Beginner's Python Cheat Sheet - Classes

What are classes?

Classes are the foundation of object-oriented programming. Classes represent real-world things you want to model in your programs: for example dogs, cars, and robots. You use a class to make objects, which are specific instances of dogs, cars, and robots. A class defines the general behavior that a whole category of objects can have, and the information that can be associated with those objects.

Classes can inherit from each other – you can write a class that extends the functionality of an existing class. This allows you to code efficiently for a wide variety of situations.

Creating and using a class

Consider how we might model a car. What information would we associate with a car, and what behavior would it have? The information is stored in variables called attributes, and the behavior is represented by functions. Functions that are part of a class are called methods.

The Car class

```python
class Car:
    """A simple attempt to model a car."""

    def __init__(self, make, model, year):
        """Initialize car attributes."""
        self.make = make
        self.model = model
        self.year = year

        # Fuel capacity and level in gallons.
        self.fuel_capacity = 15
        self.fuel_level = 0

    def fill_tank(self):
        """Fill gas tank to capacity."""
        self.fuel_level = self.fuel_capacity
        print("Fuel tank is full.")

    def drive(self):
        """Simulate driving."""
        print("The car is moving.")
```

Creating and using a class (cont.)

Creating an object from a class

```python
my_car = Car('audi', 'a4', 2016)
```

Accessing attribute values

```python
print(my_car.make)
print(my_car.model)
print(my_car.year)
```

Calling methods

```python
my_car.fill_tank()
my_car.drive()
```

Creating multiple objects

```python
my_car = Car('audi', 'a4', 2019)
my_old_car = Car('subaru', 'outback', 2015)
my_truck = Car('toyota', 'tacoma', 2012)
```

Modifying attributes

You can modify an attribute's value directly, or you can write methods that manage updating values more carefully.

Modifying an attribute directly

```python
my_new_car = Car('audi', 'a4', 2019)
my_new_car.fuel_level = 5
```

Writing a method to update an attribute's value

```python
def update_fuel_level(self, new_level):
    """Update the fuel level."""
    if new_level <= self.fuel_capacity:
        self.fuel_level = new_level
    else:
        print("The tank can't hold that much!")
```

Writing a method to increment an attribute's value

```python
def add_fuel(self, amount):
    """Add fuel to the tank."""
    if (self.fuel_level + amount
            <= self.fuel_capacity):
        self.fuel_level += amount
        print("Added fuel.")
    else:
        print("The tank won't hold that much.")
```

Naming conventions

In Python class names are written in CamelCase and object names are written in lowercase with underscores. Modules that contain classes should be named in lowercase with underscores.

Class inheritance

If the class you're writing is a specialized version of another class, you can use inheritance. When one class inherits from another, it automatically takes on all the attributes and methods of the parent class. The child class is free to introduce new attributes and methods, and override attributes and methods of the parent class.

To inherit from another class include the name of the parent class in parentheses when defining the new class.

The __init__() method for a child class

```python
class ElectricCar(Car):
    """A simple model of an electric car."""

    def __init__(self, make, model, year):
        """Initialize an electric car."""
        super().__init__(make, model, year)

        # Attributes specific to electric cars.
        # Battery capacity in kWh.
        self.battery_size = 75
        # Charge level in %.
        self.charge_level = 0
```

Adding new methods to the child class

```python
class ElectricCar(Car):
    --snip--
    def charge(self):
        """Fully charge the vehicle."""
        self.charge_level = 100
        print("The vehicle is fully charged.")
```

Using child methods and parent methods

```python
my_ecar = ElectricCar('tesla', 'model s', 2019)

my_ecar.charge()
my_ecar.drive()
```
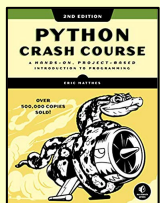
Finding your workflow

There are many ways to model real world objects and situations in code, and sometimes that variety can feel overwhelming. Pick an approach and try it – if your first attempt doesn't work, try a different approach.

Python Crash Course

A Hands-On, Project-Based Introduction to Programming

nostarch.com/pythoncrashcourse2e

Class inheritance (cont.)

