



Smart Contracts Fundamentals

FinTech

Lesson 20.1



Class Objectives



Explain what a smart contract is and explain its applications in fintech and other business areas.



Explain how Solidity works and how it differs from Python as a programming language.



Explain how the Ethereum Virtual Machine (EVM) is an isolated environment and how Solidity code can access only on-chain data.



Recognize that a smart contract is a program that runs in the EVM.



Identify the kinds of smart contracts and their top use cases.



Explain how Remix supports blockchain development.



Create three types of functions in Solidity: a deposit function that adds ether, a withdraw function that withdraws ether, and a fallback function that captures ether.

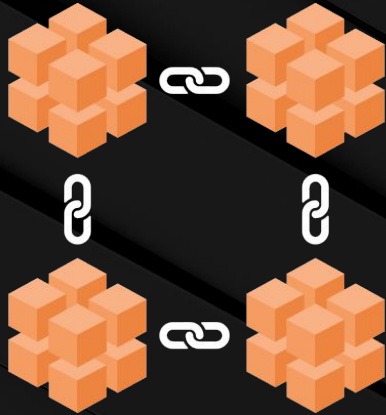


Create getters and setters, including their return types, in Solidity.

The background is a dark charcoal gray with a series of parallel diagonal lines running from the top-left to the bottom-right. In the center, there are two overlapping teal-colored triangles. The word "WELCOME" is written in a bold, black, sans-serif font across the middle of these triangles. Scattered around the central composition are various white and teal geometric symbols: a white cone-like shape with a dot at the top-left, a white plus sign at the top-right, a teal line segment at the top-right, a white dot at the top-center, a teal triangle at the top-center, a teal square at the middle-right, a white zigzag line at the bottom-right, a teal diamond at the bottom-center, a white line with a dot at the bottom-center, a teal line segment at the bottom-left, a white cylinder-like shape at the bottom-left, and a teal triangle at the bottom-left.

WELCOME

Introduction to Smart Contracts



Remember, blockchain is used to establish trust with a network that maintains an immutable ledger.

Introduction to Solidity

We are going to use **Solidity**, the most popular programming language to create and deploy smart contracts in Ethereum.



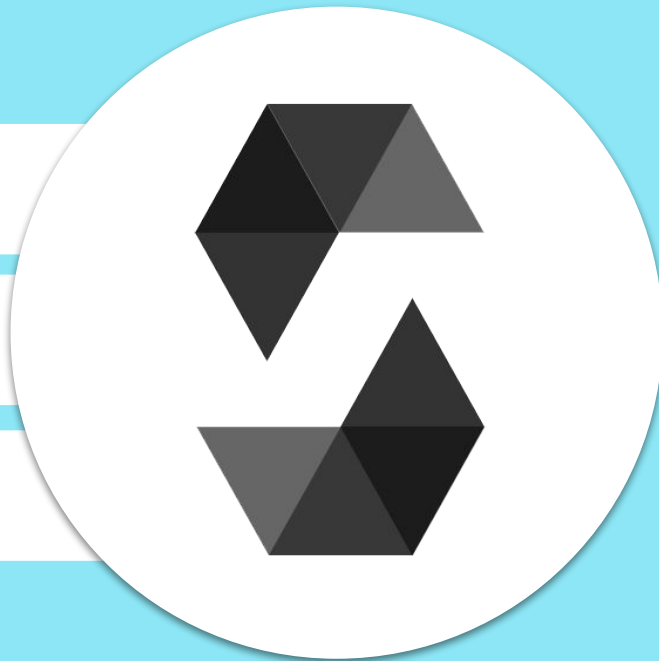
Solidity enhances our transaction processes.



Solidity allows us to establish the terms of a financial contract.



Solidity gives us the ability to create applications and services on the blockchain.

