Inheritance

Announcements

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- Midterm grades to be released Wed 3/19 (tentative)

- OH schedule updates
  - All 9 am OH canceled starting today Mon 3/17
  - More updates to come (stay tuned on Ed)

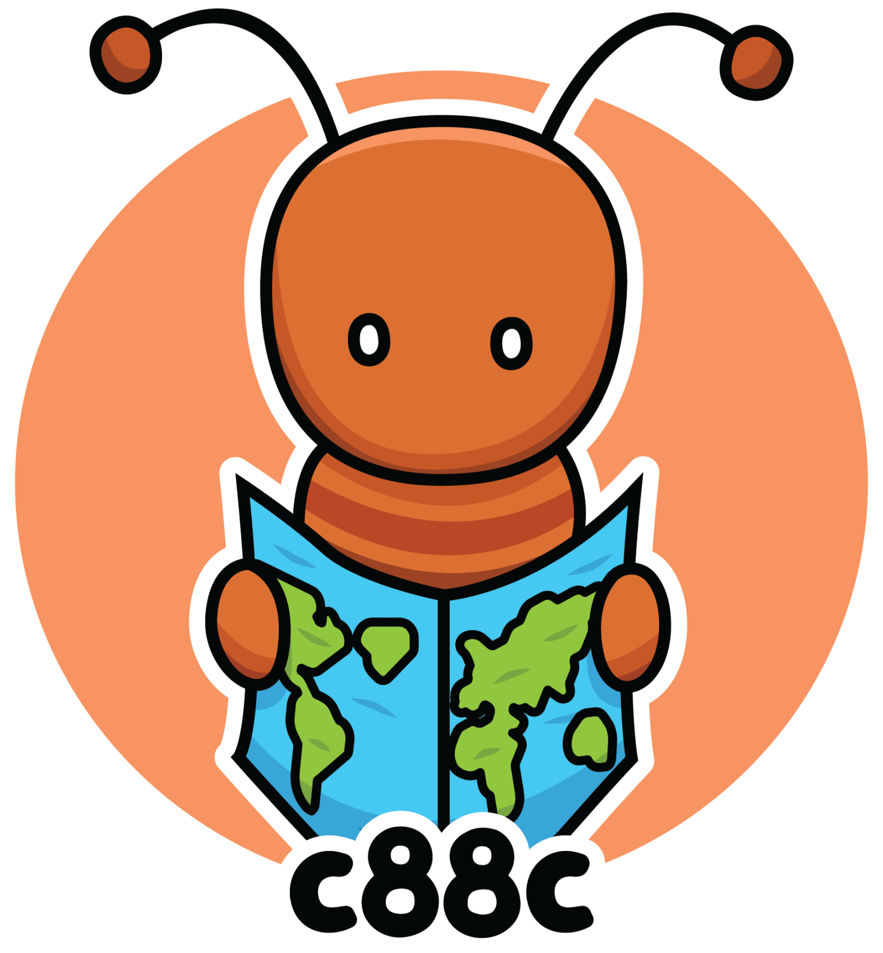
- **[EC opportunity]** Mid-semester survey to be released soon
  - If 75% or more of the class fills out the survey by Mon 3/31, everyone will receive 1 pt of EC

- Feedback: go.c88c.org/rebecca-lec or scan QR code

Inheritance Basics

Why inheritance?

- The world can be represented by objects, and objects can be related
- DRY: Don’t Repeat Yourself
- Ants project
- Fun fact: Our mascot is named InheritAnt!



Inheritance syntax

```
class <class_name>(<superclass_name>):
    <suite>
```

Examples:

```
class Dog(Animal):
    …

class Cat(Animal):
    …
```

Terminology

- superclass = parent class = base class
- subclass = child class

Overriding methods and attributes

```
class Animal:
    def __init__(self, name):
        self.name = name

    def make_noise(self):
        print(f'{self.name} made a noise!')

class Dog(Animal):
    def __init__(self, name, owner):
        super().__init__(name)
        self.owner = owner

    def make_noise(self):
        print('Woof!')

class Cat(Animal):
    def __init__(self, name, owner):
        super().__init__(name)
        self.owner = owner

    def make_noise(self):
        print('Meow!')
```

```
>>> animal = Animal('Bessie')
>>> animal.name
'Bessie'
>>> animal.owner
AttributeError: 'Animal' object has no
attribute 'owner'
>>> animal.make_noise()
Bessie made a noise!
>>> dog = Dog('Boba', 'Upasana')
>>> dog.name
'Boba'
>>> dog.owner
'Upasana'
>>> dog.make_noise()
Woof!
>>> cat = Cat('Rigatoni', 'Andie')
>>> cat.make_noise()
Meow!
>>> Cat.make_noise()
TypeError: make_noise() missing 1 required
positional argument: 'self'
>>> Cat.make_noise(cat)
Meow!
```

