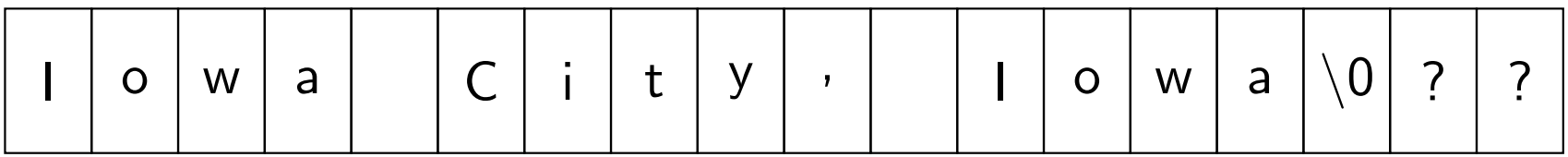
Strings

Class 35

C-Strings

- recall that a C string is an array of char with an embedded null character



C-String Library Functions

- there are several useful functions in the cstring library
  - strlen: the number of characters before the \0
  - strncat: concatenate two strings together
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- NEVER use strcpy or strcat as described on pages 569–570!
- they are crazy unsafe
- they do no bounds checking and will happily exceed the limits of the array, clobbering any memory in their way
- they have been the source of famous viruses, worms, and malicious code of all sorts

strcmp

- a very useful function
- `int result = strcmp(string1, string2);` returns
  - zero if the two strings are identical up to the null character
  - a negative if string1 is alphabetically before string2
  - a positive is string1 is alphabetically after string2

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- confusing: when the strings are identical, strcmp returns zero, which normally indicates false

```
if (strcmp("foo", "foo"))
{
  cout << "they do NOT match!" << endl;
}
else
{
  cout << "they DO match!" << endl;
}
```

strcmp

- because of this, the code is normally written like this instead:

```
if (strcmp("foo", "foo") == 0)
{
  cout << "they DO match!" << endl;
}
else
{
  cout << "they do NOT match!" << endl;
}
```

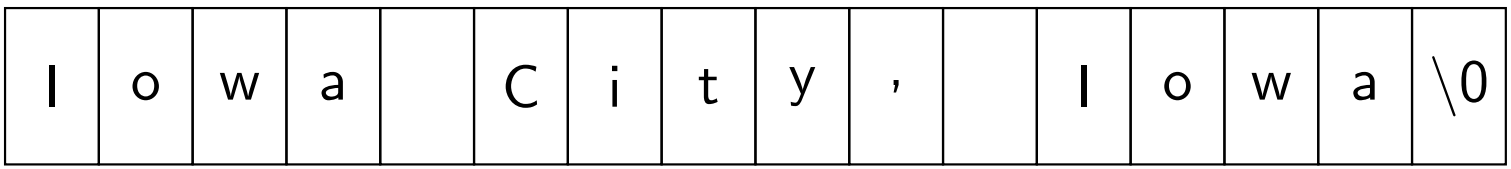
strstr

- strstr: find the location of a substring within a string
- return a pointer to the first character of the substring that matches
- return nullptr if the substring is not found

strstr

- let's say you have a string with a city name followed by a comma and space followed by a state name and are trying to find the state name

```
char* index = strstr(city_state, ", ");
```



