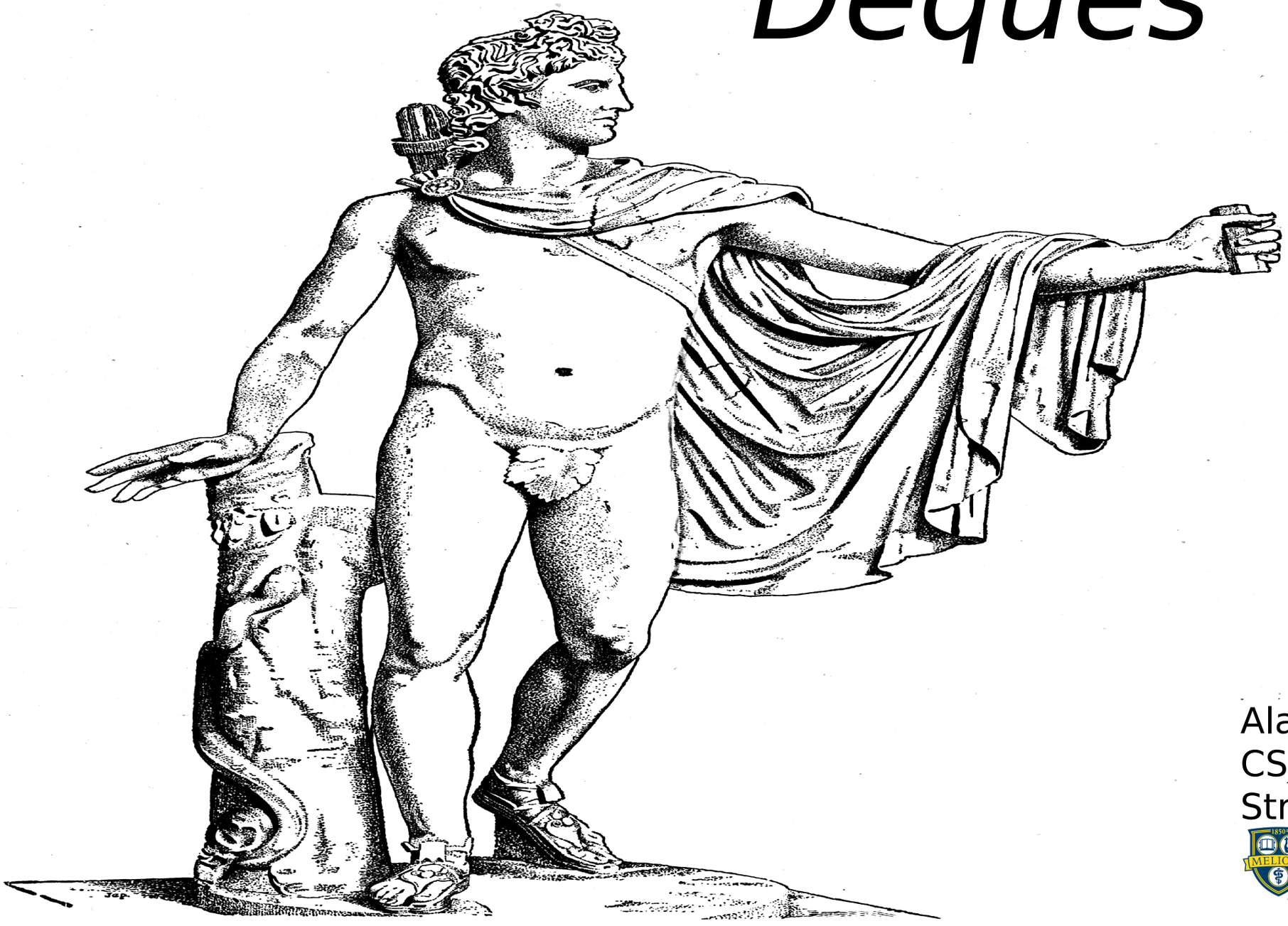
The Art of Data Structures

Deques



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CSC 162: The Art of Data Structures

UNIVERSITY of ROCHESTER

Agenda

- What Is a Deque?
- The Deque Abstract Data Type
- Implementing a Deque in Python
- Palindrome-Checker

