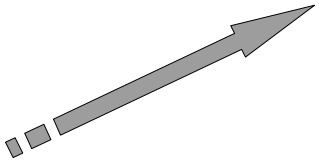
Lecture 6



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Arithmetic Operators

- C has a number of arithmetic operators which are used to combine variables and constants into expressions
  - Unary operators +, -
    - e.g. +x, -x
  - Binary operators +, -, *, /, %
    - e.g. x+y*z
- Integer expression examples

  1+2 = 3
  3*4 = 12
  17/5 = 3
  17%5 = 2
- Note that integer division discards any fractional part. The modulus operator can be useful for many things e.g. x%2 is 0 if x is even, 1 if x is odd

Operator Precedence

- If we have several operators in an expression, what order are they processed in

  e.g. does 1+2*3 evaluate to 9 or 7 ?
- C has fixed rules for this, see pg 22 of notes

  ( ), *, /, %, +, -
- We can force the order using parentheses which have top priority
- For operators of equal precedence the evaluation is from left to right

intarith.c

```
/*  Example: integer arithmetic operators */

/* Old Imperial measures: miles, furlongs, chains,
yards, feet and inches.

1 mi = 8 fur; 1 fur = 10 ch; 1 ch = 22 yd;
1 yd = 3 ft; 1 ft = 12 in */

#include <stdio.h>

#define FUR_PER_MI 8L
#define CH_PER_FUR 10L
#define YD_PER_CH 22L
#define FT_PER_YD 3L
#define IN_PER_FT 12L

/* Note: these are longs to avoid overflow later.
(The suffix L means the value should be treated
as a long.) */

main()
{
  int a = 5, b = 3;
  long x, remainder;
  int inches, feet, yards, chains, furlongs, miles;

  printf("a = %i, b = %i\n\n", a, b);

  printf("a + b = %i\n", a + b);
  printf("a - b = %i\n", a - b);
  printf("a * b = %i\n", a * b);
  printf("a / b = %i\n", a / b);
  printf("a %% b = %i\n", a % b);

  printf("\nEnter a number of inches: ");
  scanf("%li", &x);
```

```
  miles = x / IN_PER_FT / FT_PER_YD
            / YD_PER_CH / CH_PER_FUR
            / FUR_PER_MI;
  remainder = x % (IN_PER_FT * FT_PER_YD
                   * YD_PER_CH * CH_PER_FUR
                   * FUR_PER_MI);

/* Note: if the above constants are defined as ints,
overflow might occur when their product is computed.
This is because the product of ints is itself an int. */

  furlongs = remainder / IN_PER_FT / FT_PER_YD
                       / YD_PER_CH / CH_PER_FUR;
  remainder %= (IN_PER_FT * FT_PER_YD
                * YD_PER_CH * CH_PER_FUR);

  chains = remainder / IN_PER_FT / FT_PER_YD
                     / YD_PER_CH;
  remainder %= (IN_PER_FT * FT_PER_YD * YD_PER_CH);

  yards = remainder / IN_PER_FT / FT_PER_YD;
  remainder %= (IN_PER_FT * FT_PER_YD);

  feet = remainder / IN_PER_FT;
  inches = remainder % IN_PER_FT;

  puts("\nConverted to old fashioned units:");
  printf("%li inches = %i mi, ", x, miles);
  printf("%i fur, %i ch, ", furlongs, chains);
  printf("%i yd, %i ft, %i in\n", yards, feet, inches);
}
```

Traps for the unwary

```
/* BUG ZONE!!!
Example: integer arithmetic */

#include <stdio.h>

main()
{
  int r1 = 22000;
  int r2 = 10000;
  int r3 = 15000;
  int r;

  puts("Three resistors in parallel");
  printf("%i || %i || %i\n\n", r1, r2, r3);

  puts("Method 1: r = (r1 * r2 * r3)/(r1*r2 + r2*r3 + r3*r1)\n");
  r = (r1 * r2 * r3)/(r1*r2 + r2*r3 + r3*r1);  /* BUG */
  printf("Total resistance = %i\n\n", r);

  puts("Method 2: r = 1/(1/r1 + 1/r2 + 1/r3)\n");
  r = 1/(1/r1 + 1/r2 + 1/r3);  /* BUG */
  printf("Total resistance = %i\n", r);
}
```

```
/* BUG ZONE!!!
Example: integer arithmetic */

#include <stdio.h>

main()
{
  int StudentsInClass = 116;
  int MaxGroupSize = 5;
  int NumberOfGroups;
  int passes;
  int GirlsWithBrownEyes;

  NumberOfGroups = StudentsInClass/MaxGroupSize; /* BUG */

  printf("%i students at %i max. per group means %i groups\n\n",
    StudentsInClass, MaxGroupSize, NumberOfGroups);

  /* Three-quarters of the class pass the exam: */

  passes = 3/4 * StudentsInClass;  /* BUG */
  printf("%i students passed the exam\n\n", passes);

  /* Half the students are female, and
  half of these have brown eyes */

  GirlsWithBrownEyes = StudentsInClass / 2*2;  /* BUG */

  printf("There are %i brown-eyed girls in the class\n",
    GirlsWithBrownEyes);
}
```

