61A Lecture 15

Monday, October 7

Announcements

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- Homework 4 due Tuesday 10/8 @ 11:59pm.

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  - No video (except a screencast). Come to Wheeler!

Object-Oriented Programming

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A method for organizing modular programs

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- Abstraction barriers

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- Bundling together information and related behavior

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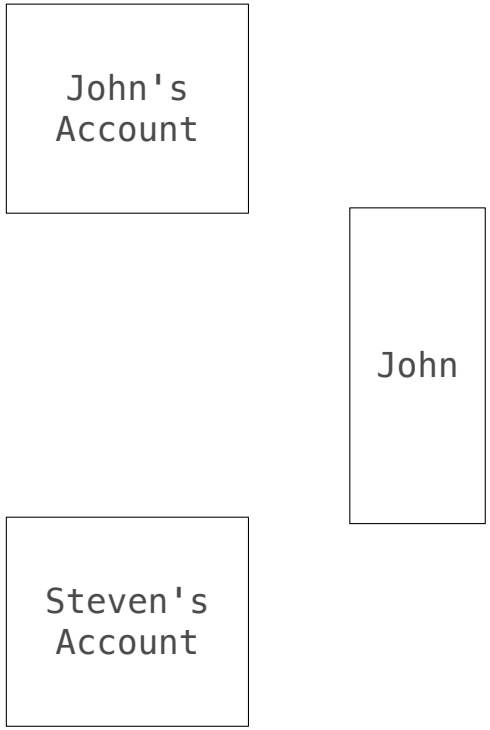

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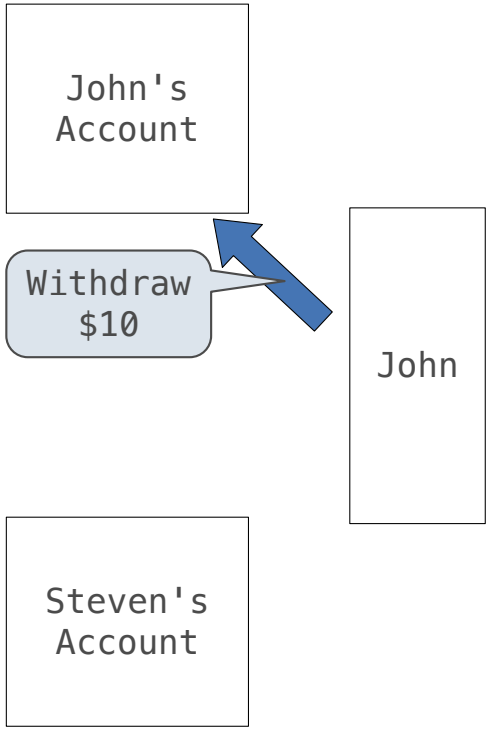

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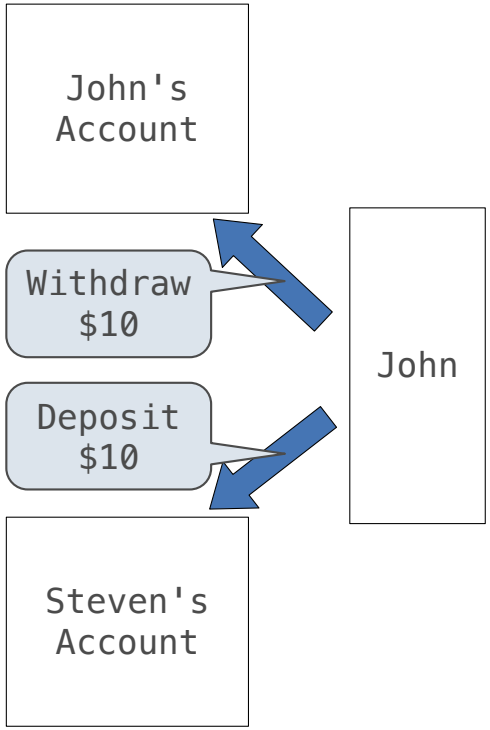

