Lecture 15: Inheritance

2/27/2015
Guest Lecturer: Marvin Zhang

Some (a lot of) material from these slides was borrowed from John DeNero.

Announcements

- Homework 5 due Wednesday 3/4 @ 11:59pm

- Project 3 due Thursday 3/12 @ 11:59pm

- Midterm 2 on Thursday 3/19 7pm-9pm

- Quiz 2 released Wednesday 3/4

  - Due Thursday 3/5 @ 11:59pm

  - Object-oriented programming

  - Similar to homework 5

- Guerrilla section this Sunday 3/1 on mutation

Inheritance

- Powerful idea in Object-Oriented Programming

- Way of *relating* similar classes together

- Common use: a *specialized* class inherits from a more *general* class

```
class <new class>(<base class>):
                 ...
```

- The new class *shares* attributes with the base class, and *overrides* certain attributes

- Implementing the new class is now as simple as specifying how it's *different* from the base class

Inheritance Example

```python
class Account:
    """A bank account."""
    ...
```

- Bank accounts have:

  - an account holder

  - a balance

  - an interest rate of 2%

- You can:

  - deposit to an account

  - withdraw from an account

```python
class CheckingAccount(Account):
    """A checking account."""
    ...
```

- Checking accounts have:

  - an account holder

  - a balance

  - an interest rate of 1%

  - a withdraw fee of $1

- You can:

  - deposit to a checking account

  - withdraw from a checking account (but there's a fee!)

Inheritance Example

```python
class Account:
    """A bank account."""
    ...
```

- Bank accounts have:

  - an account holder

  - a balance

  - an interest rate of 2%

- You can:

  - deposit to an account

  - withdraw from an account

```python
class CheckingAccount(Account):
    """A checking account."""
    ...
```

- Checking accounts have:

  - an account holder

  - a balance

  - **an interest rate of 1%**

  - a withdraw fee of $1

- You can:

  - deposit to a checking account

  - withdraw from a checking account (but there's a fee!)

Inheritance Example

```python
class Account:
    """A bank account."""
    ...
```

- Bank accounts have:

  - an account holder

  - a balance

  - an interest rate of 2%

- You can:

  - deposit to an account

  - withdraw from an account

```python
class CheckingAccount(Account):
    """A checking account."""
    ...
```

- Checking accounts have:

  - an account holder

  - a balance

  - **an interest rate of 1%**

  - **a withdraw fee of $1**

- You can:

  - deposit to a checking account

  - withdraw from a checking account (but there's a fee!)

Inheritance Example

```
class Account:
    """A bank account."""
    ...
```

- Bank accounts have:

  - an account holder

  - a balance

  - an interest rate of 2%

- You can:

  - deposit to an account

  - withdraw from an account

```
class CheckingAccount(Account):
    """A checking account."""
    ...
```

- Checking accounts have:

  - an account holder

  - a balance

  - **an interest rate of 1%**

  - **a withdraw fee of $1**

- You can:

  - deposit to a checking account

  - withdraw from a checking account **(but there's a fee!)**

Attribute Look Up

To look up a name in a class:

1. If the name is in the attributes of the class, return the corresponding value

2. If not found, look up the name in the base class, if there is one

Base class attributes *are not copied* into subclasses!

```
>>> tom = CheckingAccount('Tom')
```

Attribute Look Up

To look up a name in a class:

1. If the name is in the attributes of the class, return the corresponding value

2. If not found, look up the name in the base class, if there is one

Base class attributes *are not copied* into subclasses!

```
>>> tom = CheckingAccount('Tom')   # Account.__init__
```

Attribute Look Up

To look up a name in a class:

1. If the name is in the attributes of the class, return the corresponding value

2. If not found, look up the name in the base class, if there is one

Base class attributes *are not copied* into subclasses!

```
>>> tom = CheckingAccount('Tom')   # Account.__init__
>>> tom.interest
```

Attribute Look Up

To look up a name in a class:

1. If the name is in the attributes of the class, return the corresponding value

2. If not found, look up the name in the base class, if there is one

Base class attributes *are not copied* into subclasses!

```
>>> tom = CheckingAccount('Tom')   # Account.__init__
>>> tom.interest      # Found in CheckingAccount
0.01
```

Attribute Look Up

To look up a name in a class:

1. If the name is in the attributes of the class, return the corresponding value

2. If not found, look up the name in the base class, if there is one

Base class attributes *are not copied* into subclasses!

```
>>> tom = CheckingAccount('Tom')   # Account.__init__
>>> tom.interest      # Found in CheckingAccount
0.01
>>> tom.deposit(20)
```

Attribute Look Up

To look up a name in a class:

1. If the name is in the attributes of the class, return the corresponding value

2. If not found, look up the name in the base class, if there is one

Base class attributes *are not copied* into subclasses!

```
>>> tom = CheckingAccount('Tom')   # Account.__init__
>>> tom.interest       # Found in CheckingAccount
0.01
>>> tom.deposit(20)   # Found in Account
20
```

Attribute Look Up

To look up a name in a class:

1. If the name is in the attributes of the class, return the corresponding value

2. If not found, look up the name in the base class, if there is one

Base class attributes *are not copied* into subclasses!

```
>>> tom = CheckingAccount('Tom')   # Account.__init__
>>> tom.interest      # Found in CheckingAccount
0.01
>>> tom.deposit(20)   # Found in Account
20
>>> tom.withdraw(5)
```

Attribute Look Up

To look up a name in a class:

1. If the name is in the attributes of the class, return the corresponding value

2. If not found, look up the name in the base class, if there is one

Base class attributes *are not copied* into subclasses!

```
>>> tom = CheckingAccount('Tom')  # Account.__init__
>>> tom.interest       # Found in CheckingAccount
0.01
>>> tom.deposit(20)    # Found in Account
20
>>> tom.withdraw(5)    # Found in CheckingAccount
14
```

Designing for Inheritance

✓ • Don't repeat yourself! Use *existing implementations*

✓ • Reuse overridden attributes by accessing them through the *base class*

✓ • Look up attributes on *instances* if possible

```python
class CheckingAccount(Account):
    withdraw_fee = 1
    interest = 0.01
    def withdraw(self, amount):
        return Account.withdraw(
                self, amount + self.withdraw_fee)
```

Inheritance vs Composition (demo)

- Inheritance: relating two classes through specifying *similarities and differences*

  - Represents "is a" relationships, e.g. a checking account *is a* specific type of account

- Composition: connecting two classes through their *relationship to one another*

  - Represents "has a" relationships, e.g. a bank *has a* collection of bank accounts

Multiple Inheritance

- In Python, a class can inherit from multiple base classes

- This exists in many *but not all* object-oriented languages

- This is a tricky and often dangerous subject, so proceed carefully!

```python
class SavingsAccount(Account):
    deposit_fee = 2
    def deposit(self, amount):
        return Account.deposit(
                self, amount - self.deposit_fee)
```
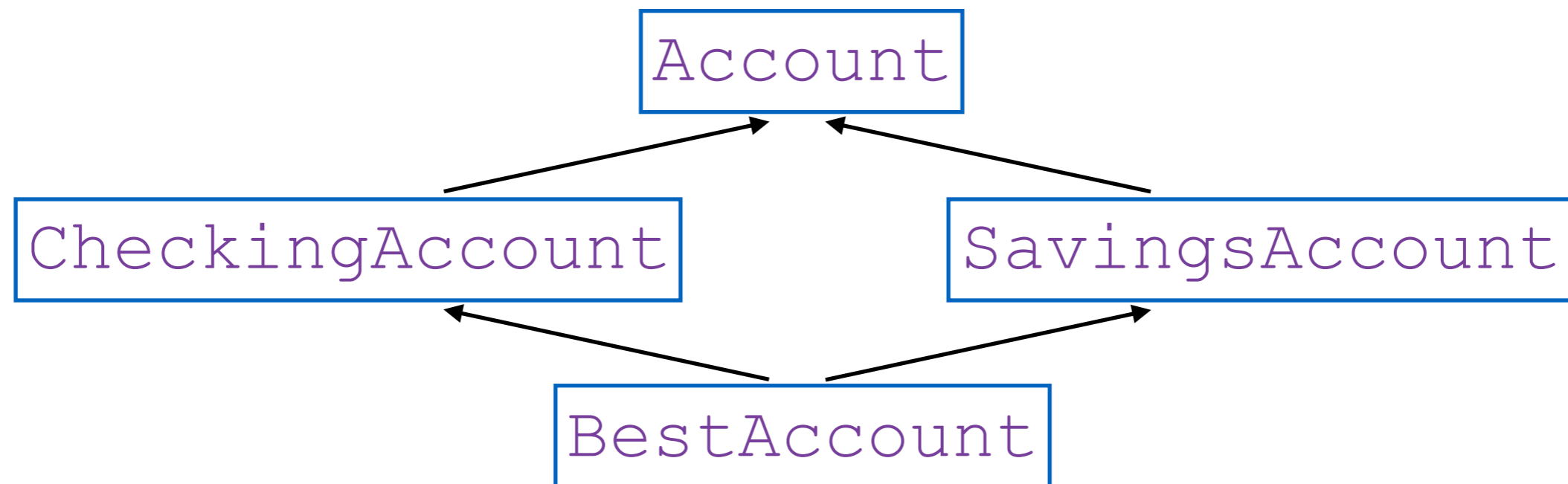
Multiple Inheritance Example

