61A Lecture 16

Wednesday, October 3

Terminology: Attributes, Functions, and Methods

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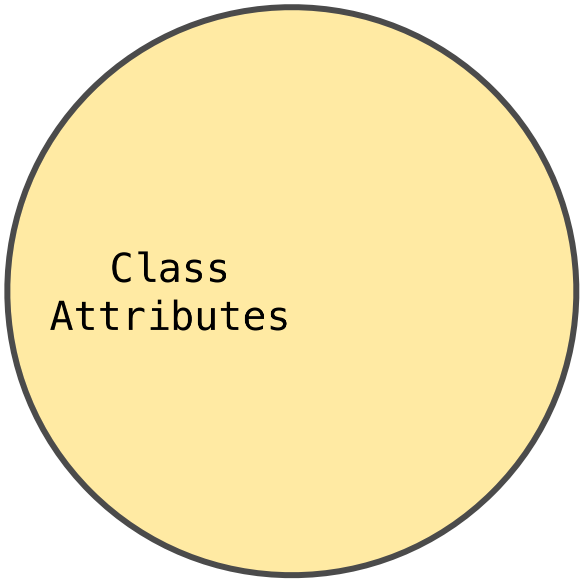

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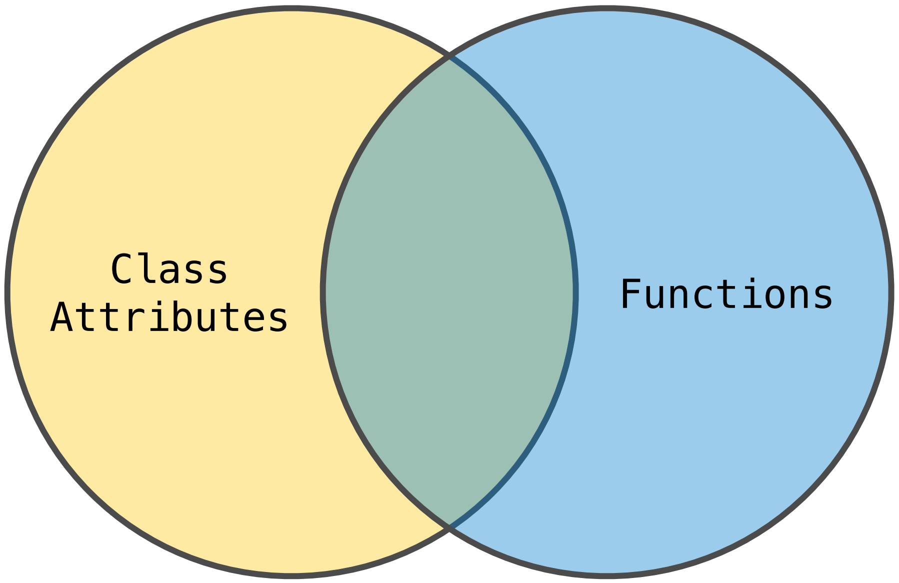

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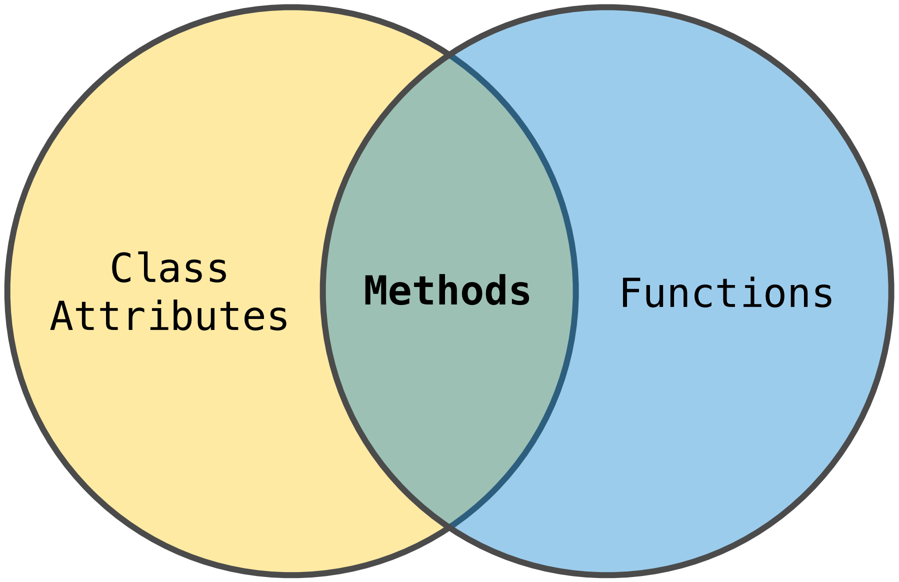

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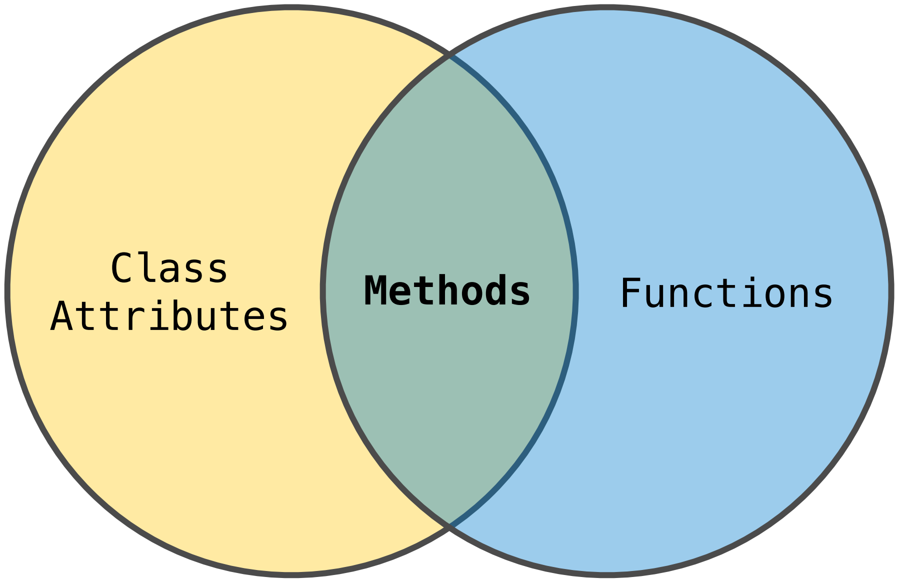

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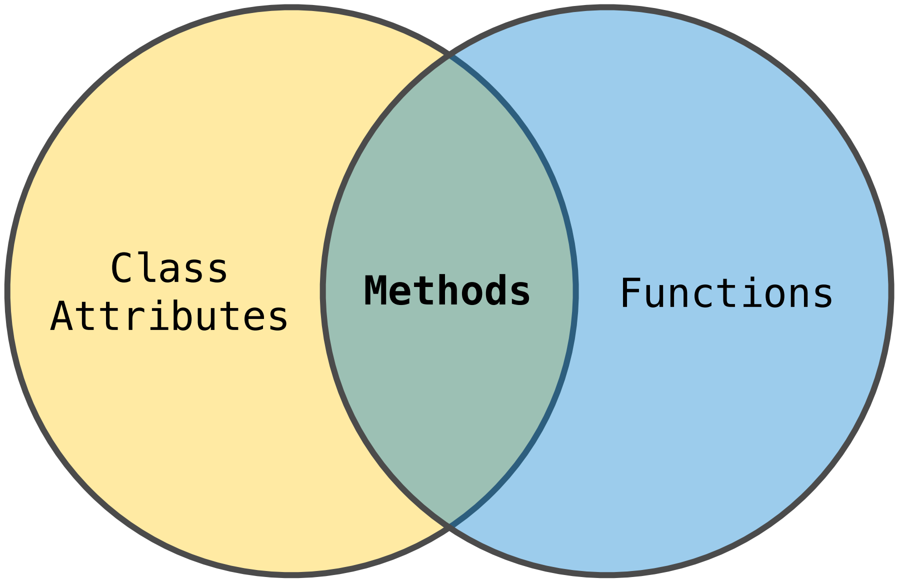

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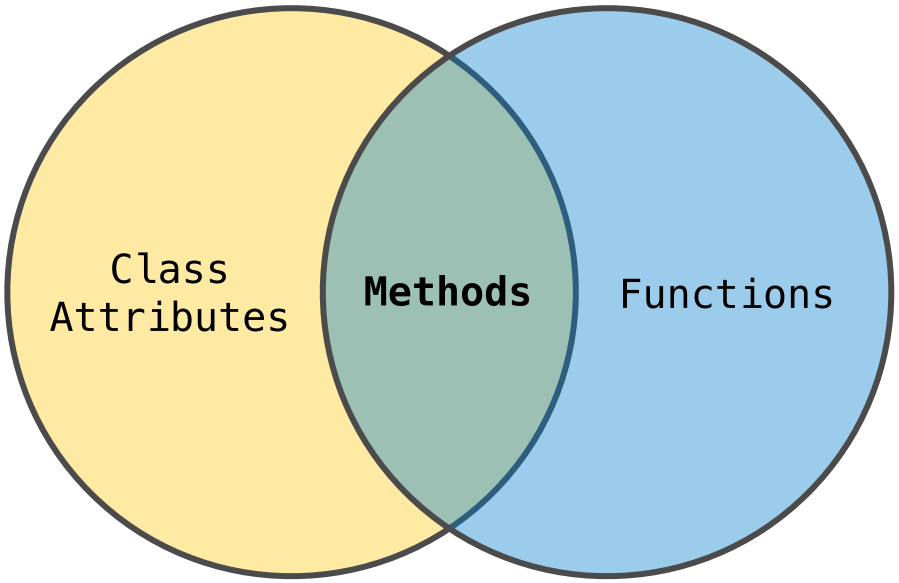

Python object system:

Functions are objects.

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

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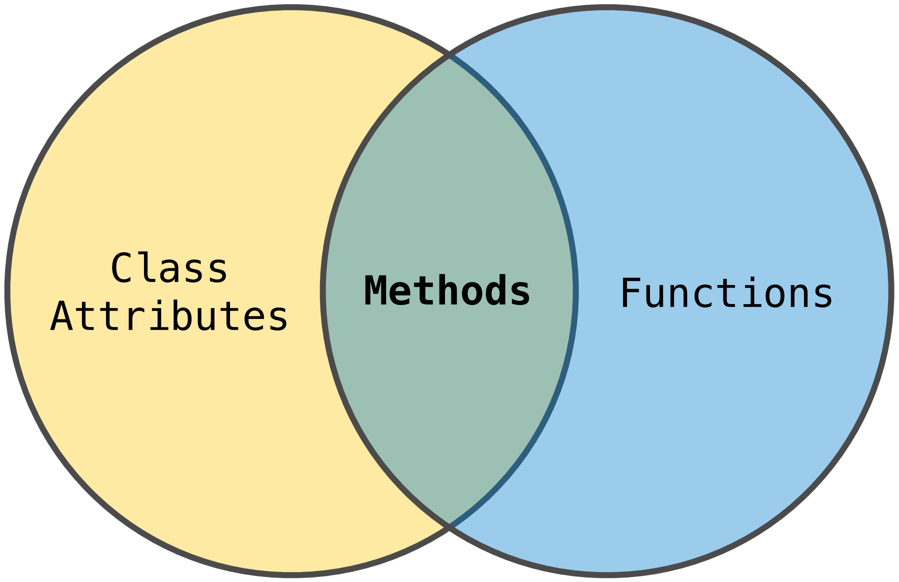

Python object system:

Functions are objects.

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

Looking Up Attributes by Name (Abbreviated)

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

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To evaluate a dot expression:

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3. If not found, `<name>` is looked up in the class.

