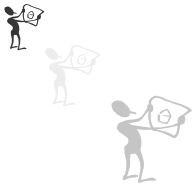
The C Programming Language

Types, Operators and Expressions

Computer Application

Outline



Data Type and Size

Type	signed	unsigned
char	8 2'com	8
short	16 2'com	16
long	32 2'com	32
int	16/32 2'com	16/32
float	32 fp	x
double	64 fp	x
long double	80 fp	x

Constant

Type	signed	unsigned
short	1234	1234U
long	1234L	1234UL
float	123.4f	x
double	123.4	x
long double	123.4L	x

Type	hexa	octal
integer	0x30FF	0377

Amazing Example

```
#include <ansi_c.h>
void main()
 {
  char x;
  unsigned char y;
  float z;
  int A;
  double B, C, D;

  x = 127;
  y = 1;
  z = -1.75;

  x = x+2;
  y = y-2;
  memcpy (&A, &z, 4);

  B = 2147483647 + 2;
  C = 2147483647 + 2U;
  D = 2147483647;
  D = D + 2;
  printf("%d  %d  %08x\n", x, y, A);
  printf("%12.0f  %12.0f\n", B, C);
  printf("%12.0f\n", D);
  getchar();
 }
```

```
<< Waiting for Input >>
-127    255    bfe00000
-2147483647    2147483649
 2147483649
```


Amazing Example FP

```
##include <ansi_c.h>
void main()
 {
  int k;
  float X, Y, Z;
  double A, B, C;

  X = 1.0;
  for (k=0; k<100000; k++)
            X+=1e-8;
  Y = 0.0;
  for (k=0; k<100000; k++)
            Y+=1e-8;
  Z = 1.0;
  Z += 100000*1e-8;
   printf("%12.8f  %12.8f  %12.8f\n", X, Y, Z);

  A = 1.0;
  for (k=0; k<100000; k++)
            A+=1e-8;
  B = 0.0;
  for (k=0; k<100000; k++)
            B+=1e-8;
  C = 1.0;
  C += 100000*1e-8;
  printf("%12.8f  %12.8f  %12.8f\n", A, B, C);
}
```

```
<< Waiting for Input >>
 1.00000000    0.00100084    1.00100005
 1.00100000    0.00100000    1.00100000
```

Constant

Type	symbol	ascii
Character	‘A’	‘\xhh’

Type	symbol
String (Fin by Null)	“Hello World"

String constant stored in memory continuously

‘X’ is not “X”

Character & String Example

```
#include <ansi_c.h>
void main()
 {
 char c, *s="Hello World";

 c = 65;
 printf("%c   %d\n", c, c);

 c = c+1;
 printf("%c   %d\n", c, c);

 c = 'A';
 printf("%c   %d\n", c, c);

 printf("%c   %c%c%d\n", c, 10, 13, c);

 c = '!' * 2 + 4;
 printf("%c   %d\n", c, c);

 printf("%s\n", s);
 printf("%p\n", s);
 printf("%s\n", (char*)0x4280A8);
 printf("%d\n", s[11]);
 printf("%p  %p\n", "Hello World", "Hello World");
 getchar();
 }
```

enumeration Constant

enum name {RED, GREEN, BLUE}

0 1 2

enum name {RED=7, GREEN, BLUE}

7 8 9

Enum & Base Example

```
#include <ansi_c.h>
void main()
 {
 enum Color {RED, GREEN, BLACK=10, YELLOW, BLUE=48};
 enum Color MyColor1, MyColor2;

 char a,b,c,d,e;

 a = '0';
 b = 48;
 c = 0x30;
 d = 060;
 e = BLUE;

 MyColor1 = GREEN;

 printf("%d  %d  %d  %d\n", RED, GREEN, BLACK, YELLOW);
 printf("%d\n", MyColor1);
 printf("%d  %d  %d  %d  %d\n", a,b,c,d,e);

 MyColor1 = 10;
 MyColor2 = 2;

 getchar();
 }
```

Declaration

StorageClass Qualifier DataType VarName = *InItVal*;

auto static extern register	const volatile	char short long int float double signed unsigned

Declaration Storage-Class and Qualifier

- **auto** – Identified - in the block. Life - in the block.
- **static** – Identified - in the block. Life - always.
- **extern** – Identified - anywhere. Life - always.
- **register** - auto variable recommended to CPU register
- By default auto variable init to *garbage*.
- By default extern and static variable init to zero.
- auto variable init multi-time to any value.
- extern and static variable init one’s to constant value.

- **const** is a variable that not change and init one’s.
- **volatile** is a variable that change by hardware.

