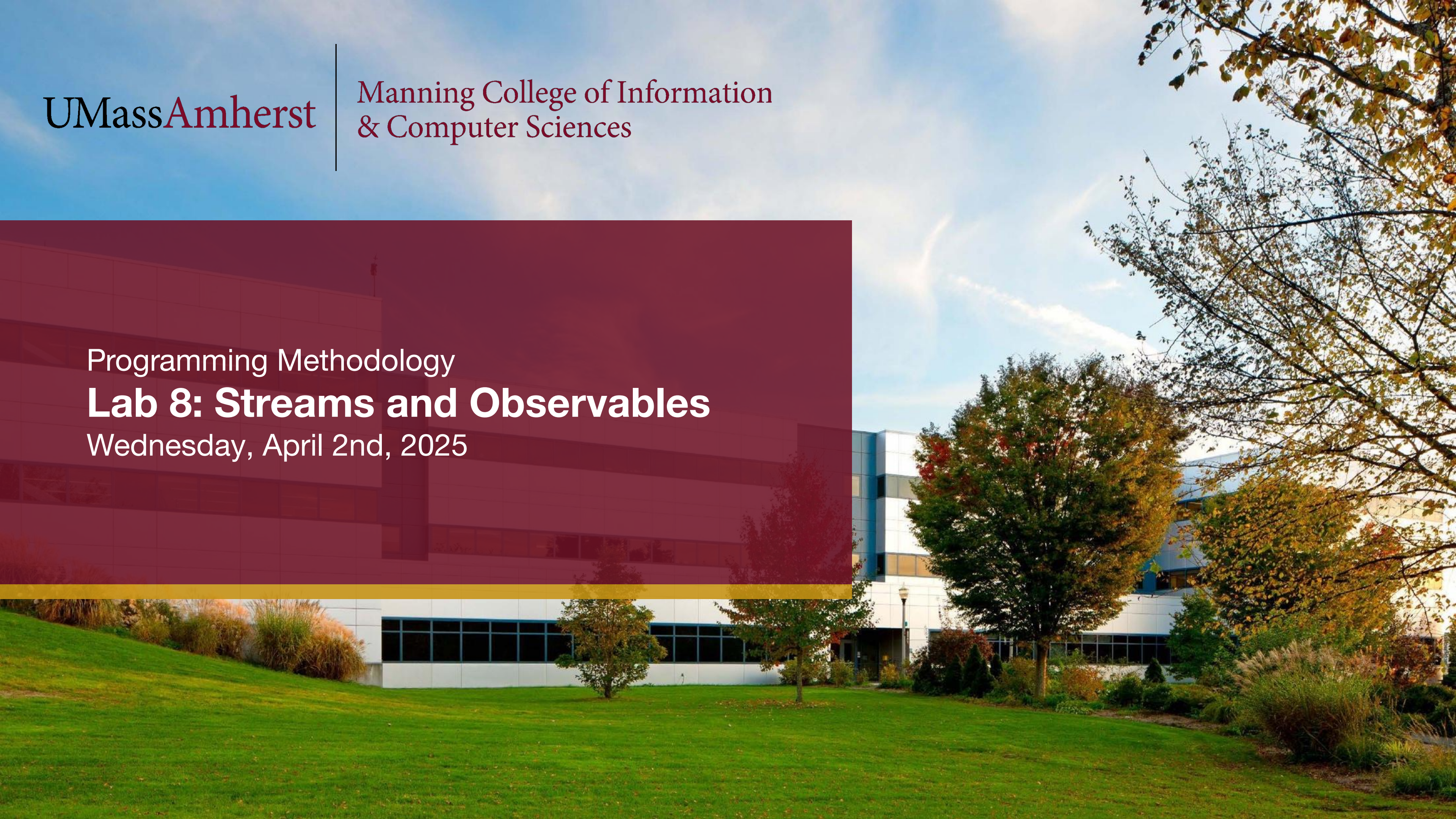


UMassAmherst | Manning College of Information & Computer Sciences

Programming Methodology

Lab 8: Streams and Observables

Wednesday, April 2nd, 2025

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 (Streams) is due tonight at 11:59pm
    - Come to office hours for help!
- The Observables HW (extra credit) will be available soon
- Midterm 2 is next week!
    - Start studying early.

