Smart Contract 2

- 陳博宇 @ 東吳大學 -

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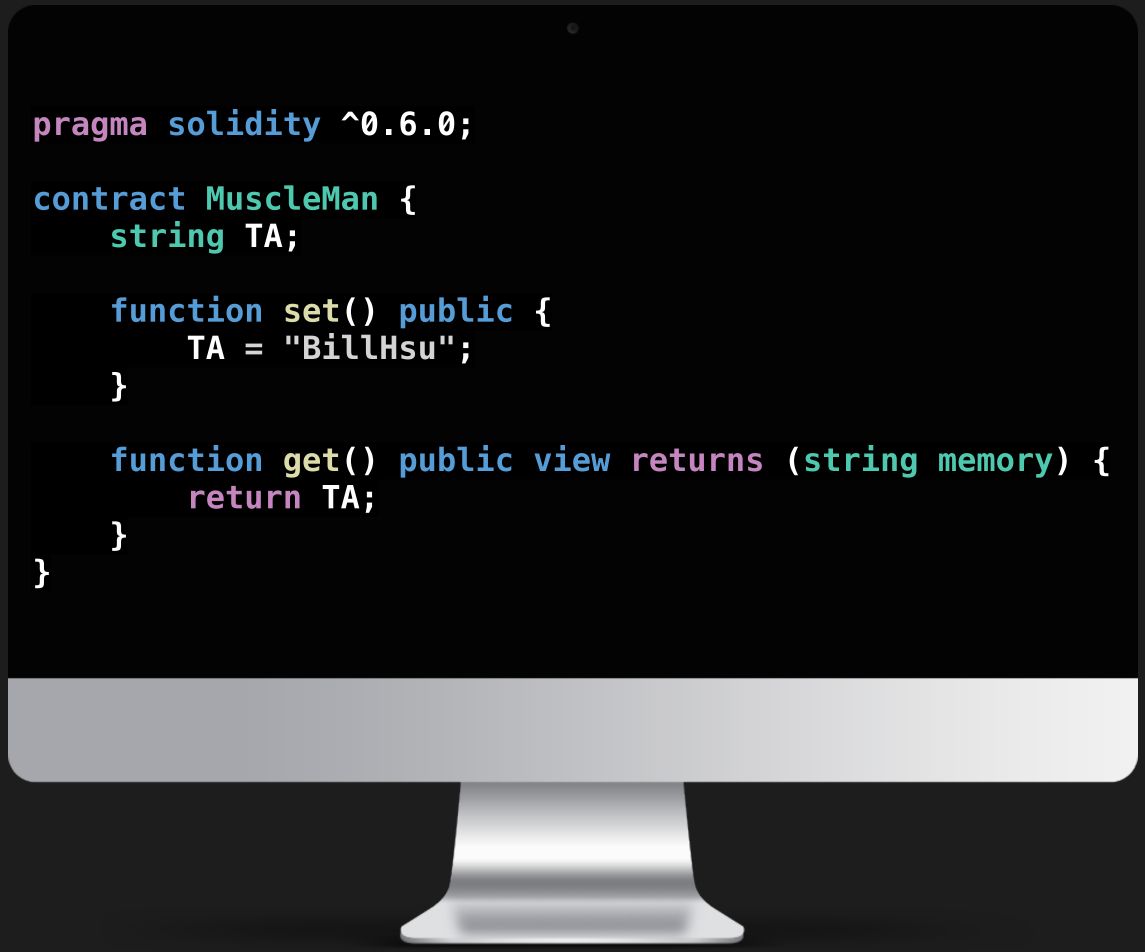


```
pragma solidity ^0.6.0;

contract MuscleMan {
    string TA;

    function set() public {
        TA = "BillHsu";
    }

    function get() public view returns (string memory) {
        return TA;
    }
}
```

- 上週回顧 + HW 1解答 -

變數宣告

● 變數型態 + ● 能見度 + ● 變數名稱

● 變數型態

○ bool

○ int / uint

○ bytes

○ address

○ string

○ array

○ mapping

● 能見度

○ public

○ private

○ internal

● 變數名稱

```
int8 public age;
bool private isOwner;
string name;
```

函數宣告

● 函數名稱(參數) + ● 能見度 + ● 回傳值

- ○ public
- ○ private
- ○ internal
- ○ external ← this.funtion( )

```
function funName() private {…}
function funName2(uint num) external returns(uint8) {…}
function deposit() public payable {…}
```

calldata v.s memory

- 如果函數參數是 struct、array (string => bytes[])、mapping 時
  - calldata => external
  - memory => public
  - storage 、memory => internal
- 在函數回傳參數中
  - memory => public、external
  - storage 、memory => internal

函數宣告

- View function
- Pure function
  - 不改變合約狀態
  - 函數執行不消耗 gas
  - 不需經過礦工驗證

```
function viewFun(uint256 a, uint256 b) public view returns (uint256) {
    return a * (b + 42) + now;
}

function pureFun(uint256 a, uint256 b) public pure returns (uint256) {
    return a * (b + 42);
}
```

