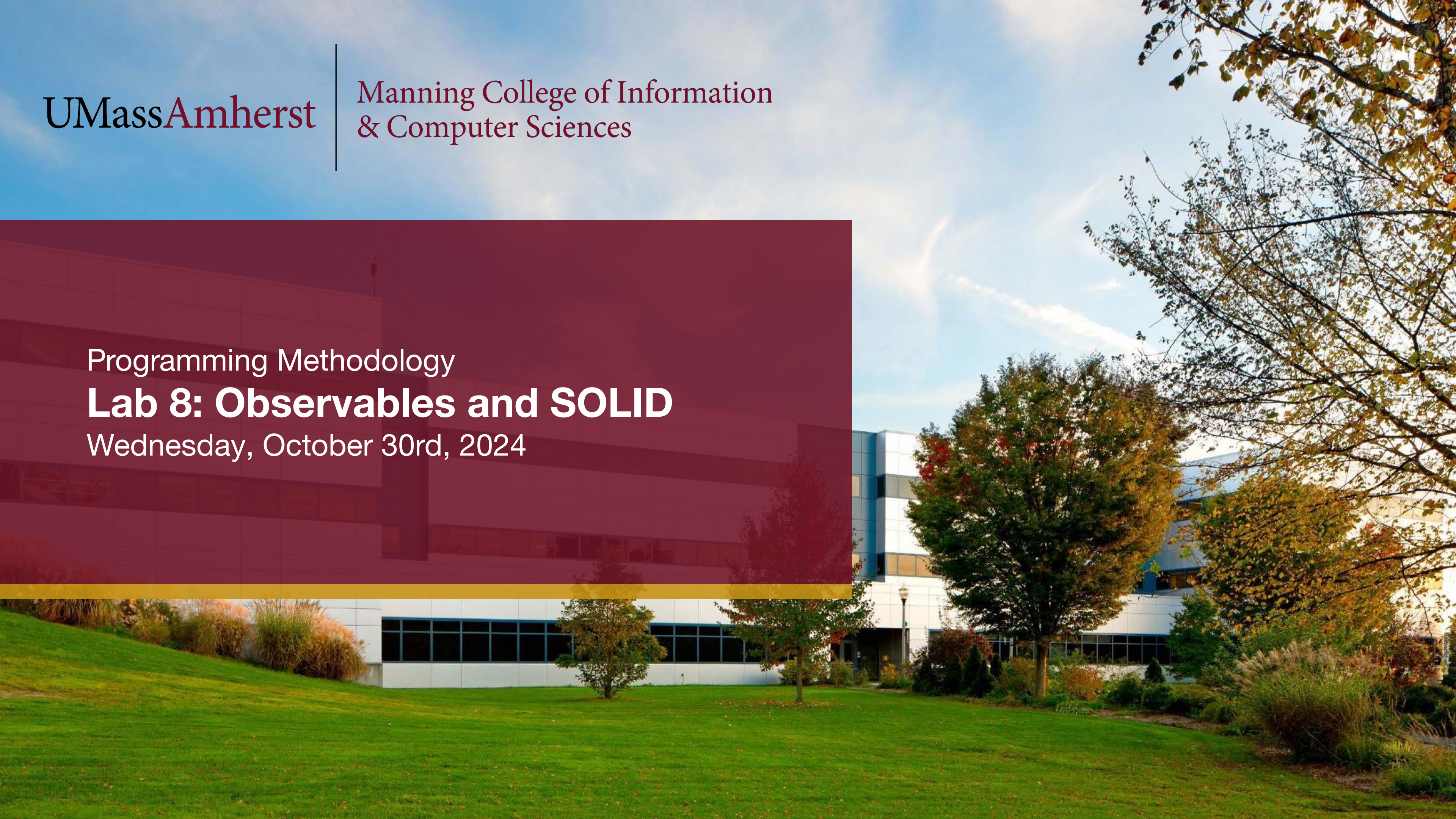

UMassAmherst
Manning College of Information & Computer Sciences
Programming Methodology
Lab 8: Observables and SOLID
Wednesday, October 30rd, 2024

Weekly Lab Agenda

- Go over reminders/goals
- Review past material
- Work in groups of 2-3 to solve a few exercises
    - Please sit with your group from last week.
- Discussion leaders will walk around and answer questions
- Solutions to exercises will be reviewed as a class
- Attendance taken at the end

