**ABSTRACT**

This paper is the introduction to Artificial intelligence (AI). Artificial intelligence is exhibited by artificial entity, a system is generally assumed to be a computer. AI systems are now in routine use in economics, medicine, engineering and the military, as well as being built into many common home computer software applications, traditional strategy games like computer chess and other video games.

The objective was to explain the brief ideas of AI and its application to various fields. It cleared the concept of computational and conventional categories.

Intelligence involves mechanisms, and AI research has discovered how to make computers carry out some of them and not others. If doing a task requires only mechanisms that are well understood today, computer programs can give very impressive performances on these tasks. Such programs should be considered ``somewhat intelligent''. It is related to the similar task of using computers to understand human intelligence.

We can learn something about how to make machines solve problems by observing other people or just by observing our own methods. On the other hand, most work in AI involves studying the problems the world presents to intelligence rather than studying people or animals. AI researchers are free to use methods that are not observed in people or that involve much more computing than people can do. We discussed conditions for considering a machine to be intelligent. We argued that if the machine could successfully pretend to be human to a knowledgeable observer then you certainly should consider it intelligent

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| “ Artificial Intelligence is the study of human intelligence such that it can be replicated artificially. |  | **”** |
| **1. INTRODUCTION** |  |  |

Artificial intelligence is the search for a way to map intelligence into mechanical hardware and enable a structure into that system to formalize thought. No formal definition, as yet, is available for as to what artificial intelligence actually is. It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

Artificial intelligence (AI) is the intelligence of machines or software, and is also a branch of computer science that studies and develops intelligent machines and software. The ability to invent intelligent machines has fascinated humans since the ancient times. Researchers are creating systems and programs that could mimic human thoughts and try doing things that human could do. The artificial Intelligence is a combination of computer science, physiology and philosophy.

The Artificial Intelligence has come a long way from the old days. It was with the invention of the computers that the Artificial Intelligence method began to manoeuvre researchers. The technology was finally available and seemed to stimulate intelligent behaviour. Intelligent here means, things which could be done at a faster pace and thinking than a human mind. The insights and theory brought about the Artificial Intelligence will set a trend in the future. The current products are just the beginning of the future trend.

 John McCarthy, who coined the term in 1955, defines it as “the science and engineering of making intelligent machines”.

AI research is highly technical and specialised, deeply divided into subfields that often fail to communicate with each other. Some of the division is due to social and cultural factors: subfields have grown up around particular institutions and the work of individual researchers. AI research is also divided by several technical issues. There are subfields which are focused on the solution of specific problems, on one of several possible approaches, on the use of widely differing tools and towards the accomplishment of particular applications.

The central problems (or goals) of AI research include reasoning, knowledge, planning, learning, communication, perception and the ability to move and manipulate objects. General intelligence (or “strong AI”) is still among the field’s long term goals. Currently popular approaches include statistical methods, computational intelligence and traditional symbolic AI. There are an enormous number of tools used in AI, including versions of search and mathematical optimization, logic, methods based on probability and economics, and many others

Many human mental activities like writing programs, understanding language, engaging in common-sense reasoning or even driving an automobile are said to demand intelligence Over the past few decades, computers have been built to perform such tasks. Specifically, there are systems that can generate computer code automatically, perform symbolic differentiation and integration, understand text to a certain extent etc. We can say that such systems possess some degree of artificial intelligence   
with this introduction, one can define Al in many ways. Some of them are   
• Al is the study of how to make computers do things at which, people are better at the moment   
• Al is that branch of computer science dealing with symbolic, non algorithmic methods of problem solving   
• Al is that part of computer science concerned with designing intelligent computer systems that exhibit the characteristics used to associate with intelligence in human behavior.

The Basic aim of using artificial intelligence is:

* Numerical computations: computers are definitely more accurate than humans when it comes to numerical calculation
* Information storage: Computers can store very huge amounts of information.the volume being limited only by availability of information. This is in contrast with humans.
* Repetitive operations: It goes without saying that human beings get bored and commit mistakes as fatigue sets in while performing repetitive tasks .Computers ,on the other hand are so specifically built to do such tasks.

**2. HISTORY**

Thinking machines and artificial beings appear in Greek myths, such as Talos of Crete, the bronze robot of Hephaestus, and Pygmalion's Galatea. Human likenesses believed to have intelligence were built in every major civilization: animated cult images were worshiped in Egypt and Greece and humanoid automatons were built by Yan Shi, Hero of Alexandria and Al-Jazari .It was also widely believed that artificial beings had been created by Jābir ibn Hayyān, Judah Loew and Paracelsus By the 19th and 20th centuries, artificial beings had become a common feature in fiction, as in Mary Shelley's *Frankenstein* or Karel Čapek's *R.U.R. .*Pamela McCorduck argues that all of these are examples of an ancient urge, as she describes it, "to forge the gods" .Stories of these creatures and their fates discuss many of the same hopes, fears and ethical concerns that are presented by artificial intelligence.

Mechanical or "formal" reasoning has been developed by philosophers and mathematicians since antiquity. The study of logic led directly to the invention of the programmable digital electronic computer, based on the work of mathematician Alan Turing and others. Turing's theory of computation suggested that a machine, by shuffling symbols as simple as "0" and "1", could simulate any conceivable act of mathematical deduction. This, along with concurrent discoveries in neurology, information theory and cybernetics, inspired a small group of researchers to begin to seriously consider the possibility of building an electronic brain.

The field of AI research was founded at a conference on the campus of Dartmouth College in the summer of 1956. The attendees, including John McCarthy, Marvin Minsky, Allen Newell and Herbert Simon, became the leaders of AI research for many decades. They and their students wrote programs that were, to most people, simply astonishing: Computers were solving word problems in algebra, proving logical theorems and speaking English. By the middle of the 1960s, research in the U.S. was heavily funded by the Department of Defense and laboratories had been established around the world. AI's founders were profoundly optimistic about the future of the new field: Herbert Simon predicted that "machines will be capable, within twenty years, of doing any work a man can do" and Marvin Minsky agreed, writing that "within a generation ... the problem of creating 'artificial intelligence' will substantially be solved".

