Lecture 17: Strategy Pattern
IN628: Programming 4
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Lecture 04: Exceptions & Automation Testing Recap

- Syntax errors
- Exceptions
- Automation testing
  - Unit testing
  - Integration testing
  - End-to-end testing
  - User acceptance testing
- Software development testing practices
  - Test-driven development
  - Behaviour-driven development
  - Continuous integration

What Are Design Patterns?

- Design patterns are typical solutions to common problems in software design
- Each pattern is like a blueprint that you can customize to solve a particular design problem in your code
- Classified into three categories:
  - Structural
  - Behavioural
  - Creational

Structural

- Identifying a simple way to realise relationships among entities
- Patterns to be familiarise yourself with:
  - Adapter
  - Flyweight
  - Proxy
  - Façade - talked about this in lecture 03

Behavioural

- Identify common communication patterns among objects & realise these patterns
- Patterns to be familiarise yourself with:
  - Strategy
  - Observer
  - State
  - Template

Creational

- Deals with object creation mechanisms
- Create objects in a manner suitable to the situation
- Two key ideas:
  - Encapsulating knowledge about which concrete classes the system uses
  - Hiding how instances of these concrete classes are created & combined
- Patterns to be familiarise yourself with:
  - Factory
  - Singleton
  - Builder

Design Patterns Table

C	Abstract Factory	S	Facade	S	Proxy
S	Adapter	C	Factory Method	B	Observer
S	Bridge	S	Flyweight	C	Singleton
C	Builder	B	Interpreter	B	State
B	Chain of Responsibility	B	Iterator	B	Strategy
B	Command	B	Mediator	B	Template Method
S	Composite	B	Memento	B	Visitor
S	Decorator	C	Prototype		

- Reference: Jason S. McDonald

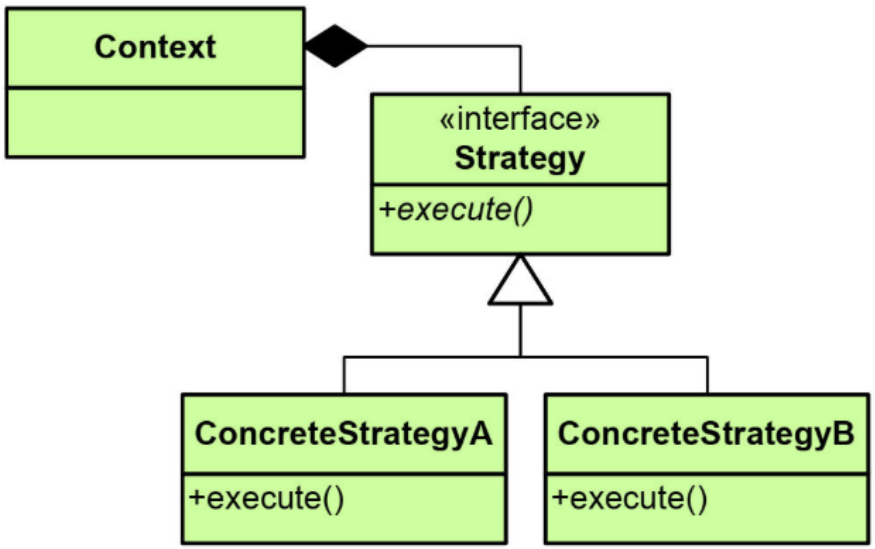
Strategy Pattern: GoF

- GoF definition & UML

Strategy

Type: Behavioral

What it is:
Define a family of algorithms, encapsulate each one, and make them interchangeable. Lets the algorithm vary independently from clients that use it.



