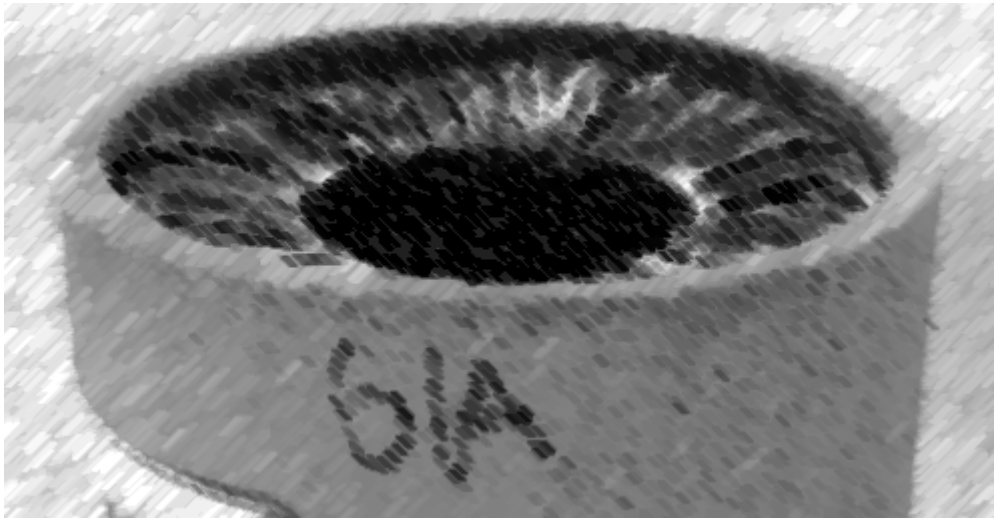

CS61A Lecture 20

Amir Kamil and Julia Oh
UC Berkeley
March 8, 2013

Announcements

- HW7 due on Wednesday
- Ants project out

Dot Expressions

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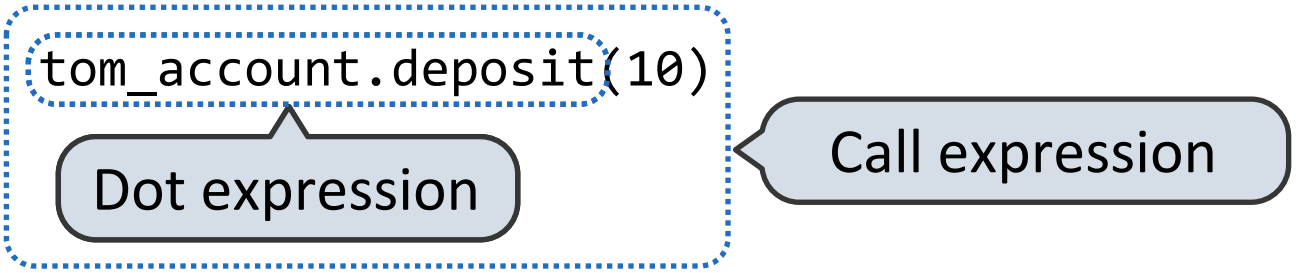

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- One of its instance attributes, **or**
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Earlier, we saw *currying*, which converts a function that takes in multiple arguments into multiple chained functions.

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        def inner(*args):
            return f(x, *args)
        return inner
    return outer
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```
>>> tom_deposit = curry(Account.deposit)(tom_account)
>>> tom_deposit(1000)
3011
```

Attributes, Functions, and Methods

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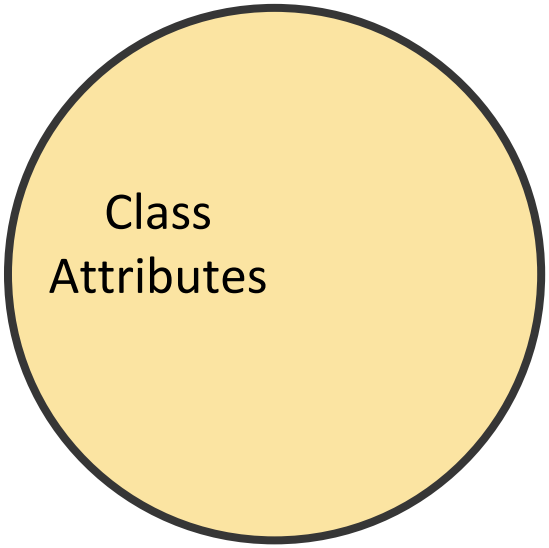

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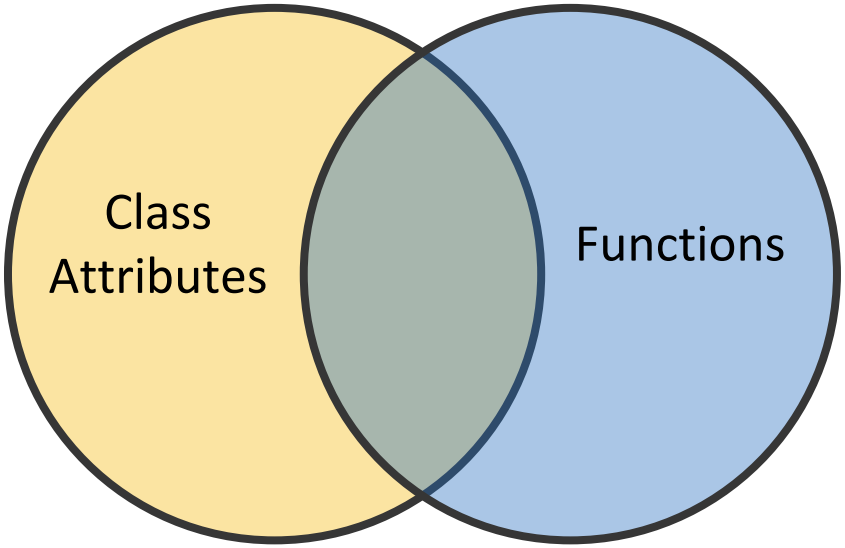

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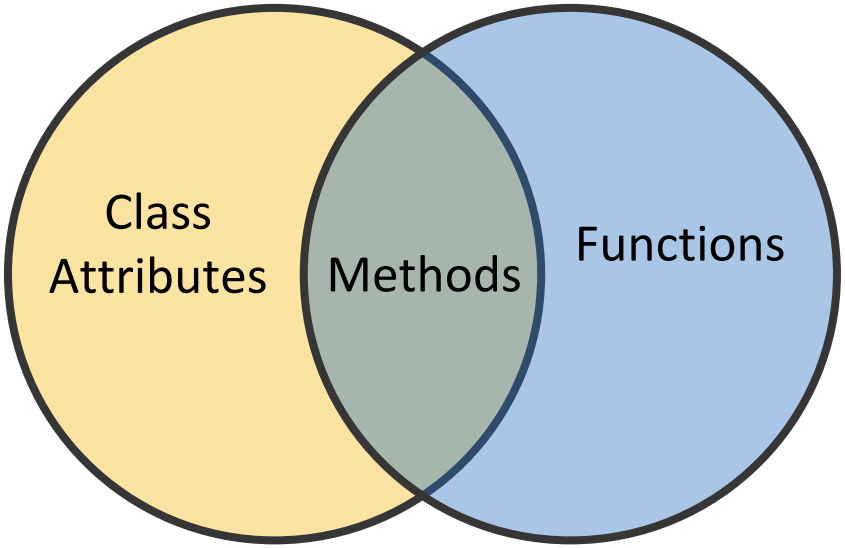

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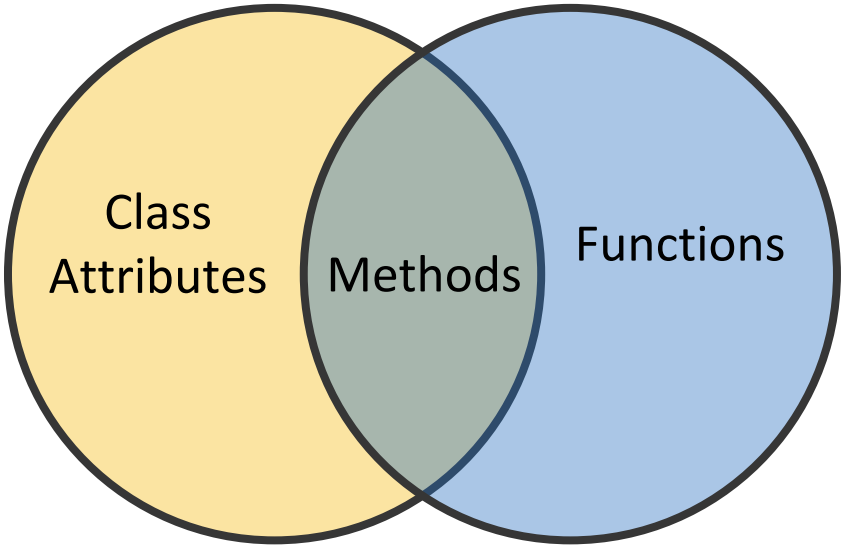
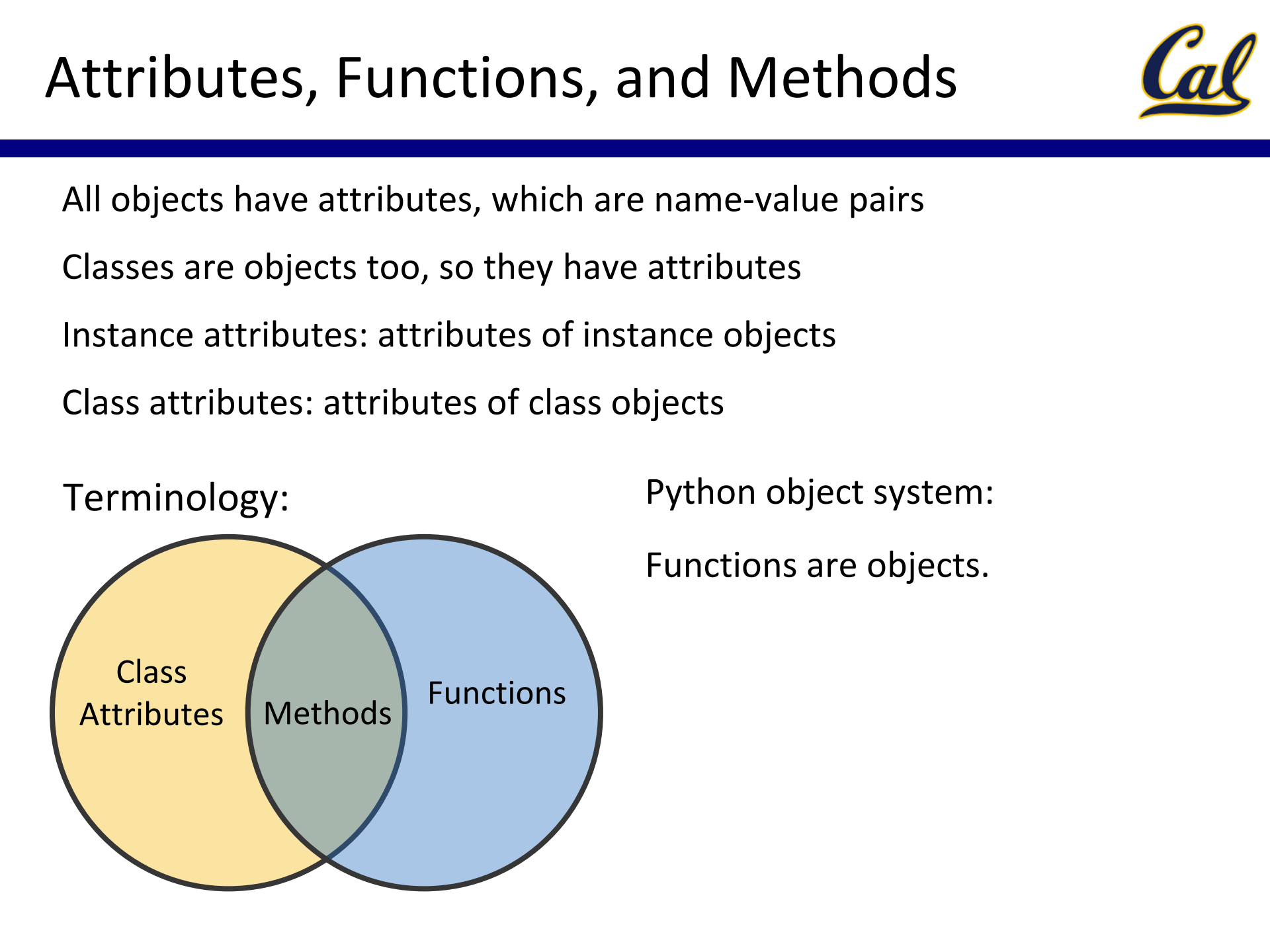


Python object system:

Attributes, Functions, and Methods



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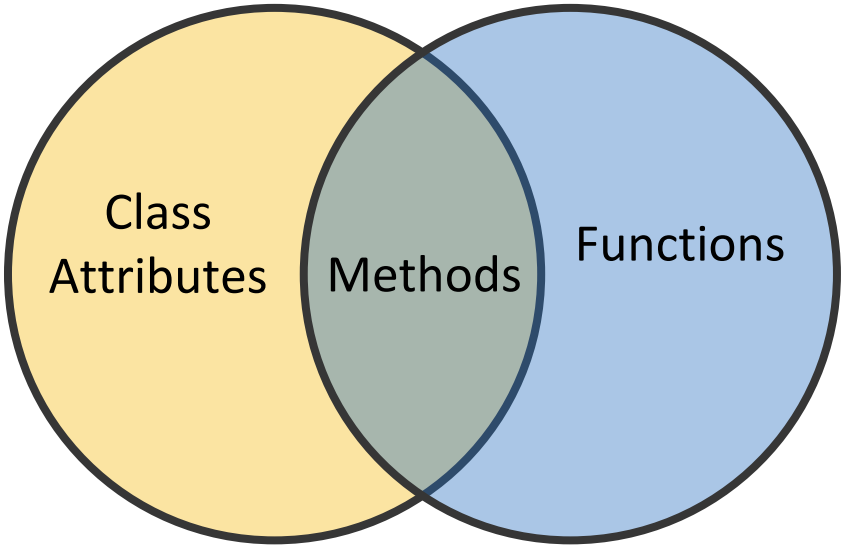

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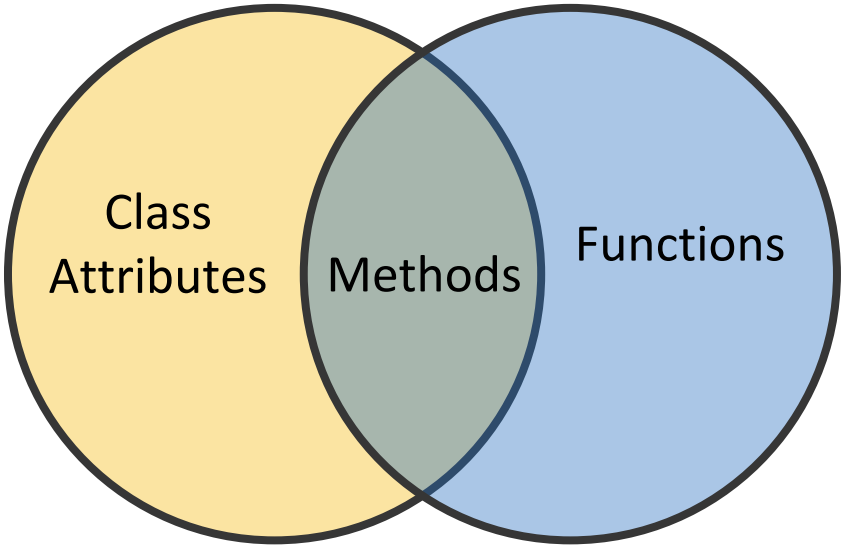

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Dot expressions on instances evaluate to bound methods for class attributes that are functions.

Looking Up Attributes by Name

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```

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class Account(object):

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

interest is not part of the instance that was somehow copied from the class!

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tom_account.interest = 0.08
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This expression evaluates to an object

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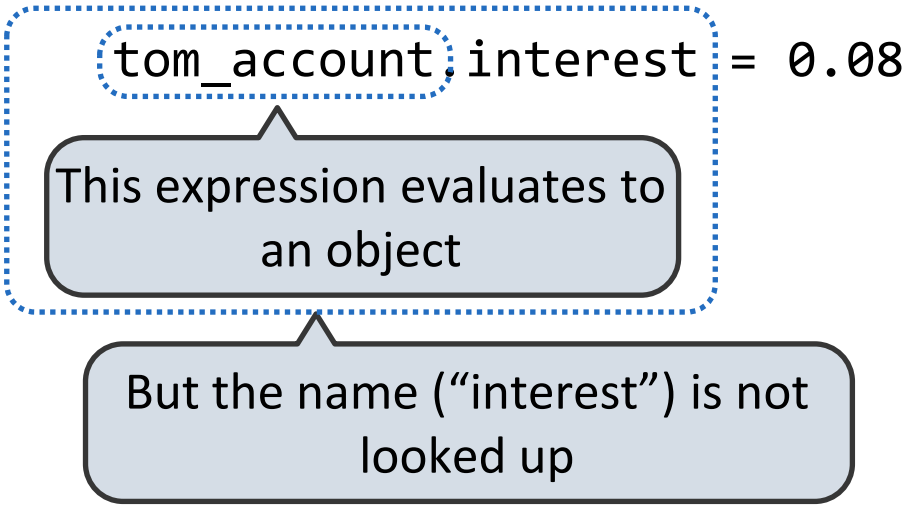

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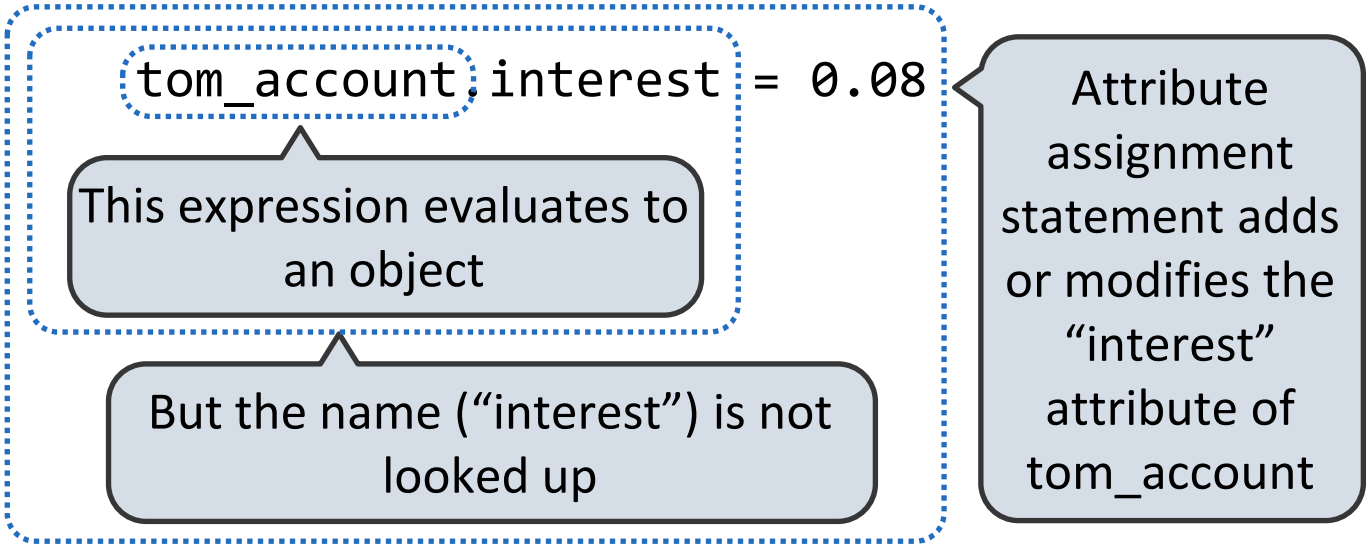

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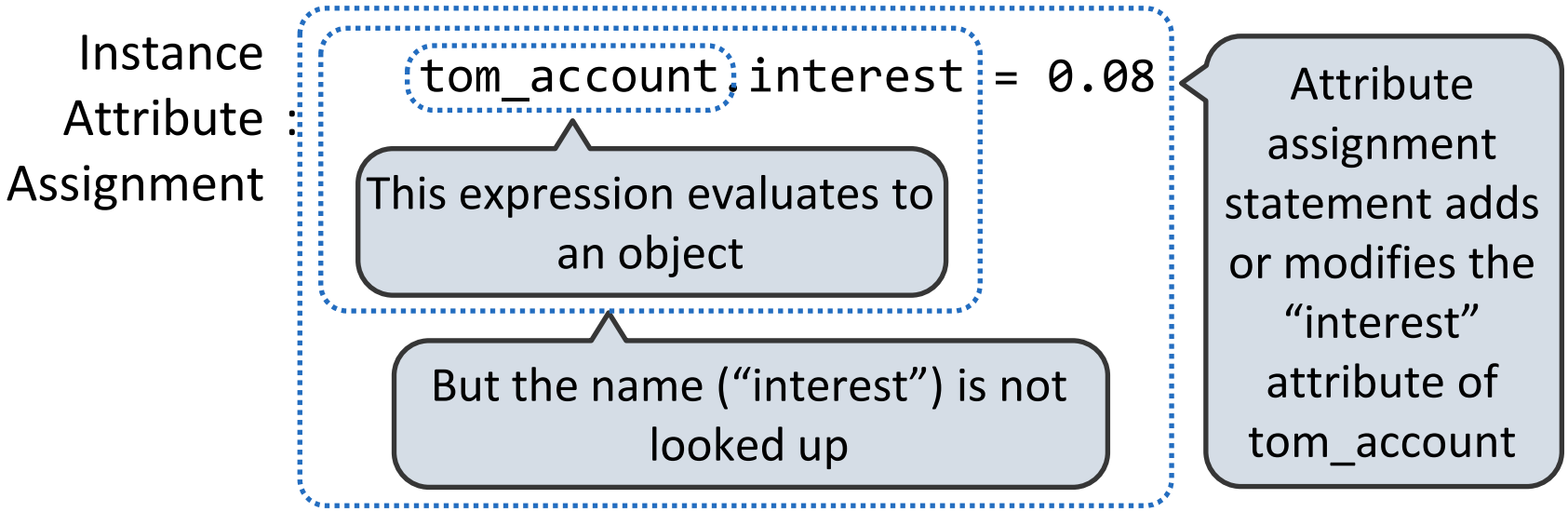

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- If the object is an instance, then assignment sets an instance attribute
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Instance Attribute Assignment :

