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UNIVERSITY OF APPLIED SCIENCES

Programming II

Introduction to Object-oriented-programming

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Course Outcome

- **Upon completion of this course, students are able to:**
  - implement complex software projects in Python,
  - utilize advanced data abstraction concepts in Python,
  - follow basic paradigms of error handling, software testing and pattern utilization.

https://www.fh-krems.ac.at/en/study/bachelor/full-time/informatics/#curriculum

Course Format

- **Theory + Exercises in class**
  - Always COMPLETE the exercises
  - Hard to cover up, if left behind
- **Additional non-graded Homeworks**
  - Not optional!, Crucial for your practical understanding
  - Discussion in class, if needed!
- **Graded Homeworks (50%)**
  - Two Projects (20% + 20%)
  - One individual skill assessment session (10%)
- **Final Examination (50%)**

Projects (50%)

- **First project**
  - Submission deadline 09.04.2023
- **Second project**
  - Submit a proposal of your choice
  - Proposal approval – deadline 15.04.2023
  - Project 2 Submission - deadline 05.06.2023
  - Presentation on 06.06.2023
- **Individual skill assessment sessions (20 min each)**
  - To be scheduled individually after the submission of the first exercise.
  - You need to be able to explain/change/extend the code you submitted.
  - May lead to cancellation of the first submission.
  - If the first project is not submitted, the assessment will be about the second project.

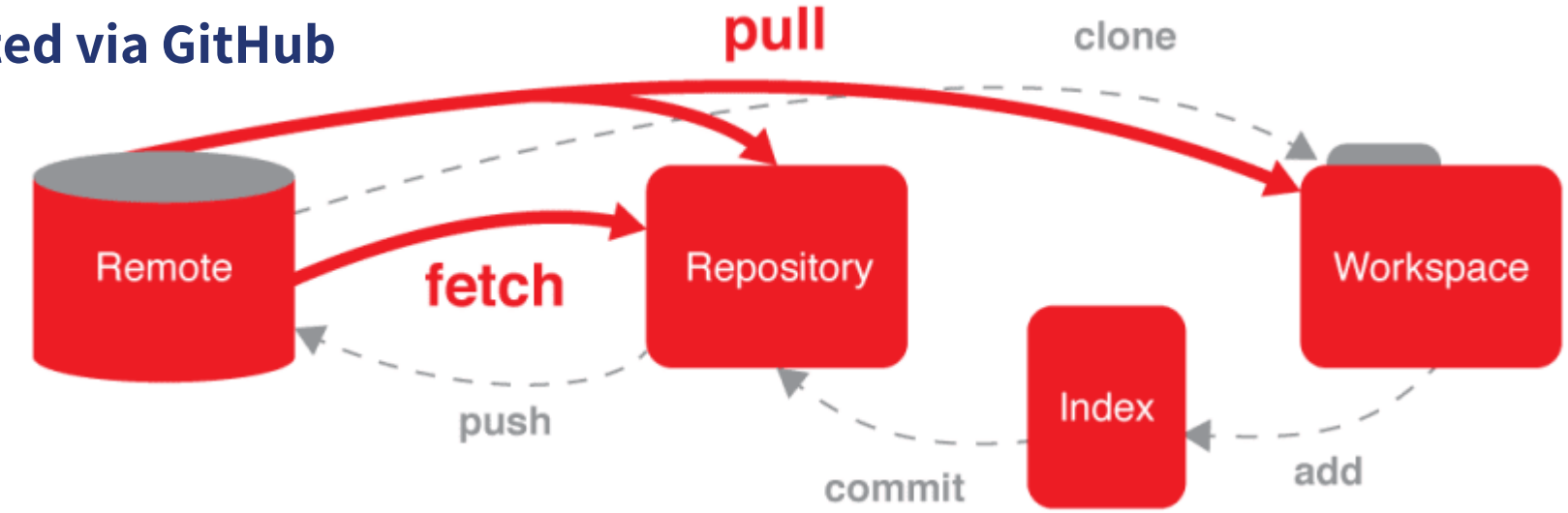
Must use networking features and a database.
Examples: games, social apps*, enterprise apps, utility apps, etc
*not mobile apps!

Proposal: 1-2 pages description of the application you wish to develop as your second exercise.

You must deliver what you propose!

Course Materials

- **Course materials incl. code will be in Github**
  https://github.com/deepak-dhungana/INF-SS23-Programming-II
  First assignment: write your Github Username to get access!
- **Learn how to use Github!**
  - https://www.youtube.com/watch?v=0fKg7e37bQE
  - https://www.youtube.com/watch?v=SWYqp7iY_Tc
- **Homework will be submitted via GitHub**



Get Professional Edition of PyCharm

- **We will gradually switch our IDE to PyCharm**
  - Get Free Educational License for Students
  - https://www.jetbrains.com/community/education/#students