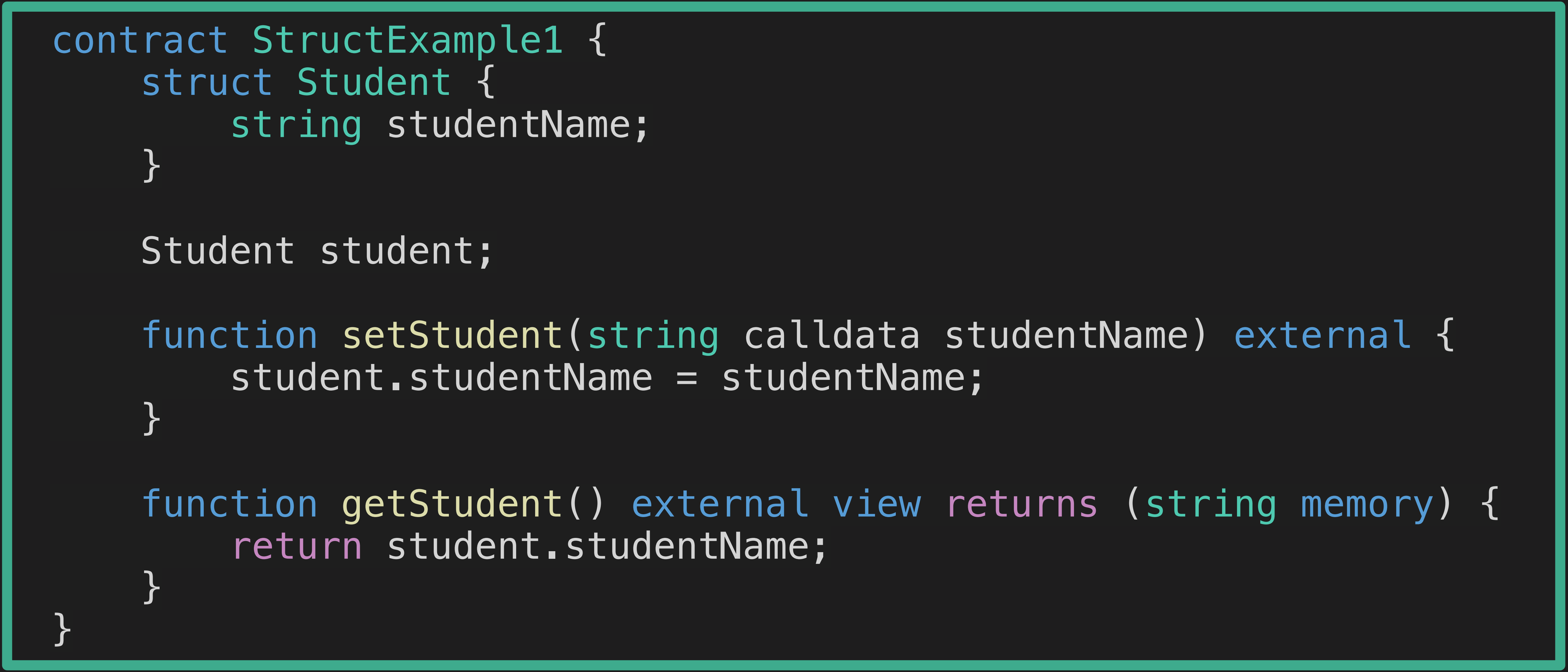
- 合約進階介紹及注意事項 -

Struct

- 自定義變數型態
- mapping 也可以用 (**only value**)
- 可複製，但是 mapping 部分無法

```
struct 變數名稱 {
          成員型態 成員變數名稱;
          成員型態 成員變數名稱;
}
```

