Inheritance

Slides adapted from Berkeley cs61a

- Attributes Assignments
- Inheritance
- Object-Oriented Design

  Inheritance vs. Composition vs. Mixin
- Multiple Inheritance
- Practice: *Attributes Lookup*

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 (a.f = x)

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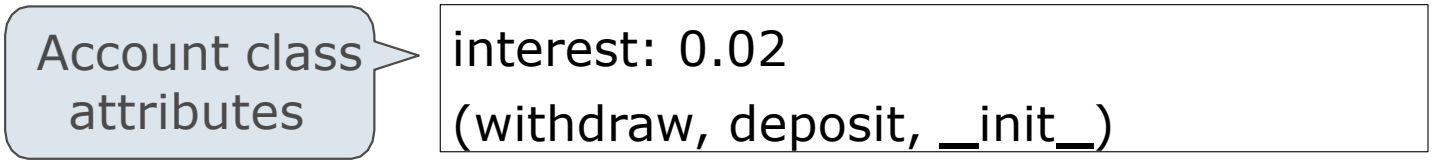
Class Attribute Assignment: Account.interest = 0.04

Attribute Assignment Statements



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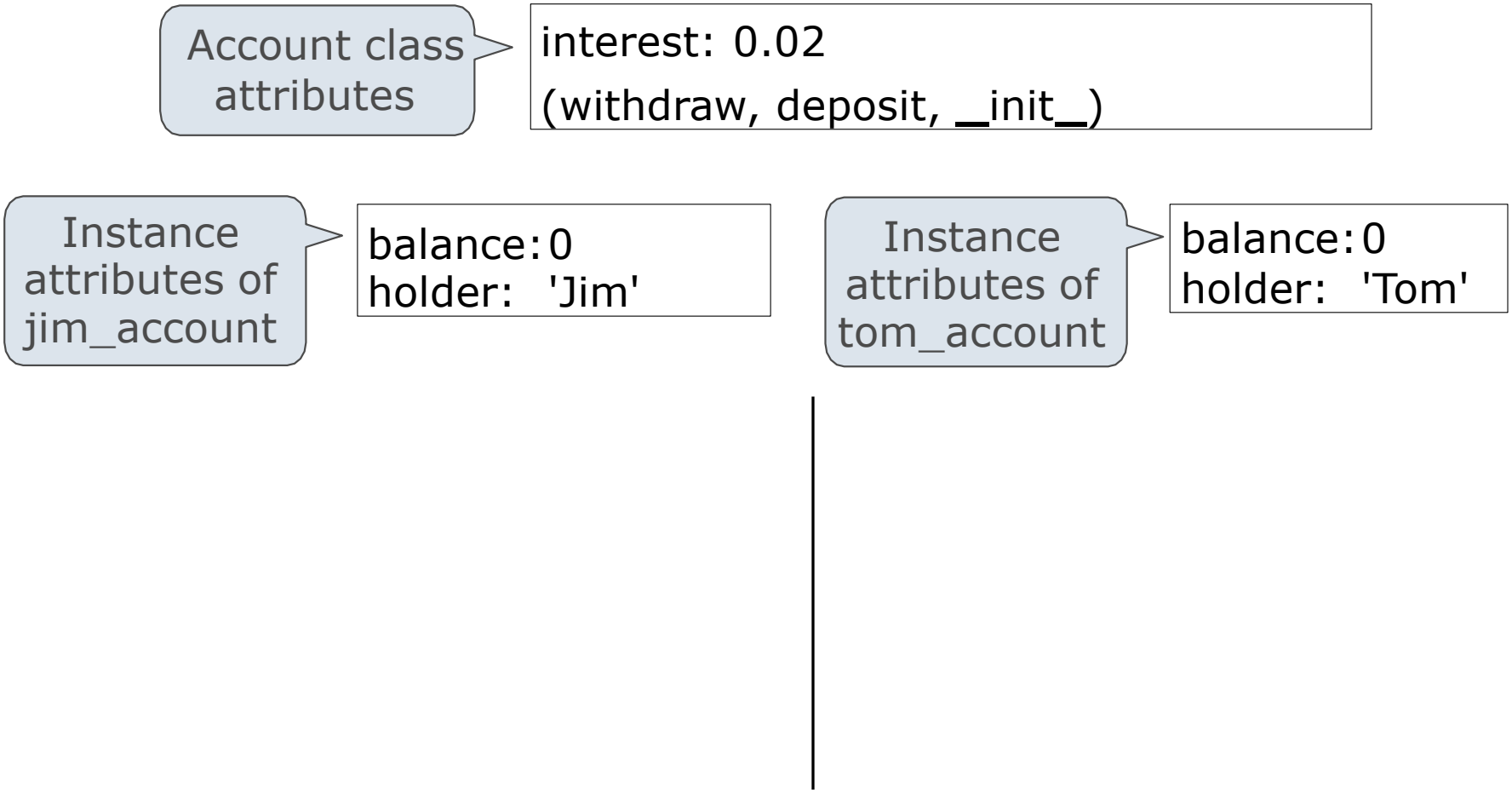

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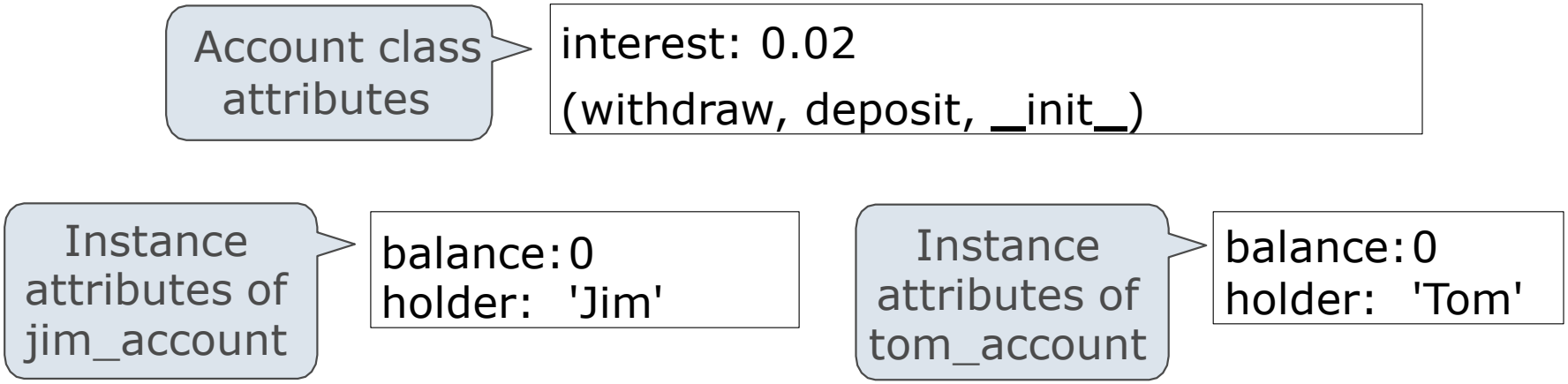


