Chapter 1. An Overview of C

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Algorithmic Thinking

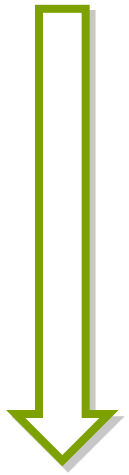
- Computer is very diligent, but not so smart

- Computer must be told in detail what to do
  - With understandable codes to computer for all possible cases.
- Algorithmic Thinking
  - Algorithms = Recipes

Programming Languages

- **Algorithms**: Developed by people

Programming Languages



High-level languages

Assembly languages

Machine languages

- **Computers**: Execute algorithms

How to Learn Programming

- Learn by doing
  - Do exercises/practices.
  - Lectures will give you basic tools only.
- In the lectures, you will learn:
  - Language syntax
  - Algorithmic thinking
  - Ideas
- Read “An Overview of C” & Try by yourself

Warning!!

- Lectures
  - seem easy
- Textbook: An Overview of C
  - seems that you understand well
- Programming assignments
  - more difficult than it seems
- Expect many bugs in your programs
  - **Programming maturity comes with p.r.a.c.t.i.c.e!!**

C Programming Language

- Born in the early 1970s with UNIX
- C is
  - Small
    - Fewer keywords
  - Portable
    - Code written on one machine easily moved to another
  - Terse
    - A very powerful set of operators
    - Able to access the machine in the bit level
  - Widely used
    - The basis for C++ and Java

C Programming Language

- Criticism
  - Complicated syntax
  - No automatic array bounds checking
- Nevertheless, C is elegant language
  - No straitjacket on the programmer’s access to the machine
  - Powerful operators

Hello World 1/3

- Create a C source file
  - http://www.tutorialspoint.com/compile_c_online.php

Compile | Execute main.c

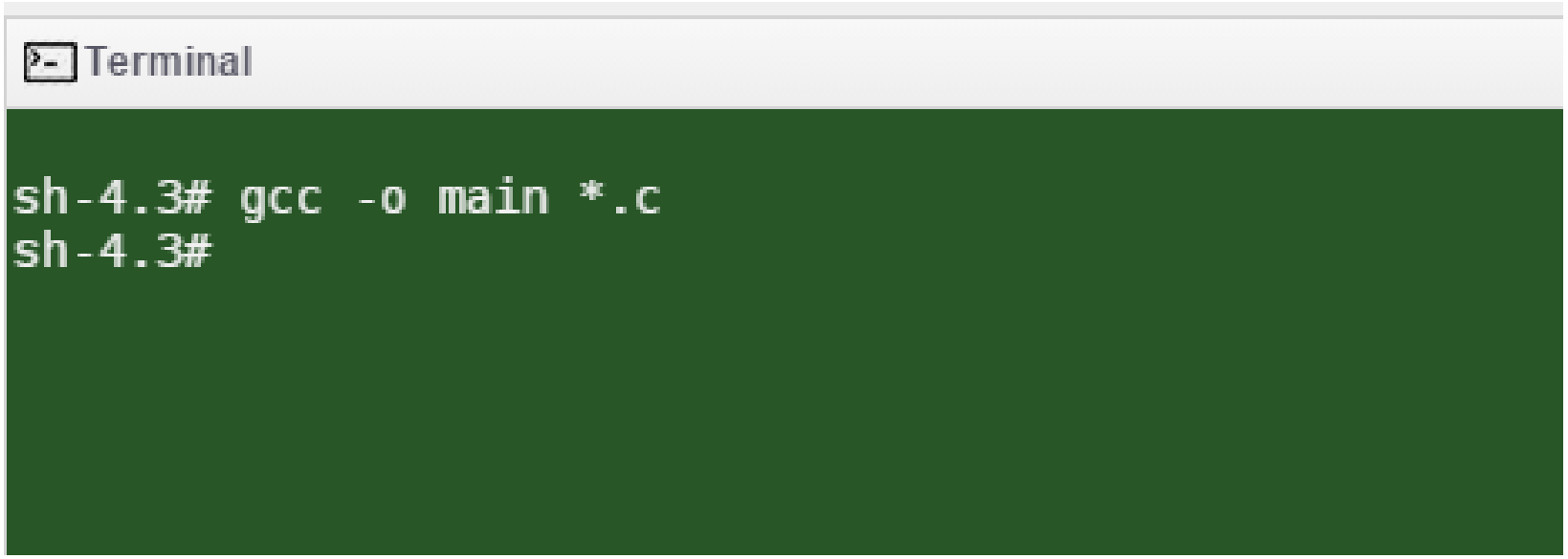
```c
#include <stdio.h>

int main()
{
    printf("Hello, World!\n");

    return 0;
}
```

