Lecture 18. Object-Oriented-Programming

Classes & Objects

A class combines (and abstracts) data and functions.
An object is an instantiation of a class.

> **cases**
>
> *string* is a bulit-in class, *append* is a function
> *int* is a built-in class, + is a function
> we can define our own classes

Object-Oriented Programming

Object-Oriented Programming

A method for organizing modular programs

- Abstraction barriers
- Bundling together information and related behavior

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.

Specialized syntax & vocabulary to support this metaphor

Classes

A class serves as a template for its instances.

Idea: All bank accounts have a balance and an account holder; the Account class should add those attributes to each newly created instance.

```
>>> a = Account('Jim')
>>> a.holder
'Jim'
>>> a.balance
0
```

Idea: All bank accounts should have "withdraw" and "deposit" behaviors that all work in the same way.

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

```
>>> a.deposit(15)
15
>>> a.withdraw(10)
5
>>> a.balance
5
>>> a.withdraw(10)
'Insufficient funds'
```


Class Statements

The Class Statement

```
class <name>:
    <suite>
```

The suite is executed when the class statement is executed.

A class statement creates a new class and binds that class to <name> in the first frame of the current environment.

Assignment & def statements in <suite> create attributes of the class (not names in frames)

```
>>> class Clown:
...     nose = 'big and red'
...     def dance():
...         return 'No thanks'
...
>>> Clown.nose
'big and red'
>>> Clown.dance()
'No thanks'
```

Object Construction

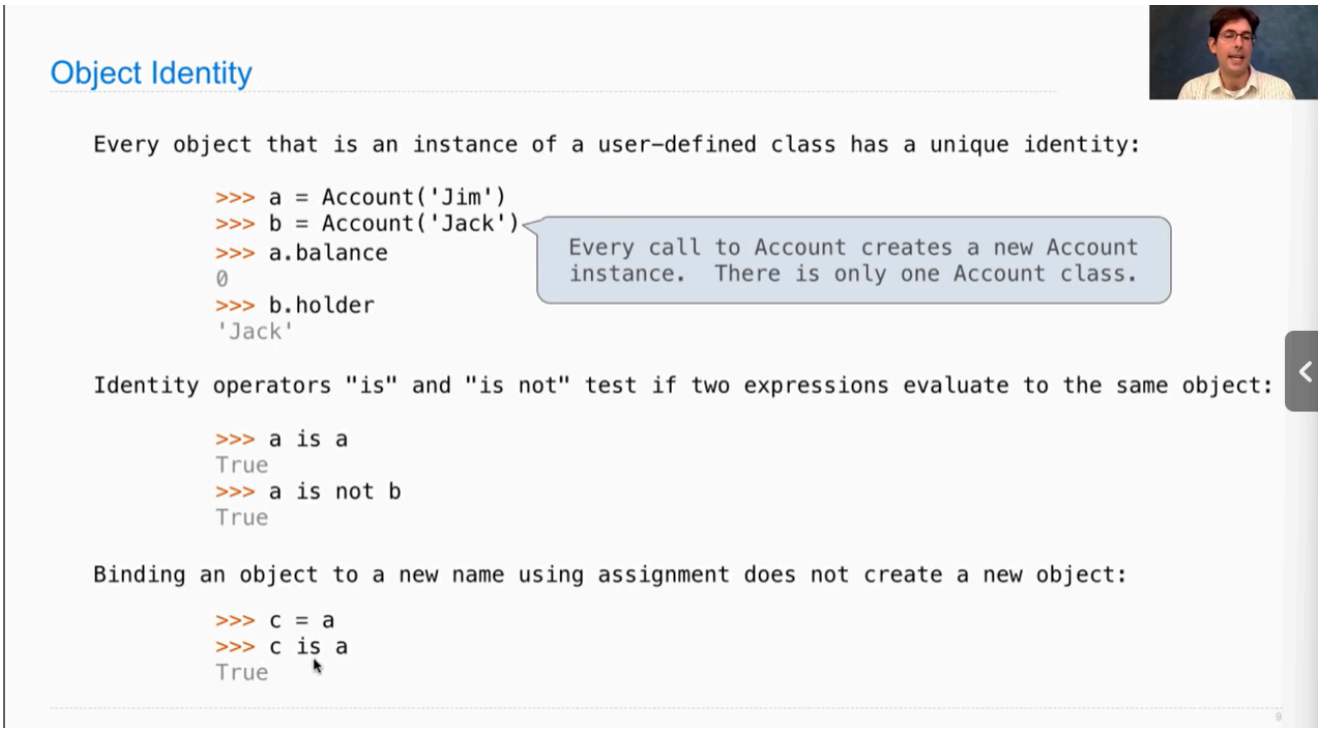
Idea: All bank accounts have a balance and an account holder;
the Account class should add those attributes to each of its instances

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

When a class is called:

1. A new instance of that class is created: [redacted]
2. The `__init__` method of the class is called with the new object as its first argument (named `self`), along with any additional arguments provided in the call expression.

