Programming I

Course 10

Introduction to programming

What we talked about?

- Object Oriented Programming
- Classes
- Objects

What we talk today?

- Relation between classes
  - Has a
  - A kinf of
  - Is a

- Inheritance

Classes. Objects

- Abstractization
  - Possibility to add user defined data types (new abstractizations)
- Classes
  - Describe one or more objects
  - A template for creating, or instantiating, specific objects within a program.
- Objects
  - A realization of the class

Classes & Objects

Class Implementation

- implementing a new object type with a class
  - define the class
  - define data attributes (WHAT IS the object)
  - define methods (HOW TO use the object)

Class Usage

- using the new object type in code
  - create instances of the object type
  - do operations with them

Classes & Objects

Class Definition

- class name is the type class Coordinate(object)
- class is defined generically
  - use `self` to refer to some instance while defining the class
  - `self` is a parameter to methods in class definition
- class defines data and methods common across all instances

Class Instantiation

- instance is one specific object `coord = Coordinate(1,2)`
- data attribute values vary between instances
  - `c1 = Coordinate(1,2)`
  - `c2 = Coordinate(3,4)`
  - `c1` and `c2` have different data attribute values `c1.latitude` and `c2.latitude` because they are different objects
- instance has the structure of the class

Objects

- Objects
  - A unique identifier
  - A type
  - A internal representation
  - A set of operations that allows interaction with the information stored in the object

  - INTERACT WITH EACH OTHERS

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  - INTERACT WITH EACH OTHERS
    - A Bird is a kind of Animal
    - A Team has a list of Employee
    - An Engine is a part of a Car
    - A Shop uses Card Payment

Object Relations

- Inheritance
  - A Bird is a kind of Animal
- Association
  - A Team has a list of Employee
- Composition
  - An Engine is a part of a Car
- Dependency
  - A Shop uses Card Payment

Can be identified by the constructions that are used to describe the relation

Object Relations

- Inheritance
  - A Bird is a kind of Animal
  - Bird class is a subclass of Animal class

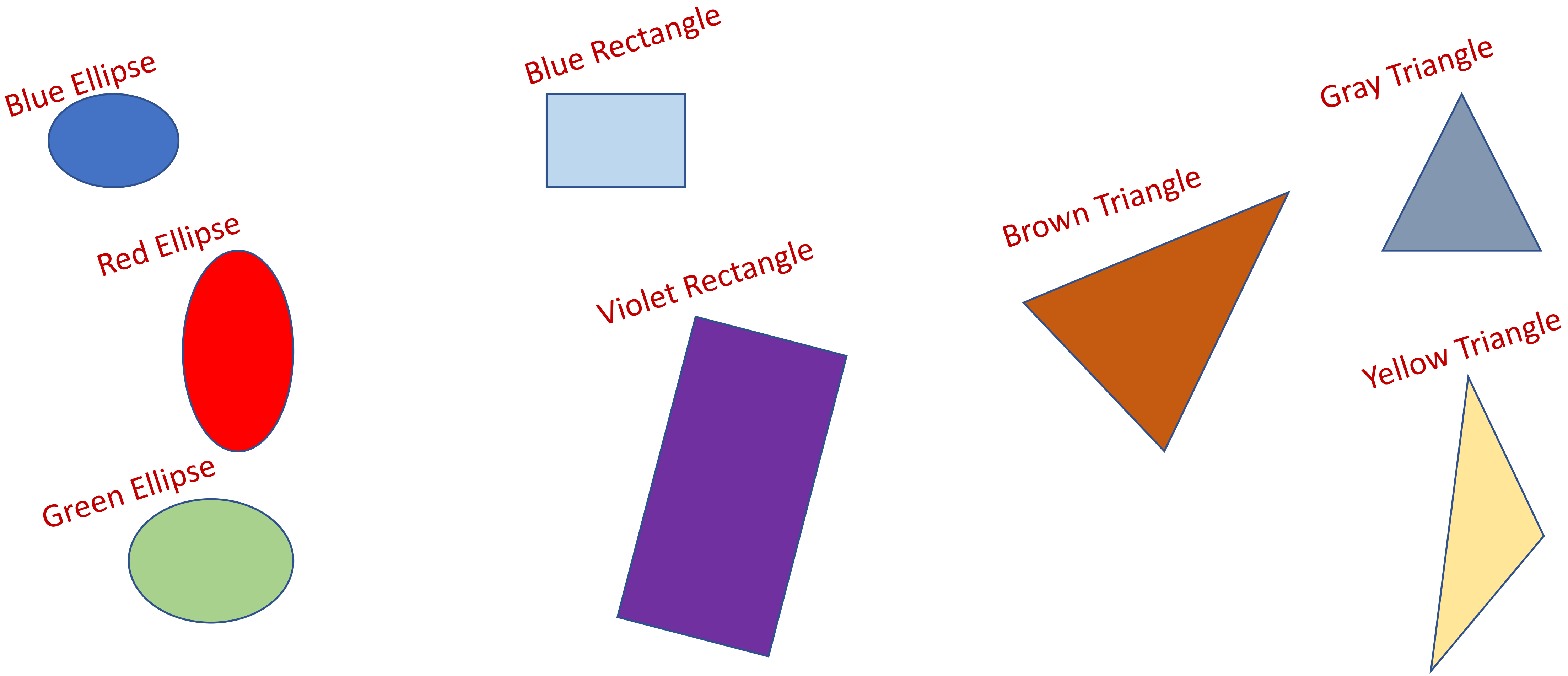
- Association
  - A Team has a list of Employee
  - The Team class has an attribute that contains the list of Employee and does not control the life circle of the employees objects
    - If a team is dissolved the employee are not fired

