Classes, Objects & Methods

Learning Outcome

- Explain the OO concepts of classes, objects, methods and messages
- Implement a class with instance variables, instance methods and constructors
- Explain the concept of abstraction and encapsulation
- Construct a program using classes, objects, methods and messages

Procedural vs Object Oriented

Procedural Programming

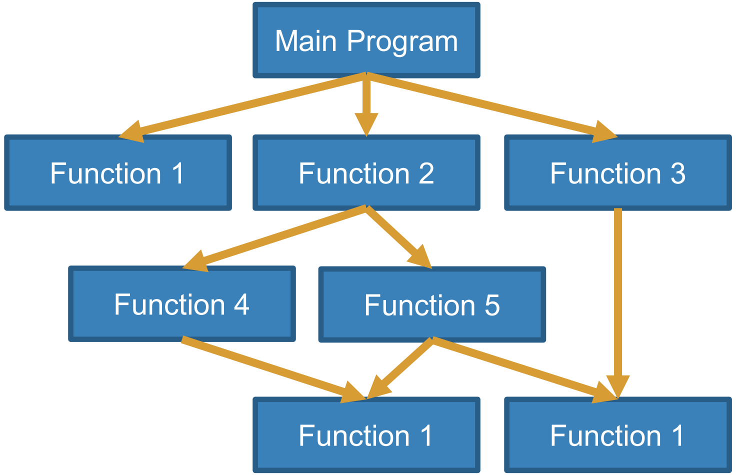
- Centered on the procedures or action that take place in a program
- Procedures (or functions) and data are separated

Object-Oriented Programming

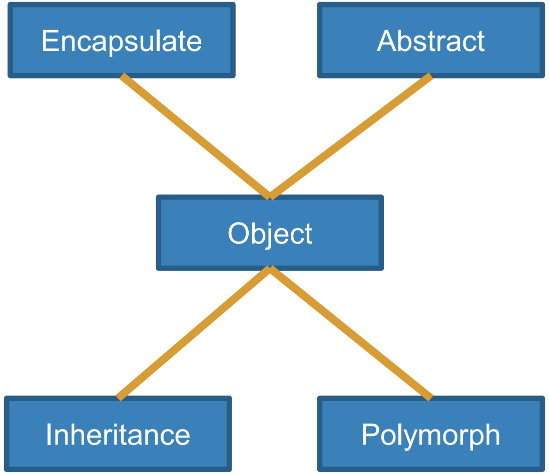
- Centered on objects that are created from abstract data types that encapsulate data and functions together

Procedural vs Object Oriented

Procedural Programming



Object-Oriented Programming



Procedural Programming

```
weight = input('What is your weight?')
height = input('What is your height?')
bmi = float(weight) / float(height) ** 2
print(bmi)
```

Focus of procedural programing is on the creation of procedures that operate on the program’s data.

functions	data
input()	‘What is your weight?’
input()	‘What is your height?’
float()	weight
float()	height
print()	bmi

As the procedural program becomes larger, your program becomes more complex and harder to change

Object-Oriented Programming

```
class Person:
    def __init__(self, weight, height):
        self.__weight = weight
        self.__height = height
    def get_bmi(self):
        return self.__weight / self.__height ** 2

p = Person(71, 1.76)
print(p.get_bmi())
```

Centered on creating objects that contains both data (attributes) and procedures (methods).

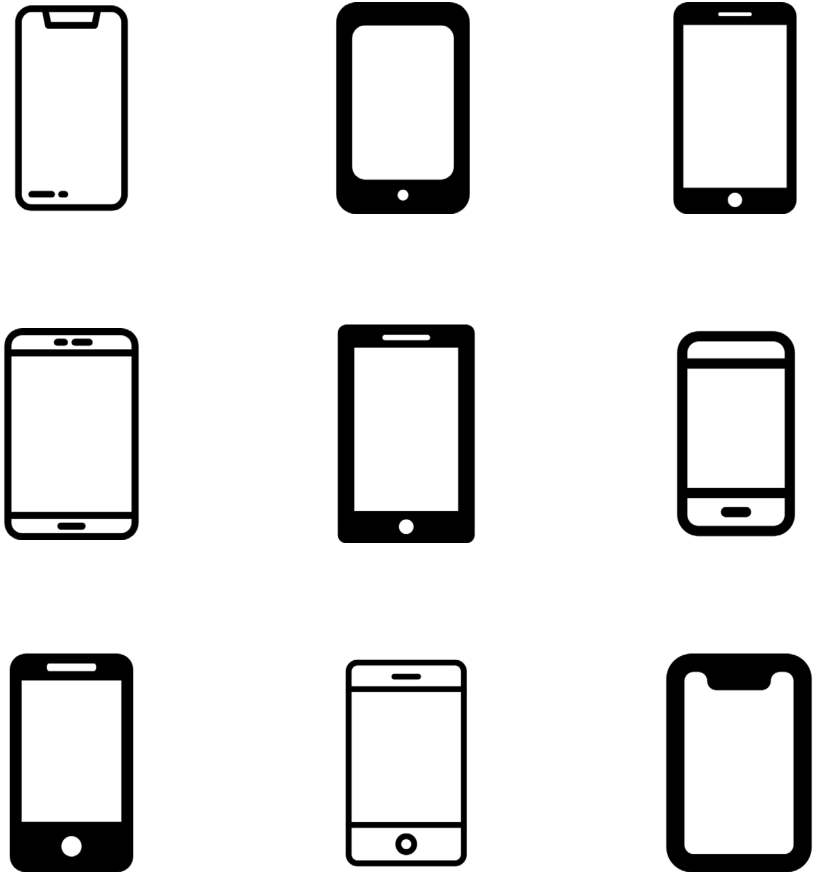
methods	parameter variable
__init__()	self, weight, height
get_bmi()	self

attributes

__weight

__height

Object Oriented Programming addresses the problem of code and data separation through encapsulation and data hiding.



Why OOP?

Object Reusability

Objects are abstracted, and can be reused in other projects, speed up development process

Maintainability

Codes are modular and bugs can be discovered and fixed more easily

Extensibility

New objects can be added with minimum impact to existing objects

Classes & Objects

A class is a code that specifies the data attributes and methods for a particular type of object.

A class is a blueprint, that objects may be created from.

Class Definitions

```
class Customer:
    def __init__(self, name, email):
        self.__name = name
        self.__email = email
```

A class definition is a set of statements that define a class's methods and data attributes.

methods

__init__()

attributes

__name

__email

The __init__ method is usually the first method inside a class definition.

It executes automatically when an instance of the class is created in memory.

What is self?

```
class Customer:
    def __init__(self, name, email):
        self.__name = name
        self.__email = email
```

All methods, including the initializer must have the required **self** parameter variable.

