Strategy
Design Pattern

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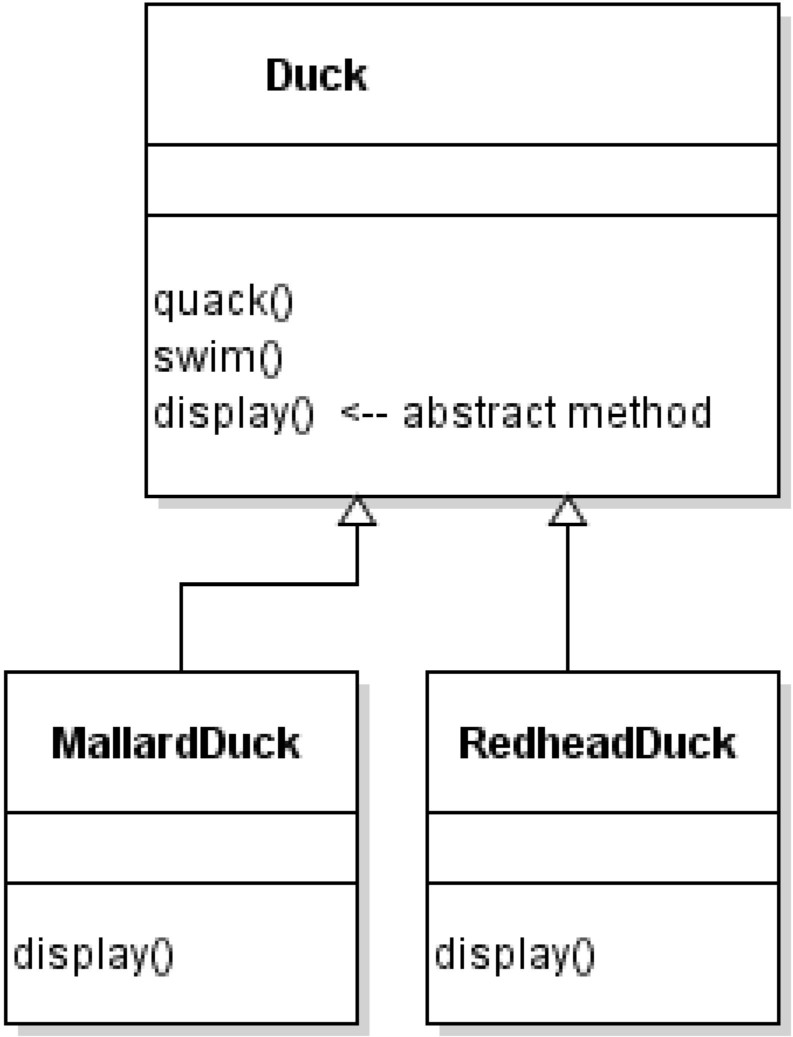
Topics

1) What are the limits of using inheritance?
2) What principles can we use to evaluate an OOD?
3) How can we configure an object with a new behaviour at runtime? (flexibility)

