

Module 23: "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?

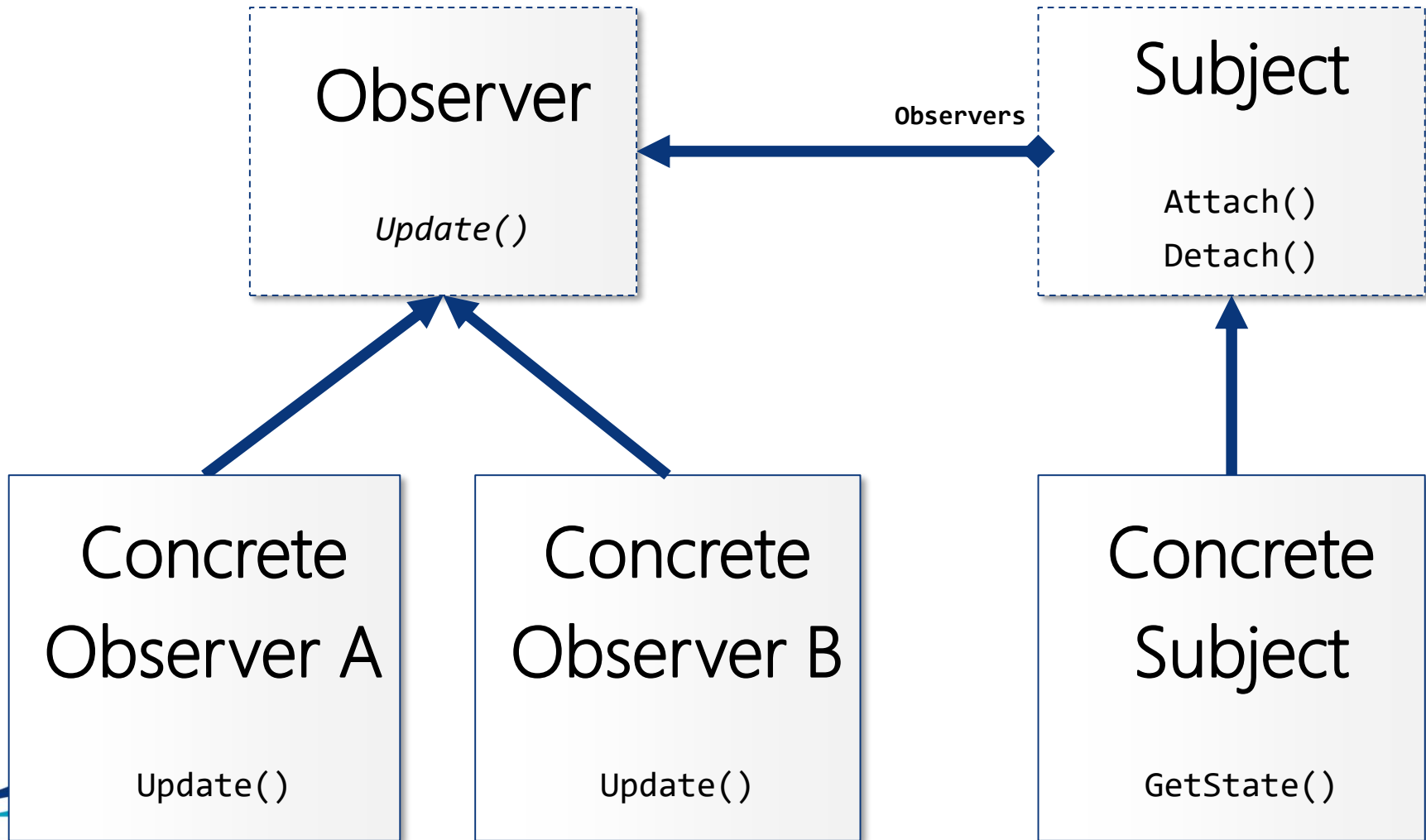


Pattern: Observer

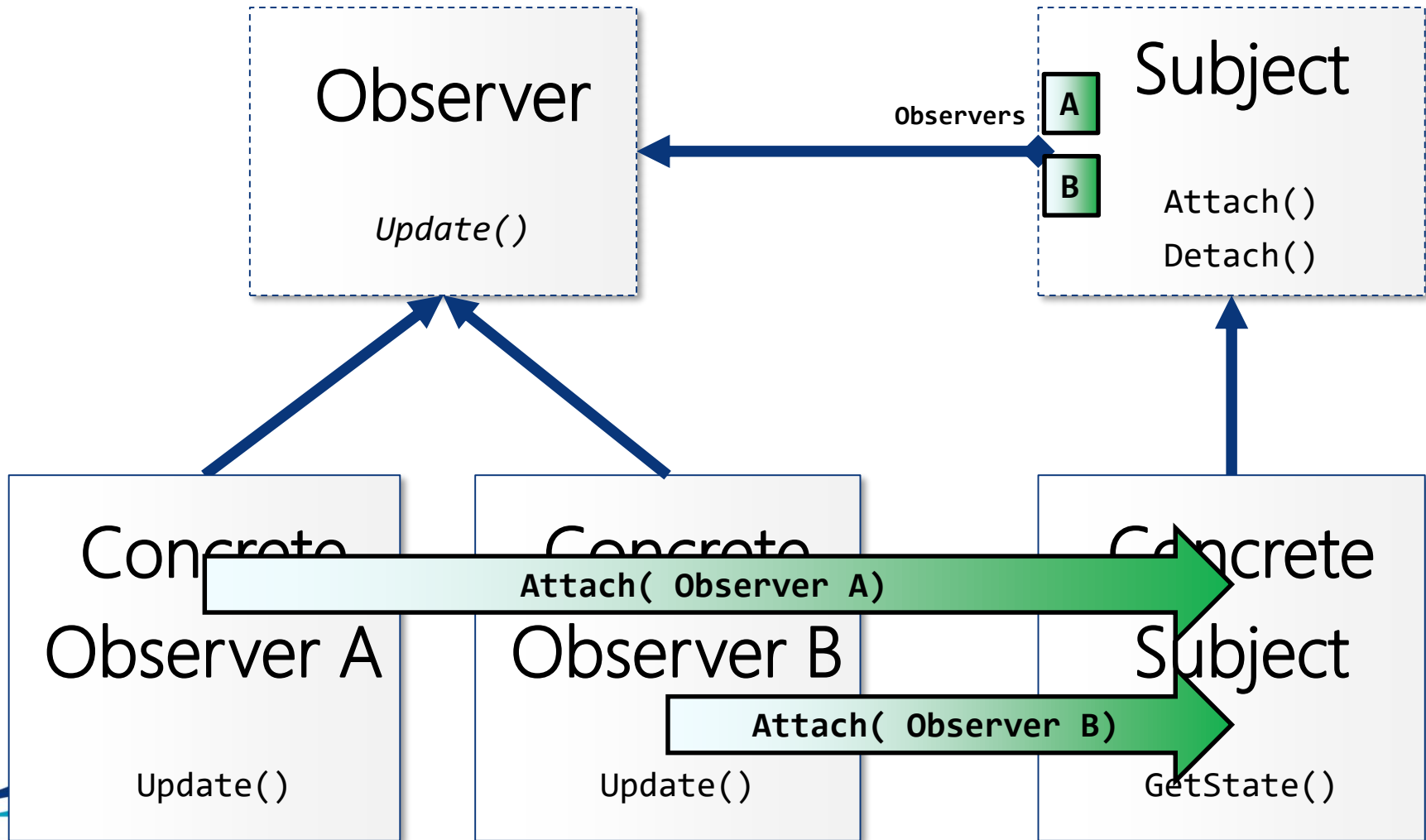
- ▶ *Define a one-to-many dependency relation between objects so that when one object changes state, all its dependents are notified and updated automatically.*
- ▶ Outline
 - Define Subject and Observer objects
 - Let observers register and deregister with Subject
 - Ensure that when a Subject changes state, it will notify all registered Observers
- ▶ Origin: Gang of Four