Struct 練習

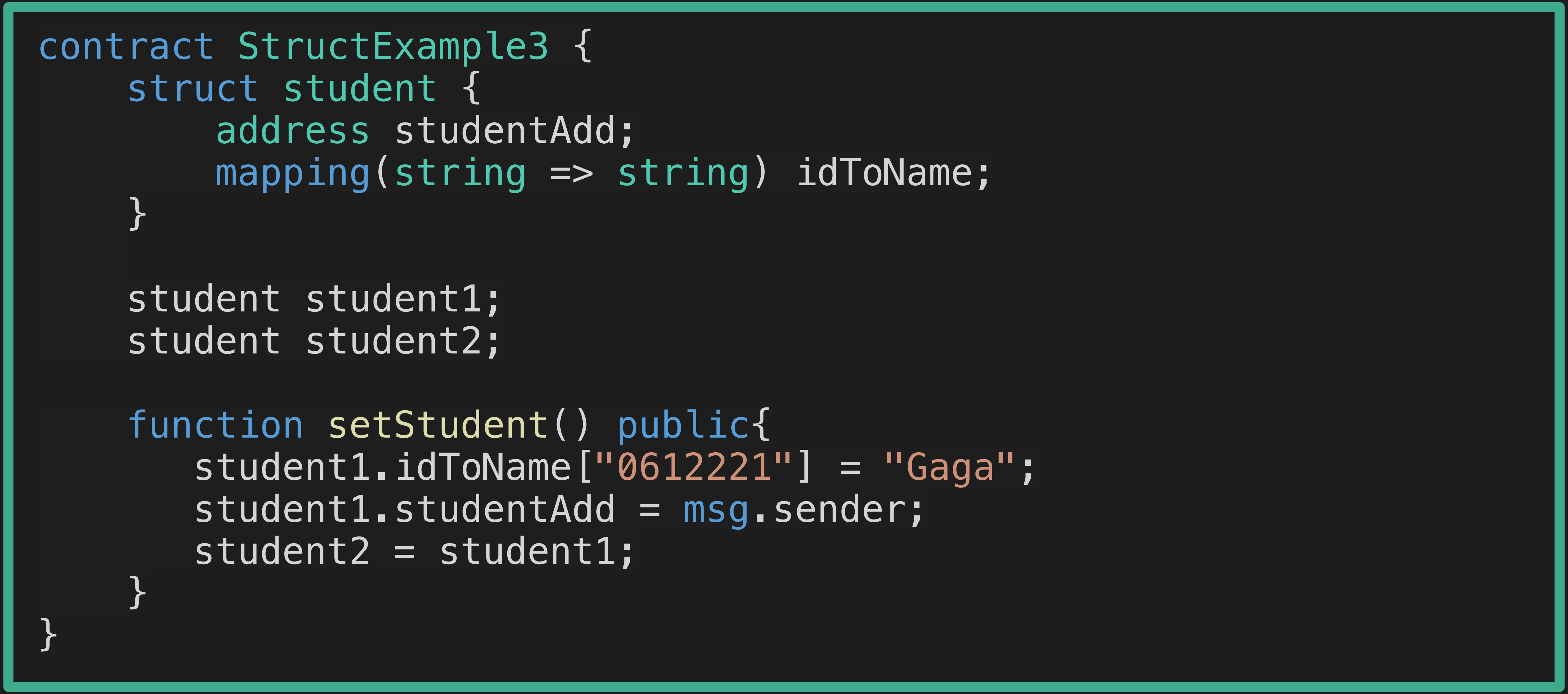


```
contract StructExample1 {
    struct Student {
        string studentName;
    }

    Student student;

    function setStudent(string calldata studentName) external {
        student.studentName = studentName;
    }

    function getStudent() external view returns (string memory) {
        return student.studentName;
    }
}
```

Struct 練習 — mapping

```
contract StructExample2 {
    struct student {
        string studentId;
        string studentName;
    }

    mapping(address => student) public studentAdd;

    function addStudent(string studentId, string studentName) {
        studentAdd[msg.sender] = student(studentId, studentName);
    }
}
```

Struct 練習 – mapping 複製



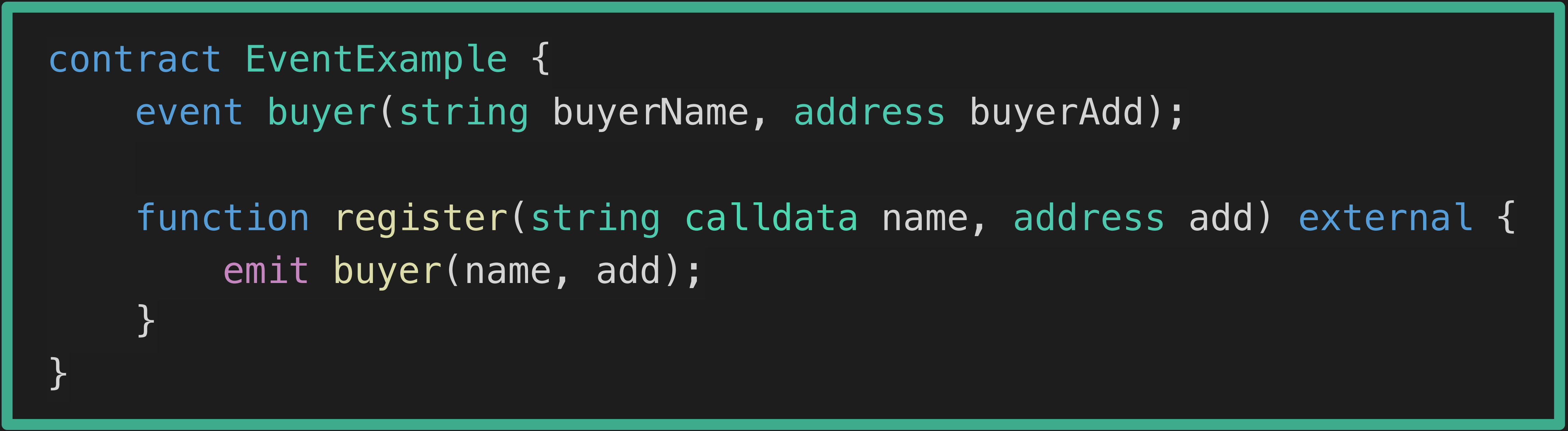
```
contract StructExample3 {
    struct student {
        address studentAdd;
        mapping(string => string) idToName;
    }

    student student1;
    student student2;

    function setStudent() public{
       student1.idToName["0612221"] = "Gaga";
       student1.studentAdd = msg.sender;
       student2 = student1;
    }
}
```