```
tom_account.interest = 0.08
```

This expression evaluates to an object

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

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

Class Attribute Assignment :

```
Account.interest = 0.04
```

Attribute Assignment Statements

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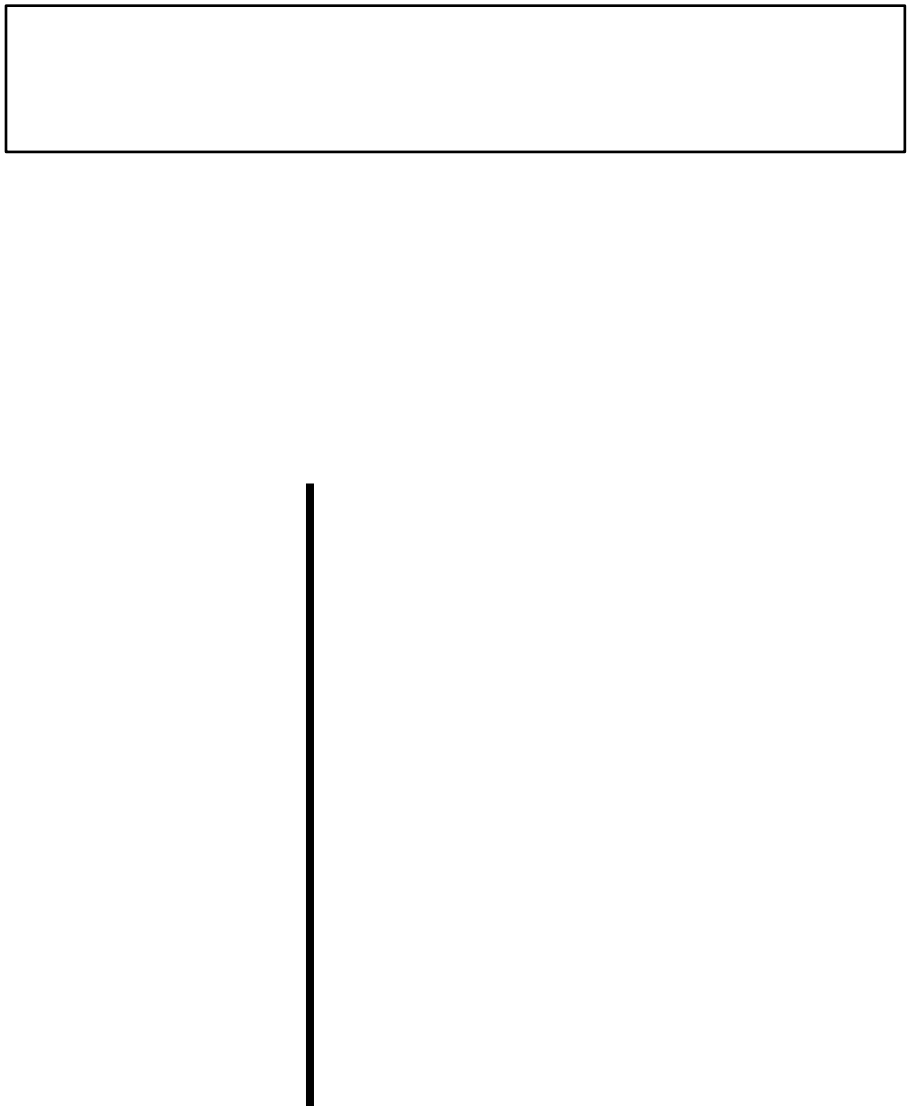

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```
interest: 0.02
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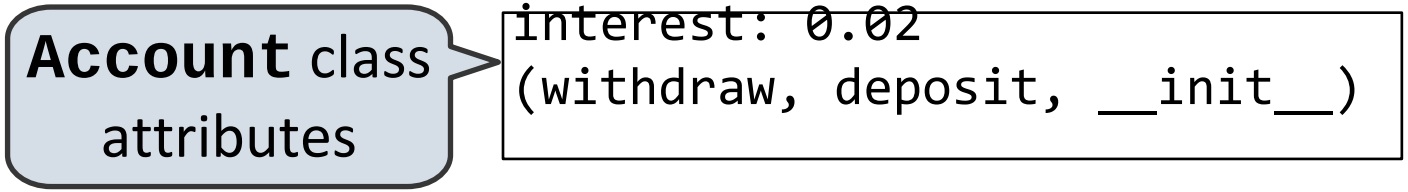

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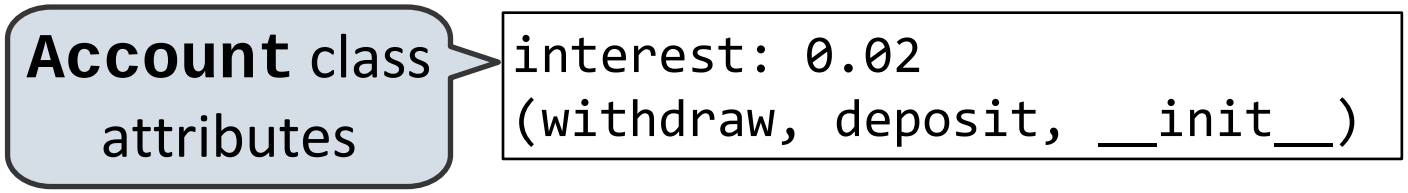


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>>> jim_account = Account('Jim')
```

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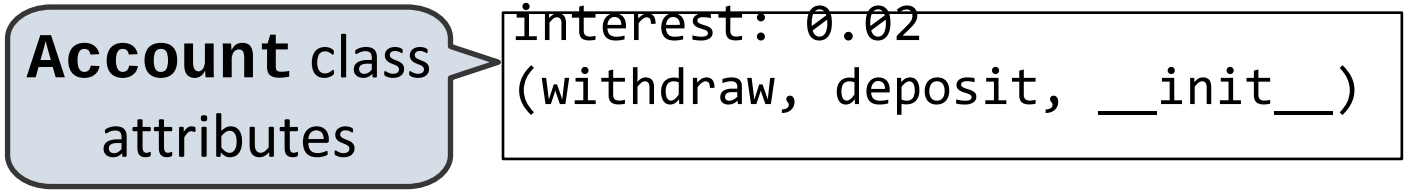
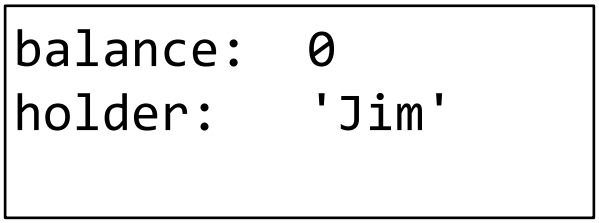
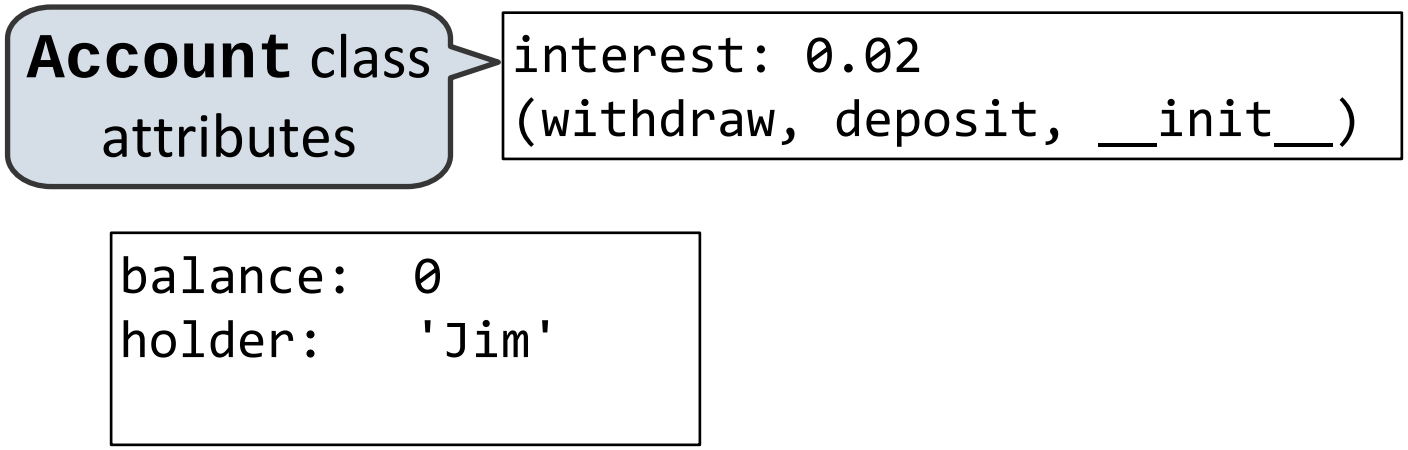