Looking Up Attributes by Name (Abbreviated)

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

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```
class Account(object):

    interest = 0.02         # Class attribute

    def __init__(self, account_holder):
        self.balance = 0    # Instance attribute
        self.holder = account_holder

    # Additional methods would be defined here
```

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

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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!

Assignment to Attributes

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tom_account.interest = 0.08
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This expression evaluates to an object

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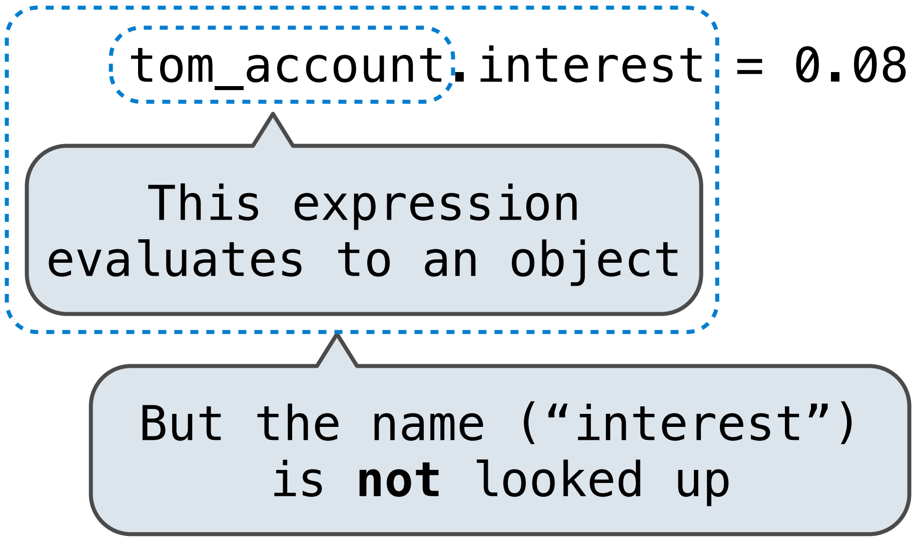

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This expression evaluates to an object
But the name ("interest") is **not** looked up

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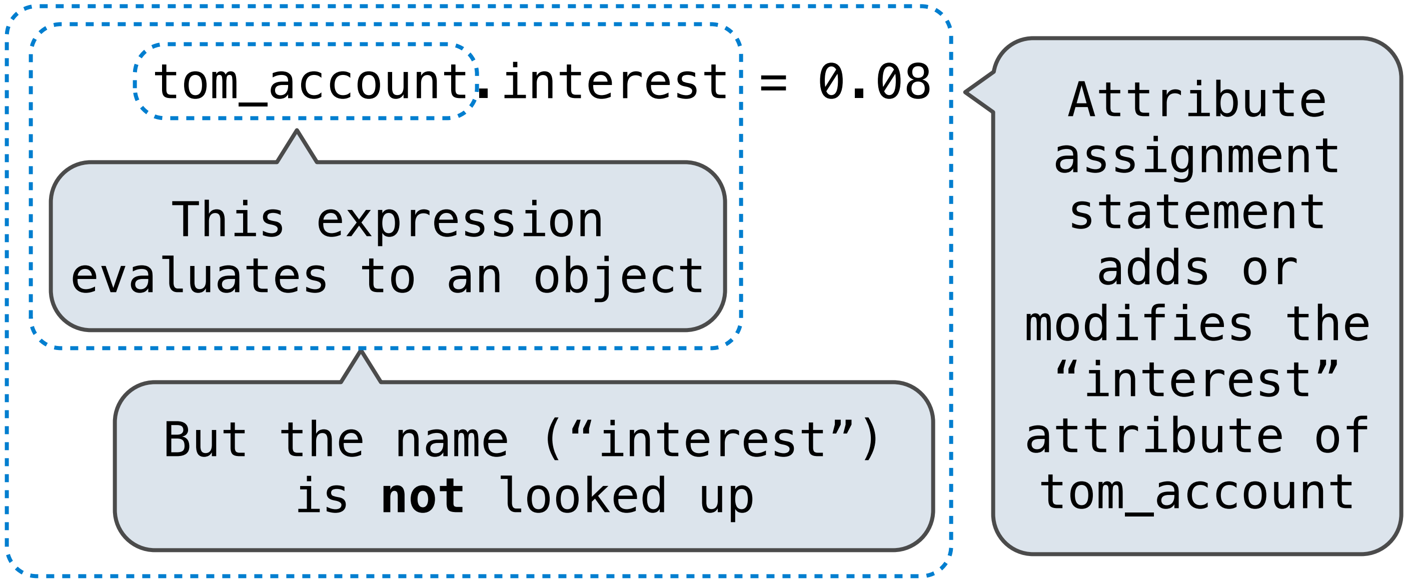

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But the name ("interest") is **not** looked up
Attribute assignment statement adds or modifies the "interest" attribute of tom_account

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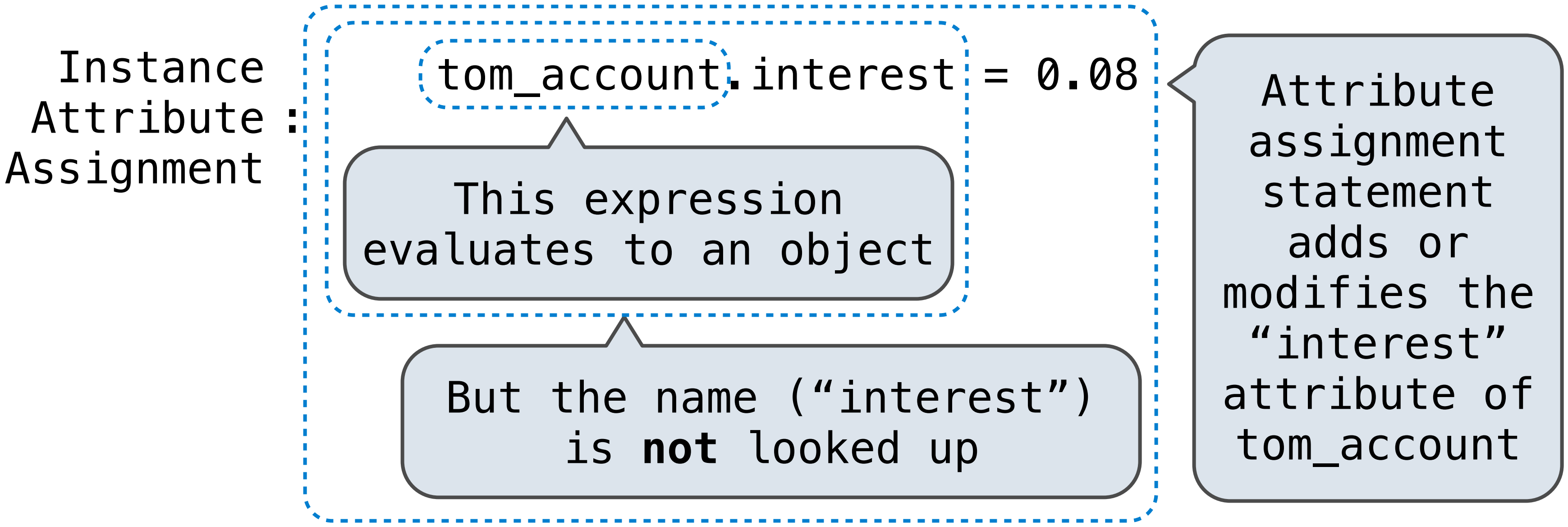

Instance Attribute Assignment:

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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
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Assignment to Attributes

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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 "interest" attribute of tom_account

Class Attribute Assignment :

```
Account.interest = 0.04
```

Attribute Assignment Statements

Attribute Assignment Statements

```
interest: 0.02
```

Attribute Assignment Statements

Account class attributes

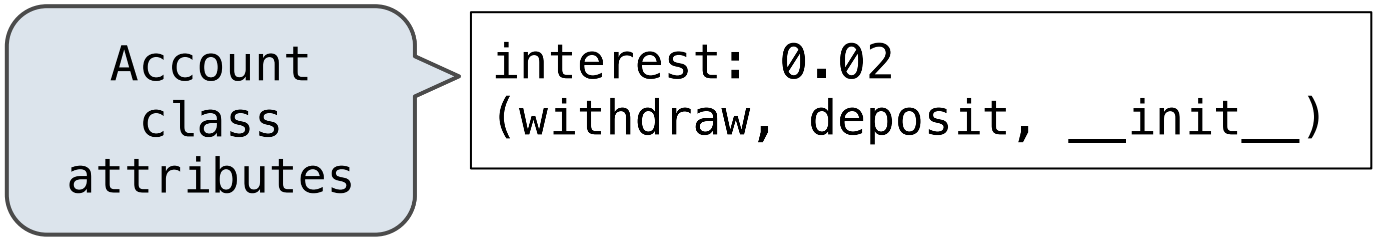
```
interest: 0.02
```

Attribute Assignment Statements

Account class attributes

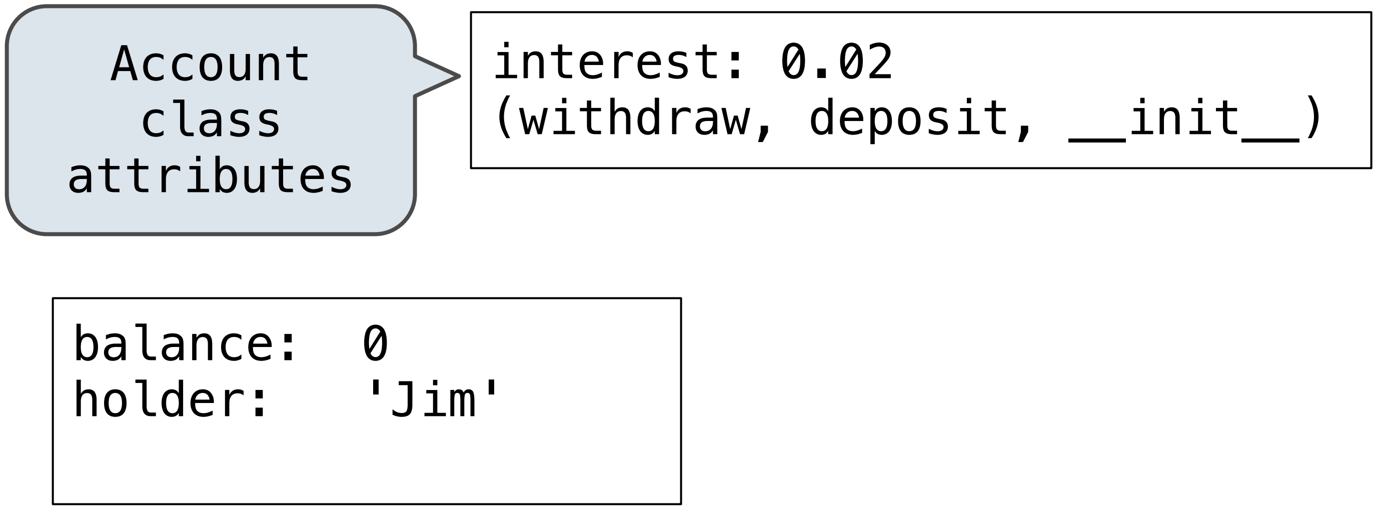
```
interest: 0.02
(withdraw, deposit, __init__)
```

Attribute Assignment Statements



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

Attribute Assignment Statements



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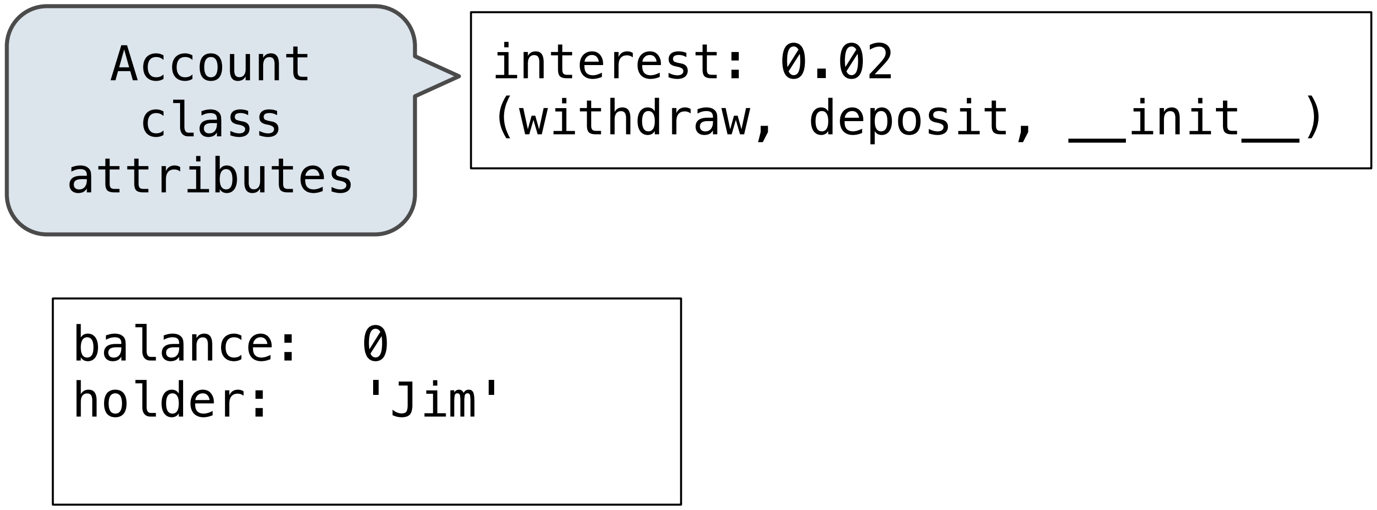

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>>> tom_account = Account('Tom')
```