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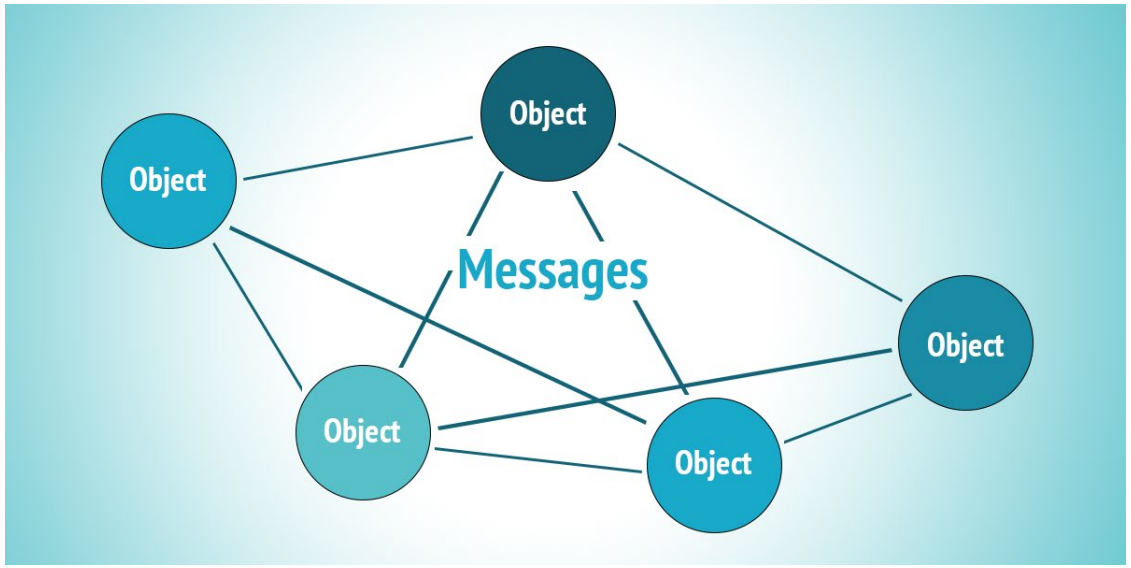
Object-oriented Programming

Keywords in Python

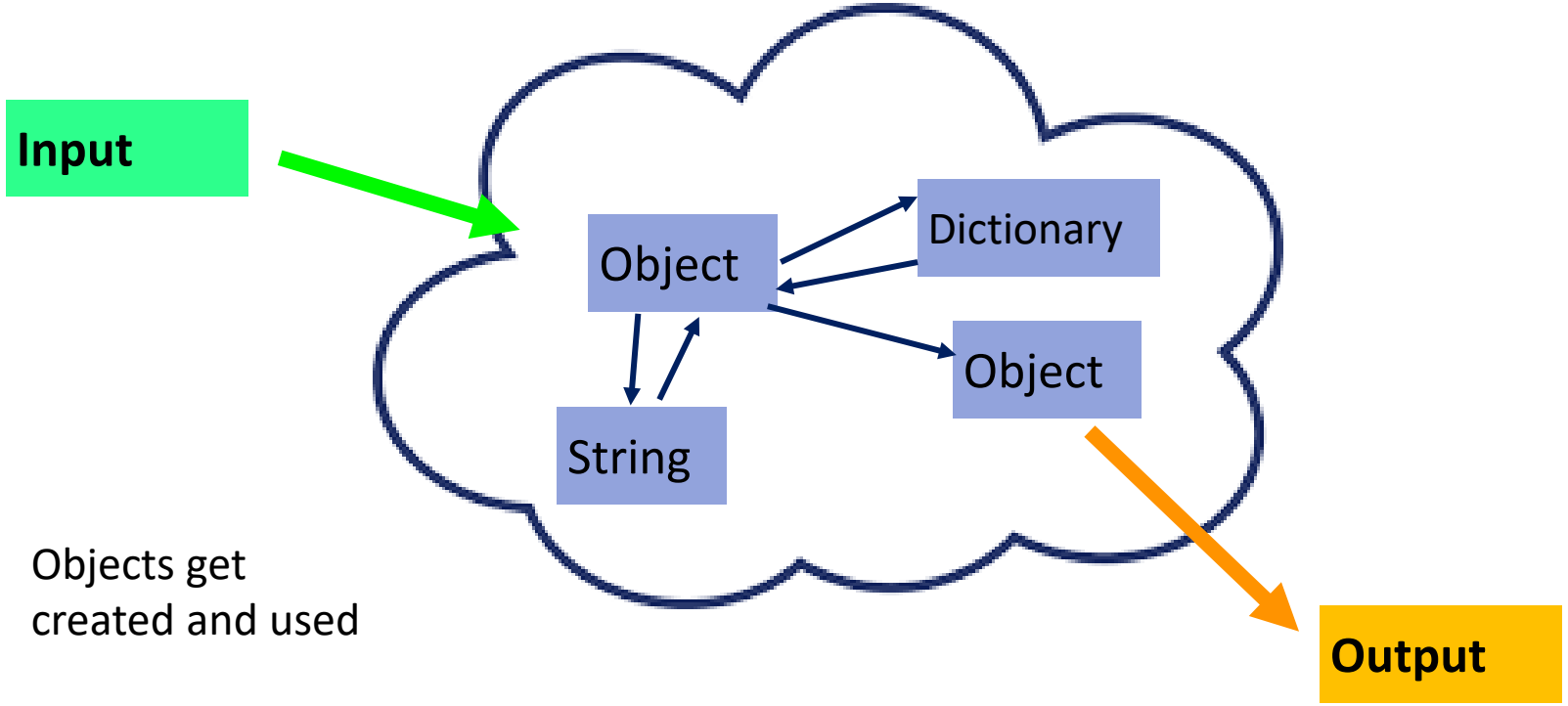
False	class	finally	is	return
None	continue	for	lambda	try
True	def	from	nonlocal	while
and	del	global	not	with
as	elif	if	or	yield
assert	else	import	pass	
break	except	in	raise	