- Composition
  - An Engine is a part of a Car
  - The Car class has an attribute of type Engine and it controls the life circle of the engine object
    - If the car is destroyed the engine is also destroyed

- Dependency
  - A Shop uses Card Payment
  - One of the methods of Shop class uses a Card Payment object in order to make the payment
  - Card Payment is not an attribute of class Shop

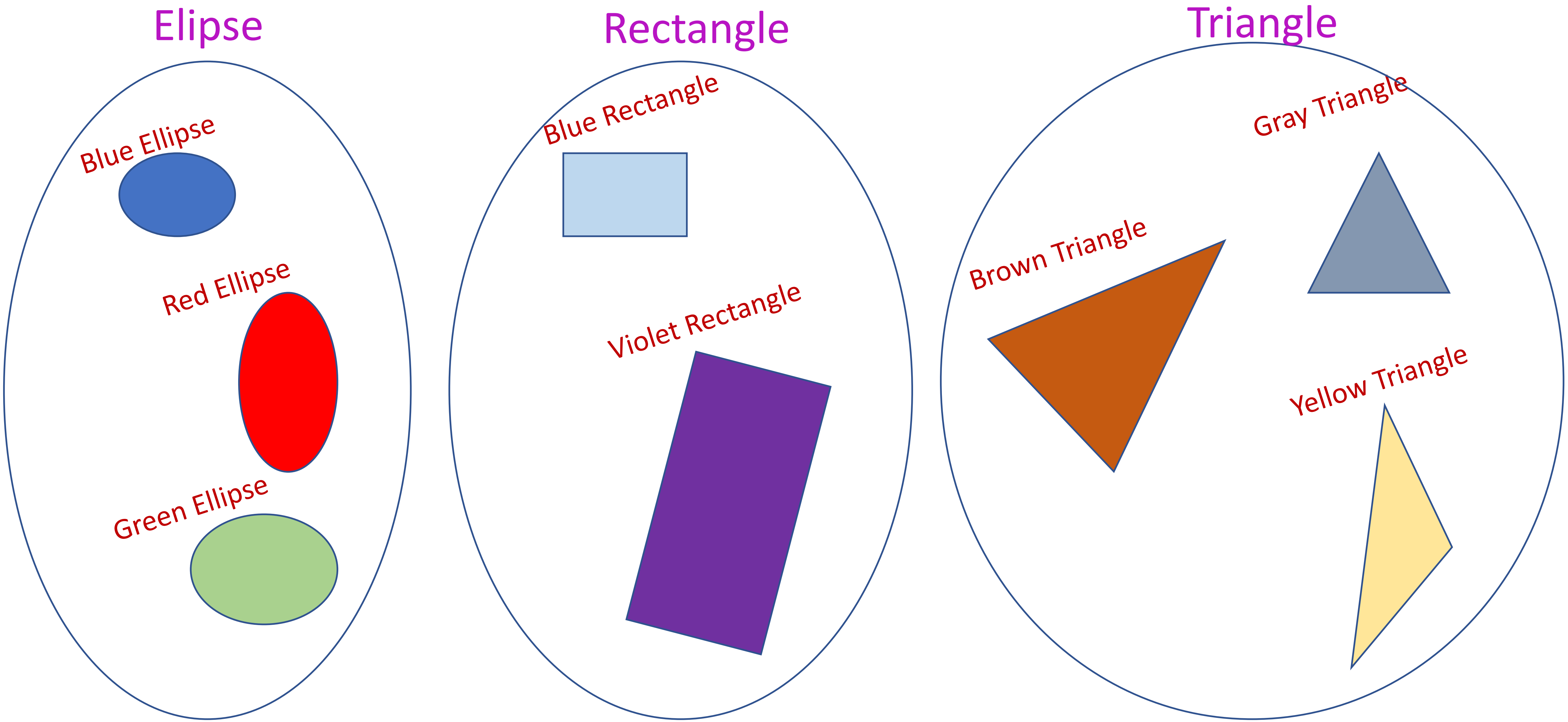
Inheritance

In how many classes can be the objects grouped?



Inheritance

Which could be the properties of each class?



