**Deepfake Detection on Social Media: Leveraging Deep Learning and FastText Embeddings forIdentifying Machine-Generated Tweets**

**ABSTRACT:**

The proliferation of deepfake technology has raised concerns about the spread of misinformation on social media platforms. In this paper, we propose a deep learning-based approach for detecting deepfake tweets, specifically those generated by machines, to help mitigate the impact of misinformation online.Our approach leverages FastText embeddings to represent tweet text and combines them with deep learning models for classification. We first preprocess the tweet text and then use FastText embeddings to convert them into dense vector representations. These embeddings capture semantic information about the tweet content, which is crucial for distinguishing between genuine and machine-generated tweets.We then feed these embeddings into a deep learning model, such as a Convolutional Neural Network (CNN) or a Long Short-Term Memory (LSTM) network, to classify the tweets as genuine or machine-generated. The model is trained on a labeled dataset of tweets, where machine-generated tweets are synthesized using state-of-the-art text generation models.Experimental results on a real-world dataset of tweets demonstrate the effectiveness of our approach in detecting machine-generated tweets. Our approach achieves high accuracy and outperforms existing methods for deepfake detection on social media.Overall, our proposed approach provides a promising solution for identifying machine-generated tweets and combating the spread of misinformation on social media platforms.

**INTRODUCTION :**

The rise of deepfake technology has introduced new challenges in detecting and combating misinformation on social media platforms. Deepfake refers to the use of artificial intelligence (AI) and machine learning techniques to create realistic-looking but fake audio, video, or text content. This technology has been used to create convincing fake news, hoaxes, and other forms of misinformation, posing a significant threat to online discourse and public trust.Detecting deepfake content, especially in text form such as tweets, is challenging due to the sophistication of the technology and the sheer volume of content posted on social media platforms. Traditional detection methods often rely on manual inspection or keyword-based approaches, which are not scalable and may not be effective against sophisticated deepfake techniques.In this paper, we propose a deep learning-based approach for detecting deepfake tweets, specifically those generated by machines. Our approach leverages FastText embeddings, which are capable of capturing semantic information about the tweet content, and combines them with deep learning models for classification.The key contributions of our work are as followsWe propose a novel approach for detecting machine-generated tweets using FastText embeddings and deep learning models.We demonstrate the effectiveness of our approach on a real-world dataset of tweets, where machine-generated tweets are synthesized using state-of-the-art text generation models.We compare our approach with existing methods for deepfake detection on social media and show that it outperforms them in terms of accuracy and scalability.The rest of this paper is organized as follows: In Section 2, we provide an overview of related work in the field of deepfake detection. In Section 3, we describe our approach in detail, including the dataset used, the preprocessing steps, and the deep learning models employed. In Section 4, we present our experimental results and discuss the implications of our findings. Finally, in Section 5, we conclude the paper and suggest directions for future research.

**Literature Survey:**

In this literature survey, we review key studies and methodologies related to deepfake detection on social media, with a focus on leveraging deep learning and FastText embeddings for identifying machine-generated tweets. This survey provides a comprehensive overview of existing research, highlighting the strengths and limitations of various approaches.

#### 1. Deepfake Detection Techniques

\*\*1.1 Generative Adversarial Networks (GANs)\*\*

Generative Adversarial Networks, introduced by Goodfellow et al. (2014), are a class of machine learning frameworks used to generate realistic data. GANs consist of two neural networks, a generator and a discriminator, which compete against each other. The generator creates synthetic data, while the discriminator attempts to distinguish between real and synthetic data. GANs have been widely used for creating deepfakes, making their detection a significant challenge.

\*\*1.2 Transformer Models\*\*

Transformer models, such as BERT (Devlin et al., 2019) and GPT (Radford et al., 2019), have revolutionized natural language processing (NLP) by enabling better understanding and generation of human-like text. These models leverage self-attention mechanisms to capture contextual relationships in data, making them effective for tasks like text classification and generation. Transformer-based models have been employed for detecting machine-generated text due to their superior performance in capturing nuanced linguistic patterns.

#### 2. Text Embeddings

\*\*2.1 Word2Vec and GloVe\*\*

Word2Vec (Mikolov et al., 2013) and GloVe (Pennington et al., 2014) are traditional word embedding techniques that represent words in continuous vector spaces. These embeddings capture semantic relationships between words, which can be useful for various NLP tasks. However, these models have limitations in handling out-of-vocabulary words and fail to capture subword information.

\*\*2.2 FastText\*\*

FastText, developed by Bojanowski et al. (2017), addresses the limitations of Word2Vec and GloVe by representing words as bags of character n-grams. This allows FastText to capture subword information and handle rare or misspelled words more effectively. FastText embeddings have shown to improve the performance of text classification tasks by providing richer representations of words.

#### 3. Machine-Generated Text Detection

\*\*3.1 Detecting AI-Generated Fake News\*\*

Kumar et al. (2021) explored the use of machine learning models for detecting AI-generated fake news. They demonstrated that advanced models, when trained on diverse datasets, could effectively identify fake news articles. Their research emphasized the importance of using robust training data and sophisticated models to combat the evolving nature of AI-generated content.

\*\*3.2 Defense Against Neural Fake News\*\*

Zellers et al. (2019) proposed a novel approach for defending against neural fake news. They developed the GROVER model, which both generates and detects fake news articles. By leveraging large-scale language models, their method achieved state-of-the-art results in identifying machine-generated news, highlighting the potential of transformer-based models in deepfake detection.

#### 4. Social Media and Deepfake Detection

\*\*4.1 Mining Disinformation and Fake News\*\*

Shu et al. (2020) provided a comprehensive review of methods for mining disinformation and fake news on social media. Their survey covered various detection techniques, including content-based, social context-based, and hybrid approaches. They highlighted the challenges in detecting disinformation, such as the dynamic nature of social media and the sophistication of fake content generation techniques.

\*\*4.2 Limitations and Challenges\*\*

Schuster et al. (2020) discussed the limitations of current neural network models in modeling human behavior in language. They pointed out that while deep learning models have achieved significant progress, they still struggle with capturing the complexity of human language and behavior. This underscores the need for continuous advancements in model architectures and training techniques to improve deepfake detection.

#### Conclusion

The literature survey reveals that leveraging deep learning and FastText embeddings holds significant promise for detecting machine-generated tweets on social media. Transformer models, in particular, have shown remarkable success in capturing linguistic patterns and contextual information. However, challenges remain, such as the need for large-scale and diverse training data, as well as the ability to adapt to rapidly evolving fake content generation techniques. Future research should focus on enhancing the robustness and generalizability of detection models, incorporating multimodal data, and developing real-time detection systems to effectively combat the spread of deepfakes on social media.

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This literature survey provides an in-depth overview of the key research areas relevant to your study, setting a solid foundation for understanding the current state of deepfake detection and identifying avenues for future research.

**EXISTING SYSTEM :**

Existing systems for detecting deepfake content on social media often rely on a combination of manual and automated methods. Manual methods typically involve human moderators reviewing content and flagging suspicious posts for further investigation. While effective, this approach is time-consuming and cannot scale to the vast amount of content posted on social media platforms.Automated methods for deepfake detection often leverage machine learning techniques, such as natural language processing (NLP) and computer vision, to analyze the content of posts and identify patterns indicative of deepfake content. These methods may use features such as the use of specific words or phrases, the presence of certain visual artifacts, or inconsistencies in the content to flag potentially fake posts.However, existing automated methods for deepfake detection face several challenges. For example, they may struggle to distinguish between genuine and machine-generated content, especially as deepfake technology becomes more sophisticated. Additionally, these methods may be prone to false positives, flagging genuine content as fake.

**DRAW BACKS :**

Existing systems for deepfake detection on social media have several drawbacks:

1. **Limited Scalability:** Manual methods for deepfake detection, such as human moderation, are not scalable to the vast amount of content posted on social media platforms. Automated methods may struggle to keep up with the volume and speed of content creation.
2. **False Positives:** Automated methods for deepfake detection may produce false positives, flagging genuine content as fake. This can lead to unnecessary censorship and impact freedom of speech.
3. **Limited Detection Capabilities:** Existing automated methods may struggle to detect deepfake content that is created using sophisticated techniques. As deepfake technology advances, it becomes increasingly difficult to distinguish between genuine and fake content.

**PROPOSED SYSTEM :**

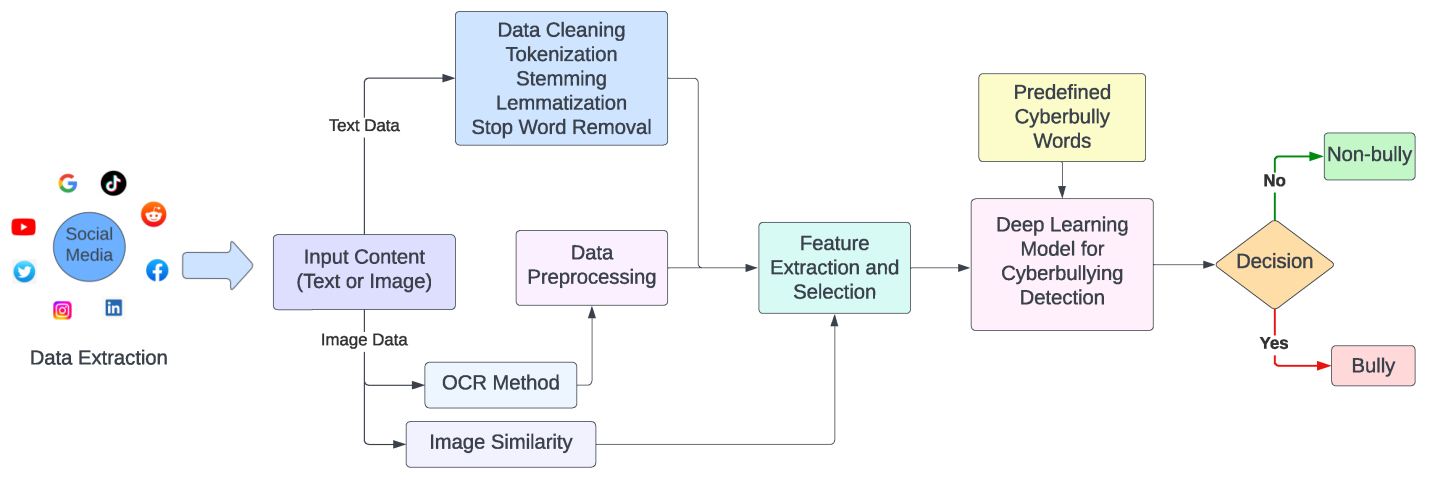
In our proposed system for deepfake detection on social media, we aim to address the limitations of existing systems by leveraging deep learning and FastText embeddings for identifying machine-generated tweets. The key components of our proposed system include.**FastText Embeddings:** We use FastText embeddings to represent the text content of tweets. FastText embeddings are capable of capturing semantic information about the text, which is crucial for distinguishing between genuine and machine-generated tweets.**Deep Learning Models:** We employ deep learning models, such as Convolutional Neural Networks (CNNs) or Recurrent Neural Networks (RNNs), to process the FastText embeddings and classify tweets as genuine or machine-generated. These models are trained on a labeled dataset of tweets, where machine-generated tweets are synthesized using state-of-the-art text generation models.

**ADVANATGES :**

Our proposed system for deepfake detection on social media leveraging deep learning and FastText embeddings offers several advantages over existing systems:

1. **Improved Accuracy:** By leveraging deep learning models and FastText embeddings, our system can achieve higher accuracy in identifying machine-generated tweets compared to existing methods.
2. **Robustness:** The use of adversarial training techniques improves the robustness of our model against adversarial attacks, making it more reliable in real-world scenarios.
3. **Scalability:** Our system is designed to be scalable, allowing it to handle large volumes of tweets posted on social media platforms.

**SYSTEM ARCHITECTURE :**



**HARDWARE & SOFTWARE REQUIREMENTS:**

**HARD REQUIRMENTS :**

* System    :   i3 or above
* Ram    :   4GB Ram.
* Hard disk : 40GB

**SOFTWARE REQUIRMENTS :**

* Operating system   : Windows
* Coding Language  : python

**MODULES:**

We have implemented this project as REST based web services which consists of following modules

1. User Login: user can login to system using username and password as ‘admin and admin’.
2. Load Design Patterns Code: after login user will run this module to upload dataset to application
3. Code to Numeric Vector: all codes will be converted to numeric vector which will replace each word occurrence with its average frequency.
4. Train ML Algorithms: processed numeric vector will be split into train and test with a ratio of 80:20. 80% dataset will be input to training algorithms to train a model and this model will be applied on 20% test data to calculate accuracy
5. Predict Design Patterns: user will upload test source code files and then ML algorithms will rank test file to predict accurate design patterns.

**3.4 SYSTEM STUDY**

**FEASIBILITY STUDY**

The feasibility of the project is analyzed in this phase and business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are

* ECONOMICAL FEASIBILITY
* TECHNICAL FEASIBILITY
* SOCIAL FEASIBILITY

**ECONOMICAL FEASIBILITY**

This study is carried out to check the economic impact that the system will have on the organization. The amount of fund that the company can pour into the research and development of the system is limited. The expenditures must be justified. Thus the developed system as well within the budget and this was achieved because most of the technologies used are freely available. Only the customized products had to be purchased.

### TECHNICAL FEASIBILITY

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. This will lead to high demands on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

**SOCIAL FEASIBILITY**

The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

**4.SYSTEM DESIGN**

**4.2 UML DIAGRAMS**

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group.

The goal is for UML to become a common language for creating models of object oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems.

The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems.

The UML is a very important part of developing objects oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

**GOALS:**

The Primary goals in the design of the UML are as follows:

1. Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models.
2. Provide extendibility and specialization mechanisms to extend the core concepts.
3. Be independent of particular programming languages and development process.
4. Provide a formal basis for understanding the modeling language.
5. Encourage the growth of OO tools market.
6. Support higher level development concepts such as collaborations, frameworks, patterns and components.
7. Integrate best practices.

**USE CASE DIAGRAM:**

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

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**CLASS DIAGRAM:**

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.

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**SEQUENCE DIAGRAM:**

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.

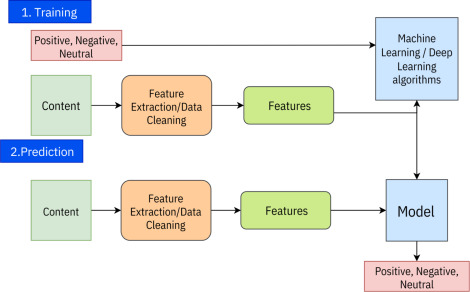
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**COLLRABATION DIAGRAM:**

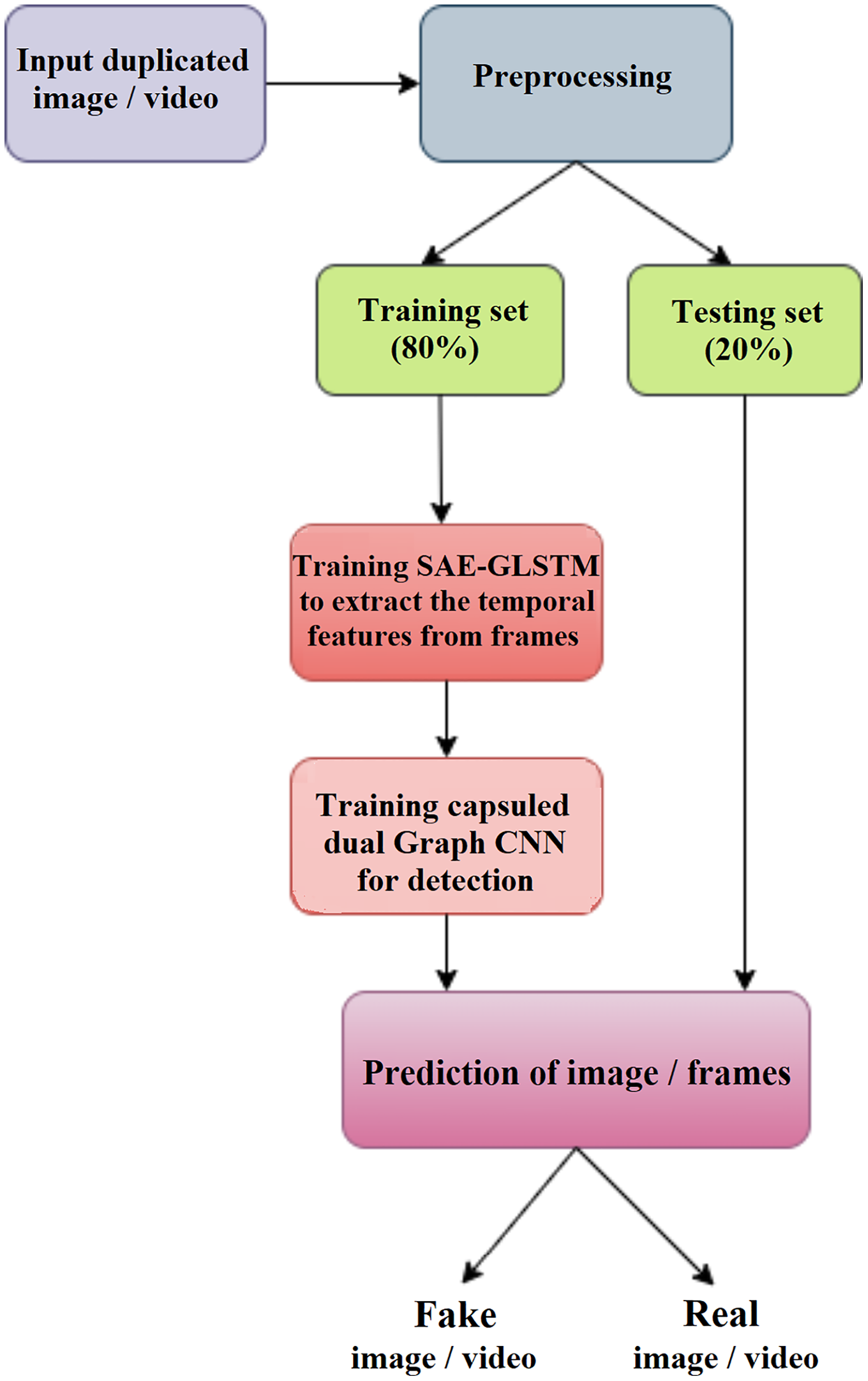
Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams can be used to describe the business and operational step-by-step workflows of components in a system. An activity diagram shows the overall flow of control.

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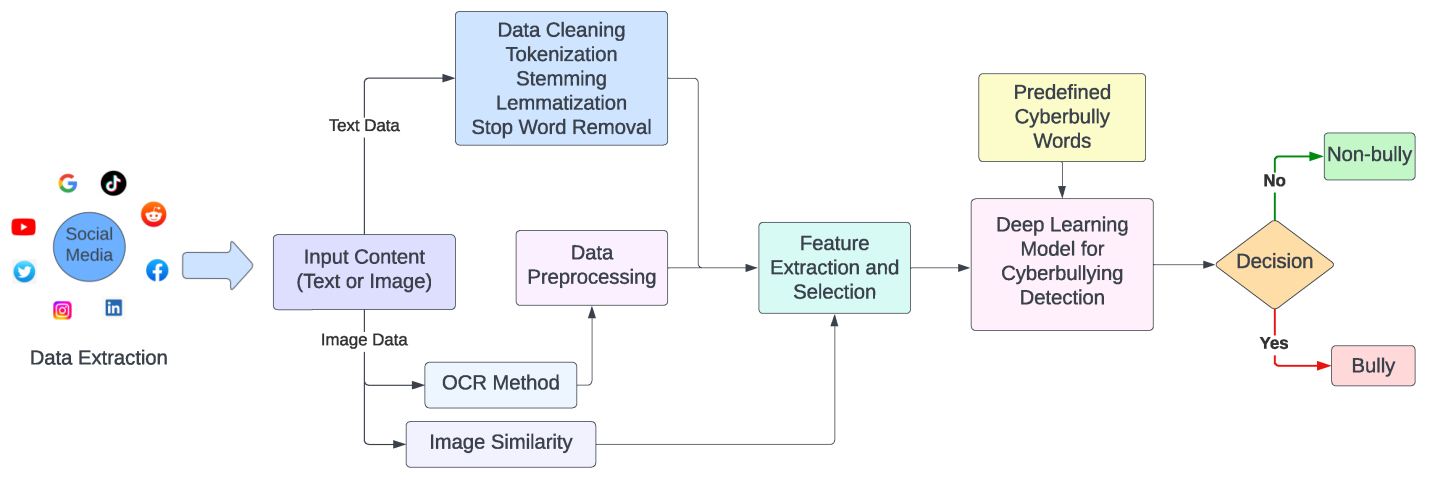
**DATA FLOW :**



**FLOW CHAT:**



**ACTIVITY DIAGRAM :**



**MODULES:**

To implement this project we have designed following modules

1. User Login: user can login to system using username and password as ‘admin and admin’
2. Load Dataset: after login user can click this link to load dataset to application
3. Fast Text Embedding: loaded dataset will be clean by removing stop words, special symbols and other text processing techniques and then input to FASTTEXT algorithm to generate numeric vector
4. Run All Algorithms: numeric vector will be normalized and then split into train and test and then training data will be input to all algorithms to train a model and this models will be applied on test data to calculate prediction accuracy
5. Predict Deep Fake: in this module will enter some tweets text and then CNN algorithm will predict weather tweet is written by Human or BOT

**Designing the input and output:**

Designing the input and output of the Blockchain-Based Autonomous Notarization System (BANS) using National eID cards involves considering the system's requirements for document authentication, user interaction, and data processing. Here's a proposed design:

### Input Design:

1. \*\*Document Submission\*\*: Users input the document(s) they wish to notarize into the system. This may involve uploading digital copies of the documents through a secure web interface or providing access to documents stored in cloud storage platforms.

2. \*\*National eID Card Authentication\*\*: Users authenticate their identity using their National eID cards, which are equipped with digital signatures and biometric authentication features. This input ensures that only authorized individuals can access notarization services and submit documents for authentication.

3. \*\*Document Metadata\*\*: Users may provide metadata associated with the document(s) being notarized, such as document title, description, purpose, and relevant timestamps. This metadata helps categorize and organize notarized documents within the system.

### Output Design:

1. \*\*Notarization Confirmation\*\*: Upon successful authentication and verification, users receive a confirmation message indicating that their document(s) have been successfully notarized. This output assures users that their documents have been authenticated and added to the blockchain ledger.

