Template and Strategy Patterns

CHANGE... Software evolves

- Over time code changes
  - But we want to change as little as possible
- Maximise re-use
  - Change something once rather than n times
- Designing code with change in mind can lead to
  - Quicker releases
  - Less bugs

Problem

- You have been asked to write some code that will
- Produce a File Report for a given directory, the report will contain
  - Header, Report on Files in Directory XXX
  - Column Headings Name,Size,Last Modified
  - A row for each file with comma separated values
  - Footer, stating when the report was run and by whom

```
Report on Files in Directory D:\
Filename,Size,Last Modified
coolestbab552507.wmv , 745048 , 02/03/2007 13:56:57
data.xml , 154 , 21/11/2006 07:21:21
foo.html , 106 , 19/04/2007 23:01:13
Report ran 02/05/2007 09:46:15 by AndyMobile\andy
```

Possible Solution

```
public class FileReport
{
   private string dir;

   public FileReport(string directory) {
        dir= directory;
   }

   public void ProduceReport() {
      Console.WriteLine("Report on Directory {0}" , dir);
      Console.WriteLine("Filename,Size,Last Modified");
      foreach( FileInfo file in new DirectoryInfo(dir).GetFiles() )
      {
          // Write File Details
      }

      Console.WriteLine("Report ran {0} by {1}" , DateTime.Now ,
                        WindowsIdentity.GetCurrent().Name );
    }
}
```


That works!!! However…

- What we want now is same report format but for directories
- Possible Solutions
  - CUT + PASTE File Report, and modify...
    - Changes to report structure and common pieces made N times
  - Modify Report generation to take a parameter and use if/switch
    - We risk breaking existing functionality when we extend
- Or perhaps there is an OO Design Principle that may help

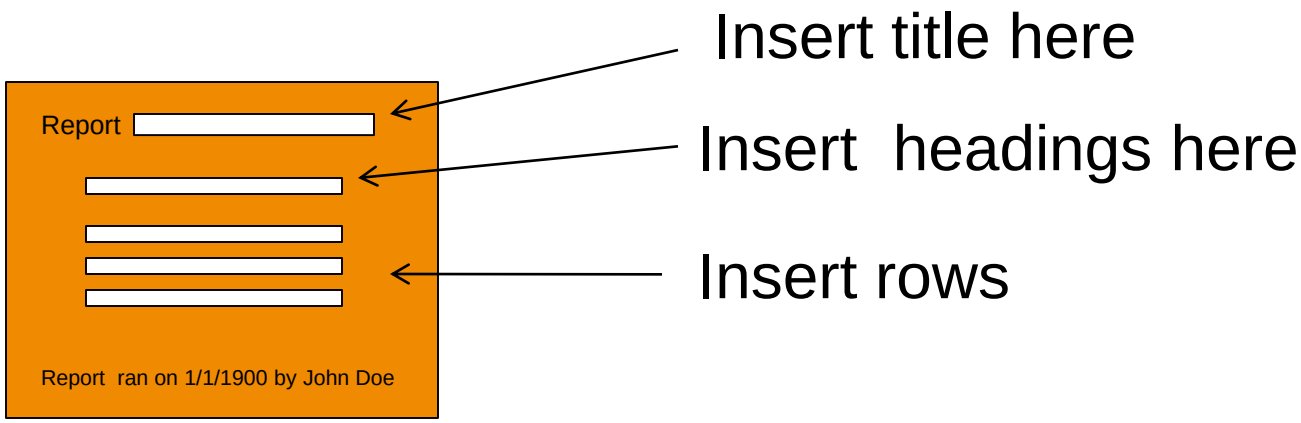
Identify the aspects of your application that vary and separate them from what stays the same.

So what's constant and what varies?

