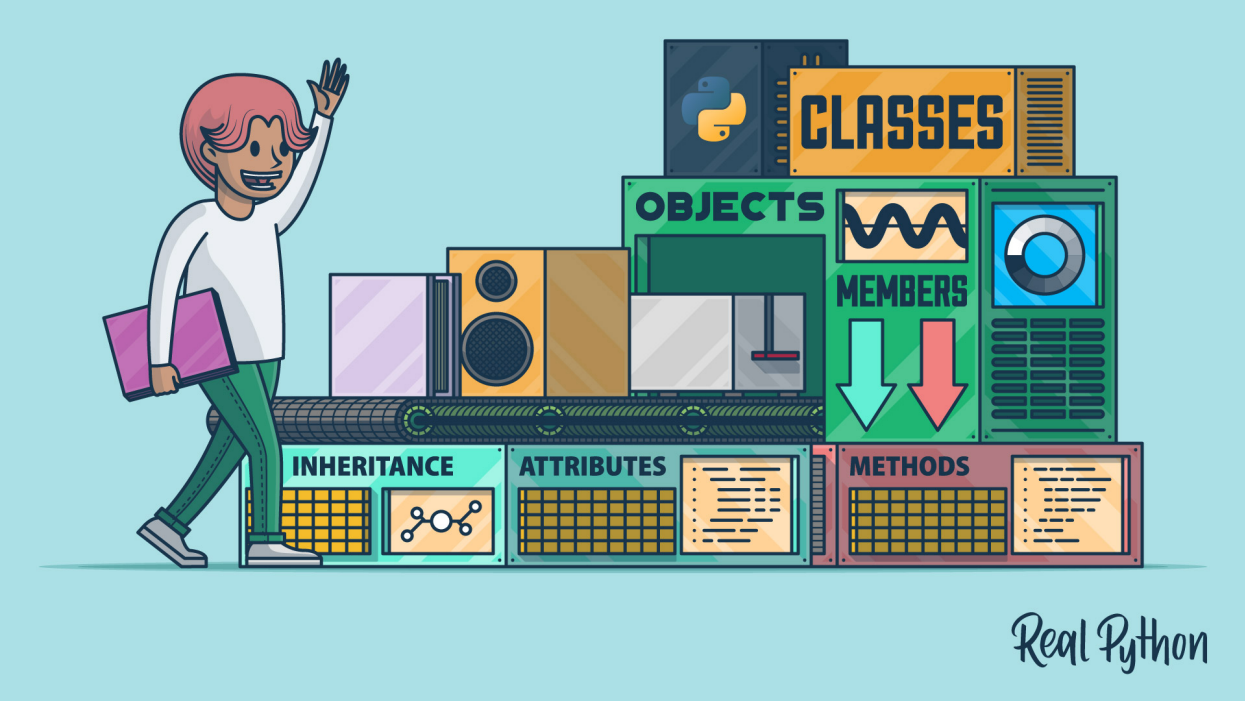
INHERITANCE AND INTERNALS: OBJECT-ORIENTED CODING IN PYTHON



MULTI-PART COURSE

- Course parts:
  - **A: Class Concepts**
  - **B: Inheritance and Internals**
  - C: Design and Guidance

IN THIS COURSE, YOU WILL LEARN ABOUT:

1. Class inheritance
2. Multi-level inheritance
3. Multiple inheritance
4. More special-methods
5. Some classes in the standard library
6. Abstract base classes

VERSIONS

Note:

- Code samples were tested using:
  - Python 3.11.4

OVERVIEW

- The previous course introduced you to declaring classes, their attributes, and their methods
- A class definition can be based on another class
  - Use hierarchical structure to match real-world structure
  - Code re-use
- Classes can inherit from classes that inherit
- Classes can inherit from multiple classes
- Partially define a class to describe a promised interface
- Some structures native to other programming languages have been implemented as classes in Python instead

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Inheritance

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INHERITANCE

- Creates a hierarchy of class definitions
- Child classes gain all aspects of their parent
- Child classes can override an ancestor's definitions
- Useful for:
  - Expressing actual hierarchical relationships
  - Code re-use

