2. Introduction to C Programming

C Programming

Agenda

- Background
- Compiling and Executing
- Structure of C Programs
- Variables and Types
- Constants
- Formatted Input/Output
- Identifiers
- Comments

Why C Language ?

- Ease to write programs
  - But C is not a language for beginners.
- Has some aspects of low level programming language
  - Effective, simple, practical
  - Control of fine details of low-level elements
    - Pointers, bit-wise operators
- World-wide popular programming languages

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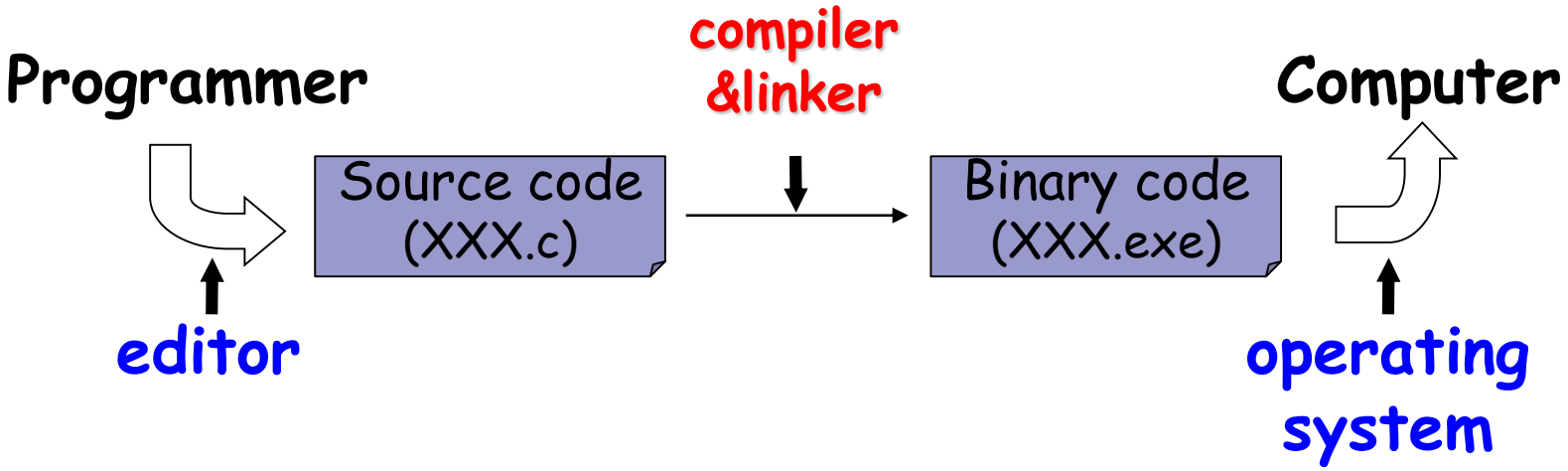
Developing a Program in C

- Developing process




```
#include <stdio.h>

int main(void)
{
   printf("Hello World!₩n");
   return 0;
}
```

```
0000020 00b8 0000 0000 0000 0040 ...
0000040 0000 0000 0000 0000 0000 ...
0000060 0000 0000 0000 0000 0000 ...
0000100 1f0e 0eba b400 cd09 b821 ...
0000120 7369 7020 6f72 7267 6d61 ...
0000140 2074 6562 7220 6e75 6920 ...
0000160 6f6d 6564 0d2e 0a0d 0024 ...
0000200 4550 0000 014c 0007 be3c ...
0000220 079f 0000 00e0 0107 010b ...
                    ...
```

Popular C Compilers

- cc: default compiler of UNIX
- gcc: the most popular free compiler
  - UNIX/Linux: gcc
  - Windows: MinGW, DJGPP, Dev C++ …
- Visual Studio (Visual C++)
- DevC++
- Turbo C++ / C++ builder, …

Example: A Greeting Program

- Hello.c: a program that prints out a greeting message.
  - Open a text editor and type the following codes
  - Save as “Hello.c”

```
#include <stdio.h>


int main()
{
   printf(“Hello World!₩n”);
   return 0;
}
```

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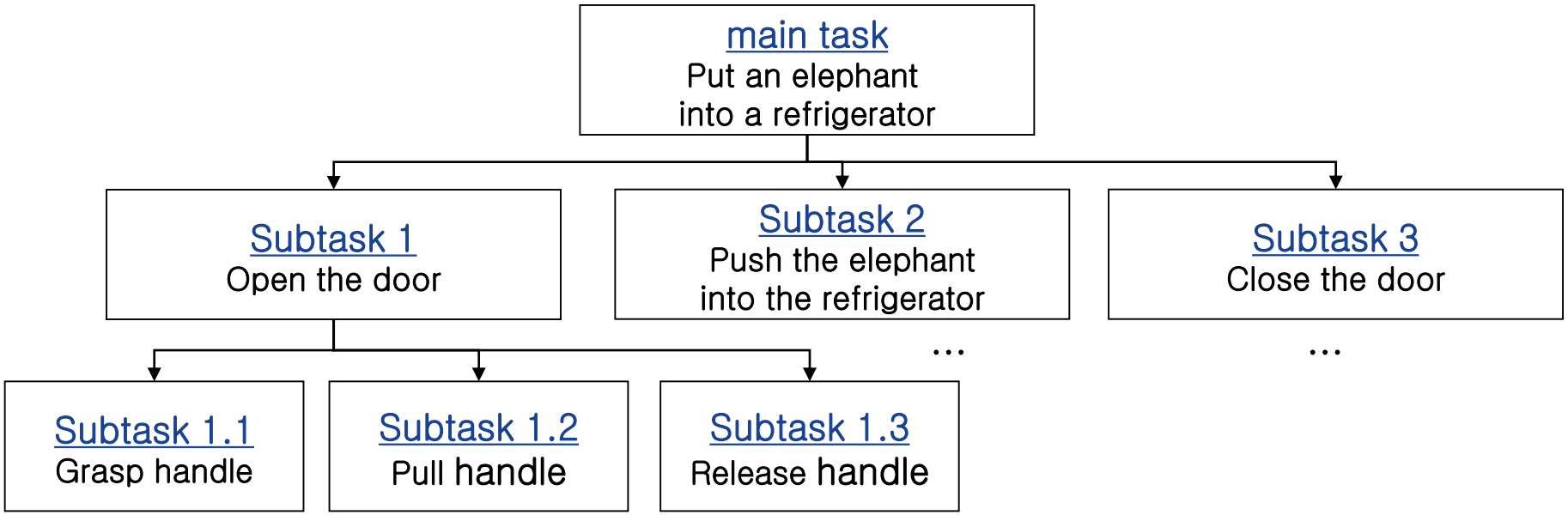
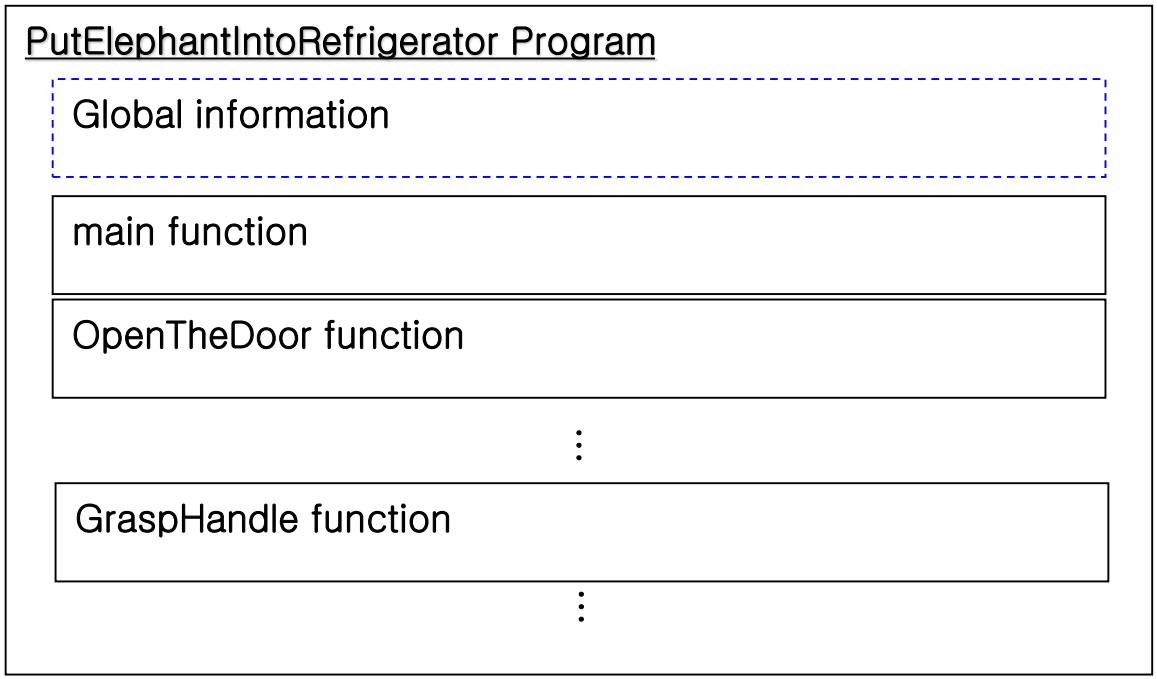
Structure of C Programs

- Observation
  - A large main task can be divided into one or more subtasks
    - If some subtasks are still large, each of them can be divided into even smaller subtasks.



