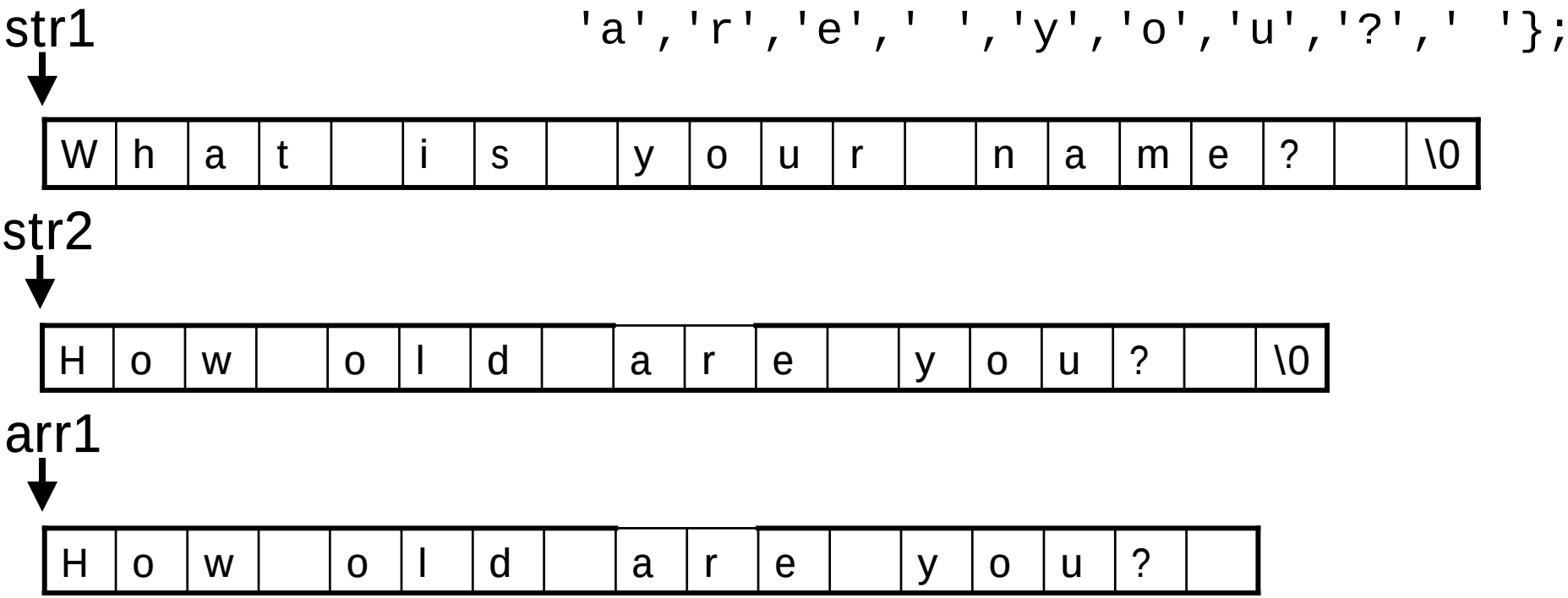
Strings and Stream I/O

C Strings

- In addition to the string class, C++ also supports old-style C strings
- In C, strings are stored as null-terminated character arrays

```
char * str1 = "What is your name? ";
char str2[] = "How old are you? ";
char arr1[] = {'H','o','w',' ','o','l','d',' ',
               'a','r','e',' ','y','o','u','?',' '};
```



C Library String Functions

```
#include <string.h>
#include <stdlib.h>

void F() {
  char message[100];

  // copy string into message
  strcpy(message, "The following error has occurred:");

  // concatenate string to message
  strcat(message, "Out of memory");

  // compute length of the string
  int msgLen = strlen(message);

  // convert a string to an integer
  int num = atoi("-272");
}
```

C String Examples

```
int strlen(const char *str) {
   int len = 0;
   const char * p = str;
   while (*p != '\0') {
      ++len;
      ++p;
   }
   return len;
}

void strcpy(char * dest, const char * src) {
   char * d = dest;
   const char * s = src;
   while (*s != '\0') {
      *d++ = *s++;
   }
   *d = '\0';
}

void strcat(char * str1, const char * str2) {
  strcpy(str1 + strlen(str1), str2);
}
```

Dynamic String Allocation

```
#include <string.h>
#include <iostream>
using namespace std;

void F() {
  const char * A = "Hello";
  const char * B = ", ";
  const char * C = "how are you today?"
  char * message;

  int msgLen = strlen(A) + strlen(B) + strlen(C);
  message = new char[msgLen + 1];

  strcpy(message, A);
  strcat(message, B);
  strcat(message, C);

  cout << message << endl;
  delete [] message;
}
```