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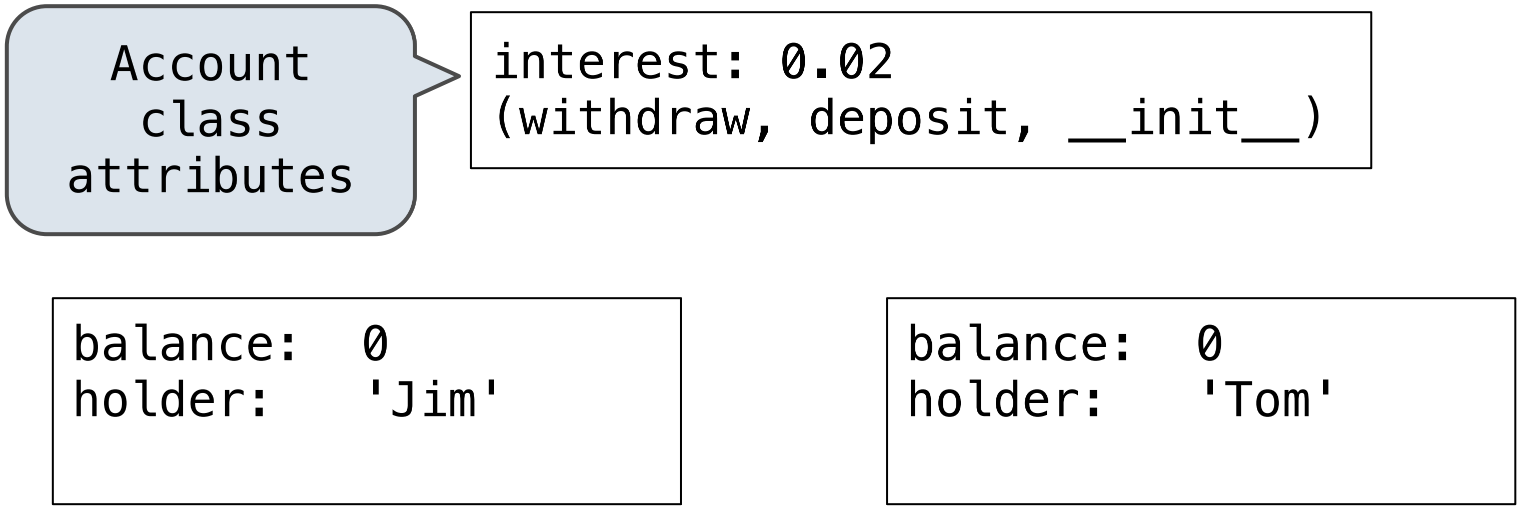

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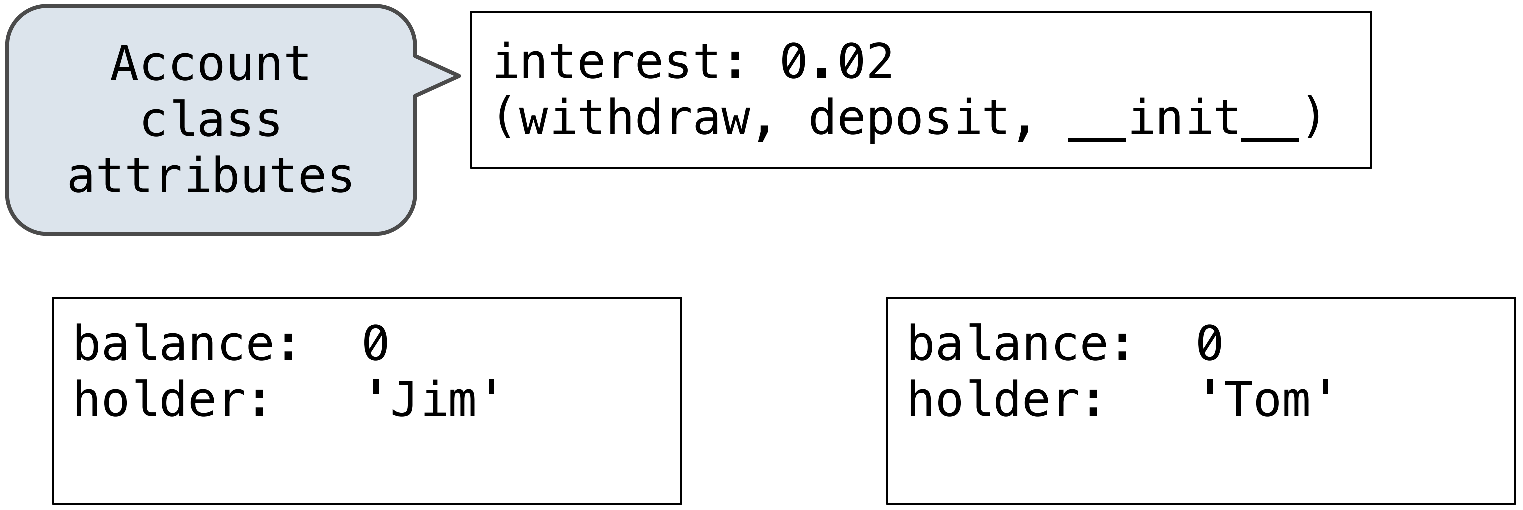
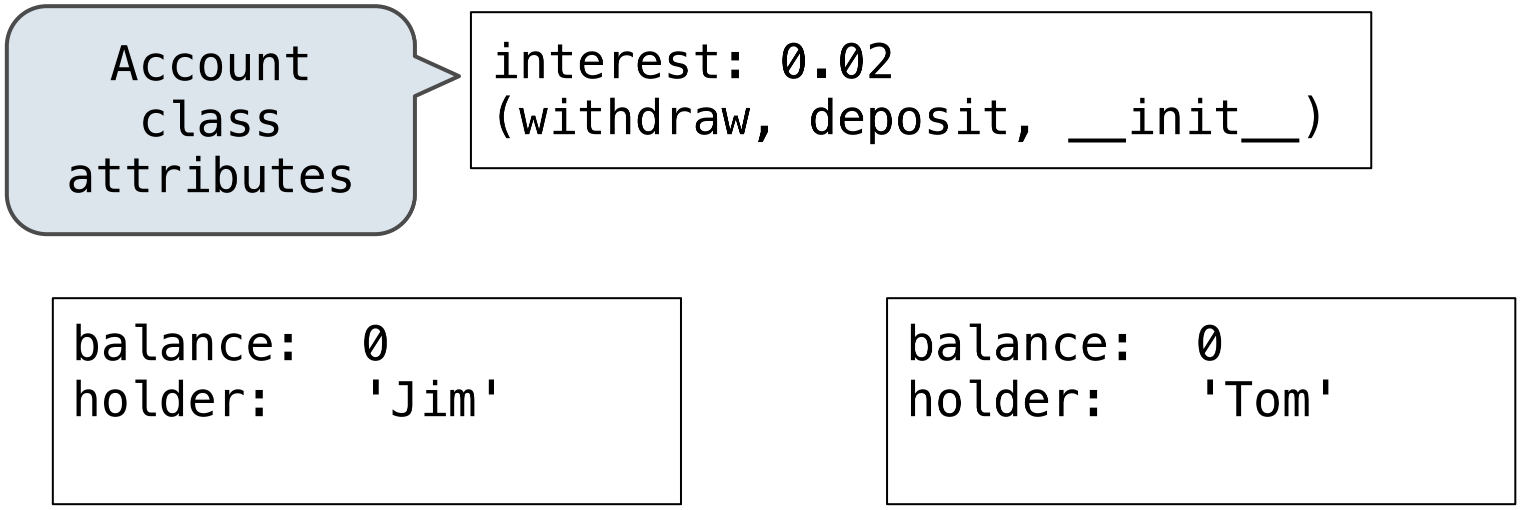


```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
```

