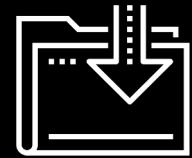


Introduction to Blockchain

FinTech
Lesson 18.1



Class Objectives

By the end of this lesson, you will be able to:



Explain how a blockchain works and its implementations.



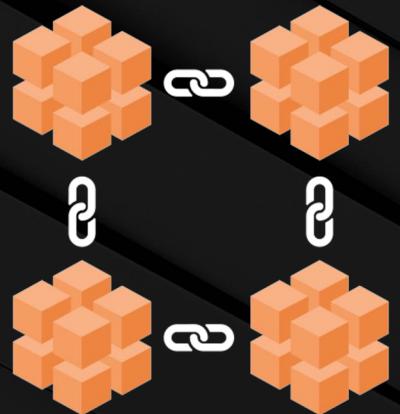
Describe the key features of all blockchains.



Describe the differences between centralized and decentralized systems.



Launch a shareable web application using the Streamlit Python library.



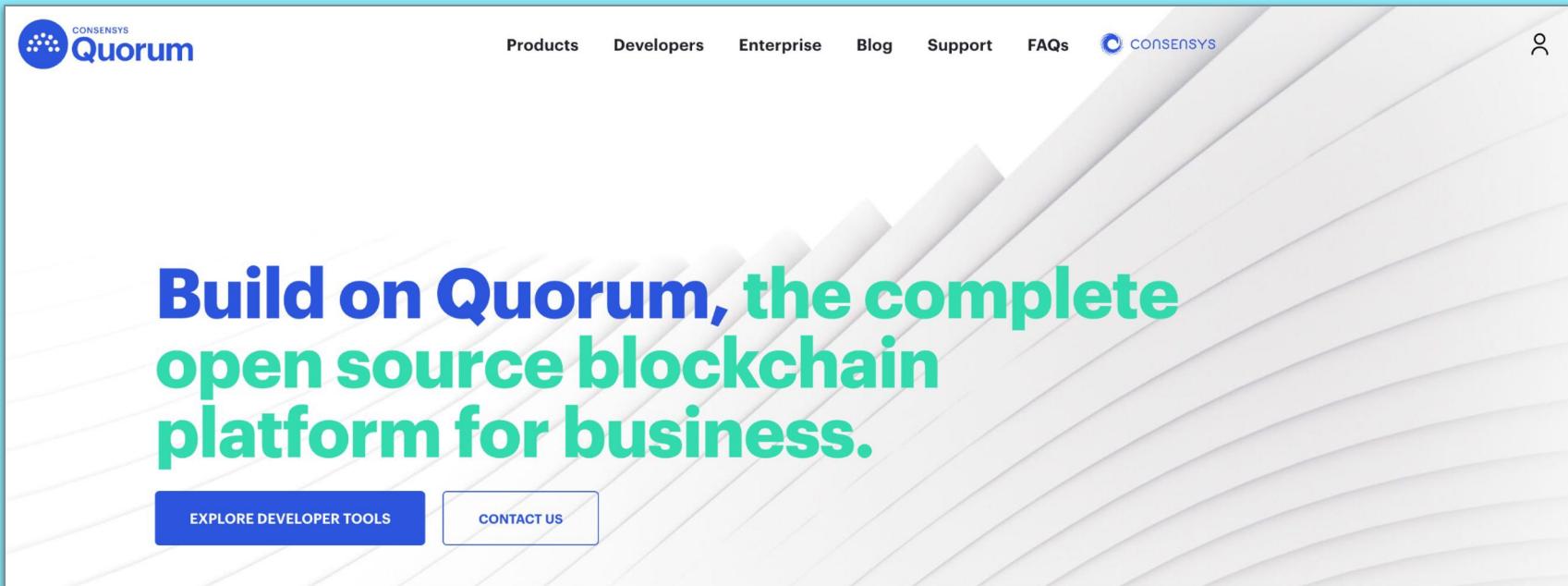
Blockchain is exciting and critical for any career in fintech. Blockchain technology powers not just cryptocurrencies, but also decentralized applications and, in some cases, even business networks.



Blockchain may be a buzzword in the industry, but it's also much more than that—it's a new way of thinking about money and software applications.

Quorum

Traditional financial institutions have been skeptical about blockchain technology. However, JP Morgan Chase created Quorum, an Ethereum-based blockchain, in order to leverage the security that blockchain provides for their own systems.



The image shows the homepage of the Quorum website. At the top left is the Quorum logo, which includes a blue circular icon with white dots and the word "Quorum". To its right are navigation links: Products, Developers, Enterprise, Blog, Support, and FAQs. Next to these is the ConsenSys logo, which consists of a blue circle with a white dot and the word "CONSENSYS". On the far right is a user icon. The main title "Build on Quorum, the complete open source blockchain platform for business." is displayed in large, bold, blue and green text. Below the title are two buttons: "EXPLORE DEVELOPER TOOLS" and "CONTACT US". The background features a light gray grid pattern.

Build on Quorum, the complete
open source blockchain
platform for business.

EXPLORE DEVELOPER TOOLS

CONTACT US

Questions?





How many of you have heard
of blockchain?



How many of you have heard
of cryptocurrency?



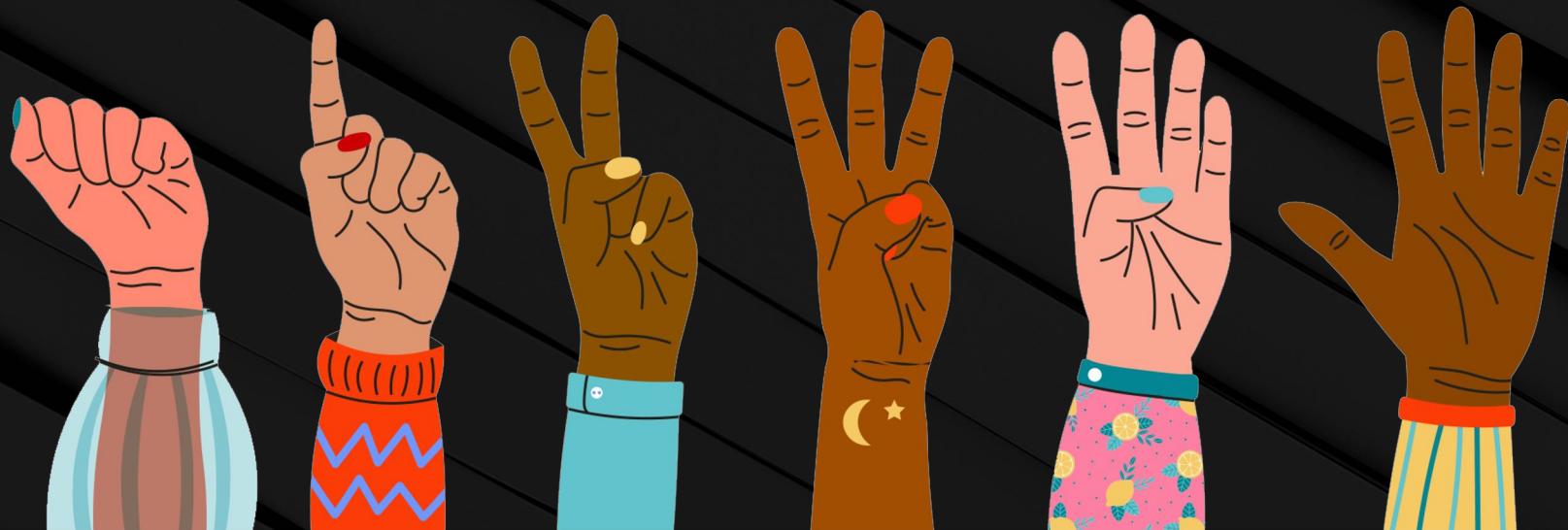
How many of you have conducted
a transaction on a blockchain by
using a digital wallet?



How many of you have ever
traded cryptocurrency?

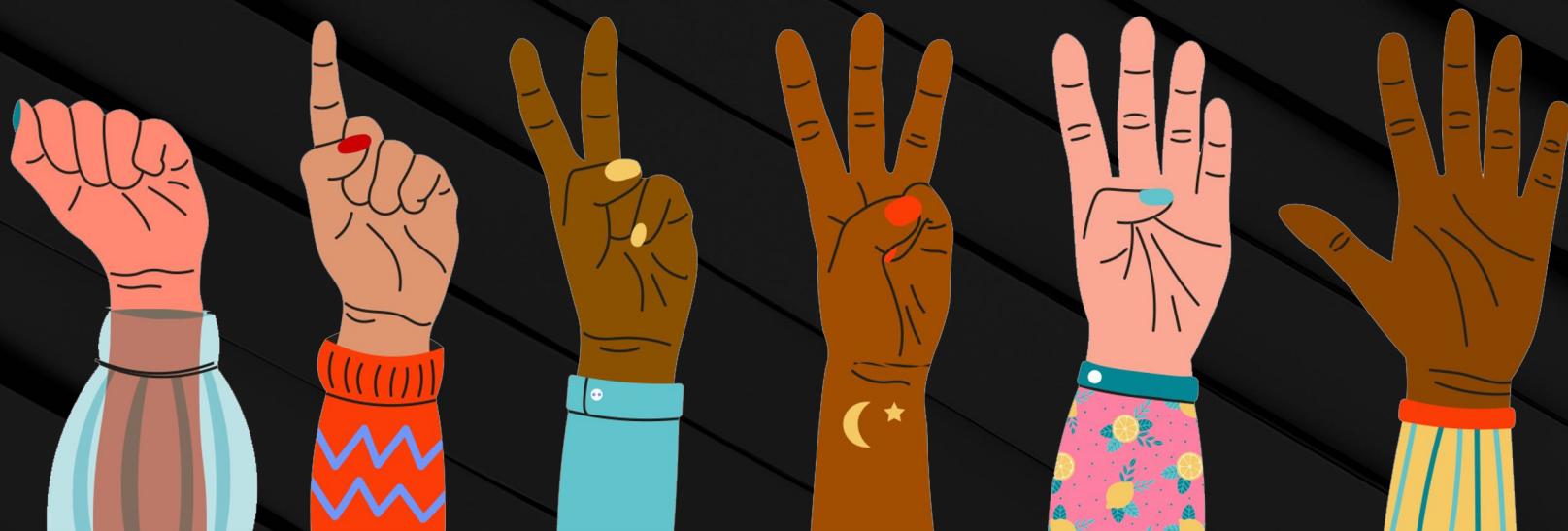
FIST TO FIVE:

How familiar are you with blockchain?



