Master in Innovation Management

Friday, 14th April 2023, 5 PM (CET)

Module V: The Blockchain and Its Possible Applications.

Module VI: Big Data. The Challenge of The Future.

- How does the Blockchain work? What are its main features? Protocols and potential applications for business.
- What is Big Data? What are their dimensions? Opportunities and benefits of the most important technological asset.

SPEAKER

Claudia Tarabù
University Researcher

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Welcome to the fifth and sixth lesson of the Master In Innovation Management of Ascheri Academy.

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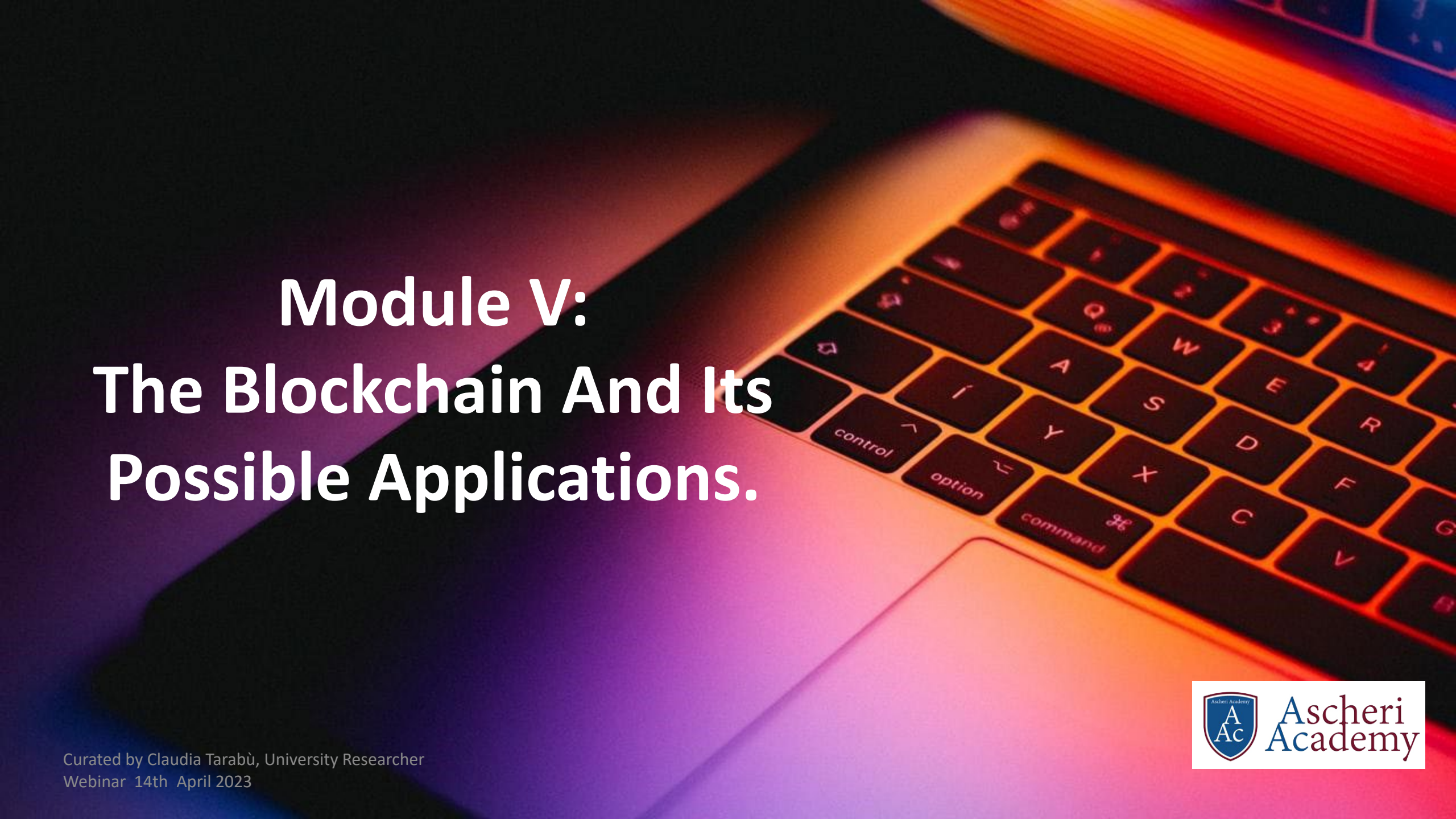

Module V:
The Blockchain And Its Possible Applications.

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Introduction to Blockchain

Blockchain is one of the most-hyped topics of the computing world recently, as well as in the financial technology (FinTech) industry. Experts say that the future of monetary transactions and secure information exchange rests on the shoulders of blockchain. Blockchain provides the potential to change how the world moves forward. For instance, if you want to buy any asset, such as a house, vehicle, or any other tangible or intangible property, you currently need to go through a lot of paperwork and labor-intensive effort. Instead, blockchain makes life easier and accomplishes these cumbersome functions within a short period of time. **Blockchain can be defined as a simple block of transparent digital information which is highly secured and shareable but immutable. Transparent digital information means the data exploited is traceable and identifiable.**

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The History of Blockchain

The blockchain technology was described in **1991** by the research scientist **Stuart Haber** and **Scott Stornetta**. They wanted to introduce a computationally practical solution for time-stamping digital documents so that they could not be backdated or tampered. **They developed a system using the concept of cryptographically secured chain of blocks to store the time-stamped documents.** The two then co-founded Surety Technologies, a Bellcore spin-off which offered digital time-stamping services. It was the first commercial deployment of a blockchain and began in 1994.

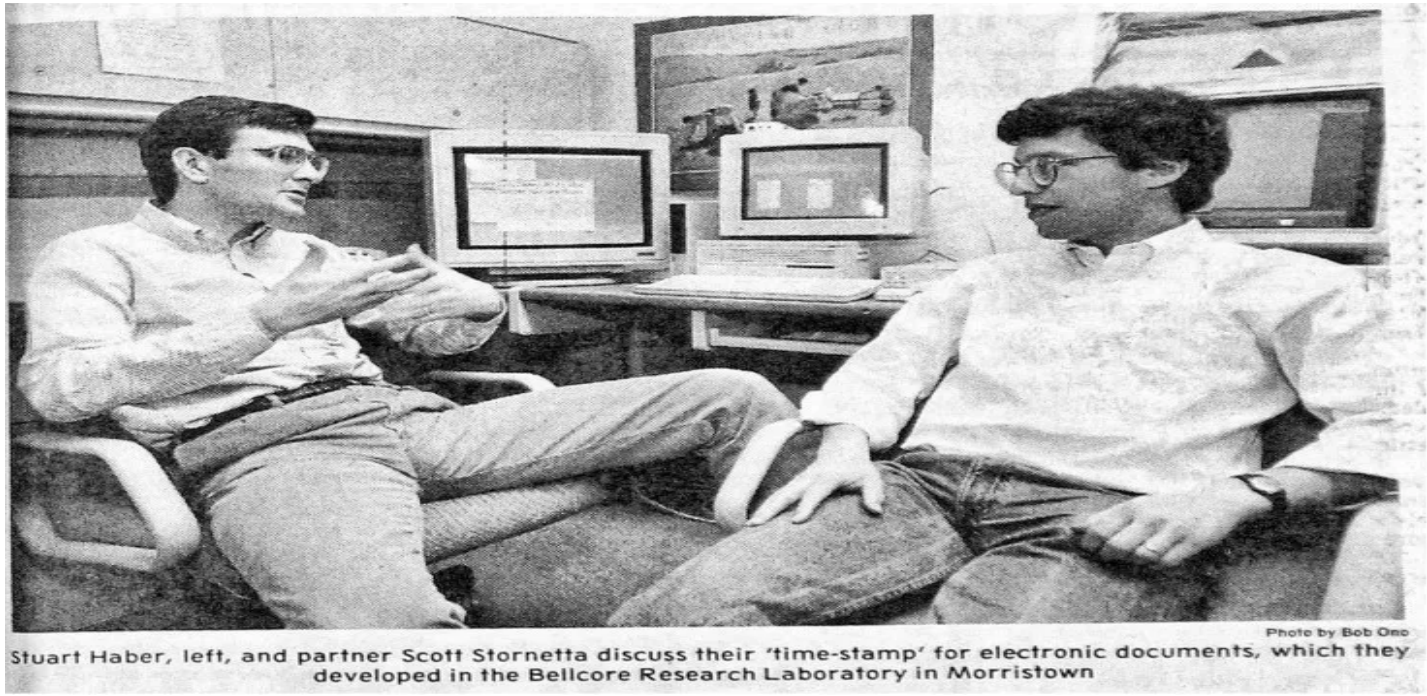

Photo by Bob Ono

Stuart Haber, left, and partner Scott Stornetta discuss their 'time-stamp' for electronic documents, which they developed in the Bellcore Research Laboratory in Morristown