Immediately after an object is created in memory, the **__init__** method executes, and the **self** parameter is automatically assigned the object that was just created.

Things to note

self

When **defining** your **class method**, you must **explicitly list self as the first argument**

When you call the method from outside the class, python automatically adds the self instance reference for you.

__init__

The initializer is optional, but if defined, it will be called automatically after an instance is created.

You can **define** multiple initializer with different parameters but the **last one will override the earlier definitions**

Lifecycle of Classes and Objects

Working with instances

Each instance has its own set of data attributes

Use the self parameter to create an instance attribute

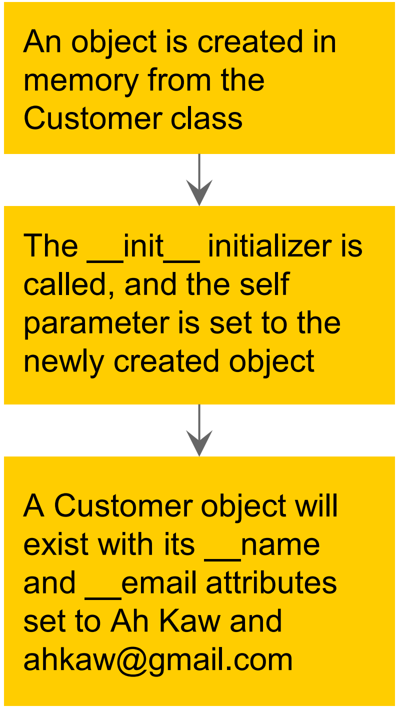
Can create many instances of the same class in a program

```
#class definition

class Customer:
  def __init__(self, name, email):
      self.__name = name
      self.__email = email
```

```
#test program

# create c1 instance from Customer class
c1 = Customer(“Ah Kaw”, “ahkaw@gmail.com”)

# create c2 instance from Customer class
c2 = Customer(“Ah Hua”, “ahhua@gmail.com”)
```

Life cycle of an instance

```
class Customer:
    def __init__(self, name, email):
        self.__name = name
        self.__email = email
```

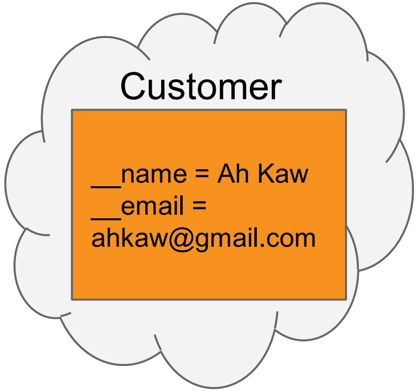


An object is created in memory from the Customer class

The __init__ initializer is called, and the self parameter is set to the newly created object

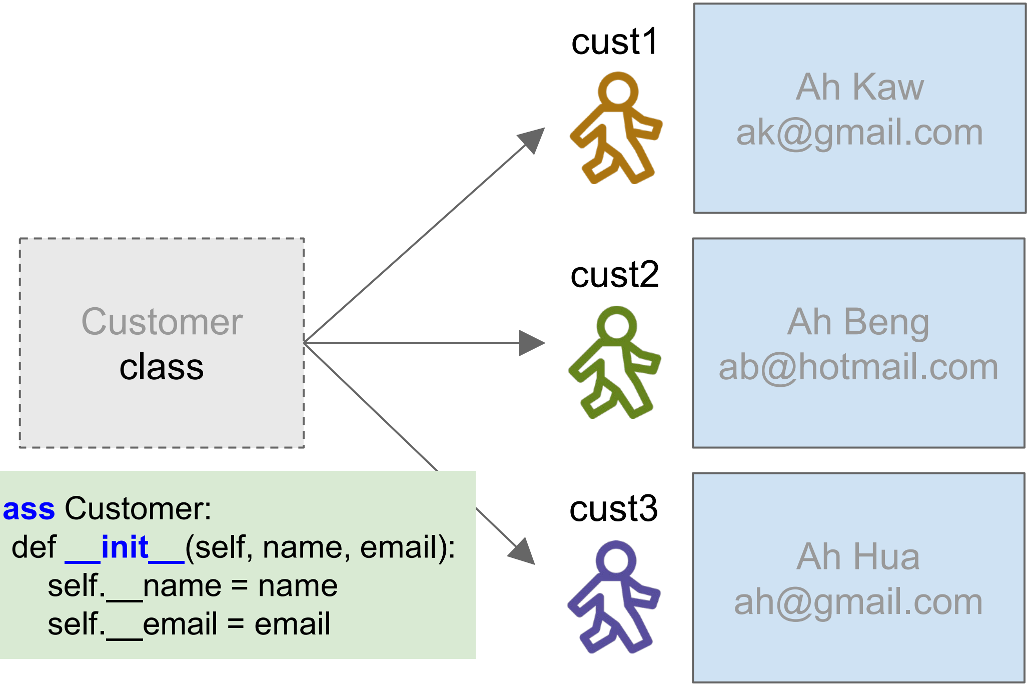
A Customer object will exist with its __name and __email attributes set to Ah Kaw and ahkaw@gmail.com

```
c = Customer("Ah Kaw", "ahkaw@gmail.com")
```



The Customer class describes the data attributes and methods of a particular type of object may have.

```
cust1  = Customer ('Ah Kaw', 'ak@gmail.com')
```

