Adapting interfaces

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INFDEV02-4

Introduction

Introduction

Lecture topics

- Issues arising from connecting domains
- The adapter design pattern
- Examples and considerations
- Conclusions

Introduction

Issues:

- Independent domains each based on its interface(s)
- No shared code, so they cannot communicate directly
- Semantically compatible: we want to connect them

Introduction

Examples:

- Legacy systems
- Different frameworks
- Closed libraries
- Etc..

Adapter

Adapter

Introduction

- Today we are going to study adapters
- In particular, we are going to study how to make existing classes work within other domains without modifying their code
- How? By means of a design pattern: the adapter (a behavioral design pattern)
- A clean and general mechanism that allows an instance of an interface to be used where another interface is expected

Adapter

Adapting existing classes

- A further constraint is that we cannot change the original implementation
- Why?

Adapter

Adapting existing classes

- A further constraint is that we cannot change the original implementation
- Why?
- *We might break other programs depending on such implementation*

Adapter

Examples:

- An option as an iterator
- A traditional iterator as a safe iterator
- A class belonging to a closed library with the interface required by our application
- A shape in another drawing library
- ...

Adapter

An example of similar but incompatible classes

- Consider the following two classes `LegacyLine` and `LegacyRectangle`
- Both implementing a draw method

```
1  class LegacyLine {
2    public void Draw(int x1,int y1,int x2,int y2) {
3      Console.WriteLine("line␣from␣(" + x1 + ',' + y1 + ")␣to␣(" + x2 + ',' +
           y2 + ')'");
4  ␣␣}
5  }
6  class␣LegacyRectangle␣{
7  ␣␣public␣void␣Draw(int␣x,int␣y,int␣w,int␣h)␣{
8  ␣␣␣␣Console.WriteLine("rectangle at ("␣+␣x␣+␣',’␣+␣y␣+␣") with width "␣+␣w␣+
       ␣" and height "␣+␣h);
9  ␣␣}
10 }
```

Adapter

Consuming our LegacyLine and LegacyRectangle

- Suppose we wished to build a drawing system
- We need to group lines and rectangles together, plus our own classes
- Cast to `Object`?

```
1  List<Object> shapes = new List<Object>();
2  shapes.Add(new LegacyLine());
3  shapes.Add(new LegacyRectangle());
4  shapes.Add(new NonLegacyCircle());
5  foreach(Object shape in shapes){
6    if(shape is NonLegacyCircle) {
7      (NonLegacyCircle)shape.Draw(...);
8    }
9    if(shape is LegacyLine) {
10     (LegacyLine)shape.Draw(...);
11   }
12   if(shape is LegacyRectangle) {
13     (LegacyRectangle)shape.Draw(...);
14   }
15  }
```

Adapter

Issues with consuming LegacyLine and LegacyRectangle

- This technique is complex and error-prone
- We cannot even apply a visitor, since we cannot touch the implementation of `Legacy*`
- We wish now to reduce such complexity and to achieve safety

Adapter

Safely consuming LegacyLine and LegacyRectangle: idea

- We define a mediating layer that abstracts instances of both `LegacyLine` and `LegacyRectangle`
- For this implementation we first define an interface `Shape` with one method signature `Draw`
- This interface defines the entry of our own domain

```
1 interface Shape {
2   void Draw(int x1,int y1,int x2,int y2);
3 }
```

Adapter

An adapter for our LegacyLine

- We declare a class `Line` that takes as input a `LegacyLine` object
- Whenever the `Draw` method is called also the `Draw` of the `LegacyLine` object is called
- `Line` exists both in the legacy and our new domain

```
1  class Line : Shape {
2    private LegacyLine underlyingLine;
3    public Line(LegacyLine line) {
4      this.underlyingLine = line;
5    }
6    public void Draw(int x1,int y1,int x2,int y2) {
7      underlyingLine.Draw(...);
8    }
9  }
```

Adapter

An adapter for our LegacyRectangle

- We apply the same mechanism to our LegacyRectangle

```
1  class Rectangle : Shape {
2    private LegacyRectangle underlyingRectangle;
3    public Rectangle(LegacyRectangle rectangle) {
4      this.underlyingRectangle = rectangle;
5    }
6    public void Draw(int x1,int y1,int x2,int y2) {
7      underlyingRectangle.Draw(...);
8    }
9  }
```

Adapter

- Our drawing system can now define a list of shapes

```
1  List<Shape> shapes = new List<Shape>();
2  shapes.Add(new Line(new LegacyLine()));
3  shapes.Add(new Rectangle(new LegacyRectangle()));
4  shapes.Add(new NonLegacyCircle());
5  foreach(Shape shape in Shapes){
6    shape.Draw(...);
7   }
```