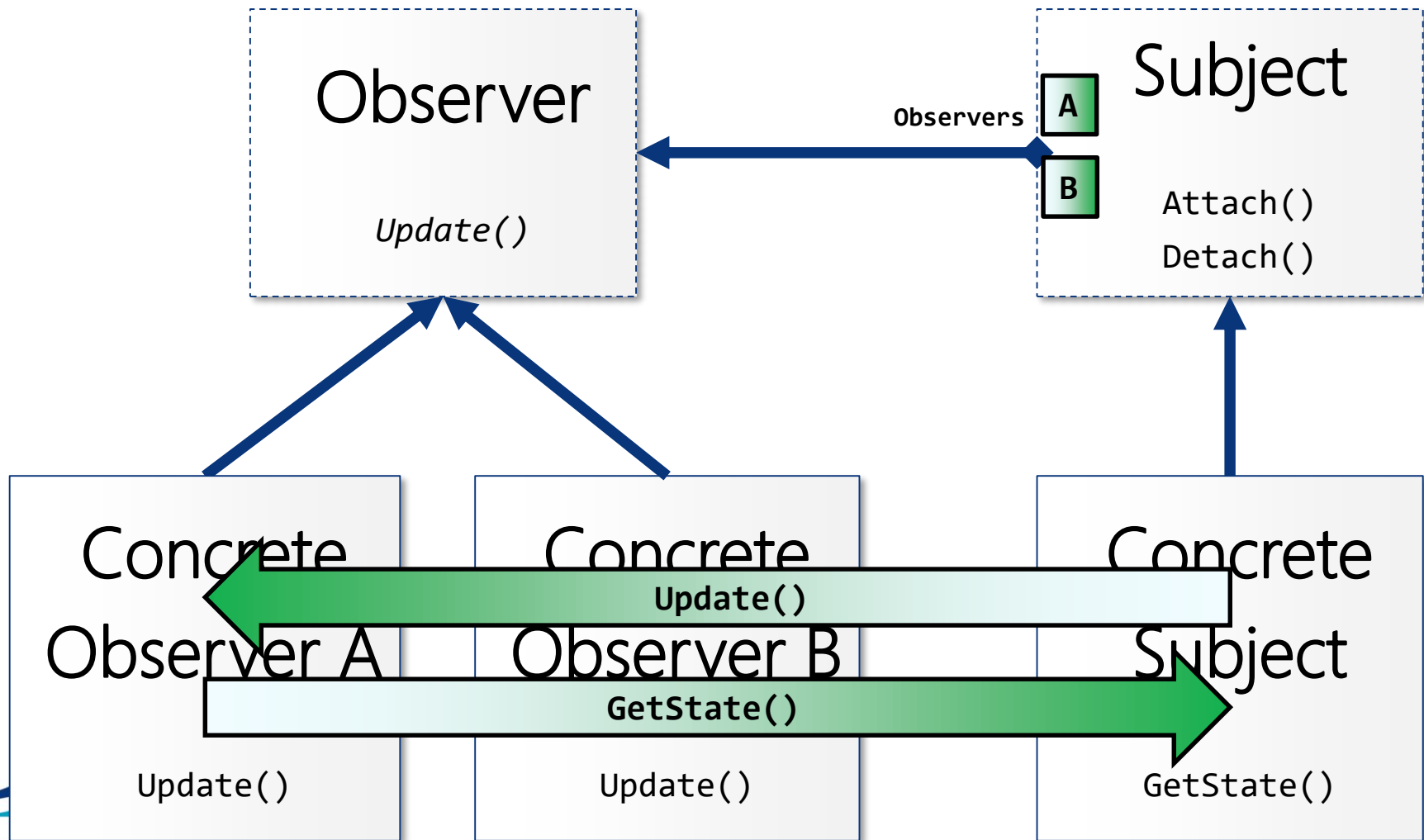
Original Observer Pattern