Event

- 合約內部函數觸發
- 將觸發參數存進 log 中
- Contract 無法直接取 log 的資料
- 額外的儲存空間，很便宜
- 方便 DAPP 監聽事件
- 搭配 **emit** 使用

```
event 事件名稱(參數型態1 參數名稱1, 參數型態2 參數名稱2, ... );
```

Event 練習



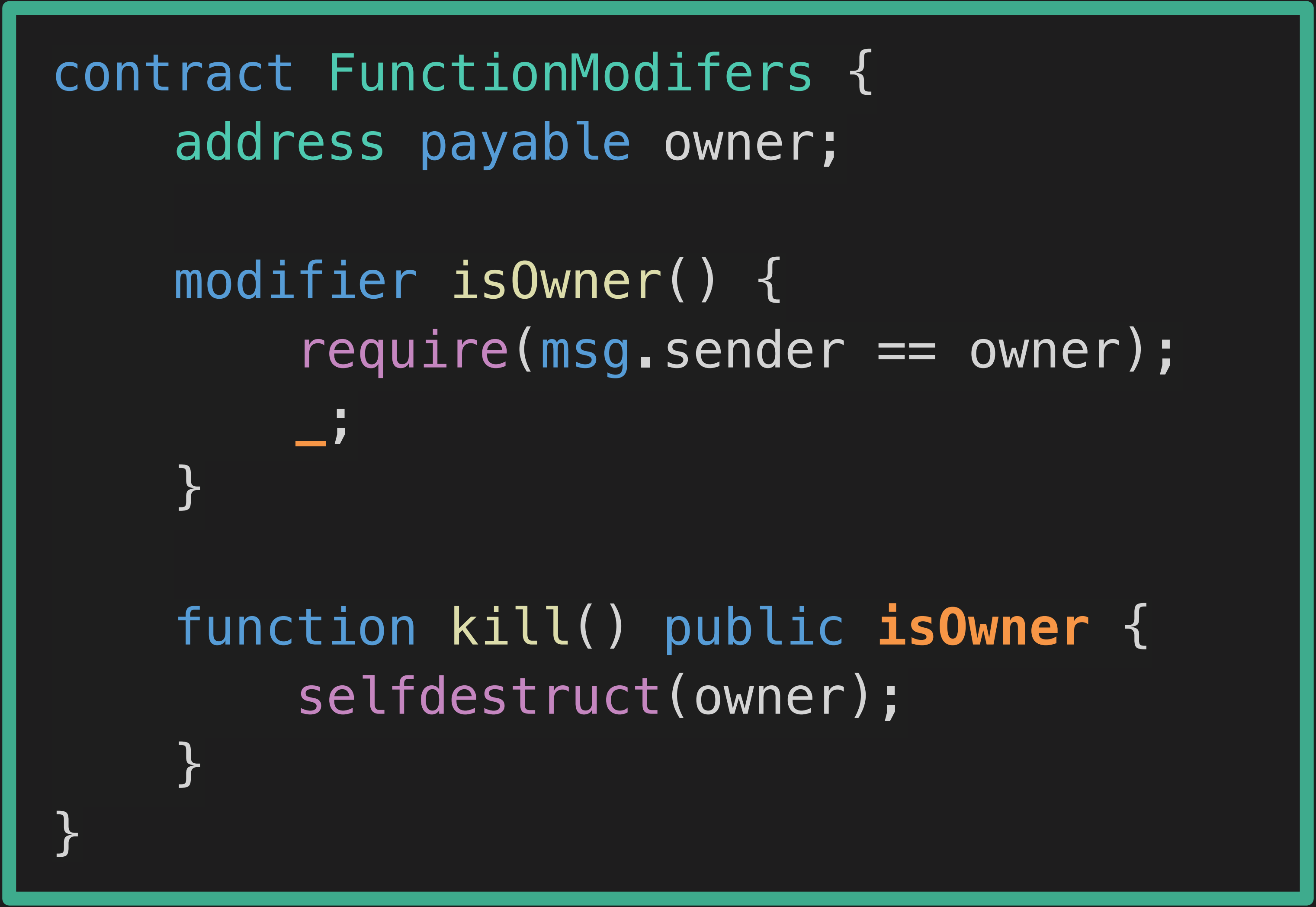
```
contract EventExample {
    event buyer(string buyerName, address buyerAdd);

    function register(string calldata name, address add) external {
        emit buyer(name, add);
    }
}
```

Function Modifiers

- 提供函數執行前的檢查、預先處理。
- 支援繼承屬性
- 可接收參數
- 可被覆寫
- 可以多個 modifier

```
modifier 名稱() {
    條件檢查式; //可以有很多個
    _;
}
```

