61A Lecture 15

Monday, October 3

Terminology: Attributes, Functions, and Methods

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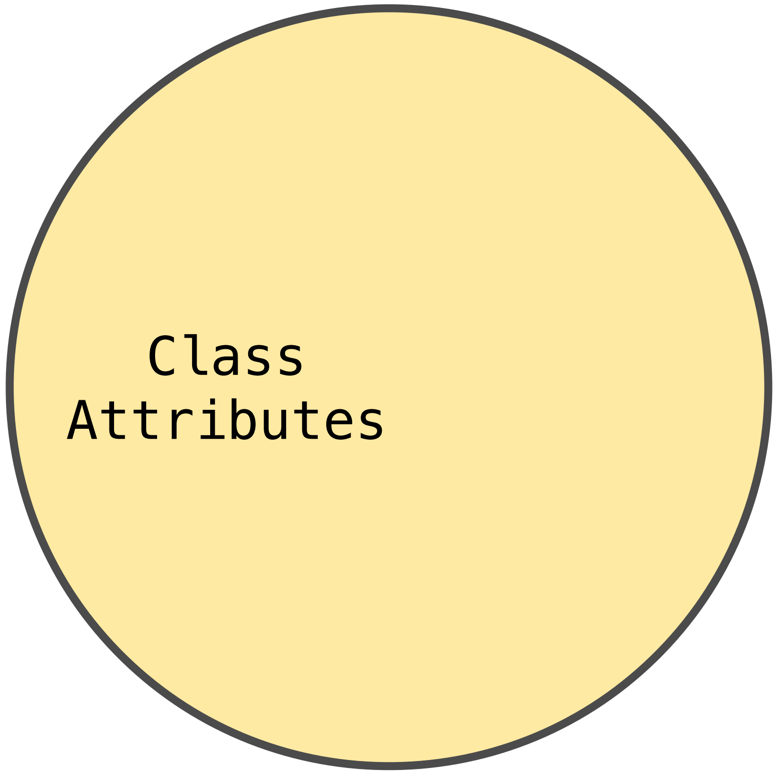

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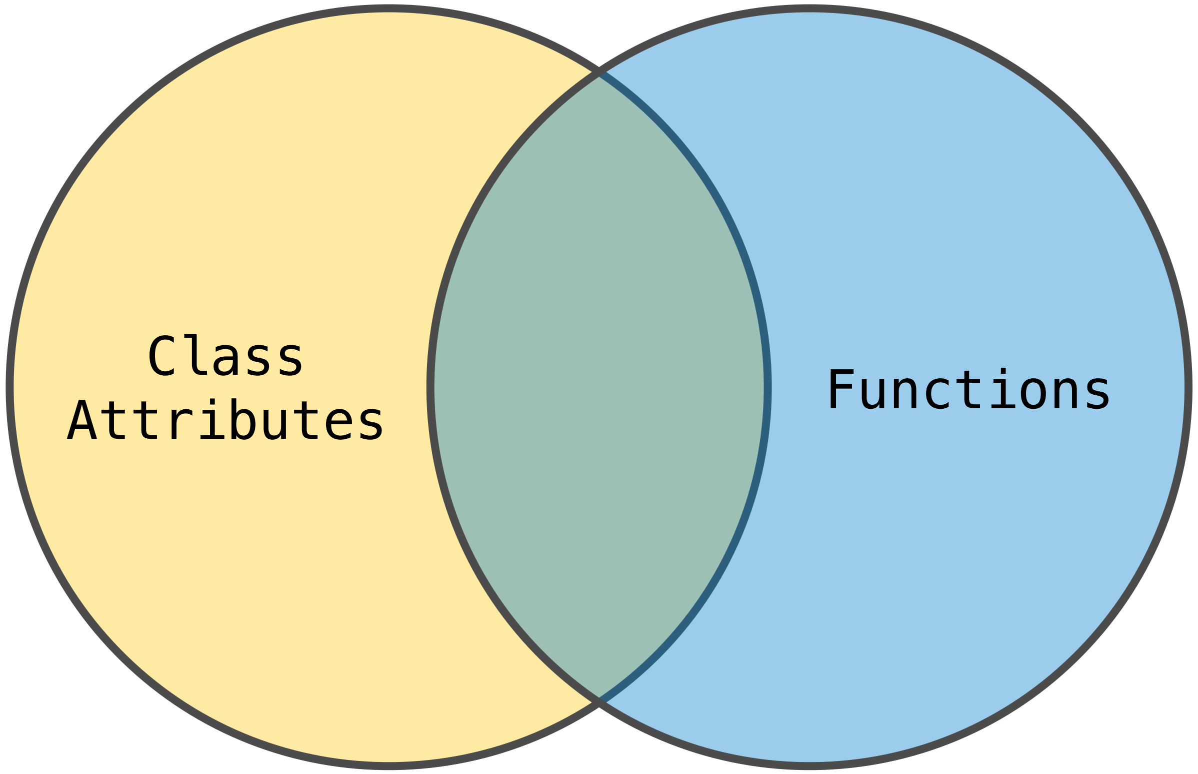

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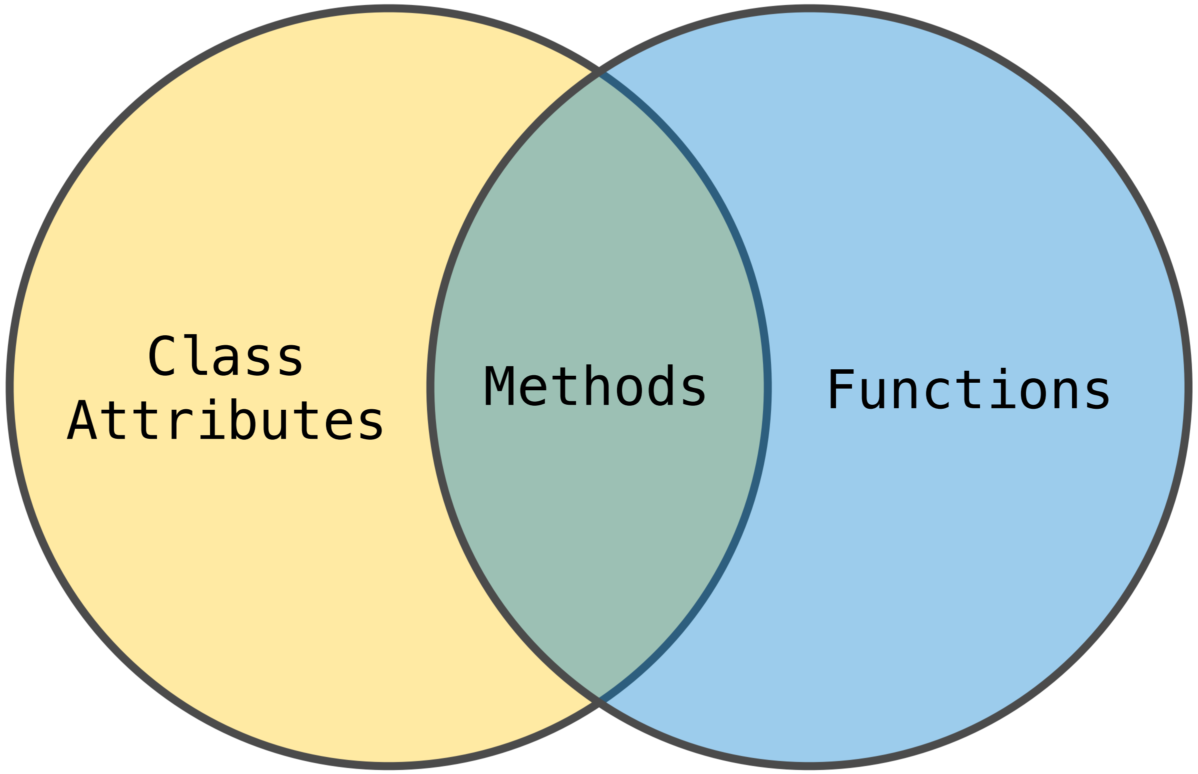

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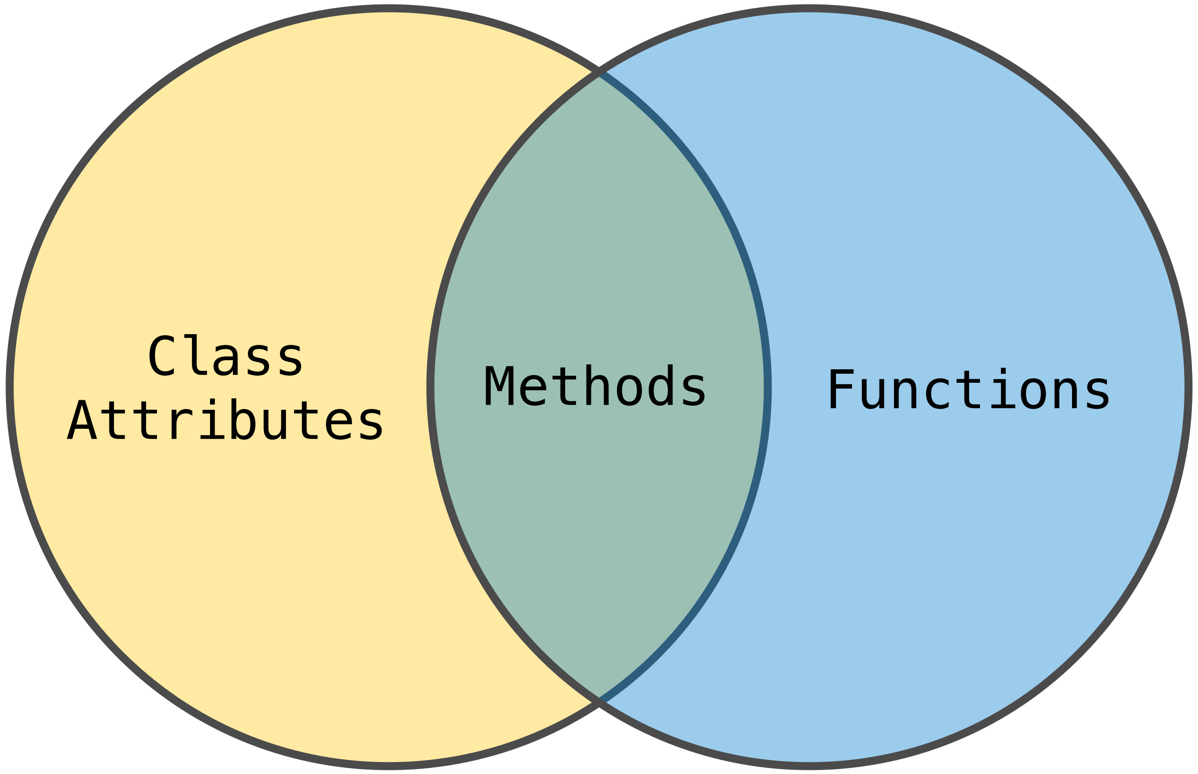

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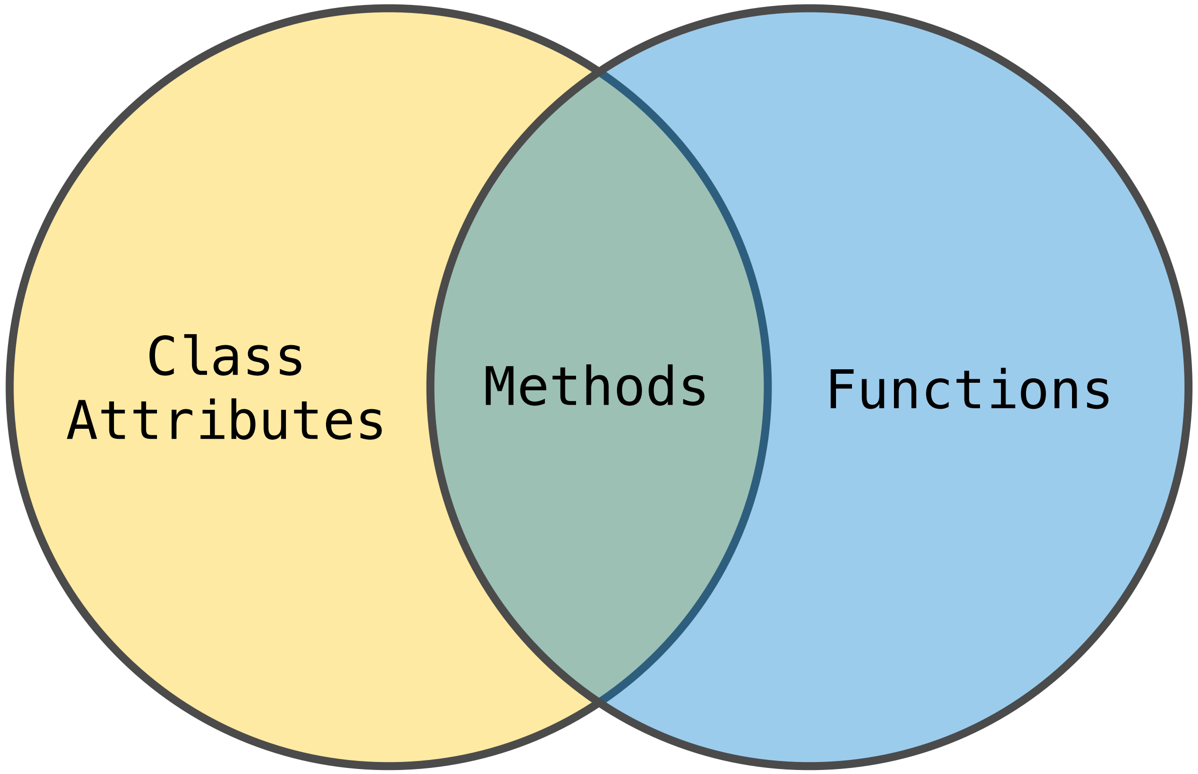

