C Operators

Comparison, Arithmetic, Logical Operators, Expressions

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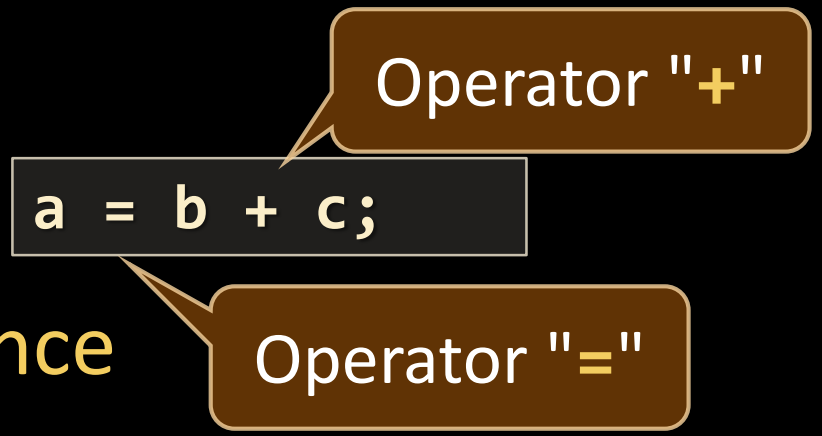
What is an Operator?

- Operator is an operation performed over data at runtime
  - Takes one or more arguments (operands)
  - Produces a new value
  - Example of operators:



- Operators have precedence
  - Precedence defines which will be evaluated first
- Expressions are sequences of operators and operands that are evaluated to a single value, e.g. `(a + b) / 2`

Operators in C#

- Operators in C# :
  - Unary – take one operand
  - Binary – take two operands
  - Ternary (`? :`) – takes three operands

- Except for the assignment operators, all binary operators are left-associative
- The assignment operators and the conditional operator (`? :`) are right-associative

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Operators in C

Arithmetic, Logical, Comparison, Assignment, Etc.

Categories of Operators in C

Category	Operators
Arithmetic	`+ - * / % ++ --`
Logical	`&& || ^ !`
Binary	`& | ^ ~ << >>`
Comparison	`== != < > <= >=`
Assignment	`= += -= *= /= %= &= |= ^= <<= >>=`
Type size	`sizeof`
Other	`* & . -> ?:`

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Operators Precedence

Operators Precedence

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Precedence	Operators
Highest	`()`
	`++ --` (postfix)
	`++ --` (prefix) `+ -` (unary) `! ~`
	`* / %`
	`+ -`
	`<< >>`
	`< > <= >= is as`
	`== !=`
	`&`
Lower	`^`

Operators Precedence (2)

Precedence	Operators
Higher	|
	&&
	||
	?:
Lowest	= *= /= %= += -= <<= >>= &= ^= |=

- Parenthesis operator always has highest precedence
- Note: prefer using parentheses, even when it seems stupid to do so

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Arithmetic Operators

Arithmetic Operators

- Arithmetic operators `+`, `-`, `*` are the same as in math
- Division operator `/` if used on integers returns integer (without rounding) or exception
- Division operator `/` if used on real numbers returns real number or `inf` or `nan`
- Remainder operator `%` returns the remainder from division of integers
- The special addition operator `++` increments a variable

Arithmetic Operators – Examples


```
int squarePerimeter = 17;
double squareSide = squarePerimeter / 4.0;
double squareArea = squareSide * squareSide;
printf("%f\n", squareSide); // 4.250000
printf("%f\n", squareArea); // 18.062500

int a = 5;
int b = 4;
printf("%d\n", a + b); // 9
printf("%d\n", a + b++); // 9
printf("%d\n", a + b); // 10
printf("%d\n", a + (++b)); // 11
printf("%d\n", a + b); // 11
```

Arithmetic Operators – Example (2)


```
printf("%d\n", 12 / 3); // 4
printf("%d\n", 11 / 3); // 3

printf("%f\n", 11.0 / 3); // 3.666666667
printf("%f\n", 11 / 3.0); // 3.666666667
printf("%d\n", 11 % 3);   // 2
printf("%d\n", 11 % -3);  // 2
printf("%d\n", -11 % 3);  // -2

printf("%f\n", 1.5 / 0.0);  // inf
printf("%f\n", -1.5 / 0.0); // -inf
printf("%f\n", 0.0 / 0.0);  // -nan

int x = 0;
printf("%f\n", 5 / x); // Floating point exception (core dumped)
```