Object-orientation

- **Python is an object-oriented programming language**
  - A program is made up of many cooperating objects
  - Instead of being the “whole program” - each object is a little “island” within the program and cooperatively working with other objects.
  - A program is made up of one or more objects working together - objects make use of each other’s capabilities



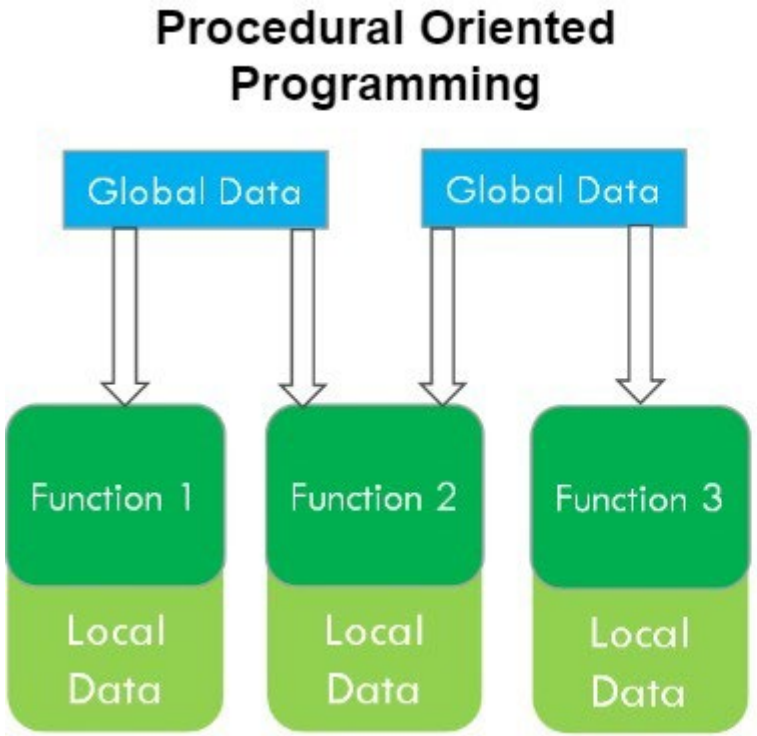
Objects interact with each other!

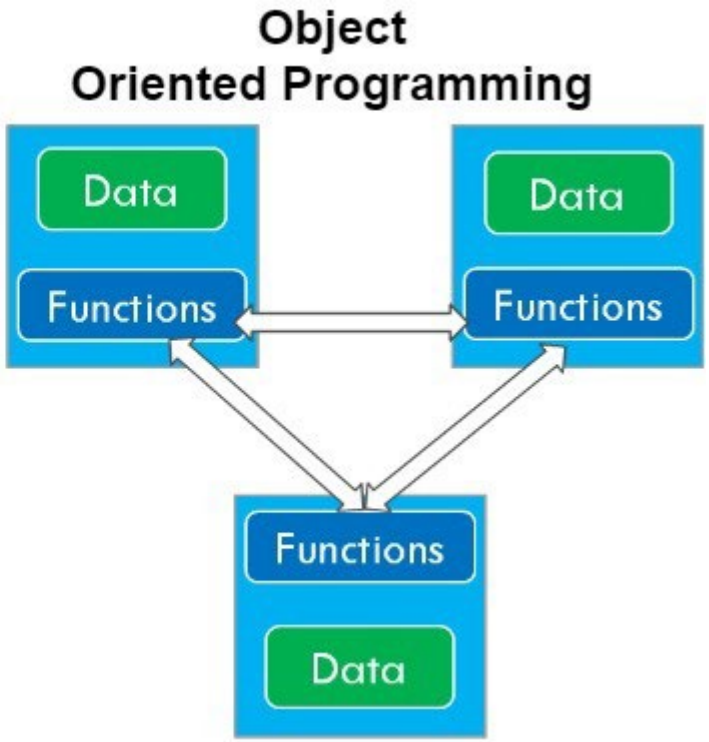


Objects get created and used

Procedural vs. Object-oriented

- Classes & Objects
- Data Abstraction
- Data Encapsulation
- Inheritance
- Polymorphism
- Message Passing





Objects Everywhere

- **Everything in Python is really an object.**
  - We've seen hints of this already…

```
"hello1".upper()
list3.append('a')
dict2.keys()
```

  - New types of Objects can be easily defined.
  - In fact, programming in Python is typically done in an object-oriented fashion.