They had failed to recognize the difficulty of some of the problems they faced. In 1974, in response to the criticism of Sir James Lighthill and ongoing pressure from the US Congress to fund more productive projects, both the U.S. and British governments cut off all undirected exploratory research in AI. The next few years would later be called an "AI winter", a period when funding for AI projects was hard to find.

In the early 1980s, AI research was revived by the commercial success of expert systems, a form of AI program that simulated the knowledge and analytical skills of one or more human experts. The market for AI had reached over a billion dollars. At the same time, Japan's fifth generation computer project inspired the U.S and British governments to restore funding for academic research in the field .However, AI once again fell into disrepute, and a second, longer lasting AI winter began.

In the 1990s and early 21st century, AI achieved its greatest successes, albeit somewhat behind the scenes. Artificial intelligence is used for logistics, data mining, medical diagnosis and many other areas throughout the technology industry. The success was due to several factors: the increasing computational power of computers, a greater emphasis on solving specific subproblems, the creation of new ties between AI and other fields working on similar problems, and a new commitment by researchers to solid mathematical methods and rigorous scientific standards.

On 11 May 1997, Deep Blue became the first computer chess-playing system to beat a reigning world chess champion, Garry Kasparov. In 2005, a Stanford robot won the DARPA Grand Challenge by driving autonomously for 131 miles along an unrehearsed desert trail. Two years later, a team from CMU won the DARPA Urban Challenge when their vehicle autonomously navigated 55 miles in an Urban environment while adhering to traffic hazards and all traffic laws. In February 2011, in a Jeopardy! quiz show exhibition match, IBM's question answering system ,Watson, defeated the two greatest Jeopardy champions, Brad Rutter and Ken Jennings, by a significant margin. The Kinect, which provides a 3D body–motion interface for the Xbox 360, uses algorithms that emerged from lengthy AI researchas does the iPhones's Siri.

**3. GOALS**

The general problem of simulating (or creating) intelligence has been broken down into a number of specific sub-problems. These consist of particular traits or capabilities that researchers would like an intelligent system to display. The traits described below have received the most attention**.**

***Deduction, reasoning, problem solving***

Early AI researchers developed algorithms that imitated the step-by-step reasoning that humans use when they solve puzzles or make logical deductions. By the late 1980s and 1990s, AI research had also developed highly successful methods for dealing with uncertain or incomplete information, employing concepts from probability and economics.

For difficult problems, most of these algorithms can require enormous computational resources – most experience a "combinatorial explosion": the amount of memory or computer time required becomes astronomical when the problem goes beyond a certain size. The search for more efficient problem-solving algorithms is a high priority for AI research.

Human beings solve most of their problems using fast, intuitive judgements rather than the conscious, step-by-step deduction that early AI research was able to model. AI has made some progress at imitating this kind of "sub-symbolic" problem solving: embodied agent approaches emphasize the importance of sensorimotor skills to higher reasoning; neural net research attempts to simulate the structures inside the brain that give rise to this skill; statistical approaches to AI mimic the probabilistic nature of the human ability to guess

***Knowledge representation***

Knowledge representation and knowledge engineering are central to AI research. Many of the problems machines are expected to solve will require extensive knowledge about the world. Among the things that AI needs to represent are: objects, properties, categories and relations between objects; situations, events, states and time; causes and effects; knowledge about knowledge (what we know about what other people know); and many other, less well researched domains. A representation of "what exists" is an ontology: the set of objects, relations, concepts and so on that the machine knows about. The most general are called upper ontologies, which attempt to provide a foundation for all other knowledge.

Among the most difficult problems in knowledge representation are:

Default reasoning and the qualification problem

Many of the things people know take the form of "working assumptions." For example, if a bird comes up in conversation, people typically picture an animal that is fist sized, sings, and flies. None of these things are true about all birds. John McCarthy identified this problem in 1969 as the qualification problem: for any commonsense rule that AI researchers care to represent, there tend to be a huge number of exceptions. Almost nothing is simply true or false in the way that abstract logic requires. AI research has explored a number of solutions to this problem.

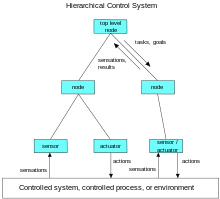
**The breadth of commonsense knowledge**

The number of atomic facts that the average person knows is astronomical. Research projects that attempt to build a complete knowledge base ofcommonsense knowledge (e.g., Cyc) require enormous amounts of laborious ontological engineering — they must be built, by hand, one complicated concept at a time. A major goal is to have the computer understand enough concepts to be able to learn by reading from sources like the internet, and thus be able to add to its own ontology.

**The sub symbolic form of some commonsense knowledge**

Much of what people know is not represented as "facts" or "statements" that they could express verbally. For example, a chess master will avoid a particular chess position because it "feels too exposed" or an art critic can take one look at a statue and instantly realize that it is a fake. These are intuitions or tendencies that are represented in the brain non-consciously and sub-symbolically. Knowledge like this informs, supports and provides a context for symbolic, conscious knowledge. As with the related problem of sub-symbolic reasoning, it is hoped that situated AI, computational intelligence, or statistical AI will provide ways to represent this kind of knowledge.

***Planning***

**[](http://en.wikipedia.org/wiki/File:Hierarchical-control-system.svg)**

A hierarchical control system is a form of control system in which a set of devices and governing software is arranged in a hierarchy.

Intelligent agents must be able to set goals and achieve them. They need a way to visualize the future (they must have a representation of the state of the world and be able to make predictions about how their actions will change it) and be able to make choices that maximize the utility (or "value") of the available choices.

In classical planning problems, the agent can assume that it is the only thing acting on the world and it can be certain what the consequences of its actions may be. However, if the agent is not the only actor, it must periodically ascertain whether the world matches its predictions and it must change its plan as this becomes necessary, requiring the agent to reason under uncertainty.