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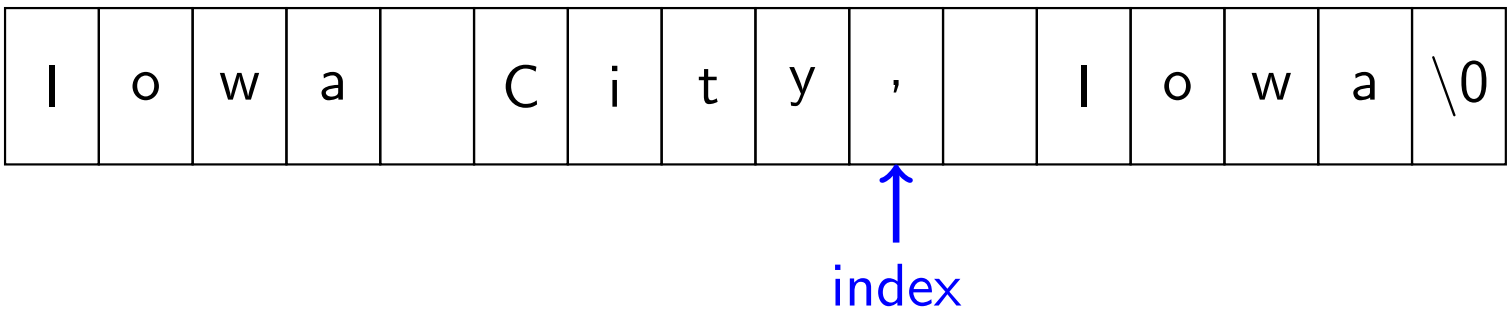
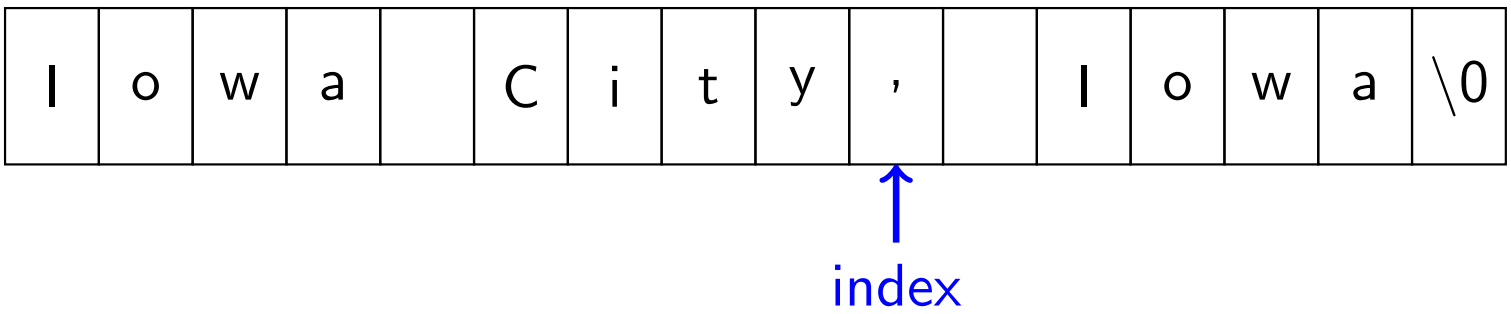


strstr

- let's say you have a string with a city name followed by a comma and space followed by a state name and are trying to find the state name

```
char* index = strstr(city_state, ", ");
cout << (index + 2) << endl;
```



- the output is Iowa

Program 10-6

- this program (page 572) has several features that make it worth looking at
- before we start, note that it has several unacceptable style issues:
  - if statements without braces
  - a break in a for loop
  - int instead of size_t for an index
  - mixed endl and \n

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- before we start, note that it has several unacceptable style issues:
  - if statements without braces
  - a break in a for loop
  - int instead of size_t for an index
  - mixed endl and \n
- on line 13, it has a two-dimensional array, an array of arrays of chars
- i.e., an array of strings

- let's do two exercises with this code
- first, draw a picture of how the variable products is actually organized in memory

Program 10-6

- conceptually, there are five rows of twenty-seven characters each
- but physically in memory there are simply 135 contiguous memory locations


T V 3 2 7 3 1 - i n c h T e l e v i
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
s i o n \0 ? ? C D 2 5 7 C D P l a y
1
20 21 22 23 24 25 26 0 1 2 3 4 5 6 7 8 9 10 11 12
e r \0 ? ? ? ? ? ? ? ? ? ? ? T A 6 7 7
2
13 14 15 16 17 18 19 20 21 22 23 24 25 26 0 1 2 3 4 5
A n s w e r i n g M a c h i n e \0 ? ?
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Program 10-6

- next, convert the for-loop-with-break into a proper while loop

```
for (size_t index = 0; index < NUM_PRODS; index++)
{
  char* str_ptr = strstr(products[index], look_up);
  if (str_ptr != nullptr)
    break;
}
```

Program 10-6

- better code:

```
size_t index = 0;
bool found = false;
char* found_location = nullptr;

while (!found && index < NUM_PRODS)
{
  found_location = strstr(products[index], look_up);
  if (found_location != nullptr)
  {
    found = true;
  }
  else
  {
    index++;
  }
}
```

