Язык C++

STL. Итераторы и основные алгоритмы - II

Функциональные объекты

- minus;
- multiplies
- ….
- equal_to
- not_equal_to
- greater
- ...
- logical_and
- …
- bit_and

Контейнеры

- Контейнеры последовательностей:
  - vector<T>
  - deque<T>
  - list<T>
  - array<T>
  - forward_list<T>
- Ассоциативные контейнеры:
  - set<Key> (multiset)
  - map<Key,T> (multimap)
- Неупорядоченные ассоциативные контейнеры
  - unordered_set<Key> (multiset)
  - unordered_map<Ket, T> (multimap)

Named Requirements

- ***Container***
- ***ReversibleContainer***
- ***AllocatorAwareContainer***
- ***SequenceContainer***

- ***ContiguousContainer***
- ***AssociativeContainer***

- ***UnorderedAssociativeContainer***
- ***etc***

Sequence containers

- array
- vector
- deque
- forward_list
- list

```
template<class T,  class Allocator = std::allocator<T>>
class vector;
```

std::array

- *Container*
- *ReversibleContainer*
- *SequenceContainer*
- *ContiguousContainer*

std::array Container requirements

```
template <class _Tp, size_t _Size>
struct array
{
  typedef _Tp                   value_type;
  typedef value_type&           reference;
  typedef const value_type&     const_reference;
  typedef value_type*           iterator;
  typedef const value_type*     const_iterator;
  typedef size_t                size_type;
  typedef ptrdiff_t             difference_type;

  _Tp __elems_[_Size];
……..
};
```

std::array Container requirements

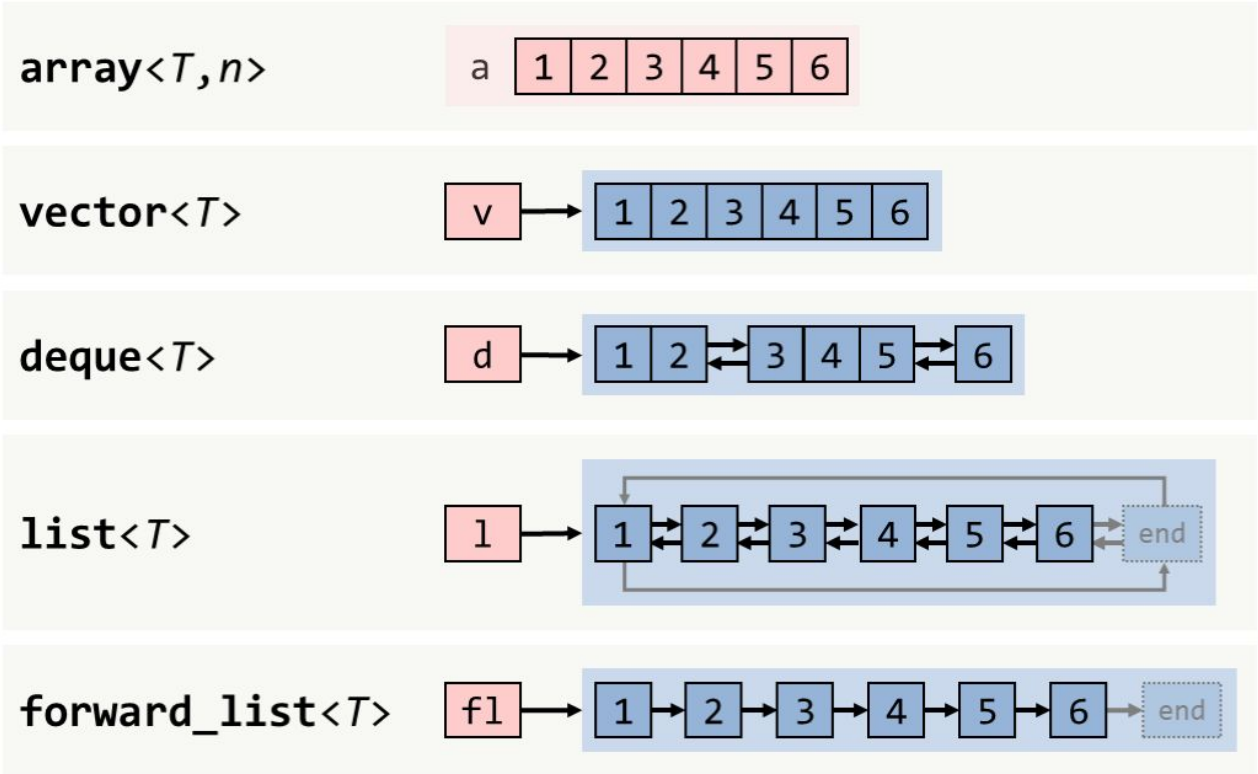
```
iterator begin() {return iterator(data());}
const_iterator begin() const {return const_iterator(data());}
iterator end() {return iterator(data() + _Size);}
const_iterator end() const {return const_iterator(data() + _Size);}


size_type size() const {return _Size;}
size_type max_size() const {return _Size;}
bool empty() const {return _Size == 0;}
```

std::array *ReversibleContainer* requirements

```
typedef _VSTD::reverse_iterator<iterator>       reverse_iterator;
typedef _VSTD::reverse_iterator<const_iterator> const_reverse_iterator;
```

```
reverse_iterator rbegin() {return reverse_iterator(end());}
const_reverse_iterator rbegin() const {return const_reverse_iterator(end());}
reverse_iterator rend() {return reverse_iterator(begin());}
const_reverse_iterator rend() const {return const_reverse_iterator(begin());}
```