- In the File and Directory Report model
  - Constant
    - Report structure: Headings , Body , Footer
  - Varies
    - Text for Headings , Rows in Body
- So we need to find some way to
  - Write the constant part once
  - But still allow us to develop new reports
- Perhaps we could think of the constant part representing a template
- The template is re-used by each of the reports

Report as a template

- The constant part of our code is a template
- The template defines the basic algorithm for the report
  - Title, Headings , Rows , Footer
- The template needs to call other code to fill in the gaps

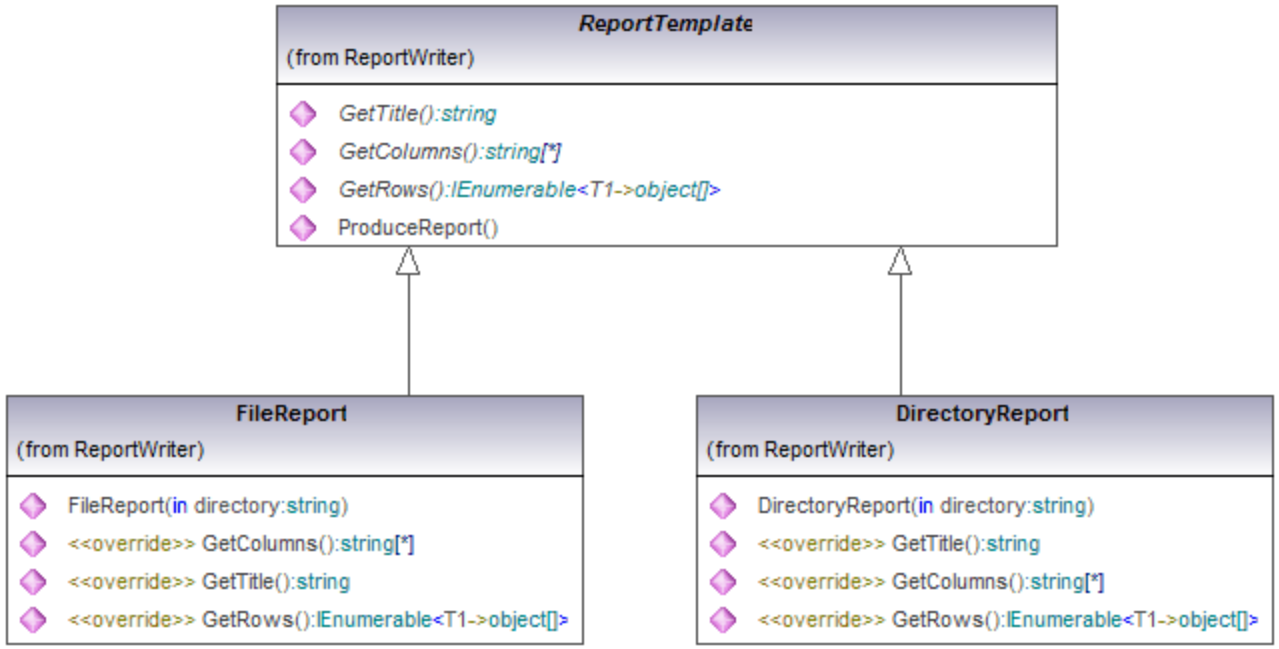


Template in Code

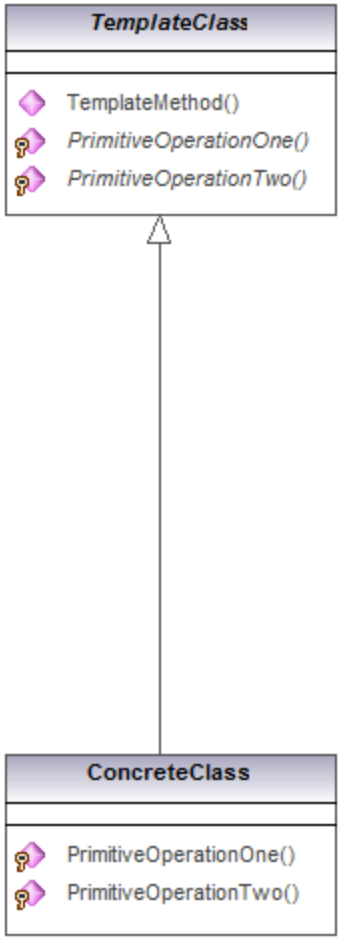
```
public abstract class ReportTemplate
{
   public void ProduceReport() {
    Console.WriteLine("Report {0}" , GetTitle() );

    foreach (string column in GetColumnNames())
    {
        // Output column heading
    }

    foreach (object[] row in GetRows())
    {
      // Output Row
    }

    Console.WriteLine( "Report Produced {0} by {1}",
      DateTime.Now,
      WindowsIdentity.GetCurrent().Name);
    }
}
```

