Classes

Solve the following exercises and upload your solutions to Moodle until the specified due date. Make sure to use the *exact filenames* that are specified for each individual exercise. Unless explicitly stated otherwise, you can assume correct user input and correct arguments. You are allowed to implement additional attributes and methods as long as the original interface remains unchanged. You are *not allowed* to use any concepts and modules that have not yet been presented in the lecture.

```
Important Note: In this assignment, we don't allow any Python built-in module
except math module to use only sin and cos.
```

Exercise 1 – Submission: `a7_ex1.py` 30 Points

Create a class `Radian` that converts degree angles. The class has the following instance attribute:

- `degree: float`

  Represents the degree angle.

The class has the following instance methods:

- `__init__(self, degree: float)`

  Sets this instance attribute.

- `rad(self) -> float`

  Returns the radian angle of this `degree` angle. The conversion from radians to degrees is defined as $(a * (pi/180))$, where a is the angle in a degree, and pi is equal to 3.14.

- `print(self)`

  Prints both `angles` to the console. The outputs should be formatted with `2 decimal places`. Format: `The degree is <deg> and the radian is <rad>`, where `<deg>` is the angle in a degree, `<rad>` is the angle in a radian.

Example program execution:

```
c = Radian(90)
print(c.rad())
c.print()
```

Example output:

```
1.57
The degree is 90.00 and the radian is 1.57
```

Exercise 2 – Submission: `a7_ex2.py` 20 Points

This exercises is a bonus exercise !

Create a class `Rotate` that rotates the matrix. The class has the following instance attributes:

- `matrix: list`

  Represents the intended matrix to be rotated.

- `degree: float`

  Represents the rotation angle in a degree .

- `inplace: bool`

  Represents the change of the matrix in-place or not. If `inplace` is True, the replacement of the numbers should be done in-place. Otherwise, the replacement should be done in a new matrix. The default `boolean` is `False`.

The class has the following instance methods:

- `__init__(self, matrix: list, degree: float, inplace=False)`

  Sets these instance attributes.

- `rotation(self) -> list`

  Returns the rotated matrix at designated `degree` angle. For conversion from degree to radian, you must use the above class by importing it as `from a7_ex1 import Radian`. You can only use `sin` and `cos` from `math`, which is a Python built-in module.

You can assume that the dimension of the matrix is nxn which n being an odd numbers, for example, 3X3, 5X5, 7X7, 9X9, etc. Moreover, you can assume the rotation degree will be either 90, 180, or -90. Please write your code based on those assumptions only.

Example program execution:

```
matrix = [[1,2,3],[4,5,6],[7,8,9]]
c1 = Rotate(matrix,90)
c11= c1.rotation()
print(c11)
print(matrix)

matrix = [[1,2,3],[4,5,6],[7,8,9]]
c2 = Rotate(matrix,-90, True)
c22= c2.rotation()
print(c22)
print(matrix)

matrix = [[1,2,3,4,5],[6,7,8,9,10],[11,12,13,14,15],[16,17,18,19,20],[21,22,23,24,25]]
c3 = Rotate(matrix,180)
c33 = c3.rotation()
print(c33)
```

Example output:

`[[3,6,9],[2,5,8],[1,4,7]]` which corresponds to c11 = $\begin{bmatrix} 3 & 6 & 9 \\ 2 & 5 & 8 \\ 1 & 4 & 7 \end{bmatrix}$

`[[1,2,3],[4,5,6],[7,8,9]]` which corresponds to matrix = $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$

`None` which corresponds to c22 = None

`[[7,4,1],[8,5,2],[9,6,3]]` which corresponds to matrix = $\begin{bmatrix} 7 & 4 & 1 \\ 8 & 5 & 2 \\ 9 & 6 & 3 \end{bmatrix}$

