NATIONAL LAW SCHOOL OF INDIA UNIVERSITY,

BANGALORE.

APPLICATION OF ARTIFICIAL INTELLIGENCE IN JUDICIAL DECISION MAKING

UNDER THE SUPERVISION OF

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Id No: 543

LL. M: 2nd year (Business Laws)

Dissertation Submitted in partial fulfilment of the LL.M degree programme for the academic year 2012 - 2014

DECLARATION

I, the undersigned, hereby declare that the work titled **"Application of Artificial Intelligence in Judicial Decision Making"** is the outcome of the research carried out by me under the able guidance and supervision of Professor S.B.N Prakash at the National Law School of India University, Bangalore.

I further declare that this work is original, except for such assistance, taken from such sources, as have been referred to or mentioned at the respective places and for which necessary acknowledgments have been made.

I also declare that this work has not been submitted either in part or in whole for any degree or diploma at any other university.

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CERTIFICATE

This is to certify that the dissertation entitled **"Application of Artificial Intelligence in Judicial Decision Making"** submitted by Yadukrishan.B (I.D. No. 543) in partial fulfillment of the LL.M degree programme for the academic year 2012 – 2014 at the National Law School of India University, is the bona fide research satisfactorily carried out by her under my guidance and supervision.

Prof. S.B.N. Prakash,

National Law School of India University,

Bangalore,

30th May 2014

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I express my sincere gratitude to Prof. Dr. S.B.N Prakash and owe my foremost regards to him for giving me an opportunity to carry out this dissertation work under his guidance. This work would not have been possible without his invaluable support and thought provoking comments. It is due to his patient guidance that I have been able to complete the task.

I am very glad to present this research work based on "**Application of Artificial Intelligence in Judicial Decision Making**". This is a sincere effort by me. I also extend my gratitude to the Librarian and the Library staff who made available the required materials.

Though I have tried out best at the same time I know that there is nothing called perfection so I would like to have all valuable suggestion by Sir for future.

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Contents

RESEARCH METHODOLOGY

Aims and Objectives

The main aim of this research paper is to find out the scope Artificial Intelligence in Judicial Decision Making. The objectives include how it proved to be a significant thing in helping the judges in giving the decision more wisely and judiciously. The paper also talks about the comparison between Artificial intelligence and E-judiciary and how it helped the courts to give a steamline system of justice from a paper based system to a technology based concept.

Research Problem

How Artificial Intelligence proved to be a significant thing in helping the judges in rendering the justice to the society. What will be the impact of computer based systems that help the courts in rendering speedy justice to the common man

Research Question

1) Can a computer think like a man?
2) Can a computer be intelligent like human beings?
3) What do you mean by Artificial Intelligence?
4) What is the difference between intelligence and knowledge?
5) How expert systems help in rendering proper legal reasoning through court?
6) What do you mean by an artificial legal entity?
7) How Artificial Intelligence helps in rendering speedy justice through courts? What are the criteria behind it?
8) What is liability if an Artificial Intelligence Entity commits an offense in the probable course of time? Will it goes to the maker or to the entity? If so what punishment can be granted?

9) How the voice recognition tests help the lawyers as well as the courts in rendering justice to the society. What are the main challenges faced by it?
10) What are the positive and negative aspects of Artificial Intelligence?
11) Explain about the criminal liability theories which highlight the liability of the artificial legal entities?
12) Explain the theories which govern intelligence and the difference exist between A.I and H.I?

Hypothesis

This dissertation proceeds with the hypothesis that with the development of information technology rapid changes has been occurred. The same thing created far reaching changes in the field of judicial decision making also. Artificial Intelligence is one of the significant contribution form the field of information technology. It reduced the delay with respect to dealing of cases through the introduction of computer based softwares. Hence A.I plays a significant role in judicial decision making.

Research Methodology

In this paper the researcher has primarily used descriptive and analytical methodology of research. He has mainly relied upon the secondary sources, which includes books relating to Artificial Intelligence available in the Library, internet sources, journals, magazines and newspaper.

Scope

The scope of this paper is to find out the interlinkage between A.I and Law and how it proved to be a significant thing in rendering judicial decision through court.

Limitation

A field study would have been desirable to bring some more ideas related to the topic. But due to the paucity of time my research work is confined only to books and journals relating to Artificial Intelligence.

Sources

In this paper various secondary sources have been used by the research student in the form of books, article from various journals and websites for understanding this topic.

Mode of Citation

A uniform method of citation is followed throughout this paper.

Chapter-1

1. INTELLIGENCE AND IT'S IMPORTANCE

What do you mean by Intelligence? It's a common question asked by every individual. How intelligence can be measured. Who is intelligent? How it can be understood. All these questions pose the importance of Intelligence. The term intelligence has been defined in different ways such as in terms of one's capacity for logic, abstract thought, understanding, self-awareness, communication, learning, emotional knowledge, memory, planning, and problem solving. Intelligence is a term which is widely observed in human beings but at the same time it is reflected in plants and animals. Animals and plants also possess intelligence just like human beings. But the way it possesses is subjected to the concerned circumstances. The term artificial intelligence is totally different from the ordinary concept of intelligence. In simple terms artificial intelligence refers to the simulation of intelligence in machines. Within the discipline of psychology, various approaches to human intelligence have been adopted. The psychometric approach is especially familiar to the general public, as well as being the most researched and by far the most widely used in practical settings[1].

[1] Neisser, U.; Boodoo, G.; Bouchard, T. J. , J.; Boykin, A. W.; Brody, N.; Ceci, S. J.; Halpern, D. F.; Loehlin, J. C.; Perloff, R.; Sternberg, R. J.; Urbina, S. (1996). "Intelligence: Knowns and unknowns". *American Psychologist* **51** (2): 77. doi:10.1037/0003-066X.51.2.77 (visited on May 11, 2014)

1.1 HISTORY OF THE TERM

The term intelligence is derived from the Latin word "*intelligere*" which means to comprehend or to perceive. A form of this verb, *intellectus*, became the medieval technical term for understanding, and a translation for the Greek philosophical term *nous*. This term was however strongly linked to the metaphysical and cosmological theories of teleological scholasticism, including theories of the immortality of the soul, and the concept of the Active Intellect (also known as the Active Intelligence). This entire approach to the study of nature was strongly rejected by the early modern philosophers wsuch as Francis Bacon, Thomas Hobbes, John Locke, and David Hume, all of whom preferred the word "understanding" in their English philosophical works. Hobbes for example, in his Latin *De Corpore*, used "*intellectus intelligit*" (understanding – English term- meaning) as a typical example of a logical absurdity. The term "intelligence" has therefore become less common in English language philosophy, but it has later been taken up (with the scholastic theories which it now implies) in more contemporary psychology[2].

The terms "Nous" has got some relationship with the term intelligence. It's a Greek term which can be sometimes equated to intellect or intelligence, is a philosophical term for the faculty of the human mind which is described in classical philosophy as necessary for understanding what is true or real, similar in meaning to intuition. The three commonly used philosophical terms are from Greek, and Latin *intellectus* and *intelligentia* respectively.

In the Aristotelian scheme, *nous* is the basic understanding or awareness which allows human beings to think rationally. For Aristotle, this was distinct from the processing of sensory perception, including the use of imagination

[2] Nidditch, Peter. "Foreword". *An Essay Concerning Human Understanding*. Oxford University Press. p. xxii

and memory, which other animals can do. The historical development of the term intelligence can be analyzed from various stages. It is through these stages the concept of intelligence has been developed. The first stage is known as pre Socratic stage or pre Socratic usage. The period before Socrates highlights the pre Socratic stage. The second stage is Socratic stage or Socratic philosophy. The third stage is about the medieval stage or medieval intelligence in religion. The fourth one is medieval Islamic philosophy. The fifth one talks about Christianity or the Christian philosophy on intelligence. The final stage talks about the modern philosophy on intelligence. These are the main stages through which the term intelligence developed. It is better to give a brief explanation of those concerned stages so that everyone will get an idea on which how intelligence has been developed.

a. PRE SOCRATIC STAGE

This is the first stage that talks about the evolution of intelligence. It is a stage prior to the Greek scholar Socrates. In early Greek uses, Homer (Greek thinker and scholar) used *nous (intelligence)* to signify mental activities of both mortals and immortals, for example what they really have on their mind as opposed to what they say aloud. It was one of several words related to thought, thinking, and perceiving with the mind. Amongst pre-Socratic philosophers it became increasingly distinguished as a source of knowledge and reasoning and opposed to mere sense perception, or thinking influenced by the body such as emotion. For example Heraclitus complained that "much learning does not teach *nous*"[3]. Among some Greek authors the faculty of intelligence that is higher mind can be considered as a property of the cosmos as a whole.

[3] Long, A.A. (1998), *Nous*, Routledge

In ancient Indian philosophy also the higher mind is considered as the property of the cosmos as a whole[4].

b. SOCRATIC STAGE

This is the second and the most important stage with respect to the evolution of the term intelligence. In this stage Xenophon, the less famous of the two students of Socrates whose written accounts of him have survived, recorded that he taught his students a kind of teleological justification of piety and respect for divine order in nature. This has been described as an "intelligent design" argument for the existence of God, in which nature has its own *nous*[5]. Plato used the word *nous* in many ways which were not unusual in the everyday Greek of the time, and often simply meant "good sense" or "awareness"[6]. On the other hand, in some of his dialogues it is described by key characters in a higher sense, which was apparently already common. Socrates in his famous work *philebus* has held that "all philosophers agree whereby they really exalt themselves that mind (*nous*) is king of heaven and earth. Perhaps they are right." and later states that the ensuing discussion "confirms the utterances of those who declared of old that mind (*nous*) always rules the universe".

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[4] for example, in the Sankhya philosophy, the faculty of higher intellect (buddhi) is equated with the cosmic principle of differentiation of the world-soul (hiranyagarbha) from the formless and unmanifest Brahman. This outer principle that is equated with *buddhi* is called *mahat*

[5] For example: McPherran, Mark (1996), *The Religion of Socrates*, The Pennsylvania State University Press, pp. 273-275; and Sedley, David (2007), *Creationism and Its Critics in Antiquity*, University of California Press. It has been claimed that his report might be the earliest report of such an argument in Ahbel-Rappe, Sara, *Socrates: A Guide for the Perplexed*

[6] Kalkavage (2001), "Glossary", *Plato's Timaeus*, Focus Publishing. In ancient Greek the word was used for phrases such as "keep in mind" and "to my mind".

Plato in his famous work *Cratylus*, gives the etymology of Athena's name, the goddess of wisdom, from *Atheonoa* which means God's mind. In his *Phaedo*, Plato's teacher Socrates is made to say just before dying that his discovery of Anaxagoras' concept of a cosmic *nous* as the cause of the order of things was an important turning point for him. But he also expressed disagreement with Anaxagoras' understanding of the implications of his own doctrine, because of Anaxagoras' materialist understanding of causation. Socrates said that Anaxagoras would "give voice and air and hearing and countless other things of the sort as causes for our talking with each other, and should fail to mention the real causes, which are, that the Athenians decided that it was best to condemn me"[7]. On the other hand Socrates seems to suggest that he also failed to develop a fully satisfactory teleological and dualistic understanding of a mind of nature, whose aims represent the good things which all parts of nature aim at.

Aristotle's philosophical works continue many of the same Socratic themes as his teacher Plato. Amongst the new proposals he made was a way of explaining causality, and *nous* is an important part of his explanation. As mentioned above, Plato criticized Anaxagoras' materialism, or understanding that the intellect of nature only set the cosmos in motion, but is no longer seen as the cause of physical events. Aristotle explained that the changes of things can be described in terms of four causes at the same time. In the philosophy of Aristotle the soul (psyche) of a body is what makes it alive, and is its actualized form; thus, every living thing, including plant life, has a soul. The mind or intellect (*nous*) can be described variously as a power, faculty, part, or aspect of the human soul.

[7] Fowler translation of the *Phaedo* as on the Perseus webpage: 97-98

c. MEDIEVAL STAGE

The third stage is the medieval stage. This stage shows how religion played a dominant role in the evolution of religion. Greek philosophy had an influence on the major religions which defined the middle ages, and one aspect of this was the concept of *nous*. In order to understand this first of all we should understand about Gnosticism, Valentinus, Basilides, Simon Magus and Gospel of Mary.

Gnosticism describes a collection of ancient religions that taught that people should shun the material world created by the demiurge and embrace the spiritual world.

In the **Valentinian system**, *Nous* is the first male *Aeon*. Together with his conjugate female *Aeon*, *Aletheia* (truth), he emanates from the *Propator Bythos* and his coeternal *Ennoia* or *Sige*; and these four forms the primordial Tetrad. He alone is capable of knowing the *Propator*; but when he desired to impart like knowledge to the other *Aeons*, was withheld from so doing by *Sige*. When *Sophia* (wisdom), youngest *Aeon* of the thirty, was brought into peril by her yearning after this knowledge, *Nous* was foremost of the *Aeons* in interceding for her. From him, or through him from the *Propator*, Horos was sent to restore her. After her restoration, *Nous*, according to the providence of the *Propator*, produced another pair, Christ and the Holy Spirit, "in order to give fixity and steadfastness to the *Pleroma*." For this Christ teaches the *Aeons* to be content to know that the *Propator* is in himself incomprehensible, and can be perceived only through the Only Begotten (*Nous*)[8].

A similar conception of *Nous* appears in the later teaching of the **Basilidean School**, according to which he is the first begotten of the Un begotten Father,

[8] Iren. *Haeres.* I. i. 1-5; Hippol. *Ref.* vi. 29-31; Theod. *Haer. Fab.* i. 7

and himself the parent of *Logos*, from whom emanate successively *Phronesis*, *Sophia*, and *Dunamis*. But in this teaching *Nous* is identified with Christ, is named Jesus, is sent to save those that believe, and returns to Him who sent him, after a passion which is apparent only,—Simon the Cyrenian being substituted for him on the cross. It is probable, however, that *Nous* had a place in the original system of Basilides himself; for his *Ogdoad*, "the great Archon of the universe, the ineffable" is apparently made up of the five members named by Irenaeus (as above), together with two whom we find in Clement, *Dikaiosyne* and *Eirene*,—added to the originating Father.

Under **Simon Magus** the antecedent of these systems is that of Simon of whose six "roots" emanating from the Un begotten Fire, *Nous* is first. The correspondence of these "roots" with the first six *Aeons* which Valentinus derives from *Bythos*, is noted by Hippolytus. Simon says in his *Apophasis Megalē*,

There are two offshoots of the entire ages, having neither beginning nor end...Of these the one appears from above, the great power, the *Nous* of the universe, administering all things, male; the other from beneath, the great *Epinoia*, female, bringing forth all things.

To *Nous* and *Epinoia* corresponds Heaven and Earth, in the list given by Simon of the six material counterparts of his six emanations. The identity of this list with the six material objects alleged by Herodotus to be worshipped by the Persians, together with the supreme place given by Simon to Fire as the primordial power, leads us to look to Persia for the origin of these systems in one aspect. In another, they connect themselves with the teaching of Pythagoras and of Plato.

The ***Gospel of Mary*** is an apocryphal book discovered in 1896 in a 5th-century papyrus codex. According to the *Gospel of Mary*, Jesus himself articulates the essence of *Nous*.

d. MEDEIVAL ISLAMIC PHILOSOPHY

The fourth stage refers to Medieval Islamic Philosophy. During the middle ages, philosophy itself was in many places seen as opposed to the prevailing monotheistic religions, Islam, Christianity and Judaism. The strongest philosophical tradition for some centuries was amongst Islamic philosophers, who later came to strongly influence the late medieval philosophers of western Christendom, and the Jewish diaspora in the Mediterranean area. While there were earlier Muslim philosophers such as Al Kindi, chronologically the three most influential concerning the intellect were Al Farabi, Avicenna, and finally Averroes, a westerner who lived in Spain and was highly influential in the late middle ages amongst Jewish and Christian philosophers.

e. CHRISTIAN PHILOSOPHY OF INTELLIGENCE

Under Christian Philosophy especially while we are dealing with the writings of Christian fathers a sound or pure *nous* is considered essential to the cultivation of wisdom.

The philosophical works were not commonly read or taught in the early middle ages in most of Europe, the works of authors like Boethius and Augustine of Hippo formed an important exception. Both were influenced by neo Platonism, and were amongst the older works that were still known in the time of the Carolingian Renaissance, and the beginnings of Scholasticism.

In his early years Augustine was heavily influenced by Manichaeism and afterward by the Neo-Platonism of Plotinus[9]. After his conversion to Christianity and baptism, he developed his own approach to philosophy and theology, accommodating a variety of methods and different perspectives.

Augustine used neo Platonism selectively. He used both the neoplatonic *Nous*, and the Platonic Form of the Good (or *"The Idea of the Good"*) as equivalent terms for the Christian God, or at least for one particular aspect of God. For example, God, *nous*, can act directly upon matter, and not only through souls, and concerning the souls through which it works upon the world experienced by humanity, some are treated as angels.

Scholasticism becomes more clearly defined much later, as the peculiar native type of philosophy in medieval catholic Europe. In this period, Aristotle became "the Philosopher", and scholastic philosophers, like their Jewish and Muslim contemporaries, studied the concept of the *intellectus* on the basis not only of Aristotle, but also late classical interpreters like Augustine and Boethius.

Human reasoning is not enough: there will always remain an "irrational residue" which escapes analysis and which cannot be expressed in concepts: it is this unknowable depth of things, that which constitutes their true, indefinable essence that also reflects the origin of things in God. In Eastern Christianity it is by faith or intuitive truth that this component of an objects existence is grasped. The operation of faith being the means of free will by which mankind faces the future or unknown, these noetic operations

[9] Cross, Frank L. and Livingstone, Elizabeth, ed. (2005). "Platonism". *The Oxford Dictionary of the Christian Church.* Oxford Oxfordshire: Oxford University Press.

contained in the concept of insight or noesis. Faith (*pistis*) is therefore sometimes used interchangeably with *noesis* in Eastern Christianity[10].

f. MODERN PHILOSOPHY OF INTELLIGENCE

The "early modern" philosophers of western Europe in the 17th and 18th centuries established arguments which led to the establishment of modern science as a methodical approach to improve the welfare of humanity by learning to control nature. As such, speculation about metaphysics, which cannot be used for anything practical, and which can never be confirmed against the reality we experience, started to be deliberately avoided, especially according to the so-called "empiricist" arguments of philosophers such as Bacon, Hobbes, Locke and Hume. The Latin motto "*nihil in intellectu nisi prius fuerit in sensu*" (nothing in the intellect without first being in the senses) has been described as the "guiding principle of empiricism" in the *Oxford Dictionary of Philosophy.*

These philosophers explain the intellect as something developed from experience of sensations, being interpreted by the brain in a physical way, and nothing else, which means that absolute knowledge, is impossible. For Bacon, Hobbes and Locke, who wrote in both English and Latin, "*intellectus*" was translated as "understanding". Far from seeing it as secure way to perceive the truth about reality, Bacon, for example, actually named the *intellectus* in his *Novum Organum*, and the prœmium to his *Great Instauration*, as a major source of wrong conclusions, because it is biased in many ways, for example towards over-generalizing. For this reason, modern science should be methodical, in order not to be misled by the weak human intellect. He felt that lesser known Greek philosophers such as Democritus "who did not suppose a mind or reason in the frame of things", have been

[10] ANTHROPOLOGICAL TURN IN CHRISTIAN THEOLOGY: AN ORTHODOX PERSPECTIVE by Sergey S. Horujy

arrogantly dismissed because of Aristotelianism leading to a situation in his time wherein "the search of the physical causes hath been neglected, and passed in silence".

