AN OVERVIEW OF C

Algorithmic Thinking

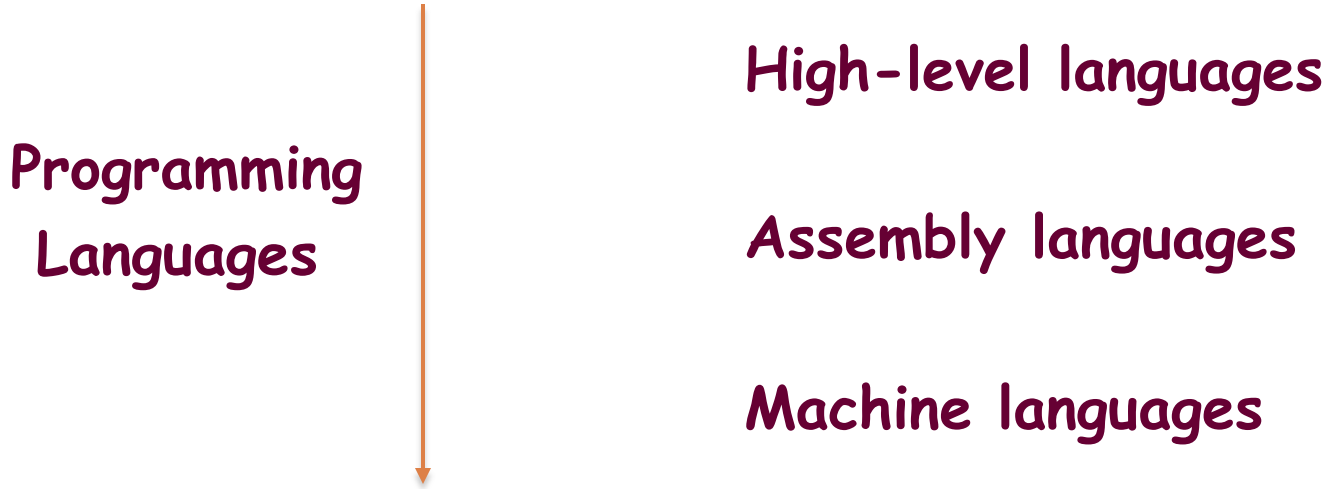
- Very diligent
- But, not so smart

- Must be told in detail what to do
  - understandable to computer
  - for all possible cases

