南方科技大学
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

C/C++ Program Design

CS205

Week 4

Prof. Shiqi Yu (于仕琪)

<yusq@sustech.edu.cn>

Prof. Feng Zheng(郑锋)

<zhengf@sustech.edu.cn>

Content

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

Array

The slides are based on the book <Stephen Prata, C++ Primer Plus, 6th Edition, Addison-Wesley Professional, 2011>

Data Types

Fundamental types

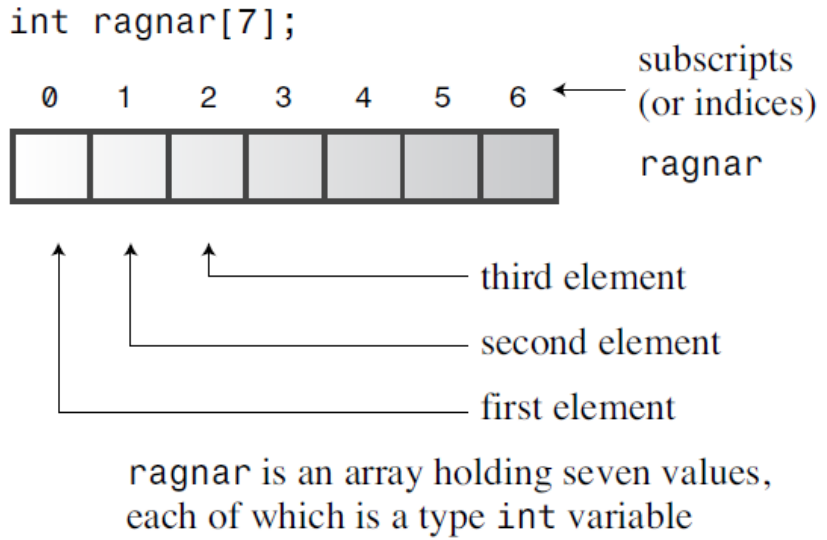
- Integer Type
  `bool`
  `short, int, long`
- Char Type:
  `char`
- Floating-point Type:
  `float, double`

Compound types

- Array
- Array-style string
- String class
- Structure
- …

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 Why?
  - Square brackets []



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 example
  - // 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)

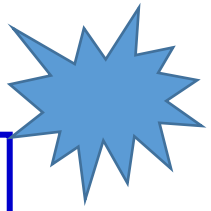
```
long plifs[] = {25, 92, 3.0};              // not allowed
char slifs[4] {'h', 'i', 1122011, '\0'}; // not allowed
char tlifs[4] {'h', 'i', 112, '\0'};     // allowed
```

The slides are based on the book <Stephen Prata, C++ Primer Plus, 6th Edition, Addison-Wesley Professional, 2011>

String

Strings

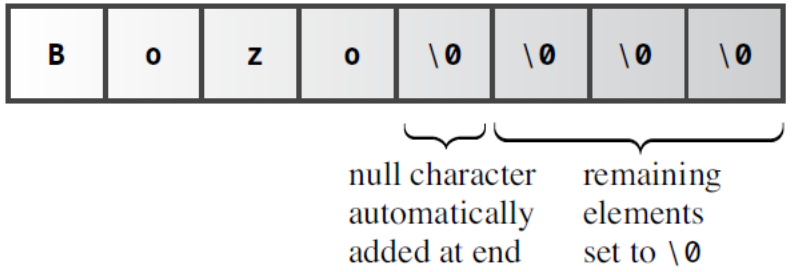
- A string is a series of characters stored in consecutive bytes of memory
  - C-style (array) string
  - string class library
- Store a string in an array of char (C-style)
  - The last character of every string is the null character
  - This null character is written \0
  - The character is with ASCII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

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



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

```
char shirt_size = 'S';          // this is fine

char shirt_size = "S";          // illegal type mismatch
```

```
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' ')

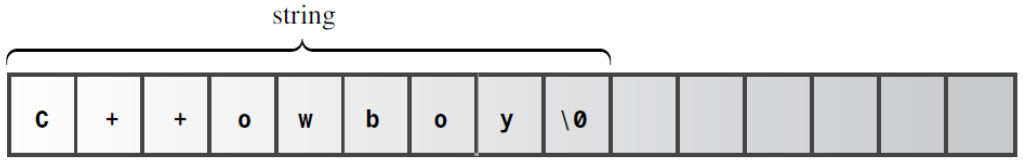
Example cstrinit.cpp

Concatenating String Literals

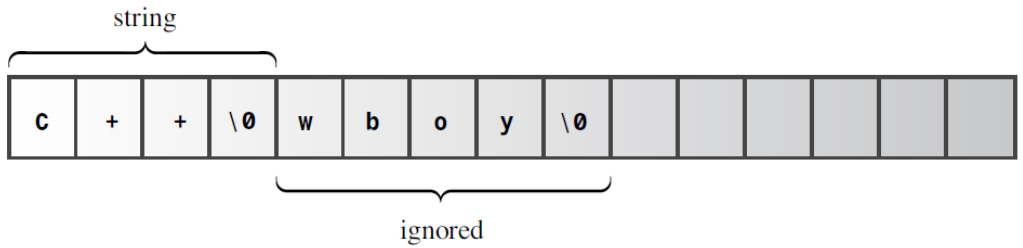
- C++ enables to concatenate string literals
  - Any two string constants separated only by whitespace

