ADVANCED TECHNOLOGIES IN INDUSTRY 4.0

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EDGE COMPUTING

Introduction To Edge Computing

With the goal of bringing processing power near to IoT sensors, smartphones, and linked technology, edge computing is a relatively new concept. Edge computing has emerged as a promising technology thanks to the sharp increase of smart IoT applications in autonomous vehicles and other computation-sensitive industrial use cases that require low-latency data processing. Gartner predicts that 50% of enterprise-generated data will be created and processed beyond centralized cloud data centres via edge computing by the year 2022. Other research finds that, by 2025, the global IoT installed base will reach over 75.4 billion devices. Edge computing is the computational processing of sensor data away from the centralized nodes and close to the logical edge of the network, toward individual sources of data. It may be referred to as a distributed IT network architecture that enables mobile computing for data produced locally. Instead of sending the data to cloud data centres, edge computing decentralizes processing power to ensure real-time processing without latency while reducing bandwidth and storage requirements on the network. The concept dates to the 1990s, when Akamai solved the concept of web traffic congestion by introducing Content Delivery Network (CDN) solutions. Technology involving network nodes that store cached static media information at locations closer to the end user.

Today, edge computing takes this concept a step further by bringing computing capabilities to the nodes at the edge of the network to process information and provide services.

- **Analysis**

Intelligent edge alludes to the computing forms performed at the location of information generation—the edge of the arrange or a geographic edge. Shrewdly Edge empowers the conglomeration, examination and preparing of IoT information in inaccessible and indeed, decentralized arrange hubs that will not be online and associated with backend cloud data centres. We will encourage categorize the brilliantly edge as: Operational innovation edge. The most distant layer of computing innovation where the innovation causes changes in physical forms. Cases incorporate the SCADA arrange gadgets within the power transmission and dissemination arrange. IoT edge. The layer of physical gadgets creating information to encourage changes in physical and advanced forms. Illustrations run from shrewd domestic gadgets to associated cars and everything savvy in between. The term is utilized to depict the more extensive concept of the modern-day Brilliantly Edge. Data innovation edge. This speaks to computing operations at the organize layer, absent from the backend data centre assets and closer to the information sources. The computing forms at the IT edge cause changes within the advanced organize operations. Although the advancing concept of clever Edge encompasses the three categories, the foremost well-known and broadly embraced term, of IoT edge, is utilized to speak to the concept of shrewd Edge. Some time ago, while burrowing into the reasoning behind Shrewdly Edge and its future, we got to know the key components that characterize insights in a gadget at the edge:

Network: The gadgets ought to be associated to the Web or an internal, decentralized organization.

Computing: Implanted processing chips ought to encourage brilliant decision-making to perform physical or computerized changes within the operation of the associated gadget.

Control: A layer of robotization to control the changes inside the gadget or actuated activities remotely inside other gadgets over the arrange.

Independence :The gadget or the edge organized hub works independently to perform computing functions such as conglomeration, investigation, and handling of data without sending crude streams of information to the backend. Considering the fast-paced advancement of brilliantly associated gadgets, the concept of Cleverly Edge may incorporate next-generation independent capabilities such as:

1)Data handling

2)Decision making

- Activities inside a decentralized sensor arrange A move toward a truly Brilliantly Edge is driven by headway in omnipresent computing, AI, and requests for multi-device end-user encounters. A consistent and synchronized client encounter over the expanding number of associated gadgets is required to guarantee valuable end-user intuitive with a universe of interconnected gadgets.

- As a result, there will be a negligible edge to switch between the gadgets to perform facilitated computing operations and get to data over different gadgets. Computing capabilities will be show ubiquitously in so numerous gadgets and objects that it will be troublesome to recognize a computing gadget from a question with no computing capabilities. Within the future, Brilliantly Edge guarantees exceptional esteem to innovation sellers and customers alike:
- Low reliance on arrange performance. Computing on the edge disposes of the got to exchange information between frontend associated gadgets and centralized backend cloud servers. As a result, the computing execution does not depend on arrange execution parameters such as transfer speed, inactivity and information rate.
- Low fetched. Moo utilization of arrange assets lead to moo fetched of operations. The computing prerequisites on cloud information centres are moreover decreased since information and compute preparing takes put at the edge. Progressed framework effectiveness advance upgrades the benefit of edge computing ventures.
- Seamless client involvement. App usefulness and administrations can be moved over edge organize hubs without requiring adjustments or benefit intrusions on portion of end-users. When clients move between diverse electronic situations, the edge computing gadgets can coordinate and synchronize the desired data to empower the specified app usefulness.
- Real-time insights. Quickened improvements in AI chips have the potential to revolutionize the IoT industry and change associated IoT gadgets into keen computing frameworks. Applications such as voice help, autonomous vehicle driving highlights and electronic wellbeing observing advances can coordinated into human lives with negligible disturbance and chance. As a result, cleverly computing capabilities can be commoditized to expand the worldwide userbase.
- Compliance & security. Businesses that confront rigid directions can diminish the compliance hazard essentially as delicate quiet data can be totalled and prepared at the gadget level. The information remains at rest inside a secure organize edge since it is not gotten to or associated with backend IT foundation to gather and prepare crude streams of data into valuable information.

For innovation sellers, Intelligent Edge has developed as an opportunity to form associated gadgets more competent and mindful of the encompassing arrange environment. At the same time, the gadgets decrease the burden on the arrange despite creating and handling more information than ever some time recently.

For customers, Brilliantly Edge is developing as a significant leap forward to form associated devices truly keen and coordinates inside our way of life. Brilliantly Edge has as of now demonstrated its potential to form a genuine affect to the society within the same way as desktop computers accomplished within the early 90s.

But some time recently Cleverly Edge gets to be an omnipresent reality, sellers will have to be demonstrate its money related practicality, security, and real-world execution from a client point of view. All of this may take a long time ahead to materialize.

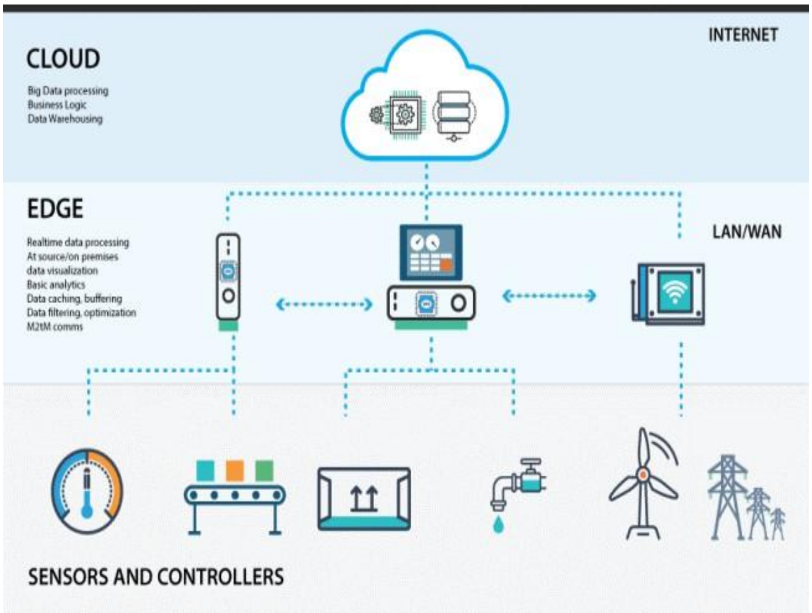


Figure 1. Block diagram of edge computing

Key steps to implementing edge computing

Here are the key steps to achieving edge computing success.

Decide how much intelligence will be in your IoT devices. The more intelligence per device, the less intelligence the Edge Servers themselves need. This is because the data has been filtered at the source: IoT devices. Smart, standardized IoT devices deliver lower volumes of data in more manageable formats. However, smart IoT devices have a higher associated cost; The important thing is to find a happy medium. Remember that adding a few dollars to each

IoT device for a small amount of extra intelligence can add up to thousands of dollars in total costs, money that could be better spent on systems. intelligent edge computing system.

Decide how you will group your IoT devices.

This can be decided to some extent by how you manage the first stage - a group of different smart IoT devices may be easier to manage than a group of relatively dumb devices, as it will take Less filtering, scanning, and reporting on stream data. Do not group all similar IoT devices on the network into one edge device. This will always result in large data transmissions over the network. The idea is to group data generating devices into manageable areas and collect data as close to the group as possible to minimize cross-platform data traffic. Therefore, it may be better to group devices by distance rather than capacity. Neighbourhood clustering also reduces latency and enables much faster responses to identified events. Again, this means that the edge server needs to be smarter, as it will handle different data streams signalling different events.

3. Determine carefully which outcome is more appropriate.

You should try to use edge systems to perfect areas of the platform and use those servers to fully manage IoT devices, but you should not. For example, a high reading monitored in an IoT device through an edge server may not make any sense but compared to similar devices monitored through all edge servers, it can extremely large. Therefore, it is necessary to determine what the exception really is and how to handle them.

4. Use the star approach.

To handle the required data flow, you need an edge infrastructure consisting of different edge servers located on the network with a hierarchical way of processing data between them. The best way to manage such a complex system is to have the least expensive and least intelligent edge servers - to use relative terms, these systems can be quite smart and expensive - as close to IoT devices as possible.