Arithmetic Operators – Overflow Examples


```
#include <stdio.h>
#include <limits.h>

int main()
{
    int bigNum = 2000000000;
    int bigSum = 2 * bigNum; // Integer overflow!
    printf("%d\n", bigSum); // -294967296

    bigNum = INT_MAX;
    printf("%d\n", bigNum);
    bigNum = bigNum + 1;
    printf("%d\n", bigNum); // -2147483648

    return 0
}
```

`int` varies according to platform (2 or 4 bytes)

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Arithmetic Operators

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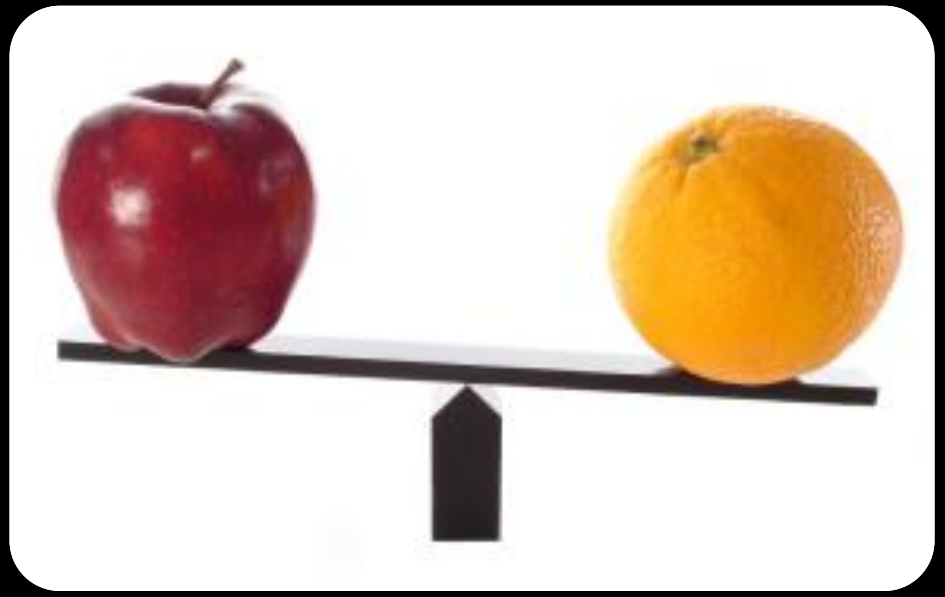
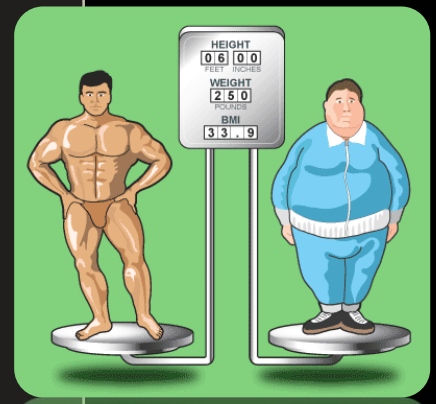
Comparison and Assignment Operators



Comparison Operators

- Comparison operators are used to compare variables
  - `==`, `<`, `>`, `>=`, `<=`, `!=`
  - Return `1` if the comparison is true, `0` if it is false

```
int a = 5;
int b = 4;
int result = a >= b; // 1
result = a != b; // 1
result = a == b; // 0
result = a == a; // 1
result = a != ++b; // 0
result = a > b; // 0
```



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Comparison and Assignment Operators

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Logical Operators

Logical Operators

- In C all logical operators take integer operands and return integers as result (`1` → true, `0` → false)
- Operator `!` turns `1` to `0` and `0` to `1`
- Behavior of the operators `&&`, `||` and `^` (`1` == `true`, `0` == `false`):

Operator	||	||	||	||	&&	&&	&&	&&	^	^	^	^
Operand1	0	0	1	1	0	0	1	1	0	0	1	1
Operand2	0	1	0	1	0	1	0	1	0	1	0	1
Result	0	1	1	1	0	0	0	1	0	1	1	0