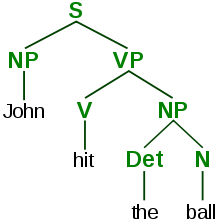
Multi-agent planning uses the cooperation and competition of many agents to achieve a given goal. Emergent behavior such as this is used by evolutionary algorithms and swarm intelligence. Planning programs start with general facts about the world (especially facts about the effects of actions), facts about the particular situation and a statement of a goal. From these, they generate a strategy for achieving the goal. In the most common cases, the strategy is just a sequence of actions.

***Learning***

Machine learning is the study of computer algorithms that improve automatically through experience and has been central to AI research since the field's inception.

Unsupervised learning is the ability to find patterns in a stream of input. Supervised learning includes both classification and numerical regression. Classification is used to determine what category something belongs in, after seeing a number of examples of things from several categories. Regression is the attempt to produce a function that describes the relationship between inputs and outputs and predicts how the outputs should change as the inputs change. In reinforcement learning the agent is rewarded for good responses and punished for bad ones. These can be analyzed in terms of decision theory, using concepts like utility. The mathematical analysis of machine learning algorithms and their performance is a branch of theoretical computer science known as computational learning theory.

***Natural language processing***

**[](http://en.wikipedia.org/wiki/File:ParseTree.svg)**

A parse tree represents the syntactic structure of a sentence according to some formal grammar.

Natural language processing gives machines the ability to read and understand the languages that humans speak. A sufficiently powerful natural language processing system would enable natural language user interfaces and the acquisition of knowledge directly from human-written sources, such as Internet texts. Some straightforward applications of natural language processing include information retrieval (or text mining) and machine translation.

A common method of processing and extracting meaning from natural language is through semantic indexing. Increases in processing speeds and the drop in the cost of data storage makes indexing large volumes of abstractions of the users input much more efficient.

***Motion and manipulation***

The field of robotics is closely related to AI. Intelligence is required for robots to be able to handle such tasks as object manipulation and navigation, with sub-problems of localization (knowing where you are, or finding out where other things are), mapping (learning what is around you, building a map of the environment), and motion planning (figuring out how to get there) or path planning (going from one point in space to another point, which may involve compliant motion - where the robot moves while maintaining physical contact with an object).

***Perception***

Machine perception is the ability to use input from sensors (such as cameras, microphones, sonar and others more exotic) to deduce aspects of the world. Computer vision is the ability to analyze visual input. A few selected subproblems are speech recognition, facial recognition and object recognition.

***Social intelligence***

Affective computing is the study and development of systems and devices that can recognize, interpret, process, and simulate human affects. It is an interdisciplinary field spanning computer sciences, psychology, and cognitive science. While the origins of the field may be traced as far back as to early philosophical inquiries into emotion, the more modern branch of computer science originated with Rosalind Picard's 1995 paper on affective computing. A motivation for the research is the ability to simulate empathy. The machine should interpret the emotional state of humans and adapt its behaviour to them, giving an appropriate response for those emotions.

Emotion and social skills play two roles for an intelligent agent. First, it must be able to predict the actions of others, by understanding their motives and emotional states. (This involves elements of game theory, decision theory, as well as the ability to model human emotions and the perceptual skills to detect emotions.) Also, in an effort to facilitate human-computer interaction, an intelligent machine might want to be able to *display* emotions—even if it does not actually experience them itself—in order to appear sensitive to the emotional dynamics of human interaction.

***Creativity***

A sub-field of AI addresses creativity both theoretically (from a philosophical and psychological perspective) and practically (via specific implementations of systems that generate outputs that can be considered creative, or systems that identify and assess creativity). Related areas of computational research are Artificial intuition and Artificial imagination.

***General intelligence***

Most researchers think that their work will eventually be incorporated into a machine with *general* intelligence (known as strong AI), combining all the skills above and exceeding human abilities at most or all of them. A few believe that anthropomorphic features like artificial consciousness or an artificial brain may be required for such a project.

Many of the problems above may require general intelligence to be considered solved. For example, even a straightforward, specific task like machine translation requires that the machine read and write in both languages (NLP), follow the author's argument (reason), know what is being talked about (knowledge), and faithfully reproduce the author's intention (social intelligence). A problem like machine translation is considered "AI-complete". In order to solve this particular problem, you must solve all the problems.

**APPROACHES**

Historically there were two main approaches to AI:

* classical approach (designing the AI), based on symbolic reasoning - a mathematical approach in which ideas and concepts are represented by symbols such as words, phrases or sentences, which are then processed according to the rules of logic.
* a connectionist approach (letting AI develop), based on artificial neural networks, which imitate the way neurons work, and genetic algorithms, which imitate inheritance and fitness to evolve better solutions to a problem with every generation.

Symbolic reasoning have been successfully used in expert systems and other fields. Neural nets are used in many areas, from computer games to DNA sequencing. But both approaches have severe limitations. A human brain is neither a large inference system, nor a huge homogenous neural net, but rather a collection of specialised modules. The best way to mimic the way humans think appears to be specifically programming a computer to perform individual functions (speech recognition, reconstruction of 3D environments, many domain-specific functions) and then combining them together.

There is no established unifying theory or paradigm that guides AI research. Researchers disagree about many issues. A few of the most long standing questions that have remained unanswered are these: should artificial intelligence simulate natural intelligence by studying psychology or neurology? Or is human biology as irrelevant to AI research as bird biology is to aeronautical engineering? Can intelligent behavior be described using simple, elegant principles (such as logic or optimization)? Or does it necessarily require solving a large number of completely unrelated problems? Can intelligence be reproduced using high-level symbols, similar to words and ideas? Or does it require "sub-symbolic" processing? John Haugeland, who coined the term GOFAI (Good Old-Fashioned Artificial Intelligence), also proposed that AI should more properly be referred to as synthetic intelligence, a term which has since been adopted by some non-GOFAI researchers.