One of the results of the early modern philosophy has been the increasing creation of specialist fields of science, in areas that were once considered part of philosophy, and infant cognitive development and perception now tend to be discussed now more within the sciences of psychology and neuroscience than in philosophy.

All these stages give you a clear idea about the various stages of intelligence or how these concepts got evolved.

1.2 DEFINITION OF INTELLIGENCE

It is difficult to give a specific definition on the term intelligence. However several authorities have managed to define the term intelligence in a specific manner. Despite a long history of research and debate, there is still no standard definition of intelligence. This has led some to believe that intelligence may be approximately described, but cannot be fully defined. We believe that this degree of pessimism is too strong. Although there is no single standard definition, if one surveys the many definitions that have been proposed, strong similarities between many of the definitions quickly become obvious. In many cases different definitions, suitably interpreted, actually say the same thing but in different words. This observation leads us to believe that a single general and encompassing definition for arbitrary systems was possible. Indeed we have constructed a formal definition of intelligence, called *universal intelligence* which has strong connections to the theory of

optimal learning agents. Some relevant definitions related to intelligence are highlighted as follows:-

1) From "Mainstream Science on Intelligence" (1994), an editorial statement by fifty-two researchers:

A very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—"catching on," "making sense" of things, or "figuring out" what to do[11].

2) From "Intelligence: Knowns and Unknowns" (1995), a report published by the Board of Scientific Affairs of the American Psychological Association:

Individuals differ from one another in their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought.

PSYCHOLOGIST DEFINITIONS

This section contains definitions from psychologists. In some cases we have not yet managed to locate the exact reference and would appreciate any help in doing so.

[11] Gottfredson, Linda S. (1997). "Mainstream Science on Intelligence (editorial)". *Intelligence* 24: 13–23.

1. "Intelligence is not a single, unitary ability, but rather a composite of several functions. The term denotes that combination of abilities required for survival and advancement within a particular culture[12]." - A. Anastasi

2. ". . . that facet of mind underlying our capacity to think, to solve novel problems, to reason and to have knowledge of the world[13]." -M. Anderson

3. "It seems to us that in intelligence there is a fundamental faculty, the alteration or the lack of which, is of the utmost importance for practical life. This faculty is judgment, otherwise called good sense, practical sense, initiative, the faculty of adapting one's self to circumstances." - A. Binet

COLLECTIVE DEFINITIONS

There are some collective definitions which show the relevant meaning of the term intelligence. Some relevant definitions are stated as follows:-

1. "The ability to use memory. knowledge. experience, understanding, reasoning, imagination and judgment in order to solve problems and adapt to new situations." – All Words Dictionary, 2006.

2. "The capacity to acquire and apply knowledge." - The American Heritage Dictionary,
   Fourth edition, 2000

[12] A. Anastasi. What counselors should know about the use and interpretation of psychological tests. *Journal of Counseling and Development*, 70(5):610–615, 1992.

[13] M. Anderson. Intelligence. *MS Encarta online encyclopedia*, 2006.

3. "Individuals differ from one another in their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought[14]." -American Psychological Association

The above stated definitions give ample information about the concept of intelligence in a significant manner not only in a psychologist point of view but also in a general point of view.

1.2.1 HUMAN INTELLIGENCE

Human intelligence is the intellectual capacity of humans, which is characterized by perception, consciousness, self-awareness, and volition. Through their intelligence, humans possess the cognitive abilities to learn, form concepts, understand, apply logic, and reason, including the capacities to recognize patterns, comprehend ideas, plan, problem solve, make decisions, retaining, and use language to communicate. Intelligence enables humans to experience and think.

Robert Sternberg defines human intelligence as "your skill in achieving whatever it is you want to attain in your life within your socio cultural context by capitalizing on your strengths and compensating for, or correcting, your weaknesses".

[14] L. S. Gottfredson. Mainstream science on intelligence: An editorial with 52 signatories, history, and bibliography. *Intelligence*, 24(1):13–23, 1997.

1.2.2 EVOLUTION OF HUMAN INTELLIGENCE

The **evolution of human intelligence** refers to a set of theories that attempt to explain how human intelligence has evolved. These theories are closely related to the evolution of the human brain and to the emergence of human language.

The timeline of human evolution spans approximately 7 million years, from the separation of the *Pan* genus until the emergence of behavioral modernity by 50,000 years ago. The first 3 million years of this timeline concern *Sahelanthropus*, the following 2 million concern *Australopithecus* and the final 2 million span the history of actual *human* species.

The historical evolution of intelligence can be traced back from great apes. It is through apes the concept of human intelligence have been evolved. The great apes show considerable abilities for cognition and empathy. Chimpanzees make tools and use them to acquire foods and for social displays; they have sophisticated hunting strategies requiring cooperation, influence and rank; they are status conscious, manipulative and capable of deception; they can learn to use symbols and understand aspects of human language including some relational syntax, concepts of number and numerical sequence[15]. In one study, young chimpanzees outperformed human college students in tasks requiring remembering numbers[16]. This claim was refuted in a later study after it was noted that the chimpanzees had received extensive practice with the task while the students were evaluated on their first attempt. When human subjects were given time to practice, they

[15] "Chimpanzee intelligence". Indiana University

[16] Hooper, Rowan (2007-12-03). "Chimps outperform humans at memory task". New Scientist,

substantially outperformed the young chimps[17]. Chimpanzees are capable of empathy.

From about 5 million years ago, the Hominin brain began to develop rapidly in both size and differentiation of function.

There has been a gradual increase in brain volume as humans progressed along the timeline of evolution, starting from about 600 cm in *Homo habilis* up to 1500 cm in *Homo neanderthalensis.* Thus, in general there's a correlation between brain volume and intelligence. With their three times smaller brain the Flores hominids apparently used fire and made tools as sophisticated as those of their ancestor *Herectus.* In this case, it seems that for intelligence, the structure of the brain is more important than its volume.

By 2.4 million years ago *Homo habilis* had appeared in East Africa: the first known human species, and the first known to make stone tools.

The use of tools conferred a crucial evolutionary advantage, and required a larger and more sophisticated brain to co-ordinate the fine hand movements required for this task. The evolution of a larger brain created a problem for early humans, however. A larger brain requires a larger skull, and thus requires the female to have a wider birth canal for the newborn's larger skull to pass through. But if the female's birth canal grew too wide, her pelvis would be so wide that she would lose the ability to run: still a necessary skill in the dangerous world of 2 million years ago.

The solution to this was to give birth at an early stage of fetal development, before the skull grew too large to pass through the birth canal. This adaptation enabled the human brain to continue to grow, but it imposed a

[17] Cook, Peter; Wilson, Margaret (2010). "Do young chimpanzees have extraordinary working memory?" *Psychonomic Bulletin & Review* **17** (4): 599.

new discipline. The need to care for helpless infants for long periods of time forced humans to become less mobile Human bands increasingly stayed in one place for long periods, so that females could care for infants, while males hunted food and fought with other bands that competed for food sources. As a result, humans became even more dependent on tool-making to compete with other animals and other humans, and relied less on body size and strength.

About 200,000 years ago Europe and the Middle East were colonized by Neanderthal man, extinct by 20,000 following the appearance of modern humans in the region from 40,000 years ago.

1.3 THEORIES OF INTELLIGENCE

There are different theories about intelligence, none of which agree with each other. Every approach to thinking comes up with its own different perspective and assumptions, often contradicting at least one earlier theory[18].

Faculty theory: It is the oldest theory regarding the nature of intelligence and flourished during 18th and 19th century. According to this theory, mind is made up of different faculties like reasoning, memory, discrimination, imagination, etc. These faculties are independent of each other and can be developed by vigorous training. Faculty Theory had been under criticism by experimental psychologists who disproved the existence of independent faculties in the brain.

One factor/UNI factor theory: It reduces all abilities to a single capacity of general intelligence or 'common sense'. This would imply that they are all

[18] Theories of Intelligence by HR Pal, A.Pal and P.Tourani (*www.bhel.com/dynamic_files/press_files/pdf/pdf_14-Mar-2005.pdf*) **(visited on May 12th 2014)**

perfectly correlated, and would make no allowance for the unevenness of people that is the abilities along different lines.

Since it goes against the common observation that "an individual does possess different levels of different abilities and does not shine equally in all directions"—it has no ground to stand.

Spearman's two-factor theory: It was developed in 1904 by an English Psychologist, Charles Spearman, who proposed that intellectual abilities were comprised of two factors: one general ability or common ability known as 'G' factor and the other a group of specific abilities known as 'S' factor. 'G' factor is universal inborn ability. Greater 'G' in an individual leads to greater success in life. 'S' factor is acquired from the environment. It varies from activity to activity in the same individual[19].

Thorndike's multifactor theory: Thorndike believed that there was nothing like General Ability. Each mental activity requires an aggregate of different set of abilities. He distinguished the following four attributes of intelligence:

(a) Level—refers to the level of difficulty of a task that can be solved.

(b) Range—refers to a number of tasks at any given degree of difficulty.

(c) Area—means the total number of situations at each level to which the individual is able to respond.

[19] Butcher, H. J. Human Intelligence and Its Nature & Assessment. London : Methun & Co., 1968.

(d) Speed—is the rapidity with which we can respond to the items.

Thurstone's theory: Primary mental abilities/Group factor theory: States that Intelligent Activities are not an expression of innumerable highly specific factors, as Thorndike claimed. Nor is it the expression primarily of a general factor that pervades all mental activities. It is the essence of intelligence, as Spearman held. Instead, the analysis of interpretation of Spearman and others led them to the conclusion that 'certain' mental operations have in common a 'primary' factor that gives them psychological and functional unity and that differentiates them from other mental operations[20]. These mental operations then constitute a group. A second group of mental operation has its own unifying primary factor, and so on. In other words, there are a number of groups of mental abilities, each of which has its own primary factor, giving the group a functional unity and cohesiveness.

GUILFORD'S MODEL OF STRUCTURE OF INTELLECT

Guilford (1967, 1985, 1988) proposed a three dimensional structure of intellect model.

According to Guilford every intellectual task can be classified according to it's (1) content, (2) the mental operation ivolved and (3) the product resulting from the operation. He further classified content into five categories, namely, Visual, Auditory, Symbolic, Semantic and Behavioral. He classifieds

[20] Sternberg, Robert J. The Triarchic Mind : A new Theory of Human Intelligence. New York : Penguin Books., 1989

operations into five categories, namely, Cognition, Memory retention, Memory recording, Divergent production, Convergent production and evaluation. He classified products into six categories, namely, Units, Classes, Relations, Systems, Transformations and Implications[21].

VERNON'S HIERARCHICAL THEORY:

Vernon' description of different levels of intelligence may fill the gaps between two extreme theories, the two-factor theory of Spearman, which did not allow for the existence of group factors, and the multiple-factor theory of Turstone, which did not allow a "g" factor. Intelligence can be described as comprising abilities at varying levels of generality:

1. The highest level: "g" (general intelligence) factor with the largest source of variance between individuals. (Spearman)

2. The next level: major group factors such as verbal-numerical-educational and practical-mechanical-spatial-physical ability.

3. The next level: minor group factors are divided from major group factors.

[21] Spearman, C. "General Intelligence" Objectively Determined & Measured, *American Journal of Psychology* 15, 201-293, 1904.

4. The bottom level: "s" (specific) factor. (Spearmen) Beginning in 1969, Vernon became increasingly involved in studying the contributions of environmental and genetic factors to intellectual development.

CATTELL'S FLUID AND CRYSTALLIZED THEORY

The fluid aspect of this theory says that intelligence is a basic capacity due to genetic potentiality. While this is affected by the past and new experiences, the crystallized theory is a capacity resultant of experiences, learning and environment.

GARDENER'S THEORY OF MULTIPLE INTELLIGENCE

Howard Gardner in his book "Frames of Mind, The Theory of Multiple Intelligence" (1983), puts forth a new and different view of human intellectual competencies. He argues boldly and cogently that we are all born with potential to develop a multiplicity of Intelligence, most of which have been overlooked in our testing society, and all of which can be drawn upon to make us competent individuals.

Sternberg's triarchic theory: Psychologist Robert Sternberg (1985) has constructed a three—pronged, or triarchic theory of intelligence. The Three types are:

Analytical Intelligence—is what we generally think of as academic ability. It enables us to solve problems and to acquire new knowledge. Problem—solving skill shall include encoding information, combining and comparing pieces of information and generating a solution.

Creative Intelligence—is defined by the abilities to cope with novel situations and to profit from experience. The ability to quickly relate novel situations to familiar situations fosters adaptation. Moreover, as a result of experience, we also become able to solve problems more rapidly.

Practical Intelligence—or "street smarts", enable people to adapt to the demands of their environment. For example, keeping a job by adapting one's behavior to the employer's requirements is adaptive. But if the employer is making unreasonable demands, reshaping the environment (by changing the employer's attitudes) or selecting an alternate environment (by finding a more suitable job) is also adaptive.

ANDERSON'S THEORY: COGNITIVE DEVELOPMENT

Anderson proposes that human cognitive architectures will have adapted optimally to the problems posed in their environment. Therefore, discovering the optimal solution to the problem posed by the environment, independent of the architecture, is equivalent to discovering the mechanism used by the architecture. A 'Rational Analysis', as it is called, takes into account the available information in the enviornment, the goals of the agent, some basic assumptions about computational cost (in terms of a 'general' architecture mechanism), and produces the optimal behavioral function.

EYSENCK'S STRUCTURAL THEORY

Eysenck discovered the neurological correlates of intelligence. He identified three correlates of intelligence i.e. reaction time, inspection time and average evoked potential. First two are observed behavior. Third behavior is description of mental waves. Brighter individual progressively takes less time

These are the major and the relevant theories related to intelligence. Until a clear-cut definition of intelligence can be given, theories will continue not to be able to explain it. The likelihood of such a definition occurring is virtually zero, as there will always be alternatives given, and so theories of intelligence are bound to be self-defeating.

1.5 MEASURING OF INTELLIGENCE

The next prominent area with respect to intelligence is how intelligence is measured. What is the basic criterion behind it? All these aspects are discussed under this arena. The approach to understanding intelligence with the most supporters and published research over the longest period of time is based on psychometric testing. It is also by far the most widely used in practical settings. Intelligence quotient (IQ) tests include the Stanford-Binet, Raven's Progressive Matrices, the Wechsler Adult Intelligence Scale and the Kaufman Assessment Battery for Children. There are also psychometric tests that are not intended to measure intelligence itself but some closely related construct such as scholastic aptitude. In the United States examples include the SSAT, the SAT, the ACT, the GRE, the MCAT, the LSAT, and the GMAT[24].

Intelligence tests are widely used in educational, business, and military settings because of their efficacy in predicting behavior. IQ and *g* are correlated with many important social outcomes—individuals with low IQs are more likely to be divorced, have a child out of marriage, be incarcerated, and need long-term welfare support, while individuals with high IQs are associated with more years of education, higher status jobs and higher income. Intelligence is significantly correlated with successful training and

[24] Neisser U (1997). "Rising Scores on Intelligence Tests". *American Scientist*

in responding. They show less variability in reaction time. Their inspection time is also less as compared to less intelligent. Average evoked potential is often measured by the wavelength in electroencephalogram and complexities of waveform. He found that the waves of intelligent individuals are complex.

CECI'S BIOLOGICAL THEORY

Ceci (1990) proposes that there are multiple cognitive potentials. These multiple intelligence's are biologically based and place limits on mental processes. These are closely linked to the challenges and opportunities in the individual's environment. In his view, context is essential to the demonstration of cognitive abilities. By context, he means domain of knowledge and other factors such as personalities, motivation and education. Context can be mental, social or physical[22].

THEORY OF EMOTIONAL INTELLIGENCE

According to Goleman (1995), Emotional Intelligence consists of "abilities such as being able to motivate oneself and persist in the face of frustrations; to control impulse and delay gratification; to regulate one's moods and keep distress from swamping the ability to think : to empathize, and to hope". The main areas are: knowing one's emotions, managing emotions, motivating oneself, recognizing emotions in others, and handling relationships[23].

[22] Ceci S. J. On Intelligence.... More or Less : A Bio-Ecological Treatise on Intellectual Development, Englewood Cliffs, NJ : Prentice Hall, 1990

[23] Goleman, D. Emotional Intelligence. New York: Bantam, 1995.

performance outcomes, and IQ/*g* is the single best predictor of successful job performance[25].

Regarding the measuring of intelligence there are two basic theories which analyzes it in a different perspective. They are explained below:

1) **General Intelligence Factor**

There are many different kinds of IQ tests using a wide variety of test tasks. Some tests consist of a single type of task; others rely on a broad collection of tasks with different contents and asking for different cognitive processes. The psychologist Charles Spearman early in the 20th century carried out the first formal factor analysis of correlations between various test tasks. He found a trend for all such tests to correlate positively with each other, which is called a *positive manifold*. Spearman found that a single common factor explained the positive correlations among tests. Spearman named it *g* for "general intelligence factor". He interpreted it as the core of human intelligence that, to a larger or smaller degree, influences success in all cognitive tasks and thereby creates the positive manifold. This interpretation of *g* as a common cause of test performance is still dominant in psychometrics. An alternative interpretation was recently advanced by van der Maas and colleagues. Their *mutualism model* assumes that intelligence depends on several independent mechanisms, none of which influences performance on all cognitive tests. These mechanisms support each other so that efficient operation of one of them makes efficient operation of the others more likely, thereby creating the positive manifold.

[25] Markus Jokela, G. David Batty, Ian J. Deary, Catharine R. Gale, Mika Kivimäki (2009). "Low Childhood IQ and Early Adult Mortality: The Role of Explanatory Factors in the 1958 British Birth Cohort". *PEDIATRICS* **124** (3): e380 – e388

IQ tasks and tests can be ranked by how highly they load on the *g* factor. Tests with high *g*-loadings are those that correlate highly with most other tests. One comprehensive study investigating the correlations between a large collection of tests and tasks has found that the Raven's Progressive Matrices have a particularly high correlation with most other tests and tasks.

Cattell-Horn-Carroll Theory

Many of the broad, recent IQ tests have been greatly influenced by the Cattell-Horn-Carroll theory. It is argued to reflect much of what is known about intelligence from research. A hierarchy of factors is used. *g* is at the top. Under it there are 10 broad abilities that in turn are subdivided into 70 narrow abilities. The broad abilities are:

- Fluid Intelligence (Gf): includes the broad ability to reason, form concepts, and solve problems using unfamiliar information or novel procedures.
- Crystallized Intelligence (Gc): includes the breadth and depth of a person's acquired knowledge, the ability to communicate one's knowledge, and the ability to reason using previously learned experiences or procedures.
- Quantitative Reasoning (Gq): the ability to comprehend quantitative concepts and relationships and to manipulate numerical symbols.
- Reading & Writing Ability (Grw): includes basic reading and writing skills.
- Short-Term Memory (Gsm): is the ability to apprehend and hold information in immediate awareness and then use it within a few seconds.
- Long-Term Storage and Retrieval (Glr): is the ability to store information and fluently retrieve it later in the process of thinking.

- Visual Processing (Gv): is the ability to perceive, analyze, synthesize, and think with visual patterns, including the ability to store and recall visual representations.
- Auditory Processing (Ga): is the ability to analyze, synthesize, and discriminate auditory stimuli, including the ability to process and discriminate speech sounds that may be presented under distorted conditions.
- Processing Speed (Gs): is the ability to perform automatic cognitive tasks, particularly when measured under pressure to maintain focused attention.
- Decision/Reaction Time/Speed (Gt): reflect the immediacy with which an individual can react to stimuli or a task (typically measured in seconds or fractions of seconds; not to be confused with Gs, which typically is measured in intervals of 2–3 minutes).

