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COULD ARTIFICIAL INTELLIGENCE (AI) BE A REAL THREAT TO HUMANITY OR EVERYTHING IS JUST “MUCH ADO ABOUT NOTHING”? DOES AI BECOME AN EXISTENTIAL RISK OR OPPORTUNITY FOR SCIENTIFIC KNOWLEDGE AND RESEARCH?

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Abstract. *Starting from Confucian virtuous man to Human Intelligence (HI), some major aspects are revealed in this paper's introduction. Two other sections are successively dedicated to the definition, typological detailing and measurement of Human Intelligence (HI), as well as to a brief history of Artificial Intelligence (AI) and to the impact of Artificial Intelligence (AI). In the central section of this article, a distinctive discussion about the risks and opportunities redefines AI. Modern scientific opinions maintain the ambiguity in predicting AI's future as evolution or involution for Humanity, not only from classical Shakespearean attitude following his well-known expression “much ado about nothing” but also based on the recent essential question regarding the ability of AI to destroy human civilization. Some final remarks offer in a concise manner the most underlined ideas about the future of AI for Human Knowledge (HK) and Scientific Research (SR), based on inter-, multi- and transdisciplinary approaches and Big Data vision.*

Keywords: *Human Intelligence (HI), Artificial Intelligence (AI), Human Knowledge (HK), Scientific Research (SR) Inter-, Multi-, and Transdisciplinarity (IM&TD), Big Data, Internet of Things (IoT).*

1. INTRODUCTION

A researcher or scientist as an intelligent man must be morally virtuous at the same time, otherwise, this human quality ceases to be creative and sooner or later becomes destructive. In its beginnings, an honest individual appeared in the Chinese conceptualization of intelligence, more precisely it characterizes the Confucian conception whose essence was exposed in the Analects two and a half millennia ago (Confucius, 1999) [1].

Between the thought or thought of Confucius, his word or speech and his deed or activity there was a continuity or at least a total agreement, unanimously considered as an absolute type of agreement, which his disciples desired and felt to be almost perfect... A Confucian approach to an implicitly virtuous way of intelligent thinking

presupposes that the meaning given to virtue in thought describes the unequivocal continuity of thought in intelligent communication and intelligent deed or act... In a synthetic expression, intelligent individuals continuously and invariably define themselves by the fact that what they think, say and do is not contradictory but in a perfect similitude. The difference between the Chinese and the Greek meaning of intelligence known as “*noesis*” which just means “*the act of thinking*” is a limiting one. The ancient Greek meaning of intelligence has generated by extension a science called “*noesiology*” which studies the effects produced in life by each thought.

This way of investigating scientifically has as a consequence the fact that the formation, evolution and even healing of man are achieved through thinking, consistently defining “*noesis therapy*” ...

The Roman accent was moved to “*sapientia*” or the need for knowledge and more pragmatism. What is the different nature and evolutionary essence of Human Intelligence (HI), from the beginning to modern or the most recent concept? The solution of the philosophy's significance followed an entire circle, described by mathematics, and then by psychology to evolve finally towards the same philosophy:

i) *Associationism-sensualist-empiricist philosophy* emphasizes the role of active research of correlations and associations as essences of pragmatic thinking;

ii) *Gestaltism-phenomenology and Kantian apriorism* insist on the finding that the holism of thinking requires the structural knowledge of its components but also of the relationships between the components, expanding thinking beyond the simple aggregation or summation of information;

iii) *Behaviorism - vulgar materialism and pragmatism* bring behaviour and virtue back into the space of thought as an important goal of humanity's evolution;

iv) *Freudianism* - disinterested in the study of thinking, considers a secondary way (in genetic order) to satisfy biological motivation identifying in thought and especially in intelligent thought a survival and reproduction of the individual

as motivation that can significantly alter any type of reasoning, as a priority.

Thinking intelligent became and remained the fundamental attribute of the human individual with René Descartes and his *Discourse on Method* (*Discours de la méthode*). (1637) [2]. By his famous statement “*cogito ergo sum*” [“*Je pense, donc je suis*” or “*I think, therefore I am* (exist)”],

René Descartes identified the way of thinking with consciousness and considers it as a given quality, the peremptory proof of self-existence is practically identified with the in vivo realization of the process of thought. In the most important research, not the answer, but the question generates a new way of intelligent thinking and prepares everyone for coherent scientific knowledge...

In this context, what are and how are Human Intelligence (HI) and Artificial Intelligence (AI) become fundamental questions for the present and the future of mankind. The conceptualization of Human Intelligence (HI) and Artificial Intelligence AI have complex and controversial tasks, as there still is no consensus on how to define or operationalize both. However, philosophers, mathematicians, psychologists and physicists have developed various methods and instruments to assess different aspects and dimensions of intelligence, from tests to scores offered by quotients, factors of analysis and multiplying etc.

2. HUMAN INTELLIGENCE (HI)

In any fundamental concept's essence, in order to clarify both notionally and practically, the idea of human intelligence (HI), several questions must find a simple and clear answer: What is intelligence? What is human intelligence? Historically, what was the original notion and how did it evolve according to the main theories in the fields of philosophy and psychology? How are forms of HI practically measured? What typology does HI have? Who are the key figures in this process of conceptualization and deepening of HI?

Nowadays, intelligence is defined in the most common way as the ability to understand, learn and apply knowledge. Intelligence reunites skills in many different domains and in various actions when human beings must reason, solve problems and think logically or based on evidence. The word intelligence is coming from Greek Culture and its famous Cosmos and the term was characterized as the divine minds. The first used expression was the Greek word “*nous* (νοῦς) or *the power of the mind to Xenofan*” and the first signification was considered similar to the highest faculty of the human mind. The original meaning was associated to the responsibility for rational thinking, understanding, and intuition. “*Nous*” became to Aristotle “*proton kinoun*” and it was described as “*noesiss* or *energeia*” making a clear separation

from the other ancient forms of thinking as “*episteme, aesthesis, doxa and dianoia*”. Gradually, “*noesiss*” acquired the meaning of intermittent thinking, because it implies the transition from potency to act or action (Peters, 1967, pp. 190-199) [3] But, looking for the presence of morality, the ancient Greeks have created and used another term “*phronesis* (φρόνησις)”, transforming intelligence in a real virtue and adapting it to reality. The new significance was closer to practical wisdom or prudence, and the phronesis enabled human beings to act morally and virtuously in different situations. This more complete sense could be learned and cultivated in ancient Greek agora and through dialogues with adequate mentors. The intuition of ethical values, treated with slight disdain by the cynic Antisthenes, becomes intellectual intuition in dialogues with Socrates, being synonymous with virtue or “*arête*”. The nuance of intelligence through *phronesis* will be restricted to the sphere of morality in Aristotle, being separated from “*theory*” or “*Sophia*”, which has become theoretical wisdom (Peters, 1967, p. 224) [3].

The ancient Roman philosophers continued the search for the most appropriate term to name intelligence and left a legacy of the closest synonym “*intellectus*” (from Latin *intellegere*, with the meaning of *understand*). Thus the ancient Roman language used *intellectus* to refer to the faculty of understanding, comprehending, and reasoning, underlying also the importance of the term “*ratio*” as the real basis for logic and science. Ancient Latin as the language of the Roman Empire used also the term “*sapientia*” (from “*sapere*” meaning to know) as the major reference to the wisdom or knowledge that enabled human individuals to live well and achieve happiness. But “*sapientia*” was simultaneously related to the concept of “*virtus*” (*virtue*), which was the moral excellence and courage that characterized a good Roman citizen.

A deeper or more extensive knowledge and understanding of reality, including human nature, transformed “*sophia*” from Greek philosophers into “*sapientia*” to the much more pragmatic Roman thinkers (Saunders, 2023) [4].

Human Intelligence (HI) is usually defined as a “*mental quality that consists of the abilities to learn from experience, adapt to new situations, understand and handle abstract concepts, and use knowledge to manipulate one's environment*” (Sternberg, 2022) [5] or in a real brief proposition “*human intelligence is rational thinking*”.

Some initial psychological definitions or inceptive conceptual boundaries overestimated the role of the ability to think abstractly as a special talent for verbal and symbolic thinking (Terman, 1916) [6], while others redefined the attitudes emphasizing the importance of learning ability to achieve success based on personal standards and

sociocultural context (Thorndike, 1920) [7] or exaggerated the capacity to give good answers to difficult questions or expanding the similitude with a set of skills that make it possible for a person to solve problems in life and especially to find solutions, which involve gathering new knowledge (Gardner, 1983; 1989) [8-9]. The concept of intelligence was for the first time generalized by a British psychologist, Charles Edward Spearman, in his book “*The Abilities of Man*” (1927), being established as the most adequate and somehow unique term, able to describe a general mental ability or a set of mental abilities (Spearman, 1927) [10]. Perhaps the brief and synthetic definition including the importance of self-critical thinking belongs to Alfred Binet, born *Alfredo Binetti*: “*intelligence is a capacity to think well, to judge well and to be self-critical.*” (Binet, 2016) [11]. New and completely different definitions as accent have emphasized specific aspects of intelligence multiplying the skills required of a man or woman to 10 broad abilities that in turn are subdivided into 70 narrow abilities, in a specific period of time, characterizing different traditions and cultures or certain professions (Fig. 1).

- [1] Fluid intelligence (reason, form concepts, and solve problems)
- [2] Crystallized intelligence (breadth and depth of a person's acquired & communicate knowledge)
- [3] Quantitative reasoning (comprehend quantitative concepts and manipulate numerical symbols)
- [4] Reading & writing ability (basic reading and writing)
- [5] Short-term memory (apprehend and hold information in immediate awareness and use it in a few seconds)
- [6] Long-term storage and retrieval (store information and fluently retrieve it later in the thinking process)
- [7] Visual processing (perceive, analyze, synthesize, and think with visual patterns)
- [8] Auditory processing (analyze, synthesize, and discriminate auditory stimuli)
- [9] Processing speed (perform automatic cognitive tasks, particularly when measured under pressure).
- [10] Decision/reaction time/speed (immediacy with which an individual can react to stimuli or a task)

Source: Realized by author from Kaufman, 2009 [12].

Fig. 1. The 10 broad abilities that generate Human Intelligence (HI)

An educational dictionary underlines the capacity to acquire and apply knowledge as the major characteristic of human intelligence (HI), but more and more frequently, adaptation to the environment becomes the key to defining what HI is and understanding what HI does. Modern definitions try to prove that only certain human individuals are truly intelligent or to measure different types of Human Intelligence (HI) based on different characteristics of the basic level established from

different criteria, based on various processes of conceptualization (Fig. 2):

HI is inborn.
HI of every person is different like DNA.
HI is basic ability and practiced skill.
HI is a group of abilities.
HI and knowledge are closely related.
HI helps in learning and in adjustment.
HI helps in solving complex problems.
HI is an ability to gather experience.
HI is an ability to do intellectual works.
HI is an ability to face social situations.

Environment affect HI.
Environment training & education affect HI
Heredity affects HI.
HI cannot be acquired.
HI does not differ due to sex differences.
HI is not knowledge but is related to it.
HI is not talent.
HI is not memory.
Skill can be learnt but not HI.

Source: Realized by author based on (Piaget, 2001) [13]; (Kaufman, 2009 [12]; (Sternberg and Kaufman, 2011) [14]; (Hunt, 2011) [15].

Fig. 2. Some Characteristics of Human Intelligence (What is HI appears in blue and what is not in red outline)

Allport Gordon defined creativity in his book titled “*Personality: A psychological interpretation*”, in 1937, as a personality formation, which cannot be limited only to some categories of personality manifestation, to skills or only to intelligence and thus he recognized the importance of HI, in psychology (Allport, 1937) [16]. The human being as a creative person can possess multiple variants of intelligence, from a verbal-linguistic or visual-spatial nature of HI, to a kinetic or rhythmic-musical type, from the category of interpersonal HI to intrapersonal HI, from individual HI to team HI, or even more to social HI, from the naturalistic one to academic or intellectual HI, complemented by the new type of emotional intelligence (EI), partnership intelligence (PI), existential and social intelligence (E&SI). Emotional intelligence (EI), as an example, was used for the first time in 1985, by Wayne Leon Payne in his PhD thesis with the sense of ability which implies a creative relation with states of fear, pain and desire (Savoivu, 2006) [17]. One of the first conceptual delimitations belongs to Peter Salovey and John Mayer: „*the abilities to perceive emotions as correctly as possible and to express them, to accede to or generate feelings when they facilitate thinking, to know and understand the emotions in order to promote*

intellectual and emotional development” (Săvoiu, Jovanovska, 2010) [18].

The meanings given to Emotional Intelligence later and EI definitions become quite different from the original ones. Daniel Goleman offers the most credible significance of Emotional intelligence, where EI contains different substances and elements like self-knowledge (self-trust), self-control (*adaptability, desire for truth and innovation*), motivation, empathy, and social aptitudes. Reuven Bar-On considers EI rather a reunion of intrapersonal aspects with interpersonal aspects, adaptability, stress control and the general state, underlying the self-satisfaction (Săvoiu, Jovanovska, 2010) [18].

Any human being can try to identify and measure not only his own Human Intelligence (HI) using different quotients (QI for academic intelligence, QE for emotional intelligence, QP for partnership intelligence) but also to analyze HI factors. A German psychologist, like William Stern, renowned for his development of the intelligence quotient (IQ), concept underlined the importance of the quantity of intelligence in measuring IQ scores as the average performance (100). The purely quantitative approach to intelligence sets standard tests and limits or thresholds for IQ called scores, usually placed between 70 and 130. The qualitative approach to intelligence is rather focused on factor analysis of HI. This statistical method or technique entitled factor analysis can identify clusters of related items on tests that measure common underlying abilities or constructs. *Factor analysis* can be used to analyze the structure and components of intelligence tests and to identify different types of intelligence or mental abilities that contribute to overall intelligence (Sternberg, 2022) [5]. Based on this statistical method Charles Spearman proposed a general intelligence factor (g) able to identify and underly all specific mental abilities (s), such as verbal, spatial, or numerical skills, and Louis Thurstone and Raymond Cattell suggested and define other multiple primary or independent factors of intelligence, such as fluid intelligence (the ability to reason and solve novel problems) and crystallized intelligence (the ability to use acquired knowledge and skills).

Even the theories of multi-dimensional HI reveal the importance of understanding both the diversity and unicity of HI, whether it is coming from any type of the major intelligence theories:

- i) general intelligence;
- ii) primary mental abilities;
- iii) multiple intelligences;
- iv) triarchic approach to intelligence.

(unitary, monarchic, group factor, oligarchic, anarchic, or eclectic theories etc.)

HI remains for each human being the intellectual capability marked by complex cognitive attributes or characteristics and high levels of

motivation and self-awareness, characterized by Confucian virtue (modern ethics or morality) and realized with self-impact consciousness. The most used synonyms for HI are: Human Cognition (HCo), Human Intellect (HIn), Human Reasoning (HRe), Human Mental Abilities Reunited (HMAR), Human Brainpower (HBp) etc.

The creative person was thus considered over-gifted as compared to the medium intelligence level. A creative individual is original, innovative and adequate reality. The creative person can possess many types of intelligence, ranging from the verbal-linguistic or visual-spatial one to the kinetic or rhythmical-musical one, from the category of interpersonal or intrapersonal one to the social intelligence, from the naturalistic one to the academic or intellectual intelligence, supplemented by the emotional intelligence & partnership intelligence (Săvoiu, 2006) [17].

A modern vision of the competitive type of human intelligence is generally considered three-dimensional, comprising synthetically *the academic or intellectual intelligence* (II) (theoretical), defined as an aggregate capacity to reason, express oneself and calculate together with cognitive abilities, *emotional intelligence* (EI), synthesizing people’s capacity to solve problems and to face challenges and difficulties, as well as *partnership intelligence* (PI), reuniting the ability to build relationships with that of developing trust, simultaneously with achieving some predetermined objectives through association with someone else.

The most modern widely used intelligence tests are the Stanford - Binet Intelligence Scale, the Wechsler Adult Intelligence Scale (WAIS), the Wechsler Intelligence Scale for Children (WISC), and the Raven’s Progressive Matrices, Goleman or Reuven Bar-On derived emotional intelligence test (EQ), Stephen Dent test for partnership intelligence (Dent, 2004; Goleman, 2006) [19-20].

Perhaps not accidentally after 1900, the quite various typology of intelligence has widened the already specific HI with another form, with an exceptional future, existential intelligence (Săvoiu, 2006, Săvoiu, Jovanovska, 2010 [17-18]. This type of intelligence “*amplifies the empathetic character of pragmatic activities (politic, economic or social) of major projects or activity, evaluating a special talent, a very rare ability, respectively that of answering convincingly the most delicate of the questions of the team’s members, concerning the existence and meanings of their common activities, cultivating the feeling of common belonging, simultaneously with the praise of the individuality*”. (Săvoiu, Jovanovska, 2010) [8].

Simplifying or summarizing all previous explanations, HI is dominantly inborn and seems to come not in too large a proportion from experience. HI help an individual to adapt to new situations, to understand and handle abstract concepts, and use

knowledge to manipulate one's environment. Some of the *key people* for the concept of HI remain Confucius, Xenofan, Aristotle, René Descartes, Alfred Binet, William Stern, Allport Gordon, Lewis Terman, Edward Thorndike, Alan Kaufman, Jean Piaget, Henri Bergson, Francis Galton, Howard Gardner, Robert Sternberg, Louis Thurstone, Raymond Cattell, Wayne Leon Payne, Daniel Goleman, Reuven Bar-On, etc.

3. ARTIFICIAL INTELLIGENCE (AI)

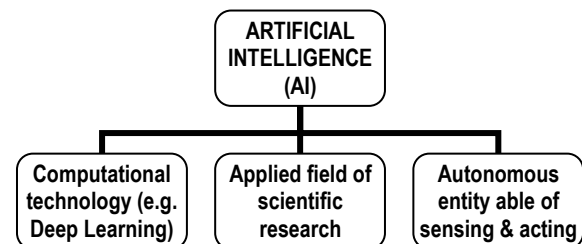
Similarly to the historical meaning of Human Intelligence (HI), the conceptualization and even the exemplification of the notion of Artificial Intelligence (AI) must identify coherent answers to several questions: What is the definition of Artificial Intelligence (AI)? What is and what is not AI? What exactly does this type of intelligence represent? What is the brief history of the concept of AI and how has it evolved up to now? Who are the parents, fathers & mothers as major figures in the process of conceptualizing and multiplying the real forms of AI? What are the usual forms and practical types more often encountered by AI? What typology does AI have in the modern world? What is the future of AI and the currently anticipated dangers for intelligence and even the human being?

The public perception of AI remains still nebulous for the majority of people. One can suppose primarily that Human Intelligence (HI) is commonly defined as a combination of too many and too diverse abilities. Indeed, HI underlines the final aim of human beings, especially how to make one individual understand the world as real and potential risks, and thus to offer individuals the possibilities to adapt and to survive. In that case, Human Intelligence (HI) seems to be rather more complex compared with limited Artificial Intelligence (AI), which appears to focus only on the following components: learning, reasoning, solving problems, perceiving and using many languages and modern ways of communication.

Artificial Intelligence (AI) is currently gaining in popularity compared with Human Intelligence (HI) and the potential of HI. This aspect is in part the result of the fact that individuals have started to use the term AI more and more often than HI. Human beings refer to many things frequently as AI, including not only usual components of AI but special concepts and “smart” systems:

1. Big Data;
2. Internet of Things (IoT);
3. Machine Learning (ML);
4. Chatbots or AI bot (e.g. Google's AI-powered chatbot or AI bot ChatGPT-Generative Pre-Trained Transformer), etc.

