grammar all the sentences that are syntactically correct (well-formed). According to [1], the syntax of First-Ordered-Logic is given in Figure 01.

$$
\begin{aligned}
&Sentence \rightarrow AtomicSentence \mid ComplexSentence\\
&AtomicSentence \rightarrow Predicate \mid Predicate(Term, \dots) \mid Term = Term\\
&ComplexSentence \rightarrow (Sentence) \mid [Sentence] \mid \neg Sentence \mid Sentence\ \text{A}\ Sentence\\
&\qquad \mid Sentence \vee Sentence \mid Sentence \Longrightarrow Sentence \mid Sentence \Leftrightarrow Sentence\\
&\qquad \mid Quantifier\ Variable, \dots Sentence\\
&Term \rightarrow Function(Term) \mid\\
&Constant \mid Variable\\
&Quantifier \rightarrow \forall \mid \exists Constant \rightarrow A \mid X_1 \mid \text{John} \mid \dots\\
&Variable \rightarrow \alpha \mid x \mid s \mid \dots\\
&Predicate \rightarrow True \mid False \mid After \mid Loves \mid Raining \mid \dots\\
&Function \rightarrow Mother \mid LeftLeg \mid \dots
\end{aligned}
$$

Figure 01: Syntax of First-Order-Logic in Backus-Naur-Form

ii. *Semantics*

A logic must also define the meaning (semantics) of sentences. Depending on the used logic, this task can be simple or more sophisticated. Propositional logic simply assumes that there are facts that either hold or do not hold in the world. Propositional logic has the advantage of using a declarative, context- independent and unambiguous semantics. It is sufficient to illustrate the basic concepts of logic and knowledge-based agents. Nevertheless, it is not suitable to represent knowledge of complex environments in a concise way. For this reason, first-order-logic is preferred. It builds a more expressive logic on the foundation of propositional logic, borrowing representational ideas from natural language and at the same time avoiding its disadvantages. Its language is built around objects and relations. It also forms the foundation of many other representation languages.

iii. *Model*

For every sentence, its truth or falsehood is specified through a model. The possible models are just all possible assignments to the concerned variables. If a sentence α is true in model m, we say that *m satisfies* α or *m is a model of* α. M(α) is the set of all models of α. For example, the sentence *a * 3 = 6* is true in a world where *a is 2*, but false in any other world.

iv. *Logical Entailment*

Logical entailment is a relation between two sentences the second of which follows logically from the first one. It is the basis of l*ogical reasoning.* In mathematical notation, we write $\alpha \subset \beta$ to mean that the sentence α *entails the sentence* β. The formal definition of entailment is

$$\alpha \subset \beta \text{ if and only if } M(\alpha) \subseteq M(\beta)$$

In clear: $\alpha \subset \beta$ if and only if, in every model in which α is true, β is also true.

v. *Logical inference*

Entailment is applied to carry out *logical inference* (to derive conclusions). If an inference

algorithm *x* can derive α from KB, we write $KB \vdash_x \alpha$, which is pronounced "α is derived from KB by x" or "x derives α from KB", where α is just one possibility among the set of all consequences of KB.

An inference algorithm is called *sound* or *truth-preserving* if it derives only entailed sentences. An unsound inference procedure essentially announces the discovery of nonexistent or false conclusions.

An inference algorithm is called *complete* if it can derive any sentence that is entailed.

vi. *Grounding*

The connection between logical reasoning processes and the real environment of an agent is called *grounding*. Since KB is just a set of sentences inside the agent's *mind*, how do we know that KB is true in the real world? The agent program achieves grounding by creating a suitable sentence whenever a perceptible event occurs. Then, whenever that sentence is in the knowledge base, it is true in the real world.

c) Knowledge engineering with First-Order-Logic

Knowledge engineering is the process of knowledge base construction. It includes the following steps [1]:

a. Identifying the task
b. Assembling the relevant knowledge
c. Deciding on a vocabulary of predicates, functions and constants
d. Encoding general knowledge about the domain
e. Encoding a description of the specific problem instance
f. Posing queries to the inference procedure and getting answers

Let us directly illustrate with the example of Tontolo Malagasy. *Tontolo Malagasy* is expected to inform us about Malagasy culture (including historical facts and events, language, personalities, places). For simplicity in this example, we will observe a restricted world, namely the world of the former presidents of Madagascar. We will further narrow down to the observation of a single President, Zafy Albert, a deceased President (to avoid any political controversy).

Suppose the agent gets from any source the information that he was born on *May 1 in 1927*, that he died on *October 13 in 2017* and that he had two prime ministers during his office: *Francisque Ravony (term of office 1993 to 1995)* and *Emmanuel Rakotovahiny (term of office 1995 to 1996)*.

We know furthermore that the legal duration of a presidential term is 5 years and that a President must be at least 18 years old. A President may nominate successively different Prime Ministers (PM) during his presidential term.

Choice of the vocabulary to use for predicates, functions and constants

- *The following predicates will be used:* Person, President, Prime minister (PM).
- *The following functions[1] will be used:* BirthDate, DeathDate
- The following relations will be used: *TermPeriod, Tenure*
- The following constants will be used: *Zafy Albert, Francisque Ravony, Emmanuel Rakotovahiny, 1993, 1995, 1996.*

Encoding general knowledge about the domain in the language of First-Order-Logic

1) $Presid(x) \Longrightarrow Person(x)\ \Lambda(year2 - year1) \leq 5$ A $Tenure(x, year1, year2)$ A $year1 \geq d + 18$ A $BirthDat(x, d)$

Meaning: A president is a person, who is older than 18 and whose tenure is delimited betweenyear1 and year 2.

2) $(x, y) \Longrightarrow Perso(x)$ A $President(y)$ A $(year1_x \geq year1_y)$ A $TermPeriod(x, y, year1_x,$ $year2_x)$ A $Ten(y, year1_y, year2_y)$ A $(year2_x \leq year2_y)$

Meaning: A prime minister is a person who is associated with a president and whose term of office is necessarily within the term of the president in question

3) $Per(x) \Longrightarrow BirthDate(x, dat1)$

4) $Per(x) \Longrightarrow DeathDate(x, dat2)$

Encoding of the Specific Problem Instance Description

1) $Presiden(Zafy\ Albert)$
2) $BirthDat(Zafy\ Albert,\ 1927/05/01)$
3) $DeathDat(Zafy\ Albert,\ 2017/10/13)$
4) $P(Francisque\ Ravony, Zafy\ Albert)$
5) $PM\ (Emmanuel\ Rakotovahiny, Zafy\ Albert)$
6) $P(Francisque\ Ravony,\ Zafy\ Albert)$ A $PM\ (Emmanuel\ Rakotovahiny,\ Zafy\ Albert)$ A $Francisque\ Ravony \neq Emmanuel\ Rakotovahiny$ A $\forall x\ PM(x,\ Zafy\ Albert) \Longrightarrow (x = Francisque\ Ravony \vee x = Emmanuel\ Rakotovahiny)$

   Meaning: Zafy Albert had no prime ministers other than F. Ravony and E. Rakotovahiny
7) $TermPerio(Francisque\ Ravony, 1993, 1995)$
8) $TermStar(Emmanuel\ Rakotovahiny, 1995, 1996)$

All this information (general or specific) encoded in the KB and to which others will be added via the agent's percepts will remain simple sentences as long as no request comes to give them life. These are the queries that will trigger the inference procedure, which will use them as part of a sequence of entailments.

The goal of inference is to find out whether KB⊂ α for some sentence α. Compared to conventional databases, the reward with a knowledge base is that we can let the inference procedure operate on the axioms

and problem specific facts to drift by itself the fact we are interested in knowing. There are different inference algorithms like model checking, theorem proving, forward-chaining, Davis-Putnam algorithm, Hill-climbing search [1]. They have respectively their advantages and their drawbacks but their studies are beyond the scope of the present article. An upcoming article will be dedicated to the explanation as well as the demonstration of the operating mode of an inference algorithm.

So far we have studied knowledge as an abstract and a general concept with an abstract representation language. In this abstract form, knowledge reuse and knowledge sharing will not be possible. In the following section, we will learn knowledge implementation through the use of ontologies.

III. Ontology

In philosophy, the term ontology refers to the science that *studies being as being*. With the emergence of knowledge engineering and the Semantic Web, and emphasizing the importance of knowledge sharing and reuse, this definition has been extended. *"An ontology is a formal specification of a shared conceptualization" [6].* Ontology represents a means of materializing knowledge in a form and in a structure that makes its reuse and its sharing possible.

a) Taxonomy

A general ontology organizes everything in the world into a hierarchy of categories - called a taxonomy - such as Events, Time, Physical objects and beliefs. The organization of objects into categories is a vital part of knowledge representation since much reasoning takes place at the level of categories. Categories permit also to make predictions about classified objects. A taxonomy has a *tree* structure.

Categories (or classes) serve to organize and simplify the knowledge base through inheritance. If we say that all instances of the category *Persons* have the property *are Mortal*, and if we assert that *Women* is a subclass of *Persons* and *Mothers* is a Subclass of *Women*, then our agent will know that every mother is mortal. We say that the individual woman inherit the property of mortality, in this case from their membership in the *Persons* category.

b) Relationships

It is possible to bring more precisions into the characterization of the relations between categories. To state that two categories that are not subclasses of each other (e.g. *Males* and *Females)* have no members in common, we use the relation *Disjoint: Disjoint (*{Males, Females}). We can go further and precise that an animal that is not a male must be a female, and say therefore that males and females constitute an exhaustive decomposition of the animals. A disjoint exhaustive decomposition is known as a partition. *Partition* ({Males, Females}, Animals). We use the general *Part Of* relation to state that one thing is part of another. Through the introduction of such types of relations between categories, the tree becomes a graph.

c) Named Entities

For the purpose of our project, we need an ontology that should not only contain categories or concepts but also *named entities* designating among other people, organizations, places and other important things. It should be possible to establish relations between *individuals* of different kinds: *What is located where? Who was born where? Which sovereign reigned during which period?*

d) Ontology Language

The best known languages to write ontologies are OWL (Web Ontology Language) and RDFS (Resource Description Framework Schema). Both are computational logic-based languages such that knowledge expressed in OWL or in RDFS can be exploited by computer programs.

In the following section, we present the YAGO model that is a slight extension of RDFS. it is designed to be extendable by other sources (high quality sources, domain-specific extensions, or data gathered through information extraction from Web pages), what makes it highly interesting for our project.

IV. Yago (Yet-Another-Great-Ontology)

YAGO was developed at the Max-Planck-Institute for Informatics in Germany. It is able to express entities, facts, relations between facts and properties of relations, while it is at the same time simple and decidable.In contrast to other existing ontologies, that are limited to a single source of background knowledge, YAGO combines high coverage with high quality [8]. Its latest version YAGO 4 (2022) is a cleaned version of Wikidata that contains more than 50 million entities and 2 billion facts.

a) The Components of YAGO

In YAGO, all objects (concepts) are represented as *entities* which are organized according to a taxonomy. The higher classes come from *schema.org* [2]and the lower classes from Wikidata. In the leaves of the tree, we no longer have classes but named entities, that is, concrete objects, individuals. We will refer to entities that are neither facts nor relations as *common entities*.

An ontology represents also relationships between entities that have no hierarchical link between them. Example: In "An author writes a book", there is no hierarchical link between *author* and *book.* The two concepts are related by "writing". YAGO does not only allow relationships between entities but even between

relationships or between a relationship and an entity. This is possible by considering a relationship itself as an entity.

The triple of an entity, a relation and an entity is called a fact. They represent respectively *a subject, a predicate, and an object.* Example: *yago: Zafy_Albert rdf: type schema: Person*. The two entities are called the *arguments* of the fact. In YAGO, each fact is given a fact identifier, that is one of its strengths.

To maintain the semantic integrity of the data, YAGO uses the SHACL [3]Standard which makes it possible toexpress semantic integrity constraints.

b) Mathematical Definition of YAGO

A YAGO ontology over a finite set of common entities C, a finite set of relation names R and a finite set of fact identifiers I is a function with the following *definition:*

y $y: I \rightarrow (I \cup C \cup R) \times R \times (I \cup C \cup R)$

For facts that require more than two arguments, it is assumed that for each n-ary relation, a primary pair of its arguments can be identified. The primary pair can be represented as a binary fact with a fact identifier: #1: AlbertEinstein HASWONPRIZE NobelPrize. All other arguments can be represented as relations that hold between the primary pair and the other argument: #2: #1 TIME 1921.

Now, it's time to see how to exploit YAGO for *Tontolo Malagasy.*

c) Exploiting YAGO for Tontolo Malagasy

In the mass of YAGO data, there is very little portion of information on Malagasy culture. After a brief test, we noticed that out of 1,048,576 facts, only 80 mention Madagascar as a subject or as an object. In addition, there are specific Malagasy concepts and relationships that are totally unknown to YAGO. And finally, and obviously, YAGO does not understand the Malagasy language.

However, thanks to the flexibility of YAGO, including all these specificities that it currently lacks is not an impossible mission. There are three things we can do to enable YAGO extension on *Tontolo Malagasy*:

1. Data integration
2. Implicit translation
3. Implicit specification

i. *Data integration*

The challenge is to know how to recognize everything that is essential to our project and also to know at what level we must act (adapt, adopt, add, personalize, withdraw). Actually we are more interested in the taxonomy and in the common entities than in the named entities or in the facts because we would like to contribute our own named entities and our own facts. However, it is quite tricky because even if Madagascar is an island, it is not isolated from the rest of the world, so we still have to leave room for everything related to the outside world. Let us for now mainly focus on persons, places and organizations. In the YAGO taxonomy, the class *person* has 1569 subclasses that correspond to 1569 different professions. They don't all interest us right away. We will start with a small number to be able to accommodate the historical and cultural characters of our knowledge base. Here are some examples of professions that we could integrate: *Ambassador, Contestant, Entrepreneur, Evangelist, Foreigner, Governer, Head_of_State, Historian, Humanitarian, Leader, Sovereign…*

Each person may be defined through YAGO-predicates like

<hasChild>, <hasGivenName>, <isCitizenOf>, <hasFamilyName>, <wasBornIn>, <isMarriedTo>, <worksAt>, <isLeaderOf>, <diedIn>, <hasGender>, <holdsPoliticalPosition>, <diedOnDate>, <livesIn>, <wasBornOnDate>, <graduatedFrom> …

Concerning places, YAGO integrates data from *GeoNames* for places. *GeoNames* is a geographical user- editable database that covers all countries and contains over eleven million placenames that are available for download free of charge. The *Tontolo Malagasy* project could extract directly from *GeoNames* all the geographical entities that concern Madagascar, if they lack in YAGO.

In the YAGO taxonomy, the class *organization* has 278 subclasses that correspond to 278 different types of organization. As with persons, they don't all interest us. Here are some examples of organization types that we will certainly integrate: *academy, church_school, diplomatic_mission, deputation, educational institute, family, industry, institution, local*.

Finally, here is an example of how to describe the President Zafy Albert in the language of YAGO.

<Zafy_Albert > rdf:type <wordnet_president_110467179> <Zafy_Albert> <hasGender> <male> <Zafy_Albert > schema:birthDate <1927-05-01> <Zafy_Albert > schema:deathDate <2017-10-13> <Zafy_Albert > <isCitizenOf><Madagascar>

ii. *Implicit Translation*

We have to create a new prefix- *tontoloMG* - to permit any extensions and to associate new relations. This step is necessary if we want to incorporate translations into Malagasy in our ontology.

The following relations will be used to indicate translation:

- *mg_classic:* to associate a concept (entity, predicate, relation) with its translation into classic and official Malagasy.

  Example:

  President ***tontoloMG : mg_classic*** Filoha
  <isMarriedTo> ***tontoloMG : mg_classic*** '(dia) manambady an'i'

- *mg_dialect:* to associate a concept with its dialect-version.

  Example:

  Olona ***tontoloMG : mg_dialect*** olo

- *mg_familiar. to* associate a concept with colloquial language. Colloquial language may include foreign words or words of foreign origin.
  Here are some examples :

  Boy ***tontoloMG: mg_familiar*** Kôfboay (from English: *cow-boy)*
  Money ***tontoloMG: mg_familiar*** Sôsy

iii. *Implicit Specification*

The *mg_specific* relation will allow us to introduce into our ontology concepts specific to the Malagasy culture. They are necessarily expressed in Malagasy. In the official Malagasy language, for example, there is no single word to designate an uncle or an aunt. The Malagasy *specifies:*

- If it is an uncle who is the eldest in the siblings, he is called *dadatoa*
- If it is an uncle who is the youngest in the siblings, he is called *dadafara*
- If it is an uncle who is somewhere inbetween, he is called *dadanaivo*

In praxis however, certainly for simplicity, many people use familiar language which permit to call invariably an uncle *Tonton* (a French word).
We would therefore write:

Uncle *tontoloMG:mg_specific Dadatoa |Dadanaivo| Dadafara*

Uncle *tontoloMG:mg_familiar Tonton*

V. Conclusion

This project was motivated by the obvious exclusion of emerging worlds by the new paradigms of AI because of the lack of massive data describing them. These worlds are actually just as old as the world known to AI. It's just that they have never been taken into account because they are not part of dominant cultures. Consequently, there is very little, if any, data that could be exploited by statistics for the purpose of making decisions or making predictions automatically. The approach we propose to remedy this lack is cognitive in nature and relies on knowledge engineering. We are experimenting it on the case of Malagasy culture. Our objective is to build a historical and cultural knowledge base in order to conserve and preserve the essence of Malagasy cultural identity. We therefore adopt YAGO, a state-of-the-art ontology, and exploit it to the limit of the possible to then customize it manually and complete it with specific concepts and facts. By doing so, we also facilitate the integration of the Malagasy universe into an already multicultural ontology. Another very important achievement is the potential for using our ontology as an instrument for the automatic production of corpora in Malagasy language. We are aware that over time, as automatic processing advances on these emerging worlds, new, more sophisticated needs will arise that will need to be solved by contemporary AI techniques. In the meantime, we will have time to massively produce data (through projects like this one) so that we can one day catch up with the bandwagon. We must see in this type of project a way to start the road, where there is nothing, to facilitate the integration of emerging worlds into the known world so they can finally be detected by the new AI.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Journey of Artificial Intelligence Frontier: A Comprehensive Overview

By Saphalya Peta

Abstract- The field of Artificial Intelligence (AI) is a transformational force with limitless promise in the age of fast technological growth. This paper sets out on a thorough tour through the frontiers of AI, providing a detailed understanding of its complex environment. Starting with a historical context, followed by the development of AI, seeing its beginnings and growth. On this journey, fundamental ideas are explored, looking at things like Machine Learning, Neural Networks, and Natural Language Processing. Taking center stage are ethical issues and societal repercussions, emphasising the significance of responsible AI application. This voyage comes to a close by looking ahead to AI's potential for human-AI collaboration, ground-breaking discoveries, and the difficult obstacles that lie ahead. This provides with a well-informed view on AI's past, present, and the unexplored regions it promises to explore by thoroughly navigating this terrain.

The incorporation of Artificial Intelligence (AI) has emerged as a transformational trend across numerous industries in today's linked and technologically advanced society.

Keywords: *artificial intelligence, machine learning, deep learning, issues, natural language processing.*

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Journey of Artificial Intelligence Frontier: A Comprehensive Overview

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Abstract- The field of Artificial Intelligence (AI) is a transformational force with limitless promise in the age of fast technological growth. This paper sets out on a thorough tour through the frontiers of AI, providing a detailed understanding of its complex environment. Starting with a historical context, followed by the development of AI, seeing its beginnings and growth. On this journey, fundamental ideas are explored, looking at things like Machine Learning, Neural Networks, and Natural Language Processing. Taking center stage are ethical issues and societal repercussions, emphasising the significance of responsible AI application. This voyage comes to a close by looking ahead to AI's potential for human-AI collaboration, ground-breaking discoveries, and the difficult obstacles that lie ahead. This provides with a well-informed view on AI's past, present, and the unexplored regions it promises to explore by thoroughly navigating this terrain.

The incorporation of Artificial Intelligence (AI) has emerged as a transformational trend across numerous industries in today's linked and technologically advanced society. This study examines the complex landscape of AI implementation, examining the range of difficulties encountered across diverse fields. The complex problems are identified that emerge when AI technologies collide with operational contexts through a methodical investigation of industries including healthcare, finance, manufacturing, and education. Each industry has its own unique set of challenging issues, ranging from worries about data privacy and security to ethical issues involving bias and decision-making. By exploring these problems, light is shed on the complex interactions between AI and industry and highlight the need for customized solutions that strike a balance between innovation and responsible deployment. This paper presents a comprehensive perspective on the issues that AI introduces and the potential solutions to successfully navigate them by bridging the technological and industry-specific complexity gap.

Keywords: artificial intelligence, machine learning, deep learning, issues, natural language processing.

I. Introduction

1. *Artificial Intelligence:* The two primary dimensions of artificial intelligence definitions—reasoning, thought processes, and behavior—variate. Systems that think and act like people and Systems that think and act rationally are the two main categories under which these definitions fall.
2. *Machine Learning*[1]*:* The usage and creation of computer systems that can learn and adapt without being given explicit instructions by analyzing data patterns and drawing s using algorithms and statistical models.
3. *Deep Learning*[2]*:* A kind of artificial neural network-based machine learning in which data is processed through successive layers to extract increasingly complex properties.
4. *Modern Definition of Artificial Intelligence*[3]*:* An intelligent agent is a system that observes its surroundings and acts to maximize its chances of success. Artificial intelligence (AI) is "the study and creation of intelligent agents."

The foundations of Artificial Intelligence[4] are:

- *Philosophy:* Is it possible to reach reliable results using formal rules? How does a physical brain give rise to the mental mind? From where does knowledge originate? How can information become action?
- *Mathematics:* What are the formal guidelines for arriving at reliable s? What is calculable? How do we make decisions based on ambiguous data?
- *Economics:* How should we choose to maximize reward? How should we proceed when others might not agree? How should we proceed when the reward could be years away?
- *Neuroscience:* How do minds interpret data?
- *Psychology:* How do people and other creatures think and behave?
- *Computer Engineering:* How can an effective computer be created?
- *Cybernetics and Control Theory:* How may artifacts function under their control?
- *Linguistics:* How do mind and language interact?

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[1] Tom Mitchel "Machine Learning", Tata McGraW Hill, 2017.
[2] Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with Tensor Flow: Explore neural networks with Python", Packt Publisher, 2017.
[3] Melanie Mitchell, "Artificial Intelligence: A Guide for Thinking Humans", 2020.
[4] Peter Norvig and Stuart J. Russell, "Artificial Intelligence: A Modern Approach", 1995

II. Perceptions of Intellectuals and Institutions

1. "AI needs to be created to help people. AI needs to be open, optimize efficiency without undermining human dignity, be designed for intelligent privacy, have algorithmic accountability so humans can repair unintended harm, defend against bias, and be transparent. Human empathy and education are also crucial. Human ingenuity will always be needed, and a person must ultimately bear responsibility for the results of a computer-generated diagnostic or judgment." ~ Satya Nadella, CEO Microsoft.
2. "Artificial intelligence needs to be regulated. It is too important not to. The only question is how to approach it." ~ Sundar Pichai, CEO Google
3. "Artificial intelligence is the future not only of Russia but of all of mankind," ~Vladimir Vladimirovich Putin, President of Russia
4. "Artificial Intelligence is a tribute to human intellectual power," ~ Narendra Modi, Prime Minister, India
5. "We need international and national policies and regulatory frameworks to ensure these emerging technologies benefit humanity. We need a human-centered AI. AI must be for the greater interest of the people, not the other way around."~ UNESCO.
6. "Who ought to Stop Unethical A. I.? At artificial-intelligence conferences, experimenters are more and more hysterical by what they see."~ Matthew Hutson, Eminent Author, New York, USA.
7. "AI bias is the underpinning prejudice in data that produces AI algorithms, which can eventually affect demarcation and other social consequences." ~ Terence Shin, Data Scientist, KOHO Data and Marketing Advisor.
8. "AI creates bottomless severance." ~www.weforum.org.
9. "The development of full artificial intelligence could spell the end of the human race. It would take off on its own, and re-design itself at an ever-increasing rate. Humans, who are limited by slow biological evolution, could not compete, and would be superseded."
10. ~ Stephen Hawking, English theoretical physicist, cosmologist, and author, Director of research at the Centre for Theoretical Cosmology, University of Cambridge.
11. "The pace of progress in artificial intelligence (I am not referring to narrow AI) is incredibly fast. Unless you have direct exposure to groups like Deepmind, you have no idea how fast- it is growing at a pace close to exponential. The risk of something seriously dangerous happening is in the five-year time frame. 10 years at most." ~ Elon Musk, CEO Tesla Motors.
12. "We must address, individually and collectively, moral and ethical issues raised by cutting-edge research in artificial intelligence and biotechnology, which will enable significant life extension, designer babies, and memory extraction." ~ Klaus Schwab, Chairperson of World Economic Forum.
13. "Artificial intelligence is growing up fast, as are robots whose facial expressions can elicit empathy and make your mirror neurons quiver." ~ Diane Ackerman, American poet, essayist, and naturalist.

III. Review of Literature

a) *History of Artificial Intelligence*[5]

Maturation of Artificial Intelligence (1943-1952).

- *The year 1943:* Warren McCulloch and Walter Pits produced the first work today known as AI in 1943. They put forth a model of synthetic neurons.
- *Year 1949:* Donald Hebb presented a rule for updating the strength of the connections between neurons, and Hebbian learning is the modern name for his rule.
- *The year 1950:* English mathematician Alan Turing invented machine learning in that year. In his book "Computing Machines and Intelligence," Alan Turing outlined a test. A Turing test can be used to determine whether a machine can behave intelligently on par with a human.

The birth of Artificial Intelligence (1952-1956).

