

Inheritance

Announcements

Attributes

Terminology: Attributes, Functions, and Methods

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All objects have attributes, which are name-value pairs

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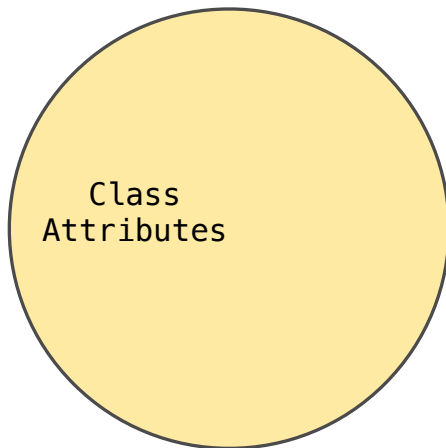
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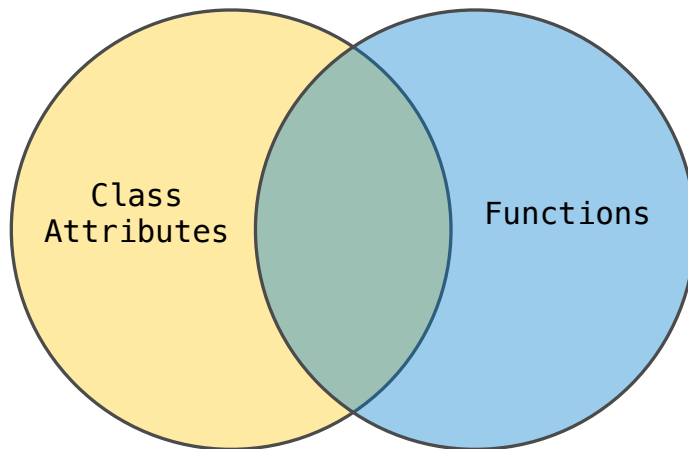
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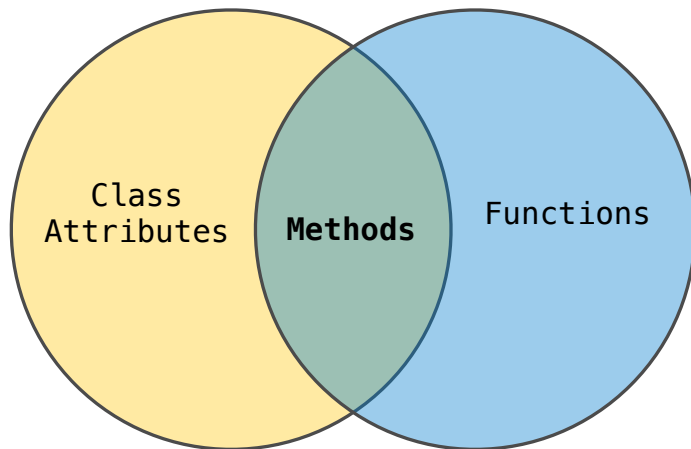
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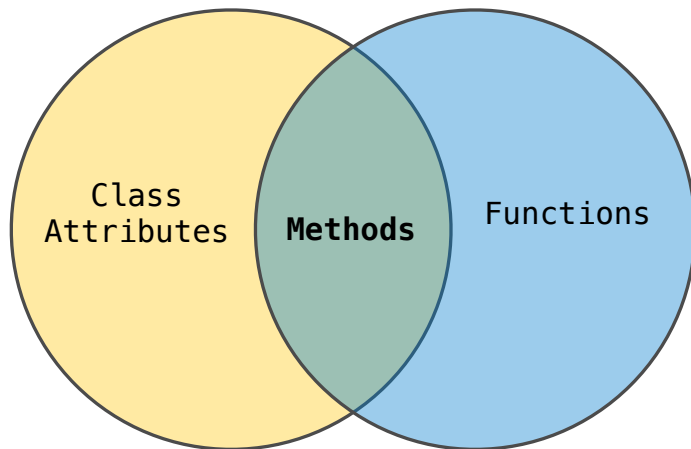
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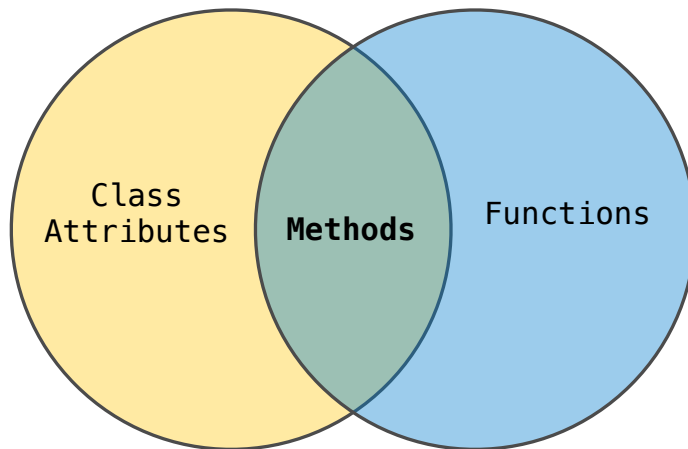
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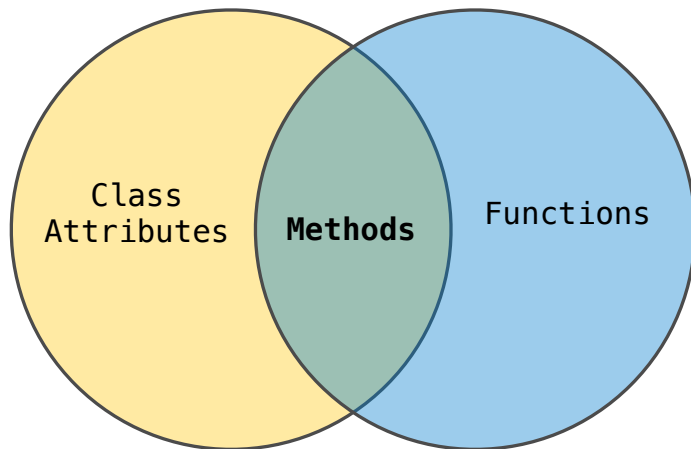
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Bound methods are also objects: a function that has its first parameter "self" already bound to an instance

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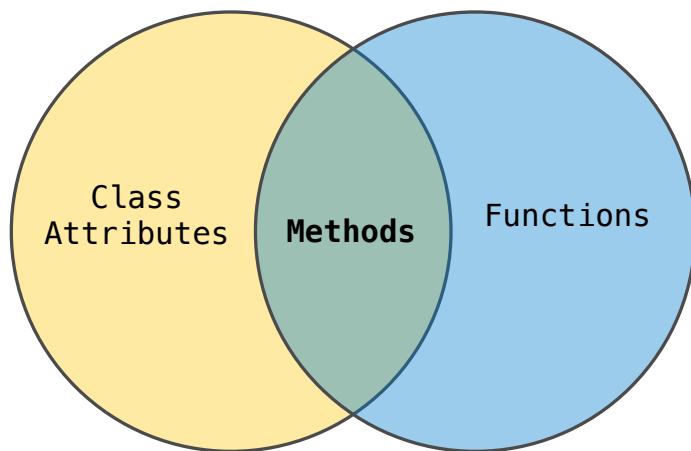
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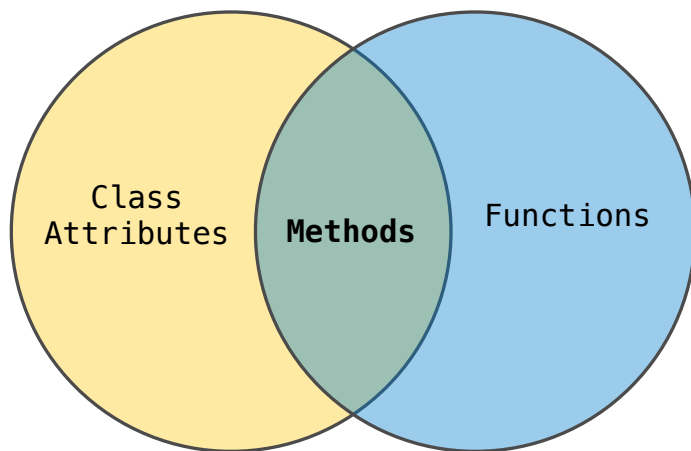
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`<instance>.<method_name>`

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

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```
class Account:

    interest = 0.02    # A class attribute

    def __init__(self, account_holder):
        self.balance = 0
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# Additional methods would be defined here
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The **interest** attribute is *not* part of the instance; it's part of the class!

