

Data Types, Variables, and Operators in C

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Data Types and Variables

Basic Data Types in C

- **int**: whole numbers (typically 4 bytes).
Usage: integer data, counters, loop indices.
- **float**: single-precision decimals (~6 digits).
Usage: decimal data.
- **double**: double-precision decimals (~15 digits).
Usage: precise calculations, finance.
- **char**: single character (1 byte, ASCII).
Usage: characters, text handling.
- **void**: represents no value.
Usage: function return type, pointers.
- **short, long, unsigned**: integer variants.
Usage: memory optimization, large values.

Variable Sizes and Precision

- **Sizes vary by system/compiler**, but common values:
 - `char`: 1 byte
 - `short`: 2 bytes
 - `int`: 4 bytes
 - `long`: 4 or 8 bytes
 - `float`: 4 bytes (about 6 decimal digits)
 - `double`: 8 bytes (about 15 decimal digits)
- Use `sizeof()` operator to check actual size.
- Precision: `float` (single) vs. `double` (double precision).

Variable Definition and Declaration

- Syntax: `data_type variable_name;`
- Initialization: `int x = 10;`
- Can also do: `int x; x = 10;`
- Scope:
 - Local: inside a function.
 - Global: outside all functions.
- Constants:
 - `const int MAX = 100;`
 - `#define PI 3.14`

Type Casting in C

- **Type casting** converts a variable from one data type to another
- **Implicit casting (type promotion):**
 - Done automatically by the compiler.
 - Example: `int x = 5; double y = x;` (*x promoted to double*)
- **Explicit casting:**
 - Done by the programmer using cast operator.
 - Syntax: `(type) expression`
 - Example: `double a = 5.7; int b = (int)a;` (*b = 5*)
- Use casting carefully: may cause data loss (e.g., truncation).

Variable Naming Rules in C

- Must begin with a letter or underscore (`_`).
- Can contain letters, digits, and underscores.
- Case-sensitive: `value` and `Value` are different.
- Cannot be a reserved keyword (`int`, `return`, etc.).
- Should be meaningful for readability (e.g., `total`, not `x1`).

Operators

Operators in C

- **Arithmetic:** +, -, *, /, %
Perform basic mathematical operations.
- **Relational:** <, <=, >, >=, ==, !=
Compare two values, result is either true (1) or false (0).
- **Logical:** &&, ||, !
Combine conditions: && (AND), || (OR), ! (NOT).
- **Assignment:** =, +=, -=, *=, /=
Store values in variables or update them with shorthand forms.

Prefix vs Postfix Operators

- **Increment / Decrement operators:** ++, --
- **Prefix form** (++x, --x)
 - Variable is updated first, then used in the expression.
 - Example:
 - ▶ `int x = 5;`
 - ▶ `int y = ++x;` (x=6, y=6)
- **Postfix form** (x++, x--)
 - Variable is used first, then updated.
 - Example:
 - ▶ `int x = 5;`
 - ▶ `int y = x++;` (x=6, y=5)
- Rule of thumb: prefix = “increment before use”, postfix = “increment after use”.

Truth Tables for Logical Operators

AND (&&)

A	B	A && B
0	0	0
0	1	0
1	0	0
1	1	1

OR (||)

A	B	A B
0	0	0
0	1	1
1	0	1
1	1	1

NOT (!)

A	!A
0	1
1	0

Order of Evaluation and Precedence

Operators in C follow a precedence hierarchy.

Examples (highest to lowest):

- `()`: Parentheses
- `*`, `/`, `%`: Multiplication, Division, Modulus
- `+`, `-`: Addition, Subtraction
- `<`, `>`, `<=`, `>=`: Relational
- `==`, `!=`: Equality
- `&&`: Logical AND
- `||`: Logical OR
- `=`: Assignment (lowest)

Use parentheses `()` to make evaluation explicit.

Example: `int x = 2 + 3 * 4;` \rightarrow result is 14, not 20.

Input, Output (IO)

Formatted Output: printf()

- Used to display output to the screen.
- General form: `printf("format string", values);`
- Format specifiers:
 - `%d` → integer
 - `%f` → float/double
 - `%c` → char
 - `%s` → string
- Example: `printf("Sum = %d", x);`

Formatted Input: scanf()

- Used to take input from the user.
- General form: `scanf("format string", &variables);`
- Format specifiers are the same as for `printf`.
- Example: `scanf("%d", &x);`

Why use the ampersand sign (&) in scanf()?

- scanf() needs the **address of a variable** to store the input value.
- The operator & (“address-of”) provides that memory location.
- Example:
 - `int x;`
 - `scanf("%d", &x);`
 - Without &, the program will not know where to put the value.
- **Exception:** For strings (%s), the variable itself is already an address, so no & is needed.

Exercise

Exercise

- Write a C program that demonstrates the basic arithmetic operations.
- Write a C program that divides an 5 (integer) by 2 (integer), 5.0 (float) by 2 (integer), and 5 (integer) by 2.0 (float).
- Write a C program that checks whether a user-given number is odd or even, you can use the modulo (%) operator.
- Guess is the outputs:

```
int x = 5; printf("%d", x++);  
int y = 5; printf("%d", ++y);
```

Questions?
