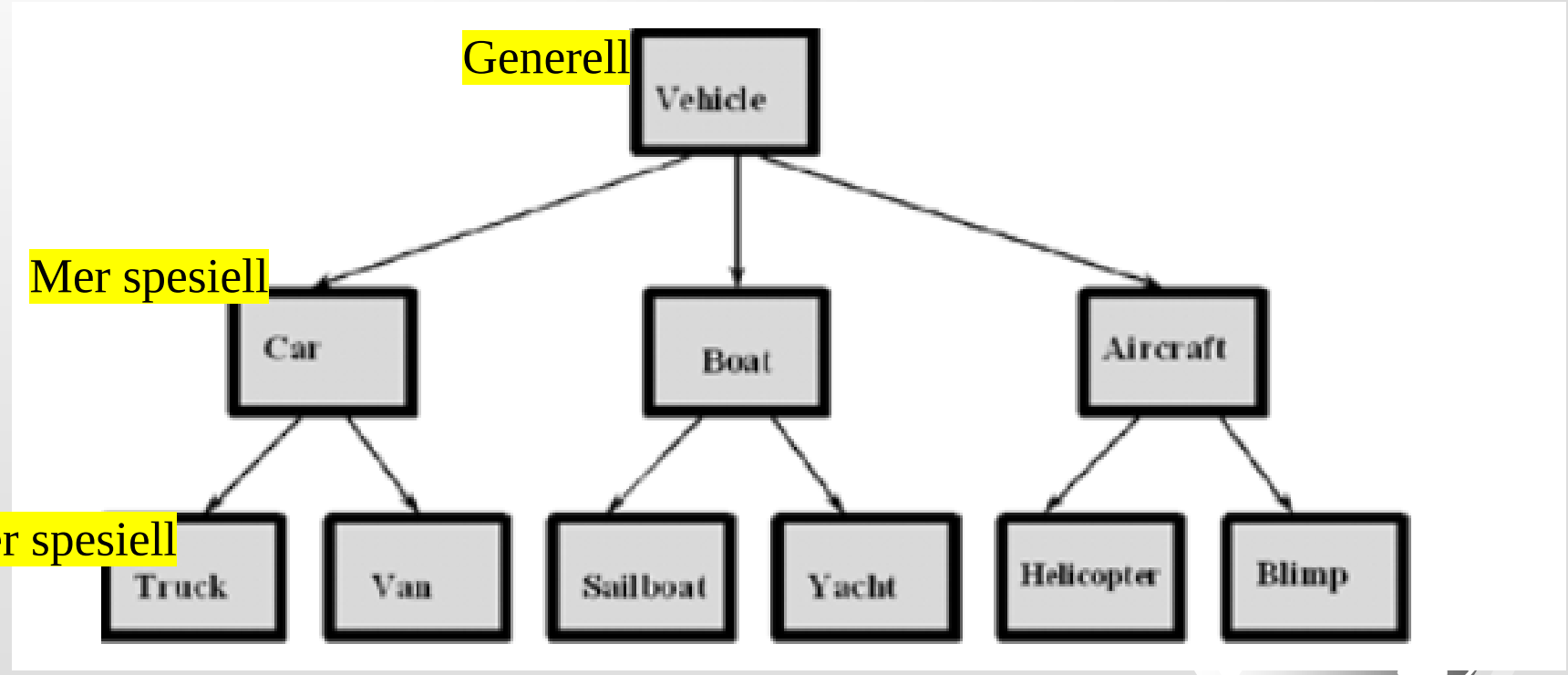
Chapter 12 Inheritance and Class Design

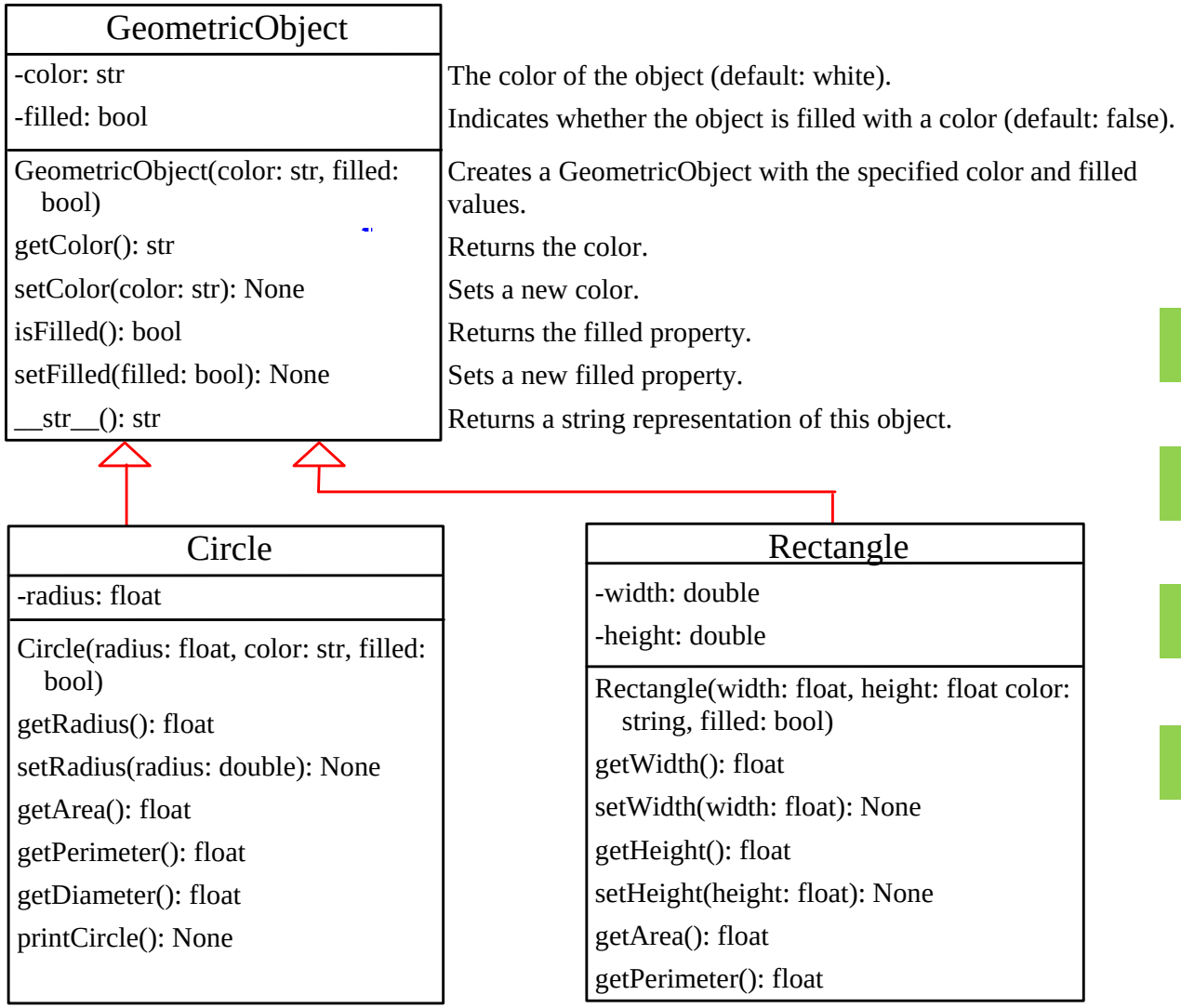
Arv / Inheritance

- Arv betyr at en klasse baseres på en annen klasse
  - Klassen som arves kalles base class / parent class
  - Klassen som arver kalles subclass / barneklasse
  - Subklassen har «mer» enn foreldreklassen
    - subklassen har både egne data og metoder, samt at den arver alt fra foreldreklassen

Subklassene blir mer og mer spesialisert jo lengre ned en går i hierarkiet



Superclasses and Subclasses



GeometricObject

Circle

Rectangle

TestCircleRectangle

Overriding Methods

A subclass inherits methods from a superclass. Sometimes it is necessary for the subclass to modify the implementation of a method defined in the superclass. This is referred to as *method overriding*.

```
class Circle(GeometricObject):
    # Other methods are omitted
    # Override the __str__ method defined in GeometricObject
    def __str__(self):
        return super().__str__() + " radius: " + str(radius)
```

The object Class

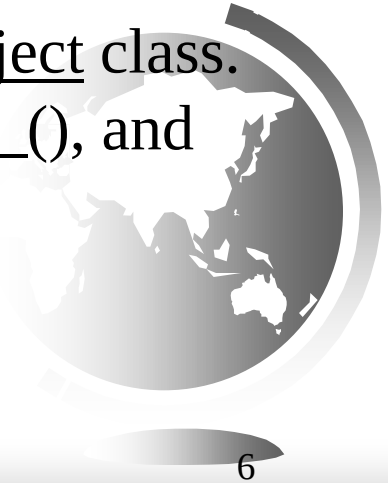
Every class in Python is descended from the object class. If no inheritance is specified when a class is defined, the superclass of the class is object by default.