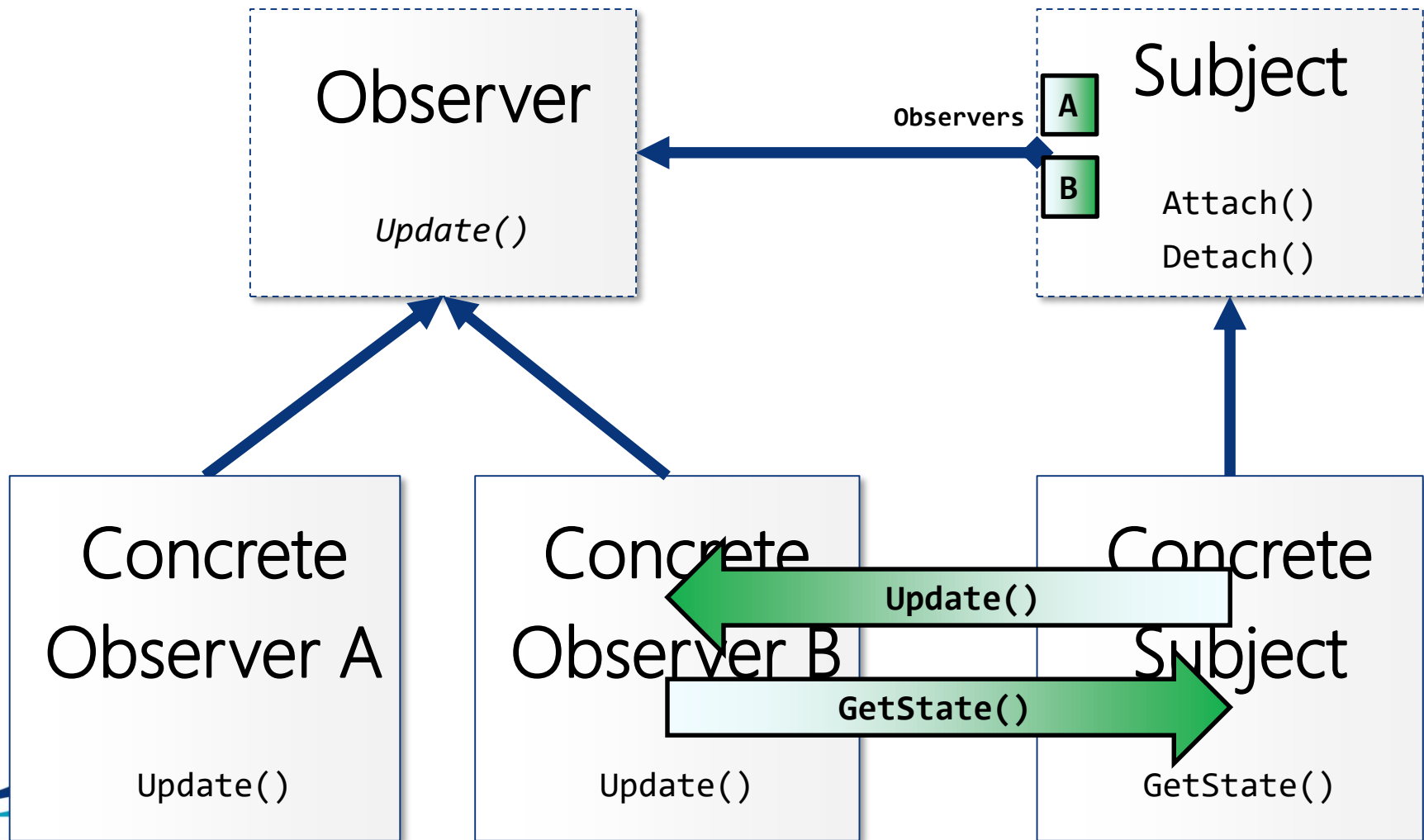
Original Observer (Registration)