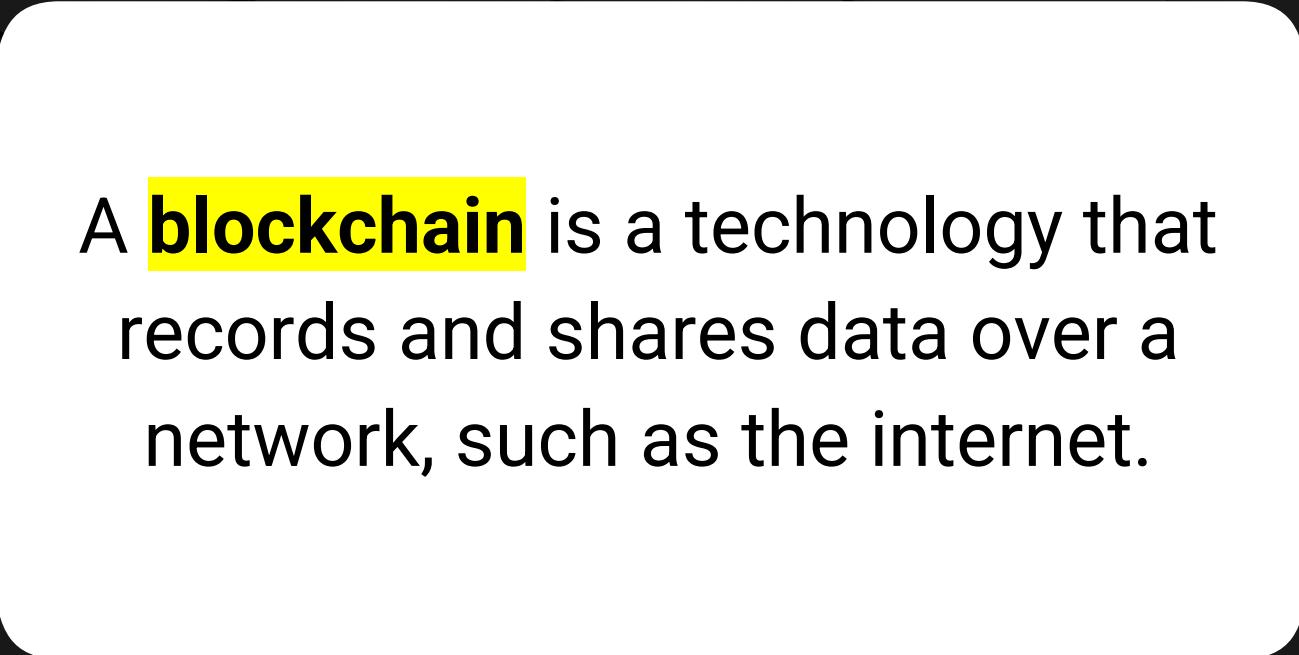
FIST TO FIVE:

How comfortable are you having a conversation
about blockchain technology?





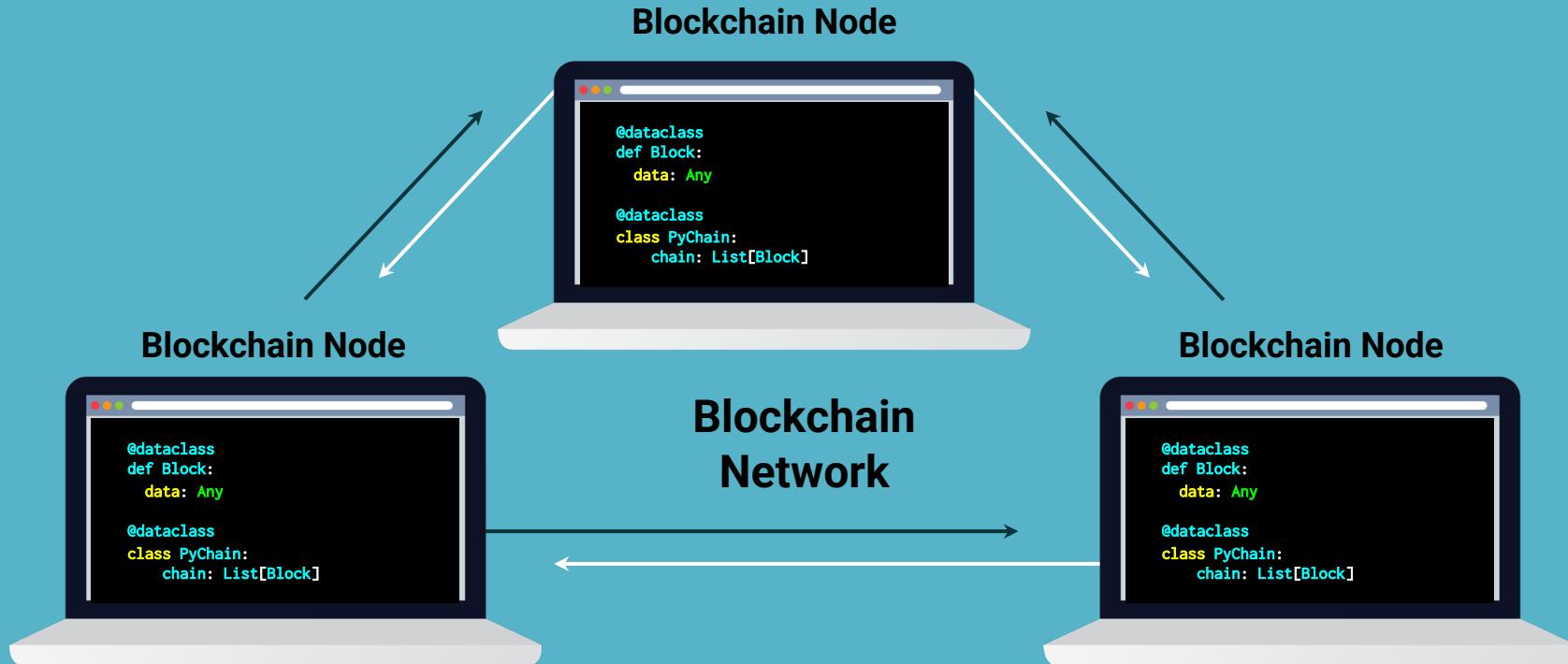
What Is Blockchain?



A **blockchain** is a technology that records and shares data over a network, such as the internet.

Blockchain Network

Blockchains can be thought of as a bunch of computers that allow users to securely record and access data from anywhere on the network.



Blockchain Examples

Most often, people associate blockchain with cryptocurrencies. This association is accurate, but cryptocurrency is just one application of blockchain.

Blockchains can be used to record any type of transaction or data.

Examples include:



Recording an agreement to buy a house



Recording a vote



Recording a marriage contract

Blockchain Examples

Mythical Games

Mythical Games, a large games studio, allows users to buy and sell digital in-game items over a blockchain, even across different games.



Doc.ai links medical records across a distributed ledger to lower healthcare costs and advance scientific research.

The image shows a grid of mobile phone screens demonstrating the Doc.ai platform. One screen in the foreground displays a dashboard with a large blue button labeled 'Cleared' and a list of items: 'Work location', 'Health Reported', 'Test Results', and 'Generate badge'. Another screen shows a 'Log' section with 'Daily check-in' and 'Symptom reporting' options. A third screen features a blue background with a white starburst graphic and text about contributing to an AI model for Myasthenia Gravis. Other screens show messaging and activity tracking interfaces. The overall theme is digital health and data management.

We accelerate digital transformation in healthcare.

From edge to cloud, and from cloud to edge.

Bloq

Bloq, an infrastructure platform, allows any company to add blockchain applications to its existing business.

The image shows the Bloq website homepage on the left and a screenshot of the Bloq Console interface on the right.

Homepage (Left):

- Header:** bloq, Products, Solutions, Company, Contact, Blog, Log In, Sign Up.
- Section:** Protocols, Build it with bloq.
- Text:** Managed infrastructure for building on blockchain networks.
- Buttons:** SIGN UP →, Request Demo.

Bloq Console (Right):

- Section 1: Setup Chain**
 - Bitcoin, Bitcoin Testnet, Bitcoin Cash, Bitcoin Cash Testnet, Ethereum, Ethereum Classic.
- Section 2: Configure Node Cluster**
 - Node Performance: Standard, High.
 - Authentication: (options not visible).
- Side Panel:** Bloq Connect provides real-time blockchain access and indexing, with a Setup Connect button.

TraDove

TraDove is a platform that connects suppliers with customers. It relies on blockchain to enable trust and lower transaction costs.

The image shows the TraDove homepage. At the top left is the logo with the text "TraDove" and "Find. Connect. Trade.". To the right are navigation links: "About Us", "Blogs", a green "Join for Free" button, and a white "Sign In" button. The main headline on the left reads: "Where business Buyers and Sellers meet, connect and trade around the world." Below this is a graphic illustrating the TraDove connection. It features three puzzle pieces labeled "Buyers", "TraDove", and "Sellers". A central vertical stack of five blockchain blocks is labeled "TRADOVE CONNECTION" and "BLOCKCHAIN SMART CONTRACT". This stack is connected by arrows to a "SELLER" station on the left and a "BUYER" station on the right. The "SELLER" station shows a robotic arm and a person at a computer screen displaying a graph. The "BUYER" station shows a person at a computer screen displaying a green plus sign. Arrows also point from the blockchain stack to the "SMART CONTRACT" label between the stations.

Blockchain for Energy!

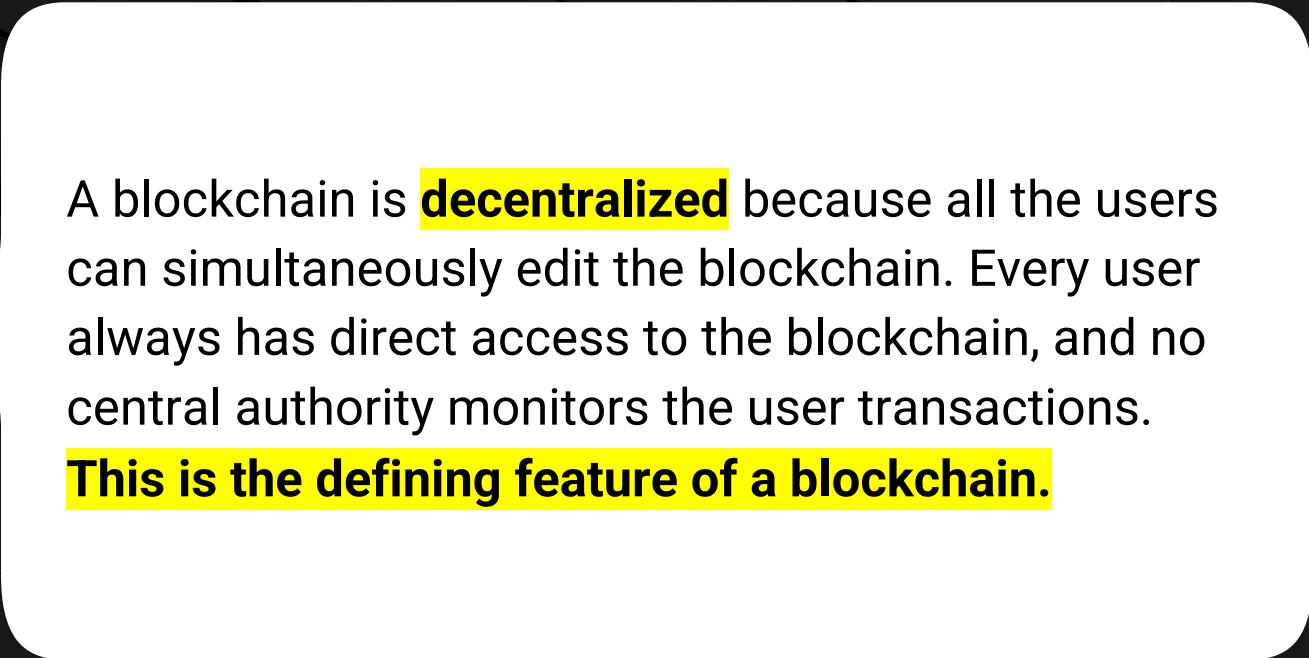


LEADING TECHNOLOGY
TRANSFORMATION WITH
BLOCKCHAIN FOR ENERGY



BLOCKCHAIN
FOR ENERGY

Features of Blockchain

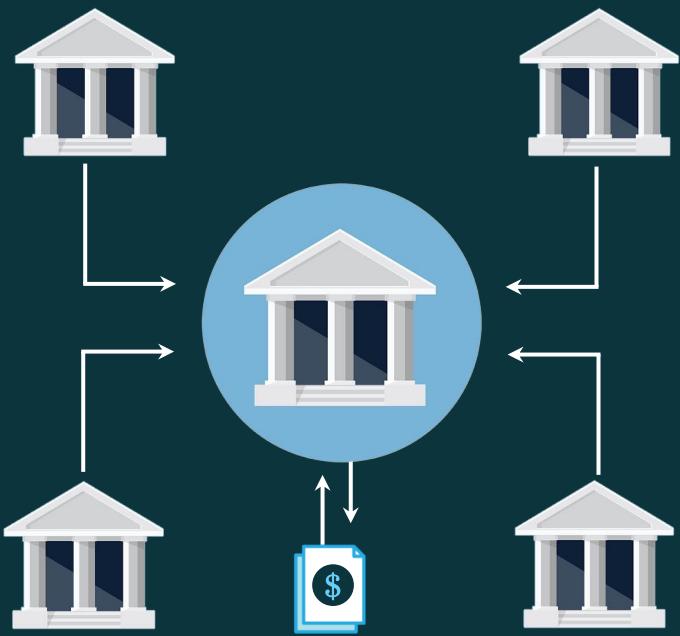


A blockchain is **decentralized** because all the users can simultaneously edit the blockchain. Every user always has direct access to the blockchain, and no central authority monitors the user transactions.

