# Artificial Intelligence: An overview

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***Abstract—* Intelligence has been, since the dawn of humanity, the driving factor for the development of civilization and humanity's progress. In this survey paper, we give an overview of the field of Artificial Intelligence (AI) with its various subfields like Deep learning and neural networks. Artificial Intelligence (AI) isn't only concerned with understanding intelligence but also building machines that can "think" or in other words building intelligent entities that can compute how to act effectively in novel situations. The term AI encompasses many fields, from general fields like learning, perception, intelligent decision making, etc to the specific like playing chess, Tetris, or performing image detection and analysis. This paper reviews the main methods and algorithms used in the field of AI starting with an overview of machine learning, supervised and unsupervised learning, concluding with deep learning and neural networks. It is sufficient to state that all machine learning algorithms are artificial intelligence approaches, yet not all AI methods qualify as machine learning algorithms. While deep learning is concerned with creating models (algorithms) that study data with multiple factors**

***.Keywords—* Intelligence, Artificial Intelligence, Supervised learning, Unsupervised learning, Deep learning, Neural Networks**

## I. INTRODUCTION

After 60 years of innovation, research, inventions, and discovery; Artificial Intelligence (AI) has reached every part of our life through industry, medicine, agriculture, etc. AI methods and analysis have become an essential concept in our practice and personal life, that's why in this survey paper; we simply illustrate various fields in AI. Through this paper, we focused on AI's definitions and systems. An overview of Machine Learning (ML), its methods, and workflow, where we would discuss Supervised and Unsupervised-Learning. Deep Learning (DL) and Neural Networks (NN) discuss the idea of image processing systems that can now distinguish practically any object in pixel images, thanks to this technology. This resulted in the first computer program capable of defeating one of the world's finest Go players, among other things. We would also discuss what will be in the future of AI. Finally, we would summarize this paper and conclude our idea and point of view

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## II. ARITIFICIAL INTELLIGENCE

Machine learning aims to create algorithms that allow the computer to learn. Learning is a process of finding statistical similarities between different data points. Machine learning algorithms are created to be able to represent the human approach of learning. These algorithms also provide an insight into relative difficulty of learning in different environments.

### *A. Defining Intelligence*

Defining intelligence is next to impossible. Despite the existence of the many terms and definitions of intelligence, there's no agreed-upon definition. Over the decades, researchers have tried defining artificial intelligence in many ways. Some have defined it in comparison to human intelligence, meaning by AI's fidelity to human intelligence. Others have defined it based on rationality. Rationality, loosely speaking, means "doing the right thing". The subject matter itself is up to debate as some think of intelligence as a property of an internal thought and reasoning process, an internal characterization. On the other hand, some think of intelligence in terms of behavior, an external characterization. From these dimensions, four combinations can be used to measure the intelligence level of machines, that is deciding if that machine is intelligent or not [1]

1) *Acting humanly (Turing Test)* the test proposed by Alan Turing (1950) is designed as a thought experiment where a computer or a machine is considered intelligent when a human interrogator after proposing some questions can't tell whether the answers came from a human or a machine. For a computer to pass such a test, it should be able to: Process natural language, store what it knows and hears, to answer questions and draw new conclusions, and to adapt to new circumstances
2) *Thinking humanly (The cognitive modeling approach)-* For a program to think humanly we need

to understand how humans think. Once this is achieved a model of the brain can be constructed and simulated using computer programs

3) *Thinking rationally* to think rationally, one is required to have a knowledge of the world that is certain but, that is seldom achieved. Probability theory fills this gap allowing us to reason in uncertainty. This allows the construction of rational thought, but it doesn't lead to intelligent behavior.
4) *Acting rationally* an agent is expected to act rationally, that is acting to achieve the best outcome or in the case of uncertainty, achieve the best expected outcome

### B. *What makes system intelligent?*

An intelligent system can't be measured in terms of a certain definition but it being intelligent can be regarded as a series of traits or properties, that help that system "do the right thing" or "think intelligently", the following is a list of these traits [2]

1) *Perception* includes manipulation, integration, and interpretation of the data using sensors
2) *Action* controlling the different parts of the system to perform a particular task, this task can include the manipulation and exploration of the surrounding environment
3) *Reasoning* inferring information and taking decisions based on analysis of the given data in the face of uncertainty.
4) *Adaptation and Learning* Adapting its behavior to cope with new occurrences or changes in the environment
5) *Communication* Communicating with other intelligent systems including humans, using signals, signs, language, touch, and other communication methods
6) *Planning and goal-directed problem-solving F*ormulation of plans — sequences or agenda of actions to accomplish externally or internally determined goals and choosing a particular plan in the case of unexpected changes in the environment
7) *Autonomy* Setting goals and deciding the next course of action in a certain situation without explicit instructions from another entity
8) *Creativity* exploration, and modification of constraints
9) *Reflection and awareness* of its internal self as well as awareness of other entities
10) *Aesthetics* articulation, and use of aesthetic principles.
11) *Organization* into social groups based on shared objectives, development of shared conventions to facilitate orderly interaction, culture.