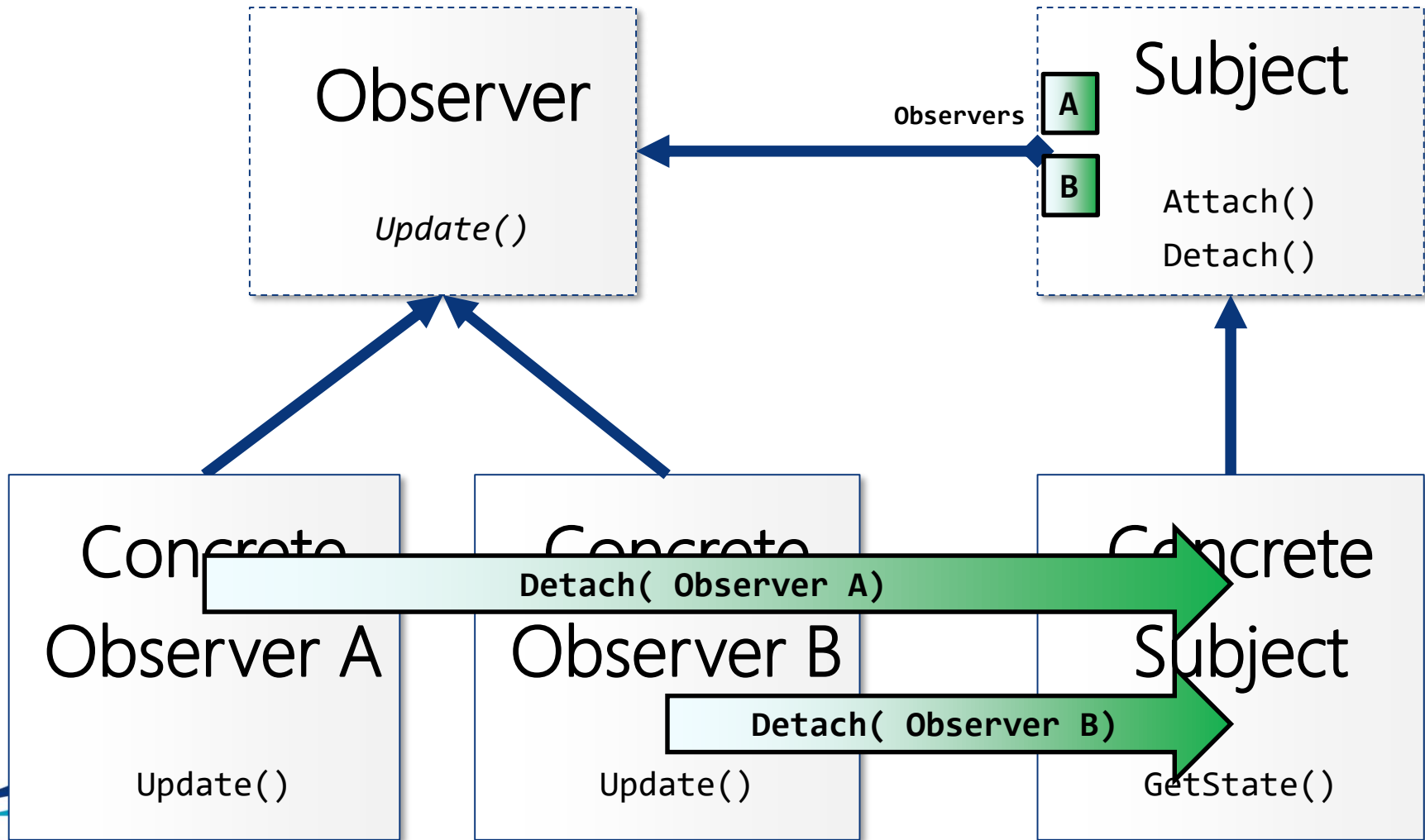
Original Observer (Update)