Binding the template to code

- Place the template method into a base class
- Base class defines the template steps as abstract
- Actual report class derive from base class
- A[illegible]ods



Template Method Pattern




```
public abstract class TemplateClass {
        protected abstract void TemplateStepOne();
        protected abstract void TemplateStepTwo();

        public void TemplateMethod()
        {
            TemplateStepOne();
            TemplateStepTwo();
        }
}
```

```
public class ConcreteClass : TemplateClass {
   protected override void TemplateStepOne() {
         // Do Step
   }
   protected override void TemplateStepTwo()  {
         // Do Step
   }
}
```

What have we achieved

- The ReportTemplate class controls the format of reports
  - Maximises re-use of code across all report variants
  - The report structure lives in one place, meaning code changes happen once
  - Provides a framework for new types of report to be plugged into
- Adding a new report
  - Does not affect any existing tested and working code
  - Focuses on knowledge specific for this report
- A more maintainable and scalable solution

More Change

- Console Reports are dull we want to provide the report in various output formats but keep structure the same
  - XML
  - HTML
  - XAML Flow document
- The Report base class is currently tightly coupled with console output
- How about
  - Use if/switch inside the Report base class to select output type? Means modifying working code. Smells bad...
- Perhaps we need a new *Strategy....*

OO Design Principle, revisited

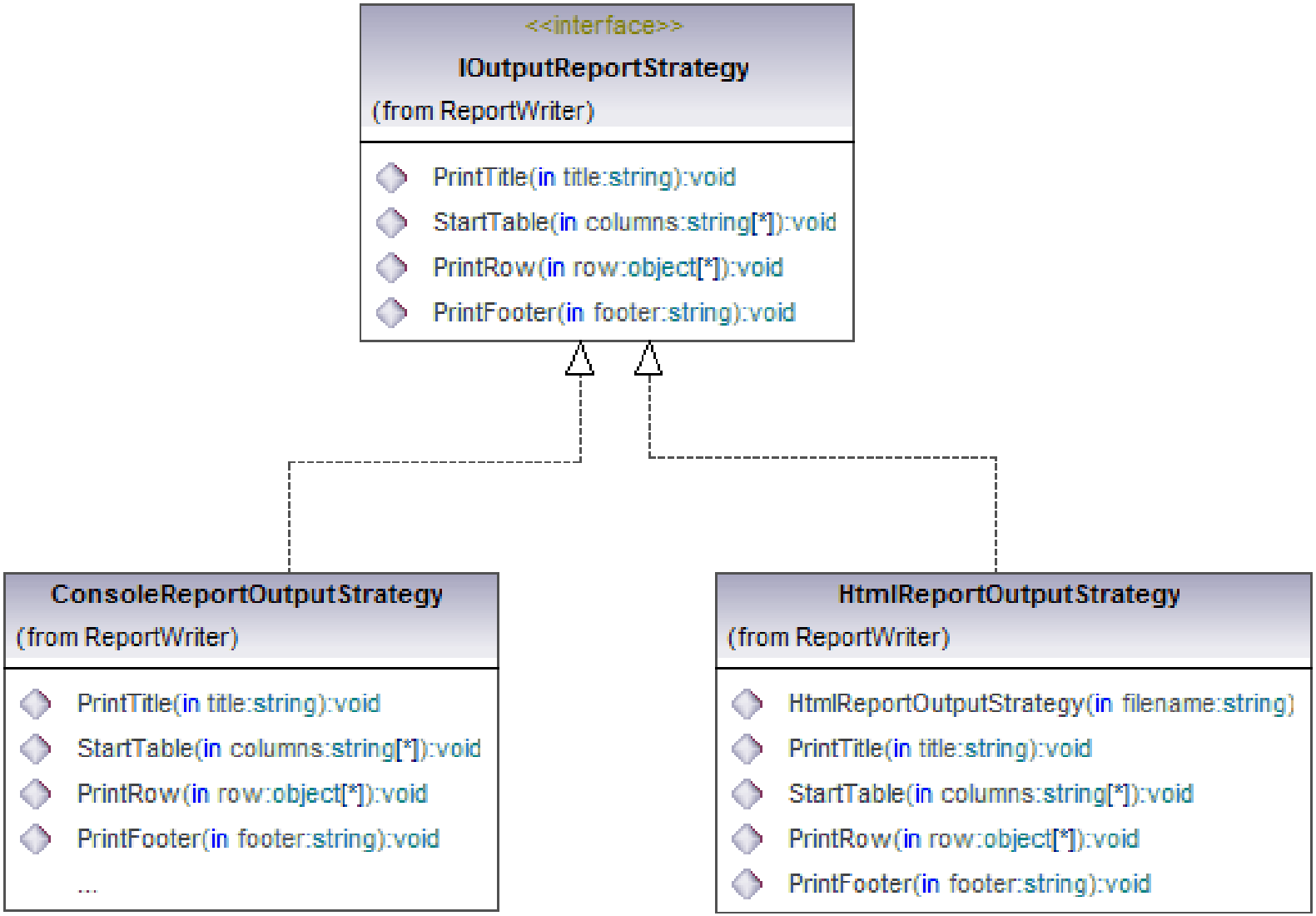
Identify the aspects of your application that vary and separate them from what stays the same