1.6 ANIMAL AND PLANT INTELLIGENCE

Although humans have been the primary focus of intelligence researchers, scientists have also attempted to investigate animal intelligence, or more broadly, animal cognition. These researchers are interested in studying both mental ability in a particular species, and comparing abilities between species. They study various measures of problem solving, as well as mathematical and language abilities. Some challenges in this area are defining intelligence so that it means the same thing across species (e.g. comparing intelligence between literate humans and illiterate animals), and then operationalizing a measure that accurately compares mental ability across different species and contexts.

Wolfgang Kohler's pioneering research on the intelligence of apes is a classic example of research in this area. Stanley Coren's book, *The Intelligence of*

Dogs is a notable popular book on the topic[26]. Nonhuman animals particularly noted and studied for their intelligence include chimpanzees, bonobos (notably the language-using Kanzi) and other great apes, dolphins, elephants and to some extent parrots, rats and ravens.

Cephalopod intelligence also provides important comparative study. Cephalopods appear to exhibit characteristics of significant intelligence, yet their nervous systems differ radically from those of backboned animals. Vertebrates such as mammals, birds, reptiles and fish have shown a fairly high degree of intellect that varies according to each species. The same is true with arthropods.

It has been argued that plants should also be classified as being in some sense intelligent based on their ability to sense the environment and adjust their morphology, physiology and phenotype accordingly[27].

Plants do not have a brain or neuronal network, but reactions within signaling pathways may provide a biochemical basis for learning and memory[28]. Controversially, the brain is used as a metaphor in plant intelligence to provide an integrated view of signaling[29].

Plants are not passive entities merely subject to environmental forces, nor are they 'automata'-like organisms based only on reflexes and optimized solely for accumulation of photosynthate . Plants respond sensitively to

[26] Coren, Stanley (1995). *The Intelligence of Dogs*. Bantam Books

[27] Trewavas, Anthony (September 2005). "Green plants as intelligent organisms". *Trends in Plant Science* **10** (9): 413–419.

[28] Bhalla, US; Iyengar, R (1999). "Emergent properties of networks of biological signaling pathways". *Science* **283** (5400): 381–7.

[29] Brenner, E.; Stahlberg, R.; Mancuso, S.; Vivanco, J.; Baluska, F.; Vanvolkenburgh, E. (2006). "Plant neurobiology: an integrated view of plant signaling". *Trends in Plant Science* **11** (8): 413

environmental stimuli by movement and changes in morphology. They signal and communicate within and among themselves as they actively compete for limited resources, both above and below ground. In addition, plants accurately compute their circumstances, use sophisticated cost–benefit analysis and take tightly controlled actions to mitigate and control diverse environmental stressors. Plants are also capable of discriminating positive and negative experiences and of 'learning' (registering memories) from their past experiences. Plants use this information to update their behavior in order to survive present and future challenges of their environment. Plants are also capable of refined recognition of self and non-self, and are territorial in behavior.

1.7 KINDS OF INTELLIGENCE

There are mainly two kinds of intelligence. They are passive intelligence and active intelligence. The **active intelligence** is a concept in classical and medieval philosophy. The term refers to the formal (*morphe*) aspect of the intellect (*nous*), in accordance with the theory of hylomorphism.

The nature of the active intelligence was the subject of intense discussion in medieval philosophy, as various Muslim, Jewish and Christian thinkers sought to reconcile their commitment to Aristotle's account of the body and soul to their own theological commitments. At stake in particular was in what way Aristotle's account of an incorporeal soul might contribute to understanding of the nature of eternal life[30].

The **passive intellect,** also known as the **potential intellect** or the **material intellect**, is a term used in philosophy alongside the notion of the active intellect in order to give an account of the operation of the intellect (*nous*), in

[30] Sachs, Joe (2001), *Aristotle's On the Soul and On Memory and Recollection*, Green Lion Books

accordance with the theory of hylomorphism, as most famously put forward by Aristotle.

Aristotle gives his most substantial account of the passive intellect in *De Anima (On the Soul)*, Book III, and chapter 4. In Aristotle's philosophy of mind, the passive intellect "is what it is by becoming all things." By this Aristotle means that the passive intellect can potentially become anything by receiving that thing's intelligible form. The active intellect is then required to illuminate the passive intellect to make the potential knowledge into knowledge in fact, in the same way that light makes potential colors into actual colors. The analysis of this distinction in is very brief, and it has led to dispute as to what it means[31].

1.8 DIFFERENCE BETWEEN INTELLIGENCE AND KNOWLEDGE

While we are dealing with the major aspects of intelligence it is pertinent deal with the basic difference between intelligence and knowledge. Knowledge is defined variously as expertise, and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject, what is known in a particular field or in total; facts and information or awareness or familiarity gained by experience of a fact or situation.

Intelligence (also called intellect) is an umbrella term used to describe a property of the mind that encompasses many related abilities, such as the capacities to reason, to plan, to solve problems, to think abstractly, to comprehend ideas, to use language, and to learn. There are several ways to define intelligence. In some cases, intelligence may include traits such as

[31] Davidson, Herbert (1992), *Alfarabi, Avicenna, and Averroes, on Intellect*, Oxford University Press, page 3

creativity, personality, character, knowledge, or wisdom. However, some psychologists prefer not to include these traits in the definition of intelligence.

Knowledge is information, understanding, and intuition. It can be thought of as data stored in one's brain in an organized way, as memories and the way these memories are associated with one another. If, say, you're a skilled chess player, you have a vast internal database of moves, tactics, strategies, and patterns, all interlinked and cross-referenced. At any point in a game, you can draw from this database in choosing your next move.

Intelligence refers to one's ability to create new knowledge, whether by making connections between existing pieces of knowledge, by gathering fresh data from the outside world, or both. Going back to the chess example, if you're a highly intelligent chess player, then you'll be able to build a knowledge database about chess more quickly than a player of average intelligence. And your database will contain deeper insights and richer connections. You'll learn the game faster and understand it better[32].

In this chapter I explained purely about what is intelligence, its evolution, kinds, theories and how it is measured etc. Apart from animal and plant intelligence the term intelligence can be classified into human intelligence and artificial intelligence. The major aspects related to human intelligence have been discussed before. Now I am going to explain in detail the major aspects of artificial intelligence in my coming chapters.

[32] http://www.quora.com/What-is-the-difference-between-knowledge-and-intelligence (visited on 12th may 2014)

Chapter 2

ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is usually defined as the science of making computers to do things that require intelligence when done by humans. AI has had some success in limited, or simplified, domains. However, the five decades since the inception of AI have brought only very slow progress, and early optimism concerning the attainment of human-level intelligence has given way to an appreciation of the profound difficulty of the problem. Artificial intelligence is probably one of the most successful branches of a broad area of computing. The credit may be given to the media hype created for the area of AI. In the beginning, the field the AI promised to be the most exciting area and though out of shear overconfidence, at times even threatened to replace the human beings. In the historic Darthmoth conference, scientists predicted that by 1970's they would be able to build intelligent systems that could equal grand masters at chess game, understand spoken language and even compose classical music[33].

[33] Definition of AI as the study of intelligent agents:

- Poole, Mackworth & Goebel 1998, p. 1, which provides the version that is used in this article. Note that they use the term "computational intelligence" as a synonym for artificial intelligence.
- Russell & Norvig (2003) (who prefer the term "rational agent") and write "The whole-agent view is now widely accepted in the field" (Russell & Norvig 2003, p. 55).
- Nilsson 1998

However, the process involved in building intelligent systems is not a fish that can be caught easily, as it would have been imagined by the early researchers; rather it is one of the most intricate, complex and in one way or other most challenging job ever taken by human beings on their hands, willingly or unwillingly! We are calling it most challenging job ever, since human is trying to prototype his own mind. Yes! , astonishing but true! AI is in one way, an endeavour to prototype human mind. It could only be man could think of building something about which he hardly had enough knowledge initially, because it is only the man who since inventing fire among the first things invented by him thousands of years back up to inventing his own prototype Robot till today, can boast of inventing so many great and wonderful things in-between, that he has developed confidence to do anything he could think about! Consciously or unconsciously! In reality or in dreams!

The most challenging job in taking up the challenge mentioned above is the study of the complexity of human mind. Lot of work has been done, remaining is in progress[34].

2.1 ARTIFICIAL INTELLIGENCE: CONCEPT AND DEFINITION

Artificial is, what is not real or natural. We may term intelligence possessed by human beings as real intelligence because human beings develop this intelligence on their own. Hence, artificial intelligence is the intelligence which is created by human beings by applying various scientific and engineering techniques[35]. Since ages, man always used his mind and capacity to make others around him his slaves. Human endeavors were directed towards

[34] Artificial Intelligence by Ela Kumar L.k Publications

[35] Artificial Intelligence by S.K Bansal APH Publishing Corporation

making his tasks simpler by using other means and developing techniques which replace him from performing his duties which required labor and time. In achieving this feat, man developed many machines to assist him in not only performing routine tasks but also in the intricate areas of problem solving; effectively, efficiently and economically not only to match his own capabilities but to exceed the abilities of his own and others. For example, it was not possible for man to fly like birds. But seeing the birds fly made the man to think and develop some means to assist him in flying. It was this thought which led to the invention of aero planes. Now, a migratory bird takes weeks to fly from America to India whereas man can fly the same distance only in hours.

In the same way, many other machines were developed and also computers, which changed the human life and brought a revolution in many areas which required lot of labor, expertise and time in solving problems otherwise by employing other means. It is not at all difficult to imagine, that after developing computer and using it successfully over the years, the innovative mind of man would have thought about many questions such as:

1. Can a computer think like a man?
2. Can computer be intelligent like human beings? etc

Mere thinking about something new is different but if you go through the history, you will believe that man had always tried to embody his thoughts, dreams and ideas, sometimes unsuccessfully but most of the times, successfully. It is this nature of quest and zeal of man that made not only the animals but even machines his slaves. Hence, it cannot be a point of any contention that man ultimately tried to make most sophisticated and most precise tool on his hand, computer, and his slave. A slave is supposed not only to obey you but to perform or in some better way. Hence, when above

questions came to the mind of man, he started making computer intelligent so that it can think and act intelligently the same way as he himself acts by imparting intelligence in to it. Thus, in simple terms, developing a machine which can act intelligently is the scope of AI. Since, perhaps the intelligence possessed by machines is not real, that is not developed by themselves naturally of their own like humans, and it is artificial. The term Artificial Intelligence was first used by John McCarthy in 1956 and we are not very sure whether it is the right term used for the purpose and the process but it is used unanimously and widely by all the scientists, engineers and researchers worldwide[36].

It is not necessary for them to worry for a computer exhibiting general intelligence and development of a universal intelligent system. Hence, for majority of people,

" AI is the branch of engineering employed for the creation of computers that possess some form of intelligence and can be used to solve real world problems and function within a limited domain."

We cannot claim whether this is the appropriate definition of AI. Different researchers have proposed different definitions of AI based of their own study and understanding of the subject. Some of these are given below:

"AI is the automation of activities that we associate with human thinking, activities such as decision making, problem solving, learning....."
Bellman, 1978

[36] ibid

" AI is concerned with designing intelligent computer systems which exhibit the characteristics we associate with intelligence in human behaviour"

Barr and Feignenbaum, 1981

"AI is the study of mental faculties through the use of computational models"

Charniak and McDermott, 1985

"AI is the exciting new effort to make computers think.....machines with minds, in the full and literal sense."

Haugeland, 1985

There can still be more definitions of AI. Hence, as stated earlier, because of the abstract nature, it is difficult to define intelligence or Artificial Intelligence and it can be concluded that there is no standardize definition of AI as such, yet it has been accepted that whichever system exhibits the following characteristics/behavior can be considered as intelligent:

1. Learning
2. Understanding ambiguity
3. Handling the complexity
4. Responding quickly
5. Reasoning
6. Inferencing
7. Having vision
8. Maintaining knowledge regarding a particular task
9. Drawing conclusions from knowledge

In other words what people usually associate with thinking includes several facets of intelligence. Thus, a working definition of AI can be:

"To program computers to carry out tasks that would require intelligence if carried out by human beings."

This definition is relevant to a particular era, e.g. many years ago when the first computer that printed the payroll slip would have been considered intelligent because at that time a human being was preparing the payroll, but in today's context it is not an intelligent task.

After gaining sufficient understanding of AI, many questions would be coming to your mind, such as:

1. How does human mind function? What is the mechanism involved in process of thinking?
2. How much knowledge is required for making a computer intelligent?
3. How can knowledge be acquired?
4. How can knowledge be coded and represented?
5. What type of language is required for interacting with intelligent computer?
6. How can computers be made to learn and think?

There can be many such type of questions and it is answering of these questions that forms the scope of this dissertation. In this entire dissertation my basic obligation is to find out the answers of the above questions. The next important thing I would like to discuss is with respect to the History of Artificial Intelligence.

2.2 HISTORY OF ARTIFICIAL INTELLIGENCE

The origins of AI can be seen in Turing's work in his paper on intelligent machines published in 1950. Whilst working at Bletchley part, Turing formulated the first "paper models" of game playing programs[37]. Some date the origins of AI to McCarthy's invention of the LISP programming language in the 1950s. This was the first language designed for solving symbolic problems rather than numerical ones. Newell and Simon's GPs, showed how general search knowledge could be used to solve a range of problems such as the missionaries and cannibals problem. In the 1970s, expert systems were developed which embodied as a set of rules the knowledge of an expert. The most famous of these was the MYCIN medical expert system. At the same time systems were developed to understand language, of which the most famous was Winograd's SHRDLU system. The 1980s saw the development of neutral networks as a method of learning examples.

AI is good around 65 years old now. We can divide the developments taken place during its lifetime, since its inception way back in 1940s, till date, into various groups as mentioned subsequently for getting an account of the history of AI which will not only provide us an information about what all has already been done, how and by whom, but also will help us to form guidelines for future scope of work in the field of AI in particular, and other related fields in general[38].

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[37] This insight, that digital computers can simulate any process of formal reasoning, is known as the Church–Turing thesis

[38] Formal reasoning:

Berlinski, David(2000). *The Advent of the Algorithm*. Harcourt Books

CONCEPTION OF AI (1943-1955)

Warren McCulloch and Walter Pitts proposed a model of artificial neurons way back in 1943. This is the first work that is considered as AI. McCulloch, after acquiring medical degree began his research in epilepsy, head injuries and the central nervous systems. In their work, McCulloch and Pitts showed that any computable function could be computed by some network of neurons and that all the connectives used in framing sentences like, and, or, not etc, are computational in nature. In their study, they were guided by basic physiology, analysis of propositional logic and Turing's theory of computation. They also suggested that suitably defined networks could learn.

Marvin Minsky and Dean Edmonds, two students of Princeton mathematics department built the first neutral network computer in 1951 which is known as SNARC. Their work though, did not get early recognition, Minsky later on proved influencing theorems showing the limitations of neutral network research[39].

There were many such types of early works which could be recognized as AI, but it was Alan Turing who is given credit for evolving and exhibiting complete vision of AI in his article published in 1950, 'Computing Machinery and Intelligence'. After this only he introduced his famous **"Turing Test"**.

[39] Artificial Intelligence by Ela kumar Lk publications

THE BIRTH OF AI (1956)

Another important and influential figure in the field of AI was John McCarthy, who joined Dartmouth College after graduation. He made it convenient to organize a two month long workshop along with Minsky and others which involved U.S. researchers also who were interested in automata theory, neural nets and the study of intelligence. The workshop was organized in the summers of 1956 at Dartmouth which ultimately became the official birthplace of AI.

Though there were ten attendees in the workshop, Allen Newell and Herbert Simon, two researchers from Carnegie Tech overtook the scene because they already had a reasoning program called 'Logic Theorist' that could boast of thinking and solving the mind-body problem. Although, others also had their own ideas and same program for particular applications, the work of Newell and Simon was far more advance.

Though Dartmouth conference did not come out with something substantial and new, it at least provided researchers from different institutes working in different areas a common platform to interact with one another and it is not surprising that for the next 20 years or so, the field of AI was dominated by these people and their students. We can imagine that perhaps none discussed or inferred topics or issues on the said conference would be lasting till date, but one thing which came out of the conference and turned everlasting was the consensus to adopt new name for the field given by McCarthy as artificial intelligence[40].

[40] ibid

ADOLESCENCE OF AI (1952-1969)

Few years earlier before people started thinking to use computer as an intelligent machine, it was acting as mere a calculator that could do arithmetic and nothing more. Hence, in the beginning, there was lot of enthusiasm among the researchers and they started considering each and every thing little clever and unconventional as AI. Alan Turing listed following things which were considered taboo for machines:

"Be kind, resourceful, beautiful, friendly, have initiative, have a sense of humour tell right from wrong, make mistakes, fall in love, enjoy strawberries and cream, make someone fall in love with it, learn with experience, use words properly, be the subject of its own thought, have as much diversity of behavior as man, do something really new."

If we view the above mentioned things closely, we would believe that all those are typically associated with living beings or man and are abstract in nature. It would have been very difficult for someone to imagine that machines could possess any of those. Hence, whenever computers performed some new task and the researchers tend to believe that as AI, others were there to mention any of the above mentioned things to contradict their point of view. Thus, early years of 1950s were full of controversies, actions and counteractions in spite of being full of enthusiasm.

The year 1958 became the historic year in the field of AI because of crucial contributions by McCarthy while working at MIT. First, he developed the high-power language LISP which became dominant programming language and is the second oldest language still in use. Secondly, McCarthy in the same year published a paper entitled *'programs with common sense'*. In this paper he described a hypothetical program called *Advice Taker* that can be considered

as first complete AI program. Marvin Minsky also moved to MIT in 1958. He along with McCarthy started working at MIT and their association, though not very long produced some notable works.

Parallel works were done at IBM also by Rochester and his colleagues who produced some of the early AI programs. In 1959, Herbert Gelernter built the Geometry Theorem Prover that could prove theorems which were difficult and tedious for students of mathematics. Arthur Samuel wrote many programs for checkers starting from 1952 which learned to play like a professional player and later on could achieve degree of proficiency of the level that surpassed even that of its creator[41].

YOUTHFULNESS OF AI (1969-1979)

As has been mentioned earlier, during the early stage of the research in the field of AI, even small clever things computer did were considered as intelligent. Out of shear enthusiasm, Simon predicted that within 10 years computer would become a chess champion and machine would be able to prove mathematical theorem considered difficult even for humans. These predictions were made during 1955 and today we know that they became reality but only after around 40 years from the date those were made. Such type of overconfidence of the likes of Simon was not undesired because the response of the computer in solving small problems was highly encouraging, but when the same systems were tested for extended versions of the problems or for varying nature of problems, they failed miserably.

[41] Cybernetics and early neural networks (in History of artificial intelligence) Among the researchers who laid the foundations of AI were Alan Turing, John von Neumann, Norb

When earlier intelligent systems faced reality, they could not perform satisfactorily because they contained very less or almost nil knowledge of the area in which they functioned. It was then when the importance of knowledge was really felt in developing an intelligent system. Almost a decade of the early research was inclined to find out complete solutions of the problems by trying out different permutations and combinations of the steps involved. This method was termed as ***weak method*** because, though the method was intended to generalize the system, they were unable to produces systems that could handle difficult problems. This is when need arose to build systems that could handle almost all the problems of a particular area using a powerful knowledge base in a limited domain. This approach was termed as ***strong method*** and became very successful in building intelligent programs having human like expertise in a particular application area.