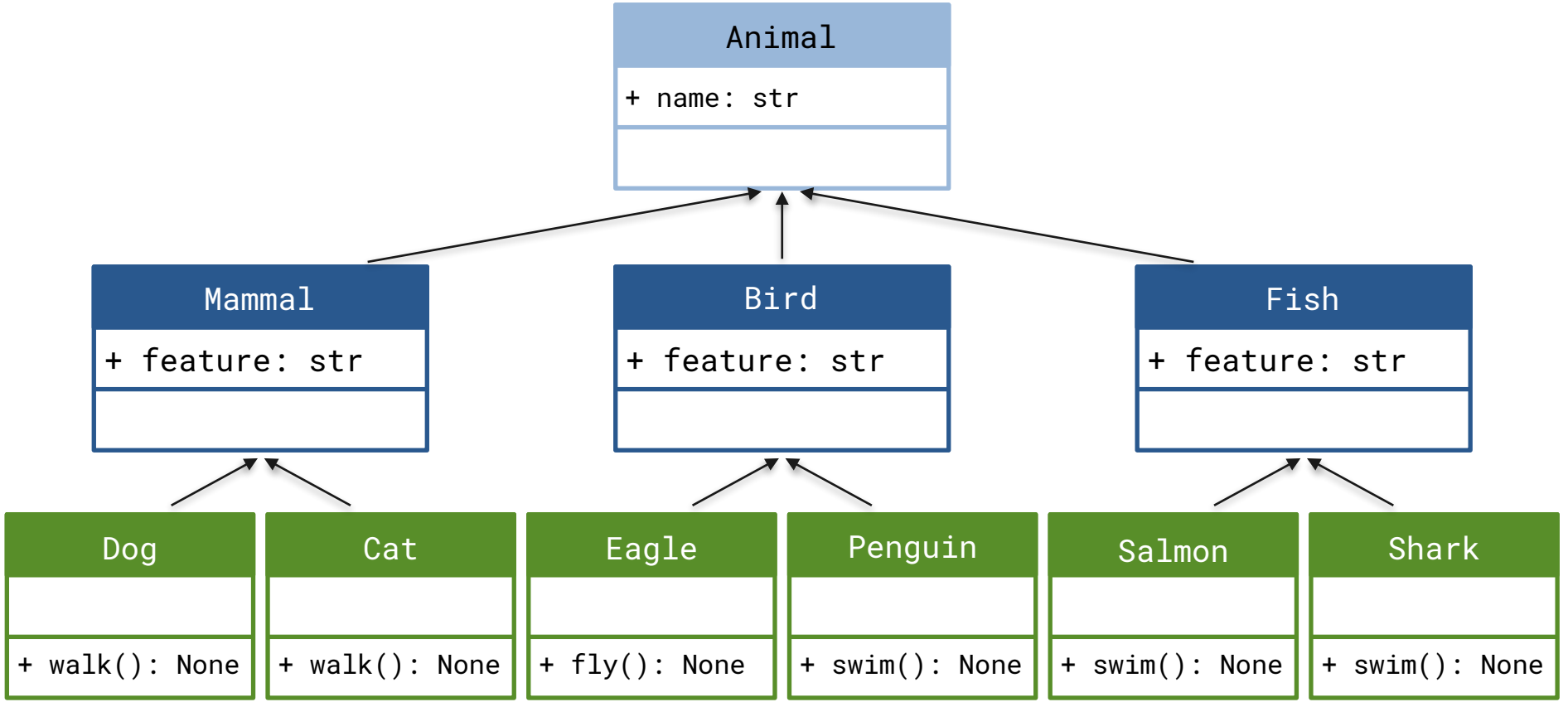
INHERITANCE TERMINOLOGY

- The class you inherit from can be known as:
  - Parent
  - Superclass (or just super)
  - Base class
- A class that inherits can be known as:
  - Child class
  - Derived class
  - Subclass
  - Extending the class
- There are many object-oriented programming languages out there and the terminology bleeds between languages

INHERITANCE TERMINOLOGY

- Overriding a method means disregarding parent's code
  - Writing a method in the child class with the same name as the parent
- Extending a method means including its parent's code
  - Using `super()` in the child's method of the same name

MULTI-LEVEL HIERARCHIES



MULTI-LEVEL HIERARCHIES

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

```
class Mammal(Animal):
    feature = "Mammary glands"

class Bird(Animal):
    feature = "Feathers"

class Fish(Animal):
    feature = "Gills"
```

```
class Dog(Mammal):
    def walk(self):
        print("The dog is walking")
...

class Eagle(Bird):
    def fly(self):
        print("The eagle is flying")

class Penguin(Bird):
    def swim(self):
        print("The penguin is swimming")
...

class Salmon(Fish):
    def swim(self):
        print("The salmon is swimming")
```