Reminders

- Download the starter code.
- Homework 6 is due tonight at 11:59pm
  - Come to office hours for help!
- The observables extra credit assignment will be released
  - Due Tuesday October 31st November 5 at midnight
- Complete the CATME Survey by next Friday November 3rd at midnight
- Midterm 2 is next week!
  - Start studying early.
  - Lab next week will be held as scheduled and attendance is required

Today’s Goals

- Practice working with the observer pattern
- Practice working with streams

Observer Review

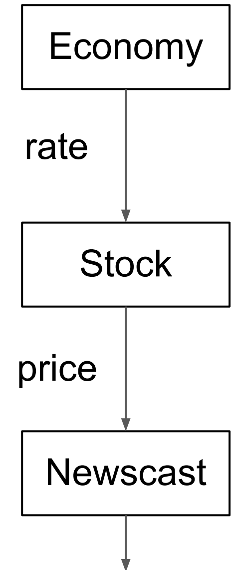
- What: A design pattern in which an observable subject automatically notifies dependent observers of any state changes
- Why: It’s everywhere. E.g: GUI updates
- How: Reusable class

```
type Observer<T> = (x: T) => any;

class Observable<T> {
  private observers: Observer<T>[] = [];  // Maintain a list of observers

  subscribe(f: Observer<T>) {             // Add an observer to the list
    this.observers.push(f);
  }

  update(x: T) {                          // Notify each observer of update
    this.observers.forEach(f => f(x));
  }
}
```

Exercise 1

- Model the stock market with 3 classes. Make sure to test!

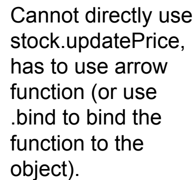
```
// Should be "observable"
class Economy /* possibly extends something */ {
    updateRate(rate: number): void {} // Notify whoever cares about the economy
}

// Should observe Economy's rate, and be "observable"
class Stock /* possibly extends something */ {
    constructor(name: string, base: number) {}
    updatePrice(rate: number): void {} // Update price = base * rate
}

//  Should observe and report Stock's price
class Newscast {
    constructor() {}
    report(name: string, price: number): void {
        console.log(`Stock ${name} has price ${price}.`)
    }
}
```



Exercise 1: Solution

```
class Economy extends Observable<number> {
    updateRate(rate: number): void {
        this.update(rate);
    }
}

class Stock extends Observable<number> {
    private price: number;
    // use property parameters for declaration + initialization
    constructor(name: string, private base: number){
        super();
        this.price = base;
    }

    updatePrice(rate: number): void {
        this.price = this.base * rate;
        this.update(this.price);
    }
}
```

```
const USEconomy = new Economy();
const stock = new Stock("GME", 1.0);
const news = new Newscast();

USEconomy.subscribe(rate => stock.updatePrice(rate));
stock.subscribe(price => news.report(stock.name, price));

USEconomy.updateRate(5); // "Stock GME has price 5."
USEconomy.updateRate(1); // "Stock GME has price 1."
```



‘Rest’ syntax

The **rest syntax** (`...`) in TypeScript (and JavaScript) allows a function to accept an indefinite number of arguments as an array. It’s useful when you don’t know in advance how many arguments will be passed to a function.

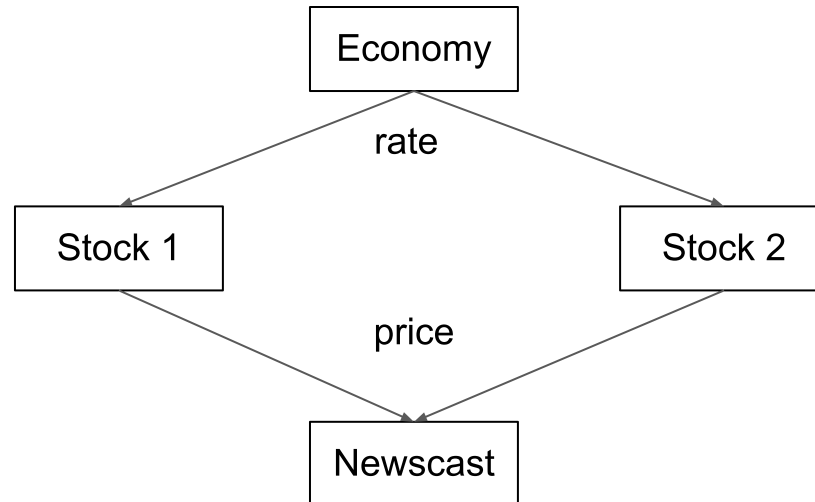
```
function multiplyAll(...numbers: number[]): number {
    return numbers.reduce((product, num) => product * num, 1);
}
```