Converting From C-strings to Numbers

- the cstdlib library contains functions to allow you to convert a C-string to a numeric value
- `int number = atoi("1234");`
  atoi stands for "ASCII to integer"
- `double pi = atof("3.14159");`

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- there is not a standard function to go the other direction
- some compilers have non-standard functions for this, and there are ways to do it, but not a simple built-in function

Arguments to main

- all of this semester's programs are console applications that are text based, not graphical
- they are designed to be run from a terminal
- we are using the Code::Blocks IDE to make life easier, but that is just for development
- for deploying and using the programs, you would use a terminal, not Code::Blocks
- you can run a console program manually in a terminal on Mac, Linux, or Windows
- or click the little green Run arrow in Code::Blocks to get a terminal window where your program runs

Initial Arguments

- a number of our programs have required user input to run
- recall the rectangle area program, for example:

```
$ ./rectangle_area
This program displays the area of rectangles
The widths are between 1 and 75 and the lengths, 1 and 500

How many rectangles to you want? 4
The area of a 40 by 276 rectangle is 11040
The area of a 45 by 400 rectangle is 18000
The area of a 68 by 376 rectangle is 25568
The area of a 28 by 338 rectangle is 9464
```

Initial Arguments

- it is possible in a terminal application to supply this number on the command line without having to prompt for it

```
$ ./rectangle_area_cl 4
This program will show the area of 4 random rectangles

The area of a 57 by 20 rectangle is 1140
The area of a 21 by 348 rectangle is 7308
The area of a 72 by 29 rectangle is 2088
The area of a 2 by 405 rectangle is 810
```

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- when the operating system calls main, it passes the command line arguments to main as actual parameters

main Parameters

- so far, our main function has had no parameters
- but two formal parameters are in fact defined for it
  1. argc: an integer that is the count of arguments
  2. argv: an array of strings, i.e., an array of arrays of characters, which are the arguments themselves as strings
     argv stands for "vector of arguments"

```
int main(int argc, char* argv[])
{ ...
```

main Parameters

```
int main(int argc, char* argv[])
{ ...
```

- argc can be used to determine how many command line arguments were passed to main
- there is always one argument, which is the name of the program itself
- the other arguments (if any) can be addressed with the functions we have discussed above
- the entire array of strings is very similar to the array of strings in Program 10-6

main Parameters

a simple program to echo command line arguments to screen

```
int main(int argc, char* argv[])
{
  for (int index = 0; index < argc; index++)
  {
    cout << index << ": " << argv[index] << endl;
  }
  return 0;
}
```

Doing It Yourself

- if you know how to run programs from the command line in a terminal, you can do this yourself
- if you only know how to run programs from Code::Blocks, you need to tell Code::Blocks what command line arguments you want to use
- to set command line arguments in Code::Blocks, do

  Project $\rightarrow$ Set programs' arguments...

  and then enter the program arguments in the box labeled Program arguments: on the lower half of the box
- enter the arguments in one line, space separated, just as though the program were being run at the terminal

C++ String Functions

- the `string` library has many functions for dealing with C++ strings
- first is a family of functions to convert strings to numbers
- examples are stoi, stol, stoul, stof, stod for converting a string into an int, a long, an unsigned long, and a double, respectively
- there are a number of others
- strangely, there is no stoui, to convert directly from a string to an unsigned integer, so you have to typecast for that

From Number to String

- the to_string function can convert *any* of the numeric types to its string representation, e.g.,

```
string s = to_string(12.34); // returns "12.34"
```

C++ String Operators

- you can concatenate strings with +

```
string message = "Hello ";
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  name1 == name2

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  message += "world!";
  ```

- you can compare strings with the relops (we've seen this before)
  name1 == name2
  name1 <= name2

- to access a single character from a string, DO NOT use square brackets; use .at()
  ```
  char initial = name.at(0);
  ```

String Methods

- string is a class, so the functions that belong to a string object are called *methods*
- there are many useful string methods

- .length() tells you how many characters are in the string
- .substr() extracts a substring

- the table on page 598 lists two dozen more

npos

- there is a predefined constant `string::npos` which is the largest possible `size_t` value
- npos stands for “no position”
- it is used by methods such as find that return a position, if what is being searched for is not found