Module 07: "Observer"





Agenda

- Introductory Example: Stock Market
- Challenges
- Pattern: Observer
- Original Observer Pattern
- Observer Pattern in .NET: Events
- Implementing the Observer Pattern
- Overview of Observer Pattern
- Discussion



Introductory Example: Stock Market

```
class StockMarket
{
   public StockMarket() { ... }

   private void OnStockTraded( string ticker, decimal latest )
   {
       Console.WriteLine( $"{ticker} traded at USD {latest:f2}");
   }
}
```

```
class StockObserver
{
    // ???
}
```

```
class OtherStockObserver
{
    // ???
}
```



Challenges

- How do stock observers get the new stock prices as soon as they happen at the stock market?
 - ...without repeatedly polling?
 - ...without too tight coupling?



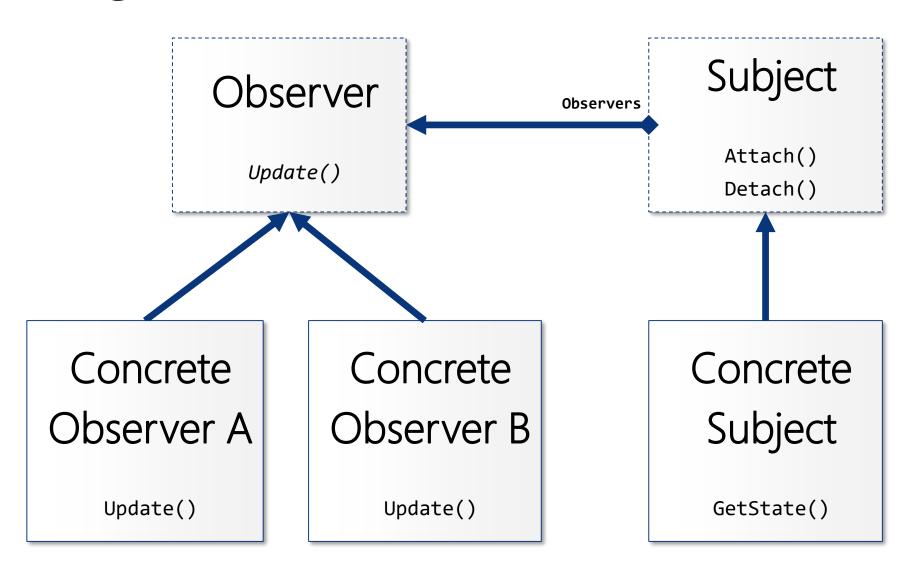
Pattern: Observer

 Define a one-to-many dependency relation between objects so that when one object changes state, all its dependents are notified and updated automatically.

- Outline
 - Define Subject and Observer objects
 - Let observers register and deregister with Subject
 - Ensure that when a Subject changes state, it will notify all registered Observers
- Origin: Gang of Four

