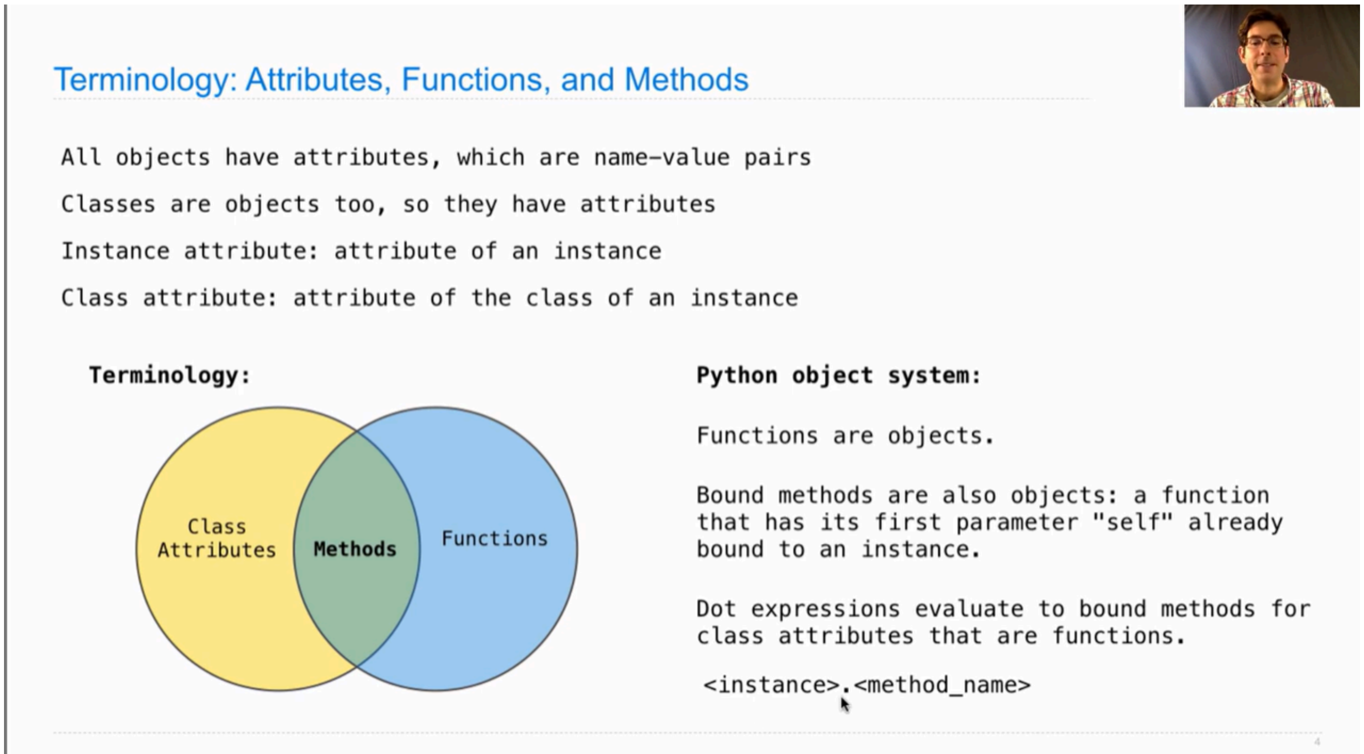
# Lecture19. inheritence

## Attributes



### Terminology: Attributes, Functions, and Methods

All objects have attributes, which are name-value pairs

Classes are objects too, so they have attributes

Instance attribute: attribute of an instance

Class attribute: attribute of the class of an instance

**Terminology:**

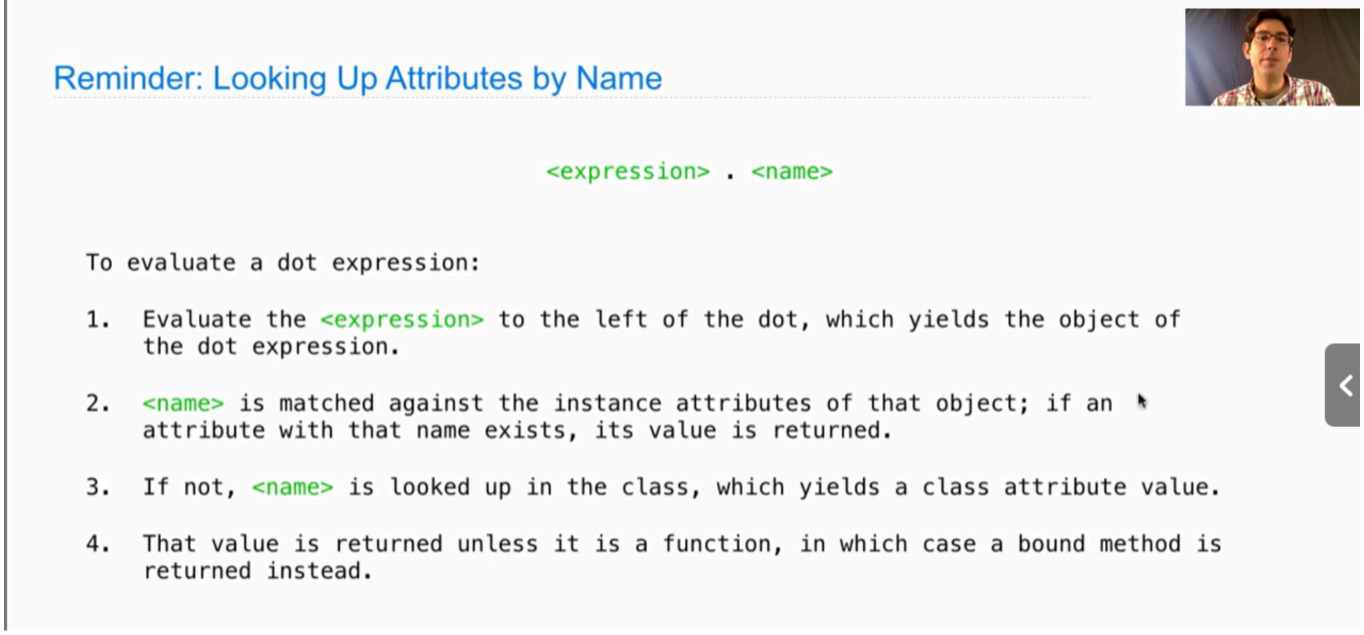
**Python object system:**

Functions are objects.