MATURITY AND COMMERCIALIZATION OF AI (1980-present)

Once AI attained required level of maturity, commercial applications of AI started in form of building expert systems to solve real world problems. The first commercial system in its aim was RI that started operations in 1882. By the year 1988, the AI department of Digital Equipment Corporation was able to develop about 40 expert systems. Every major U.S. Corporation had its own AI group which was associated in research and development works related to AI. Japanese announced 'Fifth Generation' project in 1981 to build expert systems running prolong. During the same period, U.S. formed the Microelectronics and Computer Technology Corporation (MCC) as a research establishment keeping AI as part of broad effort that included design and manufacturing of chips.

The earlier developments and concepts of the field of AI might not be relevant today and the approach as well as the process the undergone a sea changes over the years especially during last 20 years or so. Many exciting and interesting innovations have occurred in the fields of knowledge representation, robotics and computer vision. With the advancements made in the field of AI and increased association of more and more researchers, scientists and engineers to the field, it has become possible to understand the problems and their complexities in a better way. Use of technology and knowledge of divergent fields led to application of vigorous methods and workable research agendas. Today, the field has become so big and diversified that it has been divided into different specializations and the areas such as vision and robotics etc. have been isolated from the main stream AI[42].

2.3 RELATED CONCEPTS ABOUT AI

Under this area I would like to deal with the general and related concepts about the field of Artificial Intelligence. They are stated as follows:

General Artificial Intelligence

There is one research group that claims to develop the concepts exhibiting artificial intelligence in general domain. It is called general artificial intelligence. General artificial intelligence research aims to create AI that can replicate human's intelligence completely, often called an *Artificial General Intelligence* (AGI) to distinguish it from less ambitious AI projects. As yet,

[42] Artificial Intelligence by ELa kumar Lk publications

researchers have devoted little attention to AGI, many claiming intelligence is too complex to completely replicate[43].

The AI and Consciousness

Efforts have been made to develop a relationship between the concepts of Artificial Intelligence and human consciousness. It is analyzed that whether a machine can be developed giving the attention towards a particular problem like a human being[44]. Even a machine that passed the Turing test would not necessarily be conscious in its efforts like the human beings are. The supporters of strong AI claim that machine can really develop the human consciousness equal to human being. The truth of Strong AI depends upon whether information processing machines can include all the properties of minds such as consciousness. However, Weak AI is independent of the Strong AI problem and there can be no doubt that many of the features of modern computers such as multiplication or database searching might have been considered 'intelligent' only a century ago[45].

Weak and Strong AI

There are two themes of thoughts in Artificial intelligence, namely *weak AI* and *strong AI*. Strong AI is the supposition that some forms of artificial intelligence can truly reason and solve problems; strong AI supposes that it is possible for machines to become sapient, or self-aware, but may or may not

[43] (Kurzweil 2005, p. 260) or see Advanced Human Intelligence where he defines strong AI as "machine intelligence with the full range of human intelligence."

[44] The Age of Artificial Intelligence: George John at TEDxLondonBusinessSchool 2013

[45] Newell & Simon 1976. This the term they use for "human-level" intelligence in the physical symbol system hypothesis

exhibit humanlike thought processes. The term strong AI was originally coined by John Searle, who writes:

"according to strong AI, the computer is not merely a tool in the study of the mind; rather, the appropriately programmed computer really is a mind".

In the contrast to strong AI, weak AI refers to the use of software to study or accomplish specific *problem solving or reasoning* tasks that do not encompass the full range of human cognitive abilities[46].

Turing Test

Turing test is considered as the basic test for intelligence. It is said that a machine passing this test can be considered as intelligent. In 1950 famous mathematician Alan Turing proposed this test. He proposed to consider the question "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think".

Turing Test is meant to determine if a computer program has intelligence. When talking about the Turing Test today what is generally understood is the following: The interrogator is connected to one person and one machine via a terminal, therefore can't see her counterparts. Her task is to find out which of the two candidates the machine is, and which the human is only by asking those questions. If the machine can "fool" the interrogator, it is intelligent[47].

[46] Encyclopædia Britannica Strong AI, applied AI, and cognitive simulation or Jack Copeland What is artificial intelligence? on AlanTuring.net

[47] The Dartmouth conferences of 1956 are widely considered the "birth of AI". (Crevier 1993, p. 49)

In order to keep the test simple, conversation is limited to text channel only. Though the Turing test is considered as the basic test for considering a machine as intelligent, it faced lot of criticism subsequently. Some of the points criticizing it are mentioned below:

1. People said befooling somebody is not intelligence. Rather intelligence should be defined in a positive sense because doing the assigned work properly and more efficiently is intelligence.
2. Computer, as a machine possesses more memory than human being does, so it should be better at tasks that require memory. Comparing it equal to human being is itself a faulty definition of intelligence.
3. The speed of solving a task from computer should be faster than human being. The Turing test did not talk anything about the speed.

Besides the criticisms and many modifications in the basic definitions of intelligence, the Turing test is still considered as basic test of intelligence[48].

2.4 COMPARISON OF HUMAN AND COMPUTER SKILLS

The Artificial intelligence is the area of making the computers able to do the works now done by humans. Hence, it is must to understand deeply the skills of human and computers.

There are certain tasks computers can perform better than human beings. These are:

1) Problems requiring big numerical computation

[48] "Intelligent Machinery" (1948) was not published by Turing, and did not see publication until 1968 in:

- Evans, A. D. J.; Robertson (1968), *Cybernetics: Key Papers*, University Park Press

2) Problems requiring large amount of information storage
3) Problems requiring a task to be performed repeatedly.

It is a well-known fact that computers do not get bored, to repeat the same process every day. Hence, the jobs where a task is to be repeated periodically the computers outperform their creator, the human being.

Humans use common sense to make our way through a world, which seemingly sometimes appears highly illogical. The possession and use of common sense knowledge is very positive aspect of human being over computers. It includes finding the solution in very limited number of steps. It also includes knowing what we know vaguely and what we know clearly. Possessing the intelligence requires the possession of following characteristics:

1) Flexibly reacting in any situation
2) Drawing the conclusion and making sense out of ambiguous or contradictory messages
3) To attach relative importance to different elements of a situation.
4) To find similarities between situations despite differences which may separate them.
5) To find the differences between situations despite similarities which may link them. The two situations may look similar on the surface, yet we are able to note the difference and hence adjust our reaction.

The list of skills where, humans outperform the computers is long. In fact, the activities involving cognitive skills are performed better by human beings[49].

[49] ibid

2.5 PRACTICAL SYTEMS BASED ON AI

Some of the systems based on AI and used practically are:

1) ***Autonomous vehicles:*** A DARPA-funded onboard *computer system from Carnegie Mellon University* drove a van all but 52 of the 2849 miles from Washington, DC to San Diego, averaging 63 miles per hour day and night, rain or shine;
2) ***Computer chess:*** *Deep Blue*, a chess computer built by IBM researchers, defeated world champion Gary Kasparov in a landmark performance;
3) ***Mathematical theorem proving:*** A *computer system at Argonne National Laboratories* proved a long-standing mathematical conjecture about algebra using a method that would be considered creative if done by humans;
4) ***Advanced user interfaces:*** *PEGASUS* is a spoken language interface connected to the American Airlines EAASY SABRE reservation system, which allows subscribers to obtain flight information and make flight reservations via a large, on-line, dynamic database, accessed through their personal computer over the telephone.

THE DEVELOPMENT OF LOGIC

In the seventeenth century, Gottfried Wilhelm von Leibniz, with his Calculus Philosophicus, introduced the first system of formal logic as well constructed the machine for automating its calculation. In eighteenth century, Euler, with his analysis for the connectedness of the bridges joining the river bank and

islands of the city of Konigsberg, introduced the study of representation that abstractly captures the structure of relationship in the world.

The 19th century Charles Babbage, who is considered as originator of the science of operation research, also has contributed a lot in the area of artificial intelligence. Babbage's "difference engine" was a special purpose machine for computing the value of certain polynomial functions and is considered as a pioneer of analytical engine. The analytical engine designed but not successfully constructed during his lifetime was a general purpose programmable computing machine that possessed many of the architectural assumptions underlying the modern computer.

Another 19th century mathematician George Boole contributed a lot by developing formal languages. Later on, these logic based languages were popularly used for the implementation of AI problems. Though he made contributions to number of areas of mathematics, his best known work was in the mathematical formalization of the laws of the logic, an accomplishment that forms the very heart of modern computer science.

Though in the eighteenth, nineteenth and twentieth century the development of logic was done in a big way, it was not until in twentieth century the introduction of digital computers. AI became the viable scientific field. By the end of 1940 the digital computers were available in well developed form to have memory and processing power required by intelligent programs. With this development it became possible to implement formal reasoning system on a computer and to empirically test their ability for exhibiting intelligence[50].

[50] Artificial Intelligence by Ela Kumar Lk publications

2.6 COMPONENTS OF A.I

Theoretical Components

The theory of Artificial Intelligence consists of the following components. They are stated as follows:

1. Problem solving through heuristics techniques
2. Knowledge representation
3. Handling uncertain situations
4. Theorem proving
5. Game playing
6. Natural language processing
7. Expert systems
8. Computer vision
9. Dealing philosophical issues

HARDWARE/SOFTWARE COMPONENTS OF AI

Software

The software, which takes part in AI software systems, is:

1) Machine language
2) Assembly language
3) High level language
4) LISP language
5) 4^{th} generation language
6) Object oriented language
7) Distributed language
8) Natural language

Architecture

1) Uniprocessor
2) Multiprocessor
3) Special purpose processor
4) Array processor
5) Vector processor
6) Parallel processor
7) Distributed processor

AI Components

1) Symbolic processing
2) Numeric processing
3) Pattern matching
4) Problem/puzzle solving
5) Logic representation
6) Heuristic search
7) Natural language processing
8) Knowledge representation
9) Expert system
10) Neutral networks
11) Learning
12) Planning

2.7 INTRODUCTION TO KNOWLEDGE

Knowledge is a familiarity, awareness or understanding of someone or something, such as facts, information, descriptions, or skills, which is acquired through experience or education by perceiving, discovering, or learning[51]. Knowledge can refer to a theoretical or practical understanding of a subject. It can be implicit (as with practical skill or expertise) or explicit (as with the theoretical understanding of a subject); it can be more or less formal or systematic. In philosophy, the study of knowledge is called epistemology; the philosopher Plato famously defined knowledge as "justified true belief". However, no single definition of knowledge exists, though there are numerous theories to explain it[52].

Knowledge acquisition involves complex cognitive processes: perception, communication, association and reasoning; while knowledge is also said to be related to the capacity of *acknowledgment* in human beings.

Knowledge plays an important role in building AI systems. It is the core aspect of Artificial Intelligence. It is the presence of knowledge that differentiates ordinary human from an expert. An expert of any field possesses more knowledge of that field. In a layman's language knowledge can be defined as the body of facts and principles accumulated by human being, or act or state of knowing. In addition of these basic aspects, knowledge has familiarity with language, concepts, procedures, rules, ideas, abstraction, places, customs, facts, and associations coupled with the ability to use these notions effectively in modeling different aspects of the world. Without this ability these concepts and aspects are worthless. Knowledge is

[51] http://oxforddictionaries.com/view/entry/m_en_us1261368#m_en_us1261368 (visited on 12th May 2014)

[52] Stanley Cavell, "Knowing and Acknowledging", *Must We Mean What We Say?* (Cambridge University Press, 2002), 238–266.

related with the intelligence by the fact that intelligence requires possession and access of knowledge[53].

TYPES OF KNOWLEDGE

Knowledge can be of various types like:

1. Declarative Knowledge
2. Procedural knowledge
3. Inheritable knowledge
4. Inferential knowledge
5. Relational knowledge
6. Heuristic knowledge
7. Common sense knowledge
8. Explicit knowledge
9. Implicit knowledge
10. Uncertain knowledge

1. Declarative Knowledge

Descriptive knowledge, also **declarative knowledge** or **propositional knowledge**, is the type of knowledge that is, by its very nature, expressed in declarative sentences or indicative propositions. This distinguishes descriptive knowledge from what is commonly known as "know-how", or procedural knowledge (the knowledge of how, and especially how best, to perform some task), and "knowing of ", or knowledge by acquaintance (the knowledge of something's existence).

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53 http://www.centenary.edu/attachments/philosophy/aizawa/courses/epistemologyf2008/kirkham1984.pdf (visited on May 12th 2014)

The difference between knowledge and beliefs is as follows: A belief is an internal thought or memory which exists in one's mind. Most people accept that for a belief to be knowledge it must be, at least, true and justified. The Gettier problem in philosophy is the question of whether there are any other requirements before a belief can be accepted as knowledge. This knowledge tells 'what' about a situation, e.g., the facts about the college like its building, its courses, location, organizational set up consist of declarative knowledge[54].

2. Procedural Knowledge

In artificial intelligence, procedural knowledge is one type of knowledge that can be possessed by an intelligent agent. Such knowledge is often represented as a partial or complete finite-state machine or computer program. A well-known example is the Procedural Reasoning System, which might, in the case of a mobile robot that navigates in a building, contain procedures such as "navigate to a room" or "plan a path". In contrast, an AI system based on declarative knowledge might just contain a map of the building, together with information about the basic actions that can be done by the robot (like moving forward, turning, and stopping), and leave it to a domain-independent planning algorithm to discover how to use those actions to achieve the agent's goals[55].

3. Inheritable knowledge

In real world, there are many situations where general concepts regarding some event, thing or activity are already known, and object of that particular

[54] http://en.wikipedia.org/wiki/Descriptive_knowledge (visited on 12th may 2014)

[55] Koedinger, K.R. & Corbett, A. (2006). Technology Bringing Learning Sciences to the Classroom. In Sawyer, R.K. (Ed.), The Cambridge Handbook of the Learning Sciences (61-75). New York: Cambridge University Press

type inherits all features of that event, e.g., consider the word "college". A "college" has certain features like it will have classrooms, teachers, a playground, building, students, office etc, further, the classrooms will have a blackboard, cupboard, furniture, students etc, Besides these, there will be some general concepts regarding the functioning of the college, like it will have time table for each class, a fee deposit plan, examination pattern, course module, cultural activity, etc. Similarly, it can have many more deep concepts like promotional scheme of its staff, placement of its student etc[56].

4. Inferential knowledge

Inferential knowledge is based on reasoning from facts or from other inferential knowledge such as a theory. Such knowledge may or may not be verifiable by observation or testing. The distinction between factual knowledge and inferential knowledge has been explored by the discipline of general semantics. The inferential knowledge requires an inference mechanism for the purpose of exploiting it. The inference procedures implement the standard logic rules of inference. The forward inference moves from start state to goal state, and backward inference starts from goal towards start state. Resolution is one such procedure. This form of knowledge is powerful structure, which describes relationships among values.

[56] Artificial Intelligence by Ela Kumar Lk publications

5. Relational knowledge

In this type of knowledge, the facts are expressed as set of relations in a tabular form. The table stores salient attributes of object, e.g., the knowledge regarding students may be represented as mentioned in the following figure

Player	Height	Weight	Bats
A	6-0	180	Left
B	5-10	170	Right
C	6- 2	215	
D	6-3	205	

Fig: knowledge about student

This representation is the simplest and can be used in database systems. It can be used to answer simplest questions like "who is the tallest boy, "whose marks are maximum", "who is worst in communication skills", but this representation is very simple and cannot store any semantic information,

e.g., from this representation, it cannot answer the queries like "is Adwet a good boy?"[57].

6. Heuristic knowledge

This type of knowledge can be defined as experimental, rarely discussed and individualistic knowledge. This is more of a judgmental knowledge of any performance. For example, knowledge of good guessing is heuristic knowledge. Such type of knowledge cannot be acquired from books; rather it comes from within the individual and differs from individual to individual.

7. Commonsense knowledge

In artificial intelligence research, **commonsense knowledge** is the collection of facts and information that an ordinary person is expected to know. The **commonsense knowledge problem** is the ongoing project in the field of knowledge representation (a sub-field of artificial intelligence) to create a **commonsense knowledge base**: a database containing all the general knowledge that most people possess, represented in a way that it is available to artificial intelligence programs that use natural language or make inferences about the ordinary world. Such a database is a type of ontology of which the most general are called upper ontologies[58].

The problem is considered to be among the hardest in all of AI research because the breadth and detail of commonsense knowledge is enormous. Any task that requires commonsense knowledge is considered AI-complete: to be done as well as a human being does it, it requires the machine to appear as intelligent as a human being. These tasks include machine

[57] ibid

[58] Lenat, Douglas; Guha, R. V.(1989), *Building Large Knowledge-Based Systems*, Addison-W

translation, object recognition, text mining and many others. To do these tasks perfectly, the machine simply has to know what the text is talking about or what objects it may be looking at, and this is impossible in general unless the machine is familiar with all the same concepts that an ordinary person is familiar with[59].

8. Explicit knowledge

Explicit knowledge is knowledge that has been articulated, codified, and stored in certain media. It can be readily transmitted to others. The information contained in encyclopedias and textbooks are good examples of explicit knowledge. The most common forms of explicit knowledge are manuals, documents, procedures, and how-to videos. Knowledge also can be audio-visual. Works of art and product design can be seen as other forms of explicit knowledge where human skills, motives and knowledge are externalized.

9. Tacit knowledge

Tacit knowledge (as opposed to formal, codified or explicit knowledge) is the kind of knowledge that is difficult to transfer to another person by means of writing it down or verbalizing it. For example, stating to someone that London is in the United Kingdom is a piece of explicit knowledge that can be written down, transmitted, and understood by a recipient. However, the ability to speak a language, use algebra, or design and use complex equipment requires all sorts of knowledge that is not always known explicitly, even by expert practitioners, and which is difficult or impossible to explicitly transfer to other users.

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[59] Davis, Ernest (1990), *Representations of Commonsense Knowledge*, Morgan Kaufmann

With tacit knowledge, people are not often aware of the knowledge they possess or how it can be valuable to others. Effective transfer of tacit knowledge generally requires extensive personal contact, regular interaction and trust. This kind of knowledge can only be revealed through practice in a particular context and transmitted through social networks. To some extent it is "captured" when the knowledge holder joins a network or a community of practice[60].

Tacit knowledge is not easily shared. Although it is that which is used by all people, it is not necessarily able to be easily articulated. It consists of beliefs, ideals, values, schemata and mental models which are deeply ingrained in us and which we often take for granted. While difficult to articulate, this cognitive dimension of tacit knowledge shapes the way we perceive the world.

10. Uncertain knowledge

There is one more property of knowledge, that is, it is uncertain and usually incomplete. Though we have defined various types of knowledge above, but still it is crude fact that regarding any organization/phenomenon/problem the complete knowledge cannot be provided. What we provide, is the information which is known to us. Hence we can say that we provide knowledge complete to the best of our capacity, but that is never absolutely complete. Moreover, the knowledge is uncertain also. The real world phenomenons are highly uncertain. The kind of knowledge required to represent this is uncertain knowledge. It provides the methods to deal with uncertain situations. The set of methods for using uncertain data in the form of uncertain knowledge in the reasoning process is called reasoning with

[60] Goffin, K. & Koners, U. (2011). Tacit Knowledge, Lessons Learnt, and New Product Development. J PROD INNOV MANAG, 28, 300–318.

uncertainty[61]. An important subclass of methods adopted for reasoning with uncertainty are by using probabilistic techniques or "fuzzy logic", and the systems that use such methods are called "fuzzy systems".