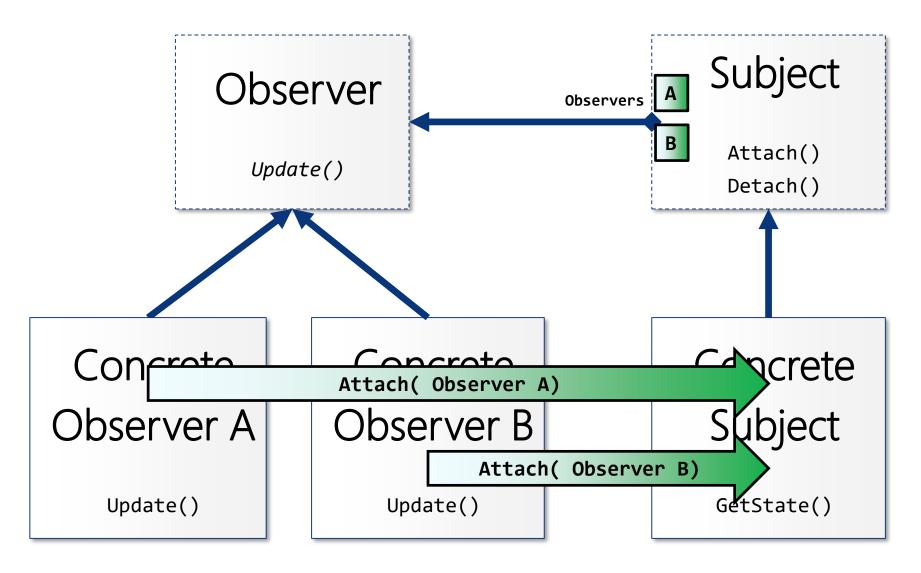


Original Observer Pattern



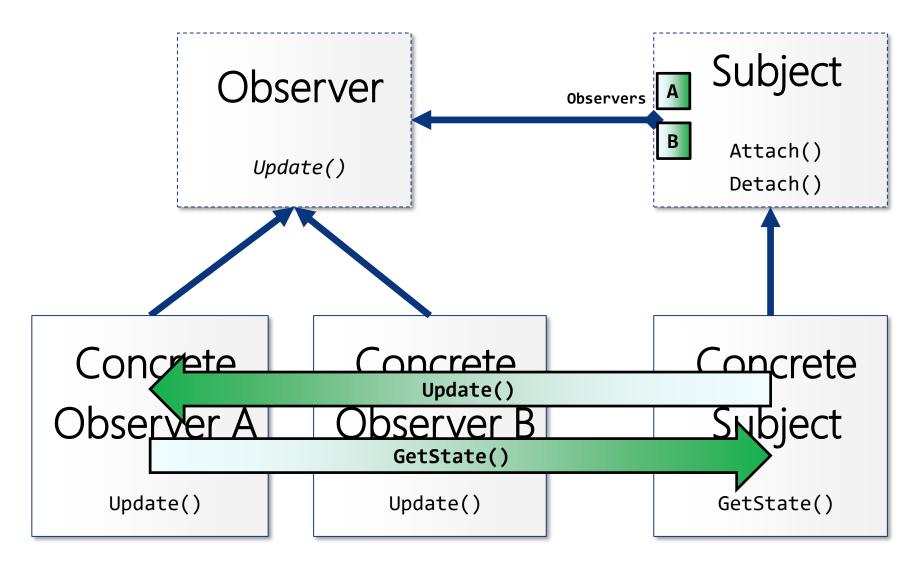


Original Observer (Registration)



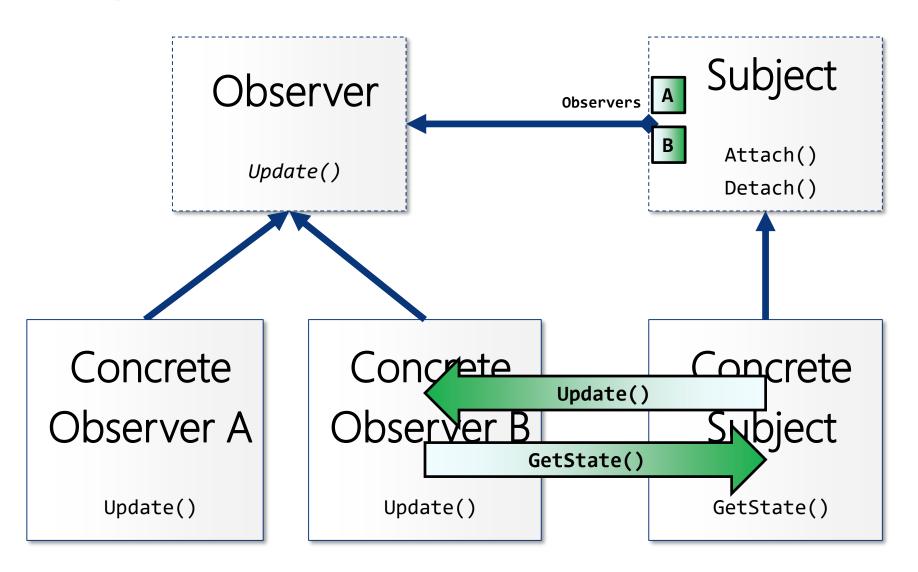


Original Observer (Update)



