DRIVES

Development and Research on Innovative Vocational Education Skills

U3 DEEP LEARNING AND NEURAL NETWORKS

U3.E3 FUNDAMENTAL CONCEPTS AND TERMINOLOGIES OF DEEP LEARNING NEURAL NETWORKS

Artificial Intelligence Technician

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LEARNING OBJECTIVES

The student is able to

AIT.U3.E3.PC1	Define and explain AI concepts and terms like machine learning, deep learning and neural networks.
AIT.U3.E3.PC2	Understand the connection and the differences between artificial intelligence, machine learning and deep learning.
AIT.U3.E3.PC3	Define and explain what an artificial neural network is.
AIT.U3.E3.PC4	Understand the relationship between deep learning and big data.

WHAT IS ARTIFICIAL INTELLIGENCE?

IS THERE A SINGLE DEFINITION POSSIBLE?

“Branch of Computer Science that has to do with the automation of intelligent behaviors, proper of the human beings.”

(Luger&Stubblefield, 1998)

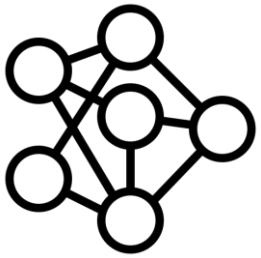
A wide-ranging branch of computer science concerned with the construction of intelligent machines that are able to perform tasks that typically require human intelligence.

“The ability to use memory, knowledge, experience, understanding, imagination and judgment to solve problems and adapt to new situations.”

(AllWords Dictionary, 2006)

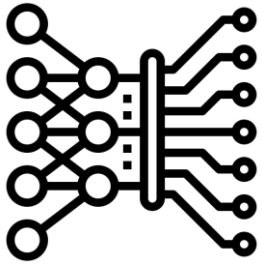
Technology that seeks to simulate the human process of learning and decision making.

ARTIFICIAL INTELLIGENCE: KEY CONCEPTS



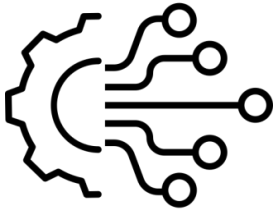
Machine Learning is an application of artificial intelligence (AI) that allows one to automatically learn from experience and improve without being explicitly programmed.

Machine Learning



Deep learning is a type of machine learning that trains computers to perform tasks like humans. Deep learning defines basic parameters for the data and trains the computer to learn on its own, recognizing patterns at various levels of processing.

Deep Learning



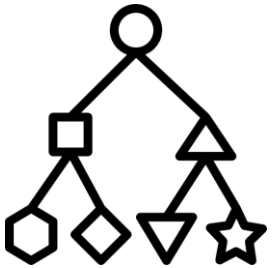
ANN is a type of computer system, that based on a mathematic model simulates the behavior of the human brain in order to learn patterns and predicts.

Artificial neural network (ANN)

ARTIFICIAL INTELLIGENCE: KEY CONCEPTS

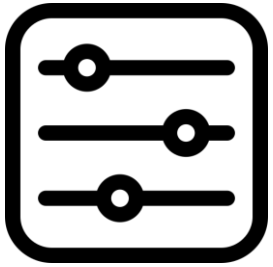
Categorization is the process by which you divide elements into groups where the same elements are in some way similar to each other.

Categorization



The term "classification" can refer to three distinct but related concepts. These are a class system (organized according to a certain set of principles), a group or class in the classification system, and the process of assigning entities to classes in a classification system.

Classification



Collaborative filtering (CF) is the process of filtering elements based on the opinions of other people. It is based on the idea that people who have agreed on the evaluation of certain items are likely to agree again in the future.

Collaborative filtering

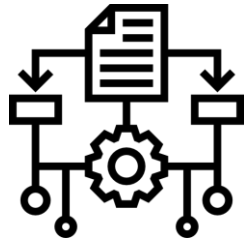
ARTIFICIAL INTELLIGENCE: KEY CONCEPTS

Natural language processing (NLP) refers to the branch of computer science more specifically the branch of artificial intelligence that enables computers to understand text and spoken words in the same way that humans do.