Artificial intelligence (AI) is a concept realized in a multidisciplinary intersection of three modelling academic disciplines, the first being psychology (through cognitive modelling and the first knowledge of human intelligence), the second philosophy (through the unique knowledge of the mind and the modelling of human intelligence, the example of syllogism ancient philosophers being a revealing one) and informatics, the latter but not the last, through the input brought with the help of linguistic, mathematical and logical components. There are too many modern definitions of Artificial Intelligence (AI). Totally distinctive significances can be collected from relevant and different sources, with diverse research topics. At the same time, it is increasingly more difficult to define AI. “*A significant variety of judgements and viewpoints that allow for first understanding and then creating an agreed upon the message on the goal and definition of A.I.*” (Monett & Lewis, 2017) [21]. Even the process of defining AI means a dependence on too many inter-, trans-, and multidisciplinary natures of scientific approaches, the context of research or focus type. In this case of too much diversity of significances one can prefer the major benchmarks of Artificial Intelligence (AI) (Fig. 3)



Source: Realized by author from (Theodorou & Dignum, 2020) [22].

Fig. 3. Some major benchmarks of Artificial Intelligence (AI)

Also, Artificial Intelligence (AI) is increasingly connected to the Big Data phenomenon, pervasive nowadays and applied across more and more domains, various cultures and geographic areas. In this apparently very complicated case, after a standard conceptualization of AI, extracted from the *Encyclopaedia Britannica*, in which “*Artificial Intelligence is the ability of a digital computer or a computer-controlled robot to perform tasks commonly associated with intelligent beings*” (Copeland, 2023) [23], a short passage through the history of the concept itself is immediately welcome. There is a big difference between all the significances of AI, even among the pioneers or founders of the concept. From AI concept of “*using computers to simulate intelligent behaviour and critical thinking*” (1950), as was originally signified this type of intelligence by Alan Turing to the specific versions of AI definitions belonging to

Marvin Minsky as “*the ability of machines to perform certain tasks, which need the intelligence showcased by humans and animals*” (1955) or to John McCarthy’s own conceptualization whence transpires a relative common significance of the same artificial intelligence (AI) as “*science and engineering of making intelligent machines, especially intelligent computer programs, is related to the similar task of using computers to understand human intelligence (HI)*” (also in 1955), there is a total opposition even though there are only five years between the appearances of the three meanings. A brief history of AI, resignified as “*a system’s ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation.*” (Haenlein & Kaplan, 2019) [24] must summarize a lot of books and articles, and thus presenting a wide variety of perspectives and also a comprehensive outlook on the future of AI. An adequate answer to *what exactly does this type of intelligence represent* means also to delimit *what AI is and what AI is not?* Two types of definitions generated and distinguished strong AI from weak AI. The major cause of these two types is the descriptive or prescriptive scope, Thus, a descriptive AI definition focuses on the most important technologies and uses (Machine Learning, Deep Learning, Natural Language Processing, etc.). A prescriptive one underlines the key conditions & characteristics that are the essence of AI systems. Many researchers and scientists believe that replication of human thinking or HI, is not a smart endeavour for defining AI and they are focusing not on what AI is, but on what is not AI (Fig. 4)

AI is an abstraction of HI, with rationality corresponding to a certain level.
AI is a specific system of abilities.
AI is an intelligent machines science.
AI is beyond a specific technology.
AI is focused on Machine Learning.
AI is concentrated on Deep Learning.
AI is centred on Natural Language Processing
AI is an efficient solution for Bigdata
AI is a self-learning system.
AI is a need to learn & be trained to reason from historical data.
AI is a system to learn & respond ergo to what has been learned.
AI is built as a system of devices or tools.
AI is a system’s ability to do activities.
AI is a system to know what, when & how to do
AI is an “idiotic” system trying to understand & react like humans.
AI is a system that thinks & acts like humans.
AI is a system that thinks & acts rationally.
AI is a system that does automation.
AI is a system built on the understanding of existing phenomena, acting wisely based on it.

AI is a system acting with little human input but appropriately, independently & intelligently
AI is a system to collect applications, analyzes & make initial decisions.
AI is a system approach where there is a context & data are collected, and analyzed.
AI enables machines to perform automation activities.
AI is an automated data analysis & automated decision-making system.
AI is computers/machines doing intelligent work.
AI is just computer program.
AI is a computer vision.
AI is beyond software development.
AI is a device/software to sense/measure & act/ learn from it.
AI is a device & technology combination.
AI is a various technologies’ combination.
AI is a system generating adaptive behaviour.
AI is a system using reasoning, and rules, learning from data & adapt behaviour.
AI is an artificial system built by humans.
AI is a system with cognitive abilities like humans.
AI is a set of abilities to perform any assigned tasks.
AI is any activity created to make machines intelligent.
AI is a simulation or replication of HI in machines.
AI is like an augmented intelligence that provides info for HI.
AI is a combination of abilities to analyze situations based on data & act upon them etc.

AI is not only a theory.
AI is not a specific technology.
AI is not a computer system.
AI is not only an algorithm.
AI is not only data.
AI is not only software.
AI is not only a way of training.
AI is not the same as HI.
AI is not completely imitating HI.
AI is not a replacement for HI.
AI is not a substitute for HI.
AI is not generating optimal behaviour like humans.
AI doesn’t have the capability of being human.
AI is not an added value until it gets learning outcomes, visibility & measures.
AI is not everything considered to be intelligent and not human.
AI is not independent, needs human interventions etc.

Source: Realized by authors from (Kaul, et al., 2020) [25] and (Gbadegeshin et al., 2021) [26].

Fig. 4. What is and what is not AI? (What *is* AI appears in blue and what *is not* in red outline)

Just as HI manifests itself in different forms (academic-HAI, emotional-HEI, partnership-HPI, social-HSI, etc.) AI is classified as imitating HI, but according to other criteria in: i) structure AI; ii) behaviour AI; iii) capabilities AI; iv) function AI; v) principle AI; etc. Similar to HI which helps man to think about work, AI seems to have become just the computer doing intelligent stuff... The universe of AI, implicitly the multiplied AI significances, previously described and listed (Fig. 4), would not have been possible without the presence of the amazing British mathematician Charles Lutwidge Dodgson, better known as Lewis Carroll (Wilson, (2008) [27] and of the magic science fiction writer Arthur Clarke Together with Isaac Asimov they anticipated the AI amazing areas or territory of “*advanced technology indistinguishable from magic*” (Haenlein & Kaplan, 2019) [24].

Michael Haenlein & Andreas Kaplan distinguish four seasons-like periods in a brief history of AI similar to their presence during the year, in an original manner focus on the repetitive seasonal substrate criterion (Fig. 5). The spring means the birth of the first machine, test, word and theory of. The birth of the English AI roots is connected with Alan Turing, a mathematician, and his work on creating and developing a machine with the purpose of deciphering the secret Enigma code. The American Birth of AI is associated with cognitive scientist Marvin Minsky (co-founder of the MIT laboratory) and to computer scientist John McCarthy (Stanford). Together with Rockefeller Foundation, they organized a famous workshop in which they brought among the participants two other great American researchers considered the founding AI fathers, a computer scientist Nathaniel Rochester, who later designed IBM and Claude Shannon a mathematician who founded the *information theory* (Haenlein & Kaplan, 2019)[24].

The next two seasons-like periods, known as the summer and winter of AI history, are full of ups and downs, related to problems that were first seen as “impossibly non-mechanical”, but were solved based on AI Intelligence and AI Machines providing solutions “*in the domain of apparently ordinary computing processes*” (McCorduck, 2004) [28]. AI winters mean a decreased interest in publicity on artificial intelligence. The first two AI winters can be detailed as periods: (1974-1980) and (1987-1993). Some major signs from scientists and companies predict a new AI winter from 2023, till the legal rules of AI can be fulfilled. Some major ascendant evolutions of AI are generated by the following events and actions, synthesizing how it evolved from its inception:

i) the first program-capable *Logic Theorist* to perform automated reasoning was realized in 1956, by Allen Newell, Herbert Simon and Cliff Shaw, frequently described as “*the first AI program*” (Nilsson, 2010) [29];

ii) the well-known program *General Problem Solver* (GPS), developed in 1957, by the same researchers Herbert Simon, Cliff Shaw and Allen Newell, based on the technique of *Means - Ends Analysis* (MEA), which was used commonly in AI (Newell & Simon, 1961; Simon, 1981) [30 – 31];

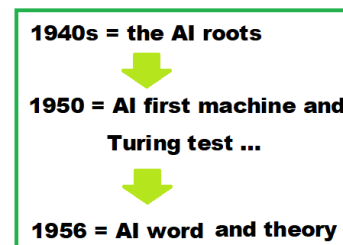
iii) the famous program ELIZA for computer, considered the first chatbot, created by Joseph Weizenbaum between 1964 and 1966 (Haenlein & Kaplan, 2019) [24];

iv) the first general-purpose mobile robot called Shakey was built in 1969, capable of doing things with a purpose, compared to a list of instructions;

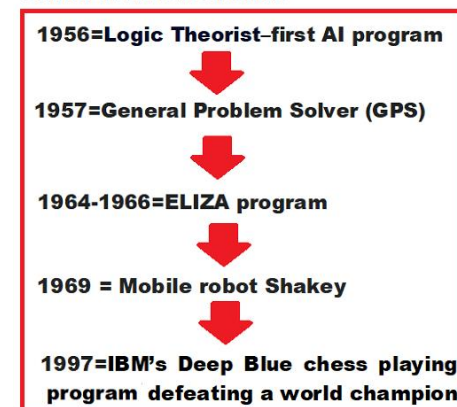
v) the expert system made by James Lighthill beat the world champion Gary Kasparov in 1997 (IBM’s Deep Blue chess playing program); etc.

vi) the emergence and increasingly intense development of deep learning, Bigdata, Internet of Things (IoT) and Artificial General Intelligence (AGI) characterize the last 12 years of AI's existence, from 2011 till the present.

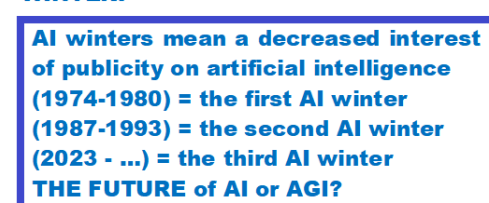
SPRING:



SUMMER AND AUTUMN:



WINTER:



Source: Realized by author from (Haenlein & Kaplan, 2019) [24], McCorduck, 2004 [28] Nilsson, 2010) [29] Newell & Simon, 1961; Simon, 1981) [30-31]). Note: Although being unanimously accepted, the roots of the first AI program seem to be older (1951), when Christopher Strachey gave birth to a checkers-playing program for the Ferranti Mark I computer (Strachey, 1952; 1954) [32-33].

Fig. 5. A brief sketch of the Artificial Intelligence (AI) history characterized by a timeline focus on seasons-like periods as substrate criterion

In a much more realistic overview and more inclusive history, the roots of AI are connected to the emergence of the first computer, without which it would have been virtually impossible for this type of intelligence to ever appear. Charles Babbage in 1822 built the first digital (calculating) machine that produced the most useful of mathematical tables automatically.

Thus, the great-grandfather Babbage of the modern computer showed his extraordinary ability to quantify quickly and with great accuracy, first at the University of Cambridge, between 1828 and 1839. After 1920, Babbage’s digital machines expanded step by step in the area of being useful and were present wherever digital machines were requested. After the Second World War, apparently aged but still effective, the new computing machines will change their name initially to “analog” and finally to “digital” computers (Babbage, 1994) [34]. The “analog” computer was created by James Thomson, the inventor of the mechanical disk integrator used as the foundation of analog computing (Thomson, 1876) [35].

In 1936, at Cambridge University, Alan Turing outlined the principle of the modern computer transformed into a digital calculating machine, consisting of unlimited memory and a scanner that moves back and forth through memory, symbol by symbol, reading whatever also finds by writing additional symbols (Turing, 1936) [36].

Max Newman eventually noted the essential components of a computer:

- i) storage for numbers (or commands);
- ii) augmenters, multipliers, etc.
- iii) “an automatic telephone exchange” that selects “cases”, connecting to the arithmetic organ and writing the answers in prescribed cases;
- iv) moving the control in any stage and in any chosen order, if a certain condition is met, otherwise moving to the next order in the normal sequence;
- v) ways of setting up the machine from scratch and extracting the final answer in a usable form (Newman, 1948, pp. 273–274) [37].

These outstanding scientists and their contributions are considered the minimum milestones of the beginning of modern computer history (Copeland, 2020) [38] and it is absolutely normal to include this computer-focused sub-periodization as a distinct chapter in the evolution of AI. Also, AI entered the home as Roomba, a vacuum cleaner (2002), then like speech recognition, robotic process automation (RPA), dancing robots, and Alexa Skills Kit (ASK), to generate at the end even smart homes. Based on other innovations, AI penetrated the business world through companies like Facebook, Twitter, and

Netflix (2006), in the entertainment universe, IBM's Watson won Jeopardy, a quiz show, where AI solved complex questions as well as riddles (2011). In 2012, *Google now* launched an Android app feature able to provide information (prediction) to the user, and in 2014, the famous *Eugene Goostman* Chatbot won a competition in the infamous *Turing test*. Finally, in another year, 2016, DeepMind's AlphaGo program, powered by a deep neural network, beats Lee Sodol, the world champion *Go* player, in a five-game match. Year by year, AI developed itself to a remarkable level of intelligence. The concept of Deep Learning, Bigdata, the Internet of Things (IoT) and many others are now areas of excellence for AI, that can solve all promptly and, above all, much more correctly and efficiently in time, compared to HI. Nowadays companies like Google, Facebook, IBM, and Amazon are working with AI and creating amazing new and useful devices. In 2023, new ChatGPT models leveraging large linguistic models (LLMs), generate the biggest change in AI performance and its potential to generate value (companies) new deep learning models can be trained in the prior analysis of large amounts of data raw, unlabeled.

The parents of AI, detailed as fathers and mothers are major figures in the process of conceptualizing and multiplying Artificial Intelligence. Analyzing the last century in search of the parents responsible for the rise of AI, one can identify, after a careful selection five prominent figures who laid the foundations for the development of such an impressive technology, perhaps the most holistic approach to reality and objectivity from all types of intelligence. Alan Turing, Allen Newell, Herbert Simon, John McCarthy and Marvin Minsky are not only exceptional scientists but also researchers called the “*fathers of AI*”. Even a category of “*mothers of AI*” can be found and detailed too (Spark Cognition, 2018). *Although it is really difficult to pinpoint among so many contributors, the most important parents of AI remain forever Alan Turing & John McCarthy.*

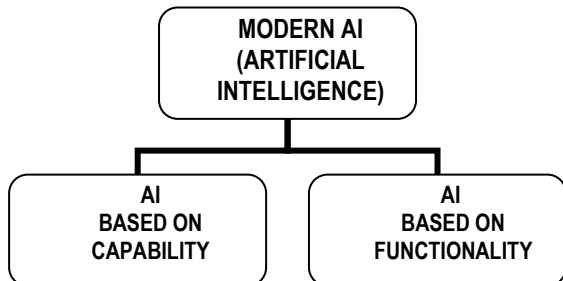
What is the essential typology of AI? Stuart Russell and Peter Norvig offered four objectives that became four starting criteria for a basic typology and even for some potential definitions of AI (Russell & Norvig, 1962) [39]. These objectives & criteria differentiate computer systems based on rationality & human thinking versus human action generating four distinctive AI categories (Fig. 6).

1. THINKING LIKE HUMANS ARTIFICIAL INTELLIGENCE
2. ACTING LIKE HUMANS ARTIFICIAL INTELLIGENCE
3. THINKING RATIONAL ARTIFICIAL INTELLIGENCE
4. ACTING RATIONAL ARTIFICIAL INTELLIGENCE

Source: Realized by author from (Russell & Norvig, 1962) [39]

Fig. 6. One of the first typology of AI

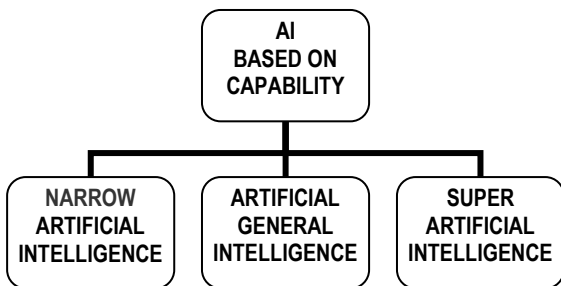
Modern AI benefits from a “tiered” typology and is successively divided into different types and subtypes. If the subtypes are addressed directly, two major typologies can be distinguished, that share all subtypes: *AI based on capability* and *AI based on the functionality* of this continuously expanding kind of intelligence (Fig. 7).



Source: Realized by author from (Theodorou & Dignum, 2020) [22] and (McCarthy, 1996) [40]

Fig. 7. A “tiered” typology’s example of AI

AI, based on capability, has three recognized subtypes on this major criteria being exemplified in the following lines and presented in Fig. 8:



Source: Realized by author from (Theodorou & Dignum, 2020) [22] and (McCarthy, J. 1996) [40]

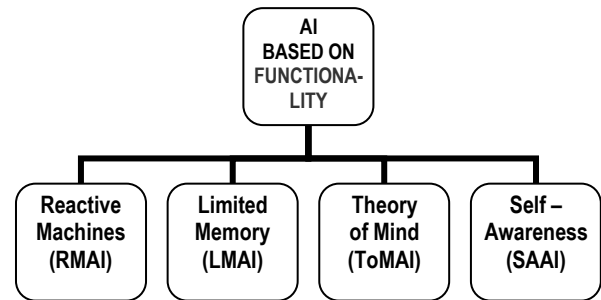
Fig. 8. A sub-typology of AI based on capability.

i) Narrow Artificial Intelligence (*Narrow AI or NAI*) is considered the most common and available subtype of AI, able to perform a task in which was trained but no more (e.g. playing chess, playing Go, self-driving cars, speech & image recognition etc.);

ii) Artificial General Intelligence (*General AI or AGI*) can theoretically perform any intellectual task more efficiently compared to a human being (e.g. no machine “gifted” with General AI or system equipped with General AI exist till now, but a lot of projects are still under research);

iii) Artificial Super Intelligence (*Super AI or ASI*) is the dream or a hypothetical level of AI at which machines or systems could surpass HI, performing any task better than human beings with cognitive properties, based on some key characteristics of strong AI including ability to think, to reason, to solve a puzzle, to make judgments, to plan, to communicate, to learn, to foresight by its own (e.g. such machine or system still does not exist, but projects are in the minds of researchers and even in full process of creation and becoming).

There are also another four subtypes of AI on the functionality criterion (Fig. 9):



Source: Realized by author from (Theodorou & Dignum, 2020) [22] and (Copeland, 2023) [23].

Fig. 9. A sub-typology of AI based on capability.

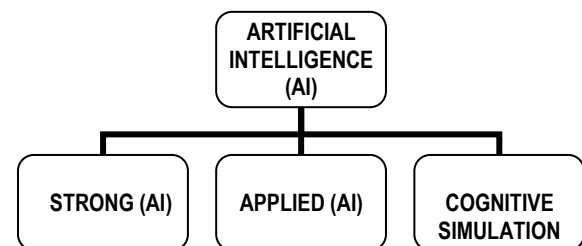
i) Reactive Machines (RMAI) is one of the most basic subtypes, RMAI does not store memories or past experiences for future actions (e.g. IBM’s Deep Blue system, Google’s AlphaGo etc.);

ii) Limited Memory (LMAI) is based on current scenarios and react on searching for the possible best action, LMAI can store past experiences or some data for a short or limited period of time (e.g. self-driving car can store variables evolutions like: speed of the other cars, the distances of other cars, legal speed limit, and other information to optimize the navigation)

iii) Theory of Mind (ToMAI) can understand human beings’ emotions, people’s beliefs, ability to interact socially etc., but **ToMAI still remains in plain development and an unfinished project.**

iv) Self-Awareness (SAAI) is the future, not only because of the idea of super-intelligence, but also for the wish of having own consciousness, sentiments & self-awareness; SAAI. does not exist in reality now and remains a hypothetical concept, something smarter than the human mind or HI.