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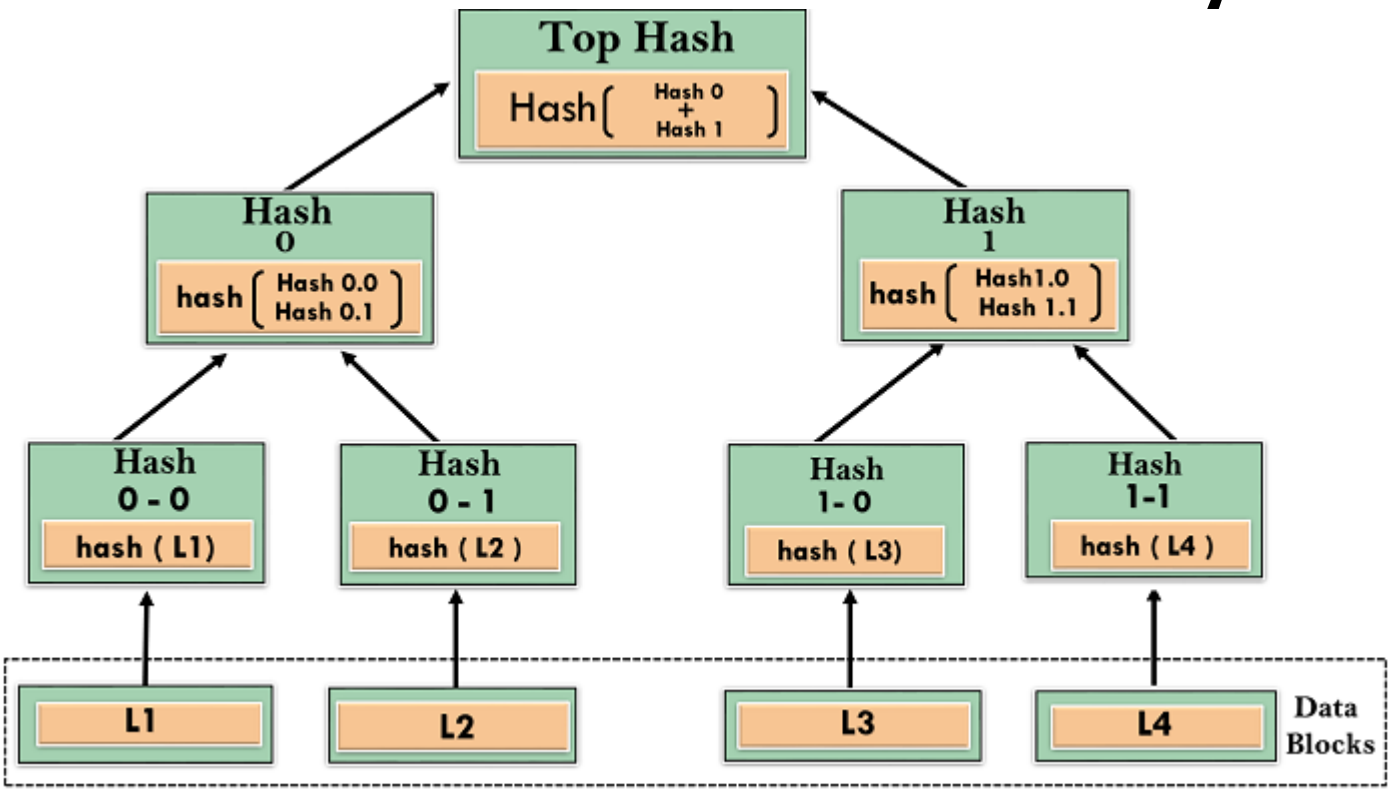
The History of Blockchain



In **1992**, Merkle Trees were incorporated into the design, which makes blockchain more efficient by allowing several documents to be collected into one block. **Merkle Trees were introduced to create a 'secured chain of blocks.'** It stored a series of data records, and each data records connected to the one before it. The newest record in this chain contains the history of the entire chain. However, this technology went unused and the patent lapsed in 2004.

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The History of Blockchain

In **2004**, computer scientist and cryptographic activist **Hal Finney** introduced a system called **Reusable Proof Of Work (RPoW) as a prototype for digital cash. It was a significant early step in the history of cryptocurrencies.** The RPoW system worked by receiving a non-exchangeable or a non-fungible Hashcash-based, proof-of-work token in return. **It created an RSA-signed token** that further could be transferred from person to person.

The RPoW solved the double-spending problem by keeping the ownership of tokens registered on a trusted server. This server was designed to allow users throughout the world to verify its correctness and integrity in real-time.

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The History of Blockchain

In **2008**, **Satoshi Nakamoto** conceptualized the theory of **distributed blockchains**. **He/she/they improves the design in a unique way to add blocks to the initial chain without requiring them to be signed by trusted parties**. **The modified trees would contain a secure history of data exchanges. The entire process utilizes a peer-to-peer network for timestamping and verifying each exchange. It could be managed autonomously without requiring a central authority**. These improvements were so beneficial that makes blockchains as the backbone of cryptocurrencies. Today, the design serves as the public ledger for all transactions in the cryptocurrency space.

The evolution of blockchains has been steady and promising. The words **block** and **chain** were used separately in Satoshi Nakamoto's original paper but were eventually popularized as a single word, **the Blockchain**, **by 2016**.

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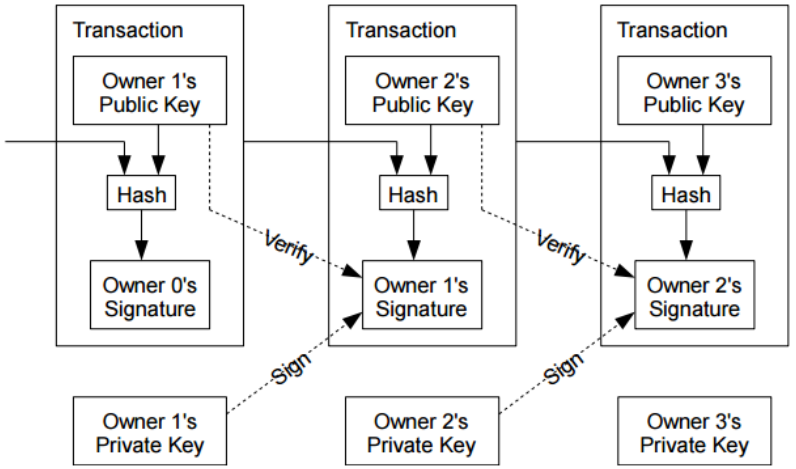
Satoshi Nakamoto and His/Her/Their Bitcoin Whitepaper

A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. *Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending.* ***We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work.*** *The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.*



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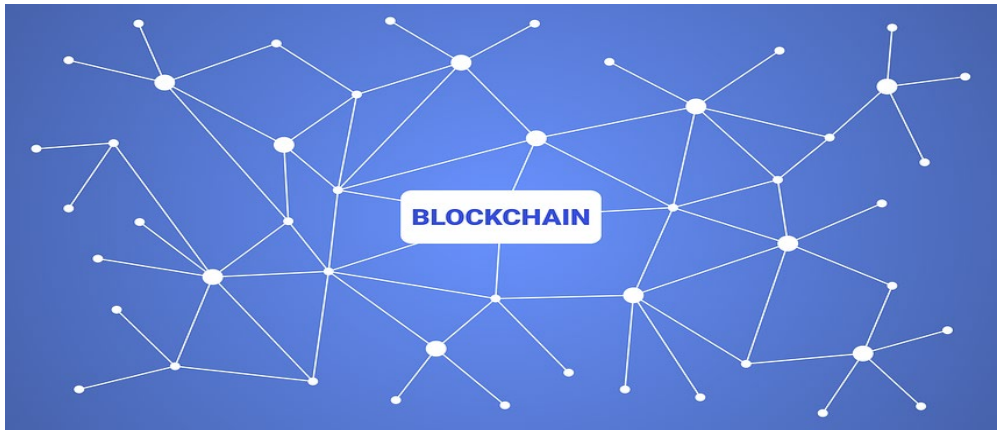
What Is A Blockchain?



A blockchain is a distributed database or ledger that is shared among the nodes of a computer network. As a database, a blockchain stores information electronically in digital format. Blockchains are best known for their crucial role in cryptocurrency systems, such as Bitcoin, for maintaining a secure and decentralized record of transactions. The innovation with a blockchain is that it guarantees the fidelity and security of a record of data and generates trust without the need for a trusted third party.