As these edge servers identify events that may be of further interest, they need

to be able to send relevant data to a more intelligent, central server to manage a group or all of the servers. record. This central system can then apply more intelligence to the data analysis and better decide on the necessary actions. Edge servers must also work bilaterally: The external edge servers must be able to identify events and send data to the hub, and the hub must also be able to request real-time data from the external edge servers to consolidate the data. whether it handles. An example here might be in a data centre where an edge server captures high temperature readings. As far as he knows, it is a local event, but he sends the event to the central server. This server requests all other external peripheral servers to send readings from all appropriate temperature monitors. If they are all within limits then yes, it is a local problem, most likely caused by an element overheating. However, if other reports show even a slight increase in temperatures, it could mean that the cooling system for the entire data centre has failed, requiring a very different set of events. In the case of neighbourhood clustering which reduces live data latency for all IoT devices under the control of a single edge server, the star model reduces the time required for data analysis because the central server does not need to handle only known and high-priority data.

5. Use advanced data analysis and reporting. While automation has come a long way, it is still not 100%. As such, there will be cases - possibly many because the current domain is immature - where edge servers need to alert humans to an action to take. False positives and negatives should be avoided, and possible remedies should be pointed out to anyone involved. Therefore, do not ignore the analytical tools used and ensure that the report is made in a clear and meaningful way.

Conclusion

Benefits of edge computing :

1) It provides high speed, lower latency, and better reliability for faster data processing and content delivery.

2) It provides better security by distributing processing, storage, and applications across a wide range of devices and data centres, making it difficult for a network to be disrupted with a single outage.

3) It provides a much lower cost route for scalability and flexibility, allowing enterprises to expand their compute capabilities through a combination of IoT devices and edge data centres. .

Since data is processed locally, less time and resources are needed to transfer data between millions of connected devices.

4) It ensures data privacy and security when sending data across international cross-border networks, as a significant amount of raw data is processed near protected devices. In the case of intermittent connectivity and limited bandwidth caused by remote locations, such as forests or sailing ships, edge computing will benefit.

Drawbacks:

1) It requires more space.

2) Security challenges in edge computing are high due to the huge amount of data.

3) It is simply a data analysis.

4) The cost of advanced computers is very high.

DATAFICATION

Datafication is a technological trend turning many aspects of our life into data which is subsequently transferred into information realised as a new form of value.[1] Kenneth Cukier and Viktor Mayer-Schoenberger introduced the term datafication to the broader lexicon in 2013. Up until this time, datafication had been associated with the analysis of representations of our lives captured through data, but not on the present scale. This change was primarily due to the impact of big data and the computational opportunities afforded to predictive analytics.

Big Data, characterized by high volume, high velocity and a high variety of formats, is a result of and also a driving force for IoT. The datafication of business presents completely new opportunities and risks. To hedge the technical risks posed by the interaction between "everything", IoT requires comprehensive modelling tools.

INTRODUCTION: In a world where personal data is readily made available by the people in return for the conveniences of digital technologies, mass surveillance prevails, and with it, datafication – the process designed to turn every aspect of our everyday life into computerized data. And it's all about prediction, inferring potential outcomes objectively through extensive amounts of data gathered from the proliferation of mass surveillance. With prediction at its core, the impact of datafication has stretched beyond the typical concerns of privacy and surveillance into shaping how decisions in society are made. The rise of mass surveillance through technology, the invasion of privacy, the exploitation of human experiences, and the way in which data systems produce discriminatory results that mask the political nature behind an illusion of objectivity are prominent concerns of datafication. The implications of datafication often have their roots in the way that it is fundamentally designed.

Figure 3. Characteristic of datafication

DATAFICATION:

While technological developments have occurred over the last couple of decades, the current stage of digital technology focuses on datafication, the process of turning every aspect of our everyday life into computerized data. As a concept, datafication is tied closely to the way the huge abundance of data is collected, processed, analysed, measured and used to impact society through the proliferation of technological developments, such as the Internet, big data, algorithmic selection and the internet of things. At its core, datafication is about prediction. This section describes datafication from the perspective of how data is collected and used.

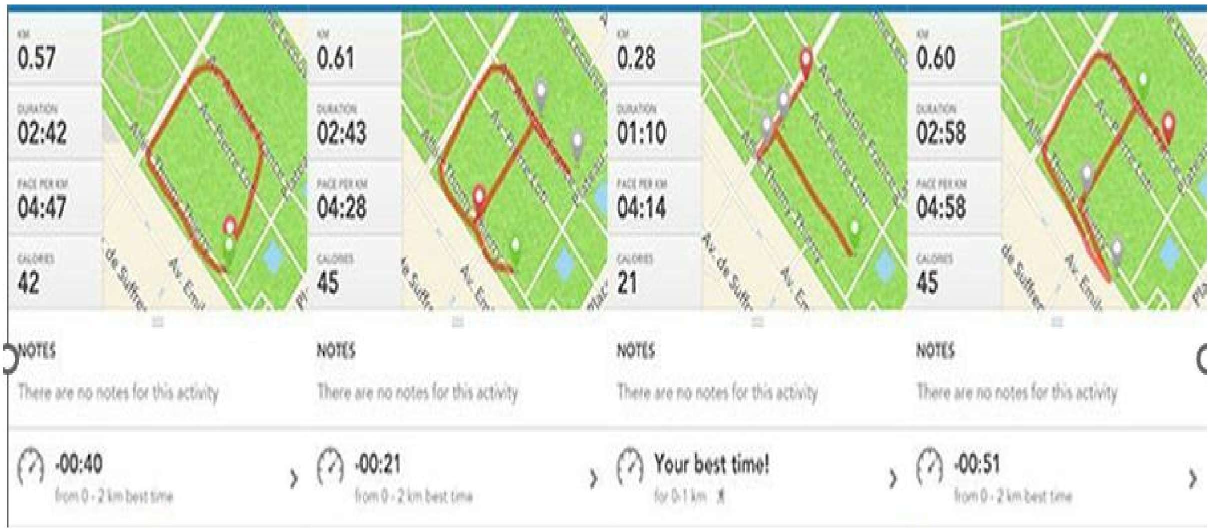


Figure 4. collection of data

How data is collected:

The relentless data-driven pursuit of efficiency in the new media has led Google, Amazon and Facebook to treat media and everything in it as a commodity. Personal data are extracted through the capitalization of peoples' participation in the new media regarding all areas of life, including private, affective and emotional dimensions. For every "like" given on Facebook or every search conducted through Google, the company concerned gains data which they can use to identify their users, building up a vast collection of data on hobbies, interests, demographic profiles, political leanings and relationships through every interaction we have with them. In addition to voluntarily offering up our data through our daily interactions with social media and the digital environment, mass surveillance is conducted through the pervasive and hard to avoid internet of things, such as the connectedness of our daily appliances to the sensors in street lights that we drive past to the conversational technologies listening intently in the background. In the most visionary of predictions, data will soon flow and be collected from everything; our clothing, our vehicles and our bodies. The Snowden revelations demonstrated the extent to which mass surveillance is employed by the state, from harvesting data from the internet's backbone cables to intercepting communication nodes to the proliferation of collaboration with technology companies, such as Facebook, Google and Apple, to collect and analyse millions of data every day. The responses to the revelations have been varied. While some countries witnessed a retreat from state surveillance, some are observed to have strengthened their state surveillance capabilities through the adoption of new laws and regulations, prioritizing the concerns of national security over privacy.

Although people have raised concerns about their privacy, the average citizen still voluntarily, perhaps unknowingly, provides personal information to powerful technology companies such as Google and Facebook, for they are the operating systems of our lives

How data is used:

The data-driven practices are designed to make profits for technology giants. A relatively simple example is the way in which Amazon exploited data stored on a personal computer to allow customers to conveniently purchase goods by removing the tedious process of having to recurrently type in credit card details for each transaction; resulting in an estimated way. Alternatively, through the selection of more complex algorithms, the abundance of processed data enables optimized efficiency, lower costs of operation and allows enormous profits to be made from the production of behavioural predictions. While these data are initially collected solely to improve the algorithmic-based services which these companies provide, the same data now provides a means of predicting customer behaviours. Amazon makes billions of dollars by predicting customer interest and showcasing relevant merchandise upfront, and up to 60 % of Netflix's rentals come from accurate personalized offerings regarding movie preferences. The surplus of these predictions is then sold to third parties, such as advertisers, political organisations or even the state. In consequence, digital connection becomes just a means to others' commercial ends. Aside from the pursuit of economic profit, the surplus of predictive behavioural data is used by organizations in various other ways. In state politics, Facebook became the go-to consultant for voter-targeting and political engineering, in which data about citizens are harvested and then algorithmically processed to determine profiles that are effective targets for political messages. Furthermore, these data may be employed to diminish the democratic potential of digital media, perhaps through a system that is algorithmically fine-tuned and detailed, much like the behavioural advertisements that we receive every day.