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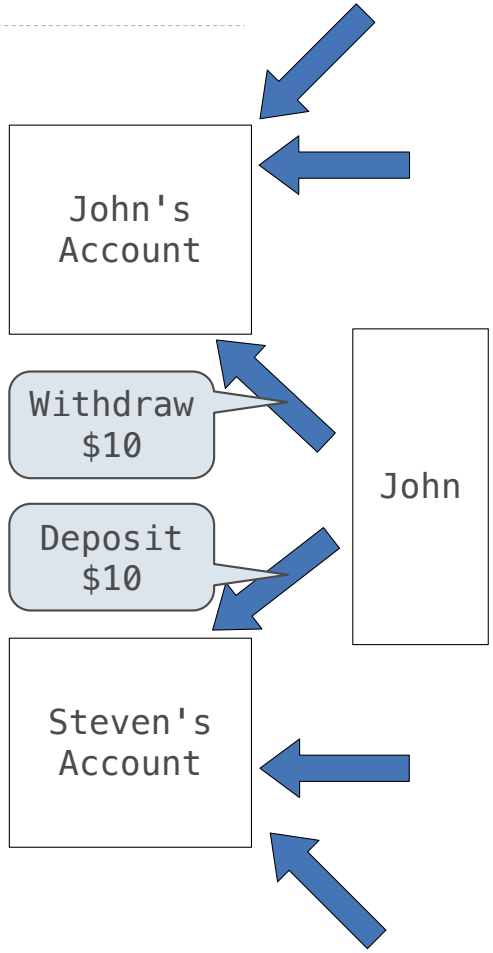

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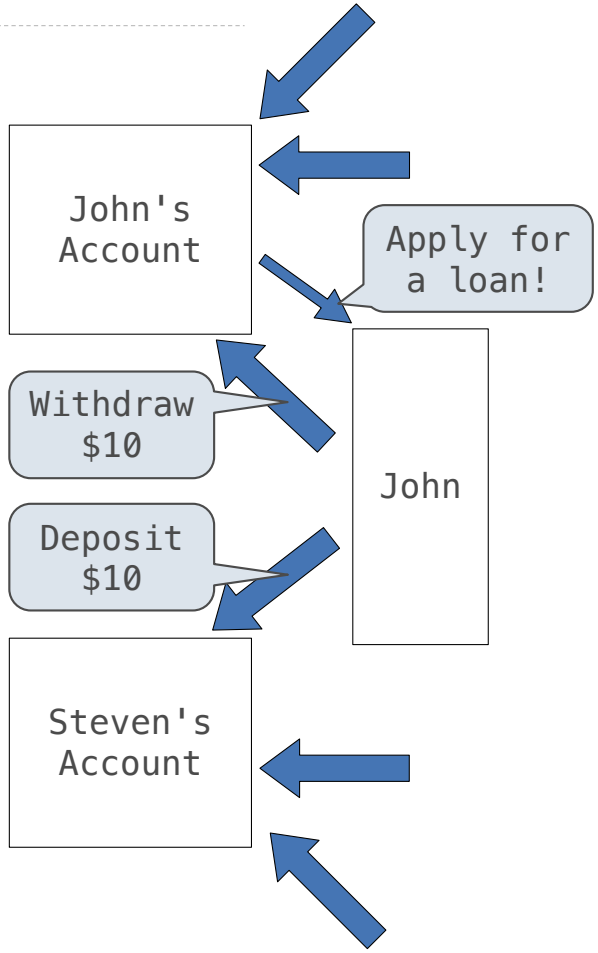

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>>> a = Account('Jim')
>>> a.holder
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>>> a.balance
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Idea: All bank accounts should have "withdraw" and "deposit" behaviors that all work in the same way.