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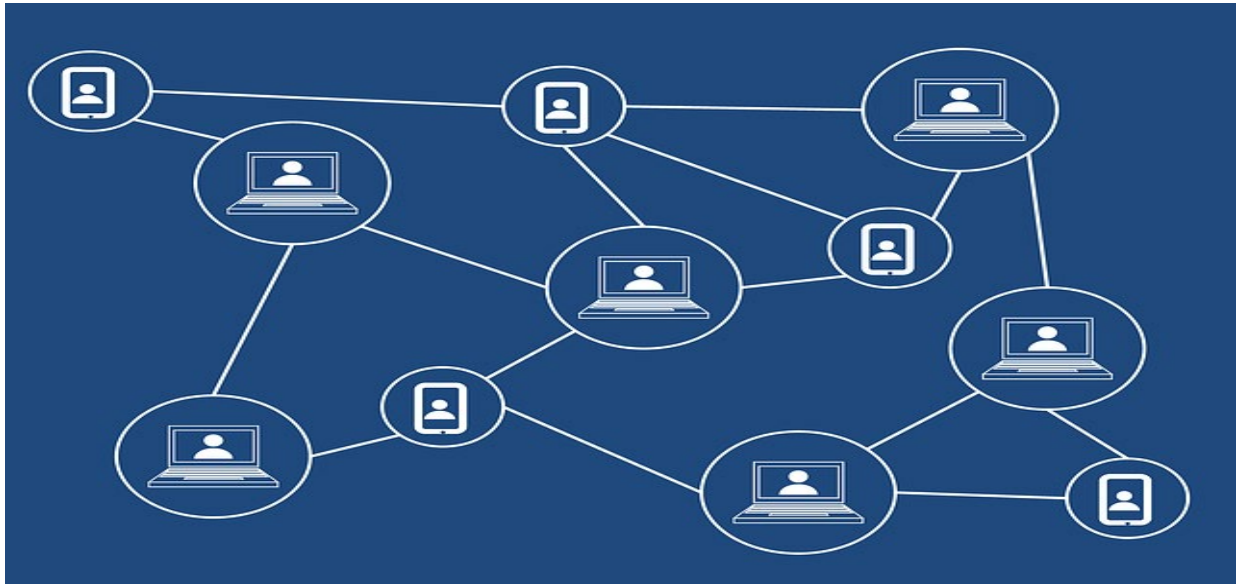
How Does It Work?

The goal of blockchain is to allow digital information to be recorded and distributed, but not edited. In this way, a blockchain is the foundation for immutable ledgers, or records of transactions that cannot be altered, deleted, or destroyed. This is why blockchains are also known as a distributed ledger technology (DLT). First proposed as a research project in 1991, the blockchain concept predated its first widespread application in use: Bitcoin, in 2009. In the years since, the use of blockchains has exploded via the creation of various cryptocurrencies, decentralized finance (DeFi) applications, non-fungible tokens (NFTs), and smart contracts.



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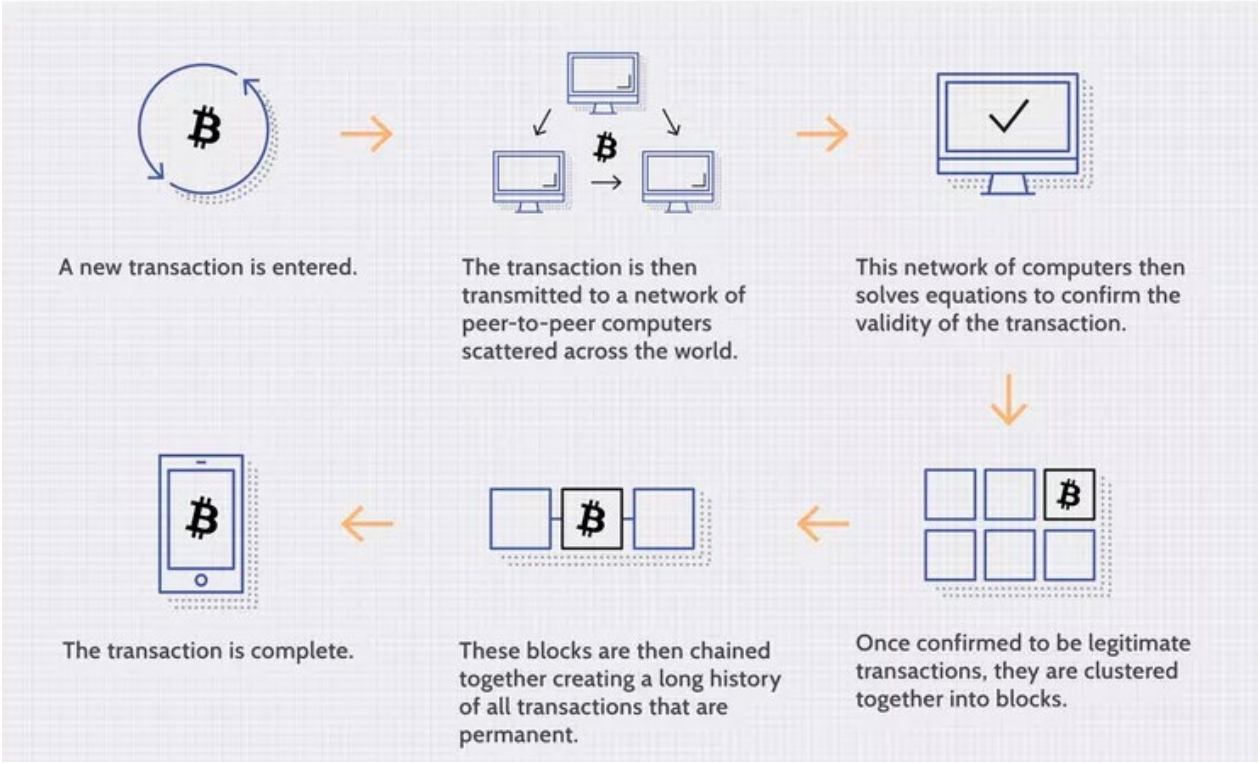
Transaction Process



(Source: Investopedia)

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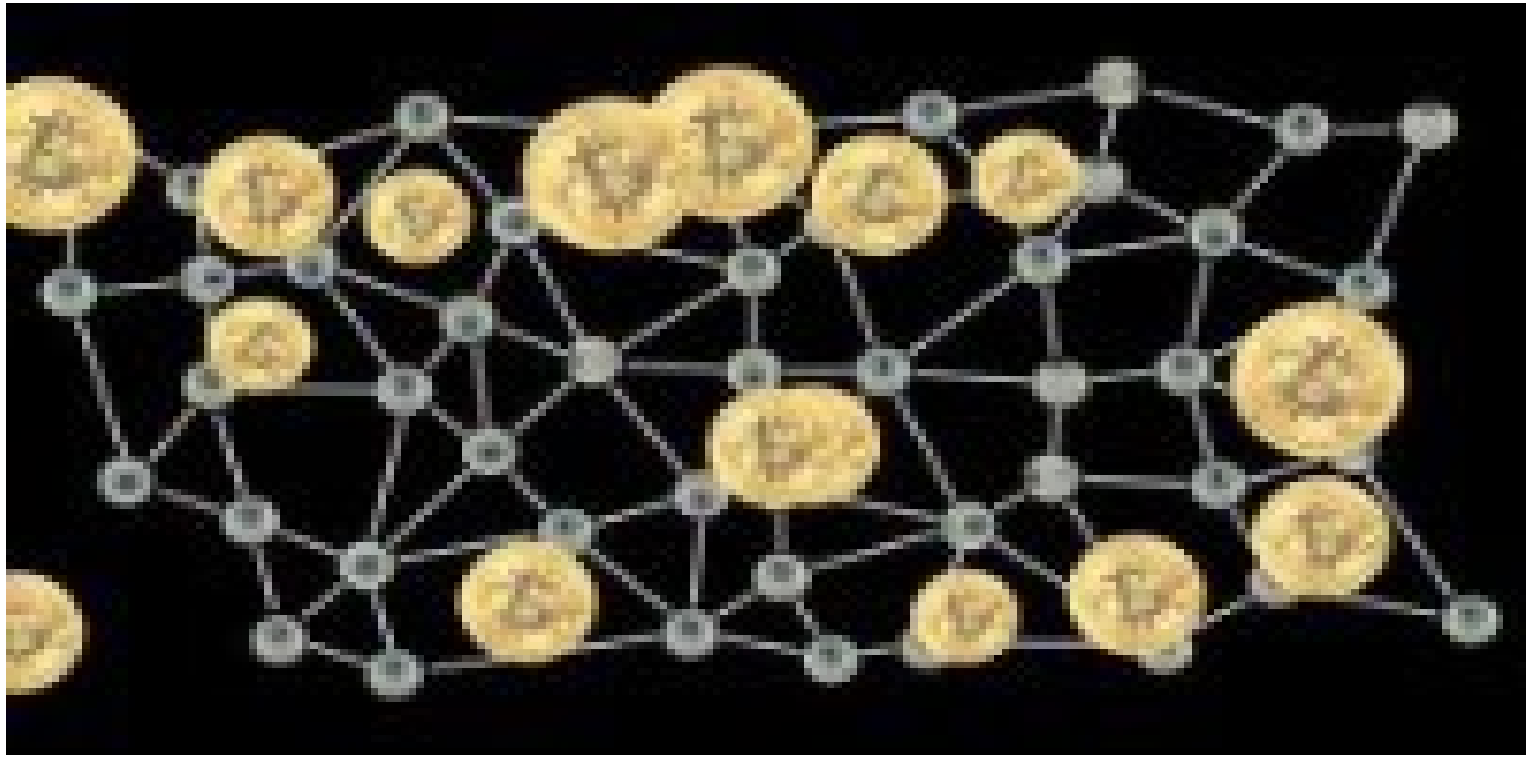
Let’s watch this explanatory video 👀



https://www.youtube.com/watch?v=r43LhSUUGTQ
(Source: Institute for The Future IFTF)

