CS180 - Linked lists & iterators

Note Title 10/1/2010

Announcements

- Program due Sunday by midnight
- Next program is posted
  - ↳ due Tuesday the 12th

Recap of Vectors:

Idea: extend arrays, so that they grow when needed

But keep things efficient

Running times

Constructor: $O(1)$

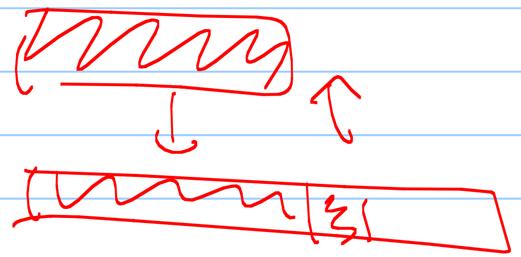
Operator [ ]: $O(1)$

Destructor: $O(1)$

Insert: $O(N)$ if N elements in vector

Remove: $O(N)$

Push_back: $O(N)$



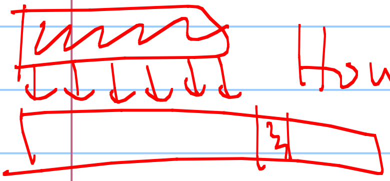
Proposition: The running time of making N push_back operations in an initially empty array is O(N).

Proof: (called Amortized analysis)

virtual dollars

make every function call "pay" for its time

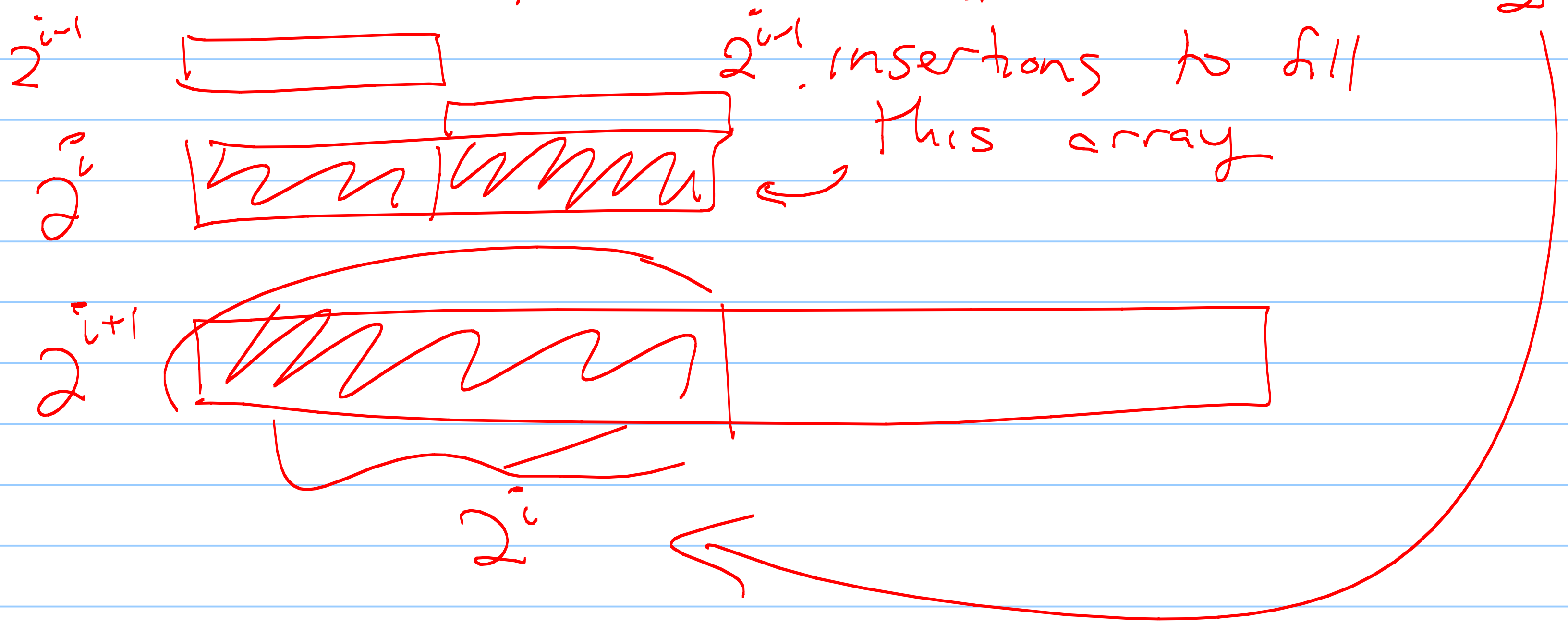
If we don't double the array, each call will cost $1



How much do the doubling calls take?

Instead of \$1, I'm going to charge \$3.