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>
```



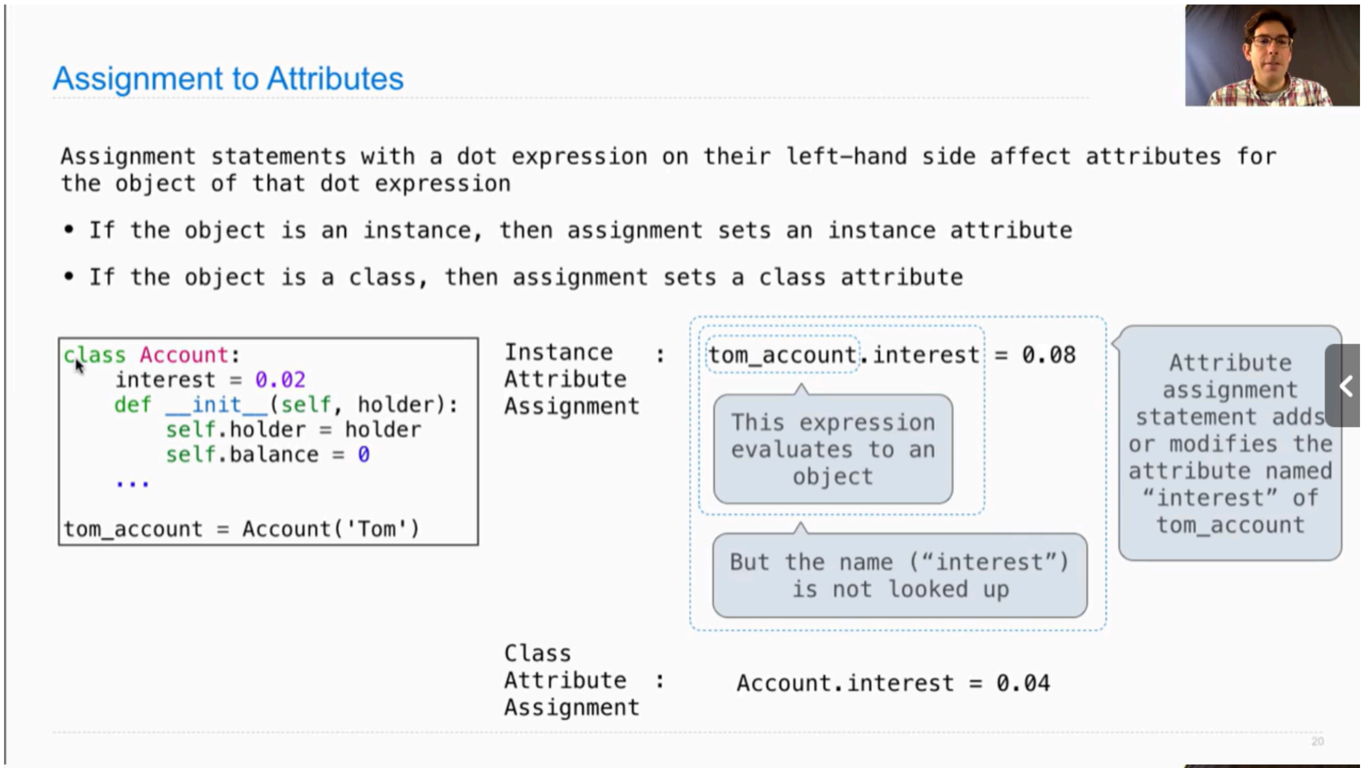
### Reminder: Looking Up Attributes by Name

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

To evaluate a dot expression:

1. Evaluate the `<expression>` to the left of the dot, which yields the object of the dot expression.
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



## Assignment to Attributes

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

- If the object is an instance, then assignment sets an instance attribute
- If the object is a class, then assignment sets a class attribute

```
class Account:
    interest = 0.02
    def __init__(self, holder):
        self.holder = holder
        self.balance = 0
    ...