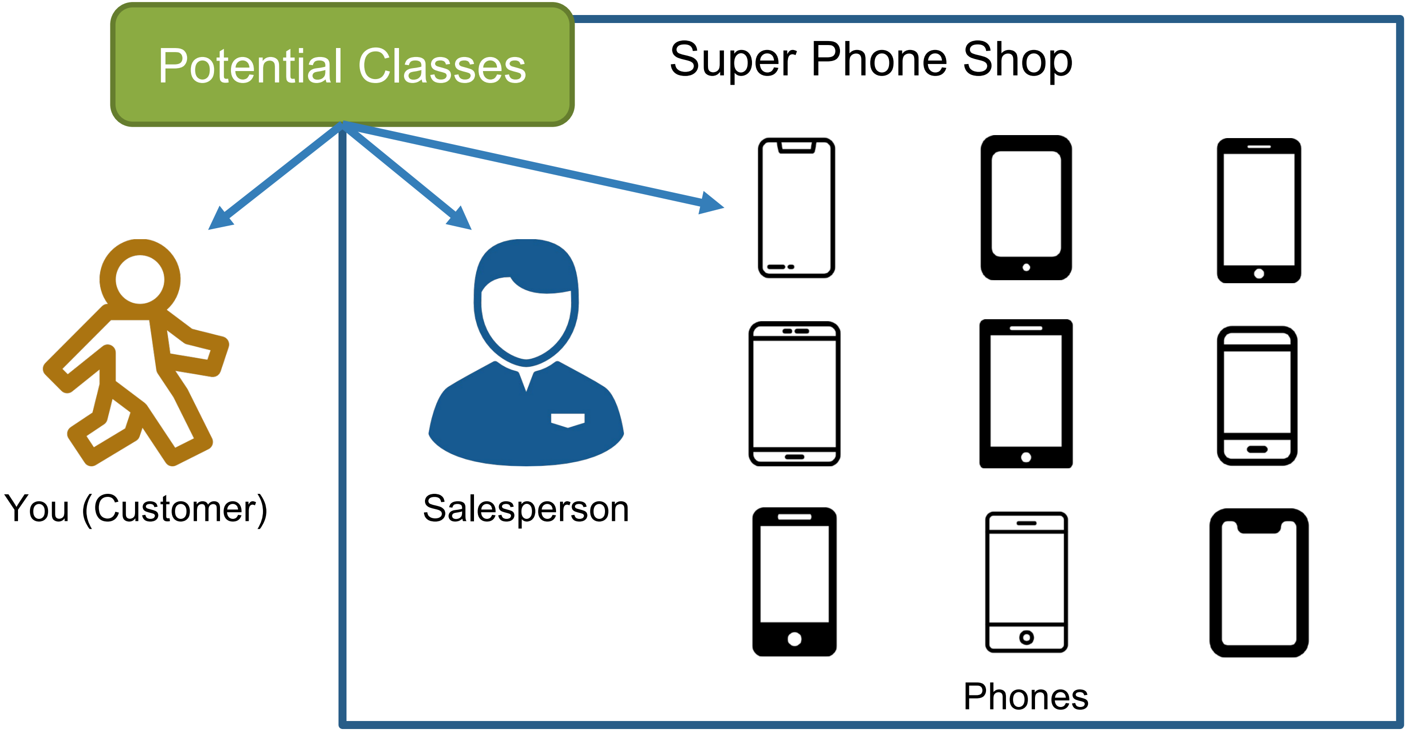


```
class Customer:
    def __init__(self, name, email):
        self.__name = name
        self.__email = email
```

The cust1, cust2, cust3 objects are instances of the Customer class. It has the data attributes and methods described by the Customer class.

Attributes and Methods of a Class

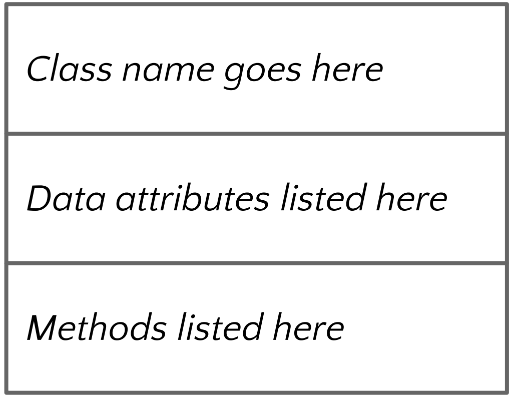
Scenario – Buying a Phone



Unified Modelling Language

UML

Provides a standard diagrams for graphically depicting object-oriented system.
A class is represented with a box that is divided into three sections



Class name goes here

Data attributes listed here

Methods listed here

Designing UML Diagram

Data attributes are values that define the state of the phone

Each method manipulates one or more of the data attributes

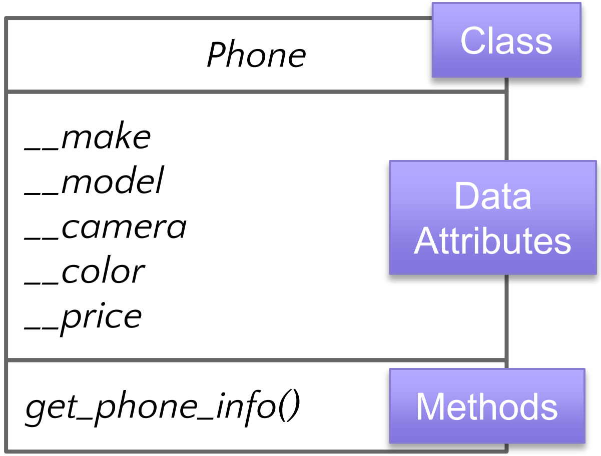
attributes

- make
- model
- camera
- color
- price

methods

- get_phone_info()

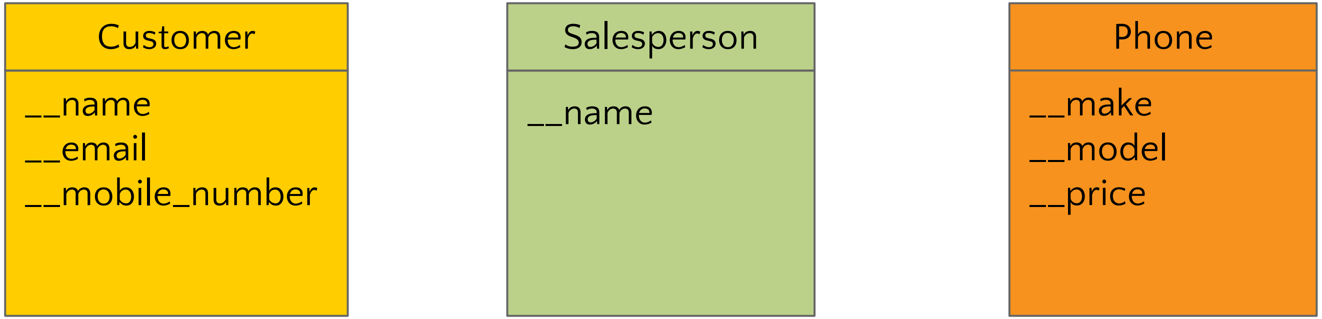
UML diagram for Phone class?



Data Attributes

Identify Attributes

Every class has their own attributes, lets identify them!