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Attribute Assignment

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```

```
tom_account.interest = 0.08
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But the name ("interest")
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Class
Attribute
Assignment

Account.interest = 0.04

Attribute Assignment Statements

Account class
attributes

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

Attribute Assignment Statements

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

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

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attributes

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interest: 0.02  
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```

Instance
attributes of
jim_account

```
balance: 0  
holder: 'Jim'
```

```
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```



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```

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Instance
attributes of
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```
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holder: 'Jim'
```

Instance
attributes of
tom_account

```
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holder: 'Tom'
```

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

Attribute Assignment Statements

Account class
attributes

interest: 0.02
(withdraw, deposit, __init__)

Instance
attributes of
jim_account

balance: 0
holder: 'Jim'

Instance
attributes of
tom_account

balance: 0
holder: 'Tom'

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

Attribute Assignment Statements

Account class
attributes

interest: 0.02
(withdraw, deposit, __init__)

Instance
attributes of
jim_account

balance: 0
holder: 'Jim'

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
```

Attribute Assignment Statements

Account class
attributes

interest: 0.02
(withdraw, deposit, __init__)

Instance
attributes of
jim_account

balance: 0
holder: 'Jim'

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
```

Attribute Assignment Statements

Account class
attributes

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

Instance
attributes of
jim_account

balance: 0
holder: 'Jim'

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
```

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Account class
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Instance
attributes of
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holder: 'Tom'

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

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holder: 'Jim'

Instance
attributes of
tom_account

balance: 0
holder: 'Tom'

```
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>>> 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
```


Attribute Assignment Statements

Account class
attributes

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

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
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balance: 0
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interest: 0.08

Instance
attributes of
tom_account

balance: 0
holder: 'Tom'

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>>> 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
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```
>>> jim_account.interest = 0.08
>>> jim_account.interest
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attributes of
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Instance
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>>> tom_account.interest
0.02
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>>> jim_account = Account('Jim')
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>>> 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
```

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attributes

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Instance
attributes of
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holder: 'Jim'
interest: 0.08

Instance
attributes of
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holder: 'Tom'

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>>> tom_account.interest
0.02
>>> jim_account.interest
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>>> tom_account.interest
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```

```
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```

```
>>> jim_account.interest = 0.08
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>>> tom_account.interest
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>>> Account.interest = 0.05
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>>> jim_account.interest = 0.08
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class <Name>(<Base Class>):  
    <suite>
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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`

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```
>>> ch = CheckingAccount('Tom')
```

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>>> ch.interest      # Lower interest rate for checking accounts
0.01
```

Inheritance Example

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

```
>>> ch = CheckingAccount('Tom')
>>> ch.interest      # Lower interest rate for checking accounts
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>>> ch.deposit(20)   # Deposits are the same
20
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class CheckingAccount(Account):
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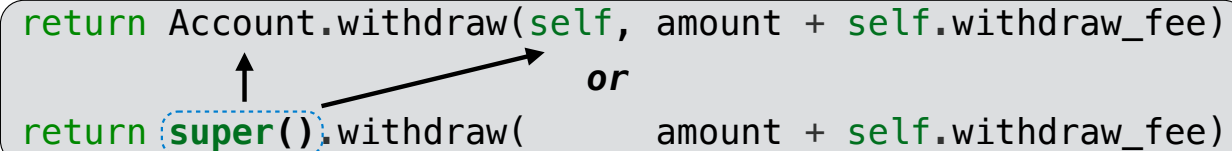
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(Demo)

Object-Oriented Design

Designing for Inheritance

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Don't repeat yourself; use existing implementations

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Designing for Inheritance

Don't repeat yourself; use existing implementations

Attributes that have been overridden are still accessible via class objects

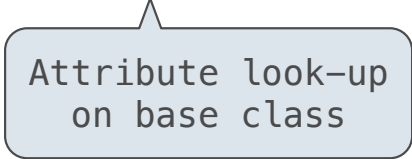
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Attribute look-up
on base class

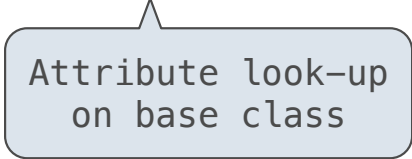
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    def withdraw(self, amount):  
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```

Attribute look-up
on base class

Preferred to `CheckingAccount.withdraw_fee`
to allow for specialized accounts

Inheritance and Composition

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(Demo)

