

Final exam: 03/21 (Tuesday) noon - 3p

- All information posted on the exam page:
 - <https://ucsb-cs24.github.io/w23/exam/e02/>
- Paper pencil, closed-book, closed-notes
- Location: NH 1006 or Phelps 3526, seating will be assigned

ITERATORS QUEUES

Problem Solving with Computers-II

C++

```
#include <iostream>
using namespace std;

int main(){
    cout<<"Hola Facebook\n";
    return 0;
}
```



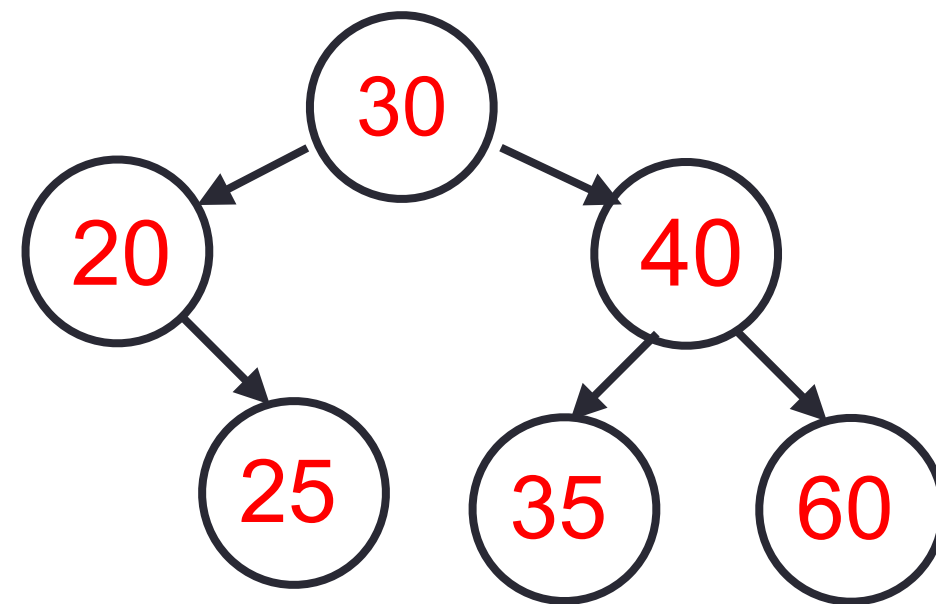
Make a copy of the handout for today's lecture:
<https://bit.ly/cs24-lect16-handout>

Iterators: Standard way to iterate through containers

```
template <class T>
void printKeys(T& t) {
    for(auto item : t){
        std::cout << item <<" ";
    }
    cout<<endl;
}
```

| | | | | | |
|----|----|----|----|----|----|
| 30 | 20 | 25 | 40 | 35 | 60 |
|----|----|----|----|----|----|

`vector<int> v {30, 20, 25, 40, 35, 60};`



`set<int> s {30, 20, 25, 40, 35, 60};`

Iterating through a vector using pointers

- Let's consider how we generally use pointers to parse an array or vector

```
void printKeys(vector<int>& t) {  
    int *p = &(t[0]);  
    for(int i = 0; i < t.size(); i++) {  
        cout << *p <<" ";  
        ++p;  
    }  
}
```

| | | | | | |
|----|----|----|----|----|----|
| 30 | 20 | 25 | 40 | 35 | 60 |
|----|----|----|----|----|----|

- We would like our print “algorithm” to also work with other data structures e.g. linked list or BST

