Fundamentals of Computer System
- Lecture 2 (Introducing C)

민기복

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Last Lecture

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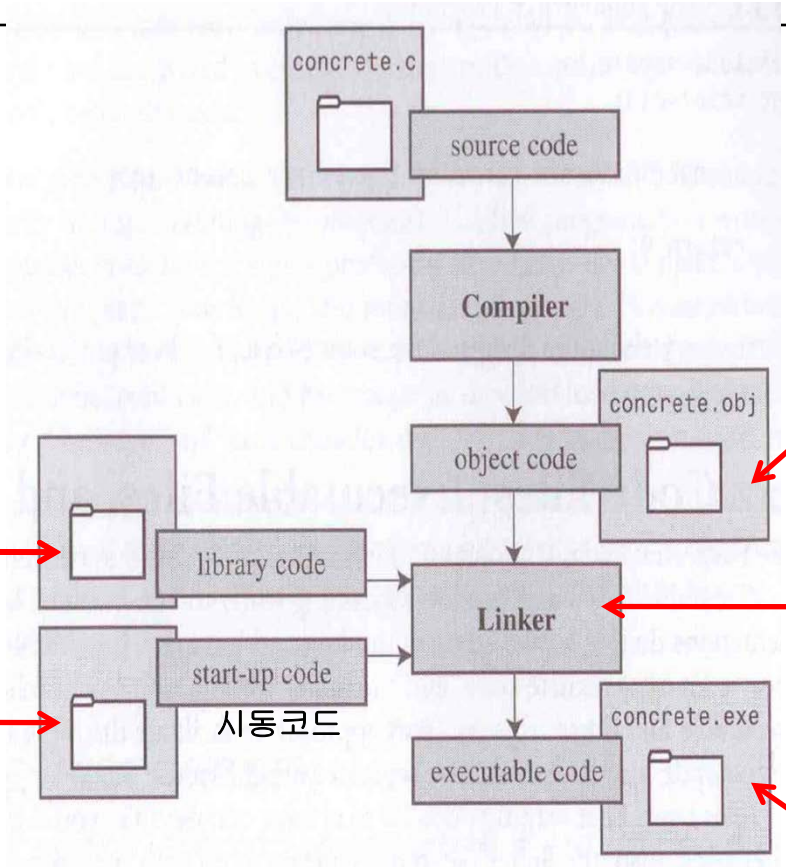

Object file contains machine language, but not ready to run

Collection of useful functions

Linker bring together object file, startup code and library code

Interface between your computer & operation system (DOS or Linux?).

Executable program!

The compiler we will use – which is MS Visual C++ express ed – starts linker automatically.

Today's content

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- Putting together a simple C program
- Functions (함수): main(), printf()
- Creating variables, assigning them values, and displaying those values on screen
- The newline character (개행문자), Operator (연산자): =
- Comments in your program, creating programs with more than one functions, and finding program errors
- Keywords – vocabulary of C

1. First C program

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```c
#include <stdio.h>
int main(void)
{
    printf("hello, world\n");
}
```

last week

this week

```c
#include <stdio.h>
int main(void)                  /* a simple program                  */
{
    int num;                    /* define a variable called num      */
    num = 1;                    /* assign a value to num             */

    printf("I am a simple ");   /* printf() 함수를 사용한다          */
    printf("computer.\n");
    printf("My favorite number is %d because it is first.\n",num);

    return 0;
}
```

1. First C program

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Include another file

```c
#include <stdio.h>
int main(void)                  /* a simple program                 */
{
    int num;                    /* define a variable called num     */
    num = 1;                    /* assign a value to num            */

    printf("I am a simple ");   /* printf() 함수를 사용한다         */
    printf("computer.₩n");
    printf("My favorite number is %d because it is first.₩n",num);

    return 0;
}
```

- Tells the compiler to include the information found in the file stdio.h.
- stdio.h: a standard part of all C compiler packages, support for keyboard input and for displayinig output
- #include : preprocessor instructions (전처리 지시자)

1. First C program

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a function name