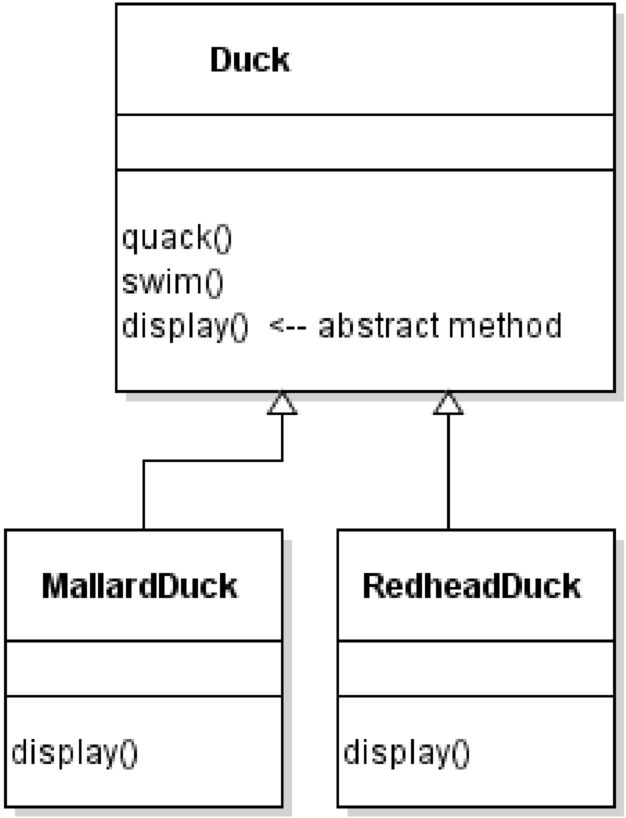
Case Study

- We want to:
  - Create a duck simulator which shows ducks swimming and quacking
  - Make it flexible to add new features



Case Study

- Inheritance good because:
  - : implement quack() and swim() just once
  - gives runtime polymorphism



Duck

quack()
swim()
display() <-- abstract method

MallardDuck

display()

RedheadDuck

display()

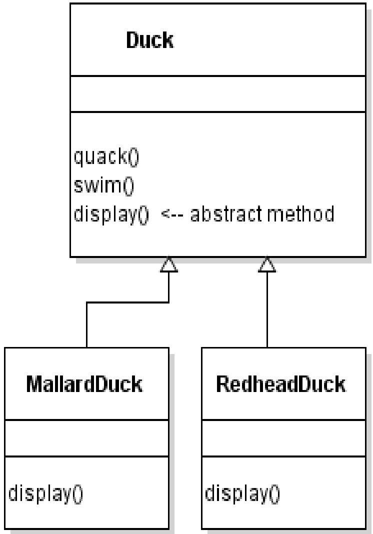
Polymorphism

- ..
  - The specific method called is decided at runtime based on ..
  - myDuck.display() could run one of two (or more) implementations.

```
Duck myDuck;
if (wantsMallard()) {
    myDuck = new MallardDuck();
} else {
    myDuck = new RedHeadDuck();
}
myDuck.display();
```

- Static (compile time) polymorphism:
  - method overloading, C++ template classes