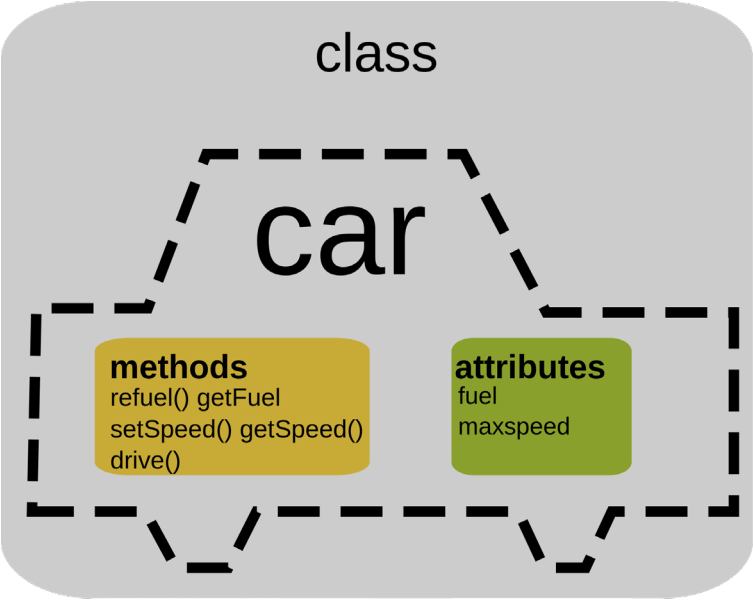
```
from bs4 import BeautifulSoup
import requests
url = input("Enter a URL: ")
r  = requests.get("http://" +url)
data = r.text
soup = BeautifulSoup(data)
for link in soup.find_all('a'):
    print(link.get('href'))
```

Can you spot all the objects?

Object-Orientation Terminology

- **OOP allows representation of real-life objects as software objects**
  - **Object**: A single software unit that combines attributes and methods
  - **Attribute**: A "characteristic" of an object; like a variable associated with a kind of object
  - **Method**: A "behavior" of an object; like a function associated with a kind of object
  - **Class**: Code that defines the attributes and methods of a kind of object

(A class is a collection of
variables and
functions working with these variables)



Example: Terminology in OOP

- **Class** - a template - **Dog**
- **Method** - A defined capability of a class - **bark**()
- **Attribute -** A bit of data in a class – **color** of the dog
- **Object** or **Instance** - A particular instance of a class - **Lassie**

Define your classes

- **Class** - a template - Dog
- **Method** - A defined capability of a class - bark()
- **Attribute -** A bit of data in a class – color of the dog
- **Object** or **Instance** - A particular instance of a class - Lassie

```
class Dog:
    pass
```

Type Definition:
Code that defines the attributes and methods of a kind of object

```
lassie = Dog()
rocky = Dog()
```

Instantiation
To create an object. A single object is called an **Instance**

Adding to Our Dog Class

```
class Dog:
   def __init__(self, name, color):
      self.name = name
      self.color = color
            print ("a new dog is born")
```

Constructor

```
lassie = Dog("Lassie", "white")
rocky = Dog("Rocky", "black")
```

Instantiation
(calls the constructor)

Dog:Lassie
name:Lassie
color:white

Dog:Rocky
name:Rocky
color:black

- **Create new object with class name followed by set of parentheses**
  - **Dog()** creates new object of class Dog
- **Can assign a newly instantiated object to a variable of any name**
  - **lassie = Dog(...)** assigns new Dog object to lassie
- **Avoid using variable that's same name as the class name in lowercase letters**

Constructors

- **Constructor**: A special method that is automatically invoked right after a new object is created
- Usually sets up the initial attribute values of new object in constructor
- New **Dog** object automatically announces itself to world

```
def __init__(self):
    print ("A new dog has been born!“)
```

- **__init__**
  - Is a special method name
  - Automatically called by new Dog object

Constructors and Methods

- **Constructor**: A special method that is automatically invoked right after a new object is created
- An **__init__** method can take any number of arguments.
- Like other functions or methods, the arguments can be defined with default values, making them optional to the caller.
- However, the first argument **self** in is special…

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

    def bark(self):
        print ("I am", self.color, self.name)
```

Constructor

Method

self

- The first argument of every method is a reference to the current instance of the class
- By convention, we name this argument **self**
- In **__init__**, **self** refers to the object currently being created; so, in other class methods, it refers to the instance whose method was called
- Although you must specify **self** explicitly when *defining* the method, you don't include it when *calling* the method.
- Python passes it for you automatically

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

    def bark(self):
        print ("I am", self.color, self.name)
```

Constructor

Method

```
lassie = Dog("Lassie", "white")
lassie.bark()
```

Instantiation

Invoking/Calling a Method

- Every **Dog** object has method bark()

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

    def bark(self):
        print ("I am", self.color, self.name)
```

Constructor

Method

lassie.bark() invokes **bark** method of Dog object lassie

```
lassie = Dog("Lassie", "white")
lassie.bark()
```

Instantiation

rocky.bark() invokes **bark** method of Dog object rocky