Customer

__name
__email
__mobile_number

Salesperson

__name

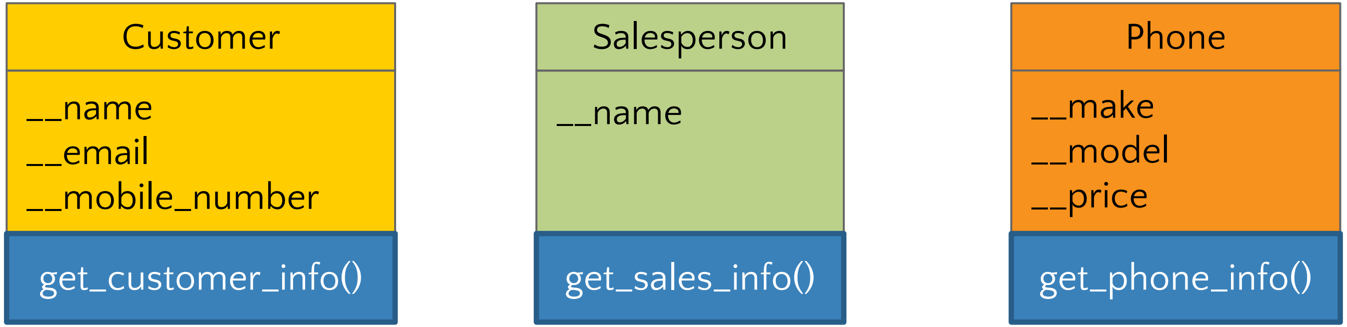
Phone

__make
__model
__price

Methods

Identify Methods

Every class has their own methods, lets identify them!



Customer

__name
__email
__mobile_number

get_customer_info()

Salesperson

__name

get_sales_info()

Phone

__make
__model
__price

get_phone_info()

Abstraction

Abstraction

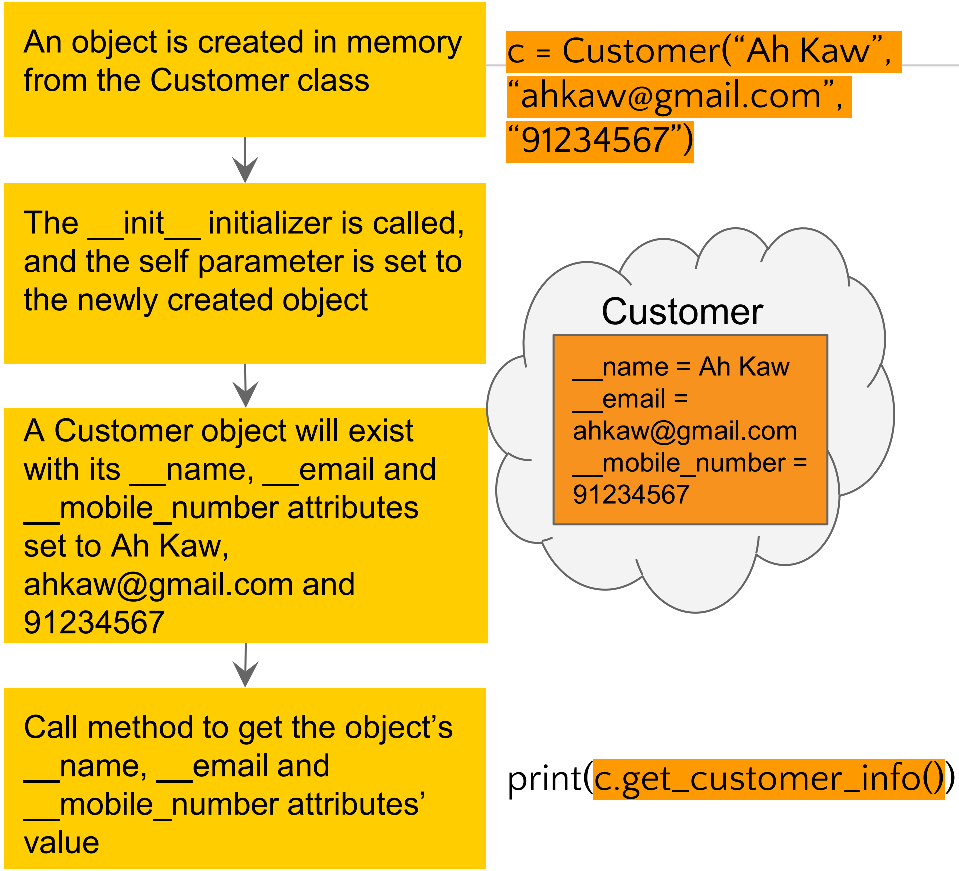
- hides unnecessary details from users
- allows implementation of more complex logic without having the need to understand the hidden details

```
# class definition

class Customer:
    def __init__(self, name, email, mobile):
         self.__name = name
         self.__email = email
         self.__mobile_number = mobile

    def get_customer_info(self):
        return ‘Name: ‘ + self.__name + ‘, Email:
                 ‘ + self.__email + ‘Mobile:’ +
                    self.__mobile_number

# test program

c = Customer(‘Ah Kaw’, ‘ahkaw@gmail.com’,
’91234567’)
print(c.get_customer_info())
```

Life cycle of an instance

```
class Customer:
    def __init__(self, name, email, mobile):
        self.__name = name
        self.__email = email
        self.__mobile_number = mobile

    def get_customer_info(self):
        return ‘Name: ‘ + self.__name + ‘, Email: ‘ +
                    self.__email + ‘Mobile:’ +
                    self.__mobile_number
```

method



An object is created in memory from the Customer class

c = Customer(“Ah Kaw”, “ahkaw@gmail.com”, “91234567”)

The __init__ initializer is called, and the self parameter is set to the newly created object

A Customer object will exist with its __name, __email and __mobile_number attributes set to Ah Kaw, ahkaw@gmail.com and 91234567

Call method to get the object’s __name, __email and __mobile_number attributes’ value

print(c.get_customer_info())