```c
#include <stdio.h>
int main(void)                  /* a simple program                */
{
    int num;                    /* define a variable called num    */
    num = 1;                    /* assign a value to num           */

    printf("I am a simple ");   /* printf() 함수를 사용한다        */
    printf("computer.₩n");
    printf("My favorite number is %d because it is first.₩n",num);

    return 0;
}
```

- C program consist of one or more *functions (함수)*.
- This particular program (first.c) consists of one function called **main**.
- The parenthesis identify **main()** as a function name
- **int** → **main()** returns an integer, void → main() doesn't have argument (전달인자)
- main() is always the first function called.
- Old compiler → int main() :pre ISO/ANSI C compiler

1. First C program

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a comment (주석)

```c
#include <stdio.h>
int main(void)
{
    int num;
    num = 1;

    printf("I am a simple ");
    printf("computer.₩n");
    printf("My favorite number is %d because it is first.₩n",num);

    return 0;
}
```

```c
/* a simple program                          */
/* define a variable called num              */
/* assign a value to num                     */
/* printf() 함수를 사용한다                  */
```

- The symbols /* and */ enclose comments.
- Clarify a program.
- They are intended for the reader only
- Ignored by the compiler

1. First C program

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Beginning & finishing of the body of the function

```
#include <stdio.h>
int main(void)                  /* a simple program                */
{
    int num;                    /* define a variable called num    */
    num = 1;                    /* assign a value to num           */

    printf("I am a simple ");   /* printf() 함수를 사용한다        */
    printf("computer.₩n");
    printf("My favorite number is %d because it is first.₩n",num);

    return 0;
}
```

- Opening and closing brace marks make up the function

1. First C program

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```c
#include <stdio.h>
int main(void)
{
    int num;                    /* define a variable called num    */
    num = 1;                    /* assign a value to num           */

    printf("I am a simple ");   /* printf() 함수를 사용한다        */
    printf("computer.₩n");
    printf("My favorite number is %d because it is first.₩n",num);

    return 0;
}
```

A declaration statement
선언 명령문

- Announces that you are using a variable called **num**
- **num** will be an **int** (integer) type

1. First C program

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```c
#include <stdio.h>
int main(void)
{
    int num;
    num = 1;

    printf("I am a simple ");    /* printf() 함수를 사용한다      */
    printf("computer.₩n");
    printf("My favorite number is %d because it is first.₩n",num);

    return 0;
}
```

an assignment statement
(대입명령문)

- Assigns the value 1 to the variable called num

1. First C program

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```c
#include <stdio.h>
int main(void)
{
    int num;
    num = 1;

    printf("I am a simple ");  /* printf() 함수를 사용한다 */
    printf("computer.₩n");
    printf("My favorite number is %d because it is first.₩n",num);

    return 0;
}
```

a function call statement
(함수 호출 명령문)

- Displays the phrase **I am a simple** on your screen
- Leaves the cursor on the same line
- **printf()** is called function and is part of the standard C library
- Using a function in the program is termed *calling a function* (함수호출)

1. First C program

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```
#include <stdio.h>
int main(void)                  /* a simple program                */
{
    int num;                    /* define a variable called num    */
    num = 1;

    printf("I am a simple ");
    printf("computer.₩n");
    printf("My favorite number is %d because it is first.₩n",num);

    return 0;
}
```

last function call statement
(마지막 함수 호출 명령문)

- Prints the value of **num** embedded in the phrase in quotes.
- **%d** instructs the computer ‘where’ and ‘in what form’ to print the value of **num**

1. First C program

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```
#include <stdio.h>
int main(void)                  /* a simple program                */
{
    int num;                    /* define a variable called num    */
    num = 1;                    /* assign a value to num           */

    printf("I am a s                                                */
    printf("computer
    printf("My favor                                        num);

    return 0;
}
```

a return statement
(리턴 명령문)

- a C function can furnish (or return) a number to the agency that used it.
- ISO/ANSI C requirement for a properly written main() function.

