Object-Oriented Programming

Slides adapted from Berkeley cs61a

- OOP
- Classes and Objects
- Methods and Attributes
- Lookup up Attributes by Name

OOP, an example

Object-Oriented Programming

A method for organizing programs

- Data abstraction
- Bundling together information and related behavior

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- A metaphor for computation using distributed state
- Each object has its own local state
- Each object also knows how to manage its own local state, based on method calls
- Method calls are messages passed between objects
- Several objects may all be instances of a common type
- Different types may relate to each other

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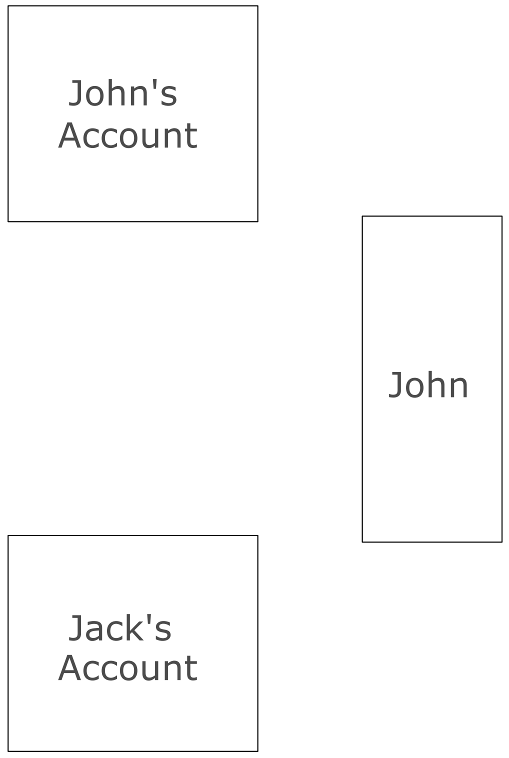

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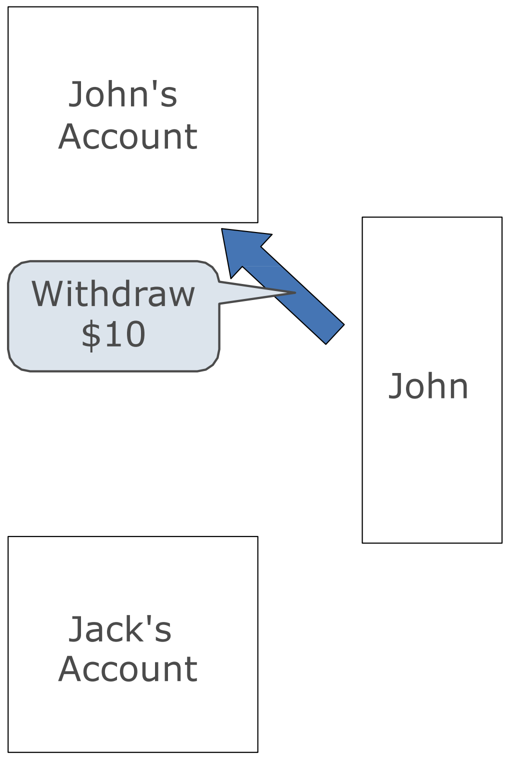

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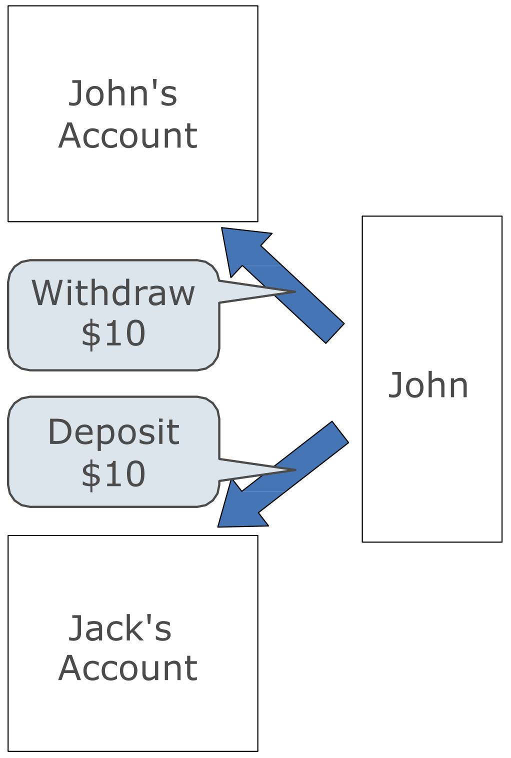