Review: Attributes Lookup, Methods, & Inheritance

Inheritance and Attribute Lookup

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

```
class B(A):  
    n = 4  
    def __init__(self, y):  
        if y:  
            self.z = self.f(y)  
        else:  
            self.z = C(y+1)
```

```
class C(B):  
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```

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a = A()  
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>>> C(2).n
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>>> a.z == C.z
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Which evaluates
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None of these

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None of these

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

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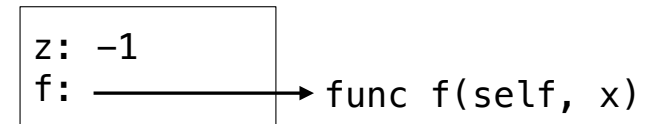
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Global

<class A>

z: -1

f: —————→ func f(self, x)

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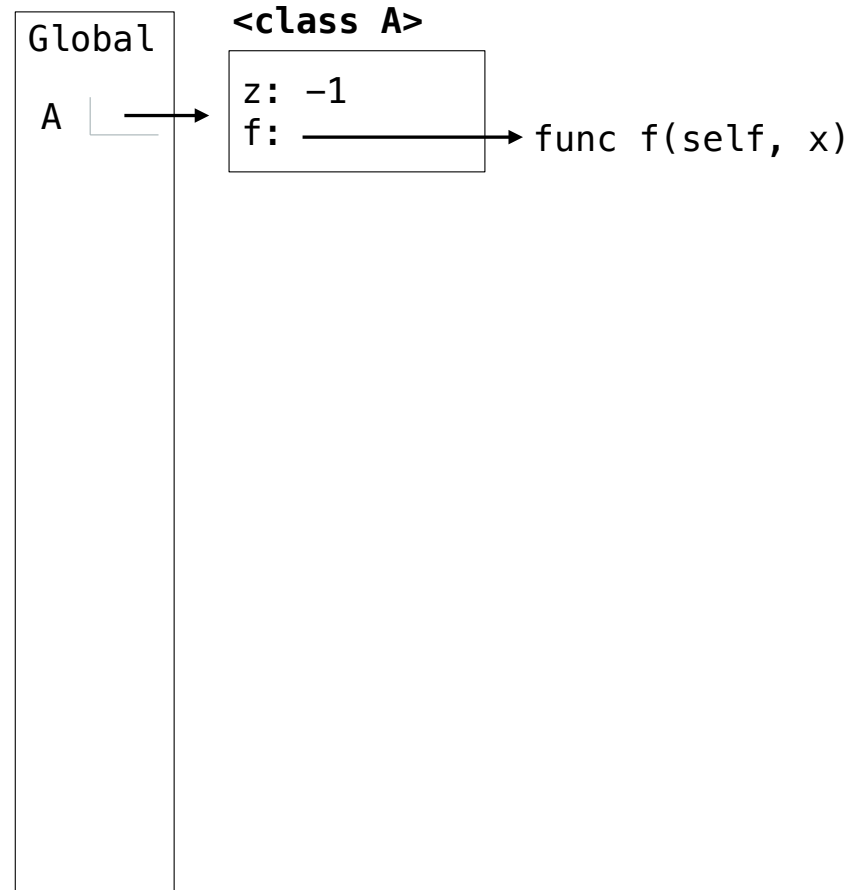
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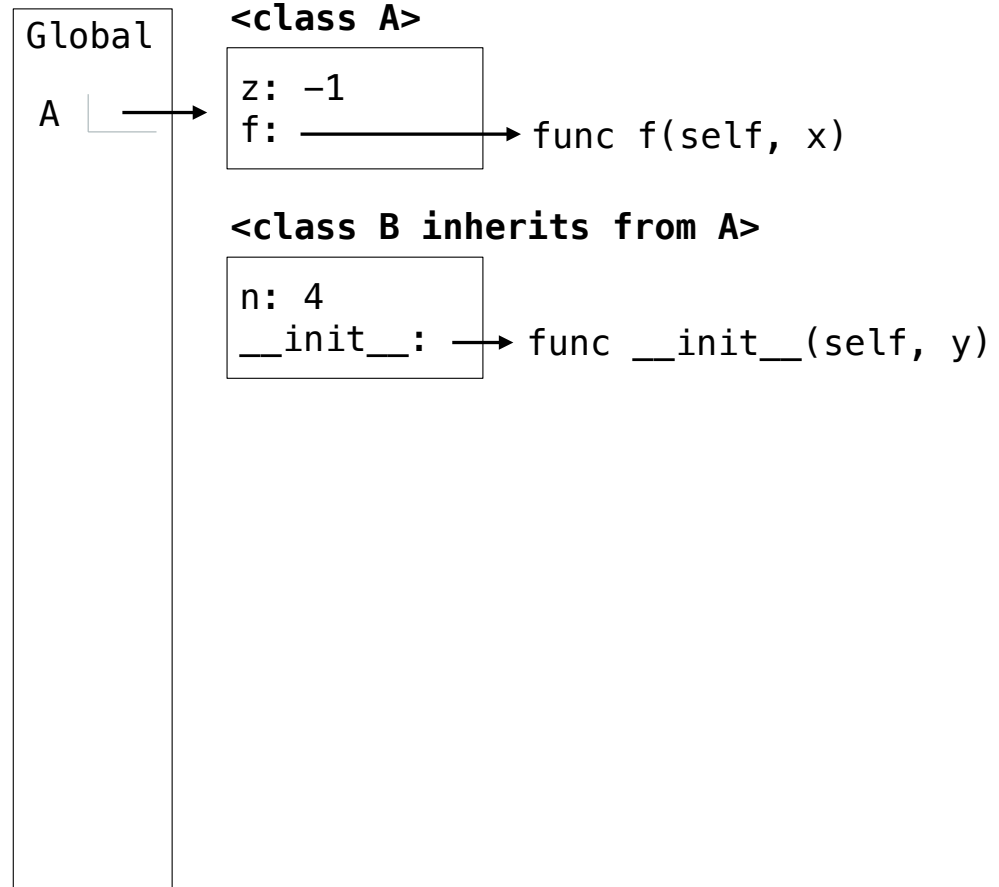
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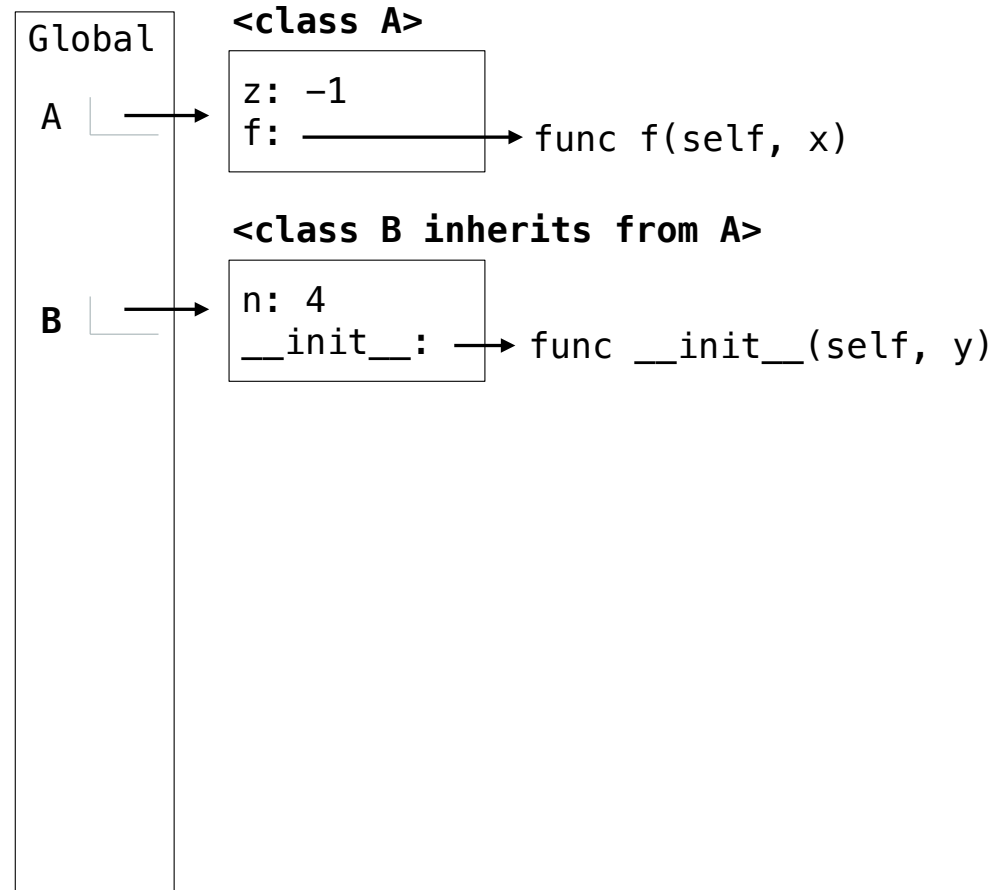
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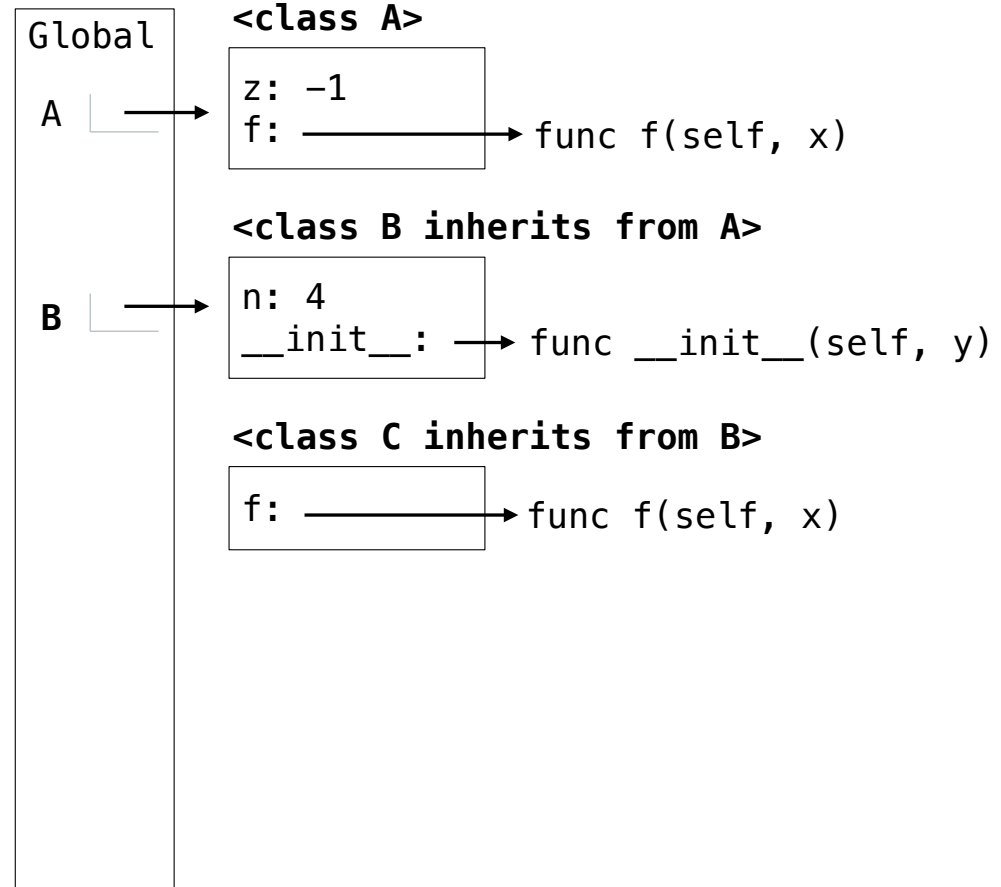
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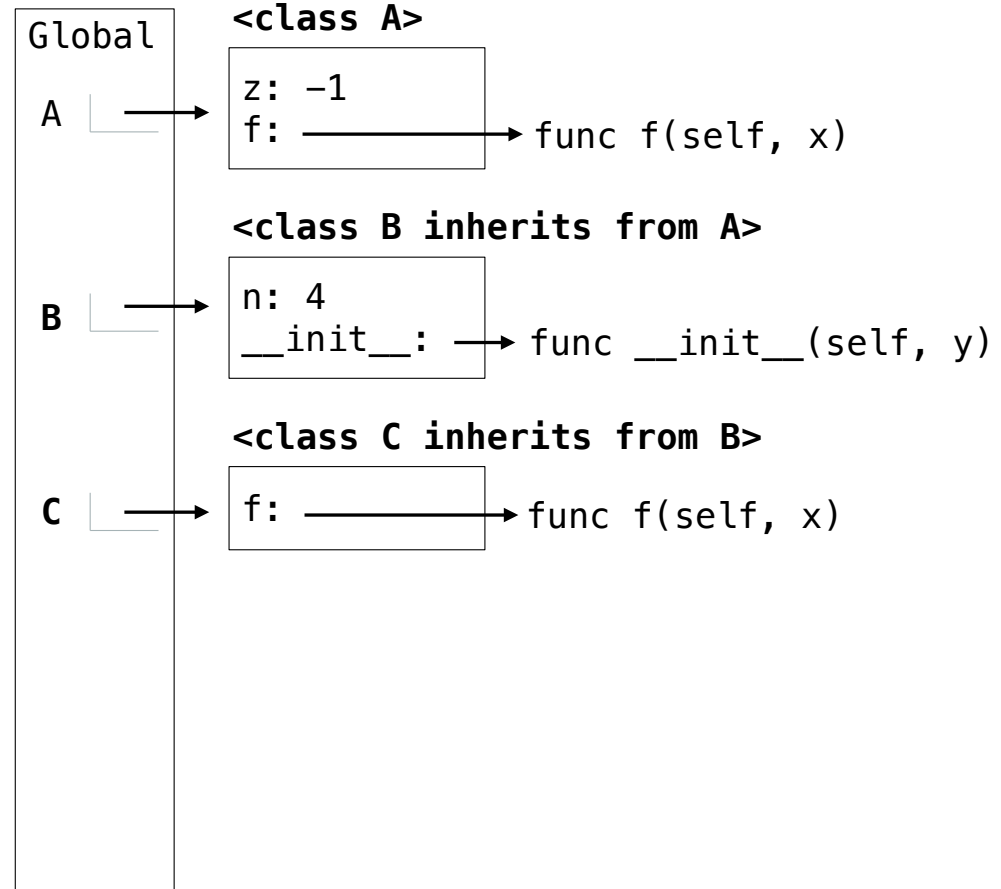
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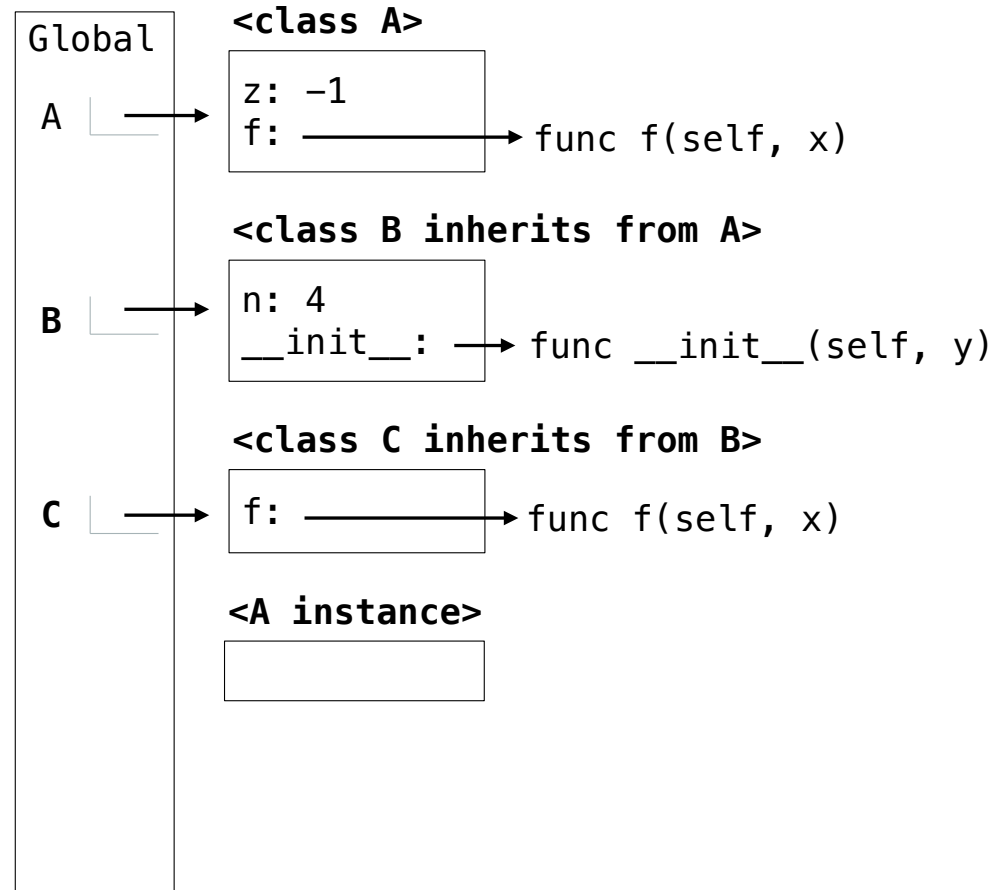
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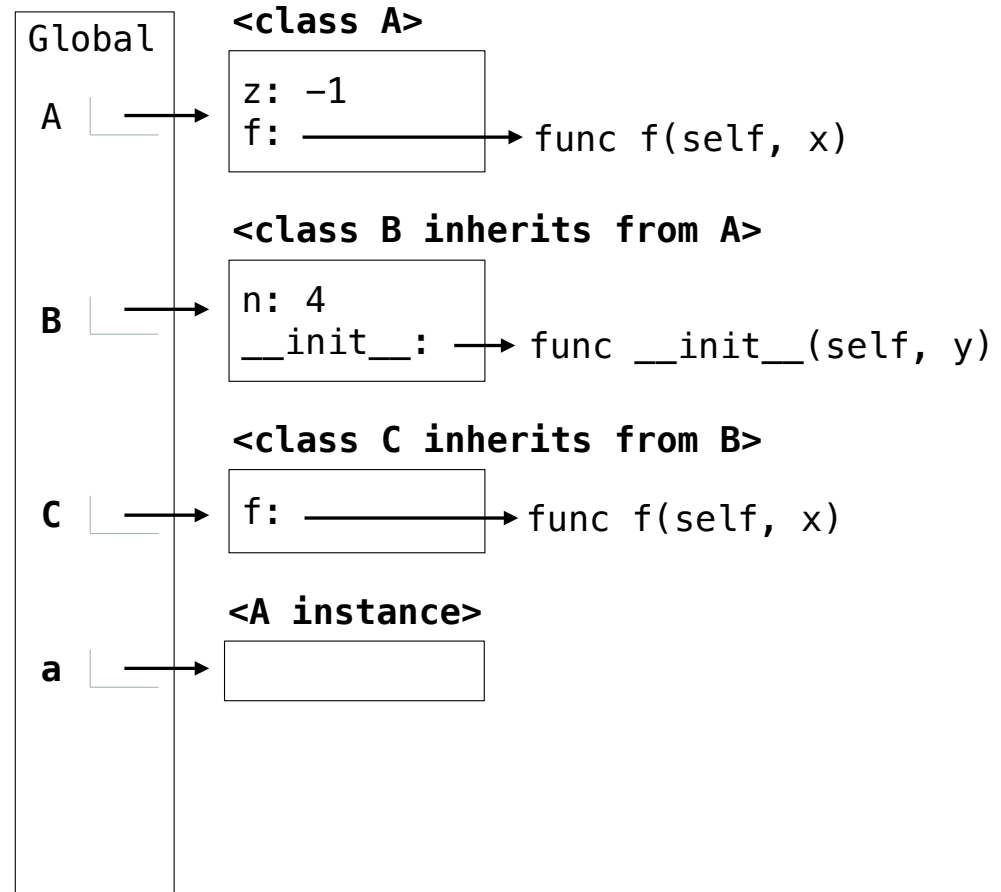
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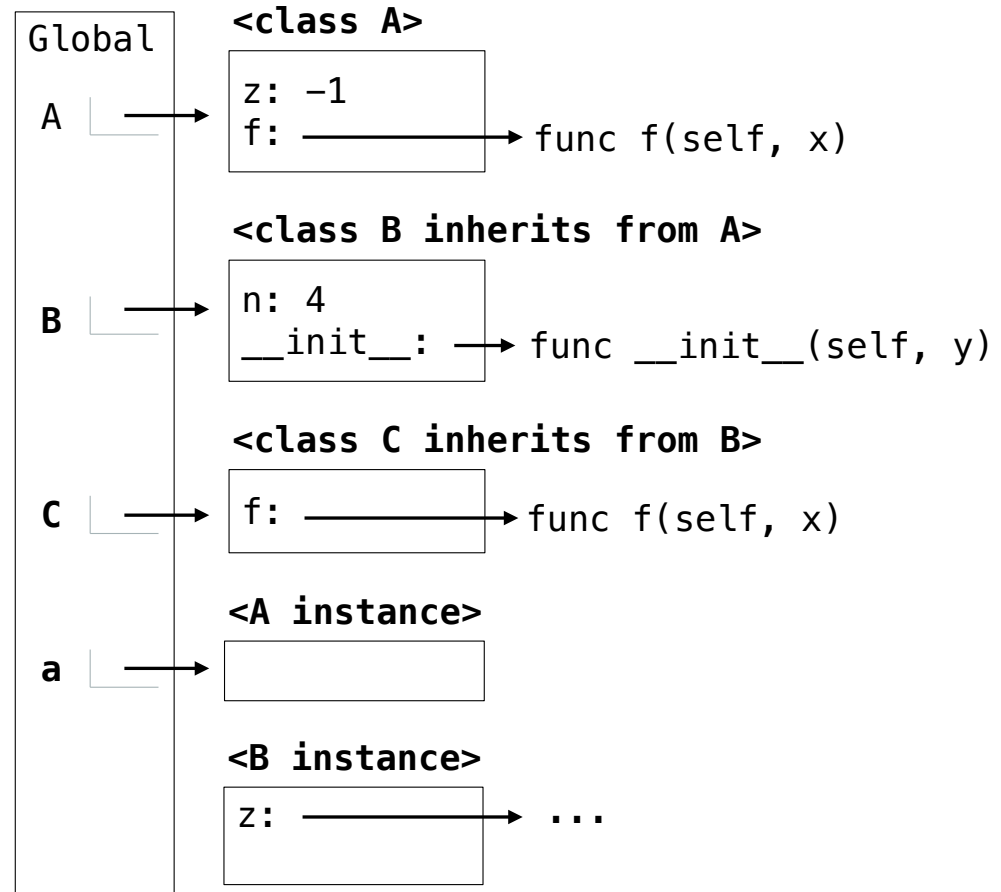
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b.z.z.z
b.z.z.z.z
None of these



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

Inheritance and Attribute Lookup