2. Program Details
#include directives and Header Files

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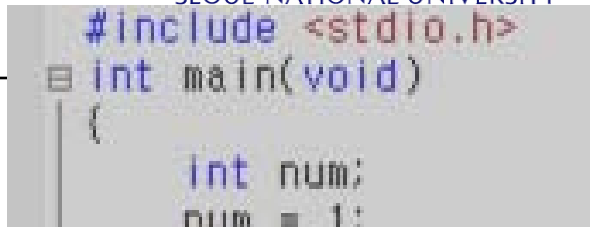

- #include<stdio.h>
  - An example of C preprocessor directive (C 전처리 지시자)
  - Preprocessing (전처리): C compiler perform some preparatory work on source code
  - Same as typing the entire **stdio.h** file (~300 lines) into your file
  - **stdio.h** stands for Standard input/output header
  - Contains information about input and output functions, ex) **printf()**
  - A collection of information at the top of a file: **header**
    - Library: contains actual code for a function,
    - header files: help guide the compiler in putting your program together

2. Program Details
#include directives and Header Files

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- Why wasn’t this automatically included???

2. Program Details
the main() function

```
#include <stdio.h>
int main(void)
{
    int num;
    num = 1;
```

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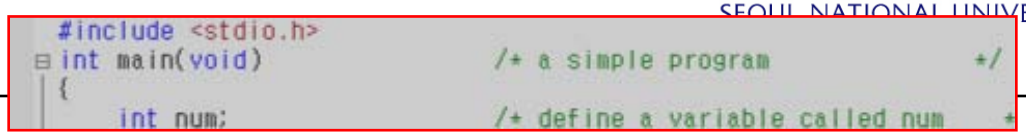
- C always begins execution with the function called **main()**.
- You are free to choose names for other functions, but **main()** must be there to start things.
- **int** is the main() function's return type.
- Parenthesis enclose information being passed along to the function.
  - In this particular example, nothing is being passed along, so 'void'.
  - main() or void main() may or may not work in your compiler. But don't use this *old* format.

2. Program Details
Comments



- Everything between /* and */ is ignored by the compiler.
- Valid and invalid comment

```
/* This is a C comment. */

/* This comment is spread over
   TWO LINES. */

/*

You can do this, too.

*/

/* Hopefully, this works.
```

→ Not valid

2. Program Details

Comments

```
/* a simple program                    */
```

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// : confined to a single line

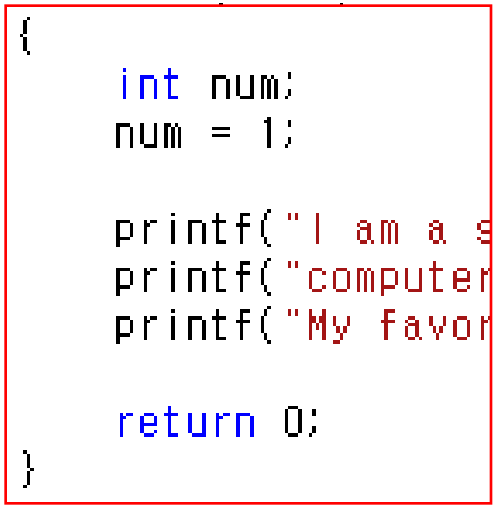
Ex)

```
// Here is a comment

int rigue;   //such comments can go here, too.

 /*
I hope this works.
*/
x = 100;
y = 200;
/* now for something else. */
```

2. Program Details
Braces (중괄호)



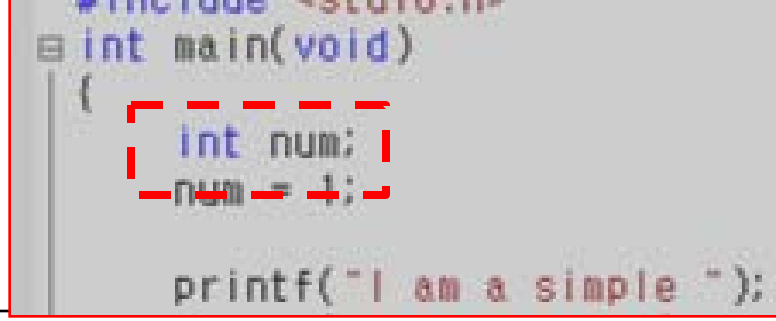
```
{
    int num;
    num = 1;

    printf("I am a s
    printf("computer
    printf("My favor

    return 0;
}
```