2.8 KNOWLEDGE REPRESENTATION

Knowledge representation is the method used to encode knowledge in an intelligent system's knowledge base. A knowledge representation (KR) is most fundamentally a surrogate, a substitute for the thing itself, used to enable an entity to determine consequences by thinking rather than acting, i.e., by reasoning about the world rather than taking action in it. It is a set of ontological commitments, i.e., an answer to the question: In what terms should I think about the world? It is a fragmentary theory of intelligent reasoning, expressed in terms of three components: (i) the representation's fundamental conception of intelligent reasoning; (ii) the set of inferences the representation sanctions; and (iii) the set of inferences it recommends. It is a medium for pragmatically efficient computation, i.e., the computational environment in which thinking is accomplished. One contribution to this pragmatic efficiency is supplied by the guidance a representation provides for organizing information so as to facilitate making the recommended inferences. It is a medium of human expression, i.e., a language in which we say things about the world.

Understanding the roles and acknowledging their diversity has several useful consequences. First, each role requires something slightly different from a representation; each accordingly leads to an interesting and different set of properties we want a representation to have.

[61] Artificial Intelligence by Ela kumar Lk publications

Second, we believe the roles provide a framework useful for characterizing a wide variety of representations. We suggest that the fundamental "mindset" of a representation can be captured by understanding how it views each of the roles, and that doing so reveals essential similarities and differences[62].

Third, we believe that some previous disagreements about representation are usefully disentangled when all five roles are given appropriate consideration. We demonstrate this by revisiting and dissecting the early arguments concerning frames and logic.

Finally, we believe that viewing representations in this way has consequences for both research and practice. For research, this view provides one direct answer to a question of fundamental significance in the field. It also suggests adopting a broad perspective on what's important about a representation, and it makes the case that one significant part of the representation endeavor--capturing and representing the richness of the natural world--is receiving insufficient attention. We believe this view can also improve practice by reminding practitioners about the inspirations that are the important sources of power for a variety of representations[63].

2.9 KNOWLEDGE ACQUISITION

Knowledge acquisition is a method of learning, first proposed by Aristotle in his seminal work "Organon". Aristotle proposed that the mind at birth is a blank slate, or tabula rasa. As a blank slate it contains no knowledge of the objective, empirical universe, or of itself. ("Knowing subject" is often the description of a mind with acquired knowledge. It is found in the writings of

[62] http://groups.csail.mit.edu/medg/ftp/psz/k-rep.html (visited on 12th may 2014)

[63] Maynard Smith, John (1986). *Problems in Biology*. Oxford: Oxford University Press. p. 78. ISBN 0-19-219213-2, "We can treat the brain as a black box into whose contents it is not efficient to enquire... This is in effect the behaviorist approach."

David Hume, Karl Popper, and many others. Therefore, a human mind cannot be a "knowing subject" until it has "acquired knowledge". "Acquired" in this sense can be either an adjective, as in "that which has been acquired"; or a verb, as in the act of acquisition.

As a method, it is opposed to the concept of "a priori" knowledge, and to "intuition" when conceived as religious revelation. It has been suggested that the mind is "hard wired" to begin operating at birth, beginning a lifetime process of acquisition through abstraction, induction, and conception. The acquisition of empirical knowledge, which begins the process of filling the *tabula rasa*, is thus by means of the *experience* of sensation and perception. Though sensation and perception are described elsewhere in Wikipedia as parts of "psychology, and not [of] anatomy or physiology," they belong to cognitive science.

The "five senses" referred to by the word *sensation* [see sense] are metaphorically the interface between empirical (sensate) reality and the consciousness of the *knowing subject*. A *knowing subject* for the purpose of this discussion of knowledge acquisition may be defined as any conscious creature capable of deriving direct and immediate sensate data from its environment[64].

[64] Gruber, Thomas R. (June 1993). "A translation approach to portable ontology specifications"-Knowledge acquisitions

2.10 KNOWLEDGE ORGANIZATION AND MANAGEMENT

A **knowledge organization** is a management idea, describing an organization in which people use systems and processes to generate, transform, manage, use, and transfer knowledge-based products and services to achieve organizational goals. A knowledge organization also links past, present, and future by capturing and preserving knowledge in the past, sharing and mobilizing knowledge today, and knowledge organizations can be viewed from a number of perspectives: their general nature, networks, behavior, human dimensions, communications, intelligence, functions and services[65].

Knowledge organizations have a network dimension. Davis (1977) states that networks would not replace hierarchies, but that the two would coexist within a broader organizational concept. Similarly, Amidon (1997) points out those traditional industrial-era hierarchies are neither flexible nor fluid enough to mobilize an organization's intellectual capacity and that much less constrained networked organizational forms are needed for modern decision making. There is also a behavioral approach. Bartlett (1999) indicates that organizational structure is just a skeleton. Knowledge organizations also have a physiology in the form of the flow of information and knowledge, as life-blood. They also have a psychology represented by people's values and how they act as individuals and collectively.

Knowledge is created and used by people. Strassman (1985) described the transformation of work in the electronic age from the standpoint of education and training for managers and employees, human aspects of the working

[65] Hoetzlein R., 2007. The Organization of Human Knowledge: Systems for Interdisciplinary Research.

environment, and issues of morale, motivation, privacy, and displacements. Bartlett (1999) indicates that empowerment is not possible in an autocratic organization that networks cannot be sustained in fixed hierarchical structure, and that learning is not possible in an environment constrained by rigid policies and procedures. Davenport (1997) used an information ecology approach, in which he explored the use and abuse of information in the context of infighting, resource hoarding, and political battles as well as appropriate management in such a context.

Knowledge organizations also have collective intelligence. Liautaut (2001) points out that in the knowledge economy, being an intelligent business is not only a prerequisite to winning, but even to compete in the first place. In a fluid, fast-paced knowledge market, companies that can find and exploit the slightest advantage for faster, better decision making will dominate. He also indicates that the greater the exchange of data and information across an organization, the more intelligent it will be.

BASIC CONCEPTS OF KNOWLEDGE ENGINEERING

Knowledge engineering (KE) was defined in 1983 by Edward Feigenbaum and Pamela McCorduck, as follows:

KE is an engineering discipline that involves integrating knowledge into computer systems in order to solve complex problems normally requiring a high level of human expertise.

It is used in many computer science domains such as artificial intelligence, including databases, data mining, bioinformatics, expert systems, decision support systems and geographic information systems. Knowledge

engineering is also related to mathematical logic, as well as strongly involved in cognitive science and socio-cognitive engineering where the knowledge is produced by socio-cognitive aggregates (mainly humans) and is structured according to our understanding of how human reasoning and logic works[66].

Various activities of KE specific for the development of a knowledge-based system:

- Assessment of the problem
- Development of a knowledge-based system shell/structure
- Acquisition and structuring of the related *information*, *knowledge* and specific *preferences* (IPK model)
- Implementation of the structured knowledge into knowledge bases
- Testing and validation of the inserted knowledge
- Integration and maintenance of the system
- Revision and evaluation of the system.

Being still more art than engineering, KE is not as neat as the above list in practice. The phases overlap, the process might be iterative, and many challenges could appear[67].

[66] Negnevitsky, Michael (2005), *Artificial Intelligence: A Guide to Intelligent Systems*, Addison Wesley,

[67] Schreiber, August Th.; Akkermans, Hans; Anjewierden, Anjo; Dehoog, Robert; Shadbolt, Nigel; Vandevelde, Walter; Wielinga, Bob (2000), *Knowledge engineering and management: the CommonKADS methodology* (1st ed.), Cambridge, MA: The MIT Press, ISBN 978-0-262-19300-9

2.11 APPLICATIONS OF ARTIFICIAL INTELLIGENCE

Neural Networks

In computer science and related fields, **artificial neural networks (ANNs)** are computational models inspired by animals' central nervous systems (in particular the brain) that are capable of machine learning and pattern recognition. They are usually presented as systems of interconnected "neurons" that can compute values from inputs by feeding information through the network.

For example, in a neural network for handwriting recognition, a set of input neurons may be activated by the pixels of an input image representing a letter or digit. The activations of these neurons are then passed on, weighted and transformed by some function determined by the network's designer, to other neurons, etc., until finally an output neuron is activated that determines which character was read[68].

Neural networks are also similar to biological neural networks in performing functions collectively and in parallel by the units, rather than there being a clear delineation of subtasks to which various units are assigned. The term "neural network" usually refers to models employed in statistics, cognitive psychology and artificial intelligence. Neural network models which emulate the central nervous system are part of theoretical neuroscience and computational neuroscience[69].

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[68] Bhadeshia H. K. D. H. (1999). "Neural Networks in Materials Science". *ISIJ International* **39** (10): 966–979. doi:10.2355/isijinternational.39.966.

[69] Bishop, C.M. (1995) *Neural Networks for Pattern Recognition*, Oxford: Oxford University Press

History of Neural Networks

In the late 1940s psychologist Donald Hebb created a hypothesis of learning based on the mechanism of neural plasticity that is now known as Hebbian learning. Hebbian learning is considered to be a 'typical' unsupervised learning rule and its later variants were early models for long term potentiation. These ideas started being applied to computational models in 1948 with Turing's B-type machines[70].

Neural network research stagnated after the publication of machine learning research by Marvin Minsky and Seymour Papert (1969). They discovered two key issues with the computational machines that processed neural networks. The first issue was that single-layer neural networks were incapable of processing the exclusive-or circuit. The second significant issue was that computers were not sophisticated enough to effectively handle the long run time required by large neural networks. Neural network research slowed until computers achieved greater processing power. Also key later advances was the back propagation algorithm which effectively solved the exclusive-or problem (Werbos 1975).

The parallel distributed processing of the mid-1980s became popular under the name connectionism. The text by David E. Rumelhart and James McClelland (1986) provided a full exposition on the use of connectionism in computers to simulate neural processes[71].

Neural networks, as used in artificial intelligence, have traditionally been viewed as simplified models of neural processing in the brain, even though the relation between this model and brain biological architecture is debated,

[70] Egmont-Petersen, M., de Ridder, D., Handels, H. (2002). "Image processing with neural networks – a review". *Pattern Recognition* **35** (10): 2279–2301.

[71] Artificial Intelligence by S.K Bansal APH Publishing Corporation

as it is not clear to what degree artificial neural networks mirror brain function.

In the 1990s, neural networks were overtaken in popularity in machine learning by support vector machines and other, much simpler methods such as linear classifiers. Renewed interest in neural nets was sparked in the 2000s by the advent of deep learning.

Recent Improvements

Between 2009 and 2012, the recurrent neural networks and deep feedforward neural networks developed in the research group of Jürgen Schmidhuber at the Swiss AI Lab IDSIA have won eight international competitions in pattern recognition and machine learning. For example, the bi-directional and multi-dimensional long short term memory (LSTM) of Alex Graves et al. won three competitions in connected handwriting recognition at the 2009 International Conference on Document Analysis and Recognition (ICDAR), without any prior knowledge about the three different languages to be learned. Fast GPU-based implementations of this approach by Dan Ciresan and colleagues at IDSIA have won several pattern recognition contests, including the IJCNN 2011 Traffic Sign Recognition Competition, the ISBI 2012 Segmentation of Neuronal Structures in Electron Microscopy Stacks challenge, and others. Their neural networks also were the first artificial pattern recognizers to achieve human-competitive or even superhuman performance on important benchmarks such as traffic sign recognition (IJCNN 2012), or the MNIST handwritten digits problem of Yann LeCun at NYU. Deep, highly nonlinear neural architectures similar to the 1980 neocognitron by Kunihiko Fukushima and the "standard architecture of vision" can also be pre-trained by unsupervised methods of Geoff Hinton's lab at University of Toronto. A team from this lab won a 2012 contest

sponsored by Merck to design software to help find molecules that might lead to new drugs.

Employing Artificial Neural Networks

Perhaps the greatest advantage of ANNs is their ability to be used as an arbitrary function approximation mechanism that 'learns' from observed data. However, using them is not so straightforward, and a relatively good understanding of the underlying theory is essential.

- Choice of model: This will depend on the data representation and the application. Overly complex models tend to lead to problems with learning.
- Learning algorithm: There are numerous trade-offs between learning algorithms. Almost any algorithm will work well with the *correct hyper parameters* for training on a particular fixed data set. However, selecting and tuning an algorithm for training on unseen data requires a significant amount of experimentation.
- Robustness: If the model, cost function and learning algorithm are selected appropriately the resulting ANN can be extremely robust.

With the correct implementation, ANNs can be used naturally in online learning and large data set applications. Their simple implementation and the existence of mostly local dependencies exhibited in the structure allows for fast, parallel implementations in hardware. The utility of artificial neural network models lies in the fact that they can be used to infer a function from observations. This is particularly useful in applications where the complexity of the data or task makes the design of such a function by hand impractical[72].

[72] D. Ciresan, A. Giusti, L. Gambardella, J. Schmidhuber. Deep Neural Networks Segment Neuronal Membranes in Electron Microscopy Images. In Advances in Neural Information Processing Systems (NIPS 2012), Lake Tahoe, 2012.

The tasks artificial neural networks are applied[73] to tend to fall within the following broad categories:

- Function approximation, or regression analysis, including time series prediction, fitness approximation and modeling.
- Classification, including pattern and sequence recognition, novelty detection and sequential decision making.
- Data processing, including filtering, clustering, blind source separation and compression.
- Robotics, including directing manipulators, prosthesis.
- Control, including Computer numerical control.

Application areas include the system identification and control (vehicle control, process control, natural resources management), quantum chemistry, game-playing and decision making (backgammon, chess, poker), pattern recognition (radar systems, face identification, object recognition and more), sequence recognition (gesture, speech, handwritten text recognition), medical diagnosis, financial applications (e.g. automated trading systems), data mining (or knowledge discovery in databases, "KDD"), visualization and e-mail spam filtering[74].

Artificial neural networks have also been used to diagnose several cancers. An ANN based hybrid lung cancer detection system named HLND improves the accuracy of diagnosis and the speed of lung cancer radiology. These networks have also been used to diagnose prostate cancer. The diagnoses can be used to make specific models taken from a large group of patients

[73] D. C. Ciresan, U. Meier, J. Schmidhuber. Multi-column Deep Neural Networks for Image Classification. IEEE Conf. on Computer Vision and Pattern Recognition CVPR 2012.

[74] A. Graves, M. Liwicki, S. Fernandez, R. Bertolami, H. Bunke, J. Schmidhuber. A Novel Connectionist System for Improved Unconstrained Handwriting Recognition. IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 31, no. 5, 2009.

compared to information of one given patient. The models do not depend on assumptions about correlations of different variables. Colorectal cancer has also been predicted using the neural networks. Neural networks could predict the outcome for a patient with colorectal cancer with more accuracy than the current clinical methods.

2.12 EXPERT SYSTEMS

In artificial intelligence, an **expert system** is a computer system that emulates the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning about knowledge, represented primarily as if–then rules rather than through conventional procedural code. The first expert systems were created in the 1970s and then proliferated in the 1980s. Expert systems were among the first truly successful forms of AI software.

An expert system is divided into two sub-systems: the inference engine and the knowledge base. The knowledge base represents facts and rules. The inference engine applies the rules to the known facts to deduce new facts. Inference engines can also include explanation and debugging capabilities[75].

WORKING OF EXPERT SYSTEMS

The strength of an ES derives from its ***knowledge base*** - an organized collection of facts and heuristics about the system's domain. An ES is built in a process known as ***knowledge engineering***, during which knowledge about the domain is acquired from human experts and other sources by knowledge engineers.

[75] Jackson, Peter (1998), *Introduction To Expert Systems* (3 ed.), Addison Wesley, p. 2,

The accumulation of knowledge in knowledge bases, from which conclusions are to be drawn by the inference engine, is the hallmark of an expert system.

The knowledge base of an ES contains both factual and heuristic knowledge. ***Knowledge representation*** is the method used to organize the knowledge in the knowledge base. Knowledge bases must represent notions as actions to be taken under circumstances, causality, time, dependencies, goals, and other higher-level concepts[76].

Several methods of knowledge representation can be drawn upon. Two of these methods include

1. Frame-based systems

They are employed for building very powerful ESs. A frame specifies the attributes of a complex object and frames for various object types have specified relationships.

2. Production rules

They are the most common method of knowledge representation used in business. ***Rule-based expert systems*** are expert systems in which the knowledge is represented by production rules.

A production rule, or simply a rule, consists of an IF part (a condition or premise) and a THEN part (an action or conclusion). IF condition THEN action (conclusion).

[76] Kwak, S.. H. (1990). "A mission planning expert system for an autonomous underwater vehicle". *Proceedings of the 1990 Symposium on Autonomous Underwater Vehicle Technology*: 123–128. Retrieved 30 November 2013.

The ***explanation facility*** explains how the system arrived at the recommendation. Depending on the tool used to implement the expert system, the explanation may be either in a natural language or simply a listing of rule numbers[77].

ADVANTAGES

An ES is no substitute for a knowledge worker's overall performance of the problem-solving task. But these systems can dramatically reduce the amount of work the individual must do to solve a problem, and they do leave people with the creative and innovative aspects of problem solving[78].

Some of the possible organizational benefits of expert systems are:

1. An Es can complete its part of the tasks much faster than a human expert.

2. The error rate of successful systems is low, sometimes much lower than the human error rate for the same task.

3. ES's makes consistent recommendations

4. ES's is a convenient vehicle for bringing to the point of application difficult-to-use sources of knowledge.

5. ES's can capture the scarce expertise of a uniquely qualified expert.

6. ES's can become a vehicle for building up organizational knowledge, as opposed to the knowledge of individuals in the organization.

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[77] Nelson, W. R. (1982). *REACTOR: An Expert System for Diagnosis and Treatment of Nuclear Reactors*. Retrieved 30 November 2013.

[78] http://www.umsl.edu/~joshik/msis480/chapt11.htm (visited on May 13th 2014)

7. When use as training vehicles, ES's result in a faster learning curve for novices.

8. The company can operate an ES in environments hazardous for humans

DISADVANTAGES

No technology offers an easy and total solution. Large systems are costly and require significant development time and computer resources[79]. ES's also have their limitations which include:

1. Limitations of the technology

2. Problems with knowledge acquisition

3. Operational domains as the principal area of ES application

4. Maintaining human expertise in organizations.

2.13 POSITIVE AND NEGATIVE ASPECTS OF ARTIFICIAL INTELLIGENCE

In our modern era, we always strive for innovation. This is one of the many good aspects of human beings, being ambitious. Even in the past, people aspire for something great like robots, super computers and many more. Nowadays, even if we are still in the middle of making our dreams come true for a modern Earth, we are slowly making our progress.

[79] ibid

Artificial intelligence is one of the promising inventions that some of the people are excited about. Many contend that artificial intelligence will change the face of how we live our life. There are movies that popularize artificial intelligence and we see a promising future with artificial intelligence in our side. However, there also others who are not so optimistic about it and fear that artificial intelligence may bring more harm than good[80].

Disadvantages of Artificial Intelligence

Some people insist that artificial intelligence can bring more destruction to the people. For one, there are movies like *I, Robot* that depict our future with the advancement of artificial intelligence and most of the movies suggest that products with artificial intelligence may fight against us. Some people believe that in the future, robots with artificial intelligence can overpower us because they are smarter and possess super human powers which are very frightening. Furthermore, because computer and robots are more accurate in their work, they can replace the human workforce and create fewer jobs for people[81].

