CHAPTER IV

CENTRAL QUESTIONS IN
ARTIFICIAL INTELLIGENCE
Human beings are animals. (Darwin)

Animals are machines. (Descartes)

Therefore, Human beings are machines. (La Mettrie)

- Philip Johnson - Laird
- loves (she, me)
- not/loves (she, me)
- loves (she, me)
- not/loves (she, me)
CHAPTER IV

CENTRAL QUESTIONS IN ARTIFICIAL INTELLIGENCE

4.1 Natural and Artificial Intelligence What is intelligence?

This is the question most thinkers would not like to be asked. Despite the enormous intensity in doing research to determine what intelligence is over the period of years, there is very little consensus of opinion among the researchers. Numerous tests are available to measure the level of intelligence. Yet no one is sure what one means by intelligence. The very fact that there are numerous approaches with each investigator emphasizing on a particular aspect has given rise to a feeling that the views of the experts on this matter are no more improvement on that of a layman. It is more common for a man to encounter a situation in which he does not know what option to choose from the pack that lies before him and the best way to come out of situations like that is to seek expert’s opinion. And this is what one of the major psychological journal did in 1921, when they sought the opinions of the experts to give their opinions on "What they ‘conceive intelligence’ to be and by what means it can best be measured." The responses varied from Thorndike’s power of good responses to Terman’s ability to carry on abstract thinking to Thurstone’s capacity to inhibit instinctive adjustment to the advantage of individual as a social being. What was surprising was the fact that there were as many definitions as the number of psychologists who indulged themselves in the
act of defining. So, this made many to feel that the psychologists have been shuttled back to square number one. But that was not the case to be. Viewed broadly, at least two attempts seem to stand out and subsume other definitions within themselves: the capacity to learn from experience and adaptation to one's environment. Many were naturally dissatisfied with this attempt. Edwin Boring, and many others, made attempts to find out what intelligence is, but ended up by begging the question. He defined intelligence as whatever it is that the tests measure. Only the attempts of this type forced the psychologists back to square one. This and other related questions compelled psychologists to look for an alternative line of thinking and such a search led to the emergence of various theories. Most of the scientific theories have evolved through a succession of paradigms and theories of intelligence is no exception either. "The major paradigms have been those of psychological measurement (often called psychometrics), cognitive psychology, which concerns itself with the mental process by which the mind functions; the merger of cognitive psychology with contextualism (the interaction of the environment and processes of the mind); and biologic science, which considers the neural bases of intelligence."

Psychometric theories, by and large, attempted to understand the structure and constituent parts of intelligence. All the psychometric theories depend upon the data obtained through paper-and-pencil tests. Again all the psychometric theories have at the fundamental level a psychological model according to which intelligence is a composite of abilities measured by tests. Earliest of the psychometric theorists, Charles E.
Spearman sought to determine the nature of individual differences. Spearman was primarily interested in that aspect which distinguishes the less intelligent from bright people. Spearman devised a method of statistical analysis called Factor analysis. The primary task of this method is to identify the factors of human intellect. Spearman after a thorough analysis proposed what he called as general factor or g, which he said pervades in fulfilling all the tasks requiring intelligence. So according to this theory, regardless of the task, if it requires intelligence, it requires g. But what is this g? Spearman expressed ignorance, though he did propose later on that it might be something like mental energy.

But is it tenable to isolate one such factor of general intelligence and construct a mega-theory on top of it? American Psychologist L.L. Thurstone attacked Spearman’s theory in general and his attempt to isolate one such factor. Thurstone did not deny or reject g, but disputed the importance of this factor. Instead, Thurstone proposed seven factors which he called primary mental abilities. He said g is important, but it is only second-order factor or a phenomenon which arises only because the primary or first order factors are related to each other. A year later Godfrey H. Thomson attacked Spearman’s analysis somewhat on the same line but in a vague manner.

Many Psychologists such as Philip E. Vernon, and Raymond B. Cattell suggested that both Spearman and Thurstone were correct in some sense. They believed that the abilities referred to were more or less hierarchical, with g on top of the
hierarchy. Cattell further suggested that the general ability can be further subdivided into *fluid* and *crystallized*. In this connection, John L. Horn proposed that the crystallized ability increases with life and fluid ability increases early in the childhood and decreases later on.¹¹

American Psychologist J.P. Guilford ¹² parted company from majority of the field [factorial theorists] by rejecting the general factor. Instead he proposed a structure-of-intellect theory, according to which intelligence comprises 120 abilities. Each of these various facets of intelligence combine multiplicatively to produce sum product. Later, Guilford increased the number of abilities to 150. This enormous number indicated that there are indeed serious problems in psychometric theories. The number of abilities that psychometric theories proposed simply grew out of hand. This and other difficulties compelled the soul-searching theorists to opt for an entirely different line of thought. Thus cognitive science which was slowly growing up during the psychometric era proved a useful tool for them and cognitive theories of intelligence emerged one after the other.

Without overplaying the role of Cronbach,¹³ it can be asserted that he was one of the thinkers who were mainly responsible for the emergence of Cognitive theories. He pleaded to the fellow psychologists to unite various disciplines of scientific psychology. Soon people understood the value of the study of these underlying processes and it became a common knowledge that without knowing these underlying processes, if the tests are conducted, then such tests will be of no better use and may mislead those who
are attempting at such an endeavour.

The assumption that forms the central core of most of the cognitive approaches is that intelligence comprises a set of representations and there also exists a set of processes that operate on mental representations. Another assumption is that these underlying processes are executed serially, though with the progress of time some lines of thought have emerged which allow for partial or complex parallel processing.¹¹ A more intelligent person is taken to be the one who represents information and operates on this representation more efficiently and quickly than the less intelligent person. Number of cognitive psychologists such as Earl B. Hunt¹² performed a variety of experiments to show that cognitive approach and psychometrics can be united together and the results of these experiments also proved that cognitive processes are the building blocks of intelligence. But others hypothesized that the ability underlying intelligence is that of rapidly retrieving information from memory.¹³ Among the cognitive psychologists, Sternberg deviated a little bit and suggested that the psychologists should study the tasks first and then should go on to determine the mental processes and strategies that people use to perform the tasks. Using the means and end analysis, Newell & Simon constructed a model of human problem solving. This gave way to the emergence of numerous ideas on creating computer models of human cognition and human intelligence. But can such models represent clearly the abilities of human intelligence? Number of Psychologists such as Michael Cole argued that Cognitive processing of this type fails to take into account a very crucial fact: intelligence varies with culture.¹⁴
The most radical treatment on intelligence comes from Howard Gardner. According to Gardner the hitherto proposed theories on intelligence were too narrow. According to him there is no single intelligence comprising many abilities as envisaged earlier. Rather there exists multiple intelligence. Intelligences are multiple including, at a minimum, linguistic, logical, mathematical, spatial, musical, bodily-kines thetic, interpersonal and intrapersonal intelligences.\textsuperscript{18} Sternberg agreed with Gardner in that the earlier approaches were too narrow. But he disagreed with Gardner on multiple intelligence. He felt that they are not intelligences, but only talents and they are not prerequisite for adaptation in most cultures. Instead he proposed a theory that [which came to be known as Triarchic theory], intelligence has three aspects. These aspects relate intelligence to what goes on within oneself, in the world and to experience which mediates both.\textsuperscript{19}

The findings of Roger Sperry and Michael Gazzaniga have already been explained in detail and their implications have been discussed in the last chapter. So let us not venture into the biological theories of intelligence such as hemispheric theories, brain-wave theories and blood-flow studies.

Before winding up our discussion on the formal theories of intelligence, a small note about the development of intelligence. None of the above approaches were able to provide a satisfactory account for the development of intelligence in human beings -- for
various reasons. The most outstanding work in this area comes from the Swiss Psychologist Jean Piaget. His remarkable theory comprises mainy two aspects, one concerning the mechanisms that facilitates the growth of intellectual development and the other concerning the periods through which children develop. First of these two aspects contains two mechanisms, *assimilation* -- a process that involves incorporating the information into the existing "schema" and *accommodation* -- a process that involves creating new "schema" to incorporate new and hitherto unknown information. Cognitive development, Piaget asserted, depends on the equilibrium between assimilation and accommodation. In the second aspect, Piaget proposed four major periods in the cognitive development, viz., *sensorimotor period*, *pre-operational*, *concrete-operational* and *formal-operational periods*. Despite some of the drawbacks, Piaget’s thought influenced many fields especially in 60’s and 70’s. Later thinkers tried to make several possibilities, thereby removing the flaws in Piaget’s theory.²⁰

Related somewhat to cognitive-context theories, a view championed by Soviet Psychologist L.S. Vygotsky, argues that the intellectual development is largely influenced by child’s interaction with the world.²¹ Elaborating on this, Israeli Psychologist Lander-Stein suggested that mediated learning experience is the key to cognitive development.

Finally a view on malleability of intelligence. Over the centuries it has come to be accepted that intelligence is more or less a fixed trait. It is a common belief that people are born with intelligence. Many researchers have taken this line and posit that
intelligence is out and out connected with heredity and is passed through genes. Various measures are available, but the most interesting one is the study of identical twins reared apart. 23

All the above and the related theories, I feel, despite their stated claims and achievements do not discuss intelligence as such. This is, in my opinion, a primary reason why the intelligence barrier is yet to be solved. All these approaches analyze, examine and deal only with intelligence as expressed, and not intelligence as it is. It is interesting to note in this connection that Gregory, arguing from an entirely different angle, says that there are two kinds of intelligence -- Kinetic and Potential intelligence. 24 I suggest that when intelligence is expressed, it takes an entirely different form altogether. Can there be such a possibility? May be not, but I feel that intelligence when expressed need not be the same just as the thought unexpressed need not be the same as language or behaviour indicates. Is intelligence a... connected only with human beings? We will return to the wider philosophical implications of this question later but now let us consider the claims and counter-claims on Animal Intelligence.

Are non-human beings conscious or intelligent? Often non-human beings are not attributed with consciousness or intelligence. I am afraid, probably due to the false philosophical linking of language with thought and intelligence. No doubt language is connected with intelligence and thought most of the time, but I am afraid, it need not be
the sole trait of intelligence or consciousness. Moreover much of the sophisticated thinking can be carried on without verbalization. There is ample evidence for this especially in the light of hemisphere studies. 24

Moreover research in the recent decades seem to prove that the speech and language are not the sole possessions of human beings. Chimpanzees do seem to grasp and use the sign language. 25 Dolphins proved that they are capable not only of grasping the meaning of spoken sentences, but also the changes in the structure of the sentences. 26 Even birds seem to have the ability to focus attention and may be they have the capacity to think. 27 There is an interesting evidence for the capacity to learn to Aplysia, the sea slug. 28 Dolphins have exhibited, over the years their ability to mimic and imitate. 29 The capacity called Subitizing - the ability to perceive at a glance up to a limited number of items without actually counting them -- hitherto associated with human beings, has been found in the chimpanzees. 30 They seem to have most of the intellectual capacity of human beings, but may be lacking organization and co-ordination and they may work in a remarkably slower rate. Many researchers due to the reasons like these feel that the brain of the humans are not fundamentally different from that of animals. 31 However thinkers like Bitterman seem to disagree. 32

A dramatically different, but a suggestive line of thinking comes from the work on the bird songs by Wotthbohm and his associates. "Many species of birds sing songs, and it is well known that these species, and sometimes even subspecies, can be
recognized by their peculiar song. But where does this song come from, and how does it acquire its characteristic pitches, tempo, and lift? It turns out that the answer differs from one species to another. In some cases, the species song is part of the bird's birthright. Thus in the ringdove, a certain song is sung by every member of the species. No feedback or external stimulation is needed. In fact, even if the bird is deafened at birth, it will sing its species song. There is less of a step-by-step route towards the acquisition of song in most other species. Typically, birds begin with a period of babble-like subsong, followed by a period of plastic song, when syllables are repeated or rehearsed until they constitute short phrases. Finally, within a year, the plastic song gives rise to a stereotyped song similar to the songs produced by other normal adult males.  