Function Modifiers 練習



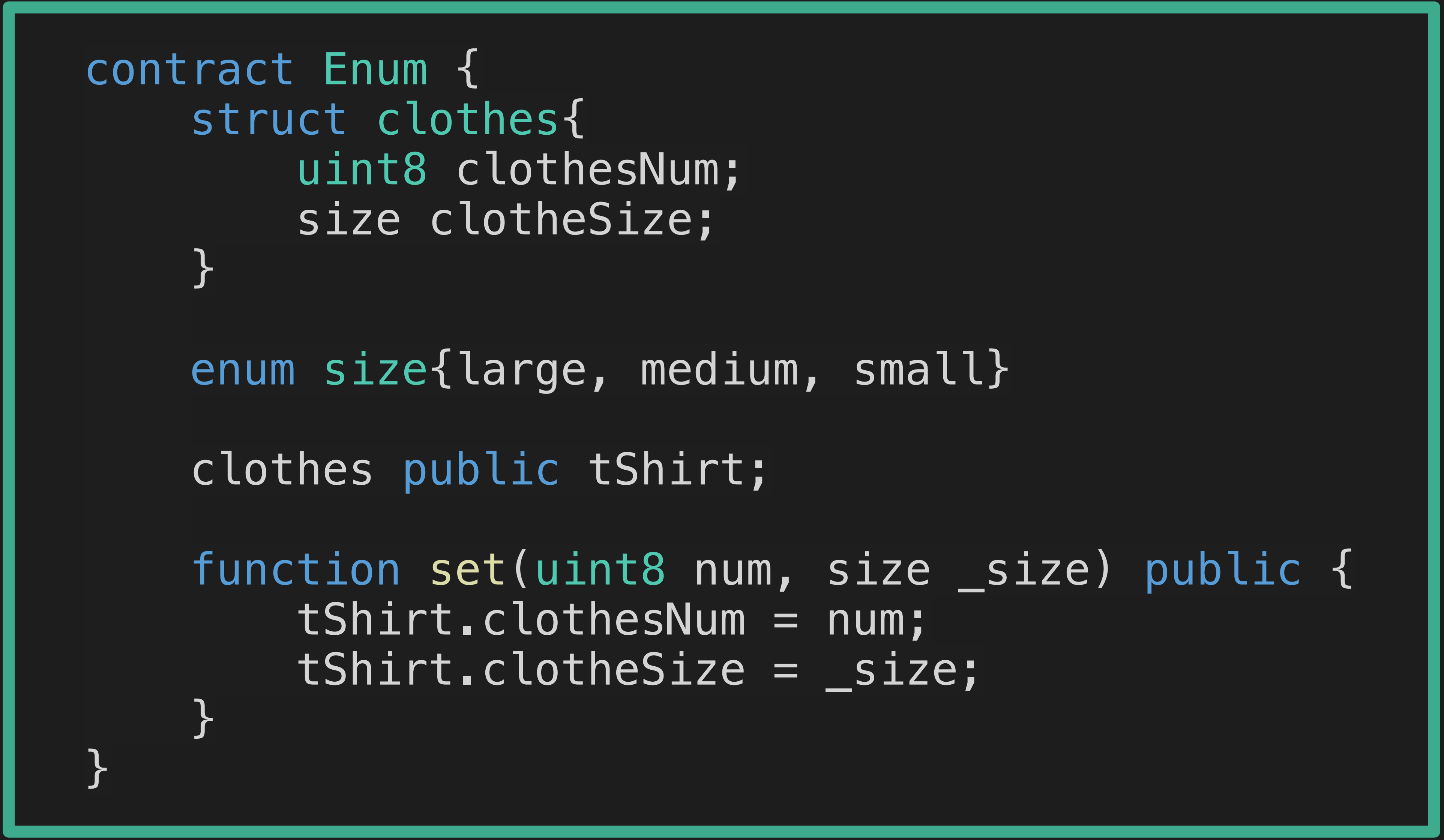
```
contract FunctionModifers {
    address payable owner;

    modifier isOwner() {
        require(msg.sender == owner);
        _;
    }

    function kill() public isOwner {
        selfdestruct(owner);
    }
}
```

Enum

- 自定義變數、不需要指定型態
- 裡面的值依照宣告的順序從零開始遞增
- 可搭配 Struct 使用，表示 Struct 中的某個狀態

```
enum 變數名稱 { 成員1, 成員2, … }
```

