Lab 4: Dictionaries and Classes

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Exercise 1: Canadian Postal Codes

AIM:

In Canada, the first, third, and fifth characters in the postal code are letters while the second, fourth, and sixth characters are digits. We can determine the province or territory in which an address resides from the first character of its postal code as shown in the following table. No valid postal codes currently begin with D, F, I, O, Q, U, W, or Z.

Province/Territory	First Character(s)
Newfoundland and Labrador	A
Nova Scotia	B
Prince Edward Island	C
New Brunswick	E
Quebec	G, H, and J
Ontario	K, L, M, N, and P
Manitoba	R
Saskatchewan	S
Alberta	T
British Columbia	V
Nunavut or Northwest Territories	X
Yukon	Y

The second character in a postal code identifies whether the address is rural or urban. If that character is a 0, then the address is rural; otherwise, it is urban. Write a Python program that prompts a postal code from the user and displays the province or territory associated with it, along with whether the address is urban or rural. Your program should use a dictionary to map from the first character of the postal code to the province or territory name. Here are the sample input and output of the program:

```
Enter a Canadian postal code: X0D 0A0
The postal code is for a rural address in Nunavut or Northwest
Territories.
```

```
Enter a Canadian postal code: H8Z 7R6
The postal code is for an urban address in Quebec.
Enter a Canadian postal code: ABB 2L5
The second character in the postal code must be a digit!
Enter a Canadian postal code: Q5N 8P4
The first character in the postal code is invalid!
It cannot be D, F, I, O, Q, U, W, or Z!
```

ALGORITHM:

- Initialize a python dictionary which maps characters to territories
- Obtain the postal code from the user
- Extract the 1st and 2nd letters from the postal code
- Find the image of the 1st letter through the dictionary mapping
- Determine if the rurality is urban or not depending on if the 2nd letter is non-zero or not.
- Handle cases where the first two letters can be invalid and output the result in the desired way using f-strings

PROGRAM:

```
# Canada's Postal Codes
# Created by Shaheer Ziya

# Postal Code Letters & Their Corresponding Territories
postalCodes = {
    'A': "Newfoundland and Labrador",
    'B': "Nova Scotia",
    'C': "Prince Edward Island",
    'D': "Invalid",
    'E': "New Brunswick",
    'F': "Invalid",
    'G': "Quebec",
    'H': "Quebec",
    'I': "Invalid",
    'J': "Quebec",
    'K': "Ontario",
    'L': "Ontario",
    'M': "Ontario",
```

```
    'N': "Ontario",
    'O': "Invalid",
    'P': "Ontario",
    'Q': "Invalid",
    'R': "Manitoba",
    'S': "Saskatchewan",
    'T': "Alberta",
    'U': "Invalid",
    'V': "British Columbia",
    'W': "Invalid",
    'X': "Nunavut or Northwest Territories",
    'Y': "Yukon",
    'Z': "Invalid"
}

def main():
  # Obtain postal code from user
  code = input("Enter a Canadian postal code: ")
  # Obtain first letter of postal code
  firstLetter = code[0]
  # Obtain corresponding territory
  territory = postalCodes[firstLetter]

  # Determine if the area is rural or urban
  secondLetter = code[1]
  # 0 -> Rural, 1-9 -> Urban
  if secondLetter == '0':
    rurality = "a rural"
  elif (not secondLetter.isdigit()):
    rurality = "invalid"
  else:
    rurality = "an urban"

  # Error Handling & I/O
  # If the postal code's letter is invalid
  if territory == "Invalid":
    print("The first character in the postal code is invalid!")
```

```
    print("It cannot be D, F, I, O, Q, U, W, or Z!")
  # If the postal code's digit is invalid
  elif rurality == "invalid":
    print("The second character in the postal code must be a digit!")
  else:
    print(f"The postal code is for {rurality} address in {territory}.")


main()
```