Overriding methods and attributes

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class Animal:
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class Dog(Animal):
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        self.owner = owner

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        print('Meow!')
```

Q: What additional superclass might we want to make to avoid repeating ourselves?

A: Pet class that inherits from Animal and includes an owner attribute. Then Dog and Cat can inherit from Pet!

Lookup

Lookup rules

Instance variable lookup

1. Lookup name in <u>instance</u>
2. Lookup name in <u>class</u> that instance belongs to
3. Lookup in parent class, if one exists (recursively)
4. Error if still not found

Class variable lookup

1. Lookup in <u>class</u>
2. Look up in parent class, if one exists (recursively)
3. Error if still not found

Lookup exercise

```
class A:
    foo = 0
    def __init__(self, foo, bar):
        self.foo = foo + A.foo
        A.foo += 1
        self.bar = bar

class B(A):
    foo = 5
    def __init__(self, bar):
        super().__init__(B.foo, bar)
```

```
>>> first = A(2, 3)
>>> first.foo
2
>>> first.bar
3
>>> A.foo
1
```

```
>>> second = A(2, 3)
>>> second.foo
3
>>> second.bar
3
>>> A.foo
2

>>> third = B(2, 3)
TypeError: __init__() takes 2 positional
arguments but 3 were given
>>> third = B(3)
>>> third.foo
7
>>> third.bar
3
>>> B.foo
5
>>> A.foo
3
>>> third.foo = 100
>>> third.foo
100
>>> B.foo
5
```

type vs. isinstance

