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Summer School of Solana

LECTURE 5

Solana Programming model 3/3

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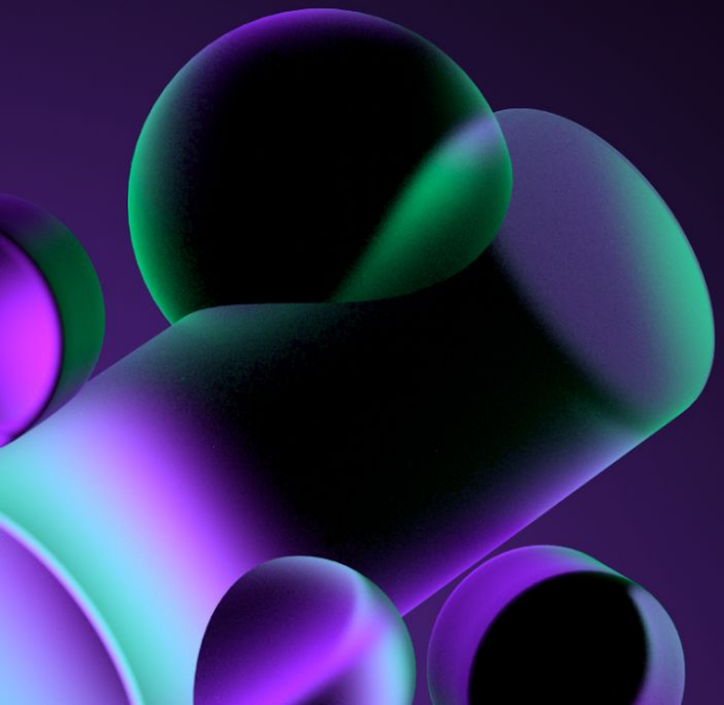
About this lecture

- **Solana Programming model - recap**
  - Recap
  - Program Derived Addresses (PDAs)
  - Tokens
- **Hands on Example**
  - Turnstile program (fixes)

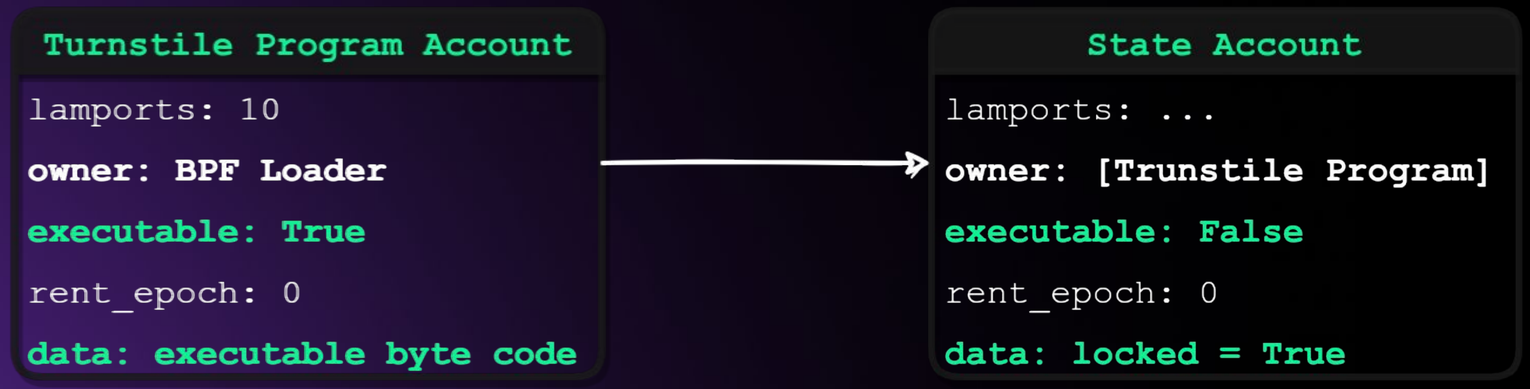
Recap




ACCOUNTS
LIGHTYEAR
ACCOUNTS EVERYWHERE
imgflip.com

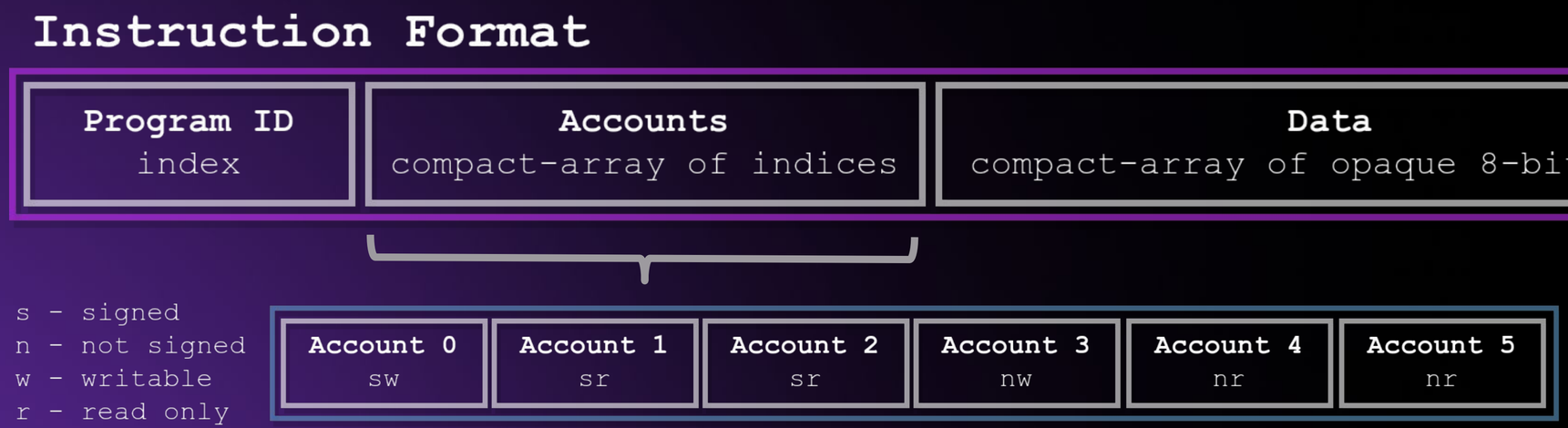
Accounts

- Solana accounts:
  - Program accounts
  - Data accounts
- Program accounts do not store state!
- Only a data account's owner can modify its data and subtract lamports.
- To prevent an account from being deleted, you must pay rent.