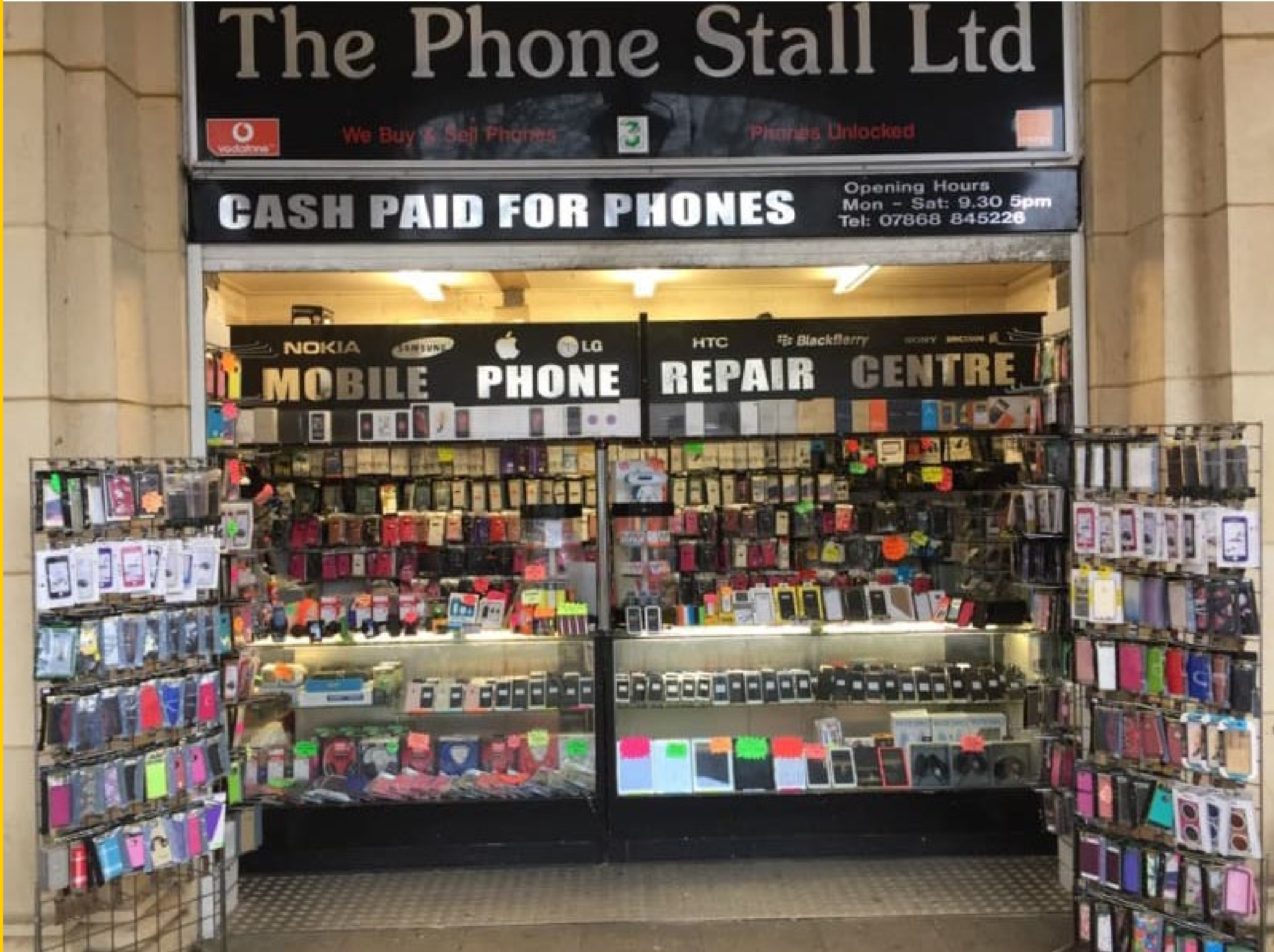
Working with instances

```
#class definition

class Customer:
    def __init__(self, name, email, mobile):
        self.__name = name
        self.__email = email
        self.__mobile_number = mobile
    def get_customer_info(self):
        return “Name:” +self.__name + “,Email:” + self.__email + “, Mobile:” +self.__mobile_number
```

```
#test program

# create c1 instance from Customer class
c1 = Customer(“Ah Kaw”, “ahkaw@gmail.com”, “91234567”)
print(c1.get_customer_info())  #display the object information

# create c2 instance from Customer class
c2 = Customer(“Ah Hua”, “ahhua@gmail.com", “88674556”)
print(c2.get_customer_info()) #display the object information
```

Activity

Practical Question 1

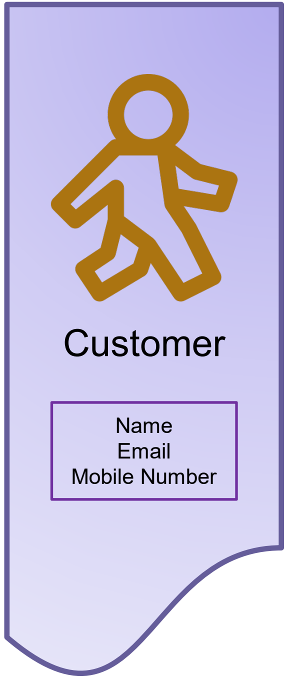


Encapsulation

Encapsulation

Encapsulation

- hides internal representation of an object from the outside
- allows the access of **private** attribute of an object to be controlled via methods



Accessor methods

Also known as **get**ter

Provide a safe way for external code outside the class to retrieve the values of attributes

Mutator methods

Also known as **set**ter

Control the way that an instance attribute value is modified

Encapsulation

Customer

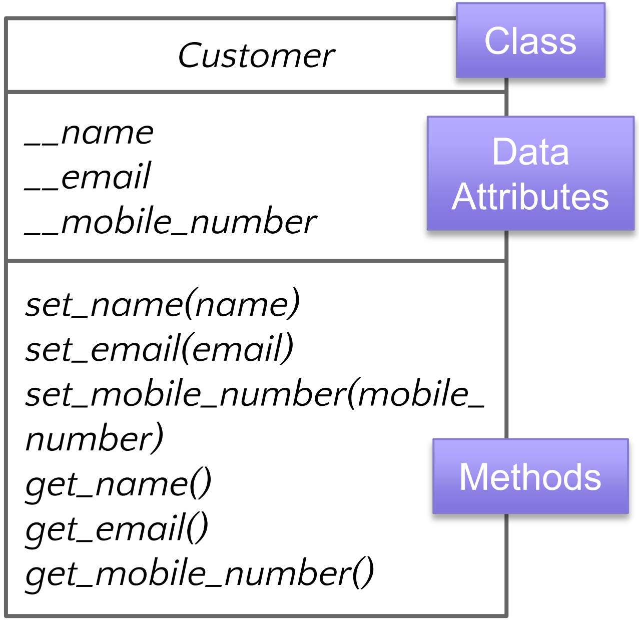
attributes

- name
- email
- mobile_number

methods

- get_name()
- get_email()
- get_mobile_number()
- set_name(name)
- set_email(email)
- set_mobile_number(mobile_number)

UML diagram for Customer class?



Customer

__name
__email
__mobile_number

set_name(name)
set_email(email)
set_mobile_number(mobile_number)
get_name()
get_email()
get_mobile_number()

Encapsulation

attributes

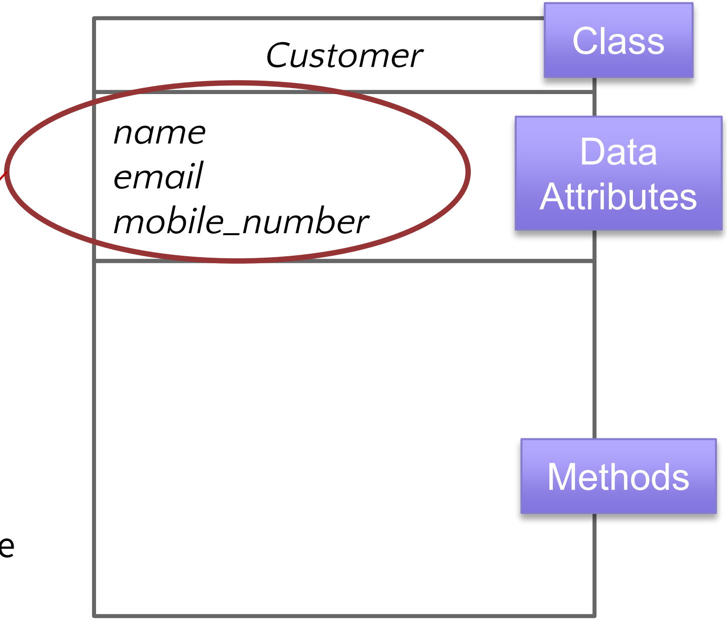
name

email

mobile_number

Customer

UML diagram for Customer class?

