Name: Pranav Pol **Class : D20A** **Roll no: 44** **Batch: C**

EXPERIMENT 5

AIM: Deploying a Voting/Ballot Smart Contract

Tasks:

1. Open **Remix IDE**
2. Under **Workspaces,** open **contracts** folder
3. Open **Ballot.sol**, contract.
4. Understand **Ballot.sol** contract.
5. Deploy the contract by changing the Proposal name from **bytes32 → string**

THEORY:

1. Relevance of require Statements in Solidity Programs

In Solidity, the require statement acts as a guard condition within functions. It ensures that only valid inputs or authorized users can execute certain parts of the code. If the condition inside require is not satisfied, the function execution stops immediately, and all state changes made during that transaction are reverted to their original state. This rollback mechanism ensures that invalid transactions do not corrupt the blockchain data.

For example, in a Voting Smart Contract, require can be used to check:

- Whether the person calling the function has the right to vote (require(voters[msg.sender].weight > 0, "Has no right to vote");).
- Whether a voter has already voted before allowing them to vote again.
- Whether the function caller is the chairperson before granting voting rights.

Thus, require statements enforce security, correctness, and reliability in smart contracts. They also allow developers to attach error messages, making debugging and contract interaction easier for users.

2. Keywords: mapping, storage, and memory

mapping:

- A mapping is a special data structure in Solidity that links keys to values, similar to a hash table. Its syntax is mapping(keyType => valueType). For example:

mapping(address => Voter) public voters;

Here, each address (Ethereum account) is mapped to a Voter structure. Mappings are very useful for contracts like Ballot, where you need to associate voters with their data (whether they voted, which proposal they chose, etc.). Unlike arrays, mappings do not have a length property and cannot be iterated over directly, making them gas efficient for lookups but limited for enumeration.

storage:

- In Solidity, storage refers to the permanent memory of the contract, stored on the Ethereum blockchain. Variables declared at the contract level are stored in storage by default. Data stored in storage is persistent across transactions, which means once written, it remains available unless explicitly modified. However, because writing to blockchain storage consumes gas, it is more expensive. For example, a voter's information saved in the voters mapping remains available throughout the contract's lifecycle.

memory:

- In contrast, memory is temporary storage, used only for the lifetime of a function call. When the function execution ends, the data stored in memory is discarded. Memory is mainly used for temporary variables, function arguments, or computations that don't need to be permanently stored on the blockchain. It is cheaper than storage in terms of gas cost. For instance, when handling proposal names or temporary string manipulations, memory is often used.

Thus, a smart contract developer must balance between storage and memory to ensure efficiency and cost-effectiveness.

- **bytes32** is a fixed-size type, meaning it always stores exactly 32 bytes of data. This makes storage simple, comparison operations faster, and gas costs lower. However, it limits proposal names to 32 characters, which is not very flexible for user-friendly names.
- **string** is a dynamically sized type, meaning it can store text of variable length. While it is easier for developers and users (since names can be written normally), it requires more complex handling inside the Ethereum Virtual Machine (EVM). This increases gas usage and may slow down comparisons or manipulations.

To make the system more user-friendly, modern implementations of the Ballot contract often convert from bytes32 to string. Tools like the Web3 Type Converter help developers easily switch between these two types for deployment and testing.