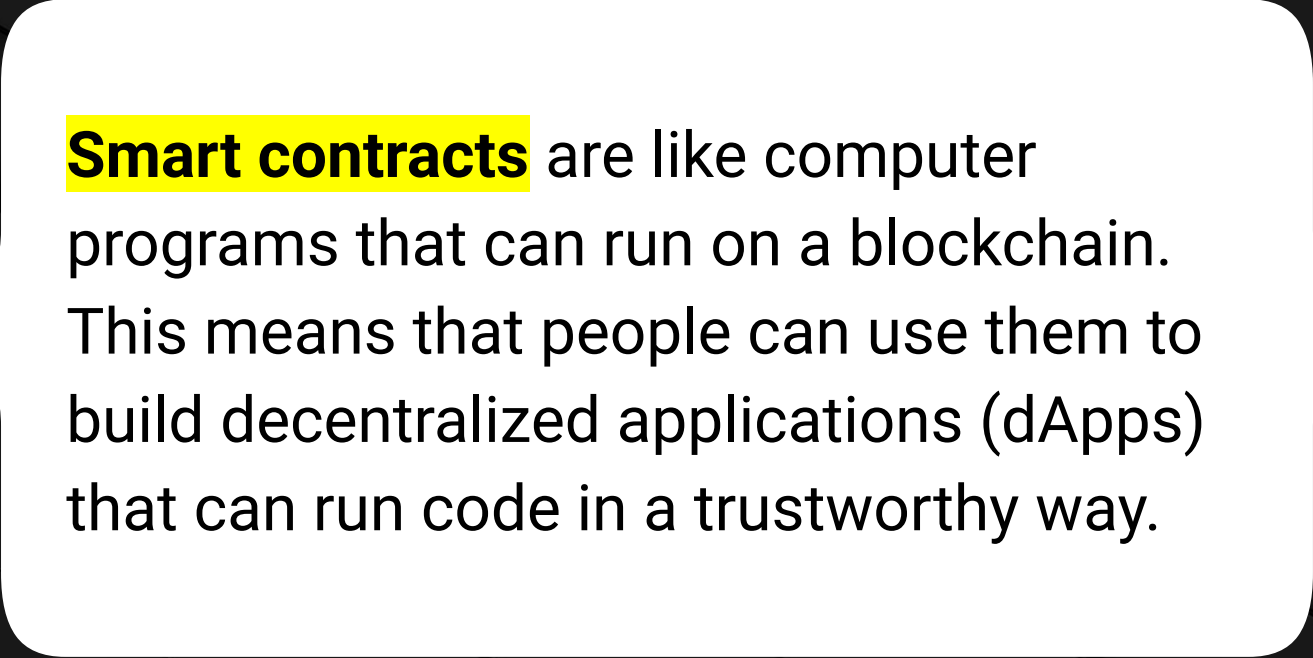


Introduction to Smart Contracts

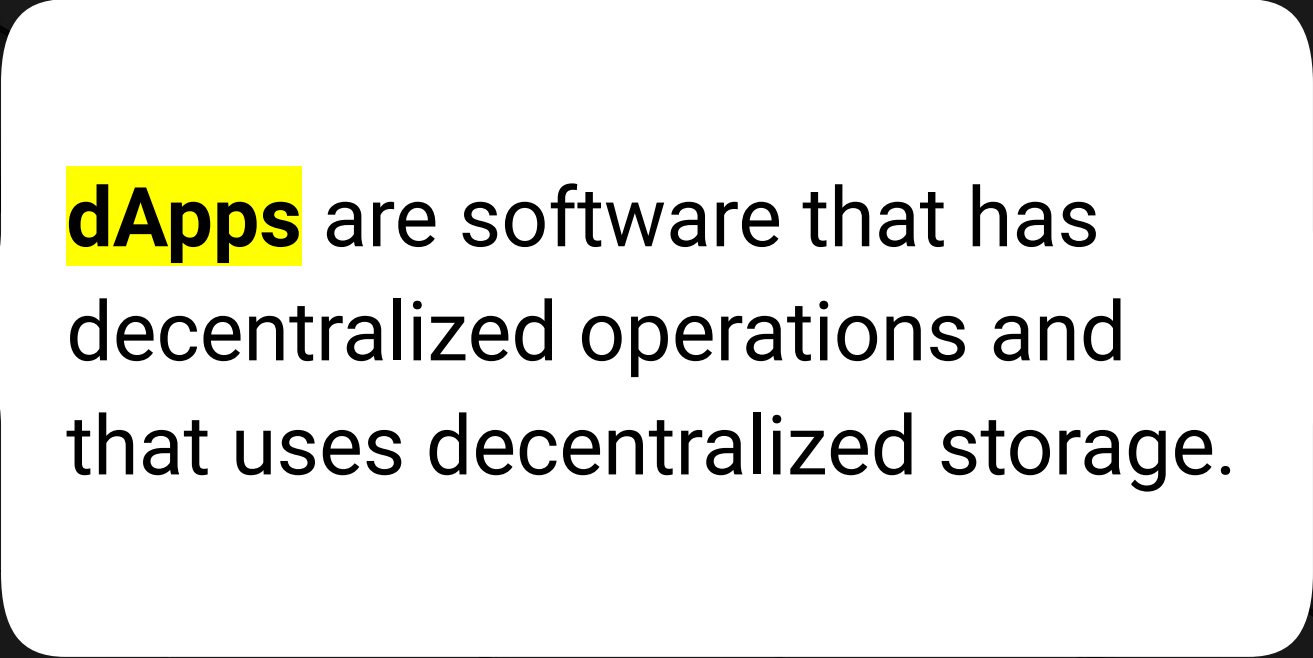


We can use smart contracts to define the parameters for a purchase, an auction, voting, banking transactions, and more.

So, a developer that can program in Solidity is valuable to institutions that are involved with blockchain transactions.



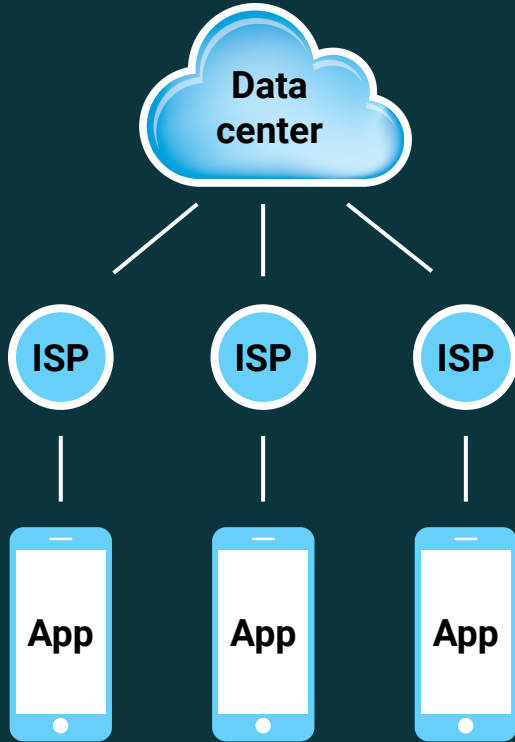
Smart contracts are like computer programs that can run on a blockchain. This means that people can use them to build decentralized applications (dApps) that can run code in a trustworthy way.



dApps are software that has decentralized operations and that uses decentralized storage.

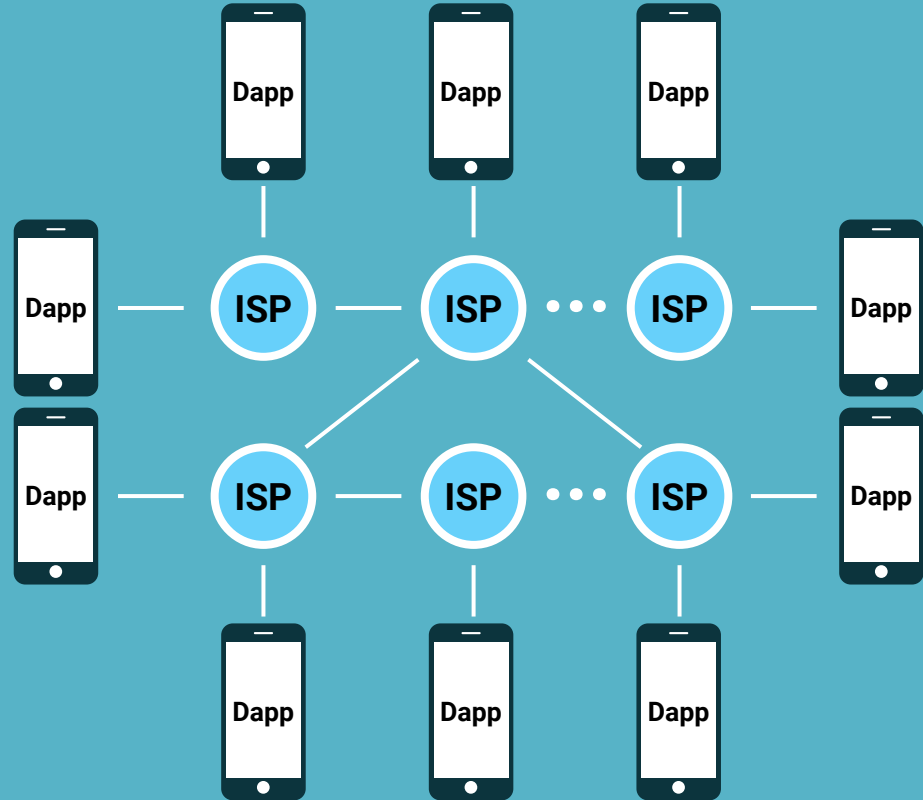
Apps

Run on a centralized server
and use centralized storage.