Adapter

- We could even extend our Shape with a visitor

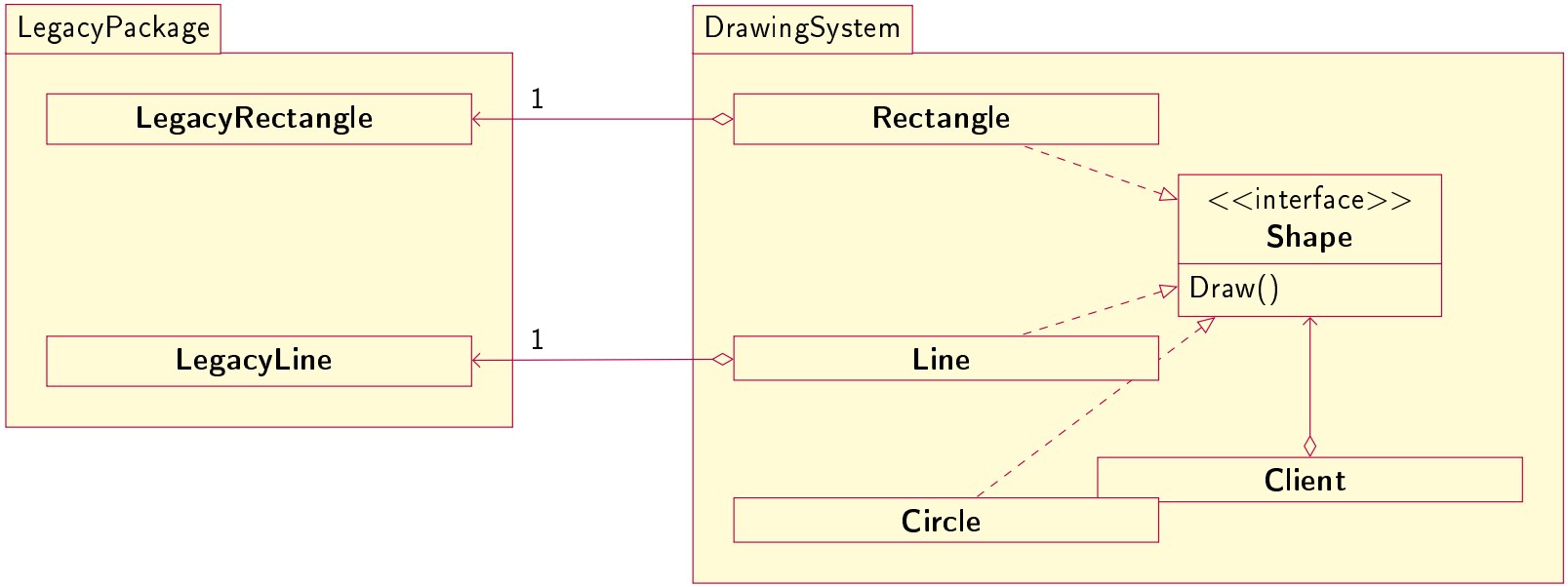
```
1 interface Shape {
2   void Draw(int x1,int y1,int x2,int y2);
3   U Visit<U>(Func<U> onLegacyLine,Func<U> onLegacyRectangle,Func<U>
        onNonLegacyCircle);
4 }
```

Adapter

Considerations

- Instances of both `LegacyLine` and `LegacyRectangle` are now harmoniously integrated with our own framework
- Code is more maintainable, and we have not changed (and potentially broken) the legacy implementations
- Only requirement is that we never manipulate legacy instances directly, but go through `Rectangle` and `Line`
- `Rectangle` and `Line` are **adapters**

