

std::set

Storing “distinct” element with fast look up

Set

- Storing distinct data of same type
 - The data type must be **comparable**, i.e., we can tell if a is more or less than b
- Somewhat slow insert
- Fast look up
- Fast erase
- Iterator starts from “minimum element” and goes in increasing value direction
 - Can be used to (somewhat) fast sorting

Basic

- Notice that s does not include duplicate elements
- Also see that when we iterate, member is sorted
 - This is distinct characteristic of set

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

int main() {
    set<int> s = {4,1,3,2,1,1,3,4};

    cout << "Size of s is " << s.size() << endl;

    s.insert(10);
    s.insert(5);
    s.erase(3);

    cout << "member of s: ";
    for (auto it = s.begin(); it != s.end(); it++)
        cout << *it << " ";
}
```

```
Size of s is 4
Member of s: 1 2 4 5 10
```



Somewhat slow insert, iterate but fast find

- We will see this in the detail around last part of this course
 - For now, please believe that
 - If there is N elements in the set
 - Insert take times directly proportional to $\log(N)$
 - Each $it++$ or $it--$ take times directly proportional to $\log(N)$
 - Each find takes times directly proportional to $\log(N)$

Demo Comparing Vector & Set

See `set-2.cpp` and `set-3.cpp`

Set iterator

- We cannot do `s.begin() + x`
 - Because, going to the next element (which is the **successor**) in set is not as fast as vector, c++ forbids `begin() + x`
 - We cannot **compare by** `>` or `<`
- We can still use `it++` or `it--` to go to the next or previous (**successor** or **predecessor**) or `x`

```
abc,6
abcd,-3
somchai,-4
somchai,5
z,-1
z,0
z,9
-- find --
z,-1
somchai,-4
somchai,5
```

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

int main() {
    set< pair<string,int> > s = { {"somchai",5},
                                   {"abc",6}, {"abcd",-3}, {"somchai",-4},
                                   {"z",0}, {"z",-1}, {"z",9} };

    for (auto &x : s) {
        cout << x.first << ", " << x.second << endl;
    }

    cout << "-- find -- " << endl;
    auto it = s.find( {"z",-1});
    cout << (*it).first << ", " << (*it).second << endl;
    it--;
    it--;
    cout << it->first << ", " << it->second << endl;
    it++;
    cout << it->first << ", " << it->second << endl;
}
```

Additional Function

- `set.lower_bound`
- `set.upper_bound`
- `set.count`

std::map

Association data structure with same property as set



Map

- Is very similar to Python's `dict` in usage
- Is internally implemented as a set with “pair” data type
 - Same properties, same limitations as set but more convenience to use as associative data structure
- Associative (mapping) between a `Key Type` and a `Mapped Type`

Basic

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

int main() {
    //map between "Key Type" string and "Mapped Type" int
    map<string,int> m;
    m["somchai"] = 10;
    m["somying"] = -5;
    cout << "Size = " << m.size() << endl;

    //accessing unseen Key create a map with default value
    cout << "m[\"xxx\"] = " << m["xxx"] << endl;
    //each element is a pair of Key Type and Mapped Type
    for (auto it = m.begin(); it != m.end();it++) {
        cout << it->first << " is mapped to " << it->second << endl;
    }

    //this will create mapping "abc" to 0 first and then increase it
    m["abc"]++;
    cout << "now size = " << m.size() << endl;
    for (auto &x : m) {
        cout << x.first << " is mapped to " << x.second << endl;
    }
}
```

```
Size = 2
m["xxx"] = 0
somchai is mapped to 10
somying is mapped to -5
xxx is mapped to 0
now size = 4
abc is mapped to 1
somchai is mapped to 10
somying is mapped to -5
xxx is mapped to 0
```

Checking if map has this key?

- Use find()

Key 99 is mapped to nattee exists

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

int main() {
    //map between "Key Type" string and "Mapped Type" int
    map<int,string> m;
    m[1] = "somchai";
    m[99] = "nattee";

    int k = 99;
    map<int,string>::iterator it;
    if ((it = m.find(k)) != m.end()) {
        cout << "Key " << it->first << " is mapped to " << it->second << endl;
    } else {
        cout << "Key " << k << " is not exists in m." << endl;
    }

    //this is not the correct way to check if key exists why??
    if (m[k] != "") {
        cout << "exists" << endl;
    } else {
        cout << "does not exists" << endl;
    }
}
```

Requirement of `std::set` and `std::map`

- Set data type and map Key Type must be comparable
 - We must be able to compare **order** of two element
- Type that we can use directly
 - `int`, `bool`, `float`, `string`, `double`, `char...` and most of other numerical data type
 - Pair can also be used if both the type of first and second are comparable
 - Pair compare first then second

Practice reading c++ docs

- Both map and set has `insert` and `erase` function
- What is the return value of both function of each data structure?
 - For `set<int> s`, we can do `s.erase(20)`
 - For `map<string,bool> m`, can we do `m.erase("Somchai")` ??
- If we wish to erase element from index 3 to index 4096 in a vector
 - Is there any function from vector that we can easily use?

Problem

- Pair Sum
 - Given an array of integers, our task is to find whether there exists a pair of elements in the array such that their summation equal to X
- Input:
 - Array of integer (our main array) <-- this is a large array
 - M values of X , for each value X , we have to determine if a pair whose sum equal to X exists.
- Output:
 - For each value of X , print “YES” if we found such pair; print “NO” otherwise