Sequence containers



Associative containers

- set
- map
- multiset
- multimap

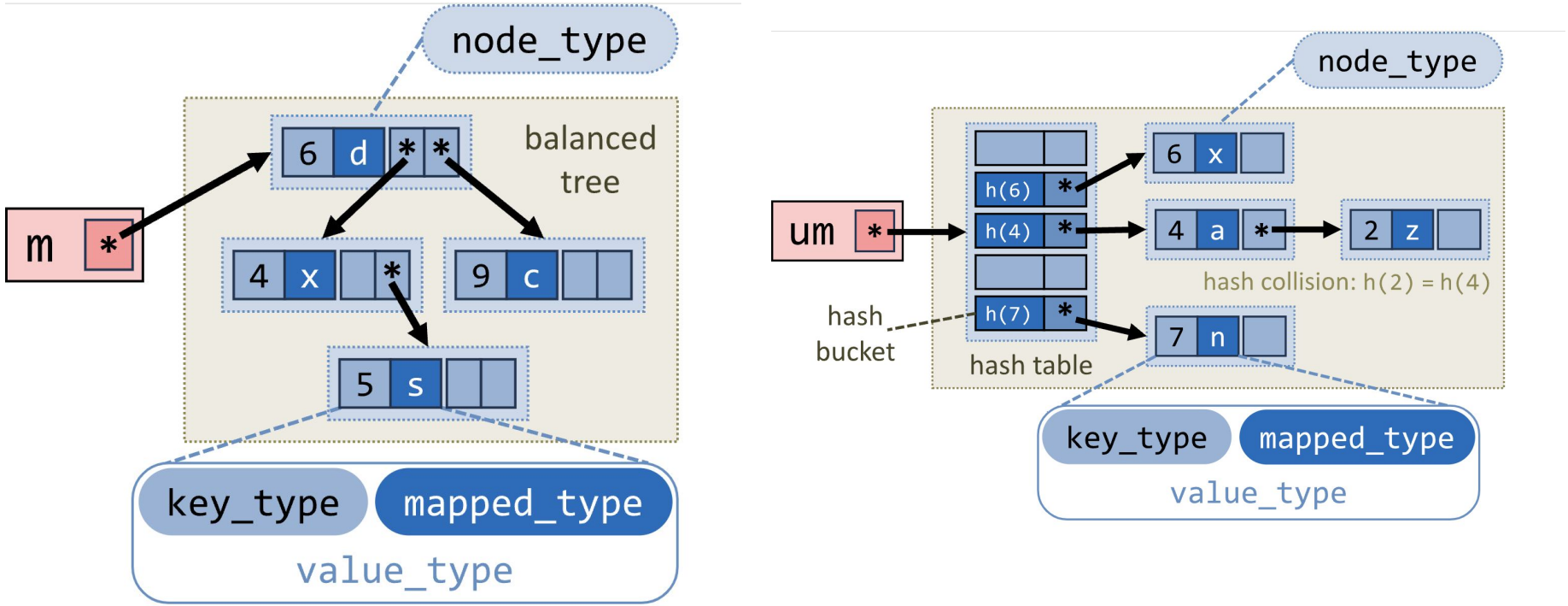
```
template<
    class Key,
    class T,
    class Compare = std::less<Key>,
    class Allocator = std::allocator<std::pair<const Key, T> >
> class map;
```

Unordered associative containers

- unordered_set
- unordered_map
- unordered_multiset
- unordered_multimap

```
template<
    class Key,
    class T,
    class Hash = std::hash<Key>,
    class KeyEqual = std::equal_to<Key>,
    class Allocator = std::allocator< std::pair<const Key, T> >
> class unordered_map;
```

Associative containers



Iterator Invalidation

- Insert/erase
- Capacity change
- After
- Before
- Rehash

Allocator

Класс, отвечающий требованиям, основная задача - инкапсулировать стратегию выделения/очистки памяти и созданий/удаления объектов.