### C. *Fields of Artificial Intelligence*

The term Artificial Intelligence focuses on studying and building intelligent entities.AI is a science of intelligence. It focuses on falsifiable claims meaning claims that can be tested regarding the structures and processes (actions) that are necessary and sufficient for intelligent behavior. It is also the study of computational cognitive models of intelligent behaviors - like perception, action, cognition, and awareness. There are several subfields under the umbrella of AI, these include:

1) *Machine Learning* An agent is learning if its performance is improved by making observations about the world. If that agent is a computer, it is called machine learning
2) *Computer Vision* - Is used in the classification of images and videos to extract useful information, for example, detection of faces
3) *Natural Language Processing* Used in understanding and deciphering languages, like French, English, and others and extracting information from them for example, news analysis
4) *Deep Learning* a better model of learning, where its advantage is that this style of learning can fit the different points of data into a curve, thus enabling it to do more complex analysis
5) *Reinforcement Learning* a type of AI where the agent learns through trial and error

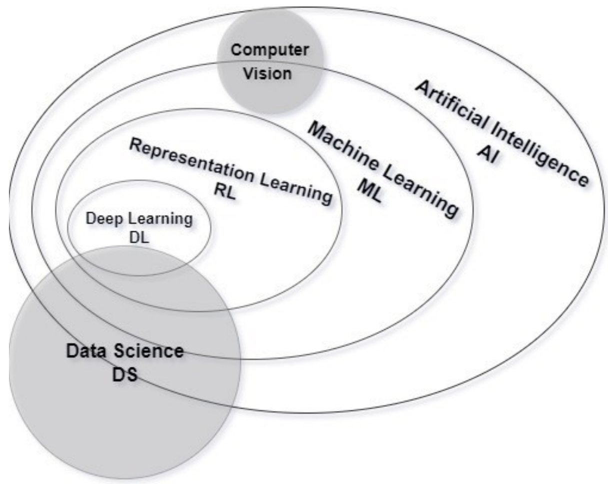


Fig. 1 Map of AI Fields

## III. LEARNING METHODS AND WORKFLOWS

In order for a machine to learn , mathematical models that mimic the human learning behavior are used

### *A. What is Learning?*

An agent is said to be learning if its performance is improved when it makes observations about the surrounding environment. If that agent is a computer, it is called machine learning. Machine learning is where a machine processes a set of data, builds a model describing that data, and then can draw conclusions using that model as well form hypotheses about the world. It can also use the model to solve problems. These agents are made of different components acting together, every component can then be modified by observing more data. Components of agents differ from one system to another but generally speaking they should contain the following component properties in one form or another. The properties are: A direct mapping from a condition on the current system state to actions, a way to collect and infer information about the environment of the system, information about how the system's environment can change and the different actions the agent can take, information about the desirability of different states, information describing the desirability of the different possible actions, goals that describe the most desirable states, a means of measuring how well the agent is doing as well as a means of incentivizing the agent towards the desirable state, a learning element that helps the agent to improve.

### *B. Supervised Learning*

Supervised learning is the capacity of an algorithm to generalize information from known data with a target or labeled examples such that the algorithm can anticipate new (unlabeled) cases [3]. Supervised machine learning, according to Kotsiantis [4], requires a specified output attribute. The algorithms seek to predict and classify the predefined attribute, and their accuracies and misclassification, as well as other performance measures, are based on the counts of the predetermined attribute that are correctly predicted or categorized. It's also worth noting that the learning process ends when the algorithm reaches a satisfactory level of performance. Given the approach utilized in machine learning, a training subset of roughly 66 percent is reasonable and aids in reaching the desired outcome without requiring more processing time. Classification and regression algorithms are two types of supervised learning algorithms. There are several techniques used to perform supervised machine learning and they are:

1) *Decision Trees* - The algorithm works in the same way as a tree, sorting qualities into groups based on data values. The algorithm comprises branches and nodes, just like a traditional tree, with nodes indicating variable groups for classification and branches assuming the values that the attribute can take as part of the class.
2) *Naïve Bayes* the naive Bayes classifier greatly simplifies learning by assuming that features are independent given class. Although independence is generally a poor assumption, in practice naive Bayes often competes well with more sophisticated classifiers. Bayesian classifiers assign the most likely class to a given example described by its feature vector.
3) *Support Vector Machines (SVM)* it is a model that learns by example to assign labels to objects. Simply put, SVM uses margins to create a line between the classes in the dataset. The theory behind it is to set the margins so that the distance between each class and the nearest margin is as little as feasible, resulting in the smallest possible classification error.