- Bank executive wants the following:

  - Low interest rate of 1%

  - $1 withdrawal fee

  - $2 deposit fee

  - A free dollar for opening the account!

```python
class BestAccount(CheckingAccount, SavingsAccount):
    def __init__(self, account_holder):
        self.holder = account_holder
        self.balance = 1  # best deal ever
```

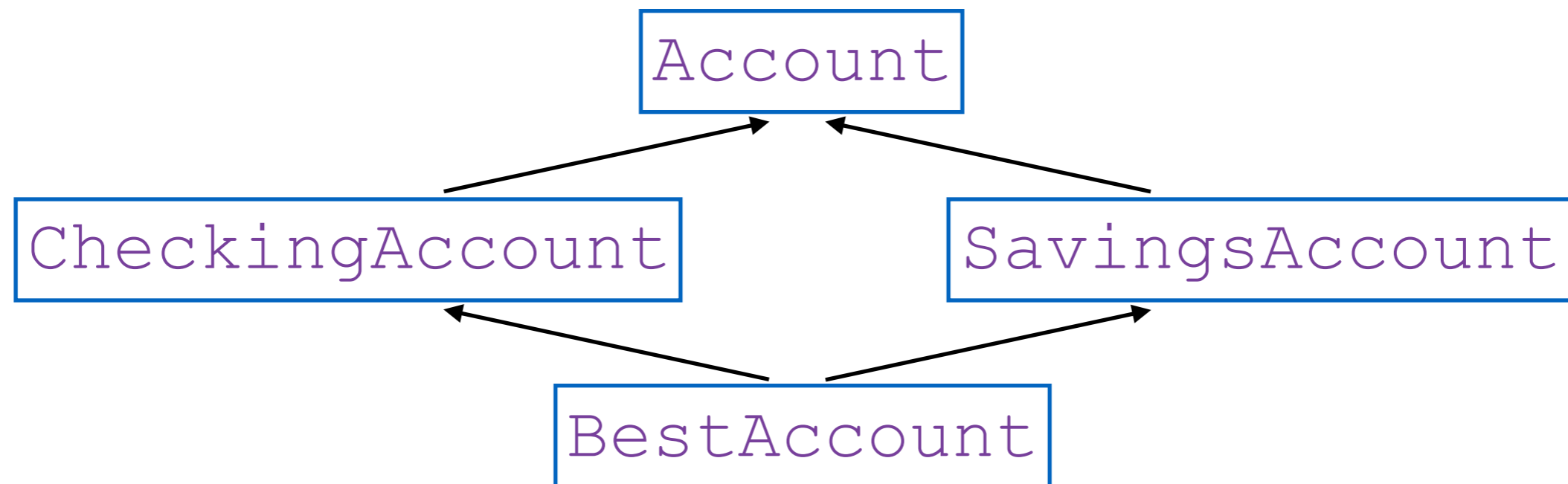# Multiple Inheritance Example


```
>>> such_a_deal = BestAccount('Marvin')
```
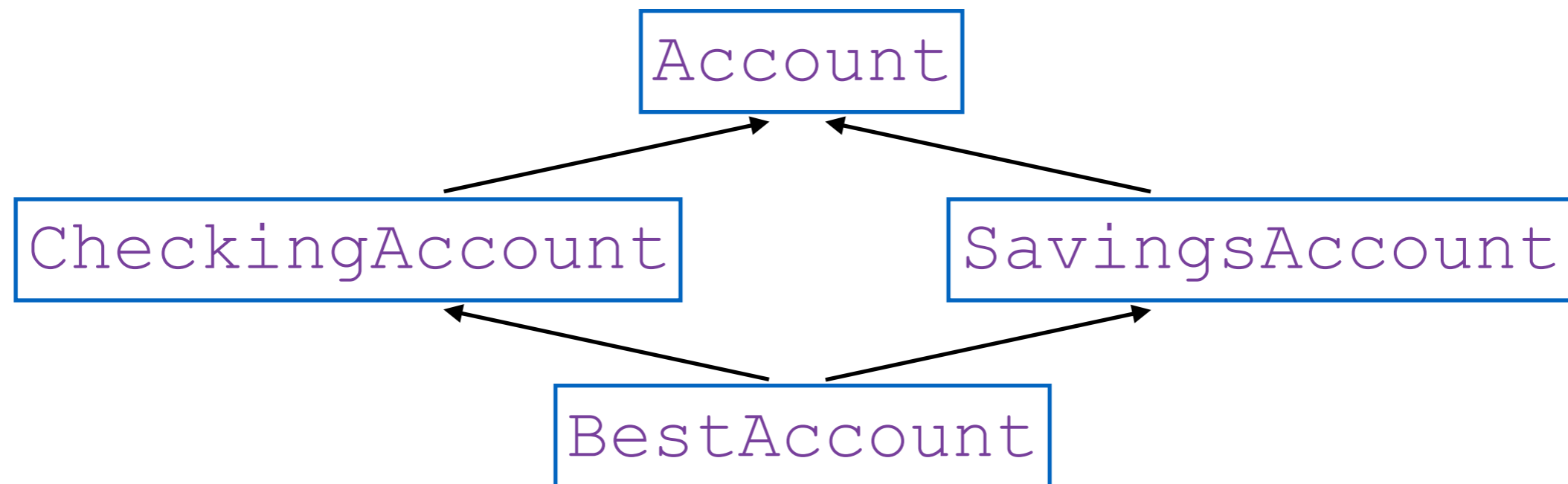
Multiple Inheritance Example


```
>>> such_a_deal = BestAccount('Marvin')
>>> such_a_deal.balance  # instance attribute
1
```