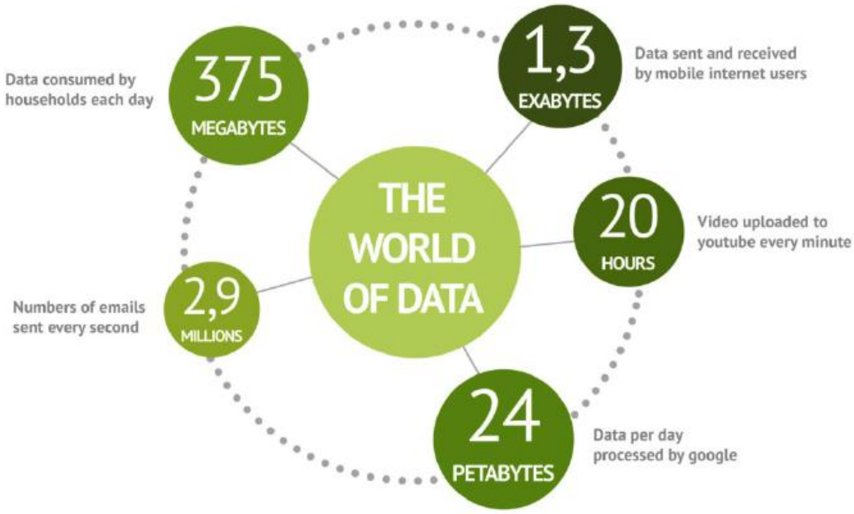


Figure 5. How data is used every day?

Data Design:

Data design is a craft with an amazing amount of power, the power to choose and the power to influence. With that in mind, this section tries to describe the development of design within the context of digital technology.

Figure 6. Designing of the data

Design in the digital technology:

The practice and outcome of design is broad. National organizations, such as the Danish Design Centre, have broadly defined design as “a systematic, creative process. The process is visual and experimental and revolves around human experiences and behaviour. The outcome may be graphic or tangible products, new services, systems or business model”. Similarly, the Design Council UK has also refrained from confining design to a certain sector or occupation, instead, supporting the idea that designers have always drawn from different fields and it is that which makes design unique. Nevertheless, design is also increasingly digital. Within the context of digital technology, the evolution of design can be seen from the interface, which has itself evolved throughout the development of technology, from the designing of physical products to the designing of complex interactions between humans and computers. However, as technological innovation prevails to turn the wide-spreading range of everyday human activities into computerized data, the “interface” becomes far more than just the graphical user interface – it becomes invisible, natural and everywhere.

As a consequence of such pervasiveness, many different ways of human interaction with computer-based systems have become possible, from that of which we are conscious of controlling to that of which we may be unaware.

The value of design:

Design has been a valuable contributor to the economic growth of some countries. Design has flourished as an enabler for business development in times of economic challenges in the past, for example, during the American economic depression. Similarly, the Design Council UK was founded during the wartime government of Winston Churchill as the Council of Industrial Design to support Britain’s economic recovery. Looking at more recent times, the design economy in the UK generated a total of £ 85.2 billion in gross value, matching the contribution of the distribution, transportation and food sectors.

In addition, a nationwide survey of industry in Denmark concludes that the use of design generates growth and economic value for the companies. The value of design is further strengthened by an industry report conducted by McKinsey & Company. The report, which studies the business value of design through rigorously analysing design practices of 300 publicly listed companies over a five-year period, showed that companies with excellent design practices outperform their industry counterparts by twice as much in terms of revenue and shareholder returns. Furthermore, design that is well integrated into key decision-making and business strategy claims to have proven results on revenue, cost savings, time to market and valuation and has an overall positive impact on business profit in the fast-paced growing technology industry, design is in high demand due to the value that it brings. Over 100 design-related companies have been acquired by large technology companies, such as Facebook and Google, and by large consulting firms, such as McKinsey, Deloitte, Accenture and BCG, since 2004.Furthermore, technology giants, such as Google, Amazon and Facebook, have collectively increased the headcount of design positions by 65% over the course of a year.

Datafication and design:

Considering the high demand for designers within the growing technology industry and the value that design can potentially bring into the digital world, it goes without saying that design should also be a craft with great responsibility, which may perhaps be needed within the context of datafication. This section showcases some examples of how the implications of datafication are often rooted in their design.

Datafication by design for technology companies:

For technology companies, the capitalization of people’s participation in social media is by design. Similar to casinos and slot machines, Facebook is designed for ‘stickiness’. It keeps its users drawn to its flow of images and emotions. By exploiting the emotions of its users, contents generating strong reactions from users are amplified and showcased to the feed through a measurement of “likes”, shares and comments. It is designed to keep users immersed and lose track of depth and time, and to reward them just enough so that they return to Facebook to provide more behavioural data to sell to advertisers.

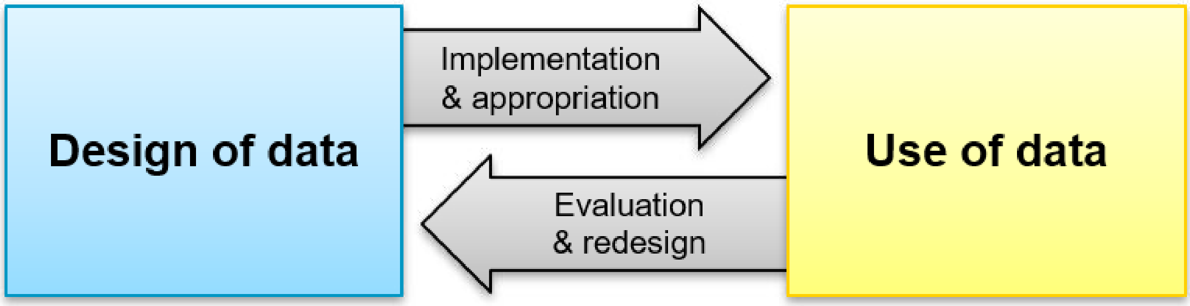


Figure 7. Use of data

Data field design problems:

The design problem encompassing mass surveillance and privacy then becomes one of how to design for privacy protection without sacrificing the perceived trade-offs with convenience and security. A popular concept of privacy by design has been proposed by Cavoukian (2009), in which the fundamental design principles remain relevant as it reflects some essential elements of modern regulations, such as the European Union General Data Protection Regulation. As such, the key essentials of various privacy by design concepts may be relevant in the context of datafication, especially for practitioners of digital design, where there is an increasing awareness of designing for privacy. However, tackling the concerns of privacy by focusing on the regulation of data may divert attention from the fundamental issue of mass surveillance itself. Another design problem encompassing data systems lies in the outcome of its predictive capabilities in profiling and social sorting. In many cases, the outcomes often lead to discrimination and exclusion of certain groups, potentially deepening the inequality in society from unfair treatment of immigrants at security point to the application of a social credit scoring system in China to predicting the crime behaviour of US cities, which ends up widening the inequality gap between good and bad neighbour hour. While discriminatory outcomes are not intentionally programmed as the output of data systems, they are inherently designed within human contexts, biases, values and agendas. These underlying human roots influence the design choices of data systems: from the choice of which data to collect to the decision of how the variables are weighted. Consequently, these factors mask the true nature of datafication behind the illusion of objectivity.

Potential considerations:

The implications of datafication often have their roots in the way that it is fundamentally design. As designers face more complex and morally ambiguous design problems, there should be a designers' code of ethics, akin to the Hippocratic Oath taken by doctors, one to which designers can adhere before each design decision.

However, a well-meaning code of ethics may not be enough. According to the new era, designers nowadays have become applied behavioural scientists but are woefully undereducated for the task, which becomes the basis of his argument that design education must radically change to meet the needs of the present. It has been implied that the typical designer of technology companies lacks the leverage to challenge the status quotes, therefore people suggest that designer's band together as a union to form collective power and influence. However, he has yet to elaborate on how a designers' collective could effectively challenge the status quo. In addition, the formation of a collective may be challenging due to the broad nature of design work, arguments of different definitions of design and the gap between researchers and practitioners of the field.

Examples:

And here could be many examples of datafication.

Let's say social platforms, Facebook or Instagram, for example, collect and monitor data information of our friendships to market products and services to us and surveillance services to agencies which in turn changes our behaviour; promotions that we daily see on the socials are also the result of the monitored data. In this model, data is used to redefine how content is created by datafication being used to inform content rather than recommendation systems.

However, there are other industries where datafication process is actively used:

- Insurance: Data used to update risk profile development and business models.
- Banking: Data used to establish trustworthiness and likelihood of a person paying back a loan.
- Human resources: Data used to identify e.g., employees risk-taking profiles.
- Hiring and recruitment: Data used to replace personality tests.
- Social science research: Datafication replaces sampling techniques and restructures the manner in which social science research is performed.