2. \*\*Digitally Signed Notarization Certificate\*\*: Users receive a digitally signed notarization certificate for each document notarized through the system. This certificate includes details such as the document hash, timestamp, notary public's digital signature, and blockchain transaction ID, providing irrefutable proof of notarization.

3. \*\*Blockchain Transaction ID\*\*: Users receive a unique transaction ID associated with each notarization transaction recorded on the blockchain. This ID serves as a reference for verifying the authenticity and integrity of notarized documents on the blockchain ledger.

4. \*\*Real-Time Access to Notarization Records\*\*: Users have real-time access to their notarization records on the blockchain, allowing them to independently verify the authenticity and integrity of their documents. This output enhances transparency and accountability in the notarization process.

5. \*\*Notification Alerts\*\*: Users may receive notification alerts via email or SMS to inform them of important events related to their notarization transactions, such as successful notarization, document expiration, or updates to notarization records.

6. \*\*Error Messages and Notifications\*\*: In case of errors or issues during the notarization process, users receive informative error messages and notifications guiding them on how to resolve the issue or retry the notarization process.

By designing a user-friendly input and output system for BANS, users can securely authenticate their documents using National eID cards and blockchain technology, ensuring the integrity, authenticity, and accessibility of notarized documents in the digital age.

**BLOCK CHAIN :**

Over the past few years, you have consistently heard the term ‘blockchain technology,’ probably regarding [cryptocurrencies](https://www.simplilearn.com/tutorials/blockchain-tutorial/what-is-cryptocurrency), like [Bitcoin](https://www.simplilearn.com/bitcoin-digital-currency-article). In fact, you may be asking yourself, “what is blockchain technology?” It seems like blockchain is a platitude but in a hypothetical sense, as there is no real meaning that the layman can understand easily. It is imperative to answer “what is blockchain technology, “including the technology that is used, how it works, and how it’s becoming vital in the digital world.

As [blockchain](https://www.simplilearn.com/tutorials/blockchain-tutorial/what-is-blockchain) continues to grow and become more user-friendly, the onus is on you to learn this evolving technology to prepare for the future. If you are new to blockchain, then this is the right platform to gain solid foundational knowledge. In this article, you learn how to answer the question, “what is blockchain technology?” You’ll also learn how blockchain works, why it’s important, and how you can use this field to advance your career.

What Is Blockchain Technology?

Blockchain is a method of recording information that makes it impossible or difficult for the system to be changed, hacked, or manipulated. A blockchain is a distributed ledger that duplicates and distributes transactions across the network of computers participating in the blockchain.

Blockchain technology is a structure that stores transactional records, also known as the block, of the public in several databases, known as the “chain,” in a network connected through peer-to-peer nodes. Typically, this storage is referred to as a ‘digital ledger.’

Every transaction in this ledger is authorized by the digital signature of the owner, which authenticates the transaction and safeguards it from tampering. Hence, the information the digital ledger contains is highly secure.

In simpler words, the digital ledger is like a Google spreadsheet shared among numerous computers in a network, in which, the transactional records are stored based on actual purchases. The fascinating angle is that anybody can see the data, but they can’t corrupt it.

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Become a Full Stack Developer in Just 6 Months!

Dive into the transformative world of blockchain technology with our intensive [Cyber security Bootcamp](https://www.simplilearn.com/cybersecurity-bootcamp). Uncover the revolutionary potential of blockchain while honing your skills in safeguarding these decentralized systems. From understanding the intricacies of smart contracts to fortifying digital transactions, this bootcamp equips you to navigate the evolving landscape of cybersecurity within the blockchain domain. Don't miss this opportunity to become a proficient cybersecurity professional in the realm of blockchain.

Why is Blockchain Popular?

Suppose you are transferring money to your family or friends from your bank account. You would log in to online banking and transfer the amount to the other person using their account number. When the transaction is done, your bank updates the transaction records. It seems simple enough, right? There is a potential issue which most of us neglect.

These types of transactions can be tampered with very quickly. People who are familiar with this truth are often wary of using these types of transactions, hence the evolution of third-party payment applications in recent years.  But this vulnerability is essentially why Blockchain technology was created.

Technologically, [Blockchain](https://www.simplilearn.com/tutorials/blockchain-tutorial/what-is-blockchain) is a digital ledger that is gaining a lot of attention and traction recently. But why has it become so popular? Well, let’s dig into it to fathom the whole concept.

Record keeping of data and transactions are a crucial part of the business. Often, this information is handled in house or passed through a third party like brokers, bankers, or lawyers increasing time, cost, or both on the business. Fortunately, Blockchain avoids this long process and facilitates the faster movement of the transaction, thereby saving both time and money.

Most people assume [Blockchain and Bitcoin](https://www.simplilearn.com/blockchain-beyond-bitcoin-making-world-a-better-place-article) can be used interchangeably, but in reality, that’s not the case. Blockchain is the technology capable of supporting various applications related to [multiple industries](https://www.simplilearn.com/tutorials/blockchain-tutorial/blockchain-industries) like finance, supply chain, manufacturing, etc., but Bitcoin is a currency that relies on Blockchain technology to be secure.

Blockchain is an emerging technology with many advantages in an increasingly digital world:

* Highly Secure

It uses a digital signature feature to conduct fraud-free transactions making it impossible to corrupt or change the data of an individual by the other users without a specific digital signature.

* Decentralized System

Conventionally, you need the approval of regulatory authorities like a government or bank for transactions; however, with Blockchain, transactions are done with the mutual consensus of users resulting in smoother, safer, and faster transactions.

* Automation Capability

It is programmable and can generate systematic actions, events, and payments automatically when the criteria of the trigger are met.

Structure and Design of Blockchain

A blockchain is a distributed, immutable, and decentralized ledger at its core that consists of a chain of blocks and each block contains a set of data. The blocks are linked together using cryptographic techniques and form a chronological chain of information. The structure of a blockchain is designed to ensure the security of data through its consensus mechanism which has a network of nodes that agree on the validity of transactions before adding them to the blockchain.

Blocks:

A block in a blockchain is a combination of three main components:

1. The header contains metadata such as a timestamp which has a random number used in the mining process and the previous block's hash.

2. The data section contains the main and actual information like transactions and smart contracts which are stored in the block.

3. Lastly, the hash is a unique cryptographic value that works as a representative of the entire block which is used for verification purposes.

Block Time:

Block time refers to the time taken to generate a new block in a blockchain. Different blockchains have different block times, which can vary from a few seconds to minutes or may be in hours too. Shorter block times can give faster transaction confirmations but the result has higher chances of conflicts but the longer block times may increase the timing for transaction confirmations but reduce the chances of conflicts.

Hard Forks:

A hard fork in a blockchain refers to a permanent divergence in the blockchain's history that results in two separate chains. It can happen due to a fundamental change in the protocol of a blockchain and all nodes do not agree on the update. Hard forks can create new cryptocurrencies or the splitting of existing ones and It requires consensus among the network participants to resolve.

Decentralization:

Decentralization is the key feature of blockchain technology. In a decentralized blockchain, there is no single central authority that can control the network. In decentralization,the decision-making power is distributed among a network of nodes that collectively validate and agree on the transactions to be added to the blockchain. This decentralized nature of blockchain technology helps to promote transparency, trust, and security. It also reduces the risk to rely on a single point of failure and minimizes the risks of data manipulation.

Finality:

Finality refers to the irreversible confirmation of transactions in a blockchain. If and when a transaction is added to a block and the block is confirmed by the network, it becomes immutable and cannot be reversed. This feature ensures the integrity of the data and prevents double spending, providing a high level of security and trust in Blockchain Types & Sustainability

Openness:

Openness in blockchain technology makes the blockchain accessible to anyone who intends to participate in the network. This implies that it is open for all and anyone can join the network, validate transactions, and can add new blocks to the blockchain, so long as they know the consensus rules. Openness promotes inclusivity, transparency, and innovation, as it allows for participation from various stakeholders.

Public Blockchain:

It is a kind of blockchain  which is open for the public and allows everyone to join the network to perform transactions and to participate in the consensus process. Public blockchains are transparent, because all transactions are publicly recorded.

How Does Blockchain Technology Work?

In recent years, you may have noticed many businesses around the world integrating Blockchain technology. But how exactly does Blockchain technology work? Is this a significant change or a simple addition? The advancements of Blockchain are still young and have the potential to be revolutionary in the future; so, let’s begin demystifying this technology.

Blockchain is a combination of three leading technologies:

1. Cryptographic keys
2. A peer-to-peer network containing a shared ledger
3. A means of computing, to store the transactions and records of the network

[Cryptography](https://www.simplilearn.com/understanding-cryptography-article) keys consist of two keys – Private key and Public key. These keys help in performing successful transactions between two parties. Each individual has these two keys, which they use to produce a secure digital identity reference. This secured identity is the most important aspect of Blockchain technology. In the world of cryptocurrency, this identity is referred to as ‘digital signature’ and is used for authorizing and controlling transactions.

The digital signature is merged with the peer-to-peer network; a large number of individuals who act as authorities use the digital signature in order to reach a consensus on transactions, among other issues. When they authorize a deal, it is certified by a mathematical verification, which results in a successful secured transaction between the two network-connected parties. So to sum it up, Blockchain users employ cryptography keys to perform different types of digital interactions over the peer-to-peer network.

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Types of Blockchain

There are different [types of blockchains](https://www.ibm.com/topics/what-is-blockchain). They are as follows:

Private Blockchain Networks

Private blockchains operate on closed networks, and tend to work well for private businesses and organizations. Companies can use private blockchains to customize their accessibility and authorization preferences, parameters to the network, and other important security options. Only one authority manages a private blockchain network.

Public Blockchain Networks

Bitcoin and other cryptocurrencies originated from public blockchains, which also played a role in popularizing distributed ledger technology (DLT). Public blockchains also help to eliminate certain challenges and issues, such as security flaws and centralization. With DLT, data is distributed across a peer-to-peer network, rather than being stored in a single location. A consensus algorithm is used for verifying information authenticity; proof of stake (PoS) and proof of work (PoW) are two frequently used consensus methods.

Permissioned Blockchain Networks

Also sometimes known as hybrid blockchains, permissioned blockchain networks are private blockchains that allow special access for authorized individuals. Organizations typically set up these types of blockchains to get the best of both worlds, and it enables better structure when assigning who can participate in the network and in what transactions.

Consortium Blockchains

Similar to permissioned blockchains,  consortium blockchains have both public and private components, except multiple organizations will manage a single consortium blockchain network. Although these types of blockchains can initially be more complex to set up, once they are running, they can offer better security. Additionally, consortium blockchains are optimal for collaboration with multiple organizations.

Hybrid Blockchains

Hybrid blockchains are the combination of both public and private blockchains. In a hybrid blockchain, some parts of the blockchain are public and transparent, while others are private and accessible only to authorized and specific participants. This makes hybrid blockchains ideal for use in those cases where a balance is required between transparency and privacy. For example, in supply chain management multiple parties  can access certain information, but sensitive data can be kept private.

Sidechains

Sidechains are different blockchains that run parallel to the main blockchain, allowing for additional functionality and scalability. Sidechains enable developers to experiment with new features and applications without affecting the main blockchain's integrity. For example, sidechains can be used for creating decentralized applications  and to implement specific consensus mechanisms. Sidechains can also be used to handle transactions of the main blockchain to reduce congestion and increase scalability.

Blockchain Layers

Blockchain layers refer to the concept of building multiple layers of blockchains on top of each other. Each layer can have its own consensus mechanism, rules, and functionality which  can interact with other layers. This ensures greater scalability, as transactions can be processed in parallel across different layers. For example, the Lightning Network, built on top of the Bitcoin blockchain, is a second layer solution that enables faster and cheaper transactions by creating payment channels between users.

The Process of Transaction

One of Blockchain technology’s cardinal features is the way it confirms and authorizes transactions. For example, if two individuals wish to perform a transaction with a private and public key, respectively, the first person party would attach the transaction information to the public key of the second party. This total information is gathered together into a block.

The block contains a digital signature, a timestamp, and other important, relevant information. It should be noted that the block doesn’t include the identities of the individuals involved in the transaction. This block is then transmitted across all of the network's nodes, and when the right individual uses his private key and matches it with the block, the transaction gets completed successfully.

In addition to conducting financial transactions, the Blockchain can also hold transactional details of properties, vehicles, etc.

Here’s a use case that illustrates how Blockchain works:

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* Hash Encryptions

blockchain technology uses [hashing and encryption](https://www.baeldung.com/cs/hashing-vs-encryption) to secure the data, relying mainly on the [SHA256 algorithm](https://www.simplilearn.com/tutorials/cyber-security-tutorial/sha-256-algorithm) to secure the information. The address of the sender (public key), the receiver’s address, the transaction, and his/her private key details are transmitted via the SHA256 algorithm. The encrypted information, called hash encryption, is transmitted across the world and added to the blockchain after verification. The SHA256 algorithm makes it almost impossible to hack the hash encryption, which in turn simplifies the sender and receiver’s authentication.

* Proof of Work

In a Blockchain, each block consists of 4 main headers.

* + Previous Hash: This hash address locates the previous block.
  + Transaction Details: Details of all the transactions that need to occur.
  + Nonce: An arbitrary number given in cryptography to differentiate the block’s hash address.
  + Hash Address of the Block: All of the above (i.e., preceding hash, transaction details, and nonce) are transmitted through a hashing algorithm. This gives an output containing a 256-bit, 64 character length value, which is called the unique ‘hash address.’ Consequently, it is referred to as the hash of the block.
  + Numerous people around the world try to figure out the right hash value to meet a pre-determined condition using computational algorithms. The transaction completes when the predetermined condition is met. To put it more plainly, Blockchain miners attempt to solve a mathematical puzzle, which is referred to as a proof of work problem. Whoever solves it first gets a reward.



* Mining

In Blockchain technology, the process of adding transactional details to the present digital/public ledger is called [‘mining.](https://www.simplilearn.com/bitcoin-mining-explained-article)’ Though the term is associated with [Bitcoin](https://www.simplilearn.com/tutorials/blockchain-tutorial/dogecoin-vs-bitcoin), it is used to refer to other Blockchain technologies as well. Mining involves generating the hash of a block transaction, which is tough to forge, thereby ensuring the safety of the entire Blockchain without needing a central system.

History of Blockchain

Satoshi Nakamoto, whose real identity still remains unknown to date, [first introduced the concept of blockchains](https://www.forbes.com/sites/bernardmarr/2018/02/16/a-very-brief-history-of-blockchain-technology-everyone-should-read/?sh=1bcf60497bc4) in 2008. The design continued to improve and evolve, with Nakamoto using a Hashcash-like method. It eventually became a primary component of bitcoin, a popular form of cryptocurrency, where it serves as a public ledger for all network transactions. Bitcoin blockchain file sizes, which contained all transactions and records on the network, continued to grow substantially. By August 2014, it had reached 20 gigabytes, and eventually exceeded 200 gigabytes by early 2020.

Advantages and Disadvantages of Blockchain

Like all forms of technology, blockchain has several [advantages and disadvantages](https://www.redbytes.in/advantages-and-disadvantages-of-blockchain-technology/) to consider.

Advantages

One major [advantage of blockchains](https://www.simplilearn.com/tutorials/blockchain-tutorial/why-is-blockchain-important) is the level of security it can provide, and this also means that blockchains can protect and secure sensitive data from online transactions. For anyone looking for speedy and convenient transactions, blockchain technology offers this as well. In fact, it only takes a few minutes, whereas other transaction methods can take several days to complete. There is also no third-party interference from financial institutions or government organizations, which many users look at as an advantage.

Disadvantages

Blockchain and cryptography involves the use of public and private keys, and reportedly, there have been problems with private keys. If a user loses their private key, they face numerous challenges, making this one disadvantage of blockchains. Another disadvantage is the scalability restrictions, as the number of transactions per node is limited. Because of this, it can take several hours to finish multiple transactions and other tasks. It can also be difficult to change or add information after it is recorded, which is another significant disadvantage of blockchain.

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How is Blockchain Used?

[Blockchains store information](https://www.investopedia.com/terms/b/blockchain.asp) on monetary transactions using cryptocurrencies, but they also store other types of information, such as product tracking and other data. For example, food products can be tracked from the moment they are shipped out, all throughout their journey, and up until final delivery. This information can be helpful because if there is a contamination outbreak, the source of the outbreak can be easily traced. This is just one of the many ways that blockchains can store important data for organizations.

Hyperledger, Hosted by the Linux Foundation

Hyperledger is a global collaboration hosted by The Linux Foundation, including finance, banking, IoT, supply chain, manufacturing, and technology leaders. By creating a cross-industry open standard for distributed ledgers, Hyperledger Fabric allows developers to develop blockchain applications to meet specific needs.

Ten Steps to Your First Blockchain Application

1. Understand what Blockchain is and its key components.
2. Understand the purpose of your application.
3. Create a use case for your application.
4. Find out if there's already an existing blockchain for your purpose.
5. Explore the different types of Blockchain platforms available for your application. There are many types of Blockchain, each with its strengths and weaknesses.
6. Choose the right platform for developing your app.
7. Select the consensus algorithm you will use.
8. Learn Solidity - Ethereum's programming language for smart contracts and DApps (decentralized applications).
9. Learn how to use Truffle or Remix - development tools for Ethereum DApps and smart contracts.
10. Get an Ethereum account or wallet and buy some Ether (ETH), the currency of the Ethereum network.

Decentralization

Decentralization is difficult to Understand, but it is vital in the world today; decentralization is distributing or dispersing functions, powers, people, or things away from a central location or authority. Within the business world, decentralization typically refers to delegating authority from senior executives to middle managers and other employees further down the organizational hierarchy. The benefits of devolution are many and varied, but the most commonly cited advantages include improved communication, greater employee empowerment, and increased flexibility and responsiveness.

Transparency

One of the most critical aspects of decentralization is transparency. All employees have access to information and decision-making processes in a decentralized organization. This transparency fosters a greater sense of trust and cooperation among employees. Furthermore, it allows employees to hold managers accountable for their decisions.

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Bitcoin vs. Blockchain

Bitcoin is a digital currency that was first introduced in 2009 and has been the most popular and successful cryptocurrency to date. Bitcoin's popularity is attributed to its decentralized nature, which means it doesn't have a central authority or bank controlling its supply. This also means that transactions are anonymous, and no transaction fees are involved when using bitcoin.

Blockchain is a database of transactions that have taken place between two parties, with blocks of data containing information about each transaction being added in chronological order to the chain as it happens. The Blockchain is constantly growing as new blocks are added to it, with records becoming more difficult to change over time due to the number of blocks created after them.

Blockchain vs. Banks

Blockchain has the potential to revolutionize the banking industry. Banks need to be faster to adapt to the changing needs of the digital age, and Blockchain provides a way for them to catch up. By using Blockchain, banks can offer their customers a more secure and efficient way to conduct transactions. In addition, Blockchain can help banks to streamline their operations and reduce costs.

Why is Blockchain Important?

Blockchain is important because it has the potential to revolutionize the banking industry. Banks need to be faster to adapt to the changing needs of the digital age, and Blockchain provides a way for them to catch up. By using Blockchain, banks can offer their customers a more secure and efficient way to conduct transactions. In addition, Blockchain can help banks to streamline their operations and reduce costs.

What is a Blockchain Platform?

A blockchain platform is a shared digital ledger that allows users to record transactions and share information securely, tamper-resistant. A distributed network of computers maintains the register, and each transaction is verified by consensus among the network participants.

Proof of Work (PoW) vs. Proof of Stake (PoS)

Proof of work (PoW) is an algorithm to create blocks and secure the Blockchain. It requires miners to solve a puzzle to create a block and receive the block reward in return.

Proof of stake (PoS) is an alternative algorithm for securing the Blockchain, which does not require mining. Instead, users must lock up some of their coins for a certain time to be eligible for rewards.

Energy Consumption Concerns of Blockchain

The main concern with blockchain technology is its energy consumption. Traditional blockchains like  Bitcoin and Ethereum, use a consensus mechanism called PoW( Proof of Work), which requires computational power and electricity to solve complex mathematical puzzles. This energy-intensive process has raised concerns about the environmental impact of blockchain technology because it produces carbon emissions and consumes a huge amount of electricity.

Blockchain or Scalability Trilemma: Decentralization, Security, and Scalability

Blockchain is a distributed database that maintains a continuously growing list of records called blocks. Blockchain is often said to have the potential to disrupt many industries, including banking, law, and healthcare.

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What are the Benefits of Blockchains Over Traditional Finance?

Blockchain offers several potential advantages over traditional finance. One of the most touted advantages is that Blockchain is decentralized, while traditional finance is centralized. This means there is no single point of failure in a blockchain system. Another advantage of Blockchain is that it is more transparent than traditional finance.

Promising Blockchain Use Cases and Killer Applications

Promising Blockchain Use Cases and Killer Applications: Although there are many potential applications for blockchain technology, there are a few that stand out as having the potential to be truly game-changing. These are often referred to as killer applications. Some of the most promising killer applications for blockchain technology include supply chain management, identity management, and data management.

Promising blockchain use cases and killer applications are being developed every day. The Shiba Inu team is committed to finding and developing the most promising applications for the SHIB community. The team has a proven track record in the cryptocurrency space, and they are committed to creating value for the SHIB community.

How to Invest in Blockchain Technology

Blockchain technology and stocks can be a [lucrative investment,](https://www.fool.com/investing/stock-market/market-sectors/financials/blockchain-stocks/how-to-invest/) and there are several ways to take the next step toward making your first blockchain investment purchase. Bitcoin is typically the first thing that comes to mind when it comes to investing in blockchain technology, and it shouldn’t be overlooked. Aside from Bitcoin, there is also the option of investing in cryptocurrency penny stocks, such as Altcoin and Litecoin. There are also certain apps and services that are in the pre-development phase and that are using blockchain technology to raise funding. As an investor, you can buy coins, with the expectation that prices will go up if the service or app becomes popular. Another way to invest in blockchain technology is to invest in startups built on blockchain technology. Finally, there is always the option to invest in pure blockchain technology.

Traditional Finance and Blockchain Investment Strategies

In traditional finance, there are two main investment strategies: active and passive. Active investing involves picking stocks or other assets, and then holding onto them for a long period of time. Passive investing, on the other hand, involves investing in a basket of assets, and then holding onto them for a long period of time. Both of these strategies have their pros and cons, but there is one major difference between them: active investing is much more risky than passive investing.

How Do Different Industries Use Blockchain?

Blockchain has the potential to streamline processes across many different industries.

* In the supply chain industry, for example, Blockchain can track the movement of goods and materials as they change hands. This would allow for greater transparency and accountability and reduce the risk of fraud.
* In the healthcare industry, Blockchain can be used to secure patient data and streamline the process of billing and claims.