CODE:

```
// SPDX-License-Identifier: GPL-3.0
pragma solidity >=0.7.0 <0.9.0;

/**
 * @title Ballot
 * @dev Implements voting process along with vote delegation
 */
contract Ballot {

    struct Voter {
        uint weight;
        bool voted;
        address delegate;
        uint vote;
    }

    struct Proposal {
        string name;     // CHANGED from bytes32 → string
        uint voteCount;
    }

    address public chairperson;
    mapping(address => Voter) public voters;
    Proposal[] public proposals;

    /**
     * @dev Create a new ballot
     * @param proposalNames names of proposals
     */
    constructor(string[] memory proposalNames) {
        chairperson = msg.sender;
        voters[chairperson].weight = 1;
```

```
    for (uint i = 0; i < proposalNames.length; i++) {
        proposals.push(
            Proposal({
                name: proposalNames[i],
                voteCount: 0
            })
        );
    }
}

function giveRightToVote(address voter) external {
    require(msg.sender == chairperson, "Only chairperson can give right to vote");
    require(!voters[voter].voted, "The voter already voted");
    require(voters[voter].weight == 0, "Voter already has right");

    voters[voter].weight = 1;
}

function delegate(address to) external {
    Voter storage sender = voters[msg.sender];

    require(sender.weight != 0, "No right to vote");
    require(!sender.voted, "Already voted");
    require(to != msg.sender, "Self-delegation not allowed");

    while (voters[to].delegate != address(0)) {
        to = voters[to].delegate;
        require(to != msg.sender, "Delegation loop detected");
    }

    Voter storage delegate_ = voters[to];
    require(delegate_.weight >= 1, "Delegate has no right");

    sender.voted = true;
```

```
        sender.delegate = to;

        if (delegate_.voted) {
            proposals[delegate_.vote].voteCount += sender.weight;
        } else {
            delegate_.weight += sender.weight;
        }
    }

    function vote(uint proposal) external {
        Voter storage sender = voters[msg.sender];

        require(sender.weight != 0, "No right to vote");
        require(!sender.voted, "Already voted");

        sender.voted = true;
        sender.vote = proposal;

        proposals[proposal].voteCount += sender.weight;
    }

    function winningProposal() public view returns (uint winningProposal_) {
        uint winningVoteCount = 0;

        for (uint p = 0; p < proposals.length; p++) {
            if (proposals[p].voteCount > winningVoteCount) {
                winningVoteCount = proposals[p].voteCount;
                winningProposal_ = p;
            }
        }
    }

    function winnerName() external view returns (string memory) {
        return proposals[winningProposal()].name;
```

```
    }
}
```

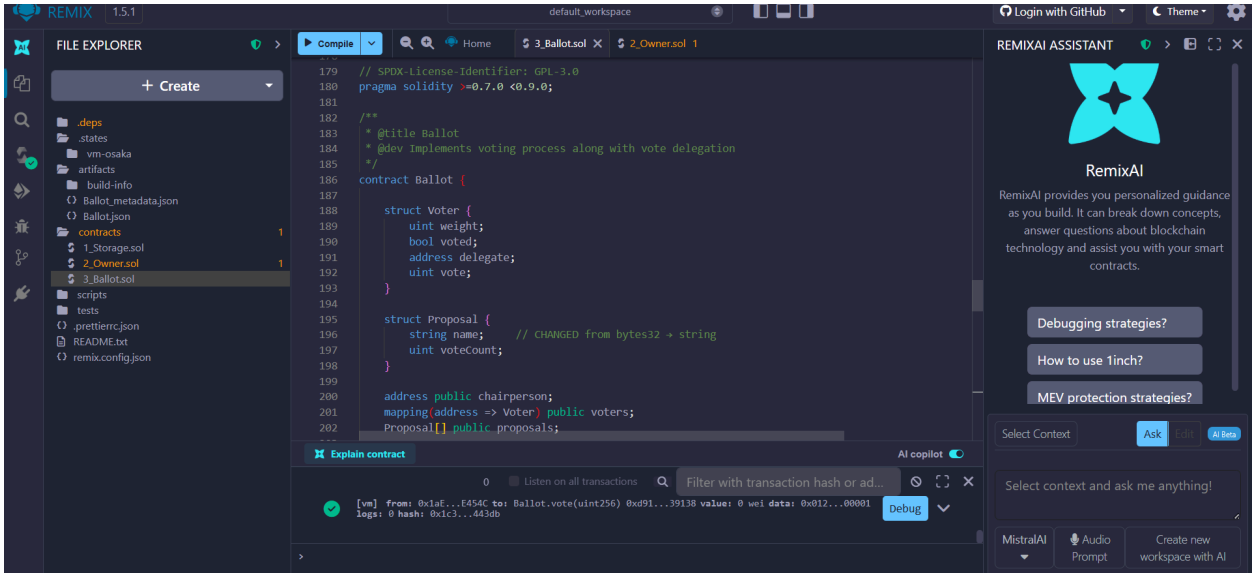
OUTPUT:

Step 1: Open Remix

Go to 👉 https://remix.ethereum.org
No install needed.