tom_account = Account('Tom')
```

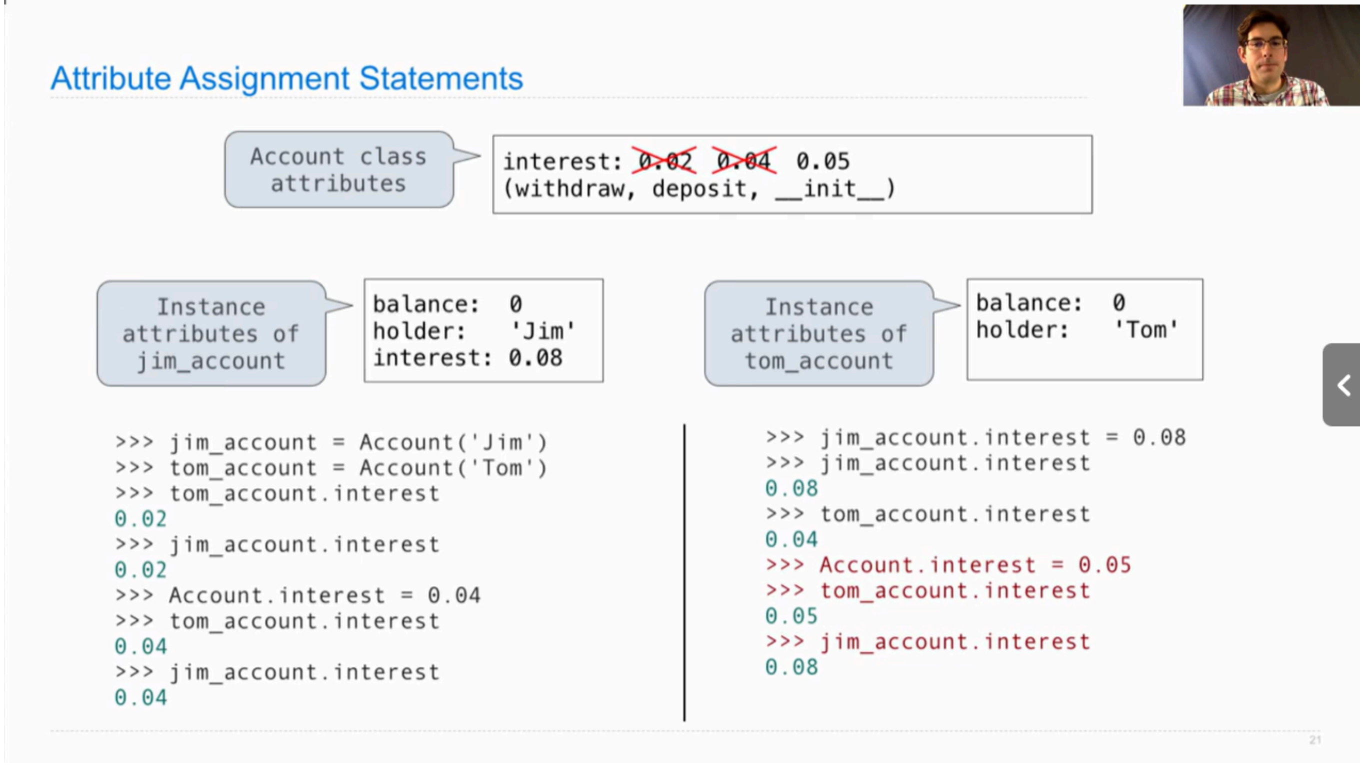
Instance Attribute Assignment : `tom_account.interest = 0.08`

This expression evaluates to an object

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

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

Class Attribute Assignment : `Account.interest = 0.04`