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What are the Features of Blockchain Technology?

* Blockchain technology is a distributed ledger that is secure, transparent, and immutable.
* Blockchain technology can be used to create a decentralized database that is tamper-proof and has the potential to revolutionize the way we interact with the digital world.
* Blockchain technology is secure, transparent, and tamper-proof.

What are the Key Components of Blockchain Technology?

There are three key components to blockchain technology:

* The distributed ledger, the consensus mechanism, and the smart contracts.
* The distributed ledger is a database that is spread across a network of computers. The consensus mechanism is what allows the network of computers to agree on the state of the ledger.
* The smart contracts are what allows the blockchain to be used for more than just a database.

What are Blockchain Protocols?

The three most common protocols Bitcoin was the first blockchain protocol and is still the most widely used is:

* Bitcoin-  Bitcoin is a decentralized digital currency, often referred to as a cryptocurrency. It exists on a decentralized network of computers, often called a blockchain, that keeps track of all transactions made using the currency. Bitcoin uses a proof-of-work algorithm to validate transactions and add them to the blockchain. Bitcoin was the first cryptocurrency to be created and is the most well-known.
* Ripple- Ripple is a cryptocurrency that is similar to Bitcoin. Ripple uses a decentralized network of computers to keep track of all transactions made using the currency. Ripple uses a proof-of-work algorithm to validate transactions and add them to the blockchain. Ripple was created in 2012 and is the second largest cryptocurrency by market capitalization.
* Ethereum- The Ethereum blockchain was initially described in a white paper by Vitalik Buterin in 2013. Buterin, a programmer who was born in Russia and raised in Canada, had been involved with bitcoin from its early days. He was excited by the technology, but he thought that bitcoin needed a scripting language for application development. He decided to create a new platform that would be more general than bitcoin.

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What is the Difference Between a Database and a Blockchain?

So what is the difference between a database and a blockchain? A database is centralized, meaning that a single entity controls it. This entity can be a company, government, or individual. On the other hand, a blockchain is decentralized, meaning that any entity does not control it.

How is Blockchain Different From the Cloud?

Blockchain is a new technology that is different from the cloud in several ways:

* Blockchain is decentralized, while the cloud is centralized. This means that Blockchain is distributed across a network of computers, while the cloud is stored on a central server.
* Blockchain is immutable, meaning that once data is written to the Blockchain, it cannot be changed.

What is Blockchain as a Service?

Blockchain as a Service is a cloud-based offering that allows customers to build, host, and use their blockchain applications, smart contracts, and functions on the Azure cloud platform. Azure offers integrated services that make it easy to develop, deploy, and manage blockchain applications. Customers can use Azure's managed services to create and deploy blockchain applications without having to set up and manage their infrastructure.

BLOCK CHAIN :

A **blockchain** is a [distributed ledger](https://en.wikipedia.org/wiki/Distributed_ledger) with growing lists of [records](https://en.wikipedia.org/wiki/Record_(computer_science)) (*blocks*) that are securely linked together via [cryptographic hashes](https://en.wikipedia.org/wiki/Cryptographic_hash_function).[[1]](https://en.wikipedia.org/wiki/Blockchain#cite_note-fortune20160515-1)[[2]](https://en.wikipedia.org/wiki/Blockchain#cite_note-nyt20160521-2)[[3]](https://en.wikipedia.org/wiki/Blockchain#cite_note-te20151031-3)[[4]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cryptocurrencytech-4) Each block contains a cryptographic hash of the previous block, a [timestamp](https://en.wikipedia.org/wiki/Trusted_timestamping), and transaction data (generally represented as a [Merkle tree](https://en.wikipedia.org/wiki/Merkle_tree), where [data nodes](https://en.wikipedia.org/wiki/Node_(computer_science)) are represented by leaves). Since each block contains information about the previous block, they effectively form a *chain* (compare [linked list](https://en.wikipedia.org/wiki/Linked_list) data structure), with each additional block linking to the ones before it. Consequently, blockchain transactions are irreversible in that, once they are recorded, the data in any given block cannot be altered retroactively without altering all subsequent blocks.

Blockchains are typically managed by a [peer-to-peer (P2P)](https://en.wikipedia.org/wiki/Peer-to-peer) computer network for use as a public [distributed ledger](https://en.wikipedia.org/wiki/Distributed_ledger), where nodes collectively adhere to a [consensus algorithm](https://en.wikipedia.org/wiki/Consensus_algorithm) [protocol](https://en.wikipedia.org/wiki/Communication_protocol) to add and validate new transaction blocks. Although blockchain records are not unalterable, since [blockchain forks](https://en.wikipedia.org/wiki/Fork_(blockchain)) are possible, blockchains may be considered [secure by design](https://en.wikipedia.org/wiki/Secure_by_design) and exemplify a distributed computing system with high [Byzantine fault tolerance](https://en.wikipedia.org/wiki/Byzantine_fault_tolerance).[[5]](https://en.wikipedia.org/wiki/Blockchain#cite_note-5)

A blockchain was created by a person (or group of people) using the name (or [pseudonym](https://en.wikipedia.org/wiki/Pseudonym)) [Satoshi Nakamoto](https://en.wikipedia.org/wiki/Satoshi_Nakamoto) in 2008 to serve as the public [distributed ledger](https://en.wikipedia.org/wiki/Distributed_ledger) for [bitcoin](https://en.wikipedia.org/wiki/Bitcoin) [cryptocurrency](https://en.wikipedia.org/wiki/Cryptocurrency) transactions, based on previous work by [Stuart Haber](https://en.wikipedia.org/wiki/Stuart_Haber), [W. Scott Stornetta](https://en.wikipedia.org/wiki/W._Scott_Stornetta), and [Dave Bayer](https://en.wikipedia.org/wiki/Dave_Bayer).[[6]](https://en.wikipedia.org/wiki/Blockchain#cite_note-6) The implementation of the blockchain within bitcoin made it the first digital currency to solve the [double-spending](https://en.wikipedia.org/wiki/Double-spending) problem without the need for a trusted authority or central [server](https://en.wikipedia.org/wiki/Server_(computing)). The [bitcoin](https://en.wikipedia.org/wiki/Bitcoin) design has inspired other applications[[3]](https://en.wikipedia.org/wiki/Blockchain" \l "cite_note-te20151031-3)[[2]](https://en.wikipedia.org/wiki/Blockchain#cite_note-nyt20160521-2) and blockchains that are readable by the public and are widely used by [cryptocurrencies](https://en.wikipedia.org/wiki/Cryptocurrencies). The blockchain may be considered a type of [payment rail](https://en.wikipedia.org/wiki/Payment_rail).[[7]](https://en.wikipedia.org/wiki/Blockchain#cite_note-7)

Private blockchains have been proposed for business use. *Computerworld* called the marketing of such privatized blockchains without a proper security model "[snake oil](https://en.wiktionary.org/wiki/snake_oil)";[[8]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cw20160905-8) however, others have argued that permissioned blockchains, if carefully designed, may be more decentralized and therefore more secure in practice than permissionless ones.[[4]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cryptocurrencytech-4)[[9]](https://en.wikipedia.org/wiki/Blockchain#cite_note-auto-9)

History

[](https://en.wikipedia.org/wiki/File:2011-2021_blockchain_transactions.jpg)[Bitcoin](https://en.wikipedia.org/wiki/Bitcoin), [Ethereum](https://en.wikipedia.org/wiki/Ethereum) and [Litecoin](https://en.wikipedia.org/wiki/Litecoin) transactions per day (January 2011 – January 2021)

[Cryptographer](https://en.wikipedia.org/wiki/Cryptography) [David Chaum](https://en.wikipedia.org/wiki/David_Chaum) first proposed a blockchain-like protocol in his 1982 dissertation "Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups."[[10]](https://en.wikipedia.org/wiki/Blockchain#cite_note-10) Further work on a cryptographically secured chain of blocks was described in 1991 by [Stuart Haber](https://en.wikipedia.org/wiki/Stuart_Haber) and [W. Scott Stornetta](https://en.wikipedia.org/wiki/W._Scott_Stornetta).[[4]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cryptocurrencytech-4)[[11]](https://en.wikipedia.org/wiki/Blockchain#cite_note-11) They wanted to implement a system wherein document [timestamps](https://en.wikipedia.org/wiki/Timestamp) could not be tampered with. In 1992, Haber, Stornetta, and [Dave Bayer](https://en.wikipedia.org/wiki/Dave_Bayer) incorporated [Merkle trees](https://en.wikipedia.org/wiki/Merkle_tree) into the design, which improved its efficiency by allowing several document certificates to be collected into one block.[[4]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cryptocurrencytech-4)[[12]](https://en.wikipedia.org/wiki/Blockchain#cite_note-12) Under their company Surety, their document certificate hashes have been published in [*The New York Times*](https://en.wikipedia.org/wiki/The_New_York_Times) every week since 1995.[[13]](https://en.wikipedia.org/wiki/Blockchain#cite_note-:0-13)

The first decentralized blockchain was conceptualized by a person (or group of people) known as [Satoshi Nakamoto](https://en.wikipedia.org/wiki/Satoshi_Nakamoto) in 2008. Nakamoto improved the design in an important way using a [Hashcash](https://en.wikipedia.org/wiki/Hashcash)-like method to [timestamp](https://en.wikipedia.org/wiki/Timestamp-based_concurrency_control) blocks without requiring them to be signed by a trusted party and introducing a difficulty parameter to stabilize the rate at which blocks are added to the chain.[[4]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cryptocurrencytech-4) The design was implemented the following year by Nakamoto as a core component of the [cryptocurrency](https://en.wikipedia.org/wiki/Cryptocurrency) [bitcoin](https://en.wikipedia.org/wiki/Bitcoin), where it serves as the public ledger for all transactions on the network.[[3]](https://en.wikipedia.org/wiki/Blockchain#cite_note-te20151031-3)

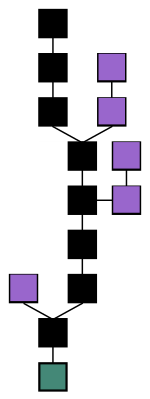
In August 2014, the bitcoin blockchain file size, containing records of all transactions that have occurred on the network, reached 20 GB ([gigabytes](https://en.wikipedia.org/wiki/Gigabyte)).[[14]](https://en.wikipedia.org/wiki/Blockchain#cite_note-14) In January 2015, the size had grown to almost 30 GB, and from January 2016 to January 2017, the bitcoin blockchain grew from 50 GB to 100 GB in size. The ledger size had exceeded 200 GB by early 2020.[[15]](https://en.wikipedia.org/wiki/Blockchain#cite_note-15)

The words *block* and *chain* were used separately in Satoshi Nakamoto's original paper, but were eventually popularized as a single word, *blockchain,* by 2016.[[16]](https://en.wikipedia.org/wiki/Blockchain#cite_note-16)

According to [Accenture](https://en.wikipedia.org/wiki/Accenture), an application of the [diffusion of innovations](https://en.wikipedia.org/wiki/Diffusion_of_innovations) theory suggests that blockchains attained a 13.5% adoption rate within financial services in 2016, therefore reaching the [early adopters](https://en.wikipedia.org/wiki/Early_adopter)' phase.[[17]](https://en.wikipedia.org/wiki/Blockchain#cite_note-17) Industry trade groups joined to create the Global Blockchain Forum in 2016, an initiative of the [Chamber of Digital Commerce](https://en.wikipedia.org/wiki/Chamber_of_Digital_Commerce).

In May 2018, [Gartner](https://en.wikipedia.org/wiki/Gartner) found that only 1% of [CIOs](https://en.wikipedia.org/wiki/Chief_information_officer) indicated any kind of blockchain adoption within their organisations, and only 8% of CIOs were in the short-term "planning or [looking at] active experimentation with blockchain".[[18]](https://en.wikipedia.org/wiki/Blockchain#cite_note-18) For the year 2019 Gartner reported 5% of CIOs believed blockchain technology was a 'game-changer' for their business.[[19]](https://en.wikipedia.org/wiki/Blockchain#cite_note-19)

Structure and design

[](https://en.wikipedia.org/wiki/File:Blockchain.svg)Blockchain formation. The main chain (black) consists of the longest series of blocks from the genesis block (green) to the current block. Orphan blocks (purple) exist outside of the main chain.

A blockchain is a [decentralized](https://en.wikipedia.org/wiki/Decentralized_computing), [distributed](https://en.wikipedia.org/wiki/Distributed_computing), and often public, digital ledger consisting of records called *blocks* that are used to record transactions across many computers so that any involved block cannot be altered retroactively, without the alteration of all subsequent blocks.[[3]](https://en.wikipedia.org/wiki/Blockchain#cite_note-te20151031-3)[[20]](https://en.wikipedia.org/wiki/Blockchain#cite_note-20) This allows the participants to verify and audit transactions independently and relatively inexpensively.[[21]](https://en.wikipedia.org/wiki/Blockchain#cite_note-21) A blockchain database is managed autonomously using a [peer-to-peer](https://en.wikipedia.org/wiki/Peer-to-peer) network and a distributed timestamping server. They are [authenticated](https://en.wikipedia.org/wiki/Authentication) by [mass collaboration](https://en.wikipedia.org/wiki/Mass_collaboration) powered by [collective](https://en.wikipedia.org/wiki/Collective) [self-interests](https://en.wikipedia.org/wiki/Self-interest).[[22]](https://en.wikipedia.org/wiki/Blockchain#cite_note-22) Such a design facilitates [robust](https://en.wikipedia.org/wiki/Robustness_(computer_science)) [workflow](https://en.wikipedia.org/wiki/Workflow) where participants' uncertainty regarding data security is marginal. The use of a blockchain removes the characteristic of infinite [reproducibility](https://en.wikipedia.org/wiki/Reproduction_(economics)) from a [digital asset](https://en.wikipedia.org/wiki/Digital_asset). It confirms that each unit of value was transferred only once, solving the long-standing problem of [double-spending](https://en.wikipedia.org/wiki/Double_spending). A blockchain has been described as a *value-exchange protocol*.[[23]](https://en.wikipedia.org/wiki/Blockchain#cite_note-23) A blockchain can maintain [title rights](https://en.wikipedia.org/wiki/Title_(property)) because, when properly set up to detail the exchange agreement, it provides a record that compels [offer and acceptance](https://en.wikipedia.org/wiki/Offer_and_acceptance).[*[citation needed](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*]

Logically, a blockchain can be seen as consisting of several layers:[[24]](https://en.wikipedia.org/wiki/Blockchain" \l "cite_note-24)

* infrastructure (hardware)
* [networking](https://en.wikipedia.org/wiki/Network_layer) (node discovery, information propagation[[25]](https://en.wikipedia.org/wiki/Blockchain#cite_note-25) and verification)
* [consensus](https://en.wikipedia.org/wiki/Consensus_(computer_science)) ([proof of work](https://en.wikipedia.org/wiki/Proof_of_work), [proof of stake](https://en.wikipedia.org/wiki/Proof_of_stake))
* data (blocks, transactions)
* [application](https://en.wikipedia.org/wiki/Application_layer) ([smart contracts](https://en.wikipedia.org/wiki/Smart_contract)/[decentralized applications](https://en.wikipedia.org/wiki/Decentralized_application), if applicable)

**Blocks**

Blocks hold batches of valid [transactions](https://en.wikipedia.org/wiki/Transaction_processing) that are hashed and encoded into a [Merkle tree](https://en.wikipedia.org/wiki/Merkle_tree).[[3]](https://en.wikipedia.org/wiki/Blockchain#cite_note-te20151031-3) Each block includes the [cryptographic hash](https://en.wikipedia.org/wiki/Cryptographic_hash) of the prior block in the blockchain, linking the two. The linked blocks form a chain.[[3]](https://en.wikipedia.org/wiki/Blockchain#cite_note-te20151031-3) This [iterative](https://en.wikipedia.org/wiki/Iteration) process confirms the integrity of the previous block, all the way back to the initial block, which is known as the *genesis block* (Block 0).[[26]](https://en.wikipedia.org/wiki/Blockchain#cite_note-26)[[27]](https://en.wikipedia.org/wiki/Blockchain#cite_note-hadc-27) To assure the integrity of a block and the data contained in it, the block is usually [digitally signed](https://en.wikipedia.org/wiki/Digital_signature).[[28]](https://en.wikipedia.org/wiki/Blockchain#cite_note-FOOTNOTEKnirschUnterwegerEngel20192-28)

Sometimes separate blocks can be produced concurrently, creating a temporary [fork](https://en.wikipedia.org/wiki/Fork_(blockchain)). In addition to a secure [hash-based](https://en.wikipedia.org/wiki/Hash-based_cryptography) history, any blockchain has a specified algorithm for scoring different versions of the history so that one with a higher score can be selected over others. Blocks not selected for inclusion in the chain are called orphan blocks.[[27]](https://en.wikipedia.org/wiki/Blockchain#cite_note-hadc-27) Peers supporting the database have different versions of the history from time to time. They keep only the highest-scoring version of the database known to them. Whenever a peer receives a higher-scoring version (usually the old version with a single new block added) they extend or overwrite their own database and retransmit the improvement to their peers. There is never an absolute guarantee that any particular entry will remain in the best version of history forever. Blockchains are typically built to add the score of new blocks onto old blocks and are given incentives to extend with new blocks rather than overwrite old blocks. Therefore, the probability of an entry becoming superseded decreases exponentially[[29]](https://en.wikipedia.org/wiki/Blockchain" \l "cite_note-bsm-29) as more blocks are built on top of it, eventually becoming very low.[[3]](https://en.wikipedia.org/wiki/Blockchain#cite_note-te20151031-3)[[30]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t12-30): ch. 08[[31]](https://en.wikipedia.org/wiki/Blockchain#cite_note-paper-31) For example, bitcoin uses a [proof-of-work system](https://en.wikipedia.org/wiki/Proof-of-work_system), where the chain with the most cumulative proof-of-work is considered the valid one by the network. There are a number of methods that can be used to demonstrate a sufficient level of [computation](https://en.wikipedia.org/wiki/Computation). Within a blockchain the computation is carried out redundantly rather than in the traditional segregated and [parallel](https://en.wikipedia.org/wiki/Parallel_computing) manner.[[32]](https://en.wikipedia.org/wiki/Blockchain#cite_note-32)

**Block time**

The *block time* is the average time it takes for the network to generate one extra block in the blockchain. By the time of block completion, the included data becomes verifiable. In cryptocurrency, this is practically when the transaction takes place, so a shorter block time means faster transactions. The block time for [Ethereum](https://en.wikipedia.org/wiki/Ethereum) is set to between 14 and 15 seconds, while for bitcoin it is on average 10 minutes.[[33]](https://en.wikipedia.org/wiki/Blockchain#cite_note-33)

**Hard forks**

*This section is an excerpt from*[*Fork (blockchain) § Hard fork*](https://en.wikipedia.org/wiki/Fork_(blockchain)#Hard_fork)*.*[[edit](https://en.wikipedia.org/w/index.php?title=Fork_(blockchain)&action=edit)]

A *hard fork* is a change to the blockchain protocol that is not backward compatible and requires all users to upgrade their software in order to continue participating in the network. In a hard fork, the network splits into two separate versions: one that follows the new rules and one that follows the old rules.

