

# Smart Contract Development

## In Solidity

# About me



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# 什么是智能合约

智能合约是运行在链上的程序

合约开发者可以通过智能合约实现  
与链上资产、数据进行交互

用户可以通过自己的链上账户来  
调用合约、访问资产与数据



# 与一般程序的差异

原生支持资产流动

部署与后续写入需要一定费用

存储数据的成本更高

部署后无法更改（可升级合约？）

...

# Solidity

一门面向合约的、为实现智能合约而创建的高级编程语言

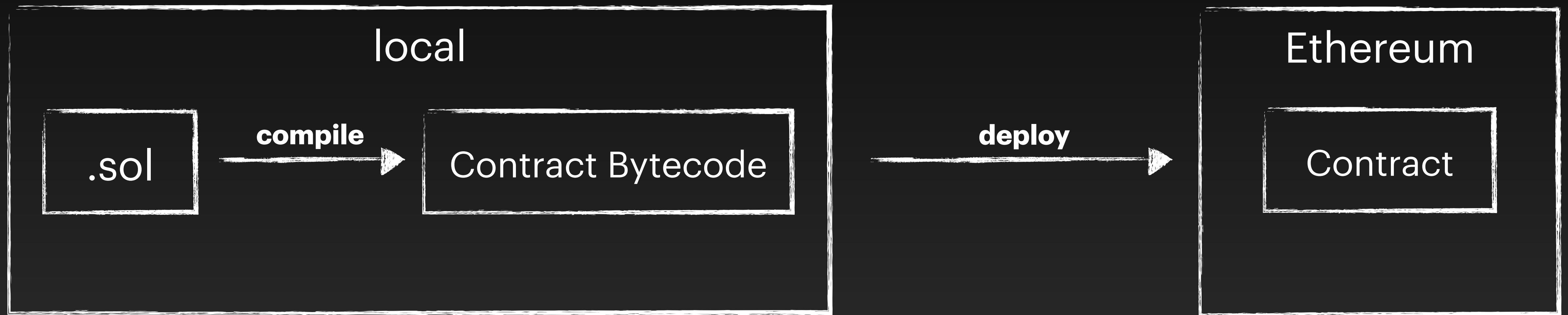
在 **EVM** 虚拟机上运行

语法整体类似于 **javascript**

是目前最流行的智能合约语言

也是入门区块链与 **web3** 所必须掌握的语言

# 如何部署智能合约



**Solidity** 合约是以 **.sol** 为后缀的文件，无法直接执行，需要编译为 **EVM** (Ethereum Virtual Machine) 可识别的字节码才能在链上运行。



# 开发框架 & 工具

**Brownie**  
**(python)**



通过简洁的 python 语法  
便于本地调试与部署测试

**Hardhat**  
**(javascript)**



丰富的插件系统  
适合复杂的合约项目

**Foundry**  
**(solidity)**



使用Solidity编写合约、测试和脚本

# 开发框架 & 工具

**Remix**  
**IDE**

提供完整的 IDE、编译工具、部署调试的测试节点环境、账户等，可以通过 MetaMask 插件与测试网、主网进行直接交互

**Anvil/Ganache**

提供了一个虚拟区块链网络，可以通过各类 Remix IDE 或一些框架工具与之交互，适合有一定规模的项目进行本地调试与测试

**Others**

MetaMask  
Infura  
OpenZeppelin  
Chainlink

...



# *Solidity* 核心语法讲解

# 数据类型

## 基本

boolean

int

uint

**address**

bytes

...

# 数据类型

## enum

```
enum Status {  
    Unknown,  
    Start,  
    End,  
    Pause  
}  
  
// 实例化枚举类型  
Status public status;  
  
// 更新枚举值  
function pause() public {  
    status = Status.Pause;  
}  
  
// 初始化枚举值  
function reset() public {  
    delete status;  
}
```



# 数据类型

## array



```
// 定义数组类型
uint[7] public arr;

// 添加数据
arr.push(7);

// 删除最后一个数据
arr.pop( );

// 删除某个索引值数据
delete arr[1];

// 获取数组长度
uint len = arr.length;
```

# 数据类型

## mapping



```
// 定义嵌套 mapping 类型
mapping(string => mapping(string => string)) nestedMap;

// 设置值
nestedMap[id][key] = "0707";

// 读取值
string value = nestedMap[id][key];

// 删除值
delete nestedMap[id][key];
```

# 数据类型

## struct

```
contract Struct {
    struct Data {
        string id;
        string hash;
    }

    Data public data;

    // 添加数据
    function create(string calldata _id) public {
        data = Data{id: _id, hash: "111222"};
    }

    // 更新数据
    function update(string _id) public {
        // 查询数据
        string id = data.id;

        // 更新
        data.hash = "222333"
    }
}
```



# 变量

## 类型

local

state

global

## 关键字声明

storage

memory

calldata

**constant**  
/  
**immutable**

**constant**

值不可变

节约 gas fee

**immutable**

可以在 constructor 中初始化

但不可以再次改变



# 函数

## 可见性与关键字

### 可见性

public

private

internal

external

### 关键字

view

pure

# 函数 modifier

```
modifier onlyOwner() {  
    require(msg.sender == owner, "Not owner");  
    _;  
}  
  
modifier validAddress(address _addr) {  
    require(_addr != address(0), "Not valid address");  
    _;  
}  
  
modifier noReentrancy() {  
    require(!locked, "No reentrancy");  
    locked = true;  
    _;  
    locked = false;  
}  
  
function changeOwner(address _newOwner) public onlyOwner validAddress(_newOwner) {  
    owner = _newOwner;  
}  
  
function decrement(uint i) public noReentrancy {  
    x -= i;  
  
    if (i > 1) {  
        decrement(i - 1);  
    }  
}
```