## 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

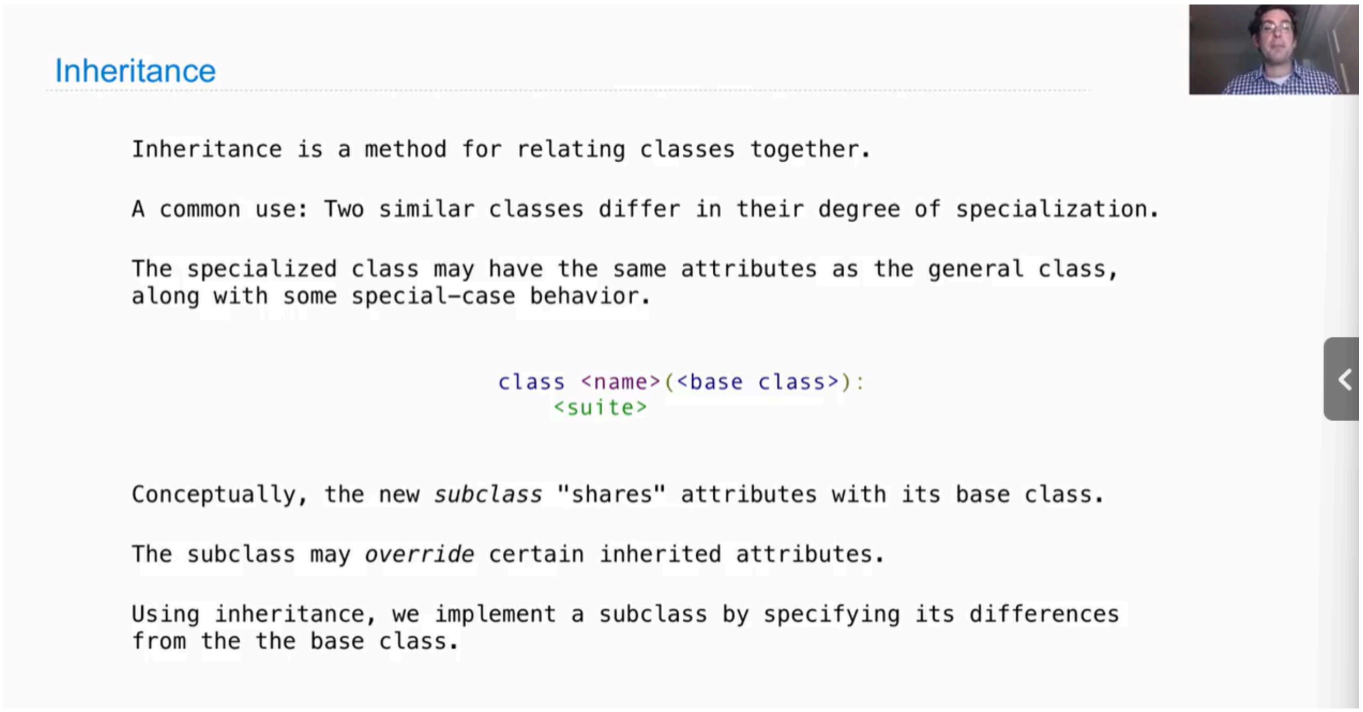
```
balance:  0
holder:   'Tom'
```

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

## Inheritence

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


Inheritance

Inheritance is a method for relating classes together.

A common use: Two similar classes differ in their degree of specialization.