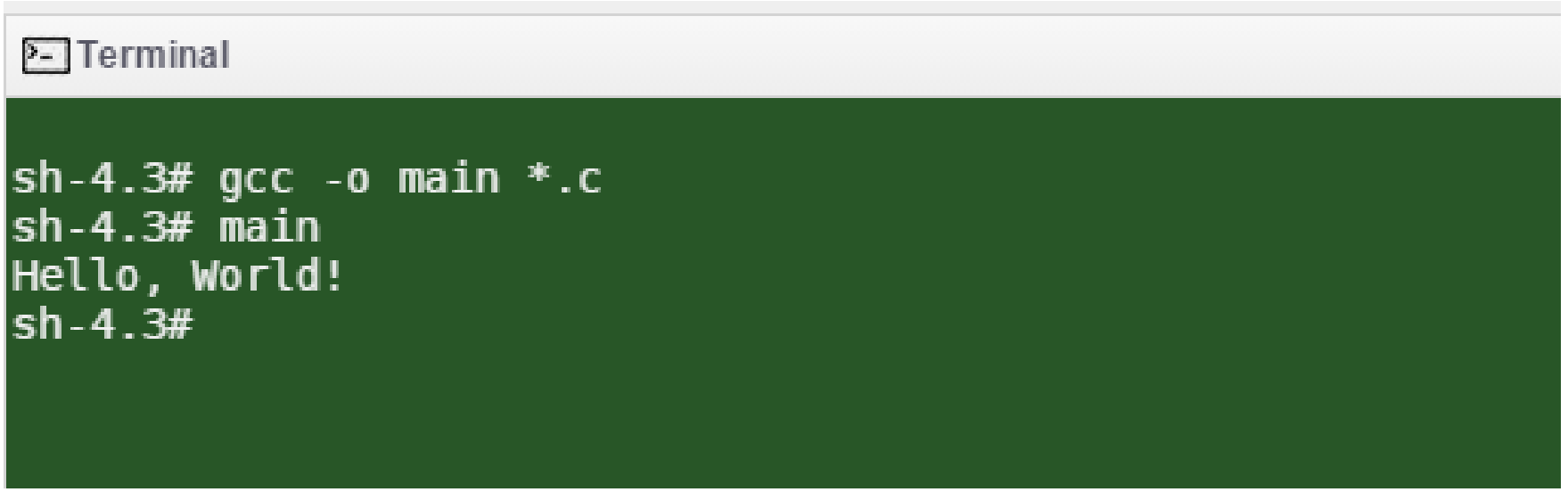
Hello World 2/3

- Compilation & Linking
  - Compile the source.
  - Following command makes executable file(main) directly from the source files.
  - It also do linking process after the compilation.



Hello World 3/3

- Execution
  - Execute the program.



Compilation & Linking

- **Compile**
  - Convert source files to object files.
  - Object file
    - It contains machine codes.
    - These object files are not executable yet, since they need to be combined and include other external codes(library).
- **Linking**
  - Combine **object files** and other **external codes**(library) to a single executable file.