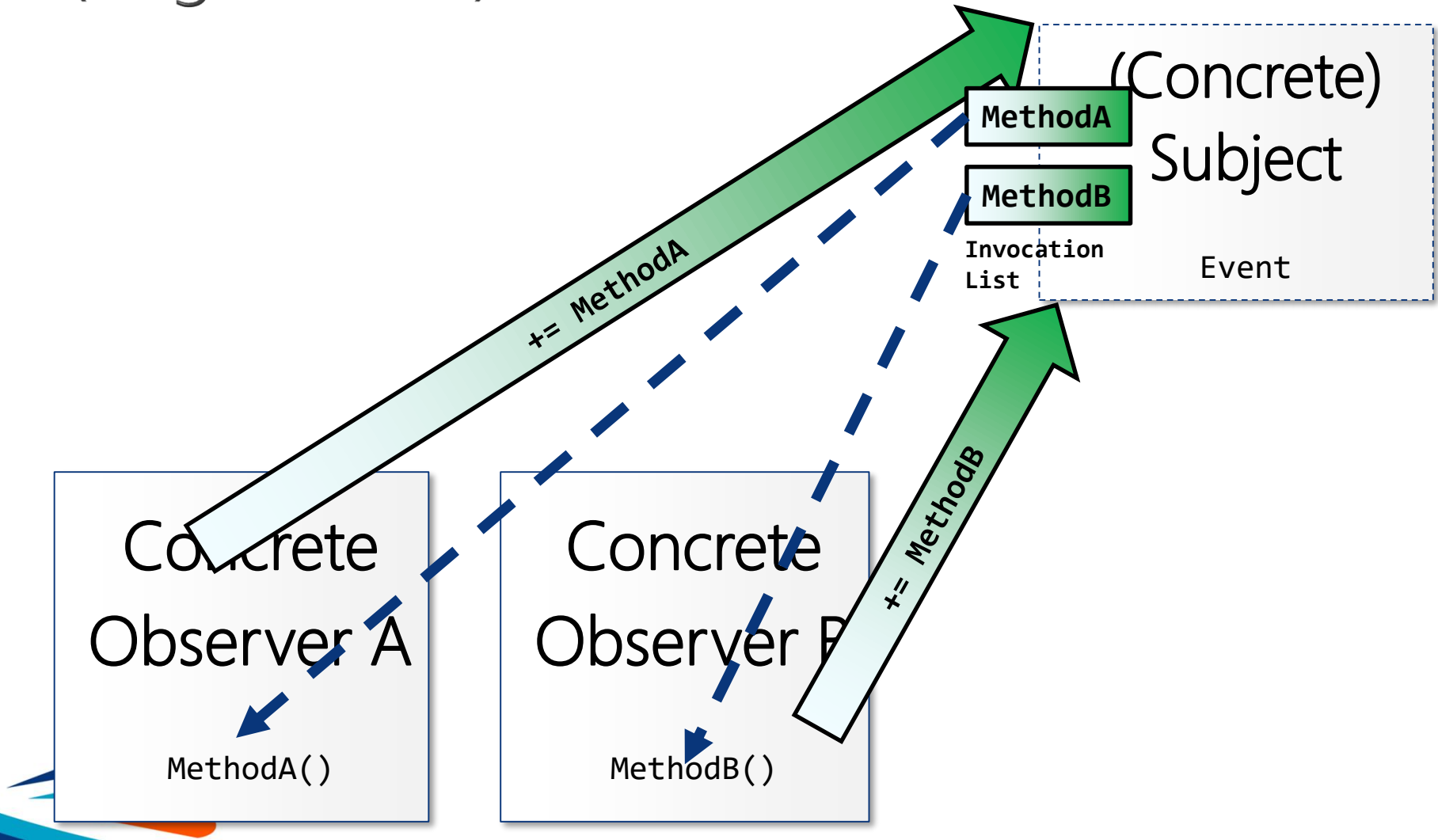
Original Observer Pattern (Update)



