C/C++ Programming Language

CS205 Spring

Feng Zheng

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南方科技大学

SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Content

- Brief Review
- Compound Types
  - Array
  - String
  - string-class string
  - Structure
  - Pointer
- Managing memory for data
- Summary

Brief Review

Fundamental types

- Integer Type
  - Bits and Bytes
  - Unsigned and signed types
- Char Type
- Floating-point Type
  - Precision
- Arithmetic Operators
  - Conversions

Compound Types

Content

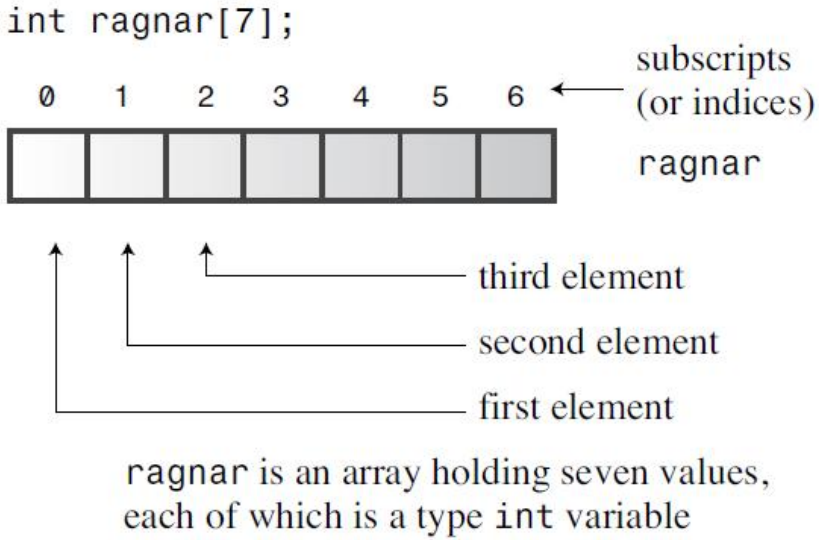
- Arrays
- Array-style strings
- string-class strings
- Structures
- Unions
- Enumerations

Array

Arrays

- An array is a data form that can hold several values, all of **one type**
- To define:
  - The type of value to be stored in each element
  - The name of the array
  - The number of elements in the array must be an integer constant, such as 10 or a const value, MICROS, or a constant expression
  - Square brackets []

Why?



ragnar is an array holding seven values, each of which is a type int variable

Arrays

- Some statements for an array
  - Declaring an array
  - Assigning values to array elements
  - Initializing an array
- Run program
  - // arrayone.cpp -- small arrays of integers
  - Note that if you use the sizeof operator with an array name, you get the number of bytes in the whole array
  - First element index is 0
  - Error: if subscript is equal or greater than the number of elements

Initialization Rules for Arrays

- Several rules about initializing arrays
  - Able to
    - ✓ Use the initialization form only when defining the array
    - ✓ Use subscripts and assign values to the elements of an array individually
    - ✓ Partially initialize an array, the compiler sets the remaining elements to zero
  - Cannot
    - ✓ Use initialization later
    - ✓ Assign one array wholesale to another

```
int cards[4] = {3, 6, 8, 10};   // okay
int hand[4];                    // okay
hand[4] = {5, 6, 7, 9};         // not allowed
hand = cards;                   // not allowed
```

```
float hotelTips[5] = {5.0, 2.5};
long totals[500] = {0};
short things[] = {1, 5, 3, 8};
```

C++11 Array Initialization

- Rules in C++11
  - Can drop the = sign

```
double earnings[4] {1.2e4, 1.6e4, 1.1e4, 1.7e4};  // okay with C++11
```

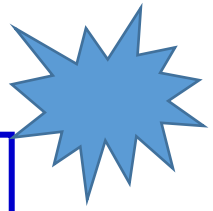
  - Cannot convert from a floating-point type to an integer type(narrowing)
  - Cannot assign int type to char type (Outside the range of a char)

```
long plifs[] = {25, 92, 3.0};            // not allowed
char slifs[4] {'h', 'i', 1122011, '\0'}; // not allowed
char tlifs[4] {'h', 'i', 112, '\0'};     // allowed
```