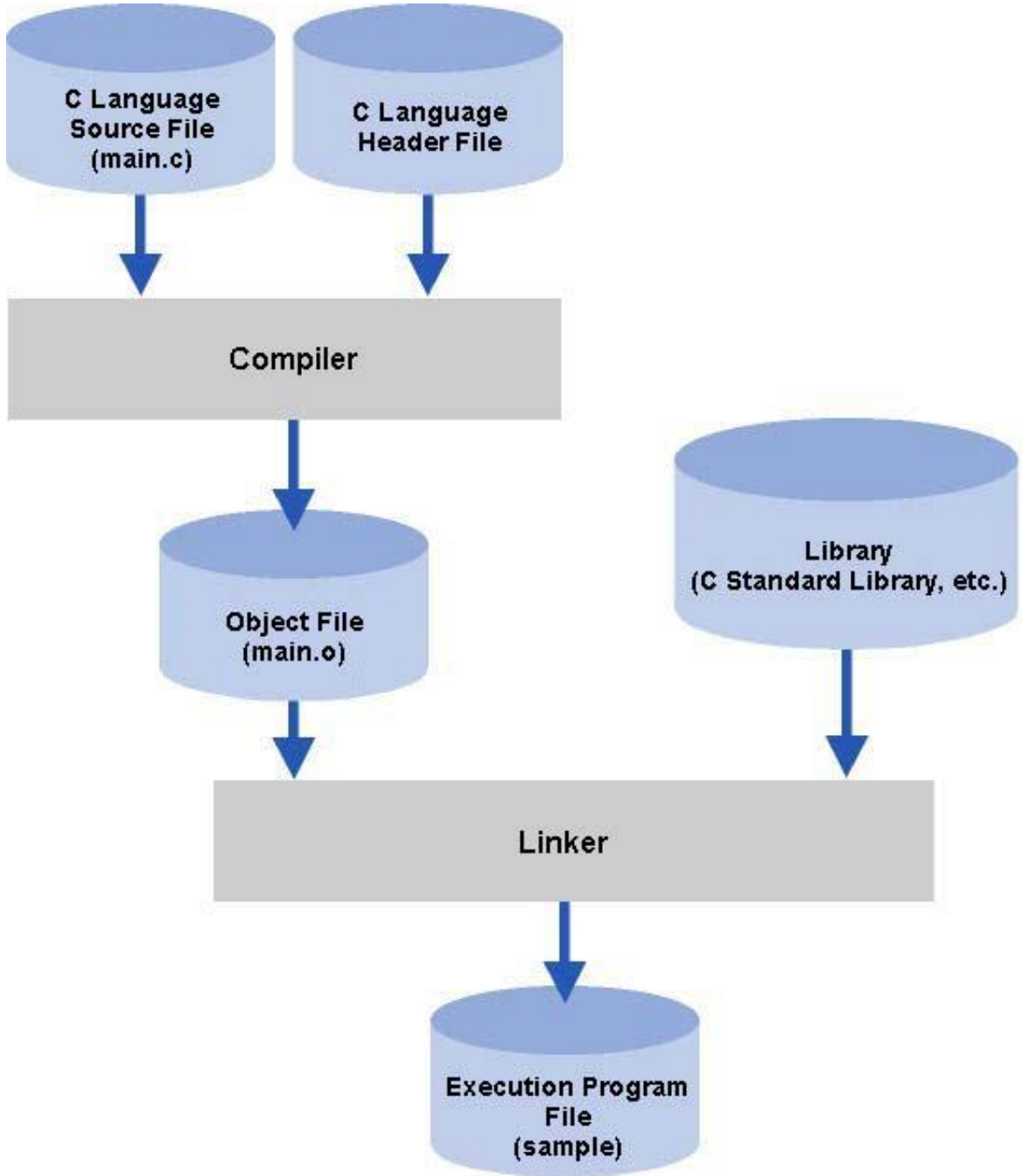


Figure 1. The build process

Program Output

```
#include <stdio.h>


int main(void)
{
   printf("from sea to shining C\n");
   return 0;
}
```

Source file:
sea.c

from sea to shining C

Program Output

#include <stdio.h>

- Preprocessor
  - It is built in the C compiler.
  - It manipulates source codes before the compilation.
  - They are also called as macro.
- #include <[header file name]>
  - It includes a copy of the header file into the source code.
  - For example, '**#include <stdio.h>**' includes **stdio.h** file.
  - **stdio.h** is a standard library containing declaration of input/output functions.

