> 由 KiOii (*_EM_Cpper*)整理。 (KiOii (*_EM_Cpper*) makes this note.)



# Part I: The Basics

# Chapter 2. Variables and Basic Types

Contents



## 2.1 Primitive Built-in Types

- *include :* ***arithmetic types*** and ***void***
  - *arithmetic-include:* ***characters***、***integers***、***boolean***、***float-point numbers***
  - *void:* **no value,most as the return type**

### 2.1.1 Arithmetic Types

- *include:* ***integral types***(include ***character*** and ***boolean types***) and ***floating-point types***


***long long***: introuced by C++11 standard.

**byte**

- *defind:* **The smallest chunk of addressable memory**

**Signed and Unsigned Types**

- *include:* **expect for bool** and **the extended charactor type,**the **integeral types** may be **signed** or **unsigned.**
- *three-charactor types:* ***char***、***signed char***、***unsigned char***
  - *wraning:* ***char*** is not the same type as ***signed char***
  - *wraning:* due to compiler,***char*** is one of the ***signed char*** and ***unsigned char***[1]
  - *wraning:* **The standard does not define how signed types are represented**
- *advice:* Use ***double*** for floating-point computations

### 2.1.2 Type Conversions

what happens depends on the range of the values that the types permit:

- When we assign one of the nonbool arithmetic types to a bool object, theresult is false if the value is 0 and true otherwise.
- When we assign a bool to one of the other arithmetic types, the resulting value is 1 if the bool is true and 0 if the bool is false.
- When we assign a floating-point value to an object of integral type, the value is truncated. The value that is stored is the part before the decimal point.
- When we assign an integral value to an object of floating-point type, the fractional part is zero. Precision may be lost if the integer has more bits than the floating-point object can accommodate.
- If we assign an out-of-range value to an object of unsigned type, the result is the remainder of the value modulo the number of values the target type can hold. For example, an 8-bit unsigned char can hold values from 0 through 255, inclusive. If we assign a value outside this range, the compiler assigns the remainder of that value modulo 256. Therefore, assigning –1 to an 8-bit unsigned char gives that object the value 255.
- If we assign an out-of-range value to an object of signed type, the result is undefined. The program might appear to work, it might crash, or it might produce garbage values.

**Expressions Involving Unsigned Types**

*both unsigned and int:* ***int*** is converted to ***unsigned***

*wraning:* **unsigned never be less than 0**

## 2.1.3 Literals

- *wraning:* **Every literal has a type**

**Integer and Floating-Point Literals**

**Integer Literals**

- *notation:* **decimal、octal、hexadecimal**
  - *decimal:* such that **20** **signed**
  - *octal:* begin with 0,such that **024** **unsigned or signed**
  - *hexadecimal:* begin with 0x,such that **0x14** **unsigned or signed**

**Floating-Point Literals**

- notation: 3.14159、3.14159E0、0.、0e0、.001

**Character and Character String Literals**

```
'a'           // character literal
"Hello World!" // string literal
```

*string literal:* **array of constant chars**

- *wraning:* **The compiler appends a null character ('\0') to every string literal.**

```
// multiline string literal
std::cout << "a really,really long string literal "

          << "that spans two lines" << std::endl;
```

**Escape Sequences**

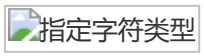
**No Visible Imge Character**

- *such that:* **backspace** or **control characters**
- *sort:* **nonprintable**、**escape sequence**
- *escape sequence*
    - 



- wraning: **Note that if a \ is followed by more than three octal digits, only the first three are associated with the \.**
- wraning:**\x uses up all the hex digits following it**

**Specifying the type of a Literal**





**Boolean and Pointer Literals**

**Boolean Literals**

- *two:* **true** and **false**

**Pointer Literals**

- **nullptr**

# 2.2 Variables

> - Variables in C++ has a **type**
> - The type dermines the **size and layout** of the variables's memory

## 2.2.1 Variable Definitions

- *doing:* **type specifier + a list of one or more variable**
- *such that:* `int sum = 0,value;`