Some of the modern approaches to Artificial Intelligence (AI) already have an adequate structure and brief history, being connected to the specificity of the investigated complex phenomenon (Fig. 10):



Source: Realized by author from (Copeland, 2023) [23]

Fig. 10. A modern major classification of Artificial Intelligence (AI)

Strong AI, Applied AI & Cognitive Simulation are the major types of AI and the result of the most important AI’s classification. In fact, this typology reflects the three goals to be achieved by AI’s

research. *Strong AI*, introduced by John Searle the philosopher from the University of Berkley, means *to build machines that think*, one of the ultimate ambitions of *Strong AI* being to produce machines with intellectual abilities but indistinguishable from any human person or HI. *Applied AI* is also known as advanced information processing with the visible intention to produce commercially viable “*smart*” or “*expert*” systems and in *Cognitive Simulation*, computers are used to test theories about how HI solves problems, using new methods and techniques.

TYPOLOGIES AND SUBTYPOLOGIES OF AI (ESSENCE & CONTOUR OF AI)	
Machine Learning	Expert System
Weak Artificial Intelligence	
Cognitive Computing	Speech Recognition
Image Recognition	Self-Driving Car
Applied Artificial Intelligence	
Pattern Recognition	Reactive Machine
Cognitive Simulation	Deep Learning
Natural Language Processing	
Machine Vision	Self-Awareness
Learning	Theory of Mind
Artificial Super Intelligence	Robotics
Limited Memory Reinforcement Learning	
Strong Artificial Intelligence	
Artificial General Intelligence	
Narrow Artificial Intelligence	
Artificial Neural Network	
Unsupervised Learning	
Speech Recognition	Deep Neural Network
Positive Reinforcement Learning	
Multiple	Narrow Artificial Intelligence

Source: Realized by author

Fig. 11. Some major words on AI’s wall as a visual synthesis of AI significances & colloquial forms

The first 12 original branches and applications of AI were relatively easy to predict from the beginnings of this type of intelligence (McCarthy, 1959; 1989; 1990; 1996; 2007) [41- 45].




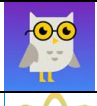
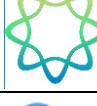




12 AI Branches	12 AI applications
Logical AI	Game Playing
Search AI	Recommendation System
Pattern Recognition	Speech & Image (Facial) Recognition
Representation	Autonomous Vehicles
Inference	Expert Systems
Common Sense Knowledge&Reasoning	Understand/Learn Natural Language
Learning from Experience	Data Security and Surveillance
Planning	Computer Vision
Epistemology	Convolutional

	Neural Networks
Ontology	Chatbot/ ChatGPT
Heuristics	Heuristic Classification
Genetic Programming	Predictive Analytics

Source: Realized by author from (Copeland, 2023) [23] and from (McCarthy, 1959; 1989; 1990; 1996; 2000; 2007) [40 - 45]

Fig. 12. The first 12 branches & applications of AI

There must be at least one well-known image and logo of AI applications in Fig. 13 for anyone, as real proof that AI is deeply involved in every human life, from communication to the learning process, or that AI is already indispensable in everyday life:

LOGO	EXPLAINED LOGO (INITIAL RELEASE YEAR)
	Microsoft SwiftKey is a virtual keyboard offering more accurate autocorrect & predictions by learning the client’s way of writing, developed by Touch Type for Android & iOS devices (2010).
	Databot assistant is a virtual talking robot-iOS, Android & Windows answering requests upon the topic of interest, giving back images, searches, and multimedia presentations (2011).
	Amazon Alexa , also known simply as Alexa, is a virtual AI assistant technology based on a Polish speech synthesizer named Ivona, bought by Amazon (2013).
	Socratic By Google is an educational tool that, by means of photographic recognition, allows its users to answer practically any scientific question (2013)
	ELSA Speak & Speech Analyzer is an AI-powered conversational English fluency coach that listens to your speech and provides you with immediate feedback (2015).
	Google Assistant software, based on AI is an application engaged in two-way conversations that was primarily available on mobile & home automation devices (2016)
	FaceApp is the best mobile photorealistic and video editing application for iOS & Android, developed by FaceApp Technology Ltd, using neural networks based on AI (2016)
	Replika (Robot ChatGPT) is a virtual companion powered by AI for anyone who wants a friend with no judgment, drama, or social anxiety involved, created by Luca Inc (2017)*
	ChatGPT is an artificial intelligence chatbot developed by OpenAI and it was released in November 2022.

Source: Realized by author from Applications/Artificial Intelligence-From sources across the web, Available online at:<https://www.google.com/search?client=avast-a-l&sa=X&q=Artificial+Intelligence+applications&stick>

*Note: Eugenia Kuyda established *Replika* when she was working at Luka, in 2012. After a friend of hers died in 2015, she converted his messages into a chatbot.

Fig. 13. Some examples of images & logos of the first nine well-known AI applications

4. COULD BECOME “AI vs HI” A CONFLICT FOR FINDING NEW SOLUTIONS IN INTER-, TRANS-, & MULTIDISCIPLINARITY, OR A IMPROVED SOLUTION FOR BIG DATA, INTERNET OF THINGS & CHATBOT?

What could be the cleavages or conflicts between HI and AI? The purpose of human intelligence is to combine a series of cognitive activities to adapt to new circumstances. The goal of artificial intelligence (AI) is to create computers capable of behaving like humans and completing tasks that humans would normally do. As long as AI does not serve the optimization or the integration of HI, can appear signs of evolution, which isolate first, and then even generate conflicts?

Certainly and continuously, some essential characteristics, differences and idiosyncrasies of HI & AI must appear. All these existed, are and will multiply always, but at the same time will have to be permanently known, understood in their dynamics, and also revealed to all human beings.

What is the essential difference between human and artificial intelligence? The purpose of human intelligence is to combine a range of cognitive activities in order to adapt to new circumstances, new information, and new universe evolutions. The goal of artificial intelligence (AI) is to create computers that are able to behave like humans and complete jobs that humans would normally do... HI means more than just logically processing data and information and this aspect help human being to reach a superior stage of survival on Earth. Here some fundamental reasons are detailed suggesting why AI will never be able to compete with HI: i) Sensory Data means HI is based on all five uman senses, while AI is not able to replicate all of these senses; ii) Creativity of HI remains unique compared with AI, which cannot AI can be trained to behave like a human being or to develop a human personality; iii) Moral or ethical judgment based on HI’s specific way to explain and distinguish between what is right and what is wrong for humanity; iv) Intuition or inspiration specific to HI, based or not on logical reasoning of human beings, which can break new ground in knowledge and discover new solutions in research using emotional, team and partnership energy.

AI is only one or two levels above basic computer programming but below the much higher HI’s level or horizontal. Of course, with such a brief history, AI is still far beyond what HI remains capable of. HI applies acquired knowledge with logic, reasoning, understanding, learning and experience and even though AI advancements are connected to language processing, vision, image processing, development and common sense still remains a great lag in the challenge or debate AI vs HI that requires human intervention.

Perhaps this is caused by the reality of the fact, and maybe AI in the future can mimic human behaviour using something similar to human “common sense”. Figure 14 compares & opposes Human Intelligence and Artificial Intelligence (HI vs AI) in a synthetic manner, underlying some important features and specificity and reveals once more the idea of no conflict in between:

FACTORS		SOME DIFFERENT ASPECTS (HI vs AI)
Emergence & Nature	HI - Natural Specificity	HI was a philosophical term used for the first time in the ancient cultures of Greece and the Roman Empire, naturally enriched with cognitive abilities of human beings from thinking, reasoning, analyzing, controlling to evaluating etc. and thus to adapt to new situations through a natural combination of cognitive processes.
	AI - Induced Features	AI is coming from Norbert Weiner's concept of feedback mechanisms and John McCarthy's machine intelligence is defined as a “ <i>science and engineering of making intelligent machines, especially intelligent computer programs</i> ” and focuses on improving the HI development to perform optimally any task, from visual perception, speech recognition, decision-making to natural language understanding.
Knowledge & Inference	HI - Natural Specificity	The implicative-causal approach precedes specific reasoning, but the rules that human experts use, frequently contain subjective and vague expressions, so it is more useful the idea of an expert system's inference engine than humans.
	AI - Induced Features	The rules are based on If questions (e.g. If x, then y, if y then z), and the inference engine is able to deduce correctly (e.g. If x, then z). Later, the expert system queries its user, and if the answer is affirmative the system will proceed to infer.
Multi-tasking & decision making	HI - Natural Specificity	HI can work on several different tasks at the same time and in different fields. Faster access to inter-, trans-, cross- & multidisciplinary is still favourable to any intelligent human being as a major ability, and a holistic approach still remains a specific aspect of HI.
	AI - Induced Features	AI still faces significant difficulties in front of multi-tasking, no computer, machine, software or program could do simultaneously so many tasks as HI, or take much longer to do such a thing. AI's access to inter-, trans-, cross- and multidisciplinary is only in its beginnings.
State & Functions	HI - Natural Specificity	HI is rather comparable to any analogical mind and is better in processing information in a continuous and non-linear fashion and faces difficulties in processing in the case of Big Data type phenomena, HI can use better cognitive abilities to understand and interpret the world around, but take subjective decisions based on experiences and knowledge.
	AI - Induced Features	AI is connected to digital & virtual unlimited possibilities. AI operates better Big Data Bases. using binary code, as some series of 0s and 1s. AI is well-suited for repetitive or data-intensive tasks, and can process and analyse large amounts of data accurately, but depends on HI instructions,

Learning & Pattern Recognition	HI - Natural Specificity	HI has a key ability to learn from past experiences and adjust human behaviour accordingly, allowing human beings to adapt & survive. HI includes another significant ability to find order in complex data, and Ray Kurzweil was among the first to point out that pattern recognition is the basis of human thought (HI).
	AI - Induced Features	AI is nearly devoid of the ability to reason abstractly, think creatively, make connections, and uses 3 types of pattern recognition: statistical, structural (or syntactic) & neural. AI includes more recognition types, from speech, text pattern, facial, movement and video recognition, to medical image recognition.
Versatility & Endless Multiplication	HI - Natural Specificity	HI possesses the ability of multitasking, performs many totally different assignments, and is always subject to human error, and it remains typified between classic limits to academic or intellectual, emotional, partnership, existential & social intelligence as the major HI kinds.
	AI - Induced Features	AI perform simultaneously a limited number of tasks but compensates for this aspect with the multiplication of its forms from Narrow, General & Super AI, to Strong, Applied AI & Cognitive Simulation or to Reactive Machines, Limited Memory, Theory of Mind & Self-Awareness etc.
Common Sense & Context and Nuances	HI - Natural Specificity	HI signals and differentiates instantly in terms of context and nuances benefiting from common sense whenever it is called textually or verbally, in images or sounds. Human communication and interaction rely on a vast background of unspoken assumptions and this large notion of common sense allows human beings to communicate quickly, efficiently, and with deep meaning
	AI - Induced Features	Common-sense reasoning becomes a field of AI that aims to help computers understand and interact with people in more natural ways for deciphering contexts, nuances, and meanings and thus teach all to computers NLP as an area of ML helping common-sense systems to become highly adaptive.

Source: Realized by author from (McCarthy, 1996) [40] (Kurzweil, 2012) [47] (Havasi, 2014) [48] (Hoa, 2020) [49] (Naveen, 2022) [50] Thakkar, 2023) [51].

Fig. 14. Factors and Differences between HI & AI (HI vs AI)

Of course, there are many more differences or opposite characteristics between AI and HI, from distinct origins, born or inborn, the calculation speed and accuracy or related errors, objectivity or subjectivity in scientific approach, power and speed of adaptation, social interaction, self-awareness and maturity, legal restrictions and ethics, etc.

Big Data, the Internet of Things (IoT), and Chatbot are some major applications of AI, as they heavily rely on AI algorithms and technologies, but also most accessed solutions as machines using AI by all generations. The most important aspect in the communication and promotion of AI or the major purpose of continuous development of AI, from viable Big Data solutions to adequate IoT reactions or Chatbots' replies, is well-known as trying to outperform HI in time and power of synthesis. AI

must be adapted, changed and transformed in many cases according to the model of Big Data, Internet of Things (IoT), and Chatbot to ensure helping, optimizing or even perfecting HI.

Big Data involves a better and briefing analysis of large datasets, IoT uses AI to rapidly automate processes, and chatbots use natural language processing to communicate more clearly than HI. Big Data represents an inter-, trans-, and multidisciplinary concept, initially used and valued only in statistics, informatics, mathematics and econometrics and, finally, subsequently generalized, to describe large and complex sets of data arising from multiple sources and requiring much more advanced technologies and methods processing, storage, and analysis. Big Data appears in the practice of scientific research in more and more fields and subfields, in which the volume of information continuously increases, generating both new applications and benefits for companies and for the entire human community (sometimes going as far as human society as a whole). Big Data applications cover a diversity of fields from government & public administration, management, marketing, transportation, business, healthcare, to cybersecurity etc.

The large volume of data interpreted with the help of AI becomes easier to understand, being distributed more structured and homogeneous, becoming more cursive from a logical & chronological point of view. Big Data ultimately reduces the typology of data and limits the associativity or correlation of unreliable sources, validating/invalidating more and more investigative hypotheses, but constantly increasing the veracity of solutions as more sources, processes and types of data appear in which the assurance of accuracy, completeness, their timeliness and reliability, as well as protecting data against unauthorized access, use or disclosure, by calling on new types of devices, such as cloud systems, web applications, video streaming, social networks. media, voice assistants, IoT sensors and biometric scanners, edge computing devices, fog computing networks and hybrid cloud environments (Dwivedi, et al. 2021) [52].

Among the advantages of using Big Data solutions with AI technologies [from machine learning (ML), deep learning (DL), natural language processing (NLP), computer vision (CV), graph analysis (GA)] to non AI solutions [from quantum computing to neuromorphic calculus] we can mention: i) more advanced processing and analysis; ii) more detailed and more easily scalable technologies and methods to process, store and analyze massive amounts of data in real-time or as close to real-time as possible; iii) ensuring more personalized and smarter services; iv) automation of tasks, optimization of processes, improvement of performance, generation of synthetic information,

more reliable prediction or forecasting & creation of informational (added) value etc. (Dwivedi, et.al. 2021; 2023) [52-53].

The Internet of Things (IoT) is a complex concept consisting physically of a network of objects in which they are embedded with sensors, software and other technologies and which allow to connect and exchange data with other devices and systems through the Internet and or other communication networks based on AI. IoT includes a large typology of physical objects, from appliances to cars, vehicles, wearables, etc. IoT has multiple applications in different industries and fields: i) health monitoring and improvement in healthcare; ii) automation and optimization of functions and comfort at home, through devices such as smart thermostats, lighting systems, security cameras or voice assistants in the new smart homes; iii) improving navigation and safety, using devices such as GPS systems, traffic sensors, cameras or smart cars in transport; iv) business efficiency with the help of RFID tags, barcode scanners, stock management systems; v) optimization of work performance and productivity, based on sensors, actuators or robots; vi) creating added value through analysis platforms, dashboards or recommendation systems; vi) improving public services and governance, through the use of smart meters, street lights or waste management systems by governments and administrations; vii) increasing transparency and accountability, with open data platforms, citizen feedback systems or blockchain networks.

“*Smart city*” becomes the trendy application area of AI through IoT, incorporating “*smart home*” as well. Smart home consists of IoT enabled based on AI and home appliances, air-conditioning/heating system, television, audio/ video streaming devices, and security systems. All of these communicate with each other using AI in order to provide optimal comfort, security and reduced energy consumption. All these new dialogues and communications take place through IoT-based central control unit using the Internet and AI. The concept of a smart city gained popularity in the last decade and attracted a lot of research-connected activities.

Modern applications of AI illustrate that intern and international markets’ share of IoT projects is higher year by year. It is evident that industry, smart city, smart home, smart energy, smart business and smart vehicle based on AI and IoT

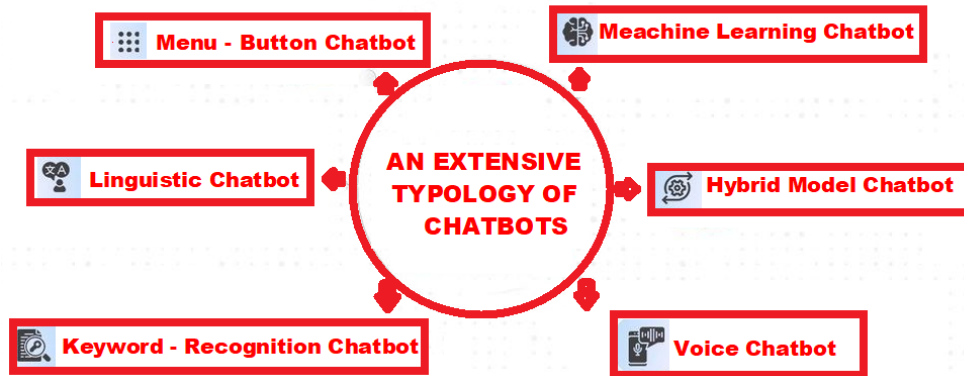
projects have a big market share in comparison to others non-AI or classical activities and projects

IoT has a major impact on various ethical aspects of human life and values, from privacy to surveillance of people's locations, behaviours and interactions without violating human rights and civil liberties.

The original chatterbot or chatbot is nothing else but a software application that aims to mimic human conversation through text or using voice interactions, typically online. The beginnings of the notion and practical example of “ChatterBot” were originally coined by Michael Mauldin in 1994, who was in fact the first creator of the first Verbot based on conversational programs. At the most basic level, the first chatbot is equivalent to any computer program able to simulate & process human beings’ dialogues or conversations (either written or spoken communications). Any chatbot is driven by AI, based on automated rules and Natural-Language Processing (NLP) & Machine Learning (ML), being ready to answer requests of all kinds. Also, all chatbots allows a human being to interact with digital devices, as if AI tries to communicate with HI. Major Chatbots types can be: i) simple (e.g. rudimentary answers to dialogue with just a line response); ii) sophisticated (e.g. digital assistants that evolve day by day).

Modern classification of chatbots uses tasks to detail the same categories and identifies: i) *Task-Oriented* or *declarative chatbot* (e.g. based on a single program that focuses on performing one simple function and generating conversational responses to user inquiries); ii) *Data-Driven* or *predictive/conversational chatbots*, often being met under the name of digital or virtual assistants (e.g. Alexa is a sophisticated and multi-task interactive chatbot). Advanced digital assistants are also able to connect several single-purpose chatbots under one umbrella, pull disparate information from each of them, and then combine this information to perform a task while still maintaining context, so the chatbot doesn’t become “*confused*.”

A detailed classification of Chatbots must be a more extensive typology including new or modern subtypes or subclasses. From all the six subclasses presented in Fig. 15, the hybrid chatbot model can offer the best of both worlds (rules-based Bots & AI-Bots) and thus it becomes the best solution, reuniting the simplicity of dialogue, from question to answer, with the complexity of investigation or literature review research, in the Chatbots’ universe which looks apparently infinite or inaccessible.