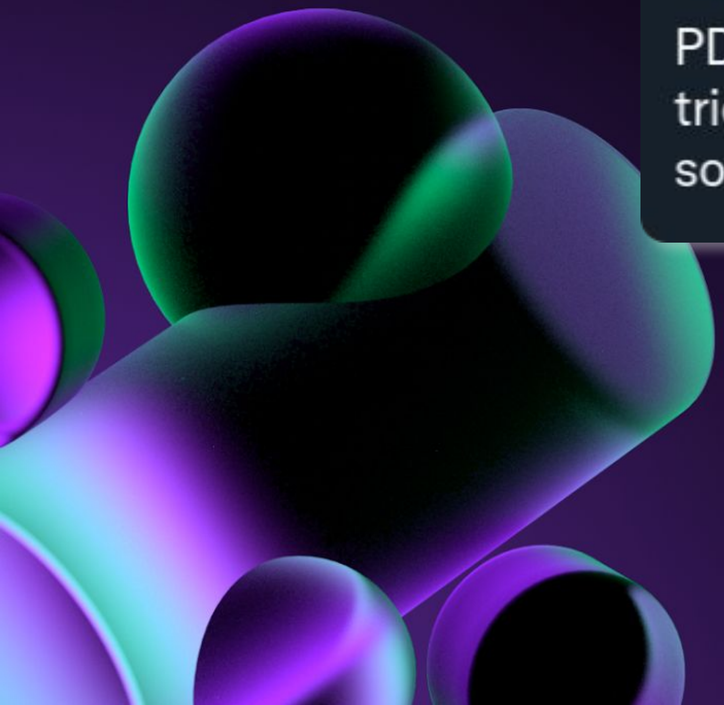


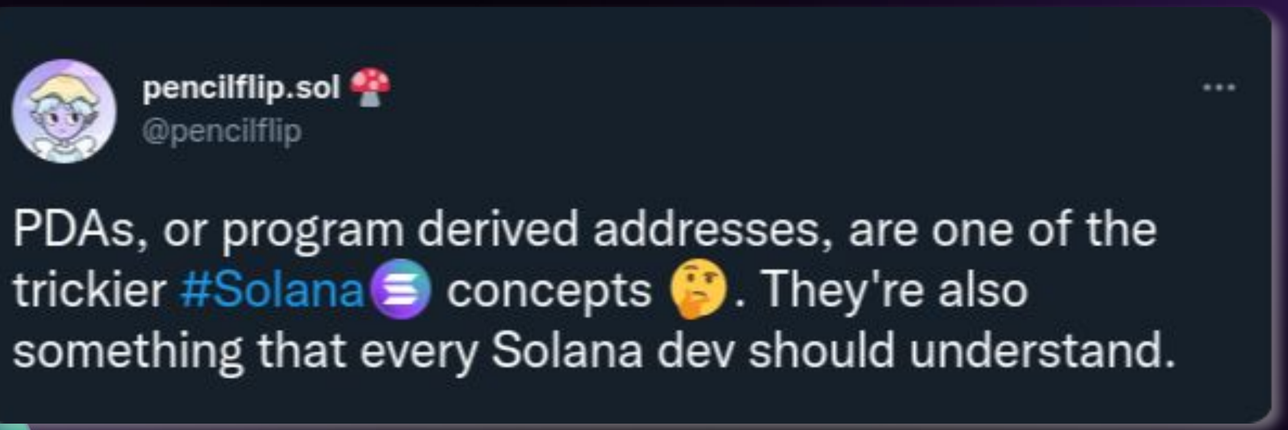
Transactions

- The basic operational unit on Solana is an instruction.
- One or more instructions can be bundled into a transaction.
- Instructions in one transaction are processed in order and atomically.
- You must forward-declare every account you intend to read from or write to.
  - be aware of potential **SECURITY RISKS**



PDAs

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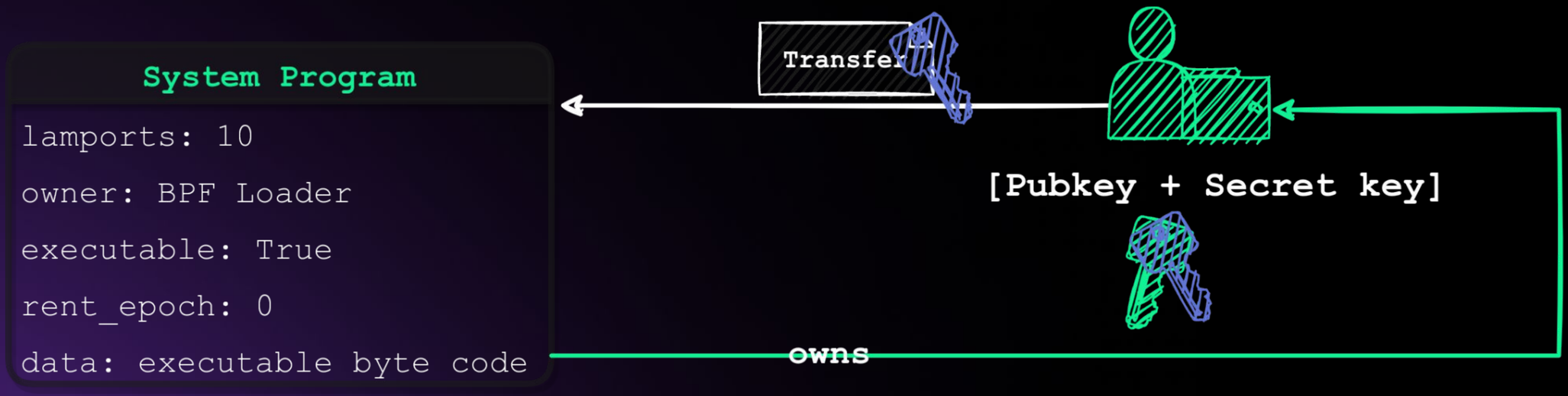
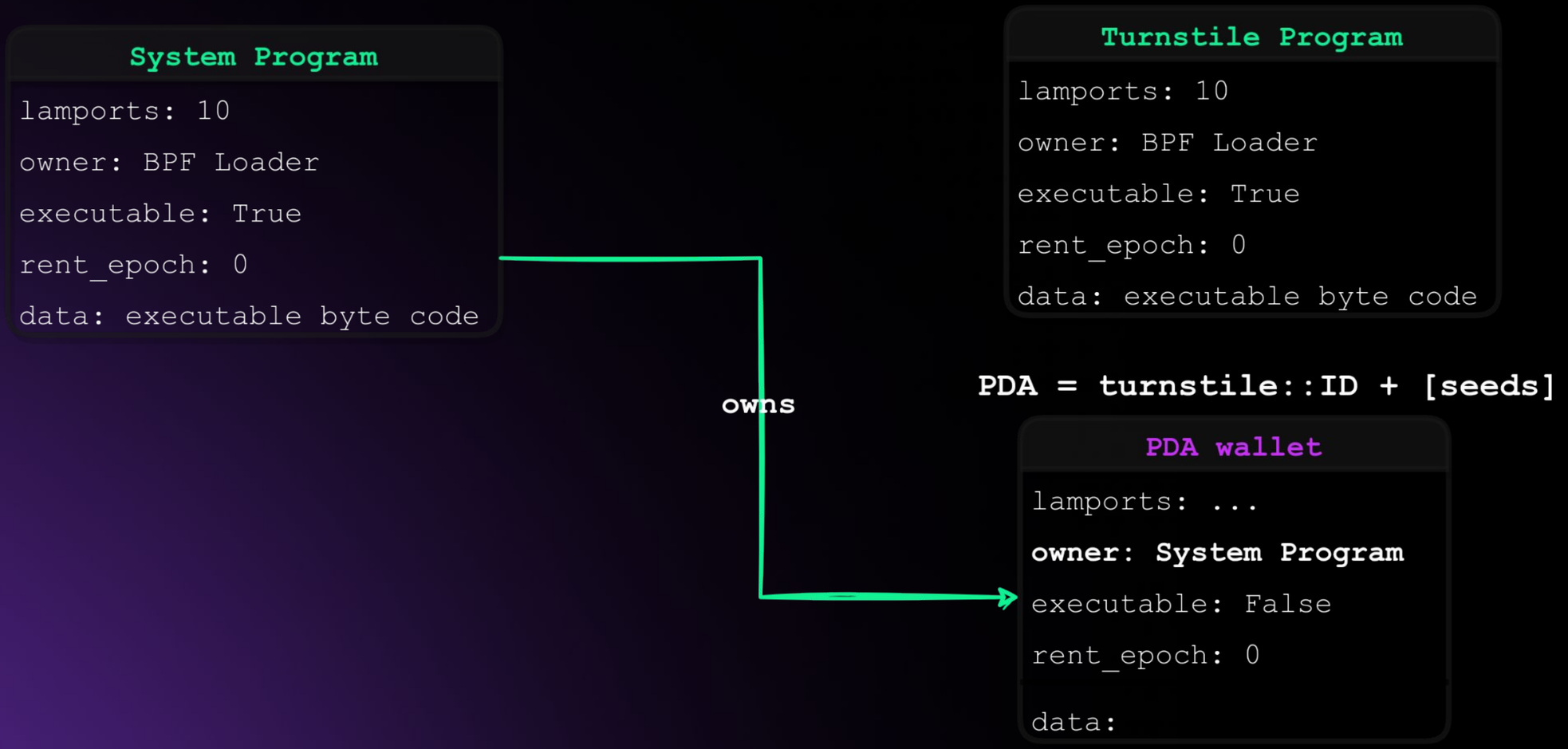
PDAs, or program derived addresses, are one of the trickier #Solana concepts. They're also something that every Solana dev should understand.

