61A Lecture 16

Announcements

Attributes

Terminology: Attributes, Functions, and Methods

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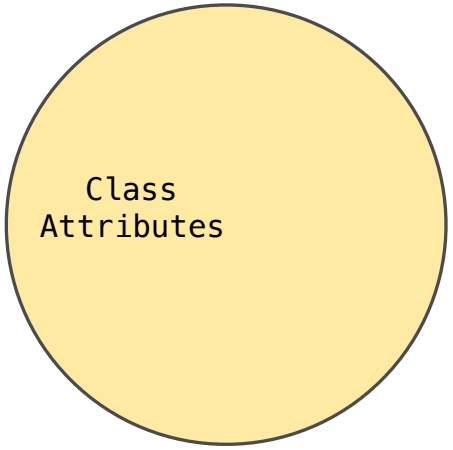

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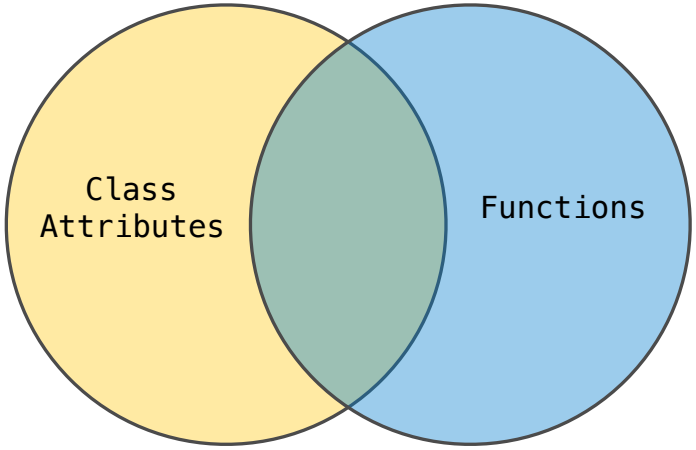

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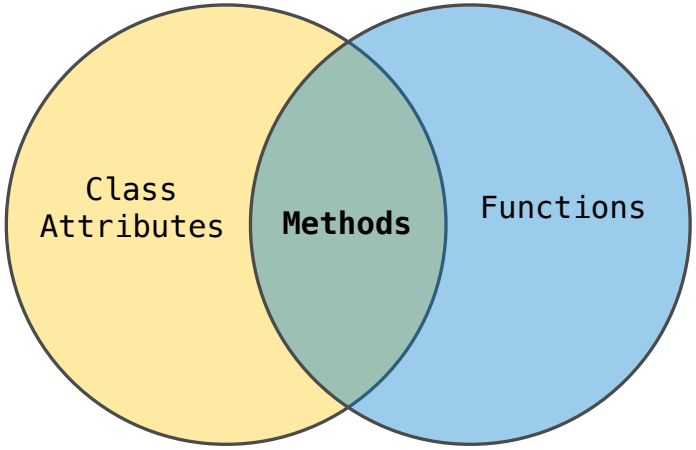

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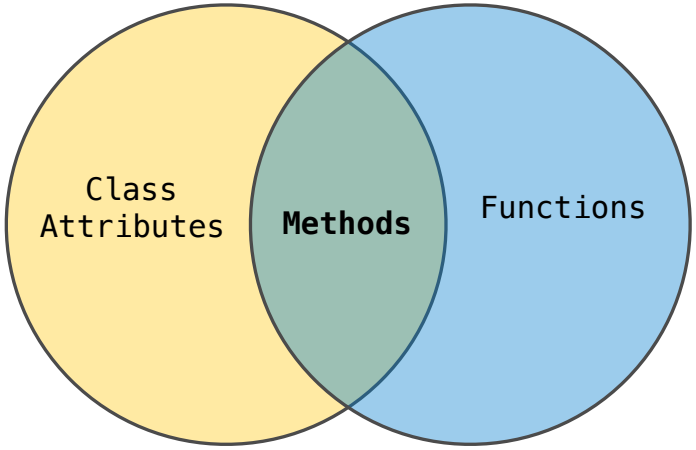

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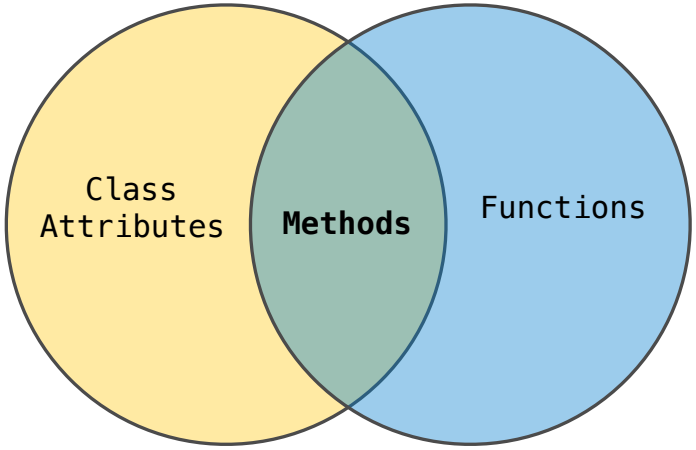

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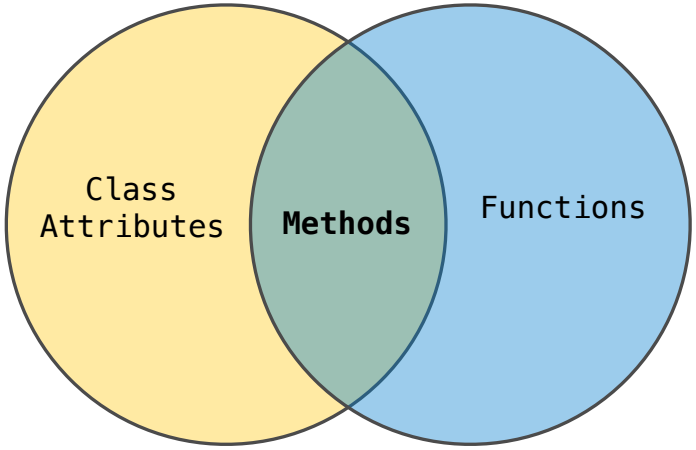

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Bound methods are also objects: a function that has its first parameter "self" already bound to an instance

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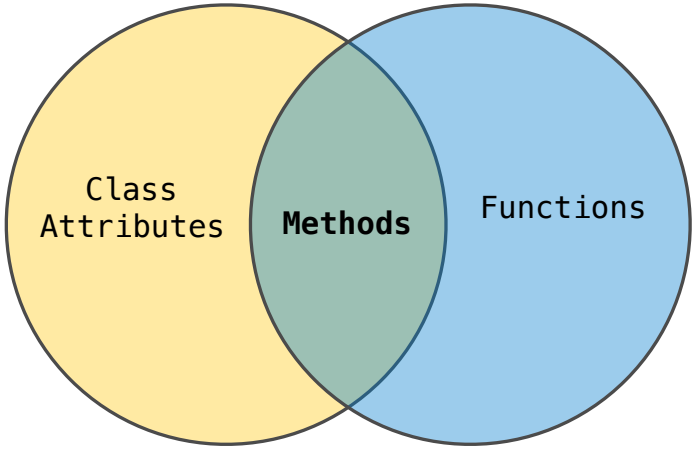

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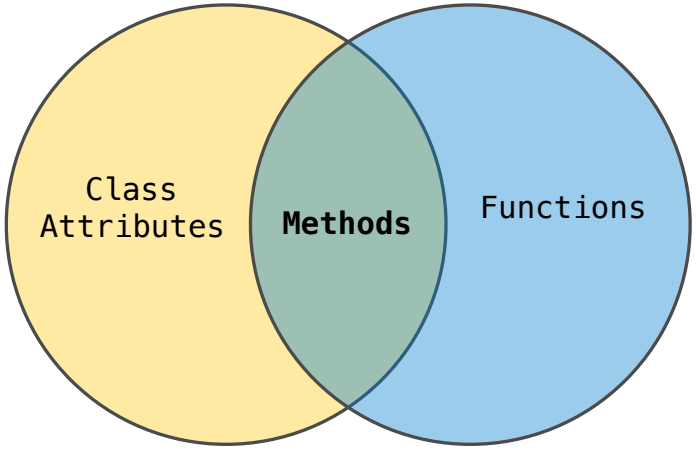

Python object system:

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

Dot expressions evaluate to bound methods for class attributes that are functions

<instance>.<method_name>

Reminder: Looking Up Attributes by Name

```
<expression> . <name>
```

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2. <name> is matched against the instance attributes of that object; if an attribute with that name exists, its value is returned

3. If not, <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

Attribute Assignment

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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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class Account:
    interest = 0.02
    def __init__(self, holder):
        self.holder = holder
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tom_account = Account('Tom')
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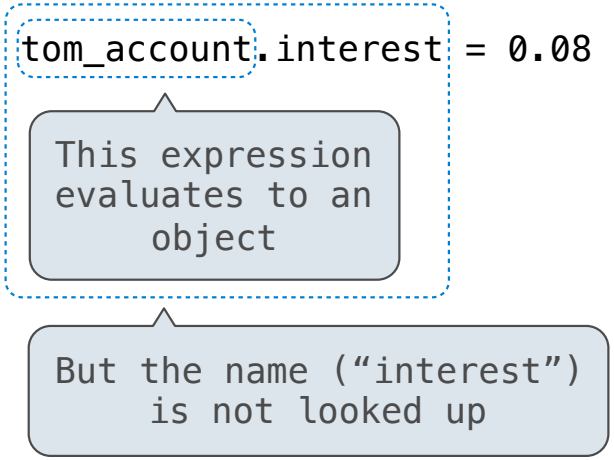