Logical Operators – Example

```
int a = 1;
int b = 0;
int result = a && b; // 0
result = a || b; // 1
result = a ^ b; // 1
result = !b; // 1
result = b || 1; // 1
result = b && 1; // 0
result = a || 1; // 1
result = a && 1; // 1
result = !a; // 0
result = (5>7) ^ (a==b); // 0
```

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Logical Operators

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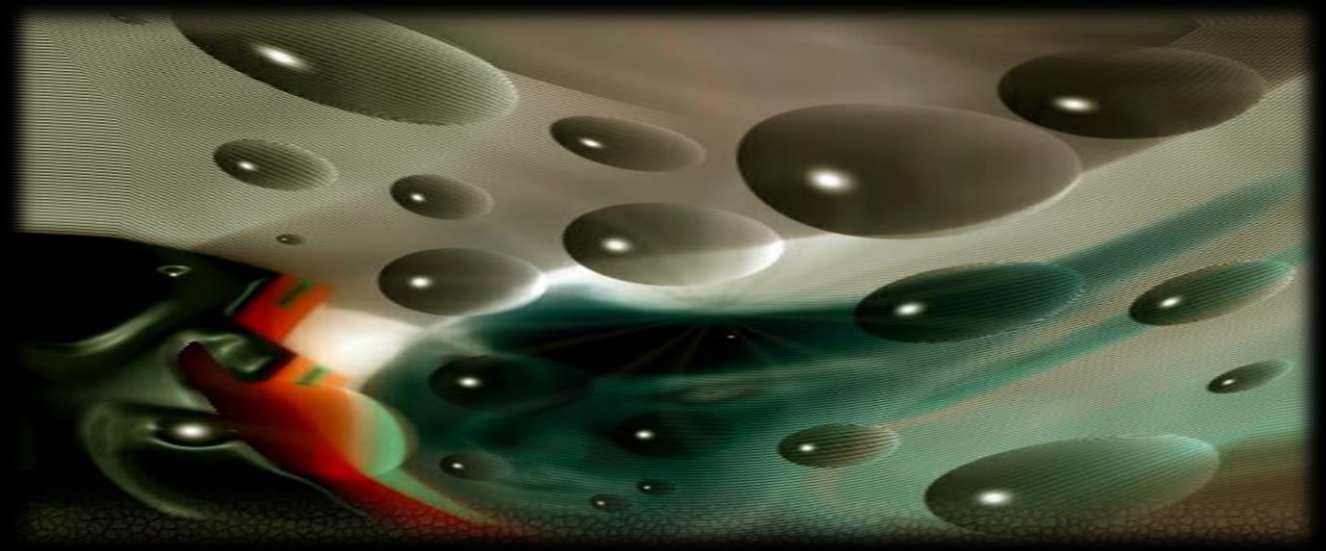
Other Operators



Assignment Operators

- Assignment operators are used to assign a value to a variable:
  - `=`, `+=`, `-=`, `|=`, …
- Assignment operators example:

```
int x = 6;
int y = 4;
y *= 2; // 8
int z = y = 3; // y=3 and z=3
printf("%d\n", z); // 3
x += 3; // 9
x /= 2; // 4
```

Other Operators

- `sizeof()` – returns the size (in bytes) of the type

```
int intSize = sizeof(int);   // 4
int longSize = sizeof(int);  // 8
int charSize = sizeof(char); // 1
```

- Square brackets `[]` are used with arrays for accessing index

```
char name[5] = "Asya";
char firstLetter = name[0]; // Get character at 0th index
printf("%c", firstLetter);  // A
printf("%c", name[3]);      // y
printf("%c", name[4]);      // (\0 character)
printf("%c", name[5]);      // Illegal access!
```

Other Operators (2)

- `{type} *` is used for declaring pointers

```
char *text = "Hey, pedestrian!";
char *pointer = text; // pointer points to the memory of text
```

- `&{identifier}` returns a pointer to a variable
- `*{identifier}` dereferences a pointer (i.e. returns the value)

```
int a = 5;
int* b = &a; // b now points to the memory of a

printf("%d", *b); // Returns the memory where b points to: 5
```

Other Operators (3)

- Member access operators for **`struct`** / **`union`**:
  - `.` when working with the variable

```
struct Point
{
    int x;
    int y;
};
```

```
struct Point point;
point.x = 5;
point.y = 10;
```

  - `->` when working with pointer to the variable

```
struct Point point;
struct Point *ptr = &point;
ptr->x = 2;
ptr->y = -3;
printf("X: %d, Y: %d\n", ptr->x, ptr->y);
```