OUTPUT:

```
/usr/local/bin/python3 "/Users/matthewsummons/Documents/GitHub/PHYS2160/Lab 4/1.py"
→  PHYS2160 git:(main) ✗ /usr/local/bin/python3 "/Users/matthewsummons/Documents/GitHub/PHYS2160/Lab 4/1.p
y"
Enter a Canadian postal code: X0D 0A0
The postal code is for a rural address in Nunavut or Northwest Territories.
→  PHYS2160 git:(main) ✗ /usr/local/bin/python3 "/Users/matthewsummons/Documents/GitHub/PHYS2160/Lab 4/1.py"
Enter a Canadian postal code: H8Z 7R6
The postal code is for an urban address in Quebec.
→  PHYS2160 git:(main) ✗ /usr/local/bin/python3 "/Users/matthewsummons/Documents/GitHub/PHYS2160/Lab 4/1.py"
Enter a Canadian postal code: ABB 2L5
The second character in the postal code must be a digit!
→  PHYS2160 git:(main) ✗ /usr/local/bin/python3 "/Users/matthewsummons/Documents/GitHub/PHYS2160/Lab 4/1.py"
Enter a Canadian postal code: Q5N 8P4
The first character in the postal code is invalid!
It cannot be D, F, I, O, Q, U, W, or Z!
→  PHYS2160 git:(main) ✗
```

Exercise 2: Converting Floating-Point Values to Monetary Amounts

AIM:

Write a Python class `MoneyFmt` for converting floating-point values to monetary amounts. The class has one data attribute of type `float` for the floating-point value called `value`. It also provides the following methods:

(a) `__init__(self, value=0.)` for creating a new instance of the class with the floating-point value initialized,

(b) `update(self, value=None)` for updating the floating-point value,

(c) `__str__(self)` for displaying the floating-point value as a monetary amount to two decimal places with the correct sign,

(d) `__repr__(self)` for returning a string such that `eval` applied to the string recreates the instance,

(e) `isnonzero(self)` for checking if the floating-point value is non-zero where a value with absolute value less than 0.005 is regarded as zero.

Here are the sample input and output for using the class `MoneyFmt`:

```
>>> cash = MoneyFmt(135.79)
>>> cash
MoneyFmt(135.79)
>>> print(cash)
$135.79
>>> cash.update(5000000.2468)
>>> cash
MoneyFmt(5000000.2468)
>>> print(cash)
$5,000,000.25
>>> cash.update(-1386.42)
>>> print(cash)
-$1,386.42
>>> cash.isnonzero()
True
>>> cash.update(-0.0049)
>>> cash.isnonzero()
```

```
False
```

ALGORITHM:

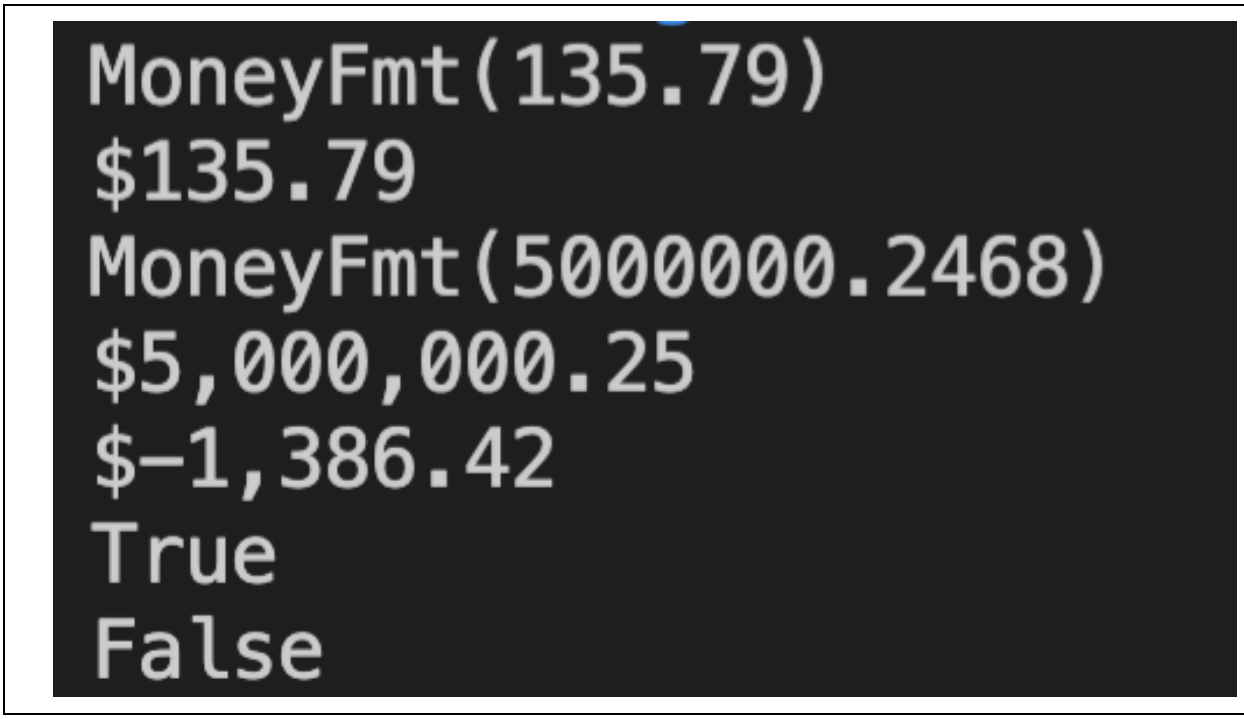
- Define the class
- Initialize the object with an instance variable value set to the passed value
- Write the required methods for the class