An aside

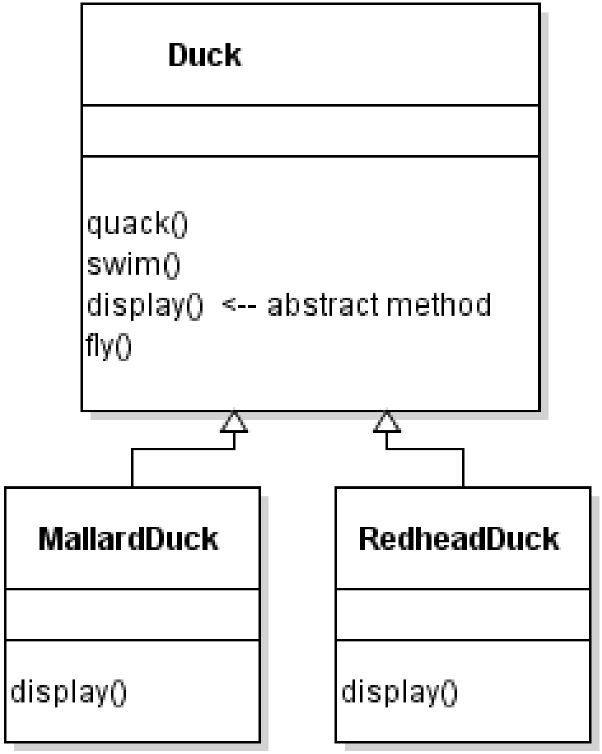


Make Ducks Fly

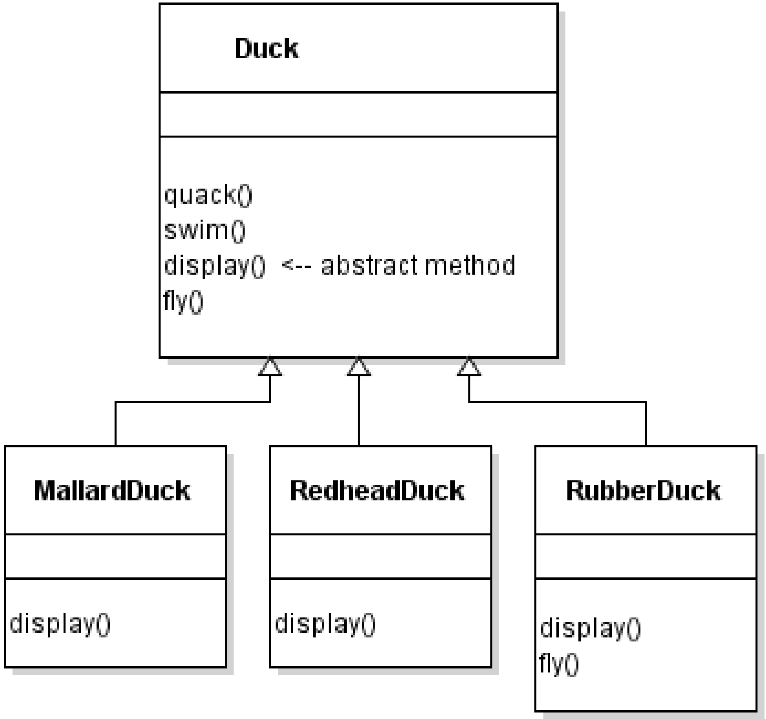
- Make ducks fly!
  - Add fly() to base class
  - Derived classes get behaviour for free

- But, adding fly()

  ..



Make Ducks Fly

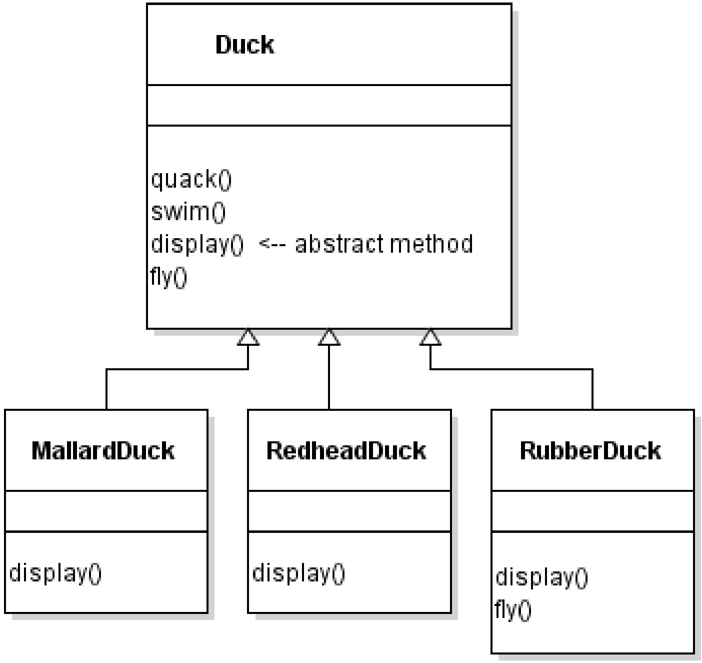


Make Ducks Fly – Bad?

- Inheritance is bad here because:
  - ..

    (non-local effects);
  - ..
  - ..

    (fixed when instantiated)
- Inheritance requires:
  all base-class functionality to be shared by all derived classes



Polymorphism allows you to point to different objects, but once instantiated, a concrete object has but one behaviour/method