Today's Goals

- Practice working with Streams
- Practice working with Observables

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

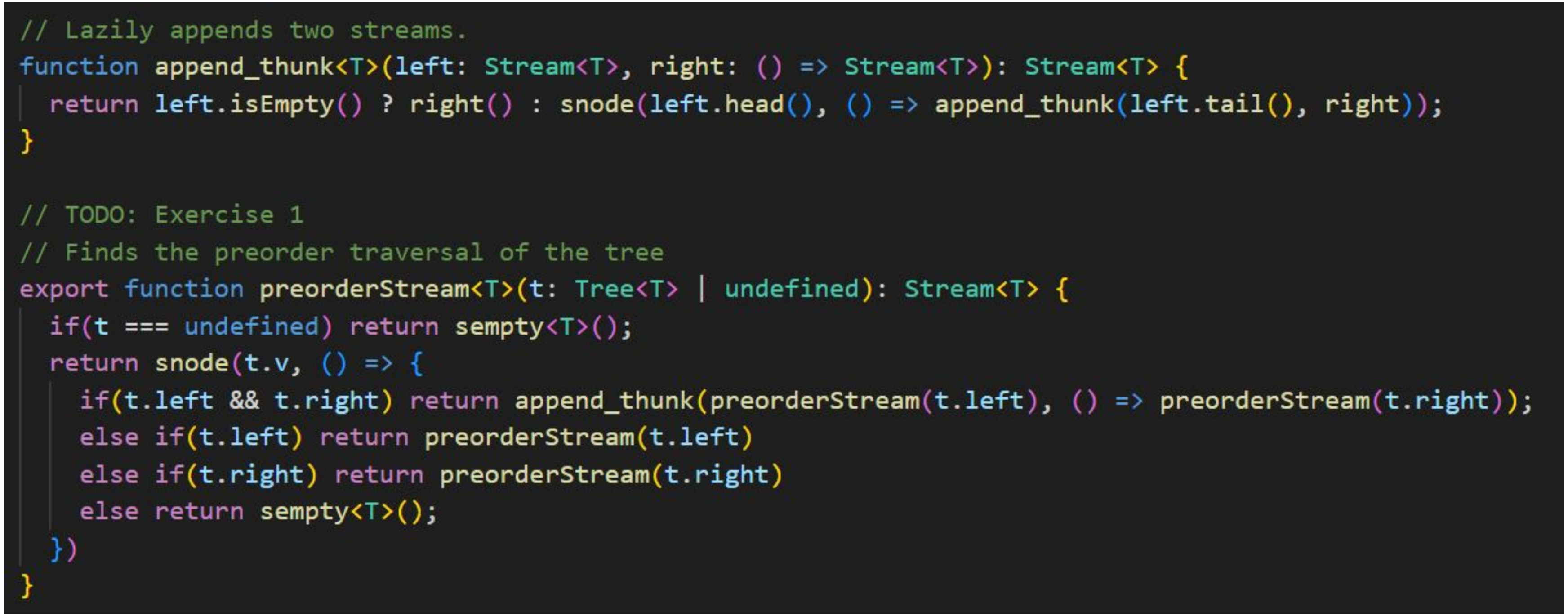
```
interface Stream<T> {
  head: () => T;
  tail: () => Stream<T>;
  isEmpty: () => boolean;
  toString: () => string;
  map: <U>(f: (x: T) => U) => Stream<U>;
  filter: (f: (x: T) => boolean) => Stream<T>;
  reduce: <U>(f: (acc: U, e: T) => U, init: U) => Stream<U>; // This is new
}

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

Exercise 1: Preorder Traversal of Binary Tree

- Implement preorderStream<T>(t: Tree<T> | undefined): Stream<T>
- Input: A binary tree with the following type alias:
  type Tree<T> = { left?: Tree<T>; v: T; right?: Tree<T> };
- Output: A stream of values that follow the prefix order (preorder) traversal of the tree.
- Example:
  Input tree: Output stream: 1 -> 2 -> 3 -> 4 -> 5 -> 6 -> sempty()