The specialized class may have the same attributes as the general class, along with some special-case behavior.

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

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

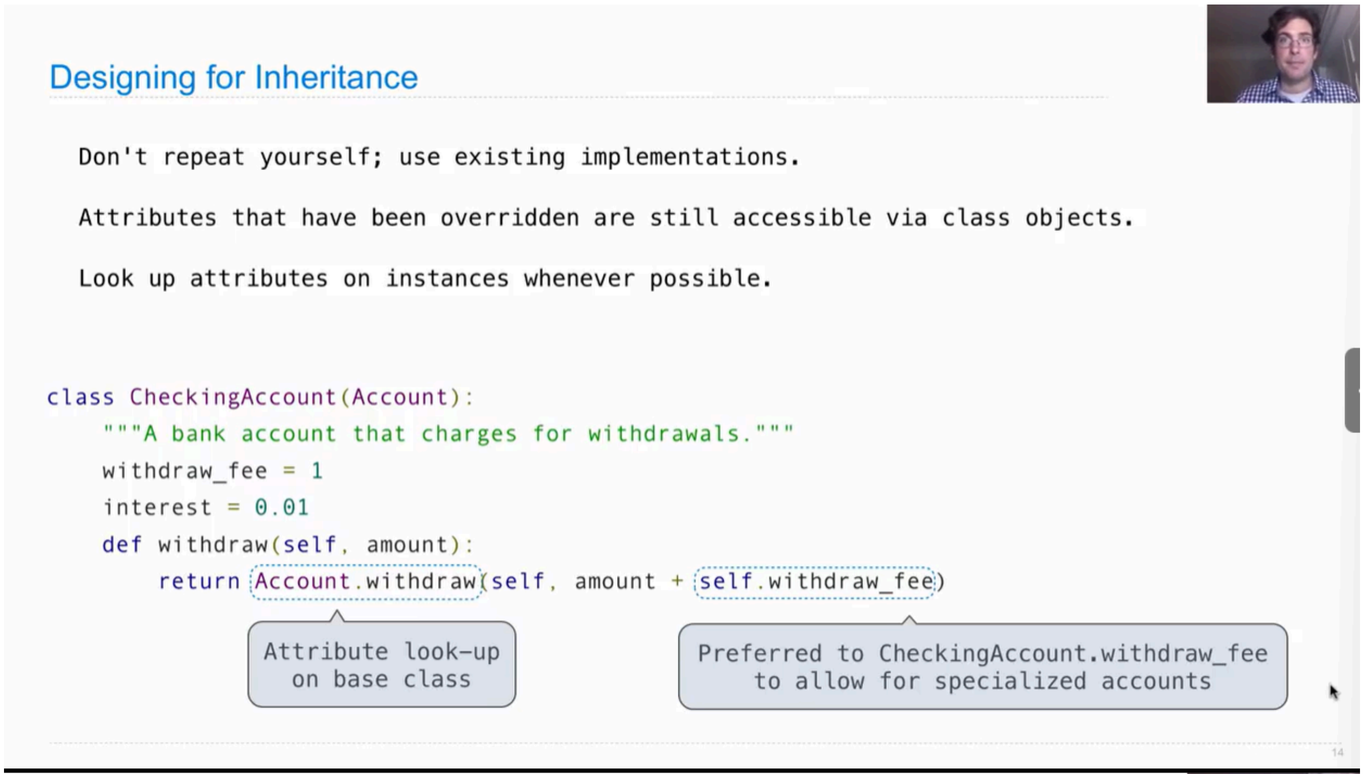
The subclass may *override* certain inherited attributes.

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

case:

```
class Account:
    interst = 0.02
    def __init__(self, holder):
        self.holder = holder
        self.balance = 0

    def withdraw(self, amount):
        if amount > self.balance:
            return "Insufficient funds"
        self.balance -= amount
        return self.balance



    def deposit(self, amount):
        self.balace += amount
        return balance

# inheritence

class CheckingAccount(Account):
    withdraw_fee = 1
    interest = 0.01
    def withdraw(self, amount):
        return Account.withdraw(self, amount + self.withdraw_fee)
```

## Object-Oriented Design



## Designing for Inheritance

Don't repeat yourself; use existing implementations.

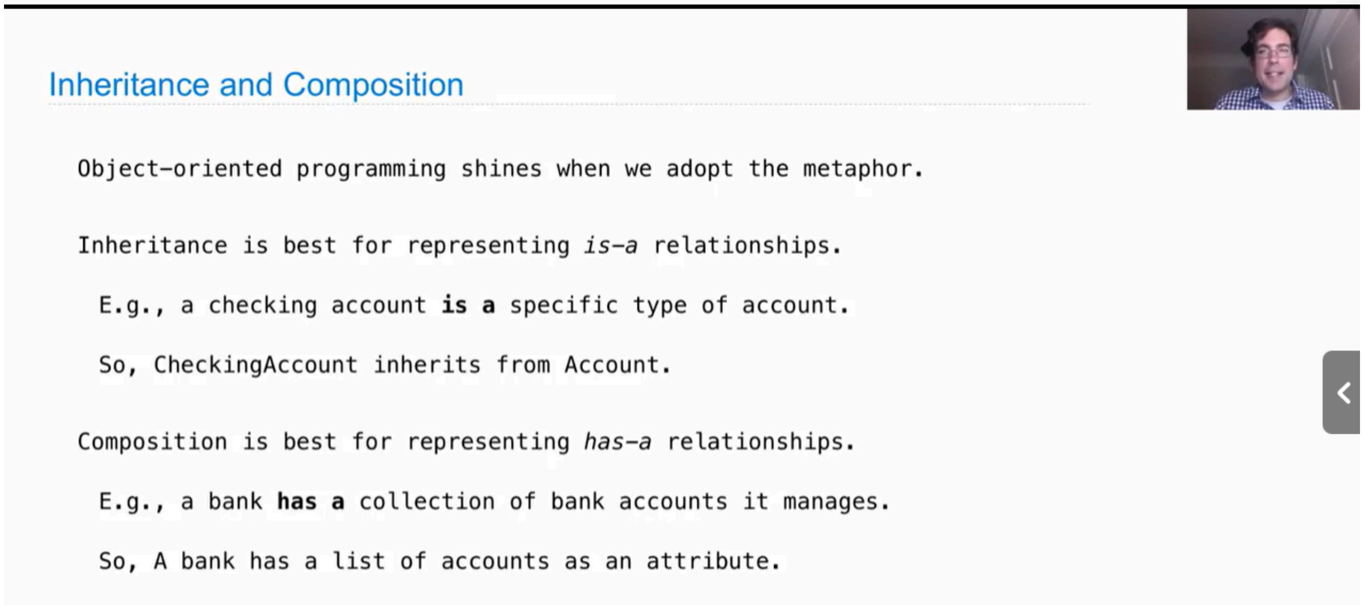
Attributes that have been overridden are still accessible via class objects.

Look up attributes on instances whenever possible.