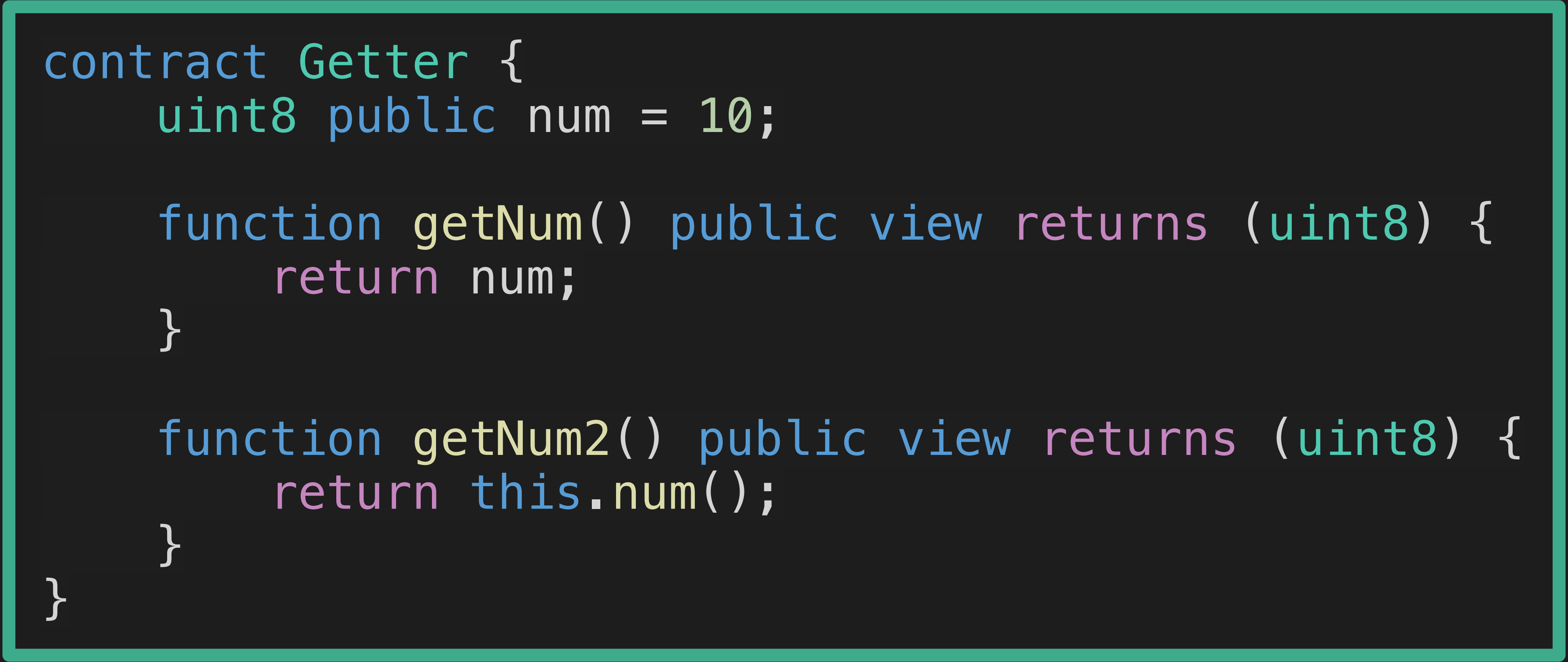
Enum 練習



```
contract Enum {
    struct clothes{
        uint8 clothesNum;
        size clotheSize;
    }

    enum size{large, medium, small}

    clothes public tShirt;

    function set(uint8 num, size _size) public {
        tShirt.clothesNum = num;
        tShirt.clotheSize = _size;
    }
}
```

Getter Function

- 對於所有 public 變數宣告後會自動生成
- Getter function 為 external

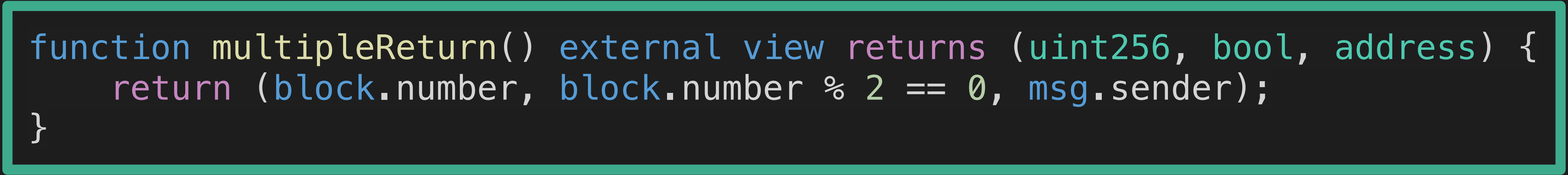


```
contract Getter {
    uint8 public num = 10;

    function getNum() public view returns (uint8) {
        return num;
    }

    function getNum2() public view returns (uint8) {
        return this.num();
    }
}
```

Function Overloading

```
function fun1(uint8 num1) external pure returns (uint8) {
        return num1;
    }

function fun1(uint8 num1, uint8 num2) external pure returns (uint8) {
    return num1 + num2;
}
```

Function Multiple Returns



```
function multipleReturn() external view returns (uint256, bool, address) {
    return (block.number, block.number % 2 == 0, msg.sender);
}
```

Inheritance

- 支援多重繼承
- virtual 函數在繼承中可以被修改
- 要修改 virtual 函數，要先宣告 override

```
contract Owned {
    address payable owner;

    constructor() public {
        owner = msg.sender;
    }
}
```

```
contract Shop is Owned {
    string shopName;

    function setName(string calldata _shopName) external virtual {
        if (msg.sender == owner)
            shopName = _shopName;
    }
}
```

Inheritance

```
contract Shop is Owned {
    string shopName;

    function setName(string calldata _shopName) external virtual {
        if (msg.sender == owner)
            shopName = _shopName;
    }
}
contract Mall is Owned, Shop {
    string[] shopArr;

    function setName(string calldata _shopName) external override {
        if (msg.sender == owner) {
            shopName = _shopName;
            shopArr.push(_shopName);
        }
    }
}
```