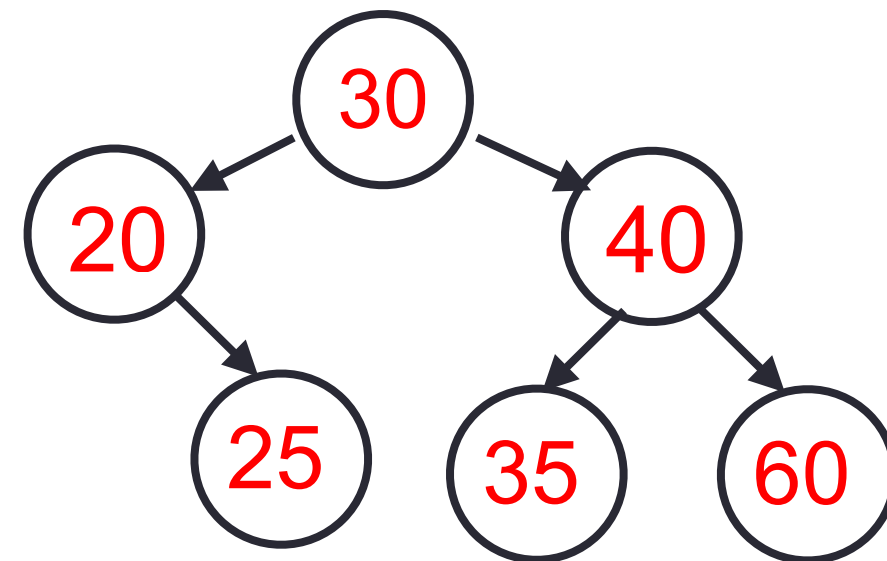
Iterating through set: first try

```
void printKeys(set<int>& t) {  
    _____// Declare p  
    for(int i = 0; i < t.size(); i++) {  
        cout << *p <<" ";  
        ++p;  
    }  
}
```

How should **p** be declared and initialized?

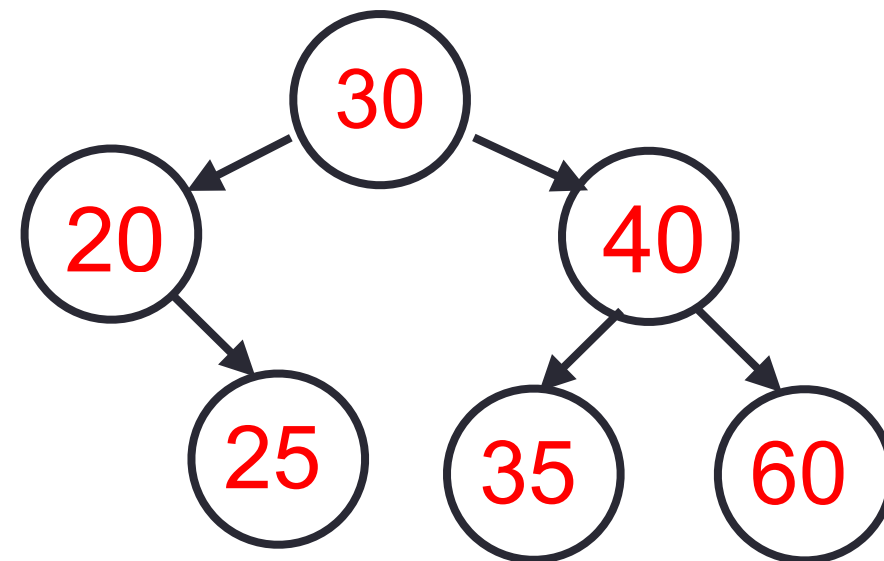
We need ***p** to return an int and

++p to call the successor function of set



What is an iterator?

```
set<int> s{30, 20, 25, 40, 35, 60};  
set<int>::iterator it;  
_____ = s.find(25);
```