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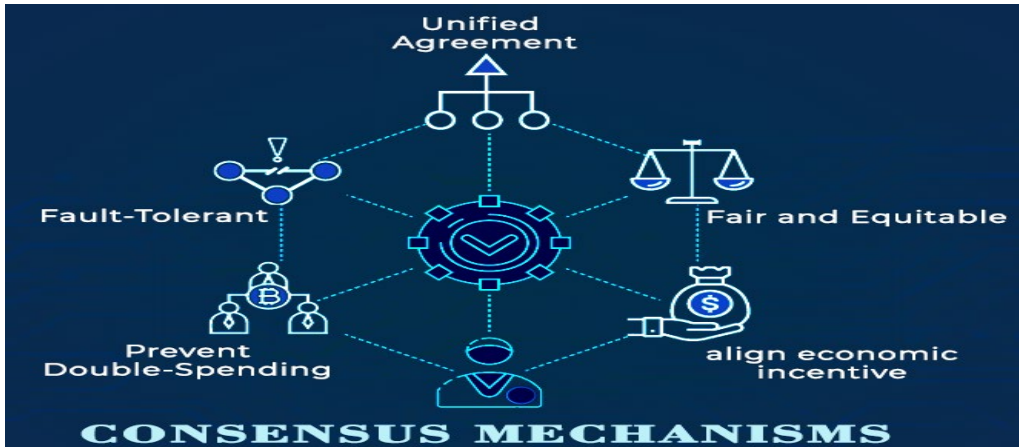
The Role of Consensus in Blockchain

A consensus mechanism is a program used in blockchain systems to achieve distributed agreement about the ledger's state. Generally, it is implemented in a network with many processes and users. Cryptocurrencies, blockchains and distributed ledgers benefit from their use because the consensus mechanism replaces much slower human verifiers and auditing.

For instance, the Bitcoin blockchain uses a mechanism called **Proof-of-Work (PoW),** which requires computational power to solve an encrypted puzzle, called **the hash**. After the hash is solved by one miner (or a group working together), Bitcoin's PoW requires that every node on the network verifies the data that has been changed by checking the data structure, the block header hash, the block timestamp, the block size, the first transaction.

It then completes a long transaction verification checklist. This verification takes much less time than the process of solving the hash, which is called **mining**, and is orders of magnitude less time-consuming than human verification.



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The Role of Smart Contracts in Blockchain

Enterprises, irrespective of size or industry, are supported by written contracts. Unfortunately, these are often cumbersome and a source of business and legal conflict. A solution can be found in replacing traditional contracts with smart ones. **A smart contract is an agreement, in the form of a computer program that is executed automatically once certain pre-programmed conditions are satisfied. On blockchain, the goal of a smart contract is to simplify business and trade between both anonymous and identified parties, sometimes without the need for a middleman.** A smart contract scales down on formality and costs associated with traditional methods, without compromising on authenticity and credibility.

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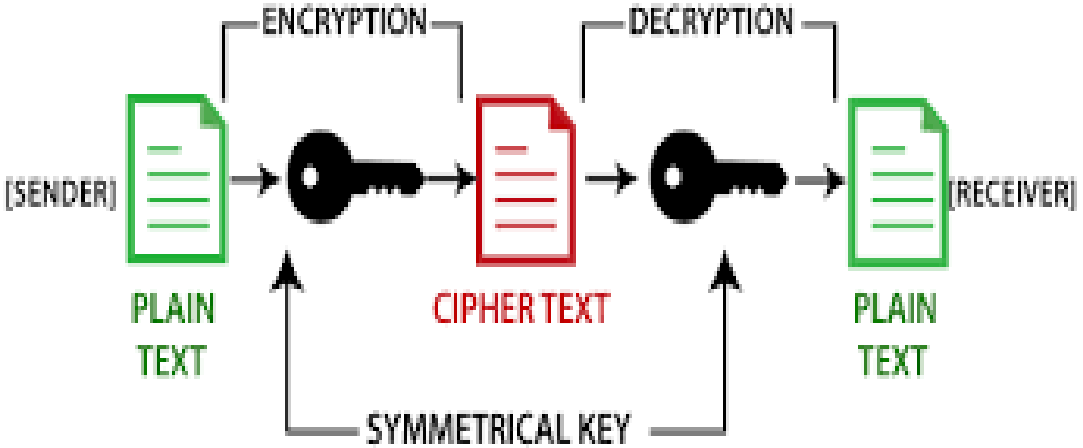
The Role of Cryptography in Blockchain

Cryptography is a way of securing data against unauthorized access. In the blockchain, cryptography is used to secure transactions between two nodes in the blockchain network. There are two main concepts in blockchain: cryptography and hashing. Cryptography encrypts messages in the P2P network, and hashing is used to secure block information and link blocks in the blockchain.

Cryptography primarily focuses on ensuring the safety of participants, transactions, and security against double-spending. It helps in securing various transactions in the blockchain network. It ensures that transactions can only be obtained, read, and processed by the individuals for whom the transaction data is intended.



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https://www.youtube.com/watch?v=tUSNJQkjM-Y
(Source: Growth Tribe)

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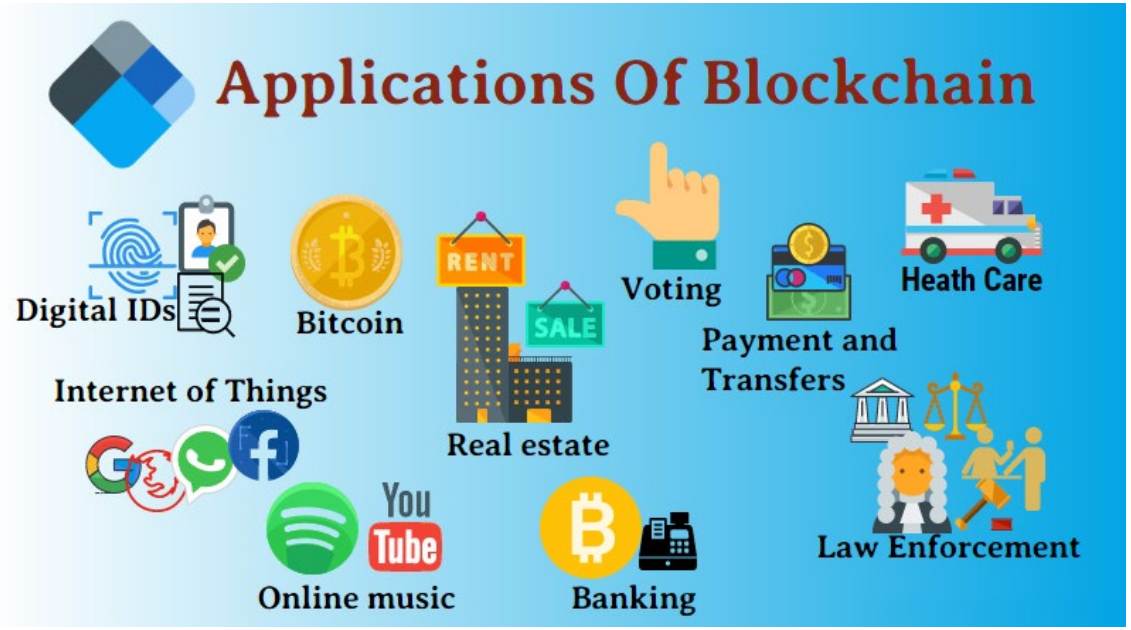
Applications of Blockchain

- Money transfers;
- Financial exchanges;
- Lending;
- Insurances;
- Real estate;
- Secure personal information;
- Voting;
- Government benefits;
- Securely share medical information;
- Artist royalties;
- Non-fungible tokens (NFT);
- Logistics and supply chain tracking;
- Secure Internet of Things (IoT) networks;
- Data storage;
- Gambling.