Program Output

int main(void)

{ … }

- Function definition for main ()
- int, void
  - keywords, or reserved words
  - Special meanings to the compiler
- Every C program has a function named **main()**
- **void,** no argument / return an **int** value
- **{** … **}**, the body of a function definition

Program Output

printf()

- A function that prints on the screen
- It's definition is in the header file ***stdio.h***

"from sea to shinning C\n"

- "… " : string constant in C
- **\n** : a single character called *newline*

printf("from sea to shinning C\n");

- Prints from sea to shinning C

Program Output

return 0;

- A return statement of the main()
- Causes the value *zero* to be returned to the operating system
- A value returned by the main() indicates how the program is finished.
- Normally *zero* means that the program is finished well.

Program Output

```
#include <stdio.h>


int main(void)
{
    printf("from sea to ");
    printf("shining C");
    printf("\n");
    return 0;
}
```

from sea to shining C

```
#include <stdio.h>


int main(void)
{
    printf("from sea\n");
    printf("to shining\nC\n");
    return 0;
}
```

from sea
to shining
C

Errors in Source Codes

```
#include <stdio.h>


int main(void)
{
    printf("from sea to shining C\n");
    return 0;
}
```

Errors in Source Codes

- Compilation failed
  - ‘**return 0;**’ is incorrect C language grammar.

Terminal

```
sh-4.3# gcc -o main *.c
main.c: In function 'main':
main.c:6:5: error: 'return' undeclared (first use in this function)
     return 0;
     ^
main.c:6:5: note: each undeclared identifier is reported only once for each function it appears in
main.c:6:12: error: expected ';' before numeric constant
     return 0;
            ^
sh-4.3#
```

Variable, Expression, Assignment

```
/*the distance of a marathon in kilometers*/
#include <stdio.h>
int main(void)
{
    int             miles, yards;
    float           kilometers;

    miles = 26;
    yards = 385;
    kilometers = 1.609 * (miles + yards / 1760.0);
    printf("\nA marathon is %f kilometers.\n\n",
        kilometers);
    return 0;
}
```

Variable, Expression, Assignment

/*the distance of a marathon in kilometers*/

- **/* … */**
  - comment (used for documentation or memo)
  - ignored by the compiler

Variable, Expression, Assignment

int miles, yards;

- declaration of the variables **miles** and **yards** of type integer (**int**)
- Declarations and statements end with a semicolon.

float kilometers;

- float
  - real value type
  - shortened version of ‘floating point number’
- declaration of a variable **kilometers** of type **float**

Variable, Expression, Assignment

miles = 26;

- assignment statement
- **26** is assigned to a variable **miles**

kilometers = 1.609 * (miles + yards / 1760.0);

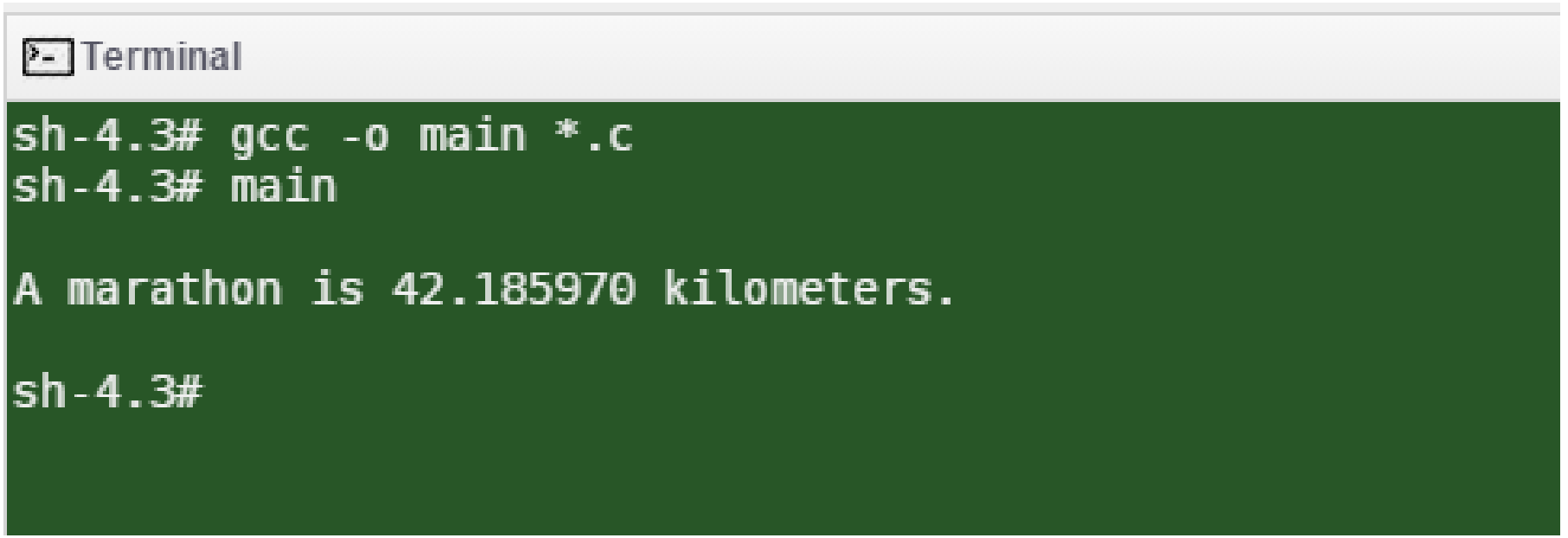
- The value of the expression on the right side of the equal sign is assigned to a variable **kilometers**