`[[25,24,23,22,21],[20,19,18,17,16],[15,14,13,12,11],[10,9,8,7,6],[5,4,3,2,1]]`

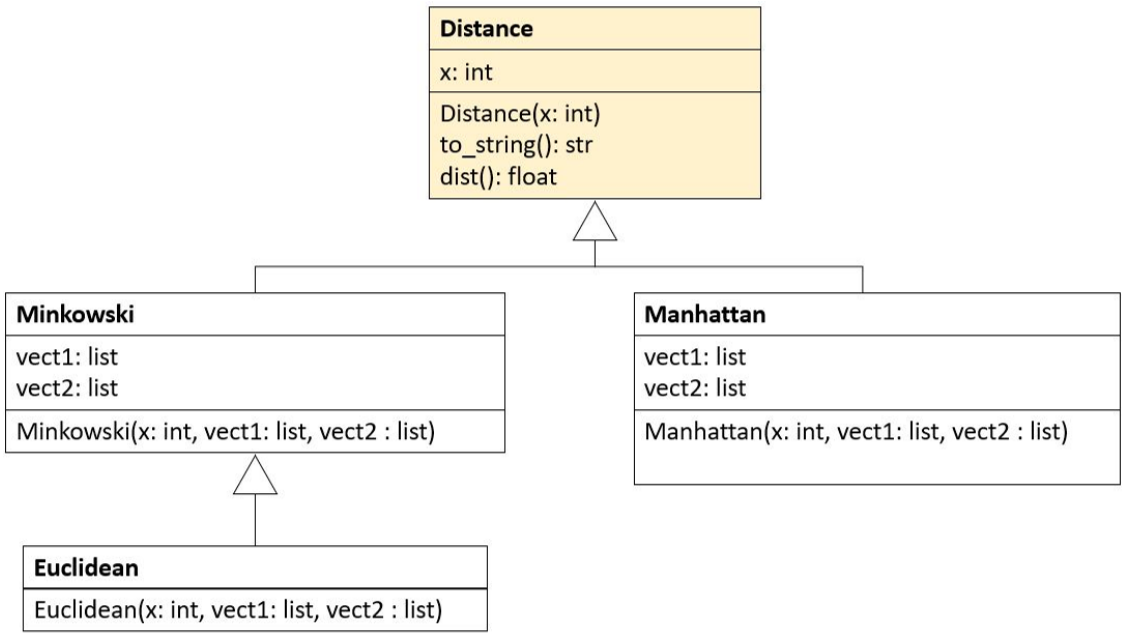
which corresponds to c33 = $\begin{bmatrix} 25 & 24 & 23 & 22 & 21 \\ 20 & 19 & 18 & 17 & 16 \\ 15 & 14 & 13 & 12 & 11 \\ 10 & 9 & 8 & 7 & 6 \\ 5 & 4 & 3 & 2 & 1 \end{bmatrix}$

Hints:

- To rotate the matrix please refer to this link wikipedia.
- You can find an example of how to get the new coordinates in `matrix_rotation.txt`.
- You need to convert the angle from degrees to radians.

Exercise 3 – Submission: `a7_ex3.py` 25 Points

You are given the following class hierarchy that models distances between 2 vectors. You have to implement the classes in this and the following exercises.



In this exercise, you have to implement the class `Distance`, which represents the base class of 1D vectors. The class has the following instance attributes:

- `x: int`

  The number of vectors.

The class has the following instance methods:

- `__init__(self, x: int)`

  Set instance attribute.

- `to_string(self) -> str`

  Returns a string representation of the form `"Distance: the number of vectors =<x_value>"`, where `<x_value>` represents the value of the corresponding attribute.