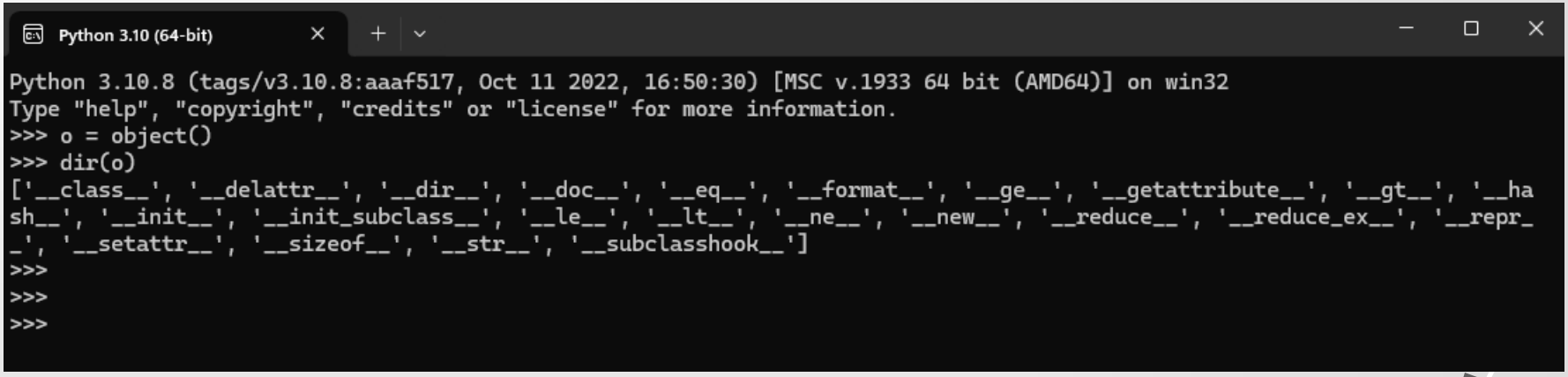
```
class ClassName:
    ...
```

Equivalent

```
class ClassName(object):
    ...
```

There are more than a dozen methods defined in the object class. We discuss four methods __new__(), __init__(), __str__(), and __eq__(other) here.





The __new__, __init__ Methods

All methods defined in the object class are special methods with two leading underscores and two trailing underscores. The __new__() method is automatically invoked when an object is constructed. This method then invokes the __init__() method to initialize the object. Normally you should only override the __init__() method to initialize the data fields defined in the new class.

`__new__()`

- The `__new__()` method in Python is a special method that is responsible for creating a new instance of a class.
- It is called before the `__init__()` method and is used to control the creation of a new instance.
- The `__new__()` method is typically used in scenarios where you need to customize the instance creation process, such as implementing singleton patterns, immutable objects, or metaclasses.

__new__() for å implementere *singleton pattern*

```
class Singleton:
    _instance = None

    def __new__(cls, *args, **kwargs): # cls er referansen til klassen
        if cls._instance is None:
            cls._instance = super().__new__(cls)
        return cls._instance

    def __init__(self, value):
        self.value = value

# Test the Singleton class
s1 = Singleton(10)
s2 = Singleton(20)

print(s1.value)  # Output: 10
print(s2.value)  # Output: 10
print(s1 is s2)  # Output: True (both references point to the same instance)
```

*args

```
def example_function(*args):
    for arg in args:
        print(arg)

example_function(1, 2, 3)  # Output: 1 2 3
```

**kwargs

```
def example_function(**kwargs):
    for key, value in kwargs.items():
        print(f"{key} = {value}")

example_function(a=1, b=2, c=3)
                    # Output: a = 1, b = 2, c = 3
```

cls

- **`cls`**
  - brukes for å referere til selve klassen innenfor *klassemetoder*.
    Det er tilsvarende `self`, som refererer til *instansen av klassen*, men `cls` brukes i klassemetoder som er bundet til *klassen* i stedet for instansen.
- **Klassemetoder**
  - Klassemetoder er metoder som er bundet til klassen og ikke til instansen av klassen. De kan kalles på selve klassen, i stedet for på en instans av klassen. For å definere en klassemetode, bruker du `@classmethod` - dekoratøren, og den første parameteren til metoden skal være `cls`.

```
class MyClass:
    class_variable = 0

    def __init__(self, value: int) -> None:
        self.instance_variable = value

    @classmethod
    def increment_class_variable(cls) -> None:
        cls.class_variable += 1

    @classmethod
    def get_class_variable(cls) -> int:
        return cls.class_variable

# Test klassemetodene
MyClass.increment_class_variable()
print(MyClass.get_class_variable())  # Output: 1

instance = MyClass(10)
instance.increment_class_variable()
print(instance.get_class_variable())  # Output: 2
```

The __str__ Method

The __str__() method returns a string representation for the object. By default, it returns a string consisting of a class name of which the object is an instance and the object's memory address in hexadecimal.

```
def __str__(self):
        return "color: " + self.__color + \
            " and filled: " + str(self.__filled)
```

The `__eq__` Method

The `__eq__` method returns `True` if two objects are the same.