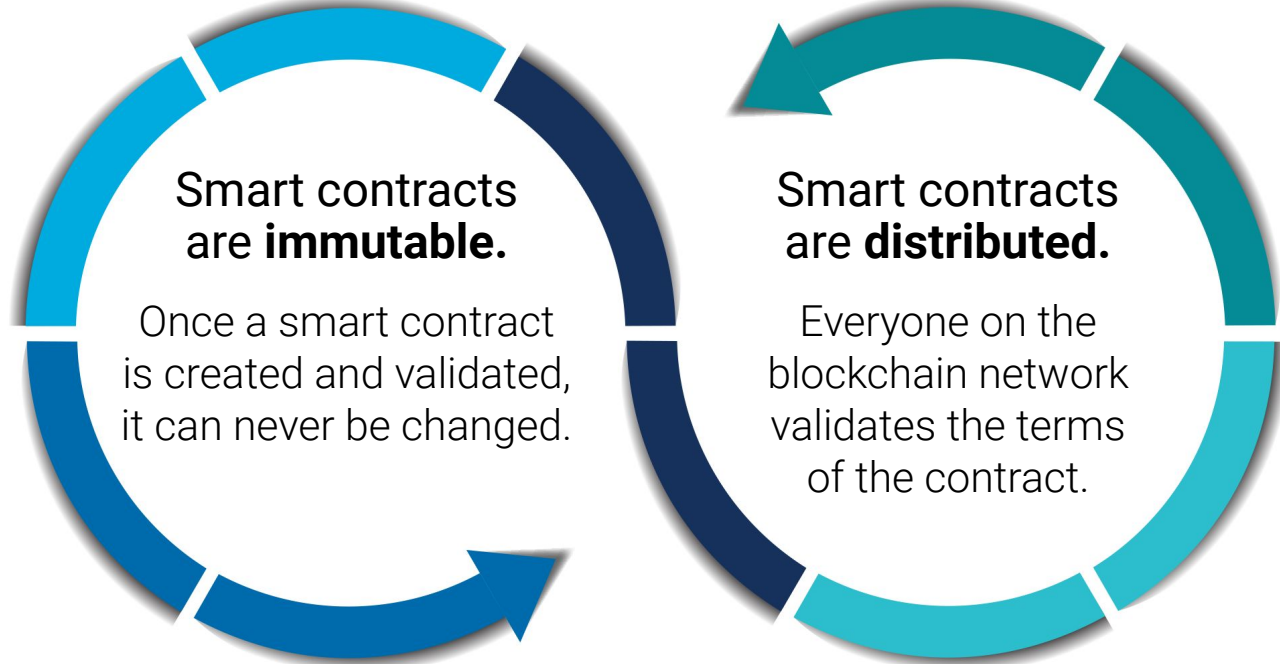
dApps

Run in a decentralized environment
that the blockchain nodes provide.



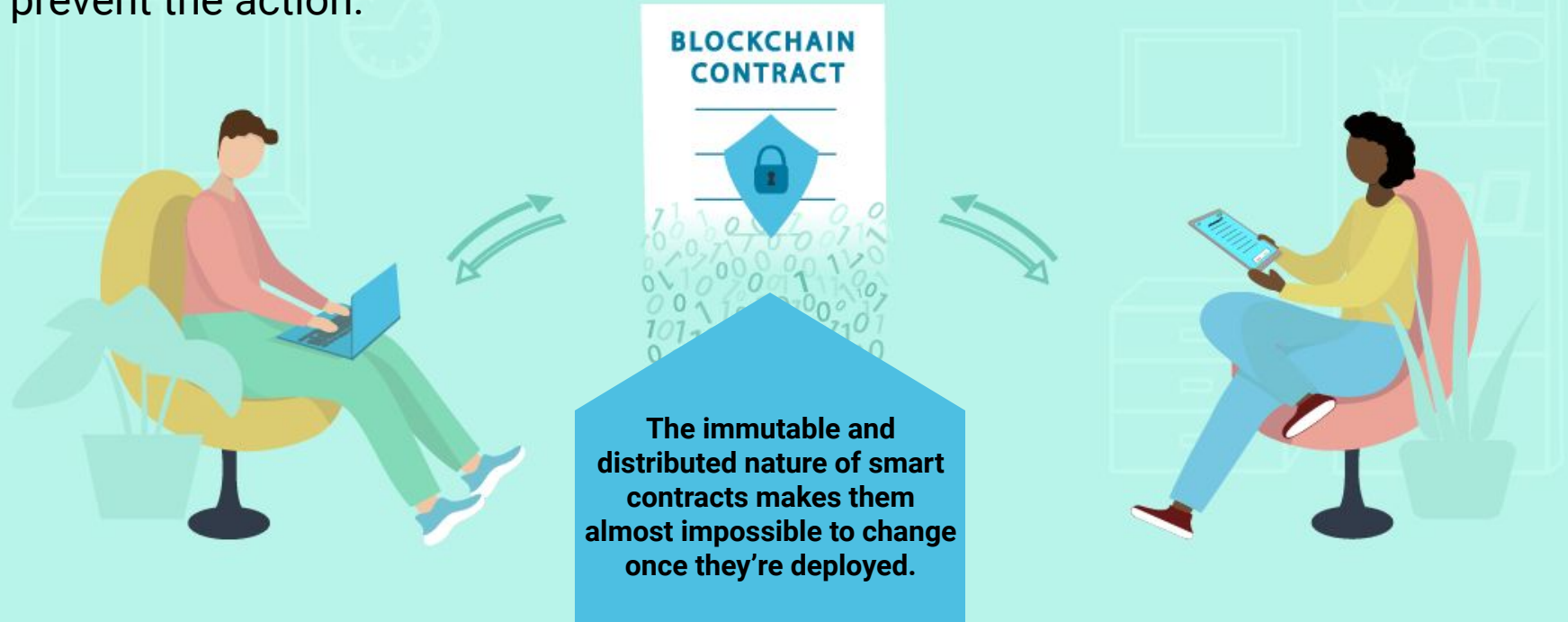
Introduction to Smart Contracts

Smart contracts that exist on a blockchain inherit two valuable properties:



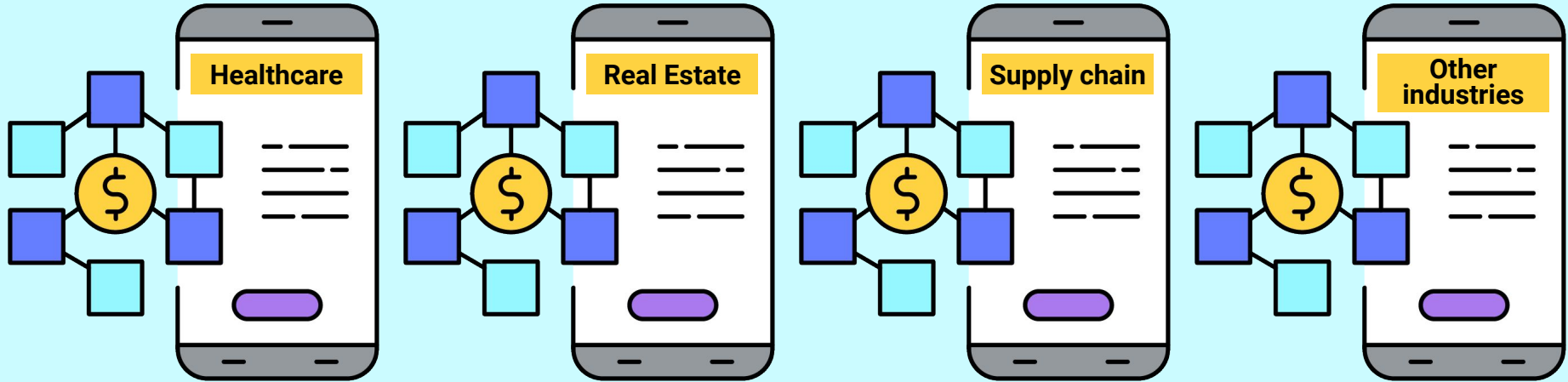
Introduction to Smart Contracts

If one party to the contract or member of the blockchain network tries to override the terms of the contract by trying to trigger an early release of funds, the other network members will recognize the change to the contract as invalid and prevent the action.



Introduction to Smart Contracts

That's why, in addition to the financial sector extensively using them, people are using smart contracts to solve problems in:



People can even use smart contracts to build decentralized games, voting applications, and marriage contracts.

