

Week 3 - Lecture 2

Operators

Edited by: Dr. Wooi Ping Cheah
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Overview

- **Operators**
- Meaningful names
- Encapsulation and Refactoring

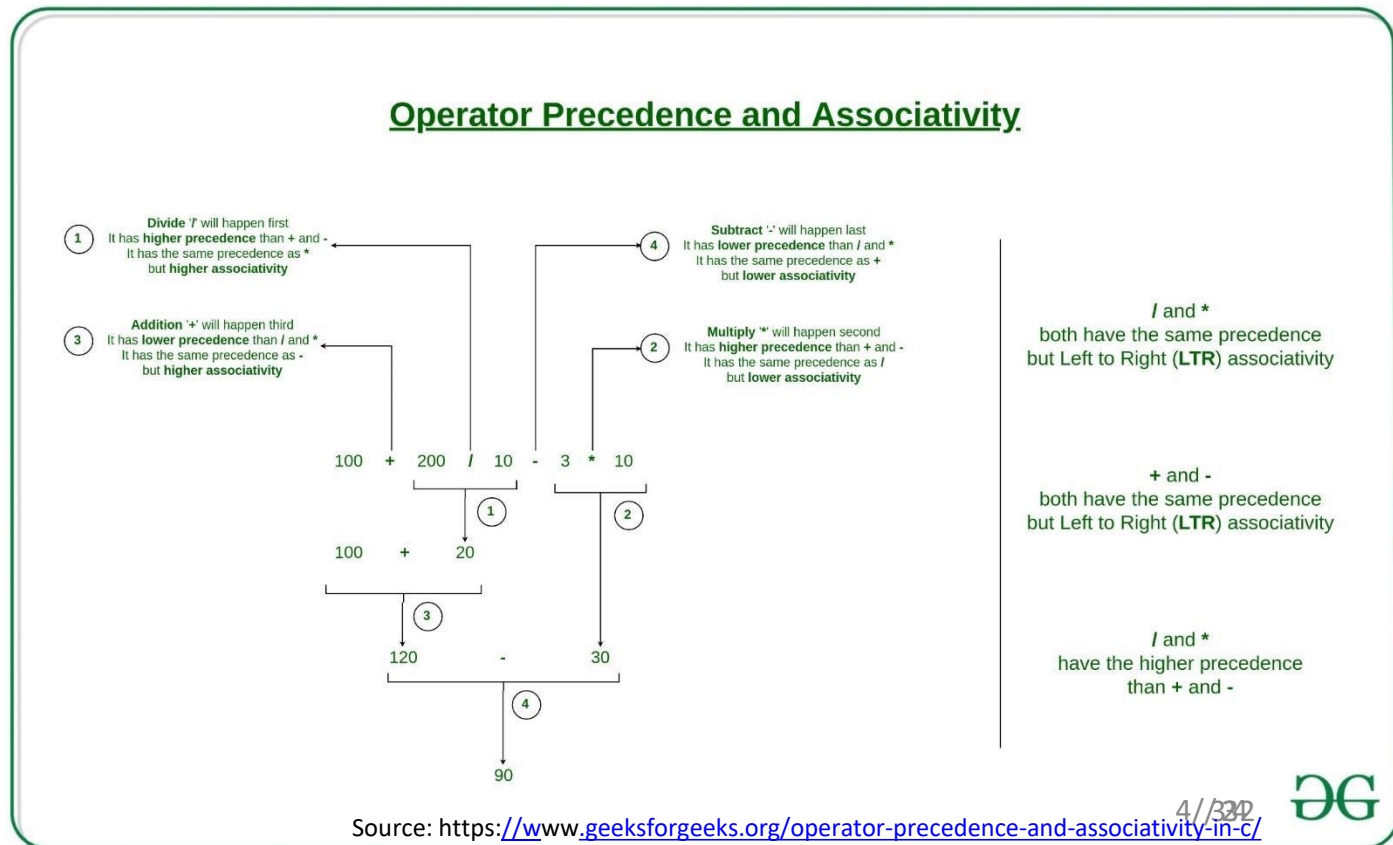


Operator Precedence

- $7 + 5 * 3 - 1 = 21$ $*$ has higher precedence
 $7 * 4 / 2 + 5 = 19$ $*$ and $/$ are left associative
- $a = 7 + (5 * 3) - 1;$
 rather than $(7 + 5) * (3 - 1);$
- $a = (((7 * 4) / 2) + 5);$

Operator Associativity

- Suggestion: ALWAYS use brackets and simply your statements!