Abstract Contract

- 合約內有至少一個函數未實現
- 未實現的合約要宣告為 virtual
- 如果繼承者也未完全實現全部函數，也應宣告為 abstract

```
abstract contract Abstract {
    uint8 num;
    function setNum(uint8) public virtual;
    function getNum() public view returns (uint8) {
        return num;
    }
}
```

Interface

- 與 abstract contract 相似，但它沒有實現任何函數
- 不能繼承其他合約或介面
- 不能定義 **constructor**、**變數，但是 struct 、 enum 、event可以**
- 所有的 function 必須是 **external**，且預設都是 **virtual**
- 就像是蓋房子前的藍圖

```
interface Member {
    function setName(string calldata) external;
    function setAge(uint8) external;
    function getInfo() external returns (string memory, uint8);
}
```

Library

- 函式庫合約不能有狀態儲存
- 不能繼承或被繼承
- 不能被 destroyed
- 不能接受 Ether

OpenZeppelin

```
library Math {
    function max(uint256 a, uint256 b) internal pure returns (uint256) {
        return a >= b ? a : b;
    }

    function min(uint256 a, uint256 b) internal pure returns (uint256) {
        return a < b ? a : b;
    }

    function average(uint256 a, uint256 b) internal pure returns (uint256) {
        return (a / 2) + (b / 2) + ((a % 2 + b % 2) / 2);
    }
}
```

- ERC 20 介紹與實作-

EIP (Ethereum Improvement Proposals)

- Standard Track EIP
  - Core - 共識分叉的改進、核心開發相關。(EIP-5 OP Code Gas Price)
  - Networking - 網路協議相關。 (EIP-1459 DNS)
  - Interface - client端的規範和標準的改進，或是語言層級的標準。(EIP-1102)
  - ERC - 應用程式層級相關標準與協定。(EIP-55、EIP-75、EIP-85)
- Informational EIP
  - 描述以太坊設計的問題，或向以太坊社群提供一般指導或資訊，但不提出新功能。
- Meta EIP
  - 對 Ethereum 的改進或建議。(EIP-1)

EIP

ERC20

發行總量

```
function totalSupply() external view returns (uint);
```

帳戶 Token 餘額

```
function balanceOf(address tokenOwner) external view returns (uint balance);
```

A 批准給 B 的數量

```
function allowance(address tokenOwner, address spender) external view returns (uint remaining);
```

```
function transfer(address to, uint tokens) external returns (bool success);
```

轉移代幣

```
function approve(address spender, uint tokens) external returns (bool success);
```

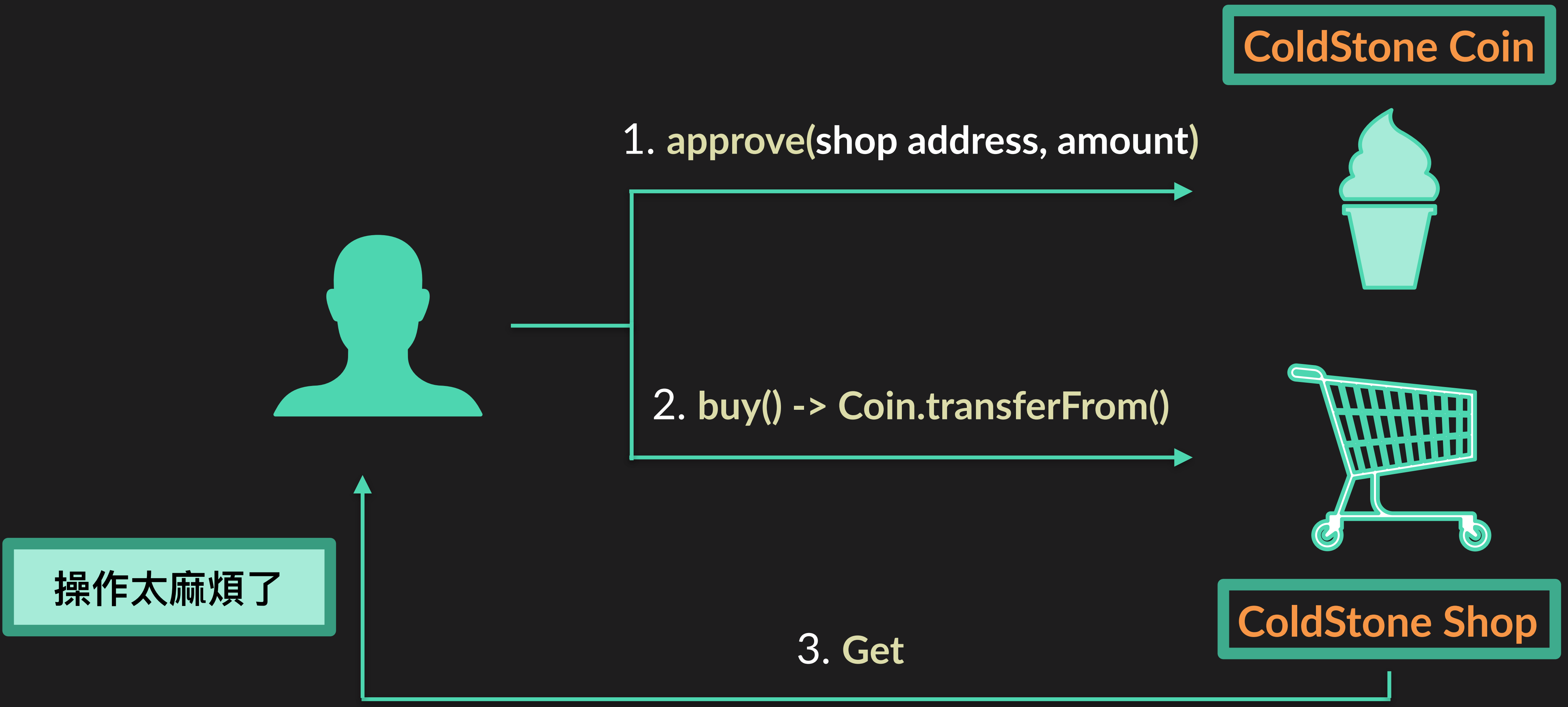
批准自己代幣轉移

```
function transferFrom(address from, address to, uint tokens) external returns (bool success);
```