Natural Language Processing (NLP)

Data mining is a process by which anomalies, patterns, and correlations are detected in large amounts of data, with the primary goal of predicting outcomes.

Data Mining



An algorithm is nothing more than a set of instructions, with a defined order, designed in order to solve a given problem.

Algorithm

WHAT IS MACHINE LEARNING?

Machine Learning empowers learning systems to act and take data driven decisions to carry out a certain task.

Machine Learning is a subset of Artificial Intelligence that focuses on the development of computer programs (algorithms) that can grant access to data and then use it to learn for themselves.

These algorithms can learn and improve over time when exposed to new data, i.e., ML uses statistical methods to enable machines to learn and improve with experience.

Its main goal is to enable computers to learn automatically without human intervention or assistance, as well as, to reduce distance between estimated value and real value (the error).

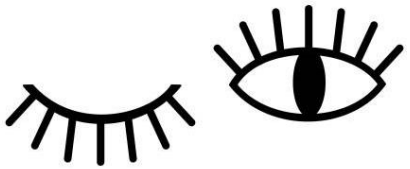
MACHINE LEARNING: KEY CONCEPTS

Supervised Learning trains a function to compute output variables based on a given data in which both input and output variables are known.
The goal of a learning process is to find a function that minimizes the risk of a prediction error

Supervised Learning

Unsupervised Learning is a class of Machine Learning algorithms that uses them to analyze and cluster unlabeled datasets. The goal is to learn useful structure without labeled classes, optimization criterion, feedback signal, or any other information beyond the raw data

Unsupervised Learning



Semi-Supervised Learning (SSL) is a mixture between supervised and unsupervised approaches.
In addition to unlabeled data, the algorithm is provided with some supervision information – but not necessarily for all examples.

Semi-Supervised Learning

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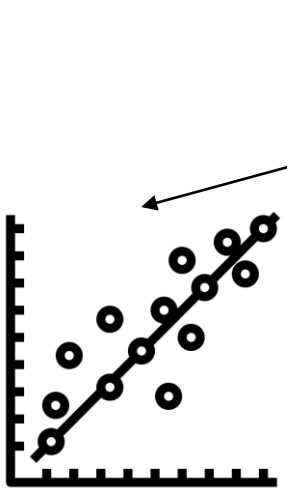
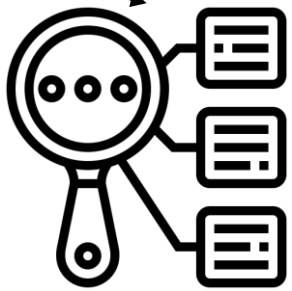
Regression vs Classification

Classification and Regression are two major prediction problems which are usually dealt with Data mining and Machine learning.





Regression is the process of finding a model or function for distinguishing the data into continuous real values instead of using classes or discrete values.

Classification is the process of finding or discovering a model or function which helps in separating the data into multiple categorical

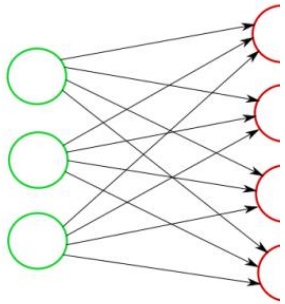
An Artificial Neural Network is an information processing paradigm that is inspired by the biological nervous systems, such as the human brain's information processing mechanism.

Neural networks are set of algorithms **inspired by the functioning of human brain.**

Neural networks work with a large set of data, process the data(draws out the patterns from data), and outputs what it is.

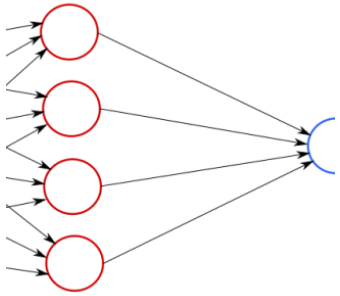
Artificial neural network consists of three groups, or layers, of units: a layer of "**input**" units is connected to a layer of "**hidden**" units, which is connected to a layer of **"output"** units.

