

A review of Bjarne's small book

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September 19, 2020

1 The Basics

- Programs
- Functions
- Types, Variables and Arithmetic
- Scope and Lifetime
- Constants
- Pointers, arrays and References
- Tests
- Mapping to Hardware

2 User-defined type

The set of C++ build-in types¹ and operations is rich, but deliberately low-level. The directly and efficiently reflect the capabilities of conventional computer hardware. However, they don't provide programmers with high-level facilities to write advanced applications easily. To overcome this, C++ augments the built-in types and operations with a sophisticated set of abstraction mechanisms out of which programmers can build such high-level facilities.

2.0.1 Structures

The first step is building a new type is to putting elements we need into a data structure, a `struct`:

```
struct Vector {  
    int sz;      // number of elements  
    double* elem; // pointer to elements  
};
```

The first version of `Vector` consists of an `int` and a `double*`. A variable of type `Vector` can be defined as

```
Vector v;
```

However, by itself that is not of much use because `v`'s `elem` pointer doesn't point to anything. For it to be useful, we must give `v` some elements to point to. For instance, construct a `Vector` like

```
void vector_init(Vector& v, int s)  
{  
    v.elem = new double[s];  
    v.sz = s;  
}
```

¹types that can be built from the fundamental types, the `const` modifier, and the declarator operator

That is, `v`'s `elem` member gets a pointer produced by the `new` operator, and `v`'s `sz` member gets the number of elements. The `&` in `Vector&` indicates that we pass `v` by non-`const` ref, so that `vector_init()` can modify the vector passed to it.

The `new` operator allocates memory from *free store* (also known as *dynamic memory*, or *heap*). Object allocated on the free store are independent of the scope from which they are created and live until they are destroyed using the `delete` operator.

A simple implementation of `Vector` could be

```
double read_and_sum(int s)
// read s integers from cin and return their sum, s is //assumed to be positive
{
    Vector v;
    vector_init(v, s); // allocate s elements for v
    for (int i = 0; i!=s; ++i)
    {
        std::cin >> v.elem[i]; // read into elements
    }
    double sum = 0;
    for (int i = 0; i!=s; ++i)
    {
        sum+=v.elem[i];
    }
    std::cout << sum << " \n";
    return sum;
}

int main()
{
    read_and_sum(10);
}
```

There was a long to go from above to the elegant `std::vector`.

Compiler Explorer: <https://godbolt.org/z/vjEMeP>

We use `.`(dot) to access `struct` members through a name (and through a reference) and `->` to access `struct` members through a pointer. For instance

```
void f(Vector v, Vector& rv, Vector* pv)
{
    int i1 = v.sz; // access through name
    int i2 = rv.sz; // access through reference
    int i3 = pv->sz; // access through pointer
}
```

Now another example from Herb's talk.

```
#include <iostream>
#include <vector>
#include <string>
#include <algorithm>

struct User {
    std::string name;
    int age;
};

std::vector<User> users = { {"Cat", 3}, {"Fish", 5} };

int main()
{
    auto sort_by_age = [] (auto& lhs, auto& rhs)
```

```

{
    return lhs.age < rhs.age;
};

std::sort(users.begin(), users.end(), sort_by_age);
}

```

Compiler explorer: <https://godbolt.org/z/noea68>

2.0.2 Classes

From the `struct` example we see that having the data specified separately from the operations on it has advantages. Now we will establish a tighter connection between the representation and the operations for a user-defined type to have all the properties of a ‘real type’. Specifically, we should keep representation inaccessible to users so as to ease use, ensure consistent use of the data, and allow us to later improve the representation. To this end, we need to distinguish

1. The interface
2. A type (to be used by all)
3. The implementation of the type (which has access to the otherwise inaccessible data)

This is the so-called class. Class provides a greater level of abstraction compared to `struct`. The interface is defined by the `public` member of a class, and `private` members are accessible only through that interface. For instance,

```

class Vector {

}

```

2.0.3 Unions

2.0.4 Unions

2.0.5 Enumerations