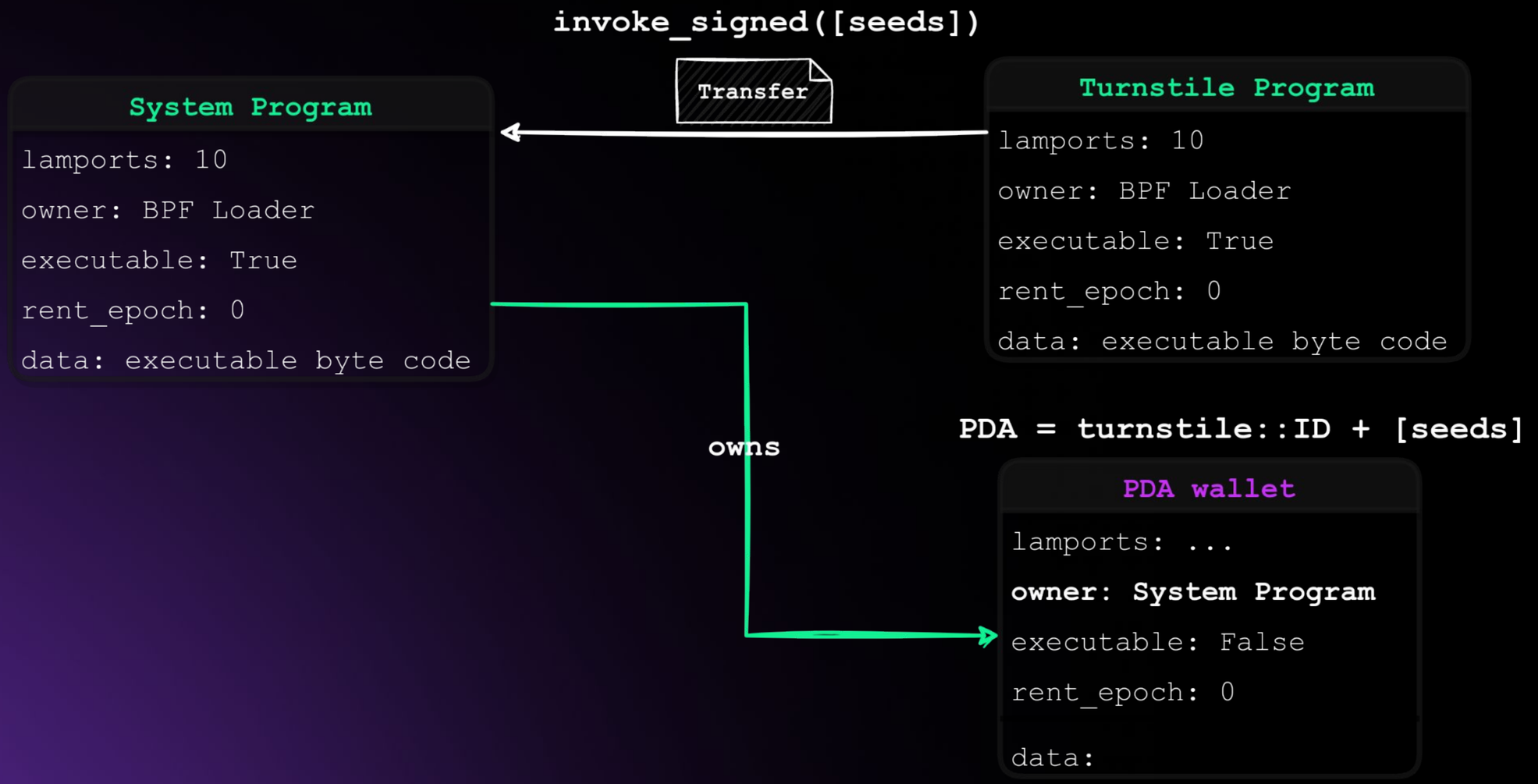
PDAs motivation



PDAs (invoke_signed)



PDAs (invoke_signed)

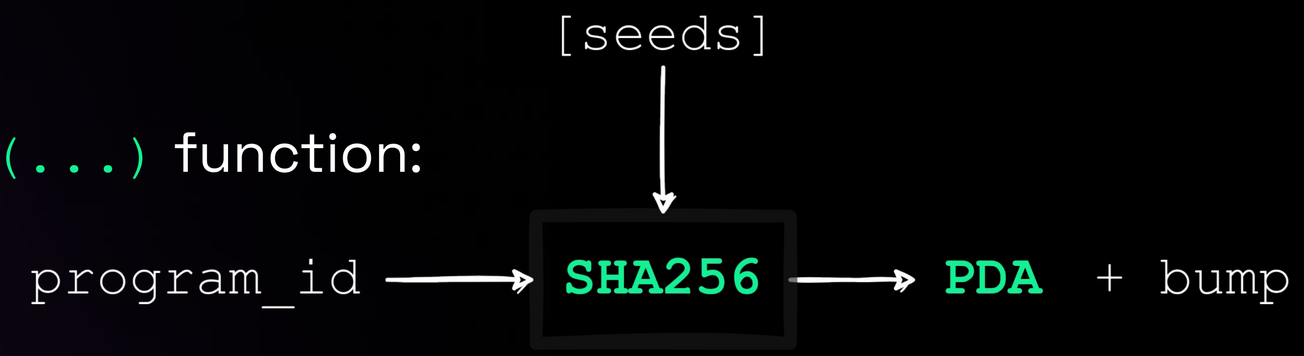


PDA

- **Programs want to be able to sign accounts for cross-program invocation.**

- PDA = program derived address
- PDA account = an account whose address is a PDA.

- How does a PDA get derived?
  - `Pubkey::find_program_address(...)` function:



- PDA is bumped off the Ed25519 elliptic curve. Hence, there is no private key.

