CSIT110

Fundamental Programming with Python

Class and Object

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In this lecture

- Class and Object
  - Instance attribute
  - Class attribute
  - Instance method
  - Special (dunder) method
- Class inheritance

Class and Object

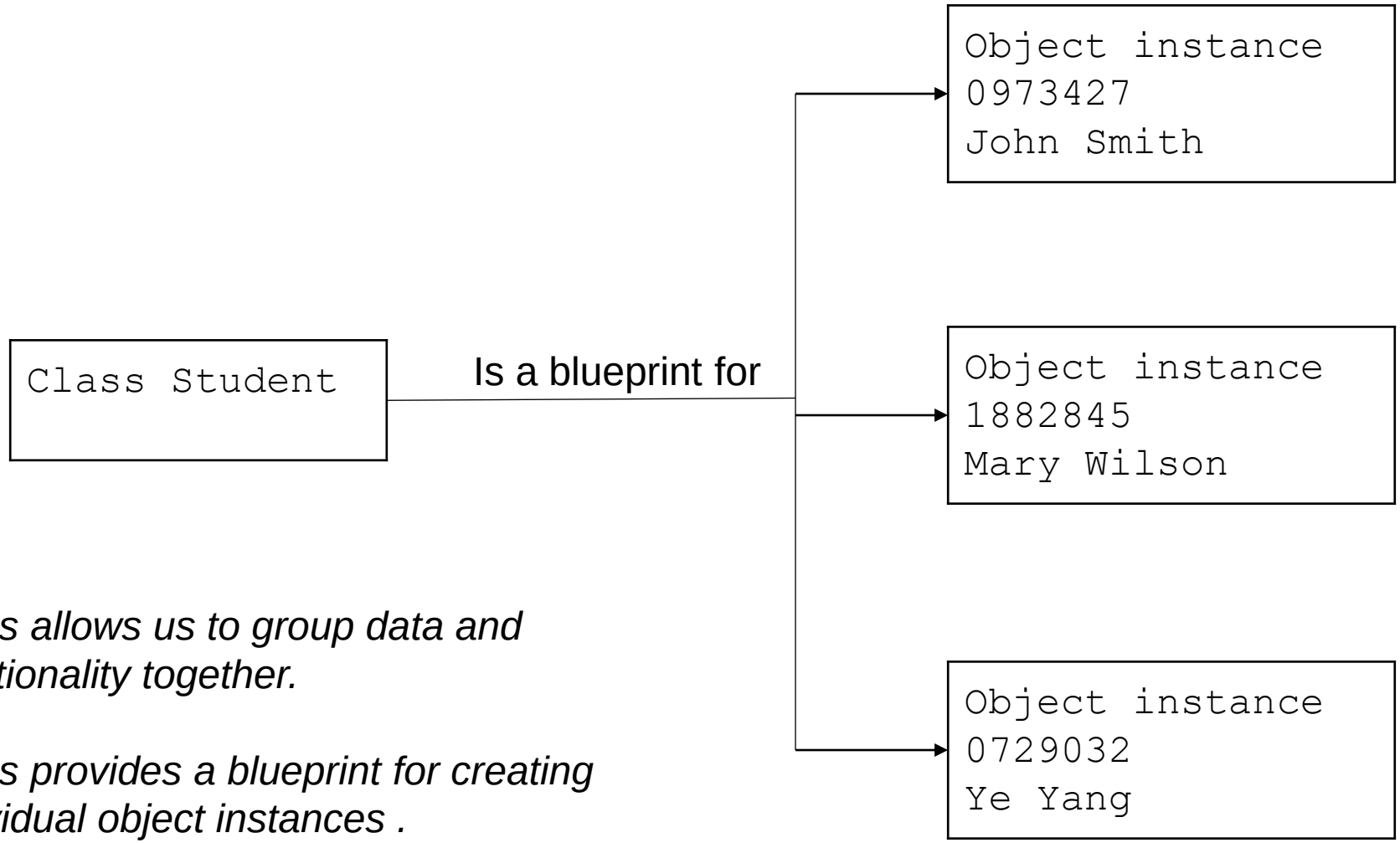
1. Definition

Specifies the behaviour of the class objects

2. Instantiation

Creates an instance of the class

Class Definition



Class allows us to group data and functionality together.