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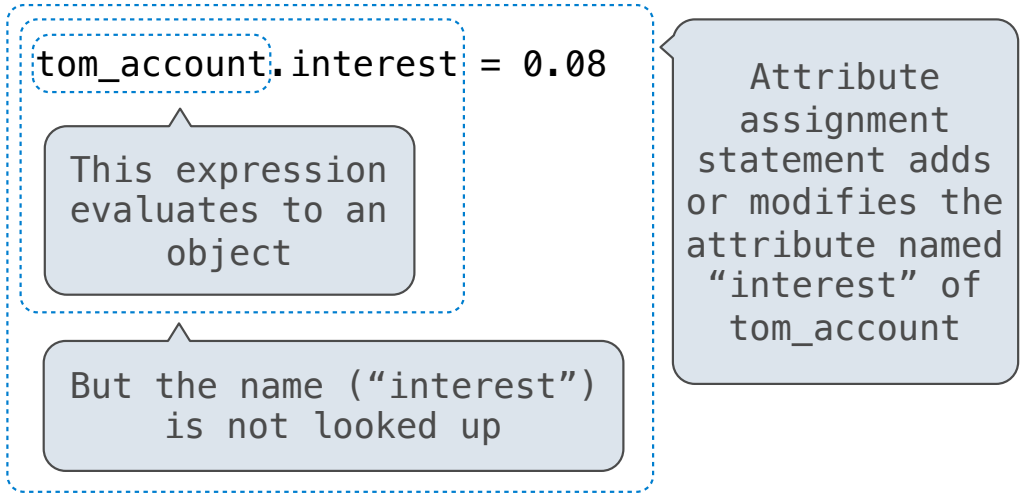

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Instance Attribute Assignment :

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tom_account.interest = 0.08
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This expression evaluates to an object

But the name ("interest") is not looked up

Attribute assignment statement adds or modifies the attribute named "interest" of tom_account

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Attribute assignment statement adds or modifies the attribute named "interest" of tom_account

Class Attribute Assignment :

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Account.interest = 0.04
```

Attribute Assignment Statements

Account class attributes

```
interest: 0.02
(withdraw, deposit, __init__)
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Instance attributes of jim_account

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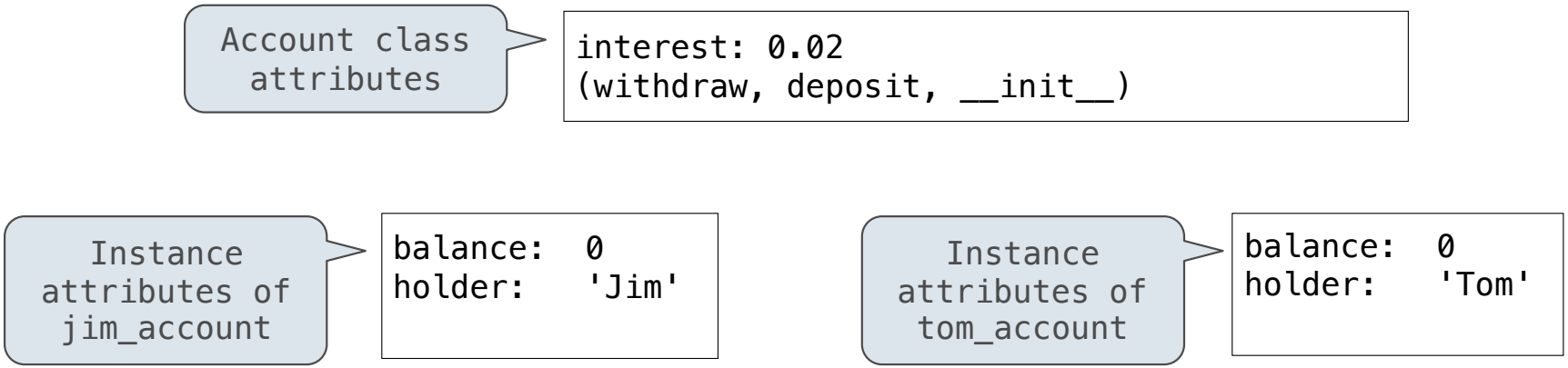


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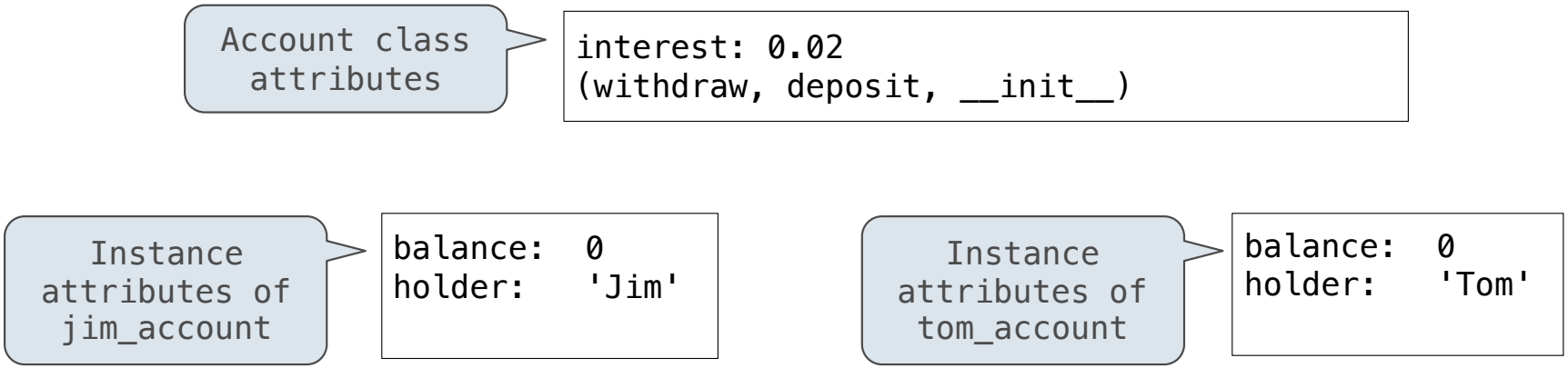
Attribute Assignment Statements

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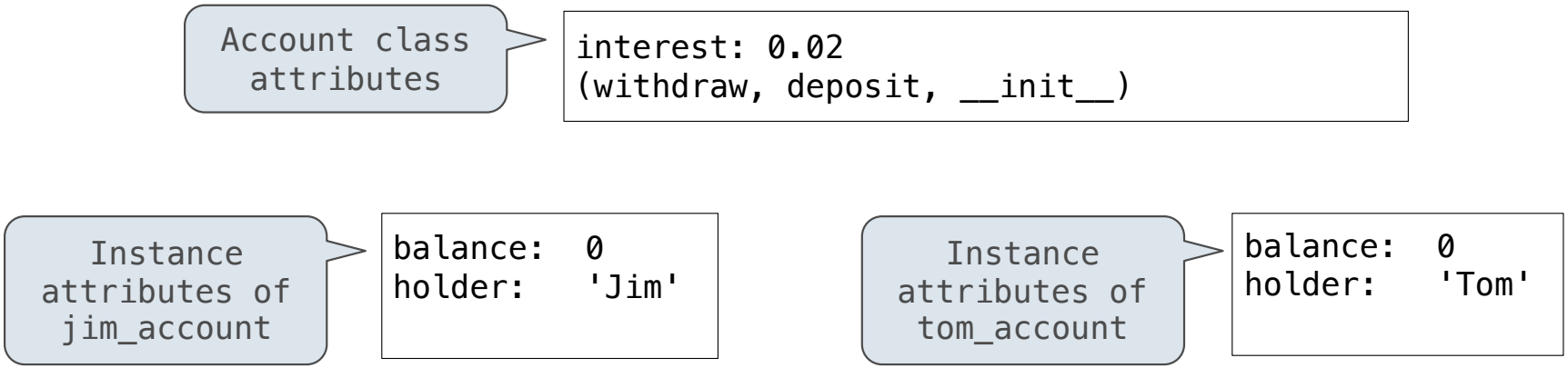