Variable, Expression, Assignment

printf(“\nA marathon is %f kilometers.\n\n”, kilometers);

- **%f**
  - format, conversion specification
  - matched with the remaining argument, the variable **kilometers**

Variable, Expression, Assignment



Flow of Control

```
#include <stdio.h>
int main(void)
{
    int   a, b;
    ……
    a = 1;
    if ( b == 3 )
       a = 5;
    printf("%d", a);
    return 0;
}
```

Alternative actions

Flow of Control

if (expr)

statement

- If **expr** is nonzero(true), then **statement** is executed.

if (b==3)

a = 5;

- **==** : *equal* operator
  - **a==b** is one if ***a*** and ***b*** are same, otherwise zero.
  - for example, **3==3** is one, and **2==3** is zero
  - **a = 5**; will be executed only if **b==3** is one(true); that is, ***b*** is 3.

Flow of Control

```
#include <stdio.h>
int main(void)
{
    int   a, b;
    b = 3;
    a = 1;
    if ( b == 3 )
        a = 5;
    printf("%d", a);
    return 0;
}
```

5

```
#include <stdio.h>
int main(void)
{
    int   a, b;
    b = 2;
    a = 1;
    if ( b == 3 )
        a = 5;
    printf("%d", a);
    return 0;
}
```

1

Flow of Control

```
if (a == 3)
{
    b = 5;
    c = 7;
}
```

- Compound statement **{…}**
  - a group of statements surrounded by braces
  - a statement, itself

Flow of Control

```
if (expr)
    statement1
else
    statement2
```

```
if (a == 3)
{
        b = 5;
        c = 7;
}
else
{
        a = 10;
        b = a + c;
}
```