***Cybernetics and brain simulation***

In the 1940s and 1950s, a number of researchers explored the connection between neurology, information theory, and cybernetics. Some of them built machines that used electronic networks to exhibit rudimentary intelligence, such as W. Grey Walter's turtles and the Johns Hopkins Beast. Many of these researchers gathered for meetings of the Teleological Society at Princeton University and the Ratio Club in England. By 1960, this approach was largely abandoned, although elements of it would be revived in the 1980s.

***Symbolic***

When access to digital computers became possible in the middle 1950s, AI research began to explore the possibility that human intelligence could be reduced to symbol manipulation. The research was centered in three institutions: Carnegie Mellon University, Stanford and MIT, and each one developed its own style of research. John Haugeland named these approaches to AI "good old fashioned AI" or "GOFAI". During the 1960s, symbolic approaches had achieved great success at simulating high-level thinking in small demonstration programs. Approaches based on cybernetics or neural networks were abandoned or pushed into the background. Researchers in the 1960s and the 1970s were convinced that symbolic approaches would eventually succeed in creating a machine with artificial general intelligence and considered this the goal of their field.

***Cognitive simulation***

Economist Herbert Simon and Allen Newell studied human problem-solving skills and attempted to formalize them, and their work laid the foundations of the field of artificial intelligence, as well as cognitive science, operations research and management science. Their research team used the results of psychological experiments to develop programs that simulated the techniques that people used to solve problems. This tradition, centered at Carnegie Mellon University would eventually culminate in the development of the Soar architecture in the middle 1980s.

***Logic-based***

Unlike Newell and Simon, John McCarthy felt that machines did not need to simulate human thought, but should instead try to find the essence of abstract reasoning and problem solving, regardless of whether people used the same algorithms. His laboratory at Stanford (SAIL) focused on using formal logic to solve a wide variety of problems, including knowledge representation, planning and learning. Logic was also the focus of the work at the University of Edinburgh and elsewhere in Europe which led to the development of the programming language Prolog and the science of logic programming

***Knowledge-based***

When computers with large memories became available around 1970, researchers from all three traditions began to build knowledge into AI applications. This "knowledge revolution" led to the development and deployment of expert systems (introduced by Edward Feigenbaum), the first truly successful form of AI software. The knowledge revolution was also driven by the realization that enormous amounts of knowledge would be required by many simple AI applications.

**Sub-symbolic**

By the 1980s progress in symbolic AI seemed to stall and many believed that symbolic systems would never be able to imitate all the processes of human cognition, especially perception ,robotics, learning and pattern recognition. A number of researchers began to look into "sub-symbolic" approaches to specific AI problems.

***Bottom-up, embodied, situated, behavior-based or nouvelle AI***

Researchers from the related field of robotics, such as Rodney Brooks, rejected symbolic AI and focused on the basic engineering problems that would allow robots to move and survive.Their work revived the non-symbolic viewpoint of the early cybernetics researchers of the 1950s and reintroduced the use of control theory in AI. This coincided with the development of the embodied mind thesis in the related field of cognitive science: the idea that aspects of the body (such as movement, perception and visualization) are required for higher intelligence.

***Computational Intelligence***

Interest in neural networks and "connectionism" was revived by David Rumelhart and others in the middle 1980s. These and other sub-symbolic approaches, such as fuzzy systems and evolutionary computation, are now studied collectively by the emerging discipline of computational intelligence.

***Statistical***

In the 1990s, AI researchers developed sophisticated mathematical tools to solve specific subproblems. These tools are truly scientific, in the sense that their results are both measurable and verifiable, and they have been responsible for many of AI's recent successes. The shared mathematical language has also permitted a high level of collaboration with more established fields (like mathematics, economics or operations research). Stuart Russell and Peter Norvig describe this movement as nothing less than a "revolution" and "the victory of the neat." Critics argue that these techniques are too focused on particular problems and have failed to address the long term goal of general intelligence. There is an ongoing debate about the relevance and validity of statistical approaches in AI, exemplified in part by exchanges between Peter Norvig and Noam Chomsky.

***Integrating the approaches***

Intelligent agent paradigm

An intelligent agent is a system that perceives its environment and takes actions which maximize its chances of success. The simplest intelligent agents are programs that solve specific problems. More complicated agents include human beings and organizations of human beings (such as firms). The paradigm gives researchers license to study isolated problems and find solutions that are both verifiable and useful, without agreeing on one single approach. An agent that solves a specific problem can use any approach that works – some agents are symbolic and logical, some are sub-symbolic neural networks and others may use new approaches. The paradigm also gives researchers a common language to communicate with other fields—such as decision theory and economics—that also use concepts of abstract agents. The intelligent agent paradigm became widely accepted during the 1990s.

Agent architectures and cognitive architectures

Researchers have designed systems to build intelligent systems out of interacting intelligent agents in a multi-agent system. A system with both symbolic and sub-symbolic components is a hybrid intelligent system, and the study of such systems is artificial intelligence systems integration. A hierarchical control system provides a bridge between sub-symbolic AI at its lowest, reactive levels and traditional symbolic AI at its highest levels, where relaxed time constraints permit planning and world modelling. Rodney Brooks' subsumption architecture was an early proposal for such a hierarchical system.

**TOOLS**

In the course of 50 years of research, AI has developed a large number of tools to solve the most difficult problems in computer science.

***Search and optimization***

*Search algorithm, Mathematical optimization, and Evolutionary computation*

Many problems in AI can be solved in theory by intelligently searching through many possible solutions. Reasoning can be reduced to performing a search. For example, logical proof can be viewed as searching for a path that leads from premises to conclusions, where each step is the application of an inference rule. Planning algorithms search through trees of goals and subgoals, attempting to find a path to a target goal, a process called means-ends analysis. Robotics algorithms for moving limbs and grasping objects use local searches in configuration space. Many learning algorithms use search algorithms based on optimization.

Simple exhaustive searches are rarely sufficient for most real world problems: the search space (the number of places to search) quickly grows to astronomical numbers. The result is a search that is too slow or never completes. The solution, for many problems, is to use "heuristics" or "rules of thumb" that eliminate choices that are unlikely to lead to the goal (called "pruningthe search tree"). Heuristics supply the program with a "best guess" for the path on which the solution lies. Heuristics limit the search for solutions into a smaller sample size.