Inheritance

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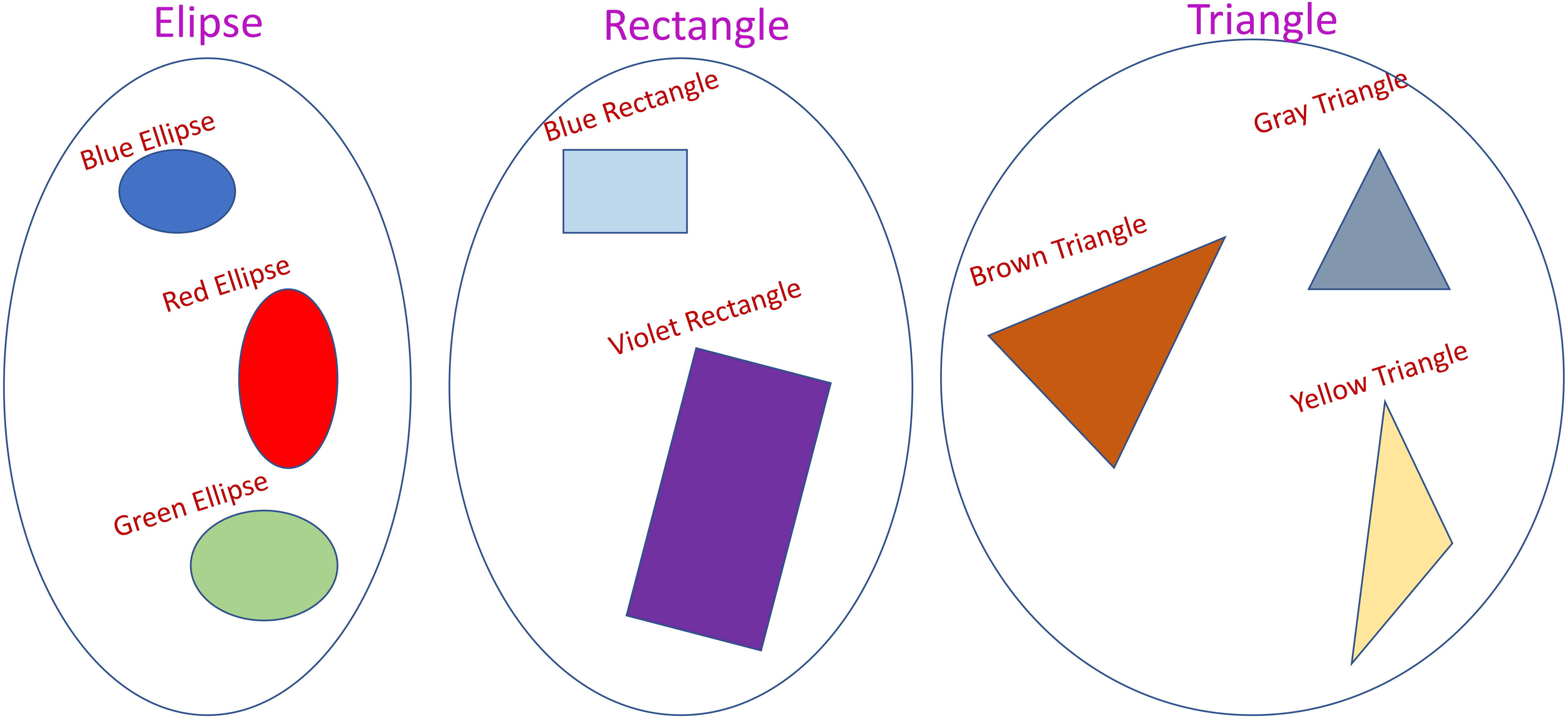
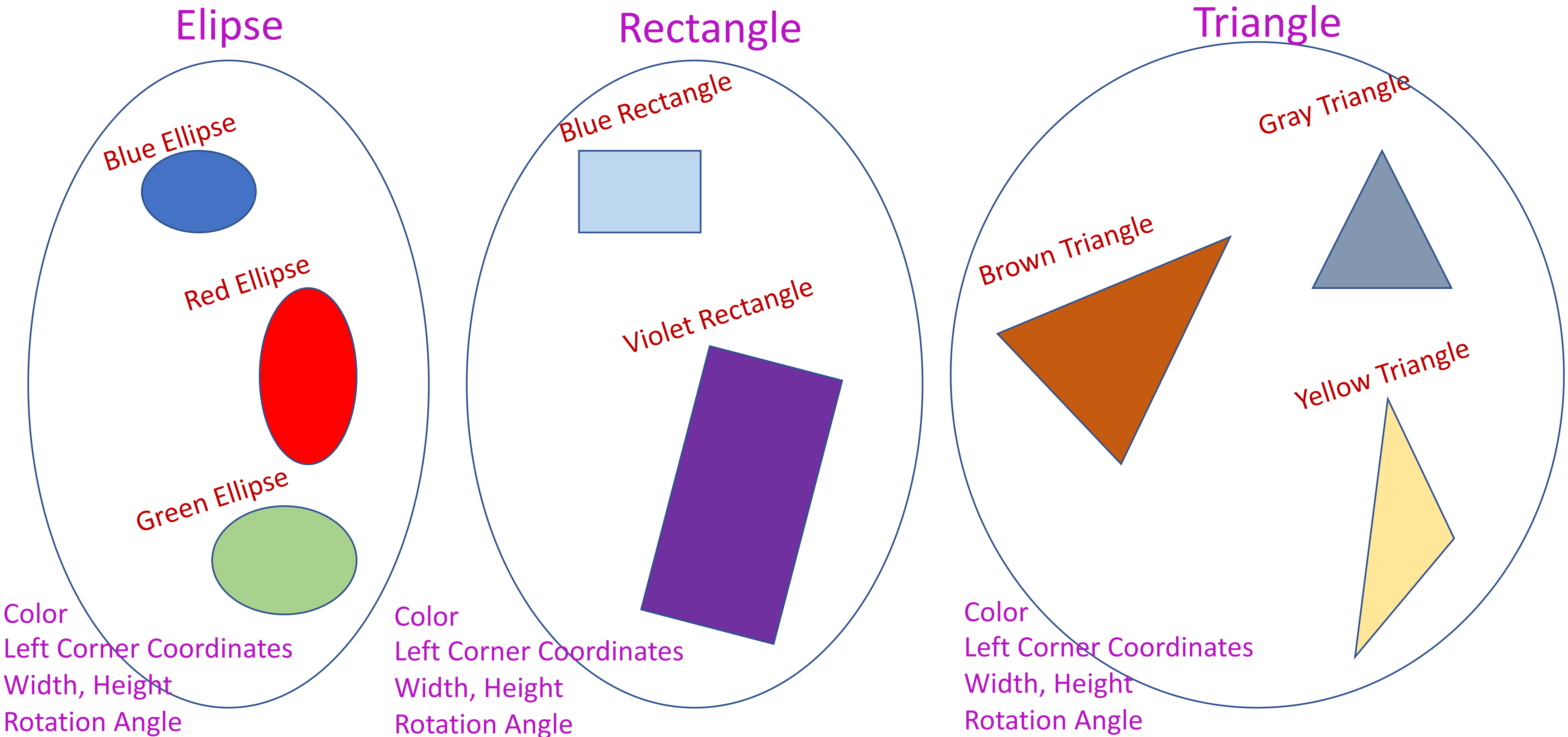