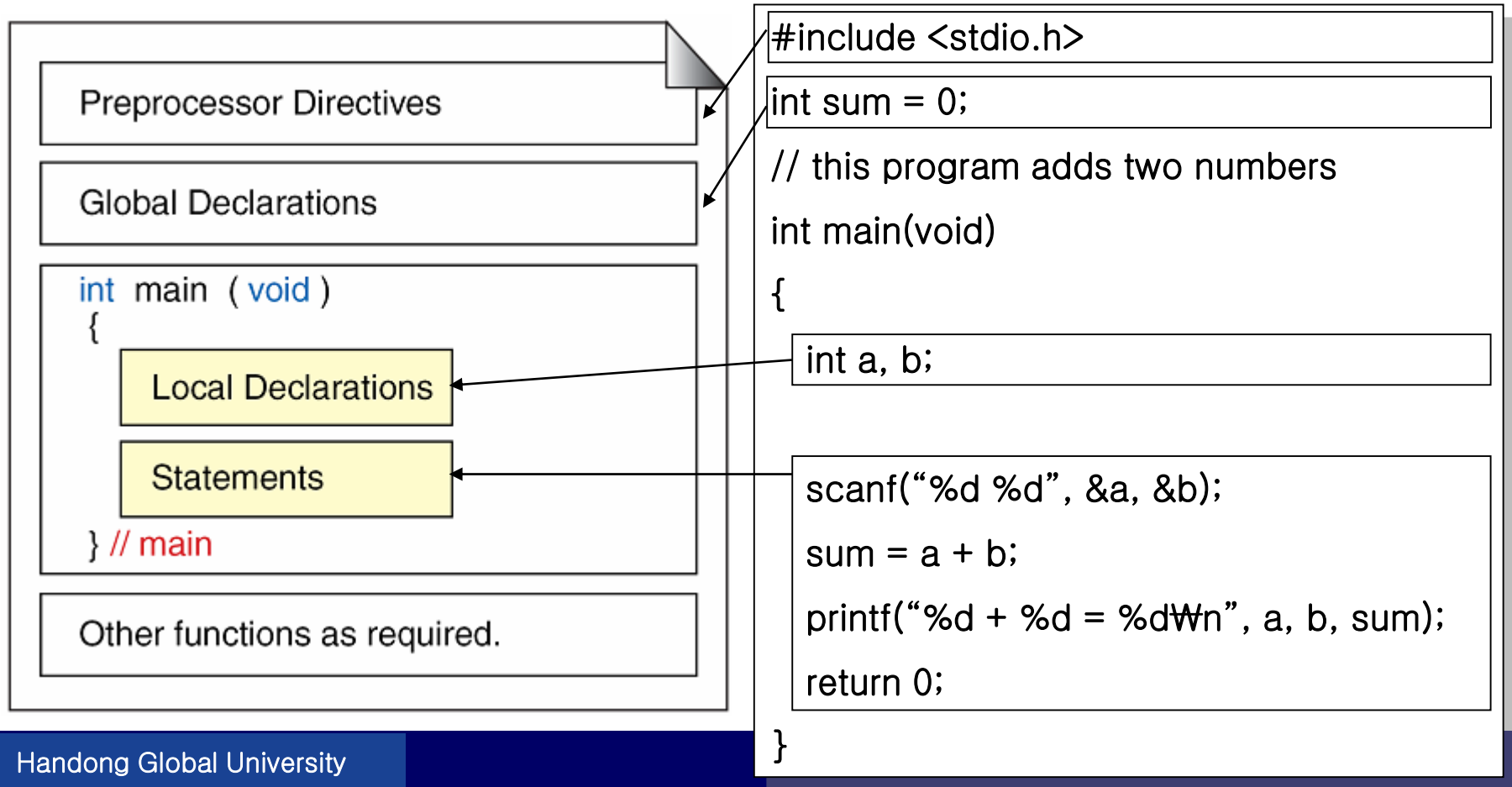
Structure of C Programs

- Main task can be implemented by writing functions for the subtasks and organizing them.
  - ➔ C program is composed of one or more functions
- Function (or subroutine): A portion of program within a larger program.
  - Performs a specific task, relatively independent of the remaining code.



Structure of C Programs

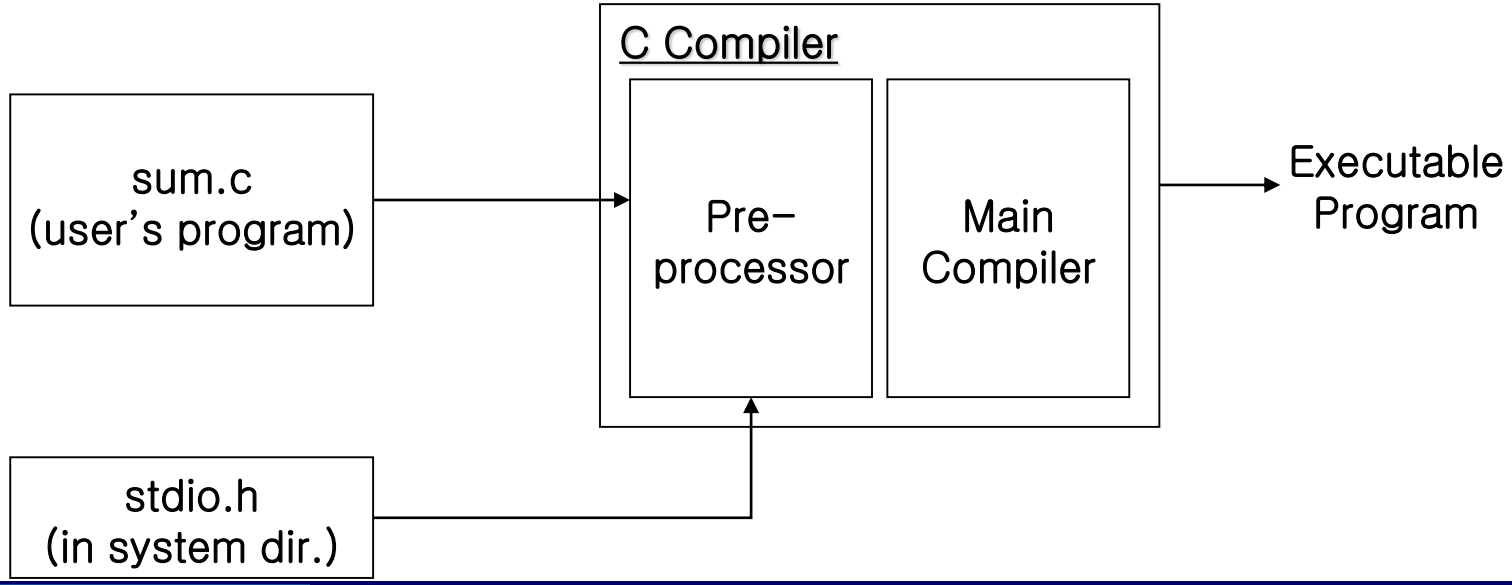
- A C program consists of preprocessor directives, global declarations and functions



Structure of C Programs

- Preprocessor directives
  - Indications for preprocessor

    Ex) "#include <stdio.h>" – indicate to include a file "stdio.h" at this position to use *printf* and *scanf* functions
    - This line is substituted by stdio.h
  - Starts with # sign



Structure of C Programs

- Global declarations
  - Declarations of variables, functions, etc. visible in all functions
    - Indicating compiler some elements will be defined and used
    - Globally declared elements are visible in all functions
- Function definitions
  - Local declarations: declarations of variables, functions, etc. visible only in that function
    - Indicating compiler some elements will be defined and used
    - Locally declared elements are visible only in the corresponding function
  - Statements: actions that function does

    Ex) sum = a + b; // add a and b and store the result into sum

    printf("%d + %d = %d₩n", a, b, sum); // print values of a, b and sum

Declaration and Statement

- Declaration: Specification of identifier, type, and other aspects of variables or functions.
  - Used to announce the existence of a variable or function
  - In C language, all variables and functions should be declared before use.