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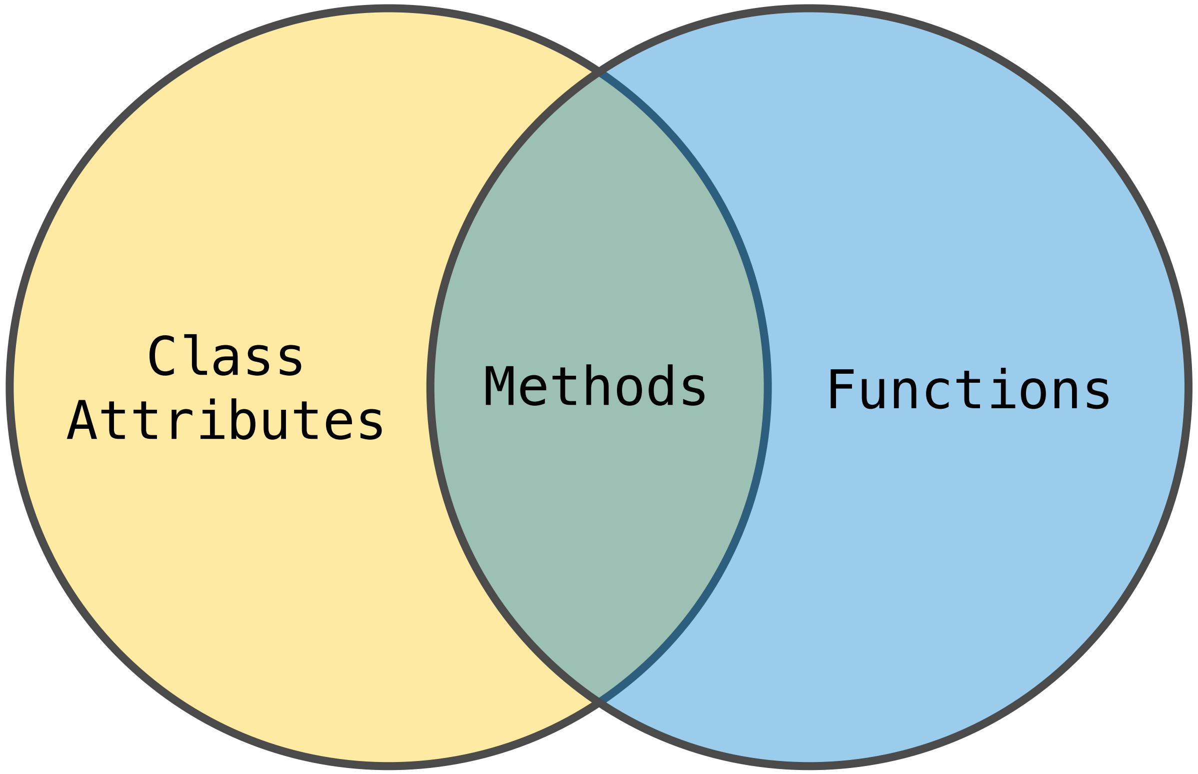

Python object system:

Functions are a type of object

Bound methods are also a type: a function that has its first parameter "self" already bound to an instance

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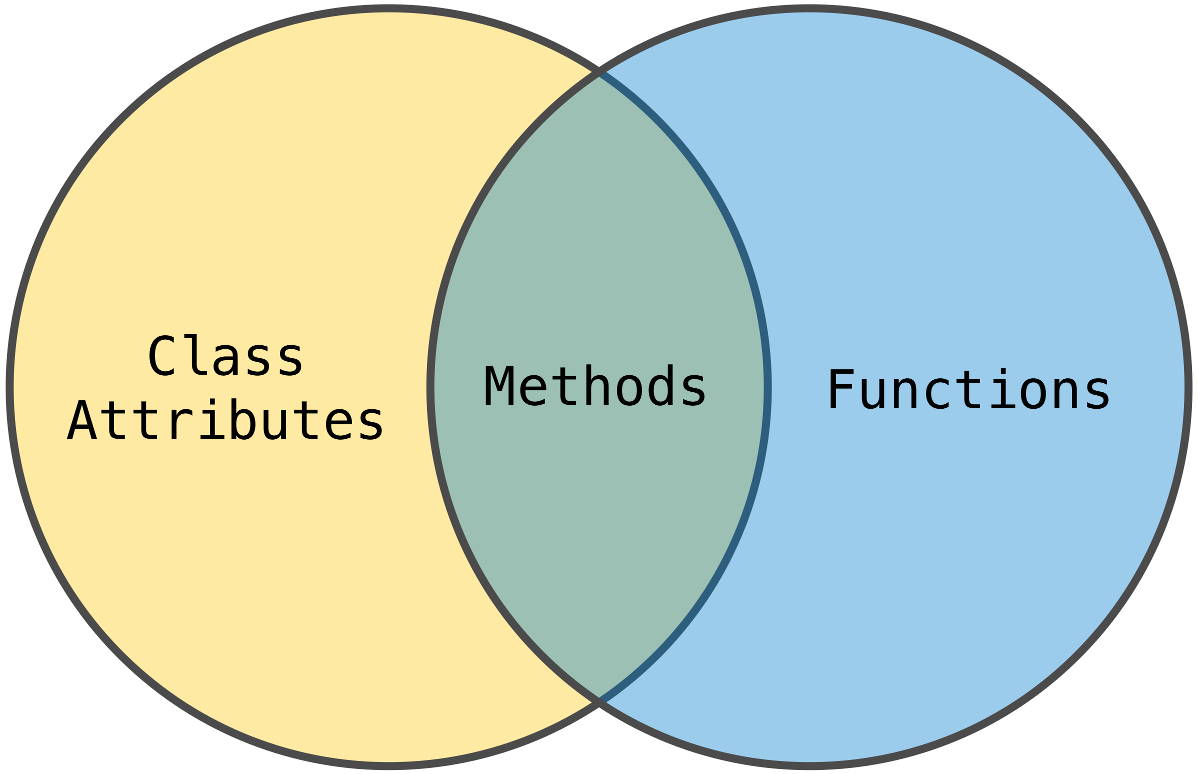

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Dot expressions create bound methods from functions

Assignment Statements and Attributes

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Assignment statements with a dot expression on their left-hand side affect attributes for the object of that dot expression

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tom_account.interest = 0.08
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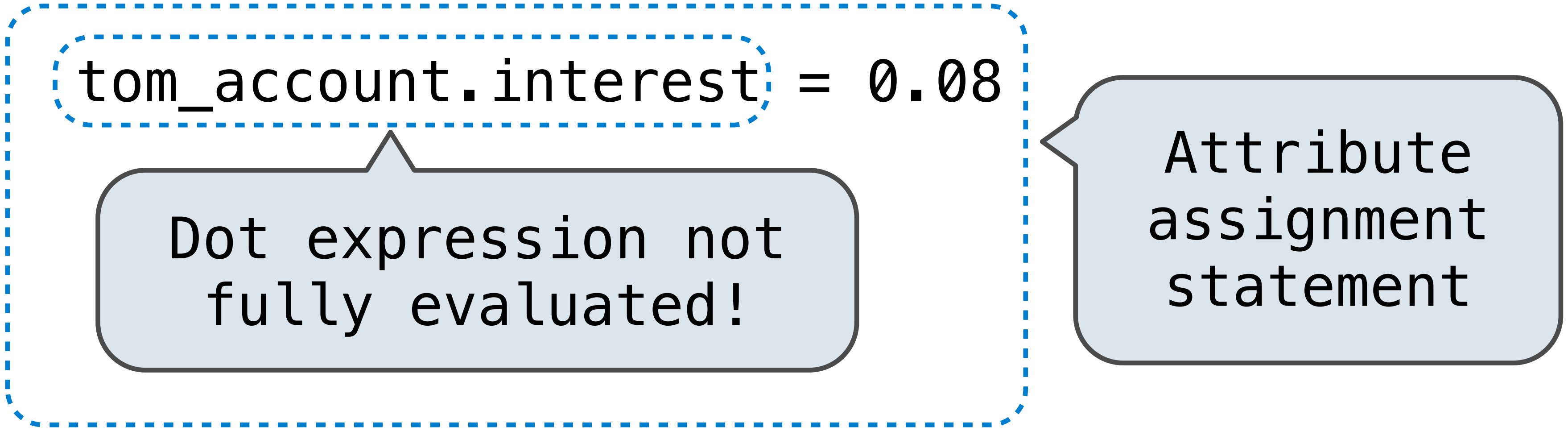

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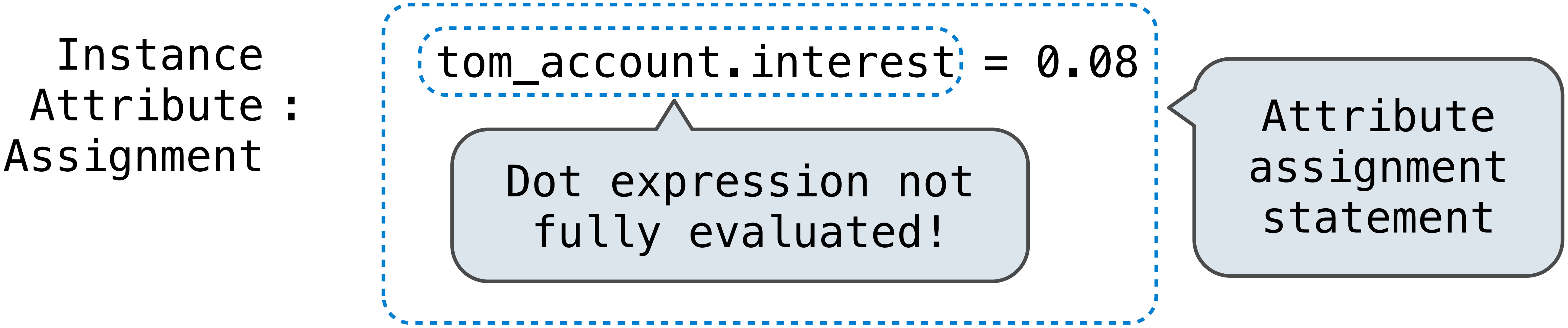

Instance Attribute : Assignment

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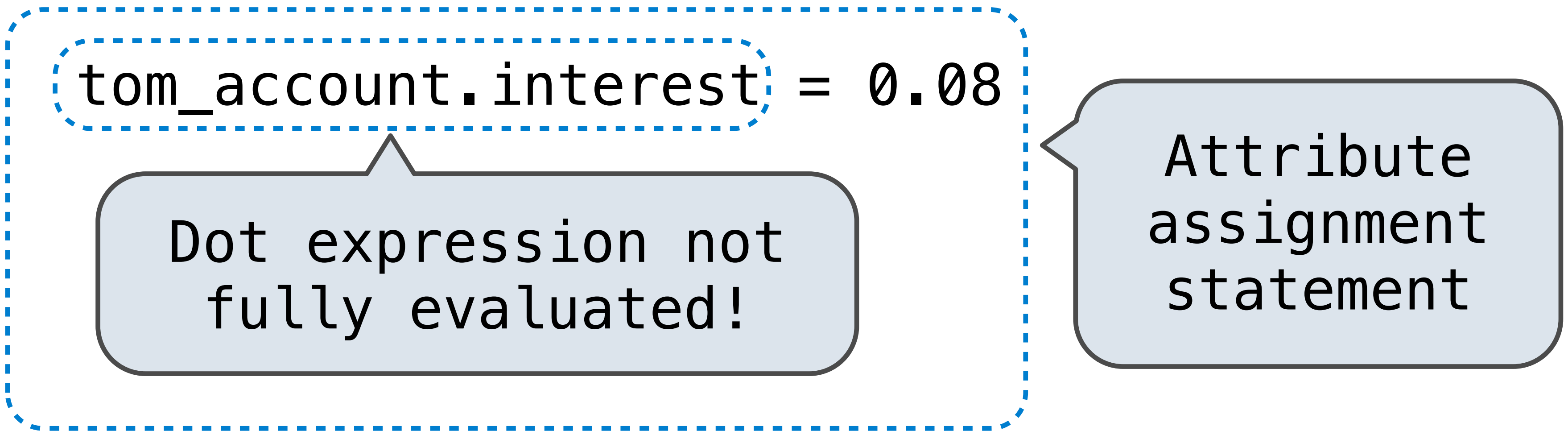
Instance Attribute Assignment :



```
tom_account.interest = 0.08
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Attribute assignment statement

Class Attribute Assignment :