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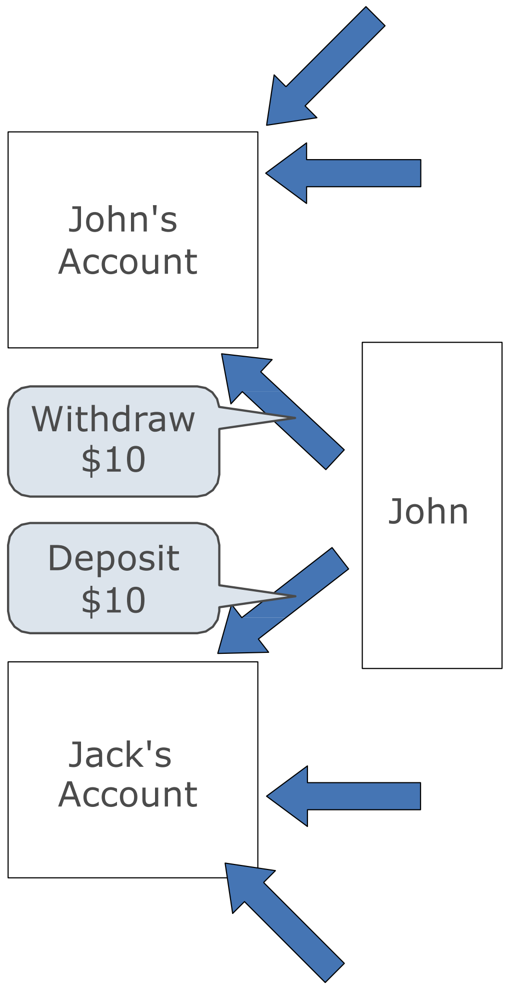

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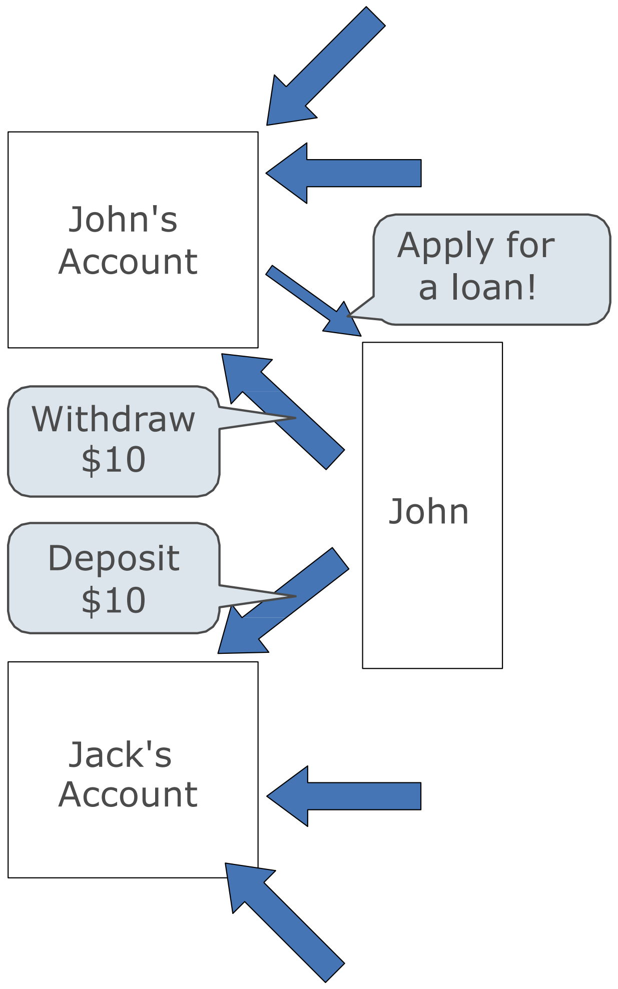