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(withdraw, deposit, __init__)

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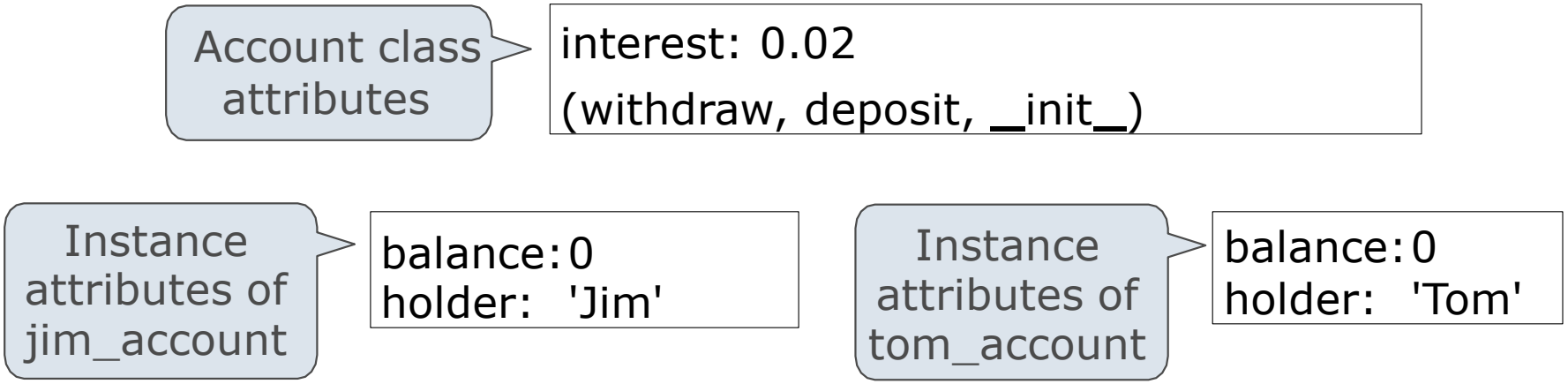


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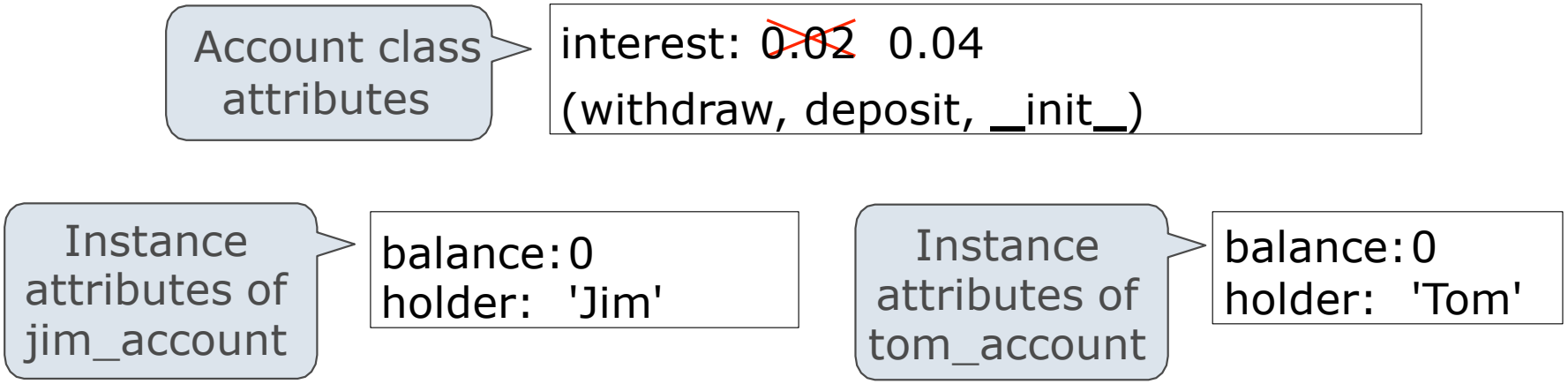


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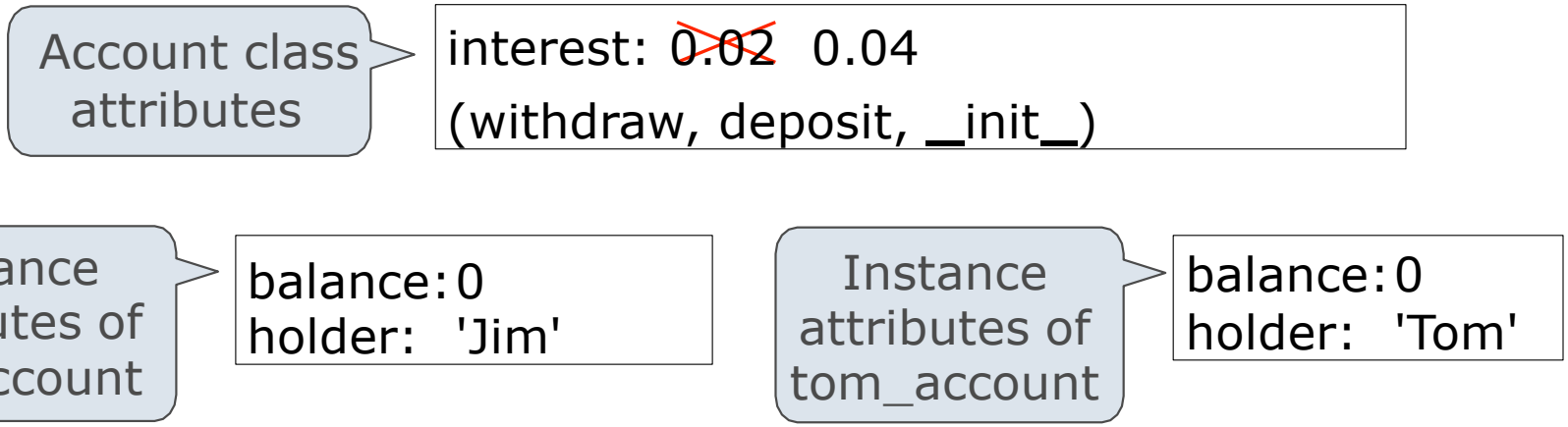