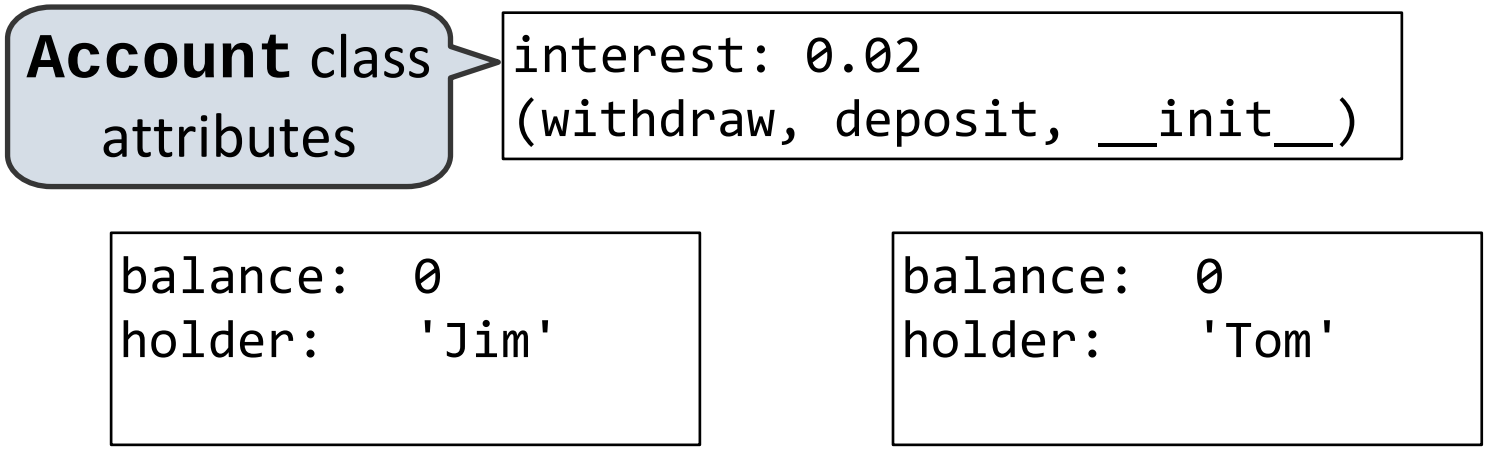

```
>>> jim_account = Account('Jim')
```

Attribute Assignment Statements



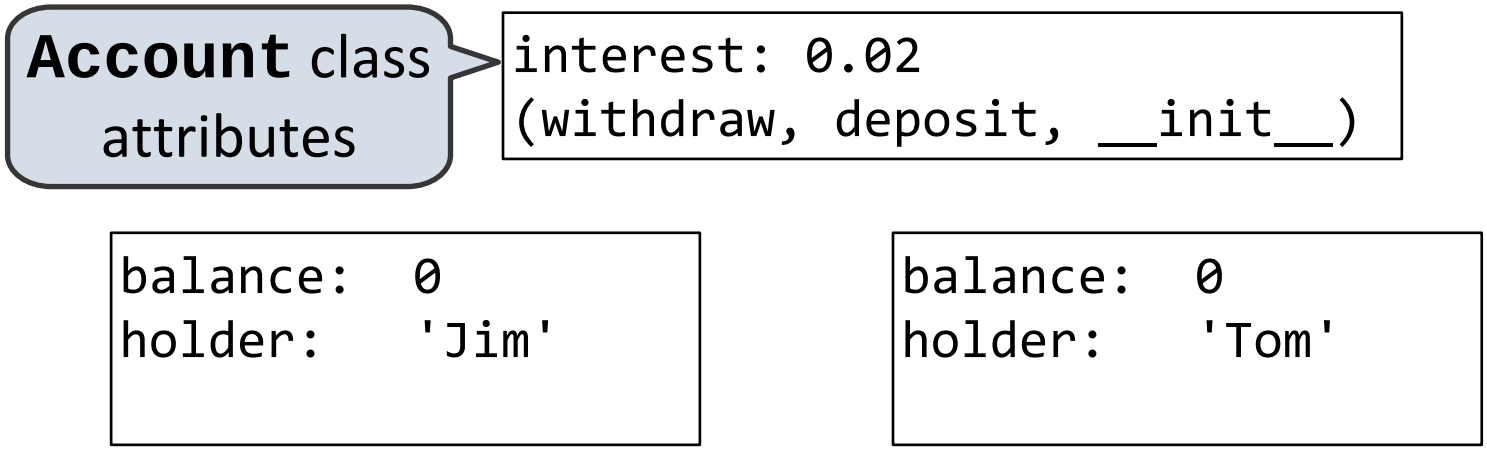

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
```

Attribute Assignment Statements



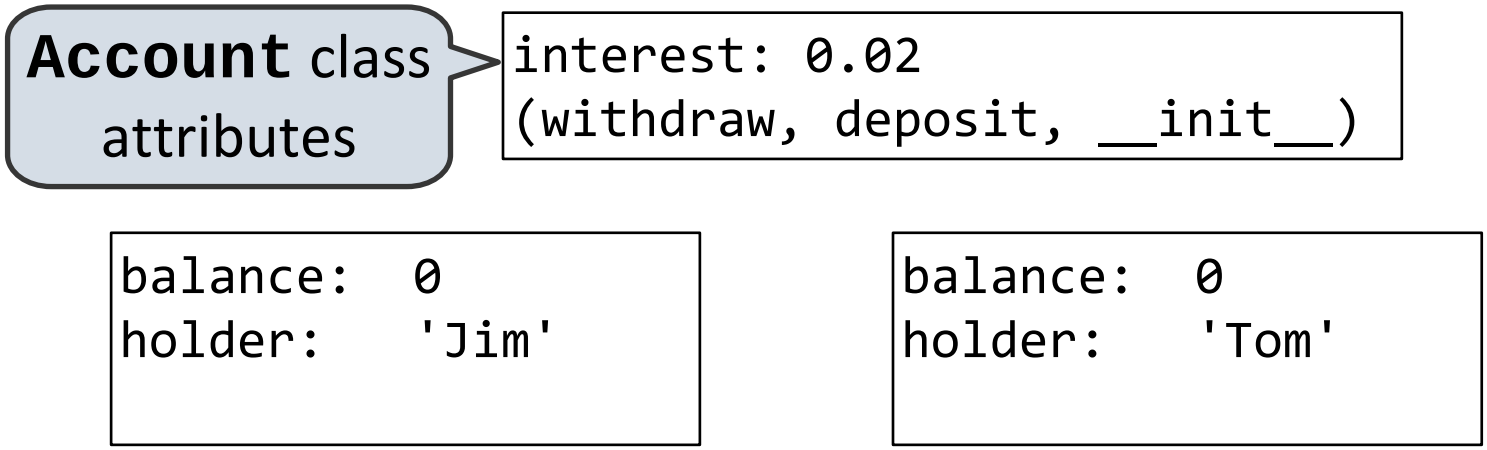

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
```

Attribute Assignment Statements



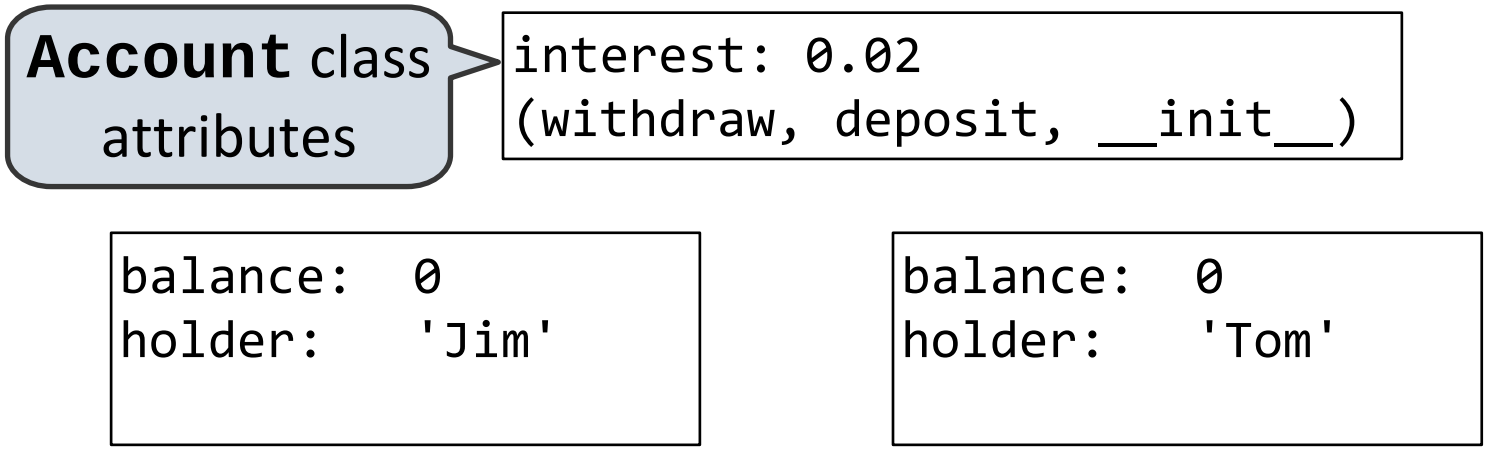

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
```

Attribute Assignment Statements



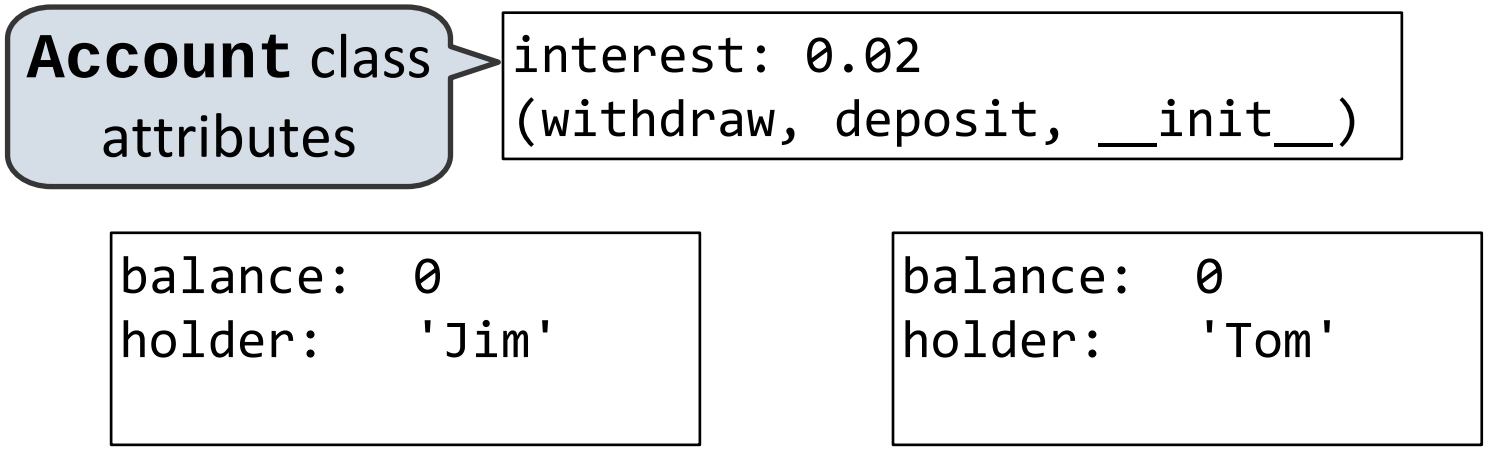

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
```

Attribute Assignment Statements



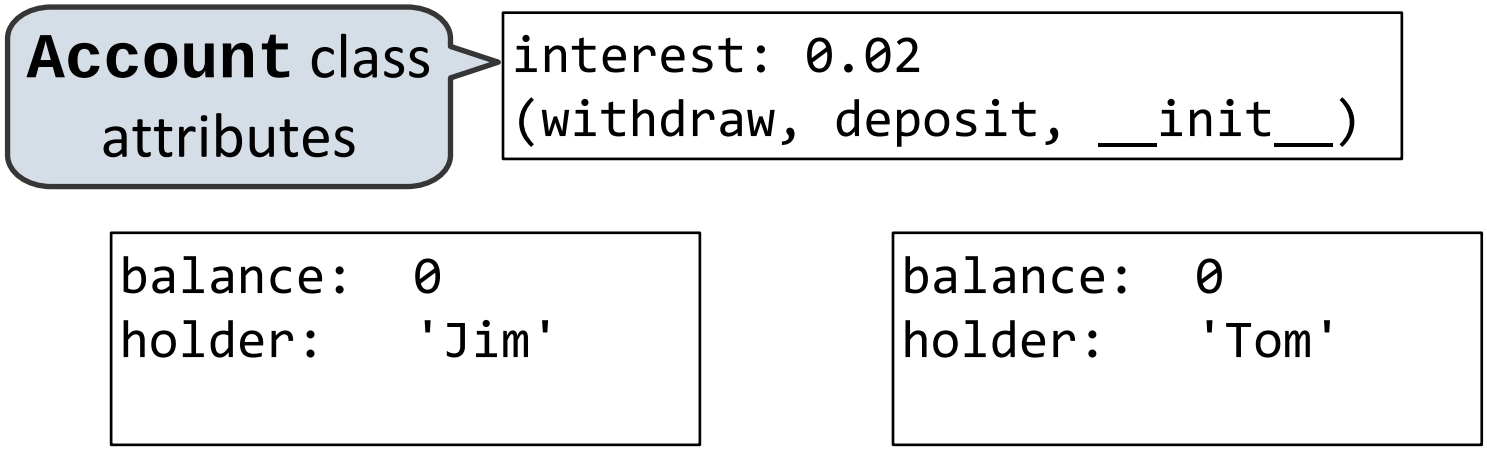

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
```

Attribute Assignment Statements



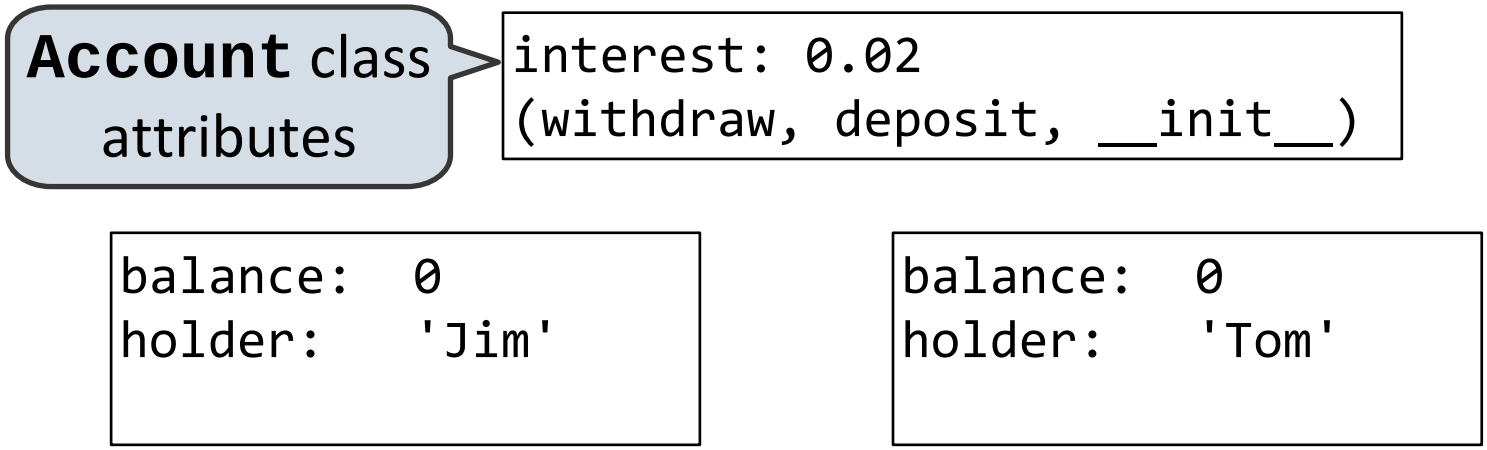

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
```