For example, [Ethereum](https://en.wikipedia.org/wiki/Ethereum) was hard forked in 2016 to "make whole" the investors in [The DAO](https://en.wikipedia.org/wiki/The_DAO_(organization)), which had been hacked by exploiting a vulnerability in its code. In this case, the fork resulted in a split creating [Ethereum](https://en.wikipedia.org/wiki/Ethereum) and [Ethereum Classic](https://en.wikipedia.org/wiki/Ethereum_Classic) chains. In 2014 the [Nxt](https://en.wikipedia.org/wiki/Nxt) community was asked to consider a hard fork that would have led to a rollback of the blockchain records to mitigate the effects of a theft of 50 million NXT from a major [cryptocurrency exchange](https://en.wikipedia.org/wiki/Cryptocurrency_exchange). The hard fork proposal was rejected, and some of the funds were recovered after negotiations and ransom payment. Alternatively, to prevent a permanent split, a majority of nodes using the new software may return to the old rules, as was the case of bitcoin split on 12 March 2013.[[34]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Fork_(blockchain)_ArsFork-34)

A more recent hard-fork example is of [Bitcoin](https://en.wikipedia.org/wiki/Bitcoin) in 2017, which resulted in a split creating [Bitcoin Cash](https://en.wikipedia.org/wiki/Bitcoin_Cash).[[35]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Fork_(blockchain)_bpr-35) The network split was mainly due to a disagreement in how to increase the transactions per second to accommodate for demand.[[36]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Fork_(blockchain)_CNN_2017-08-01-36)

**Decentralization**

By storing data across its [peer-to-peer network](https://en.wikipedia.org/wiki/Peer-to-peer), the blockchain eliminates some risks that come with data being held centrally.[[3]](https://en.wikipedia.org/wiki/Blockchain#cite_note-te20151031-3) The decentralized blockchain may use [ad hoc](https://en.wikipedia.org/wiki/Ad_hoc) [message passing](https://en.wikipedia.org/wiki/Message_passing) and [distributed networking](https://en.wikipedia.org/wiki/Distributed_networking).[[37]](https://en.wikipedia.org/wiki/Blockchain#cite_note-37)

In a so-called "51% attack" a central entity gains control of more than half of a network and can then manipulate that specific blockchain record at will, allowing [double-spending](https://en.wikipedia.org/wiki/Double-spending).[[38]](https://en.wikipedia.org/wiki/Blockchain#cite_note-38)

Blockchain security methods include the use of [public-key cryptography](https://en.wikipedia.org/wiki/Public-key_cryptography).[[39]](https://en.wikipedia.org/wiki/Blockchain#cite_note-primer-39): 5 A *public key* (a long, random-looking string of numbers) is an address on the blockchain. Value tokens sent across the network are recorded as belonging to that address. A *private key* is like a password that gives its owner access to their digital assets or the means to otherwise interact with the various capabilities that blockchains now support. Data stored on the blockchain is generally considered incorruptible.[[3]](https://en.wikipedia.org/wiki/Blockchain#cite_note-te20151031-3)

Every [node](https://en.wikipedia.org/wiki/Node_(networking)) in a decentralized system has a copy of the blockchain. [Data quality](https://en.wikipedia.org/wiki/Data_quality) is maintained by massive database [replication](https://en.wikipedia.org/wiki/Replication_(computing))[[40]](https://en.wikipedia.org/wiki/Blockchain#cite_note-40) and [computational trust](https://en.wikipedia.org/wiki/Computational_trust). No centralized "official" copy exists and no user is "trusted" more than any other.[[39]](https://en.wikipedia.org/wiki/Blockchain#cite_note-primer-39) Transactions are broadcast to the network using the software. Messages are delivered on a [best-effort](https://en.wikipedia.org/wiki/Best-effort_delivery) basis. Early blockchains rely on energy-intensive mining nodes to validate transactions,[[27]](https://en.wikipedia.org/wiki/Blockchain" \l "cite_note-hadc-27) add them to the block they are building, and then [broadcast](https://en.wikipedia.org/wiki/Broadcasting_(networking)) the completed block to other nodes.[[30]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t12-30): ch. 08 Blockchains use various time-stamping schemes, such as [proof-of-work](https://en.wikipedia.org/wiki/Proof-of-work_system), to serialize changes.[[41]](https://en.wikipedia.org/wiki/Blockchain#cite_note-kopstein-41) Later consensus methods include [proof of stake](https://en.wikipedia.org/wiki/Proof-of-stake).[[27]](https://en.wikipedia.org/wiki/Blockchain#cite_note-hadc-27) The growth of a decentralized blockchain is accompanied by the risk of [centralization](https://en.wikipedia.org/wiki/Centrality) because the computer resources required to process larger amounts of data become more expensive.[[42]](https://en.wikipedia.org/wiki/Blockchain#cite_note-42)

**Finality**

Finality is the level of confidence that the well-formed block recently appended to the blockchain will not be revoked in the future (is "finalized") and thus can be trusted. Most distributed blockchain protocols, whether [proof of work](https://en.wikipedia.org/wiki/Proof_of_work) or [proof of stake](https://en.wikipedia.org/wiki/Proof_of_stake), cannot guarantee the finality of a freshly committed block, and instead rely on "probabilistic finality": as the block goes deeper into a blockchain, it is less likely to be altered or reverted by a newly found consensus.[[43]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Deirmentzoglou_et_al-43)

[Byzantine fault tolerance](https://en.wikipedia.org/wiki/Byzantine_fault_tolerance)-based proof-of-stake protocols purport to provide so called "absolute finality": a randomly chosen [validator](https://en.wikipedia.org/wiki/Validator_(blockchain)) proposes a block, the rest of validators vote on it, and, if a supermajority decision approves it, the block is irreversibly committed into the blockchain.[[43]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Deirmentzoglou_et_al-43) A modification of this method, an "economic finality", is used in practical protocols, like the Casper protocol used in [Ethereum](https://en.wikipedia.org/wiki/Ethereum): validators which sign two different blocks at the same position in the blockchain are subject to "slashing", where their leveraged stake is forfeited.[[43]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Deirmentzoglou_et_al-43)

**Openness**

Open blockchains are more [user-friendly](https://en.wikipedia.org/wiki/Usability) than some traditional ownership records, which, while open to the public, still require physical access to view. Because all early blockchains were permissionless, controversy has arisen over the blockchain definition. An issue in this ongoing debate is whether a private system with verifiers tasked and authorized (permissioned) by a central authority should be considered a blockchain.[[44]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t16-44)[[45]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t10-45)[[46]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t11-46)[[47]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t8-47)[[48]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t9-48) Proponents of permissioned or private chains argue that the term "blockchain" may be applied to any **data structure** that batches data into time-stamped blocks. These blockchains serve as a distributed version of [multiversion concurrency control](https://en.wikipedia.org/wiki/Multiversion_concurrency_control) (MVCC) in databases.[[49]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t4-49) Just as MVCC prevents two transactions from concurrently modifying a single object in a database, blockchains prevent two transactions from spending the same single output in a blockchain.[[50]](https://en.wikipedia.org/wiki/Blockchain#cite_note-tapscott201605-50): 30–31 Opponents say that permissioned systems resemble traditional corporate databases, not supporting decentralized data verification, and that such systems are not hardened against operator tampering and revision.[[44]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t16-44)[[46]](https://en.wikipedia.org/wiki/Blockchain#cite_note-t11-46) Nikolai Hampton of [*Computerworld*](https://en.wikipedia.org/wiki/Computerworld) said that "many in-house blockchain solutions will be nothing more than cumbersome databases," and "without a clear security model, proprietary blockchains should be eyed with suspicion."[[8]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cw20160905-8)[[51]](https://en.wikipedia.org/wiki/Blockchain#cite_note-51)

**Permissionless (public) blockchain**

An advantage to an open, permissionless, or public, blockchain network is that guarding against bad actors is not required and no [access control](https://en.wikipedia.org/wiki/Access_control) is needed.[[29]](https://en.wikipedia.org/wiki/Blockchain#cite_note-bsm-29) This means that applications can be added to the network without the approval or trust of others, using the blockchain as a [transport layer](https://en.wikipedia.org/wiki/Transport_layer).[[29]](https://en.wikipedia.org/wiki/Blockchain#cite_note-bsm-29)

Bitcoin and other cryptocurrencies currently secure their blockchain by requiring new entries to include proof of work. To prolong the blockchain, bitcoin uses [Hashcash](https://en.wikipedia.org/wiki/Hashcash) puzzles. While Hashcash was designed in 1997 by [Adam Back](https://en.wikipedia.org/wiki/Adam_Back), the original idea was first proposed by [Cynthia Dwork](https://en.wikipedia.org/wiki/Cynthia_Dwork) and [Moni Naor](https://en.wikipedia.org/wiki/Moni_Naor) and Eli Ponyatovski in their 1992 paper "Pricing via Processing or Combatting Junk Mail".

In 2016, [venture capital](https://en.wikipedia.org/wiki/Venture_capital) investment for blockchain-related projects was weakening in the USA but increasing in China.[[52]](https://en.wikipedia.org/wiki/Blockchain#cite_note-btt17-52) Bitcoin and many other cryptocurrencies use open (public) blockchains. As of April 2018, bitcoin has the highest [market capitalization](https://en.wikipedia.org/wiki/Cryptocurrency#Price_trends).

**Permissioned (private) blockchain**

*See also:*[*Distributed ledger*](https://en.wikipedia.org/wiki/Distributed_ledger)

Permissioned blockchains use an access control layer to govern who has access to the network.[[53]](https://en.wikipedia.org/wiki/Blockchain#cite_note-btit-53) It has been argued that permissioned blockchains can guarantee a certain level of decentralization, if carefully designed, as opposed to permissionless blockchains, which are often centralized in practice.[[9]](https://en.wikipedia.org/wiki/Blockchain#cite_note-auto-9)

**Disadvantages of permissioned blockchain**

Nikolai Hampton argued in [*Computerworld*](https://en.wikipedia.org/wiki/Computerworld) that "There is also no need for a '51 percent' attack on a private blockchain, as the private blockchain (most likely) already controls 100 percent of all block creation resources. If you could attack or damage the blockchain creation tools on a private corporate server, you could effectively control 100 percent of their network and alter transactions however you wished."[[8]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cw20160905-8) This has a set of particularly profound adverse implications during a [financial crisis](https://en.wikipedia.org/wiki/Financial_crisis) or [debt crisis](https://en.wikipedia.org/wiki/Debt_crisis) like the [financial crisis of 2007–08](https://en.wikipedia.org/wiki/Financial_crisis_of_2007%E2%80%9308), where politically powerful actors may make decisions that favor some groups at the expense of others,[[54]](https://en.wikipedia.org/wiki/Blockchain#cite_note-54) and "the bitcoin blockchain is protected by the massive group mining effort. It's unlikely that any private blockchain will try to protect records using [gigawatts](https://en.wikipedia.org/wiki/Gigawatts) of computing power — it's time-consuming and expensive."[[8]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cw20160905-8) He also said, "Within a private blockchain there is also no 'race'; there's no incentive to use more power or discover blocks faster than competitors. This means that many in-house blockchain solutions will be nothing more than cumbersome databases."[[8]](https://en.wikipedia.org/wiki/Blockchain#cite_note-cw20160905-8)

**Blockchain analysis**

The [analysis of public blockchains](https://en.wikipedia.org/wiki/Blockchain_analysis) has become increasingly important with the popularity of [bitcoin](https://en.wikipedia.org/wiki/Bitcoin), [Ethereum](https://en.wikipedia.org/wiki/Ethereum), [litecoin](https://en.wikipedia.org/wiki/Litecoin) and other [cryptocurrencies](https://en.wikipedia.org/wiki/Cryptocurrencies).[[55]](https://en.wikipedia.org/wiki/Blockchain#cite_note-55) A blockchain, if it is public, provides anyone who wants access to observe and analyse the chain data, given one has the know-how. The process of understanding and accessing the flow of crypto has been an issue for many cryptocurrencies, crypto exchanges and banks.[[56]](https://en.wikipedia.org/wiki/Blockchain#cite_note-56)[[57]](https://en.wikipedia.org/wiki/Blockchain#cite_note-57) The reason for this is accusations of blockchain-enabled cryptocurrencies enabling illicit [dark market](https://en.wikipedia.org/wiki/Darknet_market) trade of drugs, weapons, money laundering, etc.[[58]](https://en.wikipedia.org/wiki/Blockchain#cite_note-58) A common belief has been that cryptocurrency is private and untraceable, thus leading many actors to use it for illegal purposes. This is changing and now specialised tech companies provide blockchain tracking services, making crypto exchanges, law-enforcement and banks more aware of what is happening with crypto funds and [fiat](https://en.wikipedia.org/wiki/Fiat_money)-crypto exchanges. The development, some argue, has led criminals to prioritise the use of new cryptos such as [Monero](https://en.wikipedia.org/wiki/Monero_(cryptocurrency)).[[59]](https://en.wikipedia.org/wiki/Blockchain#cite_note-59)[[60]](https://en.wikipedia.org/wiki/Blockchain#cite_note-60)[[61]](https://en.wikipedia.org/wiki/Blockchain#cite_note-61)

**Standardisation**

In April 2016, [Standards Australia](https://en.wikipedia.org/wiki/Standards_Australia) submitted a proposal to the [International Organization for Standardization](https://en.wikipedia.org/wiki/International_Organization_for_Standardization) to consider developing standards to support blockchain technology. This proposal resulted in the creation of ISO Technical Committee 307, Blockchain and Distributed Ledger Technologies.[[62]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Blockchain-62) The technical committee has working groups relating to blockchain terminology, reference architecture, security and privacy, identity, smart contracts, governance and interoperability for blockchain and DLT, as well as standards specific to industry sectors and generic government requirements.[[63]](https://en.wikipedia.org/wiki/Blockchain#cite_note-ISO/TC_307_Blockchain_and_distributed_ledger_technologies-63)[[*non-primary source needed*](https://en.wikipedia.org/wiki/Wikipedia:No_original_research#Primary,_secondary_and_tertiary_sources)] More than 50 countries are participating in the standardization process together with external liaisons such as the [Society for Worldwide Interbank Financial Telecommunication](https://en.wikipedia.org/wiki/Society_for_Worldwide_Interbank_Financial_Telecommunication) (SWIFT), the [European Commission](https://en.wikipedia.org/wiki/European_Commission), the [International Federation of Surveyors](https://en.wikipedia.org/wiki/International_Federation_of_Surveyors), the [International Telecommunication Union](https://en.wikipedia.org/wiki/International_Telecommunication_Union) (ITU) and the [United Nations Economic Commission for Europe](https://en.wikipedia.org/wiki/United_Nations_Economic_Commission_for_Europe) (UNECE).[[63]](https://en.wikipedia.org/wiki/Blockchain#cite_note-ISO/TC_307_Blockchain_and_distributed_ledger_technologies-63)

Many other national standards bodies and open standards bodies are also working on blockchain standards.[[64]](https://en.wikipedia.org/wiki/Blockchain#cite_note-64) These include the [National Institute of Standards and Technology](https://en.wikipedia.org/wiki/National_Institute_of_Standards_and_Technology)[[65]](https://en.wikipedia.org/wiki/Blockchain#cite_note-BLOCKCHAIN_Overview-65) (NIST), the [European Committee for Electrotechnical Standardization](https://en.wikipedia.org/wiki/European_Committee_for_Electrotechnical_Standardization)[[66]](https://en.wikipedia.org/wiki/Blockchain#cite_note-CEN_and_CENELEC_publish_a_White_Paper_on_standards_in_Blockchain_&_Distributed_Ledger_Technologies-66) (CENELEC), the [Institute of Electrical and Electronics Engineers](https://en.wikipedia.org/wiki/Institute_of_Electrical_and_Electronics_Engineers)[[67]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Standards-67) (IEEE), the Organization for the Advancement of Structured Information Standards ([OASIS](https://en.wikipedia.org/wiki/OASIS_(organization))), and some individual participants in the [Internet Engineering Task Force](https://en.wikipedia.org/wiki/Internet_Engineering_Task_Force)[[68]](https://en.wikipedia.org/wiki/Blockchain#cite_note-An_Interoperability_Architecture_for_Blockchain/DLT_Gateways_draft-hardjono-blockchain-interop-arch-02-68) (IETF).

**Centralized blockchain**

Although most of blockchain implementation are decentralized and distributed, [Oracle](https://en.wikipedia.org/wiki/Oracle_Corporation) launched a centralized blockchain table feature in [Oracle 21c database](https://en.wikipedia.org/wiki/Oracle_Database). The Blockchain Table in [Oracle 21c database](https://en.wikipedia.org/wiki/Oracle_Database) is a centralized blockchain which provide immutable feature. Compared to decentralized blockchains, centralized blockchains normally can provide a higher throughput and lower latency of transactions than consensus-based distributed blockchains.[[69]](https://en.wikipedia.org/wiki/Blockchain#cite_note-OracleBlockchainDetails-69)[[70]](https://en.wikipedia.org/wiki/Blockchain#cite_note-OracleBlockchainTable-70)

Types

Currently, there are at least four types of blockchain networks — public blockchains, private blockchains, [consortium](https://en.wikipedia.org/wiki/Consortium) blockchains and hybrid blockchains.

**Public blockchains**

A public blockchain has absolutely no access restrictions. Anyone with an [Internet](https://en.wikipedia.org/wiki/Internet) connection can send [transactions](https://en.wikipedia.org/wiki/Financial_transaction) to it as well as become a validator (i.e., participate in the execution of a [consensus protocol](https://en.wikipedia.org/wiki/Consensus_(computer_science))).[[71]](https://en.wikipedia.org/wiki/Blockchain#cite_note-71)[[*self-published source?*](https://en.wikipedia.org/wiki/Wikipedia:Verifiability#Self-published_sources)] Usually, such networks offer [economic incentives](https://en.wikipedia.org/wiki/Incentive) for those who secure them and utilize some type of a [proof-of-stake](https://en.wikipedia.org/wiki/Proof-of-stake) or [proof-of-work](https://en.wikipedia.org/wiki/Proof-of-work) algorithm.

Some of the largest, most known public blockchains are the bitcoin blockchain and the Ethereum blockchain.

**Private blockchains**

A private blockchain is permissioned.[[53]](https://en.wikipedia.org/wiki/Blockchain#cite_note-btit-53) One cannot join it unless invited by the network administrators. Participant and validator access is [restricted](https://en.wikipedia.org/wiki/Closed_platform). To distinguish between open blockchains and other peer-to-peer decentralized database applications that are not open ad-hoc compute clusters, the terminology [Distributed Ledger](https://en.wikipedia.org/wiki/Distributed_Ledger) (DLT) is normally used for private blockchains.

**Hybrid blockchains**

A hybrid blockchain has a combination of centralized and decentralized features.[[72]](https://en.wikipedia.org/wiki/Blockchain#cite_note-72) The exact workings of the chain can vary based on which portions of centralization and decentralization are used.

**Sidechains**

A sidechain is a designation for a blockchain ledger that runs in parallel to a primary blockchain.[[73]](https://en.wikipedia.org/wiki/Blockchain#cite_note-73)[[74]](https://en.wikipedia.org/wiki/Blockchain#cite_note-74) Entries from the primary blockchain (where said entries typically represent [digital assets](https://en.wikipedia.org/wiki/Digital_asset)) can be linked to and from the sidechain; this allows the sidechain to otherwise operate independently of the primary blockchain (e.g., by using an alternate means of record keeping, alternate [consensus algorithm](https://en.wikipedia.org/wiki/Consensus_(computer_science)), etc.).[[75]](https://en.wikipedia.org/wiki/Blockchain#cite_note-75)[[*better source needed*](https://en.wikipedia.org/wiki/Wikipedia:NOTRS)]

**Consortium blockchain**

A consortium blockchain is a type of blockchain that combines elements of both public and private blockchains. In a consortium blockchain, a group of organizations come together to create and operate the blockchain, rather than a single entity. The consortium members jointly manage the blockchain network and are responsible for validating transactions. Consortium blockchains are permissioned, meaning that only certain individuals or organizations are allowed to participate in the network. This allows for greater control over who can access the blockchain and helps to ensure that sensitive information is kept confidential.

Consortium blockchains are commonly used in industries where multiple organizations need to collaborate on a common goal, such as supply chain management or financial services. One advantage of consortium blockchains is that they can be more efficient and scalable than public blockchains, as the number of nodes required to validate transactions is typically smaller. Additionally, consortium blockchains can provide greater security and reliability than private blockchains, as the consortium members work together to maintain the network. Some examples of consortium blockchains include [Quorum](https://en.wikipedia.org/wiki/Quorum) and [Hyperledger](https://en.wikipedia.org/wiki/Hyperledger).[[76]](https://en.wikipedia.org/wiki/Blockchain#cite_note-76)

Uses

[](https://en.wikipedia.org/wiki/File:Bitcoin.svg)[Bitcoin's](https://en.wikipedia.org/wiki/Bitcoin) transactions are recorded on a publicly viewable blockchain.

Blockchain technology can be integrated into multiple areas. The primary use of blockchains is as a [distributed ledger](https://en.wikipedia.org/wiki/Distributed_ledger) for [cryptocurrencies](https://en.wikipedia.org/wiki/Cryptocurrency) such as [bitcoin](https://en.wikipedia.org/wiki/Bitcoin); there were also a few other operational products that had matured from [proof of concept](https://en.wikipedia.org/wiki/Proof_of_concept) by late 2016.[[52]](https://en.wikipedia.org/wiki/Blockchain#cite_note-btt17-52) As of 2016, some businesses have been testing the technology and conducting low-level implementation to gauge blockchain's effects on organizational efficiency in their [back office](https://en.wikipedia.org/wiki/Back_office).[[77]](https://en.wikipedia.org/wiki/Blockchain#cite_note-77)

In 2019, it was estimated that around $2.9 billion were invested in blockchain technology, which represents an 89% increase from the year prior. Additionally, the International Data Corp has estimated that corporate investment into blockchain technology will reach $12.4 billion by 2022.[[78]](https://en.wikipedia.org/wiki/Blockchain#cite_note-78) Furthermore, According to [PricewaterhouseCoopers](https://en.wikipedia.org/wiki/PricewaterhouseCoopers) (PwC), the second-largest professional services network in the world, blockchain technology has the potential to generate an annual business value of more than $3 trillion by 2030. PwC's estimate is further augmented by a 2018 study that they have conducted, in which PwC surveyed 600 business executives and determined that 84% have at least some exposure to utilizing blockchain technology, which indicates a significant demand and interest in blockchain technology.[[79]](https://en.wikipedia.org/wiki/Blockchain#cite_note-79)

In 2019, the [BBC World Service](https://en.wikipedia.org/wiki/BBC_World_Service) radio and podcast series [*Fifty Things That Made the Modern Economy*](https://en.wikipedia.org/wiki/50_Things_That_Made_the_Modern_Economy) identified blockchain as a technology that would have far-reaching consequences for economics and society. The economist and *Financial Times* journalist and broadcaster [Tim Harford](https://en.wikipedia.org/wiki/Tim_Harford) discussed why the underlying technology might have much wider applications and the challenges that needed to be overcome.[[80]](https://en.wikipedia.org/wiki/Blockchain#cite_note-80) His first broadcast was on June 29, 2019.

The number of blockchain wallets quadrupled to 40 million between 2016 and 2020.[[81]](https://en.wikipedia.org/wiki/Blockchain#cite_note-81)

A paper published in 2022 discussed the potential use of blockchain technology in [sustainable management](https://en.wikipedia.org/wiki/Sustainable_management).[[82]](https://en.wikipedia.org/wiki/Blockchain#cite_note-82)

**Cryptocurrencies**

*Main article:*[*Cryptocurrency*](https://en.wikipedia.org/wiki/Cryptocurrency)

Most cryptocurrencies use blockchain technology to record transactions. For example, the [bitcoin network](https://en.wikipedia.org/wiki/Bitcoin_network) and [Ethereum](https://en.wikipedia.org/wiki/Ethereum) network are both based on blockchain.