Class provides a blueprint for creating individual object instances .

Class Definition

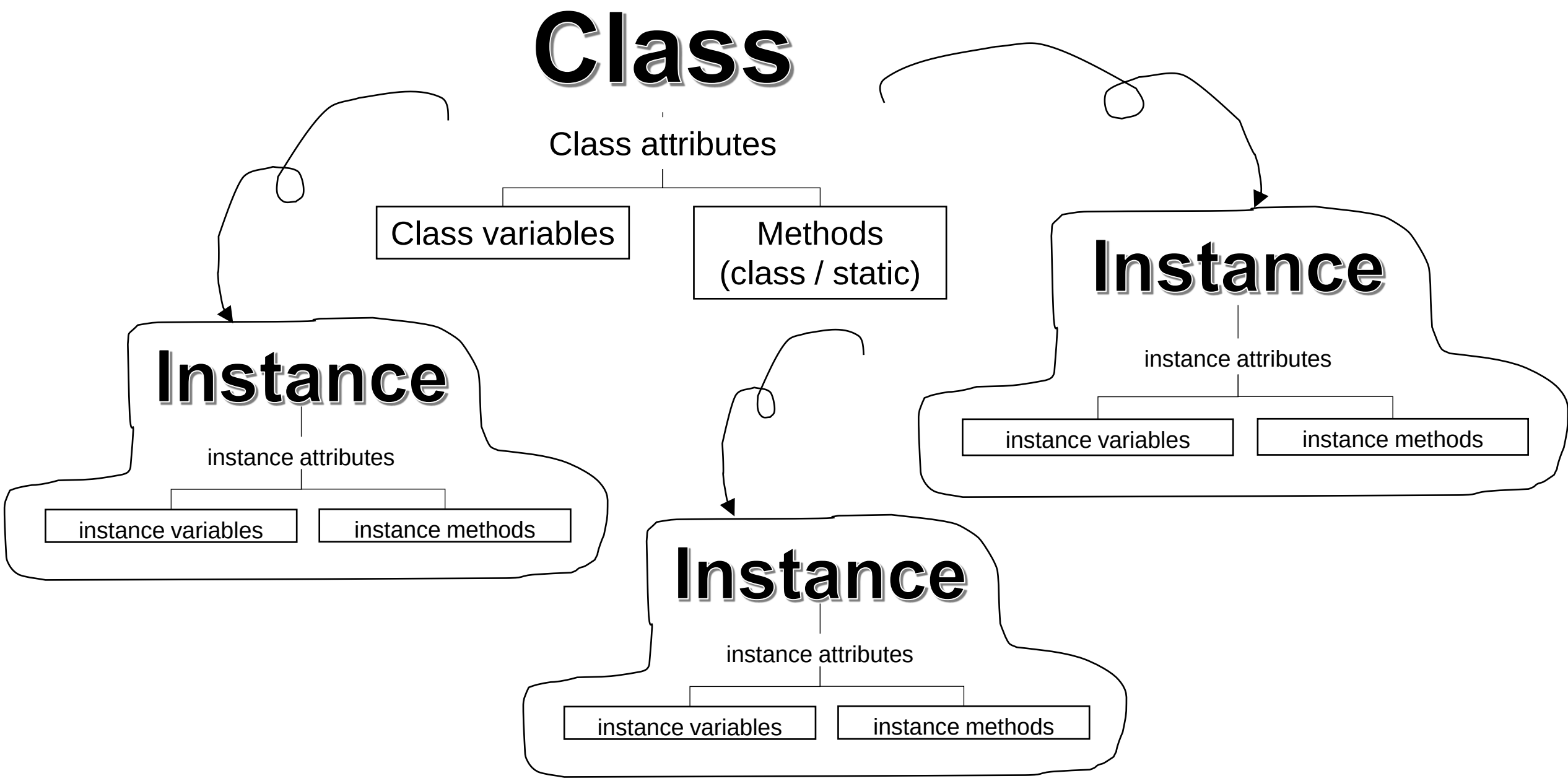
```
class ClassName:
    """ Documentation
        description of the Class
    """
    class_variable1 = "Fixed text"  # class variable shared by all instances
    class_variable2 = 6248
    class_variable3 = "the list goes on"

    def __init__(self, id, first_name, last_name):
      # things to be done such as instantiating instance variables
      # when an object instace of this class is created goes here
      self.first_name = first_name  # instance variable unique to each instance
      ...
    def method1(self):
        # do something

    def method2(self):
        # do something
```