- *Year 1955:* Herbert A. Simon and Allen Newell developed "Logic Theorist," the first artificial intelligence program. In addition to finding new and better proofs for some theorems, this program has proven 38 of 52 mathematical theorems.
- *1956:* During the Dartmouth Conference, American computer scientist John McCarthy coined "artificial intelligence." AI was originally recognized as a legitimate academic discipline.

High-level programming languages like FORTRAN, LISP, and COBOL were created during that period. And at that time, interest in AI was at an all-time high.

The Golden Years-Early enthusiasm (1956-1974).

- *Year 1966:* The researchers strongly emphasized creating algorithms that can resolve mathematical issues. In 1966, Joseph Weizenbaum invented the first chatbot, ELIZA.
- *1972:* The first intelligent humanoid robot was built in Japan, WABOT-1.

The first AI winter (1974-1980).

The first AI winter period ran from the years 1974 through 1980. The term "AI winter" describes a

[5] Osondu Oguike, "A First Course in Artificial Intelligence", 2021

period when computer scientists struggled with a severe lack of government funding for AI research.

Public interest in artificial intelligence fell during AI winters.

A boom of AI (1980-1987).

- In 1980, AI returned with "Expert System" after its winter hiatus. Expert systems that can make decisions like a human expert have been programmed.
- The American Association of Artificial Intelligence had its inaugural national conference at Stanford University in the year 1980.

The second AI winter (1987-1993).

The second AI Winter period spanned the years 1987 to 1993.

Again, due to excessive costs and ineffective results, investors and the government ceased sponsoring AI research. An extremely cost-effective expert system was XCON.

The emergence of intelligent agents (1993-2011).

- *Year 1997:* The first computer to defeat a global chess champion was IBM Deep Blue, which accomplished this feat in 1997 by defeating Gary Kasparov.
- *Year 2002:* AI debuted in the house as a vacuum cleaner called Roomba.
- *The Year 2006:* Up to 2006, AI was introduced to the business world. Additionally, businesses like Facebook, Twitter, and Netflix began utilizing AI.
- *Deep learning, big data, and artificial general intelligence (2011-present):*
- *Year 2011:* In 2011, IBM's Watson, a computer program that had to answer challenging questions and riddles, won the quiz show Jeopardy. Watson had demonstrated its ability to comprehend natural language and quickly find answers to challenging problems.
- *The Year 2012:* Google introduced the "Google Now" function for Android apps, which can predict information for the user.
- *Year 2014:* The chatbot "Eugene Goostman" achieved first place in the famed "Turing test" competition in 2014.
- *Year 2018:* The IBM "Project Debater" excelled in a debate with two master debaters on difficult subjects. In a demonstration, Google's artificial intelligence program "Duplex" took on-call appointments for a hairdresser. At the same time, the person on the other end of the line was unaware that she was speaking with a machine.
- *Year 2019:* With the introduction of fresh methods like unsupervised learning and reinforcement learning in 2019, deep learning made more advancements. In 2019, big data, which entails the analysis of enormous datasets, remained an essential part of AI. In 2019, researchers continued to work towards creating artificial general intelligence (AGI), or AI that can carry out any intellectual endeavor that a human can.
- *Year 2020:* With the creation of new models and methods, deep learning—which entails training artificial neural networks with lots of data—has continued to advance. The rise of self-supervised learning, a method that enables neural networks to learn from data without explicit labels or supervision, was one significant discovery in 2020. In 2020, big data will still be a crucial part of AI, and the growing availability of data will fuel the field's innovation. The development of federated learning, a method that enables several parties to cooperatively train machine learning models without sharing their data, was one theme in 2020. In 2020, researchers' long-term objective was still artificial general intelligence (AGI), but progress was slowly being made.
- *Year 2021:* With the creation of new models and methods, deep learning continued to advance. The growing application of transformer models, such as GPT-3, for various natural language processing applications was one noteworthy breakthrough in 2021. Big data continued to be a crucial part of AI in 2021, with the field's innovation being driven by the expanding availability of data. The application of machine learning in industries like banking and healthcare, where analyzing massive datasets can improve decision-making and patient outcomes, was one theme in 2021. In 2021, researchers' long-term objective remained the development of artificial general intelligence (AGI).
- *Year 2022:* With the development of new models and methods, such as the improvement of self-supervised learning and the utilization of attention mechanisms, deep learning is anticipated to continue to evolve. In 2022, big data is anticipated to continue to be a vital part of AI, with the field's ongoing innovation being fueled by the expanding availability of data. In 2022, researchers' long-term objective is still anticipated to be the development of artificial general intelligence (AGI). Even if obtaining AGI remains a formidable obstacle, it is anticipated that current research in fields like cognitive architectures, reinforcement learning, and explainable AI will advance the discipline. Also, there will probably continue to be an emphasis on making sure that the advancement of AI technology is responsible and advantageous for society, focusing on concerns like prejudice and fairness.
- *Year 2023:* Deep learning, big data, and artificial general intelligence are projected to continue to be significant areas of research and development in AI in 2023, based on current trends and prior developments.

The Amount of AI development nowadays is astounding. Deep learning, big data, and data science are currently in vogue like never before. Nowadays, businesses like Google, Facebook, IBM, and Amazon use AI to develop incredible technology[6]. Artificial intelligence has a bright future and will be highly intelligent.

Privacy and surveillance, bias or discrimination, and the potential philosophical problem of using human judgment are among the legal and ethical problems[7] that artificial intelligence has brought about in society. As a result of its use, worries about more recent digital technologies becoming a new source of inaccuracy and data breaches have increased.

Artificial intelligence is in its early stages but is already widespread in applications[8] such as policing, stock trading, social networking, and medical diagnosis. The impact of AI is unevenly distributed across economic activity and social and political life. The full effects of AI are difficult to predict, and both optimistic and pessimistic predictions tend to contain exaggerations. Roy Amara's insight suggests that people overestimate the immediate effects and underestimate the long-term effects of new technologies like AI. However, it is widely acknowledged that AI will have significant effects on society. The approach we take to AI will shape our future, as stated by the European Commission. The mastery of AI is seen to global dominance, as stated by the president of Russia.
AI is described as "a combination of technologies that enable computers to see, learn, reason, and aid in decision-making to solve issues in ways that are comparable to what people do," in a book published by Microsoft in 2018. (Yet AI differs from human reasoning in important ways.) Artificial intelligence is defined as "systems that demonstrate intelligent behavior by assessing their surroundings and executing actions with some degree of autonomy to achieve certain goals," according to the European Commission's Communication on AI.

AI can resolve issues people cannot independently, particularly issues requiring enormous volumes of data and several possible solutions. AI could adjust for bias and human error. AI is not magic, though. Every AI algorithm incorporates human judgments and trade-offs. Algorithms do not have any value. AI may add new kinds of bias or errors or duplicate human error or bias.

b) Interconnected Disciplines within the Broader Field of AI

1. *Machine Learning*[9]

A data analysis technique called machine learning automates the creation of analytical models. It is a subfield of artificial intelligence founded on the notion that machines can learn from data, spot patterns, and make judgments with little assistance from humans.

2. *Evolution of Machine Learning*

Modern machine learning is distinguished from its predecessors by advancements in computing technologies. The concept of computers learning from data without explicit programming led to the emergence of artificial intelligence research. The iterative nature of machine learning, where models adjust and learn from previous calculations, is crucial for trustworthy and reproducible outcomes. While machine learning techniques have existed for some time, recent breakthroughs in processing vast amounts of data have propelled its progress. Well-known applications include self-driving cars, exemplifying the core of computer learning, and online recommendations from platforms like Netflix and Amazon, which utilize machine learning to understand user preferences. Machine learning also plays a role in analyzing customer feedback on platforms like Twitter and involves a combination of language rule creation and machine learning. Additionally, fraud investigation stands out as a significant real-world application of machine learning.

3. *Machine Learning and Artificial Intelligence*[10]*:*

Machine learning is a particular branch of artificial intelligence that teaches a machine how to learn, whereas artificial intelligence is the general science that aims to emulate human abilities.

The increasing popularity of data mining, Bayesian analysis, and machine learning is driven by factors such as expanding data quantities, diverse data types, more powerful and affordable computation, and reasonably priced data storage. These factors enable the creation of models that can analyze complex data, provide faster and accurate answers, and uncover lucrative opportunities or potential threats. Machine learning focuses on developing techniques that use data to improve performance on specific tasks, often incorporating elements of artificial intelligence. Machine learning algorithms generate predictions or decisions without explicit programming, making it useful in various fields such as medicine, email filtering, speech recognition, and computer vision. While closely related to computational statistics, not all machine learning is

[6] James V. Stone, "Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning", 2019
[7] Nick Bostrom, "Super intelligence: Paths, Dangers, Strategies", 2014
[8] Kevin Warwick, "Artificial Intelligence: The Basics", 2011
[9] Giuseppe Bonaccorso, "Machine Learning Algorithms", 2nd Edition, Packt, 2018
[10] Parag Mahajan, "Artificial Intelligence in Healthcare: AI, Machine Learning, and Deep and Intelligent Medicine Simplified for Everyone", 2019

statistical learning. Machine learning benefits from mathematical optimization research and incorporates unsupervised learning for exploratory data analysis. Some machine learning systems utilize neural networks to simulate biological brain functioning. Predictive analytics is another term used for machine learning in solving business challenges. Learning algorithms assume that past successful methods will likely continue to be successful. Machine learning programs can perform tasks without explicit programming, learning from available data. This approach is particularly useful for increasingly complex tasks where manually designing algorithms becomes challenging. Machine learning employs techniques such as recognizing multiple valid responses and refining algorithms through practice data. The two main goals of modern machine learning are constructing data-supported models for classification and using these models to predict future events, such as identifying malignant moles or advising stock traders.

c) Machine Learning as Subfield of AI

Machine learning is an area of study that developed from the search for artificial intelligence. Some academics were intrigued by the idea of having machines learn from data in the early stages of artificial intelligence as a field of study. They tried using various symbolic techniques, including what was then referred to as "neural networks"- mostly perceptron and other models that were later discovered to be reimagining of the generalized linear statistics models. The use of probabilistic reasoning was widespread, particularly in automated diagnosis.

A gap has emerged between AI and machine learning due to a shift towards a logical, knowledge-based approach in AI. Probabilistic systems faced challenges in data gathering and representation, leading to a decline in the popularity of statistics and the rise of expert systems in AI. Symbolic/knowledge-based learning and pattern recognition, more statistical in nature, moved beyond the realm of AI. Neural network development was abandoned by both AI and computers until researchers from other fields reintroduced it in the 1980s, known as connectionism. In the 1990s, machine learning experienced a resurgence as a distinct field, focusing on practical problem-solving using techniques from applied mathematics, statistics, and symbolic logic. Understanding the distinction between AI and machine learning is important. AI involves agents interacting with the world to learn and take actions, while machine learning learns and predicts based on passive observations. Some consider machine learning as a subset of AI, while others see it as a distinct but intelligent subset.

1. *Supervised Learning*

In supervised learning[11], a mathematical model is created based on training data consisting of inputs and expected outputs. Each training example contains a supervisory signal in the form of desired output. Supervised learning algorithms learn a function through iterative optimization to accurately predict outputs for new inputs. Regression is used for numerical output, classification for limited set outputs, and Active Learning is another category. Similarity learning, connected to regression and classification, focuses on learning from examples using a similarity function. Applications of similarity learning include speaker verification, visual identification tracking, recommendation systems, rating, and face and identity verification. These techniques enhance machine learning's ability to make accurate predictions or outputs over time by learning from data.

2. *Unsupervised Learning*

Unsupervised learning[12] is a type of machine learning where the training algorithm does not receive labeled data but instead searches for patterns and structures in the input data. It is used for feature learning or finding hidden patterns in data. Unsupervised learning algorithms analyze input-only data to identify similarities or groupings, such as clustering. These algorithms do not rely on feedback and instead act based on commonalities found in the data. Unsupervised learning is applied in various fields, including density estimation and data summarization. Cluster analysis is a technique in unsupervised learning that divides a dataset into subsets or clusters based on predetermined criteria. Different clustering approaches make assumptions about data structure and use similarity metrics to evaluate clusters. Internal compactness and separation are measures used to assess the quality of clustering, along with estimated density and graph connectedness. Unsupervised learning plays a vital role in understanding and describing data features without relying on labeled information.

3. *Semi-Supervised Learning*

Between supervised Learning (fully labeled training data) and unsupervised Learning (no labeled training data), there is semi-supervised Learning[13]. Many machine learning researchers have discovered that unlabeled data can significantly improve learning accuracy, even though some training examples lack training labels when used with a small amount of labeled data. Although the training labels in poorly supervised Learning are frequently less expensive to obtain, this results in larger functional training sets.

[11] Abhishek Vijavargia "Machine Learning using Python", BPB Publications, 1st Edition, 2018

[12] Yuxi Liu, "Python Machine Learning by Example", 2nd Edition, PACT, 2017

[13] Tom Mitchel "Machine Learning", Tata McGraW Hill, 2017.

4. *Reinforcement Learning*

Reinforcement learning is a subset of machine learning that focuses on how software agents interact with dynamic environments to maximize cumulative rewards. It involves feedback and incentives to guide the agent's behavior. Markov decision processes (MDPs) are commonly used to represent the environment in reinforcement learning. Dynamic programming is employed in many reinforcement learning systems, and these algorithms can be applied when exact models of the environment are impractical. Reinforcement learning finds applications in various fields, including autonomous vehicles and training agents to play games against human opponents.

5. *Neuromorphic/Physical Neural Networks:*

An artificial neural network that mimics the function of a neural synapse using an electrically changeable material is known as a physical neural network, also known as a neuromorphic computer. The term "physical" neural network[14] emphasizes using hardware rather than software-based methods to simulate neurons. The phrase refers to other artificial neural networks that simulate neural synapses using a memristor or another material with electrically changeable resistance.

6. *Deep Learning*

Deep learning[15] is a subset of machine learning that utilizes neural networks with multiple layers to mimic human brain functions and learn from vast amounts of data. It is a key component of data science and enables quicker and simpler analysis of large datasets. Deep learning is employed in various applications, such as driverless cars recognizing objects and distinguishing between them. The term "deep" refers to the additional layers added to the neural network for learning purposes. The weights in the model are updated through optimization functions during the learning process. Deep learning falls under the broader field of artificial intelligence (AI) and facilitates the development of AI-driven applications. Deep Learning Applications.

1. Virtual Assistants
2. Chatbots
3. Healthcare
4. Entertainment
5. News Aggregation and Fake News Detection
6. Composing Music
7. Image Coloring
8. Robotics
9. Image Captioning
10. Advertising
11. Self-Driving Cars
12. Natural Language Processing
13. Visual Recognition
14. Fraud Detection
15. Personalization
16. Detecting Developmental Delay in Children
17. Colorization of Black and White images
18. Adding Sounds to Silent Movies
19. Automatic Machine Translation
20. Automatic Handwriting Generation
21. Automatic Game Playing
22. Language Translations
23. Pixel Restoration
24. Demographic and Election Predictions
25. Deep Dreaming

Artificial intelligence (AI) enables machines to mimic human activity, while machine learning (ML) incorporates AI to facilitate continuous learning and improvement. Deep learning (DL) is a subset of ML that involves training models using sophisticated algorithms and deep neural networks. Convolutional neural networks (CNNs) are a specific type of deep learning architecture used for tasks like image recognition. DL focuses on transforming and extracting features to establish relationships between stimuli and neural responses in the brain. It addresses the opaqueness or "black box" issue, making it challenging to understand how judgments are reached. DL requires large amounts of data for effective training and often relies on powerful hardware for complex calculations. It excels in tasks such as audio, text, and image classification but may not be suitable for general-purpose algorithms. DL is utilized in various fields including computer vision, speech recognition, natural language processing, and medical image analysis.

Artificial neural networks (ANNs)[16] are inspired by biological systems but differ in their static and symbolic nature compared to the dynamic and analog nature of biological brains. Deep learning refers to the usage of multiple layers in neural networks to gradually extract higher-level features from raw data. These deep learning layers can depart significantly from biologically informed models. Convolutional neural networks (CNNs)[17] are commonly used in deep learning, especially for image processing tasks. Each layer in deep learning learns to transform the input data into increasingly abstract representations. Deep learning algorithms avoid manual feature engineering by automatically learning concise intermediate representations. They can handle unsupervised learning tasks, which is advantageous due to the prevalence of unlabeled data. However, deep learning techniques have faced challenges in matching the performance of other models in certain domains, such as speech

[14] Ganguly Kuntal, "Learning generative adversarial networks: next-generation deep learning simplified", Packt Publishing, 2017.
[15] Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.
[16] Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.
[17] LiMin Fu, "Neural Networks in Computer Intelligence", McGraw-Hill edition, 1994.

recognition, due to issues like gradient fading and limited training data.

d) Artificial Neural Networks

Artificial neural networks (ANNs) or connectionist systems are computing systems inspired by biological neural networks. They learn tasks through examples rather than explicit programming. ANNs, built with artificial neurons, process signals through connections (synapses) and can adjust the weights of these connections during learning. Neurons are typically organized in layers, and signals can pass through multiple layers before reaching the output layer. Originally aimed at emulating human brain functions, the focus shifted towards specific tasks, leading to techniques like back propagation.

ANNs have been successfully applied in computer vision, speech recognition, machine translation, social network filtering, games, and medical diagnosis. While ANNs have far fewer neurons than the human brain, with millions of connections and thousands to millions of units, they can outperform humans in certain tasks such as playing "Go" or recognizing faces. Their ability to process vast amounts of data and learn from examples makes them powerful tools in various applications.

e) Deep Neural Networks

A deep neural network (DNN)[18] is an artificial neural network with more than two layers between the input and output layers. Neurons, synapses, weights, biases, and functions are common building blocks shared by all types of neural networks. DNNs can be trained and perform tasks like the human brain. They are capable of recognizing patterns, such as identifying dog breeds from images, by analyzing the probabilities associated with different outcomes. The term "deep" refers to the multiple layers involved in mathematical operations within the network.

DNNs excel in modeling complex non-linear relationships, using layers to compile characteristics from lower layers and represent objects as compositions of primitives. They are particularly efficient in approximating sparse multivariate polynomials. Various DNN architectures exist, each with its own strengths and performance in specific fields, but comparisons require standardized datasets for fair evaluation.

DNNs are often feedforward networks, where information flows from the input layer to the output layer. Weights between virtual neurons are initially assigned random numerical values and adjusted through algorithms to improve pattern recognition. Recurrent neural networks (RNNs) are employed in applications like language modeling, allowing bidirectional data flow, while convolutional deep neural networks (CNNs) are used in computer vision tasks. CNNs have also found application in acoustic modeling for automated speech recognition (ASR), among others. Some of the applications are:

1. Automatic speech recognition
2. Image Recognition
3. Visual art Processing
4. Natural Language Processing
5. Drug discovery and Toxicology
6. Customer relationship management
7. Recommendation systems
8. Bioinformatics
9. Medical image analysis
10. Mobile advertising
11. Image Restoration
12. Financial fraud detection
13. Relation to human cognitive and brain development
14. Commercial activity

f) Natural Language Processing

A branch of linguistics, computer science, and artificial intelligence called "natural language processing" (NLP)[19] studies how computers and human language interact, with a focus on how to program computers to handle and analyze massive volumes of natural language data. The goal is to create a machine that can "understand" the contents of documents, including the subtle subtleties of language used in different contexts. Once the information and insights are accurately extracted from the documents, the technology can classify and arrange them. Speech recognition, natural language interpretation, and natural language synthesis are complex tasks in natural language processing.

g) Common NLP Tasks

The most frequently investigated tasks in natural language processing are listed below. Some of these jobs have direct applications in the real world, while others are more frequently utilized as subtasks to help solve more significant challenges. Even though the tasks involved in natural language processing are interconnected, it is nevertheless possible to categorize them for ease of use.

1. *Text and Speech Processing*
2. *Morphological Analysis:* Lemmatization, Stemming
3. *Syntactic Analysis:* Parsing
4. *Lexical Semantics:* Vocabulary extraction, Disambiguation of words- WSD, Linking of entities
5. *Relational Semantics*

[18] Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.

[19] Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta & Harshit Surana "Practical Natural Language Processing: A Comprehensive Guide to Building Real world NLP Systems", O' Reilly Media, Inc., 1st Edition, 2020.

h) Computer Vision

Computer vision (CV)[20] is a multidisciplinary scientific field that aims to enable computers to understand and automate operations performed by the human visual system. It involves capturing, processing, analyzing, and comprehending digital images to extract meaningful information and make judgments. CV tasks encompass various methods, including image understanding, scene reconstruction, object identification, event detection, video tracking, and more.

The field focuses on developing theoretical foundations and computational models to achieve autonomous visual understanding. By leveraging principles from geometry, physics, statistics, and learning theory, computer vision aims to decouple symbolic information from image data.

Computer vision finds applications in diverse domains, such as industrial machine vision systems for quality control, research in artificial intelligence, and the development of computers or robots capable of understanding their environment. It overlaps with machine vision, which combines automated image analysis with other technologies for industrial inspection and robot guidance.

While traditional computer vision approaches involve pre-programmed tasks, there is an increasing trend toward learning-based methods in the field. This allows systems to adapt and improve their performance through experience and training. A few examples of computer vision applications.

1. Learning 3D shapes Controlling operations
2. Medicine
3. Machine vision.
4. Military
5. Automated Vehicles
6. Tactile feedback
7. Motion Analysis
8. Scene reconstruction
9. Image Restoration
10. System methods
11. Image understanding systems

IV. How does AI Work?

A vast volume of labeled training data is typically ingested by AI systems, which then examine the data for correlations and patterns before employing these patterns to forecast future states. For the software to learn automatically from patterns or features in the data, artificial intelligence combines massive amounts of data with quick, iterative processing and sophisticated algorithms. Large data sets are combined with clever, iterative processing algorithms to create AI systems[21] that can learn from patterns and features in the data they analyze. An AI system assesses and evaluates its own performance after each round of data processing, adding to its knowledge base. ML-based financial fraud detection, picture recognition for face unlocks in mobile devices, and voice assistants are a few examples of AI software already being used daily.

In most cases, all that is needed is AI software, which can be downloaded from an online retailer. AI refers to a machine's capacity to exhibit traits shared by humans, such as creativity, Learning, planning, and reasoning. AI allows technical systems to comprehend their surroundings, deal with what they see, solve issues, and take action to reach a particular objective.

a) Solving Problems by Searching

Intelligent agents[22] aim to maximize their performance metric, which can be accomplished more quickly if the agent can embrace a goal and work towards achieving it. Imagine that an agent wishes to see Europe while on vacation. The agent's effectiveness is measured by various variables, including how quickly they travel, how many places they visit, how adventurous they are, how well they are accommodated, how much variety they sample, etc.

b) Logical Agents

An intelligent agent needs information about the outside environment to make wise decisions. Agents know the form of knowledge representation language sentences kept in knowledge bases. A representation language is described by its semantics, which describes the truth of each statement in each conceivable model, and by its syntax, which specifies the structure of sentences. The theory behind logical AI is that an agent may express its knowledge of the world, its objectives, and the current situation using logical phrases and can then decide what to do by assuming that a specific course of action will effectively achieve its objectives.

c) Inference in First-Order Logic

Declarative and expressive knowledge representation languages for ideal knowledge bases should be compositional, context-independent, and unambiguous. First-order logic[23], in contrast to propositional logic[24], makes an ontological commitment to the existence of objects and relations, enhancing its expressive power. First-order logic models consist of objects, their connections, and applicable functions. Atomic sentences are formed by applying predicates to

[20] V Kishore Ayyadevara and Yeshwanth Reddy, "Modern Computer Vision with PyTorch: Explore Deep Learning Concepts and Implement Over 50 Real-world Image Applications", 2020

[21] Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill, 3rd Edition, 2018.

[22] Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Ed., Prentice Hall, 2010.

[23] Osondu Oguike, "A First Course in Artificial Intelligence", 2021

[24] Kevin Warwick, "Artificial Intelligence: The Basics", 2011

objects, while connectives and quantifiers are used for complex and quantified sentences.

Building first-order logic knowledge bases requires careful domain analysis, vocabulary selection, and encoding of axioms to support intended inferences. The inference problem in first-order proofs involves the instantiation phase, which can be expedited using unification to find suitable variable substitutions. Generalized Modus Ponens is an inference rule that employs unification and is an effective method for first-order logic.

