# CS118 – Programming Fundamentals

Lecture # 23
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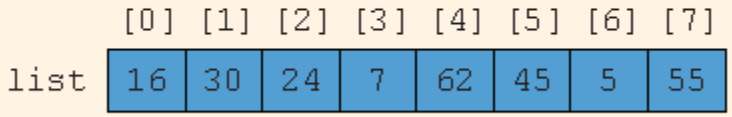
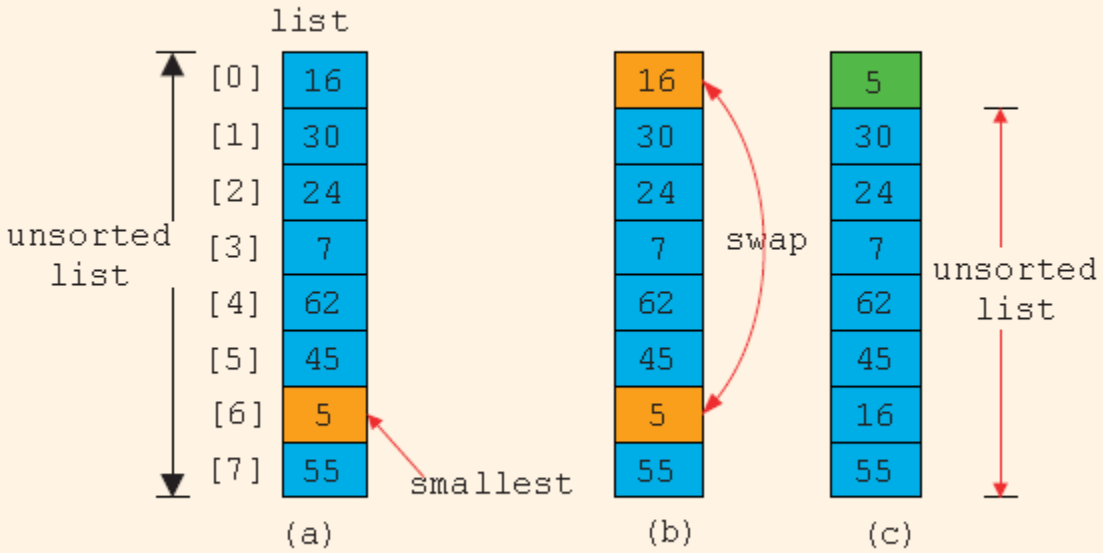
# Selection Sort

- This algorithm finds the location of the smallest element in the unsorted portion of the list
- And moves it to the top of the unsorted portion of the list
- The first time, we locate the smallest item in the entire list
- The second time, we locate the smallest item in the list starting from the second element in the list

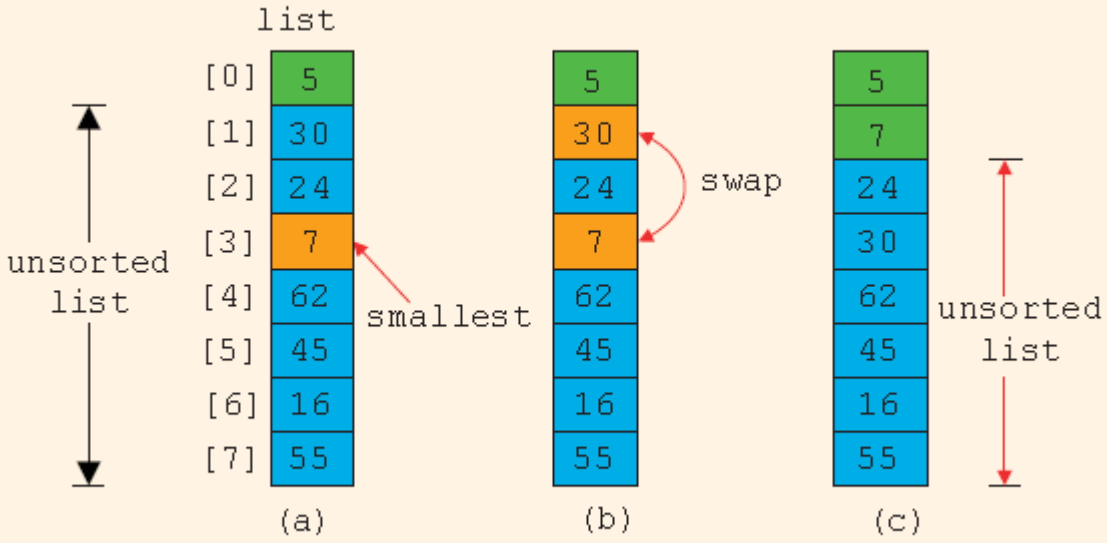
# Contd..