Attribute Assignment Statements



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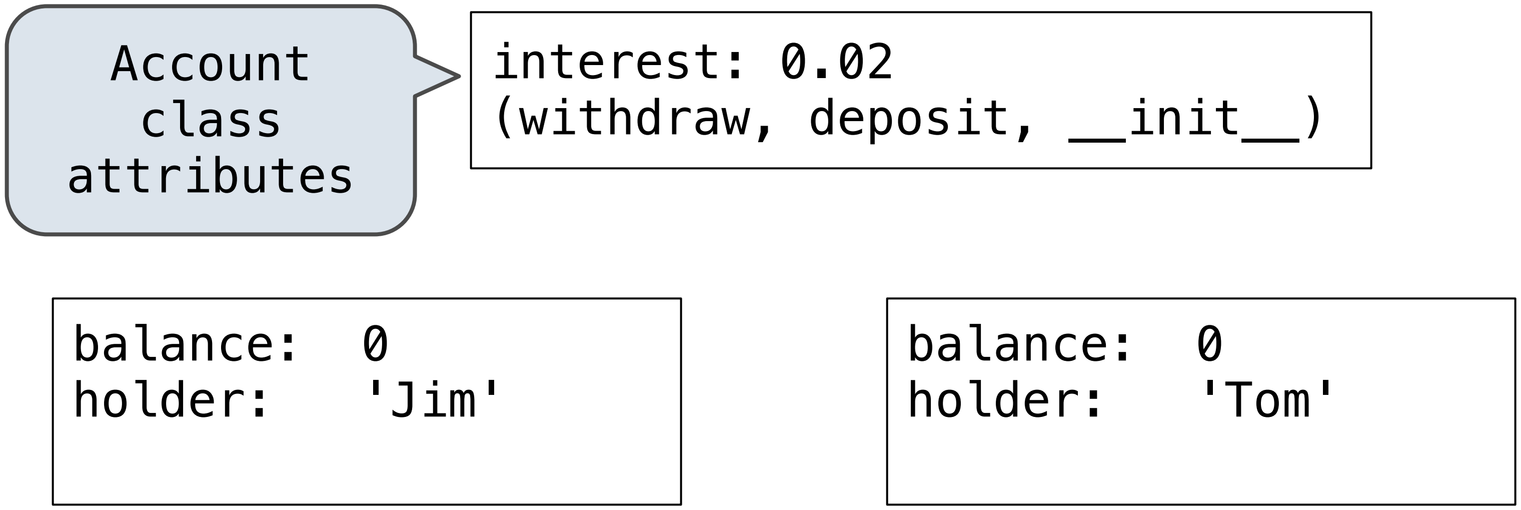
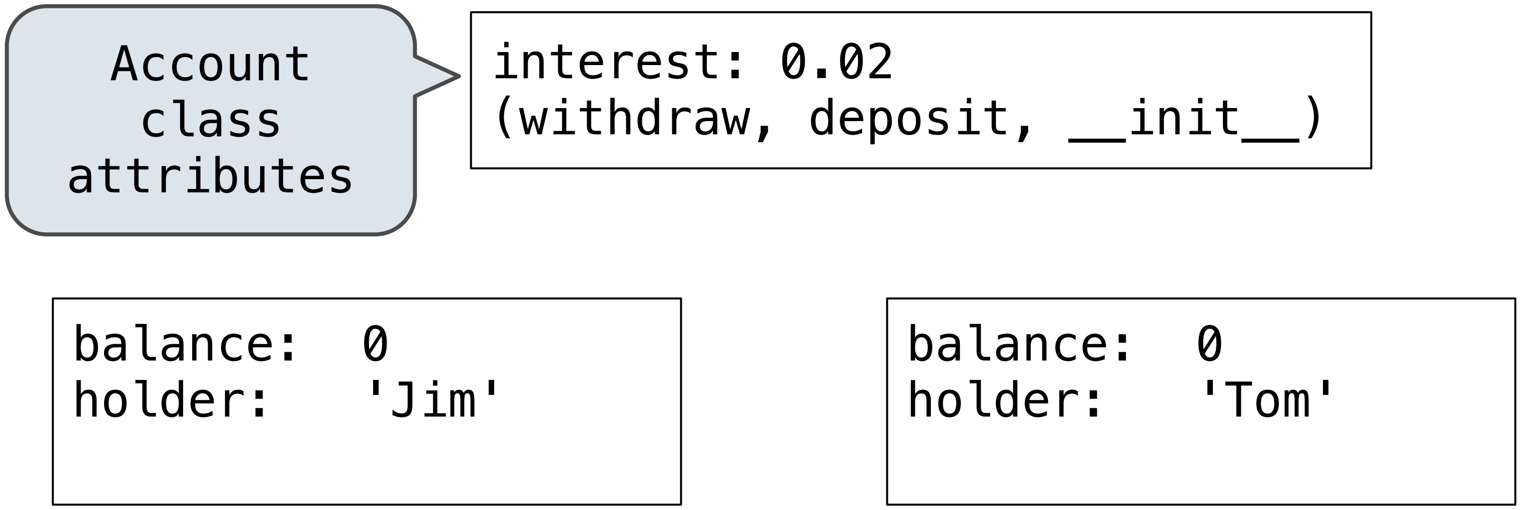
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
```

Attribute Assignment Statements



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

Attribute Assignment Statements



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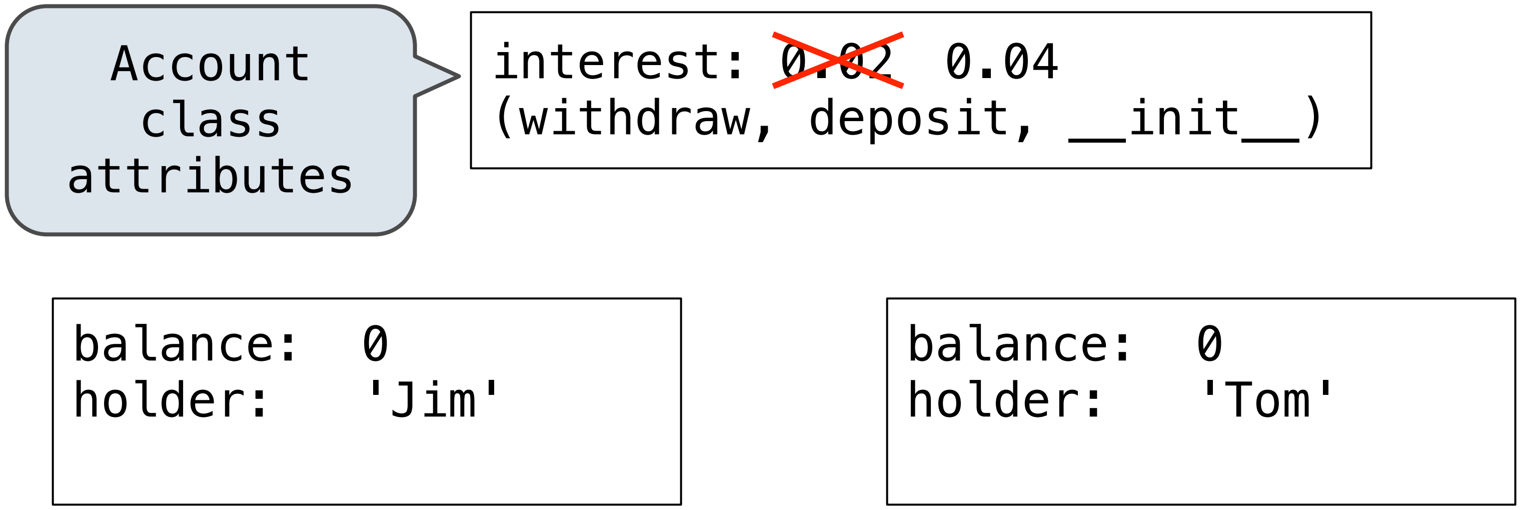

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>>> tom_account.interest
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>>> jim_account.interest
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>>> tom_account.interest
0.02
>>> Account.interest = 0.04
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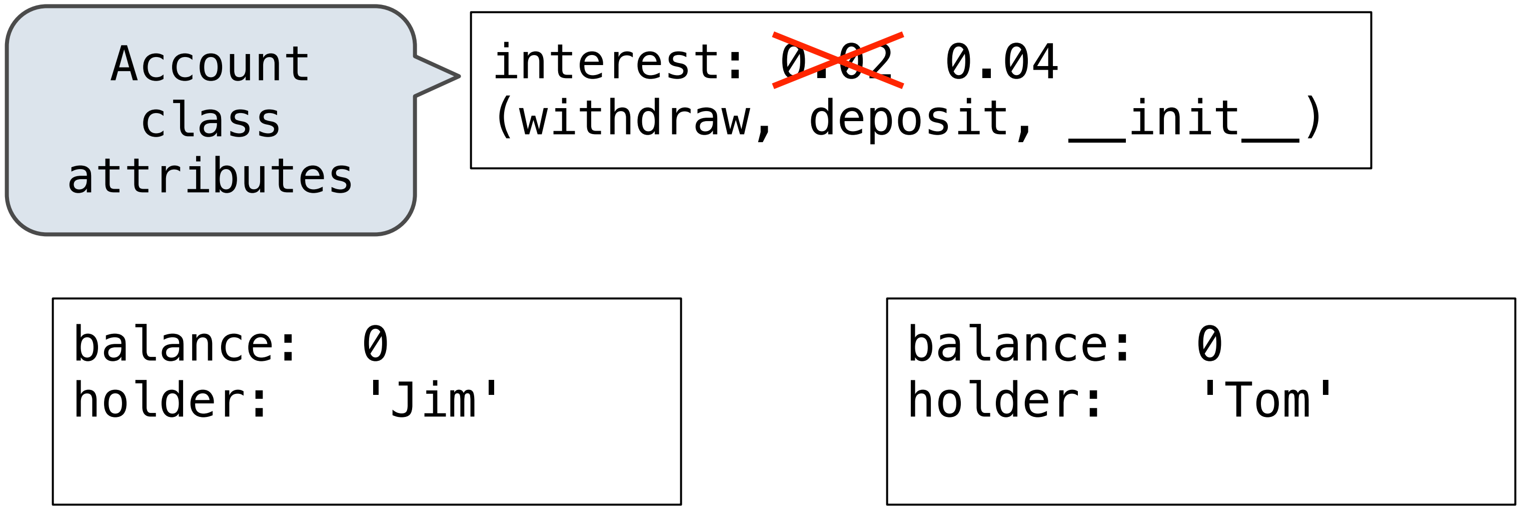

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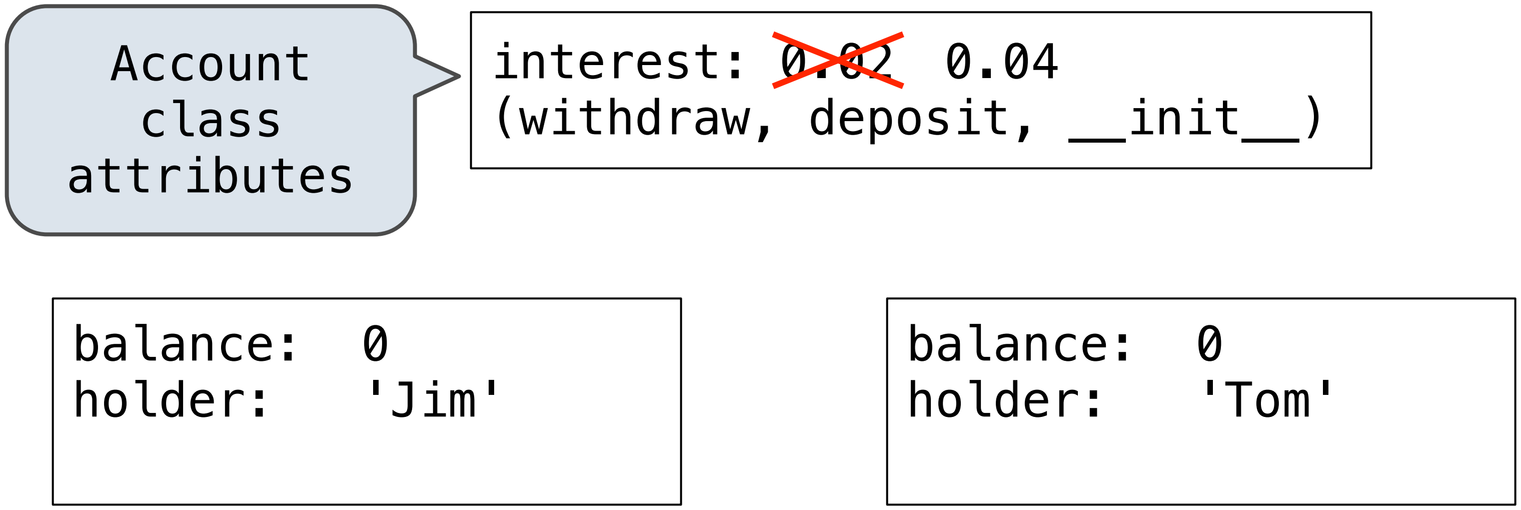
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

Attribute Assignment Statements



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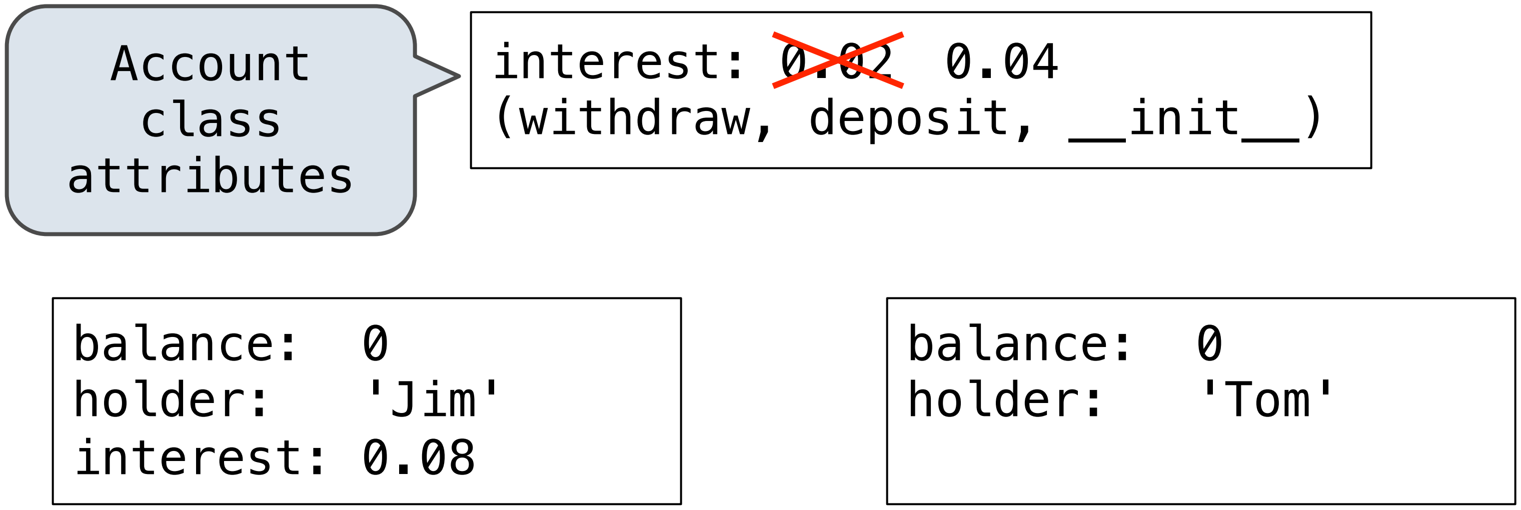
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

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

Attribute Assignment Statements



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