Netflix Case:

Netflix, an internet streaming media provider, is a bright example of datafication process. It provides services in more than 40 countries and 33 million streaming members. Originally, operations were more physical in nature with its core business in mail order-based disc rental (DVD and Blu-ray). Simply said, the operating model was that the subscriber creates and maintains the queue (an ordered list) of media content that they want to rent (for example, a movie). If you limit the total number of disks, the contents can be stored for a long time, as the subscriber wishes. However, to rent a new disk, the subscriber sends the previous one back to Netflix, which then forwards the next available disk to the subscribers queue. Thus, the business goal of the disk rental model is to help people fill their turn. The model has changed and now Netflix is actively transforming their service into a smart one, actively using datafication process

Conclusion:

Datafication is the process of collecting huge amounts of data through mass surveillance and processing it to infer predictions and potential outcomes. As a concept, it is tied to technological developments, such as the internet, big data, algorithmic selection and the internet of things. The processing of extensive amounts of data are designed to make profits for technology giants, whether through improving their own services or selling the surplus of data to third parties. While design is a valuable contributor to the economy of both countries and technology companies, it also contributes to the implication of datafication. From exploiting human emotions in ‘social stickiness’ designs to the unintentional designs of discriminatory outcomes, the implication of datafication and its data systems often find their roots in the underlying human contexts of their designers. Consequently, designers must then face the challenges of complex and morally ambiguous design problems to look for values beyond providing only economic gains and band together as a community to collectively answer the question: “Are we designing the right thing?”.

BLOCKCHAIN

INTRODUCTION

Blockchain is a digital ledger maintained and distributed among multiple interconnected computers called “nodes.” The blockchain is made up of consecutive “blocks” that store an accounting of relevant information, such as transaction time, amount and addresses involved in transactions. Each data set is linked to the one before it using a cryptographic algorithm to verify and create a time-stamped hash of the data. Copies of the blockchain are then distributed to the users within the network with access to view the stored information. Through this technology, Bitcoin and other digital currencies maintain privacy and security while having a public, decentralized ledger.

Blockchain could be a data structure that could be a growing list of information blocks. The knowledge blocks area unit coupled along, such recent blocks cannot be removed or altered. Blockchain is the backbone Technology of the Digital Crypto Currency Bitcoin. The blockchain is a distributed database of records of all transactions or digital events that have been executed and shared among participating parties. Each transaction is verified by most participants of the system. It contains every single record of each transaction. Bitcoin is the most popular cryptocurrency an example of the blockchain. Blockchain Technology first came to light when a person or Group of individuals name ‘Satoshi Nakamoto’ published a white paper on “*Bitcoin: A peer-to-peer electronic cash system*” in 2008. Blockchain Technology Records Transaction in Digital Ledger which is distributed over the Network thus making it incorruptible. Anything of value like Land Assets, Cars, etc. can be recorded on Blockchain as a Transaction.

How does Blockchain Technology Work?

One of the famous uses of Blockchain is Bitcoin. Bitcoin is a cryptocurrency and is used to exchange digital assets online. Bitcoin uses cryptographic proof instead of third-party trust for two parties to execute transactions over the Internet. Each transaction protects through digital signature

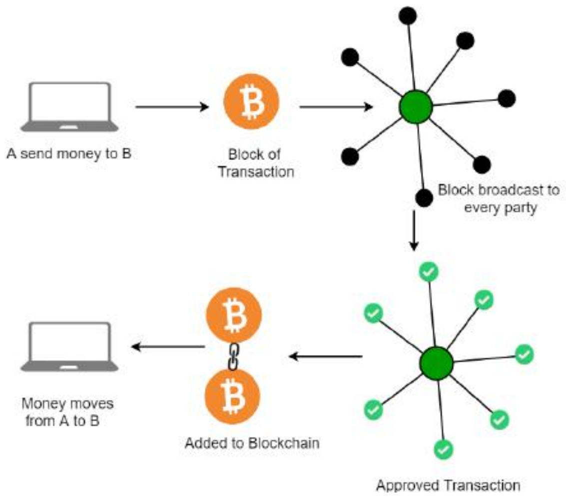


Figure 8. Working of blockchain technology

Blockchain architecture

The banking sector is making extensive use of blockchain architecture. However, today's technology encourages the creation of software solutions for payment systems, digital notaries, and cryptocurrency record-keeping.

Meanwhile, the general distribution in the blockchain architecture functions in complicated ways, with each block distributing data across networks. The shared state in a database refers to the fact that all systems are configured with similar data criteria and conditions.

Decentralization, liability, and protection comprise the three pillars on which this architecture bases its whole functioning.

Public Blockchain

In the public blockchain architecture, anyone can set up a node and become part of the P2P network without seeking permission from anyone.

Also, those who join the network often remain pseudonymous. Nevertheless, the public blockchain architecture incentivizes stakeholders to act honestly through mining or staking rewards and opportunity costs.

The advantage of public blockchain architecture is that they offer more security since they are highly decentralized. The downside is that they can be rigid, and upgrades often face contentious governance processes.

Private Blockchain

In this case, a person, business, or an institution owns and controls all the nodes on the P2P network. In such a setting, only the blockchain owner can allow another person or entity to join the network. The advantage of a private blockchain is that the owner can customize it to the extent they want. Also, upgrades are easy to implement as there are few stakeholders to persuade. On the other hand, private blockchains are the least secure and more likely to have censorship. That is because there is a central authority that can be compromised. Also, they are not immutable as the owner can easily change the rules.

Consortium Blockchain

A consortium blockchain architecture is a collaboration of many entities. Each of them can have a node on the network, participate in the decision-making, and own shares in the company that oversees its operations.

The stakeholders in consortium blockchain architectures often must identify themselves. Also, those who want to join the network and the consortium must meet established requirements, and that could include paying a fee.

Hyperledger, R3, and b31 are examples of consortium blockchains.

Hybrid blockchain

This is a blockchain architecture that has two levels. The foundational level is a public P2P network. The second layer on top of it is a private blockchain that an entity builds.

The private blockchain benefits from the security that the public blockchain architecture gets from high decentralization. Meanwhile, an entity like a business can easily build and customize a blockchain for its unique needs.

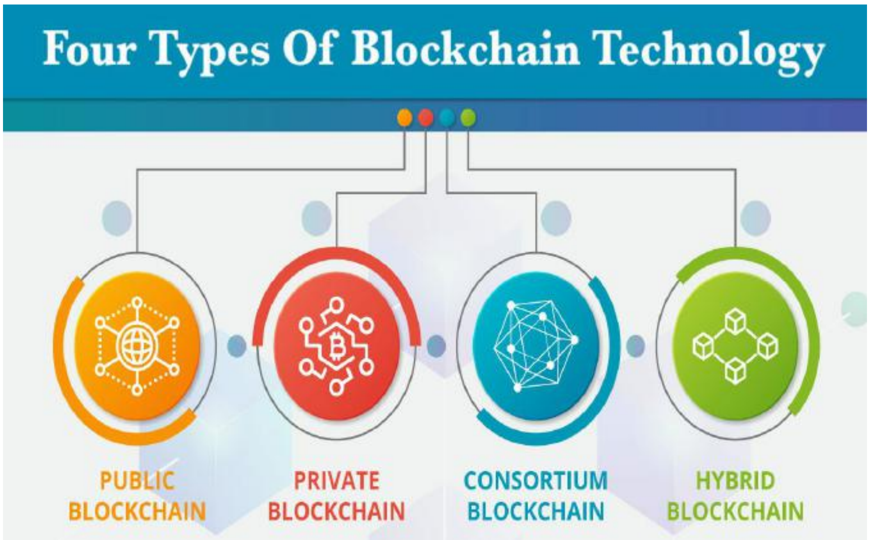


Figure 9. blockchain architecture

Blockchain and Cryptocurrency: A long-lasting Relationship

The blockchain of a cryptocurrency is the master ledger that generally records all prior transactions and activities, validating the ownership of all units of the currency at any given point in time. The blockchain contains the entire transaction history of a cryptocurrency as a record.

It has a finite length containing a finite number of transactions that eventually surge in due course of time. Identical copies of the blockchain are stored in every node of the cryptocurrency's software network. This network of decentralized server farms is managed by tech-savvy individuals or groups of individuals known as miners. Miners continually record and authenticate cryptocurrency transactions.

A blockchain currency transaction technically isn't necessarily finalized until it has been added to the blockchain. Once the transaction is finalized, it is usually irreversible. Unlike traditional payment processors, such as PayPal and credit card modes of transactions, most cryptocurrencies have no built-in refund or chargeback functions.

During the lag time between the transaction's initiation and finalization, cryptocurrency units cannot be used by either party. They are held in a state of freeze-down for all intents and purposes. Blockchain thus prevents double-spending or the manipulation of cryptocurrency code to allow the same currency units to be duplicated and sent to multiple recipients.

Basis of Comparison	**Blockchain**	**Cryptocurrency**
Nature	A technology that records transactions	Tools used in virtual exchanges
Use	Record transactions	Make payments, investments, and storage of wealth
Value	Have monetary value	Have no monetary value
Mobility	Can be transferred	Cannot be transferred

Major blockchain protocols are listed below:

Bitcoin: The first blockchain application, Bitcoin enables users to perform non-reversible transactions restlessly. This protocol includes technologies such as hash, digital signature, public-key cryptography, P2P networking, Proof of Work, and Proof of Work mining.

Ethereum: Known for smart contracts, Ethereum features a native cryptocurrency, namely Ether, and an Ethereum wallet. This protocol allows users to create decentralized applications and democratic autonomous organizations.

Ripple: ripple blockchain supports tokens that are used to represent fiat, other cryptocurrencies, commodities, or other value units such as mobile minutes and frequent flyer miles.