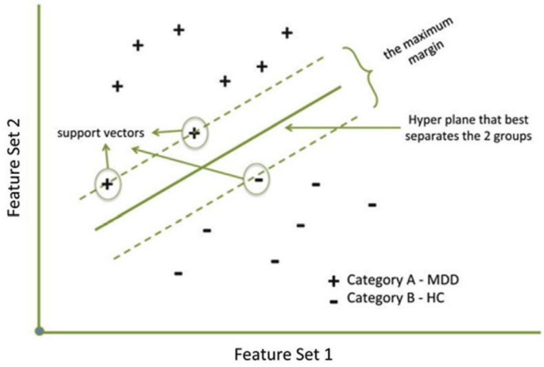


**Fig. 2** Support Vector Machines (SVM) [5]

### *C. Unsupervised Learning*

Unsupervised learning is the practice of grouping data into clusters using automated methods or algorithms on data that has not been classified or categorized. Unsupervised data learning, on the other hand, involves pattern recognition without the use of a target attribute. That is, all of the variables utilized in the study are employed as inputs, and the techniques are suited for clustering and association mining techniques because of the methodology. Unsupervised learning algorithms, according to Hofmann, are excellent for establishing labels in data that are then utilized to conduct supervised learning tasks. Unsupervised clustering algorithms, in other words, find intrinsic groupings in unlabeled data and then apply labels to each data value.

Unsupervised association mining algorithms, on the other hand, are more likely to find rules that accurately describe associations between attributes.

## IV. NEURAL NETWORK

Artificial neural networks play an integral part in the field of AI. They enabled computers to learn more efficiently and classify data with the models more flexibly than before.

### A. *Key Features of Neural Networks*

Artificial neural networks (neural nets for short) are computational models inspired by the nervous system of living beings. They can acquire and maintain knowledge (information-based units), and they can also be considered processing units called nodes, making artificial neurons (simulating the neurons in the nervous system). Each node is connected to either another node or a set of nodes by artificial synapses, which are implemented using vectors and matrices of synaptic weights. Neural networks have seven main features, these are [6]:

1) *Adapting from experience* the acquisition of knowledge is done by iterating the calculations done by each node, these calculations alter the weights in each iteration, therefore changing the probability of one piece of information over the other, combined with backpropagation the neural network can improve itself with each iteration thus adapting from its experience
2) *Learning Capability* Using the learning method mentioned above the neural net can improve the initial relationships between the several variables of the application or model. This can improve the efficiency of the machine learning model substantially
3) *Generalization the* relationships discovered during the learning (training) process, can then be generalized into even a broader set of examples even if the model has never seen this data or example before
4) *Data Organization* Neural nets can cluster certain information together, based on the information of a particular process thus enabling a better method to analyze data and create insights from it. This can also help in creating different patterns that help the model in classifying different data.
5) *Fault Tolerance* Due to the vast number of interconnections between nodes, the model becomes a fault-tolerant system, if part of its internal structure is corrupted to some degree.
6) *Distributed Storage* The information about a particular relationship or pattern is stored inside the synapses between each node, therefore the storage inside the model is distributed. In case some neurons (nodes) are lost, they can be recovered using the data in the synapses.
7) *Facilitated Prototyping* Depending on a particular application, software or hardware neural nets architectures can be easily implemented and prototyped as after the training phase is done, its results are usually obtained by simple mathematical procedures.

### B. *Neural Networks Model*

The artificial neurons used in neural networks are non-linear, providing continuous outputs and performing simple mathematical functions. Every neural network is made of a series of layers and each layer has a certain number of nodes. The first layer is called the input layer and the last layer is called the output layer. Neural networks begin by collecting the information given to them at their input layer, then this information (usually in numbers) is processed by some built-in functions in the mid-layers between the input and output layers. Neural networks then produce an output based on their activation functions. The simplest neuron model that includes the main features of a biological neural network—parallelism and high connectivity—was proposed by McCulloch and Pitts still is the most used model in different artificial neural network architectures. The model consists of seven main parts [7]:

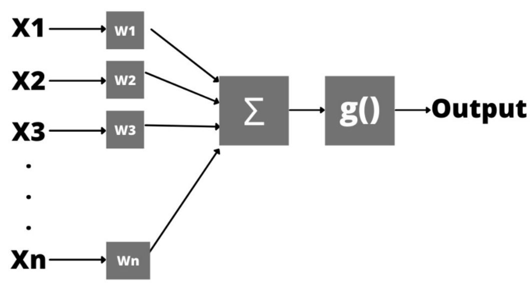


**Fig.3Neural Network Model**

1) *Input Signals (x1, x2, x3, x4.....xn)* These are the signals coming from an external input source and they represent the values assumed by the variable of the particular application the model is built for.
2) *Synaptic weights (w1, w2, w3, w4.....wn)* These are the values used to weight each input variable, which helps the model in determining the importance of each input and its contribution to the overall function (relationship) of that application.
3) *Linear aggregator (Σ)* This part of the neuron, gathers all the input signals weighted by the different weights to produce a certain number called the activation voltage.
4) *Activation threshold (θ)* This is a variable used to specify the threshold that the result from the linear aggregator should generate to trigger a value toward the neuron output.
5) *Activation potential (u)* is the result produced by the difference between the linear aggregator and the activation threshold. If this value is positive, i.e. if u ≥ then the neuron produces an excitatory potential; otherwise, it will be inhibitory.
6) *Activation function (g)* The activation function decides whether a neuron should be activated or not by calculating the weighted sum and further adding bias with it. The purpose of the activation function is to introduce non-linearity into the output of a neuron.
7) *Output Signal* Consists of the final output produced by the neuron given a certain set of inputs at the input layer.

## V. Deep Learning

Deep learning is a class of machine learning that works better with unstructured and complex data. It enables the model to learn the features on multiple levels. The popularity of the deep learning methods increased by the exponential increase in the amount of data generated.

### A. *Unsupervised pre-trained networks*

In unsupervised pre-trained networks, the model is trained in an unsupervised manner first , then it is tested and used for prediction , some architectures of these networks are [8]:

1) *Autoencoders* they are generally used for anomaly detection and data dimension reduction problems. The first layer of an autoencoder is built as an encoding layer and a transpose of that layer is built as a decoder. In order to train the model, it is made to recreate the inputs in an unsupervised manner and then after training the weights of that layer are fixed. Then, we move to the subsequent layer until we pre-train all the layers.
2) *Deep Belief Networks* In order to train this model of networks, the first step is to learn the features of the first layer. Then , use the features of the previously trained layer in the next layer. The model is trained sequentially until we reach the final layer.
3) *Generative Adversarial Networks* Proposed by Ian Goodfellow [9] this model is comprised of a generator layer and a discriminator layer. The model is trained by a minimax-like approach between the two layers. The generator generates content while the discriminator checks and validates the generated content.

### B. *Convolutional Neural networks*

Convolutional neural networks (CNNs) are used mainly for image processing and image detection tasks. It is trained by assigning weights to different parts of the image and differentiates one from the other. CNN uses relevant filters to capture the spatial and temporal dependencies in an image. Examples of the different of CNNs architectures are LeNet , AlexNet , VGGNet , GoogLeNet.

## VI. Artificial General Intelligence (AGI)

we have been discussing how computers learn to perform specific tasks on their own. But what if we want computers to apply what they learned about a certain task and apply the method of learning into another task that it has never seen any data for it before. Like humans, computers should theoretically be able to apply different learning methods to learn different types of tasks on their own. As we defined intelligence in the previous sections of the paper, we will define general intelligence. General intelligence is the ability to learn and acquire knowledge and then apply that knowledge in reasoning about certain choices or actions taken by the agent (machines or humans) in a variety of domains, not for a certain domain like learning languages, or playing chess. Cassio Pennachin and Ben Goertzel[9] proposed in their book a series of properties an AI system should have to emulate human artificial intelligence, the system can solve problems in a non-domain restricted way, be able to solve domain specific problems with a relative efficiency, be able to combine both its specific and general intelligence in a unified way, be able to learn from its environment as well as other intelligent entities like teachers, other machines...etc and have the ability to solve novel types of problems as it gains more experience with them

### *A. Deep Mind's GATO*

Among the efforts to achieve AGI, is DeepMind's GATO [11]. GATO is works as a multi-modal, multi-task, multi-embodiment generalist policy agent. The concept of the model is that the same networks with the same weights, that can play Atari, can capture images and understand chats as well as move a robotic arm.etc. There are great benefits to using a single neural sequence model across all tasks. This approach reduces the necessity for making policy models with appropriate biases for each domain. It also increases the amount and diversity of the training data since the sequence model can take any data that can be serialized into a flat sequence. Even more , its performance continues to get better even at the cutting edge technology of data, compute, and model scale. Generic models that are better at using computation tended to take a more domain-specific or specialized approaches.

## VII. CONCLUSION

After explaining the Idea of AI, while illustrating the difference between AI and ML, and the concept that a system should have, in order to be intelligent. We discussed different learning methods Supervised and Unsupervised Learning, with many cases and the workflow of each learning method. Diving deeper, we discussed Deep Learning and Neural Networks, their features, models, and parts for each one. Lastly, we encountered the aim of AGI, its system diagnostics and identification.

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