Strategy Pattern: Definition

- Policy pattern
- Behavioural pattern
- Defining a family of algorithms
- Encapsulating each algorithm
- Enabling an algorithm to be selected at runtime
- Each algorithm is interchangeable

Strategy Pattern: Problem 1

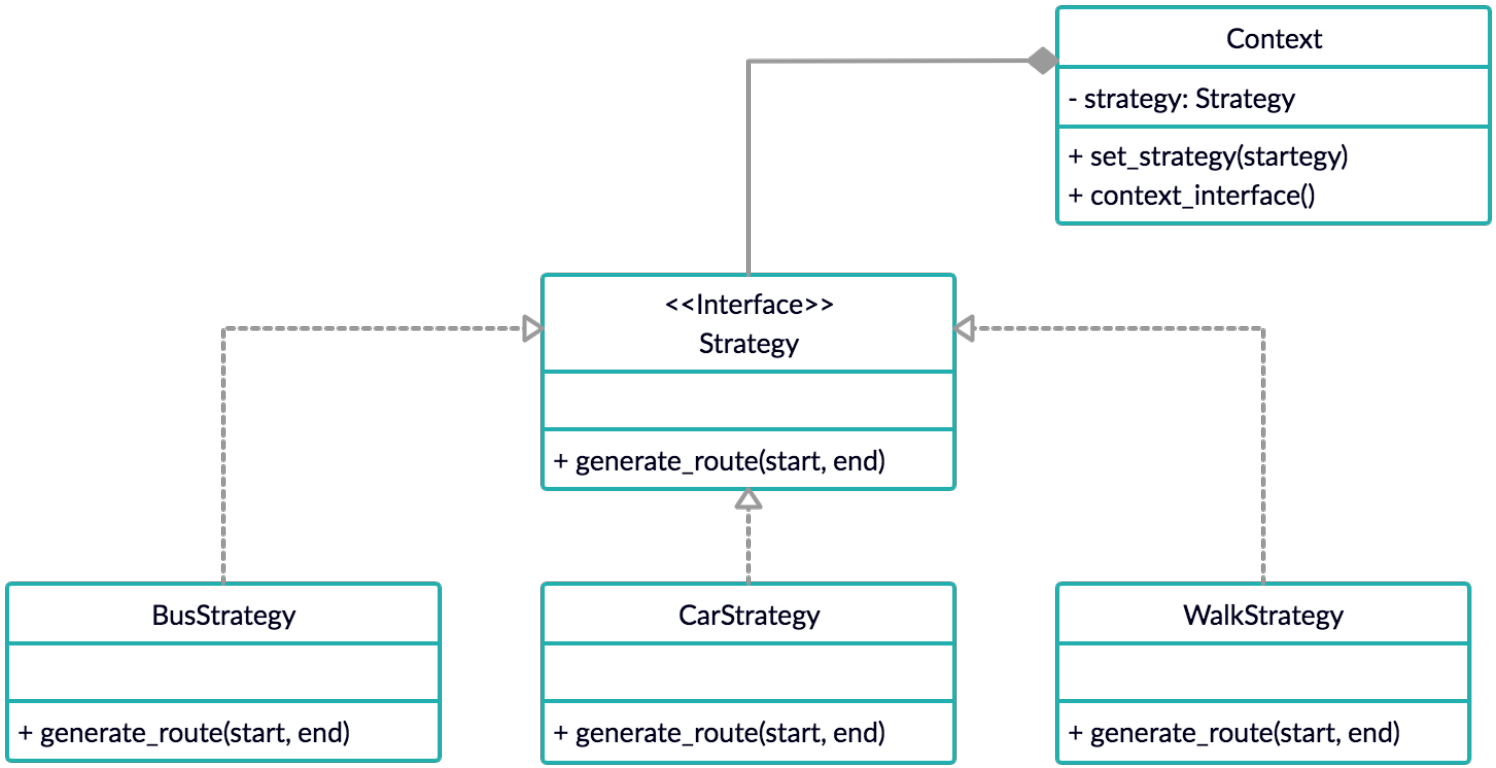
- Performing validation on incoming data
  - Many ways to validate data:
    - Data-type checking
    - Simple range & constraint checking
    - Code & cross reference checking
- Select a validation algorithm depending on different factors
  - Factors are not known until runtime & may require a different validation algorithm to be performed
- The validation algorithms may be used by other validation objects in different areas of the system without code duplication