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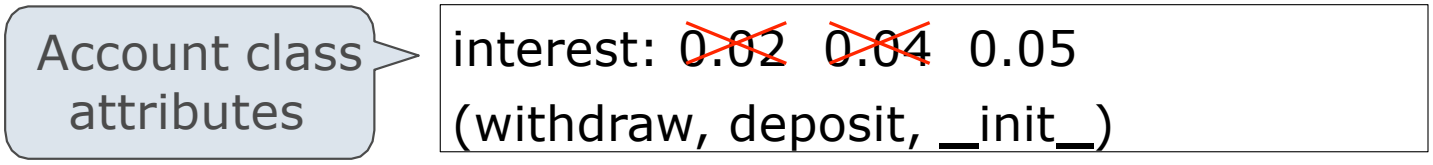

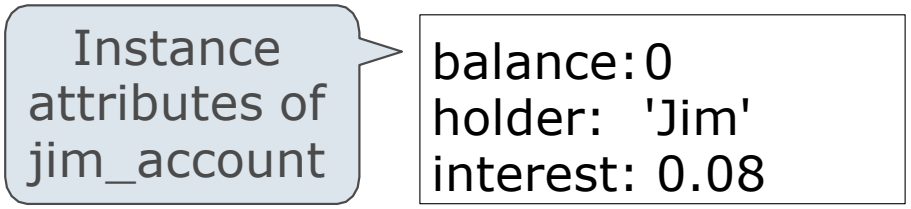

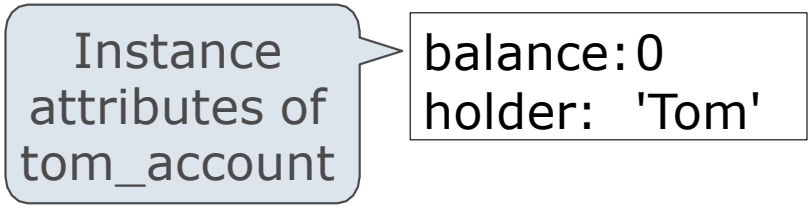


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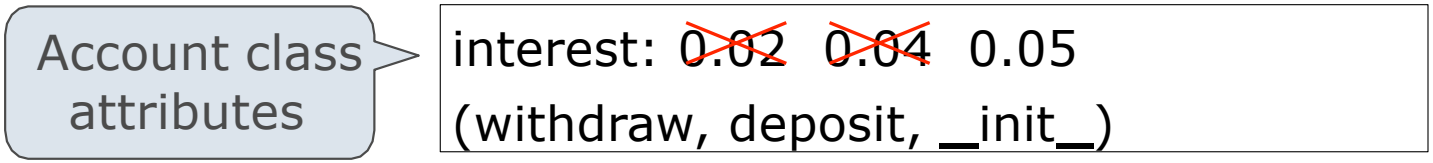

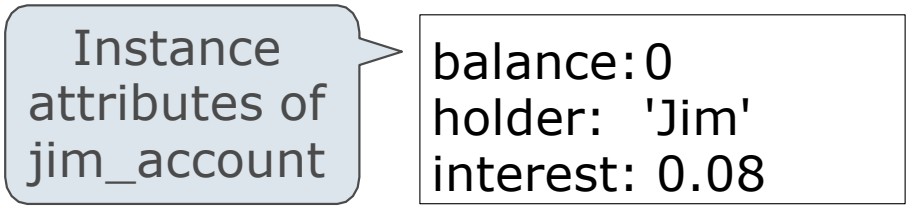

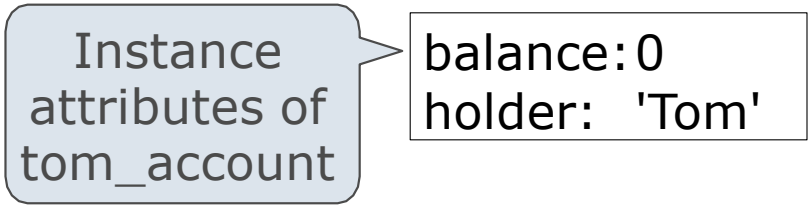


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Using inheritance, we implement a subclass by specifying its differences from the the base class

Inheritance Example

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>>> ch = CheckingAccount('Tom')

>>> ch.interest          # Lower interest rate for checking accounts
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>>> ch.deposit(20)       # Deposits are the same
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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)
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Looking Up Attribute Names on Classes

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

To look up a name in a class:

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demo_2: CheckingAccount

Object-Oriented Design

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Attributes that have been overridden are still accessible via class objects (Account)

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Attribute look-up on base class

Preferred to CheckingAccount.withdraw_fee to allow for specialized accounts

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Assume in the future, a subclass **GreenCheckingAccount** whose interest is 0.01 but withdraw_fee is only 0.23

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- Unnecessary cost for inheritance maintenance

  e.g., the cost of superclasses' fields storage, constructors invocation, while only few behaviors of superclasses are needed

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- Composition does not break encapsulation, and does not affect the types (all public interfaces remain unchanged)
- No need to involve in possibly complex hierarchy, and easy to understand and implement

Inheritance vs. Composition

Guidance to choose inheritance or composition

- By conceptual difference

- By practical need

Inheritance vs. Composition

Guidance to choose inheritance or composition

- By conceptual difference

  Inheritance represents “is-a” relationship

  e.g., a checking account is a specific type of account

  Composition represents “has-a” relationship

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

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demo_3: Bank

Inheritance vs. Composition

Implementing composition means we need to wrap the delegation logic (delegated to the composed object) into certain methods, in which case inheritance's "direct reuse" seems more convenient.

Inheritance vs. Composition

Do we have some approach to somewhat take the advantages of both inheritance and composition?

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Mixin

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- Mixin is usually considered as a mean for 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

CleverAccount 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

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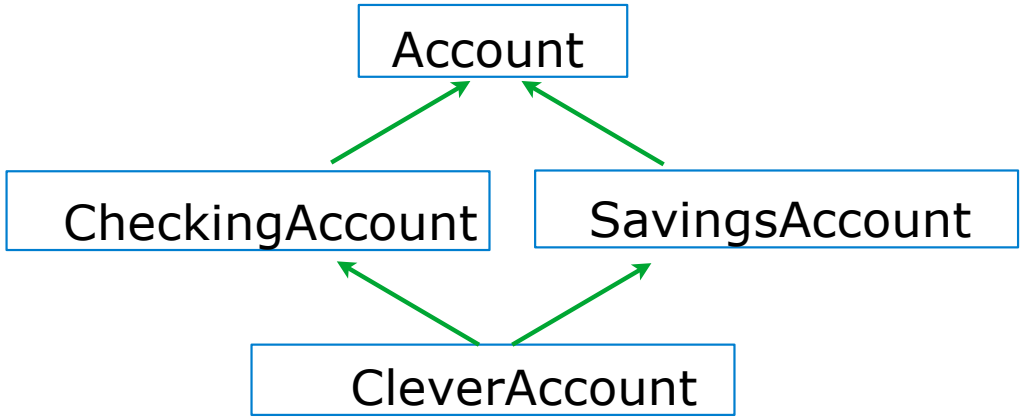
- Low interest rate of 1%
- A $1 fee for withdrawals
- A $2 fee for deposits
- A free dollar when you open your account