```python
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)
```

Attribute look-up on base class

Preferred to CheckingAccount.withdraw_fee to allow for specialized accounts



## Inheritance and Composition

Object-oriented programming shines when we adopt the metaphor.

Inheritance is best for representing *is-a* relationships.

E.g., a checking account **is a** specific type of account.

So, CheckingAccount inherits from Account.

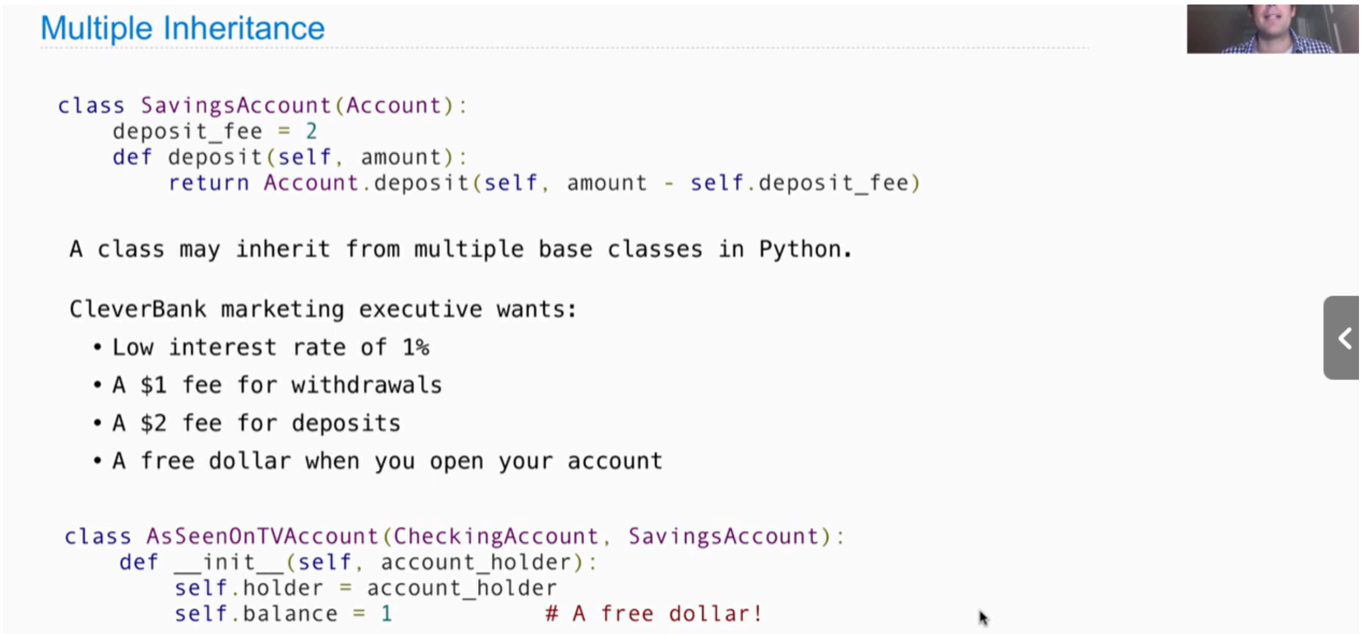
Composition is best for representing *has-a* relationships.

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

So, A bank has a list of accounts as an attribute.