PDAs (deterministic addresses)

```rust
pub fn push(
  turnstile_program: Pubkey,
  state: Pubkey
) -> Instruction {
    Instruction {
        program_id: turnstile_program,
        accounts: vec![AccountMeta::new(state, false)],
        data: TurnstileInstruction::Push.try_to_vec().unwrap()
    }
}
```

PDAs (deterministic addresses)

```rust
// function which builds the Push instruction
pub fn push(
  turnstile_program: Pubkey,
) -> Instruction {
    let (state, bump) =
        Pubkey::find_program_address(
          &[b"STATE"],
          turnstile_program
        );
    Instruction {
        program_id: turnstile_program,
        accounts: vec![AccountMeta::new(state, false)],
        data: TurnstileInstruction::Push
                .try_to_vec()
                .unwrap(),
    }
}
```

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PDAs (hash map)

[Pubkey1]

[Pubkey2]

[Pubkey3]

Program

lamports: 10

owner: BPF Loader

executable: True

rent_epoch: 0

data: executable byte code

[Pubkey1] + Program ID

User Account

lamports: ...

owner: Program

executable: False

rent_epoch: 0

data:

```
User {
 balance: [u64],
 ...
}
```

[Pubkey2] + Program ID

User Account

lamports: ...

owner: Program

executable: False

rent_epoch: 0

data:

```
User {
 balance: [u64],
 ...
}
```

User Account

lamports: ...

owner: Program

executable: False

rent_epoch: 0

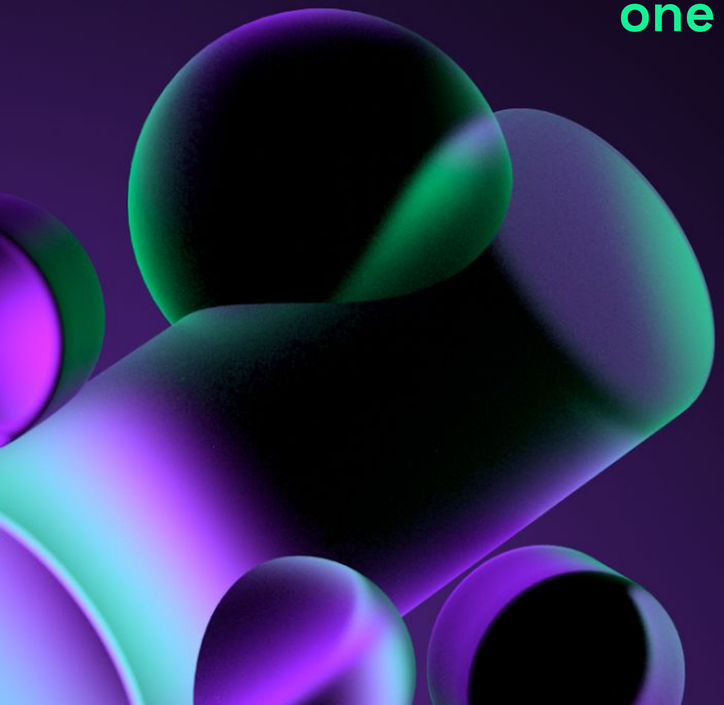
data:

```
User {
 balance: [u64],
 ...
}
```

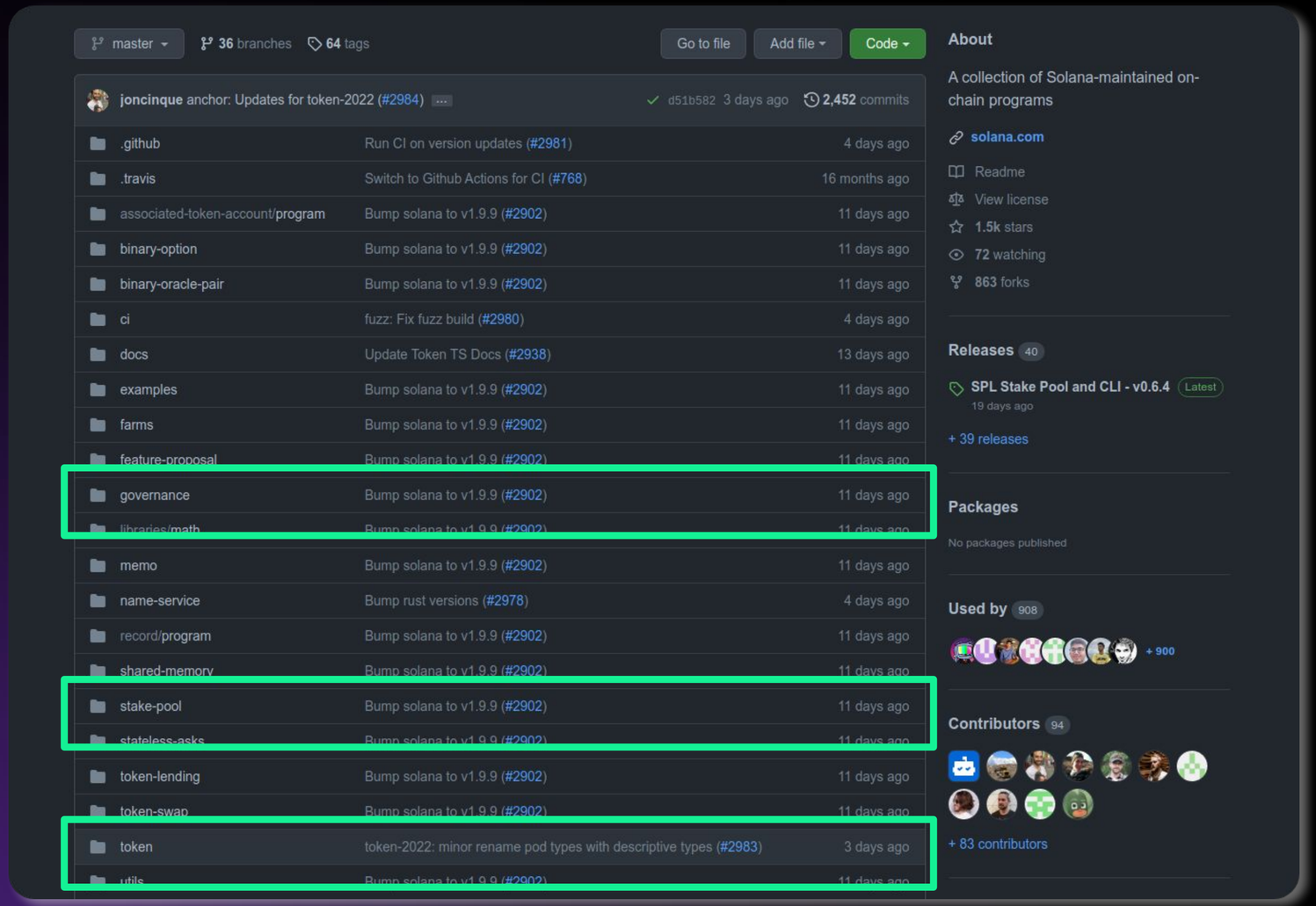
[Pubkey3] + Program ID

Solana Program Library

The advantage of the program/account model is that you can have **one generic program** that operates on **various data**.



Solana Program Library (SPL)



https://github.com/solana-labs/solana-program-library

Solana Tokens

ERC20 token = a token whose smart contract uses the ERC20 standard

- Fungible tokens use the ERC20 standard.
- Smart contract template to create a new token.
- To create a new token, you deploy ERC20 smart contract on chain.

