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Priority Queues and Min Priority Queues in STL / C++

Posted by Andy on 5 November 2011, 3:36 pm

Priority Queues

A priority queue is just like a normal queue data structure except that each element inserted is associated with a "priority". It supports the usual `push()`, `pop()`, `top()` etc operations, but is specifically designed so that its first element is always the greatest of the elements it contains, according to some strict weak ordering condition.

STL Usage

In STL, priority queues take three template parameters:

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

`T` is the element type, eg an integer;
`Container` is the container type, eg a vector.
`Compare` is the comparison class which can be a function call operator or function pointer used to compare container elements. Its default is the less-than operator, `less<T>`.

Example 1: Max Priority Queues

As can be seen in the following example, using a priority queue in its default format gives you a max priority queue:

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

int main()
{
    priority_queue<int> pq;

    pq.push(3);
    pq.push(5);
    pq.push(1);
    pq.push(8);
    while ( !pq.empty() )
    {
        cout << pq.top() << endl;
        pq.pop();
    }
    cin.get();
}
```

Giving you the following output:

Example 2: Min Priority Queues

Supposing you wish to get a min priority queue out of it. A posting of this subject appears over at Cprogramming.com, showing how to implement this, which I have borrowed here. A possible solution could be to define a suitable comparator with which to operator on the ordinary priority queue, such that the priority is reversed, as shown:

```
#include <iostream>
```

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

struct compare
{
  bool operator()(const int& l, const int& r)
  {
      return l > r;
  }
};

int main()
{
    priority_queue<int,vector<int>, compare > pq;

    pq.push(3);
    pq.push(5);
    pq.push(1);
    pq.push(8);
    while ( !pq.empty() )
    {
        cout << pq.top() << endl;
        pq.pop();
    }
    cin.get();
}
```

Giving the following output:

Example 3: Priority Queues of Pointers

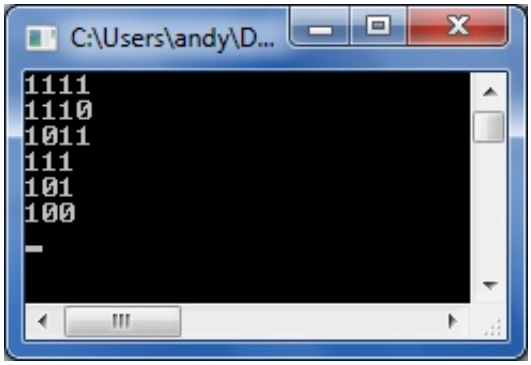
Suppose you wish to implement a priority queue of pointers which point to some class object. In this example I wish to implement a priority queue of `Node` pointers, where `Node` is a class that I have defined myself.

Having a priority queue of pointers will result in the pointers themselves being sorted, rather than (say) some value that the class object holds. Unless sorting by pointer value is what you actually want, that is.

The solution is to specify how to sort the Node objects in the priority queue using a function object (functor), similar to that implemented in the previous section, by using a class or a struct that contains a function that takes two class objects as arguments and returns the desired comparison.

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

class Node
{
private:
    int value;

public:
    Node( int v )  : value( v ) {}
    int Val() const { return value; }
};

struct CompareNode : public std::binary_function<Node*, Node*, bool>
{
  bool operator()(const Node* lhs, const Node* rhs) const
  {
     return lhs->Val() < rhs->Val();
  }
};

int main()
{
    priority_queue<Node*,vector<Node*>, CompareNode > pq;

    pq.push( new Node( 111 ) );
    pq.push( new Node( 1111 ) );
    pq.push( new Node( 1011 ) );
    pq.push( new Node( 100 ) );
    pq.push( new Node( 1110 ) );
    pq.push( new Node( 101 ) );

    while ( !pq.empty() )
    {
        Node* n = pq.top();
        cout << n->Val() << endl;
        pq.pop();

        // Delete pointer that vector contains
        delete n;
    }
    cin.get();
}
```

Resulting in the following output:



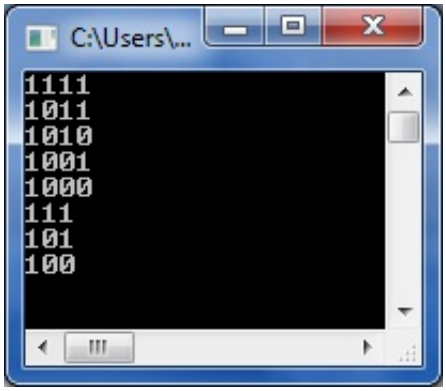
Example 4: Sedgewick's Implementation of Priority Queues

And here is a non-STL example of a priority queue, as implemented by Robert Sedgewick. Full code listing as follows:

```
#include <iostream>

using namespace std;

template <class Item>
void exch(Item &A, Item &B)
{
    Item t = A;
    A = B;
    B = t;
}

template <class Item>
class PQ
{
private:

    Item *pq;
    int N;
public:

    PQ(int maxN)
    {
    pq = new Item[maxN];
    N = 0;
    }

    int empty() const
    { return N == 0; }

    void insert(Item item)
    {
        pq[N++] = item;
    }

    Item getmax()
    {
        int max = 0;
        for (int j = 1; j < N; j++)
            if (pq[max] < pq[j])
```

```
                max = j;
        exch(pq[max], pq[N-1]);
        return pq[--N];
    }
};


int main()
{
    PQ<int> pq( 8 );

    pq.insert( 101 );
    pq.insert( 111 );
    pq.insert( 1111 );
    pq.insert( 1001 );
    pq.insert( 1011 );
    pq.insert( 1010 );
    pq.insert( 100 );
    pq.insert( 1000 );

    while ( !pq.empty() )
    {
        cout << pq.getmax() << "\n";
    }

    return 0;
}
```

The queue members being output in order of importance:



Filed under C++ / MFC, STL | Tagged max priority queue, min priority queue, priority queue, priority_queue, STL | 11 Comments | Permalink

11 Comments

Sai kiran Nagaragiri

9 September 2012 at 11:08 am

gud work and good collection

Andy
9 September 2012 at 5:24 pm

Thank you!

d555
27 December 2012 at 2:14 am

Your explanation is very useful to reminder this use in cplusplus, thanks for write this.

Andy
30 December 2012 at 5:20 pm

Thanks d555.

uttam kumar ray
1 April 2013 at 4:43 pm

Really, this page is very useful.

happyuk
1 April 2013 at 6:31 pm

Thanks Uttam. Glad to hear it.

Andy

linuxgeek
14 October 2013 at 10:34 am

Example number 3 method of binary_function is deprecated??

Cathy
20 October 2014 at 6:39 am

Very intriguing and informative tips. Saved to favorites …
Thhank you for the excellent read.

ais99
2 December 2014 at 1:26 pm

awesome post!!

Khan
23 January 2015 at 7:20 pm

Very good! thank you ,
Khan Germany

akky
3 July 2015 at 9:32 am

does priority queue lib support operations like increase key and decrease key???? if yes then what is the commnad????