The criminal enterprise [Silk Road](https://en.wikipedia.org/wiki/Silk_Road_(marketplace)), which operated on [Tor](https://en.wikipedia.org/wiki/Tor_(anonymity_network)), utilized cryptocurrency for payments, some of which the [US federal government](https://en.wikipedia.org/wiki/US_federal_government) has seized through research on the blockchain and [forfeiture.](https://en.wikipedia.org/wiki/Forfeiture_(law))[[83]](https://en.wikipedia.org/wiki/Blockchain#cite_note-83)

[Governments have mixed policies](https://en.wikipedia.org/wiki/Legality_of_bitcoin_by_country_or_territory) on the legality of their citizens or banks owning cryptocurrencies. China implements blockchain technology in several industries including a [national digital currency](https://en.wikipedia.org/wiki/Central_bank_digital_currency) which launched in 2020.[[84]](https://en.wikipedia.org/wiki/Blockchain#cite_note-84) To strengthen their respective currencies, Western governments including the European Union and the United States have initiated similar projects.[[85]](https://en.wikipedia.org/wiki/Blockchain#cite_note-85)

**Smart contracts**

*Main article:*[*Smart contract*](https://en.wikipedia.org/wiki/Smart_contract)

Blockchain-based [smart contracts](https://en.wikipedia.org/wiki/Smart_contract) are contracts that can be partially or fully executed or enforced without human interaction.[[86]](https://en.wikipedia.org/wiki/Blockchain#cite_note-86) One of the main objectives of a smart contract is [automated](https://en.wikipedia.org/wiki/Automation) [escrow](https://en.wikipedia.org/wiki/Escrow). A key feature of smart contracts is that they do not need a trusted third party (such as a trustee) to act as an intermediary between contracting entities — the blockchain network executes the contract on its own. This may reduce friction between entities when transferring value and could subsequently open the door to a higher level of transaction automation.[[87]](https://en.wikipedia.org/wiki/Blockchain#cite_note-87) An [IMF](https://en.wikipedia.org/wiki/International_Monetary_Fund) staff discussion from 2018 reported that smart contracts based on blockchain technology might reduce [moral hazards](https://en.wikipedia.org/wiki/Moral_hazard) and optimize the use of contracts in general. But "no viable smart contract systems have yet emerged." Due to the lack of widespread use, their legal status was unclear.[[88]](https://en.wikipedia.org/wiki/Blockchain#cite_note-88)[[89]](https://en.wikipedia.org/wiki/Blockchain#cite_note-89)

**Financial services**

According to [*Reason*](https://en.wikipedia.org/wiki/Reason_(magazine)), many banks have expressed interest in implementing [distributed ledgers](https://en.wikipedia.org/wiki/Distributed_ledger) for use in [banking](https://en.wikipedia.org/wiki/Banking) and are cooperating with companies creating private blockchains,[[90]](https://en.wikipedia.org/wiki/Blockchain#cite_note-90)[[91]](https://en.wikipedia.org/wiki/Blockchain#cite_note-91)[[92]](https://en.wikipedia.org/wiki/Blockchain#cite_note-92) and according to a September 2016 [IBM](https://en.wikipedia.org/wiki/IBM) study, this is occurring faster than expected.[[93]](https://en.wikipedia.org/wiki/Blockchain#cite_note-93)

Banks are interested in this technology not least because it has the potential to speed up [back office](https://en.wikipedia.org/wiki/Back_office) settlement systems.[[94]](https://en.wikipedia.org/wiki/Blockchain#cite_note-94) Moreover, as the blockchain industry has reached early maturity institutional appreciation has grown that it is, practically speaking, the infrastructure of a whole new financial industry, with all the implications which that entails.[[95]](https://en.wikipedia.org/wiki/Blockchain#cite_note-95)

[Banks](https://en.wikipedia.org/wiki/Bank) such as [UBS](https://en.wikipedia.org/wiki/UBS) are opening new research labs dedicated to blockchain technology in order to explore how blockchain can be used in financial services to increase efficiency and reduce costs.[[96]](https://en.wikipedia.org/wiki/Blockchain#cite_note-96)[[97]](https://en.wikipedia.org/wiki/Blockchain#cite_note-97)

[Berenberg](https://en.wikipedia.org/wiki/Berenberg_Bank), a German bank, believes that blockchain is an "overhyped technology" that has had a large number of "proofs of concept", but still has major challenges, and very few success stories.[[98]](https://en.wikipedia.org/wiki/Blockchain#cite_note-98)

The blockchain has also given rise to [initial coin offerings](https://en.wikipedia.org/wiki/Initial_coin_offering) (ICOs) as well as a new category of digital asset called security token offerings (STOs), also sometimes referred to as digital security offerings (DSOs).[[99]](https://en.wikipedia.org/wiki/Blockchain#cite_note-99) STO/DSOs may be conducted privately or on public, regulated stock exchange and are used to tokenize traditional assets such as company shares as well as more innovative ones like intellectual property, real estate,[[100]](https://en.wikipedia.org/wiki/Blockchain#cite_note-100) art, or individual products. A number of companies are active in this space providing services for compliant [tokenization](https://en.wikipedia.org/wiki/Tokenization_(data_security)), private STOs, and public STOs.

**Games**

*Main article:*[*Blockchain game*](https://en.wikipedia.org/wiki/Blockchain_game)

Blockchain technology, such as cryptocurrencies and [non-fungible tokens](https://en.wikipedia.org/wiki/Non-fungible_token) (NFTs), has been used in video games for [monetization](https://en.wikipedia.org/wiki/Video_game_monetization). Many [live-service games](https://en.wikipedia.org/wiki/Games_as_a_service) offer in-game customization options, such as character skins or other in-game items, which the players can earn and trade with other players using in-game currency. Some games also allow for trading of virtual items using real-world currency, but this may be illegal in some countries where video games are seen as akin to gambling, and has led to [gray market](https://en.wikipedia.org/wiki/Gray_market) issues such as [skin gambling](https://en.wikipedia.org/wiki/Skin_gambling), and thus publishers typically have shied away from allowing players to earn real-world funds from games.[[101]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Verge-Valve-101) Blockchain games typically allow players to trade these in-game items for cryptocurrency, which can then be exchanged for money.[[102]](https://en.wikipedia.org/wiki/Blockchain#cite_note-inverse_blockchain_games-102)

The first known game to use blockchain technologies was [*CryptoKitties*](https://en.wikipedia.org/wiki/CryptoKitties), launched in November 2017, where the player would purchase NFTs with Ethereum cryptocurrency, each NFT consisting of a [virtual pet](https://en.wikipedia.org/wiki/Virtual_pet) that the player could breed with others to create offspring with combined traits as new NFTs.[[103]](https://en.wikipedia.org/wiki/Blockchain#cite_note-103)[[102]](https://en.wikipedia.org/wiki/Blockchain#cite_note-inverse_blockchain_games-102) The game made headlines in December 2017 when one virtual pet sold for more than [US$](https://en.wikipedia.org/wiki/United_States_dollar)100,000.[[104]](https://en.wikipedia.org/wiki/Blockchain#cite_note-104) *CryptoKitties* also illustrated scalability problems for games on Ethereum when it created significant congestion on the Ethereum network in early 2018 with approximately 30% of all Ethereum transactions[[*clarification needed*](https://en.wikipedia.org/wiki/Wikipedia:Please_clarify)] being for the game.[[105]](https://en.wikipedia.org/wiki/Blockchain#cite_note-105)[[106]](https://en.wikipedia.org/wiki/Blockchain#cite_note-106)

By the early 2020s, there had not been a breakout success in video games using blockchain, as these games tend to focus on using blockchain for speculation instead of more traditional forms of gameplay, which offers limited appeal to most players. Such games also represent a high risk to investors as their revenues can be difficult to predict.[[102]](https://en.wikipedia.org/wiki/Blockchain#cite_note-inverse_blockchain_games-102) However, limited successes of some games, such as [*Axie Infinity*](https://en.wikipedia.org/wiki/Axie_Infinity) during the [COVID-19 pandemic](https://en.wikipedia.org/wiki/COVID-19_pandemic), and corporate plans towards [metaverse](https://en.wikipedia.org/wiki/Metaverse) content, refueled interest in the area of GameFi, a term describing the intersection of video games and financing typically backed by blockchain currency, in the second half of 2021.[[107]](https://en.wikipedia.org/wiki/Blockchain#cite_note-107) Several major publishers, including [Ubisoft](https://en.wikipedia.org/wiki/Ubisoft), [Electronic Arts](https://en.wikipedia.org/wiki/Electronic_Arts), and [Take Two Interactive](https://en.wikipedia.org/wiki/Take_Two_Interactive), have stated that blockchain and NFT-based games are under serious consideration for their companies in the future.[[108]](https://en.wikipedia.org/wiki/Blockchain#cite_note-108)

In October 2021, [Valve Corporation](https://en.wikipedia.org/wiki/Valve_Corporation) banned blockchain games, including those using cryptocurrency and [NFTs](https://en.wikipedia.org/wiki/Non-fungible_token), from being hosted on its [Steam](https://en.wikipedia.org/wiki/Steam_(service)) digital storefront service, which is widely used for personal computer gaming, claiming that this was an extension of their policy banning games that offered in-game items with real-world value. Valve's prior history with [gambling](https://en.wikipedia.org/wiki/Gambling), specifically [skin gambling](https://en.wikipedia.org/wiki/Skin_gambling), was speculated to be a factor in the decision to ban blockchain games.[[109]](https://en.wikipedia.org/wiki/Blockchain#cite_note-pcgamer-109) Journalists and players responded positively to Valve's decision as blockchain and NFT games have a reputation for scams and fraud among most PC gamers,[[101]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Verge-Valve-101)[[109]](https://en.wikipedia.org/wiki/Blockchain#cite_note-pcgamer-109) and [Epic Games](https://en.wikipedia.org/wiki/Epic_Games), which runs the [Epic Games Store](https://en.wikipedia.org/wiki/Epic_Games_Store) in competition to Steam, said that they would be open to accepted blockchain games in the wake of Valve's refusal.[[110]](https://en.wikipedia.org/wiki/Blockchain#cite_note-110)

**Supply chain**

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| --- | --- |
| https://upload.wikimedia.org/wikipedia/commons/thumb/b/bd/Ambox_current_red_Asia_Australia.svg/42px-Ambox_current_red_Asia_Australia.svg.png | This section needs to be **updated**. Please help update this article to reflect recent events or newly available information. *(August 2023)* |

There have been several different efforts to employ blockchains in [supply chain management](https://en.wikipedia.org/wiki/Supply_chain_management).

* [**Precious commodities mining**](https://en.wikipedia.org/wiki/Mining) — Blockchain technology has been used for tracking the origins of gemstones and other precious commodities. In 2016, [*The Wall Street Journal*](https://en.wikipedia.org/wiki/The_Wall_Street_Journal) reported that the blockchain technology company Everledger was partnering with [IBM](https://en.wikipedia.org/wiki/IBM)'s blockchain-based tracking service to trace the origin of diamonds to ensure that they were ethically mined.[[111]](https://en.wikipedia.org/wiki/Blockchain#cite_note-111) As of 2019, the [Diamond Trading Company](https://en.wikipedia.org/wiki/Diamond_Trading_Company) (DTC) has been involved in building a diamond trading supply chain product called Tracer.[[112]](https://en.wikipedia.org/wiki/Blockchain#cite_note-Wharton,_Gstettner_July_30,_2019-112)
* [**Food supply**](https://en.wikipedia.org/wiki/Food_supply) — As of 2018, [Walmart](https://en.wikipedia.org/wiki/Walmart) and [IBM](https://en.wikipedia.org/wiki/IBM) were running a trial to use a blockchain-backed system for [supply chain](https://en.wikipedia.org/wiki/Supply_chain) monitoring for lettuce and spinach — all nodes of the blockchain were administered by Walmart and were located on the IBM [cloud](https://en.wikipedia.org/wiki/Cloud_computing).[[113]](https://en.wikipedia.org/wiki/Blockchain#cite_note-113)
* [**Fashion industry**](https://en.wikipedia.org/wiki/Fashion_industry) — There is an opaque relationship between brands, distributors, and customers in the fashion industry, which prevents the sustainable and stable development of the fashion industry. Blockchain makes up for this shortcoming and makes information transparent, solving the difficulty of sustainable development of the industry.[[114]](https://en.wikipedia.org/wiki/Blockchain#cite_note-114)
* **Motor vehicles** — [Mercedes-Benz](https://en.wikipedia.org/wiki/Mercedes-Benz) and partner [Icertis](https://en.wikipedia.org/wiki/Icertis) developed a blockchain prototype used to facilitate consistent documentation of contracts along the supply chain so that the [ethical standards](https://en.wikipedia.org/wiki/Ethical_standard) and contractual obligations required of its direct suppliers can be passed on to second tier suppliers and beyond.[[115]](https://en.wikipedia.org/wiki/Blockchain#cite_note-115)[[116]](https://en.wikipedia.org/wiki/Blockchain#cite_note-116) In another project, the company uses blockchain technology to track the emissions of climate-relevant gases and the amount of secondary material along the supply chain for its [battery cell](https://en.wikipedia.org/wiki/Battery_cell) manufacturers.[[117]](https://en.wikipedia.org/wiki/Blockchain#cite_note-117)

**Domain names**

There are several different efforts to offer [domain name](https://en.wikipedia.org/wiki/Domain_name) services via the blockchain. These domain names can be controlled by the use of a private key, which purports to allow for uncensorable websites. This would also bypass a registrar's ability to suppress domains used for fraud, abuse, or illegal content.[[118]](https://en.wikipedia.org/wiki/Blockchain#cite_note-techrepublic-118)

[Namecoin](https://en.wikipedia.org/wiki/Namecoin) is a cryptocurrency that supports the ".bit" [top-level domain](https://en.wikipedia.org/wiki/Top-level_domain) (TLD). Namecoin was forked from bitcoin in 2011. The .bit TLD is not sanctioned by [ICANN](https://en.wikipedia.org/wiki/ICANN), instead requiring an [alternative DNS root](https://en.wikipedia.org/wiki/Alternative_DNS_root).[[118]](https://en.wikipedia.org/wiki/Blockchain#cite_note-techrepublic-118) As of 2015, .bit was used by 28 websites, out of 120,000 registered names.[[119]](https://en.wikipedia.org/wiki/Blockchain#cite_note-orcutt-119) Namecoin was dropped by [OpenNIC](https://en.wikipedia.org/wiki/OpenNIC) in 2019, due to malware and potential other legal issues.[[120]](https://en.wikipedia.org/wiki/Blockchain#cite_note-120) Other blockchain alternatives to ICANN include *The Handshake Network*,[[119]](https://en.wikipedia.org/wiki/Blockchain" \l "cite_note-orcutt-119) *EmerDNS*, and *Unstoppable Domains*.[[118]](https://en.wikipedia.org/wiki/Blockchain#cite_note-techrepublic-118)

Specific TLDs include ".eth", ".luxe", and ".kred", which are associated with the Ethereum blockchain through the Ethereum Name Service (ENS). The .kred TLD also acts as an alternative to conventional [cryptocurrency wallet](https://en.wikipedia.org/wiki/Cryptocurrency_wallet) addresses as a convenience for transferring cryptocurrency.[[121]](https://en.wikipedia.org/wiki/Blockchain#cite_note-121)

**Other uses**

Blockchain technology can be used to create a permanent, public, transparent ledger system for compiling data on sales, tracking digital use and payments to content creators, such as wireless users[[122]](https://en.wikipedia.org/wiki/Blockchain" \l "cite_note-122) or musicians.[[123]](https://en.wikipedia.org/wiki/Blockchain#cite_note-123) The Gartner 2019 CIO Survey reported 2% of higher education respondents had launched blockchain projects and another 18% were planning academic projects in the next 24 months.[[124]](https://en.wikipedia.org/wiki/Blockchain#cite_note-124) In 2017, [IBM](https://en.wikipedia.org/wiki/IBM) partnered with [ASCAP](https://en.wikipedia.org/wiki/ASCAP) and [PRS for Music](https://en.wikipedia.org/wiki/PRS_for_Music) to adopt blockchain technology in music distribution.[[125]](https://en.wikipedia.org/wiki/Blockchain#cite_note-125) [Imogen Heap](https://en.wikipedia.org/wiki/Imogen_Heap)'s Mycelia service has also been proposed as a blockchain-based alternative "that gives artists more control over how their songs and associated data circulate among fans and other musicians."[[126]](https://en.wikipedia.org/wiki/Blockchain#cite_note-126)[[127]](https://en.wikipedia.org/wiki/Blockchain#cite_note-127)

New distribution methods are available for the [insurance](https://en.wikipedia.org/wiki/Insurance) industry such as [peer-to-peer insurance](https://en.wikipedia.org/wiki/Peer-to-peer_insurance), [parametric insurance](https://en.wikipedia.org/wiki/Parametric_insurance) and [microinsurance](https://en.wikipedia.org/wiki/Microinsurance) following the adoption of blockchain.[[128]](https://en.wikipedia.org/wiki/Blockchain#cite_note-128)[[129]](https://en.wikipedia.org/wiki/Blockchain#cite_note-129) The [sharing economy](https://en.wikipedia.org/wiki/Sharing_economy) and [IoT](https://en.wikipedia.org/wiki/Internet_of_Things) are also set to benefit from blockchains because they involve many collaborating peers.[[130]](https://en.wikipedia.org/wiki/Blockchain#cite_note-130) The use of blockchain in libraries is being studied with a grant from the U.S. Institute of Museum and Library Services.[[131]](https://en.wikipedia.org/wiki/Blockchain#cite_note-131)

Other blockchain designs include [Hyperledger](https://en.wikipedia.org/wiki/Hyperledger), a collaborative effort from the [Linux Foundation](https://en.wikipedia.org/wiki/Linux_Foundation) to support blockchain-based distributed ledgers, with projects under this initiative including Hyperledger Burrow (by Monax) and Hyperledger Fabric (spearheaded by IBM).[[132]](https://en.wikipedia.org/wiki/Blockchain#cite_note-132)[[133]](https://en.wikipedia.org/wiki/Blockchain#cite_note-133)[[134]](https://en.wikipedia.org/wiki/Blockchain#cite_note-134) Another is Quorum, a permissioned private blockchain by [JPMorgan Chase](https://en.wikipedia.org/wiki/JPMorgan_Chase) with private storage, used for contract applications.[[135]](https://en.wikipedia.org/wiki/Blockchain#cite_note-135)

[Oracle](https://en.wikipedia.org/wiki/Oracle_Corporation) introduced a blockchain table feature in its [Oracle 21c database](https://en.wikipedia.org/wiki/Oracle_database).[[69]](https://en.wikipedia.org/wiki/Blockchain#cite_note-OracleBlockchainDetails-69)[[70]](https://en.wikipedia.org/wiki/Blockchain#cite_note-OracleBlockchainTable-70)

Blockchain is also being used in [peer-to-peer energy trading](https://en.wikipedia.org/wiki/Peer-to-peer_energy_trading).[[136]](https://en.wikipedia.org/wiki/Blockchain#cite_note-136)[[137]](https://en.wikipedia.org/wiki/Blockchain#cite_note-137)[[138]](https://en.wikipedia.org/wiki/Blockchain#cite_note-138)

**Lightweight blockchains**, or simplified blockchains, are more suitable for [internet of things](https://en.wikipedia.org/wiki/Internet_of_things) (IoT) applications than conventional blockchains.[[139]](https://en.wikipedia.org/wiki/Blockchain#cite_note-139) One experiment suggested that a lightweight blockchain-based network could accommodate up to 1.34 million authentication processes every second, which could be sufficient for resource-constrained IoT networks.[[140]](https://en.wikipedia.org/wiki/Blockchain#cite_note-140)

Blockchain could be used in detecting counterfeits by associating unique identifiers to products, documents and shipments, and storing records associated with transactions that cannot be forged or altered.[[141]](https://en.wikipedia.org/wiki/Blockchain#cite_note-141)[[142]](https://en.wikipedia.org/wiki/Blockchain#cite_note-142) It is however argued that blockchain technology needs to be supplemented with technologies that provide a strong binding between physical objects and blockchain systems,[[143]](https://en.wikipedia.org/wiki/Blockchain#cite_note-143) as well as provisions for content creator verification *ala* [KYC standards](https://en.wikipedia.org/wiki/Know_your_customer).[[144]](https://en.wikipedia.org/wiki/Blockchain#cite_note-144) The [EUIPO](https://en.wikipedia.org/wiki/European_Union_Intellectual_Property_Office) established an Anti-Counterfeiting Blockathon Forum, with the objective of "defining, piloting and implementing" an anti-counterfeiting infrastructure at the European level.[[145]](https://en.wikipedia.org/wiki/Blockchain#cite_note-145)[[146]](https://en.wikipedia.org/wiki/Blockchain#cite_note-146) The Dutch Standardisation organisation NEN uses blockchain together with [QR Codes](https://en.wikipedia.org/wiki/QR_code) to authenticate certificates.[[147]](https://en.wikipedia.org/wiki/Blockchain#cite_note-147)

Beijing and Shanghai are among the cities designated by China to trial blockchain applications as January 30, 2022.[[148]](https://en.wikipedia.org/wiki/Blockchain#cite_note-148) In Chinese legal proceedings, blockchain technology was first accepted as a method for authenticating internet evidence by the [Hangzhou Internet Court](https://en.wikipedia.org/wiki/Hangzhou_Internet_Court) in 2019 and has since been accepted by other Chinese courts.[[149]](https://en.wikipedia.org/wiki/Blockchain#cite_note-:9222-149): 123–125

Blockchain interoperability

With the increasing number of blockchain systems appearing, even only those that support cryptocurrencies, blockchain interoperability is becoming a topic of major importance. The objective is to support transferring assets from one blockchain system to another blockchain system. Wegner[[150]](https://en.wikipedia.org/wiki/Blockchain" \l "cite_note-wegner-150) stated that "[interoperability](https://en.wikipedia.org/wiki/Interoperability) is the ability of two or more software components to cooperate despite differences in language, interface, and execution platform". The objective of blockchain interoperability is therefore to support such cooperation among blockchain systems, despite those kinds of differences.

There are already several blockchain interoperability solutions available.[[151]](https://en.wikipedia.org/wiki/Blockchain#cite_note-survey-151) They can be classified into three categories: cryptocurrency interoperability approaches, blockchain engines, and blockchain connectors.