```
rocky = Dog("Rocky", "black")
rocky.bark()
```

Accessing Attributes

- Assessing attributes using methods: **bark**()
  - Uses a Dog object's name attribute
  - Receives reference to the object itself into **self**
- Accessing Attributes Directly

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

    def bark(self):
        print ("I am", self.color, self.name)
```

Constructor

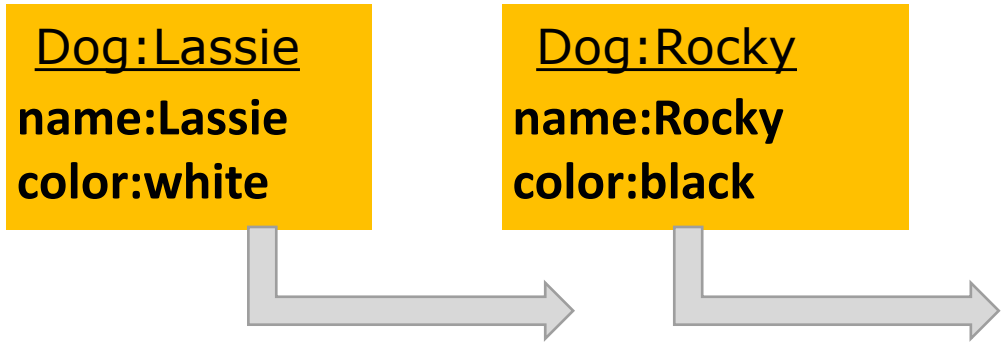
Method

```
lassie = Dog("Lassie", "white")
lassie.bark()
```

Instantiation

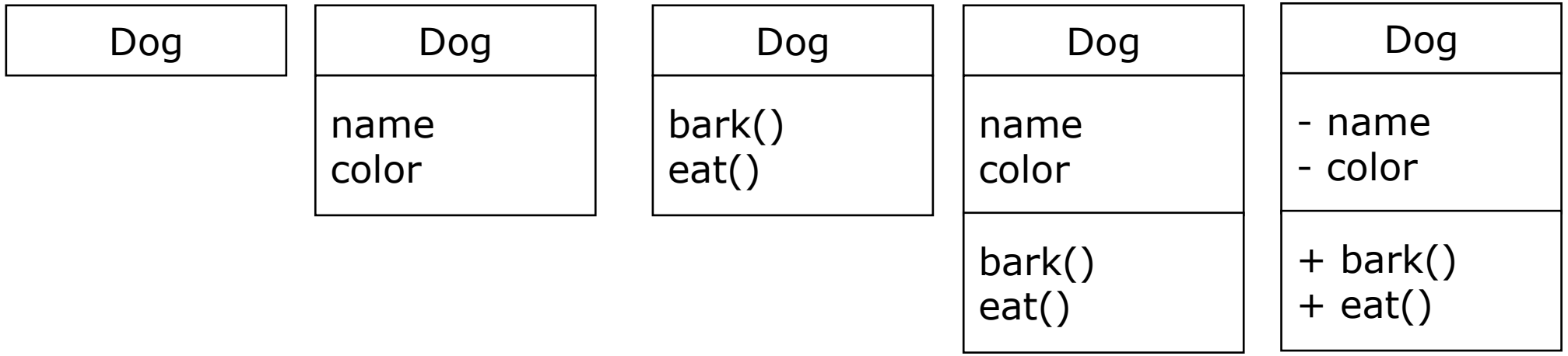
```
rocky = Dog("Rocky", "black")
rocky.bark()
```

```
print (lassie.name)
print (lassie.color)
```



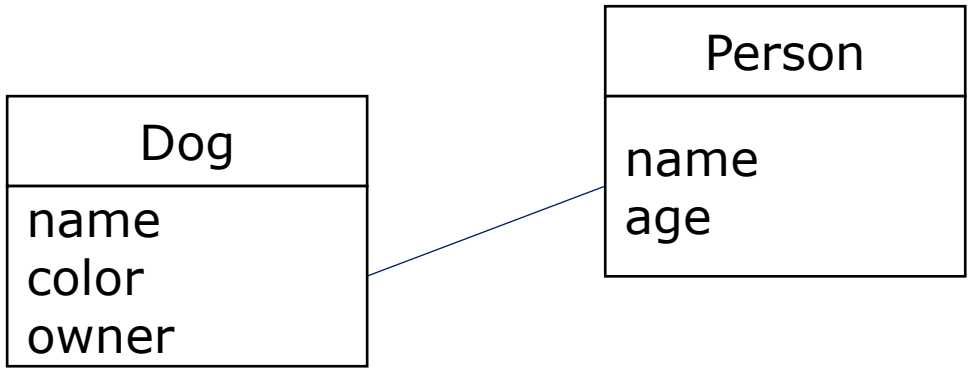
UML Class Diagrams

- **A class is simply represented as a box with the name of the class inside**
  - The diagram may also show the attributes and operations