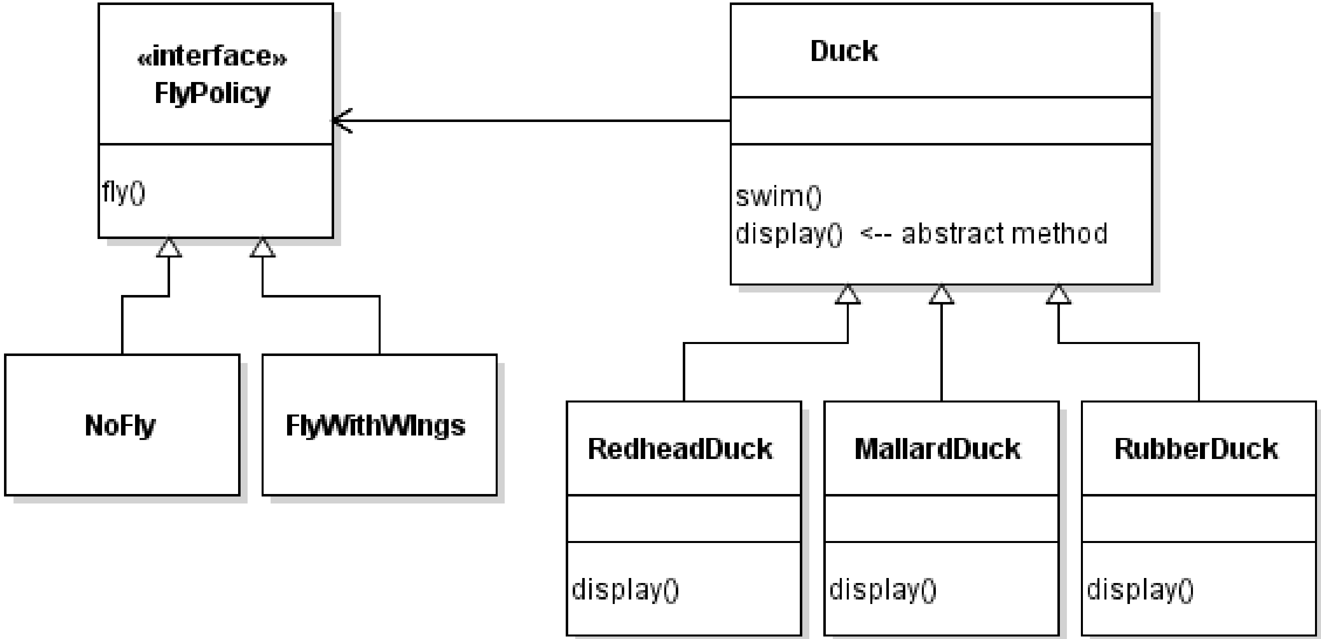
Separate out Behaviours

- Put fly() into a family of..
  - Instantiate the desired fly policy; each Duck has-a FlyPolicy

- ..
  vs having its own hard coded policy

Create an supertype (interface or ABC);

All concrete policies (behaviours) implement this supertype.

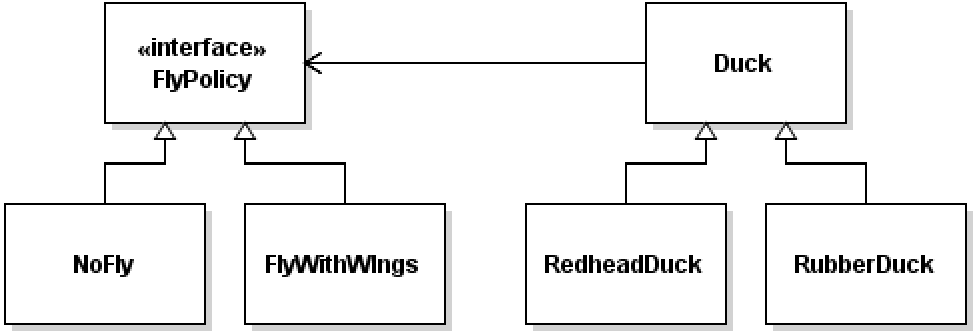


Design Principle (Separate Change)

- Design Principle

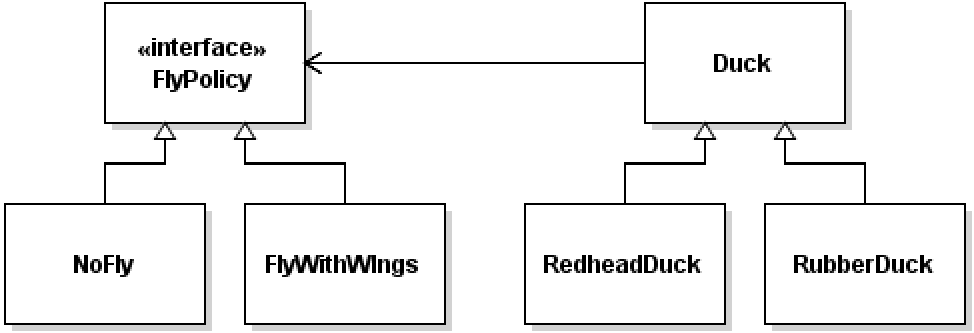
  ..