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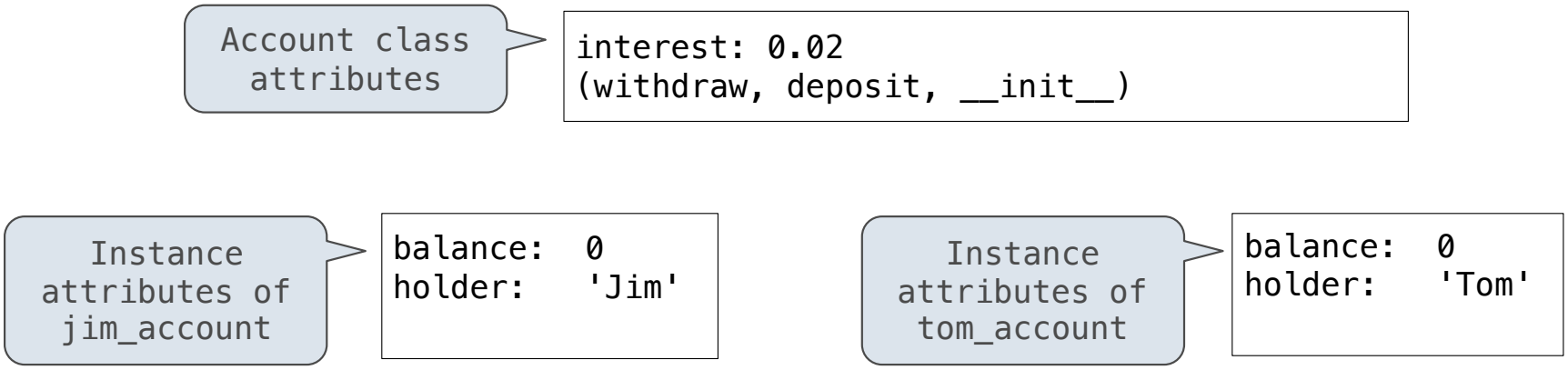


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>>> tom_account.interest
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>>> jim_account.interest
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>>> Account.interest = 0.04
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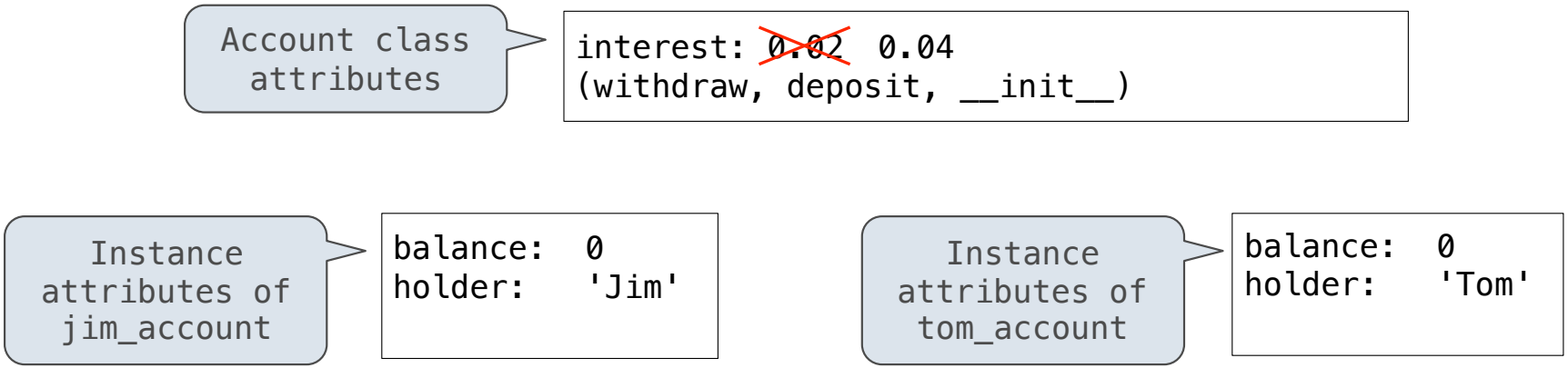


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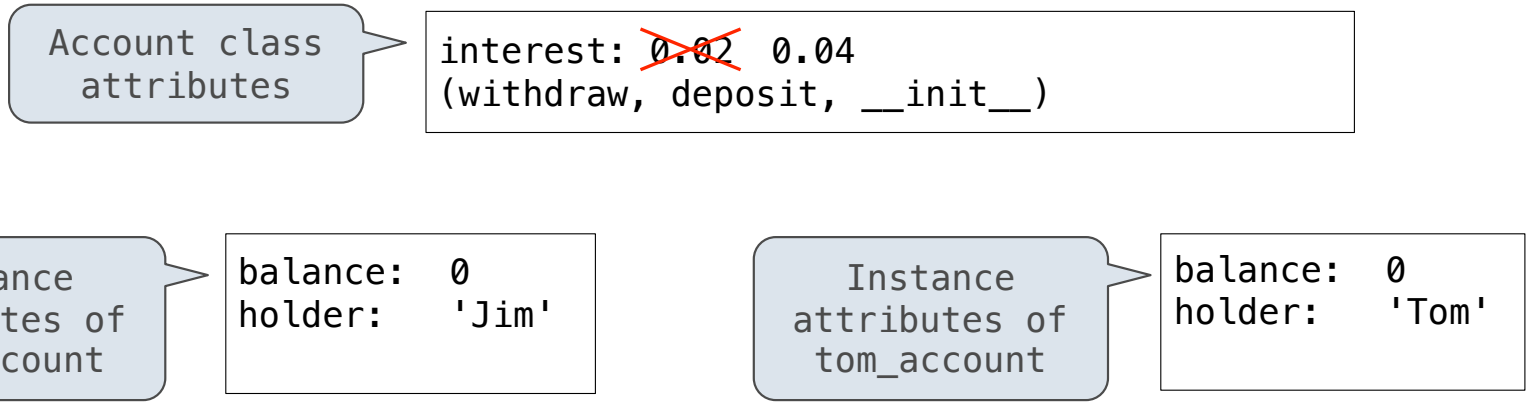


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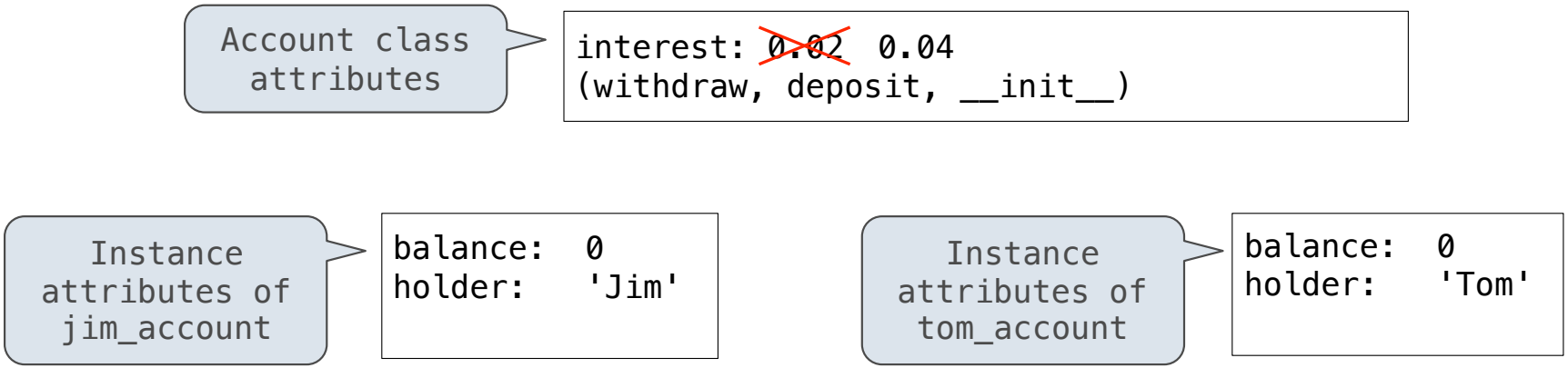


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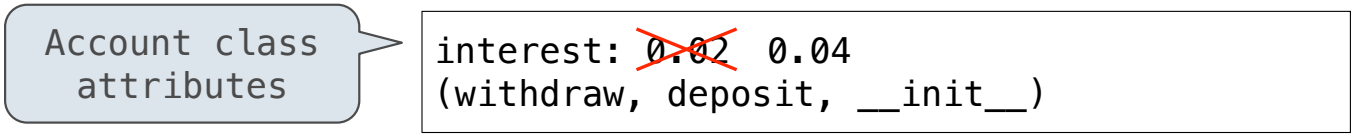