String

Strings

- A string is a series of characters stored in consecutive bytes of memory
  - C-style (array) string
  - string class library
- Store a string in an array of char (C-style)
  - The last character of every string is the null character
  - This null character is written \0
  - The character is with ASCII code 0
  - It serves to mark the string's end

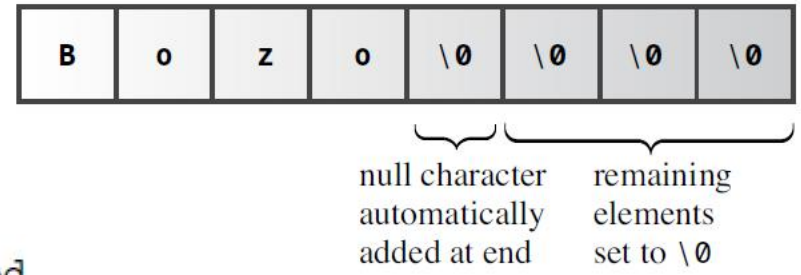


```
char dog[8] = { 'b', 'e', 'a', 'u', 'x', ' ', 'I', 'I'};      // not a string!
char cat[8] = {'f', 'a', 't', 'e', 's', 's', 'a', '\0'};      // a string!
```

Strings

- Using a double quoted string
  - Called a string constant or string literal
  - Include the terminating null character implicitly

```
char boss[8] = "Bozo";
```




```
char bird[11] = "Mr. Cheeps";      // the \0 is understood
char fish[] = "Bubbles";           // let the compiler count
```

  - Make sure the array is large enough to hold all the characters
  - Note that a string constant (with double quotes" ") is not interchangeable with a character constant (with single quotes' ')

```
char shirt_size = 'S';          // this is fine
char shirt_size = "S";          // illegal type mismatch
```

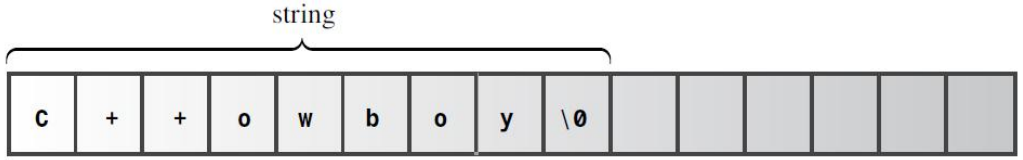
Concatenating String Literals

- C++ enables to concatenate string literals
  - Any two string constants separated only by whitespace

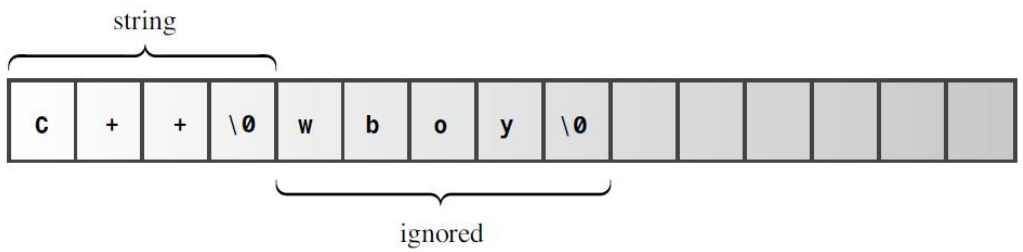
```
cout << "I'd give my right arm to be" " a great violinist.\n";
cout << "I'd give my right arm to be a great violinist.\n";
cout << "I'd give my right ar"
"m to be a great violinist.\n";
```

- Run program
  - Using Strings in an Array
  - // strings.cpp -- storing strings in an array
- Shortening a string with \0
- Beware of memory overflow (Problem)

```
const int ArSize = 15;
char name2[ArSize] = "C++owboy";
```