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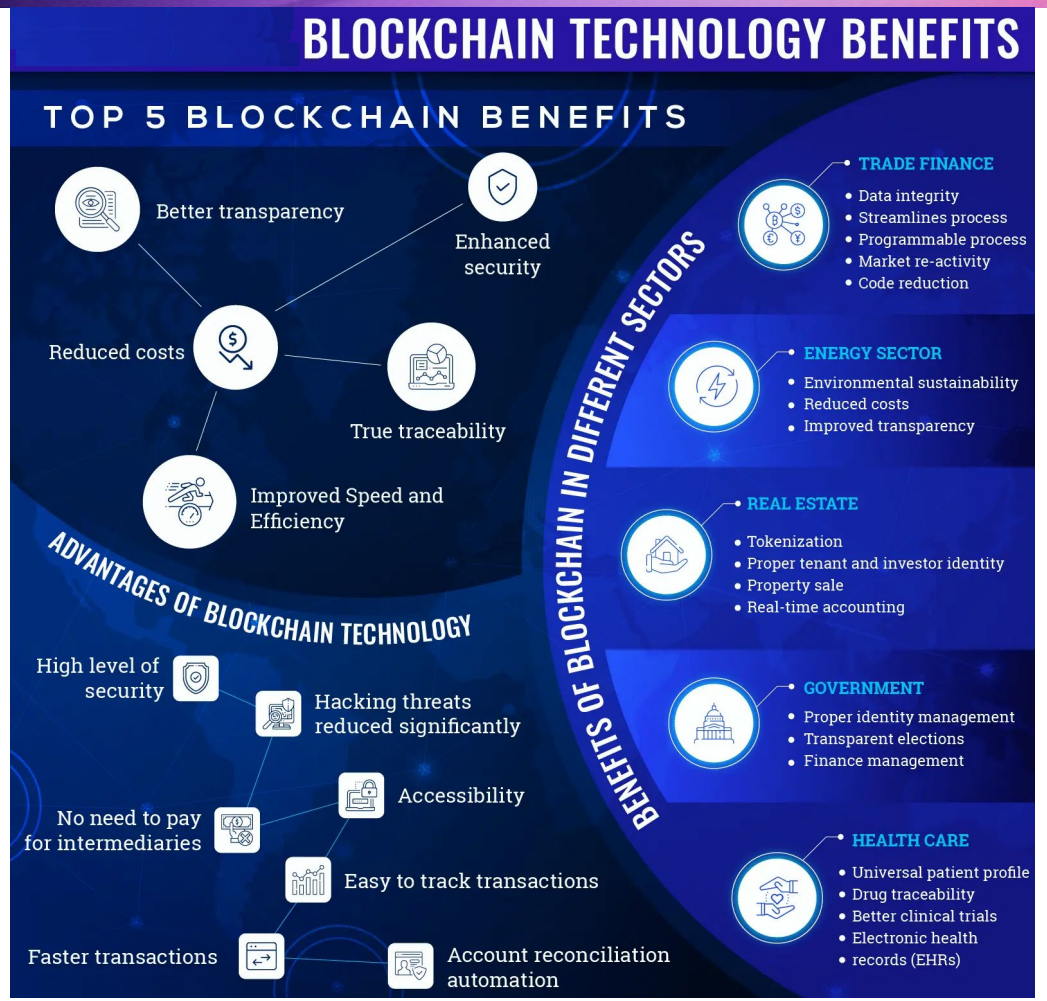

(Source: www.101blockchains.com)

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Disadvantages of Blockchain Technology

This slide defines the various disadvantages of blockchain technology based on speed, energy, cost, scalability, maturity, and integration.

Slower Process

Public blockchains are very slow due to a large number of the nodes

High Energy Consumption

A few networks utilize too much energy

Inefficient

Due to its working process sometimes, it becomes inefficient

Expensive

Setting a blockchain network is an expensive process

No Interoperability

As of now, it doesn't allow interoperability

Difficult to Scale

Due to the consensus method, it becomes difficult to scale

Immutability

No amendments can be made as information is immutable

Self-maintenance

Every node must maintain their wallets if they want to stay in the network

Not Mature

New technology, and it will take time to standardized

Integration

Difficult to integrate into legacy systems

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Module VI:
Big Data. The Challenge of The Future.

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An Introduction to Big Data

Digital data are nowadays collected at an unprecedented scale in many formats in a variety of domains (e-commerce, social networks, sensor networks, astronomy, genomics, medical records, etc.). This has been made possible by the **incredible growth of the last years of the capacity of data storage tools and of the computing power of electronic devices, as well as the advent of mobile and pervasive computing, cloud computing and cloud storage.**

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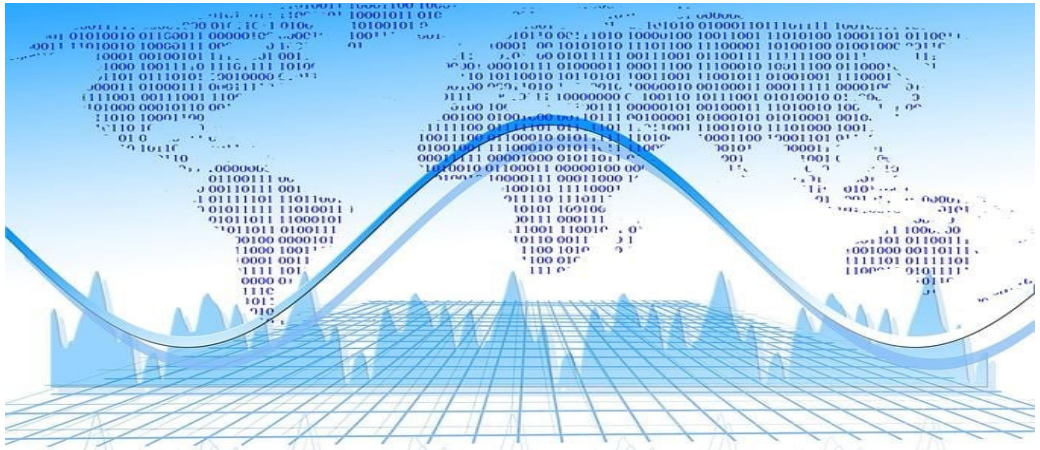
What Is Big Data?



The definition of big data is data that contains greater variety, arriving in increasing volumes and with more velocity. This is also known as the three V's.

Put simply, **big data is larger, more complex data sets, especially from new data sources. These data sets are so voluminous that traditional data processing software just cannot manage them.** These massive volumes of data can be used to address business problems that would have been impossible to tackle before.

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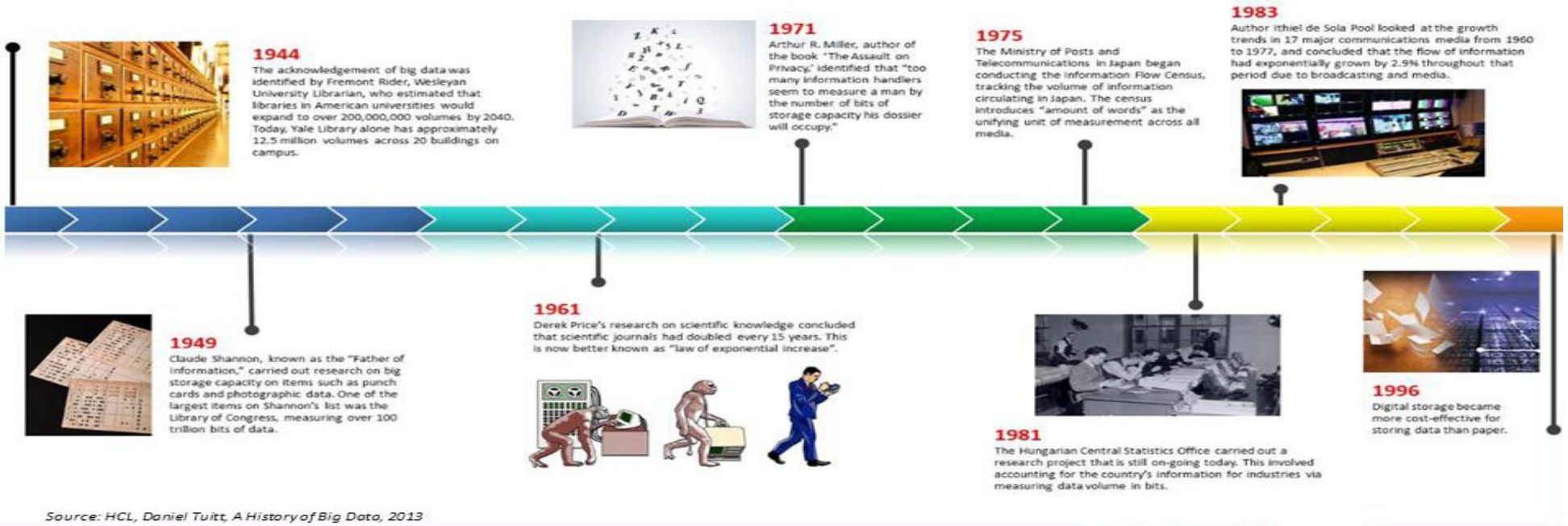
The History of Big Data



