COMPARISON CLASSES AND GENERIC POINTERS

Problem Solving with Computers-II

From last class….

```
int main(){
      int arr[]={10, 2, 80};
      priority_queue<int> pq;
      for(int i=0; i < 3; i++)
            pq.push(arr[i]);

      while(!pq.empty()){
            cout<<pq.top()<<endl;
            pq.pop();
      }
      return 0;
}
```

What is the output of this code?

A. 10 2 80
B. 2 10 80
C. 80 10 2
D. 80 2 10
E. None of the above

Comparison class

- A class used to perform comparisons.
- Implements a function operator that compares two keys

```
class cmp{
        bool operator()(int& a, int& b) const {
                return a > b;
         }
};

//Use cmp to compare any two keys
cmp foo;
cout<<foo(x, y);
```

Configure PQ with a comparison class

```
class cmp{
        bool operator()(int& a, int& b) const {
                return a > b;
        }
};
int main(){
      int arr[]={10, 2, 80};
      priority_queue<int, vector<int>, cmp> pq;
      for(int i=0; i < 3; i++)
            pq.push(arr[i]);

      while(!pq.empty()){
            cout<<pq.top()<<endl;
            pq.pop();
      }
      return 0;
}
```

What is the output of this code?

A. 10 2 80

B. 2 10 80

C. 80 10 2

D. 80 2 10

E. None of the above

std::priority_queue template arguments

The template for priority_queue takes 3 arguments:

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

- The first is the type of the elements contained in the queue.
- If it is the only template argument used, the remaining 2 get their default values:
  - a **vector<T>** is used as the internal store for the queue,
  - **less is a comparison** class that provides priority comparisons

CHANGING GEARS: C++STL

- The C++ Standard Template Library is a very handy set of three built-in components:
  - Containers: Data structures
  - Iterators: Standard way to search containers
  - Algorithms: These are what we ultimately use to solve problems

C++ Iterators

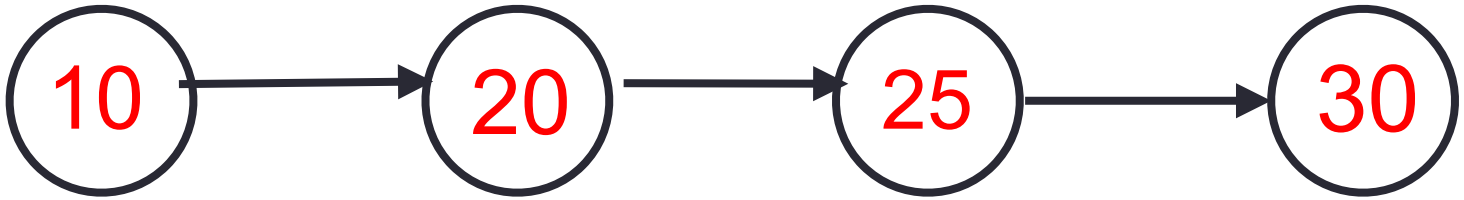
- Iterators are generalized pointers.
- Let's consider how we generally use pointers to parse an array

10	20	25	30	46	50	55	60

```
void printElements(int arr[], int size) {
    int* p= arr;
    for(int i=0; i<size; i++) {
          std::cout << *p << std::endl;
          ++p;
    }
}
```

- We would like our print "algorithm" to also work with other data structures
- E,g Linked list or BST

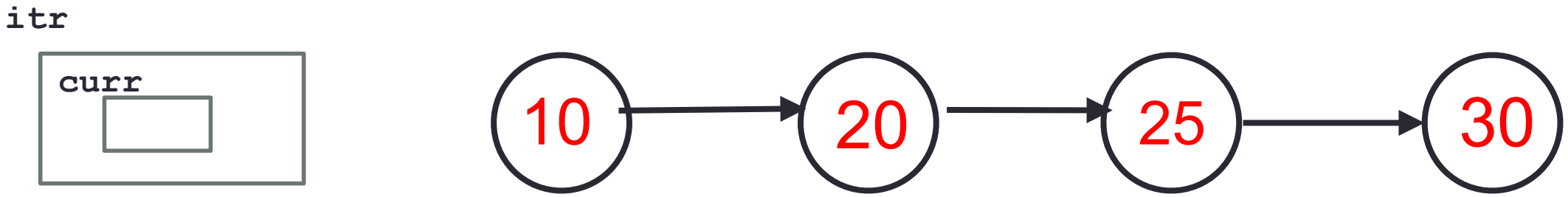
Can a similar pattern work with a LinkedList? Why or Why not?




```
void printElements(LinkedList& ll, int size) {
    ____________________________________//How should we define p?
    for(int i=0; i<size; i++) {
        std::cout << *p << std::endl;
        ++p;
    }
}
```

