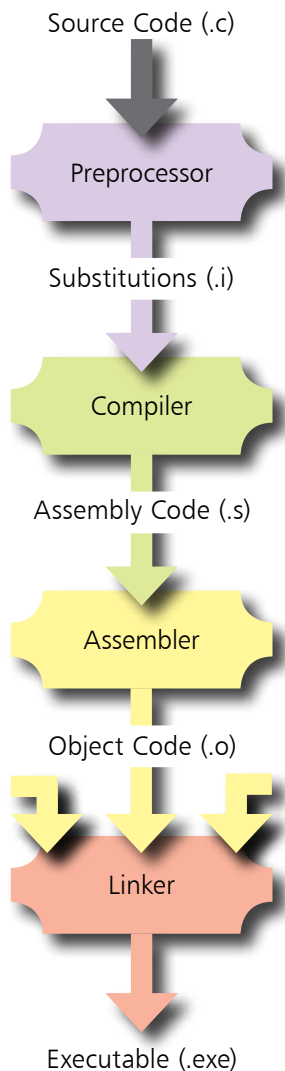# Understanding compilation

In producing an executable file from an original C source code file, the compilation process actually undergoes four separate stages, which each generate a new file:

Source Code (.c)

Preprocessor

Substitutions (.i)

Compiler

Assembly Code (.s)

Assembler

Object Code (.o)

Linker

Executable (.exe)

- Preprocessing – The preprocessor substitutes all preprocessor directives in the original source code **.c** file with actual library code that implements those directives. For instance, library code is substituted for **#include** directives. The generated file containing the substitutions is in text format and typically has a **.i** file extension.

- Translating – The compiler translates the high-level instructions in the **.i** file into low-level Assembly language instructions. The generated file containing the translation is in text format and typically has a **.s** file extension.

- Assembling – The assembler converts the Assembly language text instructions in the **.s** file into machine code. The generated object file containing the conversion is in binary format and typically has a **.o** file extension.

- Linking – The linker combines one or more binary object **.o** files into a single executable file. The generated file is in binary format and typically has a **.exe** file extension.

Strictly speaking, "compilation" describes the first three stages above, which operate on a single source code text file and ultimately generate a single binary object file. Where the program source code contains syntax errors, such as a missing semi-colon statement terminator or a missing parenthesis, they will be reported by the compiler and compilation will fail.

The linker, on the other hand, can operate on multiple object files and ultimately generates a single executable file. This allows the creation of large programs from modular object files that may each contain reusable functions. Where the linker finds a function of the same name defined in multiple object files it will report an error and the executable file will not be created.

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Normally, the temporary files created during the intermediary stages of the compilation process are automatically deleted, but they can be retained for inspection by including a **-save-temps** option in the compiler command:

1 At a command prompt in the **MyPrograms** directory, type **gcc hello.c -save-temps -o hello.exe** then hit Return to recompile the program and save the temporary files
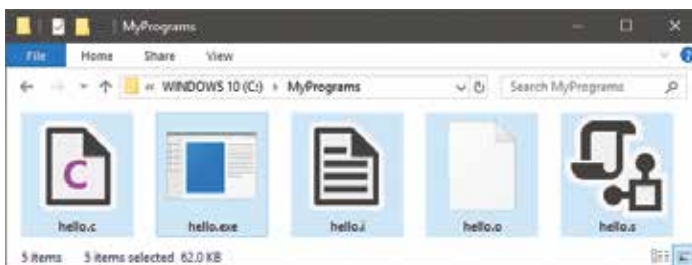
2 Open the **hello.i** file in a plain text editor such as Windows' Notepad, to see your source code at the very end of the file preceded by substituted **stdio.h** library code

3 Now, open the **hello.s** file in a plain text editor to see the translation into low-level Assembly code and note how unfriendly that appears in contrast to the C code version

Programs tediously written in Assembly language can run faster than those written in C but are more difficult to develop and maintain. For traditional computer programming, C is almost always the first choice.