Modus Ponens is a fundamental rule of inference stating that if P and P → Q are confirmed, we can infer Q. Forward chaining is used in production systems and deductive databases, executing in polynomial time and being complete for Datalog programs. Backward chaining is employed in logic programming languages like Prolog, utilizing compiler technology for faster inference, but it can encounter infinite loops that can be resolved by memoization.

d) Knowledge Representation

A general-purpose ontology is necessary for large-scale knowledge representation[25] to organize and connect the several sample domains of information. A general-purpose ontology should, in theory, be able to handle any domain and cover a wide range of knowledge. An ontology in AI is a term for a common language among researchers, and it offers definitions of fundamental ideas and their connections that are machine-interpretable. With the aid of ontology-based AI, a system can infer things that resemble human conduct by using the contents and connections between them.

e) Planning

Planning systems employ first-order or propositional representations of states and actions to address problems effectively. The STRIPS[26] language describes actions based on preconditions and effects, while initial and goal states are represented as conjunctions of positive literals. ADL (Action Description Language)[27] is an extension of STRIPS that allows for disjunctions, negation, and quantifiers, enabling robot-specific planning and scheduling. State-space search can be conducted in forward (progression) or backward (regression) directions. Heuristics can be generated by assuming subgoal independence and using various relaxations of the planning problem. Partial-Order-Planning (POP)[28] algorithms maintain a partial ordering of actions and explore the space of plans without committing to a fully ordered sequence of actions, making them suitable for divide-and-conquer strategies.

f) Probabilistic Reasoning over Time

Bayesian Networks[29] are probabilistic graphical models that represent variables and their conditional dependencies using a directed acyclic graph. Each node has a conditional distribution given its parents, allowing for precise depiction of conditional independence relationships. Hybrid Bayesian Networks combine discrete and continuous variables and use various canonical distributions. Exact inference in singly connected networks can be performed in linear time, but it is generally challenging in most cases. Relational Probability Models offer a rich representation language for structured statistical models, combining probability theory with ideas from first-order logic. Representational constraints ensure a precise probability distribution that can be represented by an equivalent Bayesian network. Truth-functional systems have been used in alternative reasoning systems but may have limitations for reasoning under uncertainty.

g) Decision Process

Markov Decision Processes (MDPs)[30] are stochastic models for sequential choice problems in ambiguous situations. They have a transition model that specifies probabilistic outcomes of actions and a reward function for each state. The next state only depends on the current state, independent of the past. The utility of a state sequence is the total of rewards received, possibly discounted over time. An MDP's solution is a policy that determines the agent's choice for each possible state. The value iteration algorithm iteratively resolves equations to compute state utilities, while policy iteration involves calculating utilities and refining the policy.

h) Making Complex Decisions

Partially Observable Markov Decision Processes (POMDPs)[31] combine Markov Decision Processes with hidden Markov models to model system dynamics and unobservable states. Decision theoretic agents can be developed for POMDP environments using dynamic decision networks. Game theory is a mathematical branch used to model strategic interactions between rational agents in predefined contexts. Nash equilibrium strategy, where no player has an incentive to change their approach, is often used to resolve games. Mechanisms can be employed to define rules for agents to maximize global utility while considering individual rationality. These mechanisms

[25] Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011.

[26] https://www.aiforanyone.org/glossary/stanford-research-institute-problem-solver#:~:text=STRIPS%20is%20a%20formalism%20used,in%20AI%20applications%20since%20then.

[27] https://www.adl.org/resources/blog/six-pressing-questions-we-must-ask-about-generative-ai

[28] https://www.cs.utexas.edu/users/mooney/cs343/slides/pop.pdf

[29] Trivedi M.C., "A Classical Approach to Artificial Intelligence", Khanna Publishing House, Delhi, 2018.

[30] Tom Taulli, "Artificial Intelligence Basics: A Non-Technical Introduction", 2019

[31] Peter Norvig and Stuart J. Russell, "Artificial Intelligence: A Modern Approach", 1995

may not require every agent to take other agents' decisions into account.

i) Learning with Complete Data

Learning can involve supervised learning and inductive learning, which focus on learning functions from examples. Supervised learning relies on feedback from a teacher or environment to improve performance. Classification and regression are types of learning for discrete valued functions. Inductive learning aims to find a reliable theory that supports the given examples. Occam's razor suggests favoring simpler models with fewer assumptions to avoid overfitting.

j) Learning with Hidden Variables: The Expectation-Maximized Algorithm

The cortex is constantly learning and inferring elements that produce sensory information. New learning algorithms and techniques have been presented in recent years that enable neural network models to learn these properties from real-world photos, text, audio signals, etc. The Expectation-Maximization (EM) algorithm, which is used to calculate the local maximum likelihood estimates (MLE) or maximum a posteriori estimates (MAP) for unobservable variables in statistical models, is described as the combination of many unsupervised machine learning algorithms.

k) Statistical Learning Method

Data comprehension technologies encompass statistical learning, which can be categorized into supervised and unsupervised learning. Supervised learning involves predicting or estimating an output based on inputs, while inferential statistics and descriptive statistics are commonly used in data analysis. Machine learning utilizes statistical methods, linear algebra, and calculus for improvement. Statistical learning plays a crucial role in various fields, such as research, business, and industry. An example application is predicting the likelihood of a patient experiencing another heart attack after being hospitalized for one.

l) Reinforcement Lear

Reinforcement learning[32] is a machine learning method that uses rewards and penalties to train agents. It involves perceiving and understanding the environment, taking actions, and learning from mistakes. Positive reinforcement learning includes two forms: 1) Markov Decision Process and 2) Q-learning. Unlike supervised learning, which relies on example data, reinforcement learning involves interaction with the environment. It finds applications in trajectory optimization, motion planning, dynamic pathing, controller optimization, and scenario-based learning policies for autonomous driving. For example, it can be used to learn automated parking strategies. Reinforcement learning is a powerful tool for decision-making and optimization, and it is widely utilized in machine learning applications today.

V. Communication

Artificial intelligence and communication go hand in hand. AI's defining test case and experimental data come from communication, especially interpersonal conversational interaction.

Level 1: We will initially receive meeting bots that resemble the command-and-control bots we presently use; we will not have to press any buttons; instead, we may say to a bot, "Join the meeting," and it will set everything up for us. These meeting bots will require active activation and will have limited language and knowledge of context. Streamlining the mechanical processes, we all detest, like dialing complex conference numbers, will make meetings more comfortable.

Level 2: Understanding of Natural Language: Beyond simple voice recognition, bots that comprehend the context and know the status of a meeting they are in will begin to appear. It will be possible for us to command, "Remind Sam to send this presentation to the team." On-demand Level 2 meeting bots can understand simple linguistic connections, monitor meeting activity (e.g., who is present, what file is being exhibited), and manage more complex aspects of professional interactions.

Level 3: Semantic Comprehension and Domain Knowledge: A meeting bot at this level can tell us, "I have analyzed your meeting, and here is a summary of the key points." A meeting bot at this level will listen to meetings and be able to tell what subjects are being addressed. It will provide its analysis following a discussion, which can aid our memory of important spoken issues. These bots will collect word clouds from meeting recordings and perform sentiment analysis to create summaries of what happened. They can include company- and domain-specific knowledge bases, such as jargon dictionaries and FAQs, in their analysis for greater accuracy. A Level 3 bot will provide more than just operational ease; it will assist participants in achieving their goals by cognitively processing some of the meeting content. Although there are now some reliable post-meeting support tools that summarize subjects and sentiment, it will still be five years before we can construct Level 3 bots that are trustworthy enough to begin releasing goods. Speech-to-text conversion (which machines can now do) is a much simpler task than analyzing human intent from human speech, and it is also outside the capabilities of current natural-language technology. However, this is the way we are going.

[32] Andrew Barto and Richard S. Sutton, "Reinforcement Learning: An Introduction", 2018

Level 4: Bots will be permitted to enter a conference in real-time at this level because they can discern human intent with sufficient accuracy: Here is the most recent research from Gartner on market estimates for the next three years in case we curious.AI may be able to comprehend nonverbal interpersonal interactions at this level as well. In a meeting, if we turn to someone and ask, "So we will follow up?" The bot will comprehend who and what we are speaking with and whether the other person has given their consent to be followed up with. After a meeting, it will be able to assist participants in keeping their commitments. Teams that use Level 4 meeting bots will succeed because they will keep participants on task following a meeting. A Level 4 meeting AI is fully extended when it can perceive and comprehend the complete spectrum of human communication, the majority of which is non-verbal. Nevertheless, it will be a fascinating challenge for engineers to figure out how AI would use human speech that can vary from what humans say.

Level 5: Level 4 bots will support special teams, whereas Level 5 bots will unite disparate teams. According to Andy Payne, Senior Director of Cisco Emerge, one of our research arms, "The meeting intelligence is not just in one meeting, it is in every meeting" at this utopian (or dystopian, depending on your perspective) level. Based on information gathered from meeting material and social network analysis, which includes chat and email data mining, this level of the bot is aware of overlapping meeting subjects, employees' particular skill sets, and the projects individuals are working on across the firm. A Level 5 bot might be aware of the overall business objectives, suggest team members for projects, and introduce people based on objectives, project requirements, and compatibility. A Level 5 bot might affect how well a company performs by enhancing team and interpersonal relationships. No one is ready for a robot boss, and we may never be. However, if we follow the trends in artificial intelligence, machine learning, and social data mining, we will inevitably be able to develop this capability.

a) Probabilistic Language Processing

Assuming a probabilistic model of the language, probabilistic language processing employs that model to infer things like how sentences should be broken down or how to understand unclear words. Applying statistical analysis codes to data analysis is known as probabilistic models in machine learning. It was one of the earliest approaches to artificial intelligence, and even now, it has still used quite a bit. The Naive Bayes algorithm[33] is one of the group's most well-known algorithms. In addition to creating data distributions in latent space representations, ML models are probabilistic in assigning probabilities to predictions in a supervised learning setting. These models can be entirely random, partially deterministic, or both.

b) Image Formation and Designing

The study of image formation covers the radiometric and geometric processes by which 2D images of 3D objects are created. Analog-to-digital conversion and sampling are also a part of the image generation process for digital images. Image processing is modifying an image to make it larger and produce information. There are two ways to process images:

- Photographs, prints, and other tangible copies of images are processed using analog image processing.
- Digital image processing, which uses intricate algorithms to manipulate digital images.

Businesses are scrambling to show off how AI is used in their products and services as interest in AI has surged. Often, they refer to AI as merely one element of AI, like machine learning, and AI needs specialized hardware and software to create and refine machine learning algorithms. No one computer language is exclusively associated with AI, but a few stand out, including Python, R, and Java.

Large amounts of labeled training data are typically consumed by AI systems, which then analyze the data for correlations and patterns before using these patterns to predict future states. A chatbot given samples of text chats may learn to have realistic conversations with people by looking at millions of instances. On the other hand, an image recognition program may be taught to identify and describe objects in pictures.

AI programming focuses on three cognitive processes[34]: Learning, reasoning, and self-correction.

1. *Learning Processes:* This part of AI programming focuses on acquiring data and creating rules for turning the data into information that can be used. The guidelines, sometimes called algorithms, instruct computer equipment on carrying out a specific activity step-by-step.
2. *Reasoning Processes:* The best way to accomplish a goal is what this field of AI programming is all about.
3. *Self-Correction Procedures:* This aspect of AI programming aims to continuously improve algorithms and make sure they deliver the most accurate results.

[33] Giuseppe Bonaccorso, "Machine Learning Algorithms", 2nd Edition, Packt, 2018

[34] Adelyn Zhou, Mariya Yao, and Marlene Jia, "Applied Artificial Intelligence: A Handbook for Business Leaders", 2018

VI. Categorization of Artificial Intelligence

The degree to which an AI system can replicate human abilities is used to define AI because AI research aspires to make computers mimic human-like functioning. Considering how a machine performs and compares to humans in terms of variety, AI can be divided into several categories. In such a system, an AI is considered more evolved if it can carry out more human-like tasks with equivalent levels of skill. On the other hand, with limited functionality and performance, AI is thought to be more straightforward and less sophisticated.

AI is frequently divided into two categories based on this criterion. One classification is based on how human-like AI and AI-enabled robots are and their capacity to "think" and possibly "feel" like people. Reactive machines, limited memory machines, theory of mind, and self-aware AI are the four kinds of AI or AI-based systems according to this classification scheme.

Reactive machines are task-specific and lack memory. Deep Blue, the IBM chess program that defeated Garry Kasparov in the 1990s, is one such. Deep Blue can identify chess pieces and make predictions, but because it lacks memory, it cannot use the past to shape the present.

1. *Limited memory:* Because these AI systems have memories, they might draw on the past to inform their decisions in the future. Some of the autonomous vehicles' decision-making processes are developed in this manner.
2. *Theory of mind:* The term "theory of mind" is used in psychology, and this can be used in AI, showing it has the social intelligence to understand emotions. This kind of AI can predict human behavior and deduce human intentions, which is a necessary skill for AI systems to join human teams as vital members.
3. *Self-awareness:* These AI systems possess a sense of self, which gives them awareness. Self-aware machines are conscious of their current state, and there is no this kind of artificial intelligence.

The alternative categorization scheme that is more commonly used in technical jargon is the classification of technology into Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Superintelligence (ASI).

1. *Artificial Narrow Intelligence (ANI):* All currently existing artificial intelligence, even the most complex and capable AI yet created, falls under this category. Artificial narrow intelligence describes AI systems that can only carry out a single task independently while displaying human-like capabilities. These machines have a limited or constrained set of capabilities since they can only complete the tasks for which they were created. These systems fit the reactive and limited memory AI categories described above. Even the most sophisticated AI that trains itself using deep Learning and machine learning is included in ANI.
2. *Artificial General Intelligence (AGI):* Artificial general intelligence is the ability of an AI agent to learn, sense, understand, and behave exactly like a human being. AI systems will be as competent as humans by imitating our multitasking abilities. These systems can develop various competencies independently and create connections and generalizations between domains, significantly reducing training time.
3. *Artificial Superintelligence (ASI):* Artificial Superintelligence (ASI), the most competitive type of intelligence on the planet, will mark the culmination of AI research. Due to their substantially improved memory, hastened data processing and analysis, and superior decision-making abilities, ASI will be far superior at everything they do in addition to emulating human intelligence. A singularity will happen as a result of the development of AGI and ASI. Although it may be alluring to have such potent weapons, these tools could imperil our existence or, at the very least, our way of life.

a) Distinction between Artificial Intelligence and Machine Learning

Artificial intelligence (AI) has many subsets and applications, including machine learning, which enables a system to learn from experience without being fully programmed. Machine learning uses data to learn and produce accurate results. Making computer software that that reads data and uses it to learn from itself is known as machine learning.

The artificial neural network and the recurrent neural network are two examples of the recurrent neural network, a subset of machine learning. It uses algorithms and its strategy to deal with complex problems. Like machine learning, the algorithms are built. Algorithms come in many more stages, in any case. Artificial neural networks (ANNs) are the networks created by the algorithm. Since all neural networks in the brain are connected according to deep Learning, it essentially copies the human brain.

Stats and Facts about Artificial Intelligence that Are Interesting and Surprising[35]

By 2027, it is expected that the market for AI, one of the technologies with the most outstanding growth rates, will be worth $270 billion. By 2030, it has anticipated to reach $15.7 trillion. 77% of people use artificial intelligence (AI) capabilities of machines in some capacity, although only 33% are aware of them.

[35] Osondu Oguike, "A First Course in Artificial Intelligence", 2021

The use of AI increased significantly during the COVID-19 pandemic. By 2021, 37% of jobs will use AI technology, up from 10% in 2015. The use of AI surged by 37% in the financial sector, 27% in retail, and 20% in IT. Building and implementing an AI algorithm is essential to their strategic goals, according to 83% of businesses.

b) AI Adoption in Various Industries

Security (25%), business analytics (33%), and sales and marketing (16%) are currently the top three industries using AI. However, 40% of companies claim that enhancing customer experience is the primary justification for adopting new technology. In 54% of organizations using AI, productivity has increased. However, according to 80% of business executives, productivity might be increased. Companies utilizing AI technology reported lower operational costs in 44% of cases. AI may reduce call times in customer service businesses by 70%, saving 40% to 60% in costs.

Using AI in sales could increase leads by more than 50%. 28% of companies utilize AI for marketing. However, compared to other technologies, artificial intelligence (AI) is seen as being more important by 84% of marketers. The market for agricultural robotics will be valued at $20.6 billion by 2025. Uncrewed aerial vehicles, drones, or UAVs, will cost $6.2 billion. By 2024, $6 billion is expected to be spent on AI in education. 80% of retail companies anticipate implementing AI in some capacity by 2027.

1. Wearables and Artificial Intelligence
2. AI in Autonomous Vehicles
3. AI in Robotics
4. AI in Voice Search
5. AI for Cybersecurity
6. AI in Healthcare

Artificial intelligence (AI) applications have been employed in business and academics to solve specific issues. Artificial intelligence is a general-purpose technology with many uses, like electricity or computers. It has been applied to areas such as e-commerce, credit scoring, picture recognition, and language translation.

c) Future of Artificial Intelligence

Unquestionably, artificial intelligence (AI) is a ground-breaking area of computer science that is poised to dominate several new technologies, including big data, robotics, and the Internet of Things. In the upcoming years, it will continue to be a technical innovator. AI has gone from being science fiction to reality in a matter of years. In the real world, as much as in science fiction films, intelligent machines assist humans. We live in a world of artificial intelligence, which was only a story for a while.

Whether we know it or not, artificial intelligence technology is being used daily and has already been ingrained into our culture. Everyone now uses AI in their daily lives, from chatbots to Alexa and Siri. Rapid advancement and evolution are taking place in this field of technology. However, it was more complex than it seemed to us. Many years of arduous labor and contributions from numerous people were required to get AI to this point. Being such a cutting-edge technology, AI also deals with many debates concerning its future and effects on people. It could be risky, but it is also a fantastic opportunity. AI will be used to improve cyber operations on the offensive and defensive sides. In addition, new cyber attack techniques will be developed to exploit specific AI technology weaknesses.

d) Present-Day Artificial Intelligence

Let us first understand what artificial intelligence is and where it is in its development before delving deeper into the topic in the future. The ability of machines or computer-controlled robots to carry out tasks connected to intelligence is what we call artificial intelligence (AI). AI is, therefore, the study of computers to create intelligent devices that can imitate human behavior.

- Three categories of AI can be distinguished based on their capabilities, including.
- *Narrow AI:* It has the intelligence to carry out specific tasks. AI is now in the narrow AI stage.
- *General AI:* Artificial General Intelligence, or AGI, refers to robots that exhibit intelligence comparable to humans.
- Super AI is a term used to describe self-aware AI with more extraordinary cognitive capacities than humans. At this point, machines can perform every cognitively capable human task.

The type of AI that exists now, referred to as Narrow AI or Weak AI, can only carry out specific jobs. Take autonomous vehicles, speech recognition, etc., as examples.

e) Myths about Advanced Artificial Intelligence

1. *Superintelligence by the Year 2100 is not Possible:* The truth is that we cannot now determine whether superintelligence exists. Nothing is confirmed; therefore, it could happen in a few decades, a few centuries, or it could never happen. In several surveys, the question of how long they believe it will take for human-scale AI to become a reality with at least a 50% likelihood has been posed to AI experts. All these studies conclude: We do not know because the top specialists have differing views. For instance, the (average) response to this question in a survey of AI experts at the 2015 Puerto Rico AI conference was by 2045. However, several experts gave estimates of hundreds or even more years.
2. *It will Replace all Human Jobs:* It is undeniably true that the emergence of AI and automation has the potential to disrupt the job market substantially. In

many cases, it is already doing so. It would be vastly oversimplified to think of this as a simple transfer of labor from humans to machines. People worry about losing their jobs as AI continues to advance because it has revolutionized industries across all sectors. Nevertheless, AI has increased the number of jobs and possibilities available to individuals across all industries, and every machine needs a person to run it. Although AI has replaced certain occupations, it still creates more jobs for people.

3. *Super-Intelligent Computers will become Better than Humans at doing anything we can do:* As was said above, there are three categories of AI: weak AI, which can do certain tasks like weather prediction. Super AI, also known as general AI, is an artificial intelligence that can execute any task better than a human. Weak AI is used to carry out specific tasks and enhance performance. On the other hand, research is ongoing, and general AI and super AI still need to be developed. They will be able to do various tasks with intelligence akin to that of humans. However, the creation of such AI applications is a long way off and will take many years or even decades. Furthermore, it is now impossible to anticipate whether such AI will be as effective as humans.
4. *AI does not Require Human Intervention:* People mistakenly believe AI can function without human involvement. However, the truth is that AI still needs to be sufficiently advanced to make independent decisions. To preprocess the data, create the models, create a training dataset, identify the bias and variance, and remove them, etc., a machine learning engineer or specialist is needed. Every AI model still depends on people, and however, once the model is prepared, it automatically enhances its performance due to the experiences.

f) Future Impacts of Artificial Intelligence on Different Sectors

1. *Healthcare*: AI will be essential in the healthcare industry for making quicker and more accurate diagnoses of illnesses. AI will speed up and reduce the cost of finding new drugs. Additionally, it will increase patient involvement in their care, making booking appointments and paying bills more accessible and less error-prone. Apart from these advantageous applications, the most significant barrier for AI in healthcare is getting it accepted into routine clinical procedures.

AI is frequently used in healthcare to classify, assess electrocardiograms or CT scans, or identify high-risk patients for population health. AI is assisting with the expensive dosage problem. According to one study, AI may help save $16 billion. A study published in 2016 claimed that an AI-derived formula determined the proper dosage of immunosuppressants to administer to transplant recipients.

Hanover, a Microsoft AI initiative, assists physicians in selecting cancer treatments from among more than 800 drugs and vaccinations. It aims to memorize all pertinent publications to anticipate which (combinations of) medications will be most beneficial for each patient. Among the targets is myeloid leukemia. An AI that could detect skin cancer as accurately as medical professionals was the subject of another investigation. Another initiative asks each patient questions based on information gathered from doctor /patient contacts to keep track of many high-risk patients. In one transfer learning study, an AI made therapy recommendations and diagnoses of eye disorders comparable to those of an ophthalmologist.

An autonomous robot was used to perform surgery in another investigation. The crew watched as the robot stitched a pig's gut back together under the supervision of a surgeon while doing soft-tissue surgery. Artificial neural networks, such as concept processing technology in EMR software, are employed as clinical decision support systems for medical diagnosis.

Other healthcare tasks thought suitable for an AI that is in development include:

2. *Cyber security:* Without a doubt, any organization prioritizes cyber security to guarantee data security. According to various projections, cyber security using AI will evolve in the ways listed below:

- Security incidents will be tracked using AI techniques.
- Locating the source of cyberattacks using NLP.
- RPA bots are used to automate processes and tasks that follow rules.

Being a terrific technology, it can also be utilized by attackers as a threat. They can use AI unethically by employing automated attacks that may be impossible to prevent.

3. *Transportation:* Although researchers are working in this area, the transportation industry has yet to produce a completely autonomous car. In the cockpit, artificial intelligence (AI) and machine learning are used to lessen the workload, manage pilot stress and fatigue, and boost on-time performance. The use of AI in transportation has several obstacles, particularly in locations where there is public transit. Over-reliance on automatic and autonomous technologies is quite dangerous.

4. *E-commerce:* Soon, artificial intelligence will be crucial to the e-commerce industry. It will favorably affect every facet of the e-commerce industry, from user experience to product marketing and delivery. Future developments in e-commerce include the usage of chatbots, automated warehousing and inventory systems, and shopper customization.

5. *Employment:* Thanks to the application of artificial intelligence, finding work is now straightforward for job seekers and companies. Artificial intelligence (AI) is already being employed in the job market, where tight regulations and algorithms automatically reject a CV from an applicant if it does not meet the requirements of the organization. In the future, most AI-enabled applications will likely control the hiring process, from marking written interviews to conducting phone interviews. Various AI programs, like Rezi, Jobseeker, etc., are assisting job searchers in creating outstanding resumes and locating the finest positions that match their skills.

6. *Recommendation Systems:* The "rating" or "preference" that a user would assign to anything is predicted by a recommendation system. For example, recommendation algorithms are used to create playlists for video and music services, suggest products for online shops, and propose content for social networking platforms and open web content.

7. *Web Feeds and Posts:* Web feeds also utilize machine learning, for example, to choose which posts appear in social network feeds. Machine learning is used in many different sorts of social media analysis, and there is a study into its application for (semi) automated labeling, augmentation, and correction of online disinformation and associated filter bubbles.

8. *Targeted Advertising and Increasing Internet Engagement:* Web adverts are targeted using AI to reach people most likely to click or interact with them. Choosing exciting material for the viewer is also utilized to lengthen the time spent on a website. It can extrapolate or forecast customer behavior based on their digital traces. Online gaming organizations use AI to enhance client targeting. Personality analysis, in addition to more conventional social demographics or behavioral targeting, AI models often include psychological targeting. AI has been applied to tailor offers and shopping possibilities.

9. *Virtual Assistants:* AI is used by intelligent personal assistants to comprehend many natural language requests in addition to simple instructions. The popular AIs Siri from Apple, Alexa from Amazon, and ChatGPT from OpenAI are more recent examples.

10. *Language Translation:* Artificial intelligence has been used to translate text and spoken language automatically. Additionally, efforts are being made in research and development to decipher and carry out animal communication. No system can fully automate high-quality machine translation of the unlimited text to the ideal, yet several fully automated methods can generate acceptable results. If the domain is constrained and regulated, machine translation quality is significantly increased. As a result, it is possible to employ machine translation to expedite and streamline translations and generate subpar but valuable low-cost or ad-hoc translations.

11. *Facial Recognition and Image Labeling:* Systems for facial recognition that use AI have a 99% accuracy rate. Examples include FaceID from Apple and Face Unlock from Android, both of which are used to protect mobile devices. Google has employed image labeling to find objects in pictures and enable image-based searches. It has also been shown that image labeling may provide speech to describe images to blind persons.

12. *Games:* Since the 1950s, games have effectively used AI's capabilities. AIs have achieved superhuman achievements in various games in the twenty-first century, including chess (Deep Blue) and Jeopardy! (Watson), go (AlphaGo), poker (Pluribus and Cepheus), e-sports (StarCraft), and general game playing (AlphaZero and MuZero). Most chess programs no longer use hand-coded algorithms; they now use AI. Poker is an imperfect-information game, unlike go or chess; hence a program that plays poker needs to be able to reason under uncertainty. Without knowing the rules, most game players rely on feedback from the game system.

13. *Economic and Social Challenges:* An ITU effort called AI for Good helps organizations use AI to address some of the most significant economic and social problems in the world. ToFornstance, the University of Southern California established the Centre for Artificial Intelligence in Society. To combat issues like homelessness Researchers at Stanford utilize AI to identify high-poverty areas by analyzing satellite pictures.

14. *Agriculture*: AI in agriculture has aided farmers in locating regions that require irrigation, fertilization, application of pesticides, or a higher yield. AI is used by agronomists in their research and development. AI has been used to control agricultural robots, monitor soil moisture, anticipate when crops like tomatoes will ripen, and do predictive analytics. Classify pig emotions in livestock, detect illnesses and pests, automate greenhouses, and conserve water.

