

Generic Programming, Exception Handling, and Multiple Threads in C++

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Generic Programming

- the term “generic programming” refers to a way of coding which is not dependent on any particular type;
- for example, the *sort* function available in the C++ algorithm library, is able to sort any container, as long as *start()* and *end()* are specified. For example,

```
#include <vector>
#include <list>
#include <algorithm>

int main() {
    ...
    std::vector<int> my_integers;
    std::list<string> my_strings;
    ...
    std::sort (my_integers.begin(), my_integers.end()); // sort the integers
    std::sort (my_strings.begin(), my_strings.end());   // sort the strings
    ...
    return 0;
}
```

- C++ has features such containers, iterators, and algorithms which are tools to help us program more “generically”; why is this useful?

C++ containers...

Until now, we have only used the C++ `std::vector` container. But C++ has several containers to choose from:

- sequential containers:
 - `std::vector` : indexed, elements can be accessed instantly (via index)
 - `std::list` : linked-list like, efficient insertion or deletion anywhere
 - `std::deque` (pronounced “deck”, stands for “double-ended queue”)
: indexed, a queue with efficient insert/delete available at either head or tail
- sequential-container-like:
 - `std::string` : (almost) like `std::vector<char>`
- associative containers: think (`<key>`, `<value>`) pairs
 - `std::map` : associative array; elements retrieved by key, efficient lookup & retrieval
 - others (not covered here: `std::set`, `std::multimap`, `std::multiset`)

iterators

every container offers an iterator mechanism that makes coding more generic...

e.g.,

```
int    load_arr[50]; // storage for our integers
```

```
...
```

```
std::vector<int> integer_data;
```

```
std::vector<int>::iterator iter;
```

```
...
```

```
iter = integer_data.begin();
```

```
size_t i = 0;
```

```
while (i != 50)
```

```
{
```

```
    *iter.push_back(load_arr[i]);
```

```
    ++i;
```

```
}
```

```
...
```



Multiple Threads in C++

```
// thread example
#include <iostream>    // std::cout
#include <thread>       // std::thread

void foo()
{
    // do stuff...
}

void bar(int x)
{
    // do stuff...
}

int main()
{
    std::thread first (foo);    // spawn new thread that calls foo()
    std::thread second (bar,0); // spawn new thread that calls bar(0)

    std::cout << "main, foo and bar now execute concurrently...\n";

    // synchronize threads:
    first.join();               // pauses until first finishes
    second.join();              // pauses until second finishes

    std::cout << "foo and bar completed.\n";

    return 0;
}
```

Exceptions Revisited

next time