Lecture 08: Singleton Pattern
IN710: Object-Oriented Systems Development
Semester One, 2020

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Thursday, 12 March

Lecture 07: Factory Pattern Recap

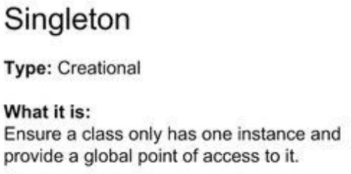
- Design pattern 03: factory pattern
  - Definition
  - Problem/solution
  - UML & implementation
  - Applicability
  - Pros & cons

Lecture 08: Singleton Pattern Topics

- Design pattern 04: singleton pattern
  - Definition
  - Problem/solution
  - Real world analogy
  - UML & implementation
  - Pros & cons

Singleton Pattern: GoF

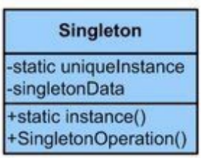
- GoF definition & UML



Singleton

Type: Creational

What it is:
Ensure a class only has one instance and provide a global point of access to it.



Singleton Pattern: Definition

- Creational pattern
- Restricts the instantiation of a class to a single instance
- Useful when exactly one object is needed to coordinate actions within a system
- The term comes from the mathematical concept of a singleton
- Considered to be an anti-pattern
  - Used in situations where is not beneficial
  - Introduces unnecessary restrictions where a single instance is not actually required
  - Introduces global state into an application

Singleton Pattern: Problem

- Ensure that a class has just a single instance
- Provide a global access point to that instance

Singleton Pattern: Solution

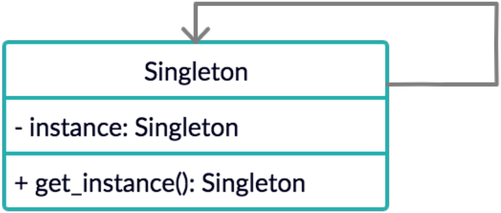
- Make a private default constructor
- Prevents other objects from using the "new" keyword
- Create a static method that acts as a constructor
- To create an object, call the private default constructor & save it in a static variable

Singleton Pattern: Real World Analogy

- The government
- A country can only have one official government

Singleton Pattern: UML

- Consider the following UML diagram:



Singleton

- instance: Singleton

+ get_instance(): Singleton

Singleton Pattern: Implementation

- Naïve singleton

```
class SingletonMeta(type):
    __instance = None

    def __call__(self):
        if not self.__instance:
            self.__instance = super().__call__()
        return self.__instance

class Singleton(metaclass=SingletonMeta):
    pass

def main():
    singleton_1 = Singleton()
    singleton_2 = Singleton()

    if id(singleton_1) == id(singleton_2):
        print('singleton_1 & singleton_2 contain the same instance')
    else:
        print('singleton_1 & singleton_2 contain different instances')

if __name__ == "__main__":
    main() # singleton_1 & singleton_2 contain the same instance
```

Singleton Pattern: Implementation

- Thread-safe singleton

```
from threading import Lock, Thread

class SingletonMeta(type):
    __instance = None
    __lock = Lock()

    def __call__(cls, *args, **kwargs):
        with cls.__lock:
            if not cls.__instance:
                cls.__instance = super().__call__(*args, **kwargs)
        return cls.__instance

class Singleton(metaclass=SingletonMeta):
    def __init__(self, val):
        self.val = val

def test_singleton(val):
    singleton = Singleton(val)
    print(singleton.val)

def main():
    process_1 = Thread(target=test_singleton, args=('One␣singleton␣instance',))
    process_2 = Thread(target=test_singleton, args=('Two␣singleton␣instances',))
    process_1.start()
    process_2.start()

if __name__ == '__main__':
    main()  # One singleton instance
            # One singleton instance
```

Singleton Pattern: Implementation

- Two singleton instances

```
from threading import Lock, Thread

class SingletonMeta(type):
    __instance = None
    __lock = Lock()

    def __call__(cls, *args, **kwargs):
        with cls.__lock:
            if not cls.__instance:
                cls.__instance = super().__call__(*args, **kwargs)
        return cls.__instance

class Singleton:
    def __init__(self, val):
        self.val = val

def test_singleton(val):
    singleton = Singleton(val)
    print(singleton.val)

def main():
    process_1 = Thread(target=test_singleton, args=('One␣singleton␣instance',))
    process_2 = Thread(target=test_singleton, args=('Two␣singleton␣instances',))
    process_1.start()
    process_2.start()

if __name__ == '__main__':
    main()  # One singleton instance
            # Two singleton instances
```

Singleton Pattern: Pros

- Ensures a class has only one instance
- Object is only initialised when it's requested for the first time
- Global access point to the singleton instance

Singleton Pattern: Cons

- Violates the single responsibility principle
- Requires a different implementation in a multi-threaded environment

Practical

- Series of tasks covering today’s lecture
- Worth 1% of your final mark for the Object-Oriented Systems Development course
- Deadline: Friday, 12 June at 5pm

Exam 02

- Series of tasks covering lectures 05-08
- Worth 6% of your final mark for the Object-Oriented Systems Development course
- Deadline: Thursday, 19 March at 5pm

Lecture 09: Adapter Pattern Topics

- Design pattern 05: adapter pattern
  - Definition
  - Problem/solution
  - Real world analogy
  - UML & implementation
  - Pros & cons