15. *Cyber security:* NeCyber security firms are adopting neural networks, machine learning, and natural language processing to enhance their systems.
Among the uses of AI in cyber security are:

- Network security: By Machine learning enhances intrusion detection systems extending the search beyond previously detected threats; Endpoint security: By being familiar with typical malware behaviors, attacks like ransomware can be prevented.
- Application security: can assist in defending against threats such as distributed denial-of-service, SQL injection, cross-site scripting, and server-side request forgery.

User behavior that raises suspicion: Machine learning can spot fraud or compromised applications as they happen.

According to Google's fraud czar Shuman Ghosemajumder, AI will eventually fully automate most cyber security tasks.

16. *Education:* AI tutors enable one-on-one instruction for students. They can help students who receive human or robotic tutors feel less anxious and stressed. AI can lead to a dysfunctional environment with retaliatory repercussions, such as using technology to make it difficult for kids to focus. In another example, AI could assist teachers in making early predictions about their students in a virtual learning environment (VLE) like Moodle. Learning activities must be conducted online, especially during the COVID-19 pandemic, to prevent the virus from spreading through in-person contact.

17. *Finance:* Financial institutions have used artificial neural network algorithms for a long time to identify charges or claims that are unusual and flag them for further human inquiry. When Security Pacific National Bank established a fraud prevention taskforce in 1987 to combat debit card fraud, AI's application in banking was officially underway. Kasisto and Moneystream use AI. Banks use AI to streamline operations, handle books, invest in stocks, and manage real estate. Even when there is no business, AI can respond to changes. By watching for unusual changes or anomalies in behavioral patterns, AI fights fraud and financial crimes. Major economic theories have been altered using AI in decision-making and online trading applications. For instance, AI-based platforms for buying and selling estimate unique demand and supply curves, enabling special pricing. Markets have become more efficient due to the reduction of information asymmetry brought about by AI machines.

18. *Trading and Investment:* Algorithmic trading is the process of making millions of trades a day without the help of a human by using AI systems to make trading choices at speeds orders of magnitude faster than any human can. Such high-frequency trading is a rapidly expanding industry. Nowadays, many banks, funds, and proprietary trading companies handle their whole portfolios using AI. Large institutional investors frequently utilize automated trading systems, but smaller businesses can also deploy AI trading systems.

Large financial firms use AI to support their investment procedures. Aladdin, BlackRock's AI engine, is utilized by businesses and clients to assist in making investment decisions. Among its features is the use of natural language processing for text analysis, including that found in news articles, broker reports, and social media feeds. Then it determines how people feel about the companies mentioned and gives them a score. SQREEM (Sequential Quantum Reduction and Extraction Model) is a data mining d by banks like UBS and Deutsche Use Bank to create consumer profiles and match them with wealth management products.

19. *Audit:* AI makes continuous auditing possible. Potential benefits include reducing audit risk, increasing assurance, and reducing audit duration.

20. *Anti-Money Laundering:* For anti-money laundering (AML), artificial intelligence (AI) software like Laundro Graph, which employs modern suboptimal datasets, could be deployed. It is possible to "develop the AML pipeline into a robust, scalable solution with a reduced false positive rate and high adaptability" using AI. A study on deep learning for AML identified "key challenges for researchers" as "access to recent real transaction data and scarcity of labeled training data, and data being highly imbalanced" and recommends that future research focus on "explainability, graph deep learning using natural language processing (NLP), unsupervised and reinforcement learning to handle lack of labeled data; and joint research programs between the research community and industry to benefit both parties."

21. *Government:* AI facial recognition systems are utilized, particularly in China, for widespread monitoring. 2019 saw the deployment of AI-managed traffic signals in Bengaluru, India. The signal timing in this system is adjusted based on the amount of time required to clear traffic using cameras to monitor traffic density.

22. *Military:* Many nations are using AI for military purposes. The primary applications improve integration, interoperability, communications, sensors, command, control, etc. Research focuses on semi-autonomous and autonomous vehicles, logistics, cyber operations, information operations, and intelligence gathering and analysis. AI technologies can coordinate sensors and effectors, identify threats, designate enemy positions, mark targets, acquire targets, and coordinate and deconflict distributed joint fires between networked combat vehicles involving manned and unmanned teams. In Syria and Iraq, AI was used in military operations.

Robotics expenditures for the military increased from US$5.1 billion in 2010 to US$7.5 billion in 2015. The employment of unnerved military drones is widespread, and many scientists avoid military applications.

23. *Workplace Health and Safety*: AI-enabled chatbots eliminate the need for people to handle routine call center duties. To avoid overworking, machine learning in sentiment analysis can detect weariness. Like how they help avert natural catastrophes, decision support systems can improve the effectiveness of disaster response. Predictive analytics may be applied to material handling manual employees to lower the risk of musculoskeletal injury. Wearable sensor data can help with risk analysis, research, and occupational health surveillance.

AI can automatically code workers' compensation claims. Virtual reality systems with AI capabilities can improve danger recognition training. Accident near-misses, which are crucial in lowering accident rates but frequently go unreported, can be detected by AI more effectively.

24. *Biochemistry*: It was used to provide the likely structures of all proteins in the human body and all proteins known to science (more than 200 million). AlphaFold two can determine the 3D structure of a (folded) protein in hours as opposed to the months required by older automated approaches.

25. *Chemistry and Biology:* Drug design has made use of machine learning. Additionally, it has been used to investigate huge chemical/reaction spaces and predict molecular attributes. The origins of life on Earth, drug syntheses, and developing pathways for recycling 200 industrial waste chemicals into effective drugs and agrochemicals (chemical synthesis design) have all been investigated using computer-planned syntheses via computational reaction networks. This platform combines "computational synthesis with AI algorithms to predict molecular properties." The subject of the investigation has been which forms of computer-aided chemistry would benefit from machine learning. "Drug discovery and development, drug repurposing, improving pharmaceutical productivity, and clinical trials" are possible uses. Proteins with predetermined functional locations have been designed using it.

In a 46-day process, a medication that inhibits the enzymes of the DDR1 gene has been designed, synthesized, and tested using databases. One explanation for the high-quality datasets that made it possible for these results is the role of DDR1 in fibrosis and cancer.

Machine learning has a variety of uses in deciphering human biology, such as assisting the mang of gene expression patterns to functional activation patterns or locating functional DNA motifs. In genetic research, it is frequently employed.

Machine learning is also used in materials science, disease biology, nanotechnology (including bio nanotechnology and nanostructured materials), and synthetic biology.

26. *Digital Ghosts:* Roboticist Hans Moravec suggested that a future supercomputer could revive long-dead minds using the knowledge that still existed in his book 1988 Mind Children. Examples of this kind of data include recollections, film clips, social media interactions, personality traits that have been modeled, personal favorites, lists of tasks and notes, medical records, and genetic data.

The dead will be able to be digitally recreated when Ray Kurzweil's theory of singularity is realized, according to the American inventor and futurist. This is one method for implementing the idea of digital immortality, also known as the resurrection of the dead as "digital ghosts" or "digital avatars." Virtual personas could "assist in knowledge capture, retention, distribution, access, and use" in knowledge management. Post-mortem privacy is a concern, as is the possible use of individualized digital twins and related systems by big data companies and marketers.

27. *Astronomy, space activities, and ufology*: Artificial intelligence is used in astronomy to analyze the ever-growing amounts of available data and applications, primarily for "classification, regression, clustering, forecasting, generation, discovery, and the development of new scientific insights," such as finding exoplanets, predicting solar activity, and differentiating between signals and instrumental effects in gravitational wave astronomy. It could also be utilized for space operations like exploration, which includes data processing from space missions, real-time scientific decision-making for spacecraft, avoiding space junk, and more autonomous operations.

Machine learning has been applied in the search for extraterrestrial intelligence (SETI) to find artificially created electromagnetic waves in data sources, including real-time observations and other techno signatures, such as via anomaly detection. Machine learning is used in ufology by the SkyCAM-5 projects, led by Prof. HakanKayal, and the Galileo Project, led by Prof. Avi Loeb, to identify and categorize unusual types of UFOs. 'Oumuamua-like interstellar objects and naturally occurring artificial satellites are potential extraterrestrial technology indicators that the Galileo Project hopes to find using AI.

28. *Astrochemistry*: Additionally, it can be used to create datasets of the spectral signatures of molecules involved in the atmospheric production or consumption of specific chemicals, such as the phosphine that may have been detected on Venus. This could prevent missed assignments and, if accuracy is improved, be used in the future detection and identification of molecules on other planets.

29. *Archaeology, history, and imaging of sites:* Ancient manuscripts can be attributed and restored with the aid of machine learning. For example, texts can benefit from indexing to make searching and categorizing fragments better and more accessible Geneticgenetic history can be uncovered by using artificial intelligence to analyze genomes. For example, interbreeding between ancient and modern humans has led researchers to deduce that a population that is not Neanderthal or Denisovan once existed. Additionally, "non-invasive and non-destructive access to internal structures of archaeological remains" can be accomplished with its help.

30. *Physics:* An emerging field of physics research is devoted to using classical machine-learning techniques in investigating quantum systems. Quantum state tomography, which learns a quantum state from

measurement, is a simple illustration. Hamiltonians, quantum phase transitions, and the automatic creation of new quantum experiments are further exa-Classicalassical machine learning is advantageous in areas like quantum information theory, the development of quantum technologies, and the design of computational materials because it is efficient at processing sizable amounts of experimental or calculates order to characterize an unknown quantum sFor instance, item. It can be utilized, in this instance, as a tool to directly solve the Schrödinger equation using a variational approach or to interpolate already determined interatomic potentials.

Based on an undisclosed methodology inspired by research on visual cognition in infants, a deep learning system was reported to learn intuitive physics from visual data (virtual 3D settings). Other researchers have created a machine learning algorithm that can identify sets of fundamental variables of different physical systems and forecast the dynamics of those systems based on video recordings of those systems in action. Such techniques might one day be utilized to automate the identification of physical laws in intricate systems.

31. *Online and Telephone Customer Service:* An automated online assistant working as a website's customer support representative

Automated online assistants, or avatars, on websites, are powered by AI. Costs for operations and training might be decreased. For their mobile application, Pypestream automates customer service to streamline customer interactions.

Google has a tool that analyses language and turns spoken words into text. The platform can recognize irate users and respond appropriately by analyzing their verbal cues. Amazon uses a chatbot for customer assistance that can verify the progress of an order, cancel it, issue a refund, and put the consumer in touch with a live agent.

32. *Hospitality:* AI is utilized in the hotel sector to automate tedious processes, identify patterns, engage with visitors, and anticipate their requirements. A chatbot, applications, virtual voice assistants, and service robots are some ways artificial intelligence is used in hotels.

33. *Image Restoration:* Artificial intelligence (AI) applications analyze user-generated material, TV shows, movies, and commercials. Computer vision is frequently used to find solutions. Examples of such cases include the analysis of photographs employing techniques for face or object recognition or the analysis of videos for scene, object, or face recognition. Media search, the development of descriptive keywords for content, content policy monitoring (such as determining the appropriateness of content for a specific TV viewing time), speech-to-text for archival or other purposes, and the identification of logos, products, or famous faces for ad placement can all be made easier with AI-based media analysis.

34. *Video games:* AI is frequently employed in video games to create behavior in non-player characters (NPCs), and AI is also utilized for pathfinding. Some researchers see NPC AI in video games as a "solved problem" for most production jobs. Games using less usual AI include Left 4 Dead's (2008) AI director and Supreme Commander 2's (2010) neuroevolutionary platoon training. In Alien Isolation (2014), AI is employed to direct the Alien's subsequent activities. For the Xbox 360 and Xbox One, Kinect offers a 3D body-motion interface using algorithms developed through AI research.

35. *Art:* Visual art has been created using AI. In order to be able to code the act of painting, Harold Cohen created the first AI art program, dubbed AARON, in 1968. It began by producing basic black-and-white sketches before moving on to painting with unique paints and brushes that were selected by the program without Cohen's involvement.

36. *Energy System:* Power electronics converters are used in high-voltage direct current transmission, electric cars, energy storage, and renewable energy. These converters are prone to failure, which can cause service interruptions, expensive maintenance, or catastrophic results in applications that depend on them. AI can direct the design process for dependable power electronics converters by determining the precise design parameters that guarantee the requisite lifetime. Machine learning can estimate and schedule energy usage, for example, to help manage the intermittent nature of renewable energy sources.

37. *Telecommunications:* Heuristic search is a standard tool telecom companies use to manage their workforces. Heuristic search, for instance, was implemented by BT Group in an application that schedules 20,000 engineers. Additionally, voice-controlled devices and speech recognition (SR)-related video transcription is done using machine learning.

38. *Manufacturing Sensors:* Artificial intelligence has been combined with digital spectrometry by IdeaCuria Inc. to enable applications such as at-home water quality monitoring.

39. *Toys and Games:* The Internet, the first widely available robot, Furby, Tamagotchis, and Giga Pets, were controlled by early AI in the 1990s. Aibo was a home robot that resembled a robotic dog and had autonomy and intelligence built in. A variety of AI-enabled toys were developed by Mattel that can "understand" conversations, respond intelligently, and learn.

40. *Oil and Gas:* The oil and gas industry has utilized artificial intelligence techniques to automate tasks, anticipate equipment problems, and boost production.

41. *Transport Automotive:* AI in transportation is anticipated to offer reliable, safe, and efficient transportation with minimal adverse effects on the environment and local populations. The complex transport networks, including numerous separate parts and parties with potentially competing goals, are a significant development problem.

AI-based fuzzy logic controllers run gearboxes. Autonomous parking and adaptive cruise control are two examples of driver assistance features based on AI. Additionally, autonomous rail transportation and electric minibusses are prototypes of autonomous automotive public vehicles.

There are other autonomous delivery vehicle prototypes, some of which contain delivery robots. Due to the intricacy of transportation, it is frequently impractical to train an AI in a real-world driving context, and On-road training can be safer when done in a simulator.

AI supports self-driving cars. Among the businesses utilizing AI are Tesla, Waymo, and General Motors. AI-based systems oversee choreographing actions, including braking, lane switching, collision avoidance, navigation, and mapping.

Testing for autonomous trucks is now underway. After the UK government passes legislation, 2018 will see the start of testing for autonomous truck platoons. Uncrewed trucks follow each other closely in a queue. The Freightliner Inspiration is being tested by the German company Daimler.

For autonomous vehicles to navigate between destinations, precise maps are a need. Some autonomous vehicles (which lack steering wheels and pedals) do not allow human drivers.

42. *Traffic Management:* Wait times, energy use, and emissions have all been reduced by up to 25% thanks to the application of AI in traffic management. Using predictive algorithms and cameras with radar and ultrasonic acoustic location sensors, artificially intelligent traffic lights can be created to improve traffic flow.

43. *Military:* The Air Operations Division (AOD) of the Royal Australian Air Force (RAAF) employs AI in its expert systems. AIs serve as stand-in operators for humans in training and battle simulators, mission management tools, tactical decision support systems, and post-processing simulator data into symbolic summaries.

AI is used in aircraft simulators to train pilots. It is possible to replicate flight conditions that let pilots make mistakes without endangering themselves or expensive aircraft. Simulated air combat is another option. Like how AI is used to drive ground vehicles, it can also be used to fly airplanes. Drones with autonomy can fly alone or in groups.

Drones can receive vocal instructions from traffic controllers thanks to speech recognition.

AIDA, or artificial intelligence-supported aircraft design, is a tool used by designers to assist in the development of conceptual designs for airplanes. Thanks to this program, the designers may concentrate more on the design itself and less on the design process. The software enables the user to lessen their attention to the software tools. The AIDA computes its data using rule-based systems. This diagram shows how the AIDA modules are set up. Despite being straightforward, the program is working well.

44. *NASA:* The software was developed in 2003 as part of a Dryden Flight Research Centre study to allow a damaged aircraft to fly on until a safe landing is possible. The software used the remaining undamaged components to compensate for the broken ones.

The 2016 Intelligent Autopilot System integrated behavioral cloning with apprenticeship learning, allowing the Autopilot to monitor both the high-level strategy and low-level actions needed to control the airplane.

45. *Environmental Monitoring:* Machine learning is used in passive acoustics, remote sensing, AI-driven satellite data analysis, autonomous ocean monitoring ships, and other environmental monitoring applications.

In order to reduce plastic pollution, especially ocean pollution, "Global Plastic Watch" is an AI-based satellite surveillance platform that analyses and tracks plastic waste sites. It identifies who and where improperly disposes of plastic garbage and dumps it into the ocean.

46. *Early-Warning Systems:* Machine learning can identify early warning signals of natural disasters and environmental problems, such as pandemics, landslides, heavy rain, long-term water supply vulnerability, tipping points of ecosystem collapse, cyanobacterial bloom epidemics, and droughts.

47. *Computer Science:* GitHub Copilot is a piece of artificial intelligence that GitHub and OpenAI created that can autocomplete code in various programming languages.

48. Neural Network Design: Other AIs can be made using AI. For instance, Google's AutoML project, which develops novel neural network topologies, produced NASNet, a system tailored for ImageNet and POCO F1, around November 2017. NASNet surpassed all previously published performances on ImageNet.

g) Applications based on Artificial Intelligence:

Chatbots are used for consumer interactions on corporate websites and social media platforms, such as answering frequently requested inquiries. Chatbots give round-the-clock assistance and replace humans, helping businesses reduce costs.

1. *OpenAI'sChatGPT:* OpenAI created the modern AI language model ChatGPT. It is based on the GPT architecture, often called the "Generative Pre-trained Transformer." ChatGPT can carry on sophisticated context-aware discussions since it is built to comprehend and produce text that resembles human speech. It can be used for many jobs and sectors, including customer service, content creation, translation, and virtual assistance.

The model is regularly improved and added with new features based on a sizable dataset. However, it occasionally produces illogical or erroneous but plausible answers. It may also be susceptible to the wording of user input and leading questions. ChatGPT involves ethical questions about content generation and potential abuse while requiring a robust computational infrastructure for optimal performance.

2. *Google's DeepMind AlphaFold:* An artificial intelligence program called AlphaFold was created by DeepMind, an Alphabet Inc. subsidiary, to forecast protein shapes. By predicting the three-dimensional structure of proteins based on their amino acid sequences with unprecedented levels of precision, it has revolutionized the study of structural biology. This has significant ramifications for researching the effects of genetic changes on protein structure, discovering new drugs, and understanding diseases.

Based on a deep learning architecture, AlphaFold uses cutting-edge methods, including attention mechanisms and distance geometry. Its open-source codebase enables scientists and programmers to expand upon its capabilities. However, its use is restricted to making predictions about protein folding and requires significant computing power and resources. Access to and control over breakthroughs in biotechnology are likewise ethically problematic.

3. *Tesla's Autopilot:* Tesla Inc. created Tesla Autopilot, an advanced driver-assistance system (ADAS), for its electric automobiles. It has semi-autonomous driving features like self-parking, adaptive cruise control, and lane-keeping assistance. Autopilot combines cameras, radar, ultrasonic sensors, and neural networks to process the environment and make driving judgments.

By assisting with navigation and collision avoidance and lowering driver tiredness and stress on lengthy travels, the technology is intended to increase safety. In order to continuously enhance its performance, it learns from the data gathered. Autopilot, however, still needs the driver's attention and participation and is not entirely autonomous. Drivers may feel uneasy as a result, which encourages abuse and accidents. Its functionality is constrained in various driving situations and environments, and there are legal and moral issues regarding accountability and safety.

4. *IBM Watson:* IBM created Watson, an AI platform with sophisticated machine learning and natural language processing capabilities. It is adaptable to a variety of industries and applications and has a high capacity for processing and analyzing massive datasets. Watson has been used in various industries, including healthcare, banking, and customer service.

The system effectively concludes unstructured data since it is built to comprehend and respond to complex questions in natural language. However, Watson's implementation and upkeep can be expensive and challenging. For best outcomes, it needs domain-specified help and fine-tuning, but it needs to be clarified, able to clarifications that are unclear or ambiguous. Concerns over data privacy and probable job loss are also ethical issues.

h) The Impact of Artificial Intelligence on Work:

In a lecture at Northwestern University, AI specialist Kai-Fu Lee highlighted the potential impact of AI on job displacement, particularly for the bottom 90% of the population. He emphasized that routine and quantifiable tasks are more likely to be replaced by AI, such as sorting items, customer service calls, and manual labor. Companies like Amazon are already utilizing AI-powered robots in their warehouses, leading to concerns about job reduction goals. Lee stressed that AI lacks creativity and compassion, serving as a tool to amplify human creativity. He suggested that individuals in repetitive roles should acquire new skills to remain competitive and that investing in education and retraining is crucial for AI's success. However, the transition to new jobs may not be as seamless as some anticipate. Experts like Klara Nahrstedt emphasize the need for widespread education in programming and coding to adapt to the future demands. While there is optimism that people will eventually find new opportunities, the immediate effects of job displacement can be significant. Nonetheless, there is a growing recognition among programmers to identify AI problems within their domains.

i) Possibilities of AGI

Simulating the complexity of the human brain remains a significant challenge in the pursuit of AGI. John Laird, a computer science professor, emphasizes the need for a cognitive architecture that goes beyond simple neuron models and incorporates elements like procedural, semantic, and episodic memory. Laird's lab conducts experiments teaching robots games and puzzles using natural language instructions to improve their planning abilities. Progress in this field has been slow, as each advancement reveals the difficulty of the task. Concerns have been raised about the collection of personal data for AI purposes, with Apple CEO Tim Cook emphasizing the importance of respecting human values and privacy in AI development. Research suggests that responsible implementation of AI can benefit society, but there is a risk of negative impacts on

human rights and privacy with commercial and state use of AI technology.

Prominent AI experts express different views on the concept of the singularity, where super-intelligent machines could pose existential threats to humanity. Stephen Hawking warned about the potential of AI surpassing human intelligence, while Elon Musk considers AGI as the greatest threat and has expressed concerns about unintended consequences. However, some experts like Gyongyosi and Diego Klabjan hold more skeptical or optimistic perspectives. The Future of Humanity Institute conducted a survey with machine learning specialists predicting various advancements, such as computers writing essays by 2026 and AI surpassing human performance in retail by 2031. However, skepticism remains about achieving true AGI with the current state of technology, as human brains are far more complex than current AI systems. Mechanization of all human employment is predicted by 2137, according to the survey, although the implications for humanity itself remain uncertain.

j) Artificial Intelligence in Different Parts of the world

1. *USA:* The USA is a global leader in AI research and development. Prominent universities and technology companies drive innovation in AI. Major companies like Google, Microsoft, IBM, Amazon, and Facebook invest heavily in AI technologies. The government has initiatives to support AI research and development. Efforts are being made to establish a regulatory framework for responsible AI use. There is a shortage of skilled AI professionals in the USA. Educational programs and initiatives are addressing the need for AI workforce development. AI is applied across various sectors, including healthcare, transportation, and finance. Ethical considerations, such as bias and transparency, are important in AI development. Discussions around AI's impact on society and ethics are ongoing. AI is transforming industries and shaping the future of technology in the USA.

2. *UK:* The UK is actively involved in AI research and development. Leading universities and research institutions contribute to cutting-edge AI advancements. The government has implemented strategies to support AI growth, including the AI Sector Deal and the AI Council. AI is being applied across various sectors in the UK, with a focus on ethical development. The country aims to become a global leader in AI for economic growth and societal benefit.

3. *Australia:* Australia is actively advancing in the field of AI, with government support and investment. Leading universities and research organizations are conducting innovative AI research. AI is being applied across various sectors in Australia, including healthcare, agriculture, finance, and defense. The country is focused on developing AI infrastructure and fostering collaboration with industry partners. Australia aims to leverage AI to drive economic growth, enhance public services, and tackle societal issues.

4. *Europe:* AI in Europe is thriving with significant investments in research and development. The European Union's AI strategy and funding initiatives drive innovation and collaboration. Ethical and responsible AI development is a priority, with a focus on regulations and guidelines. Europe is home to leading AI research institutions and startups. The region aims to leverage AI's potential for economic growth, healthcare advancements, and societal benefits while safeguarding privacy and data protection.

5. *Africa:* AI in Africa is gaining momentum with increased investment and interest. It is being utilized to tackle societal and economic issues in sectors such as agriculture, healthcare, and education. Startups and research institutions are driving innovation, focusing on solutions tailored to local challenges. However, obstacles such as limited infrastructure, data access, and skill gaps remain. Collaboration and knowledge sharing are playing a crucial role in advancing AI development in Africa.

6. *Asia:* AI in Asia is thriving with significant advancements and investment. Countries like China, Japan, and South Korea lead in AI research and development. Various sectors, such as healthcare, finance, and manufacturing, are embracing AI technologies. Governments are actively supporting AI infrastructure and talent development. The region's market diversity and abundant data sources contribute to its thriving AI ecosystem. AI in India is experiencing rapid growth and innovation. The country has a strong focus on AI research and development, with prominent institutions and startups driving advancements. The government has launched initiatives to promote AI adoption, such as the National AI Strategy and AI-focused centers of excellence. Key sectors like healthcare, agriculture, and education are leveraging AI for transformative solutions. India's large population and vast data availability offer immense opportunities for AI applications and development.

k) Ethical and Privacy Issues due to Artificial Intelligence

The potential effects of AI on people, society, and fundamental rights give rise to ethical and privacy concerns. The potential for bias and discrimination in AI systems is a big worry. The resulting AI models can reinforce biases and produce unfair or discriminating results if the training data used to construct AI algorithms is biased or reflects preexisting societal prejudices. This raise concerns in several areas, including hiring procedures, criminal justice systems, and service accessibility.