Assignment and Arithmetic Operators

- Assignment (=)

```
int a, b, c;
```

```
a = b = c = 10;
```

From right to left

Watch out for types e.g.

```
int a;
```

```
float b;
```

```
b = a = 10.22;
```

MUST be int % int

- Arithmetic

```
+ - * / %
```

Increment and Decrement Operators

- `int a = 4;`
`a++;` `a = a + 1 = 5`
- `int a = 4, b;`
`b = a++;` `b = a; a = a + 1 = 5`
`BUT b = 4!!!`
- `int a = 1, b = 2, c = 3, d;`
`d = (++a)-(b--)+(--c);`

`d = 2 - 2 + 2 = 2`
`BUT a, b, c becomes 2, 1, 2`

Relational Operators

- $>$, \geq , $<$, \leq , \neq , $==$

```
60     int a = 4;
61     int b = 5;
62     int c = 5;
63     int d = 6;
64
65     printf("%d > %d = %d\n", a, b, a > b);
66     printf("%d < %d = %d\n", a, b, a < b);
67
68     printf("%d <= %d = %d\n", a, b, a <= b);
69     printf("%d >= %d = %d\n", d, b, d >= b);
70     printf("%d >= %d = %d\n", c, b, c >= b);
71     printf("%d <= %d = %d\n", c, b, c <= b);
72
73     printf("%d == %d = %d\n", c, b, c == b);
74     printf("%d != %d = %d\n", c, b, c != b);
```

Not Operator

- Every non-zero number is true.
 - Not operator (!) acts on a single operand
- ```
int a = 4;
printf("%d\n", !a);
```

Display zero

if(!a) is equivalent to if(a == 0)

if(a) is equivalent to if (a != 0)

```
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int a = 4;

if(!a)
{
 printf("a is equal to false\n");
}
else
{
 printf("a is equal to true\n");
}

if(a)
{
 printf("a is equal to true\n");
}
else
{
 printf("a is equal to false\n");
}

if(a == 0)
{
 printf("a is equal to false\n");
}
else
{
 printf("a is equal to true\n");
}

if(a != 0)
{
 printf("a is equal to true\n");
}
else
{
 printf("a is equal to false\n");
}
```

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# Make Errors Obvious

- Try your best to avoid implicit statements.

```
.54 int a = 1;
.55 int b = 2;
.56 int c = 0;
.57
.58 if(a) // not recommended, it is best to make your purpose explicit
.59 {
.60 printf("a is true\n");
.61 }
.62
.63 if(a == 1)
.64 {
.65 printf("a is true\n");
.66 }
.67
```

# Compound Operators

- $\text{exp1 op} = \text{exp2};$   
 $\text{exp1} = \text{exp1 op} (\text{exp2});$

Now ... let's suppose that  $a = 4$  and  $b = 2$

$a += 6;$

$$a = a + 6 = 10$$

$a *= b + 3;$

$$a = a * (b + 3) = 4 * (2 + 3) = 20$$

$a -= b + 8;$

$$a = a - (b + 8) = 4 - (2 + 8) = -6$$

$a /= b;$

$$a = a / b = 4 / 2 = 2$$

$a \% = b + 1;$

$$a = a \% (b + 1) = 4 \% (2 + 1) = 1$$

# Logical && Operators

- && is left associative, returns 1 if all operands are true
- ```
int a = 10, b = 20, c;  
c = (a > 15) && (++b > 15);
```
- ```
printf(“%d %d\n”, c, b);
```