Storage-Class and Qualifier Example

```
#include <ansi_c.h>
int Ex;
static int SEx;
const int CEx = 100;
int Tx = 10;

void f1(void)
  {
  char x1, x2 = 1;
  char static x3, x4 = 1;
  int N = 1000;
  x1++; x2++; x3++; x4++;
  {
  int N = x2 + x4;
  printf("%d  %d  %d  %d  %d\n\n", x1, x2, x3, x4, N);
  }
  }
void main()
  {
  int i;
  int Tx = 20;
  for (i=0; i<5; i++)
                f1();
  printf("\n\n%d  %d  %d  %d\n", Ex, SEx, CEx, Tx);
  getchar();
  }
```

```
21  2  1  2  4
21  2  2  3  5
21  2  3  4  6
21  2  4  5  7
21  2  5  6  8


0  0  100  20
```


Arithmetic Operator

Binary Operators

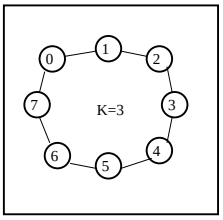
+ - * / %

Unary Operators

+ -

Arithmetic Operator

- The operators are associative to the operands.
- The minus is in 2-compliment representation.
- The integer arithmetic is modulo 2^k.



1 + 3 = 4 = 100 = – 4
6 + 3 = 1 = 001 = + 1
1 – 2 = 7 = 111 = – 1

Arithmetic Example

```
#include <ansi_c.h>
void main()
  {
  int A, B, C;
  double X, Y;

  A = 3 / 2;
  X = 3 / 2;
  printf("%d   %f\n", A, X);

  A = 3.0 / 2;
  X = 3.0 / 2;
  printf("%d   %f\n", A, X);

  A = 3 / 5 * 10;
  B = 3 * 10 / 5;
  printf("%d   %d\n", A, B);

  A = 3 / 5 * 10.0;
  B = 3 / 5.0 * 10;
  printf("%d   %d\n", A, B);

  A = 256 * 256 * 256 * 256 / 256 / 256 / 256;
  B = 256 / 256 * 256 / 256 * 256 / 256 * 256;
  printf("%d   %d\n", A, B);

  A =  7 % 4;
  B = -7 % 4;
  printf("%d   %d\n", A, B);

  getchar();
  }
```

```
1   1.000000
1   1.500000
0   5
0   2
0   256
3   -3
```


Relational and Logical Operator

> >= < <= == !=

&& || !

- **The type of Relational and Boolean expression is integer.**
- **The evaluation of Relational and Boolean expression is 0 or 1**
- **The value of operand for logical expression is:**

0 – False Non 0 – True

Relational and Logical Operator Example

```
#include <ansi_c.h>
void main()
  {
  int A, B, C;

  A = 3 > 2;
  B = 1 > 2;
  printf("%d   %d\n", A, B);

  A = 3 && 7;
  B = 2 || 0;
  printf("%d   %d\n", A, B);

  A = (3 > 0) * 5 + 2;
  B = ((7 == 1) + 3) * 2;
  printf("%d   %d\n", A, B);

  A = 5;
  B = !!A;
  printf("%d   %d\n", A, B);


  getchar();
  }
```

```
1   0
1   1
7   6
5   1
```

Assignment and Expressions

The assignment has a value of the expression.

X = Expressions

Shortened assignment

X *OP*= Expressions

X = X *OP* Expressions

Assignment Example

```
#include <ansi_c.h>
void main()
 {
 int A, B, C;

 A = 1;  B = 2;
 printf("%d   %d\n", A, B);
 printf("%d   %d\n", A=5, B=9);

 A = 3 * (B=2);
 printf("%d   %d\n", A, B);

 A = 3 * (B==3);
 printf("%d   %d\n", A, B);

 A = 4;   B = 8;
 A += 2;
 B /= 4;
 printf("%d   %d\n", A, B);

 A = B = C = 0;
 printf("%d   %d   %d\n", A, B, C);

 A *= B-= C+=3;
 printf("%d   %d   %d\n", A, B, C);

 A = (B=5, C=7);
 printf("%d   %d   %d\n", A, B, C);

 getchar();
 }
```

Increment and Decrement Operations

Post

Var++ Var--

Pre

++Var --Var

Increment and Decrement Example

```
#include <ansi_c.h>
void main()
 {
 int A, B, C;

 A = 5;
 B = A++;
 printf("%d   %d\n", A, B);

 A = 5;
 B = ++A;
 printf("%d   %d\n", A, B);

 A = 5;
 B = A-- * 3;
 printf("%d   %d\n", A, B);

 A = 8;
 B = 8;
 printf("%d   %d\n", A++, ++B);

 getchar();
 }
```

Conditional Expressions

expr1 ? expr2 : expr3

```
if (exp1 == TRUE)
      Expr2;
else
      Expr3;
```


Conditional Expressions Example

```
#include <ansi_c.h>
void main()
 {
 int A, B, C;

 A = 1;
 B = 2;
 printf("%d\n", A>B ? A : B);

 A = 50;
 B = 30;
 C = A>B ? A : B;
 printf("%d\n", C);

 A = -10;
 C = A>=0 ? A : -A;
 printf("%d\n", C);

 A = 1;
 printf(A ? "Hello True\n" : "Hello False\n");
 A = !A;
 printf(A ? "Hello True\n" : "Hello False\n");

 getchar();
 }
```