```
Account.interest = 0.04
```

Attribute Assignment Statements

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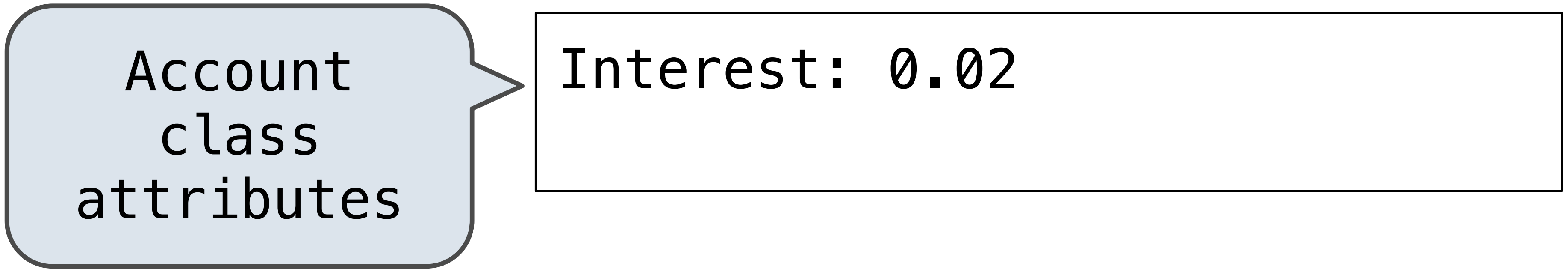
```
Interest: 0.02
```

Attribute Assignment Statements



Account class attributes

Interest: 0.02

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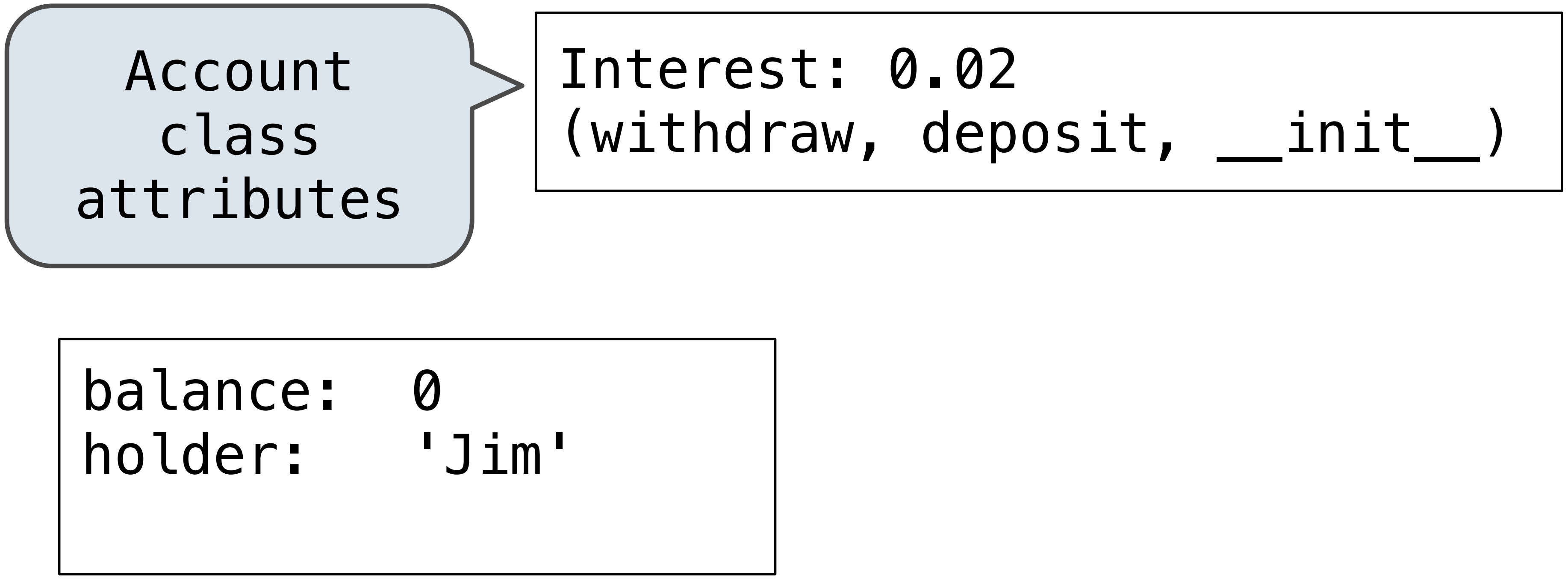

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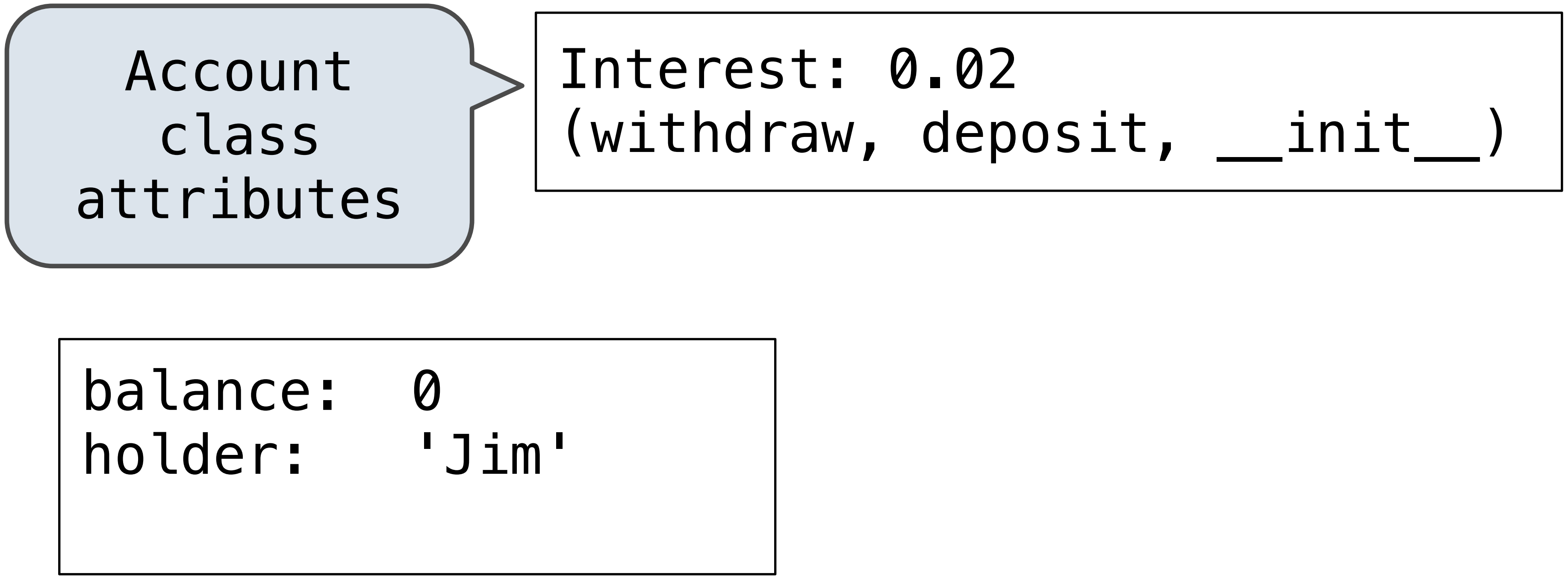

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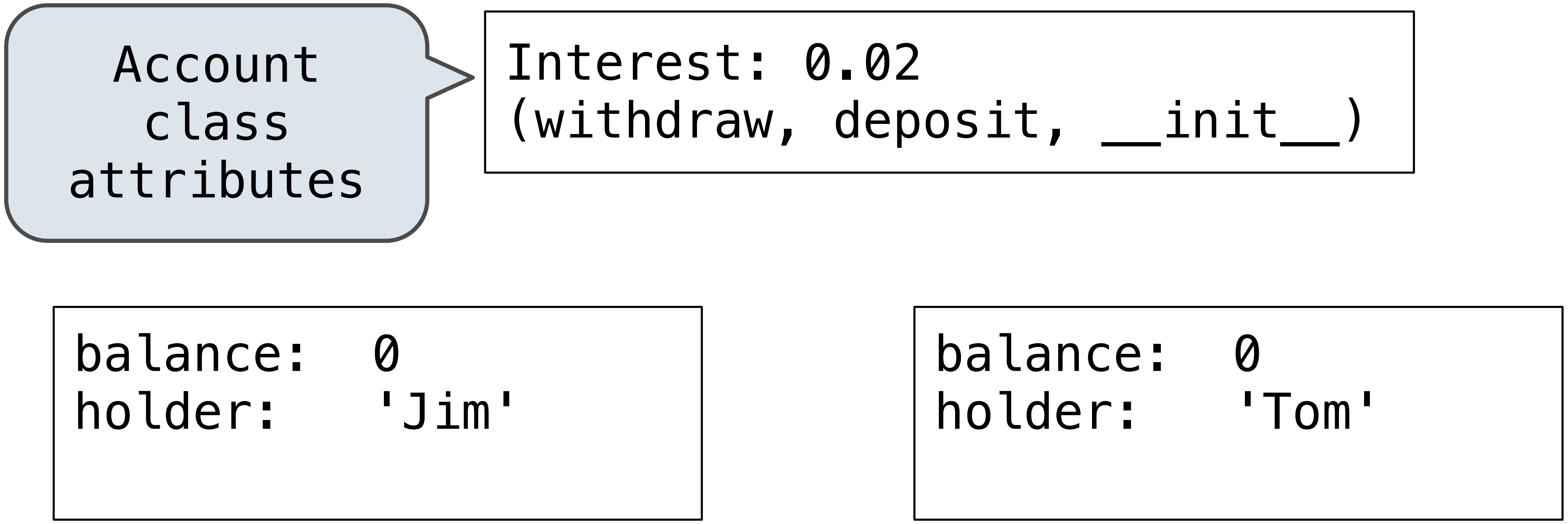

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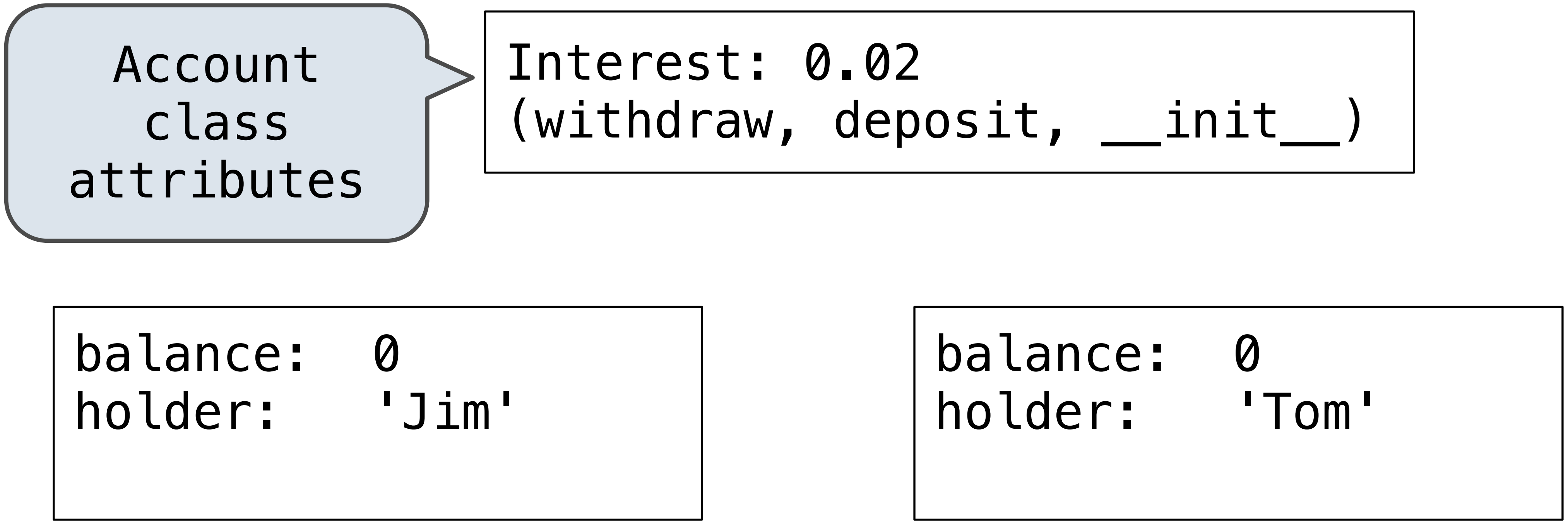

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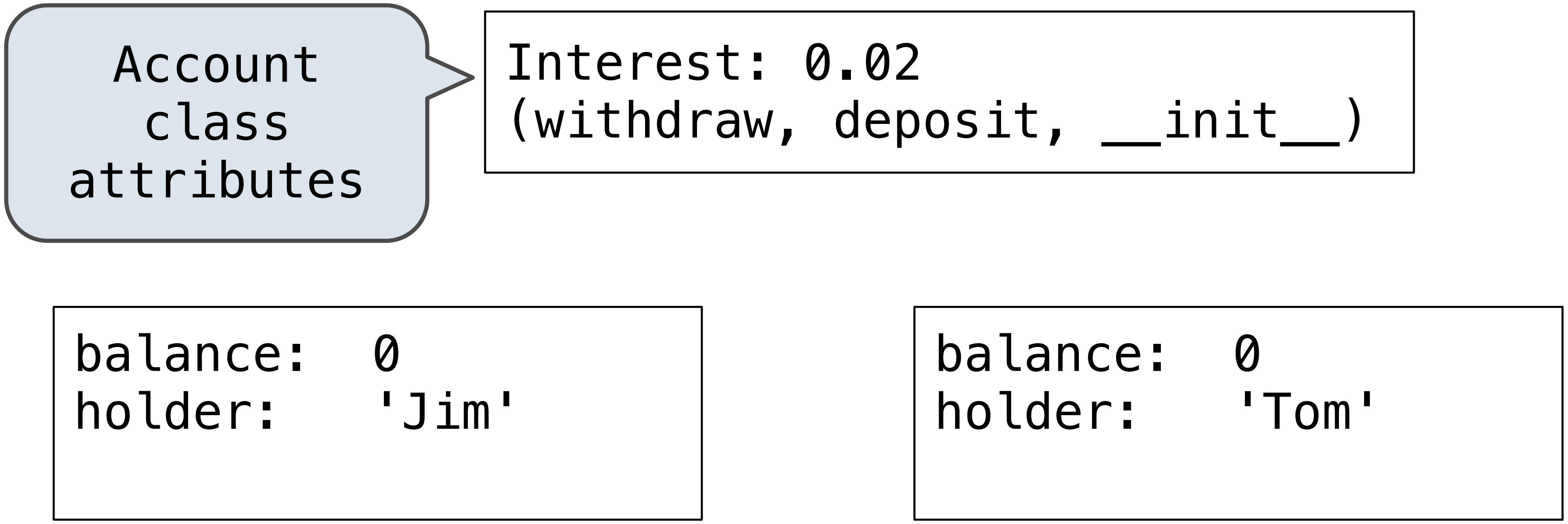

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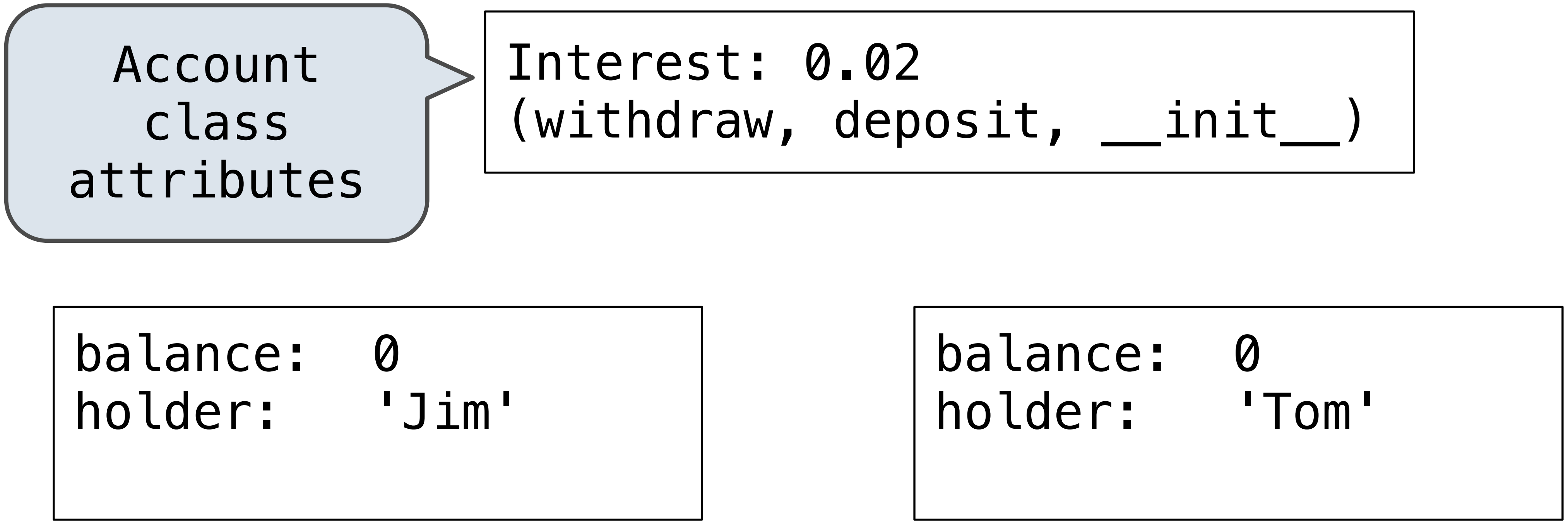

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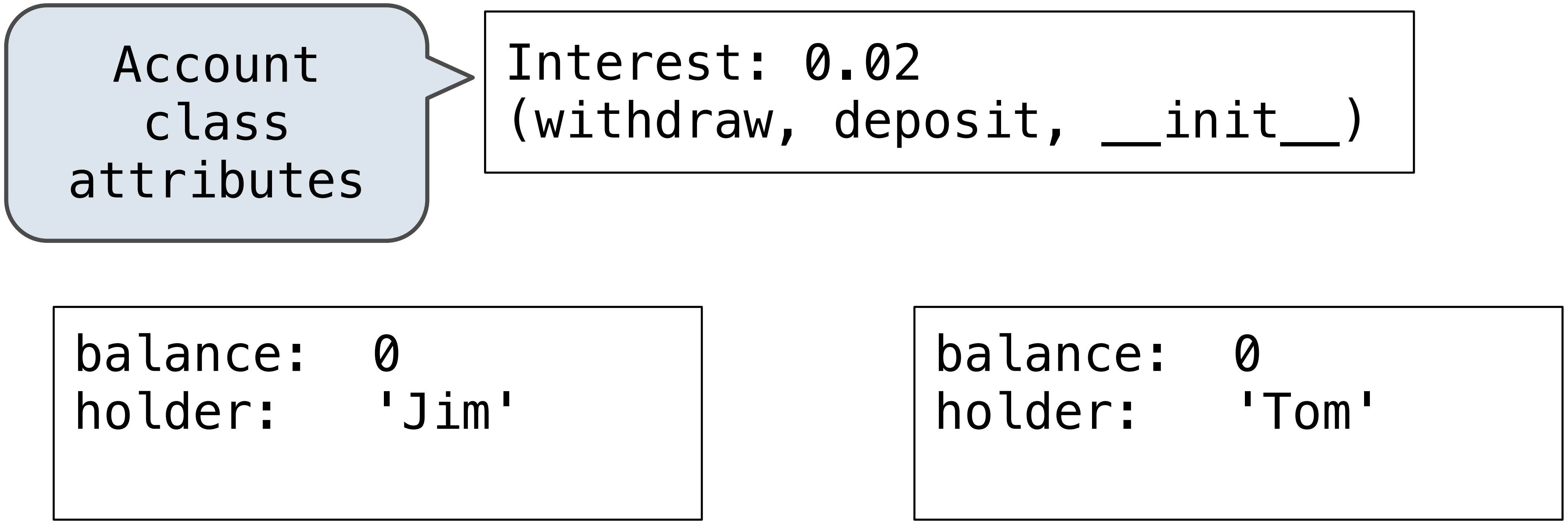

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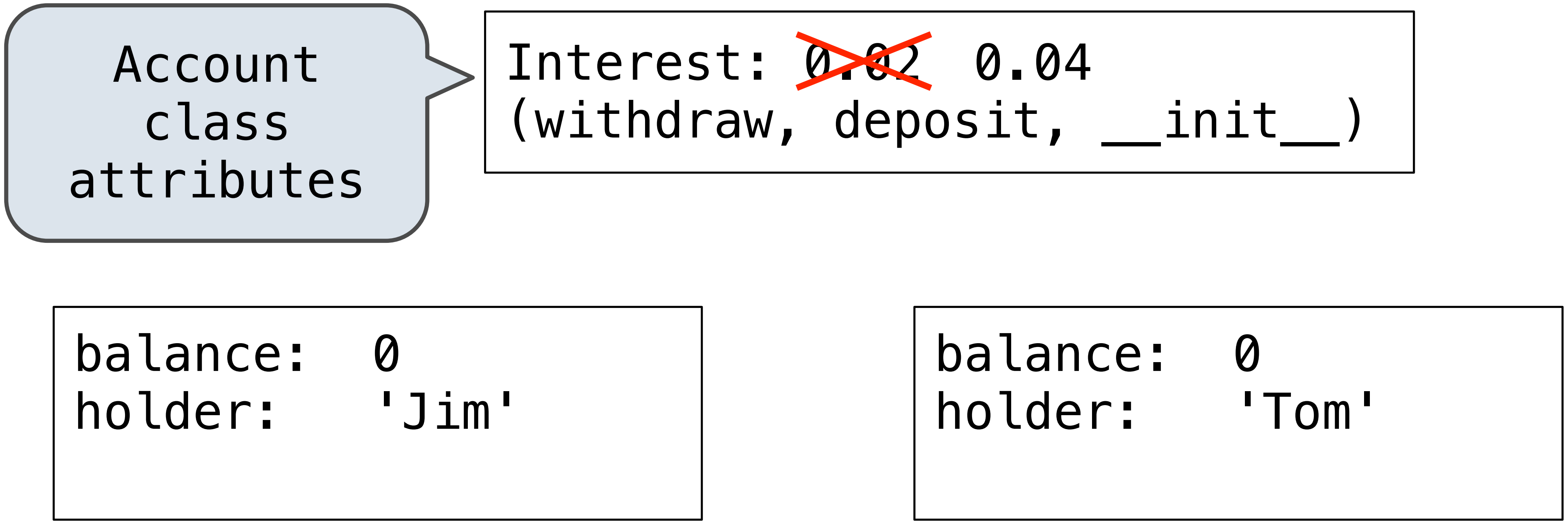

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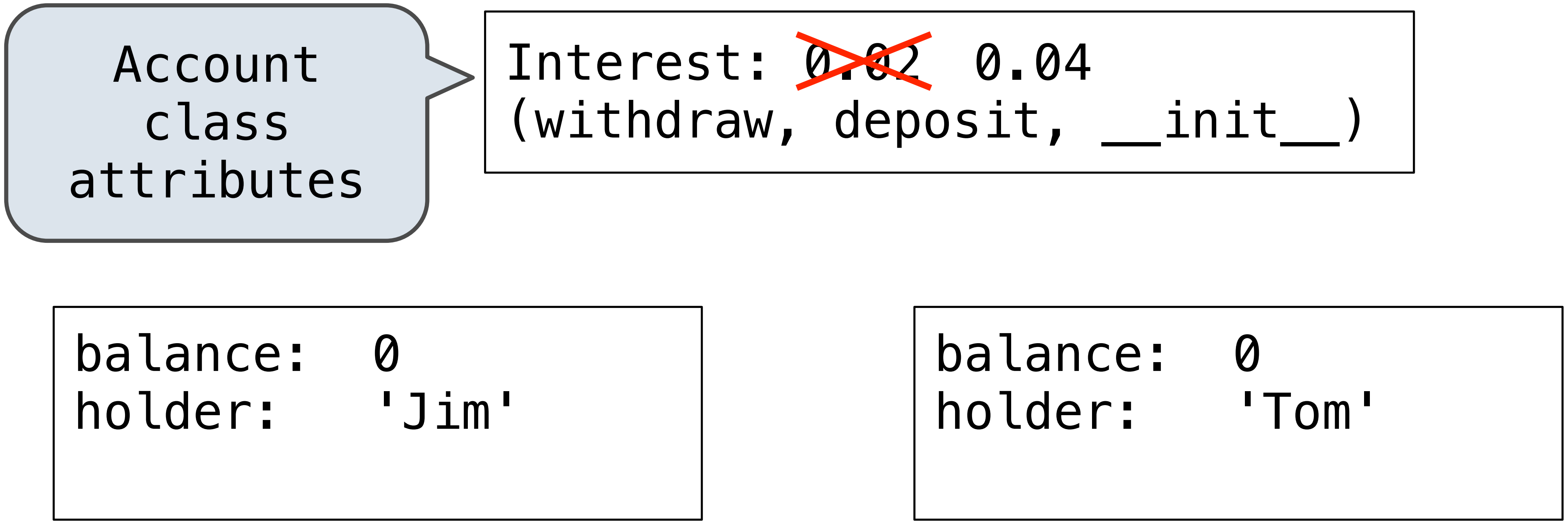

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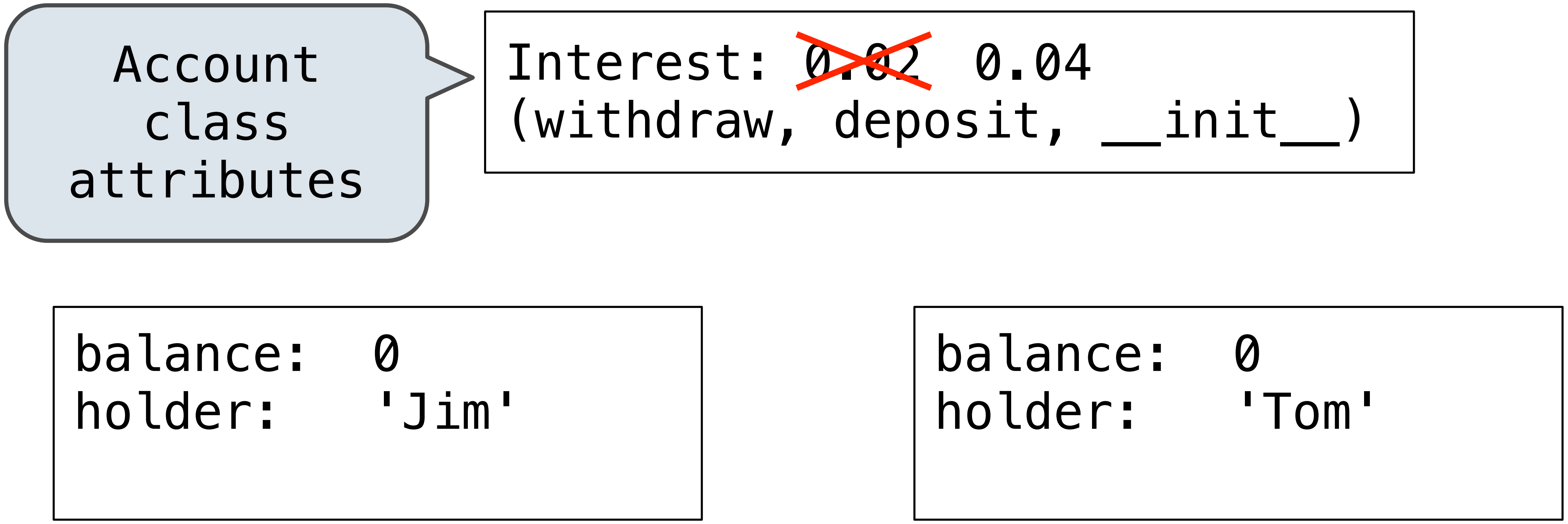

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```