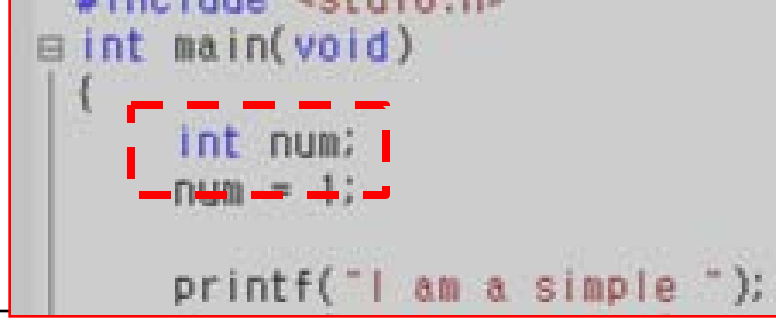
- Only { }
- 중괄호만 쓸 것!!!

2. Program Details
Declaration (선언 명령문)



- One of C's most important features
- Does two things;
  - 1. Somewhere in the function, you have a variable called **num**
  - 2. **int** proclaims num as an integer (정수형) (there are other types, ex) character, floating-point,…)
- Compiler uses this info for suitable storage space in memory
- **;** identifies the line as **C statement**.
- **int** is a keyword – reserved for C, so don't use it for your name of a function or a variable.

2. Program Details
Declaration (선언 명령문)



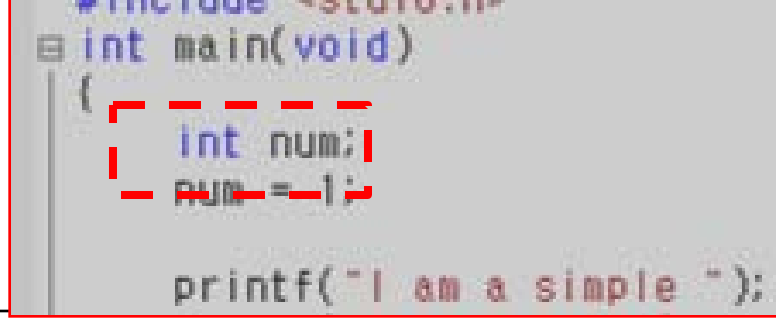
- num is called an *identifier* (식 별 자) – name selected for a variable, a function, or some other entity. Declaration connects a particular identifier with a particular location in computer memory
- All variables must be declared *before* they are used.

Ex)

```
int main()                          // C99 rules
{
//    some statements
      int doors;
      doors = 5;     // first use of doors
//    more statements
      int dogs;
      dogs =3                       //first use of dogs
      // other statements
}
```

As long as it is declared before its first use → okay
But, it is a good practice to declare variables from the beginning.

2. Program Details
Declaration (선언 명령문)



- The maximum number of characters for variables: 63

The_maximum_number_OF_characters_for_variables_is_63_the_rest_will_be

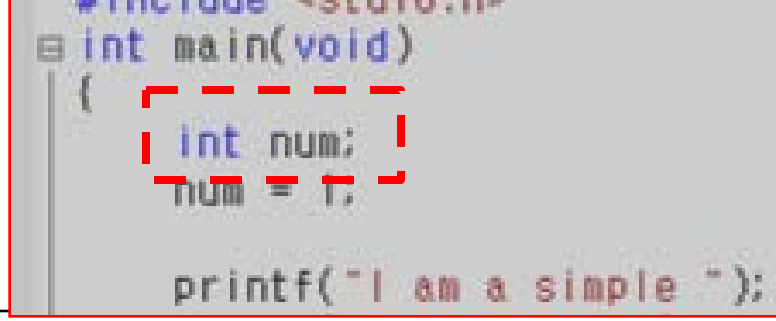
- Use lowercase or uppercase letters, digits, & underscore.
- The first character cannot be a digit.