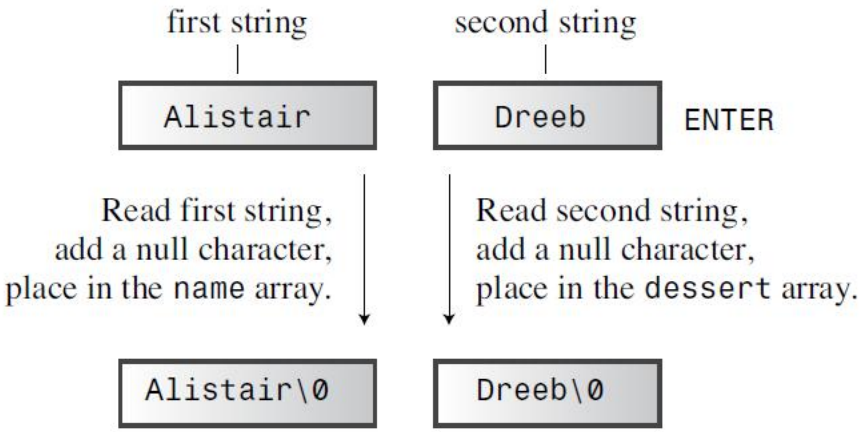



```
name2[3] = '\0';
```



Adventures in String Input

- Run program
  - // instr1.cpp -- reading more than one string
  - The cin technique is to use whitespace—spaces, tabs, and newlines (\0)—to delineate a string
  - The input string might turn out to be longer than the destination array (buffer)



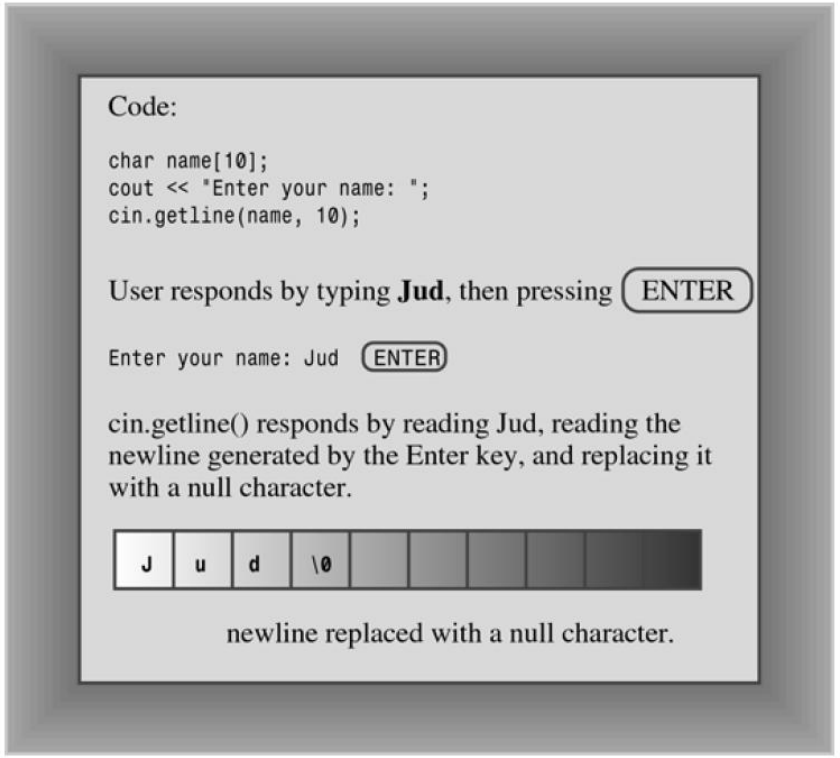
- A white space causes a problem

Reading String Input a Line at a Time (solved)

- To solve the problem:
- 1. Line-oriented input with **getline()**
- Run program
  - // instr2.cpp -- reading more than one word with getline()
  - Two arguments
- 2. Line-oriented input with **get()**
- Run program
  - Read the single next character, even if it is a newline
  - // instr3.cpp -- reading more than one word with get() & get()