Step 2: Create the file

- **In File Explorer**
  Ballot.sol

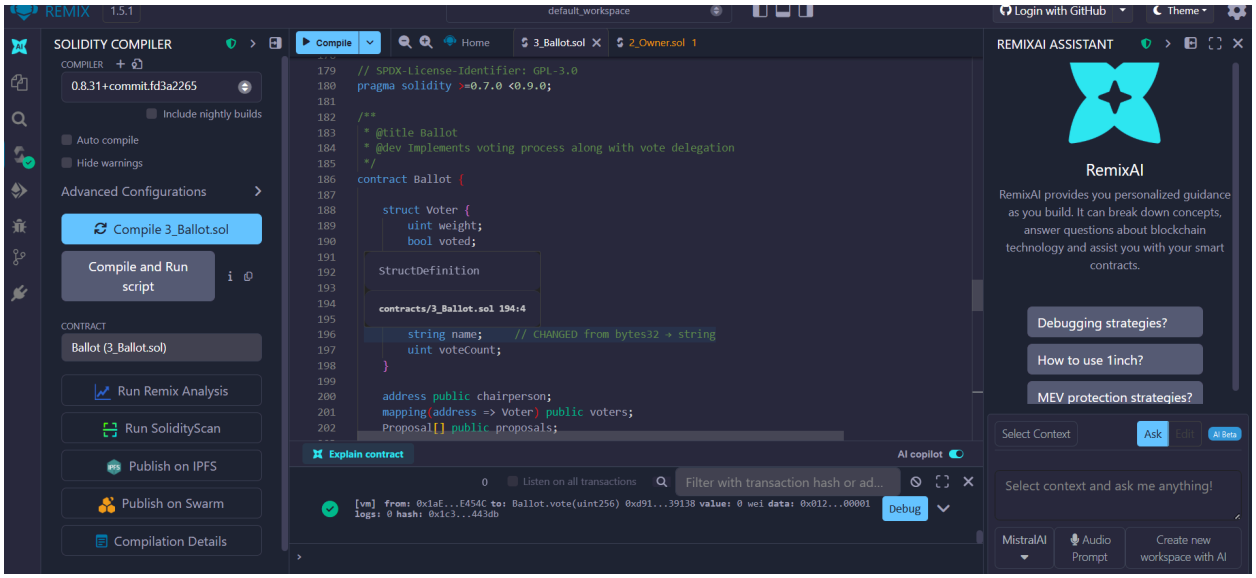


Step 3: Compile the contract

1. **Open Solidity Compiler (left sidebar)**
2. **Click Compile Ballot.sol**
3. **Make sure green tick appears (no errors)**

Step 4: Deploy the contract

1. **Open Deploy & Run Transactions**
2. **Set:**
    - **Environment → Remix VM**
    - **Account → keep default**
    - **Contract → Ballot**



Step 5: Enter constructor input (IMPORTANT)