The above and other evidences of the similar nature... throw more and more profound questions and more mystery to the evolution of human beings. The theories of ascent in evolution and increasing intelligence over the period of years are under serious threat. Can we consider ourselves to be more intelligent than our ancestors? Most of us would like to say impulsively 'Yes'. But wisdom points out at the opposite direction. Then, can we say that intelligence is a fixed 'ability' of human beings or non-humans that has remained static over the period of years? The present genetic science is not sufficient to answer this question. May be Rene Descartes is correct in that we are indeed born with numerous innate qualities including intelligence. But is intelligence an innate quality? May be we are born with certain amount of knowledge within us. In this connection Michael Polanyi's Tacit knowledge and its role in
intelligence evokes lot of interest. Polanyi says that Tacit knowing is the power of mind to create explicit knowledge. Viewing from a different angle I would like to suggest that probably we are all born with mind and this ability to create knowledge. And probably this ‘faculty’ of mind is that which initiates the process of intelligence. May be not. Development of intelligence, culture and thought in the increasing scale of human evolution may be a wrong notion.\(^\text{16}\)

As the mists of pre-history begin to lift a little, culture is seen to be extremely ancient, reaching back perhaps as far as three million years ago, to the time of Australopithecus, a man like ape who may have had some glimmerings of symbolism... Neanderthal man, who appeared about 100,000 years ago, was in one time portrayed as a slouching, primitive brute, a mental incompetent hardly fit to be spoken of as human. That view has now entirely changed. Neanderthal man is known to have used sophisticated tools constructed from carefully built components... Neanderthals practiced rituals and buried their deads with ceremony and had a sense of the transcendent; stone implements and cooked food have been found in single graves and atleast seven different kinds of flowers were laid in a shallow Neanderthal pit in Shanidar, Iraq. ... Neanderthal man used symbols and abstract notations. Intentional Zigzag images and fine parallel lines have been found engraved on bones excavated at Neanderthal sites and these are the type of markings which appear later in the more full blown culture of Cro-Maytron, with its profusion of complex symbol and image. Evidently the capacity for intellectual activity of a high order was in place long before the first civilizations, a fact which makes it difficult to sustain traditional ideas of human culture as progressing by gradual increments as a result of slowly increasing mental competence.

If Neanderthals were as intelligent as modern people, then, how come we live in a more sophisticated environment and how come only modern man was able to invent so many things? The British Archaeologist Clive Gamble \(^\text{17}\) suggests that.
It is no longer sufficient to look at human evolution over the past 300,000 years as simply a process of increasing intelligence and offer an explanation in terms of changes in the brain. Recent studies have demonstrated the existence, some 300,000 years ago, of mental ability equivalent to that of modern man. The dramatic developments in material culture, such as the appearances of art, now seem to be more closely related to the changes in the amount and kind of information needed by paleolithic societies, rather than being dependent on the evolution of the brain.

Before proceeding further, I would like to suggest -- as stated in the previous chapter -- that intelligence is nothing but a facet or aspect of the mind. Intelligence is very much bound up with consciousness and mind. We do not attribute intelligence to those entities that are not conscious. One inference of this statement could be that most, if not all, of the non-human beings too possess consciousness or mind. They can be attributed with intelligence. I don't see any problem in animals and birds possessing consciousness or capacity for thinking. I call those who deny the existence of consciousness or mind in non-human beings as the ones with Homo sapien chauvinism.

Then intelligence can be viewed as a primary disposition of a living, conscious, cognitive being, which Nature has endowed upon such a being. Out of this primary disposition arises numerous abilities and talents. Thus, in this sense, adapting to a new environment, or learning or thinking about abstract concepts, grasping new information or planning for the unknown future or giving good responses or passing the tests, all these are not intelligences, rather they are abilities or talents emerging out of this disposition. I further state that all knowledge is dependent upon intelligence. For, all the knowing process is not possible if the person acquiring knowledge is not intelligent. Only
the intelligent persons can receive, process, express and retrieve the information. May be both intelligence and consciousness are bound up, but both are only the faculties or aspects of mind. This bound up consciousness -- intelligence enable a person to be aware of himself, know the environment and reflect upon his own thoughts. Probably, this view is unacceptable to many thinkers. But I feel only perceiving the problems in this way can solve numerous philosophical problems.

Accepting this viewpoint is bound to take one to two conclusions. First, by this account even plants should be considered intelligent! Thinkers such as Dr Bose, Peter Tompkins, and Chintopher Bars and Swami Jitatmananda have argued for the existence of intelligence in plants in our own times. But this might create moral problems.

For instance, if non-human animals, birds and even plants are considered intelligent, then will it be possible for us to treat them on par with human beings? Science and Philosophy of this day is likely to find loop holes to escape rather than giving a satisfactory answer. Surprisingly we find no such problem arising in Hindu Philosophy in which all are treated as same with different degrees of sentience. But consider an animal, which gets angry and kills a man, will it be possible for us to put that animal through u. and give it a punishment? Does that look sane and sensible? Without hesitating even for a second we are killing non-human animals and birds to make our food. Are we being put to trial for doing this? Certainly not. I find Hindu Philosophy and Hindu eco-system far more superior to that of any other system in this respect. There
are numerous recordings in Hindu History where both animals as well as human beings were handed out punishment for committing a mistake. This may look, prima facie, a non-sense, but contains a great depth of understanding and gives a new meaning to life. Second, going by my account of intelligence, Artificial Intelligence is not possible. Creation of thinking machines are only day dreamings. For machines are non-living, non-conscious and non-cognitive physical entities. The whole thing looks so easy and simple. If the matter is this simple, then do the workings of Artificial Intelligence people have got some sense? I am afraid matter is much more complicated than this.

Soviet Scientist I.S. Shklovsky argues that our notions of intelligence and life may be wrong. He states that a well known definition of life as a form of existence of proteins is insufficient, since it is likely to exclude various forms of life. He quotes Lyapunov: "Life may be characterized as a stable state of substance that develops preserving reactions by using information coded by the state of individual molecules". Shklovsky goes further to conclude that a "living ‘naturally’ intelligent being does not fundamentally differ from a specially manufactured artificial device." Acceptance of this viewpoint is, again, bound to take us to two options. One, Artificial Intelligence is possible. And two, Extra terrestrial intelligence is possible too. On those who deny the possibility of existence of intelligence outside our planets, Hofstadter says that they are affected with a Earth Chauvinism.

Perhaps we are unknowingly burdened with a similar chauvinism with respect to intelligence, and consequently with respect to meaning. In our
Chauvinism, we would call any being with a brain sufficiently much like our own "intelligent", and refuse to recognize other types of objects as intelligent. To take an extreme example, consider a meteorite which, instead of deciphering the outer-space Bach record, punctures it with colossal indifference and continues in its merry orbit. It has interacted with the record in a way which we feel disregards the record's meaning. Therefore we might feel tempted to call the meteorite "stupid". But perhaps we would thereby do the meteorite a disservice. Perhaps it has "higher intelligence" which we in our Earth Chauvinism cannot perceive, and its interaction with the record was a manifestation of that higher intelligence. Perhaps, then, the record has a "higher meaning" -- totally different from that which we attribute to it; perhaps its meaning depends on the type of intelligence perceiving it.

Well, this may be a possibility. But that is not the way in which we think every other day. A question may be asked: Even granting that the said approach may yield fruitful results, what is the necessity to think in an alternative line? One opts for the alternative line of argument only when one is not satisfied with the present option. But one may add: we feel comfortable and satisfied with the present approach of treating only human beings as intelligent and machines as non-intelligent. So why should we consider machines to be intelligent? Moreover, machine being intelligent in the same sense of we being intelligent is only a dream.

But I feel that is too defeatistic and negative line of thinking. Opinion and reality may turn out to be radically different and one's opinion is always bound to be false. So, let us proceed to check out whether the claims of Artificial Intelligence are tenable.

4.2 Artificial Intelligence
We saw in the first chapter that Artificial Intelligence is an attempt to make machines do things that would require intelligence if done by man. So before proceeding further one should know what are the tasks requiring intelligence that are performed by human minds. So those who are interested in making machines intelligent have identified the tasks such as "holding a conversation, answering questions sensibly on the basis of incomplete knowledge, assembling another machine from its components given the blueprint, learning how to do things better, playing chess, writing or translating stories, understanding analogies, neurotically suppressing knowledge that is too threatening to admit consciously, and recognizing the various things seen in a room -- even an untidy or ill-lit room" require intelligence if performed by the human beings. Let us grant that these tasks require intelligence and only intelligent persons are capable of carrying out these tasks.

But how to make the machines carry out these tasks? Artificial Intelligence experts tried to do exactly that, but in different ways. One way is to look at the underlying mental processes and make the machines possess them. But the difficulty with this approach are manifold. Not many believe that there exist mental processes. Moreover, even if they exist, we do not know much about such processes. Again, even if we come to have complete knowledge of such mental processes, it may not be possible to run them on the machines. And even if the models of such processes are fed to such machines, the possibility of the machines failing in executing such processes is very high.
So, this option is ruled out, if not completely. Another way of making machines carry out these tasks is to ignore the underlying processes in human beings. Instead one should look at the procedures that human beings employ in carrying out such tasks. This approach has been highly prevalent since it was highly successful in making computers carry out the tasks exhibiting intelligence. I would like to mention here the work of Newell and Simon as the most outstanding and also virtually a starting point for this line of approach. Their program Logic Theorist was able to solve various logical problems and put forward elegant proofs for Whitehead and Russell's *Principia Mathematica*.\(^{42}\) This proved that computers were not mere number-crunchers but symbolic manipulators. The program contains basic rules of operation just as the human being involves in the problem solving act. Then the program is instructed to discover proofs for the given problems. The very fact that machines can work at logical problems is remarkable and if they are able to do so by not using mere brute force, but according to a set of procedures then can we say that such machines are indeed intelligent? Newell, Simon and Shaw stressed that their machines engage only in a sort of thinking, which the humans involve in. According to them the procedures utilized by the Logic Theorist were analogous to that of human logicians. "Among the methods used by Logic Theorist are substitution of one kind of expression for another; a detachment method, where the program works backward from something that has already been proved to something that needs to be proved; and a syllogistic form of reasoning, where if "a implies b" is true, and "b implies c" is true then "a implies c" is also true."\(^{43}\) How closely Logic Theorist resembles the human beings! It brought the Artificial Intelligence experts very much near
their purpose expressed years back: "The study to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it." Simon, Newell and Shaw in one sense at least reached near their purpose. To underscore this parallel between man and machine, they performed numerous experiments with Logic Theorist. They also found certain traits of the human problem solving in machines as well. More significantly they deviated from the workers of the earlier decade such as McCulloch and Norbert Wiener. "We do not believe that this functional equivalence between brains and computers implies any structural equivalence at a more minute atomic level (for example, equivalence of neurons with circuits). Discovering what neural mechanisms realize these information processing functions in the human brain is a task for another level of theory construction. Our theory is a theory of the information processes involved in the problem-solving and not a theory of neural or electronic mechanisms for information processing."

Their attempts impressed one and all. Even critics who vehemently attacked the basic principles of their attempts, yielded that the demonstration of Logic Theorist was impressive. Moreover by devising and running Logic Theorist, Newell and Simon showed that "AI was a possibility, if not a reality. While all claims before had, in a sense, been handwaving, two key demonstrations had now been made: (1) Computers could engage in behaviour that, if exhibited by humans, would unambiguously be considered intelligent; (2) the steps through which the programs pass in the course of
proving theorems bear a non-trivial resemblance to the steps observed in human problem solving." Soon Newell devised a General Problem Solver capable of wide variety of tasks. But the basic principle remained the same as before: mimic the processes used by the human beings to carry out apparently wide variety of tasks. Using "means-ends analysis", General Problem Solver attempted to facilitate the task of problem solving.

"In means-end analysis, one first states the desired form of the solution of a problem, and then compares one's present place in the process of problem solution with the final goal desired. If these two instances coincide, then the problem has been solved. If not, the solver [human or mechanical] clarifies the difference and searches for methods to reduce the difference between where one is and where one wants to go. The art in the General Problem Solver lies in the methods of reducing this distance. A table is set up that associates the system's goals with operators that may be of use in achieving them.