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



> anyway, in short, self-defined objects are immutable values.

methods

Methods

Methods are defined in the suite of a class statement

```
class Account:

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

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

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

These def statements create function objects as always,
but their names are bound as attributes of the class.

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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.

```
class Account:
    ...

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

Defined with two arguments

Dot notation automatically supplies the first argument to a method.

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

Invoked with one argument

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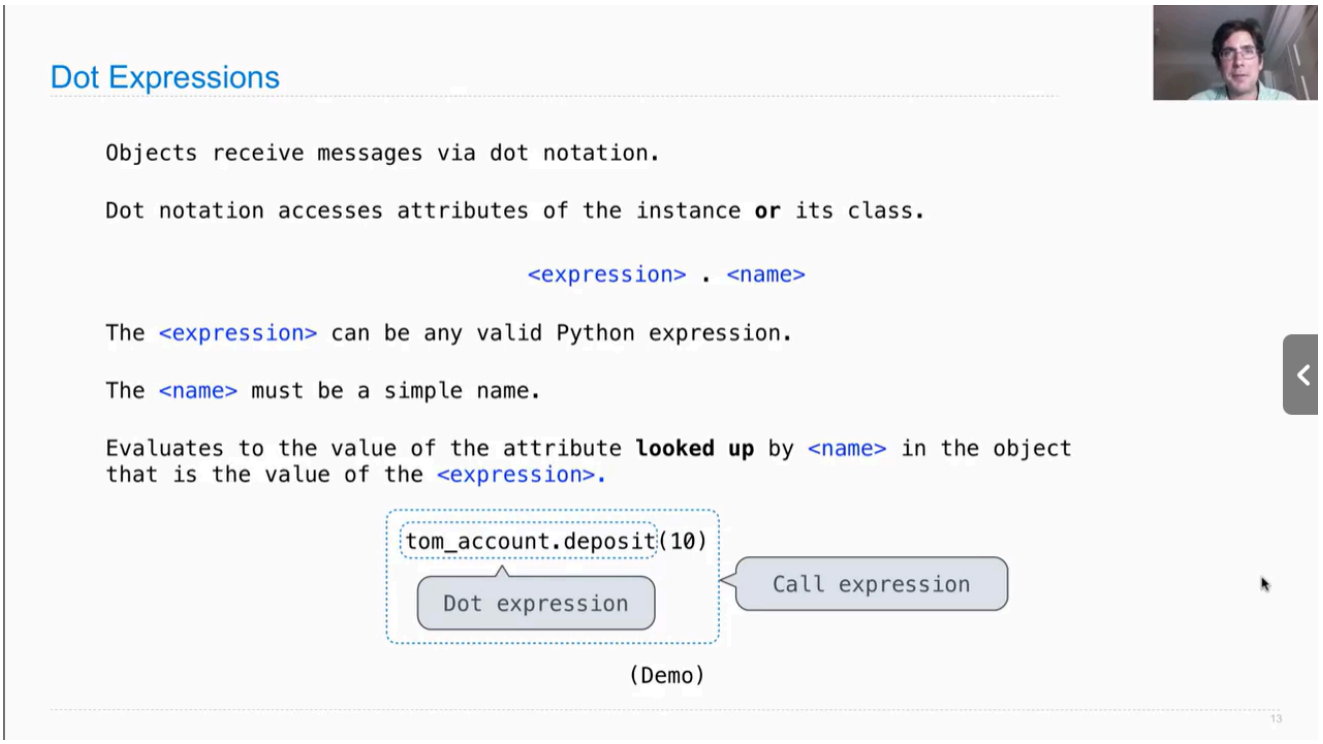
Dot Expressions


Dot Expressions
Objects receive messages via dot notation.
Dot notation accesses attributes of the instance or its class.
<expression> . <name>
The <expression> can be any valid Python expression.
The <name> must be a simple name.
Evaluates to the value of the attribute looked up by <name> in the object that is the value of the <expression>.
tom_account.deposit(10)
Dot expression
Call expression
(Demo)

Attributes

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

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.

Object + Function = Bound Method

```
>>> type(Account.deposit)
<class 'function'>
>>> type(tom_account.deposit)
<class 'method'>
```

```
>>> Account.deposit(tom_account, 1001)
1011
>>> tom_account.deposit(1000)
2011
```

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.

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> everything in python is an object

class attributes

Class Attributes

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
```

interest is not part of the instance that was somehow copied from the class!

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