Strategy Pattern: Problem 2

- Navigation application

Strategy Pattern: Solution 2

- Three separate strategy classes - bus, car & walk

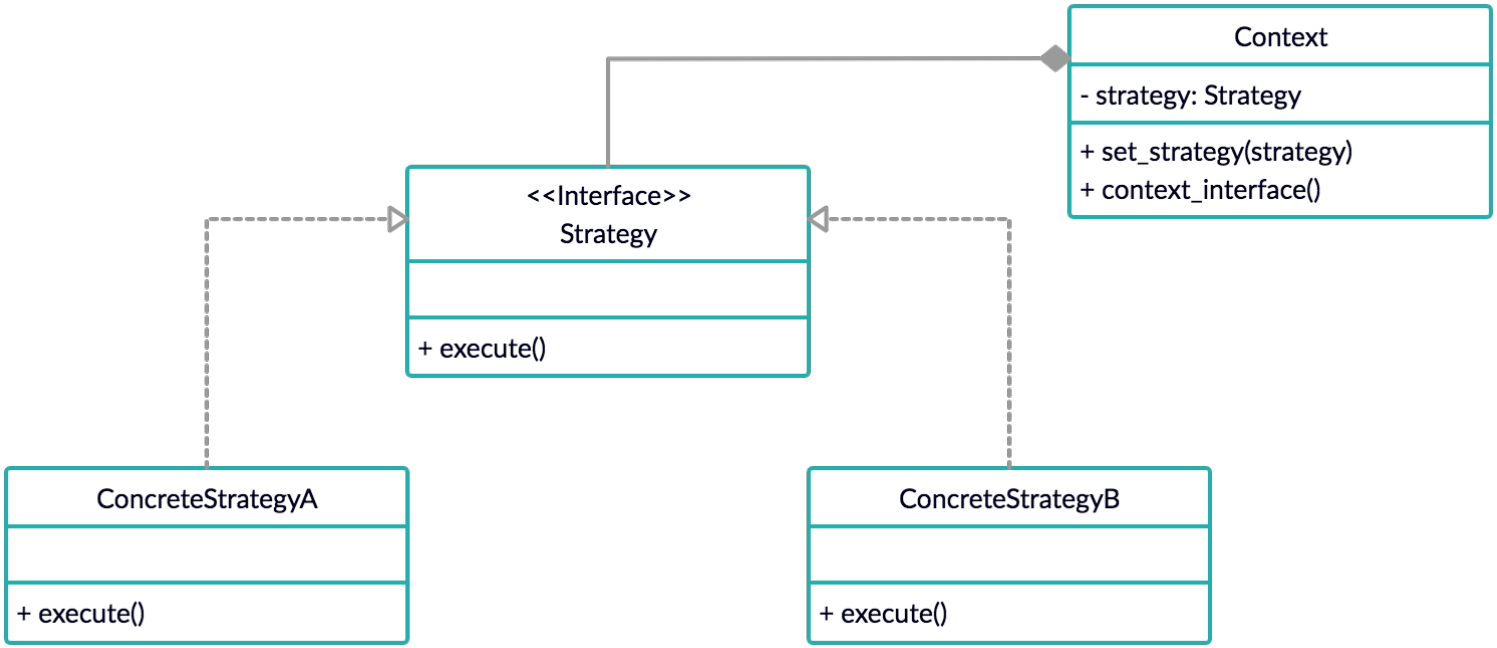


Strategy Pattern: Real World Analogy

- Transport to Dunedin airport
- Transportation strategies - car, shuttle, taxi, etc
- Constraints - cost & time