Attribute Assignment Statements



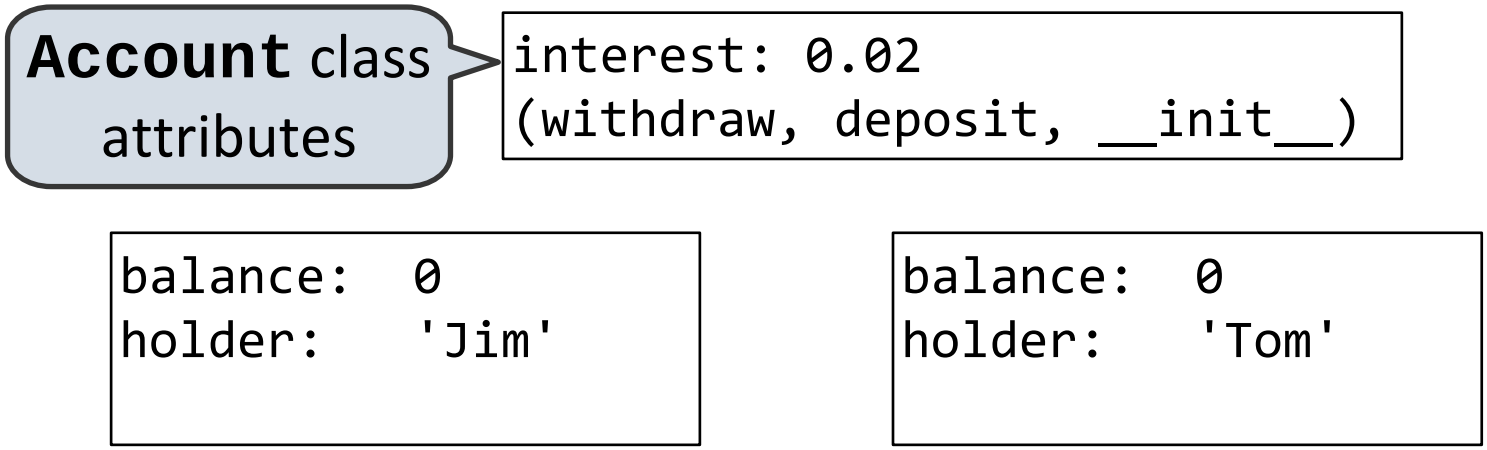

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
```

Attribute Assignment Statements



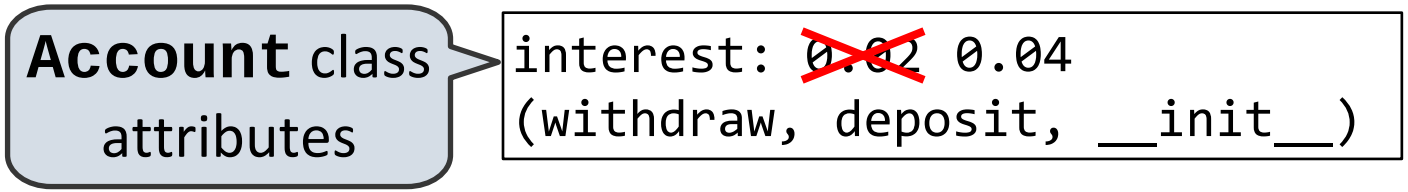

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
```

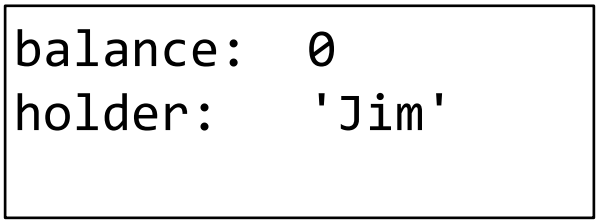
Attribute Assignment Statements

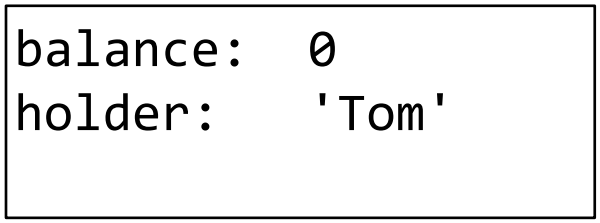



```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
```

Attribute Assignment Statements

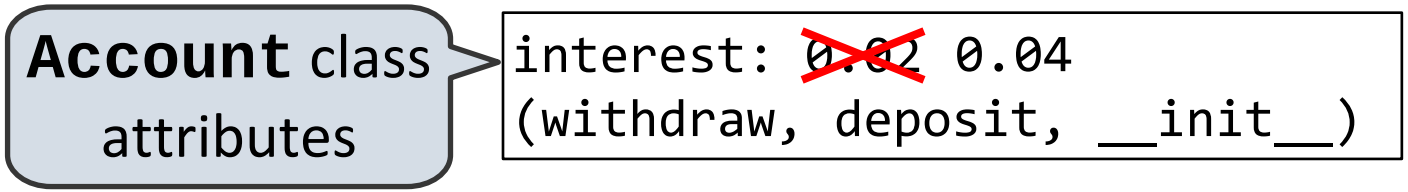


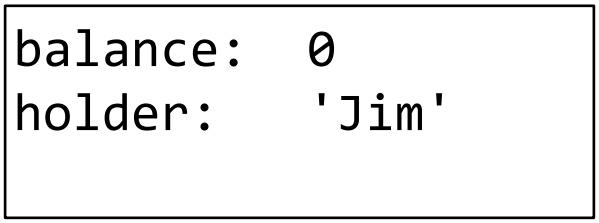


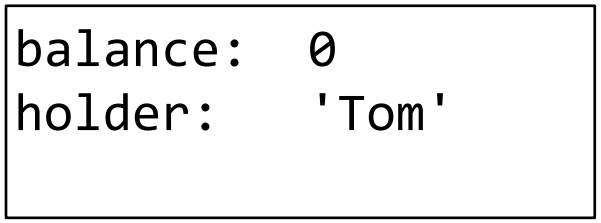



```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
```

Attribute Assignment Statements

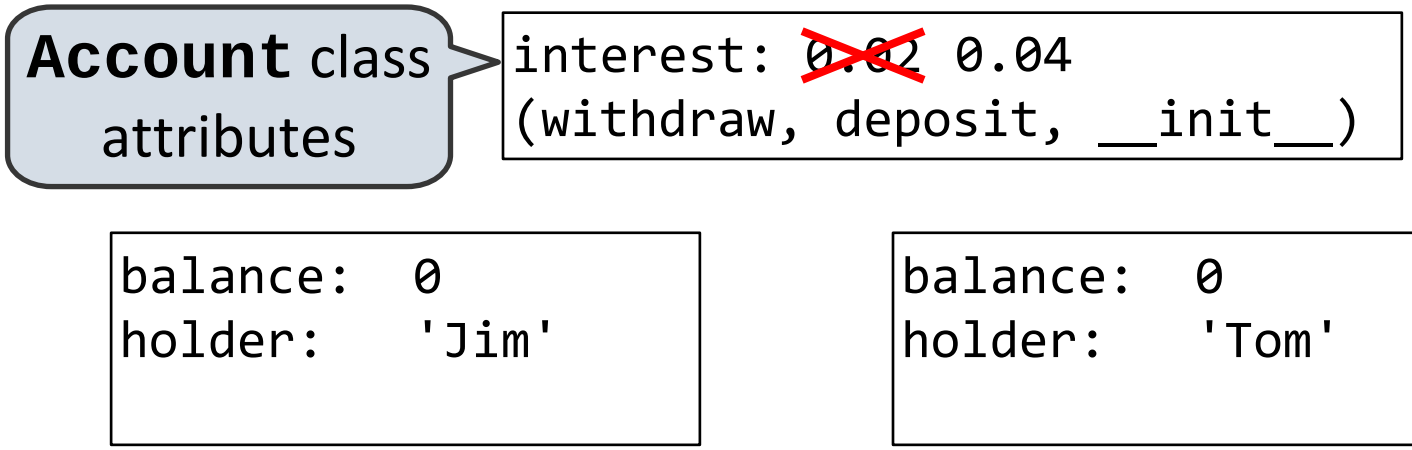






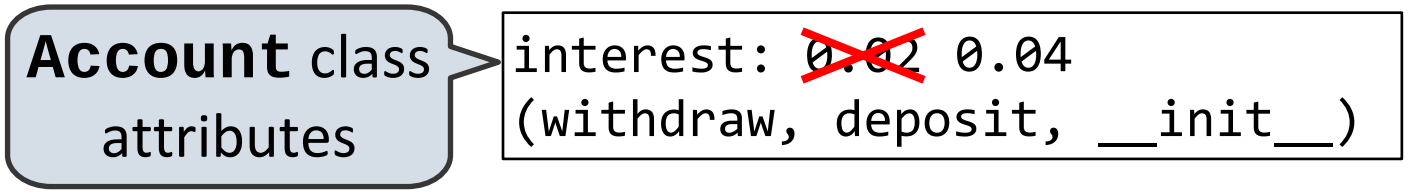

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
```

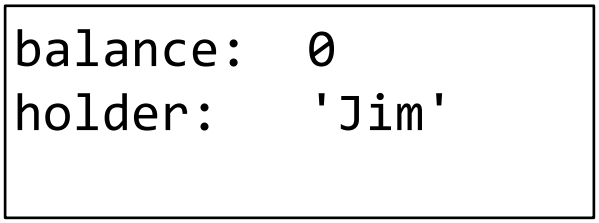
Attribute Assignment Statements

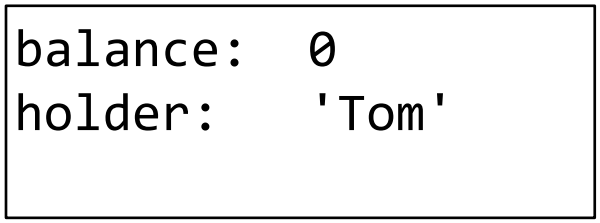



```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

Attribute Assignment Statements



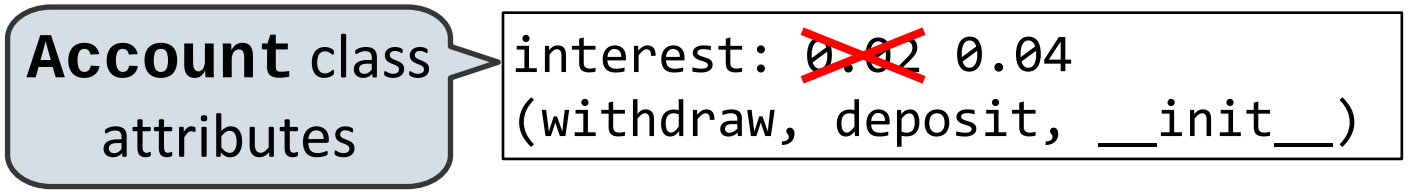


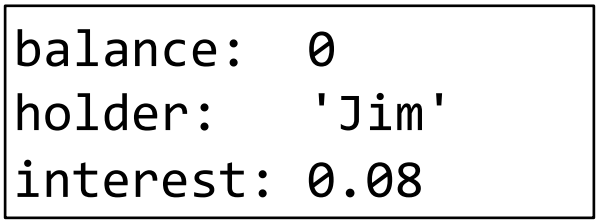


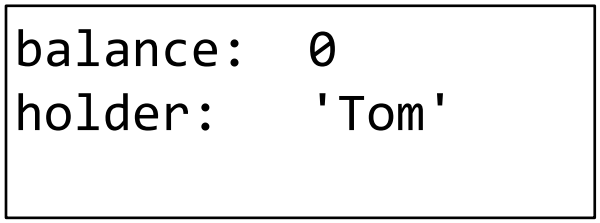

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

```
>>> jim_account.interest = 0.08
```

Attribute Assignment Statements



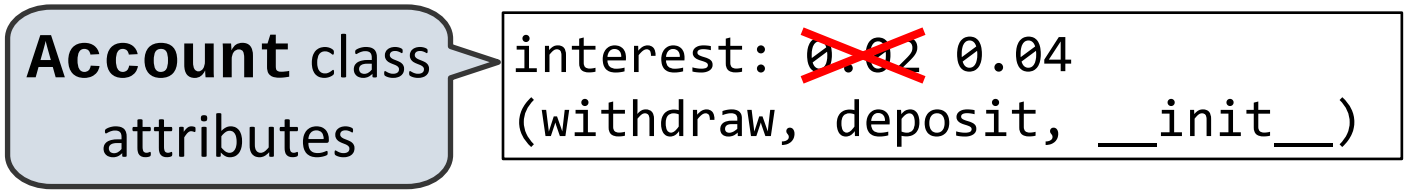


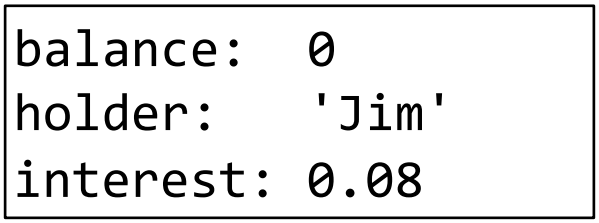


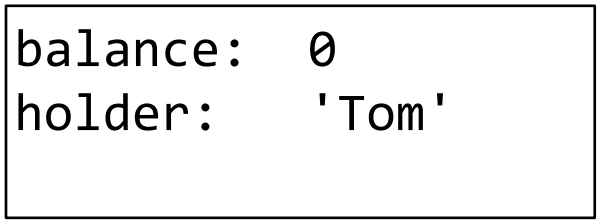

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

```
>>> jim_account.interest = 0.08
```

Attribute Assignment Statements



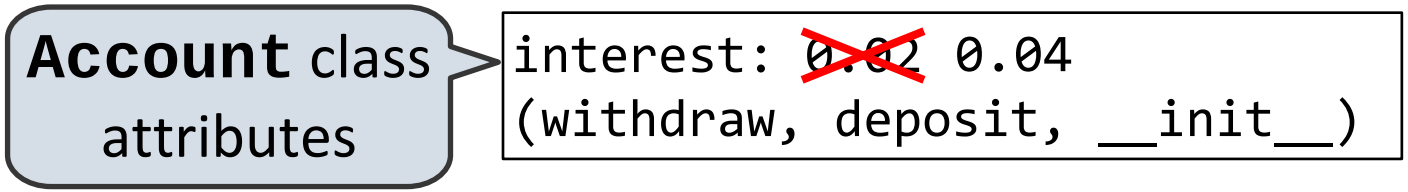





```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

```
>>> jim_account.interest = 0.08
>>> jim_account.interest
```

Attribute Assignment Statements



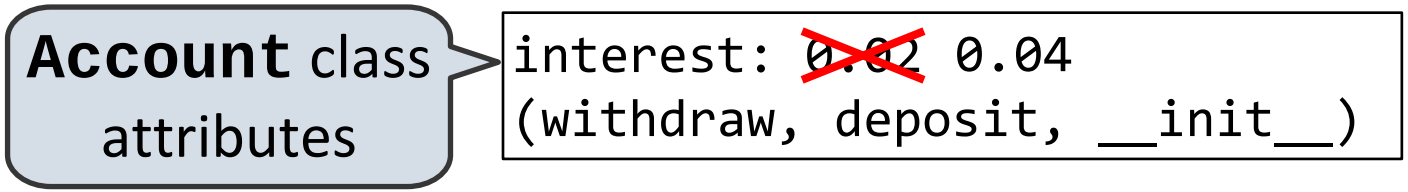

