COMSW 1003-1

Introduction to Computer Programming in C

Lecture 5

Spring 2011

Instructor: Michele Merler

http://www1.cs.columbia.edu/~mmerler/comsw1003-1.html

Announcements

- Exercise 1 solution out
- Exercise 2 out

- Read PCP Ch 6

Today

- Review of operators and printf()
- Binary Logic
- Arrays
- Strings

Review : printf

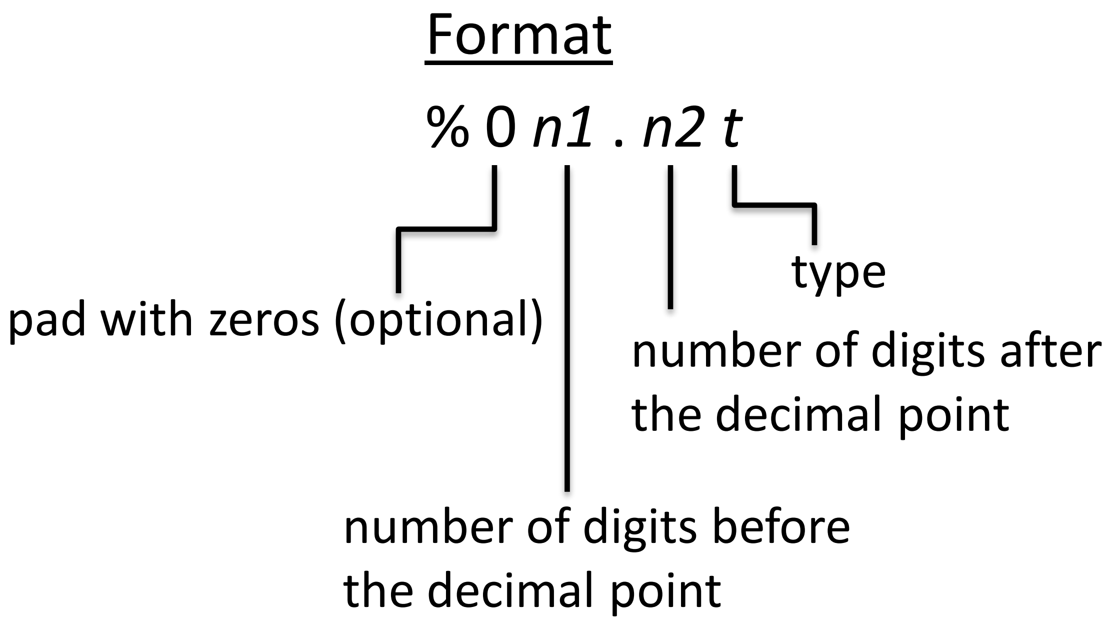
- `printf` is a function used to print to standard output (command line)

- Syntax:

```
printf("format1 format2 …", variable1, variable2,…);
```

- Format characters:

– %d or %i	integer
– %f	float
– %lf	double
– %c	char
– %u	unsigned
– %s	string


Format
% 0 *n1* . *n2* *t*
pad with zeros (optional)
number of digits before the decimal point
number of digits after the decimal point
type

printfExample.c

Review : printf

```c
#include <stdio.h>

int main() {

   int a,b;
   float c,d;
   a = 15;
   b = a / 2;

   printf(”%d\n”,b);
   printf(”%3d\n”,b);
   printf(”%03d\n”,b);

   c = 15.3;
   d = c / 3;
   printf(”%3.2f\n”,d);

   return(0);

}
```

Output:

```
7
  7
007



5.10
```

Review : printf

Escape sequences

\n	newline
\t	tab
\v	vertical tab
\f	new page
\b	backspace
\r	carriage return

Binary Logic

- In binary logic, variables can have only 2 values:
  - True (commonly associated with 1)
  - False (commonly associated with 0)

- Binary Operations are defined through TRUTH TABLES

AND

v = x & y

x	y	v
0	0	0
0	1	0
1	0	0
1	1	1

NOT

v = !x

x	v
0	1
1	0

OR

v = x | y

x	y	v
0	0	0
0	1	1
1	0	1
1	1	1

EXOR

v = x ^ y

x	y	v
0	0	0
0	1	1
1	0	1
1	1	0

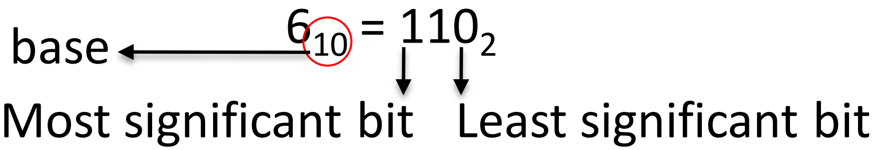
Binary Logic

- 1 = true, 0 = false
- Decimal to binary conversion

$$6_{10} = 110_2$$

Binary Logic

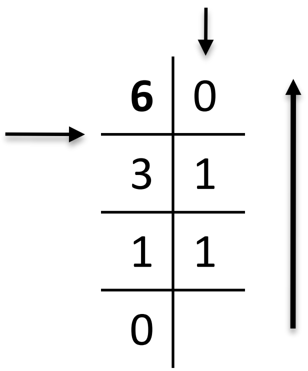
- 1 = true, 0 = false
- Decimal to binary conversion