**Initializers**

- *define:* An **object** that is initialized **gets the specitfied value** the moment it is **created.**
- *such that:* `int sum = 0,value = sum;`
- *wraning:* **initialization** and **assignment** are **different** operation in C++

**List Initialization**

```
int var = 0;
int var = {0};
int var{0};          // C++11
int var(0);
```

- *how initialize:* use **{}**

`int var {1.1}; // compile error`

**Default Initialization**

- **default value**(*depend on the **type** and depend on **where** the variable is defined*)
- *specified:* the object of **built-in type** depend one **where** it is deined
  - *outside any function body:* **0**
  - *inside function body:* **uninitialized**

## 2.2.2 Variable Declarations and Definitions

> *separate compilation:* split our programs into **several files**, **each** of which can be **compiled independently**.

> To support separate compilation,C++ distinguishes between **declarations and definitions**.

**declaration**

- *do-what:* **makes a name known to the program**
- *use:* use a name defined elsewhere **includes a declaration** for that name
- *code-look:* `extern int i; //declares but does not define i`

**definition**

- *do-what:* **create the associated entity**
- *code-look:* `int i;// declares and defines i`
- *code-look:* `extern int i = 10;// initialization ignore extern`

**Static Type**

> C++ is a **statically typed language**,which means that types are checked at compile time.
>
> The process by which types are checked is referred to as **type checking.**[1]

## 2.2.3 Identifiers

- *include:* **letters(a,b,c,...)、digits(0,1,2,...)、underscore character( _ )**
- *wraning:* `__、_A // 用户不允许使用连续两个下划线 和 不允许下划线紧靠大写字母开头`

**Conventions for Variable Names**

- meaning
- variable: index,not Index or INDEX
- class: Index、Sales_item
- student_loan,studentLoan,not studentloan

## 2.2.4 Scop of a Name

- *define:* name are **visible** in scope

**global scope**

- *visible:* can be used throughout the program

**Nested Scopes**

```
{
    // ...
    {
        //...
    }
    //...
}
// ...
```

# 2.3 Compound Types

- *define:* a type that is defined **in terms of another type**

**generallay declaration**

- **base type** + a list of **declarator**

> declarator: more than vatiable's name

## 2.3.1 References

> we use the term reference,we mean "lvalue reference"

- *declarator:* **&** variable-name
- *code-look:* `int var = 1024;int &refVar =  var;`
- *wraning:* Because there is no way to rebind a reference, references **must be initialized.**

**A Reference Is an Alias**

> A reference is not an object.Instead,a reference is just another name for an already existing object.

- *wraning:* Because references are not objects, we may **not define a reference to a reference**.

**Reference Definitions**

```
int i = 1024,i2 = 2048;
int &r = i,&r2 = i2;
```

- *wraning:* `int &refVar = 10; // error: initializer must be an object`
- *wraning:* `double var = 3.14;int &refVar = var; // error: initalizer must be an int object`

## 2.3.2 Pointers

- *define:* a compound type that **"points to" another type**
- *wraning:* **pointer is an object**
- *default initialized:* the same to built-in type
- *declarator:* ***** variable-name
- *code-look:* `int *p1,*p2;`

**Taking the Address of an Object**

- *use:* **&**
- *code-look:* `int var = 1024;int *p = &var;`
- *wraning:* objects have address,so **reference does not has address**
- *wraning:* we may not define a pointer to a refrence

**Pointer Value**

1. point to an object
2. point to the location just immediately past the end of an object.[2]
3. null pointer
4. invalid

**Using a Pointer to Access an Object**

- *use:* **dereference operator( * )**
- *code-block*

```
int var = 1024;
int *p = &var;
cout << *p;      // call dereference operator( * )
```

**Null Pointers**

- *define:* **does not point to any object**
- *code-look:* `int *p = nullptr;// C++ 11 defines nullptr`
- *wraning:* `int *p = 0; // ok`
- *wraning:* `int zero = 0; int *p = zero; // error :zero is an int object but the address of an int object`