Source: Realized by author from (Engati Team,2023) [55]

Fig. 15. An extensive typology of Chatbots including some of the dominant modern subclasses

Even when the first three major advantages and disadvantages of Chatbots are selected hierarchically (Fig. 16), there are solutions for permanent AI improvement:

<p>Chatbots' Strengths</p> <p>A. I can recall data, information, texts and synthesis from previous conversations with clients and thus can offer specific or personalized responses (Everything has continuity).</p> <p>B. Can allow clients to correct any misunderstandings or errors in the previous interactions (everything implies errors' presence).</p> <p>C. Can be programmed to refuse inadequate or harmful clients' requests (everything has inadequacy in relation to an unethical request).</p>
<p>Chatbot's Weaknesses</p> <p>A. I can sometimes provide incorrect or even untruthful data and information due to natural limitations in training data or understanding information (nothing is deeply correct).</p> <p>B. May inadvertently provide instructions or suggestions that are harmful or biased without knowing this aspect (nothing is deeply usefull).</p> <p>C. Can offer limited knowledge of current events and developments beyond the training data and information (nothing is unlimited).</p>

Source: Realized by author

Fig. 16. The first three strengths & weaknesses of Chatbots

From these strengths & weaknesses of Chatbots, one can define some derived major AI principles:

<p>Everything in AI has continuity and discontinuity. Everything implies errors' presence, even errors' absence. Everything has inadequacy linked to an unethical request.</p>
<p>Nothing in AI is totally correct or incorrect. Nothing is definitely useful or unuseful. Nothing is really unlimited or limited.</p>

Source: Realized by author

Fig. 17. Six derived principles of AI from the strengths & weaknesses of Chatbots

From the simplest form, where AI is described as a field, which combines computer science and robust datasets, to enable problem-solving to its complex conceptualization as an inter-, trans-, and multidisciplinary term, where AI becomes the real substitute of the modern holistic approach in research and education, trying to help HI. AI can be also defined as an attempt of combining concepts, techniques and methods, from more and more disciplines, including computer science, cognitive science, linguistics, physics, statistics, mathematics psychology, sociology, neuroscience, philosophy or ethics, etc. AI also encompasses sub-domains in education or sub-fields in scientific research-based machine learning and deep learning investigations, which are frequently mentioned in conjunction with artificial intelligence. All these disciplines and many others are comprised of AI algorithms which seek to create expert systems which make better predictions or classifications in education based on input data, and also find more correct solutions in research activities.

5. COULD AI BE A REAL THREAT TO HUMANITY OR EVERYTHING IS JUST "MUCH ADO ABOUT NOTHING"?

From the conceptualization of Intelligence, as "the computational part of the ability to achieve goals in the world" (McCarthy, 2007) [45], Human Intelligence in a so-called "heuristic hypothesis" is a human characteristic or a specific feature of human being (Turing, 1950) [56], somehow similar and different at the same time, to all humans benefitting of similar intellectual mechanisms with only some small differences, all related to "quantitative biochemical and physiological conditions" (Jensen, 1998) [46], a leading researcher in human intelligence, suggests that I see them as speed, short term memory, and the ability to form accurate and retrievable long term memories.

Human intelligence (HI) is typologically much more extensive in relation to artificial intelligence (AI). Psychologist Howard Gardner identified no less than eight types of intelligence: linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, interpersonal, intrapersonal and naturalistic, to which Robert Sternberg and Daniel Goleman added other types of intelligence: creative, practical or emotional, and the multiplication continues even today with other forms of partnership-type intelligence, social existential, etc. Some possible synonyms for HI remain viable for a long period of two millennia as wit, insight, wisdom, intellect, acumen, shrewdness, astuteness, keenness, etc. Some possible synonyms for AI are totally new and permanently updated like: Machine Intelligence (MI), Computational Intelligence (CI), Synthetic Intelligence (SI), Artificial Cognition (AC), Artificial Intellect (AIntellect) etc.

Intelligence, whether human intelligence or artificial intelligence, can be both a threat and an opportunity, depending on how it is used and the context in which it must operate. Intelligence can be a threat anytime when HI or AI are used for malicious purposes or to manipulate and exploit other human beings. Advanced technologies driven by HI, such as AI, can be employed for cyber-attacks, surveillance, or the development of autonomous weapons. In the wrong hands, intelligence (HI or AI) can be harnessed to cause harm, disrupt social systems, or infringe upon privacy or security.

The same concept or term, named intelligence, whether human intelligence or artificial intelligence can present numerous opportunities for positive advancements. It enables human beings to understand and solve complex problems, make informed decisions, and create innovative solutions. Both HI and AI are essential for scientific and technological progress, leading to advancements in healthcare, education, communication, and more. Together HI and AI can help human beings address global challenges like climate change, poverty, and inequality, playing a crucial role in personal development and self-improvement of human beings. It is more and more important to understand the real truth or the pragmatism, that intelligence, be HI or AI, each one by itself is always neutral or must remain together non-committal forms of thinking. How intelligence is used in general and the ethical considerations surrounding HI and AI applications determine whether each one can become a threat or an opportunity. Only human society must prioritize responsible and ethical use of intelligence (both HI and AI) to maximize the opportunities presented together while mitigating their common risks. Or threats.

Does artificial intelligence (AI) become an existential risk or opportunity for academic education and scientific knowledge and research?

Of course, according to this vision, AI alone can be both an existential risk and an opportunity for academic education and scientific research. As necessary exemplifications, the first three general aspects in which AI could become an existential risk would be:

i) *automation of jobs*, when AI has the potential to automate certain tasks and jobs, which could lead to significant disruptions in the job market, including the academic sector, with a negative result consisting in job losses and unemployment for certain professions;

ii) *bias & discrimination*, where AI systems are trained on data, and the training data is biased, inevitably the AI algorithms could perpetuate and amplify those biases (e.g. in academic education & research, biased AI systems could reinforce existing inequalities or hinder the progress of marginalized groups);

iii) *ethical challenges*, which appear instantly when the development and use of AI raise ethical questions that need careful consideration (e.g. in academic education and research, issues like privacy, data security, and responsible AI deployment, need continuously to be addressed to ensure ethical practices and prevent misuse of AI technology).

But also, AI can be an opportunity, as one can see from the following four examples:

i) *enhancing learning experiences*, when AI can be used to develop personalized learning systems, more adapted to individual student needs or preferences, and providing intelligent tutoring, virtual simulations, and personalized feedback, or finally, more engaging educational experiences);

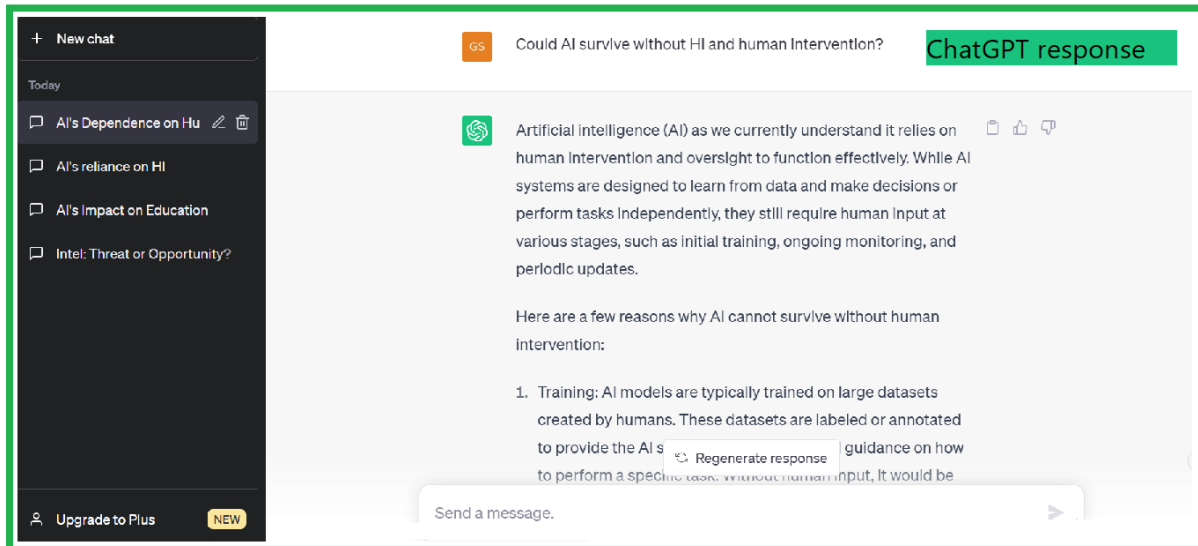
ii) *accelerating scientific discoveries*, where AI has the potential to analyze Big Data quickly and identify patterns and insights that HI may not easily discern, leading to breakthroughs in scientific research, such as drug discovery, genomics, climate modelling, and other complex scientific endeavour;

iii) *automation of repetitive tasks*, where AI can automate routine and repetitive tasks in academic education and research, such as grading assignments, managing administrative duties, generating free up time for professors and researchers to focus on more creative and critical aspects of their activity;

iv) *collaboration and access to knowledge*, when AI-powered platforms can facilitate collaboration among researchers and educators, enabling them to share resources, insights, and data more efficiently, enhancing access to knowledge by providing language translation, text-to-speech capabilities, and content recommendation systems to bridge language and accessibility barrier etc.

In an attempt to synthesize and maximize the benefits of AI and mitigate potential risks, it is crucial to ensure responsible development, deployment, and governance of AI technologies in academic education and scientific research. Ethical considerations, transparency, and ongoing evaluation are key to leveraging AI as a valuable

tool rather than a threat. The most difficult aspect of AI remains the idea of threat and existential risk, and this is generating many other subsequent questions, and from all of them the following interrogation was selected at the end of the paper: *Could AI survive without HI and human intervention?*



Source: Image retrieved by author from <https://chat.openai.com/?model=text-davinci-002-render-sha> Accessed May 30, 2023

Fig. 18. ChatGPT response to one of the major paper's questions: *Could AI survive without HI and human intervention?*

Probably the most convergent answer is the one given by a Chatbot. Here the incredible entire answer to a ChatGPT is following:

“Artificial Intelligence (AI) as we currently understand it relies on human intervention and oversight to function effectively. While AI systems are designed to learn from data and make decisions or perform tasks independently, they still require human input at various stages, such as initial training, ongoing monitoring, and periodic updates. Here are a few reasons why AI cannot survive without human intervention:

1. Training: AI models are typically trained on large datasets created by humans. These datasets are labelled or annotated to provide the AI system with examples and guidance on how to perform a specific task. Without human input, it is challenging to create accurate & relevant training data.

2. Bias and Ethics: AI systems are susceptible to bias and can reflect the biases present in the data they are trained on. Human intervention is crucial to identify and address bias in AI algorithms, ensuring fair and ethical outcomes. Additionally, humans are responsible for defining ethical guidelines and regulations that govern AI use.

3. Adaptability and Updates: AI systems need to adapt to changing circumstances and new information. Human intervention is essential to

evaluate and update AI models to ensure their continued accuracy and effectiveness. Without human intervention, AI systems would struggle to keep up with evolving needs and challenges

4. Unforeseen Situation: AI systems may encounter situations they were not explicitly trained for, or they may encounter data that differs significantly from their training data. In such cases, human intervention becomes necessary to guide the AI system or make critical decisions that fall outside its.

While there is ongoing research and development in the field of AI, including areas like unsupervised learning and self-improving systems, the current state of AI heavily relies on human input and intervention.”

No answer could be more credible as long as it is also so easy to argue because: i) AI systems are developed and designed by humans, and they require human intervention and oversight to function effectively; ii) AI systems rely on human programmers and engineers to develop algorithms, train models, provide data, set objectives, etc. and requires ongoing monitoring and maintenance to ensure their performance and address any issues that may arise; iii) to ensure that AI systems align with societal values and legal frameworks human

input is crucial for setting goals, and defining ethical guidelines.

However, the new idea of Artificial General Intelligence (AGI) surpassing HI and operating entirely without human intervention raises the same complex questions and concerns related to control, ethics, and the potential impact on society. It is a topic of ongoing debate and speculation, and there is no consensus among experts on when or if such scenarios may become a reality. In summary, while AI systems currently require human intervention and oversight, future advancements may bring us closer to the possibility of AI systems operating more autonomously, but the extent and implications of such autonomy are yet to be fully understood.

Though there already exist a lot of identified advantages or major opportunities, especially in academic education and scientific research, however, interest in AI's disadvantages and risks has grown nearly exponentially.

Some major risks are more highlighted during the last year, mostly focused on:

- i) automation-spurred job loss;
- ii) privacy and security violations;
- iii) deep fakes and manipulations;
- iv) algorithmic bias caused by bad data and false databases or sources;
- v) deep socio-economic inequalities;
- vi) market volatility and even major instability;
- vii) weapons automatization, etc.

But it should not be overlooked that although AI has done, is doing and will continue to do an excellent job imitating intelligent action, it has not yet succeeded in replicating human thought processes or HI's creativity and deep common sense. As the hope for a better future for AI dies last, I continue to believe that AI-assisted HI will eliminate the vast majority of risks through prompt regulations and offer more real advantages and a better perspective of opportunities.

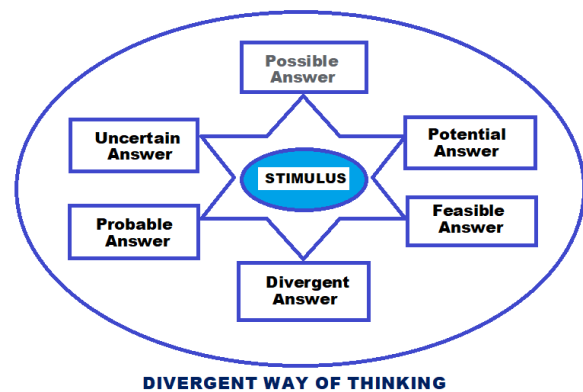
Artificial Consciousness (AC) or Machine Consciousness (MC) with direct reference to the new non-biological machine, created by a human being and his creative HI, tries to become aware of its own existence and think as if it had a human mind, awareness and common sense. AC represents the next level of future strong AI. Specifically, AC is about nothing else but a chatbot equipped with AI, awareness and common sense. Artificial Consciousness (AC) or Machine Consciousness (MC) will greatly help systems that involve relationships or human interactions.

Finally, I believe that everything about AI threats or risks can be considered after a faster approval of new regulations regarding HI's use of AI, the vast majority of fears will acquire ironic shades of

Shakespeare's language, more precisely, all will generate perhaps "*much ado about nothing*"!

6. SOME FINAL REMARKS

Is artificial intelligence (AI) more intelligent than humans or is it not? To answer this question, it is essential to understand the way new ideas appear, the birth and source of human creativity and the specificity of HI. In 1967, American psychologist Joy Paul Guilford split and restructured creative thinking into *convergent thinking* and *divergent thinking*. In the psychometrics performed by Guilford on the human intellect, the essential and detailed differences of the two ways of thinking were very well addressed. In essence, *convergent thinking* brings together the abilities of the human being to correctly answer questions, which represent in detail a suite of successive demonstrations of memory and logic. *Divergent thinking* becomes a way of thinking that is used to generate creative ideas by exploring several possible solutions, spontaneously, freely, and "*non-linearly*", generating in a short time a lot of new ideas, through unexpected connections and in an emergent cognitive manner (Fig. 19):



DIVERGENT WAY OF THINKING

Source: Realized by author

Fig. 19. A synthetic image for a divergent way of thinking

Convergent thinking has already become the property of AI and slowly, slowly divergent thinking will be divided between AI and HI.

Many recent studies estimate that by 2030, about 70% of companies will become AI customers and adopt some form of AI technology in industrial, business, educational, research, planning and decision-making processes, so "*AI could potentially deliver an additional economic output of around \$13 trillion by 2030, boosting global GDP by about 1.2 per cent a year*". (Bughin, *et al.*, 2018) [57].

One essential question still remains without answer: *What is the future of AI and the currently*

anticipated dangers for intelligence and even human being? This question and many others like it have recently found a coherent, effective and encouraging answer for the human being and for the future of Artificial Intelligence.

These very days when I finished writing this paper dedicated to HI & AI, a new form of association and dialogue between AI and HI appears in international scientific research, known as the “*Digital Bridge*”. “*Digital Bridge*” has become perhaps the most exciting invention of a multi-disciplinary team of neuroscience researchers in Switzerland, which has a long-standing program to develop brain-computer interfaces to overcome paralysis. The project aimed to use wireless signals to reconnect the brain with muscles that become useless when spinal cord nerves are severed. Thus this new form of successful communication & clear collaboration between AI and HI digital bridge opens an exceptional future for both. Future opportunities AI technology in all its forms is likely to see greater levels of adoption within organisations as the range of applications and levels of automation increase. Procrastination or the intentional delay of AI evolution, as in the case of other major scientific discoveries is a widespread phenomenon (Rabin, et al.,2011) [58].

But AI's procrastination can negatively impact learning, political, economic, and social achievements, from governance to public administration, from academic self-efficacy to quality of life, from holistic scientific research to companies and efficiency in affairs, etc [59-60].

AI's procrastination is increasingly viewed as the worst consequence or the result of the lack of AI rules implementations involving failures in self-regulation & ethics, processes commonly regarded as extremely important.

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ANALYSIS OF FRACTIONAL ORDER HEAT CONDUCTION PROBLEMS IN NONCYLINDRICAL DOMAINS WITH DIFFERENT BOUNDARY CONDITIONS

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Abstract. *The present article concerning the mathematical modelling of thermophysical processes in the electric arcs of high-current tripping devices. The heat conduction equation, which takes into account the influence of thermal sources in the arc and the effect of shrinkage of the axial section of the arc in the cathode region into a contact, is one of the tools for describing the physics of processes in the arc. The contacts are in a closed state at the start of time, and there is no domain of problem solution. From a mathematical point of view, the problematicity of the problem at hand is precisely the presence of a moving boundary and the degeneracy of the solution domain at the outset.*

Keywords: *Fractional derivative, Heat conduction, Noncylindrical Domains, Mittag-Leffler function.*

1. INTRODUCTION

Heat conduction was defined as the transfer of thermal energy from the more energetic particles of a medium to the adjacent less energetic ones. It was stated that conduction can take place in liquids and gases as well as solids provided that there is no bulk motion involved.

Caputo [1] developed the fractional order derivatives of the differential equations and its filters. Povstenko [2,4] solved the Boundary value problems using the fractional order derivatives, in an infinite medium with a spherical inclusion. Ankhmanova et al. [3] Solved a singular integral equation of the voltera type and its adjoint. Jenaliyev et al. [5], studied boundary value problems of the heat equation in noncylindrical domains degenerating at the initial moment leads to the necessity of research of the singular Volterra integral equations of the second kind, when the norm of the integral operator is equal to 1. The

paper deals with the singular Volterra integral equation of the second kind, to which by virtue of 'the incompressibility' of the kernel the classical method of successive approximations is not applicable.

Amangaliyeva et al. [6, 7] established that in an infinite angular domain for Dirichlet problem of the heat conduction equation the unique (up to a constant factor) non-trivial solution exists, which does not belong to the class of summable functions with the found weight. It is shown that for the adjoint boundary value problem the unique (up to a constant factor) non-trivial solution exists, which belongs to the class of essentially bounded functions with the weight found in the work. It is proved that the operator of a boundary value problem of heat conductivity in an infinite angular domain in a class of growing functions is Noetherian with an index which is equal to minus one. Dzhemaliyev et al. [8] solved the boundary value problems of heat conduction equation in an unbounded plane. Recently many of fractional order heat conduction problems have been discussed [9-16].

There are presently issues concerning the mathematical modelling of thermophysical processes in the electric arcs of high-current tripping devices. The heat conduction equation, which takes into account the influence of thermal sources in the arc and the effect of shrinkage of the axial section of the arc in the cathode region into a contact, is one of the tools for describing the physics of processes in the arc.

The contacts are in a closed state at the start of time, and there is no domain of problem solution. From a mathematical point, the problematicity of the problem at hand is precisely the presence of a moving boundary and the degeneracy of the solution domain at the outset.

2. BASIC DEFINITIONS

➤ Riemann Liouville Fractional Integral:

The Riemann-Liouville fractional integral defined as:

$${}_a D_x^{-\alpha} f(x) = \frac{1}{\Gamma(\alpha)} \int_a^x (x-t)^{\alpha-1} f(t) dt$$

Where $\alpha > 0$ is any non-negative real number, $f(x)$ be piecewise continuous on (a, x) and integrable on any finite subinterval of $[a, x]$.

