FILES, MAKEFILES

Problem Solving with Computers-I

I/O in programs

Different ways of reading data into programs

- cin
- Command line arguments (int main(int argc, char* argv[])
- Read from file

Ways to report results

- Std output: cout
- Std error: cerr
- Write to file

Where are files stored?

A. In main memory
B. In secondary memory
C. On the processor
D. In C++ programs
E. None of the above

Reading from files

- Open a file
- If open fails, exit
- In a loop
  - Read a line and process it
  - If you reach the end of file, break
- Close the file

Reading from files

```
#include <fstream>
ifstream ifs;  // Create a ifstream object
ifs.open("numbers.txt"); //Open a file to read
if(!ifs){ // open failed}
getline(ifs, line); // read a line from the file into a
                    // string line.
                    // If you attempt to read past the end
                    // of file, ifs change to fals

if(!ifs){ // read past the end of file} //Only check this
after a read from the file
ifs.close()
```

Writing to files

```
#include <fstream>
ofstream ofs;  // Create a ifstream object
ofs.open("animals.txt"); //Open a file to write to
ofs<<"Duck\n"<<"Cat\n"<<"Cow\n";
```

FILE IO: Which of the following is correct?

A.

```
while(1){
        getline(ifs, line);
        if (!ifs)
            break;
        cout<<line<<endl;
}
```

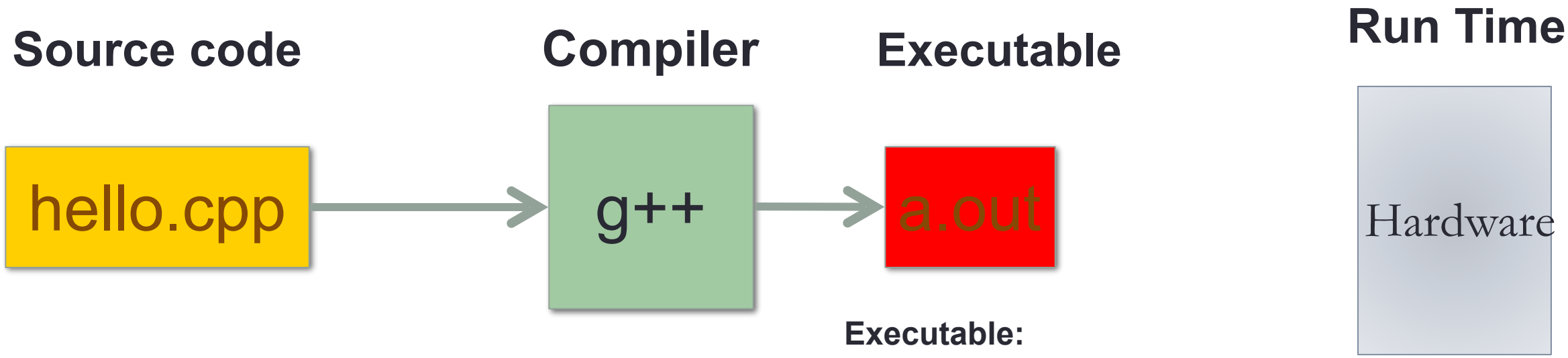
B.

```
while(ifs){
        getline(ifs, line);
        cout<<line<<endl;
}
```

C. Both A and B are correct

D. Neither is correct

The compilation process



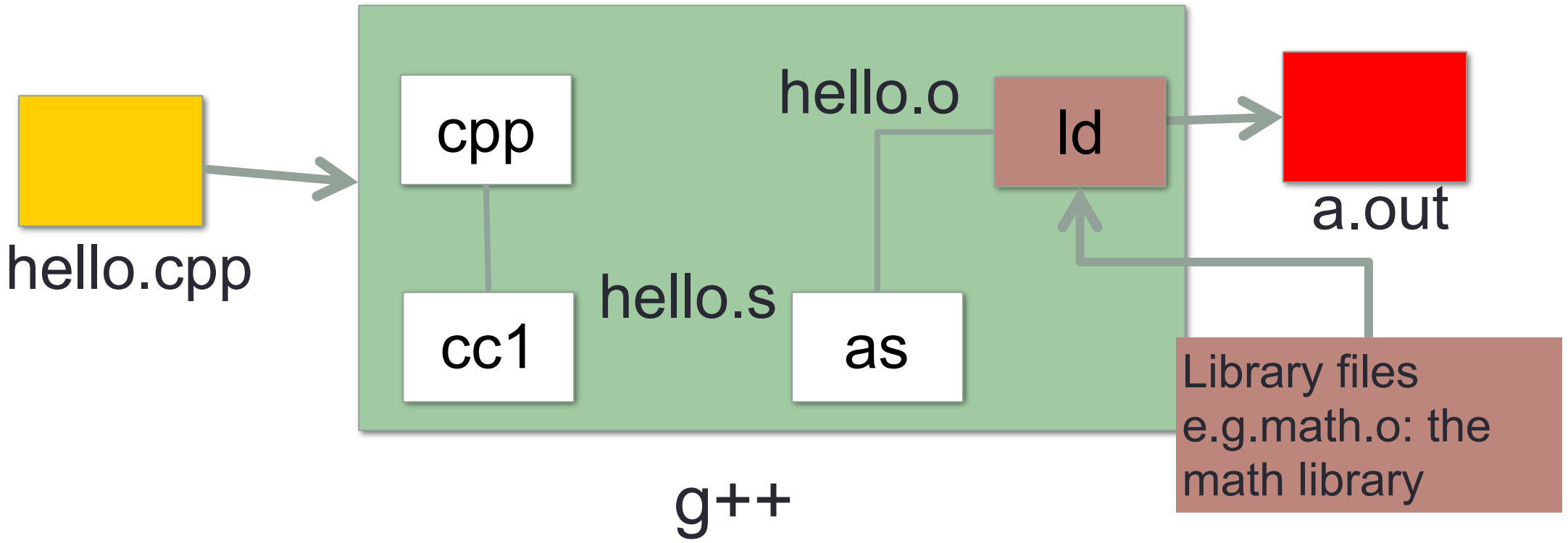
Executable:
Program in machine code
+Data in binary