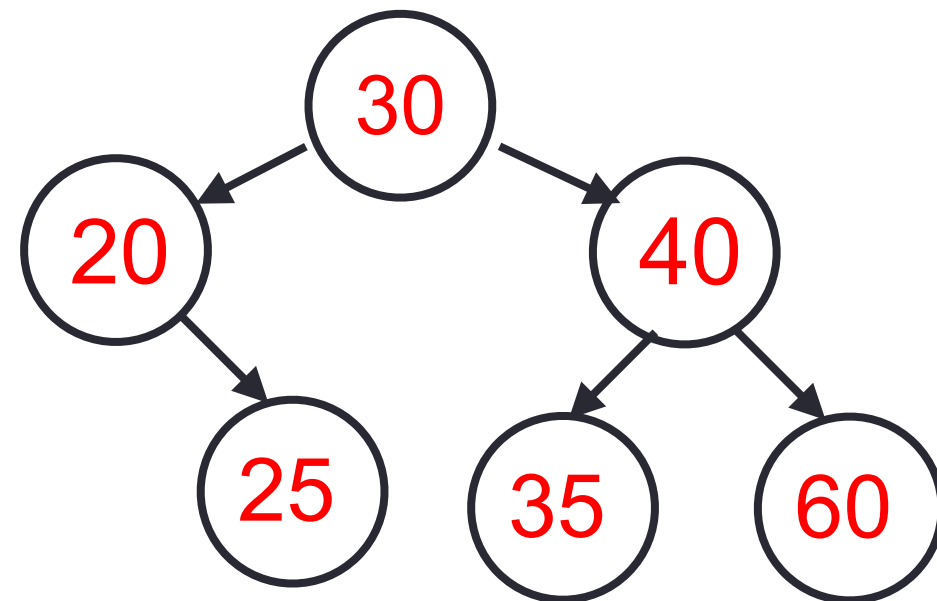


Iterators behave like **pointers** but in fact they are a class (ADT)

```
set<int> s{30, 20, 25, 40, 35, 60};  
set<int>::iterator it = s.find(25);  
cout << *it;  
it++;
```

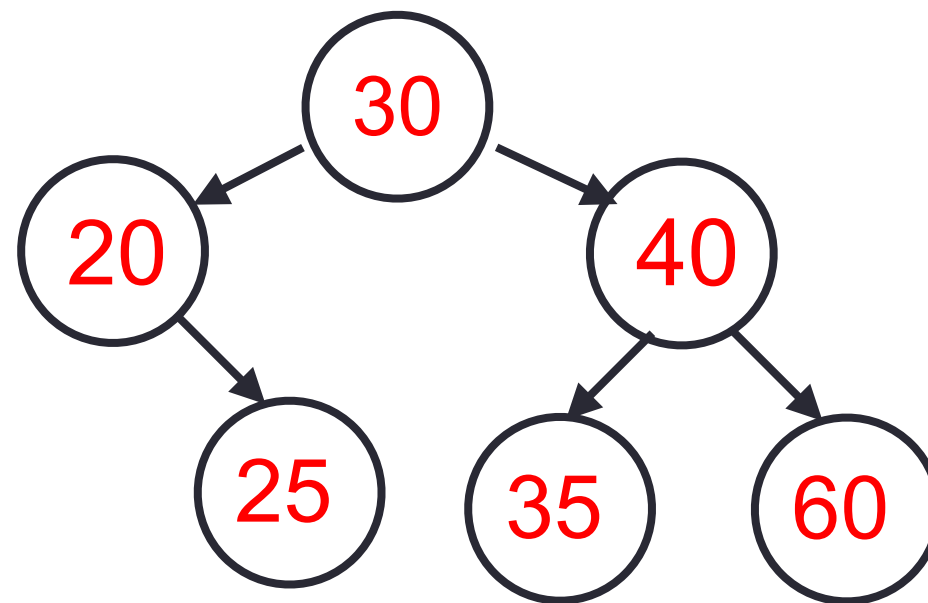
Which operators that must be overloaded for set<int>::iterator?

- A. *
- B. ++
- C. <<
- D. All of the above
- E. Only A and B



How can we initialize an iterator?

```
set<int> s{30, 20, 25, 40, 35, 60};  
set<int>::iterator it = s.begin();  
set<int>::iterator en = s.end();
```



Iterating through set using the set<T>::iterator

```
void printKeys(set<int>& s) {  
    set<int>::iterator it = s.begin();  
    set<int>::iterator en = s.end();  
    while(it!=en){  
        cout << *it <<" ";  
        it++;  
    }  
    cout << endl;  
}
```

C++ shorthand: auto

```
void printKeys(set<int>& s) {  
    auto it = s.begin();  
    auto en = s.end();  
    while(it!=en){  
        cout << *it <<" ";  
        it++;  
    }  
    cout << endl;  
}
```

Finally: unveiling the range based for-loop

```
template <class T>
void printKeys(T& t){
    for (auto item : t){
        cout << item << " ";
    }
    cout << endl;
}
```