Multiple Inheritance Example

```
         Account
        ↗        ↖
CheckingAccount    SavingsAccount
        ↖        ↗
        BestAccount
```
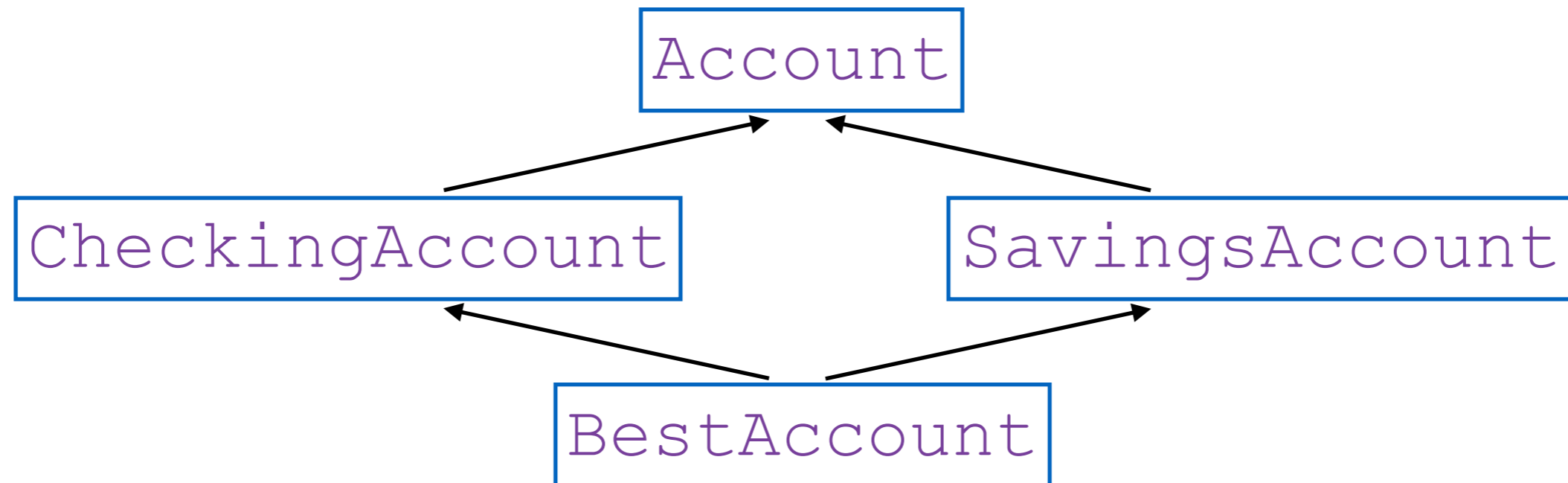
```
>>> such_a_deal = BestAccount('Marvin')
>>> such_a_deal.balance  # instance attribute
1
>>> such_a_deal.deposit(20)  # SavingsAccount
19
```
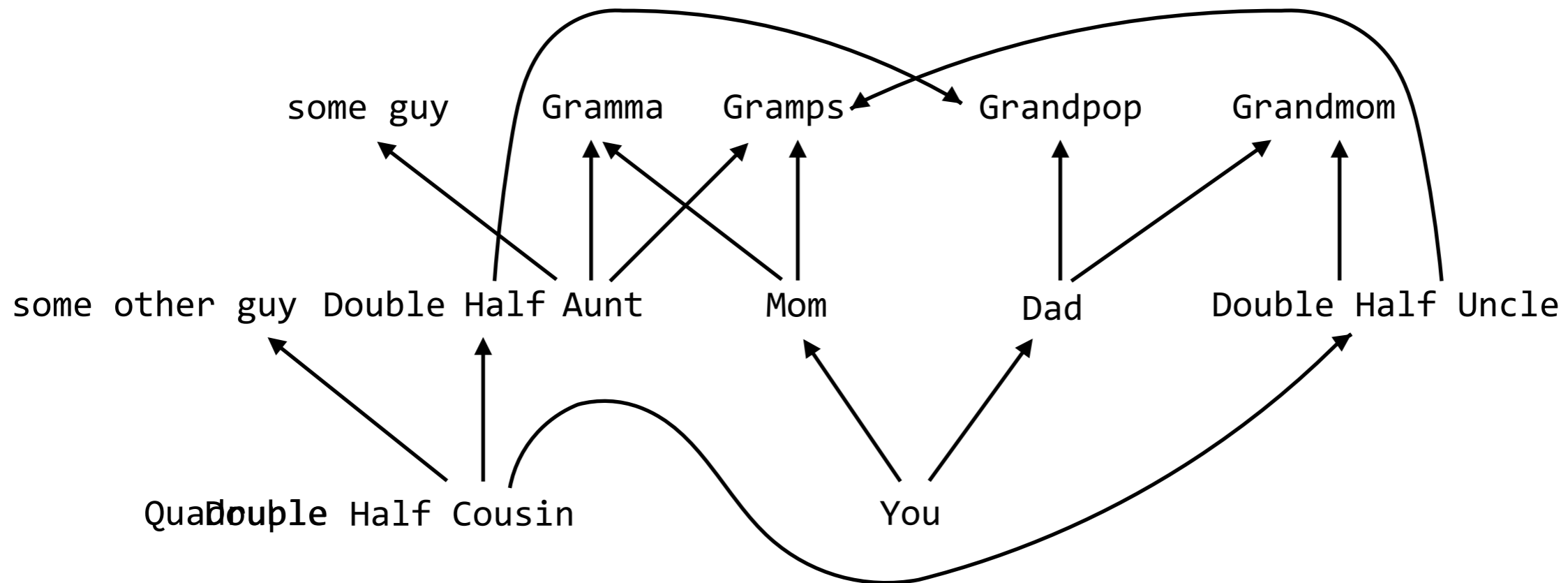
Multiple Inheritance Example


```
>>> such_a_deal = BestAccount('Marvin')
>>> such_a_deal.balance  # instance attribute
1
>>> such_a_deal.deposit(20)  # SavingsAccount
19
>>> such_a_deal.withdraw(5)  # CheckingAccount
13
```

Complicated Inheritance

To show how complicated inheritance can be, let's look at an analogy through biological inheritance.

Moral of the story: inheritance (especially multiple inheritance) is complicated and weird. Use it carefully!