Source code:
Text file stored on computers hard disk or some secondary storage

```
10001100011000100000000000000000
10001100111100100000000000000100
10101100111100100000000000000000
10101100011000100000000000000100
```

g++ is composed of a number of smaller programs

- Code written by others (libraries) can be included
- ld (linkage editor) merges one or more object files with the relevant libraries to produce a single executable



Steps in gcc

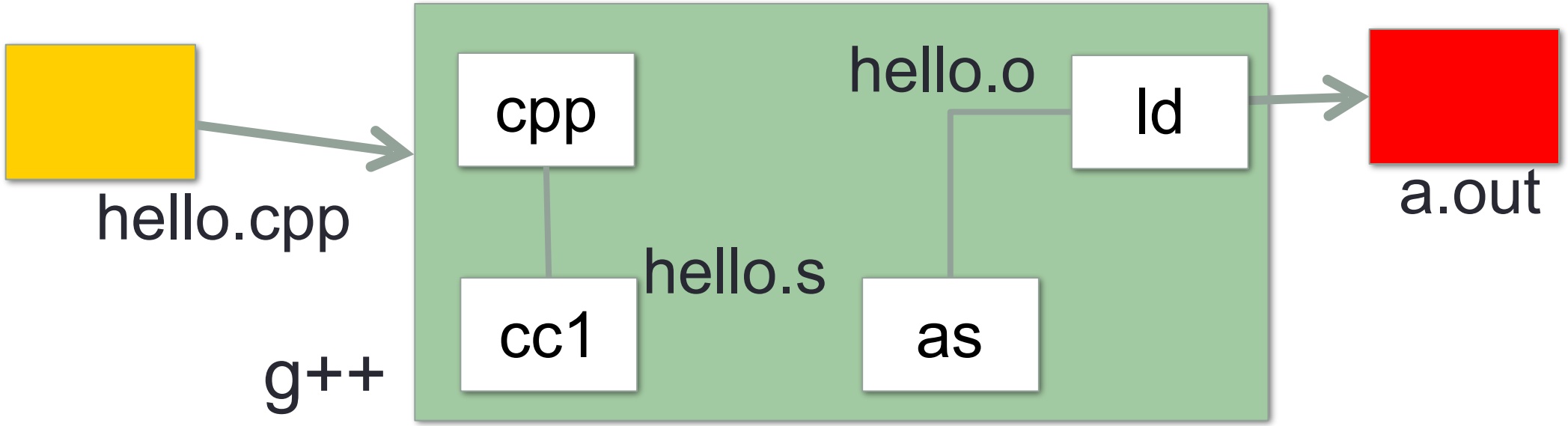
- Ask compiler to show temporary files:

$ g++ –S hello.cpp

$ g++ –c hello.o

$ g++ –o hello hello.cpp

$ g++ functions.o main.o –o myhello



Make and makefiles

- The unix make program automates the compilation process as specified in a Makefile
- Specifies how the different pieces of a program in different files fit together to make a complete program
- In the makefile you provide a recipe for compilation
- When you run make it will use that recipe to compile the program

```
$ make
g++ testShapes.o shapes.o tdd.o -o testShapes
```

Specifying a recipe in the makefile

- **Comments** start with a #
- **Definitions** typically are a variable in all caps followed by an equals sign and a string, such as:

```
CXX=g++
CXXFLAGS=-Wall

BINARIES=proj1
```

```
# testShapes is the target - it is what we want to produce
# To produce the executable testShapes we need all the .o files
# Everything to the right of ":" is a dependency for testShapes

testShapes: testShapes.o shapes.o tdd.o
	#The recipe for producing the target (testshapes) is below
	g++ testShapes.o shapes.o tdd.o -o testShapes
```

Demo

- Basics of code compilation in C++ (review)
- Makefiles (used to automate compilation of medium to large projects) consisting of many files
- We will start by using a makefile to compile just a single program
- Extend to the case where your program is split between multiple files
- Understand what each of the following are and how they are used in program compilation
  - Header file (.h)
  - Source file (.cpp)
  - Object file (.o)
  - Executable
  - Makefile
  - Compile-time errors
  - Link-time errors

The runtime Stack

Stack: A region in program memory to “manage” local variables

Every time a function is called, its local variables are created on the stack

When the function returns, local variables are removed from the stack

Local variables are created and deleted on the stack using a Last in First Out principle

```
int sum(int a, int b){
        cout<< a+b;
}
int main(){
        int result =0;
        int x =10, y =20;
        result = sum(x, y);
        cout<<result;
}
```

Print vs return

What is the output of the following code

```
int sum(int a, int b){
        return a+b;
}
int main(){
        int result =0;
        int x =10, y =20;
        result = sum(x, y);
        cout<<result;
}
```

Function call mechanics

What is the output of the following code

```
int sum(int a, int b){
        int result= a+b;
        exit(0);
}

int main(){
        int result =0;
        int x =10, y =20;
        result = sum(x, y);
        cout<<result;
}
```

Next time

- Number and data representation