SPL token = a token created with the Solana token program

- Every SPL token has a standard set of functionality.
- On Solana, there is a single token program (spl-token-program).
- To create a new token, you just call a `create_mint` instruction of the token program.

Solana Tokens

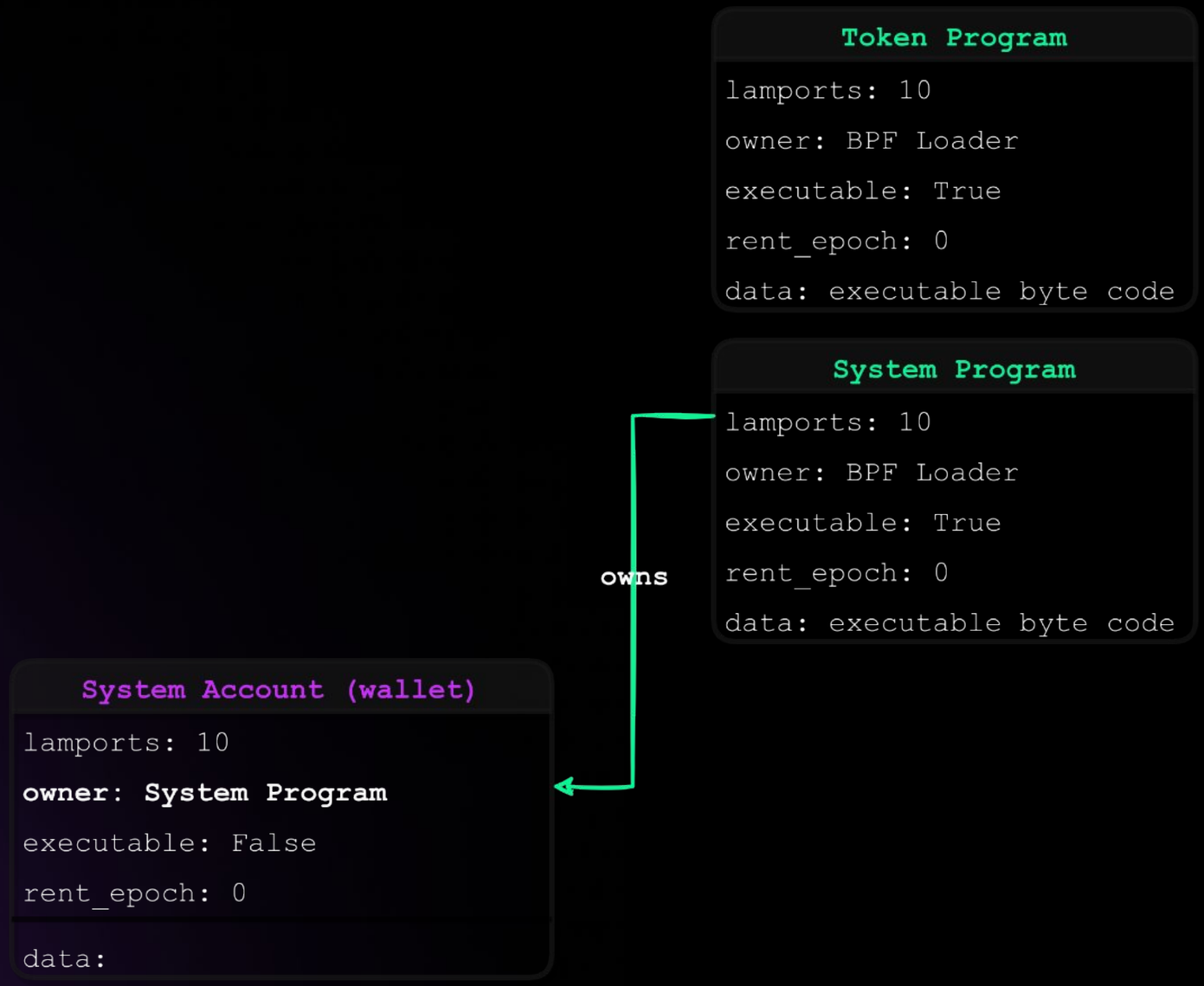
Token Program

lamports: 10
owner: BPF Loader
executable: True
rent_epoch: 0
data: executable byte code

System Program

lamports: 10
owner: BPF Loader
executable: True
rent_epoch: 0
data: executable byte code

Solana Tokens



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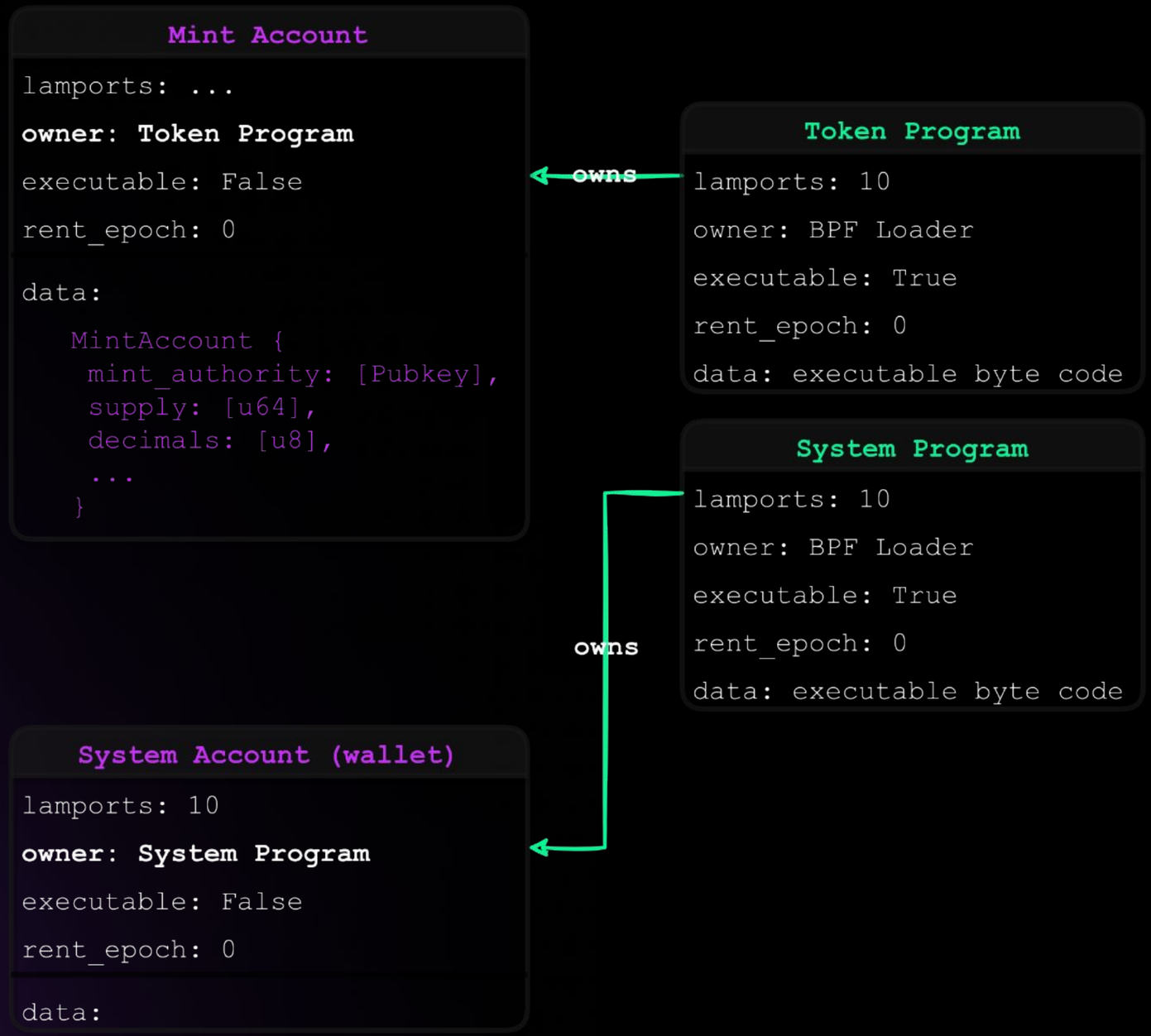
Solana Tokens