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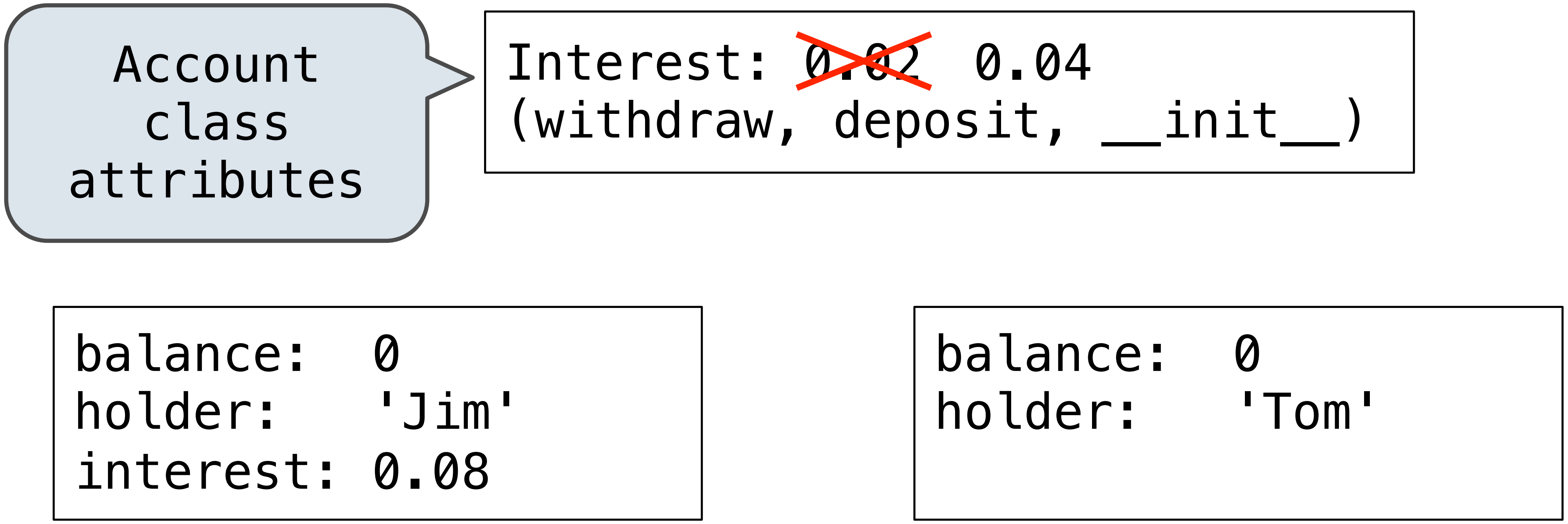

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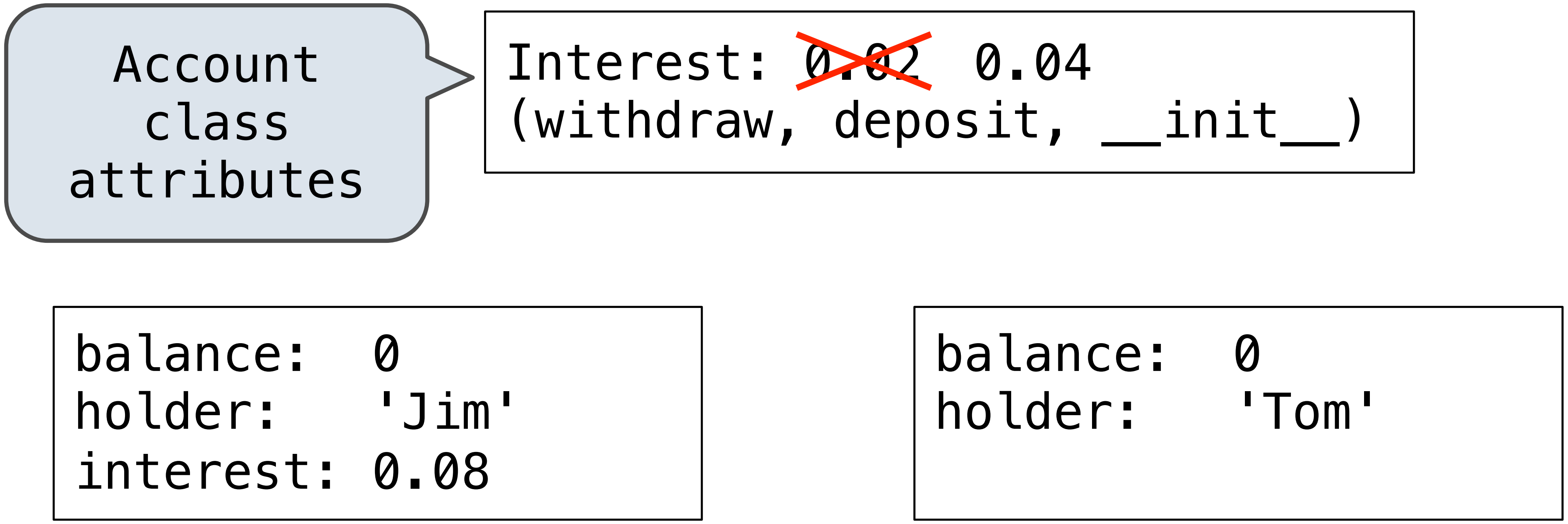

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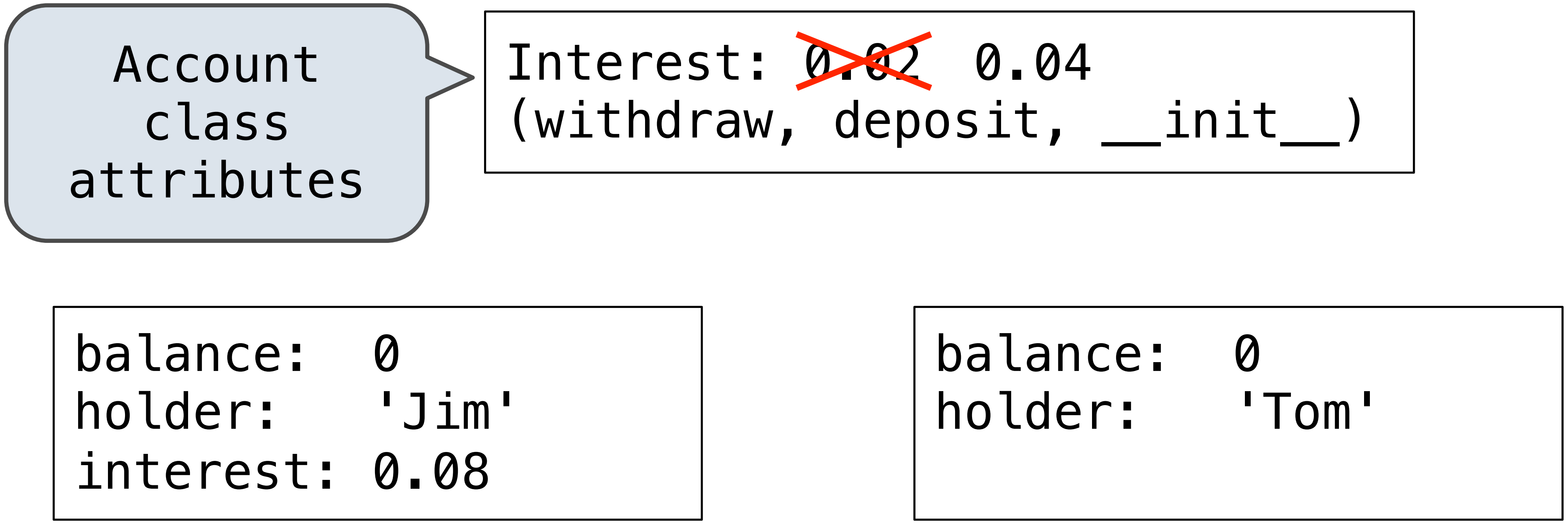

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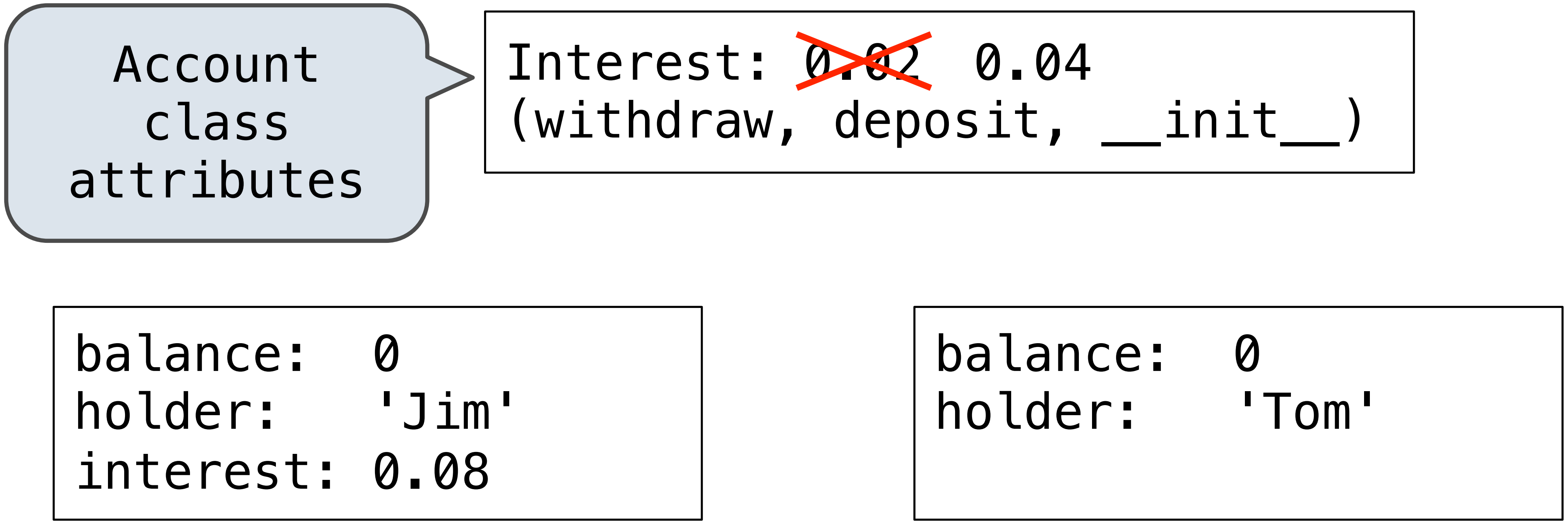

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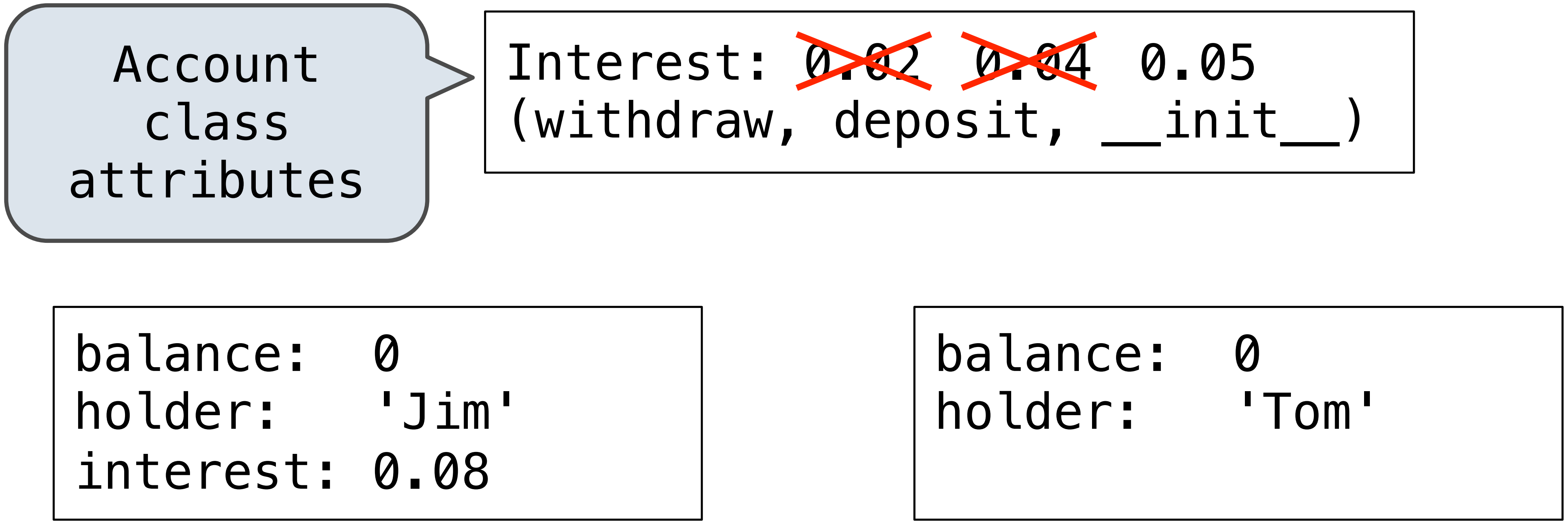

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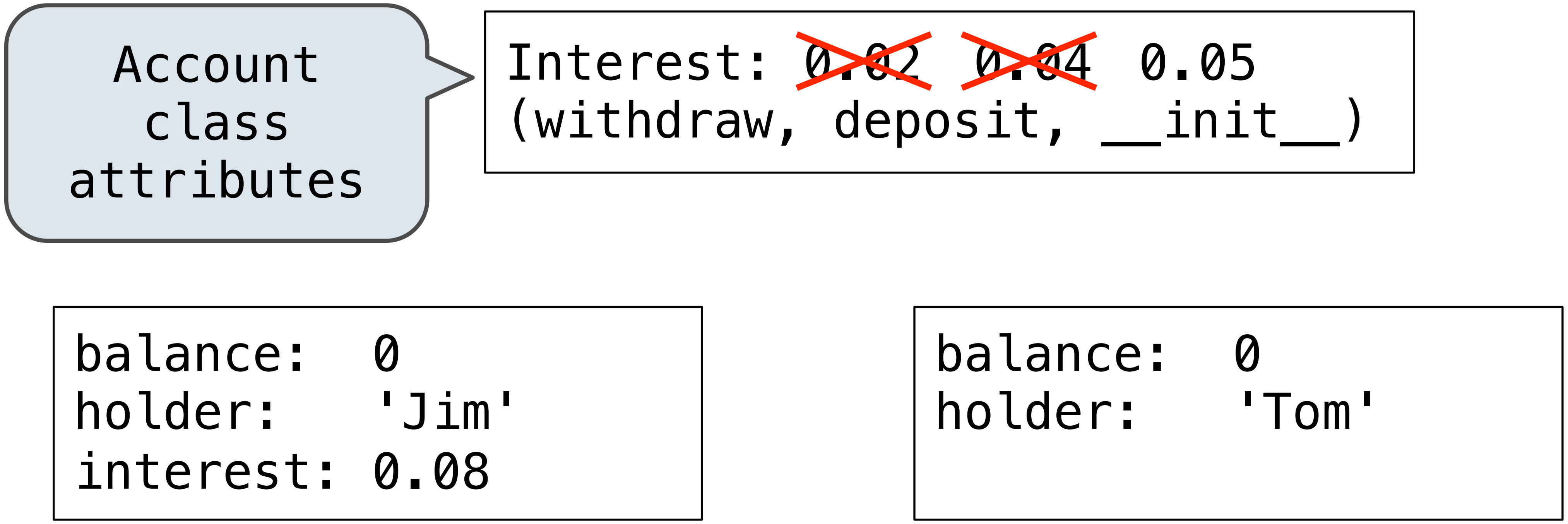

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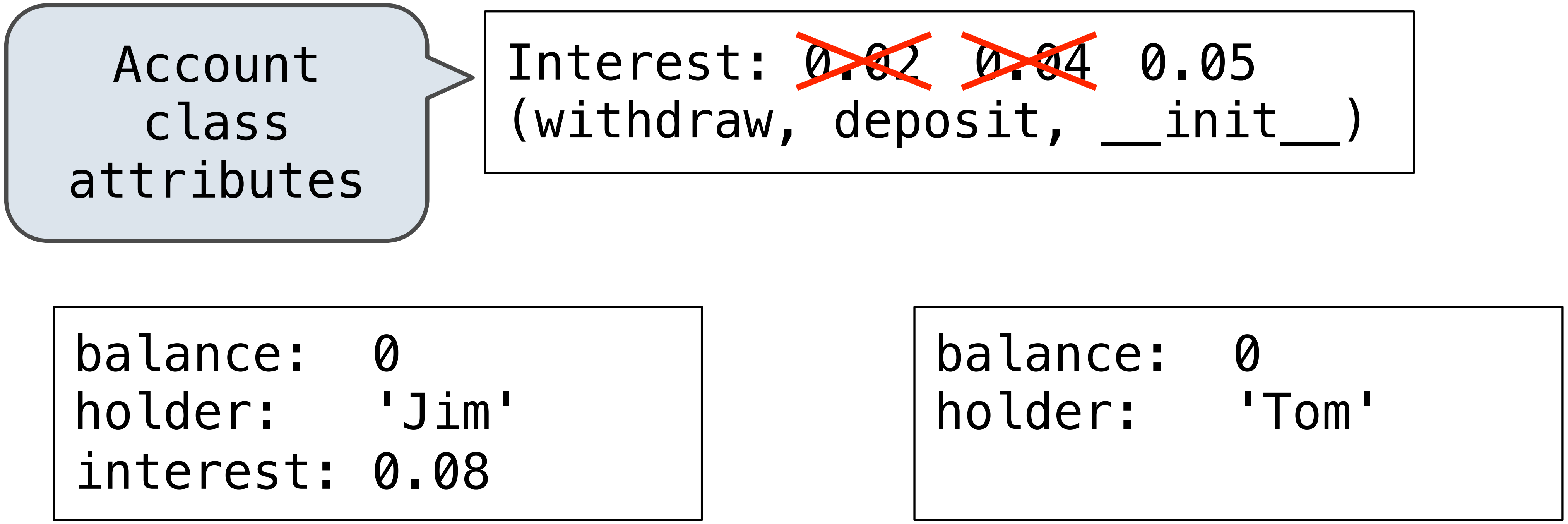
Attribute Assignment Statements



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Looking Up Attributes by Name (Abbreviated)

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<expression> . <name>
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1. Evaluate the <expression>...

Looking Up Attributes by Name (Abbreviated)

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<expression> . <name>
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```
To evaluate a dot expression:

1. Evaluate the <expression>...

2. <name> is matched against the instance attributes...
```