- `dist(self) -> float`

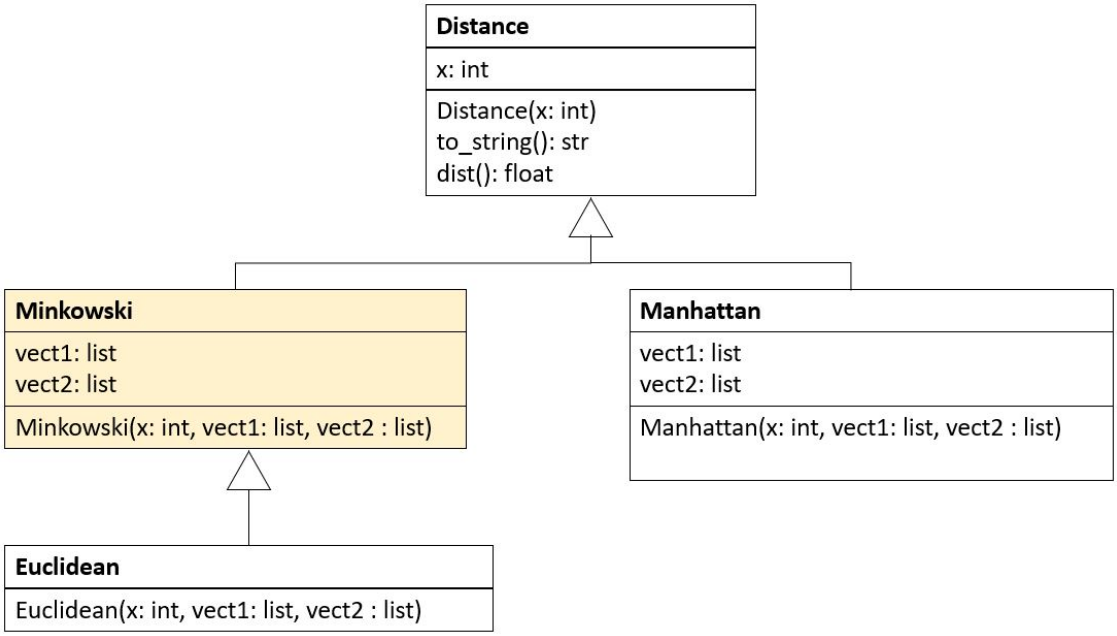
  Returns the distance between 2 vectors as a float, which must be implemented by all concrete subclasses. In the `Distance` class, a `NotImplementedError` is raised.

Hints:

- In the `to_string` method, you need the name of the class. While this could be hard-coded, you could also use `type(x).__name__` to get the name of the type/class of some object `x`. This has the benefit that instances of any subclasses will also return their correct names. Alternatively, you can write a helper method that returns the name, and you override it in the sublcasses.

Exercise 4 – Submission: `a7_ex4.py` 15 Points

You are given the same class hierarchy as in the previous exercise that models 1D vectors.



In this exercise, you have to implement the concrete subclass `Minkowski`, which represents an minkowski distance and extends the base class `Distance`. The class has the following additional instance attributes:

- `vect1: list`

  The first vector.

- `vect2: list`

  The second vector.

The class has the following instance methods (reuse code from superclasses to avoid unnecessary code duplication):

- `__init__(self, x: int, vect1: list, vect2:list)`

  Sets both instance attributes (in addition to the attributes of the base class `Distance`).

- `to_string(self) -> str`

  Returns a string representation of the form `"Minkowski: the number of vectors =<x_value >, vector_1=<vect1_value>, vector_2=<vect2_value>"`, where `<?_value>` represents the value of the corresponding attribute.