$6_{10} = 110_2$

Divide by 2

remainder



6	0
3	1
1	1
0	

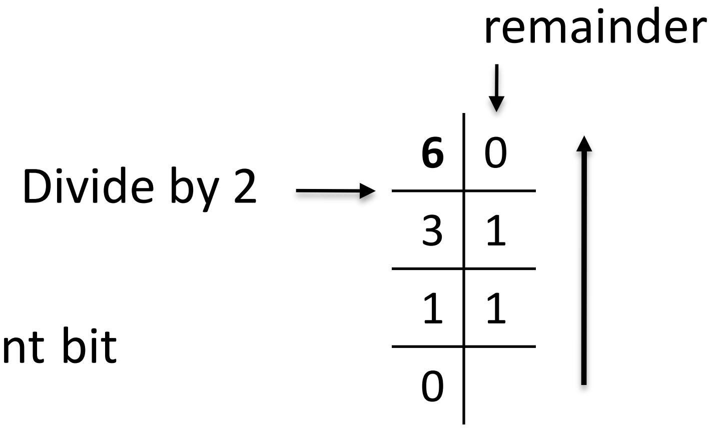
Binary Logic

- 1 = true, 0 = false

- Decimal to binary conversion

base ← $6_{10} = 110_2$

Most significant bit   Least significant bit



remainder

Divide by 2

6	0
3	1
1	1
0	

- Binary to decimal conversion

$11001_2 = 1x2^0 + 0x2^1 + 0x2^2 + 1x2^3 + 1x2^4 = 25$

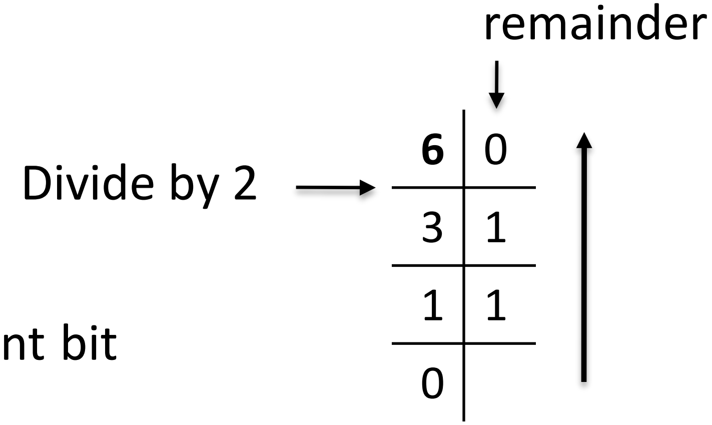
Binary Logic

- 1 = true, 0 = false

- Decimal to binary conversion

base ← $6_{10} = 110_2$

Most significant bit   Least significant bit



remainder

Divide by 2

6	0
3	1
1	1
0	

- Binary to decimal conversion

$11001_2 = 1x2^0 + 0x2^1 + 0x2^2 + 1x2^3 + 1x2^4 = 25$

- AND
  v = x & y

x	y	v
0	0	0
0	1	0
1	0	0
1	1	1

- OR
  v = x | y

x	y	v
0	0	0
0	1	1
1	0	1
1	1	1

- NOT
  v = !x

x	v
0	1
1	0

- EXOR
  v = x ^ y

x	y	v
0	0	0
0	1	1
1	0	1
1	1	0

Review: Operators

• Assignment	=
• Arithmetic	* / % + -
• Increment	++ - - += -=
• Relational	< <= > >= == !=
• Logical	&& | | !
• Bitwise	& | ~ ^ << >>
• Comma	,

Operators - Bitwise

- Work on the binary representation of data
- Remember: computers store and see data in binary format!

```
int x, y, z , t, q, s, v;
```

`x = 3;`		00000000000000000000000000000011
`y = 16;`		00000000000000000000000000010000
`z = x << 1;`	equivalent to $z = x \cdot 2^{1}$	00000000000000000000000000000110
`t = y >> 3;`	equivalent to $t = y \cdot 2^{-3}$	00000000000000000000000000000010
`q = x & y;`		00000000000000000000000000000000
`s = x | y;`		00000000000000000000000000010011
`v = x ^ y;`		00000000000000000000000000010011