Mixing String and Numeric Input

- Problem: mixing numeric input with line-oriented string input
- See a problem in program example
  - // numstr.cpp -- following number input with line input
  - The problem is that when cin reads the year, it leaves the newline generated by the Enter key in the input queue. Then cin.getline() reads the newline as an empty line and assigns a null string to the address array
- Solve it: cin.get();



string-class strings

string class

- The ISO/ANSI C++98 Standard expanded the C++ library
- Include the string header file: #include<string>
- Run: // strtype1.cpp -- using the C++ string class
  - Initialize a string object, in a similar way as a C-style string
  - Use cin to store keyboard input in a string object
  - Use cout to display a string object
  - Use array notation to access individual characters stored in a string object
- Differences
  - Treat object as a simple variable, not as an array
  - Allow the program to handle the sizing automatically

C++11 String Initialization

- C++11 enables 4 kinds of initialization
  - Array-style
  - String class

```
char first_date[] = {"Le Chapon Dodu"};
char second_date[] {"The Elegant Plate"};
string third_date = {"The Bread Bowl"};
string fourth_date {"Hank's Fine Eats"};
```

- Assign one string object to another
  - Array assignment

```
char charr1[20];            // create an empty array
char charr2[20] = "jaguar"; // create an initialized array
string str1;                // create an empty string object
string str2 = "panther";    // create an initialized string
charr1 = charr2;            // INVALID, no array assignment
str1 = str2;                // VALID, object assignment ok
```

- Use the + and += operators

```
string str3;
str3 = str1 + str2;         // assign str3 the joined strings
str1 += str2;               // add str2 to the end of str1
```

More string Class Operations

- Three functions for array-style string
  - strcpy(): copy a string to a character array → =
  - strcat(): append a string to a character array → +=
  - strlen(): calculate the length of a character array → ***.size()

- See three operations in program
  - // strtype3.cpp -- more string class features

- Conclusions
  - string objects tends to be **simpler** than using the C string functions
  - string objects tends to be more **safe** than that of the C

More on string Class I/O

- See length of string in program
  - //strtype4.cpp -- line input

- The difference and problems of array-style string
  - strlen() reaches a null character
  - string object is automatically set to zero size

  - Array-style string has fixed size of input

```
cin.getline(charr, 20);  // Array-style string
getline(cin, str);       // string class
```

Other Forms of String Literals

- Beside char, we have more following types
  - wchar_t
  - char16_t
  - char32_t

```
wchar_t title[] = L"Chief Astrogator";  // w_char string
char16_t name[] = u"Felonia Ripova";    // char_16 string
char32_t car[] = U"Humber Super Snipe"; // char_32 string
```

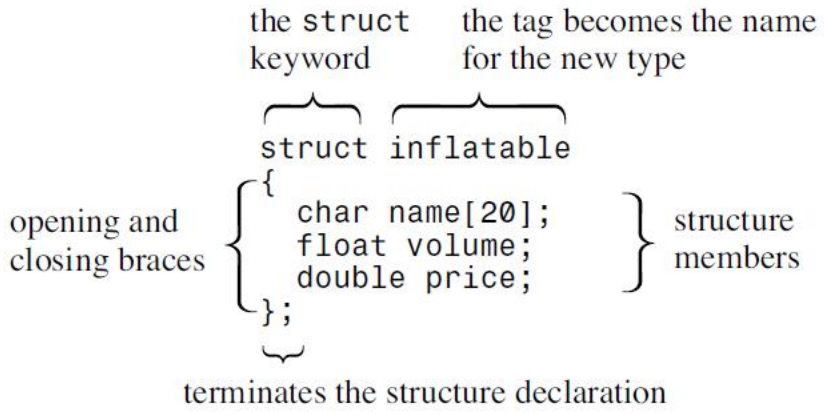
- Unicode characters called UTF-8
  - Using u8 prefix to indicate