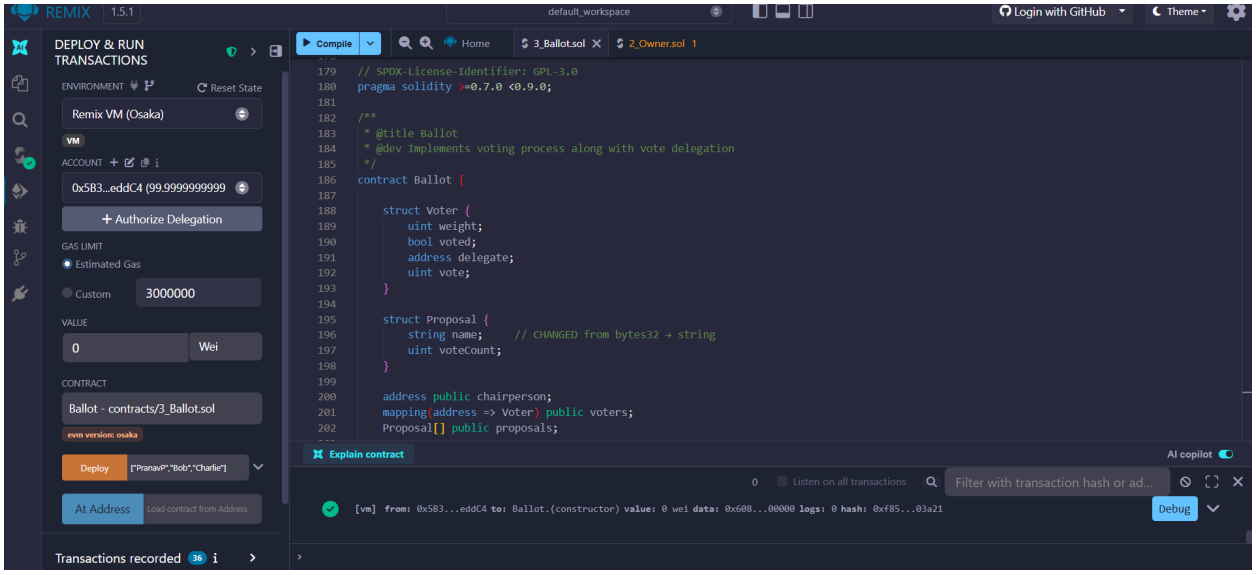
Your constructor is:

constructor(string[] memory proposalNames)

So input must be a string array 👇

Example:

["PranavP", "Bob", "Charlie"]



Step 6: Click Deploy

- **Click Deploy**
- **Contract appears under Deployed Contracts 🎉**
- **The deployer is automatically the chairperson**

giveRightToVote (address voter)

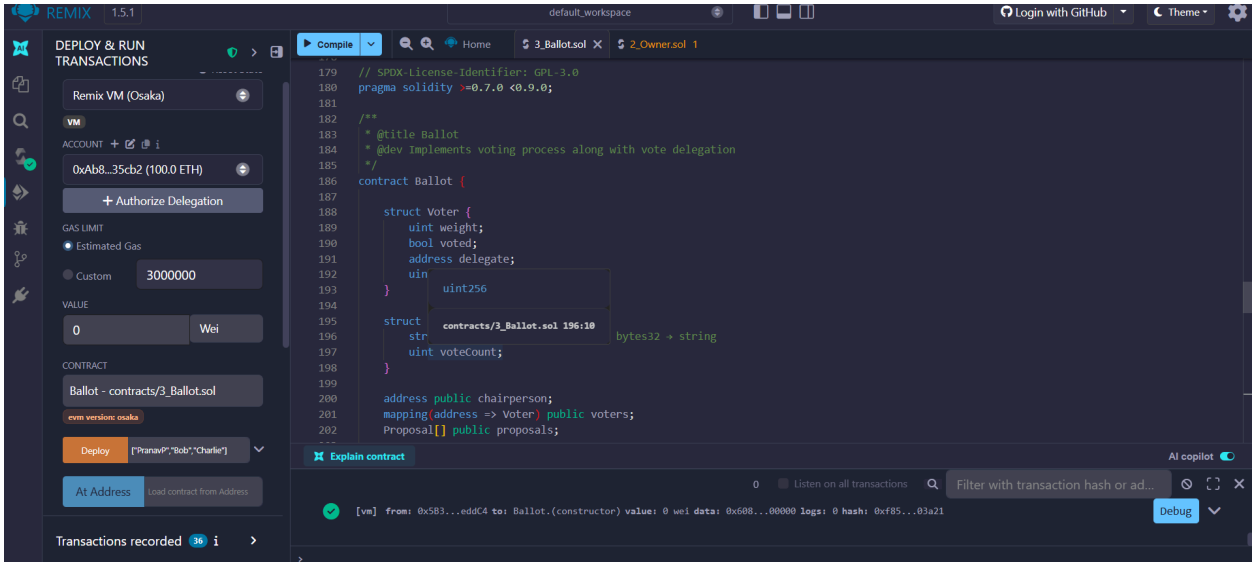
What to add:

Paste a Remix account address (NOT the chairperson).