Floating point expressions

- arithmetic with floats or doubles works more or less as expected, however we cant use % operator

```
/* Example: floating point arithmetic */

#include <stdio.h>

main()
{
  float r1 = 22000;
  float r2 = 10000;
  float r3 = 15000;
  float r;

  puts("Three resistors in parallel");
  printf("%5.0f || %5.0f || %5.0f\n\n", r1, r2, r3);

  puts("Method 1: r = (r1 * r2 * r3)/(r1*r2 + r2*r3 + r3*r1)\n");
  r = (r1 * r2 * r3)/(r1*r2 + r2*r3 + r3*r1);
  printf("Total resistance = %7.2f\n\n", r);

  puts("Method 2: r = 1/(1/r1 + 1/r2 + 1/r3)\n");
  r = 1/(1/r1 + 1/r2 + 1/r3);
  printf("Total resistance = %7.2f\n", r);
}
```

Type Casting

- Conversion between data types (eg `int` to `float`) is called casting. It can be :
  - implicit (done automatically)
    `int x=1.34;`
  - explicit (we force it to happen)
    `int x=(int)1.34;`
- Note:
  `int -> float` is straightforward, e.g. 32 -> 32.000
  `float -> int` involves truncation, e.g. 32.73 -> 32

typecast.c

```
/* Example: type casting */

#include <stdio.h>

main()
{
  float x = 34.256, y;
  int n = 27, m;
  char c = 'A';

  /* Implicit casting: */

  m = x * n; /* implicit (int) cast */
  y = n/2; /* implicit (float) cast */
  printf("m = %i, y = %6.2f\n\n", m, y);

  m = c * n; /* implicit (int) cast */
  printf("m = %i\n\n", m);

  /* Explicit casting: */

  m = (int)x * n; /* explict (int) cast */
  y = (float)n/2; /* explicit (float) cast */
  printf("m = %i, y = %6.2f\n\n", m, y);

  y = (float)c + x;
  printf("y = %6.3f\n\n", y);

  /* Explicit and implicit casting: */

  m = (float)n/2;
  y = ((int)x + 1)/2 + x;
  printf("m = %i, y = %6.3f\n\n", m, y);
}
```

Increment and Decrement Operators

- We could write `x=x+1` (this is valid C)
- But shorthand versions are:
  - pre increment : `++x`
  - post increment : `x++`
- The difference is that with `x++` the value of x is used first then incremented; the reverse for `++x`

eg

```
int a=5, b;
b=a++;
/*Now a is 6, b is 5*/
```

```
int a=5, b;
b=++a;
/*Now a is 6, b is 6*/
```

- There is also a decrement operator -- which follows the same rules

Assignment Operators

- We have already seen the basic assignment operator '=' e.g. `x=y`
- C also has some useful shorthand's

`a+=b`	means	`a=a+b`
`a-=b`	means	`a=a-b`
`a*=b`	means	`a=a*b`
`a/=b`	means	`a=a/b`
`a%=b`	means	`a=a%b`

- Something that can be used on the LHS of an assignment is called an lvalue e.g.
  x is an lvalue
  `x/2, 3+y, a+b` are not
- Because assignments are operators several can be combined in a single statement:
  `x=y=z=0;`

Relational Operators

- They are >, <, >=, <=, ==, !=
- Expressions involving these operators evaluate to true or false, e.g.
  - 27>21 is true
  - 27<=3 is false
- In C there is no logical or boolean data type, but integers can be used
  - 0 -> false
  - anything else -> true
- However, these relational operators give 1 for true

relation.c

```
/*  Example: relational and logical operators */

#include <stdio.h>

main()
{
  int a = 5, b = 6, c = 7;

  puts("int a = 5, b = 6, c = 7;\n");

  printf("The value of  a > b  is         \t%i\n\n", a > b);
  printf("The value of  b < c  is         \t%i\n\n", b < c);

  printf("The value of  a + b >= c  is    \t%i\n\n", a + b >= c);
  printf("The value of  a - b <= b - c  is\t%i\n\n", a - b <= b - c);

  printf("The value of  b - a == b - c  is\t%i\n\n", b - a == b - c);
  printf("The value of  a * b != c * c  is\t%i\n\n", a * b < c * c);
}
```

Statements

- Expressions can be made into statements by a suffixing semicolon
- Statements can be simple or complex

e.g.

```
x;
y++;
tall=height>180;
poly=a*x*x+b*x+c;
```

Blocks (or Compound Statements)

- These are simply one or more statements enclosed within braces { } to group them together.

```
{
    x=3;
    y=x+p;
    ++x;
}
```

- The compound statement is treated as a single entity, as well see in the next 2 lectures