This is the defining feature of a blockchain.

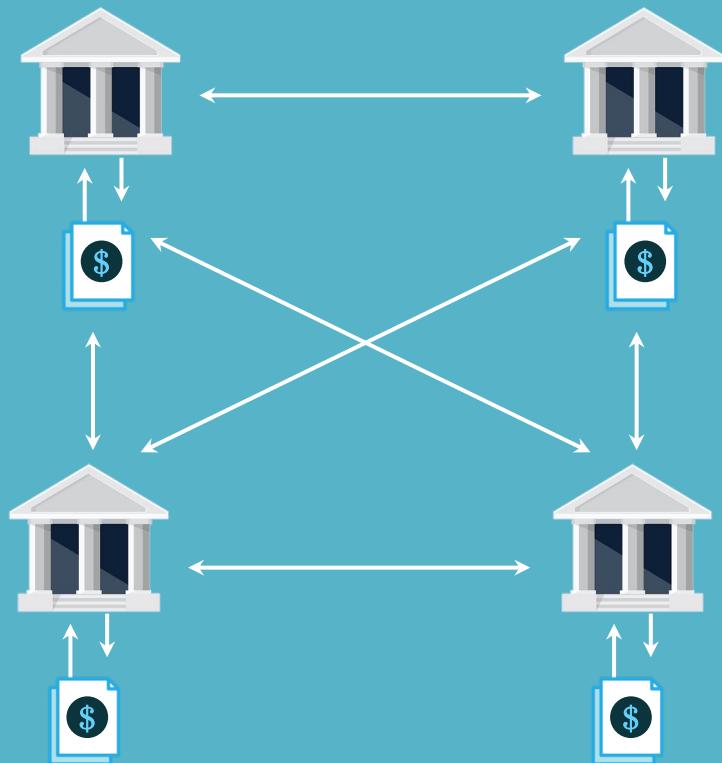
Traditional Approach

A central and trusted third party controls the database.



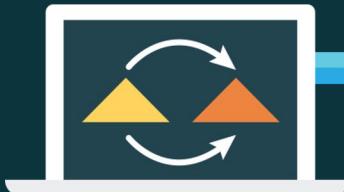
Blockchain Approach

Each participant has a copy of the database, helping to ensure reliability.

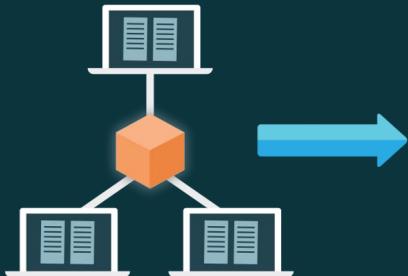


A distributed architecture: A blockchain is distributed for two reasons. First, many computers in various locations store identical copies of the same ledger. Second, these computers communicate with each other to arrive at particular decisions, like the validity of a new block in the chain.

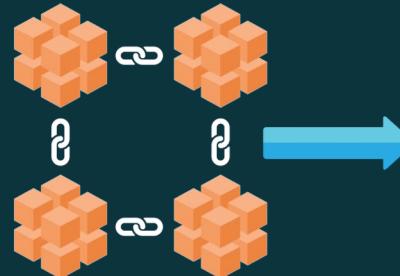
A Distributed Architecture



Blockchain participants
create transactions.



Miners compete to
mine new blocks.

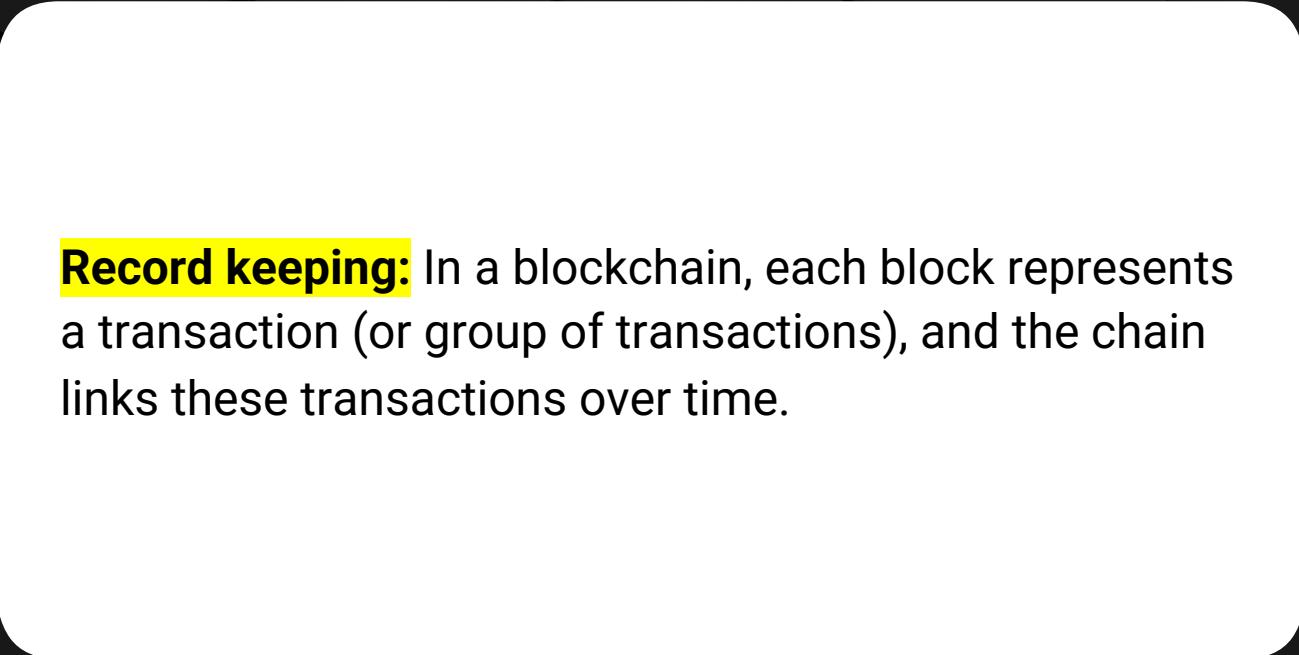


As new block is linked
to the blockchain. All
computers participating
with the blockchain update
their copies of the ledger to
include the new block.



Once the transaction
has been written to
the blockchain it
cannot be altered.

Trust: Blockchain technology is designed so that users can trust that the blockchain accurately records data and prevents tampering with that data. Without this trust, no one would use a blockchain for a transaction.



Record keeping: In a blockchain, each block represents a transaction (or group of transactions), and the chain links these transactions over time.

Transparency: Anyone can review the history of the transactions in a blockchain. However, this doesn't mean that anyone can review all the data that the transactions contain—the data itself might be private or sensitive. Users can verify the existence of the transactions, as well as who added the data and when. Not all blockchains have full transparency, but it's a common feature.

Cryptocurrencies

These five key features apply to any blockchain application, including cryptocurrencies.





A blockchain isn't a cryptocurrency.
Rather, it's a common component of
how cryptocurrencies are structured.



Group Activity: Use Case Study

In this activity, you will work in groups to examine a use case for different cryptocurrency and blockchain projects.

The goal is to list the blockchain features that are applicable to each use case.

Suggested Time:

15 minutes



Time's Up! Let's Review.

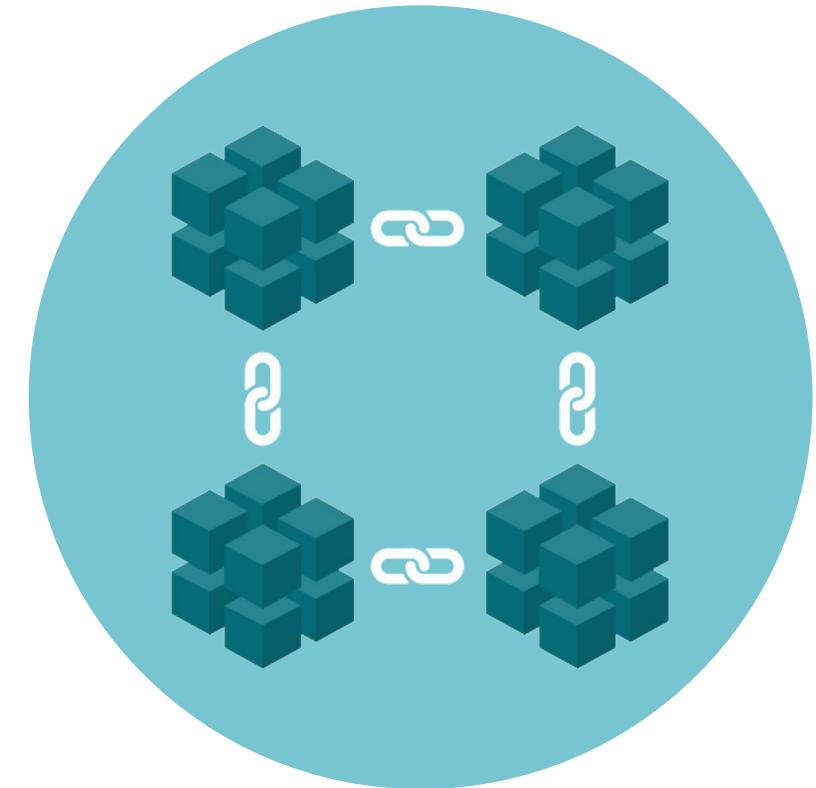


What are the five key features
of blockchains?

Blockchains

The five key features of blockchains:

- 01 Decentralization
- 02 Distributed architecture
- 03 Record keeping
- 04 Trust
- 05 Transparency



Bitcoin in Venezuela

The key features of blockchains applicable in the Bitcoin in Venezuela example:

Decentralization	There is no fear of the government devaluing the currency.
Distributed architecture	Users only need a computer in order to participate in the Bitcoin blockchain. It's publicly accessible to almost anyone in the world, and it doesn't require bank accounts that are located abroad.
Record keeping	
Trust	Users trust that their currency will not be devalued and that their funds are secure.
Transparency	

Monero

The key features of blockchains applicable in the Monero example:

Decentralization	There is no authority overseeing the distribution or use of the Monero cryptocurrency. Therefore, its use in potentially illegal transactions is unmonitored.
Distributed architecture	
Record keeping	
Trust	Users trust that the transactions conducted on the blockchain will remain anonymous and private.
Transparency	

Stellar

The key features of blockchains applicable in the Stellar in Venezuela example:

Decentralization	
Distributed architecture	Stellar's business focuses primarily on developing markets where a centralized system can be more challenging to implement. The cross-border nature of the systems design is integral to making the application accessible.
Record keeping	Stellar seeks to provide money remittance and bank loan distribution to the unbanked population—two areas where accurate and immutable records are paramount.
Trust	
Transparency	Stellar is open source.