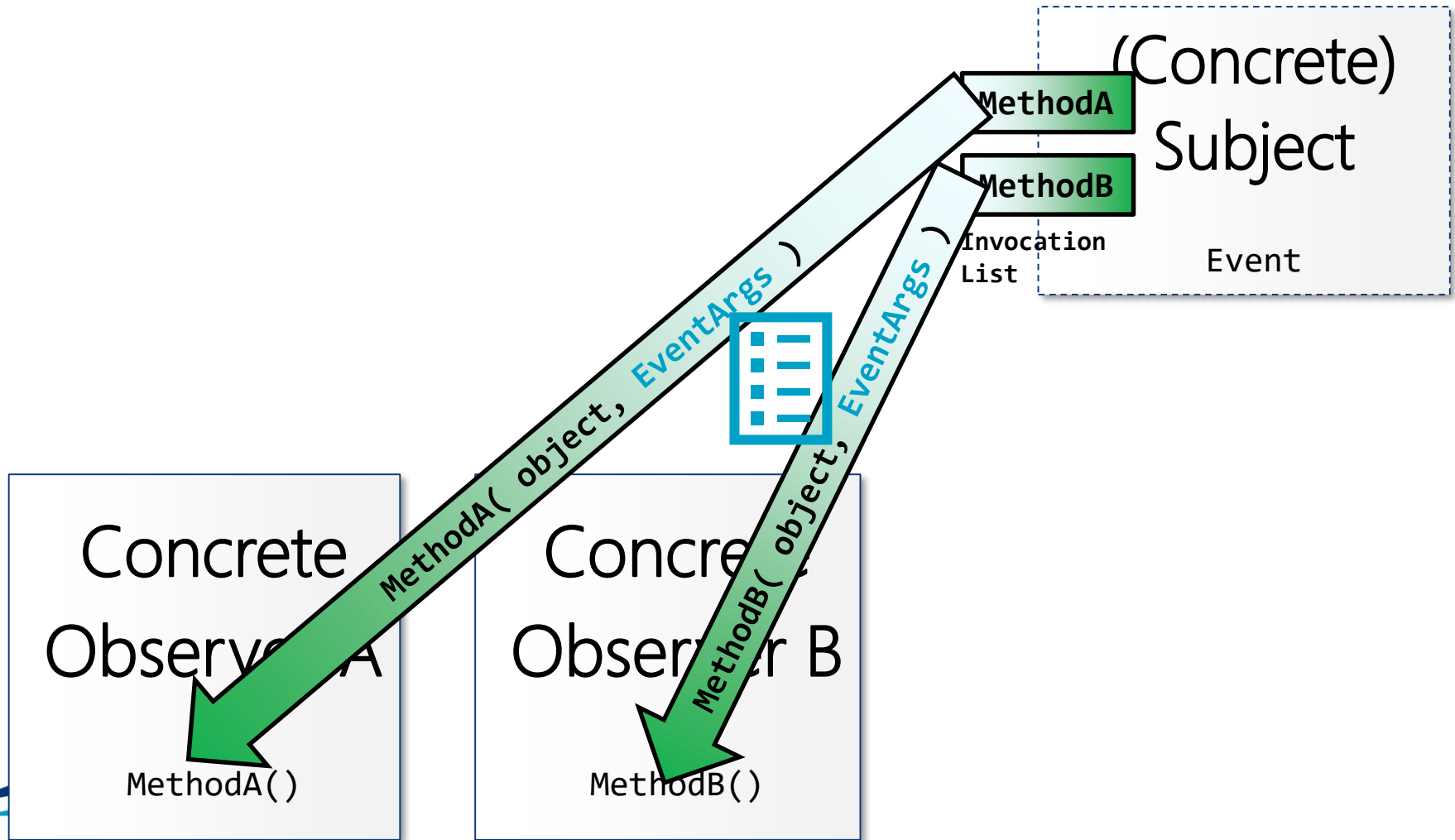
Original Observer (Deregistration)