Once the difference has been computed between the present situation and the goal, the system then selects an operator associated with that difference and tests whether the operator is applicable to the current situation. If it can be applied, and if it produces a result that is closer to the desired end state, it is repeated again. If it proves inapplicable, then the system generates a subgoal, whose aim is to reduce the difference between the current situation and the situation where the operator can be applied. This procedure is simply repeated until the goal is achieved or it has been demonstrated that it cannot be achieved with the information given, or with the operators available in the program." Though General Problem Solver was abandoned after sometime for various reasons, I feel that it was definitely a pivotal point in the history of Artificial
Intelligence. Though it was met with array of criticisms and the defence was not all that satisfactory, I would like to mention here that an element that existed latent in the attempts of Newell and Simon, that was clearly the forerunner of expert systems. Number of issues were raised against Newell and Simon’s attempts by the critics. First, it was pointed out that all the information was placed inside the program only by the humans and the problem solver was doing only what it was instructed to do. Newell and Simon simply said that such a line of argument was too anachronistic and so long as the program was not simply repeating the instructions, but instead used tools to solve the problems, then it’s behaviour is definitely as intelligent as that of human beings. Not many were convinced with this reply of Newell and Simon. Although it is not all that clear what the critics of Newell and Simon had in their minds, often such an argument tends to mislead. "Accordingly, the common slogan, "A computer can only do what you tell it to do", may be misleading. If it is taken to mean that everything the computer does is done at the behest of the instructions in the program the slogan is, of course, true. But if it is taken to mean either that the programmer can foresee everything the program will do, or that the program will do all and only what the programmer intended it to do, then it is false."

Other lines of criticisms pertain to other aspects of Artificial Intelligence and therefore we shall see them later.

Following Newell, Simon and Shaw’s success, numerous attempts were made to devise programs that exhibited intelligence. Most noteworthy among them are from Marvin Minsky’s two students T.G. Evans and Daniel Bobrow. But they took the field
in other directions. Evans’ program solved analogies of visual sort. Though all of us do that most effortlessly, it became clear that it was very, very complex than expected. Evans’ program was one of the most complex that had been written till date. But Daniel Bobrow adopted problem solving in a linguistic domain. His program STUDENT was designed to solve the sort of algebraic problem which every high school going student will be able to solve. Programs of this sort illustrated very clearly how solid the programs were in the 60’s and during that period the machines seemed to carry out the tasks that were deemed intelligent almost effortlessly because of such solid programs. However such programs contained enormous limitations as well. Moreover though the way in which programs carried the tasks at hand reminded the way in which humans carried them out, the way in which humans approach the problem was radically different from that of the machines. Since the computers’ knowledge, as Gardner puts it, is purely syntactic, the computers have no idea of what the problem is about. It is programmed to solve all the problems in a similar way irrespective of the status of the problem. “The computer’s difficulty is that it cannot look through the particular way in which it has been programmed in order to pick up the actual reference of a word or a number. Having no insight about the subject matter of a problem, the computer is consigned to make blunders that, in human beings would never happen or would be considered extremely stupid.”

While the others were busy devising machines that they claimed to think, one of the earliest Artificial Intelligence experts, John McCarthy, quietly spent his time to
discover the most important tool of Artificial Intelligence - a high level language LISP. LISP is the most influential language and is also a widely used one. Because of the efficiency that LISP and other similar languages exhibited, they were even considered at one time as mathematics of Artificial Intelligence. McCarthy believed that all knowledge [and hence all the problems we face] can be thought of in terms of purely logical notations. He called for the formalization of many abstract concepts. He deviated from other practitioners of the day when he argued with his collaborator Patrick Hayes for the system embedded with predicate calculus substrate in order to achieve a highly sophisticated system for understanding natural language. Though the followers of McCarthy tried to revive the concepts of General Problem Solver in several ways later on, the ideas of McCarthy find few practitioners today -- for various reasons. But still it should be stressed here that without McCarthy, Artificial Intelligence could not have progressed this far. Before proceeding to other prominent lines, two outstanding efforts [though both were of the similar nature] should be mentioned here. These two investigative programs came almost near to fulfilling Turing’s dream of machines -- engaging in intelligent conversations. Kenneth Colby, Stanford Psychiatrist devised a program capturing paranoid personality with a particular obsession about the mafia.

WHY ARE YOU IN THE HOSPITAL?  
i shouldn’t be here

WHO BROUGHT YOU HERE?  
the police.

WHAT TROUBLE DID YOU HAVE WITH THE POLICE?  
cops don’t do their job.
WHAT DO THEY DO INSTEAD?
cops arrest the wrong people.

ARE YOU ITALIAN?
my background is british but i was born in this country.

DO YOU KNOW ANY ITALIAN CROOKS?
i try to avoid the underworld.

and Joseph Weizenbaum attempted to reproduce the behaviour of a therapist who assumes
a non directive stand towards Clients.

men are all alike.
IN WHAT WAY?

they're always bugging us about something or other.
CAN YOU THINK OF A SPECIFIC EXAMPLE?

well, my boyfriend made me come here.
YOUR BOYFRIEND MADE YOU COME HERE.

he says i am depressed much of the time.
I AM SORRY TO HEAR THAT YOU ARE DEPRESSED.

it's true. i am unhappy.
DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY?

i need some help, that much seems certain.
WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP?

perhaps i could learn to get along with my mother.
TELL ME MORE ABOUT YOUR FAMILY.57

Both Colby and Weizenbaum agreed that if anyone who knew the design beforehand
hand or anyone who is able to make correct inferences will be able to unmask the
program very easily.
Another line of reasoning is that the machines can be made intelligent, without mimicking human ways. That is, computers can be made to solve the problems in their own way, irrespective of how human beings solve them. This line was carried on by Edward Feigenbaum and his colleagues. They devised a program DENDRAL to analyse the data from a mass spectrograph. DENDRAL was designed to figure out which organic component was being analysed. DENDRAL's performance was treated favourably by the chemical experts. I feel, that this line of thinking, that is, the cultivation of intelligence by other means than simulating the human behaviour, and consequently the cultivation of intelligent machines without any reference to human ways in anyway what so ever, is more likely to yield fruitful results than other routes and will also be able to settle many philosophical controversies arising in this connection more amicably. Hence Feignbaum's this early effort is more significant than it appeared in the beginning.

Another line of thinking is to simulate the neural basis of human behaviour and to infuse the knowledge of a specialist in a particular domain into the computer.

Let us grant that these attempts are valid. But the question is: despite all these remarkable attempts can machine intelligence or Artificial Intelligence ever be achieved? Even if these attempts are successful can we call the machines carrying out such tasks as intelligent? Let us first take the latter. This issue more than any other has been hotly debated with the bitterest critics of Artificial Intelligence rejecting the usage of psychological terminology in Artificial Intelligence and the advocates of Artificial
Intelligence defending such usages. The former says that Artificial Intelligence is a contradiction in terms. Is Artificial Intelligence a contradiction in terms? I feel that the answer to the questions of this sort stems more from the way one treats Artificial Intelligence and one's personal beliefs on the issue such as mechanism.

Humanists claim that any sort of psychological vocabulary cannot be literally applied to machines, but they also conclude from their basic premises that machine intelligence or Artificial Intelligence is an illusion. Moreover, they also hold a view that this sort of research is incapable of throwing any amount of light on any human problem. Many humanists allege that much of the Artificial Intelligence literature encourages [explicitly or implicitly] the view that there is no essential difference between human beings and machines. Some of them even go to the extent of saying that accepting such a view point also means accepting those social systems that treat human beings as if they are machines. Here at this point more than elsewhere the help of philosophers is being felt.59

Prof. C.V. Radhakrishnan in a brief but excellent article Artificial Intelligence -- A misnomer 60 argues that the term intelligence should not be used for the computers. For, "the computers have neither intelligence, not to speak of self-consciousness nor do they know what they are doing, about other things or themselves."

Radhakrishnan believes that the general claim of intelligence in favour of Artificial Intelligence as another form of intelligence on par with human intelligence is a gross error. "It appears,
as though the genus intelligence has Artificial Intelligence as one of its species. Whether human intelligence is unique in the animal kingdom or not, is not a fully established concept; at least we can show that the computers do not share the characteristics of the genus intelligence." Probably the advocates of this line of thought, especially Radhakrishnan would like to borrow from Guy Robinson, a famous rhetoric which was in turn borrowed by Robinson from Thomas Hobbes, to describe the efforts of Artificial Intelligence experts: "When men write whole volumes of such stuff, are they not mad, or intend to make others so?"

Why should the humanists and those who argue that Artificial Intelligence is a contradiction in terms disallow the application of psychological vocabulary literally to machines? The primary reason for this is that they view machines as not capable of purposive action. They are incapable of praxis or truly self-directed action. They argue that the machines actions (?!?) can be represented as meaningful only by appealing to the ends of a higher agent who created it. So, even when we talk of meaning and achievement of a high level program, we would be talking about them only in relation to the ends of the agent. Boden, following Turing, states that the justification of the humanistic stance depends on the usage of the terms such as purpose and thought. "Not everyone uses these concepts in precisely the same way; moreover, as I shall stress presently, conceptual usage can change -- one of the circumstances leading to such change being technological development within the linguistic community involved. So the way in which 'purpose' is thought of today may differ from the way in which it will be
thought of tomorrow. But it is currently true that one of the commonly [if not universally] accepted criteria of purposive activity is that it can be explained by reference to ends that are intrinsic to the nature of the agent herself, rather than to any outside agency. Intrinsic ends are not necessarily to be thought of as fixed principles of "human nature", but are purposes or interests that cannot be further explained in purposive terms."\(^{64}\) Despite the apparent slackness in the argument, it is a very powerful one. One should agree that many conceptions have changed with the time and many words have gone into oblivion giving way to the new ones. Despite all this, at the best it can be stated that by Artificial Intelligence one means only a non-literal and analogical sense of the word. It would be very interesting to find out how humanists would react if the term is applied in this sense. I am afraid the humanistic conclusion that to use Artificial Intelligence in a literal way as an inexcusable misuse of language is bit too harsh. Moreover whether the term Artificial Intelligence is applied literally or analogically, so long as "the computer analogies can serve the general human interest of increasing the understanding of the mind, the careful use of "psychological" terminology in speaking about certain machines should be encouraged rather than forbidden."\(^{64}\) Moreover if such non-literal applications are going to continue, the humanistic position would, I am sure, vanish into thin air. However, one should concede to the humanist that at the moment machines are nowhere near the desired state where they can possess even the intentional phenomena. But the advocates of Artificial Intelligence are not giving up so easily. They feel that the attacks of this type are based "not only on 'cold' metaphysical beliefs about the logical incompatability of subjectivity and mechanism, but also on what Ableson
would term ‘hot’ ideological commitments of a largely implicit kind concerning the nature and proper ends of human beings. This explains the societal mistrust and moral disdain with which people often approach -- or, rather, adamantly refuse to approach -- Artificial Intelligence." The belief and attitude of those who blindly arrive at the conclusion similar to that of a humanist is well presented by Ninnes in the following words: 67

What mistakes are being made by protagonists of machine intelligence?

1. Reductionism - the view that thinking as something we subjectively do, is no different from the electrical movement in a machine. Here we find a translation from the subjective side of existence to the objective side. This is a mistake of the first order.

2. Physicalism - the view that there are only physical phenomena. So everything must be restated in physicalist language. A new language is constructed eliminating reference to subjectivity. The problem with this language is that it lacks meaning. A subject is necessary for meaning, which by definition is impossible. ...

3. Machine intelligence is a tool of bourgeois society, it aims at strengthening existing social relations, and at eliminating protest and social action. This is the realization of Comte’s (positivist) dream -- some dream! This utilization is explainable in dialectical terms. Machines are incapable of praxis, of purposive action -- they are merely a series of blind processes arranged by a programmer. The ‘intelligent’ machine or computer is qualitatively no different than a gun or whip, it serves the same function.
But I feel that in addition to all these reasons one more factor that may also be the cause for such ruthless attack: an inherent fear that if allowed to be created, intelligent machines may outwit us and will alienate us forever from our place of pride. Such advocates have an inherent feeling that the computers are mere calculatory mechanisms and this is enough to show that (i) they can never be intelligent and also (ii) that subjectivity and reason cannot be reduced to causal processes. So from this point of view, psychological phenomena can never be explained even in terms of neural processes, leave alone computers. Can these claims be correct? This question naturally takes us to the problem of relating mental phenomena to mechanical systems. Cartesian ghost seems to be chasing us even in the discussions on machines and mechanism!