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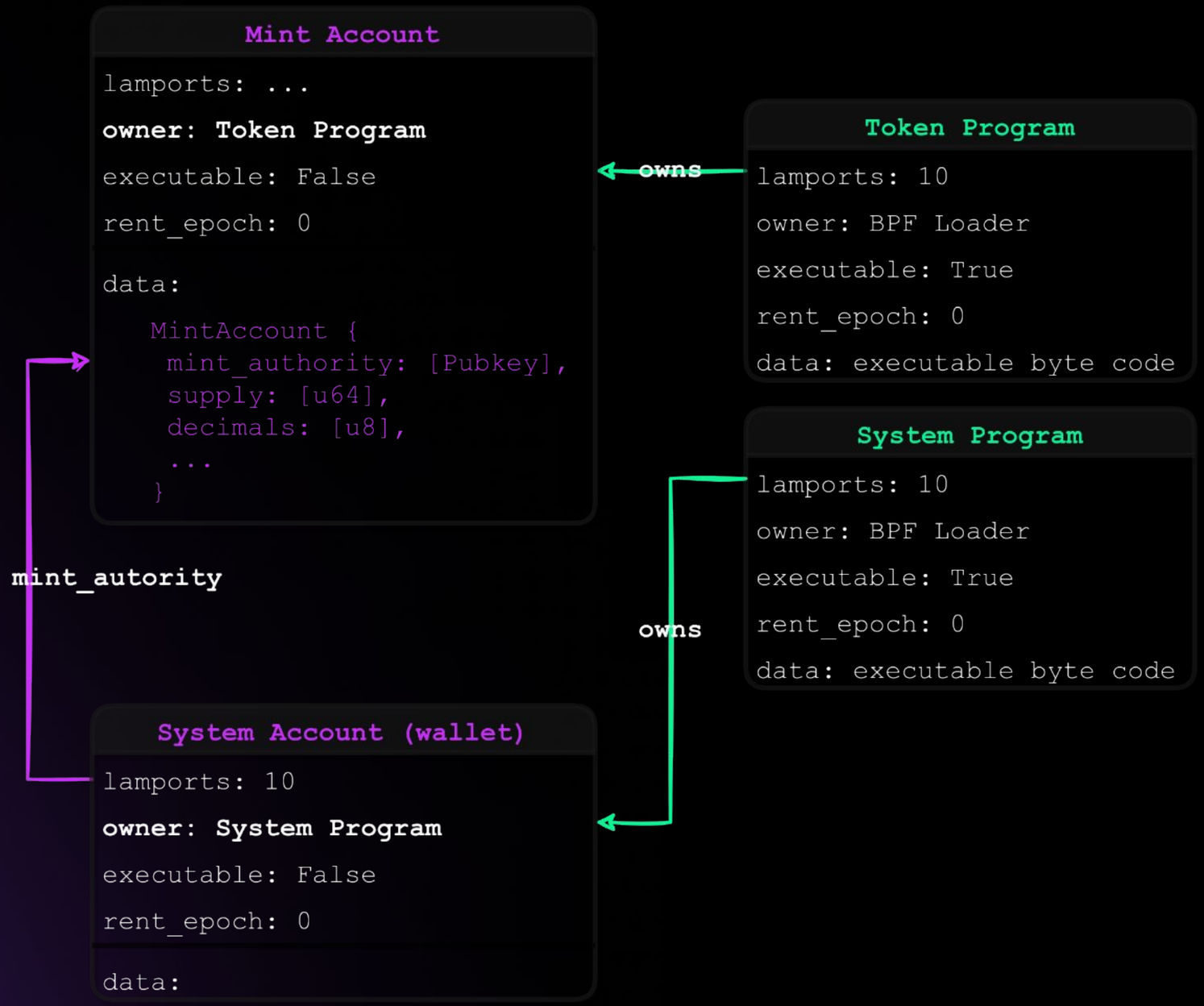
Solana Tokens



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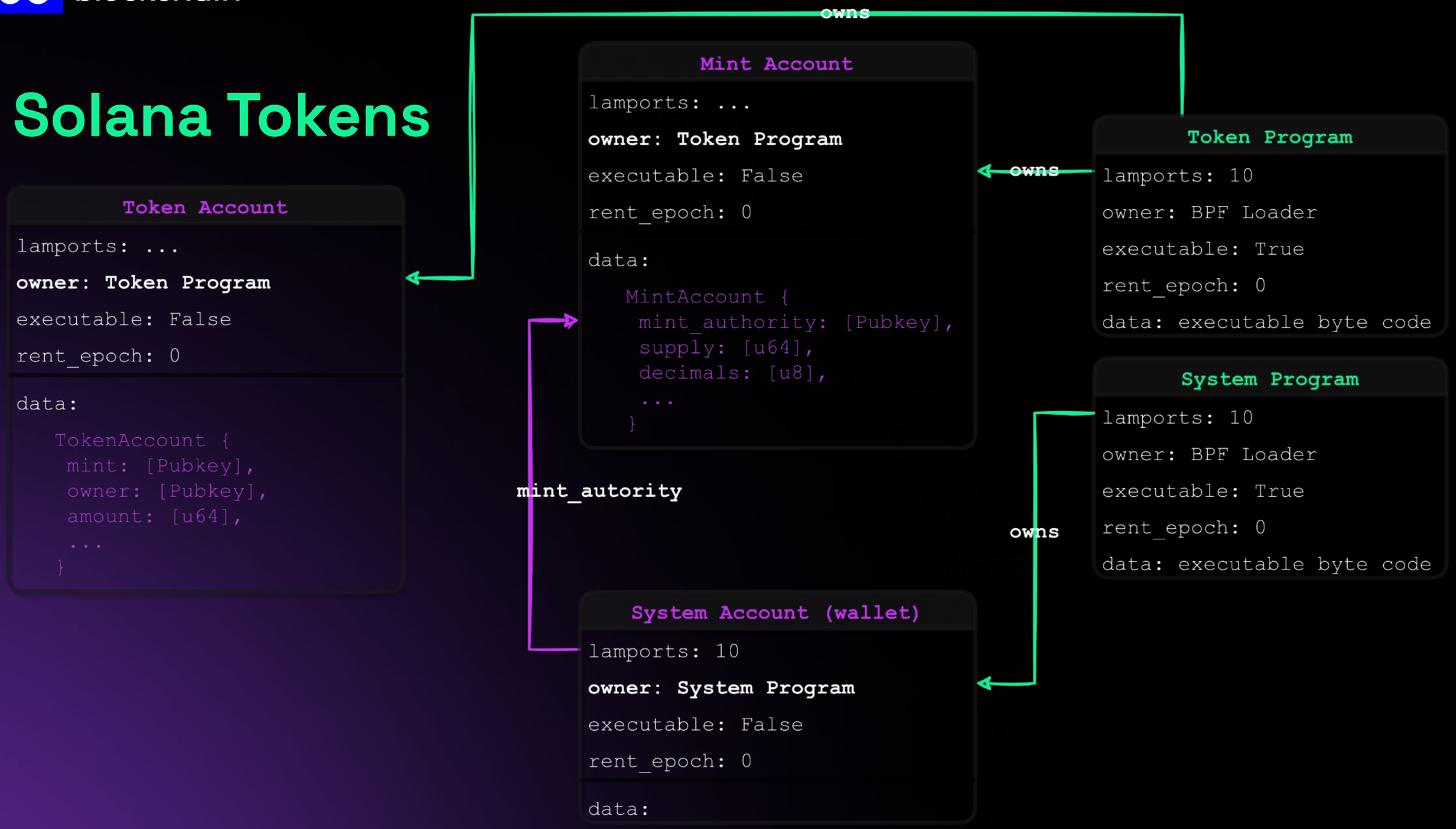
Solana Tokens