  - Limits the extent of a likely change by encapsulating that feature inside a class.



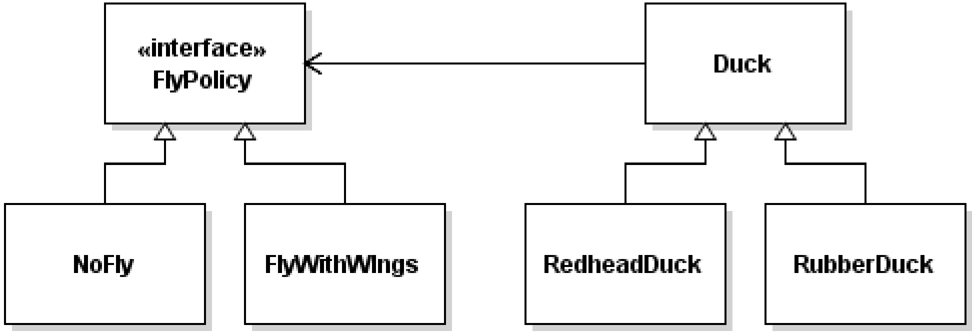
Design Principle (OCP)

- Design Principle: Open-Closed Principle
  - ..
  - Ex: adding a new policy/behaviours should not require re-coding parts of existing system.
  - ..
    not changing existing (tested/debugged) code, such as at the root of the inheritance tree.



Design Principle (OCP cont)

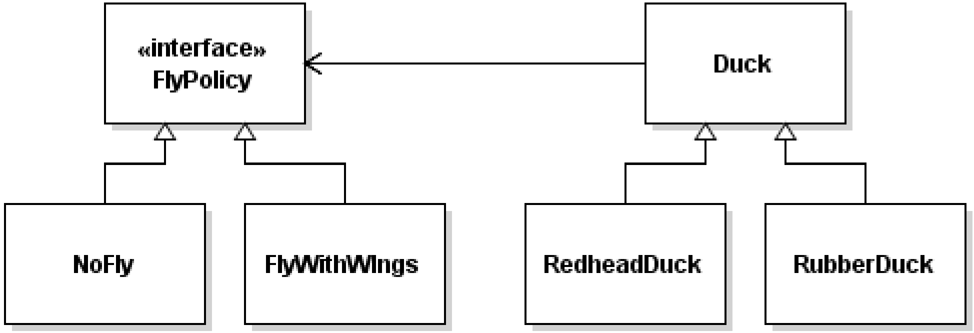
- Ex: Observable classes can be extended with new observers without modification
- Don’t apply open/closed principle everywhere:
  - adds extra level of abstraction (*complexity*)
  - only use in areas expected to change
- Predict likely changes with OOD experience and domain knowledge



Design Principle (Interface over Impl.)

- Design Principle
  - ..

    “interface” = super-type for polymorphism (interface/ABC)
- Code depend on just the supertype,
  not a concrete implementation
  - the behaviour we get completely depends
    on the object we are given



Code Example

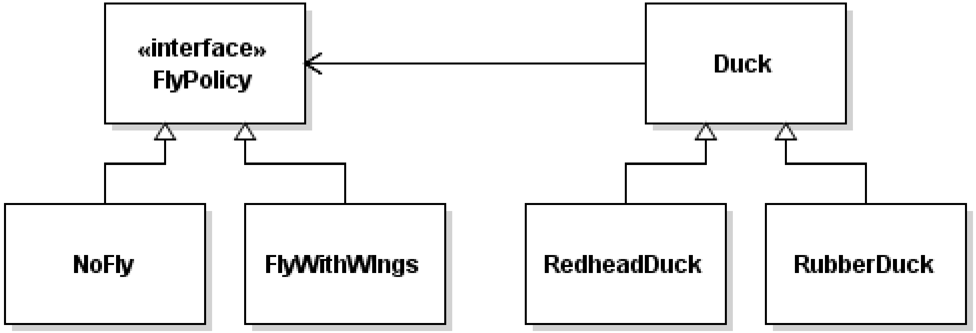
```
abstract class Duck {
    FlyPolicy flyP;

    Duck(FlyPolicy flyP) {
        this.flyP = flyP;
    }

    void performFly() {
        flyP.fly();
    }

    abstract void display();
}


class MallardDuck extends Duck {

    MallardDuck() {
        super(new FlyWithWings());
    }

    void display() {
        System.out.println("I'm a Mallard");
    }
}
```