Source: HCL, Daniel Tuitt, A History of Big Data, 2013

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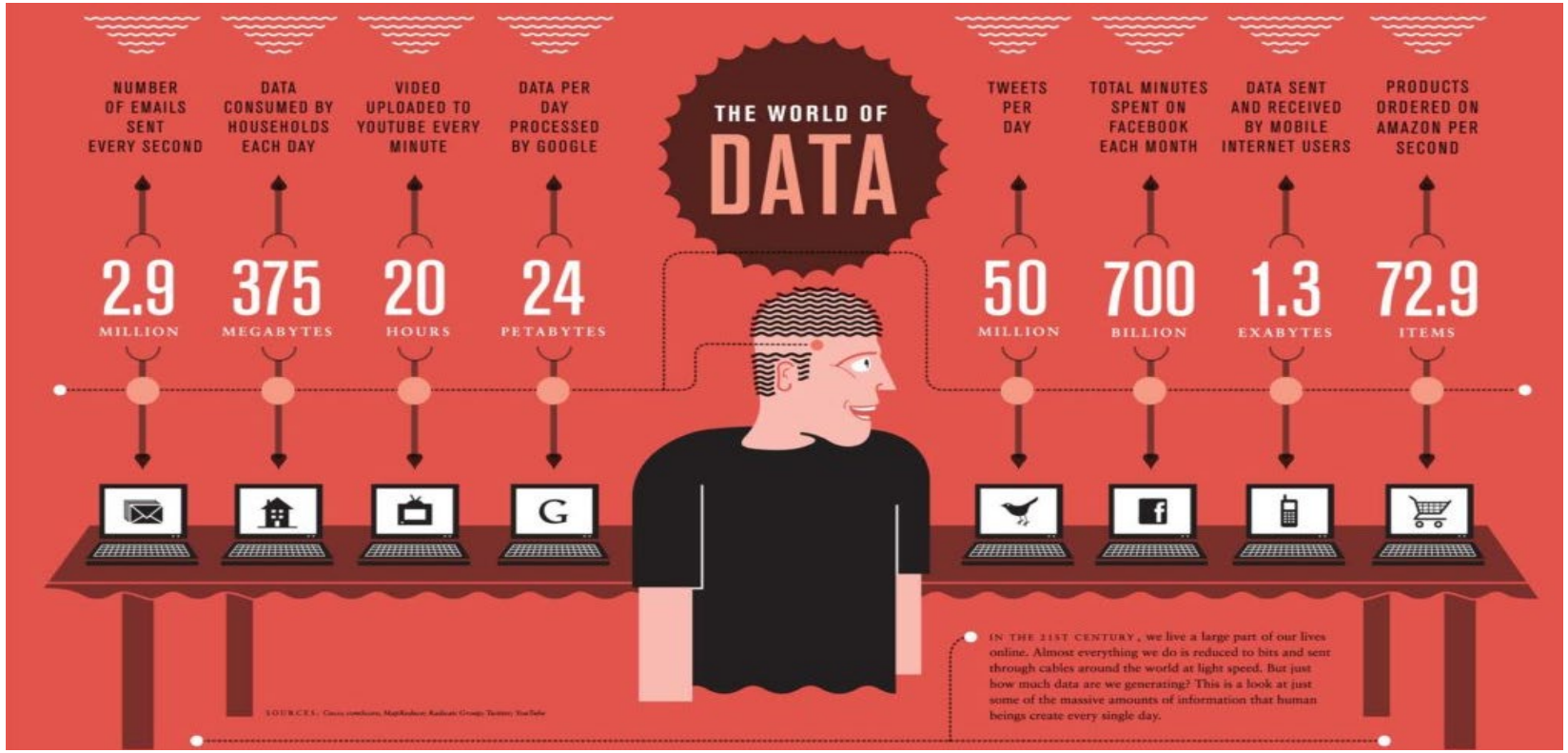
The World of Data



(Source: IBM)

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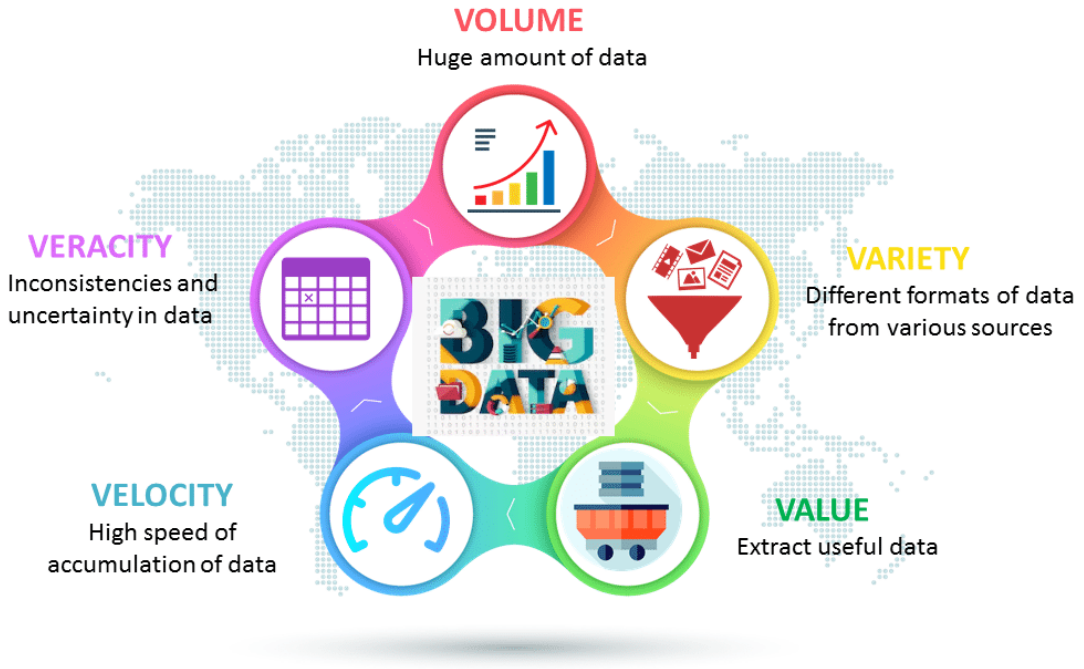
The Five V's of Big Data



(Source: www.edureka.co)

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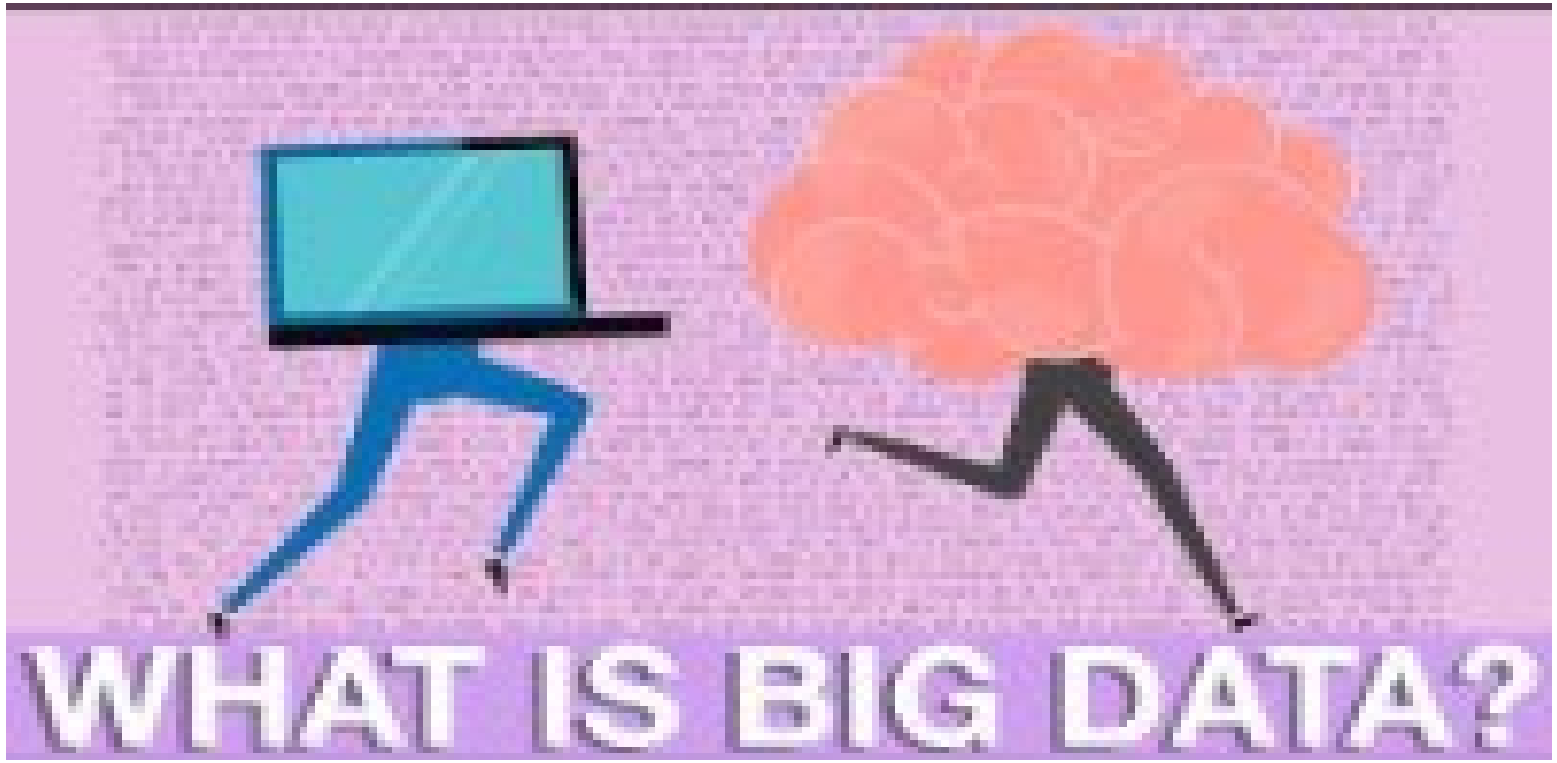

https://www.youtube.com/watch?v=eVSfJhssXUA
(Source: World Economic Forum)