- Statement: the smallest standalone element that specifies an action.
  - In C language, each statement terminates by semicolon (;)
  - A program or a function is formed by a sequence of one or more statements.

Ex)

```
...
int i, j;                    // declaration
i = 10;                      // statement
j = i * 2;                   // statement
...
```

Analysis of Hello.c

- Line1: indicates pre-processer to include another file “stdio.h”
  - stdio.h should be include to use printf function in line 4
- Line2: function definition
  - main is the entry function
    - Each program should have a function named as “main”
    - Whenever a program is executed, the program starts from main function
- Line3 and 6: start and end of function main
- Line4: statement to print the greeting message on screen
- Line5: statement to terminate the program execution

```
1.  #include <stdio.h>
2.  int main(void)
3.  {
4.      printf(“Hello World!₩n”);
5.      return 0;
6.  }
```

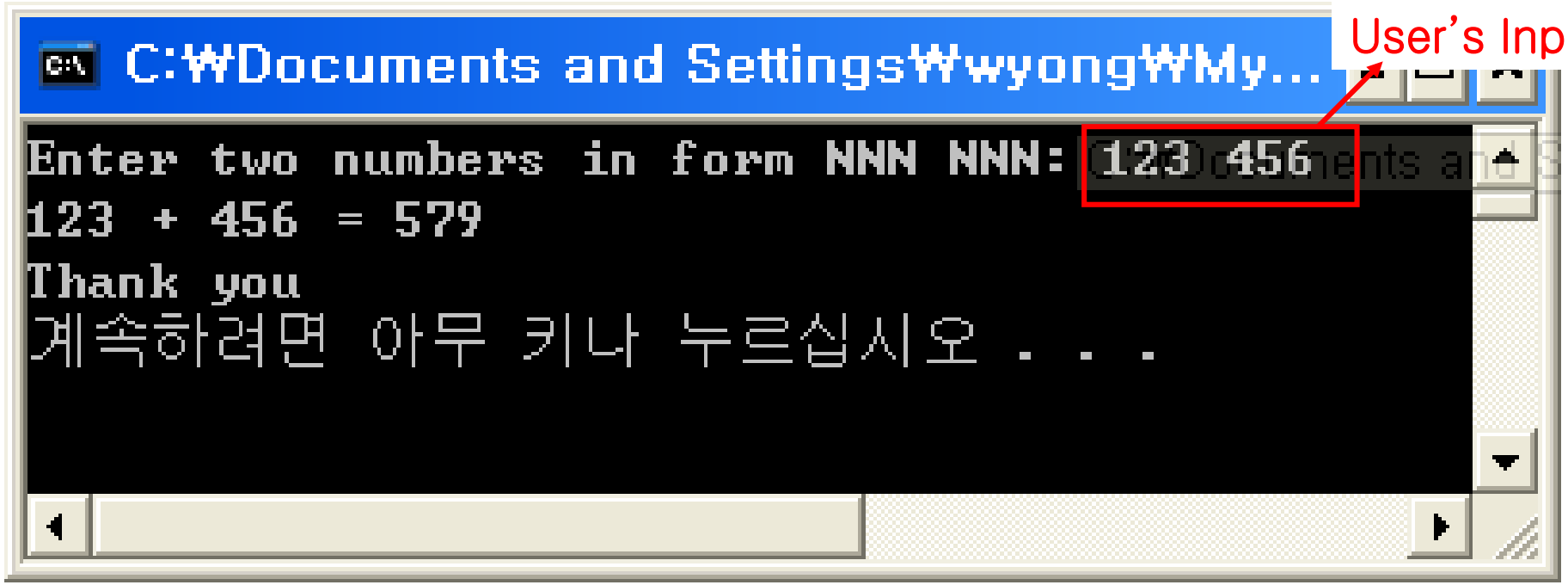
Example: Adding Two Numbers

- Add.c: a program that reads two numbers and prints their sum

```
1   #include <stdio.h>
2   int main(void)
3   {
4      int a = 0, b = 0;
5      int sum = 0;
6
7      printf("Enter two numbers in form NNN NNN: ");
8      scanf("%d %d", &a, &b);
9      sum = a + b;
10     printf("%d + %d = %d₩n", a, b, sum);
11     printf("Thank you₩n");
12
13     return 0;
14  }
```

Example: Adding Two Numbers

- Result



New Elements in Add.c

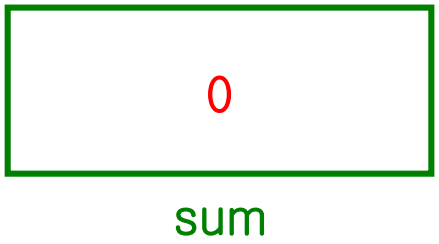
- Variable declaration (4, 5)
  - int sum = 0;
- Formatted Input/output
  - printf("%d + %d = %d₩n", a, b, sum); // output (7,10,11)
  - scanf("%d %d", &a, &b); // input (8)
- Statement
  - sum = a + b; (9)

Variable Declaration

- Reserve a memory space and name it ‘sum’
  - Variable: a memory space with a name

```
int sum = 0;
```

  - sum: variable name
  - int: type of *sum* (integer)
  - 0: an integer constant zero
  - = : initialization
    - “Put a value 0 into a variable *sum*”



Types

- Type defines a set of values that can be applied to the values

- Important types in C
  - int: integer numbers
    Ex) −1, 5, 7, 152, …
  - float: floating point numbers (real number)
    Ex) 34.2, 5.0, −53.98, 3.141592, …
  - char: a single character (letter)
    Ex) ‘a’, ‘X’, ‘5’, ‘$’ …
  - char []: string (a sequence of characters)
    Ex) char mesg[30] = “Hello”;

maximum length

Formatted Input/Output

- Formatted output

```
printf("%d + %d = %d₩n", a, b, sum);
```

  - %d's are replaced by value of a, b and sum respectively.

- Formatted input

```
scanf("%d %d", &a, &b);
```

  - Two integer numbers are read from keyboard and stored in a and b, respectively
    - & should precede the variable name except for string type

Conversion Specifications

- Keyboard input: scanf
  - Integer

```
int i;
scanf("%d", &i);
```

  - Float

```
float f;
scanf("%f", &f);
```

  - Character

```
char ch;
scanf("%c", &ch);
```

  - String

```
char str[100];
scanf("%s",str);
```

- Display output: printf
  - Integer

```
printf("value = %d₩n", i);
```

  - Float

```
printf("value = %f", f);
```

  - Character

```
printf("ch = %c₩n", ch);
```

  - String

```
printf("str = %s₩n",str);
```

%d, %f, %c, %s are conversion specifications

Analysis of Add.c

- Analysis
  - 4~5: variable a, b, sum are declared
  - 7: display message
  - 8: receives two numbers from keyboard
  - 9: add content of a and b and store the result in sum
  - 10: display a, b, and sum
  - 11: display ending message

```
1   #include <stdio.h>
2   int main(void)
3   {
4      int a = 0, b = 0;
5      int sum = 0;
6
7      printf("Enter two numbers in form NNN NNN: ");
8      scanf("%d %d", &a, &b);
9      sum = a + b;
10     printf("%d + %d = %d₩n", a, b, sum);
11     printf("Thank you₩n");
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13     return 0;
14  }
```