It is true, as the anti-AI protagonists insist, that theories employing subjective concepts cannot be translated into non-psychological terms. "The reason is that intentional sentences, whose meaning involves the notion of subjectivity, have a very different pattern of logical implications from sentences that do not involve this notion. In technical terms, the logical peculiarities of intentional sentences include indeterminacy, referential opacity, failure of existential generalization, no implication of any embedded clause (or its negation), and non-extensional occurrences of embedded clauses ... In general, the intentional object can be described only by reference to the subject's thoughts, such as her purposes, beliefs, expectations, and desires."

Moreover, there need not be any 'corresponding reality' existing outside the
person. For instance to 'say X exists' need not be the same as 'X exists'. "There may be no actual thing with which the object of thought can be sensibly identified, and even if there is, the identification will seem sensible only on the basis of certain descriptions of the real thing, and the intentional object may be indeterminate in a way that no actual object can be. For example, to say that a person sees a vertex in a grey-scale picture is not to commit oneself to saying that there actually is a vertex there. ..." 5 In this connection, it is interesting to recall one of the very odd views that we have mentioned earlier: Non-verality of thought. Despite the oddity of such a view, I feel that it is much more stronger than it might first seem to be. Penrose explains that all thought is essentially non-verbal. I would like to go one step further and assert that thought processes may be connected with verbalization and capacity for linguistic expression at times but it should not be mistaken to view that verbalization is a necessity for thought. Einstein asserts that "The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychical entities which seem to serve as elements of thought are certain signs and more or less clear images which can be 'voluntarily' reproduced and combined ... The above mentioned elements are, in my case, of visual and some muscular type. Conventional words or other signs have to be sought for labouriously only in a second stage, when the mentioned associative play is sufficiently established and can be reproduced at will." 71 Astonishingly, Nietzsche, no Platonist, confesses to his friend Overbeck "My philosophy... can no longer be communicated atleast not in print and also in Beyond Good and Evil he says "One no longer loves one's insight enough when one communicates it" and Heidegger when he
talks about himself says "The internal limit of all thinking ... is that the thinker never can say what is most his own... because the spoken word receives its determination from the ineffable." French Mathematician Jacques Hadamard seems to be agreeing with this view when he writes "I insist that words are totally absent from my mind when I really think and I shall completely align my case with Galton's in the sense that even after reading or hearing a question, every word disappears the very moment that I am beginning to think it over; and I fully agree with Schopenhauer when he writes, 'thoughts die the moment they are embodied by words!'." So, if one would not be able to precisely translate the thoughts into words, how is it possible for anyone even to dream of transmitting such processes into machines? Margaret Boden's attempt on these issues presents a fascinating picture. She takes up different senses of reductionism and mechanism for discussion and proceeds to show that even the so-called humanistic theories can be mechanistic, at least in one sense. Thus emerges from the discussion a vague concept something similar to the epiphenomenalism. Mental phenomena are not seen as identical or similar with the neural processes, but rather as the effects of bodily causes. She feels that the crucial notion in understanding how subjectivity or mental phenomena of similar nature can be grounded in a causal mechanism is the concept of an internal model. Using this as a ladder, Boden goes on, to arrive at, what I see as a very crucial conclusion which boosts the claims of Artificial Intelligence protagonists.

It is possible for the categories of subjectivity to be properly attributed to human beings because bodily processes in our brains function as models or representations, of the world -- and of hypothetical worlds -- for the individual concerned. ... To identify or describe the neural processes concerned as models is itself to describe meaning or
intentionality, to them. They could alternatively be described at least, in principle, at the level of 'objective' physiological events occurring at a particular neuroanatomical location (such as the events within the visual system of animals). At this level, however, their meaning cannot be expressed so that (psychological) function in the life of the individual is lost to view. Even so simple a neurophysiological concept as a 'bug detector', for example, is implicitly psychological in so far as it identifies a functional relation within the animal's intentional world. Consequently, the categories of meaning, subjectivity and purpose would still be required to describe a person as a psychological being even if full neurophysiological knowledge were available. Indeed, a large proportion of 'physiological' data would be expressed in intentional terms. To forbid such intentional language would be to omit all mention of mental phenomena, since there is no possibility of saying anything about the mind using only the language of the body.

Whether the usage of intentional terminology to describe the physiological processes is tenable or not is another question. But the fact remains that despite its unpleasantness, this approach of Boden is a very strong one and this sort of conclusion has abetted the pro-Artificial Intelligence advocates. Boden feels that the notion of internal models as expressed above is crucial to and forms the basis of analogue of subjectivity in the Artificial information processing systems. But can't it be said that we use such a terminology only for a convenience sake and not as pictured above? Each has its own claimants. If the usage of psychological vocabulary is essential to describe the physiological processes, then why can't the same be extended to the machines as well—after all they are another form of physical matter. Viewed from this standpoint, La Mettrie's mechanistic views and Huxley's epiphenomenalist ideas are hardly convincing and so also the modern cybernetic approaches. Extended to another extreme, even the recent attempts foisted on such ideologies are bound to be only
failures. If such vocabulary is being used only for convenience, may be scare-quotes on them will be enough and no more dispute on whether such terminology being applied from one domain to another. It is a well known fact that mental phenomena or psychological processes do not always and necessarily express themselves in the outward behaviour. Still, we are lured in to attach the labels of this domain to many of the outward actions. But from an observer point of view often they are connected. If this be the case that it is only we who attribute the meaning to the behaviour and procedures used by the subjects under consideration, is it a feasible idea to simulate only those procedures and then claim that this way of doing things help us to get more knowledge of how the mind functions or the brain works? I doubt that we can be sure of making such a claim. To conclude this discussion on the linguistic distinction and the ensuing conclusions proceeding from such distinctions, I would like to say that any psychological vocabulary cannot be applied to any sort of machines. But this is not to say that the computers can never be made intelligent. Again, as Boden insists, the conceptual usage can indeed change and the meaning attached to one word today may indicate something entirely different in future. But as of today the terminology describing mental phenomena cannot be applied literally to machines. Even Boden seems to be agreeing to this sort of view: "By this, I do not mean the terms like ‘free’, for instance, can plausibly be applied to any computer example." But some of the Artificial Intelligence advocates might assert that such a vocabulary is being applied by them only in an analogical and derivative sense. But I feel that there exists a difference -- however suitable and negligent it might be -- between these two ways of applying the terminology. Such an
approach will definitely solve the problem of contradiction in terms. But will the advocates of thinking machines accept then that the machines they claim to be intelligent are not intelligent actually but only in an analogous sense? At times it looks as if no one is interested in solving the issue at hand; but rather they want to amuse themselves in Rorty’s language game mentioned earlier.

Going to the first question, there are numerous counter arguments for Artificial Intelligence. However these counter arguments can be broadly divided into three. But before going into them, let us see some, isolated, yet monumental opinions on Artificial Intelligence. First I would like to mention Weizenbaum’s later work.\(^{44}\) Weizenbaum feels that there are certain areas in which computers should not be used [cannot be ?]. His arguments in this line are very well known. For Artificial Intelligence advocates more disturbing than Weizenbaum’s lines of attack came from Sir James Lighthill who was requested by British Government’s Science Research Council to evaluate the state of the art. Lighthill commented:\(^{45}\)

Most workers in AI research and in related fields confess to a pronounced feeling of disappointment in what has been achieved in the last 25 years. Workers entered the field around 1950, and even around 1960, with high hopes that are very far from being realized in 1972. In no part of the field have the discoveries made so far produced the major impact that was then promised. ... When able and respected scientists write in letters to the present author that AI, the major goal of computing science, represents "another step in general process of evolution"; that possibilities in 1980s include an all-purpose intelligence on a human scale knowledge basis; that awe-inspiring possibilities suggest themselves based on machine intelligence exceeding human intelligence by the year 2000 (one has the right to be skeptical).
Counter punches of this type have been countered at various times by the reputed advocates of Artificial Intelligence. For instance: 

Suffice it to say that programs already exist that can do things -- or, at the very least, appear to begin doing things -- which ill-informed critics have asserted a priori to be impossible. Examples include: perceiving in a holistic as opposed to an atomistic way; using language creatively; translating sensibly from one language to another by way of a language neutral semantic representation; planning acts in a broad and sketchy fashion, the details being decided only in execution, distinguishing between different species of emotional reaction according to the psychological context of the subject.

As already stated there are numerous arguments against Artificial Intelligence, much of them are intended to prove that certain things done by people could not be done by computers. Even if the psychological vocabulary is not used and computers achieve some of the things that are believed to be beyond the reach of computers, can we say then that such actions do not involve intelligence? I think the situation is more complex than one might imagine.

The three arguments referred to above belong of course to this group of arguments. They are (1) argument based on appealing to model (2) argument based on Michael Polanyi's tacit knowing and (3) argument based on the lack of capacity on the part of computers to simulate emotion.

The first argument is interesting since it starts by asserting the superiority of human mind over mere logic and then is extended to computers and programs. This is
one of the earliest arguments. According to this argument since a given program seemingly cannot decide the truth of at least one well formed statement that the programmer knows to be true, Turing in his seminal paper countered one such argument. We mentioned earlier that it is a controversial question as to whether Gödel’s proof can be extended to other disciplines as well. The debate on this topic is still going on over the interpretation of Gödel’s theorem and both the sides have enormous amount of substantiation to prove that their viewpoint is correct. Essentially Gödel’s theorem applies only to the closed systems. So, I feel that despite granting validity to some of the counter arguments one can still apply the theorem to other disciplines as well. But again the debate continues, but in a different form, on what constitutes closed systems. But what about the present analogy? Boden feels that “...it still does not show that programs are essentially inferior to the human mind. A program (like a person) is capable of learning new rules and axioms, by communicating with a teacher or with the outside world and extending its internal representations accordingly,...then something that was undecidable yesterday may be decidable today. To be sure, there will be something else that is undecidable today -- but it, in turn, may be decidable tomorrow. In sum, Gödel’s proof does not show that there must be some statements that could be known to be true by people, but not by programmed machines.” I feel that Boden carries her appeal to conceptual reality a bit too much here. No doubt what is undecidable today may turn out to be decidable tomorrow. But what is undecidable is undecidable today. So there may exist some statements that could be known to be true by people but not by programmed machines.” I am advancing such
an idea not to prove that machines can never become intelligent but rather to show that in all likelihood machines may never be more intelligent than human beings. This takes us to the second argument based on tacit knowing. According to Michael Polanyi, all human reasoning employs the integrative principle of tacit inference of which one is not aware, but which crucially determines the nature of the thought contents of which one is aware of. Tacit knowing is the fundamental power of the mind and according to Polanyi, it is this fundamental power which creates the explicit knowing. Interestingly, Polanyi says that some tacit processes can indeed be formalized and such formalization of tacit knowing expands the powers of the mind. But he also says that not all cognitive achievements can be made formalizable. There will always remain one thing or the other that has not been made explicit. Using the powerful theory of Michael Polanyi, as their foundation, the followers of Polanyi [especially H.L. Dreyfus] have vehemently attacked the basic principles of Artificial Intelligence. According to Dreyfus, there are some "introspectively obscure aspects of human thought and they cannot be simulated by a purely digital machine, since such aspects are essentially 'intuitive'."11 Appealing to Gestalt and Merleau-Ponty, Dreyfus claims that there are four types of thinking that are essential to the human thought process, viz., reliance on the fringe of consciousness, discrimination between the essential and the accidental, tolerance of ambiguity and perspicuous grouping. In the opinion of Dreyfus these enable the human thought to deal efficiently with ambiguous and indeterminate information. Mostly human thought does not proceed in concrete and determined steps and since programs rely on such methods only, human thought can never be simulated in a digital machine.12
Dreyfus gives much emphasis to the "indeterminate" nature of the information and Boden feels that Dreyfus confuses "the information code" and "the information coded" and hence Dreyfus's emphasis on physical discontinuity of digital machines is also misplaced. However to judge whether such conclusions are correct one should first of all know what Dreyfus says completely. Dreyfus's attack can be divided into three main classes of arguments, viz., objections based on the usage of digital machines; arguments based on computers not sharing the human context and the arguments based on computers not having bodies. Some of the points presented above in this connection form a considerable portion of the foundation on which these attacks are based. Arguments concerning the need to have analog machines instead of digital machines have been in existence for long time now. Arguments differ only in the aspect of emphasis. Whatever aspect be the focus of attention, it is becoming clear now that the presence of analog machines will be inevitable. Richard L. Gregory argues that robots "working" in real time should possess atleast a partially analog physiology, since, as Gregory puts it, only analog systems can represent the outside world directly and swiftly by parallel changes into the internal states. But how efficient and successful these analog machines can be? Despite the huge claims in support of such attempts and the great amount of truth in such a line of argument, I feel that analog machines are not the final steps to reach the desired state. We shall see the need to have a feasible hardware to achieve the machine intelligence later. Searle has been arguing on similar lines but from an entirely different dimension.

