

# Inheritance

May 7, 2021

## 0.1 Inheritance

Other languages automatically call base class initializers. However, Python treats `__init__()` like any other method.

Base class `__init__()` is not called if overridden. Use `super()` to call base class `__init__()`.

```
[1]: class SimpleList:
    def __init__(self, items):
        self._items = list(items)

    def add(self, item):
        self._items.append(item)

    def __getitem__(self, index):
        return self._items[index]

    def sort(self):
        self._items.sort()

    def __len__(self):
        return len(self._items)

    def __repr__(self):
        return 'SimpleList({!r})'.format(self._items)
```

```
[2]: class SortedList(SimpleList):
    def __init__(self, items=()):
        super().__init__(items)
        self.sort()

    def add(self, item):
        super().add(item)
        self.sort()

    def __repr__(self):
        return 'SortedList({!r})'.format(list(self))
```

```
[3]: sl = SortedList([1, 3, 6, 2, 4, 7, 5, 9])
      print(sl)
      sl.add(-1)
      sl.add(10)
      print(sl)
```

```
SortedList([1, 2, 3, 4, 5, 6, 7, 9])
SortedList([-1, 1, 2, 3, 4, 5, 6, 7, 9, 10])
```

## 0.2 isinstance()

Determines if an object is of a specified type. `isinstance()` will return `True` if the object is an instance of a subclass of the second argument.

In addition, a tuple of types can be passed as the second argument. This is equivalent to asking if the first argument is an instance of any of the types in the tuple.

```
[4]: isinstance(3, int)
```

```
[4]: True
```

```
[5]: isinstance('hello', str)
```

```
[5]: True
```

```
[6]: isinstance(4.567, bytes)
```

```
[6]: False
```

```
[7]: isinstance(sl, SortedList)
```

```
[7]: True
```

```
[8]: isinstance(sl, SimpleList)
```

```
[8]: True
```

```
[9]: x = []
      isinstance(x, (float, dict, list))
```

```
[9]: True
```

```
[10]: class IntList(SimpleList):
        def __init__(self, items=()):
            for x in items: self._validate(x)
            super().__init__(items)

        @staticmethod
```

```

def _validate(x):
    if not isinstance(x, int):
        raise TypeError('IntList only accepts int values')

def add(self, item):
    self._validate(item)
    super().add(item)

def __repr__(self):
    return 'IntList({!r})'.format(list(self))

```

```

[11]: il = IntList([1, 3, 2, 4])
      il.add(19)
      print(il)

```

```
IntList([1, 3, 2, 4, 19])
```

### 0.3 issubclass()

Determines if a type is a subclass of another.

```
[12]: issubclass(IntList, SimpleList)
```

```
[12]: True
```

```
[13]: issubclass(SortedList, SimpleList)
```

```
[13]: True
```

```
[14]: issubclass(SortedList, IntList)
```

```
[14]: False
```

```

[15]: class MyInt(int): pass
      class MyVerySpecialInt(MyInt): pass

```

```
[16]: issubclass(MyVerySpecialInt, int)
```

```
[16]: True
```

### 0.4 Multiple Inheritance

Defining a class with more than one base class.

If a class has multiple base classes and doesn't define its `__init__()` method. Then, **only the initializer of the first base class is automatically called.**

The list of base classes of a type is stored in the `__bases__` member.

```
[17]: class SortedIntList(IntList, SortedList):
      def __repr__(self):
          return 'SortedIntList({!r})'.format(list(self))
```

```
[18]: sil = SortedIntList([1, 3, 2, 4, 6, 5])
      print(sil)
      sil.add(-1234)
      print(sil)
```

```
SortedIntList([1, 2, 3, 4, 5, 6])
SortedIntList([-1234, 1, 2, 3, 4, 5, 6])
```

```
[19]: SortedIntList([1, 3, 2, '4', 6])
```

```
-----
TypeError                                Traceback (most recent call last)
<ipython-input-19-59656f4f0ffa> in <module>
----> 1 SortedIntList([1, 3, 2, '4', 6])

<ipython-input-10-b7ed9fffcde6> in __init__(self, items)
      1 class IntList(SimpleList):
      2     def __init__(self, items=()):
----> 3         for x in items: self._validate(x)
      4         super().__init__(items)
      5

<ipython-input-10-b7ed9fffcde6> in _validate(x)
      7     def _validate(x):
      8         if not isinstance(x, int):
----> 9             raise TypeError('IntList only accepts int values')
     10
     11     def add(self, item):

TypeError: IntList only accepts int values
```

```
[20]: class Base1:
      def __init__(self):
          print('Base1.__init__')

      class Base2:
          def __init__(self):
              print('Base2.__init__')

      class Sub(Base1, Base2):
          pass
```

```
[21]: s = Sub()
```

```
Base1.__init__
```

```
[22]: Sub.__bases__
```

```
[22]: (__main__.Base1, __main__.Base2)
```

## 0.5 Method Resolution Order (MRO)

The **MRO** of a class is the ordering of a class' inheritance graph used to determine **which implementation to use when a method is invoked**.

When you invoke a method on an object which has one or more base classes, the actual code that gets run may be defined in multiple places.

The **MRO** is the way Python resolves the **diamond problem of inheritance**

The **MRO** of a type is stored in the `__mro__` member or calling the `mro()` method.

### 0.5.1 C3

Python uses the **C3** algorithm to build the **MRO** in a deterministic way.