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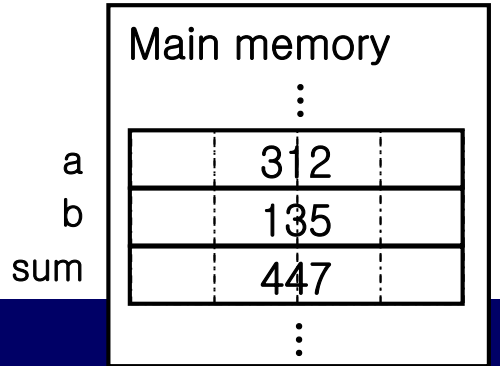
Variables

- Variable: named memory location to store or read data of a particular type

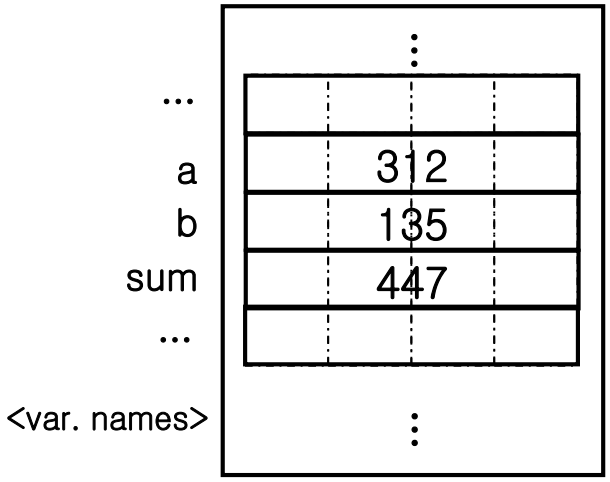
```
#include <stdio.h>

int main(void)
{
   int a = 0, b = 0, sum = 0;

   scanf("%d %d", &a, &b);                  // input numbers into a and b
   sum = a + b;                             // add a and b and store it into sum
   printf("%d + %d = %d₩n", a, b, sum);     // print sum
   return 0;
}
```



Properties of Variables

- Each variable should be specified with a data type
  - int i = 10; // integer variable
  - char c = 'c'; // character variable

- Actual location (address) in memory of a variable is determined by compiler and OS



0 or 512 or 348104
4 or 516 or 348108
8 or 520 or 348112

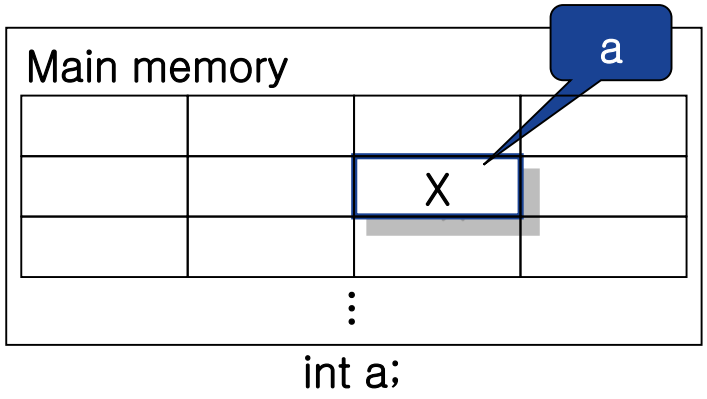
<Addresses of variables>

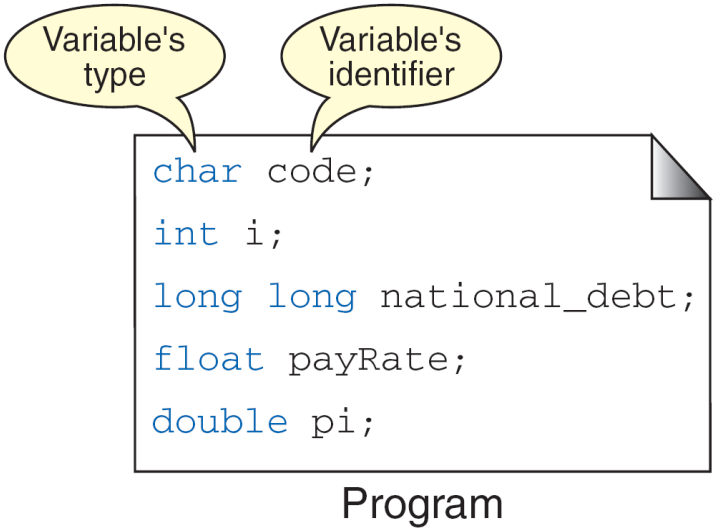
Variable Declaration

- Each variable should be declared before use
  - Variables are created when they are declared.
    - Reserves memory
    - Defines a symbolic name

Ex) int a; // declaring a variable

int b, c; // declares two variables in a line



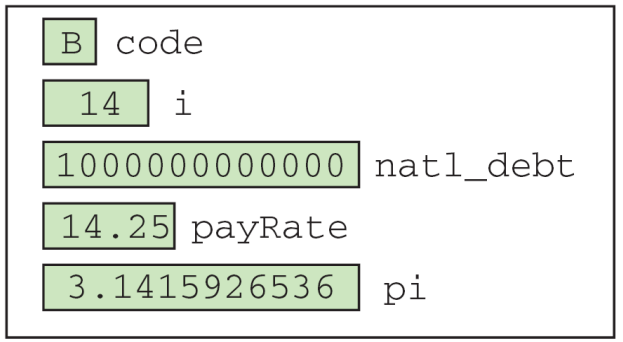


Variable Initialization

- Initialization: first assignment of a value to a variable

```
char code = 'b';
int  i    = 14;
long long natl_debt = 1000000000000;
float     payRate   = 14.25;
double    pi        = 3.1415926536;
```

Program



Memory

Note! If a variable is not initialized, its initial value is undefined. (It might have a random value)

➔ Not initialized variable can cause error extremely difficult to find.

Variable Initialization

- Not initialized variable

```
int main()
{
    int i = 0, j = 0;

    i = 100;            // What if this line is missed?
    j = i + 2;
    printf("j = %d₩n", j);

    return 0;
}
```

Recommendation

- To build a stable program, all variables should be initialized to when they are declared.
  - Valid, but not desirable

```
int a = 10, b = 20;
int sum;                    // not initialized
...
sum = a + b;                // what happens this line is omitted?
MyFunc(sum);
```

→ Result may depend on undefined value

  - Redundant, but safe

```
int a = 10, b = 20;
int sum = 0;                // initialization is not necessary,
                            // but desirable for safety
...
sum = a + b;                // first assign
MyFunc(sum);
```

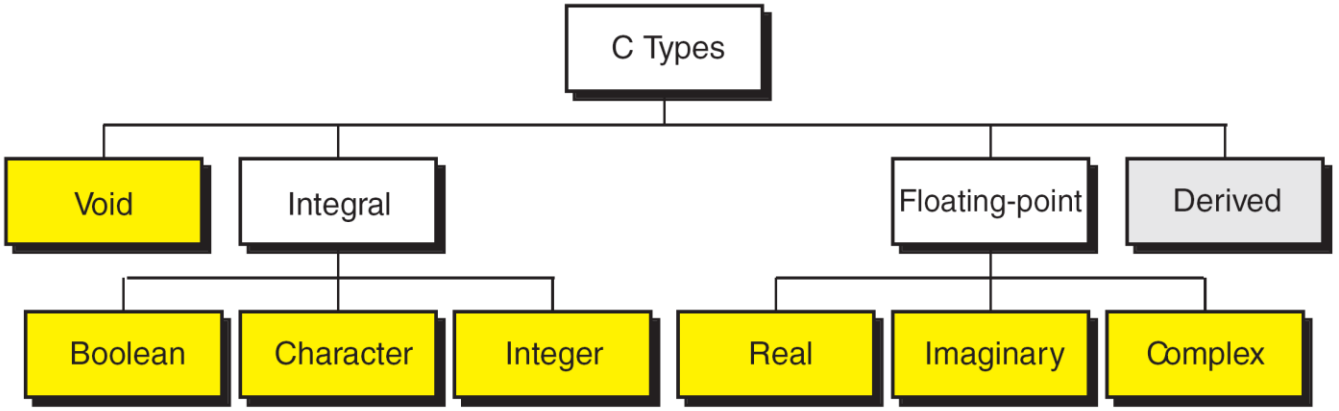
→ Produces consistent result

Recommendations for Variable Naming

- Easy to understand its use, meaning, and properties
  - int a; // what is it for ?
  - int counter; // counter
- Easy to read
  - int myname; // difficult to find bound of words (bad)
  - int myName; // words are separated by capital letter (good)
  - int my_name; // words are separated by underscore (good)
- Too long names are not desirable
  - int the_salary_i_received_from_previous_job; // too long
  - int prev_salary; // better