NEURAL NETWORKS: KEY CONCEPTS



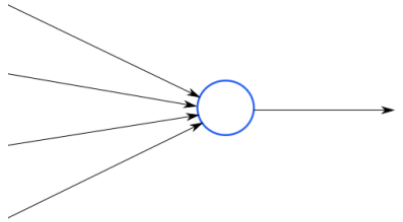
The **input layer** of a neural network is composed of artificial **input** neurons and brings the initial data into the system for further processing by subsequent **layers** of artificial neurons.

Input Layer



Hidden layers, simply put, are **layers** of mathematical functions each designed to produce an output specific to an intended result.

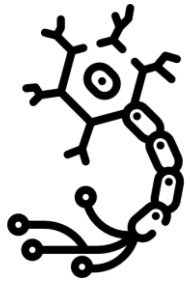
Hidden Layer



The **output layer** is responsible for producing the result. There must always be one **output layer** in a neural network.

Output Layer

NEURAL NETWORKS: KEY CONCEPTS

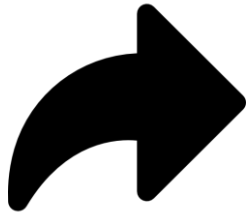


Neurons or nerve cells, send and receive signals from your brain. In short, neurons are part of a system that deals with all the sensations that control our daily lives.

Neuron

Weight space (representation theory) Parameter space in artificial neural networks, where the parameters are weights on graph edges.

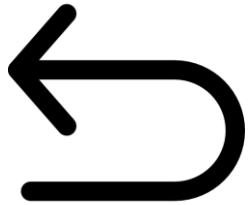
Weight Space



The "**forward pass**" refers to calculation process, values of the output layers from the inputs data. The input data is fed in the forward direction through the network. Each hidden layer accepts the input data, processes it as per the activation function and passes to the successive layer.

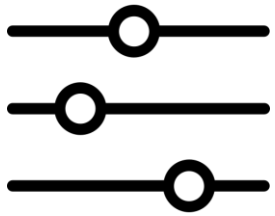
Forward Pass

NEURAL NETWORKS: KEY CONCEPTS



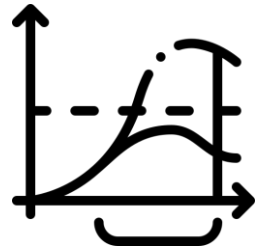
Backpropagation is an algorithm commonly used to train neural networks. Backpropagation helps to adjust the weights of the neurons so that the result comes closer and closer to the known true result.

Backpropagation



Hyperparameters are the variables which determines the network structure and the variables which determine how the network is trained.

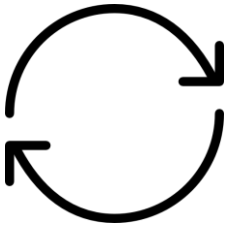
Hyperparameters



Activation functions are mathematical equations that determine the output of a neural network. Activation functions also help normalize the output of each neuron to a range between 1 and 0 or between -1 and 1.

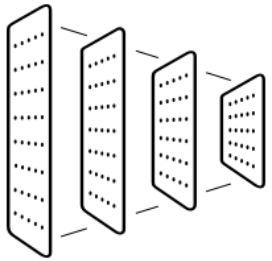
Activation functions

NEURAL NETWORKS: KEY CONCEPTS



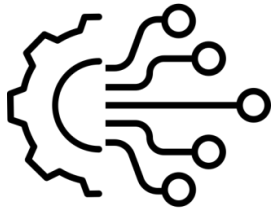
Recurrent neural networks (RNNs) are a class of neural networks useful in modeling sequential data. RNNs are derived from feedforward networks and therefore behave similarly to the human brain.

Recurrent Neural Networks (RNN)



A convolutional neural network (CNN) is a Deep Learning algorithm that has the ability to given an image , assign meaning to one or several aspects/objects in the image and differentiate them from each other.