➤ Riemann Liouville Fractional Derivative:

The fractional derivative can be defined using the definition of the fractional integral. Suppose that on $n-1 < \alpha \leq n$ and n is the smallest integer greater than on α . Then the fractional derivative of $f(x)$ of order $\alpha > 0$ is:

$${}_a D_x^{-\alpha} f(x) = \frac{1}{\Gamma(n-\alpha)} \left(\frac{d}{dx}\right)^n \int_a^x (x-t)^{n-\alpha-1} f(t) dt$$

➤ Caputo's Fractional Derivative:

The Caputo's fractional derivative of $f(x)$ of order $\alpha > 0$, is

$${}_a^c D_x^{-\alpha} f(x) = \frac{1}{\Gamma(n-\alpha)} \int_a^x (x-t)^{n-\alpha-1} f^n(t) dt,$$

where $n-1 < \alpha \leq n$

3. PROBLEM FORMULATION

We consider BVP's of fractional heat conduction in a degenerate domain.

a) In the domain

$G = \{(x; t) : 0 < x < t, t > 0\}$ it is required to find a solution to the equation of fractional heat conduction.

$$\frac{\partial^\alpha u}{\partial t^\alpha} = \alpha^2 \frac{\partial^2 u}{\partial x^2} \quad (1)$$

with the boundary conditions

$$u(x, t)|_{x=0} = 0, u(x, t)|_{x=t} = 0 \quad (2)$$

b) In the domain

$G = \{(x; t) : 0 < x < t, t > 0\}$ it is required to find a solution to the equation of fractional heat conduction.

$$\frac{\partial^\alpha u}{\partial t^\alpha} = \alpha^2 \frac{\partial^2 u}{\partial x^2} \quad (3)$$

with the boundary conditions

$$u_x(x, t)|_{x=0} = 0, u_x(x, t)|_{x=t} = 0 \quad (4)$$

c) In the domain

$G = \{(x; t) : 0 < x < t, t > 0\}$ it is required to find a solution to the equation of fractional heat conduction.

$$\frac{\partial^\alpha u}{\partial t^\alpha} = \alpha^2 \frac{\partial^2 u}{\partial x^2} \quad (5)$$

with the boundary conditions

$$u(x, t)|_{x=0} = 0, u_x(x, t)|_{x=t} = 0 \quad (6)$$

d) In the domain

$G = \{(x; t) : 0 < x < t, t > 0\}$ it is required to find a solution to the equation of fractional heat conduction.

$$\frac{\partial^\alpha u}{\partial t^\alpha} = \alpha^2 \frac{\partial^2 u}{\partial x^2} \quad (7)$$

with the boundary conditions

$$u_x(x, t)|_{x=0} = 0, u(x, t)|_{x=t} = 0 \quad (8)$$

4. CONVERSION OF PROBLEMS IN INTEGRAL EQUATIONS

We consider a solution of the Problem (a) as the sum of the thermal potentials of the double layer

$$\begin{aligned} u(x, t) &= \frac{1}{4\alpha^3\sqrt{\pi}} \int_0^t \frac{x}{(\sqrt{t-\tau})^3} x^\beta \\ &\times E_{\alpha\beta}(-4\alpha^2(t-\tau)^\alpha) v(\tau) d\tau \\ &+ \frac{1}{4\alpha^3\sqrt{\pi}} \int_0^t \frac{x-\tau}{(\sqrt{t-\tau})^3} (x-\tau)^\beta \\ &\times E_{\alpha\beta}(-4\alpha^2(t-\tau)^\alpha) \varphi(\tau) d\tau. \end{aligned} \quad (9)$$

where $E_{\alpha\beta}(\cdot)$ is Mittag-Leffler function of two parameters.

We consider a solution of the Problem (b) as the sum of the thermal potentials of the simple layer

$$\begin{aligned} u(x, t) &= \frac{1}{2\alpha\sqrt{\pi}} \int_0^t \frac{1}{\sqrt{t-\tau}} x^\beta \\ &\times E_{\alpha\beta}(-4\alpha^2(t-\tau)^\alpha) v(\tau) d\tau \\ &+ \frac{1}{2\alpha\sqrt{\pi}} \int_0^t \frac{1}{\sqrt{t-\tau}} (x-\tau)^\beta \\ &\times E_{\alpha\beta}(-4\alpha^2(t-\tau)^\alpha) \varphi(\tau) d\tau. \end{aligned} \quad (10)$$

We consider a solution of the Problem (c) as the sum of a combination of the thermal potentials of a double and a simple layer

$$\begin{aligned}
u(x, t) &= \frac{1}{4a^2\sqrt{\pi}} \int_0^t \frac{x}{(\sqrt{t-\tau})^3} x^\beta \\
&\times E_{\alpha\beta}(-4a^2(t-\tau)^\alpha) v(\tau) d\tau \\
&+ \frac{1}{2a\sqrt{\pi}} \int_0^t \frac{1}{\sqrt{t-\tau}} (x-\tau)^\beta \\
&\times E_{\alpha\beta}(-4a^2(t-\tau)^\alpha) \varphi(\tau) d\tau.
\end{aligned} \tag{11}$$

We consider a solution of the Problem (d) as the sum of a combination of the thermal potentials of a simple and a double layer

$$\begin{aligned}
u(x, t) &= \frac{1}{2a\sqrt{\pi}} \int_0^t \frac{1}{\sqrt{t-\tau}} x^\beta \\
&\times E_{\alpha\beta}(-4a^2(t-\tau)^\alpha) v(\tau) d\tau \\
&+ \frac{1}{4a^3\sqrt{\pi}} \int_0^t \frac{x-\tau}{(\sqrt{t-\tau})^3} (x-\tau)^\beta \\
&\times E_{\alpha\beta}(-4a^2(t-\tau)^\alpha) \varphi(\tau) d\tau.
\end{aligned} \tag{12}$$

It is clear that the functions (9)-(12) satisfy the heat equation for any $v(t)$ and $\varphi(t)$ [20].

$$\varphi(t) - \int_0^t K(t, \tau) \varphi(\tau) d\tau = 0 \tag{13}$$

where

$$K(t, \tau) = \frac{1}{2a\sqrt{\pi}} \left\{ \begin{aligned} &\frac{t+\tau}{(\sqrt{t-\tau})^3} (t+\tau)^\beta \left(E_{\alpha\beta}(-4a^2(t-\tau)^\alpha) \right) \\ &+ \frac{1}{\sqrt{t-\tau}} \left((t-\tau)^{\beta-\frac{1}{2}} E_{\alpha\beta}(-4a^2 t^\alpha) \right) \end{aligned} \right\}$$

Problem (c) and (d) are reduced to the integral equation:

$$\varphi(t) - \int_0^t K(t, \tau) \varphi(\tau) d\tau = 0 \tag{14}$$

where

$$K(t, \tau) = \frac{1}{2a\sqrt{\pi}} \left\{ \begin{aligned} &-\frac{t+\tau}{(\sqrt{t-\tau})^3} \exp\left(-\frac{(t+\tau)^2}{4a^2(t-\tau)}\right) \\ &+ \frac{1}{\sqrt{t-\tau}} \exp\left(-\frac{t-\tau}{4a^2}\right) \end{aligned} \right\}$$

Singularity of the kernel $K(t, \tau)$ of equation (13) is determined by the properties

$$\lim_{t \rightarrow 0} \int_0^t K(t, \tau) d\tau = 1, \quad \lim_{t \rightarrow +\infty} \int_0^t K(t, \tau) d\tau = 1. \tag{15}$$

By the Carleman-Vekua method, solving the integral equation (13) is reduced to solving a nonhomogeneous Abel equation. The boundary value problems (a) and (b) are studied weight spaces, and the classes of uniqueness for their solutions.

The following theorem is proved.

Theorem 1:

The function

$$\varphi(t) = \frac{1}{\sqrt{t}} \exp\left(-\frac{t}{4a^2}\right) + \frac{\sqrt{\pi}}{2a} \operatorname{erf}\left(\frac{\sqrt{t}}{2a}\right) + \frac{\sqrt{\pi}}{2a}$$

where

$$\operatorname{erf} z = \frac{2}{\sqrt{\pi}} \int_0^z \exp(-\zeta^2) d\zeta$$

is a solution of the integral equation (13) in the weight class of functions

$$\sqrt{t} \exp\left(-\frac{t}{4a^2}\right) \varphi(t) \in L_\infty(0, \infty).$$

Singularity of the kernel $K(t, \tau)$ of equation (14) is determined by the properties

$$\lim_{t \rightarrow 0} \left| \int_0^t K(t, \tau) d\tau \right| = 1, \quad \lim_{t \rightarrow +\infty} \left| \int_0^t K(t, \tau) d\tau \right| = 1. \tag{16}$$

In fact, for the kernel $K(t, \tau)$ of equation (14) making a substitution $\sqrt{t-\tau}$ we obtain

$$\int_0^t K(t, \tau) d\tau = -\exp\left(\frac{2t}{a^2}\right) \operatorname{erfc}\left(\frac{3\sqrt{t}}{2a}\right) + \operatorname{erf}\left(\frac{\sqrt{t}}{2a}\right).$$

4. CONCLUDING REMARK

The singularity of the obtained integral equations lies in the equation (15) and (16) of the corresponding kernel $K(t, \tau)$ and this singularity is expressed in the fact that the corresponding nonhomogeneous equations cannot be solved by the method of successive approximations. Equations (15) and (16) indicate the ‘‘incompressibility’’ of the kernel of integral equations. The results presented here will be more useful in studying the heat conduction problem in noncylindrical bodies in real-life engineering problems, mathematical biology by considering the fractional derivative in the field equations.

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IDENTIFYING MARKET CRASHES USING ELASTIC NETS: A CHANGE POINT ANALYSIS

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Abstract. *Change point detection (CPD) is a widely used statistical technique in financial studies to identify abrupt shifts or transitions in the behavior of financial time series data. In the context of market crashes, CPD becomes crucial for detecting critical points in the evolution of financial systems, characterized by sudden and severe declines in market prices and investor confidence. This research paper presents a novel approach to CPD using Elastic Net imputation for the detection of market crashes. The methodology involves splitting the return time series of different stocks into equidistant windows and constructing networks based on these windows. Structural properties of the resulting graphs are computed, as these properties are known to change with variations in market conditions. To identify potential market crashes, we employ Elastic Net imputation by introducing missing values in the dataset of structural properties and predicting their values. The time points with the highest errors between the predicted and original values correspond to instances of market crashes. The proposed method is applied to the S&P 500 stocks dataset, demonstrating its effectiveness in detecting market crashes. The findings highlight the potential of Elastic Net imputation and structural properties of graphs for accurate and timely identification of market crashes, contributing to improved risk management and decision-making in financial markets.*

Keywords: *Change Point Detection, Elastic Nets, Market Crash, Network Theory.*

PACS numbers: 89.65.Gh, 89.75.Fb, 05.45.Tp

1. INTRODUCTION

Change point analysis, also known as change point detection, is a statistical technique used to identify points or periods in a dataset where there is a significant change in the underlying behavior, characteristics, or parameters of the data. It aims to detect and quantify abrupt shifts, discontinuities, or transitions in a time series or multivariate data [4]. The concept behind change point analysis is that data often exhibit different patterns or regimes over

time, and identifying these changes is crucial for understanding the underlying processes or phenomena. By detecting change points, we can investigate factors causing the shifts, assess the impact of interventions or external events, and model the data more accurately. Change point analysis can be applied to various types of data, including time series data, spatial data, image sequences, and biological sequences. The changes detected can be related to mean shifts, variance changes, changes in the distributional shape, or changes in the relationships between variables.

For a sequence of independent random variables represented by x_1, x_2, \dots, x_n , with respective probability distribution functions denoted by F_1, F_2, \dots, F_n . The objective of the change point problem is to assess the validity of the null hypothesis, which can be formulated as follows:

$$H_0 = F_1 = F_2 = \dots = F_n. \quad (1)$$

The alternate hypothesis is:

$$H_1: F_1 = F_{k_1} \neq F_{k_2} = \dots = F_{k_2} \neq F_{k_1} \quad (2)$$

where $1 < k_1 < k_2 < \dots < k_q < n$ and q is an unknown quantity representing the number of change points, and k_1, k_2, \dots, k_q are the unknown positions that need to be estimated.

In the context of financial markets, a market crash represents a sudden and severe decline in asset prices, often accompanied by a significant increase in market volatility. A market crash is typically characterized by a departure from the previous market regime. It signifies a shift from a period of relative stability or upward trend to a sudden downward movement. This change in market behavior can manifest as a structural break, where the underlying dynamics governing the market fundamentally change [1]. Change point analysis helps identify these structural breaks by detecting changes in the statistical properties of financial data. It focuses on detecting points where key parameters such as mean, trend, volatility, or correlation significantly deviate from their previous values. These deviations indicate a departure from the previous market regime and the emergence of a new regime associated with the market crash. By applying change point analysis to financial time series data, we can identify the specific point or period when the market crash occurs. This provides valuable insights into the timing and magnitude of the crash,

helping to understand the underlying factors and dynamics leading up to it. Additionally, change point analysis can help economists and analysts understand the dynamics leading up to market crashes and potentially develop early warning systems. By integrating change point analysis into predictive models, models can provide early warning signals or probabilities of market downturns.

Researchers have utilized various regression and machine learning models for change point detection and identifying market crashes. Logistic regression, support vector machines, random forests, recurrent neural networks, and hidden Markov models are commonly employed in this context. Logistic regression predicts market crashes based on historical data and relevant indicators. Support vector machines can discern boundaries between different market regimes. Random forests aggregate decision trees to identify significant market shifts. Recurrent neural networks capture temporal dynamics, while hidden Markov models model transitions between market regimes. The choice of model depends on data characteristics and the problem complexity, and ensemble methods can yield improved results. With the increased interest in network theory, researchers have tried to infer change points from the evolution of the structural properties of the network. Several models utilize network theory to detect change points in various fields, including finance. One approach is network connectivity analysis, where a financial network is constructed with variables or assets as nodes, and edges represent their relationships or correlations. Change points are identified by examining alterations in the network's structure or strength of connections. Community detection algorithms are another model that identifies change points by analyzing shifts in the community structure within the network. Changes in community assignments indicate shifts in relationships or dependencies between variables. Centrality measures, such as degree centrality or betweenness centrality, quantify node importance and can be used to detect change points when there are significant shifts in the influence of specific nodes. Dynamic network analysis models explicitly capture the temporal evolution of a network, allowing for the detection of change points when there are substantial variations in the network's structure or dynamics over time. Similarly, various regression and machine learning models can be utilized for change point detection and identifying market crashes. Logistic regression, support vector machines, random forests, recurrent neural networks, and hidden Markov models are commonly employed in this context. Logistic regression can predict market crashes based on historical data and relevant indicators. Support vector machines can discern boundaries between different market regimes.

Random forests aggregate decision trees to identify significant market shifts. Recurrent neural networks capture temporal dynamics, while hidden Markov models model transitions between market regimes.

The choice of model depends on data characteristics and the problem complexity, and ensemble methods can yield improved results.

In this research paper we introduce a novel change point method for detecting market crashes by leveraging Elastic Net imputation. The proposed method follows a stepwise process involving the segmentation of return time series of different stocks into equidistant windows. For each window, a network is constructed, and various structural properties of the resulting graph are calculated. These structural properties are known to exhibit changes corresponding to shifts in market conditions. Subsequently, for each time point in the dataset of structural properties, a row is intentionally set as NA, and its value is predicted using Elastic Net imputation. Remarkably, it is observed that time points with the highest errors between the predicted and original values coincide with periods of market crashes. To demonstrate the efficacy of the proposed method, an application is conducted using S&P 500 stocks, wherein the results confirm the successful detection of market crashes.

2. METHODOLOGY

To detect market crashes, we propose a novel Change point method utilizing Elastic Net imputation. To validate the effectiveness of our method, we apply it to the S&P500 stocks as an application. By analyzing the identified time points with high prediction errors, we demonstrate that these correspond to the actual occurrences of market crashes in the S&P 500 market. The methodology involves the following steps:

- ***Data Preparation:***

We gather the return time series data for various stocks and divide them into equidistant windows. This ensures a comprehensive analysis of local market dynamics.

- ***Network Construction:***

For each window, we create a network by representing the stocks as nodes and establishing edges that represent their relationships. This network captures the interdependencies among the stocks.

- ***Calculation of Structural Properties:***

From each network, we calculate the structural properties, which provide insights into the characteristics of the graph. These

properties are known to change with variations in market conditions and reflect important aspects of the market dynamics.

- **Elastic Net Imputation:**

Next, we employ Elastic Net imputation to predict the missing values in the dataset of structural properties. Elastic Net imputation is a regression technique that combines L1 and L2 regularization, balancing feature selection and handling multicollinearity.

- **Error Analysis:**

We compare the predicted values with the original values in the dataset of structural properties. By calculating the prediction error for each time point, we identify the time points with the highest errors. These time points correspond to periods where market crashes occur.

2.1. Data

The research focuses on the utilization of historical daily adjusted logarithmic returns derived

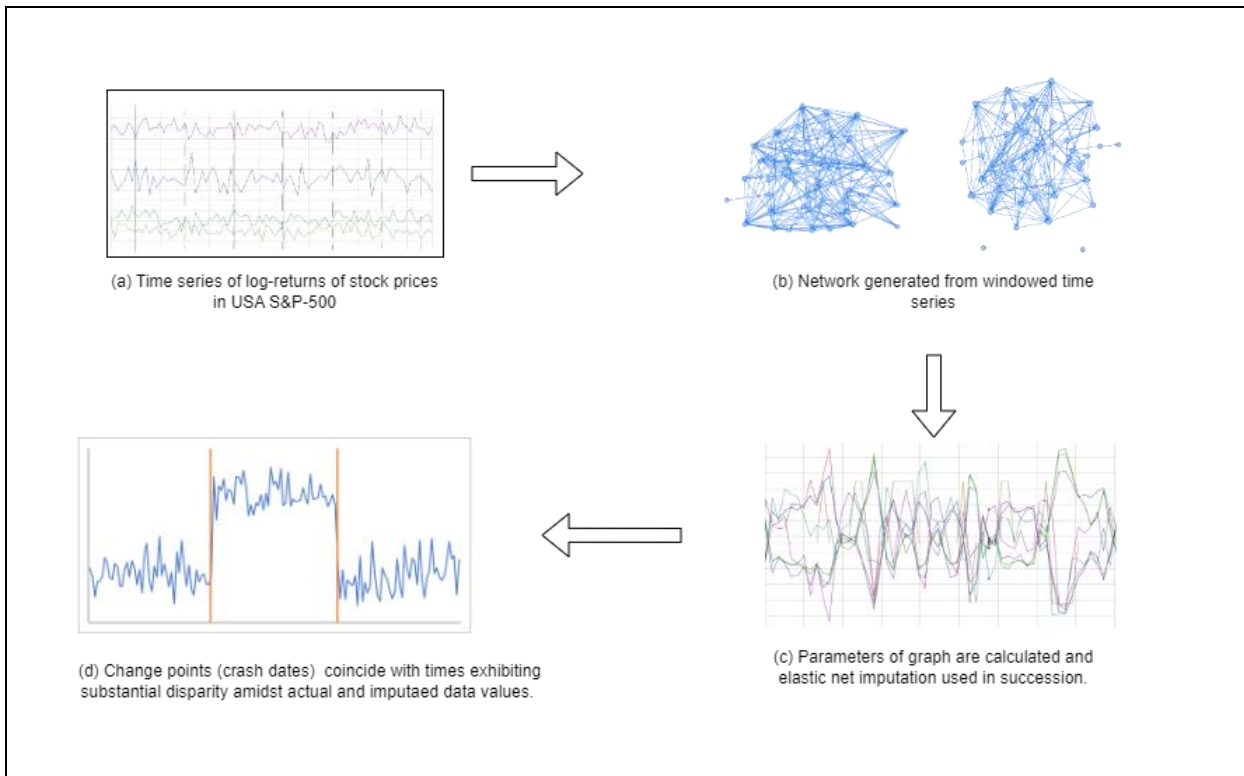
from the widely recognized Standard & Poor 500 index (S&P 500) during the period spanning from January 3rd, 2018 to March 30th, 2021. This dataset encompasses 1,183 days and is obtained from Yahoo Finance API, using daily closing prices.