The rest will be simply ignored

  - Valid names: snu2 Snu2 Hot_Tub _kcab
  - Invalid names: $Z]** 2cat Hot-Tub don't

- Avoid starting with _ (not an error but confusing with other C library identifiers)
- Case sensitive

2. Program Details
Declaration (선언 명령문)

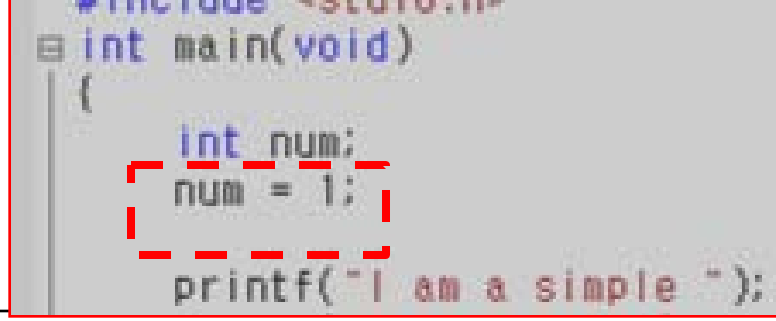


- Four reasons to declare variables
  - Easier for a reader to grasp what the program is about
  - Encourages you to do some planning before you plunging into writing a program
  - Prevent hard-to-find bugs,

  Ex) Radius1 = 20.4
  Circum = 6.28 * Radiusl

  - Compiler won't work without declaration!

2. Program Details
Assignment (대입 명령문)



- Assign the value 1 to the variable **num**.
- You can assign **num** a different value later – that's why is it a *variable*
- Assigns the value from the right side to the left side.
- Statement is completed with semicolon ;

2. Program Details
The printf() function

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```
printf("I am a simple ");    /* printf( ) 함수를 사용한다      */
printf("computer.₩n");
printf("My favorite number is %d because it is first.₩n",num);
```

- () → printf is a function
- I am a simple is passed to printf().
- Printf("I am a simple");

  Argument (전달인자)

- When the program reaches this line, control is to function is executed. After function is finished, control is returned to the original (*calling*) function – **main**() in this case.

2. Program Details
The printf() function

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```
printf("I am a simple ");    /* printf( ) 함수를 사용한다      */
printf("computer.₩n");
printf("My favorite number is %d because it is first.₩n",num);
```

printf("computer. \n");

Newline character (개행문자) – a escape sequence
Start a new line at the left = pressing 'enter' key.

printf("My favorite number is %d because it is first.\n",num)

- % alert the program that a variable is going to be printed
- d tells it to print as a *decimal* integer

2. Program Details
Return statement

```
num = 1;                    /*

printf("I am a simple ");
printf("computer.\n");
printf("My favorite number i

return 0;
```

- int main(void) → **main()** function is supposed to return an integer
- Return 0;
- Even if you don't do this, it will work.
- Don't worry too much about this.

3. The structure of a simple program
A function consists of a header and a body

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Header

Body

```
{
...
return 0;
 }
```

```
#include <stdio.h>
int main(void)

{
int q;
q = 1;
printf("%d is neat. \n", q);
return 0;
}
```

Preprocessor instructions (전처리 지시자)

Function name (함수이름)

Declaration statement (선언명령문)

Assignment statement (대입명령문)

Function statement (함수호출명령문)

4. Tips on making a readable program
Style matters

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- A readable program is much easier to understand, to correct or modify
  - Choose meaningful variables
  - Use comments as much as possible
  - Use blank lines to separate one section from another
  - Use one line per statement – C has a free-form format and allows for multiple statements per line

```
#include <stdio.h>

int main(void)  { int q; q = 1; printf("%d is neat. \n", q); return 0; }
```

This program works okay but this a bad program!!

