

# Inheritance

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## Announcements

Attributes

## Terminology: Attributes, Functions, and Methods

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All objects have attributes, which are name-value pairs

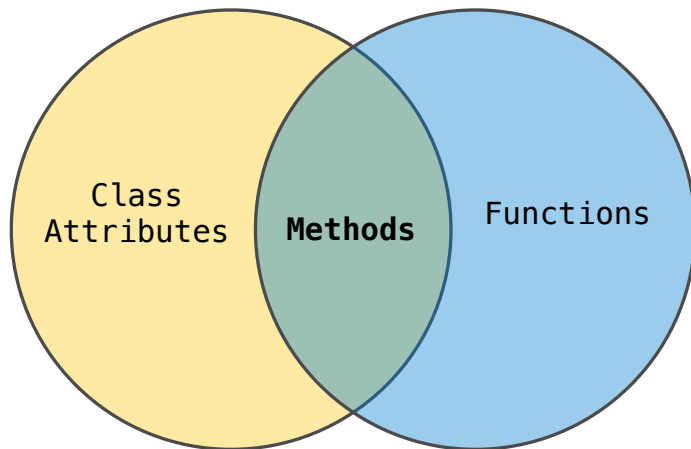
A class is a type (or category) of objects

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>`

## Looking Up Attributes by Name

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`<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

## Class Attributes

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Class attributes are "shared" across all instances of a class because they are attributes of the class, not the instance

```
class Account:
    interest = 0.02 # A class attribute

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

# Additional methods would be defined here
```

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

The **interest** attribute is ***not*** part of the instance; it's part of the class!

## 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'

does not change the CLASS  
-> change INSTANCE

```
>>> 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
```

# Inheritance

## Inheritance

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Inheritance is a technique 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 inherits attributes of 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

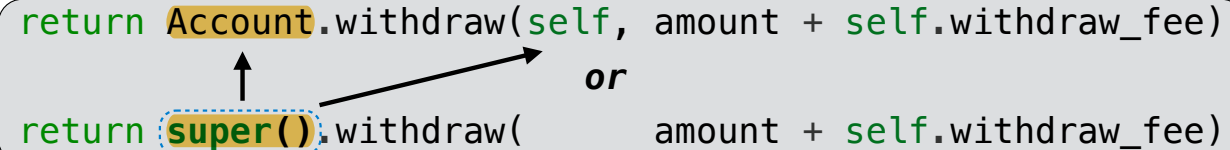
## Inheritance Example

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

```
>>> ch = CheckingAccount('Tom')
>>> ch.interest      # Lower interest rate for checking accounts
0.01
>>> ch.deposit(20)   # Deposits are the same
20
>>> ch.withdraw(5)   # Withdrawals incur a $1 fee
14
```

Most behavior is shared with the base class `Account`

```
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)
        or
        return super().withdraw(amount + self.withdraw_fee)
```



## Looking Up Attribute Names on Classes

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

To look up a name in a class:

1. If it names an attribute in the class, return the attribute value.
2. Otherwise, look up the name in the base class, if there is one.

```
>>> ch = CheckingAccount('Tom') # Calls Account.__init__
>>> ch.interest                 # Found in CheckingAccount
0.01
>>> ch.deposit(20)              # Found in Account
20
>>> ch.withdraw(5)              # Found in CheckingAccount
14
```

(Demo)

# Object-Oriented Design

## Designing for Inheritance

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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

```
class CheckingAccount(Account):  
    """A bank account that charges for withdrawals."""  
    withdraw_fee = 1  
    interest = 0.01 # Account 안에 있는 interest랑 같이 바뀌기 싫을 경우  
    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

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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

X inherit, just have.

(Demo)



Review: Attributes Lookup, Methods, & Inheritance

## Inheritance and Attribute Lookup

```
class A:
    z = -1
    def f(self, x):
        return x-1

class B(A):
    n = 4
    def __init__(self, y):
        self.z = self.f(y)