Ethereum

All five key features are demonstrated by the Ethereum blockchain and underlie its success, especially as it relates to the creation of smart contracts.

01

Decentralization

02

Distributed architecture

03

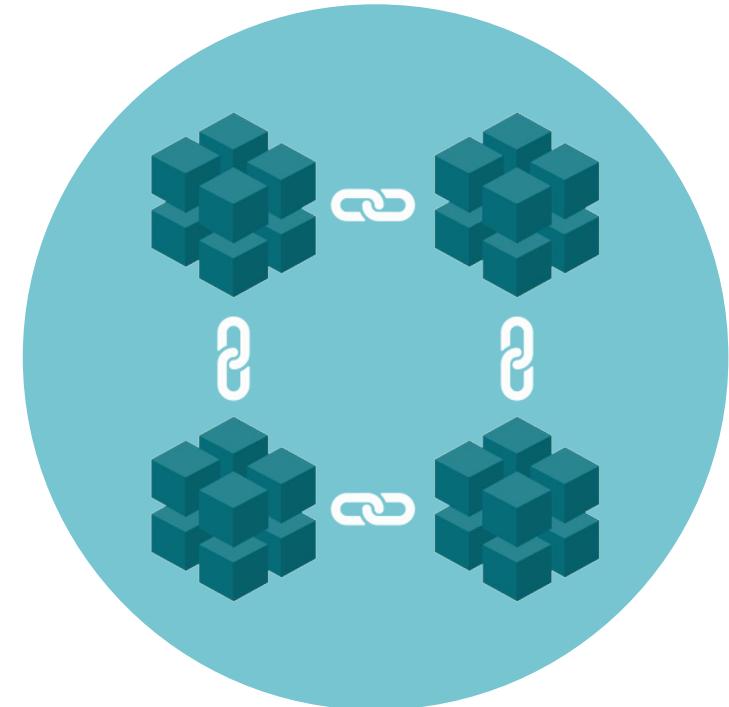
Record keeping

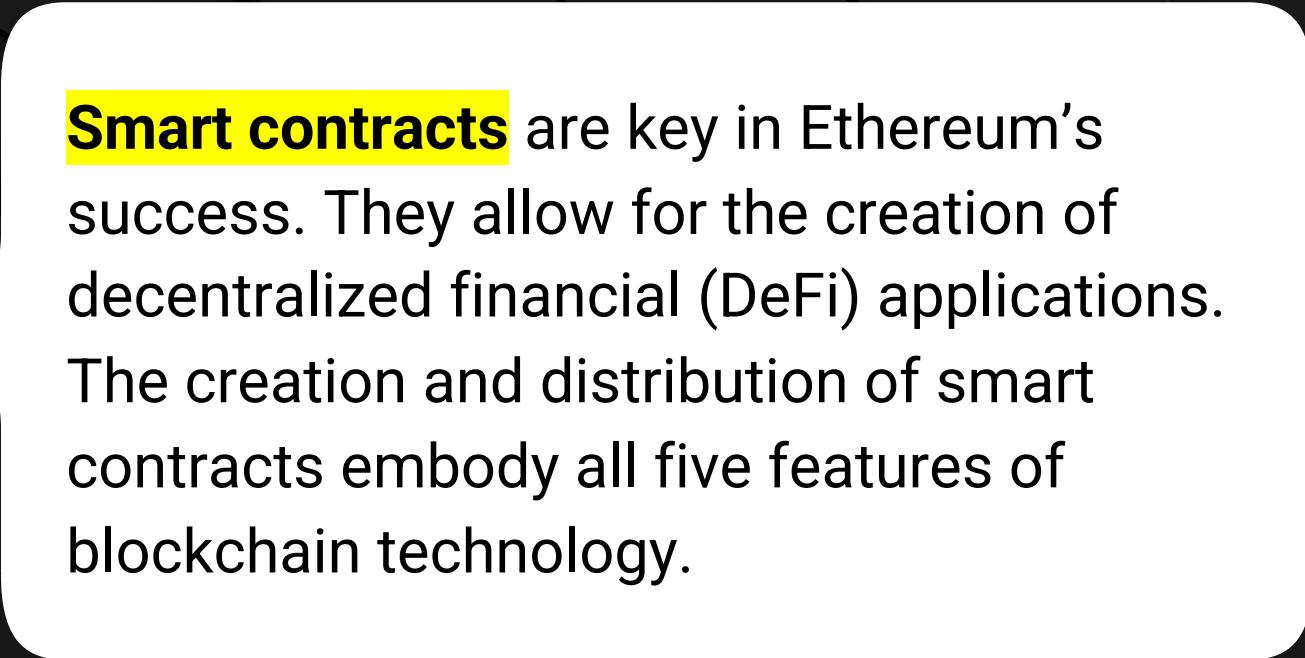
04

Trust

05

Transparency





Smart contracts are key in Ethereum's success. They allow for the creation of decentralized financial (DeFi) applications. The creation and distribution of smart contracts embody all five features of blockchain technology.

Machine-to-Machine Transactions

The key features of blockchains applicable in the Machine-to-Machine Transactions example:

Decentralization	
Distributed architecture	The software can be scaled to many machines.
Record keeping	The record-keeping functionality makes it easy to track usage and payments from one machine to another.
Trust	
Transparency	

CryptoCribs

The key features of blockchains applicable in the CryptoCribs example:

Decentralization	CryptoCribs is a service provider. Its application is built on a decentralized network, which makes it more resistant to outages.
Distributed architecture	Because all renters and rentees can access the software, CryptoCribs works toward eliminating intermediaries in the rental process.
Record keeping	
Trust	Trust is integral to the short-term, peer-to-peer rental business.
Transparency	

Proof of Impact

The key features of blockchains applicable in the Proof of Impact example:

Decentralization	
Distributed architecture	Proof of Impact provides data that is readily available to all users.
Record keeping	
Trust	The immutable nature of information contained on a blockchain ensures data integrity.
Transparency	

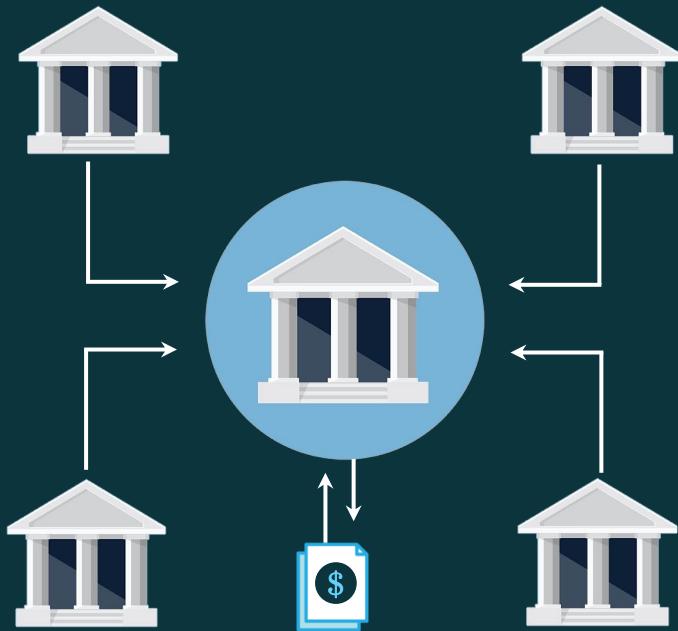
Questions?



Centralization and Traditional Banking

Centralization and Traditional Banking

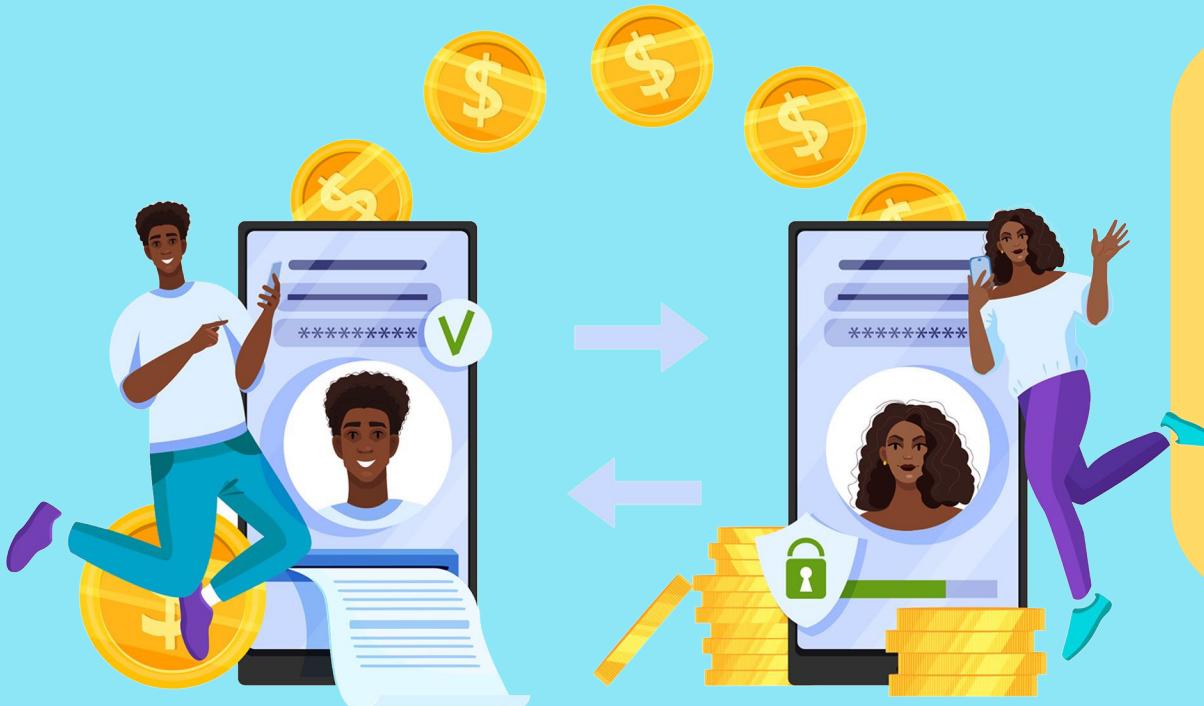
Historically, most systems that maintain financial records—for example, banks and governments—have been centralized. This means that one location or one authoritative source runs the financial tasks that are involved in maintaining the system.



For example: Banks keep internal logs of their money flows. A bank exchanges assets (like cash and stocks) with a wide variety of customers. But the bank doesn't rely on those customers to agree on the amount of money that the bank currently has. The bank keeps its own authoritative record.

Centralization and Traditional Banking

People usually consider banks to be trustworthy institutions.



So, when \$50 is transferred from one bank account into a friend's account at a different bank, both parties can trust that the money will arrive at the correct destination. They can also trust that the bank will record a decrease of \$50 in the sender's balance and an increase of \$50 in the receiver's balance.

The bank's internal log of its money flow is an example of a centralized accounting system, which is also called a **ledger**.

Centralization

At a basic level, a ledger keeps track of financial transactions. Any financial ledger includes both settlement and reconciliation.