Use Camelcase

Method vs Function

Method is a function which belongs to a class, function may not be associated with a class object.

- Built-in function
  - e.g. type(), input(), print(), range()
- User-defined function
- Class methods
  - <str>.find()
  - <str>.format()
  - <list>.sort()
  - Import random
    random.randint()


Class
Class attributes
Class variables
Methods
(class / static)
Instance
instance attributes
instance variables
instance methods
Instance
instance attributes
instance variables
instance methods
Instance
instance attributes
instance variables
instance methods

Example

In a University called Solla Sollew where each student has a\an

- unique student id
  - e.g. student `John Smith` has student id `0973427`)
- username
  - constructed from the first name initial, last name initial and the first 3 digits of the student id
  - e.g. `John Smith`'s username is `js097`
  - constructed at the enrolment day
  - will **never be changed** even though student may change their name.
- Unix home directory
  - e.g. `John Smith` home directory is `/user/student/js097`)
- an email
  - it will never be changed even though student may change their name
  - e.g. `John Smith`'s email is `js097@solla.sollew.edu`
- an email alias
  - e.g. `John Smith`'s email alias is `John.Smith.097@solla.sollew.edu`).
  - Changes automatically when student changes name.
  - e.g. for example, if `John Smith` last name changed to `Lee` then his email alias is automatically changed to `John.Lee.097@solla.sollew.edu`)

Instance variables vs Class variables

Instance variables: data belong to individual object instance.

Class variables: data that is common to all objects. (Some classes do not have any class variables.)

For example,

- Each student object has its own first name, last name and student id, etc...
  - student id `0973427`, first name `John`, last name `Smith`, username `js097`, ...

- All students share the same email domain and Unix student directory.
  - Email domain `solla.sollew.edu`, Unix student directory `/user/student`, ...

Defining class and creating object

```
class Student:
    """
    The class, Student, represents a student
    with the following attributes:
      id: student number
      first_name: first name
      last_name: last name
      username: Unix account username
    """

    email_domain = "solla.sollew.edu"
    student_dir = "/user/student"

    def __init__(self, arg1, arg2, arg3):
        ...
```

class variables

A Student instance is automatically parsed as the 1st argument

instance attributes

Defining class and creating objects

```
class Student:
    def __init__(self, arg1: str, arg2: str, arg3:str):
        self.id = arg1
        self.first_name = arg2
        self.last_name = arg3
        # username is constructed in the beginning
        # and will not change if name changed
        # username = lowercase initials + first 3 id digits
        self.username = arg2[0].lower() + arg3[0].lower() + arg3[0:3]
```

A Student instance is automatically parsed as the 1st argument

Attributes that are bound to the instance are called **instance attributes**

```
# creating 3 student objects
student1 = Student("0973427", "John", "Smith")

student2 = Student("1882845", "Mary", "Wilson")

student3 = Student("0729032", "Ye", "Yang")
```