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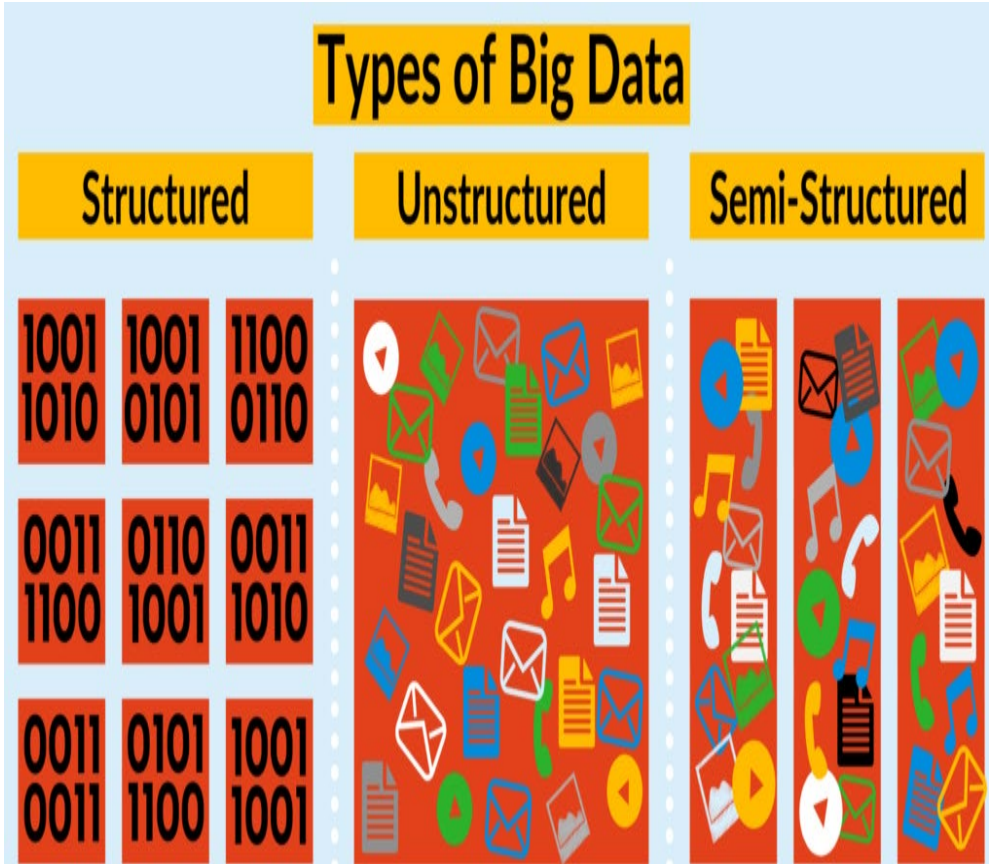

(Source: www.selecthub.com)

- **Structured Data is the easiest to work with. It is highly organized with dimensions defined by set parameters.**
Think spreadsheets; every piece of information is grouped into rows and columns. Specific elements defined by certain variables are easily discoverable;
- **Unstructured data is all our unorganized data.** You might be able to figure out why it constitutes so much of the modern data library. Almost everything we do with a computer generates unstructured data. No one is transcribing our phone calls or assigning semantic tags to every tweet we send;
- **Semi-structured data toes the line between structured and unstructured.** Most of the time, this translates to unstructured data with metadata attached to it. This can be inherent data collected, such as time, location, device ID stamp or email address, or it can be a semantic tag attached to the data later.

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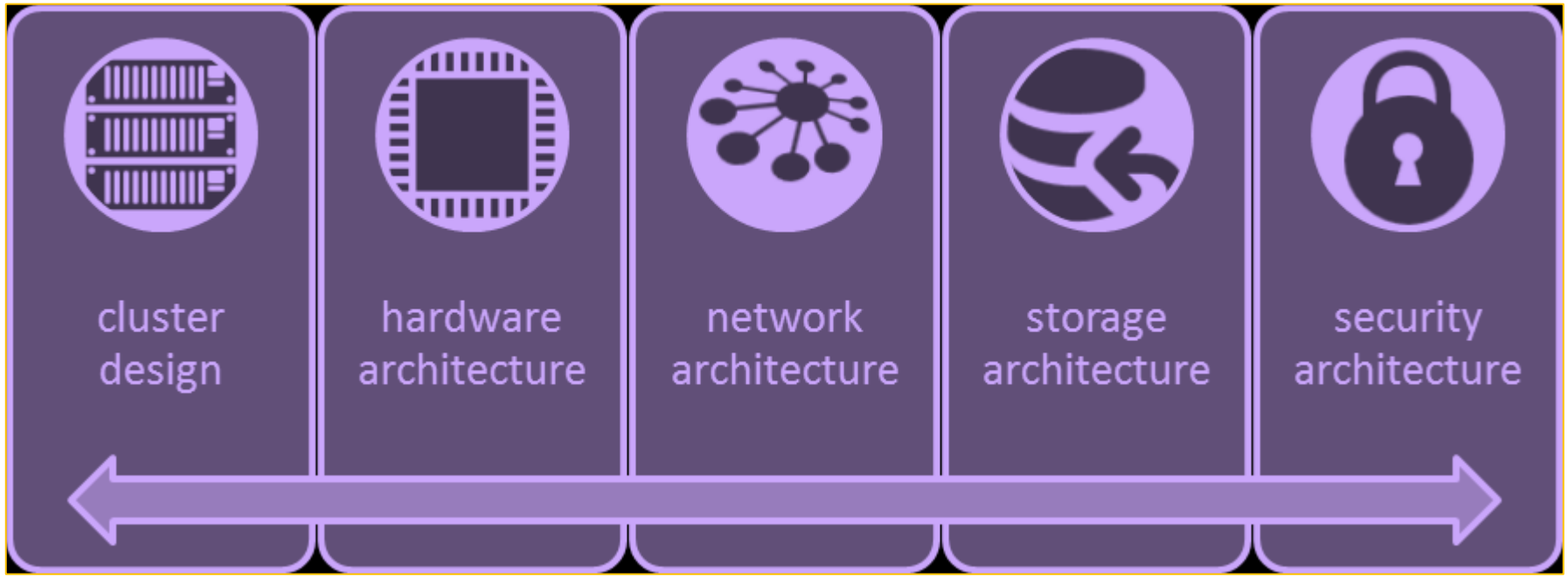
Understanding Big Data Infrastructure

Before delving further into big data infrastructure, let's have a look at the big data high–level landscape. The following figure captures high–level segments that demarcate the big data space. It clearly depicts the various segments and verticals within the big data technology canvas (bottom up).

Segments	Example
Vertical Apps	Predictive policing, BloomReach, Myrrix
Ad/Media Apps	Media Science, Turn, Recorded Future
Data as a service	Factual, Gnip, Kaggle
Business Intelligence	Oracle, SAP, IBM
Log Data Apps	Splunk, Loggly, Sumo Logic
Analytics Infrastructure	Hortonworks, Cloudera, DataStax
Operational Infrastructure	Couchbase, Teradata, Hadapt
IaaS	Amazon web services, Microsoft Windows Azure, Google Cloud Platform
Technologies	Apache Hadoop, Apache HBase, Apache Cassandra
Structured Databases	Microsoft SQL Server, MySQL, PostgreSQL

Big Data Infraspace



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The 10 Challenges of Big Data Management

1- Unmanageable volume of Big Data;
2- Poor quality of data that leads to bad results;
3- Multiple data formats (unstructured and semi-structured);
4- Multiple sources and integration hurdles;
5- High cost of data projects and infrastructure;
6- Scarce big data talents in-house and in the market;
7- Slow time to insight;
8- No clear understanding of how to get and use insights;
9- Complex security and compliance;
10 – No one-size-fits-all solution for all data needs.

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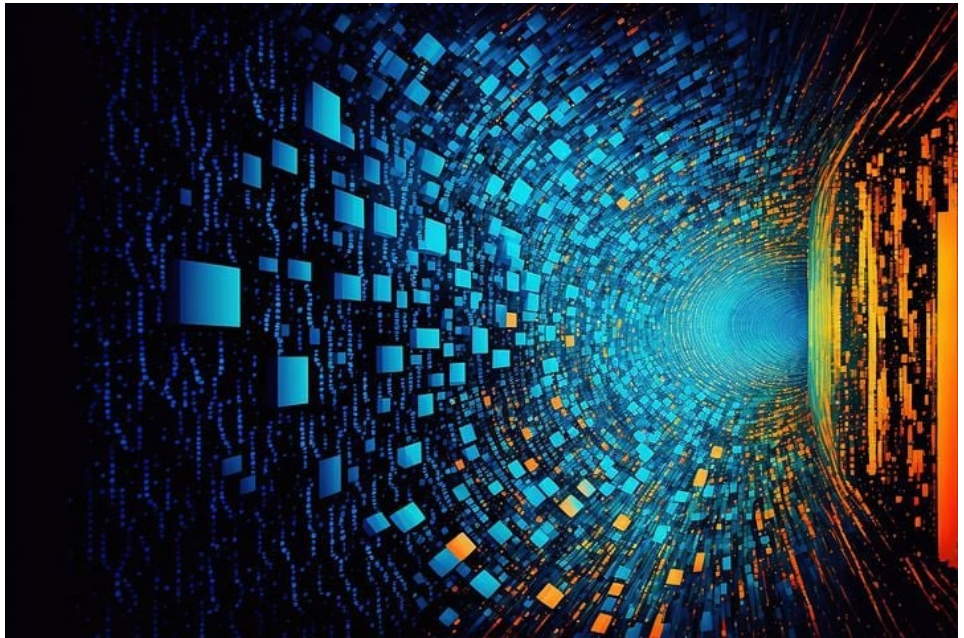
Data Visualization for Big Data

There is no point in collecting large chunks of big data if you fail to churn it and **harness the information lying beneath it. To resolve this issue, data visualization tools are the exact instruments you need.** These tools show us various insights into the collected data. Big names like Google and Microsoft collect and manipulate big data to design the future of their business strategies. Today, we will discuss some of these popular visualization tools for big data.