Settlement

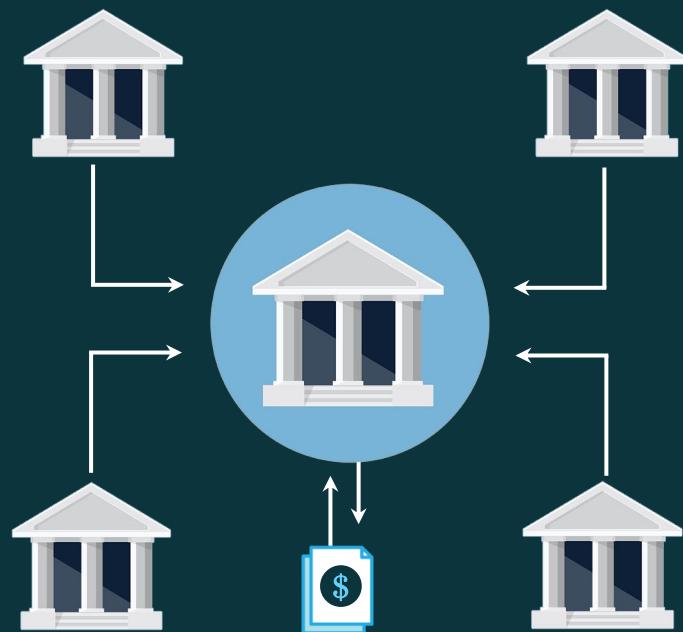
A ledger must facilitate the transfer of assets between one entity and another, which is known as a settlement.

Reconciliation

A ledger must also verify that all its transactions have been correctly done, which is known as reconciliation.

Centralization Advantages

It makes transactions easy and fast. Transactions just need to be logged to the appropriate server, and it's done!



Transactions are not cross-checked against other copies on the network, which saves time and energy. If the settlement and reconciliation of a single transaction in a centralized system was reviewed, it could likely be determined, in a simple manner, whether that transaction was correctly done.

Hidden Costs of Centralization

Consider a centralized system that processes millions or even billions of transactions every day. There are now complex and expensive problems, such as:

01

Investment in extra servers is needed in case a server goes down or reaches capacity.

02

Any downtime can lead to a chain reaction of failed transactions and other costly problems.

03

Specialists are required—and need to be paid—to monitor these millions of transactions, and then audit any transactions that appear to be erroneous.

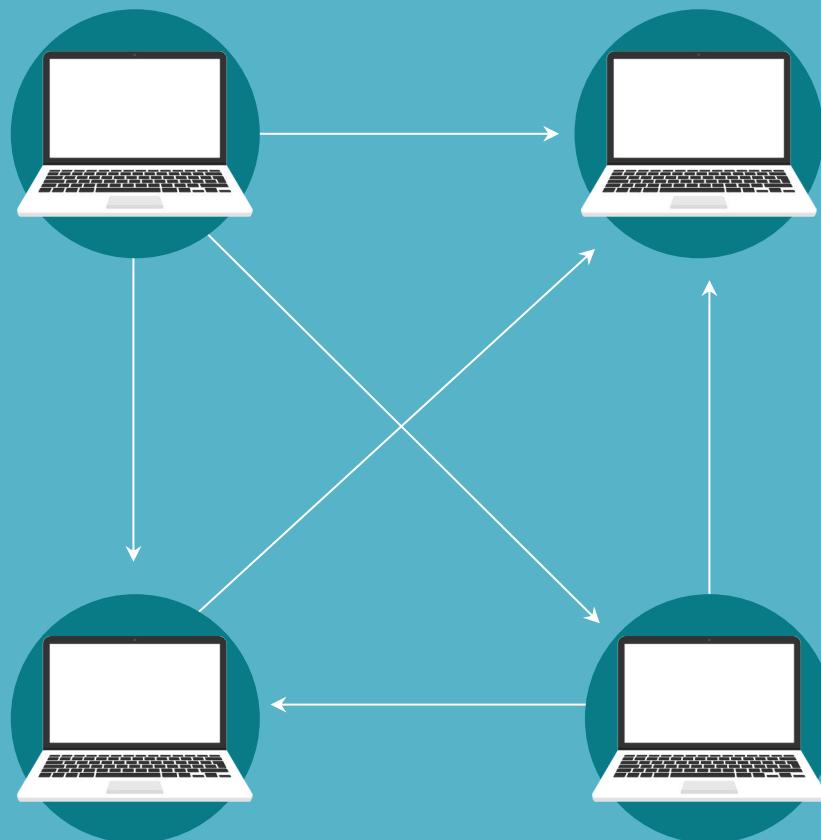
Decentralization and Blockchains

Unlike a centralized financial system that has one authoritative ledger to record all transactions, the ledger of a blockchain is **distributed** across all the computers that have a copy of the blockchain.

Centralized Database

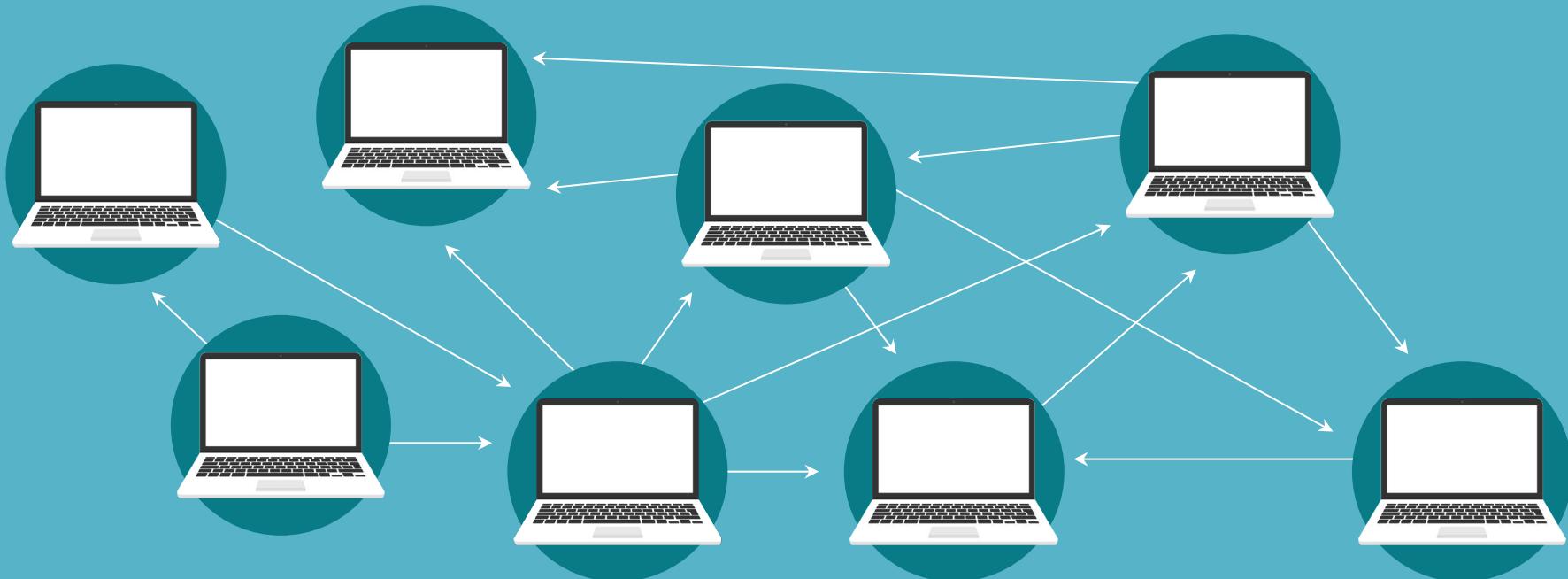


Decentralized Database



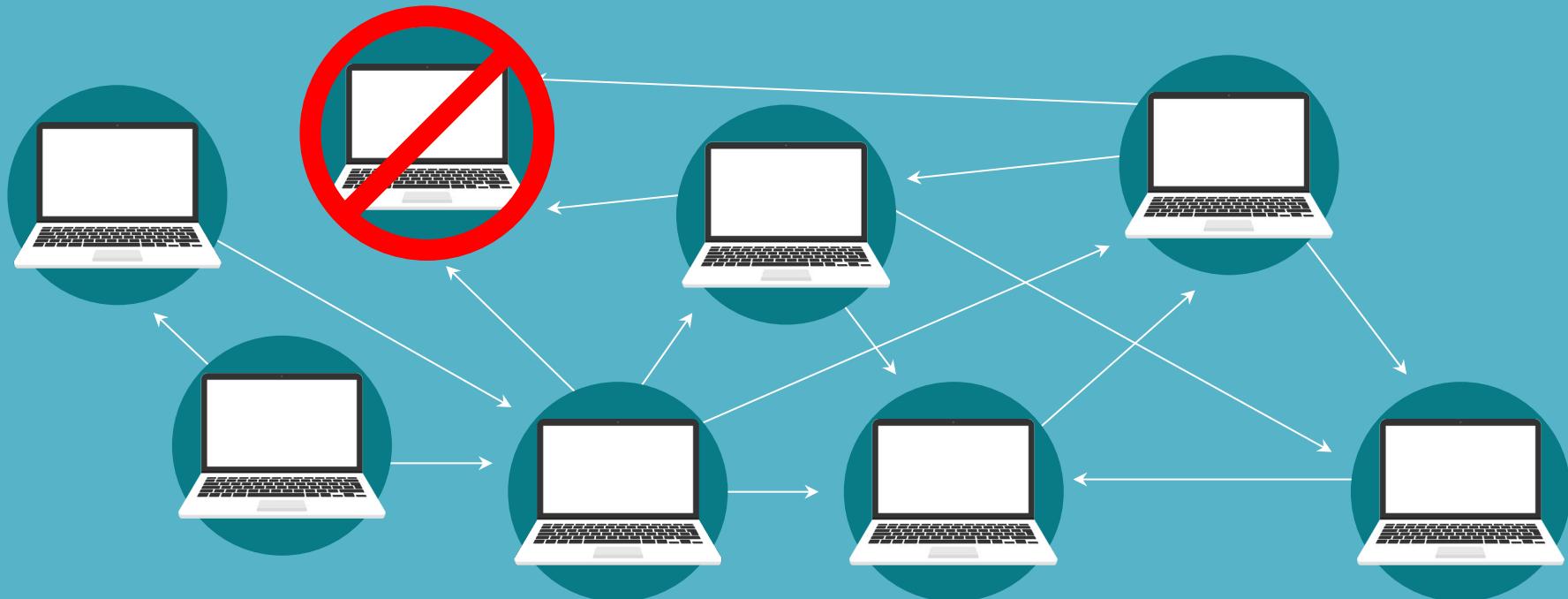
Decentralized Database

When correctly designed, this kind of distributed ledger—spread across thousands or millions of computers, or nodes—is more immune to server outages, malicious hackers, and other factors that can cause transactions to go wrong.