Since **the first operand (a > 15) is false**, the second operand is not evaluated, the program displays 0 and 20;

# Logical && Operators (2)

C:\ Command Prompt

```
C:\Users\z2017233\Desktop>operators
a = 10, b = 21, and c = 1
a = 10, b = 20, and c = 0
C:\Users\z2017233\Desktop>
```

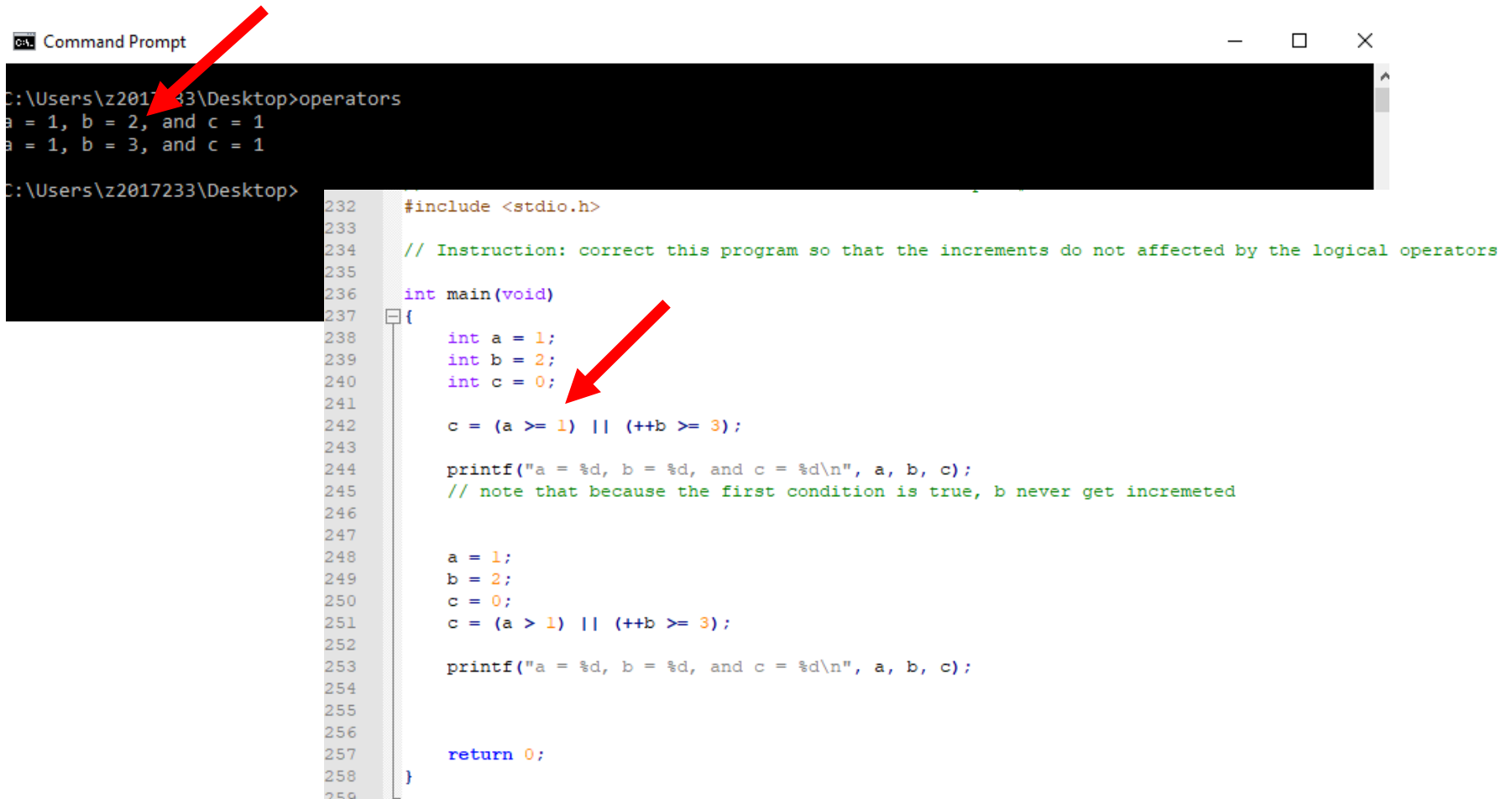
```
203 #include <stdio.h>
204
205 int main(void)
206 {
207 int a = 10;
208 int b = 20;
209 int c = 0;
210
211 c = (a >= 10) && (++b >= 15);
212
213 printf("a = %d, b = %d, and c = %d\n", a, b, c);
214
215
216 a = 10;
217 b = 20;
218 c = 0;
219 c = (a > 10) && (++b >= 15);
220
221 printf("a = %d, b = %d, and c = %d\n", a, b, c);
222 // note that because the first condition is false, b never get incremented
223
224
225 return 0;
226 }
227
```

