EECS 204002
Data Structures 資料結構
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C++ STL (STANDARD TEMPLATE LIBRARY)

https://www.tutorialspoint.com/cplusplus/index.htm

1.6

The Standard Template Library

Standard C++ Libraries

- The C++ Standard Library: a rich set of functions manipulating files, strings, etc.
- The Standard Template Library (STL): provide general-purpose classes and functions with templates that implement many commonly used algorithms and data structures like vectors, lists, queues, and stacks.

The STL

- An ISO C++ standard framework of about 10 **containers** and about 60 **algorithms** connected by **iterators**
  - Other organizations provide more containers and algorithms in the style of the STL
    - Boost.org, Microsoft, SGI, …
- Probably the best known and most widely used example of generic programming

Stroustrup/Programming 4

Four STL Components

- **Containers**: used to manage collections of objects of a certain kind.
- **Algorithms**: act on containers.
  - E.g. initialization, sorting, searching….
- **Iterators**: used to step through the elements of collections of objects.
- **Functors** are objects that can be treated as though they are a function or function pointer.

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Containers

- A container is an object to store data, either built-in data types like int and float, or class objects
- The STL provides several basic types of containers
  - <vector> : one-dimensional array
  - <list> : double linked list
  - <deque> : double-ended queue
  - <queue> : queue
  - <stack> : stack
  - <set> : set
  - <map> : associative array

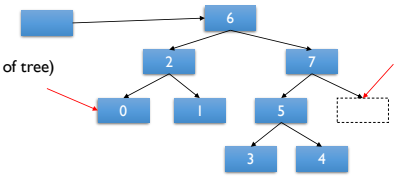
Sources: http://ext02.fh-kaernten.at/rts/intern/downloads/Info/Info%203/Standard%20Template%20Library.ppt

Containers
(hold sequences in different ways)

- **vector**
(array)

- **list**
(doubly linked)

- **set**
(a type of tree)



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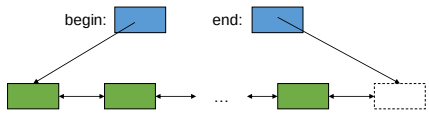
Basic Iterator Model

- A pair of iterators define a sequence
  - The beginning (points to the first element – if any)
  - The end (points to the one-beyond-the-last element)



- An iterator is a type that supports the "iterator operations"
  - ++ Go to next element
  - * Get value
  - == Does this iterator point to the same element?
- Some iterators support more operations (e.g. --, +, and [ ])

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Algorithms

- Algorithms such as searching and sorting are provided in the STL.
- Require user to specify comparison operator < or custom comparator function.

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The simplest algorithm: find()

```
// Find the first element that equals a value
template<class In, class T>
In find(In first, In last, const T& val)
{
    while (first!=last && *first != val) ++first;
    return first;
}
```

We can ignore ("abstract away") the differences between containers

<algorithm> sort

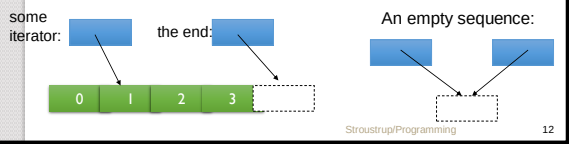
http://www.cplusplus.com/reference/algorithm/sort/

```
// sort algorithm example
#include <iostream>     // std::cout
#include <algorithm>    // std::sort
#include <vector>       // std::vector

bool myfunction (int i, int j) { return (i<j); }

struct myclass {
  bool operator() (int i,int j) { return (i<j);}
} myobject;

int main () {
  int myints[] = {32,71,12,45,26,80,53,33};
  std::vector<int> myvector (myints, myints+8);          // 32 71 12 45 26 80 53 33

  // using default comparison (operator <):
  std::sort (myvector.begin(), myvector.begin()+4);      //(12 32 45 71)26 80 53 33

  // using function as comp
  std::sort (myvector.begin()+4, myvector.end(), myfunction); // 12 32 45 71(26 33 53 80)

  // using object as comp
  std::sort (myvector.begin(), myvector.end(), myobject);  //(12 26 32 33 45 53 71 80)

  // print out content:
  std::cout << "myvector contains:";
  for (std::vector<int>::iterator it=myvector.begin(); it!=myvector.end(); ++it)
    std::cout << ' ' << *it;
  std::cout << '\n';

  return 0;
}
```

Output:
myvector contains: 12 26 32 33 45 53 71 80

Algorithms and iterators

- The end of the sequence is "one past the last element"
  - ***not*** "the last element"
  - That's necessary to elegantly represent an **empty** sequence
  - One-past-the-last-element isn't an element
    - You can compare an iterator pointing to it
    - You can't dereference it (read its value)
- Returning the end of the sequence is the standard idiom for "not found" or "unsuccessful"



Functor

- A Functor can be a general function
- Functor can also be a class object, which overloads operator()
- The STL algorithm takes user's Functor to perform customized actions.
- In the std::sort, Functor *Comp* lets user define customized comparison function.
- One may define a complex comparison function
  - E.g. triple comparison : (1,1,3) ? (1,2,1)

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Container adaptors

Container adaptors

Container adaptors provide a different interface for sequential containers.

`stack`	adapts a container to provide stack (LIFO data structure) (class template)
`queue`	adapts a container to provide queue (FIFO data structure) (class template)
`priority_queue`	adapts a container to provide priority queue (class template)

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Simple Sample Code : <vector> (Like Dynamic Array)

```
// vector example
#include <iostream>
#include <vector>

int main ()
{
//initialize
std::vector<int> myVector;

//-----------------------------------------
// ADD ELEMENTS
int myData=9;

// add ten integer
for( int i=0 ; i < 10 ; i++) {
  myData++;
  myVector.push_back(myData);
}
```

```
// TRAVEL ELEMENTS
// get the number of elements
int vSize = myVector.size();

for( int i=0 ; i < vSize ; i++){
      std::cout<< myVector[i] << '\n';
}
//-----------------------------------
// DELETE SPECIFIED ELEMENT
// get the iterator of beginning elements
auto iter = myVector.begin();
// remove 2nd element in this vector
myVector.erase(iter+1);

myVector[0] = 5 ;
// print out
for( int i=0 ; i < myVector.size() ; i++){
    std::cout<< myVector[i] << '\n';
}
```

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References

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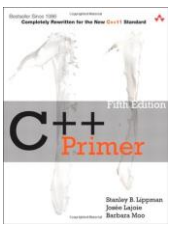

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