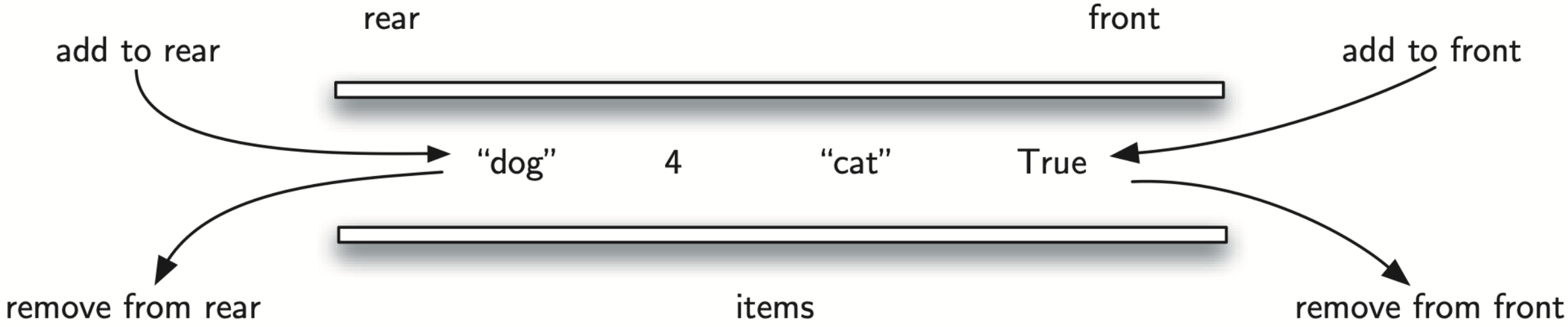
Deques

Deques

- Not as widely used as queues, but still handy for some important applications

Deques

A Deque of Python Data Objects



Implementation

Implementation
Queue Operations

- `Deque()` creates a new deque that is empty; it needs no parameters and returns an empty sequence

- `add_front(item)` adds a new item to the front of the deque; it needs the item and returns nothing

- `add_rear(item)` adds a new item to the rear of the deque; it needs the item and returns nothing

Implementation
Queue Operations

- `remove_front()` removes the front item from the deque; it needs no parameters and returns the item; the deque is modified
- `remove_rear()` removes the rear item from the deque; it needs no parameters and returns the item; the deque is modified

Implementation
Queue Operations

- `is_empty()` tests to see whether the deque is empty; it needs no parameters and returns a boolean value
- `size()` returns the number of items in the deque; it needs no parameters and returns an integer

Implementation

Deque Operation	Deque Contents	Return Value
d.is_empty()	[]	TRUE
d.add_rear(4)	[4]	
d.add_rear('dog')	['dog',4,]	
d.add_front('cat')	['dog',4,'cat']	
d.add_front(True)	['dog',4,'cat',True]	
d.size()	['dog',4,'cat',True]	4
d.is_empty()	['dog',4,'cat',True]	FALSE
d.add_rear(8.4)	[8.4,'dog',4,'cat',True]	
d.remove_rear()	['dog',4,'cat',True]	8.4