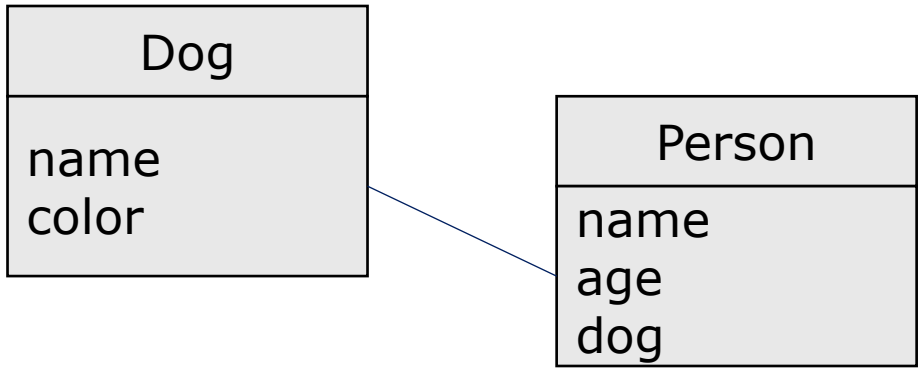
Interaction between Classes

Associations



Dog has a reference to its owner!

```
p = Person("Mr Smith")
d = Dog("Lassie")
d.owner = p
```

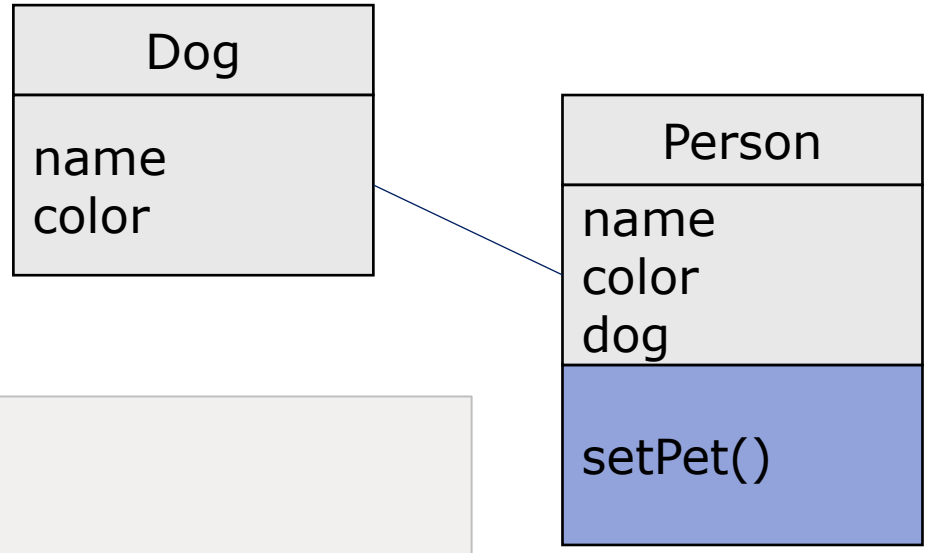


Owner has a reference to his/her dog!

```
p = Person("Mr Smith")
d = Dog("Lassie")
p.dog = d
```

Methods

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




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

    def setPet(self, d):
        self.dog = d
```

```
p = Person ("Mr. Smith")
d = Dog("Lassie")
p.setPet(d)

print (d)
print(p.dog)
```

```
<__main__.Dog object at 0x000002AC4030E978>
<__main__.Dog object at 0x000002AC4030E978>
```

Exercise

- Define classes required for a Zoo!
- Zoo has many animals – each animal has a name, age and weight.
- The animals can make noises and eat, and sleep.
- Zoo has animal care takers. Each caretaker has a name. Care takers feed animals.
- Create a list of 10 animals.
- Create one care taker, who feeds all the animals.
- Write code for the classes Animal and Person, so that the instantiation works as expected.

```
animals = [
        Animal("Tiger32", 12, 121),
        Animal("Lion42", 4, 131),
        Animal("Zebra 12", 12, 11),
        Animal("Bison 23", 4, 121),
        # add more
        ]

caretaker = Person ("Joe")

for animal in animals:
        caretaker.feed(animal, "Apple")
```

output

```
Joe just fed Tiger32: Apple
Joe just fed Lion42: Apple
Joe just fed Zebra 12: Apple
Joe just fed Bison 23: Apple
```

Exercise

- Define the classes (Student, Exam, University) so that following Excerpt of code from a Student Management System works as expected.