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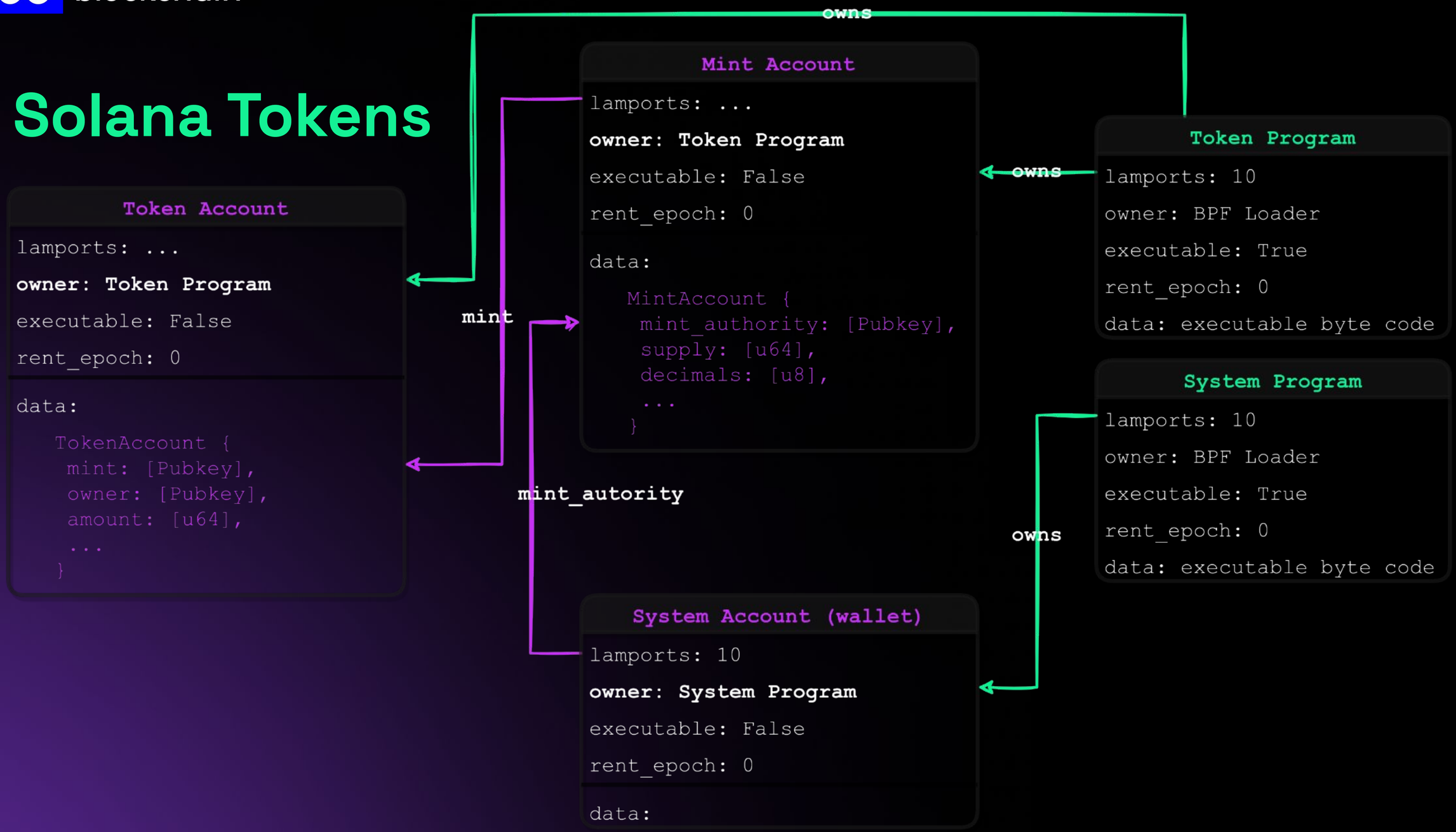
Solana Tokens