```
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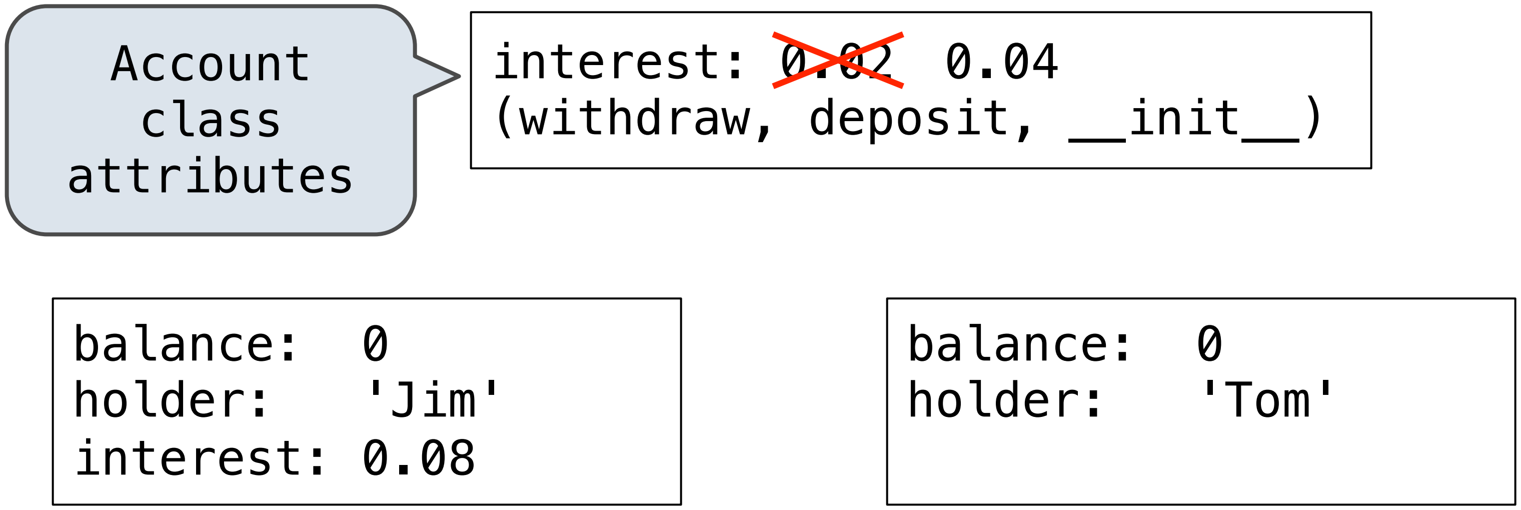

```
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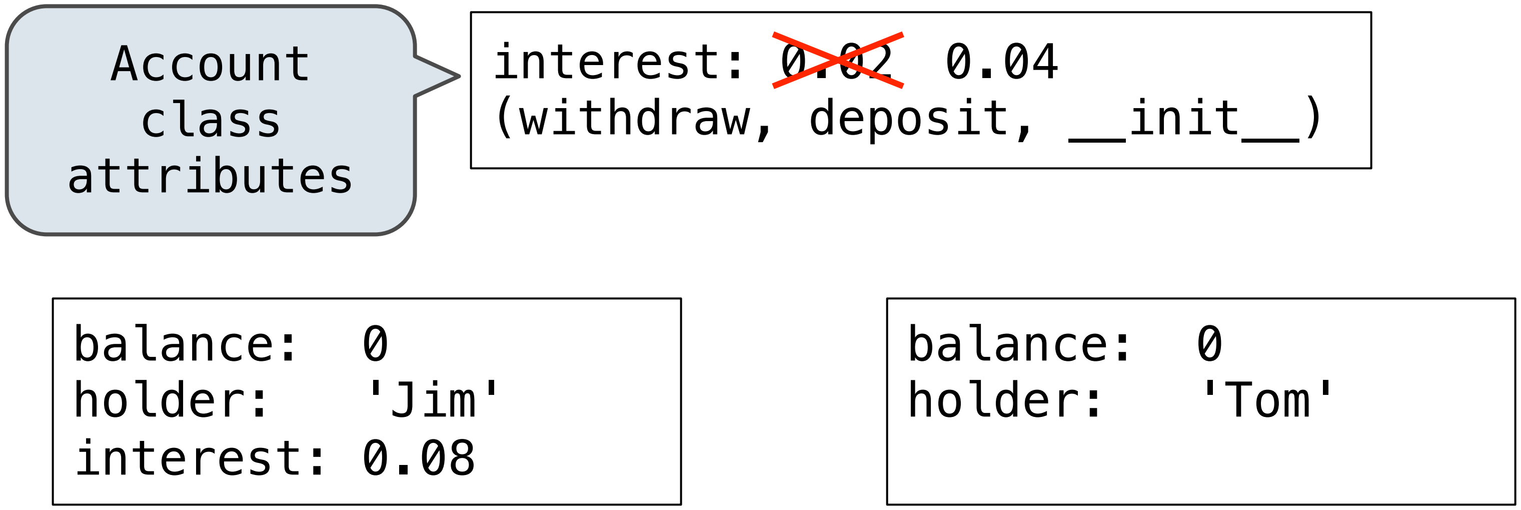
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

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

Attribute Assignment Statements



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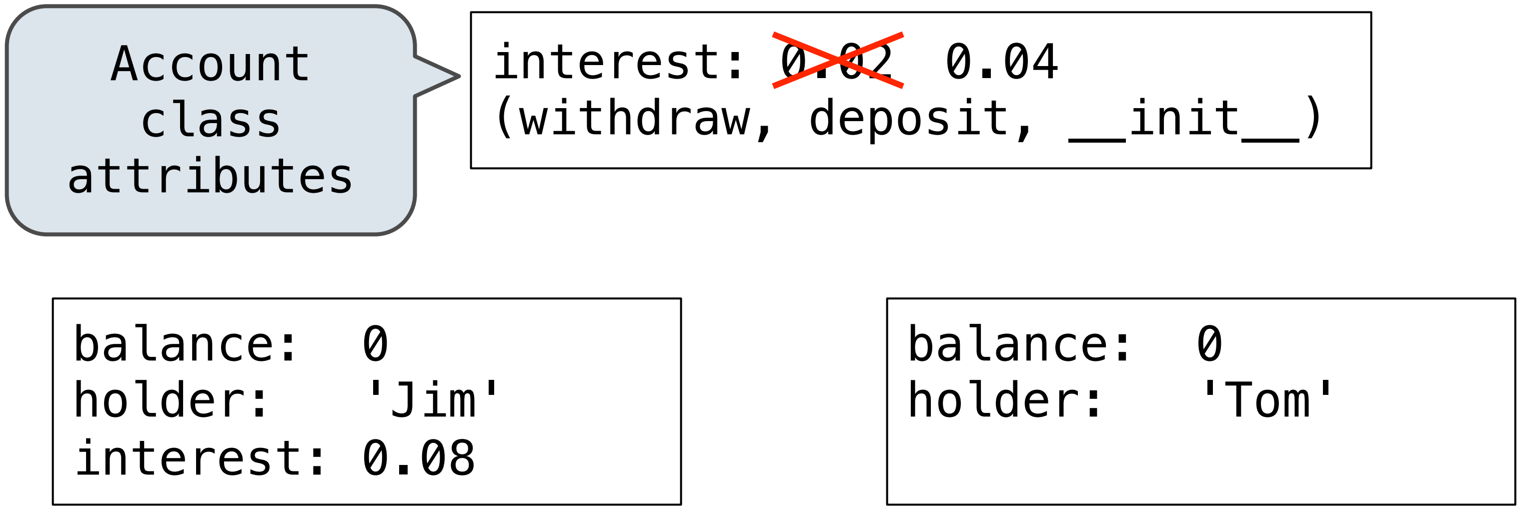
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
>>> tom_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
```

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

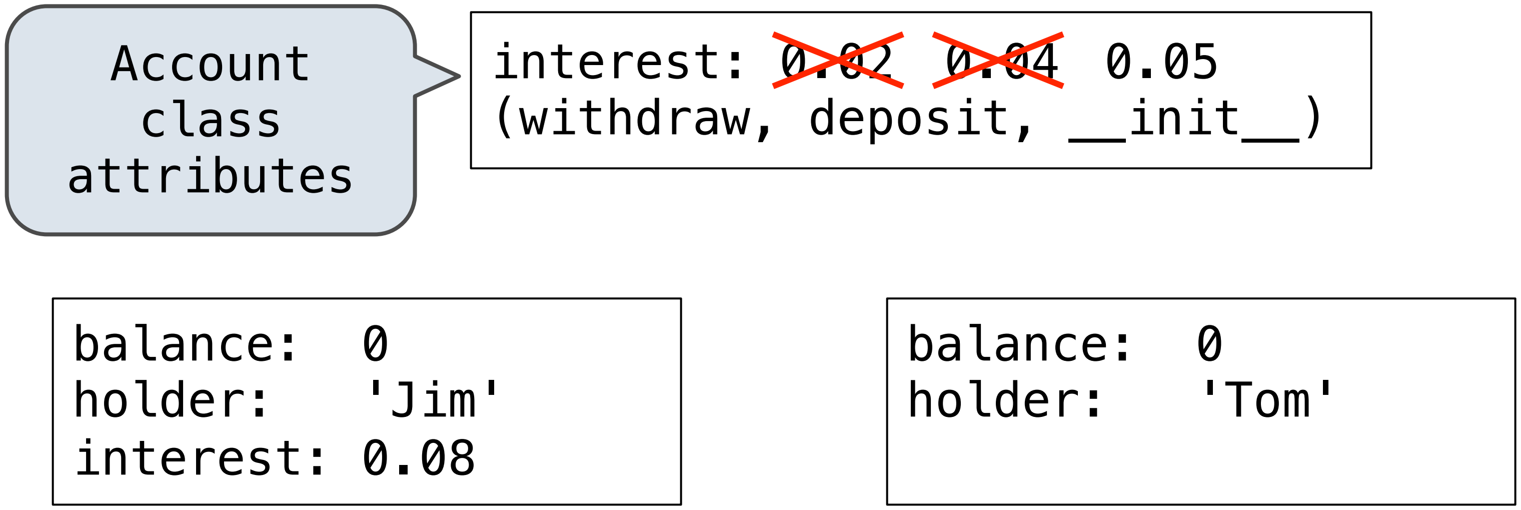
Attribute Assignment Statements



```
>>> 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



```
>>> 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

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
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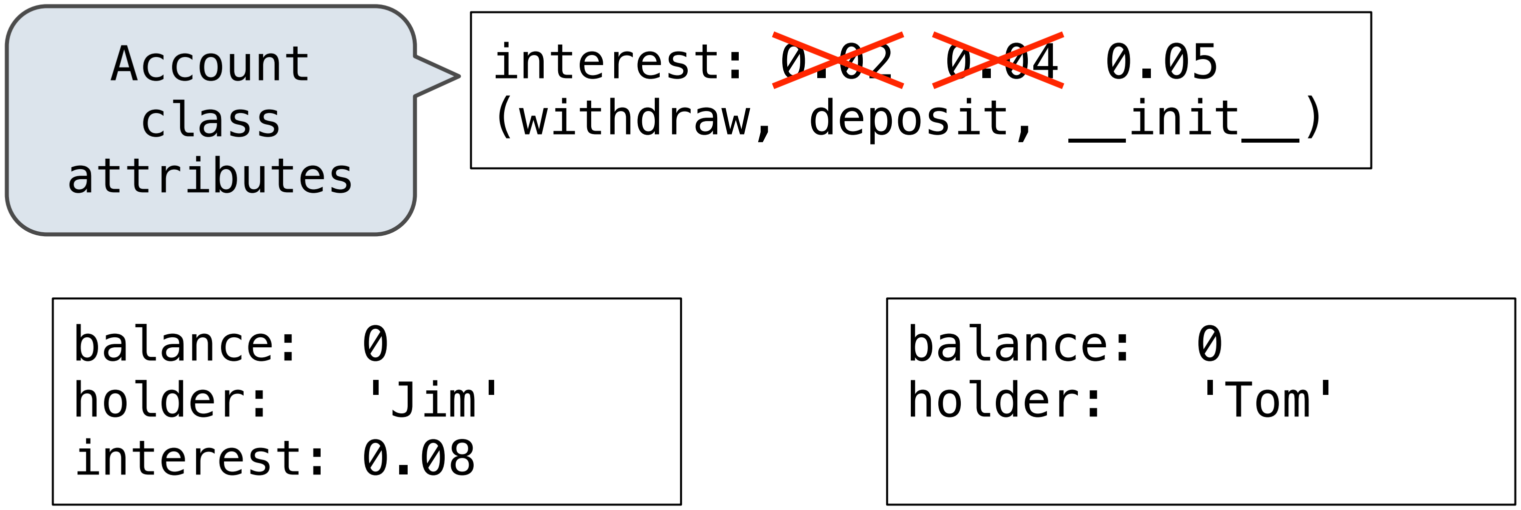
```

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

Attribute Assignment Statements



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>>> tom_account.interest
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```

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>>> 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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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.

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

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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>
```

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.`

Inheritance Example

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Most behavior is shared with the base class Account

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Designing for Inheritance

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Attribute look-up on base class

Preferable alternative to CheckingAccount.withdraw_fee

Designing for Inheritance: General Base Classes

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Base classes may contain logic that is meant for subclasses.
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Designing for Inheritance: General Base Classes

Base classes may contain logic that is meant for subclasses.