Hyperledger: Developed by the Linux Foundation in 2015, Hyperledger supports Python, endorsement policies for transactions, and confidential channels for private information sharing.

Open chain: A scalable and secure blockchain protocol, Open chain is suitable for organizations that wish to issue and manage their digital assets.

IOTA: Known for its block less distribution ledger 'Tangle', IOTA enables infinitesimally small payments without charging extra fees.

Lisk: A relatively new blockchain protocol, Lisk allows the development of decentralized applications in pure JavaScript.

Big chain DB: This open-source system starts with a big data distributed database and then adds blockchain characteristics to the network including decentralized control and digital asset transfers.

How Are Blockchains Used?

As we now know, blocks on Bitcoin's blockchain store transactional data. Today, more than 23,000 other cryptocurrency systems are running on a blockchain. But it turns out that blockchain is a reliable way of storing data about other types of transactions.

Some companies experimenting with blockchain include Walmart, Pfizer, AIG, Siemens, and Unilever, among others. For example, IBM has created its Food Trust blockchain to trace the journey that food products take to get to their locations.

Why do this? The food industry has seen countless outbreaks of E. coli, salmonella, and listeria; in some cases, hazardous materials were accidentally introduced to foods. In the past, it has taken weeks to find the source of these outbreaks or the cause of sickness from what people are eating.

Using blockchain allows brands to track a food product's route from its origin, through each stop it makes, to delivery. Not only that, but these companies can also now see everything else it may have encounter, allowing the identification of the problem to occur far sooner—potentially saving lives. This is one example of blockchain in practice, but many other forms of blockchain implementation exist.

Banking and Finance

Perhaps no industry stands to benefit from integrating blockchain into its business operations more than banking. Financial institutions only operate during business hours, usually five days a week. That means if you try to deposit a check on Friday at 6 p.m., you will likely have to wait until Monday morning to see that money hit your account.

Even if you make your deposit during business hours, the transaction can still take one to three days to verify due to the sheer volume of transactions that banks need to settle. Blockchain, on the other hand, never sleeps.

By integrating blockchain into banks, consumers might see their transactions processed in minutes or seconds—the time it takes to add a block to the blockchain, regardless of holidays or the time of day or week. With blockchain, banks also could exchange funds between institutions more quickly and securely. Given the size of the sums involved, even the few days the money is in transit can carry significant costs and risks for banks.

The settlement and clearing process for stock traders can take up to three days (or longer if trading internationally), meaning that the money and shares are frozen for that period. Blockchain could drastically reduce that time.

Currency

Blockchain forms the bedrock for cryptocurrencies like Bitcoin. The U.S. dollar is controlled by the Federal Reserve. Under this central authority system, a user's data and currency are technically at the whim of their bank or government. If a user's bank is hacked, the client's private information is at risk.

If the client's bank collapses or the client lives in a country with an unstable government, the value of their currency may be at risk. In 2008, several failing banks were bailed out—partially using taxpayer money. These are the worries out of which Bitcoin was first conceived and developed. By spreading its operations across a network of computers, blockchain allows Bitcoin and other cryptocurrencies to operate without the need for a central authority. This not only reduces risk but also the processing and transaction fees.

Healthcare

Healthcare providers can leverage blockchain to store their patients' medical records securely. When a medical record is generated and signed, it can be written into the blockchain, which provides patients with the proof and confidence that the record cannot be changed. These personal health records could be encoded and stored on the blockchain with a private key so that they are only accessible to specific individuals, thereby ensuring privacy.

Medical records

Blockchains can allow for the standardization of the secure electronic exchange of medical records between healthcare providers, which would be less burdensome than current approaches. Blockchain technology allows for a decentralized records management system that eliminates the need for an organization to manage patients' access to records. Blockchain-enabled healthcare applications have potential benefits such as the ability to instantly verify the authenticity of prescriptions and automatically detect the possibility of harmful drug interactions.

Supply chain management

When combined with properly validated business practices, a blockchain can serve as a verifiable method for documenting supply chains. For example, this technology can be used to ensure that diamonds are not tied to conflict, to guard against counterfeiting of IoT devices, and to reliably track materials and manufactured products from source to destination, thus promoting ethical practice

CONCLUSION

Blockchain technology creates a permanent and immutable record of every transaction. This impenetrable digital ledger makes fraud, hacking, data theft, and information loss impossible. We have only touched on the basics of blockchain but it will provide the starting point to explore this technology. There is no limit to the application of the technology and innovations are just waiting to happen.

Pros and Cons of Blockchain

For all its complexity, blockchain's potential as a decentralized form of record-keeping is almost without limit. From greater user privacy and heightened security to lower processing fees and fewer errors, blockchain technology may very well see applications beyond those outlined above. But there are also some disadvantages.

Pros

- Improved accuracy by removing human involvement in verification
- Cost reductions by eliminating third-party verification
- Decentralization makes it harder to tamper with
- Transactions are secure, private, and efficient
- Transparent technology
- Provides a banking alternative and a way to secure personal information for citizens of countries with unstable or underdeveloped governments

Cons

- Significant technology cost associated with some blockchains
- Low transactions per second
- History of use in illicit activities, such as on the dark web
- Regulation varies by jurisdiction and remains uncertain
- Data storage limitations

DISADVANTAGE

- Small loops have poor efficiency and hence are mainly used as receiving antenna at lower frequencies.
- Small loop antennas have very low value of radiation resistance. This results into power loss as heat due to flow of current with high levels. Hence large loop antennas are preferred over smaller ones
- **Reduced portability:** If you've ever seen a fully built-out magnetic loop antenna in action, you know it's not something you can fold into four pieces and put in your backpack. These antennae are designed to be mounted and stay there. Everyone in the radio space should know the dangers of assembling antennae.

ARTIFICIAL INTELLIGENCE

What is Artificial Intelligence?

Artificial intelligence (AI) is the theory and development of computer systems capable of performing tasks that historically required human intelligence, such as recognizing speech, making decisions, and identifying patterns. AI is an umbrella term that encompasses a range of technologies, including machine learning, deep learning, and natural language processing.

Although the term is commonly used to describe a range of different technologies in use today, many disagree on whether these actually constitute artificial intelligence. Instead, some argue that much of the technology used in the real world today actually constitutes highly advanced machine learning that is simply a first step towards true artificial intelligence, or “general artificial intelligence” (GAI).

Figure 10. Introduction to AI

How does AI work?

Advanced AI requires vast amounts of data, the quantity and quality of which really drives AI effectiveness. Its capability is then to extract certain features from this data and classify them to provide an output. In machine learning, some human intervention is needed to tell the machine how to extract features. In deep learning, which is a much more advanced level of AI, the machine can teach itself to extract and classify features.

Let’s take the example of autonomous driving. The vehicle receives data both visually through cameras but also using radar or different sensing technologies to recognise what’s happening in its environment. Simultaneously it is continuously receiving and monitoring data from how the vehicle is performing. AI uses and classifies that data to see whether the scenario the vehicle is facing requires some type of intervention and produces an output to the vehicle to navigate safely through the scenario it perceives.

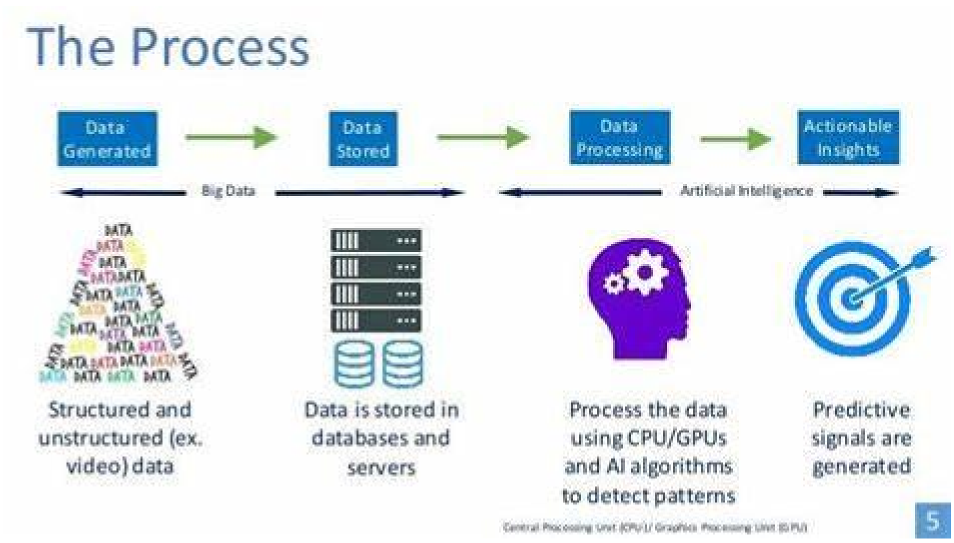


Figure 11. Working of AI

Types of AI
There are four main types of AI. They are:

1. Reactive Machines
This kind of AI is purely reactive and does not have the ability to form 'memories or use 'past experiences' to make decisions. These machines are designed to perform specific tasks. For example, programmable coffeemakers or washing machines are designed to perform specific functions, but they do not have memory.