Defining class and creating objects

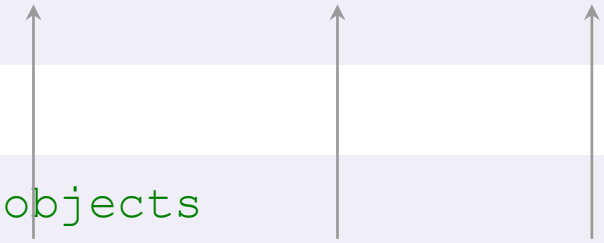
```
class Student:
    def __init__(self, id: str, first_name: str, last_name: str):
        self.id = id
        self.first_name = first_name
        self.last_name = last_name
        # username is constructed in the beginning
        # and will not change if name changed
        # username = lowercase initials + first 3 id digits
        self.username = first_name[0].lower() + last_name[0].lower() + id[0:3]
```

Change the names of the parameters to reflect their contents

```
# creating 3 student objects
student1 = Student("0973427", "John", "Smith")

student2 = Student("1882845", "Mary", "Wilson")

student3 = Student("0729032", "Ye", "Yang")
```

Defining class and creating objects

```
# Defining the class - Student
class Student:
    def __init__(self, id, first_name, last_name):
    ...
```



```
# creating 3 student objects
student1 = Student("0973427", "John", "Smith")

student2 = Student("1882845", "Mary", "Wilson")

student3 = Student("0729032", "Ye", "Yang")
```

Instance method, `exampleFcn(self, args)` :

- Automatically pass the object instance (**`self`**) as the first parameter

Defining class and creating objects

```
# Defining the class - Student
class Student:
    def __init__(self, id, first_name, last_name):
        ...
```

```
# creating 3 student objects
student1 = Student("0973427", "John", "Smith")

student2 = Student("1882845", "Mary", "Wilson")

student3 = Student("0729032", "Ye", "Yang")

# get object attributes
print(student1.id)
print(student1.first_name)
print(student1.last_name)
print(student1.username)
```

Accessing class attributes

```
class Student:

    email_domain = "solla.sollew.edu"
    student_dir = "/user/student"
```

```
# creating 3 student objects
student1 = Student("0973427", "John", "Smith")
student2 = Student("1882845", "Mary", "Wilson")
student3 = Student("0729032", "Ye", "Yang")
# get class attributes
print(student1.email_domain)     # not recommended
print(student2.email_domain)     # not recommended
print(student3.email_domain)     # not recommended
print(Student.email_domain)      # recommended
```

Modifying object instance attributes

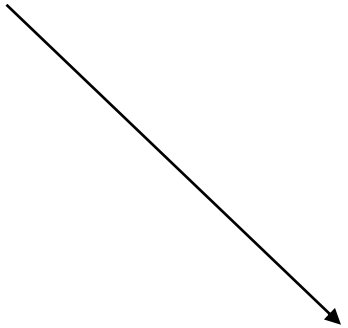
```
student2 = Student("1882845", "Mary", "Wilson")

# display object attributes
print("Before: ")
print(student2.id)
print(student2.first_name)
print(student2.last_name)
# change student last name
student2.last_name = "Davis"

# display object attributes after update
print("After: ")
print(student2.id)
print(student2.first_name)
print(student2.last_name)
```

```
Before:
1882845
Mary
Wilson
```

```
After:
1882845
Mary
Davis
```

Modifying class attributes

```
# change email domain
Student.email_domain = "mail.solla.sollew.edu"
# change student directory
Student.student_dir = "/usr/home/student"
```



Use Class name and not the name of the object instance

Defining an object instance method

```
class Student:
    ...
    def fullname(self):
        """
        Get student's full name
        """
        return self.first_name + " " + self.last_name
```

Instance method:

- Automatically pass the object instance as the first parameter, in this case - **`self`**
- May use instance attribute and instance method