Ethics in AI must include responsibility and transparency. Deep neural networks are one example of

an advanced AI model that operates as a "black box," making it difficult to comprehend how it makes decisions. Concerns regarding potential biases, mistakes, or unethical decision-making are brought up by this lack of openness. To solve this problem and give people the capacity to comprehend and query AI outputs, efforts are being made to develop interpretable AI approaches and explainable AI methodologies.

The privacy issue is very important in the context of AI. In order to be trained and perform better, AI systems frequently need access to enormous volumes of personal data. This data's collection, storage, and processing raise concerns about data security, consent, and the possibility of abuse. A careful balance must be struck between protecting individual private rights and using data for AI development. To do this, strict privacy laws, data anonymization methods, and informed permission mechanisms are needed.

A wider range of ethical issues are connected to AI. Concerns regarding mass surveillance and privacy invasion are raised by the emergence of AI-powered surveillance technology. Deepfake technology raises moral questions regarding false information and its capacity to sway public opinion because it can produce incredibly realistic fake media. The outsourcing of the ability to make fatal decisions to machines to autonomous weapons powered by AI raises ethical concerns.

l) Security and Transparency Issues due to Artificial Intelligence

AI technology brings both security and transparency challenges that need to be addressed. Here are some key issues related to security and transparency in AI:

1. *Security Vulnerabilities*: AI systems can be susceptible to attacks, such as adversarial attacks, where malicious actors manipulate inputs to deceive or mislead AI algorithms. These attacks can have serious consequences, especially in critical domains like finance, healthcare, and autonomous vehicles.
2. *Privacy Concerns:* AI systems often rely on collecting and analyzing large amounts of data, raising concerns about the privacy of individuals. It is crucial to handle and protect sensitive data appropriately to ensure privacy rights are respected.
3. *Bias and Fairness:* AI systems trained on biased data can perpetuate and amplify existing biases, leading to unfair outcomes and discrimination. Ensuring fairness and mitigating bias in AI algorithms is a significant challenge that requires careful attention.
4. *Explainability* and accountability: Many AI algorithms, particularly those based on deep learning, are often regarded as black boxes, making it challenging to understand their decision-making process. It is crucial to develop methods for explaining AI decisions and making algorithms more transparent to ensure accountability and build trust.
5. *Cybersecurity Risks:* The increasing use of AI in critical infrastructure and autonomous systems introduces new cybersecurity risks. AI-powered systems may become targets for cyber-attacks, leading to potential disruptions and threats to safety and security.

m) Socio-Economic Issues due to Artificial Intelligence

Numerous socio-economic difficulties are raised by the broad usage of AI technology and must be taken into consideration. Here are a few major issues:

1. *Employment Displacement:* As machines begin to perform some functions that have historically been done by people, it is possible that AI automation will disrupt entire industries and result in employment loss. This may lead to unemployment and economic inequality, especially for those with routine or low-skill jobs.
2. *Skills Gap:* The quick development of AI technology necessitates a workforce with the abilities to comprehend, create, and oversee AI systems. The demand for AI-related talents, however, outpaces the supply, and this skills gap is widening. This emphasizes the necessity for programs that help people upskill and reskill in order to ensure that they are prepared for the occupations of the future.
3. *Economic Inequality:* AI can make already existent economic inequities worse. Access to AI technology and data may provide organizations a competitive edge, which could result in a concentration of power and money. Addressing these disparities is essential to ensuring that the advantages of AI are distributed more fairly.
4. *Algorithmic Bias and Discrimination:* AI systems may unintentionally reinforce prejudices found in the training data, producing discriminating results. These include hiring, lending, and the criminal justice system. Fairness assurance and algorithmic discrimination prevention are a serious problem that necessitates rigorous AI system design and evaluation.
5. *Ethics:* The ethical ramifications of AI create significant socioeconomic issues. It is crucial to give critical thought to and act on issues like privacy, consent, accountability, and transparency. To direct the development and application of AI technology in a responsible and socially beneficial manner, ethical frameworks and guidelines are required.

n) Unemployment Issues due to Artificial Intelligence

The development of AI technology has sparked worries about potential job loss and unemployment. Here are some important causes of the problems with AI-related unemployment.

1. *Automation of Routine Tasks:* AI-powered automation can take the place of human workers in the more accurate and efficient performance of repetitive and routine tasks. Data entry, customer service, transportation, and other industries are all impacted by this automation, which could result in job losses there.
2. *Industry Disruption:* By replacing human labor with AI systems and robots, technological advances in AI have the potential to upend whole sectors. Self-driving cars, for instance, may have an influence on the delivery and transportation industries, while AI-powered chatbots may eliminate the need for customer support agents.
3. *Skill Requirements and Job Transformation:* AI technology integration in the workplace frequently necessitates the development of new skills and competences. Jobs requiring repetition and manual labor may become less popular, while those requiring knowledge of AI programming, data analysis, and machine learning may become more popular. If a worker does not possess the requisite abilities for the new job market, this change in skill requirements may result in their unemployment.
4. *Structural Unemployment:* AI-driven automation may result in structural unemployment, as workers struggle to move from lagging to growing industries. Displaced people may need some time to develop the skills required for new employment possibilities, which could lead to underemployment or unemployment.

o) Cyber Security Issues due to Artificial Intelligence

While artificial intelligence (AI) has many advantages, it also poses certain cybersecurity risks. The following are some significant AI-related cyber security concerns:

1. *Adversarial Attacks:* When hostile individuals deliberately alter input data to fool or confuse an AI system, AI models are susceptible. Data categorization errors brought on by these assaults may jeopardize the integrity and dependability of AI-powered systems.
2. *Breach of Data Privacy:* The functioning and training of AI rely heavily on data. Unauthorised access, disclosure, or misuse of sensitive information can be caused by insufficient data protection mechanisms, which can result in privacy violations and identity theft.
3. *AI-Powered Cyberattacks:* Cybercriminals can use AI technology to carry out sophisticated and automated cyberattacks. AI-enabled malware and botnets are more difficult to protect against since they can alter their behavior, avoid detection, and exploit weaknesses more effectively.
4. *Bias and Discrimination:* Discriminatory outcomes might result from biases in the training data that AI algorithms can inherit. This might have serious ramifications for hiring, lending, and law enforcement, reinforcing prejudices in society and raising ethical questions.
5. *Lack of Transparency and Explainability:* A subset of AI called deep learning algorithms frequently operates as a "black box," making it challenging to comprehend the decision-making process. Concerns regarding accountability and the capacity to identify and correct potential biases or weaknesses are brought up by this lack of openness.

p) Accountability Issues due to Artificial Intelligence

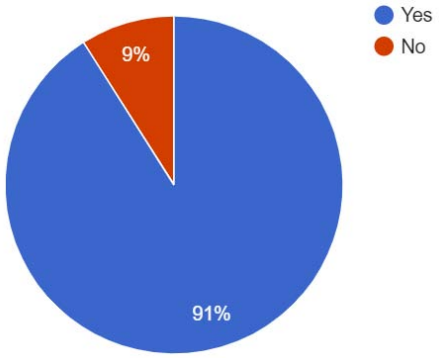
Concerns about accountability are very important when using artificial intelligence (AI). The following are some significant AI-related accountability concerns:

1. *Lack of Clear Accountability:* Assigning unambiguous accountability for the decisions and actions taken by AI systems can be difficult because to the involvement of numerous stakeholders, including developers, data scientists, and organizations using AI systems. This raises questions about who should be responsible for any undesirable outcomes or mistakes.
2. *Unintentional Biases and Discrimination:* AI systems have the potential to reinforce biases found in training data, producing discriminating results. It becomes difficult to hold people or organizations responsible for biased decisions produced by AI systems because doing so requires identifying and fixing the biases present in the data and algorithms.
3. *Transparency and Explainability:* Deep learning models frequently function as "black boxes," making it challenging to comprehend the decision-making process. Accountability can be hampered by a lack of transparency and explicability since it becomes difficult to track and defend the logic underlying AI-driven actions.
4. *Legal and Regulatory Issues:* The specific issues that AI technologies provide may not be sufficiently addressed by current legal systems. In situations where AI systems are engaged, determining legal liability, and defining precise guidelines for accountability can be challenging and call for legislative reforms.
5. *Ethics:* AI systems have the potential to have significant effects on people and society. Clear accountability frameworks and adherence to ethical principles are necessary for ensuring ethical usage of AI and addressing ethical issues like privacy violations, data exploitation, or biased decision-making.

VII. Survey

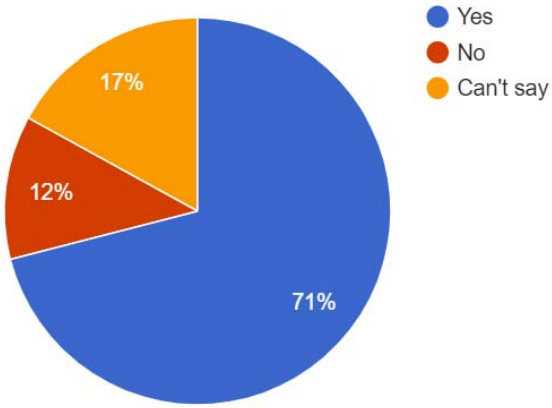
Using standard research methodology, an Empirical study, a survey is conducted. The survey is conducted by direct interaction, mobile calling, E-Mailing, and various social media platforms, and the survey is conducted demographically where 850 Male and 650 Female respondents participated, together with 1500. This survey comprises India, the USA, Canada, the UK, Australia, New Zealand, Singapore, Malaysia, UAE, and Kuwait. The questionnaire with the respondents' responses is recorded, and the reports are formed as pie diagrams. The survey reports are as follows:

1. Do you have basic knowledge of Artificial Intelligence?



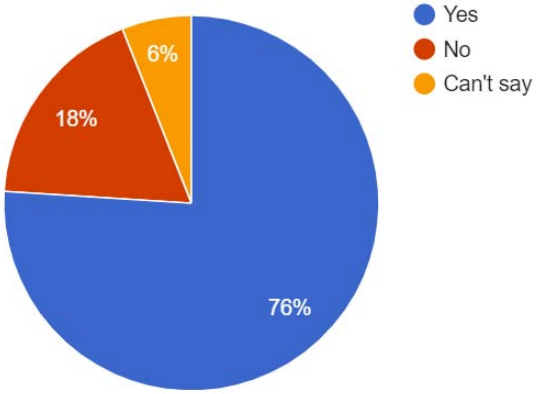
91% of the respondents said they have basic knowledge of AI, and the rest, 9%, said they do not know about AI.

2. Do you think that emerging Artificial Intelligence is a threat Human Rights?



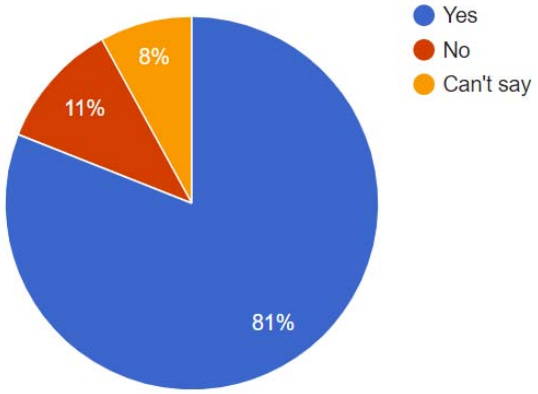
71% of respondents have answered that they are aging with Human Rights are affected by Artificial Intelligence, 12% have answered that Human Rights may not be affected by Artificial Intelligence, whereas 17% have answered they cannot say.

3. Do you believe that AI has the potential to significantly transform the way we live and work?



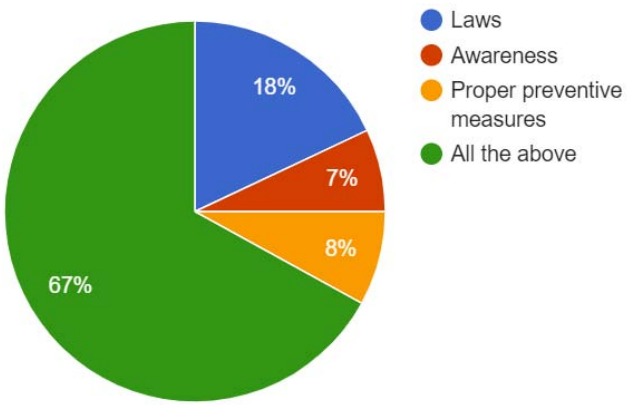
76% of respondents have answered that AI has the potential to significantly transform the way we live and work, 18% have answered that AI does not have the potential to significantly transform the way we live and work, whereas 6% have answered they cannot say.

4. Should there be Regulations or Guidelines in Place to Govern the Development and use of AI?



81% of respondents have answered that there should be regulations or guidelines to govern the development and use of AI, 11% have answered that thereis no need of regulations or guidelines to govern the development and use of AI, whereas 8% have answered they cannot say.

5. What do you Suggest to Prevent such Damage?



67% of the respondents stated that the Governments must make proper laws, 7% stated that proper awareness is suggestible, 8% stated that Tech Companies who adopt AI should take proper preventive steps, and 66% of respondents stated It is the responsibility of all.

VIII. Recommendations

A comprehensive approach encompassing cooperation between governments, business, academia, and civil society is required to lessen these socioeconomic obstacles. Investments in education and training programs can assist people in adapting to the shifting nature of employment, while policies and regulations should be devised to ensure a fair and inclusive transition to an AI-driven society. Furthermore, promoting moral behavior and open discussion around AI can help the technology be used ethically and sustainably.

Addressing the issues requires a combination of technical solutions, ethical frameworks, and regulatory measures. Researchers, policymakers, and industry professionals are actively working towards developing standards and best practices to ensure the security, transparency, and responsible use of AI technology.

Governments, organizations, and researchers are attempting to create ethical frameworks and guidelines for responsible AI development and deployment to address these ethical and privacy problems. Aiming to ensure that AI is created and used in a manner that respects individual rights, promotes fairness, and is in line with societal values are initiatives including the creation of AI ethical committees, regulatory frameworks, and industry standards.

AI-related unemployment challenges necessitate proactive initiatives, including:

1. *Development of New Skills and Retraining for Jobs that Complement AI Technology:* Giving workers the chance to do both can help reduce unemployment.

The shift to AI-driven sectors can be facilitated by investing in educational and vocational training programs.

2. *Job Creation and Entrepreneurship:* Encouraging entrepreneurship and innovation can lead to the development of new jobs and aid the expansion of sectors related to artificial intelligence. Supporting small businesses and encouraging new ventures can help the economy thrive and create jobs.
3. *Social Safety Nets and Income Support:* Implementing social safety nets and income support programs can act as a safety net for employees who have lost their jobs as a result of AI. This includes monetary support for retraining programs, job placement services, and unemployment benefits.
4. *Collaboration and Policy Development:* To create laws and regulations that address the socioeconomic effects of AI, governments, corporations, and academia should work together. This involves considering policies like work transition assistance, labor market restrictions, and ethical standards for the application of AI.

Societies can better handle the potential issues of AI-related unemployment by taking a comprehensive approach that incorporates technical development, skill development, and supportive legislation. This will also help to build a more inclusive and sustainable workforce for the future.

Proactive steps are needed to address these cybersecurity issues.

1. *Robust Data Protection:* Strong data encryption, access controls, and secure storage techniques can all be used to safeguard sensitive data from being accessed or disclosed by unauthorized parties.
2. *Adversarial Defense Mechanisms:* Using methods like robust training, anomaly detection, and model verification, it is possible to create AI models that are resistant to adversarial attacks and hence improve system security.
3. *Ethical AI Development:* Promoting the creation and implementation of ethical norms and guidelines for AI can help reduce biases and guarantee that the technology is used fairly and responsibly.
4. *Enhanced Cybersecurity Measures:* Advanced threat detection systems, intrusion prevention systems, and reaction mechanisms can assist organizations protect against cyberattacks powered by AI. Enhanced cybersecurity measures.
5. *Explainable AI:* Investigating and developing methods for interpretable and explicable AI might increase openness and make it easier to spot potential flaws or biases.
6. *Collaboration:* Promoting knowledge, best practices, and threat information sharing amongst business, academic, and government organizations can improve cybersecurity overall resilience in the context of AI.

We can maximize the benefits of AI while reducing the dangers involved and preserving the security and integrity of AI-powered systems and data by tackling the cybersecurity concerns and taking preventative action.

The resolution of accountability challenges in AI necessitates coordinated efforts and aggressive actions:

1. *Standards and Guidelines for Ethics:* Creating and implementing ethical frameworks and principles for AI can serve as a foundation for accountability. This incorporates values like openness, equity, responsibility, and accountability in the creation and application of AI.
2. *Regulatory Frameworks:* In creating legal frameworks that specify the obligations and liabilities of stakeholders involved in AI systems, governments and regulatory organizations can play a critical role. These frameworks ought to take bias reduction, data security, and transparency into account.
3. *Algorithmic Auditing:* Routine auditing and evaluation of AI systems can assist in discovering biases, mistakes, and unintended effects. Independent audits can guarantee accountability and adherence to moral and legal requirements.
4. *Explainable AI:* By advancing research and development of explainable AI models, stakeholders will be able to better understand and assess how AI systems make decisions.
5. *Education and Awareness:* Promoting a culture of accountability requires raising knowledge and understanding of AI among policymakers, organizations, and the general public. This includes educating people on the restrictions, dangers, and ethical issues related to AI.

We can encourage responsible AI development and deployment by addressing accountability problems, ensuring that AI technologies are used in a way that is consistent with moral and societal norms while reducing the possibility of harm.

IX. Conclusion

In conclusion, the tour through the thorough overview of the Artificial Intelligence (AI) frontier reveals its development, underlying ideas, and game-changing applications. The investigation highlights the importance of moral considerations and responsible deployment while also pointing to a future of cooperation, innovation, and possible solutions. This overview highlights the significance of adjusting to AI's changing environment with knowledge and purpose, participating in its

developing story to harness its power for advancement and human improvement.

The assessment of AI's difficulties in various fields, emphasizes the necessity for industry-specific solutions. Significant themes include the human-technology balance, bias mitigation, ethical considerations, privacy issues, and privacy concerns. This analysis emphasizes the significance of responsible AI deployment and stresses that the full promise of technology can only be realized by carefully considering its implications. Stakeholders may use AI's revolutionary power for innovation and efficiency while preserving moral norms and societal well-being by tackling these issues as a group. In order to negotiate its difficulties and maximize its advantages, the process of integrating AI across industries is continuous.

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Traffic Flow Forecast based on Vehicle Count

By Pavanee Weebadu Liyanage & K. P. G. C. D. Sucharitharathna
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Abstract- Real-time traffic predictions have now become a time-being need for efficient traffic management due to the exponentially increasing traffic congestion. In this paper, a more pragmatic traffic management system is introduced to address traffic congestion, especially in countries such as Sri Lanka where there is no proper traffic monitoring database. Here the real-time traffic monitoring is performed using TFmini Plus light detection and ranging (LiDAR) sensor and vehicle count for next five minutes will be predicted by feeding consecutively collected data into the LSTM neural network. More than ten separate prediction models were trained, varying both window size and the volume of input data delivered to train the models. Since the accuracy results of all prediction models were above 70%, it demonstrates that this system can produce accurate predictions even if it is trained using less input data collection. Similarly the sensor accuracy test also resulted in 89.7% accuracy.

Keywords: traffic monitoring, lstm neural network traffic predictions, vehicle count, traffic flow forecast, real- time traffic monitoring, lidar sensor traffic monitoring.

GJCST-D Classification: LCC: TE175-178

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Pavanee Weebadu Liyanage [α] & K. P. G. C. D. Sucharitharathna [σ]

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I. Introduction

Vehicle usage has risen significantly throughout the world in recent years. As a result, road traffic has gotten more complex and chaotic. Traffic congestion is becoming a more highlighted issue in cities throughout the world, owing to continuous urbanization and population increase. According to the Victoria Transport Policy Institute's Congestion Costing Critique (CCC) Critical Evaluation of the "Urban Mobility Report" (UMR), which was published on 1 September 2021 [1], congestion cost is estimated to cost between $130 to $500 per capita annually, particularly in comparison to $2,000 in crash damages, $3,000 in vehicle ownership costs and $1,800, $600, $400 respectively in parking, pollution damage, and roadway costs. Similarly, the UMR estimates that by 2025, congestion cost will have risento $200 billion [1].

According to the statistical records by The National Highway Traffic Safety Administration (NHTSA) [2], in 2013, more than 2.3 million injuries and 32,719 deaths were recorded due to vehicular accidents. Among those recorded fatalities majority were aged between 4–27 [2]. According to the NHTSA report, the direct economic cost and the social impact that occurs due to vehicular accidents are accounted for $871 billion per year, with an average of 5.8 million collisions each year only on the United State's highways [2]. NHTSA statistical records also emphasize that most of road accidents occur as a result of traffic congestion [2]. Further almost 5.5 billion hours are lost recorded due to traffic congestion, resulting in 2.9 billion gallons of fuel loss [2]. It is also estimated that automobile tailpipes produce around 31% (or 56 billion pounds) of CO2 due to vehicle traffic congestion each year [3].

The Global Traffic Scoreboard for 2021, published by data analytics company INRIX [5], provides insights into how people move throughout the world and provides more detailed information on congested traffic and commute times during the peak and off-peak hours in over 1000 urban cities across 50 countries. It also examines the per capita time spent on traffic congestion [5]. According to research [5], the most congested and crowded cities are "either older or developing cities". It also exclaimed that many of those developing cities where the significant population expansion is met, yet have inadequate infrastructures [5]. Therefore, the failure to develop adequate transportation infrastructures and roads to meet the increasing demand has led to traffic congestion.

Similarly, when global traffic mitigation strategies are considered, there can be seen several efficient approaches, such as intelligent traffic management systems. However, most of these mitigation methods have been limited to developed countries. Most of the remaining countries do not even have adequate traffic sensing infrastructures to monitor the traffic flow [5]. Therefore, there is no way to have an acknowledgment or a method to analyze the existing congestion having a confirmation of whether the implemented or existing congestion mitigation projects have achieved the desired progress. Since the traffic is always random, which means the vehicular traffic on the roads varies from time to time depending on the number of vehicles on the road, it is important to have a clear dataset of the number of vehicles on the road at a considerable very short intervals and effective feedback on-road operations are essential in order to carry out effective traffic congestion management.

Both vehicle detection and surveillance play an integral role in both effective traffic congestion management and intelligent traffic management systems (ITMS). Since ITMS plays a critical role in national traffic management systems (TMS), the quality of provided data and the geographical arrangement of traffic sensors are also important factors for ITS success

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[6]. Similarly, vehicle detection and surveillance functions are always subject to constantly being improved in order to increase vehicle detection and monitoring, observing traveling direction, counting their speed, and categorizing vehicles [6].

There is no doubt that vehicle identification and monitoring are vital components of both successful traffic management and ITMS. Similarly more effective traffic management may be achieved if future traffic volume estimates can be made through predictions. It performs a vital service for traffic management. Because the traffic density prediction methods depend on several factors, such as current and historic traffic measurements [6]. Accurate calculations are always important for accurate predictions. Therefore, the overall success predictions depend on the precise and efficient operation of the utilized medium to monitor traffic behavior.

The remainder of this paper is organized as follows. In section II, the research problem is discussed under the context of Sri Lanka. In section III, background and earlier studies carried out on real-time traffic monitoring and forecasting are presented, evaluating the research gaps. Moreover, part A and B of section III provide an extensive evaluation of each traffic monitoring and forecasting method, including tables that compare the performances of each technology. Section IV expresses the methodology, whereas section V includes the results and validation. Section VI summarizes all the facts as a conclusion and introduces future work.

II. Research Problem Definition in the Context of Sri Lanka

Traffic congestion is one of the major issues in Sri Lanka. Initially, this problem was found only in the urban areas, including Colombo, but now with the increasing number of vehicles being added to the road day by day, the problem is further enhanced in other suburban areas as well [7], becoming traffic congestion is a prominent issue.

Excessive fuel consumption due to prolonged travel time results in economic loss and frequent acceleration and breakage, leading to frequent repairs and replacements, which create a significant loss to the national economy [8]. The cost of traffic congestion in Sri Lanka's Western Province exceeds Rs. 20,000 million per year, which is approximately 2% of regional GDP [9]. Total greenhouse gas (GHG) and CO2 emissions in the Sri Lankan transport sector are accounted for 25% of GHG and 47% of CO2 which indicates that traffic congestion has a substantial environmental impact in Sri Lanka when compared to global averages [10].

Nowadays Sri Lankan government is grappling with a large fiscal deficit, with the depreciation of the Sri Lankan rupee against major currencies and high debt. Traffic congestion is also a factor affecting a country's economy. And especially in a country like Sri Lanka, which is suffering from fuel and energy crises along with recent economic losses, this traffic congestion problem now has become an issue that can no longer be overlooked.

Several remedial strategies have been taken by the government to avoid rising traffic jams and to prevent it being worsening the congestion level. Short-term strategies such as adding new transport infrastructures: new roads, and expressways, and improving existing infrastructure capacities to be compatible with increasing road and transport capacity have been taken. Similarly, as with other possible alternative actions, the number of lane miles has been expanded, and alternate routes have been created to increase capacity and enhance the efficiency of existing infrastructure [4]. Long- term strategies such as introducing new vehicle ownership and public transport strategies and policies to be compatible with existing road and transport capacity have been taken to overcome this issue [9]. But the existing traffic congestion proves that those actions are insufficient to create an effective impact on traffic management.