Adapter



The adapter design pattern

The adapter design pattern

General idea

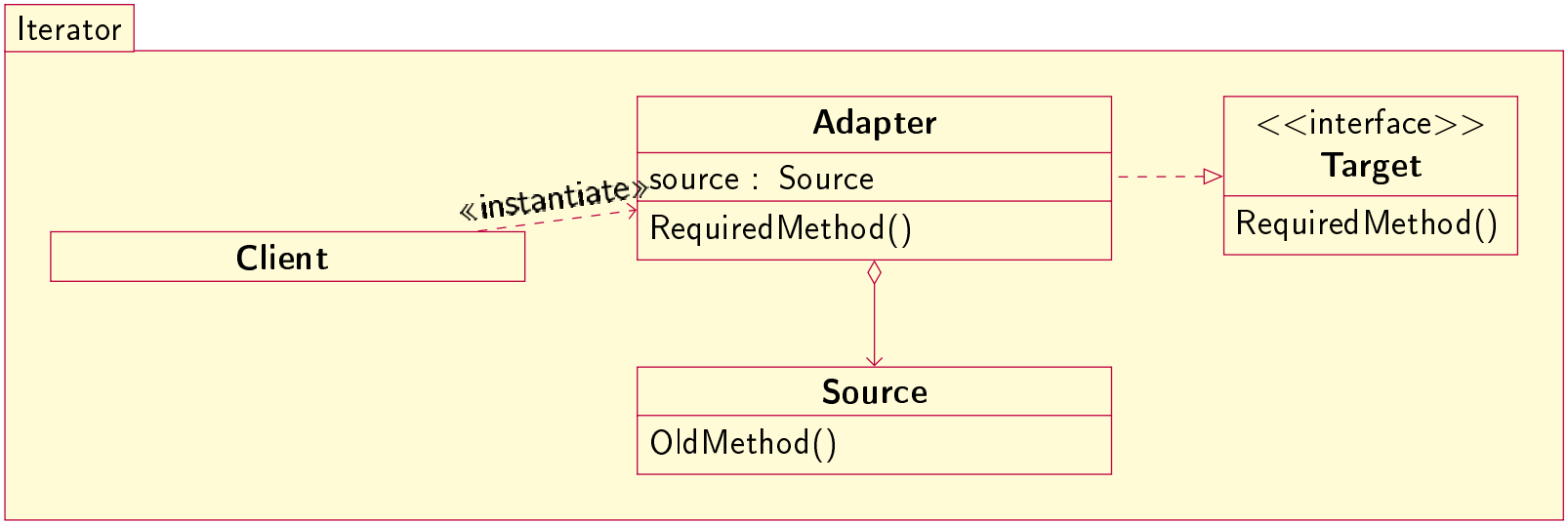
- By means of adapters, we "convert" the interface of a class into another, without touching the class sources
- In what follows we will study such design pattern and provide a general formalization

The adapter design pattern

The adapter design pattern structure

- Given two different interfaces `Source` and `Target`
- An `Adapter` is built to adapt `Source` to `Target`
- The `Adapter` implements `Target` by means of a reference to texttttSource
- A `Client` interacts with the `Adapter` whenever it a `Target`, but we have a `Some`
- In the following we provide a UML for such structure

The adapter design pattern



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Example:

- Consider the `Option` data type
- It is a collection of sorts
- It could be iterated, but it does not implement an interator!

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Making Option "iterable", a naive approach:

- Without adapter, we need `Option<T>` to implement `Iterator<T>`

```
1 interface Iterator<T> {
2   public Option<T> GetNext();
3 }
```

```
1 interface Option<T> : Iterator<T> {
2   ...
3 }
```

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Making Some "iterable", a naive approach

- Calling `GetNext` on Some returns only once its `Value` within a Some

```
1  class Some<T> : Iterator<T> {
2    private T value;
3    private bool visited = false;
4    public Some(T value) {
5      this.value = value;
6    }
7    Option<T> GetNext() {
8      if(visited) {
9        return new None<T>();
10     }
11     else{
12       visited = true;
13       return new Some<T>(value);
14     }
15   }
16   ...
17 }
```

The adapter design pattern

Making None "iterable", a naive approach

- Calling `GetNext` returns always `None`

```
1  class None<T> : Iterator<T> {
2    Option<T> GetNext() {
3      return new None<T>();
4    }
5    ...
6  }
```

Making an option "iterable": considerations

- Is it always needed for the option to be iterable?

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Making an option "iterable": considerations

- Is it always needed for the option to be iterable?
- No!
- According to the single responsibility principle of SOLID, `Option` should not include considerations regarding iteration[a]
- Adapter solution is better, as it allows to extend option to any additional services required without changing the option data structure

[a] That is why we presented all the iterators through adapter in the previous lecture.

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Iterating an Option<T> with adapters

- In this case `Target` is `Iterator<T>`, `Source` is `Option<T>`, and `Adapter` is `IOptionIterator<T>`
- Now, `GetNext` returns `Some` only the at the first iteration
- Note, if we iterate a `None` entity we return `None`

```
1  class IOptionIterator<T> : Iterator<T> {
2    private Option<T> option;
3    private bool visited = false;
4    public IOptionIterator(Option<T> option) {
5      this.option = option;
6    }
7    Option<T> GetNext() {
8      if(visited) {
9        return new None<T>();
10     }
11     else{
12       visited = true;
13       if(option.IsSome()) {
14         return new Some<T>(option.GetValue());
15       }
16       else{
17         return new None<T>();
18       }
19     }
```