Important:

- **You must be using Account 1 (chairperson) when clicking this**
- **Switch account at the top if needed**

Click Transact



Then vote

2 vote (uint256 proposal)

What to add:

A number, based on proposal index:

0 → PranavP

1 → Bob

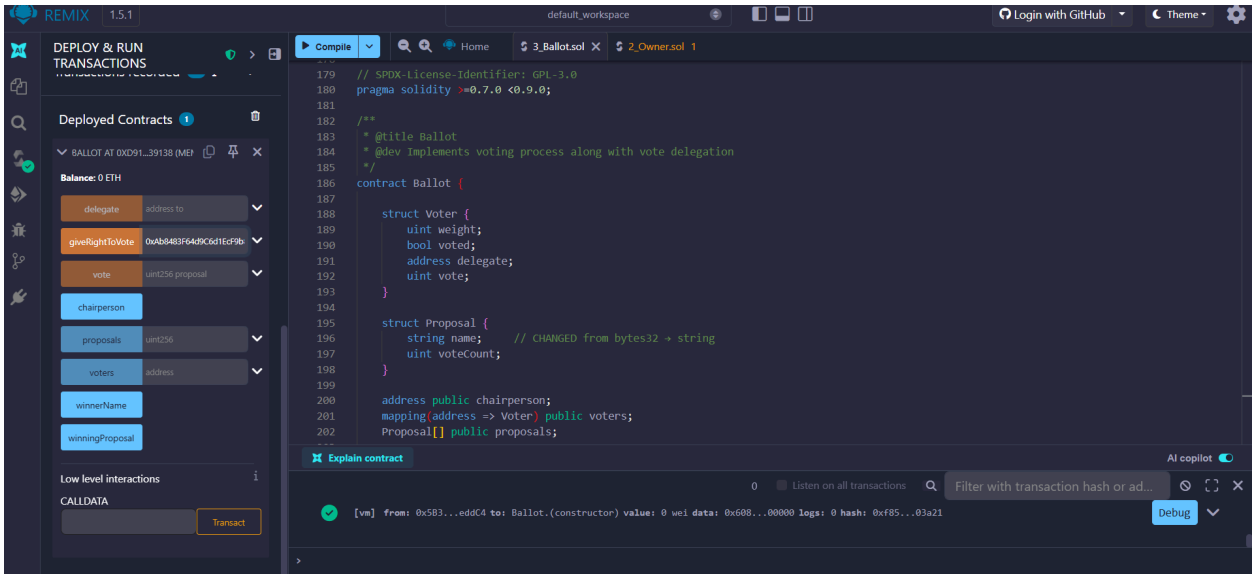
2 → Charlie

Example:

0

Important:

- **Switch to the voter account (the one you gave rights to)**
- **Then click Transact**