- C++11 adds a raw string
  - Delimiter: "(***)"
  - Using R prefix to indicate

Structures, Unions and Enumerations

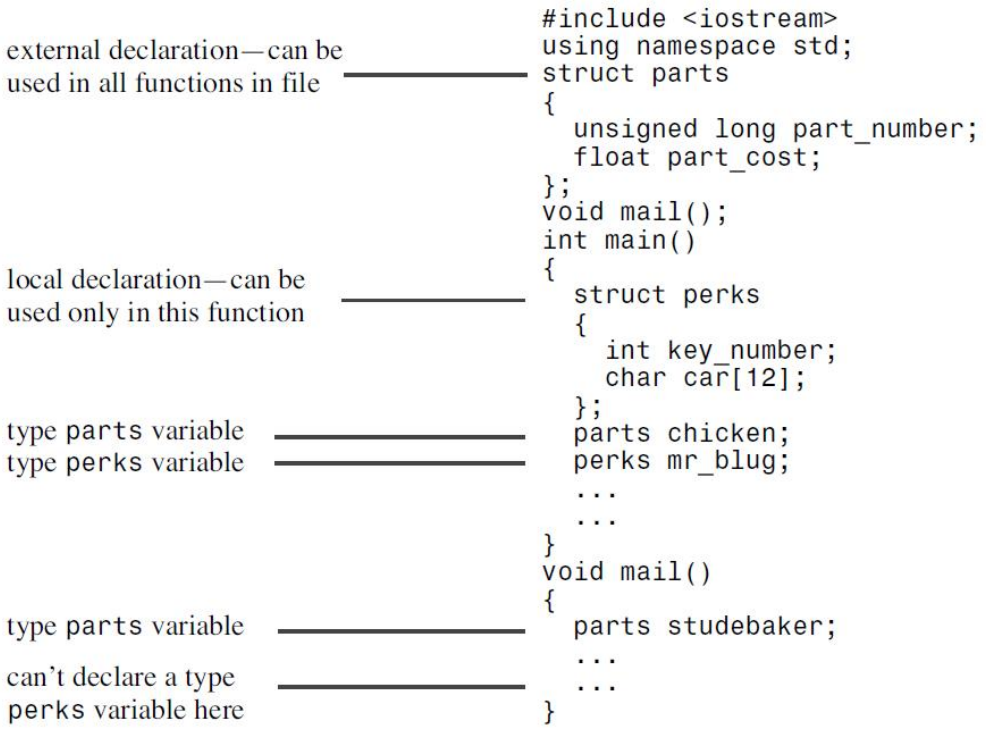
Introducing Structures

- Why structures?
  - Almost all previous types are those you can directly use
  - A structure is a more versatile data form than an array
  - A structure is a user-definable type
- The keyword struct → make a new type



Using a Structure in a Program

- How to create a structure?
  - Where to place the structure declaration? Inside or outside of main
  - Can a structure use a string class member? Yes
  - Assignment: use a comma-separated list of values enclosed in a pair of braces
  - In C++11, the = sign is optional
  - Empty braces result in the individual members being set to 0
- See assignment and member access
  - // structur.cpp -- a simple structure



Other Structure Properties

- What actions you can do for structures?
  - Pass structures as arguments (multiple) to a function
  - Have a function use a structure as a return value (multiple)
  - Combine the definition of a structure form with the creation of structure variables
  - Have member functions in addition to member variables

```
struct Books {
   char  title[50];
   char  author[50];
   char  subject[100];
   int   book_id;
} book;
```

- Run program
  - // assgn_st.cpp -- assigning structures
  - Member-wise assignment: use the assignment operator (=) to assign one structure to another of the same type

More Structure Properties: Array

- Arrays of Structures
  - Create arrays whose elements are structures
  - An example
    - ✓ gifts itself is an array, not a structure
    - ✓ gifts[0] is a structure

```
inflatable gifts[100];  // array of 100 inflatable structures

cin >> gifts[0].volume;           // use volume member of first struct
cout << gifts[99].price << endl; // display price member of last struct


inflatable guests[2] =              // initializing an array of structs
    {
        {"Bambi", 0.5, 21.99},      // first structure in array
        {"Godzilla", 2000, 565.99}  // next structure in array
    };
```