Despite the fact that Dreyfus's arguments have been countered in a very effective
way, there is a lot of truth in this type of objection. For instance, Dreyfus is correct in that the entire thought process does not take place in concrete, discrete, steps. Put in Artificial Intelligence terminology: It is not algorithmic. I suggest that all insight whether philosophical or mathematical is not algorithmic. In the paper cited elsewhere in this work, Lucas (1961) even suggested that the brain's action cannot be entirely algorithmic. But number of counter arguments have been put forward ever since Lucas's paper was first published. A number of them have enormous philosophical implication. For instance, Benacerraf, Good, Bowie, Lewis and Hofstadter have argued that this is a gross error by Lucas. But I feel that the very nature of human though process is non algorithmic. If at all any steps are perceived in the entire thought process, they are only pseudo-steps. Talking of non algorithmic nature of mathematical insight, Penrose states that, "Mathematical truth is not something that we ascertain merely by the use of an algorithm. I believe, also, that our consciousness is a crucial ingredient in our comprehension of mathematical truth."

4.3. Inspiration And Creativity

The nature of thought process compels us to take a fresh look at some of the phenomena connected with it such as inspiration and creativity. Dreyfus says that there are some areas of human thought process that could not possibly be simulated in a computer. But I suggest that there are many more than the ones that Dreyfus points out that are difficult to simulate in the computer. Probably because we are yet to know them
completely. The two mentioned above, viz., inspiration and creativity belong to such a list. These two, in my opinion, are the best examples to prove that the thought process is non-algorithmic in nature.

I have used the word inspiration though one might put in that place words like insight or intuition. But I think that, to my own surprise, they are not so easily separable as one might think. In fact, they are closely knit up and work together. They form the foundation of every invention. Almost all of the inventions emerge from the split-second inspiration or intuition. The case of Archimedes is very well known. But how come such occasional flashes occur in us? Are such flashes that we often refer to as insight or inspiration, the product of unconscious? The essence of intuition is to arrive at decisions or conclusions without explicit or Conscious processes of reasoned thinking. If that is true and that all the major inventions take place only by this occasional flashes that are more or less the products of unconscious, then, can we say that consciousness is not at all needed for making inventions and discoveries? There are some like J. D. Watson [who discovered the structure of the DNA molecule along with Francis Crick], who might differ a little. Infact Watson goes to some extent in describing the procedures or stages involved [or what he thinks as the steps involved], in all creative thinking. But often the entire process of creative thinking is not all that clear and explicit. Jacques Hadamard has recorded numerous instances where after having failed to arrive at any conclusion through serious efforts over the period of time, a split-second insight
brings forth the answer. At least in the case of Archimedes it can be stated that he was pondering over the subject, even when he was bathing. But often it sprouts out, as it from the unconscious, as it happened for Poincare.

I left Caen, where I was living, to go to a geologic excursion under the auspices of the School of Mines. The incidents of the travel made me forget my mathematical work. Having reached Coutances, we entered an omnibus to go to some place or other. At the moment when I put my foot on the step, the idea came to me, without anything in my former thoughts seeming to have paved the way for it, that the transformations I had used to define the Fuchsian functions were identical with those of non-Euclidean geometry. I did not verify the idea; I should not have had time, as upon taking my seat in the omnibus, I went on with a conversation already commenced, but I felt a perfect certainty. On my return to Caen, for convenience sake, I verified the result at my leisure.

"... What is even more remarkable is the fact that such flashes are always correct. Moreover such flashes have got some degree of beauty and attached to it and the moments of such flashes are mostly pleasant. Penrose even goes further when he says that the validity of such a flash of inspiration is very closely bound up with its aesthetic qualities."

"The above anecdote brings me to another issue concerning inspiration and insight, namely that aesthetic criteria are enormously valuable in forming our judgements... A beautiful idea has a much greater chance of being a correct idea than an ugly one."

But should such a conception occur in sciences as well? I feel so, since truth and beauty are not very different in nature from each other. As Hadamard said once...

It clear that no significant discovery or invention can take place without the will of finding. But with Poincare, we see something else, the intervention of the sense of beauty playing its part as an indispensable means of finding. We have reached the double conclusion: That invention is choice.
That this choice is imperatively governed by the sense of scientific beauty.

In the recent years, Dirac, for instance, has stated that it was his keen sense of beauty that enabled him to come out with his famous equation, governing the motion and spin of electrons.\textsuperscript{107} I suggest that all creative thinking do contain such leaps, as it happened in the case of Kekule. This means that not only mathematicians and physicists make such creative leaps. All of us at one time or the other do take such leaps but most of the time we are not explicitly aware of them. Penrose differs from others when he posits the presence of consciousness in all such creative leaps. "It is these judgements that I consider to be the hallmark of conscious thinking. My guess is that even with the sudden flash of insight, apparently produced ready-made by the unconscious mind, it is consciousness that is the arbiter, and the idea would be quickly rejected and forgotten if it did not 'ring true'. ... The 'aesthetic' rejection that I am referring to might, I am supposing, be such as to forbid unappealing ideas to reach any very appreciably permanent level of consciousness at all."\textsuperscript{108} Finally, I feel that what makes such flashes so special is the factor of grandness, as I would like to call it, which enables one to have unhindered comprehension of the subject when the flashes occur. As Mozart once said, "Then my mind seizes it as a glance of my eye a beautiful picture or a handsome youth: It does not come to me successively, with various parts worked out in detail, as they will later on, but in its entirety."\textsuperscript{109}

In this background I would like to differ a bit from Polanyi and suggest that it is
impossible *a fortiori* to simulate tacit knowing or for that matter the entire thought process. Dreyfus is correct if he intends to say that intuition and creativity cannot even be stated in terms of mathematical notations, leave alone simulating them on computers. So, viewing from a different dimension, I state that, contrary to Boden's opinion, Dreyfus's argument is not misplaced.

All creative thinking involves a great amount of innovation and analogical thinking. So, it looks *prima facie*, stupidity to claim that even machines can be infused with these properties! Now let us see what are the achievements of Artificial Intelligence experts and their claims about machines being creative. One of the related abilities in this regard is the ability to learn and thereby being knowledgeable. Can machines learn and be intelligent and creative? Let us now see how far Artificial Intelligence programs have gone in achieving this desired state.

We mentioned earlier that it may be too much of asking the computer to converse intelligently. But what about computers being intelligent writers instead of their being intelligent conversationists? One of the earlier attempts in this connection is to manufacture an automatic novel writer by Sheldon Klein. However those who went through the final product were completely disappointed at the lack of finesse of all intelligent writing and it should be obvious from the following excerpt:  

"
The day was Monday. The pleasant weather was sunny. Lady Buxley was in a park. James ran into Lady Buxley. James talked with Lady Buxley. Lady Buxley flirted with James. James invited Lady Buxley. James liked Lady Buxley. Lady Buxley liked James. Lady Buxley was with James in a hotel. Lady Buxley was near James. James caressed Lady Buxley with passion. James was Lady Buxley’s lover. Marion following them saw the affair: Marion was jealous.

This excerpt brings to my mind a funny incident concerning a beginner attempting to write a novel. He was asked to write a brief story combining a glimmering of religion, a touch of class, a soupcon of sex and a strong aura of mystery. He immediately wrote a piece which ran like this:

"My God!" said the Duchess, "I am pregnant. Who Done it?"

No need to say that a man who asked for a story was stumped. But none of us will accept that as a good piece of literature. At the foundation of all creative writing, whether it is Kant’s Critique of Pure Reason or Lewis Carroll’s Alice in the Wonderland, is the ability to immerse the reader into the depth of the text, guiding him from known to the unknown. But that indicates a pre-requisite knowledge of the world in both the writer and the reader. No doubt Klein’s program was clearly expressed, but expression skill alone cannot make a text creative.

In this connection it would be worth noting that the improved version of D.E. Rumelhart’s Story Grammar might be of great help to the attempts of this sort.
Story Grammar is intended to express one's intuitive sense of the shape of stories in computational terms. The basic rules of this grammar, which are eleven in all, are context free and generally applicable to any sort of stories independent of the plot or theme.\textsuperscript{111}

But there is another aspect to all these. The representation of the real life situations. As long as this is not done, the stories created by such automatic novel writers will only be crude. In this connection, R.P. Abelson's theory of themes and scripts could provide far more richly structure plots than Klein's program contains. Abelson's molecules and plans, and his analysis of mundane social structures and actions evoke a lot of interest in this respect.\textsuperscript{112} Ever since the initial attempts were made, efforts are directed to represent complex knowledge of the world at the same time avoiding combinatorial explosion. Abelson's plans, themes, scripts and "situational schemata"\textsuperscript{113} are the right suggestions on how such a complex knowledge could be represented in a program. I wish to suggest here that not merely representing such a huge amount of data into the program will help one in this cause. Rather there should be some method by which the machines should be able to manipulate the symbols in an effective way.

Marvin Minsky has offered such a conceptual schemata, which he calls frames.\textsuperscript{114} Minsky's discussion is an attempt to give some theoretical unity to a wide variety of particular hypotheses about knowledge -- using systems in artificial and natural intelligence, and as such it inevitably blurs some of the distinction already made within
the relevant literature. But while there may be many differences of detail between different types of epistemological schemata, or frames, a number of broadly similar questions arise with respect to their manner of functioning in the formation processing of the system concerned. As Boden mentions, a number of related questions came up such as, how we come to know what we need and the role of memory in perception.

For instance, how are we able to recall a human face from the thousands we see everyday or how a physician is able to diagnose the disease very quickly? In the earlier part century, Bartlett's memory schemata and stereo typed representations interacting with particular details evoked a lot of interest. But, as it was for Bartlett, the epistemological issues connected with these matters are unclear and too obscure to understand. However shabby these attempts might have been, they inspired lot of others to go in for more sophisticated attempts and also served as models in some others. Such efforts have also thrown light into the functioning of mind. For instance, Charnaik has devised a supermarket frame, a program to express the mundane knowledge of how one goes about shopping. Charnaik's effort has known how complicated such an apparently simple matter as shopping is. Application of Schank's and Abelson's ideas have led to the creation of programs to generate stories. Yale's SAM which deals with the texts and how one might organize and select the best possibilities from many possible inference, is another best example. Wendy Lenthert has contributed a module to SAM and this has given SAM an intelligent look. Another program inspired by Schank and Abelson is Jim Mechan's TALE-SPIN. TALE-SPIN is devised to generate stories.
Mechan's program generates the stories exactly in the manner in which one would expect a machine's program to do -- by creating structures representing goals and methods of achieving those goals. And C.J. Rieger has chosen a slightly different line and has devised a program EX-SPECTRE not to generate stories but to interpret stories.122

One main component of creativity is the ability for analogical thinking. Despite the claims of the staunch advocates of Artificial Intelligence, I am afraid, the computational knowledge of comparative or analogical thinking is at its very infancy. But there are few bright spots too. The program SCHOLAR has exhibited the capacity to reason analogically and draw inferences from complete data.124 MERLIN was devised "to use an operation typically employed on concept on a different though analogous, concept, by means of 'forced matches' between disparate features."123 We are witnessing the theorem proving programs printing out elegant proof for the pons asinorum theorem.125

Mere representation of the knowledge of the world and dealing with the problems with the help of such a general representation cannot make machines intelligent. Rather such a representation will only make them stupid. For, the situations in the real world are likely to be changing all the time and may be the internal models within a human being are also changing. I suggest, if this picture is true, that only such rapid changes make human beings as intelligent and creative. If this be true, then even the problem-representation have to be changing. For one representation of a problem may be better.
than the other. This means, the creation of intelligent machines becomes more difficult. The work of Saul Amarel discusses these issues. One of his celebrated papers illustrates the comparative power of different representations with reference to a specific problem.\(^{126}\)