By default, `x.__eq__(y)` (i.e., `x == y`) returns `False`, but `x.__eq__(x)` is `True`.

You can override this method to return `True` if two objects have the same contents.

Polymorphism

The three pillars of object-oriented programming are *encapsulation*, *inheritance*, and *polymorphism*.

The inheritance relationship enables a subclass to inherit features from its superclass with additional new features. A subclass is a specialization of its superclass; every instance of a subclass is also an instance of its superclass, but not vice versa. For example, every circle is a geometric object, but not every geometric object is a circle. Therefore, you can always pass an instance of a subclass to a parameter of its superclass type.

Dynamic Binding

Dynamic binding works as follows: Suppose an object o is an instance of classes C_1, C_2, ..., C_{n-1}, and C_n, where C_1 is a subclass of C_2, C_2 is a subclass of C_3, ..., and C_{n-1} is a subclass of C_n. That is, C_n is the most general class, and C_1 is the most specific class. In Python, C_n is the object class. If o invokes a method p, the interpreter searches the implementation for the method p in C_1, C_2, ..., C_{n-1} and C_n, in this order, until it is found. Once an implementation is found, the search stops and the first-found implementation is invoked.

The isinstance Function

The isinstance function can be used to determine if an object is an instance of a class.

IsinstanceDemo

Relasjoner mellom klasser

- Assosiasjon
  - Den mest generelle relasjon
    - Et objekt har en referanse til et annet objekt
- Aggregat
  - Type «har»: En bedrift har filialer (filialer kan opprettes og legges ned)
  - Uavhengig levetid
- Composition
  - Sterkere enn aggregat, er «uløselig knyttet» til / «kan ikke eksistere uten»
  - De aggregerte og det aggregerende objekt lever like lenge
  - Et hus har rom
- Vi snakker uansett om at et objekt har en *referanse* til ett eller flere objekter av en annen type (hvis flere, gjerne en liste).

Association

Association represents a general binary relationship that describes an activity between two classes.


```
class Student:
  def addCourse(self,
      course):
  # add course to a list
```

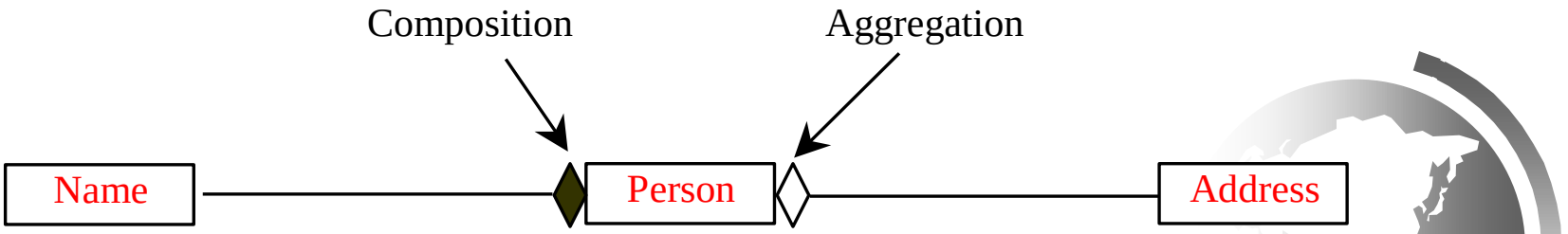
```
class Course:

  def addStudent(self,
      student):
    # add student to a list

  def setFaculty(self, faculty):
    # Code omitted
```

```
class Faculty:
  def addCourse(self,
     course):
     # add course to a list
```

An association is usually represented as a data field in the class.