↓ XOR

Operators - Arithmetic

* / % + -

- Arithmetic operators have a **precedence**

```
int x;

x = 3 + 5 * 2 - 4 / 2;
```

- We can use parentheses () to impose our precedence order

```
int x;

x = (3 + 5) * (2 – 4) / 2;
```

- % returns the module (or the remainder of the division)

```
int x;

x = 5 % 3;  // x = 2
```

- We have to be careful with integer vs. float division : remember automatic casting!

```
int x = 3;
float y;

y = x / 2; // y = 1.00
```

Possible fixes:
1)`float x  = 3;`
2)`y = (float) x /2;`
Then `y = 1.50`

```
float y;

y = 1 / 2;  // y = 0.00
```

Possible fix: `y = 1.0/2;`
Then `y = 0.50`

Operators – Increment/Decrement

```
++    --    +=    -=
```

```
int x = 3, y, z;
```

`x++;` → x is incremented at the end of statement

`++x;` → x is incremented at the beginning of statement

```
y = ++x + 3; // x = x + 1; y = x + 3;

z = x++ + 3; // z = x + 3; x = x + 1;

x -= 2;      // x = x - 2;
```

Operators - Relational

```
<   <=   >   >=   ==   !=
```

- Return 0 if statement is false, 1 if statement is true

```
int x = 3, y = 2, z, k, t;

z = x > y;        // z = 1

k = x <= y;       // k = 0

t = x != y;       // t = 1
```

Operators - Logical

&& || !

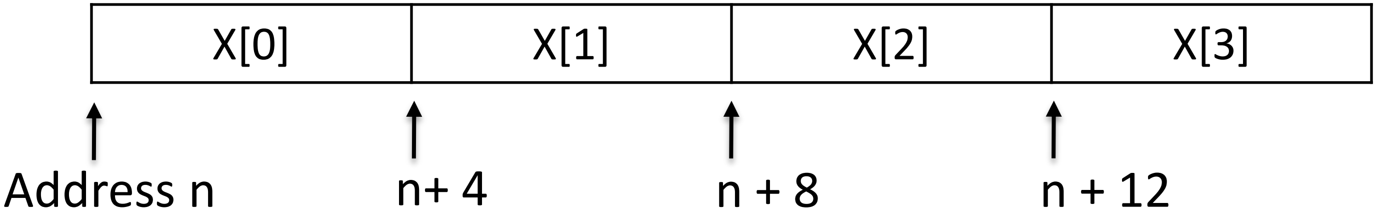
- A variable with value 0 is false, a variable with value !=0 is true

```
int x = 3, y = 0, z, k, t, q = -3;

z = x && y;     // z = 0;     x is true but y is false

k = x || y;     // k = 1;     x is true

t = !q;         // t = 0;     q is true
```

Arrays

- “A set of consecutive memory locations used to store data” [PCP, Ch 5]

```
int X[4];  // a vector containing 4 integers
```



X[0] X[1] X[2] X[3]

Address n

n+ 4

n + 8

n + 12

- Indexing starts at 0 !

```
X[0] = 3;
X[2] = 7;
```

- Be careful not to access uninitialized elements!

```
int c = X[7];
```

gcc will not complain about this, but the value of x is going to be random!

Arrays

- Multidimensional arrays

```
int arr[4][3];  // a matrix containing 4x3 = 12 integers
```

arr[0][0]	arr[0][1]	arr[0][2]
arr[1][0]	arr[1][1]	arr[1][2]
arr[2][0]	arr[2][1]	arr[2][2]
arr[3][0]	arr[3][1]	arr[3][2]

- Indexing starts at 0 !

```
arr[0][0] = 1;
arr[3][1] = 7;
```

- Initialize arrays

```
int X[4] = { 3, 6, 7, 89};
int Y[2][4] = { {19, 2, 6, 99}, {55, 5, 555, 0} };
int Arr[] = { 3, 6, 77};
```

This automatically allocates memory for an array of 3 integers

Strings

- Strings are arrays of `char`
- ‘\0’ is a special character that indicates the end of a string

```
char s[6] = {'H', 'e', 'l', 'l', 'o', '\0'};
```

We need 6 characters because there is ‘\0’

‘H’	‘e’	‘l’	‘l’	‘o’	‘\0’

```
char s[10] = "Hello";
```

‘H’	‘e’	‘l’	‘l’	‘o’	‘\0’				

```
char s[6];
s[0] = 'H';
s[1] = 'e';
s[2] = 'l';
s[3] = 'l';
s[4] = 'o';
s[5] = '\0';
```

- Difference between string and char

```
char c = 'a' ;
```

‘a’

```
char s[2] = "a" ;
```

‘a’	‘\0’

Strings functions

String specific functions are included in the library string.h

```
#include <string.h>

char s[6];
s = “Hello”;
```

Illegal ! String assignment can be done only at declaration!