Inheritance

Which is the difference between the classes?



Inheritance

Create three classes or just one?

- In how many classes can be the objects grouped?
  - Elipse
  - Rectangles
  - Triangles
- Which could be the properties of each class?
  - Color
  - Left Corner Coordinates
  - Width
  - Height
  - Rotation Angle
- Which is the difference between the classes?
  - The way in which the figures are rendered

Inheritance. One class

- Creating only one class
  - How we discriminate between different types of figures?
    - Add an attribute
  - How we create objects?
    - Pass the figure type as parameter to `__init__` method
    - Define different functions for creating different types of objects

Disadvantages?
- Figure_type attribute can have any vakue
- Modify the class if new figure is added

```
class Figure(object):
    def __init__(self, figure_type, color, x, y, width, height, rotation_angle):
        self.figure_type = figure_type
        self.color = color
        # … the rest of the assignments here
    def draw(self):
        if self.figure_type == "Elipse":
            print("Eclipse drawing ...")
        elif self.figure_type == "Rectange":
            print("Rectange drawing ...")
        elif self.figure_type == "Triangle":
            print("Triangle drawing ...")
        else:
            print("? ...")
f = Figure("Elipse", "red", 10, 10, 100, 50, 0)
f.draw()
```

Inheritance. One class

- Creating only one class
  - How we discriminate between different types of figures?
    - Add an attribute
  - How we create objects?
    - Pass the figure type as parameter to `__init__` method
    - <u>Define different functions for creating different types of objects</u>

```
class Figure(object):
    def my_init(self, figure_type, color, x, y, width, height, rotation_angle):
        self.figure_type = figure_type
         # … the rest of the assignments here
    def create_eclipse(self, color, x, y, width, height, rotation_angle):
        self.my_init("Elipse", color, x, y, width, height, rotation_angle)
    def create_rectange(self, color, x, y, width, height, rotation_angle):
        self.my_init("Rectange", color, x, y, width, height, rotation_angle)
    def create_triangle(self, color, x, y, width, height, rotation_angle):
        self.my_init("Triangle", color, x, y, width, height, rotation_angle)
    def draw(self):
        if self.figure_type == "Elipse":
            print("Eclipse drawing ...")
        elif self.figure_type == "Rectange":
            print("Rectange drawing ...")
        elif self.figure_type == "Triangle":
            print("Triangle drawing ...")
f = Figure()
f.create_eclipse("red", 10, 10, 100, 50, 0)
f.draw()
```