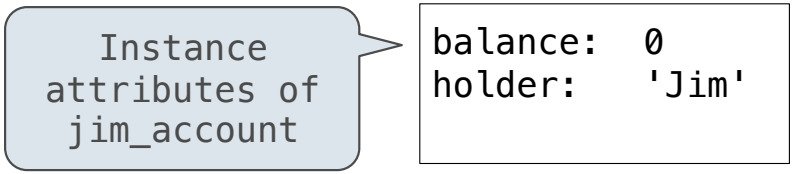

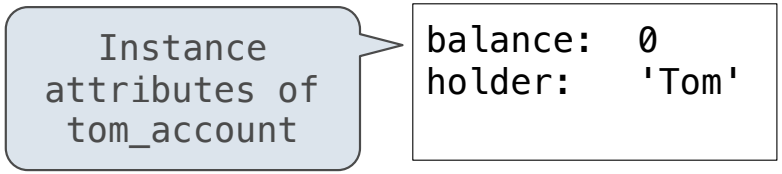


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>>> tom_account.interest
0.02
>>> jim_account.interest
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>>> Account.interest = 0.04
>>> tom_account.interest
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>>> jim_account.interest
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```

```
>>> jim_account.interest = 0.08
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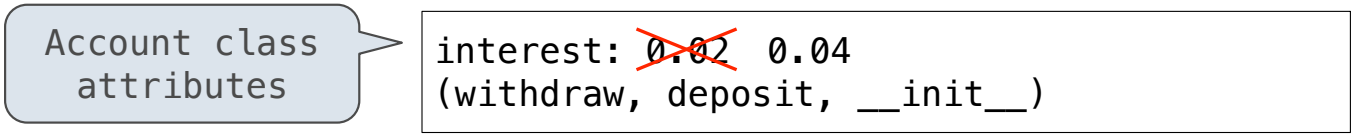

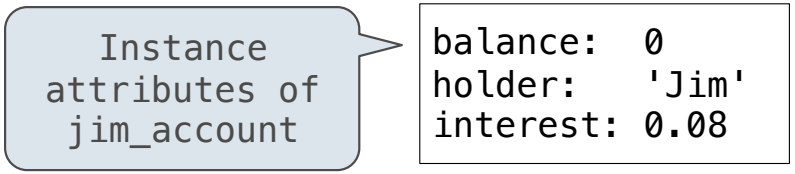

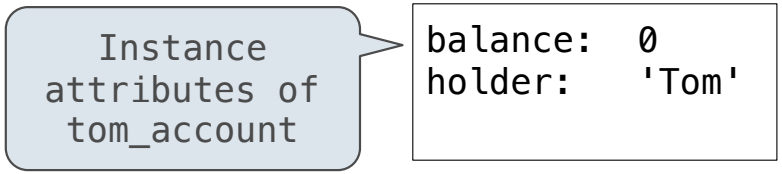


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Attribute Assignment Statements

Account class attributes

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interest: 0.02  0.04
(withdraw, deposit, __init__)
```

Instance attributes of jim_account

```
balance:  0
holder:   'Jim'
interest: 0.08
```

Instance attributes of tom_account

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balance:  0
holder:   'Tom'
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0.02
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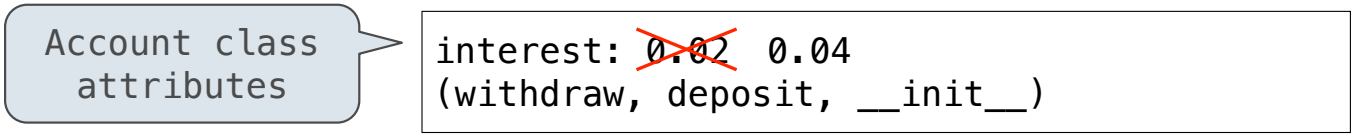
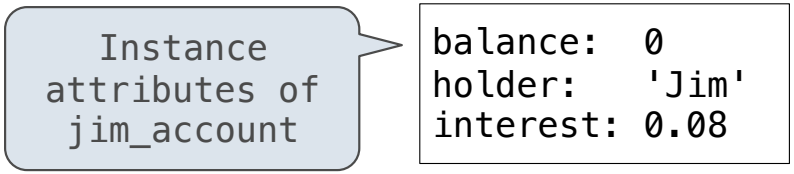
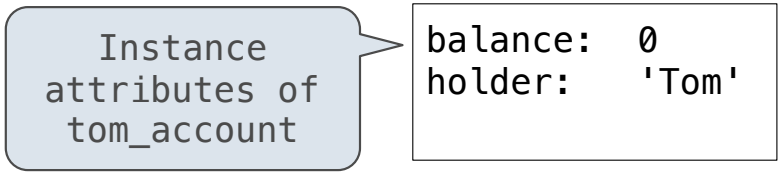
Attribute Assignment Statements





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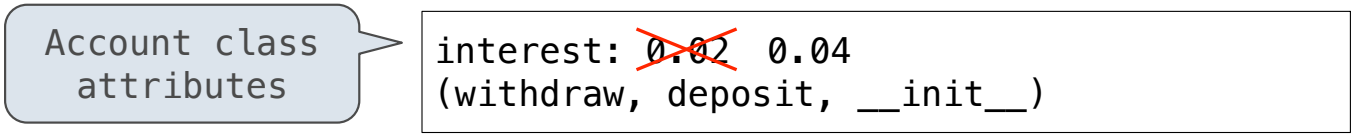

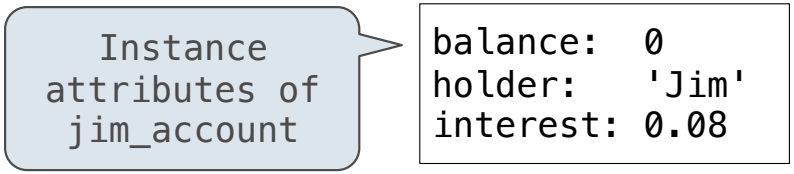

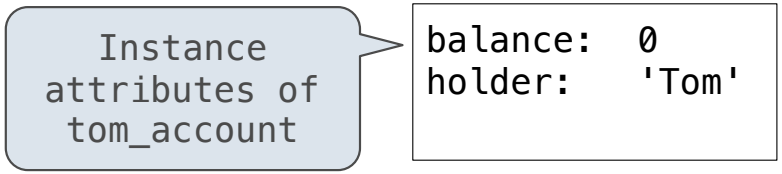


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balance:  0
holder:   'Tom'
```

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
>>> jim_account.interest
0.04
```

```
>>> jim_account.interest = 0.08
>>> jim_account.interest
0.08
>>> tom_account.interest
0.04
>>> Account.interest = 0.05
>>> tom_account.interest
0.05
```

Attribute Assignment Statements

Account class attributes

```
interest: 0.02  0.04  0.05
(withdraw, deposit, __init__)
```

Instance attributes of jim_account

```
balance:  0
holder:   'Jim'
interest: 0.08
```

Instance attributes of tom_account

```
balance:  0
holder:   'Tom'
```

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>>> jim_account = Account('Jim')
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>>> tom_account.interest
0.02
>>> jim_account.interest
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>>> Account.interest = 0.04
>>> tom_account.interest
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>>> jim_account.interest
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```

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>>> jim_account.interest = 0.08
>>> jim_account.interest
0.08
>>> tom_account.interest
0.04
>>> Account.interest = 0.05
>>> tom_account.interest
0.05
>>> jim_account.interest
0.08
```

Inheritance

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```
Inheritance is a technique for relating classes together
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Conceptually, the new subclass inherits attributes of its base class

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The subclass may override certain inherited attributes

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

Inheritance Example

A `CheckingAccount` is a specialized type of `Account`

Inheritance Example

A CheckingAccount is a specialized type of Account