- `dist(self) -> float`

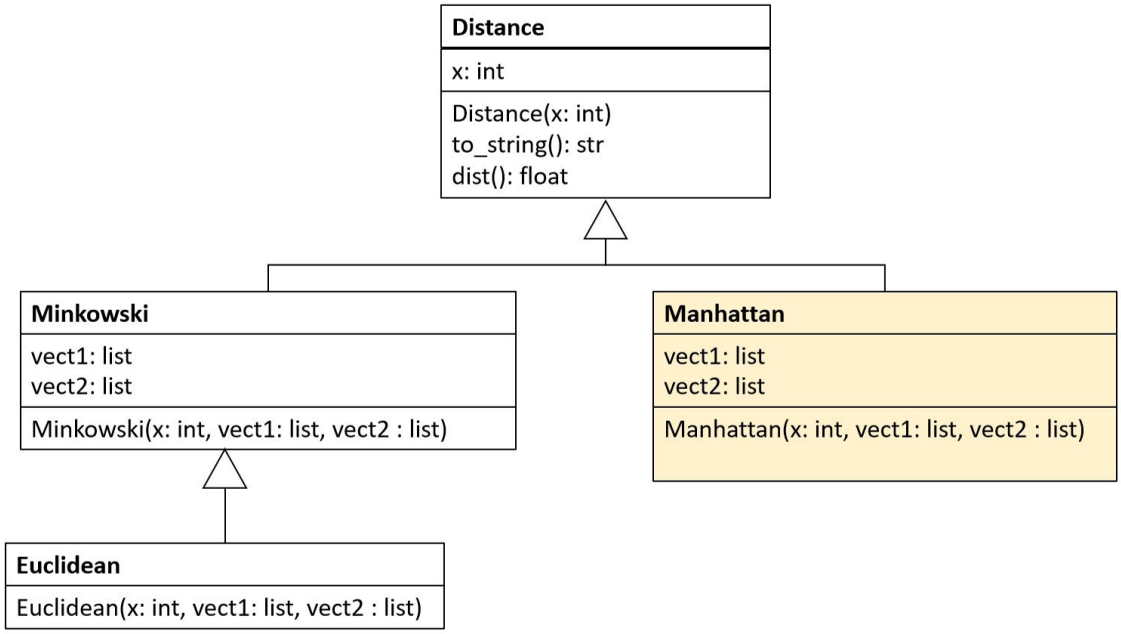
Returns the minkowski distance of the 2 vectors as a float. The output should be formatted with `4 decimal places`. The minkowski distance is defined as, $(\sum_{i=1}^{n}(|x(i)-y(i)|)^p)^{1/p}$, where `p=2`. Also, `x` and `y` are the first and second vectors, respectively.

Hints:

- You can import the previous exercise as module to avoid having to copy the entire class hierarchy. For example, you can write `from a7_ex3 import Distance`.
- Use `super().some_method()` to access the `some_method` implementation of the superclass.

Exercise 5 – Submission: `a7_ex5.py` 15 Points

You are given the same class hierarchy as in the previous exercise that models 1D vectors.



In this exercise, you have to implement the concrete subclass `Manhattan`, which represents a city-block distance and extends the base class `Distance`. The class has the following additional instance attributes:

- `vect1: list`

  The first vector.

- `vect2: list`

  The second vector.

The class has the following instance methods (reuse code from superclasses to avoid unnecessary code duplication):

- `__init__(self, x: int, vect1: list, vect2:list)`

  Sets both instance attributes (in addition to the attributes of the base class `Distance`).

- `to_string(self) -> str`

  Returns a string representation of the form `"Manhattan: the number of vectors =<x_value>, vector_1=<vect1_value>, vector_2=<vect2_value>"`, where `<?_value>` represents the value of the corresponding attribute.