Figure 1: Traffic Behaviour of Countries Such as Australlia, Russia and European Countries

Figure 2: Traffic Behaviour of Sri Lanka

Despite the above-mentioned facts, compared to some other countries where the drivers' disciplines are very high, in Sri Lanka, vehicles do not move systematically in a lane following one after the other while maintaining adequate space. Figures 1 and 2 which are presented above, illustrate the traffic behavior of Sri Lanka in comparison to other countries such as Russia, Australia, and other European countries. In the first figure, there can be seen adequate spaces between the vehicles and all of them are moving forward following one lane. But according to Figure 2, which illustrates the traffic behavior in Sri Lanka, vehicles move incloser to each other without following any lane.

This traffic behavior in Sri Lanka is the main issue, especially behind the difficulty in implementing image processing-based traffic monitoring systems since contours cannot be properly generated with this irregular traffic behavior in Sri Lanka. And it is harder to identify vehicles, especially in real-time traffic monitoring systems. Even though color lights are used to reduce traffic congestion since they are not intelligent and programmed for a certain period and there can be frequently seen several instances where the green color is still in "on" state even when there are no vehicles on the road. These phenomena can be commonly seen which causes traffic jams by lacking the chances for the vehicles on other lane's access to the road. Similarly, a large number of road accidents has also significantly increased dueto the traffic jams in Sri Lanka, which now has become an adverse social impact [10].

Moreover, there can be seen poor technical and digital literacy in Sri Lanka compared to other countries. Even though many traffic surveys are conducted annually, there cannot be seen any proper traffic database. Similarly, there isno any automated system to retrieve past data from that analysis to do comparisons or other estimations such as trafficpredictions [11].

III. Literature Review

As early as the 1970s, an autoregressive integrated moving average (ARIMA) model for short-term highway traffic flow forecasting was introduced which has been recorded as the foremost approach under ITMS strategies [12]. Since then, scholars and academics from a variety of fields, including transportation engineering, electronic and mechatronic engineering, statistics, economics as well as machine learning have proposed a wide range of models for forecasting traffic flow. Similarly, a considerable number of surveys and extensive analyses have also been carried out on traffic management in recent years, concentrating on various trafficfactors.

A massive project was carried out to enhance traffic management and control of Hong Kong's Road network, which is known as one of the busiest roads in the world [13]. In this project [12], an ITMS was built beginning in 2001 andwas successfully finished in 2010. Traffic monitoring, control operations, data collection, and analysis are among the primary platforms featured in this project to manage traffic congestion. By tracking all major highways and road tunnels, this initiative has ensured effective traffic control [12].

A low-cost sensor-based network instrument for traffic monitoring was developed and tested to be used in a work zone [14]. In that project, the entire sensor network system was used to collect data from that work zone [14]. Then the data was sent for post-facto analysis and uploaded to the internet. Al-Holou et al.[15] developed a multi-dimensional model to estimate the influence of vehicles on the environment, traffic congestion, and traffic safety.

This chapter includes a comprehensive literature review on similar traffic monitoring and prediction approaches and effective traffic monitoring and short-term forecasting techniques. First of all, the overview of real-time traffic monitoring and forecasting projects, research and surveys thathave been carried out worldwide and their approaches are evaluated using the above paragraphs with the research gaps identified. Then the literature analysis is further extended, covering the traffic detection and prediction methods in separate sections.

a) Traffic Detection Methods

Vehicle detection and surveillance play an integral role in both effective traffic congestion management and ITMS. Since ITMS plays a critical role in national traffic management systems (TMS), the quality of provided data and the geographical arrangement of traffic sensors are also important factors for ITMS success [6]. Similarly, both the vehicle detection and surveillance functions are always subject to constantly being improved in order to increase vehicle detection and monitoring, counting their direction headway, and speed, and categorizing vehicles. Further the real-time traffic information such as the number of vehicles and various sorts of road users and the vehicle types are useful to enhance the performances of the traffic management system.

Vehicle detection technologies that are widely used can be classified into three groups: intrusive, non intrusive, and off- roadway sensors [16]. The inductive loops, magnetic detectors, piezoelectric sensors, weight in-motion sensors and pneumatic road tubes are considered invasive sensors according to the above classification. These are usually embedded in the road surface after saw-cutting the surface or adding roadway holes. The detection methods such as vision- based systems such as image processing traffic monitoring systems, infrared sensors, microwave radar and ultrasonic detectors are categorized as non-intrusive sensors which can be installed atop roadway or roadside surfaces or mounted overhead. Remote sensing by airplane or satellite, as well as probe vehicles equipped with GPS receivers, are examples of off roadway sensors that do not require installation on highways [16]. More detailed descriptions of these technologies are available in [17], [18]. Consequently, these sensors are not suitable for large-scale integration or temporary installation. They are exclusively stationed in strategic areas and operate independently of one another.

Video Image Processor is a very common traffic monitoring method since now Image processing has become a tendency and the most prominent traffic monitoring system in the world [6]. Video Image Processor (VIP) systems normally consist of a camera, a processor-based workstation for analyzing the images, and software for understanding the images and transforming them into data. This can also be operated in multiple lanes. Image processing systems provide live images of real-time traffic status, which covers multiple detection zones. So that it offers broad area detection [19]. In addition to that, wide-area detection can also perform by gathering information generated from cameras located at different locations. Vehicular detection of the image processing systems is performed with the assistance of the contours drawn in the snapshots taken in constant time intervals thereby the vehicular presence is identified. It offers occupancy, classification, and count of vehicles, as usual in most other sensors.

Moreover, in the literature, several disadvantages of image processing have also been discussed. Being sensitive to weather conditions, vehicle shadows, and dust on the camera lens is notable. Lane closure requirements for installation and maintenance, specific camera mounting height requirements for better vehicle presence detection and speed measurement, higher installation, and maintenance costs are also significant drawbacks of this camera-based traffic monitoring system [19]. In spite of the weaknesses like costly equipment for the transfer of real-time video-image data, separating algorithms required for day and night traffic detections, possibilities of discrepancies appearing during traffic data transition, and performance prone to obscurants and heavy atmospheric conditions cannot be ignored [19]. Besides image processing, there are a variety of technologies for traffic monitoring that use various types of electronic sensors.

Light Detection and Ranging (LiDAR) technology is a novel technology in which research and investigations have been performed in recent years [24], [25]. LiDAR is a remote sensing method that uses light in the form of a pulsed laser to measure ranges of variable distances. The point cloud of LiDAR data is made up of thousands of points in X, Y, and Z coordinates. A point cloud depicts the environment in three dimensions. However, point cloud data is huge and contains duplicate information [25]. Downsampling, noise reduction, ground removal, object grouping, distant irrelevant object rejection, and ultimately vehicle recognition utilizing point cloud data are all part of this architecture.

The authors of [26] have proposed a technique for removing backdrops and detecting lanes from a point cloud based on roadside LiDAR data. Several articles and researchers have proposed many approaches for vehicle detection using LiDAR technology [26]. The authors propose an L-shape fitting model for automobile identification. It makes use of the fact that a vehicle's top view in LiDAR data resembles an L shape. A segment-based technique for recognizing automobiles using mobile LiDAR has also been suggested [25], [26]. Geometric characteristics such as size, form, and height are retrieved for categorization in this method. The distance traveled by the segments and the direction of movement is utilized to locate moving autos [25]. The strengths and weaknesses of each traffic monitoring technique are compared in Table 1 below.

Table I: Strengths and Weakness Comparison of Detector Types[6]

Type of the Detector	Detector Methods Comparison		
	Working Mechanism	Strengths	Weaknesses
Inductive loop	Detects the vehicle by sensing the loop	• Flexible design to fulfill a great variety of applications. • Unresponsive to bad weather. • Offers accurate count data.	• Traffic disruptions while installation and maintenance • Prone to damage by heavy vehicular movements and during road repairs h
Microwave radar	Transmits signals in the recognition regions and captures the echoed signals from vehicles	• Unresponsive to bad weather. • Speed is measured directly. • Multiple lane operation.	• Continuous-wave Doppler sensors are incapable of sensing immobile vehicles.
Acoustic	Detect audible sounds produced by vehicular traffic. Using them vehicle presence and speed are measured.	• Unresponsive to precipitation. • Multiple lane operation.	• Vehicle count accuracy may be affected by cold temperature.
Magnetic	Detects the presence of a vehicle by measuring the perturbation in the Earth's magnetic field	• Applicable where loops are not likely. • Insensitive to bad weather. • Installation of some models does not require a pavement cut. • Less prone than inductive loops to pressures of vehicles.	• Installation needs a boring under the road. • Incapable of sensing immobile vehicles.
Ultrasonic	Transmits ultrasonic waves and again collect the echoed waves from an object.	• Monitors multiple lanes. • Proficient in detecting over - height vehicles.	• Performance is affected by environmental circumstances. • Occupancy measurement on freeways may be degraded with large pulse repetition periods.
VIP (Video image processor)	This system normally consists of a camera, processor, and software.	• Monitors multiple lanes. • Simple to add and change detection areas. • Offers broad-area detection.	• Installation and maintenance require lane closure. • Performance is sensitive to bad weather, vehicle shadows, and dust on the camera lens.
			• Requires specific camera mounting height for finest vehicle presence detection and speed measurement.
Light Detection and Ranging (LIDAR)	This is a remote sensing method that uses a pulsed laser to measure ranges of variable distances.	• Monitors multiple lanes. • Simple to add and change detection areas. • Insensitive to bad weather. • Offers broad-area detection.	• Traffic disruptions while installation and maintenance.

b) Prediction Methods

Traffic flow is a real-time, totally non-linear, high-dimensional, and non-stationary random process. Reviewing the literature emphasizes that vehicle forecasting is a common research topic and that more research has been done while many approaches have been taken. Most of the research articles have a special focus on these traffic predictions due to the uncertainty and random non-linearity of the traffic flow. Similarly, most of them have introduced Traffic predicting and forecasting traffic strategies which assist to minimize these increasing traffic jams [27], [28]. According to the reference [28], traffic forecasting is classified into two basic categories: long-term prediction and short-term prediction. The projections for the near future are known as short-term predictions typically these short-term predictions are for the next 5 to 10 minutes in immediate future. Short-term predictions are a common prediction method since to the changing weather conditions, cultural or political occasions, and events, road accidents may cause sudden changes in traffic conditions [28].

There can be seen several research articles which evaluatethe accuracy and the efficiency of several prediction models comparing one another. Among them [27], [28] reference emphasizes that both data-driven and experimental traffic flow prediction approaches can be classified as parametric, non-parametric, or hybrid, each having its own set of benefits and drawbacks [28]. The majority of traffic flow prediction research has been conducted under regular traffic conditions,while unusual traffic variables such as climate, the presence of noise in the data, and highway disruptions have seldom been addressed. Providing a complete detailed analysis of these three prediction methods, above mentioned reference emphasizes linear regression, maximum likelihood (ML), Historical Mean Average, exponential smoothing method, and time series model as parametric prediction approaches [28]. Moreover, it claimed that the parametric prediction method is more accurate than the other two methods, still its poor functionality amid the noise and other disturbances is an encountered major drawback [28].

Extensive research by Van Lint and Hoogendoorn which provides an overview of predictive models for short-term traffic forecasting also emphasizes that forecasting methods can be divided into three major groups: parametric, non- parametric, and hybrid (naive) [29].

i. *Non-Parametric Models*

Non-parametric models imply that the number of parameters which assigned to a model is flexible. This means it is not fixed, in which the model structure and parameters should be developed based on the available data. Usually, theamount of data should be significant in contrast to the other two approaches. These models have the benefit of allowing for the discovery of intricate non-linear correlations between traffic factors. However, the disadvantage of these models is that while the model's structure is derived from the data, unanticipated events and outliers may have an impact [29]. The intricacy of these models, as well as their reliance on vast amounts of data, are also other significant drawbacks. Non- parametric prediction approaches use current models rather than traditional models to estimate traffic flow in proportion to road conditions. Neural networks, such as the multilayer perceptron (MLP), time-delay neural network (TDNN), and radial basis function (RBF) are the most popular and prominent non-parametric approaches. Besides these neural networks, Fuzzy [30], Bayesian networks k-nearest neighbor (KNN)[31], support vector machine, and wavelet are other non-parametric methods used for predictions [28].

Neural networks are the most common and popular model that is used for traffic predictions. They consist of the abilityto model and simulate complicated non-linear relationships [29]. There can be seen different neural network types such as Feed forward artificial neural networks, Convolutional Neural Network (CNN), Recurrent neural networks (RNN) as well as Long Short-Term Memory networks (LSTM) based on their training procedure, internal structure, methods of preprocessing input data and their models including spatial ortemporal patterns. Among them, the feed forward artificial neural network is the simplest neural network category whilethe LSTM is the most powerful model to process sequential data. The type of the neural network varies depending upon the task being performed with it. Typically, a neural network comprises an input layer, several hidden layers and an output layer [29]. According to the research paper by Van Hinsbergen, Van Lint, et al., a typical neural network might deliver reliable findings in terms of extensions required for higher accuracy in traffic predictions [29].

ii. *Parametric Models*

Parametric models imply that the model's structure and the number of parameters are tightly established, and the model'sparameters must be derived using data. The advantage of suchmodels is that unseen cases and incidents can be captured. Another advantage is the necessity of less data. Some models are capable of offering higher accuracy even with less computational work [29].

The hybrid model is the combined version of both parametric and non-parametric prediction models where the accuracy of the prediction is higher than the other two types. Most hybrid prediction models are combinations of neural networks and other parametric and non-parametric models such as ARIMA models, MLP, and fuzzy. According to the reference [28] the Neural network-based MLP model is the most suitable prediction model for data-driven traffic forecasting

systems combined with image processing compared to all other models.

Despite the facts that were included on these parametric, non-parametric and hybrid prediction models, in the literaturesection, there can be seen a vast number of projects and research approaches subject to predictions and forecasting models which evaluate the existing gaps. Further, when the literature on traffic prediction methods are referred to, there can be seen an outstanding tendency toward using LSTM neural networks for traffic predictions, especially in recently published research articles. Similarly, novel projects and research have given great attention to these LSTM neural networks. The reference [33] evaluates the recent rise in the usage of LSTM algorithms for traffic prediction. It reveals that now the LSTM model has become common and prominent. According to another research carried out on LSTM[34], most prediction approaches have concentrated on accuracy rather than immediacy.

LSTM neural network is an improved version of RNN where the vanishing gradient problem and long-term dependency of recurrent neural networks are successfully overcome. Input, output, and forget gates are three gates that are introduced in LSTM. However, the reference [35] claims that even though most of the novel traffic management approaches used Long short-term memory (LSTM) models, those existing projects and their models have failed to address the issue of massive traffic flow data being processed simultaneously with parallel to computing and distributed data storage. But it also emphasizes that the LSTM model is a better prediction model for more random and time-varying predictions such as traffic flow [35].

According to reference [40], traffic prediction research should focus on the data-intensive era, which is now missing. The existing traffic categorization algorithms are ineffective in low-light situations [41]. Also, there can be seen a lack ofstudies focusing on the time series for the Internet of Things (IoT) traffic forecast [33]. Existing research has not properly simulated or created to be compatible with the dynamic trafficpatterns of irregular locations [33].

Traffic prediction studies are controversial due to a lack of more efficient computational methodologies and algorithms, as well as excellent quality data. Research article [43] indicated that the performance of the Convolutional Neural Network (CNN) for traffic prediction was somewhat disappointing based on the implementations of prior research. Table II compares the strengths and weaknesses of eachprediction model.

Table II: Prediction Models Comparison

Prediction Model	Prediction Models Comparison	
	Strengths	*Weaknesses*
Mean Average model	• Low Prediction Error.	• Poor functionality in the presence of noise. • Average of all inputs are needed for the predictions. High dependency on recorded data.
Linear Regression Method	• Low Prediction Error. • Predicts the next variable online using real data.	• Poor functionality amid the noise and other disturbances.
Maximum Likelihood (ML)	• Low Prediction Error. • Robust for sensor failures and rapidly changing conditions.	• High dependency on recorded data.
Exponential Smoothing Method	• Low Prediction Error.	• Poor functionality amid the noise and other disturbances. • Difficulties to determine constant coverage.
ARIMA Model	• Low Prediction Error. Simplicity. • More mathematical model • Obtain the relationship between past and future data.	• Poor functionality amid the noise and other disturbances. • High dependency on recorded data.
MLP Model	• High Accuracy.	• High dependency on recorded data.

Prediction Model	Prediction Models Comparison	
	Strengths	*Weaknesses*
	• Predict traffic flow in proportion • to road conditions.	
Fuzzy Model	• Low Prediction Error. Simplicity. • High Accuracy.	• Poor functionality amid the noise and other disturbances. • High dependency on recorded data.
KNN Model	• High Accuracy. • Predict traffic flow in proportion to road	• Poor functionality amid the noise and other disturbances. • High

IV. Methodology

The methodology is introduced by being split into two main sections: the traffic monitoring stage and the forecastingstage using neural networks emphasizing the main milestonesof the project.

a) Traffic monitoring stage

Vehicle detection was accomplished using a TFMini Plus LiDAR sensor installed by the side of the road, to monitor the vehicles directed to one side, determining the desired tilt angle and height. Sensor positioning is illustrated in below figure 3.

TFMini Plus sensor's Time of Flight (ToF) principle is used to detect the presence of vehicles. The sensor's periodically emitted modulation waves are used to detect andcalculate the proximity to the object and its time-of-flight is estimated by measuring the round-trip phase difference of its reflection when it contacts an object [49]. These periodic modulation waves are always set to be directed towards the road and to be released at a frequency of 16.667 Hz with 60-millisecond intervals. Universal Asynchronous Receiver / Transmitter (UART) communication was used to communicate with the microcontroller. Distance limitations for the sensor were configured as the distance should be between the range of 800 to 1220 meters considering white lines which indicate the margins and use to separate traffic traveling in the same direction, assuring the sensor is not triggered for pedestrian movements or the vehicles in the other direction.

Additionally, distance measurements must persist longer than 50 milliseconds and return to zero which is the initial distance value. The presence of a vehicle will therefore be counted as present if both prerequisites are met, where the count will be one. Likewise, the vehicle count is taken and increased within a 5-minute interval. And the vehicle count isprogrammed to be zero after every 5 minutes (5 $\times$1000 $\times$ 60 milliseconds) intervals and the latest value which is recordedas the vehicle count inside that interval is to be delivered to the ThingSpeak IoT platform as well as to an SD card. Here the ThingSpeak online IoT platform was used as the source to create the database. A database was developed by recording consecutively collecting data. ESP8266 (NodeMCU) modulewas used as the microcontroller which can enable further improvements with IoT connecting several nodes.

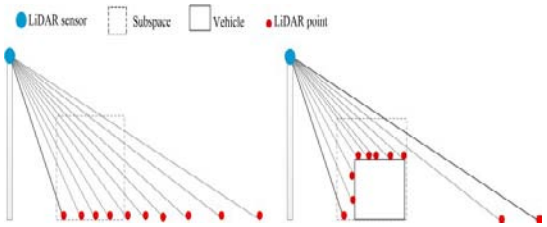

Figure 3: An Illustration of a Subspace Without (Left) Or With(Right) a Vehicle [50]

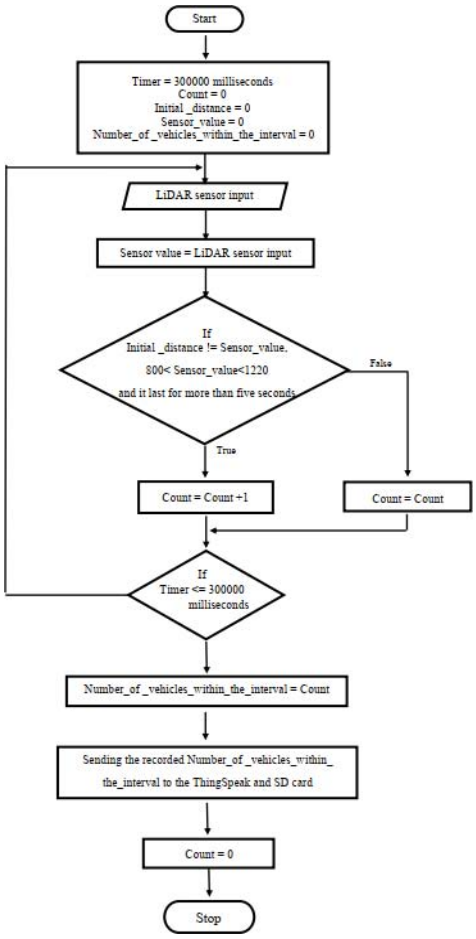

Figure 4: Flow Chart of the Vehicle Detection Algorithm

Then, sensor accuracy was tested by plotting the actual vehicle counts vs sensor detected vehicle counts graph considering 200 data points of that data entries. Similarly, the accuracy of the sensor was also measured as a percentage to ensure the sensor's performance.

b) Neural Network Training and Forecasting Stage

This stage includes training LSTM neural network model. To accomplish this task, data preparation and segmentation were carried out before sending to the neural network model for training. The data gathered to Thing Speak was exported as. csv files to train the LSTM model. During the data consolidation process, .csv files gathered from Thing Speak were modified separating date and time into two columns, removing the entry ID column, and adding missing entries. Similarly, the values which imply significant deviations were removed from the data set. Those modified .csv files were fed into the system as inputs by dividing them into four segments. And the input data volume that is taken to train the model andwindow size were used as variable parameters to find the bestcase of the prediction model.

Since the vehicle count is taken in five minutes intervals,

In one hour: 12 data points
In one day: $12 \times 24 = 288$ data points
In a week: $12 \times 24 \times 7 = 2016$ data points
In a month: $12 \times 24 \times 30 = 8640$ data points

Likewise, data gathered over five weeks by monitoring the vehicular traffic were employed to create the forecasting models.

Then the entire data collection was separated into two setsfor training purposes and testing purposes. Eight thousand sixty-four data points (data gathered over a duration of a month) were employed as the training data set while the remaining set of 2016 data points (data gathered over a week) were used as test data for the model testing purposes. The entire training data set was again split into four segments as week 1, week 2, week 3 and 4.

Then obtained data patterns over a day and week were observed to identify the patterns of the traffic behavior. Afterthat more than ten separate models were tested to find the besttraffic prediction model. Initially, the first set of models were created by setting the window size to 12 while changing the input data volume from 2016 data points to 8064 data points. When the 2016 input data set is considered, it includes the datagathered

during the last week of the month, which is fed to the system for training. Accordingly, the 4032 data points indicates the data gathered over the last two weeks and 6048 indicates the collection of data over three weeks and 8064 data points represents the data gather over a month. (i.e., a separate data set with 2016 data points collected over another week was employed as test data to test the models.)

In the second model set, depending upon the results of thefirst four models, input data volume was set to 8064 data points and the window size was changed to 6, 12, 24, 60 and 288. Window size 6 means 6 data points are fed into the system at a time, which means 30-minute (1/2 hour) intervals. 12 means 1-hour data is fed at a time. Likewise, three other models were trained for 2 hours, 5 hours and 24 hours. Depending upon the results of those five models, the desiredwindow size was determined. And then in the third model set, the window size was set to 24 and once again the input data volume was changed from 2016 data points to 8064 data points.

After obtaining all of these prediction model sets, all the models that have been trained varying both window size and the volume of input data delivered to train the models were critically evaluated in terms of accuracy in order to identify the most suitable prediction method. Accuracy formulas provide a vital contribution to projects since precise calculations are always helpful to critically evaluate the resulted outcomes to determine the most suitable solutions to apply. Accordingly, all accuracy-related calculations of this project (sensor accuracy calculations, prediction models' accuracy calculations) have been done using the following two equations which are used to measure the world-accepted accuracy in accordance with IEEE standards [51]. The accuracy formula provides accuracy as a difference of error rate from 100%. To find accuracy, first it is needed to calculate the error rate. And the error rate is the percentage value of the difference between the observed and the actual value, divided by the actual value [51].

Therefore, below equation 1 was utilized to determine the error rate.

$$\text{Error Rate} = \frac{|Observed\ Value\ -\ Actual\ Value|}{\text{Actual Value}} \times 100$$

Once the error rate is calculated the accuracy is determined using the below equation 2 as the difference of error rate from100%.

$$\text{Accuracy} = 100\% - \text{Error Rate}$$

V. Results and Validation

a) Results of the Sensor Accuracy Test

First of all, the accuracy of the sensor was tested considering the data gathered during a random day. Actual vehicular counts were taken by counting the actual vehicle count and the sensor detected vehicle count was directly obtained from the sensor records. Then the actual vehicle count vs sensor-detected vehicle count was plotted and the accuracy of the sensor has been tested considering 200 data points.

Obtained the accuracy results of the sensor was 89.86%. Figure 5 illustrates the behavioral differences between actual vehicle count and sensor-detected vehicle count. This emphasizes that sensor detected vehicle count is almost closer actual vehicle count. Similarly, this sensor accuracy plot is also helpful to understand the traffic behavior of a day, starting from 0.00hr to 23.59hr. Accordingly, it was understood that the traffic behavior of a day more takes normal distribution behavior, in which the higher values cluster in the middle of the range and the rest taper off symmetrically toward either extreme.