```
>>> 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
```

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(Demo)

Object-Oriented Design

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Attribute look-up on base class

Preferred to CheckingAccount.withdraw_fee to allow for specialized accounts

Inheritance and Composition

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Object-oriented programming shines when we adopt the metaphor
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(Demo)

Multiple Inheritance

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class SavingsAccount(Account):
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```
class AsSeenOnTVAccount(CheckingAccount, SavingsAccount):
    def __init__(self, account_holder):
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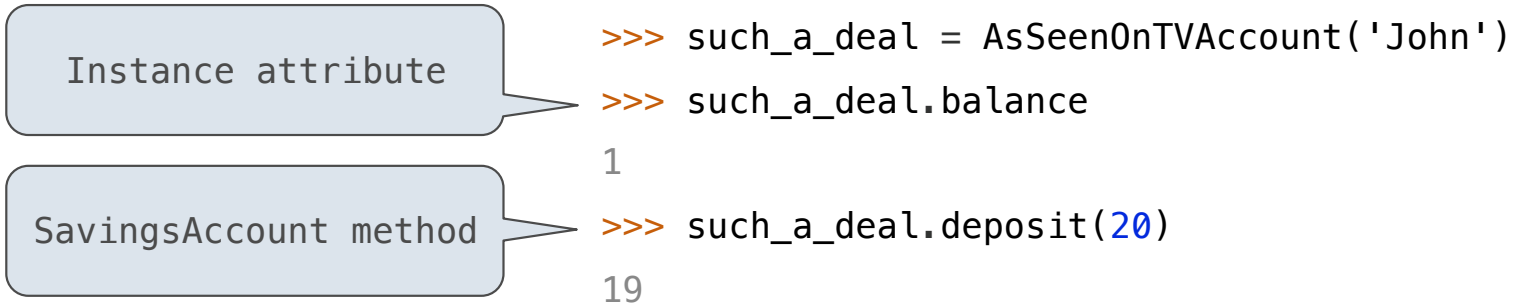

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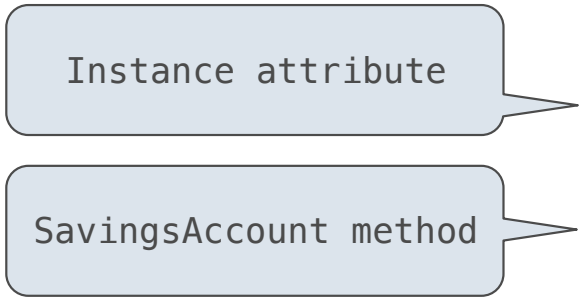


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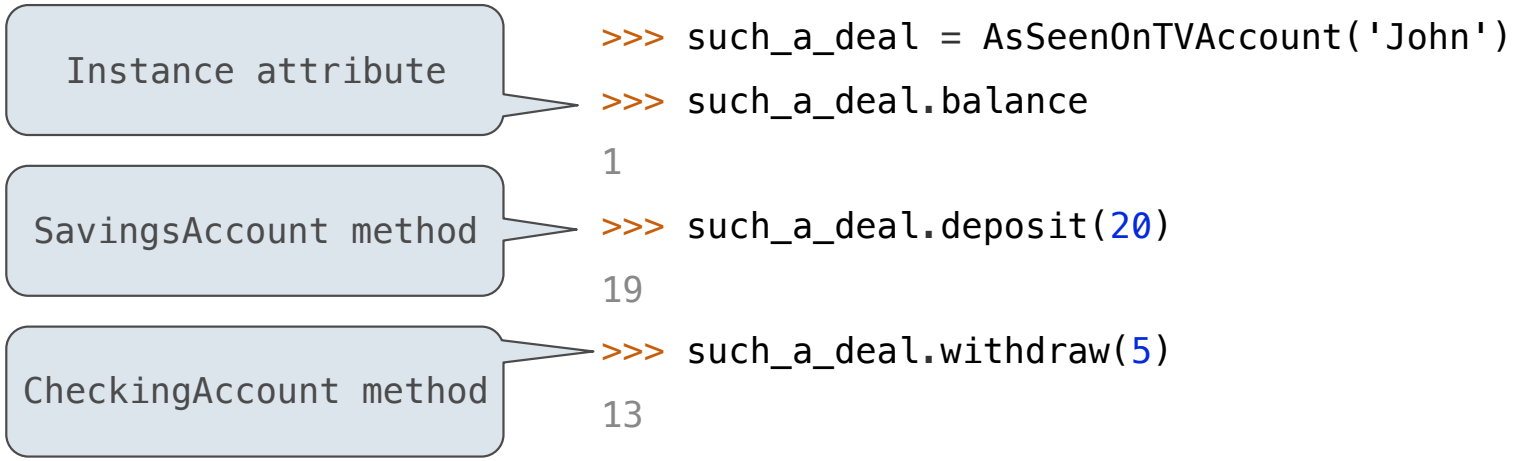
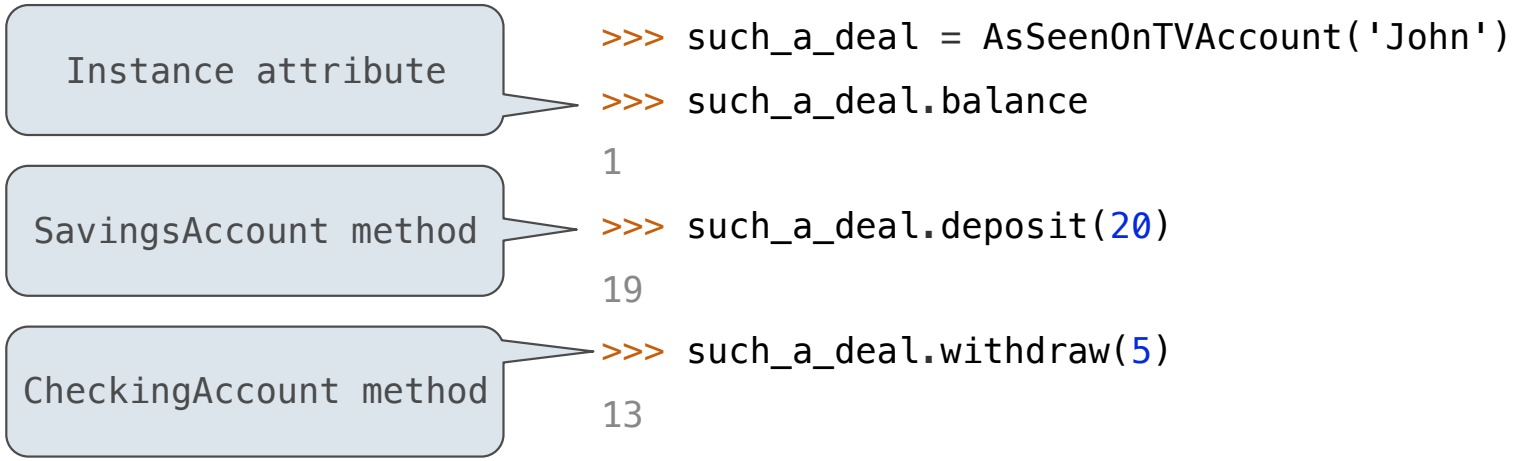


Resolving Ambiguous Class Attribute Names



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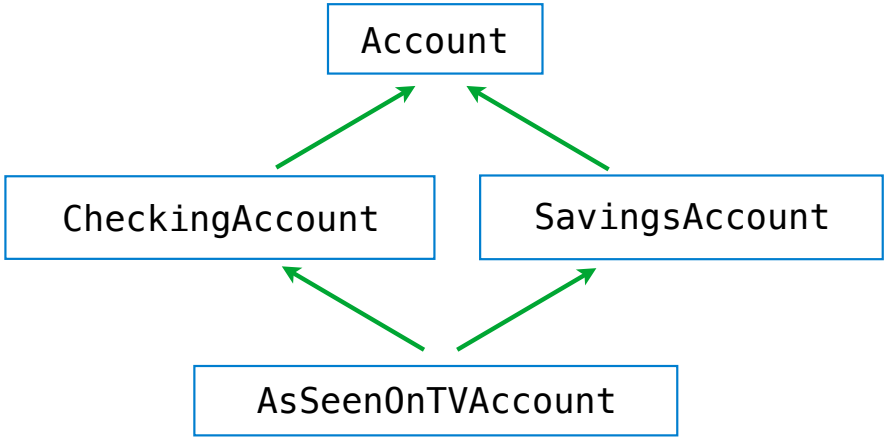

Instance attribute

SavingsAccount method

CheckingAccount method

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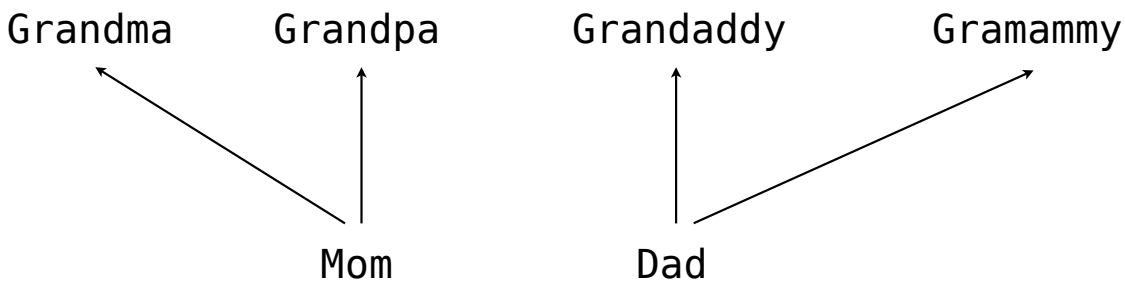
Complicated Inheritance

Biological Inheritance

Biological Inheritance

