Data Types, Variables, and Operators in C

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Outline

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

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;` → 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 & 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

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- 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 demonstrates the use of the modulo (%) operator.
- Predict the output:
  ```
  int x = 5; printf("%d", x++);
  int y = 5; printf("%d", ++y);
  ```

Questions?