```
balance:  0
holder:   'Jim'
interest: 0.08
```

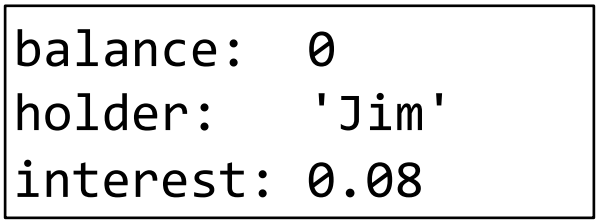
```
balance:  0
holder:   'Tom'
```

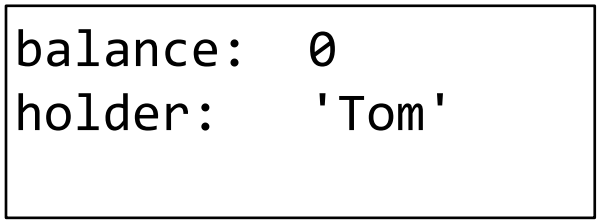
```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

```
>>> jim_account.interest = 0.08
>>> jim_account.interest
0.08
```

Attribute Assignment Statements



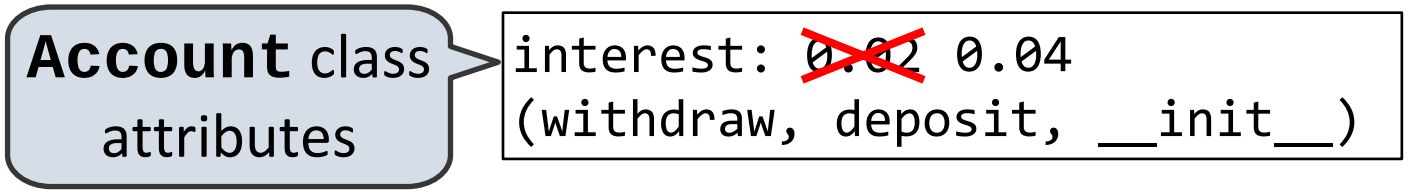


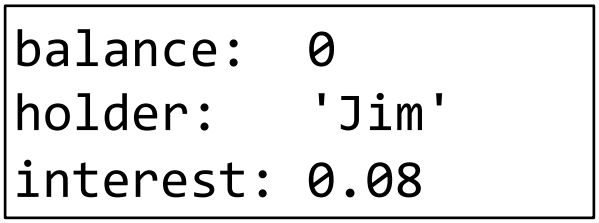


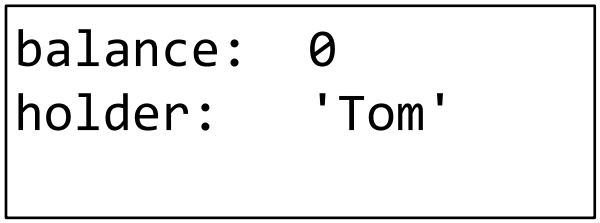

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

```
>>> jim_account.interest = 0.08
>>> jim_account.interest
0.08
>>> tom_account.interest
```

Attribute Assignment Statements



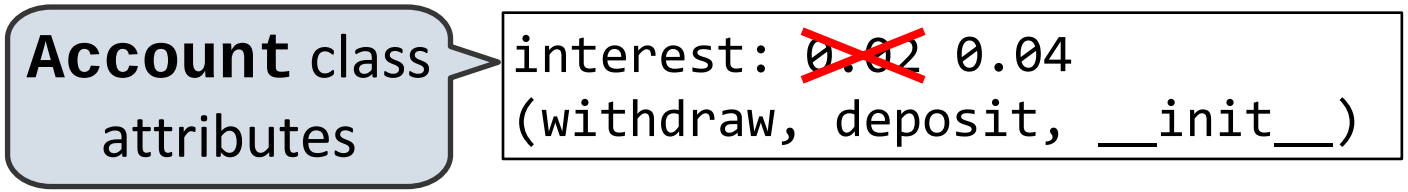


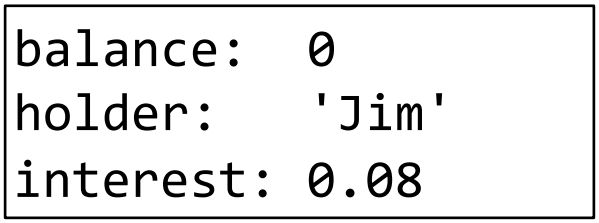


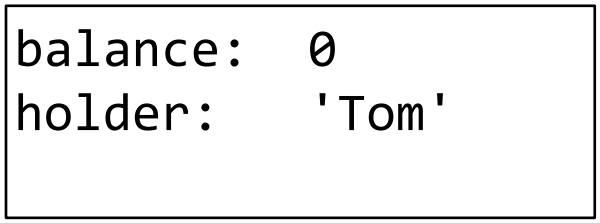

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

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

Attribute Assignment Statements



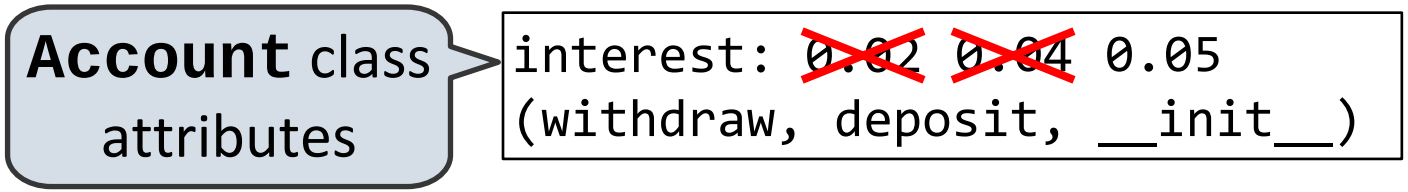





```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

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

Attribute Assignment Statements



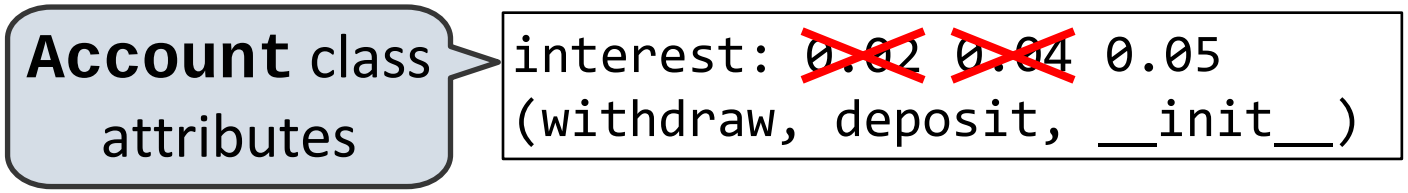

```
balance:  0
holder:   'Jim'
interest: 0.08
```

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

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

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

Attribute Assignment Statements



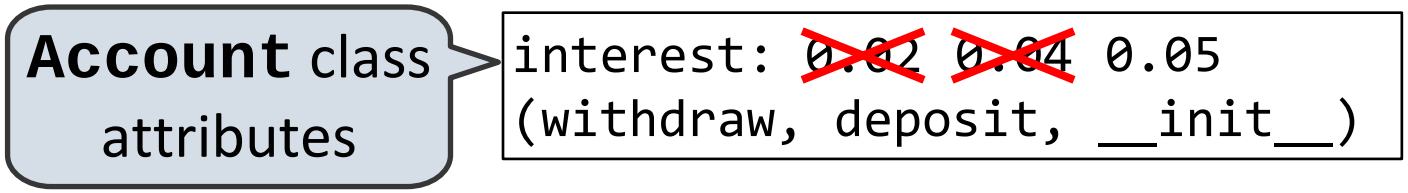

```
balance:  0
holder:   'Jim'
interest: 0.08
```

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

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

Attribute Assignment Statements




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

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

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

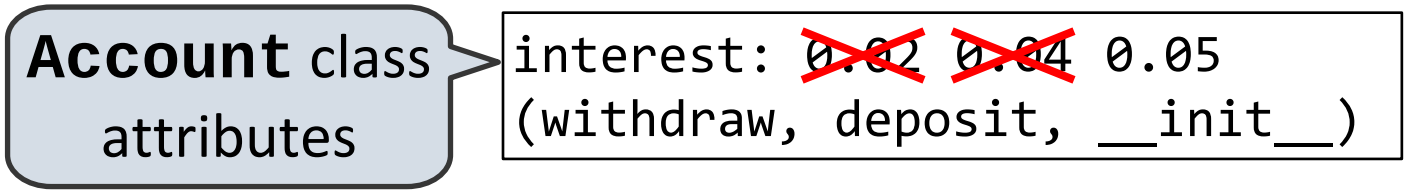
```
balance:  0
holder:   'Jim'
interest: 0.08
```

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

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

Attribute Assignment Statements




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

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

```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_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
>>> jim_account.interest
0.08
```

Inheritance

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A technique for relating classes together

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Common use: Similar classes differ in amount of specialization

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Two classes have overlapping attribute sets, but one represents a special case of the other.

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A technique for relating classes together

Common use: Similar classes differ in amount of specialization

Two classes have overlapping attribute sets, but one represents a special case of the other.

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

Inheritance

A technique for relating classes together

Common use: Similar classes differ in amount of specialization

Two classes have overlapping attribute sets, but one represents a special case of the other.

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

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

Inheritance

A technique for relating classes together

Common use: Similar classes differ in amount of specialization

Two classes have overlapping attribute sets, but one represents a special case of the other.

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

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

The subclass may override certain inherited attributes.

Inheritance

A technique for relating classes together

Common use: Similar classes differ in amount of specialization

Two classes have overlapping attribute sets, but one represents a special case of the other.

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

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

Inheritance Example

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

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Designing for Inheritance

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class CheckingAccount(Account):
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    def withdraw(self, amount):
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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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Look up attributes on instances whenever possible.

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Attribute look-up on base class

Preferable alternative to `CheckingAccount.withdraw_fee`

General Base Classes

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class Account(object):
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        if amount > self.balance:
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class Account(object):
    interest = 0.02

    def withdraw(self, amount):

        if amount > self.balance:
            return 'Insufficient funds'
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class Account(object):
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Nothing else needed in this class

Inheritance and Composition

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E.g., a bank has a collection of bank accounts it manages.

So, A bank has a list of **`Account`** instances as an attribute.

No local state at all? Just write a pure function!

Multiple Inheritance

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```
class SavingsAccount(Account):
    deposit_fee = 2
    def deposit(self, amount):
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- A $2 fee for deposits
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```
class AsSeenOnTVAccount(CheckingAccount, SavingsAccount):
    def __init__(self, account_holder):
        self.holder = account_holder
        self.balance = 1           # A free dollar!
```

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A class may inherit from multiple base classes in Python.

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

Instance attribute

SavingsAccount method

```
>>> such_a_deal = AsSeenOnTVAccount("John")
>>> such_a_deal.balance
1
>>> such_a_deal.deposit(20)
19
>>> such_a_deal.withdraw(5)
13
```

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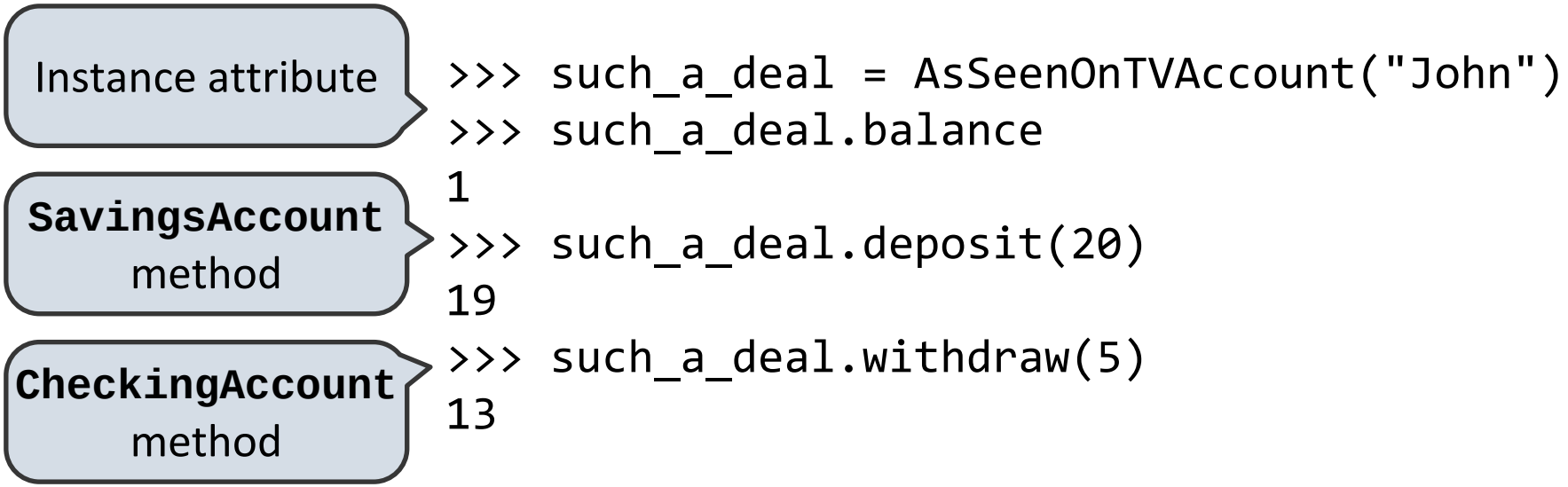
Resolving Ambiguous Class Attribute Names



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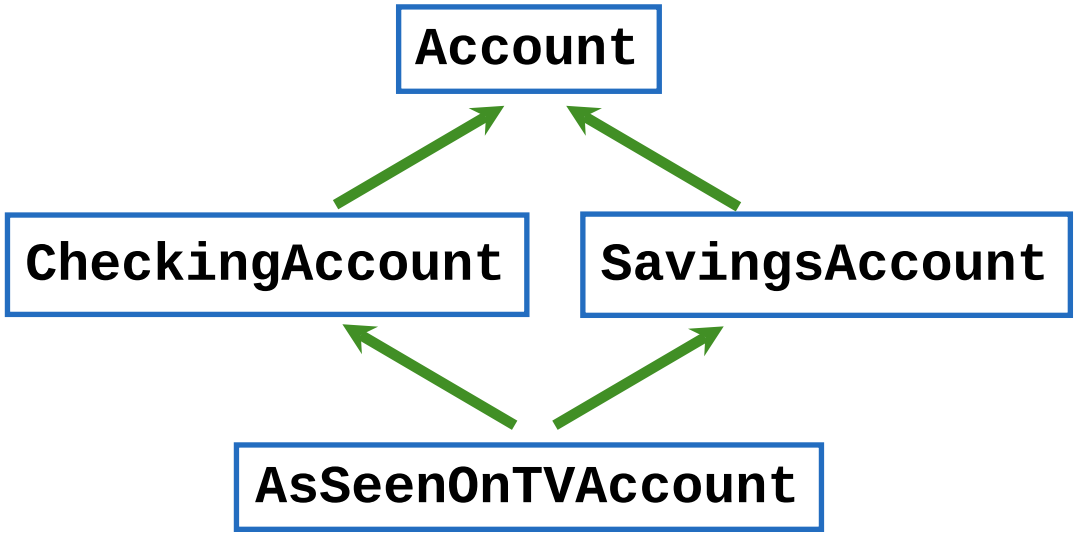