Suppose you have the list shown in Figure 10-6.



# Contd..


list
[0]
[1]
[2]
[3]
[4]
[5]
[6]
[7]
5
30
24
7
62
45
16
55
unsorted
list
smallest
swap
unsorted
list
(a)
(b)
(c)

# Selection Sort

- In the unsorted portion of the list:

a. Find the location of the smallest element.

b. Move the smallest element to the beginning of the unsorted list.

```
for (index = 0; index < length - 1; index++)
{
   a. Find the location, smallestIndex, of the smallest element in
      list[index]...list[length - 1].
   b. Swap the smallest element with list[index]. That is, swap
      list[smallestIndex] with list[index].
}
```

# Contd..

- Step a is similar to the algorithm for finding the index of the largest item in the list

```
smallestIndex = index; //assume first element is the smallest

for (location = index + 1; location < length; location++)
    if (list[location] < list[smallestIndex])
        smallestIndex = location;  //current element in the list
                                   //is smaller than the smallest so
                                   //far, so update smallestIndex
```

# Contd..

- Step b swaps the contents of **list[smallestIndex]** with **list[index].** The following statements accomplish this task:

```
temp = list[smallestIndex];
list[smallesIndex]= list[index];
list[index] = temp;
```

```
void selectionSort(int list[], int length)
{
    int index;
    int smallestIndex;
    int minIndex;
    int temp;

    for (index = 0; index < length - 1; index++)
    {
            //Step a
        smallestIndex = index;

        for (minIndex = index + 1; minIndex < length; minIndex++)
            if (list[minIndex] < list[smallestIndex])
                smallestIndex = minIndex;

            //Step b
        temp = list[smallestIndex];
        list[smallestIndex] = list[index];
        list[index] = temp;
    }
}
```

# Contd..

```
//Selection sort

#include <iostream>

using namespace std;

void selectionSort(int list[],  int length);

int main()
{
    int list[] = {2, 56, 34, 25, 73, 46, 89, 10, 5, 16}; //Line 1
    int i;                                                //Line 2

    selectionSort(list, 10);                              //Line 3

    cout << "After sorting, the list elements are:"
         << endl;                                         //Line 4
    for (i = 0; i < 10; i++)                              //Line 5
        cout << list[i] << " ";                           //Line 6

    cout << endl;                                         //Line 7

    return 0;                                             //Line 8
}

//Place the definition of the function selectionSort given
//previously here.
```

# Sorting a List: Bubble Sort



- Suppose `list[0]...list[n - 1]` is a list of n elements, indexed `0` to `n - 1`
- Bubble sort algorithm:
  - In a series of `n - 1` iterations, compare successive elements, `list[index]` and `list[index + 1]`
  - If `list[index]` is greater than `list[index + 1]`, then swap them

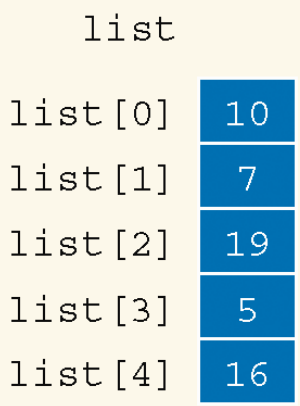



**FIGURE 10-3** List of five elements

- In the first iteration, we consider **list[0]...list[n - 1]**
- in the second iteration, we consider **list[0]...list[n - 2]**
- in the third iteration, we consider **list[0]...list[n - 3]**, and so on.