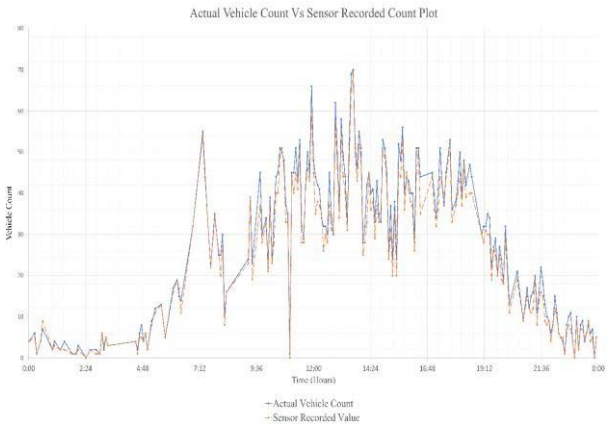

Figure 5: Actual Vehicle Count vs Sensor-Recorded Vehicle CountPlot

b) Traffic Behavior Analysis

After observing the traffic behavior of a day, the traffic behavior of a week was also plotted. There also the traffic behavior of each day takes normal distribution behavior. Therefore, the traffic behavior of a week was a combination of seven normal distributions. Additionally, after gathering traffic data over a month, the traffic behavior of each week was also plotted to identify whether the traffic flow remains the same following a pattern every week or is there any significant increase or decrease in the traffic behavior. Belowfigure 6 represents the overall traffic behavior of the entire month. These plots which were plotted observing the traffic behavior of a day, a week and entire month were helpful in understanding the traffic pattern as well as in deciding the window size that should be taken to train the LSTM neural network since there was not any other source to be observed to identify the traffic patterns.

c) Prediction Results

When obtained data patterns were observed, it was recognized that there could be significant deviations in traffic flow after intervals of 60 minutes which means during an hour, there could be seen slight differences but from hour to hour there can be seen significant increasements or decrements in traffic behavior. Therefore, first it was identified it is better totake 12 data points at a time to train the prediction model. Then the desired window size was kept to twelve and using data gathered over a month the very first LSTM neural network model was trained. Below figure 7 illustrates the resulted predicted traffic behavior vs test data plot and figure8 illustrates the entire plot of the trained data, test data and resulted predicted traffic data.

Finding the best traffic prediction model is one major research objective of this project. Therefore, more than ten LSTM neural network models were created and evaluated in terms of accuracy to identify the most suitable forecasting model. Here all the model sets that were tested able to result accuracy more than 70%. And no model exhibits large deviations in predicted traffic behavior vs test data plot proving that fact. Further, it seems that the strategy that has been carried out by changing the window size and the volume of the input data as the variable parameters to figure out the best model was successful because there can be seen a noticeable pattern in the prediction accuracies.

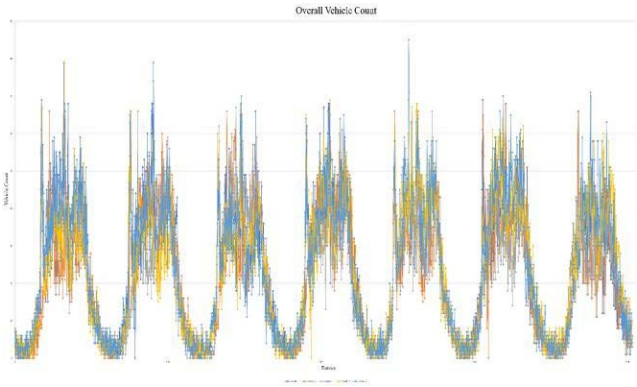

Figure 6: Overall Traffic Behavior of Each Week

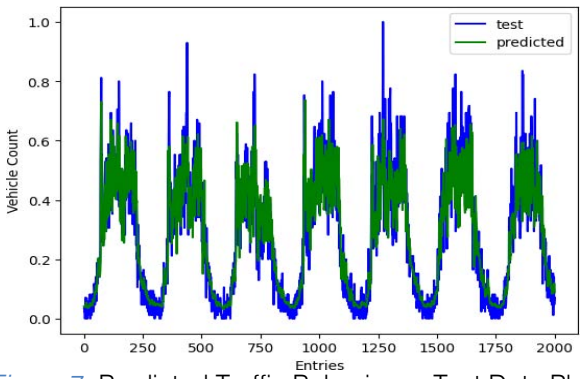

Figure 7: Predicted Traffic Behavior vs Test Data Plot

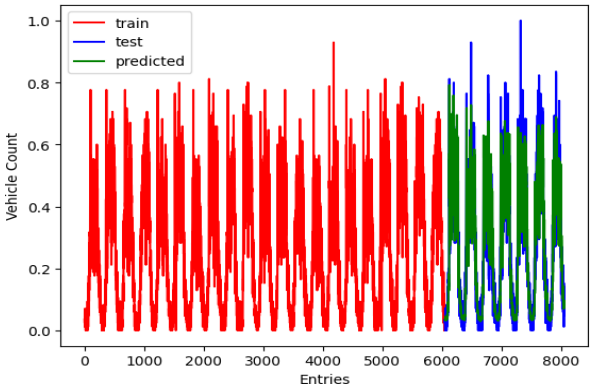

Figure 8: Train, Test and Predictions Results of the Most Precise Forecasting Model

The accuracy results for each prediction mode that was developed employing both window size and the volume of input data delivered into the model to be trained as variable parameters are shown in Table III, IV, and Table V below.

Table III: Accuracy Table of the Models Trained using Window Size_12

Volume of input (Data Points)	Window size (Data Points)	Accuracy %
2016	12	72.87
4032	12	72.91
6048	12	73.42
8064	12	74.59

Table IV: Accuracy Table of the Models Trained using Variable Window Sizes

Volume of input (Data Points)	Window size (Data Points)	Accuracy %
8064	6	74.49
8064	12	74.59
8064	24	75.34
8064	60	73.58
8064	288	72.07

Table V: Accuracy Table of the Models Trained using Window Size_24

Volume of input (Data Points)	Window size (Data Points)	Accuracy %
2016	24	74.20
4032	24	73.78
6048	24	73.96
8064	24	75.34

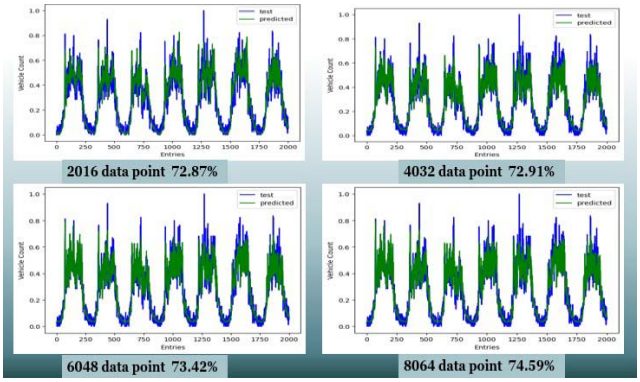

Figure 9: Predicted Traffic Behavior vs Test Data Plots

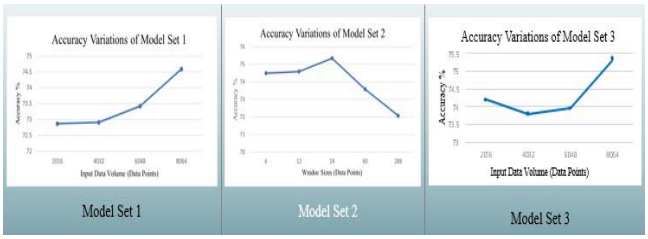

Figure 10: Accuracy Variations of the Prediction Model Sets

Further, the accuracy results of these test models which are presented above shown in Table III, IV, and Table V emphasize that both window size and the volume of the input data creates a significant impact on the prediction accuracy of the prediction models. The accuracy test results of all the 3 model sets show that all of them were above 70%.

Above Table III includes accuracy results of the training model set 1 which was created by setting the window size to 12 while changing the input data volume from 2016 data points to 8064 data points. As per described in the methodology section, when 2016 input data set is considered, it includes the data gathered during the last week of the month and that data was fed to the system for training. Accordingly, the other models were tested using increasing input data points while keeping the window size constant. In model set 1, there can be seen a gradual increase in accuracy when the input data volume gets larger.

In the second model set (represented in Table IV), the input data volume was set to 8064 data points and the window size was changed to 6, 12, 24, 60 and 288 (explained in the methodology section). Even though the accuracy has increased in the first three models, there can be seen a noticeable decrease in accuracy with larger window sizes. This implies that the most suitable window size is 24.

Third model set in which results are presented in Table V, the window size was set to 24 and once again the input data volume was changed from 2016 data points to 8064 data points. There also can be seen a gradual increase in accuracy when the input data volume is getting larger.

Above figure 9 illustrates several predicted traffic behavior vs test data plots. All of them are quite similar and both predicted vs actual traffic behavior lies on top of each other showing a closer behavior. Similarly, there are no larger deviations. Figure 10 includes the graphical representation of the above Tables III, IV and V. It also provides graphical comparison on the accuracy results that were obtained from each model set.

As illustrated, there can be seen noticeable changes when varying both window size and the volume of input data. A gradual increase in accuracy can be seen when increasing the input data volume. Meanwhile, it implies that the window size should remain under a fixed value, and increasing it enhances the accuracy but after a certain value, the accuracy may decrease if it is further increased.

Therefore, according to the obtained results it was identified that the highest prediction accuracy could be obtained by setting the window size to 24 windows in which the data gathered for two hours will be fed into the system to be trained at a time and increasing the input data volume to the greatest extent possible. Similarly, resulted accuracy values also indicate that the model should be trained using 80% data and tested using 20% data from the gathered data in order to obtain higher precision.

VI. Conclusion

The main objective of this project was to introduce A better traffic management system and traffic forecasting system to reduce traffic congestion,

especially in the context of Sri Lanka. The results of both the sensor accuracy tests and the results obtained from the prediction models emphasize that the aforementioned objectives have been successfully achieved and the strategies that were utilized in this project to address the issues have been able to effectively contribute to the successful completion of the entire project by accomplishing their individual tasks. Here the efficiency of the methodology has been successfully illustrated by the practical implementation and using the obtained accuracy test results.

Further, there can be seen several benefits in this project. The traffic monitoring and forecasting system, which is introduced in this project, is low-cost as well as it can be easily implemented. This system can be implemented in any country, under any circumstances, since it has the ability to adapt to any type of traffic behavior. It is a well-known fact that monitoring vehicular movement is a really challenging task, especially in Sri Lanka, where the traffic behavior is messy and chaotic since vehicles do not move consistently following a lane, maintaining adequate distance one after another. However, the traffic monitoring method that has been utilized in this project which employs TFmini plus LiDAR sensor to monitor the traffic, is able to provide 89.86% accurate readings, avoiding difficult circumstances, even under an unsystematic traffic condition like Sri Lanka. Therefore, since this sensor system is able to address the traffic issue in Sri Lanka successfully, it proves the adaptability of implementing it anywhere under any type of traffic behavior.

Moreover, even though image processing-based video traffic monitoring systems are commonly used in many other countries, it appears that those image processing-based systems require advanced technological feasibility as well as considerable capital to implement them. Therefore, when considering the existing technical feasibilities and the traffic infrastructures in Sri Lanka, this system is more appropriate as a low-cost as well as a system that can be implemented with low technical capabilities. Especially its resistance to dust and rain makes it possible to place it anywhere in a country like Sri Lanka.

The other thing is most of the traffic forecasting models need a sizable traffic database to train their prediction models. Prediction models based on image processing need a previous database to identify the vehicles by drawing the contours. And it takes significant time to train the model. But especially in the countries like Sri Lanka, there is no traffic database gathered over a considerable time period. Therefore, the prediction model which is introduced in this project is more suitable for such countries because it does not require a large volume of data to be trained. Obtained prediction accuracy results depict that this prediction model can produce predictions with an accuracy rate of 74.20% even if it is trained using the data gathered over one week. Therefore, this implies that the absence of a proper traffic database would no longer be an issue for implementing traffic prediction models with this system.

Therefore, it is clear that this traffic monitoring and forecasting system is a more practical approach to solving the traffic congestion issue effectively, especially in Sri Lanka, where there is no valid database regarding the traffic behaviors and congested areas, where the traffic behavior is messy and chaotic and where there are less advanced technical feasibilities. And the other important fact is that the accuracy testing results of the prediction models reveal that when the volume of the input data is increased it significantly increases the accuracy of the prediction model. Therefore, at the beginner level, this traffic monitoring and forecasting system can be implemented with the data gathered over a short period like one month, and later this can be developed further, with better forecasting accuracies by including data collected by training the system.

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List of Abbreviations

Abbreviation	Definition
LiDAR	Light Detection And Ranging
LSTM	Long Short-Term Memory
CCC	Congestion Costing Critique
UMR	Urban Mobility Report
NHTSA	National Highway Traffic SafetyAdministration
CO2	Carbon Dioxide
ITMS	Intelligent Traffic ManagementSystems
TMS	Traffic Management Systems
GDP	Gross Domestic Product
GHG	Greenhouse Gas
ARIMA	Autoregressive Integrated MovingAverage
GPS	Global Positioning System
VIP	Video Image Processing
ML	Machine Learning
MLP	Multilayer Perceptron
TDNN	Time Delay Neural Network
RBF	Radial Basis Functions
KNN	K-Nearest Neural Network
CNN	Conventional Neural Networks
RNN	Recurrent Neural Network
UART	Universal Asynchronous Receiver/Transmitter
IEEE	Institute of Electrical and ElectronicsEngineers

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A Study of Artificial Intelligence in Education

By Anjana C M

Abstract- Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think and mimic human cognitive processes. It includes a wide range of tools that enable machines to carry out operations that otherwise need human intelligence. Learning, logical thinking, problem-solving, perception, speech recognition, and language understanding are some of these tasks. One of the key areas where AI will have a profound effect is education. Both students and teachers benefit from enhanced educational experiences because of AI. It offers a personalized learning experience. Although AI in education hasn't received much attention over the years, understanding its concepts, functions, methodology, and applications would provide the groundwork for the development of the education sector.

Indexterms: artificial intelligence (AI), chatbots, robotics, virtual reality (VR).

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I. Introduction

AI is now applied in education in a number of different ways, from chatbots that offer 24/7 student help to personalized learning algorithms that adjust to the needs of each student. Additionally, administrative duties like grading assignments and delivering feedback are being automated using AI-powered technologies. AI is also being used to analyze vast volumes of data in order to find trends and insights that can guide the creation of new educational initiatives and regulations. Artificial intelligence (AI) has the potential to revolutionize the way we think about education. AI-powered tools and technologies are improving the learning experience for students in ways we never thought possible, from personalized learning algorithms to virtual and augmented reality. AI technologies were increasingly being used to personalize education for individual students. By collecting data on a student's learning style and comprehension level, AI tools can provide personalized feedback and recommendations. AI can process large volumes of educational data to identify trends, patterns, and correlations that can inform education policies and practices.

Adaptive learning is a popular AI based method that adjusts the learning experience to match the learning pace and style of each student. Additionally, AI powered tutoring systems can provide personalized support and feedback in real-time enhancing student learning outcomes. To complement conventional teaching materials, AI systems can provide educational content including tests, practice questions, and study guides. AI cal also identify students who are at risk of falling behind or dropping out, allowing educators to intervene early and provide additional support. With AI's ability to personalize education, students can receive improved academic performances and great engagement in learning process. Not only students, teachers can also benefit from personalized professional development opportunities that can help them strengthen their teaching strategies and stay current with the most recent findings in the field of education with the assistance of AI.

II. AI Education Model

In AI learning system, learner model is critical for improving independent learning capabilities. It is established based on behavior data of learners generated from the learning process. Learners' thinking and capability is analyzed to assess their learning abilities. Then knowledge analysis is mapped to obtain learners' knowledge mastery. Learner modeling establishes connections between learning results and various factors including learning materials, resources and teaching behaviors [1]. Knowledge model establishes knowledge structure map with detailed learning contents, usually including expert knowledge, rules of making mistakes often made by learners and misunderstanding [2]. Combining knowledge field model and learner model, teaching model determines the rules to access knowledge field, which enables instructors to tailor teaching strategies and actions. Learners are likely to behave favorably, take action, or ask for assistance as education progresses. The built-in teaching ideas of tutoring models can be used by AI systems to always be ready to offer assistance. User interface explains learners' performance through multiple input media (voice, typing and click) and provides output (texts, figures, cartoons and agencies). The sophisticated human-machine interface offers AI-related capabilities such natural language interaction, speech recognition, and learner emotion detection. The customization and personalization of curriculum and content in accordance with students' needs, abilities, and capabilities is a significant way that AI has been used to improve students' learning [3]. AI in education has also eliminated some barriers to access to learning opportunities, such as national and international borders, enabling global access to learning through online and web-based platforms [3][4].

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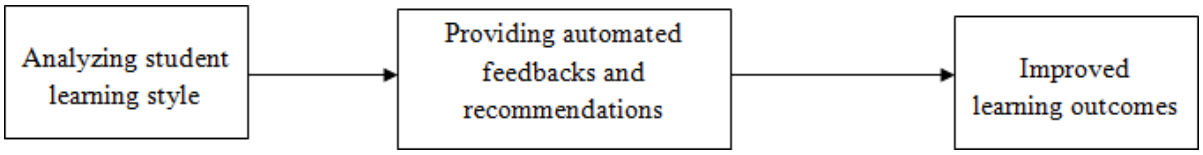

Fig. 1: Impact of AI in Student's Learning Style

III. Impact of AI in Education

The internet is currently the main source of entertainment, education, and information. Hours spent learning in classrooms using chalkboards have drastically dropped since the start of the Covid-19 pandemic. It also comes after the effect of lockdowns and social restrictions. Several educational institutions across the world are already using AI. The emotional state of a child affects their motivation, involvement, and focus while learning. When emotion detection technology is applied, virtual surroundings can be equally as effective as actual learning environments. As gamification is acknowledged, it is possible to make learning and teaching more enjoyable. In addition, AI can identify areas where students are having difficulty and offer support so that they can finally excel.

One application of AI is chatbots. It is the technical core of the future. More and more chatbots are being used in educational institutions where students utilize computers or iPads to communicate with the bots. It is intended to make certain things easier for students to understand, like Mathematics or reading comprehension. The potential uses of chatbots go beyond simply imparting knowledge to students. Moreover, if necessary, they can assist with the analysis. It lessens the workload placed on the teachers. Additionally, it can also swap emails between parents and teachers and record parent-teacher conferences.

Over the past few years, the application of AI and robotics in education has increased. Both teachers and students can use it within the system. It may increase the safety and involvement of students. Both educators and students can benefit greatly from using robots as learning tools. Both can have enjoyable discussionsthat go in-depth on the subject. Robots may provide teachers with a method to spend more time directly instructing kids who require extra assistance. They may be able to try out new teaching techniques as a result.

The education sector already uses AI with VR. It instructs pupils in everything from History to Mathematics. A 3D computer-generated environment can be explored and interacted with in virtual reality (VR). Students can maintain relationships with one another through VR. Students can safely speak across distances while using the same VR programme while seated in various classrooms. Teachers and students can watch things that they might never have learnt about or seen in real life. Teachers now have the chance to experiment with more interesting teaching strategies. Both teachers and students will gain from more involvement and in-depth learning.

IV. Conclusion

In conclusion, AI has had a huge impact on learning and education. For parents who are constantly concerned about their children's social lives, AI has proven to be beneficial. They may now more closely monitor their children's online interactions than ever thanks to AI technologies. Software is used in educational institutions to analyze data points, such as student comprehension of the lessons. Students are then divided into groups based on their needs. AI can also make teachers and classes fully available anywhere, 24/7. It uses AI algorithms to give students individualized feedback on tests, assignments, and other materials. The adoption of AI in the education sector will enable students as well as teachers to build a successful future for the mselves.

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Strengthening Smart Contracts: An AI-Driven Security Exploration

By M. Sai Mohan, T. L. N Swamy & V. Chandu Reddy
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Abstract- Smart contracts are automated agreements in which the conditions between the purchaser and the vendor are encoded directly into lines of code, allowing them to execute automatically. Smart contracts have emerged as a ground-breaking technology, facilitating the decentralized and trustless execution of agreements on blockchain platforms. However, the widespread adoption of smart contracts exposes them to various security threats, leading to substantial financial losses and reputational harm. Artificial Intelligence has the capability to aid in the detection and reduction of vulnerabilities, thereby enhancing the overall strength and resilience of smart contracts. This integration can create highly secure and transparent systems that reduce the risk of fraud, corruption, and other malicious activities, thereby increasing trust and confidence in these systems and improving overall security. This research paper delves into the innovative applications of Artificial Intelligence techniques to enhance the security of smart contracts.

Keywords: *blockchain technology, artificial intelligence, smart contracts (SCs).*

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M. Sai Mohan [α], T.L.N Swamy [σ] & V. Chandu Reddy [ρ]

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Keywords: blockchain technology, artificial intelligence, smart contracts (SCs)

I. Introduction

Some of the most popular blockchain platforms include Ethereum, Corda, EOS, and Tron. Each of these platforms has its own unique programming language for creating smart contracts. For example, Ethereum uses the contract-oriented programming language Solidity, which is designed to be as accessible as JavaScript. Hyperledger Fabric utilizes chain code, which can be written in Go, Java, or JavaScript. Corda, on the other hand, employs Kotlin, a language closely associated with Java, for its smart contract development. EOS and Tron utilize C++ and Solidity, respectively, for smart contract development. Different blockchain platforms employ a range of programming languages for smart contract development, but their common goal is to simplify the process of creating secure and efficient smart contracts that can operate on the blockchain.

Smart contracts are software programs stored on a blockchain, and they are designed to execute automatically when certain predefined conditions or events are fulfilled. By doing so, they eliminate the need for intermediaries and ensure that all participants involved can instantly verify the outcome. This automated process brings several advantages, such as faster execution, reduced delays, and increased certainty compared to traditional contract enforcement. The versatility of smart contracts allows them to automate various workflows and initiate subsequent actions based on predetermined conditions, making them an efficient and powerful tool for optimizing processes in a decentralized and trustless environment. However, alongside its disruptive benefits, this technology also faces significant challenges, with security being a top concern.

In this context, Artificial Intelligence emerges as a promising and innovative solution to bolster the security of smart contracts. Despite the immense potential of smart contracts, their vulnerabilities have been frequently exploited by malicious actors, resulting in catastrophic consequences. From the infamous DAO hack to various token thefts and vulnerabilities, the smart contract ecosystem has witnessed a string of security breaches that have undermined trust in the technology.

Whereas traditional security measures such as manual audits and code reviews have been employed to detect and mitigate smart contract vulnerabilities, these approaches are labour-intensive, time-consuming, They may still overlook certain types of threats. As the smart contract ecosystem continues to evolve and scale, there is an urgent need for more robust and efficient methods to enhance the security of smart contracts.

AI has the capability to analyze vast amounts of data, identify patterns, and detect potential vulnerabilities at a scale and speed that surpass human capabilities. By harnessing AI-powered tools and techniques, the smart contract development community can significantly enhance the detection and prevention of security flaws, thereby reinforcing the overall integrity of blockchain-based applications.

As we strive to unlock the full potential of blockchain technology, ensuring the security and trustworthiness of smart contracts remains an imperative task. By embracing the power of AI to fortify the security landscape, we can pave the way for a more robust and secure future for decentralized applications, fostering confidence and enabling further innovation in this exciting domain.

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This paper explores the intersection of AI and smart contract security, diving into the numerous ways AI can be leveraged to mitigate risks and bolster the robustness of smart contracts. We will investigate AI applications across various phases of the smart contract development lifecycle, encompassing design, coding, auditing, and monitoring. Moreover, we will address the challenges and constraints linked to AI based security measures and propose potential avenues for future research in this rapidly advancing field.

II. Background on Smart Contracts

Smart contracts are automated agreements with their terms written directly into code, and they are utilized on various blockchain platforms. Ethereum is one of the pioneering platforms for smart contracts, hosting a vast ecosystem of decentralized applications (dApps) and using Solidity as its programming language. Binance Smart Chain (BSC) is a popular alternative, offering compatibility with Ethereum's Virtual Machine (EVM) for those seeking lower transaction fees. Cardano distinguishes itself in the blockchain space with a focus on sustainability, scalability, and secure smart contracts, using Plutus as its programming language. Polkadot offers a unique multi-chain environment, allowing custom blockchains with smart contract functionality to interact seamlessly. Other notable blockchain platforms supporting smart contracts include EOS, Tron, and Tezos. Each of these platforms caters to various application domains and contributes to the growth of decentralized applications and programmable financial ecosystems.

Smart contracts function through the use of simple 'if/when…then…' statements written in code on a blockchain. Once predefined conditions are verified, a network of computers executes the actions specified in the contract. These actions can encompass a variety of tasks, including releasing funds to designated parties, registering vehicles, sending notifications, or issuing tickets. The immutable nature of the blockchain guarantees that completed transactions cannot be altered, and access to the results is restricted to authorized parties only.

In a smart contract, participants can include numerous stipulations to ensure the satisfactory completion of the agreed-upon task. To establish the contract's terms, participants collaborate to determine how transactions and their associated data will be represented on the blockchain. They reach a consensus on the "if/when...then..." rules that govern these transactions, consider potential exceptions and devise a framework for dispute resolution.

Smart contracts are typically programmed by developers, but organizations are increasingly providing user-friendly tools such as templates, web interfaces, and online resources to simplify the process for businesses. These advancements aim to promote the broader adoption of blockchain technology across various industries. Within a smart contract, participants can incorporate multiple stipulations to ensure satisfactory task completion. Participants collaboratively decide on the contract's terms, including rules governing transactions, data representation on the blockchain, potential exceptions, and dispute resolution frameworks. This approach facilitates smart contract creation and encourages wider adoption across industries.

Smart contracts have revolutionized contract management by offering several key benefits. They operate on blockchain technology, ensuring enhanced security and trust. Once deployed, smart contracts become immutable, making them resistant to tampering and fraud. Their transparency on the blockchain fosters trust among parties, reducing the chances of disputes. The automation and efficiency of smart contracts streamline processes, eliminating the need for intermediaries and saving time and costs. Furthermore, their global accessibility simplifies cross-border transactions. Smart contracts execute with precision based on predefined conditions, guaranteeing the accurate fulfillment of contractual obligations. They have also fueled innovation by enabling decentralized applications across various industries. With these advantages, smart contracts are transforming contract execution and bringing significant improvements to business operations.