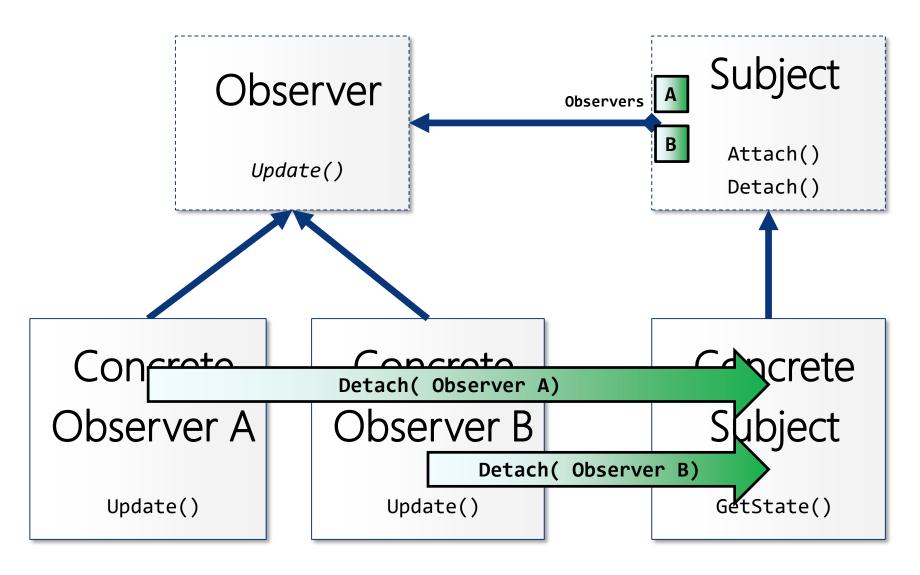


Original Observer Pattern (Update)



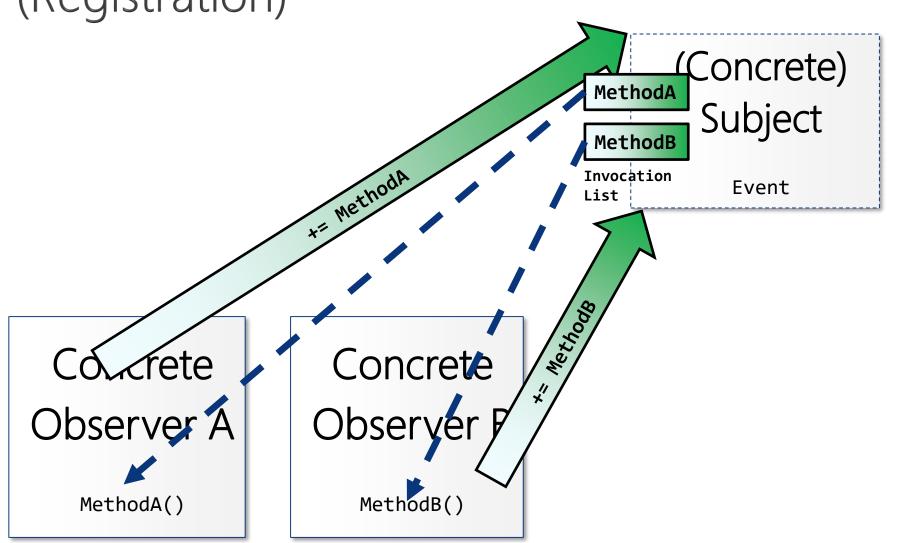


Original Observer (Deregistration)