PROGRAM:

```
# Convert Floating Point to Monetary Values
# Created by Shaheer Ziya

# A class to convert floating point values to monetary values
class MoneyFmt:

 def __init__(self, value: "float" = 0) -> None:
   '''Initialize the MoneyFmt object with the passed value argument'''
   self.value = value



 def __str__(self) -> str:
    '''Return a human readable string representation of the MoneyFmt object'''
    # Add commas & round to 2 decimal places
    return f"${self.value:,.2f}"



 def __repr__(self) -> str:
    '''Return a string representation of the MoneyFmt object that instantiates the object under eval()'''
    return f"MoneyFmt({self.value})"



 def update(self, value: "float" = None) -> None:
    '''Update the existing value of the MoneyFmt object'''
    self.value = value
```

```
  def isnonzero(self):
      '''Return True if the magnitude of value of the MoneyFmt object is not less than 0.005'''
      if abs(self.value) >= 0.005:
        return True
      else:
        return False


def main():
  cash = MoneyFmt(135.79)

  print(repr(cash))
  print(str(cash))

  cash.update(5000000.2468)

  print(repr(cash))
  print(str(cash))

  cash.update(-1386.42)
  print(str(cash))

  print(cash.isnonzero())

  cash.update(-0.0049)
  print(cash.isnonzero())

main()
```

OUTPUT:



Exercise 3: Queue

AIM:

A queue behaves like a real-world queue such as a checkout line in a supermarket. The customer at the front of the line is serviced first and other customers can only enter at the back of the line. So the first customer in line is always the first one to be serviced (i. e. it follows the First In First Out principle). Write a Python class `Queue` for representing queues of integers. The class has two data attributes `qlst` and `maxsize` where `qlst` is the list holding the elements of the queue and `maxsize` is the size limit for the queue. It also provides the following methods:

(a) `__init__(self, maxsize=10)` for initializing the queue with an empty list and a size limit,

(b) `enqueue(self, item)` for adding an element to the back of a non-full queue,

(c) `dequeue(self)` for removing an element from the front of a non-empty queue,

(Hint: use the `pop` function)

(d) `isempty(self)` for checking whether the queue is empty,

(e) `isfull(self)` for checking whether the queue is full (i.e. whether the number of elements in the queue is equal to `maxsize`),

(f) `count(self)` for returning the number of elements in the queue,

(g) `__str__(self)` for displaying all the elements in the queue.