```
s1= Student ("Sandy", "24.01.1992") # name, dob
s2= Student ("Spili", "14.10.1993") # name, dob
s3= Student ("Waile", "04.06.1994") # name, dob

imc = University ("FH Krems")

imc.enroll(s1)
imc.enroll(s2)
imc.enroll(s3)

e1 = Exam("Programming II")
e2 = Exam("Software Eng")
e3 = Exam("Creativity")

# assign a random value as grade
s1.takeExam (e1)
s2.takeExam (e1)
s3.takeExam (e1)

s1.takeExam (e2)
s2.takeExam (e2)

s1.takeExam (e3)
s3.takeExam (e3)

# print statistics
imc.stats()
```

Output

```
Sandy took 3 exams
        Got 4 in Programming II
        Got 1 in Software Eng
        Got 2 in Creativity
Spili took 2 exams
        Got 3 in Programming II
        Got 1 in Software Eng
Waile took 2 exams
        Got 3 in Programming II
        Got 2 in Creativity
```

Exercise

- Extend the class structure from previous exercise, so that the new code excerpt works as expected.
- Add a new method called stats() in the Exam class.

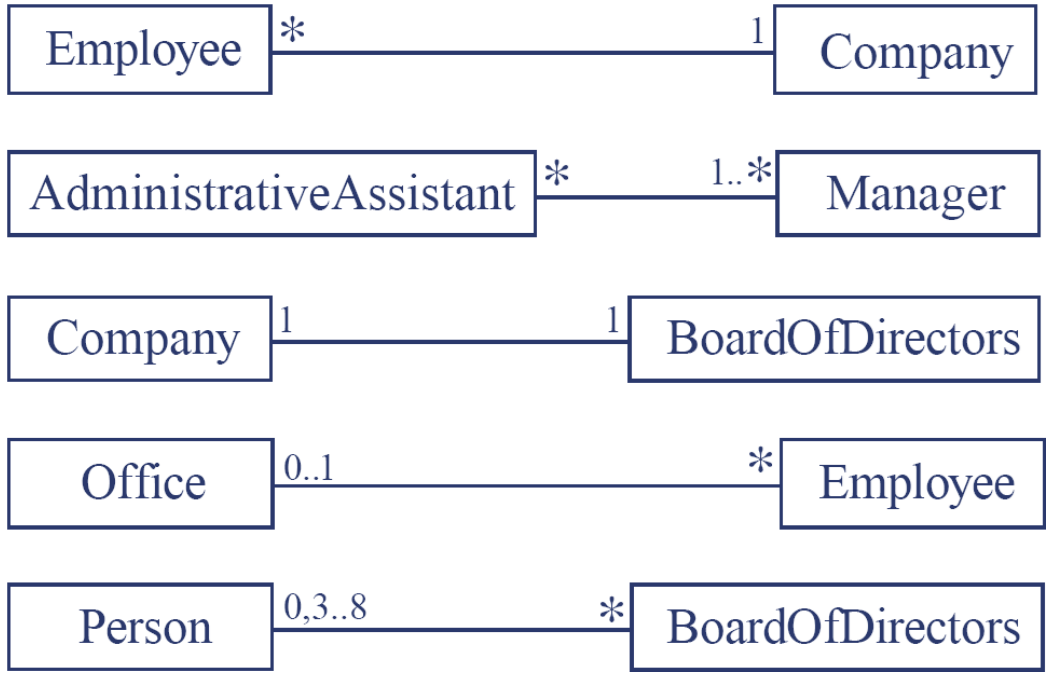
```
Sandy took 3 exams
        Got 1 in Programming II
        Got 3 in Software Eng
        Got 1 in Creativity
Spili took 2 exams
        Got 5 in Programming II
        Got 4 in Software Eng
Waile took 2 exams
        Got 5 in Programming II
        Got 4 in Creativity
Programming II exam was taken by 3 students. Average score = 3.6666666666666665
Software Eng exam was taken by 2 students. Average score = 3.5
Creativity exam was taken by 2 students. Average score = 2.5
```

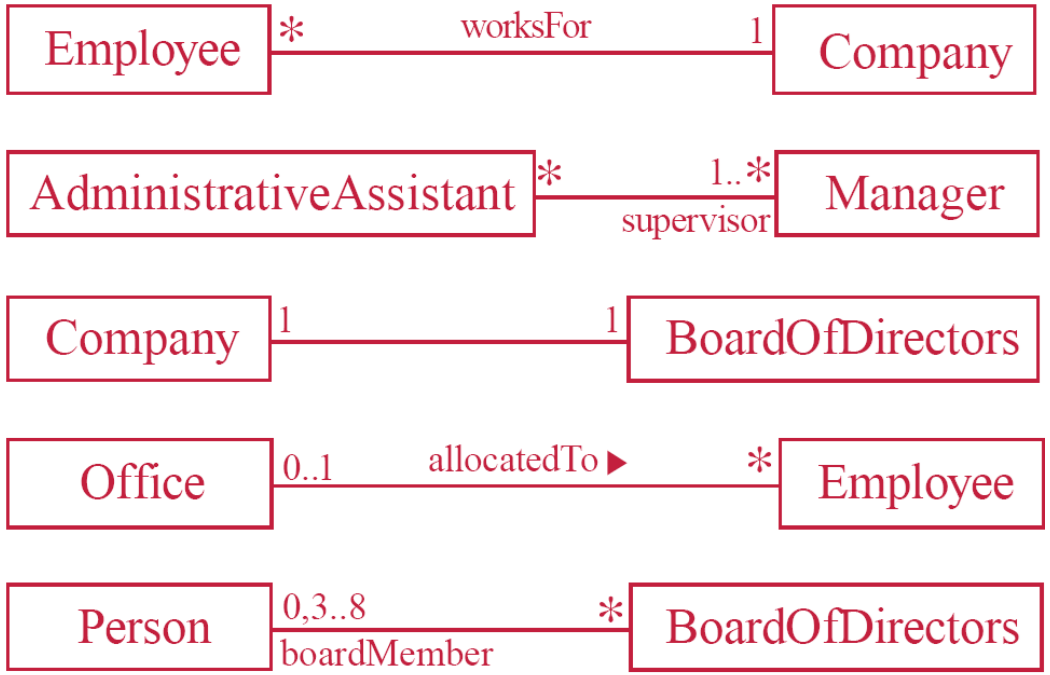
New