Introduction to Smart Contracts

Smart contracts need to allow application development and credible transactions that involve assets without a third-party overseer. So, smart contracts rely on the following building blocks:



A robust and reliable blockchain technology



A robust and reliable programming language



An isolated execution environment



Robust encryption mechanisms



An industry-supported blockchain technology



A suitable set of development tools for creating and deploying the smart contracts

These building blocks involve a lot,
but as you work with smart contracts,
they'll all start to make more sense.



Introduction to Smart Contracts

In the upcoming sections, you'll learn about the differences between Solidity and Python. This will involve how they create, compile, and use the code. Then, you'll build your very first smart contract by using this new language!



vs.






**How would you define a
smart contract to someone who's
new to blockchain technology?**



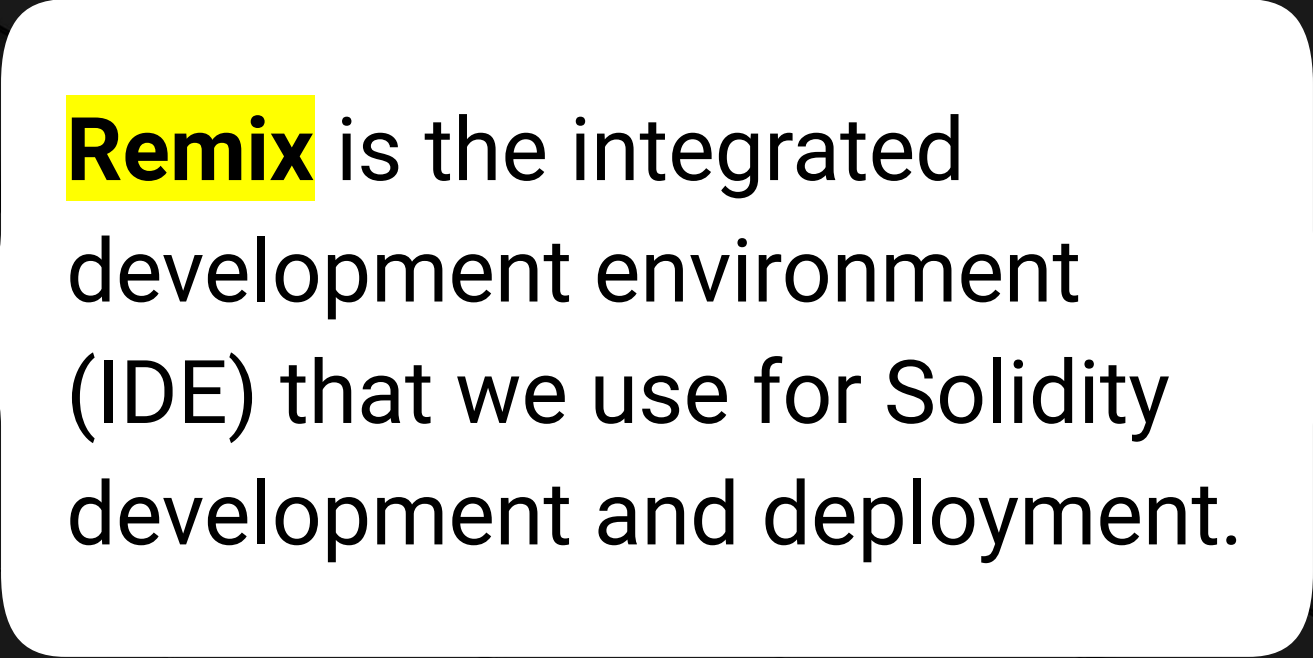
Smart contracts are just computer programs that run on a blockchain.

People use them for credible transactions of digital assets without third parties.

Solidity and Remix



Solidity is the programming language that people use for smart contract development on the Ethereum blockchain.



Remix is the integrated development environment (IDE) that we use for Solidity development and deployment.

Remix Integrated Development Environment (IDE)

The screenshot displays the Remix IDE interface with a dark theme. On the left, the 'FILE EXPLORERS' sidebar shows 'Workspaces' with 'default_workspace' selected. Below it, a file tree lists 'contracts', 'scripts', 'tests', and 'README.txt'. The main area features a 'Home' tab with a cartoon character holding a guitar. To the right, the 'Quicklinks' section provides a 'Guide for migrating the old File System' and 'Migration tools' including 'Basic migration', 'Download all Files as a backup zip', and 'Restore files from backup zip'. Below this, a 'Help' section links to the 'Gitter channel' and 'Report on Github'. The 'Featured Plugins' section displays buttons for 'SOLIDITY', 'OPTIMISM', 'LEARNETH', 'SOLHINT LINTER', 'SOURCIFY', and 'MORE'. The bottom section is divided into 'File' and 'Resources'. The 'File' section includes 'New File', 'Open Files', and 'Connect to Localhost' options, along with a 'LOAD FROM:' section with buttons for 'Gist', 'GitHub', 'Ipfs', and 'https'. The 'Resources' section lists 'Documentation', 'Gitter channel', 'Featuring website', and 'Old experience'. At the very bottom, a status bar shows '0' files, a 'listen on network' checkbox, a search bar with 'Search with transaction hash ...', and a help message: 'remix (run remix.help() for more info)'.

FILE EXPLORERS

Workspaces

default_workspace

contracts

scripts

tests

README.txt

Quicklinks

[Guide](#) for migrating the old File System

Migration tools:

- [Basic migration](#)
- [Download all Files](#) as a backup zip
- [Restore files](#) from backup zip

Help:

[Gitter channel](#)

[Report on Github](#)

Featured Plugins

SOLIDITY

OPTIMISM

LEARNETH

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MORE

File

New File

Open Files

Connect to Localhost

LOAD FROM:

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GitHub

Ipfs

https

Resources

[Documentation](#)

[Gitter channel](#)

[Featuring website](#)

Old experience

0 ☐ listen on network

• remix (run remix.help() for more info)

Solidity and Remix

Solidity will help us develop smart contracts that work on Ethereum-compatible blockchains. These include:

Hyperledger Fabric from
the Linux Foundation



HYPERLEDGER

Quorum from Consensys



Ethereum Classic

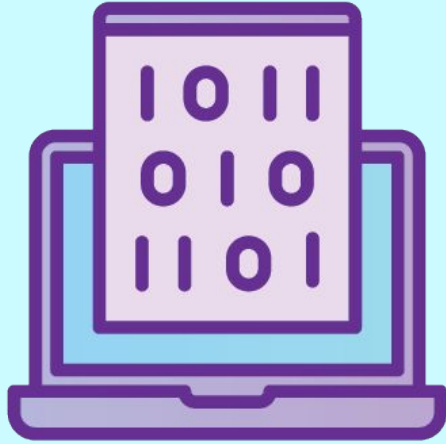




Before getting into the fundamentals of Solidity coding, we need to discuss how to write and run Solidity code.

Solidity and Remix

Solidity code is considered particularly human readable, with characteristics that resemble those of both Python and JavaScript.