Advantages of Artificial Intelligence

On the other hand, others believe the opposite and insist that artificial intelligence has a lot of advantages. Artificial intelligence can make work faster and therefore it makes life easier. There are jobs that are dangerous for humans such as disarming bombs but with artificial intelligence, we can just send a robot to the field and disarm the bornb. We can spare lives and make the situation a lot safer. Another reason, with artificial intelligence, it can help us with our passion with innovation. It can help us achieve

[80] http://www.aigicrvis.ca/the-positive-and-negative-aspects-of-artificial-intelligence/
[81] ibid

greatness when it comes to inventing things like producing massive buildings and many more.

Chapter-3

APPLICATION OF ARTIFICIAL INTELLIGENCE IN JUDICIAL DECISION MAKING

This is the most significant chapter in my dissertation. I have already mentioned that A.I plays a significant role in almost all fields of human interference. Like that the most significant area that A.I touches upon is judicial decision making. All those things are highlighted in this chapter.

Before going to the details first of all we should understand about Artificial Legal Intelligence. Artificial Legal Intelligence presents a thought-provoking approach to both computational models of legal reasoning and the use of evolutionary thinking about the law. A number of artificial intelligence systems implement various types of case-based reasoning[82]. A case-based reasoning program seeks to solve a problem by relying on solutions to previous, similar problems. Such an approach has an obvious affinity to the use of precedents in legal reasoning. Another important category of Artificial Legal intelligence is the expert system is that it seeks to reproduce the way that a human expert applies her skills to specific types of problems. Artificial intelligence in legal scenario also stress upon its importance in the field of artificial neutral networks. Neural Networks are intended to function in a way analogous to the networks of neurons that comprise the brain. In a neural network, the input points are connected to output points by a simulated network[83]. Thus, there have been a number of projects that claim some progress toward

[82] Artificial Legal Intelligence by Pamela N. Gray Brookfield, VT: Dartmouth Publishing Co., 1997

[83] https://www.ischool.utexas.edu/~palmquis/courses/project98/ailaw/ailaw.htm (visited on may 13th 2014)

automating legal reasoning. This naturally raises the question; to what extent do the programs actually model the task at issue, or, alternatively, succeed in producing results similar to human decisions? Artificial Legal Intelligence, however, gives little attention to these questions. Artificial Legal Intelligence steers clear of these deep, muddy, embattled waters. It states that this concept does not linger over questions of how well existing programs actually perform legal reasoning. It also makes the questionable assumption that artificial intelligence will be achieved, and turns to a vision of a future, all encompassing computer system. In this regime the concept of legal intelligence can be classified into two types. They are "holistic legal intelligence" and "cyclic paradigms of legal intelligence". These concepts make explicit some major assumptions of more modest approaches to computerizing legal reasoning[84].

The term, "holistic legal intelligence," has a contemporary ring, but the concept captures several widespread assumptions about legal reasoning that have long buttressed the legal profession. In this view, legal reasoning is a unique, autonomous form of reasoning. The advocacy and advising of lawyers, like the decision-making processes of judges, rely on specialized skills that use concepts and rules of inference that could be represented in symbolic form. Legal reasoning is seen as simply a process of "moving from one unit of legal data to the next to make a selection. This view binds together the idea that law is an autonomous discipline with the notion that that the law consists of its formal representations, whether in statutes, cases, or other written embodiments, and that such representations are linked together by a coherent logic of some sort[85].

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[84] Judicial Applications of Artificial Intelligence Edited by Giovanni Sartor and Karl Branting Kluwer Publications

[85] Artificial Legal Intelligence by Pamela N. Gray Brookfield, VT: Dartmouth Publishing Co., 1997

Now as a part of dissertation a common question comes under this area is it possible to build a system of computer-support to aid discretionary judicial decision- making? If so, how can that decision process be understood and that understanding are most appropriately represented. Computer systems have been used both to support sentencing reform, and as a reform in themselves. However, in developing such systems we need to pay close attention to conceptualizing the decision process of that domain. Oskamp, Tragter, and Groendijk (1995) suggest that in AI and law research, "the impression is sometimes given that the legal assignment to be carried out by the system is of secondary interest". Instead, they argue, research needs to focus more explicitly upon the appropriateness of different strategies of system modeling for different domains and for different purposes. By implication, closer examination of the appropriateness of different strategies necessitates the need to pay closer attention to the nature of that domain.

The history of artificial intelligence (AI) has been characterized by a steady expansion of the aspects of human cognition and expertise amenable to computational models. The earliest AI applications were in formal domains, such as theorem proving, that are relatively divorced from the complexity of ordinary human experience. Progress in natural language processing, expert systems, planning, robotics, and qualitative reasoning has extended the range of human experience and behavior addressed by AI. This general trend also characterizes research on AI and law. Early research addressed primarily routine legal domains, such as administrative procedures, that involve the straightforward application of clear-cut rules to uncontroversial facts. Recent research, however, has focused increasingly on more complex and challenging areas of the legal process typified by judicial decision making because the judiciary has the task of producing reasonable and

acceptable solutions in exactly those cases in which the facts, the rules, or how they fit together are controversial[86].

Judicial decision-making is an area of daunting complexity, where highly sophisticated legal expertise merges with cognitive and emotional competence. Many of the central concepts in the judicial application of the law – such as "justice", "reasonable care", and "intent" – are deeply enmeshed in the fabric of human life. Moreover, judicial reasoning combines diverse cognitive skills, such as assessing facts, interpreting texts, making analogies, and engaging in dialectical interactions. Besides its complexity, judicial decision – making is also characterized by its social importance. It is, indeed, the most characteristic moment of legal experience. Individual cases may involve important interests and deep feelings, and their solution impacts upon the expectations of all legal factors and shapes their understanding of the legal system.

These features of judicial activity justify a cautious approach. The hazards of replacing judicial discretion with a rigid computer model can hardly be overestimated. However, AI research projects in this field have consistently abjured any attempt to usurp the discretionary reasoning of judges. Rather than aiming at the impossible dream (or nightmare) of building an automatic judge, AI research has aimed at developing practical tools to support judicial activities as well as new analytical tools for understanding and modeling judicial decision - making. While I am explaining about the concept of AI and judicial decision making it is better to know more about E-judiciary or how judiciary works with the help of computers for providing justice to the common man. It can also be included under the area of A.I.

[86] ibid

3.1 E-JUDICIARY AND ARTIFICIAL INTELLIGENCE – A COMPARISON

Administration of justice is one of the primary functions of the state. State administers justice through courts and tribunals[87]. The concept of e- judiciary has been evolved as one of the resultant products of e- governance of the modern world which is computer savvy. This is an initiative of information technology which had acted as an eye – opener at the need of over burdening of courts with mounting cases which could not be resolved manually even at least with minimal difficulty. E – Justice is considered and rendered as an organ of e-governance[88].

The Indian judiciary comprises of nearly 15,000 courts situated in approximately 2,500 courts complexes throughout the country. It is estimated that there are about 30 million cases pending before various courts in India. One estimate is that if the Indian courts were not to take more cases from today and dispose off the cases at the present rate, then, it may take nearly 300 years to clear the present back log of 30 million cases pending in the various courts of India. It is in this context that information technology offers a ray of hope. The idea of 'e-courts', was first conceptualized by former Chief Justice of India RC Lahoti[89].

Information Technology (IT) has found its way into legal practice and as a part thereof to the judiciary. The extent to which IT is used in judiciary can be looked from two angles. One is the use of information technology to improve

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[87] see Dr.N.K.Jayakumar, *Lectures in Jurisprudence*, 2nd Ed(2006), Lexis Nexis Butterworths, p.175

[88] K.Pandurangan, "*e – Justice – Practical Guide for the Bench and the Bar*", 2009 Edition, Universal, p.73

[89] N.Vittal, *E-Courts and E – Justice*, available at http: //iacits2005.iitm.ernet.in/presentations/E Courts Mr Vittal.pdf<>(visited on 13 – 5– 2014)

the present paper based system by bringing in the advantage of IT[90] to increase the speed enormously and also to bring greater transparency. Information Technology can be used in functions like filing the schedules, posting of cases, grouping of cases and so on. Information Technology can increase the speed of justice delivery system, thereby enhancing the efficiency of the system. The second aspect of the use of IT in judiciary is when the computer network is used for trials of crimes in cyber space.

The main objectives of the e court system are stated as below:-

1) To help judicial administration of the courts in streamlining their day-to-day activities.
2) To assist judicial administration in reducing the pendency of cases.
3) To provide transparency of information to the litigants.
4) To provide access to legal and judicial databases to the judges[91].

These are the main objectives of e court system. It reduced the backlog of cases pending in the various courts in a simple and in a fruitful manner. Hence the use of computer applications in judiciary has improved the judicial decision making[92] to a great extent. Thus the concept of E-judiciary is a contribution from A.I.

Courts Information Systems Projects (COURTIS – Project) are computer based software applications that integrate many judicial, administrative and miscellaneous functions of courts.

In 1992, the Chief Justices of High Court's Conference decided to implement the computerization project in their courts on the lines of Apex Court's

[90] http://ecourts-pms.nic.in<> (visited on 13 – 5- 2014)

[91] See http://ecourts – pms.nic.in/<> 1-8-2013; see also K. Pandurangan, "e-justice – Practical Guide for the Bench and the Bar", 2009 Edition, Universal, p.80.

[92] e – Courts Mission Mode Project: The Journey So Far. See *Supra*

Computerization Project. Thus the COURTIS project was developed by NIC. Following are some of the applications which have been successfully implemented at Supreme Court and 18 High Courts and these applications have either direct or indirect impact on the masses:

1) List of Business Information System (LOBIS)

LOBIS involves computerization of scheduling of cases to be heard by the courts on the following day. It enables the Registries of Supreme Court and High Courts in eliminating manual process[93] of Cause List generation, thus avoiding any manipulation by vested interests. These databases contain details of fresh cases, disposed and pending cases. It is the backbone application of every Court.

2) Filing Counter Computerization

Computerization of filing process in Supreme Court and High Courts is another outcome of COURTIS project. Computerized filing counters receive fresh cases which are filed before Supreme Court and High Courts. Data entry operator in these counters enters preliminary details required for registration[94] such as party names, advocate details, etc. Queries and defects are instantaneously addressed. Time limitation is also checked by the system automatically. This has streamlined the filing process. The amount collected towards Court fees in a day is automatically calculated.

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[93] K.Pandurangan, *"e – Justice – Practical Guide for the Bench and the Bar"*, 2009 Edition, Universal, p.88

[94] *Good Governance through ICT*, (2005), National Informatics Centre (NIC), p.63.

3) Case Status

Case – status gives the latest information with respect to the status of a case like: case number, disposed/adjourned, lower court details, party and advocate names, date on which last listed, waiting position, subject category along with exact verbatim of the text of the Court's order. The moment a case is filed in the court, its 'Case – Status' is available on the web, giving filing details such as dairy number date of filing, etc[95].

4) COURTNIC

COURTNIC is an information system designed to provide information on the Apex Court to a wide range of users. COURTNIC is intended to cater to the information requirements of judges of the lower courts, advocates, litigant public and others who are interested in the judgments of the Apex Court. Databases of COURTNIC are created by NIC and maintained by the Supreme Court. Information will be available to the litigant public at nominal charges. COURTNIC answers about two hundred queries[96] of litigants/advocates per day all over the country on the status of their pending cases.

5) Cause lists on the internet

Cause Lists are scheduling of cases to be heard by the courts on the following day. NIC servers host cause lists of Supreme Court and various High Courts. Currently, cause lists of Supreme Court and 21 High Courts and 10 Benches are maintained by NIC. The Cause list application is the

[95] Ibid

[96] http://indiancourts.nic.in/courts/itinjud.html

backbone application of all courts as no court can function without that day's Cause list[97].

6) The Judgment Information System (JUDIS)

The JUDIS or Judgment Information System is an online case law library developed by NIC. JUDIS consists in complete text of all reported judgments[98] of Supreme Court and several High Courts. In the case of Supreme Court all reported judgments in Supreme Court Reporter (SCR) since its inception, i.e, from 1950 onwards are available. While judgments reported in SCR till 1993 have head notes, all cases reported in SCR after 1993 are available in JUDIS without head notes. Judgments can be accessed through party name, advocate, Date of judgment and more importantly by free text search. This enables the users to retrieve all relevant judgments on a particular subject.

7) Daily orders on the Internet

Daily orders of Supreme Court and High Courts are available on the internet. Uploading of daily orders take place as soon a judge signs the orders. It is the easiest way for litigants to get a copy of the latest order[99] delivered in the court from their residences/offices. The free text based search enables the users to access relevant orders of the court on the same subject.

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[97] http://courtnic.nic.in/

[98] K.Pandurangan, "*e – Justice – Practical Guide for the Bench and the Bar*", 2009 Edition, Universal, pp.95 – 96.

[99] www.judis.nic.in

8) Computerization of Courts – Supreme Court, High Courts and Subordinate Courts

Computerization of Courts in India commenced during early 1990's. Under COURTIS project, several projects have been initiated in Supreme Court, High Courts and subordinate courts. Flagship projects are mentioned above. Apart from these projects a few more projects deserve mention.

9) Filing Defects on Web

In close coordination with the Registry of the Supreme Court of India, NIC has implemented 'Filing Defects' along with the already implemented[100] 'case-status information system' on the Supreme Court's web site.

10) Digitization of Old Records

Followed by the successful computerization of many decision making and decision support system, NIC has taken up computerization of Digitalization of Old Records i.e. Disposed Case files.

11) SUPLIS

This package contains the citation Information of all reportable cases decided by the Supreme Court. It provides citation from five Journals and cases can be easily located on the basis of citation.

12) Digital Display Boards on Internet

NIC developed an application tool to convert the Digital Display of the display board and make it available on Supreme Court's Web Site. Digital Board Information can be accessed at (www.supremecourtofindia.nic.in).

[100] ibid

13) SUPNET

It is application software developed by NIC which provides information access about employees of Supreme Court.

14) E- Kiosks

Kiosk is a booth with an open window on one side. An electronic kiosk houses a computer terminal that often employs custom kiosk software designed to function flawlessly while preventing users from accessing system functions.

15) Interactive Voice Response System (IVRS)

The litigant public can access the status of their cases filed in the Supreme Court using an ordinary telephone using IVRS.

16) Computerization of High Courts

National Informatics Centre (NIC) also took up the task of computerization of High Courts along the lines of Supreme Court. NIC implemented LOBIS in all High Courts[101]. Court orders/ proceedings are digitized. Software has been developed for storing and retrieval of orders. Record Room Information System which keeps track of all old files and maintains records of the consignment of matters have been implemented. Another application developed is the Notice Generation, which generates notices to be served to litigants/advocates issued by the registry.

17) Computerization of Subordinate Courts

In 1997 NIC took up the computerization of all 430 District Courts in the country. In 2002-2003 NIC took up the computerization of the City Courts of four metropolitan courts ie Delhi, Mumbai, Kolkata and Chennai. Under the

[101] *Good Governance through ICT*, (2005), National Informatics Centre (NIC), p.67.

project, many decision making, decision support and public interface application areas which will help in simplifying routine activities and provide easy and transparent access facilities to the litigant public, are taken up for computerization.

NIC has taken up the Computerization of City Civil Courts of 26 States and Union territories under its project **"City Civil Courts Information System (CC-COURTIS)".**

18)Application Software for Courts

In addition to mega a project, NIC has also developed several application software's meant for various administrative branches of the Courts. Some of them are payroll application software, Budget Monitoring System (BMS), Revision & Gradation Process Information System (RGPIS), Certified Delivery System (CCDS), Library Information System (LIS), Disposal Information System (DIS), Vigilance Monitoring System (VMS), and Works Monitoring System (WMS) etc[102].

19)Case Finder Software's

Many private law reports have developed simple and efficient case finder software's to their subscribers. Prominent among them are *All India Reporter*, which had digitized their case reports and are marketed as AIR Supreme Court and AIR High Courts. Supreme Court Cases had launched their case finder software called SCC *Online*. *Manupatra*[103] is another online legal database, which provides latest decisions of Supreme Court, High Courts in addition to maintaining huge archives of earlier decisions. In Kerala, Kerala

[102] K.Pandurangan, "*e – Justice – Practical Guide for the Bench and the Bar*", 2009 Edition, Universal, p.107

[103] www.manupatra.com

Law Times (KLT) has launched its case finder software called *'Verdis'*[104]. Another case search tool available in Kerala is Law Book Centre's 'Complete Kerala High Court Cases' (KHC), *'Case Search'*[105].

All these applications make the concept of E-judiciary. These applications help the judges to make a clean decision easily even without using their intelligence. So all these techniques helped the judges to perform justice in a judicious and in a wise manner. These techniques are purely the contribution of Artificial Intelligence. This shows how AI plays a significant role in the legal field. Next major thing I would like to discuss is how these computers based applications helps the judges to reach a fine decision without any difficulties. In this context it is better to go through the following general details.

1) <u>E Filing of FIR</u>

FIR is an important document because it sets the process of criminal justice in motion. It is only after the FIR is registered in the police station that the police take up investigation of the case. Anyone who knows about the commission of a cognizable offence, including police officers, can file an FIR. Section 154 of Crpc is the provision which explains about the filing of FIR. Recent trend with respect to filing of FIR is that now we can file FIR electronically. This is a great gift from science and technology. The government must allow the online filing of first information reports in rape cases as that alone will ensure mandatory and automatic registration of complaints. The online registration of FIRs was supposed to be implemented by 2013. On March 21, 2012, the then Union Home Minister, P. Chidambaram, stated in the RajyaSabha that online registration of FIRs would be possible once the server and network connectivity was established

[104] www.scconline.com

[105] www.CaseSearch.in

by the end of 2012 or early 2013. However, the online filing of FIRs will be made possible only upon the implementation of the Crime and Criminal Tracking Network and Systems (CCTNS), an ambitious Rs. 2,000 crore project of the Home Ministry, aimed at increasing the efficiency and effectiveness of policing through e-governance by creating a state-of-the-art IT-enabled crime tracking system for investigation of crime and detection of criminals.

Under CCTNS, 14,000 police stations will be automated as well as 6,000 offices of higher police officials. The CCTNS is a platform for sharing real time information by law-enforcement agencies, which will improve identification of criminals and crime investigation. Funds in the amount of Rs. 418 crore have reportedly been released to the States/Union Territories and 4.54 lakh people have been trained. The CCTNS project was supposed to be completed in March 31, 2012. However, in June 2012, the Cabinet Committee on Economic Affairs (CCEA) extended the deadline to March 2015.

In November 2012, the Home Ministry began monitoring the status of the CCTNS project on a weekly basis and appointed 20 Joint Secretaries to monitor the progress of the project and ensure completion by March 2015. The delay in project implementation was reportedly due to the non-availability of common application software (CAS) and infrastructure problems. Since law and order is a State issue, issues of coordination between the States also contributed to the delay. However, it is unclear why the Indian government needs to implement a Rs.2, 000 crore project before enabling online filing of FIRs. In view of the great national imperative in creating

deterrence against rape, websites and e-filing mechanisms should be immediately created to permit e-filing of FIRs at least in rape cases[106].