Before winding up our discussions on analogical thinking, a word or two about Sloman's attempt. Aaron Sloman has raised some interesting questions in comparing [what he terms as] analogical and Fregean representations.\(^{127}\) "An analogical representation of something is one in which there is some significant correspondence between the structure of the representation and the structure of the thing represented. To understand an analogical representation is to know how to interpret it by matching these two structures [and their associated inference procedures] in a systematic way. But in a Fregean representation there need be no such correspondence, since the structure of the representation reflects not the structure of the thing itself, but the structure of the procedure (thought process) by which that thing is identified."\(^{128}\) Boden comments that Sloman's distinction holds significance since it suggests the possibility of there being very different ways of arriving at valid and rigorous proofs in problem solving. Sloman goes on to point out that the philosophers, mathematicians and logicians have assumed that the Fregean methods are superior and efficient compared to informal proofs. Sloman argues that the notions of validity and rigor can be applied to informal proofs as well. Sloman even suggests that the analogical representations can be more powerful than the Fregean representations. "This raises interesting questions about which of the "intuitively
obvious" steps in proofs, whether formal or not, need further explanation or justification. When does heuristic adequacy need to be underpinned by explicit logical indication? No one acquainted with Artificial Intelligence will be surprised to find that one can specify underlying computations in explication of intuitive steps within a proof. 129 Is this a possibility? 120

L.N. Landa has formulated a criterion to find out the elementary operations of thought by way of what can be called as Algorithms.141 Douglas Hofstadter mentions a chess program that was very different from other chess playing programs. It had the unusual feature of quitting long before the game was over. It splendidly spotted the hopeless position well in advance and hence it did not wait like other programs till the ritual of checkmating was over. Here Hofstadter is referring to a very important and in my opinion unique feature of human thought -- ability to jump out of the system. "It is an inherent property of intelligence that it can jump out of the task which it is performing, and survey what it has done; it is always looking for, and often finding, patterns. ... I am sure that every human being is capable to some extent of working inside a system and simultaneously thinking about what he is doing."132 I feel that it is this ability -- ability to jump out of the system to check and learn about the system itself and at times about the very jumping out, and thoughts that form the foundation for such a jumping -- that makes human beings unique and very interesting. But can machines have this ability? Despite the reference cited above, I am afraid, it may not be possible entirely to make machines possess this ability. For, I strongly suggest that this ability is
in principle unformalizable. It belongs to one of those dark areas of which we are yet to have complete knowledge. But are machines at least capable of learning?

4.4. Learning

Learning is often divided into three broad groups, viz., learning by example, learning by being told, and learning by doing. Are machines capable of anyone of these? John McCarthy once stated that the problem of how to enable a system to learn is inseparable from the problem of how to represent the knowledge. Generally learning is understood as a generation of new thoughts from the old and more simply an improvement with or without the help of prior knowledge. Thus answer to the questions of this sort depends on how one treats learning. Bertrand Russell made a distinction between knowledge by acquaintance and knowledge by description. Russell regarded knowledge by acquaintance as independent of and superior to knowledge by description, mainly because of its directness. According to Russell such a knowledge would be free of all abstraction and description. For, knowledge by acquaintance involves the direct apprehension of reality. Thus for Russell learning by example would be superior to learning by being told. Which one of them is superior is a different matter. Can machines possess this ability to learn by example? If it can, then, like every other human being it too would perceive reality and will have illusions, and by sensations? Numerous attempts have been made in this regard. For instance, J.M. Tenenbaum's program is taught (!) to recognize (!) various things. Tenenbaum's program involves two data structures.
to represent the concepts learnt, viz., semantic and iconic, and it learns to recognize various objects by ostensive definitions and to pick out the picture of an object it has learnt from the bunch of photographs.

But anyone who follows such attempts very carefully will definitely notice that Tenenbaum’s program has to start with great knowledge in store. The programs, even if granted that they are capable of learning, should first of all have the elementary knowledge of the things, basic knowledge of how to store the information, etc. The implication of this is that not only should the system that is learning possess the ability to construct and manipulate the symbols, but also should possess the knowledge of primary capacities and abilities before hand. This was argued by Immanuel Kant in different terms in his account of a priori prerequisites of empirical knowledge. Stretched a little bit, another implication of this is that we are all born with powerful innate qualities. Granting that they start with immense knowledge of the world as well as the knowledge of procedure to acquire such world knowledge can machines learn by themselves from following the examples? Some of the related issues in this regard are discussed by P.H. Winston, whose program learns from examples and counter examples to the examples shown already. M.J. Fredling’s program is alleged to recognize some of the functional possibilities inherent in the structures. His system is supposed to recognize a wide variety of three-dimensional structures, the movements of walking animals, flying creatures or fast moving trains etc. But can these or should these so-called achievements be considered as worthy illustrations of learning by example?
would like to push it further and ask: do these programs proceed from the old thoughts to the new ones? Boden feels that learning by example is not the direct apprehension of reality. "Unsullied by any intermediary interpretative activity. It involves the discerning development of descriptions, or interpretative schemata, representing the target domain, which are constantly checked by reference to example and counter example so that salient cues are identified (what Piagetian psychologists term assimilation and accommodation). The ability to compare concepts with one another in a discriminating fashion is the basis of the recognition of analogy, in terms of which concepts can be intelligently used to describe things that were not included within the target domain as initially conceived."

One possible implication of this is that knowledge by acquaintance need not be the direct apprehension of reality and hence machines too can possess "knowledge by acquaintance." It may be true that the machines [again of course granting that they do possess the ability to learn] can be better at times than human beings especially at the cases when disjunctive concepts are involved [which people find difficult to cope up with] and where the presentation of many differences at one time.

Often people wrongly assume that learning by being told is more of a passive reception of new information and often it requires no thought on the part of the learner. But learning by being told is very complex and often involves inferential thought processes. To illustrate this point let us consider an incident. "A mayor was delayed on his way to open the town fete, and the local priest was asked to speak to the crowd meanwhile. He described some aspects of his pastoral experience, including his distress
and embarrassment when, many years before, his first penitent had confessed to a particularly nasty murder. Eventually the mayor arrived, and in thanking the priest for entertaining the audience in his absence, he said: 'I am very glad to see Father Brown here today. He and I are old friends -- indeed, I was his very first penitent. 'Naturally, many of the listeners immediately realized that the mayor was the murderer.'

This is an excellent example of learning by being told not as a passive reception of new information but involving massive thought operation. The priest did not explicitly state that the Mayor was the murderer nor the Mayor confessed so. People were able to infer immediately that the Mayor was the murderer. I suggest in this connection that there can be no more passive reception at all for even in the so-called automatic behaviour, immense thought process is involved. For instance to learn from the statement "Mr. X moved the chair", one should first of all know who Mr. X is, what chair is and what is movement. Then one connects these ideas and infers that chair has been moved from one place to another by Mr. X. Are machines capable of such a learning?

D.V McDermott's TOPLE uses inferential strategies somewhat similar to the inferential process we have observed. Though it is not as sophisticated as in the case above, it definitely uses inferences to some extent at least. But the most outstanding work in this direction is C.J. Rieger's MEMORY. MEMORY is intended as a simulation of human verbal memory and MEMORY represents (?) the world in such a way that it enables the program to make many simple inferences. Moreover MEMORY is also able to interrelate such inferences for further interpretation. Astonishingly MEMORY comes very close to an inference much similar to the one people made - Mayor was a murderer.
Despite the program’s achievement [or the programmer’s ?] even the staunch advocates are not so willing to grant that MEMORY could have realized ‘the first penitent was the murderer’ and connected such realization with ‘mayor was father’s first penitent’ as many people did immediately. Another reason that probably could be the deciding factor in this direction is the lack of sufficient hardware and current computations are too small to allow MEMORY to run in more than one inference at a time. Though many have deviated from the philosophy of using demons, 147 Rieger’s reason for preferring spontaneous inferences to the demon-based approaches of the likes of Charniak, is that demons are normally represented as potential rather than actual, and hence the information does not reach other parts of the system that may need the information 148. But there are lot of similarities in the approaches of Rieger and Charniak, and though their methods are not radical, they have enabled the researchers to proceed towards the better understanding of human understanding. 149

Practice makes man perfect is the old proverb. Often people learn to do the job better by sheer practice. As they perform again and again, men sometimes find out their weaknesses and learn to rectify them. Though it looks more or less monotonous or seem to involve no thought processes at all, learning by doing can at times be very complex.

A.L. Samuel’s Checkers program 150 is one of the earliest and most impressive of the learning programs that rely on their memory to progress with the current performance. Samuel says that his program achieves this by two methods, viz., rote
learning and learning by generalization. Though the former was expected naturally of such programs, the latter was a pleasant surprise. By this latter method, program keeps on improving by adjusting the weighing of the parameters involved in accordance with the real life situations. The program starts with sixteen of the total number of thirty eight parameters listed by Samuel, and as the game proceeds the lesser needed are replaced by the more suitable ones. Many of the advocates of machine intelligence and those from cognitive psychology and medicine claim that this is the way in which humans too perform, but with more powerful computations and complex underpinnings. Though this is a very clumsy line of argument, it is a very powerful one, probably because of the evidence that it has. To the astonishment of the experts themselves Samuel’s program functioned beyond the expectations and it made the champion player to confess shamelessly. It was the high point for the AI advocates since hitherto theoretical works were proved capable of working in reality as well. Advantages from learning by doing and other related matters were enumerated by two most outstanding programs in this direction, STRIPS and HACKER. Both the programs go about generalising solutions more intelligently than Samuel’s program. But interestingly both depended on the representation of knowledge of the purposive structure of the task, to learn from doing the work. STRIPS has the potential to solve a wide range of problems and is used to produce plans of action for execution by SRI robot SHAKES.13

The crucial point is that STRIPS produces a means end analysis of the task, and expresses the plan as a series of actions that cumulatively establish the preconditions necessary for the final, consummatory action. ... STRIPS’s representation of the plan not only lists the relevant actions
in order of their execution, but also clearly shows which actions [or subsets of actions] satisfy which preconditions for which actions [or subsets of actions]. It also distinguishes the important effects of actions from their side effects. And it shows how the state of the world changes progressively at different steps of the plan. In short, the inner purposive structure of the plan is made apparent by the representation, which can consequently direct the flexible use of it in varying circumstances without the need for a new plan to be worked out.

As it is obvious from the foregoing, STRIPS comes closer to achieving what humanists or Anti AI protagonists would like to call as learning by doing. The hallmark of human insight engaged in all the work is the ability to learn from mistakes and the consequent disappearance of error and clumsiness from the system with the progress of time. I think STRIPS almost achieves that. But can we call such a program intelligent? We shall see. These points as well as smooth transition from principle to practice discussed by G.J. Sussman. Sussman has devised a computational model of skill learning called HACKER. Talking of learning from the mistakes, Sussman’s program has been named after people who are called Hackers because they spend a lot of time in programming. The human hacker has to locate and eliminate bugs in the program. "As the contemptuous term suggests, 'bugs' are annoying, and often essentially trivial mistakes made by the programmer in writing the program. By a trivial mistake, I mean something like forgetting to close a parenthesis, or negligently omitting a line of code that one knows perfectly well to be essential." Such bugs are very trivial from the human point of view and a person may not find it worth indulging into, as no new insight is gained in the process. But there are other more significant bugs such as the assumptions of linearity in problem solving and Sussman calls these as "manifestations
of powerful strategies of creative thinking," and talks of the virtuous nature of bugs. HACKER has established well beyond doubt that it learns from its mistakes. Philosopher of Language J.L. Austin once suggested on effective classification of different types of mistakes in his discussion on excuses. Sussman has classified bugs in these terms. What is even more surprising is that though programmed in an efficient way, HACKER constructively criticises its own efforts and accordingly learns. One of the functions of a teacher is to do the same and make his student more intelligent. The teacher criticises the student's every effort constructively and makes the student realize his own mistakes and instructs the student to learn from such mistakes. Goldstein's MYCROFT is an attempt on these lines.