5. Taking another step
Calculation & multiple variables

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```c
// fathm_ft.c -- 2 fathoms를 feet로 변환한다
#include <stdio.h>
int main(void)
{
    int feet, fathoms;

    fathoms = 2;
    feet = 6 * fathoms;
    printf("%d fathoms는 %d feet다!₩n", fathoms, feet);
    printf("맞아, %d feet야.₩n", 6 * fathoms);

    return 0;
}
```

Begins with a comment

Declares two variables instead of just one,
Use comma ,

calculation. feet = 6 × 2

Printing multiple variables

Printing a value (not just a variable)

5. Taking another step
Multiple functions

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prototype

Function call

butler() executed here!!!

Function definition

```c
/* two_func.c -- 하나의 파일에서 두 개의 함수를 사용하는 프로그램 */
#include <stdio.h>
void butler(void);      /* ISO/ANSI C 함수 프로토타입 */
int main(void)
{
    printf("butler 함수 밖에 있느냐?\n");
    butler();
    printf("그래. 차 한 잔 내오고, CD-ROM 드라이브도 가져오너라.\n");

    return 0;
}
void butler(void)       /* 함수 정의의 시작 */
{
    printf("부르셨습니까? 주인님!\n");
}
```

- **butler**() function appeared three times: prototype, function call, function definition
- void butler(void);

no return value

no argument

- Prototype: - a declaration telling the compiler that you are using a function.
  - specifies properties of the function
- The location of function definition does not matter. But it's nice to put **main**() first.

5. Taking another step
Debugging – Syntax errors

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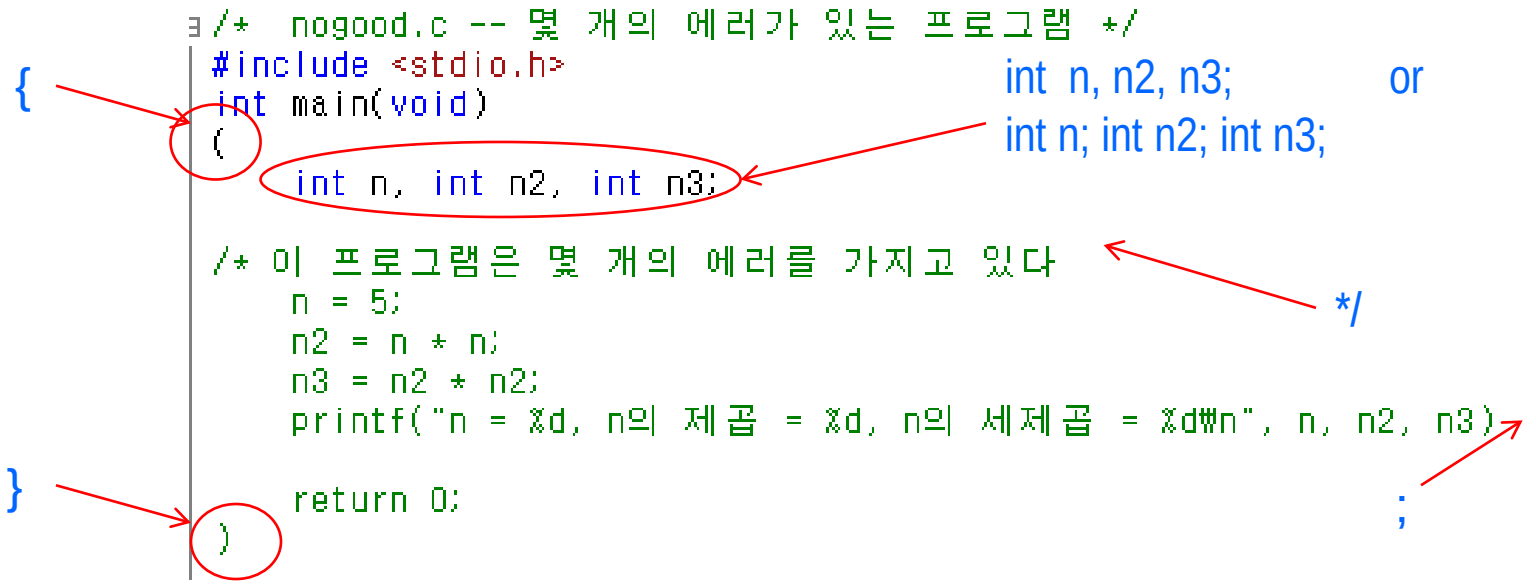
- Bugs: program errors.
- Debugging: finding and fixing the errors.
- Syntax error = Grammatical error in C, compiler will find these (but don't just rely on that)~ grammatical error in English



5. Taking another step
Debugging – semantic errors

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- Semantic errors: errors in meaning
- Compiler does not detect semantic errors ← don't violate C rules.
- You have to find these errors.