Types

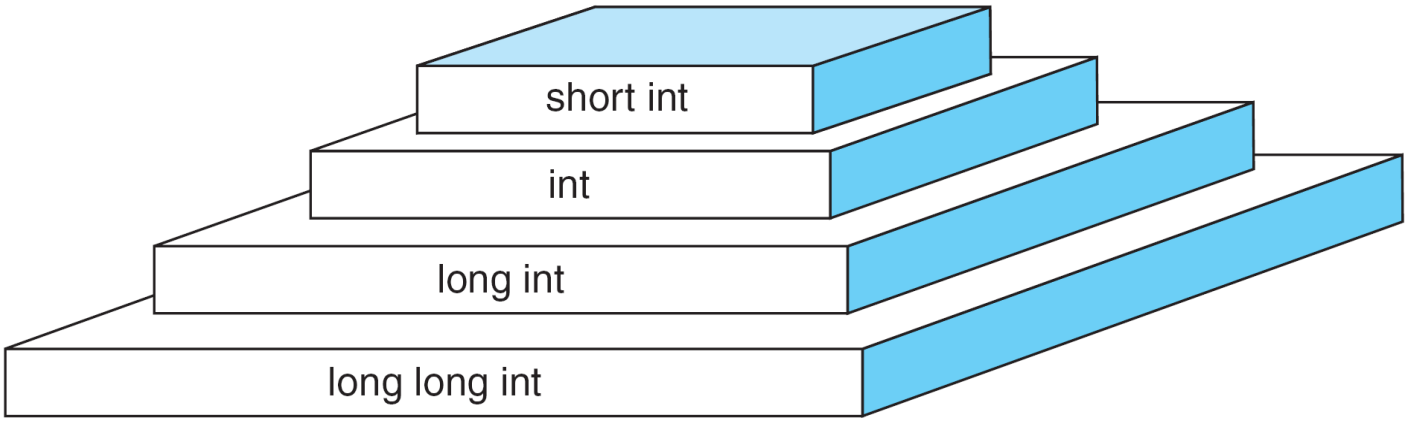
- Types in C language



- Each type is different from others in
  - Actual representation
  - Size
  - Operations applicable to it.

Integral Types

- Integer types: types for numbers without fraction parts
  - short int (= short)
  - int
  - long int (= long)
  - long long int (= long long)



Integral Types

- Types of integers determine the size of the storage and the range of values

  Ex) assume int type takes 4 bytes

  ➔ it can represent 2^{32} different values ($-2^{31} \sim 2^{31}-1$)

- Relative sizes of integer types
  - Note: actual size of each type depends on H/W and compiler
  - sizeof(short) ≤ sizeof(int) ≤ sizeof(long) ≤ sizeof(long long)

Type	Byte Size	Minimum Value	Maximum Value
short int	2	–32,768 (-2^{15})	32,767 ($2^{15}-1$)
int	4	–2,147,483,648 (-2^{31})	2,147,483,647 ($2^{31}-1$)
long int	4	–2,147,483,648 (-2^{31})	2,147,483,647 ($2^{31}-1$)
long long int	8	–9,223,372,036,854,775,807 (-2^{63})	9,223,372,036,854,775,806 ($2^{63}-1$)

Character Type

- Character types: types for letters

  Ex) char c = ‘a’;

  In computer, each letter is represented by a number.

  - ‘a’: 0x61, ‘b’: 0x62, …,’e’: 0x65, …, ‘h’: 0x68, …, ‘l’: 0x6C, …, ‘o’: 0x6F ‘z’: 0x7A, …

  Ex) “hello” ➔ 68 65 6C 6C 6F 00 (in hex)

  cf. ‘a’ + 1 makes ‘b’

  ‘a’ + 1 = Ox61 + 1 = Ox62 = ‘b’

```
printf(“char = [%c]₩n”, ‘a’);      // char = [a]
printf(“code = %d₩n”, ‘a’);        // code = 97 ( = 0x61)
```

ASCII Code Chart

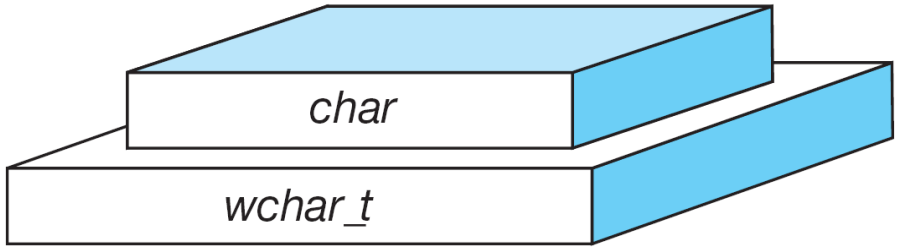
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	TAB	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	₩	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	

- Each character is represented by 7 bits
  - 0x00~0x1f: control characters
  - 0x20~0x7f: printable characters
    Ex) ‘a’ = 0x61, ‘0’ = 0x30, ‘–’ = 0x2D

Character Types

- char: 8 bit character type (ASCII)
  - 2^8 = 256 different values are possible
  - A char variable can store only alphabets, digits, symbols and some control characters

  Cf. a Hangul letter is stored by two consecutive char variables
- wchar_t: 16 bit character type (UNICODE)
  - 2^{16}= 65536 different values are possible
  - A wchar_t type variable can store not only alpha-numerals and symbols but also Hangul, Chinese characters, etc.

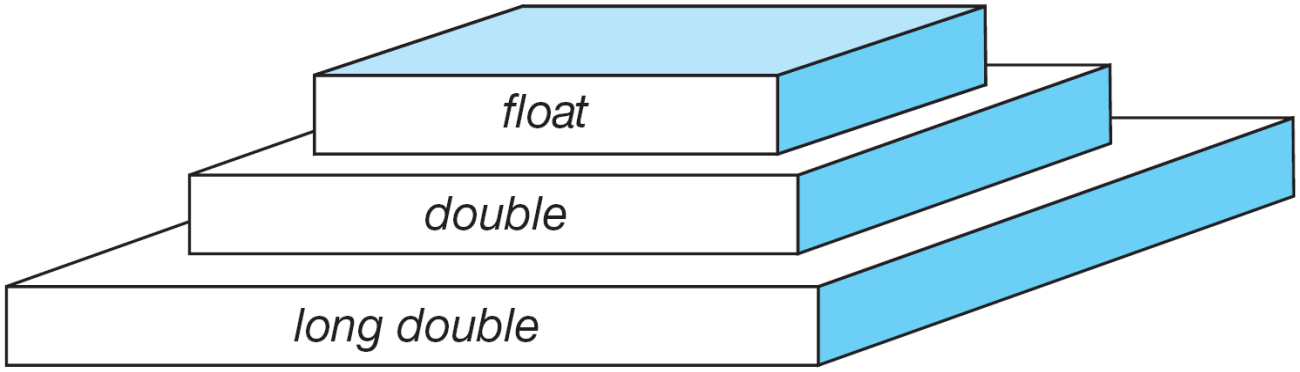


Floating-Point Types

- Floating-point types: types for fractional numbers

  Ex) float f = 0.5;

  - float, double, long double
- Relative sizes of floating-point types
  - Actual size of each type depends on machine and compiler
  - sizeof(float) ≤ sizeof(double) ≤ sizeof(long double)



Void Type

- void type: no value, no operation
  - int my_func1(void);
    - my_func1 doesn't receive any argument
  - void my_func2(int i);
    - my_func2 doesn't provides return value

Note! void type cannot be used for variable declarations but pointers

Other Types

- unsigned integer
  - A variable of unsigned types can store only non-negative values, but it can store larger numbers.
    - short i; // $-32768(=-2^{15}) \sim 32767(=2^{15}-1)$
    - unsigned short u; // $0 \sim 65535(=2^{16}-1)$