```
class C:
    pass

class D(C):
    pass
```

```
>>> first = C()
>>> type(first)
<class '__main__.C'>
>>> second = D()
>>> type(second) == D
True
>>> isinstance(first, C)
True
>>> isinstance(second, C)
True
>>> isinstance(second, D)
True
```

Applications / System Design

Inheritance vs. Composition

Inheritance: *is-a* relationship

Composition: *has-a* relationship

Let’s design Spotify!

Q: What are some objects we might want to define?

A: User, Artist, Song, Playlist, Album, etc.

Let’s design Spotify!

Q: How are these objects related to each other?

A:

- An Artist *is a* User
- An Artist *has many* Songs
- A Playlist *has many* Songs
- An Album *is a* Playlist
- A User *has many* Playlists
- An Artist *has many* Albums
- etc.

Demo: Design Spotify

Multiple Inheritance

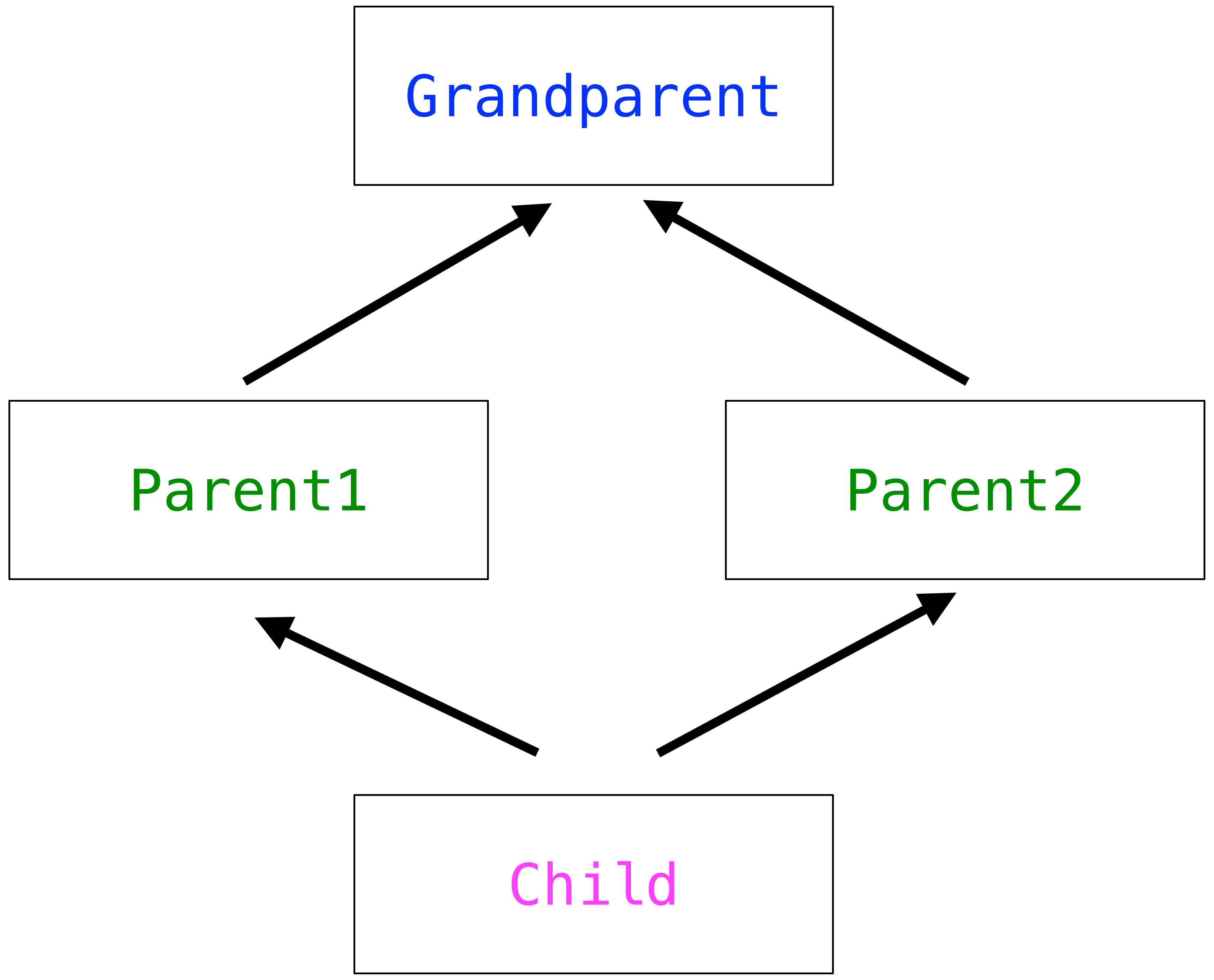
Method Resolution Order (MRO) with diamond inheritance

```
class Grandparent:
    def where_am_i(self):
        print('In grandparent')

class Parent1(Grandparent):
    def where_am_i(self):
        super().where_am_i()
        print('In parent 1')

class Parent2(Grandparent):
    def where_am_i(self):
        super().where_am_i()
        print('In parent 2')

class Child(Parent1, Parent2):
    def where_am_i(self):
        super().where_am_i()
        print('In child')
```



Python looks up attributes/methods from:
1. Current class
2. Parent classes, from left to right
3. Grandparent class

Method Resolution Order (MRO) with diamond inheritance

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class Grandparent:
    def where_am_i(self):
        print('In grandparent')

class Parent1(Grandparent):
    def where_am_i(self):
        super().where_am_i()
        print('In parent 1')

class Parent2(Grandparent):
    def where_am_i(self):
        super().where_am_i()
        print('In parent 2')

class Child(Parent1, Parent2):
    def where_am_i(self):
        super().where_am_i()
        print('In child')
```

Python looks up attributes/methods from:
1. Current class
2. Parent classes, from left to right
3. Grandparent class

```
>>> g = Grandparent()
>>> p1 = Parent1()
>>> p2 = Parent2()
>>> c = Child()
>>> g.where_am_i()
In grandparent
>>> p1.where_am_i()
In grandparent
In parent 1
>>> p2.where_am_i()
In grandparent
In parent 2
>>> c.where_am_i()
In grandparent
In parent 2
In parent 1
In child
>>> Child.mro()
[<class '__main__.Child'>,
<class '__main__.Parent1'>,
<class '__main__.Parent2'>,
<class '__main__.Grandparent'>,
<class 'object'>]
```