Flow of Control

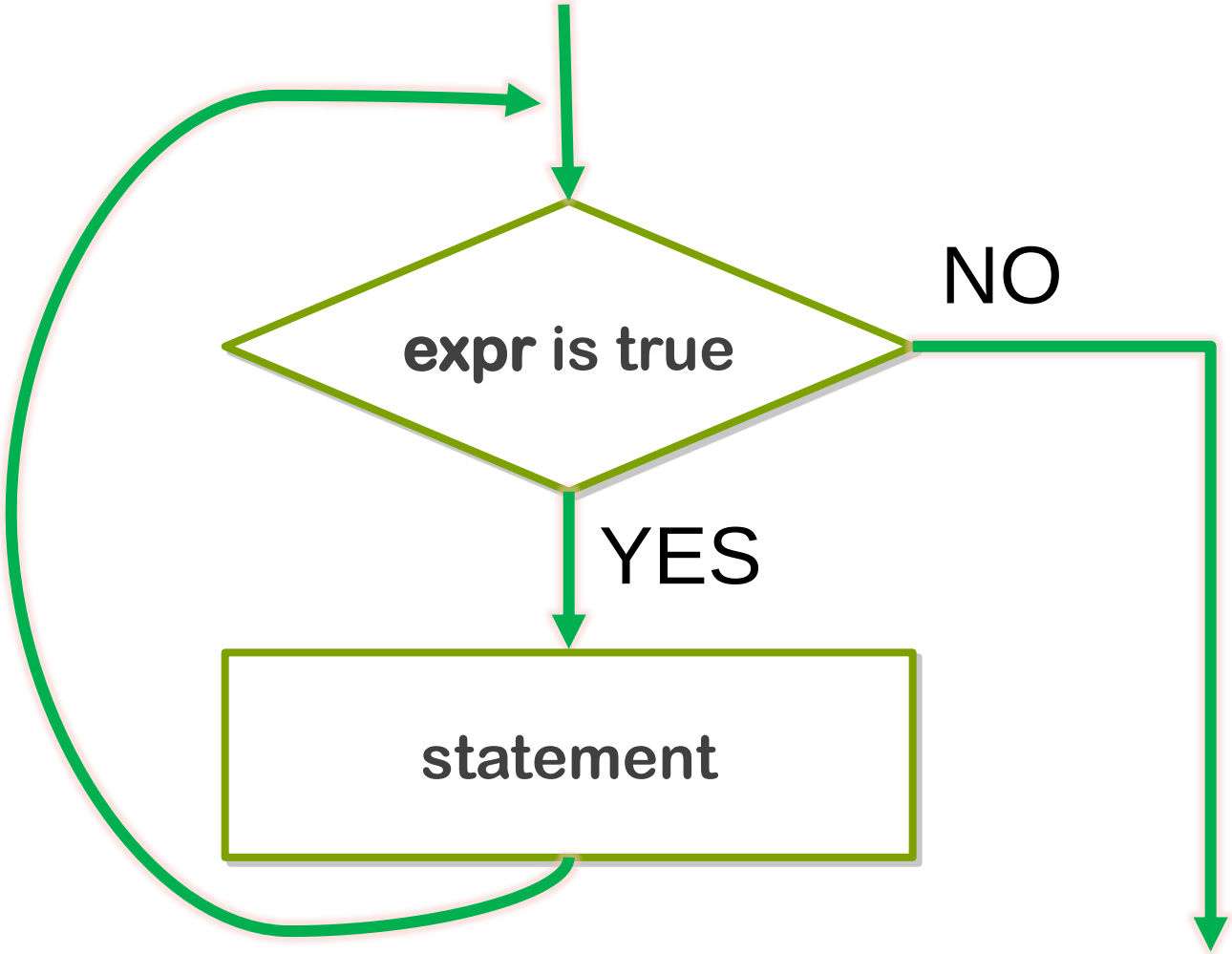
```
#include <stdio.h>
int main(void)
{
    int    i = 1, sum = 0;

    while ( i <= 5 )
    {
        sum = sum + i;
        ++i;
    }
    printf("sum = %d\n", sum);
    return 0;
}
```

Looping mechanism

Flow of Control

```
while (expr)
    statement
```



Flow of Control

```
while (i  <=  5)
{
    sum = sum + i;
    ++i;
}
```

- ***sum*** is added by ***i***, until ***i*** is less than or equal to 5
- **++i**
  - ++ : increment operator
  - i = i + 1

Flow of Control

```
#include <stdio.h>
int main(void)
{
    int    i = 1, sum = 0;

    while ( i <= 5 )
    {
        sum = sum + i;
        ++i;
    }
    printf("sum = %d\n", sum);
    return 0;
}
```

1+2+3+4+5

sum = 15

C Program is ...

- A sequence of **FUNCTIONS**
  - main() function executed first
- A **FUNCTION** consists of:
  - Declarations
  - Statements
- **Declaration**: variable names and their types
  - **int miles;**
- **Statement**: data processing or control
  - **miles = 26;**
  - **if (b == 3) { …};**
  - **printf(…);**