**Assignment and Pointers**

```
int i = 42;
int *pi = 0;
int *p2 = &i;
int *pi3;
pi3 = pi2;
pi2 = 0;
```

- *keep in mind:* assignment changes its **left-hand operand.**

**Ohter Pointer Operations**

- *use in condition:* if the pointer is **0**,then the condition is **false**,else **true**
- *compare:* two valid pointer of **the same type**,can use ( == ) and ( != )

**void * Pointer**

- *define:* hold the address of any object

## 2.3.3 Understanding Compound Type Declarations

```
int i = 1024,*p = &i,&r = i;
```

**Defining Multiple Variables**

```
// ①
int *p1,*p2;
// ②
int* p1;
int* p2;
```

- *advice:* choose a style and use it consistently

**Pointers to Pointers**

```
int var = 1024;
int *pv = &var;
int **ppv = &pv; // pointers to pointers
```

**Reference to Pointers**

```
int var = 1024;
int *p = nullptr;
int *&r = p;          // reference to pointers
r = &var;
*r = 0;
// result: var == 0
// *&r     : r is a reference,because & is the closest symbol
// int *&r : r is a reference to a pointer to an int
```

- *wraning:* from variable'name,read the definition **right to left**

# 2.4 const Qualifier

> Because we can't change the value of a const object after we create it, it **must be initialized.**

- *code-look:* `const int buffSize = 512;`

**Initialization and const**

- *wraning:* `int var = 42;const int cVar = var; // ok`

**By default,const Objects Are Local to a File**

- *single instace of a const variable:* use **extern** on both its **definition and declaration**
  - code-look

```
extern const int buffSize = fcn(); // file.cpp
extern const int buffSize;         // file.h
```

## 2.4.1 Reference to const

- *define:* bind a reference to an object of a **const type**

```
const int cVar = 1024;     // ok
const int &rcVar = cVar;   // ok
int &rcVar2 = cVar;        // error
rcVar = 0;                 // error
```

**Initialization and References to const**

```
int i = 42;
const int &r1 = i;       // ok
const int &r2 = 42 * 42; // ok
int &r3 = 42;            // error

/*  <<
*   what "const int &r2 = 42*42" doing?
*
*   const int temp = 42*42;
*   const int &r2 = temp;         // is bound to a temporary object
*/
```

- *temporary object:* **unnamed object created by the compiler**

**A Reference to const May Refer to an Object That Is Not const**

```
int i = 42;
const int &ri = i;
ri = 0;       // error
i = 0;        // ok
```

## 2.4.2 Pointers and const

**pointer to const**

- *code-look*

```
const double pi = 3.14;
double *ptr = &pi;           // error
const double *cptr = &pi;    // ok
```

- *wraning:* **pointer to const object** and **const pointer to object**

**const Pointers**

- *code-look*

```
int num = 0;
int *const p = &num;  // p can't change
const int *p2= &num;  // *p can't change
```

## 2.4.3 Top-Level const

**top-level const**

- *define:* **const pointer**

**low-level const**

- define:pointer to a variable,but we can **not use pointer to change the variable**

## 2.4.4 constexpr and Constant Expressions

**constant expression**

- *define:* is an **expression** and its **value cannot change** and value **can be evaluated at compile time.** (*three points*)
- *depend:* **type** and **initializer**
- *code-look*

```
int expr = 20;        // expr is not a constant expression.
const int expr2 = 20; // yes
const int expr3 = expr2 + 1; // yes

const int expr4 = get();     // no,compile time can not know
```

**constexpr Variables**

- *defined standard:* **C++ 11**
- *do what:* ask the compiler to verify that a variable is a constant expression.[3]
- *how:* **Variable** declared as constexpr are **const** and must be **initialized by constant expression.**
- *wraning*

```
constexpr int sz = size();
/*
*   ok only if size is a constexpr function
*/

int num = 20;
const int var = num; // ok,but is not constant expression
```

**Literal Types**

- *define:* can use constexpr
- *such that:* **arithmetic、reference、pointer type**
- *wraning:* our class、IO library...and so on are not Literal Type

```
constexpr int *p = nullptr; // p only can be initialized by 0 or nullptr or fixed address
(inside the function,the address of variable are not fixed address)
```