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Multiple Inheritance

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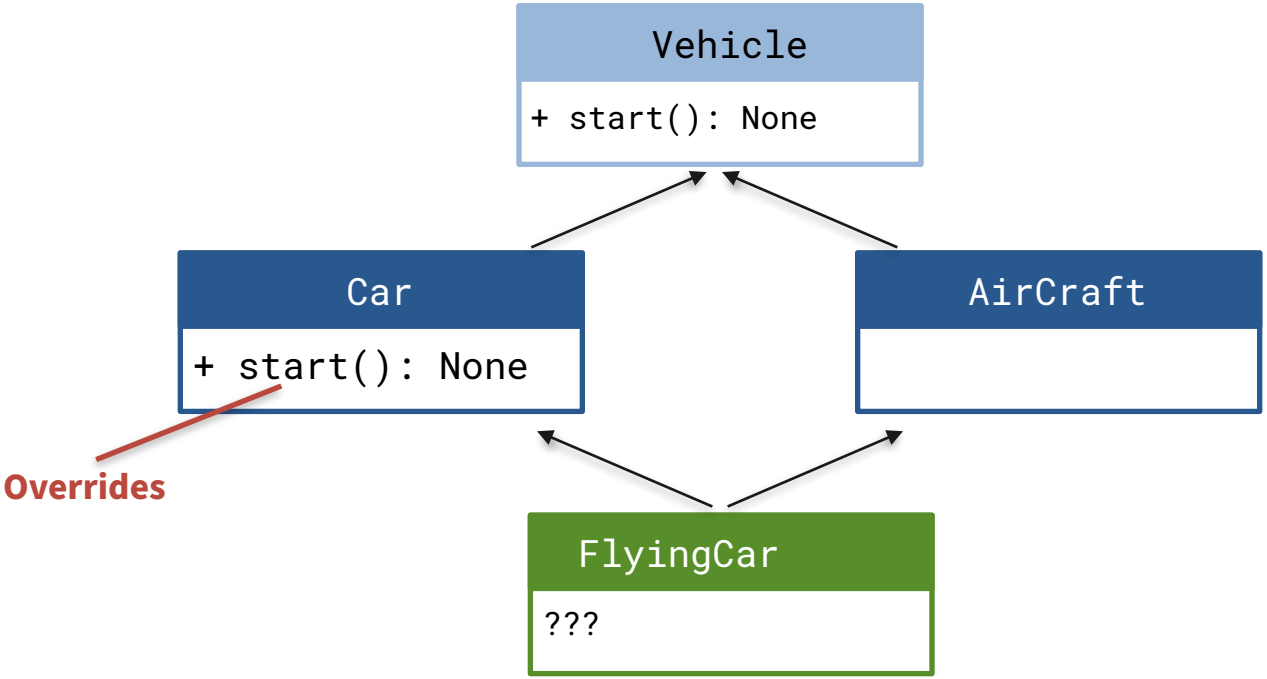
MULTIPLE INHERITANCE

- A child class can inherit from more than one parent
- Gains all the members of both parents

THE DIAMOND PROBLEM

- Multiple inheritance mechanisms need to resolve the “Diamond Problem”



METHOD RESOLUTION ORDER (MRO)

- MRO is Python's solution to the "Diamond Problem"
- Class members are discovered in the following order:
  - Current class
  - Leftmost superclass
  - Next listed superclass, left-to-right
  - Superclasses of inherited classes
  - Object class
- Inheritance definition order of the class statement is the MRO

MIXINS

- A class that doesn’t declare any attributes
- You inherit from it in order to add its methods to a child class
- Like a utility module but adds functionality to a class instead
- Never instantiated directly
- Common in frameworks

CLASS INTERNALS (TANGENT)

- Classes and instances store their writable members in a dictionary
- Dictionary is named `.__dict__`
- Built-in `vars()` function displays the contents of `.__dict__`
- “Writable”:
  - Instance object: the attributes
  - Class: class attributes and methods

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More class internals

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DUNDER-GET AND DUNDER-SET

- Can use `@property` and `@.setter` to perform side-effects of getting and setting a value
- Part of the descriptor protocol
- Special methods give you finer control:
  - `.__set_name__()`
  - `.__get__()`
  - `.__set__()`