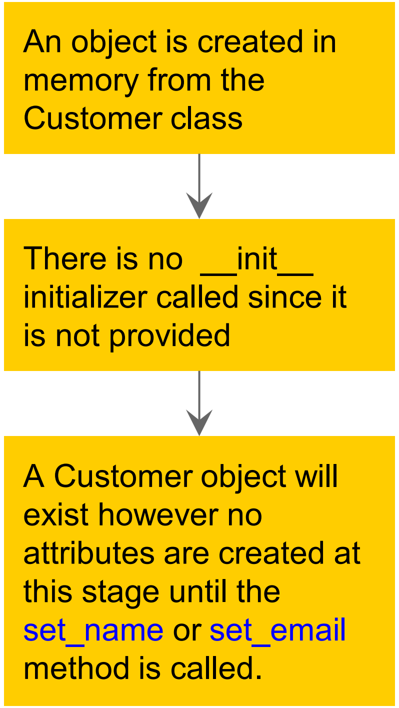


Public attribute **name, email** and **mobile_number** can be accessed externally directly from another program

Hence, **methods are not required** to control the access of attributes of an object

Life cycle of an instance

```
#class definition. In this example there is NO
__init__ provided

class Customer:
  def set_name(self, name):
      self.__name = name
   def set_email(self, email):
      self.__email = email
   def get_customer_info(self):
      return “Name: “ + self.__name + “, Email:
                  “ + self.__email
```

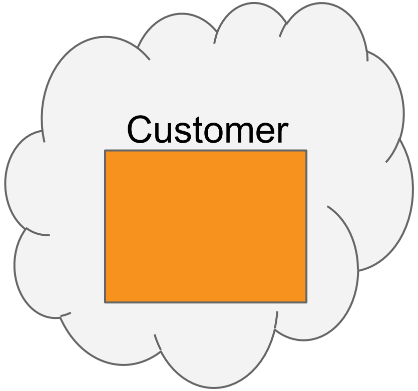


An object is created in memory from the Customer class

There is no __init__ initializer called since it is not provided

A Customer object will exist however no attributes are created at this stage until the set_name or set_email method is called.

c = Customer()



Encapsulation

```
class Customer:
   def set_name(self, name):
        self.__name = name
    def get_name(self):
        return self.__name

cust2 = Customer()
cust2.set_name(‘Ah Beng’)
print(cust2.get_name())
```

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

cust1 = Customer(‘Ah Beng’)
print(cust1.name)
```

self.__name and **self.name** are the attributes of the instance

Public attribute **name** can be accessed externally directly from another program.
Private attribute **__name** cannot be accessed externally from another program.
The access of attributes will be controlled via **set_name(name) and get_name()** methods

Encapsulation

name is the passed in parameter from the calling program

Encapsulation

```
class Customer:
   def set_name(self, name):
        if name.isalpha():
            self.__name = name
        else:
            print(‘Only alphabets are allowed.’)

   def get_name():
       return self.__name
```

Only alphabets are allowed.

```
cust1 = Customer()
cust1.set_name(‘Beng’)
```

Name is set to Beng

```
cust2 = Customer()
cust2.set_name(‘123456’)
```

Error Message will be printed

isalpha() is a built in function for testing whether string contains only alphabets.

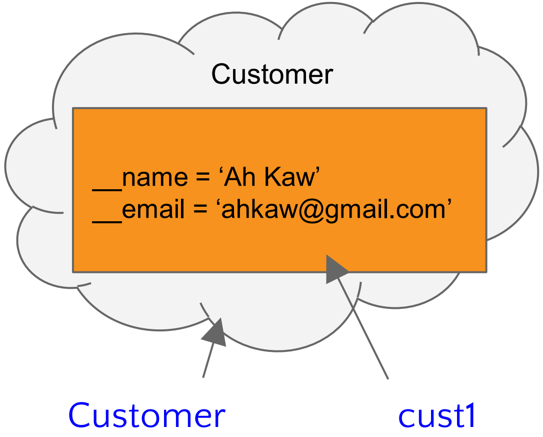
For cust1, the name contains only alphabets.

Validation

For cust2, the name contains numbers, therefore error message will be printed.

Passing Objects as Arguments

```
#test program

def display_customer_info(customer):
   print(customer.get_customer_info())

cust1 = Customer()
cust1.set_name('Ah Kaw')
cust1.set_email('ahkaw@gmail.com')
display_customer_info(cust1)
```