Example: Same CheckingAccount behavior; different approach

Demo

Inheritance and Composition

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

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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Instance attribute

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Resolving Ambiguous Class Attribute Names

Instance attribute

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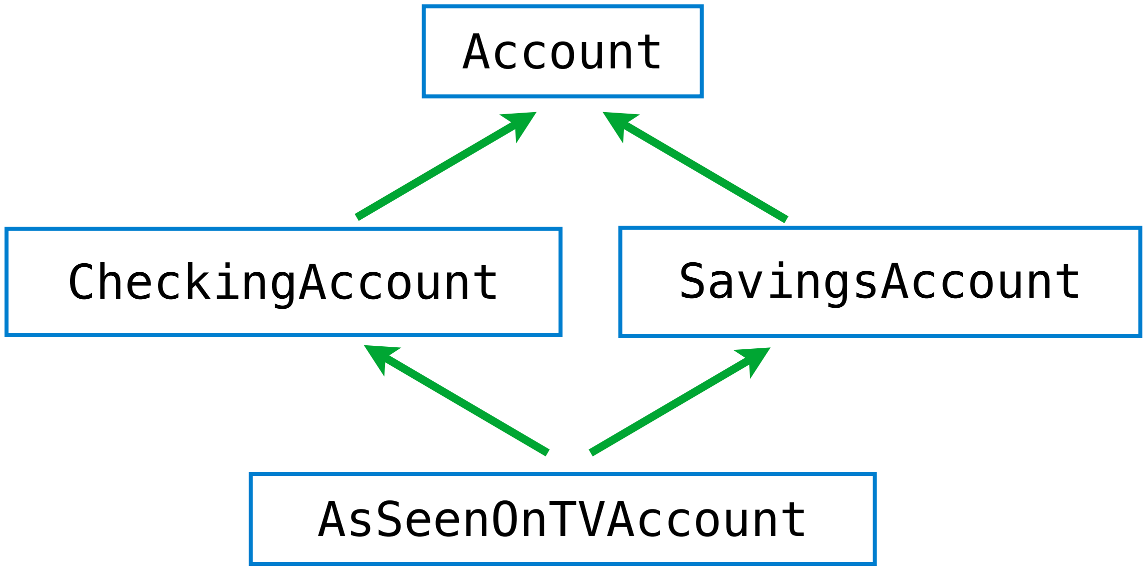
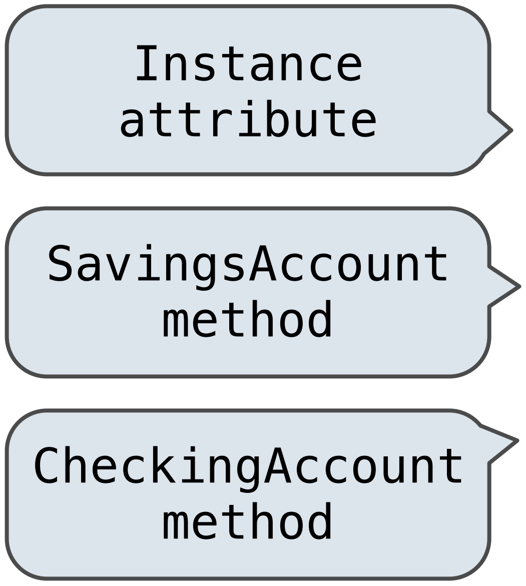
Resolving Ambiguous Class Attribute Names





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Human Relationships

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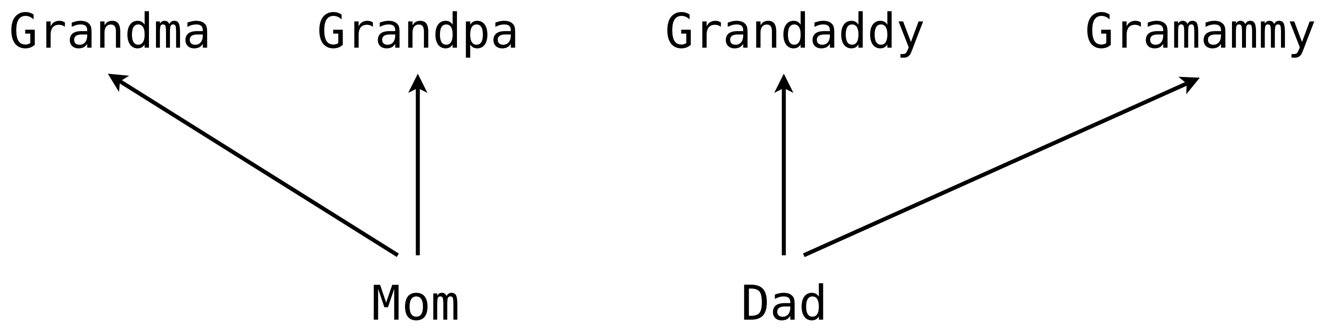
```
Grandma    Grandpa     Grandaddy     Gramammy
```

Human Relationships



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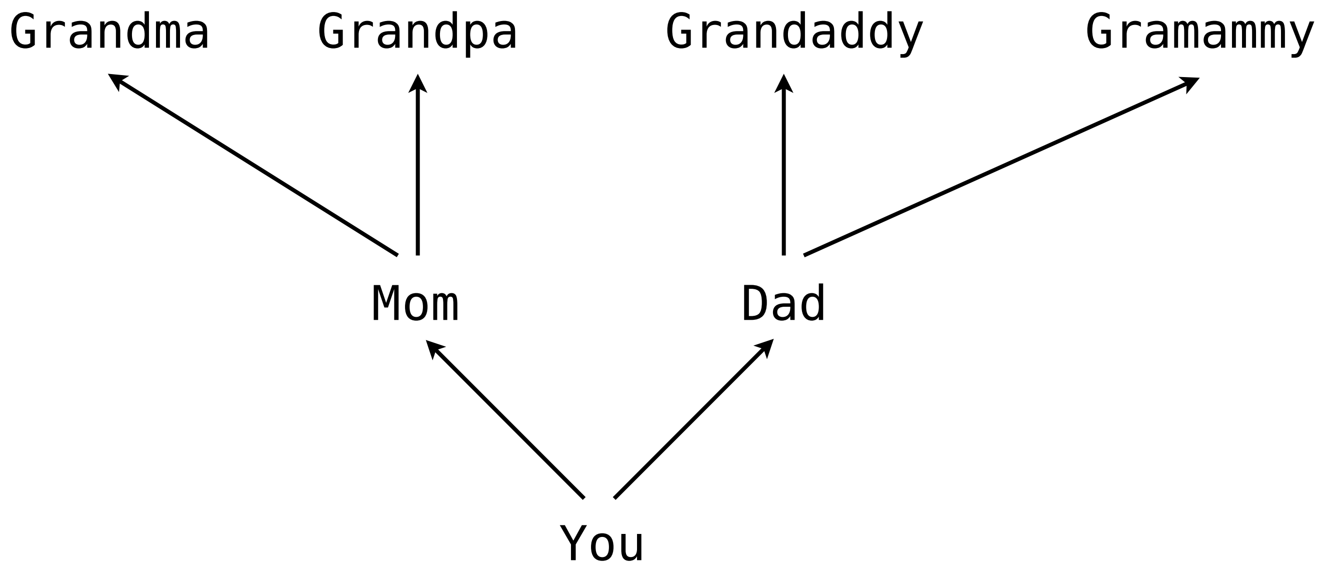

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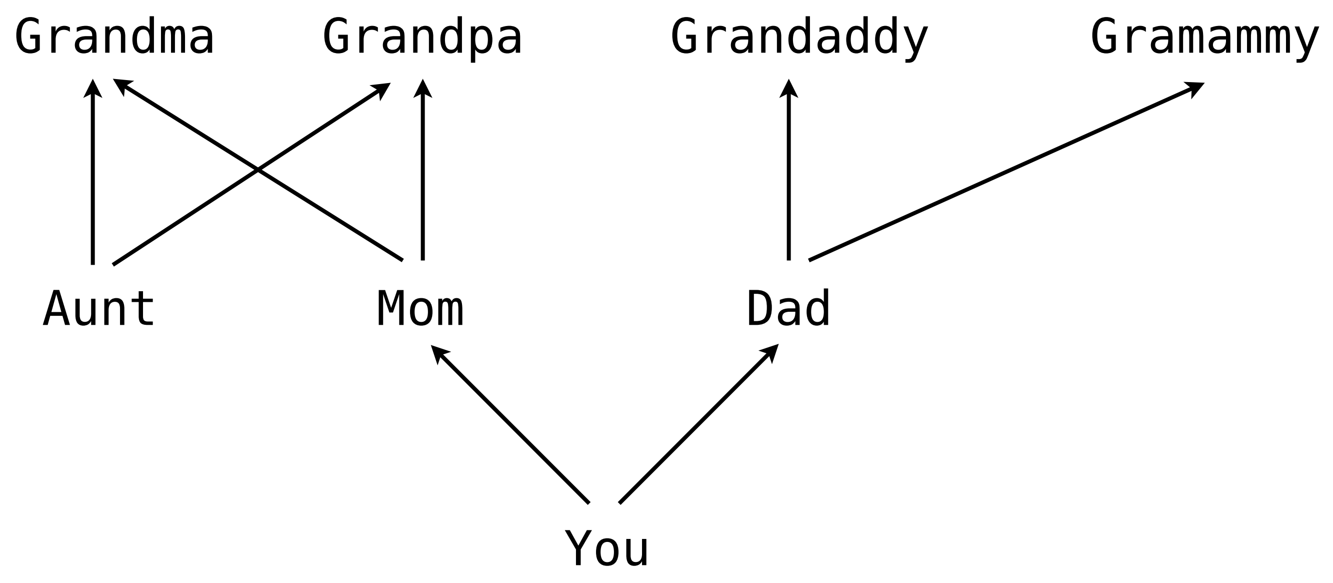

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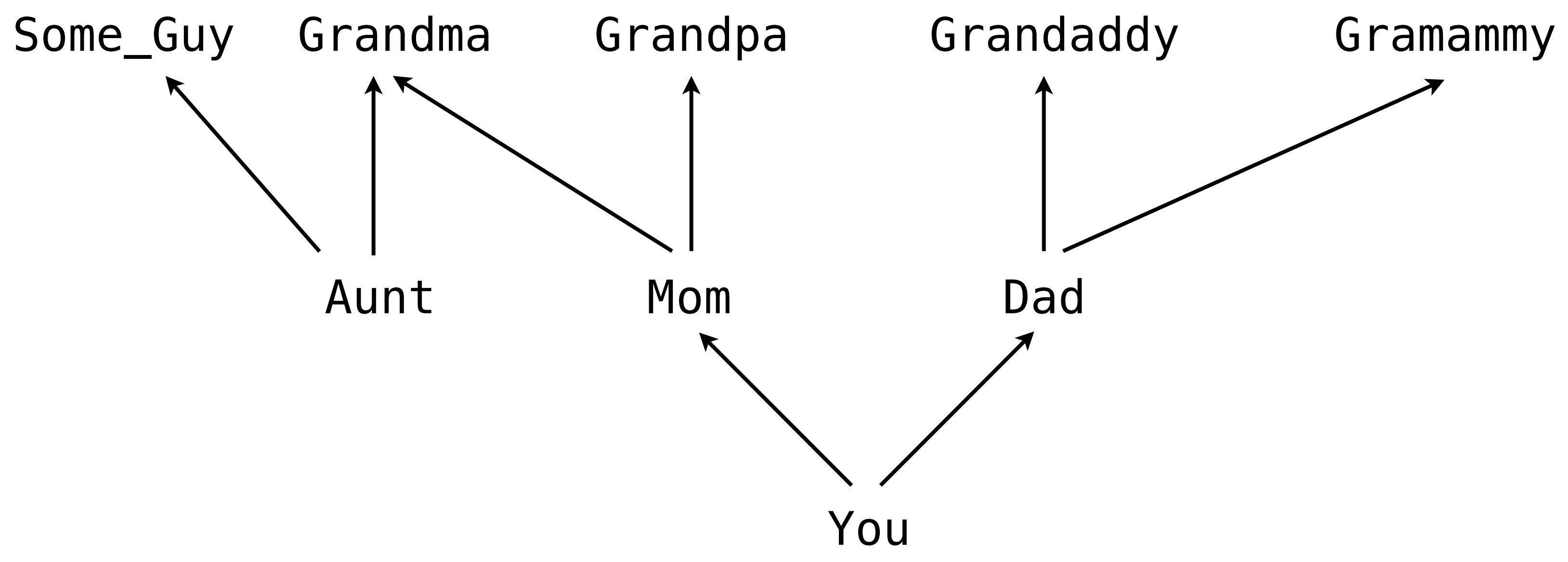