A very different kind of search came to prominence in the 1990s, based on the mathematical theory of optimization. For many problems, it is possible to begin the search with some form of a guess and then refine the guess incrementally until no more refinements can be made. These algorithms can be visualized as blind hill climbing: we begin the search at a random point on the landscape, and then, by jumps or steps, we keep moving our guess uphill, until we reach the top. Other optimization algorithms are simulated annealing, beam search and random optimization.

Evolutionary computation uses a form of optimization search. For example, they may begin with a population of organisms (the guesses) and then allow them to mutate and recombine, selecting only the fittest to survive each generation (refining the guesses). Forms of evolutionary computation include swarm intelligence algorithms (such as ant colony or particle swarm optimization)and evolutionary algorithms (such as genetic algorithms, gene expression programming, and genetic programming).

***Logic***

*Logic programming and Automated reasoning*

Logic is used for knowledge representation and problem solving, but it can be applied to other problems as well. For example, the satplan algorithm uses logic for planning and inductive logic programming is a method for learning.

Several different forms of logic are used in AI research. Propositional or sentential logic is the logic of statements which can be true or false. First-order logic also allows the use of quantifiers and predicates, and can express facts about objects, their properties, and their relations with each other. Fuzzy logic,is a version of first-order logic which allows the truth of a statement to be represented as a value between 0 and 1, rather than simply True (1) or False (0). Fuzzy systems can be used for uncertain reasoning and have been widely used in modern industrial and consumer product control systems. Subjective logic models uncertainty in a different and more explicit manner than fuzzy-logic: a given binomial opinion satisfies belief + disbelief + uncertainty = 1 within a Beta distribution. By this method, ignorance can be distinguished from probabilistic statements that an agent makes with high confidence.

Default logics, non-monotonic logics and circumscription are forms of logic designed to help with default reasoning and the qualification problem. Several extensions of logic have been designed to handle specific domains of knowledge, such as: description logics; situation calculus, event calculus and fluent calculus (for representing events and time);causal calculus; belief calculus; and modal logics.

Probabilistic methods for uncertain reasoning

*(Bayesian network, Hidden Markov model, Kalman filter, Decision theory, and Utility theory)*

Many problems in AI (in reasoning, planning, learning, perception and robotics) require the agent to operate with incomplete or uncertain information. AI researchers have devised a number of powerful tools to solve these problems using methods from probability theory and economics.

Bayesian networks are a very general tool that can be used for a large number of problems: reasoning (using the Bayesian inference algorithm), learning (using the expectation-maximization algorithm), planning (using decision networks) and perception (using dynamic Bayesian networks). Probabilistic algorithms can also be used for filtering, prediction, smoothing and finding explanations for streams of data, helping perception systems to analyze processes that occur over time (e.g., hidden Markov models or Kalman filters).

A key concept from the science of economics is "utility": a measure of how valuable something is to an intelligent agent. Precise mathematical tools have been developed that analyze how an agent can make choices and plan, using decision theory, decision analysis, information value theory. These tools include models such as Markov decision processes, dynamic decision networks, game theory and mechanism design.

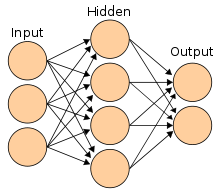
Classifiers and statistical learning methods

*(Classifier (mathematics), Statistical classification, and Machine learning)*

The simplest AI applications can be divided into two types: classifiers ("if shiny then diamond") and controllers ("if shiny then pick up"). Controllers do however also classify conditions before inferring actions, and therefore classification forms a central part of many AI systems. Classifiers are functions that use pattern matching to determine a closest match. They can be tuned according to examples, making them very attractive for use in AI. These examples are known as observations or patterns. In supervised learning, each pattern belongs to a certain predefined class. A class can be seen as a decision that has to be made. All the observations combined with their class labels are known as a data set. When a new observation is received, that observation is classified based on previous experience.

A classifier can be trained in various ways; there are many statistical and machine learning approaches. The most widely used classifiers are the neural network, kernel methods such as the support vector machine, k-nearest neighbor algorithm, Gaussian mixture model, naive Bayes classifier, and decision tree .The performance of these classifiers have been compared over a wide range of tasks. Classifier performance depends greatly on the characteristics of the data to be classified. There is no single classifier that works best on all given problems; this is also referred to as the "no free lunch" theorem. Determining a suitable classifier for a given problem is still more an art than science.

Neural network

[](http://en.wikipedia.org/wiki/File:Artificial_neural_network.svg)

A neural network is an interconnected group of nodes, akin to the vast network of neurons in the human brain.

The study of artificial neural networks began in the decade before the field AI research was founded, in the work of Walter Pitts and Warren McCullough. Other important early researchers were Frank Rosenblatt, who invented the perceptron and Paul Werbos who developed the back propagation algorithm.

The main categories of networks are acyclic or feed forward neural networks (where the signal passes in only one direction) and recurrent neural networks (which allow feedback). Among the most popular feed forward networks are perceptrons, multi-layer perceptrons and radial basis networks. Among recurrent networks, the most famous is the Hopfield net, a form of attractor network, which was first described by John Hopfield in 1982.Neural networks can be applied to the problem of intelligent control (for robotics) or learning, using such techniques as Hebbian learning and competitive learning.

Hierarchical temporal memory is an approach that models some of the structural and algorithmic properties of the neocortex.

***Control theory***

Control theory, the grandchild of cybernetics, has many important applications, especially in robotics.

Languages

AI researchers have developed several specialized languages for AI research, including Lisp and Prolog.

**6. EVALUATING PROGRESS**

In 1950, Alan Turing proposed a general procedure to test the intelligence of an agent now known as the Turing test. This procedure allows almost all the major problems of artificial intelligence to be tested. However, it is a very difficult challenge and at present all agents fail.