REMIX 1.5.1
default_workspace
Login with GitHub
Theme
DEPLOY & RUN TRANSACTIONS
Compile
Home
3_Ballot.sol
2_Owner.sol 1
Deployed Contracts 1
BALLOT AT 0XD91...39138 (MEM
Balance: 0 ETH
delegate
address to
giveRightToVote
0xAb8483F64d9C6d1EcF9b
vote
uint256 proposal
chairperson
proposals
uint256
voters
address
winnerName
winningProposal
Low level interactions
CALLDATA
Transact
// SPDX-License-Identifier: GPL-3.0
pragma solidity >=0.7.0 <0.9.0;
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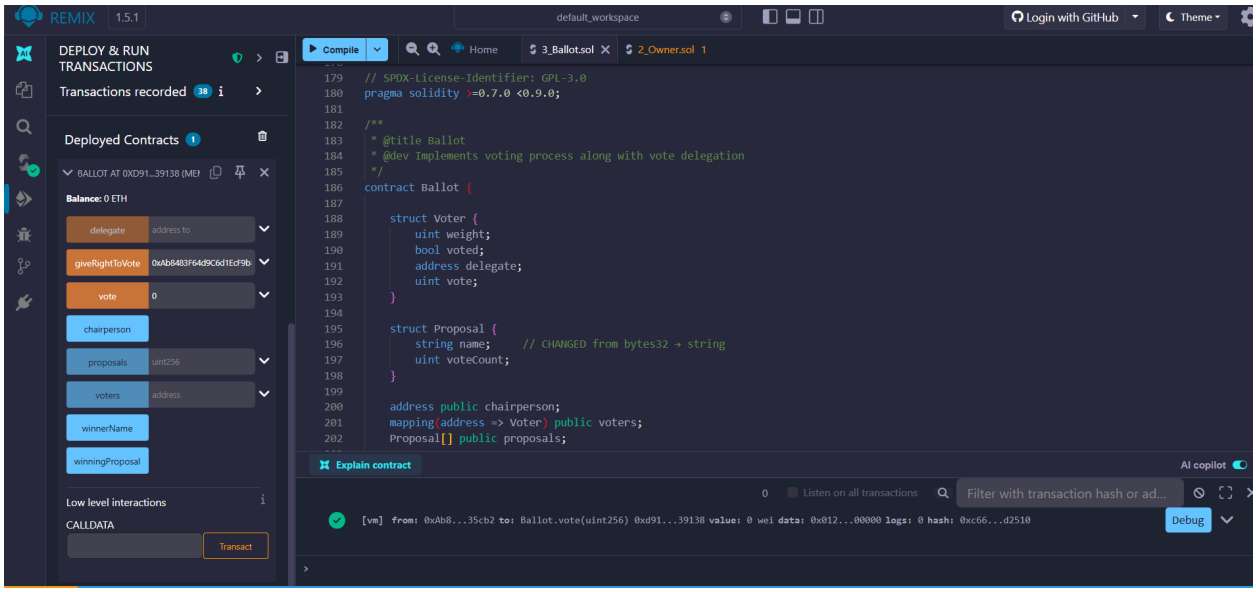
uint weight;
bool voted;
address delegate;
uint vote;
}
struct Proposal {
string name; // CHANGED from bytes32 → string
uint voteCount;
}
address public chairperson;
mapping(address => Voter) public voters;
Proposal[] public proposals;
Explain contract
AI copilot
0
Listen on all transactions
Filter with transaction hash or ad...
[vm] from: 0x5B3...eddC4 to: Ballot.(constructor) value: 0 wei data: 0x608...00000 logs: 0 hash: 0xf85...03a21
Debug


REMIX 1.5.1
default_workspace
Login with GitHub
Theme
DEPLOY & RUN TRANSACTIONS
Transactions recorded 38
Compile
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3_Ballot.sol
2_Owner.sol 1
Deployed Contracts 1
BALLOT AT 0XD91...39138 (MEM
Balance: 0 ETH
delegate
address to
giveRightToVote
0xAb8483F64d9C6d1EcF9b
vote
0
chairperson
proposals
uint256
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address
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string name; // CHANGED from bytes32 → string
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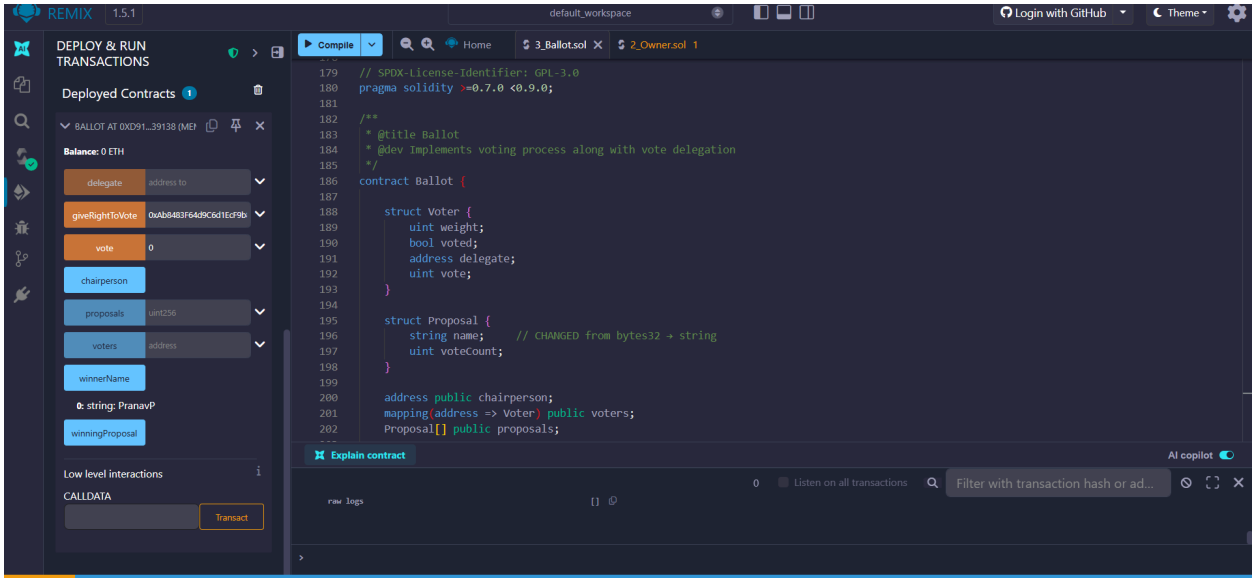
}
address public chairperson;
mapping(address => Voter) public voters;
Proposal[] public proposals;
Explain contract
AI copilot
0
Listen on all transactions
Filter with transaction hash or ad...
[vm] from: 0xAb8...35cb2 to: Ballot.vote(uint256) 0xd91...39138 value: 0 wei data: 0x012...00000 logs: 0 hash: 0xc66...d2510
Debug