Bank account: $3 \cdot 2^{i-1} - 1 \cdot 2^{i-1} = 2 \cdot 2^{i-1} = 2^i$

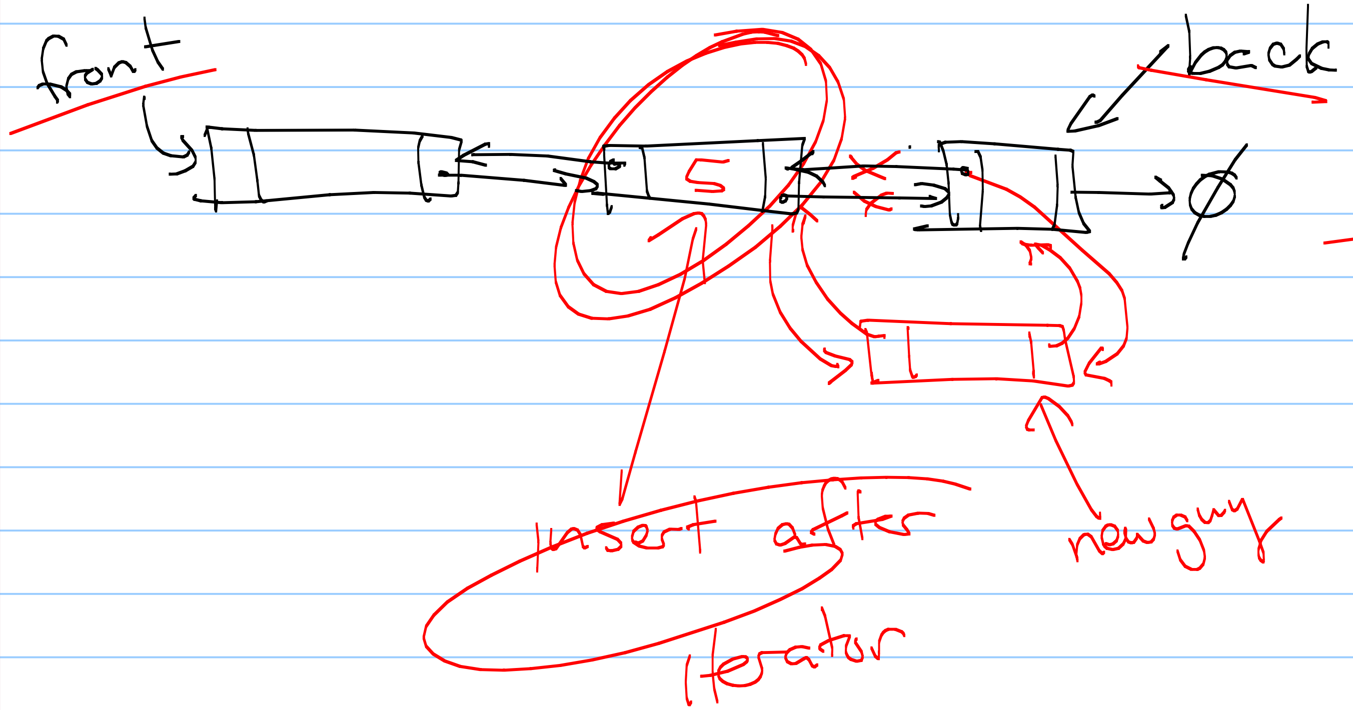


Linked lists

Motivation: The running time of insert in a vector is awful!

Idea: If we know where an element should go, inserting should be faster.

Doubly Linked List: Insert



Operations

new

4 pointers

⇓

O(1) time

Problem: What do we need the user to have in order to implement insert?

Need to specify a node.

But the user can't know about Nodes!

Solution: Iterator

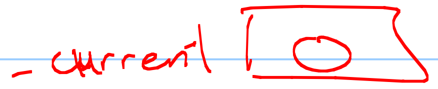
An iterator will give the user a "pointer", but with a heavily controlled structure (so they can't manipulate the nodes directly).

Compromise between hiding the underlying data & allowing the user / to specify a location directly.

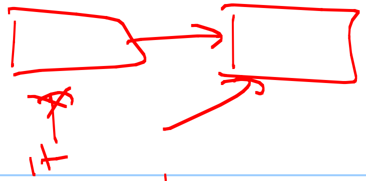
```
template <typename ItemType>
class List {
    protected:
        struct Node {
            ItemType   _data;
            Node*      _prev;
            Node*      _next;

            Node (const ItemType& data, Node* next,
                      Node* prev):
                 _data(data), _next(next), _prev(prev) {}
        }
```

"private" data –
add underscore

Iterator class: What should we code?



```
public: //in list class
    class iterator {
        private:
            Node* _current;
        public:
            iterator() : _current(NULL) {}
            iterator(const iterator& other) :
                _current(other._current) {}
```



```
// takes an iterator + points it
// to front of the list
void front(iterator& it) {
    it._current -> _front;
}
```

read only -> const,

```
ItemType& operator*() {
    return _current -> _data;
}

iterator operator++() {
    _current = _current -> next;
    return *this;
}
```