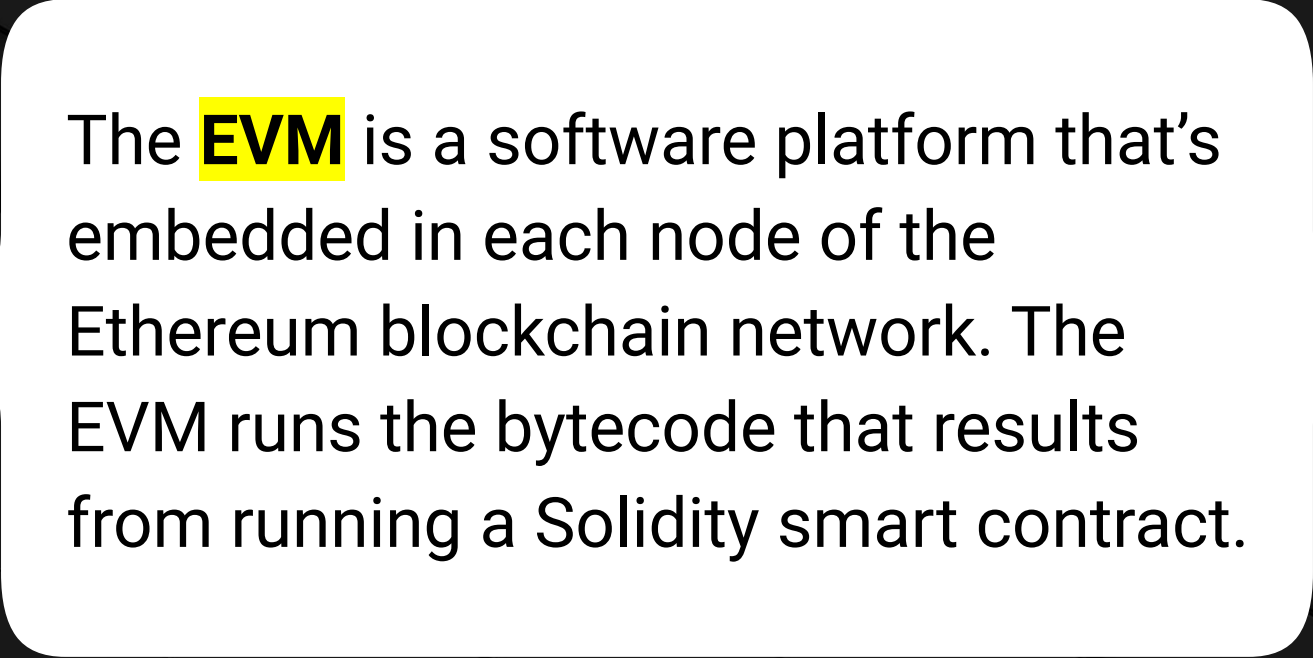
When a Solidity smart contract runs, the program first gets compiled.



This means that it's converted from human-readable syntax into a computer-friendly version of the code, called bytecode.



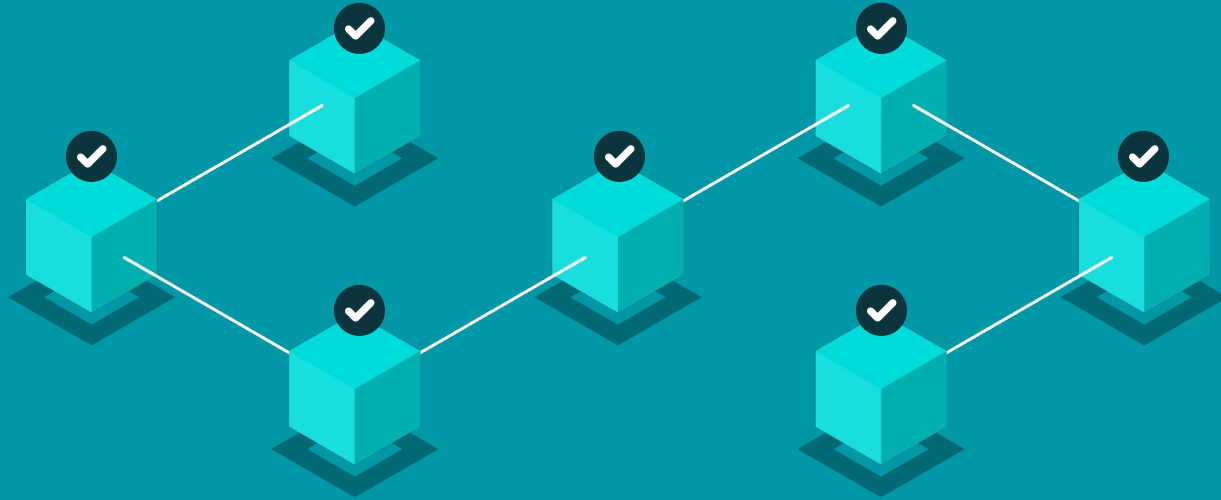
Once compiled, the code runs in the EVM.



The **EVM** is a software platform that's embedded in each node of the Ethereum blockchain network. The EVM runs the bytecode that results from running a Solidity smart contract.

A Key Benefit of Using the EVM

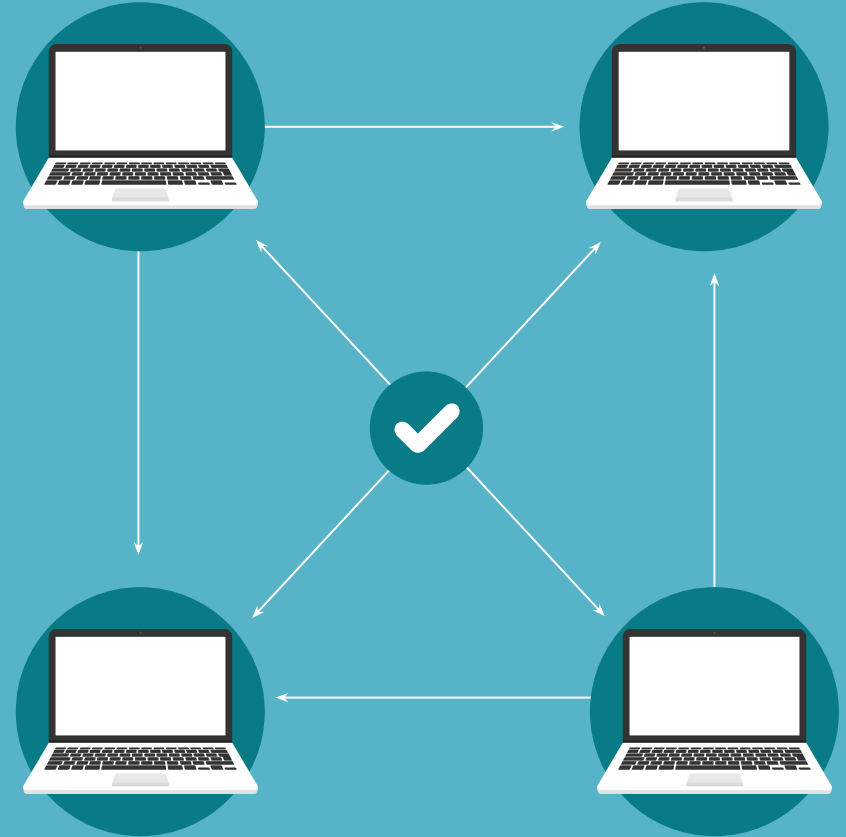
The EVM offers an isolated environment in which Solidity code can run—without accessing the computer network, files, or other resources of the host computer.