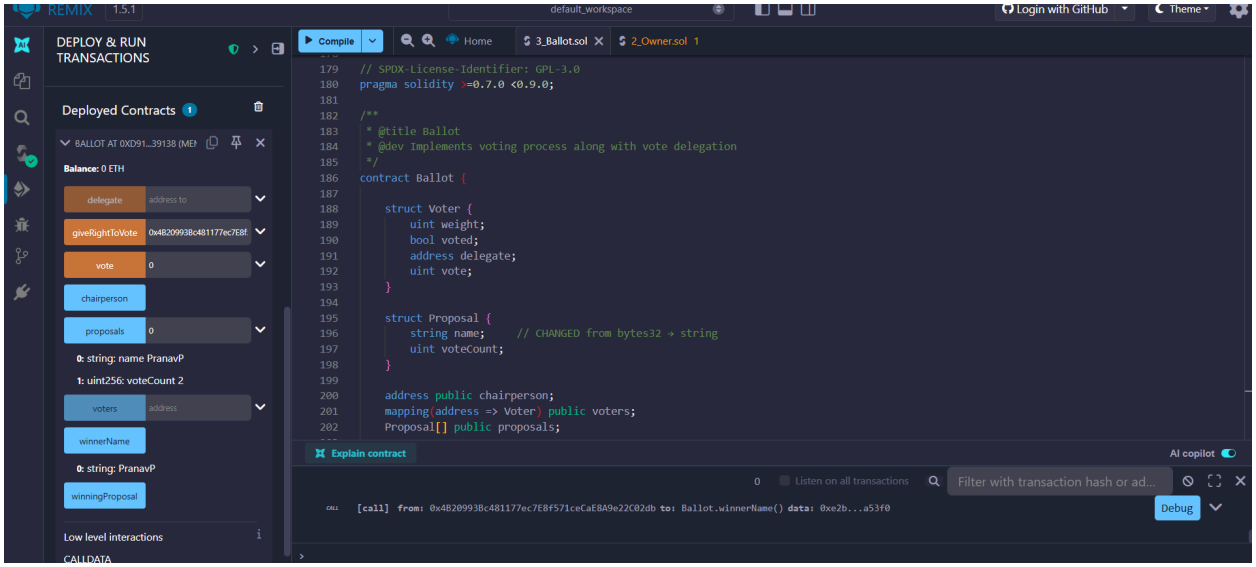
proposals (uint256)

What to add:

Proposal index:

0

Returns proposal details.



Conclusion:

In this experiment, a Voting/Ballot smart contract was deployed using Solidity on the Remix IDE. The concepts of require statements, mapping, and data location specifiers like storage and memory were explored to understand their role in ensuring security, efficiency, and correctness in smart contracts. The difference between using bytes32 and string for proposal names was also studied, highlighting the trade-off between gas efficiency and readability. Overall, the experiment provided practical insights into the design and deployment of voting contracts on the blockchain.