```
Grandma      Grandpa      Grandaddy      Gramammy
```

Biological Inheritance



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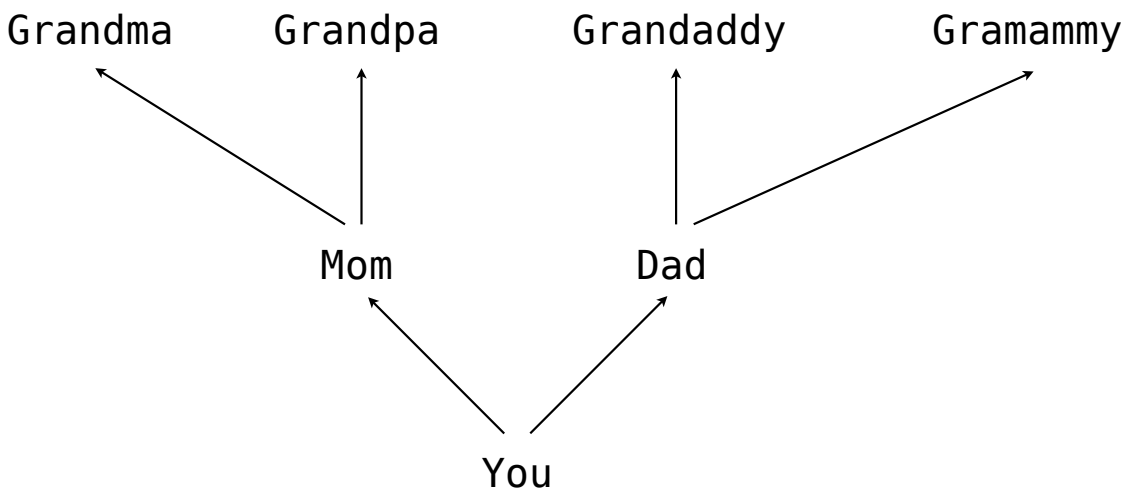

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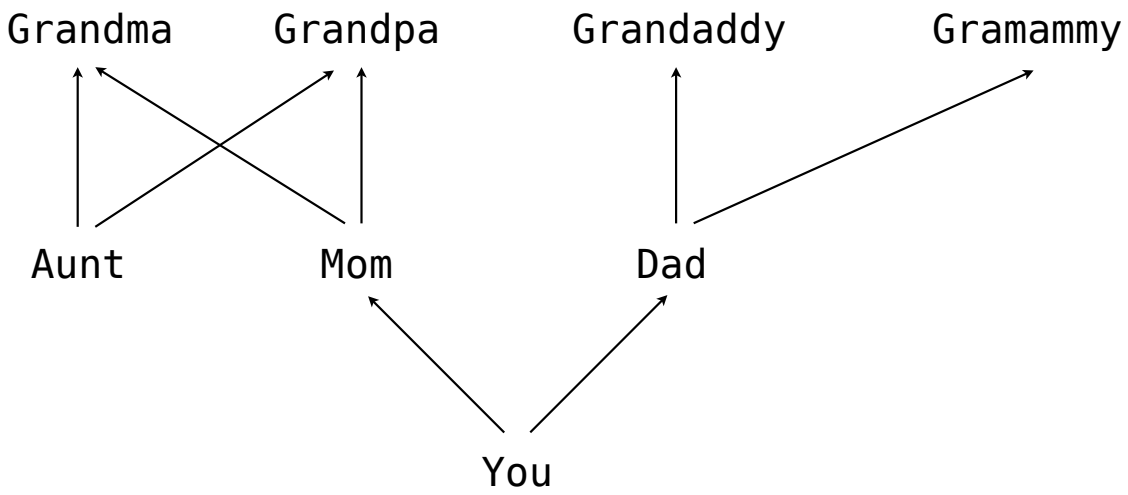

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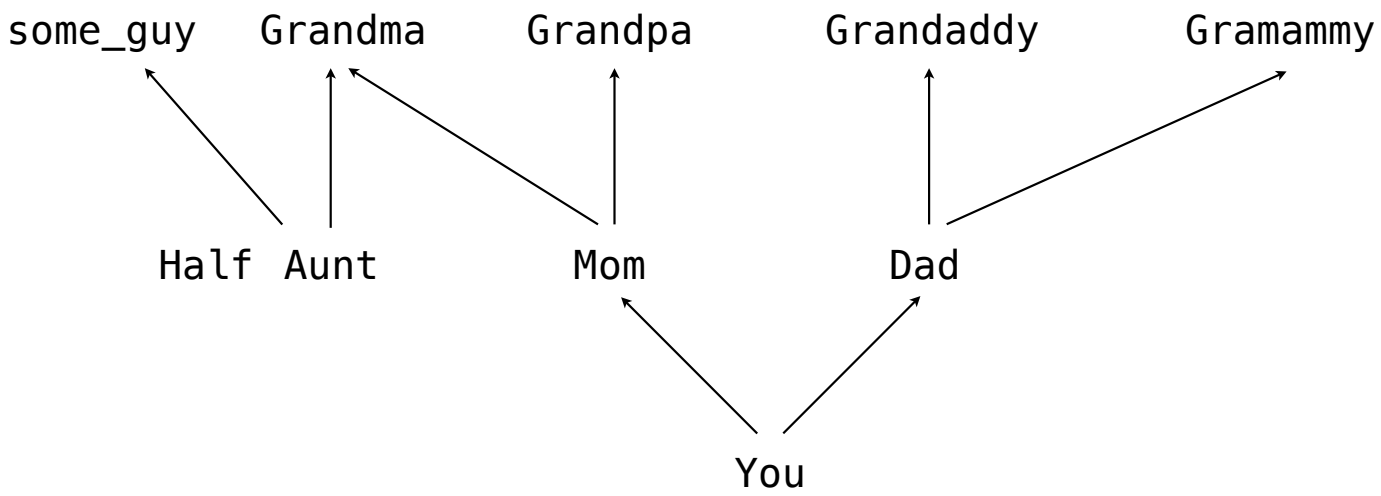