# Logical II Operators

- `||` returns 1 if one of more operands are true
- ```
int a = 10, b = 20, c;  
c = (a > 5) || (++b > 15);
```
- ```
printf("%d %d\n", c, b);
```

Since **the first operand (a > 5) is true**, the second operand is not evaluated, the program displays 1 and 20;

# Logical II Operators (2)



```
CA: Command Prompt
C:\Users\z2017233\Desktop>operators
a = 1, b = 2, and c = 1
a = 1, b = 3, and c = 1
C:\Users\z2017233\Desktop>

#include <stdio.h>
// Instruction: correct this program so that the increments do not affected by the logical operators
int main(void)
{
 int a = 1;
 int b = 2;
 int c = 0;

 c = (a >= 1) || (++b >= 3);

 printf("a = %d, b = %d, and c = %d\n", a, b, c);
 // note that because the first condition is true, b never get incremented

 a = 1;
 b = 2;
 c = 0;
 c = (a > 1) || (++b >= 3);

 printf("a = %d, b = %d, and c = %d\n", a, b, c);

 return 0;
}
```

# Suggestions: Sequence Statements

- Put only one statement per line
- Avoid statements that rely on **side-effect order** e.g. ++, -- put the variables on lines by themselves
- Use blank lines to organise statements into paragraphs and to separate logically related statements
- Use indentations

Source: <http://homepages.inf.ed.ac.uk/dts/pm/Papers/nasa-c-style.pdf>



# Recommended coding style

- blank lines, spaces and indentation

```
1 #include <stdio.h>
2
3 #define LOWER 0
4 #define UPPER 300
5 #define STEP 20
6
7 int main() /* Fahrenheit - Celsius table */
8 {
9 int fahr = 0;
10
11 for (fahr = LOWER; fahr <= UPPER; (fahr = (fahr + STEP)))
12 printf("%4d %6.1f\n", fahr, ((5.0 / 9.0) * (fahr - 32)));
13
14 return 0;
15 }
```

```
1 #include <stdio.h>
2 #define LOWER 0
3 #define UPPER 300
4 #define STEP 20
5 int main()
6 {
7 int fahr;
8 for (fahr=LOWER;fahr<=UPPER;fahr=fahr+STEP)
9 printf("%4d %6.1f\n",fahr,(5.0/9.0)*(fahr-32));
10 return 0;
11 }
```

Your compiler doesn't check your comments !!