Convolutional Neural Networks (CNN)



Generative modeling is an unsupervised learning task in Deep Learning, whereby regularities or patterns in the input data are automatically recognized and learned such that the model can be used to generate or produce new examples that could plausibly come from the original data set .

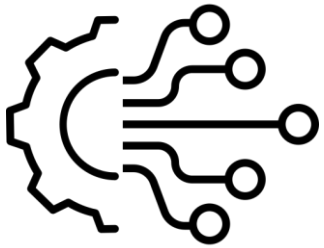
Generative Adversarial Networks (GAN).

Conceptual Definition: Computer program that is capable of identify what something is....

Technical Definition: Deep Learning consists in using a neural networks with several layers of nodes between input and output

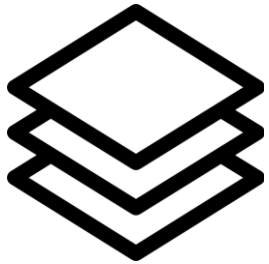
Definition: Subfield of machine learning based on algorithms inspired in artificial neural networks with many layers of nodes, that are capable of identify what something is....

DEEP LEARNING: KEY CONCEPTS



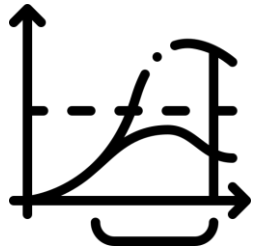
A artificial neural network is a set of algorithms that attempts to recognize relationships between a set of data through a process that resembles how the human brain works.

Artificial Neural Networks



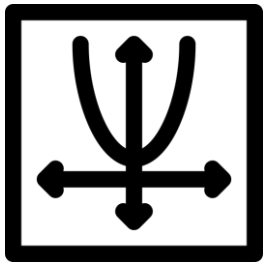
A layer groups together an array of neurons. In an artificial neural network there is always an input layer, one or more hidden layers, and an output layer.

Layers



Activation functions are mathematical equations that determine the output of a neural network. Activation functions also help normalize the output of each neuron to a range between 1 and 0 or between -1 and 1.

Activation Function

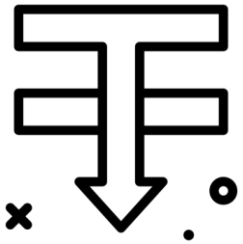


The cost or loss function aims to reduce all the positive and negative aspects of a system (be it complex or not) to a single number (scalar value) which allows ranking and comparing the candidate solutions.

Loss Function

Overfitting refers to a model that models the test dades too well. This phenomenon happens when a model learns both detail and noise in the training data negatively impacting the model's performance on new data.