- bool: type for binary value true or false (C99)

  Ex) bool b = true;
  - int type is still more frequently used than boolean type

- complex/imaginary (C99)

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Constants

- Constant: data values that cannot be changed during execution
  - Integer constants
    Ex) 0, 100, +123, -378
  - Floating-point (real) constants
    Ex) 0.5, 3.141592, -5.0, 10., .78
  - Character constants
    Ex) 'A', 'b', '0', '+'
  - String constants
    Ex) "Hello", "h", "HOW ARE YOU?"

```
Ex) int i = 10;          // initialize i with integer constant 10
    float f = 10.5;      // initialize f with real constant 10.5
```

Postfixes for Integer/Float Constants

- Postfixes to specify a particular integral type
  - Integer number without postfix: int
  - U or u: unsigned
  - L or l: long
  - LL or ll: long long int

  Ex) +123, -32271L, 76542LU, 12789845LL

- Postfixes to specify a particular floating-point type
  - floating-point number without postfix: double
  - F or f: float
  - L or l: long double

  Ex) 2., .0, 3.1416, -2.0f, 3.1415926536L

  Recommendation: avoid to use l (use L instead)

Character/String Constants

- Character constants: single character enclosed by single quotes
  Ex) 'A', 'b', '0', '+'
- String constant: a sequence of zero or more characters enclosed in double quotes.
  Ex) "Hello₩n", "HOW ARE YOU?", "h", ""

- Backslash (\ or ₩) has a special use to represent non-graphical characters
  - printf("Hello, World₩n");
  ➔ Hello, World↵
  - printf("He said ₩"Hello.₩"₩n"); // OK!
  ➔ He said "Hello."↵
  cf. printf("He said "Hello."₩n"); // causes error

Character/String Constants

- Special characters represented by escape sequence

ASCII Character	Symbolic Name
null character	'\0'
alert (bell)	'\a'
backspace	'\b'
horizontal tab	'\t'
newline	'\n'
vertical tab	'\v'
form feed	'\f'
carriage return	'\r'
single quote	'\''
double quote	'\"'
backslash	'\\'

Character/String Constants

- Tab character '₩t'
  - Conceptually, the screen is vertically divided into tabs.
    - Tab size depends on systems but typically 8 or 4 columns
  - '₩t' indicates to print the following characters from the next tap position

    Ex) printf("Hello World₩n");

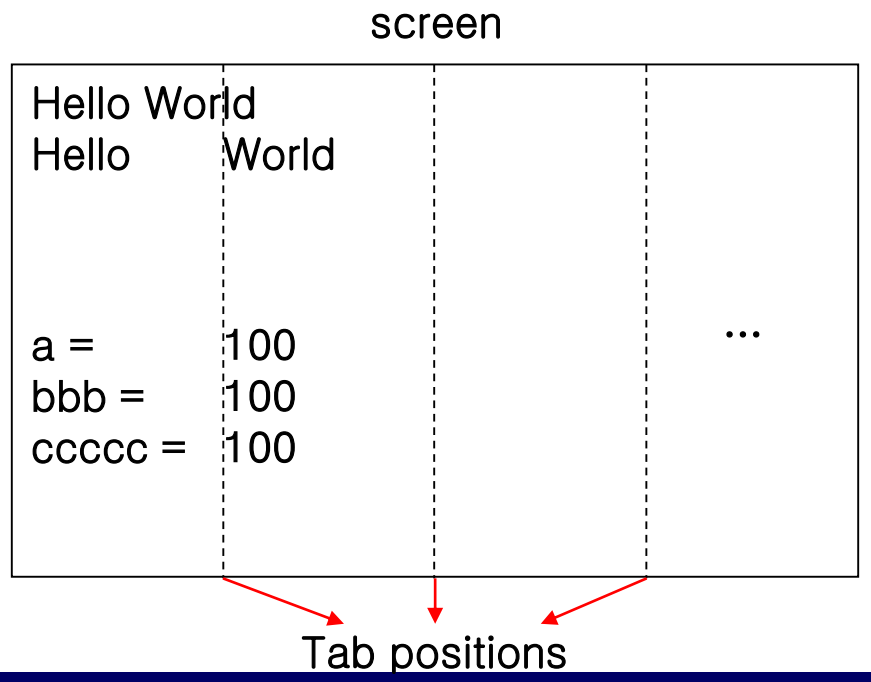
    printf("Hello₩tWorld₩n");

  - Useful to make an alignment

    printf("a =₩t%d₩n", a);

    printf("bbb =₩t%d₩n", b);

    printf("ccccc =₩t%d₩n", c);



Alternative Categorization of Constants

- Literal constants: unnamed constant to specify data
  Ex) a = b + 5;

- Defined constants
  Ex) #define SALES_TAX_RATE .0825
  float tax_rate = SALES_TAX_RATE;
  → Every occurrence of SALES_TAX_RATE is replaced by 0.0825
  Note! #define is preprocessor directive

- Memory constants: similar to variables except its value cannot be changed
  - Syntax: const *type identifier = value;*
    - Note! A memory constants has its own type

```
Ex) const float cPi = 3.141592;        // cPi cannot be changed
    float Pi_2 = cPi / 2;              // Pi_2 can be changed
```

Example

```
 1  //  This program demonstrates three ways to use constants.
 2  #include <stdio.h>
 3  #define PI 3.1415926536     // literal constant and defined constant
 4
 5  int main (void)
 6  {
 7  // Local Declarations
 8      const double cPi = PI;     // memory constant
 9
10  // Statements
11     printf("Defined constant PI: %f₩n", PI);
12     printf("Memory constant cPi: %f₩n", cPI);
13     printf("Literal constant:    %f₩n", 3.1415926536);
14
15     return 0;
16  }          // main
```

Example

```
1  //  Caution
2  #include <stdio.h>
3  #define exp 2+3
4
5  main ()
6  {
7  // Local Declarations
8      int result=0;        // memory constant
9
10 // Statements
11    result = 2*exp;
12    printf("%d₩n", result);
13
14
15
16 }           // main
```

Agenda

- Background
- Compiling and Executing
- Structure of C Programs
- Variables and Types
- Constants
- Formatted Input/Output
- Identifiers
- Comments

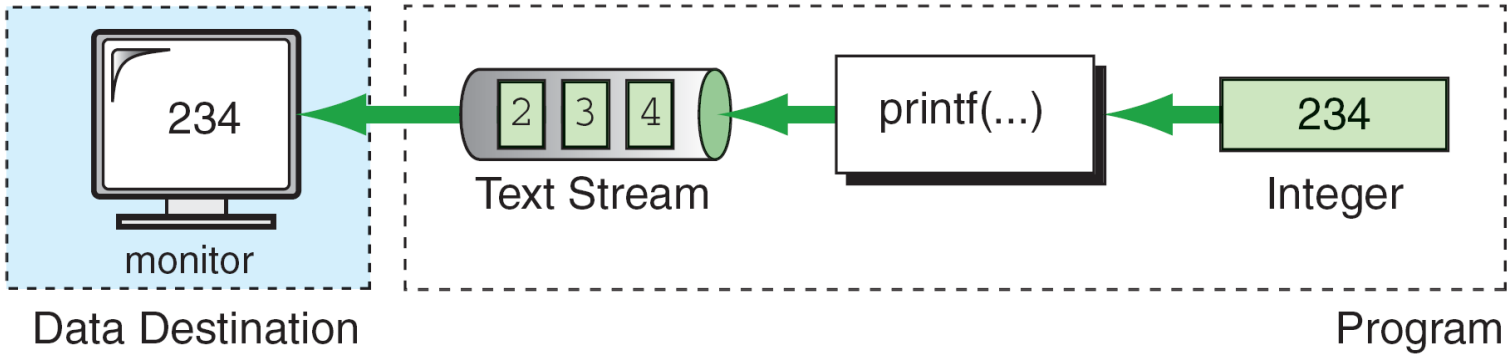
Example

```
#include <stdio.h>

int main()
{
    int i = 0;
    char ch = 0;
    char str[100];

    printf(“Enter an integer: ");
    scanf(“ %d", &i);
    printf(“₩tInteger value = %d₩n", i);

    printf(“Enter a character: ");
    scanf(“ %c", &ch);
    printf(“₩tCharacter value = %c₩n", ch);

    printf(“Enter a string: ");
    scanf(“ %s", str);
    printf(“₩tString value = %s₩n", str);

    return 0;
}
```