Looking Up Attributes by Name (Abbreviated)

```
<expression> . <name>
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To evaluate a dot expression:

1. Evaluate the <expression>...

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3. If not found, <name> is looked up in the class, which
   yields a class attribute value.
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Looking Up Attributes by Name (Abbreviated)

`<expression> . <name>`

To evaluate a dot expression:

1. Evaluate the `<expression>`...

2. `<name>` is matched against the instance attributes...

3. If not found, `<name>` is looked up in the class, which yields a class attribute value.

4. That value is returned **unless it is a function,** in which case a *bound method* is returned instead.

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Common use: Similar classes differ in amount of specialization

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class <name>(<base class>):
    <suite>
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Inheritance

A technique for relating classes together

Common use: Similar classes differ in amount of specialization

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Conceptually, the new *subclass* "shares" attributes with its base class

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```
class <name>(<base class>):
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Conceptually, the new *subclass* "shares" attributes with its base class

The subclass may *override* certain inherited attributes

Using inheritance, we implement a subclass by specifying its difference from the the base class

Inheritance Example

A CheckingAccount is a specialized type of Account

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>>> ch = CheckingAccount('Tom')
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>>> ch = CheckingAccount('Tom')
>>> ch.interest     # Lower interest rate for checking accounts
0.01
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>>> ch = CheckingAccount('Tom')
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>>> ch.deposit(20)  # Deposits are the same
20
```