- `dist(self) -> float`

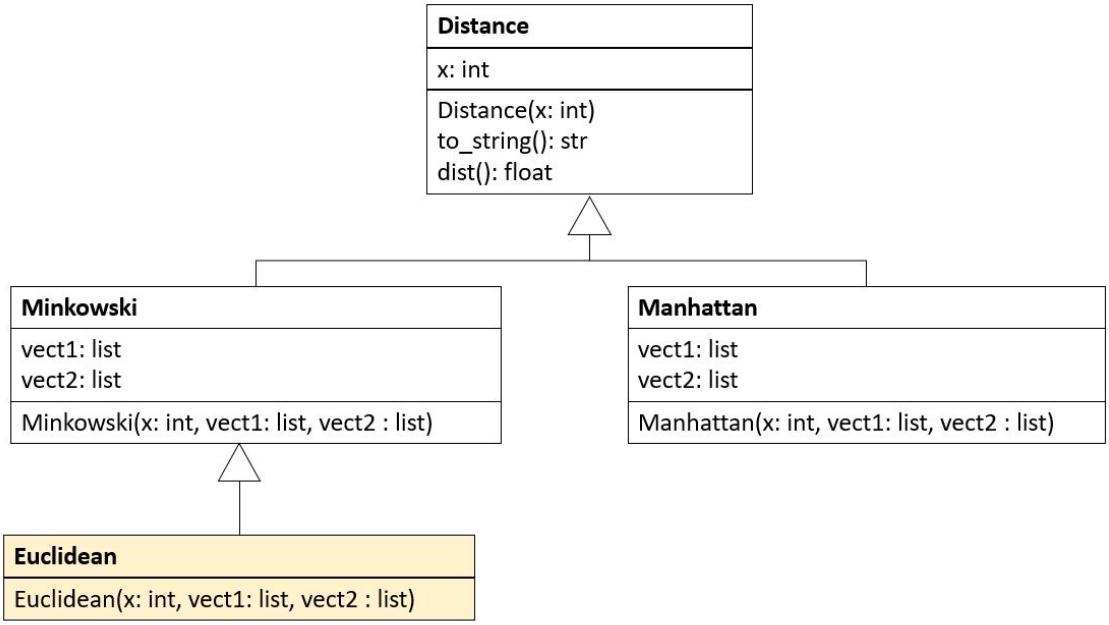
Returns the manhattan distance of the 2 vectors as a float. The output should be formatted with `4 decimal places`. The manhattan distance is defined as, $\sum_{i=1}^{n}|(x(i) - y(i))|$, where `x` and `y` are the first and second vectors, respectively.

Hints:

- You can import the previous exercise as module to avoid having to copy the entire class hierarchy. For example, you can write `from a7_ex3 import Distance`.
- Use `super().some_method()` to access the `some_method` implementation of the superclass.

Exercise 6 – Submission: `a7_ex6.py` 15 Points

You are given the same class hierarchy as in the previous exercise that models 1D vectors.



In this exercise, you have to implement the concrete subclass `Euclidean`, which represents a Euclidean distance and extends the base class `Minkowski`. The class has *no* additional instance attributes.

The class has the following instance methods (reuse code from superclasses to avoid unnecessary code duplication):

- `__init__(self, x: int, vect1: list, vect2:list)`

  Sets both instance attributes (in addition to the attributes of the base class `Distance`). The `vector` parameters only exist for user convenience. Internally, the attributes `vect1` and `vect2` are fed to the base class `Minskowski`.

- `to_string(self) -> str`

  Returns a string representation of the form `"Euclidean: x=<x_value>, vector_1=<vect1_value>, vector_2=<vect2_value>"`, where `<?_value>` represents the value of the corresponding attribute.

- `dist(self) -> float`

  Returns the Euclidean distance of the 2 vectors as a float. The euclidean distance is defined as, $\sqrt{\sum_{i=1}^{n}(x(i)-y(i))^2}$, where `x` and `y` are the first and second vectors, respectively.

Hints:

- You can import the previous exercise as module to avoid having to copy the entire class hierarchy. For example, you can write `from a7_ex4 import Minkowski`.
- The above requirement "reuse code from superclasses to avoid unnecessary code duplication" is especially relevant in this exercise. Depending on your implementation, it might be that you do not need to override any methods of the superclass `Minkowski`.

Combined Examples for Exercises 3, 4, 5 and 6

Example program execution:

```
vect1 = [1,2,3]
vect2 = [4,5,6]
d = Distance(2)
print(d.to_string())

k = Minkowski(2, vect1, vect2)
print(k.to_string())
print("Minkowski distance:", k.dist())

m = Manhattan(2, vect1, vect2)
print(m.to_string())
print("Manhattan distance:", m.dist())

e = Euclidean(2, vect1, vect2)
print(e.to_string())
print("Euclidean distance:", e.dist())
```

Example output:

```
Distance: the number of vectors =2
Minkowski: the number of vectors =2, vector_1=[1, 2, 3], vector_2=[4, 5, 6]
Minkowski distance: 5.1962
Manhattan: the number of vectors =2, vector_1=[1, 2, 3], vector_2=[4, 5, 6]
Manhattan distance: 9.0
Euclidean: the number of vectors =2, vector_1=[1, 2, 3], vector_2=[4, 5, 6]
Euclidean distance: 5.1962
```