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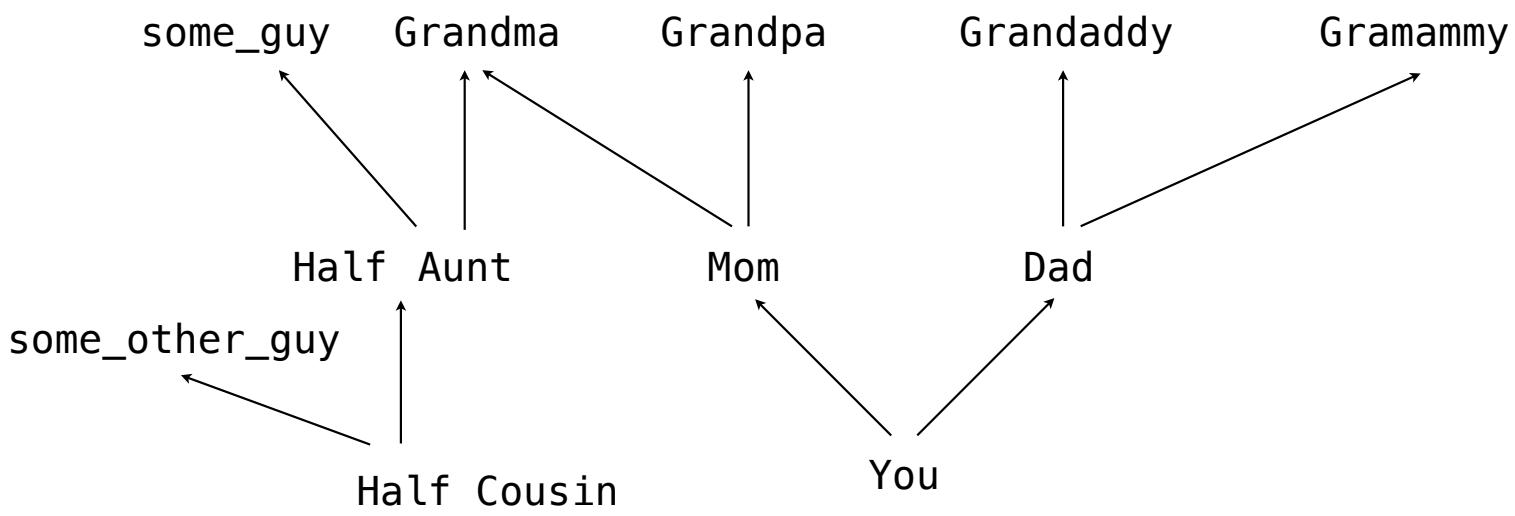
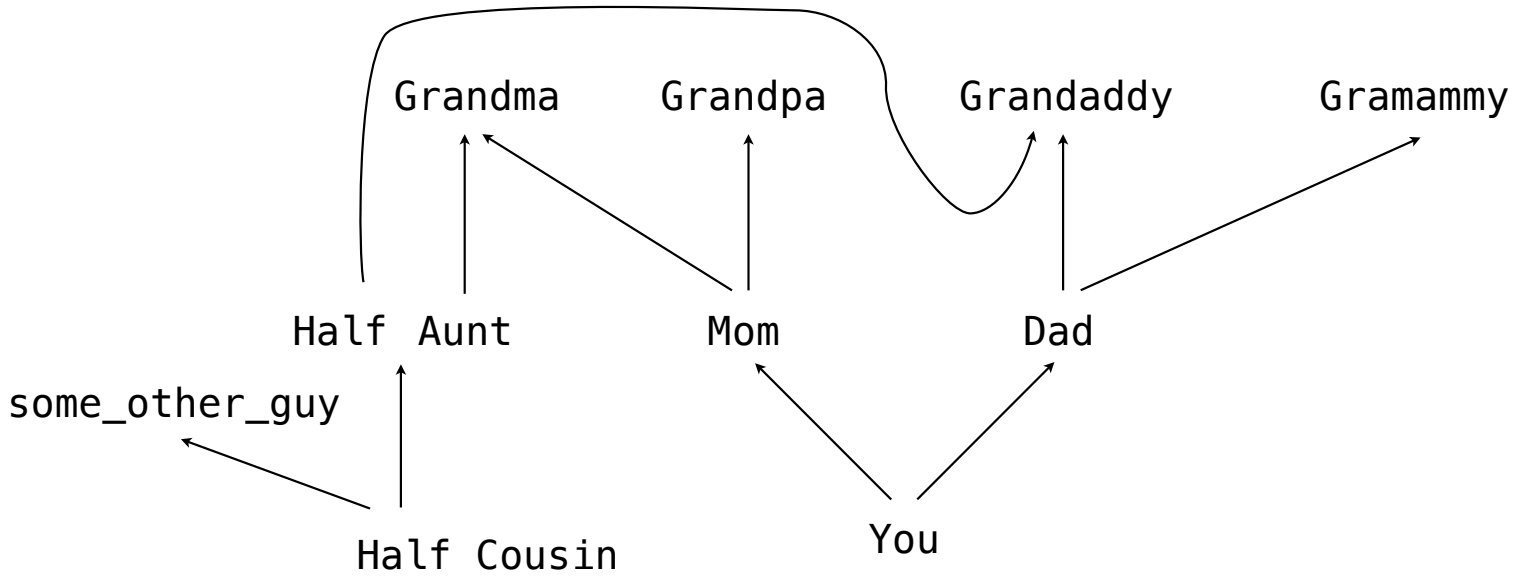


Biological Inheritance



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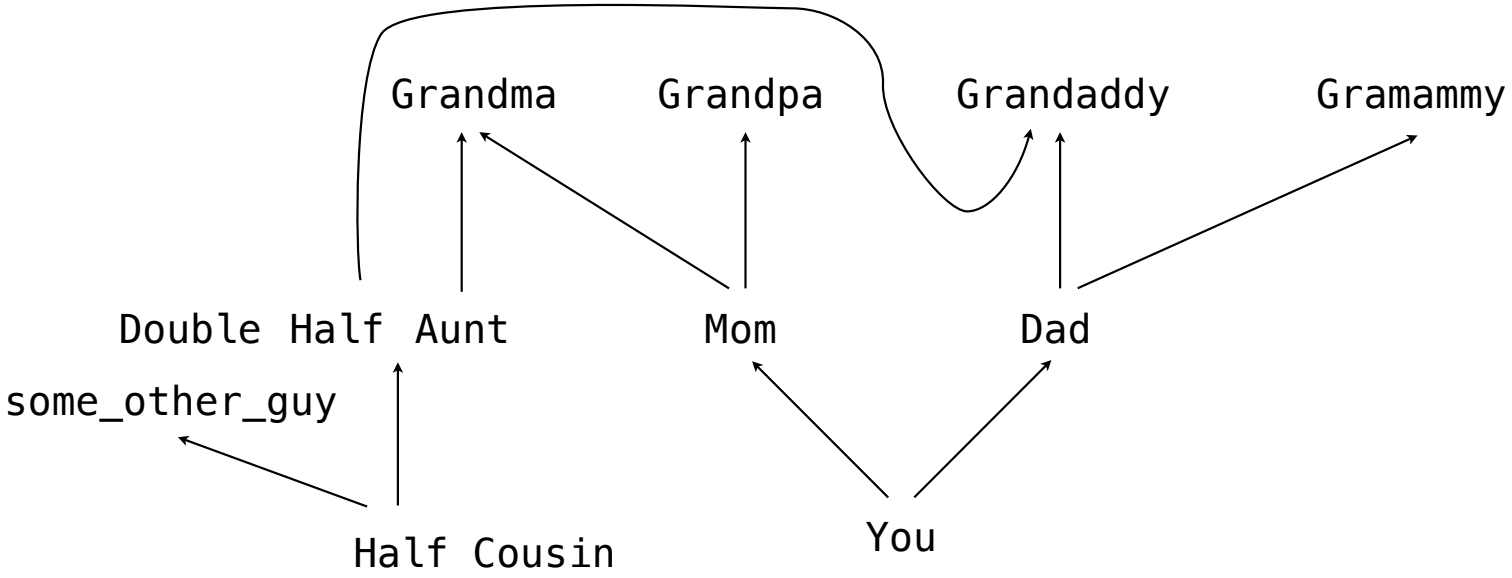

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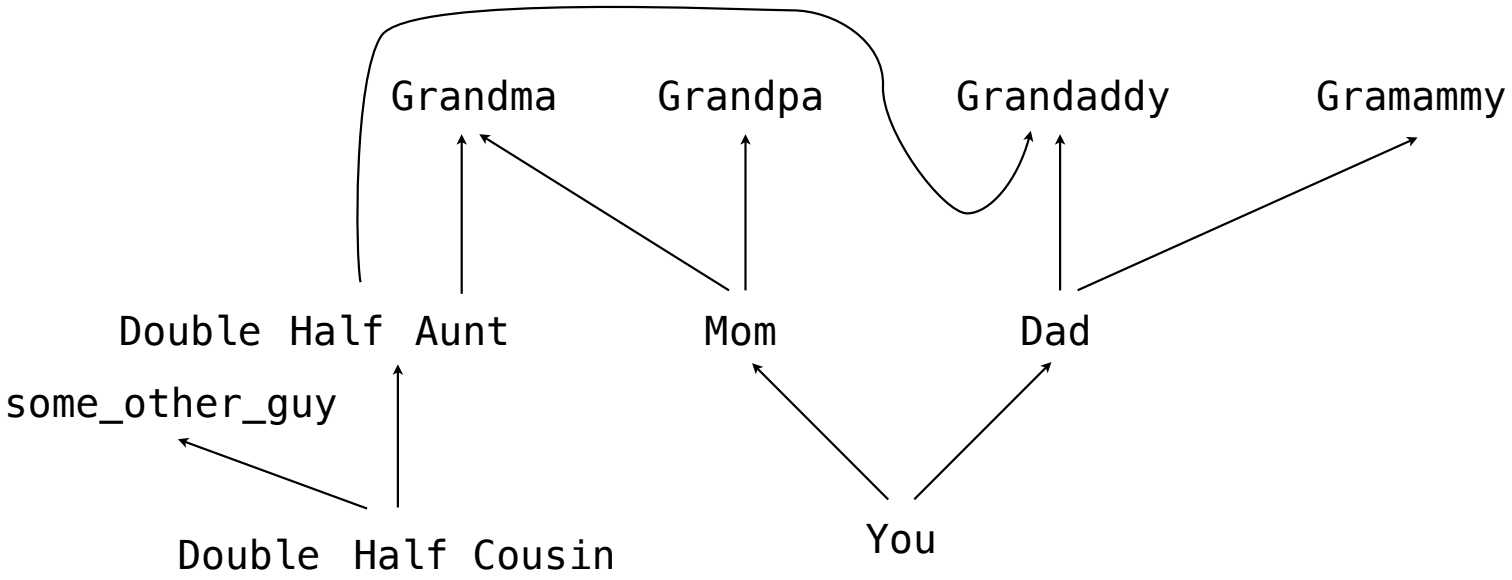

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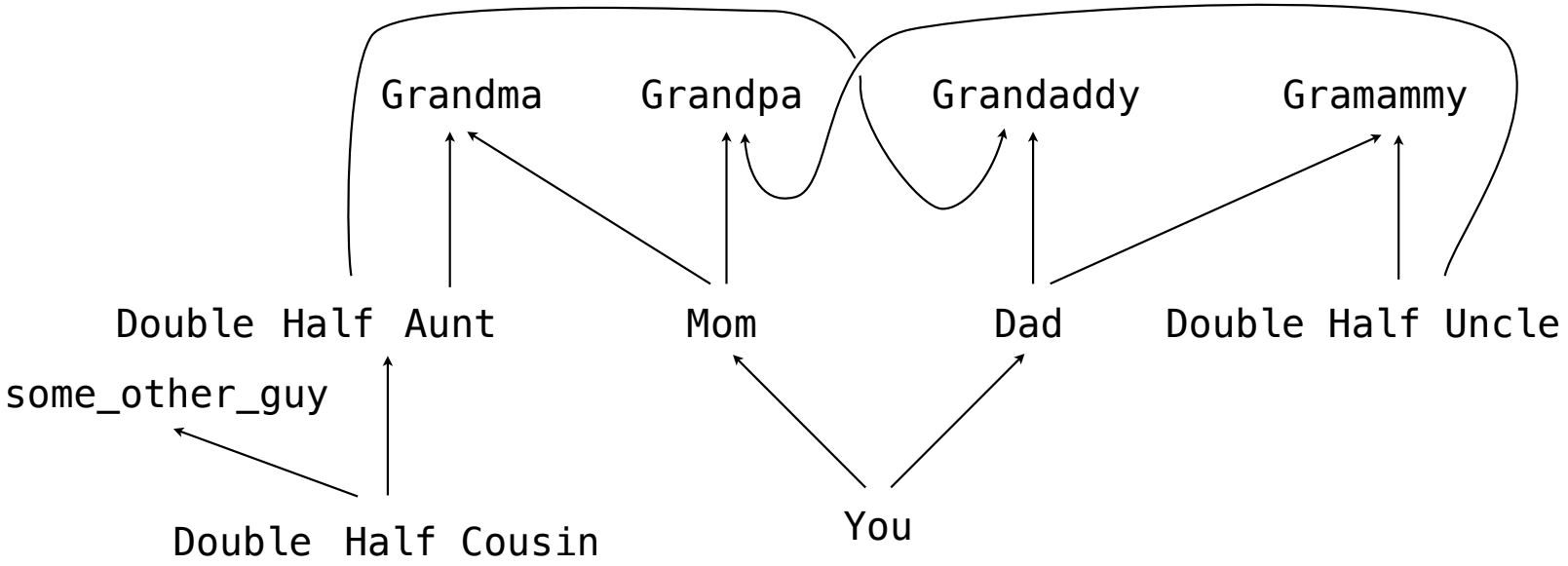