```
...
# same as in previous slide

# assign a random value as grade
s1.takeExam (e1)
s2.takeExam (e1)
s3.takeExam (e1)

s1.takeExam (e2)
s2.takeExam (e2)

s1.takeExam (e3)
s3.takeExam (e3)

# print statistics
imc.stats()


e1.stats()
e2.stats()
e3.stats()
```

Associations and Multiplicity

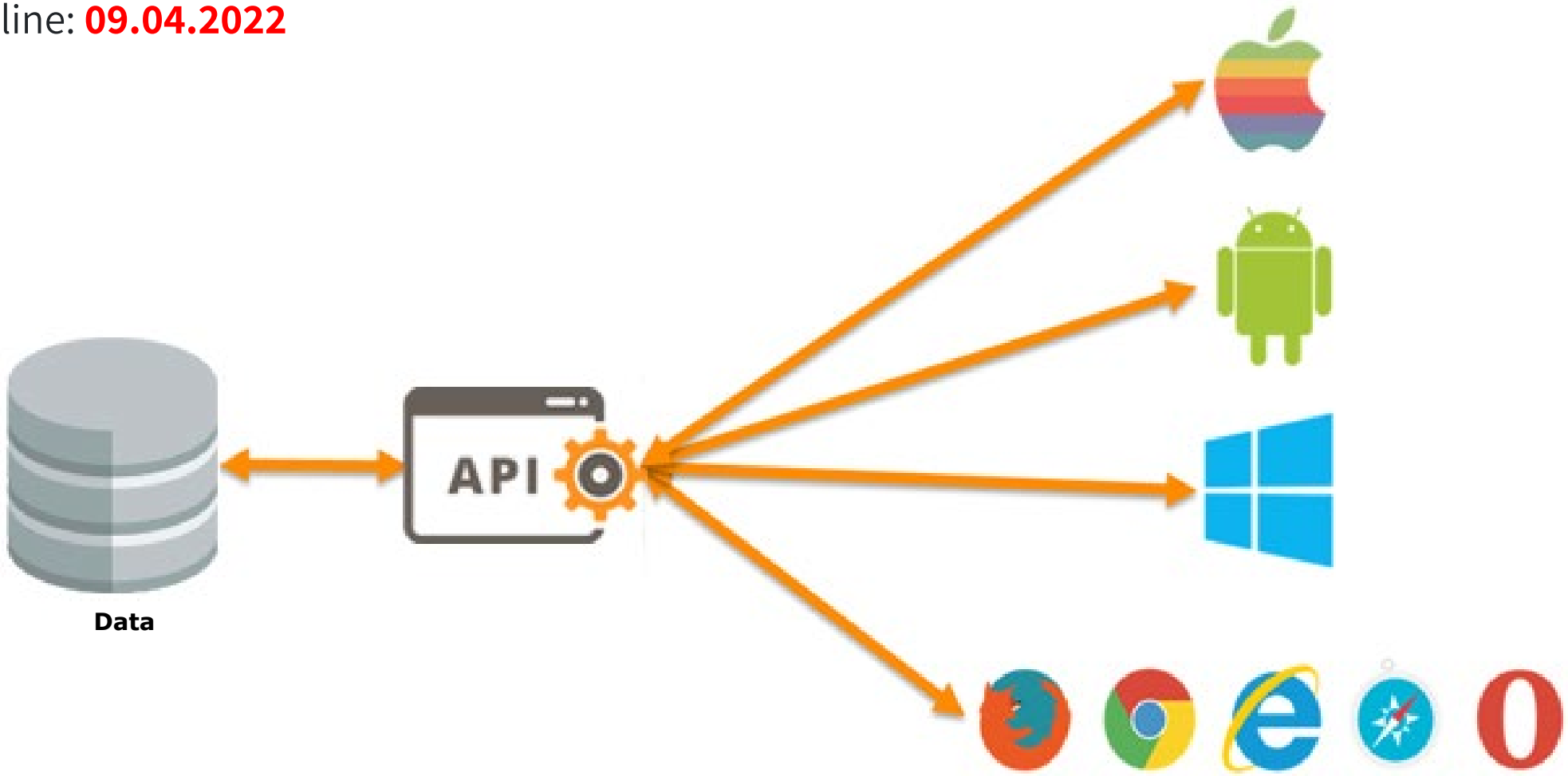
- An association is used to show how two classes are related to each other
- Symbols indicating multiplicity are shown at each end of the association





First Project Description is Online

- Deadline: **09.04.2022**



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