Here's how you can use the `multiplyAll` function:

```
const result1 = multiplyAll(2, 3, 4);     // result1 will be 24
const result2 = multiplyAll(5, 10);       // result2 will be 50
const result3 = multiplyAll();            // result3 will be 1
```

Exercise 2

- Add a function `observe(...stocks: Stock[])` to `Newscast` so that it can observe any number of input stocks
- Make `Newscast` be an Observable that updates subscribers with the tuple [stockName, stockPrice] of type [string, number] whenever it reports



Exercise 2: Solution

```
class Newscast extends Observable<[string, number]> {
    report(name: string, price: number): void {
        console.log(`Stock ${name} has price ${price}.`)
        this.update([name, price]);
    }

    observe(...stocks: Stock[]): void {
        stocks.forEach(stock => stock.subscribe(price => this.report(stock.name, price)));
    }
}
```

What does this do?

Using the rest parameter syntax lets us pass parameters separated with a comma and turn them into an array. (called rest operator)

For example: If called like this observe(stock1, stock2, stock3)
Then stocks will be the array [stock1, stock2, stock3].

Exercise 3: Rectangle and Square

Does this class hierarchy satisfy the Liskov Substitution Principle?

```
interface Shape {
  area: () => number, perimeter: () => number
}
class Rectangle implements Shape {
  // use parameter properties shorthand
  constructor(private w: number, private h: number) {}
  area() { return this.w * this.h; }
  perimeter() { return 2 * (this.w + this.h); }
  getW() { return this.w; }
  getH() { return this.h; }
  setW(w: number) { this.w = w; return this; }
  setH(h: number) { this.h = h; return this; }
  symmetryAngles() { return [0, 90]; }
}
```

```
class Square extends Rectangle {
 constructor(len: number) { super(len, len); }
 setW(w: number) { super.setW(w);super.setH(w); }
 setH(h: number) { super.setH(h);super.setW(h); }
 symmetryAngles() { return [0, 45, 90, 135]; }
}
```

Give a code example where the expectations of the LSP are violated.
Restructure the hierarchy so the LSP holds.
You may introduce new classes, change method behavior (return new objects), etc.

Exercise 3: Solution

The following code will fail:

```
function breakLSP(r: Rectangle, newH: number) {
  const w = r.getW();
  r.setH(newH);
  assert(r.area() === w * newH);
}
breakLSP(new Square(3), 4);
```

If `setH()`, `setW()` are inherited, this still breaks the LSP:
`new Square(3).setH(4)` no longer has expected symmetries

`Rectangle.setW()` has an implicit invariant of not changing `h`
(likewise for `setH()` and `w`). This is broken in `Square`.
Inheriting `setW()/setH()` would not maintain a square shape

Exercise 3: Solution

One option is to separate interfaces, realizing that `setH/setW` mutate the shape, which is not always needed/intended.

```
class Rectangle implements Shape { // immutable
 constructor(protected w: number,
             protected h: number) {}
 area() { return this.w * this.h; }
 perimeter() { return 2 * (this.w + this.h); }
 getW() { return this.w; }
 getH() { return this.h; }
 symmetryAngles() { return [0, 90]; }
}
class Square extends Rectangle {
 constructor(len: number) { super(len, len); }
 symmetryAngles() { return [0, 45, 90, 135]; }
}
```

```
class MutableRectangle extends Rectangle {
 setW(w: number) { this.w = w; return this; }
 setH(h: number) { this.h = h; return this; }
}

// does not extend MutableRectangle
// since it always preserves square shape
class MutableSquare extends Square {
 setL(len: number) {
   this.w = this.h = len;
   return this;
 }
}
```

Exercise 3: Solution

Another solution is to make the setters return new objects (Rectangle or Square)

```
class Rectangle implements Shape {
 constructor(private w: number,
             private h: number) {}
 area() { return this.w * this.h; }
 perimeter() { return 2 * (this.w + this.h); }
 getW() { return this.w; }
 getH() { return this.h; }
 setW(w) { return w === this.h ? new Square(w)
          : new Rectangle(w, this.h); }
 setH(h) { return h === this.w ? new Square(h)
          : new Rectangle(this.w, h); }
 symmetryAngles() { return [0, 90]; }
}
```

```
class Square extends Rectangle { // unchanged
 constructor(len: number) { super(len, len); }
 symmetryAngles() { return [0, 45, 90, 135]; }
}
```

TS/JS would allow us to return the same object, changing its prototype, but this would be confusing for any client code.