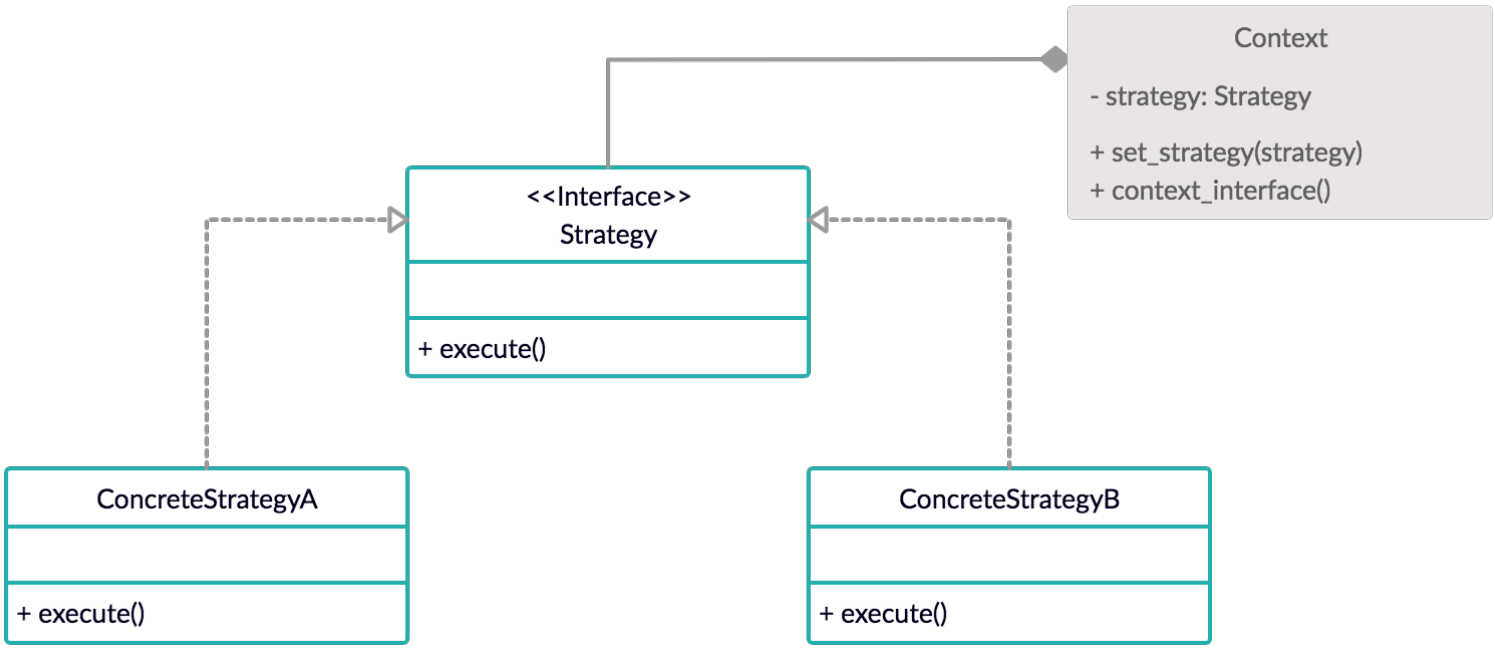
Strategy Pattern: UML

- Consider the following UML diagram:



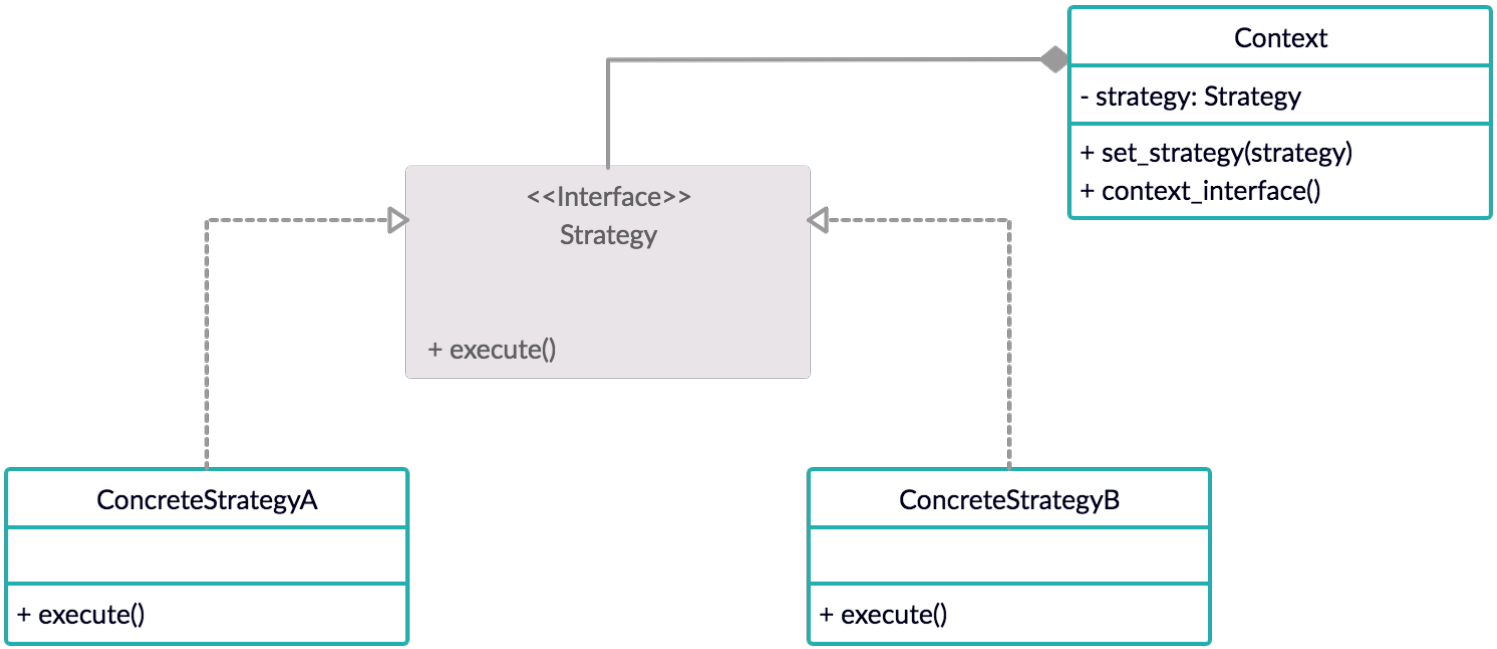
Strategy Pattern: UML

- Context class
- An algorithm isn't implemented directly
- Refers to the strategy interface for executing an algorithm
- Independent of how an algorithm is implemented