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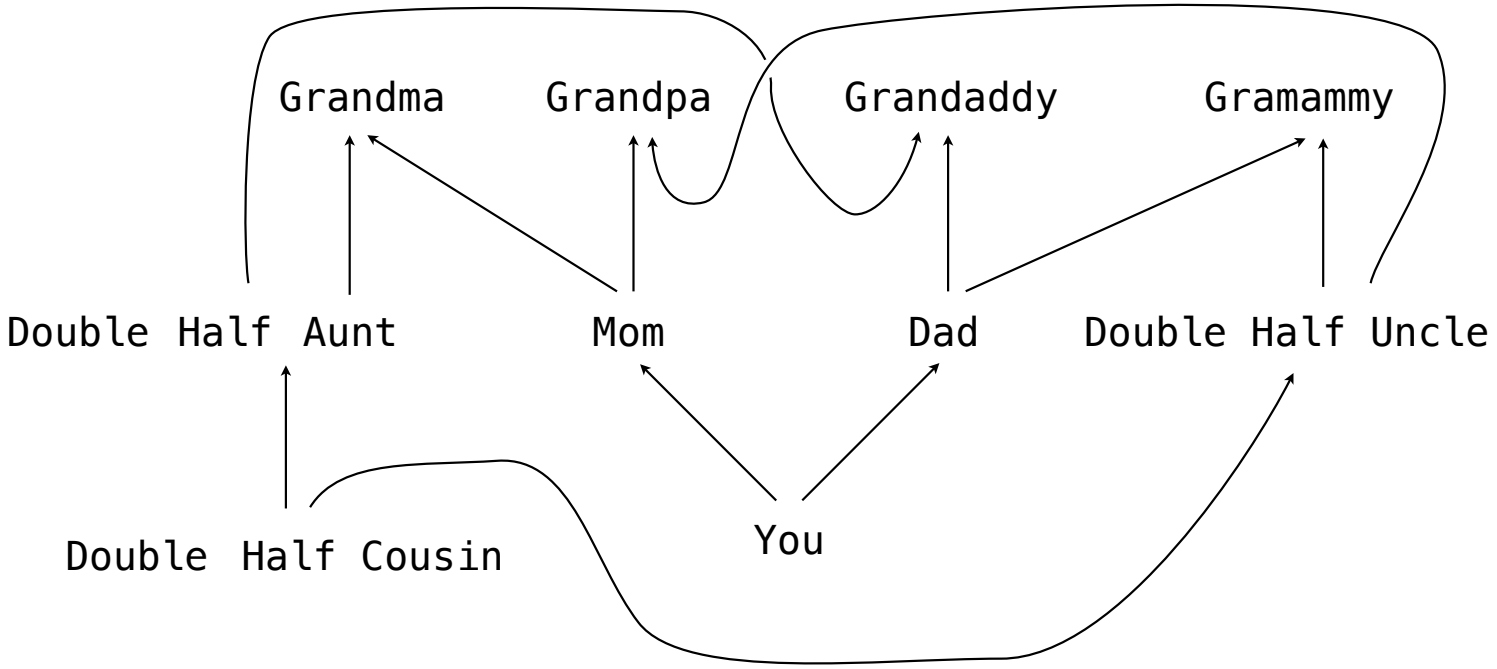

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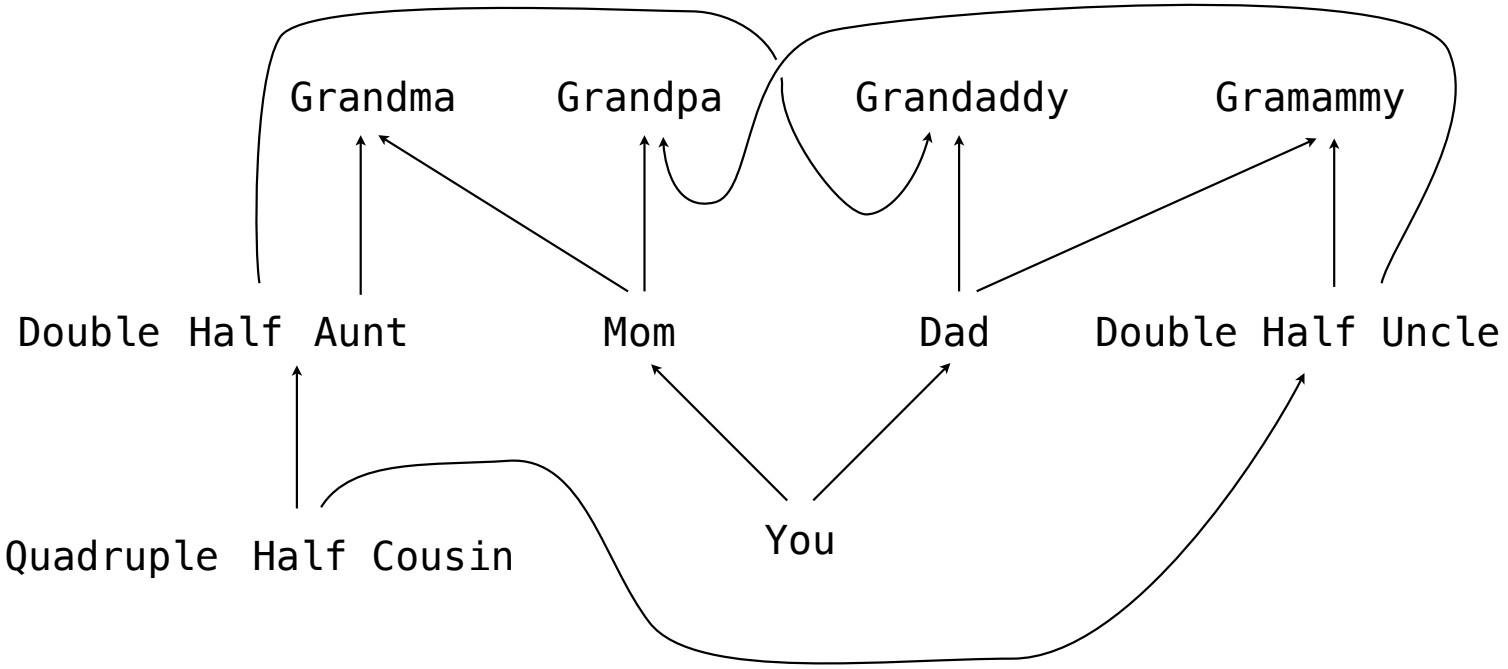

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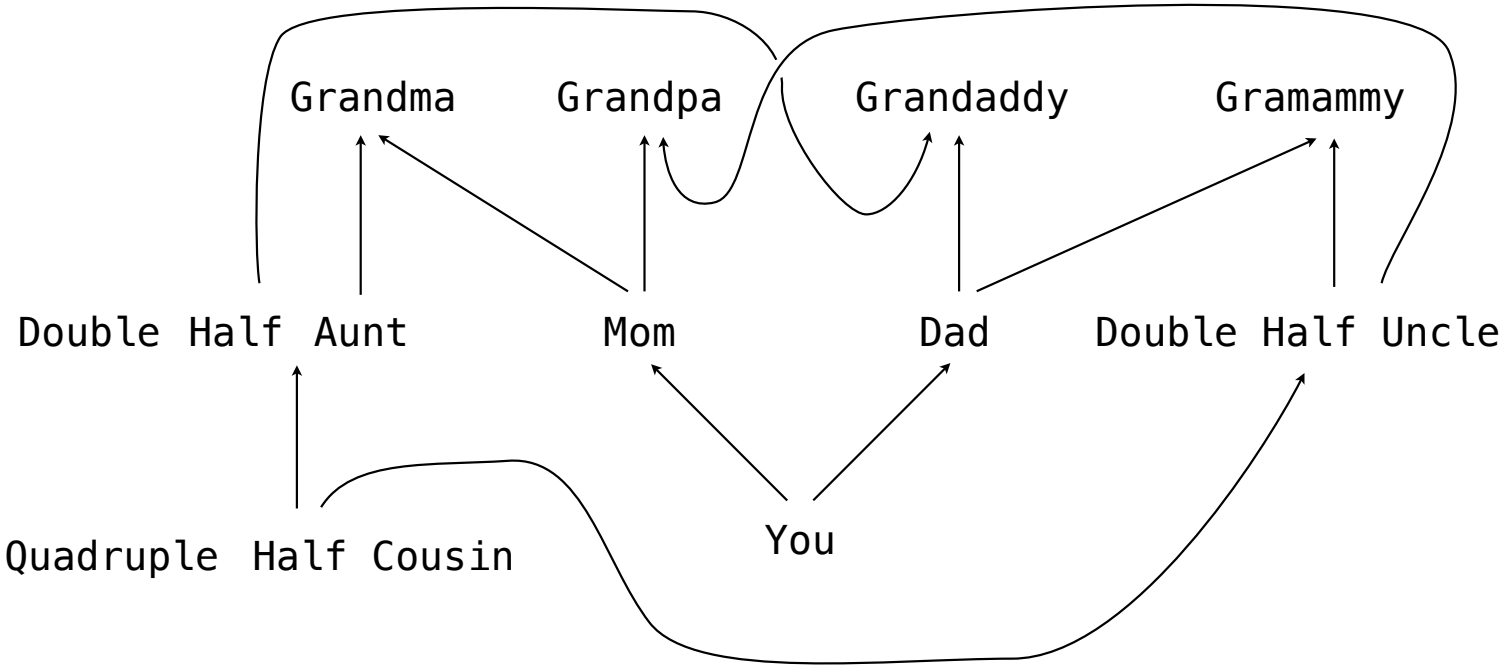

Moral of the story: Inheritance can be complicated, so don't overuse it!