UMassAmherst | Manning College of Information & Computer Sciences

Programming Methodology

Lab 8: Observer and Streams

Wednesday, October 23rd, 2023

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 5 is due tonight at 11:59pm
  - Come to office hours for help!
- The observables extra credit assignment has been released
  - Due Tuesday October 31st 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

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Today’s Goals

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

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Observer Review

- What: A design pattern in which an <u>observable</u> subject automatically notifies dependent <u>observers</u> 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));
  }
}
```

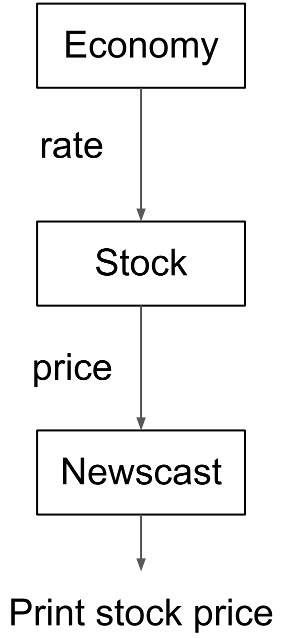
Exercise 1

- 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, price: 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> {
    name: string
    base: number;
    price: number;

    constructor(name: string, base: number, price: number) {
        super();
        this.name = name;
        this.base = base;
        this.price = price;
    }

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

Cannot directly use stock.updatePrice, has to use arrow function (or use .bind to bind the function to the object).

```
const USEconomy = new Economy();
const stock = new Stock("GME", 5.0, 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."
```

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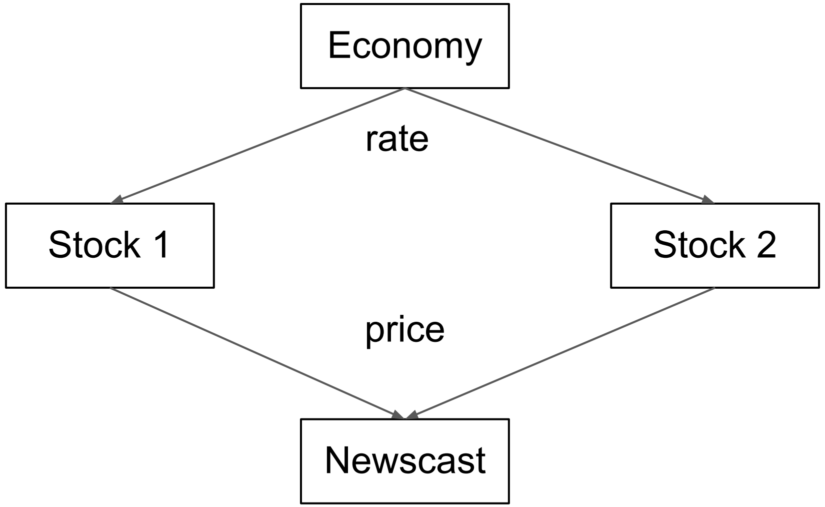
Exercise 2

- 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]> {
    constructor() {
        super();
    }

    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 spread operator in the parameter will let us pass parameters separated
with a comma and turn them into an array.

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

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Stream Review

- What: A sequence of data made available over time
- Why: Useful abstraction for the paradigm where there's limited random data access and each data record can only be seen once*. E.g: Data reading, signal processing
- How: We implemented stream as a lazily constructed list with memoized tail

```
interface Stream<T> {
  head: () => T;
  tail: () => Stream<T>;
  isEmpty: () => boolean;
  toString: () => string;
  map: <U>(f: (x: T) => U) => Stream<U>;
  filter: (f: (x: T) => boolean) => Stream<T>;
  reduce: <U>(f: (acc: U, e: T) => U, init: U) => Stream<U>; // This is new
}

reduce: (f, init) => snode(init, () => memoizedTail.get().reduce(f, f(init, head)))
```

Exercise 3: Maxima stream (in a previous exam!)

- Implement maxUpTo(s: Stream<number>): Stream<number>
- Input: A stream of numbers a1, a2, a3, ...,
- Output: A stream of maxima of numbers up to the current one:
  a1 => max(a1, a2) => max(a1, a2, a3) =>.... => sempty
- Example:
  Input stream: 1 => 4 => 3 => 2 => 5 => 1 => sempty
  Output stream: 1 => 4 => 4 => 4 => 5 => 5 => sempty

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Exercise 3: Solution

```
// Solution 1
function maxUpTo(s: Stream<number>): Stream<number> {
    function maxUpToHelper(s: Stream<number>, prevMax: number): Stream<number> {
        if (s.isEmpty()) {
            return s;
        }
        const curMax = Math.max(prevMax, s.head());
        return snode(curMax, () => maxUpToHelper(s.tail(), curMax));
    }

    return maxUpToHelper(s, -Infinity);
}

// Solution 2
function maxUpTo(s: Stream<number>): Stream<number> {
    let max = -Infinity;
    return s.map(x => max = Math.max(x, max));
}

// Solution 3
function maxUpTo(s: Stream<number>): Stream<number> {
    return s.reduce(Math.max, -Infinity).tail(); // Why .tail()?
}
```