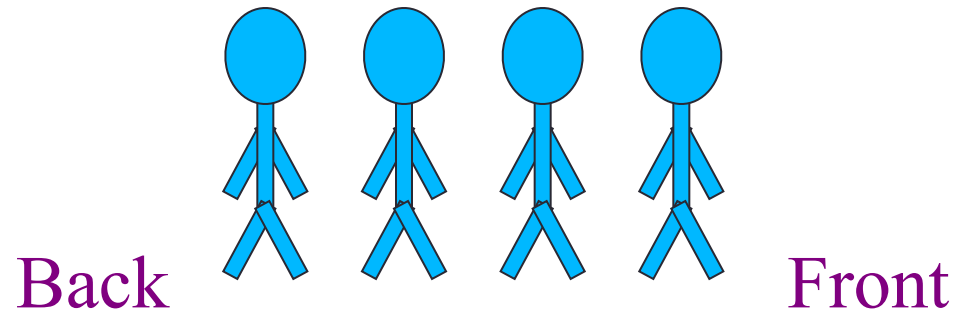
The range-based for loop is just a shorthand for code that uses iterators.

Activity (2 min) Write the expanded version of the printKeys() function using iterators

*Note that not all containers have iterators.
For example the same code would not
work with stack, queue, or priority_queue*

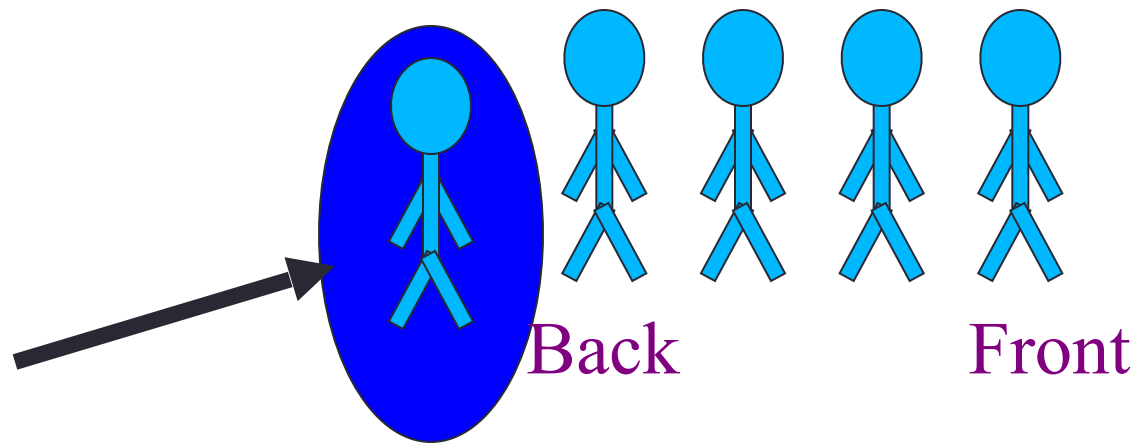
Queue

- A queue is like a queue of people waiting to be serviced
- The queue has a front and a back.



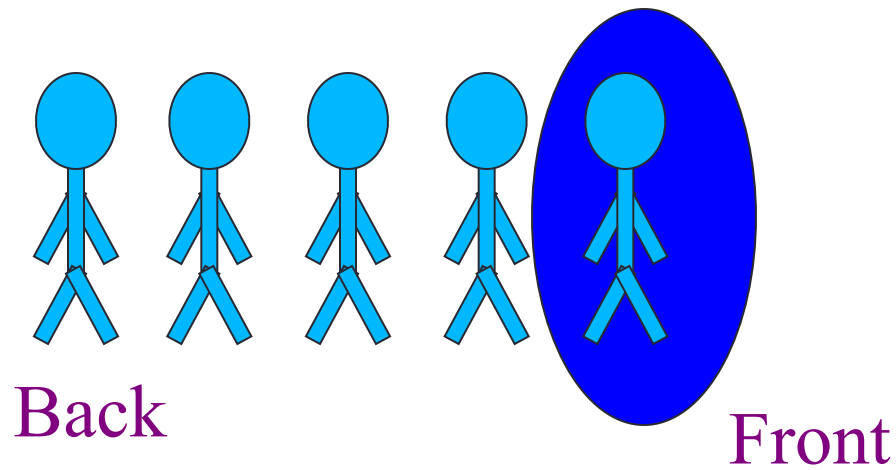
Queue Operations: push, pop, front, back

New people must enter the queue at the back. The C++ queue class calls this a push operation.