# 函数 选择器



```
addr.call(abi.encodeWithSignature("transfer(address,uint256)", 0xSomeAddress, 123))

contract FunctionSelector {
    function getSelector(string calldata _func) external pure returns (bytes4) {
        return bytes4(keccak256(bytes(_func)));
    }
}
```



# 条件

if / else if / else



```
if (x < 10) {  
    return 0;  
} else if (x < 20) {  
    return 1;  
} else {  
    return 2;  
}
```

```
x < 20 ? 1 : 2;
```

# 循环

for / while / do while



```
for (uint i = 0; i < 10; i++) {  
    // 业务逻辑  
}  
  
uint j;  
while (j < 10) {  
    j++;  
}
```

# 合约

## constructor



```
constructor(string memory _name) {  
    name = _name;  
}
```



# 合约 interface

```
contract Counter {
    uint public count;

    function increment() external {
        count += 1;
    }
}

interface ICounter {
    function count() external view returns (uint);
    function increment() external;
}

contract MyContract {
    function incrementCounter(address _counter) external {
        ICounter(_counter).increment();
    }

    function getCount(address _counter) external view returns (uint) {
        return ICounter(_counter).count();
    }
}
```

# 合约 继承

```
// 定义父合约 A
contract A {
    function foo() public pure virtual returns (string memory) {
        return "A";
    }
}

// B 合约继承 A 合约并重写函数
contract B is A {
    function foo() public pure virtual override returns (string memory) {
        return "B";
    }
}

// D 合约继承 B、C 合约并重写函数
contract D is B, C {
    function foo() public pure override(B, C) returns (string memory) {
        return super.foo();
    }
}

contract B is A {
    function foo() public virtual override {
        // 直接调用
        A.foo();
    }

    function bar() public virtual override {
        // 通过 super 关键字调用
        super.bar();
    }
}
```



# 合约 创建



```
function create(address _owner, string memory _model) public {  
    Car car = new Car(_owner, _model);  
    cars.push(car);  
}
```



```
function create2(address _owner, string memory _model, bytes32 _salt) public {  
    Car car = (new Car){salt: _salt}(_owner, _model);  
    cars.push(car);  
}
```

# 合约 导入合约



// 本地导入

```
import "./Foo.sol";
```

// 外部导入

```
import "https://github.com/owner/repo/blob/branch/path/to/Contract.sol";
```

# 合约 导入库



```
library SafeMath {  
    function add(uint x, uint y) internal pure returns (uint) {  
        uint z = x + y;  
        require(z >= x, "uint overflow");  
        return z;  
    }  
}  
  
contract TestSafeMath {  
    using SafeMath for uint;  
}
```



# 事件

## event



```
// 定义事件
event Log(address indexed sender, string message);
event AnotherLog( );

// 抛出事件
emit Log(msg.sender, "Hello World!");
emit Log(msg.sender, "Hello EVM!");
emit AnotherLog( );
```

# 错误处理

## require / revert / assert

```
function testRequire(uint _i) public pure {
    require(_i > 10, "Input must be greater than 10");
}

function testRevert(uint _i) public pure {
    if (_i <= 10) {
        revert("Input must be greater than 10");
    }
}

function testAssert() public view {
    assert(num == 0);
}
```

# 错误处理

## try / catch



```
event Log(string message);
event LogBytes(bytes data);

function tryCatchNewContract(address _owner) public {
    try new Foo(_owner) returns (Foo foo) {
        emit Log("Foo created");
    } catch Error(string memory reason) {
        emit Log(reason);
    } catch (bytes memory reason) {
        emit LogBytes(reason);
    }
}
```



# 资产

## payable



```
// 地址类型可以声明 payable  
address payable public owner;  
  
constructor() payable {  
    owner = payable(msg.sender);  
}  
  
// 方法声明 payable 来接收 Ether  
function deposit() public payable {}
```

# 资产 发送



```
contract SendEther {  
    function sendViaCall(address payable _to) public payable {  
        (bool sent, bytes memory data) = _to.call{value: msg.value}("");  
        require(sent, "Failed to send Ether");  
    }  
}
```



# 资产 接收

```
contract ReceiveEther {  
  
    // 当 msg.data 为空时  
    receive() external payable {}  
  
    // 当 msg.data 非空时  
    fallback() external payable {}  
  
    function getBalance() public view returns (uint) {  
        return address(this).balance;  
    }  
}
```

# 资产

## Gas Fee

### 参数

gas spent

gas price

gas limit

block gas limit

### 技巧

使用 calldata 替换 memory

将状态变量载入内存

使用 i++ 而不是 ++i

缓存数组元素

...

# References

## **Demo code repository**

<https://github.com/pseudoyu/social-dApp-demo-contracts>

## **Solidity Smart Contract Development - Basics**

[https://www.pseudoyu.com/zh/2022/05/25/learn\\_solidity\\_from\\_scratch\\_basic/](https://www.pseudoyu.com/zh/2022/05/25/learn_solidity_from_scratch_basic/)

## **foundry-starter-kit**

<https://github.com/pseudoyu/foundry-starter-kit>

## **Other resources**

[Solidity by Example](#)

[Learn Solidity, Blockchain Development, & Smart Contracts](#)



# Thank you!

```
emit Log(msg.sender, "Thank You");
```

pseudoyu