2. Limited Memory AI
This kind of AI uses past experiences and the present data to make a decision. Limited memory means that the machines are not coming up with new ideas. They have a built-in program running the memory. Reprogramming is done to make changes in such machines. Self-driving cars are examples of limited memory AI.

3. Theory of Mind
These AI machines can socialize and understand human emotions and will have the ability to cognitively understand somebody based on the environment, their facial features, etc. Machines with such abilities have not been developed yet. There is a lot of research happening with this type of AI.

4. Self-Awareness
This is the future of AI. These machines will be super-intelligent, sentient and conscious. They are able to react very much like a human being, although they are likely to have their own features.

How Does AI Work and applications of AI
A common AI application that we see today is the automatic switching of appliances at home.

When you enter a dark room, the sensors in the room detect your presence and turn on the lights. This is an example of non-memory machines. Some of the more advanced AI programs are even able to predict your usage pattern and turn on appliances before you explicitly give instructions.
Some AI programs are able to identify your voice and perform an action accordingly. If you say, “turn on the TV”, the sound sensors on the TV detect your voice and turn it on. With the Google dongle and a Google Home Mini, you can actually do this every day.

AI benefits and dangers

AI has the potential to transform how we work and live in the world today. While many of these transformations are exciting, like self-driving cars or the ability to automatically generate new content, they also pose many challenges that may leave some of us worse off than before.It’s a complicated picture that often summons competing images: a utopia for some, a dystopia for others. The reality is likely to be much more complex. Here are a few of the possible benefits and dangers AI may pose

Benefits

Greater accuracy for certain repeatable tasks, such as assembling vehicles or computers. Decreased operational costs due to greater efficiency of machines. Increased personalization within digital services and products. Improved decision-making in certain situations. Ability to quickly generate new content, such as text or images.

Dangers

Job loss due to increased automation. Potential for bias or discrimination as a result of the data set on which the AI is trained. Possible cybersecurity concerns. Lack of transparency over how decisions are arrived at, resulting in less-than-optimal solutions. Potential to create misinformation, as well as inadvertently violate laws and regulations.

Challenges and Limitations of AI

While AI is certainly viewed as an important and quickly evolving asset, this emerging field comes with its share of downsides. The Pew Research Canter surveyed 10,260 Americans in 2021 on their attitudes toward AI. The results found 45 percent of respondents are equally excited and concerned, and 37 percent are more concerned than excited. Additionally, more than 40 percent of respondents said they considered driverless cars to be bad for society. Yet the idea of using AI to identify the spread of false information on social media was more well received, with close to 40 percent of those surveyed labelling it a good idea.AI is a boon for improving productivity and efficiency while at the same time reducing the potential for human error. But there are also some disadvantages, like development costs and the possibility for automated machines to replace human jobs. It’s worth noting, however, that the artificial intelligence industry stands to create jobs, too — some of which have not even been invented yet.

Future of Artificial Intelligence

When one considers the computational costs and the technical data infrastructure running behind artificial intelligence, actually executing on AI is a complex and costly business. Fortunately, there have been massive advancements in computing technology, as indicated by Moore’s Law, which states that the number of transistors on a microchip double about every two years while the cost of computers is halved. Although many experts believe that Moore’s Law will likely come to an end sometime in the 2020s, this has had a major impact on modern AI techniques without it, deep learning would be out of the question, financially speaking. Recent research found that AI innovation has actually outperformed Moore’s Law, doubling every six months or so as opposed to two years.By that logic, the advancements artificial intelligence has made across a variety of industries have been major over the last several years. And the potential for an even greater impact over the next several decades seems all but inevitable.

MACHINE LEARNING

What is Machine Learning?

Machine learning (ML) is a subfield of artificial intelligence focused on training machine learning algorithms with data sets to produce machine learning models capable of performing complex tasks, such as sorting images, forecasting sales, or analysing big data.

It is an umbrella term for solving problems for which development of algorithms by human programmers would be cost-prohibitive, and instead the problems are solved by helping machines 'discover' their 'own' algorithms, without needing to be explicitly told what to do by any human-developed algorithms. generative artificial neural networks have been able to surpass results of many previous approaches. Machine learning approaches have been applied to large language models, computer vision, speech recognition, email filtering, agriculture and medicine, where it is too costly to develop algorithms to perform the needed tasks. The mathematical foundations of ML are provided by mathematical optimization methods. Data mining is a related (parallel) field of study, focusing on exploratory data analysis through unsupervised learning.ML is known in its application across business problems under the name predictive analytics. Although not all machine learning is statistically-based, computational statistics is an important source of the field's methods.

How Does Machine Learning Work?

Machine Learning is, undoubtedly, one of the most exciting subsets of Artificial Intelligence. It completes the task of learning from data with specific inputs to the machine. It’s important to understand what makes Machine Learning work and, thus, how it can be used in the future. The Machine Learning process starts with inputting training data into the selected algorithm. Training data being known or unknown data to develop the final Machine Learning algorithm. The type of training data input does impact the algorithm, and that concept will be covered further momentarily. New input data is fed into the machine learning algorithm to test whether the algorithm works correctly. The prediction and results are then checked against each other.If the prediction and results don’t match, the algorithm is re-trained multiple times until the data scientist gets the desired outcome. This enables the machine learning algorithm to continually learn on its own and produce the optimal answer, gradually increasing in accuracy over time.

Types of Machine Learning

Machine Learning is complex, which is why it has been divided into two primary areas, supervised learning and unsupervised learning. Each one has a specific purpose and action, yielding results and utilizing various forms of data. Approximately 70 percent of machine learning is supervised learning, while unsupervised learning accounts for anywhere from 10 to 20 percent. The remainder is taken up by reinforcement learning.

1. **Supervised Learning**

In supervised learning, we use known or labelled data for the training data. Since the data is known, the learning is, therefore, supervised, i.e., directed into successful execution. The input data goes through the Machine Learning algorithm and is used to train the model. Once the model is trained based on the known data, you can use unknown data into the model and get a new response.

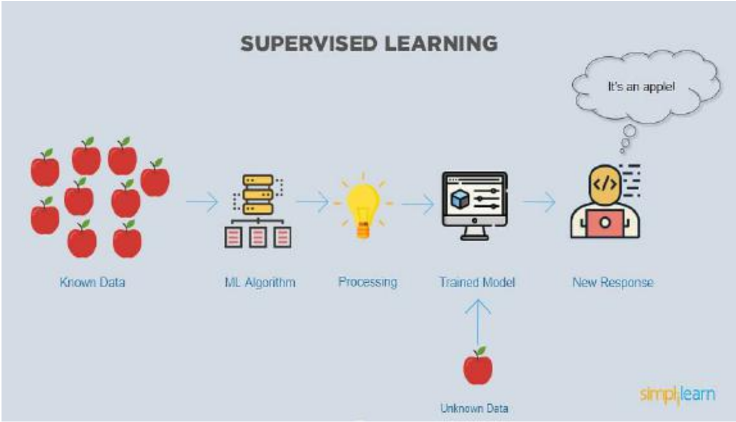


Figure 13. Supervised Learning

2. **Unsupervised Learning**

In unsupervised learning, the training data is unknown and unlabelled - meaning that no one has looked at the data before. Without the aspect of known data, the input cannot be guided to the algorithm, which is where the unsupervised term originates from. This data is fed to the Machine Learning algorithm and is used to train the model. The trained model tries to search for a pattern and give the desired response. In this case, it is often like the algorithm is trying to break code like the Enigma machine but without the human mind directly involved but rather a machine.

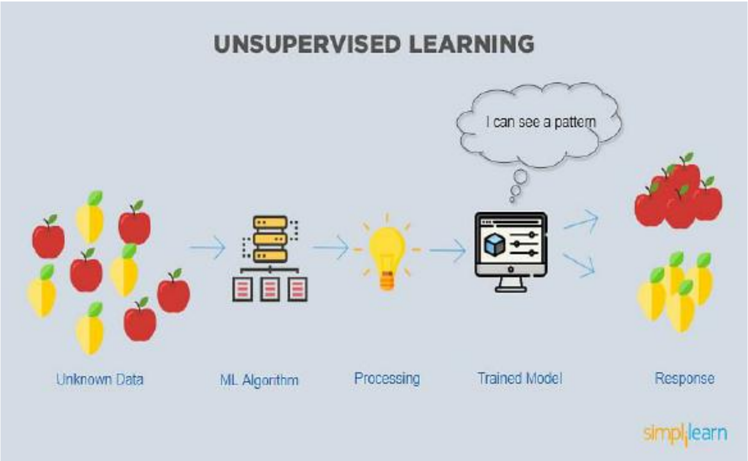


Figure 14. Unsupervised Learning

all these things possible by filtering useful pieces of information 3. Reinforcement Learning

Like traditional types of data analysis, here, the algorithm discovers data through a process of trial and error and then decides what action results in higher rewards. Three major components make up reinforcement learning: the agent, the environment, and the actions. The agent is the learner or decision-maker, the environment includes everything that the agent interacts with, and the actions are what the agent does.Reinforcement learning happens when the agent chooses actions that maximize the expected reward over a given time. This is easiest to achieve when the agent is working within a sound policy framework.

Why is Machine Learning Important?