```
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";
```

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



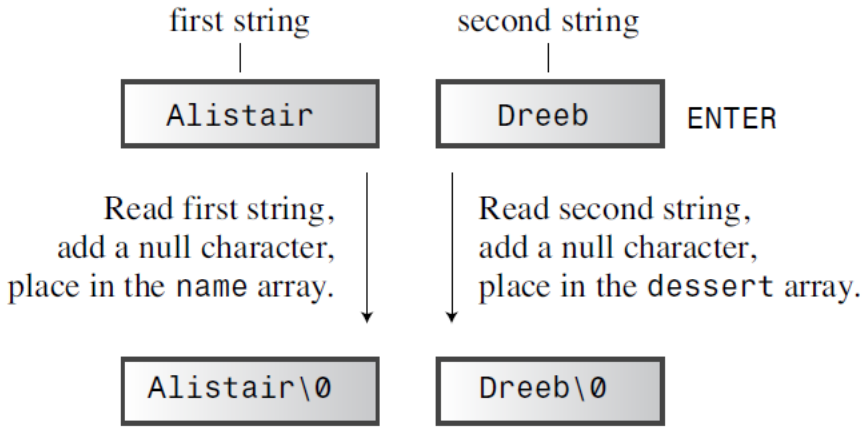

```
name2[3] = '\0';
```



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

Adventures in String Input

- Run program example
  - // 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:
- Line-oriented input with **getline()**
- See program example
  - // instr2.cpp -- reading more than one word with getline()
  - Two arguments

Other Forms of String Literals

- Beside char, we have more following types
  - wchar_t
  - char16_t
  - char32_t
  - char8_t //c++2a

```
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
char8_t name[] = u8"SUSTech";    // UINT8
```

- example wstr.cpp

The slides are based on the book <Stephen Prata, C++ Primer Plus, 6th Edition, Addison-Wesley Professional, 2011>

string-class strings

string class

- The ISO/ANSI C++98 Standard expanded the C++ library
- Include the string header file: #include<string>
- Run program example strtype1.cpp
  - 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 example strtype3.cpp

- 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 example strtype4.cpp
- 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

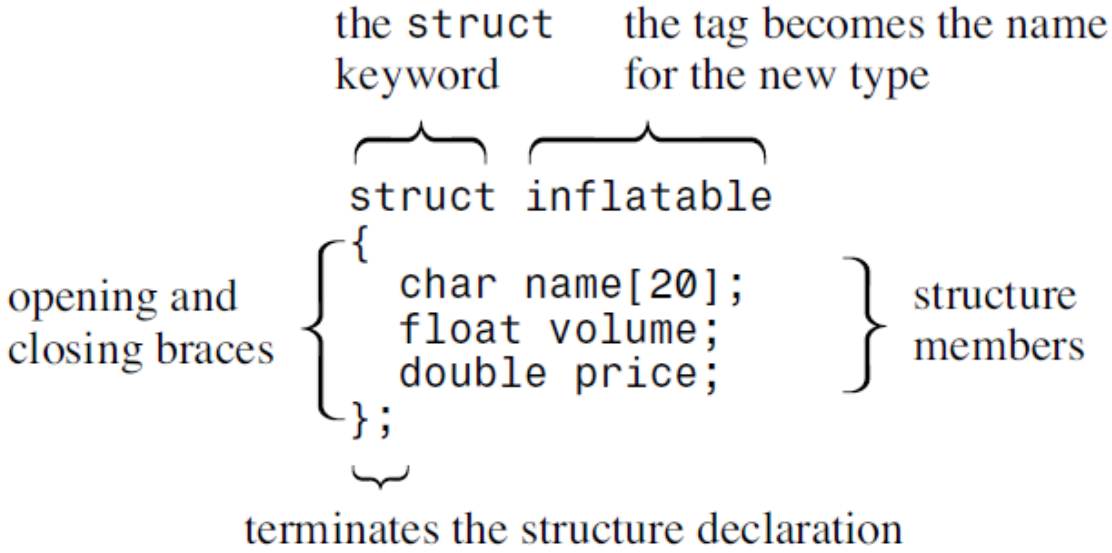
```
cin.getline(charr, 20);  // Array-style string
getline(cin, str);       // string class
```

The slides are based on the book <Stephen Prata, C++ Primer Plus, 6th Edition, Addison-Wesley Professional, 2011>

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 in program example stracture.cpp

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

- Run program example assgn_st.cpp
  - 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
    };
```

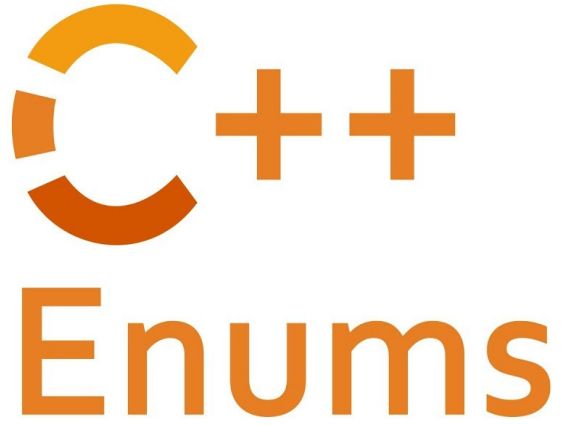
Unions

- 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;
};
```

program example union.cpp

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
```