

COMP110: Principles of Computing

10: References

Pass by reference

References

- ▶ Our picture of a variable: a labelled box containing a value
- ▶ For “plain old data” (e.g. numbers), this is accurate
- ▶ For **objects** (i.e. instances of classes), variables actually hold **references** (a.k.a. **pointers**)
- ▶ It is possible (indeed common) to have **multiple references** to the same underlying object

The wrong picture

```
class Thing:
    def __init__(self,
                    a, b):
        self.a = a
        self.b = b

x = Thing(30, 40)
y = Thing(50, 60)
z = y
```

Variable	Value		
x	a	30	
	b	40	
y	a	50	
	b	60	
z	a	50	
	b	60	

The right picture

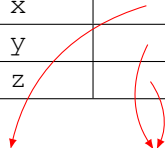
```
class Thing:
    def __init__(self,
                    a, b):
        self.a = a
        self.b = b
```

```
x = Thing(30, 40)
y = Thing(50, 60)
z = y
```

Variable	Value
x	
y	
z	

a	30
b	40

a	50
b	60



Values and references

Socrative room code: FALCOMPED

```
a = 10  
b = a  
a = 20  
print("a:", a)  
print("b:", b)
```

Values and references

Socrative room code: FALCOMPED

```
class X:
    def __init__(self, value):
        self.value = value

a = X(10)
b = a
a.value = 20
print("a:", a.value)
print("b:", b.value)
```

Values and references

Socrative room code: FALCOMPED

```
class X:
    def __init__(self, value):
        self.value = value

a = X(10)
b = X(10)
a.value = 20
print("a:", a.value)
print("b:", b.value)
```


Pass by value

In **function parameters**, “plain old data” is passed by **value**

```
def double(x):  
    x *= 2  
  
a = 7  
double(a)  
print(a)
```

`double` does not actually do anything, as `x` is just a local copy of whatever is passed in!

Pass by reference

However, instances are passed by **reference**

```
class Box:
    def __init__(self, v):
        self.value = v

def double(x):
    x.value *= 2

a = Box(7)
double(a)
print(a.value)
```

`double` now has an effect, as `x` gets a reference to the `Box` instance

Lists are objects too

```
a = ["Hello"]  
b = a  
b.append("world")  
print(a)  # ["Hello", "world"]
```

... which means you should be careful when passing lists into functions, because the function might actually change the list!

References can be circular

```
class X:  
    pass  
  
foo = X()  
foo.x = foo  
foo.y = "Hello"  
  
print(foo.x.x.x.x.x.y)
```

References and pointers

- ▶ Some languages (e.g. C, C++) use **pointers**
- ▶ Pointers are a type of reference, and have the same semantics
- ▶ C++ also has something called references...