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

Multiple Inheritance



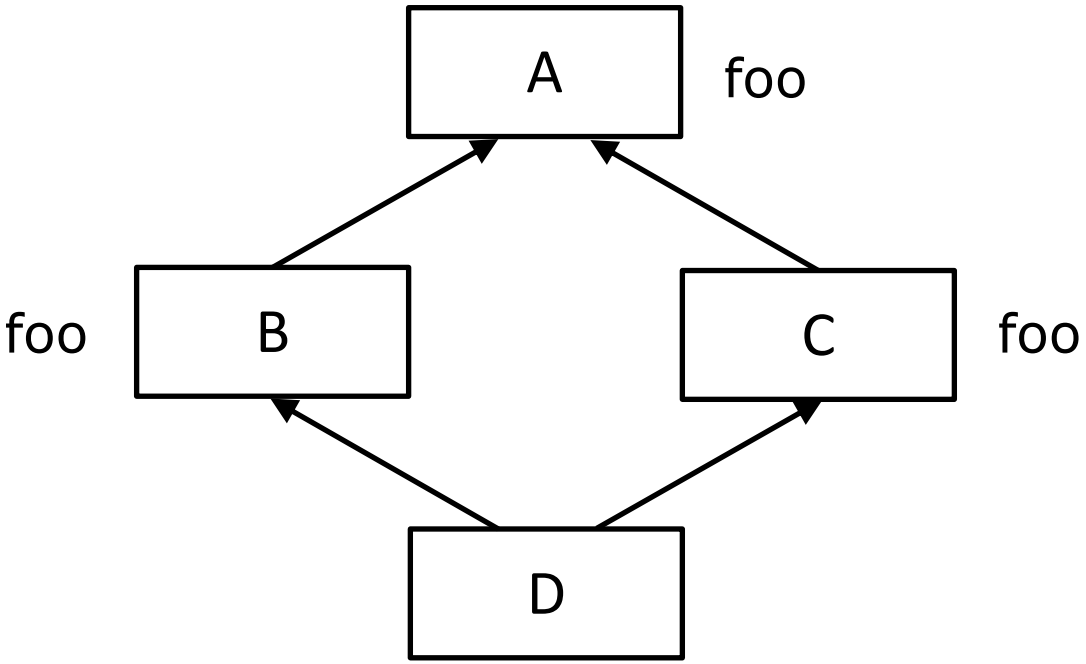
Instance attribute

SavingsAccount method

CheckingAccount method

```
>>> tom= CleverAccount('Tom')
>>> tom.balance
1
>>> tom.deposit(20)
18
>>> tom.withdraw(5)
12
```

Diamond Problem



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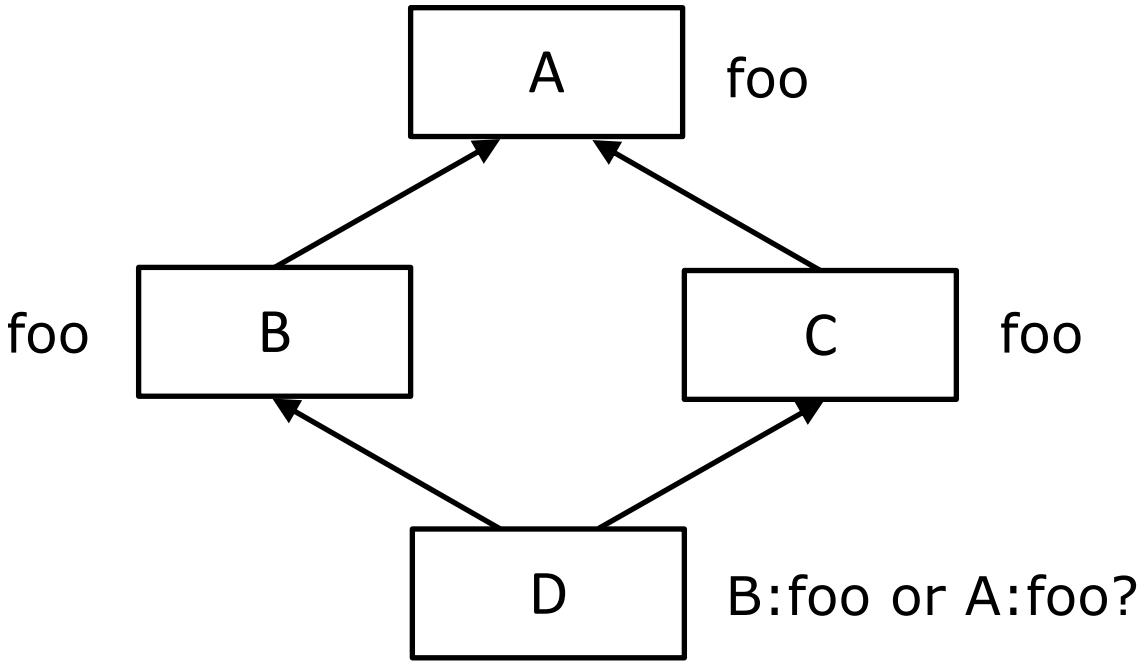

Method Resolution Order (MRO)