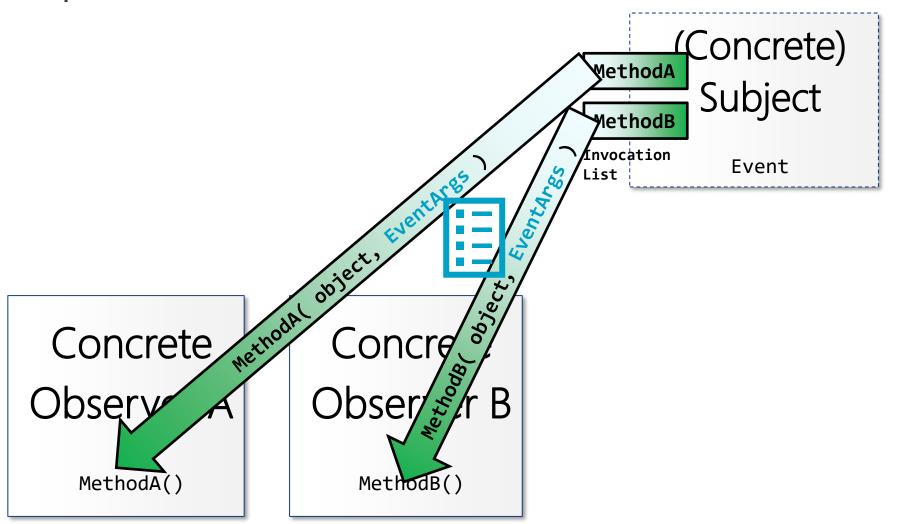


.NET Observer Pattern: Events (Registration)



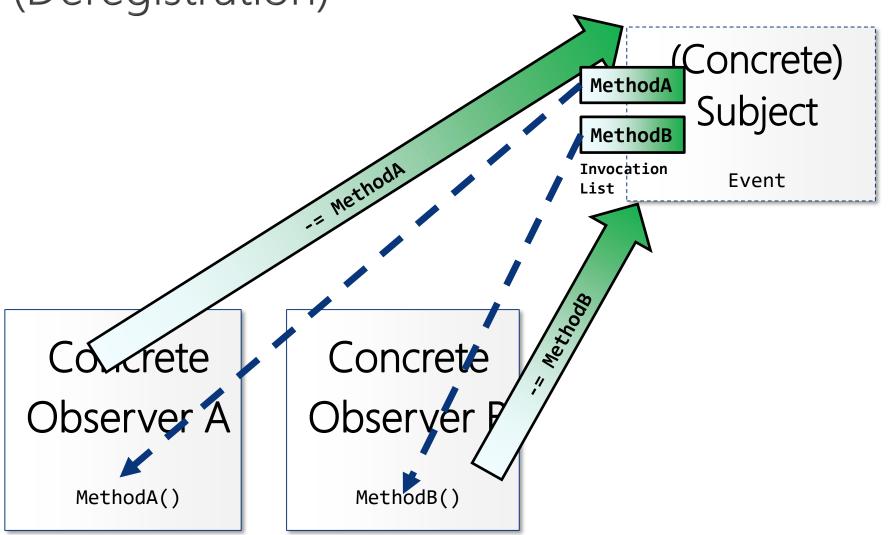


.NET Observer Pattern: Events (Update)





.NET Observer Pattern: Events (Deregistration)





Overview of Observer Pattern

- ▶ (Concrete) Subject
 - Class with event Event defined
 - Specifies EventArgs class with state
 - Raises event when there is new state (EventArgs object) to notify observers
- Concrete Observer
 - Concrete class with **Method()** of same signature as **Event**
 - Registers with +=
 - Receives state from Subject through EventArgs object
 - Deregisters with -=



Pros and Cons of Observer

Pros

- Very easy to use
- Supported by native syntax in C#
- Used extensively throughout all of .NET
- Much simpler, nicer, and cleaner than original Observer Pattern
- Works elegantly with many-to-many relationships

Cons

- Danger of resource leaks
 - Consider deregistering observer! Maybe IDisposable? But...
 - Cannot deregister lambda expressions and anonymous methods
- Be careful about multi-threading and serialization
- No obvious way of propagating Subject errors to Observer



IObservable<T> and IObserver<T>

 More modern Observer Pattern interfaces were added in .NET 4.0 (See Lab 23.1)

```
public interface IObservable<out T>
{
    IDisposable Subscribe( IObserver<T> observer );
}
```

```
public interface IObserver<in T>
{
    void OnCompleted();
    void OnError( Exception error );
    void OnNext( T value );
}
```