Can we call these programs intelligent and treat them as capable of learning? If we cannot, what about these achievements? The questions involved in these issues of creativity and learning are still very obscure and afford no more than a hint about how to identify relevant aspects of these problems and the modes in which to represent such problems. This one area has been elusive for AI research, despite some genuine attempts and useful suggestions. Bobrow has distinguished various dimensions along which representations might vary, and Hayes has raised a number of questions concerning theoretical issues involved and has offered numerous suggestions as well. Amarel has focussed his attention on the theory of representation based on definite classes of forms of rules of actions. The rules of heuristic discussed by Polya, Max Werthimer and Karl Duncker are useful in solving this elusive problem. But
unfortunately none are critical and definitive. Rather they tend to be suggestive and at
times vague. It is also interesting to note that Artificial Intelligence programs rely heavily
on the representational methods. I think here lies the key to solving this problem. I
would like to ask: to what extent should the creative problem solving rely on such
general representational methods? May be AI researchers have to reformulate their
basic notions in a radical way to arrive at the plausible solution within a reasonable
period of time. Though many of the fundamental principles underlying these attempts are
unclear, one thing at least seems to be clear. To be creative and intelligent, machines need
to have the ability to express and the ability to perceive, that is, language and perception.
So now let us move next to consider whether machines can possess language and
perception.
Before that, let us take up an important question of emotions. Can computers have emotions? This is also the last of the counter arguments on Artificial Intelligence referred to above. Prima facie, the whole argument seems very simple. There are many philosophers who would at once hold a view that it would make no sense whatsoever to attribute emotions and feelings to "inorganic artifacts" or "inanimate programmed systems". Commonsense and conventional wisdom do take us only to such conclusions. But, in making paradigm shifts and leaping beyond in a creative realm, commonsense and conventional wisdom are not sufficient. Often, Bernard Shaw's "Why not?" becomes a magical formula in finding solutions to the improbable questions. It is this proclivity that even dullest of us posses that makes it possible always to have 'one more' dimension or perceiving 'What is not there'. So, why not computers have emotions?

The advocates of AI do not trace the emotions in feelings or in the bodily sensations, but in a strong cognitive component relating to the background circumstances in which the emotions are experienced. They use highly sophisticated computational analysis to breakdown the concepts involved in or related to emotions. Each psychological concept involved is precisely defined.

Consider, for example, the analysis of the concepts by R. P. Abelson. He has defined a number of themes in terms of interrelated plans of two people. Each person is thought of as having one plan. "... a means - end series of goals, with the logical
possibility of obstruction or facilitation for each sub-goal. And each actor's relation to
the other's plan has three logically independent dimensions: role, attitude and facilitative
ability." These dimensions are internally divided and defined. So, if one takes up the
approach of computation, then, any concept can be analysed to the depth and then can
be fed into computers. There are number of other approaches than Abelson's and one
of them provides "an extensive lexicon of emotion - words classified in terms of "of the
theory". 171

If the issue in question - analysis of emotions - is so simple, then why
philosophers have been splitting their hair for thousands of years? The topic of emotion
more than any other - has bedevilled the students of mental life. All of us have been
brought up by being taught that "man is a rational animal" and most of us do have more
than a religious faith in upholding the dictum. But emotions are the biggest stumbling
blocks in conceiving a human being as a rational and intelligent being. Systematic
reflection over the period of thousands of years have made philosophers to hold a view
that rationality is contrary to emotions and emotions as a delightful remnant of our pre-
sapien nature and they represent human beings in their original state.

If rationality and intelligent actions are opposed to emotional experiences and
behavior, then, why would people involved in creating 'new species' of 'thinking things'
be interested in making them have emotions? Thinkers like Hofstadter have stressed
more than once that any intelligence has to have emotions and also that thinking is
inseparable from emotions.\textsuperscript{172} We will return to this hypothesis soon.

The single most influential contribution to the study of emotions comes from Charles Darwin.\textsuperscript{173} According to Darwin, expression of emotions is advantageous to human beings and emotions can be traced to have an evolutionary origin. Later works by ethologists such as Lorenz,\textsuperscript{174} Tinbergen\textsuperscript{175} and Eibl-Eibesfeldt\textsuperscript{176} have supported Darwin’s arguments. William James in 1884 and C.G. Lange in 1885 hypothesized independently that "instead of outward signs and emotions, being the result of some prior emotional, neural signal, they insisted that our feeling of the bodily changes as they occur is the emotion".\textsuperscript{177} Some three decades later W.B. Cannon questioned the existing ideas as he noted that the emotions did exist even when the viscera was not present in the central nervous system and he also observed several anomalies in the compatibility of emotional and visceral responses.\textsuperscript{178} Theories that emerged later were mere developments on these. Though, Stanley Schachter’s idea of "necessity of visceral arousal", F. Paulhan’s and John Dewey’s "psychological conditions" and later brain studies helped us to have new perspectives of emotion, an issue that still remains at the focal point is whether emotion is visceral or mental or it depends mainly on the background circumstances.\textsuperscript{179}

Now let us return to Hofstadter’s hypothesis. One peculiar features of emotions is that they have both positive and negative character. Any intellectual working has got to have an emotional involvement. In the same vein, it also has to be accepted that some
of the emotional experiences seem to obstruct the entire thinking process at times. It is this dual aspect of emotions that has compelled many a thinker to deal with emotions in the light of 'attaining goals' and related aspects. But there are few who believe that 'emotions' are more complex than this and hence a more broad based approach has to be adopted. 

Popular distinctions between mental, emotional and intellectual worlds and Freud's three-fold classification appear to be ill-equipped to deal with emotions in entirety. Hence, I suggest contrary to the conventional opinion that the emotionality is the basis of rationality. I feel that it is the emotional architecture that remains in the background of rationality that decides the level of intelligence, amount of intellectual involvement, etc. Our present level of knowledge prevents us from even guessing that rationality can be traced in the emotional experiences. However I feel that it may not be a fruitful idea to trace that which sets the paradigm in the paradigms. This discussions takes us to the questions of analysability of emotions and their uniqueness.

Thinkers like Boden straight away hit the sopor and try to track down emotions and feelings more as a computational mechanism. They perceive emotions in terms of high level structures [such as personal preferences, moral rules, etc.] to organize the behaviour of an intelligent being. Emotion, in short, is considered as a computational mechanism that can be traced in the humans. I feel the main drawback of all such theories is the fact that emotion is understood only in terms of 'stimulus - response'. The more safer and sane approach to emotions is to perceive them as a whole, like a mystical experience. The classic example that will prove both these points is the "emotions and music". Though the physiological experiments are enthralling and
interesting, the cases of Beethoven, Dvorak, Faure and Thyagaraja battle us. Simply, it escapes our minds. Moreover, this argument does not apply to many empirical situations. Again, the computational approach opens up the questions concerning emotion in 'any intelligent being'. Though it would be interesting to have a picture of the world in which humans, animals, plants, sands, mountains, personoids and extra-terrestrials having emotions and war-words! But that is more of a painter's or poet's dream and not that of a philosopher. With the emergence of views of emotion based on 'cognitive evaluations', the question of analysability of emotions has become even more unclear. In addition to that some excellent clinical results on 'malnutrition and emotions' and ensuing greater effects of emotions on perception and memory are also available. So in the light of all this, the very distinction between simple and complex emotions appears to be an illusory one. So, it is highly doubtful that how far one can rely on computational approach in dealing with such complicated matters. This is not to put down the computational approach altogether, but only to show that such approaches may not be equipped well enough to yield the positive results. As for the innateness of emotions, I feel that emotions are indeed innate with human beings. But one should be careful to make a distinction between emotions and feelings [as they are present in the animals] and also between wired-in inflexible responses and sophisticated inferential machineries. Experiments and ensuing results for the period of over two hundred years have enabled us to identify that emotions are indeed innate. Whatever be one's approach, I feel that we have to agree that emotions are indeed Nature's pill to human beings. Human beings are conscious, intelligent and emotional beings and any
attempt vis-a-vis computers to replace them has to include emotions as well. It is very difficult for anyone even to guess whether Nature's gifts are transparent enough to be imitated and fed into another type of structures. And as for the involvement of consciousness is concerned, I feel that this is not the appropriate place to discuss them as our focus is very different and also for various other obvious reasons.

4.5. **Language, Perception and Reality**

All of us have the knowledge of reality and two of our abilities, viz., to communicate linguistically and to perceive are mainly responsible for it. All of us do these two things almost effortlessly, but on analysis these two things are the most complex of all the things connected with human beings. First let us take up the question language.

There is enormous evidence to prove that bees do communicate, monkeys make different types of calls, birds sing and dolphins do communicate. So what is special with human communication? Is there any distinction between the communications of 'dumb dogs' and 'clever Hans' and that of humans?

Human communication is more complex than animal communication in that humans use language. Though humans can communicate in many other ways such as gestures, signs and emotional cries, it is the use of language that makes them very unique.
and no system of communication is as rich as human language. Moreover, language has got many peculiar features that makes it so special.

Language is social. It helps one to pass on one’s knowledge to another, increase one’s wisdom by using it, and control one’s environment from one generation to next. The very concept of language means solipsism has no meaning. Having noted that it should also be observed that people do not merely and straightforwardly use language. They distort the meaning of the sentence by using the tricks of the language. Again we do talk about things and processes we perceive on the one hand, and on the other we talk about non-existent objects and worlds; about familiar and unfamiliar things; and what more about sense as well as non-sense!

Besides our usage, all languages seem to possess what Thomas Hobbes called as “inconstancy of language.” Human language has got a dual aspect: it may be written or spoken. But what is really fascinating is the fact that when the language is written its nature and implications appear very different from when it is spoken and vice versa. Finally language can be about language. This capacity for self-reference that makes human communication system different in a very fundamental way from that of the animal communication system. This leaves us with some of the basic questions to be answered before moving an inch forward! What is the nature of language, how it works and how are we able to pick up almost effortlessly such a rich and complex system of communication?

Number of thinkers have approached these questions [or only some of them] in
the radical manner from time to time. Neo-grammarians turned their attention to
everyday utterances to find out the exact nature and function of language. Though neo-
grammarians' search led to the enhancement of knowledge about the development of
language over the millennia, their attempts lacked the proximity to see language as a
system. But that changed with the emergence of Ferdinand de Saussure. Gaining
inspiration from the game of chess, Saussure focussed on language as a system. Noticing
many similarities between the two, Saussure arrived to treat language as an organized
totality with various interdependent parts which derive their significance from the system
as a whole. Though Saussure's ideas did not create any revolution in the human sense, they were instrumental in creating numerous centers in the linguistic community with
diverse interests. Of them Prague school under the guidance of Roman Jakobson and
Nikolay Troubetskey stressed on phonoology and differed from saussurean school in that it gave more importance to psychological reality. Thus the notion of treating language
from the angle of 'convenience' came under a serious threat. Franz Boas' anthropological approach to language through his analysis of speech patterns of living
languages gave further impetus to the new approach. Later Leonard Bloomfield
brought these ideas to the forefront through what can be termed as physicalistic treatment
of language. Bloomfield thought of language as a purely physical phenomenon and
rejected any psychological or mentalistic features in the study of linguistic behaviour.
Since he wanted to defend his materialistic account in the most logical manner, he said
it was very dangerous to deal with the very concept of meaning. It is against this
backdrop the ideas of J.B. Watson and B.F. Skinner dominated the majority of the
field/the idea of C. Levi-Staudt/Kward Sapir209 and B. L. Whorf210 in some quarters.

But unfortunately none of these theories touched upon the kernel questions posed before them. And it appeared, as it were, destined that Noam Chomsky has to emerge with his monograph Syntactic Structures to do all the work by himself. He changed the direction of linguistic research absolutely in the opposite way and very soon this copernican revolution within the linguistic community delivered telling effects on many other disciplines, especially in Philosophy of Language, Philosophy of Mind and Epistemology.211

Chomsky started with two tough tasks on hand. One, to change the vision of verbal botany of his predecessors to the globalist vision and next to answer the key questions posed to the linguists. Thus out of his attempts was born a new concept of language as phonetics and semantics superimposed upon an underlying core of pure syntax. With this concept, the principal aim of linguists also turned towards identifying the exact nature of universal grammar that Chomsky claimed to be biologically present in all the normal children as part of their genetic birthright. He also added another idea to this new concept of universal grammar: that the grammar of each language must be generative. By generative, Chomsky meant a set of rules capable of generating all the well-formed sentences of the language and none of the ill-formed ones.
Chomsky noted that there are some properties of sentences [of any language] that the speakers intuitively know that can be explained only by employing some deep principles. The famous illustration of this is: \textit{colorless green ideas sleep furiously} which every English speaker knows intuitively to be meaningless and yet grammatically perfect. Thus Chomsky went about to identify and provide a frame work for this grammar that correctly distinguishes "good" sentences from the "bad" ones.