- Report structure code remains constant
- Report output format varies
- The question is how to separate
  - Create a HTMLReport class derived from Report using template methods for output
    - That would result in too many variants. HTMLFileReport, HTMLDirectoryReport
  - Build a separate type hierarchy for output formats
    - Supply an output format at runtime to a report instance

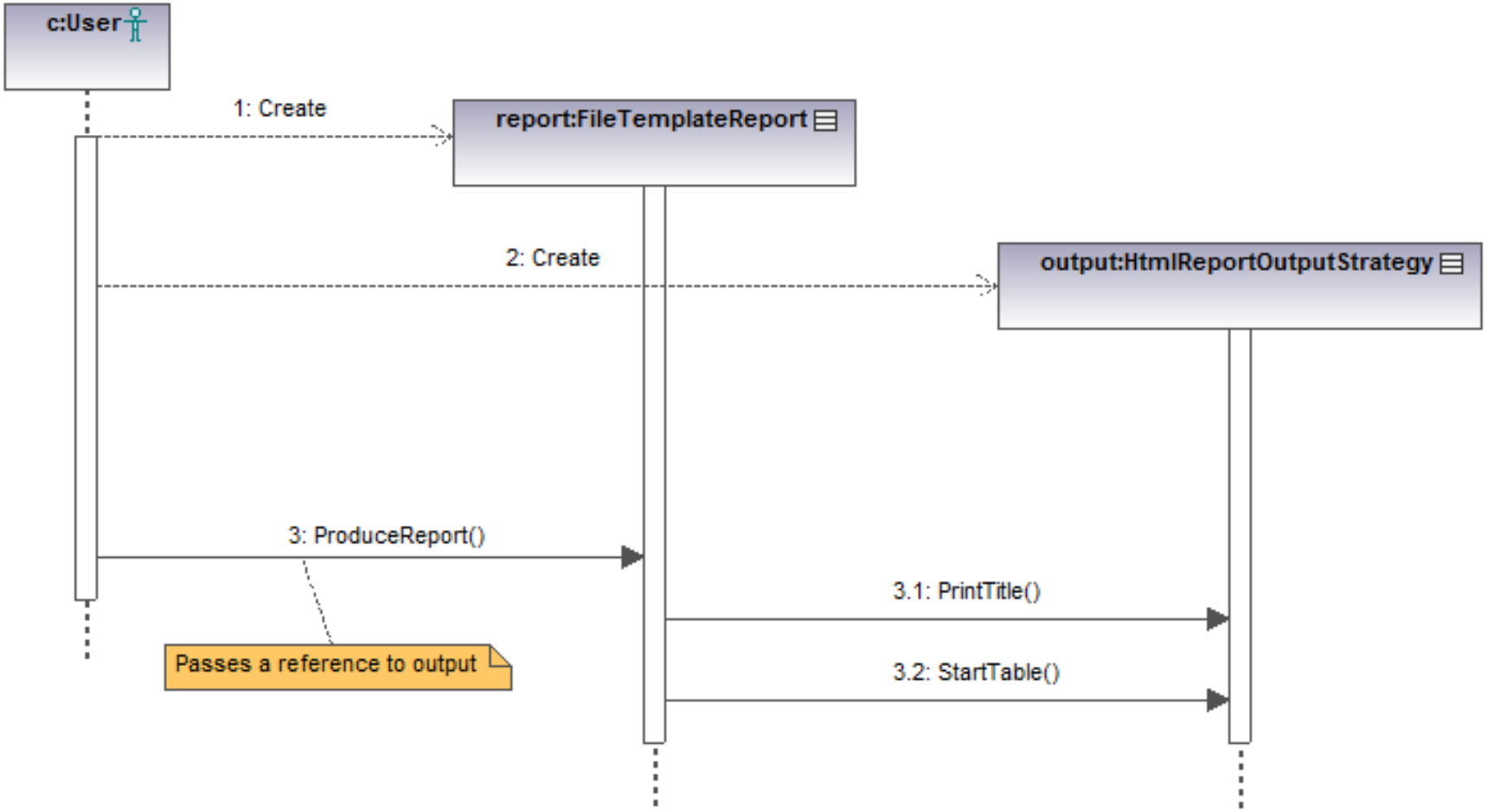
Decoupling report structure and output format