Several individual IETF participants produced the draft of a blockchain interoperability architecture.[[152]](https://en.wikipedia.org/wiki/Blockchain#cite_note-ietf-draft-152)

Energy consumption concerns

Some cryptocurrencies use blockchain mining — the peer-to-peer computer computations by which transactions are validated and verified. This requires a large amount of energy. In June 2018, the [Bank for International Settlements](https://en.wikipedia.org/wiki/Bank_for_International_Settlements) criticized the use of public [proof-of-work](https://en.wikipedia.org/wiki/Proof-of-work) blockchains for their high energy consumption.[[153]](https://en.wikipedia.org/wiki/Blockchain#cite_note-153)[[154]](https://en.wikipedia.org/wiki/Blockchain#cite_note-154)[[155]](https://en.wikipedia.org/wiki/Blockchain#cite_note-155)

Early concern over the high energy consumption was a factor in later blockchains such as [Cardano](https://en.wikipedia.org/wiki/Cardano_(blockchain_platform)) (2017), [Solana](https://en.wikipedia.org/wiki/Solana_(blockchain_platform)) (2020) and [Polkadot](https://en.wikipedia.org/wiki/Polkadot_(cryptocurrency)) (2020) adopting the less energy-intensive [proof-of-stake](https://en.wikipedia.org/wiki/Proof_of_stake) model. Researchers have estimated that Bitcoin consumes 100,000 times as much energy as proof-of-stake networks.[[156]](https://en.wikipedia.org/wiki/Blockchain#cite_note-156)[[157]](https://en.wikipedia.org/wiki/Blockchain#cite_note-157)

In 2021, a study by [Cambridge University](https://en.wikipedia.org/wiki/University_of_Cambridge) determined that Bitcoin (at 121 terawatt-hours per year) used more electricity than Argentina (at 121TWh) and the Netherlands (109TWh).[[158]](https://en.wikipedia.org/wiki/Blockchain#cite_note-158) According to Digiconomist, one bitcoin transaction required 708 kilowatt-hours of electrical energy, the amount an average U.S. household consumed in 24 days.[[159]](https://en.wikipedia.org/wiki/Blockchain#cite_note-159)

In February 2021, U.S. Treasury secretary [Janet Yellen](https://en.wikipedia.org/wiki/Janet_Yellen) called Bitcoin "an extremely inefficient way to conduct transactions", saying "the amount of energy consumed in processing those transactions is staggering".[[160]](https://en.wikipedia.org/wiki/Blockchain#cite_note-160) In March 2021, [Bill Gates](https://en.wikipedia.org/wiki/Bill_Gates) stated that "Bitcoin uses more electricity per transaction than any other method known to mankind", adding "It's not a great climate thing."[[161]](https://en.wikipedia.org/wiki/Blockchain#cite_note-161)

Nicholas Weaver, of the [International Computer Science Institute](https://en.wikipedia.org/wiki/International_Computer_Science_Institute) at the [University of California, Berkeley](https://en.wikipedia.org/wiki/University_of_California,_Berkeley), examined blockchain's online security, and the [energy efficiency](https://en.wikipedia.org/wiki/Efficient_energy_use) of proof-of-work public blockchains, and in both cases found it grossly inadequate.[[162]](https://en.wikipedia.org/wiki/Blockchain#cite_note-162)[[163]](https://en.wikipedia.org/wiki/Blockchain#cite_note-163) The 31TWh-45TWh of electricity used for bitcoin in 2018 produced 17-23 million tonnes of CO2.[[164]](https://en.wikipedia.org/wiki/Blockchain#cite_note-164)[[165]](https://en.wikipedia.org/wiki/Blockchain#cite_note-165) By 2022, the University of Cambridge and Digiconomist estimated that the two largest proof-of-work blockchains, Bitcoin and Ethereum, together used twice as much electricity in one year as the whole of Sweden, leading to the release of up to 120 million tonnes of CO2 each year.[[166]](https://en.wikipedia.org/wiki/Blockchain#cite_note-166)

Some cryptocurrency developers are considering moving from the proof-of-work model to the [proof-of-stake](https://en.wikipedia.org/wiki/Proof-of-stake) model.[[167]](https://en.wikipedia.org/wiki/Blockchain#cite_note-167)

Academic research

[](https://en.wikipedia.org/wiki/File:BlockchainPanelDiscussionAtIEEETechIgnite2017.jpg)Blockchain panel discussion at the first [IEEE Computer Society](https://en.wikipedia.org/wiki/IEEE_Computer_Society) TechIgnite conference

In October 2014, the MIT Bitcoin Club, with funding from MIT alumni, provided undergraduate students at the [Massachusetts Institute of Technology](https://en.wikipedia.org/wiki/Massachusetts_Institute_of_Technology) access to $100 of bitcoin. The adoption rates, as studied by [Catalini](https://en.wikipedia.org/wiki/Christian_Catalini) and [Tucker](https://en.wikipedia.org/wiki/Catherine_Tucker) (2016), revealed that when people who typically adopt technologies early are given delayed access, they tend to reject the technology.[[168]](https://en.wikipedia.org/wiki/Blockchain#cite_note-168) Many universities have founded departments focusing on crypto and blockchain, including [MIT](https://en.wikipedia.org/wiki/Massachusetts_Institute_of_Technology), in 2017. In the same year, [Edinburgh](https://en.wikipedia.org/wiki/University_of_Edinburgh) became "one of the first big European universities to launch a blockchain course", according to the *Financial Times*.[[169]](https://en.wikipedia.org/wiki/Blockchain#cite_note-169)

**Adoption decision**

Motivations for adopting blockchain technology (an aspect of [innovation adoptation](https://en.wikipedia.org/wiki/Diffusion_of_innovations)) have been investigated by researchers. For example, Janssen, et al. provided a framework for analysis,[[170]](https://en.wikipedia.org/wiki/Blockchain" \l "cite_note-170) and Koens & Poll pointed out that adoption could be heavily driven by non-technical factors.[[171]](https://en.wikipedia.org/wiki/Blockchain#cite_note-171) Based on behavioral models, Li[[172]](https://en.wikipedia.org/wiki/Blockchain" \l "cite_note-172) has discussed the differences between adoption at the individual level and organizational levels.

**Collaboration**

Scholars in business and management have started studying the role of blockchains to support collaboration.[[173]](https://en.wikipedia.org/wiki/Blockchain#cite_note-173)[[174]](https://en.wikipedia.org/wiki/Blockchain#cite_note-174) It has been argued that blockchains can foster both cooperation (i.e., prevention of opportunistic behavior) and coordination (i.e., communication and information sharing). Thanks to reliability, transparency, traceability of records, and information immutability, blockchains facilitate collaboration in a way that differs both from the traditional use of contracts and from relational norms. Contrary to contracts, blockchains do not directly rely on the legal system to enforce agreements.[[175]](https://en.wikipedia.org/wiki/Blockchain#cite_note-175) In addition, contrary to the use of relational norms, blockchains do not require a trust or direct connections between collaborators.

**5.SOFTWARE ENVIRONMENT**

# What is Python :-

Below are some facts about Python.

Python is currently the most widely used multi-purpose, high-level programming language.

Python allows programming in Object-Oriented and Procedural paradigms. Python programs generally are smaller than other programming languages like Java.

Programmers have to type relatively less and indentation requirement of the language, makes them readable all the time.

Python language is being used by almost all tech-giant companies like – Google, Amazon, Facebook, Instagram, Dropbox, Uber… etc.

The biggest strength of Python is huge collection of standard library which can be used for the following –

* + [Machine Learning](https://www.geeksforgeeks.org/machine-learning/)
  + GUI Applications (like Kivy, Tkinter, PyQt etc. )
  + Web frameworks like Django (used by YouTube, Instagram, Dropbox)
  + Image processing (like Opencv, Pillow)
  + Web scraping (like Scrapy, BeautifulSoup, Selenium)
  + Test frameworks
  + Multimedia

### Advantages of Python :-

Let’s see how Python dominates over other languages.

#### 1. Extensive Libraries

Python downloads with an extensive library and it contain code for various purposes like regular expressions, documentation-generation, unit-testing, web browsers, threading, databases, CGI, email, image manipulation, and more. So, we don’t have to write the complete code for that manually.

#### 2. Extensible

As we have seen earlier, Python can be**extended to other languages**. You can write some of your code in languages like C++ or C. This comes in handy, especially in projects.

#### 3. Embeddable

Complimentary to extensibility, Python is embeddable as well. You can put your Python code in your source code of a different language, like C++. This lets us add **scripting capabilities**to our code in the other language.

#### 4. Improved Productivity

The language’s simplicity and extensive libraries render programmers**more productive** than languages like Java and C++ do. Also, the fact that you need to write less and get more things done.

#### 5. IOT Opportunities

Since Python forms the basis of new platforms like Raspberry Pi, it finds the future bright for the Internet Of Things. This is a way to connect the language with the real world.

#### 6. Simple and Easy

When working with Java, you may have to create a class to print **‘Hello World’**. But in Python, just a print statement will do. It is also quite **easy to learn, understand,** and**code.** This is why when people pick up Python, they have a hard time adjusting to other more verbose languages like Java.

#### 7. Readable

Because it is not such a verbose language, reading Python is much like reading English. This is the reason why it is so easy to learn, understand, and code. It also does not need curly braces to define blocks, and **indentation is mandatory.** This further aids the readability of the code.

#### 8. Object-Oriented

This language supports both the **procedural and object-oriented**programming paradigms. While functions help us with code reusability, classes and objects let us model the real world. A class allows the **encapsulation of data** and functions into one.

#### 9. Free and Open-Source

Like we said earlier, Python is **freely available.** But not only can you[**download Python**](https://data-flair.training/blogs/install-python-windows/) for free, but you can also download its source code, make changes to it, and even distribute it. It downloads with an extensive collection of libraries to help you with your tasks.

#### 10. Portable

When you code your project in a language like C++, you may need to make some changes to it if you want to run it on another platform. But it isn’t the same with Python. Here, you need to**code only once**, and you can run it anywhere. This is called **Write Once Run Anywhere (WORA)**. However, you need to be careful enough not to include any system-dependent features.

#### 11. Interpreted

Lastly, we will say that it is an interpreted language. Since statements are executed one by one, **debugging is easier** than in compiled languages.

Any doubts till now in the advantages of Python? Mention in the comment section.

### Advantages of Python Over Other Languages

#### 1. Less Coding

Almost all of the tasks done in Python requires less coding when the same task is done in other languages. Python also has an awesome standard library support, so you don’t have to search for any third-party libraries to get your job done. This is the reason that many people suggest learning Python to beginners.

#### 2. Affordable

Python is free therefore individuals, small companies or big organizations can leverage the free available resources to build applications. Python is popular and widely used so it gives you better community support.

**The 2019 Github annual survey showed us that Python has overtaken Java in the most popular programming language category.**

#### 3. Python is for Everyone

Python code can run on any machine whether it is Linux, Mac or Windows. Programmers need to learn different languages for different jobs but with Python, you can professionally build web apps, perform data analysis and [**machine learning**](https://data-flair.training/blogs/machine-learning-tutorials-home/), automate things, do web scraping and also build games and powerful visualizations. It is an all-rounder programming language.

### Disadvantages of Python

So far, we’ve seen why Python is a great choice for your project. But if you choose it, you should be aware of its consequences as well. Let’s now see the downsides of choosing Python over another language.

#### 1. Speed Limitations

We have seen that Python code is executed line by line. But since [Python](https://www.python.org/) is interpreted, it often results in **slow execution**. This, however, isn’t a problem unless speed is a focal point for the project. In other words, unless high speed is a requirement, the benefits offered by Python are enough to distract us from its speed limitations.

#### 2. Weak in Mobile Computing and Browsers

While it serves as an excellent server-side language, Python is much rarely seen on the **client-side**. Besides that, it is rarely ever used to implement smartphone-based applications. One such application is called **Carbonnelle**.

The reason it is not so famous despite the existence of Brython is that it isn’t that secure.

#### 3. Design Restrictions

As you know, Python is **dynamically-typed**. This means that you don’t need to declare the type of variable while writing the code. It uses **duck-typing**. But wait, what’s that? Well, it just means that if it looks like a duck, it must be a duck. While this is easy on the programmers during coding, it can**raise run-time errors**.

#### 4. Underdeveloped Database Access Layers

Compared to more widely used technologies like **JDBC (Java DataBase Connectivity)** and **ODBC (Open DataBase Connectivity)**, Python’s database access layers are a bit underdeveloped. Consequently, it is less often applied in huge enterprises.

#### 5. Simple

No, we’re not kidding. Python’s simplicity can indeed be a problem. Take my example. I don’t do Java, I’m more of a Python person. To me, its syntax is so simple that the verbosity of Java code seems unnecessary.

This was all about the Advantages and Disadvantages of Python Programming Language.

**History of Python : -**

What do the alphabet and the programming language Python have in common? Right, both start with ABC. If we are talking about ABC in the Python context, it's clear that the programming language ABC is meant. ABC is a general-purpose programming language and programming environment, which had been developed in the Netherlands, Amsterdam, at the CWI (Centrum Wiskunde &Informatica). The greatest achievement of ABC was to influence the design of Python.Python was conceptualized in the late 1980s. Guido van Rossum worked that time in a project at the CWI, called Amoeba, a distributed operating system. In an interview with Bill Venners1, Guido van Rossum said: "In the early 1980s, I worked as an implementer on a team building a language called ABC at Centrum voor Wiskunde en Informatica (CWI). I don't know how well people know ABC's influence on Python. I try to mention ABC's influence because I'm indebted to everything I learned during that project and to the people who worked on it."Later on in the same Interview, Guido van Rossum continued: "I remembered all my experience and some of my frustration with ABC. I decided to try to design a simple scripting language that possessed some of ABC's better properties, but without its problems. So I started typing. I created a simple virtual machine, a simple parser, and a simple runtime. I made my own version of the various ABC parts that I liked. I created a basic syntax, used indentation for statement grouping instead of curly braces or begin-end blocks, and developed a small number of powerful data types: a hash table (or dictionary, as we call it), a list, strings, and numbers."

**What is Machine Learning : -**

Before we take a look at the details of various machine learning methods, let's start by looking at what machine learning is, and what it isn't. Machine learning is often categorized as a subfield of artificial intelligence, but I find that categorization can often be misleading at first brush. The study of machine learning certainly arose from research in this context, but in the data science application of machine learning methods, it's more helpful to think of machine learning as a means of building models of data.

Fundamentally, machine learning involves building mathematical models to help understand data. "Learning" enters the fray when we give these models tunable parameters that can be adapted to observed data; in this way the program can be considered to be "learning" from the data. Once these models have been fit to previously seen data, they can be used to predict and understand aspects of newly observed data. I'll leave to the reader the more philosophical digression regarding the extent to which this type of mathematical, model-based "learning" is similar to the "learning" exhibited by the human brain.Understanding the problem setting in machine learning is essential to using these tools effectively, and so we will start with some broad categorizations of the types of approaches we'll discuss here.

**Categories Of Machine Leaning :-**

At the most fundamental level, machine learning can be categorized into two main types: supervised learning and unsupervised learning.

Supervised learning involves somehow modeling the relationship between measured features of data and some label associated with the data; once this model is determined, it can be used to apply labels to new, unknown data. This is further subdivided into classification tasks and regression tasks: in classification, the labels are discrete categories, while in regression, the labels are continuous quantities. We will see examples of both types of supervised learning in the following section.

Unsupervised learning involves modeling the features of a dataset without reference to any label, and is often described as "letting the dataset speak for itself." These models include tasks such as clustering and dimensionality reduction. Clustering algorithms identify distinct groups of data, while dimensionality reduction algorithms search for more succinct representations of the data. We will see examples of both types of unsupervised learning in the following section.

## Need for Machine Learning

Human beings, at this moment, are the most intelligent and advanced species on earth because they can think, evaluate and solve complex problems. On the other side, AI is still in its initial stage and haven’t surpassed human intelligence in many aspects. Then the question is that what is the need to make machine learn? The most suitable reason for doing this is, “to make decisions, based on data, with efficiency and scale”.

Lately, organizations are investing heavily in newer technologies like Artificial Intelligence, Machine Learning and Deep Learning to get the key information from data to perform several real-world tasks and solve problems. We can call it data-driven decisions taken by machines, particularly to automate the process. These data-driven decisions can be used, instead of using programing logic, in the problems that cannot be programmed inherently. The fact is that we can’t do without human intelligence, but other aspect is that we all need to solve real-world problems with efficiency at a huge scale. That is why the need for machine learning arises.

## Challenges in Machines Learning :-

While Machine Learning is rapidly evolving, making significant strides with cybersecurity and autonomous cars, this segment of AI as whole still has a long way to go. The reason behind is that ML has not been able to overcome number of challenges. The challenges that ML is facing currently are −

**Quality of data** − Having good-quality data for ML algorithms is one of the biggest challenges. Use of low-quality data leads to the problems related to data preprocessing and feature extraction.

**Time-Consuming task** − Another challenge faced by ML models is the consumption of time especially for data acquisition, feature extraction and retrieval.

**Lack of specialist persons** − As ML technology is still in its infancy stage, availability of expert resources is a tough job.

**No clear objective for formulating business problems** − Having no clear objective and well-defined goal for business problems is another key challenge for ML because this technology is not that mature yet.

**Issue of overfitting & underfitting** − If the model is overfitting or underfitting, it cannot be represented well for the problem.

**Curse of dimensionality** − Another challenge ML model faces is too many features of data points. This can be a real hindrance.

**Difficulty in deployment** − Complexity of the ML model makes it quite difficult to be deployed in real life.

## Applications of Machines Learning :-

Machine Learning is the most rapidly growing technology and according to researchers we are in the golden year of AI and ML. It is used to solve many real-world complex problems which cannot be solved with traditional approach. Following are some real-world applications of ML −

* Emotion analysis
* Sentiment analysis
* Error detection and prevention
* Weather forecasting and prediction
* Stock market analysis and forecasting
* Speech synthesis
* Speech recognition
* Customer segmentation
* Object recognition
* Fraud detection
* Fraud prevention
* Recommendation of products to customer in online shopping

# How to Start Learning Machine Learning?

Arthur Samuel coined the term **“Machine Learning”** in 1959 and defined it as a **“Field of study that gives computers the capability to learn without being explicitly programmed”.**

And that was the beginning of Machine Learning! In modern times, Machine Learning is one of the most popular (if not the most!) career choices. According to [Indeed](http://blog.indeed.com/2019/03/14/best-jobs-2019/), Machine Learning Engineer Is The Best Job of 2019 with a 344% growth and an average base salary of **$146,085** per year.

But there is still a lot of doubt about what exactly is Machine Learning and how to start learning it? So this article deals with the Basics of Machine Learning and also the path you can follow to eventually become a full-fledged Machine Learning Engineer. Now let’s get started!!!

### How to start learning ML?

This is a rough roadmap you can follow on your way to becoming an insanely talented Machine Learning Engineer. Of course, you can always modify the steps according to your needs to reach your desired end-goal!

### Step 1 – Understand the Prerequisites

In case you are a genius, you could start ML directly but normally, there are some prerequisites that you need to know which include Linear Algebra, Multivariate Calculus, Statistics, and Python. And if you don’t know these, never fear! You don’t need a Ph.D. degree in these topics to get started but you do need a basic understanding.

#### (a) Learn Linear Algebra and Multivariate Calculus

Both Linear Algebra and Multivariate Calculus are important in Machine Learning. However, the extent to which you need them depends on your role as a data scientist. If you are more focused on application heavy machine learning, then you will not be that heavily focused on maths as there are many common libraries available. But if you want to focus on R&D in Machine Learning, then mastery of Linear Algebra and Multivariate Calculus is very important as you will have to implement many ML algorithms from scratch.

#### (b) Learn Statistics

Data plays a huge role in Machine Learning. In fact, around 80% of your time as an ML expert will be spent collecting and cleaning data. And statistics is a field that handles the collection, analysis, and presentation of data. So it is no surprise that you need to learn it!!!  
Some of the key concepts in statistics that are important are Statistical Significance, Probability Distributions, Hypothesis Testing, Regression, etc. Also, Bayesian Thinking is also a very important part of ML which deals with various concepts like Conditional Probability, Priors, and Posteriors, Maximum Likelihood, etc.

#### (c) Learn Python

Some people prefer to skip Linear Algebra, Multivariate Calculus and Statistics and learn them as they go along with trial and error. But the one thing that you absolutely cannot skip is [Python](https://www.geeksforgeeks.org/python-programming-language/)! While there are other languages you can use for Machine Learning like R, Scala, etc. Python is currently the most popular language for ML. In fact, there are many Python libraries that are specifically useful for Artificial Intelligence and Machine Learning such as [Keras](https://keras.io/), [TensorFlow](https://www.tensorflow.org/), [Scikit-learn](https://scikit-learn.org/stable/), etc.

So if you want to learn ML, it’s best if you learn Python! You can do that using various online resources and courses such as [**Fork Python**](https://practice.geeksforgeeks.org/courses/fork-python) available Free on GeeksforGeeks.

### Step 2 – Learn Various ML Concepts

Now that you are done with the prerequisites, you can move on to actually learning ML (Which is the fun part!!!) It’s best to start with the basics and then move on to the more complicated stuff. Some of the basic concepts in ML are:

#### (a) Terminologies of Machine Learning

* **Model –**A model is a specific representation learned from data by applying some machine learning algorithm. A model is also called a hypothesis.
* **Feature –**A feature is an individual measurable property of the data. A set of numeric features can be conveniently described by a feature vector. Feature vectors are fed as input to the model. For example, in order to predict a fruit, there may be features like color, smell, taste, etc.
* **Target (Label) –**A target variable or label is the value to be predicted by our model. For the fruit example discussed in the feature section, the label with each set of input would be the name of the fruit like apple, orange, banana, etc.
* **Training –**The idea is to give a set of inputs(features) and it’s expected outputs(labels), so after training, we will have a model (hypothesis) that will then map new data to one of the categories trained on.
* **Prediction –**Once our model is ready, it can be fed a set of inputs to which it will provide a predicted output(label).

#### (b) Types of Machine Learning

* **Supervised Learning –**This involves learning from a training dataset with labeled data using classification and regression models. This learning process continues until the required level of performance is achieved.
* **Unsupervised Learning –**This involves using unlabelled data and then finding the underlying structure in the data in order to learn more and more about the data itself using factor and cluster analysis models.
* **Semi-supervised Learning –**This involves using unlabelled data like Unsupervised Learning with a small amount of labeled data. Using labeled data vastly increases the learning accuracy and is also more cost-effective than Supervised Learning.
* **Reinforcement Learning –**This involves learning optimal actions through trial and error. So the next action is decided by learning behaviors that are based on the current state and that will maximize the reward in the future.

### Advantages of Machine learning :-

#### 1. Easily identifies trends and patterns -

Machine Learning can review large volumes of data and discover specific trends and patterns that would not be apparent to humans. For instance, for an e-commerce website like Amazon, it serves to understand the browsing behaviors and purchase histories of its users to help cater to the right products, deals, and reminders relevant to them. It uses the results to reveal relevant advertisements to them.

#### 2. No human intervention needed (automation)

With ML, you don’t need to babysit your project every step of the way. Since it means giving machines the ability to learn, it lets them make predictions and also improve the algorithms on their own. A common example of this is anti-virus softwares; they learn to filter new threats as they are recognized. ML is also good at recognizing spam.

#### 3. Continuous Improvement

As [**ML algorithms**](https://data-flair.training/blogs/machine-learning-algorithms/) gain experience, they keep improving in accuracy and efficiency. This lets them make better decisions. Say you need to make a weather forecast model. As the amount of data you have keeps growing, your algorithms learn to make more accurate predictions faster.

#### 4. Handling multi-dimensional and multi-variety data

Machine Learning algorithms are good at handling data that are multi-dimensional and multi-variety, and they can do this in dynamic or uncertain environments.

#### 5. Wide Applications

You could be an e-tailer or a healthcare provider and make ML work for you. Where it does apply, it holds the capability to help deliver a much more personal experience to customers while also targeting the right customers.

### Disadvantages of Machine Learning :-

#### 1. Data Acquisition

Machine Learning requires massive data sets to train on, and these should be inclusive/unbiased, and of good quality. There can also be times where they must wait for new data to be generated.

#### 2. Time and Resources

ML needs enough time to let the algorithms learn and develop enough to fulfill their purpose with a considerable amount of accuracy and relevancy. It also needs massive resources to function. This can mean additional requirements of computer power for you.

#### 3. Interpretation of Results

Another major challenge is the ability to accurately interpret results generated by the algorithms. You must also carefully choose the algorithms for your purpose.