Artificial intelligence can also be evaluated on specific problems such as small problems in chemistry, hand-writing recognition and game-playing. Such tests have been termed subject matter expert Turing tests. Smaller problems provide more achievable goals and there are an ever-increasing number of positive results.

One classification for outcomes of an AI test is:

1. Optimal: it is not possible to perform better.
2. Strong super-human: performs better than all humans.
3. Super-human: performs better than most humans.
4. Sub-human: performs worse than most humans.

For example, performance at draughts is optimal, performance at chess is super-human and nearing strong super-human (see computer chess: computers versus human) and performance at many everyday tasks (such as recognizing a face or crossing a room without bumping into something) is sub-human.

A quite different approach measures machine intelligence through tests which are developed from *mathematical* definitions of intelligence. Examples of these kinds of tests start in the late nineties devising intelligence tests using notions from Kolmogorov complexity and data compression. Two major advantages of mathematical definitions are their applicability to nonhuman intelligences and their absence of a requirement for human testers.

An area that artificial intelligence had contributed greatly to is Intrusion detection.

**SEARCH**

In general, search is an algorithm that takes a problem as input and returns with a solution from the searchspace. The search space is the set of all possible solutions. We dealt a lot with so called "state space search" where the problem is to find a goal state or a path from some initial state to a goal state in the state space. A state space is a collection of states, arcs between them and a non-empty set of start states and goal states. It is helpful to think of the search as building up a search tree - from any given node (state): what are my options to go next (towards the goal), eventually reaching the goal.

***Uninformed Search***

Uninformed search (blind search) has no information about the number of steps or the path costs from the current state to the goal. They can only distinguish a goal state from a non-goal state. There is *no bias* to go towards the desired goal.

For search algorithms, *open list* usually means the set of nodes yet to be explored and *closed list* the set of nodes that have already been explored.

***Breadth-First-Search***

Starts with the rootnode and explores all neighboring nodes and repeats this for every one of those (expanding the "depth" of the search tree by one in each iteration). This is realized in a *FIFO* queue. Thus, it does an exhaustive search until it finds a goal.

BFS is *complete* (i.e. it finds the goal if one exists and the branching factor is finite).

It is *optimal* (i.e. if it finds the node, it will be the shallowest in the search tree).

Space:  O(bd)

Time:  O(bd)

***Depth-First-Search***

Explores one path to the deepest level and then backtracks until it finds a goal state. This is realized in a *LIFO* queue (i.e. stack).

DFS is *complete* (if the search tree is finite).

It is not *optimal* (it stops at the first goal state it finds, no matter if there is another goal state that is shallower than that).

Space:  O(bm) (much lower than BFS).

Time:  O(bm)  (Higher than BFS if there is a solution on a level smaller than the maximum depth of the tree).

Danger of running out of memory or running indefinitely for infinite trees.

***Depth-Limited-Search / Iterative Deepening***

To avoid that, the search depth for DFS can be either limited to a constant value, or increased iteratively over time, gradually increasing the maximum depth to which it is applied. This is repeated until finding a goal. Combines advantages of DFS and BFS.

ID is complete.

It is optimal (the shallowest goal state will be found first, since the level is increased by one every iteration).

Space:  O(bd) (better than DFS, d is depth of shallowest goal state, instead of m, maximum depth of the whole tree).

Time:  O(bd)

Bi-Directional Search

Searches the tree both forward from the initial state and backward from the goal and stops when they meet somewhere in the middle.

It is complete and optimal.

Space: .O(bd/2)

Time: .O(bd/2)

***Informed Search***

In *informed* search, a heuristic is used as a guide that leads to better overall performance in getting to the goal state. Instead of exploring the search tree blindly, one node at a time, the nodes that we could go to are ordered according to some evaluation function h(n) that determines which node is probably the "best" to go to next. This node is then expanded and the process is repeated (i.e. Best First Search),

 A\* Search is a form of BestFS. In order to direct the search towards the goal, the evaluation function must include some estimate of the cost to reach the closest goal state from a given state. This can be based on knowledge about the problem domain, the description of the current node, the search cost up to the current node BestFS optimizesDFS by expanding the most promising node first. Efficient selection of the current best candidate is realized by a priority queue.

***Greedy Search***

Minimizes the estimated cost to reach the goal. The node that is closest to the goal according to h(n) is always expanded first. It optimizes the search locally, but not always finds the global optimum.

It is not complete (can go down an infinite branch of the tree).

It is not optimal.

Space: O(b^m) for the worst case.

Same for time, but can be reduced by choosing a good heuristic function.

***A\* Search***

Combines *uniform cost search* (i.e. expand node on path with lowest cost so far) and greedy search. Evaluation function is f(n) = g(n) + h(n) (or estimated cost of the cheapest solution through node n). It can be proven that A\* is complete and optimal if h is admissible - that is, if it *never overestimates* the cost to reach the goal. This is optimistic, since they think the cost of solving the problem is less than it actually is.

Examples for h:

Path-Finding in a map: Straight-Line-Distance.

8-Puzzle: Manhattan-Distance to Goal State.

Everything works, it just has to be admissible (e.g. h(n) = 0 always works, but transforms A\* back to uniform cost search).

If a heuristic function h_1 estimates the actual distance to the goal better than another heuristic function h_2, then h_1 *dominates* h_2.

A\* maintains an open list (priority queue) and a closed list (visited nodes). If a node is expanded that's already in the closed list, stored with a lower cost, the new node is ignored. If it was stored with a higher cost, it is deleted from the closed list and the new node is processed.

h is monotonic, if the difference between the heuristics of any two connected nodes does not overestimate the actual distance between those nodes. Example of a non-monotonicheuristic: n and n' are two connected nodes, where n is the parent of n'. Suppose g(n)=3 and h(n)=4, then we know that the true cost of a solution path through n is at least 7. Now suppose that g(n')=4 and h(n')=2. Hence, f(n')=6.

First off, the difference in the heuristics (that is, 2) overestimates the actual cost between those nodes (which is 1).