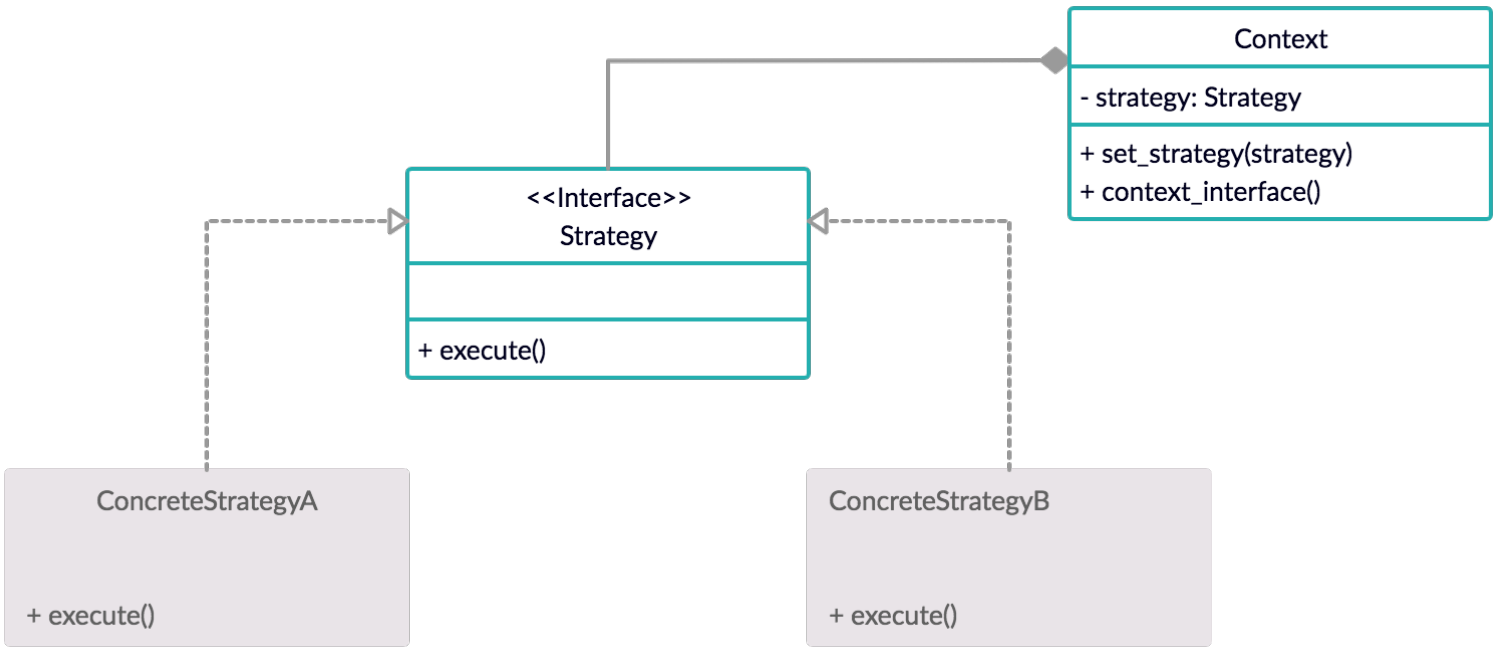
Strategy Pattern: UML

- Strategy interface class
- Declares a method which the context uses to execute an algorithm