This means that by using that same instructions, each decentralized node on the Ethereum blockchain can validate the smart contract. The EVM is thus essential to the consensus mechanism of the Ethereum blockchain.

In general, a **consensus mechanism** allows the nodes in the Ethereum blockchain to work together to both stay secure and reach an agreement on the current state of the blockchain.

Consensus mechanism

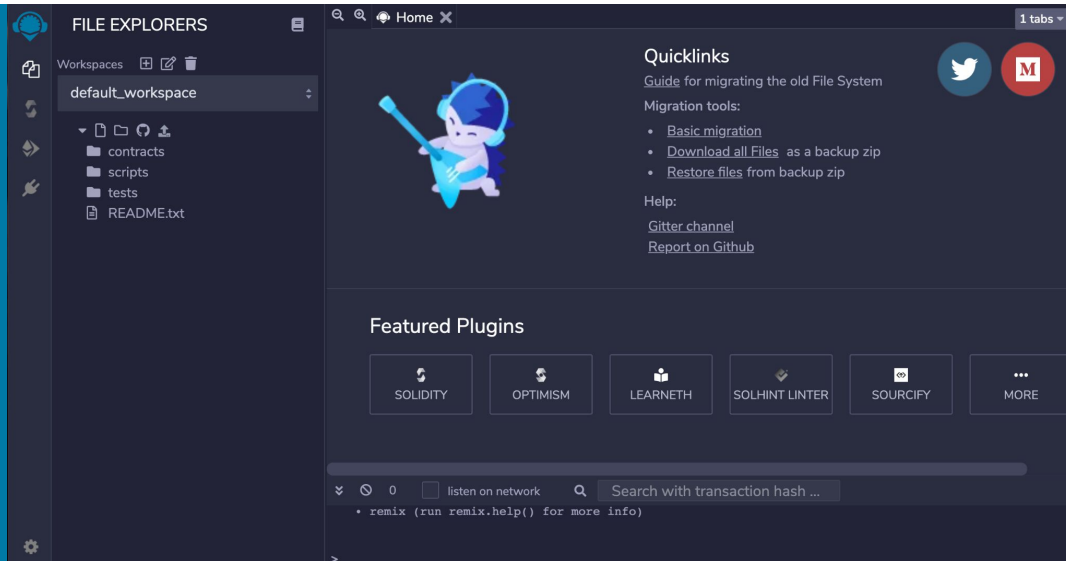


Remix IDE

We use this IDE for Solidity, just like we use an IDE for Python. But instead of using Visual Studio Code or JupyterLab, we'll use the Remix IDE.

The Remix IDE is an open-source application for developing, deploying, and administering smart contracts that run on Ethereum-based blockchains. We can use this IDE for the entire development cycle of smart contracts and as a playground for teaching and learning Ethereum.

The Remix IDE is available in both web and desktop versions. For better compatibility among operating systems, we'll use the web version of the Remix IDE.



Because Remix is an open-source application, the Remix IDE is under constant development, and its user interface often gets updated. So, the interface in the current live version might vary from the slides that appear in this lesson.



Class Slack Channel:

<https://remix-project.org/>

If you want to learn more about the entire Remix Project
or even join its development community, this is an excellent resource.



Instructor Demonstration

Coding Our First Smart Contract

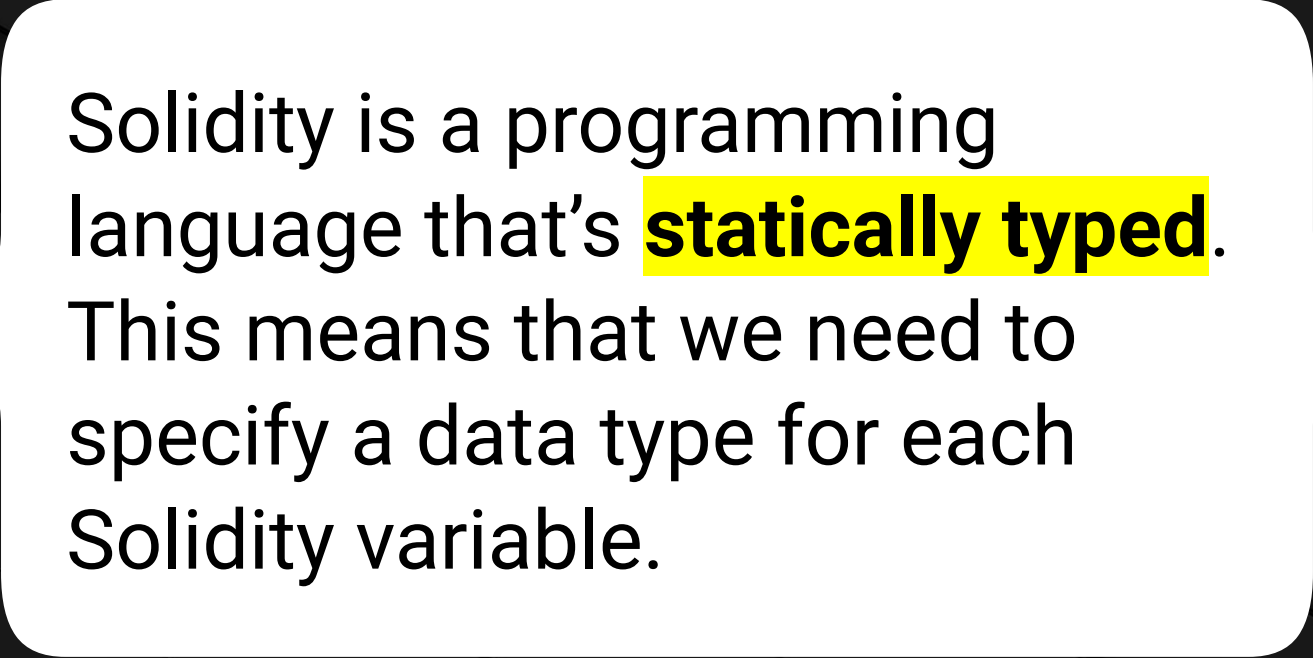


Solidity syntax differs a bit from Python syntax. That's partly because Solidity is an **object-oriented programming language**.

Case Styles

Solidity coding styles originated from the [PEP 8 – Style Guide for Python Code](#).

CapWords	Capitalize the first letter of each word.
MixedCase	Use lowercase for the first word, and capitalize the first letter of each subsequent word.
camelCase	Spaces and punctuation are removed, and the first letter of each word is capitalized.
ALL CAPS	A unicast style with capital letters only.
lowercase	A unicast style with no capital letters.



Solidity is a programming language that's **statically typed**. This means that we need to specify a data type for each Solidity variable.

Data Types

Solidity includes several data types. This image lists the main ones, which you can use for smart contracts:

Data Type	Python Example	Solidity Example
String	<code>some_string = "Name"</code>	<code>string someString = "Name";</code>
Positive number	<code>some_number = 123123123</code>	<code>uint someNumber = 123123123;</code>
Negative number	<code>some_number = -321123</code>	<code>int someNumber = -321123;</code>
Wallet address	Not applicable	<code>address myEthAddress = 0xc3879B456DAA348a16B6524CBC558d2CC984722c;</code>
Boolean value	<code>some_condition = True</code>	<code>bool someCondition = true;</code>

Data Types



A variable of type `string` stores a text value.