將 A 代幣移轉給 B

```
event Transfer(address indexed from, address indexed to, uint tokens);

event Approval(address indexed tokenOwner, address indexed spender, uint tokens);
```

ERC20 - 購物合約示意圖



ColdStone Coin

1. approve(shop address, amount)

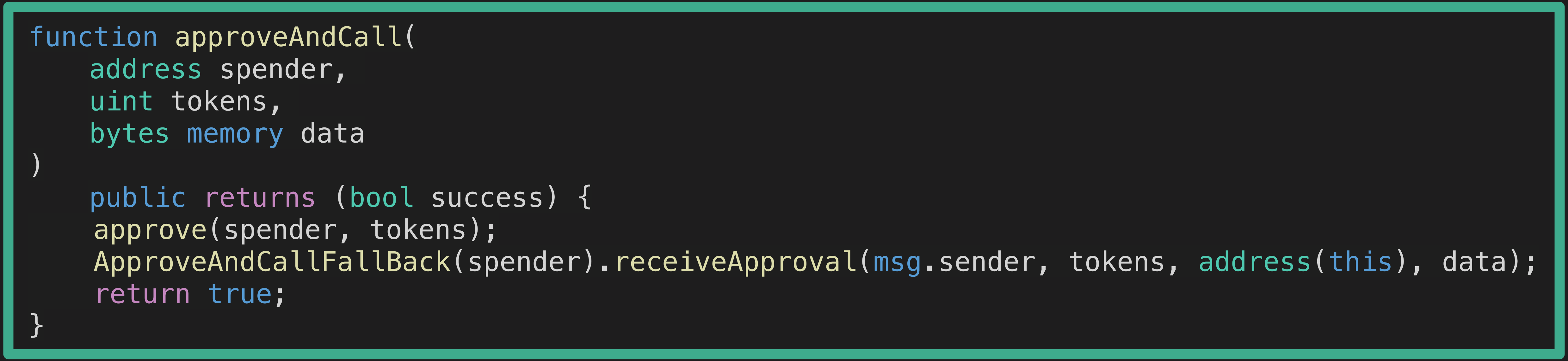
2. buy() -> Coin.transferFrom()

操作太麻煩了

3. Get

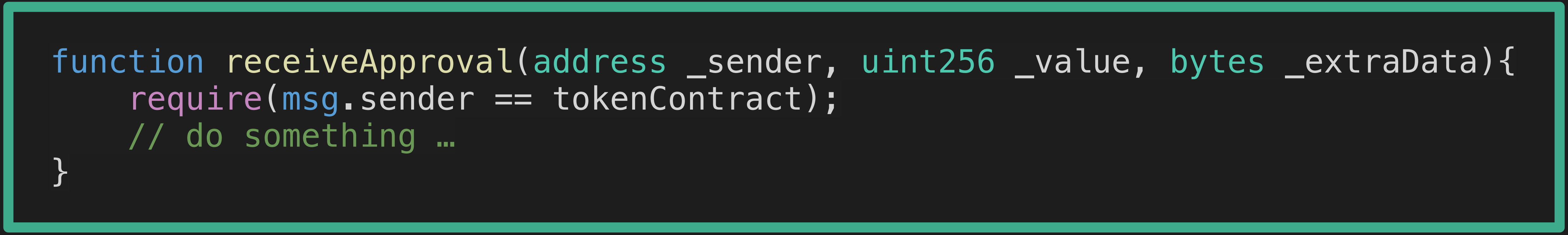
ColdStone Shop

在 Token 合約：



```
function approveAndCall(
    address spender,
    uint tokens,
    bytes memory data
)
    public returns (bool success) {
    approve(spender, tokens);
    ApproveAndCallFallBack(spender).receiveApproval(msg.sender, tokens, address(this), data);
    return true;
}
```

在 Shop 合約：



```
function receiveApproval(address _sender, uint256 _value, bytes _extraData){
    require(msg.sender == tokenContract);
    // do something …
}
```

- END -