CS 225

Data Structures

September 23 – Stacks, Queues and Design

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CS 225 So Far…

List ADT

- Linked Memory Implementation (“Linked List”)
  - O(1) insert/remove at front/back
  - O(1) insert/remove after a given element
  - O(n) lookup by index
- Array Implementation (“Array List”)
  - O(1) insert/remove at front/back
  - O(n) insert/remove at any other location
  - O(1) lookup by index

Queue ADT

- [Order]:
- [Implementation]:
- [Runtime]:

Stack ADT

- [Order]:
- [Implementation]:
- [Runtime]:

Queue.h

```
 1  #pragma once
 2
 3  template <typename T>
 4  class Queue {
 5    public:
 6      void enqueue(T e);
 7      T dequeue();
 8      bool isEmpty();
 9
10    private:
11      T *items_;
12      unsigned capacity_;
13      unsigned size_;
14  };
15
16
17
18
19
20
21
22
```

What type of implementation is this Queue?

How is the data stored on this Queue?

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```

What type of implementation is this Queue?

How is the data stored on this Queue?

```
Queue<int> q;
q.enqueue(3);
q.enqueue(8);
q.enqueue(4);
q.dequeue();
q.enqueue(7);
q.dequeue();
q.dequeue();
q.enqueue(2);
q.enqueue(1);
q.enqueue(3);
q.enqueue(5);
q.dequeue();
q.enqueue(9);
```

Queue.h

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2
3  template <typename T>
4  class Queue {
5    public:
6      void enqueue(T e);
7      T dequeue();
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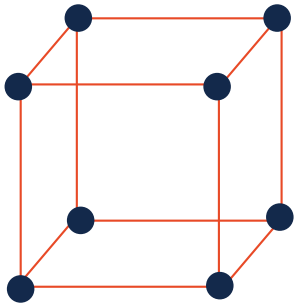
9
10   private:
11     T *items_;
12     unsigned capacity_;
13     unsigned size_;
14 };
15
16
17
18
19
20
21
22
```

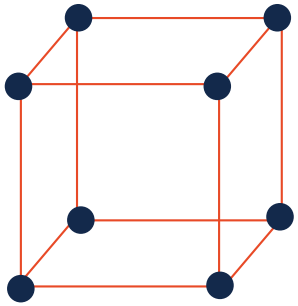

```
Queue<char> q;
…
q.enqueue(m);
q.enqueue(o);
q.enqueue(n);
…
q.enqueue(d);
q.enqueue(a);
q.enqueue(y);
q.enqueue(i);
q.enqueue(s);
q.dequeue();
q.enqueue(h);
q.enqueue(a);
```

Iterators

Suppose we want to look through every element in our data structure:



Iterators encapsulated access to our data:



Cur. Location	Cur. Data	Next

Iterators

Every class that implements an iterator has two pieces:

1. [Implementing Class]:

Iterators

Every class that implements an iterator has two pieces:

2. [Implementing Class' Iterator]:

- Must have the base class **std::iterator**
- Must implement

  operator*
  operator++
  operator!=

stlList.cpp

```
 1 #include <list>
 2 #include <string>
 3 #include <iostream>
 4
 5 struct Animal {
 6   std::string name, food;
 7   bool big;
 8   Animal(std::string name = "blob", std::string food = "you", bool big = true) :
 9     name(name), food(food), big(big) { /* nothing */ }
10 };
11
12 int main() {
13   Animal g("giraffe", "leaves", true), p("penguin", "fish", false), b("bear");
14   std::vector<Animal> zoo;
15
16   zoo.push_back(g);
17   zoo.push_back(p);   // std::vector's insertAtEnd
18   zoo.push_back(b);
19
20   for ( std::vector<Animal>::iterator it = zoo.begin(); it != zoo.end(); it++ ) {
21     std::cout << (*it).name << " " << (*it).food << std::endl;
22   }
23
24   return 0;
25 }
```

stlList.cpp

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 4
 5 struct Animal {
 6   std::string name, food;
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 8   Animal(std::string name = "blob", std::string food = "you", bool big = true) :
 9     name(name), food(food), big(big) { /* none */ }
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13   Animal g("giraffe", "leaves", true), p("penguin", "fish", false), b("bear");
14   std::vector<Animal> zoo;
15
16   zoo.push_back(g);
17   zoo.push_back(p);   // std::vector's insertAtEnd
18   zoo.push_back(b);
19
20   for ( const Animal & animal : zoo ) {
21     std::cout << animal.name << " " << animal.food << std::endl;
22   }
23
24   return 0;
25 }
```