```
class A:
    z = -1
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    def __init__(self, y):
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        else:
            self.z = C(y+1)

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

a = A()
b = B(1)
```

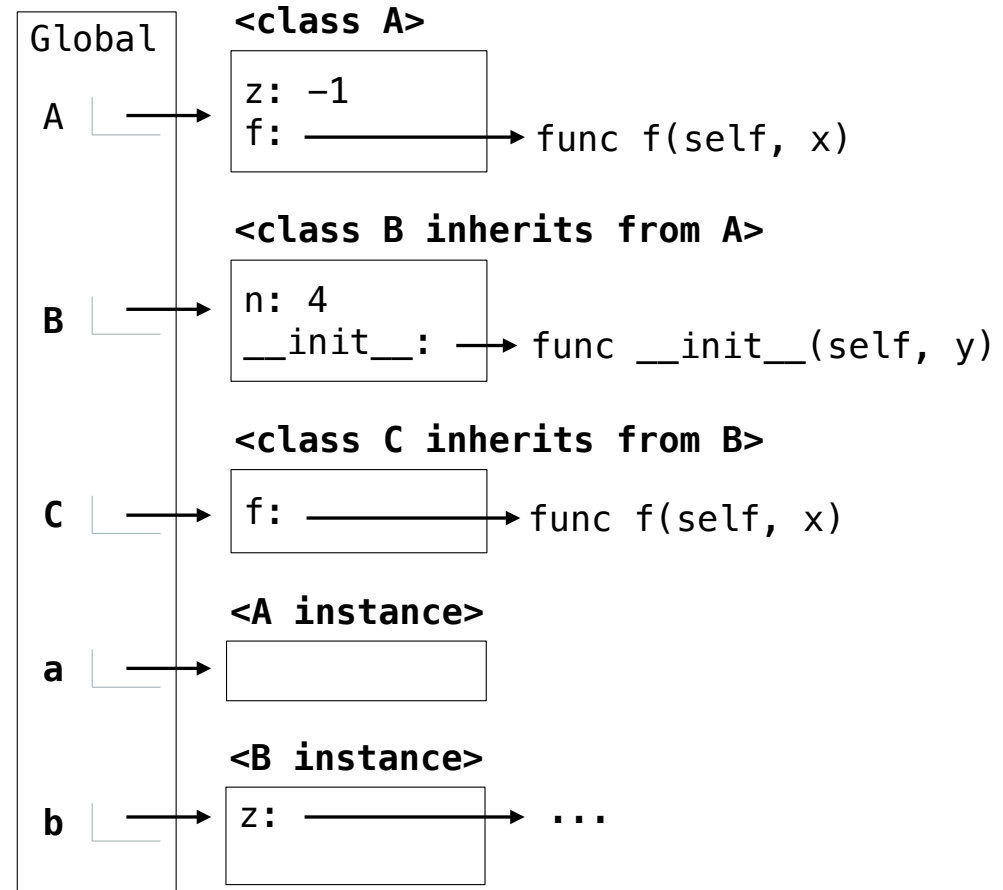
```
>>> C(2).n
```

```
>>> a.z == C.z
```

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

Which evaluates
to an integer?