However, we know that any path through n' is also a path through n and we already know that any path through n has a true cost of at least 7. Thus, the f-value of 6 for n' is meaningless and we will consider its parent's f-value.

h is consistent, if the h-value for a given node is less or equal than the actual cost from this node to the next node plus the h-value from this next node (triangular inequality).

If h is admissible and monotonic, the first solution found by A\* is guaranteed to be the optimal solution (open/close list bookkeeping is no longer needed).

Finding Heuristics:

Relax the problem (e.g. 8-puzzle: Manhattan distance).

Calculate cost of subproblems (e.g. 8-puzzle: calculate cost of first 3 tiles).

***Adversarial Search (Game Playing)***

Minimax is for deterministic games with perfect information. Non-Deterministic games will use the expectiminimax algorithm.

***Minimax Algorithm***

A two player zero-sum game, in which both players make a move alternately, is defined by an initial state (e.g. board positions), a set of operators that define legal moves, a terminal test that defines the end of the game and a utility function that determines a numeric value for the outcome of the game (e.g. "1" for win, "-1" for loss).

If it was a search problem, one would simply search for a path that leads to a terminal state with value "1". But the opponent (Min) will try to minimize one's (Max') outcome. Theminimax algorithm generates the whole game tree and applies the utility function to each terminal state. Then it propagates the utility value up one level and continues to do so until reaching the start node.

Propagation works like this: Min is assumed to always chose the option that is the worst for Max (minimum utility value). If we have three terminal states in one branch with 1, 2 and 3 as their utility values, then Min would chose 1. Hence, "1" is propagated to the next level and so forth. Max can then decide upon his opening move on the top level (the "minimax decision" = maximizing utility under the assumption that the opponent will play perfectly to minimize it).

For games that are too complex to compute the whole game tree, the game tree is cut off at some point and the utility value is estimated by a heuristic evaluation function (e.g. "material value" in chess).

***Alpha-Beta Pruning***

We don't have to look at each node of the game tree: Minimax with alpha-beta pruning yields the same result as a complete search, but with much greater efficiency (reduces its effective branching factor to its square root).

Here we store the best value for Max' play found so far in *alpha* and the best value for Min's play found so far (i.e. the lowest value) in *beta*.

If, at any given point, *alpha* becomes smaller than *beta*, we can prune the game tree at this point. Therefore, it is required to evaluate at least on set of leaf nodes branching off of one of the deepest Min nodes and then use the acquired alpha-value to prune the rest of the search.

Chance:

Introduces "chance nodes" to the decision points, based on what kind of chance is introduced (e.g. a 50/50 chance for flipping a coin), which yield the "expected value" (average - add up utility values weighted by the chance to achieve them).

Example: 3 leaf nodes, values 5, 6 and 10 = 21 altogether - the chance to get to any one of them is 1/3 - hence the expected value is  21 * 1/3 = 7

**APPLICATIONS**

Artificial intelligence techniques are pervasive and are too numerous to list. Frequently, when a technique reaches mainstream use, it is no longer considered artificial intelligence; this phenomenon is described as the AI effect.

Competitions and prizes There are a number of competitions and prizes to promote research in artificial intelligence. The main areas promoted are: general machine intelligence, conversational behavior, data-mining, robotic cars, robot soccer and games.

***Platforms***

A platform (or "computing platform") is defined as "some sort of hardware architecture or software framework (including application frameworks), that allows software to run." As Rodney Brooks pointed out many years ago, it is not just the artificial intelligence software that defines the AI features of the platform, but rather the actual platform itself that affects the AI that results, i.e., there needs to be work in AI problems on real-world platforms rather than in isolation.

A wide variety of platforms has allowed different aspects of AI to develop, ranging from expert systems, albeit PC-based but still an entire real-world system, to various robot platforms such as the widely available Roomba with open interface.

***Philosophy***

Artificial intelligence, by claiming to be able to recreate the capabilities of the human mind, is both a challenge and an inspiration for philosophy. Are there limits to how intelligent machines can be? Is there an essential difference between human intelligence and artificial intelligence? Can a machine have a mind and consciousness? A few of the most influential answers to these questions are given below.

*Turing's "polite convention"*

We need not decide if a machine can "think"; we need only decide if a machine can act as intelligently as a human being. This approach to the philosophical problems associated with artificial intelligence forms the basis of the Turing test.

*The Dartmouth proposal*

"Every aspect of learning or any other feature of intelligence can be so precisely described that a machine can be made to simulate it." This conjecture was printed in the proposal for the Dartmouth Conference of 1956, and represents the position of most working AI researchers.

*Newell and Simon's physical symbol system hypothesis*

"A physical symbol system has the necessary and sufficient means of general intelligent action." Newell and Simon argue that intelligences consist of formal operations on symbols .Hubert Dreyfus argued that, on the contrary, human expertise depends on unconscious instinct rather than conscious symbol manipulation and on having a "feel" for the situation rather than explicit symbolic knowledge. (See Dreyfus' critique of AI.)

*Gödel's incompleteness theorem*

A formal system (such as a computer program) cannot prove all true statements. Roger Penrose is among those who claim that Gödel's theorem limits what machines can do. (See *The Emperor's New Mind*.)

*Searle's strong AI hypothesis*

"The appropriately programmed computer with the right inputs and outputs would thereby have a mind in exactly the same sense human beings have minds." John Searle counters this assertion with his Chinese room argument, which asks us to look *inside* the computer and try to find where the "mind" might be.

*The artificial brain argument*

The brain can be simulated. Hans Moravec, Ray Kurzweil and others have argued that it is technologically feasible to copy the brain directly into hardware and software, and that such a simulation will be essentially identical to the original.

***Game playing***

You can buy machines that can play master level chess for a few hundred dollars. There is some AI in them, but they play well against people mainly through brute force computation--looking at hundreds of thousands of positions. To beat a world champion by brute force and known reliable heuristics requires being able to look at 200 million positions per second.

***Speech recognition***

In the 1990s, computer speech recognition reached a practical level for limited purposes. Thus United Airlines has replaced its keyboard tree for flight information by a system using speech recognition of flight numbers and city names. It is quite convenient. On the the other hand, while it is possible to instruct some computers using speech, most users have gone back to the keyboard and the mouse as still more convenient.