Using C Strings with C++ Strings

- Sometimes you need to convert a C string to a C++ string, and vice versa
- C string to C++ string
  - Initialize a C++ string with a C string

```
string name("fred");
```

  - Assign a C string to a C++ string

```
name = "fred";
```

- C++ string to C string
  - All C runtime library functions require C strings
  - The string class has a method named c_str that returns a pointer to a C string

```
int x = atoi(numStr.c_str());
```

C Library Character Classification Functions

- #include <ctype.h>
- isalpha
- isdigit
- isalnum
- isspace
- islower
- isupper
- isprint
- iscntrl
- many others

Command-Line Arguments

- Command-line arguments are passed as parameters to the main function

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

- You can omit these parameters if you don't need to process command-line arguments
- The first parameter, argc, is a count of how many command-line arguments there are
- The second parameter, argv, is an array of C strings that are the values of the command-line arguments
  - argv[0] contains the name of the program executable
  - argv[1] .. argv[argc-1] contain the actual command-line arguments

Command-Line Arguments

printargs.cpp

```
#include <iostream>
using namespace std;

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

```
$ ./printargs Computer Science 240
./printargs
Computer
Science
240
$
```

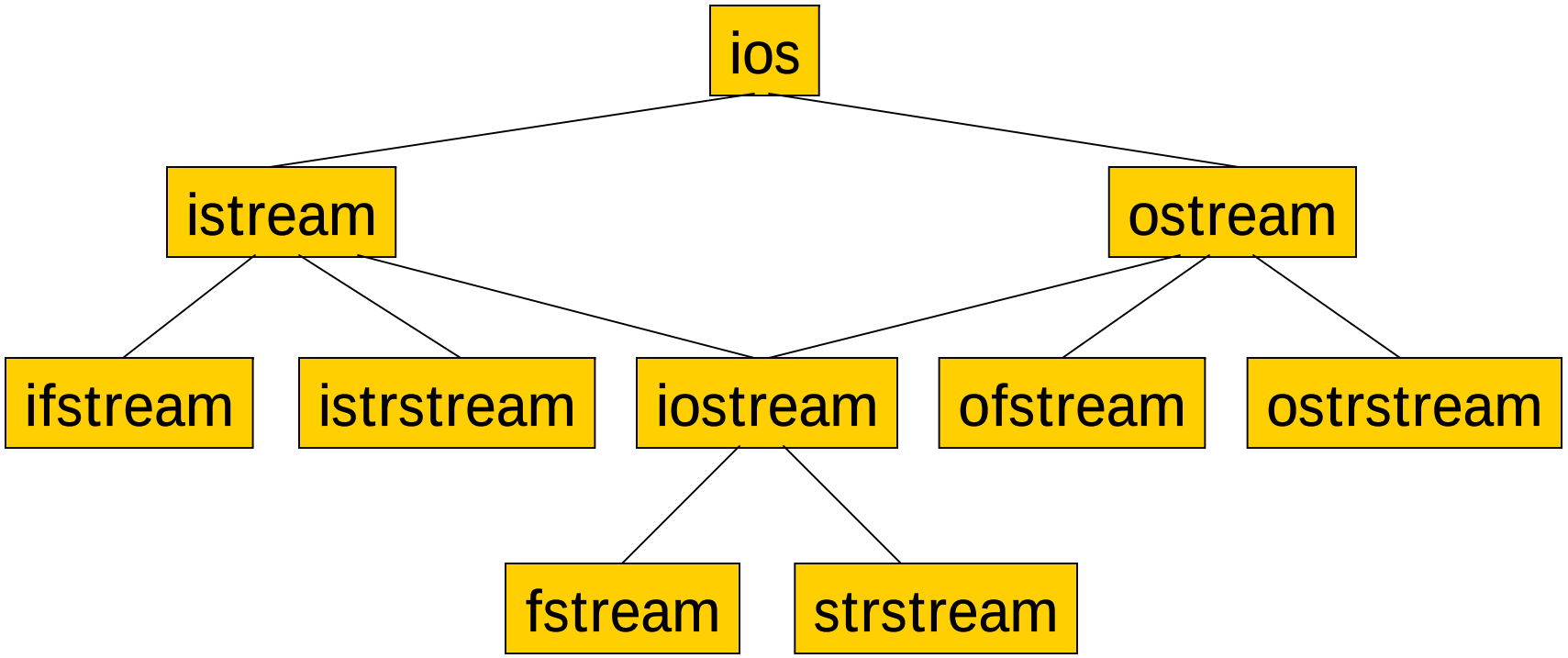
Stream I/O

- A stream is an ordered sequence of bytes
- Streams are a useful abstraction for doing I/O
- Input comes from the keyboard, files, network connections, and memory
- Output goes to the screen, files, network connections, and memory
- All of these I/O sources and destinations can be viewed as byte streams

C++ Stream I/O Library

- C++ has an extensive set of classes for doing stream-based I/O
- In class we will learn enough about stream I/O to do the programming projects
- The textbook provides much more information than will be covered in class
  - If you want to put C++ on your resume, Read The Book!

Stream Class Hierarchy



Formatted and Unformatted I/O

- The C++ stream classes support both formatted and unformatted I/O
- Formatted I/O
  - Overloaded stream insertion << and extraction >> operators
- Unformatted I/O
  - Read/write one character at a time
  - Read/write one line at a time

Reading Lines From a Text File