Queue Operations: push, pop, front, back

- When an item is taken from the queue, it always comes from the front. The C++ queue calls this a pop



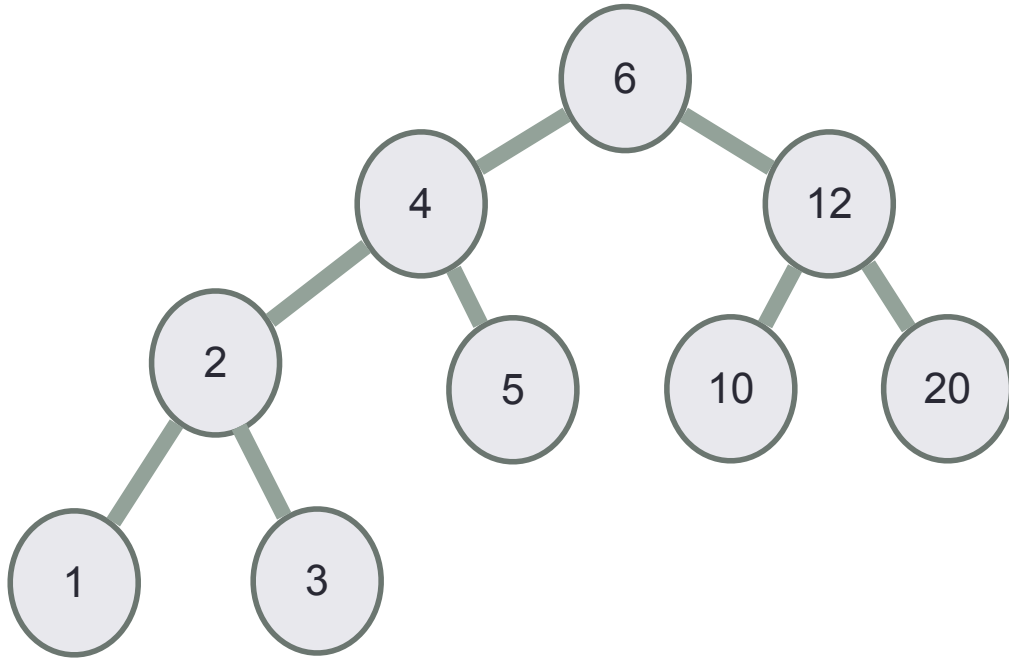
Queue class

- The C++ standard template library has a queue template class.
- The template parameter is the type of the items that can be put in the queue.

```
template <class Item>
class queue<Item>
{
public:
    queue( );
    void push(const Item& entry);
    void pop( );
    bool empty( ) const;
    Item front( ) const;
    Item back( ) const;

};
```

Breadth first traversal



- Create an empty Queue.
- Start from the root, insert the root into the Queue.
- Now while Queue is not empty,
 - Extract the node from the Queue and insert all its children into the Queue.
 - Print the extracted node.

std::priority_queue template arguments

```
template <
    class T,
    class Container= vector<T>,
    class Compare = less <T>
> class priority_queue;
```

The template for priority_queue takes 3 arguments:

1. Type elements contained in the queue.
2. Container class used as the internal store for the priority_queue, the default is **vector<T>**
3. Class that provides priority comparisons, the default is **less**

Comparison class: A class for comparing objects

```
template <class T>  
class myCompare{  
    bool operator()(T& a, T& b) const {  
        return a > b;  
    }  
};  
  
int main(){  
    myCompare<int> cmp;  
    cout<<cmp(20, 10)<<endl;  
}
```

If cmp(x, y) returns true, priority queue will interpret this as:

x has _____ priority than y

Which element will be at the top of such a priority queue?

std::priority_queue template arguments

//Template parameters for a max-heap

```
priority_queue<int, vector<int>, std::less<int>> pq;
```

//Template parameters for a min-heap

```
priority_queue<int, vector<int>, std::greater<int>> pq;
```

Reminder: Please fill course and TA evaluations

If more than 70% of the class fills the course evaluations by Wed, we will have a raffle on the last class where you can win Amazon gift cards!