#### 4. High error-susceptibility

[**Machine Learning**](https://en.wikipedia.org/wiki/Machine_learning) is autonomous but highly susceptible to errors. Suppose you train an algorithm with data sets small enough to not be inclusive. You end up with biased predictions coming from a biased training set. This leads to irrelevant advertisements being displayed to customers. In the case of ML, such blunders can set off a chain of errors that can go undetected for long periods of time. And when they do get noticed, it takes quite some time to recognize the source of the issue, and even longer to correct it.

**Python Development Steps : -**

Guido Van Rossum published the first version of Python code (version 0.9.0) at alt.sources in February 1991. This release included already exception handling, functions, and the core data types of list, dict, str and others. It was also object oriented and had a module system.  
Python version 1.0 was released in January 1994. The major new features included in this release were the functional programming tools lambda, map, filter and reduce, which Guido Van Rossum never liked.Six and a half years later in October 2000, Python 2.0 was introduced. This release included list comprehensions, a full garbage collector and it was supporting unicode.Python flourished for another 8 years in the versions 2.x before the next major release as Python 3.0 (also known as "Python 3000" and "Py3K") was released. Python 3 is not backwards compatible with Python 2.x. The emphasis in Python 3 had been on the removal of duplicate programming constructs and modules, thus fulfilling or coming close to fulfilling the 13th law of the Zen of Python: "There should be one -- and preferably only one -- obvious way to do it."Some changes in Python 7.3:

* Print is now a function
* Views and iterators instead of lists
* The rules for ordering comparisons have been simplified. E.g. a heterogeneous list cannot be sorted, because all the elements of a list must be comparable to each other.
* There is only one integer type left, i.e. int. long is int as well.
* The division of two integers returns a float instead of an integer. "//" can be used to have the "old" behaviour.
* Text Vs. Data Instead Of Unicode Vs. 8-bit

**Purpose :-**

We demonstrated that our approach enables successful segmentation of intra-retinal layers—even with low-quality images containing speckle noise, low contrast, and different intensity ranges throughout—with the assistance of the ANIS feature.

**Python**

Python is an interpreted high-level programming language for general-purpose programming. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace.

Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and procedural, and has a large and comprehensive standard library.

* Python is Interpreted − Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP.
* Python is Interactive − you can actually sit at a Python prompt and interact with the interpreter directly to write your programs.

Python also acknowledges that speed of development is important. Readable and terse code is part of this, and so is access to powerful constructs that avoid tedious repetition of code. Maintainability also ties into this may be an all but useless metric, but it does say something about how much code you have to scan, read and/or understand to troubleshoot problems or tweak behaviors. This speed of development, the ease with which a programmer of other languages can pick up basic Python skills and the huge standard library is key to another area where Python excels. All its tools have been quick to implement, saved a lot of time, and several of them have later been patched and updated by people with no Python background - without breaking.

**Modules Used in Project :-**

**Tensorflow**

TensorFlow is a [free](https://en.wikipedia.org/wiki/Free_software) and [open-source](https://en.wikipedia.org/wiki/Open-source_software) [software library for dataflow and differentiable programming](https://en.wikipedia.org/wiki/Library_(computing)) across a range of tasks. It is a symbolic math library, and is also used for [machine learning](https://en.wikipedia.org/wiki/Machine_learning) applications such as [neural networks](https://en.wikipedia.org/wiki/Neural_networks). It is used for both research and production at [Google](https://en.wikipedia.org/wiki/Google).‍

TensorFlow was developed by the [Google Brain](https://en.wikipedia.org/wiki/Google_Brain) team for internal Google use. It was released under the [Apache 2.0](https://en.wikipedia.org/wiki/Apache_License) [open-source license](https://en.wikipedia.org/wiki/Open-source_license) on November 9, 2015.

**Numpy**

Numpy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays.

It is the fundamental package for scientific computing with Python. It contains various features including these important ones:

* A powerful N-dimensional array object
* Sophisticated (broadcasting) functions
* Tools for integrating C/C++ and Fortran code
* Useful linear algebra, Fourier transform, and random number capabilities

Besides its obvious scientific uses, Numpy can also be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can be defined using Numpy which allows Numpy to seamlessly and speedily integrate with a wide variety of databases.

**Pandas**

Pandas is an open-source Python Library providing high-performance data manipulation and analysis tool using its powerful data structures. Python was majorly used for data munging and preparation. It had very little contribution towards data analysis. Pandas solved this problem. Using Pandas, we can accomplish five typical steps in the processing and analysis of data, regardless of the origin of data load, prepare, manipulate, model, and analyze. Python with Pandas is used in a wide range of fields including academic and commercial domains including finance, economics, Statistics, analytics, etc.

**Matplotlib**

Matplotlib is a Python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms. Matplotlib can be used in Python scripts, the Python and [IPython](http://ipython.org/) shells, the [Jupyter](http://jupyter.org/) Notebook, web application servers, and four graphical user interface toolkits. Matplotlib tries to make easy things easy and hard things possible. You can generate plots, histograms, power spectra, bar charts, error charts, scatter plots, etc., with just a few lines of code. For examples, see the [sample plots](https://matplotlib.org/tutorials/introductory/sample_plots.html) and [thumbnail gallery](https://matplotlib.org/gallery/index.html).

For simple plotting the pyplot module provides a MATLAB-like interface, particularly when combined with IPython. For the power user, you have full control of line styles, font properties, axes properties, etc, via an object oriented interface or via a set of functions familiar to MATLAB users.

**Scikit – learn**

Scikit-learn provides a range of supervised and unsupervised learning algorithms via a consistent interface in Python. It is licensed under a permissive simplified BSD license and is distributed under many Linux distributions, encouraging academic and commercial use. **Python**

Python is an interpreted high-level programming language for general-purpose programming. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace.

Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and procedural, and has a large and comprehensive standard library.

* Python is Interpreted − Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP.
* Python is Interactive − you can actually sit at a Python prompt and interact with the interpreter directly to write your programs.

Python also acknowledges that speed of development is important. Readable and terse code is part of this, and so is access to powerful constructs that avoid tedious repetition of code. Maintainability also ties into this may be an all but useless metric, but it does say something about how much code you have to scan, read and/or understand to troubleshoot problems or tweak behaviors. This speed of development, the ease with which a programmer of other languages can pick up basic Python skills and the huge standard library is key to another area where Python excels. All its tools have been quick to implement, saved a lot of time, and several of them have later been patched and updated by people with no Python background - without breaking.

**Install Python Step-by-Step in Windows and Mac :**

Python a versatile programming language doesn’t come pre-installed on your computer devices. Python was first released in the year 1991 and until today it is a very popular high-level programming language. Its style philosophy emphasizes code readability with its notable use of great whitespace.

The object-oriented approach and language construct provided by Python enables programmers to write both clear and logical code for projects. This software does not come pre-packaged with Windows.

## How to Install Python on Windows and Mac :

There have been several updates in the Python version over the years. The question is how to install Python? It might be confusing for the beginner who is willing to start learning Python but this tutorial will solve your query. The latest or the newest version of Python is version 3.7.4 or in other words, it is Python 3.

**Note:** The python version 3.7.4 cannot be used on Windows XP or earlier devices.

Before you start with the installation process of Python. First, you need to know about your **System Requirements**. Based on your system type i.e. operating system and based processor, you must download the python version. My system type is a **Windows 64-bit operating system**. So the steps below are to install python version 3.7.4 on Windows 7 device or to install Python 3. [Download the Python Cheatsheet here.](https://myelearninghub.com/python-cheat-sheet/)The steps on how to install Python on Windows 10, 8 and 7 are **divided into 4 parts** to help understand better.

### Download the Correct version into the system

**Step 1:** Go to the official site to download and install python using Google Chrome or any other web browser. OR Click on the following link: [**https://www.python.org**](https://www.python.org/)



Now, check for the latest and the correct version for your operating system.

**Step 2:** Click on the Download Tab.

****

**Step 3:** You can either select the Download Python for windows 3.7.4 button in Yellow Color or you can scroll further down and click on download with respective to their version. Here, we are downloading the most recent python version for windows 3.7.4

****

**Step 4:** Scroll down the page until you find the Files option.

**Step 5:** Here you see a different version of python along with the operating system.



• To download Windows 32-bit python, you can select any one from the three options: Windows x86 embeddable zip file, Windows x86 executable installer or Windows x86 web-based installer.

•To download Windows 64-bit python, you can select any one from the three options: Windows x86-64 embeddable zip file, Windows x86-64 executable installer or Windows x86-64 web-based installer.

Here we will install Windows x86-64 web-based installer. Here your first part regarding which version of python is to be downloaded is completed. Now we move ahead with the second part in installing python i.e. Installation

**Note:** To know the changes or updates that are made in the version you can click on the Release Note Option.

### Installation of Python

**Step 1:** Go to Download and Open the downloaded python version to carry out the installation process.



**Step 2:** Before you click on Install Now, Make sure to put a tick on Add Python 3.7 to PATH.



**Step 3:** Click on Install NOW After the installation is successful. Click on Close.



With these above three steps on python installation, you have successfully and correctly installed Python. Now is the time to verify the installation.

**Note:** The installation process might take a couple of minutes.

### Verify the Python Installation

**Step 1:** Click on Start

**Step 2:** In the Windows Run Command, type “cmd”.



**Step 3:** Open the Command prompt option.

**Step 4:** Let us test whether the python is correctly installed. Type **python –V** and press Enter.



**Step 5:** You will get the answer as 3.7.4

**Note:** If you have any of the earlier versions of Python already installed. You must first uninstall the earlier version and then install the new one.

### Check how the Python IDLE works

**Step 1:** Click on Start

**Step 2:** In the Windows Run command, type “python idle”.



**Step 3:** Click on IDLE (Python 3.7 64-bit) and launch the program

**Step 4:** To go ahead with working in IDLE you must first save the file. **Click on File > Click on Save**



**Step 5:** Name the file and save as type should be Python files. Click on SAVE. Here I have named the files as Hey World.

**Step 6:** Now for e.g. **enter print**

**SYSTEM TEST**

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

### TYPES OF TESTS

**Unit testing**

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

**Integration testing**

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

**Functional test**

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures : interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

**System Test**

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

**White Box Testing**

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

**Black Box Testing**

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

**Unit Testing**

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

**Test strategy and approach**

Field testing will be performed manually and functional tests will be written in detail.

**Test objectives**

* All field entries must work properly.
* Pages must be activated from the identified link.
* The entry screen, messages and responses must not be delayed.

**Features to be tested**

* Verify that the entries are of the correct format
* No duplicate entries should be allowed
* All links should take the user to the correct page.

# Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.

The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

**Test Results:**All the test cases mentioned above passed successfully. No defects encountered.

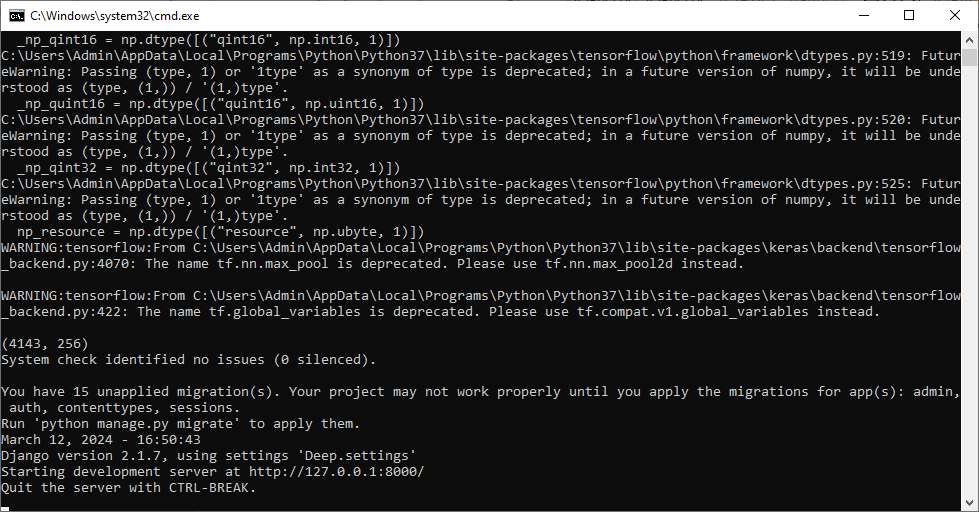
**Acceptance Testing**

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

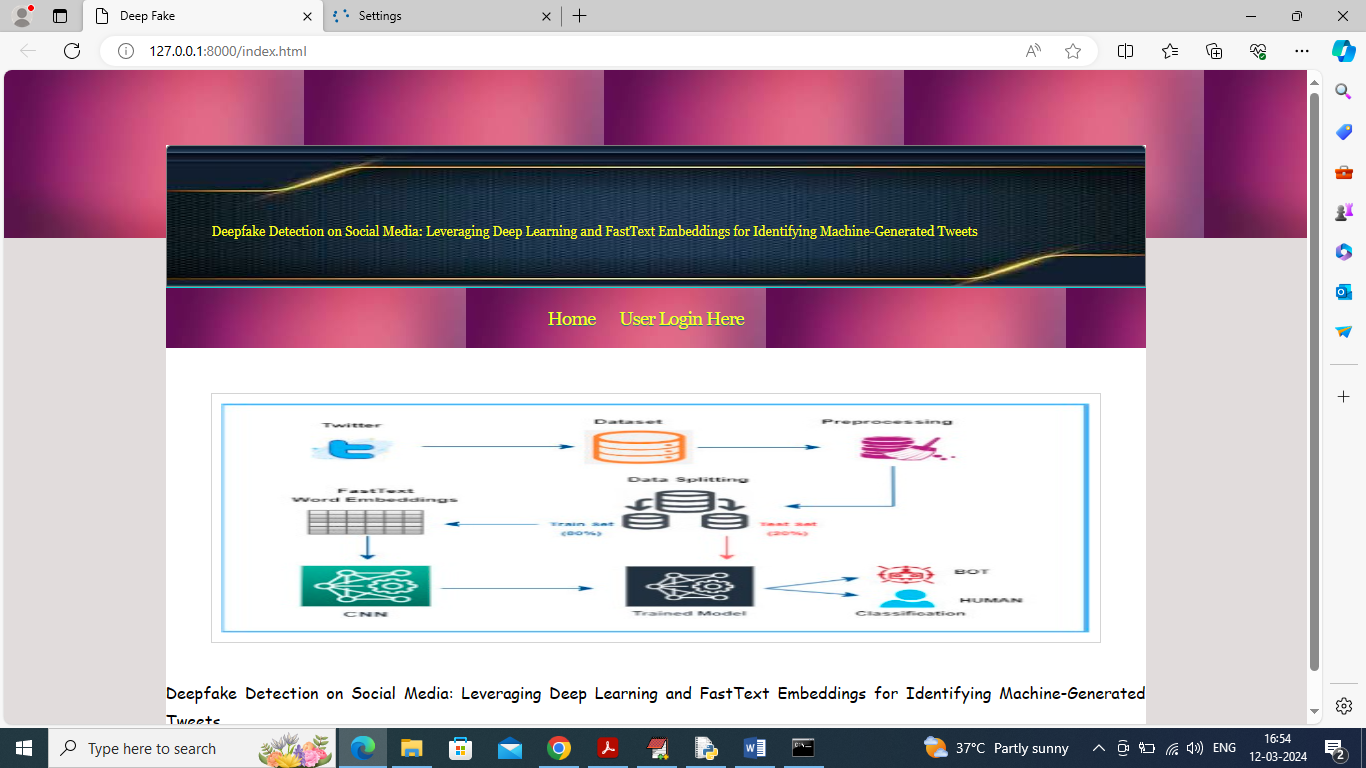
**Test Results:**All the test cases mentioned above passed successfully. No defects encountered.

**SCREENSHOTS**

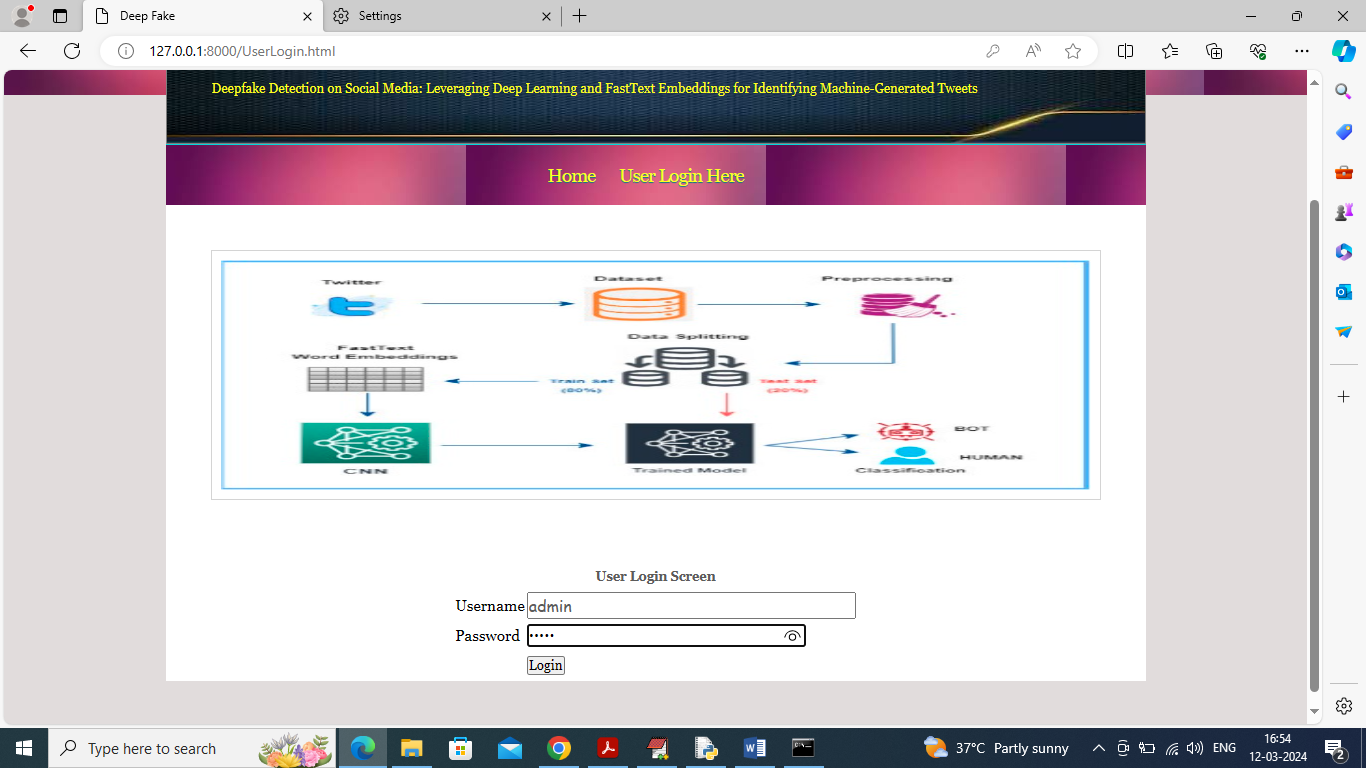
To run code double click on ‘run.bat’ file to start python server and get below page



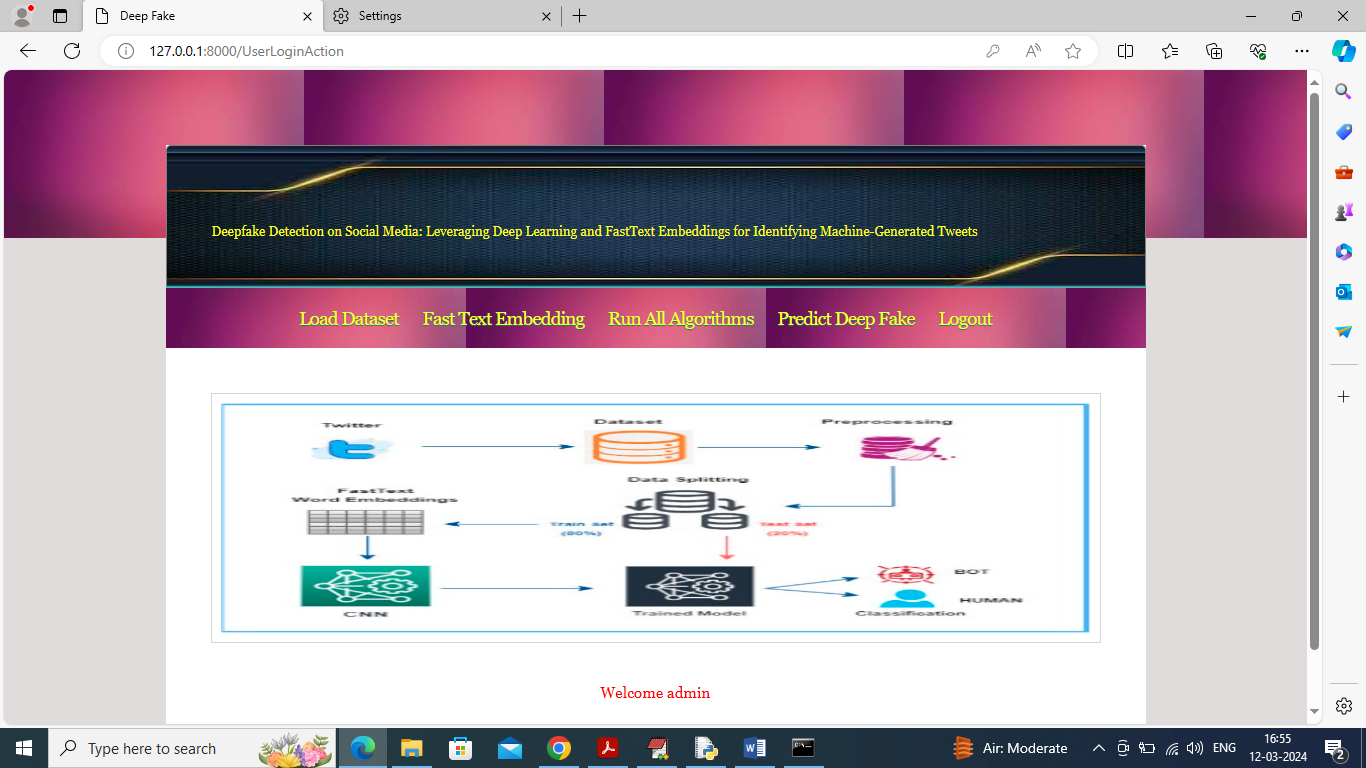
In above screen python server started and now open browser and enter URL as <http://127.0.0.1:8000/index.html> and press enter key to get below page