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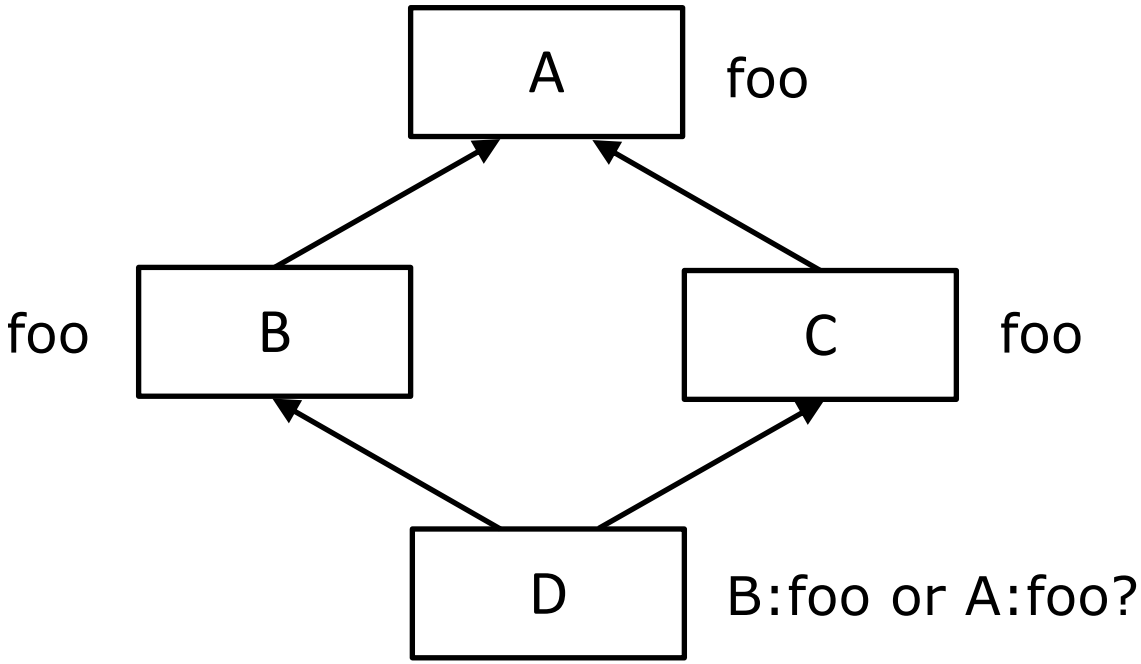

Method Resolution Order (MRO)

C3 Linearization algorithm for method resolution while doing multiple inheritance

Practice: Attributes Lookup

Inheritance and Attribute Lookup

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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)
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class C(B):
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>>> C(2).n
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>>> a.z == C.z
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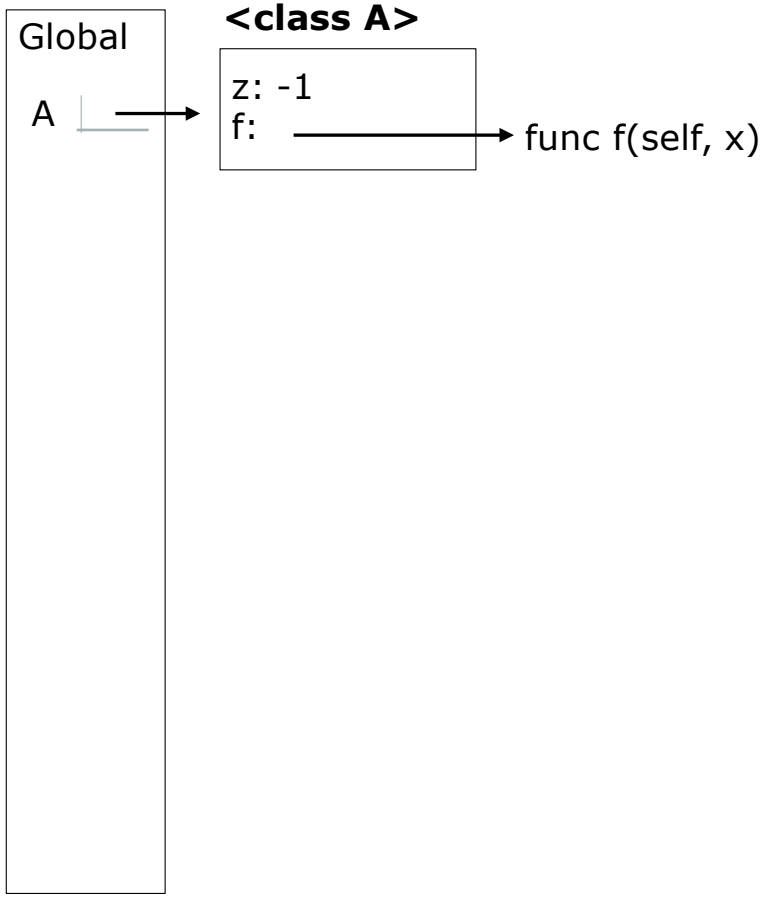

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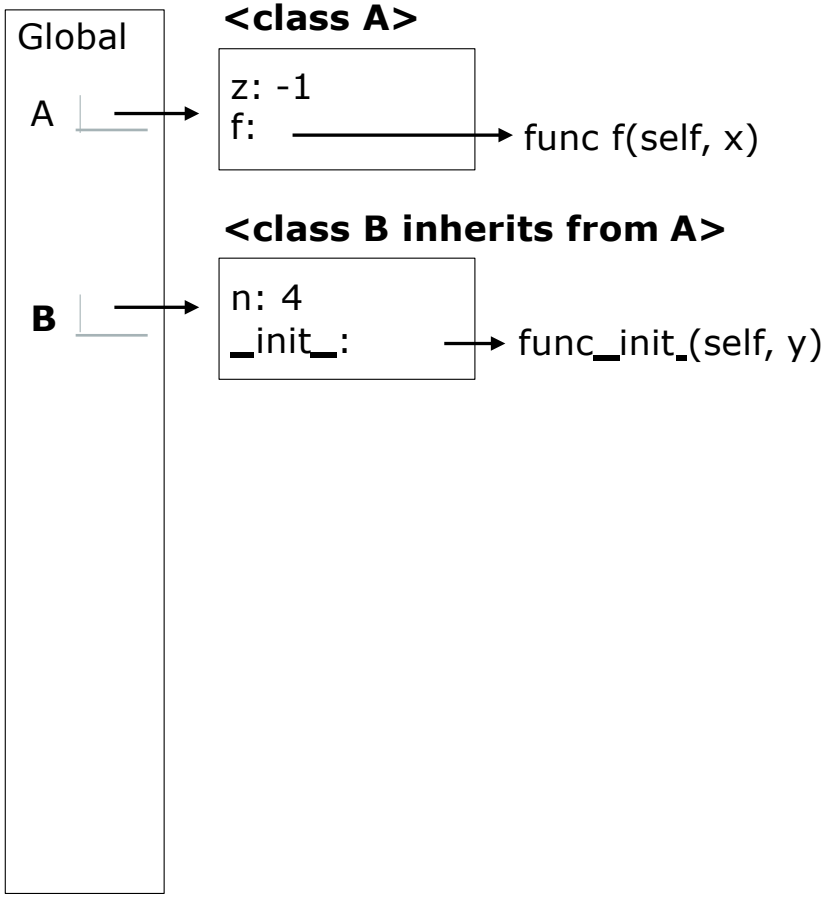