```
b.z
b.z.z
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b.z.z.z.z
None of these
```



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```

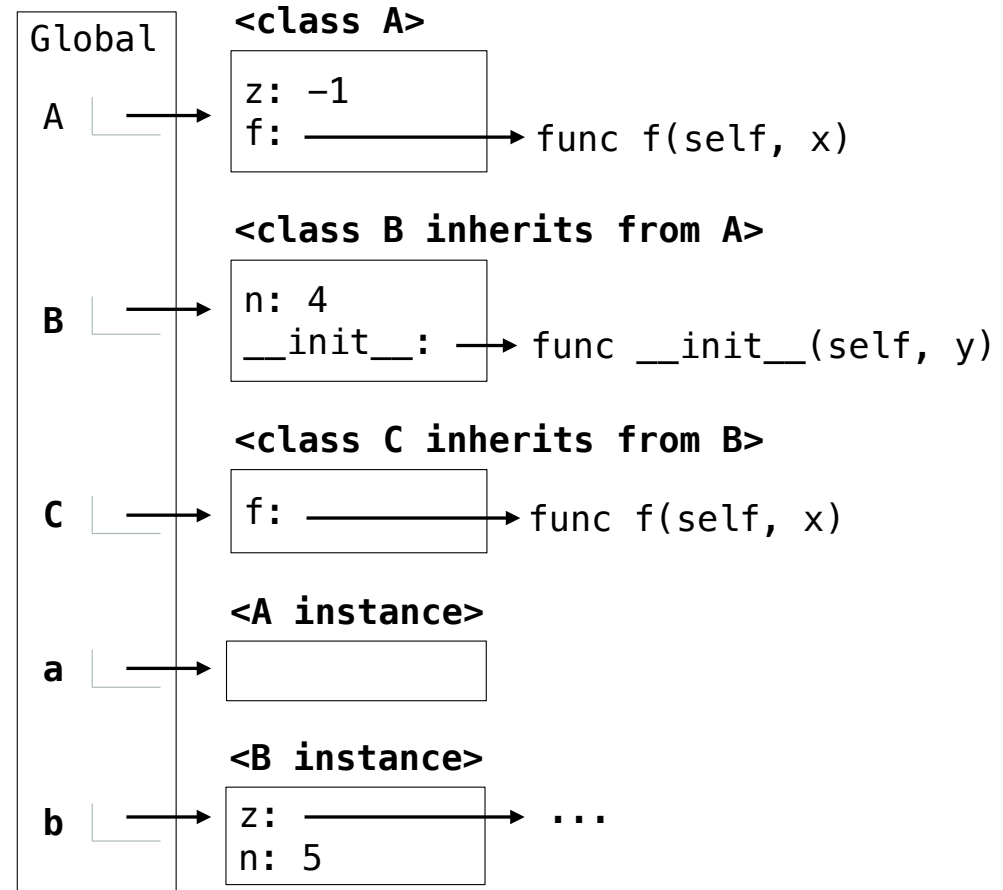
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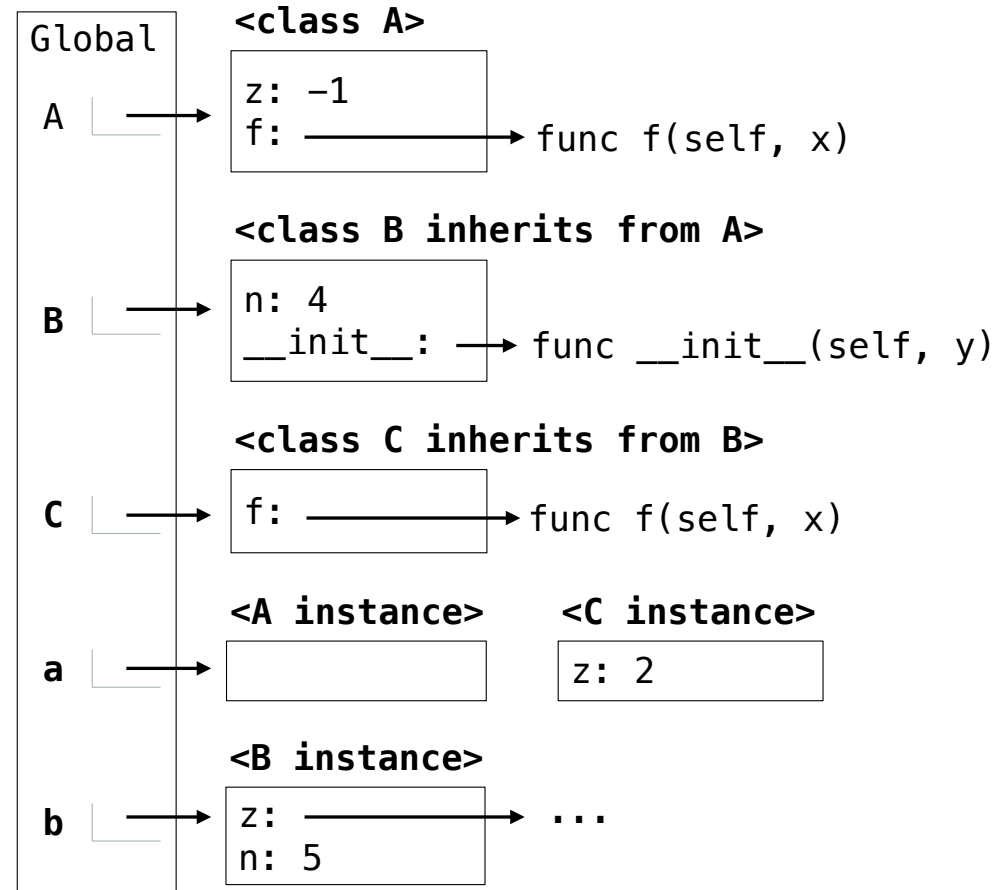
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to an integer?

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b.z.z.z
b.z.z.z.z
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```
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```
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```
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```

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

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to an integer?

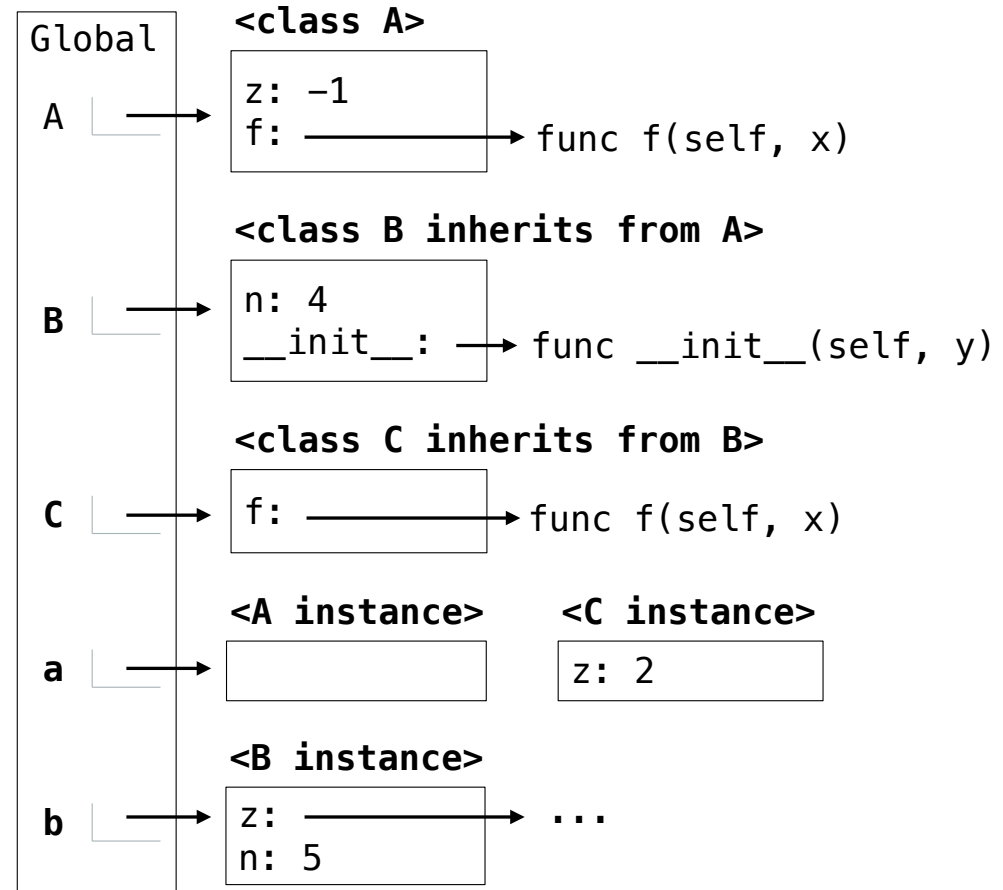
b.z

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b.z.z.z

b.z.z.z.z

None of these



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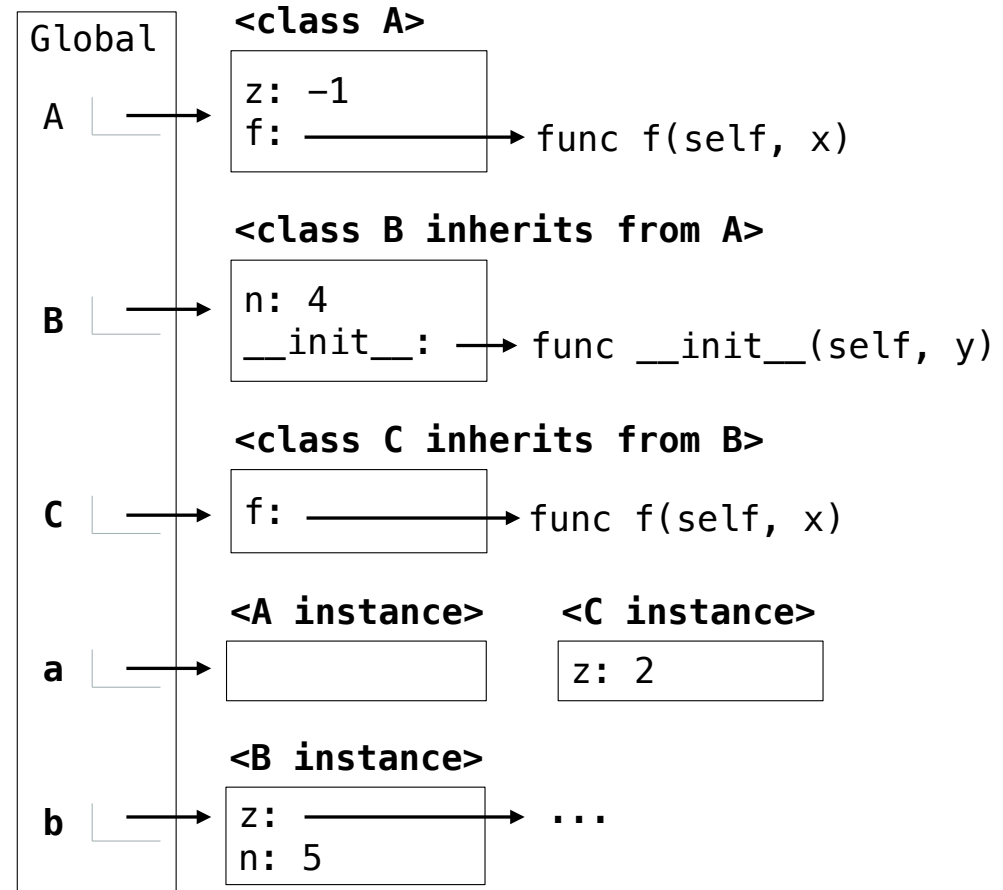
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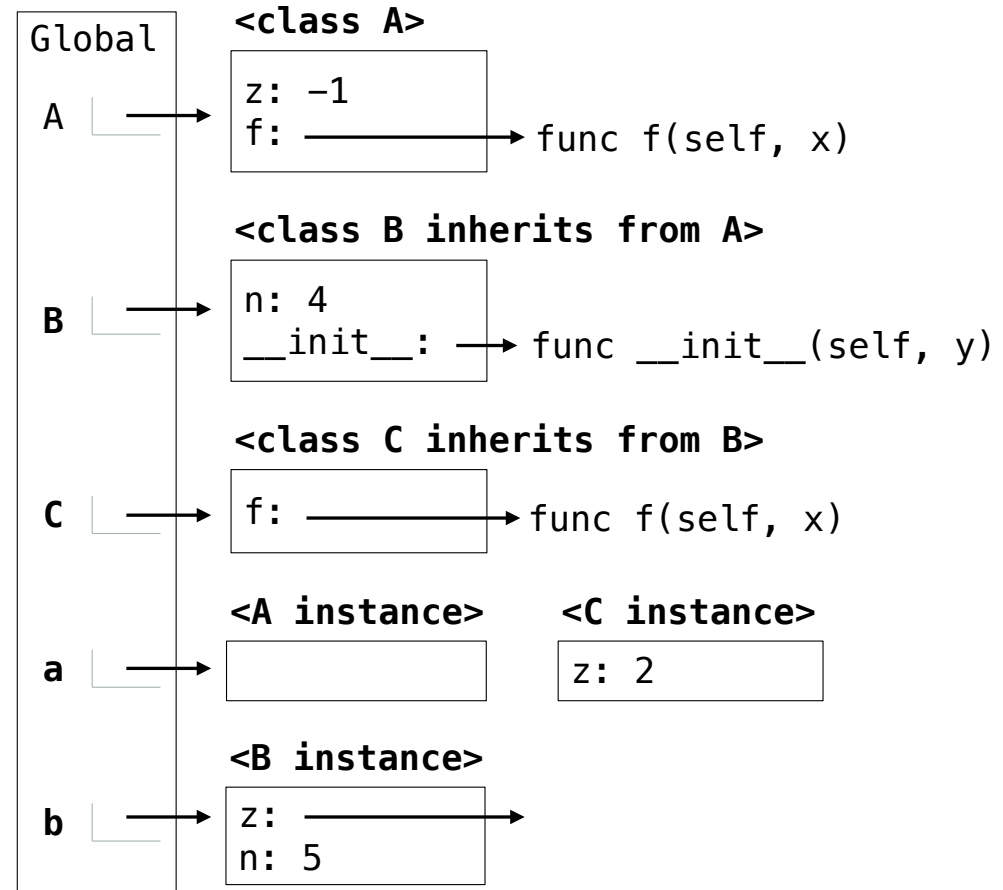
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b.z.z

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```