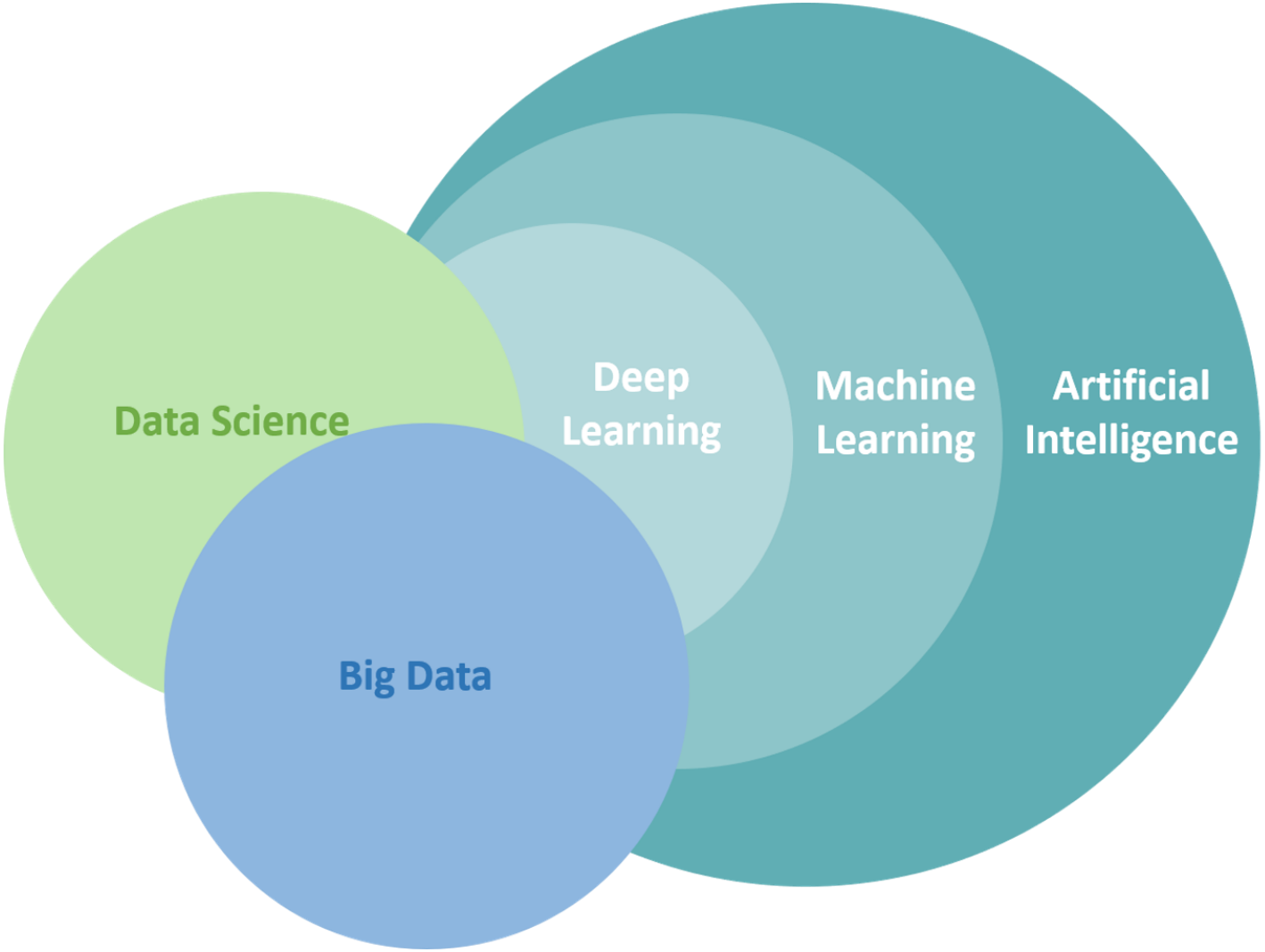
Overfitting



Underfitting refers to a model that can neither model the training data nor generalize to new data. This is obviously not a suitable DL model since it will inevitably perform poorly on new data.

Underfitting

ARTIFICIAL INTELLIGENCE VS MACHINE LEARNING VS DEEP LEARNING



ARTIFICIAL INTELLIGENCE VS MACHINE LEARNING

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- AI is defined as acquisition of knowledge intelligence
- The aim is to increase the chance of success
- It works as a computer program that does smart work
- The goal is to simulate natural intelligence to solve complex problems

- ML is defined as the acquisition of knowledge or skill
- The aim is to increase accuracy
- It is a simple machine that takes data and learns from it
- The goal is to learn from data a specific task to maximize machine performance on this task

ARTIFICIAL INTELLIGENCE VS MACHINE LEARNING

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- AI is decision making
- It leads to the development of a system that mimics human behavior to respond to circumstances
- AI pursues the optimal solution
- Leads to intelligence or wisdom

- ML enables systems to learn new things from data
- It is involved in the creation of self-learning algorithms
- ML will only come up with a solution that is either optimal or not
- Leads to knowledge