```
/*  nogood.c -- 몇 개의 에러가 있는 프로그램 */
#include <stdio.h>
int main(void)
(
    int n, int n2, int n3;

/* 이 프로그램은 몇 개의 에러를 가지고 있다
    n = 5;
    n2 = n * n;
    n3 = n2 * n2;
    printf("n = %d, n의 제곱 = %d, n의 세제곱 = %d₩n", n, n2, n3)

    return 0;
)
```

N3 = n2 * n;

5. Taking another step
Debugging – Program state

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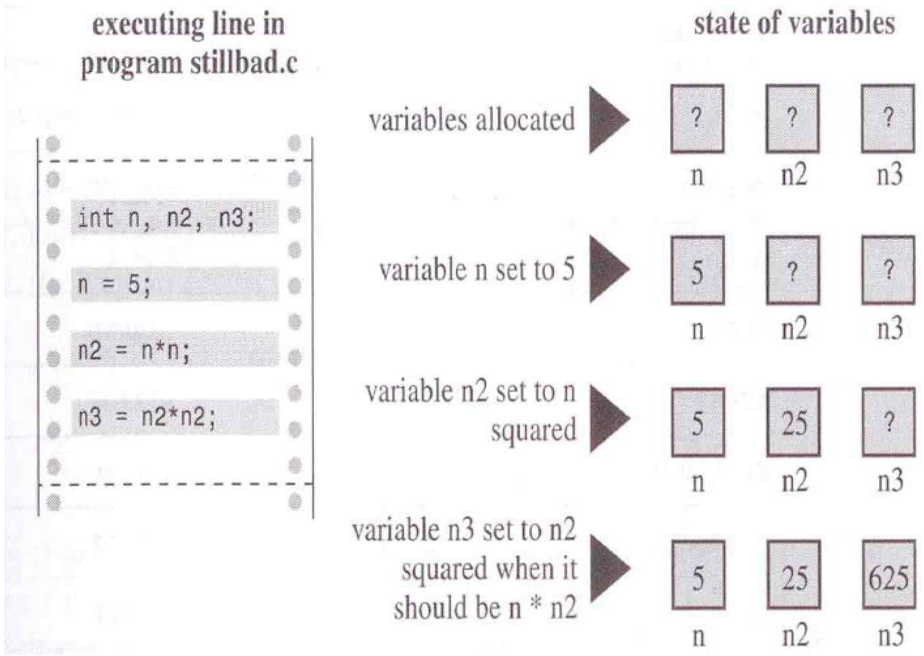
- Tracing the state
  - Follow the program steps one by one
  - Use extra (temporary) printf() to monitor the selected variables at key points
  - Use debugger

Tracing a program



5. Taking another step
Keywords and reserved identifiers

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- Keywords : vocabulary of C – not your vacabulary and we can't use them as identifier

  Ex) int float do void if long …

  - There will be syntax errors if you use them.
- Reserved identifiers: no syntax errors but you shouldn't use. Reserved

  Ex) printf(), _Bool (those beginning with _)

Summary

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- Putting together a simple C program
- Functions (함수): main(), printf()
- Creating variables, assigning them values, and displaying those values on screen
- The newline character (개행문자), Operator (연산자): =
- Comments in your program, creating programs with more than one functions, and finding program errors
- Keywords – vocabulary of C