# Comma Operator

- Comma (,) is left associative

```
int b;
```

```
b = 20, b = b + 30, printf("Num = %d\n", b);
```

Num = 50 will be displayed

- The most common use of comma is in **for** statement

```
int a, b;
```

```
for(a = 1, b = 2; b < 10; a++, b++)
```

This loop will be executed 8 times

# Suggestions: Compound Statements

- Lists of statements enclosed in braces aka blocks, i.e.  
Braces around single statements can sometime help improve the readability.
- If a for loop will not fit on one line, **do three!!**

```
for (curr = *listp, trail = listp;
 curr != NULL;
 trail = &(curr->next), curr = curr->next)
{
 statement_1;
 ...
 statement_n;
}
```

Source: <http://homepages.inf.ed.ac.uk/dts/pm/Papers/nasa-c-style.pdf>



# Suggestions: Compound Statements (cont.)

- For large block, comment closing braces

```
for (sy = sytable; sy != NULL; sy = sy->sy_link)
{
 if (sy->sy_flag == DEFINED)
 {
 ...
 }
 else
 {
 ...
 }
 /* if defined */
 /* if undefined */
 /* for all symbols */
}
```

- Look at the following example

```
/* Locate end of string */
for (char_p = string; *char_p != EOS; char_p++)
; /* do nothing */
```

# Suggestion: Limit the Complexity

Command Prompt

```
C:\Users\z2017233\Desktop>controls
10

C:\Users\z2017233\Desktop>
```

```
249 #include <stdio.h>
250
251 // Instruction: correct the program so that it will display the correct message
252
253 int main(void)
254 {
255 int i = 10;
256
257 printf("%d\n", (i==10)?i++:(i>10)?i++:(i>10)?i--:(i>10)?i--:0);
258
259 return 0;
260 }
```

# Overview

- Operators
- **Meaningful names**
- Encapsulation and Refactoring



# Meaningful Names

- Precise and consistent
- Not too long names
- Follow uniform scheme when abbreviation
- C is case sensitive!

*Example: standard short names*

|         |            |
|---------|------------|
| c       | characters |
| i, j, k | indices    |
| n       | counters   |
| p, q    | pointers   |
| s       | strings    |

*Example: standard suffixes for variables*

|       |                        |
|-------|------------------------|
| _ptr  | pointer                |
| _file | variable of type file* |
| _fd   | file descriptor        |

# Examples - Commenting

*Example: boxed comment prolog*

```
/* *****
 * FILE NAME
 *
 * PURPOSE
 *
 ***** */
```

*Example: section separator*

```
/* ***** */
```

*Example: block comment*

```
/*
 * Write the comment text here, in complete sentences.
 * Use block comments when there is more than one
 * sentence.
 */
```

*Example: short comments*

```
double ieee_r[]; /* array of IEEE real*8 values */
```

# Overview

- Operators
- Meaningful names
- **Encapsulation and Refactoring**





# Encapsulation and Information Hiding

- Grouping related elements into:
  - Files e.g., header files
  - Data sections and function sections
  - Groups of logically related functions
  - Groups of logically related data e.g., structure
- Controlling the visibility or scope of program elements:
  - Include only needed header files
  - External variable is only visible to a function when declared by the external declaration



# Example

```
1 #include <stdio.h>
2
3 int main(){
4 printf("Hello World!!\n");
5 return 0;
6 }
7
```

```
int printf(const char *format, ...)
{
 va_list args;

 va_start(args, format);
 return print(0, format, args);
}

int sprintf(char *out, const char *format, ...)
{
 va_list args;

 va_start(args, format);
 return print(&out, format, args);
}
```

```
static int print(char **out, const char *format, va_list args)
{
 register int width, pad;
 register int pc = 0;
 char scr[2];

 for (; *format != 0; ++format) {
 if (*format == '%') {
 ++format;
 width = pad = 0;
 if (*format == '\\0') break;
 if (*format == '%') goto out;
 if (*format == '-') {
 ++format;
 pad = PAD_RIGHT;
 }
 while (*format == '0') {
 ++format;
 pad |= PAD_ZERO;
 }
 for (; *format >= '0' && *format <= '9'; ++format) {
 width *= 10;
 width += *format - '0';
 }
 if(*format == 's') {
 register char *s = (char *)va_arg(args, int);
 pc += prints (out, s?s:"(null)", width, pad);
 continue;
 }
 if(*format == 'd') {
 pc += printi (out, va_arg(args, int), 10, 1, width, pad, 'a');
 continue;
 }
 if(*format == 'x') {
 pc += printi (out, va_arg(args, int), 16, 0, width, pad, 'a');
 continue;
 }
 if(*format == 'X') {
 pc += printi (out, va_arg(args, int), 16, 0, width, pad, 'A');
 continue;
 }
 if(*format == 'u') {
 pc += printi (out, va_arg(args, int), 10, 0, width, pad, 'a');
 continue;
 }
 if(*format == 'c') {
 /* char are converted to int then pushed on the stack */
 scr[0] = (char)va_arg(args, int);
 scr[1] = '\\0';
 pc += prints (out, scr, width, pad);
 continue;
 }
 else {
 out:
 printchar (out, *format);
 ++pc;
 }
 }
 if (out) **out = '\\0';
 va_end(args);
 return pc;
 }
}
```