Formatted Output

- Formatted output: printf
  - Monitor can display only text characters
    - Text data can be displayed directly, but numeral data requires formatting
  - Formatting: converting values to text stream

    ex) 234 (integer) → '2', '3', '4' (character sequence)

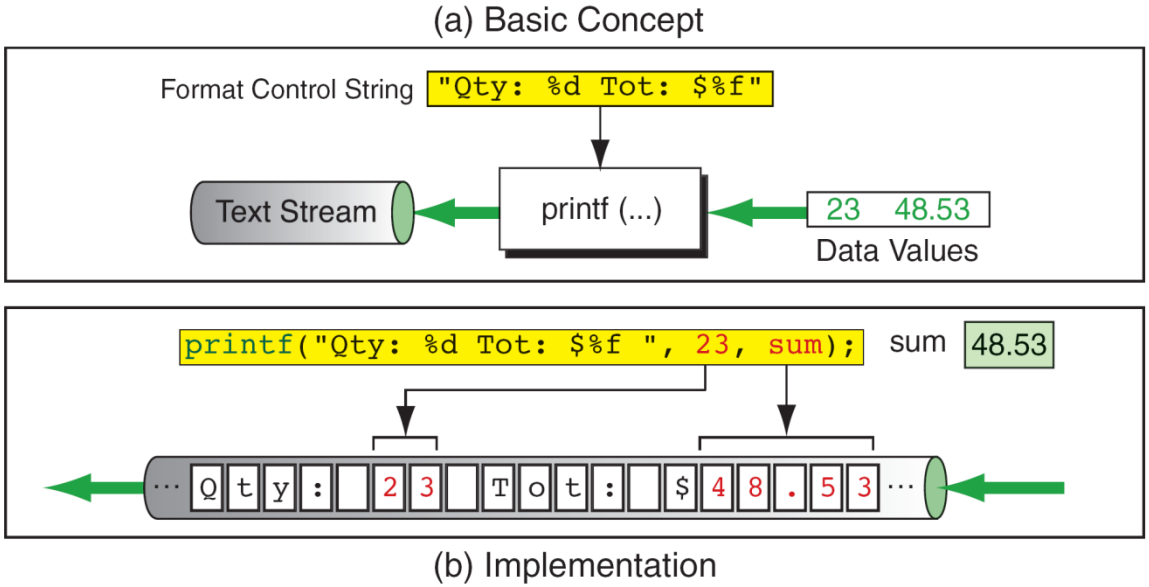


Formatted Output

- Syntax: printf(format_string, v_0, v_1, …);
  - format_string: text string containing zero or more conversion specifications
  - Each of conversion specifications is replaced by v_i's
    - v_i: value to replace i^{th} conversion specification

Ex) printf("Qty: %d Tot: $%f", 23, sum); // sum = 48.53F

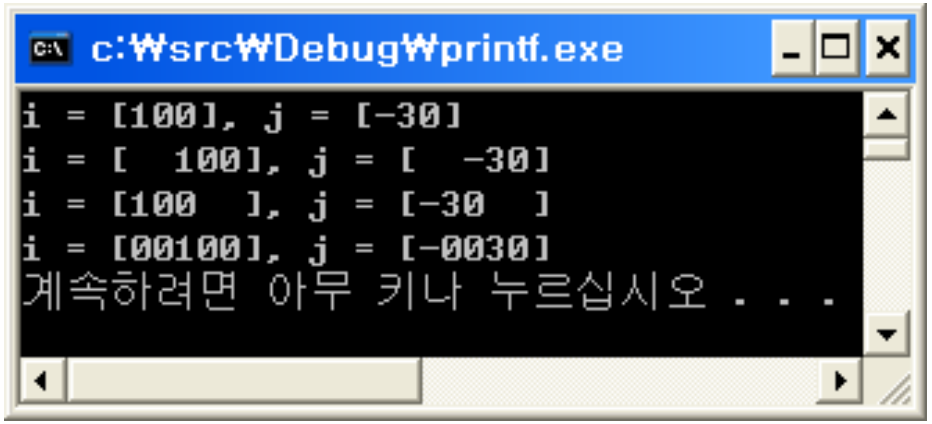
→ Qty: 23 Tot: $48.53



Example

- print.c

```
#include <stdio.h>

int main()
{
    int i = 100, j = -30;

    printf("i = [%d], j = [%d]₩n", i, j);
    printf("i = [%5d], j = [%5d]₩n", i, j);
    printf("i = [%-5d], j = [%-5d]₩n", i, j);
    printf("i = [%05d], j = [%05d]₩n", i, j);

    system("PAUSE");

    return 0;
}
```



Formatted Output

- Conversion specification of printf

%	Flag	Minimum Width	Precision	Size	Code

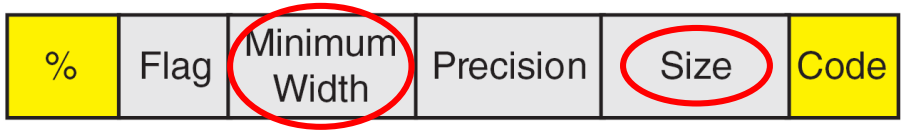
Ex) %d, %ld, %f, %Lf, %c,

- Format codes for output

Type	Size[a]	Code	Example
char	None	c	%c
short int	h	d	%hd
int	None	d	%d
long int	l	d	%ld
long long int	ll	d	%lld
float	None	f	%f
double	None	f	%f
long double	L	f	%Lf

* Integer in hexadecimal format: %x
* string : %s, * pointer: %p

Formatted Output



- Size modifier: specifies type of conversion type
  - h(short), l(long), ll(long long), L(long double)

  Ex) print("%ld", 7382949L);

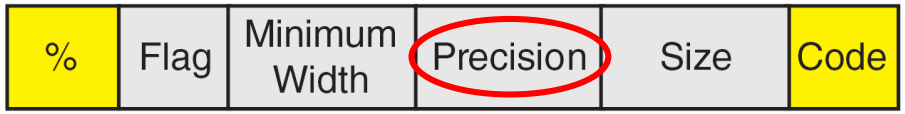
  printf("%Lf", 314159265.3578);

- Width modifier: specifies minimum width

  Ex) printf("[%5d]", 123); // [□□123]
  - If date requires more space, then printf overrides width modifier

  Ex) printf("[%3d]", 12345); // [12345]

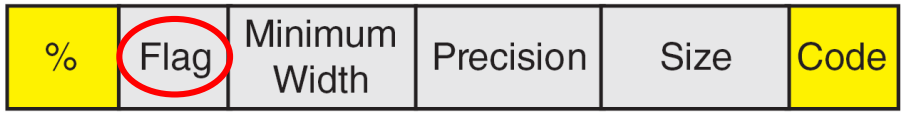
Formatted Output



- Precision modifier: specifies # of decimal places (for floating-point numbers)
  - Syntax: *n.m* (m decimal digits among n total positions)
    - n: width modifier (# of total positions)
    - m: precision modifier (# of decimal digits)

Ex) printf("[%7.2f], 123.456); // [□123.46]

Formatted Output



- Flag modifier: justification, padding, sign, etc.
  - Justification
    - printf("[%10d]₩n", 123); // [□□□□□□□123]
    - printf("[%-10d]₩n", 123); // [123□□□□□□□]
  - Padding
    - printf("[%d010d]₩n", 123); // [0000000123]
  - Sign
    - printf("[%10d]₩n", 123); // [□□□□□□□123]
    - printf("[%+10d]₩n", 123); // [□□□□□□+123]
    - printf("[%□d]₩n", 123); // [□123]
    - printf("[%□d]₩n", -123); // [-123]