The adapter design pattern

Iterating an Option<T>

- Which with visitor becomes:

```
1  class IOptionIterator<T> : Iterator<T> {
2    private Option<T> option;
3    private bool visited;
4    public IOptionIterator(Option<T> option) {
5      this.option = option;
6      this.visited = false;
7    }
8    Option<T> GetNext() {
9      if(visited) {
10       return new None<T>();
11     }
12     else{
13       visited = true;
14       option.Visit<Option<T>>(() => new None<T>(),t => new Some<T>(t));
15     }
16   }
17 }
```

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Considerations about bijective adapters

- Adapters map behaviors across domains
- Adapting may not change or add behaviors

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Considerations about bijective adapters

- Consider the `TraditionalIterator` and `Iterator` example

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TraditionalIterator and Iterator

- What was the point of one and the other?
- We need both, as they both make sense within their respective contexts!

```
1  interface TraditionalIterator<T> {
2    void MoveNext();
3    bool HasNext();
4    T GetCurrent();
5  }
6  interface Iterator<T> {
7    IOption<T> GetNext();
8  }
```

The adapter design pattern

Which in Java then becomes:

```
1  interface TraditionalIterator<T> {
2    void MoveNext();
3    bool HasNext();
4    T GetCurrent();
5  }
6  interface Iterator<T> {
7    IOption<T> GetNext();
8  }
```

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Bridging TraditionalIterator and Iterator

- How do we bridge the two worlds?
- With an adapter per direction:
- `MakeSafe` that makes `TraditionalIterator` behave as `Iterator`
- `MakeUnsafe` that makes `Iterator` behave as `TraditionalIterator`

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```
1  class MakeSafe<T> : Iterator<T> {
2    private TraditionalIterator<T> iterator;
3    public MakeSafe(TraditionalIterator<T> iterator) {
4      this.iterator = iterator;
5    }
6    Option<T> GetNext() {
7      if(iterator.MoveNext()) {
8        return new Some<T>(iterator.GetCurrent());
9      }
10     else{
11       return new None<T>();
12     }
13   }
14 }
```

The adapter design pattern

Which in Java then becomes:

```
1  class MakeSafe<T> implements Iterator<T> {
2    private TraditionalIterator<T> iterator;
3    public MakeSafe(TraditionalIterator<T> iterator) {
4      this.iterator = iterator;
5    }
6    Option<T> GetNext() {
7      if(iterator.MoveNext()) {
8        return new Some<T>(iterator.GetCurrent());
9      }
10     else{
11       return new None<T>();
12     }
13   }
14 }
```

The adapter design pattern


```
1  class MakeUnsafe<T> : TraditionalIterator<T> {
2    private _current T;
3    private Iterator<T> iterator;
4    public MakeUnsafe(Iterator<T> iterator) {
5      this.iterator = iterator;
6    }
7    T GetCurrent() {
8      return _current;
9    }
10   bool MoveNext() {
11     Option<T> opt = iterator.GetNext();
12     if(opt.IsSome()) {
13       _current = iterator.GetValue();
14       return true;
15     }
16     else{
17       return false;
18     }
19   }
20 }
```

The adapter design pattern

Which in Java then becomes:

```
1  class MakeUnsafe<T> implements TraditionalIterator<T> {
2    private _current T;
3    private Iterator<T> iterator;
4    public MakeUnsafe(Iterator<T> iterator) {
5      this.iterator = iterator;
6    }
7    T GetCurrent() {
8      return _current;
9    }
10   bool MoveNext() {
11     Option<T> opt = iterator.GetNext();
12     if(opt.IsSome()) {
13       _current = iterator.GetValue();
14       return true;
15     }
16     else{
17       return false;
18     }
19   }
20 }
```

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Bridging TraditionalIterator and Iterator

- What is the behavior of `new MakeSafe(new MakeUnsafe(it))` for a generic iterator it?

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Bridging TraditionalIterator and Iterator

- What is the behavior of `new MakeSafe(new MakeUnsafe(it))` for a generic iterator it?
- No change! The two behave exactly the same!

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Bridging TraditionalIterator and Iterator

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Bridging TraditionalIterator and Iterator

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Bridging TraditionalIterator and Iterator

- This semantic neutrality is common to all adapters: no information is added or removed
- Adapters preserve the full behavior of the adapted interface
- Adapters are simply “bridges” between domains, and contain no domain logic themselves

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Conclusion

- Code usually is partitioned in (closed) domains
- Sometimes it cannot be changed: a library, a framework, etc..
- Sometimes it is hard to make existing code work in a specific target application (for example because it is written with other conventions or is simply legacy)
- The adapter pattern allows the adaptation of such code in a way that makes the resulting solution flexible and safe
- How? By providing a neutral adapter that mediates between the target and source domains

This is it!

The best of luck, and thanks for the attention!