- Algorithmic Thinking
  - Algorithms == Recipes

Programming Languages

- **Algorithms:** Developed by people



- **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
  - A Book on C

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

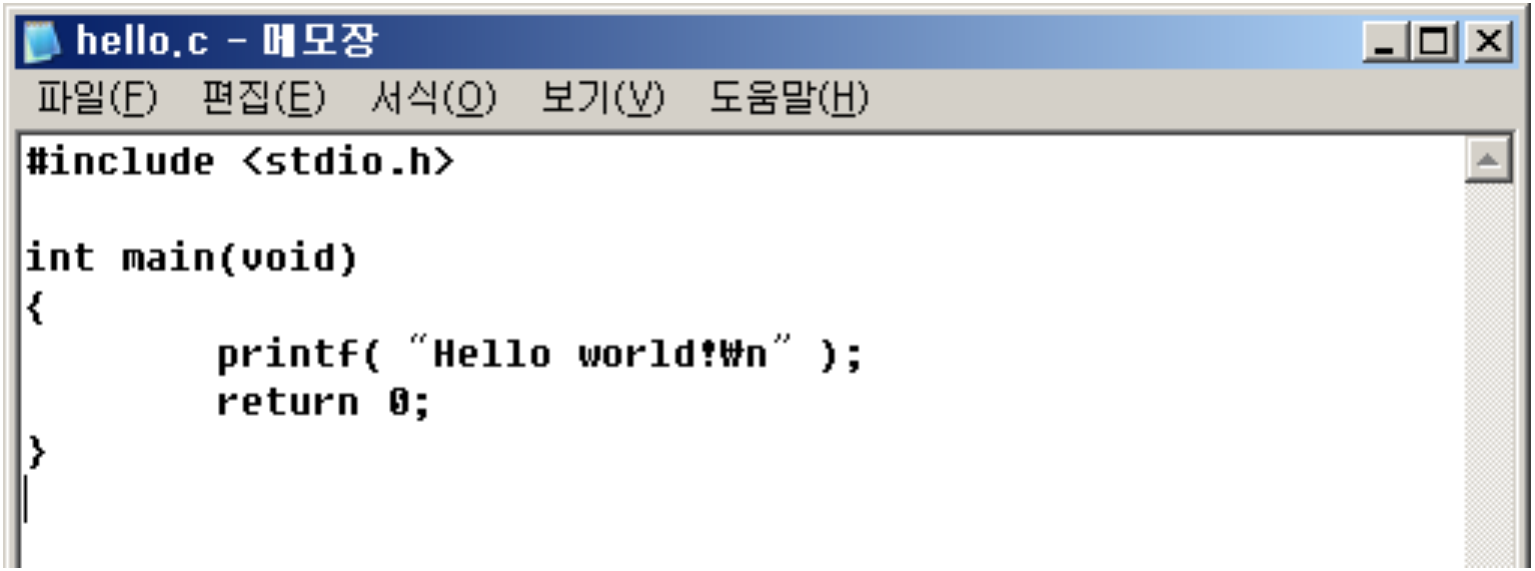
C Programming Language

- Criticism
  - Complicated syntax
  - No automatic array bounds checking
  - Multiple use of such symbols as * and =
    - **, ==

- Nevertheless, C is an elegant language
  - No straitjacket on the programmer's access to the machine
  - Powerful operators