**Pointer and constexpr**

- *wraning:* when we define a pointer in a constexpr declaration,the constexpr specifier applies to the pointer,not the type.[4]
- *code-look*

```
const int *p = nullptr;     // low-level const
constexpr int *q = nullptr; // top-level const
```

- *wraning:* when use constexpr in pointer,it is **top-level const**

# 2.5 Dealing with Types

## 2.5.1 Type Aliases

> **Reference** is the **Variable Alias**

- *how to define type aliase*
  - use ***typedef***: `typedef  double wages;// wages is the type alia of double`
  - use ***using***: `using wages = double;// C++ 11`

**Pointer、const、and Type Aliase**

```
typedef char *pstring;
const pstring cstr = 0; // const pointer,point to char
// if we want const char *,we may be re-typedef
typedef const char *pstring;
pstring cstr = 0;
```

## 2.5.2 The auto Type Specifier

- *defined standard:* **C++11**
- *wraning:* must be **initialized**
- *wraning:* `auto sz = 0,pi = 3.14; // error`
- *wraning:* `auto sz = 0,num = 3;  // ok`

**Compound Types,const、and auto**

> The type that the compiler infers for auto is **not always exactly** the same as the initializer's type.

1. **Reference**: The compiler uses that **object's type** for auto's type deduction

   ```
   int i = 0,&r = i;
   auto a = r; // auto is int
   ```

2. **const: ignore top-level const**

   ```
   int i = 0;
   const int ci  = i,&cr = ci;
   auto b = ci; // ignore top-level const,auto is int

   /*
   * if you want the deduced type to have a top-level const
   */
   const auto f = ci;
   ```

- *wraning:* ***** and **&** is part of a particular **declarator** and **not part of the base type** for the declaration.

## 2.5.3 The decltype Type Specofier

- *defined standard:* **C++11**
- *code-look:* `decltype( f() ) sum = x;// the type of sum is the return-type of f()`
- *wraning:*

```
const int ci = 0, &cj = ci;
decltype(ci) x = 0;
decltype(cj) y = x; // decltype(cj) is reference to int.
```

**decltype and Reference**

```
int i = 42,*p = &i,&r = i;
decltype(r+0) b; // int
decltype(*p) c;  // error  reference must be initialized
```

- *wraning:*
  - get reference type: **decltype( (variable) )** or **decltype( dereference )** (*such as: decltype(**p) , p is a pointer*) or **decltype( reference )**
  - get variable type:**decltype(variable's expression)**

# 2.6 Defining Our Own Data Structures

## 2.6.1 Defining the Sales_data Type

```
struct Sales_data{
    std::string bookNo;
    unsigned units_sold = 0;
    double revenue = 0.0;
};
```

**Class Data Members**

> our class has only data members.

- C++11,we can supply an **in-class initializer** ro a **data member.**[4]
- members without an initializer are **default initialized**

## 2.6.2 Using the Sales_data Class

**Adding Two Sales_data Objects**

```
#include <iostream>
#include <string>
#include "Sales_data.h"
int __cdecl main(int argc,char *argv[],char *envp)
{
    Sales_data data1,data2;
    return 0x0;
}
```

### Reading Data into a Sales_data Type

`std::cin >> data1.bookNo >> data1.units_sold ;`

## 2.6.3 Writing Our Own Header Files

### A brief Introduction to the Preprocessor

- *guard against multiple inclusion*

```
#ifndef SALES_DATA_H
#define SALES_DATA_H
#include <stding>
struct Sales_data{
    std::string bookNo;
    unsigned units_sold = 0;
    double revenue = 0.0;
};
#endif
```

---

1. 不确定时，最好显式指定***signed char*** 或者 ***unsigned char***↩↩

2. 指向紧邻对象所占空间的下一个位置↩

3. constexpr 类型用于告诉编译器去判定是否变量的值是否是 constant expression↩

4. 当在constexpr中定义了指针，限定符constexpr只对指针有效，与指针指向的对象无关。↩↩