- strcpy() : copy a string to another

```
strcpy( string1 , string2 );
```

Copy string2 to string1

```
char s[6];
strcpy(s, “Hello”);
```

String functions

String specific functions are included in the library string.h

- strcmp() : compare two strings

```
strcmp( string1 , string2 );
```

Returns :
0 if string1 and string2 are the same
value != 0 otherwise

```
char s1[] = “Hi”;
char s2[] = “Him”;
char s3[3];
strcpy( s3, s1 );
int x = strcmp( s1, s2 );   // x != 0
int y = strcmp( s1, s3 );   // y = 0
```

Strings functions

String specific functions are included in the library string.h

- strcat() : concatenate two strings

```
strcat( string1 , string2);
```

Concatenate *string2* at the end of *string1*

```
char s1[] = “Hello ”;
char s2[] = “World!”;
strcat(s1, s2);
```

‘H’	‘e’	‘l’	‘l’	‘o’	‘ ‘	‘W’	‘o’	‘r’	‘l’	‘d’	‘\0’

- strlen() : returns the length of a string (does not count ‘\0’)

```
strlen( string );
```

```
char s1[] = “Hello”;
int x = strlen(s1);     // x = 5
```

Reading Strings

Use functions from library stdio.h

- fgets() : get string from standard input (command line)

```
fgets( name , sizeof(name), stdin);
```

```
char s1[100];
fgets( s1, sizeof(s1), stdin);
```

Reads a maximum of sizeof(*name*) characters of a string from stdin and saves them into string *name*

NOTE: fgets() reads the newline character ‘\n’, so we should substitute it with ‘\0’;

```
name[strlen(name)-1] = ‘\0’;
```

‘H’	‘e’	‘l’	‘l’	‘o’	‘\n’

‘H’	‘e’	‘l’	‘l’	‘o’	‘\0’

- sizeof() : returns the size (number of bytes occupied in memory) of a variable (for strings it counts the number of elements, including ‘\0’)

Reading numbers – Option 1

- First, read a string
- Then, convert string to number
- sscanf() : get string from standard input (command line)

```
sscanf( string, “format”, &var1, …, &varN);
```

```
char s1[100];
int x, y;
printf(“Please enter two numbers separated by a space\n”)
fgets( s1, sizeof(s1), stdin);
```

User enters: 3 18

```
sscanf( s1, “%d %d”, &x, &y );

// x = 3; y = 18;
```

Reading numbers – Option 2

- Read directly the number
- scanf() : get string from standard input (command line) and automatically convert into a number

```
scanf( “format”, &var1, …, &varN);
```

```
int x, y;
printf(“Please enter two numbers separated by a space\n”)
```

User enters: 3 18

```
scanf( “%d %d”, &x, &y );

// x = 3; y = 18;
```

sumNums.c

Strings functions - recap

```
char s1[] = “Hello”;   char s2[] = “He”;   int x;   char c;
```

- strcmp(s1, s2)

  ```
  x = strcmp(s1, s2) // x != 0
  ```

- strcpy(s1, s2)

  ```
  strcpy( s2, s1 ); // s2 = “Hello”
  ```

- strcat(s1, s2)

  ```
  strcat( s2, s1 ); //s2 = “HelloHello”
  ```

- strlen(s)

  ```
  x = strlen(s1);   // x  = 5;
  ```

- sizeof(s)

  ```
  x = sizeof(s1);   // x = 6;
  ```

- fgets(s, sizeof(s1), stdin)

  ```
  fgets( s1, sizeof(s1), stdin);
  ```

  User enters “7R”

- sscanf(s, “%d”, &var)

  ```
  sscanf( s1, “%d%c”, &x, &c);
  // x = 7; c = ‘R’;
  ```

Read PCP Ch 6

Homework 1 review

HOW TO COMPRESS/UNCOMPRESS folders in UNIX

- Compress folder   ~/COMS1003/HW1   to   HW1.tar.gz

  ```
  tar -zcvf HW1.tar.gz  ~/COMS1003/HW1
  ```

- Uncompress   HW1.tar.gz   to folder   ~/COMS1003/HW1new

  ```
  tar -zxvf HW1.tar.gz  -C  ~/COMS1003/HW1new
  ```

  (note: ~/COMS1003/HW1new must exist already)