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>>> a.deposit(15)
15
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```
>>> a.deposit(15)
15
>>> a.withdraw(10)
5
```

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

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

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```

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

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    <suite>
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2. The constructor `__init__` 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.

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

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>>> a is a
True
>>> a is not b
True
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>>> c = a
>>> c is a
True
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class Account:

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

    def deposit(self, amount):
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class Account:

    def __init__(self, account_holder):
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        if amount > self.balance:
            return 'Insufficient funds'
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        return self.balance
```

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

Invoking Methods

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

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class Account:
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        self.balance = self.balance + amount
        return self.balance
```

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Dot notation automatically supplies the first argument to a method.

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```

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Dot notation automatically supplies the first argument to a method.

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

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class Account:
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```

Defined with two arguments

Dot notation automatically supplies the first argument to a method.

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

Invoked with one argument

Dot Expressions

Dot Expressions

```
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```
tom_account.deposit(10)
```

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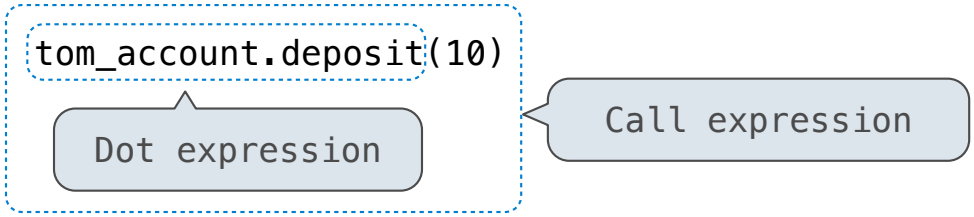

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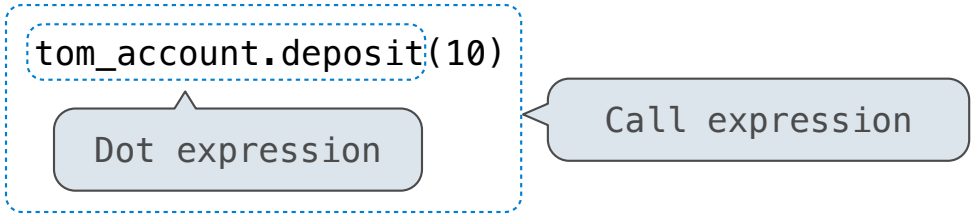

(Demo)

Attributes

Accessing Attributes

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

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```
>>> getattr(tom_account, 'balance')
10
```

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True
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- One of its instance attributes, **or**

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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

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```
>>> type(Account.deposit)
```

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

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

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<class 'method'>
```

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Object + Function = Bound Method

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

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

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- *Functions*, which we have been creating since the beginning of the course, and
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>>> 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>
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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 attributes are "shared" across all instances of a class because they are attributes of the class, not the instance.

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

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

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

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    # Additional methods would be defined here
```

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

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        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!

Attribute Assignment

Assignment Statements and Attributes

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

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>>> tom_account = Account('Tom')
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0.02
```

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

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- If the object is an instance, then assignment sets an instance attribute
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```
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02
```

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```
>>> 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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```
>>> 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
```

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```
>>> 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
```

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```
>>> 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
```

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>>> 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 = 0.08
```

Assignment Statements and Attributes

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>>> 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 = 0.08
>>> jim_account.interest
```

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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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>>> jim_account.interest = 0.08
>>> jim_account.interest
0.08
```

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

```
>>> jim_account.interest = 0.08
>>> jim_account.interest
0.08
>>> tom_account.interest
```

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

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>>> jim_account.interest = 0.08
>>> jim_account.interest
0.08
>>> tom_account.interest
0.04
```

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0.02
>>> jim_account.interest
0.02
>>> Account.interest = 0.04
>>> tom_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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```

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>>> tom_account.interest
0.04
>>> Account.interest = 0.05
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```

```
>>> jim_account.interest = 0.08
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0.08
>>> tom_account.interest
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>>> Account.interest = 0.05
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```

```
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>>> jim_account.interest
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0.04
>>> Account.interest = 0.05
>>> tom_account.interest
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>>> jim_account.interest
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