- Subclasses come **before** base classes
- Base class order from class definition is **preserved**
- First two qualities are preserved **no matter** where you start in the inheritance graph

```
[23]: SortedList.__mro__
```

```
[23]: (__main__.SortedList, __main__.SimpleList, object)
```

```
[24]: class A:
        def func(self):
            return 'A.func'

        class B(A):
            def func(self):
                return 'B.func'

        class C(A):
            def func(self):
                return 'C.func'

        class D(B, C):
            pass
```

```
[25]: D.__mro__
```

```
[25]: (__main__.D, __main__.B, __main__.C, __main__.A, object)
```

```
[26]: D().func()
```

```
[26]: 'B.func'
```

```
[27]: class E(C, B):  
      pass
```

```
[28]: E.__mro__
```

```
[28]: (__main__.E, __main__.C, __main__.B, __main__.A, object)
```

```
[29]: E().func()
```

```
[29]: 'C.func'
```

```
[30]: class AA: pass  
      class BB(AA): pass  
      class CC(AA): pass  
      class DD(BB, AA, CC): pass
```

```
-----  
TypeError                                Traceback (most recent call last)  
<ipython-input-30-c09699461d8f> in <module>  
      2 class BB(AA): pass  
      3 class CC(AA): pass  
----> 4 class DD(BB, AA, CC): pass  
  
TypeError: Cannot create a consistent method resolution  
order (MRO) for bases AA, CC
```

## 0.6 super()

Given an MRO and a class C, `super()` gives you an object which resolves methods using only the part of the MRO which comes after C.

`super()` returns a **proxy** object which **routes** method calls.

- **Bound proxy** is bound to an specific class or instance.
- **Unbound proxy** is not bound to a class or instance.

### 0.6.1 Bound Proxy

There are two types of bound proxies **instance-bound** and **class-bound**.

**Class-bound proxy** To create a **class-bound** proxy the both parameters of `super()` must be class objects. The second class argument must be a subclass of or the same class as the first argument.

```
super(base-class, derived-class)
```

Python finds the **MRO** of the **derived-class**, afterwards it finds **base-class** in that **MRO**. Then, it takes everything **after** **base-class** in the **MRO**, and finds the first class in that sequence with matching method signature.

**Instance-bound proxy** **Instance-bound** proxy behave similarly to the **class-bound** proxy, except they bind to an instance.

To create an **instance-bound** proxy the second argument of **super()** must be an instance of a class of the same class as the first argument or any class derived from it.

Python finds the type of the second argument and calculates its **MRO**, afterwards it finds the location of the first argument in that **MRO**. Then, uses everything **after** that location to find the matching method signature.

### 0.6.2 Unbound proxy

TBD

### 0.6.3 super() without parameters

When **super()** is called without parameters Python sorts out the arguments on its own.

When called from inside an **instance method** Python does the following call: **super(class-of-method, self)**. Therefore, it's using an **instance-bound** proxy.

When called from inside a **class method** Python does the following call: **super(class-of-method, class)**. Therefore, it's using a **class-bound** proxy.

```
[31]: SortedIntList.mro()
```

```
[31]: [__main__.SortedIntList,
      __main__.IntList,
      __main__.SortedList,
      __main__.SimpleList,
      object]
```

```
[32]: super(SortedList, SortedIntList)
```

```
[32]: <super: __main__.SortedList, __main__.SortedIntList>
```

```
[33]: super(SortedList, SortedIntList).add
```

```
[33]: <function __main__.SimpleList.add(self, item)>
```

```
[34]: super(SortedList, SortedIntList).add(4)
```

```
-----
TypeError                                Traceback (most recent call last)
<ipython-input-34-565a4aa6b79a> in <module>
```

```
----> 1 super(SortedList, SortedIntList).add(4)
```

```
TypeError: add() missing 1 required positional argument: 'item'
```

```
[35]: super(SortedIntList, SortedIntList)._validate(5)
      super(SortedIntList, SortedIntList)._validate('5')
```

```
-----
TypeError                                Traceback (most recent call last)
<ipython-input-35-fdaed98f0411> in <module>
      1 super(SortedIntList, SortedIntList)._validate(5)
----> 2 super(SortedIntList, SortedIntList)._validate('5')

<ipython-input-10-b7ed9fffcde6> in _validate(x)
      7     def _validate(x):
      8         if not isinstance(x, int):
----> 9             raise TypeError('IntList only accepts int values')
     10
     11     def add(self, item):

TypeError: IntList only accepts int values
```

```
[36]: super(int, IntList)
```

```
-----
TypeError                                Traceback (most recent call last)
<ipython-input-36-445c7c396676> in <module>
----> 1 super(int, IntList)

TypeError: super(type, obj): obj must be an instance or subtype of type
```

```
[37]: SortedIntList.mro()
```

```
[37]: [__main__.SortedList,
      __main__.IntList,
      __main__.SortedList,
      __main__.SimpleList,
      object]
```

```
[38]: sil = SortedIntList([5, 10, 15])
      super(SortedList, sil)
```

```
[38]: <super: __main__.SortedList, SortedIntList([5, 10, 15])>
```

```
[39]: super(SortedList, sil).add(6)
```



```
[40]: print(sil)
```

```
SortedIntList([5, 10, 15, 6])
```

```
[41]: super(SortedList, sil).add('7')
```

```
[42]: print(sil)
```

```
SortedIntList([5, 10, 15, 6, '7'])
```