DEEP LEARNING VS NEURAL NETWORK

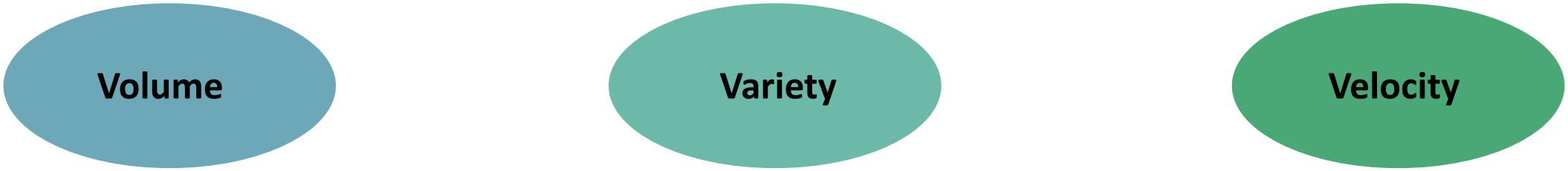
- Referring to the depth of layers in a neural network
- It is a subset of machine learning
- The architecture of a Deep Learning model includes: Unsupervised Pre-trained Networks , Convolutional Neural Networks, Recurrent Neural Networks, Recursive Neural Networks
- Leads with the transformation and extraction of feature which attempts to establish a relationship between stimuli and associated neural responses present in the brain

- It is a component of deep learning process
- The architecture of a Neural Network includes: Feed Forward Neural Networks, Recurrent Neural Networks, Symmetrically Connected Neural Networks
- Leads with the transition data in the form of input values and output values through connections

Big Data that can’t be effectively processed with traditional applications.

Arises challenges like Capturing, Storing, Transferring, Querying, and Updating data.

There’s no singular definition, the cientific community refer to the 3 V’s of big data:



A Big Data System should cover, these first three dimensions and it should be defined by them.

BIG DATA CHARACTERISTICS

VOLUME

The volume of data gives the large amount of data, mostly described in several petabytes or even more. However, not even this definition is consensual among the authors, since the definition depends on the type of data being analyzed.

VELOCITY

The velocity concerns both the rate of data generation and the speed of analysis they require. Big Data Velocity deals with the speed at which data flows in from sources.

VARIETY

Because of the diversity of data collection sources, the variety of data has grown exponentially. Data can be organized in various ways, namely in a structured, semi-structured, or even unstructured manner, and data formats must also be considered.

VERACITY

Veracity encompasses the reliability inherent in some sources of data collection. For example, information taken from a social network cannot be given the same relevance as information taken from hospital software.

Why Is Data Modeling Necessary?

Large amounts of data imply a system or method to keep everything in order. The process of sorting and storing data is called "data modeling". A data model is a method by which we can organize and store data.

Proper models and storage environments offer the following benefits to large data:

Performance: Ensures fast query and reduces I/O output.

Cost: Significantly reduces data redundancy, reducing storage and computing costs for the large data system.

Efficiency: They greatly improve the user experience as well as the efficiency of data use.

Quality: They make data statistics more consistent and reduce the possibility of computing errors.

Big Data Management is a set of practices that promotes the collection, organization, administration and interpretation of large volumes of data.

The main objective is to treat the contents so that they become accessible and reliable.There are 4 terms that are essential to the definition of this method:

Adequacy

Ability to analyze a large amount of information, structured or not, allows the detection and correction of errors in stored information.

Ability to filter and classify data so that it can later be handled assuming a standardized structure.