**Iteration 1: Sort list[0]...list[4].**

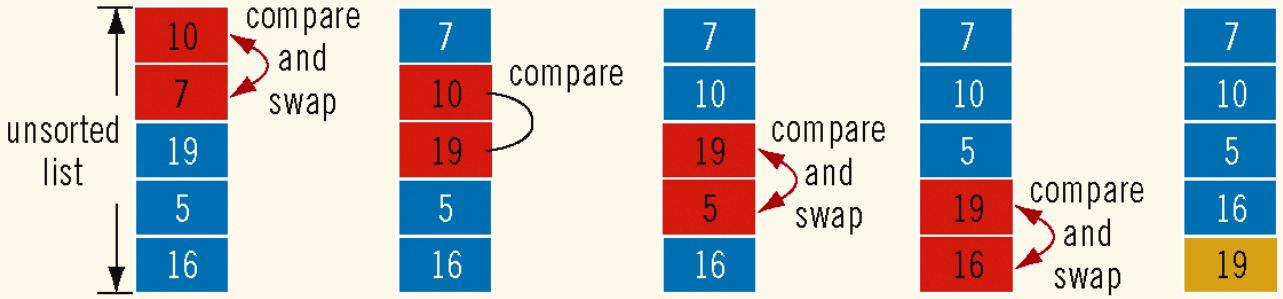



**FIGURE 10-4** Elements of `list` during the first iteration

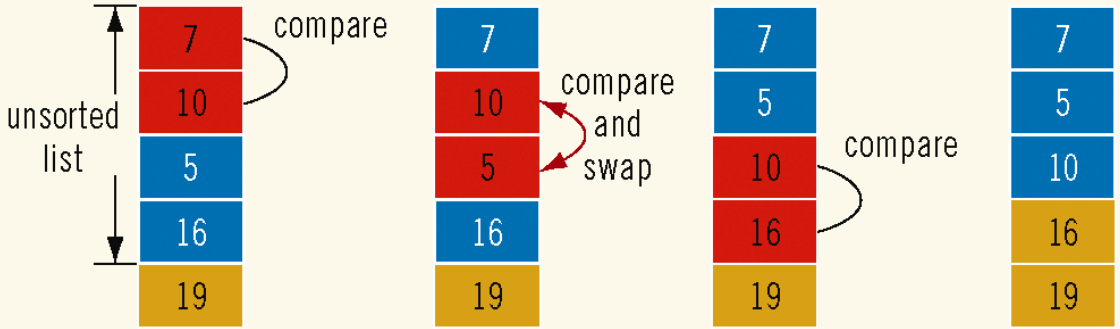



**FIGURE 10-5** Elements of `list` during the second iteration

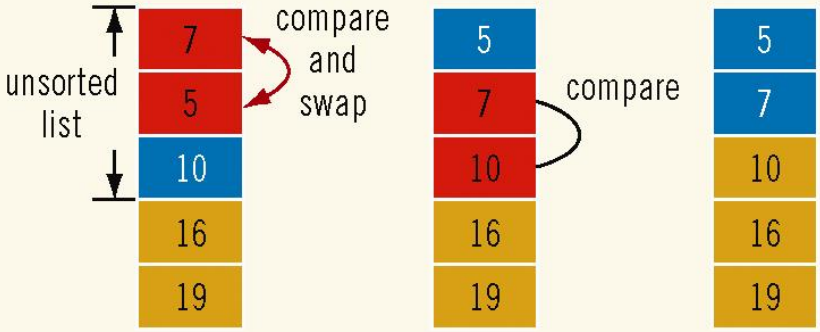



**FIGURE 10-6** Elements of `list` during the third iteration

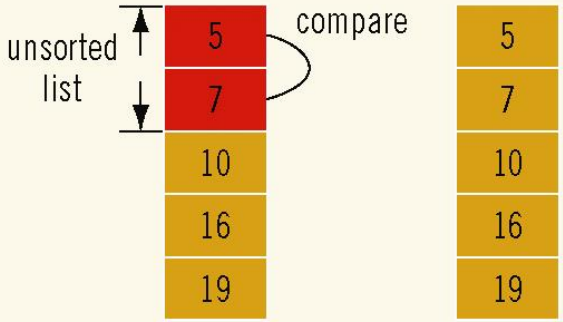



**FIGURE 10-7** Elements of `list` during the fourth iteration

```
void bubbleSort(int list[], int length)
{
    int temp;
    int iteration;
    int index;
    for (iteration = 1; iteration < length; iteration++)
    {
        for (index = 0; index < length - iteration; index++)
            if (list[index] > list[index + 1])
            {
                temp = list[index];
                list[index] = list[index + 1];
                list[index + 1] = temp;
            }
    }
}
```

```
//Bubble sort

#include <iostream>

using namespace std;

void bubbleSort(int list[],  int length);

int main()
{
    int list[] = {2, 56, 34, 25, 73, 46, 89, 10, 5, 16};  //Line 1
    int i;                                                 //Line 2

    bubbleSort(list, 10);                                  //Line 3

    cout << "After sorting, the list elements are:"
         << endl;                                          //Line 4

    for (i = 0; i < 10; i++)                               //Line 5
        cout << list[i] << " ";                            //Line 6

    cout << endl;                                          //Line 7

    return 0;                                              //Line 8
}

//Place the definition of the function bubbleSort given
//previously here.
```

# C-Strings **(Character Arrays)**



- **Character array:** An array whose components are of type char
