Duck Typing in Python

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Introduction

Python is an ***interpreted***, ***multi-paradigm*** language. It was initially designed by Guido van Rossum in 1991 and developed by Python Software Foundation. It supports:

- **Functional programming** (non pure);
- **Procedural programming**;
- **Objected oriented**.

Python's semantic

Could be useful to first recall the difference between ***strict*** and ***lazy*** evaluation:

1. **Strict evaluation strategy**: the arguments of a function are fully evaluated to values before evaluating the function call (call by value);
2. **Non-strict or Lazy evaluation:** arguments are evaluated only if it is needed in the function body (*call by name*)

Python:

- implements **strict semantic**;
- uses **whitespace indentation**, rather than curly brackets or keywords, to delimit blocks.

Semantic: Python vs Haskell

In Python we never get *true* beacause it forces the evaluation of the function wich contains an infinite loop in the body:

```
def infiniteLoop(x):
    while True:
        print("do something with x")
    return x

5 in [5, 10, infiniteLoop(5)]
```

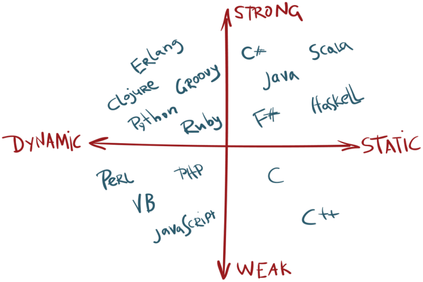
If we write the same code in **haskell** we get the *true* value:

```
elem 2 [2, 4, noreturn 5]
```

Type checker (1)

Type checking is the process of verifying and enforces the typing rules of a language.

1. **Dynamic vs. Static**
2. **Weak vs. Strong.**



Type checker (2)

1. **Dynamic vs. Static**
   - **Statically-typed languages**: typechecking is done at compile-time, in order to guarantee the absence of run-time (type) errors: formal proof of type-safety.
   - **Dynamically-typed languages:** dynamic type checking is the process of verifying type constraints at runtime, during execution.
2. **Weak vs. Strong**
   - AGGIUNGERE STRONGLY
   - AGGIUNGERE WEAKLY

Python's type checker

1. Python is **dynamic**:
   - objects have a type but it is determined at runtime;
   - variables are not explicitly typed;
   - an assignement binds a name to an object and the object could be of any type;
2. Python is also **strongly typed**.

Let's see the implications by some example.

Python's dynamic typing example (1)

```python
if False:
    print(10+"ten")
else:
    print(10+10)
```

The first branch never execute, so the type checking ignore the type incongruency.
If we try to execute **separately** the first branch, the type check raise a type error:

```
TypeError: unsupported operand type(s) for +: 'int' and 'str'
```

Python's dynamic typing example (2)

Another consequnce is that programmers are **free to bind the same names (variables) to different objects with a different type**. Then the following statements are perfectly legal:

```
variable = 10
variable = "ten"
```

So long as you only perform operations valid for the type the interpreter doesn't care what type they actually are.

Python's strong typing example

Python is not allowed to perform operations inappropriate to the type of the object:

```
print(10+"ten")
```

In a **weakly-typed** language, like PHP, the integer is forced to be a string and no type error is raised:

```
$temp = "ten";
$temp = $temp + 10; // no error caused
echo $temp;
```

The output will be "ten10".

Some exceptions (1)

There are some operations allowed even in case of type incongruence.
The **boolean equivalence** is permitted in Python 2 and 3:

```
print("10" == 10)
print("10" != 10)
```

Returning:

```
False
True
```

Some exceptions (2)

In Python 2 "*grather than*" and *"less than"* are permitted:

```
print("10">10)
print("10"<10)
```

Returning:

```
True
False
```

Python 3 do not allowed to do "*grather than*" and *"less than"* controls like these.

Annotations

Annotations were introduced in Python 3.0 and are the main way to add type hints to the code. We can annotate both **function** and **variable**.

```
import math

pi: float = 3.142

def circumference(radius: float) -> float:
    return 2 * math.pi * radius
```

Type hints and annotations ***do not add a real static typechecking*** in native Python so this should not effect the code performance.

Annotations: why use it?

From PEP 484:
" <...>using type hints for performance optimizations is left as an exercise for the reader".

Advantages:

- Type hints help document your code;
- Type hints improve IDEs and linters. This allows IDEs to offer better code completion and similar features.

Disadvantages

- Type hints take developer time and effort to add.
- Type hints introduce a slight penalty in start-up time.

Object oriented (1)

```
class Duck():
    def __init__(self, name, colour):
        self.name = name
        self.colour = colour
    def quack(self):
        return "Quaaack"
    def fly(self):
        return "The duck is flying"

donald = Duck("Donald","white")

donald.name
donald.colour
donald.quack()
donald.fly()
```

Object oriented (2)

- The first argument of every class method is always a reference to the current instance of the class (***self***).
- The ***self*** world is the equivalent of ***this*** in **Java**. However Java do not requires to pass *this* explicitly as a first parameter of a method: it could be used straight in the body of the method.
- However self **is not a reserved keyword** in Python, is just a strong convention.

```
class Duck():
    def __init__(myself, name, colour):
        myself.name = name
        myself.colour = colour
    def quack(myself):
        return "Quaaack"
    def fly(myself):
        return "The duck is flying"
```

Object oriented (3)

In Python **is not possible to define multiple constructor** for a class, still is possible to define a default value if one is not passed.

```
class Parrot():
    def __init__(self, name = "Perry"):
        self.name = name

bird1 = Parrot()
bird2 = Parrot("Jack")

print(bird1.name)
print(bird2.name)
```

The output would be:
"Perry"
"Jack"