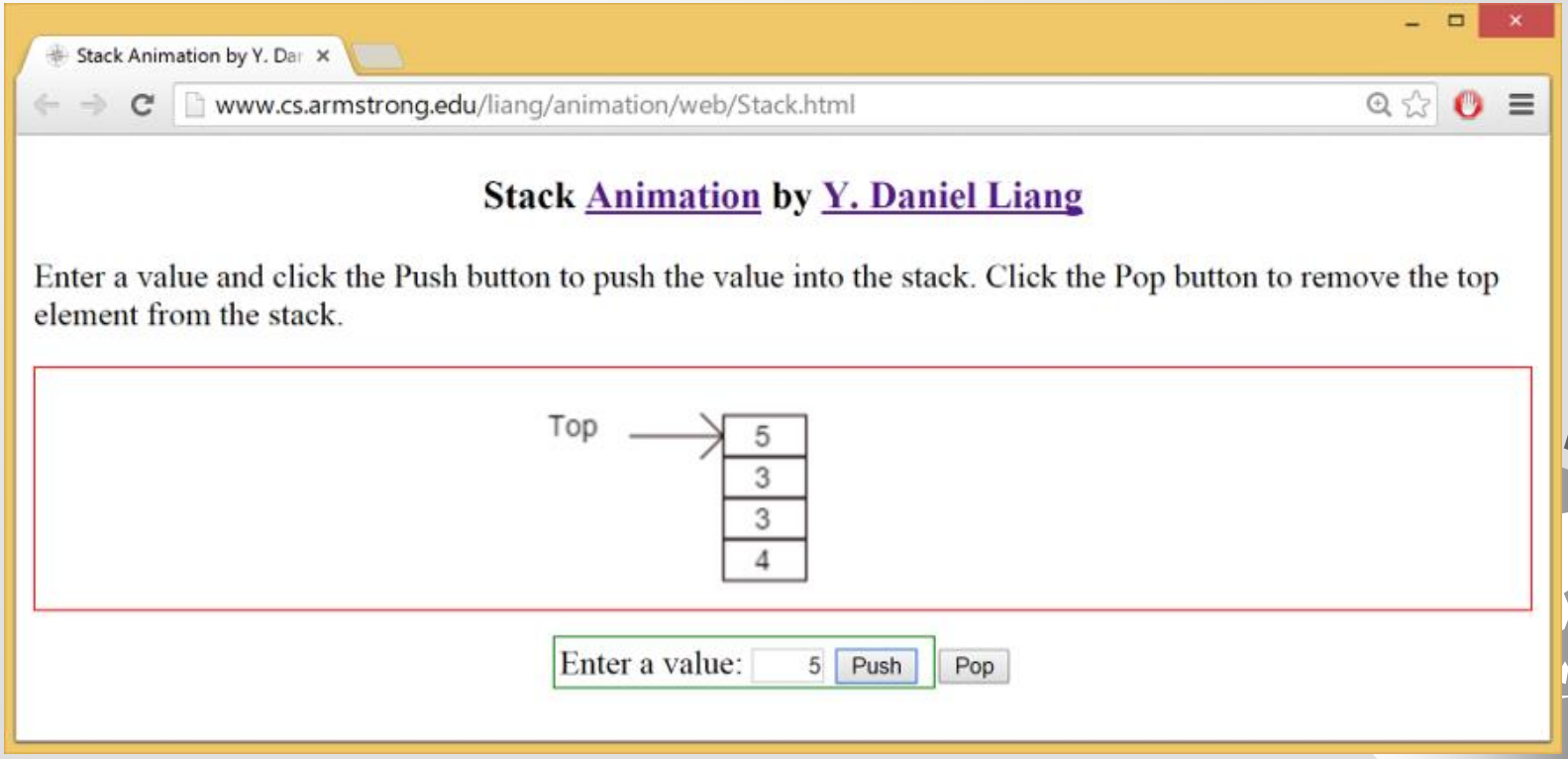
Aggregation and Composition

Aggregation is a special form of association, which represents an ownership relationship between two classes. Aggregation models the has-a relationship. If an object is exclusively owned by an aggregated object, the relationship between the object and its aggregated object is referred to as *composition*.



Stack Animation

https://liveexample.pearsoncmg.com/dsanimation/StackeBook.html

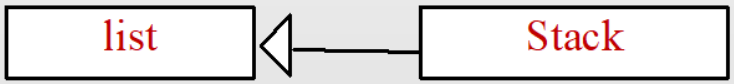


The Stack Class (1 of 2)

You can define a class to model stacks. You can use a list to store the elements in a stack. There are two ways to design the stack and queue classes:

Using inheritance: You can define a stack class by extending **list**.

Using composition: You can create a list as a data field in the stack class.



Both designs are fine, but using composition is better because it enables you to define a completely new stack class without inheriting the unnecessary and inappropriate methods from the list class.

The Stack Class

Stack	
-elements: list	A list to store elements in the stack.
+Stack()	Constructs an empty stack.
+isEmpty(): bool	Returns True if the stack is empty.
+peek(): object	Returns the element at the top of the stack without removing it from the stack.
+push(value: object): None	Stores an element into the top of the stack.
+pop(): object	Removes the element at the top of the stack and returns it.
+getSize(): int	Returns the number of elements in the stack.

Stack

TestStack