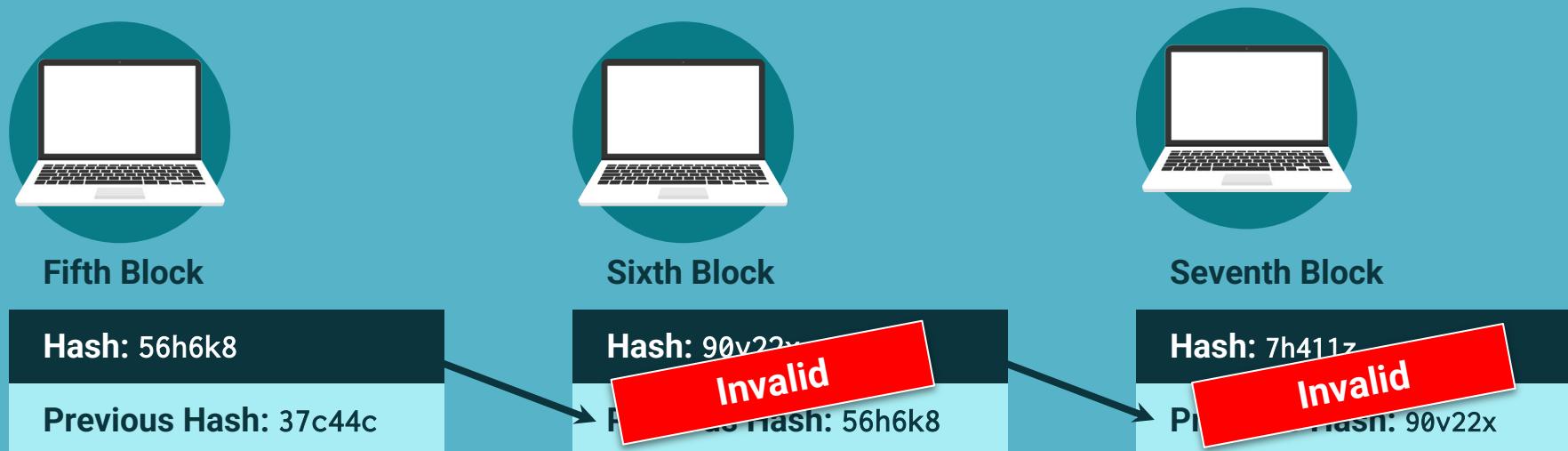
Decentralized Database

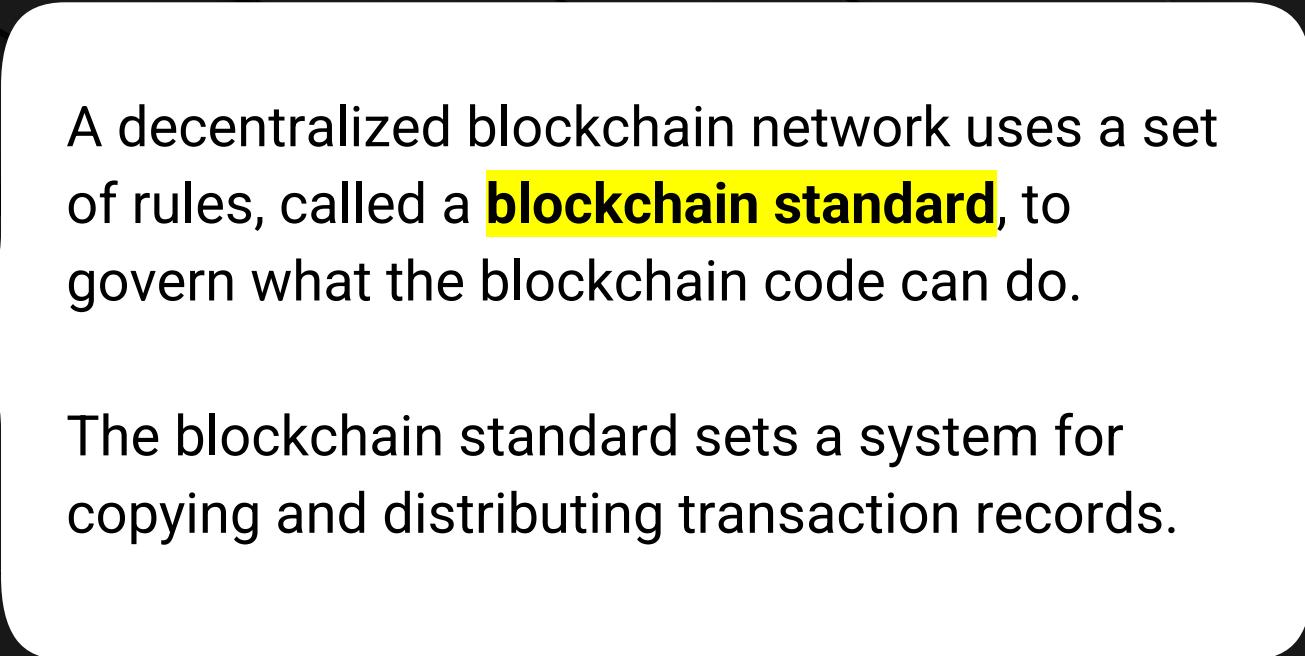
If one computer goes offline, millions remain to both maintain the transaction history and continue processing new transactions.



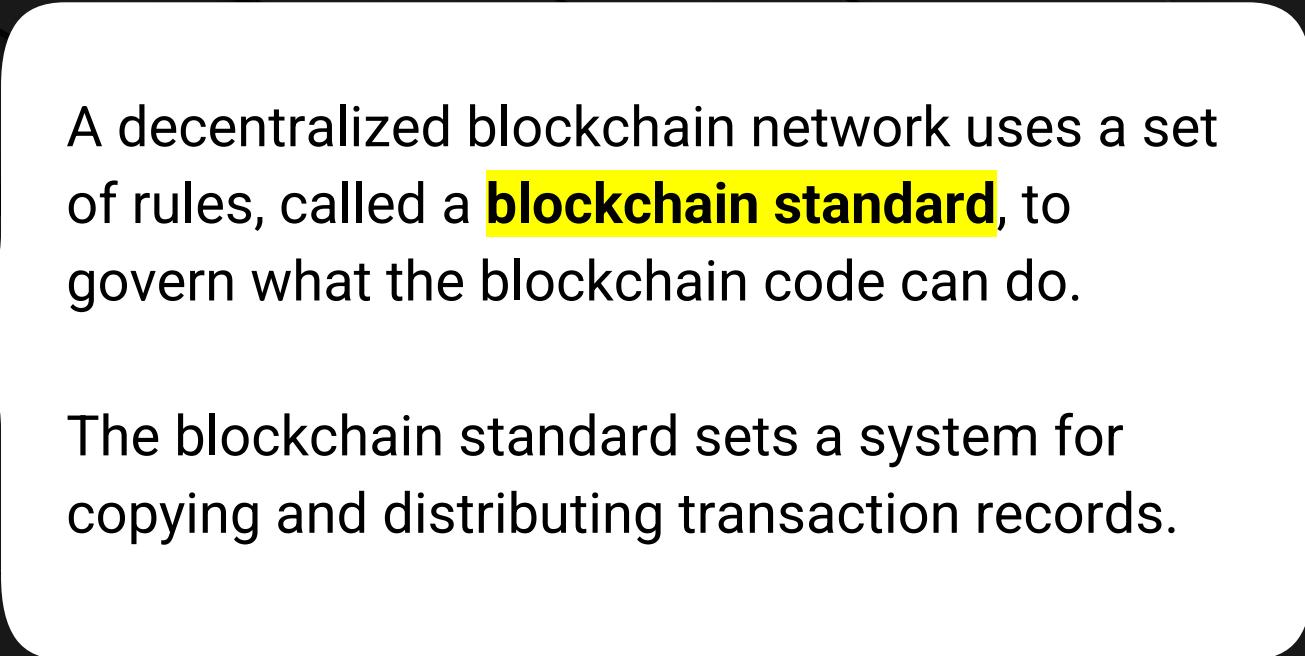
Decentralized Database

Even if a malicious hacker compromises the blockchain on thousands of computers, the system is designed so that the remaining blockchains—replicated on potentially thousands or millions more computers—will automatically identify the compromised blockchains as invalid.

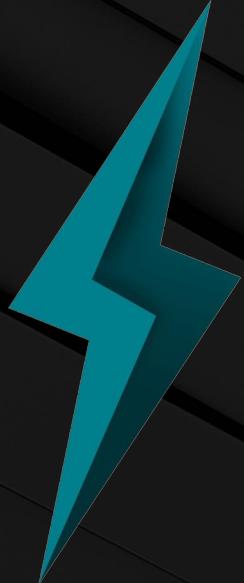




A decentralized blockchain network uses a set of rules, called a **blockchain standard**, to govern what the blockchain code can do.



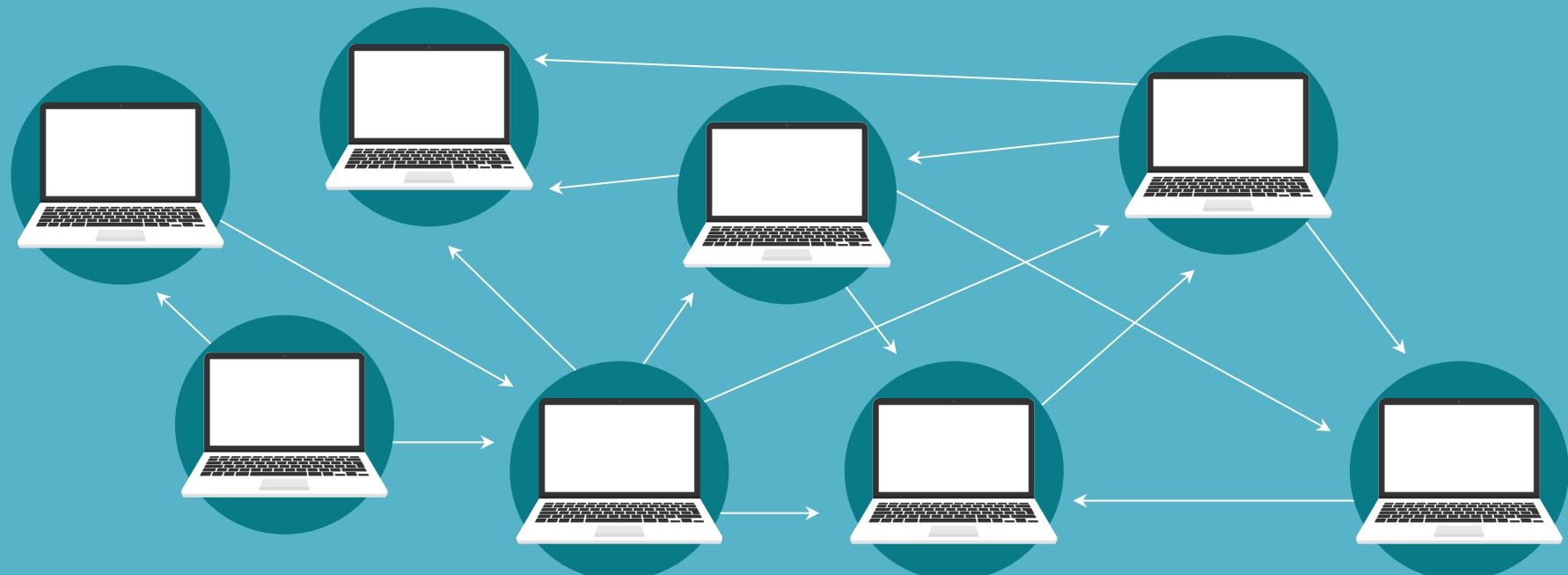
The blockchain standard sets a system for copying and distributing transaction records.



The blockchain standard assures that all of the computers in the network are validating transactions using the same rules. This way, the collection of records represents a source of truth.

Source of Truth

The source of truth is created by a number of copies of the blockchain record that are in agreement. This is what prevents hackers from compromising the system.



Centralized Blockchains

Centralized System

While most blockchains are decentralized, it's possible to operate a blockchain as a centralized system.

In a centralized blockchain, only certain participants with special permission can perform transactions on the blockchain.
These are called **permissioned blockchains**.