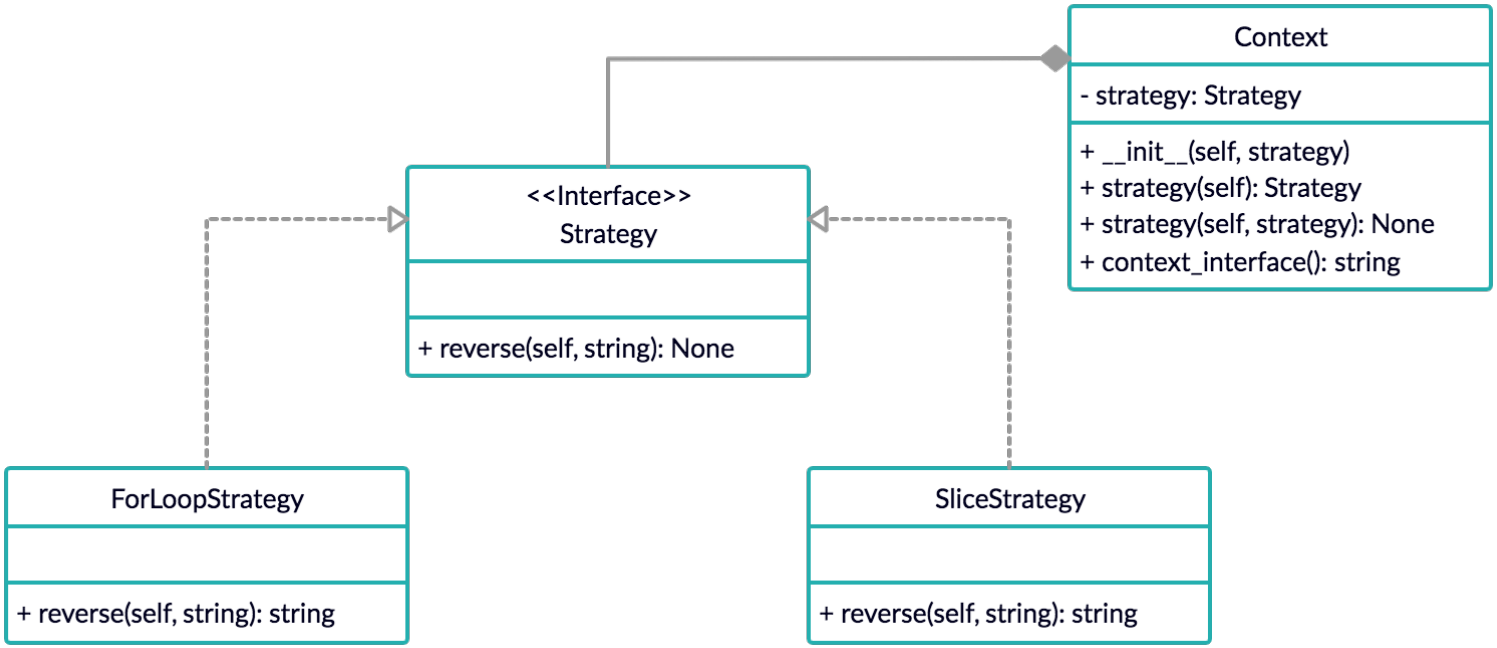
Strategy Pattern: UML

- Concrete strategy classes
- Implement the strategy interface
- Encapsulate the algorithm



Strategy Pattern: UML

- Consider the following UML diagram:



Strategy Pattern: Implementation

```
from abc import ABC, abstractmethod

class Context:
    def __init__(self, strategy):
        self.__strategy = strategy

    @property
    def strategy(self):
        return self.__strategy

    @strategy.setter
    def strategy(self, strategy):
        self.__strategy = strategy

    def context_interface(self):
        return self.__strategy.reverse('abcde')
```

Strategy Pattern: Implementation

```
class Strategy(ABC):
    @abstractmethod
    def reverse(self, string):
        pass

class ForLoopStrategy(Strategy):
    def reverse(self, string):
        reverse_string = ''
        for s in string:
            reverse_string = s + reverse_string
        return reverse_string

class SliceStrategy(Strategy):
    def reverse(self, string):
        return string[::-1]

def main():
    context = Context(ForLoopStrategy())
    print(context.context_interface())
    context.strategy = SliceStrategy()
    print(context.context_interface())

if __name__ == '__main__':
            main()  # edcba
                    # edcba
```

Strategy Pattern: Implementation

```
from abc import ABC, abstractmethod

class Context:
    def __init__(self, strategy, string):
        self.__strategy = strategy
        self.__string = string

    @property
    def strategy(self):
        return self.__strategy

    @strategy.setter
    def strategy(self, strategy):
        self.__strategy = strategy

    @property
    def string(self):
        return self.__string

    @string.setter
    def string(self, string):
        self.__string = string

    def context_interface(self):
        return self.__strategy.reverse(self.__string)
```

Strategy Pattern: Implementation

```
class Strategy(ABC):
    @abstractmethod
    def reverse(self, string):
        pass

class ForLoopStrategy(Strategy):
    def reverse(self, string):
        reverse_string = ''
        for s in string:
            reverse_string = s + reverse_string
        return reverse_string

class SliceStrategy(Strategy):
    def reverse(self, string):
        return string[::-1]

def main():
    context = Context(ForLoopStrategy(), 'abcde')
    print(context.context_interface())
    context.strategy = SliceStrategy()
    context.string = 'fghij'
    print(context.context_interface())

if __name__ == '__main__':
            main()  # edcba
                    # jihgf
```

Strategy Pattern: Open-Closed Principle

- Behaviours of a class shouldn't be inherited
- Instead, a class should be encapsulated using interfaces
- Strategy pattern uses composition instead of inheritance
- Behaviours are defined as separate interfaces & specific classes that implement these interfaces
- Allows better decoupling between the behavior & the class that uses the behaviour
- The behaviour can be changed without breaking the classes that use it

Strategy Pattern: Pros

- At runtime, algorithms are interchangeable
- An algorithm's implementation details are isolated
- New strategies can be introduced without having to change the context's code

Strategy Pattern: Cons

- The client must know the difference between strategies
- The number of objects in an application increases

Strategy Pattern: Videos

- https://www.youtube.com/watch?v=-NCgRD9-C6o
- Note: Code examples are Java. Concepts still apply in Python

Practical

- Series of tasks covering today's lecture
- Worth 1% of your final mark for the Programming 4 course
- Deadline: Friday, 12 June at 5pm