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Big Data Visualization Tools for Business

Google Chart is one of the easiest tools for visualizing huge data sets. Google chart holds a wide range of chart galleries, from a simple line graph to a complex hierarchical tree-like structure and you can use any of them that fits your requirement.

Tableau desktop is an amazing data visualization tool (SaaS) for manipulating big data and it is available to everyone.

D3 or Data-Driven Document is a Javascript library for big data visualizations in virtually any way you want. This is not a tool, like the others and the user needs a good grasp of javascript to give the collected data a shape. The manipulated data are rendered through HTML, SVG, and CSS.

Fusion Charts is a Javascript charting library for the web and mobile devices. You need a bit of knowledge of Javascript for implementing it.

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Big Data Visualization Tools for Business

Highcharts is a charting library written purely in Javascript hence, a bit of knowledge of Javascript is necessary for implementing this tool. It uses HTML5, SVG and VML for displaying charts across various browsers and devices like Android, iPhone, etc.

Canvas.js is a javascript charting library with a simple API design and comes with a bunch of eye-catching themes. It also comes with a responsive design so that it can run on various devices like Android, iPhone, Tablets, Windows, Mac, etc.

Qlik is one of the major players in the data analytics space with their **Qlikview** tool. Qlik is particularly known for its highly customizable setup and a host of features that help create the visualizations much faster.

Datawrapper has an easy-to-navigate user interface where you can easily upload a CSV file to create maps, charts, and visualizations that can be quickly added to reports.

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Big Data Analytics Tools

MongoDB	Open-source cross-platform source that utilizes a document oriented program.
Apache Hadoop	An open-source platform that helps in the distribution and storage of large data.
Tableau Public	Offers a larger insight into the hypothesis generated.
Knime	Helps in analyzing and manipulating the information through the use of visual programming.
NodeXL	A free open-source network analysis and visualization software tool.
Microsoft HDInsight	Microsoft HDInsight is a big data solution powered by Apache Hadoop.
NoSQL	NoSQL databases are used to store unstructured data which have no particular scheme.
Hive	A distributed data management for Hadoop used for Data mining purpose.
Sqoop	A tool that is used to connect Hadoop with various relational databases that are used to transfer data.

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Machine Learning and Big Data: How Do They Relate?

"Big data" does not just refer to a large amount of data. **It is a paradigm of computing where large quantities of data, more considerable than has ever been assembled in human history, is used to fuel applications, analytics, and machine learning. This vast quantity of data is enabled by modern data gathering tools, primarily connected to cloud computing, that can collect information from users on platforms from around the world.**

Furthermore, "big data" is not necessarily a singular project. Businesses and organizations in different industries will collect gigabytes or even terabytes of information from users who use their services. For instance, organizations in the insurance industry can collect historical data on customer claims, accident statistics, weather patterns, road conditions, and other forms of behavior to empower more informed and accurate decision-making.

The challenge here is that the human mind cannot encompass or process this vast sea of information, much less make any meaningful sense of it. **New developments in cloud applications and processing have driven analytics to turn these vast quantities of data into actionable information.**

One of the places where this flow of information has had an impact is machine learning.

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Predictive Analytics in Conjunction with Big Data. How Do They Work?

The heart of Predictive Analytics is that it is possible to 'model' most things. Underlying this idea is the notion that, between the data parameters, there is a cause and effect relationship, i.e., that as some data parameters change (cause), other data parameters will change in response (effect).

The following is a step-by-step procedure for using Predictive Analytics in business:

- massive amounts of historical data are gathered or compiled;
- certain statistical procedures, such as regression models, are used to analyze the data;
- the results of these assessments are then used to make forecasts about potential future events;
- these future predictions can then be used to help with decision-making, business process improvement, waste reduction, and more.

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The Role of Cloud Computing in Big Data

The application of cloud computing is a recent trend to settle and handle the relevant issues of big data. The term big data can be defined as a dataset, which is too large and complex. The processing of these data is complicated in conventional data processing software. **The processing of big data demands large computational infrastructure for data analysis, and this demand can be fulfilled by the integration of cloud computing and big data. Cloud computing is an influential technology to perform gigantic and complex computing. Cloud computing provides hardware and software services through the Internet, so it eliminates the maintenance of costly computing hardware, devoted space, and software. Cloud computing enables big data to control and distribute the stored data in a suitable way.** It also provides security to big data through Hadoop. The main idea of big data is to accumulate, handle, visualize, and evaluate the huge amount of data, which is achieved by collaboration with cloud computing.

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Big Data Challenges to Information Security and Privacy

These challenges may be organized into four Big Data aspects such as:

- **infrastructure security** (e.g. secure distributed computations);
- **data privacy** (e. g. data mining that preserves privacy/granular access);
- **data management** (e. g. secure data provenance and storage);
- **integrity and reactive security** (e. g. real time monitoring of anomalies and attacks).

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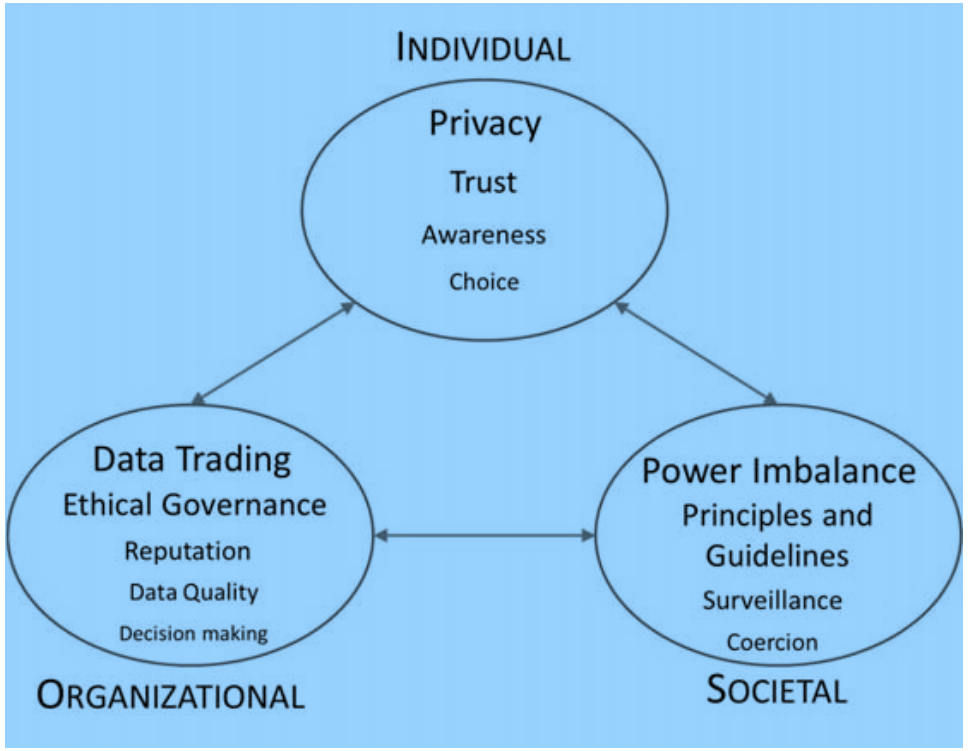
Ethical Considerations in Big Data



(Source: Asadi Someh, I., Davern, M., Breidbach, C., & Shanks, G. (2019). Ethical Issues in Big Data Analytics: A Stakeholder Perspective. *Communications of the Association for Information Systems*, *44*, 718–747. https://doi.org/10.17705/1CAIS.04434)

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Let’s reflect by watching this interesting video 👀

https://www.youtube.com/watch?v=8pHzROP1D-w
(Source: TED)

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Wrap-up

Module V:
- Introduction to Blockchain;
- The History of Blockchain;
- Satoshi Nakamoto and His/Her/Their Whitepaper;
- What Is A Blockchain?
- How Does It Work?
- Transaction Process;
- The Role of Consensus in Blockchain;
- The Role of Smart Contracts in Blockchain;
- The Role of Cryptography in Blockchain;
- Applications of Blockchain;
- Blockchain Technology Benefits;
- Disadvantages of Blockchain Technology.

Module VI
- An Introduction to Big Data;
- What Is Big Data?
- The History of Big Data;
- The World of Data;
- The Five V's of Big Data;
- Types of Big Data;
- Understanding Big Data Infrastructure;
- Big Data Infraspace;
- The 10 Challenges of Big Data Management;
- Data Visualization Tools for Business;
- Big Data Analytics Tools;
- Machine Learning and Big Data: How They Relate?
- Predictive Analytics in Conjunction with Big Data: How Do They Work?
- The Role of Cloud Computing in Big Data;
- Big Data Challenges to Information Security and Privacy;
- Ethical Considerations in Big Data.

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Many thanks for your attention. See you at the next lesson ☺

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