```
#include <string>
#include <fstream>
#include <iostream>
using namespace std;

bool ReadLine(istream & stream, string & line) {…}

int main(int argc, char * argv[]) {
  if (argc == 2) {
    ifstream file(argv[1]);
    if (file) {
      string line;
      while (ReadLine(file, line)) {
         cout << line << endl;
      }
      file.close();
      return 0;
    }
    else {
      cout << "Could not open file " << argv[1] << endl;
    }
  }
  else {
    cout << "Invalid arguments" << endl;
  }
  return -1;
}
```

ReadLine (version 1)

```
bool ReadLine(istream & stream, string & line) {
  const int BUF_SIZE = 1000;
  char buf[BUF_SIZE];
  stream.getline(buf, BUF_SIZE);
  if (stream) {
    line = buf;
    return true;
  }
  else {
    return false;
  }
}
```

ReadLine (version 2)

```
bool ReadLine(istream & is, string & line) {
  if (!is) {
    return false;
  }

  line = "";
  while (true) {
    char c;
    is.get(c);
    if (is) {
      if (c == '\n') {
        return true;
      }
      else {
        line += c;
      }
    }
    else {
      return true;
    }
  }
}
```

Writing to a Text File

```
#include <string>
#include <fstream>
#include <iostream>
using namespace std;

void WriteHTMLPage(ostream & stream) {…}

int main(int argc, char * argv[]) {
  if (argc == 2) {
    ofstream file(argv[1]);
    if (file) {
      WriteHTMLPage(file);
      file.close();
      return 0;
    }
    else {
      cout << "Could not open file " << argv[1] << endl;
    }
  }
  else {
    cout << "Invalid arguments" << endl;
  }
  return -1;
}
```

WriteHTMLPage

```
void WriteHTMLPage(ostream & stream) {
   stream << "<HTML>" << endl;
   stream << "   <HEAD>" << endl;
   stream << "      <TITLE>CS 240</TITLE>" << endl;
   stream << "   </HEAD>" << endl;
   stream << "   <BODY>" << endl;
   stream << "      <H1>Welcome to CS 240!</H1>" << endl;
   stream << "   </BODY>" << endl;
   stream << "</HTML>" << endl;
}
```

Writing to a String

```
#include <string>
#include <strstream>
#include <iostream>
using namespace std;

void WriteHTMLPage(ostream & stream) {
   stream << "<HTML>" << endl;
   stream << "   <HEAD>" << endl;
   stream << "      <TITLE>CS 240</TITLE>" << endl;
   stream << "   </HEAD>" << endl;
   stream << "   <BODY>" << endl;
   stream << "      <H1>Welcome to CS 240!</H1>" << endl;
   stream << "   </BODY>" << endl;
   stream << "</HTML>" << endl;
}

int main() {
  ostrstream stream;
  WriteHTMLPage(stream);
  stream << ends;   // writes '\0' to the stream
  cout << stream.str();
  return 0;
}
```

Reading Words From a String

```
#include <string>
#include <strstream>
#include <iostream>
using namespace std;

int main(int argc, char * argv[]) {
  if (argc == 2) {
    istrstream stream(argv[1]);
    int count = 0;
    while (true) {
      string word;
      stream >> word;
      if (stream) {
        ++count;
      }
      else {
        break;
      }
    }
    cout << count << " words" << endl;
    return 0;
  }
  else {
    cout << "Invalid arguments" << endl;
  }
  return -1;
}
```