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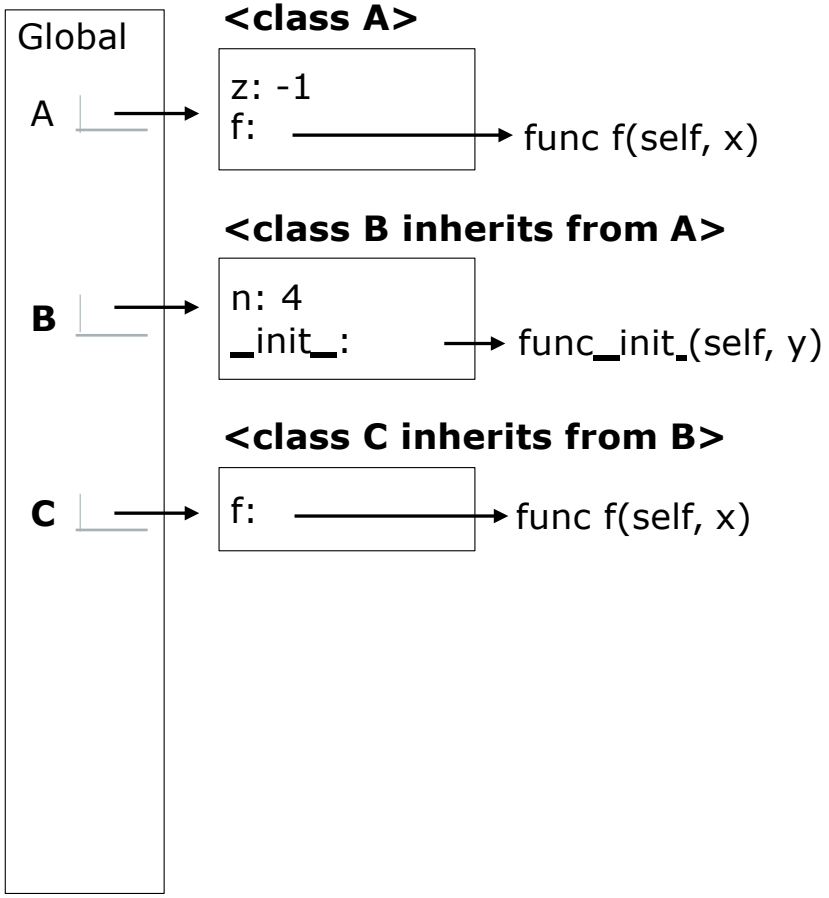

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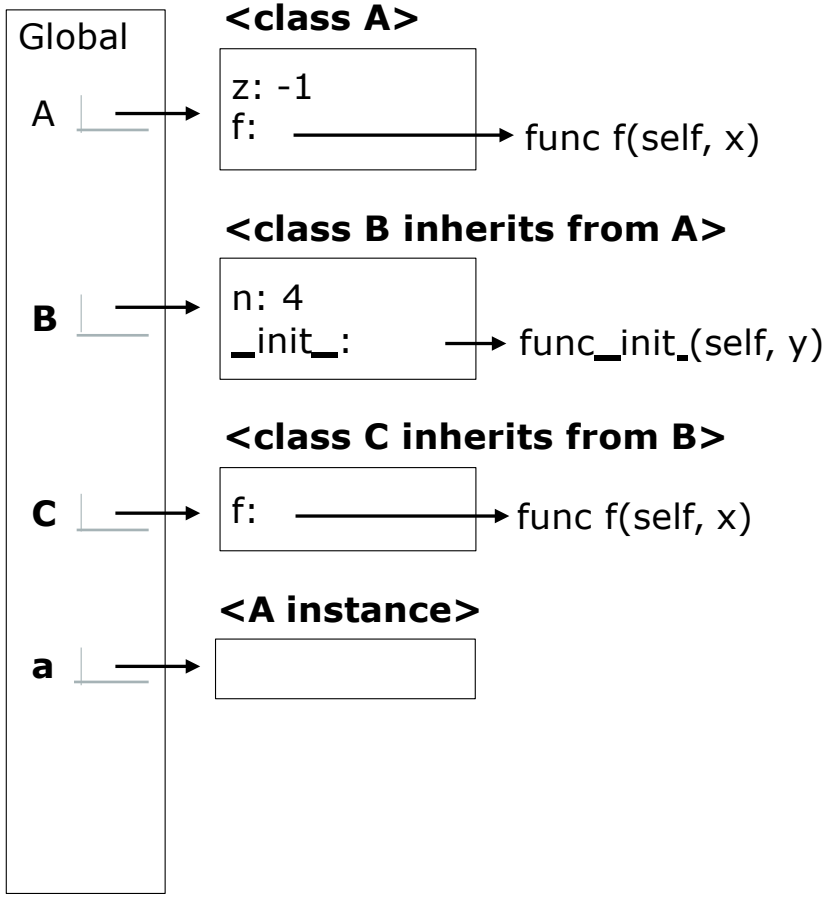

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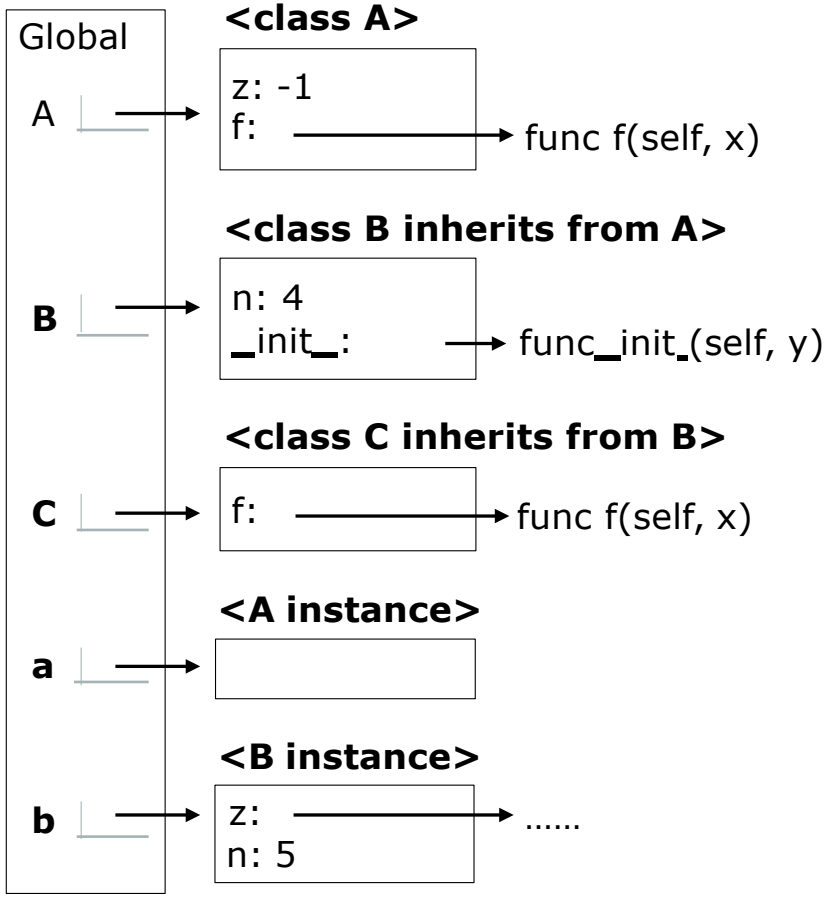