C++ Iterators

- To solve this problem the LinkedList class has to supply to the client (printElements) with a generic pointer (an iterator object) which can be used by the client to access data in the container sequentially, without exposing the underlying details of the class



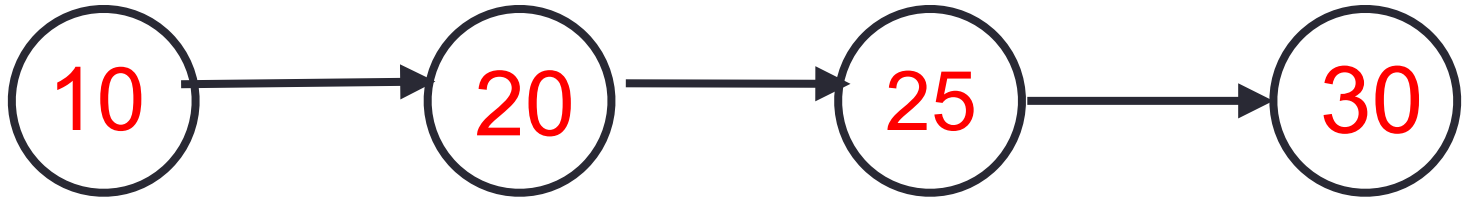

```
void printElements(LinkedList& ll)  {
  LinkedList::iterator itr = ll.begin();
  LinkedList::iterator en = ll.end();
  while(itr!=en){
        std::cout << *itr <<" ";
        ++itr;
  }
  cout<<endl;
}
```

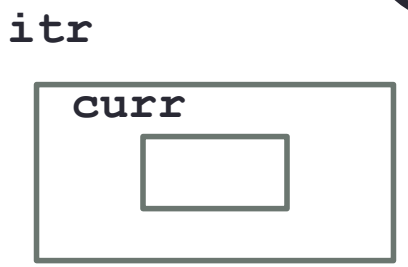
C++ Iterators: Initializing the iterator

```
void printElements(LinkedList& ll)  {
  LinkedList::iterator itr = ll.begin();
  LinkedList::iterator en = ll.end();
  while(itr!=en){
        std::cout << *itr <<" ";
        ++itr;
  }
  cout<<endl;
}
```

What is the return value of **begin()** ?

A. The address of the first node in the linked list container class
B. An iterator type object that contains the address of the first node
C. None of the above



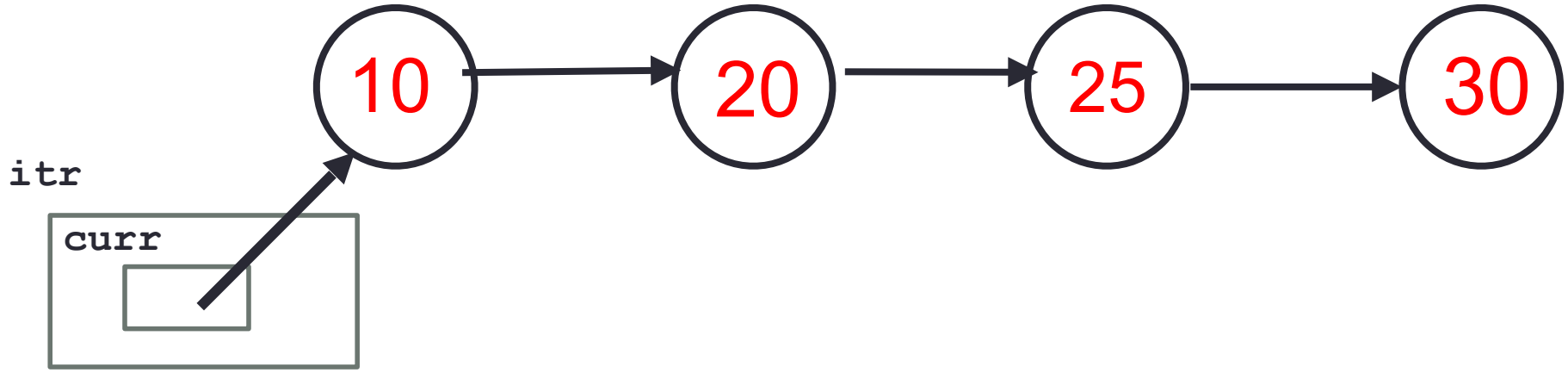


C++ Iterators: Overloading operators

```
void printElements(LinkedList& ll)  {
  LinkedList::iterator itr = ll.begin();
  LinkedList::iterator en = ll.end();
  while(itr!=en){
        std::cout << *itr <<" ";
        ++itr;
  }
  cout<<endl;
}
```