Smart contracts bring numerous advantages that have significantly transformed the traditional contract landscape and unlocked new possibilities across various industries. Operating on blockchain technology, these self-executing digital agreements offer benefits such as enhanced trust, security, transparency, efficiency, cost savings, global accessibility, accuracy, innovation, and eliminating intermediaries.

- Trust is a fundamental aspect of smart contracts, as they eliminate the need for intermediaries like banks or lawyers. The reliance on decentralized blockchain networks ensures that contract execution is guaranteed by the system's consensus mechanism, enhancing trust between parties involved in the agreement.
- The security offered by smart contracts is a critical factor in their adoption. Once deployed on the blockchain, these contracts become immutable, preventing unauthorized alterations or tampering. This cryptographic immutability ensures the integrity of the contract, making it resistant to fraud and unauthorized access.
- Transparency is inherent in blockchain technology, and smart contracts leverage this feature to provide a high level of transparency. All contract

transactions and codes are publicly recorded on the blockchain, enabling easy verification of the contract terms by anyone without the need for a third-party intermediary. This transparency fosters trust and reduces the likelihood of disputes arising from hidden clauses or undisclosed information.

- The accuracy of smart contracts is paramount. With precise coding, these contracts execute actions based on predetermined conditions, minimizing the potential for misinterpretation or human error. This precision ensures contractual obligations are fulfilled as intended, reducing the likelihood of disputes or breaches.

Smart contracts have diverse and impactful applications across various industries. In financial services, they streamline transactions, automate asset management, and facilitate decentralized finance (DeFi) applications. Supply chain management benefits from smart contracts by enhancing transparency, automating processes, and improving traceability. Real estate transactions become more efficient as smart contracts automate property transfers and manage rental agreements. Voting systems become more secure and transparent with smart contracts, ensuring the integrity of the voting process. In the realm of intellectual property, these contracts help manage copyrights and enforce fair compensation. Gaming industries leverage smart contracts to enable the creation and trade of non-fungible tokens (NFTs) for unique digital assets. healthcare benefits from secure patient record management and automated insurance claims processing. Legal and notary services are streamlined by smart contracts, reducing the need for intermediaries.

Additionally, smart contracts empower energy and utilities through peer-to-peer energy trading. Finally, decentralized governance relies on smart contracts for transparent decision making within decentralized autonomous organizations (DAOs). These applications demonstrate the wide-ranging impact of smart contracts in shaping various industries and creating more efficient, transparent, and secure processes.

Security breaches can have severe repercussions for the blockchain ecosystem. The immutability of smart contracts means that any vulnerabilities or exploits can lead to significant financial losses for users and investors. Beyond the economic impact, breaches also damage the reputation and trust in blockchain platforms and applications, hindering mainstream adoption. In extreme cases, security breaches can lead to contentious forks or hard forks in the blockchain, dividing the community and generating significant uncertainty. Regulatory scrutiny may increase, leading to potential stifling of innovation. Project failures, negative media coverage, and losses in DeFi and NFT sectors are also possible outcomes. To mitigate such breaches, developers must conduct thorough security audits, adhere to best practices, and employ formal verification tools. Collaboration among blockchain communities is essential to share knowledge and enhance security practices, safeguarding the integrity of the entire blockchain ecosystem.

a) Classification of Smart-Contract Vulnerabilities

i. *Reentrancy Attack*

A reentrancy attack represents a security vulnerability that can arise in smart contracts. It takes advantage of the asynchronous execution of smart contract functions, allowing an attacker to repeatedly call a contract function before the previous call finishes its execution. Consequently, this vulnerability can lead to unintended consequences, providing unauthorized access to funds or enabling manipulation of the contract's state. Safeguarding against re-entrancy attacks is essential to ensure the security and integrity of smart contracts and the associated decentralized applications.

Simplified bank smart contract is written in Solidity that contains a reentrancy vulnerability.

```
pragma solidity ^0.8.0;

contract SimpleBank {
    mapping(address => uint256) balances;
    bool public locked;

    constructor() {
        locked = true;
    }

    function deposit() public payable {
        require(!locked, "Contract is locked");
        balances[msg.sender] += msg.value;
    }

    function withdraw(uint256 amount) public {
        require(!locked, "Contract is locked");
        require(balances[msg.sender] >= amount, "Insufficient balance");
        (bool success, ) = msg.sender.call{value: amount}("");
        require(success, "Transfer failed");
        balances[msg.sender] -= amount;
    }

    function toggleLock() public {
        locked = !locked;
    }

    function getBalance() public view returns (uint256) {
        return balances[msg.sender];
    }
}
```

In this simplified bank smart contract, users can deposit and withdraw Ether from their accounts. The contract also has a function called 'toggleLock', which allows the contract owner to lock or unlock the contract to prevent further deposits and withdrawals.

```
contract MaliciousContract {
    SimpleBank public bank;

    constructor(address bankAddress) {
        bank = SimpleBank(bankAddress);
    }

    fallback() external payable {
        if (address(bank).balance >= 1 ether) {
            bank.withdraw(1 ether);
        }
    }

    function startAttack() public payable {
        // Initiate the attack by calling the fallback function.
        bank.withdraw(1 ether);
    }

    function getBalance() public view returns (uint256) {
        return address(this).balance;
    }
}
```

The re-entrancy vulnerability exists in the 'withdraw' function. Here's how it can be exploited.

1. An attacker deploys a malicious contract with a `fallback` function that performs a reentrant call to the `withdraw` function of the 'SimpleBank' contract
2. The attacker then calls the 'startAttack' function of the 'MaliciousContract,' initiating the reentrancy attack.
3. The `withdraw` function of the 'SimpleBank' contract transfers '1' ether to the attacker's contract. However, before the `withdraw` function completes its execution, the fallback function of the attacker's contract is triggered again due to the reentrancy call.
4. The re-entrant fallback function continues to call the `withdraw` function of the `SimpleBank` contract, resulting in multiple withdrawals of 1 ether each, even though the attacker's balance in the `SimpleBank` contract is already zero.

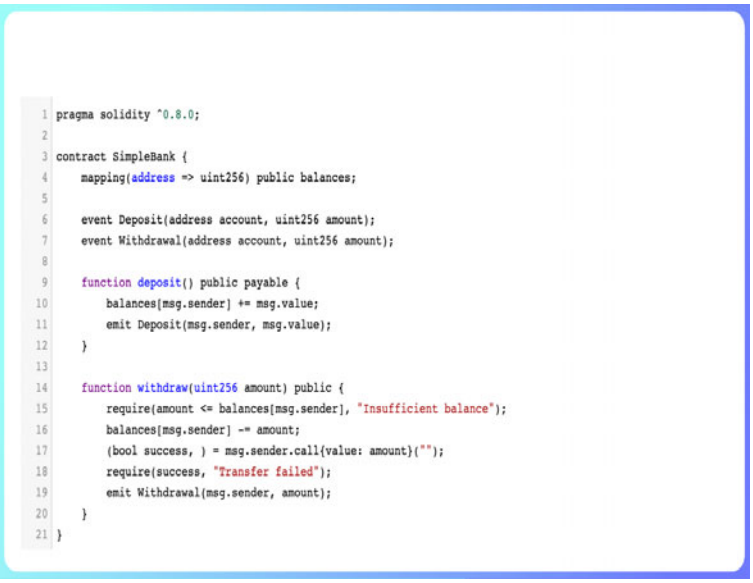
Prevention

Artificial Intelligence (AI) holds the potential to enhance the security of smart contracts by identifying and mitigating reentrancy vulnerabilities. One approach involves utilizing AI-powered tools to detect such vulnerabilities in smart contracts at the EVM bytecode level. Researchers have examined a large dataset of real-world smart contracts, allowing them to identify patterns of false positives and design effective path filters to eliminate them. Another approach employs AI-based fuzz testing to automatically generate inputs that simulate attacks on smart contracts. Subsequently, the execution logs are analyzed to determine the presence and intent of any re-entrancy processes. These AI-driven methods contribute to improving the accuracy and efficiency of detecting and preventing reentrancy vulnerabilities in smart contracts.

ii. *Overflow and Underflow*

Integer overflow and underflow vulnerabilities pose significant risks in the realm of blockchain-based applications, especially concerning smart contracts responsible for managing value transfers and storing sensitive data. These specific vulnerabilities are a subset of the general vulnerabilities we previously addressed. Smart contracts, being self-executing agreements governed by code, find widespread deployment on blockchain platforms such as Ethereum.

A simplified bank smart contract implemented in Solidity with potential integer overflow and underflow vulnerabilities.



```
pragma solidity ^0.8.0;

contract SimpleBank {
    mapping(address => uint256) public balances;

    event Deposit(address account, uint256 amount);
    event Withdrawal(address account, uint256 amount);

    function deposit() public payable {
        balances[msg.sender] += msg.value;
        emit Deposit(msg.sender, msg.value);
    }

    function withdraw(uint256 amount) public {
        require(amount <= balances[msg.sender], "Insufficient balance");
        balances[msg.sender] -= amount;
        (bool success, ) = msg.sender.call{value: amount}("");
        require(success, "Transfer failed");
        emit Withdrawal(msg.sender, amount);
    }
}
```

1. The contract 'SimpleBank' allows users to deposit and withdraw Ether (the native currency of the Ethereum blockchain).
2. The 'balances' mapping stores the balance of each account. When an account deposits Ether, its balance is increased; when it withdraws, the balance is decreased.
3. The 'deposit' function allows users to deposit funds into their account.
4. The 'withdraw' function allows users to withdraws a specified amount of funds from their account. It first checks whether the user has enough balance to withdraw the requested amount before transferring the funds.

Integer Overflow

The 'balances' mapping uses the 'uint256' data type, which has a maximum value of 2^256 - 1. If a user deposits a large enough amount, it could cause an integer overflow when adding to their current balance. This would wrap the balance back to zero and effectively allow the user to withdraw the entire contract balance.

For example, if an account with a balance of 'balances [msg.sender] = 2^256 - 2' tries to deposit 3, the balance will become 1 (due to overflow) instead of the expected value of '2^256 - 2 + 3'.

Integer Underflow

The 'balances' mapping is using the 'uint256' data type, which cannot represent negative values. If a user tries to withdraw more funds than they have, it could cause an integer underflow. In Solidity, underflow on a 'uint256' wraps the value to its maximum value (2^256 - 1).

For example, if an account with a balance of 'balances [msg.sender] = 100' tries to withdraw 200, the 'require' statement will pass because 'amount <= balances [msg.sender]' evaluates to 'false' (since 200 is not less than or equal to 100), and the subtraction operation 'balances [msg.sender] -= amount' will wrap around to the maximum value of 'uint25', i.e., '2^256 - 1'.

Prevention

To mitigate these vulnerabilities, you can use safe math libraries like OpenZeppelin's SafeMath or, starting from Solidity version 0.8.0, use the built-in 'checked' arithmetic operations (e.g., 'a + b', 'a - b', 'a * b', and 'a / b') which automatically revert on overflow/underflow.

iii. *Denial of Service (DoS) attack*

DoS attacks directed at smart contracts represent a significant security threat. In these attacks, malicious individuals aim to disrupt the regular operation of the smart contract intentionally. The main goal is to render the smart contract unavailable to legitimate users, either temporarily or permanently. Such attacks can cause severe consequences, including the disruption of critical functionalities, suspension of contract execution, and depletion of resources. Ultimately, this leads to financial losses and disturbances in decentralized applications, making it a serious concern for the blockchain community.

iv. *Access Control Vulnerabilities*

Access control vulnerabilities in smart contracts refer to security flaws that arise when unauthorized users gain unintended access to certain functions, data, or funds within the contract. These vulnerabilities can have severe consequences, including loss of funds, unauthorized manipulation of critical contract logic, or unauthorized access to sensitive data.

v. *Timestamp Dependence Aulnerability*

Timestamp Dependence vulnerability refers to a security flaw in a smart contract where the contract's logic or behavior is influenced or manipulated by the

timestamp provided by blockchain miners while mining a new block. This vulnerability mainly affects blockchain platforms that include a timestamp as part of the block data, such as Ethereum.

vi. *Gas Griefing Attacks*

These attacks exploit the Gas payment mechanism in the Ethereum network. Gas serves as a unit of measurement for the computational resources required for transactions and smart contract executions. Hackers can employ these attacks to inflate the cost of executing smart contracts, resulting in prohibitively expensive transactions and trading.

vii. *Oracle Manipulation Attacks*

These attacks exploit vulnerabilities in smart contracts associated with oracles. Oracles are third-party services that provide real-world information for smart contracts. If hackers can manipulate the information provided by oracles, they can falsify smart contracts as fraudulent.

b) Real-world Incidents and Consequences

Smart contracts are computer records that are stored on the blockchain and can be used to transact. They are mostly used in decentralized finance (DeFi) and can be used to borrow and exchange cryptocurrencies. However, smart contracts are not immune to hacking. there have been a lot of promising smart hacks in recent years. Some of the most important are

i. *The DAO Hack*

The DAO attack was a significant security breach that occurred in June 2016. DAO, short for Decentralized Autonomous Organization, was a financial resource managed by the Ethereum community, raising over $150 million worth of ether (ETH) through a token sale. However, on June 17, 2016, hackers exploited a vulnerability in the DAO's code, withdrawing 3.6 million ETH, which was valued at around $70 million at the time. This attack triggered turmoil within the Ethereum community, sparking a debate between those who advocated for making it harder to recover stolen funds and those who argued that such actions would compromise the principles of blockchain evolution.

Finally, the Ethereum community has decided to challenge the blockchain. This resulted in two separate blockchains: Ethereum and Ethereum Classic. Ethereum Classic is the first blockchain without a hard fork. Ethereum is a forked blockchain that receives stolen funds. The DAO hack is a big problem for the Ethereum project. However, it also brings some improvements in smart contract security. Smart contracts are more secure today than they were in 2016.

ii. *Yearn Finance hack*

Yearn Finance is a DeFi platform that enables users to generate profits from their cryptocurrency investments through the use of smart contracts. However, on April 13, 2023, Yearn Finance experienced a security breach resulting in the loss of approximately $11.54 million worth of cryptocurrencies. The attackers exploited a vulnerability within yUSDT, a stable currency linked to the US dollar value of the Yearn Finance smart contract. yUSDT is created by depositing USDT into the Yearn Finance platform. The attackers took advantage of this vulnerability to deposit significant amounts of USDT on the platform and subsequently generated large quantities of yUSDT. They then utilized the yUSDT to purchase other tokens on the Yearn Finance platform, causing the tokens' values to increase and enabling the attackers to profit. The hackers managed to steal approximately $11.54 million worth of cryptocurrency before the vulnerabilities were addressed. This hack posed a significant challenge for the Yearn Finance project. However, the project's team has since taken measures to enhance platform security, including the identification of smart contract vulnerabilities and the implementation of new security measures.

iii. *Merlin Hack*

Merlin is a decentralized exchange (DEX) built on top of the zkSync layer 2 scaling solution, offering users the ability to exchange coins without incurring gas fees. However, on April 26, 2023, Merlin fell victim to a security breach in which approximately $1.8 million worth of cryptocurrency was stolen. The attackers exploited a vulnerability in the way Merlin's smart contracts managed liquid pools-collections of tokens used to facilitate DEX transactions. Merlin's smart contracts utilize a single pool for all traded tokens on the platform. Exploiting this vulnerability, hackers removed a substantial number of tokens from the liquid pool, causing their values to plummet. Subsequently, the attackers repurchased these tokens at a lower cost. They then sold the tokens back to the liquidity pool, ultimately profiting by approximately $1.8 million. The Merlin Hack posed a significant challenge for the Merlin project. Nevertheless, the project's team has taken steps to enhance platform security, including the use of multiple repositories and the implementation of new security measures.

iv. *Bonq Dao Exploit*

Bonq DAO is a decentralized autonomous organization (DAO) that facilitates cryptocurrency borrowing and lending through smart contracts to expedite the loan process. On February 1, 2023, Bonq DAO was launched with approximately $120 million worth of cryptocurrencies. However, it fell victim to a security breach when hackers exploited a vulnerability within its smart contract related to price feeds. Price feeds serve as real data sources utilized by smart contracts to determine asset values. In Bonq DAO's case, it relied on the Tellor oracle to obtain price information for the AllianceBlock (ALBT) token.

The attackers took advantage of this vulnerability by manipulating Tellor oracles to provide incorrect values for ALBT tokens. This allowed them to borrow significant amounts of BEUR stablecoins from the Bonq DAO platform at an exceptionally low cost. Subsequently, the hackers drained the pool of ALBT tokens used as collateral for BEUR loans. This action caused the value of the ALBT token to plummet, further reducing the cost of their borrowing. While the attackers ultimately repaid the BEUR loans, they retained the ALBT tokens. This incident resulted in a loss of approximately $120 million for the Bonq DAO platform.

The Bonq DAO vulnerability posed a substantial challenge for the project. Nevertheless, the team has taken measures to enhance platform security, including diversifying the use of different divination services and implementing new security measures

v. *Euler Finance Hack*

Euler Finance is a decentralized finance (DeFi) platform that facilitates cryptocurrency borrowing and lending through the use of smart contracts, streamlining the lending process. However, on March 13, 2023, Euler Finance experienced a security breach resulting in the loss of approximately $196.9 million worth of cryptocurrencies. The attackers exploited vulnerabilities within Euler Finance's smart contracts related to revenue management.

In Euler Finance, a 'call' is a notification requiring borrowers to add additional collateral to their loans. Failure to do so can result in the lender freezing the borrower's position. Hackers capitalized on this vulnerability by sending a large number of 'calls' to the Euler Finance smart contract, causing it to enter a state where it could no longer process any further calls. This effectively granted hackers access to the Euler Finance platform.

The Euler Finance hack represented a significant setback for the project. However, the team managed to recover the majority of the stolen funds.

III. Artificial Intelligence for Smart Contract Security

Artificial Intelligence (AI) plays a pivotal role in enhancing smart contract security by providing advanced tools and techniques to identify vulnerabilities, detect anomalies, and mitigate risks. This integration of smart contracts with AI has the potential to revolutionize various industries and domains, spanning from finance and healthcare to logistics and energy. By harnessing the combined power of smart contracts and AI, developers can create applications that are more efficient, secure, and autonomous, enabling innovative business models and services.

For instance, AI can enhance the adaptability of smart contracts by incorporating logic, neural graphs, and neural networks[2]. This fusion of technologies has the potential to significantly reduce the manpower required to manage both contracts and the entire contracting process, adding substantial value to organizations.

AI offers a wide array of applications within the realm of smart contracts. It can be directly integrated into smart contract code or utilized to validate and ensure contract integrity. Furthermore, the combination of AI techniques with deep learning concepts, such as Tensor, holds promise for advancing blockchain-based smart contracts. Additionally, cognitive computing, a subset of AI, aims to emulate human thought processes within computing infrastructure.

a) AI for Testing and Evaluation of Smart Contracts

AI can play a crucial role in testing smart contracts through various methods, encompassing performance testing, vulnerability detection, and correctness evaluation. By harnessing AI as a utility service for blockchain, the performance of blockchain-based smart contracts can be significantly enhanced, marking a substantial contribution of AI to the field of blockchain technology.

In a study by Marwala et al. [39], the utilization of AI for verifying smart contracts was discussed. The authors highlighted the potential advantages of applying AI to blockchain-based smart contracts, which include heightened security and scalability. Furthermore, they emphasized the feasibility of employing AI-based formal verification techniques to assess the correctness of smart contracts.

b) Federated Learning

Federated learning is an innovative approach to collaborative and decentralized learning, aligning well with the decentralization capabilities of blockchain technology. In this approach, training data remains secure and private, making it particularly valuable in scenarios involving sensitive information, such as healthcare data. By combining federated learning with blockchain, various functionalities, including data access control and enhanced privacy preservation, can be achieved.

In a study by Lu et al. [40], a novel privacy preservation mechanism for industrial IoT was proposed, leveraging a combination of federated learning and blockchain. They integrated federated learning into the consensus process, resulting in improved computing resource consumption and operational efficiency. However, challenges persist, particularly in addressing resource constraints within computing infrastructure, necessitating a deeper exploration of data privacy requirements.

In another work by Kang et al. [41], a federated learning system based on a consortium blockchain was presented. The authors introduced an incentive mechanism based on contract theory to evaluate workers with a high reputation for reliable training, thus

enhancing the learning process. Nevertheless, there is room for further improvement in the realm of reputation calculation.

In summary, the integration of federated learning and blockchain presents exciting research opportunities for enhancing privacy and efficiency across various domains, such as healthcare and industrial IoT. However, certain issues, particularly those related to resource constraints and reputation calculation, warrant additional attention and development.

c) Smart Contracts and Cognitive Computing

Cognitive computing represents an advanced field of AI research that aims to replicate human thinking within computer systems. By adopting human thinking patterns and limitations in its execution, cognitive computing achieves notably higher accuracy than other AI techniques. Integrating blockchain based smart contracts into cognitive computing can potentially enhance service values across various application scenarios.

Blockchain-based smart contracts bring essential features to the forefront within the realm of cognitive computing, including data transparency, decentralized access control capabilities, and decentralized trust. These attributes significantly enhance the applicability of cognitive computing in the healthcare domain. Nonetheless, as emphasized in a study by Daniel et al. [42], implementing blockchain for healthcare is a complex undertaking. It necessitates meticulous consideration of compliance requirements to ensure the utmost data privacy and security.

d) Smart Contracts with Tensor Networks

Smart contracts integrated with tensor networks present a compelling fusion of blockchain technology and quantum computing. Tensor networks, rooted in mathematical constructs from quantum physics, hold the promise of quantum-enhanced computing within smart contracts. This potential allows for the execution of more intricate calculations and simulations than classical computers can handle, offering transformative applications in data analysis, optimization, and cryptography within blockchain-based systems. Furthermore, tensor networks enable secure multiparty computations, facilitating collaborative efforts without compromising sensitive information. Promising areas for advancement encompass quantum machine learning, quantum randomness generation, and decentralized optimization. However, while this integration holds great promise, it faces challenges related to quantum hardware and scalability, demanding careful consideration for its full realization. Charlie et al. [43], in their research, contribute valuable insights and solutions to address some of these challenges, further advancing the field.

IV. Comparison of AI Based Smart-Contract Vulnerability Detection Tools

This table serves as a valuable reference, guiding readers to relevant materials for further exploration. It provides insights into the AI methods employed by each tool, ranging from supervised learning to reinforcement learning and semi-supervised learning. Additionally, the table offers information about dataset sizes used in the research, allowing readers to gauge the impact of data scale on model performance and reliability. Furthermore, the table outlines the AI classification approaches utilized by these tools, elucidating the distinctions between different methods.

By analyzing this comprehensive table, readers can gain a deeper understanding of various AI-based smart contract vulnerability detection tools. It serves as an indispensable resource for both further research and practical applications in this domain.

Table 1: Comparison of AI Based Smart-Contract Vulnerability Detection Tools

References	Classification	Dataset Size	Adopted Technique	Contribution
[1]	Supervised Learning	More than 50,932	DL, Modular and Systematic Vulnerability Detection Framework	DeeSCVHunter is a proposed deep learning-based framework for detecting vulnerabilities such as re entrancy and time dependence in a systematic and modular manner. It offers an innovative approach to identifying and addressing these types of vulnerabilities.
[2]	Supervised Learning	7000	LSTM, ANN, GRU	GRU, ANN, and LSTM, were trained and utilized to predict the presence of vulnerabilities in smart contracts. This approach offers a new way to identify and address potential vulnerabilities in a more efficient and effective manner.

[3]	Supervised Learning	47,398	Deep Learning	ReVulDL is a deep learning-based two-phase smart contract debugger for re-entrancy vulnerability. It integrates the vulnerability detection and localization into a unified debugging pipeline.
[4]	Semi-Supervised Learning	20,829	BERT	ASSBert is a model that uses active and semi-supervised learning with BERT for smart contract vulnerability detection. It aims to improve the accuracy and scalability of vulnerability detection by combining deep learning with expert patterns in an explainable fashion.
[5]	Reinforcement Learning	Not provided	Reinforcement Learning and Fuzzing	Vulnerability-guided fuzzer based on reinforcement learning, namely RLF, for generating vulnerable transaction sequences to detect sophisticated vulnerabilities in smart contracts. The experimental results demon-strate that RLF outperforms state-of-the-art vulnerability-detection tools.
[6]	Supervised Learning	40.932	GNN and Expert Knowledge	The use of graph neural networks and expert knowledge for smart contract vulnerability detection. Empirical results show significant accuracy improvements over state-of-the-art methods on three types of vulnerabilities.
[7]	Supervised Learning	70,000	Machine Learning	SmartMixModel is a machine learning-based vulnerability detection model for Solidity smart contracts. It considers an expanded feature space covering both the source- and byte codes of the Solidity smart contracts, and achieves improved detection performance compared to state of the art models.

V. Conclusion

In conclusion, there exists a compelling need for continued research into the application of artificial intelligence (AI) in the detection of flaws within smart contracts. This research seeks to offer invaluable insights through the comparative evaluation of existing AI-based algorithms for smart contract fault detection, shedding light on the efficacy of various AI approaches. While the potential of combining AI with formal methods has been acknowledged, there remains untapped potential in need of exploration.

Future research endeavors in the realm of smart contracts will pivot towards the development of AI powered detection tools capable of addressing security breaches associated with smart contracts while handling large datasets efficiently and effectively. Additionally, attention must be directed towards the utilization of SSL (Semi-Supervised Learning) and RL (Reinforcement Learning) to potentially overcome the limitations of SL (Supervised Learning). A comprehensive investigation into smart contract flaw detection using AI is imperative, serving as a foundational reference and a wellspring of inspiration for forthcoming research.

Ultimately, the integration of AI with formal techniques holds the promise of substantially enhancing the security of smart contracts, ensuring their reliability and robustness in blockchain-based applications

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Memberships

Fellows/Associates of Computer Science Research Council

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The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

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g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

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18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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