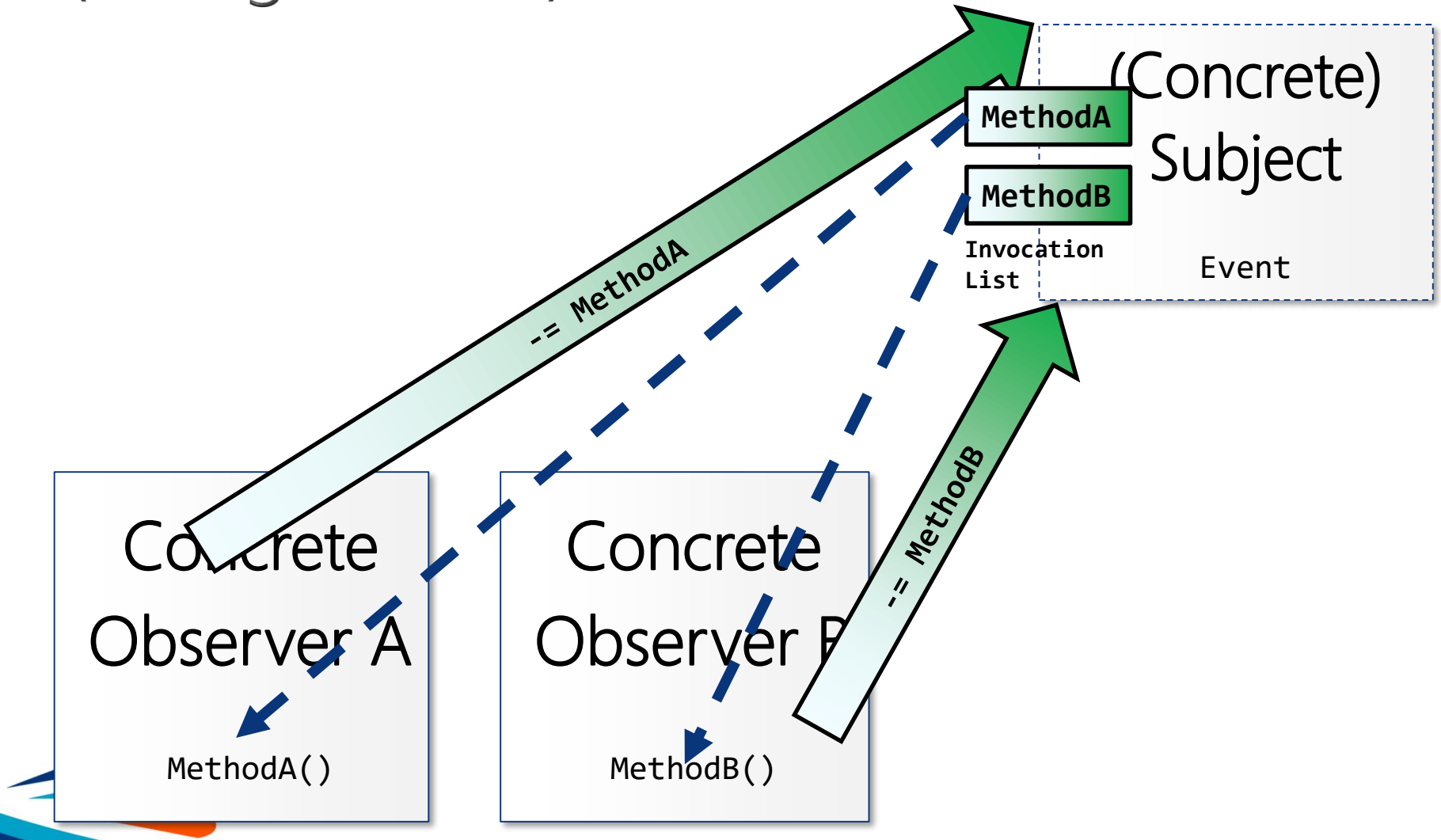
.NET Observer Pattern: Events (Registration)



.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 IObservable<T>

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

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

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




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