Inheritance Example

A CheckingAccount is a specialized type of Account

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>>> ch = CheckingAccount('Tom')
>>> ch.interest     # Lower interest rate for checking accounts
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>>> ch.withdraw(5)  # withdrawals incur a $1 fee
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Most behavior is shared with the base class Account

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class CheckingAccount(Account):
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Most behavior is shared with the base class Account

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class CheckingAccount(Account):
    """A bank account that charges for withdrawals."""
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Most behavior is shared with the base class Account

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    def withdraw(self, amount):
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class CheckingAccount(Account):
    """A bank account that charges for withdrawals."""
    withdraw_fee = 1
    interest = 0.01
    def withdraw(self, amount):
        return Account.withdraw(self, amount + self.withdraw_fee)
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Looking Up Attribute Names on Classes

Base class attributes *aren't copied* into subclasses!

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Designing for Inheritance

```
class CheckingAccount(Account):
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Designing for Inheritance

Don't repeat yourself; use existing implementations

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Attributes that have been overridden are still accessible via class objects

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Attribute look-up on base class

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Attribute look-up on base class

Preferable to CheckingAccount.withdraw_fee

Base Class Generality

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Base classes may contain logic that is meant for subclasses

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Example: Same CheckingAccount behavior; different approach

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Demo

Inheritance and Composition

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∴ A bank has a list of Account instances as an attribute

No local state at all? Just write a function!

Multiple Inheritance

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```python
class SavingsAccount(Account):
    deposit_fee = 2
    def deposit(self, amount):
        return Account.deposit(self, amount - self.deposit_fee)
```

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A class may inherit from multiple base classes in Python

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Bank of America marketing executive wants:

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- Low interest rate of 1%
- A $1 fee for withdrawals

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- A $2 fee for deposits
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Bank of America marketing executive wants:

- Low interest rate of 1%
- A $1 fee for withdrawals
- A $2 fee for deposits
- A free dollar when you open your account

```
class AsSeenOnTVAccount(CheckingAccount, SavingsAccount):
    def __init__(self, account_holder):
        self.holder = account_holder
        self.balance = 1           # A free dollar!
```

Multiple Inheritance

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>>> such_a_deal = AsSeenOnTVAccount("John")
>>> such_a_deal.balance
1
```

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Instance attribute

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>>> such_a_deal.balance
1
```

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Instance attribute

```
>>> such_a_deal = AsSeenOnTVAccount("John")
>>> such_a_deal.balance
1
>>> such_a_deal.deposit(20)
19
```

Multiple Inheritance

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class AsSeenOnTVAccount(CheckingAccount, SavingsAccount):
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Instance attribute

SavingsAccount method

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```
>>> such_a_deal = AsSeenOnTVAccount("John")
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>>> such_a_deal.deposit(20)
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Instance attribute

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CheckingAccount method

Resolving Ambiguous Class Attribute Names

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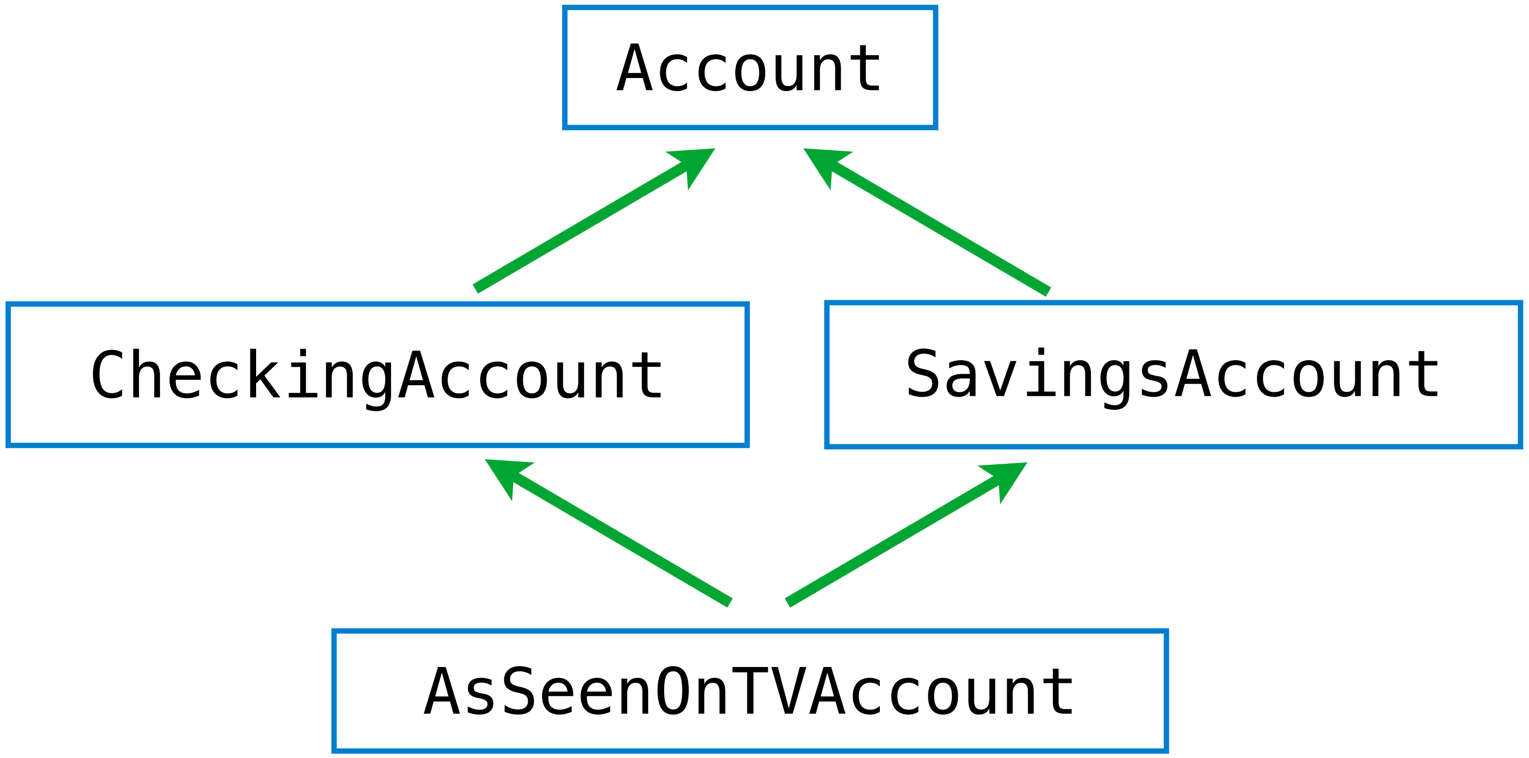
Resolving Ambiguous Class Attribute Names



```
>>> such_a_deal = AsSeenOnTVAccount("John")
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1
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Instance attribute

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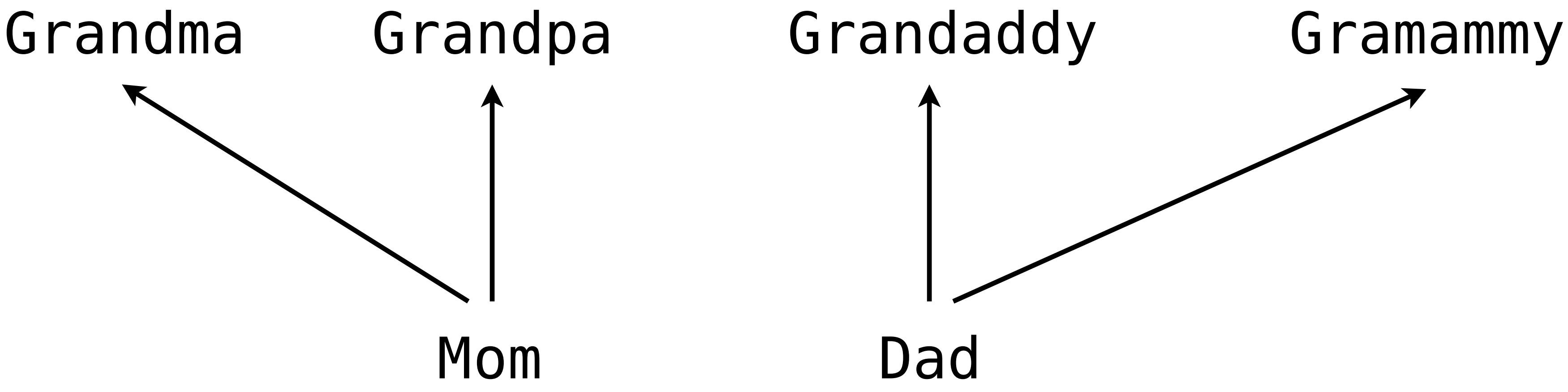
Human Relationships

Human Relationships