SLOTS

- Dictionaries have overhead
- Every class has `.__dict__` by default
- A lighter weight class can be defined using `.__slots__`
- Tuple specifying the attributes of the class
- Disallows the class dictionary
    - Raises a `AttributeError` if you attempt to use `.__dict__`

SLOTS

```
class Point:
    __slots__ = ("x", "y")
    def __init__(self, x, y):
        self.x = x
        self.y = y
```

- Less memory and overhead
  - 528 bytes with `.__dict__`
  - 112 bytes with `.__slots__`

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All the dunder

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OPERATIONS, CONVERTERS, AND COMPARISON

- Everything in Python is an object
- Special methods are called when you invoke:
  - Operation
    - Add, subtract, ... math, bitwise operations
  - Conversion
    - `str()`, `bool()`, ... casting to another type
  - Comparison
    - Equal, less-than, ...
- Override these methods to overload operations

... AND MORE

- Context managers
- Class creation and instantiation
- Containment, is-instance checks, length
- String formatting
- Object and attribute management
  - Get (multiple ways including not there), set, add, delete
- ... and others
  - Over 125 special-methods and attributes

ERRORS

- Different exceptions are raised for different issues with a class:
  - `AttributeError`
    - Member accessed / called doesn't exist on the object
  - `TypeError`
    - Operation not implemented
    - Calling `len()` on an integer
  - `NotImplementedError`
    - Un-implemented method

DRAGONS

- Some common mistakes with classes and instances:
  - Forgetting the self argument on a method
  - Using the class when you mean to use an instance
  - Confusing class and instance attributes
- Possible gotchas:
  - Using non-public members outside a class
  - Over use of multiple inheritance
  - Over use of operator overloading

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Classes in the standard library

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DATA CLASSES

- Python 3.7 introduced the data class
- Shortcut for creating classes as data objects
  - Dictionary meets named tuple, but as a class
- Declared like a class but using the `@dataclass` decorator
- Type information included

ENUMERATION

- Enumeration, also known as an enum is a grouping of constants
- Built into some languages
- Python added a class based implementation in 3.4
- Inherit from `enum.Enum` and declare attributes
- Still a class so you can add your own methods

CALLABLES

- Everything in Python is an object
- When you invoke a function through parenthesis:
  - You are calling that function object
- The `.__call__()` method is invoked when you “call” an object
- Many “functions” in the Python standard library are actually callable classes
  - All of the conversion calls: `str()`, `int()`, `bool()`, etc.
  - Iteration calls: `range()`, `enumerate()`
  - 44 of the 72 built-in “functions” aren’t

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Abstraction and interfaces

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ABSTRACT BASE CLASSES

- Define an interface for others to extend
  - Force the implementation of certain methods
  - Without a base implementation
- Built into other languages
- Python implements it as a class and a decorator
  - `abc.ABC` indicates a class contains abstract methods
  - `@abstractmethod` indicates the abstract method
  - “Implement” the abstract method with `pass`

COMMON INTERFACES

- Python supports duck-typing
- Polymorphism
- Special methods (again):
  - `.__iter__()` for use in loops
  - `.__getitem__()` for access using square brackets
  - `.__len__()` for responding to length
- Strings, lists, and tuples all implement this interface

demo/d20_poly.py

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Summary

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SUMMARY

- In order to re-use code and better represent hierarchical data relations, classes can be built based on other classes
- This is known as inheritance
- A class that extends another class gets all its members by default
- A subclass can override values from the parent
- But still access the parent using `super()`
- Class hierarchies can be multi-level
- Child classes can have more than one parent, known as multiple inheritance
- Abstract base classes allow you to define a partially implemented class

SUMMARY

- Python's approach to operators, convertors, and comparison is to invoke special methods
- The descriptor protocol uses special methods to control how a attribute behaves
- The sequence protocol uses special methods to make objects work like lists
- The standard library uses classes to implement some features
- A dataclass is a shortcut for representing attributes
- Enum is a grouping of constants built using a base class in Python

C: DESIGN AND GUIDANCE

- Just because you can doesn't mean you should
- When to, and when not to, use object-oriented concepts
- **SOLID**: guidance on writing good object-oriented code

Thanks!

Dankie ju faleminderit faleminderit شكرا Grazias Շնորհակալություն Sağ ol eskerrik asko Дзякуй তোমাকে ধন্যবাদ hvala trugéré

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Ngiyabonga paldies ačiū ви благодариме misaotra Te ma kaih Grazzi xie Māuruuru Dhanyawaadh Welálin баярлалаа barka

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