To do that Chomsky went right up to our brains. What prompted him to do that were some of the most interesting aspects connected with children's ability to acquire language. Though rest of the world did not take up this issue very seriously, Chomsky did not think that it was one of the childish matter.

Four facts stand out from others in language acquisition abilities. First, children master a rich system of knowledge without any significant learning and instruction. Second, they acquire such knowledge despite \textit{poverty of stimulus}. Thirdly, this process takes place in the most efficient and rapid manner when children are very young, especially between the ages two and three. And finally, children are able to acquire any language they are exposed to almost effortlessly. Chomsky, after a long period of introspection, postulated that every human brain contains what he called as language acquisition device. It is this organ, according to Chomsky, that defines do's and don'ts of human communication. With the help of these ideas and many other aspects of his theorizing, Chomsky went on to build a nativistic fort that remains unconquered till date. Various other aspects of his system, several criticisms that were levelled against his
theories and his encounters with Piaget an very well known.\textsuperscript{112}

To sum up, the two key points that any AI researcher has to take note of are: (1) Language Acquisition Device is innate or inherited and (2) it is unique [that is, it is specifically designed for language acquisition and is not a part of a general problem solving device]. Moreover, several independent observations have strongly supported nativist claims. For instance, Jerry Fodor pointed out that it is impossible to gain more powerful thoughts from the less powerful ones and hence all forms of reasoning capacity of a human being has got to be determined at birth.\textsuperscript{113} Arguments on these lines have posed a strong threat to AI attempts.

All of us hear, understand, interpret and respond to the spoken sentences.\textsuperscript{214} So let us proceed to see against this backdrop, what AI experts have done on these lines. Of the early programs on understanding natural language, K.M. Colby’s artificial paranoiac PARRY\textsuperscript{213} and Joseph Weizenbaum’s ELIZA\textsuperscript{215} stood out from what can be called as question-answer type programs. But such programs hardly ‘exhibited’ any ‘knowledge’ of understanding language. ‘Inconstancy’ referred to above and the knowledge of background circumstances forced AI experts to probe further in the alternative directions. These and other important theoretical issues\textsuperscript{217} were taken into account by Terry Winograd\textsuperscript{218} in his SHRDLU. SHRDLU was by and large a great leap over her [?] predecessors and it displayed a flexible interplay between syntax and semantics and partly reflected the ability to use the background knowledge. Then Eugene
Charniak stressed the need for taking into account important psychological facts playing out in words and he outlined a program incorporating a preliminary model of human intentions, desires, etc., which he hoped will provide insights into young children’s ability to understand simple stories. Few attempts on machine translation are also available. However, it is the works of Schank and his collaborators [they have produced programs that give precis of stories, skim news reports, answer questions and draw inferences about some of the psychological phenomena involved in natural language]. According to Schank all that we talk about or how we think can be traced in the basic conceptual element. And upon this primitive core, one can construct a general understanding of natural language. Though there are number of theoretical constraints on Schank’s system, his programs are the ones that have done more well than others. In addition to the above, number of other approaches have also been tried out.

But against the backdrop of Chomsky’s schema of uniqueness and innateness of LAD, it is impossible for computers to communicate linguistically. For, any intelligence sans linguistic ability is inconceivable. Though Schank’s programs are breathtaking, his attempts an incomplete, because his theory of the structure of language is very poor [speaking from the overall perspective].

Human perception is the most complex of all the processes that AI researchers are attempting to understand and mimic. For, constantly our senses probe the world, and
give back to us the data with number of internal signals monitoring the physiological activities. But hardly any of this process seems to be entering our consciousness. David Marr once stated that trying to understand vision by studying only nerve cells is like trying to understand bird flight by studying only feathers. To have a better understanding of perception, then, is to have a knowledge about what is being perceived, how the process of perception takes place and also the knowledge of underlying neurophysiological structure. We invariably scrutinize, understand and interpret all that we perceive [or only some of the things that we perceive]. When it comes to the question of understanding and interpreting, consciousness has got a larger role to play. But, in the case of perception there seems to be very little of what can be termed as 'conscious'. This also compels one to have a thorough understanding of the basic brain structure. Due to this deceptive simplicity of phenomenology of seeing, it has become customary for thinkers to turn to abnormal cases to find cues that determine normal visual experience. On the other hand, there are some psychologists who treat perception more of a sensory detection. But then, even those who treat perception as a sort of conceptual construction have not been able to clearly establish the essential link between 'thinking' and 'seeing'.

In this context, it is hardly surprising that those who are involved in 'computer vision' are forced to face such issues directly. However poor, from the human point of view, their attempts might have been, there are quite a few stunning achievements in this direction.
Mostly, the background knowledge contributes to what we understand 'visually', and this knowledge alone enables us to construct our perceptual world. The earliest of the attempts from the field of AI is that of L.G. Roberts's program.\textsuperscript{228} It differed from the earlier attempts in that it could give the exact dimensions of the objects, their absolute and relative positions and also could construct number of views about the objects. But this should not be misleading. It was possible for Roberts's program, since it incorporated a great detail of knowledge about projective geometry of 3D structures of the 2D objects and other related aspects. But it should be appreciated that it is Roberts's program that influenced to a great extent almost all the later works on scene analysis. But there has been quite a different approach than Roberts's, such as Adolfo Guzman's SEE.\textsuperscript{229} Problems related to the background of visual field that arose with the earlier programs have also been met with to some extent. For instance, SEE's daughter programme BACKGROUND was able to pick out the background in line drawings of the scene.\textsuperscript{230} But the vision in human beings is far more different and complex than this. Humans perceive even if the visual input is not complete and what more, they perceive more things irrespective of the quality of visual inputs. Humans are able to perceive the inert things in various dimensions with the same ease with which they perceive the moving objects.\textsuperscript{231} Some of the early AI programs have provided enough sparks for the futuristic research. But it has also to be accepted that even the attempts such as Gilbert Falk's INTERPRET,\textsuperscript{232} Line finding aider program by Yoshiaki Shirai,\textsuperscript{241} Intelligent Line Finder by G.R. Grape\textsuperscript{234}, Shadow identifying program of Richard Orban,\textsuperscript{245} Martin Rattner's SEEMORE,\textsuperscript{236} Adler's "Recognition of Peanuts Cartoon",\textsuperscript{247} those attempts
trying to trace causal theories and later works fall long short of the expected length and appear more as unconnected loose ends.

4.6. **Strong and Weak Artificial Intelligence**

A group of thinkers within the community of Artificial Intelligence firmly believe that, to use Searle’s words, “by designing the right programs with the right inputs and outputs, they are literally creating minds”. Thus, according to this viewpoint, mental qualities can be attributed to the logical functioning of any computational device, simple as well as complex. This viewpoint is generally referred to as *Strong-AI*. According to Strong-AI, the main difference between the human beings and a physical device, say thermostat or computer, lies only in the complication of structure and functioning of the human brain. Thus from at least one point of view, mental qualities or mental states are to be regarded as features merely of the algorithm that is being carried out by the brain.

On the other hand, there is another group of thinkers within the AI community, such as John Searle & Co, who are more cautious in their approach. This viewpoint is called as *Weak-AI*. According to Weak-AI protagonists, more sane approach to AI is to view, as opposed to Strong-AI viewpoint, computer models as useful in studying the mind in the same way that they are useful in studying the weather, economics, etc.

This distinction that lied dormant for a long time, has taken a monstrous proportion with Searle turning the AI protagonists and their ideologies inside out. Searle
attacks the very basis concept of AI - Turing Test. Any machine that passes this test is deemed to have passed the test for being intelligent. Searle first takes the test devised for understanding stories. "He envisages first of all, that the stories are to be told in Chinese rather than English ... and that all the operations of the computer's algorithm for this particular exercise are supplied (in English) as a set of instructions for manipulating counters with Chinese symbols on them. Searle imagines himself doing all the manipulations inside a locked room. The sequences of symbols representing the stories, and then the questions, are fed into the room through some small slot. No other information whatever is allowed in from the outside. Finally, when all the manipulations are complete, the resulting sequence is fed out again through the slot. Since all these manipulations are simply carrying out algorithm ... it ust turn out that this final resulting sequence is simply ... giving the correct answer to the original question in Chinese about a story in Chinese."240 Now Searle makes it quite clear that though he did not understand a single word in Chinese, since he has carried out the algorithm perfectly, he is deemed to have passed a test for understanding stories in Chinese. And Searle says that mere carrying out of the algorithm does not mean that any understanding has taken place. Number of objections have been raised against this theory of Searle ranging from the attack on Searle's insistence on understanding to lack of practicalities in his theory. Surprisingly Searle has tried to defend his ideas by replacing himself by the whole of India [surely an inessential change]. Despite this and other small flaws in Searle's theory, I think it is a quite powerful one. Besides, one particular observation by Searle has added weightage against Strong-AI.
Traditionally, Strong-AI theories are based on monistic ideologies of mind-body problem. Normally monistic theories do not accept mind, since, according to them, mind is not composed of matter. But, Searle points out that, Strong-AI arguments actually entail a form of dualism and the mind-stuff of Strong-AI is the logical structure of algorithm.

Debates are still continuing on this topic. But I feel that, though Weak-AI arguments sometimes tend to be dogmatic, they are very powerful and from the position angle they have presented [in a fresh manner] to AI researchers the issues that they have to confront immediately.241
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CHAPTER - IV


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42. Simon Newell and Shaw. (1958), op. cit.


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106. Vide Jacques Hadamard. (1945), *op. cit.*, p. 31


116. On hypothesis in the medical diagnosis refer A.D. Rubin *Hypothesis Formation and Evaluation in Medical Diagnosis*, (Cambridge, Mass.: MIT AI Lab, 1975) and also A.D. Rubin *The Role of Hypotheses in Medical Diagnosis* in *Proceedings of the Fourth International Joint Conference on Artificial Intelligence*, Tbilisi, 1975, pp. 856-862


128. Margaret Boden. (1986), op. cit., p. 341

129. Ibid., p. 342


137. Immanuel Kant. *Critique of Pure Reason*, 1781. See especially *Transcendental Aesthetic* and *Transcendental Logic*. Refer the former for discussions on intuitions of space and time and the latter for discussions on the "Categories" that are presupposed by scientific thinking.


147. Demon is a procedure that is activated for the purpose of accessing or changing VARIABLES in a DATA BASE. It is a type of suspended process that is "waiting" for a certain kind of event to occur, such as a certain kind of update operation on a database. The demon activates when the special event occurs, performs the job, and either terminates or suspends while awaiting another event. Demons are used to make INFERENCES as and new information comes into the database to perform bookkeeping tasks of some kind, or to recognize important occurrences. Cf. Rael Smith. *Dictionary of Artificial Intelligence*, (Glasgow: Collins, 1990), p. 83.


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149. In this connection refer Eugene Charniak. He Will Make You Take It Back A Study in the Pragmatics of Language, (Castagnola : 1st: Studi Semantici Cognitivi, 1974)


155. For more on bugs refer Raoul Smith. (1982), op. cit., pp. 41 and 42.


166. There is a host of evidences in this regard For more refer Paul Ziff. "The Feeling of Robots", *Analysis*, 19, 1959, pp. 64-68.


184. For more ideas on these lines refer Terrence Parsons, *Nonexistent Objects*, (New Haven: Yale University Press, 1980).


187. It is very surprising that even through many accept the uniqueness of musical, mathematical and graphic abilities, they have enormous reservations in the case of emotions. For more on these abilities refer Howard Gardner, *Frames of Mind*, (London: Fontana, 1983), Chapters 6 and 7.


195. A slight but fascinating variation can be traced in P. Fath Word Play: What Happens When People Talk. (New York: Knopf, 1974) It explores the possibility of language as an interaction between systems of grammar and human behaviour.


199. In the recent times one man who has given a new dimension to the "quality of language" vis-a-vis signifier-signified relationships is Jacques Derrida. For an exhaustive coverage of this actor, Jacques Derrida. *Of Grammatology*, (Baltimore: The Johns Hopkins University Press, 1974).


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207. B.F. Skinner. *Verbal Behavior*. (New York: Appleton-Century-Crofts, 1957) and also refer: 


211. Chomsky’s ideas presented here are mainly taken from: 


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