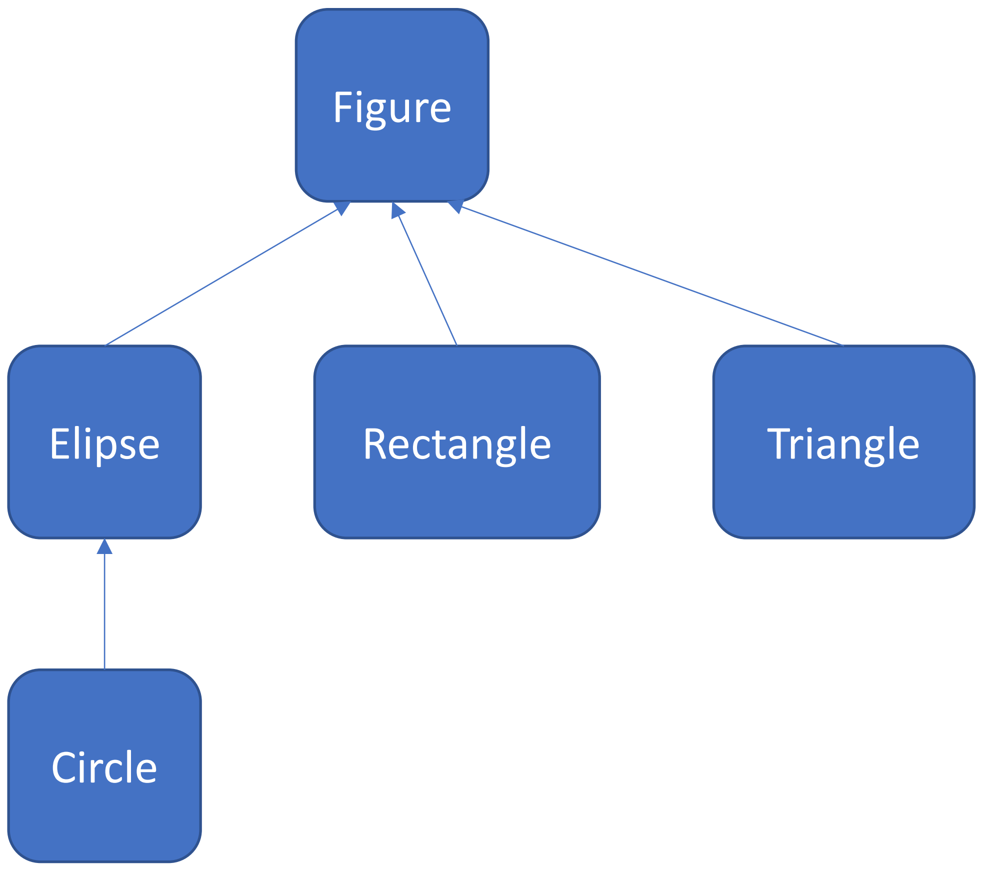
Disadvantages?

- Modify the class if new figure is added

Inheritance

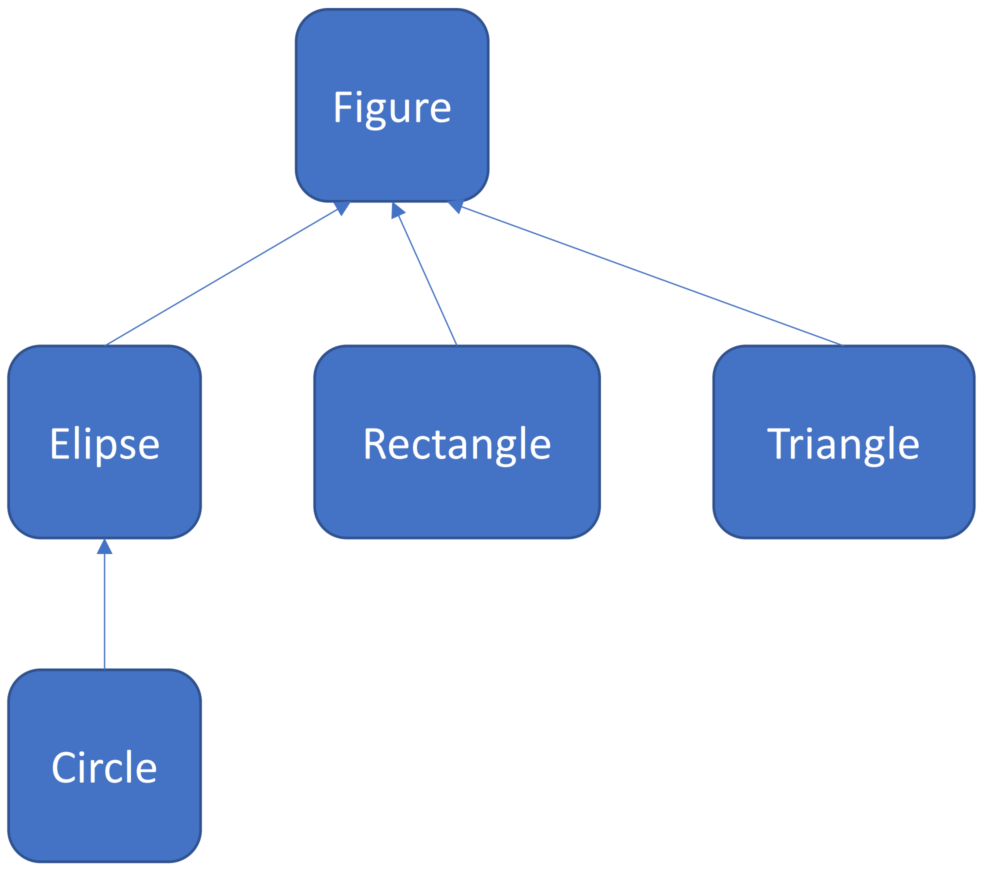
- One class disadvantages
  - Modify the class if new figure is added