Note that in the method `enqueue`, the provided element would be added to the queue only if it is an integer. Here are the sample input and output for using the class `Queue`:

```
>>> a = Queue(3)
>>> a.isempty()
True
>>> a.enqueue(1.2)
You can only add integers to the queue!
>>> a.enqueue(1)
>>> a.enqueue(2)
>>> a.enqueue(3)
>>> a.enqueue(4)
The queue is full and no new element can be added!
>>> a.isfull()
True
>>> a.count()
Number of elements in the queue = 3
>>> a.dequeue()
1
>>> print(a)
Element 1 in the queue = 2
Element 2 in the queue = 3
>>> a.dequeue()
2
>>> a.dequeue()
3
>>> a.dequeue()
The queue is empty and there is no front element!
```

ALGORITHM:

- Define the Queue class with its required methods
- The docstrings of the methods should be self-explanatory

PROGRAM:

```
# The Definition For the Queue Class
# Created by Shaheer Ziya

# A class to represent a queue using FIFO (First In First Out)
class Queue:

 def __init__(self, max_size: int = 10) -> None:
    self.queue = []
    self.max_size = max_size


 def __str__(self) -> str:
  elementsString = ""
  for idx, element in enumerate(self.queue):
    elementsString += f"Element {idx+1} in the queue = {element}\n"

  # Don't return last newline
  return elementsString[:-1]


 def enqueue(self, item) -> None:
    ''' Enter an integer to a queue '''
    # Ensure only integer values are added to the queue
    if type(item) != int:
      print("You can only add integers to the queue!")
    # See if the queue is full, if it is not then add to the queue
    elif len(self.queue) < self.max_size:
       self.queue.append(item)
    else:
       print("The queue is full and no new element can be added!")
```

```
def dequeue(self):
  ''' Remove an integer from the queue and return the removed integr '''
  # See if the queue is empty, if it is not then remove from the queue
  if len(self.queue) > 0:
      # Return the removed element
      return self.queue.pop(0)

  else:
      print("The queue is empty and there is no front element!")

def isempty(self) -> bool:
  ''' Check if the queue is empty '''
  if len(self.queue) == 0:
      return True
  else:
      return False

def isfull(self) -> bool:
  ''' Check if the queue is full '''
  if len(self.queue) == self.max_size:
      return True
  else:
      return False

def count(self) -> int:
  ''' Return the number of items in the queue '''

  print(f"Number of elements in the queue = {len(self.queue)}")
  return len(self.queue)
```

```
def main():
  a = Queue(3)

  print(a.isempty())

  a.enqueue(1.2)

  a.enqueue(1)
  a.enqueue(2)
  a.enqueue(3)
  a.enqueue(4)

  print(a.isfull())

  a.count()

  print(a.dequeue())

  print(a)

  print(a.dequeue())
  print(a.dequeue())
  print(a.dequeue())



main()
```

OUTPUT:

```
True
You can only add integers to the queue!
The queue is full and no new element can be added!
True
Number of elements in the queue = 3
1
Element 1 in the queue = 2
Element 2 in the queue = 3
2
3
The queue is empty and there is no front element!
```

Exercise 4: Quadrilaterals, Trapezoids, Parallelograms, and Squares

AIM:

Suppose a Python class `Point` is defined in the program `point.py` as follows:

```
class Point:
    """ A class representing geometric points """

    def __init__(self, x, y):
        """ Initialize the point with its x, y coordinates """
        self.x = x
        self.y = y

    def getx(self):
        """ Return the x coordinate of the point """
        return self.x

    def gety(self):
        """ Return the y coordinate of the point """
        return self.y

    def __str__(self):
        """ Return a string representation of the point """
        return "({:.1f}, {:.1f})".format(self.x, self.y)
```

Write a Python class `Quadrilateral` for representing quadrilaterals. This class has four data attributes `pt1`, `pt2`, `pt3`, `pt4` of class `Points` for the four endpoints of the quadrilateral. In addition to the constructor for initializing the instance, it provides the methods `getpt1(self)`, `getpt2(self)`, `getpt3(self)`, `getpt4(self)` for returning the individual endpoints of the quadrilateral, `getcoorstr(self)` for returning a string containing the coordinates of the endpoints of the quadrilateral, and `__str__(self)` for returning a string representation of the quadrilateral with the coordinates of its endpoints obtained by calling the method `getcoorstr`. Next, write a Python class `Trapezoid` for representing trapezoids by inheriting from the class `Quadrilateral`. It overrides the method `__str__(self)` for returning a string representation of the trapezoid with the coordinates of its endpoints, its height, and its area. It also adds the methods `getheight(self)` for returning the height of the trapezoid, `getsumoftwosides(self)` for