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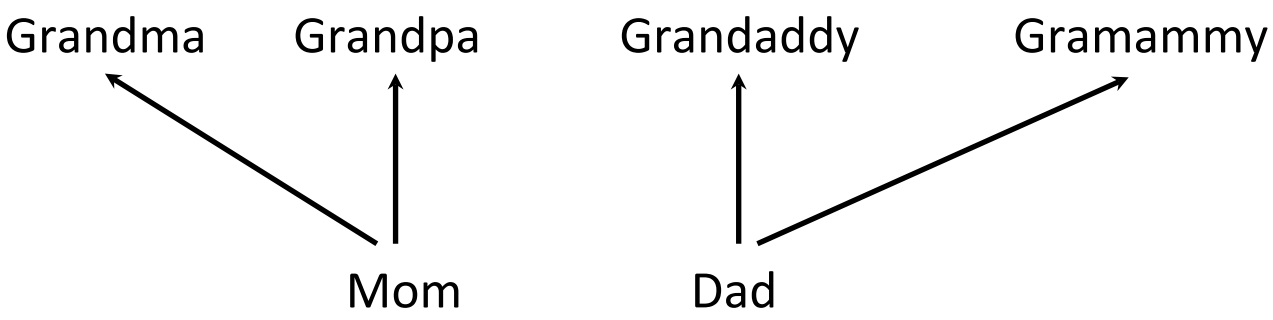
Human Relationships

Human Relationships

Grandma Grandpa Grandaddy Gramammy

Human Relationships



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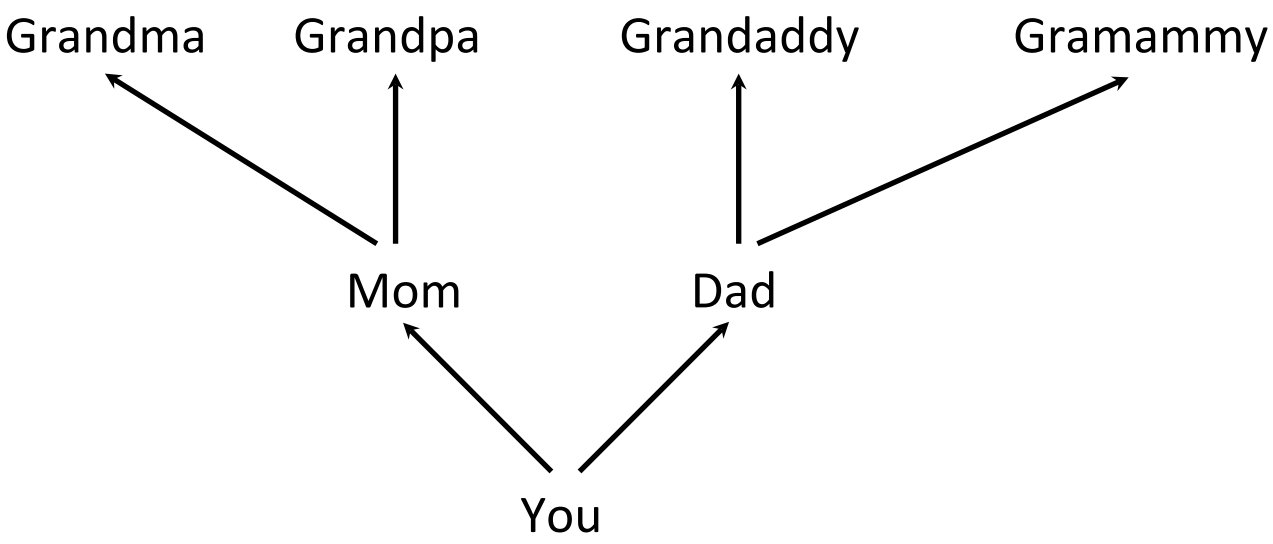

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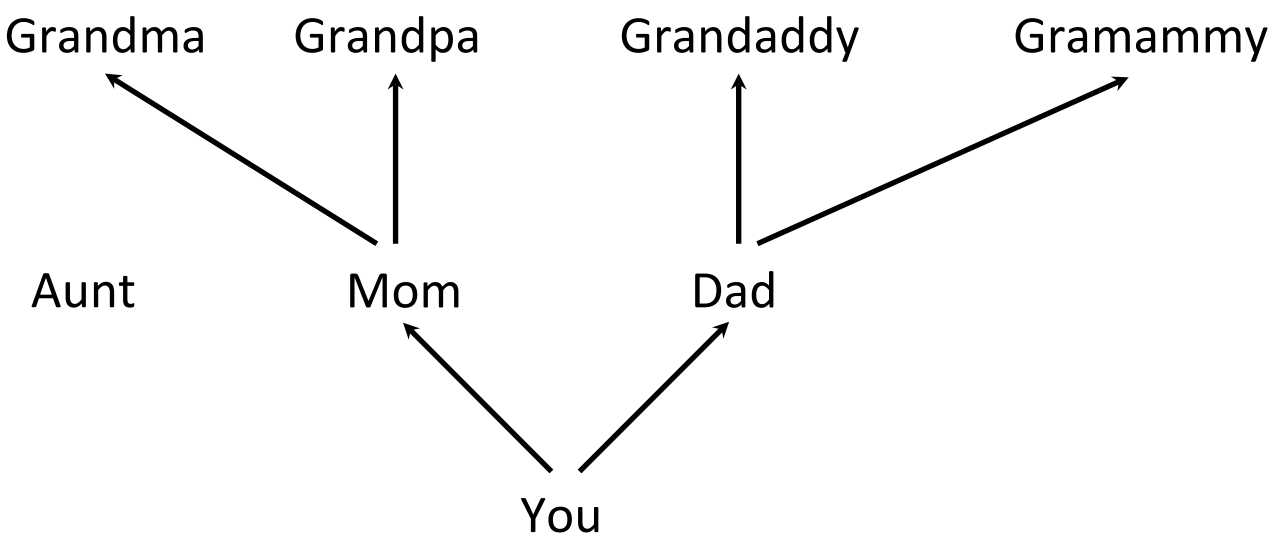

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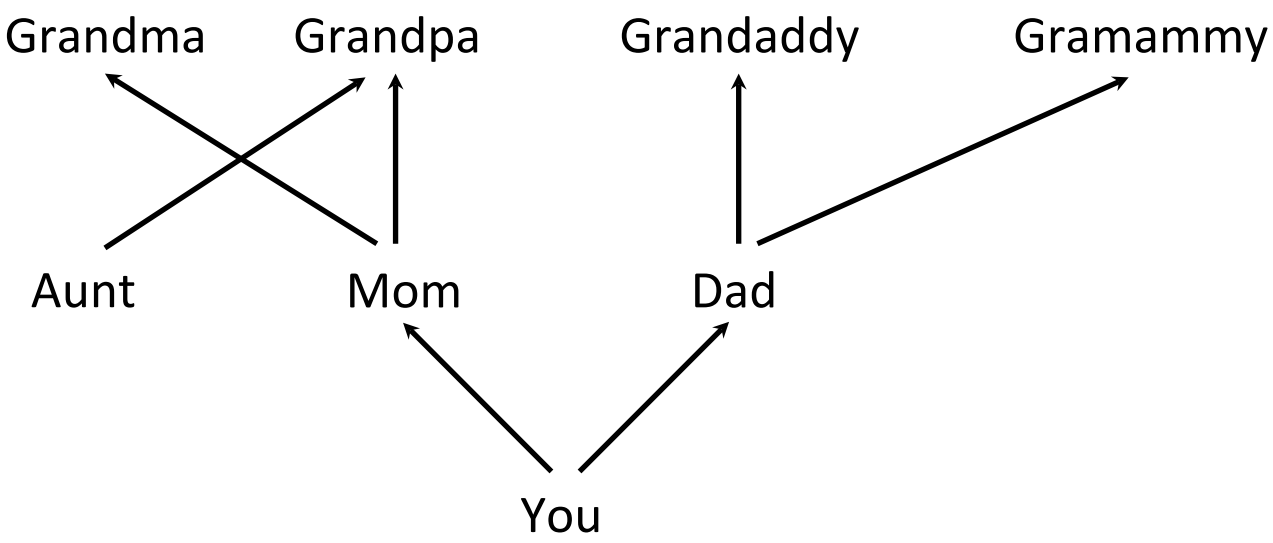

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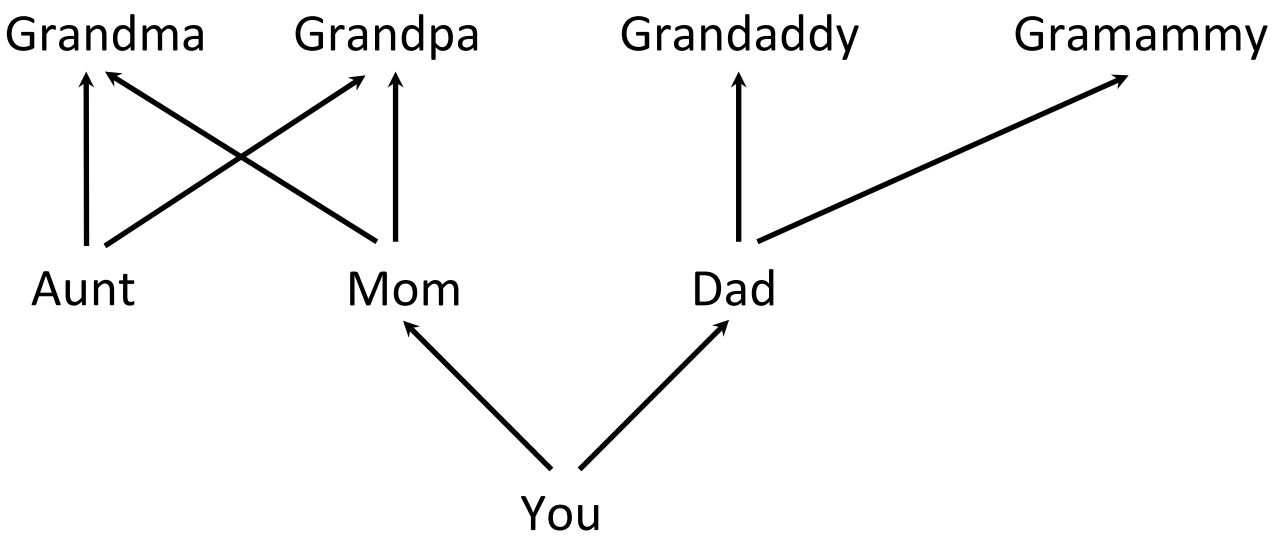

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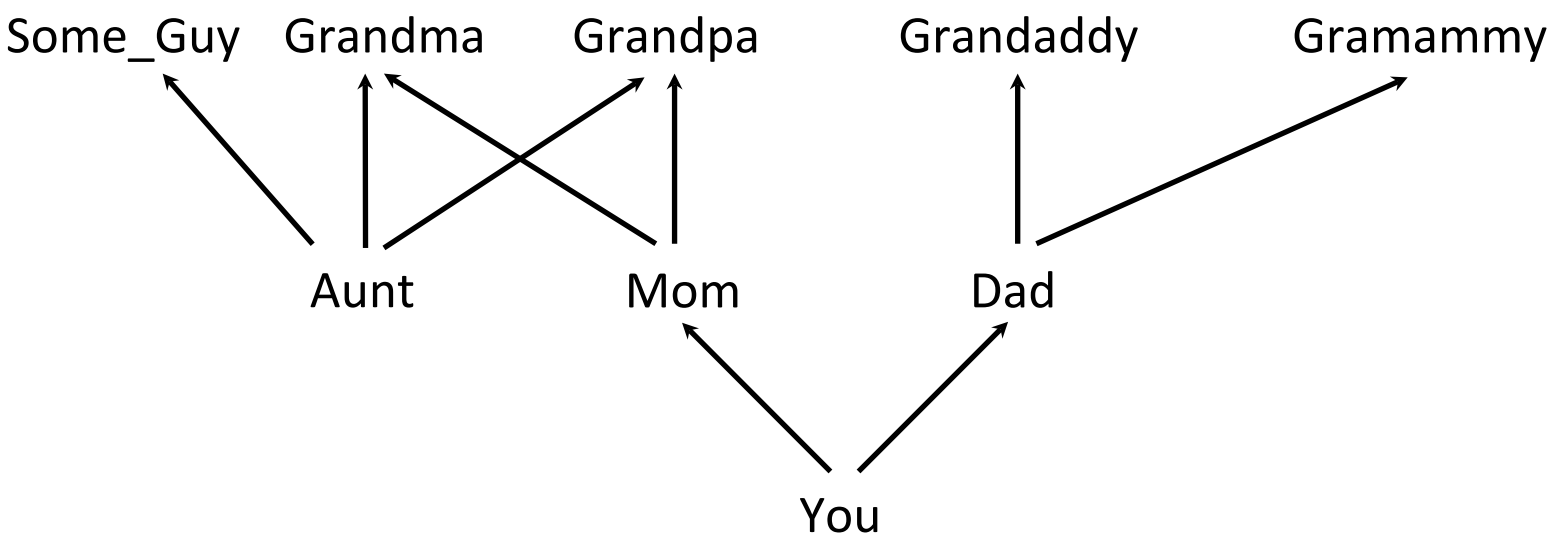

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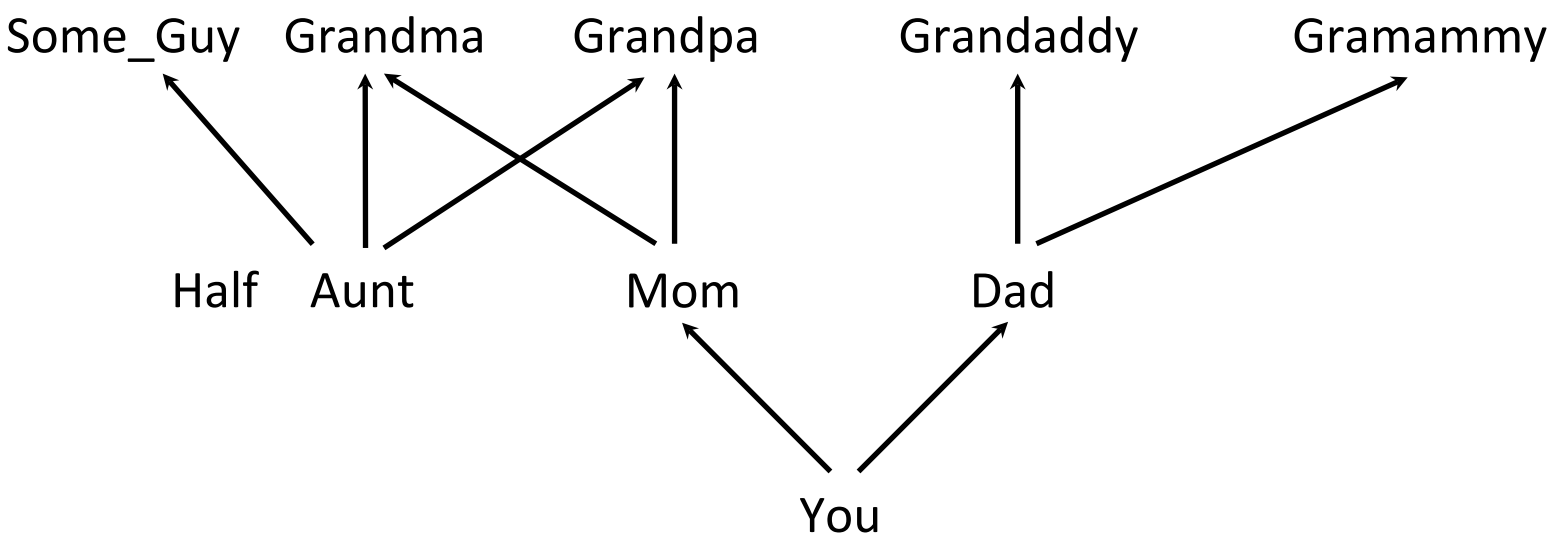