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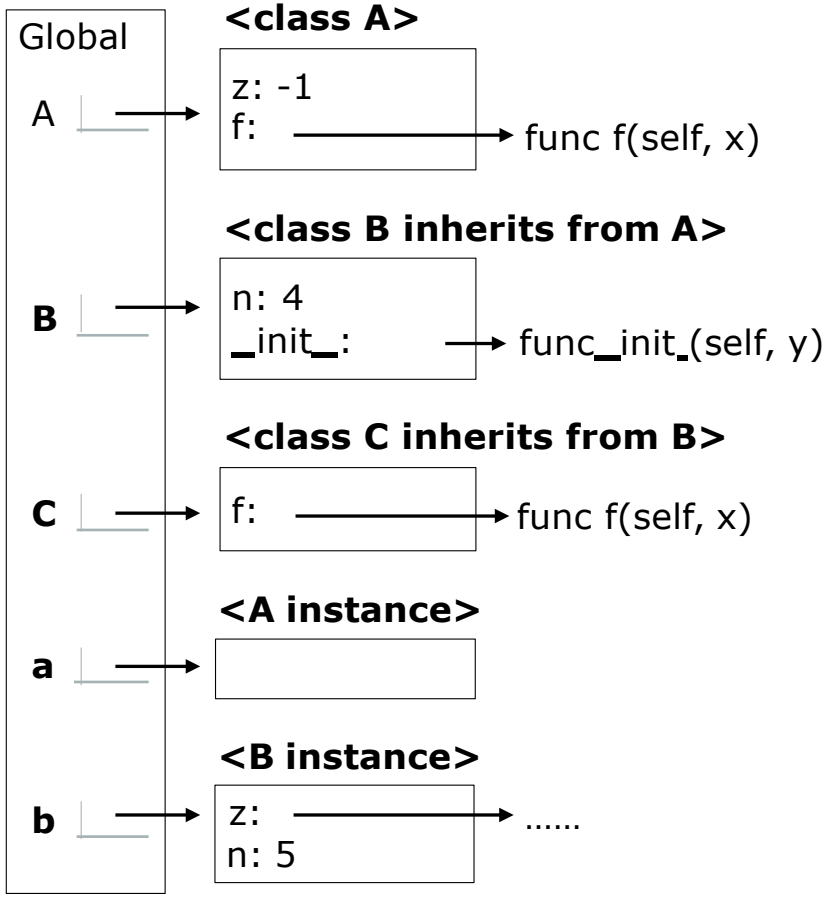

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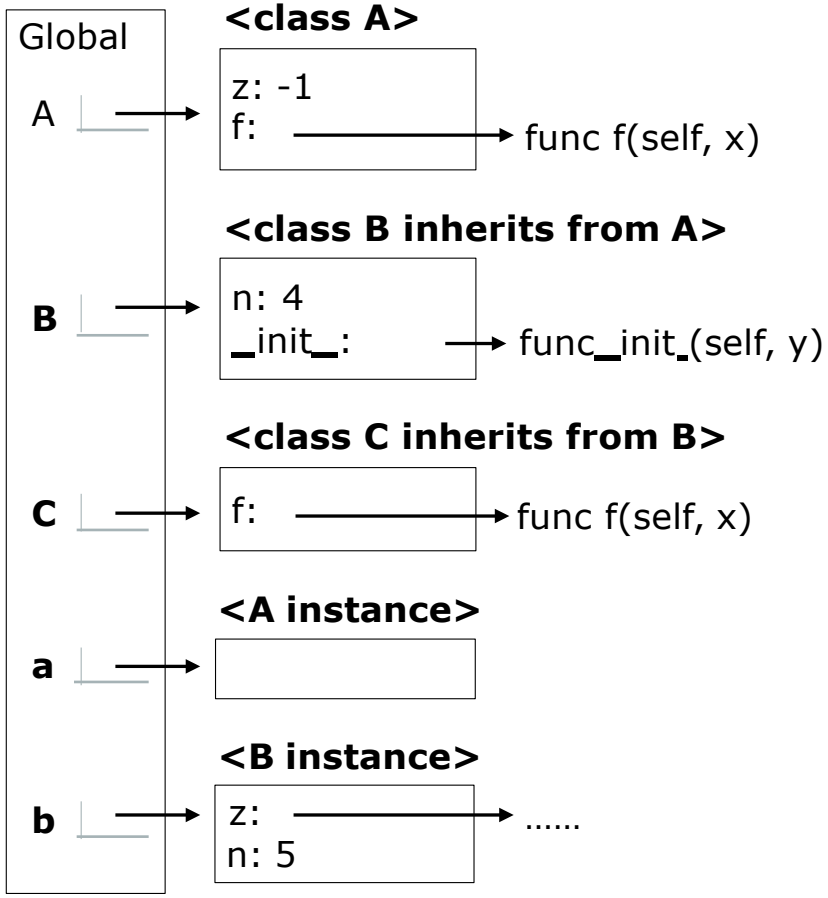

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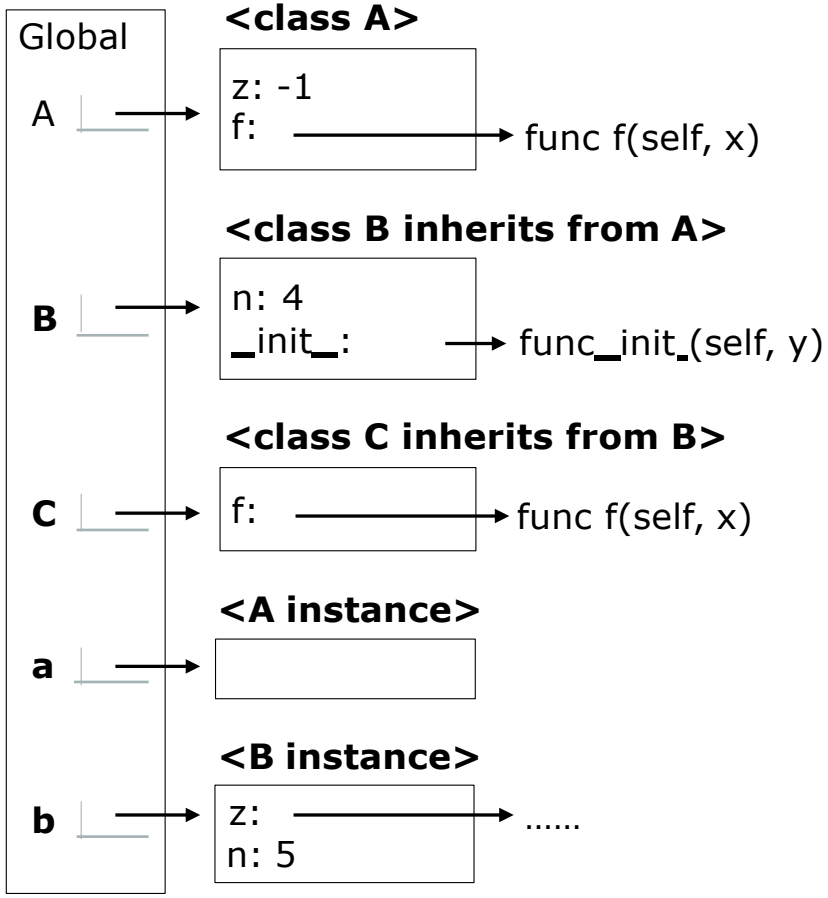