Overriding parent methods

```python
class ElectricCar(Car):
    --snip--
    def fill_tank(self):
        """Display an error message."""
        print("This car has no fuel tank!")
```

Instances as attributes

A class can have objects as attributes. This allows classes to work together to model complex situations.

A Battery class

```python
class Battery:
    """A battery for an electric car."""

    def __init__(self, size=75):
        """Initialize battery attributes."""
        # Capacity in kWh, charge level in %.
        self.size = size
        self.charge_level = 0

    def get_range(self):
        """Return the battery's range."""
        if self.size == 75:
            return 260
        elif self.size == 100:
            return 315
```

Using an instance as an attribute

```python
class ElectricCar(Car):
    --snip--

    def __init__(self, make, model, year):
        """Initialize an electric car."""
        super().__init__(make, model, year)

        # Attribute specific to electric cars.
        self.battery = Battery()

    def charge(self):
        """Fully charge the vehicle."""
        self.battery.charge_level = 100
        print("The vehicle is fully charged.")
```

Using the instance

```python
my_ecar = ElectricCar('tesla', 'model x', 2019)

my_ecar.charge()
print(my_ecar.battery.get_range())
my_ecar.drive()
```

Importing classes

Class files can get long as you add detailed information and functionality. To help keep your program files uncluttered, you can store your classes in modules and import the classes you need into your main program.

Storing classes in a file
car.py

```python
"""Represent gas and electric cars."""

class Car:
    """A simple attempt to model a car."""
    --snip—

class Battery:
    """A battery for an electric car."""
    --snip--

class ElectricCar(Car):
    """A simple model of an electric car."""
    --snip--
```

Importing individual classes from a module
my_cars.py

```python
from car import Car, ElectricCar

my_beetle = Car('volkswagen', 'beetle', 2016)
my_beetle.fill_tank()
my_beetle.drive()

my_tesla = ElectricCar('tesla', 'model s',
2016)
my_tesla.charge()
my_tesla.drive()
```

Importing an entire module

```python
import car

my_beetle = car.Car(
        'volkswagen', 'beetle', 2019)
my_beetle.fill_tank()
my_beetle.drive()

my_tesla = car.ElectricCar(
        'tesla', 'model s', 2019)
my_tesla.charge()
my_tesla.drive()
```

Importing all classes from a module
(Don't do this, but recognize it when you see it.)

```python
from car import *

my_beetle = Car('volkswagen', 'beetle', 2016)
```

Understanding `self`

People often ask what the `self` variable represents. The `self` variable is a reference to an object that's been created from the class.
  The `self` variable provides a way to make other variables and objects available everywhere in a class. The `self` variable is automatically passed to each method that's called through an object, which is why you see it listed first in every method definition. Any variable attached to `self` is available everywhere in the class.

Understanding `__init__()`

The `__init__()` method is a function that's part of a class, just like any other method. The only special thing about `__init__()` is that it's called automatically every time you make a new object from a class. If you accidentally misspell `__init__()`, the method will not be called and your object may not be created correctly.

Storing objects in a list

A list can hold as many items as you want, so you can make a large number of objects from a class and store them in a list.
  Here's an example showing how to make a fleet of rental cars, and make sure all the cars are ready to drive.

A fleet of rental cars

```python
from car import Car, ElectricCar

# Make lists to hold a fleet of cars.
gas_fleet = []
electric_fleet = []

# Make 500 gas cars and 250 electric cars.
for _ in range(500):
    car = Car('ford', 'escape', 2019)
    gas_fleet.append(car)
for _ in range(250):
    ecar = ElectricCar('nissan', 'leaf', 2019)
    electric_fleet.append(ecar)

# Fill the gas cars, and charge electric cars.
for car in gas_fleet:
    car.fill_tank()
for ecar in electric_fleet:
    ecar.charge()

print(f"Gas cars: {len(gas_fleet)}")
print(f"Electric cars: {len(electric_fleet)}")
```

More cheat sheets available at
ehmatthes.github.io/pcc_2e/