Defining an object instance method

```
class Student:
    def fullname(self):
        """
        Get student's full name
        """
        return self.first_name + " " + self.last_name
```

```
# creating a student object
student1 = Student("0973427", "John", "Smith")

# calling method - from the object instance
print(student1.fullname())          # recommended

# calling method - from the class
print(Student.fullname(student1))   # not recommended
```

Defining an object instance method

```
class Student:
    def fullname(self):
        return self.first_name + " " + self.last_name
```

```
# creating a student objectreating
student2 = Student("1882845", "Mary", "Wilson")

# display object attributes
print("Before: ")
print(student2.fullname())

# change student last name
student2.last_name = "Davis"

# display object attributes after update
print("After: ")
print(student2.fullname())
```

Before:
Mary Wilson
After:
Mary Davis

Defining an object instance method

```
class Student:
    def email(self):
        """
        Get student's email: username@domain
        """
        return self.username + "@" + Student.email_domain
```

```
# creating a student object
student2 = Student("1882845", "Mary", "Wilson")
# display email
print(student2.email())
```

```
mw188@solla.sollew.edu
```

Defining an object instance method

```
class Student:
    def email_alias(self):
        """
        Get student's email: username@domain
        """
        return self.first_name + "." + self.last_name +
           "." + self.id[0:3] + "@" + Student.email_domain
```

```
# creating a student object
student2 = Student("1882845", "Mary", "Wilson")
# display email
print(student2.email_alias())
```

```
Mary.Wilson.188@solla.sollew.edu
```

Defining an object instance method

```
class Student:
    def home_dir(self):
        """
        Get student's Unix home directory:
        studentDir/username
        """
        return Student.student_dir + "/" + self.username
```

```
# creating a student object
student2 = Student("1882845", "Mary", "Wilson")
# display home directory
print(student2.home_dir())
```

```
/user/student/mw188
```

Defining an object instance method

```
class Student:
    def print_details(self):
        print("Student ID: " + self.id)
        print("First name: " + self.first_name)
        print("Last name: " + self.last_name)
        print("Full name: " + self.fullname())
        print("Username: " + self.username)
        print("Email: " + self.email())
        print("Email alias: " + self.email_alias())
        print("Home directory: " + self.home_dir())
```

```
# creating a student object
student2 = Student("1882845", "Mary", "Wilson")
# display details
print(student2.print_details())
```

Defining an object instance method

```
# creating a student object
student2 = Student("1882845", "Mary", "Wilson")
print("Before:")
print(student2.print_details())

# change student last name
student2.last_name = "Davis"
print("After:")
print(student2.print_details())
```

```
Before:
Student ID: 1882845
First name: Mary
Last name: Wilson
Full name: Mary Wilson
Username: mw188
Email: mw188@solla.sollew.edu
Email alias: Mary.Wilson.188@solla.sollew.edu
Home directory: /user/student/mw188
```

Defining an object instance method

```
# creating a student object
student2 = Student("1882845", "Mary", "Wilson")
print("Before:")
print(student2.print_details())

# change student last name
student2.last_name = "Davis"
print("After:")
print(student2.print_details())
```

```
After:
Student ID: 1882845
First name: Mary
Last name: Davis
Full name: Mary Davis
Username: mw188
Email: mw188@solla.sollew.edu
Email alias: Mary.Davis.188@solla.sollew.edu
Home directory: /user/student/mw188
```

Special (dunder) method

Starts and ends with **d**ouble **under**scores e.g. `__methodName__`

Special (dunder) method

We have seen a special (dunder) method:

```
class Student:
    def __init__(self, id, first_name, last_name):
```

Now we will write another special (dunder) method:

```
class Student:
    def __str__(self):
```

Why do we need this method **__str__** ?
Try this and see the result:

```
student2 = Student("1882845", "Mary", "Wilson")
print("Object student2 is " + str(student2))
```

```
Object student2 is <__main__.Student object at 0x7f282523ecf8>
```