- Inheritance
  - Allow to create new abstractization without modifying the existing ones



Inheritance

- Parent class (superclass)
- Child class (subclass)
  - Inherits all data and behaviors of parent class
  - Add more info
  - Add more behavior
  - Override behavior



Inheritance. Parent class

```
class Figure(object):
    def __init__(self, color, x, y, width, height, rotation_angle):
        self.color = color
        self.x = x
        self.y = y
        self.width = width
        self.height = height
        self.rotation_angle = rotation_angle
    def __repr__(self):
        return "x={}, y={}, w={}, h={}, color={}, rotationAngle={}".format(
                self.x, self.y, self.width, self.height, self.color, self.rotation_angle)

f = Figure('red', 10, 10, 100, 50, 0)
print(f)
```

- Everything is an object
- Class `object` implements basic operations in Python, like binding variables, etc

Inheritance. Child class

```
class Ellipse(Figure):
    def draw(self):
        print("Elipse draw ...")

    def __repr__(self):
        return "Elipse " + super().__repr__()

f = Ellipse('red', 10, 10, 100, 50, 0)
f.draw()
print(f)
```

New functionality

Overrides __repr__

Access hidden implementation from the superclass

- Inherits all attribues of Figure:
  - __init__(), x, y, width, height, color, rotation_angle, __repr__()

- add new functionality with draw()
  - instance of type Elipse can be called with new methods
  - instance of type Figure throws error if called with Ellipse's new method
- __init__ is not missing, uses the Figure version

Which Methods to Use?

- Subclass can have methods with same name as superclass
- For an instance of a class, look for a method name in current class definition
- If not found, look for method name up the hierarchy (in parent, then grandparent, and so on)
- Use first method up the hierarchy that you found with that method name

More Subclasses

Parent class

Call constructor of parent class

```
class Circle(Elipse):
    def __init__(self, color, x, y, radius, filled):
        Ellipse.__init__(self, color, x, y, radius*2, radius*2, 0)
        self.filled = filled
    def __add__(self, other):
        self.width += other + other
        return self
    def __repr__(self):
        return  "Circle x={}, y={}, radius={}, color={}, filled={}".format(
                self.x, self.y, self.width//2,  self.color, self.filled)
f = Circle('red', 10, 10, 100, True)
f += 3
f.draw()
print(f)
```

New attribute

New method

Override parent method

Class Variables

- class variables and their values are shared between all instances of a class
  - `figure_nr` is used to create a unique ID for class instances

Class variable

```
class Figure(object):
    figure_nr =1
    def __init__(self, color, x, y, width, height, rotation_angle):
        self.color = color
        self.x = x
        self.y = y
        self.width = width
        self.height = height
        self.rotation_angle = rotation_angle
        self.id = Figure.figure_nr
        Figure.figure_nr += 1
```

Class variable

instance variable

OO Programming

- Create your own collections of data
- Organize information
- Division of work
- Access information in a consistent manner
- Add layers of complexity
- Like functions, classes are a mechanism for decomposition and abstraction in programming

Bibliography

- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/lecture-slides-code/
- http://www.cs.toronto.edu/~quellan/courses/summer11/csc108/lectures.shtml