A variable of type `uint` stores a positive number. The keyword `uint` stands for “unsigned integer.”



A variable of type `int` stores a number. This type of variable can store a positive or a negative integer.



A variable of type `address` stores an Ethereum address. This is a special Solidity data type for storing an Ethereum address in a way that’s computationally more efficient than storing a string.



A variable of type `bool` stores a Boolean value—that is, `true` or `false`.

Questions?





Time to Code

Create a Customer Contract

Suggested Time:

20 minutes



Time's Up! Let's Review.

Questions?



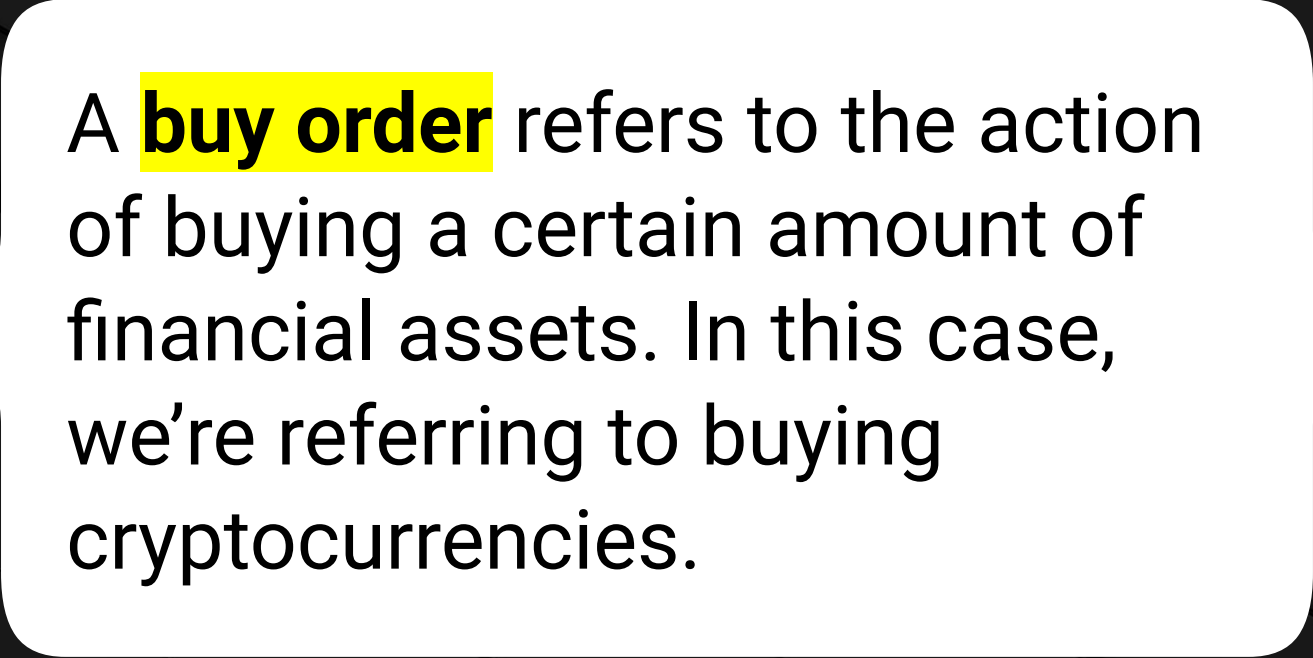
A close-up photograph of a computer keyboard. The central focus is a large, white, rectangular key with rounded corners. On this key, there is a dark blue icon of a coffee cup with three wavy lines above it representing steam. Below the icon, the word "Break" is printed in a dark blue, serif font. The key is set against a light-colored keyboard frame. Surrounding this key are other keys: to the left is a key with double quotation marks, above it is a key with a right square bracket, and to the right is a key with a left square bracket. The lighting is soft and even, highlighting the texture of the keys.

Break

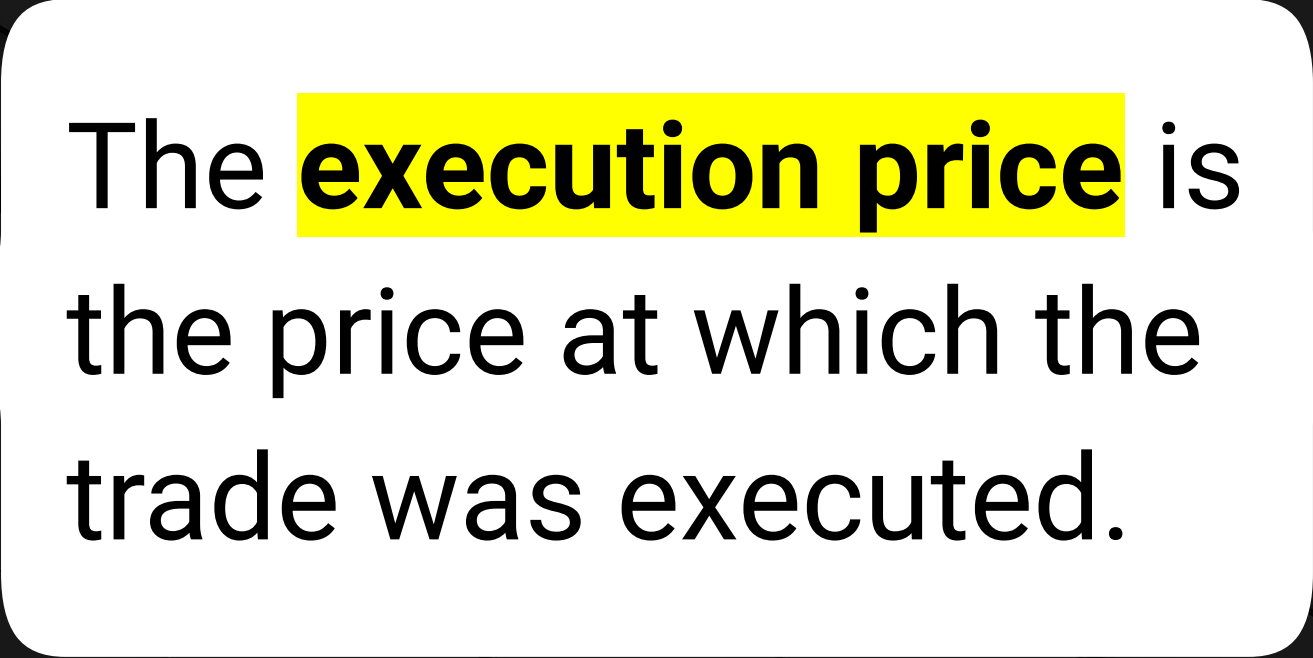


Instructor Demonstration

Solidity Functions



A **buy order** refers to the action of buying a certain amount of financial assets. In this case, we're referring to buying cryptocurrencies.



The **execution price** is
the price at which the
trade was executed.

EVM

EVM can store items in three areas:

01

In storage:

Contract variables all reside in storage.

02

In memory:

Temporary values reside in memory.

The EVM clears this memory area between function calls. So, it's less expensive to use than storage.