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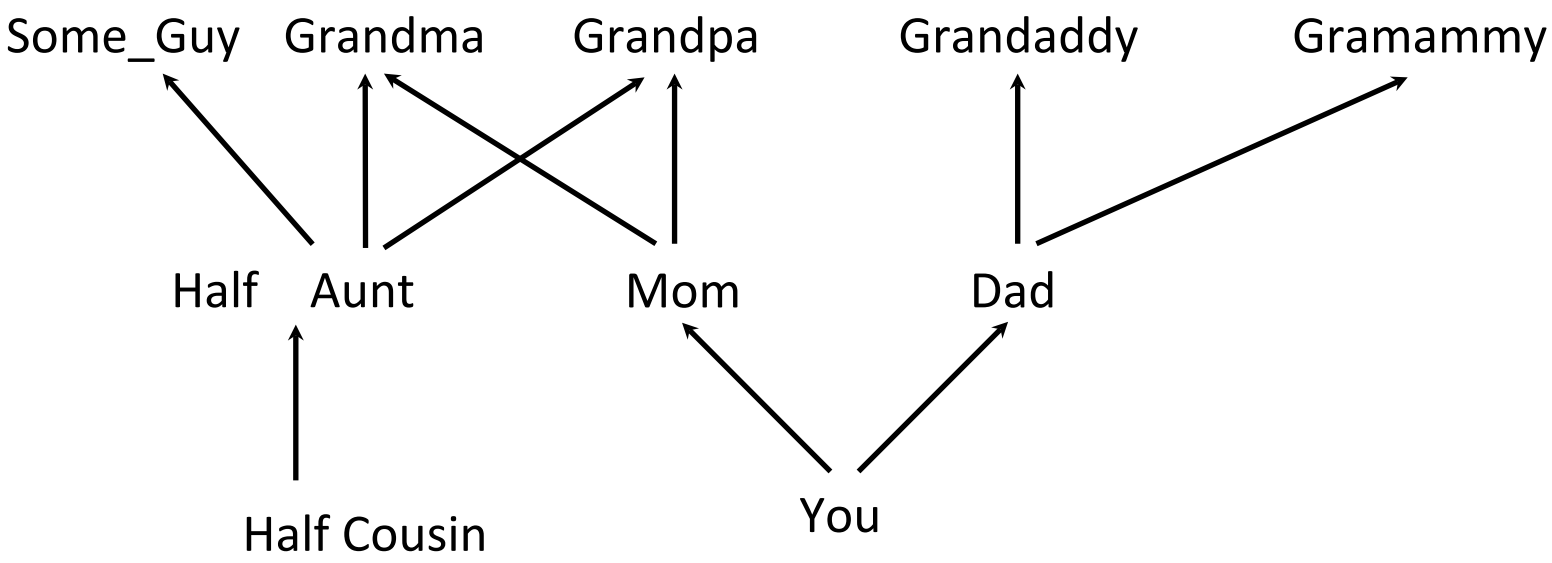

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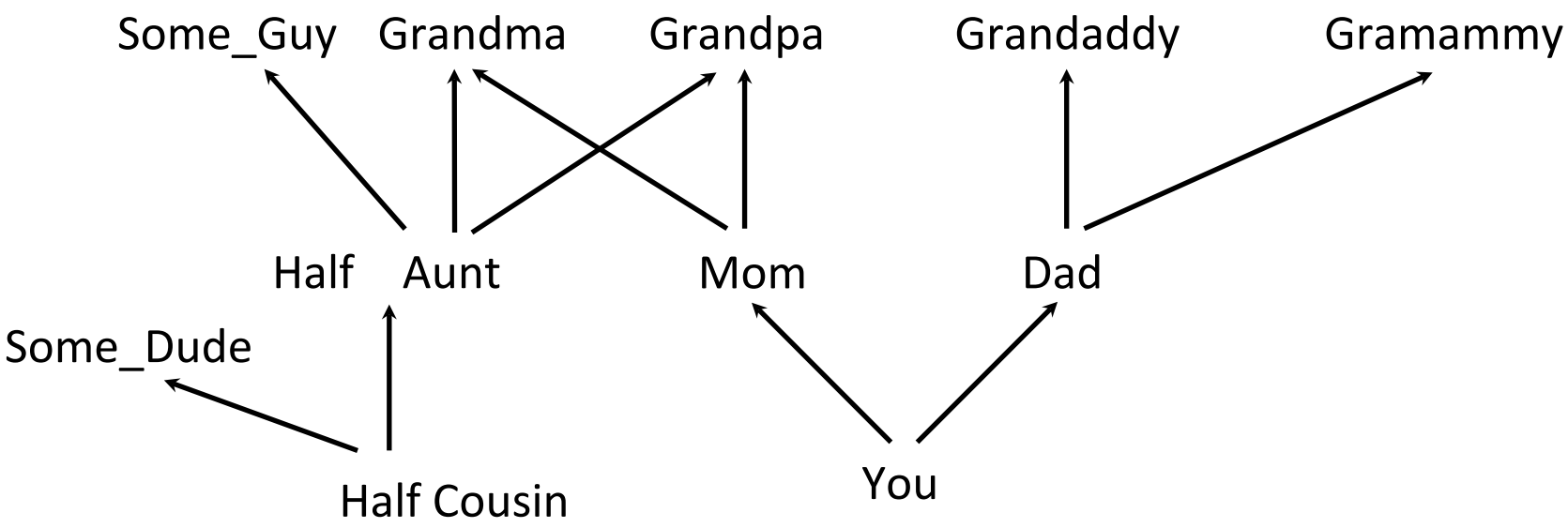

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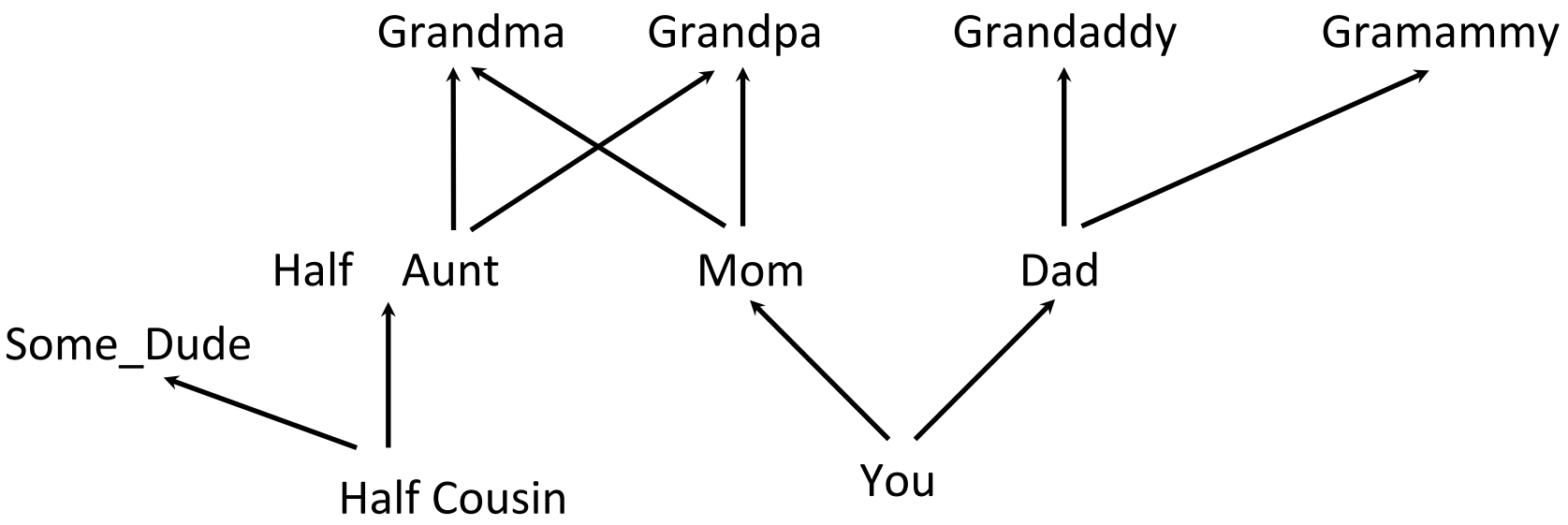

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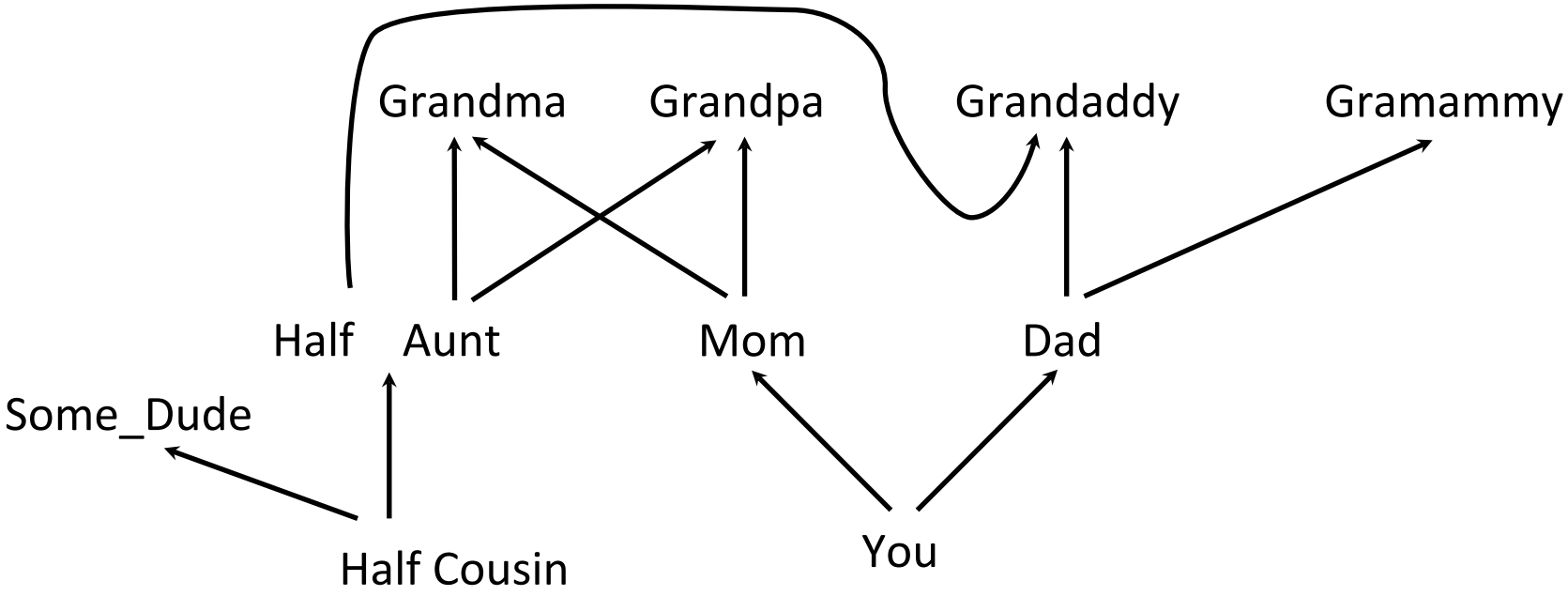

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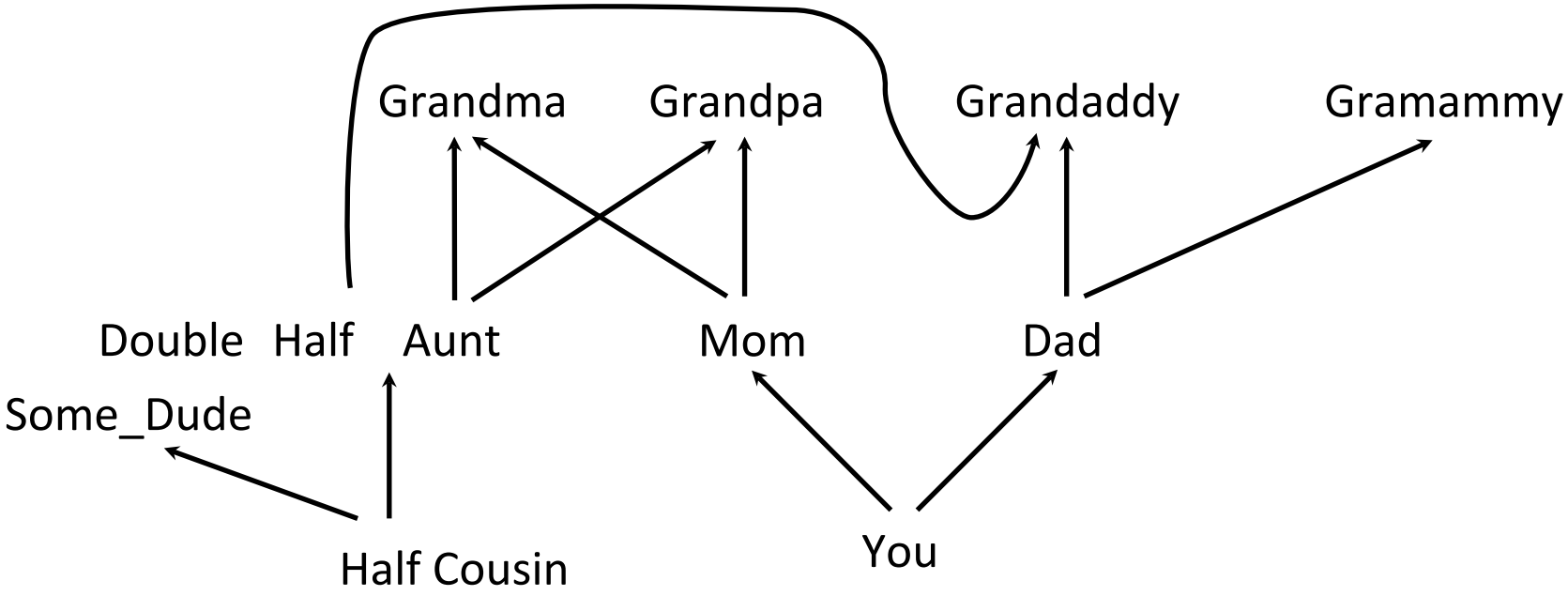