Implementation

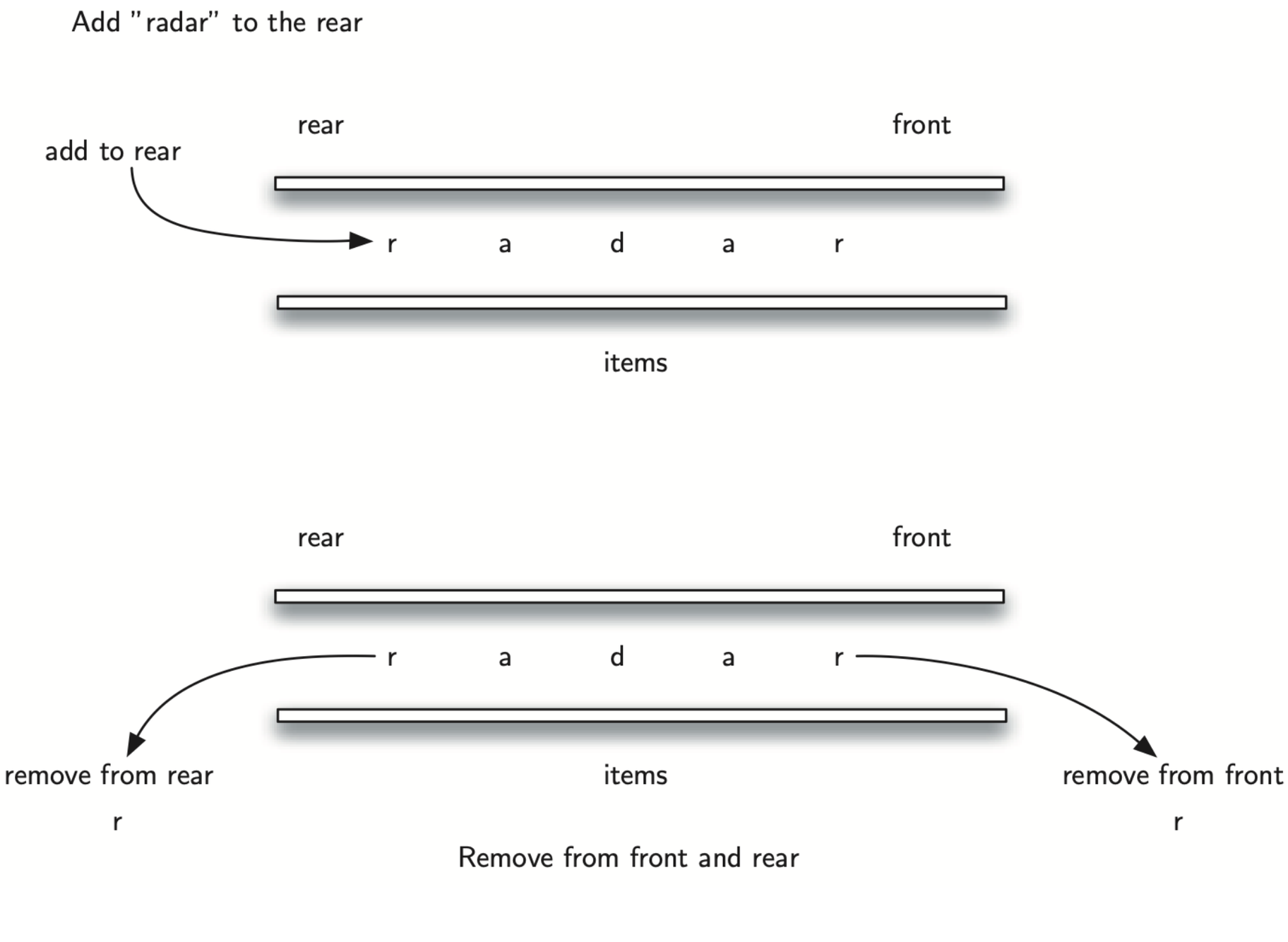
Queue Implementation in Python

```
class Deque:
    def __init__(self):
        self.items = []

    def is_empty(self):
        return self.items == []

def add_front(self, item):
    self.items.append(item)

def add_rear(self, item):
    self.items.insert(0, item)

def remove_front(self):
    return self.items.pop()

def remove_rear(self):
    return self.items.pop(0)

def size(self):
    return len(self.items)
```

Palindrome-Checker

Palindrome-Checker

A Deque



Palindrome-Checker

A Python Implementation

```
def pal_checker(a_str):
    char_deque = Deque()

    for ch in a_str:
        char_deque.add_rear(ch)

    still_equal = True

    while char_deque.size() > 1 and still_equal:
        first = char_deque.remove_front()
        last = char_deque.remove_rear()
        if first != last:
            still_equal = False

    return still_equal

print(pal_checker("lsdkjfskf"))
print(pal_checker("radar"))
```

Palindrome-Checker

Discussion

- The palindrome checker is cute, but not really compelling
- We could simply start indices at the start and end of the string and read toward the middle
- If we were reading from stdin instead of a string, we'd need to store the characters somewhere, but we could use a string just as easily as a deque

Palindrome-Checker
Discussion: Web Browser

- A slightly more compelling example: browser history
- We mostly work at the front of the deque, but when it gets too long we delete off the back
  - (We never insert at the back, though)