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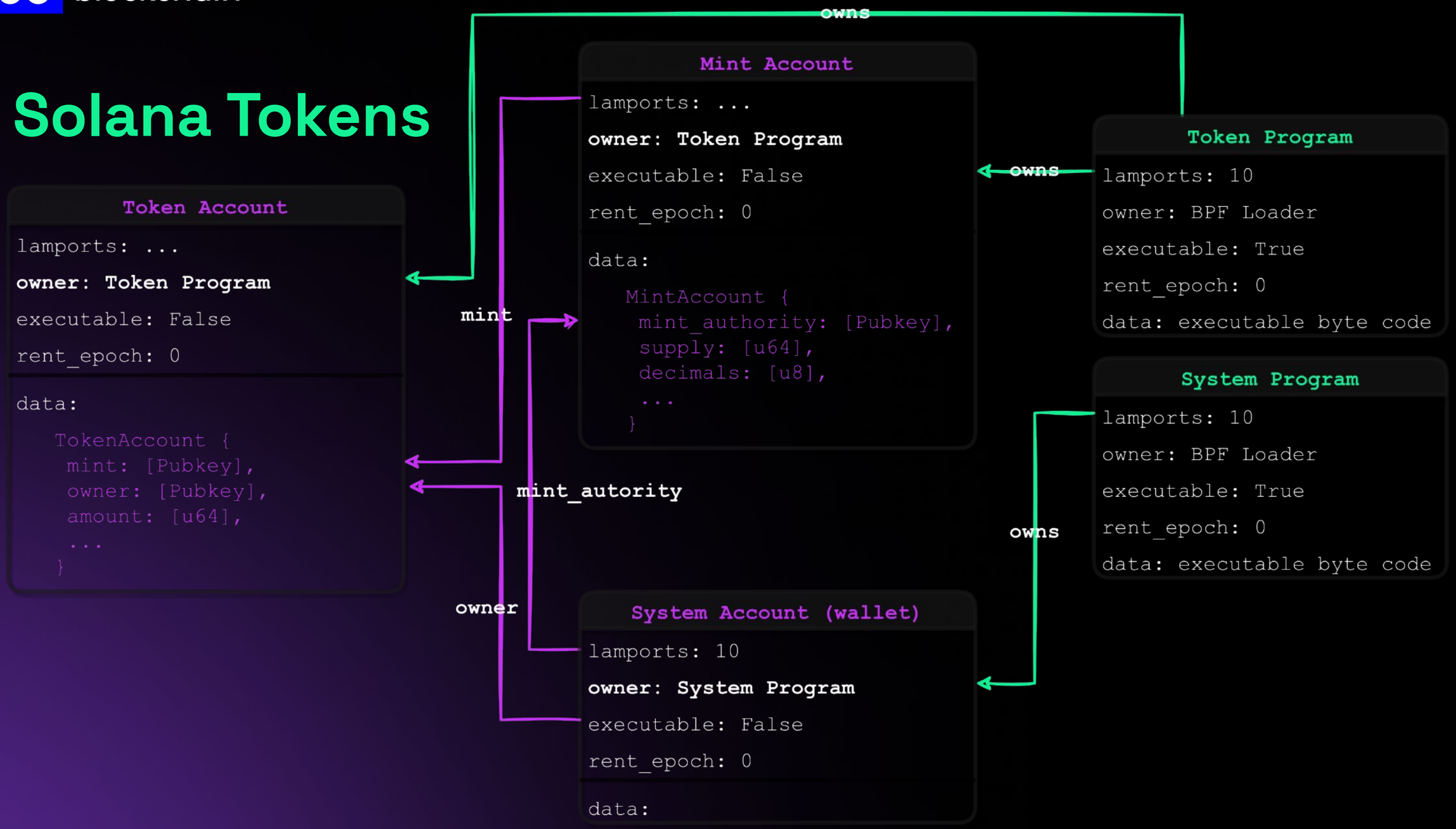
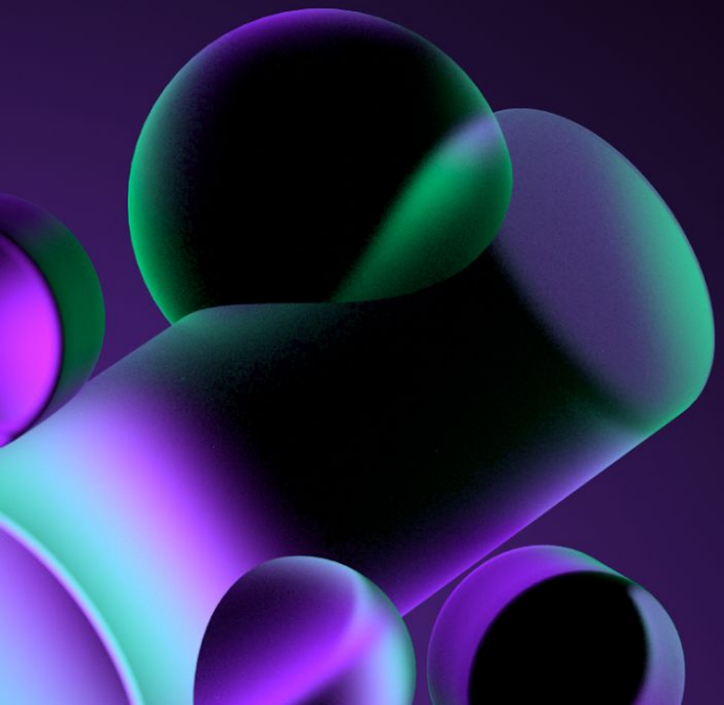
Solana Tokens



Hands on example



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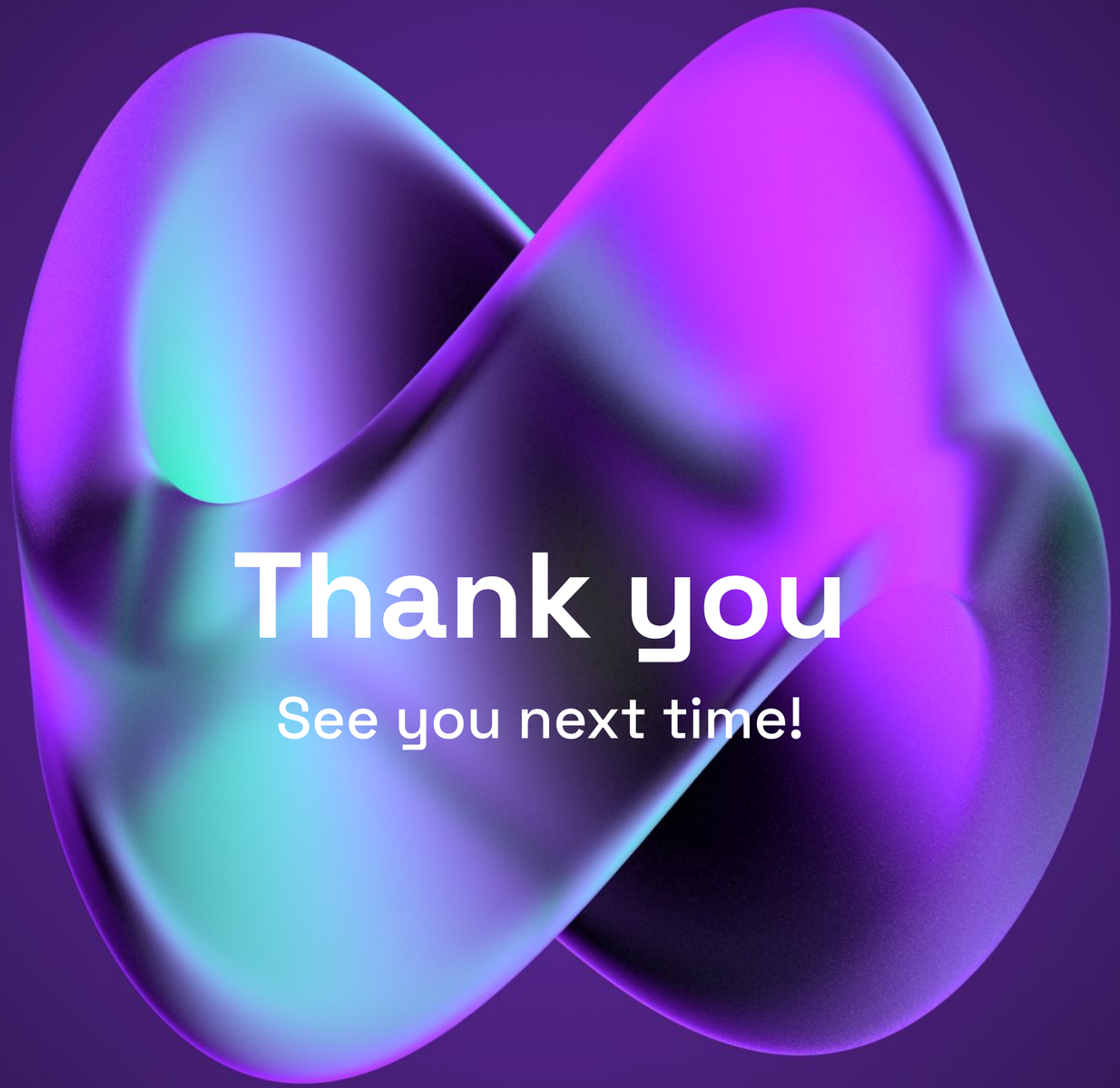

Thank you

See you next time!