```python
class Bank:
    """A bank has accounts"""
    def __init__.(self):
        self.accounts = []

    def open_accounts(self, holder, amount, kind=Account):
        account = kind(holder)
        account.deposit(amount)
        self.accounts.append(account)
        return account

    def pay_interest(self):
        for a in self.accounts:
            a.deposit(a.balance * a.interest)

    def too_bit_to_tail(self):
        return len(self.accounts) > 10
```

## Multiple Inheritance



### Multiple Inheritance

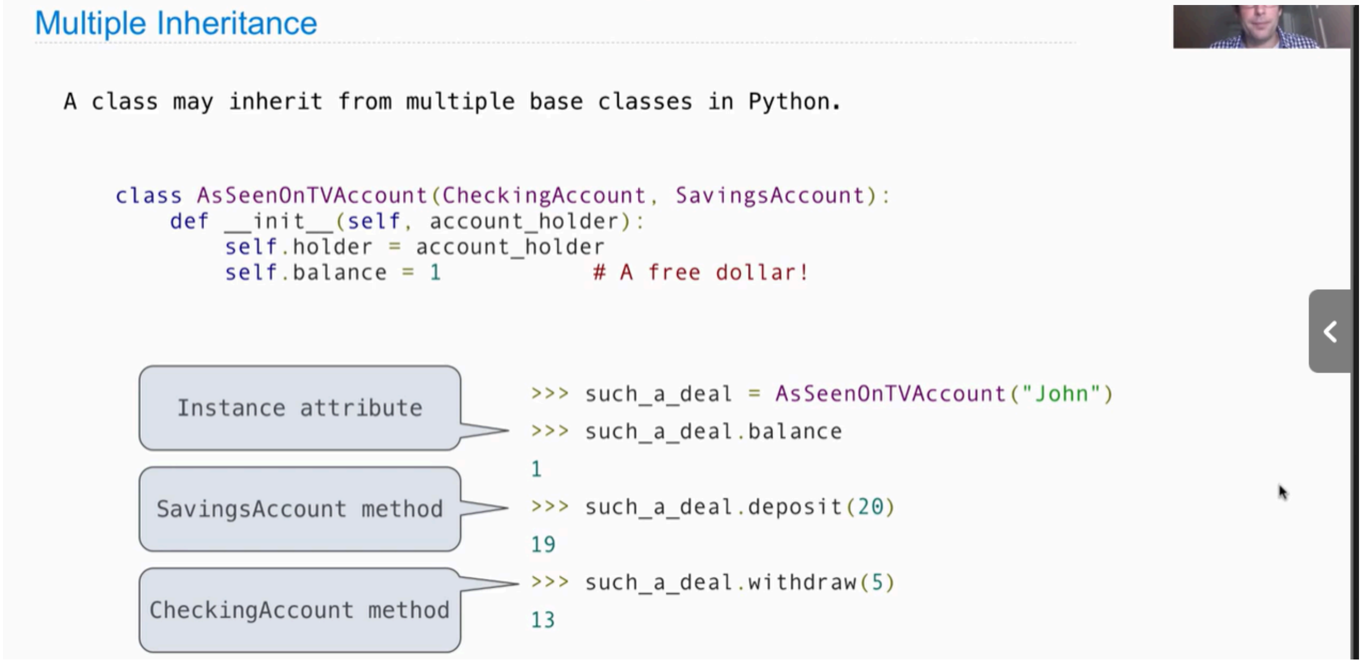
```
class SavingsAccount(Account):
    deposit_fee = 2
    def deposit(self, amount):
        return Account.deposit(self, amount - self.deposit_fee)
```

A class may inherit from multiple base classes in Python.

CleverBank 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

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!
```

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