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Better idea: All bank accounts share a withdraw method and a deposit method

Class Statements

The Class Statement

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    <suite>
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>>> Clown
<class '__main__.Clown'>
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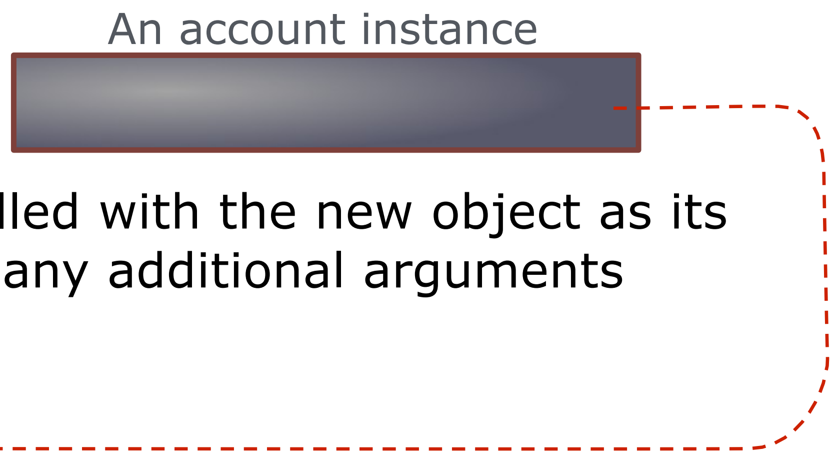

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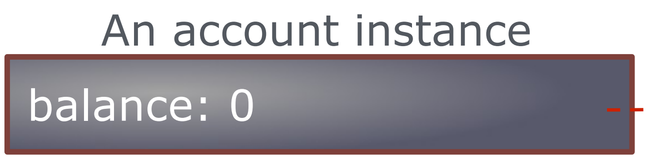

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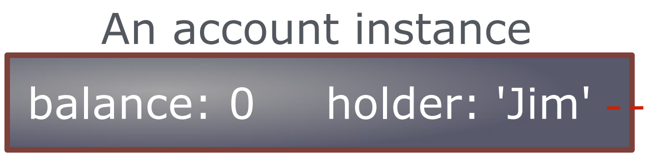

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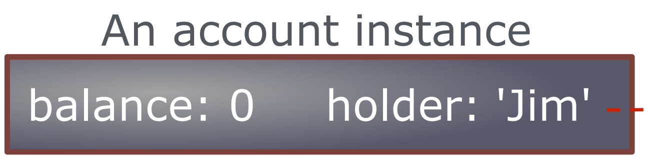

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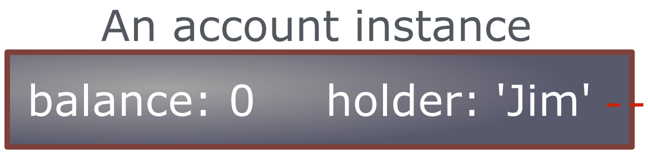

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These def statements create function objects as always, but their names are bound as attributes of the class (not bound to the particular frame)

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>>> tom_account = Account('Tom')
>>> tom_account.deposit(100)
100
```

Invoking Methods

All invoked methods have access to the object via the self parameter, and so they can all access and manipulate the object's state

Defined with two parameters

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class Account:
    . . .
    def deposit(self, amount):
        self.balance = self.balance + amount
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(demo_1)

Attributes

Class Attributes

Class attributes are "shared" across all instances of a class because they are attributes of the class, not the instance (**Instance attributes?**)