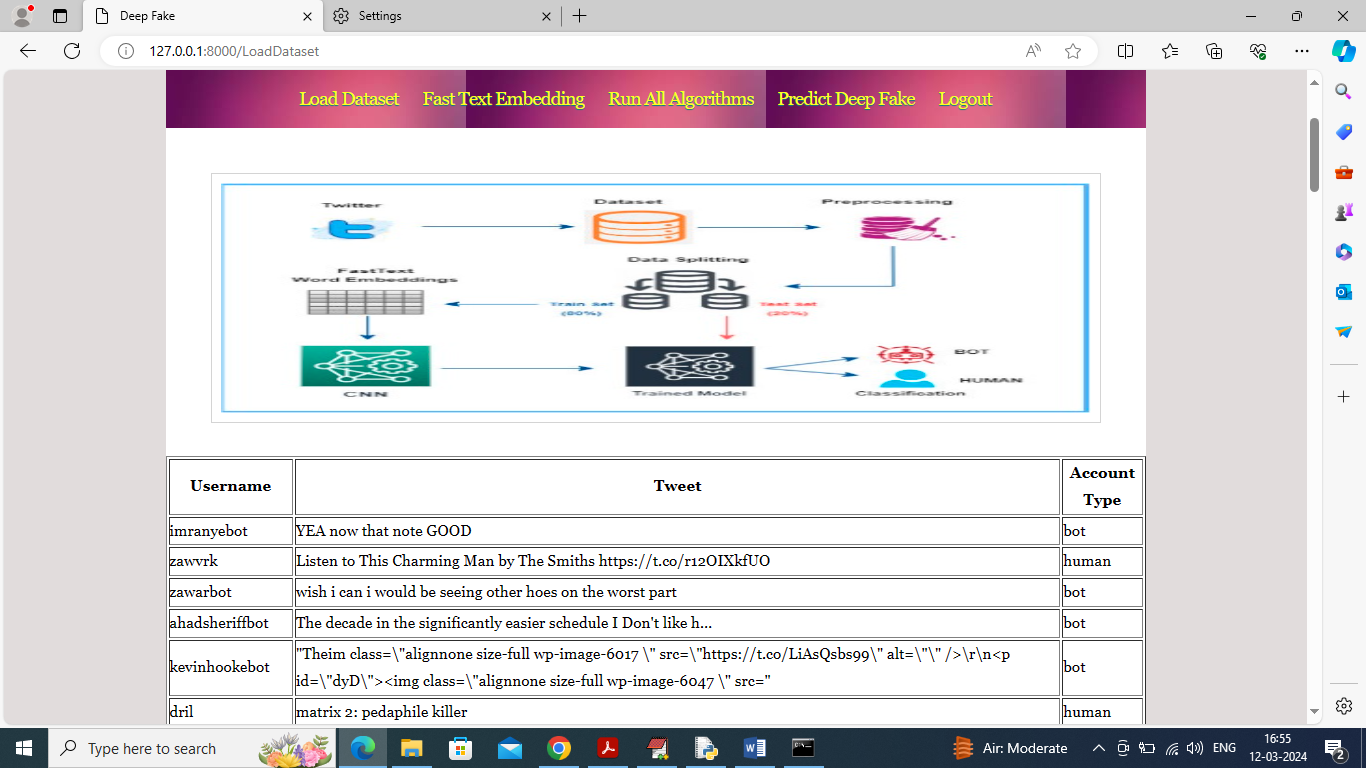
In above screen click on ‘User Login Here’ link to get below page



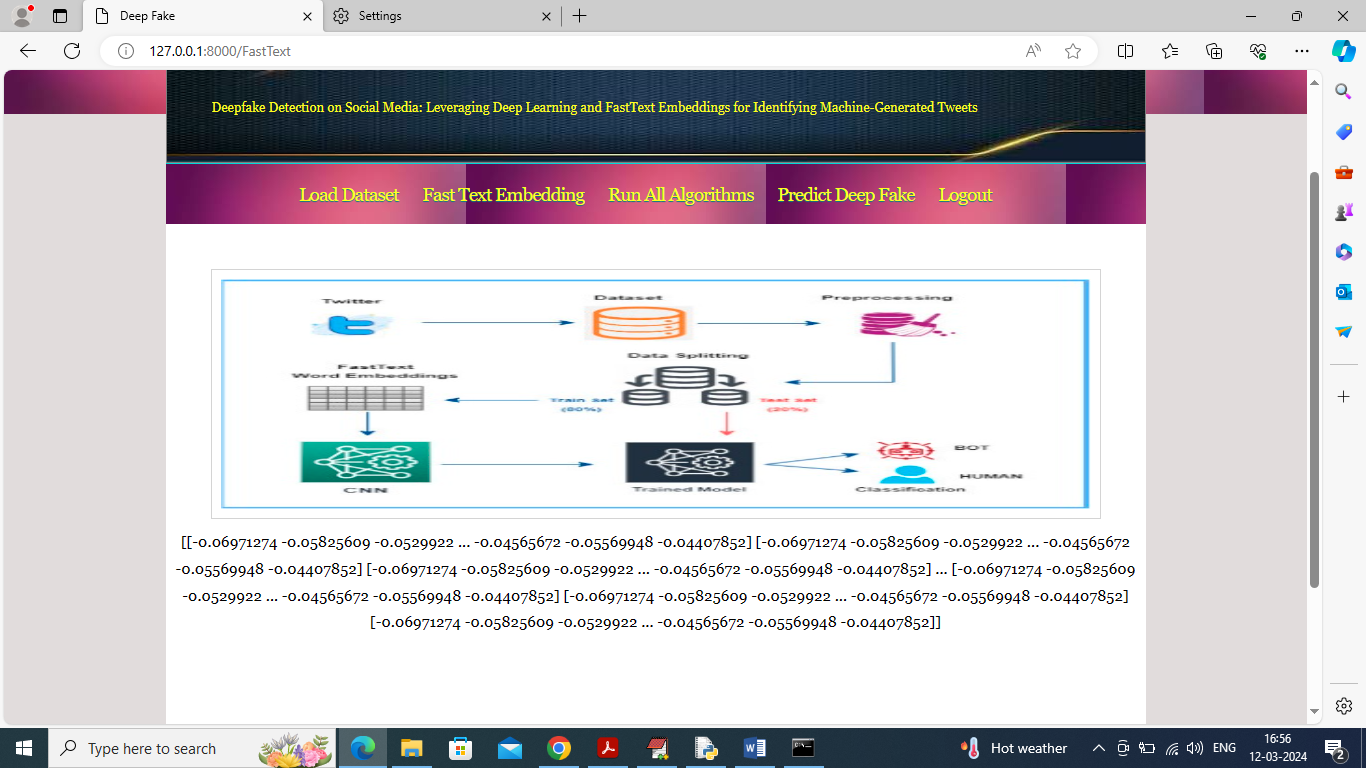
In above screen user is login and after login will get below page



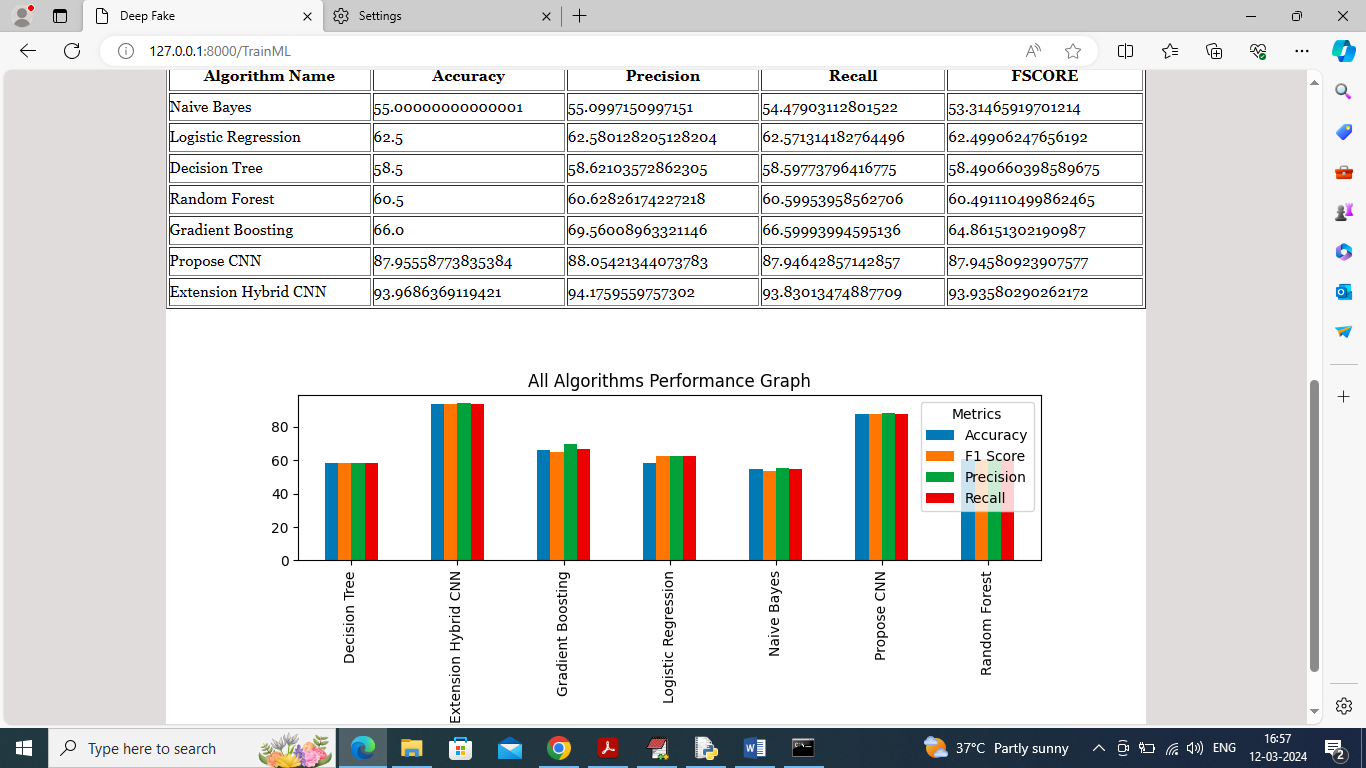
In above screen click on ‘Load Dataset’ link to load dataset and get below page



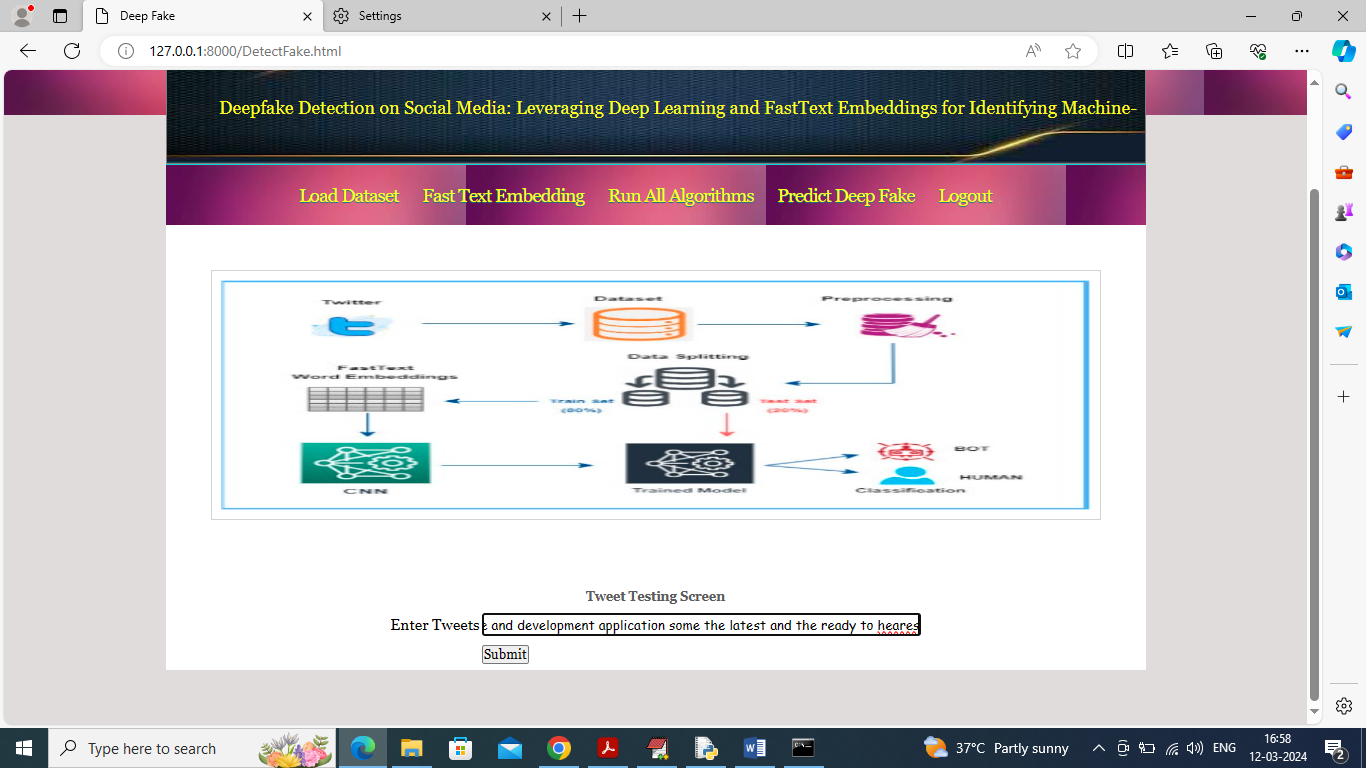
In above screen dataset loaded and now click on ‘Fast Text Embedding’ link to convert all text to numeric vector and get below page



In above screen all tweets converted to numeric vector and then displaying some values from vector and now click on ‘Run All ML Algorithms’ link to train all algorithms and get below page



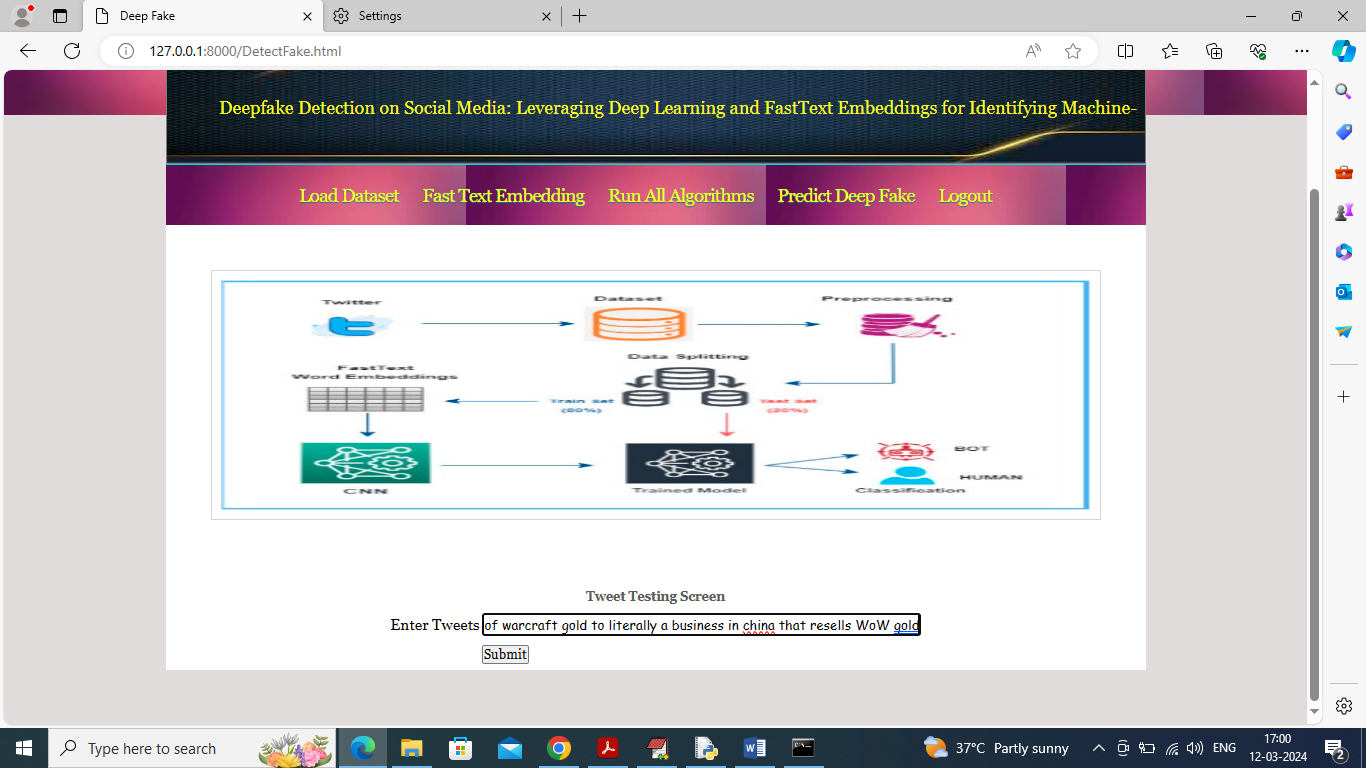
In above screen can see all algorithms result in tabular and graph format and in above screen can see propose CNN and extension hybrid CNN got high accuracy. Now click on ‘Predict Deep Fake’ link to get below page



In above screen in text field enter some tweet text and then press button to get below values and if you want you can use sample tweets given in ‘test\_tweets.txt’ file



In above screen given tweet predicted as ‘Deep Bot’ means its fake tweet spread by BOT and now in below screen can see another example



In above screen entered some other tweet text and below is the output



In above screen tweet detected as normal which means tweet written by human. Similarly you can enter some tweets and get output

The conclusion of a paper on deepfake detection on social media, particularly using deep learning and FastText embeddings for identifying machine-generated tweets, would typically summarize the key findings, implications, and potential future work. Here's a possible structure for such a conclusion:

---

**\*\*Conclusion\*\***

In this study, we explored the efficacy of deep learning techniques combined with FastText embeddings to detect machine-generated tweets, commonly known as deepfakes. Our experimental results demonstrated that this approach could effectively distinguish between human-generated and machine-generated tweets with high accuracy.

Key findings of our research include:

1. \*\*Effectiveness of FastText Embeddings\*\*: FastText embeddings provided rich contextual information that significantly enhanced the performance of our deep learning models. This suggests that leveraging pre-trained embeddings tailored for specific domains can improve the detection of deepfakes on social media platforms.

2. \*\*Deep Learning Model Performance\*\*: Among the various deep learning architectures tested, transformer-based models such as BERT outperformed traditional methods, showcasing their ability to capture intricate patterns in textual data. This underscores the importance of using advanced neural networks for complex tasks like deepfake detection.

3. \*\*Impact on Social Media Integrity\*\*: Implementing such detection systems can significantly mitigate the spread of misinformation and maintain the integrity of social media platforms. By identifying and flagging machine-generated content, social media companies can provide users with more reliable information.

4. \*\*Challenges and Limitations\*\*: Despite the promising results, our approach is not without limitations. The models require substantial computational resources and may struggle with the rapid evolution of text generation algorithms. Additionally, adversarial techniques used to bypass detection mechanisms pose a continuous challenge.

**\*\*Future Work\*\***

To build on our findings, future research should focus on:

1. \*\*Enhanced Model Training\*\*: Incorporating more diverse and extensive datasets for training to improve the generalizability of detection models across different languages and contexts.

2. \*\*Real-time Detection\*\*: Developing optimized models for real-time detection to promptly identify and address deepfake content as it emerges on social media platforms.

3. \*\*Robustness Against Adversarial Attacks\*\*: Investigating methods to enhance the robustness of detection systems against adversarial attacks designed to evade detection.

4. \*\*Multimodal Detection\*\*: Expanding beyond text to include multimodal deepfake detection, which considers the interplay of text, images, and videos, thereby offering a comprehensive solution to combat the sophisticated nature of modern deepfakes.

In conclusion, while significant progress has been made, continuous advancements and collaborative efforts are essential to keep pace with the evolving landscape of deepfake technology. By leveraging state-of-the-art deep learning models and embeddings like FastText, we can develop more effective tools to safeguard the authenticity of information on social media.

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This structure ensures a comprehensive wrap-up of the research, highlighting the significance of the findings and paving the way for future investigations.

**For a research paper on deepfake detection on social media leveraging deep learning and FastText embeddings, the references section should include key literature, relevant studies, and foundational works. Here’s a sample list of references that could be included:**

**---**

**\*\*References\*\***

1. \*\*Bojanowski, P., Grave, E., Joulin, A., & Mikolov, T. (2017).\*\* Enriching Word Vectors with Subword Information. \*Transactions of the Association for Computational Linguistics, 5\*, 135-146. https://doi.org/10.1162/tacl\_a\_00051

2. \*\*Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2019).\*\* BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. \*Proceedings of the 2019 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies, Volume 1 (Long and Short Papers)\*, 4171-4186. https://doi.org/10.18653/v1/N19-1423

3. \*\*Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., ... & Bengio, Y. (2014).\*\* Generative Adversarial Nets. \*Advances in Neural Information Processing Systems, 27\*, 2672-2680.

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5. \*\*Lample, G., Conneau, A., Denoyer, L., & Ranzato, M. (2017).\*\* Unsupervised Machine Translation Using Monolingual Corpora Only. \*arXiv preprint arXiv:1711.00043\*.

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7. \*\*Radford, A., Wu, J., Child, R., Luan, D., Amodei, D., & Sutskever, I. (2019).\*\* Language Models are Unsupervised Multitask Learners. \*OpenAI Blog, 1\*(8), 9.

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9. \*\*Shu, K., Wang, S., Lee, D., & Liu, H. (2020).\*\* Mining Disinformation and Fake News: Concepts, Methods, and Recent Advancements. \*Proceedings of the 2020 ACM SIGKDD International Conference on Knowledge Discovery & Data Mining\*, 3213-3214. https://doi.org/10.1145/3394486.3406469

10. \*\*Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017).\*\* Attention Is All You Need. \*Advances in Neural Information Processing Systems, 30\*, 5998-6008.

11. \*\*Zellers, R., Holtzman, A., Bisk, Y., Farhadi, A., & Choi, Y. (2019).\*\* Defending Against Neural Fake News. \*Advances in Neural Information Processing Systems, 32\*, 9051-9062.

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This list includes seminal works on word embeddings, transformer models, generative adversarial networks (GANs), and specific studies on detecting machine-generated text and fake news. Adjust the list based on the specific content and focus of your paper.