# Code Refactoring

```
#include<stdio.h>
void main()
{
 int a,b,result;
 printf("\nGoing to calculate the sum :");
 printf("\nEnter two numbers:");
 scanf("%d %d",&a,&b);
 result = a+b;
 printf("\nThe sum is %d",result);
}
```

```
#include<stdio.h>
void sum(int, int);
void main()
{
 int a,b,result;
 printf("\nGoing to calculate the sum :");
 printf("\nEnter two numbers:");
 scanf("%d %d",&a,&b);
 sum(a,b);
}
void sum(int a, int b)
{
 printf("\nThe sum is %d",a+b);
}
```

To improves non-functional attributes of the software

# Code Refactoring (2)

```
1 #include <stdio.h>
2 #include <stdlib.h>
3
4 int main()
5 {
6 /* square root of n with Newton-Raphson approximation */
7
8 double r = 10.0;
9 double n = 20.0;
10 double t = 30.0;
11
12 r = (n / 2);
13 while (abs(r - (n / r)) > t)
14 {
15 r = 0.5 * (r + (n / r));
16 }
17 printf("r = %.2f\n", r);
18 return 0;
19 }
```

Function Declaration

```
1 #include <stdio.h>
2 #include <stdlib.h>
3
4 double square_root_approx(double n);
5
6 int main()
7 {
8 double approx = 0.0;
9
10 approx = square_root_approx(20.0);
11 printf("r = %.2f\n", approx);
12
13 return 0;
14 }
15
16 double square_root_approx(double n)
17 {
18 /* square root of n with Newton-Raphson approximation */
19
20 double r = 10.0;
21 double t = 30.0;
22
23 r = (n / 2);
24 while (abs(r - (n / r)) > t)
25 {
26 r = 0.5 * (r + (n / r));
27 }
28
29 return r;
30 }
```

Function Definition

# Nested If Statements

- Do not use nested if statements when only if clause contains actions

*Example: absence of braces produces undesired result*

```
if (n > 0)
 for (i = 0; i < n; i++)
 if (s[i] > 0)
 {
 printf("...");
 return(i);
 }
else /* WRONG -- the compiler will match to closest */
 /* else-less if */
 printf("error - n is zero\n");
```

Without the braces, else will be paired with the nearest If.

*Example: braces produce desired result*

```
if (n > 0)
{
 for (i = 0; i < n; i++)
 {
 if (s[i] > 0)
 {
 printf("...");
 return(i);
 }
 }
}
else /* CORRECT -- braces force proper association */
 printf("error - n is zero\n");
```

Source: <http://homepages.inf.ed.ac.uk/dts/pm/Papers/nasa-c-style.pdf>

# Style Guides

- NASA

[https://mechatronics.me.wisc.edu/labresources/DataSheets/NASA-GSFC\\_C\\_Programming\\_Styles-94-003.pdf](https://mechatronics.me.wisc.edu/labresources/DataSheets/NASA-GSFC_C_Programming_Styles-94-003.pdf)

- IPA

<https://www.ipa.go.jp/files/000065271.pdf>

- In-house, etc.

# Summary

- Operators
- Meaningful names
- Encapsulation and Refactoring