Palindrome-Checker

Discussion: Cilk

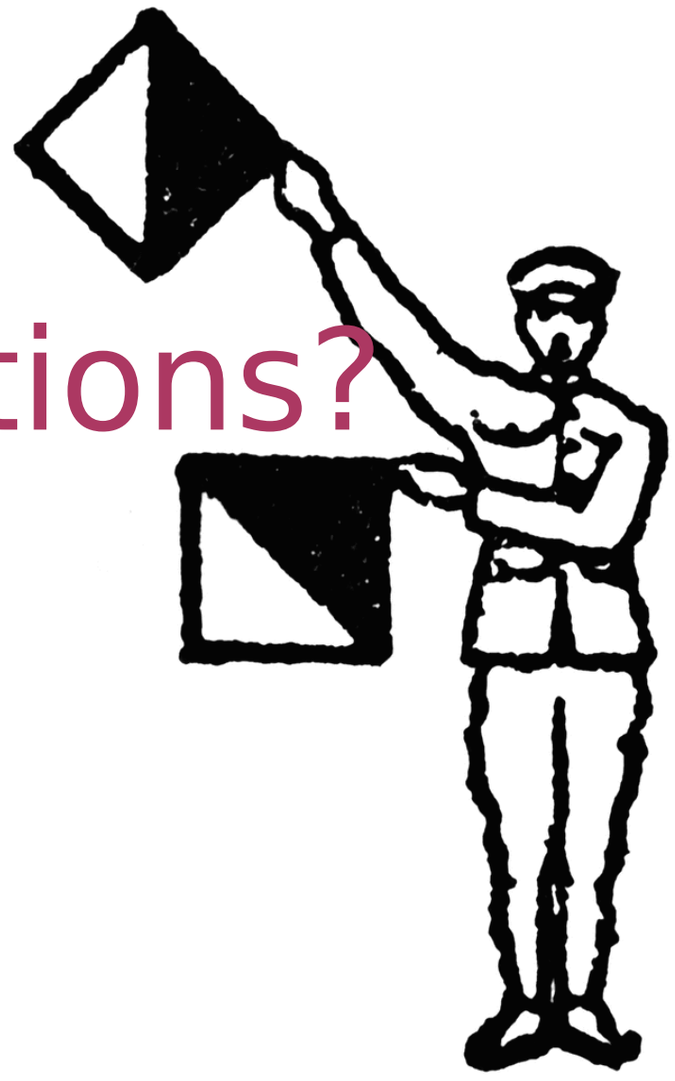
- A more compelling example: work queues in the Cilk parallel programming language
- Every thread has a deque containing work to do
- A thread pushes new tasks onto, and pulls tasks off of, the front of its own deque
- This LIFO strategy maximizes locality, which makes caches work well

Palindrome-Checker

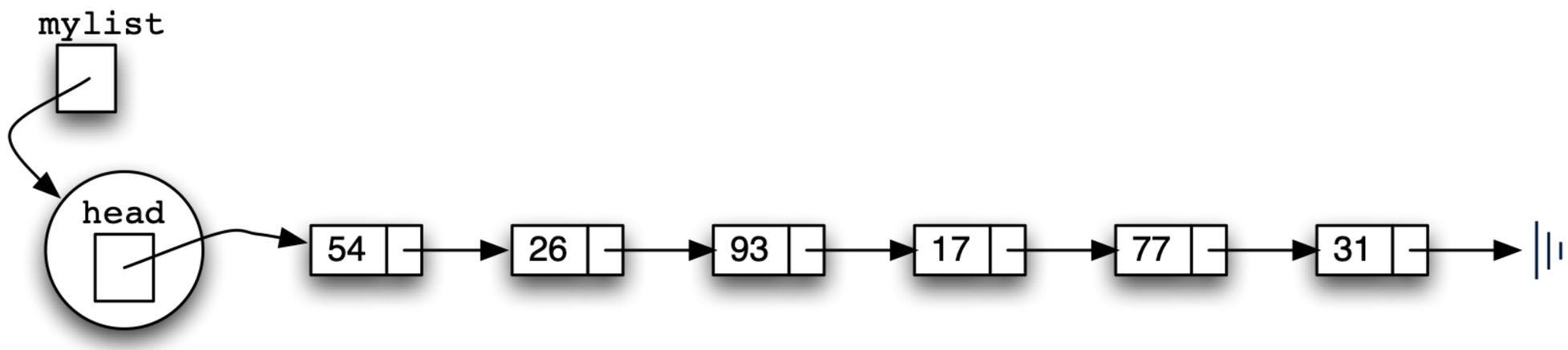
Discussion: Cilk

- If a thread runs out of work, it steals from the tail of some other thread's deque
- Using the other end avoids interfering with the other thread whenever possible
- NB: this is the same access pattern as the browser history: no insertions at the back

Questions?



Next class, linked data structures!



A Linked List of Integers

- Stacks, queues, deques, and lists can all be implemented by linking together one node for each entry
- This has some advantages and is a very common and important technique

- We have a workshop today, but no new lab
- Use the time to work on finishing the labs you already have, read the book, etc
- Friday will have two new labs, both due after 1 week.
- One will be to implement queues/deques as a linked data structure and the other will be about linked lists