The S&P 500 index is a market-cap-weighted benchmark index that reflects the performance of the US stock market, with larger companies exerting a greater influence due to their market capitalization. The dataset accounts for weekends by filling in the gaps with the previous day's values.

It includes all 500 constituent companies from various sectors such as Consumer Goods, Energy, Healthcare, Information Technology, Materials, Telecommunication Services, Utilities, and Industrials. The daily return time series is constructed as

$$r_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \quad (3)$$

where $P_{i,t}$ is the adjusted closing price of the i th stock at time t .



Source: Realized by author

Fig. 1: A novel method to detect market crashes by utilizing Elastic Net imputation.

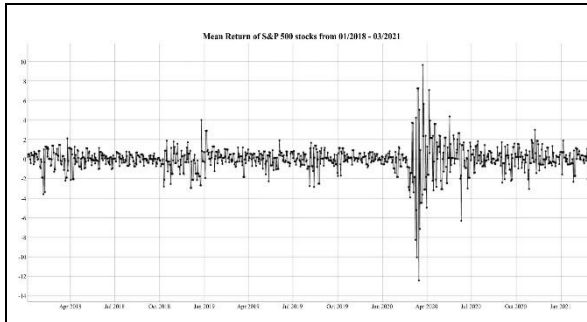
The process involves splitting return time series into equidistant windows, creating networks and calculating structural properties ((Fig. 1).

Changes in these properties reflect market

conditions. By setting rows as NA and predicting their values, we identify the time points with the highest prediction errors as market crash occurrences.

We validate our approach using S&P 500 stocks. Notably, the dataset captures the market crash date triggered by the Corona pandemic shock in March 2020, which serves as a significant change point. On March 18th, 2020, the S&P 500 index experienced a substantial crash, losing more than 12% of its value in a single day. This crash was primarily attributed to the economic uncertainty and fear induced by the COVID - 19 pandemic.

Also it is worth mentioning that the S&P 500 index swiftly recovered from the crash, regaining all losses within a few months (Fig. 2).



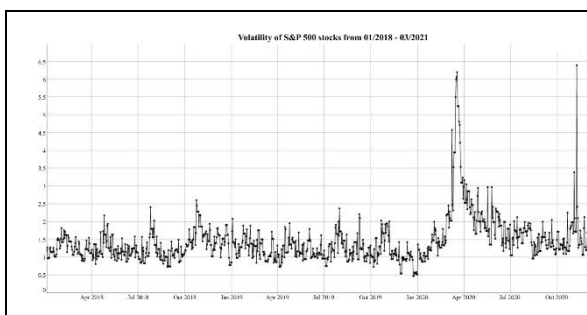
Source: Realized by author

Fig. 2: The mean return of S&P 500 stocks spanning the time period from January 2018 to March 2021.

Notably, the main market crash, attributed to the COVID-19 pandemic, occurred during the corona scare period, leading to a significant loss of approximately 12% of the market capitalization.

2.2. Network Construction

Graphical Gaussian models provide a flexible and widely- used methodology for generating networks that capture the relationships between variables. In this modeling ap- proach, each variable is represented as a node in the resulting graph, and the connections between variables are represented by edges. One common technique for constructing these networks involves utilizing the estimated precision matrix, which characterizes the partial correlations between variables in the model. The precision matrix, which is in verse of covariance matrix, plays a crucial role in network generation, as it provides valuable insights into the strength and nature of relationships among variables.



Source: Realized by author

Fig. 3: The mean volatility of S&P 500 stocks throughout the period from January 2018 to March 2021.

The visualization reveals that the volatility reaches its highest level during this critical period, reflecting the heightened uncertainty and turbulence in the market (Fig. 3).

By examining the non-zero entries in the precision matrix, researchers can identify the significant connections between variables and construct an informative network representation. Additionally, the inverse of the precision matrix, known as the covariance matrix, offers complementary information regarding the dependencies and associations among variables.

To facilitate the generation of networks from price data, we utilize the 'huge' package in the R programming language [3]. The 'huge' package offers efficient and scalable algorithms for estimating high-dimensional graphical mod- els and provides the necessary tools for constructing networks based on the estimated precision matrix.

For a 30 days' window with 15-day shift period, we capture the complex dependencies and inter-relationships present in the return data and construct a comprehensive network representation that highlights the significant connections among variables.

2.3. Structural Properties

The structural properties of a graph constructed from the return time series capture the state of the market by reflecting the underlying relationships and dependencies among the stocks. These properties provide insights into the overall structure and dynamics of the market, enabling us to assess its current state and anticipate potential changes. One crucial aspect is the network connectivity, which describes how the stocks are connected to each other in the graph. The presence or absence of connections and the strength of those connections reflect the degree of inter-dependence and co-movement among the stocks. A well-connected graph indicates a highly integrated market, where information and trends are easily transmitted among the stocks. On the other hand, a fragmented or loosely connected graph may suggest isolated sectors or less synchronized movements, potentially indicating diverse market conditions. Additionally, network centrality measures, such as degree centrality, betweenness centrality, and eigenvector centrality, provide information about the importance and influence of individual stocks within the network. Stocks with high centrality measures are considered influential or pivotal in the market. Changes in the centrality of specific stocks can indicate shifts in market dynamics or the emergence of new market leaders.

Moreover, community structure analysis helps identify groups or clusters of stocks that exhibit stronger internal connections compared to connections with stocks outside the cluster. These communities can represent sectors, industries, or groups of related stocks. Changes in the community structure can indicate shifts in sectorial relationships, market correlations, or the emergence of new market regimes.

The properties of network which were calculated are the following:

1. Entropy:

In the context of a network made of stock price series as nodes, entropy can provide insights into the level of uncertainty or randomness in the connectivity patterns and relationships among the stocks. During a market crash, the network may exhibit higher entropy, indicating increased unpredictability and disorder in the interactions between stocks. This suggests that the relationships between stocks become less predictable, potentially reflecting the turbulent and volatile nature of the market during a crash.

2. Structural Entropy:

Structural entropy measures the randomness or uncertainty in the overall structure of the network. During a market crash, the structural entropy of the network may increase as the relationships and connections between stocks undergo significant changes. The higher structural entropy suggests a greater level of complexity and disorder in the network structure during periods of market turmoil.

3. Mean Distance:

The mean distance in the network measures the average number of edges or steps required to move from one stock to another. In the context of a market crash, the mean distance may decrease, indicating shorter paths or stronger connections between stocks. This suggests a higher level of interconnectedness and comovement among stocks during a crash, as they respond collectively to market-wide shocks.

4. Mean Degree:

The mean degree of the network reflects the average number of connections or relationships that each stock has. During a market crash, the mean degree may increase, indicating a higher level of connectivity among stocks. This signifies that more stocks are influenced by or respond to market conditions, leading to a more synchronized behavior during the crash.

5. Average Path Length:

The average path length measures the average number of edges or steps needed to traverse from one stock to another across the network. In the context of a market crash, the average path length may decrease, indicating a shorter average distance between stocks. This suggests a higher level of information flow and

transmission of market shocks across the network during a crash.

6. Edge Density:

Edge density represents the proportion of actual connections present in the network compared to the total possible connections. During a market crash, the edge density of the network may increase, indicating a higher level of connectivity and interdependencies among stocks. This reflects the closer relationships and stronger correlations between stocks as they respond collectively to market conditions.

7. Clustering Coefficient:

The clustering coefficient measures the tendency of nodes (stocks) to form clusters or tightly connected groups. During a market crash, the clustering coefficient may increase, indicating the formation of cohesive substructures within the network. This suggests that stocks within the same cluster may exhibit similar price movements or share common responses to market shocks during a crash.

8. Mean Degree Centrality:

Mean degree centrality reflects the average level of influence or importance of stocks based on their connectivity. During a market crash, the mean degree centrality of the network may increase, indicating a higher average level of influence or impact of stocks. This suggests that more stocks play a crucial role in transmitting market information or driving the collective behavior of the network during a crash.

9. Mean Harmonic Centrality:

Mean harmonic centrality measures the influence or importance of stocks based on their ability to efficiently reach other stocks within the network. During a market crash, the mean harmonic centrality may increase, indicating that certain stocks have a greater ability to disseminate information or control the flow of market dynamics. These stocks may act as key players in transmitting market shocks and driving the overall behavior of the network during a crash.

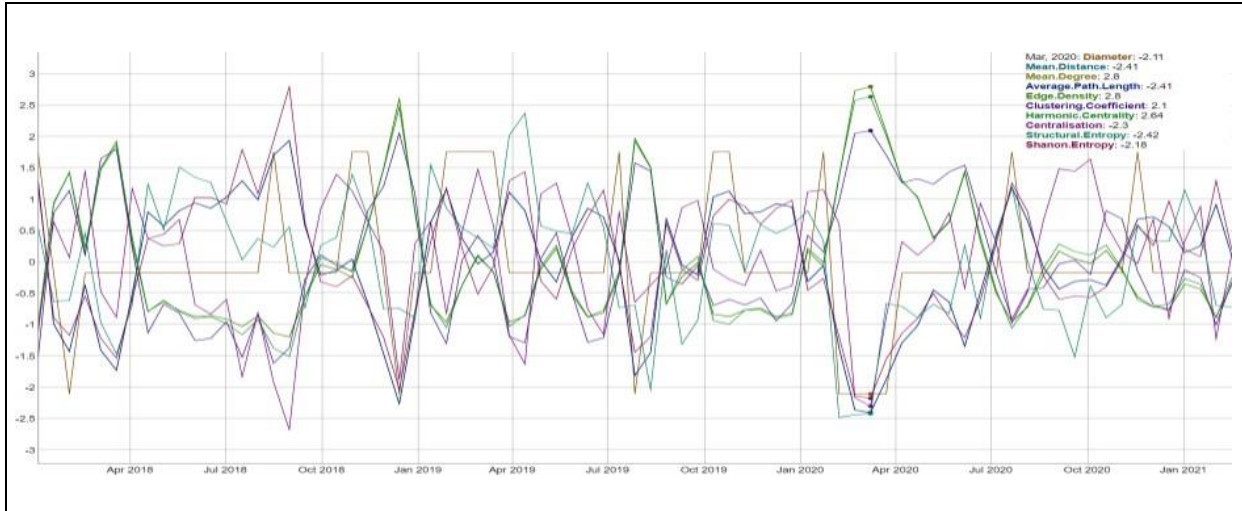
By examining these structural properties of the graph constructed from the return time series, we gain insights into the interdependencies, connectivity patterns, and overall organization of the market. These properties capture the state of the market by reflecting the collective behavior and relationships among the stocks, enabling us to understand the prevailing market conditions, detect changes in market regimes, and potentially anticipate or identify market crashes.

2.4. Elastic Net Imputation

Elastic Net regression is a statistical method used for regression analysis, particularly in scenarios where there are many predictor

variables and potential multicollinearity (correlation) among them. It combines the properties of two popular regularization methods: Lasso regression and Ridge regression [5]. In Elastic Net regression, the objective is to find the best-fitting regression model that minimizes the sum of squared errors while simultaneously

incorporating a penalty term that promotes sparsity (shrinking coefficients to zero) and handles multicollinearity. The method achieves this by adding two penalty terms to the ordinary least squares (OLS) loss function: the L1 norm (Lasso penalty) and the L2 norm (Ridge penalty).



Source: Realized by author

Fig. 4: The evolution of network properties in the S&P 500 during market crashes, specifically focusing on the notable crash that occurred in March 2020

Figure 4 showcases key network properties, including entropy, structural entropy, diameter, mean distance, mean degree, average path length, edge density, clustering coefficient, mean degree centrality, and mean harmonic centrality. The vertical dashed line marks the occurrence of the market crash in March 2020, indicating a significant deviation in the network properties during this period. The time series highlights the dynamic nature of these properties and their association with market crashes, shedding light on the structural changes and interconnectedness within the S&P 500 network during times of financial turbulence.

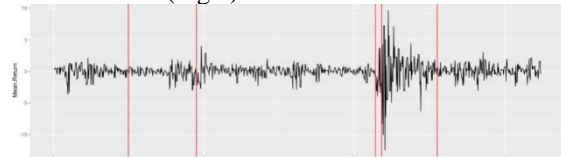
The L1 penalty encourages variable selection by shrinking less relevant variables to exactly zero, effectively performing feature selection. On the other hand, the L2 penalty encourages shrinkage of all variables while maintaining their non-zero values, reducing the impact of multicollinearity. Imputing values using Elastic Net can be achieved by employing the trained Elastic Net model to predict missing or incomplete values in a dataset. This process is particularly useful when dealing with datasets that contain missing or unreliable data. To impute missing values, the Elastic Net model utilizes the observed values of other variables to predict the missing values based on the learned relationships between the predictors target variable. We use 'mlim' package to impute values. [2]

The Elastic Net imputation process involves the following steps:

- **Train an Elastic Net regression model** using a dataset without missing values, where the target variable is known or complete.
- **Identify the rows or instances in the dataset with missing values that need to be imputed.** For each row with missing values, use the trained Elastic Net model to predict the missing values based on available observed values of other variables in that row.

3. RESULTS AND DISCUSSION

We predict every values of every row, given the entire structural indicator data set. The mean difference of every imputed/predicted from the original value is calculated. It is seen that the mean difference is highest at points of market crash. The methodology successfully locates the change points as dates of market crash. For our dataset, the dates with highest difference were "2020-03-08", "2020-07-21", "2020-02-22", "2018-07-02", "2018-12-14" (Fig.5)



Source: Realized by author

Fig. 5: The red lines indicate dates of market "crash" "2018-07-02", "2018-12-14", "2020-02-22", "2020-03-08", "2020-07-21"

4. CONCLUSION

In conclusion, change point detection plays a crucial role in understanding the critical points in the evolution of financial systems, particularly in identifying market crashes. By utilizing various methods, such as change point analysis and network theory, researchers have made significant progress in detecting market crashes and understanding their underlying dynamics. Change point analysis provides a systematic approach for identifying abrupt changes or shifts in time series data, which can be applied to financial and economic indicators to detect market crashes. Network theory, on the other hand, offers a powerful framework for analyzing the interconnectedness and dependencies among financial variables, enabling the identification of change points associated with market crashes. The relevance of change point detection in the context of market crashes cannot be overstated. Market crashes represent critical moments in the financial system, characterized by sharp declines in asset prices, increased volatility, and widespread economic distress. Detecting market crashes in a timely manner is crucial for risk management, portfolio optimization, and decision-making in financial markets.

Through the application of various regression and machine learning models, such as logistic regression, support vector machines, random forests, recurrent neural networks, and hidden Markov models, researchers have successfully utilized change point detection to identify market crashes. Additionally, the incorporation of network theory has further enhanced the understanding of market dynamics and the detection of change points through the analysis of network properties, such as connectivity, community structure, and centrality measures.

Furthermore, the use of Elastic Net imputation in change point detection has provided a novel approach to fill missing values and predict the

occurrence of market crashes. By imputing values based on the relationships between variables captured by Elastic Net regression, researchers have successfully identified time points with the highest prediction errors as indications of market crashes.

The findings and methodologies discussed in this paper underscore the importance of change point detection in the context of market crashes. The ability to identify critical points in the evolution of financial systems not only contributes to a deeper understanding of market dynamics but also facilitates risk assessment, decision-making, and the development of effective strategies for managing and mitigating the impact of market crashes.

Continued research and advancements in change point detection techniques, coupled with the integration of network theory and machine learning approaches, hold great potential for improving market crash detection and enhancing financial analysis in the future.

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A TECHNICAL ANALYSIS OF SKIN CANCER CLASSIFICATION TECHNIQUES WITH MACHINE LEARNING ALGORITHMS

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Abstract. Skin cancer is among the most common cancers. It is constantly rising. Melanoma had been highly lethal cancer among all skin cancer diseases. Melanoma is the cancer with the strongest mortality rate. If caught early enough, it can be healed. Melanoma will claim the lives of 6850 people in 2021. Computational approaches have been shown to be a vital part in the early diagnosis of this fatal disease. Due to low contrast and a significant degree of visual resemblance, discriminating between melanoma and nonmalignant lesions is difficult. A non-invasive technology known as computer aided diagnosis (CAD) has been shown to develop premature and quicker detection of malignant cancer. There are four steps to CAD: Pre-processing, dependable, segmentation, appropriate feature extraction, and an precise classifier. The focus of this research is on current machine learning algorithms for melanoma detection using clinical images. This study also includes statistics and findings from a comparison of classification methods' performance with other machine learning.

Keywords: skin cancer, melanoma, database, feature extraction, classification

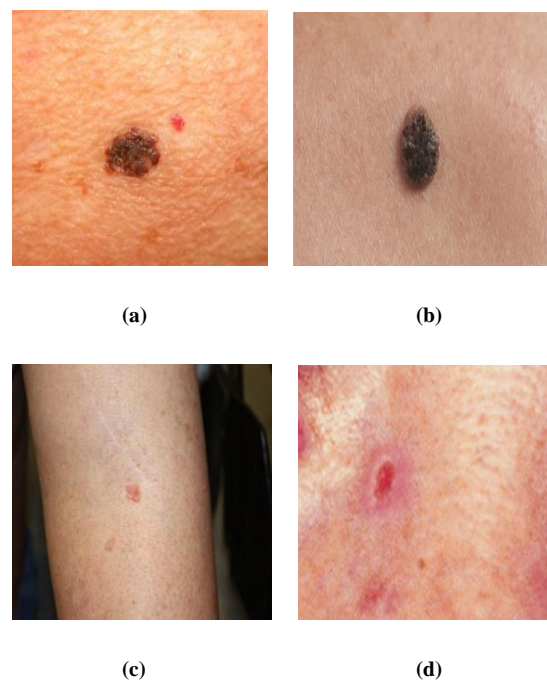
1. INTRODUCTION

The biggest area of the human body covered by skin is approximately 20 square feet [1]. The key function of our skin is to regulate body temperature and protect interior organs from UV radiation. It too contributes to the sensations of cold, warmth, and touch. Human skin has three layers: i) the epidermis, ii) the dermis, and iii) the hypodermis.

Destructed cells appear when aberrant skin cells develop out of control. Tumours are caused by abnormal growth, which results in malformations of skin cells. Skin cancer develops from these tumours. The UV rays of the sun are primarily responsible for skin cancer. Skin cancer lesions are classified as benign or malignant.

Malignant skin cancer is deadly, whereas benign mole development is non-cancerous. Squamous cell carcinoma (SCC) and Bessel cell carcinoma (BCC) are two types of skin cancer that are both innocuous

and do not spread from one place of the body to another [2]. Melanoma is caused by melanocytic cells in the skin, and it can enter in to other parts of the body [3]. Different types of skin tumours are depicted in Fig. 1. Melanoma cases are rapidly growing, according to the National Cancer Institute's records [4]. It is the most often diagnosed malignancy and the third most common cause of death [5]. Melanoma kills one person every hour, according to the report [4].



Source: Realized by authors

Fig. 1 (a) Early stage Melanoma (b) Melanoma (c) SCC and (d) BCC

The rate of growth of skin cancer has accelerated in recent years, posing a direct threat to people's lives [6].

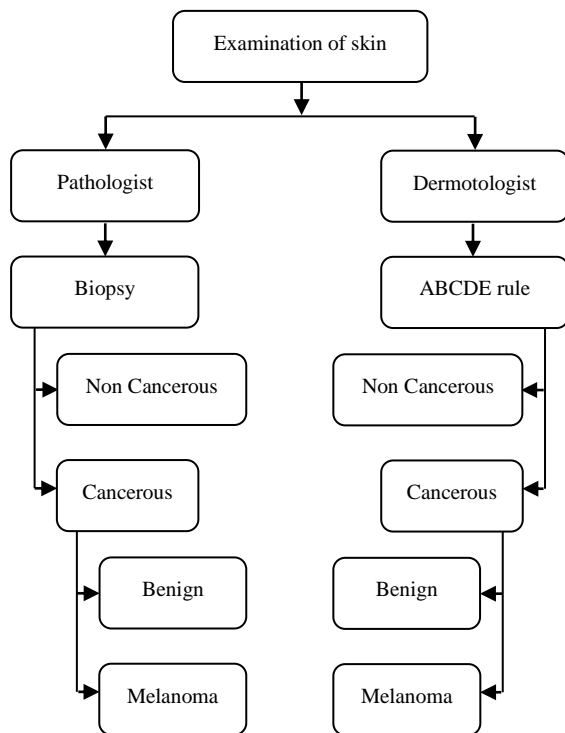
Melanoma has the highest prevalence in Australia's population. Females have a higher survival rate than men in many countries, according to the data [7].