class C(B):
    def f(self, x):
        return x

a = A()
b = B(1)
b.n = 5
c = C(2)  class C에는 __init__이 없음.
```

```
>>> c.z
```

```
2
```

```
>>> c.n
```

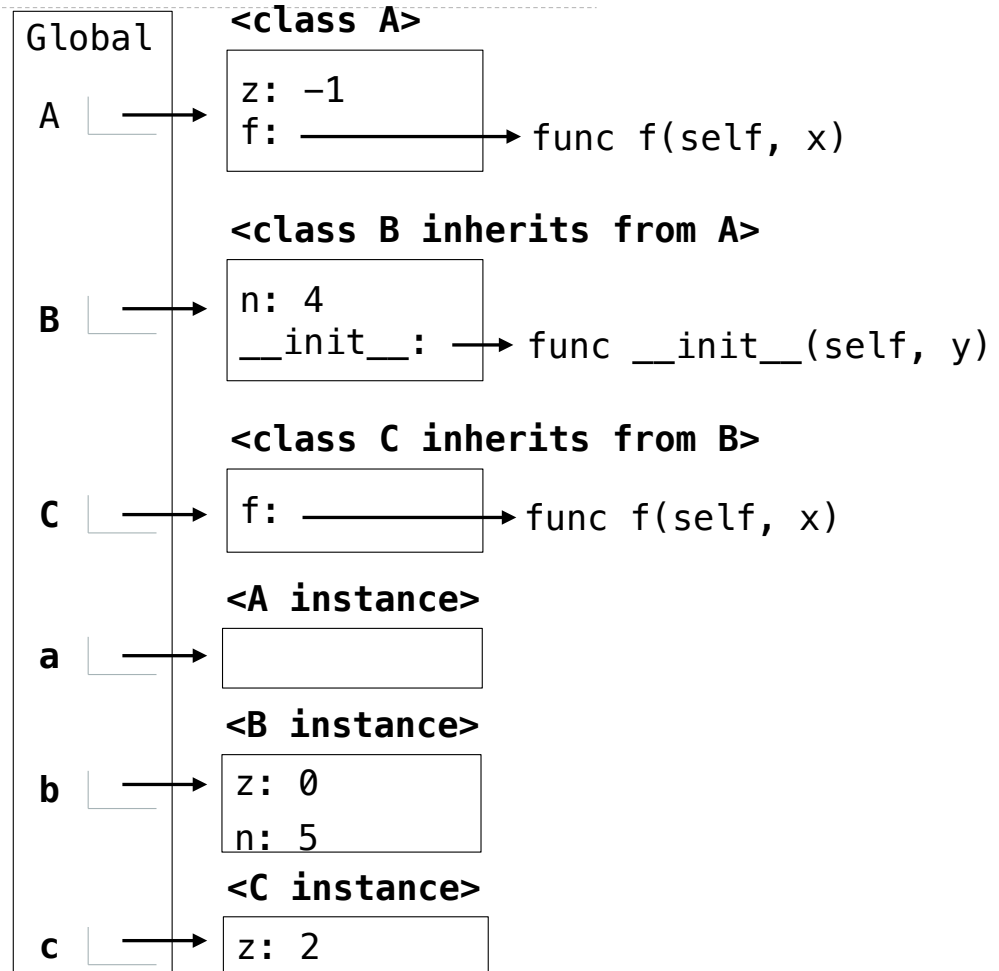
```
4
```

```
>>> a.z == c.z
```

```
True
```

```
>>> a.z == b.z
```

```
False
```



Environment diagrams for objects aren't required, but can be very helpful!

## Multiple Inheritance

## Multiple Inheritance

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```
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 has an idea:

- 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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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

```
>>> such_a_deal = AsSeenOnTVAccount('John')
```

```
>>> such_a_deal.balance
```

```
1
```

SavingsAccount method

```
>>> such_a_deal.deposit(20)
```

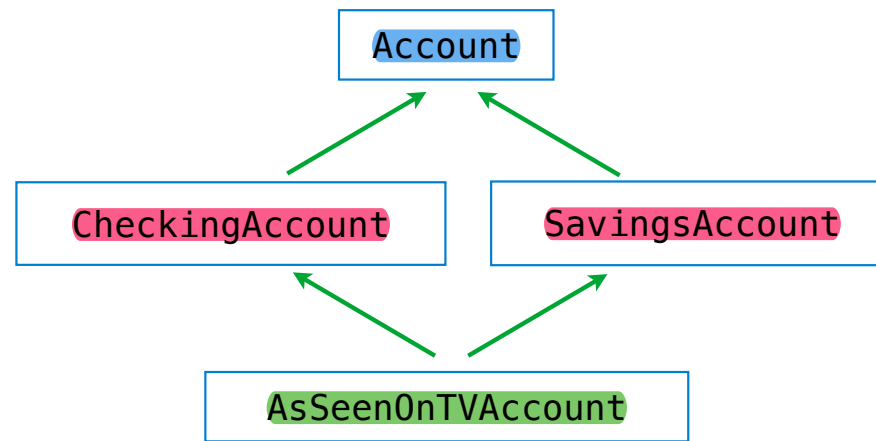
```
19
```

CheckingAccount method

```
>>> such_a_deal.withdraw(5)
```

```
13
```

## Resolving Ambiguous Class Attribute Names



Instance attribute

```
>>> such_a_deal = AsSeenOnTVAccount('John')
```

```
>>> such_a_deal.balance
```

```
1
```

SavingsAccount method

```
>>> such_a_deal.deposit(20)
```

```
19
```

CheckingAccount method

```
>>> such_a_deal.withdraw(5)
```

```
13
```