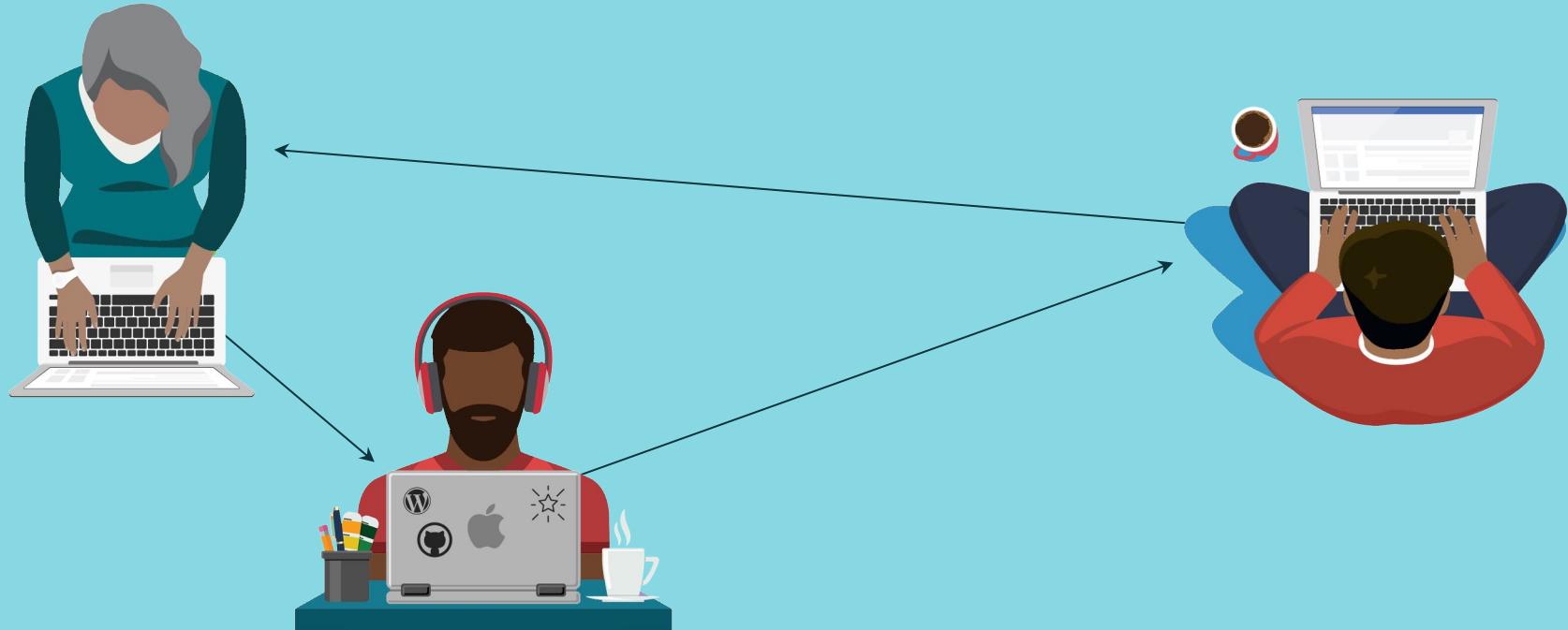
Centralized System

Consider a hypothetical blockchain that allows various departments of a city government to record transactions about each property that's located within its jurisdiction. These might include property tax payments, emergency services, ownership status, and street maintenance history. Placing all of this data in a single ledger would be terrific for efficiency.



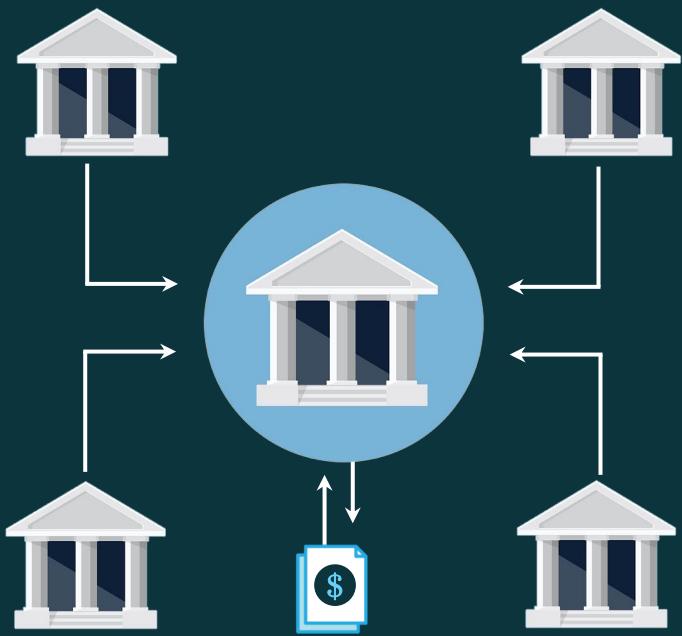
Permissionless Blockchains

By contrast, permissionless blockchains allow anyone to transact, or make changes, on the blockchain as it continues forward.



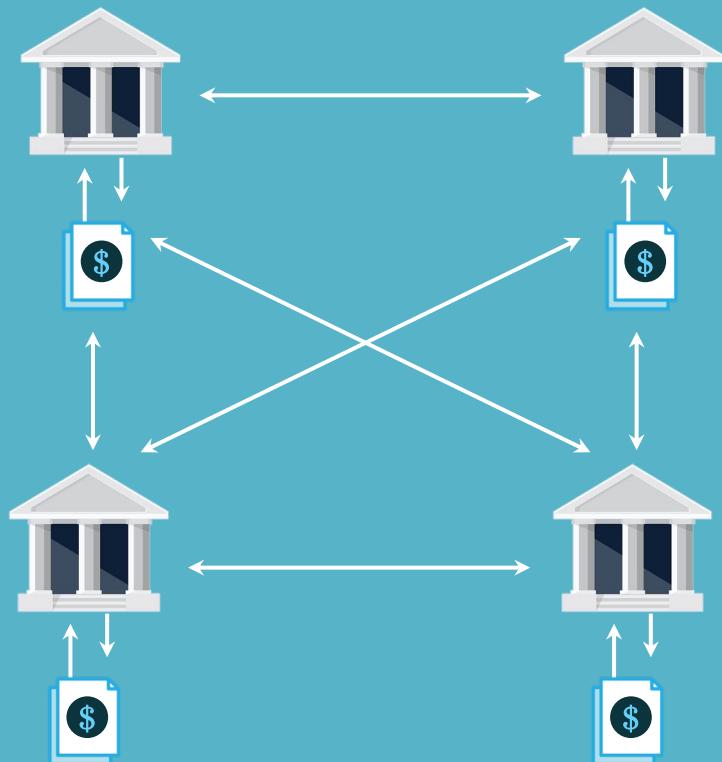
Traditional Approach

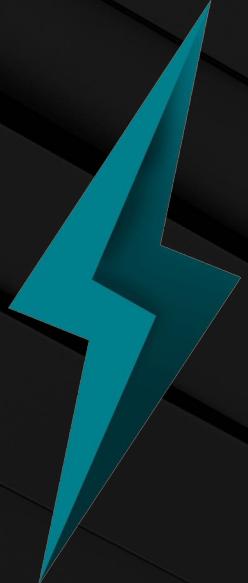
A central and trusted third party controls the database.



Blockchain Approach

Each participant has a copy of the database, helping to ensure reliability.





In summary, blockchains apply new technology to an old problem:
record keeping.

Questions?





Group Activity: Peoplechain

In this activity, you will emulate the activities of a fictitious blockchain that are involved in confirming a transaction.

Suggested Time:

20 minutes



Time's Up! Let's Review.



What are the four main steps for creating the “Peoplechain”? How do these steps relate to real blockchain functionality?

Blockchain Functionality

The four main steps for creating the “Peoplechain” are:

01

Post cryptocurrency balances on the blockchain.

02

Create blockchain transactions.

03

Validate blockchain transactions.

04

Mine blockchain transactions.

Blockchain Functionality

Post cryptocurrency balances on the blockchain	In a real blockchain, cryptocurrency balances are usually accessed through a cryptocurrency wallet.
Create blockchain transactions	All transactions on a blockchain contain at least the information detailed in the activity transactions: sender, receiver, amount of the transaction, and a transaction fee.
Validate blockchain transactions	Every transaction posted to the blockchain must be validated before it's written to a block. The validation process keeps users from spending more cryptocurrency than they have. Transactions usually wait in the mempool to be validated and written to the blockchain.
Mine blockchain transactions	Once transactions are validated, they're pulled from the mempool and mined into blocks. Each block consists of a group of validated transactions. Each block has an identifier that ties it to the previous block, which helps to ensure the continuity of the chain.

Questions?



Break



Blockchain Rules and Trust

Blockchain standards are a set of rules that define the blockchain code and how it operates. Who creates the rules that define the blockchain standard? It depends on whether the blockchain is permissioned or permissionless.

Permissioned vs. Permissionless Blockchains

Permissioned

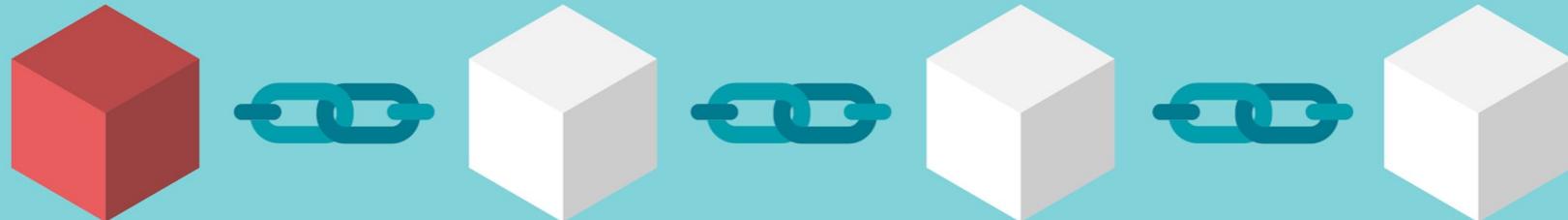
A permissioned blockchain has a trusted, third-party arbiter—for example, a government, corporate CEO or Board of Directors, or another well-respected institution—that acts as the central decision-making authority.

Permissionless

A permissionless blockchain doesn't have a central authority to provide trust. Instead, people place their trust in the prespecified rules of the blockchain, which are the incentives that keep the users acting appropriately.

Permissionless Blockchain

For permissionless or open blockchains, the code of the blockchain includes its “rules of the game.” This code runs for all the users of the chain—that is, the code is distributed across all the users.



Block 0

Block 1

The `prev_hash` attribute
contains the hash of Block 0



Bitcoin and Ethereum are examples
of permissionless blockchains.

Permissioned Blockchain

What if the rules need to change?

In this case, permissionless blockchains are rather democratic.

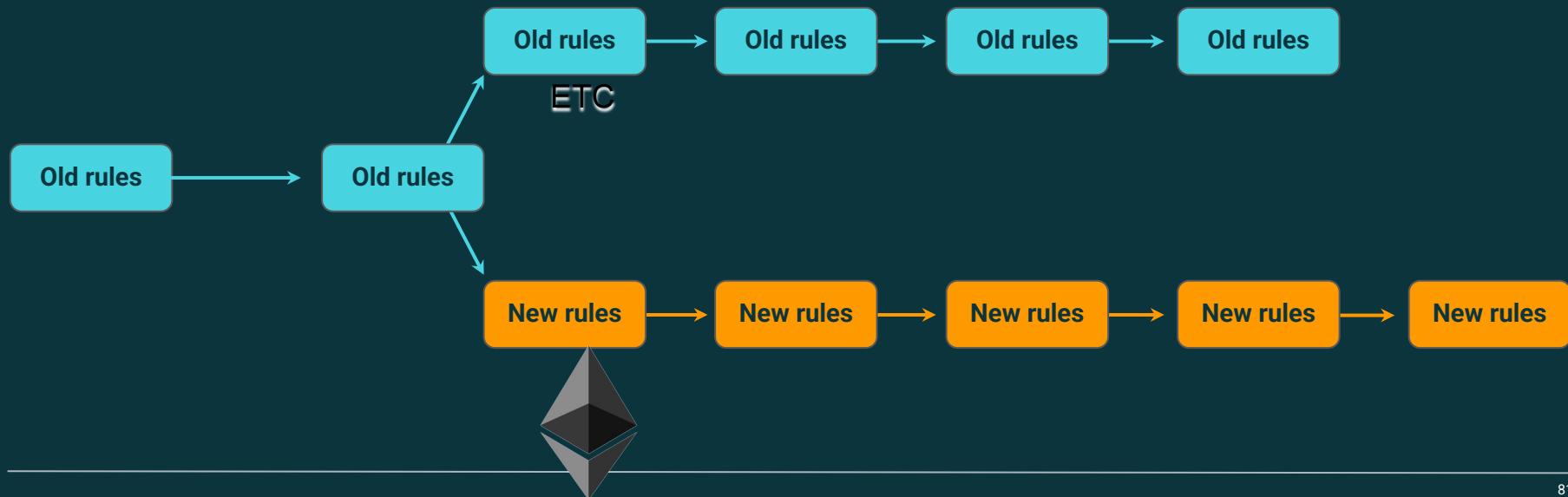
The users of the chain can vote on the proposed changes.