Integration

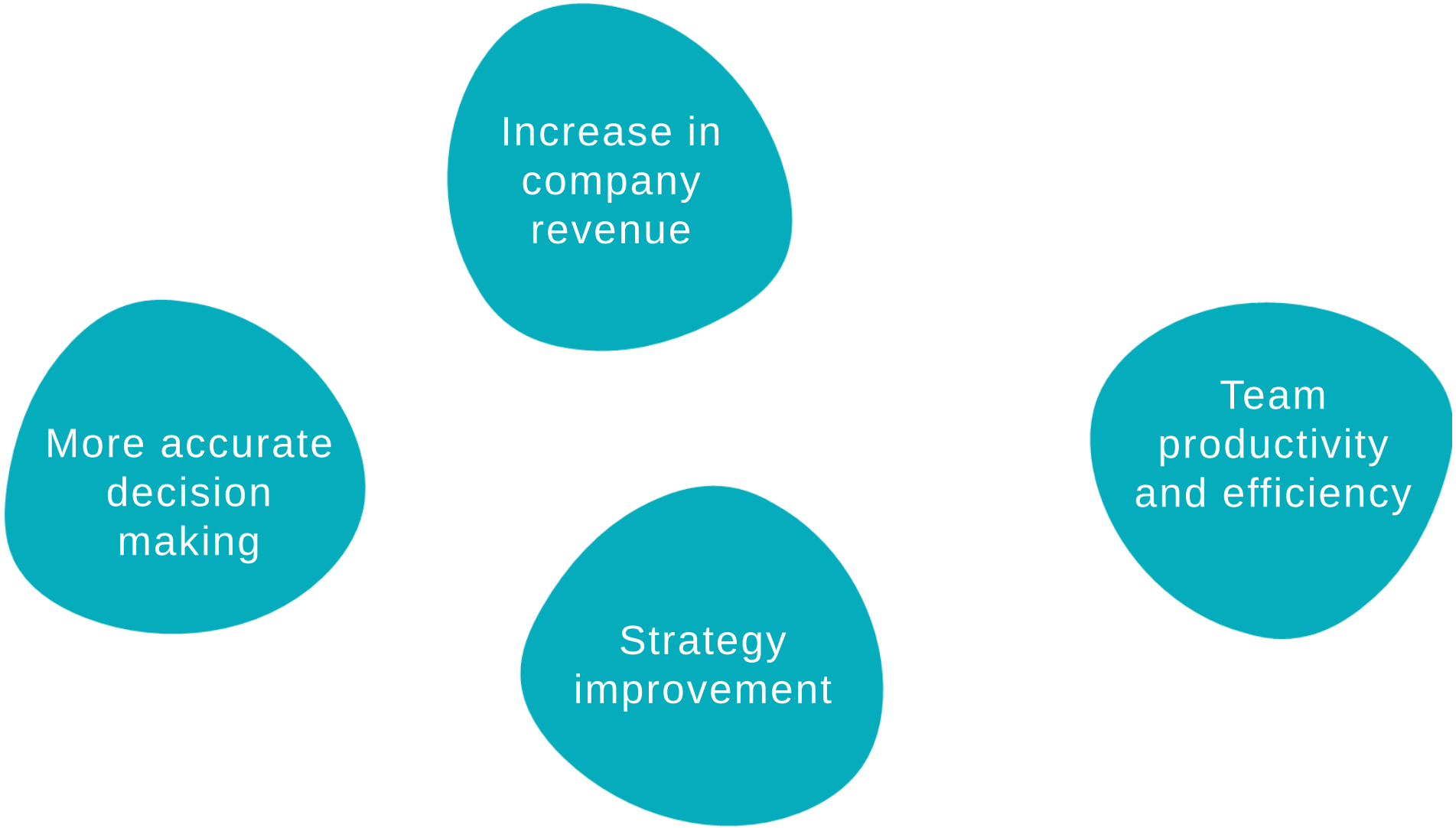
Migration

Ability to move data from one environment to another quickly and conveniently.