To better answer the question: what is machine learning" and understand the uses of Machine Learning, consider some of the applications of Machine Learning: the self-driving Google car, cyber fraud detection, and online recommendation engines from Facebook, Netflix, and Amazon. Machines make and piecing them together based on patterns to get accurate results.

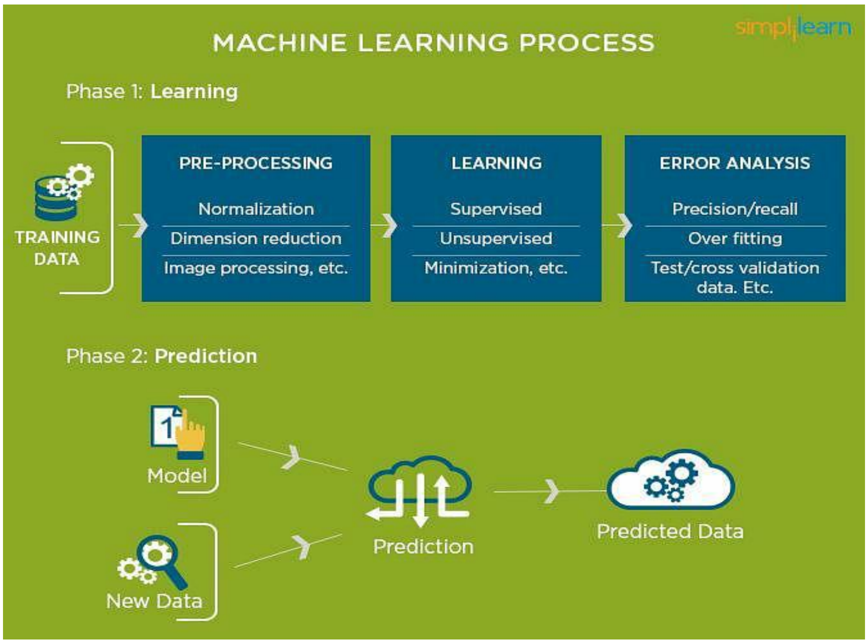


Figure 15. Processing of ML

The rapid evolution in Machine Learning (ML) has caused a subsequent rise in the use cases, demands, and the sheer importance of ML in modern life. Big Data has also become a well-used buzzword in the last few years. This is, in part, due to the increased sophistication of Machine Learning, which enables the analysis of large chunks of Big Data. Machine Learning has also changed the way data extraction and interpretation are done by automating generic methods/algorithms, thereby replacing traditional statistical techniques.

Machine Learning Applications

Social Media Features

Social media platforms use machine learning algorithms and approaches to create some attractive and excellent features. For instance, Facebook notices and records your activities, chats, likes, and comments, and the time you spend on specific kinds of posts. Machine learning learns from your own experience and makes friends and page suggestions for your profile.

Product Recommendations

Product recommendation is one of the most popular and known applications of machine learning. Product recommendation is one of the stark features of almost every e-commerce website today, which is an advanced application of machine learning techniques. Using machine learning and AI, websites track your behaviour based on your previous purchases, searching patterns, and cart history, and then make product recommendations.

Image Recognition

Image recognition, which is an approach for cataloguing and detecting a feature or an object in the digital image, is one of the most significant and notable machine learning and AI techniques. This technique is being adopted for further analysis, such as pattern recognition, face detection, and face recognition.

Sentiment Analysis

Sentiment analysis is one of the most necessary applications of machine learning. Sentiment analysis is a real-time machine learning application that determines the emotion or opinion of the speaker or the writer. For instance, if someone has written a review or email (or any form of a document), a sentiment analyser will instantly find out the actual thought and tone of the text. This sentiment analysis application can be used to analyse a review-based website, decision-making applications, etc.

limitations of Machine Learning

A key disadvantage of machine learning involves long-term and continuous exposure to large volumes of data. The technology is not readily deployable. For it to make predictions o decisions, it needs to learn through data exposure. Identifying and resolving errors is another drawback. Doing so requires specialized expertise and familiarity with the specific machine learning system because it involves analysing complex algorithms and processes. Another limitation is its sole dependence on historical data. It cannot make absolute predictions or decisions simply because there are situations that cannot be analysed with historical data alone. Deploying a capable machine learning system also requires investment and utilization of expensive computer resources. What this means is that machine learning is not readily usable for small organizations. Furthermore, its capability is dependent on the capabilities of its underlying hardware and software components.Other disadvantages and limitations of machine learning include an inability to understand context, susceptibility to unintended or hidden biases depending on input data, lack of capability to pose questions, and inability to provide rational reasons for its predictions or decisions.

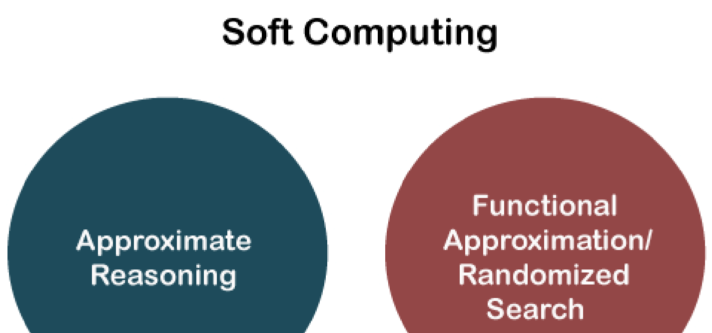
SOFT COMPUTING

Soft computing is the use of approximate calculations to provide imprecise but usable solutions to complex computational problems. The approach enables solutions for problems that may be either unsolvable or just too time-consuming to solve with current hardware. Soft computing is sometimes referred to as computational intelligence.

Soft computing provides an approach to problem-solving using means other than computers. With the human mind as a role model, soft computing is tolerant of partial truths, uncert

ainty, imprecision and approximation, unlike traditional computing models. The tolerance of soft computing allows researchers to approach some problems that traditional computing can't process.

Figure 16. Block Diagram of Soft Computing



Soft Computing is a dedicated to system solutions based on soft computing techniques. It provides rapid dissemination of important results in soft computing technologies, a fusion of research in evolutionary algorithms and genetic programming, neural science and neural net systems, fuzzy set theory and fuzzy systems, and chaos theory and chaotic systems.

Soft Computing encourages the integration of soft computing techniques and tools into both everyday and advanced applications. By linking the ideas and techniques of soft computing with other disciplines, the journal serves as a unifying platform that fosters comparisons, extensions, and new applications. As a result, the journal is an international forum for all scientists and engineers engaged in research and development in this fast growing field.

HARD COMPUTING VS SOFT COMPUTING

Hard Computing: Hard computing uses traditional mathematical methods to solve problems, such as algorithms and mathematical models. It is based on deterministic and precise calculations and is ideal for solving problems that have well-defined mathematical solutions.

Soft Computing: Soft computing, on the other hand, uses techniques such as fuzzy logic, neural networks, genetic algorithms, and other heuristic methods to solve problems. It is based on the idea of approximation and is ideal for solving problems that are difficult or impossible to solve exactly.

Soft Computing could be a computing model evolved to resolve the non-linear issues that involve unsure, imprecise and approximate solutions of a tangle. These sorts of issues square measure thought of as real-life issues wherever the human-like intelligence is needed to resolve it.

Hard Computing is that the ancient approach employed in computing that desires Associate in Nursing accurately declared analytical model. The outcome of hard computing approach is a warranted, settled, correct result and defines definite management actions employing a mathematical model or algorithmic rule. It deals with binary and crisp logic that need the precise input file consecutive. Hard computing isn’t capable of finding the real world problem’s solution

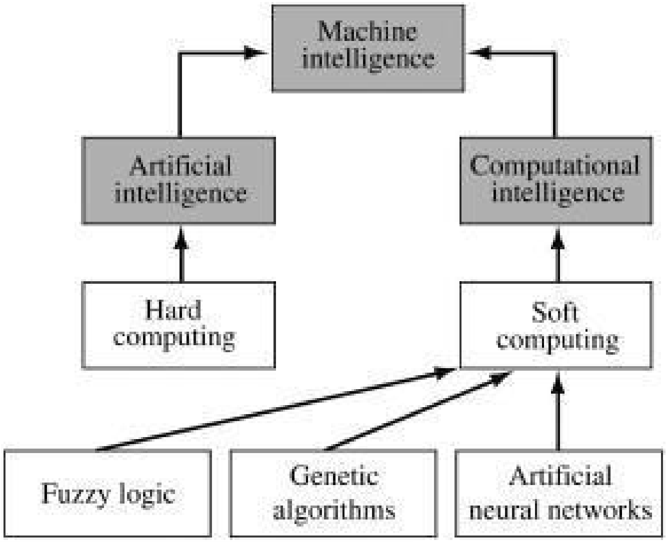


Figure 17. Computing Classification

Some characteristics of Soft computing

- Soft computing provides an approximate but precise solution for real-life problems.
- The algorithms of soft computing are adaptive, so the current process is not affected by any kind of change in the environment.
- The concept of soft computing is based on **learning from experimental data**. It means that soft computing does not require any mathematical model to solve the problem.
- Soft computing helps users to solve real-world problems by providing approximate results that conventional and analytical models cannot solve.
- It is based on Fuzzy logic, genetic algorithms, machine learning, ANN, and expert systems.