2.1. DATABASE

Dermoscopy is a non-invasive method for diagnosing melanoma. Skin cancer is frequently detected with dermoscopic pictures. These images offer a lot of promise for melanoma early detection. These images are utilised in diagnostic tool preparation, education, and research. Table 1 illustrates different types of dataset used for melanoma detection [2].

2.2. CLINICAL AND DERMOSCOPIC MEANS OF MELANOMA DIAGNOSIS

The skin is examined by a clinician using clinical methods. Initially, the doctor examines the skin for changes such as moles, colour, or shape. It is then referred to a pathologist or dermatologist to confirm if it is cancer or not. Biopsy is an invasive method used by pathologists. Skin tissues are sliced for inspection during a biopsy. In the twenty century, dermoscopy was introduced to defeat biopsy and progress cancer detection. Dermoscope was used to obtain these images, which have a good magnification and clarity. Diagnosis system is made with computer assistance. The steps involved in traditional clinical techniques is depicted in Fig. 2 [4].



Source: Realized by authors

Fig. 2 Cancer diagnosis clinical methods

Table 1 Lists all datasets that are publicly available

No.	Name of dataset	Number of images
1.	ISIC	24000
2.	HAM10000	10000
3.	MED-NODE	170
4.	DermIS	6800
5.	Dermatology Atlas	11000
6.	Danderm	1900
7.	Dermnet	23000
8.	DermnetNZ	20000
9.	Dermatoweb	7300
10.	Dermofit	1300
11.	PH2	200
12.	Interactive Dermatology Atlas	1000
13.	Atlas of Clinical Dermatology	3000

Source: Realized by authors

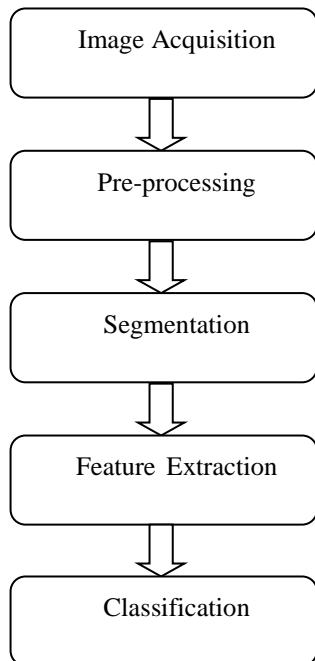
3. COMPUTER AIDED DIAGNOSIS (CAD)

Skin cancer diagnosis using a computer is a popular way these days. It is significantly more accurate than the procedure used by dermatologists. The CAD system provides a method for locating lesions and also assesses disease likelihood [8]. The key phases in computer-aided diagnosis of clinical photographs are depicted in Fig. 3 [2].

The origin of dermatoscopy belongs to the mid-17th century, after the discovery of Pierre Borel (Borrelus Petrus), considered its founder, followed by the names and important contributions of Johan Christophorus Kolhaus, Ernst Karl Abbe, Unna, Muller, Saphier and many others. While a lot of terms have been used to reveal and describe the process of dermoscopy, from dermatoscopy, surface microscopy, incident light microscopy, or even epiluminescence light microscopy, dermoscopy remains the usual conceptualization for non-invasive method, facilitating all the examination of the skin and evaluating pigmented skin lesions.

The first dermatoscope was invented by an entire team of doctors led by Professor Otto Braun-Falco with the support of the medical device manufacturer HEINE Optotechnik. That first dermatoscope was hand-held and illuminated by a halogen lamp, and was the father of modern dermatoscope used to obtain the up-to-date images, which have indeed a very good magnification and

clarity. Menzies Method, ABCDE rule, 7-point checklist etc. are used to identify cancer using dermoscopy images. Dermoscopic methods have a lot of potential for accurately diagnosing cancer.



Source: Realized by authors

Fig. 3 The process of using a CAD system

4. CLASSIFICATION OF LESIONS

Lesion classification is critical in computer-assisted diagnosis. The purpose of the classification stage is to distinguish between malignant and healthy lesions based on the features retrieved. A feature vector is created for each lesion. The data is separated into two sets for classification: training and testing. The classification model is created in the training phase with a arbitrarily chosen dataset and then verified with the remaining of the dataset for parameters like specificity, accuracy, sensitivity etc..

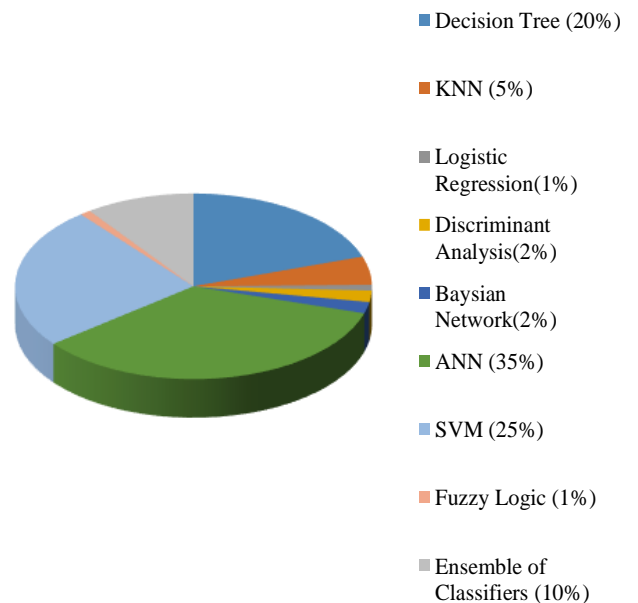
Different machine learning algorithms for classification are investigated in this research. Table 2 lists the many machine learning techniques for melanoma classification that have been published. According to the literature the percentage use of different classification techniques are displayed in Fig. 4.

Table 2. Lists all datasets that are publicly available

No.	Machine learning techniques for classification	References
1.	Decision Tree	[9], [20], [37], [38], [39],

		[40], [41], [62]
2.	KNN	[10], [21], [22], [23], [42], [43], [57]
3.	Logistic Regression	[11], [24]
4.	Discriminant Analysis	[12], [26], [27], [28],
5.	Bayesian network	[13], [29], [44], [45]
6.	ANN	[14], [30], [31], [32], [33], [46], [47], [48], [49], [50], [56], [58], [59]
7.	SVM	[15], [25], [34], [35], [36], [51], [52], [53], [54], [55], [60], [61]
8.	Fuzzy Logic	[16], [19], [63]
9.	Ensemble of classifiers	[17], [18], [62]

Source: Realized by authors



Source: Realized by authors

Fig. 4 Distribution of skin cancer detection categorization techniques in the literature

5. CONCLUSIONS

The Early detection of melanoma is an important research subject. The current strategies for ML-based skin cancer detection are presented in this article. This study also demonstrates that in the field of ML for Melanoma Detection, ANN is the most extensively utilised and accurate technique. This survey specifies categorization strategies that are specifically automated. A comparison study is presented for each and every method of classification. This study, in conclusion, emphasizes on accurate computational detection to assist dermatologists. This research can help to fill in the breaches in the literature and improve the enactment of present techniques. Furthermore, these techniques may mask a variety of issues with skin lesion classification, transforming ML Algorithms into more precise systems for identifying malignant lesions using clinical images.

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A COMPARATIVE ANALYSIS OF SOFT STARTING PERFORMANCES OF THREE PHASE SQUIRREL CAGE INDUCTION MOTOR

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Abstract: In this paper the performance optimization of soft starting the three-phase induction motor using intelligent controller is analyzed and compared with conventional starting schemes. The paper systematically evaluates and compares the performance characteristics of AC voltage controller fed induction motor and Selective Harmonic Elimination Pulse Width Modulation (SHEPWM) technique for various types of soft starting schemes. Experimental verification is done using MOSFET based analogue circuit designed in the laboratory. The originality of the work lies in the advancement of simple and humble models for MATLAB oriented simulation purpose. To increase the performance of the induction motor during soft starting, PAC, EAC, FLC, NNC and SHEPWM controllers are used and compared its results with conventional DOL, Auto transformer starter and star delta starter. As per the test results, intelligent control technique, outperforms the conventional controllers and reduces the inrush current and torque pulsations in the test motor.

Keywords: induction motor, soft analysis, thyristors, MATLAB Simulink model

1. INTRODUCTION

Basically, a soft starter is an AC voltage controller. The voltage is adjusted by varying the fire angle α of the thyristor of the ac voltage controller or soft starter. The two thyristors are connected in anti-parallel in each phase. The Figure1 shows the schematic diagram of a basic soft starter.

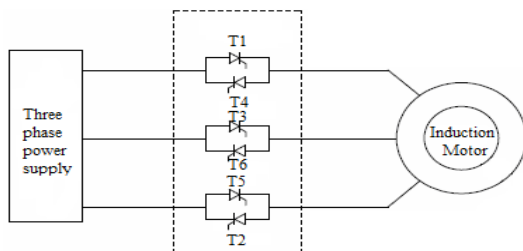


Fig.1. Schematic diagram of basic soft starter

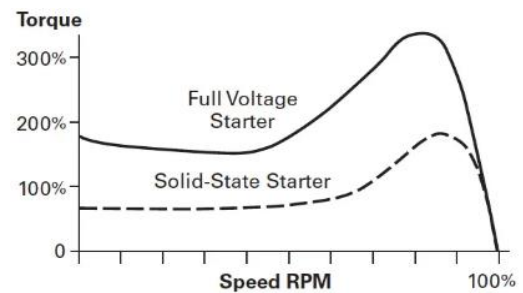
According to the sequence of firing pulses, the thyristors are fired in this method. The firing sequence of anti-parallel connected six thyristors in the circuit of soft starter is shown in Figure 1.

We can understand that at least two thyristors must conduct simultaneously at a time to allow the current flow through the load and measured the corresponding firing angle α of phase voltage at the time of zero crossing [1].

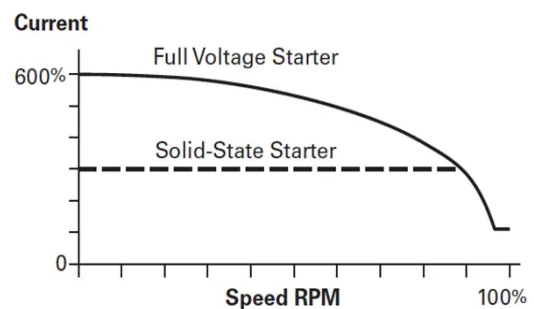
2. ADVANTAGES OF TORQUE CONTROL

Soft starter provides only the torque needed to accelerate the load which gives the constant acceleration rate, independent of motor load. Soft starter produces torque ramps and gives constant acceleration torque for different torque loads [2]. Certain variable torque load applications such as pumps and fans, it provides acceleration and deceleration ramps for torque control.

The soft starter can vary the MOSFET switching pattern for variety of application to accommodate different types of acceleration ramps and deceleration ramps. Soft starter can be designed to give constant acceleration torque for any types of constant or variable torque loads [3]. This allows a linear acceleration ramp for constant acceleration, smooth from zero to full speed as shown in Figure 2 (a) and (b).



(a) Speed vs torque



(b) Speed vs current

Fig. 2. Speed torque and speed current characteristics of SCIM

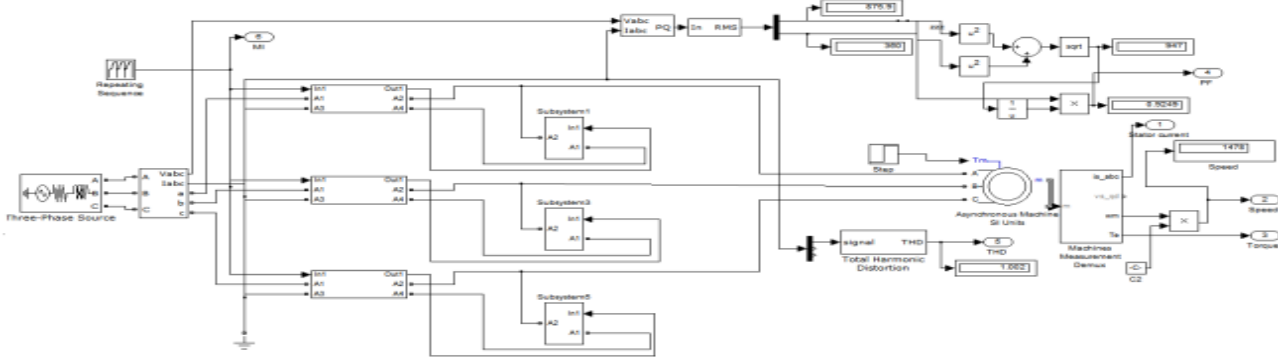
3. SELECTIVE HARMONICS ELIMINATION PULSE WIDTH MODULATION (SHEPWM) TECHNIQUE

The AC voltage controller based soft starting scheme is prone to increased source current harmonics. The AC source system is polluted due to the presence of high

harmonics in the source current [4]. Therefore, the SHEPWM technique is used to adopt minimal harmonic source current.

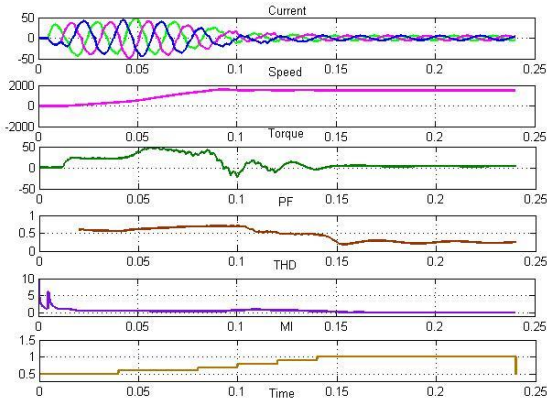
In the traditional voltage control technique, one portion of the half cycle is non-conducting instead of keeping a continuous portion of every half cycle as conducting [5].

But in the SHEPWM technique, the quarter wave symmetry is achieved. The conduction periods for the entire half cycle are symmetrically distributed with alternate conducting and non-conducting periods within each half cycle [7]. The complete system of the soft starting scheme using SHEPWM based AC voltage controller is shown in Figure 3.



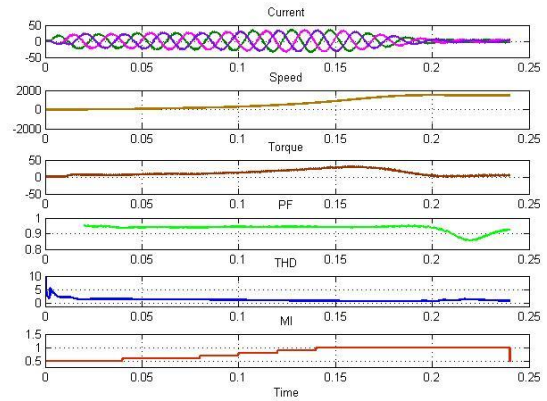
Source: Realized by authors

Fig. 3. MATLAB Simulink model of soft starting scheme with SHEPWM technique



Source: Realized by authors

(a) Response of PAC technique



Source: Realized by authors

(b) Response of SHEPWM technique

Fig. 4. Electromechanical parameters of different schemes

The modulation Index (MI) will be varied in fixed number of steps during the period of soft starting. In this work, the modulation index to be varied from 0.3 through 1 in steps of 0.1.

The fundamental voltage amplitude varied according to the modulation index applied and that all throughout the starting period the selected harmonics will be absent at all modulation indices.

4. FUZZY LOGIC CONTROL (FLC) SCHEME

FLC is one of the advanced control techniques that is meant to give an accurate result when just an approximate model of the system under control is available or no exact model exists at all [8]. The classical controllers can be modelled

even when from the available precise mathematical models. But the classical control model is mathematically more deterministic and less robust. It is very difficult to design classical control model because the loading on electric motors are subject to unexpected changes. Also, the classical controller like proportional Integral plus Derivative (PID) controller is robust enough to manage the complete range of loading conditions. So FLC is an intelligent controller to handle approximate and unpredictable values to arrive at a suitable result.

In a drive, controller is a heart of the model and a decision authority that basically contains two part such as hardware and software. Software are programmed into hardware. Software consists of several control techniques also.

Soft computation has used more in electrical drives and control as the improvement and increased number of real time applications of microcontroller in recent days.

Some of the main controllers are:

Fuzzy Logic Set (FLS)

Fuzzy Neural Network (FNN)

Artificial Neural Network (ANN)

Genetic Algorithm Based system (GAB)

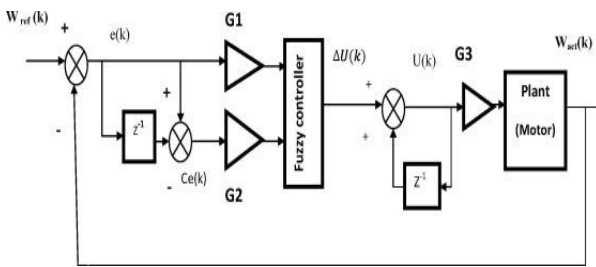
Genetic Algorithm Assisted system (GAA)

Also ANN techniques have hard computation and soft computation [2,5].

Expert system is being belongs to hard computation that has been the first artificial intelligent techniques [2,8].

The entire simulink model was developed in MATLAB for validating the FLC based soft starting method. The soft starting model using FLC scheme is shown in Figure 3.

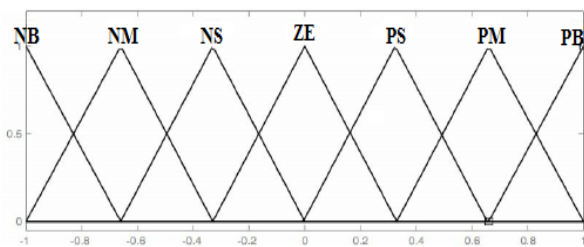
The input variables are to be normalized and the range of membership functions specify them are as shown in Figure 3. Normalization of the inputs are more important and used in model for obtaining faster response.



Source: Realized by authors

Fig. 5. Block diagram of PI-FLC

The normalized membership functions for input and output variables are shown in Figure 4 and the set of control logical rule for FLC operation is given in Table 1.



Source: Realized by authors

Fig. 6. Input output membership functions

Table 1. Fuzzy logic control rules

		Δe						
		NS	NM	NS	ZE	PS	PM	PB
e	Output							
	NB	NB	NB	NM	NM	NS	NS	ZE
	NM	NB	NM	NM	NS	NS	ZE	PS
	NS	NM	NM	NS	NS	ZE	PS	PS
	ZE	NM	NS	NS	ZE	PS	PS	PM
	PS	NS	NS	ZE	PS	PS	PM	PM
	PM	NS	ZE	PS	PS	PM	PM	PB
	PB	ZE	PS	PS	PM	PM	PB	PB

Source: Realized by authors

5. RESULTS AND DISCUSSIONS

The prime objective of this work is to compare the conventional soft starting schemes such as PAC which has single ON state and OFF state over every half cycle with the SHEPWM technique which has multiple ON states and OFF state over every half cycle offers more advantages with the support of the rich theory reported in literature it can be stated that the lower order harmonics presented in the source current of an AC voltage controller can be eliminated for any modulation index with SHEPWM technique. By eliminating the dominant lower order harmonics, the torque pulsations can be reduced using the technique SHEPWM.

The value of power factor can also lead in the source side since the quarter wave symmetry is achieved. Also, in SHEPWM technique, the multiple pulses of conduction and non-conduction over every half cycle symmetrically placed in every half cycle.