```
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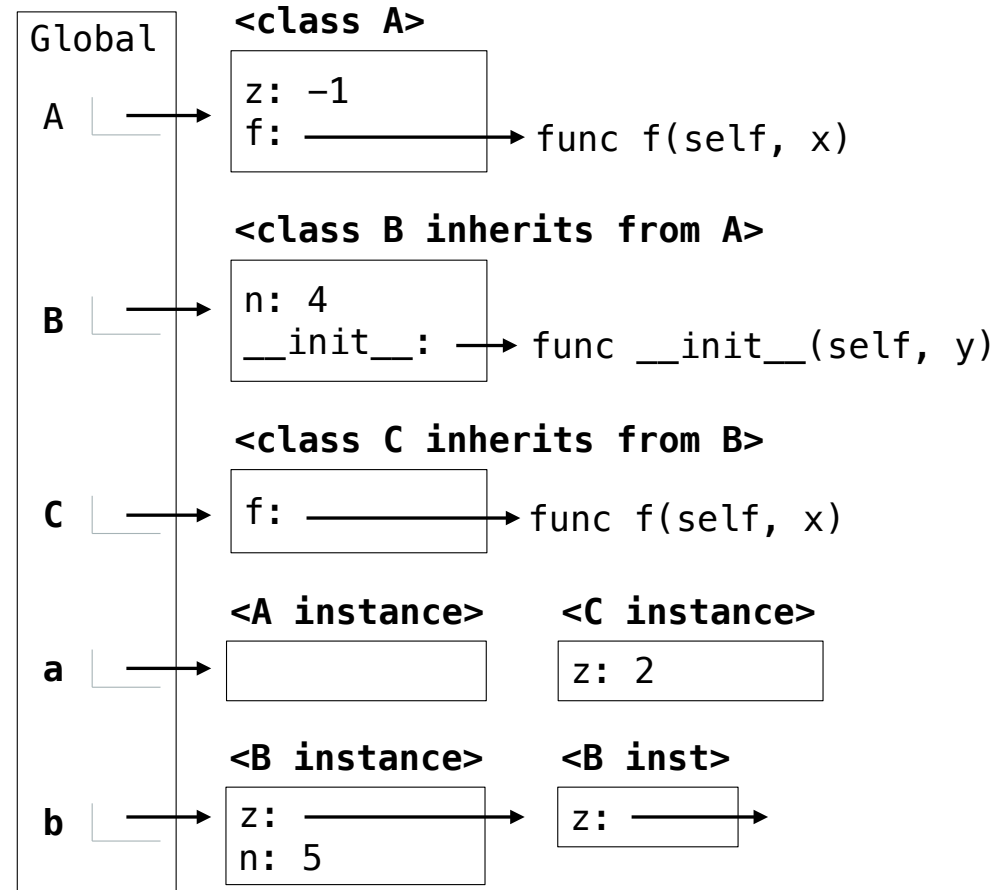
b.z

b.z.z

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None of these



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```

```
True
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```

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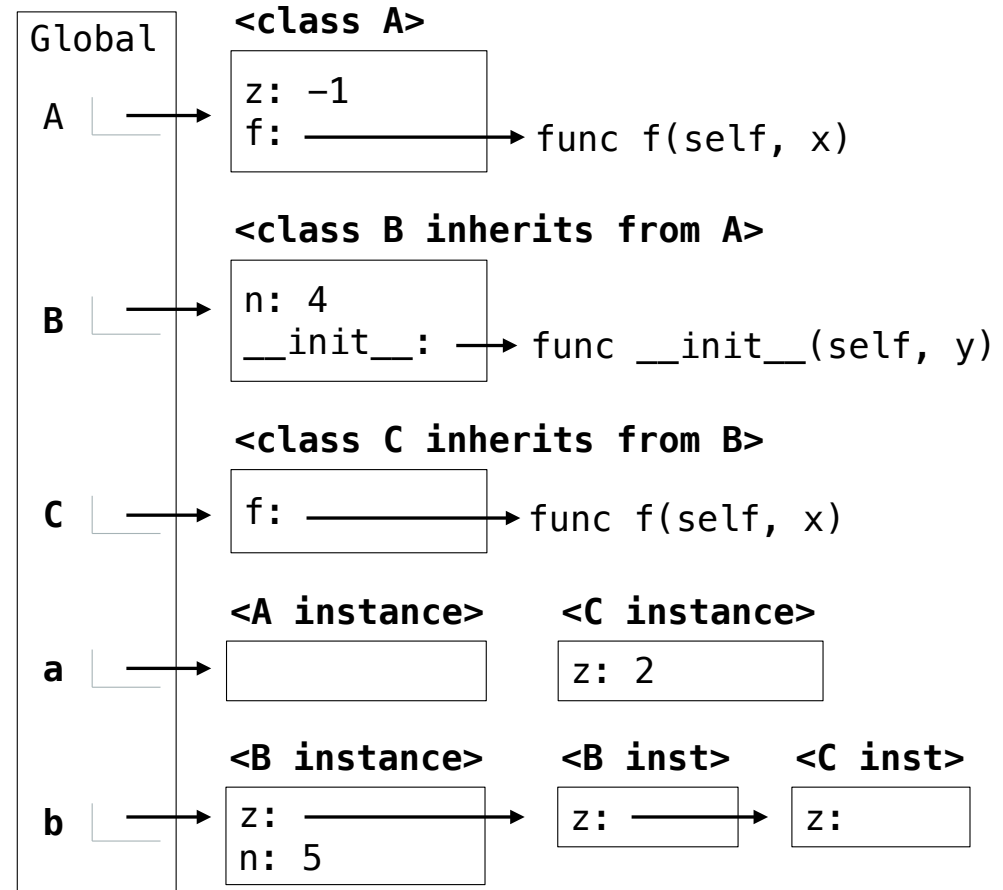
b.z

b.z.z

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None of these



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```
4
```

```
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```

```
True
```

```
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```

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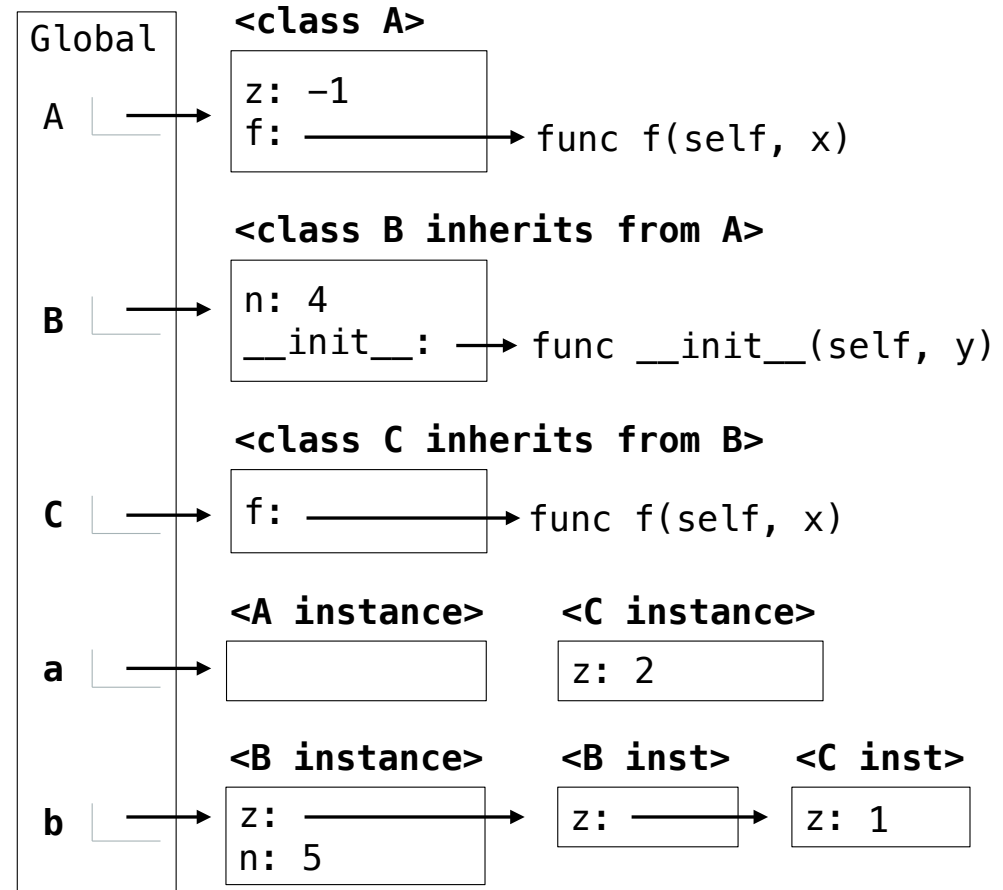
b.z

b.z.z

b.z.z.z

b.z.z.z.z

None of these



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Inheritance and Attribute Lookup