List the operators that must be overloaded for iterator objects?

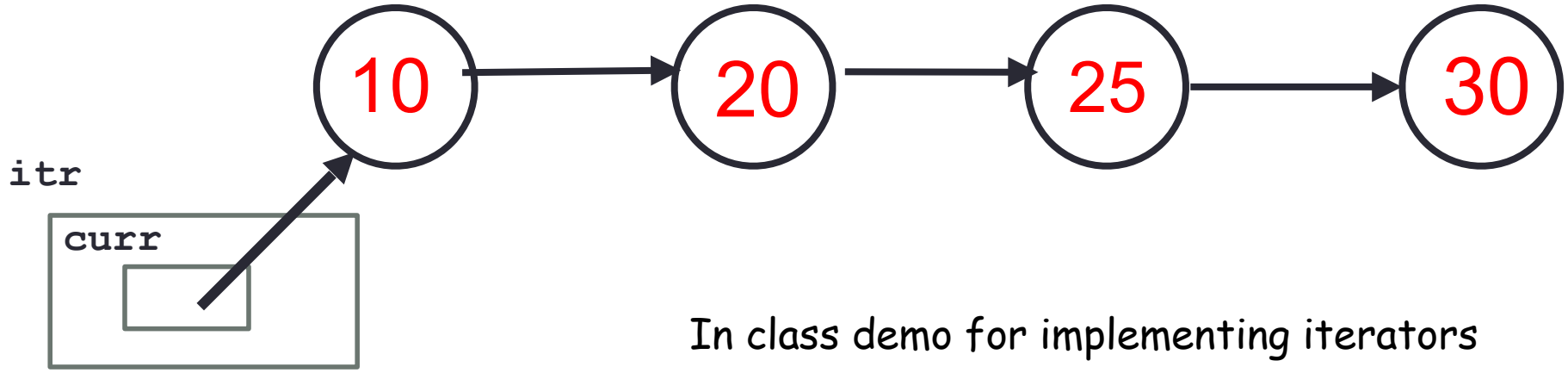
A. *
B. ++
C. !=
D. All of the above
E. None of the above



C++ Iterators

```
void printElements(LinkedList& ll)  {
  LinkedList::iterator itr = ll.begin();
  LinkedList::iterator en = ll.end();
  while(itr!=en){
        std::cout << *itr <<" ";
        ++itr;
  }
  cout<<endl;
}
```

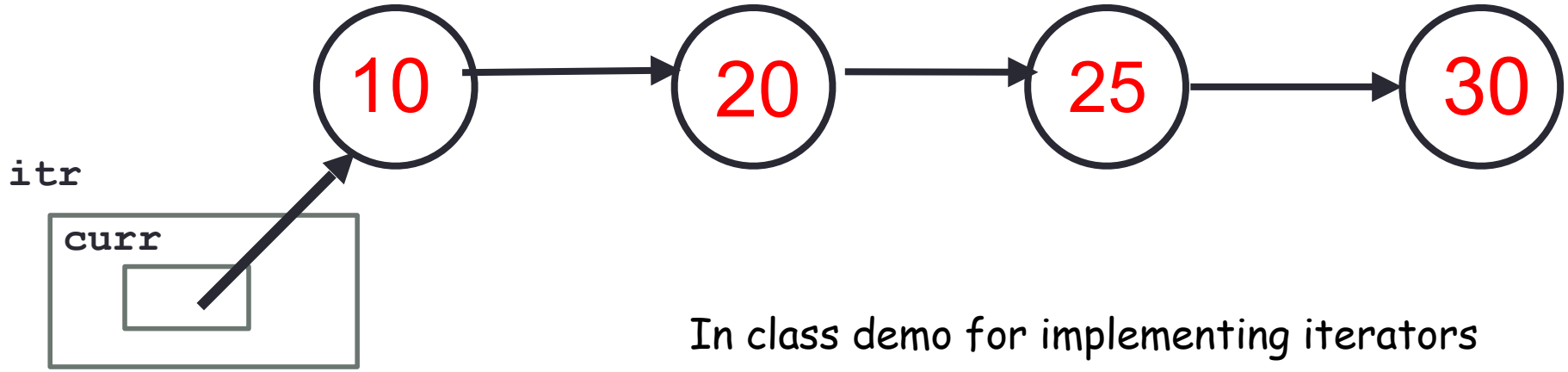
How should the diagram change as a result of the statement ++itr; ?