Special (dunder) method

```
class Student:
    ...
    def __str__(self):
        return f"{self.fullname()} ({self.id})"
```

Now try this and see the result:

```
student2 = Student("1882845", "Mary", "Wilson")
print("Object student2 is " + str(student2))
```

```
Object student2 is Mary Wilson (1882845)
```

Special (dunder) method

```
class Student:
    def __repr__(self):
        return f"Student('{self.id}', '{self.first_name}', '{self.last_name}')"
```

```
student2 = Student("1882845", "Mary", "Wilson")

print(repr(student2))
```

This method gives us the code to construct the string object

```
Student('1882845', 'Mary', 'Wilson')
```

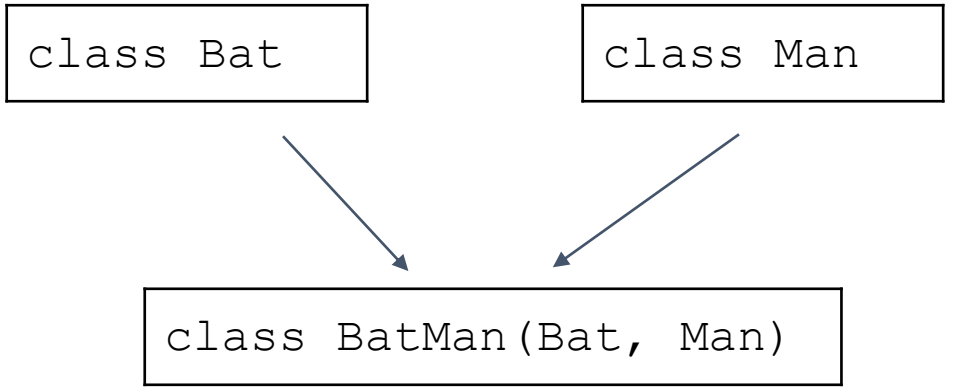
Help method

```
print(help(Student))
```

```
class Student(builtins.object)
 |  Class Student represents a student
 |  with the following attributes:
 |    id: student number
 |    first_name: first name
 |    last_name: last name
 |    username: Unix account username
 |
 |  Methods defined here:
 |
 |  __init__(self, id, first_name, last_name)
 |      Initialize self.  See help(type(self)) for accurate signature.
 |
 |  __repr__(self)
 |      Return repr(self).
 |
 |  __str__(self)
 |      Return str(self).
 |
 |  email(self)
 |      Get student's email: username@domain
 |
 |  email_alias(self)
 |      Get student's friendly-looking email:
 |      firstname.lastname.3IDdigits@domain
 |
 |  fullname(self)
 |      Get student's full name
 |
 |  home_dir(self)
 |      Get student's Unix home directory: studentDir/username
 |
 |  print_detail(self)
 |      Display student detail
 |
 |  ----------------------------------------------------------------------
```

```
 |  Data descriptors defined here:
 |
 |  __dict__
 |      dictionary for instance variables (if defined)
 |
 |  __weakref__
 |      list of weak references to the object (if defined)
 |
 |  ----------------------------------------------------------------------
 |  Data and other attributes defined here:
 |
 |  email_domain = 'solla.sollew.edu'
 |
 |  student_dir = '/user/student'
```

Class inheritance



Python supports **multiple** class inheritance: a child class can inherit from multiple parent classes.

Class inheritance allow child class:

- To inherit all parent attributes and methods;
- To override parent attributes;
- To override parent methods.