```
Grandma    Grandpa     Grandaddy     Gramammy
```

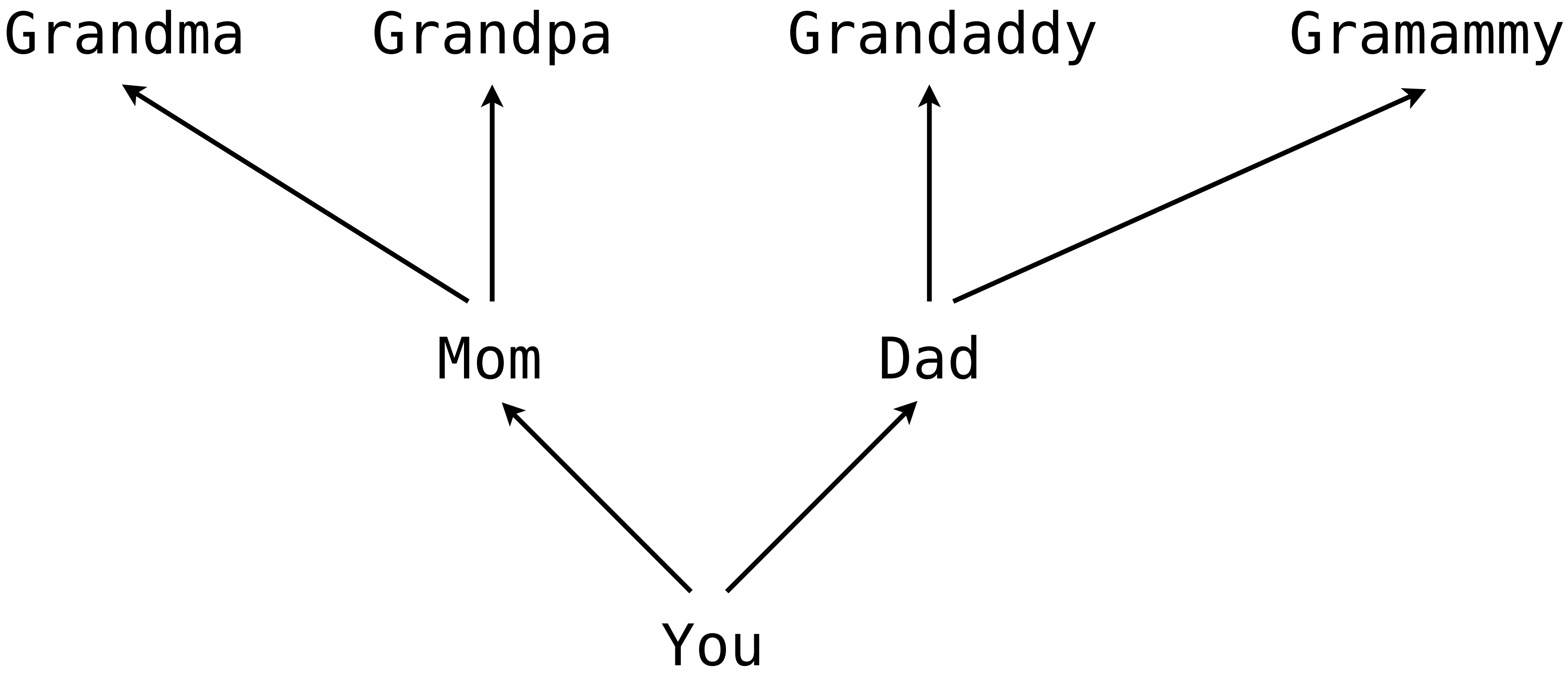
Human Relationships



Grandma Grandpa Grandaddy Gramammy

Mom Dad

Human Relationships



Grandma

Grandpa

Grandaddy

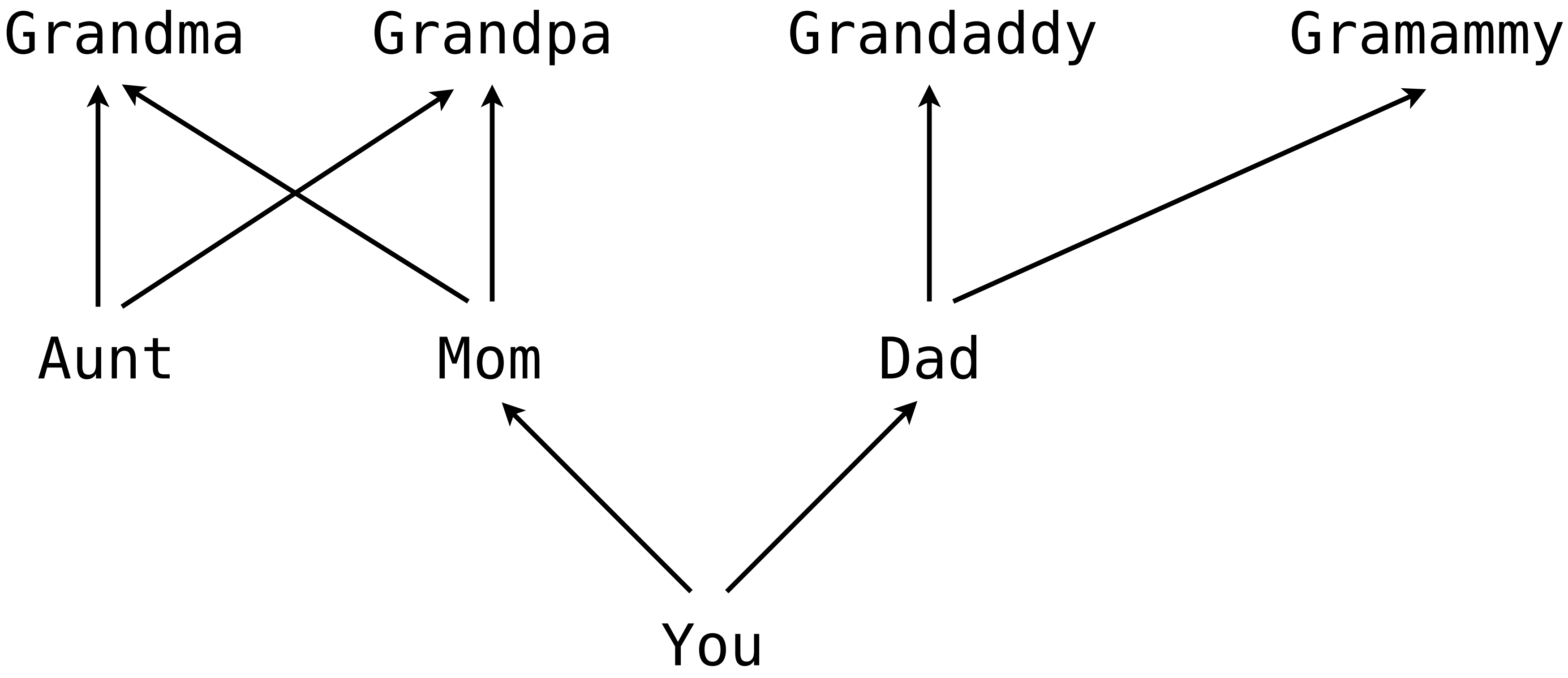
Gramammy

Mom

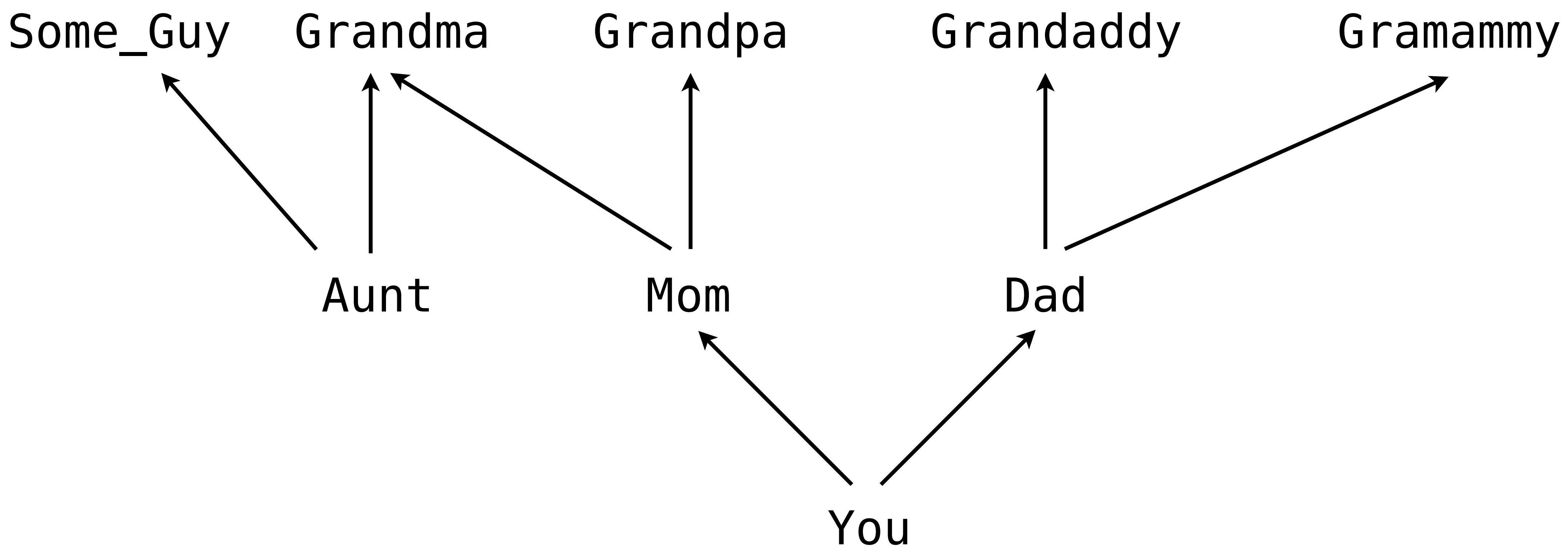
Dad

You

Human Relationships



Human Relationships



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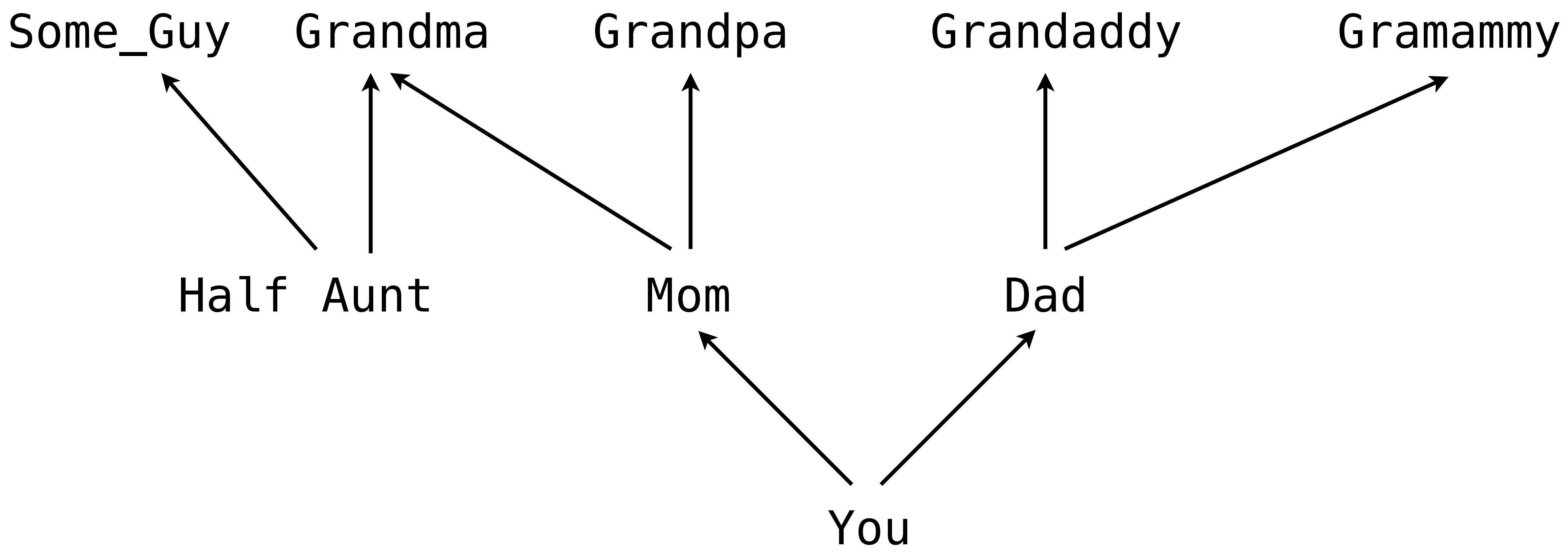

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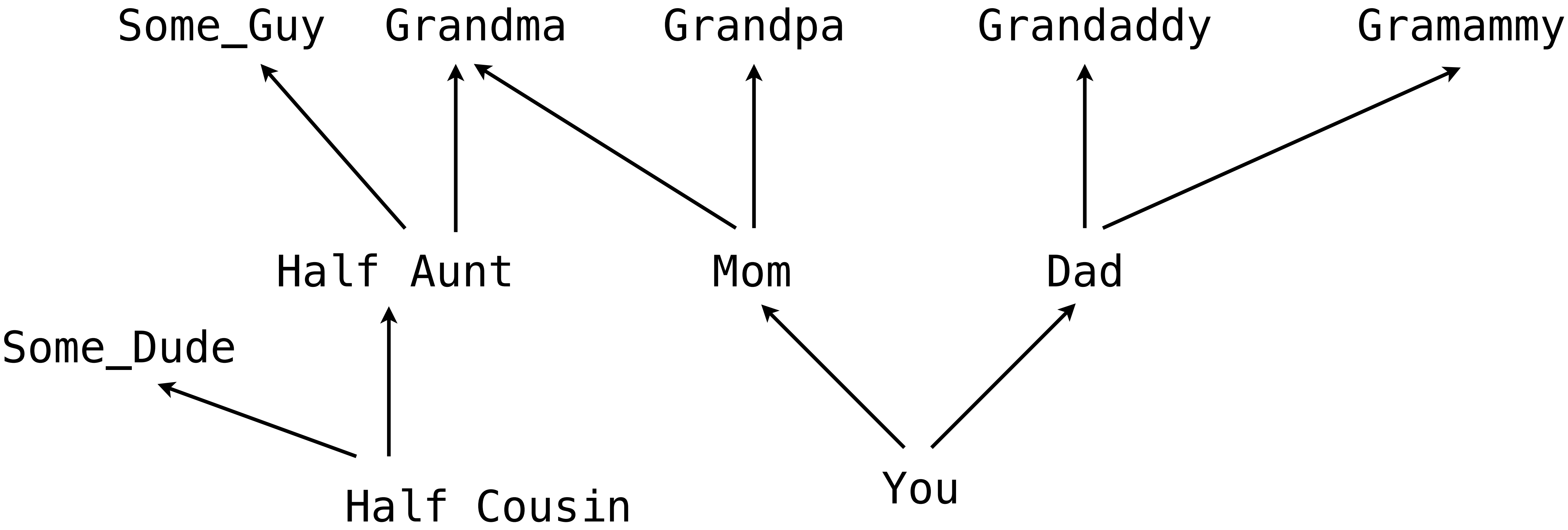

