

# SICP

## God's Programming Book

### Lecture-15 Objects



# Objects

Slides Adapted from cs61a of UC Berkeley

# Object-Oriented Programming

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# Object-Oriented Programming

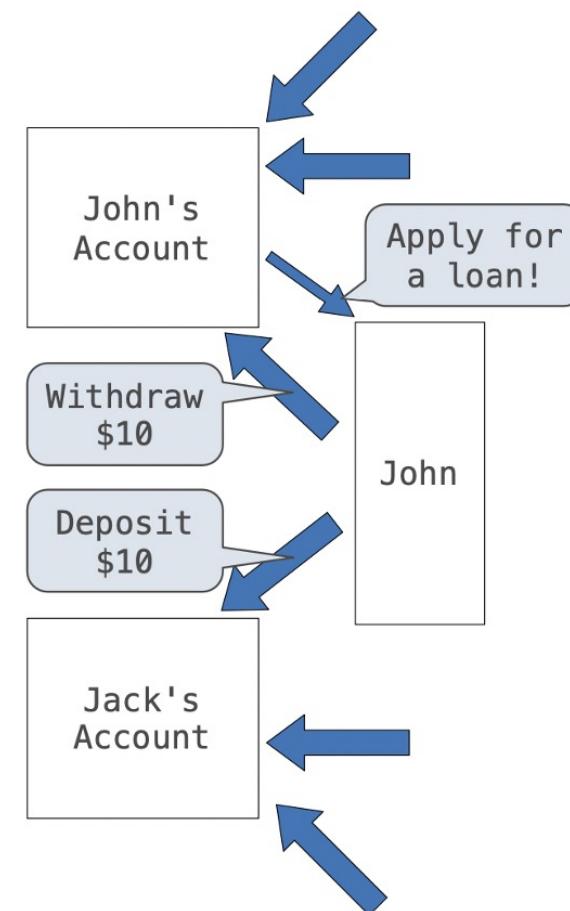
A method for organizing programs

- Data abstraction
- 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

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- **Idea:** All bank accounts have a **balance** and an account **holder**; the **Account** class should add those attributes to each newly created instance
- **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 = Account('John')
>>> a.holder
'John'
>>> a.balance
0

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

# Class Statements

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# 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'  
>>> Clown  
<class '__main__.Clown'>
```

# 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')
>>> a.holder
'Jim'
>>> a.balance
0
```

When a class is called:

1. A new instance of that class is created: An account instance  
balance: 0    holder: 'Jim'
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

`__init__` is called  
a constructor

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



# Object Identity

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Every object that is an instance of a user-defined class has a unique identity:

```
>>> a = Account('John')
>>> b = Account('Jack')
>>> a.balance
0
>>> b.holder
'Jack'
```

Every call to Account creates a new Account instance. There is only one Account class.

# Object Identity

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Identity operators "is" and "is not" test if two expressions evaluate to the same object:

```
>>> a is a
True
>>> a is not b
True
```

# Object Identity

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Binding an object to a new name using assignment does not create a new object:

```
>>> c = a  
>>> c is a  
True
```

# Methods

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# Method

- Methods are functions defined in the suite of a class statement

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

self should always be bound to an instance of the Account class

```
    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

# 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 parameters

- Dot notation automatically supplies the first argument to a method

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

```
>>> tom_account.deposit(100)
```

```
100
```

Bound to self

Invoked with one argument

# Dot Expressions

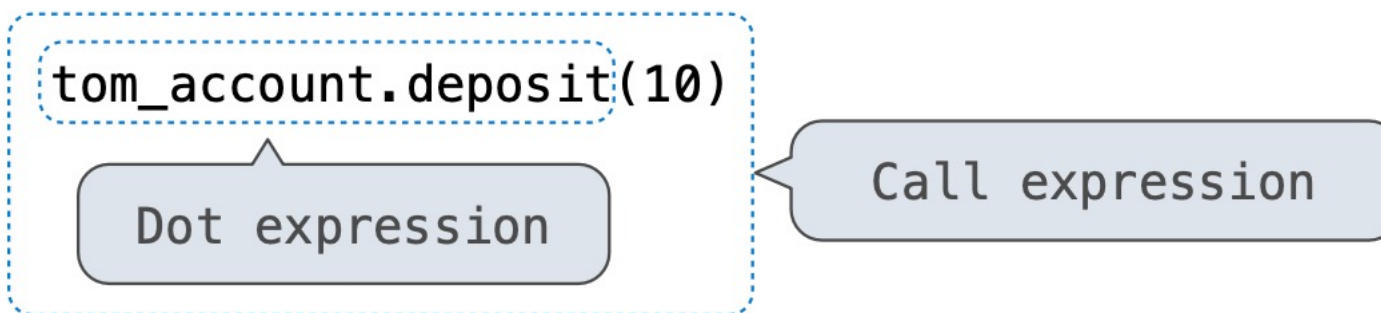
Objects receive messages via dot notation

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>`



# Attributes

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# Accessing Attributes

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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(1004)
2015
```

**Function:** all arguments within parentheses

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

# 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

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!

# Thanks for Listening

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