returning the sum of the length of the two parallel sides of the trapezoid, and `getarea(self)` for returning the area of the trapezoid, assuming the points on each parallel side to have the same *y* coordinates. Next, write a Python class `Parallelogram` for representing parallelograms by inheriting from the class `Trapezoid`. It overrides the method `__str__(self)` for returning a string representation of the parallelogram with the coordinates of its endpoints, its width, its height, and its area. It also adds the methods `getwidth(self)` for returning the width of the parallelogram. Finally, write a Python class `Square` for representing squares by inheriting from the class `Parallelogram`. It overrides the method `__str__(self)` for returning a string representation of the square with the coordinates of its endpoints, its side, and its area. Assume the constructors of these classes are called with valid input. Here are the sample input and output for using these classes:

```
>>> a = Quadrilateral(1.1, 1.2, 6.6, 2.8, 6.2, 9.9, 2.2, 7.4)
>>> print(a)
Coordinates of the Quadrilateral are:
(1.1, 1.2), (6.6, 2.8), (6.2, 9.9), (2.2, 7.4)
>>> b = Trapezoid(0.0, 0.0, 10.0, 0.0, 8.0, 5.0, 3.3, 5.0)
>>> b.getsumoftwosides()
14.7
>>> print(b)
Coordinates of the Trapezoid are:
(0.0, 0.0), (10.0, 0.0), (8.0, 5.0), (3.3, 5.0)
Height = 5.0
Area = 36.75
>>> c = Parallelogram(5.0, 5.0, 11.0, 5.0, 12.0, 20.0, 6.0, 20.0)
>>> print(c)
Coordinates of the Parallelogram are:
(5.0, 5.0), (11.0, 5.0), (12.0, 20.0), (6.0, 20.0)
Width = 6.0
Height = 15.0
Area = 90.00
>>> d = Square(4.0, 0.0, 8.0, 0.0, 8.0, 4.0, 4.0, 4.0)
>>> print(d)
Coordinates of the Square are:
(4.0, 0.0), (8.0, 0.0), (8.0, 4.0), (4.0, 4.0)
Side = 4.0
Area = 16.00
```

ALGORITHM:

- Import the point class from point.py
- Define 4 Classes that build on each other using inheritance
- Add in the required methods for each class
- Using super() and formatting methods to print required strings