Hello world 1/3

1. Create a C source file
   - use a text editor
     - Vi, text editor, Atom, ...



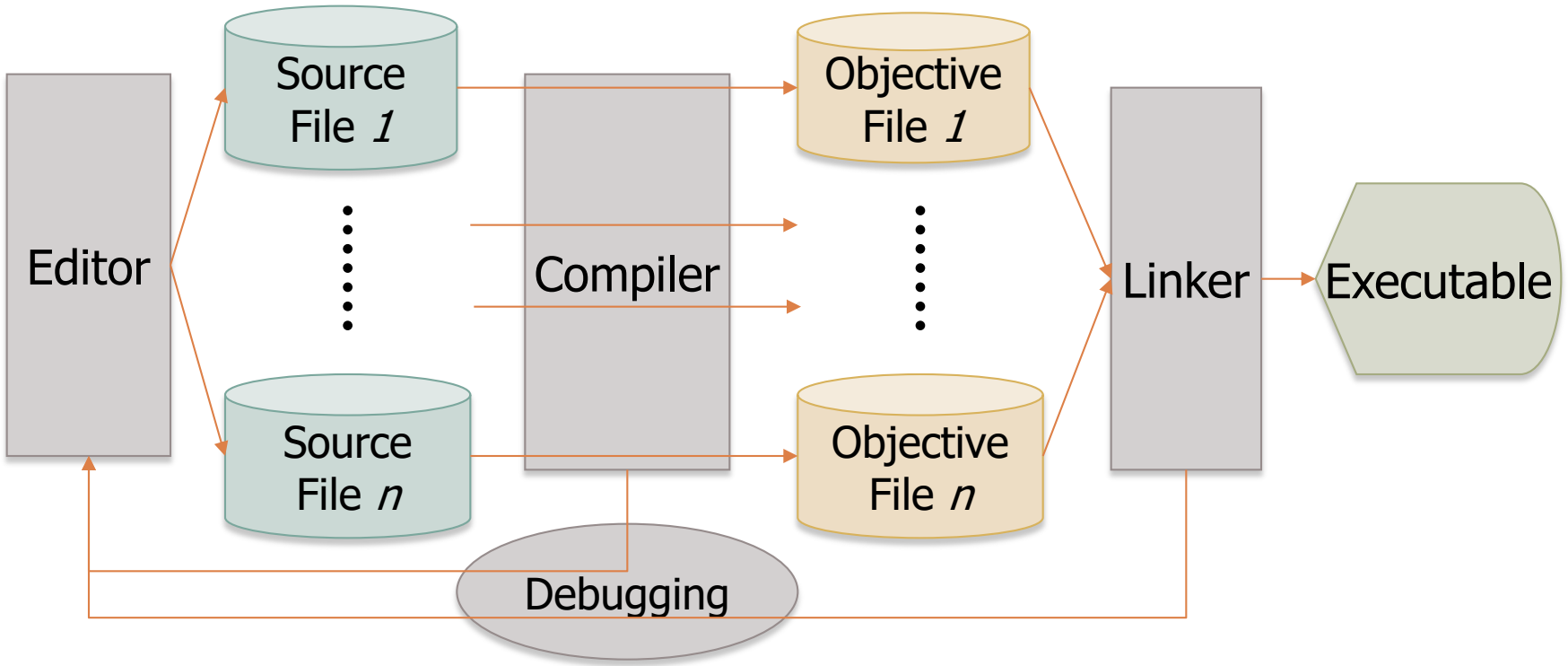
Hello world 2/3

2. Compile
    1. Convert source codes to object codes
    2. Compiler does the job

Hello world 3/3

3. Linking
   - Convert object codes to executable file
   - Linker does the job
4. Debugging
   - Fix the bugs in the source codes
   - Debugger does the job
5. Run or Excute

From Source to Executable



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
  - built into the C compiler
  - Lines beginning with #: communicate with the preprocessor

- #include
  - Preprocessor includes a copy of the header file ***stdio.h***
  - **stdio.h**
    - provided by the C system
    - Declaration of standard input/output functions, e.g., **printf()**

Program Output

int main(void)

- The 1st line of the function definition for main ()
- **int, void**
  - keywords, or reserved words
  - Special meanings to the compiler

int main(void)

{

- Every 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
- information 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");

- statement: end with a semicolon

Program Output

return 0;

- A **return** statement
- causes the value *zero* to be returned to the operating system

}

- The right brace matches the left brace
- ending the function definition for **main()**

Compiling

- Convert source file to objective file
  - sea.c to sea.o (or sea.obj)
- Object file
  - a file with expressions that computers can understand
- When compiling fails?
  - something wrong with source file …
    - expressions with wrong C grammar