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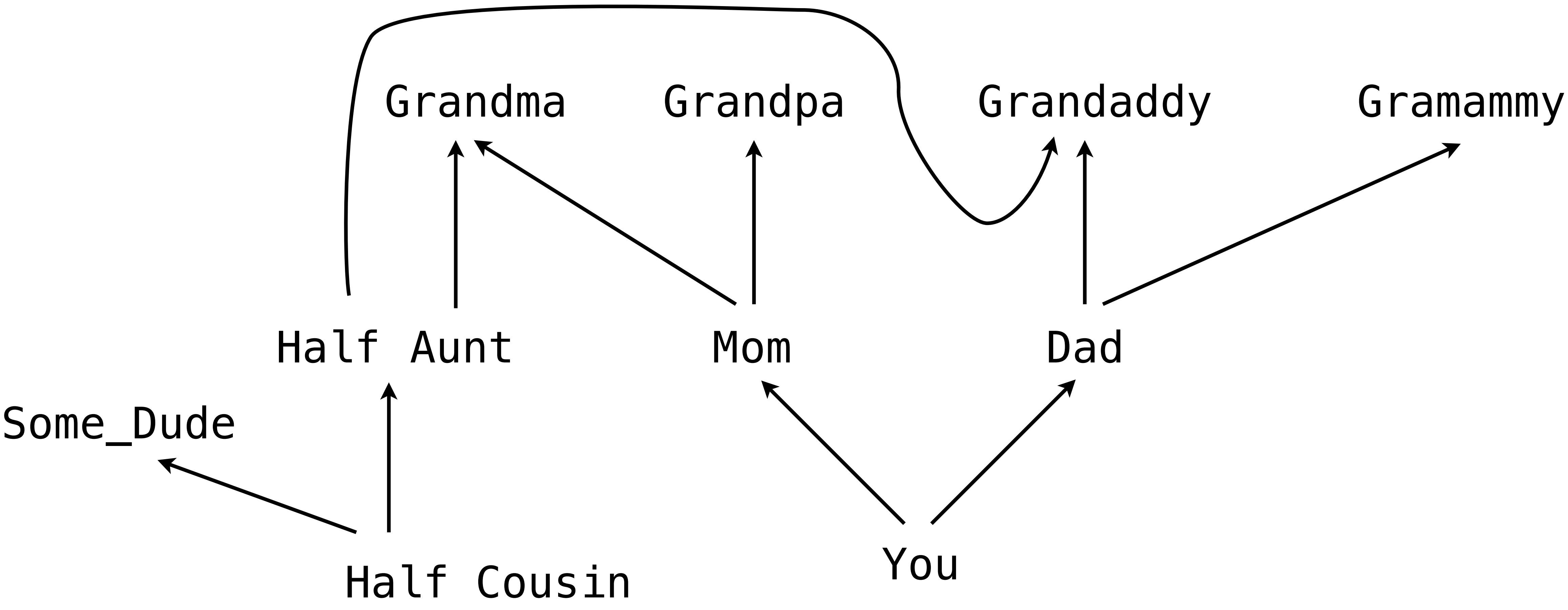
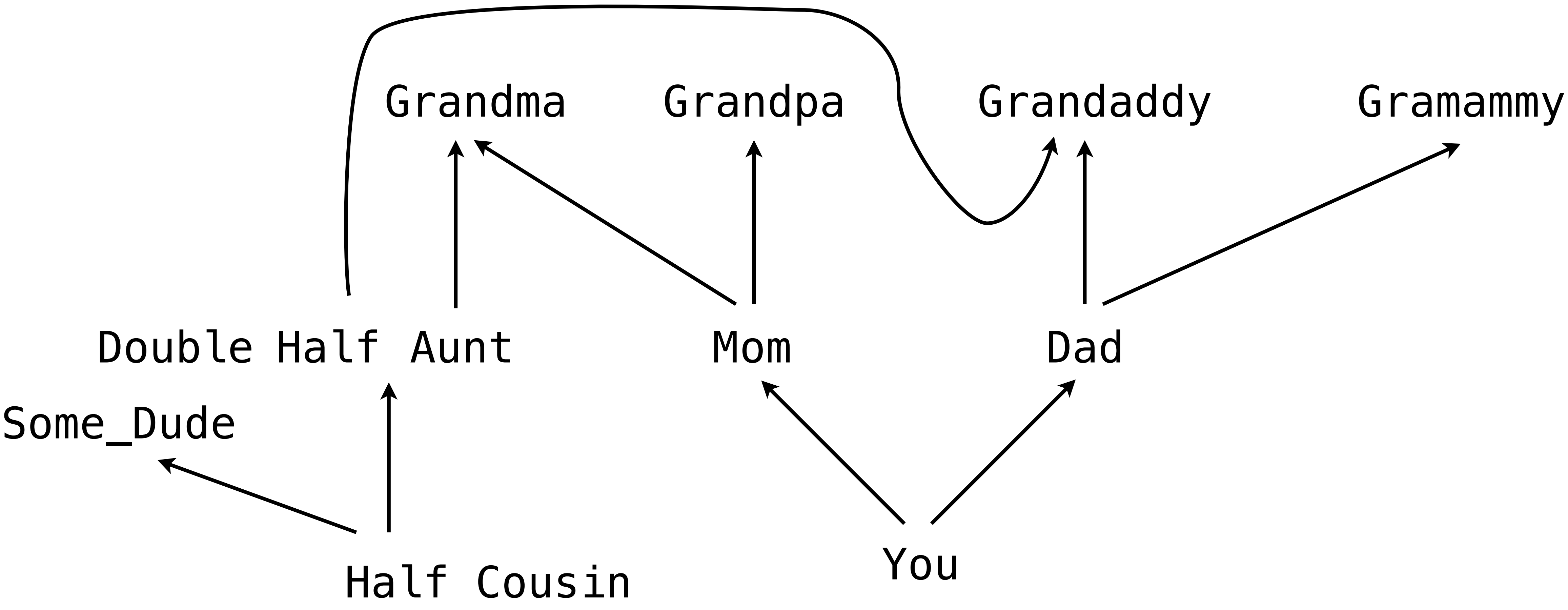


Human Relationships



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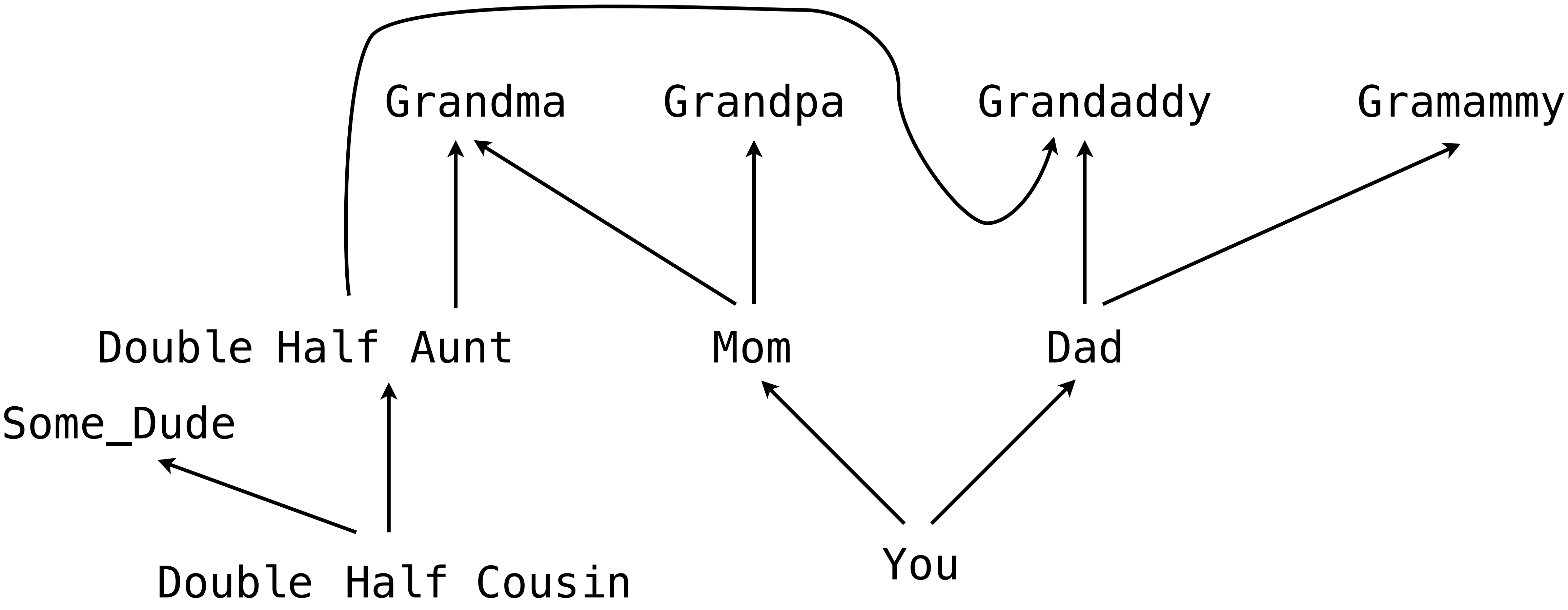

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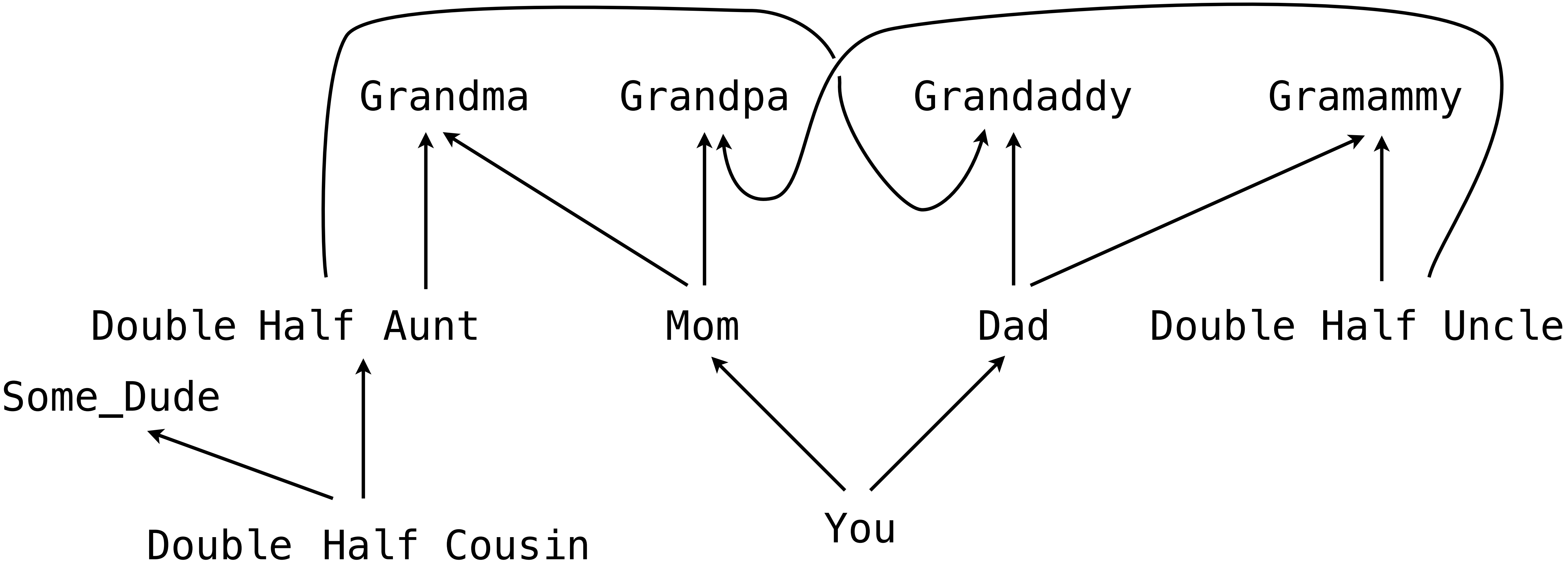
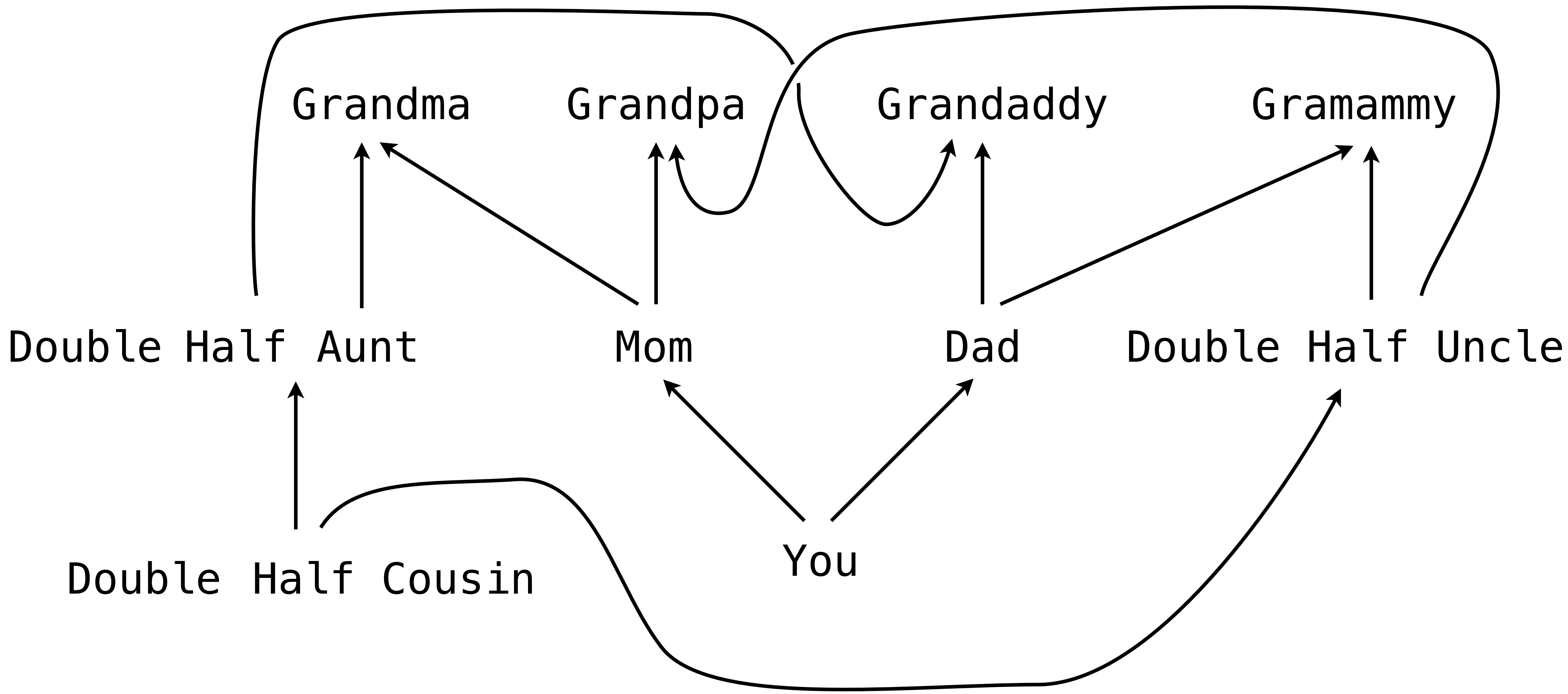


Human Relationships



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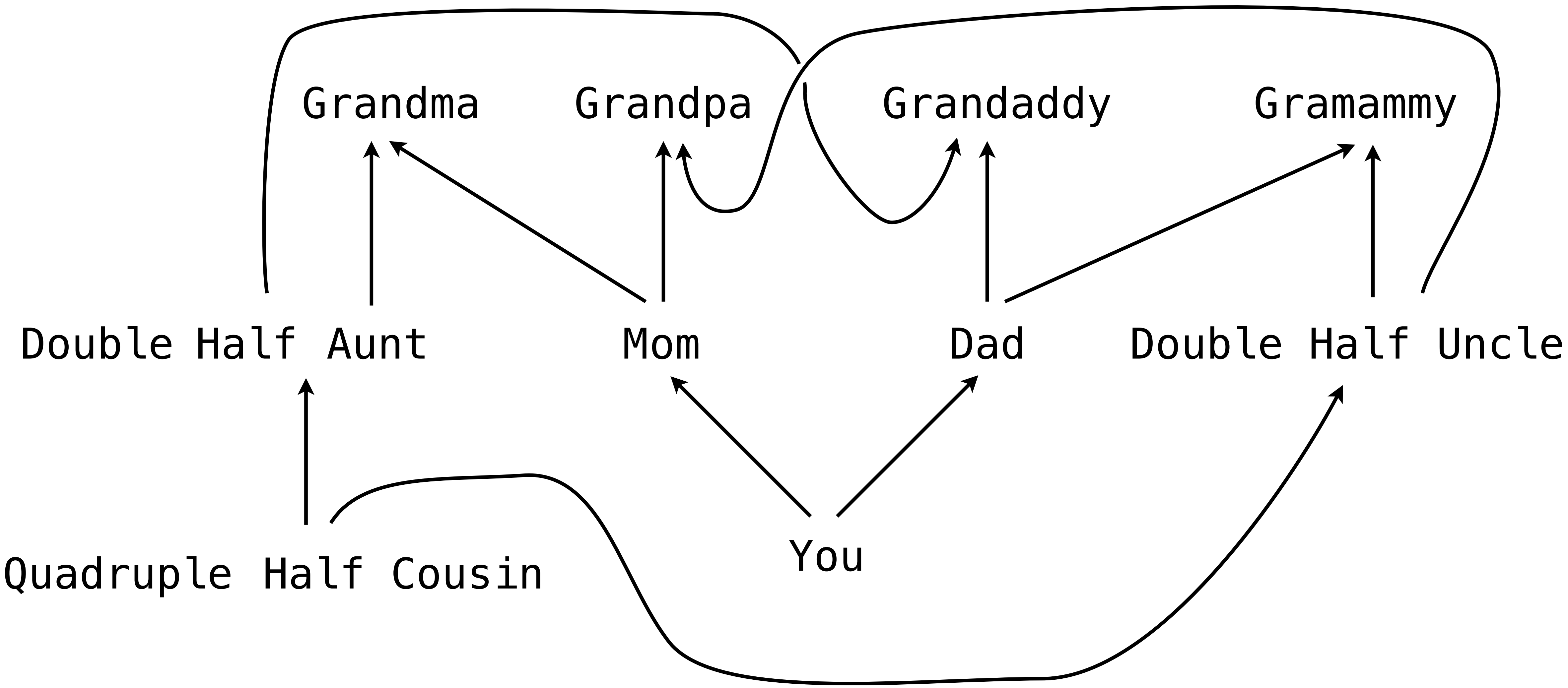

Grandma
Grandpa
Grandaddy
Gramammy
Double Half Aunt
Mom
Dad
Double Half Uncle
Quadruple Half Cousin
You