PROGRAM:

```
# Quadrilaterals, Trapezoids, Parallelograms, and Squares
# Created by Shaheer Ziya

# Import the Point class from the file point.py
from point import Point

# A class representing a geometric quadrilateral
class Quadrilateral:

 def __init__(self, *args) -> None:
   # Define the four points of the quadrilateral
   self.pt1 = Point(args[0], args[1])
   self.pt2 = Point(args[2], args[3])
   self.pt3 = Point(args[4], args[5])
   self.pt4 = Point(args[6], args[7])



 ### Methods to retrieve the coordinates of the quadrilateral ###
 def getpt1(self) -> Point:
   """ Return the first point of the quadrilateral """
   return self.pt1

 def getpt2(self) -> Point:
   """ Return the second point of the quadrilateral """
   return self.pt2

 def getpt3(self) -> Point:
   """ Return the third point of the quadrilateral """
   return self.pt3
```

```
  def getpt4(self) -> Point:
    """ Return the fourth point of the quadrilateral """
    return self.pt4


  def getcoorstr(self) -> str:
    """ Return a string representation of the coordinates of the quadrilateral """
    return f"{self.pt1}, {self.pt2}, {self.pt3}, {self.pt4}"


  def __str__(self) -> str:
    """ Return a string representation of the quadrilateral """
    return f"Coordinates of the Quadrilateral are:\n{self.getcoorstr()}"

# A class representing a geometric trapezoid
class Trapezoid(Quadrilateral):

  def __init__(self, *args) -> None:
    # Call the constructor of the Quadrilateral class
    super().__init__(*args)


  def getheight(self) -> float:
    """ Return the height of the trapezoid """
    # It has been assumed that the points will be entered in a cyclic order
    # And that the parallel sides of the trapezoiod will be parallel to the x-axis
    return self.pt3.gety() - self.pt1.gety()


  def getsumoftwosides(self) -> float:
    """ Return the sum of the two parallel sides of the trapezoid """
    # It has been assumed that the points will be entered in a cyclic order
    # And that the parallel sides of the trapezoiod will be parallel to the x-axis
    return (self.pt2.getx() - self.pt1.getx()) + (self.pt3.getx() - self.pt4.getx())
```

```
  def getarea(self) -> float:
    """ Return the area of the trapezoid """
    return (self.getheight() * self.getsumoftwosides()) / 2



  def __str__(self) -> str:
      # Adjust for the first line of the string representation
      return f"Coordinates of the Trapezoid are:\n{super().__str__()[38:]}" + "\n" + \
        f"Height = {self.getheight()}" + "\n" + \
        f"Area = {self.getarea()}"


# A class representing a geometric parallelogram
class Parallelogram(Trapezoid):

  def __init__(self, *args) -> None:
      super().__init__(*args)



  def getwidth(self) -> float:
    """ Return the width of the parallelogram """
    # It has been assumed that the points will be entered in a cyclic order
    # And that the parallel sides of the parallelogram will be parallel to the x-axis
    return self.pt2.getx() - self.pt1.getx()



  def __str__(self) -> str:
      # Insert the width part into the original string representation
      superiorLine = super().__str__()[34:]
      newline = superiorLine.find("\n")
      Cord_line = superiorLine[:newline]
      Area_line = superiorLine[superiorLine.find("\nHeight"):]
      # Area_Line =
      return "Coordinates of the Parallelogram are:\n" + Cord_line +  f"\nWidth = {self.getwidth()}" + \
        Area_line


# A class representing a geometric square
```

```
class Square(Parallelogram):

    def __init__(self, *args) -> None:
        super().__init__(*args)


    def getside(self) -> float:
        """ Return the side of the square """
        # It has been assumed that the points will be entered in a cyclic order
        # And that the parallel sides of the square will be parallel to the x-axis
        return self.pt2.getx() - self.pt1.getx()


    def __str__(self) -> str:
        superiorLine = super().__str__()[38:]
        Cord_line = superiorLine[:superiorLine.find("\n")]
        Area_line = superiorLine[superiorLine.find("\nArea"):]
        return f"Coordinates of the Square are:\n" + Cord_line + f"\nSide = {self.getside()}" + Area_line


def main():

    a = Quadrilateral(1.1, 1.2, 6.6, 2.8, 6.2, 9.9, 2.2, 7.4)
    print(a)

    print()

    b = Trapezoid(0.0, 0.0, 10.0, 0.0, 8.0, 5.0, 3.3, 5.0)
    print(b.getsumoftwosides())
    print(b)

    print()

    c = Parallelogram(5.0, 5.0, 11.0, 5.0, 12.0, 20.0, 6.0, 20.0)
    print(c)

    print()
```

```
d = Square(4.0, 0.0, 8.0, 0.0, 8.0, 4.0, 4.0, 4.0)
print(d)


main()
```

OUTPUT:

```
Coordinates of the Quadrilateral are:
(1.1, 1.2), (6.6, 2.8), (6.2, 9.9), (2.2, 7.4)

14.7
Coordinates of the Trapezoid are:
(0.0, 0.0), (10.0, 0.0), (8.0, 5.0), (3.3, 5.0)
Height = 5.0
Area = 36.75

Coordinates of the Parallelogram are:
(5.0, 5.0), (11.0, 5.0), (12.0, 20.0), (6.0, 20.0)
Width = 6.0
Height = 15.0
Area = 90.0

Coordinates of the Square are:
(4.0, 0.0), (8.0, 0.0), (8.0, 4.0), (4.0, 4.0)
Side = 4.0
Area = 16.0
```