```
#class definition

class Customer:
   def set_name(self, name):
      self.__name = name
   def set_email(self, email):
      self.__email = email
   def get_customer_info(self):
      return self.__name, self.__email
```

When developing applications that work with objects, you often need to write **functions** and methods that accept objects as arguments.

When you pass an object as an argument, the thing that is passed into the parameter variable is a reference to the object.

Recap: Identifying a class's responsibilities

A class's responsibilities are

- the things that the class is responsible for knowing
- the actions that the class is responsible for doing

Customer class

Things to know

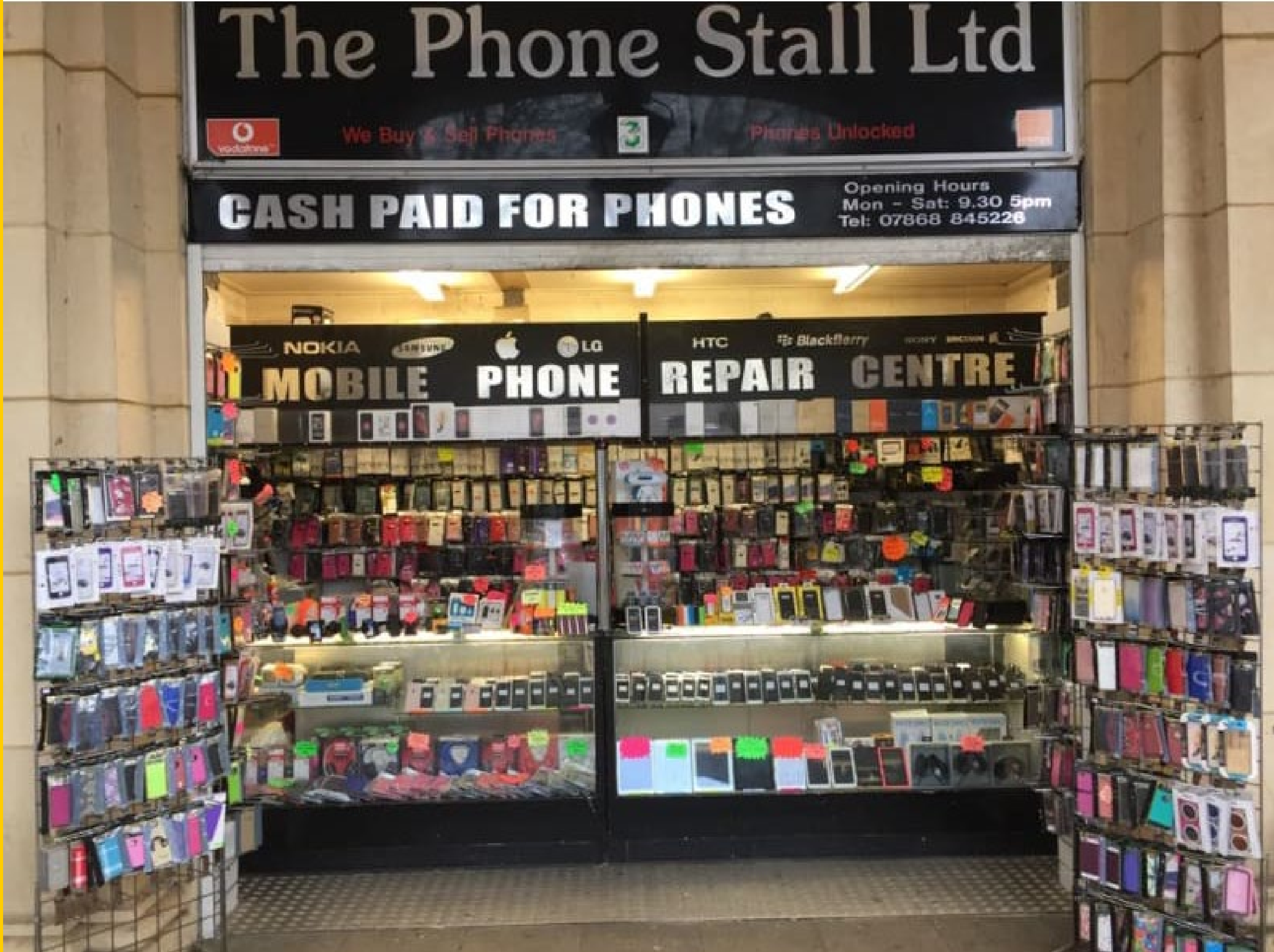
- customer's name
- customer's address
- customer's mobile

Actions to do

- initializer
- accessor / mutator methods
- methods

Activity

Practical Question 3



Data vs Class Attributes

Data vs Class Attributes

Data attributes

Data attributes are pieces of data held by a specific instance of a class (object). To reference this attribute from code outside the class, you qualify it with the instance name

Class attributes

Class attributes are variables owned by the class itself. To reference this attribute from code outside the class, you qualify it with the class name

Data vs Class Attributes

```
class Counter:
    count1 = 0
    def __init__(self):
        self.count2 = 0

c = Counter()
c.count2 += 1
Counter.count1 += 5
```

Which one of these is a class attribute? count1
Which one of these is a data attribute? count2

To reference a data attribute from **code outside** the class, you qualify it with the instance name
To reference a class attribute from **code outside** the class, you qualify it with the class name

Data vs Class Attributes

```
class Counter:
    count1 = 0
    def __init__(self):
        self.count2 = 0
    def increase_count2(self):
        self.count2 += 1
    def increase_count1(self):
        self.__class__.count1 += 1
```

To reference a data attribute from code inside the class, you qualify it with self

To reference a class attribute from code inside the class, you qualify it with self.__class__

__class__ is a built-in attribute of every class instance (of every class). It is a reference to the class that self is an instance of (in this case, the Counter class).

Data vs Class Attributes

Data attributes

Each instance of a class has its own set of data attributes.

Class attributes

Class attributes are shared by all instances of a class.

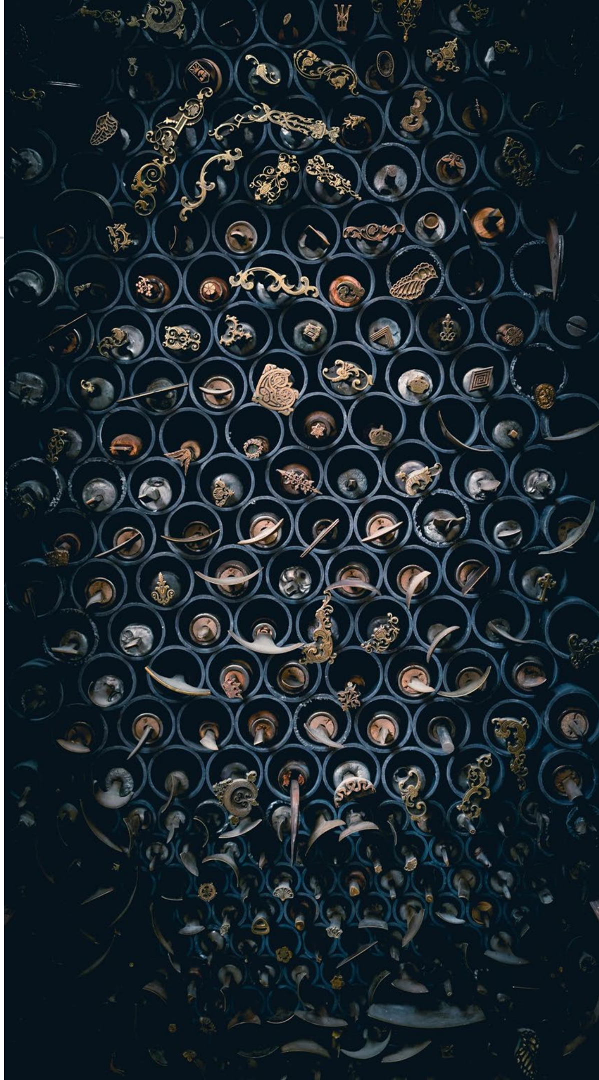
```
class Counter:
    count1 = 0
    def __init__(self):
        self.count2 = 0
        self.count2 += 1
        self.__class__.count1 += 1
c1 = Counter()
c2 = Counter()
c3 = Counter()
print(‘Class variable %d, Data variable %d' % (Counter.count1, c1.count2))
```

```
count1 = 3  # class variable shared by all instances
count2 = 1  # data variable has its own set of data attributes
```

Storing Classes in Modules

Organize class definitions by storing them in modules in a separate file. Import modules into any program that need to use the classes they contain.