- C-strings are null-terminated ('\0') character arrays
- Example:
  - 'A' is the character A
  - "A" is the C-string A
  - "A" represents two characters, 'A' and '\0‘

# C-Strings **(Character Arrays) (cont'd.)**

- Consider the statement

```
char name[16];
```

- Since C-strings are null terminated and **name** has 16 components, the largest string that it can store has 15 characters
- If you store a string of length, say 10 in **name**
  - The first 11 components of **name** are used and the last five are left unused

# C-Strings (Character Arrays) (cont'd.)



- The statement

```
char name[16] = {‘J’,’o’,’h’,’n’,’\0’) ;
```

- Equivalent

```
char name[16] = “John” ;
```

declares an array **name** of length 16 and stores the C-string **"John"** in it

- The statement

```
char name[] = “John” ;
```

declares an array **name** of length 5 and stores the C-string `"John"` in it

# C-Strings (Character Arrays) (cont'd.)



- Most rules that apply to other arrays also apply to character arrays. Consider the following statement:

```
char studentName[26] ;
```

- Suppose you want to store "Lisa L.Johnson" in **studentName**
- Because aggregate operations, such as assignment and comparison, are not allowed on arrays, the following statement is not legal:

```
studentName = "Lisa L. Johnson"; //illegal
```

# C-Strings (Character Arrays) (cont'd.)

TABLE 9-1 **strcpy**, **strcmp**, and **strlen** Functions

| Function | Effect |
|---|---|
| **strcpy(s1, s2)** | Copies the string `s2` into the string variable `s1`<br>The length of `s1` should be at least as large as `s2` |
| **strcmp(s1, s2)** | Returns a value < `0` if `s1` is less than `s2`<br>Returns `0` if `s1` and `s2` are the same<br>Returns a value > `0` if `s1` is greater than `s2` |
| **strlen(s)** | Returns the length of the string `s`, excluding the null character |