The online filing of annual accounts and other documents was successfully implemented several years ago by the Ministry of Company Affairs. Various State governments have also provided for online filing of police complaints and online payment of traffic challans. The Himachal Pradesh Police have introduced an interactive portal called "Kanoon Vyavastha," the first of its kind in the country, by which a police complaint can be filed online or by SMS. As per a report in the *Financial Express*, of 1,821 SMSs received, 22 FIRs were registered without the complainant having to visit the police station. Of these 22 FIRs, reportedly only one was related to a rape case. After the launch of SMS service in May 2010, 4,392 SMSs were received, of which 82 FIRs were registered. The complainant can check the status of the FIR online and post comments. The web portal is used for daily crime reporting, providing details of missing persons and vehicles and road accidents. Jalandhar reportedly has an online crime tip page where people can anonymously inform the police of a crime that has been committed. Similarly, Maharashtra has an e-complaint system for reporting minor crimes, that is, non-cognizable offences.

Simultaneously, with the introduction of Zero FIRs, online filing of FIRs at least in rape cases should immediately be implemented irrespective of the status of the CCTNS project. The introduction of e-FIRs will be an important signal to all criminals that rape will not go unpunished.

[106] http://www.thehindu.com/opinion/lead/going-from-zero-firs-to-efirs/article4329575.ece

2) Electronic Application For Summons

Filing an application via web service

By using the electronic services of the judicial administration, a creditor may file an application for a summons concerning undisputed debts, follow the processing of the application, and obtain a decision in the matter. The service is available in Finnish and Swedish.

Service for companies and corporations filing numerous applications for a summons (Santra system)

The service is primarily intended for those who file numerous applications for a summons, such as professional debt collection agencies. Electronic filing of an application for a summons via Santra system is reserved for simple and un disputed"summary" debt collection cases. The system transfers the electronic applications sent by the plaintiff to the case management system of the district courts.

The creditor must, at his or her own expense, develop software for his or her own information system in order to be able to compile such application records that meet the set format criteria. The file format descriptions for Santra are available at the ICT Service Centre for the Judicial Administration, which also checks that the technical requirements have been met[107].

When a case has been filed through Santra, the district court no longer sends any documents relating to the default judgment to the plaintiff, but the plaintiff himself or herself must retrieve them in the Register of court decisions.

[107] http://www.oikeus.fi/15959.htm

3) E- FILING OF PLEADINGS

With the development of Information technology a party can file his plaint in the civil court electronically. Plaint is the statement filed by a plaintiff in a civil suit against the defendant, whereas written statement is the reply filed by the defendant against the plaint filed by the plaintiff. These two constitutes pleadings in general. Before the development of E – commerce and IT law the common man faced some difficulties with respect to the filing of pleadings before the court. Now everything has been changed and speeds up because of the E- filing of pleadings. This itself ensures a clean pattern of administration of justice from Indian judiciary and provides easy access to justice to the common man.

4) Assessing the Credibility of the Witness

Under CPC also the provision of demeanor of witness is highlighted. With the development of Information technology in the Indian Judiciary the procedure with respect to demeanor of witness and examination has been done electronically which proves to be very much effective than what it was before.

5) Online Dispute Resolution (ODR)

With the emergence of internet and information technology the delivery of justice has become very much cheaper and effective to the common masses. Under this category the online dispute resolution mechanisms plays a significant role. We all know that the alternate dispute resolution mechanisms like arbitration, negotiation, mediation and Lok Adalat has been evolved to provide speedy resolution of disputes between the parties. It was found to be very much effective in providing speedy justice to people. Online dispute resolution system is a gift from information technology which helps to solve the disputes very much in a quicker manner than what it was before. ODR

can be defined as a branch of dispute resolution which uses technology to facilitate the resolution of disputes between parties. It primarily involves negotiation, mediation or arbitration, or a combination of all three. In this respect it is often seen as being the online equivalent of alternative dispute resolution (ADR). However, ODR can also augment these traditional means of resolving disputes by applying innovative techniques and online technologies to the process.

ODR is a wide field, which may be applied to a range of disputes; from interpersonal disputes including consumer to consumer disputes (C2C) or marital separation; to court disputes and interstate conflicts. It is believed that efficient mechanisms to resolve online disputes will impact in the development of e-commerce. While the application of ODR is not limited to disputes arising out of business to consumer (B2C) online transactions, it seems to be particularly apt for these disputes, since it is logical to use the same medium (the internet) for the resolution of e-commerce disputes when parties are frequently located far from one another. ODR is otherwise known as electronic dispute resolution.

All these above stated techniques are really computer based techniques which help judges to render speedy justice to the common masses. Hence it can be stated that the concept of E Judiciary is a seed of Artificial Intelligence which helps to make better judicial decision making not only in the present era but also in the future[108].

[108] enwikipedia.encyclopedia/ ODR

3.2 VOICE RECOGNITION TECHNIQUE AND COURTS

One of the most critical aspects of the judicial process is the requirement that a verbatim record be created for virtually all judicial activities. This "record" had been created and kept using three primary methods until just a few years ago. The earliest records of judicial proceedings were recorded by pen and ink. This usually involved a scribe quickly writing briefs of court proceedings during or immediately after court. Different forms of shorthand writing were implemented in the nineteenth century. Machine stenography was invented in the early part of the twentieth century and remains a popular method used by the courts. Personal computer and word processing had a major impact on transcript preparation. Subsequent inventions of computer aided transcription quickly moved machine stenography to a higher technology based process. The invention of sound recording machines in the form of tape recorders spawned the use of these devices to create an analog recording of court testimony and proceedings. Another method involves an operator repeating every word being said into a mask. Voice recognition software converts the spoken word to type for further use. Automatic speech recognition (ASR) as it is called in some countries is the process by which a machine (e.g., computer) is able to recognize and act upon spoken language or utterances. An ASR system typically consists of a microphone unit, computer, speech recognition software, and some form of audio/visual/action output. A popular ASR application is the automatic conversion of speech to text, which has the potential to increase work output efficiency and improve access to and control of various computer applications, such as word processing, email, dictation and document retrieval. The voice recognition technology has already been used by the stenographers for writing judgments through voice recognition software also termed as "voice writing". Voice recognition systems have been tested by the Austrian Justice since 1997 and already in

use in European courts by the judges. At that time a group of 10 voluntary judges and public prosecutors were equipped with voice recognition systems consisting of a notebook with headset and the program "Voice Type Simply Gold" by IBM. Both hardware and software have progressed significantly since then. Nowadays the voice recognition program can be supported by the standard equipment of all workstations, so no additional hardware is necessary[109].

3.3 VOICE RECOGNITION AND THE LAWYER

In the legal profession, planning for an appeal often begins as early as drafting the complaint or answer to the initial suit, and sometimes even before that. Clients frequently call upon a firm to assist their trial counsel in specific areas, including the initial formulation of a case, briefing and arguing motions, developing legal theories and trial strategy, preparing trial briefs and jury instructions, and briefing and arguing post-trial motions in anticipation of an appeal. Because time is always of the essence in the judicial system, the ability to quickly move case information into a digital workflow is critical to maximizing the analysis time for each client. Surprisingly, in this predominantly electronic business age, a majority of attorneys and judges are still behind the information technology curve. These legal professionals are drowning in a sea of tedious and costly manual processes for creating, collecting and organizing case data. Law offices large and small, as well as local and federal courts are looking for affordable tools that can help them effectively reduce their operating costs and increase productivity.

The lawyers also have so much work load that they have no option but to rely and take the support of paralegals which raises their work costs and

[109] http://lawyerapproved.blogspot.in/2011/06/court-reporting-with-voice-recognition_15.html

ultimately the pocket of client is affected and also the accuracy of the cases is not ensured depending on the support involved. However, researches have proved that the voice recognition technique has improved the work efficiency by manifolds. An advocate is the officer of the Court and has the duty to assist the court in the administration of the justice. Therefore, efficiency in their work leads to the efficiency in the administration of justice itself. Now, lawyers do not need to produce excuses before the court for not being prepared for the presentation of their cases. The lawyers in India can take better advantage of this computer technology and help the judicial system to regain the confidence of the people.

3.4 VOICE RECOGNITION AND THE CHALLENGES

Speech recognition software has advanced greatly since it was first invented, but it still has several big problems that prevent it from being used exclusively as a method of transcription. Some of the speech recognition problems that are difficult to solve include variations in the speech. There also is the problem of not knowing the context of the words being spoken, which can lead to text that has no punctuation or inaccurate spellings[110]. However, leading speech recognition tools can offer up to 99 percent accuracy right out of the box. Using specialty vocabularies can heighten accuracy even further. Some speech recognition software programs include a legal vocabulary – incorporating Latin and French law terms, reporter names, and abbreviations in addition to the standard business vocabulary – and can automatically recognize and format federal, regional, and state citations. For certain programs, specialty legal vocabularies can also be created in-house or purchased from third-party sources. Every law firm uses specific names, terminology, acronyms, or other vocabulary unique to its specialty or its client

[110] "Speaker Independent Connected Speech Recognition- Fifth Generation Computer Corporation"

base. These unique terms are frequently used in court papers, correspondence, and other legal documents. Now, the software carries inbuilt functions customizing, modifying, editing and deleting the vocabulary causing acoustic ambiguity[111], which can be used as per the requirements of a particular court. Voice recognition technology in the courtroom allows real time recording of the proceedings. A fully effective digital voice recognition system would eliminate the need for court reporters to be present in court at all and the same can be had from reliable companies dealing with the same. Real time transcripts can appear on computer screens in the court minutes after the proceeding occurs. The issues of security, originality and the rectification where ever required have to be taken due care of. The proper training and skill in the usage of technology will reduce the chances of cons associated with the technology[112].

3.5 THE CRIMINAL LIABILITY OF ARTIFICIAL INTELLIGENT ENTITIES

Can thinking machines be subject to criminal law? In 1981, a 37- year-old Japanese employee of a motorcycle factory was killed by an artificial-intelligence robot working near him[113]. The robot erroneously identified the employee as a threat to its mission, and calculated that the most efficient way to eliminate this threat was by pushing him into an adjacent operating

[111] "British English definition of voice recognition". Macmillan Publishers Limited. Retrieved February 21, 2012.

[112] Reynolds, Douglas; Rose, Richard (January 1995). "Robust text-independent speaker identification using Gaussian mixture speaker models". *IEEE Transactions on Speech and Audio Processing* (IEEE) **3** (1): 72–83

[113] The facts above are based on the overview in Yueh-Hsuan Weng, Chien-Hsun Chen & Chuen-Tsai Sun, *Toward the Human-Robot Co-Existence Society:On Safety Intelligence for Next Generation Robots*, 1 INT. J. SOC. ROBOT 267, 273 (2009).

machine[114]. Using its very powerful hydraulic arm, the robot smashed the surprised worker into the operating machine, killing him instantly[115], and then resumed its duties with no one to interfere with its mission. Unfortunately, this is not science fiction, and the legal question is: Who is to be held liable for this cold-blooded, premeditated murder?

The technological world is changing rapidly[116]. Robots and computers are replacing the human activities[117]. As long as humanity used computers as mere tools, there was no real difference between computers and screwdrivers, cars, or telephones. When computers became sophisticated, we used to say that computers"think" for us. The problem began when computers evolved from"thinking" machines (machines that were programmed to perform defined thought processes/computing) into thinking machines (without quotation marks), or Artificial Intelligence (AI). AI is the capability of a machine to imitate intelligent behavior[118]. AI is the simulation of human behavior and cognitive processes on a computer and hence is the study of the nature of the whole space of intelligent minds[119]. AI research began in the 1940s and early 1950s[120]. Since then, AI entities have become

[114] ibid

[115] ibid

[116] Ibid

[117] ibid

[118] N.P. PADHY, ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS 3 (Oxford University Press 2005).

[119] ibid

[120] ibid

an integral part of modern human life, functioning much more sophisticatedly than other daily tools[121]. Could they become dangerous?

In fact, they already are, as the above incident attests. In 1950, Isaac Asimov set down three fundamental laws of robotics in his science fiction masterpiece *I, Robot*. (1) A robot may not injure a human being or, through inaction, allow a human being to come to harm[122]; (2) A robot must obey the orders given it by human beings, except where such orders would conflict with the First Law[123];(3) A robot must protect its own existence, as long as such protection does not conflict with the First or Second Laws.

These three fundamental laws are obviously contradictory. What if a man orders a robot to hurt another person for the own good of the other person? What if the robot is in police service and the commander of the mission orders it to arrest a suspect and the suspect resists arrest? Or what if the robot is in medical service and is ordered to perform a surgical procedure on a patient, the patient objects, but the medical doctor insists that the procedure is for the patient's own good, and repeats the order to the robot? Besides, Asimov's fundamental laws of robotics relate only to robots. A robot without AI software would not be subject to Asimov's laws, even if these laws had any real legal significance[124]

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[121] Chris Capps, "Thinking" Supercomputer Now Conscious as a Cat, http://www.unexplainable.net/artman/publish/article_14423.shtml (last visited May 19, 2014); Boucq, *supra* note 4.

[122] ISAAC ASIMOV, I, ROBOT 40 (Doubleday 1950) [hereinafter ASIMOV, I, ROBOT].

[123] ibid

[124] Lawrence B. Solum, *Legal Personhood for Artificial Intelligences*. 70 N.C. L. REV. 1231 (1992).

The main question in that context is, what kind of laws or ethics are correct, and who is to decide? In order to cope with these same problems as they relate to humans, society devised criminal law. Criminal law embodies the most powerful legal social control in modern civilization. People's fear of AI entities, in most cases, is based on the fact that AI entities are not considered to be subject to the law, specifically to criminal law. In the past, people were similarly fearful of corporations and their power to commit a spectrum of crimes, but because corporations are legal entities subject to criminal and corporate law that kind of fear has been significantly reduced.

Therefore, the modern question relating to AI entities[125] becomes: Does the growing intelligence of AI entities subject them to legal social control as any other legal entity? In this arena it purely discusses about the criminal liability of the AI entities. At the outset, a definition of an AI entity will be presented. Based on that definition, this article will then propose and introduce three models of AI entity criminal liability:

(1) The Perpetration-via-Another Liability Model
(2) The Natural-Probable-Consequence Liability Model
(3) The Direct Liability Model.

[125] See in general, but not in relation to criminal law, e.g., Thorne L. McCarty, *Reflections on Taxman: An Experiment in Artificial Intelligence and Legal Reasoning*, 90 HARV. L. REV. 837(1977); Donald E. Elliott, *Holmes and Evolution: Legal Process as Artificial Intelligence*, 13 J.LEGAL STUD. 113 (1984); Thomas E. Headrick & Bruce G. Buchanan, *Some Speculation aboutArtificial Intelligence and Legal Reasoning*, 23 STAN. L. REV. 40 (1971); Antonio A. Martino,*Artificial Intelligence and Law*, 2 INT'L J. L. & INFO. TECH. 154 (1994); Edwina L. Rissland,*Artificial Intelligence and Law: Stepping Stones to a Model of Legal Reasoning*, 99 YALE L.J. 1957(1990). Martino,*Artificial Intelligence and Law*, 2 INT'L J. L. & INFO. TECH. 154 (1994); Edwina L. Rissland,*Artificial Intelligence and Law: Stepping Stones to a Model of Legal Reasoning*, 99 YALE L.J. 1957(1990). Martino,*Artificial Intelligence and Law*, 2 INT'L J. L. & INFO. TECH. 154 (1994); Edwina L. Rissland,*Artificial Intelligence and Law: Stepping Stones to a Model of Legal Reasoning*, 99 YALE L.J. 1957 (1990).

These three models might be applied separately, but in many situations, a coordinated combination of them (all or some of them) is required in order to complete the legal structure of criminal liability. Once we examine the possibility of legally imposing criminal liability on AI entities, then the question of punishment must be addressed. How can an AI entity serve a sentence of incarceration? How can capital punishment be imposed on an AI entity? How can probation, a pecuniary fine, etc. be imposed on an AI entity? Consequently, it is necessary to formulate viable forms of punishment in order to impose criminal liability practically on AI entities[126].

3.6 WHAT IS AN ARTIFICIAL INTELLIGENCE ENTITY?

For the last few years the main question used to hear with respect to technology is field is that what is really an AI entity. Futurologists have proclaimed the birth of a new species, *machina sapiens*, which will share the human place as intelligent creatures on earth. There are five attributes that one would expect an intelligent entity to have. The first is communication.One can communicate with an intelligent entity.The easier it is to communicate with an entity; the more intelligent the entity seems.One can communicate with a dog, but not about Einstein's Theory of Relativity. One can communicate with a little child about Einstein's theory, but it requires a discussion in terms that a child can comprehend.The second is internal knowledge.An intelligent entity is expected to have some knowledge about itself[127].

[126] Terry Winograd, *Thinking Machines: Can There Be? Are We?* THE FOUNDATIONS OF ARTIFICIAL INTELLIGENCE 167 (Derek Partridge & Yorick Wilks eds., 2006).

[127] Roger C. Schank, *What Is AI, Anyway?*, AI MAG., Winter 1987, at 59.

APPLICATION OF ARTIFICIAL INTELLIGENCE IN JUDICIAL DECISION MAKING

The third is external knowledge. An intelligent entity is expected to know about the outside world, to learn about it, and utilize that information. The fourth is goal-driven behavior.An intelligent entity is expected to take action in order to achieve its goals. The fifth is creativity. An intelligent entity is expected to have some degree of creativity. In this context, creativity means the ability to take alternate action when the initial action fails.A fly tries to exit a room and bumps into a windowpane continues to repeat the same futile behavior. When an AI robot bumps into a window, it tries to exit using the door. Most AI entities possess these five attributes by definition. Some twenty-first century types of AI entities possess even more attributes that enable them to act in far more sophisticated ways[128].

3.7 THREE MODES OF THE CRIMINAL LIABILITY OF ARTIFICIAL INTELLIGENCE ENTITIES

a) *The General requirements for the Imposition of Criminal Liability*

The basic question of criminal law is the question of criminal liability; i.e., whether the specific entity (human or corporation) bears criminal liability for a specific offense committed at a specific point in time and space. In order to impose criminal liability upon a person, two main elements must exist. The first is the external or factual element that is the criminal conduct (actus reus) while the other is the internal or mental element (*mens rea*).If one element is missing, no criminal liability can be imposed[129].

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[128] ibid

[129] *See, e.g.*, Yorick Wilks, *One Small Head: Models and Theories*, THE FOUNDATIONS OF ARTIFICIAL INTELLIGENCE 121 (Derek Partridge & Yorick Wilks eds., 2006); Alan Bundy & Stellan Ohlsson, *The Nature of AI Principles*, THE FOUNDATIONS OF ARTIFICIAL

No other criteria or capabilities are required in order to impose criminal liability, not from humans, nor from any other kind of entity, including corporations and AI entities. An entity might possess further capabilities, however, in order to impose criminal liability; the existence of *actus reus* and *mens rea* in the specific offense is quite enough. A spider is capable of acting, but it is incapable of formulating the *mens rea* requirement; therefore, a spider bite bears no criminal liability[130]. A parrot is capable of repeating words it hears, but it is incapable of formulating the *mens rea* requirement for libel[131].

In order to impose criminal liability on any kind of entity, it must be proven that the above two elements existed. When it has been proven that a person committed the criminal act knowingly or with criminal intent, that person is held criminally liable for that offense. The relevant question concerning the criminal liability of AI entities is: How can AI entities fulfill the two requirements of criminal liability?

For understanding this aspect that is impostion of criminal liability on AI entities we have to understand 3 basic possible models of liability: the Perpetration-via-Another liability model; the Natural-Probable-Consequence

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INTELLIGENCE 135 (Derek Partridge & Yorick Wilks eds., 2006); Thomas W. Simon, *Artificial Methodology Meets Philosophy*, THE FOUNDATIONS OF ARTIFICIAL INTELLIGENCE 155 (Derek Partridge & Yorick Wilks eds., 2006).