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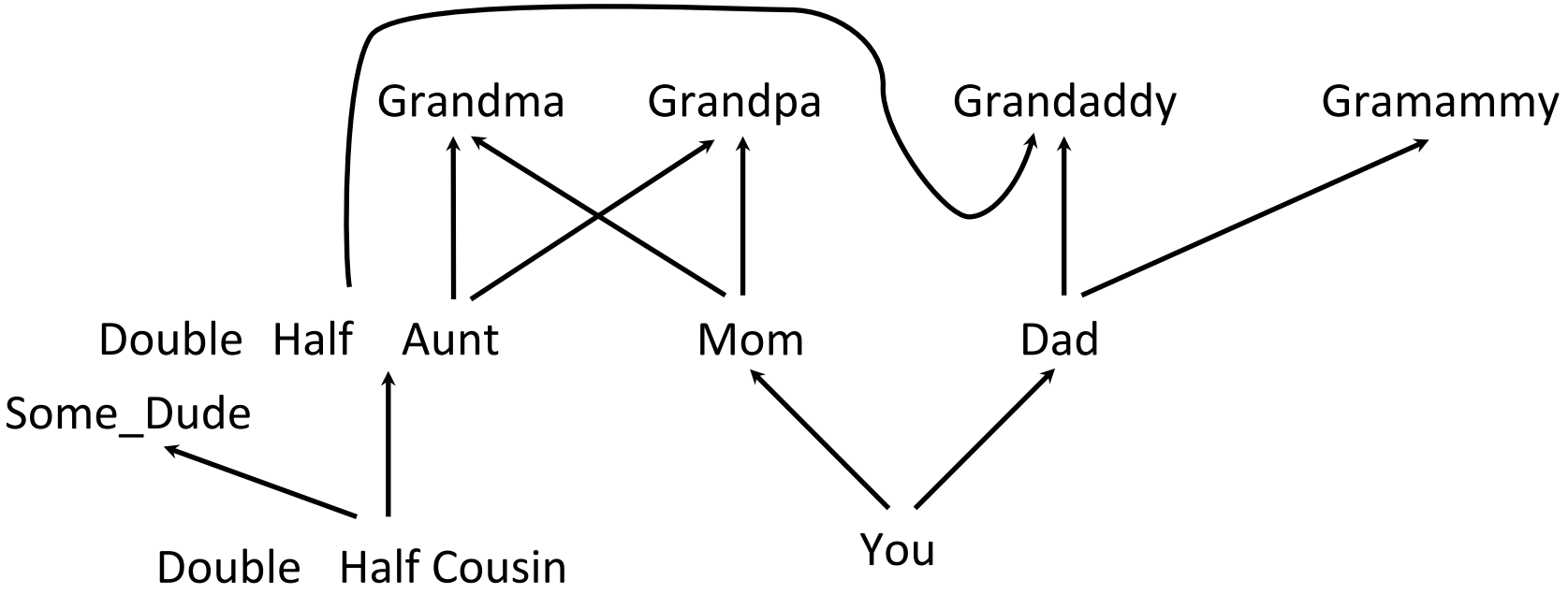

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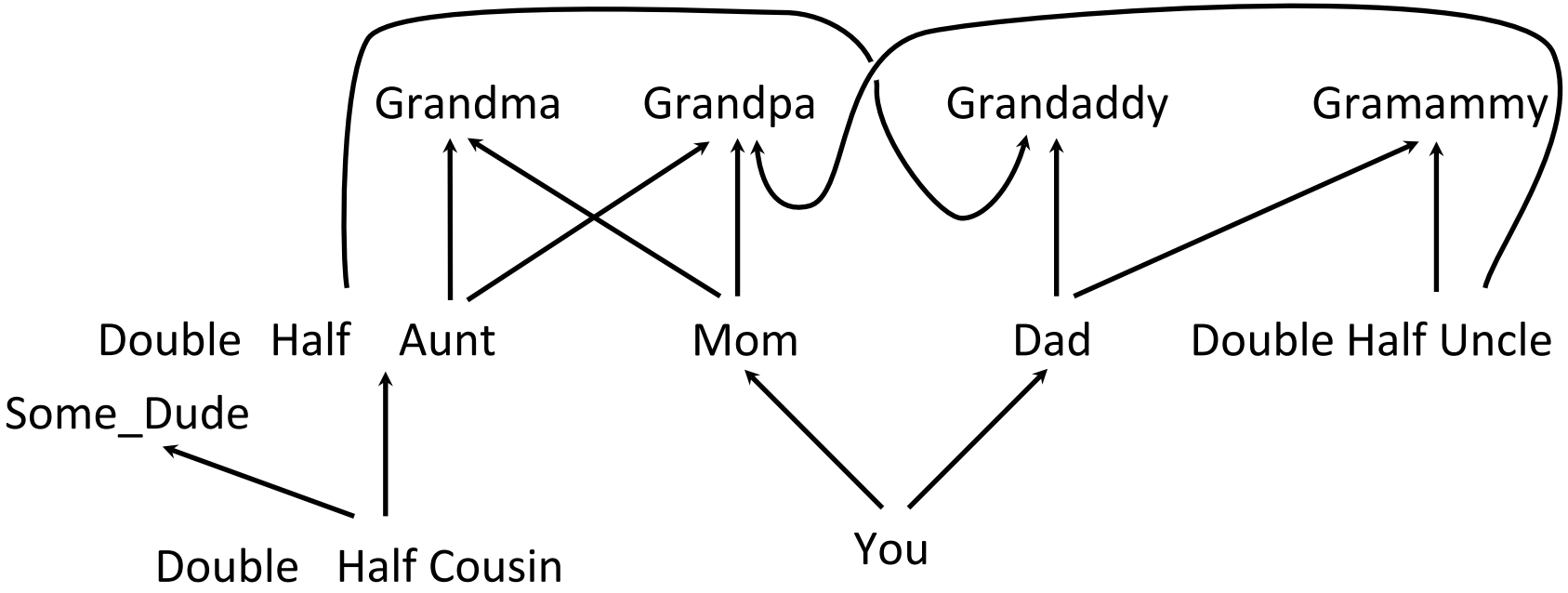

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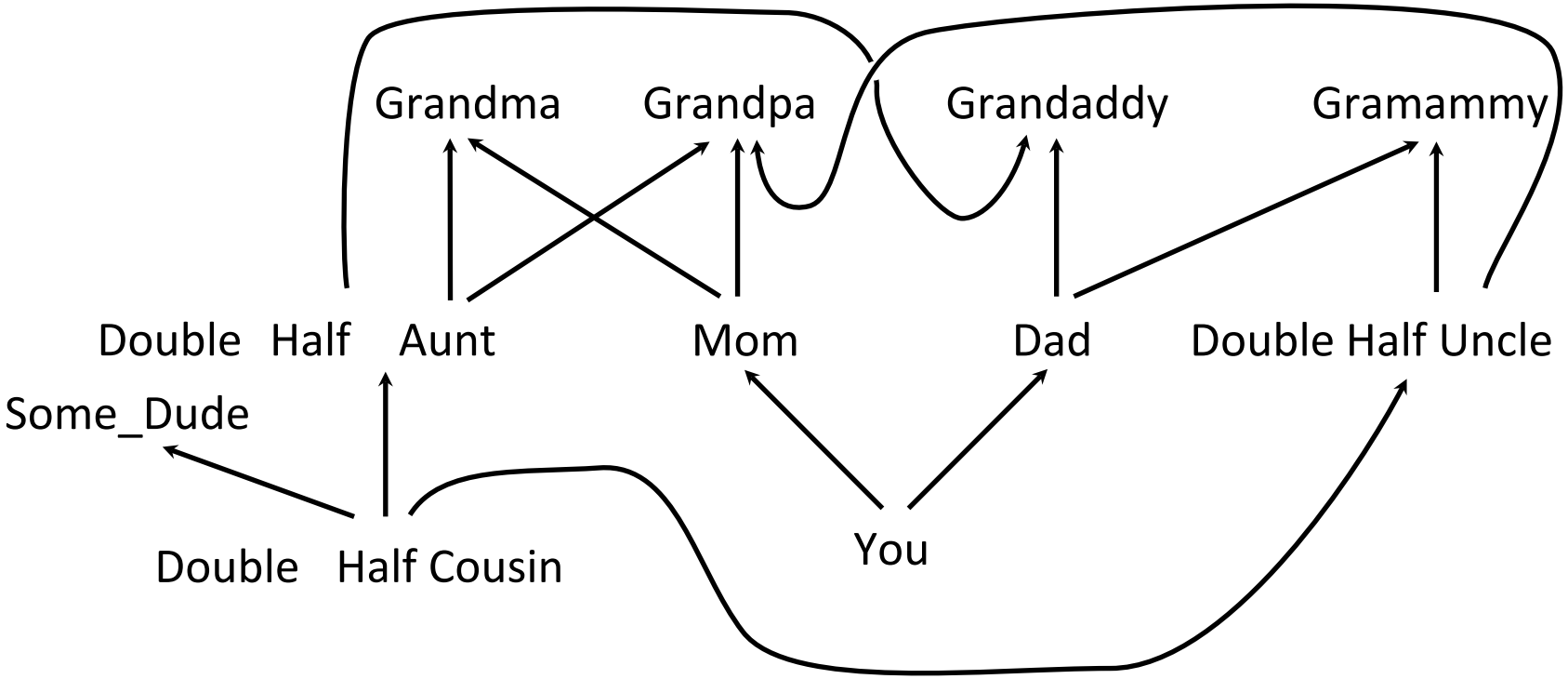

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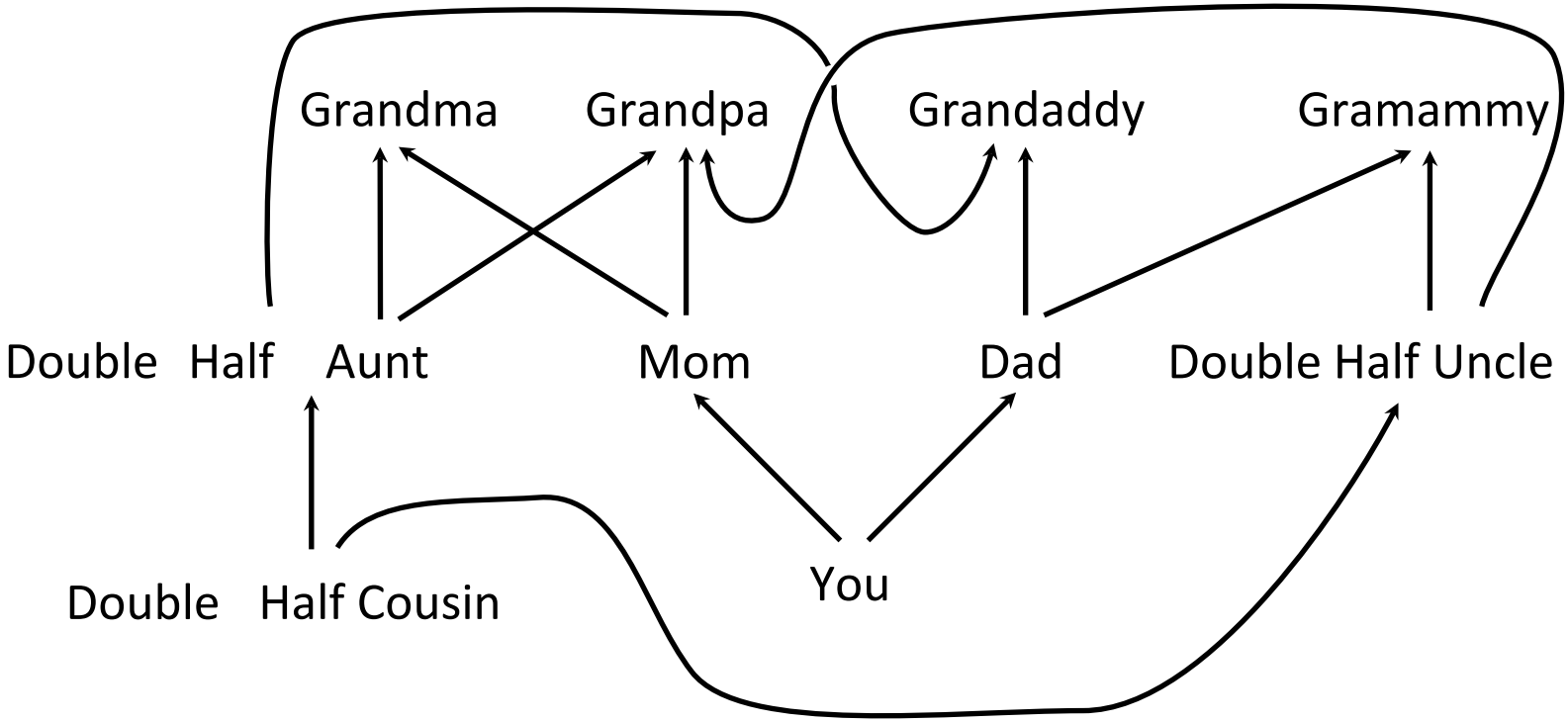

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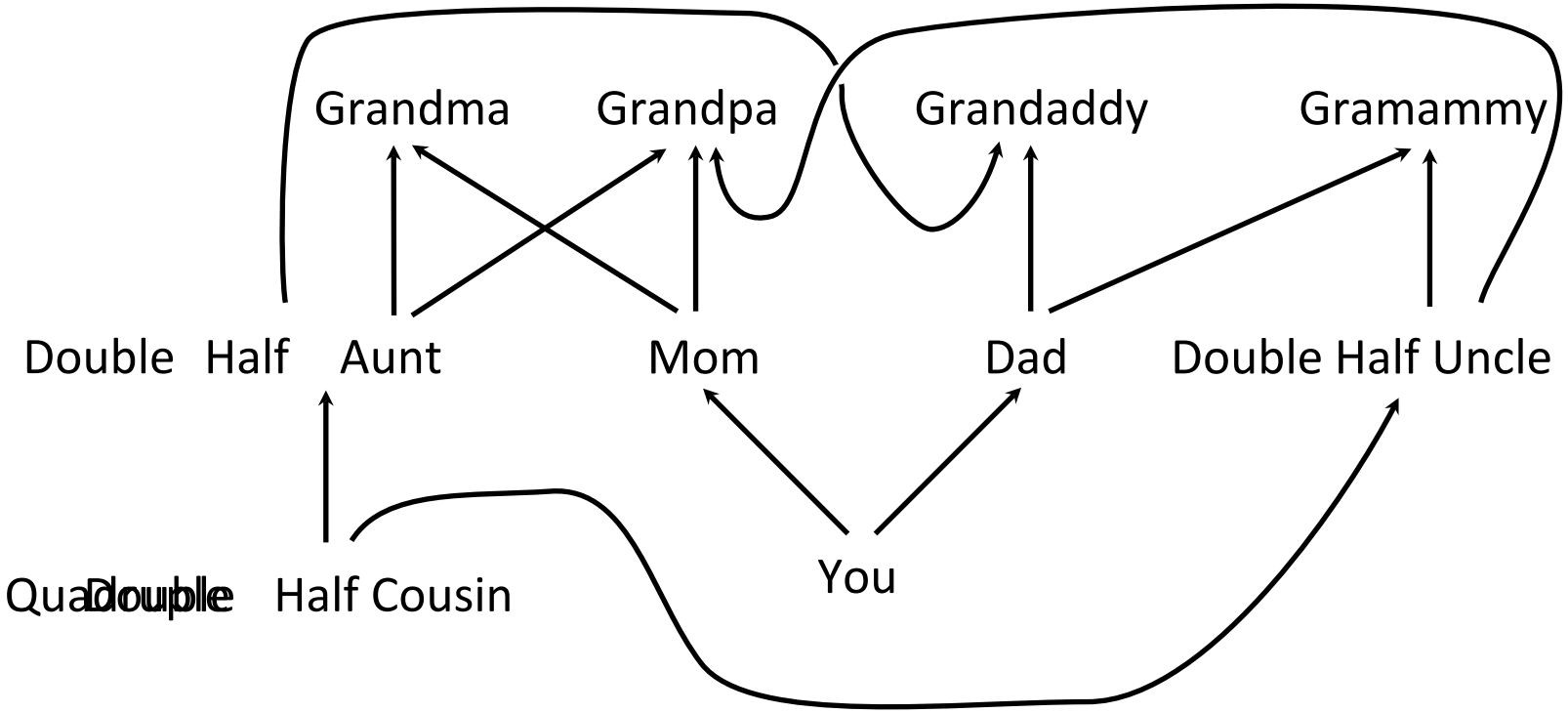

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