Examples

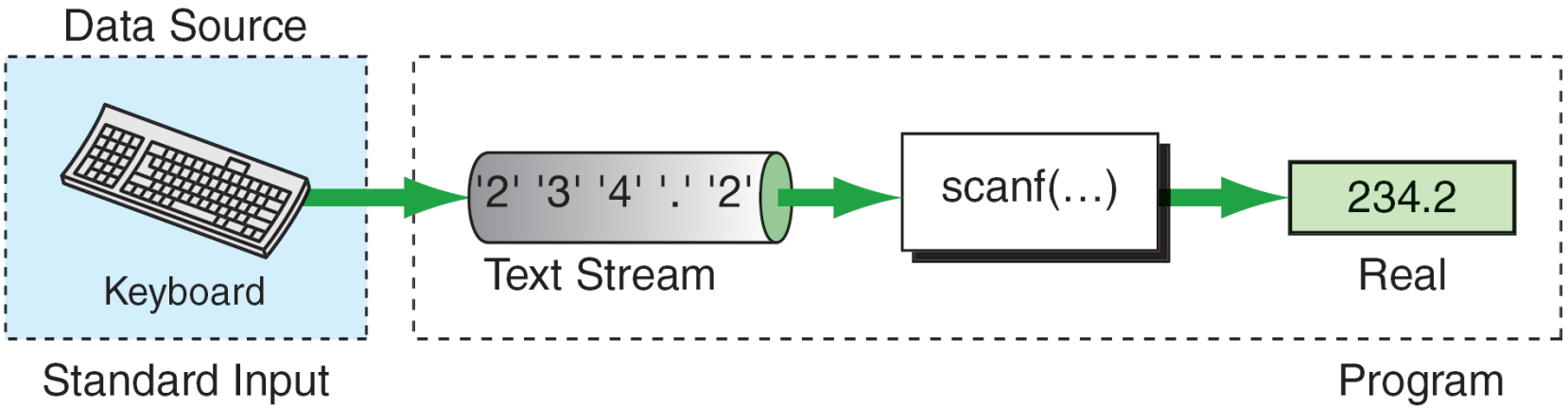
- Write the outputs of the following sentences
  - printf(“%d%c%f”, 23, ‘z’, 4.1);
  - printf(“This number is %6d”, 23);
  - printf(“The tax is %08.2f this year.”, 233.12);
  - printf(“₩”%8c %d₩””, ‘h’, 23);

- Describe the problem of each sentence and say what the result would be like.
  - printf(“%d %d %d₩n”, 44, 55);
  - printf(“%d %d₩n”, 44, 55, 66);
  - float x = 123.45;
    printf(“The data are: %d₩n”, x);

Formatted Input

- Formatted input: scanf
  - Inputs from the keyboard are sequences of characters
    - Value should be extracted from the text stream

    Ex) ‘2’, ‘3’, ‘4’, ‘.’, ‘2’ (character sequence) → 234.2 (float)
  - Function of scanf is the reverse of printf



Formatted Input

- Syntax: scanf(format_string, a_0, a_1, …);

  Ex) scanf("id = %d", &i);

  - format_string: data to be extracted from stream and reformatted
    - format_string contains zero ore more conversion specifications
  - a_0, a_1: variable addresses for conversion specifications
  - The portion matched to a conversion specification is converted and stored in the corresponding variable address

    Ex) scanf("id = %d", &i);

    input: "id = 392"

    → integer value 392 will be stored in variable i

Formatted Input

- Variable address: location of memory occupied by the variable
  - Address of a variable can be acquired by attaching address operator & before a variable name

    Ex) int a, b; // addresses of a and b are &a and &b, respectively
    char c; // address of c is &c
    scanf("%d %d %c", &a, &b, &c);

  - Array names (including char string) can be used for variable address as itself

    Ex) char inputString[100];
    scanf("input = %s", inputString); // & is not required
    Given an input "input = Thanks", "Thanks" will be stored in inputString

→ Variables should be prefixed with & to get an input through *scanf*. But character string is an exception.

Formatted Input

- Requirement for successful conversion
  - Non-conversion specification characters must be exactly matched by the characters in input stream

    Ex) To be matched with *scanf("id = %d", &i);*, the input should be *"id = XXX"*

  - A whitespace in format string can match with zero or more white spaces

    Ex) *scanf("□id = %d", &i);* accepts *"□□□id = XXX"*

  - Action of conversion is determined by the conversion specification and type of the variable

Examples

- Describe the problem of each sentence and how to fix it.
  - int a = 0;
    scanf(“%d”, a); // input: “234”
    printf(“%d”, a);
  - scanf(“%d %d %d”, &a, &b);
  - float a = 2.1;
    scanf(“%5.2f”, &a); // input: “74.35”
    printf(“%5.2f”, a); exe

Formatted Input

- Conversion specification of *scanf*

- Similar to that of printf but three differences
  - Precision modifiers are not allowed
  - Only one flag modifier: assignment suppression flag (*)

    Ex) scanf("%d %*c %f", &x, &y);

    // portion of input text matched with %c is just matched and discarded. exe
  - Width modifier does not represent minimum, but **maximum width**

Formatted Input

- Matching rule of *scanf*

1. The conversion operation processes until:
   a. End of file is reached.
   b. The maximum number of characters has been processed.
   c. A whitespace character is found after a digit in a numeric specification.
   d. An error is detected.
2. There must be a conversion specification for each variable to be read.
3. There must be a variable address of the proper type for each conversion specification.
4. Any character in the format string other than whitespace or a conversion specification must be exactly matched by the user during input. If the input stream does not match the character specified, an error is signaled and *scanf* stops.
5. It is a fatal error to end the format string with a whitespace character. Your program will not run correctly if you do.

Examples

- Write the result of the following sentences and input
  - scanf("%d%d%d%c", &a, &b, &c, &d);
    - input: "214 156 14Z"
    - input: "214 156 14 Z" // space is not discarded by %c
  - scanf("%d %d %f", &a, &b, &c);
    - input: "2314 15 2.14"
  - scanf("%d-%d-%d", &year, &month, &date);
    - Input: "2006-09-01"

Formatted Input

- Leading whitespaces

```
#include <stdio.h>

int main()
{
    char c1 = 0;
    char c2 = 0;

    scanf("  %c", &c1);
    printf("c1 = %c₩n", c1);

    scanf("  %c", &c2);
    printf("c2 = %c₩n", c2);

    return 0;
}
```

program

Agenda

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Identifiers

- Identifiers: user-specified names of functions, variables, tags or members of structures/unions, enumeration constants, type names and objects

  Cf. keywords (reserved words) syntactical words whose meanings are pre-defined in C language (if, while, int, void, …)

```
#include <stdio.h>
int main(void)
{
   int a, b;

   scanf("%d %d", &a, &b);
   printf("%d + %d = %d₩n", a, b, a + b);
   return 0;
}
```

Identifiers

- Syntactic rules for valid identifier
  - First character must be alphabetic character or underscore
    - ab10: O, _ab10: O, 10ab: X
  - Must consist only of alphabetic characters, digits, or underscore
  - First 63 characters of identifier are significant
  - Cannot duplicate a keyword

    Ex) int is not allowed
- Examples of valid and invalid identifiers

Valid Names		Invalid Name
a	// Valid but poor style	$sum
student_name		2names
_aSystemName		sum-salary
_Bool	// Boolean System id	stdnt Nmbr
INT_MIN	// System Defined Value	int

Comments

- Comment: internal documentation for programmers.
  - Comments are meaningful only to human. (compilers ignore comments)
  - Line comment / block comment

```
#include <stdio.h>
int sum = 0;

// this program adds two numbers
int main(void)
{
   int a, b;

   scanf("%d %d", &a, &b);
   sum = a + b;
   printf("%d + %d = %d₩n", a, b, sum);
   return 0;
}
```

- Line comment
  - Starts with double slash (//) and ends at the end of line

Ex)

```
// This is a whole line comment

a = 5;          // This is a partial line comment
```

Comments

- Block comment: starts with /* and ends with */
  - All characters between /* and */ are ignored by the compiler

Ex)

```
/* This is a block comment that
   covers two lines.                */


/*
** It is a very common style to put the opening token
** on a line by itself, followed by the documentation
** and then the closing token on a separate line. Some
** programmers also like to put asterisks at the beginning
** of each line to clearly mark the comment.
*/
```

  - Note! Nested comments are not allowed
    - Once the compiler sees /*, it ignores all chars until it sees */

Ex) /* ============================== */

Ex) /* ========/*------ */======== */

ignored

Error!