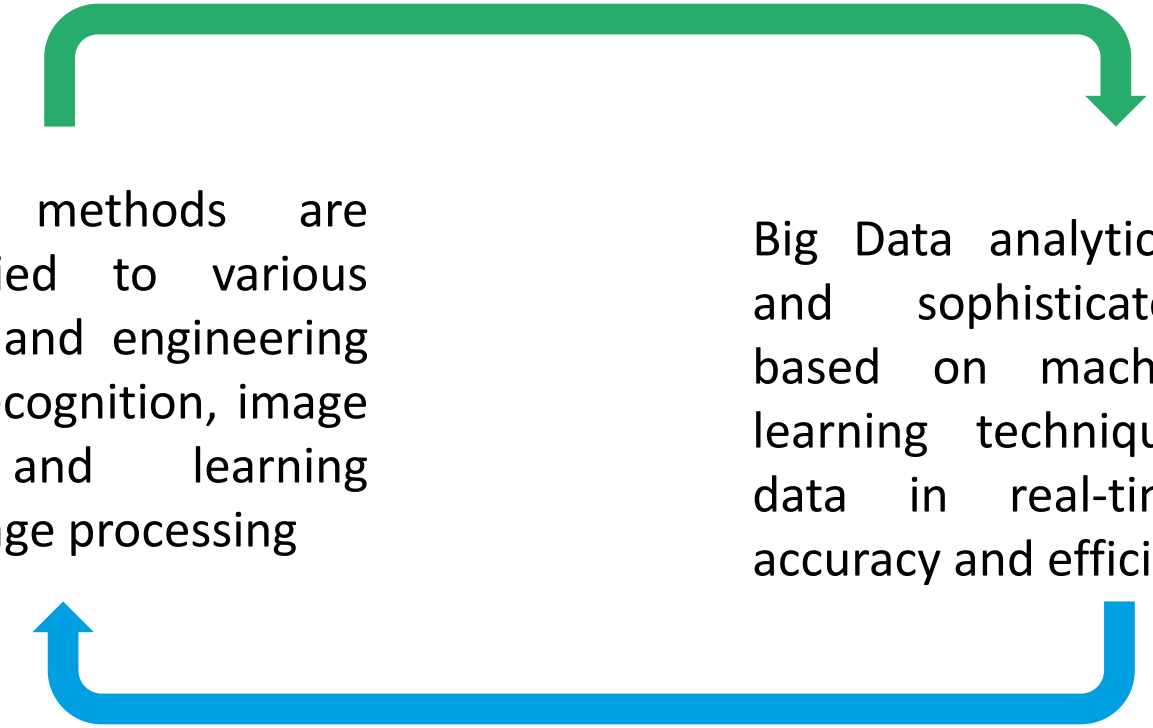
Ensure the availability and security of data, ensuring that it follows all the organization's policies and standards.

Management

BIG DATA MANAGEMENT ADVANTAGES



BIG DATA AND DEEP LEARNING



Deep learning methods are extensively applied to various fields of science and engineering such as speech recognition, image classifications, and learning methods in language processing

Big Data analytics requires new and sophisticated algorithms based on machine and deep learning techniques to process data in real-time with high accuracy and efficiency

- There is not a single definition for Artificial Intelligence.
- The key concepts for AI are Machine Learning, Deep Learning, Artificial neural network (ANN), Categorization, Classification, Collaborative filtering, Natural Language Processing (NLP), Data Mining, Algorithm
- Machine Learning is a subset of Artificial Intelligence that focuses on the development of computer programs (algorithms) that can grant access to data and then use it to learn for themselves.
- The key concepts for Machine Learning are Supervised Learning, Unsupervised Learning, Semi supervised learning, regression and classification
- An Artificial Neural Network is an information processing paradigm that is inspired by the biological nervous systems, such as the human brain's information processing mechanism.

- The key concepts for NN are Input Layer, Hidden Layer, Output Layer, Neuron, Weight Space, Forward Pass, Backpropagation, Hyperparameters, Activation Functions, RNN, CNN, GAN
- Deep Learning is a subfield of machine learning based on algorithms inspired in artificial neural networks with many layers of nodes, that are capable of identify what something is.
- Artificial Neural Network, Layers, Activation Function, Loss Funtion, Overfitting, Underfitting are the key concepts for deep Learning
- Artificial intelligence, machine learning and deep learning have many differences but also have similarities
- Deep Learning has best performance when it uses big data and big data has better analysis when algorithms of DL are applied.

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DRIVES

Development and Research on Innovative Vocational Education Skills

Thank you for your attention

DRIVES project is project under **The Blueprint for Sectoral Cooperation on Skills in Automotive Sector**, as part of New Skills Agenda.

The aim of the Blueprint is **to support an overall sectoral strategy and to develop concrete actions to address short and medium term skills needs.**

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