```
import random

if random.randint(0,1) == 0:
            print(‘Head’)
else:
            print(‘Tail’)
```



```
# Stored in Customer.py
class Customer:
    def __init__(self, name, email):
        self.__name = name
        self.__email = email
    def get_name(self):
        return self.__name
    def get_email(self):
        return self.__email
    def get_customer_info(self):
        return ‘Name: ‘ + self.__name + ‘, Email: ‘ +
                    self.__email
```

```
# testProgram.py
```

Three ways to import Customer module

1. import Customer
2. from Customer import *
3. import Customer as c

How do you create a Customer instance from Customer class that is stored in a module?

```
cust1 = Customer.Customer(‘Ah Kaw’, ‘ahkaw@gmail.com’)
```

```
cust1 = Customer(‘Ah Kaw’, ‘ahkaw@gmail.com’)
```

```
cust1 = c.Customer(‘Ah Kaw’, ‘ahkaw@gmail.com’)
```

Built-in Function

__str__

A built-in function used for string representation of object

```
class Customer:
    def __init__(self, name, email):
        self.__name = name
        self.__email = email
    def __str__(self):
        s=‘Name: {}, Email: {}’ .format(self.__name, self.__email)
        return s
```

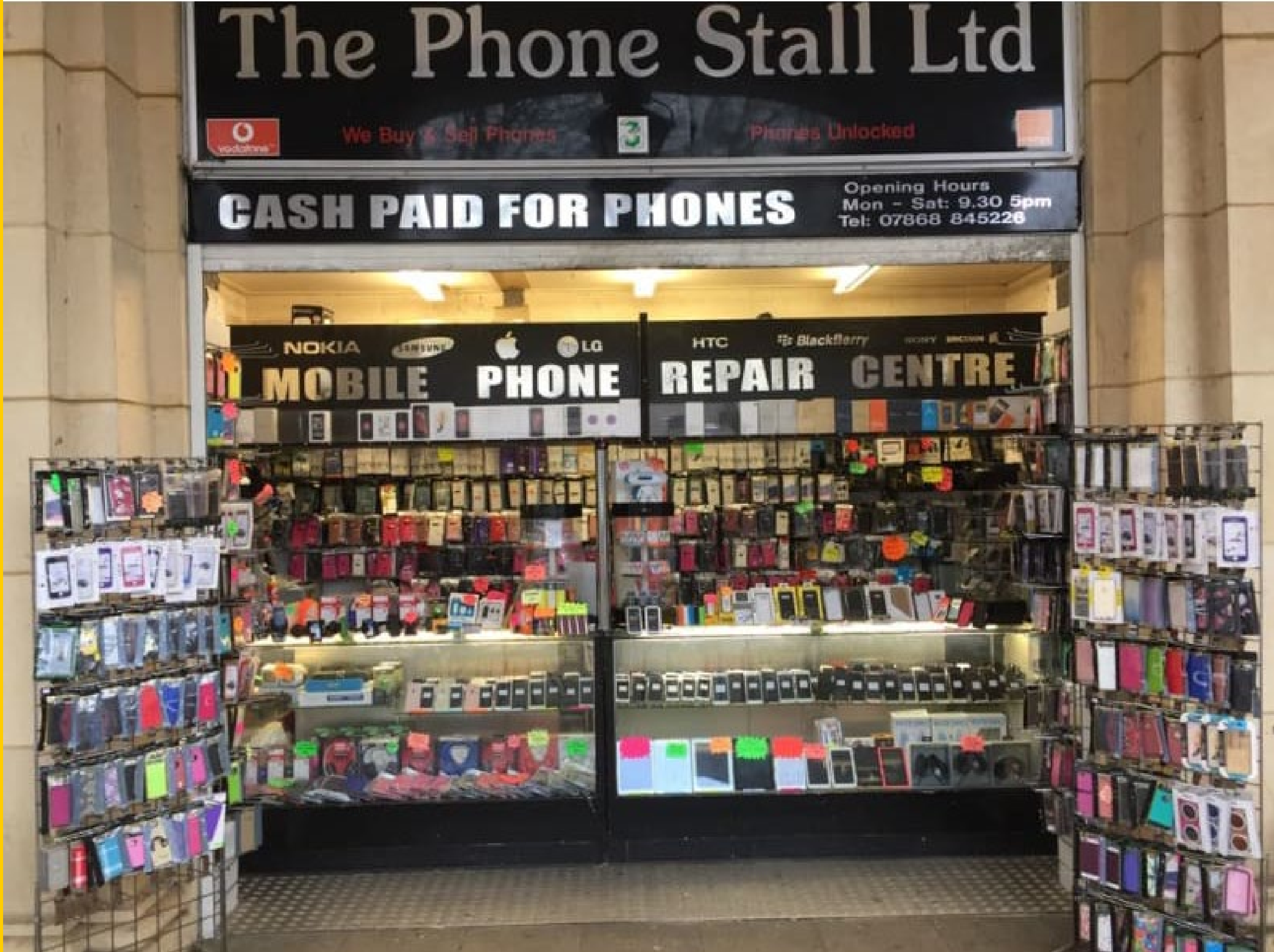
```
cust1 = Customer(‘Ah Kaw’, ‘ahkaw@gmail.com’)
print(cust1)
cust2 = Customer(‘Ah Hua’, ‘ahhua@gmail.com’)
print(cust2)
```

Output:

```
Name: Ah Kaw, Email: ahkaw@gmail.com
Name: Ah Hua, Email: ahhua@gmail.com
```

Activity

Practical Question 5



Checkpoint : class or object?

1	___ is a blueprint from which _____ are created.	____ is an instance of a ____.
2	____ is a real world entity such as pen, laptop, mobile, bed, keyboard, mouse, chair etc.	____ is a group of similar ____.
3	____ is a logical entity.	____ is a physical entity.

Checkpoint : class or object?

4	____ is created many times as per requirement.	____ is declared once.
5	____ allocates memory when it is created.	____ doesn't allocated memory when it is created.
6	There is only one way to define ____ in python	There are many ways to create _____ in python.

Summary

- Explain the OO concepts of classes, objects, methods and messages
- Implement a class with instance variables, instance methods and constructors
- Explain the concept of abstraction and encapsulation
- Construct a program using classes, objects, methods and messages