In class demo for implementing iterators

C++ shorthand: auto

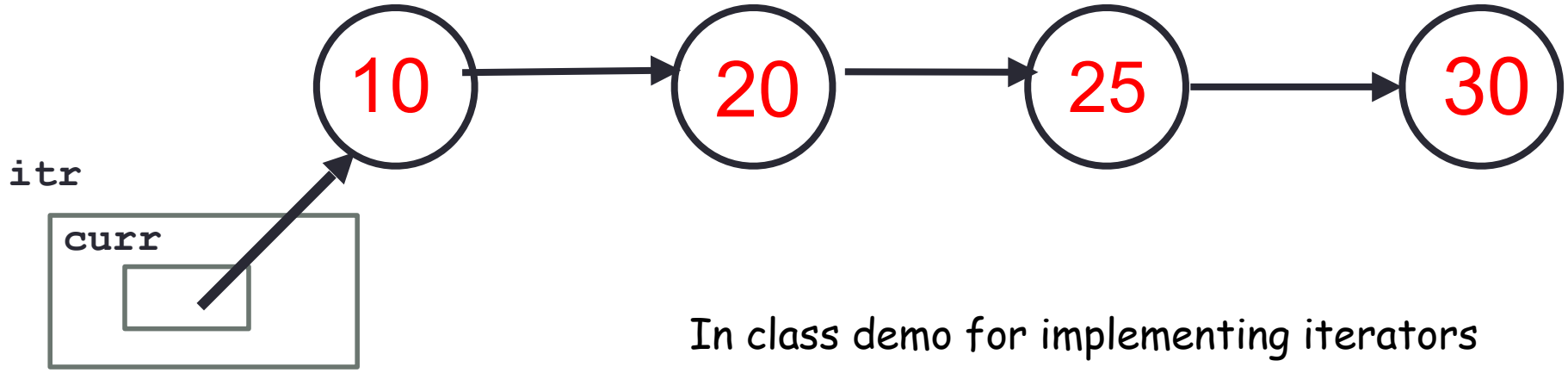
```
void printElements(LinkedList& ll)  {
  auto itr = ll.begin();
  auto en = ll.end();
  while(itr!=en){
        std::cout << *itr <<" ";
        ++itr;
  }
  cout<<endl;
}
```



In class demo for implementing iterators

Finally: unveiling the range based for-loop

```
void printElements(LinkedList& ll)  {
  for(auto item:ll){
        std::cout << item <<" ";
  }
  cout<<endl;
}
```



In class demo for implementing iterators

Practice functors and PQs:

```
int main(){
      int arr[]={10, 2, 80};
      priority_queue<int*> pq;
      for(int i=0; i < 3; i++)
            pq.push(arr+i);

      while(!pq.empty()){
            cout<<*pq.top()<<endl;
          pq.pop();
      }
      return 0;
}
```

What is the output of this code?

A. 10 2 80
B. 2 10 80
C. 80 10 2
D. 80 2 10
E. None of the above

Sort array elements using a pq storing pointers

```
int main(){
      int arr[]={10, 2, 80};
      priority_queue<int*> pq;
      for(int i=0; i < 3; i++)
            pq.push(arr+i);

      while(!pq.empty()){
            cout<<*pq.top()<<endl;
           pq.pop();
      }
      return 0;
}
```

How can we change the way pq prioritizes pointers?

Write a comparison class to print the integers in the array in sorted order

```
int main(){
      int arr[]={10, 2, 80};
      priority_queue<int*, vector<int*>, cmpPtr> pq;
      for(int i=0; i < 3; i++)
            pq.push(arr+i);

      while(!pq.empty()){
            cout<<*pq.top()<<endl;
           pq.pop();
      }
      return 0;
}
```