[130] *See, e.g.*, William B. Schwartz, Ramesh S. Patil & Peter Szolovits, *Artificial Intelligence in Medicine: Where Do We Stand?*, 27 JURIMETRICS J. 362 (1987); Richard E. Susskind, *Artificial Intelligence, Expert Systems and the Law*, 5 DENNING L.J. 105 (1990)

[131] *See* CLARK & MARSHALL, *supra* note 16, at 23.

liability model; and the direct liability model. The following is an explanation of these three possible models:

- **The Prepetration – via – Another liability model**

This model doesn't consider A.I entity as possessing any human attributes. The AI entity is considered an innocent agent. Accordingly, due to that legal viewpoint, a machine is a machine, and is never human. However, one cannot ignore an AI entity's capabilities, as mentioned above. Pursuant to this model, these capabilities are insufficient to deem the AI entity a perpetrator of an offense. These capabilities resemble the parallel capabilities of a mentally limited person, such as a child, a person who is mentally incompetent, or one who lacks a criminal state of mind[132].

Legally, when an offense is committed by an innocent agent that person is criminally liable as a perpetrator-via-another. In such cases, the intermediary is regarded as a mere instrument, albeit a sophisticated instrument, while the party orchestrating the offense (the perpetrator-via-another) is the real perpetrator as a principal in the first degree and is held accountable for the conduct of the innocent agent[133].

The Prepetrator's liability is determined on the basis of instrument's liability and its mental state. The derivative question relative to artificial intelligence entities is: Who is the perpetrator-via another? There are two candidates: the first is the programmer of the AI software and the second is the user, or the end-user. A programmer of AI software might design a program in order to

[132] Lawrence B. Solum, *Legal Personhood for Artificial Intelligences*, 70 N.C. L. REV. 1231(1992).

[133] ibid

commit offenses via the AI entity. For example: A programmer designs software for an operating robot[134]. The robot is intentionally placed in a factory, and its software is designed to torch the factory at night when no one is there. The robot committed the arson, but the programmer is deemed the perpetrator.

The second person who might be considered the perpetrator-via another is the user of the AI entity. The user did not program the software, but he uses the AI entity, including its software, for his own benefit. For example, a user purchases a servant-robot, which is designed to execute any order given by its master. The robot identifies the specific user as the master, and the master orders the robot to assault any invader of the house. The robot executes the order exactly as ordered. This is not different than a person who orders his dog to attack any trespasser. The robot committed the assault, but the user is deemed the perpetrator.

In both scenarios, the actual offense was committed by the AI entity. The programmer or the user did not perform any action conforming to the definition of a specific offense; therefore, they do not meet the *actusreus* requirement of the specific offense. When programmers or users use an AI entity instrumentally, the commission of an offense by the AI entity is attributed to them. The internal element required in the specific offense already exists in their minds. The programmer had criminal intent when he ordered the commission of the arson, and the user had criminal intent when he ordered the commission of the assault, even though these offenses were actually committed through a robot, an AI entity. When an end-user makes

[134] ibid

instrumental usage of an innocent agent to commit a crime, the end-user is deemed the perpetrator[135].

This liability model does not attribute any mental capability, or any human mental capability, to the AI entity. According to this model, there is no legal difference between an AI entity and a screwdriver or an animal. When a burglar uses a screwdriver in order to open up a window, he uses the screwdriver instrumentally, and the screwdriver is not criminally liable. The screwdriver's "action" is, in fact, the burglar's. This is the same legal situation when using an animal instrumentally. An assault committed by a dog by order of its master is, in fact, an assault committed by the master. This kind of legal model might be suitable for two types of scenarios. The first scenario is using an AI entity to commit an offense without using its advanced capabilities. The second scenario is using a very old version of an AI entity, which lacks the modern advanced capabilities of the modern AI entities. In both scenarios, the use of the AI entity is instrumental usage. Still, it is usage of an AI entity, due to its ability to execute an order to commit an offense. A screwdriver cannot execute such an order; a dog can. A dog cannot execute complicated orders; an AI entity can. The perpetration-via-another liability model is not suitable when an AI entity decides to commit an offense based on its own accumulated experience or knowledge[136].

[135] The Criminal Liability of Artificial Intelligence Entities – From Science Fiction to Legal Fiction by Gabriel Hallevy

[136] ibid

- ***The Natural – Probable – Consequence Liability Model : Foreseeable Offenses Committed by Artificial Intelligence Entities***

The second model assumes the deep involvement of the programmers or users in the AI entity's daily activities, but without any intention of committing any offense via the AI entity. For example, during the execution of its daily tasks, an AI entity commits an offense. The programmers or users had no knowledge of the offense until it had already been committed; they did not plan to commit any offense, and they did not participate in any part of the commission of that specific offense.

One example of such a scenario is an AI robot, or software, which is designed to function as an automatic pilot. The AI entity is programmed to protect the mission as part of the mission of flying the plane. During the flight, the human pilot activates the automatic pilot (which is the AI entity), and the program is initialized. At some point after activation of the automatic pilot, the human pilot sees an approaching storm and tries to abort the mission and return to base. The AI entity deems the human pilot's action as a threat to the mission and takes action in order to eliminate that threat. It might cut off the air supply to the pilot or activate the ejection seat, etc. As a result, the human pilot is killed by the AI entity's actions.

Obviously, the programmer had not intended to kill anyone, especially not the human pilot, but nonetheless, the human pilot was killed as a result of the AI entity's actions, and these actions were done according to the program. Another example is AI software designed to detect threats from the Internet and protect a computer system from these threats. A few days after the

software is activated[137], it figures out that the best way to detect such threats is by entering websites it defines as dangerous and destroying any software recognized as a threat. When the software does that, it is committing a computer offense, although the programmer did not intend for the AI entity to do so.

In these examples, the first model is not legally suitable. The first model assumes *mens rea*, the criminal intent of the programmers or users to commit an offense via the instrumental use of some of the AI entity's capabilities. This is not the legal situation in these cases. In these cases, the programmers or users had no knowledge of the committed offense; they had not planned it, and had not intended to commit the offense using the AI entity. For such cases, the second model might create a suitable legal response. This model is based upon the ability of the programmers or users to foresee the potential commission of offenses[138].

According to the second model, a person might be held accountable for an offense, if that offense is a natural and probable consequence of that person's conduct. Originally, the natural-probable-consequence liability model was used to impose criminal liability upon accomplices, when one committed an offense, which had not been planned by all of them and which was not part of a conspiracy. The established rule prescribed by courts and commentators is that accomplice liability extends to acts of a perpetrator that

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[137] CLARK & MARSHALL, *supra* note 16, at 529 (7th ed. 1967); People v. Prettyman, 926 P.2d1013 (Cal. Ct. App. 1996); Chance v. State, 685 A.2d 351, 354 (Del. 1996); Ingram v. United States, 592 A.2d 992, 1006 (D.C. App. 1991); Richardson v. State, 697 N.E.2d 462, 465 (Ind. 1998); Mitchell v. State, 971 P.2d 813 (Nev. 1998); State v. Carrasco, 928 P.2d 939 (N.M. 1996); State v. Jackson, 976 P.2d 1229 (Wash. 1999).

[138] ibid

were a "natural and probable consequence"of a criminal scheme that the accomplice encouraged or aided. Natural-probable-consequence liability has been widely accepted in accomplice liability statutes and codifications.

Natural-probable-consequence liability seems legally suitable for situations in which an AI entity committed an offense, while the programmer or user had no knowledge of it, had not intended it, and had not participated in it. The programmers or users of an AI entity, who should have known about the probability of the forthcoming commission of the specific offense, are criminally liable for the specific offense, even though they did not actually know about it. This is the fundamental legal basis for criminal liability in negligence cases.Negligence is, in fact, an omission of awareness or knowledge.The negligent person omitted knowledge, not acts[139].

Sometimes the AI entities may be held liable for certain negligent acts. It is understood on the basis of two major aspects. The first type of case is when the programmers or users were negligent while programming or using the AI entity but had no criminal intent to commit any offense. The second type of case is when the programmers or users programmed or used the AI entity knowingly and willfully in order to commit one offense via the AI entity, but the AI entity deviated from the plan and committed some other offense, in addition to or instead of the planned offense. For example, a programmer programs an AI entity to commit a violent robbery in a bank, but the programmer did not program the AI entity to kill anyone. During the execution of the robbery, the AI entity kills one of the people present at the bank who resisted the robbery. In such cases, the criminal negligence liability alone is insufficient. The danger posed by such a situation far exceeds negligence. As

[139] The Criminal Liability of Artificial Intelligence Entities – From Science Fiction to Legal Fiction by Gabriel Hallevy

a result, according to the natural-probable-consequence liability model, when the programmers or users programmed or used the AI entity knowingly and willfully in order to commit one offense via the AI entity, but the AI entity deviated from the plan and committed another offense, in addition to or instead of the planned offense, the programmers or users shall be held accountable for the offense itself, as if it had been committed knowingly and willfully.In the above example of the robbery, the programmer shall be held criminally accountable for the robbery (if committed), as well as for the killing, as an offense of manslaughter or murder, which requires knowledge and intent[140].

Now a usual question comes in this regard is that what is the criminal liability of AI entity when the natural-probable-consequence liability model is applied? In fact, there are two possible outcomes. If the AI entity acted as an innocent agent, without knowing anything about the criminal prohibition, it is not held criminally accountable for the offense it committed. Under such circumstances, the actions of the AI entity were not different from the actions of the AI entity under the first model (the perpetration-via-another liability model).However, if the AI entity did not act merely as an innocent agent, then, in addition to the criminal liability of the programmer or user pursuant to the natural-probable-consequence liability model, the AI entity itself shall be held criminally liable for the specific offense directly[141].

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[140] Ibid

[141] Robert P. Fine & Gary M. Cohen, *Is Criminal Negligence a Defensible Basis for Criminal Liability?* 16 BUFF. L. REV. 749 (1966); Herbert L. A. Hart, *Negligence, Mens Rea and Criminal Responsibility*, OXFORD ESSAYS IN JURISPRUDENCE 29 (1961); Donald Stuart, *Mens Rea, Negligence and Attempts*, 1968 CRIM. L. REV. 647 (1968).

- ***The Direct Liability Model: Artificial Intelligence Entities as beingTantamount to Human Offenders***

The third model does not assume any dependence of the AI entity on a specific programmer or user. The third model focuses on the AI entity itself. An AI algorithm might have many features and qualifications that exceed those of an average human, but such features or qualifications are not required in order to impose criminal liability. When a human or corporation fulfills the requirements of both the external element and the internal element, criminal liability is imposed. If an AI entity is capable of fulfilling the requirements of both the external element and the internal element, and, in fact, it actually fulfills them, there is nothing to prevent criminal liability from being imposed on that AI entity[142].

Generally, the fulfillment of the external element requirement of an offense is easily attributed to AI entities. As long as an AI entity controls a mechanical or other mechanism to move its moving parts, any act might be considered as performed by the AI entity. Thus, when an AI robot activates its electric or hydraulic arm and moves it, this might be considered an act, if the specific offense involves such an act. For example, in the specific offense of assault, such an electric or hydraulic movement of an AI robot that hits a person standing nearby is considered as fulfilling the *actus reus* requirement of the offense of assault.

[142] THE AMERICAN LAW INSTITUTE, MODEL PENAL CODE – OFFICIAL DRAFT AND EXPLANATORY NOTES 312 (1962, 1985); State v. Linscott, 520 A.2d 1067, 1070 (Me. 1987).

When an offense might be committed due to an omission, it is even simpler. Under this scenario, the AI entity is not required to act at all. Its very inaction is the legal basis for criminal liability, as long as there had been a duty to act. If a duty to act is imposed upon the AI entity, and it fails to act, the *actus reus* requirement of the specific offense is fulfilled by way of an omission.

The mentally ill are presumed to lack the fault element of the specific offense, due to their mental illness (*doli incapax*).The mentally ill are unable to distinguish between right and wrong (cognitive capabilities) and to control impulsive behavior. When an AI algorithm functions properly, there is no reason for it not to use all of its capabilities to analyze the factual data received through its receptors. However, an interesting legal question would be whether a defense of insanity might be raised in relation to a malfunctioning AI algorithm, when its analytical capabilities become corrupted as a result of that malfunction. The criminal liability of an AI entity does not replace the criminal liability of the programmers or the users, if criminal liability is imposed on the programmers and/or users by any other legal path. Criminal liability is not to be divided, but rather, combined. The criminal liability of the AI entity is imposed in addition to the criminal liability of the human programmer or user. However, the criminal liability of an AI entity is not dependent upon the criminal liability of the programmer or user of that AI entity. It might be summed up that the criminal liability of an AI entity according to the direct liability model is not different from the relevant criminal liability of a human. In some cases, some adjustments are necessary, but substantively, it is the very same criminal liability, which is based upon the same elements and examined in the same ways[143].

[143] ibid

- ***The Co – ordination of the Three Liability Models***

The coordination of all three liability models creates an opaque net of criminal liability. The combined and coordinated application of these three models reveals a new legal situation in the specific context of AI entities and criminal law. As a result, when AI entities and humans are involved, directly or indirectly, in the perpetration of a specific offense, it will be far more difficult to evade criminal liability. The social benefit derived from such a legal policy is of substantial value. All entities, human, legal, or AI become subject to criminal law. If the clearest purpose of the imposition of criminal liability is the application of legal social control in the specific society, then the coordinated application of all three models is necessary in the very context of AI entities.

3.8 GENERAL PUNISHMENT ADJUSTMENT CONSIDERATIONS

Let us assume an AI entity is criminally liable. Let us assume it is indicted, tried, and convicted. After the conviction, the court is supposed to sentence that AI entity. If the most appropriate punishment under the specific circumstances is one year of incarceration, for example, how can an AI entity practically serve such a sentence? How can capital punishment, probation, or even a fine be imposed on an AI entity? In instances where there is no body to arrest (especially in cases of AI software that was not installed in a physical body, such as a robot), what is the practical meaning of incarceration? Where no bank account is available for the sentenced AI entity, what is the practical significance of fining it? Similar legal problems have been raised when the criminal liability of corporations was recognized. Some asked how any of the legitimate penalties imposed upon humans could be applicable to corporations. The answer was simple and legally applicable. When a punishment can be imposed on a corporation as it is on humans, it is

imposed without change. When the court adjudicates a fine, the corporation pays the fine in the same way that a human pays the fine and in the same way that a corporation pays its bills in a civil context. However, when punishment of a Corporation cannot be carried out in the same manner as with humans, an adjustment is required.Such is the legal situation vis-à-vis AI entities[144].

The punishment adjustment considerations examine the theoretical foundations of any applied punishment. These considerations are applied in a similar manner and are comprised of three stages. Each stage may be explained by a question, as described below:

(1) What is the fundamental significance of the specific punishment for a human?

(2) How does that punishment affect AI entities?

(3) What practical punishments may achieve the same significance when imposed on AI entities?

The most significant advantage of these punishment adjustment considerations is that the significance of the specific punishment remains identical when imposed on humans and AI entities. This method of punishment adjustment considerations is referred to below in some of the punishments used in modern societies: capital punishment, incarceration, suspended sentencing, community service, and fines.

[144] The Criminal Liability of Artificial Intelligence Entities – From Science Fiction to Legal Fiction by Gabriel Hallevy

Capital punishment is considered the most severe punishment for humans, and there is no consensus regarding its constitutionality among the various jurisdictions.Capital punishment is the most effective method of incapacitating offenders as it relates to recidivism since once the death sentence is carried out, the offender is obviously incapable of committing any further offense. The significance of capital punishment for humans is the deprivation of life. The "life" of an AI entity is its independent existence as an entity. Sometimes, it has a physical appearance (e.g. a robot); sometimes it has only an abstract existence. Considering capital punishment's efficacy in incapacitating offenders, the practical action that may achieve the same results as capital punishment when imposed on an AI entity is deletion of the AI software controlling the AI entity. Once the deletion sentence is carried out, the offending AI entity is incapable of committing any further offenses. The deletion eradicates the independent existence of the AI entity and is tantamount to the death penalty.[145]

For most humans and corporations, property is gained through labor. When paying a fine, the property, which is a result of labor, is transferred to the state. That labor might be transferred to the state in the form of property or directly as labor. As a result, a fine imposed on an AI entity might be collected as money or property and as labor for the benefit of the community. When the fine is collected in the form of labor for the benefit of the community, it is not different from community service as described above. Thus, most common punishments are applicable to AI entities. The imposition of specific penalties on AI entities does not negate the nature of these penalties in comparison with their imposition on humans. Of course, some general punishment adjustment considerations are necessary in order to apply these penalties, but still, the nature of these penalties remains the

[145] ibid

same relative to humans and to AI entities. Thus, there is no substantive legal difference between the idea of criminal liability imposed on corporations and on AI entities. It would be outrageous not to subordinate them to human laws, as corporations have been. Models of criminal liability exist as general paths to impose punishment.

CONCLUSION

Hence as a concluding remark it can be said that the Artificial Intelligence technique has found its way in various fields like Banking, Academics, and Business Management and now in Judiciary also momentum is rising to include the Artificial Intelligence in decision making process and it is being already done in some of the countries and providing good results. However, Indian courts and the Judges do not seem prepared yet to accept the technology for better performance of the justice delivery system. The reason being ignorance of the technology, less skilled staff although, computer technology has already been dispensing the ministerial functions of the courts. One grey area has still been there which can very well be rectified by the use of artificial intelligence technology and that is the typing of judgment's that has become very serious issue for the delivery of justice in due time and the reason of unnecessary delays. That facet of AI is the Voice Recognition Technique which also requires AI for recognizing and identifying the words that are being delivered during the trial or final decision of the court. The Voice recognition technique has basically two types Speaker Dependant which is commonly used for dictation software and the Speaker Independent mainly found in telephone applications. The Speaker Dependant Voice Recognition Technique has worldwide usage in the Courts and it is high time for Indian Judiciary also to use and accept the technology for the efficient functioning of the court system and thereby preventing the precious time of the courts from being going waste. It is quite clear now that AI has advanced to a larger extent which can boost the judicial environment of the country to a larger extent even though there do exist differences of opinion in the 100% usage of the same, given the legal consequences that might flow from it and the clear idea that AI cannot replace the brain of the judge. However, the application of AI through the Voice Recognition Technique is something

certain and that does not create any serious implications upon adoption which has been proved by the professions using the technology. The legal and the justice system of the India is suffering a lot from the inefficient management and processing that ultimately reflects in the over-all delivery of the justice to the masses. But, the use of the voice recognition technique can definitely change the entire scenario of the procedural impediments that occur during and after the trial stage. The use of the technology will make the judgments, coherent, viable, error less, accurate and explanatory which is what the present day Informed public is required to have and also will bring down the work load of stenographers. Most of all it will save the judicial time which is precious given the scarcity of judges as well as the heavy work load in the courts. The judges will be able to take greater number cases as their time will not get wasted due to the traditional procedures. The same will provide greater scope to the judge himself to make necessary changes in the judgment if required who otherwise had to depend upon the stenographer which, the difference of which used to get fatal for the case. The use of Voice Recognition Technique will prove to bring out enhancement in the quality, efficiency, accessibility, accuracy, reliability, flexibility and satisfaction within the judicial pronouncements which will ultimately lead to greater public confidence over judiciary that has down the line faded away from the years together. Apart from that the use of dragon software or similar software which helped a lot in replacing a stenographer, that would assist in minimizing the discretionary authority of a judge. This is one of the significant contributions from the field of Artificial Intelligence.

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