Unions

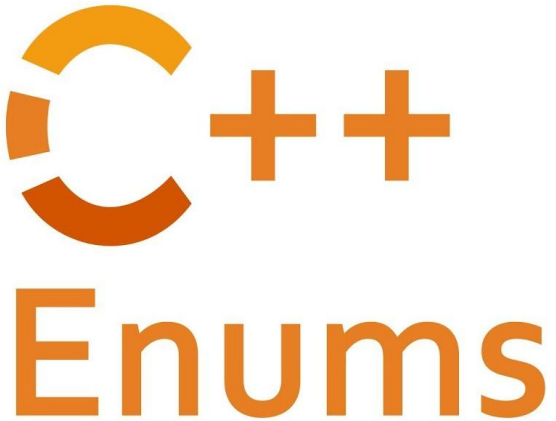
- A union is a data format
  - Can hold different data types but only one type at a time
  - Can use two or more formats but never simultaneously
  - Save memory
  - union Keyword → make a new type


```
union one4all
{
    int int_val;
    long long_val;
    double double_val;
};
```

```
one4all pail;
pail.int_val = 15;          // store an int
cout << pail.int_val;
pail.double_val = 1.38;     // store a double, int value is lost
cout << pail.double_val;
```

Enumerations

- The C++ enum facility provides an alternative to const for creating symbolic constants (#define)
  - enum spectrum {red, orange, yellow, green, blue, violet};
    - ✓ It makes spectrum the name of a new type
    - ✓ It establishes the members as symbolic constants for the integer values 0–5
  - By default, enumerators are assigned integer values starting with 0 for the first enumerator, 1 for the second enumerator, and so forth
  - The assigned values must be integers
  - enum Keyword → make a new type



Enumerations

```
enum spectrum {red, orange, yellow, green, blue, violet, indigo, ultraviolet};
```

- What operations can you do for enumerations?
  - Assign it using the member
  - You can set enumerator values explicitly

```
enum bits{one = 1, two = 2, four = 4, eight = 8};
```

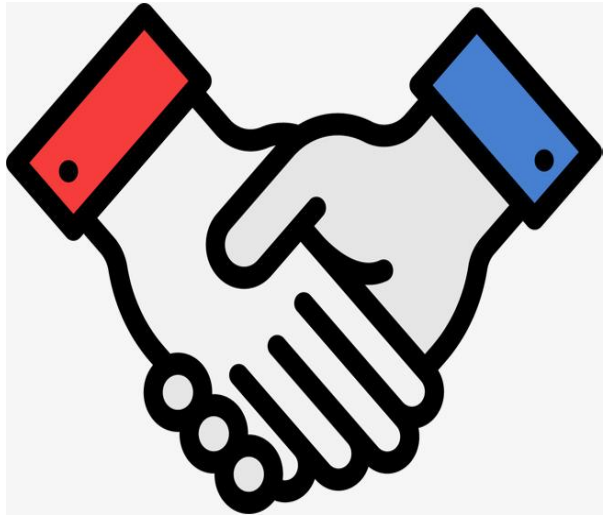
  - Assign other variables using it
  - Typecast values within the range
  - Beware of the value ranges for enumerations

```
spectrum band;  // band a variable of type spectrum
band = blue;       // valid, blue is an enumerator
band = 2000;       // invalid, 2000 not an enumerator

band = orange;           // valid
++band;                  // not valid, ++ discussed in Chapter 5
band = orange + red;     // not valid, but a little tricky

int color = blue;        // valid, spectrum type promoted to int
band = 3;                // invalid, int not converted to spectrum
color = 3 + red;         // valid, red converted to int
band = spectrum(3);         // typecast 3 to type spectrum
band = spectrum(40003);    // undefined
```

```
band = orange + red;     // not valid, but a little tricky
```

Summary

- Compound types
  - Array
  - Array-style string
  - String class
  - Structure



Thanks

zhengf@sustech.edu.cn