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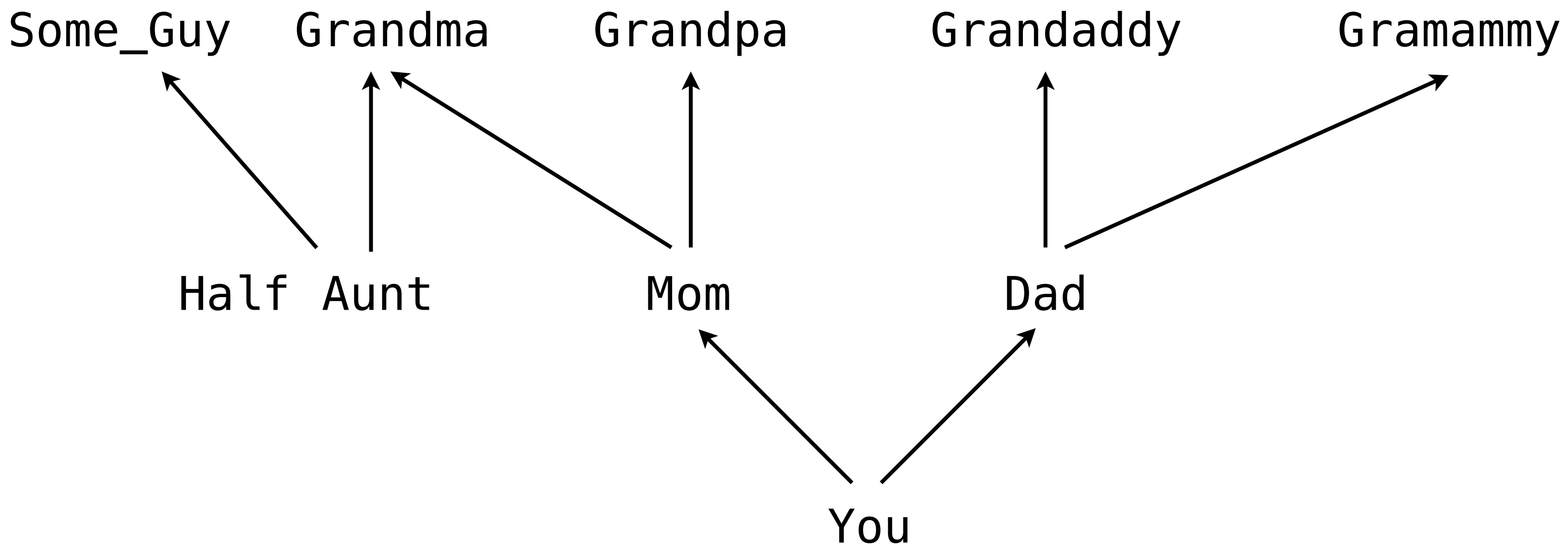

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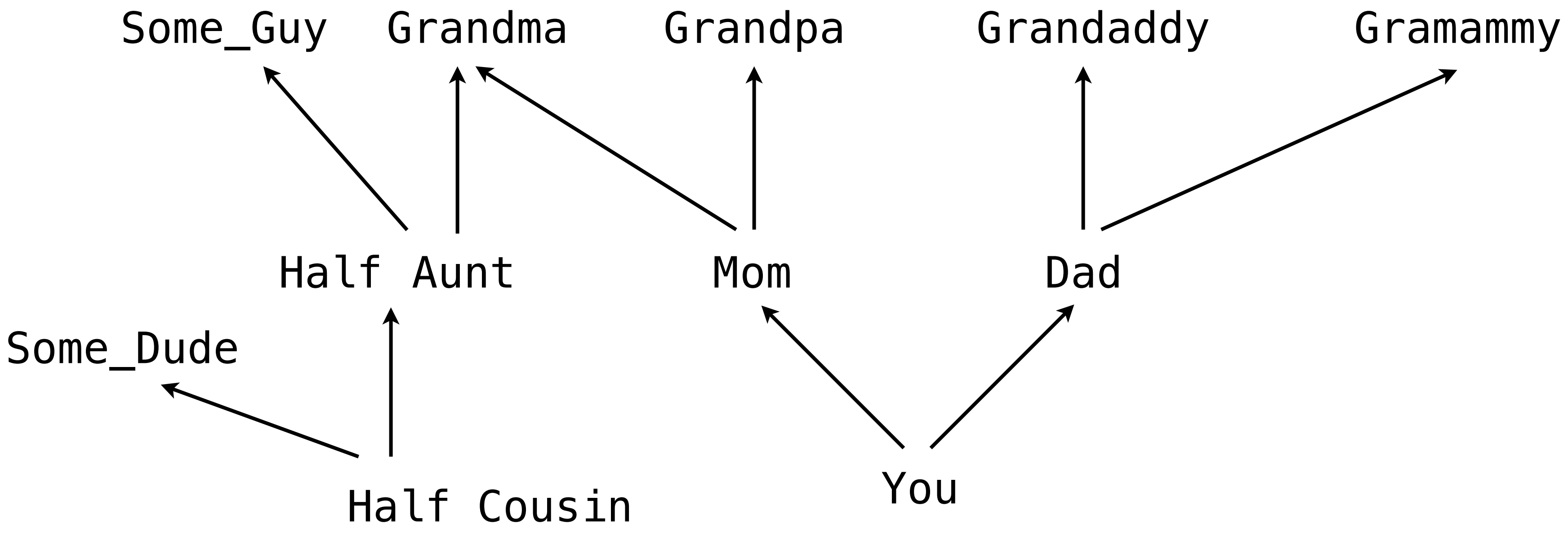

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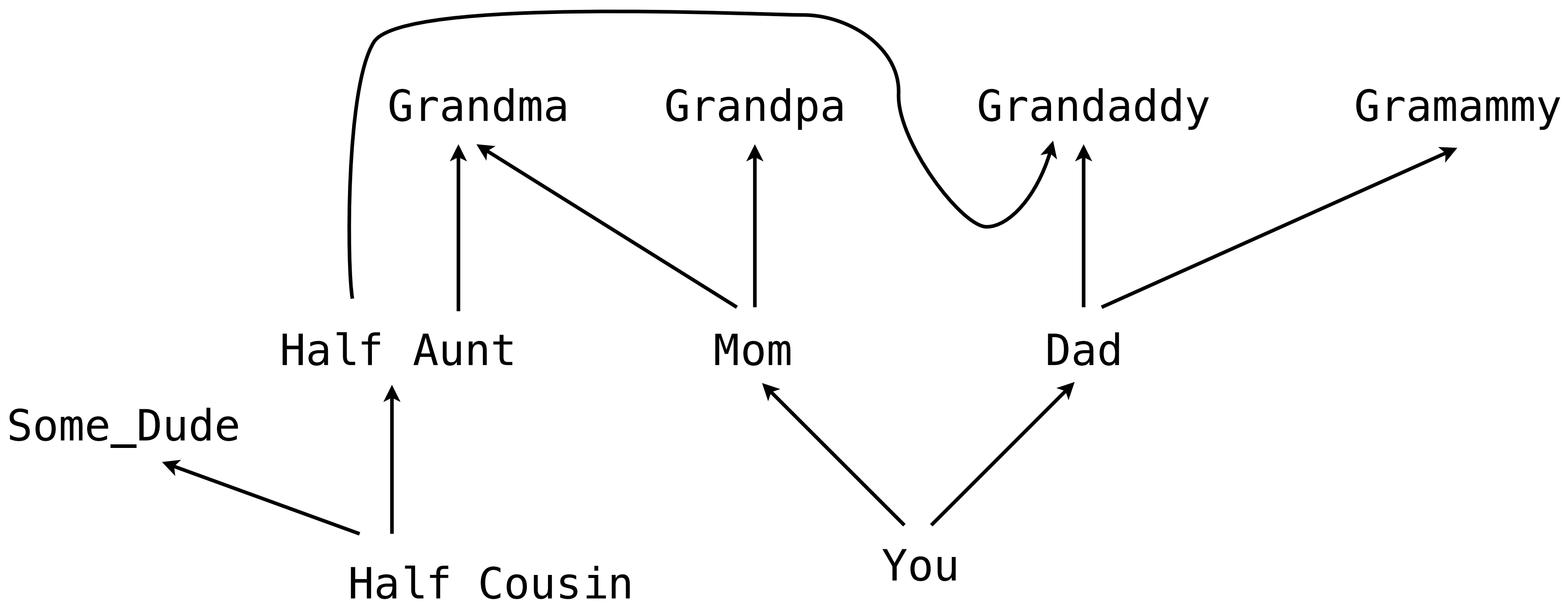

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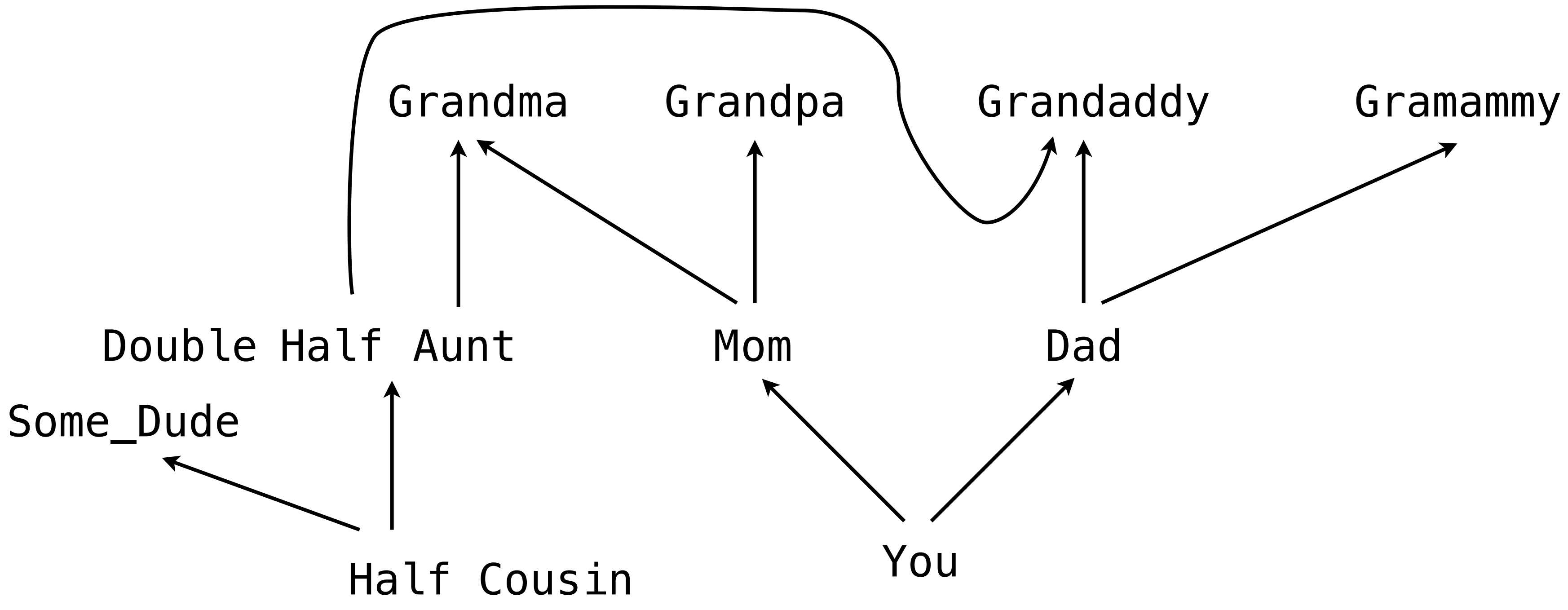