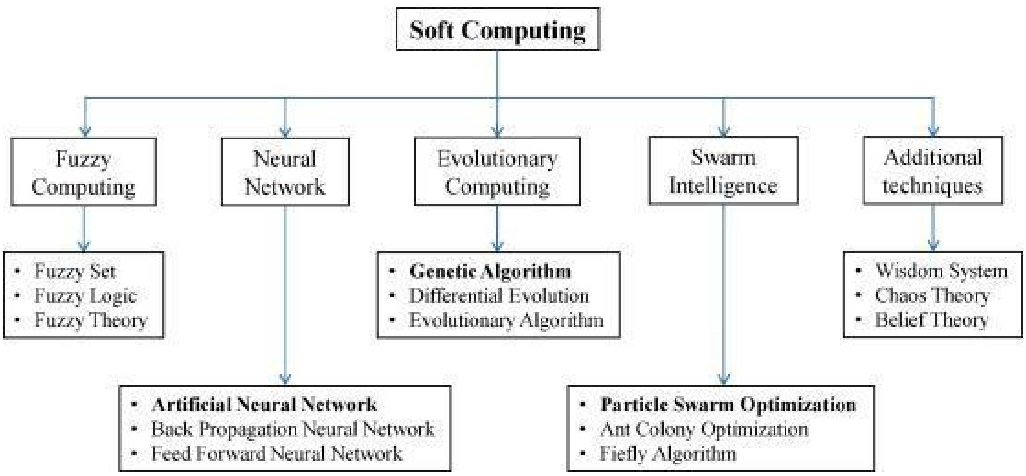


Figure 18. Features of Soft Computing

The following are some of the reasons why soft computing is needed:

- Complexity of real-world problems: Many real-world problems are complex and involve uncertainty, vagueness, and imprecision. Traditional computing methods are not well-suited to handle these complexities.
- Incomplete information: In many cases, there is a lack of complete and accurate information available to solve a problem. Soft computing techniques can provide approximate solutions even in the absence of complete information.
- Noise and uncertainty: Real-world data is often noisy and uncertain, and classical methods can produce incorrect results when dealing with such data. Soft computing techniques are designed to handle uncertainty and imprecision.
- Non-linear problems: Many real-world problems are non-linear, and classical methods are not well-suited to solve them. Soft computing techniques such as fuzzy logic and neural networks can handle non-linear problems effectively.
- Human-like reasoning: Soft computing techniques are designed to mimic human-like reasoning, which is often more effective in solving complex problems.

Artificial Neural Network

It is a connectionist modelling and parallel distributed network. There are of two types ANN (Artificial Neural Network) and BNN (Biological Neural Network). A neural network that processes a single element is known as a unit. The components of the unit are, input, weight, processing element, output. It is similar to our human neural system. The main advantage is that they solve the problems in parallel, artificial neural networks use electrical signals to communicate. But the main disadvantage is that they are not fault-tolerant that is if anyone of artificial neurons gets damaged it will not function anymore.

An example of a handwritten character, where a character is written in Hindi by many people, they may write the same character but in a different form. As shown below, whichever way they write we can understand the character, because one already knows how the character looks like. This concept can be compared to our neural network system.

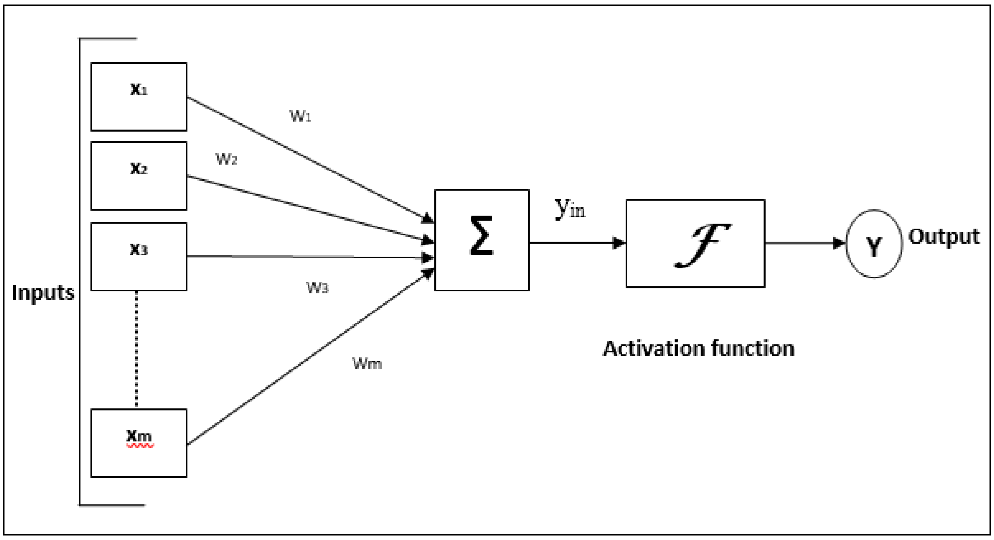


Figure 19. Artificial Neural Network

Fuzzy Logic

The fuzzy logic algorithm is used to solve the models which are based on logical reasoning like imprecise and vague. It was introduced by Latzi A. Zadeh in 1965. Fuzzy logic provides stipulated truth value with the closed interval [0,1]. Where 0 = false value, 1= true value.

An example of a robot that wants to move from one place to another within a short time where there are many obstacles on the way. Now the question arises is that how the robot can calculate its movement to reach the destination point, without colliding to any obstacle. These types of problems have uncertainty problem which can be solved using fuzzy logic.

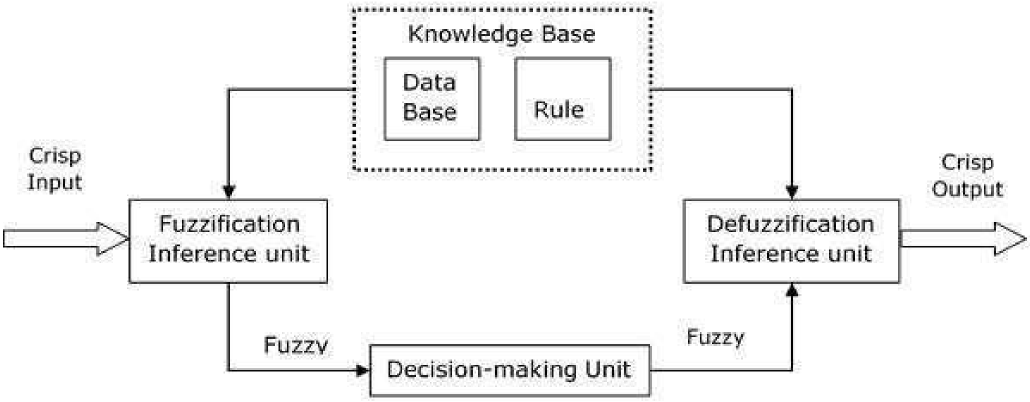


Figure20. Fuzzy logic block diagram

APPLICATIONS

Communication

Communication requires a very dynamic environment as the demand can occur randomly, and most of the time, there is not much of a pattern to work with.

Soft computing uses an artificial neural network and fuzzy logic to determine when there is a sudden surge in demand and accordingly allocates resources for that particular node.

Not only does it help save cost through reduced usage, but also helps save substantial resources that can be diverted to other areas that currently demand higher bandwidth.

Soft Computing in Home Appliances

This is a very interesting application since we are already using some of this.

Our everyday appliances such as refrigerators, microwaves, washing machines, etc. are becoming smart because of artificial intelligence, machine learning, and fuzzy logic.

Not only can they communicate with the users about their usage, but they can also adjust their settings according to the workload at that very moment.

Robotics

This is one of the very upcoming fields to use soft computing's fuzzy logic and expert systems techniques.

It helps manage industries efficiently in not only production but also inventory management.

Some of the large e-commerce companies are already employing robots with soft computing embedded to help manage the substantial load of goods that goes through the warehouse on a daily basis.

Transportation

With connected cars, transportation is another major industry making use of soft computing at its various stages.

Right from the production of cars in the factory to be on the road for navigation, traffic prediction, troubleshooting, and diagnostics of the car, fuzzy logic and evolutionary computing are widely used.

Similar solutions are also used in elevators when a single system is in charge of handling multiple elevators.

Healthcare

One wrong decision can result in loss of lives or permanent damage to the patients. But soft computing, using a horde of its various logic has been found to be quite accurate in terms of diagnosis and results.

Doctors are increasingly turning towards soft computing to diagnose the patients' ailments from the symptoms accurately and hence save on money and side effects from medications of the wrong diagnosis Moreover, early diagnosis of critical diseases has also helped save numerous live which otherwise would have been lost.

Conclusion

We have seen above as to the number of applications in which soft computing performs exceptionally. It is interesting to note that a machine can now think and function similar to humans, which can also have a flipside to the entire scenario that machines could replace humans at their workplace.

But it is not yet a fool proof system and given the numerous circumstances and conditions soft computing has to endure, it is a fact that it can never fully replace a human mind when it comes to making critical decisions.