Example

Consider a fictional Solla Sollew University again:

Each postgraduate student

- must register a thesis title

- is given a Unix home directory
  - but in a graduate directory
  - E.g. (`Adrian Creedon's (0945720)` home directory is `/user/gradstudent/ac094`, instead of `/user/student/ac094`

- is given a home page
  - E.g. `Adrian Creedon's` home page is `www.solla.sollew.edu/ac094`

Defining inheritance

```
class PostGradStudent(Student):
    """
    Class PostGradStudent represents a postgraduate student
    """

    student_dir = "/user/gradstudent"

    def __init__(self, id, first_name, last_name, thesis):
        # calling parent class constructor
        super().__init__(id, first_name, last_name)

        # initialize thesis title
        self.thesis = thesis
```

Inheriting the class Student

overriding class attributes

Initialising inherited instance attributes

adding more object attributes

```
# creating 3 postgraduate student objects
pg_student1 = PostGradStudent("0945720", "Adrian", "Creedon", "Polynomial Approximation of Functions")
pg_student2 = PostGradStudent("1892418", "Denis", "Carter", "Recursive array constructions")
pg_student3 = PostGradStudent("0793511", "Kara", "Kaufmann", "On Fundamental Semigroups")
```

Defining inheritance

```
# creating 3 postgraduate student objects
pg_student1 = PostGradStudent("0945720", "Adrian", "Creedon", "Polynomial Approximation of Functions")
pg_student2 = PostGradStudent("1892418", "Denis", "Carter", "Recursive array constructions")
pg_student3 = PostGradStudent("0793511", "Kara", "Kaufmann", "On Fundamental Semigroups")
```

```
# display object attributes

print(pg_student1.id)
print(pg_student1.first_name)
print(pg_student1.last_name)

print(pg_student1.thesis)
```

This is from parent class

This is from child class

Adding attribute and method

```
class PostGradStudent(Student):

    web_domain = "www.solla.sollew.edu"

    def web_address(self):
        """
        Get student's web address:
        webDomain/username
        """
        return PostGradStudent.web_domain + "/" + self.username
```

```
pg_student1 = PostGradStudent("0945720", "Adrian", "Creedon", "Polynomial Approximation of Functions")

print(pg_student1.web_address())

print(PostGradStudent.web_domain)
```

Overriding method

```
class Student:
    student_dir = "/user/student"

    def home_dir(self):
        """
        Get student's Unix home directory:
        studentDir/username
        """
        return Student.student_dir + "/" + self.username
```

```
class PostGradStudent(Student):
    student_dir = "/user/gradstudent"

    def home_dir(self):
        """
        Get student's Unix home directory: studentDir/username
        Override the parent method with a new directory
        """
        return PostGradStudent.student_dir + "/" + self.username
```

Overriding method

```
# creating 3 student instances student
student1 = Student("0973427", "John", "Smith")
student2 = Student("1882845", "Mary", "Wilson")
student3 = Student("0729032", "Ye", "Yang")
```

```
# creating 3 postgraduate student instances
pg_student1 = PostGradStudent("0945720", "Adrian", "Creedon", "Polynomial Approximation of Functions")
pg_student2 = PostGradStudent("1892418", "Denis", "Carter", "Recursive array constructions")
pg_student3 = PostGradStudent("0793511", "Kara", "Kaufmann", "On Fundamental Semigroups")
```

```
# compare the home directory between 2 students
print(student1.home_dir())

print(pg_student1.home_dir())
```

```
/user/student/js097
/user/poststudent/ac094
```

Overriding method

```
class PostGradStudent(Student):

  def print_details(self):
    """
    Display student details
    """
    super().print_details()

    print("Thesis: " + self.thesis)
    print("Web address: " + self.web_address())
```

parent class

additional info from child class

```
Student ID: 0945720
First name: Adrian
Last name: Creedon
Full name: Adrian Creedon
Username: ac094
Email: ac094@solla.sollew.edu
Email alias: Adrian.Creedon.094@solla.sollew.edu
Home directory: /user/poststudent/ac094
Thesis: Polynomial Approximation of Functions
Web address: www.solla.sollew.edu/ac094
```

```
pg_student1 = PostGradStudent("0945720", "Adrian", "Creedon", "Polynomial Approximation of Functions")
pg_student1.print_details()
```

Any questions?