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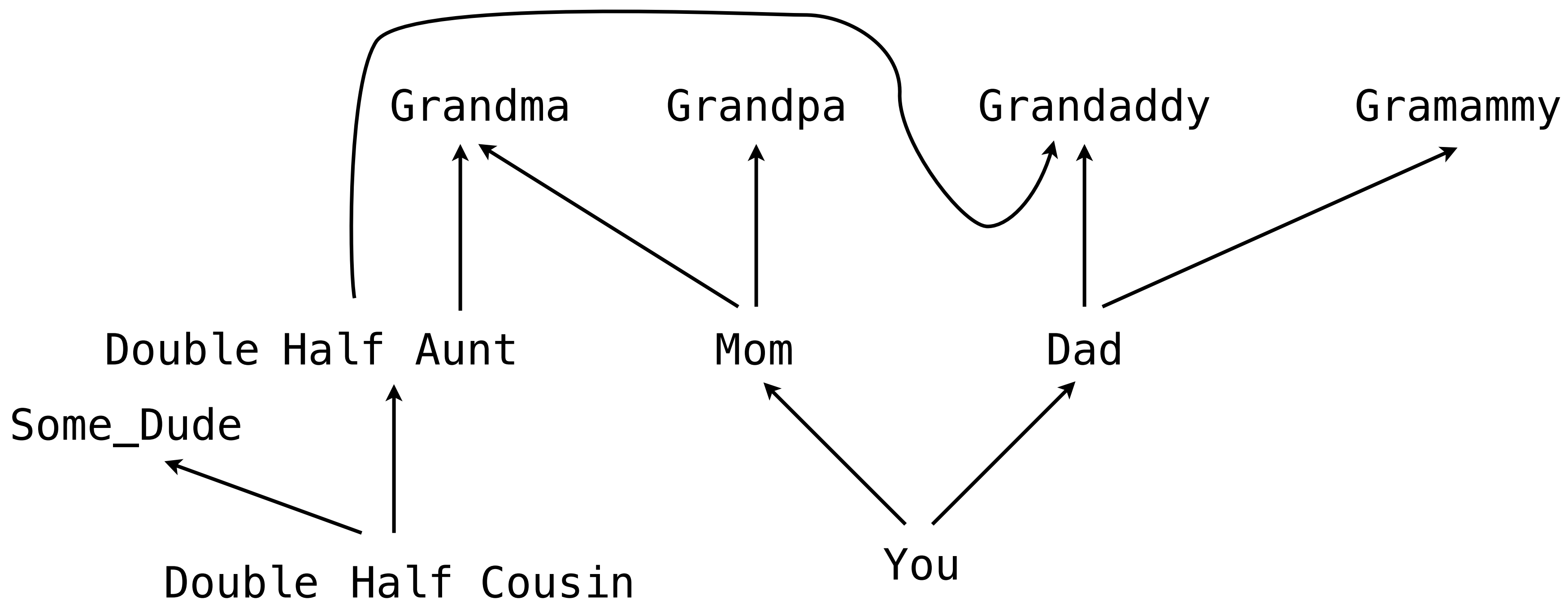

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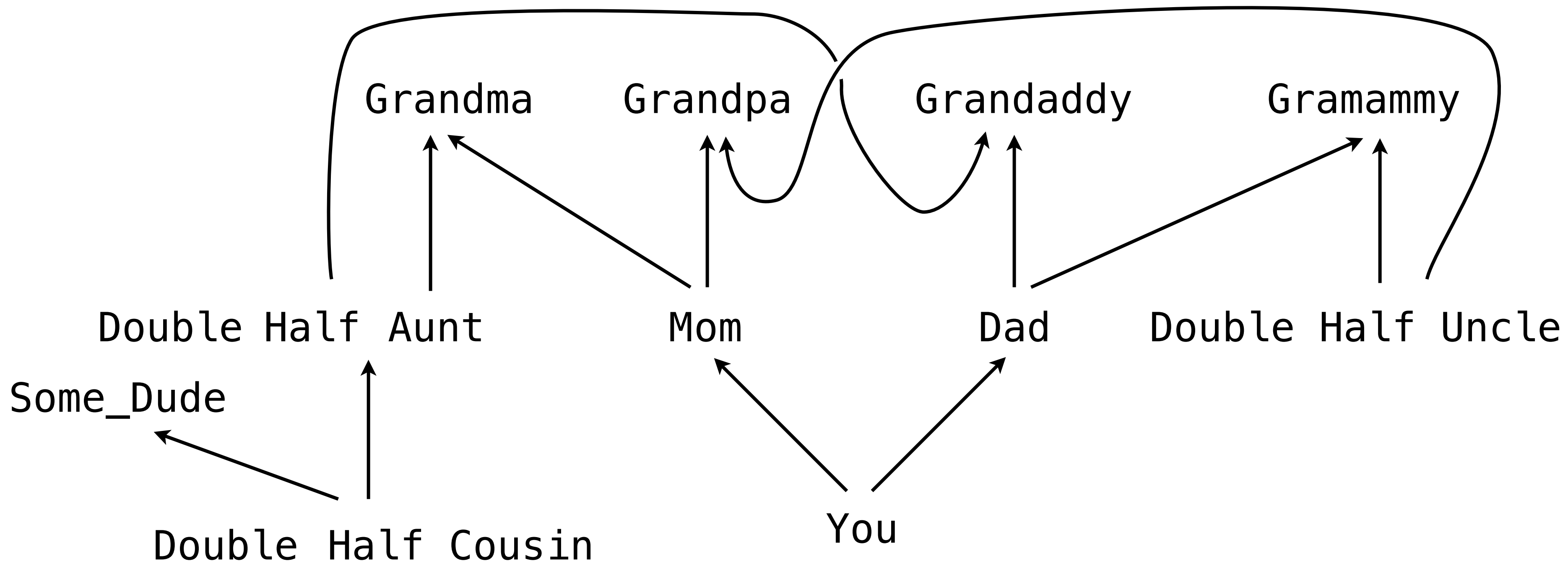

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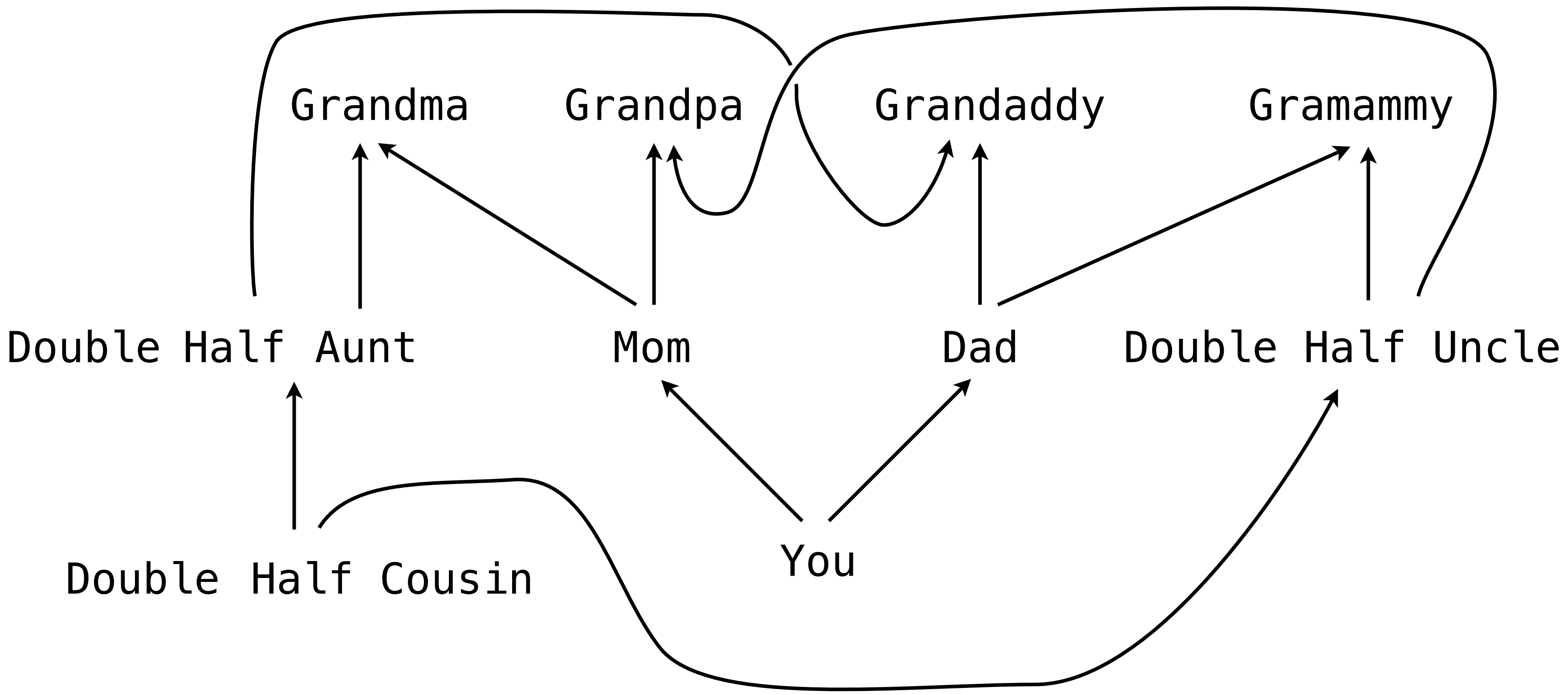

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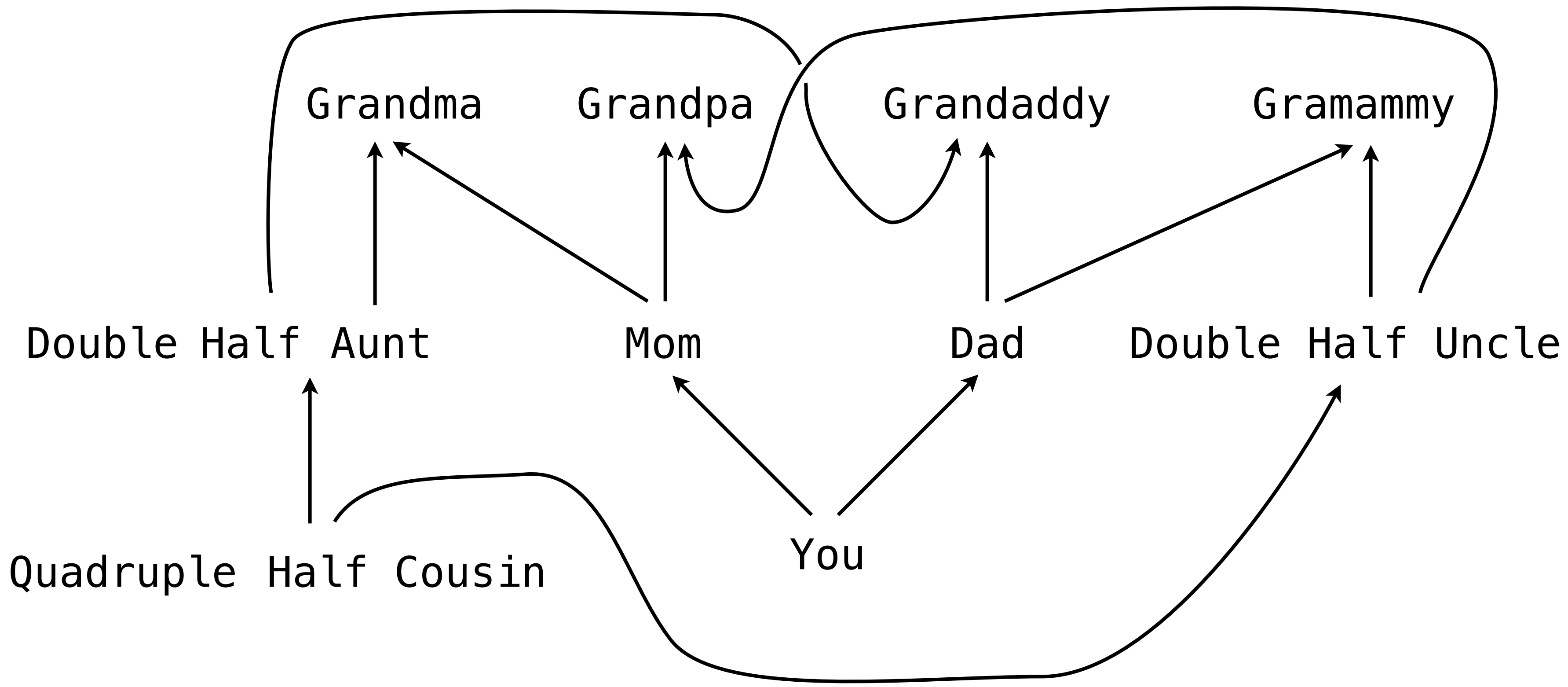
Grandma
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Mom
Dad
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Quadruple Half Cousin
You