03

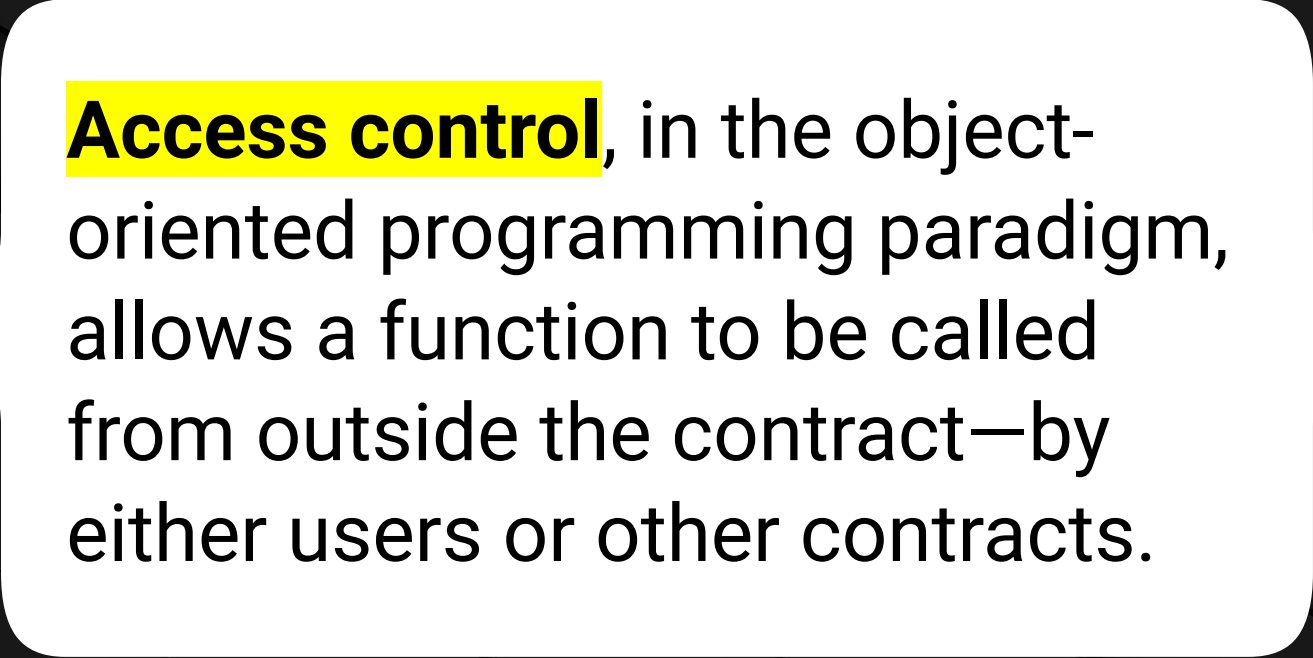
On the stack:

Holds small local variables and argument values.

It's almost free to use but can store only a limited number of values.



A great way to learn more about these storage areas is to read the [Storage, Memory and the Stack](#) section of the Solidity documentation.



Access control, in the object-oriented programming paradigm, allows a function to be called from outside the contract—by either users or other contracts.

Questions?





Time to Code



Travel Expenses Contract

Suggested Time:

30 minutes



Time's Up! Let's Review.

Questions?





Instructor Demonstration

Getters and Setters

Getters and Setters

A common practice in object-oriented programming languages is to define functions that only update the value of variables or that only get the current values.

Setter

The `updateTrade` function sets the values of the variables.

This function is called a **setter**.

A setter can set or update the value of any variable.

Getter

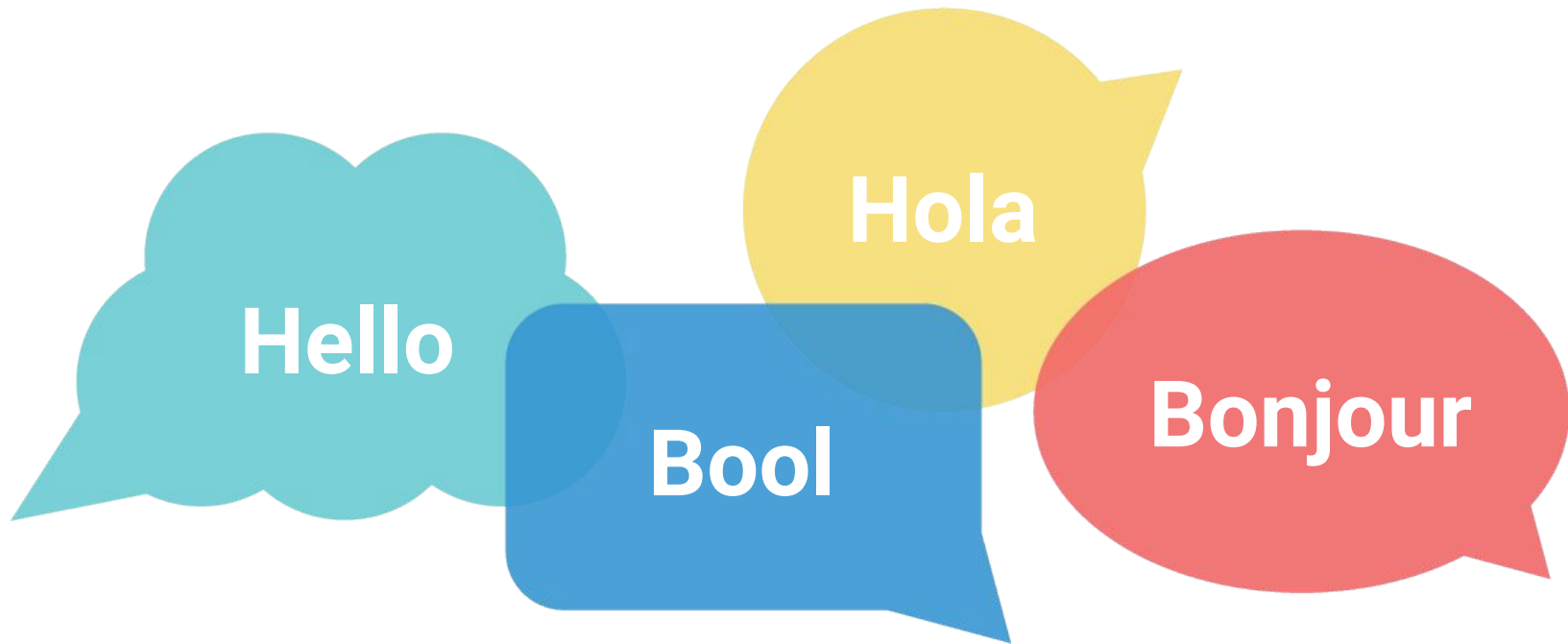
The `getLatestTrade` function gets the current values of the variables.

This function is called a **getter**.

A getter can get the current value of a variable.

The key to learning is practice.

Learning a new programming language is like learning a new human language.



You'll have the opportunity to practice your new Solidity skills throughout the remainder of this unit.

Suppose that you want to create a smart contract that allows people to transfer funds between two Ethereum addresses. You need a function that sets the transfer amount, the sender, and the recipient.



How would you define the function's signature (that is, the function name and its arguments)?

Function Signature

You might name your function `setTransferInfo` and define its signature as follows:

```
function setTransferInfo(address sender, address recipient, uint amount) public {  
    // set user data here  
}
```



Time to Code



Adding Getters and Setters

Suggested Time:

20 minutes



Time's Up! Let's Review.

Questions?



*The
End*