- Step 1
  - Define an interface with the required output behavior
  - Re-factor the ProduceReport method to use the new interface, as opposed to tightly coupled behaviour
- Step 2
  - Create a type that implements the interface
  - Pass an instance of this type into ProduceReport method
  - ProduceReport method will now use this object for the required output behaviour
- We have now decoupled the report definition from the output format through composition

Refactoring the output behaviour

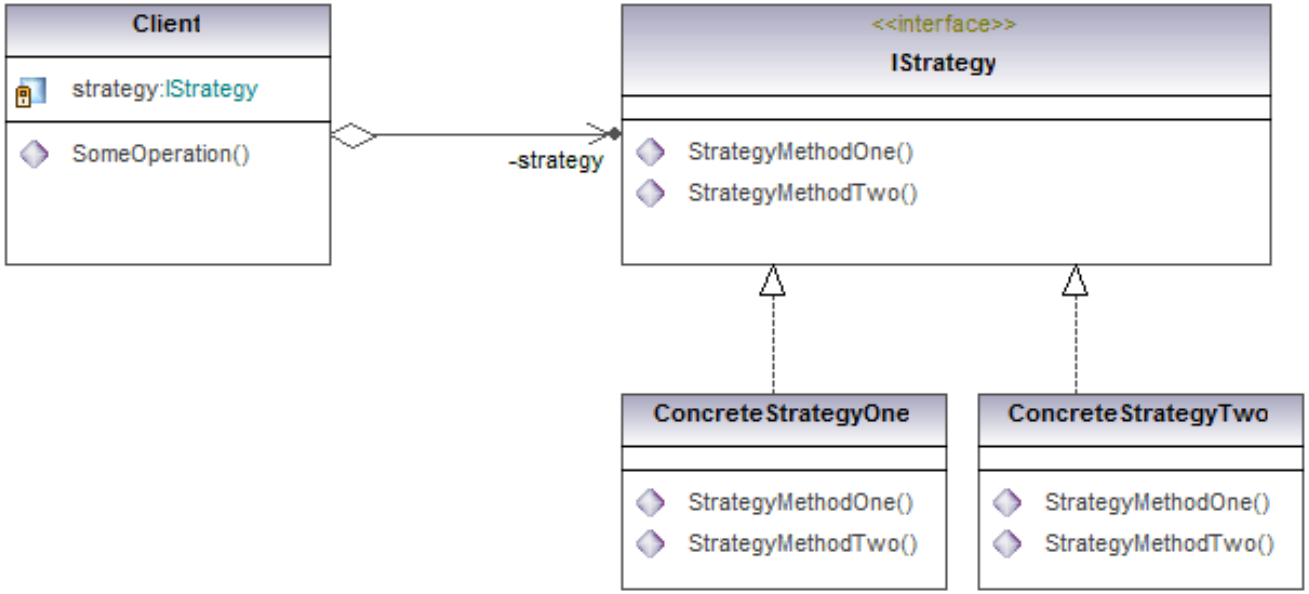


Utilising the supplied strategy

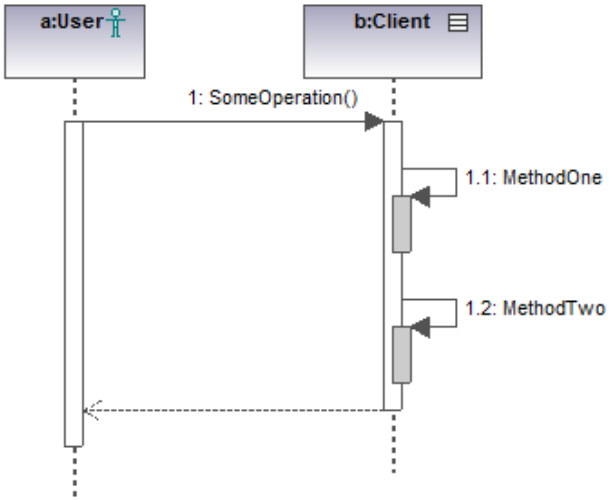


Strategy Pattern

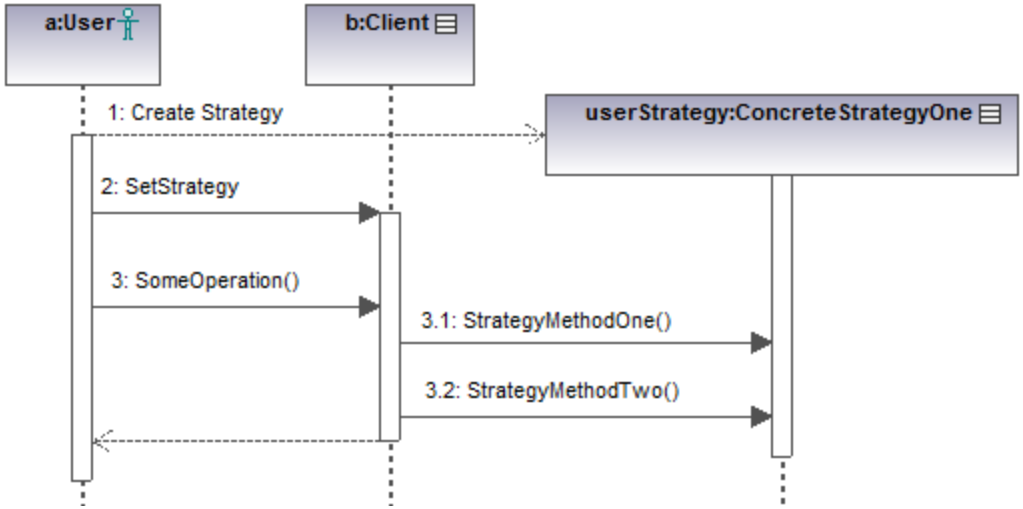
- Template method used abstract methods and inheritance to call different behaviour
- Alternatively supply implementation behaviour at run time using composition
- This is known as the Strategy pattern



Strategy in Action



Before



After

What have we achieved

- Create new types of reports, where
  - All reports follow a common structure
  - No modification is made to existing code
- Create new types of report output format, where
  - New formats can be used without changing existing code
  - Output format is selectable at runtime
- The solution is truly scalable
  - Combinations = nReportTypes * nOutputTypes
  - Number of types built = nReportTypes + nOutputTypes
- How much work would it be for the reports to support sorting?

Framework uses of Strategy

- The new generic list class makes extensive use of the strategy pattern
  - List.RemoveAll() , List.FindAll()
  - All these methods take an instance of a predicate delegate
  - The delegate instance is the strategy

```
public delegate bool Predicate<T>(T obj);


public class List<T> : IList<T>, ICollection<T> …
{
        ...
        public List<T> FindAll(Predicate<T> match);
}
```

Supplying Strategy to FindAll

```
static void Main(string[] args)
{
 var primes = new List<int>() { 2,3,5,7,11,13 };

 foreach (int prime in primes
                      .FindAll(IsValueGreaterThanSeven))
 {
  Console.WriteLine(prime);
 }
}

// The Strategy
private static bool IsValueGreaterThanSeven(int val)
{
    return val > 7;
}
```


Summary

- Use Template pattern to control the sequence of steps in the algorithm, but still allow the step implementations to vary
  - Encapsulate what doesn't change
- Use Strategy over Template
  - When algorithm needs to vary at runtime.
  - To prevent type explosion
- Use delegates for single method strategies.
  - Check for existing delegate types e.g. Predicate<T>