To use these functions, the program must include the header file **cstring** via the **include** statement. That is, the following statement must be included in the program:

```
#include <cstring>
```

# String Comparison



- C-strings are compared character by character using the collating sequence of the system
- If we are using the ASCII character set
  - "Air" < "Boat"
  - "Air" < "An"
  - "Bill" < "Billy"
  - "Hello" < "hello"

# String Comparison (cont'd.)



**EXAMPLE 9-9**

Suppose you have the following statements:

```
char studentName[21];
char myname[16];
char yourname[16];
```

The following statements show how string functions work:

| Statement | Effect |
|---|---|
| `strcpy(myname, "John Robinson");` | `myname = "John Robinson"` |
| `strlen("John Robinson");` | Returns 13, the length of the string `"John Robinson"` |
| `int len;`<br>`len = strlen("Sunny Day");` | Stores 9 into `len` |
| `strcpy(yourname, "Lisa Miller");`<br>`strcpy(studentName, yourname);` | `yourname = "Lisa Miller"`<br>`studentName = "Lisa Miller"` |
| `strcmp("Bill", "Lisa");` | Returns a value < 0 |
| `strcpy(yourname, "Kathy Brown");`<br>`strcpy(myname, "Mark G. Clark");`<br>`strcmp(myname, yourname);` | `yourname = "Kathy Brown"`<br>`myname = "Mark G. Clark"`<br>Returns a value > 0 |

# Reading and Writing Strings



- Most rules that apply to arrays apply to C-strings as well
- Aggregate operations, such as assignment and comparison, are not allowed on arrays
- Even the input/output of arrays is done component-wise
- The one place where **C++ allows aggregate operations** on arrays is the **input and output of C-strings** (that is, character arrays)

# String Input



- **cin >> name;** stores the next input C-string into **name**
  - char name[31];
  - The length of the input C-string must be less than or equal to 30
  - stores the 30 characters that are input and the null character '**\0**'

# String Input



- Recall that the extraction operator, >>, skips all leading whitespace characters and stops reading data into the current variable
  - As soon as it finds the first whitespace character or invalid data
- As a result, C-strings that contain blanks cannot be read using the extraction operator, >>
- For example, if a first name and last name are separated by blanks, they cannot be read into name

# String Input



- To read strings with blanks, use get:

```
cin.get(str, m+1);
```

- This statement stores the next **m** characters, or all characters until the newline character **'\n'** is found, into str.
- Stores the next **m** characters into **str** but the newline character is not stored in **str**
- If the input string has fewer than **m** characters, the reading stops at the newline character

# Example



Now, suppose that we have the statements:

```
char str1[26];
char str2[26];
char discard;
```

and the two lines of input:

```
Summer is warm.
Winter will be cold.
```

Further, suppose that we want to store the first C-string in **str1** and the second C-string in **str2**. Both **str1** and **str2** can store C-strings that are up to **25** characters in length. Because the number of characters in the first line is **15**, the reading stops at **'\n'**. You must read and discard the newline character at the end of the first line to store the second line into **str2**. The following sequence of statements stores the first line into **str1** and the second line into **str2**:

```
cin.get(str1, 26);
cin.get(discard);
cin.get(str2, 26);
```

To read and store a line of input, including whitespace characters, you can also use the stream function **getline**. Suppose that you have the following declaration:

```
char textLine[100];
```

The following statement will read and store the next 99 characters, or until the newline character, into **textLine**. The null character will be automatically appended as the last character of **textLine**.



```
cin.getline(textLine, 100);
```

# String Output



- Aggregate operations are allowed on string output as well
- **`cout << name;`** outputs the content of name on the screen
  - **<<** continues to write the contents of name until it finds the null character
  - If **name** does not contain the null character, then we will see strange output
    - << continues to output data from memory adjacent to name until '\0' is found

# Questions