Other Operators (4)

- Conditional operator **?:** has the form

```
b ? x : y
```

(if **b** is true then the result is **x** else the result is **y**)

- Example:

```
printf(5 > 4 ? "true" : "false")
```

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Other Operators

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Implicit and Explicit Type Conversions

Implicit Type Conversion

- Implicit type conversion
  - C allows implicitly to convert from one type to another

```
int a = 2185313921;
long b = a;
unsigned short c = b;

printf("%hu", c); // 16001
```

short is too small and overflows

  - Converting to a smaller type may cause data loss

Explicit Type Conversion

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- Explicit type conversion
  - Manual conversion of a value of one data type to a value of another data type
  - Allowed only explicitly by `(type)` operator
  - Required when there is a possibility of loss of data or precision
  - Example:

```
float a = 5.5f;
int b = (int) a; // 5
```

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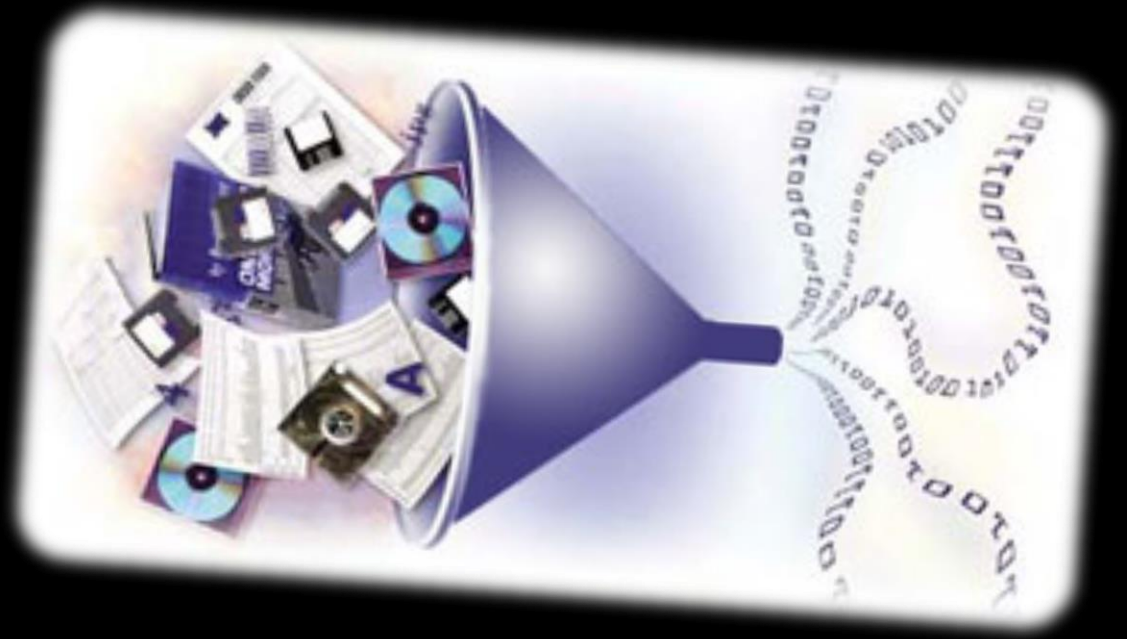
Type Conversions

Live Demo



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Expressions

Expressions

- Expressions are sequences of operators, literals and variables that are evaluated to some value

```
#define MATH_PI 3.14159265358979323846

int main()
{
    int r = (150 - 20) / 2 + 5; // r=70
    // Expression for calculating a circle area
    double surface = MATH_PI * r * r;
    // Expression for calculating a circle perimeter
    double perimeter = 2 * MATH_PI * r;
    return 0;
}
```

Expressions (2)

- Expressions have:
  - Type (integer, real, int, ...)
  - Value
- Examples:

Expression of type `int`.
Evaluated at compile time

Expression of type `int`.
Evaluated at runtime

```
int a = 2 + 3; // a = 5
int b = (a + 3) * (a - 4) + (2 * a + 7) / 4;  // b = 12
int greater = (a > b) || ((a == 0) && (b == 0));
```

Expression of type `int`.
Evaluated at runtime

Expressions

Live Demo

C Programming – Operators

Questions?

https://softuni.bg/trainings/1212/C-Programming-October-2015

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