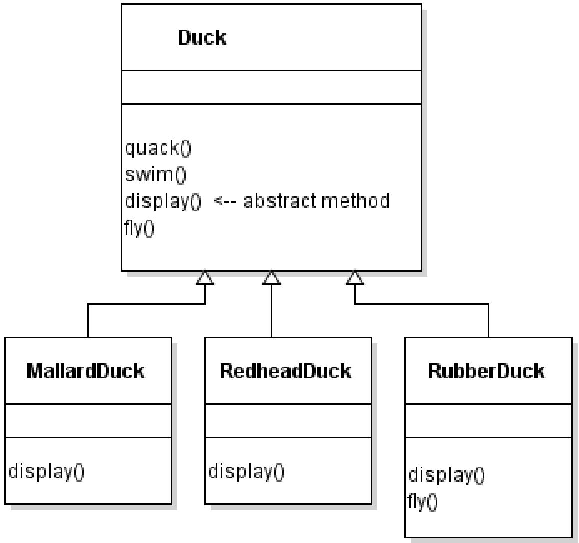
- Enhancements
  - Add a setFlyPolicy() to Duck so it can change at runtime.
  - Imagine a game where the duck is configured/upgraded.

public/private omitted for clarity

Design Principle (Favour Composition)

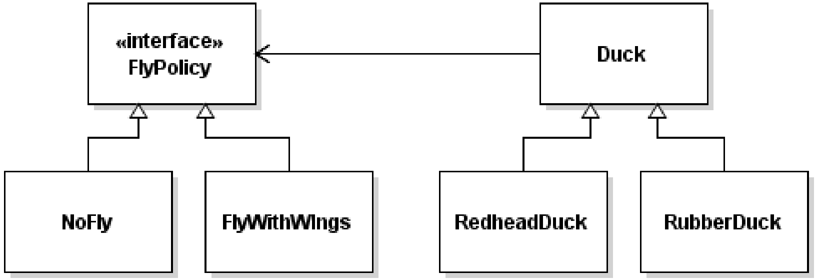
- Design Principle
  - ..
  - runtime selectable behaviour, not dictated by rigid compile-time inheritance hierarchy





Strategy Pattern

- Strategy Pattern..
  - Strategy lets the algorithm vary independently from clients that use it.
- Other applications
  - Tax codes for different provinces
  - Defining what to accept when searching file names



Code

- See example
  - HeadFirstDesign --> strategy --> Duck
- Improvements
  - Duck’s constructor accepts Quack/Fly policy
  - Make Duck fields private
  - NullQuack, NullFly?
- Discuss:
  - Do we even need different types of ducks?
    Just use policies for each variant?

Inheritance vs Composition

- Inheritance is still good!
  - Reduces duplication, supports polymorphism.
  - Pull classes that change out of primary inheritance hierarchy (rigid) and into composition (flexible). Composition of these uses inheritance for flexibility
- Use inheritance as long as it serves your needs; you should not be locked in by it.
  - ..
  - Ex Classes: Student, TA, Employee
    vs People w/ role class StudentRole, TARole, ...

Summary

- Inheritance is limited because:
  - local changes have non-local effects
  - inflexible for code maintenance
  - no run-time changes possible
- Design Principles
  - Separate aspects that change from those that stay the same.
  - Classes should be open for extension, but closed for modification.
  - Program to an interface, not an implementation
  - Favour composition over inheritance
- Strategy Design Pattern
  - Encapsulate possible behaviours into a family of interchangeable objects.