The EAC scheme offers better source side power factor as compared to PAC scheme.

The soft starting element controlling the starting of a squirrel cage induction motor with a 3 phase AC voltage controller has been carried out in MATLAB simulink.

The results of the simulation are given as follows, Table 1 shows the comparative analysis pertaining to all the important parameters in the case of PAC, EAC based soft starting and SHEPWM based soft starting.

It can be concluded from Table 1, that the generation of torque has no ripples and is gentle in the case of FL, NN and SHEPWM based soft starting schemes.

The torque oscillations more and widely in the case of conventional and the other advanced soft starting schemes such as FL and NN.

The more oscillations or pulsations in the torque may lead to much mechanical vibrations and noise.

Table 2. Comparison of simulated parameters

Parameter/Control scheme	DOL	PAC	EAC	FLC	NNC	SHEPWM	ANFIS
Time (sec) to reach steady state	0.05	0.2	0.2	0.25	0.3	0.175	0.1
Current during starting (A)	60	41	36	50	40	28	37
Total Harmonics Distortion	0.00459	0.03086	0.0266	0.1902	0.1652	0.956	0.816
Power factor in average	0.78	0.735	0.789	0.763	0.899	0.94	0.8
Maximum Torque (N-m)	127	42	38	58	40	155	60

Source: Realized by authors

Comparisons of the parameters have been carried out in Table 2. The DOL starting scheme exhibits 0.05sec and as a result the motor reaches the steady state at the earliest. Both the Phase angle control and the extinction angle control exhibit the same 0.2sec the motor reaches the steady state almost at the same time. In the case of FLC the time at 0.25 reaches the steady state similar to the PAC and EAC.

The SHEPWM and ANFIS time at 0.175 sec and 0.1 to reach the steady state and both are nearly same time. Thus, the soft starting method using the SHEPWM reaches the steady state which is earlier seconds at low starting current than other so it offers better as compared.

The DOL scheme of starting draws heavier starting current as high as 60 amps. In the case of the phase angle controlled and neural network soft starting scheme the starting current is limited to 41 and 40 amps. In the case of the extinction angle and ANFIS method of soft starting the starting current has been limited to 36 and 37 amps. In the case of the fuzzy logic control soft starting scheme the starting current is 50 amps. In the case of SHEPWM the starting currents is limited much lower to 28 amps.

Thus, it is evident that the soft starting method using the SHEPWM offers much smoother starting characteristics. The SHEPWM scheme exhibits significantly large THD as compared to the other soft starting schemes. The SHEPWM soft starting scheme offers better side power factor as compared to other soft starting schemes. Also, it offers good maximum power factor of 0.94 with less THD, quicker reaching of steady state time. The maximum torque is produced by the SHEPWM schemes and it is as high as 155 NM and 127 NM in the case of DOL. In the case of extinction angle control the maximum torque is 38 NM and the phase angle control the maximum torque is 42N-M acceleration is gradual and the motor takes a longer period to reach the steady state.

6. CONCLUSION

In this research paper, soft starter schemes for the induction motor has been carried out. Compares the performance of AC voltage controller fed induction motor and SHEPWM technique for various types of soft starting schemes. By comparing the soft starting techniques of DOL, PAC, EAC, FLC, NNC, SHEPWM and ANFIS then the parameters like starting current, time to reach steady

state, maximum torque, power factor and THD have been taken into analysis and compared. The results are obtained and the parameters were compared by the way of MATLAB/SIMULINK based simulation.

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SEGMENTATION FOR AERIAL IMAGE WITH DEEP LEARNING METHOD

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Abstract. Deep Convolution Neural Network (DCNN) have been utilized to accomplish cutting edge performance on Computer Vision Task like object recognition object discovery and Semantic Segmentation, in this paper we borrow lately popular frame U-Net in computer vision for pixel position bracket Semantic Segmentation of Aerial Imagery. In this paper model is trained with image patches of size 256x256x3 of Images and their Masks patches are cropped from original image which aren't same size, to estimate the model we crop the images due to different in their size, resize will lead the loose the original image objects we will crop them to nearest size separable by 256 and also divide all images in to patches not to resize the image to minimize the noise. We estimated our network on data set comprises of upstanding symbolism of Dubai attained by MBRSC satellites and clarified with pixel-wise semantic division in 6 classes. Result Mean IoU (Intersection over Union) is calculated and achieved good results.

Key words: Deep Learning, convolution, Neural Network, Semantic Segmentation, Aerial Imagery component.

1. INTRODUCTION

Images are most powerful media for carry lots of information and the top view images aerial images are captured easily due to advancement in drone technology. Unmanned aerial vehicles are used extensively in the military space and are turning out to be progressively popular for monitoring and surveillance of such area where human cannot reach easily, flying symbolism is pictures taken from airplanes like robots, planes, and helicopters and huge amount of data in the form of images are generated these images need to analyze for useful information which need new method technology and algorithm for object detection, classification and segmentation. These aerial Images are used to train a machine learning model to detect objects.

Aerial imagery technologies are very popular for image capturing and computer vision. Because aerial detection for the human eye is difficult in comparison to a highly trained computer vision model, Application Specific data set are available on line for the computer vision task for pattern of agriculture by UAV imagery is reported by Author [1] Ge-otagged images for efficient and Accurate Aerial imagery [2] RGB Aerial Imagery are process for precision agriculture[3] [4] Thermal and visual image registration are used for real time surveillance using light weight UAV [5]vegetation information extraction Application[6] aerial image segmentation is very useful at the time of Disaster management for the early and quick action for example flood location segmentation and forest fire detection in the scenario human cannot easily access , In medical science diseases like detection and location of diseases is identified by semantic segmentation utilizing the deep learning technique R-CNN and U-NET [7] [8] [9].

So need an efficient and fast segmentation model for Aerial imagery. As a result, we pro-pose Deep learning model based on the U-Net with different optimal hyper parameters for detecting and segmenting the Aerial images. We have used the publicly available kaggle data set named MBRSC dataset exist under the CCO license in this data set pixel wise labeled in six classes. MBRSC dataset consists of 72 limited numbers of images in HEX code and Mask is in RGB. Our assumption for this paper is summarized below.

- We use high resolution multispectral Aerial images for semantic segmentation which is supervised deep learning based on the labels of annotated mask of different classes.
- In the dataset of aerial images are annotated in six predefined classes and do not consider any class beyond the given mask.
- It is assumed that single object class is present in one place and other class objects are not overlap.

Rest of the work is coordinated into following Parts; Part-2 about the previous works and different procedures for Image processing in computer for classification and segmentation. Part-3 Describe the dataset and technique for the assessment. Part-4 is the discussion on experiment results. Part-5 closes the paper with future work.

2. PREVIOUS WORK

Aerial image segmentation and classification task are very essential for the application of urban planning aerial surveillance and Disaster management the segmentation task is challenging in aerial imagery due to variable shape, scale and appearance in Aerial view. The most approaches of solving this problem suppose the usage of deep learning algorithms. In the process of training the Machine Learning model network extract the features automatically. Lately convolutional neural Networks (CNNs) were proposed for the task of segmentation. The fundamental thought of FCNs is the Utilization of completely associated layers with a convolution layer at end, while different layers separate fundamental highlights from input information. It permits to send off this kind of organization for image segmentation [15]. Deep CNNs (DCNNs) were successful in many high-level computer vision tasks, ranging from

image classification [10][11] and detection of small object [12], visual detection and image Segmentation [13] DCNNs address teachable errands in a start to finish style, which ordinarily includes joint gaining of a progression of component extractions from crude information to a last, task-explicit result. DCNNs have additionally been applied to remote detecting. [14][15]

Author propose a multi-class, high-precision identification strategy for UAV pictures Faster RCNN[16][17] In semantic segmentation approach the fundamental step is assigning each pixel in an image to one of several semantic classes it is a supervised learning in contrast to standard unsupervised segmentation in which similar regions of pixels are groped based on basic low level features such as colour or texture. In this paper we have six semantic classes is incorporated in broad view semantic segmentation is one of the great level undertakings which give the comprehension of complete scene. Semantic segmentation of ethereal symbolism has been utilized in different applications like peril ID and aversion, traffic the executives and assessment, and metropolitan region arranging and observing[18]. The u-net is convolutional network architecture for fast and precise segmentation of biomedical images [19]. In the literature various Aerial image dataset are available publically for the image processing task summarise in table (1).

Table 1. List of dataset and description

Name of Dataset	Total images	Image size	classes	labels	operation	channels	Model used
Agri vision[1]	94986	512x512	9	169086	Segmentation	RGB,NIR	DeepLabV3+
DOTA [20]	2806	4000x4000	14	188282	Detection	RGB	R-CNN
iSAID[21]	2806	4000x4000	15	655451	Segmentation	RGB	Mask R-CNN and PANet
AID[22]	10000	600x600	30	10000	Classification	RGB	VGG-VD-16
SAT-6[23]	40500	28x28	6	40500	Classification	RGB,NIR	Deep Belief Network
Traffic image[24]	15070	1920x1080	2	155328	Detection	RGB	YOLOV5M

Source: Realised by authors

3. TOOLS AND TECHNOLOGIES

Aerial images are obtained from the satellites by high-resolution camera so these images are high spectral images which are usually 16-bit colour scheme in which most of objects are appear very small and cannot easily recognize by human eyes this motivate to extract the useful feature from the images using machine learning model and use for object classification on pixel level which is known as semantic segmentation.

A. Dataset

The dataset comprises of elevated symbolism of Dubai acquired by MBRSC (Mohammed Bin Rashid Space Center) satellites dataset incorporates 72 pictures assembled into 8 bigger tiles Each tile has pictures of various levels and widths, and a few pictures inside similar tiles are variable in size Annotated with pixel-wise semantic division in 6 classes. The pictures were portioned by the learners

of the Roia Foundation in Syria. This semantic division dataset is devoted to the public space by Humans in the know under CC0 1.0 permit.

Images in this dataset have Class colors are in Hexadecimal, whilst the mask images are in RGB and unbalanced shown in below fig (1) make these images ready for the machine learning model as a input need processing for better feature extraction buy the proposed model in the paper class cooler are converted in to RGB in fig 1:

(a) aerial images obtained from Satellites;
 (b) corresponding mask of the aerial images;
 and (c) histogram of the mask, as images are annotated in six classes of Building, Land (Unpaved area), Road, Vegetation, Water, Unlabeled so in the histogram maximum of six bars are appeared and all are in different in height which shows the object in the image are unbalanced.

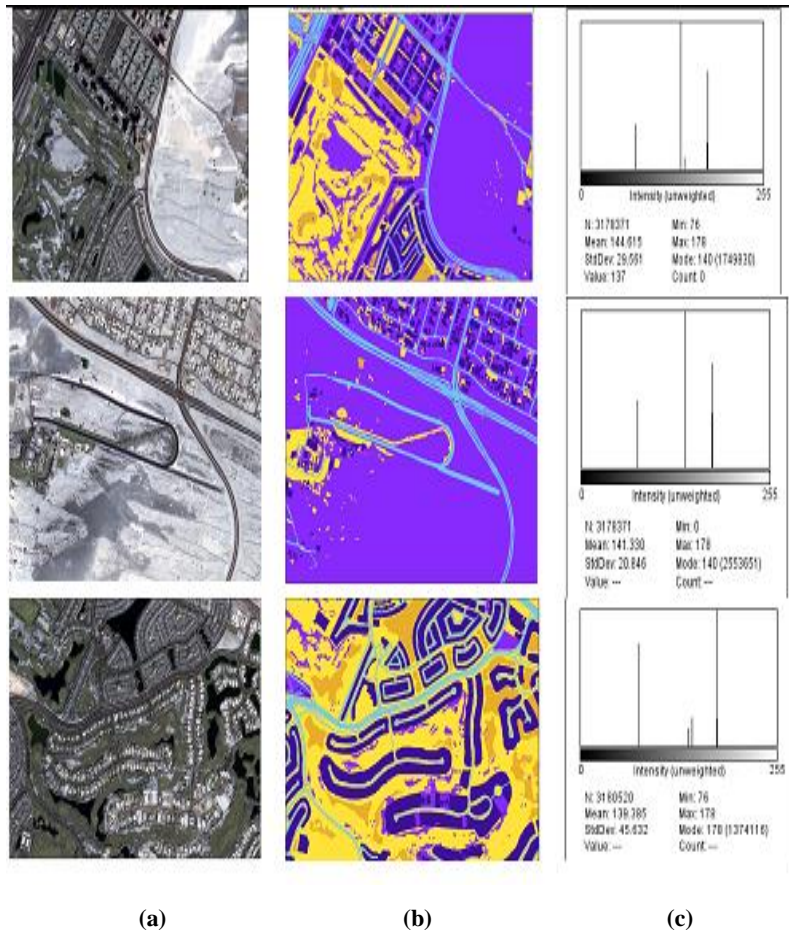


Fig 1. (a) Aerial images obtained from Satellites (b) corresponding mask of the aerial images and (c) histogram of the mask

B. Experiment Setup

In this paper U-Net model use as backbone model with some hyper parameters like optimization, Max-pooling, relu activation function, Decreasing dropout rate in Encoder block 1 to Encoder block 5. It is 0.20, 0.15, 0.10, 0.05 and 0.01 and reverse in decoder block it result the better segmentation. since images are variable in size and in limited numbers, we crop them in to patches of 256x256 in smooth manner from the original images as a result a greater number of patches are generate for the training of model. This process is also applied on mask image. U-Net model input is image patches of size 256x256

of batch size 8. For 50 epoch. Model is implemented on Google Colab in python programming with the use of standard Keras and Tensor flow environment in Google Colab with Nvidia K80/T4 GPU with ram size of 12GB/16GB. U-Net perform downwards operations(Encoder) and upwards operations (Decoder). For the encoder operation, input of size 8x256x256x3 and batch for the input is 8to the propose architecture, which contains two times of convolution two dimension of operations and size of 3 x 3 filter of 16, followed by decreasing dropout rate and this process repeats in each node, after this we apply max pooling of 2X2 with stride2, this process repeated for each encoding block.



Source: Realized by authors

Fig 2. Propose U-NET Architecture

In decoder block, reverse of encoding task is applied for producing the same output size as input the concatenation operation is performed as shown in fig 2 for the feature size has been expended.

The growing way has the up testing (deciphering) activity with the past layer in which each step has half of the component channels in convolution two layered layers that are 256 down to 16 in every hub. It followed every one of the means by up inspecting. The last soft max activation function is used because it is multi class segmentation.

It is repeated for all batches of cropped images during training. The model streamlines weight cycle by emphasis. The architecture of propose U-Net model is shown in Fig-2. For the assessment of model execution for the semantic segmentation Intersection over Union (IoU) Jaccard index is used which measure the comparability between limited number of objects of contrast class. In the data set object classes are unbalanced combination Dice loss and Focal loss is use as loss function in propose model.

Jaccard index (J) A is set of actual class and B is Predicted class.

$$J(A,B) = |A \cap B| / |A \cup B|$$

$$IoU = \frac{\sum_{j=1}^k n_{ij}}{\sum_{j=1}^k (n_{ij} + n_{ij} + n_{ij})} \quad (1)$$

3.1.1. Dice-Loss (DL)

$$DL(Y, \hat{P}) = 1 - \frac{2y\hat{p}+1}{y+\hat{p}+1} \quad (2)$$

In equation (2) 1 is added to denominator and numerator to stay away from the mistake in edge situation when y and \hat{P} are zero. Where Y, \hat{P} is actual and predicted respectively

3.1.2. Focal Loss (FL)

$$FL(p_t) = -\alpha_t (1 - p_t)^{\gamma} \log(p_t) \quad (3)$$

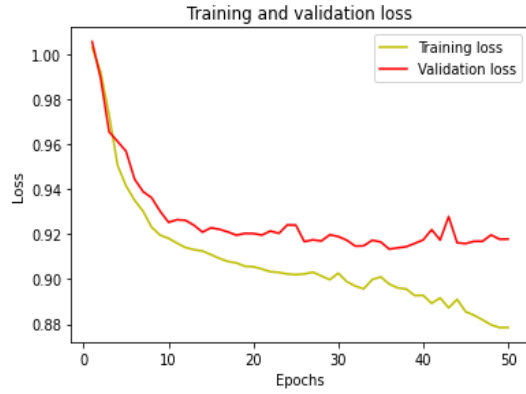
Loss function total loss TL is defined as sum of (2) and (3)

$$TL = \text{Dice Loss} + \text{Focal Loss}$$

We optimize the model by Adam optimizer. We trained the networks for 50 epochs for images and mask. Every age was prepared with a group size of 8 picture patches for all class objects. Each clump haphazardly trimmed a fix from a unique picture of 256 x 256.

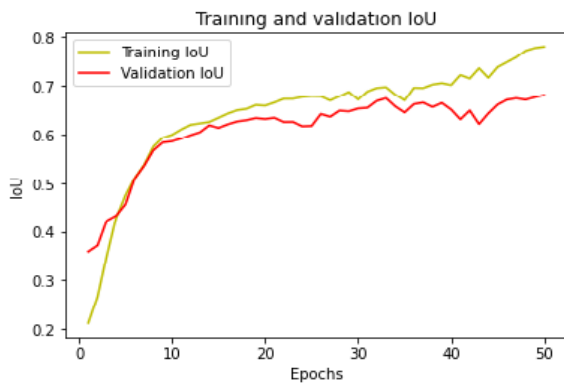
4. RESULTS AND DISCUSSIONS

In the propose model total of 1,941,190 parameters were trained by the input of images in x train and mask in y train as in dataset total of 8 tile of image folder is available and each folder have 9 images of aerial view and its corresponding mask is present, we have chosen tile no 8 in which 9 large images and 9 mask is present for training the experiment. With these limited data we have achieved the good result which is shown in give below fig 3 and Mean IoU is 0.5938 is achieved for the segmentation task IoU more than 0.50 is good and can be consider for the segmentation prediction result is shown in the fig (4)



Source: Realised by authors

(a)



Source: Realised by authors

(b)

Fig 3. (a) Training loss Vs validation loss **(b)** Training IoU vs Validation IoU of Propose U-NET Architecture

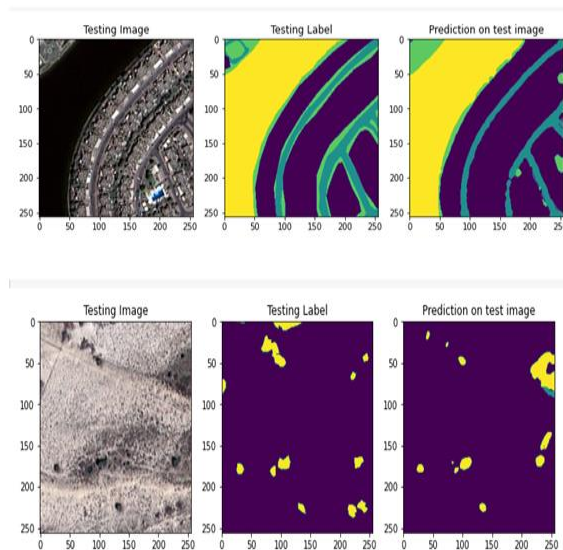


Fig 4. (a) Testing image **(b)**Testing Label **(c)** Prediction on Test

5. CONCLUSION

We are segmented the aerial images using U-net model with hyper parameters semantic segmentation result for this dataset is fair with small set of training data of only 9 images patches we were not applied any data augmentation technique we process the original images with minimum information loss during the pre-processing of data which result early and good feature extraction during the training, we introduce the different dropout rate for each encoder and decoder block which shows fair Jaccard score we have shown u-net can perform the semantic segmentation task on aerial images on small dataset in this paper images were cropped not resized to minimize the so that efficient and good features were extracted by the model. This experiment can utilize for disaster management and other monitoring activity where human cannot easily reach, in future more data with batch size of 128 can be used for better training the model.

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7. DECLARATIONS OF CONFLICT OF INTERESTS

There is no conflict of interest between the authors.

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