```
      1
    /   \
   2     5
  / \     \
 3   4     6
```

Exercise 1 Solution



```typescript
// Lazily appends two streams.
function append_thunk<T>(left: Stream<T>, right: () => Stream<T>): Stream<T> {
  return left.isEmpty() ? right() : snode(left.head(), () => append_thunk(left.tail(), right));
}

// TODO: Exercise 1
// Finds the preorder traversal of the tree
export function preorderStream<T>(t: Tree<T> | undefined): Stream<T> {
  if(t === undefined) return sempty<T>();
  return snode(t.v, () => {
    if(t.left && t.right) return append_thunk(preorderStream(t.left), () => preorderStream(t.right));
    else if(t.left) return preorderStream(t.left)
    else if(t.right) return preorderStream(t.right)
    else return sempty<T>();
  })
}
```

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));
  }
}
```

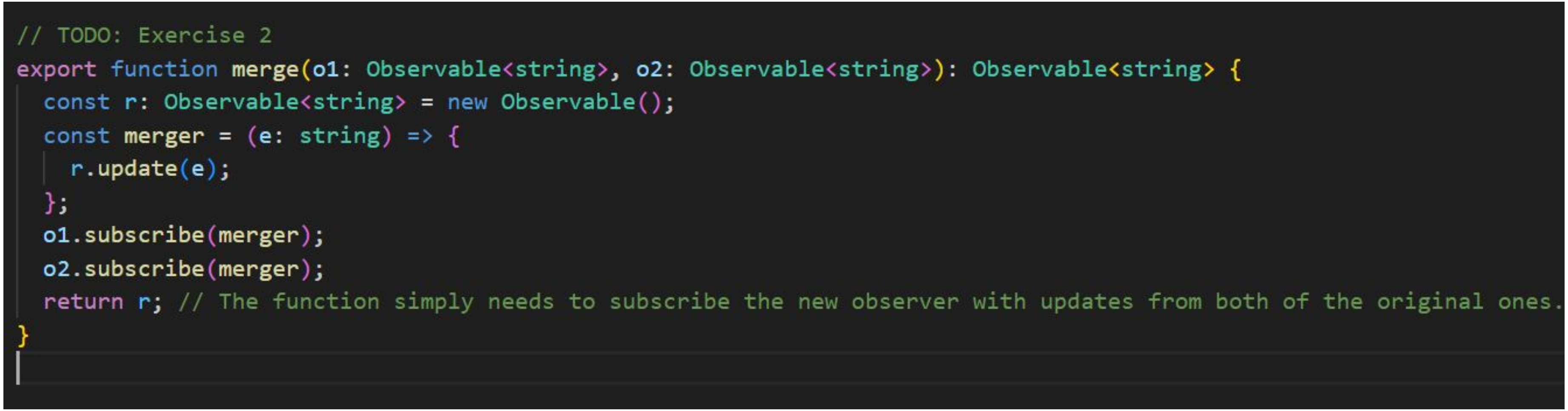
Exercise 2: Merge Observables

- Write a function

  merge(o1: Observable<string>, o2: Observable<string>): Observable<string>

  that returns a new `Observable<string>` which, whenever either o1 or o2 are updated, will be updated with the same value.

Exercise 2 Solution



```
// TODO: Exercise 2
export function merge(o1: Observable<string>, o2: Observable<string>): Observable<string> {
  const r: Observable<string> = new Observable();
  const merger = (e: string) => {
    r.update(e);
  };
  o1.subscribe(merger);
  o2.subscribe(merger);
  return r; // The function simply needs to subscribe the new observer with updates from both of the original ones.
}
```