Errors in Source File (ex)

```
#include <stdio.h>


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

-return 0;

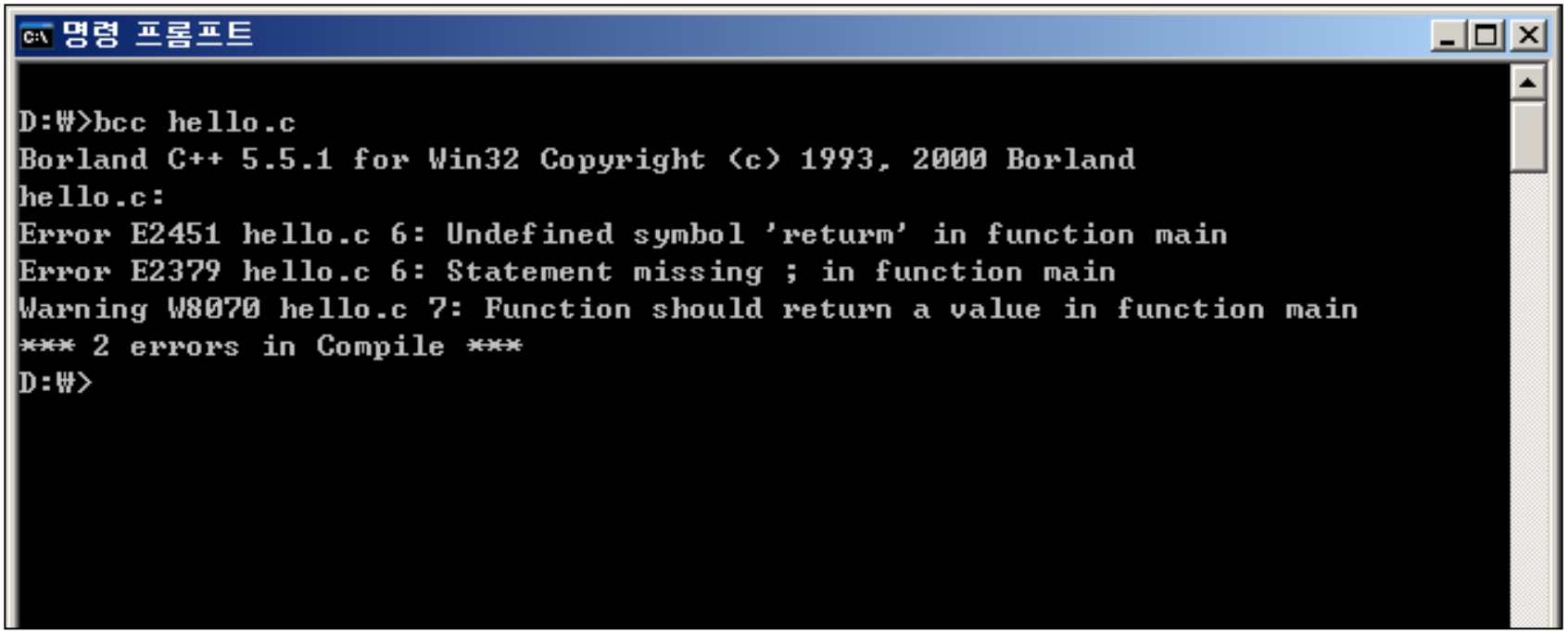
incorrect C language grammar

-compiler fails to make an obj file and returns an error.

-debugging

change "return 0;" to "return 0;"

Errors in Source File (ex)



Linking and Running a Program

- Linking
  - The process to make an executable program out of objective file(s)
    - sea.o (or sea.obj) → a.out (sea.exe)
- Run a program
  - type "a.out" or "sea"
    - computer prints "from see to shining C"

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

Variable, Expressions, &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;
}
```

Marathon:
26 miles 385 yards

miles to kilos:
X 1.609

yards to miles:
÷ 1760.0

Variable, Expressions & Assignment

/*the distance of a marathon in kilometers*/

- **/* … */**
  - comment
  - ignored by the compiler

Variable, Expressions & 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**
  - a keyword, real value
- declaration of the variable **kilometers** of type **float**

Variable, Expressions & Assignment

miles = 26;

yards = 385;

- Assignment statement
- =: assignment operator

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

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

Variable, Expressions & Assignment

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

- Control string
- **%f**: format, conversion specification
  - Matched with the remaining argument, the variable **kilometers**

Variable, Expressions & 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;
}
```

A marathon is 42.195970 kilometers.

Variable, Expressions & Assignment

1.609, 1760.0

- A decimal point
  - indicates that a floating-point constant rather than an integer constant
- Three floating types: **float**, **double**, **long double**
- floating-point constants are automatically of type **double**

Variable, Expressions & Assignment

Expression

- On the right side of assignment operators
- constants , variables, or

  combinations of operators with variables and constants

  e.g) yards = 385;

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

Evaluation of Expression

- Conversion rule
  - Division of two integers results in an integer values. 7/2 is 3
  - A double divided by an integer
    - Integer is automatically converted to double
    - 7.0/2 is 3.5

kilometers = 1.609 * (miles + yards / 1760); bug!!!

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;
- otherwise, it is skipped

if (b==3)

a = 5;

- == : *equal to* operator
- **b==3**
  - logical expression : either the integer value 1 (true) or 0 (false)

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 statement surrounded by braces
- a statement, itself

Flow of Control

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

```
if (cnt == 0)
{
   a = 2;
   b = 3;
   c = 5;
}
else
{
   a = -2;
   b = -3;
   c = -5;
}
```

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

```
while (expr)
    statement
```

- If **expr** is true, the **compound statement** is executed,
- and control is passed back to the beginning of the **while** loop for the process to start over again
- The **while** loop is repeatedly executed until the test fails

++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(…);**