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        return x
```

```
a = A()
b = B(1)
```

```
>>> C(2).n
```

```
4
```

```
>>> a.z == C.z
```

```
True
```

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

```
False
```

Which evaluates
to an integer?

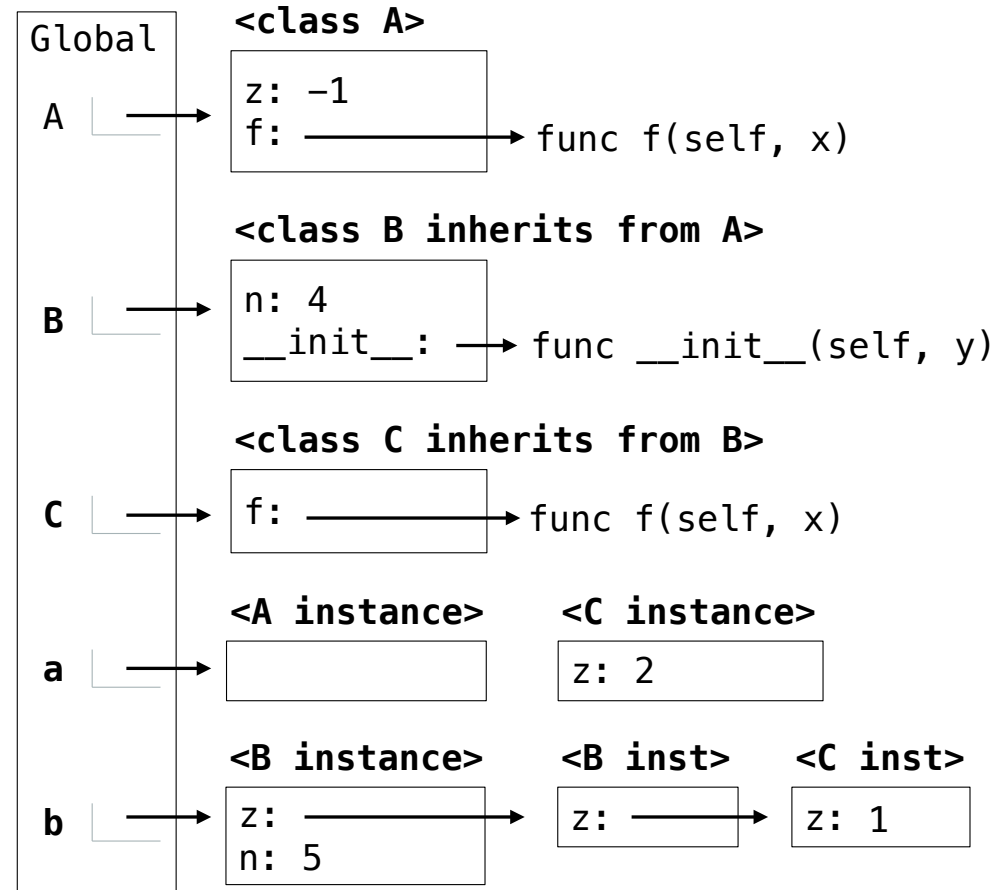
b.z

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```
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```

```
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```

```
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```

```
True
```

```
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```

```
False
```

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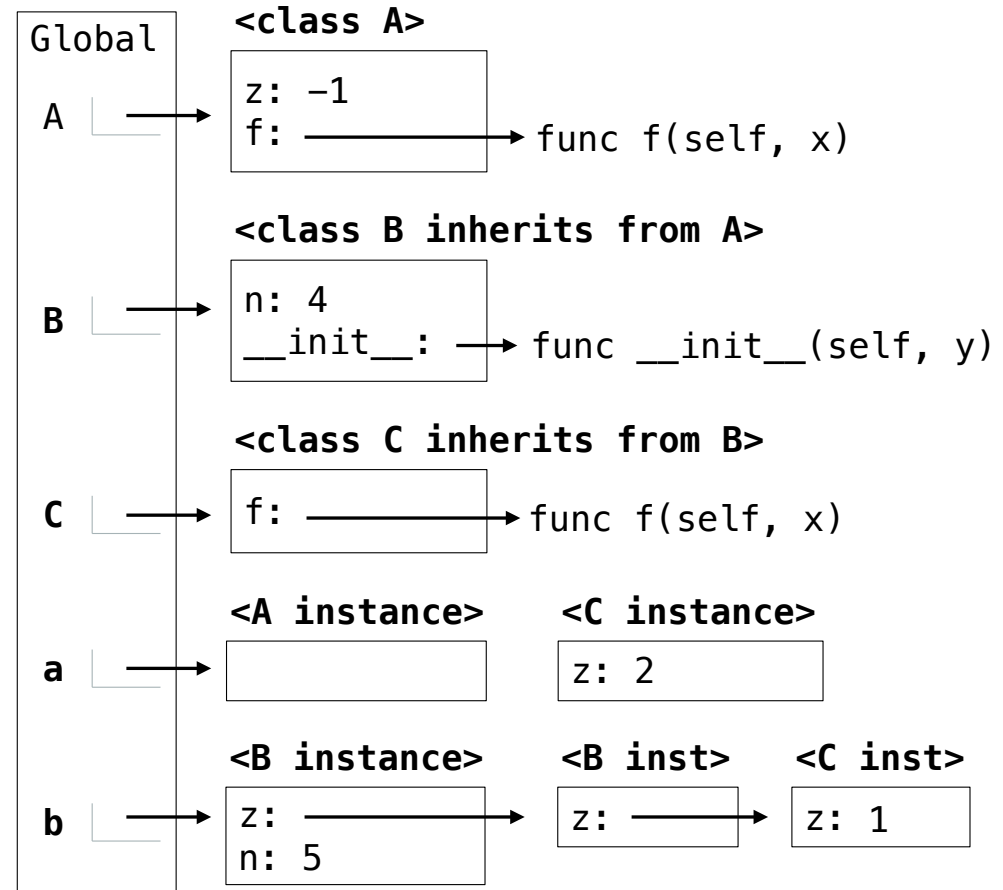
b.z

b.z.z

▶ b.z.z.z

b.z.z.z.z

None of these



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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)
```

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A class may inherit from multiple base classes in Python

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CleverBank marketing executive has an idea:

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- Low interest rate of 1%

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- Low interest rate of 1%
- A \$1 fee for withdrawals
- A \$2 fee for deposits

Multiple Inheritance

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- 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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```

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

Multiple Inheritance

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```

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

```
1
```

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        self.holder = account_holder  
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```

Instance attribute

```
>>> such_a_deal = AsSeenOnTVAccount('John')  
>>> such_a_deal.balance  
1
```

Multiple Inheritance

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```

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```
>>> such_a_deal = AsSeenOnTVAccount('John')  
>>> such_a_deal.balance  
1  
>>> such_a_deal.deposit(20)  
19
```


Multiple Inheritance

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```
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```

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

```
1
```

SavingsAccount method

```
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```

```
19
```

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SavingsAccount method

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

```
13
```

Multiple Inheritance

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```

SavingsAccount method

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```

```
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)
```

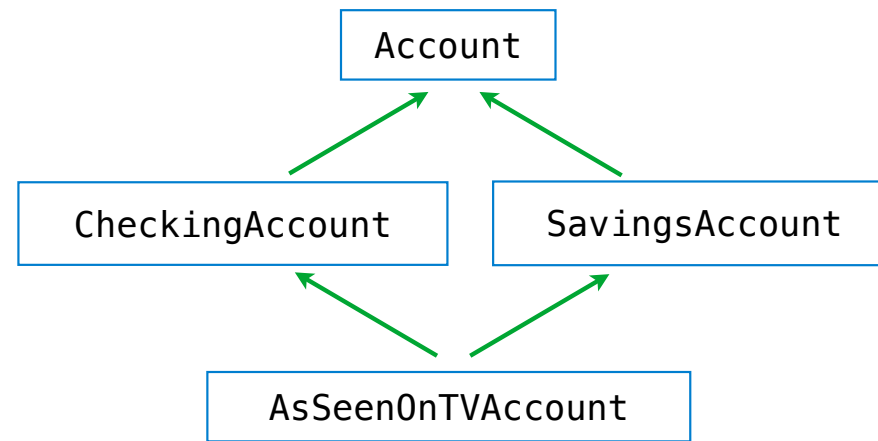
19

CheckingAccount method

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

13

Resolving Ambiguous Class Attribute Names



Instance attribute

```
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```
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```

```
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```

```
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