Understanding natural language

Just getting a sequence of words into a computer is not enough. Parsing sentences is not enough either. The computer has to be provided with an understanding of the domain the text is about, and this is presently possible only for very limited domains.

***Computer vision***

The world is composed of three-dimensional objects, but the inputs to the human eye and computers' TV cameras are two dimensional. Some useful programs can work solely in two dimensions, but full computer vision requires partial three-dimensional information that is not just a set of two-dimensional views. At present there are only limited ways of representing three-dimensional information directly, and they are not as good as what humans evidently use.

***Expert Systems***

A ``knowledge engineer'' interviews experts in a certain domain and tries to embody their knowledge in a computer program for carrying out some task. How well this works depends on whether the intellectual mechanisms required for the task are within the present state of AI. When this turned out not to be so, there were many disappointing results. One of the first expert systems was MYCIN in 1974, which diagnosed bacterial infections of the blood and suggested treatments. It did better than medical students or practicing doctors, provided its limitations were observed. Namely, its ontology included bacteria, symptoms, and treatments and did not include patients, doctors, hospitals, death, recovery, and events occurring in time. Its interactions depended on a single patient being considered. Since the experts consulted by the knowledge engineers knew about patients, doctors, death, recovery, etc., it is clear that the knowledge engineers forced what the experts told them into a predetermined framework. In the present state of AI, this has to be true. The usefulness of current expert systems depends on their users having common sense.

***Heuristic classification***

One of the most feasible kinds of expert system given the present knowledge of AI is to put some information in one of a fixed set of categories using several sources of information. An example is advising whether to accept a proposed credit card purchase. Information is available about the owner of the credit card, his record of payment and also about the item he is buying and about the establishment from which he is buying it (e.g., about whether there have been previous credit card frauds at this establishment).

***Predictions and ethics***

Artificial Intelligence is a common topic in both science fiction and projections about the future of technology and society. The existence of an artificial intelligence that rivals human intelligence raises difficult ethical issues, and the potential power of the technology inspires both hopes and fears.

**FUTURE PROSPECTS**

* In the next 10 years technologies in narrow fields such as speech recognition will continue to improve and will reach human levels. In 10 years AI will be able to communicate with humans in unstructured English using text or voice, navigate (not perfectly) in an unprepared environment and will have some rudimentary common sense (and domain-specific intelligence)
* Recreation of some parts of the human (animal) brain in silicon . The feasibility of this is demonstrated by tentative hippocampus experiments in rats . There are two major projects aiming for human brain simulation, CCortex and IBM Blue Brain.
* There will be an increasing number of practical applications based on digitally recreated aspects human intelligence, such as cognition, perception, rehearsal learning, or learning by repetitive practice.
* Robots take over everyone’s jobs .The development of meaningful artificial intelligence will require that machines acquire some variant of human consciousness. Systems that do not possess self-awareness and sentience will at best always be very brittle. Without these uniquely human characteristics, truly useful and powerful assistants will remain a goal to achieve. To be sure, advances in hardware, storage, and parallel processing architectures will enable ever greater leaps in functionality. But these systems will remain mechanistic zombies. Systems that are able to demonstrate conclusively that they possess self awareness, language skills, surface, shallow and deep knowledge about the world around them and their role within it will be needed going forward. However the field of artificial consciousness remains in its infancy. The early years of the 21st century should see dramatic strides forward in this area however.
* During the early 2010's new services can be foreseen to arise that will utilize large and very large arrays of processors. These networks of processors will be available on a lease or purchase basis. They will be architected to form parallel processing ensembles. They will allow for reconfigurable topologies such as nearest neighbour based meshes, rings or trees. They will be available via an Internet or WIFI connection. A user will have access to systems whose power will rival that of governments in the 1980's or 1990's. Because of the nature of nearest neighbour topology, higher dimension hyper cubes (e.g. D10 or D20), can be assembled on an ad-hoc basis as necessary. A D10 ensemble, i.e. 1024 processors, is well within the grasp of today's technology. A D20, i.e. 2,097,152 processors is well within the reach of an ISP or a processor provider. Enterprising concerns will make these systems available using business models comparable to contracting with an ISP to have web space for a web site. Application specific ensembles will gain early popularity because they will offer well defined and understood application software that can be recursively configured onto larger and larger ensembles. These larger ensembles will allow for increasingly fine grained computational modeling of real world problem domains. Over time, market awareness and sophistication will grow. With this grow will come the increasing need for more dedicated and specific types of computing ensemble.

**CONCLUSION**

We conclude that if the machine could successfully pretend to be human to a knowledgeable observer then you certainly should consider it intelligent. AI systems are now in routine use in various field such as economics, medicine, engineering and the military, as well as being built into many common home computer software applications, traditional strategy games etc.

AI is an exciting and rewarding discipline.  AI  is  branch  of  computer  science  that  is  concerned  with  the  automation  of  intelligent  behavior.  The  revised  definition  of  AI  is  - AI  is  the  study  of  mechanisms  underlying  intelligent  behavior  through  the  construction  and  evaluation  of  artifacts  that  attempt  to  enact  those  mechanisms. So it is concluded that it work as an artificial human brain which have an unbelievable artificial thinking power.

The future of artificial intelligence is strongly interlinked with the being, the wide application of it. Soon it is expected to cover great heights , and from the cited examples it is clear that it has already began with the work. AI is a common topic in both science fiction and projections about the future of technology and society. The existence of an artificial intelligence that rivals human intelligence raises difficult ethical issues, and the potential power of the technology inspires both hopes and fears.Artificial intelligence has been the subject of optimism, but has also suffered setbacks and, today, has become an essential part of the technology industry, providing the heavy lifting for many of the most difficult problems in computer science. The impact of AI on society is a serious area of study for futurists. Academic sources have considered such consequences as a decreased demand for human labor, the enhancement of human ability or experience, and a need for redefinition of human identity and basic values.

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