```
class Account:

    interest = 0.02 # A class attribute

    def __init__(self, account_holder):
        self.balance = 0
        self.holder = account_holder
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>>> tom_account = Account('Tom')
>>> jim_account = Account('Jim')
```

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class Account:

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

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

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```

Methods are also considered as the attributes of the class

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>>> 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!

Accessing Attributes

Using getattr, we can look up an attribute using a string

```
>>> getattr(tom_account, 'balance')
10
>>> hasattr(tom_account, 'deposit')
True
```

getattr and dot expressions look up a name in the same way

Looking up an attribute name in an object may return:

- One of its instance attributes, or
- One of the attributes of its class

(We will examine this in details later)

Methods and Functions

Python distinguishes between:

- *Functions*, which we have been creating since the beginning of the course, and
- *Bound methods*, which couple together a function and the object on which that method will be invoked

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<class 'function'>
```

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```

Function: all arguments within parentheses

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>>> tom_account.deposit(1021)
2021
```

Function: all arguments within parentheses

Method: One object before the dot and other arguments within parentheses

Terminology: Attributes, Functions, and Methods

All objects have attributes, which are name-value pairs

Classes are objects too, so they have attributes

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>>> type(tom_account)
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We define class to define objects:
type(my_object) -> MyClass

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what we use to define “class objects”?

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?

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type is the metaclass in Python

ACGN = type(‘ACGN’,
    (tuple for parent classes),
    {dic for attribute pairs})
print(ACGN)
type(ACGN)

As classes are objects in Python,
what we use to define “class objects”?

We use **metaclass** to define classes:
type(MyClass) -> MetaClass

my_object = MyClass()
MyClass = MetaClass()

Terminology: Attributes, Functions, and Methods

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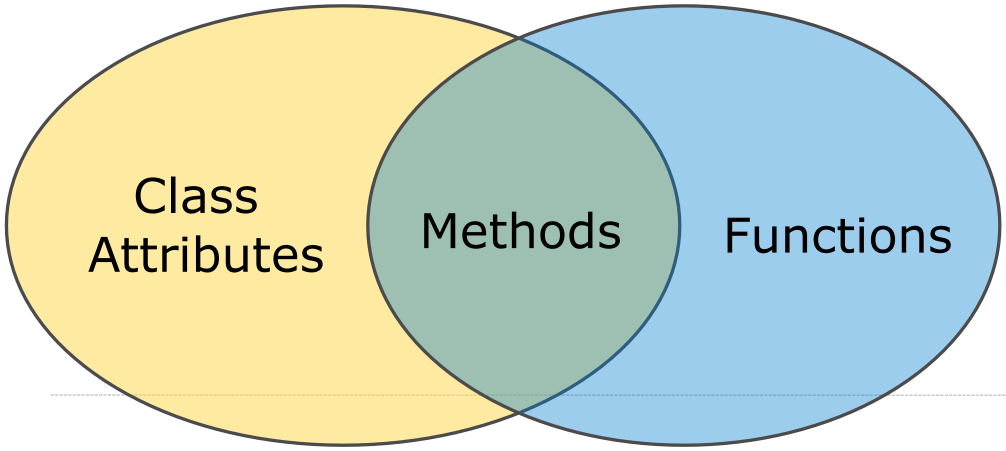
Classes are objects too, so they have attributes

Instance attribute: attribute of an instance

Class attribute: attribute of the class

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

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

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To evaluate a dot expression:

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

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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

(demo: lls.balance)

Looking Up Attributes by 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 (if no such class attribute exists, an AttributeError is reported)

(demo: lls.interest, lls.noSuchAttribute)

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 (if no such class attribute exists, an AttributeError is reported)
4. That value is returned unless it is a function, in which case a bound method is returned instead

(demo_2)

The X You Need To Understand In This Lecture

- The basic idea of OOP
- Classes vs. Objects

  What happens when instantiating an object from a class (object + __init__)
- Functions vs. Methods

  Understanding the 'self' keyword
- Instance attributes vs. Class attributes
- The rules for looking up attributes