- allocation
- deallocation
- construction
- destruction

Allocator

```
struct SPoint {
   int x;
   int y;
};

int main () {
   std::allocator_traits<CSimpleAllocator<int>> at;
   std::vector<SPoint, CSimpleAllocator<SPoint>> data;

   data.push_back({10,20});

   data.pop_back();

   return 0;
}
```

Allocator

```
template <typename T>
class CSimpleAllocator {
public:
   typedef size_t size_type ;
   typedef ptrdiff_t difference_type ;
   typedef T* pointer ;
   typedef const T* const_pointer ;
   typedef T& reference ;
   typedef const T& const_reference ;
   typedef T value_type ;
};
```

Allocator

```
template <typename T>
class CSimpleAllocator {
public:
   pointer allocate( size_type size) {
       pointer result = static_cast <pointer >(malloc(size * sizeof(T)));
       if(result == nullptr ) {
           // error
       }
       std::cout << "Allocate count" << size << " elements. Pointer:" << result << std::endl;
       return result;
   }

   void deallocate(pointer p, size_type n) {
       std::cout << "Deallocate pointer: " << p << std::endl;
       free(p);
   }
};
```

StackAllocator

Адаптеры контейнеров

- template<class T, class Container = std::deque<T>> class **stack**;
- template<class T, class Container = std::deque<T>> class **queue**;
- template<class T, class Container = std::vector<T>,
  class Compare = std::less<typenameContainer::value_type>>
  class **priority_queue**;

std::stack

```
template<typename T, typename Container=std::vector<T>>
class CMyStack {
public:
   typedef typename Container::value_type      value_type;
   typedef typename Container::reference       reference;
   typedef typename Container::const_reference const_reference;
   typedef typename Container::size_type       size_type;

   void push(const value_type& value) { data_.push_back(value); }

   void pop() { data_.pop_back();}

   bool empty() const { return data_.empty(); }

   const_reference top() const { return data_.back();}

private:
   Container data_;
};
```

Адаптеры итераторов

- back_insert_iterator<Container> (push_back)
- front_insert_iterator<Container> (push_front)
- insert_iterator<Container> (insert)

```
int main() {
    int arr[] = {1,2,3,4,5};
    std::vector<int> v;

    std::copy(arr, arr + 5, std::back_inserter(v));

    return 0;
}
```

back_insert_iterator

// Реализовываем (LegacyOutputIterator)

//

Потоковые итераторы

- istream_iterator
  - Ввод
  - Входной, но не выходной итератор
- ostream_iterator
  - Вывод
  - Выходной, но не входной итератор

Потоковые итераторы

```
int main() {
    std::vector<int> v ;

    std::copy(
        std::istream_iterator<int>(std::cin),
        std::istream_iterator<int>(),
        std::back_inserter<std::vector<int>>(v)
    );

    std::copy(v.begin(),  v.end(),  std::ostream_iterator<int>(std::cout, " "));

    return 0;
}
```

Tag Dispatch Idiom

```
struct tag_1 {};
struct tag_2 {};
struct tag_3 : public tag_2 {};

struct TypeA {};
struct TypeB {};
struct TypeC {};

template<typename T>
struct my_traits {
   typedef tag_1 tag;
};

template<>
struct my_traits<TypeB> {
   typedef tag_2 tag;
};

template<>
struct my_traits<TypeC> {
   typedef tag_3 tag;
};
```

Tag Dispatch Idiom

```
template<typename T>
void func_dispatch(const T& value, const tag_1&) {
   std::cout << "tag1\n" ;
}

template<typename T>
void func_dispatch(const T& value, const tag_2&) {
   std::cout << "tag2\n" ;
}

template<typename T>
void evaluate(const T& value) {
   func_dispatch(value, typename my_traits<T>::tag());
}
```

iterator_traits

```
int main () {
   std::vector<int> v = {1,2,3,4,5};

   std::iterator_traits<std::vector<int>::iterator> tr;

   auto it = std::find(v.begin(), v.end(), 3);

   /*
   template<typename _Iterator, typename _Predicate>
   inline _Iterator
   __find_if(_Iterator __first, _Iterator __last, _Predicate __pred)
   {
     return __find_if(__first, __last, __pred,
              std::__iterator_category(__first));
   }
   */

   return 0;
}
```

input_iterator_tag

```
struct input_iterator_tag { };

struct output_iterator_tag { };

struct forward_iterator_tag : public input_iterator_tag { };

struct bidirectional_iterator_tag : public forward_iterator_tag { };

struct random_access_iterator_tag : public bidirectional_iterator_tag { };

struct contiguous_iterator_tag: public random_access_iterator_tag { };
```

Iterator Operation

- advance
- distance
- next
- prev

Iterator operation

```
template<class It>
typename std::iterator_traits<It>::difference_type
   distance(It first, It last)
{
   return detail::do_distance(
            first, last,
            typename std::iterator_traits<It>::iterator_category())
         );
}
```

Iterator operation

```
namespace detail {
    template<typename It>
    typename std::iterator_traits<It>::difference_type
    do_distance(It first, It last, std::input_iterator_tag) {
        typename std::iterator_traits<It>::difference_type result = 0
        while (first != last) {
            ++first;
            ++result;
        }
        return result;
    }

    template<class It>
    typename std::iterator_traits<It>::difference_type
    do_distance(It first, It last, std::random_access_iterator_tag) {
        return last - first;
    }
}
```