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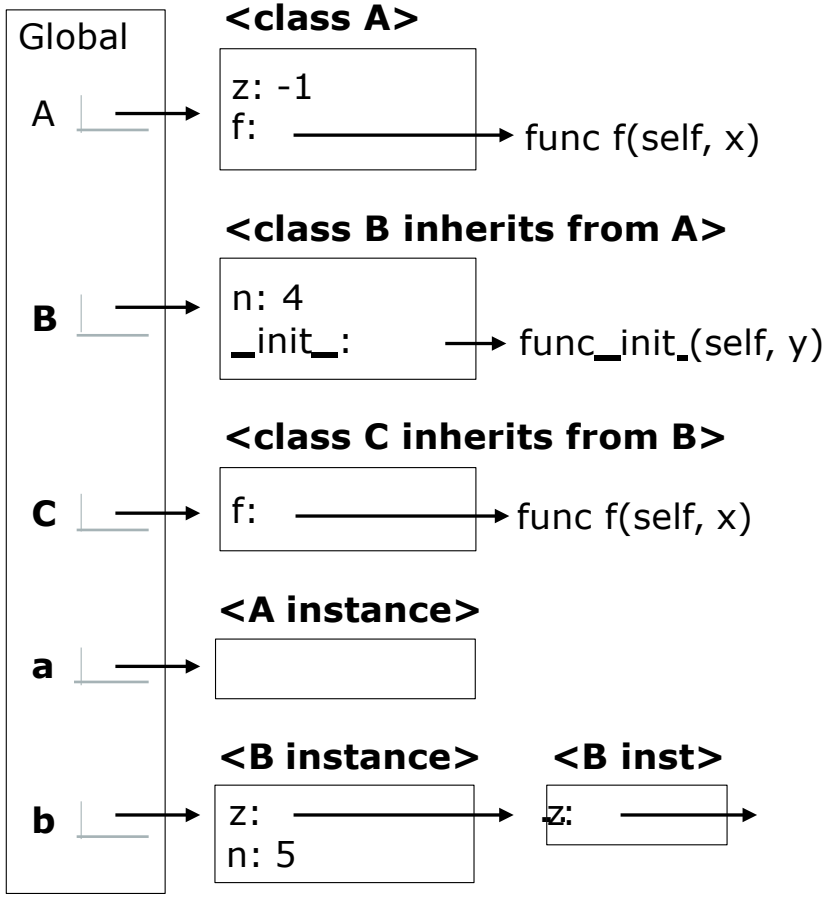

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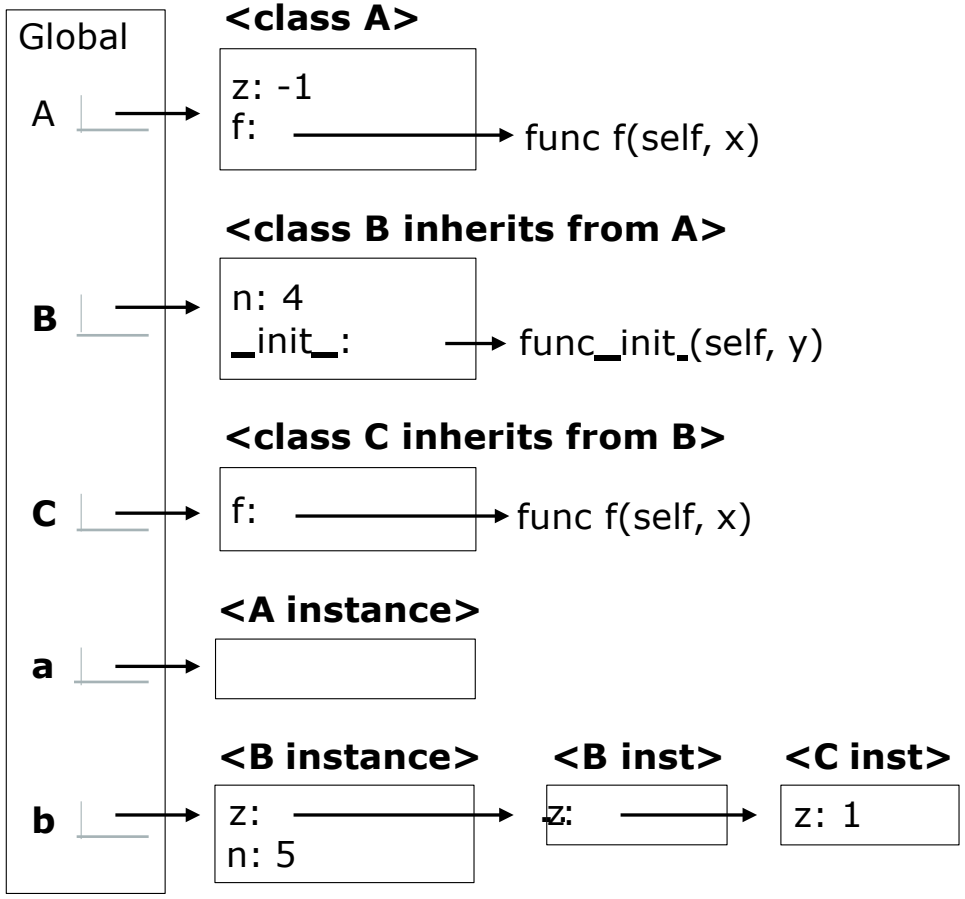

The X You Need To Understand In This Lecture

- Rules of attribute assignment
- Rules of inheritance
- Rules of attribute lookup on classes
- Difference between inheritance and composition