If a threshold of votes (usually a majority) accepts the changes, the code is rewritten going forward.



A Blockchain Fork

A strong disagreement concerning the proposed changes to a standard might result in a blockchain fork. Those in favor of the new standard “fork” the code into a new blockchain that contains the new rule. Those opposed to the new standard continue using the original blockchain.





A background composed of a dense arrangement of white and light gray triangles of varying sizes, creating a low-poly or crystalline effect.

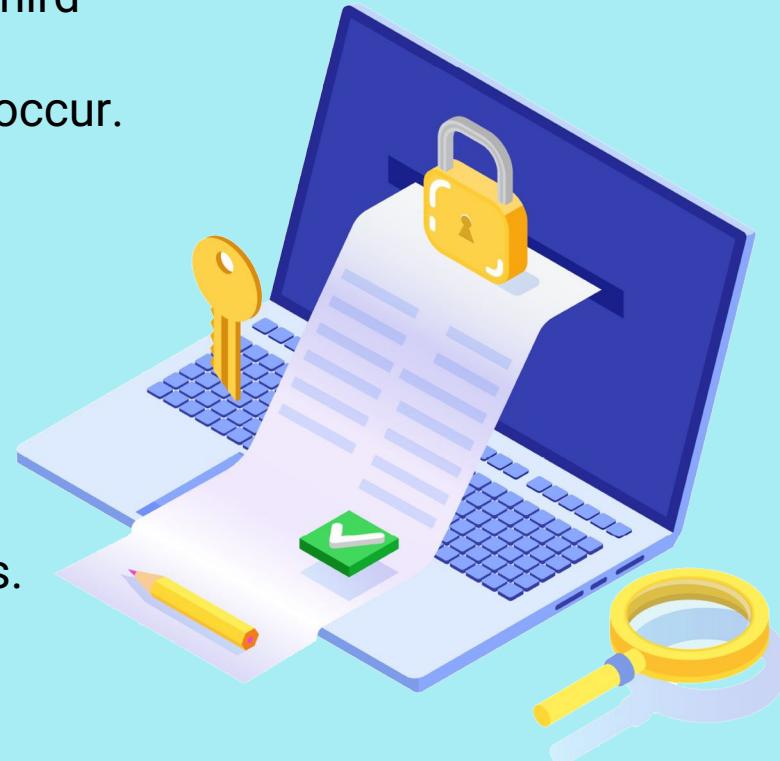
Trust and Value

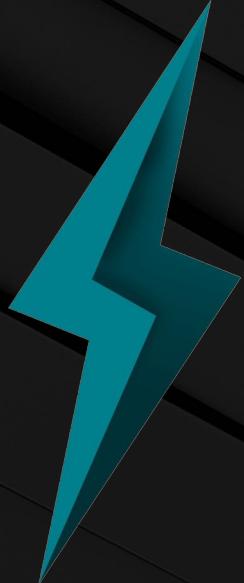
Trust and Value

Any financial transaction involves a trusted third party: a person, an institution, or a concept. Without that, the transaction simply doesn't occur.

In sum, value is built entirely around trust. And because trust is a concept, value is also a concept.

Even though a \$100 bill hardly differs physically from a paper towel, everyone agrees that it's worth something—and so it is.





One way that Bitcoin builds trust from its users is by strictly controlling supply. By design, only 21 million coins can ever be created.

Trust and Value

Some currencies that came shortly after Bitcoin—Ethereum, for example—had no restriction on supply. Yet, people seemed to trust this currency, too.

Why? One answer might be that Ethereum adopted many of the security aspects of Bitcoin but improved the usability of doing transactions. And as more users adopted Ethereum for its usability, they began to trust it both as a way to send money and as a store of value.



Trust and Value

In sum:

01

Cryptocurrencies began by presenting an alternative currency in which to place trust, at a time when people questioned their trust in traditional currencies.

02

One possible reason that some cryptocurrencies have maintained that trust is that they continue to evolve toward greater usability.

03

As long as cryptocurrencies and, more importantly, blockchain continue to strike that balance between trust and usability, they're likely here to stay.

Blockchain Recap

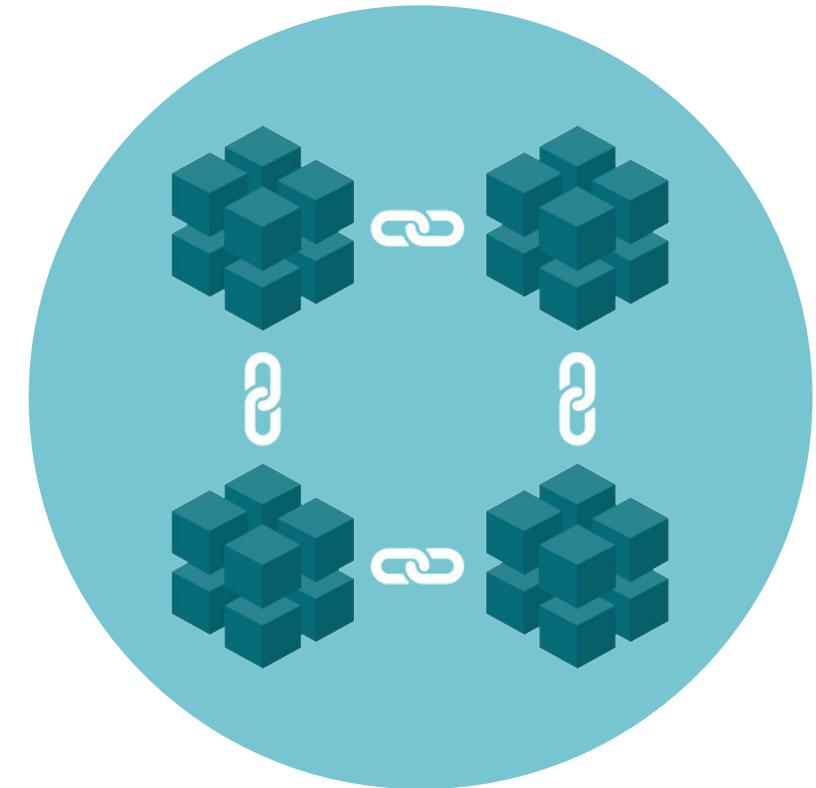


What are the key features of
blockchain technology?

Blockchain Recap

The five key features of blockchains:

- 01 Decentralization
- 02 Distributed architecture
- 03 Record keeping
- 04 Trust
- 05 Transparency





Why would a fintech entrepreneur
want to build a software application
that uses blockchain?

Blockchain Recap

Reasons to use blockchain:



Permissionless blockchain enables fast, global transactions that are not managed by a single authority.



Blockchain supports borderless, neutral, and censor-resistant finance.

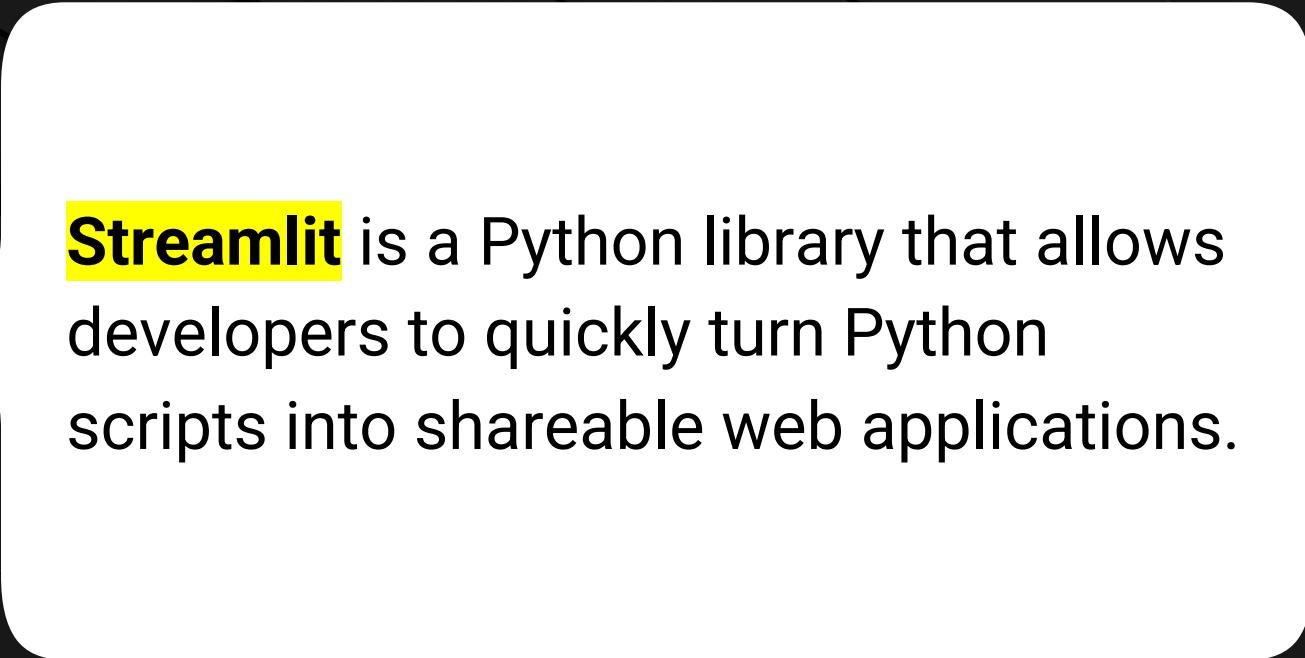


The decentralized nature of blockchain offers a more secure infrastructure for the next generation of application and web development.



A blockchain removes intermediaries such as PayPal, Venmo, and Cash App, and allows for peer-to-peer payments—and thus lower fees.

Introducing Streamlit



Streamlit is a Python library that allows developers to quickly turn Python scripts into shareable web applications.

Streamlit

Streamlit is a Python library that is used to create user-friendly webpage interfaces. In this course, Streamlit will be used to build a front-end interface for blockchain functionality.

```
:streamlit run app.py
```

You can now view your Streamlit app in your browser.

Local URL: <http://localhost:8501>

Network URL: <http://192.168.205.109:8501>

Streamlit

Streamlit is a Python library that works only with Python files (.py files).
Therefore, it won't work with Jupyter notebooks (.ipynb files).

```
:streamlit run app.py
```



You can now view your Streamlit app in your browser.

Local URL: <http://localhost:8501>

Network URL: <http://192.168.205.109:8501>



Instructor Demonstration

The Streamlit Library

Questions?





Activity: A Streamlit App

In this activity, you will create and launch a basic Streamlit application.

Suggested Time:

15 minutes



Time's Up! Let's Review.

The
End